Thunder Scientific
Corporation

Model 3900

"Two-Pressure Two-Temperature"
Low Humidity Generator

Model 3900

Low Humidity Generator

FEATURES

- **Traceable to SI** [2]
- **Two-Pressure Two-Temperature Principle**
- **Push Button (Keypad) Control**
- **Automated Control of User Setpoints**
- **Automatically Applies Enhancement Factors**
- **Computerized Internal Transducer Calibration**
- **RS-232C Serial Interface**
- **Only Nine Square Feet of Floor Space**
- **Timed/Formatted Output to Printer**
- **Battery Backed-up Real Time Clock**
- **Backlit Liquid Crystal Display**

DESCRIPTION

The **Model 3900** Low Humidity Generator is an extremely accurate means of producing known humidity values for calibrating and verifying humidity instrumentation. Based on the combined, NIST proven, fundamental "two-pressure" and "two-temperature" principles, this system will automatically supply a continuous humidified gas stream, within the frost/dew point range of -95.0 °C to 10.0 °C, for days or even weeks unattended.

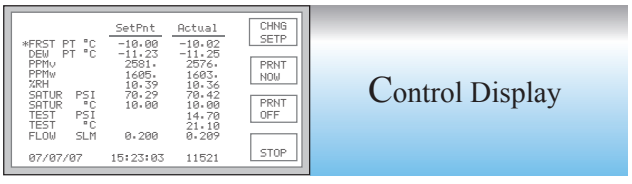
Simply apply power to the system, and the **3900** will powerup ready to purge and/or generate. Humidity setpoint values are input by the operator from the front panel keypad and are limited only by the operational range of the **3900** humidity generator.

PRINCIPLE OF OPERATION

The "two-pressure two-temperature" generation process involves saturating a continuous stream of air or nitrogen with water vapor at a known temperature and pressure. The saturated high pressure air then passes through an expansion valve where it expands to a lower pressure. The **3900** generates a particular humidity by first selecting a suitable saturation temperature, T_s. It then determines the saturation pressure, P_s, required to establish the correct saturation vapor pressure. The precision of the system is determined by the accuracy of the temperature and pressure measurements and on the constancy of them throughout. When setpoint equilibration has been reached, the

indication of saturation temperature, saturation pressure, test temperature, and test pressure may be used in the determination of all hygrometric parameters. Furthermore, because the humidity generated is based solely on the fundamental principles of temperature and pressure, no humidity sensing is used to measure or control the amount of water vapor produced by this system.

The **3900** operates using an on-board multifunction CPU in conjunction with other peripheral cards to perform calculation and control functions. The embedded computer control system allows the **3900** to generate known humidity levels completely unattended with visual indications of system status displayed in real time on the Liquid Crystal Display.



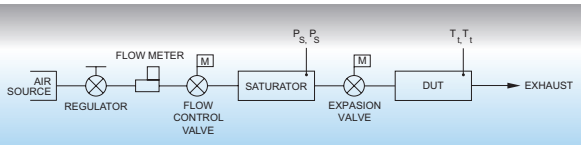
Control Display

This frees the operating technician from the task of system monitoring and adjustment. A computer and/or printer may be connected via the bi-directional RS-232C interface ports allowing remote setpoint control and continuous system data retrieval.

Temperature Control: Temperature setpoint control is attained by controlling the temperature of a circulating fluid medium that jackets the saturator of the generator. The saturation temperature is governed by the temperature of this medium, which is digitally controlled by the computer at any value between -80 °C and 12 °C through the use of PID (proportional-integral-derivative) algorithms.

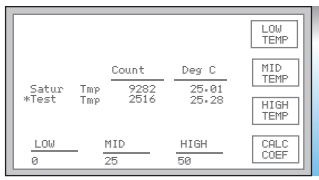
Pressure and Flow Control: Pressure control and mass flow rate control are accomplished through computer actuation of electromechanical valve assemblies. Saturation pressure and mass flow are measured continuously and controlled using PID algorithms similar to those employed in temperature control.

Two-Pressure Two-Temperature Generator: Regulated compressed air or nitrogen is directed through the saturator, which is a fluid encapsulated heat exchanger containing several planes of pure ice or water. The saturator is maintained at the required saturation temperature and saturation pressure. As the gas thermally equilibrates, it becomes saturated with water vapor. The saturation temperature (T_s) and saturation pressure (P_s) are measured at the point of final saturation. The saturation pressure is then reduced to test pressure (P_t) and the conditioned gas is admitted to the unit under test (UUT) at the desired humidity conditions. The final pressure (P_t) and temperature (T_t) of the gas is measured within or just after the UUT. The UUT is then exhausted to atmosphere or to a back pressure regulator to achieve pressure control.



Elemental Schematic of the **3900** generator

Calibration: Proper calibration of the temperature and pressure transducers ultimately determines the accuracy of the generator. This system employs an integral programmatic calibration scheme allowing the transducers to be calibrated while they are electrically connected to the humidity generator.



Calibration Display

This approach helps eliminate systemic errors that might be induced by removing the transducers from the generator. All calibration is performed mathematically by the computer so manual adjustments are not needed. Coefficients for each transducer are calculated by the computer and stored in the system's nonvolatile memory until the next calibration is performed.

The main panel has easy access to the keypad, function keys, and test temperature and test pressure connectors.

