INTERNATIONAL STANDARD

ISO 5436-2

Second edition
2012-10-01

Geometrical product specifications (GPS) — Surface texture: Profile method; Measurement standards —

Part 2: Software measurement standards

Spécification géométrique des produits (GPS) — État de surface: Méthode du profil; Étalons —

Partie 2: Étalons logiciels

Reference number
ISO 5436-2:2012(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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.

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 5436-2 was prepared by Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification*.

This second edition cancels and replaces the first edition (ISO 5436-2:2001), which has been technically revised. It also incorporates the Technical Corrigenda ISO 5436-2:2001/Cor.1:2006 and ISO 5436-2:2001/Cor.2:2008.

ISO 5436 consists of the following parts, under the general title *Geometrical product specifications (GPS) — Surface texture: Profile method; Measurement standards*:

— *Part 1: Material measures*

— *Part 2: Software measurement standards*

Introduction

This part of ISO 5436 is a geometrical product specification (GPS) standard and is to be regarded as a general GPS standard (see ISO/TR 14638). It influences chain link 6 of the chain of standards on roughness, waviness and primary profiles.

The ISO/GPS Masterplan given in ISO/TR 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 detailed information on the relationship of this part of ISO 5436 to other standards and the GPS matrix model, see Annex B.

This part of ISO 5436, together with ISO 5436-1, introduces two new measurement standards:

— Type E, for calibrating the profile co-ordinate system;

— Type F, for calibrating software.

This part of ISO 5436 is concerned with software measurement standards.

Geometrical product specifications (GPS) — Surface texture: Profile method; Measurement standards —

Part 2: Software measurement standards

1 Scope

This part of ISO 5436 defines Type F1 and Type F2 software measurement standards (etalons) for verifying the software of measuring instruments. It also defines the file format of Type F1 software measurement standards for the calibration of instruments used for measuring the surface texture by the profile method defined in ISO 3274.

NOTE 1 Throughout this part of ISO 5436, the term “softgauge” is used as a substitute for “software measurement standard Type F1”.

NOTE 2 Formerly, “measurement standards” were referred to as “calibration specimens”.

NOTE 3 ISO 3274 only refers to instruments with independent reference datums.

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 3274:1996, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Nominal characteristics of contact (stylus) instruments*

ISO 5436-1:2000, *Geometrical Product Specifications (GPS) — Surface texture: Profile method; Measurement standards — Part 1: Material measures*

ISO 12085:1996, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Motif parameters*

ISO 16610-21:2011, *Geometrical product specifications (GPS) — Filtration — Part 21: Linear profile filters: Gaussian filters*

ISO 17450-2:2012, *Geometrical product specifications (GPS) — General concepts — Part 2: Basic tenets, specifications, operators, uncertainties and ambiguities*

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in Measurement (GUM:1995)*

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 3274, ISO 5436-1, ISO 12085, ISO 16610-21:2011, ISO/IEC Guide 99 and the following apply.

3.1
software measurement standard
reference data or reference software intended to reproduce the value of a measurand with known uncertainty in order to verify the software used to calculate the measurand in a measuring instrument

3.2
ASCII string
array of ASCII characters terminating in <ASCII 0>

3.3
integer
2-byte representation of whole number

NOTE 1 Integers have a minimum value of –32 768 and a maximum value of +32 767.

NOTE 2 The less significant bytes are stored in memory addresses lower than those in which are stored the more significant bytes.

3.4
unsigned integer
2-byte representation of a positive whole number

NOTE 1 Unsigned integers have a minimum value of 0 and a maximum value of 65 535.

NOTE 2 The less significant bytes are stored in memory addresses lower than those in which are stored the more significant bytes.

3.5
long integer
4-byte representation of a whole number

NOTE 1 Long integers have a minimum value of –2 147 483 648 and a maximum value of +2 147 483 647.

NOTE 2 The less significant bytes are stored in memory addresses lower than those in which are stored the more significant bytes.

3.6
single precision float
4-byte representation consisting of a sign bit, an 8-bit excess –127 binary exponent and a 23-bit mantissa representing numbers between 1,0 and 2,0

NOTE 1 Since the high-order bit of the mantissa is always 1, it is not stored in the number.

NOTE 2 Single precision floats have an approximate range of $\pm 1{,}17e^{-38}$ to $\pm 3{,}4e^{+38}$.

NOTE 3 The less significant bytes are stored in memory addresses lower than those in which the more significant bytes are stored.

3.7
double precision float
8-byte representation consisting of a sign bit, an 11-bit excess –1 023 binary exponent, and a 52-bit mantissa, plus the implied high-order 1 bit

NOTE 1 Double precision floats have an approximate range of $\pm 2{,}22e^{-308}$ to $\pm 2{,}22e^{+308}$.

NOTE 2 The less significant bytes are stored in memory addresses lower than those in which the more significant bytes are stored.

4 Type F software measurement standards

4.1 General

Type F software measurement standards are designed to verify the measuring instrument's software (i.e. filter algorithms, parameter calculations, etc.).

These measurement standards can contain a form component which it shall be possible to remove.

4.2 Type F1 — Reference data

Type F1 measurement standards are computer data files that depict a digital representation of a primary profile in a suitable recording medium.

