TECHNICAL SPECIFICATION

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Geometrical product specifications (GPS) — Filtration —

Part 30:
Robust profile filters: Basic concepts

Spécification géométrique des produits (GPS) — Filtrage —

Partie 30: Filtres de profil robustes: Concepts de base

Reference number
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Foreword

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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:

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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 16610-30 was prepared by Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification.*

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

— *Part 1: Overview and basic concepts* [Technical Specification]

— *Part 20: Linear profile filters: Basic concepts* [Technical Specification]

— *Part 21: Linear profile filters: Gaussian filters*

— *Part 22: Linear profile filters: Spline filters* [Technical Specification]

— *Part 29: Linear profile filters: Spline wavelets* [Technical Specification]

— *Part 30: Robust profile filters: Basic concepts* [Technical Specification]

— *Part 32: Robust profile filters: Spline filters* [Technical Specification]

— *Part 40: Morphological profile filters: Basic concepts* [Technical Specification]

— *Part 41: Morphological profile filters: Disk and horizontal line-segment filters* [Technical Specification]

— *Part 49: Morphological profile filters: Scale space techniques* [Technical Specification]

The following parts are under preparation:

— *Part 28: Profile filters: End effects* [Technical Specification]

— *Part 31: Robust profile filters: Gaussian regression filters* [Technical Specification]

The following parts are planned:

— *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 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 16610 is a geometrical product specification (GPS) standard and is to be regarded as a global GPS standard (see ISO/TR 14638). It influences the chain links 3 and 5 of all chains of standards.

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

This part of ISO 16610 develops the basic concepts for robust profile filters.

Geometrical product specifications (GPS) — Filtration —

Part 30:
Robust profile filters: Basic concepts

1 Scope

This part of ISO 16610 specifies the basic concepts of robust profile filters.

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/TS 16610-1:2006, *Geometrical product specifications (GPS) — Filtration — Part 1: Overview and basic concepts*

ISO/TS 16610-20:2006, *Geometrical product specifications (GPS) — Filtration — Part 20: Linear profile filters: 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/TS 16610-1, ISO/TS 16610-20 and the following apply.

3.1
robustness
insensitivity of the output data against specific phenomena in the input data

NOTE Outliers, scratches and steps are examples of specific phenomena.

[ISO/TS 16610-1:2006, definition 3.9]

3.2
profile discontinuity
portion of a profile where there is a sudden change in profile properties

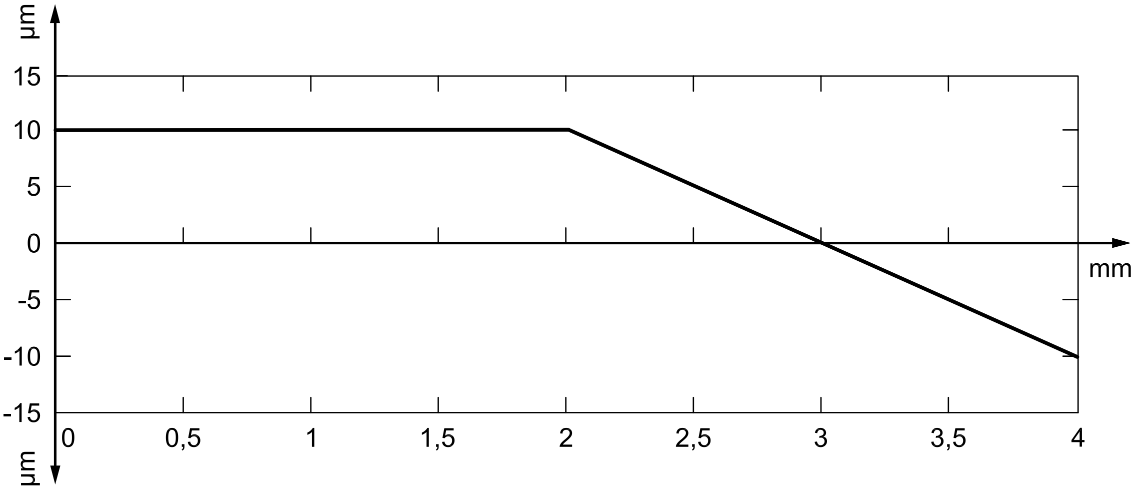


Figure 1 — Example of slope discontinuity

3.2.1
slope discontinuity
profile discontinuity (3.2) consisting of a sudden change in the slope of the profile

See Figure 1.

