



Model 644  
**Automated Mass Airflow Test Stand**

Dimensions: 70" H x 60" W x 24" D  
 1778mm H x 1524mm W x 610mm D

## **GAS TURBINE AND JET ENGINE COMPONENT TESTING**

### **Mass Airflow Test Stand**

### **PRODUCT REQUIREMENTS**

Multiple manufacturers in the Aerospace industry required Airflow Test Stands to calculate Mass Airflow and test equations. Flow test sequences, called "circuits," can automatically flow air with multiple test steps and various airflow equations (such as specialized reduced airflow measurements). CCDI was first in the industry to offer such test equations, and has continued to do so for over 30 years.

### **A VERSATILE SOLUTION**

CCDI has been developing Airflow Test Stands since 1976 and automated units since 1986. The years of experience resulted in a refined design of a product that considers the fast-paced nature of the industry. CCDI continues to satisfy customers by adding new test requirements from various turbine manufacturers. Some specifications come from ABB/Alstom Power and related, UTC P&W, P&W Canada, GE Aircraft, GE Power, Honeywell, Allison, Rolls-Royce, Solar Turbines, Snecma, and Siemens.

### **FEATURES**

- Accuracy: +/- 1% Standard
- Repeatability: +/- 0.25% Standard
- Simple WYSIWYG Windows Based Software
- Multiple Manufacturers Test Specs and Formulas, automatic correction
- Nine Nozzle design with ability to combine nozzle brings maximum measuring range
- Internal air volume reduction for fast production and realistic testing time
- Circuit Switching, pressure control and acceptance, fully automatic
- EDI feature for piping data to network systems
- Four Configurations Available: 644 Low, 644 Medium, 644 High, 644 XH



**644WorkView**  
Detail Station Area

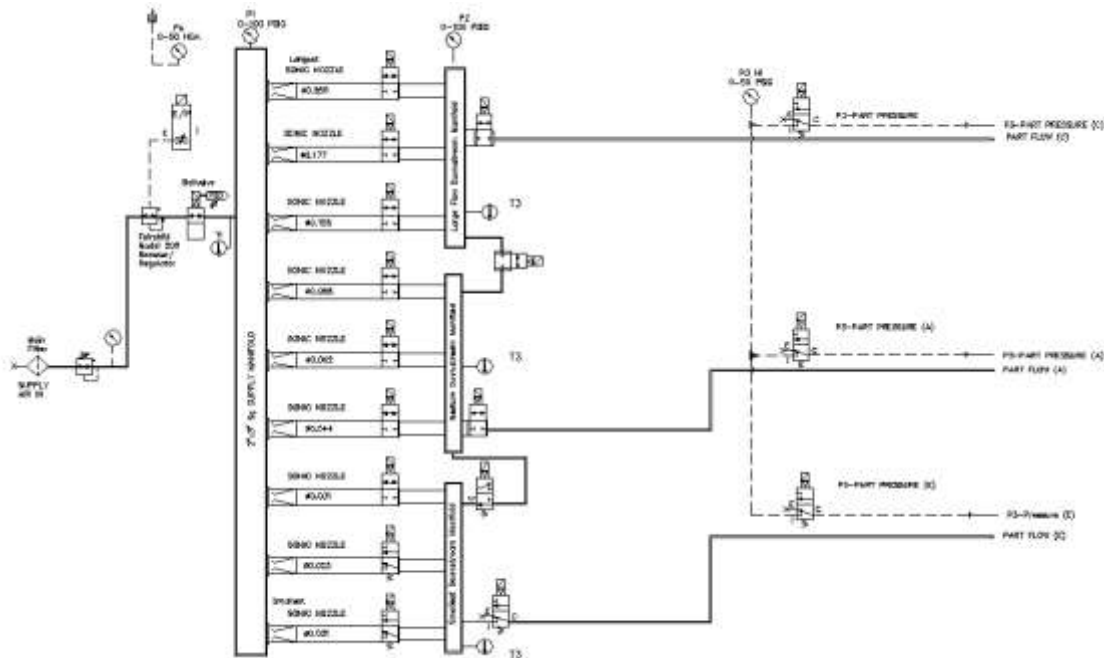


**644WorkView**  
Detail Station Interface

The machine work areas are well planned and spacious for efficient testing.

