MIKI PULLEY

Flexible Couplings and Hub-shaft Connections

COUPLINGS

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PSL Hub-shaft Connection

The PSL-G type is a mechanical-type shaft lock joint. By locking the clamp bolt, the outer sleeve moves in an axial direction. At this time, a force that pushes the inner surface of hub and shaft is generated by the wedge effect of the inner sleeve and taper surface to perfectly lock a shaft and hub.

POSI LOCK

POSI LOCK PSL-G TYPE

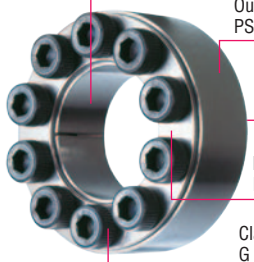
- Homogeneous transmission ability can be obtained by the simple structure and strong component.
- The PSL-G also corresponds to heavy loading.
- It is shorter to the axial direction that space can be saved.

POSI LOCK PSL-G-C TYPE

- A basic antirust specification with electroless nickel plating coated on the body.

PSL-G

Structure and Material



Inner ring material: S45C heat treated or equivalent
PSL-G-C surface treatment: Electroless nickel plating

Outer ring material: S45C heat treated or equivalent
PSL-G-C surface treatment: Electroless nickel plating

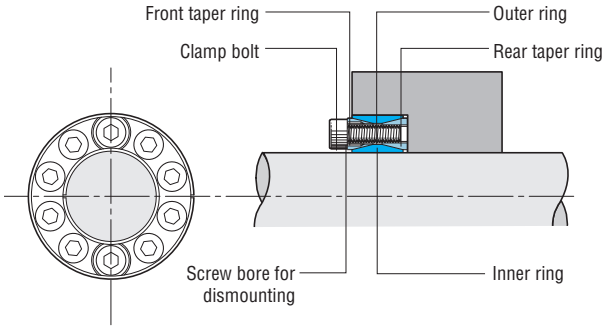
Rear taper ring material: S45C heat treated or equivalent
PSL-G-C surface treatment: Electroless nickel plating

Front taper ring material: S45C heat treated or equivalent
PSL-G-C surface treatment: Electroless nickel plating

Clamp bolt material: SCM435
G surface treatment: Black oxide finish
G-C treatment: GEOMET treatment

Operating Principle

Driving the clamp bolts will move the two taper rings axially when the outer ring and inner ring generate a force to push the shaft and inner part of the hub through the wedge action on their tapered surfaces. This force perfectly locks the shaft and hub.



Specification

PSL-G

Model	Maximum permissible torque [N·m]	Maximum permissible thrust [N]	Shaft-side surface pressure [N/mm²]	Hub-side surface pressure [N/mm²]	Screw tighening torque [N·m]	Moment of inertia [kg·m²]	Mass [kg]	Price
PSL-G-19	289	30500	250	101	17	0.70×10^{-4}	0.22	–
PSL-G-20	305	30500	238	101	17	0.70×10^{-4}	0.21	–
PSL-G-22	335	30500	216	101	17	0.69×10^{-4}	0.20	–
PSL-G-24	411	34300	223	107	17	0.89×10^{-4}	0.23	–
PSL-G-25	428	34300	214	107	17	0.88×10^{-4}	0.22	–
PSL-G-28	533	38100	212	108	17	1.28×10^{-4}	0.26	–
PSL-G-30	571	38100	198	108	17	1.25×10^{-4}	0.25	–
PSL-G-32	731	45700	223	119	17	1.80×10^{-4}	0.30	–
PSL-G-35	800	45700	204	119	17	1.74×10^{-4}	0.28	–
PSL-G-38	1020	53500	220	129	17	2.43×10^{-4}	0.34	–
PSL-G-40	1070	53500	209	129	17	2.37×10^{-4}	0.32	–
PSL-G-42	1680	80200	253	142	41	5.26×10^{-4}	0.56	–
PSL-G-45	1800	80200	236	142	41	5.11×10^{-4}	0.53	–
PSL-G-48	1920	80200	222	133	41	6.51×10^{-4}	0.59	–
PSL-G-50	2010	80200	213	133	41	6.36×10^{-4}	0.56	–
PSL-G-55	2570	93600	226	146	41	8.01×10^{-4}	0.62	–
PSL-G-60	2810	93600	207	138	41	9.68×10^{-4}	0.65	–
PSL-G-65	3090	95000	194	133	41	12.8×10^{-4}	0.77	–
PSL-G-70	4800	137000	218	138	82	28.3×10^{-4}	1.34	–
PSL-G-75	5160	138000	203	132	82	32.9×10^{-4}	1.40	–
PSL-G-80	5510	138000	190	127	82	37.9×10^{-4}	1.46	–
PSL-G-85	6500	153000	199	135	82	44.3×10^{-4}	1.56	–
PSL-G-90	6880	153000	188	130	82	50.4×10^{-4}	1.62	–
PSL-G-95	7940	167000	195	137	82	56.6×10^{-4}	1.67	–
PSL-G-100	10100	202000	205	142	142	91.4×10^{-4}	2.36	–
PSL-G-110	11100	202000	187	133	142	113.9×10^{-4}	2.53	–
PSL-G-120	13500	225000	190	138	142	142.7×10^{-4}	2.74	–

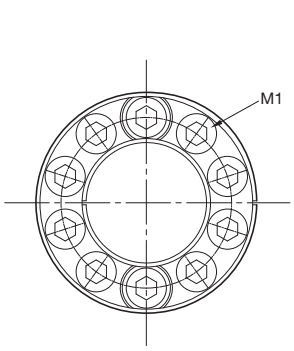
* The maximum permissible torque is the value when the thrust force is zero. The maximum permissible thrust is the value when the torque is zero.

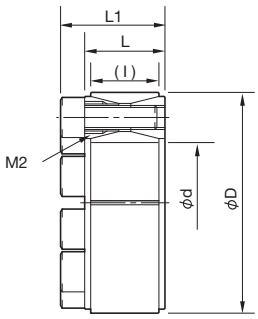
Specification

PSL-G-C

Model	Maximum permissible torque [N·m]	Maximum permissible thrust [N]	Shaft-side surface pressure [N/mm²]	Hub-side surface pressure [N/mm²]	Screw tighening torque [N·m]	Moment of inertia [kg·m²]	Mass [kg]	Price
PSL-G-19-C	289	30500	250	101	17	0.70×10^{-4}	0.22	–
PSL-G-20-C	305	30500	238	101	17	0.70×10^{-4}	0.21	–
PSL-G-22-C	335	30500	216	101	17	0.69×10^{-4}	0.20	–
PSL-G-24-C	411	34300	223	107	17	0.89×10^{-4}	0.23	–
PSL-G-25-C	428	34300	214	107	17	0.88×10^{-4}	0.22	–
PSL-G-28-C	533	38100	212	108	17	1.28×10^{-4}	0.26	–
PSL-G-30-C	571	38100	198	108	17	1.25×10^{-4}	0.25	–
PSL-G-32-C	731	45700	223	119	17	1.80×10^{-4}	0.30	–
PSL-G-35-C	800	45700	204	119	17	1.74×10^{-4}	0.28	–
PSL-G-38-C	1020	53500	220	129	17	2.43×10^{-4}	0.34	–
PSL-G-40-C	1070	53500	209	129	17	2.37×10^{-4}	0.32	–
PSL-G-42-C	1680	80200	253	142	41	5.26×10^{-4}	0.56	–
PSL-G-45-C	1800	80200	236	142	41	5.11×10^{-4}	0.53	–
PSL-G-48-C	1920	80200	222	133	41	6.51×10^{-4}	0.59	–
PSL-G-50-C	2010	80200	213	133	41	6.36×10^{-4}	0.56	–
PSL-G-55-C	2570	93600	226	146	41	8.01×10^{-4}	0.62	–
PSL-G-60-C	2810	93600	207	138	41	9.68×10^{-4}	0.65	–

* The maximum permissible torque is the value when the thrust force is zero. The maximum permissible thrust is the value when the torque is zero.





