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Cutting tool data representation and exchange —

Part 306: Creation and exchange of 3D models — Drills and countersinking tools for indexable inserts

Représentation et échange des données relatives aux outils coupants —

Partie 306: Création et échange des modèles 3D — Forets et outils à chanfreiner et à lamer à plaquettes amovibles

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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 of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 29, *Small tools*.

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.

A list of all parts in the ISO 13399 series can be found on the ISO website.

Introduction

This document defines the concept of how to design simplified 3D models of drills and countersinking tools for indexable inserts, that can be used for NC-programming, simulation of the manufacturing processes and the determination of collision within machining processes. It is not intended to standardize the design of the cutting tool itself.

A cutting tool is used in a machine to remove material from a workpiece by a shearing action at the cutting edges of the tool. Cutting tool data that can be described by the ISO 13399 series include, but are not limited to, everything between the workpiece and the machine tool. Information about inserts, solid tools, assembled tools, adaptors, components and their relationships can be represented by this document. The increasing demand providing the end user with 3D models for the purposes defined above is the basis for the development of the ISO 13399 series.

The objective of the ISO 13399 series is to provide the means to represent the information that describes cutting tools in a computer sensible form that is independent from any particular computer system. The representation will facilitate the processing and exchange of cutting tool data within and between different software systems and computer platforms and support the application of this data in manufacturing planning, cutting operations and the supply of tools. The nature of this description makes it suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases and for archiving. The methods that are used for these representations are those developed by ISO/TC 184, *Automation systems and integration*, SC 4 *Industrial data,* for the representation of product data by using standardized information models and reference dictionaries.

Definitions and identifications of dictionary entries are defined by means of standard data that consist of instances of the EXPRESS entity data types defined in the common dictionary schema, resulting from a joint effort between ISO/TC 184/SC 4 and IEC/TC 3/SC 3D *Product properties and classes and their identification*, and in its extensions defined in ISO 13584-24 and ISO 13584-25.

Cutting tool data representation and exchange —

Part 306:
Creation and exchange of 3D models — Drills and countersinking tools for indexable inserts

1 Scope

This document specifies a concept for the design of tool items, limited to any kind drilling and countersinking tools for indexable inserts, together with the usage of the related properties and domains of values.

This document specifies the requirements of simplified 3D models for data exchange of drills and countersinking tools for indexable inserts.

The following are outside the scope of this document:

— applications where these standard data may be stored or referenced;

— concept of 3D models for cutting tools;

— concept of 3D models for cutting items;

— concept of 3D models for other tool items not being described in the scope of this document;

— concept of 3D models for adaptive items;

— concept of 3D models for assembly items and auxiliary items.

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/TS 13399-50, *Cutting tool data representation and exchange — Part 50: Reference dictionary for reference systems and common concepts*

ISO/TS 13399-80, *Cutting tool data representation and exchange — Part 80: Creation and exchange of 3D models — Overview and principles*

ISO/TS 13399-201, *Cutting tool data representation and exchange — Part 201: Creation and exchange of 3D models — Regular inserts*

3 Terms and definitions

No terms and definitions are listed in this document.

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

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

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

4 Starting elements, coordinate systems, planes

4.1 General

The modelling of 3D models shall be done by means of nominal dimensions. Some examples of nominal dimensions are given in Annex A. Deviations within the tolerances are allowed.

WARNING — There is no guarantee that the 3D model, created according to the methods described in this document, is a true representation of the physical tool supplied by the tool manufacturer. If the models are used for simulation purposes — e.g. CAM simulation — it shall be taken into consideration that the real product dimensions can differ from those nominal dimensions.

NOTE Some of the definitions have been taken from ISO/TS 13399-50.

4.2 Reference system (PCS — Primary coordinate system)

The reference system consists of the following standard elements as shown in Figure 1:

— **standard coordinate system:** right-handed rectangular Cartesian system in three-dimensional space, called "primary coordinate system" (PCS);

— **3 orthogonal planes**: planes in the coordinate system that contain the axis of the system, named "xy-plane" (XYP), "xz-plane" (XZP) and "yz-plane" (YZP);

— **3 orthogonal axis:** axes built as intersections of the 3 orthogonal planes lines respectively, named "x-axis" (XA), "y-axis" (YA) and "z-axis" (ZA).

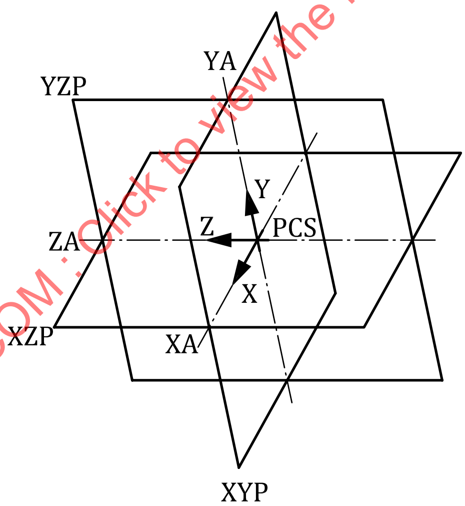


Figure 1 — Reference system

For virtually mounting of drilling and countersinking tools onto an adaptive item an additional reference system has to be defined. This reference system, called "mounting coordinate system" (MCS), shall be located at the starting point of the protruding length of a tool item. The orientation is shown in Figure 2.

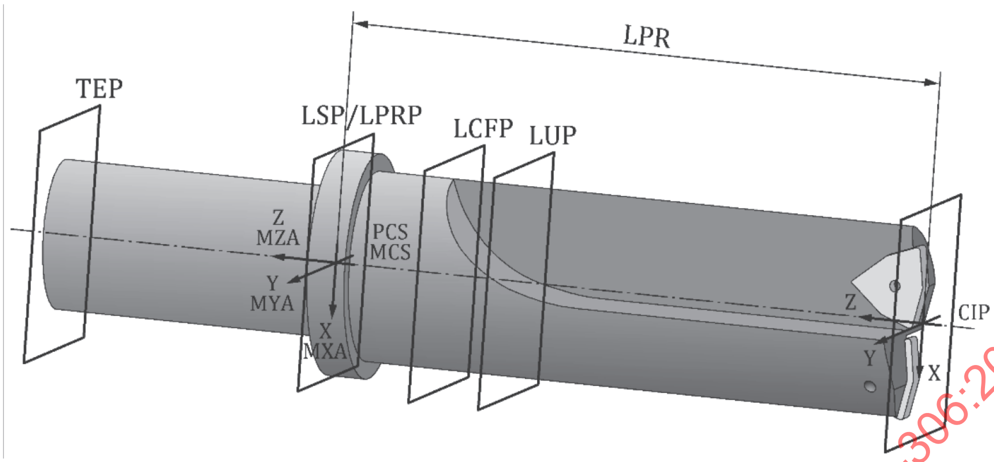


Figure 2 — Example of orientation of "PCS" and "MCS" reference system

4.3 Coordinate system at the cutting part

The coordinate system at the cutting part, named "coordinate system in process" (CIP) — with a defined distance to the PCS shall be oriented as shown in Figure 3:

- The origin is on a plane that is parallel to the XY-pane of PCS and is located on the most front cutting point;
- z-axis of CIP points to the PCS;
- z-axis of CIP is collinear to the z-axis of PCS;
- y-axis of CIP is parallel to the y-axis of PCS.

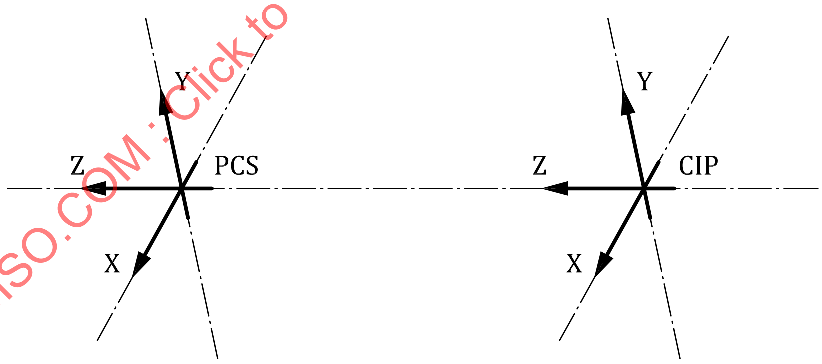


Figure 3 — Orientation of CIP

4.4 Planes

The modelling shall take place based on planes according to Figure 4, which is used as reference, if applicable. Therefore, it is assured to be able to vary the model or to suppress single features of independent design features by means of changing the value of one or more parameter of the model design. Furthermore, the identification of the different areas is simplified in using the plane concept, even if they contact each other with the same size; e.g. chip flute, shank, and so on.

For the 3D visualization of drilling and countersinking tools for indexable inserts, the general planes shall be determined according to the following (see Figure 4):

— "TEP" the tool end plane is located at that end of the connection that points away from the workpiece – if the tool does not have a contact surface and/or a gauge line the TEP is coplanar with the XY-plane of the PCS;

— "OALP" overall length plane located with the distance of "OAL" from "TEP";

— "PLP" point length plane reference to "OALP" with distance of "PL";

— "LCFP" chip flute length plane references to "OALP" with distance of "LCF";

— "LSP" shank length plane referenced to "TEP" with distance of "LS" — only applicable if the connection is a kind of cylindrical shank;

— "LUP" usable length plane referenced to "OALP" with distance of "LU".

Other planes, if necessary shall be defined in the appropriate clauses.

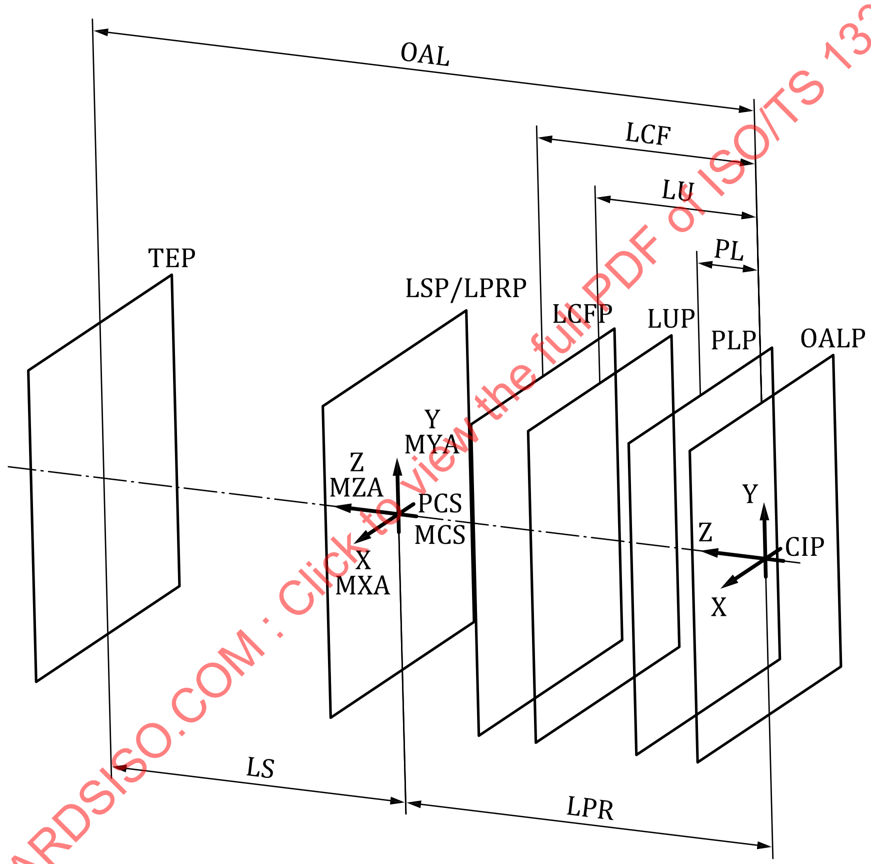


Figure 4 — Planes for design

4.5 Adjustment coordinate system on workpiece side

4.5.1 General

Additional coordinate systems for mounting components "CSWx_y" (coordinate system workpiece side) shall be defined according to ISO/TS 13399-50.

4.5.2 Designation of the coordinate system workpiece side

The designation of the coordinate system workpiece side is given in ISO/TS 13399-80:2017, 5.2.2.

5 Design of the model

5.1 General

The design of the model shall be according to ISO/TS 13399-80.

5.2 Necessary properties for inserts

5.2.1 General

Necessary properties for the design of the pocket seat features shall be taken in accordance of the defined properties for cutting items (see ISO/TS 13399-2). To be able to differentiate between tool-item and cutting-item properties, a postfix shall be added to the preferred symbols of the cutting-item properties. The postfix has the same code and sequence as the different coordinate systems on workpiece side that are defined in 4.5.

5.2.2 Properties for equilateral, equiangular and equilateral, non-equiangular inserts

Equilateral and equiangular inserts are:

— H — hexagonal insert;

— O — octagonal insert;

— P — pentagonal insert;

— S — square insert;

— T — triangular insert.

Equilateral and non-equiangular inserts are:

— C, D, E, M, V — rhombic insert;

— W — trigon insert.

Table 1 lists the properties for regular inserts with inscribed circle.

Table 1 — Properties for modelling equilateral, equiangular and equilateral, non-equiangular pocket seats

Preferred name	Preferred symbol
Clearance angle major	AN
Insert included angle	EPSR
Insert included angle minor	EPSRN
Inscribed circle diameter	IC
Cutting edge length[a]	L[a]
Corner radius	RE
Corner radius minor	REN
Insert thickness	S

[a] Shall be calculated. It is dependent on IC and EPSR.

5.2.3 Properties for non-equilateral, equiangular and non-equilateral, non-equiangular inserts

Non-equilateral and equiangular inserts are:

— L — rectangular insert.

Non-equilateral and non-equiangular inserts are:

— A, B, K — parallelogram-shaped insert.

Table 2 lists the properties for regular inserts of rectangular and parallelogram shape.

Table 2 — Properties for modelling non-equilateral, equiangular and non-equilateral, non-equiangular pocket seats

Preferred name	Preferred symbol
Clearance angle major	AN
Clearance angle minor	ANN
Insert included angle	EPSR
Insert length	INSL
Corner radius	RE
Corner radius minor	REN
Insert thickness	S
Insert width	W1
Cutting edge length[a]	L[a]

[a] Shall be calculated. it is dependent on INSL and EPSR.

5.2.4 Design of the pocket seat feature

The design shall be done in accordance with ISO/TS 13399-201, but without any corner configuration on the opposite side where the functional dimensions are based.

6 Twist drill for indexable inserts (ISYC 306-01)

6.1 General

Figure 5 shows the properties to be used for the design of a twist drill.

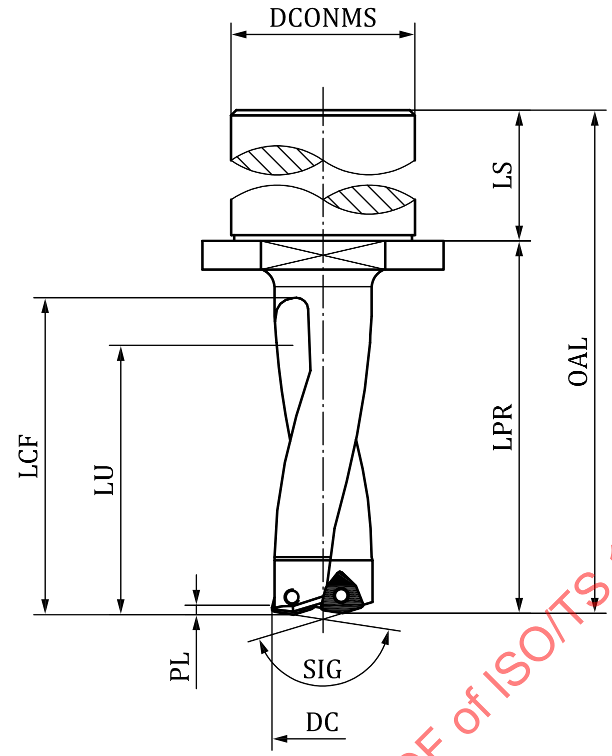


Figure 5 — Determination of properties of twist drill for indexable inserts

6.2 Necessary properties

Table 3 lists the properties being needed for the modelling of twist drills.

Table 3 — Properties for the modelling of a twist drill

Preferred name	Preferred symbol
Body diameter	BD
Cutting diameter	DC
Flange diameter	DF
Shank diameter	DCONMS
Flange thickness	FLGT
Protruding length	LPR
Shank length	LS
Usable length	LU
Overall length	OAL
Offset chip flute inner pocket	OFFCFIN
Offset chip flute outer pocket	OFFCFEX
Chip flute length	LCF
Point length	PL
Chip flute radius	RCF
Point angle	SIG

6.3 Basic geometry

A rotational design feature contains all elements between the plane "TEP" and the separation plane "CIP" to the cutting part.

The sketch (outline contour) shall include all the elements above and it shall be designed on the XZ plane of the "PCS". The rotational axis is the standard z-axis.

Design of the sketch:

— the sketch shall be determined as a half section;

— the sketch shall be constrained to the coordinate system "PCS" and to the planes "TEP" and "CIP". If the CAD software does not support the use of datum planes, the sketch shall be fully dimensioned otherwise the distances shall be in conjunction with the defined datum planes;

— the dimensioning shall be done with the appropriate properties listed in Table 1.

The sketch shall be revolved about the Z-axis by 360 ° as the basic geometry is shown in Figure 6.

