INTERNATIONAL STANDARD

ISO 29262

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Production equipment for microsystems — Interface between end effector and handling system

Équipement de production pour systèmes microtechniques — Interface entre outil et dispositif de manipulation

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

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.

ISO 29262 was prepared by Technical Committee ISO/TC 39, *Machine tools*.

Introduction

This International Standard specifies requirements for an interface between end effector and handling systems, or between functional modules in production equipment for microsystems. In production equipment for precision and microsystem technology, it is necessary for tools and end effectors to be replaced frequently because of small production runs. Interfaces for macroscopic handling systems, standardized according to ISO 9409-1 or ISO 9409-2 for instance, cannot be considered because of the small dimensions of the parts processed and, thus they are unsuitable for use as interface for end effectors and tools in micro and precision mechanics. This International Standard defines, in addition to the mechanical interface, the position and specification of the feedthroughs for fluidic and electrical coupling elements. An extra feature of this International Standard that differs from other standards in use is a central opening to permit the observation of the production or assembly process.

Production equipment for microsystems — Interface between end effector and handling system

1 Scope

This International Standard specifies provisions for the interface between end effector and handling systems in production equipment for microsystems. It specifies principal deviations, tolerances and designations for manually and automatically changeable end effectors. The aim is to specify the end effector interface in three levels with an increasing degree of specification.

2 Normative references

The following referenced documents are indispensable for the application 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 286-1, *Geometrical product specifications (GPS) — ISO code system for tolerances on linear sizes — Part 1: Basis of tolerances, deviations and fits*

ISO 286-2, *Geometrical product specifications (GPS) — ISO code system for tolerances on linear sizes — Part 2: Tables of standard tolerance classes and limit deviations for holes and shafts*

ISO 1101, *Geometrical Product Specifications (GPS) — Geometrical tolerancing — Tolerances of form, orientation, location and run-out*

ISO 3650, *Geometrical Product Specifications (GPS) — Length standards — Gauge blocks*

ISO 8734:1997, *Parallel pins, of hardened steel and martensitic stainless steel (Dowel pins)*

ISO 9409-1, *Manipulating industrial robots — Mechanical interfaces — Part 1: Plates*

ISO 9409-2, *Manipulating industrial robots — Mechanical interfaces — Part 2: Shafts*

ISO 9787, *Manipulating industrial robots — Coordinate systems and motion nomenclatures*

ISO 18265, *Metallic materials — Conversion of hardness values*

ISO/IEC 11801:2002, *Information technology — Generic cabling for customer premises*

ISO/IEC 24702, *Information technology — Generic cabling — Industrial premises*

ISO/IEC 24740, *Information technology — Responsive Link (RL)*

IEC 61131-2, *Programmable controllers — Part 2: Equipment requirements and tests*

IEC 61158 (all parts), *Industrial communication networks — Fieldbus specifications*

IEC 61784 (all parts), *Industrial communication networks — Profiles*

IEC 62026-2, *Low-voltage switchgear and controlgear — Controller-device interfaces (CDIs) — Part 2: Actuator sensor interface (AS-i)*

EN 50295, *Low-voltage switchgear and controlgear — Controller and device interface systems — Actuator Sensor interface (AS-i)*

ANSI/TIA/EIA-568-B.2-2001, *Commercial Building Telecommunications Cabling Standard — Part 2: Balanced Twisted-Pair Cabling Components*

DIN 2269, *Verification of geometrical parameters — Cylindrical measuring pin*[1)]

DIN 32564-1, *Production equipment for micro-systems — Terms and definitions — Part 1: General terms of micro-system technology*[1)]

IEEE 802.3, *IEEE Standard for Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements — Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications*

IEEE 1394, *IEEE Standard for a High Performance Serial Bus*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in DIN 32564-1 and the following apply.

NOTE As DIN 32564-1 is available in German only, it is intended to include the necessary definitions in a future edition.

3.1
end effector interface
interface between end effector and handling system

NOTE This consists of a head plate and an adaptor plate.

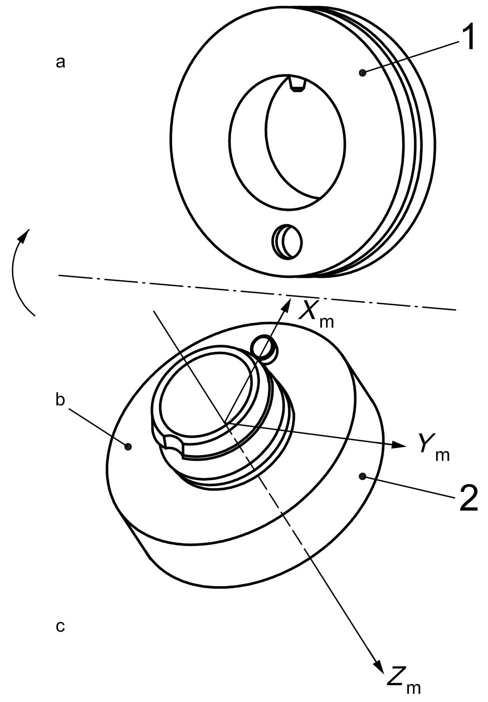
3.2
adaptor plate
part on the end effector side of an end effector interface

See Figure 1.