Ordering Information

PSL - G - ☐ - C

Size

Blank: Without surface treatment
-C: Electroless nickel plating

CAD

Dimensions PSL-G

Unit [mm]

Model	d	D	L	ℓ	L1	M1	M2	CAD file No.
PSL-G-19	19	47	20	17	26	8-M6×18	2-M8	PSL-G01
PSL-G-20	20	47	20	17	26	8-M6×18	2-M8	PSL-G02
PSL-G-22	22	47	20	17	26	8-M6×18	2-M8	PSL-G03
PSL-G-24	24	50	20	17	26	8-M6×18	2-M8	PSL-G04
PSL-G-25	25	50	20	17	26	8-M6×18	2-M8	PSL-G05
PSL-G-28	28	55	20	17	26	10-M6×18	2-M8	PSL-G06
PSL-G-30	30	55	20	17	26	10-M6×18	2-M8	PSL-G07
PSL-G-32	32	60	20	17	26	12-M6×18	2-M8	PSL-G08
PSL-G-35	35	60	20	17	26	12-M6×18	2-M8	PSL-G09
PSL-G-38	38	65	20	17	26	14-M6×18	2-M8	PSL-G10
PSL-G-40	40	65	20	17	26	14-M6×18	2-M8	PSL-G11
PSL-G-42	42	75	24	20	32	12-M8×22	2-M10	PSL-G12
PSL-G-45	45	75	24	20	32	12-M8×22	2-M10	PSL-G13
PSL-G-48	48	80	24	20	32	12-M8×22	2-M10	PSL-G14
PSL-G-50	50	80	24	20	32	12-M8×22	2-M10	PSL-G15
PSL-G-55	55	85	24	20	32	14-M8×22	2-M10	PSL-G16
PSL-G-60	60	90	24	20	32	14-M8×22	2-M10	PSL-G17
PSL-G-65	65	95	24	20	32	16-M8×22	3-M10	–
PSL-G-70	70	110	28	24	38	14-M10×25	3-M12	–
PSL-G-75	75	115	28	24	38	14-M10×25	3-M12	–
PSL-G-80	80	120	28	24	38	14-M10×25	3-M12	–
PSL-G-85	85	125	28	24	38	16-M10×25	3-M12	–
PSL-G-90	90	130	28	24	38	16-M10×25	3-M12	–
PSL-G-95	95	135	28	24	38	18-M10×25	3-M12	–
PSL-G-100	100	145	33	26	45	14-M12×30	3-M14	–
PSL-G-110	110	155	33	26	45	14-M12×30	3-M14	–
PSL-G-120	120	165	33	26	45	16-M12×30	3-M14	–

* L and L1 are the dimensions before mounting <POSI LOCK>.
* M2 is the screw bore for dismounting. The screw bore for dismounting for size 19 to 60 is shown by a tool mark and that for size 65 and larger, by paint on the screw head.

Dimensions PSL-G-C

Unit [mm]

Model	d	D	L	ℓ	L1	M1	M2	CAD file No.
PSL-G-19-C	19	47	20	17	26	8-M6×18	2-M8	PSL-G01
PSL-G-20-C	20	47	20	17	26	8-M6×18	2-M8	PSL-G02
PSL-G-22-C	22	47	20	17	26	8-M6×18	2-M8	PSL-G03
PSL-G-24-C	24	50	20	17	26	8-M6×18	2-M8	PSL-G04
PSL-G-25-C	25	50	20	17	26	8-M6×18	2-M8	PSL-G05
PSL-G-28-C	28	55	20	17	26	10-M6×18	2-M8	PSL-G06
PSL-G-30-C	30	55	20	17	26	10-M6×18	2-M8	PSL-G07
PSL-G-32-C	32	60	20	17	26	12-M6×18	2-M8	PSL-G08
PSL-G-35-C	35	60	20	17	26	12-M6×18	2-M8	PSL-G09
PSL-G-38-C	38	65	20	17	26	14-M6×18	2-M8	PSL-G10
PSL-G-40-C	40	65	20	17	26	14-M6×18	2-M8	PSL-G11
PSL-G-42-C	42	75	24	20	32	12-M8×22	2-M10	PSL-G12
PSL-G-45-C	45	75	24	20	32	12-M8×22	2-M10	PSL-G13
PSL-G-48-C	48	80	24	20	32	12-M8×22	2-M10	PSL-G14
PSL-G-50-C	50	80	24	20	32	12-M8×22	2-M10	PSL-G15
PSL-G-55-C	55	85	24	20	32	14-M8×22	2-M10	PSL-G16
PSL-G-60-C	60	90	24	20	32	14-M8×22	2-M10	PSL-G17

* L and L1 are the dimensions before mounting <POSI LOCK>.

The latest CAD data can be downloaded from our website. **http://www.mikipulley.co.jp/**

The CAD mark indicates that CAD data is available by CD-ROM.
The CAD file No. represents the file name in the CD-ROM.

Design Check Items

Selection procedure

(1) In general, torque Ta is calculated based on the output P of a driver and operating rotation speed n of the locking element even though Ta is decided by the shaft diameter to be used in operation.

$$Ta\ [N{\cdot}m] = \frac{9550 \times P\ [kW]}{n\ [min^{-1}]}$$

Ta : Torque applied to locking element [N·m]
P : Output of driver [kW]
n : Rotation speed of locking element [min-1]
Fa : Thrust force applied to locking element [N]
Also calculate the thrust force Fa.

(2) Calculate corrected torque Td and corrected thrust force Fd applied to the locking element after deciding the service factor K1 determined by the characteristics of the load.

$Td = Ta \times K1$
$Fd = Fa \times K1$

Td : Corrected torque applied to the locking element [N·m]
Fd : Corrected thrust force applied to the locking element [N]
K1 : Service factor determined by the characteristics of the load

(3) Correct in accordance with the characteristics of the load.
1. Torque only
Compare maximum permissible torque T and calculated corrected torque Td of the locking element based on the shaft diameter to be used in operation.

$Tn \geq Td$ T: Maximum permissible torque of the locking element [N·m]

2. Thrust force only
Compare maximum permissible thrust force F and calculated corrected thrust force Fd of the locking element based on the operating shaft diameter.

$F \geq Fd$ F: Maximum permissible thrust force of the locking element [N]

3. Torque and thrust force applied simultaneously.
Calculate combined radial and thrust loads Mr and compare them with maximum permissible torque T.

$$Mr = \sqrt{Td^2 + \left(Fd \times \frac{d}{2}\right)^2}$$
$$T \geq Mr$$

Mr: Combined radial and thrust loads applied to the locking element [N·m]
d: Shaft diameter [m]

(4) Calculate the minimum outer diameter of the hub and maximum inner diameter of the hollow shaft.
1. Calculate the minimum outer diameter of the hub based on the strength of the hub material to be used.

$$DO \geq D \sqrt{\frac{\delta_{0.2N} + CP_2}{\delta_{0.2N} - CP_2}}$$

C = 1 B = L
C = 0.8 L < B < 2L
C = 0.6 B ≥ 2L

DO : Minimum outer diameter of hub [mm]
D : Hub inner diameter [mm]
P_2 : Hub side pressure [N/mm²]
$\delta_{0.2N}$: Yield point stress of hub material [N/mm²]
B : Hub length [mm]
L : Effective length of contact [mm]
C : Coefficient

If the stress of the hub material at a yield point is large, adjust the ratio between the minimum outer diameter of the hub and inner diameter of the hub to be about 1.3 times or larger taking deformation of the hub into consideration.

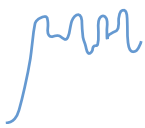
2. Calculate the maximum inner diameter of the hollow shaft based on the strength of the hollow shaft material used.

$$di \leq d \sqrt{\frac{\delta_{0.2N} - 2P_1C}{\delta_{0.2N}}}$$

C = 0.6 When only one is used.
C = 0.8 When more than one are used.

Di : Maximum inner diameter of hollow shaft [mm]
$\delta_{0.2N}$: Stress to hollow shaft at yield point [N/mm²]
d : Shaft diameter [mm]
P_1 : Shaft side pressure [N/mm²]
C : Coefficient

Service factor by the characteristics of the load: K1

Characteristics of the load			
Constant	Fluctuation: Slight	Fluctuation: Medium	Fluctuation: Large
			
1.0	1.25	1.75	2.25

Specifications

Tolerance of target shaft	h9
Tolerance of target hub	H8
Surface roughness of fitting part	12.5S (average roughness of center line 3.2a) or less
Operating ambient temperature	-40 to +150°C
Number of fitting and unfitting operations	100 cycles

Shaft with keyway

If a shaft has a keyway such as a motor and reducer, the shaft can be used if the keyway width roughly satisfies the JIS specification. In this case, however, the permissible torque and permissible thrust force will decrease by 10 to 15%.

