

# Programming and Operation Manual

## Leak Test Instrument Model E-PDQ

Firmware Revision 2.3.14 or 2.3.15

Hardware Revision A

July 6, 2021

Manual Revision 1.5

Proprietary Note:

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**WARNING:**

This product deals with gas that will expand under pressure. Pressurized volumes (components, hoses, etc.) should be handled with proper protection to avoid any harm to the user.

**WARNING:**

Use this product for the purpose of leak testing or flow measurement and testing in the pressure and temperature range specified, ONLY!

**WARNING:**

Only qualified personnel should install, or use this product. Installation must comply with the manual requirements and product specifications.

**WARNING:**

Under no circumstances while the test is on should the operator tamper with the “unit under test (UUT)”. This may result in bodily injury and/or erroneous results.

**WARNING:**

This product shall be used for leak test applications and/or flow measurement applications only.

**WARNING:**

When this Leak Test Instrument is part of a leak test system, it is the user’s responsibility to assure proper interface and maintenance in order for this instrument to utilize its measurement capabilities safely and accurately.

**CAUTION:**

This instruments measurement reflects the momentary leak flow rate of the unit under test at the present time and conditions. Any leak test cannot guarantee long term leak tightness for products in actual operating conditions.

**CAUTION:**

The user shall be familiar with flow, pressure and temperature measurement units before setting up the leak test instrument. It is the user’s responsibility to properly define leak flow rates and tolerances for a specific application.

**NOTE:**

FUSE RATING: Incoming 24VDC supply is recommended to be fused at 2A for overcurrent protection.

**CAUTION:**

Incoming supply outside 24 VDC +/-10% and unable to source 2 Amps it NOT recommended and may result in inaccurate results, product malfunction and/or damaged electronics.

# EU DECLARATION OF CONFORMITY

## 1. Produce model / Product:

Product Micro-Flow Leak and Flow Test Instrument  
Model/Type FQ/MQ/46/RD46/FPDQ and all variants/options associated with this model

## 2. Manufacturer:

Manufacturer Pfeiffer Vacuum Incorporated  
Address 4037 Guilon Lane  
Indianapolis, IN 46268  
317-328-8492  
USA  
www.pfeiffer-vacuum.com

## 3. This declaration of conformity is issued under the sole responsibility of the manufacturer.

## 4. Object of the declaration:

Product An electro-mechanical instrument for detecting micro-flow leaks

## 5. The object of the declaration described above is in conformity with the relevant Union harmonization legislation:

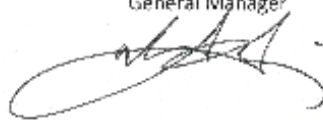
2011/65/EU The Restriction of Hazardous Substances Directive  
2014/30/EU The Electromagnetic Compatibility Directive  
2014/35/EU The Low Voltage Directive

## 6. References to specifications in relation to which conformity is declared:

UL 61010-1: 2012 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use  
CSA C22.2#61010-1-12: 2012 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use  
EN 61326-1: 2013 Electrical equipment for measurement, control and laboratory use – EMC requirements

## 7. The technical file is available from the manufacturer at the address above

Signed for and on behalf of: Pfeiffer Vacuum Incorporated  
Place of issue: USA  
Date of issue: 14<sup>th</sup> May 2021  
Name: Derek Izzi  
Position: General Manager  
Signature:



## 1. Introduction

This manual applies to the operation and maintenance of the Leak Test Instrument Model E-PDQ incorporating the Intelligent Gas Leak Sensor (IGLS) manufactured by:

Advanced Test Concepts 4037  
Guion Lane  
Indianapolis, IN 46268  
317-328-8492  
www.atcinc.net

The IGLS is a micro-flow gas sensor operating based on ATC's patented accelerated laminar flow design. The IGLS measures volume flow, pressure and temperature. The instrument can operate using volume flow, mass flow, or volume flow at std. conditions, by selecting one of 27 flow units and their combinations. The IGLS is a microprocessor based system. The microcontroller program performs on board volumetric (i.e. cc/min) or mass (e.g. g/min) flow measurements with temperature and pressure compensation. The microcontroller can total the flow during testing (i.e. total mg) using the mass extraction concept. The IGLS has capabilities to control valve sequencing as required for different applications and can operate as a stand-alone leak test system with no PLC or PC control.

There are multiple options to interface to the Model E-PDQ. It can be operated using digital I/O through the 15 pin interface or via Ethernet. The 15 pin interface provides some additional flexibility which is not currently available through the Ethernet interface.

The IGLS measures leak flow rates based on the mass conservation law. It measures the amount of flow required to maintain constant pressure at a constant temperature which is equal to the amount of flow leaking out. This method offers quick test time with reduced sensitivity to unit under test volume.

LeakTek<sup>®</sup> is a software package that allows the user to configure applications parameters as needed to meet testing requirements. This program can also be used to view, save, and analyze test data using a PC. The LeakTek<sup>®</sup> program is optional and is not required to operate the instrument.

The IGLS receives commands/data requests and returns data via a bi-directional RS-232 port. The Model E-PDQ includes a female 9-pin D-connector on the rear panel for connecting to a PC using a straight through RS-232 serial cable. Up to 9 IGLS (Model E-PDQ instruments) can be attached to a single RS-232 port. The Model E-PDQ also includes an RJ45 Ethernet connector for PLC/PC interface via a network connection either directly or through a LAN. Selection of



## INTRODUCTION

the communication method is made via the COMM SELECT toggle switch located on the right side of RS232 and Ethernet ports as shown in Appendix B. Only one communications port may be used at any time. The Ethernet connection does not support multiple user access to the instrument. Refer to the Operation Manual for LeakTek® for network setup and instrument configuration when using the Ethernet communications port.

Extensive programming commands allow the user to address any one of the connected sensors in order to configure test parameters and update calibration coefficients.

The E-PDQ instrument can be configured to run up to four (4) types. Each of the 4 test types can include different test parameters or set-ups. Test type can be selected and verified via the rear 15 pin interface. All remote or external controls (input and output) are available at the male 15 pin connector located on the rear panel.

### **1.1 Principle of Operation**

The Model E-PDQ and its accessories provide a complete solution for leak flow testing. The leak test concept is based on the mass conservation law. Per this basic law of physics, once the unit under test (UUT) is pressurized and reaches steady state conditions, the amount of mass flow into the UUT equals the amount of mass flow that is leaking out.

In other words, the IGLS measures make-up flow required to maintain steady UUT pressure. In vacuum conditions the IGLS measures the mass flow extracted from the UUT required to maintain a steady vacuum level.

The IGLS is a unique micro-flow sensor capable of measuring extremely low flow rates due to ATC's accelerated laminar flow design. The IGLS measures volume flow and converts it to mass flow based on pressure, temperature, and gas type. IGLS sensitivity is increased in vacuum conditions where a given mass flow yields a larger volume flow due to the reduced gas density at low pressure. The IGLS operates in the viscous and slip flow regimes, in pressure ranges of 13.8 kPa Absolute (~2 psia) to 448 kPa Abs (65 psia). When performing tests under 13.8 KPa absolute pressure the material transfer mechanism varies. For these applications ATC's Mass Extraction Instrumentation with the Intelligent Molecular Flow Sensor (IMFS) is recommended.

Some significant advantages of IGLS technology is that the steady state leak flow rate is independent of the UUT volume and the measurement is a direct leak flow measurement. Frequent calibration is not required, while standard annual or bi-annual calibration procedures are applicable. A verification orifice (sometimes called "calibrated leak") is used only to verify system and instrument integrity.

## INTRODUCTION

The IGLS technology offers fast and repeatable leak tests. For shorter cycle time the signature concept can be employed. The signature concept is described in detail the LeakTek® software manual.

## 2. Function Configuration

The IGLS can be used for several distinct applications as follows:

1. **Conventional Leak Test:** Automated leak testing with or without automatic pressure control. (The Intelligent Gas Leak System or IGLS)
2. **Adaptive Leak Test:** Based on dynamic leak flow analysis, the sensor will detect the leak flow result at any time during the leak test period depending on the flow stability and leak detection criteria.

### 2.1 Conventional Leak Test

When functioning as a conventional leak tester the IGLS controls all signals to the pneumatic valves which pressurize, stabilize, and test the UUT.

