TECHNICAL SPECIFICATION

ISO/TS 17863

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Geometrical product specification (GPS) — Geometrical tolerancing of moveable assemblies

Spécification géométrique des produits (GPS) — Tolérancement géométrique des assemblages mobiles

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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. 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. 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.

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

Introduction

This Technical Specification is a geometrical product specification (GPS) standard and is to be regarded as a general GPS standard (see ISO/TR 14638). It influences chain links 1 to 3 of the chain of standards on size, distance, angle, form of line dependent on datum, form of surface dependent on datum, orientation, location, circular run-out, total run-out and datums.

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 of the relation of this Technical Specification to other standards and the GPS matrix model, see Annex C.

ISO 1101 cannot be applied on movable assemblies where one part of the assembly includes tolerance indications and another part includes corresponding datum indications, because there is a specification uncertainty due to undefined conditions of the interaction and relative mobility of the parts and how the parts are kept together.

ISO 14405-1 cannot be applied on movable assemblies, because there is a specification uncertainty due to undefined conditions of the interaction and relative mobility of the parts and how the parts are kept together.

This Technical Specification provides additional GPS symbols for indication of constraint conditions, e.g. application of forces.

Geometrical product specification (GPS) — Geometrical tolerancing of moveable assemblies

1 Scope

This Technical Specification specifies the indication of constraint conditions in between the parts of movable assemblies in conjunction with tolerancing according to ISO GPS standards. On geometrical tolerancing, one part of the assembly includes tolerance indications and another part includes corresponding datum indications.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 128-24, *Technical drawings — General principles of presentation — Part 24: Lines on mechanical engineering drawings*

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

ISO 6433:2012, *Technical product documentation — Part references*

ISO 14405-1:2010, *Geometrical product specifications (GPS) — Dimensional tolerancing — Part 1: Linear sizes*

ISO 81714-1, *Design of graphical symbols for use in the technical documentation of products — Part 1: Basic rules*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 1101, ISO 14405-1 and the following apply.

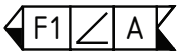
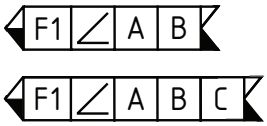
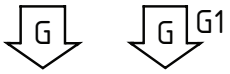
3.1
movable assembly
assembly of two or more parts where the parts can be moved relative to each other

4 Symbols

For the purpose of this document, the symbols in Table 1 apply.

Rules for the presentation of graphical symbols are given in Annex A.

Table 1 — Symbols for movable assemblies

Description	Symbol	Remark	Reference
Force indicator		a	6.2
Force indicator including basic indication of specific direction of the force relative to a single datum		a, b	6.2
Force indicator including basic indication of specific direction of the force relative to a datum system		a, b	6.2
Complementary force indicator		a	6.6
Gravity		c	6.3
Mobility – translational			6.7
Mobility – rotational			6.7
Flag		a	6.8 and 6.9
Movable part	MP		6.10.1.1
Fixed part	FP		6.10.1.1
Translational mobility in positive direction	T+		6.10.1.2
Translational mobility in negative direction	T–		6.10.1.2
Rotational mobility in positive direction	R+		6.10.1.2
Rotational mobility in negative direction	R–		6.10.1.2

a Number 1 in F1 is an example for numbering of different forces.

b Symbol ∠ is an example. Symbols //, ⊥, and ⌯ may be used as well.

c Number 1 in G1 is an example for numbering of different direction of gravity.

d Number 1 is an example for numbering of different flags.

5 General concept

All degrees of freedom that are not necessary for the concerned toleranced characteristic shall be locked.

EXAMPLE 1 For circular run-out, all translational degrees of freedom and two rotational degrees of freedom are locked. Only the third rotational degree of freedom, i.e. the one which is relevant to rotate the part relative to the datum, is kept unlocked.

Per default, the part with tolerance indications is considered as a movable part and the part with datum indications is considered as a fixed part.

Movable and fixed parts shall be numbered with item references according to ISO 6433. This shall be used in the descriptions of the conditions to specify which part is movable and which part is fixed.