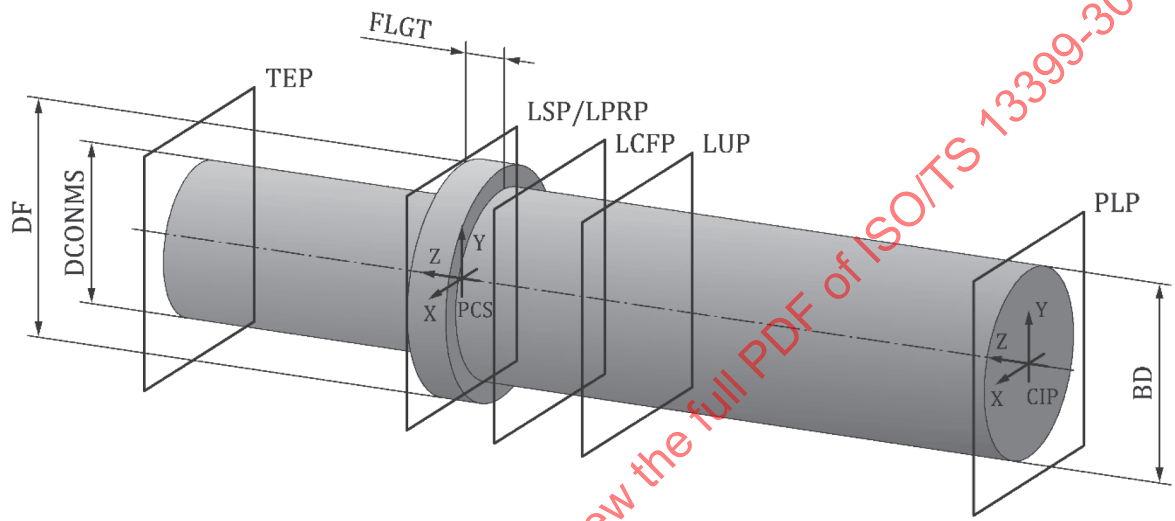


Figure 6 — Basic geometry of a twist drill

6.4 Determination of the position of the mounting coordinate system of insert

A coordinate system workpiece side and the corresponding planes shall be determined for each insert in accordance with their definitions in ISO/TS 13399-50.

The coordinate systems "CSWx_y" shall be referenced to "PCS". As illustrated in Figure 7, the position is determined through:

— the dimensions DC, LF;

— the geometry of the insert;

— the cutting reference point.

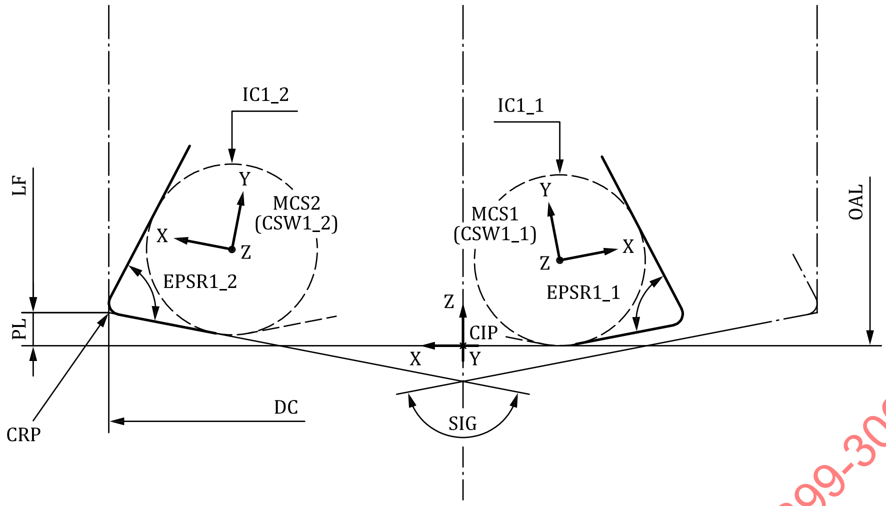


Figure 7 — Determination of CSWx_y for a twist drill

For the determination of the CSW's, Figure 8 illustrates the location of the CSW's in relation to PCS:

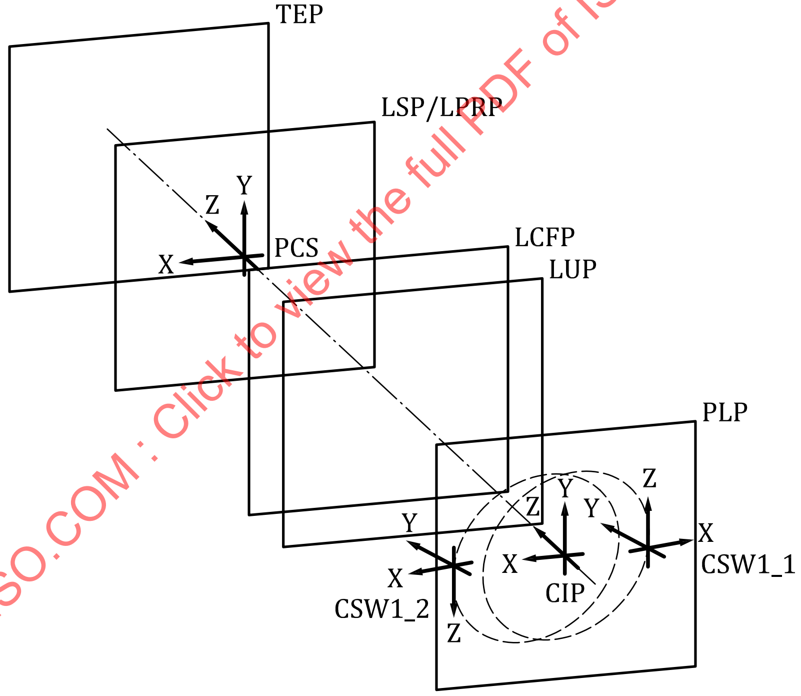


Figure 8 — Location of CSW's for a twist drill

6.5 Chip flute and pocket seat

The chip flute shall be designed as solid body for subtraction from the tool body. The sketch of the chip flute shall be referenced to the XZ-plane of PCS and to CIP.

After the chip flute body is positioned to its final location, it shall be subtracted from the tool body as shown in Figure 9. Generally, the chip flute of the inside and outside inserts is designed the same.

To be able to position the inside pocket seat across the tool axis, an additional feature shall be subtracted from the tool body to enable clearance for the pocket seat.

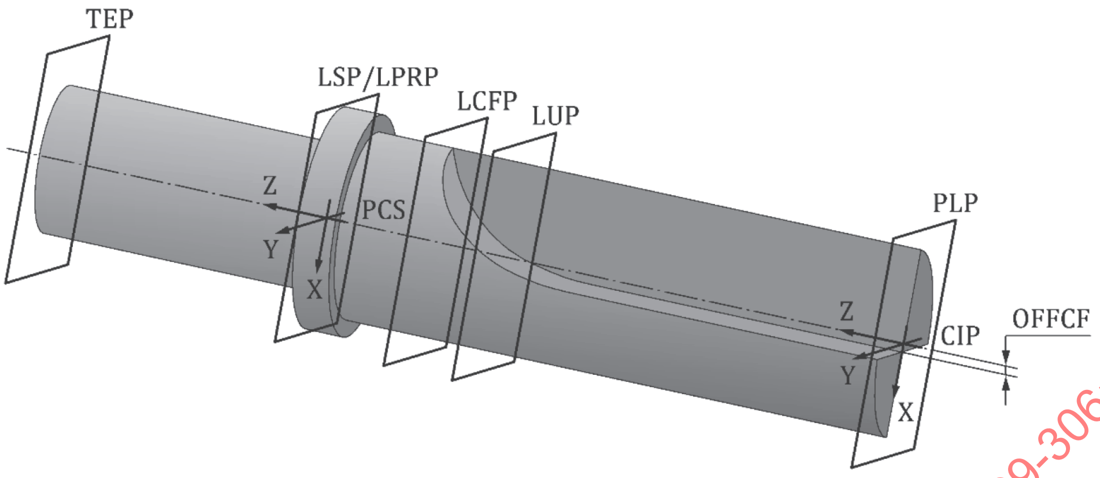


Figure 9 — Chip flute of a twist drill

To position the pocket seat features, the CRP shall be the reference with the dependency between CRP and CSWx_y. The pocket seat model according to the used insert shall be transformed to its final position and subtracted from the tool body. Figure 10 and Figure 11 show the dependency of inner and outer pocket seat.

To center the drill, the inside pocket seat shall be positioned in relation to the outside pocket seat in front of the outside insert in the -Z-direction.

The orientation of the inside insert shall be different from the outside insert.

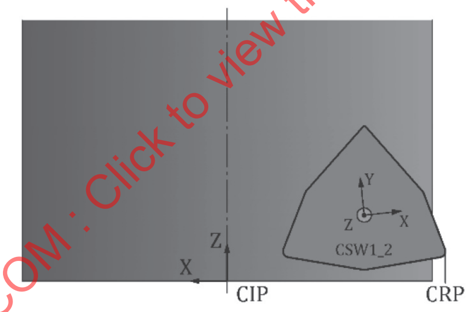


Figure 10 — Outside pocket seat

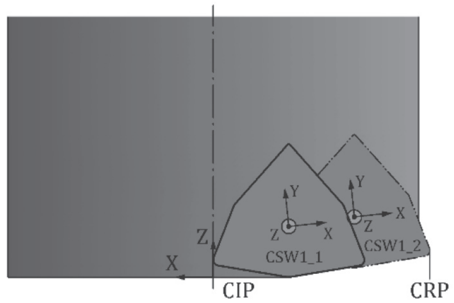


Figure 11 — Inside pocket seat

The contour beyond the inserts shall be calculated according to Formula (1) as a function of insert cutting edge height and clearance angle major.

$$d = S \times tan\left(AN\right) + o \tag{1}$$

where

d	is the distance, in mm;
S	is the insert thickness, in mm;
tan (AN)	is the tangent of the clearance angle major, in degrees;
o	is the offset, in mm.

Figure 12 illustrates the distances of the contour in relation to the inside and outside insert.

NOTE The value of the offset is in the range of 0,2 mm to 0,5 mm.

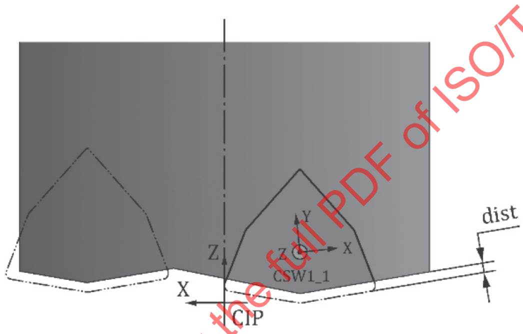


Figure 12 — Front contour

6.6 Twist drill assembly

Figure 13 shows the complete body of the twist drill.

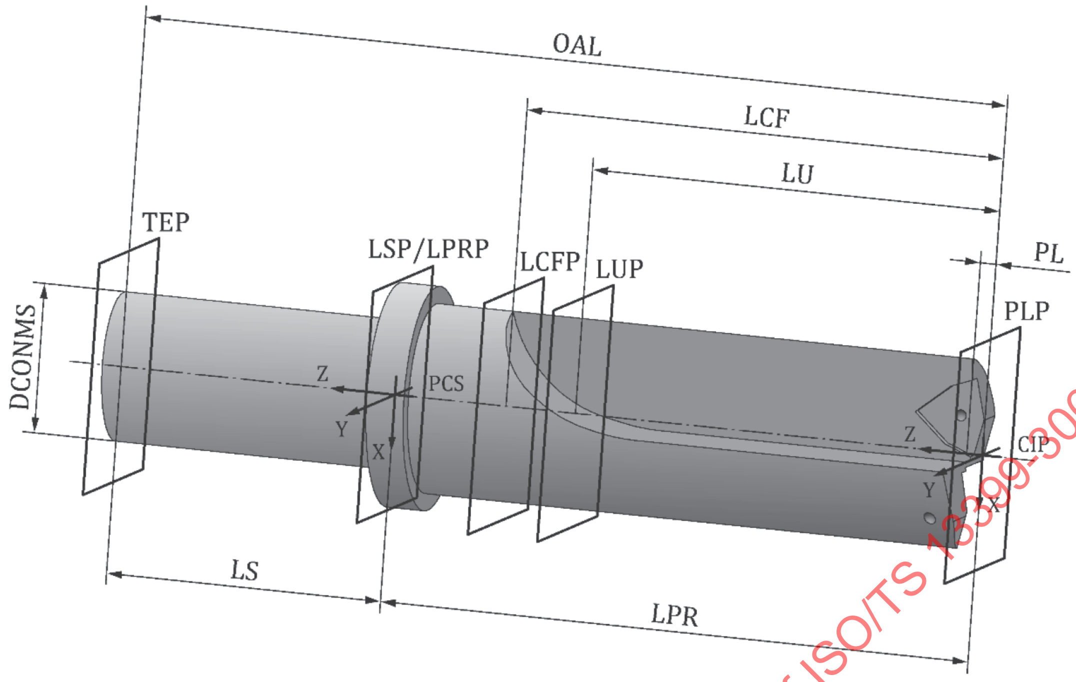


Figure 13 — Twist drill: complete body

For the assembly of the drill with inserts, the defined coordinate systems workpiece side "CSW1_1" and "CSW1_2" shall be used. Here, the mounting coordinate system of the insert (MCS_INSERT) shall be mated onto the corresponding "CSWx_y".

The position of the inserts shall be defined only with these mating procedures as illustrated in Figure 14 and Figure 15.

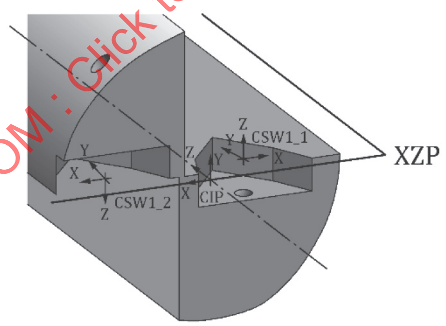


Figure 14 — Position of CSWx_y

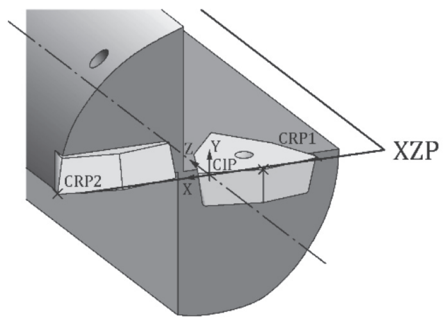


Figure 15 — Position of CRP's

Figure 16 shows an example the assembled twist drill with inserts.

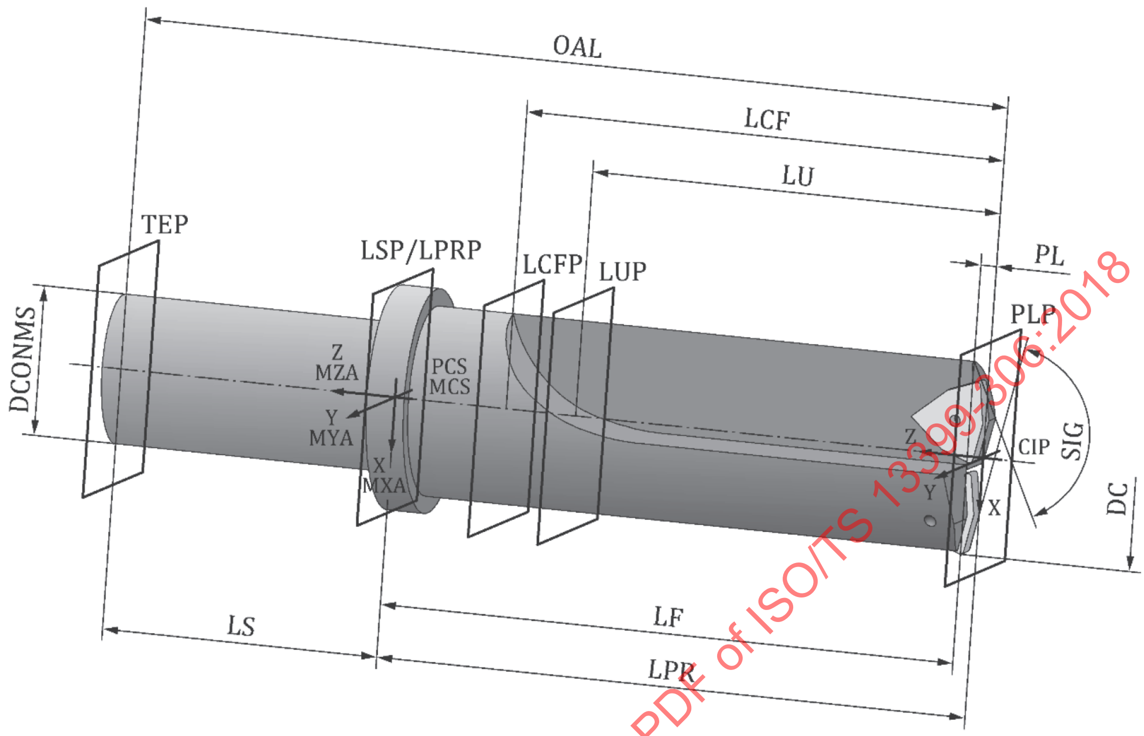


Figure 16 — Example of assembled twist drill

7 Step drill (ISYC: 306-02)

7.1 General

Figure 17 shows the properties to be used for the design of a step drill.

