INTERNATIONAL STANDARD

ISO 12181-2

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Geometrical product specifications (GPS) — Roundness —

Part 2: Specification operators

Spécification géométrique des produits (GPS) — Circularité —

Partie 2: Opérateurs de spécification

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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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 12181-2 was prepared by Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification*.

This first edition of ISO 12181-2 cancels and replaces ISO/TS 12181-2:2003, which has been technically revised.

ISO 12181 consists of the following parts, under the general title *Geometrical product specifications (GPS) — Roundness*:

— *Part 1: Vocabulary and parameters of roundness*

— *Part 2: Specification operators*

Introduction

This part of ISO 12181 is a geometrical product specification (GPS) standard and is to be regarded as a general GPS standard (see ISO/TR 14638). It influences chain link 3 of the chain of standards on form of line independent of datum.

The ISO/GPS Masterplan given in ISO/TR 14638 gives an overview of the ISO/GPS system of which this document is a part. The fundamental rules of ISO/GPS given in ISO 8015 apply to this document and the default decision rules given in ISO 14253-1 apply to specifications made in accordance with this document, unless otherwise indicated.

For more detailed information on the relationship of this part of ISO 12181 to other standards and the GPS matrix model, see Annex B.

This part of ISO 12181 specifies the specification operators according to ISO 17450-2 for roundness of integral features.

This part of ISO 12181 does not specify defaults for filter UPR, probe tip radius and method of association (reference circle). This means that it is necessary for a roundness specification to explicitly state which values are to be used for these specification operations in order for it to be unique.

Consequently, if a specification does not explicitly state which values are to be used for one or more of these operators, the specification is ambiguous (see ISO 17450-2) and a supplier can use any value for the operator(s) not specified when proving conformance.

Extracting data always involves applying a certain filtering process. An additional filtering of the extracted data might or might not be applied. This additional filter can be a mean line filter (Gaussian, spline, wavelet, etc.) or a non-linear filter (e.g. morphological filter). The type of filtering influences the definition of roundness and the specification operators and, therefore, needs to be stated unambiguously.

NOTE 1 Stylus filtering is not sufficient on its own to smooth a profile. In certain circumstances, it can create spurious high-frequency content, thus giving incorrect values. To correct this, a longwave pass filter is employed. A Gaussian filter is used, since this is the state-of-the-art. This filter has some shortcomings, e.g. it can distort, rather than eliminate some roughness features and it can distort, rather than transmit correctly some waviness features. It is envisioned that new filters under development within ISO provide better solutions for several of these issues.

NOTE 2 If a smaller tip radius than the one specified is used for a given cut-off length, the resulting measured value is generally higher. This effect is usually insignificant. If a larger tip radius is used, the resulting measured value is generally lower. The amount of change is heavily dependent on the surface measured.

NOTE 3 The measuring force of zero N is chosen to eliminate effects of elastic deformation of the workpiece from the specification operator. On metal surfaces with adequate thickness, the effect of normally occurring measuring forces is negligible.

NOTE 4 Aliasing and other problems during extraction (see Annex A) due to the higher harmonic content of the skin model, in the roundness directions, can cause specification uncertainty.

This part of ISO 12181 is not intended to disallow any means of measuring roundness.

Geometrical product specifications (GPS) — Roundness —

Part 2:
Specification operators

1 Scope

This part of ISO 12181 specifies the complete specification operator for roundness of integral features only and covers complete roundness profiles only, i.e. geometrical characteristics of features of the type circle.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11562:1996, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Metrological characteristics of phase correct filters*

ISO 12181-1:2011, *Geometrical product specifications (GPS) — Roundness — Part 1: Vocabulary and parameters of roundness*

ISO 14253-1:1998, *Geometrical Product Specifications (GPS — Inspection by measurement of workpieces and measuring equipment — Part 1: Decision rules for proving conformance or non-conformance with specifications*

ISO 17450-2:2011[1)], *Geometrical product specifications (GPS) — General concepts — Part 2: Basic tenets, specifications, operators and uncertainties*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12181-1 and ISO 17450-2 apply.

4 Complete specification operator

4.1 General

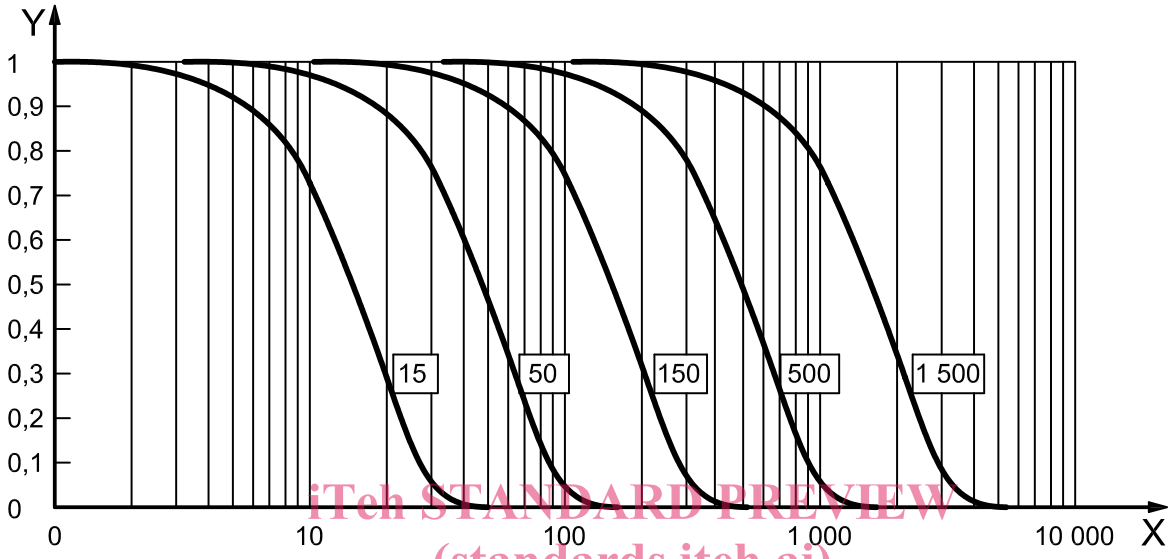
The complete specification operator (see ISO 17450-2) is a full ordered set of unambiguous specification operations in a well-defined order. The complete specification operator defines the transmission band for the roundness profile, together with an appropriate stylus tip geometry.

