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Geometrical product specifications (GPS) — Surface texture: Areal —

Part 72:
XML file format x3p

Spécification géométrique des produits (GPS) — État de surface: Surfacique —

Partie 72: Format de fichier XML x3p

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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 documents 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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification*.

A list of all parts in the ISO 25178 series can be found on the ISO website.

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 the chain link F of the chains of standards on profile and areal surface texture.

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 detailed information of the relation of this document to other standards and the GPS matrix model, see Annex C.

The x3p format was in use in industry and academia before the creation of this document. The x3p file format as defined in this document has been developed based on the definitions in ISO 5436-2. The openGPS®[1)] consortium provides a free open source software implementation of this file format to avoid the inevitable inconsistency of multiple proprietary implementations.

1) openGPS® is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

Geometrical product specifications (GPS) — Surface texture: Areal —

Part 72:
XML file format x3p

1 Scope

This document defines the XML file format x3p for storage and exchange of topography and profile data.

2 Normative references

The following document is referred to in the text in such a way that some or all of its 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 25178-600[2)], *Geometrical product specifications (GPS) —Surface texture: Areal — Part 600: Metrological characteristics for areal-topography measuring methods*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 25178-600 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
zip-container
file format that can be used as a container for multiple files and folders that does also support a compression of the stored content

Note 1 to entry: The file format description is in the public domain[1].

3.2
md5
method to calculate a unique 16-byte binary checksum used to check the integrity of files

Note 1 to entry: The binary value is typically represented by 32 hexadecimal digits.

Note 2 to entry: See Reference [2].

3.3
int16
2-byte representation of a signed integer

Note 1 to entry: The int16 type has a minimum value of −32 768 and a maximum value of 32 767.

2) Under preparation. Stage at the time of publication: ISO/DIS 25178-600.

Note 2 to entry: The less significant bytes are stored in memory addresses lower than those in which are stored the more significant bytes.

3.4
int32
4-byte representation of a signed integer

Note 1 to entry: The int32 type has a minimum value of -2 147 483 648 and a maximum value of 2 147 483 647.

Note 2 to entry: The less significant bytes are stored in memory addresses lower than those in which are stored the more significant bytes.

3.5
float32
4-byte representation of a floating point number according to IEEE 754

Note 1 to entry: The float32 type has a minimum value of -2^{128} and a maximum value of 2^{128}. The smallest positive number representable is 2^{-126}.

Note 2 to entry: The ASCII representation is a signed floating point number with 8 digits and a signed two-digit exponent in the range [-38.. +38].

Note 3 to entry: The less significant bytes are stored in memory addresses lower than those in which are stored the more significant bytes.

3.6
float64
8-byte representation of a floating point number according to IEEE 754

Note 1 to entry: The float64 type has a minimum value of $-2^{1\,024}$ and a maximum value of $2^{1\,024}$. The smallest positive number representable is $2^{-1\,022}$.

Note 2 to entry: The ASCII representation is a floating point number with 16 digits and a signed three-digit exponent in the range [- 308.. + 308].

Note 3 to entry: The less significant bytes are stored in memory addresses lower than those in which are stored the more significant bytes.

3.7
not a number
NaN
special floating point value defined in IEEE 754 specifying a number that is not computable

Note 1 to entry: Some floating point implementations define more than one value for NaN to distinguish between Quiet NaNs and Signaling NaNs. In this case the Quiet NaN is preferred.

Note 2 to entry: All mathematical operations incorporating a NaN value yield NaN as result. As a consequence, all comparisons with a NaN value yield “unequal”. This is especially true for the equality comparison of two NaN values.

3.8
element
start tag followed by a data value followed by an end tag

EXAMPLE 1 An element with the name “example” comprising a start and an end tag would be implemented as

<example>contents of element</example>

EXAMPLE 2 An empty element with the name “example” would be implemented as

<example/>

Note 1 to entry: An element begins with a start tag and ends with an end tag. Alternatively, an element may consist of an empty tag solely. The content of the element is between the start and end tag and may contain further elements.