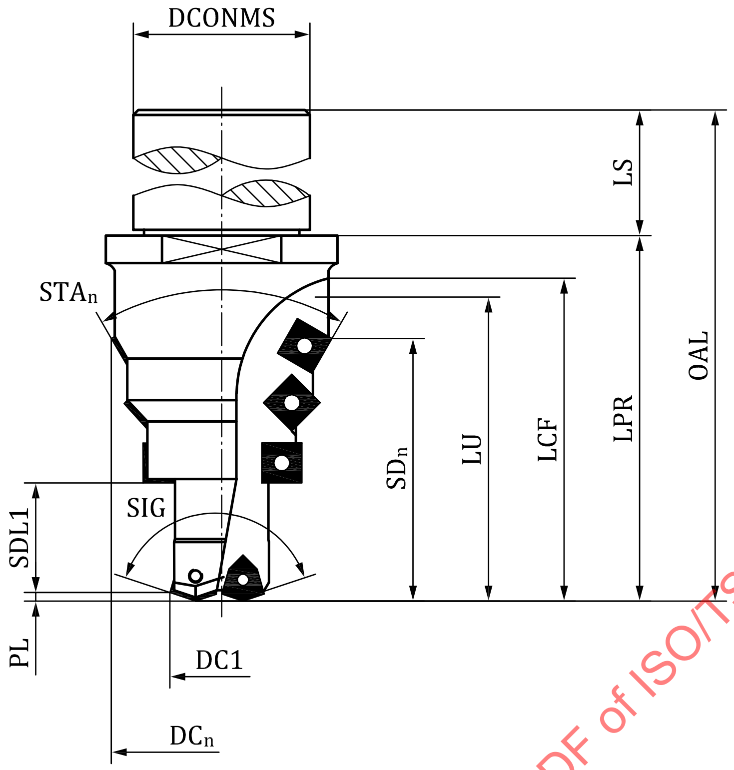


Figure 17 — Determination of properties of step drill for indexable inserts

7.2 Necessary properties

All necessary properties for the example of a step drill with 4 steps are listed in Table 4. The properties describing the appropriate cutting diameter shall be indexed by means of the ordinal number of the step. The ordinal number shall start with the cutting diameter closest to the workpiece, but excluding any plug chamfer diameter.

Table 4 — Properties for the modelling of a step drill

Preferred name	Preferred symbol
Body diameter, cutting step 1	BD_1
Body diameter, cutting step 2	BD_2
Body diameter, cutting step 3	BD_3
Body diameter, cutting step 4	BD_4
Cutting diameter, cutting step 1	DC_1
Cutting diameter, cutting step 2	DC_2
Cutting diameter, cutting step 3	DC_3
Cutting diameter, cutting step 4	DC_4
Flange diameter	DF
Shank diameter	DCONMS
Flange thickness	FLGT
Chip flute length	LCF
Protruding length	LPR
Shank length	LS
Usable length	LU
Overall length	OAL

Table 4 *(continued)*

Preferred name	Preferred symbol
Offset chip flute inner pocket	OFFCFIN
Offset chip flute outer pocket	OFFCFEX
Step count	NOS
Point length	PL
Chip flute radius	RCF
Step diameter length, cutting step 1	SDL_1
Step diameter length, cutting step 2	SDL_2
Step diameter length, cutting step 3	SDL_3
Step distance, cutting step 2	SD_2
Step distance, cutting step 3	SD_3
Step distance, cutting step 4	SD_4
Point angle	SIG
Step included angle, cutting step 2	STA_2
Step included angle, cutting step 3	STA_3
Step included angle, cutting step 4	STA_4

7.3 Basic geometry

The structure of the model shall be in accordance with Figure 6 and Figure 18.

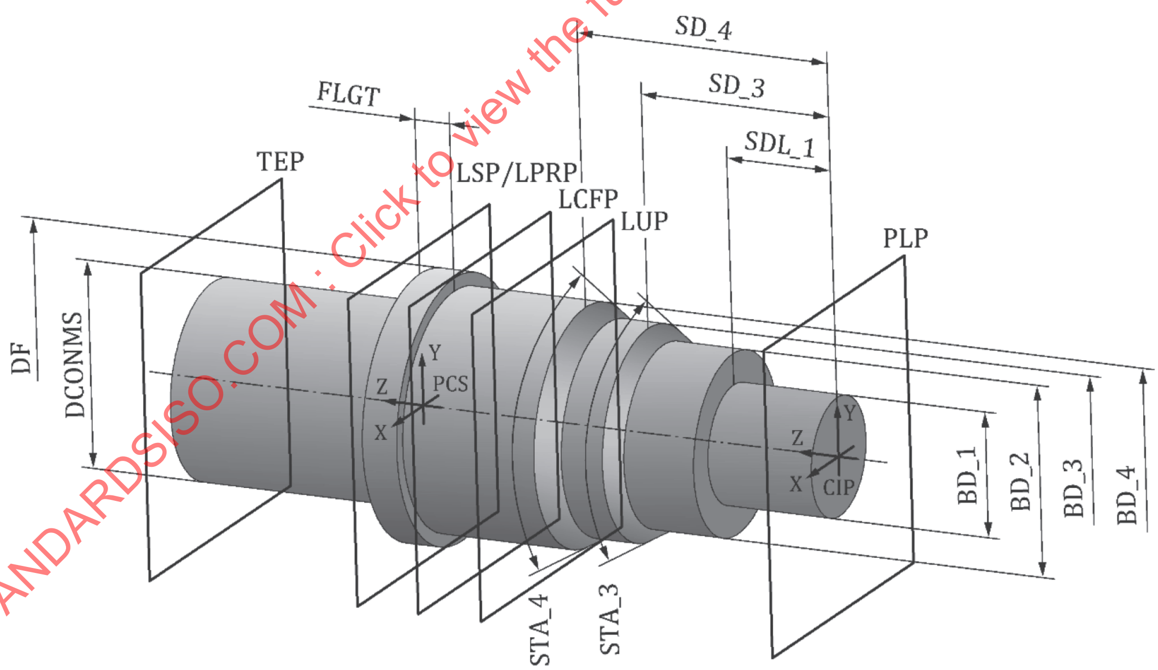


Figure 18 — Basic geometry of a step drill

NOTE The dimensions shown in Figure 18 are always related to the insert used in the appropriate cutting step. As described in 6.5 (after Figure 11), the contour of the basic body is determined as a function of the parameters of the insert.

7.4 Determination of the position of the mounting coordinate system of insert

See 6.4 for the definition of the position of the CSW's. For the first cutting step, it is recommended to use the same definitions of CSW's as in 6.4.

The remaining inserts shall be positioned in the same way as described in 6.4, but referenced to their functional dimensions given with their properties DC_x, SD_x, SDL_x.

See Figure 19 for the determination of the location of pocket seats.

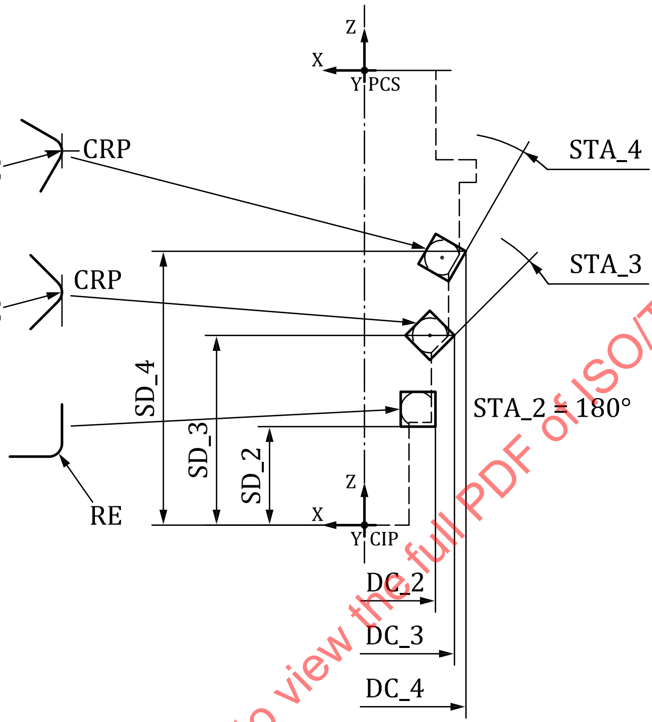


Figure 19 — Determination of the location of CSWx_y of a step drill

According to Figure 19, the CSW1_1 to CSW4_2 shall be determined as shown in Figure 20.

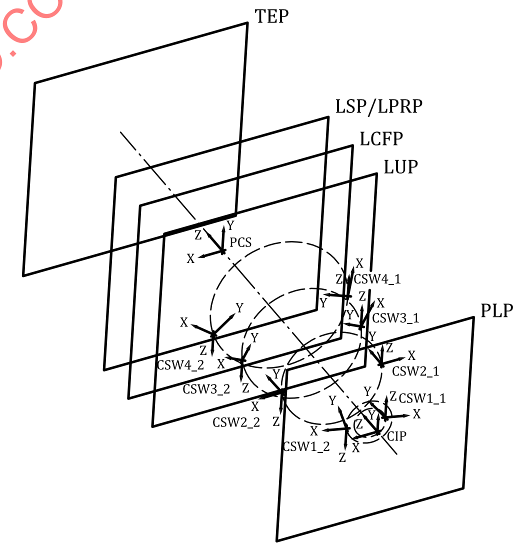


Figure 20 — Determination of coordinate systems of inserts

7.5 Chip flute and pocket seat

See 6.5 for the modelling of the chip flute and the pocket seat. The specifications of the pocket seat and its location on first step shall also be valid for the following steps.

The chip flute of step drills shall be designed as simplified like on twist drills (see Figure 21).

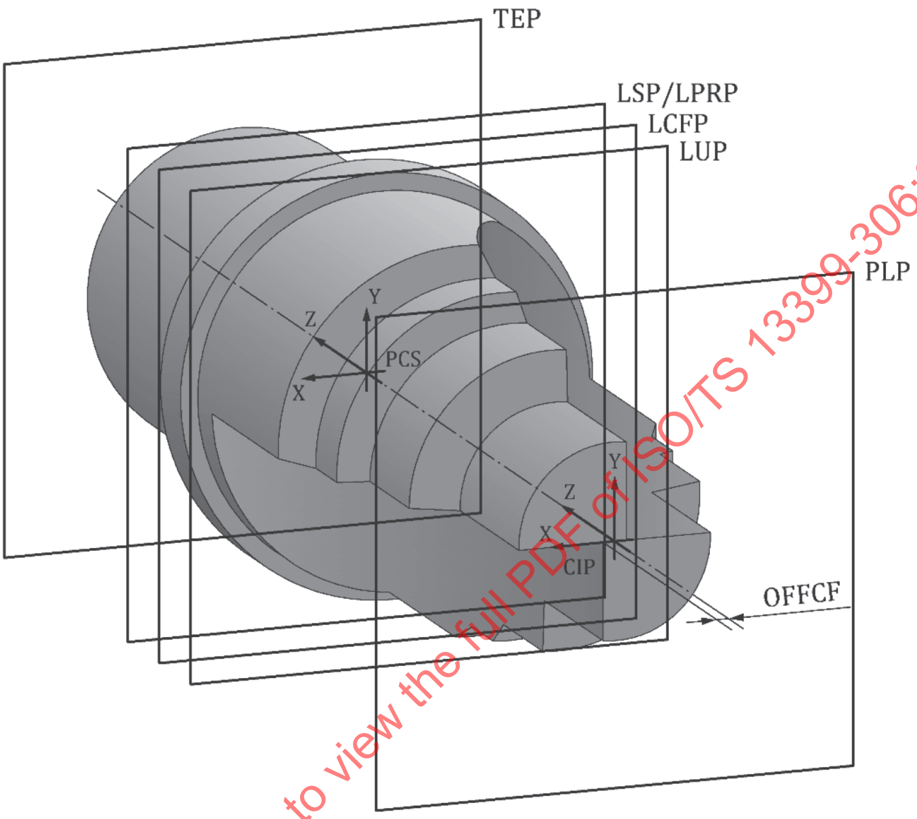


Figure 21 — Step drill: chip flute

The inserts at the front of the step drill shall be designed and positioned as done on twist drills – see Figure 10 to Figure 12. Pocket seats at the other steps shall contain also the mounting coordinate system CSWx_y and the corresponding cutting reference point as reference and shall be modelled as given in the schema shown in Figure 22.

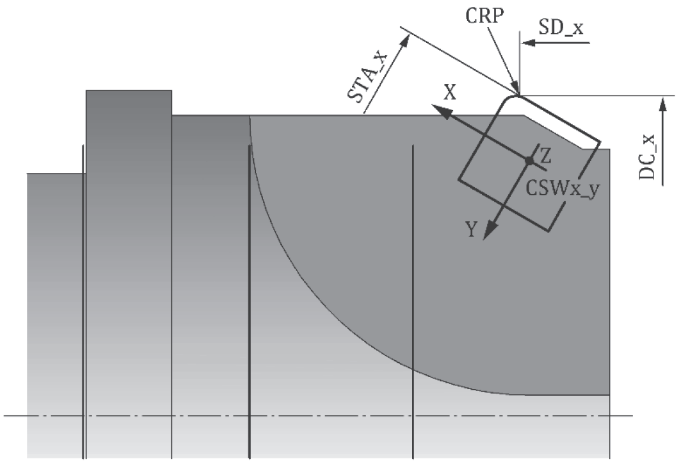


Figure 22 — Pocket seat position of a step drill

The offset of the tool body shall be calculated as described in 6.5.

7.6 Step drill assembly

See 6.6 for the modelling and assembly. Figure 23 shows the different position of CSW's and Figure 24 shows the corresponding CRP's, while Figure 25 shows the assembled step drill.

