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ISO/TS 13399-403

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Cutting tool data representation and exchange —

Part 403:
Creation and exchange of 3D models — Modelling of driven tool units

Représentation et échange des données relatives aux outils coupants —

Partie 403: Création et échanges de modèles 3D — Conception d'outils à entrainement

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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*.

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

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 defines the concept, terms and definitions of how to design simplified 3D models of driven tool units for the design of cutting tools, 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 for providing the end user with 3D models for the purposes defined above is the basis for the development of this series of International Standards.

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 403: Creation and exchange of 3D models — Modelling of driven tool units

1 Scope

This document defines the concept of how to design adaptive items, limited to any kind of driven tool units, 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 driven tool units.

The following are outside the scope of this document:

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

— concept of 3D models for cutting tools;

— concept of 3D models for cutting items;

— concept of 3D models for tool items;

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

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

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/TS 13399-4, *Cutting tool data representation and exchange — Part 4: Reference dictionary for adaptive items*

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*

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 Abbreviated terms

BD	body diameter
BDX	body diameter maximum
BD1	body diameter 1
BD2	body diameter 2
CCFMS	connection code form machine side
CCFWS	connection code form workpiece side (referred to as CCFOP in this document)
CCTMS	connection code type machine side
CCTWS	connection code type workpiece side (referred to as CCTOP in this document)
CSWx_y	coordinate system workpiece side
CZCMS	connection size code machine side
CZCWS	connection size code workpiece side (referred to as CZCOP in this document)
DCCTX	cutting diameter cutting tool maximum
DCONMS	connection diameter
DCONWS	connection diameter workpiece side
DF	flange diameter
DIX	tool changer interference diameter maximum
DRVDIA	drive diameter
DRVL	drive length
DRVLP	plane for the drive length
DRVSC	drive size code
DRVTY	drive type
HEP	plane located at the front of the tool and is coplanar with the XY-plane of CIP
HF	functional height
HF1	functional height 1
HF2	functional height 2
HF3	functional height 3
HTB	body height
KAP	the angle κ
KN_0001, KN_0002, MN_0001, NN_0001, QN_0001	temporary properties used as functions of cutting edge height, normal clearance angle major cutting edge, orthogonal rake angle, normal clearance angle minor cutting edge and inclination angle

KWW	keyway width
LB	body length
LBP	plane for the body length
LB1	body length 1
LB2	body length 2
LDG	gauge diameter distance
LF	functional length
LFSF	distance to face
LF1	functional length 1
LF2	functional length 2
LF3	functional length 3
LIN	tool changer interference length minimum
LPCON	connection protruding length
LPR	protruding length
LPRCP	protruding length of the coolant pipe
LPRP	plane for the protruding length
LS	shank length
LSP	plane for the shank length
MCS	mounting coordinate system
MXA	x-axis of MCS
MYA	y-axis of MCS
MZA	z-axis of MCS
OAH	overall height
OAL	overall length
OALP	plane for overall length
OAW	overall width
PCS	primary coordinate system
PHI	the angle ϕ
RADH	radial height
RADW	radial width
RHO	the angle ρ

SWAH	swing arm height
SWAL	swing arm length
SWANGX	swing angle maximum
SWANGXP	plane for swing angle maximum
SWANG2X	swing angle 2 maximum
SWANG2XP	plane for swing angle 2 maximum
SWANG3X	swing angle 3 maximum
SWANG4X	swing angle 4 maximum
SWAW	swing arm width
SWRAD	swing radius
TEP	plane located at the end of the interface on the machine side with reference to CIP
TQBRRD	torque bracing radial distance
TQBRANG	torque bracing angle
TQBRDIA	torque bracing diameter
TQBRL	torque bracing length
WB	body width
WB1	body width 1
WB2	body width 2
WF	functional width
WF1	functional width 1
WF2	functional width 2
WF3	functional width 3
XA	x-axis
YA	y-axis
ZA	z-axis
XYP	xy-plane
XYWP	xyw-plane
XZP	xz-plane
XZWP	xzw-plane
YZP	yz-plane
YZWP	yzw-plane

5 Starting elements, coordinate systems, planes

5.1 General

The modelling of the 3D models shall be done by means of nominal dimensions. 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.

5.2 Reference system (PCS)

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 PCS;

— **3 orthogonal planes**: planes in the coordinate system that contain the axis of the system, named XYP, XZP and YZP;

— **3 orthogonal axes**: axes built as intersections of the three orthogonal planes lines respectively, named XA, YA and ZA.

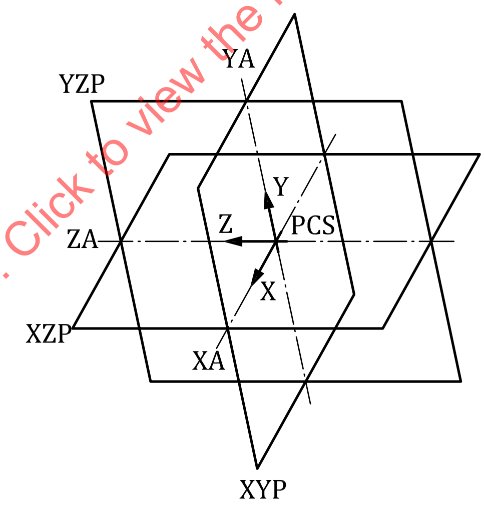


Figure 1 — Primary coordinate system

5.3 Adjustment coordinate system at workpiece side

5.3.1 General

Additional coordinate systems named CSWx_y for mounting other adaptive items or tool items shall be defined according to ISO/TS 13399-50.

5.3.2 Designation of coordinate systems at workpiece side

The designation of the coordinate system workpiece side shall be done as follows.

a) Case 1: one coordinate system at workpiece side

A single coordinate system at the workpiece side shall be designated as CSW.

b) Case 2: one coordinate system on different levels at workpiece side

A single coordinate system on different levels shall be designated as CSWx, e.g., CSW1, CSW2. The numbering shall start at the workpiece side and ends at the machine side in the direction of the positive Z-axis.

c) Case 3: multiple coordinate systems on one level and at different angles or different positions at workpiece side

Multiple coordinate systems on one level, but at different angles and not at the centre of the tool axis, shall be designated with CSWx_y, where x defines the level and y defines the number of the coordinate system itself.

The counting shall start at the three o'clock position counting in counterclockwise direction while looking towards the machine spindle (positive z-Axis). If the positions of the coordinate systems are not defined by means of different angles, the counting of the different coordinate systems shall start at that CSW with firstly the least absolute number on the x-axis and secondly the least absolute number on the y-axis of the PCS.

d) Case 4: multiple coordinate systems on one level, at one angle and with different diameters at workpiece side

The designation shall be the same as defined in case 3. The counting shall start at the smallest diameter.

e) Case 5: multiple coordinate systems on different levels, at different angles and with different diameters at workpiece side

The designation shall be the same as defined in case 3. The counting shall start at the smallest diameter and at the three o'clock position.

Figures 2 and 3 show examples of the arrangement of coordinate systems on workpiece side.

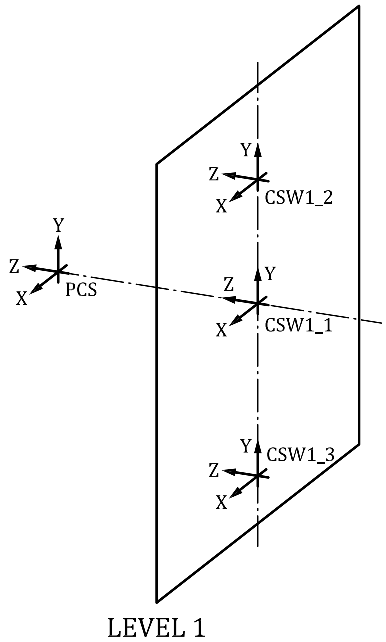


Figure 2 — Adjustment of coordinate system at workpiece side — Linear order

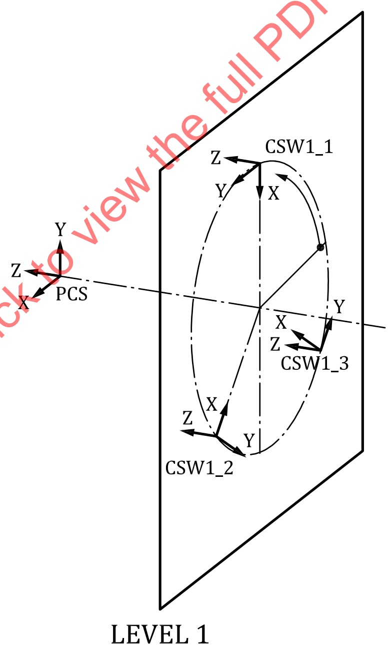


Figure 3 — Adjustment of coordinate system at workpiece side — Angular order on a circle

5.3.3 Arrangement of coordinate system at workpiece side

The CSWx_y can be arranged in relation to the PCS by means of using the six degrees of freedom as follows:

— rotation about

  — the x-axis by RHO,

  — the y-axis by KAP,

  - — the z-axis by PHI;
- — distance from the PCS origin perpendicular
  - — to XYW-plane by XYWD,
  - — to XZW-plane by XZWD,
  - — to YZW-plane by YZWD.

The orientation and location of CSW is shown in Figure 4.

