Programming and Operation Manual

Leak Test Instrument
Model E

Software Revision 2.21
Hardware Revision A, C
July 25, 2005
Manual Revision 2.00

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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:

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 while the test is on the operator should 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 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.
e.g. unit under test that is not dry and clean, and contains liquid or other particulates that can plug leak flow path which may pass the leak test but leak during actual usage.

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.

1. Introduction

This manual applies to the operation and maintenance of the Leak Test Instrument Model E incorporating 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 during (i.e. total mg) testing using the mass extraction concept. In addition, pressure control can be performed for the purpose of leak testing. The Intelligent Gas Leak Sensor (IGLS) has capabilities to control valve sequencing required for a complete stand-alone leak test.

The Model E implements the valves needed for most leak testing applications using the IGLS. Also included is an operator interface, which includes start, stop and test select buttons, pass, fail and testing indicator lights, and a large character LCD on a front panel that is easy to read and operate.

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 quick test time without sensitivity to unit under test volume.

A separate software (optional, not included with his product) Graphic 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 E includes a female 9-pin D-connector on the rear panel for connecting to a PC using a straight through RS-232 serial extension cable. Up to 9 IGLS and/or Model E units can be attached to a single RS-232 port.

Extensive programming commands allow the user to address any one of the connected sensors to configure the selected sensor, update the calibration data, and establish new test parameters.

The analog output is configured to 0-5V using an internal reference.

The IGLS can be configured to run two (2) types of tests without downloading new parameters for applications with more than one test type. Test type can be selected via the front panel controls, or remotely via the rear panel connections.

All remote or external controls (input and output) are available at the male 15-pin D connector and the 9 pin AMP circular connector both located on the rear panel of the Model E.

1.1 Principle of Operation

The Leak Test Instrument, Model E 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 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 unit under test, 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 unit under test 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 valves leakage, etc.

The Model E 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 faster and very repeatable leak test. For short cycle time, you can use the signature concept, as described in the Leak-Tek software manual

2. Function Configuration

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

1. Flow Sensor/Standard for precision measurement of mass or volume flow for calibration purposes. (The Intelligent Gas Flow Standard/Sensor or IGFS/IMFS)

2. Conventional Leak Test: Automated leak testing with or without automatic pressure control. (The Intelligent Gas Leak System, or IGLS)

3. Leak Testing using the mass extraction concept.

4. Flow Sensor with automatic flow control. (IGFS)

5. 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 Flow Measurement

When being used as a flow sensor/standard, the IGFS will continuously sample the signals from its pressure, flow, and temperature sensors. Then it calculates volume flow or mass flow based on calibration coefficients of sensors and test conditions. Analog output signal ranging from 0 V to 5 is sent out in proportion to the flow depending on setup parameters. Readings are available via an RS-232 serial communications interface.

Each IGFS/IGLS is calibrated by standards traceable to NIST. Three measurements of uncertainty ranges are available, from 10% to 100% of the sensor range, with 95% level of confidence. Setup parameters for specific gas types must be downloaded via the Leak-Tek program or Gas-Cal program or a regular MS Windows hyper-terminal.

Refer to the supplied specification sheet (Appendix B) for flow range, pressure and temperature ranges and specified accuracy.

2.2 Conventional Leak Test

When functioning as an conventional leak tester, the IGLS controls signals to the clamping valve, pressure valve, and fill valves to fill the unit under test (UUT) and allow stabilization.

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). The flow will be automatically shutdown if pass occurs. The re-test

function can be configured to allow a continuous test until the pass criteria are met. The test status is displayed on the LCD. Test pass/fail criteria, test time, and stabilization time are configurable via the RS-232 port using the Leak-Tek program or hyper-terminal.
Refer to Appendix C for application examples. If the multiple-test feature is purchased, it is possible to toggle between test type 1 and test type 2.

2.3 Mass Extraction Method Test

In some situations, the leak may not be constant, may vary significantly during the test, or the unit under test 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 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 onto the chamber and the Model-E is located between the vacuum source and the chamber.

2.4 Flow Measurement with Flow Control

The IGFS can be used as a precision flow sensor and controller. The IGFS measures flow and pressure, and uses its analog output channel to control the remote flow control valve. The analog output is configured to be 0-5 VDC. The flow setting can be either in volumetric or mass flow based on the flow unit selection. Consult ATC before doing this.

2.5 Adaptive Leak Test

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

3. Interface

3.1 MECHANICAL INTERFACE AND CONNECTION of the Model E:

WARNING:

If hazardous conditions and gasses result, consult ATC. The standard Model E 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 E 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 degrees Celsius. For a higher temperature range, consult ATC.

CAUTION:

Connections of instrument ports should be per the enclosed schematics. Support all bulkhead fittings with proper wrenches to hold those connections steady, and to avoid internal damage to the instrument. Follow Swagelock ® fitting assembly instructions. While assembling Model-E use two wrenches. Support bulk head fittings with proper backup wrench.

The Model E 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 pads bolts.

CAUTION:

The Model E need to be mounted Flat relative to the horizontal plane for the sensor to work properly.

NOTE:

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

The Model E controls an internal fill valve, an isolate valve, and a pressure/test valve, as well as an optional external exhaust valve, clamp/seal valve and/or electronic pressure controller. Solenoid valves are used for automatic control. A calibrated leak 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. Expansion tank should be 10 times larger than UUT volume, if possible. However, an expansion tank between the pressure regulator/controller and the Model E 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 E from the supply line during the measurement cycle (stability and test time).

