

SEMI E27-92 (Reapproved 0299) STANDARD FOR MASS FLOW CONTROLLER AND MASS FLOW METER LINEARITY

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1 Purpose

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 an MFC at points other than those at which its output is known.

2 Scope

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

3 Background

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 Documents

4.1 *International Electrotechnical Commission (IEC) Standard¹*

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

4.2 *Instrument Society of America (ISA) Standard²*

S51.1 — Process Instrumentation Terminology

5 Definitions (See Figures 1 and 2)

5.1 *Actual Flow* — The gas flow as measured by an external standard, not the electrical output of a mass flow meter. (See Section 4.2.)

5.2 *Linearity* — The closeness to which a curve approximates a straight line. It is measured as a non-linearity and expressed as a linearity. (See Section 4.2.)

5.3 *Range* — The region between the limits within which a quantity is measured, expressed by stating the lower and upper range values. (See Section 4.2.)

5.4 *Span* — The algebraic difference between the upper and lower range values.

e.g.,

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

Range = 0% to 100%, Span = 100%

5.5 *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.

5.6 *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.

5.7 *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.

6 Significance and Use

6.1 The linearity of a mass flow controller (MFC) is expressed in terms of its actual flow output as a function of the setpoint input (control voltage). (See Figure 2.)

6.2 The linearity of a mass flow meter (MFM) is expressed in terms of its electrical output as a function

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² Instrument Society of America, 67 Alexander Drive, P.O. Box 12277, Research Triangle Park, NC 27709

of the actual flow (input) through the device. (See Figure 1.)

6.3 Terminal-based linearity shall be used to describe the linearity of MFCs and MFMs. The maximum deviation is expressed as a percentage of the algebraic difference between the output at the upper range value and the output at the lower range value.

$$\text{Linearity} = \pm \frac{d_{\text{MAX}}}{O_U - O_L} \times 100$$

where O_U = output at the upper range value

O_L = output at the lower range value

d_{MAX} = maximum deviation

6.3.1 Terminal-based linearity may be expressed as a percentage of some other value (such as a percentage of reading) if it is so identified.

6.3.2 If results are reported using range values other than zero and full scale, the actual range values used in the calculation shall be reported.

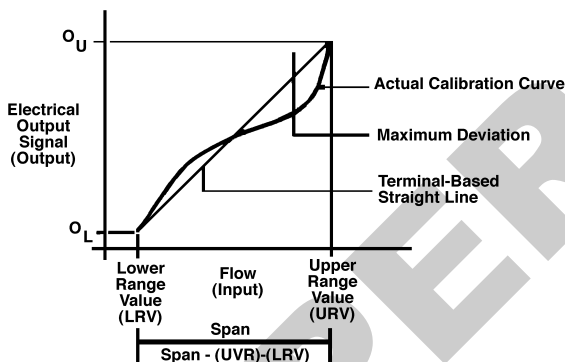


Figure 1
Terminal-Based Linearity for Mass Flow Meter

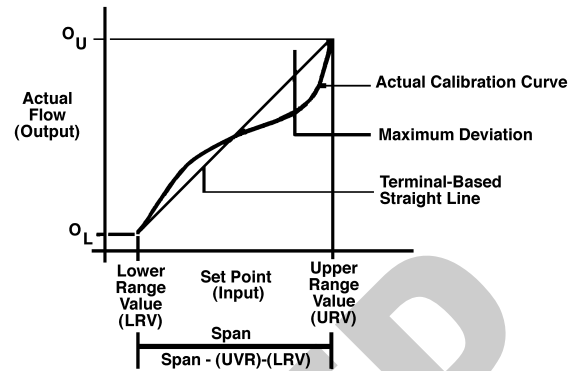


Figure 2
Terminal-Based Linearity for Mass Flow Controller

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