3.2.2
step discontinuity
profile discontinuity (3.2) consisting of a sudden change in the height of the profile

See Figure 2.

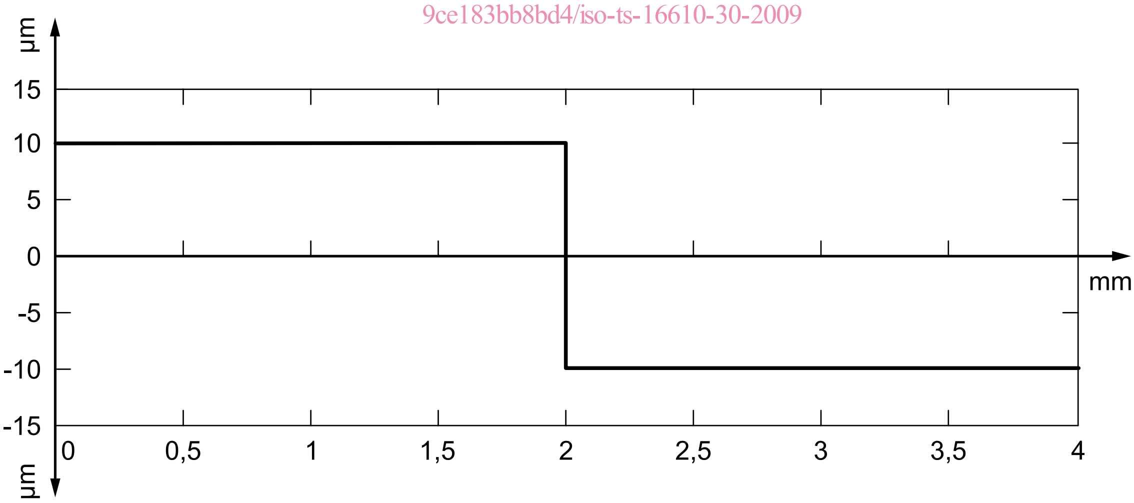


Figure 2 — Example of step discontinuity

3.2.3
spike discontinuity
profile discontinuity (3.2) consisting of an upward or downward portion of the profile with a narrow base

See Figure 3.