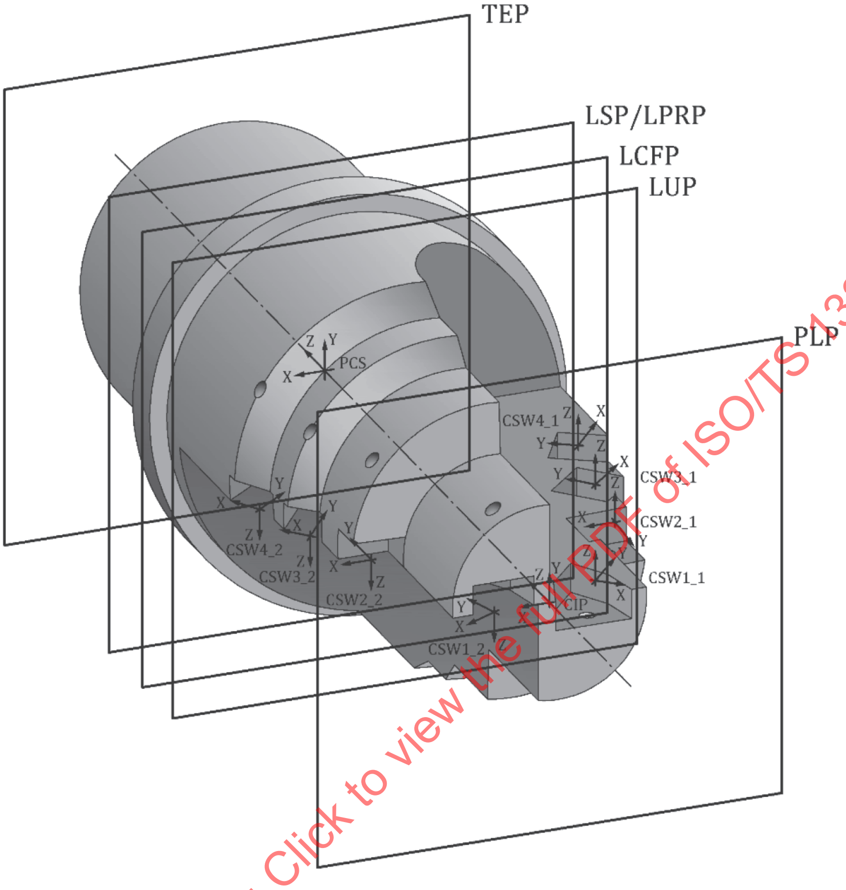


Figure 23 — Positions of nCSW's of a step drill

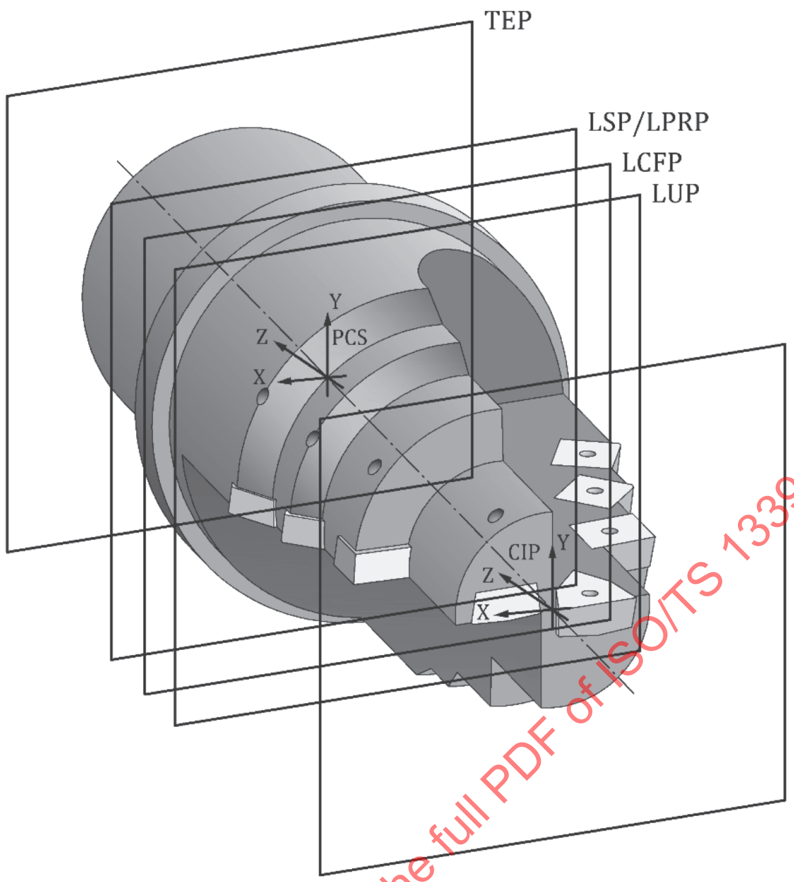


Figure 24 — Position of CRP's on a step drill

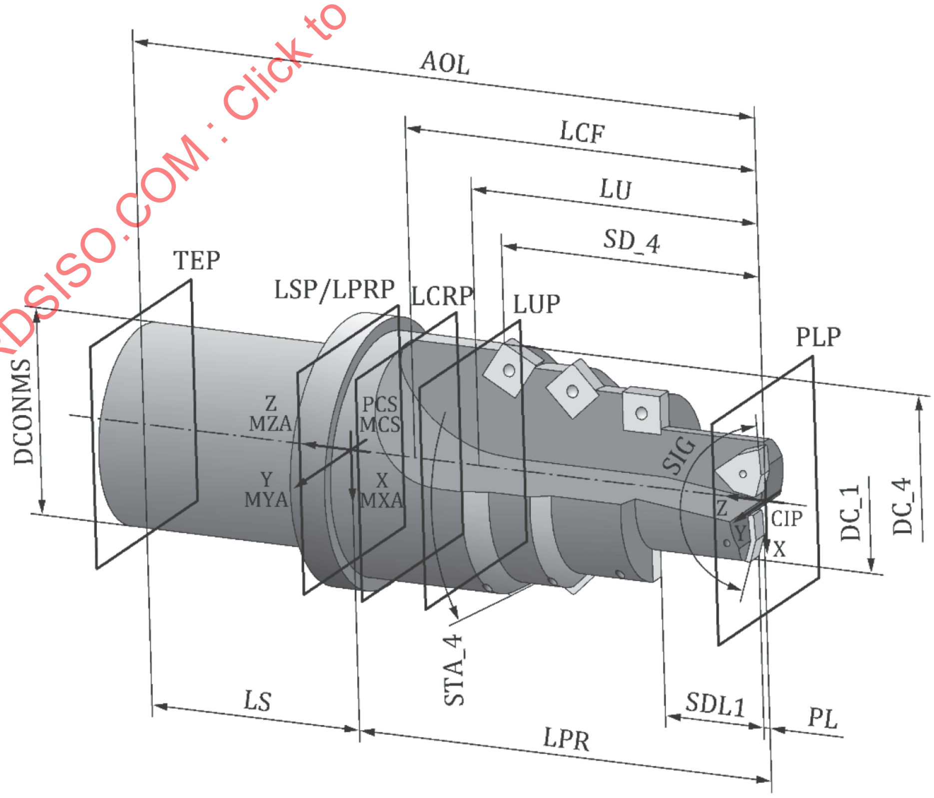


Figure 25 — Completely assembled step drill

8 Core drill (ISYC: 306-03)

8.1 General

Figure 26 shows the properties to be used for the design of a core drill.

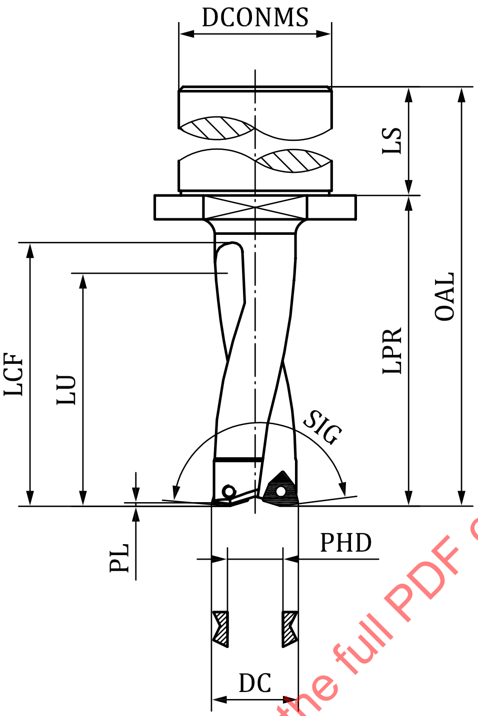


Figure 26 — Determination of properties of a core drill for indexable inserts

8.2 Necessary properties

Table 5 lists the properties being needed for the modelling of core drills.

Table 5 — Properties for the modelling of a core drill

Preferred name	Preferred symbol
Body diameter	BD
Cutting diameter	DC
Flange diameter	DF
Shank diameter	DCONMS
Flange thickness	FLGT
Protruding length	LPR
Shank length	LS
Usable length	LU
Overall length	OAL
Offset chip flute outer pocket	OFFCFEX
Chip flute length	LCF
Premachined hole diameter	PHD
Point length	PL
Chip flute radius	RCF
Point angle	SIG

8.3 Basic geometry

The structure of the model is in accordance with Figure 6 and Figure 27.

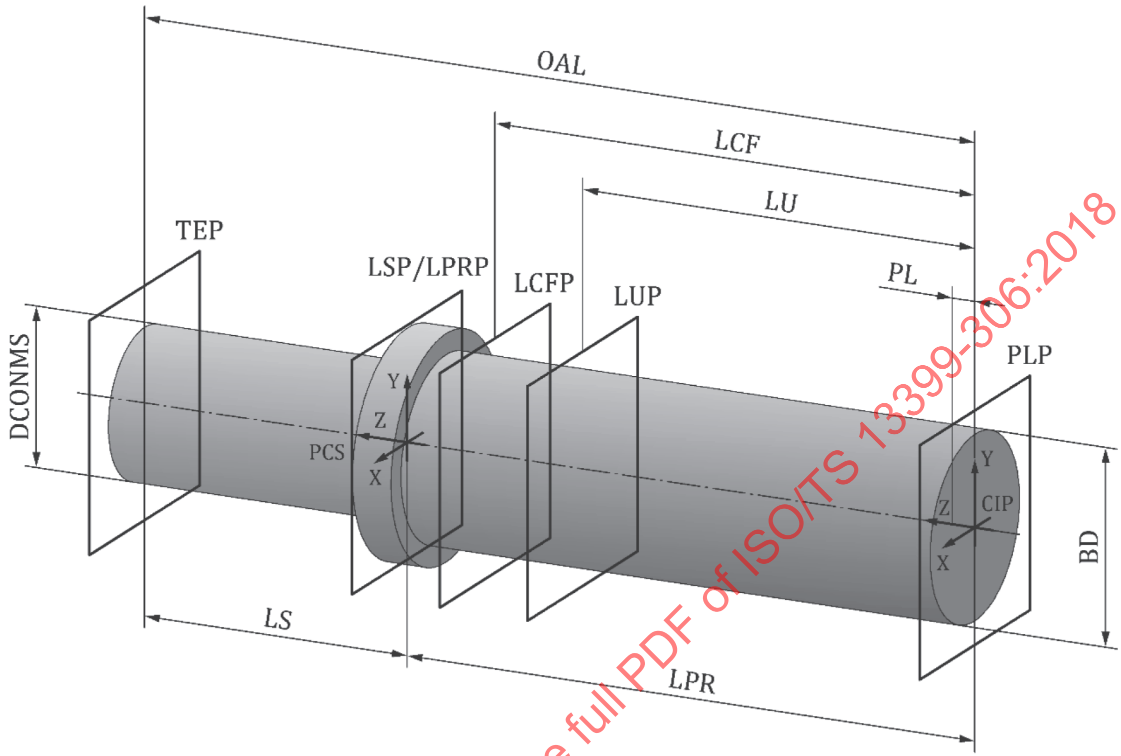


Figure 27 — Basic geometry of a core drill

8.4 Determination of the position of the mounting coordinate system of insert

See 6.4 for the definition of the position of the CSW's. For core drills it is recommended to use the same definitions of CSW's as for outer pocket seats described in 6.4.

8.5 Chip flute and pocket seat

See 6.5 for the modelling of the chip flute and the outer pocket seat.

The chip flute of core drills shall be designed as simplified as on twist drills.

Figure 28 shows the basic body with chip flutes.

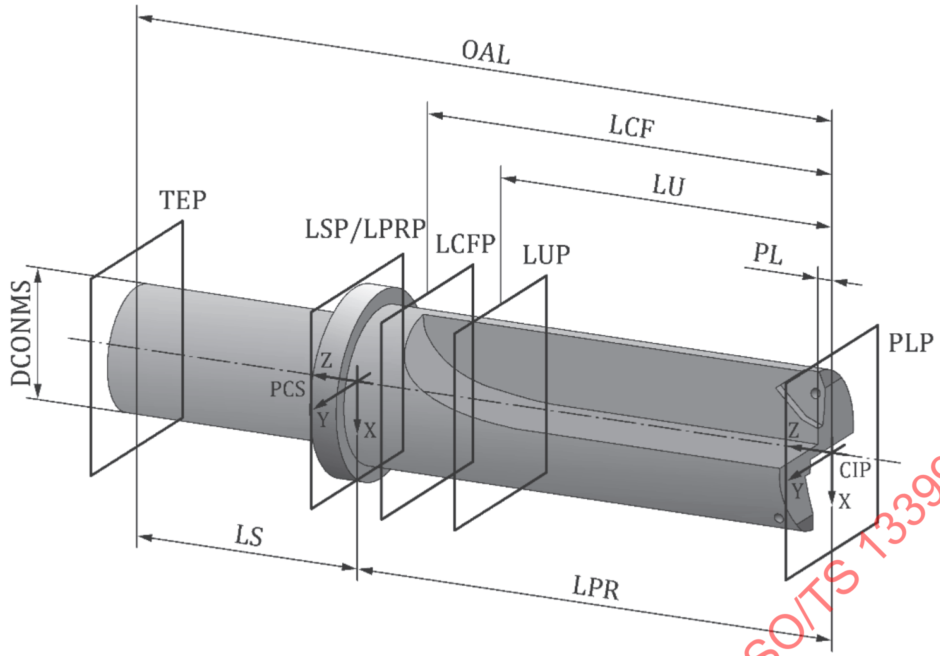


Figure 28 — Basic body of a core drill

8.6 Core drill assembly

See 6.6 for the modelling and assembly and Figure 29 and Figure 30 for the position of CSW's and CRP's. Figure 31 shows an assembled core drill.

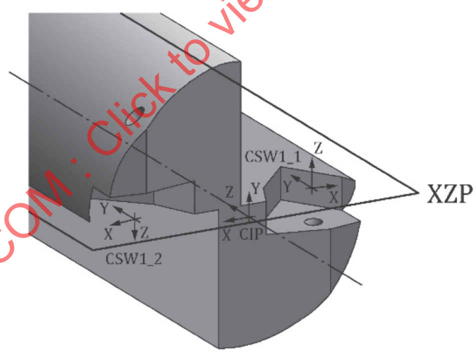


Figure 29 — Position of CSW's of a core drill

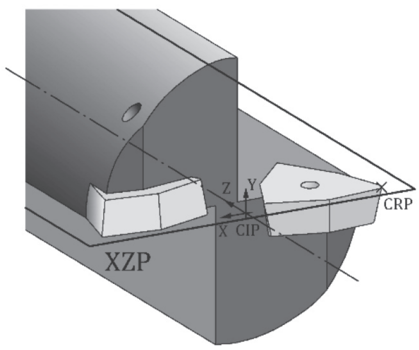


Figure 30 — Position of CRP's of a core drill

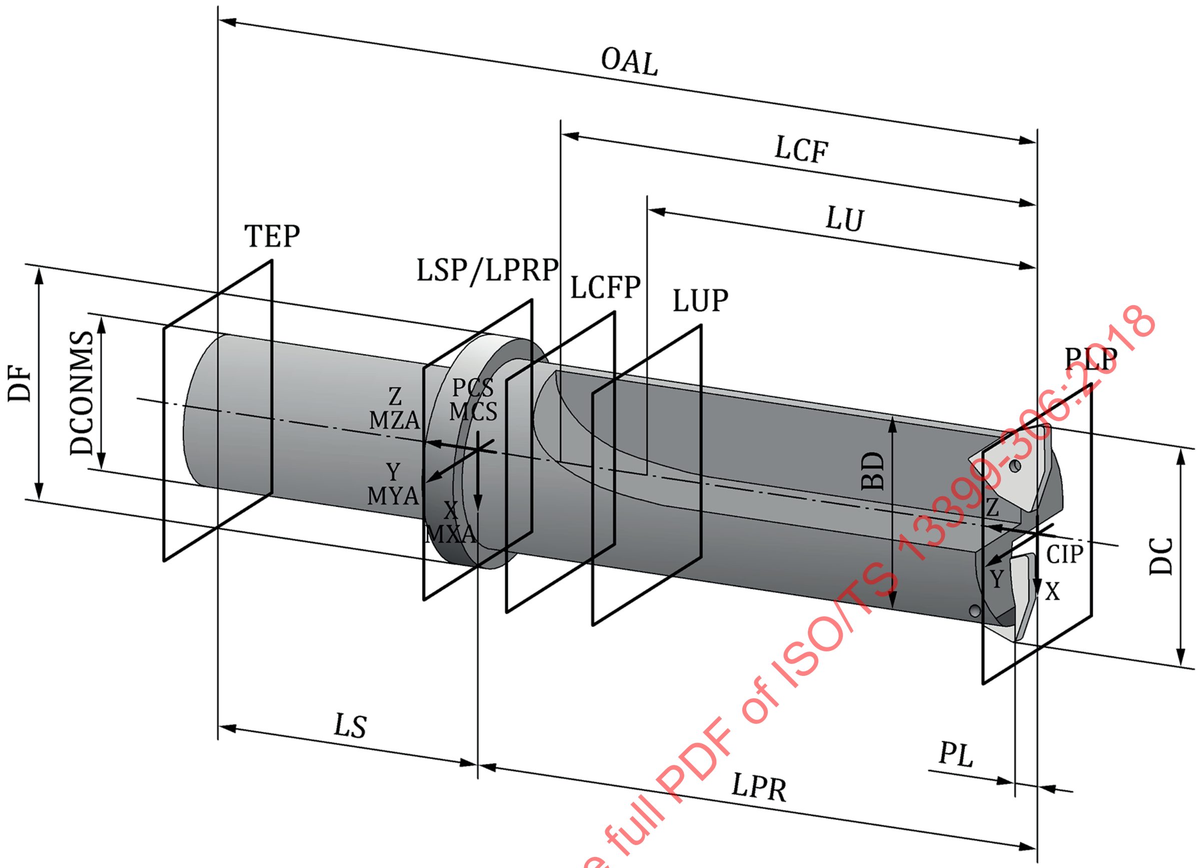


Figure 31 — Assembled core drill

9 Face countersinking tool (ISYC: 306-04)

9.1 General

Figure 32 shows the properties to be used for the design of a face countersinking tool.

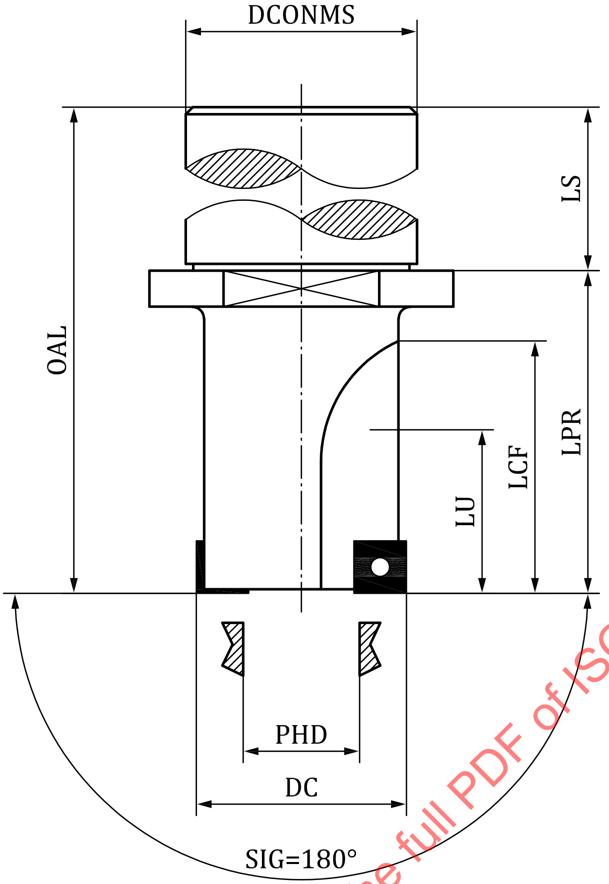


Figure 32 — Determination of properties of a face countersinking tool

9.2 Necessary properties

See 8.2 and Table 5 for necessary properties.

