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 voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 9409-2 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC 2, *Robots for manufacturing environment*.

ISO 9409 consists of the following parts, under the general title *Manipulating industrial robots — Mechanical interfaces*:

— *Part 1: Plates (form A)*

— *Part 2: Shafts (form A)*

Annex A of this part of ISO 9409 is for information only.

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Introduction

This part of ISO 9409 is one of a series of standards dealing with the requirements of manipulating industrial robots. Other documents cover such topics as terminology, general characteristics, coordinate systems, performance criteria and related test methods, safety, robot programming languages, and robot companion standard to MMS. It is noted that these standards are interrelated and also related to other International Standards.

Manipulating industrial robots are steadily growing in importance in industrial automation. Depending on the type of application, they may require removable end effectors such as grippers or tools which are attached to the mechanical interface.

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Manipulating industrial robots — Mechanical interfaces —

Part 2:
Shafts (form A)

1 Scope

This part of ISO 9409 defines the main dimensions, designation and marking for shaft mechanical interfaces with cylindrical projections (form A). It is intended to ensure the exchangeability and to keep the orientation of hand-mounted end effectors.

This part of ISO 9409 does not contain any correlation of load-carrying ranges.

The mechanical interfaces specified in this part of ISO 9409 will also find application in simple handling systems which are not covered by the definition of manipulating industrial robots, such as pick-and-place or master-slave units.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 9409. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 9409 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 286-1:1988, *ISO system of limits and fits — Part 1: Bases of tolerances, deviations and fits.*

ISO 286-2:1988, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts.*

ISO 1101:—[1], *Technical drawings — Geometrical tolerancing — Tolerancing of form, orientation, location and run-out — Generalities, definitions, symbols, indications on drawings.*

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

ISO 9409-1:1995, *Manipulating industrial robots — Mechanical interfaces — Part 1: Plates (form A).*

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

3 Definitions

For the purposes of this part of ISO 9409, the definitions given in ISO 8373 apply.

4 Dimensions

4.1 General

Is it recommended that the dimensions for shaft mechanical interfaces with cylindrical projections be specified in accordance with figure 1 and table 1 (Type 1, without a slot for end effector orientation) or figure 2 and table 2 (Type 2, with a slot for end effector orientation).

It is recommended that series 1 dimensions be used. The supplementary series 2 shall be used only in special applications where series 1 dimensions are not suitable for the intended use.

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[1] To be published. (Revision of ISO 1101:1983)

The reference plane is defined as shown in figures 1 and 2. The end effectors are positioned against the reference plane. (See the note to clause 5.)

4.2 Coordinate system

The origin of the mechanical interface coordinate system as defined in ISO 9787 is the intersecting point of the centre axis of the shaft and the reference plane.

The $+Z_m$ axis points away from the origin towards the end of the shaft.

The flat surface and the slot (optional) is aligned to the $+X_m$ axis as shown in figures 1 and 2. The flat surface is a place where a set screw is seated to fix an end effector. The slot is used for mating a pin mounted on an end effector to maintain end-effector orientation. (See clause 5.)

4.3 Tolerances

The shaft mechanical interface dimensions shall be toleranced in accordance with ISO 286. Geometric tolerances shall be interpreted in accordance with ISO 1101. The shaft diameter, d_1, shall be the datum for all geometrical tolerances (see figures 1 and 2).

4.4 Load-carrying capacity and shaft material

The shaft mechanical interfaces specified in this part of ISO 9409 are suitable for robots of relatively small load capacity and for applications where end effectors are expected to move with narrow clearance between peripherals.

The use of plate mechanical interfaces (ISO 9409-1) is recommended when shaft mechanical interfaces are not sufficient for bearing expected loads.

5 End effector requirements

The dimensions and related tolerances of the mating surface of the end effector shall be compatible with those specified in this part of ISO 9409.

The slot on the interface, $b \times l_5$ (optional, see figure 2 and table 2), is intended for mating a location pin mounted on an end effector to maintain end-effector orientation. A parallel (cylindrical) pin is recommended for this purpose. The pin axis shall be aligned to the $+X_m$ axis.

The shaft, $d_1 \times l_1$, shall be of sufficient length and strength to bear an end effector coupled with friction, for example an end effector attached by clamping.

The threaded hole on the shaft end can be used to fix end effectors.

NOTE 1 The shaft end should not be used as a dimensional reference; the end effectors should be positioned against the reference plane.

