International Standard **ISO** 6318

Measurement of roundness — Terms, definitions and parameters of roundness

Mesurage de la circularité — Termes, définitions et paramètres de circularité

First edition — 1985-08-15

UDC 531.717

ISO 6318-1985 (E)

Price based on 5 pages

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 6318 was prepared by Technical Committee ISO/TC 57, *Metrology and properties of surfaces.*

Measurement of roundness — Terms, definitions and parameters of roundness

Scope and field of application

This International Standard defines metrological terms used in the determination of deviations from roundness.

Figures 2 and 3 illustrate sequential steps involved in roundness measurement.

Terms and definitions

1 General terms (surfaces, planes, axes)

1.1 real surface: A surface limiting the body separating it from the surrounding medium.

See figure 2.

1.2 nominal axis of rotation: The theoretically exact axis about which the spindle of a perfect instrument rotates.

1.3 instantaneous axis of rotation: The axis about which the spindle of an instrument actually rotates at any instant.

NOTE — The instantaneous axis of rotation may be continuously varying within the confines of the bearings.

1.4 reference axis of rotation: The mean of the instantaneous axes about which the spindle of an instrument rotates.

1.5 instantaneous error of rotation: The difference between the position of the instantaneous axis of rotation and the reference axis of rotation.

NOTE — Errors of rotation of the instrument may comprise radial, axial and tilt components.

1.6 nominal plane of measurement: A plane perpendicular to the nominal axis of rotation of the instrument.

1.7 plane of measurement: Plane perpendicular to the reference axis of rotation and passing through the point of contact of the detecting element of the instrument with the workpiece.

1.8 direction of measurement: The direction along which radial variations are determined. It substantially intersects the axis of rotation of the instrument and it generally lies in the plane of measurement.

1.9 axis of workpiece: A defined straight line about which the relevant part of the workpiece is considered to be round.

See figure 3.

NOTE — There may be several ways in which the axis can be defined, including:

1) A straight line such that the root mean square value of the distances from it of the defined centres of a representative number of cross-sections has a minimum value.

2) A straight line passing through the defined centres of two separated and defined cross-sections.

3) A straight line which passes through the defined centre of one defined cross-section and is perpendicular to a defined shoulder.

4) A straight line passing through two support centres — this axis is independent of the surface of the workpiece.

5) An axis of two coaxial surfaces of revolution just enclosing the surface irregularities of the workpiece.

1.10 setting-up eccentricity: The distance in the plane of measurement between the point of intersection therewith of the reference axis of rotation of the instrument and the defined centre of the workpiece profile.

1.11 factor of amplification: The ratio of the output value of the instrument to the displacement of the stylus in the direction of measurement.

2 Profiles

2.1 real roundness profile: The profile resulting from the intersection of the real surface of a round workpiece by a plane perpendicular to its defined axis. The concept encompasses every feature of the surface, however small it may be.

2.2 profile transformation: The action of transforming a profile at any stage, as, for example, by a stylus, filter or recorder.

2.3 traced profile: The profile determined by the path followed by the sensing device (the stylus). It may, sometimes, be indistinguishable from the real roundness profile. Measured parameters of roundness are referred to the traced profile.

See figure 2.

NOTE — It may tend to include or exclude surface roughness according to the dimensions of the stylus.

2.4 modified profile: The traced profile intentionally modified by an analogue or digital wave filter having defined characteristics.

2.5 displayed profile: The representation of the traced or modified profile displayed by the instrument, for example as a trace, oscilloscope presentation or data log.

3 reference circle: A circle fitting the traced profile of the workpiece in a defined way, to which the departures from roundness and the geometric roundness parameters are referred.

4 displayed reference circle: A circle representing the workpiece reference circle, fitted to the displayed representation of the traced profile in a defined way.

NOTES

1 Residual eccentricity left after setting up will result in slight distortion of the displayed representation of the workpiece profile and, in principle, the displayed reference circle should be distorted correspondingly, approximately to the shape known as a limaçon. Electrical methods of plotting the reference circle on a polar graph, and digital representations, often do this automatically. The distortion, having a maximum value given by $E^2/2R$, can generally be neglected if the residual eccentricity, E, measured at the display is kept within about 15 % of the mean radius, R, of the profile for general testing, and within 7 % for more critical applications.