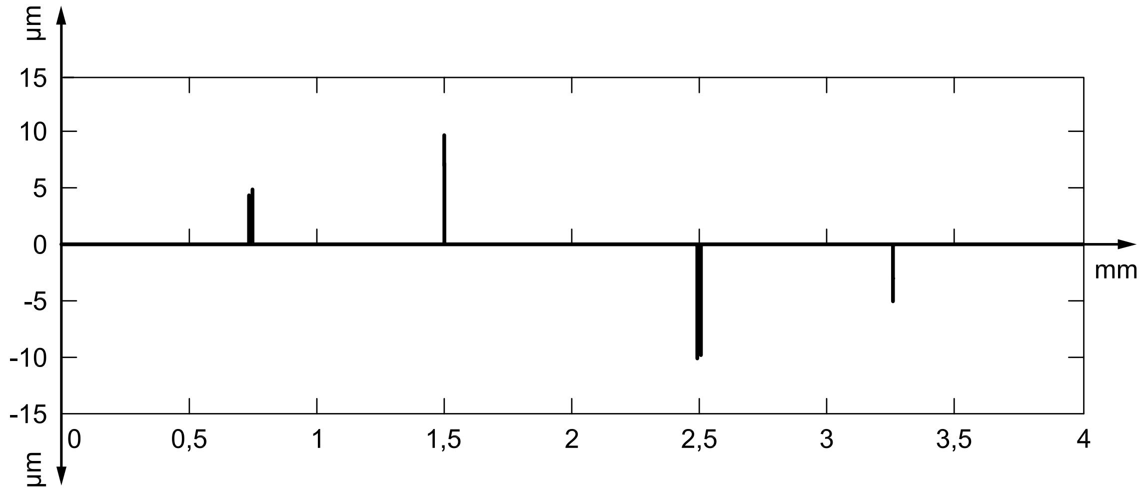


Figure 3 — Example of a series of spike discontinuities

3.3
metric
⟨profile⟩ property between two profiles obeying the following three conditions:

Positivity i.e. $\delta\left(p_1(x), p_2(x)\right) \geqslant 0$ with equality if and only if $p_1(x) = p_2(x)$

Commutativity i.e. $\delta\left(p_1(x), p_2(x)\right) = \delta\left(p_2(x), p_1(x)\right)$

Triangular inequality i.e. $\delta\left(p_1(x), p_2(x)\right) + \delta\left(p_2(x), p_3(x)\right) \geqslant \delta\left(p_1(x), p_3(x)\right)$

where $\delta(\ldots, \ldots)$ is a function of two profiles, p_1 and p_2, resulting in a real number

3.3.1
norm
⟨profile⟩ function of two profiles which can be used to define a **metric** (3.3)

3.3.2
L1-norm
continuous absolute deviation norm
⟨profile⟩ **norm** (3.3.1) defined by the following integral

$$\delta\left(p_1(x), p_2(x)\right) = \int_x \left| p_1(x) - p_2(x) \right| \mathrm{d}x$$

3.3.3
l1-norm
discrete absolute deviation norm
⟨profile⟩ **norm** (3.3.1) defined by the following summation

$$\delta\left(p_1(x), p_2(x)\right) = \sum_{i=1}^{n} \left| p_1(x_i) - p_2(x_i) \right|$$

3.3.4
L2-norm
continuous least squares norm
⟨profile⟩ **norm** (3.3.1) defined by the following integral

$$\delta\left(p_1(x), p_2(x)\right) = \sqrt{\int_x \left(p_1(x) - p_2(x)\right)^2 \mathrm{d}x}$$

3.3.5
l2-norm
discrete least squares norm
⟨profile⟩ **norm** (3.3.1) defined by the following summation

$$\delta\left(p_1(x), p_2(x)\right) = \sqrt{\sum_{i=1}^{n} \left(p_1(x_i) - p_2(x_i)\right)^2}$$

3.3.6
L∞-norm
continuous Chebychev norm
⟨profile⟩ **norm** (3.3.1) defined by the following formula

$$\delta\left(p_1(x), p_2(x)\right) = \max_{x} \left|p_1(x) - p_2(x)\right|$$

3.3.7
l∞-norm
discrete Chebychev norm
⟨profile⟩ **norm** (3.3.1) defined by the following formula

$$\delta\left(p_1(x), p_2(x)\right) = \max_{i=1,\ldots n} \left|p_1(x_i) - p_2(x_i)\right|$$

3.4
statistical estimator
rule that indicates how to calculate an estimate based on sample data from a population

3.4.1
robust statistical estimator
statistical estimator (3.4) that is insensitive against specific phenomena in the input data

3.5
M-estimator
robust statistical estimator (3.4.1) which uses an **influence function** (3.5.1) to weight points according to their signed distance from the reference line

3.5.1
influence function
function which is asymmetric and scale invariant

NOTE 1 If the value of a point in the data is replaced by an arbitrary value, the influence of this modified point on the output of the **M-estimator** (3.5) is proportional to the influence function.

