INTERNATIONAL STANDARD

ISO 17295

First edition
2023-01

Additive manufacturing — General principles — Part positioning, coordinates and orientation

Fabrication additive — Principes généraux — Positionnement, coordonnées et orientation de la pièce

Reference number
ISO 17295:2023(E)

Contents

Page

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 ISO/TC 261, *Additive manufacturing*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 438, *Additive manufacturing*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

The first edition of ISO 17295 cancels and replaces ISO/ASTM 52921:2013, which has been technically revised.

The main changes are as follows:

— terms and definitions that are included in ISO/ASTM 52900 have been removed from this document and instead referred to ISO/ASTM 52900;

— since the list of terms and definitions have been removed from this edition, it is therefore not a standard terminology anymore, and therefore it has been renamed so that the title describes the actual content of the standard;

— the remaining normative content of the document including the annex have been consolidated into one single normative document;

— specifications of some aspects of initial build orientation and orthogonal orientation notation have been integrated in the text body of the document.

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

Although many additive manufacturing systems are based heavily upon the principles of computer numerical control (CNC), the coordinate systems and nomenclature specific to CNC are not sufficient to be applicable across the full spectrum of additive manufacturing equipment. This document expands upon the principles of ISO 841 and applies them specifically to additive manufacturing.

Additive manufacturing — General principles — Part positioning, coordinates and orientation

1 Scope

This document provides specifications and illustrations for the positioning and orientation of parts with regards with coordinate systems and testing methodologies for additive manufacturing (AM) technologies in an effort to standardize the method of representation used by AM users, producers, researchers, educators, press/media, and others, particularly when reporting results from testing of parts made on AM systems. Included specifications cover coordinate systems and the location and orientation of parts. It is intended to be in accordance with the principles of ISO 841 and to clarify the specific adaptation of those principles for additive manufacturing.

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 841, *Industrial automation systems and integration — Numerical control of machines — Coordinate system and motion nomenclature*

ISO/ASTM 52900, *Additive manufacturing — General principles — Fundamentals and vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/ASTM 52900 and ISO 841 apply.

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

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

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

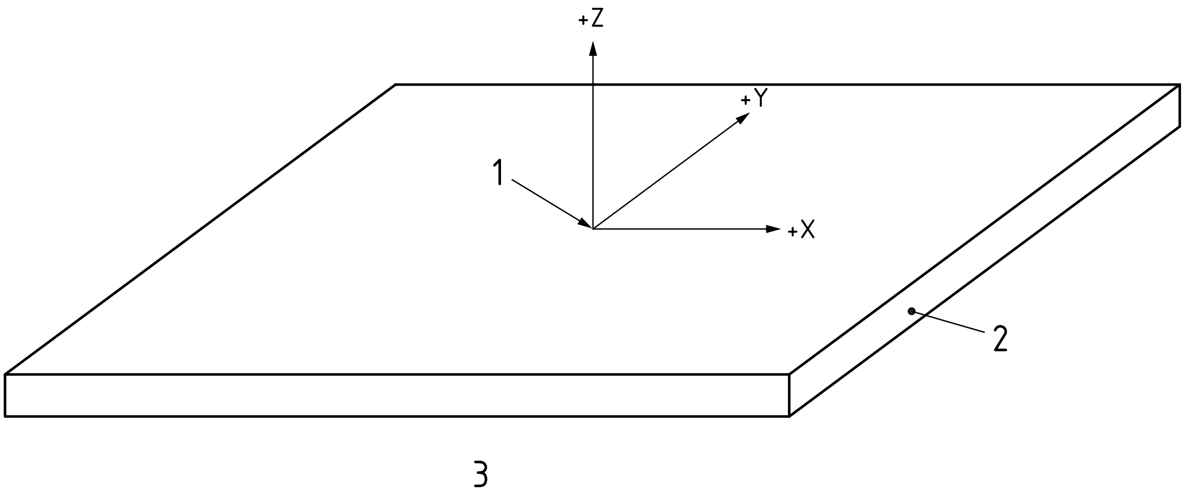
4 Machine coordinate systems for additive manufacturing machines with different build directions

4.1 General

The location and orientation of a part within the build volume shall be specified using coordinates in a three-dimensional machine coordinate system. Examples of different machine coordinate systems for different types of additive manufacturing machines are illustrated in Figures 1, 2 and 3.

