Programming and Operation Manual

Leak Test Instrument
Model E

Software Revision 1.911
Hardware Revision-A,C
March 10, 2003
Manual Revision 1.3

READ THIS FIRST

THROUGHOUT THIS MANUAL YOU WILL SEE INSERTED INTO THE TEXT, THREE KINDS OF IMPORTANT INFORMATION. EACH IS SIGNIFICANT. YOU MUST BE SURE TO READ FULLY AND UNDERSTAND EACH OF THESE NOTIFICATIONS. THEY ARE:

WARNING

WARNINGS PROVIDE INFORMATION ABOUT CONDITIONS CONCERNING YOUR PERSONAL SAFETY AND THE SAFETY OF OTHERS.

CAUTION

CAUTIONS PROVIDE INFORMATION ABOUT CONDITIONS CONCERNING POSSIBLE DAMAGE TO EQUIPMENT.

NOTE

NOTES PROVIDE IMPORTANT OPERATION INFORMATION THAT IS REQUIRED FOR OPERATION OF THE SYSTEM.

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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.

71. 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 an integrated pressure, temperature, and accelerated laminar low flow gas sensor. 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 or flow control can be performed for the purpose of mass flow control or 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 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 other 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 can be configured to 0-5V if the internal reference voltage is selected. It can also be modified to 0 to V_{ref} if the external reference is selected. (Consult ATC, Inc. for this option).

The IGLS can be configured to run two (2) types of tests without downloading new parameters (IGLS Version 1.432 or later) for applications with more than one test type. Test type can be selected from the front panel controls, or remotely via the rear panel connections.

All remote or external controls (input or output) are available at the female 15-pin D-connector on the rear panel of the Model E.

1.1 Principal of operation

The Leak Test Instrument, Model E 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 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 measure 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 sensor, capable 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.
When performing tests at low absolute pressure, or deeper vacuum (e.g., under 15 KPa absolute pressure) the material transfer mechanism varies. For those applications ATC's Mass Extraction Instrumentation 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's standard Leak Test Instrument.
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

2.1 Leak Test

When functioning as an automatic leak tester, the IGLS controls signals to the clamping valve, pressure valve, and bypass (fill) valves to fill the unit under test (UUT) and allow stabilization. By jumper setting, the IGLS can be configured with an analog output of 0-5 VDC (factory default), or a reference output (provided by the user), with a maximum of 9 VDC if this option is requested. (Consult ATC, Inc. for optional analog output up to 12V.)

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 shutdown the flow 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, as well as the red (fail) and green (pass) indicator lights. Test pass/fail criteria, test time, and stabilization time are configurable via the RS-232 port using the ATC Leak-Tek program or Windows® Hyper Terminal.
Refer to Appendix D for application examples. If the multiple test feature is purchased it is possible to toggle between test type 1 and test type 2 using the front panel button or by supplying a control signal to the rear panel D-connector.

The bleed option will help to avoid a backflow situation due to the large volume of the UUT or downstream pressure changes due to the temperature effect.

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 can not 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. (U9 shall be set to 1 to enable the mass extraction method. This feature is available on IGLS software version 1.50 or higher.)

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 flow output and input ports need to be reversed with the flow direction, and the IGLS will measure the total mass as well as flow extracted out from the chamber.

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 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 0 to 50 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.

The Model E can be mounted on a bench top, as it 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.

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, isolate valve, and pressure valve, as well as an optional external clamp/seal 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. Expansion tank should be 5-10 time 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. If necessary, select pneumatic connection "option 2" to separate fill from test ports, if the UUT has multiple inlets.

