SLOVENSKI STANDARD
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Specifikacija geometrijskih veličin izdelka (GPS) - Filtriranje - 22. del: Filtri linearnih profilov: utorni filtri (ISO/DIS 16610-22:2024)

Geometrical product specifications (GPS) - Filtration - Part 22: Linear profile filters: Spline filters (ISO/DIS 16610-22:2024)

Geometrische Produktspezifikation (GPS) - Filterung - Teil 22: Lineare Profilfilter: Spline□Filter (ISO/DIS 16610-22:2024)

Spécification géométrique des produits (GPS) - Filtrage - Partie 22: Filtres de profil linéaires: Filtres splines (ISO/DIS 16610-22:2024)

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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

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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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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:

— providing correction of the transfer characteristics and correction of examples.

— providing an informative annex for showing the influence of the tension parameter β .

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.

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. It separates 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.

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

2 Normative references

There are no normative references in this document.

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.]

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 do 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 — Definition and 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 of a 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 is the Fourier transformation of the *weighting function* (3.3).

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

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
integer 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 in undulations per revolution
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):

$$\left(\boldsymbol{I}^{n\times n} + \beta\,\alpha^2\,\boldsymbol{P}^{n\times n} + (1-\beta)\,\alpha^4\,\boldsymbol{Q}^{n\times n}\right)\boldsymbol{w}^{n\times 1} = \boldsymbol{z}^{n\times 1} \tag{1}$$

where

$$\boldsymbol{P}^{n\times n} = \begin{pmatrix} 1 & -1 & 0 & \cdots & 0 \\ -1 & 2 & -1 & \ddots & \vdots \\ 0 & \ddots & \ddots & \ddots & 0 \\ \vdots & \ddots & -1 & 2 & -1 \\ 0 & \cdots & 0 & -1 & 1 \end{pmatrix}, \boldsymbol{Q}^{n\times n} = \begin{pmatrix} 1 & -2 & 1 & 0 & \cdots & \cdots & 0 \\ -2 & 5 & -4 & 1 & \ddots & & \vdots \\ 1 & -4 & 6 & -4 & 1 & \ddots & \vdots \\ 0 & \ddots & \ddots & \ddots & \ddots & \ddots & 0 \\ \vdots & \ddots & 1 & -4 & 6 & -4 & 1 \\ \vdots & & \ddots & 1 & -4 & 5 & -2 \\ 0 & \cdots & \cdots & 0 & 1 & -2 & 1 \end{pmatrix},$$

and

n is the number of uniformly sampled values of the open profile;

$\boldsymbol{I}^{n\times n}$ is the identity matrix of dimension $n \times n$;

$\boldsymbol{z}^{n\times 1}$ is the vector of dimension $n \times 1$ of the uniformly sampled open profile;

$\boldsymbol{w}^{n\times 1}$ is the vector of dimension $n \times 1$ of the large-scale lateral component of the open profile;

λ_c is the cut-off wavelength;

α is the constant to provide 50 % transmission characteristic at the cut-off wavelength λ_c;

β is the tension parameter with $0 \le \beta \le 1$.

The constant α is given by Formula (2):

$$\alpha = \left(2\sin\frac{\pi\,\Delta x}{\lambda_c}\right)^{-1} \tag{2}$$