

JIS

JAPANESE INDUSTRIAL STANDARD

**Straight-sided splines for
cylindrical shafts with internal centering—
Dimensions, tolerances and verification**

JIS B 1601—1996

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Straight-sided splines
for cylindrical shafts with internal centering
—Dimensions, tolerances and verification

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Preface

This Japanese Industrial Standard has described based on ISO 14-1982, 2nd edition (Straight-sided splines for cylindrical shafts with internal centering—Dimensions, tolerances and verification) without any alteration in the technical contents. In addition, the irreducible minimum of necessary items was collected from the former Standard R 1601-1976 and transferred to Annex.

"Informative references" underlined (dotted lines) in the text of this Standard are those not prescribed in the original International Standard.

1. Scope and field of application This Standard lays down dimensions, in millimeters, of straight-sided splines for cylindrical shafts with internal centering, light series and medium series.

This Standard also specifies control methods and corresponding gauges.

Informative reference: This Standard refers to the following International Standards.

ISO/R 1938: 1971 ISO system of limits and fits—Part II: Inspection of plain workpieces

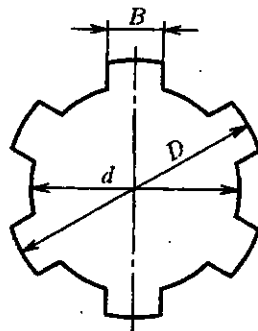
ISO 3670 Blanks for plug gauges and handles (taper lock and trilock) and ring gauges—Design and general dimensions

2. Dimensions The nominal dimensions common to shaft and hub, d , D and B are given in Table 1.

3. Designation The profile of a splined shaft or hub shall be designated by stating, in the following order: the number of splines N , the minor diameter d and the outside diameter D , these three numbers being separated by the sign $\times$.

Example: Shaft (or hub) $6 \times 23 \times 26$

Table 1. Nominal dimensions



d mm	Light series				Medium series			
	Designation	N	D mm	B mm	Designation	N	D mm	B mm
11	—	—	—	—	6×11×14	6	14	3
13	—	—	—	—	6×13×16	6	16	3,5
16	—	—	—	—	6×16×20	6	20	4
18	—	—	—	—	6×18×22	6	22	5
21	—	—	—	—	6×21×25	6	25	5
23	6×23×26	6	26	6	6×23×28	6	28	6
26	6×26×30	6	30	6	6×26×32	6	32	6
28	6×28×32	6	32	7	6×28×34	6	34	7
32	8×32×36	8	36	6	8×32×38	8	38	6
36	8×36×40	8	40	7	8×36×42	8	42	7
42	8×42×46	8	46	8	8×42×48	8	48	8
46	8×46×50	8	50	9	8×46×54	8	54	9
52	8×52×58	8	58	10	8×52×60	8	60	10
56	8×56×62	8	62	10	8×56×65	8	65	10
62	8×62×68	8	68	12	8×62×72	8	72	12
72	10×72×78	10	78	12	10×72×82	10	82	12
82	10×82×88	10	88	12	10×82×92	10	92	12
92	10×92×98	10	98	14	10×92×102	10	102	14
102	10×102×108	10	108	16	10×102×112	10	112	16
112	10×112×120	10	120	18	10×112×125	10	125	18

4. Tolerances on holes and shaft The dimensional tolerances on holes and shafts are given in Table 2, whilst Table 3 indicates tolerances on symmetry.

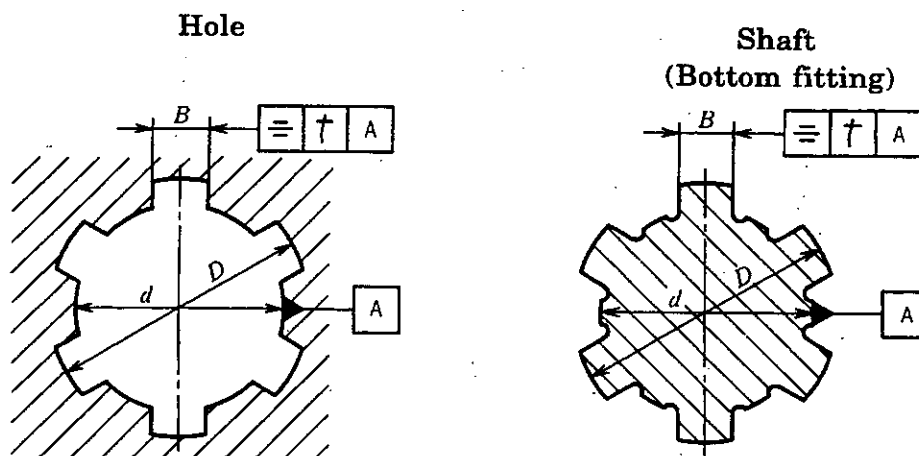
With certain milling cutters, it is possible for special applications to produce splines without bottom tool clearance with a very reduced fillet radius between the spline side and the minor diameter d (for example, milling cutters with fixed working positions).