4.2 Machine coordinate system for additive manufacturing machines with upwards Z-positive build direction

A three-dimensional Cartesian coordinate system located at the build origin for a generic additive manufacturing process using upwards Z-positive building direction, is illustrated as seen from the front of the machine in Figure 1. This is the most common type of machine coordinate system and is used for processes within all defined additive manufacturing process categories, though other types of coordinate systems can be used for specific process solutions within some process categories.



Key

1 build origin (0,0,0)

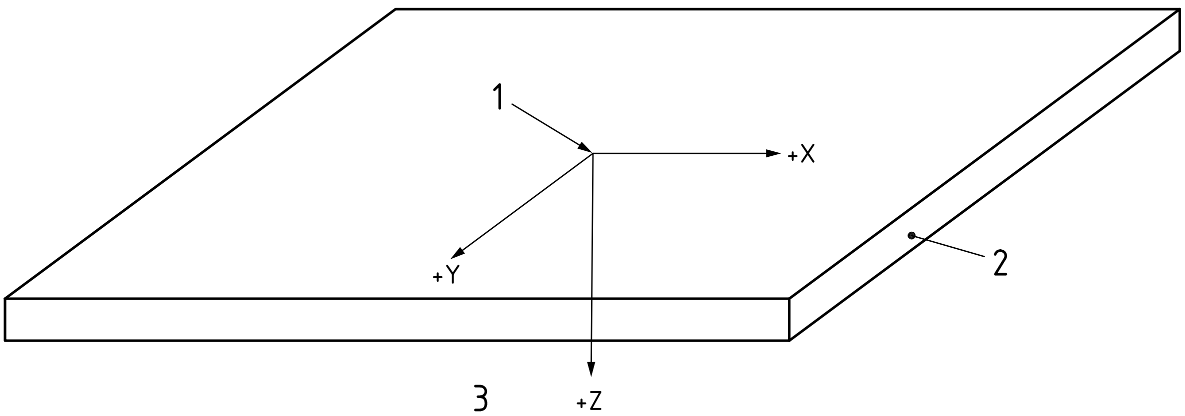
2 build platform

3 front of the machine

Figure 1 — Cartesian coordinate system for additive manufacturing with upward Z-positive building direction

4.3 Machine coordinate system for additive manufacturing machines with downwards Z-positive build direction

A three-dimensional Cartesian coordinate system located at the build origin for a generic additive manufacturing process using downwards Z-positive building direction, is illustrated as seen from the front of the machine in Figure 2. This type of machine coordinate system is mostly used for certain vat photopolymerisation process solutions.



Key

1 build origin (0,0,0)

2 build platform

3 front of the machine

Figure 2 — Cartesian coordinate system for additive manufacturing with downward Z-positive building direction

5 Rule for positive direction of axes of rotation

A, B and C define the designation of rotary axes about linear axes X, Y and Z respectively. Positive A, B and C are in the direction to advance right-hand screws in the positive X, Y and Z directions respectively (see Figure 3).

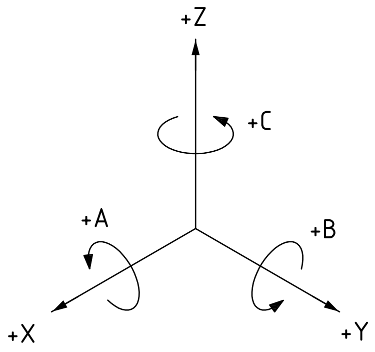
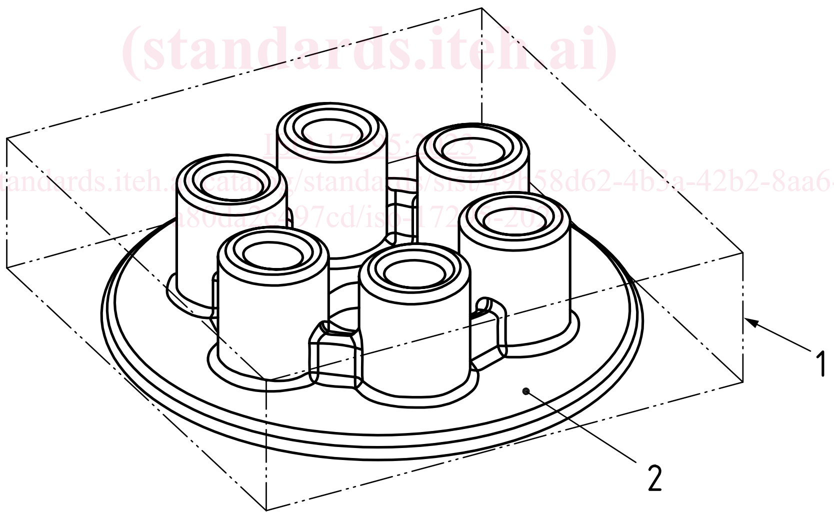


Figure 3 — Right-hand coordinate system (extracted from ISO 841:2001, Figure A.1)

6 Bounding box

An example of part geometry, in this case a pressure plate, enclosed by its bounding box is illustrated in Figure 4.



