SLOVENSKI STANDARD
SIST EN ISO 9283:2003

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Manipulirni industrijski roboti ï Merila za zmogljivost in pripadajoļ e preskuġevalne metode (ISO 9283:1998)

Manipulating industrial robots - Performance criteria and related test methods (ISO 9283:1998)

Industrieroboter - Leistungskenngrößen und zugehörige Prüfmethoden (ISO 9283:1998)

Robots manipulateurs industriels - Criteres de performance et méthodes d'essai correspondantes (ISO 9283:1998)

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Manipulating industrial robots - Performance criteria and related test methods (ISO 9283:1998)

Robots manipulateurs industriels - Critères de performance et méthodes d'essai correspondantes (ISO 9283:1998)

This European Standard was approved by CEN on 27 February 1998.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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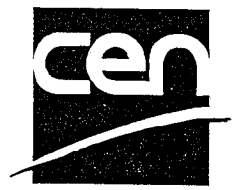

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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Foreword

The text of the International Standard ISO 9283:1998 has been prepared by Technical Committee ISO/TC 184 "Industrial automation systems and integration" in collaboration with Technical Committee CEN/TC 310 "Advanced Manufacturing Technologies", the secretariat of which is held by BSI.

This European Standard supersedes EN 29283:1992.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 1998, and conflicting national standards shall be withdrawn at the latest by October 1998.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Endorsement notice

The text of the International Standard ISO 9283:1998 was approved by CEN as a European Standard without any modification.

INTERNATIONAL STANDARD

ISO 9283

Second edition
1998-04-01

Manipulating industrial robots — Performance criteria and related test methods

Robots manipulateurs industriels — Critères de performance et méthodes d'essai correspondantes

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Contents

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Annex

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. In accordance with ISO/IEC Directives they are approved if two-thirds of the votes cast by the P-members of the technical committee or sub-committee are in favour, and not more than one-quarter of the total number of votes cast are negative.

International Standard ISO 9283 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 9283:1990 and Amendment 1:1991), of which it constitutes a technical revision.

Annex A forms an integral part of this International Standard. Annexes B and C are for information only.

Introduction

ISO 9283 is part of a series of International Standards dealing with manipulating industrial robots. Other International Standards cover such topics as safety, general characteristics, coordinate systems, terminology, and mechanical interfaces. It is noted that these International Standards are interrelated and also related to other International Standards.

ISO 9283 is intended to facilitate understanding between users and manufacturers of robots and robot systems. It defines the important performance characteristics, describes how they shall be specified and recommends how they should be tested. An example of how the test results should be reported is included in Annex C of this International Standard. The characteristics for which test methods are given in this International Standard are those considered to affect robot performance significantly.

It is intended that the user of this International Standard selects which performance characteristics are to be tested, in accordance with his own specific requirements.

The tests described in this International Standard may be applied in whole or in part, depending upon the robot type and requirements.

The core part of ISO 9283 deals with testing of individual characteristics. Specific parameters for comparison testing is dealt with in Annex A (normative) for pose-to-pose characteristics and path characteristics.

Annex B (informative) of this International Standard provides guidance for selection of tests for typical applications.

Annex C (informative) of this International Standard provides a recommended format of the test report including the minimum required information and the summary of the test results.

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Manipulating industrial robots — Performance criteria and related test methods

1 Scope

This International Standard describes methods of specifying and testing the following performance characteristics of manipulating industrial robots:

- pose accuracy and pose repeatability;
- multi-directional pose accuracy variation;
- distance accuracy and distance repeatability;
- position stabilization time;
- position overshoot;
- drift of pose characteristics;
- exchangeability;
- path accuracy and path repeatability;
- path accuracy on reorientation
- cornering deviations;
- path velocity characteristics;
- minimum posing time;
- static compliance;
- weaving deviations.

This International Standard does not specify which of the above performance characteristics are to be chosen for testing a particular robot. The tests described in this International Standard are primarily intended for developing and verifying individual robot specifications, but can also be used for such purposes as prototype testing, type testing or acceptance testing.

To compare performance characteristics between different robots, as defined in this International Standard, the following parameters have to be the same: test cube sizes, test loads, test velocities, test paths, test cycles, environmental conditions.

Annex A provides parameters specific for comparison testing of pose-to-pose characteristics and path characteristics.

This International Standard applies to all manipulating industrial robots as defined in ISO 8373. However, for the purpose of this International Standard the term "robot" means manipulating industrial robot.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All International Standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

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

ISO 9787:1990, *Manipulating industrial robots — Coordinate systems and motions.*

ISO 9946:1991, *Manipulating industrial robots — Presentation of characteristics.*

3 Definitions

For the purpose of this International Standard, the definitions given in ISO 8373 and the following definitions apply.

3.1 cluster: Set of measured points used to calculate the accuracy and the repeatability characteristics (example shown diagrammatically in figure 8).

3.2 barycentre: For a cluster of n points, defined by their coordinates $(x_j — y_j — z_j)$, the barycentre of that cluster of points is the point whose coordinates are the mean values $\bar{x}$, $\bar{y}$, *and* $\bar{z}$ calculated by formulae given in 7.2.1.