The tolerances in Table 2 relate to entirely finished workpieces (shafts and hubs). Tooling should therefore be different for untreated workpieces or workpieces treated before machining and for workpieces treated after machining.

The tolerance specified on B includes the index variation (and the symmetry variation).

For alignment errors, see 5.7.

Table 2. Tolerances on holes and shafts



Tolerances on hole						Tolerances on shaft			Mounting type
Not treaded after broaching			Treated after broaching						
<i>B</i>	<i>D</i>	<i>d</i>	<i>B</i>	<i>D</i>	<i>d</i>	<i>B</i>	<i>D</i>	<i>d</i>	
H9	H10	H7	H11	H10	H7	d10	a11	f7	Sliding
						f9	a11	g7	Close sliding
						h10	a11	h7	Fixed

Table 3. Tolerances on symmetry

Unit: mm				
Spline width B	3	3.5, 4, 5, 6	7, 8, 9, 10	12, 14, 16, 18
Tolerance of symmetry t	0.010 (IT7)	0.012 (IT7)	0.015 (IT7)	0.018 (IT7)

5. Gauging

5.1 General This clause gives general information concerning gauges and gauge control; all the other requirements concerning gauges are given in clause 6 for the case where limit gauges are used, which is not compulsory. Direct measurement gauging can be permitted by previous agreement between the parties concerned according to rules to be defined to the best of requirements.

5.2 Reference temperature and measuring force The standard reference temperature of industrial measurements is 20 °C. The dimensions prescribed for parts and gauges are measured at this temperature and shall normally be checked at this temperature.

If measurements are carried out at a different temperature, the result shall be corrected taking account of the linear expansion coefficients of workpieces and gauges respectively.

Unless otherwise specified, measurements are understood with reference to a zero measuring force.

If measurements are carried out with a measuring force differing from zero, the results shall be corrected consequently. Correction however is not required for comparative measurements carried out using the same means of comparison and the same measuring force between similar elements of the same material and surface finish.

5.3 Conditions of application A workpiece is conventionally acknowledged good when its splines are found satisfactory using gauges according to the requirements of clauses 5 and 6 of this Standard which are authoritative for gauging. Consequently, if the customer uses his own gauges for acceptance purposes, they shall be close enough to the external limits prescribed not to reject splines already accepted by the manufacturer's gauges.

In the case of dispute, both the manufacturer and customer should make their gauges available to each other for checking at their respective sites. In the event of continuing dispute the gauges shall be referred to a recognized calibration authority.

Informative reference: The external limits shown in this clause mean that; gauge wear limit for GO gauges; maximum permissible limit of hole gauge and minimum permissible limit of shaft gauge for NOT GO gauges.

5.4 Shaft gauging

5.4.1 GO side Shaft gauging on the GO side is carried out using a spline GO ring gauge simultaneously checking those characteristics relating to:

5.4.1.1 fitting, i.e. :

- spline minor diameter.

5.4.1.2 mounting, i.e. :

- spline major diameter;
- spline thickness;
- major and minor diameter concentricity;
- spline position and orientation with respect to the axis.¹⁾

5.4.2 NOT GO side Shaft gauging on the NOT GO side is carried out using segmental NOT GO gauges checking each element separately, i.e. :

- for spline major diameters : a calliper gauge or a plain ring gauge;
- for spline minor diameters : a calliper gauge (with appropriate special anvils, if necessary);

¹⁾ Spline position and orientation with respect to the axis need be verified only where gauges are lacking.

- for spline thicknesses : a calliper gauge (of appropriate external shape if necessary).

5.5 Hole gauging

5.5.1 GO side Hole gauging on the GO side is carried out using a spline GO plug gauge simultaneously checking those characteristics relating to :

5.5.1.1 fitting, i.e :

- spline minor diameter.

