

SEMI E27-0611

GUIDE FOR MASS FLOW CONTROLLER AND MASS FLOW METER LINEARITY

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1 Purpose

1.1 The purpose of this Standard is to establish a uniform, worldwide definition of linearity in order to prevent confusion and misunderstanding between manufacturers and users of mass flow devices. A linearity specification is used to allow prediction to a known level of uncertainty, the output of a mass flow controller (MFC) at points other than those at which its output is known.

2 Scope

2.1 The scope is to define the linearity of the MFC (controller with integral flow transducer and control valve) and the mass flow meter (MFM) (flow transducer only). Terminal-based linearity is used to describe the linearity of MFCs and MFMs.

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 Background

3.1 There are three commonly-used methods of describing linearity: independent, zero-referenced, and terminal-based linearity. Terminal-based linearity best describes the performance requirements for MFCs and MFMs because of its ease of application. In addition, it also yields the maximum expression of deviation. See reference documents regarding independent and zero-referenced linearity.

4 Referenced Standards and Documents

4.1 IEC Standard¹

IEC TC-65 — Industrial Process Measurement and Control Terms and Definitions

4.2 ISA Standard²

ISA S51.1 — Process Instrumentation Terminology

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

5 Terminology

5.1 Definitions (see Figure 1 and Figure 2)

5.1.1 *actual flow* — the gas flow as measured by an external standard, not the electrical output of a mass flow meter.²

5.1.2 *linearity* — the closeness to which a curve approximates a straight line. It is measured as a non-linearity and expressed as a linearity.²

5.1.3 *lower range input value* — lowest value of input at which the instrument is specified to operate. In mass flow controllers this is zero or the lowest set point at which the instrument is specified. In mass flow meters this is no flow or the lowest actual flow value at which the instrument is specified.

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² Instruments, Systems, and Automation Society, 67 Alexander Drive, PO Box 12277, Research Triangle Park, NC 27709, USA; Telephone: +1.919.549.8411, Fax: +1.919.549.8288, <http://www.isa.org>

5.1.4 *range* — the region between the limits within which a quantity is measured, expressed by stating the lower and upper range values.²

5.1.5 *span* — the algebraic difference between the upper and lower range values.

5.1.5.1 For example:

- Range = 4% to 100%, Span = 96%
- Range = 0% to 100%, Span = 100%

5.1.6 *terminal-based linearity* — maximum deviation of the calibration curve from a straight line which intercepts the calibration curve at upper and lower input range values.

5.1.7 *upper range input value* — highest value of input at which the instrument is specified to operate. In mass flow controllers this is full scale or the highest set point at which the instrument is specified. In mass flow meters this is full scale or the highest actual flow value at which the instrument is specified.

6 Significance and Use

6.1 The linearity of an MFC is expressed in terms of its actual flow output as a function of the setpoint input (control voltage) (see Figure 1).

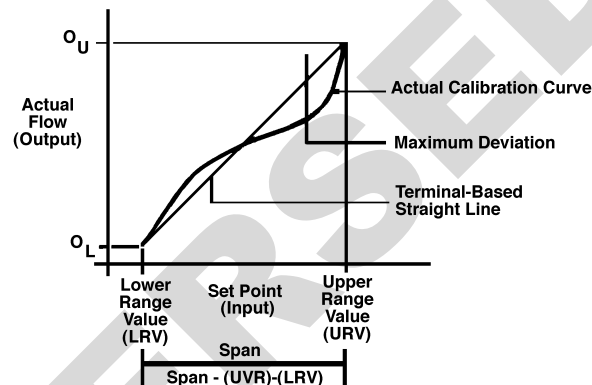


Figure 1
Terminal-based linearity of a Mass Flow Controller

6.2 The linearity of a MFM is expressed in terms of its electrical output as a function of the actual flow (input) through the device (see Figure 2).