Thunder Scientific Corporation

# Model 9500

*Automated "Two-Pressure" Humidity Generation System*

# Model 9500

## *Automated Humidity Generation System*

## FEATURES

- **Traceable to SI** [1]
- **0.3% of Reading RH Uncertainty** [5]
- **High Flow Capability**
- **Based on NIST Proven "Two-Pressure" Principle**
- **Generate: RH, DP, FP, PPM, Multipoint Profiles**
- **Computes System Uncertainties in Real Time**
- **Automatically Applies Enhancement Factors**
- **ControLog® Automation Software**

## DESCRIPTION

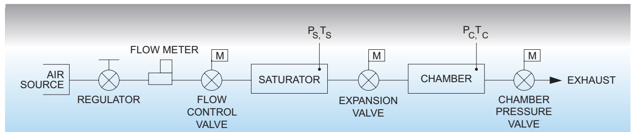
The **9500** Humidity Generation System is capable of producing known humidity values using the fundamental, NIST proven, "two-pressure" principle. The **9500** is capable of continuously supplying relative humidity, dew point, frost point, parts per million, or other calculated values for instrument calibration and evaluation as well as precision environmental testing. This system will automatically generate manually entered humidity and temperature set points as well as user created multipoint profiles. All desired humidity's, temperatures, test pressures, flow rates, and time intervals may be programmed. Visual indications of system status are displayed in real time on the computer monitor.

## PRINCIPLE OF OPERATION

The "two-pressure" humidity generation process involves saturating air or nitrogen with water vapor at a known temperature and pressure. The saturated high pressure air flows from the saturator, through a pressure reducing valve, where the air is isothermally reduced to test pressure at test temperature. Humidity generation is dependent on the measurement of temperature and pressure, not on the amount of water vapor measured in the air. System uncertainty is determined by the temperature and pressure uncertainties, *and* on the stability and uniformity of the measurements. When setpoint equilibration has been reached, the indication of saturation temperature, saturation pressure, test temperature, and test pressure, are used in the determination of all hygrometric parameters.

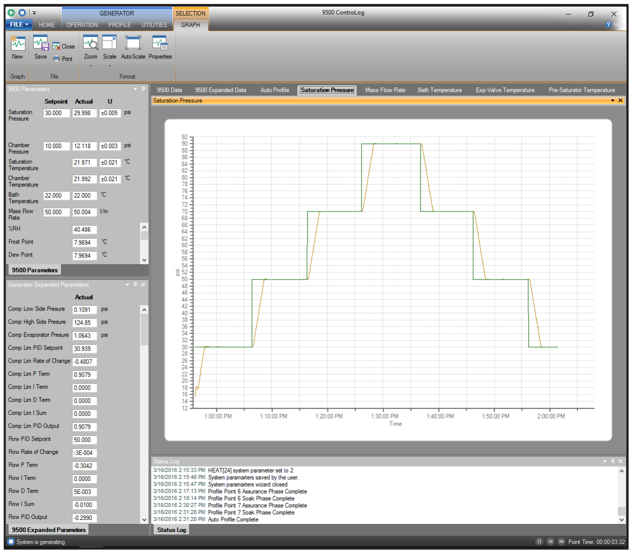
## COMPUTER/CONTROL SYSTEM

The **Model 9500** Humidity Generation System encompasses a high-performance stand-alone Control System that performs all functions required for humidity generation and control. The Control System employs 24 bit I/O modules with integrated signal conditioning to acquire data and uses serial interfaces to transducers and stepper motors to control the operation of generating humidity. The Control System utilizes an embedded operating system in conjunction with specialty software to control and interface with the human to machine interface (HMI) computer running ControLog.




Elemental Schematic of the **9500** generator

ControLog is an embedded software application that fully automates the operation of the **9500** Humidity Generation System and allows various device connections through a number of different interfaces. Data from the generator and attached devices is automatically retrieved and stored for viewing in either numerical or graphical format in real time or post process. Data can be transferred off the system via a USB drive for further viewing and post processing using an external Windows PC. The ControLog software also provides the primary interface to the operator via the multi-point touch LCD.