Bending moment

As a rule, <POSI LOCK> does not tolerate a bending moment.

Design Check Items

Centering mechanism

<POSI LOCK> does not have a centering mechanism. Provide a centering mechanism to a <POSI LOCK> if a high precision is required for concentricity and run out. As illustrated by Dimension Symbol J in the following diagram, the centering mechanism regulates concentricity and run out by having the shaft and part of the hub directly contact each other.
The accuracy by centering is decided by the centering length (length of contact part between shaft and hub) and fit tolerance. Generally, the centering length (length of contact part between shaft and hub) is acceptable if it is longer than the shaft diameter.
The accuracies of concentricity and run out by the centering mechanism are decided by the processing dimensions of the shaft and hub. In other words, the hub may incline by the clearance between the shaft outer diameter and hub inner diameter of the centering part. For this reason, the concentricities and run outs of a shaft and hub must be machined so that tolerances for accuracies of concentricities and run outs meet the desired values. Accuracies of concentricities and run outs obtained by a centering mechanism can be calculated by the following formulas.

● **Maximum Run Out Accuracy: Ea (Measure Run Out at Position of Radius r)**

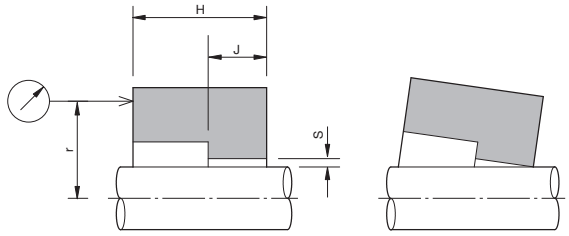
$$Ea \approx 2 \times r \times S/J$$

$$S = [(\text{Processed dimensions of hub}) - (\text{Processed dimensions of shaft})] /2$$

● **Maximum Run Out of Concentricity: Eb**

$$Eb \approx H \times S/J$$

■ Run out of Centering Mechanism



J : Centering length (length of contact part between shaft and hub)
r : Measuring position of run out accuracy
H : Full length of hub

Mounting

(1) Cleaning of shaft and hub

Thoroughly remove rust, dirt and other foreign matter attached to inner surfaces of the shaft and hub. Thinly coat them with oil or grease.

(2) <POSI LOCK> cleaning

Remove the clamp bolts on <POSI LOCK>, wipe the contact surfaces of the parts cleanly and thinly coat with oil or grease. Make sure to also coat oil or grease on the threaded surfaces, bearing surfaces of heads on the clamp bolts. Then temporarily assemble <POSI LOCK>. Tighten the clamp bolts lightly by hand avoiding any change in the inner and outer diameters of the inner ring and outer ring.

Caution

Never use oil that contains molybdic antifriction agent or other substance. Otherwise a basic change in the friction coefficient will result.

(3) Mounting onto shaft and hub

Mount <POSI LOCK> onto the shaft and hub, lightly tighten the clamp bolts to have the parts contact lightly and perform positioning.

Caution

Never clamp the clamp bolts before assembling <POSI LOCK> onto the shaft and hub.

(4) Tightening clamp bolts

Clamp the clamp bolts uniformly in about four clamping operations to the specified tightening torque by holding the bolts diagonally. (In four clamping operations, for example, clamp about 25% in each clamping.) Finally, clamp all the clamp bolts once again at the specified tightening torque. Check the tightening torque again after operating for a certain period of time to prevent initial loosening of the bolts.

Mounting precautions

<POSI LOCK> demonstrates its performance when the shaft and hub function properly along their entire lengths as against the reference lengths ℓ on the shaft and hub sides. The shaft and hub therefore need to be designed so that they will function along their entire reference length.

Dismounting

(1) Safety check

Start work after checking safety such as any torque, thrust force, etc. that are applied to <POSI LOCK> and danger of <POSI LOCK> dropping due to the self-weights of the shaft and hub being applied to it. A self-locking mechanism is not provided with <POSI LOCK>. Loosening the clamp bolts will momentarily cancel the locking force.

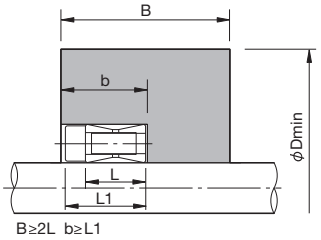
(2) Dismounting

Loosening the clamp bolts after confirming safety will automatically separate the various parts. Under some conditions, the parts cannot be dismounted even if the clamp bolts are loosened. Forcible dismounting of the parts may damage the shaft, hub and <POSI LOCK>. Never attempt to dismount the parts forcibly. If the rear taper ring does not loosen automatically even though the clamp bolts are loosened, lightly hit the heads of the clamp bolts, to move and release the rear taper ring backward by the spring action of each part. Similarly, if the front taper ring does not come off, put the bolt into a screw bore for dismounting (one size larger than the screw bore for clamp bolt) and lightly hit the bolt head with a hammer or other tool, to release it.

Design Check Items

List of minimum outer diameters of hub

The hub may deform if a large stress is applied to it. Design the hub by selecting a suitable outer diameter from the following list of minimum hub outer diameters.



øDmin Unit [mm]

PSL-G PSL-G-C Size	Hub side Surface pressure [N/mm²]	Stress of material at yield point $\delta_{0.2}$ [N/mm²]									
		150	180	210	230	250	280	300	350	400	450
		FC250	FC300 SS330 SC360 FCMB310	FC350 SS400 SC410 FCMB360 SUS304	SC450 S15C SF440	FCD400 SS490 SC480 S20C SF490	S30C SF540 SUS201	FCD450 S35C SF590	FCD500 S45C SUS410	FCD600 S55C SUS403	FCD700 SUS420
19	101	72	67	63	62	62	62	62	62	62	62
20	101	72	67	63	62	62	62	62	62	62	62
22	101	72	67	63	62	62	62	62	62	62	62
24	107	79	73	69	67	65	65	65	65	65	65
25	107	79	73	69	67	65	65	65	65	65	65
28	108	87	80	76	73	72	72	72	72	72	72
30	108	87	80	76	73	72	72	72	72	72	72
32	119	101	91	85	83	80	78	78	78	78	78
35	119	101	91	85	83	80	78	78	78	78	78
38	129	115	103	96	92	90	86	85	85	85	85
40	129	115	103	96	92	90	86	85	85	85	85
42	142	143	125	115	111	107	103	100	98	98	98
45	142	143	125	115	111	107	103	100	98	98	98
48	133	145	129	119	115	111	107	105	104	104	104
50	133	145	129	119	115	111	107	105	104	104	104
55	146	166	145	133	127	123	117	117	117	117	117
60	138	168	148	137	131	127	122	119	117	117	117
65	133	172	153	142	136	132	127	125	124	124	124
70	138	205	181	167	160	155	149	146	143	143	143
75	132	207	184	171	165	160	154	151	150	150	150
80	127	210	189	176	169	164	159	156	156	156	156
85	135	229	203	188	181	175	168	165	163	163	163
90	130	231	207	192	185	180	173	170	169	169	169
95	137	250	221	204	196	190	183	179	176	176	176
100	142	276	243	223	214	207	199	194	189	189	189
110	133	280	250	231	223	216	208	204	202	202	202
120	138	307	271	250	241	233	224	219	215	215	215

* The minimum outer diameter of hub is the diameter calculated based on C = 0.6 in the selection procedure.
* The foregoing SUS values are bearing forces [N/mm²] in a quenched and tempered condition.

Safety Precautions (Please read prior to use)

Please read carefully through the instruction manual and the technical information for proper use and safety. In this manual, safety precautions are classified by "DANGER" and "CAUTION".

⚠ DANGER

● **When death or serious injury may result by mishandling**

⚠ CAUTION

● **When disability or only physical damage may result by mishandling**

Equipment use (atomic energy, aerospace, medical treatment,transportation, or various safety devices) that may result in serious bodily injury or loss of life directly by mechanical failure or mishandling, careful examination is necessary. Contact us for further information.
The company has taken all possible measures to produce a quality product; however, continuous rotational states when the clutch can not be disengaged or coasting of the machine when the brakes went off is envisioned as emergency. Please pay attention to safety measures in case anything goes wrong.

