TECHNICAL SPECIFICATION

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Cutting tool data representation and exchange —

Part 70: Graphical data layout — Layer setting for tool layout

Représentation et échange des données relatives aux outils coupants —
Partie 70: Disposition des données graphiques — Disposition en couches des paramètres des outils

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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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For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 29, *Small tools*.

ISO/TS 13399 consists of the following parts, under the general title *Cutting tool data representation and exchange*:

— *Part 1: Overview, fundamental principles and general information model*

— *Part 2: Reference dictionary for the cutting items* [Technical Specification]

— *Part 3: Reference dictionary for tool items* [Technical Specification]

— *Part 4: Reference dictionary for adaptive items* [Technical Specification]

— *Part 5: Reference dictionary for assembly items* [Technical Specification]

— *Part 50: Reference dictionary for reference systems and common concepts* [Technical Specification]

— *Part 60: Reference dictionary for connection systems* [Technical Specification]

— *Part 70: Graphical data layout — Layer settings for tool layout* [Technical Specification]

— *Part 71: Graphical data layout — Creation of documents for the standardized data exchange — Graphical product information* [Technical Specification]

— *Part 72: Creation of documents for the standardized data exchange — Definition of properties for drawing header and their XML-data exchange* [Technical Specification]

— *Part 150: Usage guidelines* [Technical Specification]

— *Part 201: Creation and exchange of 3D models — Regular inserts* [Technical Specification]

— *Part 202: Creation and exchange of 3D models — Irregular inserts* [Technical Specification]

— *Part 203: Creation and exchange of 3D models — Replaceable inserts for drilling* [Technical Specification]

— *Part 204: Creation and exchange of 3D models — Inserts for reaming* [Technical Specification]

— *Part 301: Concept for the design of 3D models based on properties according to ISO/TS 13399-3: Modelling of thread-cutting taps, thread-forming taps and thread-cutting dies* [Technical Specification]

— *Part 302: Concept for the design of 3D models based on properties according to ISO/TS 13399-3: Modelling of solid drills and countersinking tools* [Technical Specification]

— *Part 303: Creation and exchange of 3D models — Solid end mills* [Technical Specification]

— *Part 304: Creation and exchange of 3D models — Solid milling cutters with arbor hole* [Technical Specification]

— *Part 307: Creation and exchange of 3D models — End mills for indexable inserts* [Technical Specification]

— *Part 308: Creation and exchange of 3D models — Milling cutters with arbor hole for indexable inserts* [Technical Specification]

— *Part 309: Creation and exchange of 3D models — Tool holders for indexable inserts* [Technical Specification]

— *Part 311: Creation and exchange of 3D models — Solid reamers* [Technical Specification]

— *Part 312: Creation and exchange of 3D models — Reamers for indexable inserts* [Technical Specification]

— *Part 401: Creation and exchange of 3D models — Converting, extending and reducing adaptive items* [Technical Specification]

— *Part 403: Creation and exchange of 3D models — Modelling of driven tool units* [Technical Specification]

— *Part 405: Creation and exchange of 3D models — Collets* [Technical Specification]

— *Part 406: Creation and exchange of 3D models — Modelling of connection interface* [Technical Specification]

The following parts are under preparation:

— *Part 80: Creation and exchange of 3D models — Overview and principles* [Technical Specification]

— *Part 100: Definitions, principles and methods for reference dictionaries* [Technical Specification]

— *Part 305: Creation and exchange of 3D models — Modular tooling systems with adjustable cartridges for boring* [Technical Specification]

— *Part 310: Creation and exchange of 3D models — Turning tools with carbide tips* [Technical Specification]

— *Part 313: Creation and exchange of 3D models — Creation and exchange of 3D models — Burrs* [Technical Specification]

— *Part 314: Creation and exchange of 3D models — Creation and exchange of 3D models — Cartridges for indexable inserts* [Technical Specification]

— *Part 315: Creation and exchange of 3D models — Modelling of machine operated feed out tools* [Technical Specification]

Introduction

This part of ISO/TS 13399 defines the terms, properties and definitions of the layers of a computer-aided design. The purpose of this part of ISO/TS 13399 is to provide a reference layer setting to support the use of CAD-designs of tool graphics to be used for simulation and documentation of cutting tool components and assemblies. The basis of this part of ISO/TS 13399 is the common layer structure of the production facility graphic — better known as the BMG (building model generation) layer structure. Mainly, this concept was used and will be used for the graphical layout of cutting tools and their components within the 2D area. Examples of the layer structure are given in Annex A.

Cutting tool data representation and exchange —

Part 70:
Graphical data layout — Layer setting for tool layout

1 Scope

This part of ISO/TS 13399 is intended to be used for the design of tool layouts for the simulation and the documentation of cutting tool components and cutting tool assemblies. This part of ISO/TS 13399 can be used in connection and correlation with other parts of ISO/TS 13399.