3.3
head plate
part on the handling system side of an end effector interface

See Figure 1.

1) Available in German only.



Key

1 head plate

2 adaptor plate

a Handling system side.

b Reference plane.

c End effector side.

Figure 1 — Terms relating to the end effector interface

4 General

An end effector interface consists of a handling system side part (head plate) and an end effector side part (adaptor plate). Within the framework of this International Standard, both the adaptor plate and the head plate of the interface are described. The method of locking (manual or automatic) is left to the discretion of the user. The interface specification is subdivided into the following three successive layers with increasing degrees of specification.

a) Layer 1 specifies the mechanical interface part. This includes the position, size and shape of the openings of the adaptor and head plate for the fixation of the end effector.

b) Layer 2 specifies the service interface part. This includes an additional standard configuration of the feedthroughs with electrical and fluidic coupling elements.

c) Layer 3 specifies the bus interface part. This includes the technical specification of the coupling elements (voltage, pressure, etc.) and an additional technical specification (electrical port assignments) for the use of industrial fieldbus interfaces.

The definition of the interface includes five sizes. The nominal size is the outer diameter of the interface in millimetres.

Dimensions in millimetres

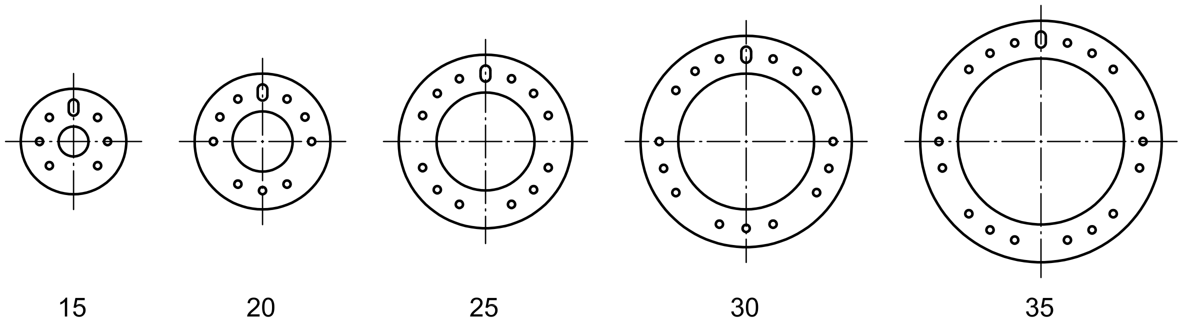


Figure 2 — Nominal sizes 15 mm **to** 35 mm

5 Interface definitions

5.1 Coordinate system

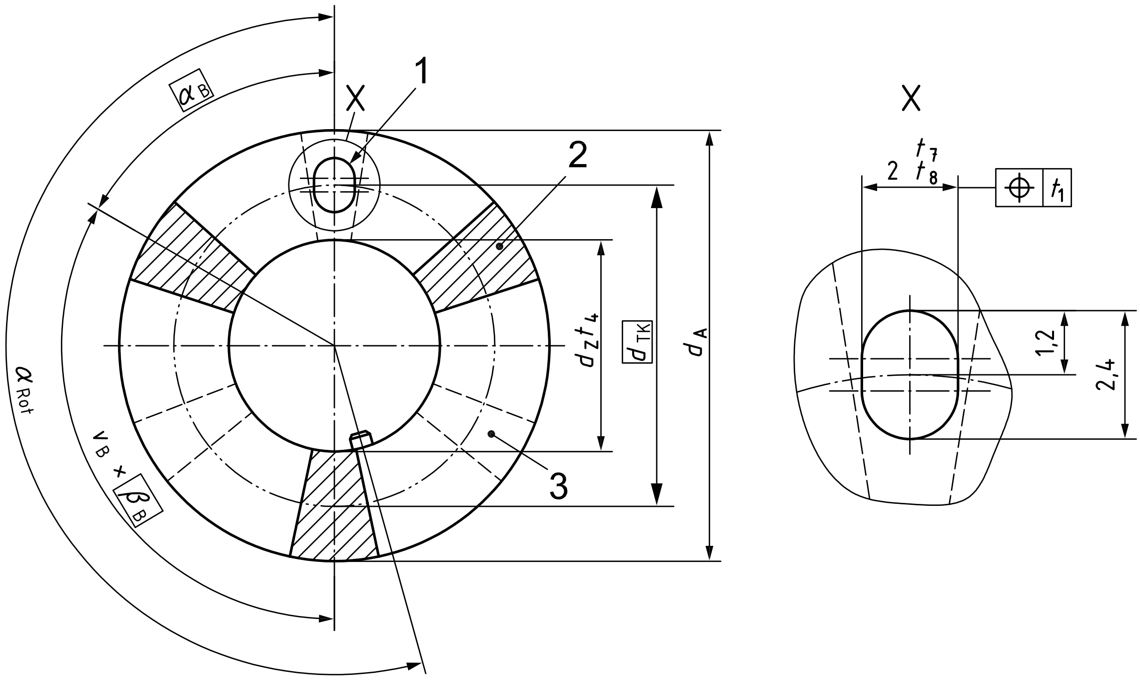
The description is based on the coordinate system in accordance with ISO 9787, as shown in Figure 1. The point of origin of the coordinate system of the mechanical interface is the intersection of the centre-line of the adaptor plate with the reference plane A. The $+Z_m$-axis points away from the origin towards the end effector. The twist lock (cylinder bolt, see 5.2) is located on the $+X_m$-axis.