During the test step the IGLS will monitor flow readings for a pre-defined period and make a pass/fail determination. Pressure and flow must be within defined range to pass the test. The sequence will stop and flow will automatically shut down if a pass occurs. A re-test function can be configured to allow a continuous test until the pass criteria are met if there are details of the test part that can be altered or adjusted to make the part stop leaking. The test status is displayed on the 3 LED's on the front of the instrument. All test parameters can be configured via the RS-232 port or Ethernet port using the LeakTek<sup>®</sup> program or hyper-terminal.

### 2.2 Adaptive Leak Test

If the leak rate of the majority of tests for the UUT is much smaller than the leak tolerance the user can configure the sensor to dynamically analyze the flow behavior and make an early detection to determine if the leak rate is going to be significantly smaller or larger than the leak tolerance. In most cases, this will significantly reduce the total test time.

### 2.3 Remote Start and Stop

The Model EPDQ and Leak Tek<sup>™</sup> Software Versions of 6.08 and later includes a remote start and stop button enabling Leak Tek program or ant PC program to start the test from the Run Screen using serial or Ethernet communication. In Firmware 2.3.15 and later, the remote start and stop function must be configured, as the default setting is no remote start and stop. To configure the remote start and stop from the maintenance screen refer to the Leak Tek<sup>™</sup> User Manual.

### 3. Interface

#### 3.1 MECHANICAL INTERFACE AND CONNECTION of the Model E-PDQ:

**WARNING:**

The standard Model E-PDQ is not rated to operate in class 1 or 2 environment.

**WARNING:**

Test gasses should be compatible with IGLS wetted materials. Gasses currently supported are dry air, nitrogen, carbon dioxide, and helium. For other test gas usage, please consult ATC.

**CAUTION:**

The Model E-PDQ is supplied with an internal filter. Excessive contamination will cause filter clogging and distortion of readings.

**CAUTION:**

The operating temperature and test gas temperature should be from 10 to 45 °C.

**CAUTION:**

Follow Swagelok® fitting assembly instructions to reduce possible tube or fitting damage.

The Model E-PDQ can be mounted on a bench top using with four rubber pads as supplied. Alternatively, it can be mounted using the DIN rail mount on the bottom of the unit. The rubber feet must be removed to utilize the DIN mounts.

**NOTE:**

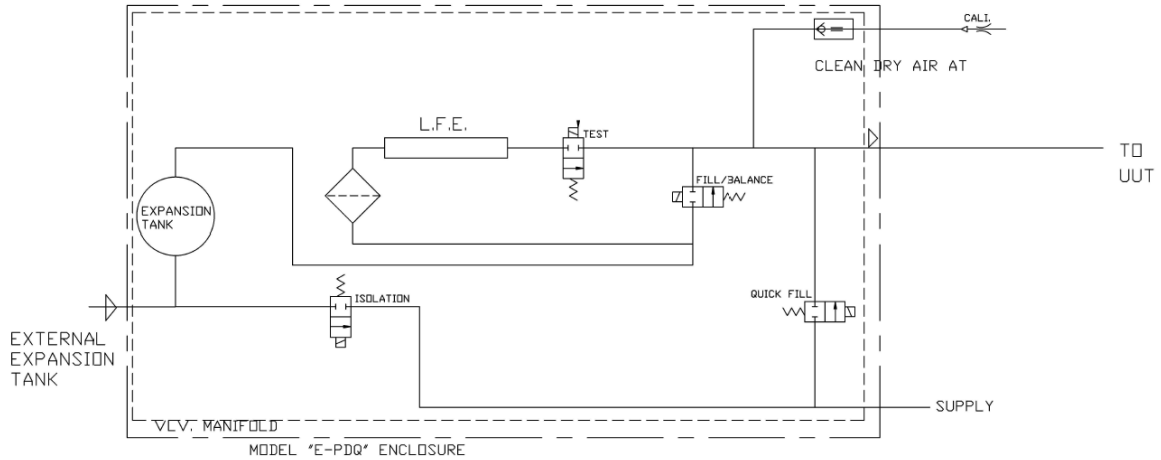
Mount and locate the Model E-PDQ as close as possible to the UUT to minimize connection tube length and volume. Larger volume will reduce system response to a given leak flow.

The Model E-PDQ controls an internal fill, isolation, pressure/test, and quick fill valves. These solenoid valves are used for automatic control of the test functions. A calibrated leak can be manually connected to the front of the instrument. The pneumatic diagram and connections are shown in Figure 3.1.1

The maximum volume of the UUT that can be tested with a standard Model E-PDQ is 10mL.

The pressure supply to the Model E-PDQ must be very stable. Air tools or other devices that use a high volume of compressed air and are connected to the same pneumatic supply line may cause supply instability. This instability can cause variability in the leak test if the pulsations are too high. Supply pressure instability can be minimized by adding a buffer tank upstream to the system pressure regulator.

## INTERFACE



**Figure 3.1.1 - Pneumatic Diagram**

### NOTE:

Please see Appendix B for connection and assembly

**Material selection and pressure ratings:** Ensure that pneumatic interface components are compatible with test gas. Ensure all components exceed test pressure requirements. Ensure tubing and fittings meet leak specification of 10 times less than leak test specification limit.

**UUT Port connection:** This 1/8" Swagelok® tube fitting is on the front of the unit. Use caution when tightening, do not over-tighten.

**Supply pressure connection:** This 1/4" Swagelok® tube fitting is on the back of the instrument. Use caution when tightening, do not over-tighten.

**Model MQ (Mass Extraction) Vacuum or Flow from UUT into the instrument configuration:** It is recommended to install an in-line filter (10 micron element pore size). For shallow or no vacuum application- a Swagelok® in-line filter is recommended. Larger filter maybe used for vacuum under -40 KPa-g and fast test. This filter should be installed by the user, connecting to the fixture.

## INTERFACE

### **3.2 ENVIRONMENTAL CONDITIONS:**

The Model E-PDQ is designed for internal use only.

The Model E-PDQ has no altitude restrictions as long as the unit is configured and/or calibrated to work at the desired altitude.

The Model E-PDQ operating relative humidity range is 20% to 80% non-condensing.

The Model E-PDQ supply voltage is 24 Volts DC +/- 10%.

The Model E-PDQ is not designed to operate in wet or condensing environments.

The Model E-PDQ is designed to operate in a Pollution Degree 1 environment where Pollution Degree 1 means no pollution or an environment that is dry which may contain non-conductive pollution.

## INTERFACE

### 3.3 ELECTRICAL INTERFACE AND CONNECTION:

The Model E-PDQ is supplied with terminal block for wire connection to a 24VDC supply.

The Model E-PDQ units are rated as shown in Table 3.2.1

**Table 3.2.1**

<b>Voltage</b>	<b>Current</b>	<b>Power</b>
24 VDC	2 A (peak)	48 W (peak)
24 VDC	150 mA (continuous)	3.6 W (continuous)

**WARNING:**

The Model E-PDQ is supplied with a screw mounted terminal connector for 24VDC power. Proper grounding and electrical practices should be used. When maintaining, or opening the Model E-PDQ enclosure, the supplied power should be disconnected!

**WARNING:**

The outer cover of the Model E-PDQ is to be assembled prior to energizing the unit. Do NOT operate unit without cover mounted (exceptions are for ATC qualified personnel only during inspection/testing/troubleshooting of the instrument).

**CAUTION:**

The Model E-PDQ unit is to be securely mounted to prevent any damage from power supply wiring pulls caused by sensor drop while energized.

**CAUTION:**

Securely mount the Model E-PDQ sensor prior to connecting and energizing of its power supply.

**WARNING:**

ATC products are to be operated in a clean location outside of reach of fluid contamination and condensation. If condensation and/or fluid is present, do NOT operate instrument.

**CAUTION:**

Improper power wiring can cause permanent damage to the unit. Always observe positive and negative polarities when connecting to 24 VDC power source. Never connect to an AC supply.

## INTERFACE

### **NOTE:**

All digital inputs are optically isolated for single polarity. Use only correctly rated voltage for inputs.

### **NOTE:**

Digital outputs are not designed to drive an inductive load. Use external relays or optically isolated modules (preferred) to drive valves or large relays.