The main purpose of this layer structure is the graphical layout of cutting tool components and cutting tool assemblies to be used within tool pre-setting, NC programming and the simulation of processes, as well as for the design of the machining equipment layout.

The common concept of the BMG (building model generation) layer structure has been extended with more layer definitions for universal use. This part of ISO/TS 13399 is applicable for a new layout; old, existing data files are not updated to this level. The use of this part of ISO/TS 13399 in terms of change management of existing cutting tool layout is at the manufacturer's discretion.

The extent of the dimensioning is limited to the number of dimensions that are also populated within manufacturer's or distributer's catalogues. The manufacturer determines the level of details and is understood as tool specific.

As the 3D-simulation systems proceed with stock removal, it is differentiated between cutting and non-cutting tool components. Also, the data concept includes the rules of zero points and mounting points for non-rotating tools (lathe tools).

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
assembled tool
AT
tool components (also single parts and spare parts) that are arranged to an assembled tool to be able to run a computer-aided application

2.2
centre line
line that defines the axis of a rotational body or the symmetric axis of a feature

EXAMPLE Axis of a hole.

2.3
cladding contour
continuous line built from single lines which describes the outer contour of a complete tool or tool component that is relevant for collision purposes

2.4
colour index DXF
numerical value of a colour within the application of data transmission under the drawing exchange format DXF

Note 1 to entry: All CAx-systems interpret uniformly this colour index.

2.5
complete tool
illustration of single-tool components as in an assembled tool that is applicable to be used in simulation processes, machining equipment layout and for the development of NC-programs

2.6
connection
<workpiece side/machine side> transition from one tool component to the other seen in the respective direction of the transition, while mounting both adjacent components

Note 1 to entry: *Machine side* means that the connection is seen in the direction of the machine spindle, *workpiece side* calls a connection on the side of the component which points in the direction of the workpiece.

2.7
cutting contour
outer contour of an object that describes the part of a cutting tool that actively takes part in a cutting process and if revolved around the axis of the tool will change to a three-dimensional object

Note 1 to entry: Anomaly exists on drilling tools, where the lateral area is to be shown up to the maximum usable (drilling) depth, while if necessary, a cone exists, and this cone is non-cutting.

2.8
data exchange format
DXF
basic version of the graphical data exchange

2.9
dimensioning
representation of the spatial expansions of an object

Note 1 to entry: In this part of ISO/TS 13399, dimensioning is performed according to International Standards, e.g. ISO 16792.

2.10
expansion of the main view
INFMAINVIEW
maximum needed space of the main view, which is determined by two of each horizontal and vertical lines and its distances

Note 1 to entry: Either the two corner points in diagonal distance, lower left and upper right $[(x_1, y_1)/(x_2, y_2)]$, or the corresponding lines are indicated.

2.11
expansion of the total drawing
INFTOTAL
maximum needed space of the entire graphic images including any additional information but without a drawing frame and its variable content, which is determined by two of each horizontal and vertical lines and its distances

Note 1 to entry: Either the two corner points in diagonal distance left lower and right upper $[(X_1, Y_1)/(X_2, Y_2)$ or the corresponding lines are indicated.

2.12
font size
standardized size of the letters within technical drawings

Note 1 to entry: The font size also controls the corresponding thickness of the lines and is defined in ISO 6428.

2.13
font type
definition of the style of lettering within the CAx-systems

2.14
inner contour
illustration of object elements placed inside the object body and are therefore not visible

Note 1 to entry: These elements are shown as invisible contours in a defined line style.

2.15
line type
characteristic of lines to differentiate the meaning within a technical drawing

Note 1 to entry: The definition and application of the line types is defined in ISO 128-20.

2.16
machining equipment layout
representation of the sequence of the work routines which are likely to produce a workpiece within a process cycle

Note 1 to entry: The work routine can follow mechanically by means of chipping working steps in the mechanical manufacture or by means of working steps without chipping in the assemblies.

Note 2 to entry: Machining equipment layouts are designed only by means of bilateral agreements between a supplier and an end user.

2.17
main view
MV
view of an object showing the function and where the main dimensions (functional dimensions) are attached to

2.18
non-cutting contour
outline contour of an object describing the area of a cutting tool which does not take part in the active cutting process and therefore can collide with the workpiece

Note 1 to entry: Anomaly on drilling tools — see 3.7.