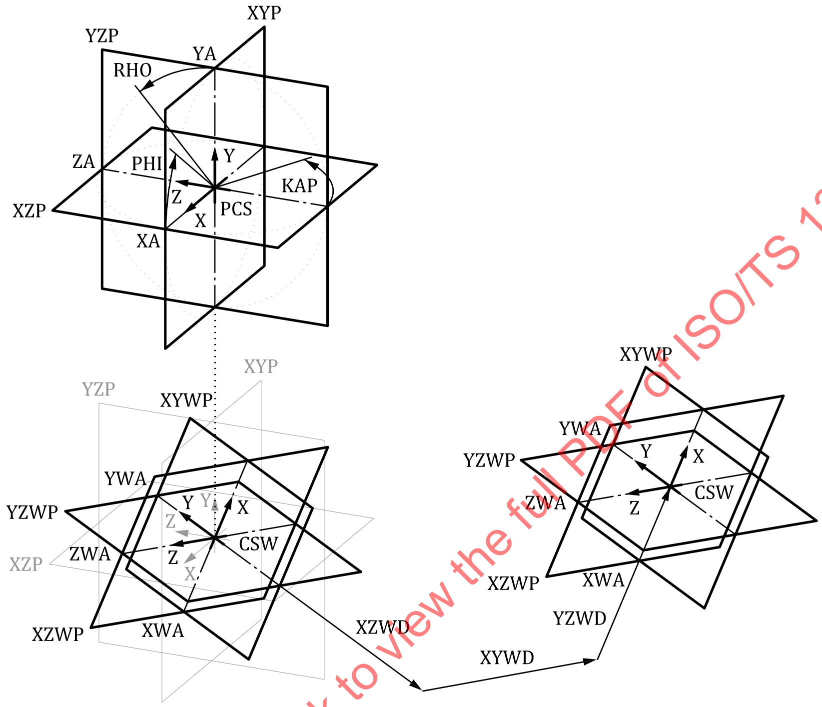


Figure 4 — Coordinate system at workpiece side — Orientation

The appropriate properties shall be indexed in the same logic as described in the different cases of the coordinate system workpiece side designations.

5.3.4 Arrangement of coordinate system at workpiece side for coolant supply

The positioning of coolant supply assemblies shall be done by means of using the coordinate system at workpiece side coolant supply CSW_C as shown in Figure 5. If more than one CSW_C is on the driven adaptive item, the CSW_Cs shall be indexed as described in case 3 but without defining the level, e.g., CSW_C1, CSW_C2.

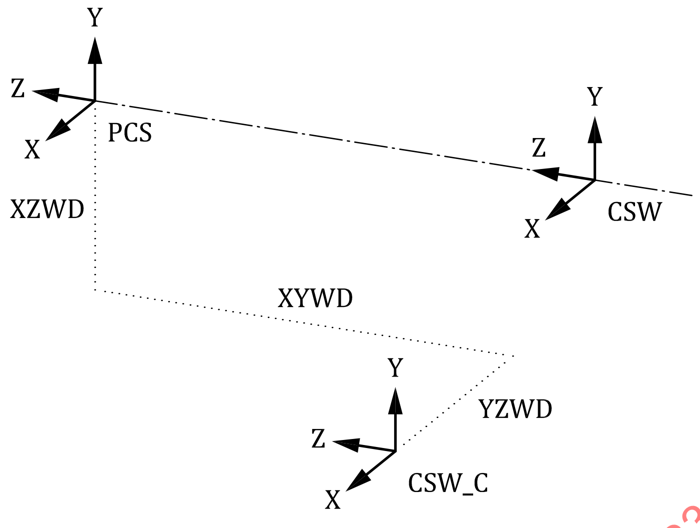


Figure 5 — Arrangement of coordinate system at workpiece side for coolant supply

5.4 Mounting coordinate system

For virtually mounting of feed out tools onto an adaptive item or directly into the machine tool an additional reference system shall be defined. This reference system shall be called MCS. It is located at the starting point of the protruding length of a tool item. The orientation is shown in Figure 6.

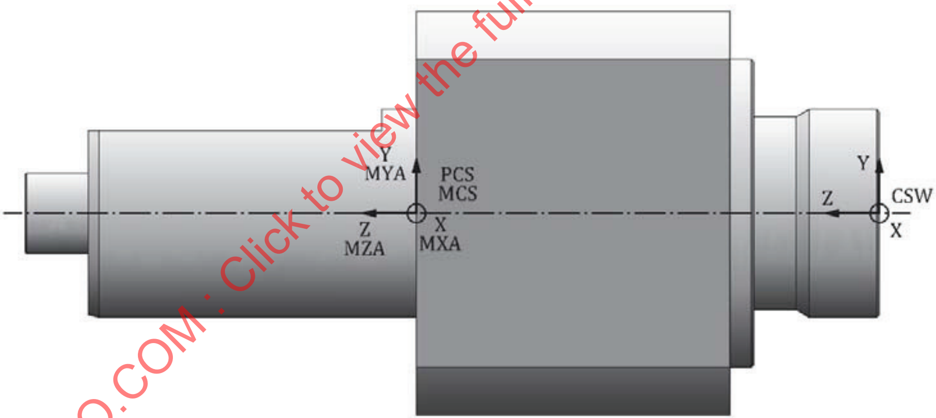


Figure 6 — Example of the orientation of PCS and MCS reference system

6 Design of the model

6.1 General

The sketches and contours of the crude geometry do not contain any details, such as grooves, chamfers or roundings. These details shall be designed as separate design features after the design of the crude geometry and therefore are named precision geometry.

The order of the structure of the model shall be kept by means of the state of the technology of the CAD systems. It shall be waived on references between the design components of the cutting and non-cutting part.

Adaptive items shall be built either as rotational symmetric design elements, if they are revolving about their axis, or as extrusion design, if they are designed non-symmetrically, both based on properties in accordance with ISO/TS 13399-4:

— geometry of the non-cutting part - including the connection interface, if applicable.

The part shall be coloured as defined in ISO/TS 13399-80.

NOTE The total amount of design elements is focused on the depth of modelling and the complexity of the adaptive item.

Within the following clauses the specific structure of the model of the defined basic shapes of driven adaptive items is described. If the driven adaptive items are equipped with decentral coolant devices that may impact possible collisions, these features shall also be a part of the model.

6.2 Assembly parts relevant for collision

6.2.1 General

All relevant parts, which may impact the collision contour, shall be designed and added to the model. If for example the connection on output side is defined as collet connection, the lock nut for the collet shall be part of the model. The same shall be determined for the pipe of a decentral coolant supply.

6.2.2 Coolant supply pipe

For the design of coolant supply pipes temporary properties shall be used. Only the protruding length of the pipe shall be part of the data exchange file, to be able to examine collision observations. Figure 7 shows an example of the design of a coolant supply pipe.

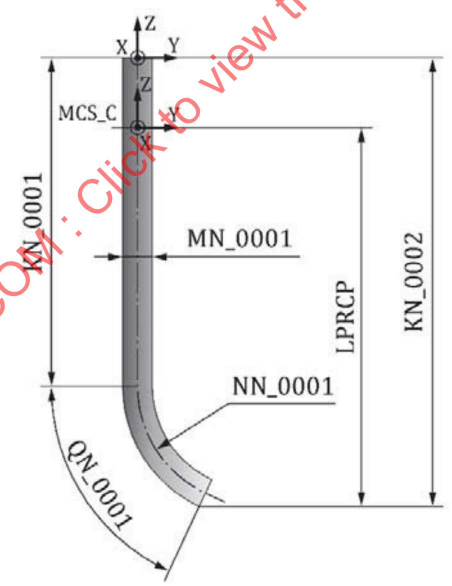


Figure 7 — Example of a coolant supply pipe

7 Driven tool unit of straight design (ISYC: 403-01)

7.1 General

Figure 8 shows the properties used for identification and classification of straight designed driven tool units. The example shows a driven unit with collet connection on workpiece side.

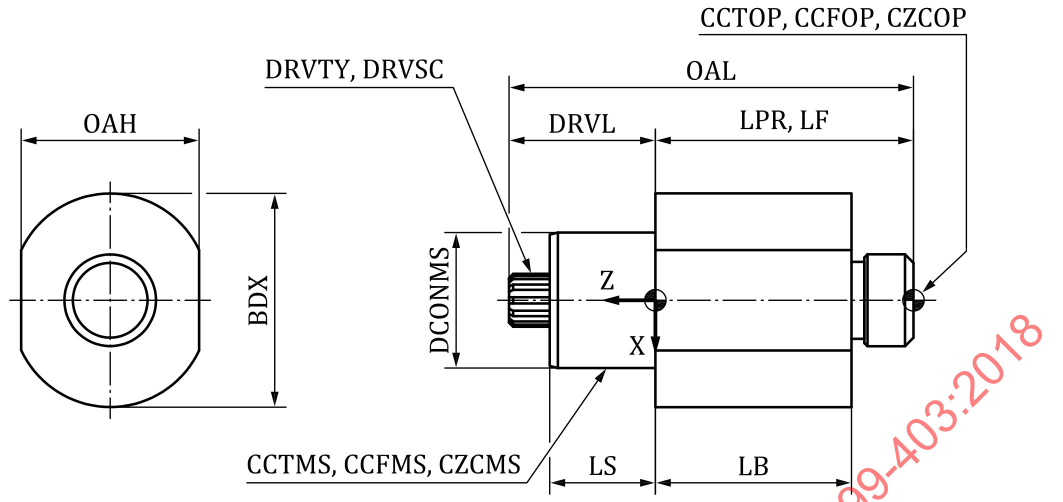


Figure 8 — Determination of properties of a driven tool unit of straight design

7.2 Basic body

Figure 9 shows the basic body without any assembly part, which are relevant for collision examination.