APPLICATIONS

Virtually any humidity may be generated, for any length of time, within the operational limits of the generator. The output of the unit under test may then be compared with the generator's printed data for analysis.

Chilled Mirror Hygrometers: Connect the generator output to your chilled mirror hygrometer and you can: verify mirror temperature measurement accuracy (calibration) when the hygrometer is in thermal equilibrium with its environment; perform operational checks of the heatpump and optical components, before and after mirror cleaning and balancing; determine whether the hygrometer is controlling the mirror deposit in the liquid phase or ice phase when operating at dew and frost points below 0 °C; determine if the hygrometer is correctly calculating other humidity parameters; determine hygrometer repeatability, stability, and drift characteristics.

Humidity Sensors and Electrolytic Hygrometers: Connect the generator output to your Electrolytic Hygrometer, sampling system, special fixtures, or sensors and you can: determine humidity calibration accuracy and/or characterize humidity sensitivity by subjecting the humidity sensor to a variety of humidity levels; perform operational checks such as the sensing systems capability to correctly calculate and display other humidity parameters; determine repeatability, stability, hysteresis, and drift characteristics of various humidity sensing systems.

Environmental Testing: The **3900** can serve as a test bed for evaluation and R&D of humidity sensors, humidity sensing systems, and humidity sensitive products, e.g., polymers, composites, film, magnetic medium, pharmaceuticals, soil hydrology, consumables, electronics, optics, etc.

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Low Humidity Generator

SPECIFICATIONS

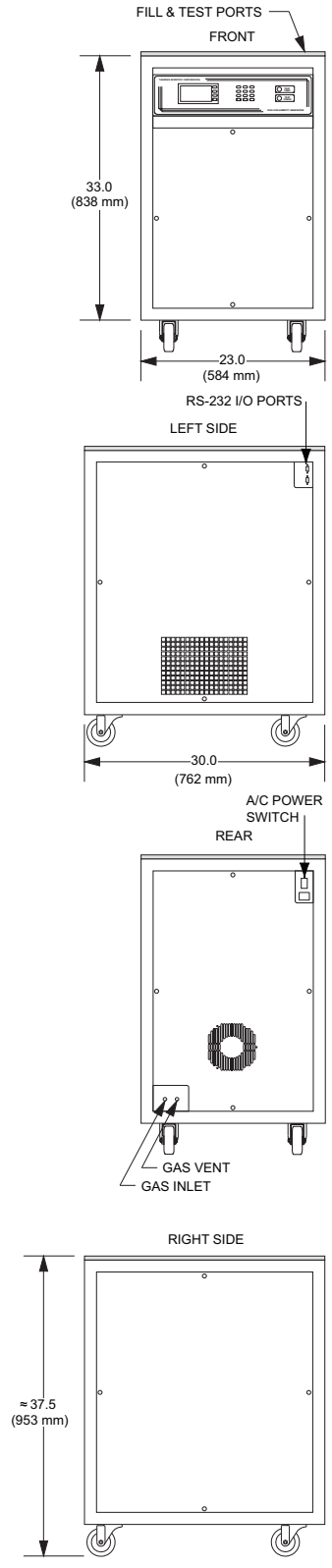
Frost / Dew Point Range: ..... –95 to +10 °C
Frost / Dew Point Uncertainty: [1] ..... (-95 to -90 °C) 0.9 °C
..... (-90 to -80 °C) 0.5 °C
..... (-80 to -70 °C) 0.2 °C
..... (-70 to 10 °C) 0.1 °C
Parts Per Million Range: ..... 0.05 to 12000 PPMv
Relative Humidity Range: ..... 0.0002 to 50%
Saturation Pressure Range: ..... Ambient to 300 psiA
Saturation Pressure Uncertainty (10-50 psiA): [1] ..... 0.05 psiA
Saturation Pressure Uncertainty (50-300 psiA): [1] ..... 0.30 psiA
Saturation Temperature Range: ..... –80 to +12 °C
Saturation Temperature Uncertainty: [1] ..... 0.08 °C
Saturation Temperature Heating/Cooling Rate: ..... 2 Minutes Per °C Average
Display Resolution: 0.01
Gas Flow Rate Range: ..... 0.1 to 5 L/min
Gas Flow Rate Resolution: ..... 0.02 L/min
Gas Flow Rate Uncertainty: [1] ..... 0.2 L/min
Gas Type: ..... Air or Nitrogen
Gas Pressure Rating (MAWP): ..... 350 psiG
Refrigeration: .....1/3 HP R-134A & 1/3 HP R-23 in cascade
Heating: ..... Stainless Steel Immersion Heaters
Test Port: ..... 1/4 Inch Swagelok® Tube Fitting (6.35mm)
Physical Dimensions: ..... 37.5” H x 23” W x 30” D (953mm x 584mm x 762mm)

UTILITIES

Electrical Power: ..... 200/240 V~, 10 A, 50/60 Hz
Gas Supply (External): ..... 350 psiG, 5 L/min, with ambient
..... pressure frost point <-80 °C
Floor Space: ..... 9 ft² (0.84 m²)

ENVIRONMENTAL

Operating Temperature: ..... 15 to 30 °C
Storage Temperature: ..... 0 to 50 °C
Humidity: ..... 5 to 95% RH Non-condensing



[1] Represents an expanded uncertainty using a coverage factor, k=2, at an approximate level of confidence of 95%.

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