2.19
outer contour
visible contour of an object

2.20
RECON
determination of layers solely used to illustrate contours and dimension to exchange information for the recondition of cutting tools only

2.21
RGB-values
red, green and blue numerical values of a colour to illustrate this colour explicit within the different CAx-systems

2.22
single part
SP
component of an assembled tool that is needed to show the function and the collision-relevant devices

2.23
SK-layer
<single component> determination of layers, which are intended to show only features that are used for cutting tool components and will be blank if an assembled tool is shown

2.24
SKVIEW
determination of layers applied only if it is sufficient to show the functional application on the main view

Note 1 to entry: All of the necessary views, cross sections and details have to be filed within this layer grouping.

2.25
tool axis
rotational axis
imaginary line on rotational tools where the tool revolves to actively take part in a machining process

2.26
tool component
single cutting tool or tool holder (adaptor) that can form an assembled cutting tool, if mounted

2.27
tool contour
whole visible outline of a tool

3 Layer concept

The layer structure shall be designed in a way that all requirements of the layout of cutting tool assemblies and their components shall be fulfilled. This is mainly feasible for the tool pre-setting to be used as information for the tool procurement and tool management.

The interface contours of the cutting tool components, which become invisible in the assembly, shall be filed at the SK-layers. Therefore, it is guaranteed that these contours are not shown on tool assemblies because of the confusing views.

On the other hand, it is very reasonable to show coolant channels, for example, in the tool assembly, as well as in the tool component. Therefore, Layer 3 shall be arranged to file the hidden contours contained in tool assemblies and tool components.

The same principle shall apply to the dimensioning. Here, the dimensions shall be on Layer 2 if they are visible in the assembled tool.

Layer 6, correspondingly layer SK6, shall be used for text which is independent from any language. This information shall be filed here and shall not be translated into a foreign language (e.g. catalogue number or ordering number of the tool component or of the assembled tool, and so on. Textual information that has to be interpreted in another language for better understanding shall be filed in the respective layers of the grouping “multilingual.”

If, beside the main view, other views, details, and cross sections, etc. are required to the designated and functional use of graphic data the layer from the grouping, SKVIEW shall be used.

Parts of this layer concept do not meet the generally admitted exchange of graphical data, but are limited to special areas, which shall be stipulated bilaterally between the tool manufacturer, or tool supplier and the user. This applies to the area of sensitive data, e.g. the reconditioning (“RECON”) of cutting tools, or also the provision of complete machine equipment layouts (Layer 100 to Layer 200).

DXF version 2000 with its code AC1015 shall be determined as the basic version for the graphical data exchange. It shall not be allowed to transfer blocks (except frames, headers, and logos), external references and OLE objects. The point of origin shall be located onto the main view, which has to be in scale 1:1.

4 Structure of the layers

4.1 General

By the explicit structure of the layers, seven main functions can be defined and shall be as given in Table 1.

Table 1 — Grouping of the layers with their main functions

Function number	Description of the function	Grouping of the function
3.0.1	Tool drawing	Main view
3.0.2	NC-geometry	CUT, NOCUT
3.0.3	Extended tool drawing	Further views, cross sections, details, references
3.0.4	Multilingualism	Global drawings with lingual information
3.0.5	Tool reconditioning	Supplier internal information for reconditioning
3.0.6	Machine equipment layouts	Machine spindle, workpiece, fixture, operation path
3.0.7	Drawing frame	Drawing frame — multilingual and drawing space

4.2 Colouring of the layers

To make it possible to show the colours of the layers in this document, patterns are assigned to the colours. The patterns are depicted in Table 2.

Table 2 — Allocation of the colours to RGB values and patterns

Colour	RGB-value			Colour index DXF	Pattern
	R	G	B		
Red	255	0	0	1	
Yellow	255	255	0	2	
Green	0	255	0	3	
Cyan	0	255	255	4	
Blue	0	0	255	5	
Magenta	255	0	255	6	
White	255	255	255	7	
Grey	192	192	192	9	
Orange	255	127	0	30	
Olive	0	127	0	96	

4.3 Grouping and definition of the layers

4.3.1 Grouping

The grouping of the layers is divided into three main groups:

— M = mandatory;

— C = conditional (depending on requirements);

— O = optional (upon request).

4.3.2 Basic layer

Each graphical file imported into another system via DXF interface shall have the basic layers according to Table 3.

Table 3 — Basic layers

Main group	Designation	Layer name	Layer number	Layer description	Definition
O	Basic layer	0	0	System layer	Layer 0 is optional. For autocad system, layer 0 is mandatory.
O	Basic layer	Defpoints[a]	0	System layer	Compulsory needed in the CAD system; no further relevance for the drawing layout.
[a] Layer is determined mainly in the 3D design mode and is not compulsory for DXF files, therefore, only optional.					

4.3.3 Tool drawing (main view — function number 3.0.1)

Within the tool drawing, Layers 1 to 4, 6, 7, and 11 for assembled tools shall be as defined in Table 4 and Layers SK1 to SK4, SK6, and SK7 for tool components shall be as defined in Table 5.