The pressure supply to the Model E must be very stable. Air tools connected to the same line may cause shock wave that will affect pressure stability. If the Model E inlet pressure “drops” during the test, the flow will reverse, and the Model E will display zero flow which may cause measurement bias. During stability and test time, supply pressure shall be stable within 1 inch of water.

Optimize tubes/hoses/valves size to get desired test times.

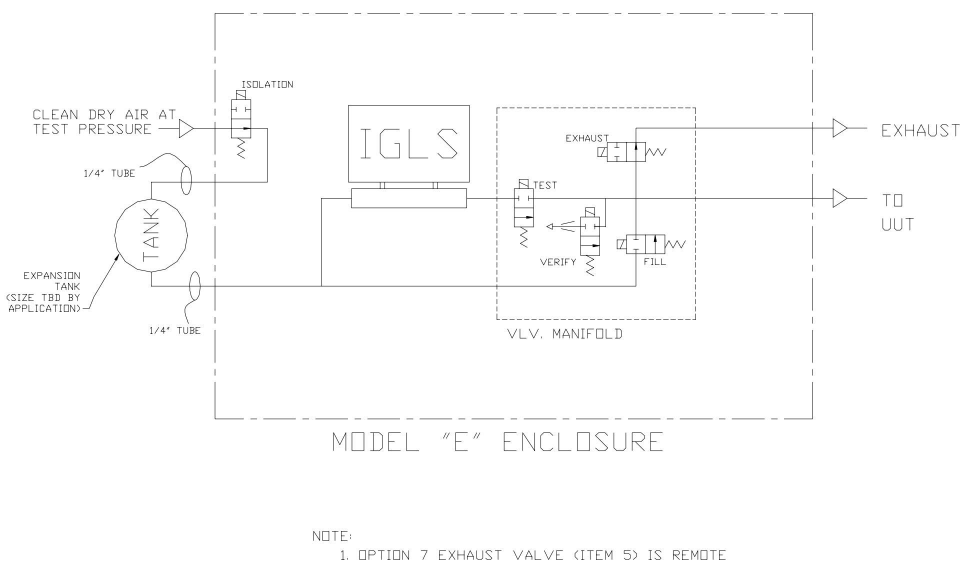


Figure 3.1.1 - Pneumatic Connection

NOTE:

For vacuum option, see DRAWINGS section for details.

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 spec. 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 E. 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.

Unit Under Test Port connection: this port is on the right hand side of the unit. Support the bulkhead fitting with 5/8” (3/4” for Vacuum) wrench when tightening the tube fitting (1/4” Swagelock ® tube fitting). Do not over-tight.

Supply Pressure and expansion tank connections: those connections are in the back of the instrument. Support the bulkhead fitting with 5/8” (3/4” for Vacuum) wrench when tightening the tube fitting (1/4” Swagelock ® tube fitting). Do not over-tighten.

3.2 ELECTRICAL INTERFACE AND CONNECTION:

The model E is supplied with a power cord for 115-VAC single-phase power. Connect it to an AC connector that complies with local electrical codes.

Specially ordered units may be capable of 220-VAC single-phase operation.

WARNING:

The Model E 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 E enclosure, the supplied power should be disconnected!

CAUTION:

Improper power wiring will cause permanent damage to the unit. Always observe hot and neutral polarities when connecting to AC power source. Never connect a 115-VAC unit to a 220-VAC source, or vice versa.

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:

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 remote I/O connectors located on the rear panel of the Model E are arranged as shown in Figures 3.2.1, 3.2.2, 3.2.3, & 3.2.4.

Pin	Function	Specifications
Pin 1	*Remote Exhaust Valve (POS)	12 VDC, 22W max. output
Pin 2	Verification Valve Switch	12 VDC, 500 mA (dry contact to +12V)
Pin 3	Failure Output	5-35 VDC, 20 mA
Pin 4	Stop Input	5 VDC, 20 mA (dry contact to +5V)
Pin 5	Blockage Failure Output	5-35 VDC, 20 mA
Pin 6	Start Input	5 VDC, 20 mA (dry contact to +5V)
Pin 7	Pass Output	5-35 VDC, 20 mA
Pin 8	Test Type Input	5 VDC, 20 mA (dry contact to +5V)
Pin 9	Fill Valve Output	5-35 VDC, 20 mA
Pin 10	Pressure Valve Output	5-35 VDC, 20 mA
Pin 11	Clamping Valve Output	5-35 VDC, 20 mA
Pin 12	+12 VDC Power (DO NOT use to power external devices! Use only for Verification switch.)	+12V
Pin 13	+5 VDC Power (DO NOT use to power external devices! Use only for Model E digital inputs.)	+5V
Pin 14	*Remote Exhaust Valve (NEG)	0 V
Pin 15	Ground/Common	0 V

Figure 3.2.1 – Rear Panel Standard Remote I/O Connections

* If other custom option purchased, see drawings section in back of this manual.