5.5.1.2 mounting, i.e :

- spline major diameter;
- spline space width;
- major and minor diameter concentricity;
- spline angular position;
- spline position and orientation with respect to the axis. ¹⁾

5.5.2 NOT GO side Hole gauging on the NOT GO side is carried out using NOT GO segmental gauges checking each element separately, i.e. :

- for spline minor diameters : a cylindrical plain plug gauge;
- for spline major diameters : a cylindrical plate gauge with appropriate measuring faces;
- for spline space widths : a plate gauge.

5.6 Additional gauging Workpiece (hole or shaft) gauging on the GO side by means of spline (plug or ring) gauges does not make it possible, if a workpiece is rejected by the gauge, to determine which element of the workpiece has provoked rejection.

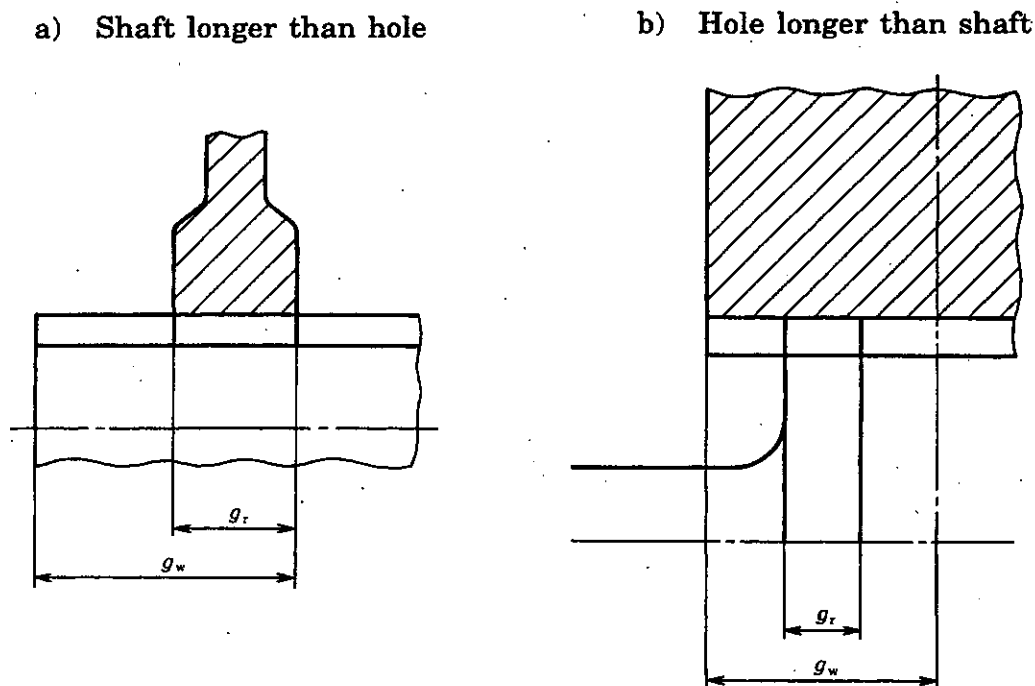
In case such indications are required, they may be obtained by additional gauging (to be prescribed explicitly) using segmental gauges controlling each element separately on the GO side.

5.7 Influence of active length and engagement length

Length of engagement g_r : The axial length of contact between mating splines.

Active length g_w : The maximum axial length in contact (when working) with the mating spline. For sliding splines, the active length exceeds the length of engagement.

Figure 1. Active length and engagement length



As gauges are generally smaller than gauged workpieces, the active length and length of engagement can influence the maximum permissible errors of alignment of splines (errors of parallelism of splines with respect to the axis).

If the active length is equal to the length of engagement, spline alignment errors will in general and unless otherwise specified be included in dimensional tolerances and checked simultaneously.

If the active length is longer than the length of engagement, it might be necessary to prescribe spline alignment errors independent of dimensional tolerances; such tolerances may then be checked separately, for example, by direct measurement.

If spline alignment tolerances are to be prescribed, it shall be considered that they must generally be all the smaller as the active length is longer.

5.8 Conditions of use of gauges

5.8.1 Go side Go gauges (spline ring or plug gauge) shall slide without clearance over the whole length of the gauged workpiece under their own weight or in accordance with a fixed working load, gauging being carried out at three angular positions at least, evenly distributed over the surface. The gauge may be moved slightly to and fro in order to minimize the effects of friction.