**SCHEMATIC**

The Model 644 uses nine (9) Sonic Nozzles to measure Mass Airflow. From years of experience with multiple nozzle machines, a wide range was determined effective unless it sacrifices production test time. Therefore, our systems have three downstream manifolds that divert air to the user. The smallest nozzles can be isolated from the other manifolds during testing and yield testing speeds that would be similar to having a three-nozzle machine.



**Model 644 Nozzles**

The control software directs the air to the correct location. "Mixer Valves" in our system allow mixing of nozzles between manifold sets, yielding 21 combinations across the flow range. Sonic Nozzle P1/P2 pressures are monitored during testing and provide a real time "Not-Sonic" message if the nozzle is not in a "choked" state.

## SYSTEM SPECIFICATIONS

NIST Traceable Airflow Measurement, ANSI/NCSLZ540  
 Flow Measurement Accurate to +/- 1.00% - Typical Mass Flow Uncertainty: 0.57%  
 Flow Measurement Repeatable to +/- 0.25% - Based on 50 flow measurement samples  
 GE, P&W, ABB, Honeywell, Siemens, Rolls-Royce, and Solar Parts Testing  
 Test Cycle Time: 15 to 45 seconds per part test  
 Fully Automatic Operation and Pressurization  
 Sonic Nozzles (9) – with Automatic Size Selection Single or Dual Sonic Flow Nozzle Operation  
 Part Test Profiles Available for Hundreds of Engine Parts  
 English and SI Units  
 High MTBF Industrial Pentium Computer, LCD Display  
 Windows XP operation, comes standard with Ethernet  
 QC Report, Label and Data Acquisition File  
 Free Operator Training, Testing and Certification at CCDI  
 One-Year Warranty on Parts and Labor  
 Standard 'off-the-shelf' components.  
 Can also flow small Effective Flow Area measurements: in<sup>2</sup>, mm<sup>2</sup>, and cm<sup>2</sup>

### Options

Additional Flow Ports B & E  
 Low Pressure P3 0-2 PSIG, 0-55" H<sub>2</sub>O (0-13.8 kPa)  
 Bar Code Reader  
 Label Printer and Bar Code Software Output  
 Printer  
 Enhanced Report Software (8.5 x 11" or A4)  
 Wireless Network Option  
 Dew point Meter w/Warning  
 Data Conversion  
 Low Pressure Warning  
 Lockout Box  
 Side Table (Left or Right)  
 Statistical Software (with additional monitor)  
 Networked Results Server  
 Inset LCD Display (Instead of external mount)  
 External Verification Master Nozzles  
 Air Dryer Systems  
 300 Gal. Accumulator tanks sold in pairs  
 Lifetime annual calibration package

### Configurations Available

Model	Sonic Nozzle Dia.	Flow Capability at 20-85 PSIG Nozzle Pressure	P&W Flow Parameter w * sqrt(t) / pa
644L	0.021" to 0.250" (0.053 to 0.635 cm)	0.0003 to 0.169 Pound-mass per Second (0.00014 to 0.07666 kg/s)	0.00047 to 0.26459
644M	0.025" to 0.353" (0.064 to 0.897 cm)	0.0004 to 0.340 Pound-mass per Second (0.00018 to 0.154 kg/s)	0.00063 to 0.53231
644H	0.031" to 0.500" (0.079 to 1.270 cm)	0.0006 to 0.670 Pound-mass per Second (0.00027 to 0.304 kg/s)	0.00094 to 1.04896
644XH	0.044" to 0.707" (0.112 to 1.796 cm)	0.0012 to 1.35 Pound-mass per Second (0.00054 to 0.61235 kg/s)	0.00188 to 2.11358

