Programming and Operation Manual

Leak Test Instrument
Model IPE2

Firmware Software Revision – 2.3.9
Hardware Revision – 1.1
Jul. 12, 2013
Manual Revision 1.8

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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:

This product is supplied with a power supply fed with 115 VAC or 220 VAC, single phase. When handling high voltage, use proper care to avoid harm to personnel and equipment due to electrical shock.

WARNING:

Leak Test Instruments sold to locations outside of North America will include a power cord that is intended for standard use in continental Europe. This cord is manufactured with a 230V IEC 7/7 "schuko" plug. It is the responsibility of the Leak Test Instrument end user to ensure that this cord is adequate and appropriate for the intended use and complies with all applicable laws, regulations, codes and standards of the region where the Leak Test Instrument will be used. If not, the end user will need to source an appropriate power cord that meets their local requirements

WARNING:

Use this product for the purpose of leak testing or flow measurement and testing in the pressure ranges and temperature ranges 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 should the operator tamper with the "unit under test (UUT)" while the test is on. This may result in bodily injury and/or erroneous results.

WARNING:

This product shall be used for leak test application 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 leak Test Instrument measurement reflects the momentary leak flow rate of the unit under test as presented to this instrument, at the test conditions and environment used. It is not a guarantee for "leak-free" products over long periods of time that are used in a different condition and environment.

CAUTION:

The user should 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.

1. Introduction

This manual applies to the operation and maintenance of the Leak and/or Flow Test Instrument Model IPE2 incorporating ATC's patented Micro-Flow technology, and Micro-Flow Sensor, the Intelligent Gas Leak System (IGLS).

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. Therefore, the instrument can display volume flow, mass flow or volume flow at std. conditions - by selecting one of 27 flow units and their combinations. The IGLS has a microprocessor based flow computer and controller. The flow computer program performs on board volumetric (i.e., cc/min.) or mass (e.g., gr./min.) flow measurements with temperature and pressure compensation. The flow computer can total the flow (i.e. total mg) during testing using the mass extraction concept. In addition, pressure or flow control can be performed for the purpose of mass flow control or leak testing. The Intelligent Gas Leak Sensor (IGLS) has the capability to control valve sequencing required for a complete stand-alone leak test.

The Model IPE2 implements the valves needed for most leak testing applications using the IGLS. The touch screen graphical LCD display includes start, stop, and test select buttons, measurement reading, and flow signature graph. 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 equal to the amount of flow "leaking out". This method offers a quick test time without sensitivity to unit under test (UUT) volume.

A separate software (optional, and may not be included with this product) with a Graphical User Interface (GUI), the Leak-Tek© program, can be used in conjunction with the IGLS. The Leak-Tek program allows the user to configure desired parameters to meet specific requirements, and can be used to download to the IGLS as well as view, save, and analyze test data using a PC.

The IGLS receives commands and data requests, and returns data via a bi-directional RS-232 port. The Model IPE2 includes a female 9-pin D-connector on the side panel for connecting to a PC using a straight through RS-232 serial extension cable. Up to 9 IGLS and/or Model IPE2 units can be attached to a single RS-232 port. The Model IPE2 also includes an RJ45 Ethernet connector on the side panel for connecting to a PC via a network connection either directly to a PC or through a LAN. Selection of the communication method is made via the COMM SELECT toggle switch located inside the Model IPE2 enclosure. Only one communications port may be used at any time. The Ethernet connection does not support multiple users access to the Model IPE2. Refer to the Operator Manual for Leak-Tek © program version 5.0 or later 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 the selected sensor, update the calibration data, and establish new test parameters.

Depending on the Model type, the instrument can be configured to run up to four (4) types of tests. Test type can be selected via the front panel graphical LCD display, or remotely via the side panel connections.
All remote or external controls (input or output) are available at the male 37-pin D-connector on the side panel of the Model IPE2.

1.1 Principle of Operation

The Leak Test Instrument, Model IPE2 and its accessories provide a complete solution for leak flow testing. The leak testing concept is based on the mass conservation law. Per this basic law of physics, once the UUT is pressurized and reaches steady state condition (stable pressure and temperature), the amount of mass flow into the UUT equals the amount of mass flow that leaks out. In other words, the IGLS measures the make up flow required to keep the pressure steady in the UUT under pressure condition. In vacuum, the IGLS measures the mass flow extracted from the UUT to maintain steady vacuum condition.

The IGLS is a unique micro-flow sensor capable of measuring extremely low flow utilizing ATC's accelerated laminar flow design. The IGLS measures volume flow and converts it to mass flow based on pressure, temperature measurements and gas type. The IGLS sensitivity is further increased in vacuum condition, where a given mass flow yields in 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 1200 Kpa Abs (175 psia). When performing tests at low absolute pressure, or deeper vacuum (e.g., 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) should be used.

The advantage of the IGLS technology, or mass flow measurement is that the leak flow rate at steady state is independent of the UUT volume, and the measurement is a direct leak flow measurement. Therefore, very frequent calibration is not required, and standard annual calibration procedures are applicable. The supplied verification orifice (sometimes called "calibrated leak") is used only to verify equipment operation, such as valve leakage, etc. The Model IPE2 utilizes valves with fixed orifices; therefore, testing large volumes with this instrument may require longer fill time. For these applications consult ATC. The IGLS technology offers a faster and very repeatable leak test. For short cycle time you can use the signature concept as described in the Leak-Tek software manual.

1.2 Options

Some Model IPE2 Instruments may come with one or more of the following options:

1. Dual (2) test circuits
2. Blockage/Constriction test circuit
3. Differential Pressure test circuit.
4. Pre-fill loop (typically for parts with large volume) with pressure switch.

1.2.1 Dual channel

This manual will refer to the Leak Test Instrument, Model IPE2 (IPE2) with a single channel or test circuit (see section 3.1). However, the IPE2 can consist of one single independent channel or 2 independent channels that perform 2 independent tests. It can be a combination of 2 leak testing circuits, a leak testing and a blockage/constriction testing circuit or two blockage/constriction test circuits. The following sections in the manual will be applicable to the first and second channel as applicable.

1.2.2 Blockage/Constriction test circuit

The Blockage Test/Constriction test circuit is designed to detect partial or full blockage/constriction of flow paths. The constriction is referred to as the constriction of the smallest diameter (throat diameter), which has a significant impact on the functional flow (of a given fluid at given pressure and temperature) during normal operation of that product. As some manufacturing process failure modes can cause full or partial blockage/constriction, this test is intended to detect such a failure mode. The Blockage/constriction test circuit measures the airflow through the given flow path while maintaining and controlling constant pressure at the inlet of the part (or as close to it). That circuit is quite sensitive and can detect reductions in throat diameters for a given product of 5-10%, depending on user set up. This test is quite fast, typically around a few seconds (3-6 seconds) per measurement.

A typical blockage constriction circuit consists of an Intelligent Gas Flow Sensor (IGFS) (common size is 0-50 Liter/min, depending on the throat diameter to be tested). It has an electronic pressure controller, upstream to the IGFS, with a remote pressure transducer providing close loop feedback to the electronic pressure controller, mounted outside the instrument, as close as possible to the UUT inlet. An isolation valve that closes when the test is not run is also included. The tube size for the blockage/constriction testers are chosen such that the ID of the tube is a least 1.5 times bigger than the size of the throat diameter under test. The control panel and the I/O are the same as the Leak testing circuit. When the unit is in idle mode, the electronic pressure controller will show higher pressure (e.g: 3 psig), which is normal due to the fact that the feedback pressure sensor is at no pressure (ambient condition).

During testing, the flow will be developed and must be above the minimum allowed flow and the maximum allowed flow to pass the test. The pressure must be between minimum and maximum value allowed to pass a test. Cases of constriction will show flow values lower than the minimum flow allowed at the same test pressure. Flow that is higher than maximum flow allowed could be due to downstream leak, or that the UUT is not properly connected.

1.2.3   Differential Pressure test circuit

Differential Pressure (DP) test circuit is to detect the leakage between two or more adjacent test cavities that can mask or bias the true leak rate. It consists of differential transducers, which are typically located out of the cabinet, connected pneumatically to the cavities under test. The electrical signal from the transducers comes back to the cabinet. At the end of the test, transducers check the pressure against a set limit. If it is out of the limits it sends a fail signal to the user PLC/PC.

The High side of the Pressure Differential transducer should be connected to the cavity with the tighter (lower) leak rate specification. The Low side of the Pressure differential transducer should be connected to the cavity with the larger allowed leak rate. The pressure differential must be within the limit set to pass. A separate pin at the output connector (refer to electrical drawing) indicates DP Test pass or fail. The pin goes high (true) for pass. If this option is installed, and the pin does not go high at the end of the test, the part is rejected, even if the leak test pass output is on.

Caution:

The IGLS (leak test) pass/fail outputs are independent of the DP test output (one output). The user controller must be set to reject the part if the leak test passes the test and the DP test fails (Pass output "true" or high, DP output is "false" or low.)

1.2.4   Pre-fill loop with pressure switch

The pre-fill loop is an additional fill circuit to the one that is ALWAYS included with the basic leak test circuit. Its purpose is to speed up the part charging or evacuation time, maintain the test circuit at steady state condition, and eliminate cases where the part is not connected or very large leaks exist, causing the air pressure to bleed off the system.

The pre-fill option is particularly helpful when a large volume part is leak tested or when the ratio of part test volume to allowed leak rate is very large. During the first few steps in the leak test the pre-fill loop fills or evacuates the part to the test pressure by bypassing the leak testing circuit and expansion tank. After that the pressure switch is checked to make sure that the part is holding pressure. If the part is holding pressure the leak test then continues and the leak test circuit and expansion tank are engaged. If the part is not holding pressure then the test fails and a fail signal is then sent to the customer I/O; and the fail light comes up on the front panel.