### **NOTE:**

The Model E-PDQ Ethernet port does not support Power Over Ethernet (POE).

### **NOTE:**

The Model E-PDQ includes (2) 3.5A fuse for incoming 24VDC supply. (example: Littelfuse PN: 015703.5DRT)

The remote I/O connectors located on the rear panel of the Model E-PDQ are arranged as shown in Figures 3.3.1 & 3.3.2. See Appendix B for wire instructions.



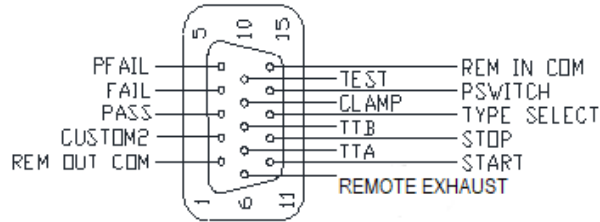
## INTERFACE

Pin	Function	Specifications
Pin 1	Remote Output Common	5-30 VDC, source or sink*, 100 mA max.
Pin 2	Custom2 Output	5-30 VDC, source or sink*, 600 mA max.
Pin 3	Pass Output	5-30 VDC, source or sink*, 100 mA max.
Pin 4	Fail Output	5-30 VDC, source or sink*, 100 mA max.
Pin 5	PFail Output	5-30 VDC, source or sink*, 100 mA max.
Pin 6	Remote Exhaust	5-30 VDC, source or sink*, 600 mA max.
Pin 7	TTA Output	5-30 VDC, source or sink*, 100 mA max.
Pin 8	TTB Output	5-30 VDC, source or sink*, 100 mA max. <b>Test Type1: TTA:1, TTB: 0</b> <b>Test Type2: TTA:0, TTB: 1</b> <b>Test Type3: TTA:1, TTB: 1</b> <b>Test Type4: TTA:0, TTB: 0</b>
Pin 9	Clamp Output	5-30 VDC, source or sink*, 100 mA max.
Pin 10	Test/Pressure Output	5-30 VDC, source or sink*, 100 mA max.
Pin 11	Start Input	5-30 VDC, source only*, 30 mA max. <b>Apply a pulse to the sensor Start input pin to start a test</b>
Pin 12	Stop Input	5-30 VDC, source only*, 30 mA max. <b>Apply a pulse to the sensor Stop input pin to stop a test</b>
Pin 13	Test Type Input	5-30 VDC, source only*, 30 mA max. <b>Apply a pulse to the sensor Test Type input pin to switch to the other test type</b>
Pin 14	Pressure Switch Input	5-30 VDC, source only*, 30 mA max.
Pin 15	Remote Input Common	Common Ground only
* Sinking or Sourcing is selected for all Outputs as a group, i.e. all sourcing outputs, or all sinking outputs. Use pin 1 to select type and voltage of outputs.		

**Figure 3.3.1 – Rear Panel Standard Remote I/O Connections**

\* If other custom options are purchased, see the drawings section in the back of this manual.

## INTERFACE



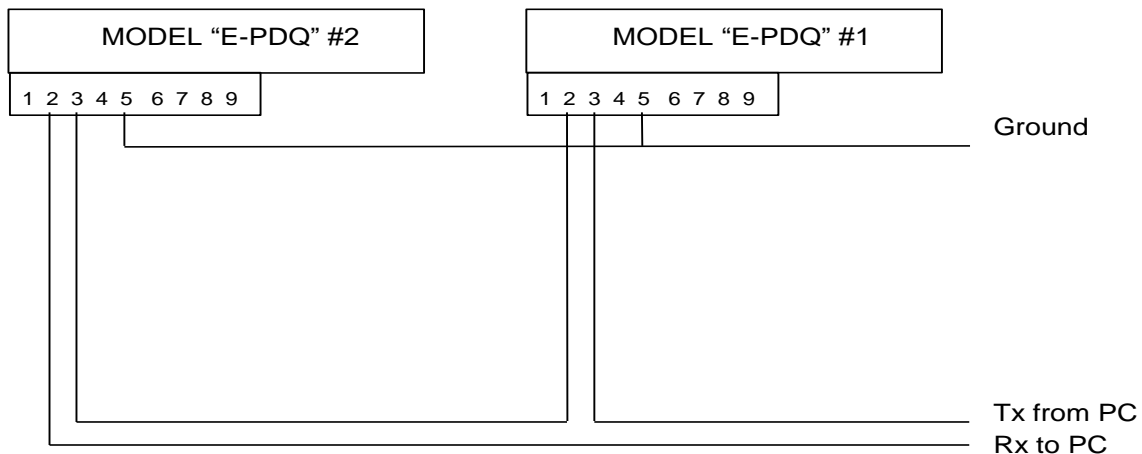
**Figure 3.3.2 – Standard E-PDQ Remote I/O Pin Connector**

Condition	Description	Pin out
Pass	The test met all criteria set in the set up screen	Pin 3
Gross leak Fail	Pressure is below the Pressure Min setting in pressure testing	Pin 4
Gross leak vacuum Fail	Pressure is larger than the Pressure Max setting in vacuum testing	Pin 4
No Pres Fail	Pressure switch not turned on in time.	Pin 4
Blockage Fail	Pressure switch not turned off at the end of the test during deplete time, External Pressure is within the limits for Ext Press Off action	Pin 4, Pin 5
Large Leak Fail	The Flow is more than the large leak setting	Pin 4
Hi Flow Relative Measurement Fail	Relative Measurement Base Line Flow larger than the set point	Pin 4
Lo Flow Relative Measurement Fail	Relative Measurement Base Line Flow Lower than the set point	Pin 4
Fine Leak Fail	Flow is above the maximum flow limit setting	Pin 4
Low Flow Fail	Flow is below the minimum flow limit setting	Pin 4
Back Flow/Sys pass	The Flow Sensor Detected the Flow in Opposite Direction or System leak check failure	Pin 4
Over pressure	The Pressure Is Larger Than The Pressure Max Setting in pressure testing	Pin 4
Under pressure	The Pressure is below the Pressure Min Setting in vacuum testing	Pin 4
Flow Saturation	Exceeding Flow Sensor Limit	Pin 4
Pressure saturation	Exceeding press Sensor Limit	Pin 4
Temperature saturation	Exceeding temperature Sensor Limit	Pin 4

**Figure 3.3.3 – List of Pass and Failure Mode with Pin outs**

## INTERFACE

Up to 9 Model E-PDQ instruments can be connected in a serial loop. A typical serial loop connection with two instruments is shown in Figure 3.2.4.



**Figure 3.3.4 - Serial Loop Connection of two Model E-PDQ Instruments**

### 3.4 Guideline for Pneumatic Interface

Proper pneumatic interface is important to ensure repeatable, reliable, and safe leak testing. Supply pressure fluctuations must be minimized to test system regulator to ensure good system performance. Most pressure regulators respond to line pressure spikes and this may cause variability in the test results. Proper connections must be used to minimize system leaks and reduce virtual leaks (leaks that flow into internal hidden cavities).

Upstream pressure fluctuations from pneumatic actuators and/or assembly tools are undesirable as they may affect precision pressure regulators and cause test pressure/flow fluctuations that are uncontrollable. A separate air supply line is recommended. If common supply is used a buffer tank is recommended.

Pneumatic supply must be clean and dry. A 10 micron (minimum) particulate filter along with a coalescing filter to separate moisture is recommended. Clean dry supply is required to protect the valves and ensure that a pinhole leaks are not plugged with debris.

Two regulators plumbed back to back with no volume between the regulators may generate a pressure ripple due to interaction between the regulators. A volume must exist between two adjacent pressure regulators.

## INTERFACE

NPT or push to connect fittings are not recommended for leak test circuits. Many push to connect fittings were not designed to be leak free to the level required for leak test pneumatic circuits. Swagelok® fittings are preferred for leak test circuits. VCO or VCR fittings are recommended for low leak specification and vacuum applications (Mass Extraction).

The Model E-PDQ is equipped with options that can be configured to detect UUT blockage. An external pressure switch is required to detect that the UUT has been pressurized from one end and vented from a second port.

