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GB/T 18459-2001

Methods for calculating the main staticperformance specifications of transducers

传感器主要静态性能指标计算方法

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1 Scope

GB/T 18459-2001 is the Chinese national standard on methods for calculating the main staticperformance specifications of transducers, in the field of metrology and measurement. The /T suffix marks it as a recommended standard: it is not compulsory by itself, but it becomes binding as soon as a contract, a tender or a customer specification calls it up - which in practice is how most foreign buyers meet it. It was issued on 8 October 2001 by the General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China, and has been in force since 1 May 2002. Classification: ICS 17.020, CCS N05. This page is published from the official record of the standard held by the Chinese standards administration: the identification, the dates, the classification and the issuing body are taken from there. The clause text, the tables and the numeric limits are in the document itself, which is delivered complete in English translation.

This Standard specifies the definitions and calculation methods of the main static performance specifications of general transducers. This Standard is applicable to the calculation of the main static performance specifications of transducers during the process of development, production and use. It is also applicable to the development and revision of product standards for various transducers.

2 Definitions

For the purposes of this document, the following terms and definitions apply.

2.1 Basic terminologies

2.1.1 static characteristics the relationship between output and input when measured under constant or slow-change conditions NOTES:

1 The static characteristics of the transducer include a variety of performance indicators that can be determined by static calibration.

2 The static performance specifications of the transducer shall normally be marked with the applicable temperature range.

2.1.2 static calibration the process of obtaining static characteristics under specified static test conditions

2.1.3 measuring range the interval expressed by the maximum measured (measured upper limit) and the smallest measured (lower measured limit) under the premise of ensuring performance indicators the transducer that working characteristics are represented by curve equation

2.2 Static calibration characteristics

2.2.1 up-travel actual average characteristics the connection curve of the arithmetic mean point of a set of measured values at each calibration point of the up-travel

2.2.2 down-travel actual average characteristics the connection curve of the arithmetic mean point of a set of measured values at each calibration point of the reverse stroke

2.2.3 up-travel and down-travel actual average characteristics the connecting curve of the average point of the arithmetic mean of the positive and down-travel strokes of each calibration point, also called the actual characteristics (curve)

2.3 Static performance specifications

2.3.1 resolution the minimum input change that produces observable output changes over the entire input range

2.3.2 sensitivity the ratio of output change to corresponding input change

2.3.3 hysteresis the difference between the positive and down-travel stroke outputs of the transducer for the same input when the input is full-span

2.3.4 repeatability the degree of dispersion between a set of measured outputs, in a short interval of time, under the same working conditions, when the input volume changes from the same direction to full scale, multiple times approaching and reaching the same calibration point

2.3.5 linearity the maximum deviation of the actual average characteristic curve of the positive and down-travel strokes from the reference line, expressed as a percentage of full-span output the linearity that the reference line is the front terminal-based line NOTES:

1 The front terminal-based line passes through the front terminal point of the actual characteristics of the transducer. However, the maximum deviation of the transducer's actual characteristics shall be minimized by changing the slope.

2 The front terminal-based line is called the zero-base line in some foreign standards and literature.

2.3.5.6 Independent linearity the linearity that the reference line is the best straight line NOTES:

1 The best straight line is the median line of two parallel lines that are closest to each other and can accommodate the up-travel and down-travel actual average characteristics of the transducer.

2 The best straight line guarantees that the actual deviation of the transducer's actual characteristics is minimal.

2.3.5.7 least-squares linearity the linearity that the reference line is the least square line NOTE: The least-squares line shall ensure that the sum of the squares of the actual characteristics of the transducer is minimal.

2.3.6 conformity the maximum deviation of the curve of the up-travel and down-travel actual average characteristics to the reference curve, expressed as a percentage of full-span output NOTES:

1 There are multiple compliances that vary with the reference curve.

2 Conformity shall be limited. Conformity without qualifiers means independent conformity.

3.1 Establishment of static calibration characteristics

3.1.1 General requirements for static calibration value of the difference between the maximum and minimum values of a set of n measured values at the ith calibration point; dR - range coefficient; it depends on the number of calibration cycles n, i.e. the number of measurements at a calibration point or the sample size n. The relationship between the range coefficient dR and the number of calibration cycles is shown in Table 2. Table 2 NOTES:

1 The range method is slightly simpler than the Bessel formula method. However, the calculated sample standard deviation S is generally slightly larger.

2 When calculating S, if not specified, it refers to Bessel formula method. In case of dispute, the Bessel formula shall prevail.

3.7.4 Selection of standard deviation of transducer sample

3.7.4.1 If the number of calibration points is m (usually m=5~11), 2m sample standard deviation S can be calculated. This Standard stipulates that the largest S (i.e. the maximum standard deviation Smax) is selected to participate in the calculation of Equation 10 so as to obtain the repeatability of the transducer as a single performance specification.

3.7.4.2 This Standard allows the user to perform an equal precision test on the transducer being tested as an option according to the method of Annex E. The variance at each measurement point of the equal precision transducer has the same mathematical expectation. Therefore, the average variance can be used instead of the variance at each measurement point. Therefore, if it is determined that the transducer is an equal-precision sensor, the maximum standard deviation Smax shall not be taken. It shall take the average standard deviation Sav to calculate the repeatability. Sav is calculated as follow: If the precision of the transducer being tested is not performed, or if the test fails, the requirements of 3. 7. 4. 1 shall still be applied. That is, calculate repeatability according to the requirements of unequal precision transducer. NOTES: - maximum and minimum input values of the transducer. NOTES:

1 The calculation method for terminal-based line is simple and easy to implement with the bridge detection circuit.

2 Compared with other linearities, the calculation results of terminal-based linearity is generally larger.

3.8.4 Shifted terminal-based linearity See equation (16) for calculation. As the shifted terminal-based equation of reference characteristics, see

3.8.3 for the calculation method of its terminal-based linear equation. See A.2.2.1 of Annex A for the translation method. NOTE: The shifted terminal-based linearity can be used to replace the independent linearity in some occasions where the requirements are not too high.

3.8.5 Zero-based linearity The principle of calculation method is shown in Figure 2. The calculation formula is shown in equation (16). By definition, a zero-based linear equation can be written as reference characteristics: where, b - zero-base linear slope, i.e. the theoretical zero point of the transducer (x = 0, y = 0) and the slope of the line connecting the center of gravity of the smallest maximum positive and negative deviation points. For the calculation of the zero-based line, see Annex A, A1. NOTE: The working characteristics of the transducer can be represented by a zero-based line. Its equation is simple and easy to use.

3 The front terminal-based linearity is generally better than zero-based linearity. And it can make the deviation near the zero point of the transducer smaller.