Glossary

Measurement definitions

Measurement Range

The range of displacement over which the measured values are within the maximum permissible errors of the transducer. For analogue products this is expressed as a displacement either side of the electrical zero or null position. For digital products, this is expressed as a single displacement from the start of the measurement range to the end position.

Example: An AX5 analogue transducer has a measurement range of ±5mm. This means it has a total measurement range of 10mm. A DP10 digital transducer has the same measurement range of 10mm.

Repeatability

Repeatability is defined as the ability of the transducer to provide measurements within a close distribution on the same measurand carried out in the same direction.

Solartron use a method of establishing repeatability where a defined side load is applied to the transducer under test which reflects how transducers are used in most real applications. Methods of measuring repeatability without applying side load usually give a better result but this may not be reflected in real life applications.

Hysteresis

Hysteresis is defined as the difference between measurements on the same measurand carried out where the transducer measures the measurand from opposite directions.

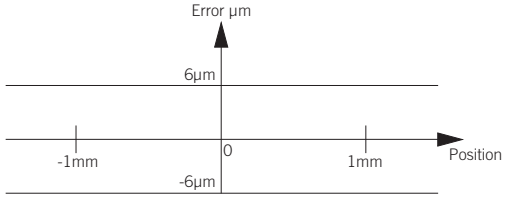
Linearity

Linearity is defined as the deviation of a transducer's response from a straight line.

Solartron use two definitions for linearity depending on the product type. These are % FRO or the more demanding % Reading (0.5% Reading approximately equals 0.25% FRO).

% Full Range Output (%FRO)

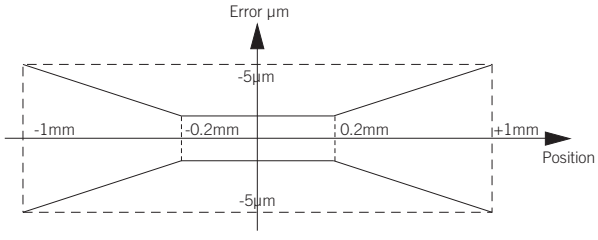
% Full Range output fits a straight line through zero to the measured characteristic which balances the positive and negative errors from this line. This is known as the "Best Fit Straight Line". The magnitude of this error is then expressed as % of full range and includes any error due to symmetry either side of zero but does not include any sensitivity error.



Example: ±1mm transducer with 0.5% FRO

% Reading

%Reading defines an error envelope within which the allowable error is proportional to the displacement. This is defined as a % of the displacement being measured with a minimum equivalent to 20% of the maximum displacement that the transducer can measure. This method results in a more stringent performance being required of the sensor operating around the electrical zero than is required with a % FRO.



Example: ±1mm transducer with 0.5% Reading

For standardised analogue transducers the error envelope is with respect to the nominal transducer sensitivity and therefore the total error includes both linearity and sensitivity errors. For non standardised transducers the error curve is with respect to the actual sensitivity and therefore any subsequent electronics will be required to adjust for the actual sensitivity of the transducer.

Measurement definitions *continued*

Accuracy

The accuracy is defined as the peak to peak variation of the measured error curve using a precision reference, usually a laser interferometer. This method is used for Digital Transducers and Linear Encoders.

Uncertainty of measurement

Uncertainty is an issue that is associated with any measurement. At Solartron Metrology, the GUM (Guide for the Expression of Uncertainties in Measurement) is used to specify the uncertainties of verification of its products. This section discusses uncertainty for the different product categories.

Analogue gauging products

The gauging products are verified using a variety of instruments such as an optical Linear Encoder, a barrel micrometer or a wedge comparator. The verification using an optical linear encoder results in an uncertainty of better than 0.5 µm.

Digital products and analogue and digital Linear encoder

The Digital probe, linear encoder and other digital products are verified using an optical interferometer, the wavelength of which is computed using Edlen's formula (B. Edlen, Metrologia Vol. 2, 71 (1966)) for operation under normal atmospheric conditions (not in vacuum).
The uncertainty of the measurement is usually less than 0.1 µm.
The user should refer to the verification or calibration sheets for actual values.

Electrical definitions

Electrical Zero

The position of the moving part of the transducer with respect to its body where the electrical output is zero. In practice, this is the transducer position where the output is minimised.
Note: Sometimes known as null.

Energising Voltage

The allowable range of voltages used to energise an LVDT or Half Bridge transducer. It is specified as a sinewave in Vrms. The energising voltage is the range over which the transducer will operate, however the transducer specification is guaranteed only at the calibration energising voltage. For DC operated transducers, the energising voltage is specified in VDC.

Energising Current

The current required to energise the transducer. It is dependent on the energising voltage and is expressed as mA/V. It also varies with the energising frequency.

Energising Frequency

The allowable range of frequencies used to energise an LVDT or Half Bridge transducer.
It is specified in kHz. The energising frequency is the range over which the transducer will operate, however the transducer specification is guaranteed only at the calibration energising frequency.

Sensitivity

This is specified as the magnitude of the output with respect to displacement (mm) and energising voltage (V) for an LVDT or Half Bridge Transducer. It is expressed in mV/V/mm.

Residual Voltage at Electrical Zero

The minimum voltage attained for the electrical zero position, i.e. the smallest output that can be detected.

Transducer and physical definitions

Total Mechanical Range

The distance over which the moving part of a transducer can be displaced between two physical end stops. Total mechanical range is always greater than measuring range.

Direction of displacement measurement

Outward travel is defined as displacement away from the body of the transducer and cable end. Inward travel is defined as displacement into the body of the transducer towards the cable end.

The conventional direction of signals for an LVDT is such that for an inward displacement from the electrical null the output signal is in phase with the excitation signal and for an outward displacement from electrical zero the output signal is in antiphase to the excitation signal.

For a digital transducer the output count increases for an inward movement.

Outward travel from Zero

This is the total mechanical movement outward from the electrical zero of an LVDT or HB transducer. It is generally greater than the measurement range from the electrical zero. (See also pre travel).

Inward travel from Zero

This is the total mechanical movement inward from the electrical zero of an LVDT or HB transducer. It is generally greater than the measurement range from the electrical zero. (Also see post travel)

Pre-travel

The mechanical movement from the fully outward position, where the moving element is against a mechanical limit stop, to the start of the measurement range.

Post Travel

The mechanical movement from the end of the measurement range to the fully inward position, where the moving element is against a mechanical limit stop.

Tip Force

The tip force of the transducer is defined as the force exerted on the sample at the electrical zero of the transducer or at the mid point of the measurement range for digital transducers and Linear Encoders. Tip force is defined in the horizontal position unless specified otherwise.