

SEMI F70.1-0320

TEST METHOD FOR DETERMINATION OF PARTICLE CONTRIBUTION OF GAS DELIVERY SYSTEM AND ITS COMPONENTS THROUGH PULSED TESTING

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1 Purpose

1.1 The purpose of this Document is to provide a standardized methodology and procedure for measuring the particle contribution performance of a gas delivery system and its components in terms of number of particles per switch added to gas flowing through the system by switching components. This standardized procedure is intended to generate design related information or verify gas delivery design, to be used by gas delivery system suppliers, equipment suppliers, component suppliers and end-users, especially for concept design calculations, prototype testing and design releases.

2 Scope

2.1 This Test Method focuses on pulsed testing which measures particle contribution per switch.

2.2 This Test Method applies to surface mount and conventional gas delivery systems used in semiconductor manufacturing equipment and the components with switching functions used in systems where gas purity is an important factor. This may range from clean dry air systems (e.g., used for wafer handling systems) to ultra-high purity systems (e.g., used for gas systems for chemical processes).

2.3 SEMI E66 describes a test method for testing mass flow controllers (MFCs). As MFCs are also valves that may be used for switching, the sampler from this Standard (SEMI F70.1) can also be used in combination with the method of Standard SEMI E66. When MFCs are also used for switching, the procedure from this Standard may be applicable to determine the particle contribution per switch.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

3 Limitations

3.1 This Test Method is limited to a maximum flow rating of 200 standard liters per minute (slm) because this Test Method is intended for point-of-use components used in the semiconductor equipment.

3.2 Due to time-intensive nature of pulsed testing, it may not be suitable for production-type testing and certification of gas delivery systems.

3.3 Proposed test does not address side-by-side comparison of components as test conditions may vary. It does, however, document test conditions.

4 Referenced Standards and Documents

4.1 SEMI Standards and Safety Guidelines

SEMI E66 — Test Method for Determining Particle Contribution by Mass Flow Controllers

NOTICE: Unless otherwise indicated, all documents cited shall be the latest published versions.

5 Terminology

5.1 Abbreviations and Acronyms

5.1.1 CDA — clean dry air

5.1.2 CNC — condensation nucleus counter

5.1.3 *DUT* — device (or system) under test

5.1.4 *LPC* — laser particle counter

5.1.5 *MFC* — mass flow controller

5.1.6 *slm* — standard liters per minute

5.2 Definitions

5.2.1 *background counts* — particle counts contributed by the test apparatus (including false counts) with the spool piece in the place of the test object.

5.2.2 *counting efficiency* — the ratio of the particle concentration calculated from the particle counts to the actual particle concentration in the sampled gas for particles equal to or larger than a given particle size.

5.2.3 *design flow* — flow normally applied to the gas delivery system.

5.2.4 *false counts* — particle counts contributed by electrical noise or by other events and not particles in the sampled gas.

5.2.5 *gas delivery system* — a system installed in semiconductor manufacturing equipment comprised of one or more lines to supply process and carrier gases to reactors, other mini environments, air bearings and handling equipment for particle sensitive material. The system typically includes tubing, fittings, valves, filters, mass flow controllers and regulators. These components can be surface mount or conventional type.

5.2.6 *minimum counting particle diameter* — a predefined minimum diameter of particles to be counted in this Test Method.

5.2.7 *particle counts* — a counted value from a laser particle counter (LPC) or condensation nucleus counter (CNC) obtained for particles larger than or equal to the minimum counting particle diameter.

5.2.8 *pulsed test* — a test performed to determine particle contribution as a result of actuation of valves in the gas delivery system.

5.2.9 *sampler* — a system used to perform partial sampling of the gas stream exiting the test system, that consists of a diffuser equipped with a pressure reducing device in which gradual expansion to atmospheric pressure occurs and a sample probe.

5.2.10 *sample flow* — the volumetric flow through the particle counter.

5.2.11 *sampling time* — the time span over which particle counts are recorded.

5.2.12 *spool piece* — a null component consisting of a straight piece of electropolished tubing or like object and appropriate fittings used in place of the test system to establish the background.

5.2.13 *standard liters per minute (slm)* — the gas volumetric flow measured in liters per minute at 0°C and 101.3 kPa (1 atm).

5.2.14 *static test* — a test performed to determine particle contribution with all components in the gas delivery system in open position.

5.2.15 *test flow* — the volumetric flow through the test system at test pressure and temperature.

5.2.16 *test pressure* — the pressure immediately downstream of the system under test.

5.2.17 *total test volume for pulsed test* — test flow multiplied by the duty cycle and the sampling time.

6 Required Apparatus

6.1 For the specifications of the components of the required apparatus, please refer to the Primary Standard SEMI F70, § 6.

6.2 *Expansion Vessel* — For pulsed testing a special sampler should be used to perform sampling of pressure pulsed gas streams, exiting the test system. This replaces the definition of the sampler from the Primary Standard SEMI F70. This special type of diffuser consists of a defined volume in which the pulsed gas stream can expand. On the side of this volume there is an opening to the ambient environment that is able to even out the pressure pulses and is able to

release excessive gas when the average flow is larger than the sample flow. If the average flow is smaller than the sample flow, air will flow from the ambient environment into the sampler, so that the needed extra flow can be added to the sampling volume. The air that is taken in over this opening must be of the same quality as the Test Gas. The particle counter pumps the required sample flow into a continuous gas stream from this volume. For more details on pressure pulsed sampling, refer to Related Information 1.

