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Geometrical product specifications (GPS) — Association

Spécification géométrique des produits (GPS) — Association

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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).

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document is a geometrical product specifications (GPS) standard and is to be regarded as a general ISO GPS standard (see ISO 14638). It influences the chain links A, B, C, E, F and G in all chains of standards in the general GPS matrix.

The ISO GPS matrix plan 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 on the relationship of this document to other International Standards and to the GPS matrix model, see Annex C.

Geometrical product specifications (GPS) — Association

1 Scope

This document gives the terminology and basic concepts of association, including objective functions and association constraints and material offset.

This document is not intended to specify association defaults and GPS syntax which are introduced in other (ISO GPS) International Standards.

NOTE The association can be used to establish for example:

— a datum;

— a reference feature for a geometrical specification or for a surface texture specification;

— an associated toleranced feature;

— any dimensional characteristic;

— an intersection plane, an orientation plane, a collection plane or a direction feature.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their 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 17450-1, *Geometrical product specifications (GPS) — General concepts — Part 1: Model for geometrical specification and verification*

ISO 17450-4, *Geometrical product specifications (GPS) — Basic concepts — Part 4: Geometrical characteristics for quantifying GPS deviations*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17450-1 and ISO 17450-4 and the following apply.

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

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

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

3.1
association
feature operation used to fit one or more ideal features to one or more *input features* (3.2) according to an association criterion

Note 1 to entry: The definition has been adapted from the definition of ISO 17450-1, to consider the term input feature.

3.2
input feature
<association> portion of an associated feature or non-ideal feature, which is an extracted feature or a real feature, which can be filtered or not

3.3
associated feature
ideal feature which is fitted to an *input feature* (3.2) with a specific *association criterion* (3.5)

Note 1 to entry: An ideal feature is defined by a mathematical description using a finite set of real numbers called description parameters (see EXAMPLE below).

Note 2 to entry: An associated feature can be a feature of size. In this case, it is possible to use the term associated feature of size.

EXAMPLE An extruded surface having as directrix an ellipse, can be described by the formula "$a \cdot (x-c)^2 + b (y-d)^2 = 1, \forall z$" (with description parameter *a, b, c* and *d* with *a* non-equal to *b*). It describes the points (having as coordinate *x*, *y* and *z*, in a local cartesian coordinate system) of an ideal feature which belongs to the prismatic invariance class (prismatic surface with an elliptic base).

3.4
restricted associated feature
set of points of an *associated feature* (3.3), where local geometrical deviations with the *input feature* (3.2) exist

3.5
association criterion
objective function (3.6) with or without *association constraints* (3.9), and with or without material offset, defined for an association

Note 1 to entry: Several association constraints may be used for one association.

Note 2 to entry: Association results (associated features) can differ, depending upon the choice of association criterion.

3.6
objective function
optimization function
<association> formula that describes the goal of association from the *input feature* (3.2) and the ideal feature [*associated feature* (3.3)]

3.7
L-function
objective function (3.6) defined from the set of the signed local geometrical deviations between an *input feature* (3.2) and the *associated feature* (3.3)

Note 1 to entry: The local geometrical deviations are defined in ISO 17450-4, with the convention sign based on the material boundary defined from the ideal geometry.

3.8
S-function
objective function (3.6) based on the size of the associated feature of size

Note 1 to entry: The maximum inscribed feature and the minimum circumscribed feature are associated feature obtained with S-function.

3.9
association constraint
set of restrictions on variability of the mathematical parameters describing an *associated feature* (3.3) in the optimization process.

EXAMPLE Orientation constraint, location constraint, material constraint or size constraint are the different types of association constraint.

3.10
orientation constraint
association constraint (3.9) related to one or more rotational degrees of freedom of *associated feature* (3.3)

3.11
location constraint
association constraint (3.9) related to one or more translational degrees of freedom of *associated feature* (3.3)

3.12
material constraint
association constraint (3.9) on the *associated feature* (3.3), in relation to the material boundary of the *input feature* (3.2)

EXAMPLE The outside material constraint implies that all distances between the associated feature and the input feature are positive or equal to zero.