Locking degrees of freedom shall be realized by application of forces (which can also be only the force of gravity) as applied in the real application of the movable assembly. Per default, the force is evenly distributed at the complete concerned integral feature, but can be limited to portions of the integral feature and/or contacting features. If the force is applied on a portion of an integral feature, the force is also evenly distributed. If the force is applied on more than one portion of an integral feature, the force

is evenly distributed to all portions. If the force is applied on more than one contacting feature, the force is evenly distributed to all contacting features.

Force shall be applied on the movable part, but might be applied on the fixed part as well in order to keep a stable location of the fixed part relative to the movable part.

EXAMPLE 2 Force by means of interference fit on a datum feature on a shaft.

Per default, the direction of the force is perpendicular to the concerned feature if not otherwise indicated.

The direction of the mobility shall be indicated on the movable part whenever mobility is possible in different directions and if there is a difference on the behaviour of the assembly dependent on the direction of the mobility.

The tolerance value for the toleranced characteristic is valid under constraint conditions which are invoked by the symbol flag. The detailed description of the conditions shall be given near the title box of the drawing.

There can be different tolerance values for the same characteristic, but valid under different conditions, e.g. real application versus test conditions.

Values for forces and other additional constraint conditions, which are needed to describe the mobility of the movable part against the fixed part, shall be specified by means of descriptions near the title box of the drawing.

6 Graphical language

6.1 Indication of item references

Item references shall be indicated according to ISO 6433. See Figure 1.

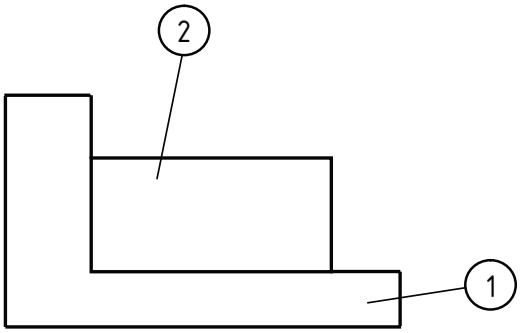


Figure 1 — Example of item references indication

6.2 Force indicator

The force indicator includes up to five compartments, i.e.

— the utmost left compartment to indicate letter F for force and an adjacent figure to number different forces;

— the subsequent compartment including symbol ∠, //, ⊥ or ⌯ to basically indicate a specific direction of the force;

— the subsequent compartment(s) including letter(s) denominating a datum feature for the indication of a specific direction.

See Figure 2.

a) Basic force indicator

b) Force indicator including basic indication of a specific direction of the force relative to a datum

c) Force indicator including basic indication of a specific direction of the force relative to a datum system

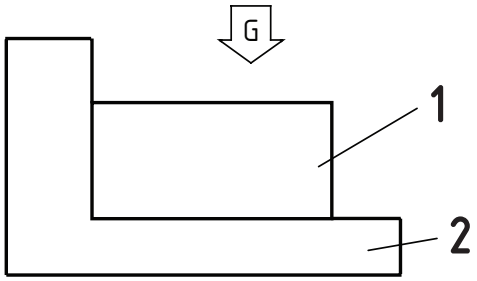
d) Force indicator including basic indication of a specific direction of the force relative to a datum system

Figure 2 — Examples of force indicators

6.3 Indication of direction of gravity

When only the force of gravity is acting on the movable part, the gravity symbol shall be indicated near to the concerned part. The symbol consists of an unfilled arrow including letter G for gravity.

See Figure 3.



