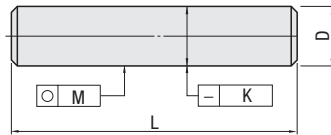


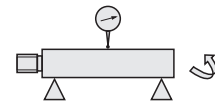
# Shafts - Precision Standards

## Accuracy Standards

### Circularity, Straightness, L Dimension Accuracy



### Straightness Measurement 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 Unit: mm		
D	or Less	Circularity M
2	13	0.004
13	20	0.005
20	40	0.006
40	50	0.007

L, Y Dimension Tolerances Unit: mm		
Dimension	or Less	Dimension Tolerance
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 Unit: mm		
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. f8 Shafts (Not Hardened)

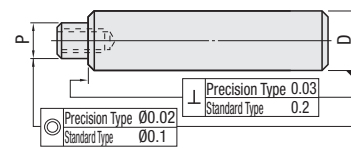
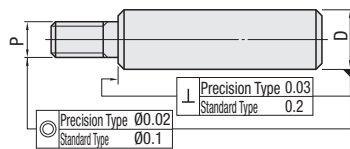
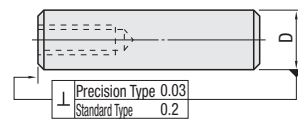
D Section Circularity Unit: mm		
D	or Less	Circularity M
5	10	0.011
10	18	0.014
18	30	0.017
30	50	0.020

L, Y Dimension Tolerances Unit: mm		
Dimension	or Less	Dimension Tolerance
3	6	±0.1
6	30	±0.2
30	120	±0.3
120	400	±0.5
400	1000	±0.8
1000	1500	±1.2

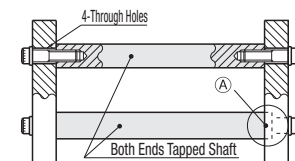
Straightness Unit: mm	
Condition	Straightness K
L ≤ 100	0.025 or Less
L > 100	(L/100)×0.025 or Less

## Concentricity, Perpendicularity

Features of Precision Shafts: Perpendicularity is  $\perp 0.03$ , Concentricity (Threaded and Stepped) is  $\odot 00.02$ .



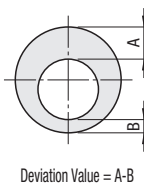
Example



\*Precision Type does not require stepped machining as  $\Delta$ , which enables effective assembly.

## About Hollow Shaft Wall Thickness Deviations

O.D. (D)	SUJ2 Wall Thickness Deviation Value	SUS440C Equivalent Wall Thickness Deviation Value
6	0.3 or Less	-
8	0.4 or Less	1.5 or Less
10		
12		
13		
16	4.0 or Less	4.0 or Less
20		
25		
30		
35	1.0 or Less	-
40		
50		



Deviation Value = A-B

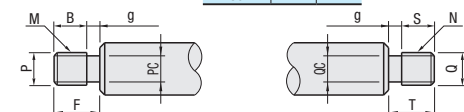
Hollow shaft interior surfaces are not plated, which causes rust.

## Thread Undercut Dimensions (PC, QC) (Reference Values)

O.D. Tolerance g6, h5 Shafts (Hardened), O.D. Tolerance f8 Shafts (Plated)

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			When combined with Fine Thread Alterations		
P(=M) Q(=N)	PC QC	F-B (T-S)	PMC, MMC QMC, NMC	PC QC	F-B (T-S)
6	4.4	2	6	4.8	2.0
8	6.0	3	8	6.4	
10	7.7	3	10	8.4	
12	9.4	4	12	10.4	
16	13.0	4	15	13.4	
20	16.4	5	17	15.4	
24	19.6	5	20	18.4	
25	22.7	5	25	22.7	
30	25.0	5	30	27.7	