3.9
extensible markup language
XML
language for encoding documents electronically

Note 1 to entry: XML is a subset of SGML (see Reference [7]).

3.10
uniform resource locator
URL
character string to locate a resource in a computer network or on a local computer

EXAMPLE A well-known use of a URL is the specification of a web site's address like "http://www.iso.org/".

3.11
uniform resource identifier
URI
character string uniquely identifying a name or resource in a hierarchical style

EXAMPLE A URI for this document could be "www.iso.org/ISO_25178_Part_72".

Note 1 to entry: A URL is the most common form of a URI.

Note 2 to entry: The relation between a URI and a URL is like the relation between a person's name (the URI) and a person's address (the URL).

Note 3 to entry: To create a unique URI, it is good practice to start a URI with a domain name that has been registered on the name of the owner.

3.12
offset
distance of the stored geometric data to the origin of the coordinate system along one axis of the coordinate system

3.13
rotation matrix
3×3 matrix defining the rotation of the data set in 3D space

Note 1 to entry: It defines the orientation of the stored point cloud in 3D space.

3.14
global coordinate system
three-dimensional coordinate system in which the position and orientation of the original point cloud is defined

3.15
view coordinate system
three-dimensional coordinate system in which the 3D points are defined

Note 1 to entry: In the view coordinate system, the represented surface or point cloud typically is projectable along one spatial direction.

3.16
data matrix
one-, two- or three-dimensional array of 3D points with a defined neighbourhood relation

Note 1 to entry: Each 3D point has two neighbours along each matrix dimension. The data matrix contains point coordinates in the view coordinate system.

Note 2 to entry: The index in the data matrix is described by the symbols *u*, *v*, and *w*.

Note 3 to entry: The array dimensions of the data matrix should not be confused with the spatial dimensions of the global coordinate system or view coordinate system.

4 Requirements

4.1 Units

All coordinates shall be specified in metres. Other units shall not be used. SI Prefixes shall not be used.

4.2 Recommended offset value

The offset should be set to a value so that the stored point cloud is centred on the origin of the coordinate system.

5 x3p file format

5.1 General

An x3p file is a zip-container for areal and profile data. It can be flexibly used for point clouds without any topology as well as for projectable 2½D topography data and for multilayer topography representations.

NOTE A general container format is described in Reference [5].

5.2 File name extension

The name of a file stored in x3p data format shall end with the string ".x3p". On case sensitive file systems the string shall be typed in lower case letters.

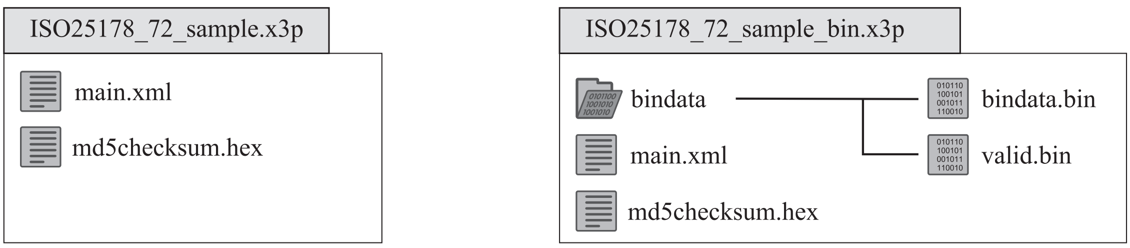
EXAMPLE 1 samplefile.x3p

EXAMPLE 2 longer_filename example123.x3p

5.3 Minimum contents of zip-container

The zip-container representing an x3p file shall contain as a minimum the files "`main.xml`" and "`md5checksum.hex`" in its root directory as displayed in Figure 1 a).

EXAMPLE Figure 1 b) shows a more complex example of the contents of the zip-container.



a) example with minimum contents of an x3p file container, text only format

b) example with binary encoded coordinates "bindata.bin" and binary validity mask "valid.bin"

Figure 1 — x3p container examples

5.4 Optional contents of zip-container

5.4.1 General

The zip-container may contain more files depending on the type and encoding of the stored data.

