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Geometriska produktspecifikationer (GPS) – Filtrering – Del 20: Linjära profilfilter: Grundläggande begrepp (ISO 16610-20:2015)

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

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Denna standard ersätter SIS-ISO/TS 16610-20:2008, utgåva 1.

The European Standard EN ISO 16610-20:2015 has the status of a Swedish Standard. This document contains the official English version of EN ISO 16610-20:2015.

This standard supersedes the Swedish Standard SIS-ISO/TS 16610-20:2008, edition 1.

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Information about the content of the standard is available from the Swedish Standards Institute (SIS), telephone +46 8 555 520 00. Standards may be ordered from SIS Förlag AB, who can also provide general information about Swedish and foreign standards.

Denna standard är framtagen av kommittén för Mätteknik GPS och Ytstruktur, SIS/TK 507/AG 6.

Har du synpunkter på innehållet i den här standarden, vill du delta i ett kommande revideringsarbete eller vara med och ta fram andra standarder inom området? Gå in på www.sis.se - där hittar du mer information.

EUROPEAN STANDARD

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EN ISO 16610-20

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English Version

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

Spécification géométrique des produits (GPS) - Filtrage - Partie 20: Filtres de profil linéaires: Concepts de base (ISO 16610-20:2015)

Geometrische Produktspezifikation (GPS) - Filterung - Teil 20: Lineare Profilfilter: Grundlegende Konzepte (ISO 16610-20:2015)

This European Standard was approved by CEN on 14 February 2015.

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Foreword

This document (EN ISO 16610-20:2015) has been prepared by Technical Committee ISO/TC 213 "Dimensional and geometrical product specifications and verification" in collaboration with Technical Committee CEN/TC 290 “Dimensional and geometrical product specification and verification” the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2015, and conflicting national standards shall be withdrawn at the latest by October 2015.

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Endorsement notice

The text of ISO 16610-20:2015 has been approved by CEN as EN ISO 16610-20:2015 without any modification.

Introduction

This part of ISO 16610 is a geometrical product specification (GPS) standard and is to be regarded as a general GPS standard (see ISO/TR 14638). It influences chain links 3 and 5 in the GPS matrix structure.

The ISO/GPS Masterplan given in ISO 14638 gives an overview of the ISO/GPS system of which this part of ISO 16610 is a part. The fundamental rules of ISO/GPS given in ISO 8015 apply to this part of ISO 16610 and the default decision rules given in ISO 14253-1 apply to the specifications made in accordance with this part of ISO 16610, unless otherwise indicated.

For more detailed information about the relation of this part of ISO 16610 to the GPS matrix model, see Annex C.

This part of ISO 16610 develops the basic concepts of linear filters, which include spline filters and spline wavelets, and the Gaussian filters.

Geometrical product specifications (GPS) — Filtration —

Part 20:
Linear profile filters: Basic concepts

1 Scope

This part of ISO 16610 describes the basic concepts of linear profile filters.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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, *Geometrical product specifications (GPS) — Filtration — Part 1: Overview and basic concepts*

ISO/IEC Guide 99:2007, *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/IEC Guide 99, ISO 16610-1, and the following apply.

3.1
linear profile filter
profile filter which separates profiles into long wave and short wave components and is also a linear function

Note 1 to entry: If F is a function and X and Y are profiles, then F being a linear function implies F(aX + bY) = aF(X) + bF(Y).

3.2
phase correct profile filter
phase correct linear profile filter
linear profile filter (3.1) which does not cause phase shifts leading to asymmetrical profile distortions

Note 1 to entry: Phase correct filters are a particular kind of the so called linear phase filters because any linear phase filter can be transformed (simply by shifting its weighting function) to a zero phase filter which is a phase correct filter.

3.3
weighting function
function for calculating the mean line which indicates, for each point, the weight attached by the profile in the vicinity of that point

Note 1 to entry: The transmission characteristic of the mean line is the Fourier transformation of the weighting function.

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

Note 1 to entry: The transmission characteristic is the Fourier transformation of the weighting function.