9.3 Basic geometry

The structure of the model is in accordance with Figure 6 and Figure 33.

The tool body does not contain a special face contour, the front face shall be designed with a dependency to the insert clearance angle major and the insert cutting edge height; see Formula (1).

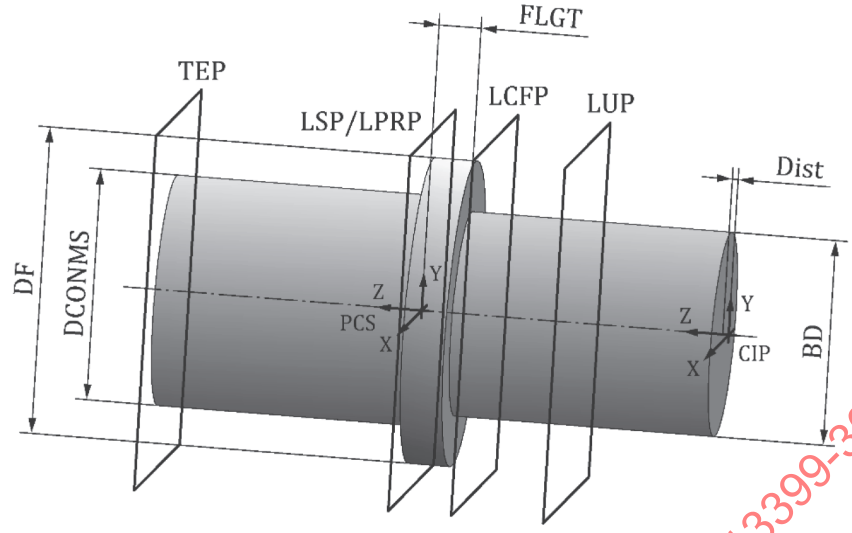


Figure 33 — Basic geometry of a face countersinking tool

9.4 Determination of the position of the mounting coordinate system of insert

See 6.4 for the definition of the position of the CSW's. The pocket seats shall be positioned with their CRP's in accordance with the number of flutes along the cutting diameter. Therefore, the mounting coordinate systems CSWx_y shall be positioned for a two fluted face countersinking tools as shown in Figure 34.

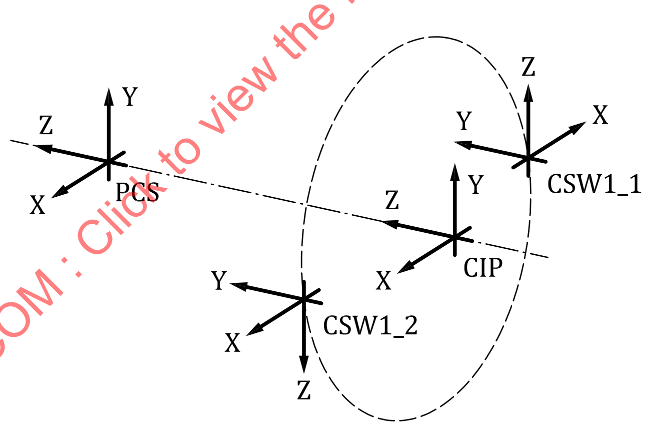


Figure 34 — Face countersinking tool: mounting coordinate sysstems CWS

9.5 Chip flute and pocket seat

See 6.5 for the modelling of the chip flute and the outer pocket seat.

The chip flute of face countersinking tools shall be designed as simplified as on twist drill and shown in Figure 35.

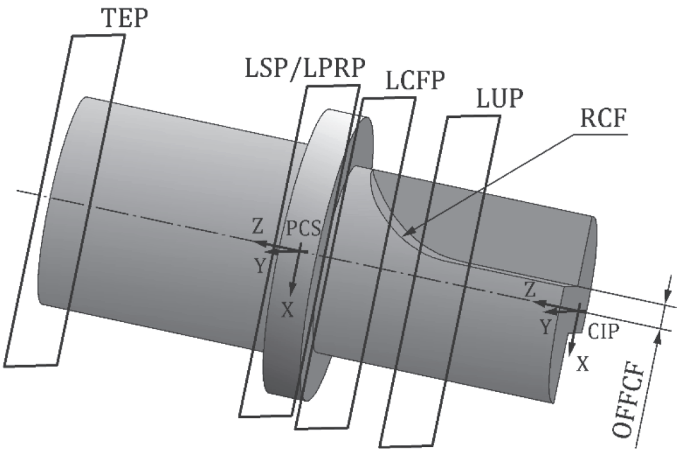


Figure 35 — Chip flute of a face countersinking tool

Further chip flutes shall be modelled and positioned to the basic body with the CAD arrangement function.

The pocket seat shall be positioned to the tool body with the use of the "CRP" as shown in Figure 36. On multiple fluted cutting tools, the remaining pocket seats shall be placed to the body using the CAD arrangement function.

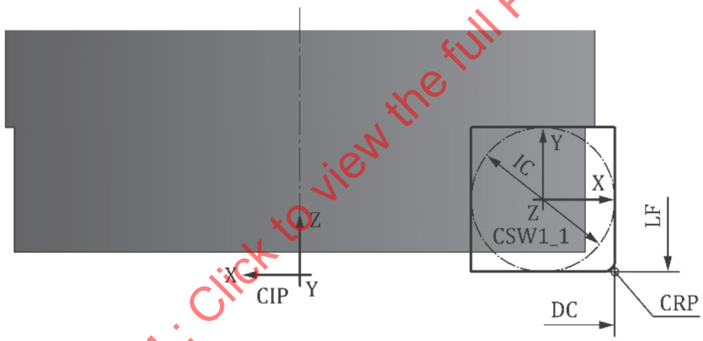


Figure 36 — Face countersinking tool: pocket seat position

9.6 Face countersinking tool assembly

See 6.6 for the modelling and assembly and Figure 37 and Figure 38 for the positions of CSW's and CRP's.

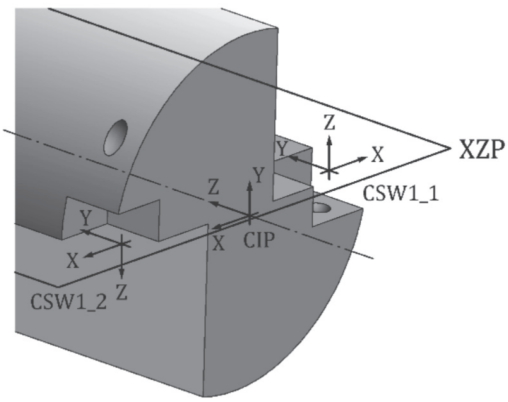


Figure 37 — Position of CSW's

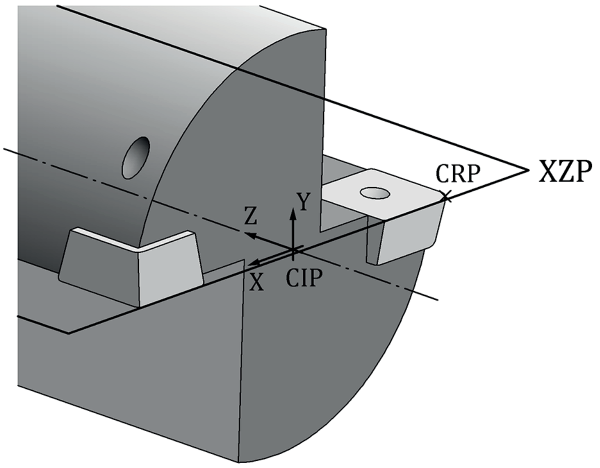


Figure 38 — Position of CRP

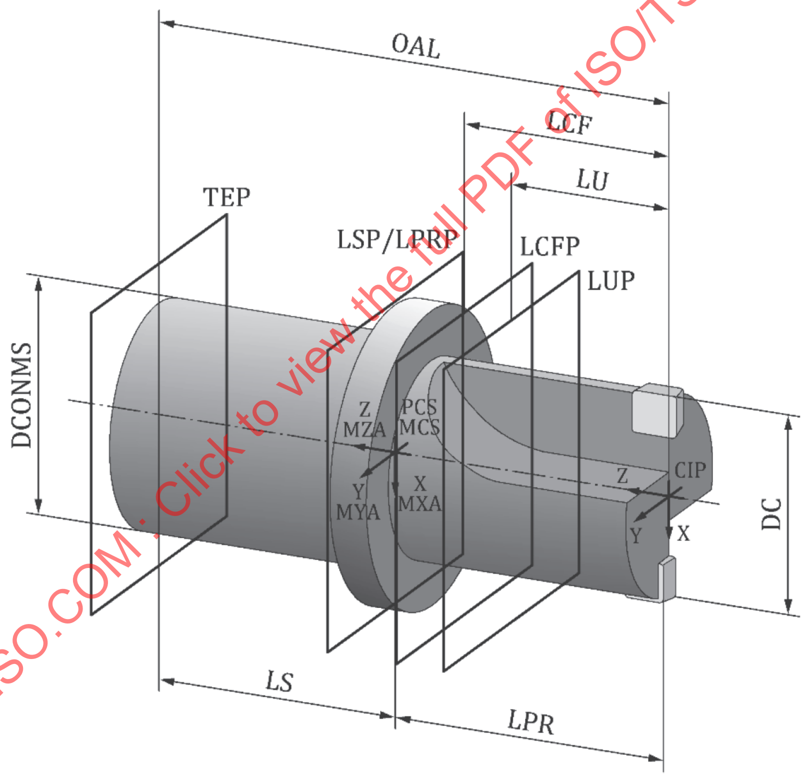


Figure 39 — Assembled face countersinking tool

10 Step countersinking tool (ISYC: 306-05)

10.1 General

The properties illustrated in Figure 40 shall be used for the design of a step countersinking tool.

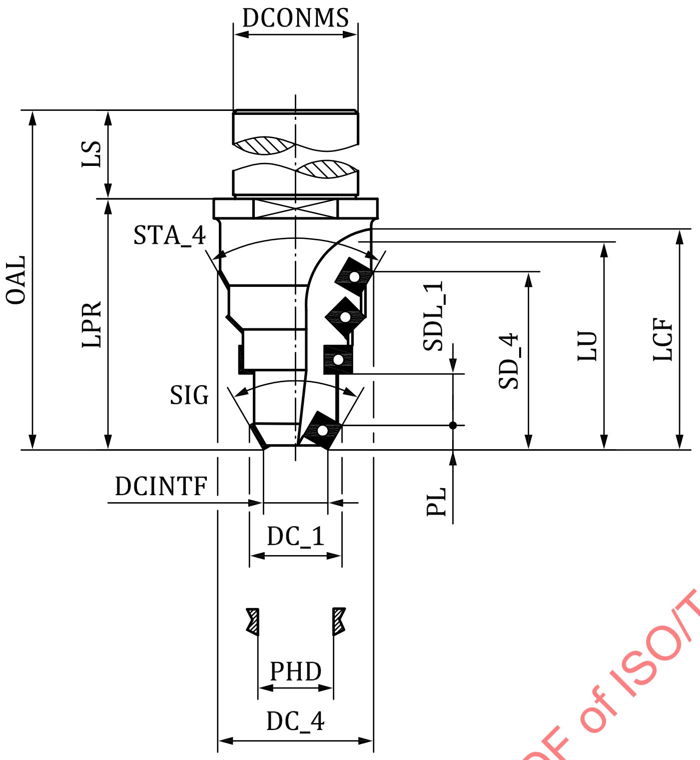


Figure 40 — Determination of properties of step countersinking tool

10.2 Necessary properties

Table 6 lists the properties being needed for the modelling of core drills.

Table 6 — Properties for the modelling of a step countersinking tool

Preferred name	Preferred symbol
Body diameter, cutting step 1	BD_1
Body diameter, cutting step 2	BD_2
Body diameter, cutting step 3	BD_3
Body diameter, cutting step 4	BD_4
Cutting diameter, cutting step 1	DC_1
Cutting diameter, cutting step 2	DC_2
Cutting diameter, cutting step 3	DC_3
Cutting diameter, cutting step 4	DC_4
Interference cutting diameter	DCINTF
Flange diameter	DF
Shank diameter	DCONMS
Flange thickness	FLGT
Chip flute length	LCF
Protruding length	LPR
Shank length	LS
Usable length	LU
Step count	NOS
Overall length	OAL

Table 6 *(continued)*

Preferred name	Preferred symbol
Offset chip flute outer pocket	OFFCFEX
Pre-machined hole diameter	PHD
Point length	PL
Chip flute radius	RCF
Step diameter length, cutting step 1	SDL_1
Step diameter length, cutting step 2	SDL_2
Step diameter length, cutting step 3	SDL_3
Step distance, cutting step 2	SD_2
Step distance, cutting step 3	SD_3
Step distance, cutting step 4	SD_4
Point angle	SIG
Step included angle, cutting step 2	STA_2
Step included angle, cutting step 3	STA_3
Step included angle, cutting step 4	STA_4

10.3 Basic geometry

The structure of the model shall be in accordance with Figure 6 and Figure 41.

The tool body does not contain a special face contour, the front face shall be designed with a dependency to the insert clearance angle major and the insert cutting edge height; see Formula (1).

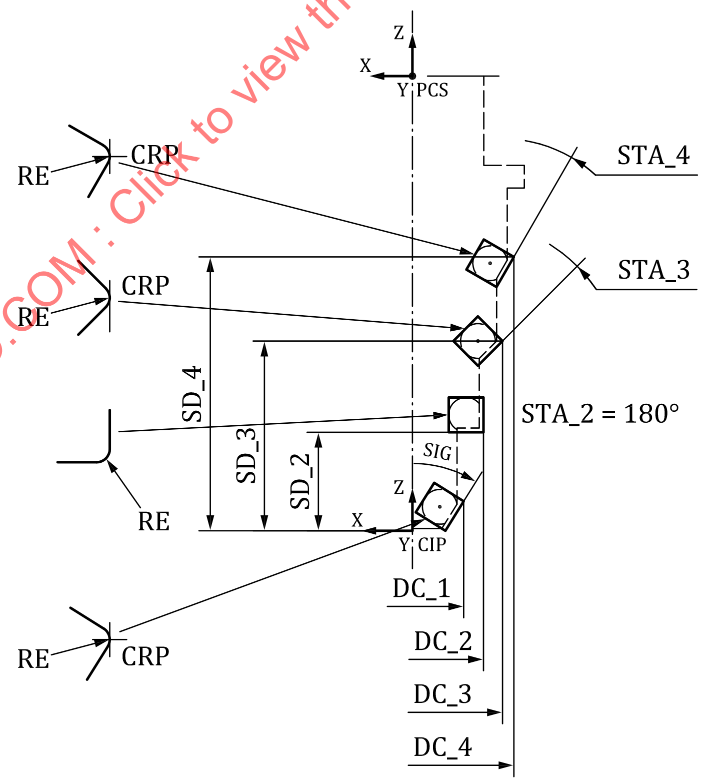


Figure 41 — Determination of CSW's and body contour on step drills

At the tool body the front surface shall be designed with a distance to CIP dependent on insert clearance angle major, cutting edge height and point angle.

10.4 Determination of the position of the mounting coordinate system of insert

See 6.4 for the definition of the position of the CSW's. The pocket seats shall be positioned with their CRP's in accordance with the number of flutes along the cutting diameter. Therefore, the mounting coordinate systems CSWx_y shall be positioned for a two-fluted face-countersinking tool as shown in Figure 20.

10.5 Chip flute and pocket seat

See 6.5 for the modelling of the chip flute and the outer pocket seat.

The chip flute of step countersinking tools shall be designed as simplified as on twist drills.

10.6 Step countersinking tool assembly

See 6.6 for the modelling and assembly and Figure 42 and Figure 43 for the positions of CSW's and CRP's.

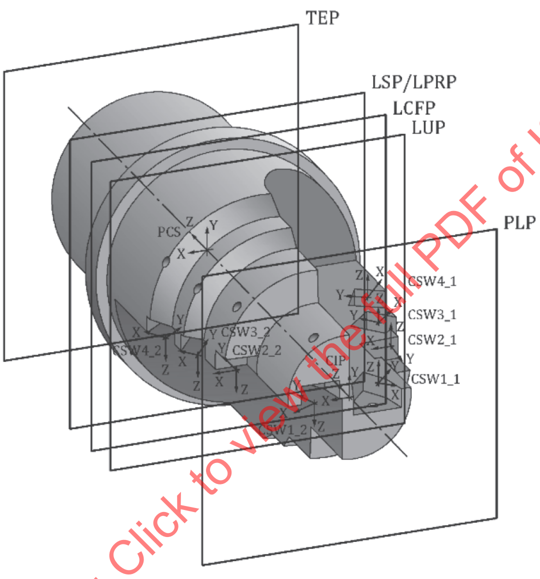


Figure 42 — Position of CSW's of a step countersinking tool

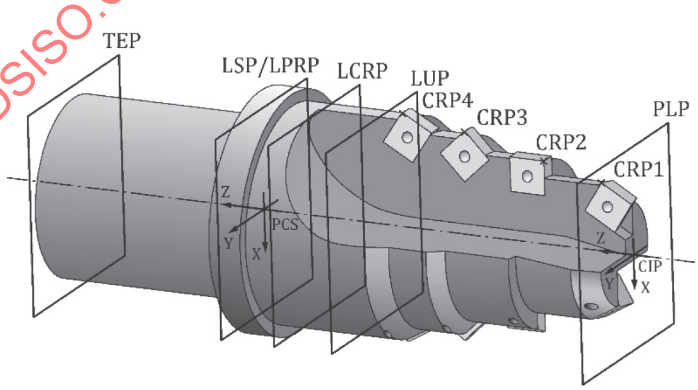


Figure 43 — Position of CRP's of a step countersinking tool

Figure 44 shows the assembled step countersinking tool.

