Linear Scales

Tests for Evaluating Linear Scales

1. Testing within the service temperature range

Confirms that there is no performance abnormality of a unit within the service temperature range and that data output is according to the standard.

2. Temperature cycle (dynamic characteristics) test

Confirms that there is no performance abnormality of a unit during temperature cycling while operating and that data output is according to the standard.

3. Vibration test (Sweep test)

Confirms that there is no performance abnormality of a unit while subject to vibrations of a frequency ranging from 30Hz to 300Hz with a maximum acceleration of 3g.

4. Vibration test (Acceleration test)

Confirms that there is no performance abnormality of a unit subject to vibrations at a specific, non-resonant frequency.

5. Noise test

This test conforms to the following
EMC Directives:
EN550111991: Group 1, Class B
EN50082-1: 1992

6. Package drop test

This test conforms to JISZ0200 (Heavy duty material drop test)

Glossary

Absolute system

A measurement mode in which every point measurement is made relative to a fixed origin point.

Incremental system

A measurement mode in which a point measurement is made relative to the point measured immediately before the current one.

Origin offset

A function that enables the origin point of a coordinate system to be translated to another point offset from the fixed origin point. For this function to work, a system needs a permanently stored origin point.

Restoring the origin point

A function that stops each axis of a machine accurately in position specific to the machine while slowing it with the aid of integrated limit switches.

Sequence control

Refers to a type of control that sequentially performs control step by step according to the prescribed order of control.

Numerical control

Refers to a type of control that controls the tool position relative to a workpiece to be machined with corresponding numerical control commands.

Binary output

Refers to output of data in binary form (ones and zeros) that represent numbers as integer powers of 2.

RS-232C

An interface standard that uses an asynchronous method of serial transmission of bits over an unbalanced transmission line for data exchange between transmitters located relatively close to each other. It is a means of communication mainly used for connecting a personal computer with peripherals.

Line driver output

This output features fast operating speeds of several tens to several hundreds of nanoseconds and a relatively long transmission distance of several hundreds of meters. A differential voltmeter line driver (RS422A compatible) is used as an I/F to the NC controller in the linear scale system.

BCD

A notation of expressing the numerals 0 through 9 for each digit of a decimal number by means of four-bit binary sequence. Data transmission is one-way output by means of TTL or open collector.

RS-422

An interface standard that uses serial transmission of bits in differential form over a balanced transmission line. RS-422 is superior in its data transmission characteristics and in its capability of operating with only a single power supply of +5V.

Accuracy

The accuracy specification refers to the maximum difference between the indicated and true positions at any point, within the range of a scale, at a temperature of 20°C. Since there is no international standard defined for scale units, each manufacturer has a specific way of specifying accuracy. The accuracies given in our catalog have been determined using laser interferometry.

Narrow range accuracy

Scale gratings marked on a scale unit normally adopt 20µm per pitch though it varies according to the kind of scale. The narrow range accuracy refers to the accuracy determined by measuring one pitch of each grating at the limit of resolution (1µm for example).

Principle of the Absolute Linear Scale (Example: AT300, 500-S/H)

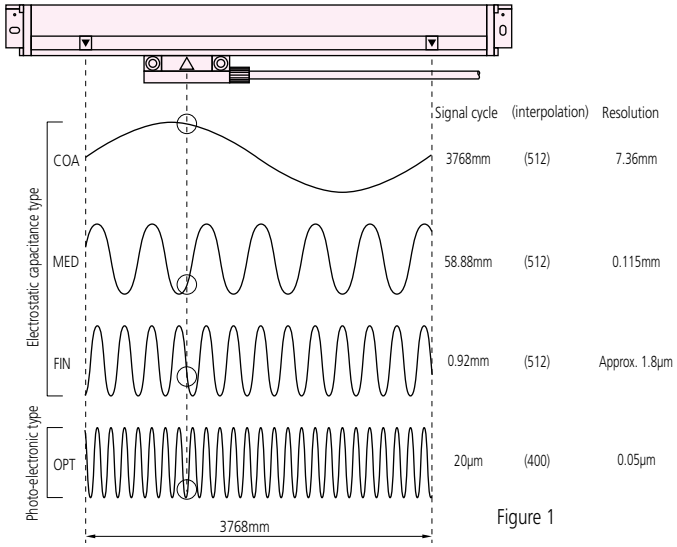

Figure 1

Upon supply of power to a linear scale, position readings from three capacitance-type sub-scales (COArse, MEDium and FINe) and one from a photoelectric sub-scale (OPTical) are taken. These sub-scales use such a combination of pitches, and are so positioned relative to each other, that the readings at any one position form a unique set and allow a microprocessor to calculate the position of the read head on the scale to a resolution of 0.05µm.

A laser holo-scale provides accurate measurements... why?

1. Hyperfine gratings

Very fine-pitched scale grids (0.5µm) are used in hologram analysis. These grids are much finer than the conventional lithographic grids used in reduction-exposure systems (1/15th to 1/200th the thickness of lithography grids). Hologram technology is essential to achieving high resolution in measuring scales.

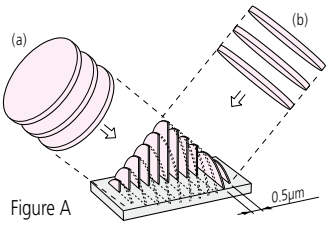

Figure A

As shown in Figure A, interference of light takes place three-dimensionally at the point of intersection when two parallel laser beams (a) and (b) intersect, generating interference fringes. The pitch of the interference fringes is approximately the same as that of the wavelength of light and exactly measures 0.5µm for the Mitutoyo hologram scale. This allows an extra-fine pitch scale to be made by recording the interference fringes.

2. Diffraction is fundamental

The mechanism of light diffraction is used to detect scale displacement as a change in the phase of light. Since the amount of phase change is equivalent to the hologram's grid pitch, an accurate length-measurement system can be created to detect scale displacement in 0.5µm steps.

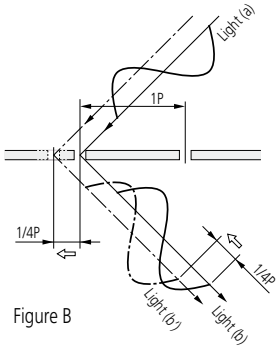

Figure B

As shown in Figure B, a light beam (a) is diffracted by the hologram grid and becomes a diffracted light beam (b). When the scale moves by a quarter of the hologram's grid pitch, the diffracted light beam (b) shows the equivalent change in the phase of light, as the light beam (b')

3. Complete sinewaves are best

Displacement is detected via the interference of diffracted light, in the form of bright-to-dark signals with a pitch equal to one-half that of the hologram grid (0.25µm). Unlike ordinary scales which use quasi-sinewaves, signals available with this scale are complete sinewaves, which are extremely immune to division error and regarded as a key factor for high resolution.

Since it is impossible to directly detect a phase shift of light with current technology, two diffracted light beams are transformed by means of interference into dark-light signals to be detected as shown in Figure C. Dividing the obtained signals by 250 makes it possible to measure down to 1nm.

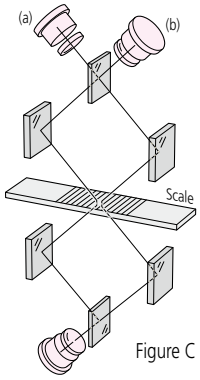

Figure C

To identify the direction of scale displacement, two light receptors (a) and (b) are used to detect one light beam as a signal having a 90-degree phase difference from the other.