TECHNICAL SPECIFICATION

ISO/TS 16610-1

First edition
2006-11-01

Geometrical product specifications (GPS) — Filtration —

Part 1: Overview and basic concepts

Spécification géométrique des produits (GPS) — Filtrage —

Partie 1: Vue d'ensemble et concepts de base

Reference number
ISO/TS 16610-1:2006(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

— an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

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/TS 16610-1 was prepared by Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification*.

ISO/TS 16610 consists of the following parts, under the general title *Geometrical product specifications (GPS) — Filtration*:

— *Part 1: Overview and basic concepts*

— *Part 20: Linear profile filters: Basic concepts*

— *Part 22: Linear profile filters: Spline filters*

— *Part 29: Linear profile filters: Spline wavelets*

— *Part 31: Robust profile filters: Gaussian regression filters*

— *Part 32: Robust profile filters: Spline filters*

— *Part 40: Morphological profile filters: Basic concepts*

- *Part 41: Morphological profile filters: Disk and horizontal line-segment filters*
- *Part 49: Morphological profile filters: Scale space techniques*

The following parts are under preparation:

- *Part 21: Linear profile filters: Gaussian filters*
- *Part 26: Linear profile filters: Filtration on nominally orthogonal grid planar data sets*
- *Part 27: Linear profile filters: Filtration on nominally orthogonal grid cylindrical data sets*
- *Part 30: Robust profile filters: Basic concepts*
- *Part 42: Morphological profile filters: Motif filters*
- *Part 60: Linear areal filters: Basic concepts*
- *Part 61: Linear areal filters: Gaussian filters*
- *Part 62: Linear areal filters: Spline filters*
- *Part 69: Linear areal filters: Spline wavelets*
- *Part 70: Robust areal filters: Basic concepts*
- *Part 71: Robust areal filters: Gaussian regression filters*
- *Part 72: Robust areal filters: Spline filters*
- *Part 80: Morphological areal filters: Basic concepts*
- *Part 81: Morphological areal filters: Sphere and horizontal planar segment filters*
- *Part 82: Morphological areal filters: Motif filters*
- *Part 89: Morphological areal filters: Scale space techniques*

Introduction

This part of ISO/TS 16610 is a geometrical product specification (GPS) Technical Specification and is to be regarded as a global GPS Technical Specification (see ISO/TR 14638). It influences the chain links 3 and 6 of all chains of standards.

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

This part of ISO/TS 16610 develops the terminology and concepts for GPS filtration. This document generalises the concept of filtration. The series of ISO/TS 16610 documents presents a toolbox of filtration techniques to enable the user to choose an appropriate filter for the functional requirements. They are fundamental documents upon which other ISO documents are built.

Geometrical product specifications (GPS) — Filtration —

Part 1:
Overview and basic concepts

1 Scope

This part of ISO/TS 16610 sets out the basic terminology for GPS filtration and the framework for the fundamental procedures used in GPS filtration.

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 14660-1:1999, *Geometrical Product Specifications (GPS) — Geometrical features — Part 1: General terms and definitions*

ISO/TS 17450-1:2005, *Geometrical product specifications (GPS) — General concepts — Part 1: Model for geometrical specification and verification*

ISO/TS 17450-2:2002, *Geometrical product specifications (GPS) — General concepts — Part 2: Basic tenets, specifications, operators and uncertainties*

International vocabulary of basic and general terms in metrology (VIM). BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML, 2nd ed., 1993

3 Terms and definitions

For the purposes of this document, the terms and definitions given in VIM, ISO 14660-1, ISO 17450-1, ISO 17450-2 and the following apply.

3.1
integral feature
surface or line on a surface

NOTE An integral feature is intrinsically defined.

[ISO 14660-1:1999, 2.1.1]

3.1.1
surface portion
SP
portion of a partitioned integral surface

3.1.2
surface profile
line resulting from the intersection between the **surface portion** (3.1.1) and an ideal plane.

NOTE The concept of profiles is under development and it is possible that the definition of surface profile will be reworded.

3.2
primary mathematical model
set of nested mathematical representations of the **surface portion** (3.1.1), wherein each representation in the set can be described by a finite number of parameters

3.2.1
nesting index
NI
number, or set of numbers, indicating the relative level of nesting for a particular **primary mathematical model** (3.2)

NOTE 1 Given a particular nesting index, models with lower indices contain more surface information, whereas models with higher nesting indices contain less surface information.

NOTE 2 By convention, as the nesting index approaches zero (or a series of all zeros), there exists a primary mathematical model that approximates the real surface of a workpiece to within any given measure of closeness.

NOTE 3 The cut-off value for the Gaussian filter is an example of a nesting index. For the morphological filter, the nesting index is the size of the structuring element (e.g. the radius of the disk), which is different from the wavelength concept that underlies the notion of “cut-off”.

3.2.2
degree of freedom
primary mathematical model number of independent parameters required to fully describe a particular **primary mathematical model** (3.2)

3.3
primary surface
PS
surface portion (3.1.1) obtained when the latter is represented as a specified **primary mathematical model** (3.2) with specified **nesting index** (3.2.1)

3.3.1
primary profile
line resulting from the intersection between the **primary surface** (3.3) and an ideal plane

NOTE The concept of profiles is under development and it is possible that the definition of primary profile will be reworded.

