High Concentration Hydrogen Peroxide Gas Delivery System

Safe, stable, consistent H_2O_2 gas delivery

The RASIRC Peroxidizer provides a safe, reliable way to deliver high-concentration hydrogen peroxide gas into ALD, annealing, dry surface preparation and cleaning processes.

RASIRC Peroxidizer Benefits

- Safely concentrates H_2O_2 from semiconductor grade 30% weight H_2O_2
- Flows H_2O_2 gas to process at up to 50,000 ppm, depending on flow rate
- Delivers high purity H_2O_2 without entrained droplets or decomposition
- Delivers low H_2O to H_2O_2 ratios

Benefits for Annealing and ALD

- Allows low temperature processing
- High oxide growth rates
- More reactive to metal-organic precursors
- Useful for *in situ* surface pre-cleaning
- Enables high-density, uniform hydroxylated surfaces
- Reduces number of defects

Benefits for Surface Preparation and Cleaning

- Delivers stable H_2O_2 gas at wide range of concentrations to remove films and residues
- Cleans in situ, requiring less chemical than wet cleaning
- Oxidizes organic hydrocarbons and metals, enabling their removal
- Removes carbon contamination without damaging the surface

H_2O_2 Delivery Challenges

H_2O_2 presents a multitude of difficulties:

- Users wish to use standard two-component 30% weight H_2O_2
- Low volatility
- Easily condenses in the gas stream to form droplets, which can lead to particles on wafer surfaces
- Decomposes to form water and oxygen at elevated temperatures, undermining the use of hot-plate vaporizers
- Generates particles when used with flash vaporizers

Overcoming Raoult's Law

H_2O_2 gas has not been used extensively in oxidation, surface preparation and cleaning applications because of the obstacle described by Raoult's Law. When a two-component solution is vaporized, the individual components will do so at different rates. In the case of 30% weight H_2O_2, the H_2O component vaporizes significantly faster than H_2O_2. H_2O dominates the vapor stream, and the H_2O_2 concentration is too low to be effective for the process.

Bubblers and traditional vaporizers do nothing to counteract the effect of Raoult's Law. If a carrier gas is bubbled through 30% weight H_2O_2 solution, less than 300 ppm of H_2O_2 will be delivered along with about 25,000 ppm of H_2O. For traditional vaporizers, high temperature operation leads to H_2O_2 decomposition. Lack of temperature control leads to entrained droplets.

For both bubblers and traditional vaporizers, the differential vaporization rate causes

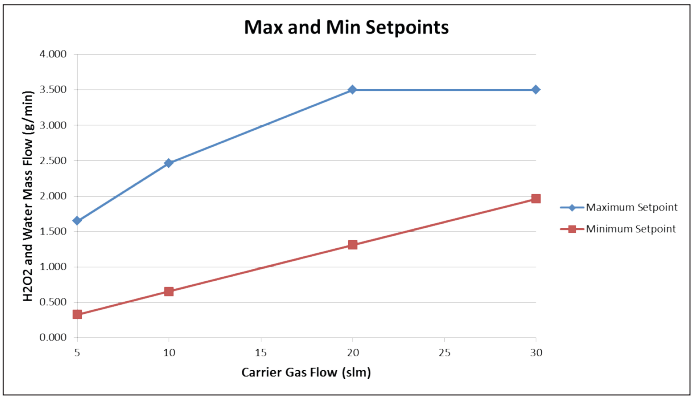

Figure 1 (left): Typical maximum H_2O_2/H_2O mass flow setpoints for a range of carrier gas flow rates. Contact RASIRC if calibration is needed outside this range.

the liquid solution to concentrate and the composition of the process gas to constantly change. This prevents repeatable process control. Process recipes cannot be written around continuously changing mixtures.

The RASIRC Peroxidizer overcomes the issues of Raoult's Law by using a patent-pending in situ liquid concentration method. Its unique vaporizer concentrates the liquid 30% weight H_2O_2 solution to a stable and consistent level that allows up to 50,000 ppm of H_2O_2 gas to flow to process along with H_2O at a ratio of four to one.

Carrier Gas (slm)	H_2O_2 Vapor (ppm)	Total H_2O_2 and water mass flow (g/min)
5	50,000	1.65
10	40,000	2.47
20	30,000	3.5
30	21,200	3.5

Table 1: Typical maximum H_2O_2/H_2O mass flow output using 31% H_2O_2 source.