5.8.2 NOT GO side NOT GO segmental gauges are used in the same way as gauges intended for plain workpiece checking. Gauging is carried out at all angular positions.

5.9 Gauge control

5.9.1 GO side GO gauges are normally controlled by direct measurement.

5.9.2 NOT GO side NOT GO segmental gauges are controlled under the same conditions as gauges for plain workpiece gauging.

6. Definitions of gauges

6.1 General This clause defines the positions and values of tolerances for GO and NOT GO gauges and their permissible wear limits on the GO side. It also specifies the length of gauge measuring parts.

The general indications concerning gauges and gauge control are given in clause 5.

- Notes
1. When gauges are manufactured at the maximum material limit, they shall not present form errors outside permitted tolerances.
 2. To limit the number of gauges, only one GO spline plug gauge is provided to check the minimum limits of hub dimensions (whether treated or not after broaching).
 3. In the following texts, the phrase zero gauge line has been used to designate the theoretical line from which GO gauges are positioned in analogy with the zero assembly line (nominal dimension).

The position of the "zero gauge line" has been determined as a function of workpiece limits at the maximum material condition, in order to satisfy assembly and operation requirements taking account of the fact that GO gauges are not segmental gauges but full form gauges.

The "zero gauge line" is in some cases coincident with the zero assembly line (or nominal dimension of assembly).

4. In conformity with clause 4, the minor diameter serves for workpiece fitting. This diameter has therefore been taken as reference for the control of geometrical defects on other elements (i.e. the other diameter of width B of splines).

In this context the phrases dimensions for fitting and dimensions not ensuring fitting have been used to designate the various elements.

6.2 Basic principles

6.2.1 GO gauges GO gauges are full form gauges checking spline minor diameter d , major diameter D and width B simultaneously.

6.2.1.1 GO gauging of dimensions for fitting (minor diameter d) For GO gauging of minor diameter d ensuring fitting, the values and positions of dimensional tolerances of hole or shaft gauges, the wear limits and form tolerances shall conform to the requirements of ISO/R 1938, *ISO system of limits and fits - Part 2: Inspection of plain workpieces*.

6.2.1.2 GO gauging of dimensions not ensuring fitting

6.2.1.2.1 Position of zero gauge line For GO gauging of major diameter D not ensuring fitting the zero gauge line common to both shaft and hole is located at mid-distance between shaft and hole at the maximum permissible material condition of the workpieces concerned.

For GO gauging of width B , the three cases considered in clause 4 shall be taken into account, i.e. sliding, closes sliding or fixed type mounting.

- a) Sliding type mounting: The zero gauge line common to both shaft and hole is located as in 6.2.1.2.1 at mid-distance between shaft and hole at the maximum permissible material condition of the workpieces.
- b) Close sliding type mounting: The hole gauge (plug gauge) is the same as for sliding type mounting gauging and the hole zero gauge line therefore lies in the same position.

For the shaft gauge (ring gauge), the zero gauge line is located on the zero line (nominal dimension), without taking into account mid-distance between shaft and hole at the maximum permissible material condition of the workpieces.

- c) Fixed type mounting: The hole gauge (plug gauge) is the same as for sliding or close sliding type mounting gauging and the hole zero gauge line therefore lies in the same position.

For the shaft gauge (ring gauge) the shaft zero gauge line is located with respect to the shaft maximum permissible material condition (nominal dimension) above the limit at a distance equal to that retained for sliding type mounting, i.e. half the deviation allowance.¹⁾

6.2.1.2.2 Values and positions of tolerances and wear limits for GO gauging of dimensions not ensuring fitting The values of dimensional tolerances for hole or shaft GO gauges correspond to values of grade 6 and include both dimensional and form errors (namely concentricity, symmetry, angular position, helix, alignment, etc.).

The deviations between the zero gauge lines as defined in 6.2.1.2.1 and the values of grade 6 quantities closest to zero lines correspond to grade 4 values.

Gauge wear limits coincide with above-mentioned zero gauge lines.

6.2.2 NOT GO gauges NOT GO gauges are segmental gauges checking spline minor diameter d , major diameter D or width B separately.