3.4
primary mapping
PM(| NI)
mapping indexed by the **nesting index** (3.2.1), used to identify a particular **primary surface** (3.3) with the specified nesting index, in order to represent a **surface portion** (3.1.1) that satisfies the sieve and projection criteria

NOTE 1 The primary mapping is defined in terms of mathematical mappings as

$$PS = PM(SP \mid NI) \tag{1}$$

where

PS is the primary surface,

SP is the surface portion.

NOTE 2 Other filters can be constructed using a combination of primary mappings, e.g. the weighted mean of primary mappings, the supremum of primary mappings.

3.4.1
sieve criterion
criterion where two **primary mappings** (3.4) applied one after another to a surface portion is entirely equivalent to only applying one of these two primary mappings to the surface portion, namely that primary mapping with the highest **nesting index** (3.2.1)

NOTE The sieve criterion is defined in terms of mathematical mappings as

$$PM[PM(SP \mid NI_1) \mid NI_2] = PM(SP \mid NI) \text{ with } NI = \max(NI_1, NI_2) \qquad (2)$$

where

SP is the surface portion.

3.4.2
projection criterion
criterion wherein a **primary surface** (3.3) with a specified **nesting index** (3.2.1) is mapped onto itself using the **primary mapping** (3.4) with the same specified nesting index

3.5
filtration
operation used to create a non-ideal feature by reducing the level of information of a non-ideal feature

[ISO/TS 17450-1:2005, 3.12]

3.5.1
profile filter
operator consisting of a **filtration** (3.5) operation for use on a **surface profile** (3.1.2)

NOTE Throughout this document, the term "operator" is interpreted in its mathematical context. When it is used in the context of ISO/TS 17450-2:2002, the qualifier "specification" or "verification" is used in front of the term "operator".

3.5.2
areal filter
operator consisting of a **filtration** (3.5) operation for use on a **surface portion** (3.1.1)

3.6
outlier
local portion in a data set that is not representative, or not typical, for the partitioned **integral feature** (3.1), and which is characterized by magnitude and scale

NOTE Not all outliers can be determined using data alone: only those that are physically inconsistent with stylus tip geometry. It is sometimes possible to give a warning based on magnitude/scale criteria.

3.7
open profile
finite length **surface profile** (3.1.2) with two ends

NOTE The surface profile does not intersect with itself.

3.8
closed profile
connected finite length **surface profile** (3.1.2) without ends

NOTE The surface profile does not intersect with itself, i.e. it is a simple closed curve or Jordan curve.

3.9
robustness
insensitivity of the output data against specific phenomena in the input data

NOTE Outliers, scratches and steps are examples of specific phenomena; more details can be tound in ISO/TS 16610-30.

3.10
filter equation
equation for the mathematical description of the filter

NOTE Filter equations do not necessarily specify an algorithm for the numerical realization of the filter.

4 General discussion

4.1 General

A filter is a way of separating features of interest from other features in data.

EXAMPLE Sieving particles, where soil particles are filtered into different sizes, depending on the size of the sieve holes.

The nesting index is the size at which features are separated. In the above example, the nesting index corresponds to the size of the holes in the sieve.

More precisely, filtration consists in the first place of defining a set of nested representations (similar to a set of Russian dolls) to be used to model the real surface, such that the further into the nesting, the smoother the model used to represent the surface. The nesting index is a number that indicates the level of the nesting/smoothness of the model, such that the higher the value of the nesting index, the smoother the model used to represent the surface. By convention, as the nesting index approaches zero, there exists a model that represents the real surface.

Secondly, a primary mapping is defined. The primary mapping is a method of choosing a particular model, with a specified nesting index and which satisfies certain properties, to represent a real surface. The primary mapping is a basic filter from which other filters can be constructed. Illustrative examples are given in Annex A.

A toolbox of new and novel filter tools is recommended, which includes mean line filters, morphological filters, robust filters and techniques that decompose surface texture into different scale components. The recommended toolbox has been developed to meet current and future GPS requirements in filtration, with the aim of publishing the filtration toolbox in the form of ISO Technical Specifications, so that GPS users can first assess their utility, before deciding upon their publication as full International Standards. These ISO Technical Specifications form the ISO/TS 16610 series of documents. The filtration masterplan (see Annex B) shows the structure of the part number allocation for the ISO/TS 16610 series. The particular filter tool and its default value are provided in other ISO application documents.

The advantages and disadvantages of different filter types are given in Annex C. Concept diagrams for the basic concepts of filtration are given in Annex D, and the relationship to the filtration matrix is given in Annex E.

4.2 Primary mathematical models

The primary mathematical models have been developed to generalise the concept of wavelength band. The aim of the nesting index is to generalise the concept of wavelength.