7 Test Condition

7.1 For the specifications of the test condition, please refer to the Primary Standard SEMI F70, § 7.

8 Preparation of Apparatus

8.1 All components must meet quality requirements (dimensional, functional, etc.) as established and controlled by manufacturers prior to testing. Care should be exercised in handling of components to maintain manufacturer's specifications.

8.2 For pulsed testing, the sampler must be able to reduce the pressure pulses to ambient. For this, special equipment is necessary, such as the expansion vessel described in § 6.2. to retrieve a valid measurement during the dynamic switching of the valves, MFCs or regulators.

8.3 Set up apparatus and the gas supply system as shown in Figure 1.

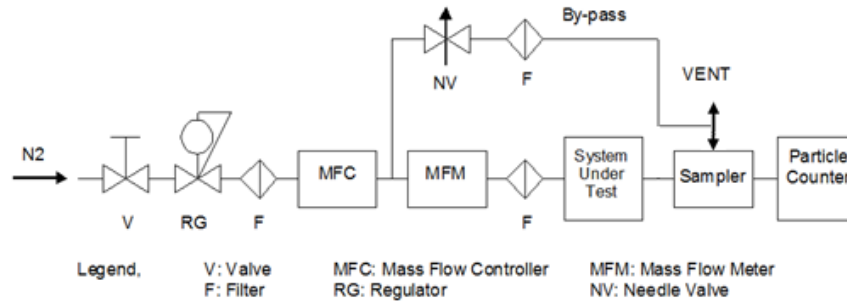


Figure 1
Test Set Up Basic Flow Diagram

8.4 If the average test flow is less than the sample flow, required by the particle counter, add make up test gas (N_2 , Ar, or clean dry air [CDA]) to fulfill the sample flow as shown in Figure 2 or 3. The extra flow of clean gas around the opening in the diffuser can be drawn in by the pump of the particle counter. This extra flow is intended to be equal or just a little more than the sample flow.

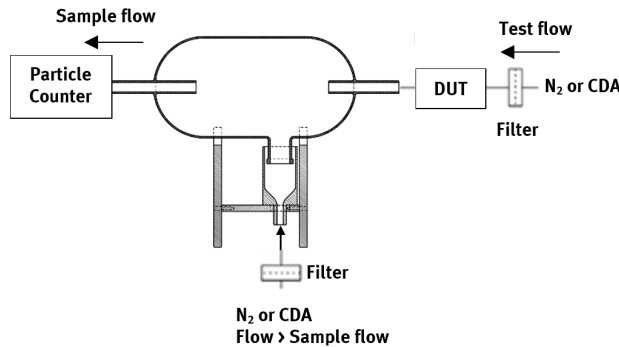


Figure 2
Pulsed Sampling when Test Flow $\leq$ Sample Flow

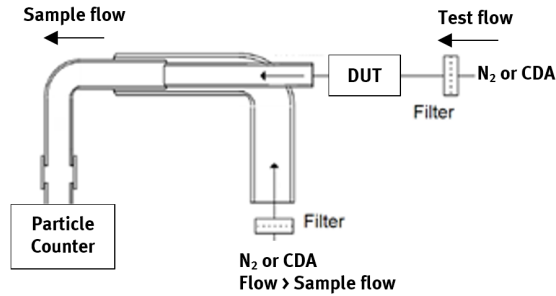


Figure 3
Full Sampling when Test Flow $\leq$ Sample Flow

8.5 If the test flow is higher than the sample flow required by the particle counter, use the sampler for partial sampling (see Figures 4 and 5). To establish the test flow and obtain an isokinetic condition, it is required to adjust the MFC in the test set up and the NV on the by-pass line. The by-pass line is required to have a capability to handle the maximum test flow when the valves in the system under test are closed during the pulsed test.

NOTE 1: This Test Method is validated by comparing the results from the same components using setup Figures 2 and 3 in a setup with an LPC. The validation tests show that both methods give the same result.

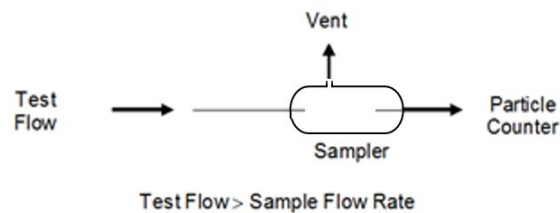


Figure 4
Partial Sampling (Pressure Pulsed)

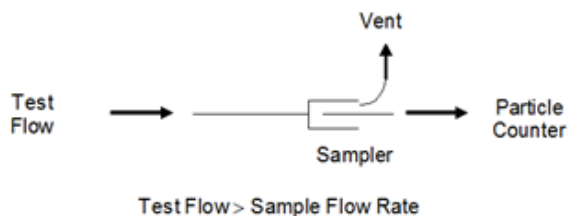


Figure 5
Partial Sampling

9 Procedure

9.1 A typical gas delivery system configuration is shown in Figure 6. But also a single component like a valve or MFC can be assigned as being a DUT (see § 9.4 for further instructions). The following test procedure shall be interpreted to apply to the actual test system and recorded by the operator.