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Geometrical product specifications (GPS) — Filtration —

Part 45:
Morphological profile filters: Segmentation

Spécification géométrique des produits (GPS) — Filtrage —

Partie 45: Filtres de profil morphologiques : Segmentation

FDIS stage

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Contents

Foreword

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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).

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 specifications made in accordance with this document, unless otherwise indicated.

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

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

This document develops the terminology and concepts for profile segmentation.

This document will replace ISO 21920-1 as the source document for profile segmentation. ISO 21920-1 is under revision and its definitions will be aligned with this document.

Geometrical product specifications (GPS) — Filtration —

Part 45:
Morphological profile filters: Segmentation

1 Scope

This document defines the terminology and develops concepts for profile morphological segmentation. In particular it specifies the watershed segmentation method, the Wolf pruning method and the ~~Crossingthe-Line Method.~~crossing-the-line method. This document assumes a continuous surface.

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, *Geometrical product specifications (GPS) — Filtration — Part 1: Overview and basic concepts*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16610-1 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 Terms related to geometrical features

3.1.1
topographic feature
line or point feature on a profile

~~Note 1 to entry: From these mutually exclusive portions the desired topological features are determined.~~

3.1.1.1
line feature
hill or dale

3.1.1.2
point feature
peak or pit

3.1.2
peak
<watershed segmentation> point on the profile which is higher than all other points within the neighbourhood of that point

Note 1 to entry: There is a theoretical possibility of a plateau. In this case, the peak is the middle single point on the plateau. Alternatively, techniques given in Annex B can be used.

3.1.3
peak
<reference line> highest point of a *hill* (3.1.7)

Note 1 to entry: There is a theoretical possibility of a plateau. In this case, the peak is the middle single point on the plateau. Alternatively, techniques given in Annex B can be used.

3.1.4
pit
<watershed segmentation> point on the profile which is lower than all other points within the neighbourhood of that point

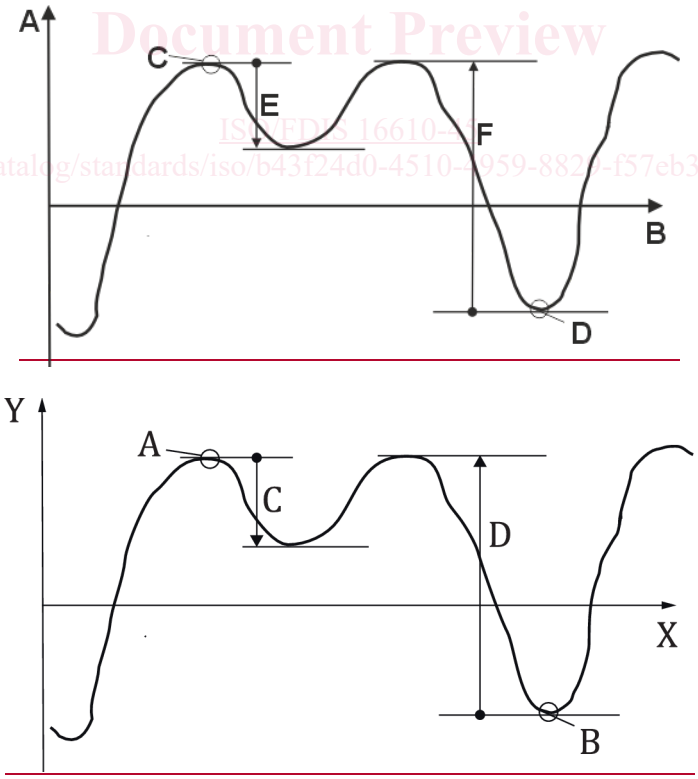
Note 1 to entry: There is a theoretical possibility of a plateau. In this case, the pit is the middle single point on the plateau. Alternatively, techniques given in Annex B can be used.

3.1.5
pit
<reference line> lowest point of a *dale* (3.1.9)

Note 1 to entry: There is a theoretical possibility of a plateau. In this case, the peak is the middle single point on the plateau. Alternatively, techniques given in Annex B can be used.

3.1.6
hill
<watershed segmentation> region around a peak such that all maximal upward paths end at the peak

Note 1 to entry: See Figure 1.



