INTERNATIONAL STANDARD

ISO 9787

Second edition
1999-05-01

Manipulating industrial robots — Coordinate systems and motion nomenclatures

Robots manipulateurs industriels — Systèmes de coordonnées et nomenclatures de mouvements

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Reference number
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Contents

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 9787 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC 2, *Robots for manufacturing environment*.

This second edition cancels and replaces the first edition (ISO 9787:1990), of which it constitutes a technical revision.

Annex A of this International Standard is for information only.

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Introduction

ISO 9787 is part of a series of International Standards dealing with manipulating industrial robots. Other International Standards cover such topics as safety, general characteristics, performance criteria and related test methods, terminology, and mechanical interfaces. It is noted that these standards are interrelated and are also related to other International Standards.

Annex A (informative) of this International Standard provides examples of application for different mechanical structures.

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Manipulating industrial robots — Coordinate systems and motion nomenclatures

1 Scope

This International Standard defines and specifies robot coordinate systems. It also provides a nomenclature including notation for the basic robot motions. It is intended to aid in robot alignment, testing, and programming.

This International Standard applies to all manipulating industrial robots as defined in ISO 8373.

In cases where there is no risk of confusion, nomenclatures or subscripts other than those specified in this International Standard may be used.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 8373:1994, *Manipulating industrial robots — Vocabulary*.

ISO 9283:1998, *Manipulating industrial robots — Performance criteria and related test methods.*

ISO 9946:1991[1)], *Manipulating industrial robots — Presentation of characteristics*.

ISO 14539:—[2)], *Manipulating industrial robots — Object handling with grasp-type clippers — Vocabulary and presentation of characteristics.*

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 8373 apply.

4 Defined coordinate systems and rotations

All coordinate systems described in this International Standard are defined by the orthogonal right-hand rule as shown in Figure 1.

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1) Currently under revision.

2) To be published.

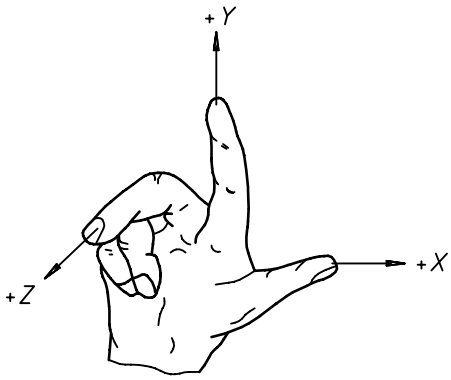

Figure 1 — Right-hand coordinate system

A, *B* and *C* define rotations about axes respectively parallel to *X*, *Y* and *Z*.

Positive *A*, *B* and *C* are in the directions to advance right-hand screws in the positive *X*, *Y* and *Z* directions respectively (see Figure 2).

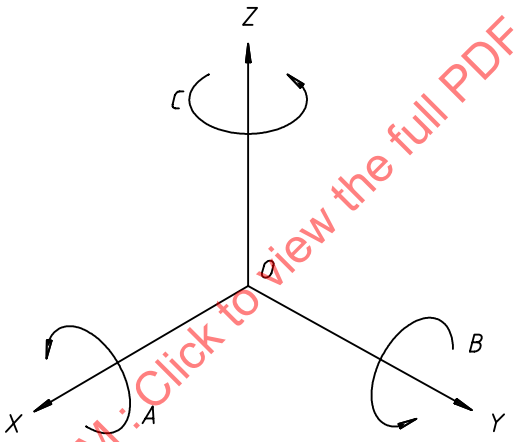

Figure 2 — Rotations

Four kinds of coordinate systems described are the world, base, mechanical interface, and tool. Figure 3 shows an example of the world, base, and mechanical interface coordinate systems described in this International Standard.

Although this International Standard defines four coordinate systems, others may be defined.