1. Structural precautions

⚠ DANGER ● Use a safety cover.

Touching the product during operation could cause injury.
Place a safety cover to avoid any accident.
Additionally, set up a safety mechanism for quick stop of the product when opening the cover.

⚠ DANGER ● Do not use the product in the presence of fire and explosive hazards.

Do not use the product near flammable liquids or in the presence of gas and other explosive air particles.

⚠ DANGER ● Set up a safety mechanism

The driven and driving sides could be completely detached when the product is damaged.
Set up a safety mechanism such as a safety brake to avoid any danger.

2. Mounting precautions

⚠ DANGER ● Tighten bolts or screws completely.

Depending on the tightening adjustment of bolt or screw, exceptionally dangerous situations such as product damage or performance degradation could occur. Always use a calibrated torque wrench and clamp at the tightening torque specified by Miki Pulley.

⚠ DANGER ● Do not turn on the power of the equipment.

It is very dangerous if the driving part starts by accident while mounting the product. Be sure that the main power of the equipment is turned off.

⚠ CAUTION ● Use the product within the specified maximum permissible misalignment.

The installation of the product must be performed within the specified maximum permissible error.
Using the product with more than the maximum permissible error could cause damage or adverse effect on the equipment.

⚠ CAUTION ● Do not use any unspecified bolt or screw.

Using a bolt or screw that is not specified by our company could damage the product. Do not use any bolt or screw unspecified.

⚠ CAUTION ● Wear protective equipment.

To avoid any injury by stripping, spring pin or keyway, make sure to wear protective equipment such as safety glasses or gloves.

⚠ CAUTION ● Carry and mount the product by using a hoist.

Lifting of a heavy weight could cause back injury.
Use a hoist when carrying or mounting the product.

3. Cautions during operation

⚠ DANGER ● Do not exceed the permissible rated speed

If the product is used in excess of more than its maximum rated permissible speed, very dangerous product damage could occur by a large vibration.

⚠ DANGER ● Do not touch the product during operation.

Due to the exposed rotor, touching the product during operation may cause injury.
Make sure not to touch the product during operation.

⚠ CAUTION ● Do not use the product with more than the specified permissible transmission torque.

Using the product with more than the specified permissible transmissing torque could cause damage or adverse effect on the equipment.

⚠ CAUTION ● When abnormal noises or vibrations occur, stop operation immediately.

If abnormal noises or vibrations occur during operation, improper mounting should be considered. Do not leave the situation as it is. It may cause damage to the equipment itself. Also, for reasons other than above, the belts and other screws may loosen or become defective even if the product is mounted correctly.

⚠ CAUTION ● Do not use the product in an environment that could cause harmful effects.

Do not use the product in an environment where chemicals may spill, humidity is high, or in hot or cold temperature.

⚠ CAUTION ● Do not use the product when the locing part is in a slip condition.

Using the product when the locking part is in a slip condition could over heat the product, which could cause damage to the equipment.

⚠ CAUTION ● Make sure to operate the product within the specified "maximum permissible misalignment."

Using the product with more than the "maximum permissible misalignment" could cause damage or adverse effect on the equipment. Always operate the product within the specified "maximum permissible misalignment."

4. Cautions for maintenance and inspection

⚠ DANGER ● Do not turn on the power of the equipment.

It is extremely dangerous if the driving part starts operating by accident while dismounting the product. Make sure that the main power of the equipment is off.

⚠ DANGER ● Do not dismantle the product.

We will refuse to take responsibility as to the damaged product that is dismantled, remodeled or repaired by a third party except our company and the designated company. Therefore, for the product that the assembly process or procedure of dismantlement is described in the manual, we will not be responsible as well. Please use our service network for repair and dismantlement.

5. Cautions for disposal

⚠ DANGER ● Do not leave the product around where young children may play.

⚠ CAUTION ● Call for a waste-control-collection company for disposal.

Please note that this safety precautions and specification described in each manual may be changed without prior notice.
Contact Miki Pulley for additional information or questions on these precautions.

Technical Data

Miki Pulley Couplings Standard Bore Processing Specification

This standard bore processing specification is applicable to bore processing for SERVO FLEX (except SFC model), SPR FLEX, BAUMANN FLEX (except ZG and LM models), and CENTA FLEX of bore diameter 6mm to 65mm. However, other standard bore processing specifications set to each model respectively will have precedence if they exist, and may differ from this specification.

● Bore Processing Tolerances for Mating Shaft Tolerances

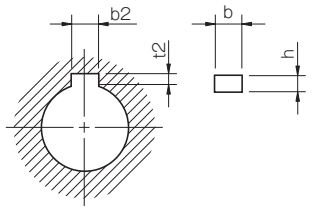
Unless there is a special order, it is processed by H7. For bore processing below 10mm, it will be H8.
Tolerances other than H7 require consultation. When pilot bores are additionally processed, the surface treatment of the processed portion is shaved. If an additional surface treatment after bore processing is required, contact us.

Shaft tolerance	Recommended bore tolerance
h6 to h9	H7
j6	G7
k6	F7
m6	F7

* The j6, k6 and m6 are adopted as new standard motor shafts.

● Keyway Dimensions for Bore Diameters (following table)

Unless there is a special order, it is processed by the former JIS (second class). For bore diameters under 12mm, keyways are not processed.



Previous edition JIS (Class 2) compliance

Unit [mm]

Bore dia.	b2		t2		Keyway dimension b×h
	Basic dimension	Tolerance (E9)	Basic dimension	Tolerance	
12 or more, 13 or less	4	+ 0.050 + 0.020	1.5	+ 0.3 0	4× 4
Over 13, 20 or less	5		2.0		5× 5
Over 20, 30 or less	7	+ 0.061 + 0.025	3.0	+ 0.3 0	7× 7
Over 30, 40 or less	10		3.5		10× 8
Over 40, 50 or less	12	+ 0.075 + 0.032			12× 8
Over 50, 60 or less	15		5.0		15×10
Over 60, 65 or less	18		6.0		18×12

New JIS compliance

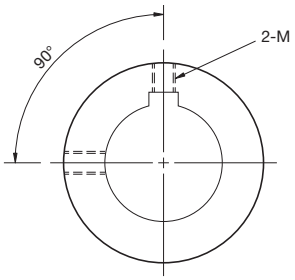
Unit [mm]

Bore dia.	b2		t2		Keyway dimension b×h
	Basic dimension	Tolerance (H9)	Basic dimension	Tolerance	
12	4	+ 0.030 0	1.8	+ 0.3 0	4× 4
Over 12, 17 or less	5		2.3		5× 5
Over 17, 22 or less	6		2.8		6× 6
Over 22, 30 or less	8	+ 0.036 0	3.3	+ 0.3 0	8× 7
Over 30, 38 or less	10				10× 8
Over 38, 44 or less	12	+ 0.043 0			12× 8
Over 44, 50 or less	14		3.8		14× 9
Over 50, 58 or less	16		4.3		16×10
Over 58, 65 or less	18		4.4		18×11

● Nominal Set Screw Diameters for Keyway

Keyway Basic dimension b2	Set screw nominal diameter
4	M4
5	M4
6	M5
7	M6
8	M6
10	M8
12	M8
14	M10
15	M10
16	M10
18	M10

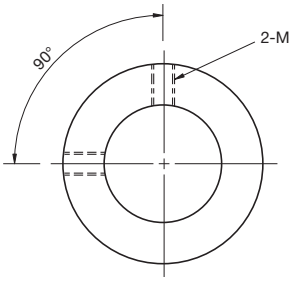
* If this is not a special order, the positions of set screws will be 2 points, 90° apart from each other.
* The positions for set screws may vary for some products. For more information, see the standard bore processing specification for each product.



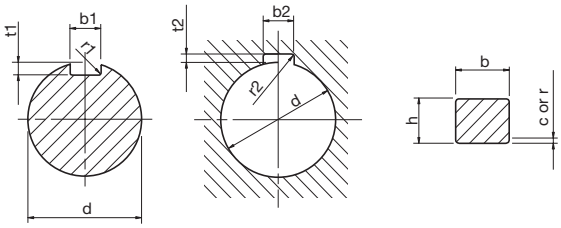
● Nominal Set Screw Diameters for Bore Diameters (without keyway)

Bore dia.	Set screw nominal diameter
6 or more, less than 12	M4

* If this is not a special order, the positions of set screws will be 2 points, 90° apart from each other.
* The positions for set screws may vary for some products. For more information, see the standard bore processing specification for each product.



