International Standard

ISO 16610-22

Geometrical product specifications (GPS) — Filtration —

Part 22: Linear profile filters: Spline filters

Spécification géométrique des produits (GPS) — Filtrage —

Partie 22: Filtres de profil linéaires: Filtres splines

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 290, *Dimensional and geometrical product specification and verification*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 16610-22:2015), which has been technically revised.

The main changes compared to the previous edition are as follows:

— correction of the transmission characteristics, Formulae (8) and (9) in the first edition, and correction of the example Figure C.4 in the first edition;

— addition of an informative Annex B to show the influence of the tension parameter β ;

— addition of the transmission characteristics for closed profiles that apply to the case of roundness filtration.

A list of all parts in the ISO 16610 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

This document is a geometrical product specification (GPS) standard and is to be regarded as a general GPS standard (see ISO 14638). It influences chain links C and E in the GPS matrix structure.

The ISO GPS matrix model given in ISO 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 the specifications made in accordance with this document, unless otherwise indicated.

For more information on the relationship of this document to the filtration matrix model, see Annex C.

For more detailed information on the relation of this document to other standards and the GPS matrix model, see Annex D.

This document develops the terminology and concepts of linear spline filters for surface profiles. Linear spline filters for surface profiles have a transmission of 50 % for sinusoidal surface profiles with wavelengths equal to the cut-off wavelength. They separate the large- and small-scale lateral components of surface profiles in such a way that the surface profiles can be reconstructed without altering. Depending on the selected nesting index and tension parameter, linear spline filters offer one method for F-operation.

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Geometrical product specifications (GPS) — Filtration —

Part 22:
Linear profile filters: Spline filters

1 Scope

This document specifies linear spline filters for the filtration of surface profiles. It defines, in particular, how to separate large- and small-scale lateral components of surface profiles.

The concepts presented for closed profiles are applicable to the case of roundness filtration. Where appropriate, these concepts can be extended to generalized closed profiles, especially for surface profiles with re-entrant features.

Examples for the application of the spline filter are given in Annex A. The influence of the tension parameter β on the large-scale lateral component of the profile is shown in Annex B.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 16610-1:2015, *Geometrical product specifications (GPS) — Filtration — Part 1: Overview and basic concepts*

ISO 16610-20:2015, *Geometrical product specifications (GPS) — Filtration — Part 20: Linear profile filters: Basic concepts*

ISO/IEC Guide 99, *International vocabulary of metrology — Basic and general concepts and associated terms (VIM)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16610-1, ISO 16610-20, ISO/IEC Guide 99 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
surface profile
line resulting from the intersection between a surface portion and an ideal plane

Note 1 to entry: The orientation of the ideal plane is usually perpendicular to the tangent plane of the surface portion.

Note 2 to entry: See ISO 17450-1:2011, 3.3 and 3.3.1, for the definition of an ideal plane.

[SOURCE: ISO 16610-1:2015, 3.1.2, modified — Note 2 to entry replaced.]

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3.1.1
open profile
finite length *surface profile* (3.1) with two ends

Note 1 to entry: An open profile has a compact support, i.e. within a certain interval the height values of an open profile can be equal to any real number. Outside the interval, the height values of an open profile are set to zero.

[SOURCE: ISO 16610-1:2015, 3.7, modified — Note 1 to entry replaced.]

3.1.2
unbounded open profile
infinite length *surface profile* (3.1) without ends

Note 1 to entry: In this document, the term “unbounded” refers to the X-axis.

Note 2 to entry: The concept of the unbounded open profile is ideal and does not apply to real surface profiles.

3.1.3
closed profile
connected finite length *surface profile* (3.1) without ends

Note 1 to entry: A closed profile is a closed curve which is periodic with the finite period length L.

Note 2 to entry: A typical example of a closed profile is one from a roundness measurement.

[SOURCE: ISO 16610-1:2015, 3.8, modified — Note 1 to entry replaced. Note 2 to entry added.]

3.2
linear profile filter
profile filter which separates *surface profiles* (3.1) into large- and small-scale lateral components and is also a linear function

Note 1 to entry: If F is a function and X and Y are surface profiles, and if a and b are independent from X and Y, then F being a linear function implies $F(a\,X + b\,Y) = a\,F(X) + b\,F(Y)$.

[SOURCE: ISO 16610-20:2015, 3.1, modified — In definition “profiles” replaced by “surface profiles” and “long wave” and “short wave” replaced by “large-scale lateral” and “small-scale lateral”; Note 1 to entry replaced.]

3.3
weighting function
function to calculate large-scale lateral components by convolution of the surface profile heights with this function

Note 1 to entry: The convolution (see ISO 16610-20:2015, 4.1) performs a weighted moving average of the surface profile heights. The weighting function, reflected at the X-axis, defines the weighting coefficients for the averaging process.

3.4
transmission characteristic
<filter>
characteristic that indicates the amount by which the amplitude of a sinusoidal surface profile is attenuated as a function of its wavelength

Note 1 to entry: The transmission characteristic for the large-scale lateral component is the Fourier transformation of the *weighting function* (3.3).

[SOURCE: ISO 16610-20:2015, 3.4]

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3.5
cut-off wavelength
λ_c
wavelength of a sinusoidal surface profile of which 50 % of the amplitude is transmitted by the profile filter

Note 1 to entry: Linear profile filters are identified by the filter type and the cut-off wavelength value.

Note 2 to entry: The cut-off wavelength is the nesting index for linear profile filters.

[SOURCE: ISO 16610-20:2015, 3.5, modified — In Note 2 to entry "recommended" deleted.]

3.6
undulations per revolution
UPR
number of sinusoidal undulations contained in a *closed profile* (3.1.3)

Note 1 to entry: In this document, UPR is a frequency and is denoted by *f*.

3.7
cut-off frequency
f_c
frequency, in UPR, of a sinusoidal *closed profile* (3.1.3) of which 50 % of the amplitude is transmitted by the profile filter

3.8
spline
linear combination of piecewise polynomials, with a smooth fit between the pieces

Note 1 to entry: The degree of the spline is equal to the degree of the polynomial of the highest degree used.

4 Characteristics of the spline filter for open profiles

4.1 General

In this clause, the filter equations and transfer characteristics of the spline filter for uniformly sampled open profiles are considered.

4.2 Filter equations

4.2.1 Determination of the large-scale lateral component

For the determination of the large-scale lateral component of an open profile, the spline filter is defined by Formula (1):

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