**Airflow Flow Test Stand Flow Ranges (see nozzle sizes)**

NOZZLE	Min Flow	Max Flow	Min	Max	Min	Max	Min	Max
DIA.IN.	lbs/sec	lbs/sec	FP	FP	EFA	EFA	EFA	EFA
					@5"H2O	@5"H2O	@10"H2O	@10"H2O
0.015	0.00014	0.00041	0.000222	0.000643	0.0018	0.0052	0.0013	0.0037
0.021	0.0003	0.0008	0.000437	0.001260	0.0035	0.0102	0.0025	0.0072
0.025	0.0004	0.0011	0.000619	0.001785	0.0050	0.0145	0.0036	0.0102
0.031	0.0006	0.0017	0.000951	0.002745	0.0077	0.0223	0.0055	0.0157
.021+.031	0.0009	0.0025	0.001388	0.004004	0.0113	0.0325	0.0080	0.0230
.025+.031	0.0010	0.0029	0.001571	0.004530	0.0127	0.0367	0.0090	0.0260
0.044	0.0012	0.0035	0.001917	0.005530	0.0155	0.0448	0.0110	0.0317
.021+.044	0.0015	0.0043	0.002354	0.006790	0.0191	0.0551	0.0135	0.0389
.025+.044	0.0016	0.0046	0.002537	0.007316	0.0206	0.0593	0.0146	0.0420
.031+.044	0.0018	0.0052	0.002868	0.008275	0.0233	0.0671	0.0165	0.0475
0.062	0.0024	0.0069	0.003807	0.010980	0.0309	0.0890	0.0218	0.0630
.062+.031	0.0030	0.0086	0.004759	0.013726	0.0386	0.1113	0.0273	0.0787
.062+.044	0.0036	0.0104	0.005724	0.016510	0.0464	0.1339	0.0328	0.0947
0.088	0.005	0.014	0.007668	0.022120	0.0622	0.1794	0.0440	0.1269
.088+.044	0.0060	0.0174	0.009585	0.027651	0.0777	0.2242	0.0550	0.1586
.088+.062	0.0072	0.0208	0.011475	0.033102	0.0931	0.2684	0.0658	0.1899
0.125	0.010	0.028	0.015473	0.044633	0.1255	0.3619	0.0888	0.2560
.125+.062	0.013	0.037	0.020232	0.058359	0.1641	0.4732	0.1161	0.3348
.125+.088	0.015	0.042	0.023141	0.066754	0.1876	0.5413	0.1327	0.3829
0.177	0.02	0.06	0.031024	0.089491	0.2516	0.7257	0.1780	0.5133
.177+.088	0.026	0.074	0.040609	0.117143	0.3293	0.9499	0.2329	0.6720
.177+.125	0.029	0.084	0.046497	0.134125	0.3770	1.0876	0.2667	0.7694
0.250	0.04	0.11	0.061891	0.178532	0.5019	1.4477	0.3550	1.0241
.250+.125	0.052	0.149	0.082123	0.236891	0.6659	1.9209	0.4711	1.3589
.250+.177	0.059	0.169	0.092915	0.268023	0.7534	2.1733	0.5330	1.5374
.250+.250	0.078	0.225	0.123784	0.357062	1.0037	2.8953	0.7101	2.0482
0.353	0.08	0.22	0.123396	0.355946	1.0006	2.8863	0.7078	2.0418
.353+.177	0.10	0.30	0.164006	0.473089	1.3299	3.8361	0.9408	2.7138
.353+.250	0.12	0.34	0.185287	0.534478	1.5024	4.3339	1.0629	3.0659
0.500	0.16	0.45	0.247567	0.714127	2.0074	5.7906	1.4201	4.0964
.500+.250	0.21	0.60	0.329690	0.951017	2.6734	7.7115	1.8912	5.4553
.500+.353	0.23	0.67	0.370963	1.070072	3.0080	8.6769	2.1279	6.1382
0.707	0.31	0.90	0.494983	1.427821	4.0137	11.5778	2.8393	8.1903
.707+.353	0.41	1.20	0.658991	1.900910	5.3436	15.4139	3.7801	10.9041
.707+.500	0.47	1.35	0.742551	2.141948	6.0211	17.3684	4.2595	12.2867

Notes: FP = Flow Parameter lbs/sec \* Sqrt(Temperature) / Room Pressure  
 EFA = Square Inch Area Measurement - Requires Inches of water gauge option

**FACILITY REQUIREMENTS**

Electrical Power and Air	100-250 VAC Single Phase, 50-60 Hz, 5A Service Pressurized air at 100 psig, dry to 0° F Dew Point		
Pressure Range	0.5 to 50 PSIG – Standard 0-50 Inches Water Gauge – Optional		
Air CFM	~225 CFM for 644L ~500 CFM for 644M ~750 CFM for 644H ~1000 CFM for 644XH		
Temperature Ranges	T1 Upstream Temperature	46-120°F	(8- 49 °C)
	T3 Part Downstream Temperature	46-120°F	(8- 49 °C)
Transducer Pressure Ranges	P1 Upstream Pressure	0-100 PSIG (0-690 kPa)	0.10% FS
	P2 Downstream Pressure	0-100 PSIG (0-690 kPa)	0.25% FS
	P3 Part Pressure	0-50 PSIG (0-345 kPa)	0.10% FS
	P4 Probe Pressure	0-30 PSIG (0-207 kPa)	0.10% FS
	PB Barometric Pressure	26-32"HgA	0.10% FS
	T1 Upstream Temp	46-120°F (8- 49 °C)	+/- 1Deg F
	T1 Downstream Temp	46-120°F (8- 49 °C)	+/- 1 Deg F

