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Geometrical product specifications (GPS) — Matrix model

Spécification géométrique des produits (GPS) — Modèle de matrice

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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.

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 meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 213, *Dimensional and geometrical product specifications and verification*.

This first edition of ISO 14638 cancels and replaces ISO/TR 14638:1995.

ISO 14638 has been revised from the earlier ISO/TR 14638 document with the aim of clarifying the text and the definitions, in order to improve the usability of the document, and to revise the matrix where developments in ISO GPS have made this necessary.

The main changes are as follows:

— The category of Global GPS standards has been removed, as it was not clearly distinguished from either fundamental or general GPS standards. Standards which were formerly classified as global GPS standards have either been withdrawn, or can be categorized as fundamental or general GPS standards.

— The headings formerly used to describe the different chains in the matrix have been reduced.

  — The headings for 'form of a line (independent of a datum)' and 'form of a surface (independent of a datum)' have been replaced with a single heading of 'form'.

  — The headings for 'form of a line dependent on a datum' and 'form of a surface dependent on a datum' have been removed, because these are covered under orientation and location.

  — The heading for 'datums' has been removed from the matrix, because datums are not geometrical properties. Clause 4 now explains how the ISO GPS standard for datums is covered in the ISO GPS matrix model.

  — The headings for 'circular run-out' and 'total run-out' have been amalgamated into a single heading of 'run-out'.

  — The three chains for 'roughness profile', 'waviness profile' and 'primary profile' have been replaced with a single entry for 'profile surface texture'.

  - The heading for ‘angle’ has been removed, as angles are covered under the headings of ‘size’ and ‘distance’.
  - The heading for ‘radius’ has been removed, as this is covered under the headings of ‘distance’ and ‘form’.
  - The heading for ‘edges’ has been removed, as edges are not a geometrical property.
- An additional category of general GPS standards for areal surface texture has been added.
- An additional chain link for conformance and non-conformance has been added.
- The chain links have been given descriptive titles and are lettered. The chain link numbers used previously have been removed.
- The GPS matrix now appears in only a single format for fundamental and general GPS standards.
- The lists of GPS standards has been removed from this document. An up-to-date list of ISO/TC 213 standards is maintained at the following location on the ISO website: http://www.iso.org/iso/home/store/catalogue_tc/catalogue_tc_browse.htm?commid=54924&published=on
- A diagram showing a version of the matrix populated with references to individual ISO standards has been removed from this document. An online version of the matrix, with facilities to interrogate it, now appears on the ISO/TC 213 website at http://isotc213.ds.dk/, where it can be kept up-to-date.
- The rules which were formerly listed for the preparation of ISO GPS standards have been redrafted as a bulleted list of principles and recommendations.
  - The ‘rule of unambiguity’ has been re-written as the first principle in the list.
  - The ‘rule of totality’ has been removed, as it was not a rule but an aspiration.
  - The ‘rule of complementarity’ has been removed because its meaning was not clear.
  - The second principle has been added to avoid conflict between different GPS standards, which was the intention behind the former ‘rule of complementarity’.
- A third recommendation has been added, specifying the format of an informative annex which will appear in all future GPS standards produced by ISO/TC 213. The annex explains how the individual GPS standard fits into the GPS matrix.

Introduction

Geometrical Product Specification (ISO GPS) is the system used to define the geometrical requirements of workpieces in engineering specifications, and the requirements for their verification.

ISO GPS standards are the responsibility of ISO/TC 213. ISO GPS standards are used in conjunction with other standards for Technical Product Documentation (TPD), which is the responsibility of ISO/TC 10, to produce Technical Product Specifications (TPS).

This International Standard provides an overview of the structure of the ISO GPS system.

The fundamental rules of ISO GPS given in ISO 8015 apply to this standard and the default decision rules given in ISO 14253-1 apply to specifications made in accordance with this standard, unless otherwise indicated.

Geometrical product specifications (GPS) — Matrix model

1 Scope

This International Standard is a fundamental ISO GPS standard. It explains the concept of Geometrical Product Specification (ISO GPS), and provides a framework to illustrate how current and future ISO GPS standards address the requirements of the ISO GPS system.

The framework is intended to be of use to users of ISO GPS standards, by illustrating the extent of the scope of the different standards, and showing how they relate to each other.