6 Recommended practices

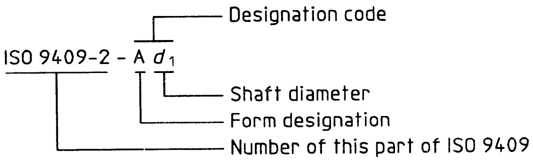
6.1 Provision for routing service lines

A threaded hole can be made as a through hole for cabling or piping, or for exhausting surrounding air.

The flange may be constructed with a hollow centre. This through hole shall have a diameter, d_4, equal to or less than the pilot hole diameter of the threaded hole, d_3.

7 Designation code

The designation of the shaft mechanical interface whose dimensions are in accordance with this part of ISO 9409 shall be as follows:



EXAMPLE — A mechanical interface of a shaft diameter, d_1 = 10 mm, shall be designated as follows:

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8 Marking

When shaft mechanical interfaces and related end effectors made in accordance with this part of ISO 9409 are marked, they shall be permanently stamped with the designation code (see clause 7).

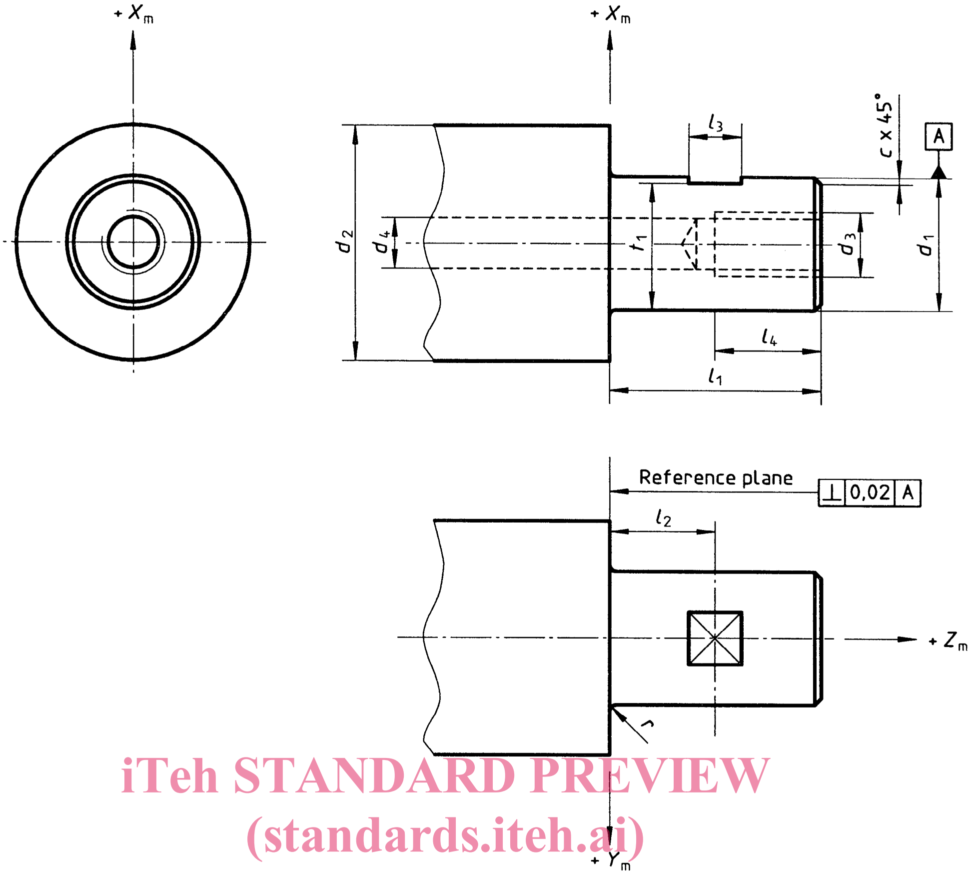

Figure 1 — Basic layout of the shaft mechanical interface Type 1

Table 1 — Preferred series 1 and supplementary series 2 of the shaft mechanical interface Type 1

Shaft diameter d_1 h7		**Reference plane diameter** d_2	**Shaft length** l_1	**Flat surface**			**Internal thread**		**Chamfer** c	**Rounding** r
				Location l_2	**Length** l_3	**Height** t_1	**Nominal diameter** d_3	**Depth** l_4		
Series 1	Series 2	min.						min.		max.
6		12	20	10	6	5,5	M3	5	1	1
	8	14	22	11		7,5	M4	7		
10		16	25	12,5	8	9	M5	8		
	12	19	28	14		11	M6	10		
	14	21	30	15		13				
16		23	32	16	10	15	M8	13		
	20	27	36	18		19	M10	16		
25		32	40	20		24	M12	20		

NOTE — Parameter d_4: see 6.1.