The tubing and valves size of the pre-fill option is application dependent and for pressure applications sizes of 3/8" and ½" tubes and valves are common. For vacuum application, sizes of ½" or ¾" are common. Pressure switch is selected based on actual test pressure and installed inside the leak test instrument.

2. Function Configuration

2.1 Leak Test

When functioning as an automatic leak tester, the IGLS controls signals to the clamping valve, pressure/test valve, exhaust valve, fill/balance valve, quick fill valve, isolation valve, and up to one custom valve to fill the UUT and allow stabilization. The IGLS is configured with two analog outputs of 0-5 VDC.

After the stabilization time, the test begins. The IGLS will monitor flow readings for a pre-defined test time period and make a pass/fail determination based on pre-defined test criteria (pressure and flow must be within a pre-defined range to pass the test). It will automatically go to a standby condition at the end of the test if pass occurs. The re-test function can be configured to allow a continuous test until the pass criteria are met or until the stop button is pressed manually to stop the unit. The test status is displayed on the LCD. Test pass/fail criteria, test time, and stabilization time are configurable via the RS-232 port or Ethernet port using the Leak-Tek © program or hyper-terminal. Refer to Appendix D for application examples. If the multiple test types feature is configured, it is possible to toggle between up to 4 test types using the front panel button or by supplying a control signal to the side panel D-connector (see figure 3.2.2 for pin outs).

2.2 Mass Extraction Method Test

In some situations, the leak may not be constant, may vary significantly during the test, or the UUT is a sealed volume, which cannot be pressurized. Therefore, the mass extraction method would be the valid test method. It accumulates (totals over test time) the leaks during the test period, and compares them to the maximum setting to make a decision of pass or fail.

In many cases, mass extraction will be performed while the part is inserted into a sealed chamber, vacuum is applied to the chamber and the IGLS circuit is located between the vacuum source and the chamber. The IGLS will measure the total mass as well as flow extracted out from the chamber.

3. Interface

3.1 BASIC CHANNEL OPERATION, MECHANICAL INTERFACE AND CONNECTION of the Model IPE2

WARNING:

If hazardous conditions and gasses result, consult ATC. The standard Model IPE2 is NOT rated to operate in class 1 or 2 environment.

WARNING:

The fluids used should be gasses compatible with IGLS wetted material, which consists of stainless steel and viton seals. Gasses currently supported are dry air, nitrogen, carbon dioxide, and helium. For other gases, consult ATC.

CAUTION:

The Model IPE2 is supplied with a filter. Clean and maintain the filter and supply lines, as excessive contamination will cause distortion of readings.

CAUTION:

The operating temperature as well as the gas temperature should be from 10 to 45 °Celsius. For a higher temperature range, consult ATC.

CAUTION:

Connections of instrument ports should be per the enclosed schematics. Support all bulkhead fittings with two proper wrenches to hold those connections steady, and to avoid internal damage to the instrument. Follow Swagelok ® fitting assembly instructions.
The Model IPE2 can be mounted on a bench top as supplied with four rubber pads. Alternatively, it can be mounted on a shelf above or below the test unit/fixture and secured with four bolts, replacing the rubber pad's bolts.

CAUTION:

It is the user's responsibility to assure that the UUT is present and properly connected before starting the leak or flow test. In the case of massive leak or test while test port is not connected, the user is responsible to allow enough time for the pressure to build up and stabilize in the supply expansion tank.

NOTE:

> Mount and locate the Model IPE2 as close as possible to the UUT, to minimize Model IPE2 UUT connection tube length and volume. Larger volumes will reduce system response to a given leak flow.

The Model IPE2 controls an internal fill/balance valve, isolation valve, test valve, and exhaust valve, as well as an optional clamp/seal valve, quick fill valve, custom valve and/or electronic pressure controller. Solenoid valves are used for automatic control. A verification orifice solenoid valve can be operated from the front panel controls. The pneumatic connection should be per the enclosed diagram (Figure 3.1.1).

Optimize inlet pressure expansion size. The Expansion tank should be at minimum 10 times larger than UUT volume, if possible. However, an expansion tank between the pressure regulator/controller and the Model IPE2 will reduce pressure fluctuations, and increase system performance. For smaller and medium leak rate, an isolation valve is required. The isolation valve isolates the Model IPE2 from the supply line during the measurement cycle (stability and test time).

The pressure supply to the Model IPE2 must be very stable. Air tools connected to the same line may cause a shock wave that will affect pressure stability. If the Model IPE2 inlet pressure "drops" during the test, the flow will reverse, and the Model IPE2 will display zero flow which may cause measurement bias. During stability and test time, supply pressure should be stable within 1 inch of water. Optimize tubes/hoses/valves sizes to get desired test times.
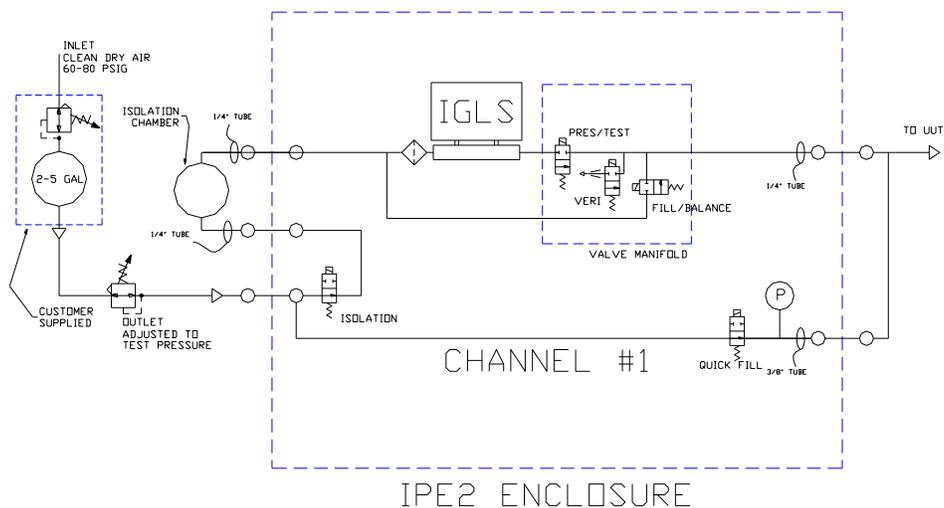
Figure 3.1.1 - Pneumatic Connection- Basic model only.

NOTE:

See Appendix E for outside dimensions.
For your application, see DRAWINGS section for details.

CAUTION:

Material selection and pressure ratings: Make sure that pneumatic interface components are compatible with the gasses. Make sure all components comply with appropriate codes for pressure ratings (such as ASME Boiler codes, SAE standards, etc.). Make sure that tubing and fittings meet leak specification of 10 times better than the rating of the instrument and leak test specification.

Pressure/vacuum controller: Two types of pressure/vacuum controllers can be used - manual (with knob adjustments) or electronic pressure controllers. The electronic pressure controller should be compatible with the electrical output signal of the Model IPE2. For higher flow rates, an electronic pressure controller with a volume booster may be required. All pressure controllers must have a vent to allow pressure reduction. When selecting a pressure controller, the most important criteria are pressure stability and response time.

Pressure spikes: Watch for pressure spikes. Very frequent pressure spikes may cause "hammering" effects on the IGLS. If necessary, use gage snubbers. In general, gas flow has higher "pressure spike damping" capabilities than liquid flow.

UUT Port connection: This port is typically on the right hand side of the unit. Support the bulkhead fitting with 5/8" wrench when tightening the tube fitting (1/4" Swagelok ® tube fitting). Do not over tighten. Depending on specific customer needs other sizes of tubes may be utilized. Consult DRAWINGS section for more detail.

Supply Pressure and expansion tank connections: These connections are typically on the left side of the instrument. Support the bulkhead fitting with 3/4" wrench when tightening the tube fitting (1/4" Swagelok ® tube fitting). Do not over tighten. Depending on specific customer needs other sizes of tubes may be utilized. Consult DRAWINGS section for more detail.

3.2 ELECTRICAL INTERFACE AND CONNECTION

WARNING:

The Model IPE2 is supplied with a power cord connected to 115VAC or 220VAC single-phase connector. Proper grounding and electrical practices should be used. When maintaining or opening the Model IPE2 enclosure, the supplied power should be disconnected.

WARNING:

The Model IPE2 is supplied with a power cord for 115 VAC or 220VAC single phase power. Connect it to an AC connector that complies with local electrical codes.

CAUTION:

Improper power wiring will cause permanent damage to the unit.

NOTE:

All digital Inputs are optically isolated. Use only 5 VDC for inputs. Directly wire the inputs via a push button or dry contact. Do not use a solid state relay for the inputs.

NOTE:

Refer to detailed electrical drawings in the Electrical Drawing Sections. If there are any additional details or discrepancies, the electrical drawings prevail. Digital outputs do not have enough power to drive an inductive load. Use small external relays or optically isolated modules (preferred) to drive valves or large relays.

The male 25-pin D-connector located on the side panel of the Model IPE2 is arranged as shown in Figures 3.2.1 & 3.2.2.