3.5
cut-off wavelength
wavelength of a sinusoidal 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 recommended nesting index for linear profile filters.

3.6
filter bank
set of high-pass and low-pass filters arranged in a specified structure

Note 1 to entry: See 5.4 for further details.

3.7
multiresolution analysis
decomposition of a profile by a *filter bank* (3.6) into portions of different scales

Note 1 to entry: The portions at different scales are also referred to as resolutions.

4 Basic concepts

4.1 General

For a filter to conform with this part of ISO 16610, it shall exhibit the characteristics described in 5.1, 5.2, 5.3, and 5.4.

NOTE A concept diagram for linear profile filters is given in Annex A. The relationship to the filtration matrix model is given in Annex B.

The most general linear profile filter is defined by

$$y(x) = \int K(x,\xi) z(\xi) \mathrm{d}\xi \tag{1}$$

where

$z(\xi)$ is the unfiltered profile;

$y(x)$ is the filtered profile;

$K(x,\xi)$ is a real symmetric and spatial invariant kernel.

If $K(x,\xi) = K(x-\xi)$, the filtering is a convolution,

$$y(x) = \int K(x-\xi) z(\xi) \mathrm{d}\xi \tag{2}$$

and the kernel is called the weighting function of the filter.

However, extracted data are always discrete. Consequently, the filters described here are also discrete. If the weighting function is not discrete (see 4.4, Example 2), it shall be converted into a discrete representation.

4.2 Discrete representation of data

An extracted profile can be represented by a vector. The length n of this vector is equal to the number of data points. The sampling is assumed to be uniform, i.e. the sampling interval is constant. The ith data point of the profile is therefore the ith component of the vector.

$$z = (a_1 a_2 \ldots a_i \ldots a_{n-1} a_n) \tag{3}$$

4.3 Discrete representation of the linear profile filter

A linear profile filter is represented by a square matrix. The dimension of this matrix is equal to the number of data points to be filtered. If the filter is non-periodic, the matrix is a constant diagonal (Toeplitz) matrix:

$$S = \begin{pmatrix} \ddots & \ddots & \ddots & \ddots & \ddots & & & \\ & a & b & c & b & c & & \\ & & c' & b' & a & b & c & \\ & & & c' & b' & c' & b' & a \\ & & & & \ddots & \ddots & \ddots & \ddots \end{pmatrix} \tag{4}$$

Otherwise, if the filter is periodic, the matrix is a circulant matrix:

$$S = \begin{pmatrix} a & b & c & \ldots & \ldots & c' & b' \\ b' & a & b & c & \ldots & \ldots & c' \\ c' & b' & a & b & c & \ldots & \\ & \ddots & \ddots & \ddots & \ddots & \ddots & \\ & \ldots & c' & b' & a & b & c \\ c & \ldots & \ldots & c' & b' & a & b \\ b & c & \ldots & \ldots & c' & b' & a \end{pmatrix} \tag{5}$$

If the filter is phase correct, the matrix representing the filter is symmetrical, i.e. $b = b', c = c', \ldots$ (generally $a_{ij} = a_{ji}$) is valid. The sum of the matrix elements a_{ij} of each row i is constant and for low-pass filters equals one, i.e.

$$\sum_j a_{ij} = 1 \tag{6}$$

NOTE 1 In the case of a symmetrical matrix, the sum of the matrix elements a_{ij} of each column j is also constant and equals one, i.e. $\sum_i a_{ij} = 1$ is also valid.

NOTE 2 The relationship between the matrix *S*, the input data by the vector z, and the output data by the vector w is given in Formula (13).

4.4 Discrete representation of the weighting function

Given that each row of the matrix representation of the filter is identical after being shifted accordingly, the matrix elements may be represented by one single row, i.e.

$$a_{ij} = s_k \text{ with } k = i - j \tag{7}$$

The values s_k form a vector s of a dimension equal to the length of the input or output data vector respectively. This vector is the discrete representation of the weighting function of the filter.

NOTE 1 The length of the weighting function is usually much smaller than the length of the data set. In this case, *s* contains zeros at each end.