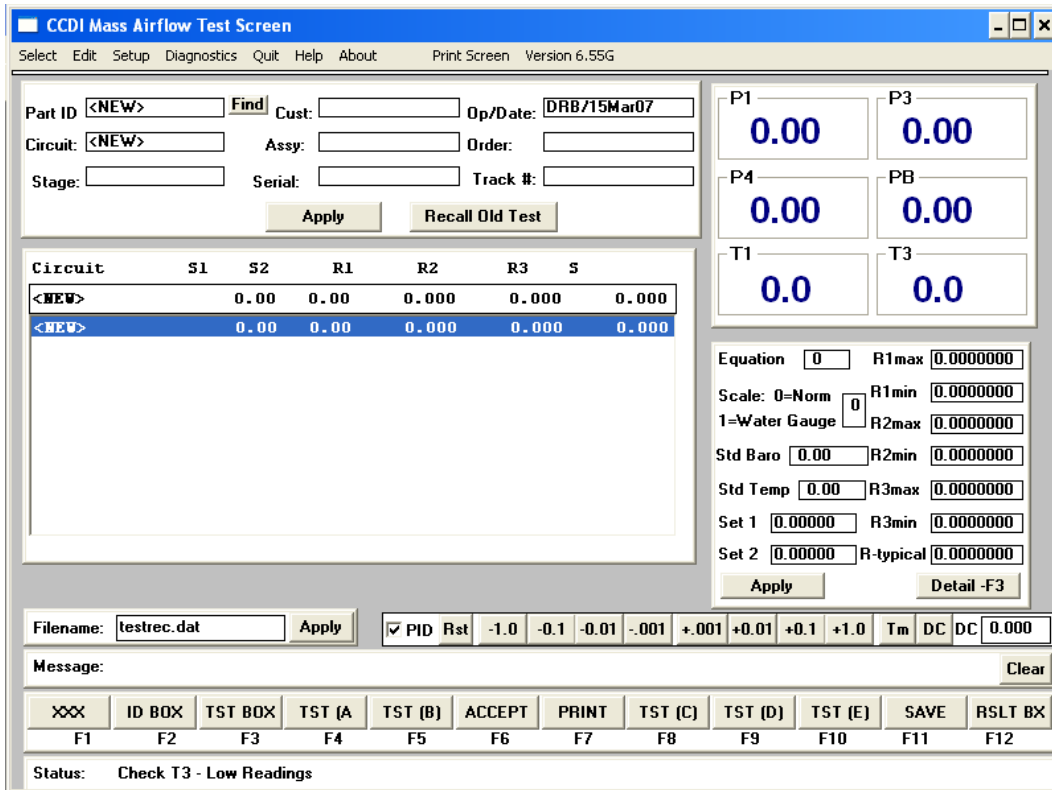
**SOFTWARE**

CCDI Airflow Test Stands have basic operation screens and a calibration screen.

Test Screen - Users operate the machine from this screen.

Setup Screen - Contains the machine configuration and calibration data.

Diagnostic Screen - Displays state of valves and nozzles used.



**Test Screen**

**Menu Bar** - Allows navigation to other screens, selection of part test programs, finding information.

**Identification Box** - In the upper left corner box, fill in details associated with the airflow test that gets recorded and printed. This information is also kept with files that can be transmitted to a network.

**Test/Log Box** - CCDI machines can have up to 64 test sequences (or increased as needed) for a single part. The first box (short) is the real time results box that shows the test data in operation. The second box (long) is the log of the test results. Some software versions have three result boxes for parts that use "Exit Flow" measurements. The log provides a summary of test data.

**Gauge Displays** - Gauge measurement readings. They are automatically converted to units that match the parts being measured.

