



SLOVENSKI STANDARD
SIST ISO/TR 14638:1999

01-marec-1999

Specifikacija geometrije izdelka - Glavni načrt

Geometrical product specification (GPS) -- Masterplan

Spécification géométrique des produits (GPS) -- Schéma directeur

Ta slovenski standard je istoveten z: ISO/TR 14638:1995

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ICS:

17.040.01	Linearne in kotne meritve na splošno	Linear and angular measurements in general
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TECHNICAL
REPORT

ISO
TR 14638

First edition
1995-12-15

**Geometrical product specification
(GPS) — Masterplan**

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Spécification géométrique des produits (GPS) — Schéma directeur
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Reference number
ISO/TR 14638:1995(E)

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International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

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 main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;
- type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;
- type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/TR 14638, which is a Technical Report of type 3, was prepared by Technical Committee ISO/TC 3, *Limits and fits*, and has been based on studies carried out by the Joint Harmonization Group of ISO/TC 3, *Limits and fits*, ISO/TC 10, *Technical drawings, product definition and related documentation*, Subcommittee SC 5, *Dimensioning and tolerancing*, and ISO/TC 57, *Metrology and properties of surfaces*.

The content of ISO/TR 14638 is the status of the standardization on Geometrical Product Specifications covered by the scopes of the above Technical Committees and Subcommittee.

Introduction

Geometrical Product Specifications, abbreviated GPS, defines - i.e. on an engineering drawing - the shape (geometry), dimensions and surface characteristics of a workpiece which ensure optimum functioning of the workpiece in question, together with the dispersion around the optimum where the function is still satisfactory.

The manufacturing will nevertheless produce workpieces which are not perfect and which will show some deviation from the optimum and from one another.

These workpieces will be measured in order to compare them with the specification.

There is a need to relate

- the workpiece imagined by the designer,
- the workpiece as manufactured,
- the knowledge of the workpiece as measured - the actual workpiece.

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To obtain this relationship and to allow mutual interpretation, standards have been developed in the field of GPS dealing with basic definitions, symbolic representation, measurement principles etc.

For many years, these GPS standards have been prepared by Technical Committees (TCs) within ISO and have been issued as soon as specific needs were emerging, but sometimes a global view was missing. This results in standards with a different approach and presentation, and sometimes with contradictions. There are also gaps between the standards.

Recognizing this fact the Joint Harmonization Group of ISO/TC 3, *Limits and fits*, ISO/TC 10/SC 5, *Dimensioning and tolerancing*, and ISO/TC 57, *Metrology and properties of surfaces* (abbreviated ISO/TC 3-10-57/JHG) tasked with the harmonization of the standards of ISO/TC 3, ISO/TC 10/SC 5 and ISO/TC 57, decided to structure the standards dealing with GPS according to a Masterplan which shall be used for future standardization.

Geometrical product specification (GPS) — Masterplan

1 Scope

This Technical Report establishes the overview of the international standardization of Geometrical Product Specification (GPS). It explains the concept of GPS and provides a Masterplan of GPS including the existing standards and standards to be issued in the field which is the responsibility of ISO/TC 3, ISO/TC 10/SC 5 and ISO/TC 57.

It also mentions GPS standards and standardization activities outside the field of responsibility of the above mentioned technical committees (TCs). This is done in order to give complete information about the status of international GPS standards. The non ISO/TC 3, ISO/TC 10/SC 5 and ISO/TC 57 standards are only referred to as examples and do not intend to be a complete and exhaustive list of complementary GPS standards.

This Technical Report provides information to the industrial user of ISO GPS standards and to other TCs within ISO, which are using the content of GPS standards in their International Standards or are producing complementary ISO GPS standards, in order to improve the common understanding and use of GPS.

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2 Concept of Geometrical Product Specifications

The concept of GPS: <https://standards.iteh.ai/catalog/standards/sist/4b3f42e1-679b-497b-80c2-c578438ed46f/sist-iso-tr-14638-1999>

- covers several kinds of standards, some are dealing with the fundamental rules of specification (*Fundamental GPS standards*), some are dealing with global principles and definitions (*Global GPS standards*), some are dealing directly with the geometric characteristics (*General - and Complementary GPS standards*), see figure 1.
- covers several kinds of geometric characteristics such as size, distance, angle, form, location, orientation, roughness, etc. (see chains of *General GPS standards* numbered 1 through 17 in figure 1).
- covers workpiece characteristics (tolerance classification) as results of several kinds of manufacturing processes and the characteristics of specific machine elements (see chains of *Complementary GPS standards* numbered A1 through A7 and B1 through B3 in figure 1).
- occurs at several steps in the development of a product: design, manufacturing, metrology, quality assurance, etc.

The concept is graphically illustrated on figure 1 indicating four different types of GPS standards, which in total is designated the *GPS matrix model*.