## Shaft Material, Hardness, Surface Treatment

Material	O.D. Tolerance	Hardness	Surface Treatment
SUJ2	g6, h5	Induction Hardening SUJ2 58HRC~ SUS440C Equivalent 56HRC~	-
SUS440C Equivalent			Hard Chrome Plating Plating Hardness HV750 ~ Plating Thickness: 5µ or More
SUJ2			Low Temp. Black Chrome Plating Plating Thickness: 1 ~ 2µ
SUS440C Equivalent	g6		Low Temp. Black Chrome Plating Plating Thickness: 1 ~ 2µ
SUJ2			Hard Chrome Plating Plating Hardness HV750 ~ Plating Thickness 10µ or More
S45C	f8		Hard Chrome Plating Plating Hardness HV750 ~ Plating Thickness 10µ or More
SUS304			

## Effective Hardened Layer Depth of Shafts (hardened) with O.D. Tolerance g6, h5 Unit: mm

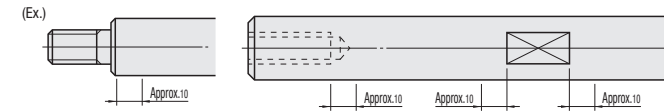
O.D. (D)	Effective Hardened Depth SUJ2	SUS440C Equivalent
3	0.5 or More	0.5 or More
4		
5		
6~10	0.7 or More	0.5 or More
12, 13		
15~20		
25~50	1.0 or More	0.7 or More

## Notes on Hardening and Surface Treating

### Reduced Hardness around Machined Areas

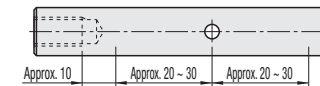
Machining is applied after base materials are case hardened.

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 areas:

- All threaded shafts
  - All stepped shafts
  - Tapped Holes: when  $M \geq D/2$ , RC threads, two tapped holes on ends, hard chrome plated SUS440C products
  - Retaining ring grooves, keyway, tapers, hex socket holes, wrench flats, tapped pilot, 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 Shafts with Cross-Drilled Hole, annealing may lower hardness in the range of 20mm and 30mm around machined area for SUJ2 and SUS440C respectively.

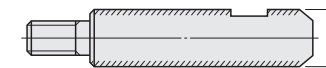
## Surface Treatment Plating Layers

Machining is applied after base materials are surface treated.

In the example below, only  $\Delta$  area is treated with hard chrome plating/low temp. black chrome plating.

Hard chrome plating, low temp. black chrome plating will not remain on cut-ends, stepped, tapered, and altered sections.

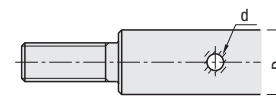
- For Features of Low Temp. Black Chrome Plating, see P.128.
- Hollow shaft interior surfaces are not plated, which causes rust.



Other plating finished shapes are:

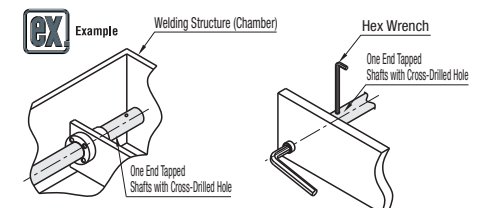
- Threaded, Stepped and Tapped
- Retaining ring grooves, keyway, tapers, hex socket holes, wrench flats, set screw grooves
- Keyway, Flats, 90-deg. Flats, V-grooves
- Surface Treatment Fully Plated Shafts will have the plating on the entire shaft except centering holes and tapped sections.

## Cross-Drilled Hole Dimension Details



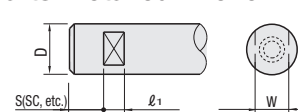
D	d
8	3
10	
12	
13	
15	4
16	

- 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 Areas)
- Orientation in relation to other features will be random.



Shafts with Cross-Drilled Hole are suitable for narrow work space.

## Shafts: Detailed Wrench Flats Dimensions



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

- S(SC, etc.) = 1mm Increment
- S(SC, etc.) + l1 ≤ L
- S(SC, etc.) = 0 or S(SC, etc.) ≥ 1
- Cannot be machined coplanar.
- Orientation in relation to other features will be random.

Not applicable to D=3, 4, 5