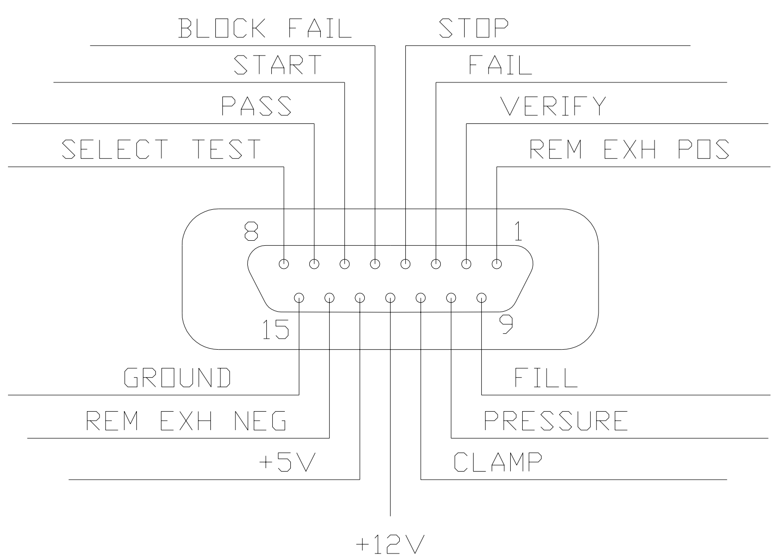


Figure 3.2.2 – Standard Remote I/O Pin Connector

Pin	Function	Specifications
Pin 1	Analog Output A	0-5 VDC
Pin 2	Analog Ground	0 V
Pin 3	Analog Output B	0-5 VDC
Pin 4	Quick Fill Valve Output	5-35 VDC, 20 mA
Pin 5	Isolate Valve Output	5-35 VDC, 20 mA
Pin 6	Custom2 Valve Output	5-35 VDC, 20 mA
Pin 7	Exhaust Valve Output	5-35 VDC, 20 mA
Pin 8	Test Type A Indicator Output	5-35 VDC, 20 mA
Pin 9	Test Type B Indicator Output	5-35 VDC, 20 mA

Figure 3.2.3 – Rear Panel Auxiliary Remote I/O Connections

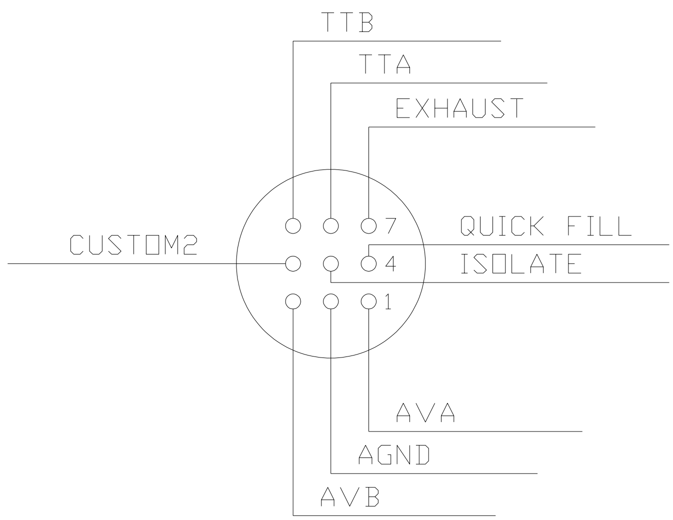


Figure 3.2.4 – Auxiliary Remote I/O Pin Connector

Condition	Description	Pin out	Signal
Pass	The test met all criteria set in the set up screen	Pin 7	Pin Goes Low (0 VDC)
Gross leak Fail	When pressure is below the min pressure setting	Pin 3	Pin Goes Low (0 VDC)
No Pres Fail	Pressure switch not turned on in time.	Pin 3	Pin Goes Low (0 VDC)
Blockage Fail	Pressure switch not turned off at the end of the test during deplete time	Pin 3, Pin 5	Pin Goes Low (0 VDC)
Large Leak Fail	The Flow is more than the large leak setting	Pin 3	Pin Goes Low (0 VDC)
Hi Flow Relative Measurement Fail	Relative Measurement Base Line Flow larger than the set point	Pin 3	Pin Goes Low (0 VDC)
Lo Flow Relative Measurement Fail	Relative Measurement Base Line Flow Lower than the set point	Pin 3	Pin Goes Low (0 VDC)
Fine Leak Fail	Flow is above the maximum flow limit setting	Pin 3	Pin Goes Low (0 VDC)
Low Flow Fail	Flow is below the minimum flow limit setting	Pin 3	Pin Goes Low (0 VDC)
Back Flow/Sys pass	The Flow Sensor Detected the Flow in Opposite Direction or System leak check failure	Pin 3	Pin Goes Low (0 VDC)
Over pressure	The Pressure Is Larger Than The Max Pressure Setting	Pin 3	Pin Goes Low (0 VDC)
Flow Saturation	Exceeding Flow Sensor Limit	Pin 3	Pin Goes Low (0 VDC)
Pressure saturation	Exceeding press Sensor Limit	Pin 3	Pin Goes Low (0 VDC)
Temperature saturation	Exceeding temperature Sensor Limit	Pin 3	Pin Goes Low (0 VDC)

Figure 3.2.5 – List of Pass and Failure Mode With Pin outs

Up to 9 Model E instruments can be connected in a serial loop. A typical serial loop connection with two instruments is shown in Figure 3.2.6.