Given a particular model within a set of nested models, higher nestings (with a smaller nesting index) contain more surface information, whereas lower nestings (with a larger nesting index) contain less surface information. By convention, as the nesting index approaches zero, there exists a primary mathematical model that approximates the partitioned integral feature to within any given measure of closeness (as defined by a suitable mathematical norm).

The sieve criterion is derived from Matheron's size criteria[33], and is a necessary condition for the following reason: if a primary mapping is applied to a partitioned integral feature, any further primary mapping with a larger nesting index is exactly equivalent to applying the second primary mapping with the larger nesting index directly to the partitioned integral feature. In other words, for a primary mapping with a specified nesting index, no information is lost concerning primary mappings of the partitioned integral feature with a larger nesting index.

The projection criterion is necessary in order to ensure that the nesting index corresponds to Matheron's definition of size.

Since the nesting index of the primary mathematical models corresponds to scale/size, and the primary mappings satisfy the sieve criterion, the nesting index can be used to define the generalised concept of wavelength.

5 Filter designations

Table 1 indicates the basic semantics in designating filters. Table 2 indicates the filter designations.

Table 1 — Basic semantics in designating filters

Filter	Type	Category
F = Filter	A = Areal (3D)	L = Linear
		M = Morphological
		R = Robust
	P = Profile (2D)	L = Linear
		M = Morphological
		R = Robust

Table 2 — Filter designations

Type	Category	Designation	Name	ISO document
FA	FAL	FALG	Gaussian	ISO/TS 16610-61
		FALS	Spline	ISO/TS 16610-62
		FALW	Spline Wavelet	ISO/TS 16610-69
	FAM	FAMCB	Closing Ball	ISO/TS 16610-81
		FAMCH	Closing Horizontal segment	ISO/TS 16610-81
		FAMOB	Opening Ball	ISO/TS 16610-81
		FAMOH	Opening Horizontal segment	ISO/TS 16610-81
		FAMAB	Alternating series Ball	ISO/TS 16610-89
		FAMAH	Alternating series Horizontal segment	ISO/TS 16610-89
	FAR	FARG	Robust Gaussian	ISO/TS 16610-71
		FARS	Robust Spline	ISO/TS 16610-72
FP	FPL	FPLG	Gaussian	ISO/TS 16610-21
		FPLS	Spline	ISO/TS 16610-22
		FPLW	Spline Wavelet	ISO/TS 16610-29
	FPM	FPMCD	Closing Disk	ISO/TS 16610-41
		FPMCH	Closing Horizontal segment	ISO/TS 16610-41
		FPMOD	Opening Disk	ISO/TS 16610-41
		FPMOH	Opening Horizontal segment	ISO/TS 16610-41
		FPMAD	Alternating series Disk	ISO/TS 16610-49
		FPMAH	Alternating series Horizontal segment	ISO/TS 16610-49
	FPR	FPRG	Robust Gaussian	ISO/TS 16610-31
		FPRS	Robust Spline	ISO/TS 16610-32
FP (special case)		F2RC	2RC	ISO 3274

Annex A
(informative)

Illustrative examples

A.1 Truncated Fourier series for a roundness profile (closed profile)

A.1.1 Integral feature

The nominal feature is assumed to be a cylinder, so the partitioned integral feature is the corresponding non-ideal feature.

A.1.2 Surface portion

The surface portion is a roundness profile taken on the partitioned integral feature (see Figure A.1).