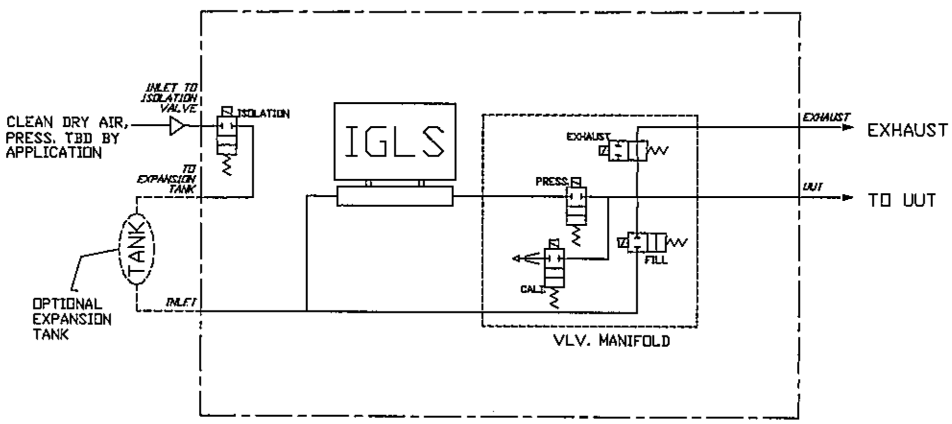


Figure 3.1.1 - Pneumatic Connection

NOTE:
For vacuum option see DRAWINGS section for detail.

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" 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 3/4" wrench when tightening the tube fitting (1/4" Swagelock ® tube fitting). Do not over-tight.

3.2 ELECTRICAL INTERFACE AND CONNECTION:

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!

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.

CAUTION:
Improper power wiring will cause permanent damage to the unit. The reference voltage input (Pin 8) should be a maximum of 9 VDC if the external reference voltage option is requested. (Consult ATC, Inc. for optional analog output up to 12V.)

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 male 15-pin D-connector located on the rear panel of the Model E is arranged as shown in Figures 3.2.1 & 3.2.2.

Pin	Function	Specifications
Pin 1	* Option	See DRAWINGS section for details
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	Clamping Valve Output, Bleed Valve Option, or 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	Analog Output (unavailable with integrated pressure switch option)	0-5 VDC
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	* Option	See DRAWINGS section for details
Pin 15	Ground/Common	0 V

Figure 3.2.1 - Rear Panel Remote I/O Connections

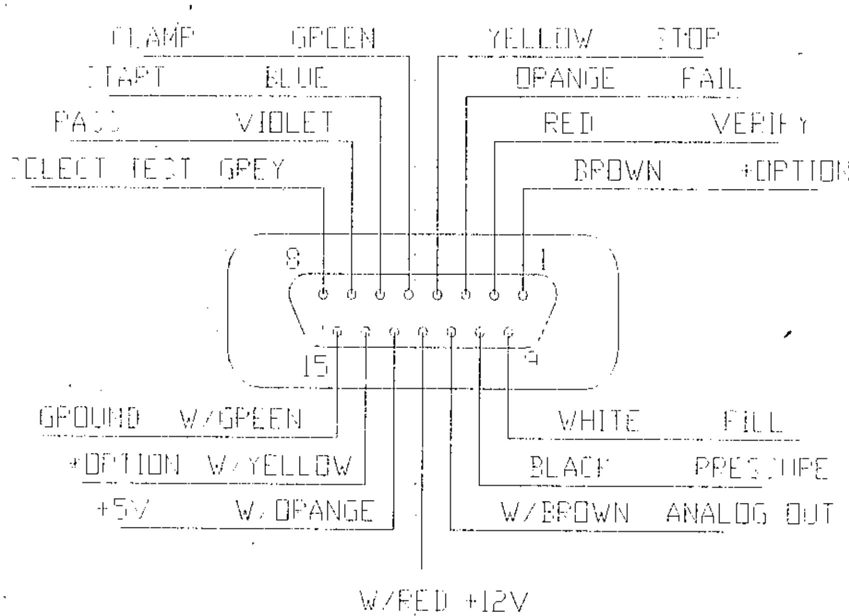


Figure 3.2.2 - Pin Connector

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 3.2.3.