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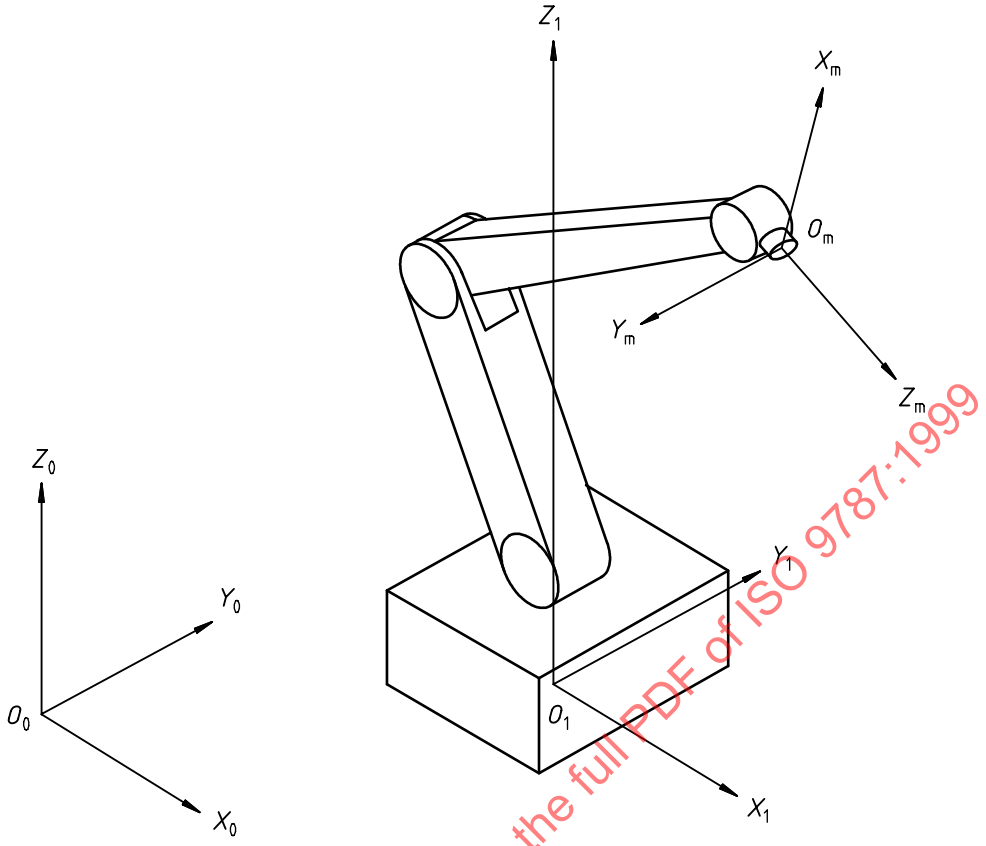

Figure 3 — Examples of coordinate systems

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5 World coordinate system

The world coordinate system is a stationary coordinate system referenced to earth which is independent of the robot motion.

5.1 Notation

O_0 - X_0 - Y_0 - Z_0

5.2 Origin, O_0

The origin of the world coordinate system, O_0, is to be defined by the users according to their requirements.

5.3 $+Z_0$ axis

The $+Z_0$ axis is colinear but in the opposite direction to the acceleration of gravity vector.

5.4 $+X_0$ axis

The $+X_0$ axis is to be defined by the users according to their requirements.

6 Base coordinate system

The base coordinate system is a coordinate system referenced to the robot base mounting surface.

6.1 Notation

O_1 - X_1 - Y_1 - Z_1

6.2 Origin, O_1

The origin of the base coordinate system, O_1, shall be defined by the manufacturer of the robot.

6.3 $+Z_1$ axis

The $+Z_1$ axis is in the direction of the mechanical structure of the robot perpendicularly away from the base mounting surface.

6.4 $+X_1$ axis

The $+X_1$ axis points away from the origin and passes through the projection of the centre of the working space, C_W, (see ISO 9946) onto the plane of the base mounting surface (see Figure 4). When the robot configuration precludes this convention, the direction of the $+X_1$ axis shall be defined by the manufacturer.

NOTE Examples of the application of the base and mechanical interface coordinate systems are found in annex A.