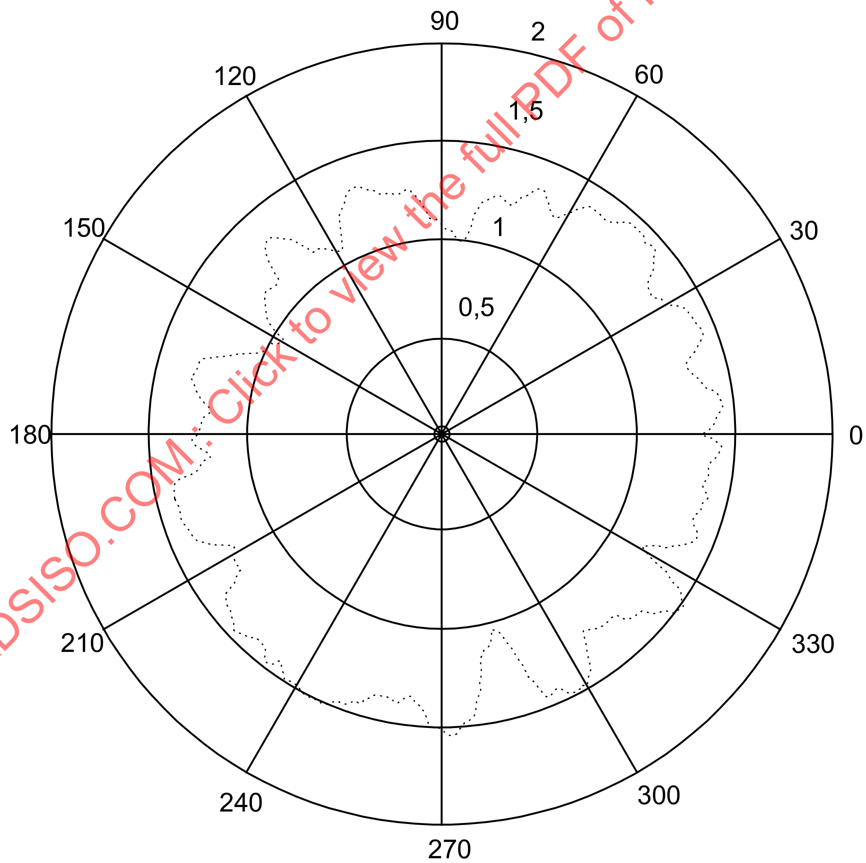


Figure A.1 — Roundness profile of partitioned integral feature

A.1.3 Primary mathematical model

The primary mathematical model is a truncated Fourier series for a roundness profile. The Nth order model includes all harmonics up to and including the Nth harmonic of the profile, and no higher order harmonics than the Nth order harmonic (see Figure A.2).

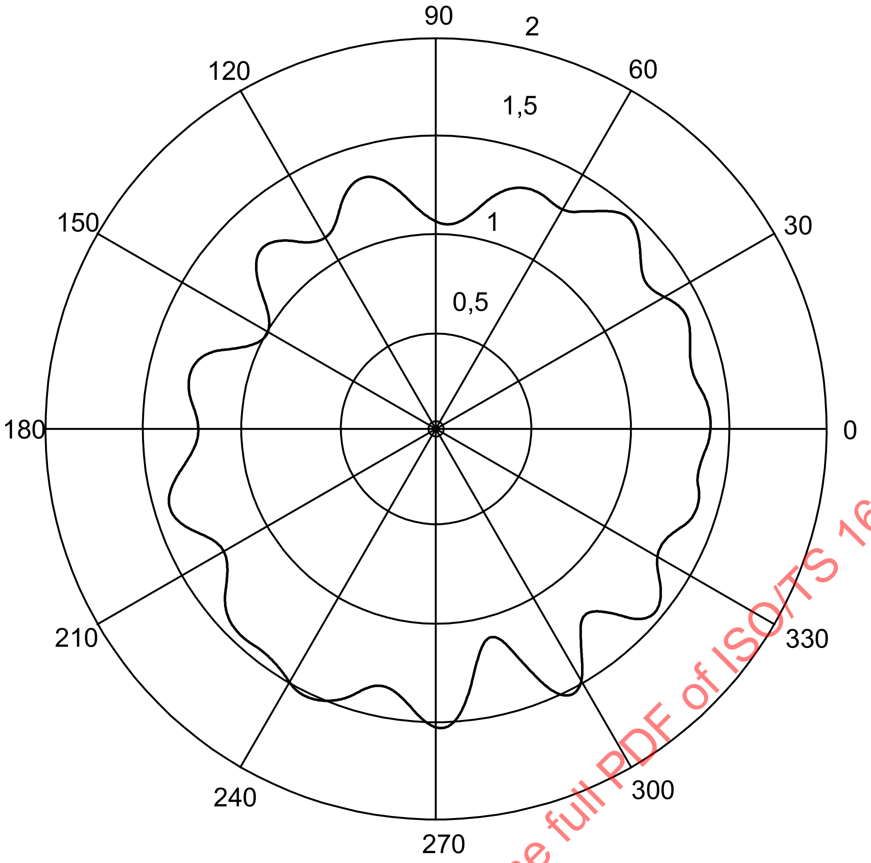


Figure A.2 — Example of 13th order primary mathematical model

In terms of polar co-ordinates, the Nth order mathematical representation is:

$$R_N(\theta) = a_0 + \sum_{i=1}^{N} \left[a_i \times \cos(i \times \theta) + b_i \times \sin(i \times \theta) \right] \tag{A.1}$$

where

R_N is the Nth order radial term;

θ is the angle;

a_i, b_i are the Fourier coefficients.

This model is nested, since the Nth order model includes all harmonics up to and including the Nth harmonic of the profile, and therefore includes all the harmonics of a model whose order is less than N.