5.2 Layer 1 — Mechanical interface

Layer 1 specifies position, size and shape of the openings of the adaptor and head plate for fixation.

Figure 3 shows the arrangement determining the position of the angles for mounting and clamping elements. In the event that adaptor plate and end effector are made in one piece, the mounting elements can be omitted.

Dimensions in millimetres



Key

1 twist lock slot; depth 1,1 mm
2 space for mounting elements
3 space for clamping elements

NOTE This is an example of nominal size 20 (see Tables 1 and 2).

Figure 3 — Head plate — Arrangement determining the position of the angles of the holes for mounting and clamping elements

Table 1 — Dimensions of fixation and angular positions of the holes for mounting elements

Dimensions in millimetres

	Nominal size, $\varnothing d_A$				
	15	**20**	**25**	**30**	**35**
Pitch circle diameter, $\varnothing d_{TK}$	10	15	20	25	30
Maximum diameter of centre hole in adaptor plate, $\varnothing d_M$	$2^{+0,1}_{0}$	$7^{+0,1}_{0}$	$12^{+0,1}_{0}$	$17^{+0,1}_{0}$	$22^{+0,1}_{0}$
Nominal diameter of clearance hole in head plate, $\varnothing d_Z$	5	10	15	20	25
Twist lock, long slot (cylinder pin), α/v	0°/1×				
Mounting elements, $\alpha_B / v_B \times \beta_B$	90°/2 × 180°	60°/3 × 120°	45°/4 × 90°	36°/5 × 72°	30°/6 × 60°
Lock against rotation, α_{Rot}	112,5°	195°	146,25°	117°	97,5°
Roller test dimension (for measurement, see Annex A), p_R	7,67 ± 0,01	12,67 ± 0,01	17,67 ± 0,01	22,67 ± 0,01	27,67 ± 0,01

NOTE 1 For the arrangement determining the position of the angles, see Figure 3.

NOTE 2 α = starting angle/ v = number of repetitions.

The external diameter of the minimal cylindrical envelope is an optional dimension and is used to define the nominal size of the interface. As preferred sizes, the nominal sizes 20 and 30 shall be selected. The clearance hole in the pitch circle at the centre of the interface allows for a visual inspection/observation of the assembly process through the axis of the tool exchange system. The diameter shall be chosen with reference to Table 1.

The holes for mounting elements, in reference to their position tolerances, may be produced in three levels of product grade (coarse, medium and fine) in accordance with Table 2. The form and position tolerances shall be in accordance with ISO 1101.

Table 2 — Levels of product grade

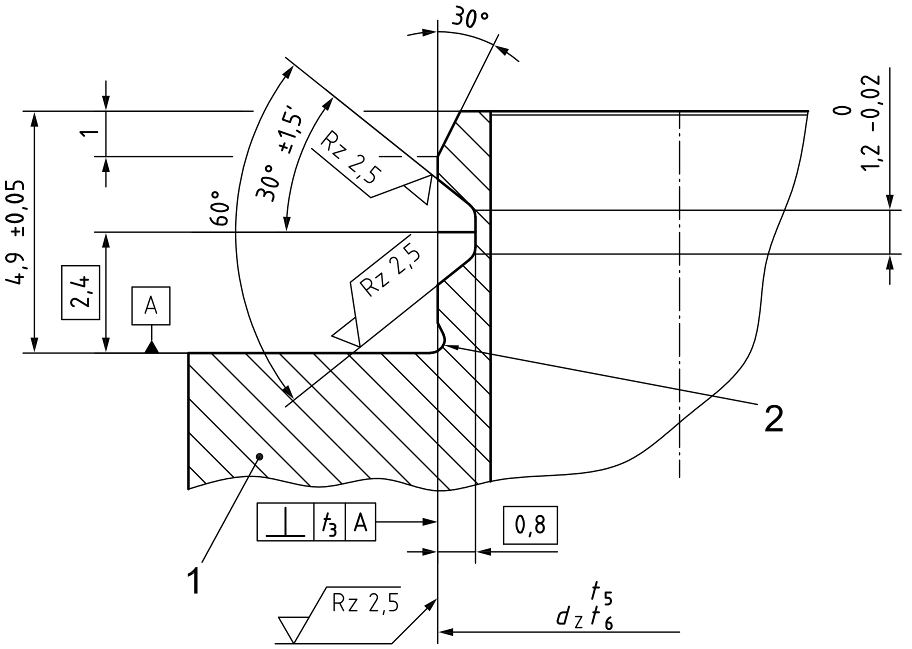
Part	Dimension	Coarse	Medium	Fine
Adaptor plate	t_1 (see Figure 5, position tolerance) t_3 (see Figure 4)	∅0,02 mm	∅0,01 mm	∅0,005 mm
	t_5 (upper deviation $\varnothing d_z$)	–0,006	–0,004	–0,002
	t_6 (lower deviation $\varnothing d_z$)	–0,019	–0,013	–0,008
Head plate	t_1 (see Figure 3, position tolerance)	∅0,02 mm	∅0,01 mm	∅0,005 mm
	t_4 (see Figure 3)	H7	H6	H5
	t_7 (upper deviation, see Figure 3)	0,023	0,019	0,016
	t_8 (lower deviation, see Figure 3)	0,010	0,010	0,010