3.13
size constraint
association constraint (3.9) on the size of *associated feature* (3.3)

Note 1 to entry: Without size constraint, the size of associated feature is variable for the association.

4 Association specification elements description of association process

The association operation is an optimization process intended to fit an ideal feature with a predefined geometry to an input feature or to fit a collection of ideal features to predefined geometries to a collection of input features. The input feature for this optimization process is a geometrical feature (portion of an associated feature, an extracted feature or a real feature, which can be filtered or not).

To perform this optimization process, an association objective function shall be specified without or with association constraints. After this step of optimization, an offset step can be optionally performed (see Figure 1).

An associated feature or a collection of associated features is thus defined from which it is possible to specify the set of one or more situation features (allowing the situation in the space of this associated feature or this collection of associated features).

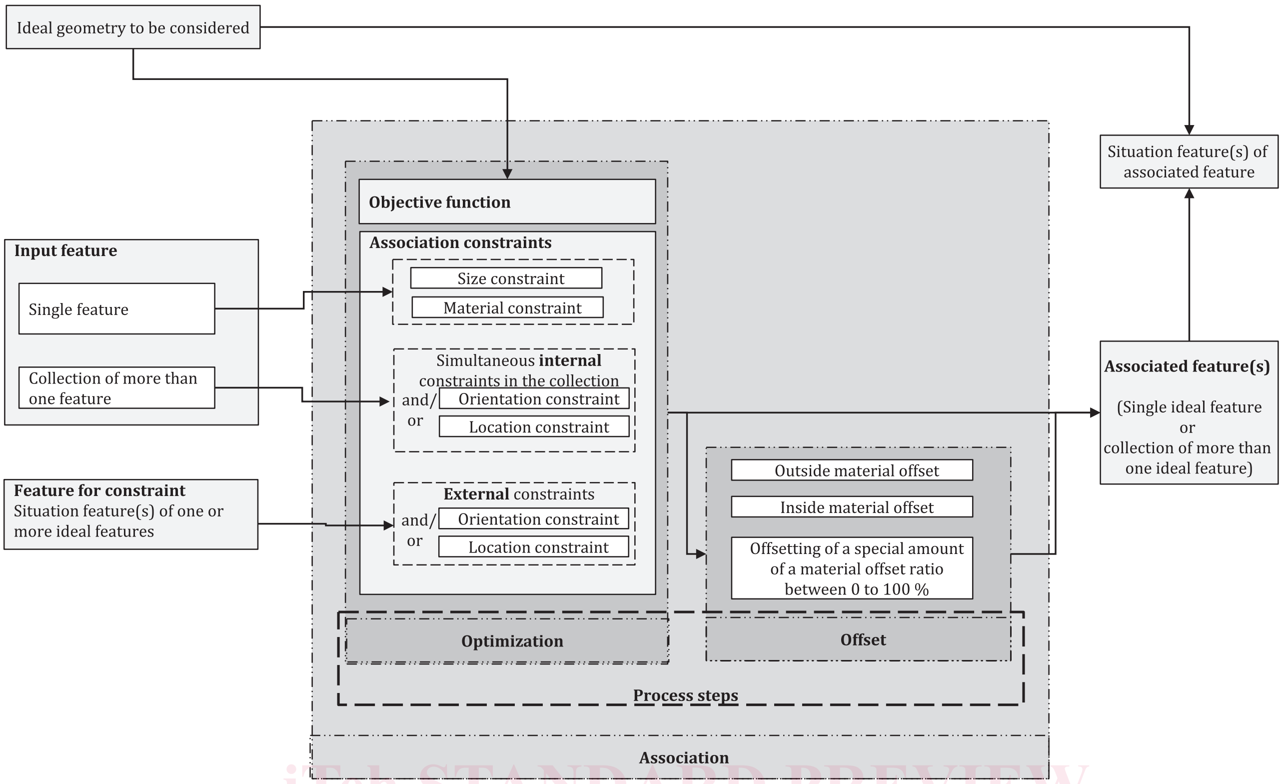


Figure 1 — Concept diagram illustrating the association process

If associations are performed on more than one non-ideal single features (input features), then the associations can be made:

— Independently.