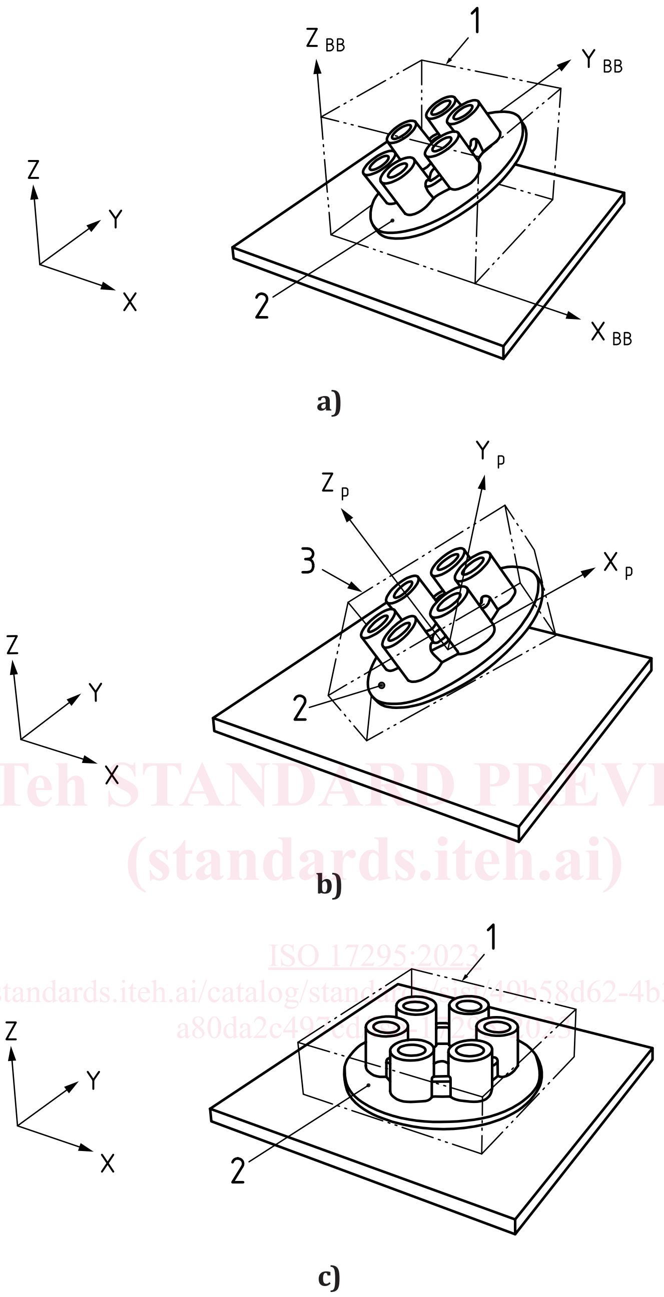
Key

1 bounding box

2 part geometry

Figure 4 — Example of a part geometry and its bounding box

Different bounding boxes with respect to their orientation and the part geometry's orientation are illustrated in Figure 5. Figure 5 a) shows an arbitrarily oriented part geometry enclosed by a bounding box that is aligned to the machine coordinate system Figure 5 b) shows the same part geometry in the same orientation, but this time enclosed by its arbitrarily oriented bounding box. In this case, the bounding box is aligned to the part coordinate system. Figure 5 c) shows the same part geometry now re-oriented so that its bounding box is aligned to the part coordinate system and to the machine coordinate system.