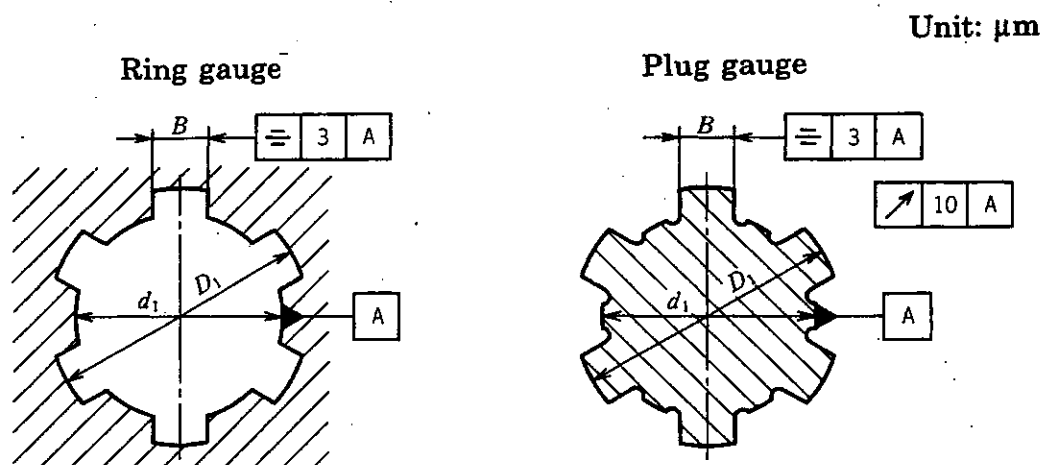
For NOT GO gauging of each element separately, the values and positions of gauge tolerances shall conform to the requirements of ISO/R 1938, *ISO system of limits and fits – Part 2: Inspection of plain workpieces*.

6.3 Tables of tolerance positions and values

6.3.1 Tolerances of symmetry and tolerances of backlash of the major diameter D_1 with respect to the minor diameter d_1 (see Figure 2)

¹⁾ The deviation allowance is simply labelled "deviation" in Attached Tables 1, 2, and 3.

Fig. 2. Geometrical tolerance of gauge



6.3.2 Tables for fitting and not fitting diameters and for spline widths (see Attached Tables 1, 2 and 3)

6.4 Length of gauge measuring part

6.4.1 Measuring part of GO gauges The length of measuring part of GO (plug or ring) gauges shall be at least equal to the minimum values indicated in Table 4 and selected from the R 20 series of preferred numbers.

The shaft Go (ring) gauge is not splined over its whole length and presents a plain cylindrical part, the diameter and tolerances of which have the same values as the major diameter D of the gauge splines.

The hole GO (plug) gauge is splined over its whole length.

Note: The hole GO gauge may however present one (or two) plain cylindrical part(s) to ease gauge introduction in the gauged hole.

6.4.2 Measuring part of NOT GO gauges The recommended length of the measuring part of NOT GO segmental gauges for holes or shafts is indicated in Table 5.

6.5 Gauge chamfers On the plugs, the presence of a chamfer may be considered necessary. In no case shall the maximum value of this 45° chamfer exceed the clearance between the shaft and hub to be inspected.

6.6 Plug handles Handles for plug gauges shall be those commonly intended for plain or screw gauges (see ISO 3670).

Table 4. Measuring part of GO gauges – Minimum length

Unit: mm

Nominal major diameter D of splines	GO plug gauge (hole)	GO ring gauge (shaft)		Nominal major diameter D of splines	GO plug gauge (hole)	GO ring gauge (shaft)	
	Minimum length				Minimum length		
	Splined	Total	Splined		Splined	Total	Splined
14	20	20	10	50	50	50	25
16				54			
20	25	20	10	58			
22				60			
25	31.5	25	12.5	62			
26				65			
28				68	50	56	28
30				72			
				78			
32	40	28	14	82			
34				88	50	63	31.5
36	45	35.5	18	92			
38				98			
40				102			
42				108			
46	50	45	22.4	112	56	71	35.5
48				120			
				125			