### 3.5 Guideline for setting up Model E-PDQ instrument

1. Un-pack the Model E-PDQ and make sure the unit is in good condition with the proper caps and ferrules.
2. Power up Model E-PDQ and check temperature and pressure readings. The temperature and pressure should read close to ambient.
3. Connect pressure source and pressurize unit to test pressure, allow time to stabilize, make sure all the connections are leak free.
4. Connect PC to the instruments Ethernet or serial port.
5. Open Leak Tek™ program. Use (or configure) serial or Ethernet configuration. When using Ethernet configuration match the IP address (see Leak Tek™ user manual) and allow approximately 60 seconds to establish initial communication after switching from serial to Ethernet (selector switch at the back of the instrument) and powering the instrument off and on.
6. Go to the Run screen and check if the remote start and stop button are enabled or disabled. Configure these buttons per your application requirements. Refer to the Leak Tek™ User Manual.
7. Go to the set up screen, and input the desired pressure setting with +/- 10% on the min/max pressure limits. Input the desired flow units, pre-fill, fill, stability, and test times. Set the max flow higher initially and the min flow about -2% of the sensor full scale or above the sensor zero offset (ex. for a 10ccm full scale sensor min flow could be -0.2ccm). Deplete pressure must be checked in the setup screen if the pressure needs to be exhausted at the end of the test.
8. Verify instrument performance per the procedure of section 6.1.2 (Leak Test Instrument Performance Verification).
9. Connect to the user test fixture, using proper tubing and connections.
10. Test known good parts (or master no-leak) with and without the calibrated leak installed.
11. Make sure the difference between the good parts and the simulated defect is 2 times or more. Adjust timing as required to achieve the minimum 2/1 ratio.
12. The max flow criteria should be set at 5% to 20% below the average of the simulated defects.

### **3.6 Verification Procedure**

Periodic system verification is recommended during normal operation of the Model E-PDQ. Run a test with a known good part and the internal calibrated leak included in the circuit. This test should fail. Run a similar good part without the calibrated leak. This test should pass. If this sequence does not provide the desired results, the system and/or parts is questionable. Once the issue is identified and addressed, the verification procedure should be repeated until the desired result is obtained.

## 4. Model E-PDQ Operation Sequence

The Model E-PDQ leak test will run based on the sequence below after the “start” input is received via Ethernet or through the remote I/O connector.

A typical Test Sequence is as follows:

1. Energize the clamping valve in order to clamp, or connect a pneumatically driven clamp or an automatic expander seal.
2. After clamping time delay:
  - a. Open the pressure valve
  - b. Open the fill valve to pressurize the UUT (Unit Under Test)
3. After filling valve delay:
  - a. Close the fill valve
4. After stability time expires, start the leak test. (The stability time can be as short as 0.01 seconds for Mass Extraction applications.)
5. If the UUT meets the test criteria within the set test time, the UUT has passed the test.
  - a. If the test is passed, de-energize all valves to deplete the pressure and display the pass message.
6. If the UUT fails the test criteria at any point during the set test time, the failure message will display.
  - a. Continue re-testing if the “deplete pressure” feature is disabled. ( $X_5=0$ . See Appendix B command list.)
  - b. If the “deplete pressure” feature is enabled, de-energize all valves. ( $X_5=1$ . See Appendix B command list.)

### CAUTION:

Test time should be equal or more than 0.5 sec
--

7. Passing or failing a test:
  - a. If the UUT meets the test criteria within the set test time, the UUT will pass the test. If the test passes, all valves will be de-energized to deplete the pressure from the UUT and to contain the internal system pressure, the GREEN “Pass” LED will illuminate on the front of the E-PDQ instrument.
  - b. If the UUT fails the test criteria at any point during the test time, the UUT will fail the test. If the test fails, the RED “Fail” LED will illuminate on the front of the E-PDQ instrument.
8. If the “stop” input is energized at any time during the test process, the test will be stop and all valves shift to standby status as set in the valve configuration.
9. To switch to another test type, pulse the “type select” digital input. Digital outputs can be used to monitor and confirm appropriate test type selection.

## OPERATION SEQUENCE

### **NOTE:**

If a PC is attached to the Model E-PDQ with LeakTek<sup>®</sup> running the Pass/Fail will be displayed in the LeakTek<sup>®</sup> run screen; however the Pass/Fail decision is made by the Model E-PDQ.

### **CAUTION:**

A "Flow saturation" or "Gross Leak" failure is a significant leak and can deplete the isolation tank. If this condition happens the tank should be allowed to recover back to its original condition. No leak test should be run during this recovery period. The recovery time depends on the leak size and at what step the test was stopped.

## 5. Communication Protocol

### NOTE:

All commands and responses should be terminated by <lf><cr>
---

### 5.1 Conventional Commands for Sensor Parameters

Read Command Format:

“!0” + ADDRESS + ”R” + COMMAND

Response Format:

“\$0”+ ADDRESS +”R” + COMMAND; DATA

Save Command Format:

“!0” + ADDRESS + ”S” + COMMAND; DATA

Response Format:

“\$0”+ ADDRESS + ”S” + COMMAND; DATA

Where:

ADDRESS is valid from 0 to 9. (The first sensor will respond to 0)

DATA is the number to be saved or read.

COMMAND, see Appendix B.

For example, to change G1 to the 287(Air) in IGLS addressed as 2, the command string will be as follows: !02SG1;287.0<lf><cr>

Note:

For commands such as U2, U3, U4, U5, the returned DATA are in Hex format of “oxFFFFFFF”. The data in the command will be treated as a decimal value unless there is a prefix “0x”. For example, either of the following commands will change IGLS addressed as 1 to flow unit mg/min.

!01SU5;91 <lf><cr>

!01SU5;0x51<lf><cr>

### 5.2 DAQ Commands

DAQ string response is in the form of \$01SQ1;Data1;Data2;Data3;StepNo

Where:

Data1: temperature reading

Data2: pressure reading

Data3: flow reading

Step No: The step no. will be interpreted as a Hex value, especially if the sensor is configured to run more than 9 steps. For more details, see Section 5.3.



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DAQ string response is in the form of !01SQ5;  
Data1;Data2;Data3;Data4;Data5;StepNo

Where:

Data1: temperature reading  
 Data2: pressure reading  
 Data3: flow reading  
 Data4: external pressure reading  
 Data5: adaptive test flow reading  
 StepNo: The step no will be interpreted as Hex value, especially if the sensor is configured to run more than 9 steps. For detail, see Section 5.3.

SQ1;1	<p>Command: !01SQ1;1                  Response: \$01SQ1;Data1;Data2;Data3;StepNo                  Engineering Value and Step                  where                  if (X6&lt;&gt;0) then                      Data1 refers to temperature in Degree C                      Data2 refers to pressure in kPa                      Data3 refers to flow in cc/min or <math>\mu\text{g}/\text{min}</math>                  Otherwise                      Data1 refers to temperature in the selected temperature unit.                      Data2 refers to pressure in the selected pressure unit.                      Data3 refers to flow in the selected flow unit.</p>
SQ1;2	<p>Command: !01SQ1;2                  Response: \$01SQ2;Data1;Data2;Data3;StepNo                  Average Count Value and Step                      Data1 refers to temperature in digital count.                      Data2 refers to pressure in digital count.                      Data3 refers to flow in digital count.</p>
SQ1;3	<p>Command: !01SQ1;3                  Response: \$01SQ3;Data1;Data2;Data3;StepNo                  Engineering Base Unit Value and Step                      Data1 refers to temperature in Degree C                      Data2 refers to pressure in kPa.                      Data3 refers to flow in cc/ or <math>\mu\text{g}/\text{min}</math></p>
SQ1;4	<p>Command: !01SQ1;4                  Response: \$01SQ4;Data1;Data2;Data3;StepNo                  Engineering Display Unit Value and Step                      Data1 refers to temperature in the selected temperature unit.                      Data2 refers to pressure in the selected pressure unit.                      Data3 refers to flow in the selected flow unit.</p>
SQ1;5	<p>Command: !01SQ1;5</p>