Key

1 movable part

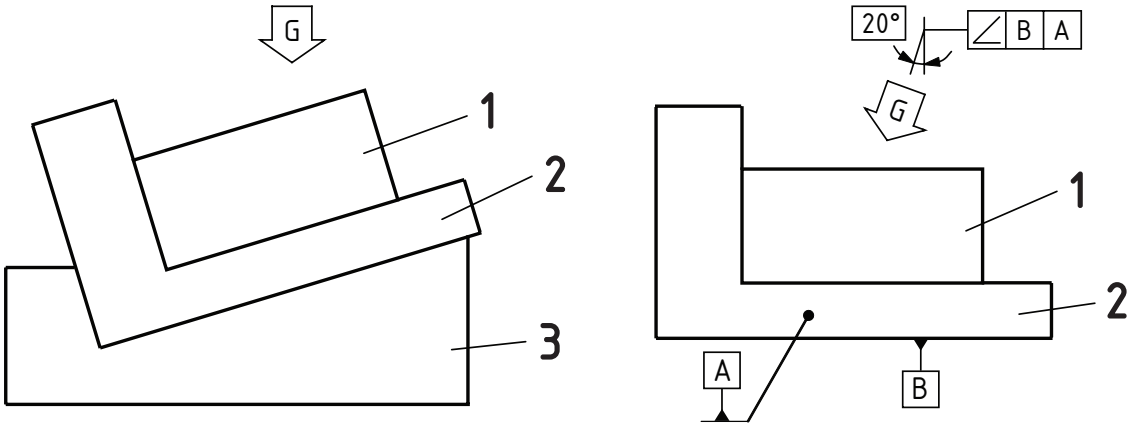
2 fixed part

Figure 3 — Indication of the gravity symbol

When the assembly is orientated in adjacent parts in a direction which is not equal to the orientation of the assembly on the assembly drawing, the gravity symbol on the assembly drawing shall be combined with corresponding indications for the orientation.

Single datums, common datums, datum systems and/or orientation planes shall be indicated to orientate the vector.

See Figure 4.



a) Direction of gravity on drawing of assembly and adjacent part

b) Direction of gravity on assembly drawing

Key

1	movable part	1+2	assembly
2	fixed part	3	adjacent part

Figure 4 — Example of indication of inclined direction of gravity on the assembly drawing

If the direction of gravity is different for different force applications, different G symbols supplemented by letter G and a related number shall be indicated.

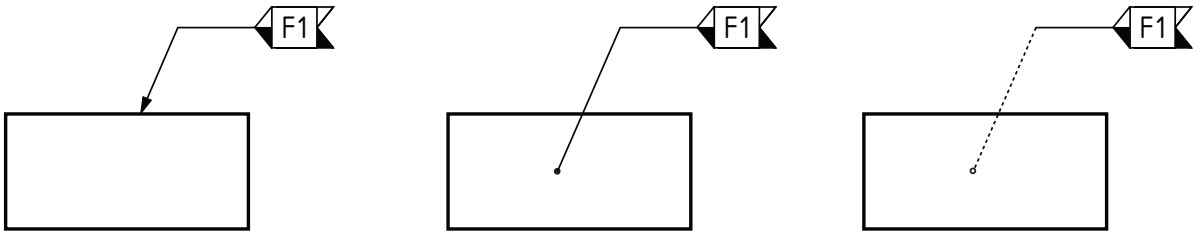
6.4 Connection of force indicator with concerned feature

The tolerance indicator shall be connected through a reference and a leader line with the concerned feature.

When the complete or a restricted area of the integral feature is concerned, the leader line shall be terminated with an arrow or a dot/open circle. See Figures 5 and 7.

When a line of the integral feature is concerned, the leader line shall be terminated with an arrow. See Figure 7.

When the concerned feature is visible, the leader line shall be continuous and terminated with a dot. When the concerned feature is hidden, the leader line shall be dashed and the leader line shall be terminated with an open circle. See Figure 5.



a) Leader line terminated with an arrow

b) Leader line terminated with a dot on a visible feature

c) Leader line terminated with an open circle on a hidden feature

Figure 5 — Connection of force indicator with concerned feature

Contacting features may be used in between the force indicator and the concerned feature in order to represent specific contacts. The contacting feature shall be drawn with long-dashed double-dotted narrow lines (type 05.1 of ISO 128-24) and dimensioned with TEDs (theoretical exact dimensions).

See Figure 6.

