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 high H_2O_2 to water 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:

- End users are typically limited to using 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 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 patented, in situ liquid concentration method. Its unique vaporizer concentrates 30% H_2O_2 to a stable and consistent level that allows for delivery of up to 50,000 ppm of H_2O_2 gas at a ratio to water vapor of one to four.

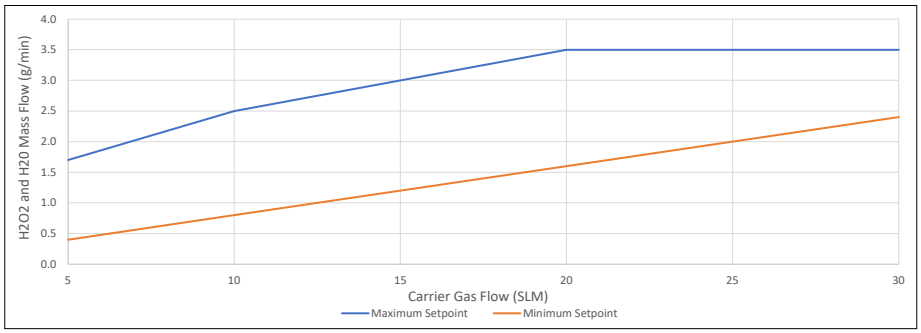

Figure 1: Maximum and minimum H_2O_2/H_2O mass flow setpoints for a range of carrier gas flow rates. Contact RASIRC if calibration outside of this range is required.

Table 1: Approximate maximum H_2O_2/H_2O mass flow output using 31% H_2O_2 source. *Higher mass flow outputs at 30slm are being evaluated.

Carrier Gas (slm)	H_2O_2 Vapor (ppm)	Total H_2O_2 and H_2O mass flow (g/min)
5	50,000	1.7
10	40,000	2.5
20	30,000	3.5
30	20,000	3.5*

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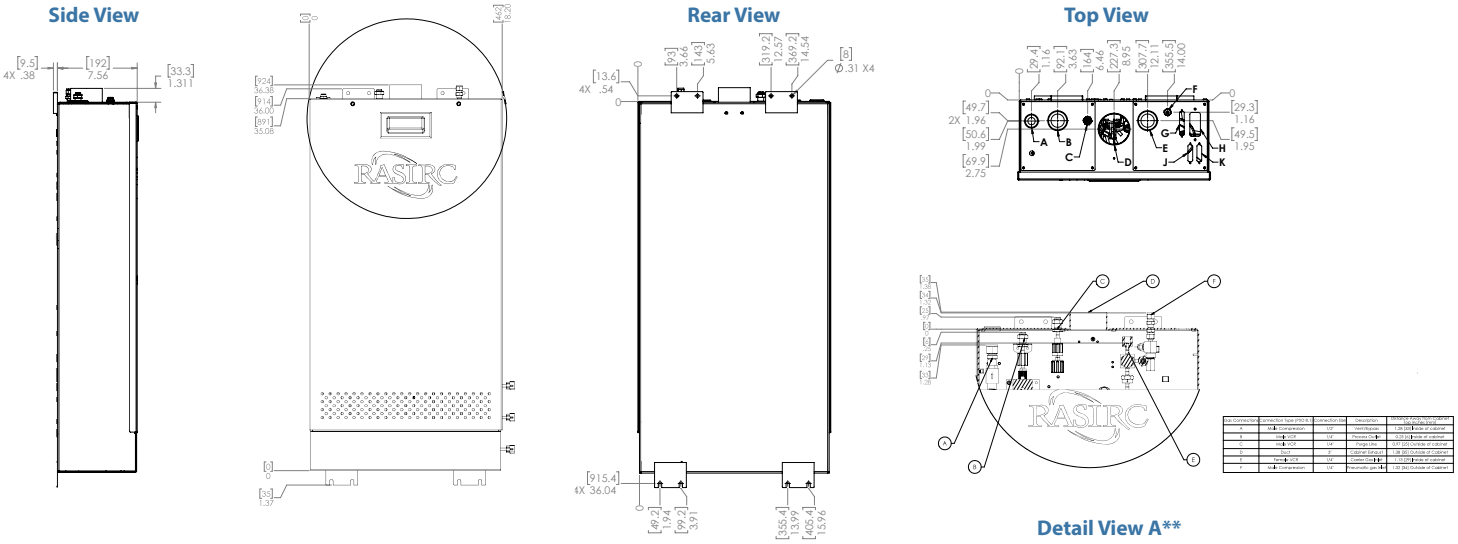