Pin	Function	Specifications
Pin 1	Analog Output A	0-5 VDC
Pin 2	Analog Output B	0-5 VDC
Pin 3	Remote Exhaust Valve Output	Switched 12 VDC, 22W max
Pin 4	Remote Exhaust Valve Return	0 VDC
Pin 5	Ground/Common	0 VDC
Pin 6	Verify Input	5-30 VDC, source or sink*, 30 mA max.
Pin 7	Remote Output Common	5-30 VDC, source or sink*, 100 mA max.
Pin 8	Clamp Output	5-30 VDC, source or sink*, 100 mA max.
Pin 9	Pressure/Test Output	5-30 VDC, source or sink*, 100 mA max.
Pin 10	Exhaust Output	5-30 VDC, source or sink*, 100 mA max.
Pin 11	Fill/Balance Output	5-30 VDC, source or sink*, 100 mA max.
Pin 12	Quick Fill Output	5-30 VDC, source or sink*, 100 mA max.
Pin 13	Isolate Output	5-30 VDC, source or sink*, 100 mA max.
Pin 14	Analog Ground	0 VDC
Pin 15	Not used	
Pin 16	Not used	
Pin 17	Not used	
Pin 18	Not used	
Pin 19	Not used	
Pin 20	Not used	
Pin 21	Custom2 Output	5-30 VDC, source or sink*, 100 mA max.
Pin 22	Pass Output	5-30 VDC, source or sink*, 100 mA max.
Pin 23	Fail Output	5-30 VDC, source or sink*, 100 mA max.
Pin 24	PFail Output	5-30 VDC, source or sink*, 100 mA max.
Pin 25	TTA Output	5-30 VDC, source or sink*, 100 mA max.
Pin 26	TTB Output	5-30 VDC, source or sink*, 100 mA max. **Test Type1: TTA:1, TTB: 0** **Test Type2: TTA:0, TTB: 1** **Test Type3: TTA:1, TTB: 1** **Test Type4: TTA:0, TTB: 0**

Pin 27	Start Input	5-30 VDC, source or sink*, 30 mA max. **Apply a pulse to the sensor Start input pin to start a test**
Pin 28	Stop Input	5-30 VDC, source or sink*, 30 mA max. **Apply a pulse to the sensor Stop input pin to stop a test**
Pin 29	Test Type Input	5-30 VDC, source or sink*, 30 mA max. **Apply a pulse to the sensor Test Type input pin to switch to the other test type**
Pin 30	Pressure Switch Input	5-30 VDC, source or sink*, 30 mA max.
Pin 31	Remote Input Common	5-30 VDC
Pin 32	Not used	
Pin 33	Not used	
Pin 34	Not used	
Pin 35	Not used	
Pin 36	Not used	
Pin 37	+5 VDC Power (DO NOT use to power external devices! Use only for Model E2 or Model VE2 digital inputs.)	+5 VDC
* Sinking or Sourcing is selected for all Inputs or Outputs as a group, i.e. all sinking inputs, all sourcing outputs, etc. Use pins 7 and 31 to select type and voltage of inputs and outputs.		

Figure 3.2.1 – Rear Panel Standard Remote I/O Connections

* If other custom options are purchased, see the drawings section in the back of this manual.
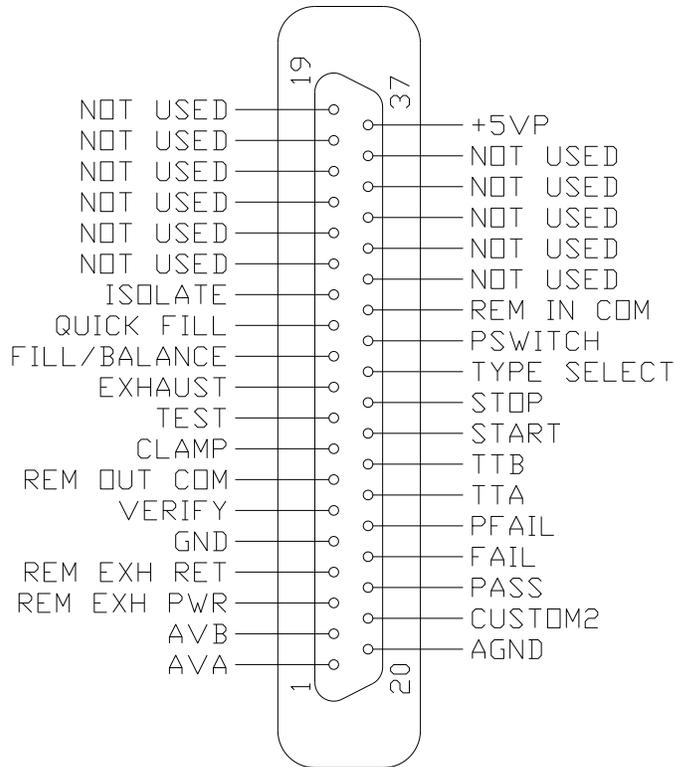
Figure 3.2.2 – Standard Remote I/O Pin Connector

Condition	Description	Pin out
Pass	The test met all criteria set in the set up screen	Pin 22
Gross leak Fail	Pressure is below the Pressure Min setting in pressure testing	Pin 23
Gross leak vacuum Fail	Pressure is larger than the Pressure Max setting in vacuum testing	Pin 23
No Pres Fail	Pressure switch not turned on in time.	Pin 23
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 23, Pin 24
Large Leak Fail	The Flow is more than the large leak setting	Pin 23
Hi Flow Relative Measurement Fail	Relative Measurement Base Line Flow larger than the set point	Pin 23
Lo Flow Relative Measurement Fail	Relative Measurement Base Line Flow Lower than the set	Pin 23

	point	
Fine Leak Fail	Flow is above the maximum flow limit setting	Pin 23
Low Flow Fail	Flow is below the minimum flow limit setting	Pin 23
Back Flow/Sys pass	The Flow Sensor Detected the Flow in Opposite Direction or System leak check failure	Pin 23
Over pressure	The Pressure Is Larger Than The Pressure Max Setting in pressure testing	Pin 23
Under pressure	The Pressure is below the Pressure Min Setting in vacuum testing	Pin 23
Flow Saturation	Exceeding Flow Sensor Limit	Pin 23
Pressure saturation	Exceeding press Sensor Limit	Pin 23
Temperature saturation	Exceeding temperature Sensor Limit	Pin 23
PresRng-HI	External Pressure higher than set limit	Pin 23, Pin24
PresRng-Lo	External Pressure Lower than set limit	Pin 23, Pin 24

Figure 3.2.3 - List of Pass and Failure Mode With Pin outs

Up to 9 Model IPE2 instruments can be connected in a serial loop. A typical serial loop connection with two instruments is shown in Figure 3.2.4.
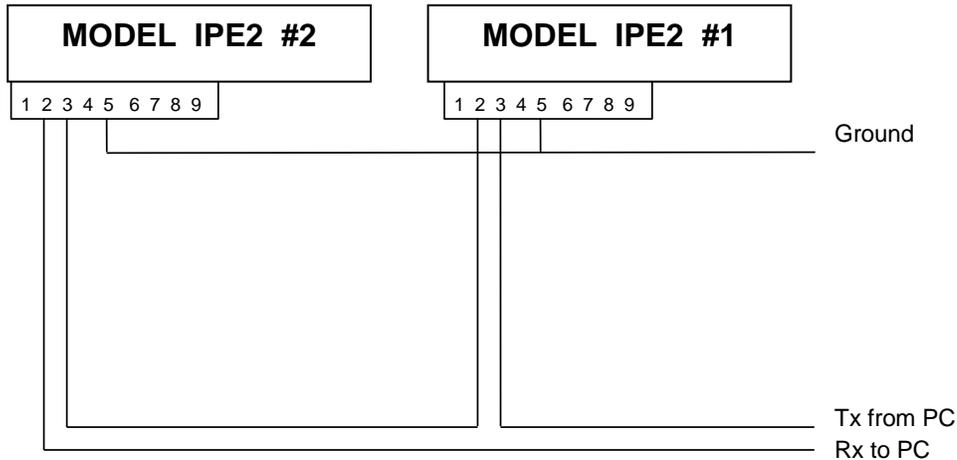
Figure 3.2.4 - Serial Loop Connection of two Model IPE2 Instruments

 * See DRAWINGS section at the end of the manual for details of Optional connections.

See the appendices for sample PLC program for remote automatic operation of the Model IPE2.

3.3 GUIDELINES FOR PNEUMATIC INTERFACE

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

3.3.2. Common rules for upstream interface:
Upstream pressure fluctuations from pneumatic actuators and/or assembly tools are undesirable, and will affect the precision pressure regulator and cause pressure/flow fluctuations that are uncontrollable. Therefore, a separate air supply line is required. If a common supply is used, a large expansion tank is required.

A. Air must be clean (10 micron filter) and dry (descent dryer) to protect the valves, and to assure that a pinhole leak is not masked up.
B. Two regulators, especially precision ones, back to back will experience pressure ripple. Therefore, a volume must exist between the adjacent pressure regulators. Include an expansion tank or use 2 separate feed lines.
C. No NPT or "push-in" fittings at test lines. Consult ATC if NPT must be used.
D. Recommended fittings: stainless steel Swagelok® or Parker (A-lok) Use one or the other. Do not mix.
E. Use VCO or VCR fittings for low leak spec. test applications and vacuum applications (Mass Extraction), to minimize virtual leaks.

3.3.3 Leak Testing pressure supply requirements:

High-pressure coarse regulator with volume (expansion tank) is recommended before ATC's supplied precision pressure regulator. Pressure shall be set higher than the test pressure for quicker regulator response as long as it does not exceed the regulator ratings. ATC typically supplies the precision pressure regulator and the test circuit expansion tank.
Note: Consult ATC if upstream regulator and expansion tanks are user supplied.

3.3.4 Blockage/Flow Test (where applicable):

A. The test is performed at a very low pressure (few inches of water).
B. Upstream regulator (coarse) set to 20 psig is required, prior to ATC's precision regulation and electronic pressure controller.
C. Dry clean air is required. Filter and dryer should not restrict flow.
D. A remote pressure transducer that helps to compensate for pressure loss at connecting tube to the UUT should be mounted as close as possible to the test inlet.
E. Connection lines are typically ½" or ¾" (application dependent, TBD).