The framework is also used for structuring the development of standards for GPS by technical committee ISO/TC 213.

The full set of standards comprising the ISO GPS system is listed on the ISO/TC 213 website at http://www.iso.org/iso/home/store/catalogue_tc/catalogue_tc_browse.htm?commid=54924&published=on. Where relevant standards and documents are available from sources other than ISO/TC213, these may also be listed, although any such listing does not intend to be complete and exhaustive.

2 Concept

ISO GPS is a system which is used to describe certain workpiece characteristics through some of the different stages of its life cycle (design, manufacture, inspection, etc.).

ISO GPS is concerned with geometrical properties such as size, location, orientation, form, surface texture, etc.

Nine geometrical properties are identified in the ISO GPS system. Additional geometrical properties may be added in the future. The properties are:

— size;

— distance;

— form;

— orientation;

— location;

— run-out;

— profile surface texture;

— areal surface texture;

— surface imperfections.

The ISO GPS standards relating to each of these nine geometrical properties are grouped together in a series of nine categories of standards (see 3.3). Each category may be further sub-divided into a number of more specific elements, and each of these specific elements identifies a chain of standards.

For example, ‘size’ is a geometrical property category. Size can then be subdivided into ‘size of cylinders’, ‘size of cones’, ‘size of spheres’, etc., each of which corresponds to a chain of standards.

Angles are covered within the properties of size and distance, and radii are covered within the properties of distance and form.

For each geometrical property, it is necessary to be able to define a specification for that property, it is necessary to be able to measure the property, and it is necessary to be able to compare the measurement with the specification. The GPS standards relating to these requirements are defined as a series of seven links in each chain of standards (see 3.3).

Some manufacturing processes, such as casting and welding (this list is non exhaustive), have requirements which are specific to that process. Standards which deal with specific processes may be grouped in further chains of standards.

Some machine elements, such as screw threads and gears (this list is non exhaustive), have requirements which are specific to those machine elements. Standards which deal with specific machine elements are grouped in further chains of standards.

Additional geometrical property categories and chains may be added in the future to reflect developments in manufacturing and inspection processes, and other industry requirements.

The standards, categories and chains of standards are arrayed in a matrix so that it is possible to clearly indicate the scope of application of each standard and the relationships between standards.

3 Structure

3.1 General

The ISO GPS standards can be arranged in a matrix of rows and columns. Each row in the matrix consists of one of the nine geometrical property categories, which may be further subdivided into chains of standards, and each column is described as a 'chain link'. The scope of each ISO GPS standard can be illustrated on the ISO GPS matrix by showing which chain links (columns) in which geometrical property categories (rows) the standard applies to.

3.2 Types of ISO GPS standards

3.2.1 Fundamental ISO GPS standards

These are ISO GPS standards which define rules and principles which apply to all categories (geometrical property categories and other categories) and all chain links in the ISO GPS matrix.

NOTE The category of Global ISO GPS standards has been removed from this document. ISO GPS standards which had previously been categorized as Global ISO GPS standards are now categorized as either fundamental or general ISO GPS standards.

3.2.2 General ISO GPS standards

These are ISO GPS standards which apply to one or more geometrical property categories, and to one or more chain links, but are not fundamental ISO GPS standards.

3.2.3 Complementary ISO GPS standards

These are ISO GPS standards which refer to specific manufacturing processes or to specific machine elements.

3.3 The ISO GPS matrix

3.3.1 Geometrical characteristic categories

A *geometrical property category* consists of all the general ISO GPS standards which relate to a particular geometrical property, such as size, distance or location. There are currently nine *geometrical property categories*.

In the ISO GPS matrix, each *geometrical property category* corresponds to a row in the matrix.

3.3.2 Complementary categories

The matrix includes two non-geometrical categories: the category of manufacturing processes and the category of machine elements.

3.3.3 Chain of standards

A geometrical property category may be subdivided into 'chains' of standards, each of which consists of all the general ISO GPS standards which relate to a particular subdivision of a geometrical property category, such as size of cylinders, size of cones, and size of spheres.

These subdivisions are not described in detail in this International Standard.

The category of manufacturing processes may be sub-divided into chains of standards, corresponding to different types of manufacturing processes.