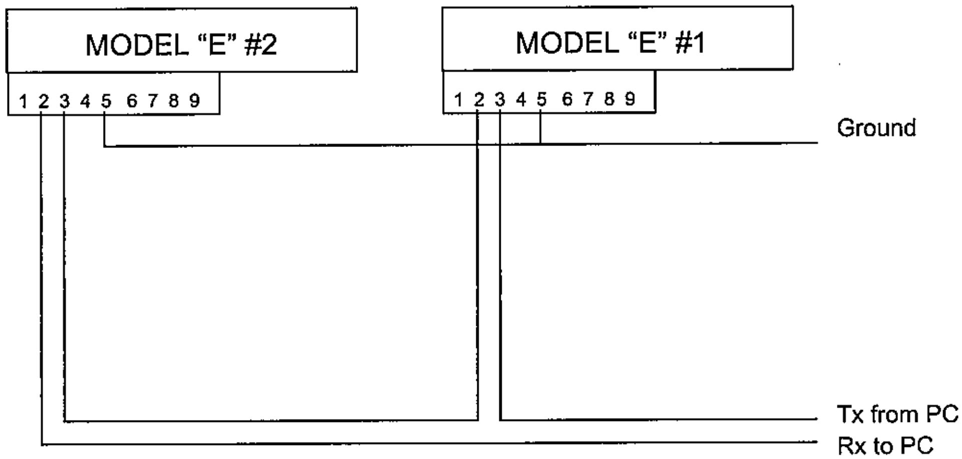


Figure 3.2.3 - Serial Loop Connection of two Model E Instruments

The clamp valve pin will be replaced by the bleed valve pin output if the bleed valve option is purchased.

In Figure 3.2.4 the electrical schematic diagram shows the digital I/O connection with RS232 cable connector for the multiple test type option.

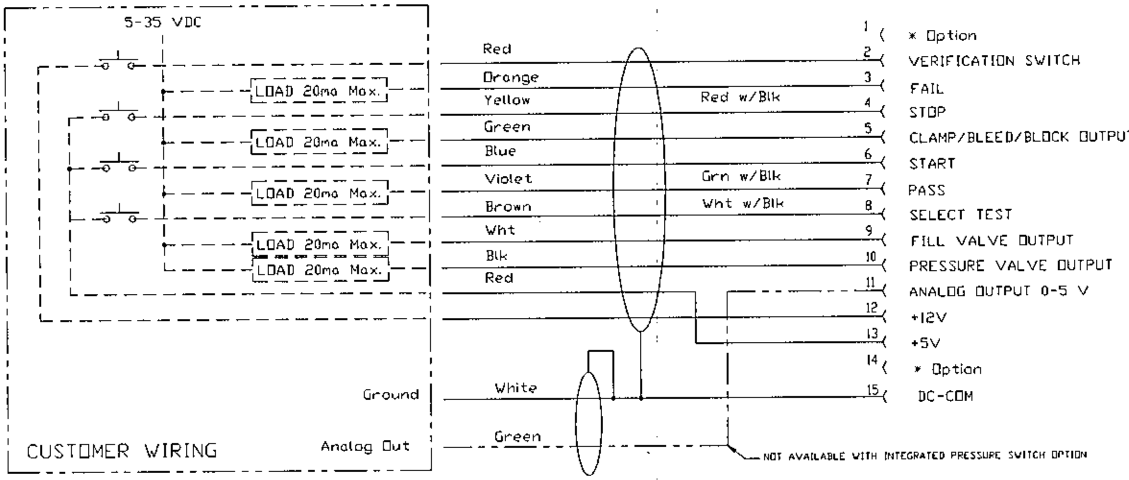


Figure 3.2.4 - Example for Multiple Test Type & Remote Verification Switch

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.

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.

Model E Leak Test Sequence:

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 clamping time delay, the pressure valve is opened. Fill valve and isolation valve (if used) is enabled, and opened to pressurize the UUT (Unit Under Test).
3. After filling valve time delay, valve fill and isolation valves are closed.
   If the deplete time is set to other than zero, the pressure switch is checked to verify it is turned on in the time specified in deplete time (T6) during the filling process.
   Note:
   The feature will be bypassed if the deplete time is set to a value longer than filling time.
4. After stability time expires, the leak test starts. Stability time can be as short as 0.025 seconds for Mass Extraction applications.
5. Test times follows the stability (no valve action between stability and test steps. During test time the flow and pressure readings are compared to the set up values in the IGLS/IGFS and a pass or fail decision is made.
6. 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)
   d. If the deplete time is set to other than zero, the pressure switch is checked to verify it is turned off in the time specified as deplete time (T6) during the depleting process.
7. If the “stop” button is pressed at any time during the test process, the test will be stopped with all valves closed and the analog output at zero.
8. To switch to the other test type, press the “test select” button or pulse the “remote test select” digital input.

