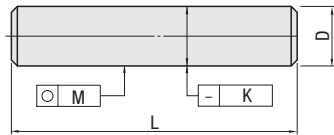


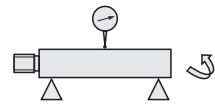
Shafts - Precision Standards

Accuracy Standards

Circularity / Straightness / L Dimension Accuracy



Straightness Measuring Method



Shaft ends are supported on V-blocks and turned 360 degrees to measure shaft runout using a dial indicator. 1/2 of measured runout is defined as the straightness.

O.D. g6/h5 Shafts (Hardened)

D Section Circularity

D		Circularity M
Over	Less than	
2	13	0.004
13	20	0.005
20	40	0.006
40	50	0.007

L / Y Dimension Tolerance

Dimension		Dimension Tolerance
Over	Less than	
2	6	±0.1
6	30	±0.2
30	120	±0.3
120	400	±0.5
400	1000	±0.8
1000	1500	±1.2

Straightness

D	L	Straightness K
3 / 4	N, A,	(L/100)×0.05 or less
5	N, A,	(L/100)×0.03 or less
6~50	100 or less	0.01 or less
	Over 100	(L/100)×0.01 or less

O.D. Tolerance f8 Shafts (Not Hardened)

D Section Circularity

D		Circularity M
Over	Less than	
5	10	0.011
10	18	0.014
18	30	0.017
30	50	0.020

L / Y Dimension Tolerance

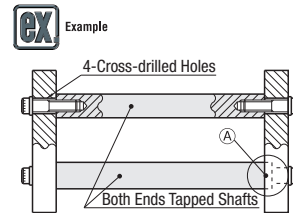
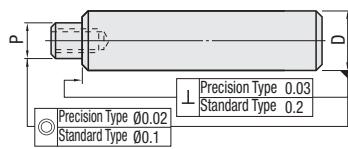
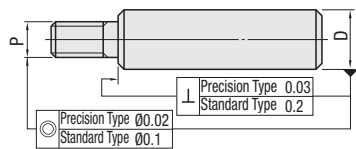
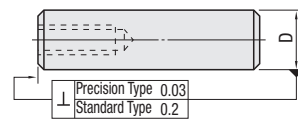
Dimension		Dimension Tolerance
Over	Less than	
3	6	±0.1
6	30	±0.2
30	120	±0.3
120	400	±0.5
400	1000	±0.8
1000	1500	±1.2

Straightness

Condition	Straightness K
L ≤ 100	0.025 or less
L > 100	(L/100)×0.025 or less

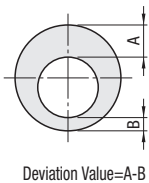
Concentricity / Perpendicularity

Precision Type Features: Straightness is $\perp 0.03$, and concentricity (Threaded and Stepped) is $\odot 00.02$



About Hollow Shaft Wall Thickness Deviations

Outer Diameter (D)	Unit: mm	
	52100 Bearing Steel Wall Thickness Deviation Value	440C Stainless Steel Equivalent Wall Thickness Deviation Value
6	0.3 or less	-
8	0.4 or less	1.5 or less
10		
12		
13		
16	0.6 or less	4.0 or less
20		
25		
30		
35	1.0 or less	-
40		
50	1.5 or less	-



Deviation Value=A-B

As hollow shaft interior surfaces are not treated with plating, it may rust.

Thread Undercut Dimensions (PC / QC) (Reference Values)

Outer diameter tolerance g6/h5 Shafts (hardened) / Outer diameter tolerance f8 Shafts (treated with plating)

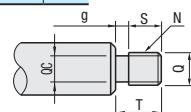
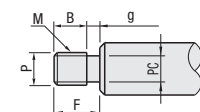
When specifying Shafts with thread undercuts or adding thread undercut alterations (PC/QC), PC and QC dimensions are as the table below. When B (S) is specified, undercut width (g) is F-B (T-S). Refer to the table below for the dimensions of PC and QC when combined with Fine Thread alterations (PMC, PMS, QMC, QMS, MMC, MMS, NMC and NMS).

- For Coarse Threads

P(=M) Q(=N)	PC QC	F-B (T-S)
6	4.4	2
8	6.0	3
10	7.7	3
12	9.4	4
16	13.0	4
20	16.4	5
24	19.6	5
30	25.0	5

- When Combined with Fine Thread Alterations

PMC / MMC QMC / NMC	PC QC	F-B (T-S)	PMS / MMS QMS / NMS	PC QC	F-B (T-S)
6	4.8	2.0	10	8.0	3.0
8	6.4		12	9.7	
10	8.4		14	11.7	
12	10.4		18	15.7	
15	13.4	3.0			
17	15.4				
20	18.4				
25	22.7				
30	27.7				