The category of machine elements may be sub-divided into chains of standards, corresponding to different types of machine elements.

Further chains may be added to each category in the future.

3.3.4 Chain links

A chain link consists of all the general ISO GPS standards which relate to a particular function in the specification or verification of a geometrical property, such as the symbols to be used, or the measurement of the property. There are currently seven chain links.

In the ISO GPS Matrix, each chain link corresponds to a column in the matrix.

NOTE Examples of the different ways in which the GPS matrix can be used to identify specific standards or groups of standards relating to a specific geometrical characteristic, or a specific chain link, are shown in Annex B.

3.4 Geometrical property categories

The nine geometrical property categories are listed in Table 1.

Complementary standards, and standards from other Technical Committees, may also be illustrated with this matrix.

4 Datums

Datums are no longer covered by a chain in the matrix, as they are not geometrical properties. Datums are essential for the definition of many of the geometrical characteristics, so ISO GPS standards dealing with datums are represented in the matrix with a filled dot in each chain link to which they relate (see Annex C).

5 Chain links

5.1 General

Each of the chain links has a title and a description.

NOTE The chain link numbers previously used in ISO/TR 14638:1995 are identified in notes for reference.

5.2 Chain Link A: Symbols and indications

This chain link consists of ISO GPS standards defining the form and proportions of symbols, indications and modifiers and the rules governing their use.

NOTE This chain link was formerly known as Chain Link 1.

5.3 Chain Link B: Feature requirements

This chain link consists of ISO GPS standards defining tolerance characteristics, tolerance zones, constraints and parameters. This includes standards defining geometrical characteristics, size properties, surface texture parameters, the shape, size, orientation and location of tolerance zones, and the definitions of parameters.

NOTE This chain link was formerly known as Chain Link 2.

5.4 Chain Link C: Feature properties

This chain link consists of ISO GPS standards defining the characteristics and conditions of features on a workpiece. This includes standards defining operations of partitioning, extraction, filtration, association, collection and construction.

NOTE This chain link was formerly known as Chain Link 3.

5.5 Chain Link D: Conformance and non-conformance

This chain link consists of ISO GPS standards defining the requirements for comparison between specification requirements and verification results.

NOTE 1 This chain link includes standards defining default values, rules for conformance and non-conformance and standards dealing with uncertainty.

NOTE 2 This chain link was formerly covered in Chain Link 4.

5.6 Chain Link E: Measurement

This chain link consists of ISO GPS standards defining the requirements for measuring feature characteristics and conditions.

NOTE This chain link was formerly known as Chain Link 4.

5.7 Chain Link F: Measurement equipment

This chain link consists of ISO GPS standards defining the requirements for equipment used for measurement.

NOTE This chain link was formerly known as Chain Link 5.

5.8 Chain Link G: Calibration

This chain link consists of ISO GPS standards defining the requirements for calibration and calibration procedures for measurement equipment.

NOTE This chain link was formerly known as Chain Link 6.

6 Preparation of ISO GPS standards

6.1 Guidance

This International Standard is intended to provide guidance for those creating ISO GPS standards, and assistance to those learning about the ISO GPS system. To facilitate these aims, the following points and recommendations should be considered when ISO GPS standards are being prepared.

a) Each chain of ISO GPS standards is intended to be unambiguous and complete.

   1) Each chain of standards should ensure traceability between the symbols and indications used, the characteristics and conditions of features, measurements taken from the workpiece and standard international units of measurement.

   2) "complete" means that each chain link contains all the necessary information, including ISO defaults, etc.

b) No ISO GPS standard or chain of standards should conflict with any other ISO GPS standard or chain of standards.

c) Each ISO GPS standard produced by ISO/TC 213 includes an informative annex, which is the last annex in the document, explaining its relationship to the ISO GPS Matrix model. The following text is recommended:

   "The ISO GPS matrix model given in ISO 14638 gives an overview of the ISO GPS system of which this standard is a part."

6.2 Additional text

6.2.1 General

Additional text may be included in the annex for fundamental, general and complementary standards as shown in 6.2.2 to 6.2.4. The informative annex should also include a table illustrating the ISO GPS matrix. See Table 1 for the matrix model, and Annex A for an example of how it would be used.