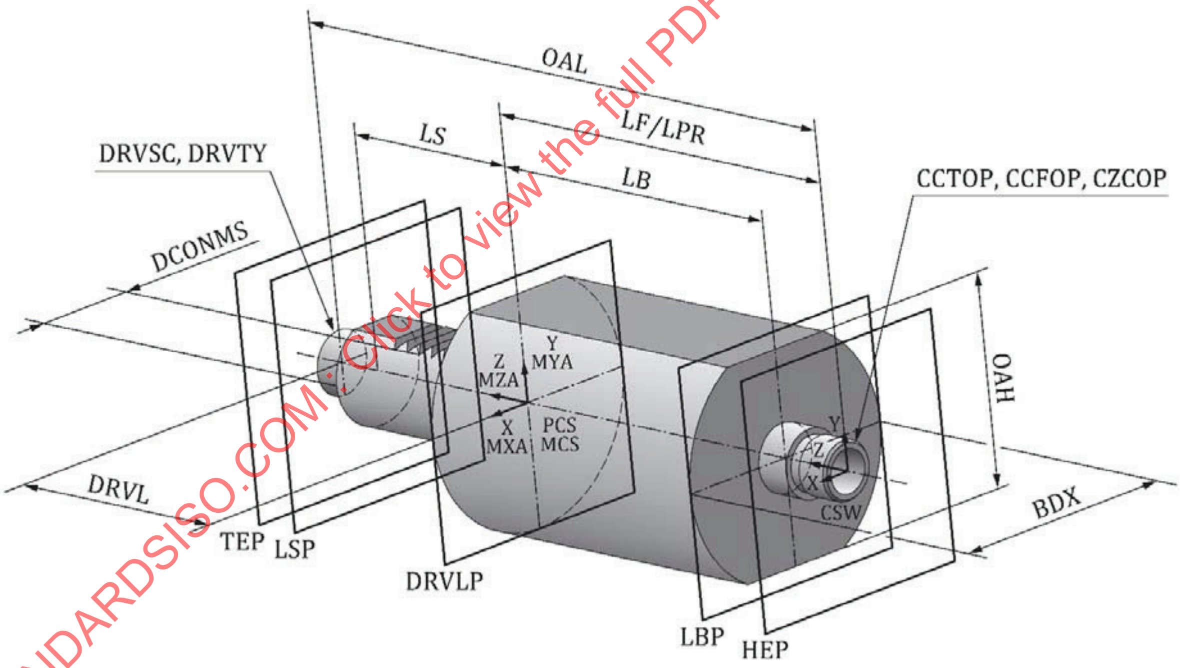
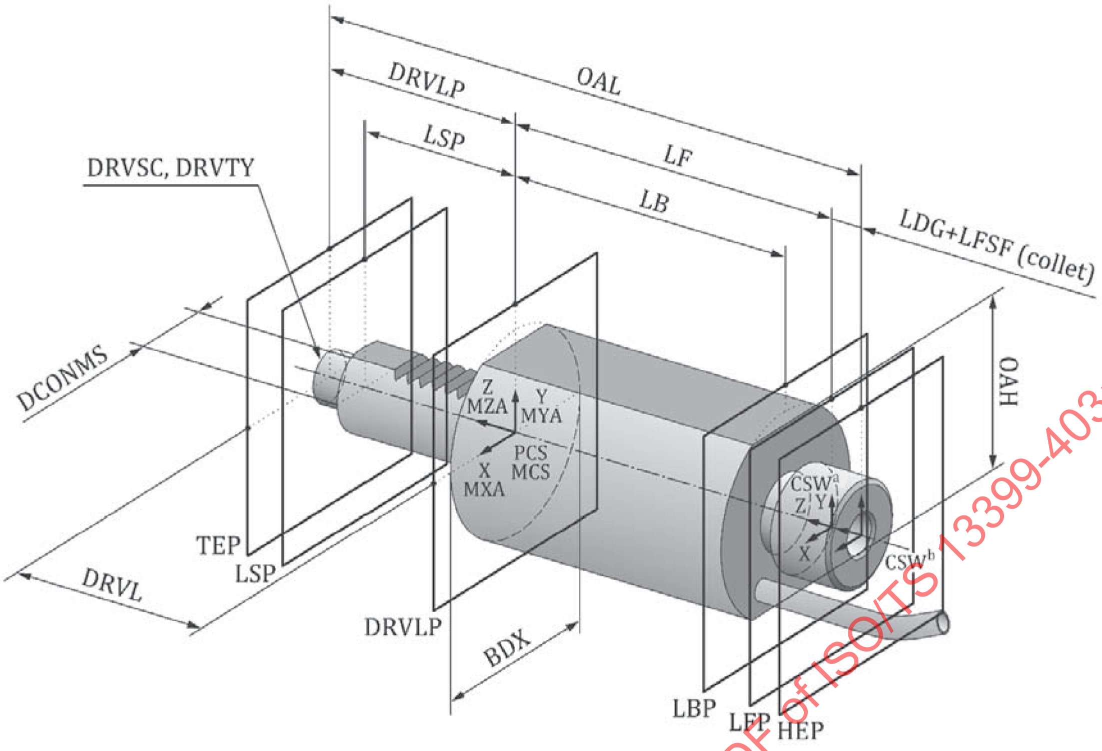


Figure 9 — Basic body of driven tool unit of straight design

7.3 Assembled driven tool unit of straight design

Figure 10 shows an assembled driven tool unit of straight design with collet nut and coolant supply pipe.



a CSW of adaptor.

b CSW of collet.

Figure 10 — Assembled driven tool unit of straight design

8 Driven tool unit with straight offset design (ISYC: 403-02)

8.1 General

Figure 11 shows the properties used for identification and classification of straight offset designed driven tool units. The example shows a driven unit with 7/24 taper connection on workpiece side.

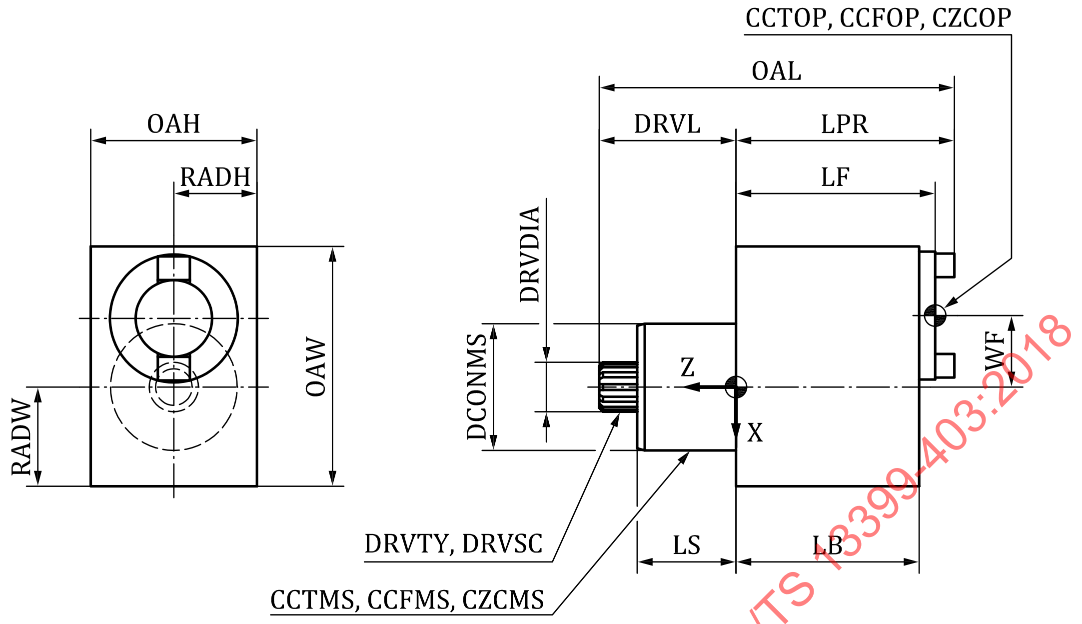


Figure 11 — Determination of properties of a driven tool unit of straight offset design

8.2 Basic body

The design shall be done as described in 7.2.

8.3 Assembled driven tool unit of straight offset design

The assembly shall be done as described in 7.3.

9 Driven tool unit with rotatable design about the y-axis (ISYC: 403-03)

9.1 General

Figure 12 shows the properties used for identification and classification of driven tool units that are rotatable about the y-axis. The example shows a driven unit with collet connection on workpiece side.

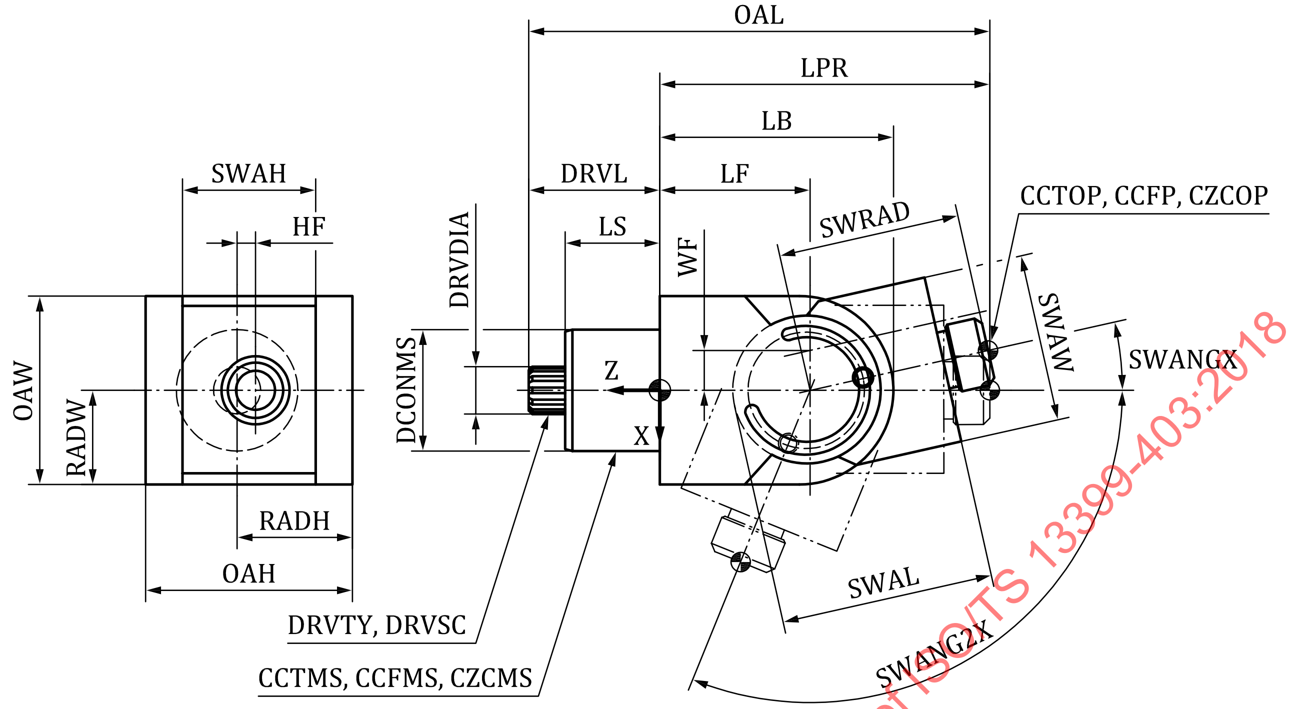


Figure 12 — Determination of properties of a driven tool unit of a design allowing rotation about y-axis

9.2 Basic body

The basic body consists of two main parts: the main body, which is connected to the machine tool, and the swing part, which carries the cutting tool. Figure 13 shows an example of the main body and Figure 14 shows an example of the swing part of the driven tool unit.