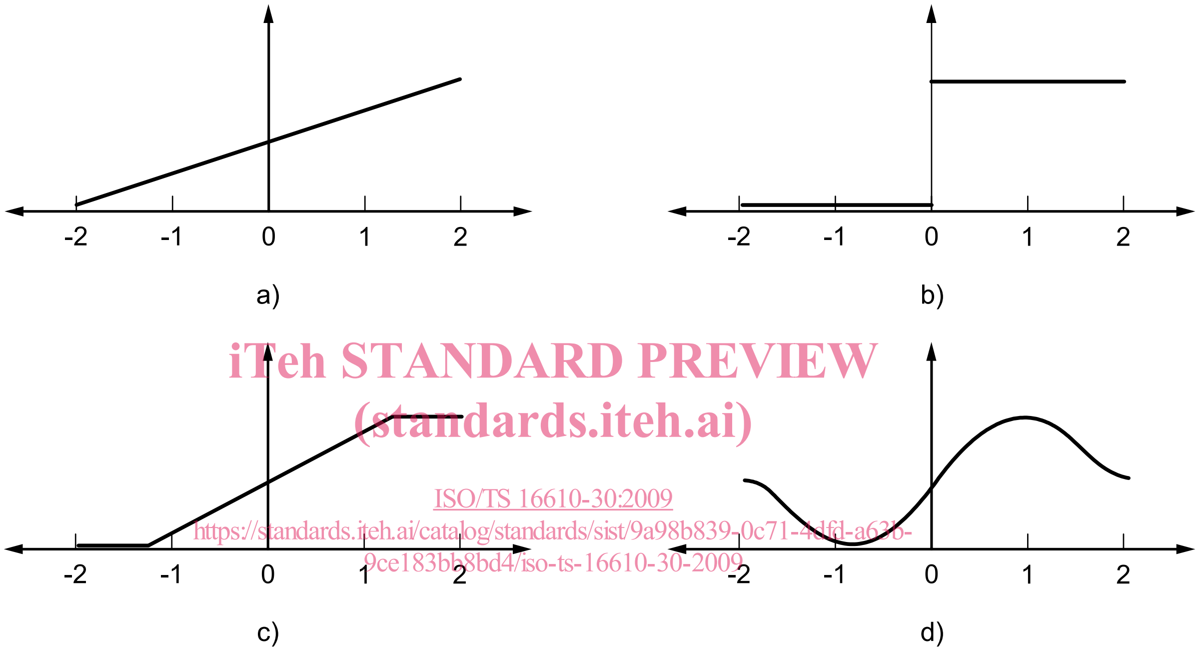
NOTE 2 To be scale invariant, many influence functions use a scale parameter which needs to be determined. An estimate of the dispersion of the profile from the reference line, such as **median absolute deviation** (3.5.2), can be used to determine the scale parameter.

3.5.2
median absolute deviation
MAD
measure of dispersion of a set of observations which is robust against **spike discontinuities** (3.2.3) and computed by taking the median of the absolute deviations of each observation from the median of the observations

NOTE 1 For a Gaussian probability distribution, the standard deviation equals 1,482 6 × MAD.

NOTE 2 For additional information on the median, see References [9] and [10].

See Figure 4.



NOTE a) is the mean; b) is the median; c) is the Huber function; d) is the biweight function.

Figure 4 — Examples of influence functions that have been considered in connection with M-estimators

3.6
Bayesian estimator
robust statistical estimator (3.4.1) which uses Bayesian statistics to weight points according to their signed distance from the reference line

4 Robustness

4.1 General

Robustness is not in general an absolute property of a profile filter but a relative one. One can only say that a particular profile filter is more robust against a particular phenomenon than another alternative profile filter if there is less distortion in that profile filter's response to that phenomenon than in the response of the alternative profile filter.

To make robustness an absolute property of profile filters, we need to define a reference class of profile filters with which to compare. The reference class of profile filters used in this technical specification is the class of