The geometry of the fixation consists of the planar reference plane A and the cylindrical cone having a lead-in chamfer and an orientation to clamp the adaptor plate to the head plate by means of a clamping mechanism. The profile of the cone is identical for all sizes of the interface; the diameter is the only variant (see Table 1). The cone and the contact area serve to fix the position of the adaptor plate relative to the head plate.

A cylinder pin (geometry in accordance with ISO 8734:1997 - 2 × 6) serves as a twist lock to fix the orientation of the adaptor plate around the Z-axis. The cylinder pin is located on the pitch circle on the adaptor plate. The pin is placed in such a way that its chamfered end protrudes by 0,9 mm to 1,0 mm over reference plane A (see Figure 5).

The cone shall have a groove for the pre-alignment of head and adaptor plate during the coupling process (see Figure 5), before the twist lock pin engages in the final phase of coupling. In the coupled state, the twist lock pin transfers torques and ensures final orientation accuracy.

Dimensions in millimetres



Key

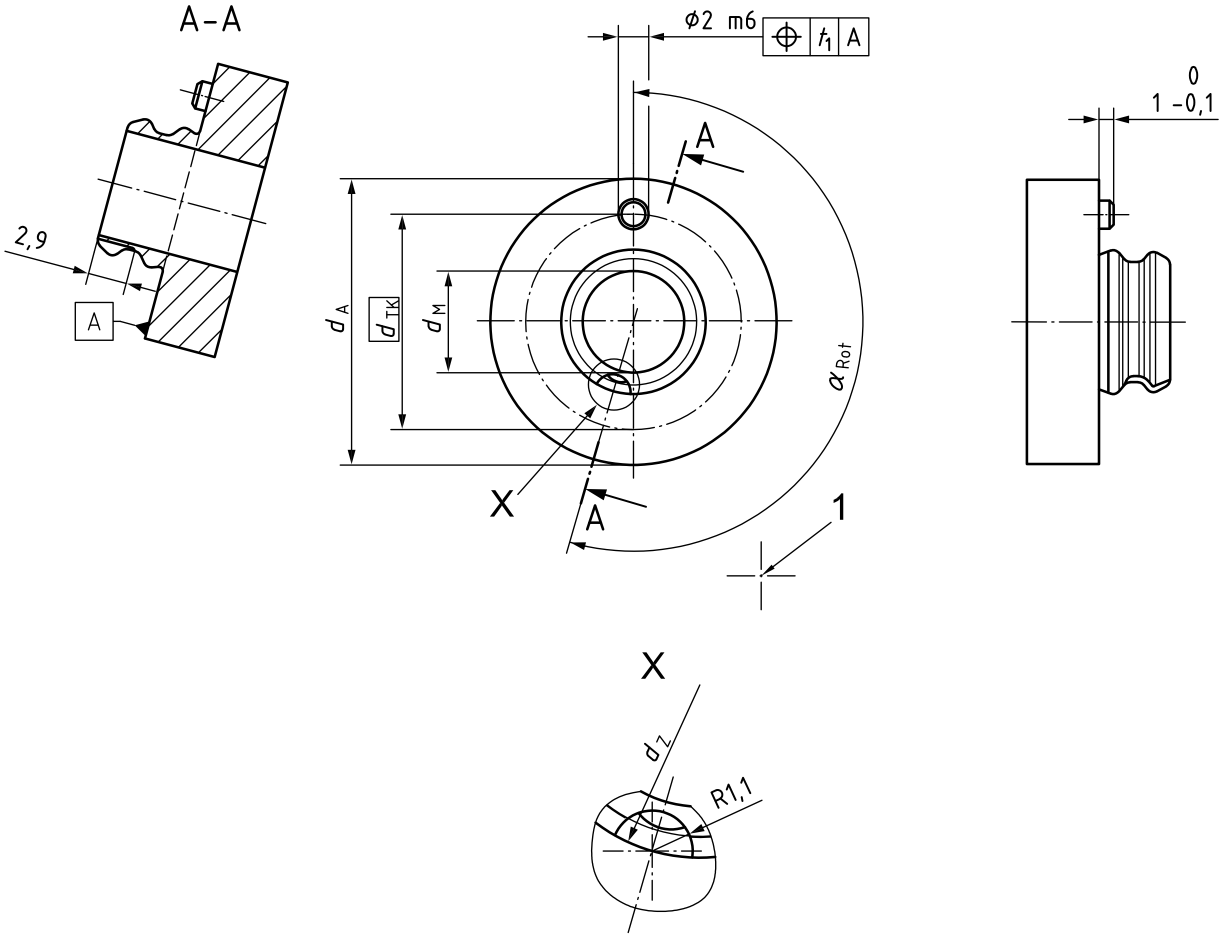
1 free space for mounting elements

2 relief groove in accordance with DIN 509 E0,2 × 0,2

NOTE For tolerances, see Tables 1 and 2.

Figure 4 — Adaptor plate — Geometry of fixation

Dimensions in millimetres