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	<p>Response: \$01SQ5;Data1;Data2;Data3;Data4;Data5;StepNo            Data1 refers to temperature in Degree C            Data2 refers to pressure in kPa            Data3 refers to flow in cc/min or µg/min            Data4 refers to external pressure (4<sup>th</sup> analog input) in kPa            Data5 refers to Adaptive flow or steady state flow in cc/min or µg/min</p>
SQ1;6	<p>Command: !01SQ1;6            Response: \$01SQ6;Data1;Data2;Data3;Data4;Data5;StepNo            Data1 refers to temperature in digital count.            Data2 refers to pressure in digital count.            Data3 refers to flow in digital count.            Date4 refers to external pressure (4<sup>th</sup> analog input) in digital count</p>
SQ1;7	<p>Command: !01SQ1;7            Response: \$01SQ7;Data1;Data2;Data3;Data4;Data5;StepNo            Engineering Base Unit Value and Step            Data1 refers to temperature in Degree C.            Data2 refers to pressure in kPa.            Data3 refers to flow in cc/min or µg/min.            Date4 refers to external pressure (4<sup>th</sup> analog input) in kPa            Data5 refers to adaptive flow in cc/min or µg/min</p>
SQ1;8	<p>Command: !01SQ1;8            Response: \$01SQ8;Data1;Data2;Data3;Data4;Data5;StepNo            Engineering Display Unit Value and Step            Data1 refers to temperature in selected temperature unit            Data2 refers to pressure in selected pressure unit            Data3 refers to flow in selected flow unit            Date4 refers to external pressure (4<sup>th</sup> analog input) in selected pressure unit            Data5 refers to adaptive flow in selected flow unit</p>
SQ1;9	<p>Command: !01SQ1;9            Response: \$01SQ9;Data1;Data2;Data3;StepNo;TimeStamp            Engineering Value and Step            where            if (X6&lt;&gt;0) then                Data1 refers to temperature in Degree C                Data2 refers to pressure in kPa                Data3 refers to flow in cc/min or µg/min            Otherwise                Data1 refers to temperature in the selected temperature unit.                Data2 refers to pressure in the selected pressure unit.                Data3 refers to flow in the selected flow unit.</p>
SQ1;A	<p>Command: !01SQ1;A            Response:            \$01SQA;Data1;Data2;Data3;Data4;Data5;StepNo;TimeStamp</p>

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	<p>Data1 refers to temperature in Degree C          Data2 refers to pressure in kPa          Data3 refers to flow in cc/min or <math>\mu\text{g}/\text{min}</math>          Data4 refers to external pressure (4<sup>th</sup> analog input) in kPa          Data5 refers to Adaptive flow in cc/min or <math>\mu\text{g}/\text{min}</math></p>
SQ1;B	<p>Command: !01SQ1;B          Response:          \$01SQB;Data1;Data2;Data3;Data4;Data5;StepNo;TimeStamp  <b>Engineering Display Unit Value and Step</b>          Data1 refers to temperature in selected temperature unit          Data2 refers to pressure in selected pressure unit          Data3 refers to flow in selected flow unit          Date4 refers to external pressure (4<sup>th</sup> analog input) in selected pressure unit          Data5 refers to adaptive flow in selected flow unit</p>
SQ2;1	<p>Command: !01SQ2;1          Response: \$01SQ2;1          Auto Zero to update C1</p>
SQ2;2	<p>Command: !01SQ2;2          Response: \$01SQ2;2          Auto Zero to update C5</p>
SQ2;3	<p>Command: !01SQ2;3          Response: \$01SQ2;3          Auto Zero to update C1 and C5</p>
SQ3; 0-3	<p>Command: !01SQ3;0 to Set the Parameter to Type 1          Command: !01SQ3;1 to Set the Parameter to Type 2          Command: !01SQ3;2 to Set the Parameter to Type 3          Command: !01SQ3;3 to Set the Parameter to Type 4          Response: Don't care the response</p> <p>Note:          After the command is sent, all following commands related to T, V, and K groups are corresponding to that test type regardless what the current test type is.</p>
RQ3	<p>Command: !01RQ3          Response: \$01RQ3;0: Currently in Test Type 1          Response: \$01RQ3;1: Currently in Test Type 2          Response: \$01RQ3;2: Currently in Test Type 3          Response: \$01RQ3;3: Currently in Test Type 4</p> <p>Note:          This command only returns with the which test type currently active, which is decided by the test type toggle switch digital input to the sensor, independent of SQ3 command result.</p>

### NOTE:

For all SQ1 commands, the sensor will respond with two strings with the first string similar to \$00SQ1;1, DAQ string as the second one if U6<>0. Otherwise, it will respond with the DAQ string only.

If the sensor is configured as mass extraction mode, Data1 carries the accumulated mass or volume instead of temperature during the test step.

#### SQ1;1 Command ONLY

When the mass extraction method is used, Data1 will refer to the temperature in °C or in the selected temperature unit in all sensor steps except in the test step. In the test step, Data1 represents the real-time accumulated leak in the selected mass or volume unit.

For example, mg if mg/min is selected as flow unit.  
Liter if liter/hr is selected as flow unit.

If the sensor is configured as an adaptive leak tester, Data1 carries the predicted flow instead of temperature during the test step.

#### SQ1;1 Command ONLY

When the sensor is configured as adaptive leak tester, Data1 will refer to the temperature in degree C or in the selected temperature unit in all sensor steps except in the test step. In the test step, Data1 represents the real-time calculated leak in the selected mass or volume unit.

**5.3 Step Number**

Typical Step Number Table (Hex System)

Step	Built-in Sequence	Customized Sequence/Description
0, 100	Standby	Standby
1	Open Clamping Valve	Customized
2	Open Pressure and Fill Valve	Customized
3	Filling	Customized
4	Stability	Customized
5	Test	Customized
6,7	Close all valves	Customized
8	Stop	Customized
9	Customized	Customized
A		Customized
B		Customized
C		Customized
D		Customized
E		Customized
F		Stop*
16	Pass	Pass
17	Pass-RM	Pass – Relative Measurement
18	Pass-RF	Pass – Reference Flow Measurement (The reference flow test must be enabled and activated in the current test type. Please refer the Leak-Tek manual (version 6.06 or later) section 6.3.3 and 5.3.3.1).
21	PresSat	Pressure Sensor Saturated Failure
22	FlowSat	Flow Sensor Saturated Failure
23	TempSat	Temperature Sensor Saturated Failure
24	GrossLeak	Gross Leak Failure (Pressure Lower than K3)in pressure testing
25	FineLeak	Fine Leak Failure (Flow larger than V2)
26	Low Flow	Low Flow Failure (Flow Lower than V1)
27	OverPres	Over Pressure Failure (Pressure larger than K2 ) in pressure testing
28	BackFlow	Backflow Failure (Flow sensor smaller than A3)
29	Blockage	Blockage Failure –Pressure Switch not turn off in deplete time (T6)
2A	No-Pres	No Pressure Failure (Pressure Switch not turned on in time)
2B	HiFlow_RM	Relative Measurement Baseline Flow Too High

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2C	LoFlow_RM	Relative Measurement Baseline Flow Too Low
2D	LargeLeak	Large Leak Check Failure (Flow larger than V7 at Large Leak check Step)
2E	UnderPres	Under Pressure Failure (Pressure Lower than K3 ) in vacuum testing
2F	GrossLeakV	Gross Leak Vacuum Failure (Pressure larger than K2 ) in vacuum testing
30	PresRng-Hi	External Pressure higher than set limit (KA)
31	PresRng-Lo	External Pressure Lower than set limit (K9)

**Figure 5.1 - Step Number Interpretation**

The Step number in DAQ response string shall be interpreted as a Hex Value although there is no hex prefix such as "0x". Any step numbers between 1 to E could be valid step numbers depending on the customized valve sequence. For example, the sensor is configured to have 12 steps in the test. The customized step number shall be C(12) steps. D(13) will be reported in the DAQ response string of the stop step if the user pushes the stop button during the test. Step numbers between 10 and 100 shall be interpreted exactly the same among all sensor versions and all different configurations.

## **6. Maintenance and Troubleshooting**

### **6.1 Periodic Maintenance and Calibration**

**WARNING:**

Only qualified and trained professional should operate and maintain the Leak Test Instrument, Model E-PDQ.

**WARNING:**

Calibrated leak should under no circumstances should it be opened or tampered with.

**WARNING:**

The Model E-PDQ may contain pressure. Make sure to deplete internal pressure before performing any maintenance work that requires opening any internal components.

