

Add Precise Amounts of Water Vapor to Atmospheric Processes

RHS purifies and controls moisture addition for a wide range of flow rates

Applications

Applications for the RainMaker® Humidification System (RHS) include atomic layer deposition (ALD), rapid thermal processing (RTP), plasma stripping, water plasma, carbon nanotubes (CNT), thermal oxidation, biomedical processing, formation and annealing of TCO layers for thin film solar cell manufacturing and decarburization.

Benefits

The RHS is the only system that can purify water vapor and control its delivery into a carrier gas stream at ppm levels to high percentages of water in atmospheric processes.

Benefits include:

- **Cost of Ownership**—increased yield through process stability, automatic water control, and continuous process purification without consumables leads to a very low cost of ownership. The turn key solution eliminates in-house engineering needed for alternative solutions. Integration of moisture sensor allows for 24/7 process control.
- **Complete System**—Integrated temperature, pressure, and water flow control as well as closed loop control through internal monitoring.
- **Purity**—Patented technology greatly reduces volatiles, ionic contaminants, dissolved gases and other impurities found in de-ionized water as well as water droplet entrainment.
- **Yield**—Metals, hydrocarbons, and particles are rejected by the non-porous membrane to deliver the purest water vapor possible. Because only molecular water can transfer across the membranes, water droplets cannot penetrate. Closed loop control eliminates the guesswork on water vapor in the process.
- **Throughput**—Continuous unattended 24/7 operation.
- **Versatility**—Can be configured to add water into a wide range of carrier gas flow rates as well as delivery into

positive or ambient pressure systems. The RHS humidifies inert gases (e.g., nitrogen, clean air, and argon), oxidizing gases (e.g., oxygen and ozone), and flammable gases (e.g., hydrogen).

- **Safety**—Humidification of flammable gases. The heater does not directly contact the water or carrier gas.

How It Works

The RHS adds a controlled amount of water vapor to a carrier gas. The RHS consists of a non-porous membrane that excludes particles, micro-droplets and volatile gases from being transferred to the carrier gas and ensures only water vapor is added. The membrane is designed specifically to select only water vapor.

- Carrier Gas flows into the RHS.
- The water is heated to match the desired dewpoint temperature or humidification level.
- Water diffuses across the nonporous membrane to fully saturate the gas to be humidified.
- Dew point of the humidified gas is measured and fed back to a process controller to adjust the humidification level.

If the water loading (dewpoint) is below ambient temperature, add a dilution leg. The gas flow must be split between two lines, one of which is fully saturated and the other kept dry. Use a sensor on the dilution leg to control the split ratio.

Competitive Comparison

Until now, the delivery of water to a process has been difficult and choices have been both limited and unsatisfactory.

Direct Liquid Injection does not purify the liquid being vaporized. It has limited control accuracy at low flow rates and at high flow



rates is susceptible to bubbles in the liquid that generate erratic values. DLI needs a metallic vaporizer or additional metal hot plate to convert liquid to gas, can vaporize only limited quantities due to thermal transfer rates, and risks water droplet entrainment—leading to challenges in uniformity and repeatability.

Bubblers are inaccurate due to the temperature of the gas and liquid, operating pressure, liquid level, and thermal droop. They cannot prevent entrainment of dissolved gases, volatile molecular contaminants, and micro-droplets. Bubblers have very limited gas flow rates and risk bacterial growth with continuous use. With over-limit flow rates, water droplets are entrained, leading to contamination, particles, flow instability, warpage and uncontrolled flow.

Membrane Contactors are made with hollow fiber membranes that are porous, allowing simultaneous transfer of the gas into the liquid and the liquid into the gas, so the carrier gas can permeate the liquid source.