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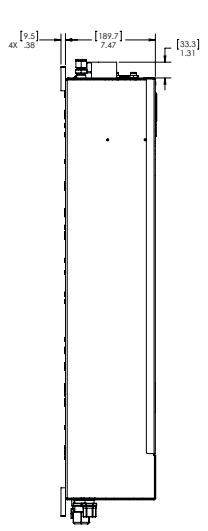
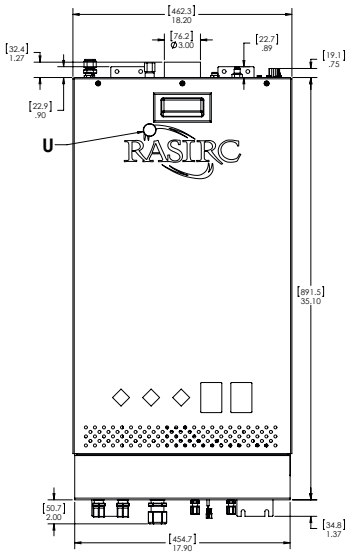
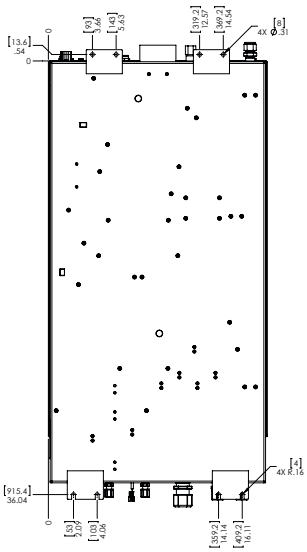


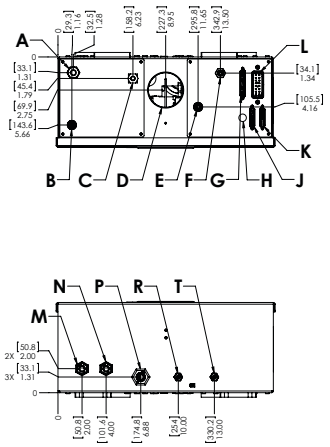
Chemical Cabinet Left View



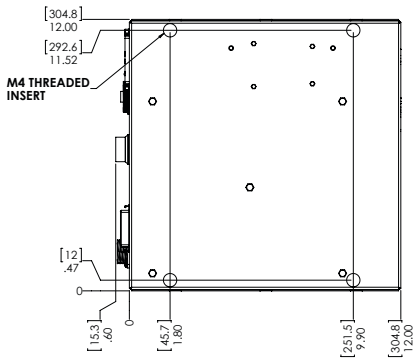
Chemical Cabinet Front View



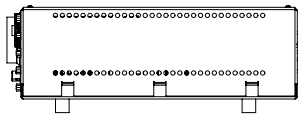
Chemical Cabinet Back View



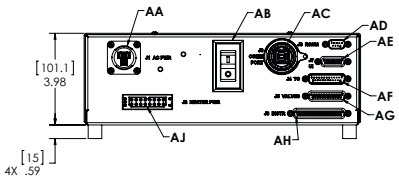
Chemical Cabinet Bottom View



Electronics Box Bottom View



Electronics Box Side View



Electronics Box Back View

	Description	Size/Type
A	H2O2/H2O vapor vent/bypass line	1/2" Female compression, SS
B	Ambient pressure port - **Do Not Use**	**Not Used**
C	H2O2/H2O vapor process line	3/8" Male flare, PFA
D	Cabinet exhaust line/duct	3" Duct adapter
E	Pneumatic gas line	1/4" Push-To-Connect tube fitting
F	Carrier gas supply line	1/4" Male face seal, SS
G	J1 Instrument cable	37 Pin D-sub plug (male)
H	Interlock safety loop	2 position panel mount receptacle, Conxall PN 6380-2PG-318
J	J4 Valves cable	25 Pin D-sub plug (male)
K	J2 TC cable	25 Pin D-sub receptacle (female)
L	J3 Heater cable	16 pin, 15A panel mount connector
M	Chilled water inlet	1/4" Male flare, PFA

	Description	Size/Type
N	Chilled water outlet	1/4" Male flare, PFA
P	Drain	1/2" Female compression, SS
R	H2O2 Bulk fill inlet	1/4" Female compression, PFA
T	DI Water inlet	1/4" Female compression, PFA
U	Process needle valve (NV1) adjustment port	Flathead slot
AA	J1 AC Power	CPC Type XIII, Male
AB	Power Switch	
AC	J3 Comm Port	USB Type B
AD	J8 RS232 Comm Port	9 Pin D Sub Receptacle
AE	J7 Remote Interface	15 Pin D Sub Receptacle, 4-40 screws
AF	J4 TC Cable	25 Pin D Sub Plug
AG	J5 Valves	25 Pin D Sub Receptacle
AH	J6 Instrumentation Cable	37 Pin D Sub Receptacle
AJ	J2 Heater AC Power Cable	

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