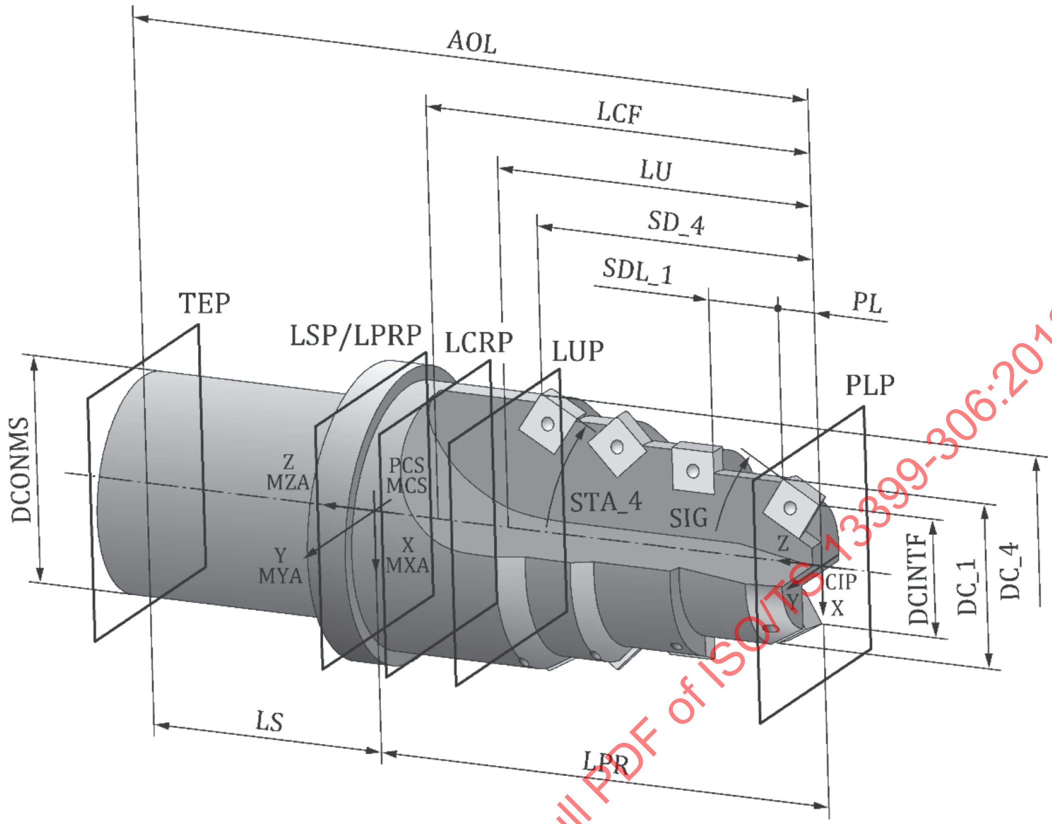


Figure 44 — Assembled step countersinking tool

11 Trepanning drill (ISYC: 306-06)

11.1 General

The properties illustrated in Figure 45 shall be used for the design of a trepanning drill.

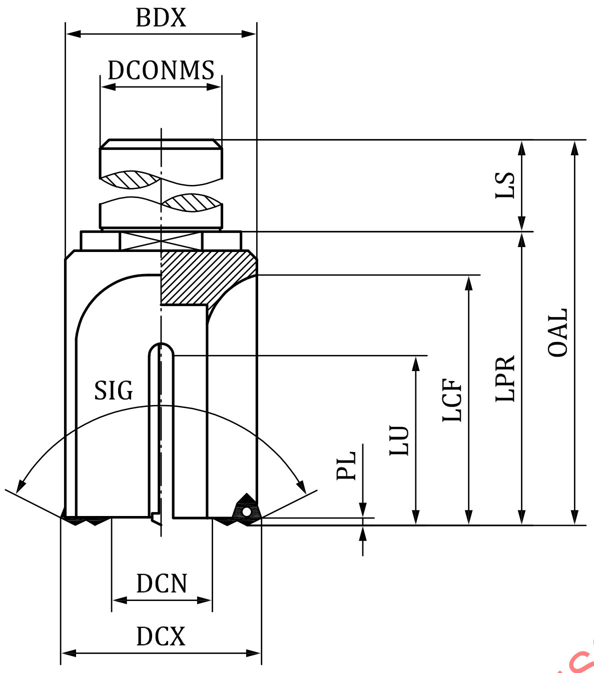


Figure 45 — Determination of properties of a trepanning drill

11.2 Necessary properties

Table 7 lists the properties being needed for the modelling of trepanning drills.

Table 7 — Properties for modelling a trepanning drill

Preferred name	Preferred symbol
Body diameter maximum	BDX
Cutting diameter maximum	DCX
Cutting diameter minimum	DCN
Flange diameter	DF
Shank diameter	DCONMS
Flange thickness	FLGT
Protruding length	LPR
Shank length	LS
Usable length	LU
Overall length	OAL
Offset chip flute outer pocket	OFFCFEX
Chip flute length	LCF
Point length	PL
Chip flute radius	RCF
Point angle	SIG

11.3 Basic geometry

The structure of the model is described in 6.3 and in accordance with Figure 6, Figure 46 and Figure 47.

The contour beyond the inserts shall be designed as a rotational contour, but with the same determination of the dimensions as described in 6.3.

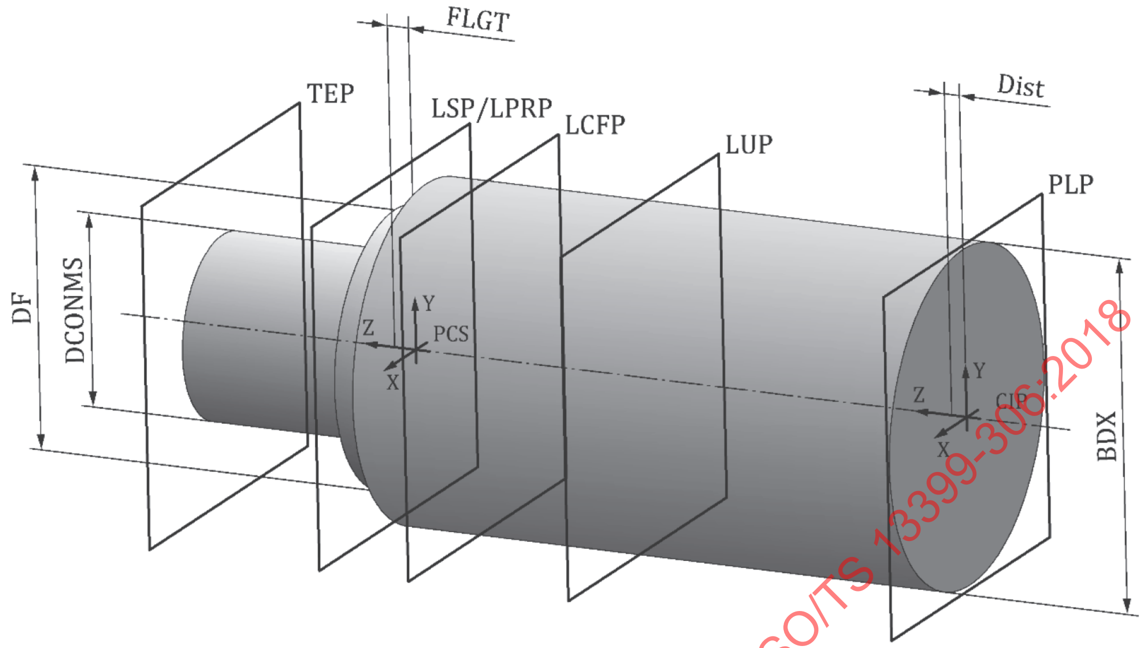


Figure 46 — Outside basic geometry of a trepanning drill

The inside contour of the trepanning drill shall be either designed as separate feature or in combination with the outside basic geometry. The depth of the inside contour shall be calculated with reference to the usable length (LU) and the diameter shall be calculated with reference to the minimum cutting diameter, cutting edge height and the clearance angle major.

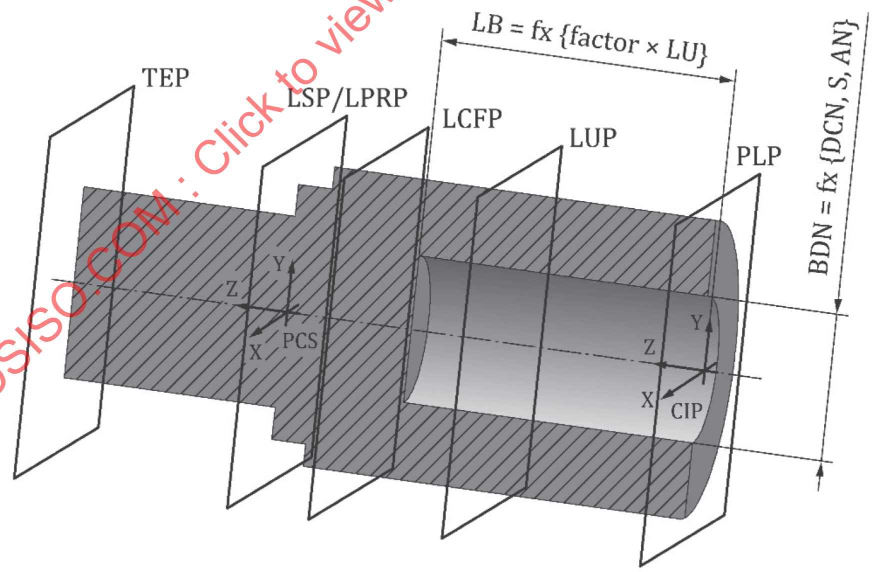
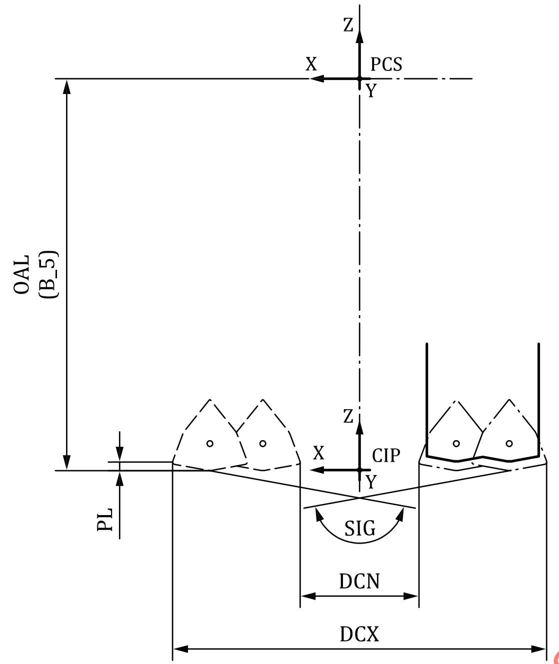


Figure 47 — Inside contour of a trepanning drill

11.4 Determination of the position of the mounting coordinate system of insert

The front face shall be designed as derivation of the used insert geometry. Figure 48 gives an example of the contour created from trigon insert shape.



NOTE For the illustration, the inside pocket seats are shown 90° rotated to the XZ plane

Figure 48 — Determination of front contour of a trepaning drill

For the design, the outside pocket seats shall be referenced to the XZ plane and the inside pocket seat shall be referenced to the YZ plane. The distance of the body contour to the cutting edges shall be calculated with the function of fx $\{S \times \tan(AN) + o\}$.

Based on the arrangement of the pocket seats, the CSW's shall be designated as shown in Figure 49.

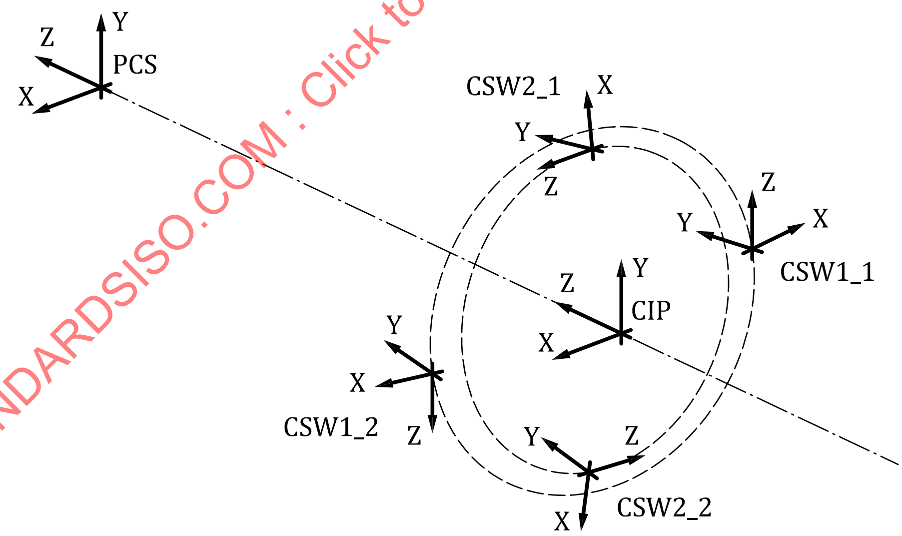


Figure 49 — Mounting coordinate systems CWS's of a trepanning drill

11.5 Chip flute and pocket seat

The structure of the model shall be in accordance with Figure 6 and Figure 50.

For modelling and positioning of the chip flutes the CAD arrangement function shall be used. The properties "number of flutes" and "face effective cutting edge count" shall be used for the arrangement of the pocket seats. A differentiation between the inner and the outer pocket seat shall not be done for the chip flutes.

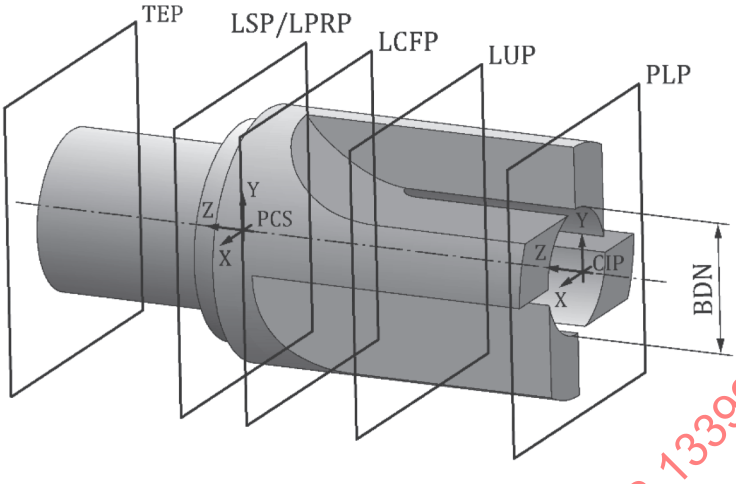


Figure 50 — Arrangement of chip flutes of a trepaning drill

Figure 51 and Figure 52 show the position and arrangement of the CSW's and CRP's.

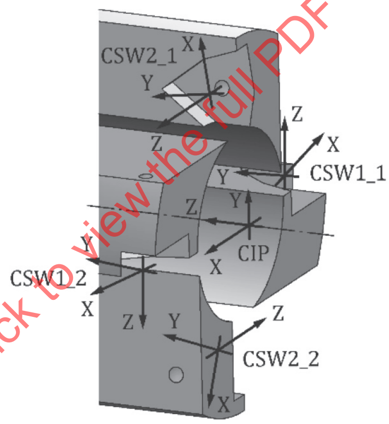


Figure 51 — Trepanning drill: position of CSW's

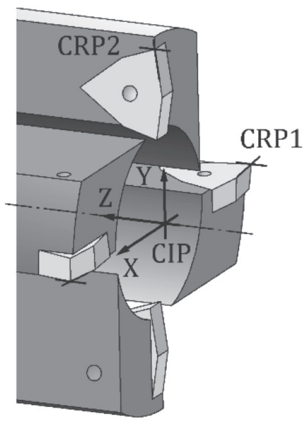


Figure 52 — Trepanning drill: position of CRP's

11.6 Trepanning drill, assembled

See 6.6 for the modelling and assembly and Figure 53 for the design of a trepanning drill.