3.4 Guideline For Fixture Design

The following are recommendations regarding fixture design using ATC's leak test instruments and low-level leak testing. This is only a recommended guideline, based on ATC's prior experience using third party fixtures.

Note:

It is the user's responsibility to properly design the test fixture, test fixture control, electrical system and pneumatic interface for proper leak testing operation.

Caution:

Duplication of fixtures operating with under water or pressure decay leak test methods can result in lack of performance using ATC's micro-flow leak test methods, especially at low level leak testing.

Warning:

Fixture design and operation should comply with all safety requirements, especially when performing pressure tests. High forces can be easily generated with relative low pressure, but large sealing area.

- Ensure that all safety aspects are per code and in place during the fixture design, build and application. Ensure operator and maintenance personnel safety.
- Mechanical fixture should provide stable volume. Fixture seal "drift" or movement during leak test will cause volume changes and bias of readings.
- Fixture and seal plate should be designed to have metal-to-metal contact with the UUT to prevent seal movement during test. Avoid adjustments that can drift or be tampered with (Figure 1 and 2).
- Seal mechanism should fit the application. For low leak rate applications, O-ring seal design (inside a dove-tail groove, Figure 1) approach should be considered. It requires tight true positioning of the sealing surfaces. Follow the O-ring "squeeze" requirements of the manufacturer.
- Note: Do not use double O-rings or seals. One seal, properly designed is all that is required. The second seal causes virtual leaks.
- Note: Gasket seals are not recommended for a tight leak spec. due to the potential for virtual leaks.
- Seal holders should have positive metal stops that are consistent. Seals should have proper relieves to minimize virtual leaks.
- Sealing material should fit the application. For high wear applications, polyurethane and natural rubber can be considered.
- Expandable seals must be properly designed (see example figure 3). When using commercially available expandable seals that are pneumatically driven, make sure that air leak from the actuating cylinder can not get into the test volume (leaking into the UUT, or vacuum chamber) as this will bias the leak test results! Expandable seals must have means to stop seal "creep" during test. Using the UUT as hard stop is always preferred.
- Fixture design should support the part to prevent expansion during actual leak test. This is applicable to flexible products such as polyethylene packages, etc.
- Minimize fixture volume or add filler for UUT with large cavities in order to minimize test setup volume (see figures 1,2,3). The larger the volume the slower a given leak flow will develop. Filler must be made out of solid machined materials. Casting or molded filler risk porosity and virtual leaks.

Be aware of "virtual leaks" for leak tests with tight leak flow specifications. Virtual Leaks are "hidden cavities" in the part and test fixture, which will take longer times to charge with pressure or to evacuate. It will also take longer times to deplete the pressure at the end of the test. Virtual leaks may look as "leaks" as they consume air to charge them.

Virtual leaks will cause test cycle times to be longer (in order to charge the parts) and require sufficient time between consecutive tests to deplete or recharge the

UUT pressure. Insufficient time between consecutive tests will result in poor test repeatability. Design your test fixture and sealing mechanism to minimize virtual leaks!
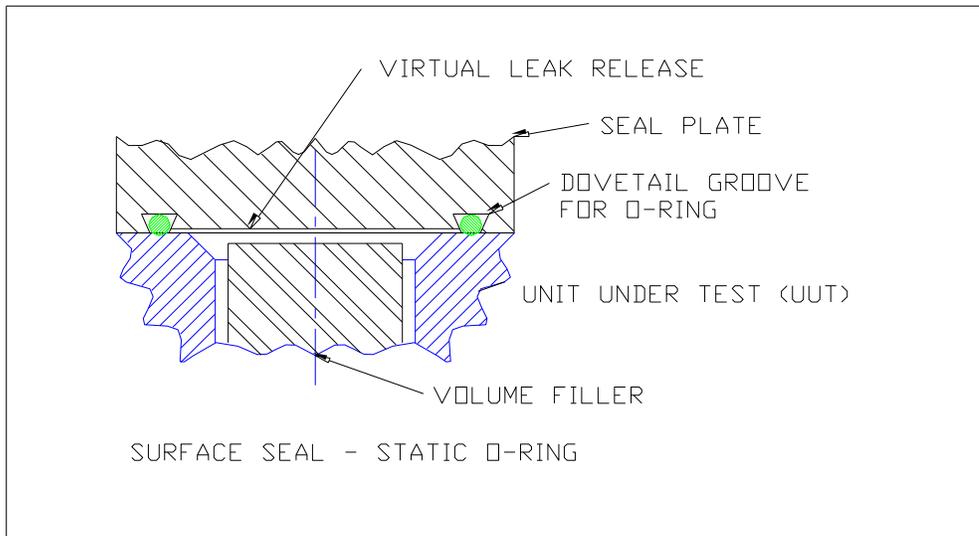
Figure 3.4.1: Surface seal design with static o-ring. Note: top plate contacts the part to provide hard stop and movement during test.
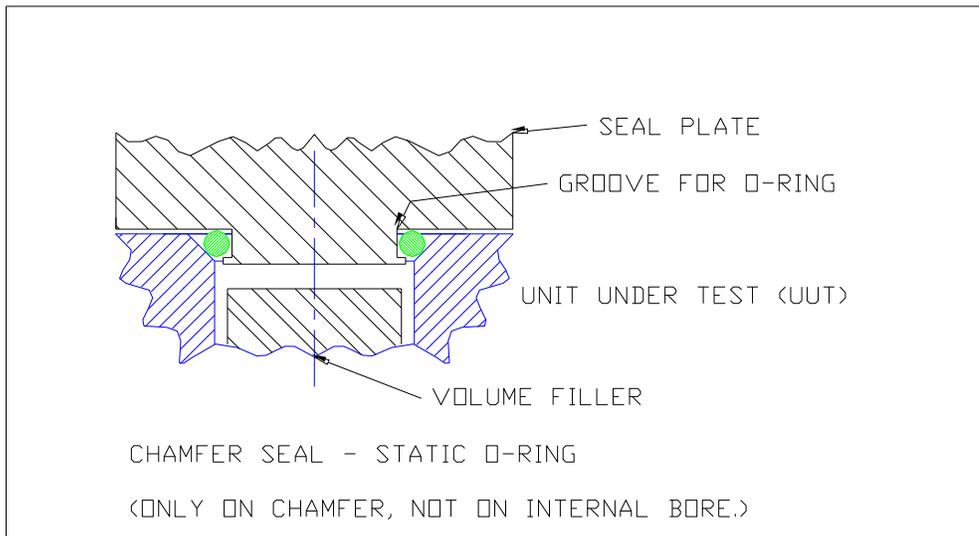
Figure 3.4.2 Chamber seal design using o-ring. Seal plate contacts the part, to provide hard stable stop. (Note: Seal does not seal on the internal bore.)
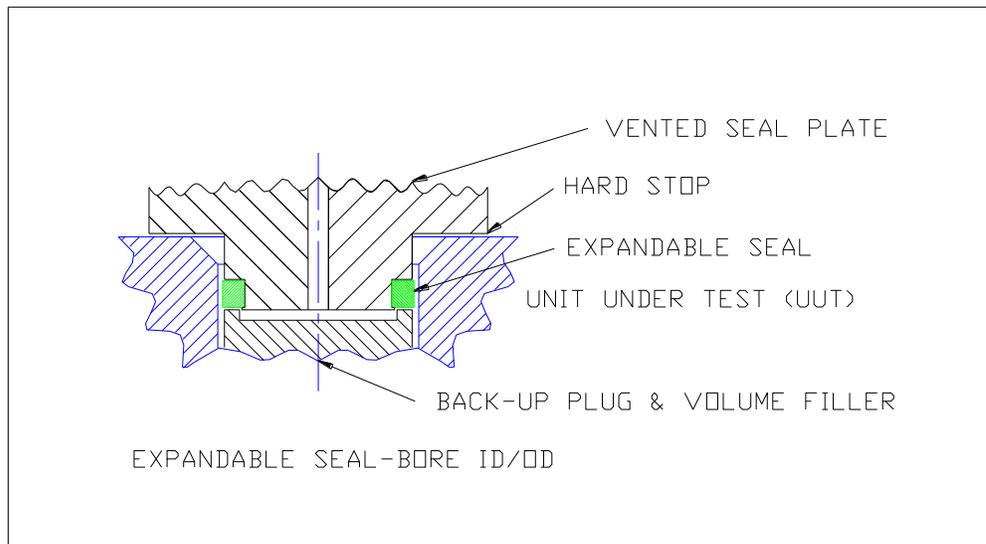
Figure 3.4.3 Expandable seal design – seal expands as seal plate moves downward. Same concept can also be applied to ODs. Seal plate contacts the part to provide stable hard stop.

3.5 Guidelines for setting up Model IPE2 Leak Tester

1. Unpack the Model IPE2 and make sure the unit is in good condition with the proper caps and ferrules.
2. Power Model IPE2 and check reading. The temperature and pressure should read close to ambient.
3. Connect expansion tank per schematic.
4. Connect pressure source and pressurized unit to test pressure, allowing time to stabilize. Make sure all the connections are leak free.
5. Run test with the unit capped with the brass cap provided. The reading should be close to "zero." If high or low flow is observed check all upstream and downstream connections for leaks.
6. Run test with the internal calibrated leak open. The reading should be close to the orifice value as indicated on the tag at the back of the Model IPE2.
7. Procure multiple non-leaking parts.
8. Connect PC or Laptop to the Model IPE2 serial Port.
9. Open Leak-Tek and go to the set up screen and input the desired pressure setting with +/- 10% on the min/max pressure. Input desired flow unit and Pre-fill, fill stability and test and min/max flow. Make sure the max flow is higher initially and the min flow about –2% of the sensor full scale (ex. for a 10ccm full scale sensor min flow could be –0.2ccm).
    (**NOTE**: For custom applications more configuration may be necessary. Contact ATC for assistance)

10. Run test with the good parts and then run the good parts with the internal calibrated leak open.
11. Make sure the difference between the good parts and the simulated bad parts is 2 times or more, adjust the timing accordingly.
12. The max flow criteria should be set at 20% below the average of the simulated bad parts.