5.4.2 Binary encoded coordinates

When storing coordinates in a binary encoded file, it should be placed in a subdirectory named "`bindata`" and the file should be named "`bindata.bin`".

NOTE Specifying a different name does not result in a dysfunctional file, because the relative path name to this file is stored in main.xml.

5.4.3 Validity mask

When storing a validity mask in a binary encoded file, it should be placed in a subdirectory named "`bindata`" and the file should be named "`valid.bin`".

NOTE Specifying a different name does not result in a dysfunctional file, because the relative path name to this file is stored in main.xml.

5.4.4 Vendor specific extensions

Vendor specific extensions shall be used to extend x3p-format to a custom file format. Vendor specific extensions can use any file type and any filename except the filenames defined in 5.3.

EXAMPLE A vendor specific extension could be an image file named "photography_of_sample.jpg".

5.5 Contents and format of main.xml

5.5.1 General

The exact specification of the xml data structures used in main.xml is defined in Annex A. Here, only the content of the elements and their usage are described.

5.5.2 Main records

The file `main.xml` contains a sequence of four main records and a vendor specific extension:

— Record1: header, data types and axes definitions (see 5.5.3)

— Record2: optional record containing the document's meta data (see 5.5.4)

— Record3: the data (see 5.5.5)

— Record4: an md5 checksum of the XML-document (see 5.5.6)

— Vendor specific extensions (see 5.5.7)

5.5.3 Record1: Header, data types, and axes definitions

5.5.3.1 Revision

The `Revision` record shall contain the string "ISO 5436:2000".

NOTE This is not a reference to ISO 5436, it is only an identification string.

5.5.3.2 FeatureType

5.5.3.2.1 General

The `FeatureType` element specifies the class of 3D data stored in the file. The contents of feature type shall be one of the strings "PRF", "SUR", "PCL". These names correspond to profile, surface and point cloud feature types.

5.5.3.2.2 PRF – Profile

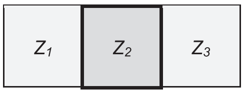
The 3D data in the x3p file represent a profile i.e. a linear sequence of 3D coordinates. Points are stored in a one-dimensional array for single layer profiles or in a two-dimensional array for multilayer profiles. Each point has up to two neighbours for a single layer profile or up to four neighbours in a multilayer profile. See Figure 2.

It shall be assured that the neighbourhood relation of all points in 3D space is the same as in the array.

NOTE 1 A 3D points matrix index *u*, *v*, *w* should not be confused with its 3D coordinates *x*, *y*, *z*.

NOTE 2 The case of a two dimensional matrix is used for multilayer profile representations. The array index *w* represents the index of the layer in this case.

NOTE 3 The 3D coordinates of all points in a profile do not need to be located on a straight line in 3D space. Profile can follow any path in space.



Key

Z_u 3D coordinates of point at matrix location

NOTE Each point has up to two direct neighbours.

Figure 2 — Sample neighbourhood relation of a 3D point in a "PRF" type feature

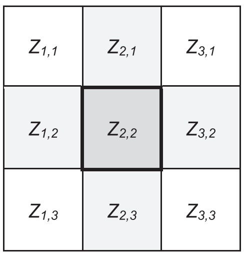
5.5.3.2.3 SUR – Surface

The 3D data in the x3p file represent the topography of a projectable surface with a well-defined topology, i.e. a neighbourhood relation for each 3D point. Points are stored in a two- or three-dimensional array and each array element has a maximum of four or six direct neighbouring elements respectively, see Figure 3.

It shall be assured that the neighbourhood relation of all points in 3D space is the same as in the array.

NOTE 1 A 3D points matrix position *u*, *v*, *w* should not be confused with its 3D coordinates *x*, *y*, *z*.

NOTE 2 The case of a three-dimensional matrix is used for multilayer surface representations. The array index *w* represents the index of the layer in this case.



Key

$Z_{u,v}$ 3D coordinates of point at matrix location *u, v*

NOTE Each point has up to four direct neighbours.

Figure 3 — Sample neighbourhood relation of a 3D point for a "SUR" type feature