A.1.3.1 Nesting index

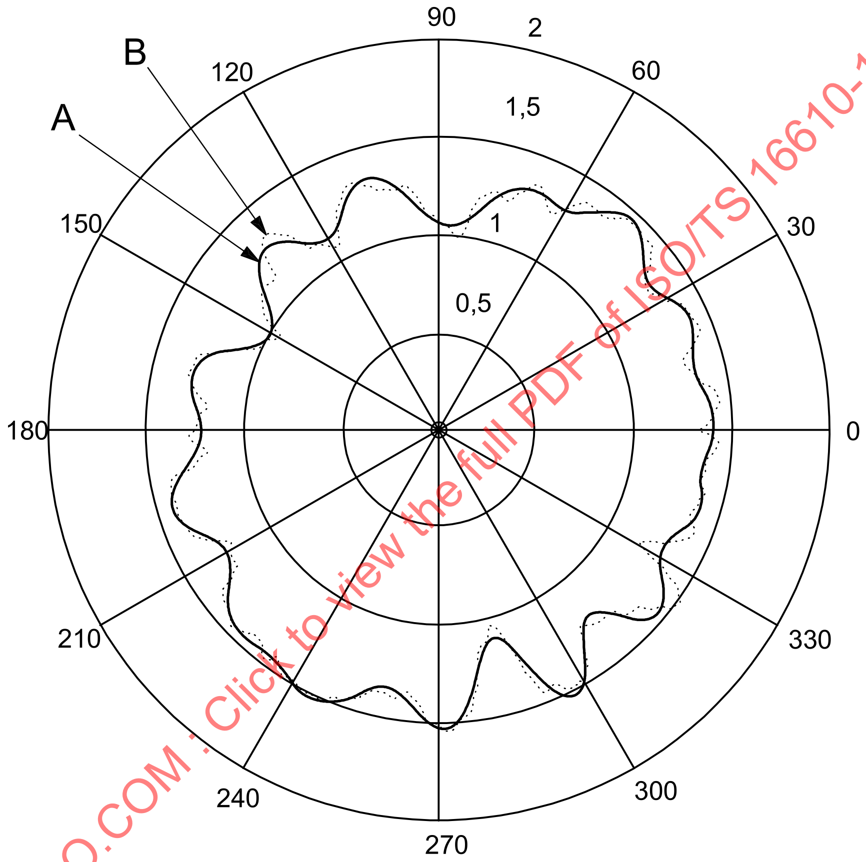
A suitable nesting index is given by $2\pi/N$, the smallest angular wavelength represented by the model. As this angular wavelength approaches zero, it implies that N tends to infinity, i.e. the model approaches a full Fourier series. It is well known that, with some very mild assumptions, roundness profiles equal their full Fourier series almost everywhere. Hence, as the nesting index approaches zero, the model $R_N(\theta)$ approaches the real roundness profile almost everywhere, as required.

A.1.3.2 Degrees of freedom

A model $R_N(\theta)$ has $2N + 1$ independent parameters and so has $2N + 1$ degrees of freedom.

A.1.4 Primary mapping

To obtain a filtered profile, it is necessary to primary map a roundness profile onto a truncated Fourier series. This can be achieved by taking the Fourier transform of the partitioned integral feature, using the Fourier series only up to the truncation point, and calculating the coefficients of the model (see Figure A.3). It can be easily shown that this method for primary mapping satisfies the sieve criterion.



Key

A primary profile

B partitioned integral feature

Figure A.3 — Primary profile

A.2 Alternating sequence morphological filter on a profile

Morphological profile filters are described in ISO/TS 16610-40, ISO/TS 16610-41 and ISO/TS 16610-49.

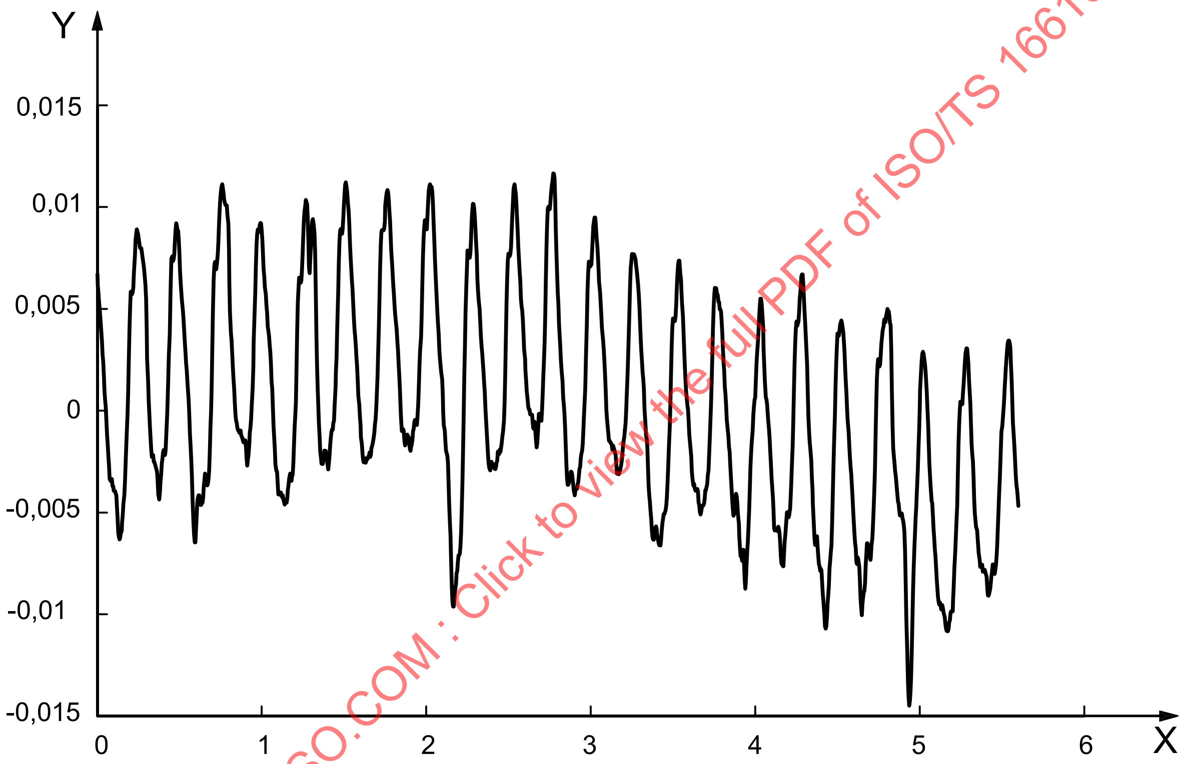
A.2.1 Integral feature

The nominal feature is assumed to be a cube, and the partitioned integral feature is a non-ideal feature corresponding to a plane of a specified face of the cube.