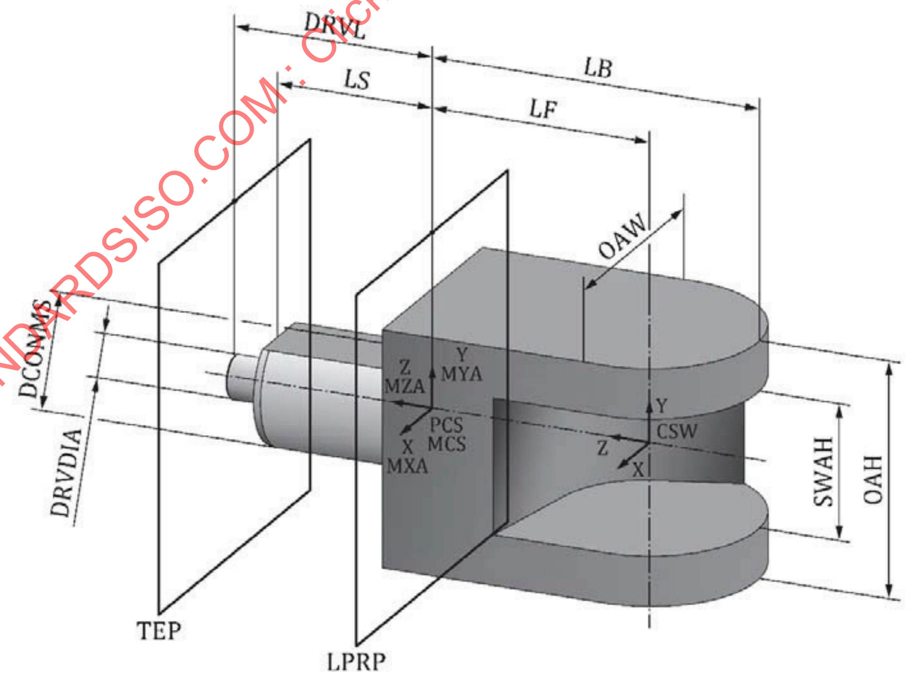
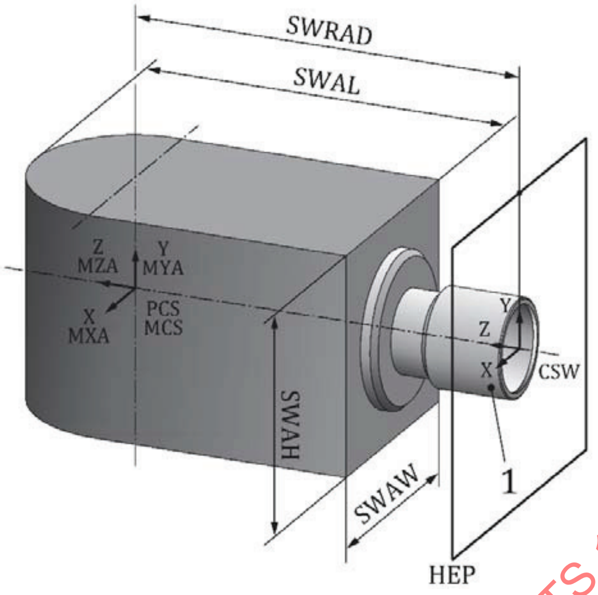


Figure 13 — Main body of driven tool unit



Key

1 outside contour of collet connection (see ISO/TS 13399-406)

Figure 14 — Swing part of driven tool unit

9.3 Assembled driven tool unit, rotatable about the y-axis

Figure 15 shows an assembled driven tool unit, rotatable about the y-axis with collet connection. Figure 15 shows also the extreme positions of the connection.

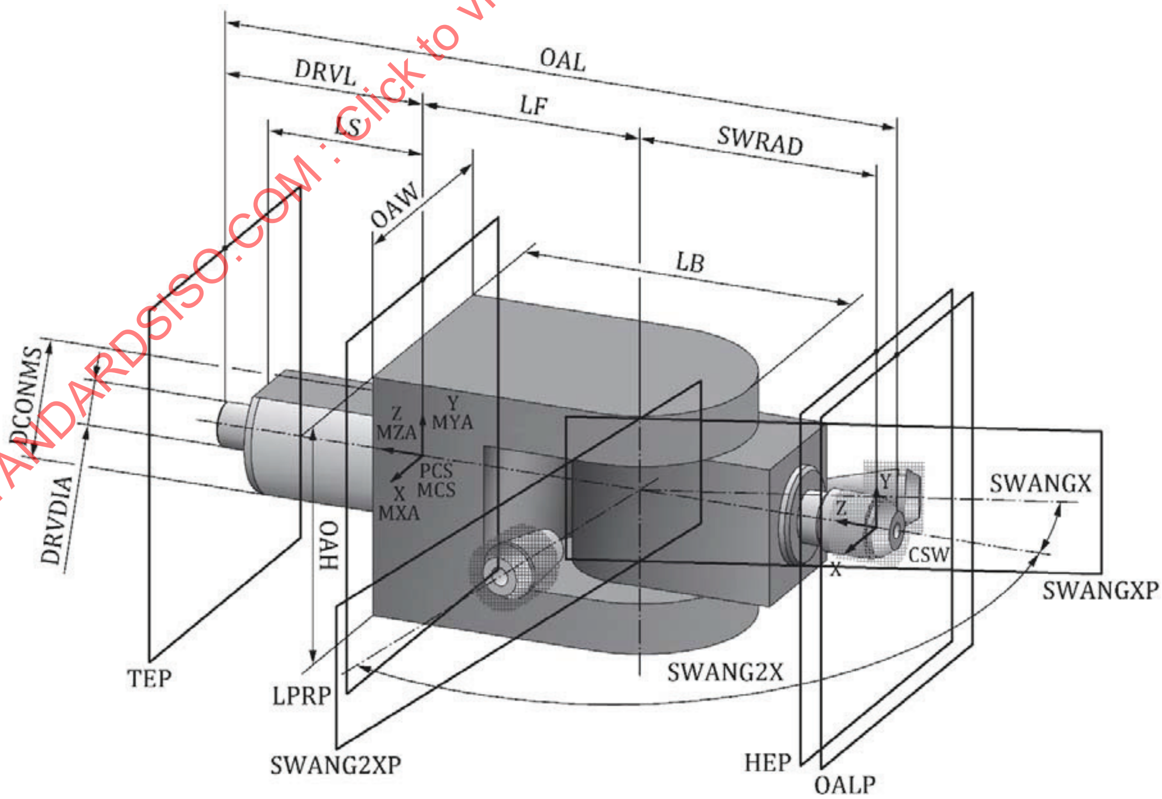
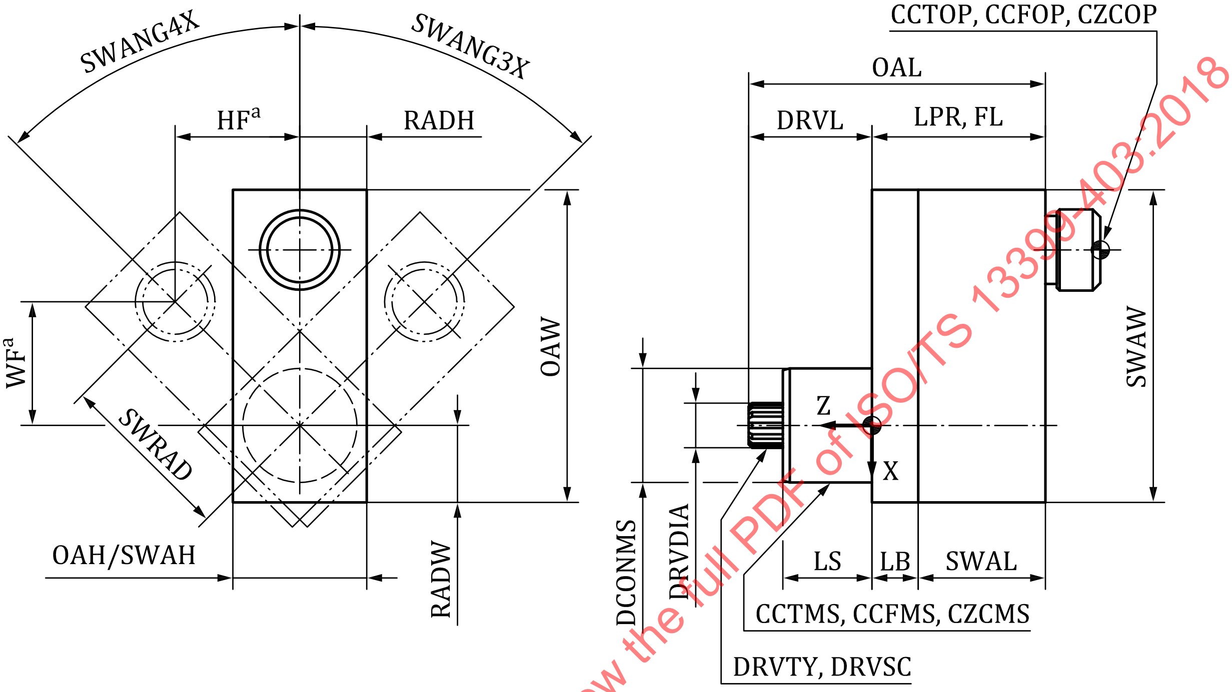


Figure 15 — Assembled driven tool unit with rotatable design about the y-axis

10 Driven tool unit with rotatable design about the z-axis (ISYC: 403-04)

10.1 General

Figure 16 shows the properties used for identification and classification of driven tool units that are rotatable about the z-axis. The example shows a driven unit with 7/24 taper connection on workpiece side.



a HF and WF are dependent on SWRAD and on SWANG3X or SWANG4X.

Figure 16 — Determination of properties of a driven tool unit of a design allowing rotation about z-axis

10.2 Basic body

The basic body consists of two main parts: the main body, which is connected to the machine tool, and the swing part, which carries the cutting tool. Figure 17 shows an example of the main body and Figure 18 shows an example of the swing part of the driven tool unit.