3.6 Verification Procedure

A periodic verification is recommended during the normal operation of the Model IPE2. Run the test with a known good part and the internal calibrated leak open. This should fail the test. Run a similar good part without the internal calibrated leak and this should pass the test. If this sequence does not give the desired results, system/parts need to be checked and verified. The procedure will need to be repeated until desired results are obtained.

CAUTION:

A test time should be more than 1 second and the buffer size should be between 4-30. Consult Leak-Tek© program manual on how to set these variables.

4. IGLS-Model IPE2 Operation Sequence

The Model IPE2 leak test will run based on the sequence below after the "start" button is pressed on the front panel. Model IPE2 Leak Test Sequence- Basic circuit only:

1. If the clamping valve is enabled, energize the clamping valve in order to clamp, or connect a pneumatically driven clamp, or an automatic expander seal.
2. After the clamping time delay, during the pre-fill time the quick fill valve is enabled, the iso valve is enabled, and the UUT is pressurized with the IGLS isolated.
3. After pre-fill time delay, the test valve is opened. The fill valve is enabled and opened to equalized pressure to the UUT.
4. After fill valve time delay, the fill valve, isolation valve, and quick fill valve are closed. Stability time begins. Stability time can be as short as 0.025 seconds for Mass Extraction applications.
5. After stability time expires, the leak test starts.
6. Test time follows the stability (no valve action between stability and test steps). During test time, the flow and pressure readings are compared to the setup values in the IGLS/IGFS, and a pass or fail decision is made.
   CAUTION:

   A test time should be no less than 1 second and the buffer size should be between 4-30.

7. Passing or failing a test:
   a. If the UUT meets the test criteria within the set test time, the UUT has passed the test. If the test passes, all valves will be de-energized to deplete the pressure from the UUT and to contain the internal pressure. The pass message will be displayed on the LCD, and the green "pass" light will be turned on.
   b. If the UUT fails the test criteria at any point during the test time, the UUT has failed the test. If the test fails, the failure message will be displayed on the LCD, and the red "fail" light will be turned on.
   c. Continue re-testing if the "deplete pressure" feature is disabled. (X_5=0. See Appendix B command list.) If the "deplete pressure" feature is enabled, de-energize all valves (X_5=1. See Appendix B command list).
8. If the "stop" button is pressed at any time during the test process, the test will be stopped with all valves de-energized and the analog output at zero.
9. To switch to the other test type, press the "test select" button or pulse the "remote test select" digital input.

NOTE:

The second generation IGLS allows flexibility in set up the test sequence. The test sequence/steps are set by ATC or only authorized persons. Many applications may have customized valve configurations and test set-ups. For assistance with these features consult Leak-Tek program© manual or contact an ATC, Inc. representative.

The following cases involve additional test steps:
- Pre-fill or Pre-evac option: test starts with pre-fill/pre-evac, while the leak test circuit and pressure/test and iso valves are closed, exhaust valve is closed. The initial pre-fill/pre-evac step follows a pressure switch test, if pressure/vacuum not reached within the allowed time, the test stops.
- Large Leak Test- Large leak test is for testing for larger leak, enabling the user to test given cavities for larger leaks before continuing to check same or other cavities to a finer leak test. During mass extraction test, for closure integrity testing (part with limited, confined air volume), the large leak test is used to detect larger defects that may deplete all the air from the closure under test.
- Blockage/pressure deplete test- if a pressure switch at the basic test circuit is installed, a step at the end of the test may be added to check if test pressure is depleted within the allowed time (indication of UUT path of flow is not totally blocked).

NOTE:

If a PC is attached to the Model IPE2 with "Leak-Tek © program" running the Pass/Fail will be displayed and saved in the Leak-Tek © program run screen. However, the Pass/Fail decision is made by the IGLS.

CAUTION:

During normal operation, if a part failed due to failure mode "Flow saturation" or "Gross Leak", the isolation tank can get significantly depleted. If this condition happens, the tank should be allowed to recover and get back to its original condition, and no leak test should be run during this recovery period. Repeat verification procedure.

NOTES:
1. When the UUT has a large volume and a small flow IGLS is used, "back flow" due to pressure fluctuations from the UUT, will "mask" leaks. Therefore, set V4 to 0 to "lock" the pressure output if the electronic pressure controller is used. (This option is applicable when running with an external pressure controller.)
2. When a large volume is used with a large flow Model IPE2, a slight pressure drop may be experienced after closing the fill valve, due to flow consumption and change of flow resistance. To compensate for this phenomenon, set K4 to a negative value, which will cause the pressure controller to aim for a higher inlet pressure during fill time. (This option is applicable when running with an external pressure controller.)
3. For high-speed applications, and especially low flow, the Model IPE2 is recommended to monitor the change in flow rates. Initially set fill and stability time to very long values and record changes in flow vs. time. Define the slope for a good and rejected part. Then set the stability time and maximum flow rate to meet this slope. Use the verification orifice for reference of known leak rate.

4. For mass extraction method, the leak criteria (V_2) depends on the size of the UUT leak, the size of the chamber if applicable, and the test time.
5. Typically,
    a. The larger the UUT leak, the larger the leak criteria will be.
    b. The smaller the chamber, the larger the leak criteria will be.
    c. The longer the test time, the larger the leak criteria will be.

5. Graphic LCD Display & Touch Screen
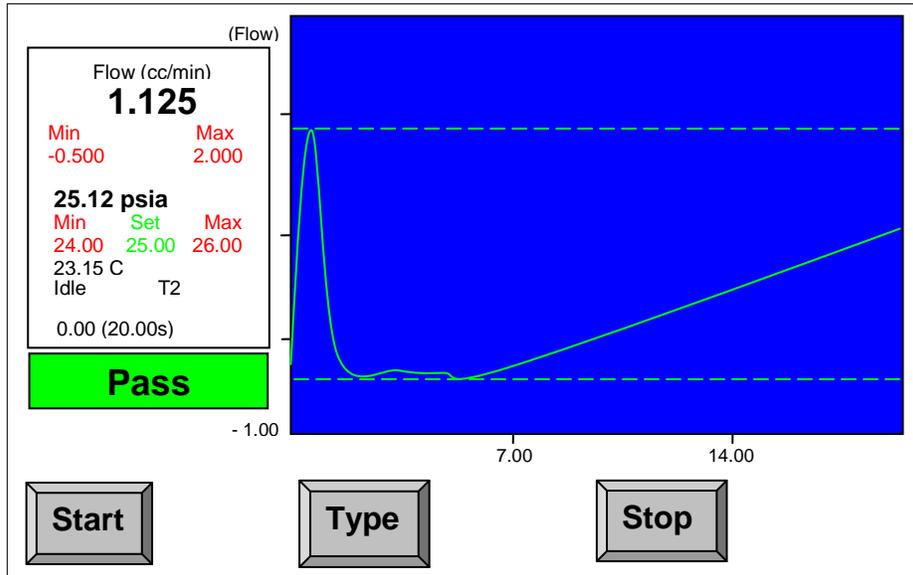
Figure 5.1 - Model IPE2 Control Panel

The Model IPE2 control panel is shown in Figure 5.1. On the left, the current pressure, temperature and flow readings are displayed in real time as well as the pressure and flow settings. The pressure, temperature, and/or flow, in the user selected engineering units by programming U_3, U_4, and U_5. (See Appendix B for details.)

On the right, a blue background graph displays the flow measurement signature for the entire leak test. The two dotted lines represent the upper and lower limits of the leak test flow tolerance. The solid line is the flow measurement.

At the bottom of the screen, there are three toggle buttons available. The visibility of the buttons can be individually configured. If they are visible, then:
      Start: Start a leak test if it is idle
      Stop: Stop an ongoing leak test
      Type: Switch from one Test Type to the other, increment by one (1) or
      back to Test Type 1 if it reaches the maximum number of the test types.

On the right side of the status message, it will display T2 if it is in test Type 2 Mode, T3 if in Test Type 3 and T4 if in Test Type 4. The sensor is in Test Type 1 if there is no message like "T2".

The verification switch opens or closes the calibrated leak valve to initiate flow through the calibrated leak.

The following table shows the various messages possible on the LCD.

