Background Statement for SEMI Draft Document 4631
REAPPROVAL OF SEMI E68-0997 (Reapproved 1103)
TEST METHOD FOR DETERMINING WARM-UP TIME OF MASS FLOW CONTROLLERS

Note: This background statement is not part of the balloted item. It is provided solely to assist the recipient in reaching an informed decision based on the rationale of the activity that preceded the creation of this document.

Note: Recipients of this document are invited to submit, with their comments, notification of any relevant patented technology or copyrighted items of which they are aware and to provide supporting documentation. In this context, “patented technology” is defined as technology for which a patent has issued or has been applied for. In the latter case, only publicly available information on the contents of the patent application is to be provided.

Background

SEMI E68-0997 (Reapproved 1103) is due for its Five Year Review. This process is required by the SEMI Regulations to ensure that the standard is still valid.

At the SEMICON West Standards Meeting, San Francisco, California, the NA Gases Committee approved for yellow ballot distribution for the reapproval of SEMI E68-0997 (Reapproved 1103)

This technical ballot is intended for the re-approval of SEMI E68-0997 (Reapproved 1103) since the contents of this standard are still technically valid.

The results of this ballot will be discussed at the next Mass Flow Task Force and adjudicated by the Gases Committee during their meetings at SEMI HQ in San Jose, CA, during the week of 3rd November, 2008.
SEMI Draft Document 4631
REAPPROVAL OF SEMI E68-0997 (Reapproved 1103)
TEST METHOD FOR DETERMINING WARM-UP TIME OF MASS FLOW CONTROLLERS


1 Purpose
1.1 The purpose of this method is to provide a standardized method for quantifying the warm-up time of an MFC.

NOTE 1: Warm-up times affect the initial performance of a mass flow controller (MFC). Warm-up time is necessary information in deciding if a process tool is ready to be put back into service. In addition, warm-up data will be useful in calibration labs.

2 Scope
2.1 The test conditions in this method are intended to simulate bench top warm-up, with an MFC that has been equalized to ambient conditions for 24 hours before the application of power.

NOTICE: 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 and health practices and determine the applicability of regulatory or other limitations prior to use.

3 Limitations
3.1 Conditions in the lab may be different from conditions found in the field and may influence test results. This test is intended to measure warm-up under a controlled condition.

3.2 The MFC is to be at ambient temperature before the beginning of the test.

3.3 Due to manufacturing variability, warm-up times may vary for the same model of MFC. This specification addresses a method for taking a single data point repetitively from the same MFC. Resulting data will show exactly how warm-up effects change the delivered flow of that particular MFC. To statistically quantify warm-up time for a particular model of MFC, multiple samples should be tested.

4 Referenced Standards and Documents
None.

5 Terminology
5.1 Abbreviations and Acronyms
5.1.1 DUT — Device under test
5.1.2 FS — Full scale
5.1.3 MFC — Mass flow controller
5.2 Definitions
5.2.1 device under test — the MFC being tested for warm-up time.
5.2.2 indicated flow — flow indicated by the MFC under test. Electrical output of the DUT.
5.2.3 stability — a condition that exhibits only natural, random variations in the absence of unnatural, assignable-cause variations. For the several purposes of this test, stability is defined as ±10% of the accuracy of the DUT at full scale.
5.2.4 steady state — state at which the indicated flow is stable for a 15-minute time period.
5.2.5 **warm-up** — a process where the MFC goes from an unpowered condition to a condition where the output is within ±1% full scale, of the final steady state output.

**6 Summary of Test Method**

6.1 The DUT is connected in series with shut-off valves on either side of the DUT. With no gas flow and the DUT powered, indicated flow is monitored until steady state is achieved. Power is briefly disconnected then reconnected and indicated flow is again monitored until steady state is achieved.

**7 Significance and Use**

7.1 Data generated by this method is used to estimate the amount of time an MFC should be powered up in a process tool before resuming production. When calibrating an MFC, the warm-up time can be used to estimate the waiting time before calibration. For power interruptions, the power interruption warm-up time may be used to determine the time required following a power interruption to resume production or calibration.

**8 Apparatus**

8.1 See Figure 1.

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**Figure 2**

Test Set Up

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8.2 *Time-Keeping Apparatus* — Capable of keeping accurate records within ± 10 seconds. Time-keeping requirements are not stringent, and almost any apparatus is acceptable.

8.3 *Data Acquisition System* — Having a resolution of one mV or better and a sample rate of one Hz.

**9 Conditioning**

9.1 Ambient temperature must be controlled and stable between 20°C and 25°C during testing for all tests. The DUT must be exposed to the ambient environment for 24 hours before the beginning of the test so that it is in equilibrium. The gas temperature must be measured and verified to be at equilibrium with both the DUT and with ambient temperature. Temperatures are in equilibrium if they are within 1°C of each other. Lab temperature may not change more than 1°C during test.
10 Procedure

10.1 Connect the DUT in series with the two shut-off valves, one upstream of the DUT and the other downstream. Electronically connect the DUT to a data acquisition system capable of recording indicated flow from the DUT. The test set-up should be set to give appropriate signals to the DUT so the DUT control valve will not dissipate power. For normally closed MFC’s, the setpoint should be zero, and for normally open MFC’s, the setpoint should be 100%. Suggested orientation of the DUT is horizontal (base down). If the DUT is positioned otherwise, the orientation should be reported in the test data (see Figure 1). Valves are to be opened in a downstream-to-upstream sequence and closed in reverse fashion. The data acquisition system must be warmed up as per the manufacturer’s instructions.

10.2 Close shut-off valves.

10.3 In Table 1, record the time of day when power was applied to the DUT. Begin recording the indicated flow from the DUT at one sample per second.

<table>
<thead>
<tr>
<th>Warm-up Time</th>
<th>Date:__________</th>
</tr>
</thead>
<tbody>
<tr>
<td>± 1% FS</td>
<td>Time to Achieve Steady State Value</td>
</tr>
<tr>
<td>Cold Start</td>
<td></td>
</tr>
<tr>
<td>Power Interruption</td>
<td></td>
</tr>
</tbody>
</table>

10.4 **Cold Start** — Apply power to the DUT and continue collecting data until the indicated flow achieves a steady state value.

10.5 **Power Interruption** — Continue to collect data while disconnecting power from the test unit for 120 ± 10 seconds. Reconnect power to the DUT and monitor indicated flow until steady state is again achieved.

11 Data Analysis

11.1 Graph the data collected from the six test scenarios as directed in Section 10.

11.2 The time required for the DUT to achieve a steady state value can be visually determined from the graph of each test scenario. This data can be used to predict the warm-up times required by an MFC experiencing a field condition similar to the test scenario.

12 Data Presentation

12.1 For the two tests in Section 10, plot DUT indicated flow vs. time as illustrated in Figures 2 and 3. Note the following on these graphs and in Table 1.
Figure 3
Cold Start Warm-Up Time

Steady State Value = 0.3% FS
Time To Achieve +/- 1% FS = 10 Min.
Time to Achieve SS = 30 Min

Time elapsed since power was applied to DUT (minutes)
12.1.1 Final steady-state value of the DUT.

12.1.2 Time to achieve a steady state value.

12.1.3 Use Table 1 to summarize warm-up times associated with each of the test scenarios.

13 Precision and Bias

13.1 Precision and bias in this test are a function of the uncertainty of the measurement equipment used. The tester or end user is responsible for determining the precision and bias of a particular setup and test.

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