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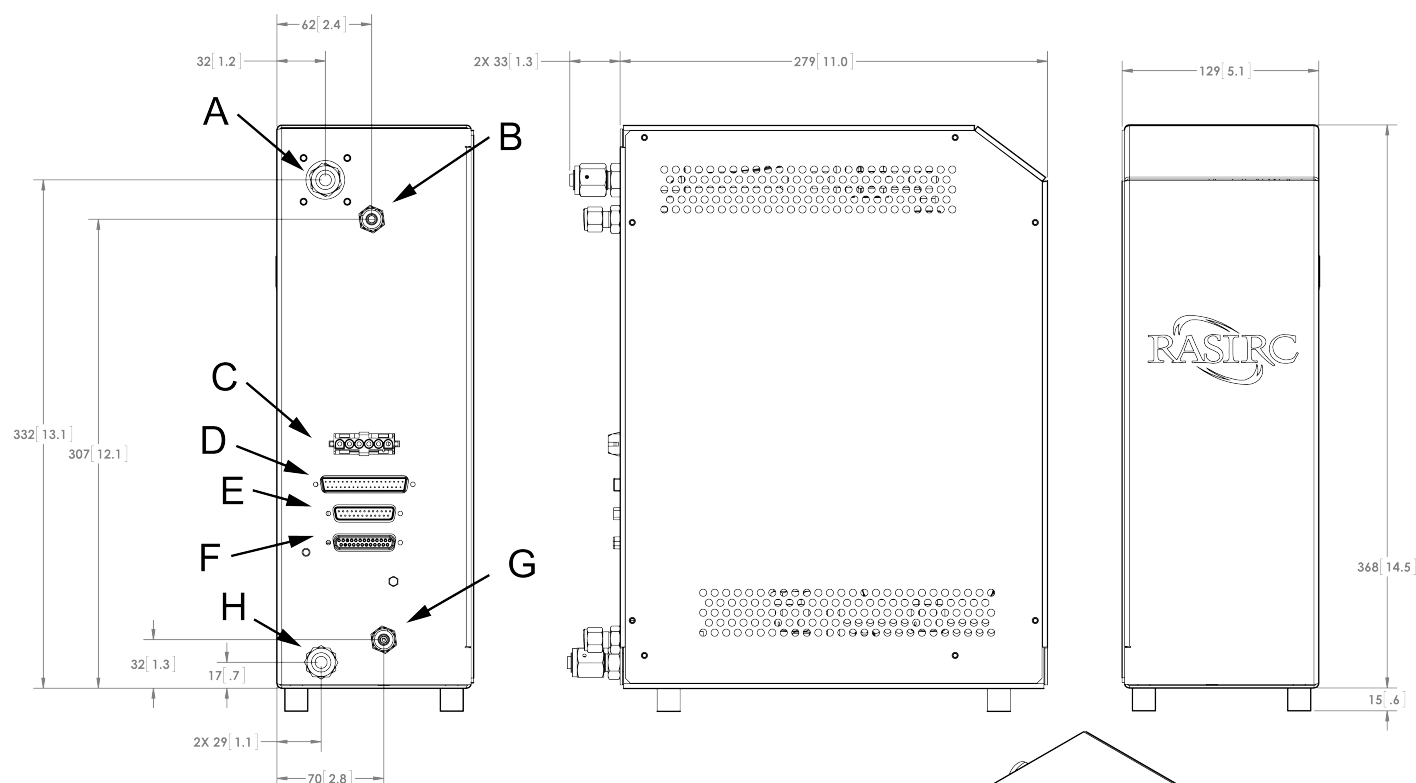
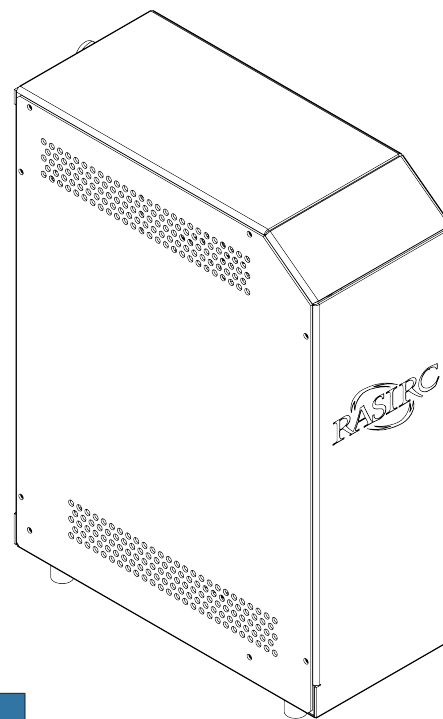