Key

~~A~~X X-axis (reference line)~~height~~

~~B~~Y height~~X-axis (reference line)~~

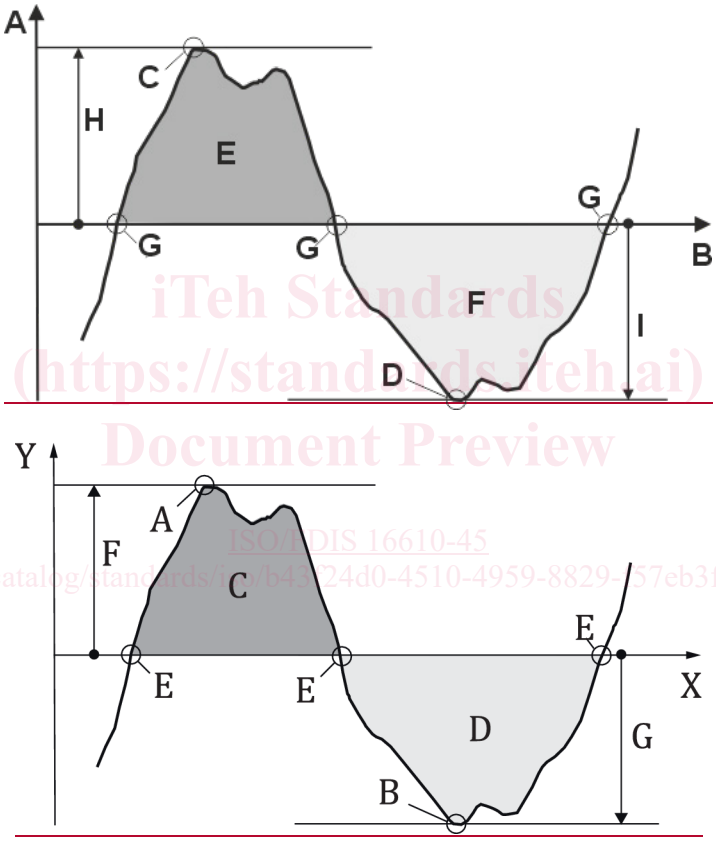
~~C~~A peak

~~D~~B pit
~~E~~C hill local height
~~F~~D dale local depth

Figure 1 — Hill local height and dale local depth (watershed segmentation)

3.1.7
hill
<reference line> outwardly directed (from material to surrounding medium) contiguous portion of the profile above the reference line bounded by the two adjacent points where the ordinate values change their sign

Note 1 to entry: See Figure 2.



Key

~~A height~~
~~B X axis (reference line)~~
~~C peak~~
~~D pit~~
~~E hill~~
~~F Dale~~
~~G Change of sign of the ordinate values~~
~~H Peak Height~~
~~I Pit Depth~~

X X-axis (reference line)
Y height
D dale
E change of sign of the ordinate values

A peak
B pit
C hill
F peak height
G pit depth

Figure 2 — Peak height and pit depth (reference line)

3.1.8
dale
<watershed segmentation> region around a pit such that all maximal downward paths end at the pit

Note 1 to entry: See Figure 1.

3.1.9
dale
<reference line> inwardly directed (from surrounding medium to material) contiguous portion of the scale-limited profile below the reference line bounded by the two adjacent points where the ordinate values change their sign

Note 1 to entry: See Figure 2.

3.2 Terms related to segmentation

3.2.1
segmentation
<profile> method which partitions a profile into distinct topographic features

Note 1 to entry: ~~Within~~ In this document, there are two types of segmentation:

a) ~~1) Watershed~~watershed segmentation (see 4.3);

b) ~~2) Crossing~~crossing-the line segmentation (see 4.4).

3.2.1.1
watershed segmentation
filtration operation that spatially decomposes a profile into mutually exclusive portions of that profile

3.2.1.2
crossing-the-line segmentation
operation based on crossings of the reference line by a profile in conjunction with a combination algorithm, to leave a set of significant segments

Note 1 to entry: The crossing-the-line segmentation requires *height discrimination* (see 3.3.6.2).

3.2.1.3
~~Event~~event
<profile> mutually exclusive profile portions whose union covers the profile

~~EXAMPLES~~EXAMPLE Ordinate values, motifs.

3.2.2
~~<profile>~~ segmentation function
<profile> function which splits a set of events into two distinct sets, called the "significant events" and the "insignificant events~~,~~", and which satisfies the three segmentation properties

Note 1 to entry: A full mathematical description of the segmentation function and the three segmentation properties can be found in Reference [8 ~~[9]~~].

3.2.3

~~<profile>~~ first segmentation property

<profile> property where each event is allocated to the set of significant events or the set of insignificant events but not both

Note 1 to entry: This property can also be given as a mathematical equation as follows:

P1 $\forall A \subseteq E, \quad \Psi(A) \cup \Phi(A) = A$ and $\Psi(A) \cap \Phi(A) = \emptyset$

~~where~~

~~E is the set of all events;~~

~~A is a subset of E~~

~~maps events onto the set of significant events~~

~~maps events onto the set of insignificant events (see Figure 3).~~

where

- E is the set of all events;
- A is a subset of E;
- $\Psi(.)$ maps events onto the set of significant events;
- $\Phi(.)$ maps events onto the set of insignificant events (see Figure 3).