*Figure 2: Peroxidizer chemical cabinet mounting dimensions. **Note for Detail View A: Port locations are taken from the top of the cabinet. Compression fitting measurements are taken to the top of the nut. VCR measurements are taken to the gland toroid.*

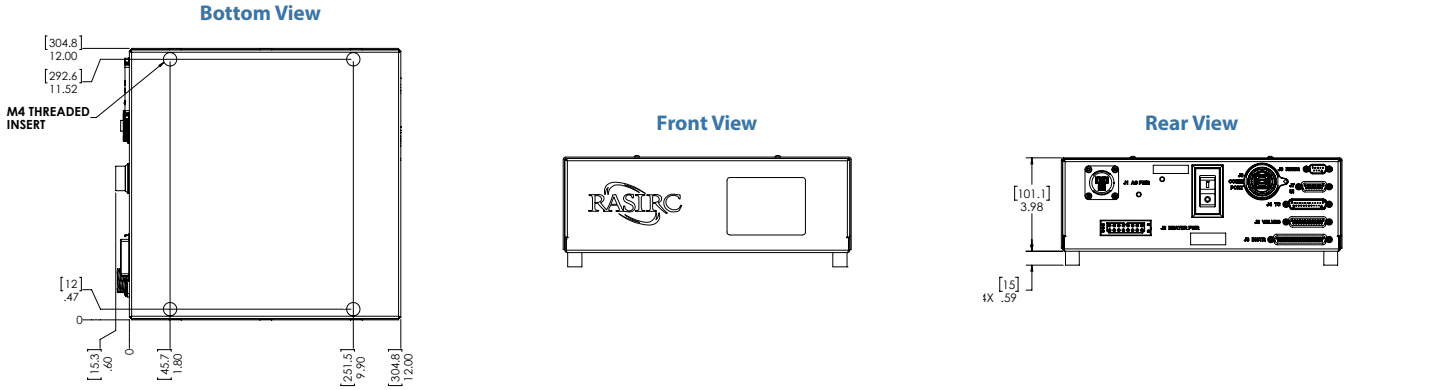

Figure 3: Electronics box mounting dimensions. Must be mounted within 3 meters of the chemical cabinet.

Table 2: Facility gas specifications.

Ref	Description	Size/Type	Specification
A	Vent/Bypass (H2O2 and H2O)	1/2" male compression	Must be maintained at atmospheric pressure and connected to an abatement system. Customer line must be heated to 120°C to prevent condensation.
B	Process Outlet (H2O2 and H2O)	1/4" male VCR	Can be configured for delivey into atmospheric or subatmospheric process pressures.
C	Purge Line Inlet	1/4" male VCR	• Nitrogen, XCDA, Argon • Filtration: 0.003µm • Pressure: Max 0.069MPa (10PSIG), regulated by customer • User is responsible for purge gas flow control. Maximum flowrate: 5SLM.
D	Cabinet Exhaust	3" duct adapter	30-50 cfm @ -0.13 to -0.16 inches H2O, connected to an H2O2 monitor
E	Carrier Gas Inlet	1/4" female VCR	• Nitrogen, Oxygen, XCDA, Argon, Helium • Purity: 99.9999% • Filtration: 0.003µm • Pressure: Min - 0.30MPa, Max - 0.85MPa • Temperature: 17-24°C • Mass flow controller included in the Peroxidizer cabinet
F	Pneumatic Gas Inlet	1/4" male compression	• Nitrogen, XCDA, Argon • Pressure: Min - 0.52MPa, Max - 0.59MPa • Filtration: 0.003µm