3.3 measuring dwell: Delay at the measurement point prior to recording data (e.g. time between control signal "in position" and the "start measuring" of the measuring device).

3.4 measuring time: Time elapsed when measurements are recorded.

4 Units

Unless otherwise stated, all dimensions are as follows:

— length in millimetres ..... (mm)
— angle in radians or degrees..... (rad) or (°)
— time in seconds ..... (s)
— mass in kilograms ..... (kg)
— force in newtons ..... (N)
— velocity in metres per second..... (m/s),
degrees per second ..... (°/s) or
radians per second ..... (rad/s)

5 Abbreviations and symbols

For the purposes of this International Standard, the following abbreviations and symbols apply.

5.1 Basic abbreviations

A	Accuracy
R	Repeatability
v	Variation
F	Fluctuation
d	Drift
P	Pose
D	Distance
T	Path (trajectory)
V	Velocity
W	Weaving
E	Exchangeability

5.2 Quantities

a, b, c	Orientation (angular components) about the *x, y, and z*-axis
x, y, z	Linear coordinates along the *x-, y-, z*-axis
n	Number of measurement cycles
m	Number of measurement points along the path
S	Standard deviation
D	Distance between two points
l	Distance between the attained pose and the barycentre of the attained poses
v	Path velocity
AP	Pose accuracy
RP	Pose repeatability
vAP	Multi-directional pose accuracy variation
AD	Distance accuracy
RD	Distance repeatability
t	Position stabilization time
OV	Position overshoot
dAP	Drift of pose accuracy
dRP	Drift of pose repeatability
AT	Path accuracy
RT	Path repeatability
CR	Cornering round-off error
CO	Cornering overshoot
AV	Path velocity accuracy
RV	Path velocity repeatability

FV	Path velocity fluctuation
WS	Weaving stroke error
WF	Weaving frequency error

5.3 Indices

a, b, c	Indicates an orientation characteristic about the *x-*, *y-*, *z*-axis
x, y, z	Indicates a positioning characteristic along the *x-*, *y-*, *z*-axis
c	Command
i	Indicates the *i*-th abscissa
j	Indicates the *j*-th cycle
k	Indicates the *k*-th direction
h	Indicates the *h*-th direction
1,2	Indicates the pose number 1,2 ....
e	Corner point (edge)
g	Point where the robot performance falls within the specified path characteristics
p	Position

5.4 Other symbols

C_1 to C_8	Corners of the test cube
E_1 to E_4	Corners of the rectangular plane for the measurement of path characteristics
G	The barycentre of a cluster of attained poses
O_c	Origin of the measurement system coordinates

NOTE 1 — Further symbols are explained in the respective subclauses.

6 Performance testing conditions

6.1 Robot mounting

The robot shall be mounted in accordance with the manufacturer's recommendations.

6.2 Conditions prior to testing

The robot shall be completely assembled and fully operational. All necessary levelling operations, alignment procedures and functional tests shall be satisfactorily completed.

The tests shall be preceded by an appropriate warm-up operation if specified by the manufacturer, except for the test of drift of pose characteristics which shall start from cold condition.

If the robot has facilities for adjustment by the user that can influence any of the tested characteristics, or if characteristics can be recorded only with specific functions (e.g. calibration facility where poses are given by off-line programming), the condition used during the test shall be specified in the test report and (where relevant for individual characteristics) shall be kept constant during each test.

6.3 Operating and environmental conditions

The performance characteristics as specified by the manufacturer and determined by the related test methods in this International Standard, are valid only under the environmental and normal operating conditions as stipulated by the manufacturer.

6.3.1 Operating conditions

The normal operating conditions used in the tests shall be as stated by the manufacturer.

Normal operating conditions include, but are not limited to, requirements for electrical, hydraulic and pneumatic power, power fluctuations and disturbances, maximum safe operating limits (see ISO 9946).

6.3.2 Environmental conditions

6.3.2.1 General

The environmental conditions used in the tests shall be as stated by the manufacturer, subject to the requirements of 6.3.2.2.

Environmental conditions include temperature, relative humidity, electromagnetic and electrostatic fields, radio frequency interference, atmospheric contaminants, and altitude limits.

6.3.2.2 Testing temperature

The ambient temperature (θ) of the testing environment should be 20° C. Other ambient temperatures shall be stated and explained in the test report. The testing temperature shall be maintained at

$(\theta \pm 2)°$ C

The robot and the measuring instruments should have been in the test environment long enough (preferably overnight) so that they are in a thermally stable condition before testing. They shall be protected from draughts and external thermal radiation (e.g. sunlight, heaters).

6.4 Displacement measurement principles

The measured position and orientation data (x_j, y_j, z_j, a_j, b_j, c_j) shall be expressed in a base coordinate system (see ISO 9787), or in a coordinate system defined by the measurement equipment.

If the robot command poses and paths are defined in another coordinate system (e.g. by off-line programming) than the measuring system, the data must be transferred to one common coordinate system. The relationship between the coordinate systems shall be established by measurement. In this case the measurement poses given in 7.2.1 shall not be used as reference positions for the transformation data. Reference and measurement points should be inside of the test cube and should be as far away from each other as possible (e.g. if P_1 to P_5 are measurement points, C_3, C_4, C_5, C_6 may be used).