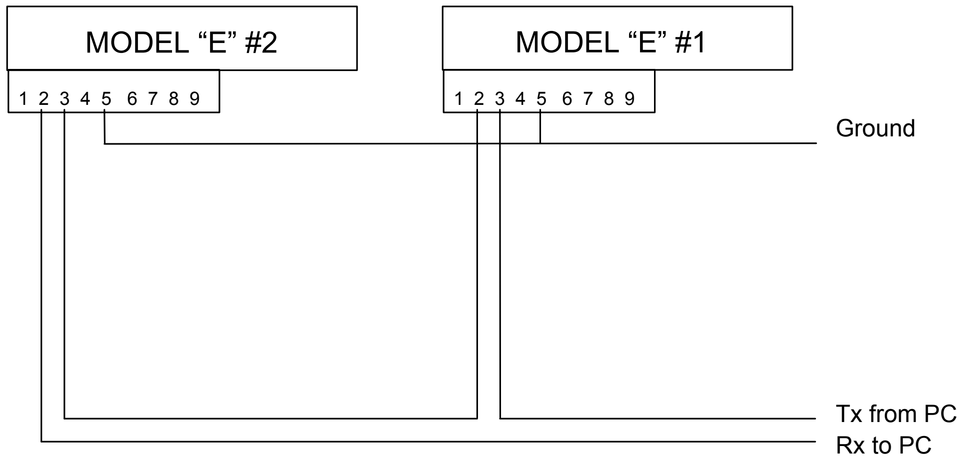


Figure 3.2.6 - Serial Loop Connection of two Model E Instruments

In Figure 3.2.7, the electrical schematic diagram shows the digital I/O connection with RS232 cable connector for the multiple test type option.

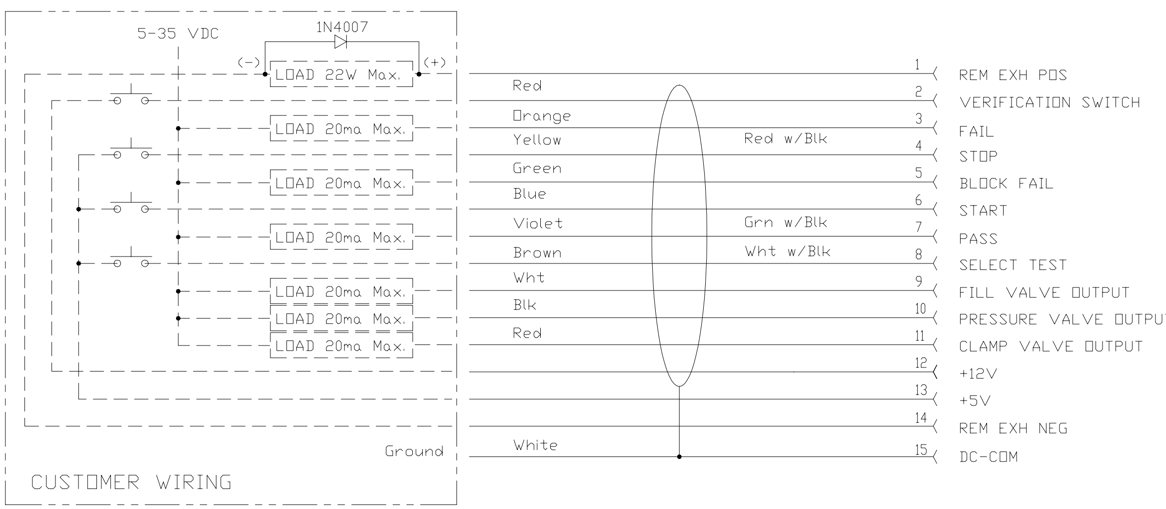


Figure 3.2.7 - Example for Multiple Test Type & Remote Verification Switch

NOTE:

The test select input must go from low to high in order to change the test type.

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

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

3.3 Guideline For Fixture Design and Pneumatic Interface

The following are recommendations regarding fixture design and pneumatic interface.

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.

- Pneumatic connections:

Use stainless steel Swagelock® type of connections for applications involving pressure or mild vacuum. Use VCO or VCR fittings for low leak flow rates to minimize virtual leaks.
Use proper tubing that is properly rated to the pressure. Do not use tubes that can change volume during test. Flexible tubes should be hard nylon or Teflon type.
Do not use "push-in" pneumatic connectors that are common for pneumatic controls.
Eliminate as much as possible, or do not use pipe thread type of connections.
Design the pneumatic system to minimize or eliminate contamination from the unit under test from getting into the leak tester. This contamination will cause valve leaks. However, using filter will slow cycle time. If tested parts are highly contaminated, use the remote exhaust valve option with the leak testers (ordered at the time of leak tester order). The remote exhaust valve offers easy access for service, and eliminates the need to deplete pressure through the leak tester.

Upstream pressure fluctuations from pneumatic actuators and/or assembly tools are un-desired, as they will effect precision pressure regulator and cause pressure/flow fluctuations that are not controllable. Therefore: a separate air supply line is required, if common supply is used- a large expansion tank is required. Air must be clean (10 micron filter) and dry (descent dryer) to protect the valves, and to assure that a pin-hole leak is not masked up.

Two regulators, especially precision one, back to back will experience pressure ripple. Therefore, a volume must exist between to adjacent pressure regulator. Include an expansion tank or use two separate feed lines.