Message	Description
Idle	Displays the pressure and flow reading in flow measurement, together with engineering unit in normal condition.
OpenFillPres	Displays the pressure and flow reading with the step status in the process of the test. The IGLS will open the pressure valve and filling valve.
Filling	Displays the pressure and flow reading with the step status in the process of the test. The IGLS is filling gas.
Stab Delay	Displays the pressure and flow reading with the step status in the process of the test. The IGLS is stabilizing the flow for testing.
Testing	Displays the pressure and flow reading with the step status in the process of the test. The IGLS is in test step.
Pass	Displays the pressure and flow reading with pass message after the test passed.
Stop	Displays the pressure and flow reading with stop message, if the test is intentionally stopped manually.
Fail	Displays the pressure and flow reading with failure message if the test fails. The reason for failure is shown on the LCD.
GrossLeak	During test time, in pressure testing, pressure is under Pressure Min setting (K3 or K7) or Pressure Switch not turned on in time
GrossLeakV	During test time, in vacuum testing, pressure exceeds Pressure Max setting (K2 or K6).
No-Pres	Pressure Switch not turned on in time (Version 2.0.0 or later)
OverPres	During test time, in pressure setting, pressure exceeds Pressure Max setting (K2 or K6).
UnderPres	During test time, in vacuum testing, pressure is under Pressure Min setting (K3 or K7)
PresSat	Pressure exceeds its full range. Deplete pressure immediately!
FineLeak	During Test, flow is larger than maximum allowed flow (V2), or the accumulated flow during the test period is larger than the allowed leak (V2)
LowFlow	During test, flow is lower than minimum allowed flow (V1).
FlowSat	Flow exceeds maximum sensor flow range.
TempSat	Temperature exceeds maximum limit.
Blockage	Pressure Switch not turned off in deplete time or the external pressure is out of range.
HiFlow_RM	Relative Measurement –Baseline Flow larger than V6
LoFlow_RM	Relative Measurement –Baseline Flow smaller than V5
LargeLeak	In large leak step, the measured flow is larger than V7
Back_Flow	The measured flow in the test step is less than A3
PresRng-Hi	The external pressure (4th analog input) is higher than the set limit
PresRng-Lo	The external pressure (4th analog input) is lower than the set limit

If the valve control sequence is customized, some of the LCD messages displayed might be worded slightly different from the diagram above. However, the messages can be interpreted in a similar fashion.

NOTE:

Starting from version 02.02.01, once the UUT failure is found, it will not be overwritten by the next failure if multiple failures occurred in the same UUT. For example, if both fine leak and blockage failures were found in the test. It will report fine leak failure because it was found first.

The detailed explanations of the graphical LCD are as follows:
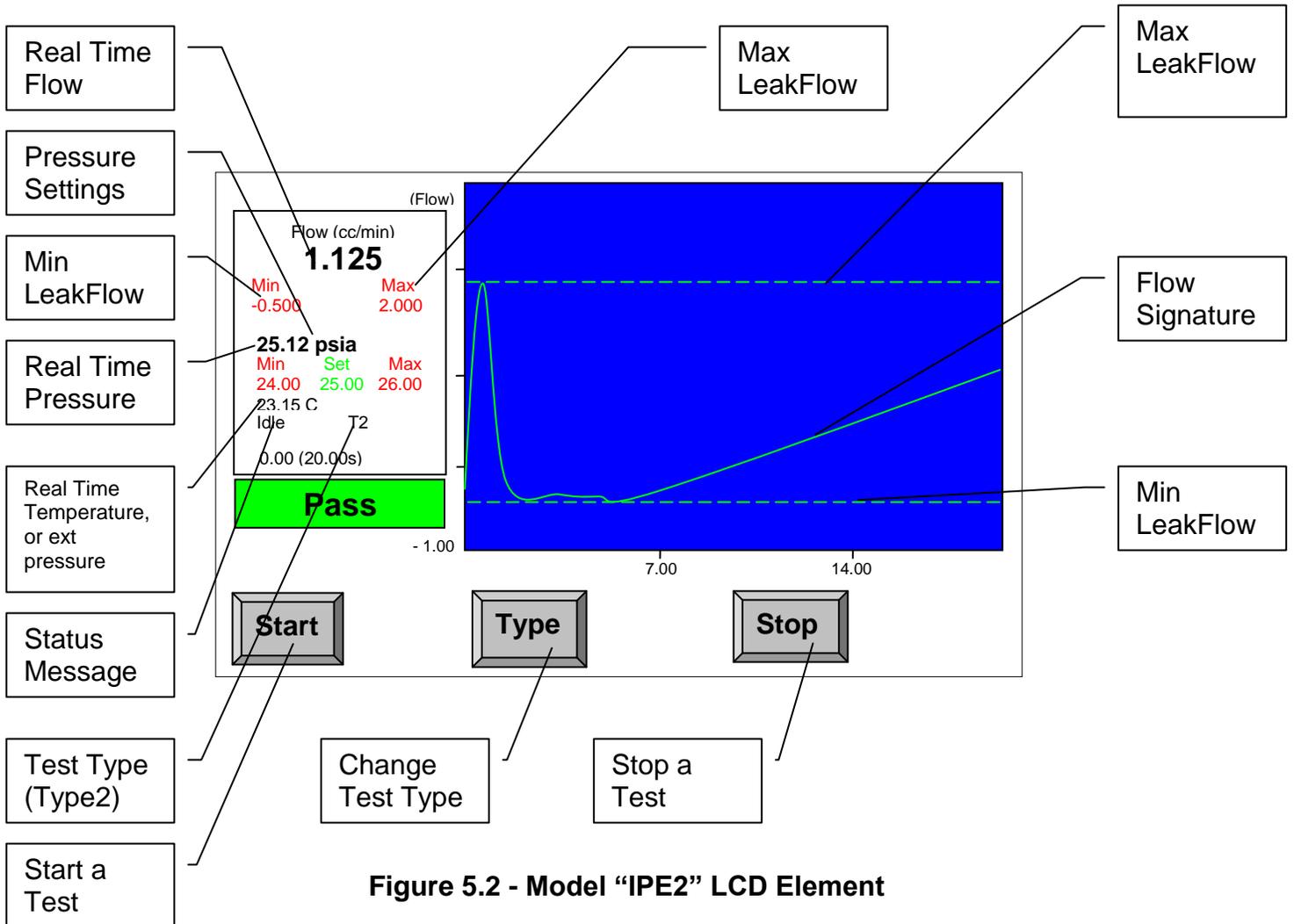
Figure 5.2 - Model "IPE2" LCD Element

6. COMMUNICATION Protocol

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

6.1 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 be 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
"oxFFFFFFFF" in version 2.0.0 or later, however, the data in the command ill be
treated as a decimal value unless there is a prefix "0x". For example, either of
the following command will change IGLS addressed as 1 to flow unit mg/min.
!01SU5;91 <lf><cr>
!01SU5;0x51<lf><cr>

6.2 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 6.3.

For Firmware 2.3.4 and greater, the 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 6.3.

SQ1;1	Command: !01SQ1;1
	Response: $01SQ1;Data1;Data2;Data3;StepNo
	Engineering Value and Step
	where
	if (X6<>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.

SQ1;2	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.

SQ1;3	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 μg/min

SQ1;4	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.

SQ1;5	Command: !01SQ1;5

	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 (4th analog input) in kPa Data5 refers to Adaptive flow in cc/min or μg/min
SQ1;6	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 (4th analog input) in digital count
SQ1;7	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 (4th analog input) in kPa Data5 refers to adaptive flow in cc/min or μg/min
SQ1;8	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 (4th analog input) in selected pressure unit Data5 refers to adaptive flow in selected flow unit
SQ2;1	Command: !01SQ2;1 Response: $01SQ2;1 Auto Zero to update C1
SQ2;2	Command: !01SQ2:2 Response: $01SQ2;2 **Auto Zero to update C5**
SQ2;3	Command: !01SQ2;3 Response: $01SQ2;3 **Auto Zero to update C1 and C5**
SQ3;0-3	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

	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.
RQ3	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 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.

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.

6.3 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
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
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 6.1 - 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.

7. Maintenance and Troubleshooting

7.1 Periodic Maintenance and Calibration

WARNING:

Only qualified and trained professionals should operate and maintain the Leak Test Instrument, Model IPE2.

WARNING:

The internal calibrated leak is an integral part of the Model IPE2.   Under no circumstances should it be opened or tampered with.

WARNING:

The Model IPE2 contains pressure. Make sure to deplete internal pressure before beginning any maintenance work that requires opening any internal components.

WARNING:

The Model IPE2 contains AC lines, power supply and valves. Disconnect the power cord from the power outlet before opening the model IPE2 rear door and during any electrical work.

WARNING:

The Model IPE2 should only be serviced by trained and authorized personnel. If for any reason the Model IPE2 needs to be opened for troubleshooting or service call ATC for authorization before opening.

7.1.1 Filter

The IGLS Model IPE2 is provided with an in-line filter. The filter is at the inlet of the IGLS. Periodically clean or replace the filter, as necessary. The exhaust valve (sometimes installed on the outside the leak test instrument) is supplied with an in-line filter. The filter must be periodically checked, replaced or cleaned. With Model ME, for vacuum applications, a filter is typically installed at the test port. Periodically check, clean, or replace this filter.

7.1.2 Periodic Calibration

The IGLS in the Model IPE2 is a measuring device. Periodic calibration, typically annually, by authorized personnel and standards is required. Refer to the Leak-Tek or GAS-CAL manuals for the instrument calibration procedures.

7.1.3 System performance Verification

The IGLS and Model IPE2 can be supplied with internal calibrated leak (optional), or equivalent channel standards (optional) that are calibrated at a certain pressure and flow. A valve isolates the orifice. This valve can be turned on and off by the calibration switch provided in the front panel. The verification orifice should not be used for instrument calibration, but system performance verification and diagnostic of a component failure (such as valves or a system leak). Follow the following procedure to verify the Model IPE2 performance:

1. Set the system pressure and allow it to stabilize.
2. Open the calibration valve and allow the flow to stabilize.
3. Record the IGLS readings and compare them to orifice flow calibration at that pressure.

NOTE:

When comparing to equivalent channel (EC) standard calibration data, compensation must be performed for different gases, pressure and temperature compared to the value recorded on the EC laminated tag, attached to the EC/verification orifice.

With a new, proven unit and system, (FIRST TIME AFTER INSTALLATION) set up one test and make sample tests (same test parameters). Establish the system verification flow tolerance. Recommended tolerance is +/- 3 times the standard deviation of the initial sample.