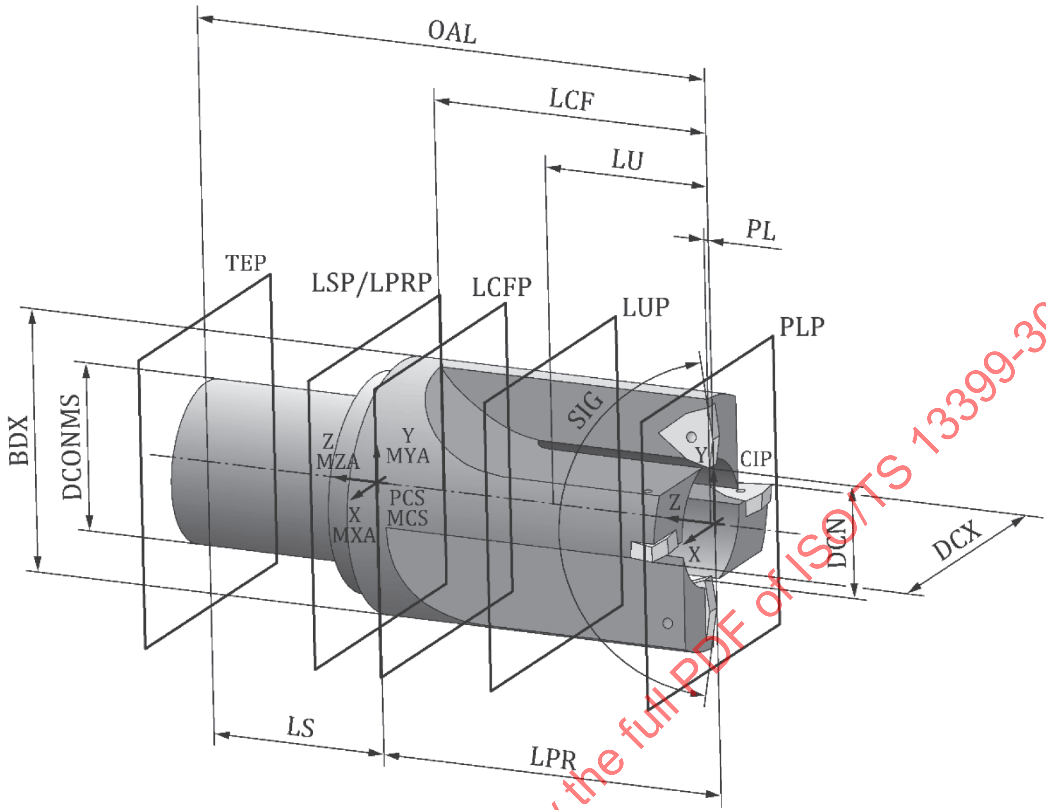


Figure 53 — Assembled trepanning drill

12 Bell style countersinking tool (ISYC: 306-07)

12.1 General

The properties illustrated in Figure 54 shall be used for the design of a bell style countersinking tool.

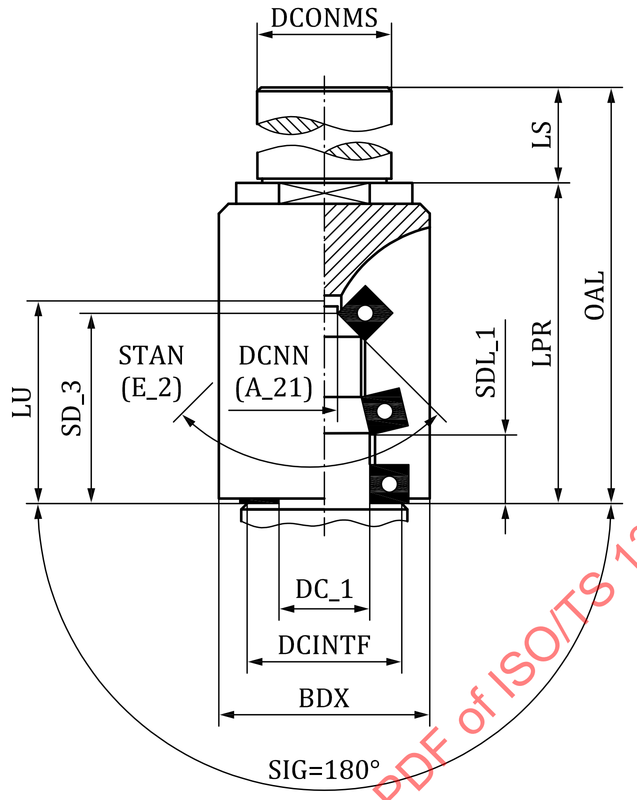


Figure 54 — Determination of properties of a bell style countersinking tool

12.2 Necessary properties

The properties listed in Table 8 lists shall be used for the modelling of bell style countersinking tool.

NOTE Table 8 lists a countersinking tool with 3 cutting steps.

Table 8 — Properties for the modelling of a bell style countersinking tool

Preferred name	Preferred symbol
Body diameter, cutting step 1	BD_1
Body diameter, cutting step 2	BD_2
Body diameter, cutting step 3	BD_3
Body diameter, maximum	BDX
Cutting diameter, cutting step 1	DC_1
Cutting diameter, cutting step 2	DC_2
Cutting diameter, cutting step 3	DC_3
Interference cutting diameter	DCINTF
Flange diameter	DF
Shank diameter	DCONMS
Flange thickness	FLGT
Chip flute length	LCF
Protruding length	LPR
Shank length	LS
Usable length	LU
Step count	NOS

Table 8 *(continued)*

Preferred name	Preferred symbol
Overall length	OAL
Offset chip flute inner pocket	OFFCFIN
Point length	PL
Chip flute radius	RCF
Step diameter length, cutting step 1	SDL_1
Step diameter length, cutting step 2	SDL_2
Step distance, cutting step 2	SD_2
Step distance, cutting step 3	SD_3
Point angle	SIG
Step included angle, cutting step 2	STA_2
Step included angle, cutting step 3	STA_3

12.3 Basic geometry

The structure of the model shall be in accordance with Figure 6, Figure 55 and Figure 56.

The contour beyond the inserts shall be designed as a rotational contour, but with the same determination of the dimensions as described in 6.3.

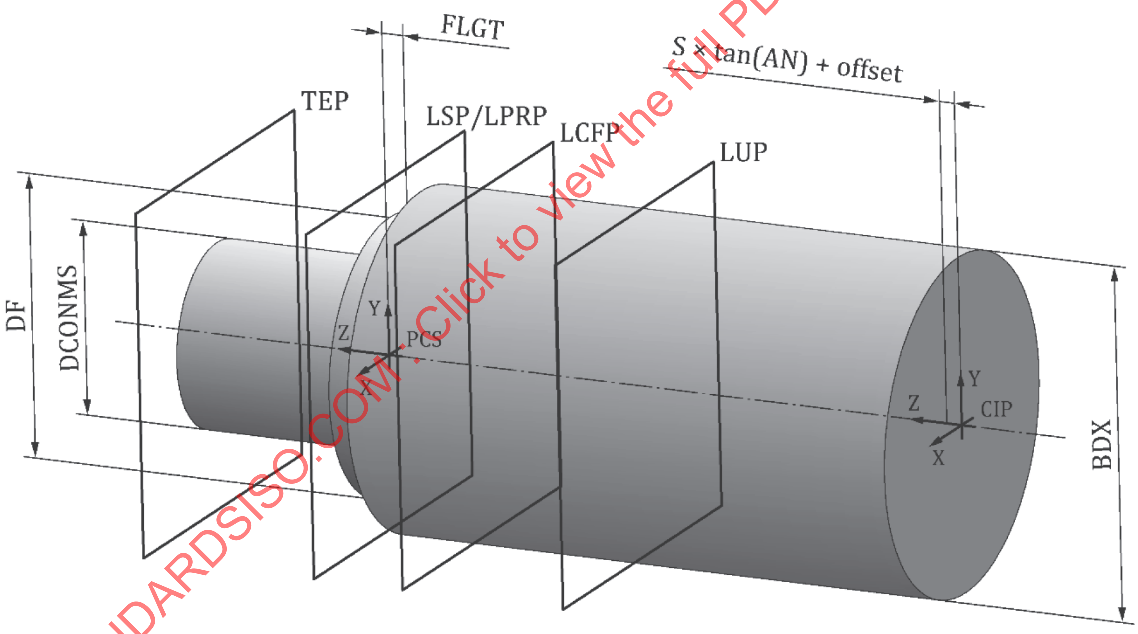


Figure 55 — Outer contour of a bell style countersinking tool

The inside contour of the bell style countersinking tool shall be either designed as separate feature or in combination with the outside basic geometry. The depth of the inside contour shall be calculated with reference to the usable length (LU) and the diameters shall be calculated with reference to the corresponding cutting diameters, cutting edge heights and the clearance angles major of the used inserts.

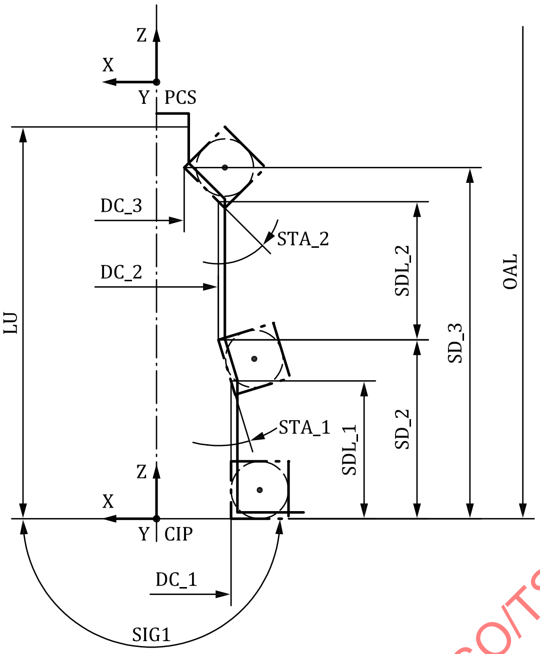


Figure 56 — Determination inside body contour on bell style countersinking tools

The relationship of the mounting coordinate systems in regard to rotational angles and distances shall be done as defined in 4.6.

12.4 Determination of the position of the mounting coordinate system of insert

Figure 57 gives an example of the mounting coordinate systems of a bell style countersinking tool with two effective cutting edges and three cutting steps.

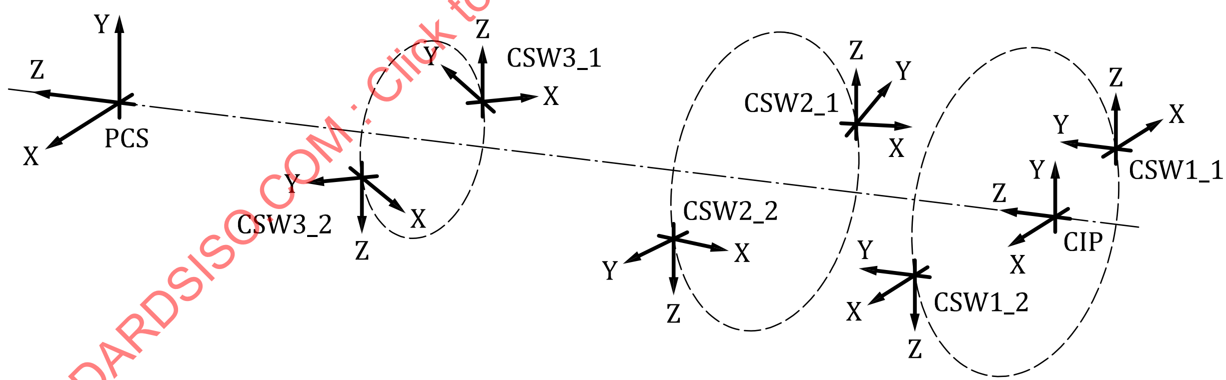


Figure 57 — Determination of CSW's

12.5 Chip flute and pocket seat

The structure of the model shall be in accordance with Figure 6, Figure 58 and Figure 59.

For modelling and positioning of the chip flutes the CAD arrangement function shall be used. The properties "number of flutes" and "face effective cutting edge count" shall be used for the arrangement of the pocket seats.

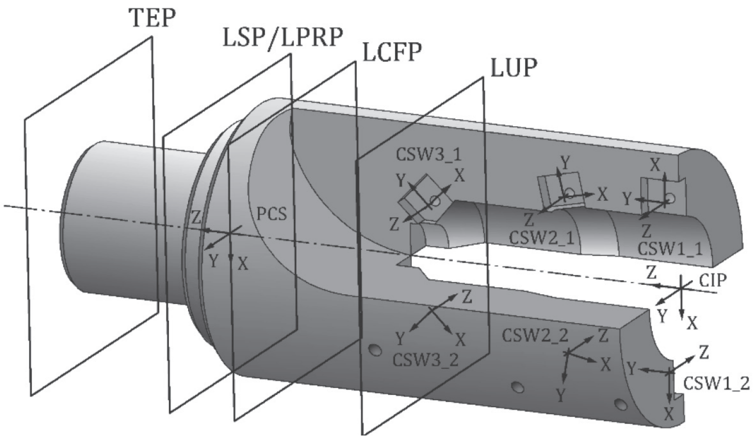


Figure 58 — Position of CSW's of a bell style countersinking tool

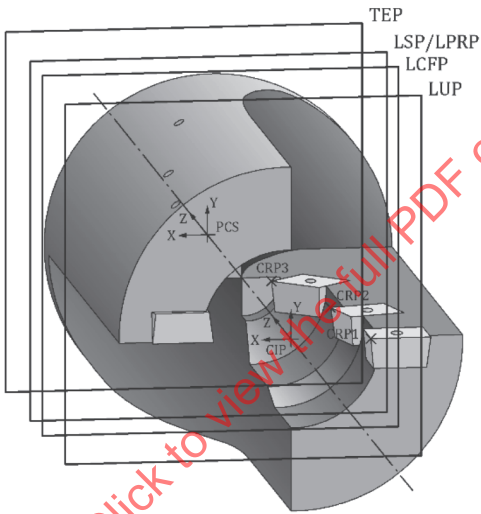


Figure 59 — Position of CRP's of a bell style countersinking tool

12.6 Bell style countersinking tool, assembled

See 6.6 for the modelling and Figure 60 for the assembly.

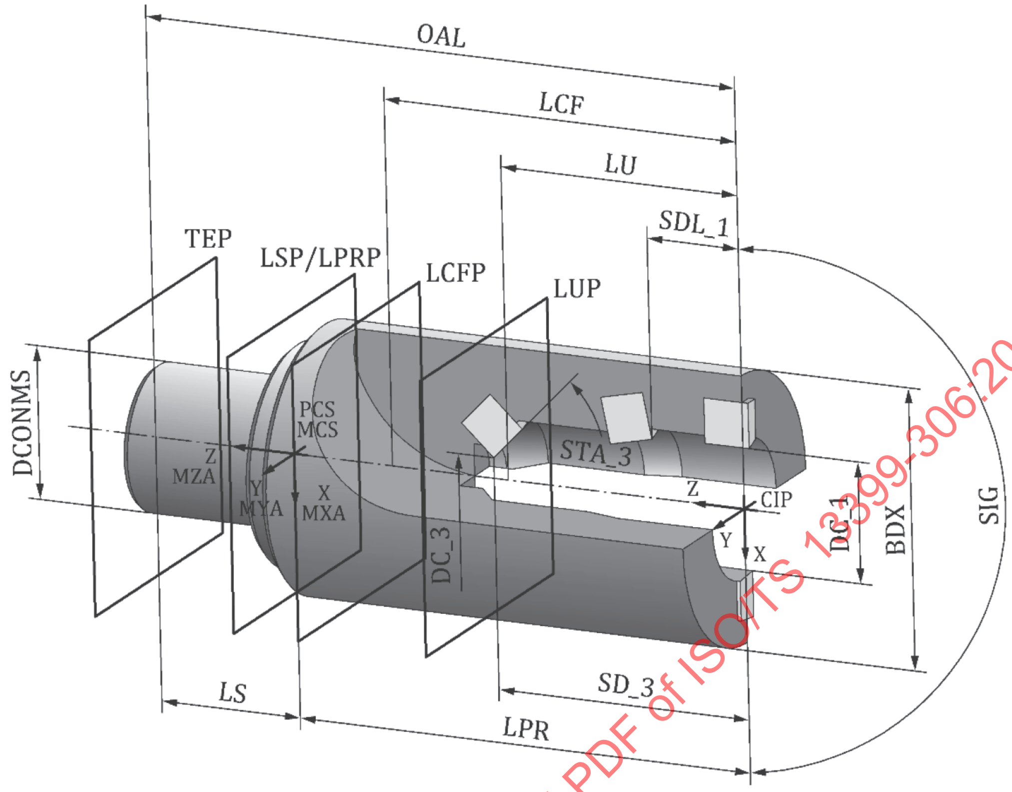


Figure 60 — Assembled bell style countersinking tool

13 Reverse countersinking tool (ISYC: 306-08)

13.1 General

The properties illustrated in Figure 54 shall be used for the design of a reverse countersinking tool with three steps (see Figure 61).

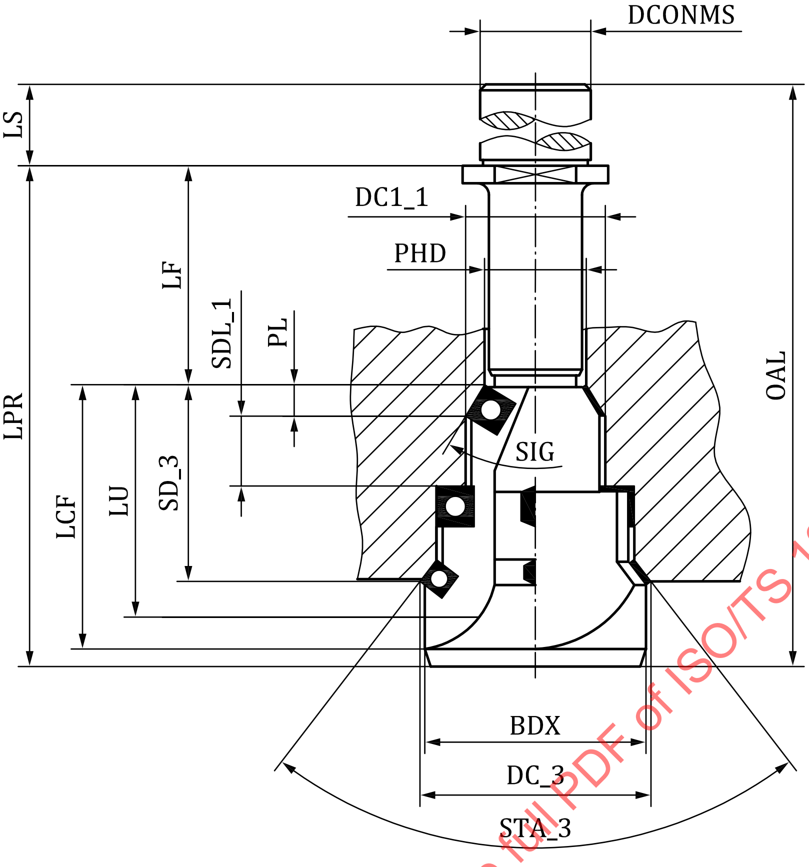


Figure 61 — Determination of properties of a reverse countersinking tool

13.2 Necessary properties

The properties listed in Table 9 shall be used for the modelling of reverse countersinking tool.

