

SEMI F63-0701

GUIDELINES FOR ULTRAPURE WATER USED IN SEMICONDUCTOR PROCESSING

This specification was technically approved by the Global Facilities Committee and is the direct responsibility of the North American Facilities Committee. Current edition approved by the North American Facilities Committee on April 30, 2001. Initially available at www.semi.org May 2001; to be published July 2001.

1 Purpose

1.1 This guide is provided for multiple purposes. It may be used as a basis for establishing performance criteria for purchases of new UPW equipment. It may also be used internally by facility engineers to set process control parameters for the operation of their UPW systems. This guide may be used by process engineers to establish reasonable expectations about the quality of the UPW being supplied to them by facilities.

NOTICE: These suggested guidelines are published as technical information and are intended for informational purposes only.

2 Scope

2.1 Water is used extensively in the production of semiconductor devices for all wet processing steps such as the rinsing of wafers. Ultrapure Water (UPW) is typically produced for this purpose using Reverse Osmosis/Deionized resin bed technologies. The quality of the water impacts device yield and as linewidths decrease, requirements for higher purity water may increase.

2.2 This standard does not purport to address safety issues, if any, associated with its use. It is the responsibility of the users of this standard to establish appropriate safety health practices and determine the applicability or regulatory limitations prior to use.

3 Referenced Standards

NOTE 1: As listed or revised, all documents cited shall be the latest publications of adopted standards.

3.1 SEMI Standards

SEMI F61 — Guide For Ultrapure Water System Used in Semiconductor Processing

3.2 ASTM Standards¹

ASTM D-5127 — Standard Guide for Ultra Pure Water Used in the Electronics and Semiconductor Industry.

ASTM F-1094 — Test Method For Microbiological Monitoring of Water Used For Processing Electron and Microelectronic Devices by Direct- Pressure Tap Sampling Valve and by the Pre-sterilized Plastic Bag Method.

4 Limitations

4.1 This guide is not intended to set an absolute number for performance of a particular UPW system. Performance guidelines should be determined based on the design of the UPW system, the components used in the water system, the sensitivity of the manufacturing process to the purity of the water, the sensitivity of the instrumentation, and the budget available to maintain and monitor the water system.

4.2 This set of guidelines has been established from a variety of sources and inputs including 1.) an industry survey that SEMI provided to members of its standards activities in facilities; 2.) typical UPW levels from a large selection of semiconductor UPW systems as measured by several independent laboratories that test high purity water for the semiconductor industry; 3.) specifications from water system equipment manufacturers; 4.) and input from producers and users of UPW during SEMI standards committee meetings and through the balloting process. However, it is up to each individual owner of a UPW system to set specifications for the purity of its water based on its own needs and available resources.

4.3 This guide is reflective of a particular design approach for a UPW system. The guidelines can be produced from a properly maintained UPW system as described and diagrammed in SEMI F61 and is typical output from existing high-end semiconductor manufacturing plants with state-of-the-art water systems. The purity of water generated in other types of water systems may differ greatly.

4.4 The guidelines are targeted to UPW produced for semiconductor manufacturing. There exists an ASTM standard D5127 which should be considered in setting specifications for the purity of reagent grade water needed in a laboratory for analytical testing of semiconductor materials and process chemicals.

¹ American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, website: www.astm.org

5 Use of the Guidelines

5.1 Sampling methods and contamination control are of paramount importance when attempting to measure the listed parameters at the levels specified.

5.2 The quality of the data measured will depend on which testing method and calibration techniques are used. Consequently, trends observed in the values may be more meaningful than absolute values.

6 Units

6.1 Parts per billion (ppb) is equivalent to ng/mL or µg/L.

6.2 Parts per million (ppm) is equivalent to mg/L.

6.3 Micron is a unit of length equal to one millionth of a meter, or one thousandth of a millimeter.

6.4 Colony Forming Units (CFU) is a measurement of bacteria organisms.

7 Description of Parameter Tests

NOTE 2: Since SEMI Guidelines do not require analytical data or methods to support them, the recommendation of specific analytical methods are only for informational purposes. Alternative methods may also be applicable.

7.1 Resistivity (megohm-centimeters or Mohm-cm)

7.1.1 Resistivity (conductivity) is only measured accurately with on-line instrumentation. 18.25 MOhm is the theoretical upper limit for pure water at 25°C.

7.2 Total Oxidizable Carbon (TOC) (ppb)

7.2.1 Involves oxidation of organic materials and detection of carbon dioxide produced by the reaction, as measured in conductivity or infrared photometry.

7.3 Dissolved oxygen (ppb) is only measured accurately with on-line instrumentation.

7.4 Particulate Matter (Particles/L)

7.4.1 On-line methods using laser technology are recommended for accurate trend analysis.

7.5 Bacteria (CFU/L)

7.5.1 Triplicate samples are cultured based on the ASTM method F 1094 using a minimum sample size of 1L.

7.6 Silica

7.6.1 Total Silica (ppb) may be measured by Graphite Furnace Atomic Absorption Spectrophotometry (GFAAS), Inductively-Coupled Plasma Atomic Emission Spectroscopy (ICP-AES) or Inductively Coupled Plasma Mass Spectroscopy (ICP-MS).

7.6.2 Dissolved Silica (ppb as SiO₂) may be measured by heteropoly blue photometry or by Ion Chromatography.

7.7 Ions and Metals (ppb)

7.7.1 Many anions and cations may be determined using Ion Chromatography.

7.7.2 Up to 68 metals may be determined by GFAAS, ICP-AES, or ICP-MS. Most typically measured metals are shown in Table 1.

8 Parameters and Typical Concentrations

8.1 Table 1 lists each parameter with its range of performance.

Table 1 Parameters and Range of Performance

<i>Typical Linewidth</i>	<i>0.13 to 0.5 MICRONS</i>
PARAMETER	RANGE OF PERFORMANCE
Resistivity on-line @ 25°C (Mohm-cm)	17.9 to 18.2
TOC on-line (ppb)	1 to 5
Dissolved Oxygen on-line (ppb)	0.5 to 20
On-line Particles/L (micron range)	
0.05-0.1	100 to 1000
0.1-0.2	50 to 500
0.2-0.3	20 to 100
0.3-0.5	10 to 50
> 0.5	0 to 4
Bacteria (CFU/L)	
1 L Sample	0 to 5
Silica	
Silica - total (ppb)	0.5 to 3
Silica - dissolved (ppb as SiO ₂)	0.2 to 1
Ions & Metals (ppb)	
Ammonium	0.02 to 0.1
Bromide	0.02 to 0.1
Chloride	0.02 to 0.1
Fluoride	0.02 to 0.1
Nitrate	0.02 to 0.1
Nitrite	0.02 to 0.1
Phosphate	0.02 to 0.1
Sulphate	0.02 to 0.1
Aluminum	0.02 to 0.1
Barium	0.02 to 0.1
Boron	0.02 to 20
Calcium	0.02 to 0.1
Chromium	0.02 to 0.1