A.2.2 Surface portion

The surface portion is a profile taken on the partitioned integral feature (see Figure A.4).

Dimensions in millimetres



Key

X distance

Y height

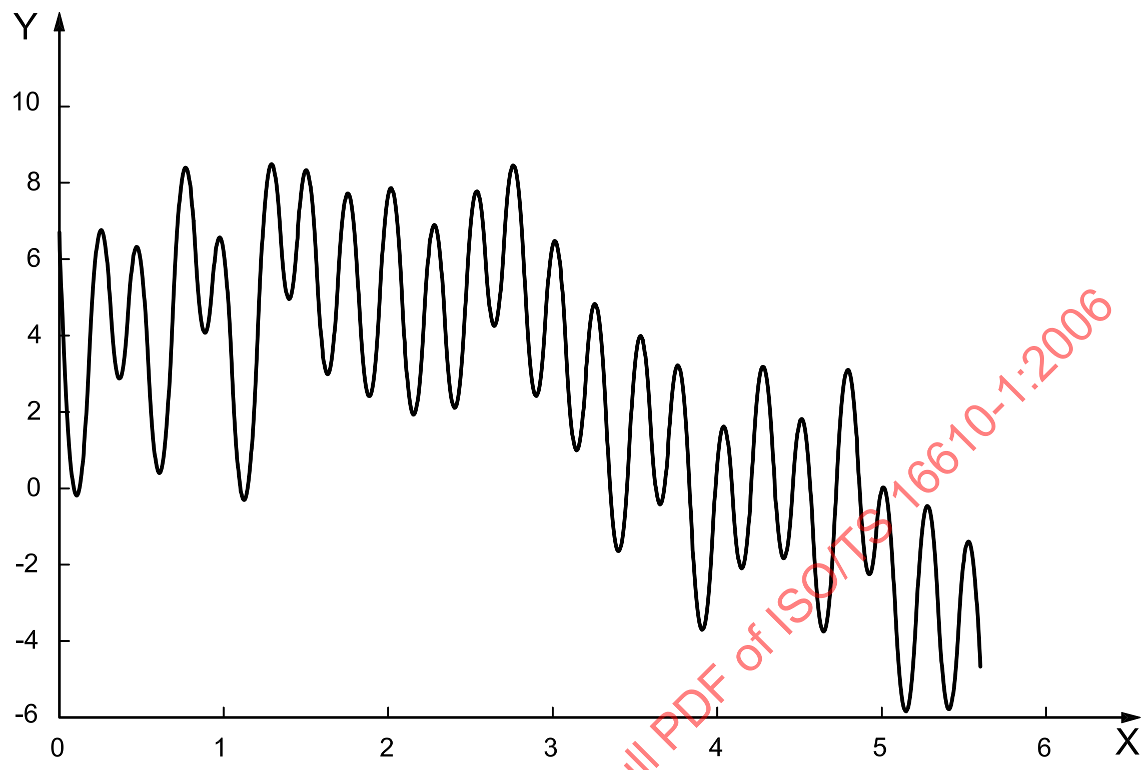
Figure A.4 — Profile of a partitioned integral feature

A.2.3 Primary mathematical model

A.2.3.1 General

The primary mathematical model is a profile whose absolute instantaneous curvature values are all below a specified maximum value (see Figure A.5). This model is nested since a model with a specified maximum absolute curvature value includes all models with a lower maximum value.

Dimensions in millimetres



Key

X distance

Y height × 10^3

Figure A.5 — Example of primary mathematical model with nesting index radius of 0,8 mm

A.2.3.2 Nesting index

A suitable nesting index is given by the radius corresponding to the inverse absolute value of the curvature. As the radius approaches zero, i.e. the value of curvature approaches infinity, the model approaches the profile as required.