Dimensions and Tolerances of Parallel Keys and Keyways



Cross section of shaft | Cross section of bore | Cross section of key

● JIS (Excerpts from JIS B 1301-1996)

Unit [mm]

Nominal key dimension b×h	Applicable shaft diameter d	Key dimension b		Key dimension h			c or r	Keyway dimension: Basic dimension of b1 and b2	Locking type: Tolerance of b1 and b2 (P9)	Normal type: b1 Tolerance (N9)	Normal type: b2 Tolerance (Js9)	r1 and r2	t1		t2	
		Basic dimension	Tolerance (h9)	Basic dimension	Tolerance								Basic dimension	Tolerance	Basic dimension	Tolerance
2× 2	6 to 8	2	0 −0.025	2	0 −0.025	h9	0.16 to 0.25	2	−0.006 −0.031	−0.004 −0.029	±0.0125	0.08 to 0.16	1.2	+ 0.1 0	1.0	+ 0.1 0
3× 3	8 to 10	3		3				3					1.8		1.4	
4× 4	10 to 12	4	0 −0.030	4	0 −0.030			4	−0.012 −0.042	0 −0.030	±0.0150		2.5		1.8	
5× 5	12 to 17	5		5			0.25 to 0.40	5				0.16 to 0.25	3.0		2.3	
6× 6	17 to 22	6		6				6					3.5		2.8	
8× 7	22 to 30	8	0 −0.036	7	0 −0.090	h11		8	−0.015 −0.051	0 −0.036	±0.0180		4.0	+ 0.2 0	3.3	+ 0.2 0
10× 8	30 to 38	10		8			0.40 to 0.60	10				0.25 to 0.40	5.0		3.3	
12× 8	38 to 44	12	0 −0.043	8				12	−0.018 −0.061	0 −0.043	±0.0215		5.0		3.3	
14× 9	44 to 50	14		9				14					5.5		3.8	
16×10	50 to 58	16		10				16					6.0		4.3	
18×11	58 to 65	18		11	0 −0.110			18					7.0		4.4	
20×12	65 to 75	20	0 −0.052	12			0.60 to 0.80	20	−0.022 −0.074	0 −0.052	±0.0260	0.40 to 0.60	7.5		4.9	
22×14	75 to 85	22		14				22					9.0		5.4	
25×14	85 to 95	25		14				25					9.0		5.4	
28×16	95 to 110	28		16				28					10.0		6.4	
32×18	110 to 130	32	0 −0.062	18				32	−0.026 −0.088	0 −0.062	±0.0310		11.0		7.4	

● Previous JIS First Class (Excerpts from JIS B 1301-1959)

Unit [mm]

Nominal key dimension b×h	Applicable shaft diameter d	Key dimension b		Key dimension h		c or r	Keyway dimension: Basic dimension of b1 and b2	b1 Tolerance (H8)	b2 Tolerance (F7)	r1 and r2	t1		t2	
		Basic dimension	Tolerance (p7)	Basic dimension	Tolerance (h9)						Basic dimension	Tolerance	Basic dimension	Tolerance
4× 4	10 or more, 13 or less	4	+ 0.024 + 0.012	4	0 −0.030	0.5	4	+ 0.018 0	+ 0.022 + 0.010	0.4	2.5	+ 0.05 0	1.5	+ 0.05 0
5× 5	Over 13, 20 or less	5		5			5				3		2	
7× 7	Over 20, 30 or less	7	+ 0.030 + 0.015	7	0 −0.036		7	+ 0.022 0	+ 0.028 + 0.013		4		3	
10× 8	Over 30, 40 or less	10		8		0.8	10			0.6	4.5		3.5	
12× 8	Over 40, 50 or less	12	+ 0.036 + 0.018	8			12	+ 0.027 0	+ 0.034 + 0.016		4.5		3.5	
15×10	Over 50, 60 or less	15		10			15				5		5	
18×12	Over 60, 70 or less	18		12	0 −0.043	1.2	18			1.0	6		6	
20×13	Over 70, 80 or less	20	+ 0.043 + 0.022	13			20	+ 0.033 0	+ 0.041 + 0.020		7		6	
24×16	Over 80, 95 or less	24		16			24				8		8	
28×18	Over 95, 110 or less	28		18			28				9		9	
32×20	Over 110, 125 or less	32	+ 0.051 + 0.026	20	0 −0.052	2	32	+ 0.039 0	+ 0.050 + 0.025	1.6	10		10	

● Previous JIS Second Class (Excerpts from JIS B 1301-1959)

Unit [mm]

Nominal key dimension b×h	Applicable shaft diameter d	Key dimension b		Key dimension h		c or r	Keyway dimension: Basic dimension of b1 and b2	b1 Tolerance (H9)	b2 Tolerance (E)	r1 and r2	t1		t2	
		Basic dimension	Tolerance (h8)	Basic dimension	Tolerance (h10)						Basic dimension	Tolerance	Basic dimension	Tolerance
4× 4	10 or more, 13 or less	4	0 −0.018	4	0 −0.048	0.5	4	+ 0.030 0	+ 0.050 + 0.020	0.4	2.5	+ 0.1 0	1.5	+ 0.1 0
5× 5	Over 13, 20 or less	5		5			5				3		2	
7× 7	Over 20, 30 or less	7	0 −0.022	7	0 −0.058		7	+ 0.036 0	+ 0.061 + 0.025		4		3	
10× 8	Over 30, 40 or less	10		8		0.8	10			0.6	4.5		3.5	
12× 8	Over 40, 50 or less	12	0 −0.027	8			12	+ 0.043 0	+ 0.075 + 0.032		4.5		3.5	
15×10	Over 50, 60 or less	15		10			15				5		5	
18×12	Over 60, 70 or less	18		12	0 −0.070	1.2	18			1.0	6		6	
20×13	Over 70, 80 or less	20	0 −0.033	13			20	+ 0.052 0	+ 0.092 + 0.040		7		6	
24×16	Over 80, 95 or less	24		16			24				8		8	
28×18	Over 95, 110 or less	28		18			28				9		9	
32×20	Over 110, 125 or less	32	0 −0.039	20	0 −0.084	2	32	+ 0.062 0	+ 0.112 + 0.050	1.6	10		10	

Permissible Dimensional Deviation of Shafts
(Excerpts from JIS B 0401)

Unit [μm]