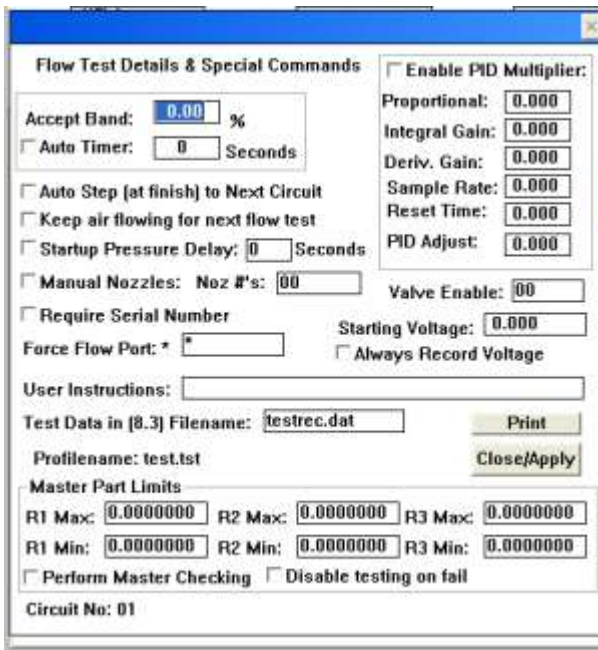
**Test Parameters Box** - Right corner box allows the test parameters and limits to be entered. More information can be entered by selecting "Detail," which will prompt the detail box.

**Filename** - This allows selection of a filename for the test data. The filename can be stored in the part "profile" - A file recipe in the hard drive for the next time you test.

**PID Control Box** - Displays activity of the pressurization controller and allows user to adjust values.

**Message and Status Boxes** - Messages from the system and operator instructions can be posted here.

**Function Key Menu** - Our test screen can be operated by mouse or function key.



From this screen, you can adjust percent error allowed on setpoints and the "Auto Timer" to shut off the air for a certain period of time. This will end the test after the pressure is consistent for the selected time interval.

Auto-step allows the next flow sequence to proceed automatically. The Startup Delay makes time at the beginning of the test to stabilize.

Manual Nozzle allows the user to select the nozzles. The system defaults to setpoint and flow limit information. The Master Parts Limits section is to be completed by the user as well.

The PID Control (Pressurization) can be finely tuned for the most demanding production lines. Note: Fixtures/Tooling varies in volume. These parameters are adjustable to achieve the best response.

**Detail Box**

**Flow Testing Features**

- CCDI Airflow machines were the first machines on the market with automatic sequencing.
- If you test a part in various manufacturing stages, the old data can be recalled at a later time to fill-in the blanks.
- Automatic or Manual, Single or Dual Nozzle Selection Available
- Two-stage cancel button can temporarily stop a test and restart; a second cancel can discard the results to start over.
- Beginning of a test can be paused for a specified number of seconds.
- Test results record all gauges and K values making analysis simple for auditing.
- In a Flow Restriction Test, the PID control can be turned off in order to monitor for flow restriction cause by external tooling.
- The program has leak tests that check for internal and external leaks at various stages
  - Our leak testing sequences can be automated
  - Volume based leak tests allow for fixed volume entry in testing parameters.
- The Diagnostic screen is great tool for technicians and makes understanding of the equipment easy for maintenance.

**Setup Screen - CCDI Mass Airflow**

Utilities Save Setup Return to Test Screen Print Screen Change Password

**Sonic Nozzle K Form**

Nozzle 1 PSIA	Dia: K
41.009	0.000187164
42.990	0.000187296
44.974	0.000187572
50.000	0.000187926
55.004	0.000188645
60.005	0.000188912
64.980	0.000189519
74.991	0.000190227
84.993	0.000190812
89.998	0.000191529

Date: 12-Sep-06  
Calib. By: .  
Sonic Ratio: 1.50  
S/N: 644-27-021  
Prev Next Apply

**System Configuration** Machine SN: 644-01-1234

Max. Shop Press: 85.00 Leak Test Delay: 08  
Accept Band %: 0.30 Nozzle Count: 09  
Xducer Input/Range: 10+100 System Series: 622  
Acquisition Device: 5141 (1602 or 5141) Display COM: 1  
PID Reset Time: 10 Acquis. COM: 2