2 Other reference profiles — elliptical, tri-lobe, electric wave filter mean line — may find auxiliary use for analytical purposes.

5 Definitions of reference circles to be fitted to the traced profile of the workpiece, and to the displayed representation of the traced profile when adequately centred on the axis of rotation

5.1 least squares mean circle (LSC): A circle such that the sum of the squares of the departures from it of the traced or modified profile of the workpiece is a minimum.

5.2 minimum circumscribed circle (MCC): Smallest possible circle that can be fitted around the traced or modified profile of a shaft.

5.3 maximum inscribed circle (MIC): Largest possible circle that can be fitted within the traced or modified profile of a hole.

5.4 minimum zone circles (MZC): Two concentric circles enclosing the traced or modified profile and having the least radial separation.

6 Terms relating to the circumference

6.1 undulations per revolution; upr: The number of complete periodic undulations contained in the periphery of the workpiece.

NOTE — There cannot be less than one complete undulation per 360° or 2π rad.

6.2 sinusoidal undulation number, n_s: The number of dominant or superimposed periodic sinusoidal waves measured during one revolution of the workpiece.

6.3 sinusoidal undulation frequency: Sinusoidal undulation number multiplied by revolutions per second of the instrument (expressed in hertz).

6.4 wavelength angle, θ: The reciprocal of the upr multiplied by 360, when expressed in degrees, or 2π when expressed in radians.
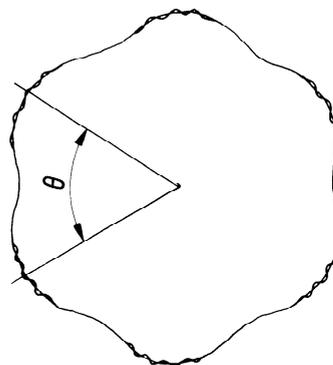
See figure 1.

Figure 1 — Wavelength angle

6.5 circumferential wavelength: The circumference of the workpiece divided by the upr.

7 Terms relating to filter function of the apparatus

7.1 wave filter: A system transmitting a range of sinusoidal frequencies for which the ratio of output to input amplitude is nominally constant, while attenuating (i.e. reducing) the ratio for frequencies lying outside the range at either or both ends.

NOTE — A characteristic of the electric wave filter is that the ratio is dependent only on frequency, and is independent of amplitude, in contrast to mechanical filtering methods (for example by the stylus) which are influenced by frequency and also by amplitude.

7.2   amplitude transmission characteristic: Ratio of output amplitude to input amplitude plotted for each of a range of sinusoidal frequencies covering the operative range of the apparatus.

NOTE — The ratio may be expressed as a percentage or in decibels.

7.3   rate of attenuation of filter: The maximum slope of the transmission characteristic.

NOTES

1   The attenuation rate is determined by the design of the filter and is expressed in decibels per octave.

2   The rate of attenuation at the 75 % transmission cut-off may also be significant and expressed.

7.4   phase shift: The displacement, in time or space, between sinusoidal output and input signals of a given frequency.

NOTE — The phase shift produced by a filter, such as the two C-R[1] filter, is generally dependent on the rate of attenuation at each frequency considered. Phase shift through a phase-corrected (digital) filter can be zero or the same for all frequencies.

7.5   undulation cut-off: The number of sinusoidal undulations per 360° at the upper or lower end of the passband, where the transmission has been attenuated to 75 % of its maximum (except for 1 upr).

7.6   undulation range of the filter: The range of undulations lying between the upper and lower undulation cut-off.

NOTE — The undulation range may be expressed in spatial terms (undulations per 360°) or in temporal terms (frequency in hertz).

8   Additional terms

8.1   method divergence: The numerical difference between two methods of measurement which are both standardized and are nominally but not precisely equal.

8.2   measurement between support centres: Method in which the axis used for measurement is the common axis between the support centres formed in the workpiece itself.

NOTE — In this method the real axis of rotation of the workpiece can lead to differences in the measurement which can be caused by

   a)   defects of form, orientation, alignment of the centres and the benchmarks;

   b)   possible eccentricity of the section being checked.