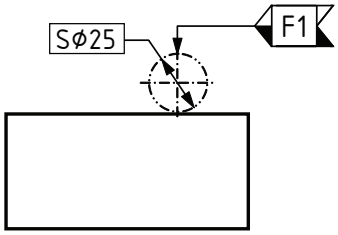


Figure 6 — Example of a contacting feature

6.5 Application of force on portions of a feature

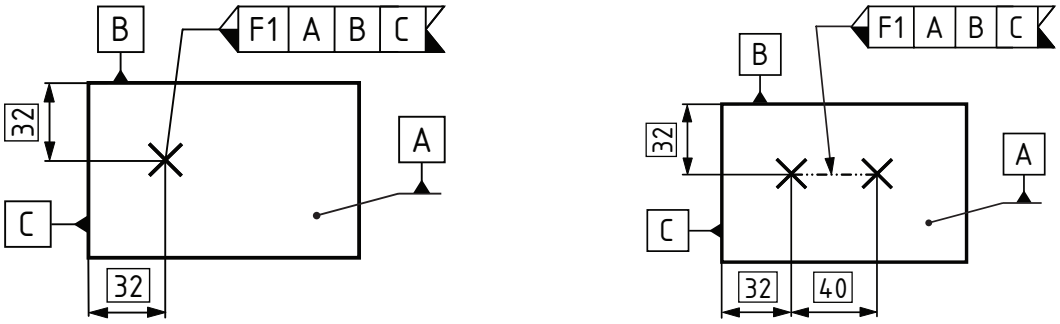
If the application of the force is restricted to a point, a cross shall be indicated and dimensioned with TEDs.

If the application of force is restricted to a line, a long-dashed narrow line (type 05.1 of ISO 128-24) shall be indicated, which, when the line is not closed, is terminated by two crosses. This line may be straight, circular or a line of any shape. The line shall be dimensioned with TEDs.

If the application of the force is restricted to an area, this shall be indicated as hatched area surrounded by long-dashed doubled-dotted narrow lines (type 05.1 of ISO 128-24) and dimensioned with TEDs.

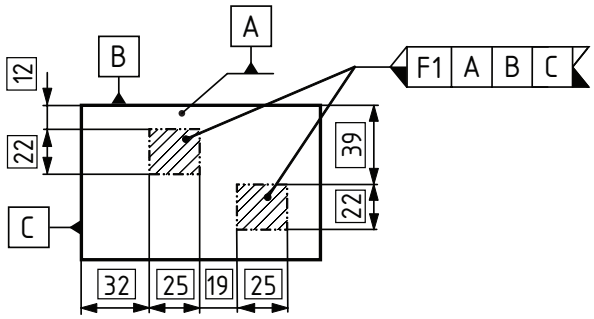
For determination of the exact position of a point, a line or an area, a datum system shall be indicated.

See Figure 7.



a) Application of the force is restricted to a point

b) Application of the force is restricted to a line



c) Application of the force is restricted to two areas

Figure 7 — Examples of application of the force on portions of an integral feature

6.6 Direction of force

By default, the direction of force is perpendicular to the concerned feature independent of the direction of the leader line according to 6.3.

Specific directions of force shall be specified by

— application of force indicator including symbol ∠, //, ⊥ or ⌯;

— indication of TEDs (theoretical exact dimensions) with regard to the concerned feature.

Single datums, common datums, datum systems and/or orientation planes shall be indicated to orientate the vector.

See Figure 8.

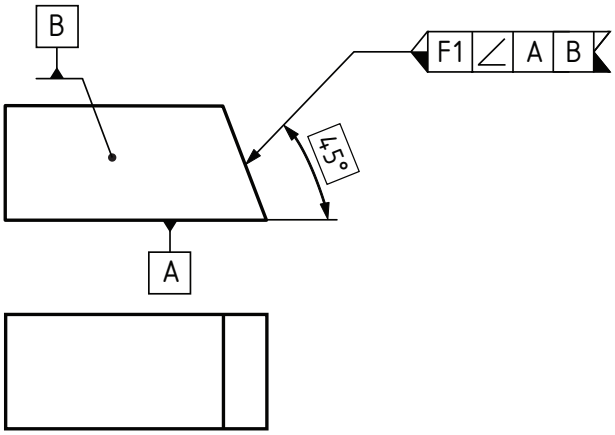
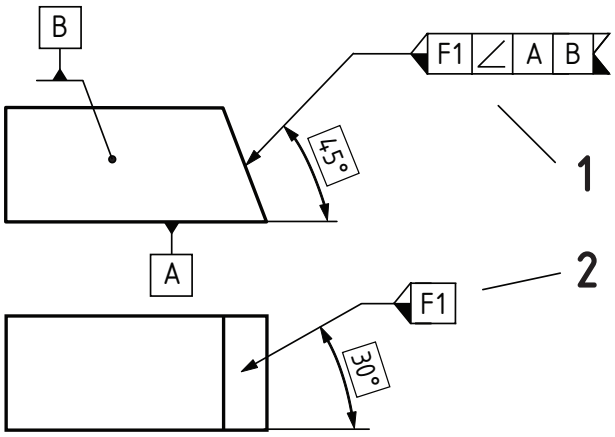