Guideline for mechanical fixture design:

- Assure that all safety aspects are per code and in place, during the fixture design, build and application. Assure 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.
- Seal mechanism should fit the application. For low leak rate applications, O-ring seal design approach can 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.
- Sealing material should fit the application. For high wear applications, polyurethane and natural rubber can be considered.
- Expandable seals must be properly designed. 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!
- 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. The larger the volume the slower a given leak flow will develop.

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!

3.4 Guideline for setting up Model E leak tester

1. Un-pack the Model E and make sure the unit is good condition with the proper caps and ferrules.
2. Power Model E and check reading. The temperature and pressure should read closed to ambient.
3. Connect expansion tank per schematic.
4. Connect pressure source and pressurized unit to test pressure, allow 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 hi or low flow observed check all up stream and down stream connections for leaks.
6. Run test with the internal calibrated leak open. The reading should be close to the orifice value as indicated in the tag at the back of the Model E.
7. Procure multiple non leaking parts
8. Connect PC or Laptop to the Model E 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 the 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 –ve 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 need to exhausted at the end of the test.

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.

3.5 Verification Procedure

A periodic verification is recommended during the normal operation of the Model E. Run test with a known good part and the internal calibrated leak open. This should fail the test. Run a similar good part with out the internal calibrated leak and this should pass the test. If this sequence does not give the desired results, the system and/or parts should be checked or verified, and the procedure repeated until the desired result is obtained.

CAUTION:

A test time should be more than 1 sec and the buffer size 4-30. Consult the Leak-Tek © software manual for information on how to set these variables.

4. IGLS-Model E Operation Sequence

The Model E leak test will run based on the sequence below after the “start” button is pressed on the front panel.

The IGLS/IGFS/IMFS (version 02.00.00 or later) has one dedicated analog output to represent the real-time flow measurement. The other analog output can be used as pressure control or flow control depending on the sensor type.

A typical IGLS 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:

A test time should be more than 1 sec and the buffer size 4-30.

1. 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.

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) The Model E need to be stopped manually by pressing the stop button

2. If the “stop” button is pressed at any time during the test process, the test will be stopped with all valves back to standby state and the analog output at zero.
3. To switch to the other test type, press the “test select” button or pulse the “remote test select” digital input.

NOTE:

If a PC is attached to the Model E with “Leak-Tek program©” running the Pass/Fail will be displayed in the Leak-Tek program © run screen; however the Pass/Fail decision is made by the Model E.

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. For high-speed applications, and especially low flow, the Model E 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.
3. 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.
4. 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. Control Panel

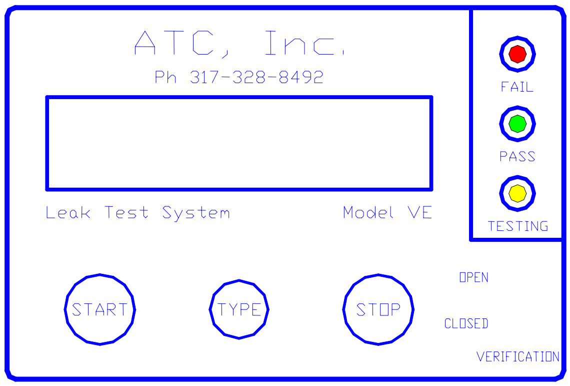


Figure 5.1 - Model "E" Control Panel

The Model "E" control panel is shown in Figure 5.1. A 2 line x 20 characters LCD shows 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.) Also provided are pushbuttons to START and STOP a test, or toggle the test TYPE (for units with dual test option). When depressing momentarily the TYPE button the display will show the number "2" on the top right hand corner, for test no. 2. When depressing one more time, the number "2" will disappear, meaning that the IGLS is on test no. 1.
The verification switch opens or closes the calibrated leak valve to initiate flow through the calibrated leak. Three LED indicators inform the operator of the leak test status: TESTING in process, PASS test, or FAIL test. All controls and indicators are clearly labeled on the control panel overlay.

Figure 5.2 shows the various messages possible on the LCD. Descriptions are below:

Diagram 1: Displays the pressure and flow reading in flow measurement, together with engineering unit in normal condition.

Diagram 2: 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.

Diagram 3: Displays the pressure and flow reading with the step status in the process of the test. The IGLS is filling gas.

Diagram 4: Displays the pressure and flow reading with the step status in the process of the test. The IGLS is stabilizing the flow for testing.

Diagram 5: Displays the pressure and flow reading with the step status in the process of the test. The IGLS is in test step.

Diagram 6: Displays the pressure and flow reading with pass message after the test passed.

Diagram 7: Displays the pressure and flow reading with stop message, if the test is intentionally stopped manually.

Diagram 8: Displays the pressure and flow reading with failure message if the test fails. The reason for failure is shown on the LCD. The following failure reasons/messages exist:

GrossLeak During test time, pressure is under min. allowable set pressure (K3) or Pressure Switch not turned on in time

No-Pres Pressure Switch not turned on in time (Version 2.0.0 or later)

OverPres During test time, pressure exceeds maximum allowable set pressure (K2).