NOTE Table 9 lists a countersinking tool with 3 cutting steps.

Table 9 — Properties for the modelling of a reverse countersinking tool

Preferred name	Preferred symbol
Body diameter, cutting step 1	BD_1
Body diameter, cutting step 2	BD_2
Body diameter, minimum	BDN
Body diameter, maximum	BDX
Cutting diameter, cutting step 1	DC_1
Cutting diameter, cutting step 2	DC_2
Cutting diameter, cutting step 3	DC_3
Interference cutting diameter	DCINTF
Flange diameter	DF
Shank diameter	DCONMS
Flange thickness	FLGT
Chip flute length	LCF
Functional length	LF
Protruding length	LPR
Shank length	LS

Table 9 *(continued)*

Preferred name	Preferred symbol
Usable length	LU
Step count	NOS
Overall length	OAL
Offset chip flute outer pocket	OFFCFEX
Pre-machined hole diameter	PHD
Point length	PL
Chip flute radius	RCF
Step diameter length, cutting step 1	SDL_1
Step diameter length, cutting step 2	SDL_2
Step distance, cutting step 2	SD_2
Step distance, cutting step 3	SD_3
Point angle	SIG
Step included angle, cutting step 2	STA_2
Step included angle, cutting step 3	STA_3

13.3 Basic geometry

The "coordinate system in process – CIP" shall not be placed on the most front part of the cutting tool, but on the first step of the reverse countersinking tools. These kinds of tools cannot be mounted automatically onto the spindle of the machine tool, because of the machining process.

Therefore, the positions of the defined planes are different to the other drilling and countersinking tools as shown in Figure 62.

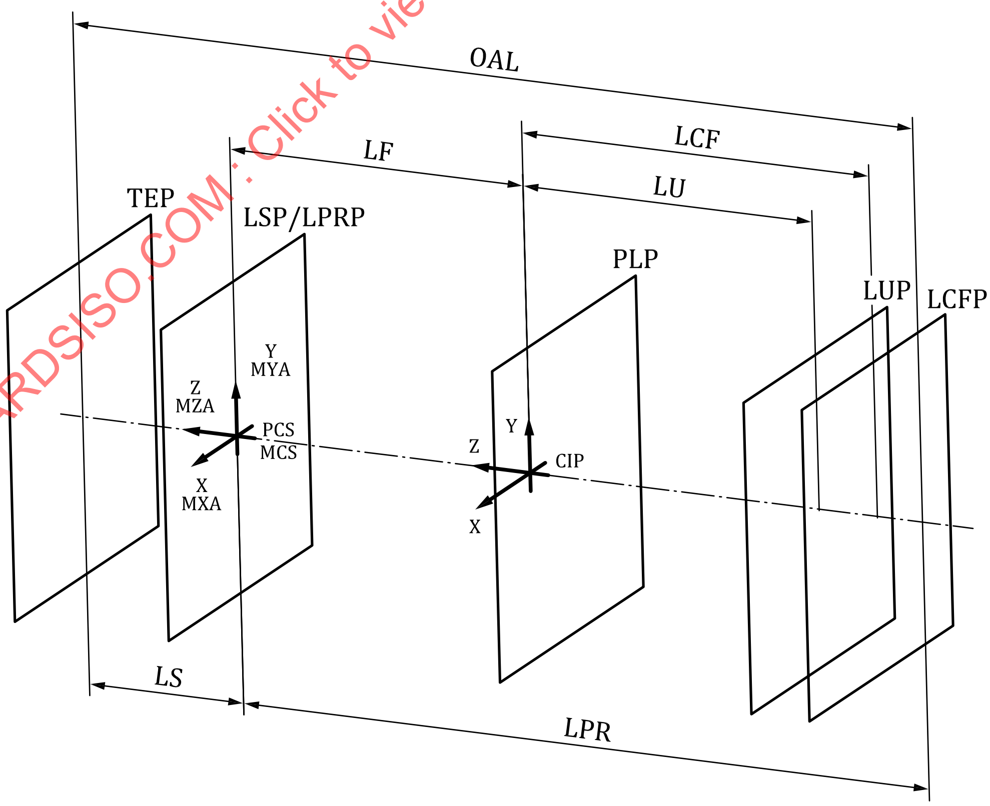


Figure 62 — Determination of planes and properties of a reverse countersinking tool

The structure of the model shall be in accordance with Figure 6, Figure 62 and Figure 63.

The contour beyond the inserts shall be designed as a rotational contour, but with the same determination of the dimensions as described in 6.3.

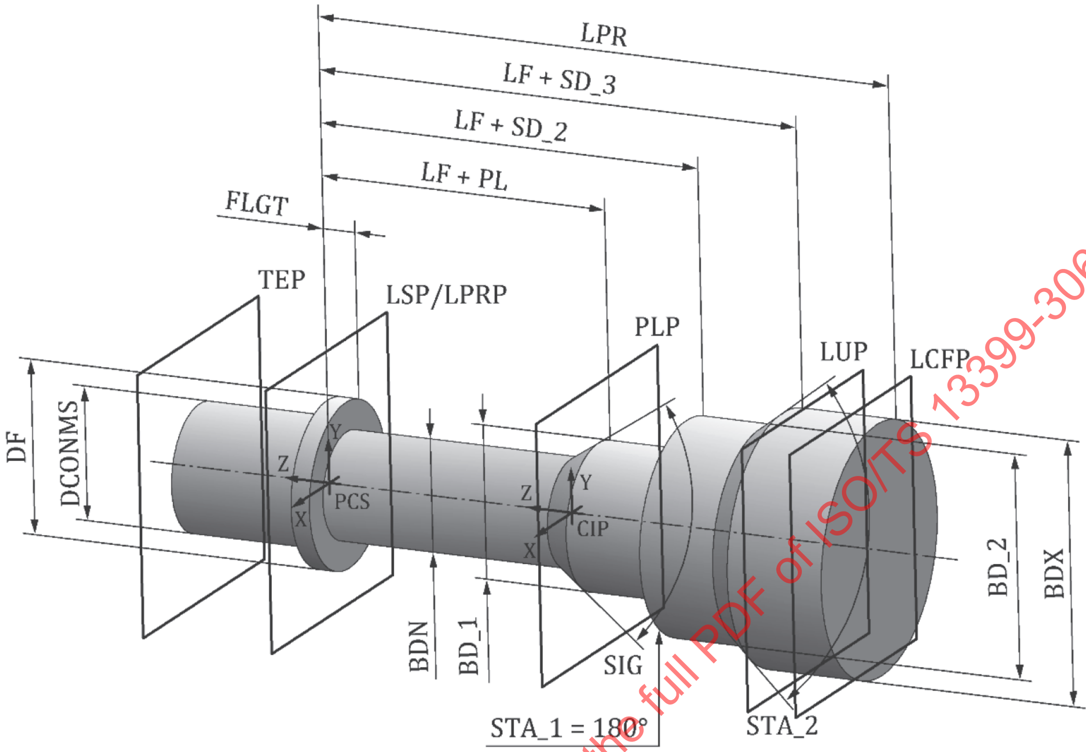


Figure 63 — Basic geometry of a reverse countersinking tool

13.4 Determination of the position of the mounting coordinate system of insert

Figure 64 and Figure 65 give an example of the mounting coordinate systems of a reverse countersinking tool with four effective cutting edges.

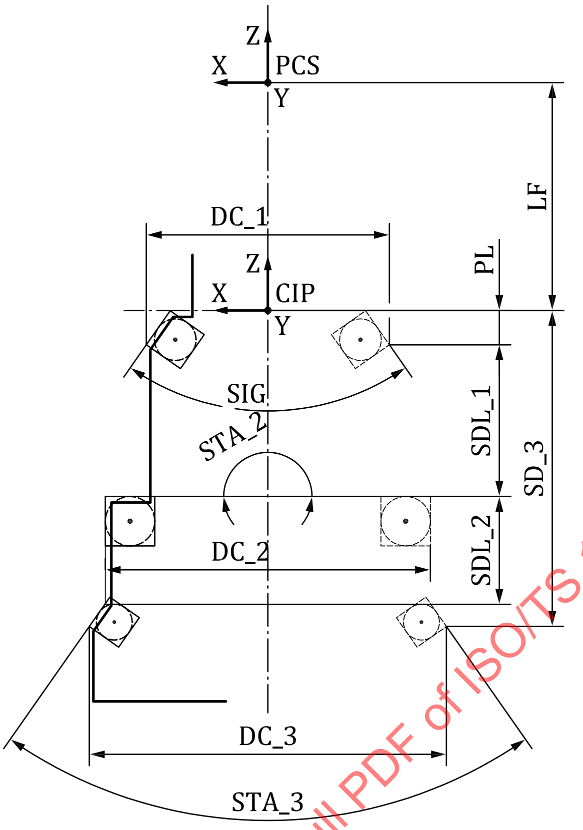


Figure 64 — Determination outside body contour on reverse countersinking tools

Relationship of the mounting coordinate systems with regard to rotational angles and distances shall be done as defined in 4.5.

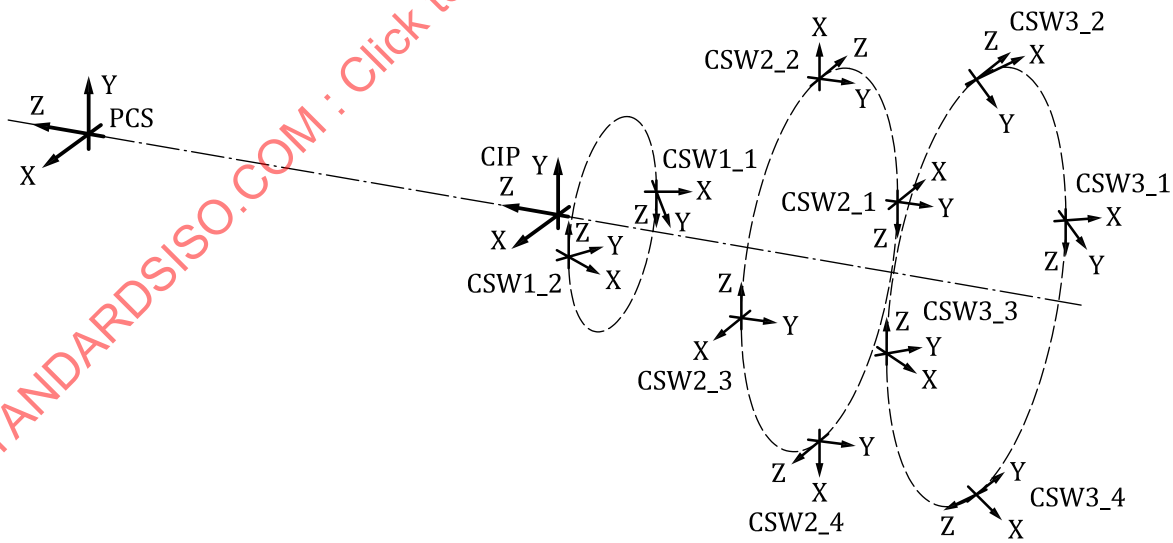


Figure 65 — Determination of CSW's

13.5 Chip flute and pocket seat

The structure of the model shall be in accordance with Figure 6, Figure 66 and Figure 67.

For modelling and positioning of the chip flutes the CAD arrangement function shall be used. The properties "number of flutes" and "face effective cutting-edge count" shall be used for the arrangement of the pocket seats.

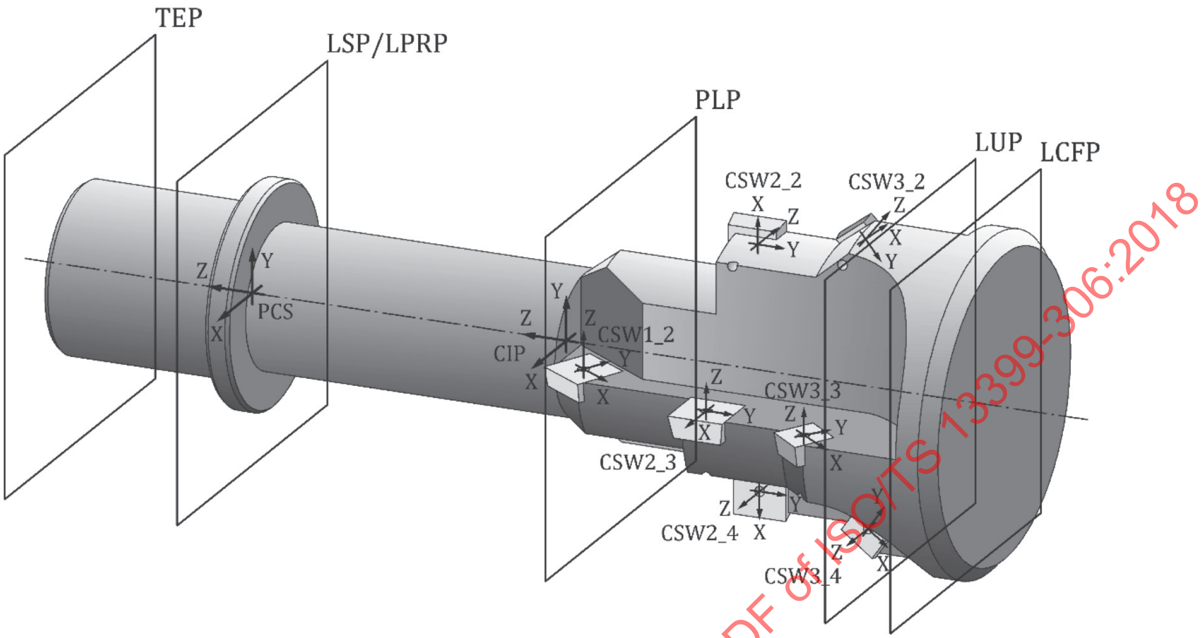


Figure 66 — Determination of CSW's of a reverse countersinking tool

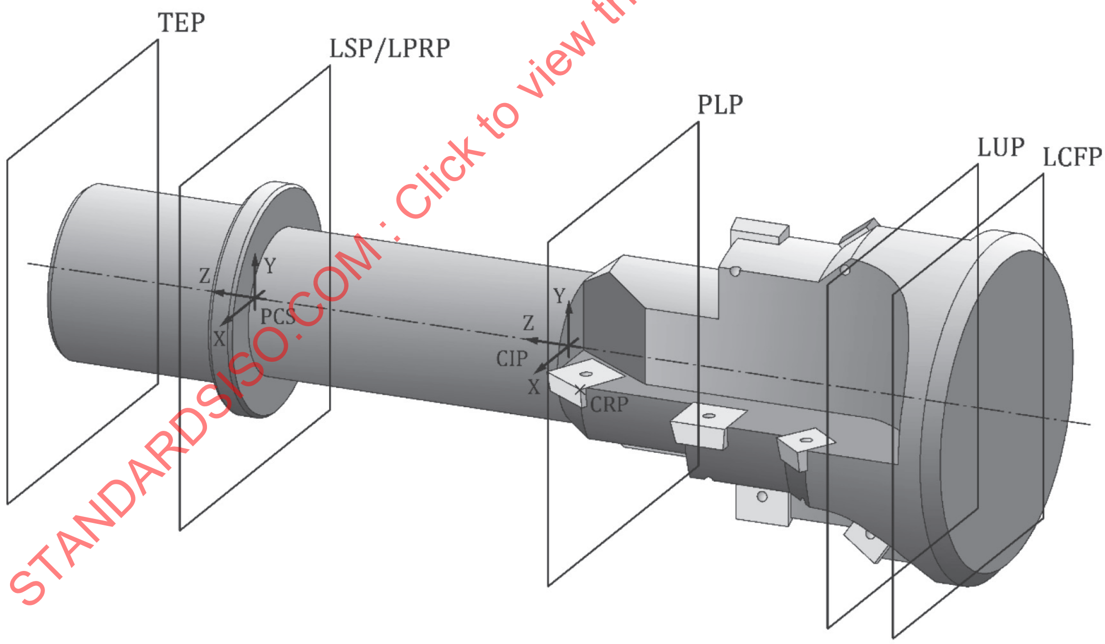


Figure 67 — Determination of CRP's of a reverse countersinking tool

13.6 Assembled reverse countersinking tool

See 6.6 for the modelling and Figure 68 for the assembly.