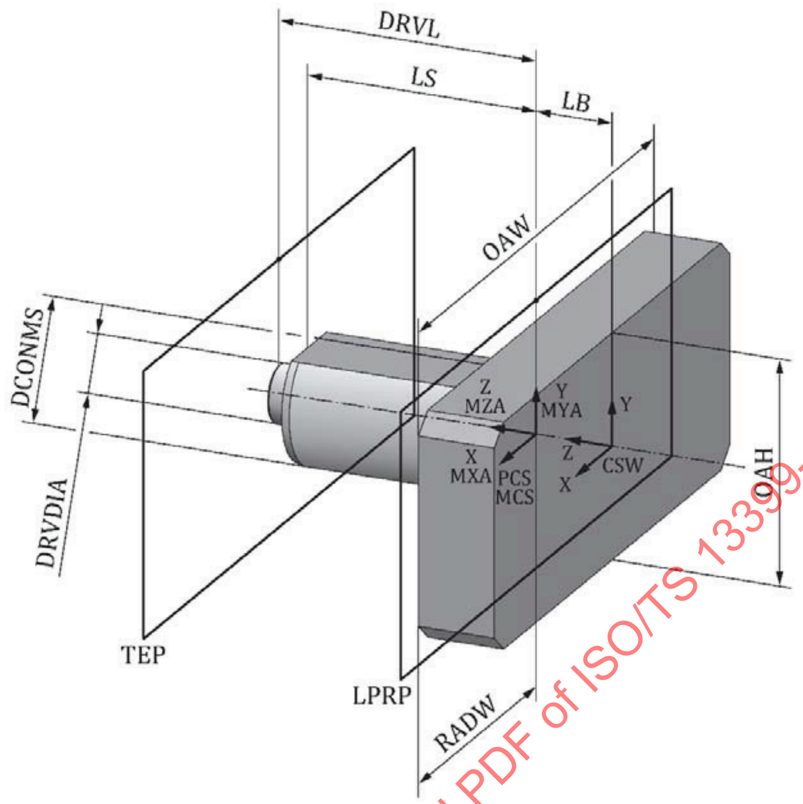


Figure 17 — Main body of driven tool unit

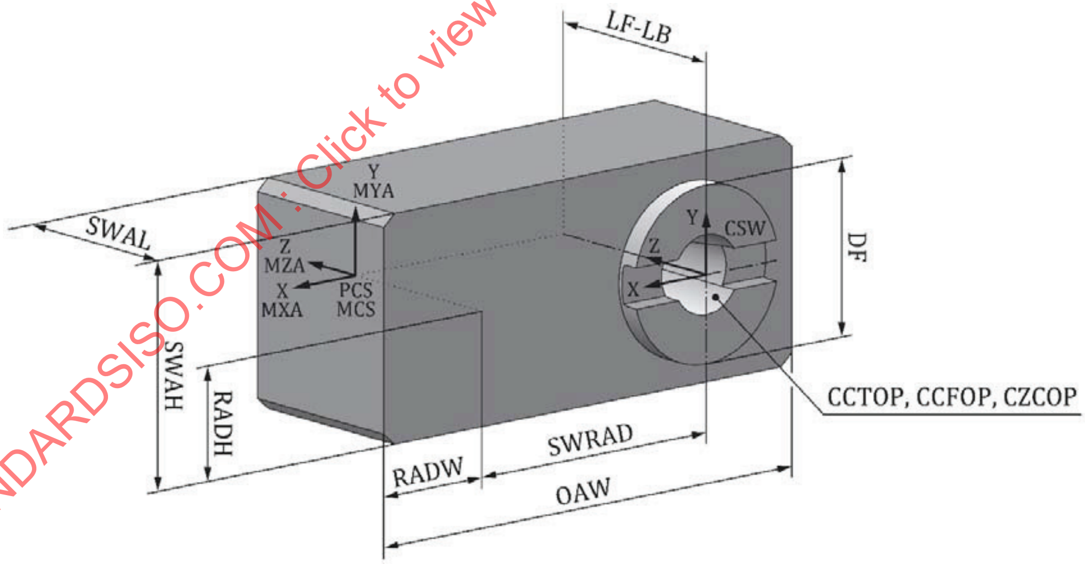


Figure 18 — Swing part of driven tool unit

10.3 Assembled driven tool unit rotatable about the z-axis

Figure 19 shows an assembled driven tool unit, rotatable about the z-axis with collet connection. Figure 19 shows also the extreme positions of the connection.

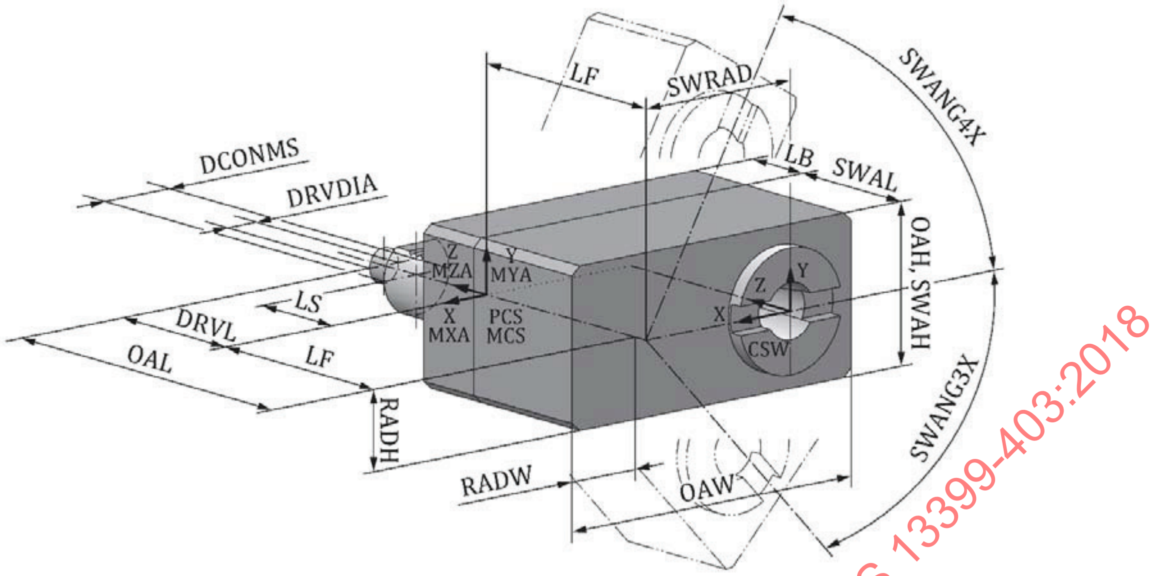


Figure 19 — Assembled driven tool unit with rotatable design about the z-axis

11 Driven tool unit with 90° output design (ISYC: 403-05)

11.1 General

Figure 20 shows the properties used for identification and classification of driven tool units having a 90° output on the side. The example shows a model of a driven unit with a hollow taper connection on workpiece side.

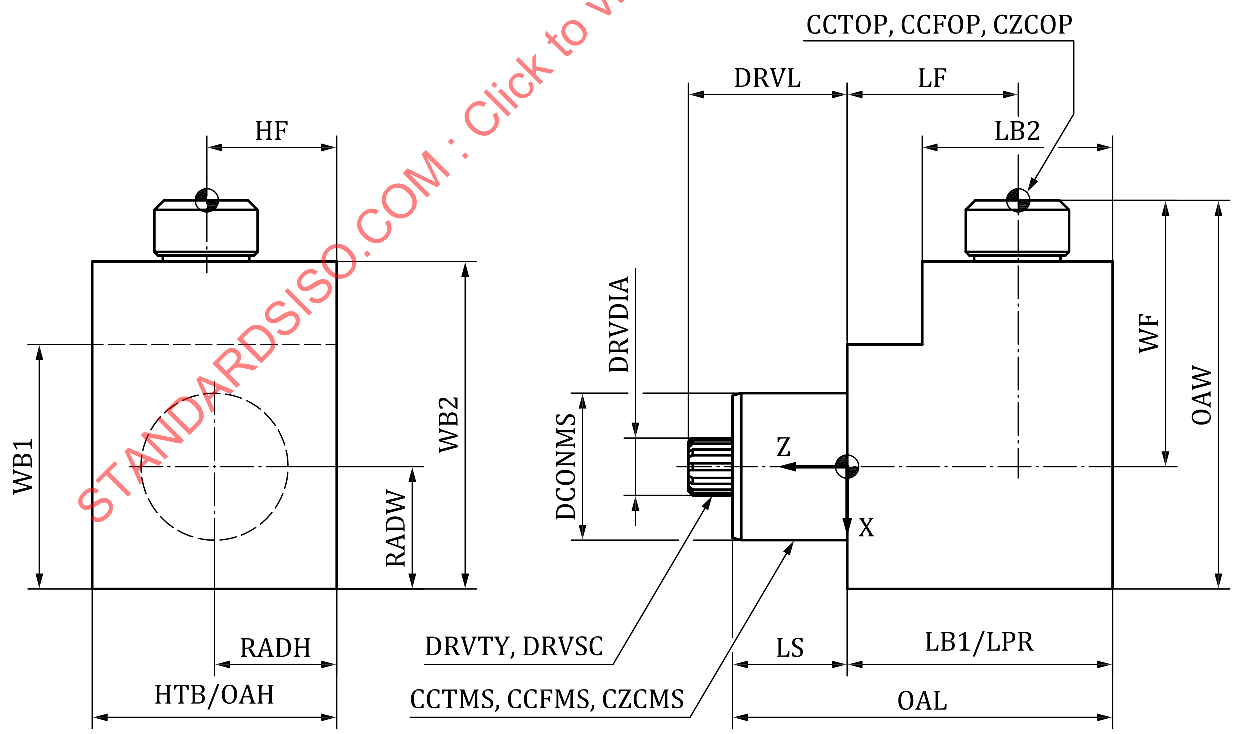


Figure 20 — Determination of properties of a driven tool unit with a 90° output design

Instead of a rectangular cross section defined with the properties WB1 and HTB the body may also have a round profile with the property BD.

11.2 Basic body

Figure 21 shows an example of a driven tool unit with hollow taper interface and torque bracing.