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

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

LCD Display Examples are as follows

LCD Display	Description
1.234 20.03 cc/min psia	Pressure and Flow Reading in Normal Condition
1.234 20.03 OpenFillPres	Opening Pressure Valve and Fill Valve
1.234 20.03 Filling	Filling the Unit Under Test (UUT)
1.234 20.03 Stab Delay	Stabilizing the Flow
1.234 20.03 Pass	Test Passed
1.234 20.03 Stop	Test Intentionally Stopped (Manually)
1.234 20.03 Fail:GrossLeak	The Pressure Is Lower Than The Min Pressure Setting or Pressure Switch is not on in filling step
1.234 20.03 Fail:OverPres	The Pressure Is Larger Than The Max Pressure Setting
1.234 20.03 Fail:PresSat	Exceeding Pressure Sensor Limit
1.234 20.03 Fail:FineLeak	The Leak Is Larger Than Max Allowed
1.234 20.03 Fail:FlowSat	Exceeding Flow Sensor Limit
1.234 20.03 Fail:LowFlow	The Leak Is Lower Than Min Allowed

1.234 20.03 Fail:BackFlow	The Flow Sensor Detected the Flow in Opposite Direction
1.234 20.03 Fail:TempSat	Exceeding Temperature Sensor Limit
1.234 20.03 Fail:Blockage	Pressure Switch not turn off in Deplete Time
1.234 20.03 Fail:HiFlow RM	Relative Measurement –Baseline Flow larger than V6
1.234 20.03 Fail:HiFlow_RM	Relative Measurement –Baseline Flow smaller than V5
1.234 20.03 cc/min cc	Test Step for Mass Extraction Test
1.234 1.345 cc/min cc/min	Test Step for Adaptive Test
1.234 20.03 Fail:LargeLeak	The Measured Flow Is Larger Than Large Leak set in V7 at Large Leak Step.

Figure 5.2 - LCD Display Examples

If the valve control sequence is customized, some of the LCD displays might be slightly different from the diagram above in words. However, all 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 failure were found in the test. It will report fine leak failure because it was found first.

6. RS-232 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 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 (X5<>0) then Data1 refer 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.
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;1 or 0	Command: !01SQ1;1 to Set the Parameter to Type 2 Command: !01SQ1;0 to Set the Parameter to Type 1 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 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 traction 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 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 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 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
0, 30,100	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	
17	Pass – Relative Measurement	
21	Pressure Sensor Saturated Failure	
22	Flow Sensor Saturated Failure	
23	Temperature Sensor Saturated Failure	
24	Gross leak Failure (Pressure Lower than K3 or K7) or Pressure Switch not turn on in time	
25	Fine Leak Failure (Flow larger than V2)	
26	Low Flow Failure (Flow Lower than V1)	
27	Over Pressure Failure (Pressure larger than K2 or K6)	
28	Backflow Failure (Flow sensor smaller than A3)	
29	Blockage Failure –Pressure Switch not turn off in deplete time (T6)	
2B	Relative Measurement Baseline Flow Too High	
2C	Relative Measurement Baseline Flow Too Low	
2D	Large Leak Check Failure (Flow larger than V7 at Large Leak check Step)	

Figure 6.1 - Step Number Interpretation

The Step number in DAQ response string shall be interpreted as 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 step in the test. The customized step number shall be C(12) steps. And D(13) will be reported in the DAQ response string the stop step if the user push the stops button during the test. Step number between 10 to 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 professional should operate and maintain the Leak Test Instrument, Model E.

WARNING:

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

WARNING:

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

WARNING:

The Model E contains AC lines, power supply and valves. Disconnect the power cord from the power outlet before removing the model E cover and during any electrical work.

WARNING:

The Model E should be only service by trained and authorized personal. If for any reason the Model E needs to be opened for troubleshooting or service, call ATC first for authorization.

7.1.1 Filter

The IGLS Model E is provided with an in-line filter. The filter is at the inlet of the IGLS. Periodically clean or replace the filter, as necessary. Consult ATC.

7.1.2 Periodic Calibration

The IGLS in Model E 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. Consult ATC.

7.1.3 System performance Verification

The IGLS Model E can be supplied with an internal calibrated leak (optional), or equivalent channel standards (optional) that are calibrated at 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 shall not be used for instrument calibration, but system performance verification and diagnostic of a component failure (such as valve or a system leak). Follow the following procedure to verify the Model E performance:

- Set the system pressure and allow it to stabilize.
- Open the calibration valve and allow the flow to stabilize.
- 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.

- With a new and proven unit and system, (FIRST TIME AFTER INSTALLATION) set up one test and make sample of 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 set up 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	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
3	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
4	Valves not working	Valves are not enable Damaged wiring Bad valves Bad control panel components Bad remote I/O connection.	Checked valve matrix and make sure they are enable. 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
5	Pressure controller does not get to zero, no control	No analog voltage output	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.

		12 VDC not available Defective pressure control	Check 12 VDC supply Check for defective pressure/flow controller

No.	Description	Possible Cause	Repair Action
6	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, verify proper calibration coefficients. Check for 12 VDC power supply In case of large reading offset, typically pressure sensor was over-pressurized. Contact ATC.
7	IGLS shift of flow	Wrong units of meas. Temperature variation IGLS tilted	Check set up and units Go to configuration screen, check A/D counts of Flow sensor. Tilt sensor to see if "zero" returns. See Auto zero procedure Press must be stable in stand by mode. Consult ATC.
8	IGLS flow reading High all the time, and in stand by mode.	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. Go through initial setup procedure 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.
9	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	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

No.	Description	Possible Cause	Repair Action
		pressure-pressure drops down. Unit clogged	Check for leaks at the IGLS outlet plugs and fittings Consult ATC for internal cleaning instructions. DO NOT AUTO ZERO the flow sensor if flow or any A/D counts are “0”
10	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 (Less than 30) Check that unit reacts normally (pressure flow readings varies with flow) Recalibrate the unit
11	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 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.
12	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!