Shaft Material / Hardness / Surface Treatment

Material	Outer Diameter Tolerance	Hardness	Surface Treatment
52100 Bearing Steel 440C Stainless Steel equivalent	g6 / h5	Induction Hardening 52100 Bearing Steel 58HRC~ 440C Stainless Steel equivalent 56HRC ~	-
52100 Bearing Steel 440C Stainless Steel equivalent			Hard Chrome Plating Plating Hardness: HV750 ~ Plating Thickness 5µ or more
52100 Bearing Steel 440C Stainless Steel equivalent	g6		Low Temperature Black Chrome Plating Plating Thickness: 1 ~ 2µ
1045 Carbon Steel			Hard Chrome Plating Plating Hardness: HV750 ~ Plating Thickness: 10µm or more.
304 Stainless Steel	f8	-	

Effective Hardened Layer Depth of Shafts (hardened) with Outer Diameter Tolerance g6/h5

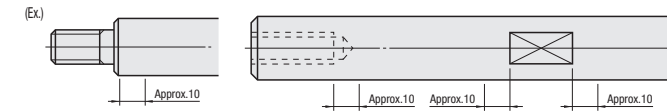
Outer Diameter (D)	Effective Hardened Depth	
	52100 Bearing Steel	440C Stainless Steel equivalent
3	Over 0.5	Over 0.5
4		
5		
6~10	0.7 or more	Over 0.5
12 / 13		
15~20		
25~50	1.0 or more	0.7 or more

Notes on Hardening and Surface Treating.

Reduced Hardness around Machined Areas

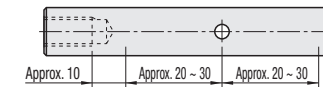
Alterations will be applied after base materials are case hardened.

In the example below, annealing caused by machining may result in reduced hardness of the machined area +10mm fore and aft.



Annealing caused by machining may lower hardness of following parts:

- All threaded shafts
 - All stepped shafts
 - Tapped holes: if $M \geq D/2$, RC threads, two tapped holes on ends, hard chrome plated 440C Stainless Steel products.
 - Retaining ring grooves, keyway, tapers, hexagonal socket holes, wrench flats, set screw grooves
 - Keyway, flats, 90-deg. flats, V-grooves
 - Shaft Ends Configurable Type (G / H shape), Hollow Shafts (lateral hole on one side)
- (Note) Excluding "Full Length Hardness Guaranteed Type"



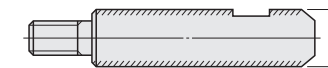
- For 52100 Bearing Steel material Shafts with cross-drilled holes and 20mm around 440C Stainless Steel material machined area, annealing may lower hardness in the range of 30mm around machined area.

Surface Treatment Plating Layers

Machining is applied after the base material is surface treated.

For the case below, only D area is treated with hard chrome plating or low temperature black chrome plating. Hard chrome plating or low temperature black chrome plating will be removed from stepped, tapered and machined areas.

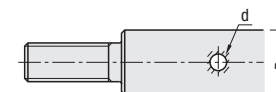
- For features of Low Temperature Black Chrome Plating, please see P118
- As hollow shaft interior surfaces are not treated with plating, it cause rust.



Other plating finished shapes are:

- Threaded and tapped shafts
- Retaining ring grooves, keyway, tapers, hexagonal socket holes, wrench flats, set screw grooves
- Keyway, flats, 90-deg. flats, V-grooves
- Fully Plated Shafts will have the plating on the entire shaft except centering holes and tapped sections.

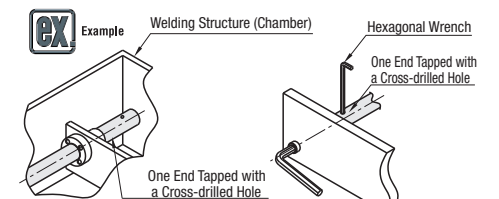
Cross-drilled Hole Dimension Details.



D	d
8	3
10	
12	
13	
15	4
16	

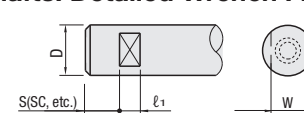
D	d
18	6
20	
25	
30	7
30	

- Cross-drilled hole areas may be out of O.D. tolerances due to annealing-induced deformation.
- Hard chrome plating layers around machined area may be flaked by deburring. (Hatched area)
- Hole position can be specified arbitrary to the other alterations.



-Shafts with cross-drilled holes are suitable for narrow work space.

Shafts: Detailed Wrench Flats Dimensions



D	W	l1	D	W	l1
6	5	8	18	16	10
8	7		20	17	
10	8		25	22	
12	10	10	30	27	15
13	11		35	30	
15	13		40	36	
16	14		50	41	

- S (SC, etc.)=1mm Increment
- S (SC etc.)+E1≤L
- S (SC etc.) = 0 or S (SC etc.) ≥ 1
- Orientation in relation to other features will be random.
- Hole position can be specified arbitrary to the other alterations.

Not applicable to D = 3, 4, 5