Table 5. Measuring part of NOT GO segmental gauges – Recommended length

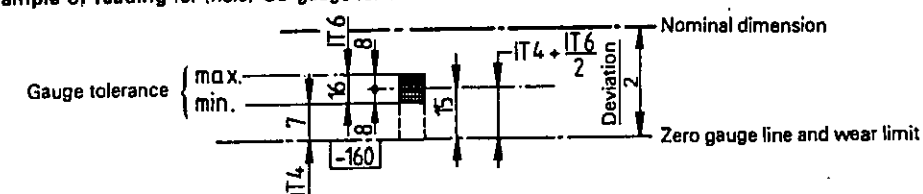
Unit: mm

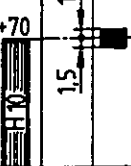
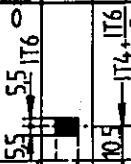
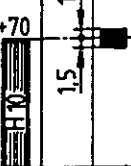
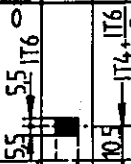
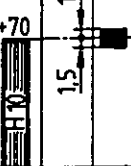
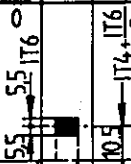
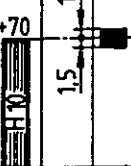
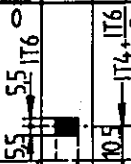
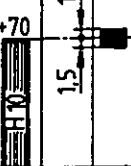
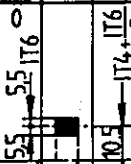
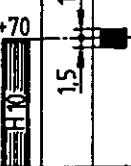
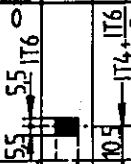
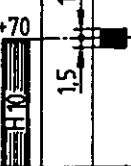
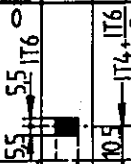
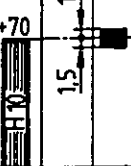
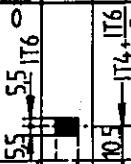
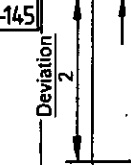
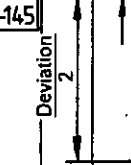
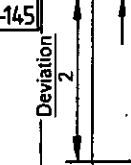
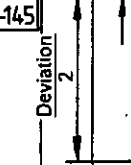
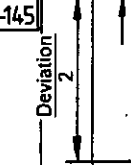
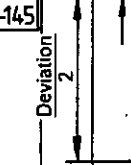
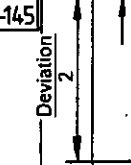
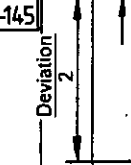
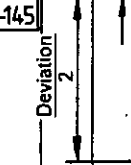
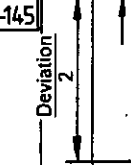
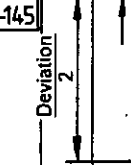
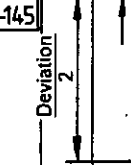
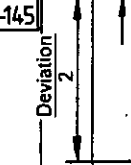
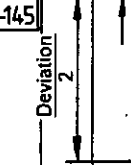
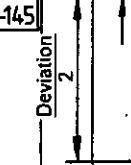
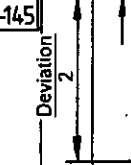
Nominal major diameter D of splines	Recommended length of NOT GO segmental gauges (for holes or shafts)	Nominal major diameter D of splines	Recommended length of NOT GO segmental gauges (for holes or shafts)
14	10	54	18
16		58	
20	12	60	
22		62	
25	14	65	
26		68	25
28		72	
30		78	
32	15	82	
34		88	
36		92	
38		98	
40		102	
42	18	108	
46		112	25
48		120	
50		125	

Attached Table 2. Diameter not ensuring fitting – Major diameter

Unit: μm

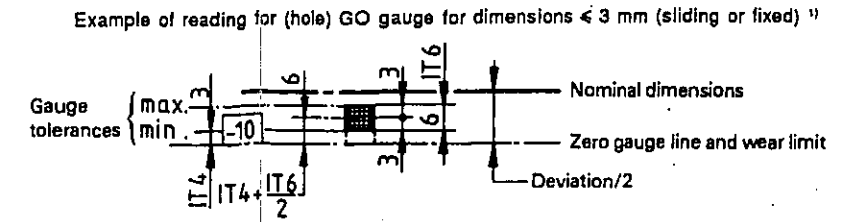
Example of reading for (hole) GO gauge for dimensions > 40 to 50 mm