**WARNING:**

The Model E-PDQ should only be serviced by trained and authorized personnel.

#### **6.1.1 Periodic Calibration**

The IGLS in Model E-PDQ is a measuring device. Periodic calibration, typically annually, by authorized personnel and standards is required. Refer to the LeakTek<sup>®</sup> or GAS-CAL<sup>®</sup> manuals for the instrument calibration procedures.

#### **6.1.2 Leak Test Instrument performance Verification**

The Model E-PDQ can be supplied with a calibrated leak (optional) or equivalent channel standard (optional) that are calibrated at specified pressure and flow rates. The leak orifice is connected via a quick disconnect on the front of the instrument. The verification orifice cannot be used for instrument calibration. The calibrated orifice can be used for system performance verification and diagnosis of a component failure. Follow the following procedure to verify the Model E-PDQ's performance:

- Set the system pressure and allow it to stabilize.
- Install the calibrated leak and allow the flow to stabilize (lengthen stability time).
- Record the IGLS readings and compare them to calibrated leak flow calibration at that pressure.

**NOTE:**

When comparing to equivalent channel standard calibration data, compensation must be performed for different gases, pressure and temperature.

- Periodic readings should be taken at the same test setup as in the production run, and compared to the flow verification tolerance.

## **MAINTENANCE AND TROUBLESHOOTING**

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- First test: Run with an instrument test port capped and install the QD male plug at the QD port. Run 1 to 3 times and record the readings.
- Second Test: Remove the QD male plug and install the calibrated leak orifice. Run same test 1 to 3 times and record the flow and pressure readings.
- Check the flow increase (or the difference in readings between first and second test, make sure the test pressure matches the orifice calibrated tag pressure. If so, the flow increase should be within +/- 10% of the orifice value at that pressure.
- If verification test fails during production run: call maintenance and engineering to troubleshoot the system.
- If readings (at same pressure range) are higher, after a few tests, look for a leak downstream from the IGLS. If the readings are too low, look for a leaking fill valve, upstream leak or clogged inlet filter or lines. In each case, the cause of the problem (readings out of the verification tolerance) must be resolved prior to continuing a test.

### **CAUTION:**

If periodic verification during production fails, all parts tested from last verification that passes should be suspected and quarantined.



**7.2 Troubleshooting**

The following table summarizes some common problems that may occur, and repair recommendations.

No.	Description	Possible Cause	Repair Action
1	No communication with PC and data saving	Communication problem	Check 9-pin RS232 cable between Model "E" and PC Check PC COM port settings Check Model "E" address Power down the unit, wait 2 minutes before power up
2	Test will not start	Damaged wiring  Bad control panel component  Bad remote I/O connection.	Check for damage to internal wiring Consult ATC  Remove remote I/O cable and start test from the button on the front panel
3	Valves not working	Valves are not enabled Damaged wiring Bad valves Bad control panel components Bad remote I/O connection.	Checked valve matrix and make sure they are enabled. Check for damage to internal wiring Check valves; Consult ATC for replacement parts Remove remote I/O cable and start test from the button on the front panel Consult ATC
4	Pressure Sensor readings are incorrect	Measurement units are not set properly Pressure sensor has large offset-sensor was over pressurized. Pressure sensor calibration coefficients corrupted Loose connection No power supply	Verify measurement units using LeakTek program. Check pressure sensor calibration and verify proper calibration coefficients. Check power supply In case of large reading offset, the pressure sensor may have been over-pressurized.
5	IGLS flow reading High all the time, and in standby mode.	Leakage downstream to the IGLS Fill valve not opening Pressure valve leakage IGLS zero shift or unit	Isolate E-PDQ by plugging the UUT outlet, check downstream fittings and tubing to the IGLS. Go through initial setup procedure Check/replace press, calibration and exhaust valve.

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		has moved	Check / replace fill valve If high readings persist, plug the IGLS outlet, check A/D counts and compare to original calibration. Auto zero the sensor if A/D counts are below 200.
6	IGLS flow reading too low or very negative (A/D counts is "0").	Leakage through the fill line Leaking fill valve External leakage through the expansion tank or isolation valve. Unstable supply pressure-pressure drops down. Unit clogged	Check/replace inlet filter Check supply pressure Isolate and check fill/by-pass lines Check leakage through fill valve. Check for expansion tank or isolation valve leak. Verify calibration coefficients Check for leaks at the IGLS outlet plugs and fittings Consult ATC for internal cleaning instructions.
7	IGLS Flow, pressure and temperature readings significantly off of expected result	Calibration scrambled Power supply damaged	Verify power supply outputs Verify calibration data with original cal. sheet. Check/increase buffer size (Less than 30) Check that unit reacts normally (pressure flow readings varies with flow) Recalibrate the unit
8	Cannot pass verification test with the calibrated leak	Upstream leak to leak tester Bad Pressure regulator Equivalent Channel or calibrated leak are plugged. Leaking fill valve Isolation valve is not closing during stability and test time IGLS measurement is incorrect.	Check test criteria and flow reading Check flow calibration coefficients. Check for upstream and expansion tank connections. Replace pressure regulator. Plug the leak tester output and repeat the test. Externally connect another Equivalent Channel (Calibrated Leak) to verify that internal calibrated leak is not plugged. If plugged- replace internal Equivalent Channel. See line (4) Consult ATC to replace defective valves. See lines 8,9,10.

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No.	Description	Possible Cause	Repair Action
9	Test Starts/stops by itself when connected to a remote PLC or PC control system	Current leakage into the opto-isolated inputs of the IGLS	Verify that start and stop signals are through dry contact relay.
10	IGLS Pressure or Flow readings unstable	Upstream pressure fluctuation cannot be damped enough by the expansion tank  Incorrect remote I/O connections. Unstable Power Supply Bad connection	Check Model E-PDQ connections. Disconnect I/O connector, to isolate for test machine possible common-ground problems. Check power supply Check internal IGLS connection Check upstream pressure, increase expansion tank size and add an isolation valve if required. Check precision regulator.

**Figure 7.2.1 - Troubleshooting**

## APPENDIX A - Command List

### Notes:

1. All calibration coefficients are in the unit of °C, flow base unit or kPa if applicable.
2. Density is in the unit of mg/cc.
3. Time is in the unit of 10 ms.
4. All configuration coefficients are in the selected flow unit or kPa if applicable, except for item 5.
5. If X6 is set to 0,  
     RS232 data acquisition response is in the selected unit.  
     If X6 is set to other than 0,  
     RS232 data acquisition response is in the °C, base flow unit or kPa.

### A.1 A Group

Command	Type	Note
A1	float	Analog Output Full scale corresponding flow in selected flow unit.
A2	float	D/A calibration, Count/kPa
A3	float	BackFlow if count reading in DP is less than A3
A4	float	Barometric condition of the pressure in kPa
A5	float	Min Pressure for Volume Flow sensor or Max Pressure For Mass Flow Sensor

### A.2 B Group

Command	Type	Note
B1	float	Temperature Calibration Slope(C/Count)
B2	float	Temperature Calibration Offset(C)
B3	float	Temperature Compensation Flow Coef (2nd order)
B4	float	Temperature Compensation Flow Coef (Linear)
B5	float	Calibrated Temperature in Deg. C

### A.3 C-Group

Command	Type	Note
C1	float	Offset Flow Coef(cc/min or µg/min)
C2	float	First-order Flow Coef(cc/min/count or µg/min/count)
C3	float	Second-order Flow Coef(cc/min/count <sup>2</sup> or µg/min/count <sup>2</sup> )
C4	float	Third-order Flow Coef(cc/min/count <sup>3</sup> count <sup>2</sup> or µg/min/count <sup>2</sup> )
C5	float	Lo Offset Flow Coef(cc/min or µg/min)

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C6	float	Lo First-order Flow Coef(cc/min/count or $\mu\text{g}/\text{min}/\text{count}$ )
C7	float	Lo Second-order Flow Coef(cc/min/count <sup>2</sup> or $\mu\text{g}/\text{min}/\text{count}^2$ )
C8	float	Lo Third-order Flow Coef(cc/min/count <sup>3</sup> or $\mu\text{g}/\text{min}/\text{count}^3$ )
C9	float	Percent Divider % (such as 10)
CA	float	Smooth % (such as 1)
CB	float	Calibrated Gas Constant
CC	float	Calibrated Gas Viscosity

