SEMI E67-1011 (Reapproved 0218)
TEST METHOD FOR DETERMINING RELIABILITY OF MASS FLOW CONTROLLER

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1 Purpose

1.1 This Document describes a method to help determine the ability of a mass flow controller (MFC) to meet the manufacturer's published specifications over its life time. The results of the test will also be useful in the comparison of MFCs.

2 Scope

2.1 This procedure applies to MFCs used in semiconductor gas systems.

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 procedure is to be used only in conjunction with another existing parametric test for mass flow controllers to obtain the reliability data for that particular parametric test.

3.2 New MFCs shall be used for reliability testing. An MFC that has been put through this Test Method may be tested for reliability again.

3.3 In addition to this procedure, the parametric test may also cycle the valve. These cycles should be ignored for determining the cumulative cycles that are described in the data table.

3.4 This test will not address root cause analysis of failures.

3.5 Read points have been selected for this test procedure so that the test will take approximately six months to complete. The read point schedule given is only a suggested schedule and if the user feels that a different read point schedule would better suit his needs, this Test Method can still be used to obtain reliability data.

4 Referenced Standards and Documents

4.1 *SEMI Standards and Safety Guidelines*

SEMI C59 — Specification for Nitrogen

SEMI E17 — Guide for Mass Flow Controller Transient Characteristics Tests

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

SEMI E69 — Test Method for Determining Reproducibility and Zero Drift for Thermal Mass Flow Controllers

SEMI F1 — Specification for Leak Integrity of High-Purity Gas Piping Systems and Components

4.2 *Other Documents*

Nelson, Wayne, Applied Life Data Analysis, New York, NY Wiley, 1982.

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

5 Terminology

5.1 *Abbreviations and Acronyms*

5.1.1 *MFC* — mass flow controller

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5.1.2 *UHP* — ultra-high purity

5.2 *Definitions*

5.2.1 *cycle* — a repeating sequence of setpoints applied to the MFC.

5.2.2 *hard failure* — a failure that renders a MFC permanently incapable of performing in accordance with the manufacturers specifications.

5.2.3 *parametric test* — the test method that determines the data for which reliability information is sought (e.g., accuracy test or particle test, SEMI E66).

5.2.4 *readpoint* — cumulative cycles applied to the MFC.

5.2.5 *reliability* — the probability that the equipment will perform its intended function, within stated conditions, for a specified period of time.

5.2.6 *soft failure* — failure that occurs when an MFC is temporarily incapable of meeting manufacturer's specification for the parameter under test.

6 Summary of Method

6.1 The MFC is installed in a fixture capable of applying and recording a number of flow cycles. When the number of cycles specified in the readpoint schedule is reached, cycling is suspended, parametric tests are performed, and the cycling is resumed until either the next readpoint is reached, or the MFC experiences a hard failure. After the cycling is completed, the parametric test data is analyzed to determine the reliability of each parameter.

7 Interferences

7.1 This test provides an estimate of the reliability of a mass flow controller. The results of the test will also be useful in the comparison of MFCs. The data provided by this test can help end users determine the reliability of equipment that uses MFCs.

7.2 The following parameters and associated test methods should be tested with this Test Method to obtain reliability data in Table 1:

Table 1 Related Test Methods

Parameter	*Test Method*
Particle Contribution	SEMI E66
Reproducibility and Zero Drift	SEMI E69
Helium Leak Rate	SEMI F1
Step Response	SEMI E17

7.3 The following modifications to the preceding parametric test methods are suggested to abbreviate the time required to complete the reliability test:

7.3.1 *SEMI E66 (Particle Contribution)* — Abbreviate this test method to perform only the dynamic control mode test. Perform ¶¶ 12.1.3 and 12.1.7, and eliminate ¶¶ 12.1.2, 12.1.4, 12.1.5, 12.1.6, 12.1.8, 12.1.9, and 12.1.10. Refer to ¶ 5.2.1 (Background), ¶ 5.2.3 (Dynamic), and Figure 5 (Particle Test Flow Chart).

7.3.2 *SEMI E69 (Reproducibility and Zero Drift)* — Omit ¶¶ 12.1 and 12.2.

7.3.3 *SEMI F1 (Leak Integrity)* — The intent of the reliability test method is to detect the development of gross leaks in the DUT due to cycling of the DUT valve. The inboard component leak test portion of this Standard should be performed.

7.3.4 *SEMI E17 (Step Response)* — No abbreviation is necessary for this test.

7.4 Change in the performance characteristics of the MFC, as measured by the above tests, may also be monitored and analyzed as indicative of drift.

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8 Apparatus

8.1 In addition to the apparatus listed below, the user must also acquire any apparatus required to perform the parametric test for which reliability data is needed. (See documents cited in ¶ 7.2.)

8.1.1 Power supply,

8.1.2 NIST-traceable flow calibration system (or equivalent recognized standards agency),

8.1.3 *MFC Control Cables* — As many as required in ¶ 8.1.4,

8.1.4 *MFCs* — For controlling test flows in addition to the DUT MFCs, as many as required for the test setup,

8.1.5 Cycling fixture.

9 Reagents and Materials

9.1 In addition to the materials listed below, the user must also acquire any materials required to perform the parametric test for which reliability data is needed. (See documents cited in ¶ 7.2.) Since reliability data for leak integrity is being sought, helium cannot be used during the cycling procedure.

9.1.1 Source of nitrogen (99.999%) per SEMI C59, Sampling, Test Specimens, and Test Units.

9.2 Three MFCs are required for meaningful data analysis. However, 20 to 30 MFCs are a recommended minimum. A larger sample size provides a more precise estimate of reliability.

10 Safety Precautions

10.1 It is the responsibility of the users of this Standard to establish appropriate safety and health practices and determine the applicability of regulatory or other limitations prior to use.

11 Preparation of Apparatus

11.1 The setup for the parameter under test is described in the document for that particular parameter (see ¶ 7.2).

12 Calibration and Standardization

12.1 Any required instrument calibration or use of reference standards must be done in accordance with the particular parametric test for which reliability data is needed.

13 Procedure

13.1 Connect all MFCs under test in parallel.

13.2 Perform the parametric test before any cycling is done and note the resulting data on the data sheet (Table 2). This is the first read point (see Figure 1).

Table 2 Data Sheet for Reliability Testing

READ POINT (Cumulative cycles applied to the MFC)	*FAILURE TYPE — SOFT OR HARD*	*SOFT FAILURE TYPE*[#1]
0 (baseline)		
10,000		
40,000		
100,000		
200,000		
300,000		
450,000		
600,000		
750,000		
875,000		

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