Key

1 centre point

NOTE See Tables 1 and 2.

Figure 5 — Adaptor plate — Pre-alignment and twist lock features

The cone may be produced in three classes of product grade as specified in Table 2. In accordance with ISO 286-1, the tolerance of the hole in the head plate depends on the nominal diameter. The form and position tolerances of the twist lock pin and the cone shall be in accordance with ISO 1101.

The material for the adaptor plate shall have a surface hardness of ⩾ HRC 45 or HV 440 (specified in ISO 18265) and a tensile strength, R_m, of the base material of ⩾ 350 N/mm^2.

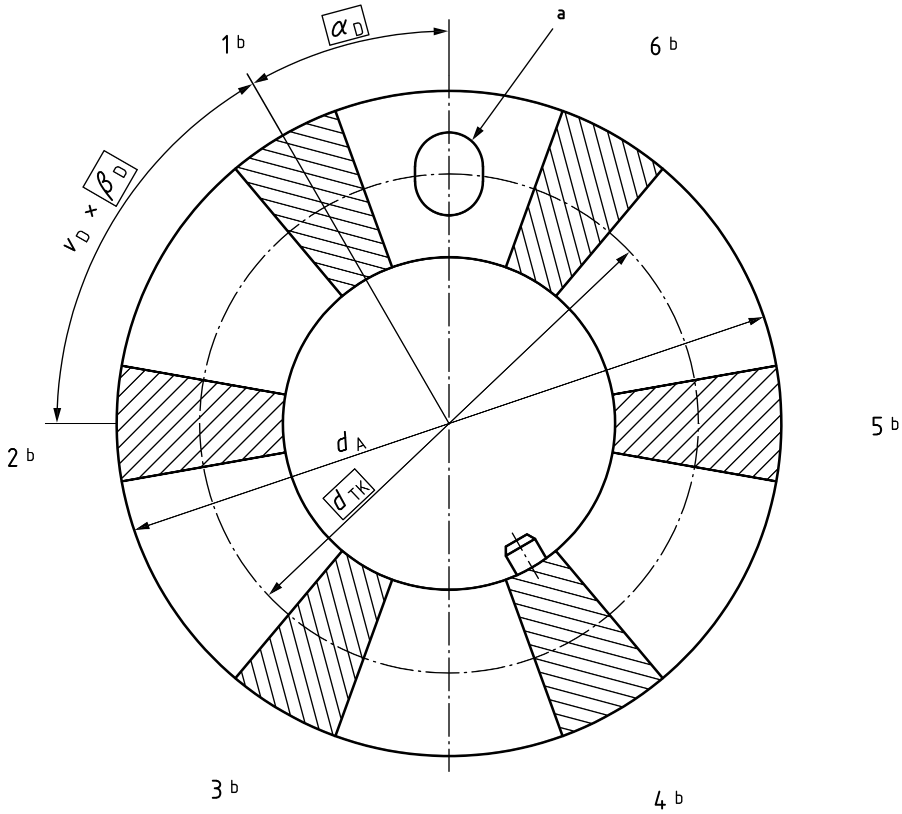
5.3 Layer 2 — Service interface

Layer 2 specifies an additional standard configuration of the feedthroughs with electrical and fluidic coupling elements.

Figure 6 shows a possible arrangement determining the position of the angles of the feedthroughs.

NOTE This defines only a volume for implementation of feedthroughs. Their geometric realization is left to the discretion of the user of this International Standard, except in the case of the contact areas defined in Figures 7 and 8.

Dimensions in millimetres



Key

a Twist lock.

b Spaces for feedthroughs.

NOTE This is an example of nominal size 20; see Table 1. For dimensions, see Table 3; for tolerances, see Table 4; for port number assignments, see Table 5).