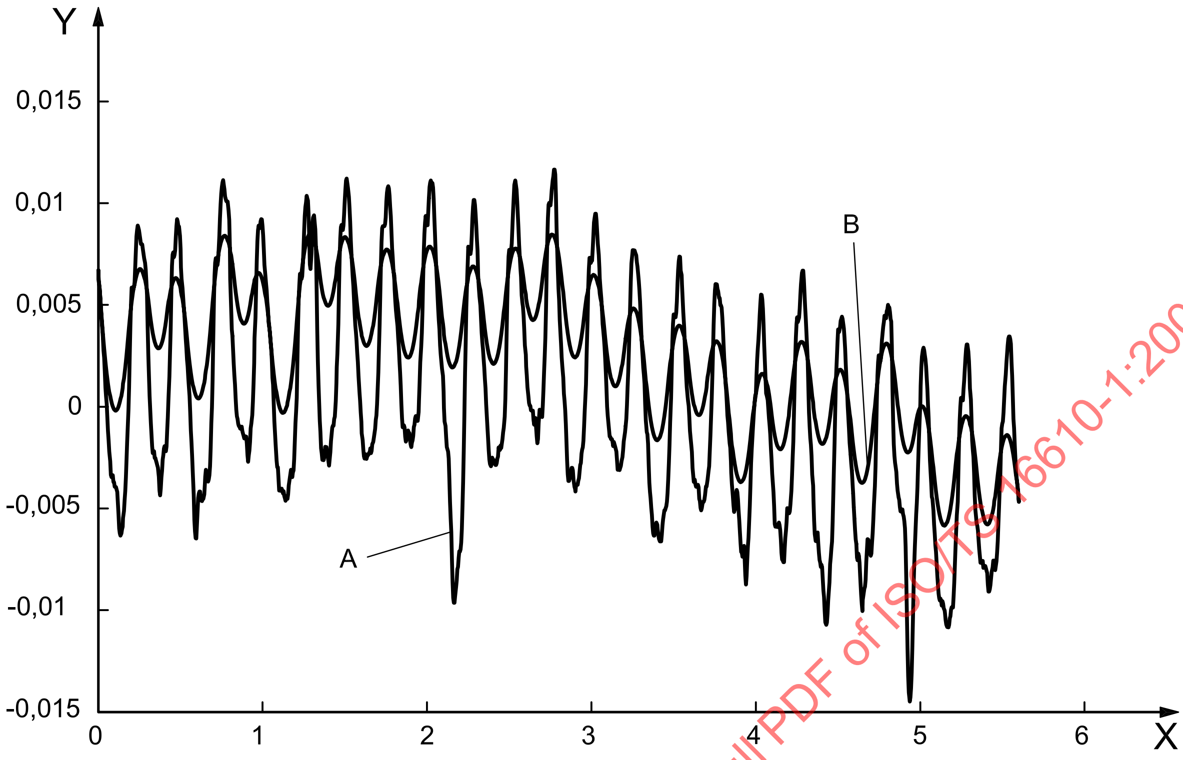
A.2.3.3 Degrees of freedom

For each nesting index, it is possible to construct a primary mathematical model. Hence finite degrees of freedom can not be specified *a priori* for a given nesting index.

A.2.4 Primary mapping

To obtain a filtered surface, it is necessary to primary map the integral feature to a primary mathematical model of a specified nesting index (see Figure A.6). This can be achieved by means of a series of morphological closings and openings of the partitioned integral feature, with circular structural elements with an increasing nesting index, and ending with the same radius as the nesting index (see ISO/TS 16610-49 for details). It can easily be shown that this method for primary mapping satisfies the sieve criterion.

Dimensions in millimetres



Key

X distance

Y height

A partitioned integral feature

B primary profile

Figure A.6 — Primary profile

Annex B
(informative)

Masterplan for filtration standards — ISO/TS 16610 series

B.1 Filtration standards

B.1.1 Filtration standard matrix

Table B.1 gives the filtration matrix for the ISO/TS 16610 series of technical specifications.

Table B.1 — Structure of parts in the ISO/TS 16610 series

General	**Filters**					
	Part 1					
Fundamental	**Profile filters**			**Areal filters**		
	Part 1[a]			Part 1[b]		
	Linear	**Robust**	**Morphological**	**Linear**	**Robust**	**Morphological**
Basic concepts	Part 20	Part 30	Part 40	Part 60	*70*	*80*
Particular filters	Part 21	Part 31	Part 41	*61*	*71*	*81*
	Part 22	Part 32	Part 42	*62*	*72*	*82*
	23	*33*	*43*	*63*	*73*	*83*
	24	*34*	*44*	*64*	*74*	*84*
	25	*35*	*45*	*65*	*75*	*85*
How to filter	Part 26	*36*	*46*	*66*	*76*	*86*
	Part 27	*37*	*47*	*67*	*77*	*87*
	28	*38*	*48*	*68*	*78*	*88*
Multiresolution	Part 29	*39*	Part 49	*69*	*79*	*89*

NOTE Numbers in italics indicate possible parts not yet available.

[a] To become Part 11 in the future.

[b] To become Part 12 in the future.