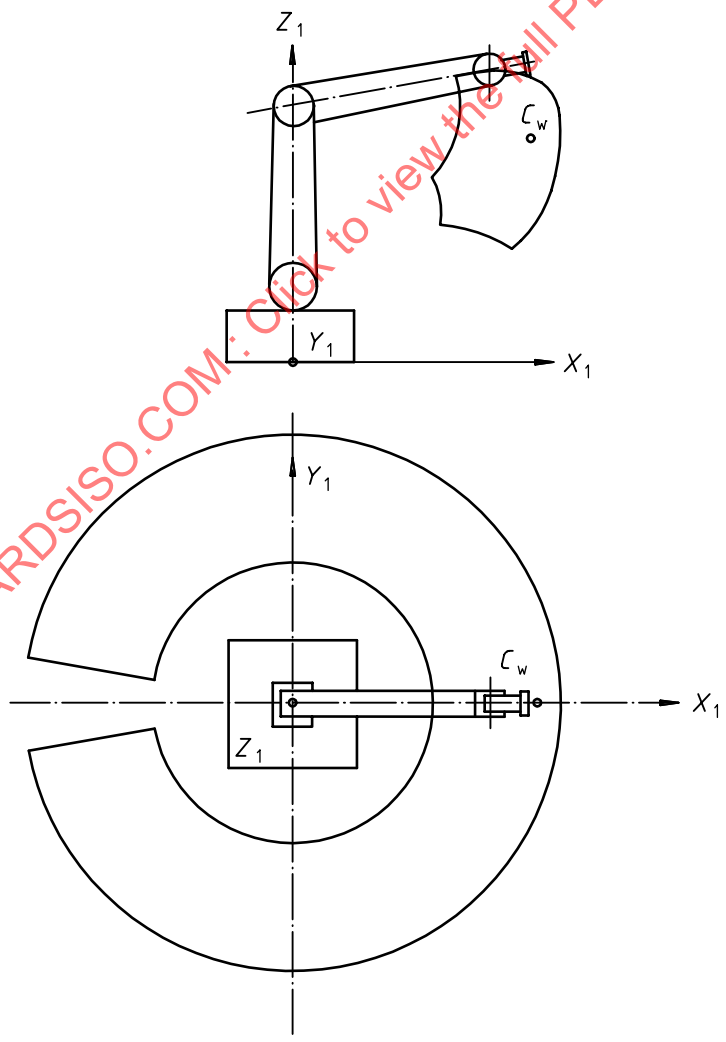

Figure 4 — Example of robot working space

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7 Mechanical interface coordinate system

The mechanical interface coordinate system is a coordinate system referenced to the mechanical interface.

7.1 Notation

O_m - X_m - Y_m - Z_m

7.2 Origin, O_m

The origin of the mechanical interface coordinate system, O_m, is the centre of the mechanical interface.

7.3 $+Z_m$ axis

The $+Z_m$ axis points perpendicularly away from the mechanical interface.

7.4 $+X_m$ axis

The $+X_m$ axis is defined by the intersection of the plane of the mechanical interface and the plane X_1 Z_1 (or a plane parallel to X_1 Z_1), with the robot primary and secondary axes in their mid-positions. When the robot configuration precludes this convention, the position of the primary axes shall be defined by the manufacturer. The $+X_m$ axis points away from the Z_1 axis.

NOTE Examples of the application of the base and mechanical interface coordinate systems are found in annex A.

8 Tool coordinate system (TCS)

The tool coordinate system is a coordinate system referenced to the end effector attached to the mechanical interface.

8.1 Notation

O_t - X_t - Y_t - Z_t

8.2 Origin, O_t

The origin, O_t, is the tool centre point (TCP), see Figure 5.