Table 4 — Layers for the main view for assembled cutting tools

Main group	Designation	Layer name	Layer number	Layer description	Definition
M	Main view of assembled tools and visible tool components	1	1	Contour	Outer contours that describe the contour of an assembled tool if tool components are mounted virtually.
		2	2	Dimensioning	Dimensions that are shown if different tool components are mounted virtually. Attention: The dimensions may not be drawn across the outer contour of Layer 1 because of the possible collision of the dimensions. There is also no associativity between the dimensions and the related geometrical features.
		3	3	Reference line/ inner contour	Reference lines and inner contours (invisible lines) that are displayed if an assembled tool is mounted virtually.
		4	4	Centre line	Centre lines of the single components, which create the entire centre line of the assembled tool, if mounted virtually. This centre line always starts at the first visible contour edge of the tool component and ends always at the last contour edge. It is not allowed to extend the centre line across the body contour.
		6	6	Text assembled tools (language independent)	Language-independent texts of the single components, which contain information for the assembled tool, if the components are mounted virtually. The positions of these texts should be located as accurate as possible above or below the tool component.
		7	7	Hatching	Hatching of cross sections or half cross sections, which has to be illustrated at the assembled tool, if mounted virtually.
		11	11	Additional line	Thin solid line for the illustration of thread root, imaginary line, bending line or similar drawing features.

Table 5 — Layers for the main view for tool components

Main group	Designation	Layer name	Layer number	Layer description	Definition
M	Main view of tool component —invisible on assembled tool	SK1	21	SK-contour	Outer contours of tool components, which should not be visible, if mounted virtually to an assembled tool
		SK2	22	SK-dimensioning	Dimensioning; this should be visible only within the illustration of the tool component and not be of interest either for the assembly or for consideration of collision. Attention: There will be no associativity between the dimensions and the related geometrical features.
		SK3	23	SK-reference line/ inner contour	Reference lines and inner contours (invisible lines) that are not displayed if an assembled tool is mounted virtually.
		SK4	24	SK-centre line	Centre lines of the single components, which are visible only if the single component is illustrated. Remark: The centre line should start and end approximately 5 mm across the body contour in relation to the component.
		SK6	26	Textual part of a tool component (language independent)	Language-independent texts of the single components, which should not be visible if components are mounted virtually and do not contain information for the assembled tool. The positions of these texts should be located as accurately as possible above or below the tool component, but also separated from the texts contained in Layer 6.
		SK7	27	SK-Hatching	Hatching of cross sections or half cross sections, which does not have to be illustrated at the assembled tool, if mounted virtually.
		SK11	29	Additional line	Thin solid line for the illustration of thread root, imaginary line, bending line or similar drawing features, which doeshave not have to be illustrated at the assembled tool, if mounted virtual.

4.3.4 NC-Geometry (CUT, NOCUT — function number 3.0.2)

Table 6 presents the information about the cutting and non-cutting part of an assembled tool of a tool component. Because of the different requirements regarding the creation of this information which

apply to the different CAM systems, the contours should consist of single lines, which should form a closed polyline — "contour of single lines in a closed polyline" with accuracy less than 0,001 mm.

These layers apply to tools with the following characteristics:

— Cutting and non-cutting tools;

— Rotating tools and stationary tools.

Table 6 — Layer for NC-geometry

Main group	Designation	Layer name	Layer number	Layer description	Definition
C	NC-contour of the tool for 3D simulation	CUT	15	Cutting	Outer contour that defines the cutting area of the tool component. a) For rotating tool: By revolving around the tool axis, this contour becomes a 3D object which is used such as for NC programming. The cutting area shall be created as a polyline containing single lines only, which shall be taken from the cutting parts placed in the 3D coordinate system but projected onto the XZ plane defined in ISO/TS 13399-50. This means that this contour created at the workpiece by the cutting tool shall be illustrated. b) For stationary tool: The cutting line shall be created as a polyline containing single lines only, which shall be taken from the cutting area in the top view of the part.
		NOCUT	16	Non-cutting	Outer contour that defines the cutting area of the tool component. By revolving around the tool axis, this contour becomes a 3D object which is used such as for NC programming. Important: The areas shall be created as a polyline containing single lines only. All contours being relevant for collision shall be taken above the rotating axis. The contour shall be in accordance to all features located on the periphery projected onto the XZ plane defined in ISO/TS 13399-50.

4.3.5 Extended tool drawing (further views — function number 3.0.3)

Table 7 gives information about the extended tool drawing. This group of layer is applicable if it is not sufficient to illustrate the function of the tool, the arrangement of the cutting items, collision determining outer contours or other graphical features, which are important for the machining process in the main view.

The application of this layer group is upon the discretion of the designer of the drawing. It shall not be formally required and needs an agreement between the originator of the drawing and the user.