Figure 1: Chemical Cabinet

	Description	Size/Type
A	Gas Outlet	¼" male VCR
B	UPW (Ultra Pure Water) Drain	¼" Swagelok compression fitting, 316L
C	J2 Heater Power	6 pin Molex
D	J6 Instr	37 pin D Sub Plug Male
E	J5 Valves	25 pin D Sub Plug Male
F	J4 TC	25 pin D Sub Plug Receptacle
G	UPW (Ultra Pure Water) In	¼" Swagelok compression fitting 316L
H	Gas Inlet	¼" male VCR



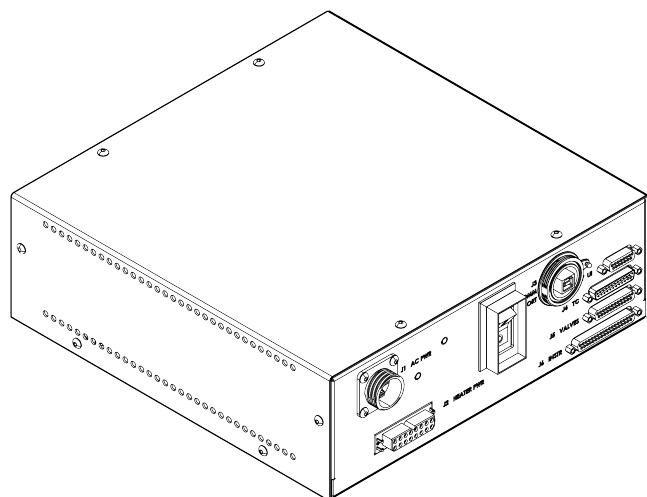
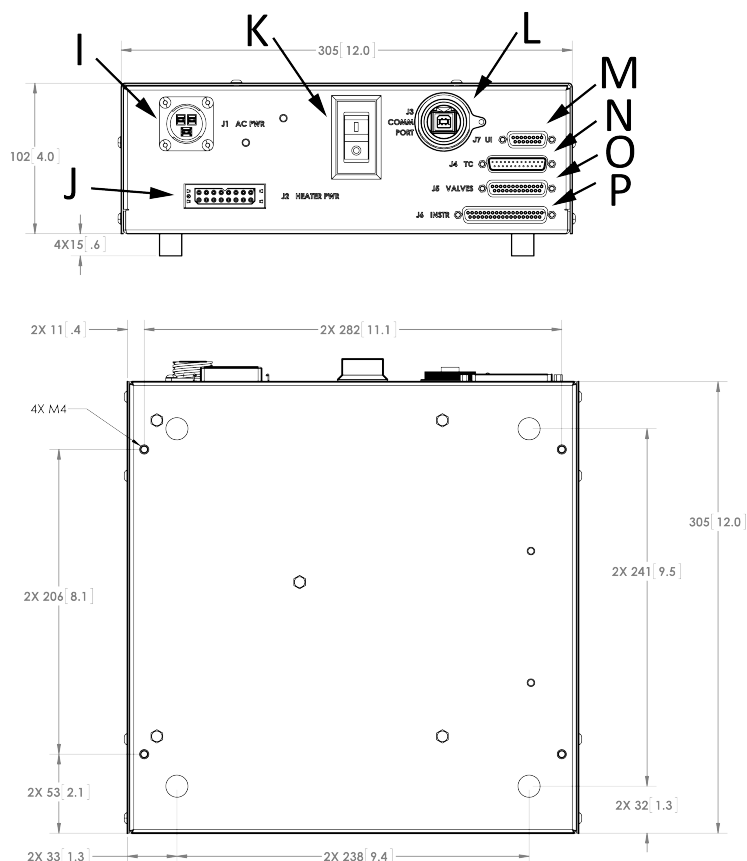


Figure 2: Electronics Box



	Description	Size/Type
I	J1 AC Power	Pin, Contact, Male, Series 3, CPC Type XII, 16/14-12 AWG
J	J2 Heater Power	PWA, AC Power
K	Power Switch	
L	J3 Comm Port	USB, Type B connector
M	J7 UI	15 pin D Sub Plug Receptacle
N	J4 TC	25 pin D Sub Plug Male
O	J5 Valves	25 pin D Sub Plug Rectacle Receptacle
P	J6 Instr	37 pin D Sub Plug Receptacle