Measurement Classification [mm]		d		e			f			g		h					js			j		k		m		n	p	r
Beyond	Below	d8	d9	e7	e8	e9	f6	f7	f8	g5	g6	h5	h6	h7	h8	h9	js5	js6	js7	j5	j6	k5	k6	m5	m6	n6	p6	r6
3	6	−30 −48	−30 −60	−20 −32	−20 −38	−20 −50	−10 −18	−10 −22	−10 −28	−4 −9	−4 −12	0 −5	0 −8	0 −12	0 −18	0 −30	±2.5	±4	±6	+3 −2	+6 −2	+6 +1	+9 +1	+9 +4	+12 +4	+16 +8	+20 +12	+23 +15
6	10	−40 −62	−40 −76	−25 −40	−25 −47	−25 −61	−13 −22	−13 −28	−13 −35	−5 −11	−5 −14	0 −6	0 −9	0 −15	0 −22	0 −36	±3	±4.5	±7.5	+4 −2	+7 −2	+7 +1	+10 +1	+12 +6	+15 +6	+19 +10	+24 +15	+28 +19
10	14	−50 −77	−50 −93	−32 −50	−32 −59	−32 −75	−16 −27	−16 −34	−16 −43	−6 −14	−6 −17	0 −8	0 −11	0 −18	0 −27	0 −43	±4	±5.5	±9	+5 −3	+8 −3	+9 +1	+12 +1	+15 +7	+18 +7	+23 +12	+29 +18	+34 +23
14	18																											
18	24	−65 −98	−65 −117	−40 −61	−40 −73	−40 −92	−20 −33	−20 −41	−20 −53	−7 −16	−7 −20	0 −9	0 −13	0 −21	0 −33	0 −52	±4.5	±6.5	±10.5	+5 −4	+9 −4	+11 +2	+15 +2	+17 +8	+21 +8	+28 +15	+35 +22	+41 +28
24	30																											
30	40	−80 −119	−80 −142	−50 −75	−50 −89	−50 −112	−25 −41	−25 −50	−25 −64	−9 −20	−9 −25	0 −11	0 −16	0 −25	0 −39	0 −62	±5.5	±8	±12.5	+6 −5	+11 −5	+13 +2	+18 +2	+20 +9	+25 +9	+33 +17	+42 +26	+50 +34
40	50																											
50	65	−100 −146	−100 −174	−60 −90	−60 −106	−60 −134	−30 −49	−30 −60	−30 −76	−10 −23	−10 −29	0 −13	0 −19	0 −30	0 −46	0 −74	±6.5	±9.5	±15	+6 −7	+12 −7	+15 +2	+21 +2	+24 +11	+30 +11	+39 +20	+51 +32	+60 +41
65	80																											+62 +43
80	100	−120 −174	−120 −207	−72 −107	−72 −126	−72 −159	−36 −58	−36 −71	−36 −90	−12 −27	−12 −34	0 −15	0 −22	0 −35	0 −54	0 −87	±7.5	±11.5	±17.5	+6 −9	+13 −9	+18 +3	+25 +3	+28 +13	+35 +13	+45 +23	+59 +37	+73 +51
100	120																											+76 +54
120	140	−145 −208	−145 −245	−85 −125	−85 −148	−85 −185	−43 −68	−43 −83	−43 −106	−14 −32	−14 −39	0 −18	0 −25	0 −40	0 −63	0 −100	±9	±12.5	±20	+7 −11	+14 −11	+21 +3	+28 +3	+33 +15	+40 +15	+52 +27	+68 +43	+88 +63
140	160																											+90 +65
160	180																											+93 +68
180	200	−170 −242	−170 −285	−100 −146	−100 −172	−100 −215	−50 −79	−50 −96	−50 −122	−15 −35	−15 −44	0 −20	0 −29	0 −46	0 −72	0 −115	±10	±14.5	±23	+7 −13	+16 −13	+24 +4	+33 +4	+37 +17	+46 +17	+60 +31	+79 +50	+106 +77
200	225																											+109 +80
225	250																											+113 +84
250	280	−190 −271	−190 −320	−110 −162	−110 −191	−110 −240	−56 −88	−56 −108	−56 −137	−17 −40	−17 −49	0 −23	0 −32	0 −52	0 −81	0 −130	±11.5	±16	±26	+7 −16	±16	+27 +4	+36 +4	+43 +20	+52 +20	+66 +34	+88 +56	+126 +94
280	315																											+130 +98
315	355	−210 −299	−210 −350	−125 −182	−125 −214	−125 −265	−62 −98	−62 −119	−62 −151	−18 −43	−18 −54	0 −25	0 −36	0 −57	0 −89	0 −140	±12.5	±18	±28.5	+7 −18	±18	+29 +4	+40 +4	+46 +21	+57 +21	+73 +37	+98 +62	+144 +108
355	400																											+150 +114
400	450	−230 −327	−230 −385	−135 −198	−135 −232	−135 −290	−68 −108	−68 −131	−68 −165	−20 −47	−20 −60	0 −27	0 −40	0 −63	0 −97	0 −155	±13.5	±20	±31.5	+7 −20	±20	+32 +5	+45 +5	+50 +23	+63 +23	+80 +40	+108 +68	+166 +126
450	500																											+172 +132

* The upper value in each column indicates the upper deviation, and the lower value in each column indicates the lower deviation.

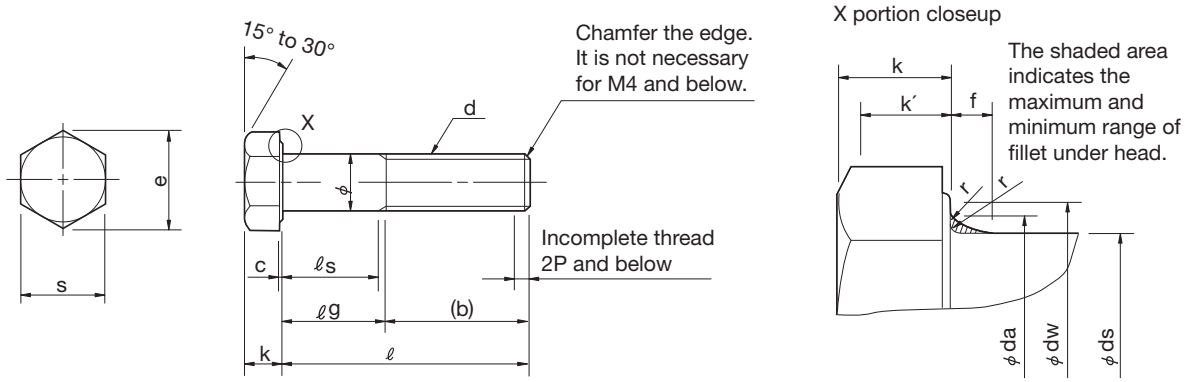
Permissible Dimensional Deviation of Bores
(Excerpts from JIS B 0401)

Unit [μm]

Measurement Classification [mm]		E			F			G		H						Js		J		K		M		N		P	R
Beyond	Below	E7	E8	E9	F6	F7	F8	G6	G7	H5	H6	H7	H8	H9	H10	Js6	Js7	J6	J7	K6	K7	M6	M7	N6	N7	P7	R7
3	6	+32 +20	+38 +20	+50 +20	+18 +10	+22 +10	+28 +10	+12 +4	+16 +4	+5 0	+8 0	+12 0	+18 0	+30 0	+48 0	±4	±6	+5 −3	±6	+2 −6	+3 −9	−1 −9	0 −12	−5 −13	−4 −16	−8 −20	−11 −23
6	10	+40 +25	+47 +25	+61 +25	+22 +13	+28 +13	+35 +13	+14 +5	+20 +5	+6 0	+9 0	+15 0	+22 0	+36 0	+58 0	±4.5	±7.5	+5 −4	+8 −7	+2 −7	+5 −10	−3 −12	0 −15	−7 −16	−4 −19	−9 −24	−13 −28
10	14	+50 +32	+59 +32	+75 +32	+27 +16	+34 +16	+43 +16	+17 +6	+24 +6	+8 0	+11 0	+18 0	+27 0	+43 0	+70 0	±5.5	±9	+6 −5	+10 −8	+2 −9	+6 −12	−4 −15	0 −18	−9 −20	−5 −23	−11 −29	−16 −34
14	18																										
18	24	+61 +40	+73 +40	+92 +40	+33 +20	+41 +20	+53 +20	+20 +7	+28 +7	+9 0	+13 0	+21 0	+33 0	+52 0	+84 0	±6.5	±10.5	+8 −5	+12 −9	+2 −11	+6 −15	−4 −17	0 −21	−11 −24	−7 −28	−14 −35	−20 −41
24	30																										
30	40	+75 +50	+89 +50	+112 +50	+41 +25	+50 +25	+64 +25	+25 +9	+34 +9	+11 0	+16 0	+25 0	+39 0	+62 0	+100 0	±8	±12.5	+10 −6	+14 −11	+3 −13	+7 −18	−4 −20	0 −25	−12 −28	−8 −33	−17 −42	−25 −50
40	50																										
50	65	+90 +60	+106 +60	+134 +60	+49 +30	+60 +30	+76 +30	+29 +10	+40 +10	+13	+19 0	+30 0	+46 0	+74 0	+120 0	±9.5	±15	+13 −6	+18 −12	+4 −15	+9 −21	−5 −24	0 −30	−14 −33	−9 −39	−21 −51	−30 −60
65	80																										−32 −62
80	100	+107 +72	+126 +72	+159 +72	+58 +36	+71 +36	+90 +36	+34 +12	+47 +12	+15 0	+22 0	+35 0	+54 0	+87 0	+140 0	±11	±17.5	+16 −6	+22 −13	+4 −18	+10 −25	−6 −28	0 −35	−16 −38	−10 −45	−24 −59	−38 −73
100	120																										−41 −76
120	140	+125 +85	+148 +85	+185 +85	+68 +43	+83 +43	+106 +43	+39 +14	+54 +14	+18 0	+25 0	+40 0	+63 0	+100 0	+160 0	±12.5	±20	+18 −7	+26 −14	+4 −21	+12 −28	−8 −33	0 −40	−20 −45	−12 −52	−28 −68	−48 −88
140	160																										−50 −90
160	180																										−53 −93
180	200	+146 +100	+172 +100	+215 +100	+79 +50	+96 +50	+122 +50	+44 +15	+61 +15	+20 0	+29 0	+46 0	+72 0	+115 0	+185 0	±14.5	±23	+22 −7	+30 −16	+5 −24	+13 −33	−8 −37	0 −46	−22 −51	−14 −60	−33 −79	−60 −106
200	225																										−63 −109
225	250																										−67 −113
250	280	+162 +110	+191 +110	+240 +110	+88 +56	+108 +56	+137 +56	+49 +17	+69 +17	+23 0	+32 0	+52 0	+81 0	+130 0	+210 0	±16	±26	+25 −7	+36 −16	+5 −27	+16 −36	−9 −41	0 −52	−25 −57	−14 −66	−33 −88	−74 −126
280	315																										−78 −130
315	355	+182 +125	+214 +125	+265 +125	+98 +62	+119 +62	+151 +62	+54 +18	+75 +18	+25 0	+36 0	+57 0	+89 0	+140 0	+230 0	±18	±28.5	+29 −7	+39 −18	+7 −29	+17 −40	−10 −46	0 −57	−26 −62	−16 −73	−41 −98	−87 −144
355	400																										−93 −150
400	450	+198 +135	+232 +135	+290 +135	+108 +68	+131 +68	+165 +68	+60 +20	+83 +20	+27 0	+40 0	+63 0	+97 0	+155 0	+250 0	±20	±31.5	+33 −7	+43 −20	+8 −32	+18 −45	−10 −50	0 −63	−27 −67	−17 −80	−45 −108	−103 −166
450	500																										−109 −172