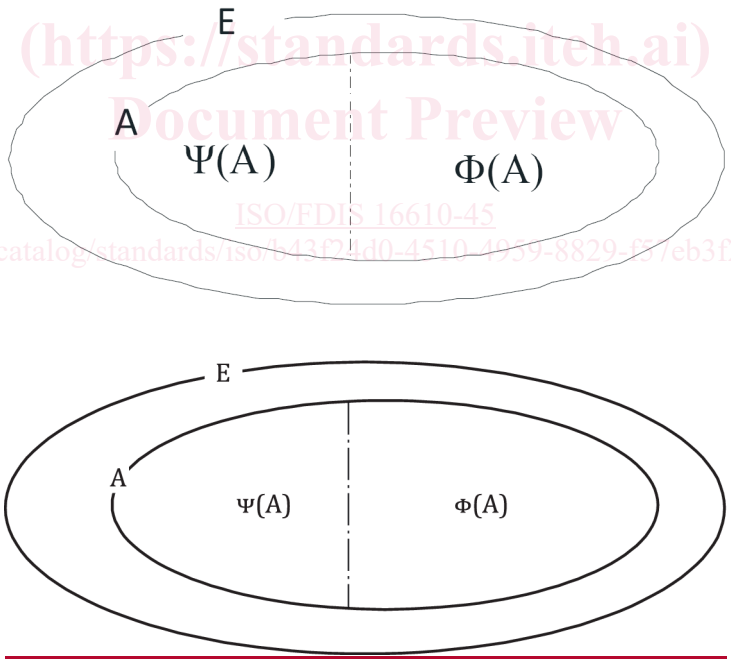


Figure 3 — Venn diagram of first segmentation property

Note 2 to entry: (.), and throughout this document, the dot is a placeholder for any set of events.

3.2.4

~~<profile>~~ second segmentation property

<profile> property where a significant event is removed from the set of events, then the remaining significant events are contained in the new set of significant events

Note 1 to entry: This property can also be given as a mathematical equation as follows:

$$\text{P2}\ \forall A \subseteq B \subseteq E, \quad \Phi(A) \subseteq \Phi(B)$$

~~where~~

~~E is the set of all events;~~

~~A, B are subsets of E~~

~~maps events onto the set of insignificant events (see Figure 4).~~

where

- E is the set of all events;
- A and B are subsets of E;
- $\Phi(.)$ maps events onto the set of insignificant events (see Figure 4).

NOTE ~~:~~The shaded areas are the significant events for subset A.

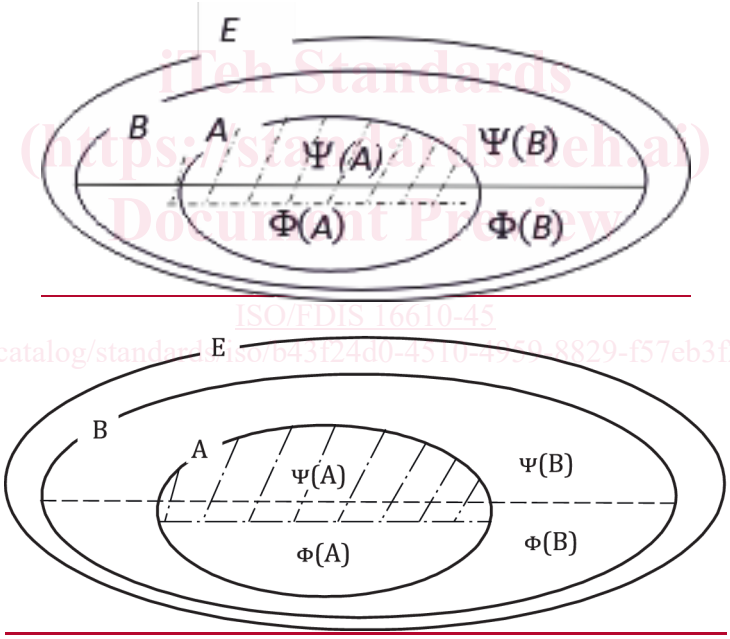


Figure 4 — Venn diagram of second segmentation property

3.2.5
~~<profile>~~ third segmentation property
<profile> property where an insignificant event is removed from the set of events, then the same set of significant events is obtained

Note 1 to entry: This property can also be given as a mathematical equation as follows:

$$\text{P3}\ \forall A \subseteq B \subseteq E, \quad \Psi(B) \subseteq A \Rightarrow \Psi(A) = \Psi(B)$$

~~where~~