Figure 8 — Example of indication of specific direction of force without complementary force indicator

If the direction of the force cannot be indicated unambiguously in one drawing view, a complementary force indicator shall be indicated in another view.

See Figure 9.



Key

1 basic force indicator

2 complementary force indicator

Figure 9 — Example of indication of specific direction of force with additional complementary force indicator

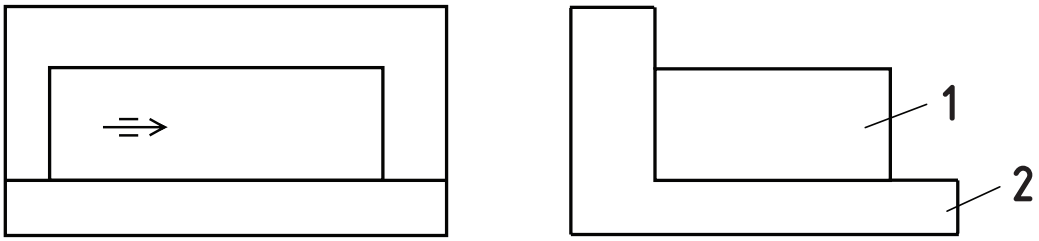
6.7 Indication of direction of mobility

The direction of mobility shall be indicated on the assembly drawing.

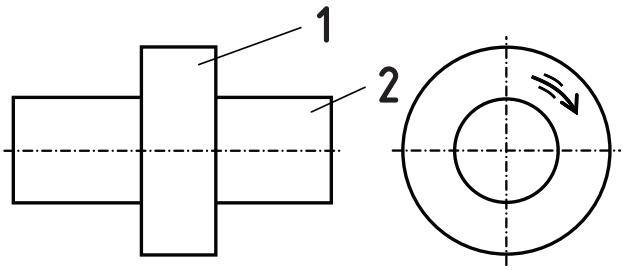
The arrow head of the mobility symbol shall point in positive direction of the mobility.

See Figure 10.

On symmetrical parts, it is recommended to physically sign the symbol mobility on the product to ensure repeatability of measurements.



a) Indication of direction of translational mobility



b) Indication of direction of rotational mobility

Key

1 movable part

2 fixed part

Figure 10 — Indication of direction of mobility

6.8 Indication of interrelation of tolerance indication and conditions

The flag symbol shall be indicated after the tolerance indicator.

It consists of a hexagon indicator including a figure to number different flags.

Different tolerance values for the same characteristic, but valid under different conditions, shall be given in several adjacent tolerance indications.

See Figure 11.

a) Indications of the flag symbol

b) Indications of different values with different conditions

Figure 11 — Examples of indications of the flag symbol

6.9 Description of conditions

The description of conditions shall be indicated near the title box of the drawing.

The indication shall consist of the flag symbol as used in the corresponding tolerance indication and subsequent detailed information. For the list and sequence of conditions, see 6.10.

See Figure 12.