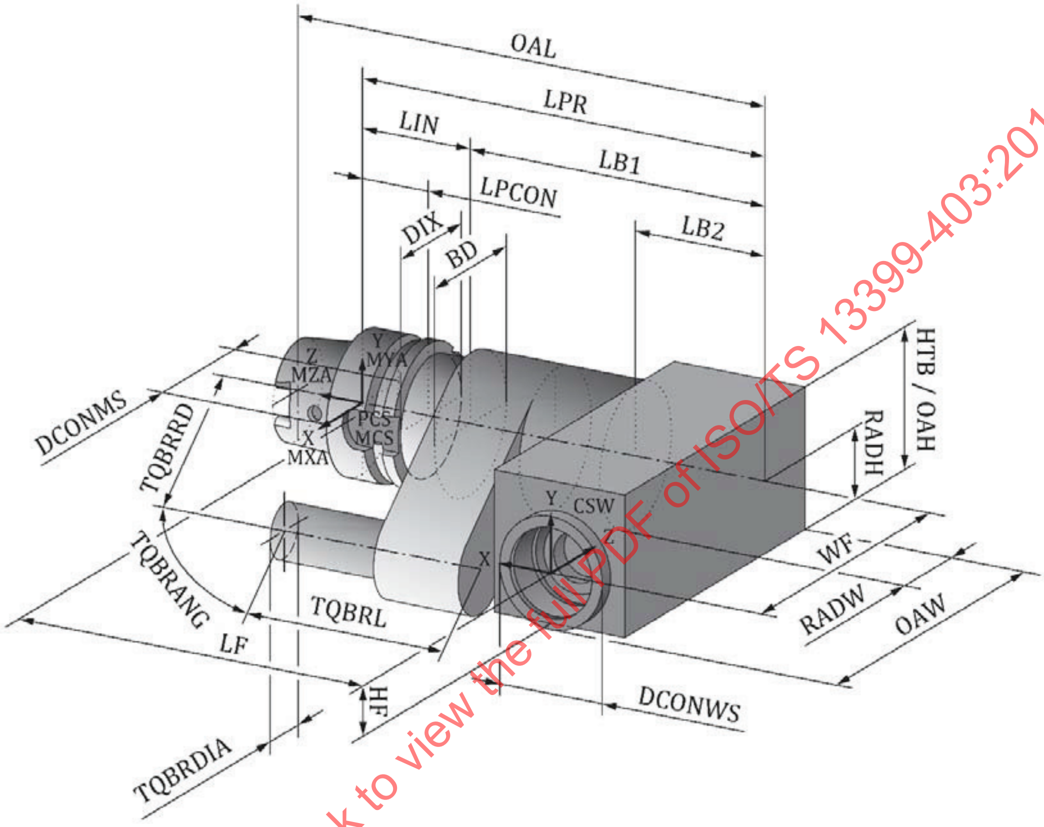
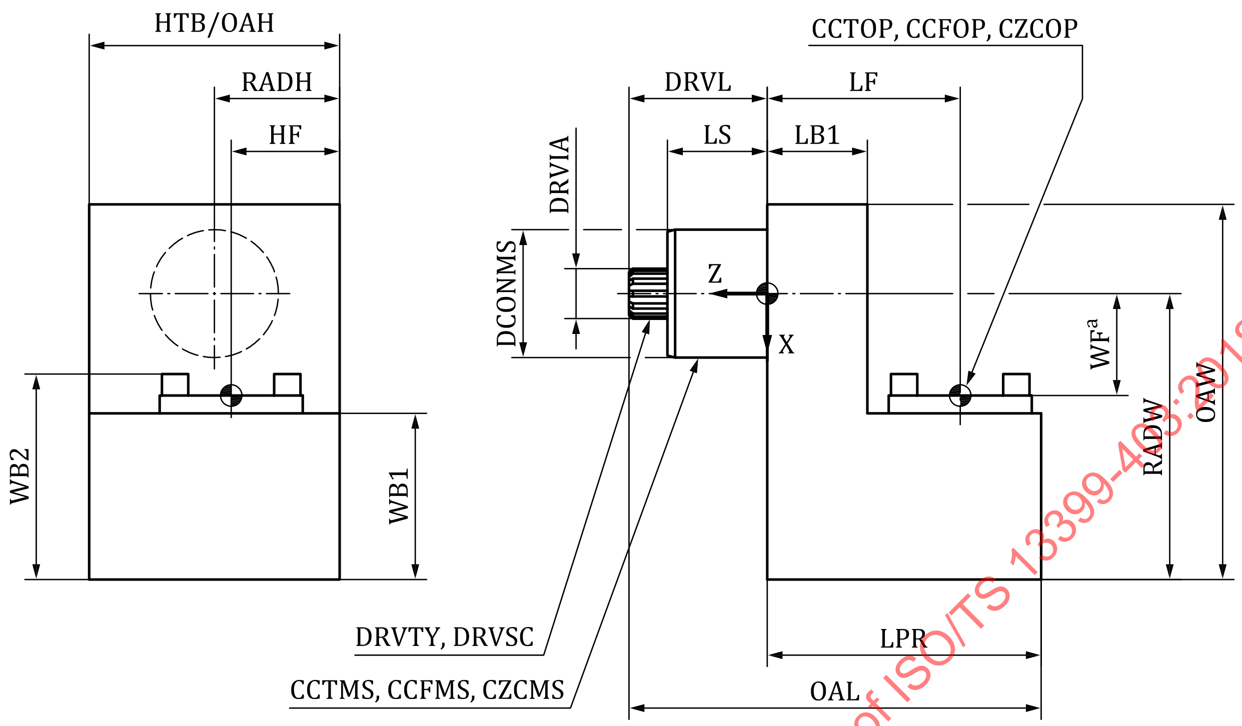


Figure 21 — Assembled driven tool unit with 90° output design and torque bracing

12 Driven tool unit of a 90° reverse position output design (ISYC: 403-06)

12.1 General

Figure 22 shows the properties used for identification and classification of driven tool units that have a 90° output on the side. The example shows a model of a driven unit with a hollow taper connection on workpiece side.



a WF shall be a negative value.

Figure 22 — Determination of properties of a driven tool unit with a 90° reverse position output design

12.2 Basic body

For the modelling, see 11.2 with a reverse position of the output connection.

13 Driven tool unit of a 90° output design allowing rotation about z-axis (ISYC: 403-07)

13.1 General

Figure 23 shows the properties used for identification and classification of driven tool units that have a 90° output design and are rotatable about the Z-axis.

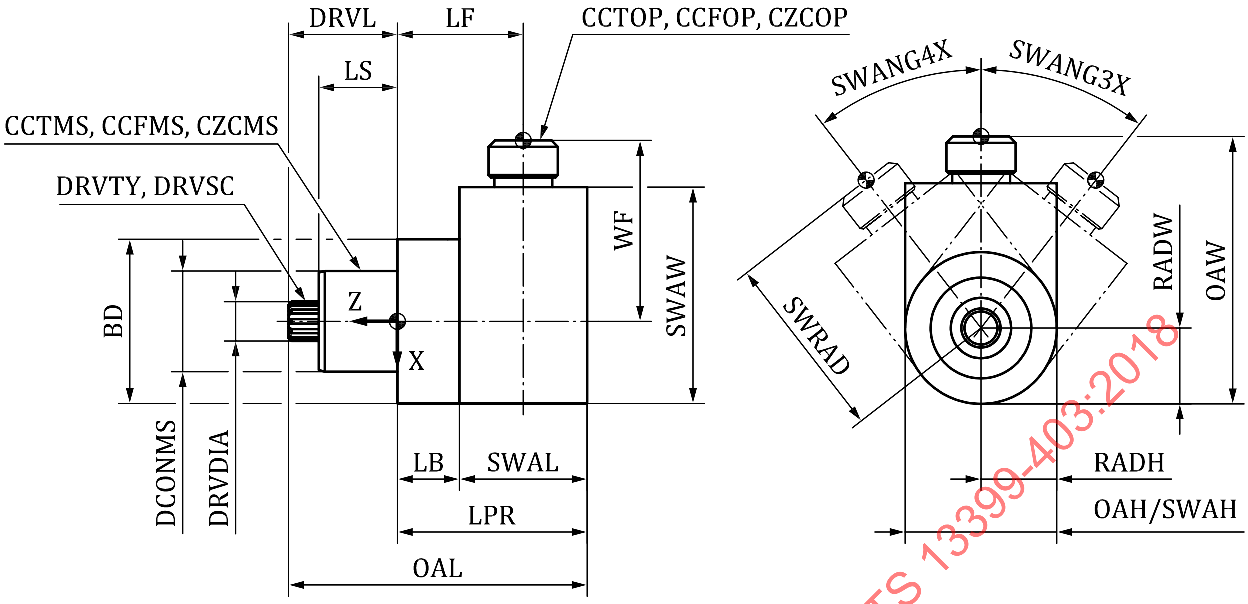


Figure 23 — Determination of properties of a driven tool unit of a 90° output design allowing rotation about z-axis

13.2 Basic body

For the modelling, see 10.2 with a 90° position of the output connection.

14 Driven tool unit of fixed angular output design (ISYC: 403-08)

14.1 General

Figure 24 shows the properties used for identification and classification of driven tool units that have a fixed angular output design.

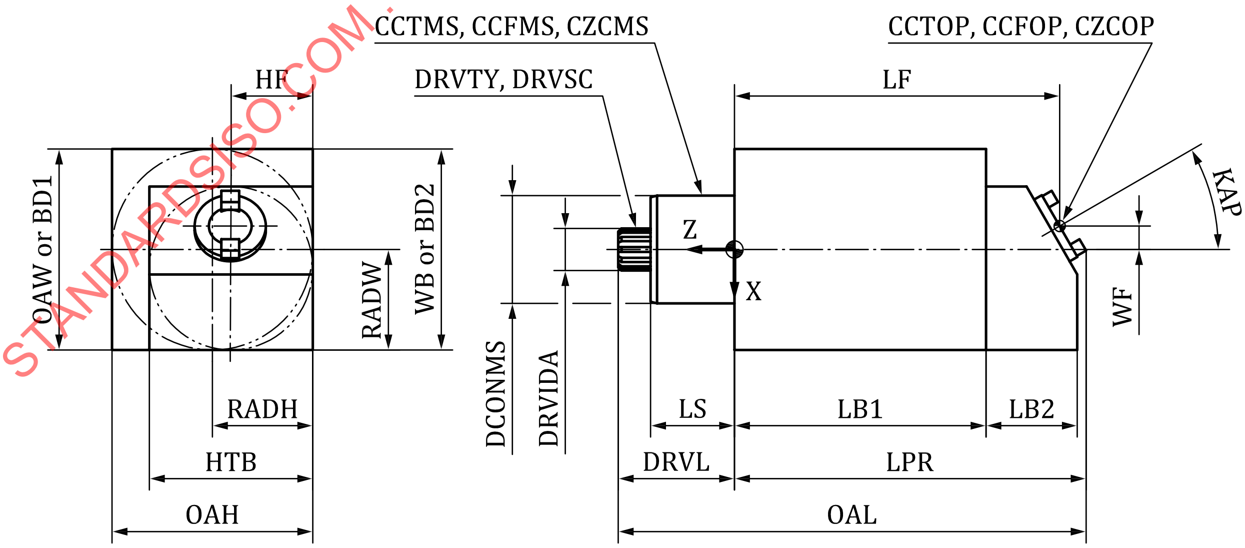


Figure 24 — Determination of properties of a driven tool unit of fixed angular output design

14.2 Basic body

Figure 25 shows a driven tool unit with fixed angular output and a positive offset from the tool axis.