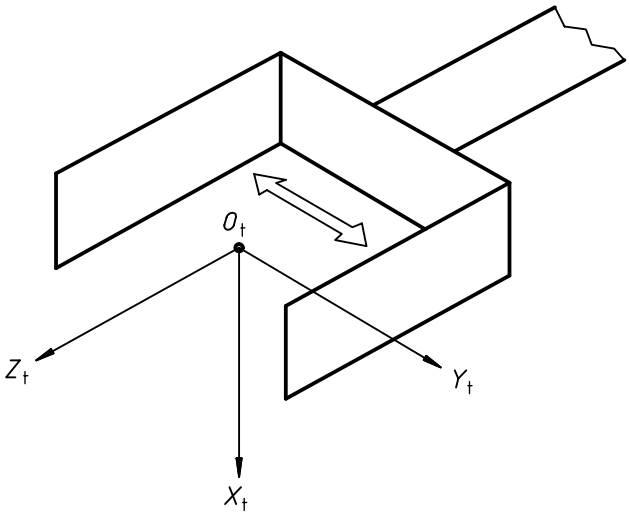

Figure 5 — Example of tool coordinate system

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8.3 $+Z_t$ axis

The $+Z_t$ axis is tool dependent, normally in the direction of the tool.

8.4 $+Y_t$ axis

In case of planar grasp type grippers (see ISO 14539) the $+Y_t$ axis is on the moving plane of fingers.

9 Robot motions

9.1 Translation

The translation of the end effector is defined in reference to the base coordinate system. It is designated by the following directions:

+ or – *x* along or parallel to the X_1 axis;

+ or – *y* along or parallel to the Y_1 axis;

+ or – *z* along or parallel to the Z_1 axis.

9.2 Rotations

Individual rotations about the axes parallel to the coordinate axes *X*, *Y* and *Z* are defined by *A*, *B* and *C* respectively, as defined in clause 4.

General rotations are expressed by the combination of individual rotations.

10 Robot axis nomenclature

If the axes are numerically designated, axis 1 shall be the first motion closest to the base mounting surface, axis 2 the second motion, and so on, and axis m the motion to which the mechanical interface is attached.

NOTE Examples of robot axis nomenclature are found in annex A.

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Annex A
(informative)

Examples of application for different mechanical structures

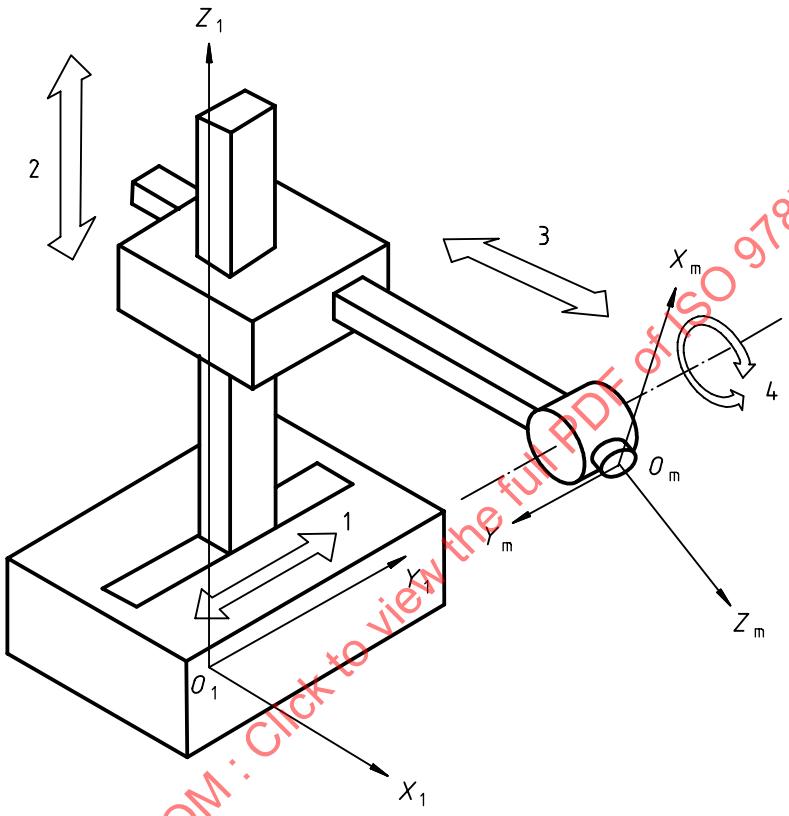

Figure A.1 — Rectangular robot

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