3 Definitions

For the purpose of this Technical Report the following definitions applies:

3.1 chain of standards : All related standards concerning the same geometrical characteristics.

NOTE 1 - *Chains of standards* applies only to the *General GPS standards* and the *Complementary GPS standards*.

NOTE 2 - A *chain of standards* is characterized by the fact that each single standard, which is a part of a link in the chain, affects the other standards, so that the full understanding and application of each standard requires the knowledge of the other standards in the chain.

NOTE 3 - The task of all the *chains of standards* is to link - unambiguously - the indication on the drawing (e.g. the surface roughness symbol) to the SI unit of length in such a way that the tolerance limits are defined in every case possible - irrespective of the deviations from ideal geometry of the tolerated features, and other deviations from theoretical correct conditions - whatever they might be.

NOTE 4 - Each single standard in a *chain of standards* often aims at a limited and special group of users when considering the title of a standard or the subject of the standard mentioned in the subtitles. It is a common opinion that specific standards either belong to the design (department), the manufacturing or to the quality assurance (measurement). The rationale is however, that each link of the chain of standards is necessary for all parties (i.e. design, production, quality control, measuring etc.) in order to make it possible to understand the full content of each single standard and the definitions mentioned in each single standard in the chain.

NOTE 5 - A *chain of standards* consists of six chain links (numbered 1 - 6). Each link in the chain of standards has a very special task of its own (for further information see 4).

3.2 GPS matrix model : Arrangement consisting of 4 different main groups of standards:

- *Fundamental GPS standards*
- *Global GPS standards*
- *General GPS standards*
- *Complementary GPS standards*.

NOTE 6 - All GPS standards fit into the *GPS matrix model* which form the GPS Masterplan.

3.2.1 fundamental GPS standards : Standards establishing the fundamental rules and procedures for the GPS dimensioning and tolerancing of workpieces and products. For the time being only the *Principle of Independency* (ISO 8015) is standardized. A list of these standards is in Annex A.

NOTE 7 - The *Fundamental GPS standards* are the responsibility of ISO/TC 3, ISO/TC 10/SC 5 and ISO/TC 57.

3.2.2 global GPS standards : Standards which cover or influence several or all chains of *General GPS standards* and *Complementary GPS standards*. A list of these standards is in Annex B.

NOTE 8 - The *Global GPS standards* are the responsibility of ISO/TC 3, ISO/TC 10/SC 5 and ISO/TC 57.

3.2.3 general GPS matrix : Arrangement consisting of the chains of *General GPS standards*.

To illustrate the different aspects and relationships of these *General GPS standards*, the matrix of chains of general GPS standards in figure 2 has been defined where the rows are dealing with the different geometrical characteristics and the columns are dealing with the technical issues and requirements, necessary for ensuring a common and unambiguous understanding. Each matrix cell in every chain of standards has to be covered by the content of at least one standard.

NOTE 9 - The order according to which the columns (chain links) of the matrix are presented is based on the natural sequence for users reading a drawing and thus understand the drawing code. It shall be noticed that the concept (i.e. the definition of characteristics or parameters of a workpiece (actual feature definitions) for each chain of standards) is given in column no. 3.

NOTE 10 - The order according to which the lines of the matrix in figure 2 are presented does not imply any priority or precedence.

3.2.3.1 general GPS standards : The main body of GPS standards which establishes rules for drawing indications, definitions and verification principles for different types of geometrical characteristics.

A list of these standards is in Annex C.

NOTE 11 - The *General GPS standards* are the responsibility of ISO/TC 3, ISO/TC 10/SC 5 and ISO/TC 57.

3.2.4 complementary GPS matrix : Arrangement consisting of the chains of *Complementary GPS standards*.

Complementary GPS standards can be arranged in chains of standards analogous to the arrangement of the *General GPS standards* illustrated in figure 2.

3.2.4.1 complementary GPS standards : Standards establishing complementary rules for drawing indications, definitions and verification principles for a specialized category of features or elements. These rules depend on the type of manufacturing process and/or the type of machine element itself.

Complementary GPS standards are categorized as:

- **Process specific tolerance standards** (e.g. machining, casting, etc.)

NOTE 12 - Process specific tolerance standards are partly (chain A1 and A2 in figure 1) the responsibility of ISO/TC 3, ISO/TC 10/SC 5 and ISO/TC 57.

- **Machine element geometry standards** (e.g. screw threads, gears and splines)

NOTE 13 - Machine element geometry standards are not the responsibility of ISO/TC 3, ISO/TC10/SC5, and ISO/TC 57.

A list of these standards is in Annex D (Process specific tolerance standards) and in Annex E (Machine element geometry standards).

4 Setup and content of chain links

The chain links are titled and has the following defined tasks in the chain of standards.