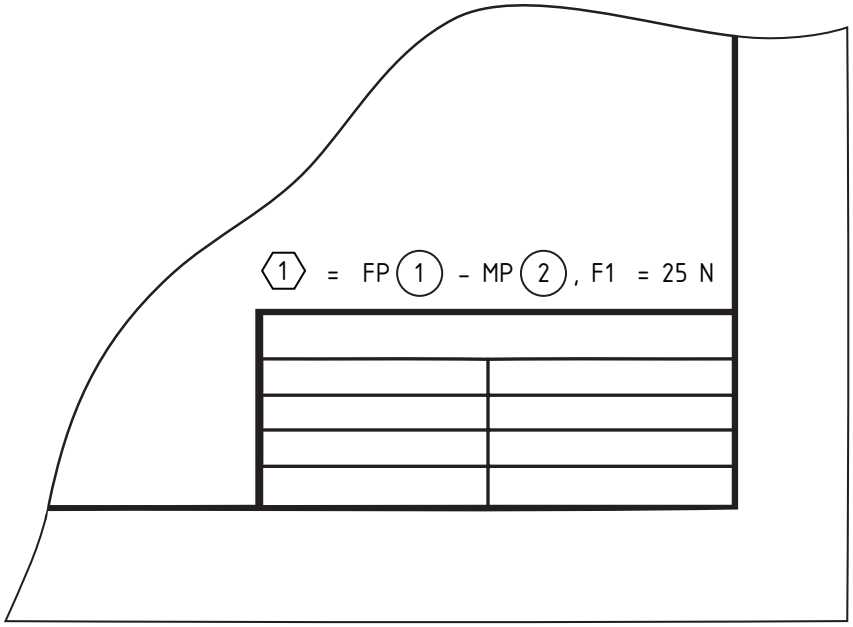


Figure 12 — Example of detailed description of conditions near the title box

6.10 List and sequence of conditions

6.10.1 List of conditions

6.10.1.1 Mobility

Symbol “FP” shall be used for the fixed part.

Symbol “MP” shall be used for the movable part.

“FP” and “MP ” shall be supplemented with the item reference of the concerned parts.

EXAMPLE FP 1

6.10.1.2 Direction of mobility

Symbol “T+” shall be used for translational mobility in positive direction.

Symbol “T–” shall be used for translational mobility in negative direction.

Symbol “R+” shall be used for rotational mobility in positive direction.

Symbol “R–” shall be used for rotational mobility in negative direction.

6.10.1.3 Velocity of mobility

Translational mobility (speed): Symbol *v*, value and unit (SI units, e.g. mm·s^{-1}) shall be indicated.

EXAMPLE 1 v = 15 mm.s^{-1}

Rotational mobility (angular speed or number of revolutions): Symbol ω, value and unit rad·s^{-1} or symbol RPM, value and unit min^{-1} shall be used.

EXAMPLE 2 ω = 3 rad·s^{-1}

EXAMPLE 3 RPM = 500 min^{-1}

6.10.1.4 Force

Force shall be indicated with letter F, adjacent figure, value and unit N.

EXAMPLE 1 F1 = 25 N

If only the force of gravity is acting, only the gravity symbol shall be indicated.

EXAMPLE 2 G1

6.10.1.5 Direction of gravity

If different directions of gravity (related to different orientations of the work piece) are indicated on the drawing, the related direction of gravity shall be indicated with letter G and the relevant number.

EXAMPLE G1

6.10.1.6 Further conditions

Further conditions like change of velocity or force over time or even full operational or test cycles shall be described in separate documentation which shall be referenced on the drawing.

6.10.2 Sequence of conditions

General structure: Conditions for fixed parts – Conditions for movable parts

The conditions as listed in 6.10.1 shall be written in following sequence:

— Mobility, Direction of mobility, Velocity of mobility, Force, Direction of gravity, Further conditions

EXAMPLE 

Annex A
(normative)

Relations and dimensions of graphical symbols

A.1 General requirement

In order to harmonize the size of the symbols specified in this International Standard with those of other inscriptions on technical drawings (dimensions, geometrical tolerances, etc.), the rules given in this annex, which are in accordance with ISO 81714-1, shall be observed. Further graphical symbols are given in ISO 3098-5.

A.2 Proportions

The graphical symbols, described in Table 1 shall be drawn in accordance with Figures A.1 to A.8.