* The upper value in each column indicates the upper deviation, and the lower value in each column indicates the lower deviation.

Configuration and Dimension of Hexagon Bolts (Parts grade A) (Excerpts from JIS B 1180-1985)



Unit [mm]

Nominal designation of screw (d)		M3	M4	M5	M6	M8	M10	M12	(M14)	M16	M20	M24
Pitch of screw (P)		0.5	0.7	0.8	1	1.25	1.5	1.75	2	2	2.5	3
b (Reference)	ℓ≤125	12	14	16	18	22	26	30	34	38	46	54
	125<ℓ≤150	—	—	—	—	—	—	—	40	44	52	60
c	Minimum	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.2	0.2	0.2
	Maximum	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.6	0.8	0.8	0.8
da	Maximum	3.6	4.7	5.7	6.8	9.2	11.2	13.7	15.7	17.7	22.4	26.4
ds	Max. (Basic dimension)	3	4	5	6	8	10	12	14	16	20	24
	Minimum	2.86	3.82	4.82	5.82	7.78	9.78	11.73	13.73	15.73	19.67	23.67
dw	Minimum	4.57	5.88	6.88	8.88	11.63	14.63	16.63	19.64	22.49	28.19	33.61
e	Minimum	6.01	7.66	8.79	11.05	14.38	17.77	20.03	23.36	26.75	33.53	39.98
f	Maximum	1	1.2	1.2	1.4	2	2	3	3	3	4	4
k	Nominal disig. (Basic dimension)	2	2.8	3.5	4	5.3	6.4	7.5	8.8	10	12.5	15
	Minimum	1.875	2.675	3.35	3.85	5.15	6.22	7.32	8.62	9.82	12.285	14.785
	Maximum	2.125	2.925	3.65	4.15	5.45	6.58	7.68	8.98	10.18	12.715	15.215
k'	Minimum	1.31	1.87	2.35	2.7	3.61	4.35	5.12	6.03	6.87	8.6	10.35
r	Minimum	0.1	0.2	0.2	0.25	0.4	0.4	0.6	0.6	0.6	0.8	0.8
s	Max. (Basic dimension)	5.5	7	8	10	13	16	18	21	24	30	36
	Minimum	5.32	6.78	7.78	9.78	12.73	15.73	17.73	20.67	23.67	29.67	35.38

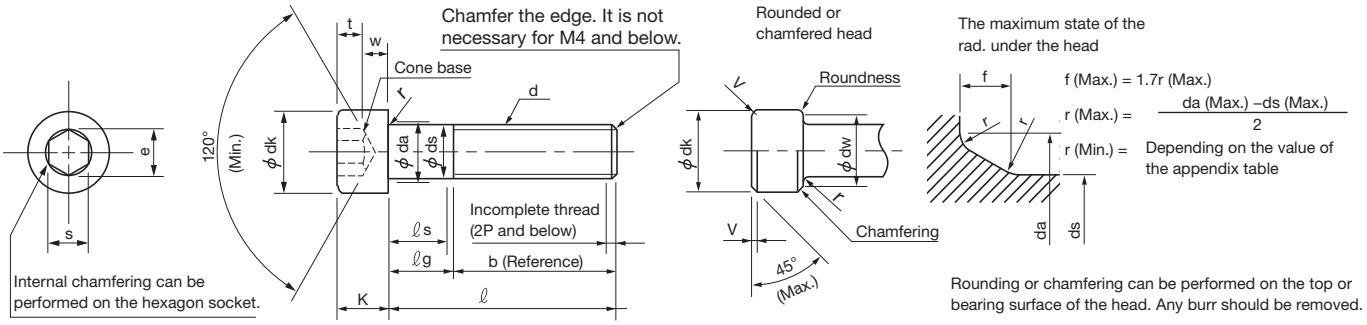
* The nominal diameter in parentheses is preferably not to be used.

Unit [mm]

Nominal designation of screw			M3		M4		M5		M6		M8		M10		M12		(M14)		M16		M20		M24	
ℓ			ℓs and ℓg																					
Nominal length (basic dimension)	Min.	Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.
20	19.58	20.42	5.5	8																				
25	24.58	25.42	10.5	13	7.5	11	5	9																
30	29.58	30.42	15.5	18	12.5	16	10	14	7	12														
35	34.5	35.5			17.5	21	15	19	12	17														
40	39.5	40.5			22.5	26	20	24	17	22	11.75	18												
45	44.5	45.5					25	29	22	27	16.75	23	11.5	19										
50	49.5	50.5					30	34	27	32	21.75	28	16.5	24	11.25	20								
55	54.4	55.6							32	37	26.75	33	21.5	29	16.25	25								
60	59.4	60.6							37	42	31.75	38	26.5	34	21.25	30	16	26						
65	64.4	65.6									36.75	43	31.5	39	26.25	35	21	31	17	27				
70	69.4	70.6									41.75	48	36.5	44	31.25	40	26	36	22	32				
80	79.4	80.6									51.75	58	46.5	54	41.25	50	36	46	32	42	21.5	34		
90	89.3	90.7											56.5	64	51.25	60	46	56	42	52	31.5	44	21	36
100	99.3	100.7											66.5	74	61.25	70	56	66	52	62	41.5	54	31	46
110	109.3	110.7													71.25	80	66	76	62	72	51.5	64	41	56
120	119.3	120.7													81.25	90	76	86	72	82	61.5	74	51	66
130	129.2	130.8															80	90	76	86	65.5	78	55	70
140	139.2	140.8															90	100	86	96	75.5	88	65	80
150	149.2	150.8																	96	106	85.5	98	75	90

* The gray portion indicates the recommended nominal length (ℓ).

