

SEMI E80-0299 (Reapproved 1104)

TEST METHOD FOR DETERMINING ATTITUDE SENSITIVITY OF MASS FLOW CONTROLLERS (MOUNTING POSITION)

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1 Purpose

1.1 The purpose of this test method is to provide a standardized method for quantifying the effect of mounting attitude on an MFC.

1.2 This document provides a common basis for communication between manufacturers and users regarding testing and describing MFC mounting effects.

2 Scope

2.1 This procedure describes a method to determine the effect of attitude (mounting position) of a Mass Flow Controller on flow span and zero.

2.2 The intent of this document is not to suggest any specific testing program but to specify the test method to be used when testing for parameters covered by this method. Reference operating conditions represent the environmental conditions where the "best" performance can be expected.

2.3 The minimum test described in this document is to test one MFC in 5 common mounting positions using Nitrogen gas at 135.8 kPa (19.7 psia) and 308 kPa (44.7 psia). This test method can be used to evaluate additional gases, pressures or mounting attitudes.

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 It is not practical to evaluate performance under all possible combinations of operating conditions. This test procedure should be applied under laboratory (reference) conditions; its intent is to collect sufficient data to form a judgment of the field performance of the MFC being tested.

3.2 The results from this test represent the performance of the specific device tested i.e., make, model, full scale flow and operating conditions. The results may not apply to devices of different manufacture, model, full scale flow or under different operating conditions.

3.3 Due to manufacturing variability, attitude sensitivity may vary for the same model of MFC. To statistically quantify attitude sensitivity for a particular model of MFC, multiple samples should be tested.

4 Referenced Standards

None.

5 Terminology

5.1 Acronyms and Abbreviations

5.1.1 % F.S. — Percent Full Scale

5.1.2 DUT — Device Under Test

5.1.3 HBD — Horizontal Base Down. Mounting attitude 1, as shown in Figure 1.

5.1.4 HED — Horizontal Either side Down. Mounting attitude 3, as shown in Figure 1.

5.1.5 HUD — Horizontal Upside Down. Mounting attitude 5, as shown in Figure 1.

5.1.6 kPa — KiloPascal

5.1.7 MFC — Mass Flow Controller

5.1.8 psia — Pounds per Square Inch Absolute

5.1.9 SAS_{max} — the maximum Span Attitude Sensitivity between two attitudes

5.1.10 SAS_{nm} — Span Attitude Sensitivity between attitudes n and m

5.1.11 Scm — Standard cubic centimeters per minute

5.1.12 Slm — Standard liters per minute

5.1.13 VFD — Vertical Flow Down. Mounting attitude 2, as shown in Figure 1.

5.1.14 VFU — Vertical Flow Up. Mounting attitude 4, as shown in Figure 1.

5.1.15 VID — Vertical Inlet Down. Mounting attitude 4, as shown in Figure 1.

5.1.16 VIU — Vertical Inlet Up. Mounting attitude 2, as shown in Figure 1.

5.1.17 ZAS_{max} — the maximum Zero Attitude Sensitivity between two attitudes.

5.1.18 ZAS_{nm} — Zero Attitude Sensitivity between attitudes n and m.

5.2 Definitions

5.2.1 *actual flow* — the flow rate as determined by the flow standard used in the test procedure.

5.2.2 *attitude* — the mounting position of the MFC with respect to the surface of the earth, as shown in Figure 1.

5.2.3 *indicated flow* — the flow rate as determined by the output of the DUT.

5.2.4 *measured value* — the actual flow through a DUT, expressed in sccm or slm.

5.2.5 *nameplate gas* — the gas intended to be controlled by the MFC in operation.

5.2.6 *setpoint* — the input signal provided to achieve a desired flow, reported as sccm, slm, or percent full scale.

5.2.7 *span* — the full scale range of the DUT.

5.2.8 *zero drift* — the undesired change in electrical output (i.e., indicated flow), at a no-flow condition, over a specified time period, reported in sccm or slm.

5.2.9 *zero offset* — the deviation from zero at a “no-flow” condition reported in sccm, slm, % F.S. or mV.

6 Summary of Test Method

6.1 Gas flow, indicated flow and setpoint data are collected for an MFC. This data is reduced to quantify the relationship between the flow control by the MFC and its relationship to the attitude of the MFC.

6.2 This method allows the user to determine the effect of different mounting attitudes on MFC zero and span.

6.3 The standard test is determining the effect of changing between attitudes 1 and 2 on Nitrogen. Other typical MFC attitudes and gases may also be tested (see Figure 1).

7 Interferences

7.1 The accuracy rating of the measuring equipment shall be superior to that of the DUT. Preferably, the measuring equipment will have an accuracy that is four times better than the DUT. Calibration equipment must have a valid calibration certificate.