ControLog Computer Screen

**Temperature Controlled Bath:** The **9500** humidity generating system incorporates an extremely stable temperature bath. Bath temperature is digitally controlled by the computer to any value between 0 °C and 72 °C using PID (proportional-integral-derivative) algorithms. The test chamber, saturators, heat exchangers, and connecting tubing are immersed in approximately 20 gallons of distilled water that is circulated at the rate of 50 gallons per minute by a magnetically coupled centrifugal pump. Fast fluid circulation provides the temperature conditioning of these components resulting in excellent bath stability and uniformity.

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

**Calibration:** Proper calibration of the temperature and pressure transducers ultimately determines the accuracy of the generator. The **9500** employs an integrated software calibration scheme allowing the **9500's** transducers to be calibrated while they are electrically connected to the humidity generator. Coefficients for each transducer are calculated by the computer and stored to memory.

## TEST CHAMBER

The **9500** humidity generating system incorporates a completely immersed test chamber, with internal dimensions of 12" x 12" x 12". Test chamber pressure range is ambient to 20 PSIA. The main chamber cover is removable utilizing quick release hold downs. Removal of the chamber cover allows a full 12 inch by 12 inch access to the test space. Access is also available through two 3.65" diameter ports in the chamber cover or two 1.125" inside diameter port cover adapters. The test chamber can accommodate various solid state sensors, chilled mirror hygrometers, as well as material samples for environmental testing. Virtually any humidity and temperature may be generated, for long periods of time, within the operational limits of the generator. The output or recording of the device under test may then be compared with the generator's data for analysis.

Four Port Option Shown

## APPLICATIONS FOR USE

**Chilled Mirror Hygrometers:** Install the actual chilled mirror head into the chamber or insert a sample tube through a test port and draw a sample through the chilled mirror head to: verify mirror temperature measurement accuracy (calibration) when the hygrometer is in thermal equilibrium with its environment; perform operational checks of the heat-pump 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 the hygrometer's repeatability, stability, and drift characteristics.

**Humidity Sensors and Chart Recorders:** Insert your humidity probe through a test port in the chamber or install the humidity sensing system directly into the chamber to: 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 the repeatability, stability, hysteresis, and drift characteristics of various humidity sensing systems.

**Environmental Testing:** The **9500** 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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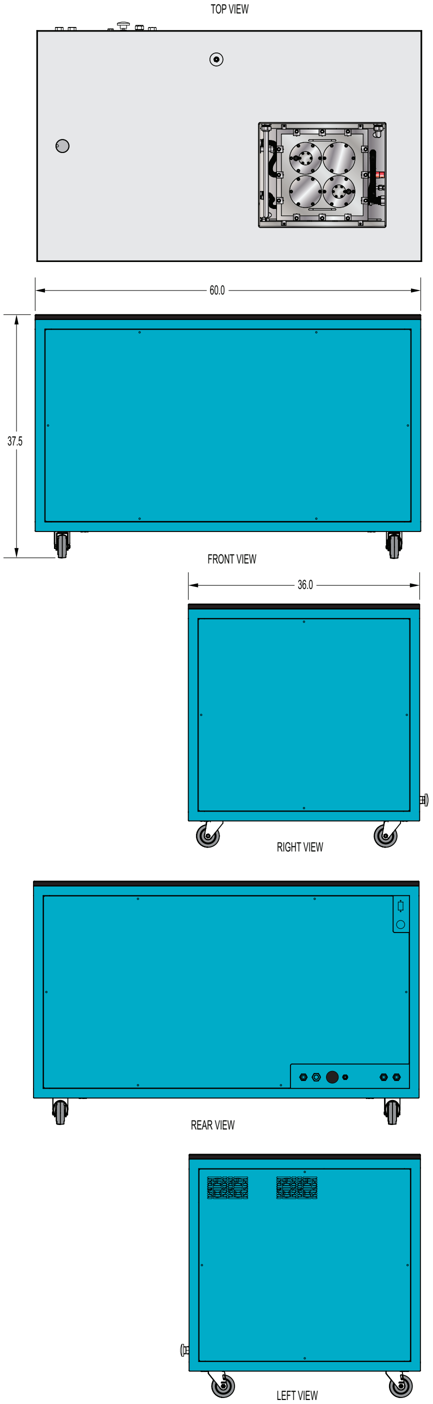