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.
2. When a large volume is used with a large flow Model E, 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.
3. 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.
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. Control Panel

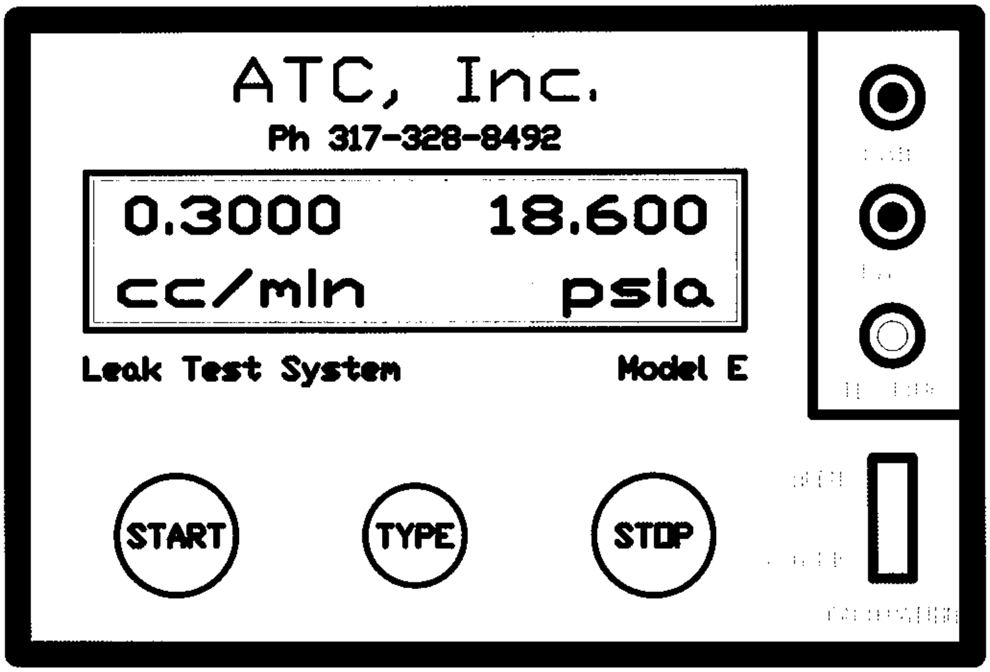


Figure 5.1 - Model "E" Control Panel

The Model "E" control panel is shown in Figure 5.1. A 2 line x 20 character 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 calibration switch opens or closes the verification orifice valve to initiate flow through the calibrated orifice. 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 stop message, if the test is intentionally stopped manually.

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

Diagram 7: Displays the pressure and flow reading with failure message if the test fails. GrossLeak - During test time, pressure is under min. allowable set pressure (K_3) or pressure switch not turned on in filling process.

Diagram 8: Displays the pressure and flow reading with failure message if the test fails. OverPres - During test time, pressure exceeds maximum allowable set pressure (K_2).

Diagram 9: Displays the pressure and flow reading with failure message if the test fails. PresSat - Pressure exceeds its full range. Deplete pressure immediately!

Diagram 10: Displays the pressure and flow reading with failure message if the test fails. FineLeak - During Test, flow is larger the maximum allowed flow (V_2). Or the accumulated flow during the test period is larger than the allowed leak (V_2)

Diagram 11: Displays the pressure and flow reading with failure message if the test fails. DPSat - Flow exceeds maximum sensor's flow range.

Diagram 12: Displays the pressure and flow reading with failure message if the test fails. LowFlow - During test, flow is lower than min. allowed flow rate (V_1).

Diagram 13: Displays the pressure and flow reading with failure message if the test fails. BackFlow - During test, flow is detected in the opposite direction.

Diagram 14: Displays the pressure and flow reading with failure message if the test fails. TempSat - Temperature exceeds maximum limit.

Diagram 15: Displays the total mass and flow reading, together with engineering unit in Mass Extraction Mode.

Diagram 16: Displays the pressure and flow result with the step status in the process of the depleting. The UUT is depleting gas.

Diagram 17: Display Blockage Failure - pressure switch not turned off in depleting process.

1.234 20.03 cc/min psia	1: Pressure and Flow Reading in Normal Condition
1.234 20.03 OpenFillPres	2: Opening Pressure Valve and Fill Valve
1.234 20.03 Filling	3: Filling the Unit Under Test (UUT)
1.234 20.03 Stab Delay	4: Stabilizing the Flow
1.234 20.03 Stop	5: Test Intentionally Stopped (Manually)
1.234 20.03 Pass	6: Test Passed
1.234 20.03 Fail:GrossLeak	7: The Pressure Is Lower Than The Min Pressure Setting **or Pressure switch not turned on in filling**
1.234 20.03 Fail:OverPres	8: The Pressure Is Larger Than The Max Pressure Setting
1.234 20.03 Fail:PresSat	9: Exceeding Pressure Sensor Limit
1.234 20.03 Fail:FineLeak	10: The Leak Is Larger Than Max Allowed
1.234 20.03 Fail:DPSat	11: Exceeding Flow Sensor Limit
1.234 20.03 Fail:LowFlow	12: The Leak Is Lower Than Min Allowed
1.234 20.03 Fail:BackFlow	13: The Flow Sensor Detected the Flow in Opposite Direction
1.234 20.03Fail:TempSat	14: Exceeding Temperature Sensor Limit
1.234 20.03 cc/min cc	15: The Sensor Is In Mass Extraction Mode
1.235 20.03 Depleting	**16: The UUT is depleting**
1.236 20.03 Fail:Blockage	**17. Blockage Failure - Pressure switch not turned off in depleting process**