Figure 6 — Head plate — Arrangement determining the position of the angles of the feedthroughs

Table 3 — Angular positions of the feedthroughs

Dimensions in millimetres

	Nominal size, $\varnothing d_A$				
	15	**20**	**25**	**30**	**35**
Pitch circle diameter, $\varnothing d_{TK}$	10	15	20	25	30
Feedthroughs, $\alpha_D/v_D \times \beta_D$	45°/4 × 90°	30°/6 × 60°	22,5°/8 × 45°	18°/10 × 36°	15°/12 × 30°

Table 4 — Position tolerances

Dimensions in millimetres

Tolerance dimension	Coarse	Medium	Fine
t_2	∅0,05	∅0,02	∅0,01

Table 5 — Port number assignment

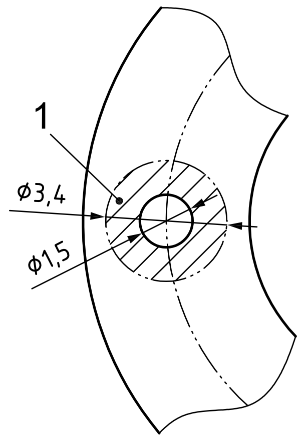
Port number/ nominal size	15	20	25	30	35
1	45,0°	30,0°	22,5°	18,0°	15,0°
2	135,0°	90,0°	67,5°	54,0°	45,0°
3	225,0°	150,0°	112,5°	90,0°	75,0°
4	315,0°	210,0°	157,5°	126,0°	105,0°
5	—	270,0°	202,5°	162,0°	135,0°
6	—	330,0°	247,5°	198,0°	165,0°
7	—	—	292,5°	234,0°	195,0°
8	—	—	337,5°	270,0°	225,0°
9	—	—	—	306,0°	255,0°
10	—	—	—	342,0°	285,0°
11	—	—	—	—	315,0°
12	—	—	—	—	345,0°

The contact areas for fluidic coupling elements shall be produced in accordance with Figure 7. The contact area consists of a circular area on the surface of the head plate. The elements needed to form a seal shall be located in the head plate, in the form of O-rings, for instance.

The adaptor head side of the fluidic interface shall be flat on surface A.

The sealing, embedded into head plate shall form a tightly sealed interface after coupling.

Dimensions in millimetres



Key

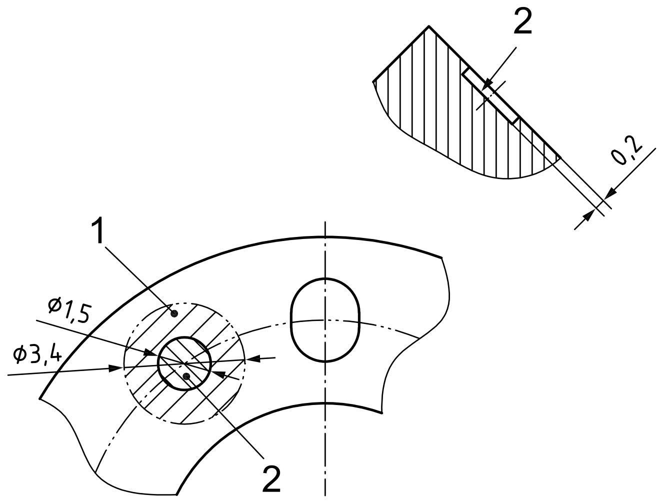
1 sealing area

Figure 7 — Head plate — Design of the contact area for fluidic coupling elements

The contact and insulation areas for electrical coupling elements shall be produced in accordance with Figure 8. The contact area consists of a circular area which is 0,2 mm below the surface of the head plate. The necessary compliance for the coupling shall be provided in the adaptor plate.

EXAMPLE Spring-loaded contact pins have been found to be suitable for this procedure.

Dimensions in millimetres



Key

1 insulation area

2 contact area

Figure 8 — Head plate — Design of the contact area for electrical coupling elements

In order to ensure changeability of active (that is, driven) tools and end effectors as well, a standard configuration for the feedthroughs has been specified (see Table 6). This standard configuration depends on the size of the interface. Table 5 shows the configurations with corresponding port assignments.

5.4 Layer 3 — Bus interface part

Layer 3 includes the technical specification of the coupling elements (voltage, gauge pressure, etc.) and an additional technical specification (electrical port assignments) for the use of industrial fieldbus interfaces.

For the coupling elements in the standard configuration, the following technical data have been specified:

NOTE Standard references for the coupling elements for electrical power (safety extra-low voltage SELV) can be found in EN 61140 and IEC/TS 60479-3.

— coupling elements for electrical power: $U = 24$ V DC, $I_{max} = 1$ A (according to SELV);

— coupling elements for pneumatics: $p_p = 0{,}6$ MPa;

— coupling elements for vacuum: $p_v = 0{,}01$ MPa.

Table 6 — Standard configuration of the feedthrough ports

Power	Nominal size				
	15	20	25	30	35
Electrical power (+)	1	1	1	1	1
Electrical power (–)	4	6	8	10	12
NOTE The values in the cells are the port numbers (see Table 5).					

