

SEMI E16-0611

GUIDE FOR DETERMINING AND DESCRIBING MASS FLOW CONTROLLER LEAK RATES

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1 Purpose

1.1 The purpose of this Guide is to establish a uniform, worldwide means for describing and measuring leak rates of mass flow controllers (MFCs). The leak integrity of a gas delivery system is important to maintaining product quality and performance. This Guide is intended to prevent confusion and misunderstanding between manufacturers and users. In particular, it distinguishes between mechanical and diffusion leak rates.

2 Scope

2.1 This Guide contains definitions of terms and procedures for determining the leak rates of MFCs as used in the semiconductor industry.

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 Referenced Standards and Documents

3.1 MIL Standard¹

MIL STD-202E — Test Method Standard Electronic and Electrical Component Parts

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

4 Terminology

4.1 Definitions

4.1.1 *leak* — a path or paths in a sealed system which will pass helium when a partial pressure differential exists. A partial pressure differential can exist for helium even though a total gas pressure differential may not exist. There are two major leak mechanisms, a mechanical passage or a material through which gas can diffuse or permeate. In a real system, a leak may have both mechanisms operating in parallel.

4.1.1.1 A mechanical leak may be a physical crack, pit, scratch or other imperfection in a sealing surface, or contamination or debris on the seals. A diffusion or permeation leak is caused by the movement of helium through gaskets, O-rings, polymers, or other materials through which helium can diffuse.

4.1.2 *measured leak rate* — the leak rate of a given system measured under specified conditions and employing a specified test gas (helium). For the purposes of comparison with rates determined by other methods of testing, measured leak rates must be converted to equivalent standard leak rates.

4.1.3 *sensitivity (minimum detectable leak rate)* — the smallest standard leak rate that an instrument, method or system is capable of measuring under specified conditions.

4.1.4 *standard leak rate* — the rate at which helium flows at 25°C and 101.3 kPa (760 Torr) through a leak when the high pressure side is at 101.32 kPa and the low pressure side is below 100 Pa (approximately 1 Torr). Standard leak rate shall be expressed in the following units:

- Pa-m³/s (He) = ‘Pascal cubic meters per second, helium’

¹ United States Military Standards, Available through the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120-5099, USA; Telephone: +1.215.697.3321.

- or, alternatively, atm-cc/s (He) = ‘atmospheric cubic centimeters per second, helium’

For the purpose of this Document, the ‘measured leak rate’ shall be corrected to standard leak rate by multiplying by the ratio of 101.32 kPa to the absolute value of the pressurizing helium.

$$\frac{\text{Measure Leak Rate} \times 101.32 \text{ kPa}}{\text{He Actual Pressure}} = \text{Standard Leak Rate} \quad (1)$$

NOTE 1: The ‘mass spectrometer helium leak detector’ is generally used for leak rate testing of high and medium level vacuum apparatus. Units of sccs, Torr-L/s, and m bar-L/s, have been used in the past but are not encouraged. Reference materials include MIL STD-202E, C-1.

NOTE 2: The Pascal (1 Pa = 1 N/m²) is defined as the pressure unit of the international unit system SI. Atm-cc/s is acceptable, as it is widely used in the semiconductor industry.

5 Testing

5.1 General Requirements

5.1.1 *Leak Detector* — The leak detector shall be of the helium mass spectrometer type. It shall have sensitivity at least equal to or smaller than the specified leak rating of the MFC to be tested. If the actual leak rate is to be reported, the sensitivity shall be five times smaller than the leak to be measured. If the sensitivity is not five times smaller, the actual leak rate may be reported if the sensitivity of the detector is also reported.

5.1.2 Helium must have access to all primary seals.

5.1.3 Connections between the MFC and the leak detector must be leak-tight.

5.1.4 The ambient temperature of the MFC should be 25°C ± 5°C unless otherwise specified. If another test temperature is used, it must be recorded during the test.

5.2 *Test Procedures* — There are two basic setups which may be used to measure the leak rate from the external environment to the internal gas passages of the MFC or from the internal passages to the external environment. Results for either test method may be reported. The method used must be reported as well. A third test, the through-the-valve setup, is intended to measure the quality of the valve seat shutoff.

5.2.1 *Internally-Pressurized Leak Test* — The purpose of this test set-up is to simulate operation of the MFC under conditions where the internal pressure is above ambient. The recommended internal pressure is 300 kPa absolute (30 psig) of helium (see Figure 1).

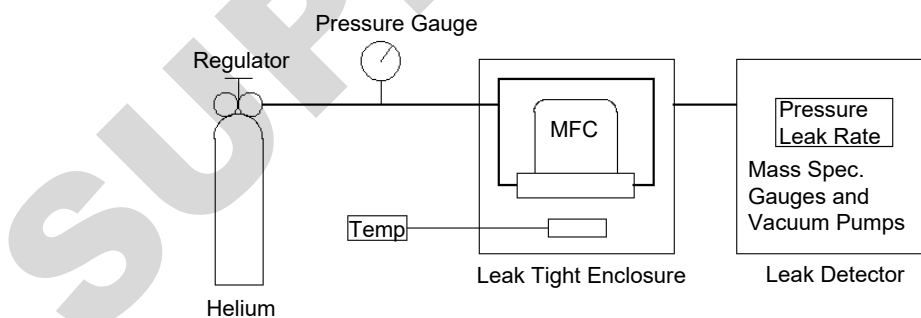


Figure 1
Internally-Pressurized Leak Test

5.2.2 *Externally-Pressurized Leak Test* — The purpose of this test is to simulate operation of the MFC under conditions where the internal pressure is at vacuum. The external pressure should be equal to atmospheric pressure. The internal pressure should be less than 100 kPa (see Figure 2).