Periodic readings should be taken at the same test setup and compared to the flow verification tolerance. 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 test continuation.

7.2 Troubleshooting

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

No.	Description	Possible Cause	Repair Action
1	LCD doesn't light	Power supply 5 VDC not available Bad LCD or internal component	Check power supply Check D connector Measure 5 VDC and common Consult ATC
2	LCD Only Displays Partial Screen	The LCD momentarily lost power	Turn off and turn on the power supply. Click the two buttons Deactivate and Activate in the LeakTek Run Screen.
3	No communication with PC and data saving	Communication problem	Check 9-pin RS232 cable between Model IPE2 and PC Check PC COM port settings Check Model IPE2 address Power down the unit, wait 2 minutes before power up
4	Test will not start	Damaged wiring Bad control panel component	Check for damage to internal wiring Consult ATC
5	Valves not working	Damaged wiring Bad valves Bad control panel components	Check for damage to internal wiring Check valves; Consult ATC for replacement parts Consult ATC
6	Pressure controller does not get to zero, no control	No analog voltage output 12 VDC not available Defective pressure control	Check analog output voltage on rear panel connector Check for damage to internal wiring Power down the unit, wait 2 minutes before power up; Analog voltage output should be 0. If not, consult ATC. Check 12 VDC supply Check for defective pressure/flow controller

No.	Description	Possible Cause	Repair Action
7	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 Leak-Tek © program. Check pressure sensor calibration and verify proper calibration coefficients. Check for 12 VDC power supply In case of large reading offset, typically pressure sensor was over-pressurized. Contact ATC.
8	IGLS shift of flow	Wrong units of meas. Temperature variation IGLS tilted	Check set up and units. Check that sensor installed in a flat/horizontal position. Go to cal. screen and check A/D counts of Flow sensor. Tilt sensor to see if "zero" returns. Perform auto zero but only after consulting with ATC and if A/D counts are less than 200 counts for first Gen IGLS or 3000 for second Gen IGLS Consult ATC
9	IGLS flow reading High all the time, and between tests	Leakage down stream to the IGLS Fill valve not opening Pressure valve leakage IGLS zero shift or unit has moved	Isolate IGLS/model E by plugging the UUT outlet,check down stream fittings and tubing to the IGLS. Check/replace press, calibration and exhaust valve. 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 under 200.
10	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.	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

No.	Description	Possible Cause	Repair Action
		Unit clogged	outlet plugs and fittings Consult ATC for internal cleaning instructions. DO NOT AUTOZERO the flow sensor if flow or any A/D counts are "0"
11	IGLS Flow, pressure and temperature readings do not make sense	Calibration scrambled Power supply damaged	Verify power supply outputs Verify calibration data with original cal. sheet. Check/increase buffer size Check that unit reacts normally (pressure flow readings varies with flow) Recalibrate the unit
12	Can not 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 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.
13	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. Install one if missing!
14	IGLS Pressure or Flow readings unstable	Incorrect remote I/O connections. Unstable Power Supply Bad connection Upstream pressure fluctuation can not be damped enough by the expansion tank	Disconnect I/O connector, to isolate for test machine possible common-ground problems. Check power supply Check Model IPE2 or IGLS connections. Check internal IGLS connection Check upstream pressure, increase expansion tank size

			and add an isolation valve if required.
15	Inconsistent test performance – many parts fails, although verification passes	Pressure supply or pressure regulator is un-stable	Use Leak-Tek and monitor test pressure at end of test of consecutive test. Pressure should be stable within few hundreds of a psi for consecutive tests. If not, check the supply line, additional buffer tank may be required, check for "cross talk" between adjacent pressure regulators, check/replace the pressure regulator.
16	Low flow or Backflow failures	Improper test set up clamp/seals are moving during test, external leak into test cavity, or part volume is not stable during test	Low flow failure is a result of airflow from the unit under test into the expansion tank (back-flow) lower than min. allowed flow. A factory built in backflow safeguard for back flow (redundant to the min flow) will prevent the user to set up min. flow too low. If flow is under this value a "backflow failure" will occur. Re-verify that there is no upstream leak. Check for eternal leak into test cavity (e.g. from air actuated expandable seals). Make sure that part is stable and seals are not compressed during leak test, and volume does not "shrink" during the stability and test time. Allow for proper seal stops and part support to overcome such cases. Check your test set up and allow (for troubleshooting purpose) longer fill and stability time. Run test with Leak-Tek and monitor the signature.
17	LCD Screen is	Power surge,	Touch the right hand side of the

	corrupted	mishandling of the instrument	LCD screen to refresh the screen

Figure 7.2.1 - Troubleshooting

Appendix A - Calculation Algorithm

1. Density Calculation

$$D = \frac{P + Q*V_3}{G_1 *(T + 273.15)}$$

where
D Density of the gas in mg/cc
R Constant of the gas (For example, Air = 287)
T Temperature of the gas in degree C
Q Flow Measurement in cc/min.
V_3 Flow compensated Pressure Coefficient (See Appendix B)
Z   Gas Compressibility coefficients.

2. Volumetric Flow Calculation
The volumetric flow calculation is based on the polynomial coefficient and the differential pressure measurement. The IGLS or IGFS measure Volumetric Flow as follows

$$Q = (C_1 + C_2 x + C_3 x^2 + C_4 x^3)(1 + B_4 T + B_3 T^2)(1 + H_4 P + H_3 P^2)$$

where
x is the count reading from the DP Sensor.
Q is flow measurement in cc/min.
C_1, C_2, C_3, C_4 are Flow Coefficients. (See Appendix B)
B_3, B_4 are Temperature/Viscosity Compensation Flow Coefficients. (See Appendix B, default is "0")
H_3, H_4 are Pressure Compensation Flow Coefficients. (See Appendix B, default is "0")
T is temperature in Degree C.
P is pressure in kPa.

 3. Mass Flow
The mass flow calculation is based on the following formula:
$$dM/dt = Q*\rho$$

where
dM/dt is the mass flow in mg/cc
Q is the volumetric flow in cc/min.
ρ is the density in mg/cc.

3.a Mass Extracted:

$$M = \int_{t_0}^{t_{test}} \frac{dM}{dt} \bullet dt$$

Where
dM/dt is the mass flow in mg/cc
t_0: The starting time of the test step.
T_{test}: The ending time of the test step.

4. Temperature Calculation

$$T = B_2 + B_1 x$$

where
x is the count reading from the temperature sensor.
T is temperature in Degree C.
B_1, B_2 is Temperature Coefficients. (See Appendix B)

5. Pressure Calculation

$$P = H_2 + H_1 x$$

where
x is the count reading from the pressure sensor.
P is pressure in kPa.
H_1, H_2 is Pressure Coefficients. (See Appendix B)

APPENDIX B - 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.

B.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

B.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

B.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^2 or μg/min/count^2)
C4	float	Third-order Flow Coef(cc/min/count^3 count^2 or μg/min/count^2)
C5	float	Lo Offset Flow Coef(cc/min or μg/min)

C6	float	Lo First-order Flow Coef(cc/min/count or μg/min/count)
C7	float	Lo Second-order Flow Coef(cc/min/count^2 or μg/min/count^2)
C8	float	Lo Third-order Flow Coef(cc/min/count^3 or μg/min/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

B.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 V2 (1.2)
D4	float	Test Start Leak Window Min in multiplier of V2 (0.8)
D5	float	Alpha (Curve) (0-1)

B.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

B.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)

B.7 K Group

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

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 Higher Limit (kPa) for external pressure switch
KA	float	Pressure Lower Limit (kPa) for external pressure switch

B.8 L Group

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

B.9 M Group

Command	Type	Phase Valve Configuration
M1	long	This is not saved in the memory. M1;1 to Calibrate the LCD M1;2 to Activate the LCD M1.3 to Deactivate the LCD
M2	long	Pass Sound Period (x 10ms), Set 0 to disable
M3	long	Fail Sound Period (x 10ms), Set 0 to disable
M4	long	Stop Sound Period (x 10ms), Set 0 to disable
M5	long	Automatically Deactivate to Screen Saver The timer setting after Idle Condition(x 10ms), Set 0 to disable
M6	long	The setting is based on the combination of the following setting Alternative Location 0x100 Temperature Reading 0x08 Start Button 0x04 Type Button 0x02 Stop Button 0x01
M7	Long	Brightness (1-255)

B10 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

B.11 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.

B.12 S Group

Command	Type	Note

S1	String	Serial Number: Up to 14 characters are allowed to enter. For example:
		XX XX XXX XXX X XXX
		 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=mm3/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

B.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.