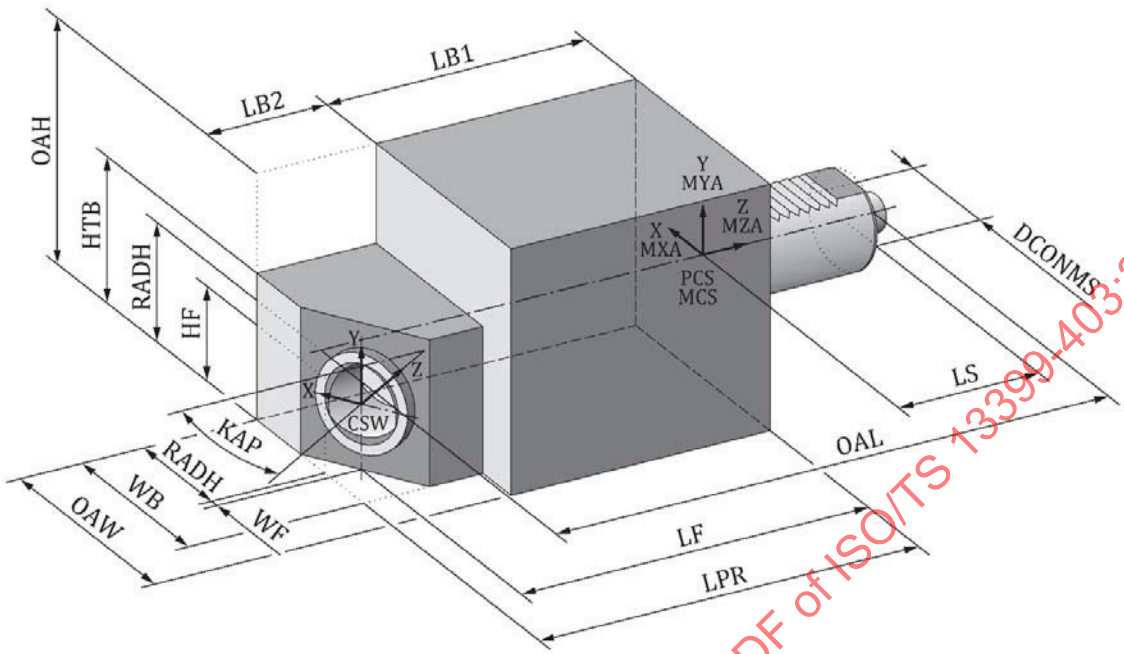
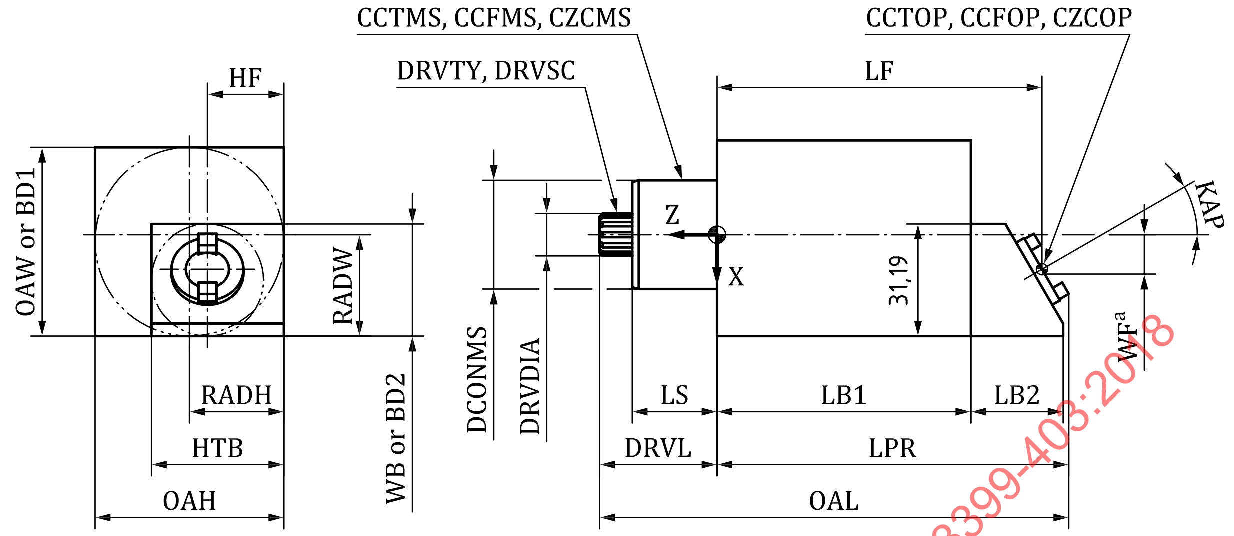


Figure 25 — Assembled driven tool unit with fixed angular output design

15 Driven tool unit of fixed angular and negative offset output design (ISYC: 403-09)

15.1 General

Figure 26 shows the properties used for identification and classification of driven tool units that have a fixed angular output design and a negative offset from the tool axis.



[a] WF shall be a negative value.

Figure 26 — Determination of properties of a driven tool unit of fixed angular and negative offset output design

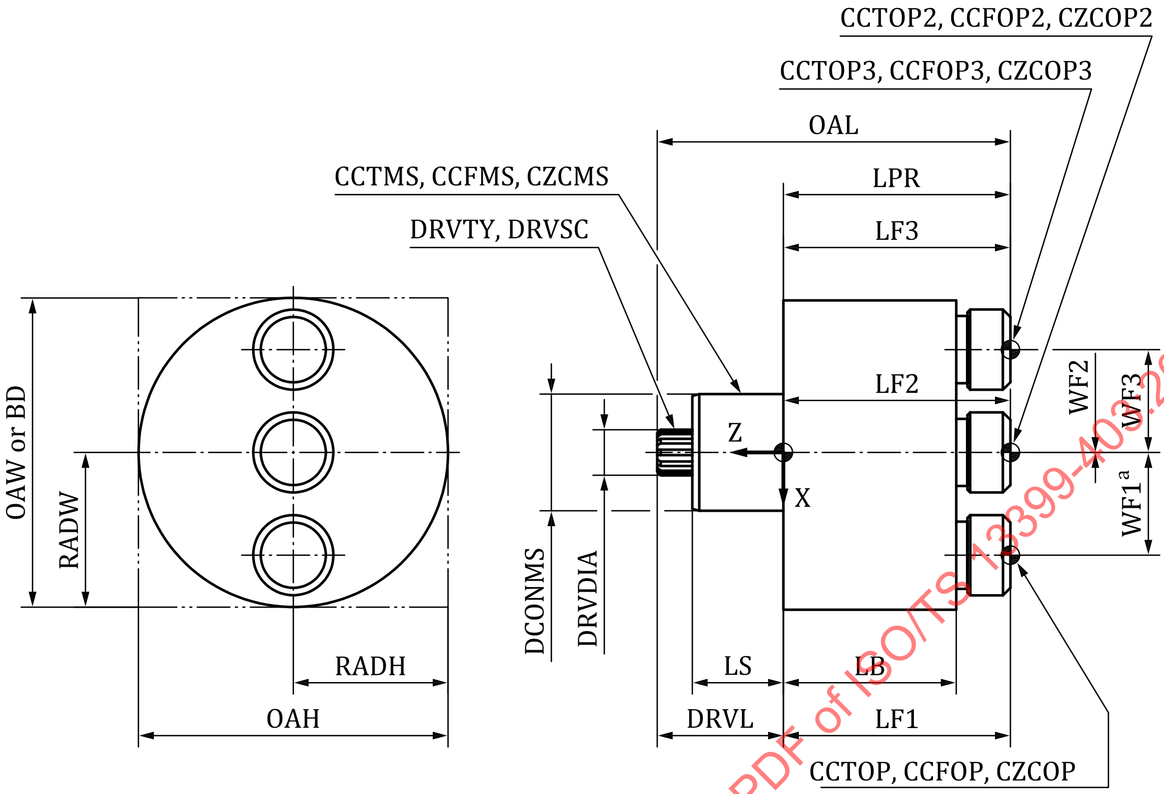
15.2 Basic body

For the modelling, see 14.2 with a negative position of the output connection.

16 Driven tool unit of straight design with multiple outputs (ISYC: 403-10)

16.1 General

Figure 27 shows the properties used for identification and classification of driven tool units that have a straight design with multiple outputs.



[a] WF1 shall be a negative value.

Figure 27 — Determination of properties of a driven tool unit of straight design with multiple outputs

16.2 Basic body

Figure 28 shows an example of a design with multiple outputs linear arranged. Other arrangements shall be possible by means of using the determinations of coordinate systems described in 5.3.