B.1.2 Titles of the individual part in the ISO/TS 16610 series

The main title is:

Geometrical product specifications (GPS) — Filtration

The individual part titles are:

— *Part 1: Overview and basic concepts*

— *Part 20: Linear profile filters: Basic concepts*

- *Part 21: Linear profile filters: Gaussian filters*
- *Part 22: Linear profile filters: Spline filters*
- *Part 26: Linear profile filters: Filtration on nominally orthogonal grid planar data sets*
- *Part 27: Linear profile filters: Filtration on nominally orthogonal grid cylindrical data sets*
- *Part 29: Linear profile filters: Spline wavelets*
- *Part 30: Robust profile filters: Basic concepts*
- *Part 31: Robust profile filters: Gaussian regression filters*
- *Part 32: Robust profile filters: Spline filters*
- *Part 40: Morphological profile filters: Basic concepts*
- *Part 41: Morphological profile filters: Disk and horizontal line-segment filters*
- *Part 42: Morphological profile filters: Motif filters*
- *Part 49: Morphological profile filters: Scale space techniques*
- *Part 60: Linear areal filters: Basic concepts*

B.2 Structure of the filtration standards — ISO/TS 16610 series

B.2.1 Structure of Parts x0 (Basic concepts)

- Foreword
- Introduction
- Scope
- Normative references (incl. ISO 31-11)
- Definitions
- Basic concepts
- X filters
- Comparison of filters (clause content shall only direct the user to clauses of other parts of the 16610 series in which comparison of filters are given)
- Annexes
- Annex n-1: “Relationship to the filtration matrix model”
- Annex n: “Relationship to the GPS matrix model”
- Bibliography

B.2.2 Structure of Parts x1 to x5 (Particular)

- Foreword
- Introduction
- Scope
- Normative references (incl. ISO 31-11)
- Definitions
- The particular filter in question
- Recommendations
- Filter designation (according to this part of ISO/TS 16610)
- Annexes (incl. Examples)
- Annex n-1: "Relationship to the filtration matrix model"
- Annex n: "Relationship to the GPS matrix model"
- Bibliography

B.2.3 Structure of Parts x6 to x7 (How to filter — Guidance)

- Foreword
- Introduction
- Scope
- Normative references (incl. ISO 31-11)
- Definitions
- Guidance
- Annexes (incl. Examples)
- Annex n-1: "Relationship to the filtration matrix model"
- Annex n: "Relationship to the GPS matrix model"
- Bibliography

B.2.4 Structure of Part x9 (Multiresolution)

- Foreword
- Introduction
- Scope

- Normative references (incl. ISO 31-11)
- Definitions
- Description of multi-resolution method(s)
- Filter designation (in accordance with this part of ISO/TS 16610)
- Annexes (incl. Examples)
- Annex n-1: “Relationship to the filtration matrix model”
- Annex n: “Relationship to the GPS matrix model”
- Bibliography

Annex C
(informative)

Advantages and disadvantages of different filter types

The following tables reflect the knowledge of the experts responsible for this document at its date of issue, and are not exhaustive.

Table C.1 — Gaussian filter (ISO 11562)

For	Against	Of particular interest
Well known Well defined Nyquist sampling Reconstruction possible Easy to compute Roundness: no end effects Easy to interpret Nested set of mathematic models Defined by cut-off wavelength No ringing No side lobes	Not robust Outlier sensitive Distorts skewed surfaces Form must be removed End effects Non-compact support No wavelet analysis possible	Linear system based on Fourier wavelengths Easy to implement on spaced data

Table C.2 — Spline filter (ISO/TS 16610-22)

For	Against	Of particular interest
End effects easier to handle No need to remove form Does not distort skewed surfaces Easy to compute Roundness: no end effects Wavelet analysis possible Nyquist sampling Defined by cut-off wavelengths De-noise Faster than Gaussian Self-adjusting Compact support Random data spacing possible Applicable to any surface	Currently range of application not fully established	Linear/non-linear Fourier interpretation possible Can be Gauss approximation As B-Spline order N tends to infinity converges to Gaussian The limiting case of the linear spline converges to the 2RC PC filter

Table C.3 — Spline wavelet (ISO/TS 16610-29)

For	Against	Of particular interest
Locates and identifies outliers Filter individual features Applicable to non stationary surfaces Form removal not necessary De-noise Nyquist sampling Reconstruction possible Easy to compute Closed profiles: no end effects Nested set of mathematical models Defined similar to cut-off wavelengths Faster than Gaussian Can be used on short profiles Can be used for surfaces	Many different mother wavelet types Difficult to interpret Currently range of application not fully established	Includes B-splines Different to Fourier wavelengths

Table C.4 — Morphological filter (ISO/TS 16610-41)

For	Against	Of particular interest
Definition of mechanical surface Simulates contact phenomena (e.g. E-system) Does not distort Chebyshev fits Closed profiles: no end effects Nested set of mathematical models No need to remove form Compact support Random data spacing possible Faster than Gaussian	Range of application not fully established Outlier sensitive	Different to Fourier wavelengths Non-linear filter Default filter for establishment of datums (alpha-hull)

Table C.5 — Alternating sequence filter (ISO/TS 16610-49)

For	Against	Of particular interest
Well defined Nested set of mathematical models Naturally robust Easy to compute Multiresolution type analysis possible End effects easy to handle Form removal not necessary Defined similar to cut-off wavelengths	Range of application not fully established Published algorithms slower than Gaussian	Different to Fourier wavelengths Non-linear Filter Ball defined by curvature not wavelength Sampling theorems (not Nyquist) Reconstruction possible