### A.4 D Group

Command	Type	Note
D1	float	Buffer Time in % of the test period
D2	float	Safety Multiplier = 2 to 6
D3	float	Test Start Leak Window Max in multiplier of $\sqrt{2}$ (1.2)
D4	float	Test Start Leak Window Min in multiplier of $\sqrt{2}$ (0.8)
D5	float	Alpha (Curve) (0-1)

### A.5 G Group

Command	Type	Note
G1	float	Universal Constant of the Gas (287 for air): necessary if density is used in calculation.
G2	float	Viscosity at 0 °C
G3	float	Viscosity change per °C.
G4	float	Density of the gas at standard barometric condition in mg/cc, used for standard flow unit such as SCCM etc

### A.6 H Group

Command	Type	Note
H1	float	Pressure Calibration Slope(kPa/count)
H2	float	Pressure Calibration Offset(kPa)
H3	float	Pressure Compensation Flow Coef (2nd order)
H4	float	Pressure Compensation Flow Coef (Linear)
H5	float	Calibrated Pressure in kPa
H6	float	Pressure Calibration Slope (kPa/Count)
H7	float	Pressure Calibration Offset (kpa)

### A.7 K Group

Command	Type	Note
K1	float	Pressure Setting for Leak Test mode (kPa)

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K2	float	Pressure Upper Limit(kPa)
K3	float	Pressure Lower Limit(kPa)
K5	float	Pressure Setting for Leak Test mode (kPa) for large leak check with dual pressure settings
K6	float	Pressure Upper Limit(kPa) for large leak check with dual pressure settings
K7	float	Pressure Lower Limit(kPa) for large leak check with dual pressure settings
K9	float	Pressure Lower Limit (kPa) for external pressure switch
KA	float	Pressure Higher Limit (kPa) for external pressure switch

### A.8 L Group

Command	Type	Phase Label
L1...LE	String	Up to 15 characters per Label

### A.9 O Group

Command	Type	Phase Valve Configuration
O1...OE	Integer	The last byte will be configured as follows: Clamp 0x80 Pres/Test 40 Exhaust 0x20 Fill/Balance 0x10 QuickFill 0x08 Isolate 0x04 Customer1 0x02 Customer2 0x01

### A.10 P Group

Command	Type	Note
P1	float	PID Proportional Coef
P2	float	PID Integral Coef
P3	float	PID Differential Coef
P4	float	Flow Setting for flow control mode in selected flow unit.
P5	float	PID External Pressure Sensor usable criteria(%)

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### A.12 S Group

Command	Type	Note
S1	String	Serial Number: Up to 14 characters are allowed to enter. For example: <u>XX XX XXX XXX X XXX</u> 1 2 3 4 5 6 1 = Release of month, i.e. 06 = June 2 = Release of year, i.e. 98 = 1998 3 = Serial No. – valid from 001 to 999 4 = Maximum Flow, i.e. 090=90, 120=120, 12H=1,200, 12K=12,000 5 = Flow Unit- C = CCM, L = LPM, U=ug/min, M=mm <sup>3</sup> /min 6 = Maximum Pressure in psia, i.e. 500=500 psia, 12H=1,200 psia, 12K=12,000 psia
S2	String	Read Only Return Version Number such as 020000 for version 2.0.0

**A.13 T Group**

Command	Type	Built-in Timers	Customized Timers
T1	Integer	Filling delay time in 10 ms	Step timer in 10ms
T2	Integer	Stability delay time in 10 ms	Ditto
T3	Integer	Test time in 10 ms	Ditto
T4	Integer	Clamping delay time in 10 ms	Ditto
T5	Integer	N/A	Ditto
T6	Integer	N/A	Ditto
T7	Integer	N/A	Ditto
T8-TE	Integer	N/A	Ditto

Note: All T group settings are defined as long integer (32 Bit) since Ver 2.1.3.

**A.14 U-Group**

Command	Type	Note
U1	Integer	Address 1-9
U2	Integer	<p><b>Mode:</b> <b>4th Byte</b></p> <p>Sensor Type Conventional Leak Tester 0 Adaptive Leak Tester 1 Flow Controller 2 Mass Extraction Method 3</p> <p><b>3rd Byte</b> 0x<u>1</u> 0 0 <u>1</u> 0 0 0 <u>1</u> Bit 0: When '1', Sensor is configured as Model XE Bit 4: When '1', Sensor is configured for 4<sup>th</sup> analog input</p> <p><b>2nd Byte</b> 0x <u>1</u> <u>1</u> <u>1</u> <u>1</u> <u>1</u> <u>1</u> <u>1</u> <u>1</u> 5 4 3 2 1</p> <p><b>1:Valve Control</b> Standard 0x0 (Disable C1, X2, X3, XA) Customized 0x1- 0xF</p> <p><b>2:Flow Calibration</b> One Set of Calibration 0 Two Set of Calibration 1</p>



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		<p>3: Relative Measurement            4: Digital Input Pulse/Level                Set to 1 if Level detection is desirable            5: Vacuum Testing Message                1—Vacuum</p> <p><b>1st Byte</b></p> <p>Bit 0: Measurement Unit            Mass Flow Base 1 <math>\mu\text{g}/\text{min}</math> as Base Unit            Volume Flow Base 0 <math>\text{cc}/\text{min}</math> as Base Unit</p> <p>Bit 1: Gas Compensation                Gas Compensation 1                No Coef Compensation 0</p> <p>Bit 2: 3<sup>rd</sup> Test Type On</p> <p>Bit 3: 3<sup>rd</sup> and 4<sup>th</sup> Test Type On            Example: 0x00(1<sup>st</sup> byte) 27(2<sup>nd</sup> byte) 00(3<sup>rd</sup> byte) 02(4<sup>th</sup> byte)</p>
U3	Integer	<p>Temperature Unit:            0-Degree C            1-Degree F</p>
U4	Integer	<p>Pressure Unit:            Pressure Unit:            0- kPa            1-kg/cm<sup>2</sup>            2-psia            3-inHg            4-inH<sub>2</sub>O            5-psig            6-Torr            7- KPA-G            8- Bar-a</p>
U5	Integer	<p>Flow Unit:            High Nibble            0 - cc            1 – mm<sup>3</sup>            2 -liter            3-gal            4 -gram            5 -mg            6- <math>\mu\text{g}</math>            Lower Nibble            0 -sec            1 -min.</p>

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		<p>2 -hour 3-SCCM etc.</p> <p>16*HighNibble+LowNibble</p> <p>Besides: 7*16+3-SCCM 8*16+3-SLM 9*16+3-SCFM</p> <p>7*16+4 SCCSe-6</p>																				
U6	Integer	<p>0: One string of response to SQ1 command 1: two string of response to SQ1 command</p>																				
U7	Integer	<p>Baud Rate: 0, and else: 9600 2:19200 4:38400 12:115200</p> <p><u>The Parameter will take effect after the power reset of the sensor</u></p>																				
U8	Integer	Hold Value Time in U8*10 ms																				
U9	Integer	<p>Set U9 =0 to disable the some of the special features.</p> <p>1) Disable Relative Measurement 2) Disable Mass Extraction Test 3) Disable Early Detection for Adaptive Test</p>																				
UA	Integer	Start Cycle Counter. Cycle number can be shown on system and maintenance screens.																				
UB	Integer	<p>Reference flow function flag. 1 Byte Within each byte of the above value the bit positions are numbered as shown:</p> <table border="1" style="margin-left: 20px;"> <tr> <td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td> </tr> </table> <table border="1" style="margin-left: 20px;"> <thead> <tr> <th style="background-color: black; color: white;">Bit #</th> <th style="background-color: black; color: white;">Description</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">0</td> <td>Reference Flow Activate: 0 = Reference Flow disabled from setup 1 = Reference Flow Enabled from setup</td> </tr> <tr> <td style="text-align: center;">4</td> <td>0 = TT1 Reference Flow activated if it is enabled 1= TT1 Reference Flow deactivated</td> </tr> <tr> <td style="text-align: center;">5</td> <td>0 = TT2 Reference Flow activated if it is enabled 1= TT2 Reference Flow deactivated</td> </tr> <tr> <td style="text-align: center;">6</td> <td>0 = TT3 Reference Flow activated if it is enabled 1= TT3 Reference Flow deactivated</td> </tr> <tr> <td style="text-align: center;">7</td> <td>0 = TT4 Reference Flow activated if it is enabled 1= TT4 Reference Flow deactivated</td> </tr> </tbody> </table>	7	6	5	4	3	2	1	0	Bit #	Description	0	Reference Flow Activate: 0 = Reference Flow disabled from setup 1 = Reference Flow Enabled from setup	4	0 = TT1 Reference Flow activated if it is enabled 1= TT1 Reference Flow deactivated	5	0 = TT2 Reference Flow activated if it is enabled 1= TT2 Reference Flow deactivated	6	0 = TT3 Reference Flow activated if it is enabled 1= TT3 Reference Flow deactivated	7	0 = TT4 Reference Flow activated if it is enabled 1= TT4 Reference Flow deactivated
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6	0 = TT3 Reference Flow activated if it is enabled 1= TT3 Reference Flow deactivated																					
7	0 = TT4 Reference Flow activated if it is enabled 1= TT4 Reference Flow deactivated																					

