

SEMI E49.2-0298

GUIDE FOR HIGH PURITY DEIONIZED WATER AND CHEMICAL DISTRIBUTION SYSTEMS IN SEMICONDUCTOR MANUFACTURING EQUIPMENT

1 Purpose

1.1 This document specifies guidelines for high purity (HP) deionized water and chemical distribution systems in semiconductor production equipment.

2 Scope

2.1 The distribution systems consist of polymer piping designed to supply the following types of liquid chemicals to the process:

- Acids, bases, and oxidizers
- Deionized water
- Corrosive solvents

2.2 Typical tools include wet clean stations, wafer scrubbers, and photolithography coaters and developers.

3 Referenced Documents

3.1 SEMI Standards

SEMI E49 — Guide for Standard Performance, Practices, and Sub-Assembly for High Purity Piping Systems and Final Assembly for Semiconductor Manufacturing Equipment

SEMI E49.7 — Guide for Subsystem Assembly and Testing Procedures - Polymer Systems

3.2 ASTM Standards¹

See Section 3.3 of SEMI E49.

4 Terminology

See Section 4 of SEMI E49.

5 Performance Guidelines

5.1 Leak Tests

5.1.1 Pressure Decay Test

- Test Media — Nitrogen (N₂)
- Pressure — 2.1 kg/cm² (30 psig) maximum
— 1.75 kg/cm² (25 psig) minimum

- Time — 120 minutes
- Fail-Pressure Loss — > 2% of test pressure, after compensation for temperature variation.

5.1.2 Hydrostatic Pressure Test

- Test Media — DI water (pumped)
- Pressurization Media — Nitrogen (N₂)
- Pressure — 2 times operating pressure or 7.0 kg/cm² (100 psig), whichever is less
- Time — 4 hours
- Fail-Pressure Loss — Any pressure loss or any visible leakage, compensated for temperature gradient and/or material expansion.

5.2 Purity Indices

5.2.1 Particle Count (ptc) at ≥ 0.5 μm Size

- < 10 ptc/L average single count
- < 50 ptc/L maximum single count
- Test media is DI water

5.2.2 *DI Water Flush Test* — The specified limit is the difference between incoming and outgoing DI water.

- Resistivity — ± 0.5 Mega ohm-cm
- Total Organic Carbons (TOC) — < 4 ppb

5.3 All performance measures are absolute values, relative to respective test instrument background level.

5.4 See SEMI E49.7 for recommended DI/chemical system testing procedures.

5.5 *Reliability and Maintainability Indices* — Equipment supplier should provide actual DIW/Chemical system performance data and/or component reliability data, accompanied by the associated failure analysis method.

Indices	Hours
Mean time between failure (MTBF)	
Mean time between assists (MTBA)	
Mean time to repair (MTTR)	
Start-up time (Initial)	

¹ American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

6 Design Guidelines

6.1 All polyvinylidene fluoride (PVDF) should be thermally socket welded, as a minimum, using interactive automated welding equipment. Thermal butt welding is preferred.

6.2 All perfluoroalkoxy (PFA) tubing should be joined with flare compression type technique. Flaring can be done at room temperature or at elevated temperature, depending on the technique required by the component supplier.

6.3 All PFA pipe should be thermally butt welded, using interactive automated welding equipment.

6.4 Dead volume areas should be minimized by the use of close connected bypass or bleed-through loops. Dead legs should be < 5 pipe diameters.

6.5 System internal volume should be minimized by the use of close fit adapters and fittings. Dead Space Free (DSF) branch valves and/or multi-component integrated assemblies are optional.

6.6 The DIW distribution system should have a continuous flow with a velocity of ≥ 0.3 m/s (1 fps).

6.7 Pipe thread type connections should not be used.

6.8 Flow meters should be installed in return side of DI water system.

6.9 Backflow/back pressure protection should be included in the system.

6.10 The system should use tee fittings and branch valves to accomplish flush, test, and sample ports. Sample ports should be located as close as possible to the chemical supply point, either to bath/tank or process chamber and also at the DIW return header, immediately before exit.

6.11 Provisions to flush and drain the chemical system completely with DIW should be included in the system.

6.12 Pumping systems should include surge/pulse suppression devices and provisions for vibration isolation.

6.13 Filters should be included on all chemical mixture recirculation loops.

6.14 All filters should be able to be isolated from process stream for maintenance.

6.15 For processes requiring pressure control, regulators should be included in the system.

6.16 The system should have a means of manifolding supply and drain lines onboard, so that there is a single point of connection for each individual liquid.

7 Materials Guidelines

7.1 All polymers for wetted flow streams should be virgin materials without filler or inert additives.

7.2 Polymer Material Types

7.2.1 High purity grade PFA or a material specified by the customer should be used for the chemical distribution system (acids/caustics).

7.2.2 High purity grade PVDF or high purity grade PFA should be used for the DI distribution system.

7.2.3 Valves, regulators, diaphragms, and custom components in both the DI water and chemical distribution systems can also be PTFE.

7.3 Source Material Mechanical Characteristics

7.3.1 All piping, tubing, and other components should conform to the manufacturer's published data regarding the following: dimensional tolerances, flow characteristics, mechanical strength characteristics, and melt temperature indices.

7.3.2 When such data is unavailable from the manufacturer, historical information of most similar products should be used for comparative purposes.

7.3.3 Manufacturer should advise purchaser in writing of any liquid stream that causes degradation of the material after purchaser states the intended use of the product.

7.3.4 Components made by the same manufacturer and intended to be joined together should have inner and outer diameters within $\pm 2\%$ of the wall thickness.

7.4 Material Performance Guidelines

7.4.1 The performance guidelines below are polymer qualification values to be demonstrated by the original component manufacturer. Semiconductor equipment suppliers should provide proof that their components conform to these requirements.

7.4.2 The performance tests should be considered production qualification tests. It is the responsibility of the component manufacturer to provide statistically significant data which correlates their production tests to these qualification tests (e.g., Statistical Process Control, MIL-STD-105D).

7.4.3 The equipment supplier should be responsible for maintaining and supplying, upon request, documentation that proves their components meet the user's materials performance requirements.