6.2.2 Fundamental standard

Fundamental standards should show a filled dot in all compartments of the matrix. The following explanatory text is recommended:

'This standard is a fundamental ISO GPS standard. The rules and principles given in this standard apply to all general and complementary ISO GPS standards in the ISO GPS matrix.'

6.2.3 General standard

The following explanatory text is recommended:

'This standard is a general ISO GPS standard. The rules and principles given in this standard apply to all segments of the ISO GPS matrix which are indicated with a filled dot (•).'

6.2.4 Complementary standard

The scope of a complementary standard can also be illustrated in a matrix by placing filled dots (•) in the appropriate compartments. The following explanatory text is recommended:

'This standard is a complementary ISO GPS standard. The requirements given in this standard apply to all segments of the Complementary ISO GPS matrix which are indicated with a filled dot (•).'

Table 1 — ISO GPS Standards matrix model

	Chain links						
	A	B	C	D	E	F	G
	Symbols and indications	Feature requirements	Feature properties	Conformance and non-conformance	Measurement	Measurement equipment	Calibration
Size							
Distance							
Form							
Orientation							
Location							
Run-out							
Profile surface texture							
Areal surface texture							
Surface imperfections							

Annex A
(informative)

Example of an informative annex for ISO GPS standards

This International Standard recommends (see Clause 6) that an illustration of the ISO GPS matrix appears in the final annex of any ISO/TC 213 GPS standard to show the relationship that the standard has with the matrix, along with some explanatory text. The matrix and text may be used in the format illustrated below (example shown for ISO 1101):

> 'The ISO GPS matrix model given in ISO 14638 gives an overview of the ISO GPS system of which this standard is a part.
>
> This standard is a general ISO GPS standard. The rules and principles given in this standard apply to all segments of the ISO GPS matrix which are indicated with a filled dot (•) in Table A.1.'

Table A.1 — ISO GPS Standards matrix model

	Chain links						
	A	B	C	D	E	F	G
	Symbols and indications	Feature requirements	Feature properties	Conformance and non-conformance	Measurement	Measurement equipment	Calibration
Size							
Distance							
Form	•	•					
Orientation	•	•					
Location	•	•					
Run-out	•	•					
Profile surface texture							
Areal surface texture							
Surface imperfections							

Annex B
(informative)

Examples of different ways in which the GPS matrix can be used to identify specific standards or groups of standards relating to a specific geometrical characteristic, or a specific chain link

NOTE 1 Data displayed in these examples is not necessarily exhaustive or fully up-to-date.

NOTE 2 The data available through the GPS Matrix web page (http://isotc213.ds.dk/) only has limited query functions at present (May 2014), but these should improve as the web page is developed.

B.1 Example 1: Matrix used to identify standards relating to 'size' characteristic

See Table B.1.

Table B.1 — ISO GPS Standards matrix model

	Chain links						
	A	B	C	D	E	F	G
	Symbols and indications	Feature requirements	Feature properties	Conformance and non-conformance	Measurement	Measurement equipment	Calibration
Size	ISO 14405-1	ISO 14405-1	ISO 286-1	ISO/TR 16015	ISO 1938-1	ISO 463	ISO/ TS 15530-3,
	ISO 286-1	ISO 286-1	ISO/TS 16610 series	ISO 14253 series		ISO 13385-1	ISO/ TS 15530-4,
		ISO 286-2	ISO 14405-1			ISO 13385-2	ISO/TR 16015
						ISO 3650	ISO/TS 16610 series
						ISO/TR 16015	ISO 14253 series
						ISO/TS 23165	
						ISO 14253 series	
						ISO 10360 series	

B.2 Example 2: Matrix used to identify standards relating to measurement equipment for 'profile surface texture' characteristic

See Table B.2.

Table B.2 — ISO GPS Standards matrix model

	Chain links						
	A	B	C	D	E	F	G
	Symbols and indications	Feature requirements	Feature properties	Conformance and non-conformance	Measurement	Measurement equipment	Calibration
Profile surface texture						ISO 3274	

B.3 Example 3: Matrix used to identify standards relating to 'Feature properties' chain link

See Table B.3.