Table 7 — Standard configuration for fluidic port assignments

Nominal size		15		20		25		30		35	
Port number		2	3	2	5	2	7	2	7	2	9
Case option	1	P	P	P	P	P	P	P	P	P	P
	2	V	V	V	V	V	V	V	V	V	V
	3	P	V	P	V	P	V	P	V	P	V
	4	V	P	V	P	V	P	V	P	V	P
P pneumatic V vacuum											

It is recommended to use case options 1 to 3 for fluidic ports.

The (field)bus interface description given in this International Standard concerns the pin assignment only. It shall be the responsibility of the implementation and/or the application to ensure the signal quality and meet the bus-specific requirements over this end effector interface.

The (field)bus pin assignments presented in this International Standard are optional (mutual exclusion). In other words, only one of them can be present at a time.

The electrical ports are specified for the use of the bus interfaces in Table 8.

Table 8 — Supported fieldbus interfaces

Fieldbus ID	Fieldbus	Reference standard
ASI	AS-Interface	IEC 62026-2 and EN 50295
CC	CC-link	IEC 61158 (all parts)
DN	DeviceNet	IEC 61784-1
ETH	Ethernet (10BASE-T/ 100BASE-TX) Cat 5e	ISO/IEC 11801, ISO/IEC 24702, IEEE 802.3 and ANSI/TIA/EIA-568-B.2-2001
FW	FireWire 400	IEEE 1394
IBS	Interbus-S	IEC 61784 (all parts)
PB	Profibus DP	IEC 61784 (all parts)
USB	USB 2.0	(www.usb.org)
IOLINK	I/O Link	IEC 61131-2
RL	Responsive Link	ISO/IEC 24740

The actual electrical pin assignments per fieldbus are specified in Table 9.

Table 9 — Port assignments for bus interfaces

Fieldbus	Signal	Description	Wire colour	Nominal size				
				15	20	25	30	35
ASI	A+	signal and power	brown	—	3	3	3	3
	A–	signal and power	blue	—	4	4	4	4
	Shield	shield	bare	—	—	—	—	—
CC	DA	signal	blue	—	—	3	3	3
	DB	signal	white	—	—	4	4	4
	DG	data ground	yellow	—	—	6	6	6
	SLD	shield	shield	—	—	5	9	11
DN	CAN_H	signal	white	—	3	3	3	3
	CAN_L	signal	blue	—	4	4	4	4
	drain	shield	bare	—	—	5	9	11
	V+	power	red	—	1[a]	1[a]	1[a]	1[a]
	V–	power	black	—	6[a]	8[a]	10[a]	12[a]
ETH	TX+	pin 1	white/ orange	—	—	3	3	3
	TX–	pin 2	orange	—	—	4	4	4
	RX+	pin 3	white/ green	—	—	5	5	5
	unused	pin 4	blue	—	—	—	—	—
	unused	pin 5	white/ blue	—	—	—	—	—
	RX–	pin 6	green	—	—	6	6	6
	unused	pin 7	white/ brown	—	—	—	—	—
	unused	pin 8	brown	—	—	—	—	—
FW	VCC	power	—	—	—	1[a]	1[a]	1[a]
	GND	ground	—	—	—	8[a]	10[a]	12[a]
	TPA+	signal	—	—	—	3	3	3
	TPA–	signal	—	—	—	4	4	4
	TPB+	signal	—	—	—	5	5	5
	TPB–	signal	—	—	—	6	6	6
PB	RxD/TxD-P	signal	red	—	3	3	3	3
	RxD/TxD-N	signal	green	—	4	4	4	4

Table 9 (*continued*)

Fieldbus	Signal	Description	Wire colour	Nominal size				
				15	20	25	30	35
IBS	DO	signal	yellow	—	—	—	3	3
	/DO	signal	green	—	—	—	4	4
	DI	signal	grey	—	—	—	5	5
	/DI	signal	pink	—	—	—	6	6
	COM	common	brown	—	—	—	9	11
USB	D+	data +	green	—	—	3	3	3
	D–	data –	white	—	—	4	4	4
	VCC	+5V VBus	red	—	—	5	5	5
	GND	ground	black	—	—	6	6	6
IOLINK	L+	power	brown	—	1[a]	1[a]	1[a]	1[a]
	L–	power	blue	—	6[a]	8[a]	10[a]	12[a]
	C/Q	signal	black	—	3	3	3	3
RL	TX Data +	pin 1	—	—	—	—	—	3
	TX Data –	pin 2	—	—	—	—	—	4
	RX Data +	pin 3	—	—	—	—	—	5
	RX Data –	pin 4	—	—	—	—	—	6
	TX Event +	pin 5	—	—	—	—	—	7
	TX Event –	pin 6	—	—	—	—	—	8
	RX Event +	pin 7	—	—	—	—	—	10
	RX Event –	pin 8	—	—	—	—	—	11

[a] Shared power supply for actuators and communication bus.

5.5 Tolerances

Specifications given in the tables, figures and text of this International Standard shall be applied.