Dual Nozzle Selection:  High Speed 232:   
Disable PID Control:  Master Checking:   
Invert Digital Outputs:  PID 2level Disable:   
Audit Flow Test:  P3 Low Option:   
Blank Serial on Save:  Don't forget to Save:   
Separate DATA Folder:  Already Mastered:   
Record Starting Voltage:  Part Recall Reset

Printout Title:   
Printout 2nd: CCDI Mass Airflow Stand - SN: 644-34-1920

**Pressurization PID Control**

PID Control for: P3 - Nozzle 1

Prop. Gain: 0.250  
Int. Gain: 0.100  
Der. Gain: 0.010  
Samp. Rate: 0.500  
Next Apply

**Sensor/Transducer Calib.**

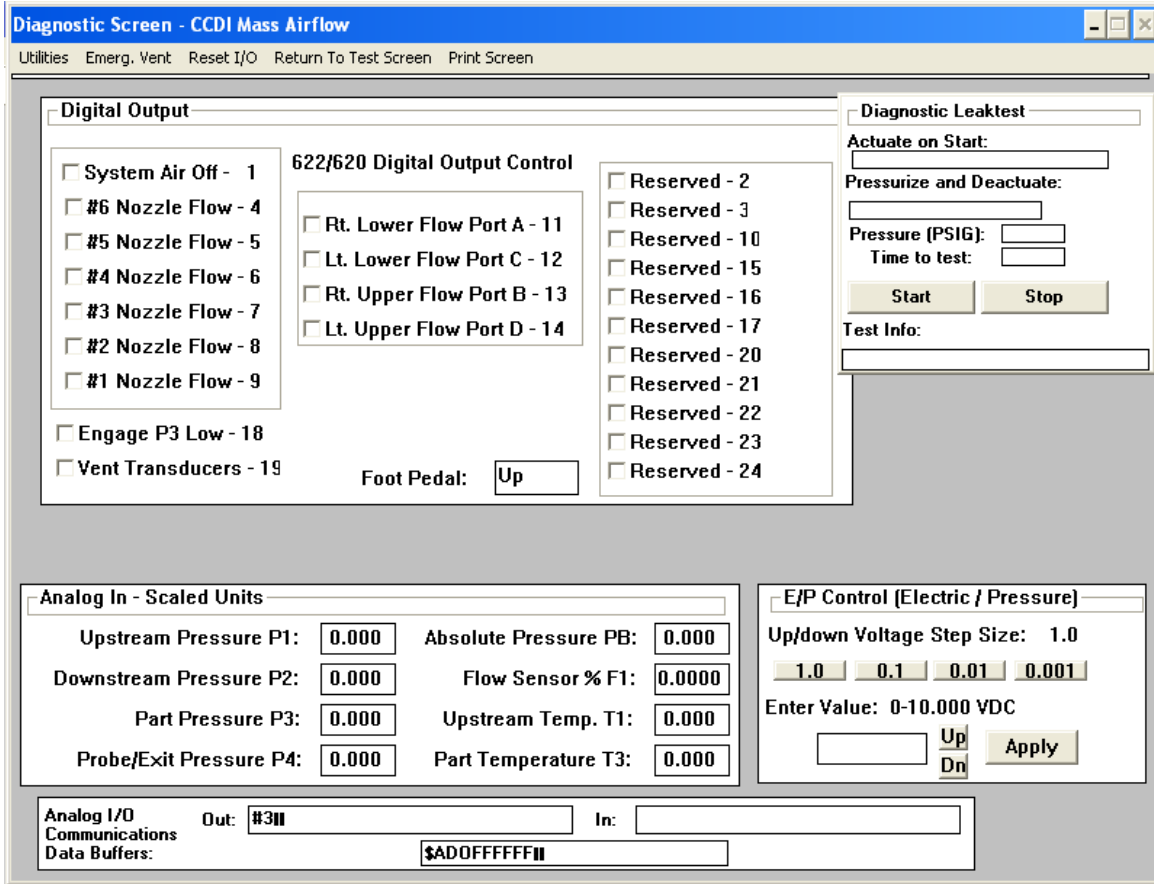
P1 Sensor Read

PSIG	% F.S.	
0.00	0.000	C
10.00	27.500	C
20.00	35.410	C
30.00	43.340	C
40.00	51.280	C
50.00	59.200	C
60.00	67.120	C
70.00	75.070	C
85.00	86.940	C
100.00	98.810	C