Table B.3 — ISO GPS Standards matrix model

	Chain links						
	A	B	C	D	E	F	G
	Symbols and indications	Feature requirements	Feature properties	Conformance and non-conformance	Measurement	Measurement equipment	Calibration
Size			ISO 286-1 ISO/ TS 16610-series ISO 14405-1				
Distance			ISO 14405-1 ISO 14405-2				
Form			ISO 1101 ISO 1660 ISO 3040 ISO 12181-1 ISO 12181-2 ISO 12780-1 ISO 12780-2				
Orientation			ISO 1101 ISO 1660 ISO 2692 ISO 5458				
Location			ISO 1101 ISO 1660 ISO 2692 ISO 5458				
Run-out			ISO 1101				
Profile surface texture			ISO 4287 ISO 4288 ISO 12085 ISO 13565 ISO 16610-21				
Areal surface texture			ISO 25178-601				
Surface imperfections							

B.5 Example 4: Result of query on standards relating to the geometrical characteristic of 'orientation':

The data obtained from a query on the GPS Matrix web page may be displayed in the form of a list, instead of in the matrix format, and references to standards may include the full textual title, as illustrated below:

Geometrical characteristic: Orientation

Chain Link A: Symbols and indications

ISO 1101:2012 *Geometrical product specifications (GPS) – Geometrical tolerancing – Tolerances of form, orientation, location and run-out*

Chain Link B: Feature requirements

ISO 1101:2012 *Geometrical product specifications (GPS) — Geometrical tolerancing — Tolerances of form, orientation, location and run-out*

Chain Link C: Feature properties

ISO 1101:2012 *Geometrical product specifications (GPS)— Geometrical tolerancing — Tolerances of form, orientation, location and run-out*

Chain Link D: Conformance and non-conformance

No standards cover this chain link for this geometrical characteristic.

Chain Link E: Measurement

ISO 1101:2012 *Geometrical product specifications (GPS) — Geometrical tolerancing — Tolerances of form, orientation, location and run-out*

Chain Link F: Measurement equipment

No standards cover this chain link for this geometrical characteristic.

Chain Link G: Calibration

No standards cover this chain link for this geometrical characteristic.

Annex C
(informative)

Representation of the ISO GPS standard for datums in the ISO GPS matrix

As 'datums' have been removed from the list of geometrical characteristic categories, some confusion could arise about the representation of ISO 5459, the ISO GPS standard for datums, in the ISO GPS matrix.

Table C.1 shows how ISO 5459, *Geometrical product specification (GPS) — Geometrical tolerancing — Datums and datum systems* would be represented in the matrix:

> This International Standard is a general ISO GPS standard. The rules and principles given in this International Standard apply to all segments of the ISO GPS matrix which are indicated with a filled dot (•).

Table C.1 — ISO GPS Standards matrix model

	Chain links						
	A	B	C	D	E	F	G
	Symbols and indications	Feature requirements	Feature properties	Conformance and non-conformance	Measurement	Measurement equipment	Calibration
Size							
Distance							
Form							
Orientation	•	•	•				
Location	•	•	•				
Run-out	•	•	•				
Profile surface texture							
Areal surface texture							
Surface imperfections							

Annex D
(informative)

The former ISO GPS Matrix model

The ISO GPS Matrix introduced in ISO/TR 14638:1995 included 6 chain links of standards (see Table D.1). An additional chain link for conformance and non-conformance has been added into this International Standard.

Former chain links 3 and 4 were ambiguous. In the new matrix, chain link C addresses specification and chain link D verification.

Table D.1 — ISO GPS matrix model from ISO/TR 14638:1995

Chain link number		1	2	3	4	5	6
Geometrical characteristic of feature		Product documentation indication - codification	Definition of tolerances - Theoretical definition and values	Definitions for actual feature - characteristic or parameter	Assessment of the deviations of the workpiece - Comparison with tolerance limits	Measurement equipment requirements	Calibration requirements - Measurements standards
1	Size						
2	Distance						
3	Radius						
4	Angle (tolerance in degrees)						
5	Form of a line independent of a datum						
6	Form of a line dependent on a datum						
7	Form of a surface independent of a datum						
8	Form of a surface dependent on a datum						
9	Orientation						
10	Location						
11	Circular run out						
12	Total run out						
13	Datums						
14	Roughness profile						
15	Waviness profile						
16	Primary profile						
17	Surface defects						
18	Edges						