7.2 Take care when using test instruments with a specified accuracy expressed in percent of full scale.

7.3 Installation effects on the flow should be minimized. Monitor pressure upstream of the DUT to ensure that flow variations due to pressure are minimized.

7.4 Verify electrical signals directly at the DUT connector to ensure that the signals at the DUT and standard agree with the signals at the data recording equipment.

7.5 All electrical measurements should be read on devices with at least 4.5 digits of resolution. These devices must have valid calibration certifications.

7.6 All instrumentation in the test apparatus must remain in a constant orientation except the device under test.

8 Significance and Use

8.1 The data generated by this method is used to estimate the effect-mounting attitude will have on the performance of a mass flow controller. It would typically be used to estimate the potential flow error caused by using an MFC in attitude, other than the one it was calibrated for.

9 Apparatus (see Figure 2)

9.1 *Flow Standard* — A device or system that accurately measures the flow and reports the actual flow.

9.2 *Data Acquisition System* — The system that measures the electrical signals from the device under test. The data acquisition system may also read the signals from the flow standard, record test data and control the test sequence.

9.3 *Isolation Valves* — Valves that will positively shut off the gas line.

9.4 *Pressure Regulator* — A device that regulates gas pressure to a set value.

9.5 *Pressure Transducer* — An instrument to measure the gas pressure and report it as an electrical signal.

9.6 *Flexible Gas Line* — Flexible tubing that will allow the DUT to be moved to the various test attitudes while the other components can remain in a fixed position.

10 Materials

10.1 Clean, Dry N_2 , with 99.9% minimum purity.

10.2 MFC Calibration Test Gas as desired.

11 Safety Precautions

11.1 Follow the manufacturer's specifications and instructions for installation and operation whenever possible. Note any exceptions in the test report.

12 Test Specimen

12.1 Allow all components in the test apparatus to warm up following the manufacturer's specification.

12.2 Take necessary steps when switching gases to ensure that only the desired gas is in the DUT and flow standard at the time the test is performed.

13 Preparation of Apparatus

13.1 Locate the DUT in the test environment to stabilize temperature prior to warm up.

13.2 The reference operating conditions shall be as follows:

13.2.1 *Ambient temperature* — 21 ± 4 °C

13.2.2 *Ambient Temperature Stability* — Ambient temperature to stay constant within ± 1 °C during data acquisition period.

13.2.3 *Gas temperature* — Same as ambient.

13.2.4 *Gas pressure, Outlet* — Ambient Pressure

13.3 Following the conditioning period (Section 12.1) warm up the device according to manufacturer's specifications.

13.4 Perform an adequate purge to ensure all previous gases and atmospheric moisture has been removed from the system.

13.5 Leak check the test set up, using available methodologies to verify the test system leak integrity.

13.6 The power supply must be sufficiently rated for the device under test.

14 Procedure

14.1 Open V1 and V2. DUT and allow the flow to stabilize. Adjust the inlet pressure to 135.8 kPa (19.7 psia).

14.2 Close the downstream isolation valve (V2); then close the upstream isolation valve (V1), (see Figure 2).

14.3 With both isolation valves closed, and a 100% setpoint wait until the pressure drop across the MFC is dissipated, ensuring a "no flow" condition through the

MFC. Dissipation of the pressure across the MFC is indicated when the indicated flow drops to a steady state value near zero.

14.4 Once the indicated flow has dropped to a steady value set the MFC setpoint so there is no power being dissipated by the control valve. For a normally closed valve this is 0% and for a normally open control valve it is 100%.

14.5 After the electrical output signal has stabilized for at least three minutes, record the MFC indicated zero in Table 1.

14.6 Open V1 and V2, command 100%.

14.7 After the electrical output signal has stabilized for at least three minutes, record the actual flow as reported by the flow standard and the indicated flow in Table 1.

14.8 Change the attitude of the DUT to the next desired attitude.

14.9 Close the downstream isolation valve (V2); then close the upstream isolation valve (V1) (see Figure 2).

14.10 With both isolation valves closed, and a 100% setpoint wait until the pressure drop across the MFC is dissipated, ensuring a "no flow" condition through the MFC. Dissipation of the pressure across the MFC is indicated when the indicated flow drops to a steady state value near zero.

14.11 Once the indicated flow has dropped to a steady value set the MFC setpoint so there is no power being dissipated by the control valve. For a normally closed valve this is 0% and for a normally open control valve it is 100%.

14.12 After the electrical output signal has stabilized for at least three minutes, record the MFC indicated zero in Table 1.

14.13 Open V1 and V2, command 100%.

14.14 After the electrical output signal has stabilized for at least three minutes, record the actual flow as reported by the flow standard and the indicated flow in Table 1.

14.15 Repeat Sections 14.8 to 14.14 for each of the desired attitudes.

14.16 Return the DUT to attitude 1.

14.17 Adjust the inlet pressure to 308 kPa (44.7 psia).

14.18 Repeat Sections 14.8 to 14.14.