Most of the operations between the total profile and primary profile are instrument-specific and, as a result, are difficult to standardize. The primary profile is currently the first point where all the subsequent operations for the definition of surface texture measurands are standardized and is thus chosen as the standardized point of entry for type F1 softgauges.

A non-exhaustive, non-ordered, informative list of operations between the total profile and primary profile may include the following.

— **Adjustment for calibration** — There are many different calibration models: gain factor, polynomial corrections for curvilinear co-ordinates, interpolation method corrections for curvilinear co-ordinates, etc.

— **Stylus tip correction** — Corrects for the finite size and shape of the stylus.

— **Decimation** — Reduces the number of the data points for subsequent calculation.

— **Equalization of interval of data points** — Makes the data by using mathematical interpolation.

— **Ls filtering** — Convolutes with previous filtering (i.e. an anti-aliasing filter of an A/D convertor) to make a true Gaussian filter.

— **End effects** — Removes a portion of the profile at the beginning and at the end to reduce possible end effects due to, for example, Ls filtering, stylus tip correction, etc.

— **Fitting of form by association** — Total least squares, linear least squares, Chebychev (minimum zone), fitting using robust norms (i.e. L1), one-sided fitting, Theil-Sen-type estimators.

— **Removal of form from profile** — Projection, orthogonal to line normal.

If the entry point for the F1 standard is before the primary profile (e.g. the total profile), the signal flow to generate the primary profile (by steps like those exemplarily listed above) shall be agreed upon between the producer and the user of the F1 standard.

NOTE The certified results for mathematically designed synthetic data can often be calculated directly without the need for certification by Type F2 measurement standards.

4.3 Type F2 — Reference software

Type F2 measurement standards are reference software. Reference software consists of traceable computer software against which software in a measuring instrument can be compared.

Type F2 measurement standards are used to test software by inputting a common data set into both the software under test/calibration and the reference software, then comparing the results from the software under test with the certified results from the reference software.

NOTE Type F2 measurement standards can also be used to certify Type F1 measurement standards.

Reference software values shall be traceable.

5 File format for Type F1 reference data

5.1 General

The file extension of this file protocol is `.smd`. The file protocol for the softgauge is divided into four separate sections or records. Each record is composed of lines of information and, within each line, there are various “fields” in which the information is coded. The file format is in 7-bit ASCII character code. Each line is terminated by a carriage return (`<cr>`) and line feed (`<lf>`).

Each record is terminated by an end of record (<ASCII 3>) with a carriage return (<cr>) and line feed (<lf>). The last record is further terminated by an end of file (<ASCII 26>). For each field, the separator consists of at least one space.

An example of a software file format is given in Annex A.

5.2 Record 1 — Header

The first record contains a fixed header that includes the following information:

— revision of the softgauge file format;

— file identifier;

— GPS feature type, number and name of the stored feature — axis information;

— number of data points in the profile;

— scaling of the data points;

— resolution of the data points.

The first line of record 1 contains two fields:

— The_revision_number;

— File_identifier.

Table 1 gives valid options for these fields.

Table 1 — Fields for line 1 of record 1

Field name	Valid options/examples	Comment
The_revision_number	'ISO 5436-2 - 2012'	ASCII string
File_identifier	'XXXXXX'	ASCII string

The second line of record 1 contains three fields:

— Feature_type;

— Feature_number;

— Feature_name.

Table 2 gives valid options for these fields.

Table 2 — Fields for line 2 of record 1

Field name	Valid options/Examples	Comment(s)
Feature_type	'PRF'	Profile data {i.e. (X,Z), (R,A), etc.}
	'SUR'	Surface data {i.e. (X,Y,Z), (R,A,Z), etc.}
Feature_number	0	Unsigned integer
Feature_name	'ISO000'	ASCII string

Each of the remaining lines of record 1 contains at least six fields:

— Axis_name;

— Axis_type;

— Number_of_points;

— Units;

— Scale_factor;

— Axis_data_type.

A seventh field, containing the incremental value, is added if the axis type is incremental.

See Figure 1 for an example.

Each axis in the softgauge has a line allocated to it. Thus, for a profile there will be two remaining lines — one for the X axis and one for the Z axis.

Table 3 gives valid options for these fields.

Table 3 — Fields for the remaining lines of record 1

Field name	Valid options/Examples	Comments
Axis_name	'CX'	Cartesian X axis
	'CY'	Cartesian Y axis
	'CZ'	Cartesian Z axis
	'PR'	Polar radius
	'PA'	Polar angle
Axis_type	'A'	Absolute data [a]
	'I'	Incremental data [b]
	'R'	Relative data [c]
Number_of_points	4003	Number of data points (Unsigned long integer)
Units	'm'	metres
	'mm'	millimetres
	'um'	micrometres
	'nm'	nanometres
	'rad'	radians
	'deg'	degrees
Scale_factor	1.0e0	Scale to indicated units (double-precision float)
Axis_data_type	'I'	Integer
	'L'	Long integer
	'F'	Single precision float
	'D'	Double precision float
Incremental_value [d]	1e-3	Value of increment (double precision float)

[a] Absolute data: each data value is the distance along the axis to the axis origin.

[b] Incremental data: assumes that the data is equally spaced in this axis so only an increment is required.

[c] Relative data: each data value is the distance along the axis to the previous data point. The first value is the distance to the axis origin.

[d] Axis type I only.