## APPENDIX A COMMAND LIST

### A.15 V Group

Command	Type	Note
V1	float	Min. Flow Alarm for leak test mode in cc/min, $\mu\text{g}/\text{min}$ or selected unit based on X6.
V2	float	Max. Flow Alarm for leak test mode in cc/min. or selected unit based on X6. For mass extraction method, Max. Leak Alarm for leak test mode in cc, $\mu\text{g}$ , or selected unit based on X6
V3	float	flow compensation to DP in kPa/(cc/min) or kPa/( $\mu\text{g}/\text{min}$ )
V5	float	Min. Flow Alarm for Relative Measurement BaseLine Flow in cc/min, $\mu\text{g}/\text{min}$ or selected unit based on X6.
V6	float	Max. Flow Alarm for Relative Measurement BaseLine Flow in cc/min. or selected unit based on X6.
V7	float	Large Leak Flow Alarm Flow in cc/min. or selected unit based on X6.

### A.16 X Group

Command	Type	Note
X1	Integer	Pressure Switch On Check Step No Lowest Byte=Step No <i>2<sup>nd</sup> Lowest&lt;&gt;0, Advance to the next step once the PS is on (ver 2.1.1)</i>
X2	Integer	Pressure Switch Off Check Step No Lowest Byte=Step No <i>2<sup>nd</sup> Lowest&lt;&gt;0, Advance to the next step once the PS is off (Ver 2.1.1)</i>
X3	Integer	Leak Check Step
X4	Integer	Buffer Size: Valid from 4 to 100
X5	Integer	Enable Flag: Deplete the pressure after the test failure
X6	Integer	Default unit is used if X6 <>0 Flow in cc/min or $\mu\text{g}/\text{min}$ . pressure in kPa and temperature in Degree C
X9	Integer	Flow baseline Step No
XA	Integer	Stop Test Step No
XB	Integer	LargeLeak Test Step No ( <i>ver 2.1.2</i> ) Lowest Byte=Step No <i>2<sup>nd</sup> Lowest&lt;&gt;0, The steps before and on LargeLeak will be set based on K5 and check against K6 and K7 3<sup>rd</sup> Lowest&lt;&gt;0, the step on LargeLeak will check against V7 as Minimum Large Flow (Version 2.37)</i>
XC	Integer	<i>Basic Check (ver2.2.0) Each bit of the integer representing the step in which the basic check shall be enforced.</i>

## APPENDIX A COMMAND LIST

		<p><i>The Basic Check verifies the sensor is not saturated and pressure is not out of settings (<math>P_{Hi}</math> and <math>P_{Lo}</math>). "XC"</i></p> <p><i>Note:</i></p> <ol style="list-style-type: none"> <li><i>1. If XC was set such as 0xFF, the gross leak check will be disabled.</i></li> <li><i>2. Any basic step check after leak check step will be ignored!</i></li> </ol> <p><i>Example of setting:</i>  <i>XC=0x06 In step 2 and step 3 the basic check will be enforced.</i></p>
XD	Integer	<p><i>External Pressure On Step No</i></p> <p><i>Lowest Byte=Step No</i></p> <p><i>2<sup>nd</sup> Lowest&lt;&gt;0, Advance to the next step once the external pressure is in range</i></p>
XE	Integer	<p><i>External Pressure Off Step No</i></p> <p><i>Lowest Byte=Step No</i></p> <p><i>2<sup>nd</sup> Lowest&lt;&gt;0, Advance to the next step once the external pressure is out of range</i></p>

Note:

The following condition has to be met in order for the IGLS to function properly:

- $X1 < X3 < XA < X2$
- $XB < X9 < X3$
- $1 < X3$
- $1 < XB$

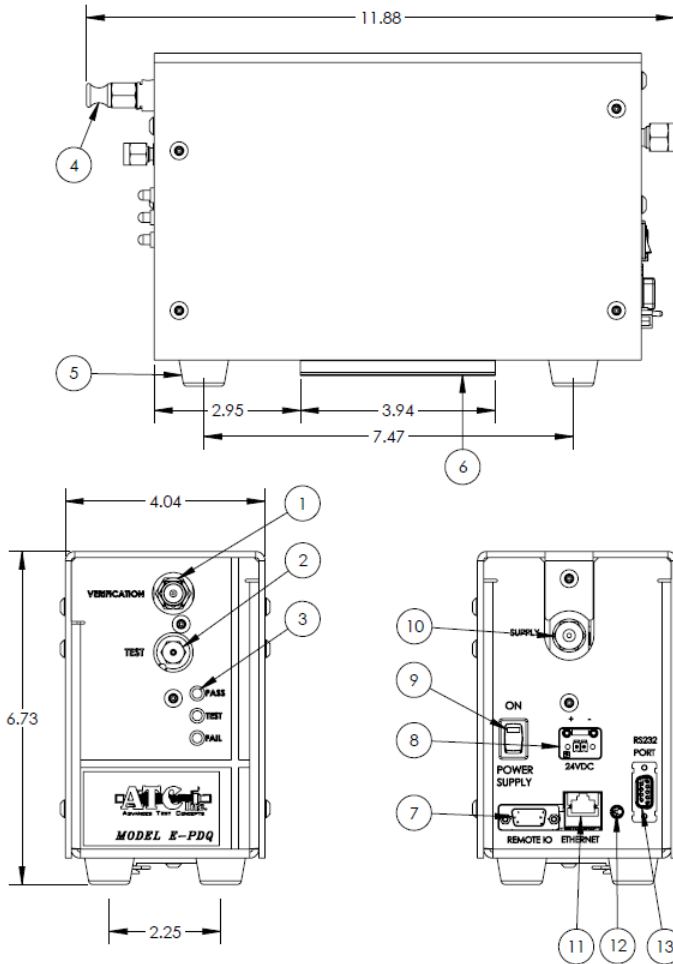
### A.17 Y-Group

Command	Type	Note
Y1	float	Reference Flow the first point time parameters.
Y2	float	Reference Flow the second point time parameters.
Y3	float	Reference Flow the third point time parameters.
Y4	float	Reference Flow the fourth point time parameters.
Y5	float	Reference Flow the fifth point time parameters.

### A.18 Z-Group

Command	Type	Note
Z1	float	Reference Flow the first point flow parameters.
Z2	float	Reference Flow the second point flow parameters.
Z3	float	Reference Flow the third point flow parameters.
Z4	float	Reference Flow the fourth point flow parameters.
Z5	float	Reference Flow the fifth point flow parameters.

## APPENDIX B – MODEL E-PDQ ASSEMBLY DRAWING and WIRING DIAGRAM



ITEM NO.	DESCRIPTION
1	ORIFICE VERIFICATION PORT
2	TEST PORT
3	INDICATOR LIGHT
4	PLUG
5	FEET
6	35 mm DIN RAIL CLIP
7	REMOTE I/O PORT
8	POWER SOCKET
9	ON/OFF SWITCH
10	AIR SUPPLY PORT
11	ETHERNET PORT
12	COMM. SELECTOR SWITCH
13	RS232 PORT