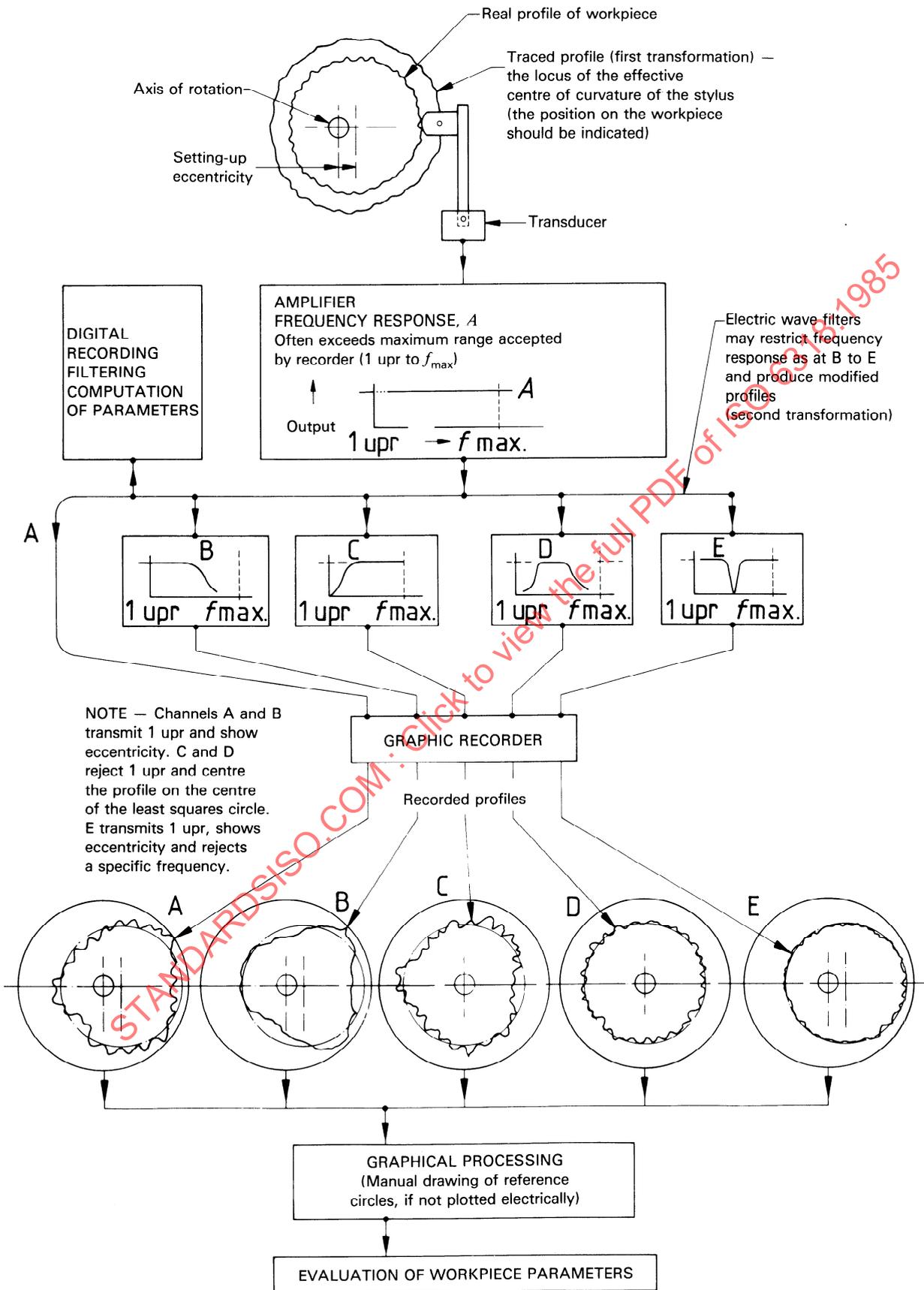1)   "C" stands for "capacitive", "R" for "resistive".

3

Figure 2 — Flowchart illustrating an example using the least squares circle