1) To be published. (Revision of ISO/TS 17450-2:2002)

4.2 Transmission band

4.2.1 Longwave-pass filter

The longwave-pass filter shall be a phase correct filter (in accordance with ISO 11562), transmitting waves from 1 UPR and attenuating profile undulations progressively in the undulation region around the cut-off frequency (in UPR) (see Figure 1).



Key

X undulations per revolution (UPR)

Y transmission

NOTE Other filter values than those shown in this figure can be used, if necessary for the application.

Figure 1 — Transmission characteristic for longwave-pass filter having cut-off frequencies f_c = 15 UPR; 50 UPR; 150 UPR; 500 UPR; 1 500 UPR

The attenuation function is given by Equation (1):

$$\frac{a_1}{a_0} = e^{-\pi\left(\frac{\alpha \times f}{f_c}\right)^2} \tag{1}$$

where

$$\alpha = \sqrt{\frac{\ln(2)}{\pi}} = 0{,}469\,7$$

a_0 is the amplitude of sine wave undulation before filtering;

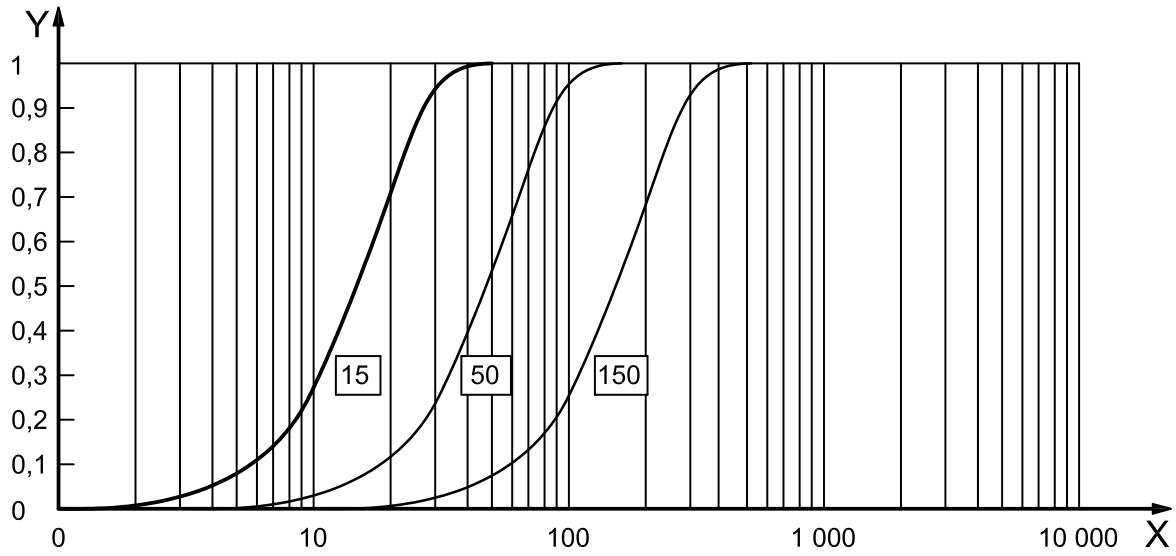
a_1 is the amplitude of this sine wave undulation after filtering;

f_c is the cut-off frequency, in undulations per revolution, of the longwave-pass filter;

f is the frequency of the sine wave, in undulations per revolution.

4.2.2 Shortwave-pass filter

The shortwave-pass filter shall be a phase correct filter (in accordance with ISO 11562), attenuating waves from 1 UPR up to the cut-off frequency (in UPR). It transmits undulations shorter than the cut-off frequency (in UPR) (see Figure 2).



Key

X undulations per revolution (UPR)

Y transmission

NOTE Other filter values than those shown in this figure can be used, if necessary for the application.

Figure 2 — Transmission characteristic for shortwave-pass filter having cut-off frequencies f_c = 15 UPR; 50 UPR; 150 UPR

The attenuation function is given by Equation (2):

$$\frac{a_2}{a_0} = 1 - e^{-\pi\left(\frac{\alpha \times f}{f_c}\right)^2} \tag{2}$$

where

$$\alpha = \sqrt{\frac{\ln(2)}{\pi}} = 0{,}469\,7$$

a_0 is the amplitude of sine wave undulation before filtering;

a_2 is the amplitude of this sine wave after filtering;

f_c is the cut-off frequency, in undulations per revolution, of the longwave-pass filter;

f is the frequency of the sine wave, in undulations per revolution.