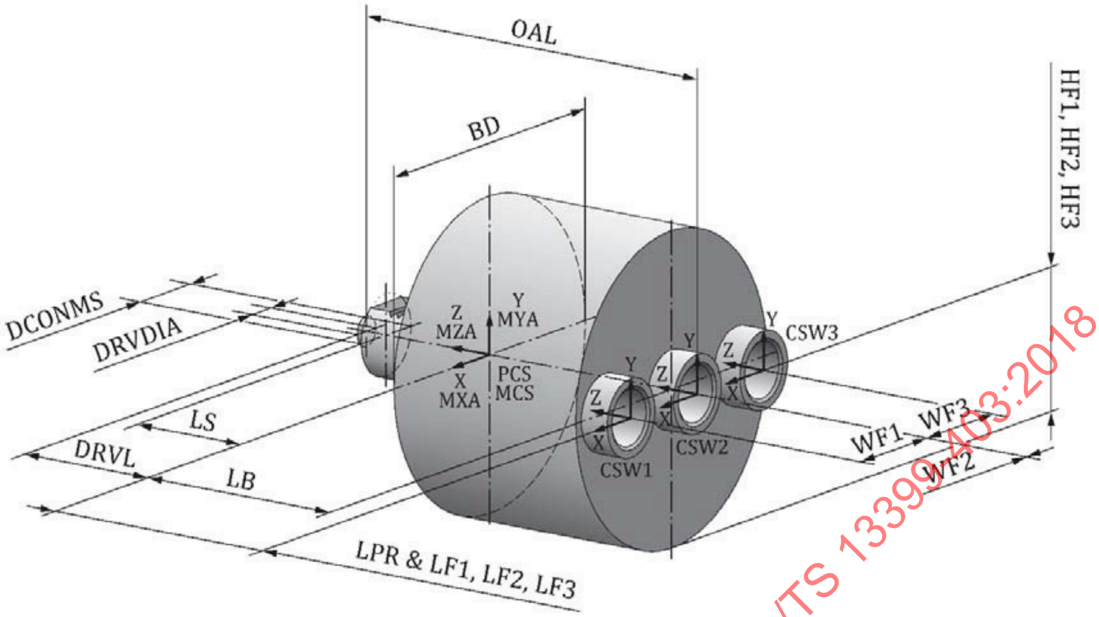


Figure 28 — Assembled driven tool unit with straight multiple output design

17 Driven tool unit of straight offset design with multiple outputs (ISYC: 403-11)

17.1 General

Figure 29 shows the properties used for identification and classification of driven tool units that have a straight offset design with multiple outputs.

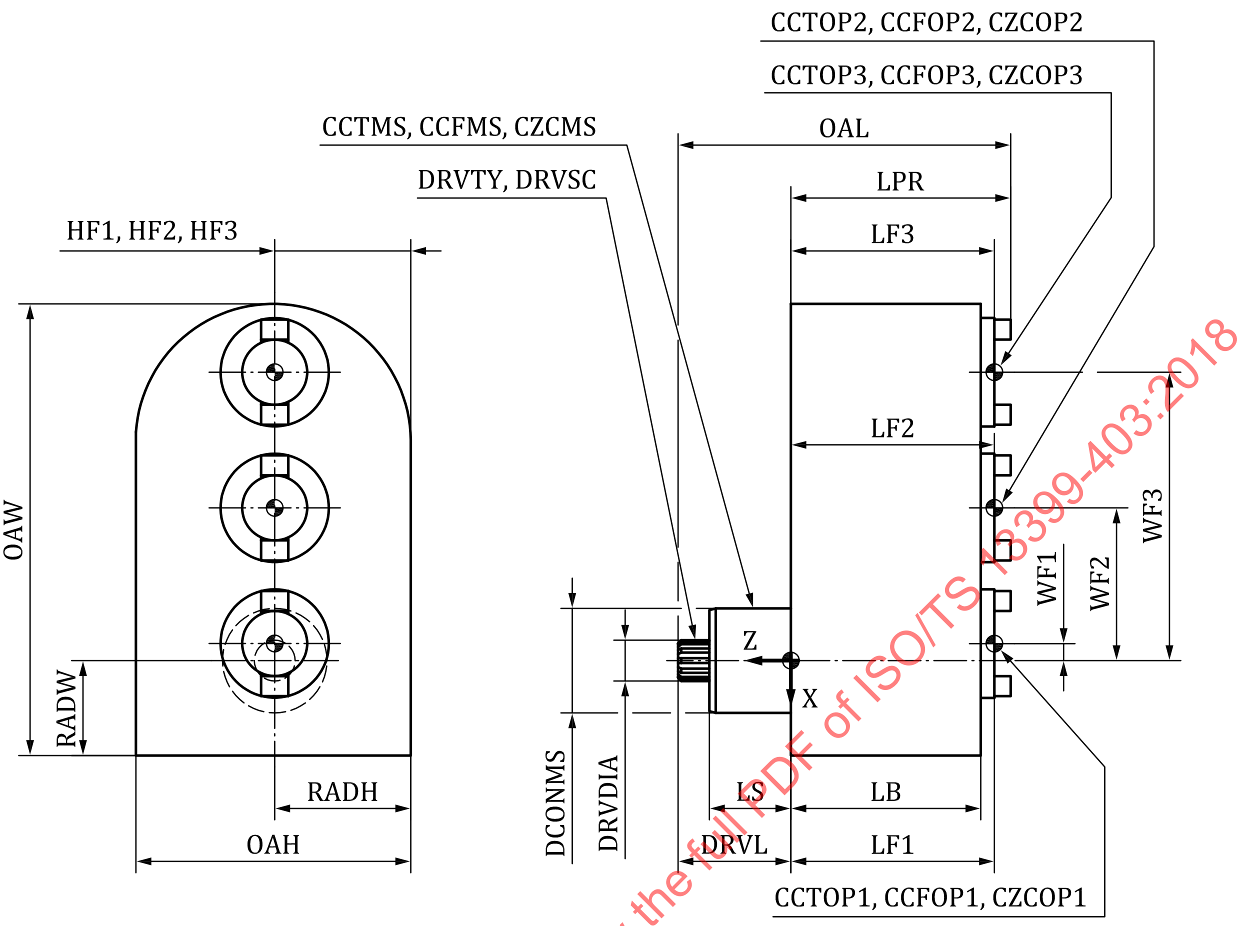


Figure 29 — Determination of properties of a driven tool unit of straight offset design with multiple outputs

17.2 Basic body

For the modelling, see 16.2 with an offset position of the output connection.

18 Driven tool unit of 90° design with multiple outputs (ISYC: 403-12)

18.1 General

Figure 30 shows the properties used for identification and classification of driven tool units that have a 90° design with multiple outputs.

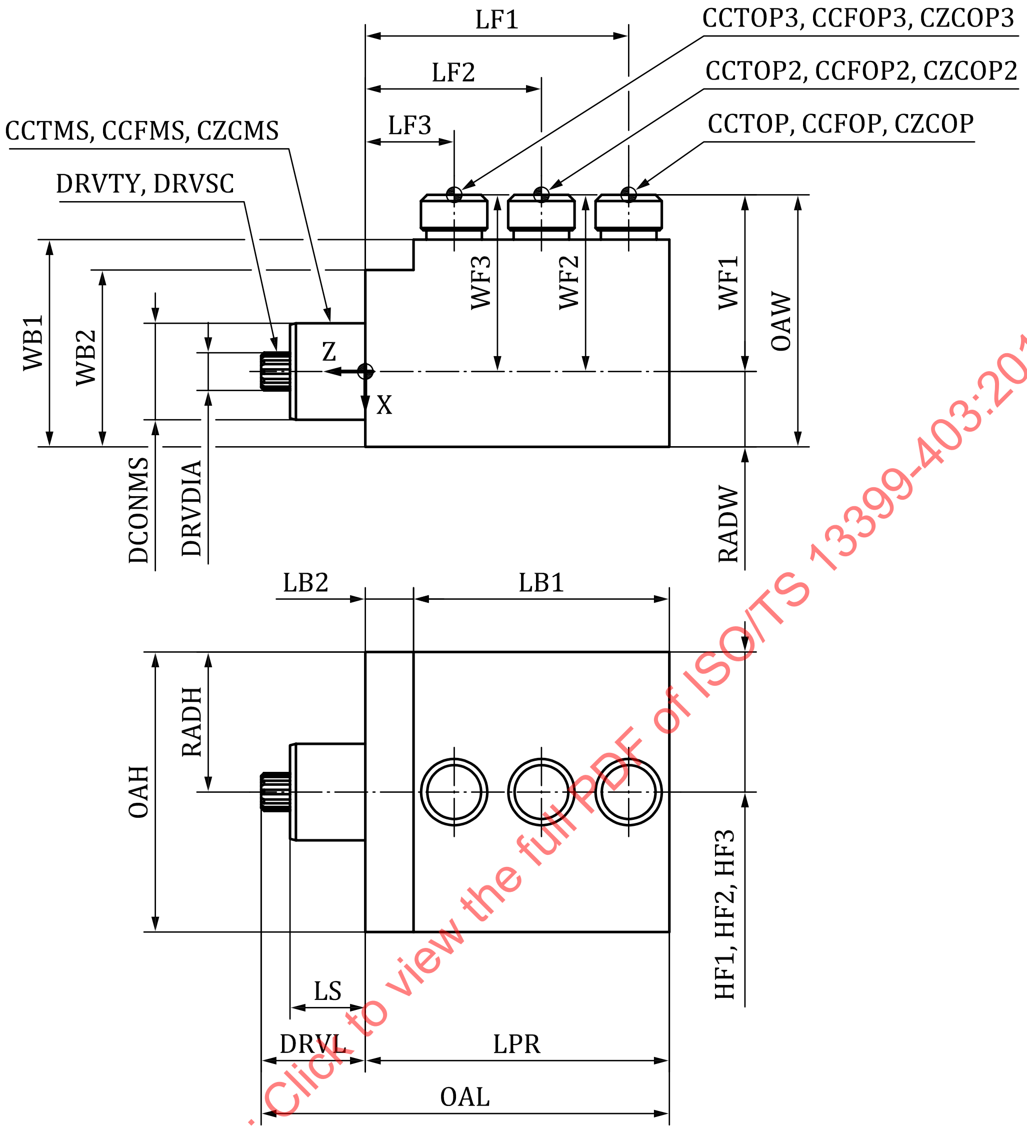


Figure 30 — Determination of properties of a driven tool unit of 90° design with multiple outputs

18.2 Basic body

For the modelling, see 16.2 with a 90° linear ordering of the position of the output connections.

19 Driven tool unit of 90° dual output design (ISYC: 403-13)

19.1 General

Figure 31 shows the properties used for identification and classification of driven tool units that have a 90° dual output design.