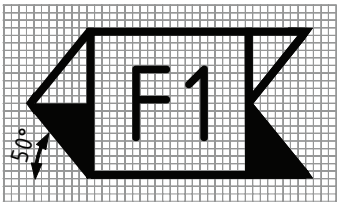


Figure A.1 — Force indicator

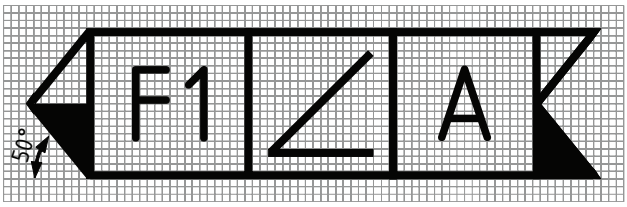


Figure A.2 — Force indicator including basic indication of specific direction of the force relative to a datum

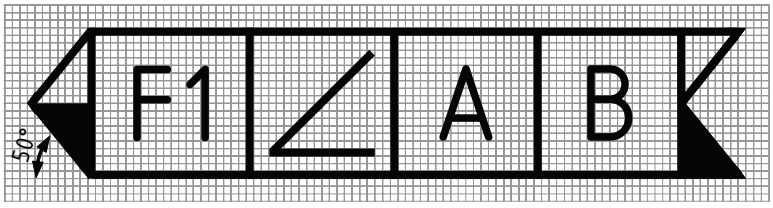


Figure A.3 — Force indicator including basic indication of specific direction of the force relative to a datum system

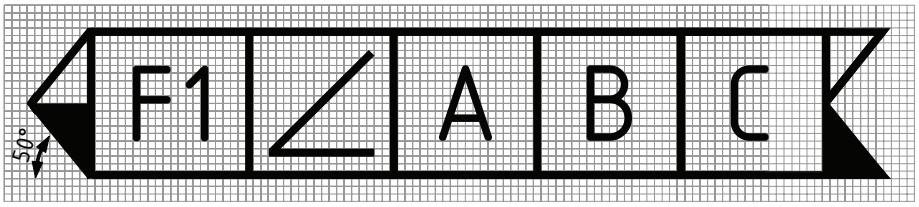


Figure A.4 — Force indicator including basic indication of specific direction of the force relative to a datum system

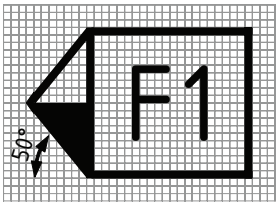


Figure A.5 — Complementary force indication

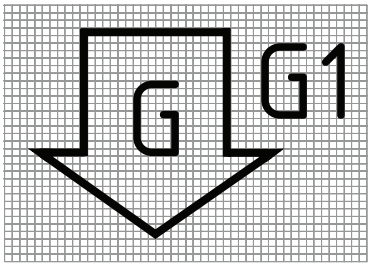


Figure A.6 — Gravity

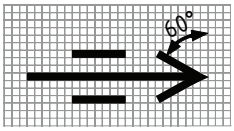
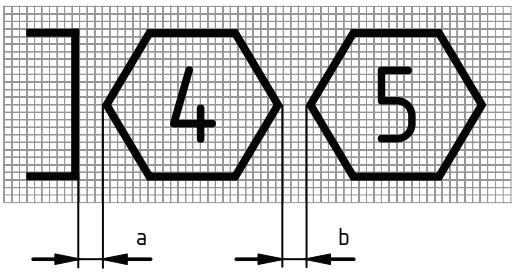


Figure A.7 — Mobility

Figure A.7 shows the symbol for “mobility – translational”. The symbol for “mobility – rotational” shall be drawn in a curved manner in relation to the contour of the work piece.



Key

a Distance between symbol flag and tolerance indicator.

b Distance in between different flag symbols.

Figure A.8 — Flag

Annex B
(informative)

Example of run-out and size tolerances on a tapered roller bearing

See Figure B.1.