4.1 Chain link no. 1 - Product documentation indication - Codification : Group of *General GPS standards* dealing with the drawing indication of the characteristic of the work piece are placed in this chain link. The indication is often in a sort of "coded" symbol - a symbolic representation of the geometric characteristic. The standards define the symbols, how to use the symbol and the associated rules of "grammar", the small differences in the symbol, which causes a major shift in meaning.

4.2 Chain link no. 2 - Definition of tolerances - Theoretical definition and values : Group of *General GPS standards* defining the numerical values related to the "code"-symbols, are placed in this chain link. The standards define the rules of translating from the code to "human understandable" (verbal) and "computer understandable" (mathematical) values into SI-units e.g. the size in mm - and vice versa.

Also the derivation of the characteristic from the geometry is placed in this chain link. These standards defines the theoretically exact feature with associated tolerances.

NOTE 14 - In some cases the theoretical limit values as defined in chain link no. 2 (e.g. defined in ISO 286 and ISO 1302) may be refined by the detailed requirements given under chain link 4 (e.g. ISO/R 1938 and ISO 4288).

4.3 Chain link no. 3 - Definitions for actual feature - characteristic or parameter : Group of *General GPS standards* with the purpose to make the supplementary definitions to extend the meaning of the theoretically exact feature, so that also the non-ideal real world geometry (actual feature characteristic) always is unambiguous defined in relation to the tolerance indication (code symbol) on the drawing. The definitions of actual feature characteristics in this chain link is based on sets of data points. The actual feature shall be defined in a verbal formulation and in a mathematical expression to oblige the human understanding of the definition as well as the computerized calculations.

NOTE 15 - The various functional requirements for geometric features may result in a need for a number of different definitions for actual features or actual feature characteristics. If this is the case the *chain of standards* shall be split up into a corresponding number of sub-chains of standards in chain link 3, 4, 5 and 6. This is not illustrated in this issue of ISO/TR 14638.

NOTE 16 - One of the sub-chains of standards shall be chosen as the default definition of the actual feature. The method of indication of the other sub-chain will be developed.

4.4 Chain link no. 4 - Assessment of the deviations of the workpiece - Comparison with tolerance limits : Group of *General GPS standards* that defines the detailed requirements for the assessment of the deviations of the workpiece from the one indicated on the drawing, taking into account the definitions in chain link 2 and 3.

NOTE 17 - The standards must state the detailed rules how to compare the measurement results with the tolerance limits to be able to prove conformance or non conformance of the workpiece with respect to the indicated geometric characteristics and its associated tolerance on the drawing, taking into account the uncertainty of the inspection or measuring process involved.

NOTE 18 - The infinite set of data points in the chain link 3 definition of the actual feature may be changed by convention to a limited set of data points. In this case the chain link 4 standard is defining the conventional true value of the indicated GPS characteristic on the drawing.

NOTE 19 - In some cases the theoretical limit values as defined in chain link no. 2 (e.g. defined in ISO 286 and ISO 1302) may be refined by the detailed requirements given under chain link 4 (e.g. ISO/R 1938 and ISO 4288).

4.5 Chain link no. 5 - Measurement equipment requirements : Group of *General GPS standards* describing specific measuring equipment or types of measuring instruments. The standards define the characteristics of measuring equipment, which are influencing the uncertainty of the measuring process in which the equipment is involved. The standards may include values for limits of maximum permissible error for the defined characteristics of measuring equipment.

NOTE 20 - Measuring equipment may be specific to one or more of the sub-chains of standards or may be universal and fit a number or several actual feature definitions in the chain of standards.

NOTE 21 - A valuable task of this chain link is the harmonizing effect on the market of measuring equipment.

4.6 Chain link no. 6 - Calibration requirements - Measurement standards : Group of *General GPS standards* describing/defining the calibration standards and the calibration procedures to be used, verifying functional requirements of the specific measuring equipment (limits of permissible error) in chain link number 5, with traceability to the definition of the SI unit concerned - e.g. the meter.