Product Features and Specifications

- Humidification from -40°C to 90°C depending upon configuration.
- Automatic water level / fill control.
- Ambient pressure delivery.
- Local and remote setpoint control.
- Microcontroller driven.
- Patented flow control of water addition.
- Dimensions: Chemical Cabinet: 129mm(w) x 279mm (d) x 368mm(h)
Electronics Box: 305mm(w) x 325mm(d) x 118mm(h)

Operation Overview

For best operations, locate the RHS as close to the tool as possible. Enter the dewpoint from the front panel or remote connector to set the amount of water vapor to be added to the carrier gas. An optional temperature controller and heat tape may be needed downstream of the RHS to prevent water vapor from condensing in the humidified gas stream.

Required Environmental Conditions

- 5°-30° Celsius
- 0% to 90% humidity, non-condensing
- De-Ionized water regulated to 7.5±2.5 psig (0.525±0.125 barg) and filtered to 0.1 micron
- Carrier Gas Pressure (must be specified at time of order)

To configure your RHS, determine:

- Maximum carrier gas flow rate
- Maximum dewpoint or humidification level
- Minimum dewpoint or humidification level
- Carrier gas pressure
- Mains voltage

How to Order

To place an order for the RHS, construct the model number from the options below. The model number should follow this pattern:

RHS-Probe-DeliveryPressure -GasFlowRate-HumidityRequirement-Power (e.g., RHS-IP-A-2-HT-A)

Item	Designation	Notes
Probe	IP	Internal with dewpoint sensor
Delivery Pressure	A	Ambient
Carrier Gas Flow Rate	2	Represents 100 sccm
	3	Represents 1,000 sccm
	4	Represents 10,000 sccm
Humidity Requirement (Dewpoint)	HT	Above Ambient Temp (>25°C)
Power	A	110-120v (7A)
	B	200-240v (3.5A)

Additional Optional Components

- Additional temperature controller & heater tape to prevent condensation of humidified gas.
- 1/4" FNPT or 3/8" male flare 3-way PFA pneumatic valves to control delivery between process tool and vent.

Orders can be placed through authorized dealers or directly with the factory.

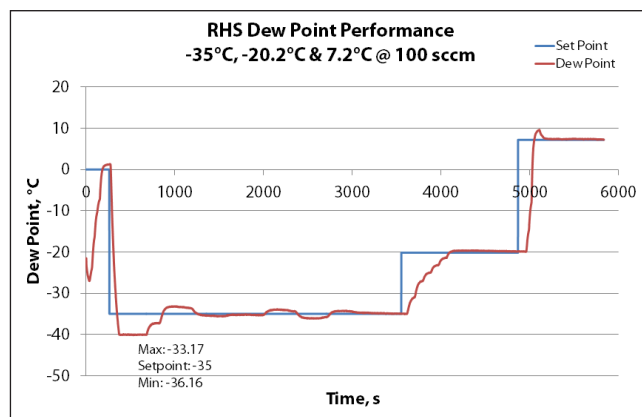


Figure 3: Sample dewpoint performance from a subambient RHS.

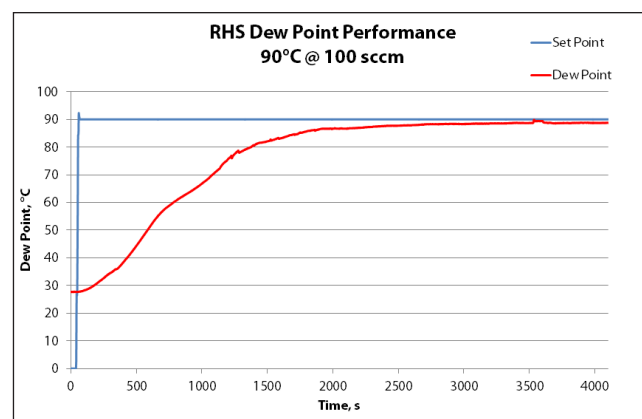


Figure 4: Sample dewpoint performance from an above ambient RHS.

About RASIRC

RASIRC develops products that purify and deliver ultra pure liquids and gases. RASIRC steam generators, humidifiers and vaporizers are of critical importance for many applications in the semiconductor, microelectronics, solar, and related manufacturing.



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