### SPECIFICATIONS

| | |
|---|---|
| Relative Humidity Range: (Test Chamber @ 1 atm. & 23 °C) | 5.2 to 99 %RH |
| Frost Point Temperature Range: (Test Chamber @ 1 atm. & 23 °C) | -31.6 to 0 °C |
| Dew Point Temperature Range: (Test Chamber @ 1 atm. & 23 °C) | -34.8 to 70 °C |
| Bath Temperature Range: [2] | 0 to 72 °C |
| Bath Temperature Control Stability: [3] | 0.005 °C |
| Bath Temperature Uniformity: [4] | 0.04 °C |
| Bath Temperature Heating Rate: from 0 to 72 °C | 0.5 °C per Minute (average) |
| Bath Temperature Cooling Rate: from 72 to 0 °C | 0.5 °C per Minute (average) |
| Temperature Specification: | ±0.018°C |
| Gas Type: | Air or Nitrogen |
| Gas Pressure Rating: (MAWP) | 350 psiG |
| Gas Flow Rate Range: | 10 to 150 L/min |
| Gas Flow Rate Specification: | ±2% of full scale |
| Saturation Pressure - Low Range: | Ambient to 45 psiA |
| Saturation Pressure - High Range: | 45 to 300 psiA |
| Low Range Pressure Specification: | ±0.0045 psiA |
| High Range Pressure Specification: | ±0.03 psiA |
| Test Chamber Pressure Range: | Ambient to 20 psiA |
| Test Chamber Pressure Specification: | ±0.0023 psiA |
| Display Resolution: | 0.001 |
| Test Chamber Dimensions: | 12” x 12” x 12” (304.8 mm x 304.8 mm x 304.8 mm) |
| Physical Dimensions: | 37.5” H x 60” W x 36” D (952.5 mm x 1524.0 mm x 914.4 mm) |

### UNCERTAINTY [5]

| | |
|---|---|
| RH Uncertainty: 95 to 99 %RH, 0 to 70 °C, 10 to 50 L/min | 0.3% of reading |
| RH Uncertainty: 10 to 95 %RH, 0 to 70 °C, 10 to 100 L/min | 0.3% of reading |
| RH Uncertainty: 5.2 to 10 %RH, 0 to 70 °C, 10 to 100 L/min | 0.03% |
| Dew/Frost Point Uncertainty: < 0 °C, 10 to 100 L/min | 0.05 °C |
| Dew/Frost Point Uncertainty: 0 to 70 °C, 10 to 100 L/min | 0.05 °C |
| Test Chamber Temperature Uncertainty: 0 to 70 °C | 0.021 °C |
| Test Chamber Pressure Uncertainty: Ambient to 20 psiA | 0.003 psiA |

### UTILITIES

| | |
|---|---|
| Electrical Power: | 220/240 V~, 20 A, 3 Ø, 50/60 Hz, 5 Wire |
| Gas Supply: | 350 psiG @ 150 L/min |
| Cooling Water: | 2 gpm (8 L/min) Maximum @ 21 °C |

### ENVIRONMENTAL

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

1. Traceable to the International System of Units (SI) through NIST-maintained standards.
2. Using glycol/water as the temperature bath heat transfer fluid from 0 to 5 °C and water as the temperature bath heat transfer fluid from 5 °C to 72 °C.
3. Temperature Control Stability is defined as the maximum deviation from a best fit line, as measured by the bath temperature control sensor. If data is logged digitally, the best fit line will be defined as the average value over the 10 minute period. All measurements made with an insulated cover in place over bath.
4. Bath Temperature Uniformity is defined as the maximum temperature difference between any two bath locations at a single point in time. Locations within one inch of the outer bath wall and within one inch of the first saturator and its' inlet are excluded from the uniformity requirement. All measurements made with an insulated cover over bath.
5. Uncertainty is not specified at flow rates below 10 slpm and above 100 slpm.
   Uncertainty values represent an expanded uncertainty using a coverage factor, k=2, at an approximate level of confidence of 95%.
   Uncertainty is based on the worst-case value from the 9500 uncertainty analysis.

## *For More Information or to Place an Order Contact:*


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