— Simultaneously, i.e. the collection of associated features is established simultaneously with location constraints (if applicable) and orientation constraints (if applicable) between them. Those are internal constraints in the collection of the ideal features (to be associated).

— In a specific order, i.e. the associated feature of the rank n+1 is established with location constraints (if specified) and orientation constraints (if specified) related to the situation feature(s) of the associated feature(s) of rank 1 to n. Those are external constraints of ideal feature(s) of rank n+1 from associated feature(s) of rank n.

5 Association criterion

5.1 General

An association criterion specifies an optimization process combining an objective function and association constraints followed optionally followed by a material offset.

The objective function shall be specified from an S-function or an L-function:

— the first one, by maximizing or minimizing the size of the associated feature of size, by considering no association constraint or one or more association constraints but without size constraint;

— the second one, through an optimization of a function of the set of signed local geometrical deviations with or without association constraint.

The local geometrical deviations are established between the points on the input feature and the corresponding points on the associated feature. This set of the points defines a restricted associated feature. The restricted associated feature can be an enclosing feature or non-enclosing feature (see Annex A).

5.2 Objective function description

An (mathematical) objective function is described from the size of associated feature, *S*, and/or from the (signed) local geometrical deviations, D_F, between an input feature and an ideal feature. The optimization of this objective function defines the final result (final ideal feature) of the association, which is the associated feature.

NOTE 1 When the input feature is a derived feature, the local geometrical deviations, D_F, are not signed: no material constraint is applied.

The result of this optimization is the associated feature (see Table 1).

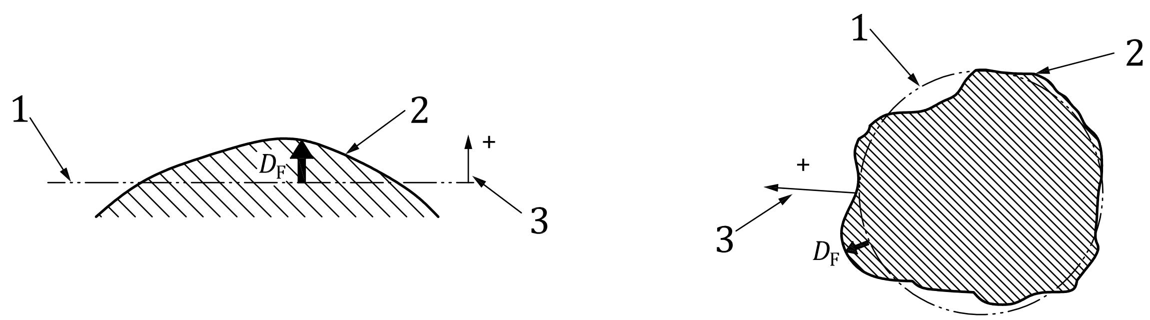
To establish a material constraint, the sign convention is established in relation with the material, see Figure 2. The local geometrical deviations, between a point of the non-ideal single feature and the associated feature, is positive when the deviation direction from a point on the associated feature to its homologous point on the input feature goes to the direction outside of material from the associated feature.

The implications of this sign convention for S-function (i.e. maximum inscribed, or minimum circumscribed) are illustrated in Figure 3.

When the associated feature is considered as a feature of size and the restricted associated feature is a non-enclosing feature, the maximum inscribed or minimum circumscribed association criteria should not be applied considering the risk to create an association result, which does not represent the intent.

When the extend of the restricted associated feature is smaller or close to its size, the minimum circumscribed objective function should be performed with orientation constraint, from a datum considering the risk to enlarge uncertainty contributor related to the association.

For one input feature, the application of a same set of association constraints with different objective function generally results in different associated features.



a) On a non-enclosing feature **b) On an enclosing feature**

Key

1 associated feature

2 input feature

3 conventional positive direction for D_F

D_F signed local geometrical deviation between a point of 2 and 1

Figure 2 — Conventional positive direction for D_F