Key

1	bounding box aligned to the machine coordinate system
2	part geometry
3	arbitrarily oriented bounding box
X, Y, Z	machine coordinate system
X_{BB}, Y_{BB}, Z_{BB}	bounding box coordinate system
X_P, Y_P, Z_P	part coordinate system

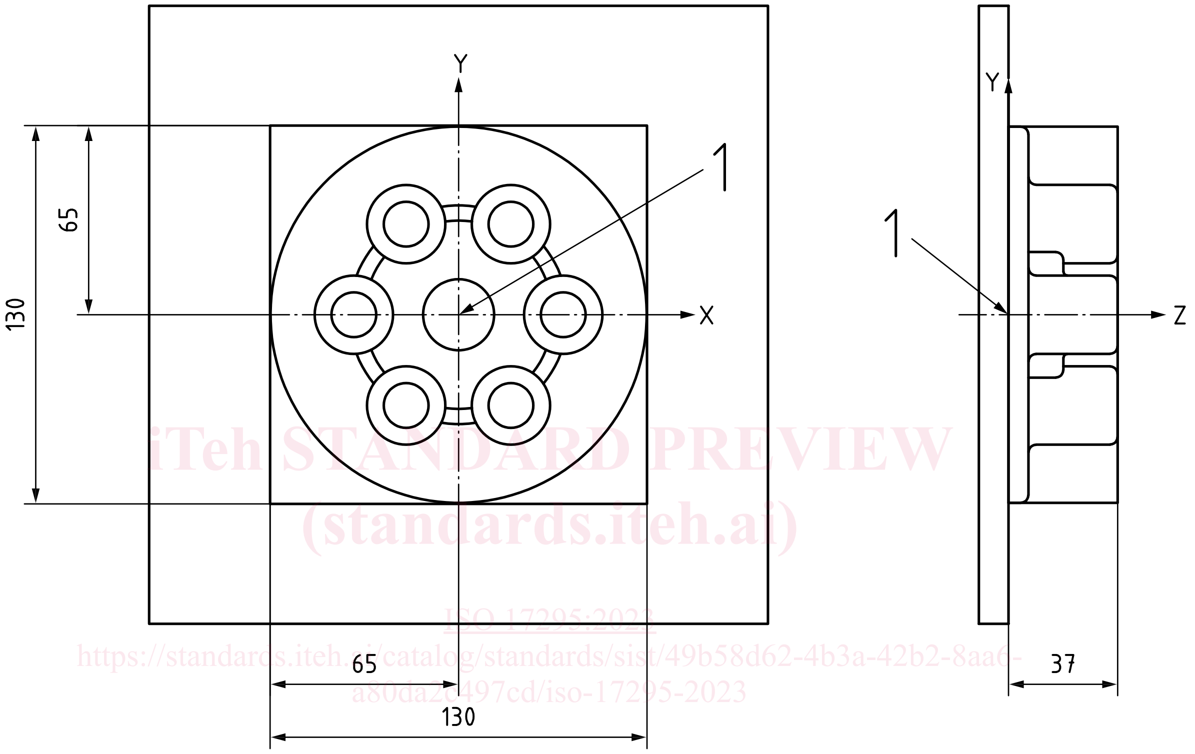
Figure 5 — Examples of part orientation and different types of bounding boxes

7 Initial build orientation

The initial build orientation is the orientation of the part as it is first placed in the build volume and is most commonly used as a reference for any further reorientation of the part. The initial build orientation shall be communicated either by 3D computer models, with the possibility to be interrogated for part position and orientation relative to the build origin, as agreed between the supplier and the user of the oriented part geometry, or by image(s) of the part(s) within the build volume and the orientation relative to the build origin.

Figure 6 show the part geometry with its intended build orientation (the positive Z-direction) relative to the build origin. The overall dimensions of its bounding box are provided so that the geometric centre can be calculated. The alignment of the major features, in this example the bolt circle, has been made apparent by the centre lines. Alternative orientations of the same part are illustrated in Figure 7.

Dimensions in millimetres



Key

1 build origin

Figure 6 — Initial build orientation

The initial build orientation of the part in Figure 6 has positioned the part directly over the build origin such that the Z-axis pass through the geometric centre of the bounding box. The sides of the bounding box are aligned parallel to the X-, and Y-axes of the coordinate system, while the part geometry is rotated such that the X-, and Y-axis intersect the part symmetrically. This is a convenient orientation, especially when specifying multiple occurrences of the part geometry with reorientation, but it is not a requirement for the initial build orientation. For example, if thoroughly dimensioned, the orientation of this part as shown in Figure 5 a) could be used as an initial build orientation as well. In practice, the more complicated the part geometry and increased number of orientations, the more advantageous it will be to communicate the initial build orientation using three-dimensional computer models, rather than methods for 2D reporting.

Orthogonal orientation notation describes the orientation of the bounding box according to overall length in decreasing magnitude parallel to the axis of the machine coordinate system. However, this only provides the orientation of the bounding box, and does not provide a full description of the orientation of the part within the bounding box. Figure 7 illustrate different orientations of a part with the same orthogonal orientation notation.