13	IGLS Pressure or Flow readings unstable	Upstream pressure fluctuation can not be damped enough by the expansion tank Incorrect remote I/O connections. Unstable Power Supply Bad connection	Check Model E or IGLS 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 - 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
G_1 Constant of the gas (For example, Air = 287)
P Pressure Measurement in Pa
T Temperature of the gas in degree C
Q Flow Measurement in cc/min.
V_3 Flow compensated Pressure Coefficient (See Appendix B)

2. Volumetric Flow Calculation
If Two Set of Calibration is disabled, then One Set of Calibration is used.
Base Unit Flow is calculated as follows:

$$F = C_1 + C_2 * x + C_3 * x^2 + C_4 * x^3$$

Where
x: The average count of flow sensor
F: Base Unit flow in cc/min or μg/min

Two Set of Calibration
All C Group (C1-CA) are Enabled

Count	α	Range
<65535*(C_9-C_A)/100	1	Low Range
>65535*(C_9+C_A)/100	0	Normal Range
65535*(C_9-C_A)/100< <65535*(C_9+C_A)/100	α=(65535*(C_9+C_A)/100-x)/(65535*2* C_A)/100)	Transient Area Between Low and Normal range

Base Unit Flow is calculated as follows:

$$F = (1-\alpha) * (C_1 + C_2 * x + C_3 * x^2 + C_4 * x^3) + \alpha * (C_5 + C_6 * x + C_7 * x^2 + C_8 * x^3)$$

Where
x: The average count of flow sensor
F: Base Unit flow in cc/min or μg/min

If any of H3, H4, B3, H4 is non-zero, then

$$F_{comp} = F * [\ (1 + H_4 * (P - H_5) + H_3 * (P - H_5)^2\ ] * [\ (1 + B_4 * (T - B_5) + B_3 * (T - B_5)^2\ ]$$

Where:
F_{comp}: Compensated flow
P: Pressure sensor reading
T: Temperature Sensor Reading

Note:
If gas compensation is enabled, then a multiplier needs to be there before the base unit flow is obtained. See the IGLS manual for details.

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 Degree 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 Degree C, base flow unit or kPa.

B.1 A Group

Command	Type	Note
A1	float	An alog 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 degree C**
G3	**float**	**Viscosity change per degree 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**

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

B.8 L Group

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

B.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**

B.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.

B.11 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 or L = LPM 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 s 020000 for version 2.0.0**

B.12 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.13 U-Group

Command	Type	Note
U1	Integer	Address 1-9
U2	Integer	**Mode:** **4th Byte** (i) Sensor Type **Conventional Leak Tester 0** **Adaptive Leak Tester 1**

		Flow Controller 2 **Mass Extraction Method 3** **3rd Byte** **2nd Byte** **0x1 1 1 1 1 1 1 1** **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 **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
U3	Integer	Temperature Unit: 0-Degree C 1-Degree F
U4	Integer	Pressure Unit: Pressure Unit: 0- kPa 1-kg/cm2 2-psia 3-inHg 4-inH2O 5-psig 6-Torr
U5	Integer	Flow Unit: High Nibble 0 - cc 1 - cf 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** **The Parameter will take effect after the power reset of the sensor**
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**

B.14 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.15 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 step3 the basic check will be enforced.

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
Pre Fill Delay	4	T7 = 160
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