Figure 5.2 - LCD Display Examples

6. RS-232 Protocol

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

The RS-232 commands are as follows:

1. Conventional Commands

Read Command Format:
"!0" + ADDRESS + "R" + Command
Response Format:
"$0"+ ADDRESS +"R" + Command; Data

Save Command Format:
"!0" + ADDRESS + "S" + Command; Data
Response Format:
"$0"+ ADDRESS + "S" + Command; Data

Where:
ADDRESS is valid from 0 to 9. (The first sensor will respond to 0)
DATA is the number to be saved or read.
For a list of commands, see Section 2 of Appendix B.

Example: to change to the Auto Test Mode for IGLS addressed as 2, the command string will be as follows:
!02SU2;1

2. Additional Commands:

Inquiry RS232 Output

Description	*Command*	*Response*
Inquiry Reading	!00SQ1;1	First string :$00SQ1;1 (No this string if U6=0) SecondString: $00SQ1;Data1;Data2;Data3;step
Inquiry Counts	!00SQ1;2	First string: $00SQ1;1 (No this string if U6=0) SecondString: $00SQ2;Count1;Count2;Count3;step
Auto Zero Flow	!00SQ2;1	$00SQ2;1
Inquiry Test Type to Run	!00RQ3;1	$00SQ3;1 (The number after the semicolon in the response is the test type)
Set Test Type to Configure	!00SQ3;1	Don't Care (The number after the semicolon in the command is the test type will be configured)

Where
if (X5<>0) then
Data1 or Count1 refer to temperature in Degree C or digital count.
Data2 or Count2 refer to pressure in kPa or digital count.
Data3 or Count3 refer to flow in cc/min or digital count.

Otherwise
Data1 or Count1 refer to temperature in the selected temperature unit or digital count.
Data2 or Count2 refer to pressure in the selected pressure unit or digital count.
Data3 or Count3 refer to flow in the selected flow unit or digital count.

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.

3. Interpretation of step number:

Step	Status
0, 30,100	Standby
1	Open Clamping Valve
2	Open pressure and Fill Valve
3	Filling
4	Stability
5	Test
6,7	Close all valves
8	Stop
9	**Depleting**
10 to 19	Pass
21	Pressure Sensor Saturated Failure
22	Flow Sensor Saturated Failure
23	Temperature Sensor Saturated Failure
24	Gross leak Failure (Pressure Lower than K3) or **Pressure Switch not turned on in time (T6)**
25	Fine Leak Failure (Flow larger than V2)
26	Low Flow Failure (Flow Lower than V1)
27	Over Pressure Failure (Pressure larger than K2)
28	Backflow Failure (Diff Pres smaller than A3)
29	**Blockage Failure -Pressure Switch not turned off in deplete time(T6)**

Figure 6.1 - Step Number Interpretation

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 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.

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.

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.

7.1.3 System performance Verification

The IGLS Model E can be supplied with verification flow orifices (optional), or virtual leak 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 reading and compare them to orifice flow calibration at that pressure.