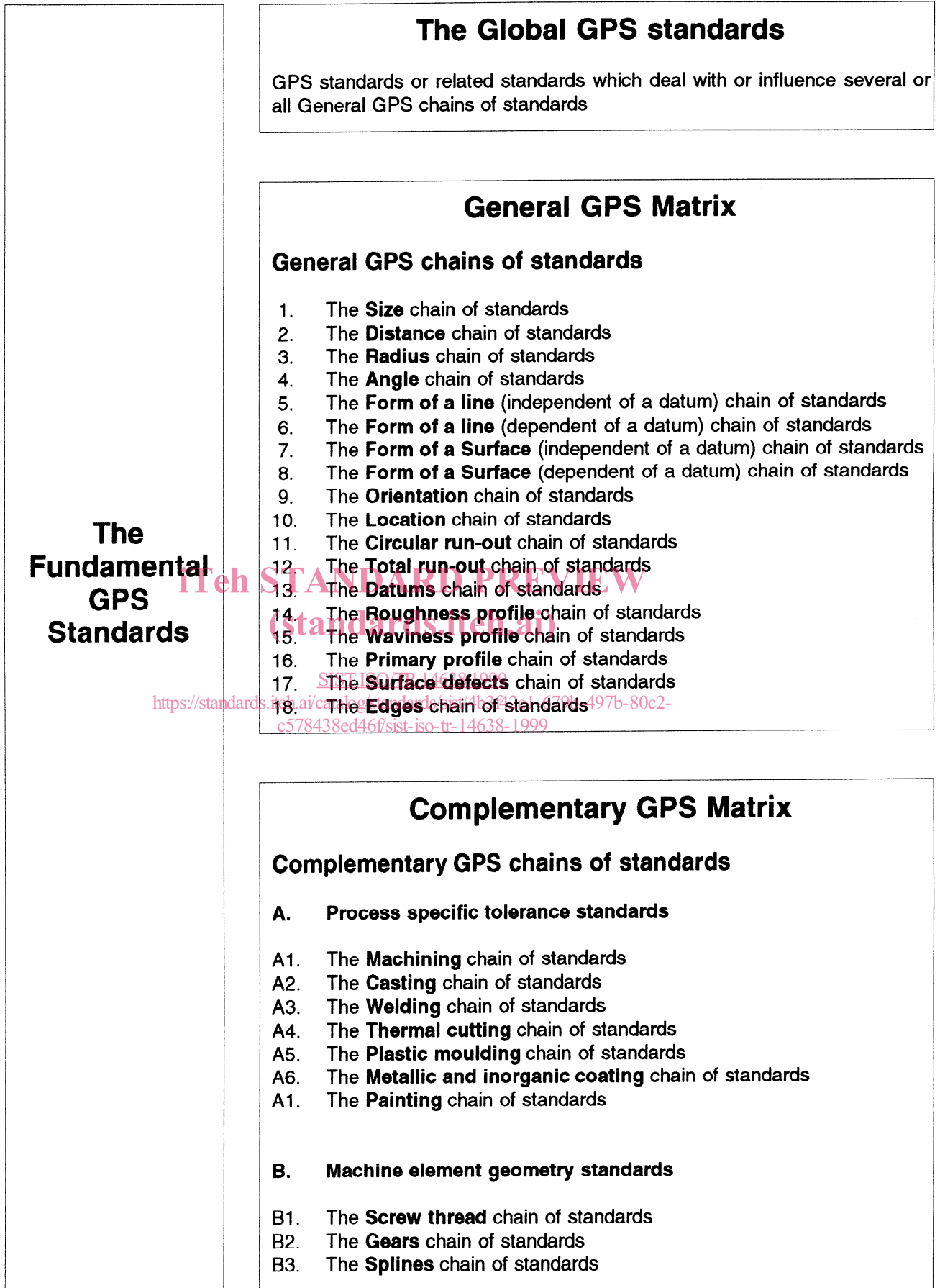


Figure 1: The GPS matrix model - GPS Masterplan - Overview

5 Masterplan in the field of Geometrical Product Specifications - GPS

The GPS masterplan (GPS matrix model) in figure 1 and the compressed General GPS matrix defined in figure 2 shall be used to decide how the needs for standardization shall be solved, i.e. future standards shall fit into the structure and the matrix to clarify their scope and relationship with other standards.

To help the future needs for standardization in the field of general GPS standards, the expanded matrix of figure 3 includes standards already existing and standards under development in the field of general GPS; and shows the gaps to be filled. These standards are referred to by their ISO issue number or, for standards not yet having an ISO number a preliminary (unofficial) number XXXYY has been used. The YYs are serial numbers which only fulfil the needs for information in this Technical Report and does not represent any relationship to official catalogues of ISO Central Secretariat.

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 of a datum						
7 Form of a surface independent of a datum						
8 Form of a surface dependent of 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						

Figure 2 - The compressed "General GPS matrix" - part of the field of responsibility of ISO/TC3, ISO/TC10/SC5 and ISO/TC57 (see figure 3 for the complete "General GPS matrix").

For the future work of ISO/TC 3, ISO/TC 10/SC 5 and ISO/TC 57 the following 3 rules will apply for the preparation of GPS standards:

5.1 The rule of unambiguity: Each chain of standards, assisted by *Global GPS standards*, shall include the necessary definitions and rules, that unambiguity exists between the drawing indication and the geometrical characteristics of the workpiece and that the assessed value(s) representing the characteristic is (are) traceable to International physical calibration Standards

NOTE 22 - The *rule of unambiguity* is influencing the content of the standards in the various chains of standards and the *Global GPS standards*, and also ensures that each measurand in the chain is measurable.