Date: 11-Dec-06  
Cal. By: cls  
S/N: 1095159  
Prev Next Apply

**Setup Errors / Notes / Warnings**

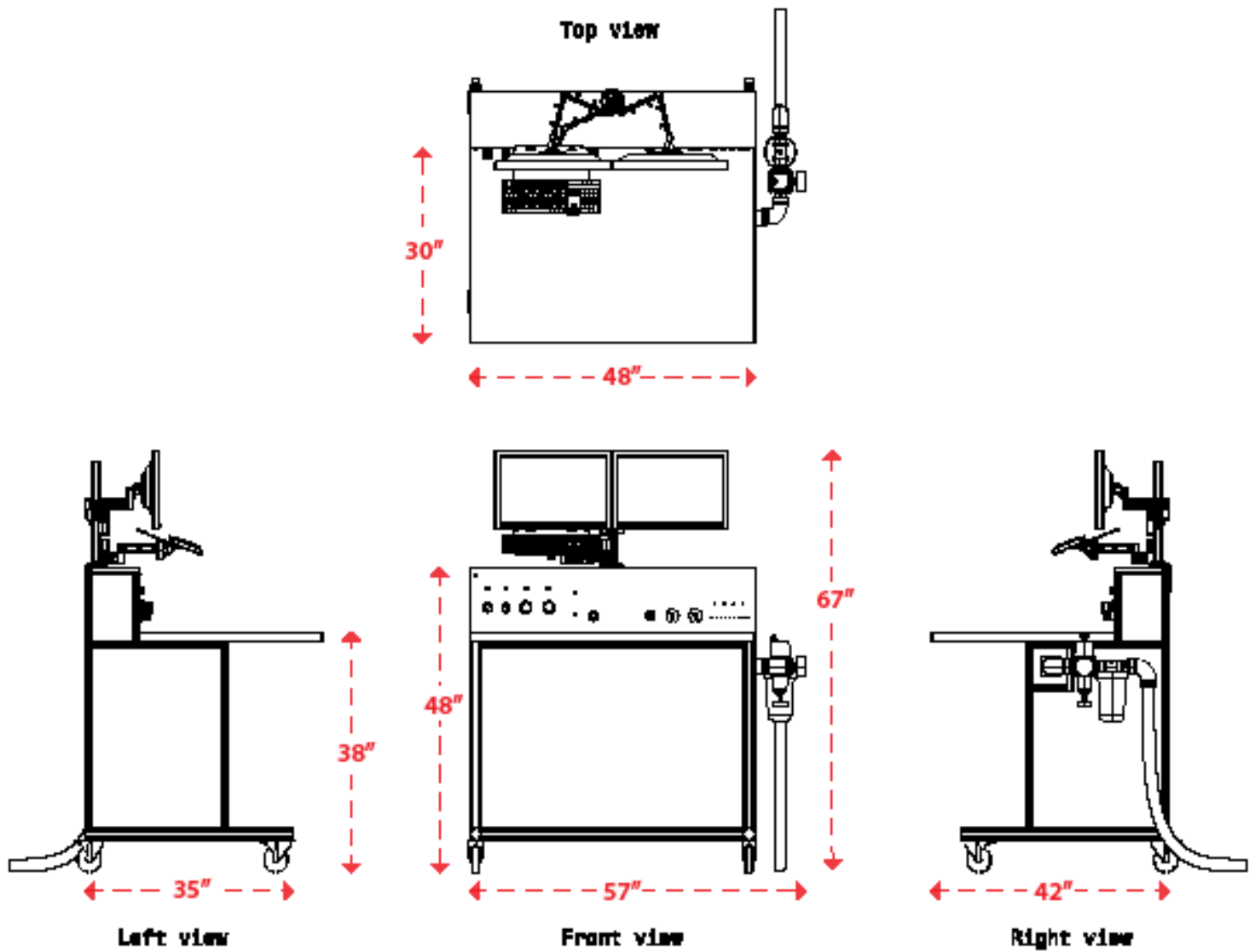
**Setup Screen:** Contains nozzle calibration, transducer calibration, system configuration data, and built-in pressurization tuning information.



### Diagnostic Screen

From the Diagnostic Screen, you can operate the valves, take pressure measurements, check data-communications, and control output pressure. Very useful for troubleshooting.





Note: Dual monitors and keyboards are optional.