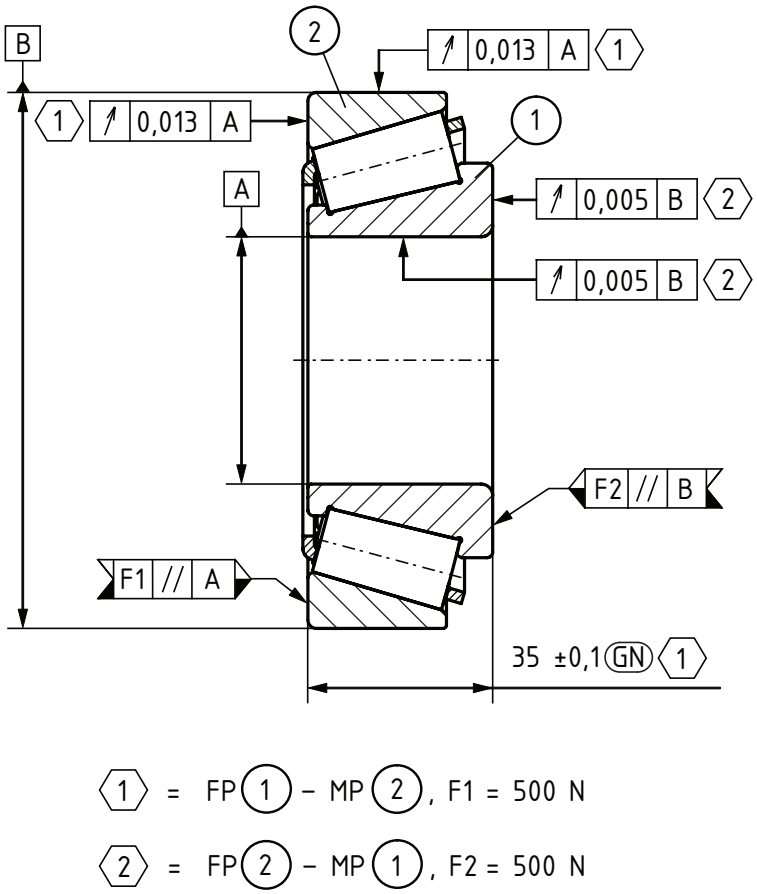


Figure B.1 — Example of run-out and size tolerances on a tapered roller bearing

Annex C
(informative)

Relation to the GPS matrix model

C.1 General

For full details about the GPS matrix model, see ISO/TR 14638.

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.

C.2 Information about this Technical Specification and its use

This Technical Specification specifies the indication of conditions in between the parts of movable assemblies in conjunction with geometrical tolerancing according to ISO GPS standards. On geometrical tolerancing, one part of the assembly includes tolerance indications and another part includes corresponding datum indications.

C.3 Position in the GPS matrix model

This Technical Specification is a global GPS standard, which influences chain links 1 to 3 of the chain of standards on size, distance, angle, form of line dependent on datum, form of surface dependent on datum, orientation, location, circular run-out, total run-out and datums in the GPS matrix, as illustrated in Table C.1.

Table C.1 — Fundamental and general ISO GPS standards matrix

		Global GPS standards						
		General GPS standards						
		Chain link number	**1**	**2**	**3**	**4**	**5**	**6**
Fundamental GPS standards		Size	•	•	•			
		Distance	•	•	•			
		Radius						
		Angle	•	•	•			
		Form of line independent of datum						
		Form of line dependent on datum	•	•	•			
		Orientation	•	•	•			
		Location	•	•	•			
		Circular run-out	•	•	•			
		Total run-out	•	•	•			
		Datums						
		Roughness profile						
		Waviness profile						
		Primary profile						
		Surface defects						
		Edges						

C.4 Related standards

The related standards are those of the chains of standards indicated in Table C.1.

Bibliography

[1] ISO/TR 14638, *Geometrical product specification (GPS) — Masterplan*

[2] ISO 3098-2, *Technical product documentation — Lettering — Part 2: Latin alphabet, numerals and marks*

[3] ISO 3098-5, *Technical product documentation — Lettering — Part 5: CAD lettering of the Latin alphabet, numerals and marks*

[4] ISO 5459:2011, *Geometrical product specifications (GPS) — Geometrical tolerancing — Datums and datum systems*

[5] ISO 8015:2011, *Geometrical product specifications (GPS) — Fundamentals — Concepts, principles and rules*

[6] ISO 14253-1:1998, *Geometrical Product Specifications (GPS) — Inspection by measurement of workpieces and measuring equipment — Part 1: Decision rules for proving conformance or non-conformance with specifications*

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