For the dimensions of the interface, the tolerances in accordance with ISO 286-1 and ISO 286-2 shall apply. Form and position tolerances shall be in accordance with ISO 1101.

The pitch circle diameter and reference plane A are the references for all form and position tolerances.

5.6 Load-bearing capacities

The interface, as specified in this International Standard, is suitable for handling systems and production equipment with a relatively low load and for applications for which it is expected that the end effectors are moved between peripheral devices with small clearances.

For applications requiring higher load-bearing capacities, interfaces conforming to ISO 9409-1 or ISO 9409-2 should be used.

5.7 Designation

5.7.1 The implementation shall be designated in accordance with the following:

a) a reference to this International Standard, i.e. ISO 29262;

b) the nominal size;

c) the layer implemented (preceded by the letter L);

d) the grade or level of implementation (see Tables 2 and 4):

   1) C = coarse;

   2) M = medium;

   3) F = fine;

e) the option for pneumatic or vacuum configurations (see Table 7):

   1) PP = case 1: pneumatics/pneumatics;

   2) VV = case 2: vacuum/vacuum;

   3) PV = case 3: pneumatic/vacuum;

   4) VP = case 4: vacuum/pneumatic;

f) the fielbus identification.

5.7.2 The following are examples of (Field)bus ID designation (see Table 8, first column).

EXAMPLE 1 End effector of nominal size 25, layer 2, grade/level medium, with no pneumatics or fieldbus option
ISO 29262 - 25 - L2 - M

EXAMPLE 2 End effector of nominal size 25, layer 3, grade/level fine, with pneumatics option PP, no fieldbus option
ISO 29262 - 25 - L3 - F - PP

EXAMPLE 3 End effector of nominal size 30, layer 3, grade/level coarse, with pneumatics option PV, with Profibus fieldbus option
ISO 29262 - 30 - L3 - C - PV - PB

Annex A
(normative)

Tests procedure for fixation interface, p_R

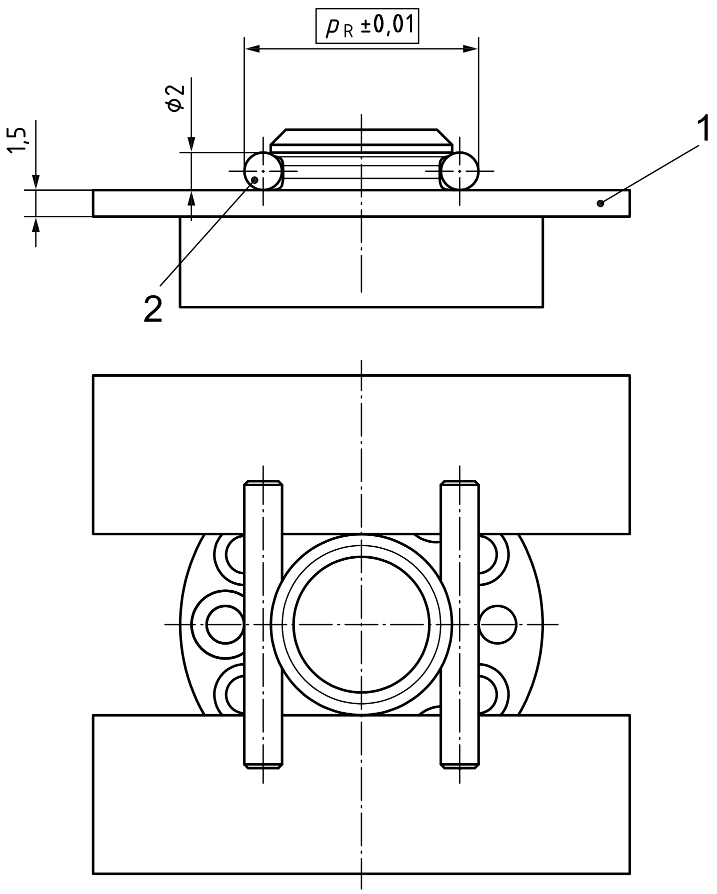
Firstly, put the two gauge blocks (1,5 mm) on to reference plane A, then place the testing rollers (∅2 mm) on the gauge blocks and roll them in to make contact with the adaptor plate body. Measure the test dimension at the testing rollers (see Figure A.1 and Table 1).

The following shall be the tolerance of additional parts for measuring:

a) gauge blocks in accordance with ISO 3650;

b) testing roller in accordance with DIN 2269.

Dimensions in millimetres



Key

1 gauge block

2 testing roller

Figure A.1 — Test configuration

Bibliography

[1] DIN 509, *Technical drawings — Relief grooves — Types and dimensions*

[2] DIN 7154-1, *ISO-fits for the hole basis system — Tolerance zones, deviations*

[3] DIN 7154-2, *ISO-fits for the hole basic system — Tolerances of fit (clearances and interferences)*

[4] IEC 61140 *Protection against electric shock — Common aspects for installation and equipment*

[5] IEC/TS 60479-3 *Effects of current on human beings and livestock — Part 3: Effects of currents passing through the body of livestock*

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