Note:
When comparing to orifice 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	check for damage to internal wiring Consult ATC
4	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
5	LCD displays foreign characters	LCD controller corrupted	- Power down the unit, wait 2 minutes before power up - Check for nearby RF/EMI emissions - Check for proper shielding on all external cables - Check for noisy AC line power
6	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;

		  12 VDC not available Defective pressure control	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	IGLS shift of flow	Wrong units of meas. Temperature variation IGLS tilted	-Check set up and units -Go to cal. screen, check A/D counts of DP sensor. Tilt sensor to see if "zero" returns. - Perform auto zero but only if A/D counts are less than 200 counts. - Consult ATC
8	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 persists, plug the IGLS outlet, check A/D counts and compare to original calibration. Autozero 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 pressure-pressure drops down. Unit clogged	-Check/replace inlet filter -Check supply pressure - Isolate and check fill/by-pass lines -Check leakage through fill valve. -Check for expansion tank or isolation valve leak. - Verify calibration coefficients - Check for leaks at the IGLS outlet plugs and fittings - Consult ATC for internal cleaning instructions.
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 - Check that unit reacts normally

			(pressure flow readings varies with flow) - Recalibrate the unit
11	IGLS Pressure or Flow readings unstable	-Unstable Power Supply -Bad connection -Upstream pressure fluctuation can not be damped enough by the expansion tank	-Check power supply -Check Model E or IGLS connections. -Check internal IGLS connection -Check upstream pressure, increase expansion tank size and add an isolation valve if required.

Figure 7.2.1 - Troubleshooting

Appendix A - Calculation Algorithm

1. Density Calculation

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

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 Degree C, cc/min or kPa if applicable.
2. Density is in the unit of mg/cc.
3. Time is in the unit of 25 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.
   In leak test mode, the flow criteria are the selected unit.
   If X6 is set to other than 0,
   RS232 data acquisition response is in the Degree C, cc/min or kPa.
   In leak test mode, the flow criteria are cc/min.

Command	Type	Note
U1	8-bit int	Address: Valid From 0 to 9
U2	8-bit int	Mode: 0 Manual Test Mode 1 Auto Test Mode 2 Flow Control mode 3 Measurement Mode 4 Calibration
U3	8-bit int	Temperature Unit: 0-Degree C 1-Degree F
U4	8-bit int	Pressure Unit: 0- kPa 1-kg/cm2 2-psia 3-inHG 4-inH20 5-psig
U5	8-bit int	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
U7	8-bit int	The test result will hold if set to other than zero The LCD will be disabled if U7=2 and measurement mode is selected
U8	8-bit int	The number of cycle to hold after the test (1-100)
U9	8-bit int	Mass Extraction Methods is enabled if set to other than zero
U6	8-bit int	0: One string of response to SQ1 command 1: two string of response to SQ1 command
X4	8-bit int	Buffer Size: Valid from 4 to 100
X6	8-bit int	Default unit is used if X6 <>0, Flow in cc/min, pressure in kPa, and temperature in Degree C
S1	char	Serial Number: Up to 8 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

Figure B.1 - Configuration Control

Command	Type	Note
G1	float	Universal Constant of the Gas: Necessary if mass flow unit is selected
G2	*float*	*Viscosity at 0 degree C. currently not implemented*

G3	*float*	*Viscosity change per degree C. currently not implemented*
G4	float	Density of the gas at standard barometric condition in mg/cc

Figure B.2 - Gas Information

Command	Type	Note
C1	float	Offset Flow Coef(cc/min.)
C2	float	First-order Flow Coef(cc/min./count)
C3	float	Second-order Flow Coef(cc/min./count^2)
C4	float	Third-order Flow Coef(cc/min./count^3)
B3	*float*	*Temperature Compensation Flow Coef, 0 is used currently*
B4	*float*	*Temperature Compensation Flow Coef, 0 is used currently*
H3	*float*	*Pressure Compensation Flow Coef, 0 is used currently*
H4	*float*	*Pressure Compensation Flow Coef, 0 is used currently*
Temperature		
B1	float	Temperature Calibration Slope(C/Count)
B2	float	Temperature Calibration Offset(C)
Pressure		
H1	float	Pressure Calibration Slope(kPa/count)
H2	float	Pressure Calibration Offset(kPa)
V3	float	Flow compensation to DP in kPa/(cc/min.)

Figure B.3 - Calibration Data

Command	Type	Note
T1	16-bit int	Filling delay time in 25 ms
T2	16-bit int	Stability delay time in 25 ms
T3	16-bit int	Test time in 25 ms
T4	16-bit int	Clamping delay time in 25 ms
T5	16-bit int	Bleed time in 25 ms after filling is done
T6	16-bit int	Deplete Time in 25 ms after the test is done

Figure B.4 - Test Timing Settings

Command	Type	Note
A1	float	Analog Output Full scale corresponding flow in selected flow unit.
A2	float	Coef of D/A calibration, depending on the reference voltage as well as the max. pressure of the proportional air valve. Count/kPa
A3	float	Backflow if count reading in DP is less than A3
A4	float	Barometric condition of the pressure in kPa