Figure D.2 - PID Coefficient

Description	Enabled	Disable
Deplete After Failure	X5=1	X5=0

Figure D.3 - Valve Setting

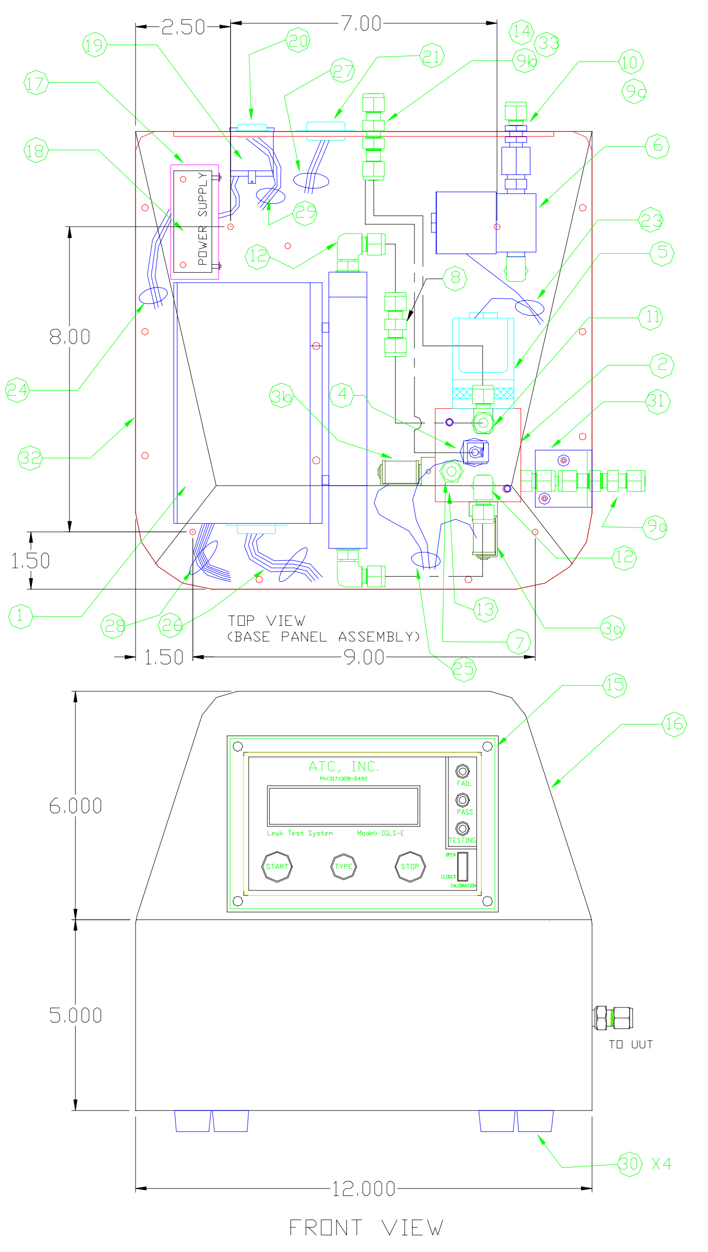
Description	Setting(kPa)	Parameters
Pressure Setting	200	K1=200
Pressure Upper Limit	210	K2=210
Pressure Lower Limit	190	K3=190

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 – MODEL E ASSEMBLY DRAWING



No.	Qty	Description
1	1	IGLS
2	1	VLV MANIFOLD BLOCK
3a	1	12VDC NC VALVE PRESS
3b	1	12VDC NC VALVE CALI.
4	1	12VDC NO EXH VLV
5	1	110AC 1/2-20 NC FILL VLV
6	1	110AC 1/4 NPT NO ISO VLV
7	1	ECD
8	1	10u IN-LINE FILTER
9a	1	1/4"B HEAD UUT PORT
9b	1	1/4" B HEAD INLET
9c	1	1/4"B HEAD EXP. TANK
10	1	1/4"T 1/4"MNPT B'HEAD ISO VLV(SWG)
11	1	7/16-20SAE 1/4"RUN T(SWG)
12	3	7/16-20 SAE 1/4" ELBOW
13	1	5/16-24SAE 1/4 MALE CALI
14	1	1/4 TUBE 1/4NPTF B'HEAD EXH PORT
15	1	FRONT PANEL ASSEMBLY
16	1	MOLD COVER
17	1	POWER SUPPLY BKT
18	1	POWER SUPPLY
19	1	INLET, AC+FUSE ASSM.
20	1	9-PIN D-CONNECT
21	1	15 PIN D-CONNECT
22	1	CABLE ASS'M AC POWER
23	1	CABLE ASS'M AC VALVE
24	1	CABLE ASS'M DC POWER
25	1	CABLE ASS'M DC VALVE
26	1	CABL ASS'M IGLS I/O
27	1	CABLE ASS'M REMOTE I/O
28	1	CABLE ASS'M LCD
29	1	CABLE ASS'M RS-232
30	4	RUBBER FEET
31	1	UUT BRACKET
32	1	BASE PANEL
33	1	EXHAUST MUFFLER
34	1	7/16-20 SAE TO 1/4 TUBE MALE ADAPTER

VACUUM OPTION

2	1	VALV MANIFOLD BLOCK VAC.
5	1	110AC 1/2-20 NC FILL VLV
6	1	110AC 3/8 NPT NO ISO VLV
9a	1	3/8"B HEAD UUT PORT
9b	1	3/8" B HEAD INLET
9c	1	3/8"B HEAD EXP. TANK
10	1	3/8"T 3/8"MNPT B'HEAD ISO VLV(SWG)
11	1	9/16-18SAE 3/8"RUN T(SWG)
34	1	9/16-18 SAE TO 3/8 TUBE MALE ADAPTER

TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS ± 1/64
2 PLACES DECIMAL ± .01
3 PLACE DECIMAL ± .005
4 PLACES DECIMAL ± .0005
ANGULAR ± 1 DEG.

STAMP PART NO. ON ALL PARTS
DO NOT SCALE DRAWING
BREAK ALL SHARP CORNERS

TOLERANCES FOR UNDERLINED DIMENSIONS
FRACTION ± 1/8
.00" ± .06"
.000" ± .030"

NOTE: CONFIDENTIAL, THIS DRAWING CONTAINS PROPRIETARY INFORMATION BELONGING TO ATC. THIS INFORMATION SHALL NOT BE DISCLOSED WITHOUT WRITTEN CONSENT FROM ATC.

REV	INTL	DATE	COMMENTS	REV	INTL	DATE	COMMENTS				
X	X	X	X	X	X	X	X	MODIFIED BY: XX	SCALE: NONE	DRAWN BY: RG	TITLE: MODEL E ASSEMBLY
X	X	X	X	X	X	X	X	APPROVED BY: XX	SIZE: A	DATE: 21 JAN 2003	CUSTOMER: ATC
X	X	X	X	X	X	X	X	DATE XX	REVISION 2.0	SHEET 1 OF 1	DRAWING NO: RD16-M0000

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