> 10 to 18 mm			> 18 to 30 mm			> 30 to 40 mm			> 40 to 50 mm			> 50 to 65 mm			> 65 to 80 mm			> 80 to 100 mm			> 100 to 120 mm			> 120 to 125 mm																							
Hole			Shaft			Hole			Shaft			Hole			Shaft			Hole			Shaft			Hole			Shaft																				
Gauge			Gauge			Gauge			Gauge			Gauge			Gauge			Gauge			Gauge			Gauge			Gauge																				
min. — max.			min. — max.			min. — max.			min. — max.			min. — max.			min. — max.			min. — max.			min. — max.			min. — max.			min. — max.																				
GO — full form			GO — full form			GO — full form			GO — full form			GO — full form			GO — full form			GO — full form			GO — full form			GO — full form			GO — full form																				
NOT GO — segmental			NOT GO — segmental			NOT GO — segmental			NOT GO — segmental			NOT GO — segmental			NOT GO — segmental			NOT GO — segmental			NOT GO — segmental			NOT GO — segmental			NOT GO — segmental																				
																																															
																																															
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Attached Table 3. Widths of splines – Sliding, close sliding or fixed type mounting

Unit: μm



< 3 mm										> 3 to 6 mm										> 6 to 10 mm										> 10 to 18 mm																			
Hole					Shaft					Hole					Shaft					Hole					Shaft					Hole					Shaft														

Annex J type straight-sided splines

1. Scope This Annex specifies the straight-sided splines (hereafter referred to as "splines") to be worked in order to mount on or into spline shafts or holes which were specified in the former Standard, B 1601-1976.

This Annex does not conform to the International Standard, therefore, in manufacture by a new design, apply the specification in the text as far as possible.

2. Definitions The definitions of terms used in this Annex are as follows:

(1) nominal diameter The nominal diameter is the nominal value indicating the diameter of the spline and the reference dimensions of the minor diameter.

(2) major diameter The major diameter is the diameter of a circle formed by the tip of the teeth in the shaft and the diameter of a circle formed by the root of the grooves in the hole.

(3) minor diameter The minor diameter is the diameter of a circle formed by the root of the teeth in the shaft and the diameter of a circle formed by the tip of the grooves in the hole.

3. Classification and type Splines are classified into 3 classes of 6, 8 and 10 grooves according to the number of grooves; and 2 types of type 1 for light series and type 2 for medium series.

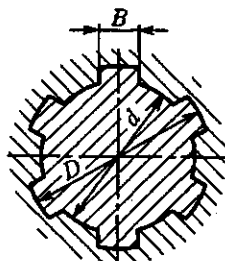
4. Shapes and dimensions The shapes and dimensions of the splines shall conform to Annex Attached Tables 1 to 3.

5. Fit The splines shall concentrically aligned with respect to the minor diameter and the fit shall conform to Annex Attached Table 3.

6. Designation Splines shall be designated by discrimination of shaft or hole, "J" which indicates an old model one, number of grooves, nominal diameter and major diameter.