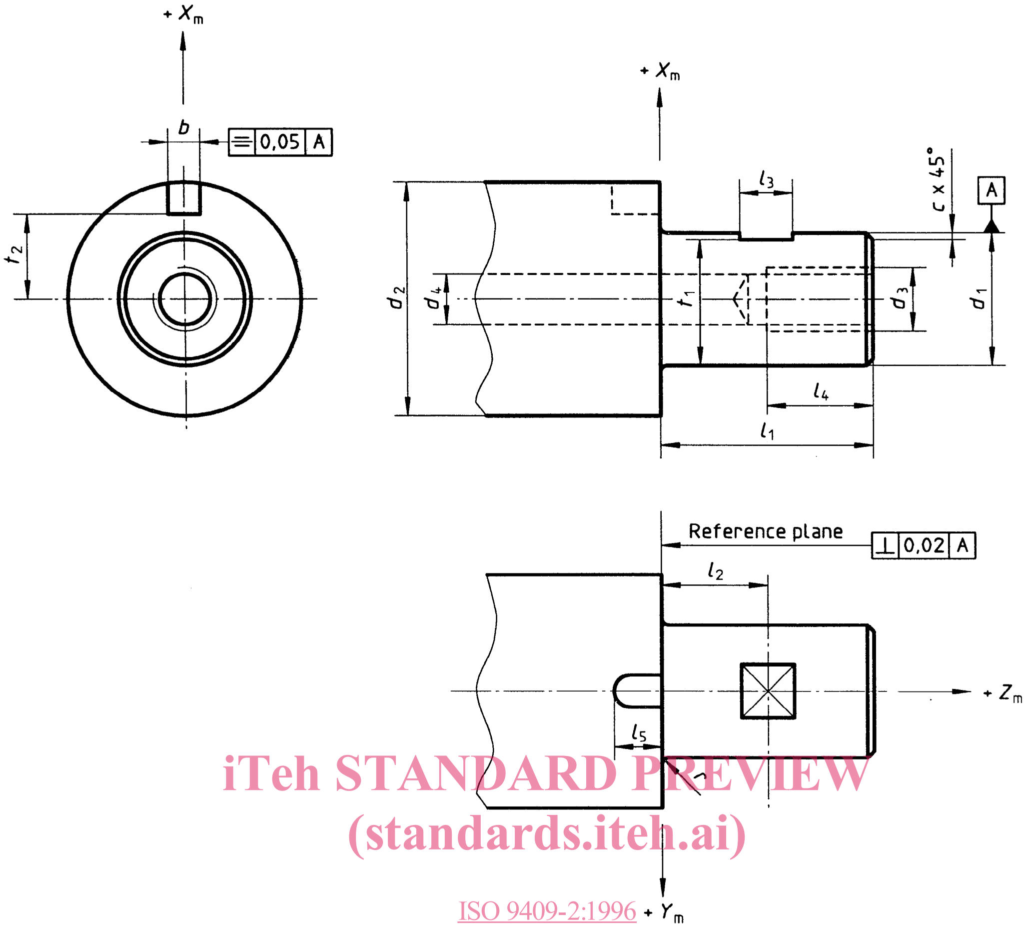

Figure 2 — Basic layout of the shaft mechanical interface Type 2

Table 2 — Preferred series 1 and supplementary series 2 of the shaft mechanical interface Type 2

Shaft diameter d_1 h7		Reference plane diameter d_2	Shaft length l_1	Flat surface			Internal thread		Chamfer c	Rounding r	Slot		
				Location l_2	Length l_3	Height t_1	Nominal diameter d_3	Depth l_4			Width b Js9	Depth l_5	Height t_2
Series 1	Series 2	min.								max.		min.	max.
6		15	20	10	6	5,5	M3	5	1	1	3	4,5	4
	8	17	22	11		7,5	M4	7					5
10		22	25	12,5	8	9	M5	8			4	6	7
	12	24	28	14		11	M6	10					8
	14	26	30	15		13							
16		34	32	16	10	15	M8	13			6	9	11
	20	38	36	18		19	M10	16					13
25		44	40	20		24	M12	20					16

NOTE — Parameter d_4: see 6.1.

Annex A
(informative)

Bibliography

ISO 261:—[1], *ISO general-purpose metric screw threads — General plan.*

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[1] To be published. (Revision of ISO 261:1973)