B.14 U-Group

Command	Type	Note
U1	Integer	Address 1-9

U2	Integer	Mode:
		4th Byte
		Sensor Type
		Conventional Leak Tester 0
		Adaptive Leak Tester 1
		Flow Controller 2
		Mass Extraction Method 3
		
		3rd Byte
		0x0 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 4th analog input
		
		2nd Byte
		0x <u>1</u> <u>1</u> <u>1</u> <u>1</u> <u>1 1 1 1</u>
		   5 4 3 2 1
		1:Valve Control
		   Standard 0x0 (Disable C1, X2, X3, XA)
		   Customized 0x1- 0xF
		2:Flow Calibration
		   One Set of Calibration 0
		   Two Set of Calibration 1

		3: Relative Measurement
		4: Digital Input Pulse/Level
		   Set to 1 if Level detection is desirable
		5: Vacuum Testing Message
		  1—Vacuum
		
		1st Byte
		
		Bit 0: Measurement Unit
		Mass Flow Base 1 μg/min as Base Unit
		Volume Flow Base 0 cc/min as Base Unit
		
		Bit 1: Gas Compensation
		   Gas Compensation 1
		    No Coef Compensation 0
		
		Bit 2: 3rd Test Type On
		
		Bit 3: 3rd and 4th Test Type On
		
		Example: 0x00(1st byte) 27(2nd byte) 00(3rd byte) 02(4th byte)

U3	Integer	Temperature Unit: 0-Degree C 1-Degree F
U4	Integer	Pressure Unit: Pressure Unit: 0- kPa-a 1-kg/cm2 2-psia 3-inHg 4-inH2O 5-psig 6-Torr 7- kPa-g 8- Bar-a
U5	Integer	Flow Unit: High Nibble 0 - cc 1 – mm3 2 -liter 3-gal 4 -gram 5 -mg 6- μg

		Lower Nibble 0 -sec 1 -min. 2 -hour 3-SCCM etc. 16*HighNibble+LowNibble Besides: 7*16+3-SCCM 8*16+3-SLM 9*16+3-SCFM 7*16+4 SCCSe-6
U6	Integer	0: One string of response to SQ1 command 1: two string of response to SQ1 command

U7	Integer	Baud Rate:
		   0, and else: 9600
		   2:19200
		   4:38400
		   12:115200
		<u>The Parameter will take effect after the power reset of</u>
		<u>the sensor</u>

U8	Integer	Hold Value Time in U8*10 ms
U9	Integer	Set U9 =0 to disable the some of the special features. 1) Disable Relative Measurement 2) Disable Mass Extraction Test 3) Disable Early Detection for Adaptive Test
UA	Integer	Start Cycle Counter. Cycle number can be shown on system and maintenance screens

B.15 V Group

Command	Type	Note
V1	float	Min. Flow Alarm for leak test mode in cc/min, μg/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, μg, or selected unit based on X6
V3	float	flow compensation to DP in kPa/(cc/min) or kPa/(μg/min)
V5	float	Min. Flow Alarm for Relative Measurement BaseLine Flow in cc/min, μg/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.

B.16 X Group

Command	Type	Note
X1	Integer	Pressure Switch On Check Step No Lowest Byte=Step No 2nd Lowest<>0, Advance to the next step once the PS is on (ver 2.1.1)
X2	Integer	Pressure Switch Off Check Step No Lowest Byte=Step No 2nd Lowest<>0, Advance to the next step once the PS is off (Ver 2.1.1)
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 µg/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 *(ver 2.1.2)* Lowest Byte=Step No 2nd Lowest<>0, The steps before and on LargeLeak will be set based on K5 and check against K6 and K7
XC	Integer	*Basic Check (ver2.2.0)* *Each bit of the integer representing the step in which the basic check shall be enforced.* *The Basic Check verifies the sensor is not saturated and pressure is not out of settings (P_{Hi} and P_{Lo}). "XC" Note:* *1. If XC was set such as 0xFF, the gross leak check will be disabled.* *2. Any basic step check after leak check step will be ignored!* *Example of setting:* *XC=0x06 In step 2 and step 3 the basic check will be enforced.*
XD	Integer	*External Pressure On Step No* Lowest Byte=Step No 2nd Lowest<>0, Advance to the next step once the external pressure is in range

XE	Integer	*External Pressure Off Step No* Lowest Byte=Step No *2nd Lowest<>0, Advance to the next step once the external pressure is out of range*

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

NOTE:

Commands implemented in 2.0.0 or later ONLY are in bold.

APPENDIX C - Specification Sheet

MODEL NUMBER:_____

S.N.:_____

SOFTWARE VERSION:_____

FLOW RATE: _____ CC/MIN. _____ LIT/MIN. (Fill One)
10% to 100% of volumetric flow range

FLOW MEASUREMENT UNCERTAINTY: +/- _____ % OF READING

PRESSURE RANGE: _____ PSIA

MAXIMUM PRESSURE: _____ PSIA

MAXIMUM PRESSURE DIFFERENTIAL   CONTINUOUS: _____ PSID

                                 STATIC: _____ PSID

PRESSURE MEASUREMENT UNCERTAINTY: +/- 0.2% OF FULL SCALE AT
OPERATING TEMPERATURE.

TEMPERATURE OPERATING RANGE: 10 - 45°C

TEMPERATURE MEASUREMENT UNCERTAINTY: +/- 0.5°C WHEN GAS
FLOW IS AT STEADY STATE OF CONDITION

NOTE:

All uncertainty statements are at a 95% confidence level, referenced to primary
standards traceable to NIST. Uncertainty statements comply with ANSI/NCSL
Z520-Z-1997 "US guide to the expression of uncertainty in measurement".

APPENDIX D - IGLS Application Setup Example

Large Volume Setup with Large Flow Example:

Description	Time (sec)	Parameter
Clamping Delay	1	T4=40
Fill Delay	200	T1=8000
Stability Delay	200	T2=8000
Test Delay	10	T3=400

Figure D.1 - Test Time Setting

Description	Setting	Parameter
Proportional	2000	P1=2000
Integral	400	P2=400
Differential	1	P3=1
Damping Coefficient	0.02	V4=0.02

Figure D.2 - PID Coefficient

Description	Enabled	Disable
Clamping Valve	X1=1	X1=0
Fill Valve	X2=1	X2=0
Pressure Valve	X3=1	X3=0
Deplete After Failure	X5=1	X5=0

Figure D.3 - Valve Setting

Description	Setting (kPa)	Parameters
Pressure Setting	200	K1=200
Pressure Upper Limit	210	K2=210
Pressure Lower Limit	190	K3=190
Pressure Control Offset	-1	K4=-1

Figure D.4 - Pressure Setting

Description	Setting (cc/min)	Parameters
Flow Min.	-1 (Disabled)	V1=-1
Flow Max.	1000	V2=1000

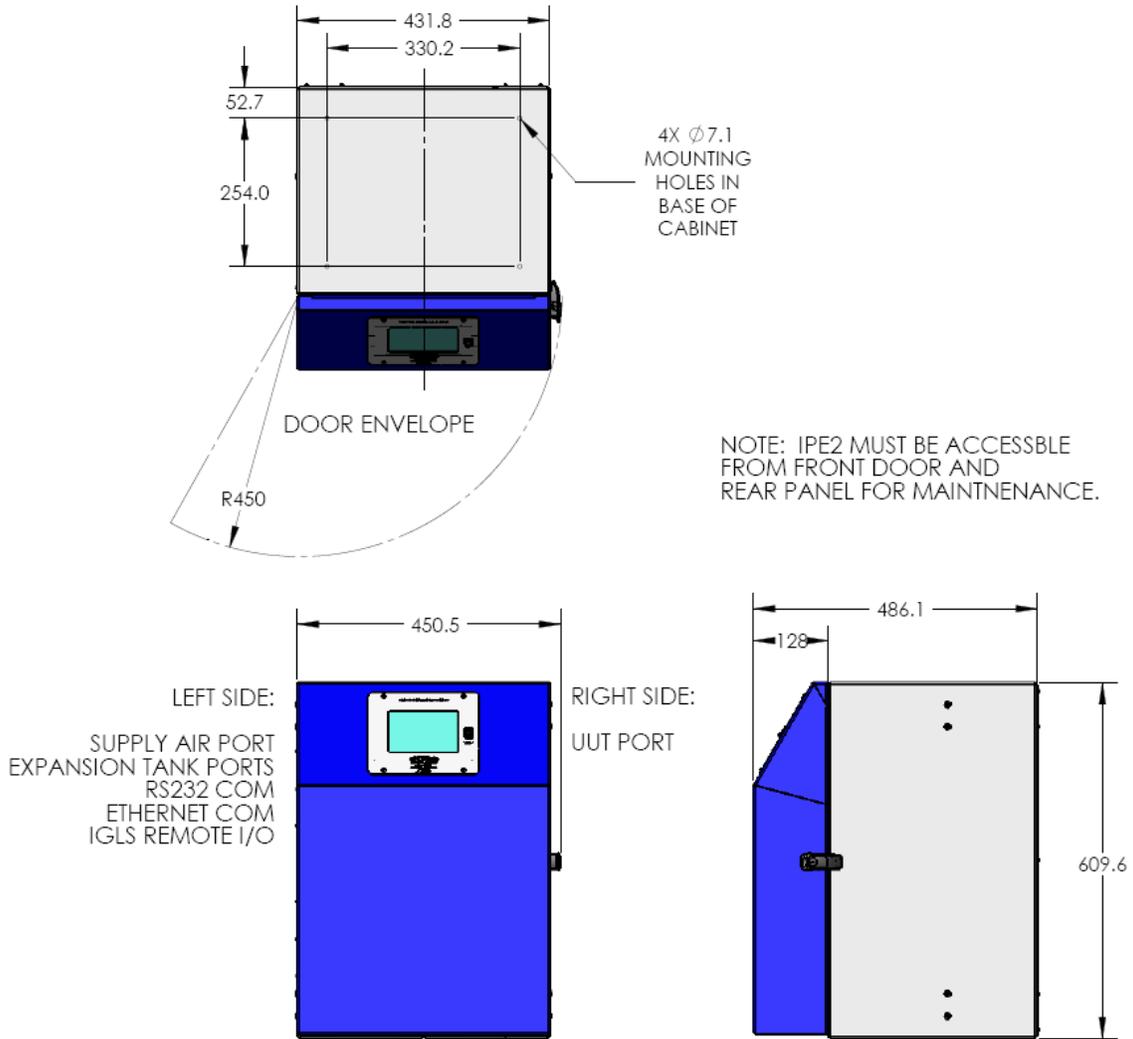**Figure D.5 - Flow Criteria**

Appendix E – IPE2 Dimensions

Figure E.1 – Dimensions of IPE2.

Note: Does not include fittings.