Figure B.5 - Analog Output Settings

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.
V1	float	Min. Flow Alarm for leak test mode in cc/min or selected unit based on X6. Disabled for mass extraction method.
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 or selected unit based on X6
V4	float	PID Coef Multiplier after filling is done
K1	float	Pressure Setting for Leak Test mode (kPa)
K2	float	Pressure Upper Limit(kPa)
K3	float	Pressure Lower Limit(kPa)
K4	float	Pressure Under Control in filling stage(kPa)

Figure B.6 - Control Parameters

Command	Type	Note
X1	8-bit int	Enable Flag: Clamping Valve
X2	8-bit int	Enable Flag: Filling Valve
X3	8-bit int	Enable Flag: Pressure Valve
X5	8-bit int	Enable Flag: Deplete the pressure after the test failure
X9	8-bit int	Enable Flag: of the initialize the DAC pressure output based on the pressure setting

Figure B.7 - Valve Control

Note:
Rule is not implemented in Microprocessor if information is in Italics.

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: 0 - 50°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

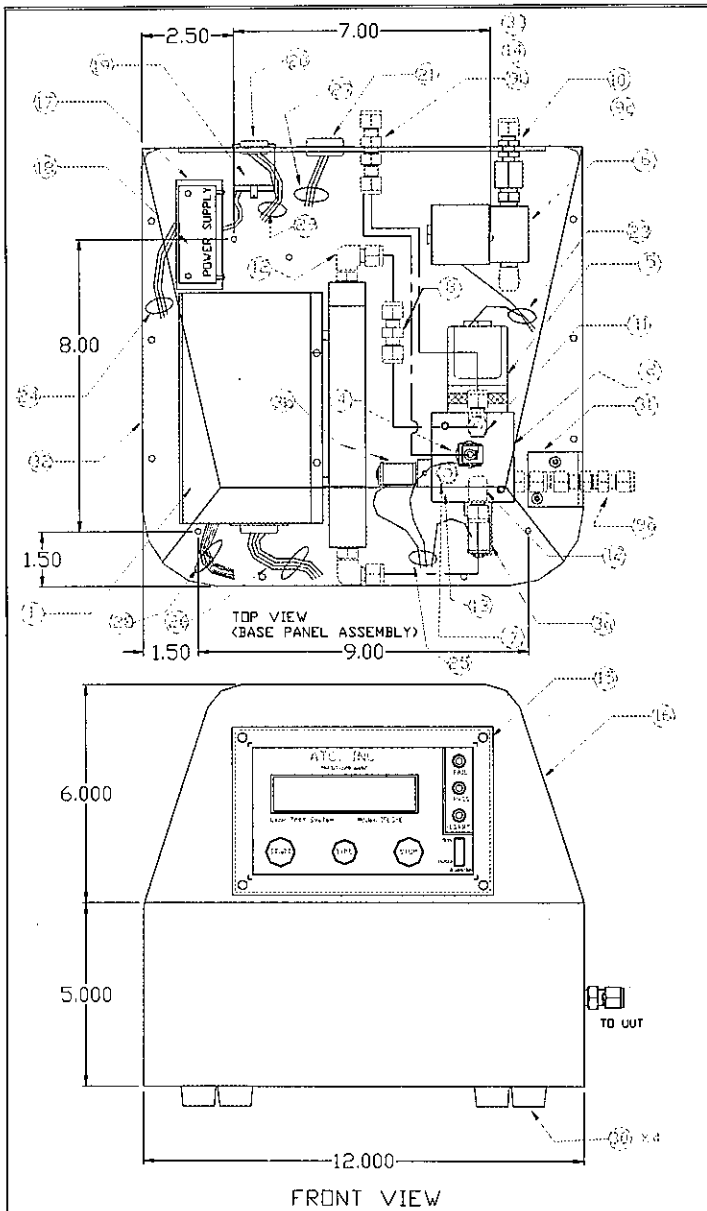
Description	Setting(kPa)	Parameters
Pressure Setting	200	K1=200
Pressure Upper Limit	210	K2=210
Pressure Lower Limit	190	K3=190
Pressure Control Offset	-1	K4=-1

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 – 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	10u ORIFICE
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'N 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

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
X	X	X	X	X	X	X	X
X	X	X	X	X	X	X	X

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

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