Examples: Spline Shaft J-6×26×30
Spline Hole J-6×26×30

Annex Attached Table 1. Reference dimensions

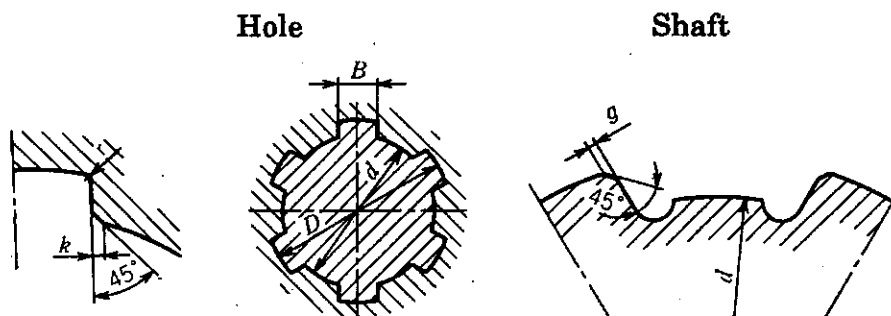


Unit: mm

Type	Type 1						Type 2					
Number of grooves	6		8		10		6		8		10	
Nominal diam. d	Major diam. D	Width B	Major diam. D	Width B	Major diam. D	Width B	Major diam. D	Width B	Major diam. D	Width B	Major diam. D	Width B
11	—	—	—	—	—	—	14	3	—	—	—	—
13	—	—	—	—	—	—	16	3.5	—	—	—	—
16	—	—	—	—	—	—	20	4	—	—	—	—
18	—	—	—	—	—	—	22	5	—	—	—	—
21	—	—	—	—	—	—	25	5	—	—	—	—
23	26	6	—	—	—	—	28	6	—	—	—	—
26	30	6	—	—	—	—	32	6	—	—	—	—
28	32	7	—	—	—	—	34	7	—	—	—	—
32	36	8	36	6	—	—	38	8	38	6	—	—
36	40	8	40	7	—	—	42	8	42	7	—	—
42	46	10	46	8	—	—	48	10	48	8	—	—
46	50	12	50	9	—	—	54	12	54	9	—	—
52	58	14	58	10	—	—	60	14	60	10	—	—
56	62	14	62	10	—	—	65	14	65	10	—	—
62	68	16	68	12	—	—	72	16	72	12	—	—
72	78	18	—	—	78	12	82	18	—	—	82	12
82	88	20	—	—	88	12	92	20	—	—	92	12
92	98	22	—	—	98	14	102	22	—	—	102	14
102	—	—	—	—	108	16	—	—	—	—	112	16
112	—	—	—	—	120	18	—	—	—	—	125	18

Remarks: Dimensions written boldly coincide with those specified in the text, but the dimensional tolerances are different.

Annex Attached Table 2. Dimensions in detail



Unit: mm

Nominal diam. d	Number of grooves N	Type 1						Type 2					
		Minor diam. d	Major diam. D	Width B	g min.	k max.	r^* max.	Minor diam. d	Major diam. D	Width B	g min.	k max.	r max.
11	6							11	14	3	0.3	0.3	0.2
13								13	16	3.5			
16								16	20	4			
18								18	22	5			
21								21	25				
23		23	26	6	0.3	0.3	0.2	23	28	6	0.4	0.4	0.3
26		26	30					26	32				
28		28	32	7				28	34	7			
32		32	36	8			0.3	32	38	8			
36		36	40					36	42				
42		42	46	10				42	48	10			
46		46	50	12	0.4	0.4	0.4	46	54	12	0.5	0.5	0.5
52		52	58	14				52	60	14			
56		56	62					56	65				
62		62	68	16				62	72	16			
72		72	78	18				72	82	18			
82		82	88	20	0.5	0.5	0.5	82	92	20	0.5	0.5	0.5
92		92	98	22				92	102	22			
32	8	32	36	6				32	38	6			
36		36	40	7				36	42	7			
42		42	46	8				42	48	8			
46		46	50	9	0.5	0.5	0.5	46	54	9	0.5	0.5	0.5
52		52	58	10				52	60	10			
56		56	62					56	65				
62	10	62	68	12	0.5	0.5	0.5	62	72	12	0.5	0.5	0.5
72		72	78					72	82				
82		82	88					82	92				
92		92	98	14				92	102	14			
102		102	108	16				102	112	16			
112		112	120	18				112	125	18			

Note * r may be replaced by chamfering.Remarks: The sectional surface of shaft shall be parallel up to intersection with the circular arc of minor diameter d .

Annex Attached Table 3. Dimensional tolerances and fits

		Width <i>B</i>		Minor diam. <i>d</i>	Major diam. <i>D</i>	Informative reference
		When hub is not hardened	When hub is hardened			Basis for selection of fit
Hole	Close sliding and fixing	D9	F10	H7	H11	—
Shaft	For close sliding	f9	d9	e8	all	For general applications of long fit (where fitting length is not less than approximately twice the minor diameter). Where precision fit is not required.
		h8	e8	f7		For general applications. For precision fit of long fit (where fitting length is not less than approximately twice the minor diameter).
		js7* or k7**	f7	g6		Where precision fit is particularly required.
	For fixing	n7	h7	js7	all	For general applications.
		p6	h6	js6		For precision fit.
		s6	js6	k6		
		s6* or u6**	js6* or k6**	m6		For firm fixing.
		u6	m6	n6		For applications in which no removing is performed.

Notes * Applicable where the width is 6 mm or under.

** Applicable where the width is over 6 mm.

Remarks: The tolerances for width *B* and minor diameter *d* are dependent on one another, therefore, the symbol for dimensions shall be selected out of the group in the same line. For example, when f7 is chosen for minor diameter, the correct symbol for width of the hole which is not hardened shall be h8.

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Edition 1

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