Configuration and Dimension of Hexagon Socket Head Cap Screws (Excerpts from JIS B 1176-1988)



Unit [mm]

Nominal designation of screw (d)			M1.6	M2	M2.5	M3	M4	M5	M6	M8	M10	M12	(M14)	M16	(M18)	M20
Pitch of screw (P)			0.35	0.4	0.45	0.5	0.7	0.8	1	1.25	1.5	1.75	2	2	2.5	2.5
b	Reference		15	16	17	18	20	22	24	28	32	36	40	44	48	52
dk	Max. (Basic dimension)*1		3	3.8	4.5	5.5	7	8.5	10	13	16	18	21	24	27	30
	Maximum *2		3.14	3.98	4.68	5.68	7.22	8.72	10.22	13.27	16.27	18.27	21.33	24.33	27.33	30.33
	Minimum		2.86	3.62	4.32	5.32	6.78	8.28	9.78	12.73	15.73	17.73	20.67	23.67	26.67	29.67
da	Maximum		2	2.6	3.1	3.6	4.7	5.7	6.8	9.2	11.2	13.7	15.7	17.7	20.2	22.4
ds	Max. (Basic dimension)		1.6	2	2.5	3	4	5	6	8	10	12	14	16	18	20
	Minimum		1.46	1.86	2.36	2.86	3.82	4.82	5.82	7.78	9.78	11.73	13.73	15.73	17.73	19.67
e	Minimum		1.73	1.73	2.30	2.87	3.44	4.58	5.72	6.86	9.15	11.43	13.72	16.00	16.00	19.44
f	Maximum		0.34	0.51	0.51	0.51	0.60	0.60	0.68	1.02	1.02	1.45	1.45	1.45	1.87	2.04
k	Max. (Basic dimension)		1.6	2	2.5	3	4	5	6	8	10	12	14	16	18	20
	Minimum		1.46	1.86	2.36	2.86	3.82	4.82	5.70	7.64	9.64	11.57	13.57	15.57	17.57	19.48
r	Minimum		0.1	0.1	0.1	0.1	0.2	0.2	0.25	0.4	0.4	0.6	0.6	0.6	0.6	0.8
s	Nominal disig. (Basic dimension)		1.5	1.5	2	2.5	3	4	5	6	8	10	12	14	14	17
	Minimum		1.52	1.52	2.02	2.52	3.02	4.02	5.02	6.02	8.025	10.025	12.032	14.032	14.032	17.050
	Maximum	Column 1	1.560	1.560	2.060	2.580	3.080	4.095	5.140	6.140	8.175	10.175	12.212	14.212	14.212	17.230
		Column 2	1.545	1.545	2.045	2.560	3.080	4.095	5.095	6.095	8.155	10.115	12.142	14.142	14.142	17.230
t	Minimum		0.7	1	1.1	1.3	2	2.5	3	4	5	6	7	8	9	10
v	Maximum		0.16	0.2	0.25	0.3	0.4	0.5	0.6	0.8	1	1.2	1.4	1.6	1.8	2
dw	Minimum		2.72	3.40	4.18	5.07	6.53	8.03	9.38	12.33	15.33	17.23	20.17	23.17	25.87	28.87
w	Minimum		0.55	0.55	0.85	1.15	1.4	1.9	2.3	3.3	4	4.8	5.8	6.8	7.7	8.6

* Knurl the side surface of the head. In this case, the dk (Maximum) shall be the values marked *2. For side surfaces with no knurling, the dk shall be the values marked *1.
* The column 1 of S (Maximum) is used for the strength class 8.8 and 10.9, and for the property class A2-50 and A2-70. The column 2 is applied to the strength class 12.9. The column 1 can be applied to the strength class 12.9 by agreement of the parties concerned.
* The nominal diameters in parentheses are preferably not to be used.

Unit [mm]

Nominal designation of screw	M1.6		M2		M2.5		M3		M4		M5		M6		M8		M10		M12		(M14)		M16		(M18)		M20	
ℓ			ℓs and ℓg																									
Nominal length	Min.	Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.	ℓs Min.	ℓg Max.
2.5	2.30	2.70																										
3	2.80	3.20																										
4	3.76	4.24																										
5	4.76	5.24																										
6	5.76	6.24																										
8	7.71	8.29																										
10	9.71	10.29																										
12	11.65	12.35																										
16	15.65	16.35																										
20	19.58	20.42			2	4																						
25	24.58	25.42					5.75	8	4.5	7																		
30	29.58	30.42							9.5	12	6.5	10	4	8														
35	34.5	35.5									11.5	15	9	13	6	11												
40	39.5	40.5									16.5	20	14	18	11	16	5.75	12										
45	44.5	45.5											19	23	16	21	10.75	17	5.5	13								
50	49.5	50.5											24	28	21	26	15.75	22	10.5	18	5.25	14						
55	54.4	55.6													26	31	20.75	27	15.5	23	10.25	19						
60	59.4	60.6													31	36	25.75	32	20.5	28	15.25	24	10	20	6	16		
65	64.4	65.6															30.75	37	25.5	33	20.25	29	15	25	11	21	4.5	17
70	69.4	70.6															35.75	42	30.5	38	25.25	34	20	30	16	26	9.5	22	5.5	18
80	79.4	80.6															45.75	52	40.5	48	35.25	44	30	40	26	36	19.5	32	15.5	28
90	89.3	90.7																	50.5	58	45.25	54	40	50	36	46	29.5	42	25.5	38
100	99.3	100.7																	60.5	68	55.25	64	50	60	46	56	39.5	52	35.5	48
110	109.3	110.7																			65.25	74	60	70	56	66	49.5	62	45.5	58
120	119.3	120.7																			75.25	84	70	80	66	76	59.5	72	55.5	68
130	129.2	130.8																					80	90	76	86	69.5	82	65.5	78
140	139.2	140.8																					90	100	86	96	79.5	92	75.5	88
150	149.2	150.8																							96	106	89.5	102	85.5	98
160	159.2	160.8																							106	116	99.5	112	95.5	108
180	179.2	180.8																									119.5	132	115.5	128
200	199.05	200.95																											135.5	148

* The gray portion indicates the recommended nominal length (ℓ). The nominal length (ℓ) that is shorter than the dashed line position indicates a complete thread. The incomplete thread length under head is about 3P.

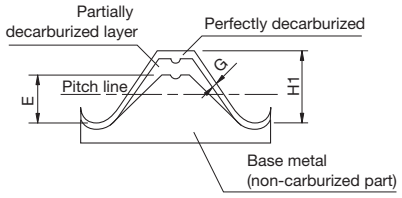
Mechanical Properties of Fasteners Made of Carbon Steel and Alloy Steel (Excerpts from JIS B 1051-2000)

● Mechanical Properties of Strength Category

Mechanical properties			Strength category										
			3.6	4.6	4.8	5.6	5.8	6.8	8.8 d≤16*1	8.8 d>16*1	9.8*2	10.9	12.9
Tensile strength Rm*3 *4 [N/mm²]		Nominal	300	400		500		600	800	800	900	1,000	1,200
		Min.	330	400	420	500	520	600	800	830	900	1,040	1,220
Hardness	Vickers hardness HV	Min.	95	120	130	155	160	190	250	255	290	320	385
		Max.	220*5					250	320	335	360	380	435
	Brinell hardness HB	Min.	90	114	124	147	152	181	238	242	276	304	366
		Max.	209*5					238	304	318	342	361	414
	Rockwell hardness HRB	Min.	52	67	71	79	82	89	–	–	–	–	–
		Max.	95.0*5					99.5	–	–	–	–	–
	Rockwell hardness HRC	Min.	–	–	–	–	–	–	22	23	28	32	39
		Max.	–						32	34	37	39	44
Surface hardness HV0.3		Max.	–						*6				
Lower yield point ReL*7 [N/mm²]		Nominal	180	240	320	300	400	480	–				
		Min.	190	240	340	300	420	480	–				
0.2% bearing force Rp0.2*8 [N/mm²]		Nominal	–						640	640	720	900	1,080
		Min.	–						640	660	720	940	1,100
Proof load stress		Stress ratio	0.94	0.94	0.91	0.93	0.90	0.92	0.91	0.91	0.90	0.88	0.88
		[N/mm²]	180	225	310	280	380	440	580	600	650	830	970
Total elongation %		Min.	25	22	–	20	–	–	12	12	10	9	8
Wedge tensile strength			Must not be smaller than the minimum tensile strength										
Impact strength [J]		Min.	–			25	–		30	30	25	20	15
Head percussion strength			Must not be fractured										
Height of non-carburized part of screw thread E		Min.	–						1/2H1			2/3H1	3/4H1
Depth of completely carburized part G [mm]		Max.	–						0.015				

* *1: Bolts for steel structures of strength category 8.8 are categorized by nominal screw diameter of 12mm.
* *2: Strength category 9.8 is applicable only to screws whose nominal diameter is 16mm or less.
* *3: Minimum tensile strength is applicable to a nominal length of 2.5d or more. Minimum hardness is applied where the nominal length is smaller than 2.5d or where a tensile test cannot be conducted such as the head has a special profile.
* *4: Tensile loads in tests conducted in a product state shall be the values calculated based on minimum tensile strength Rm min.
* *5: The hardness of the tip of threaded parts of bolts, screws and studs shall be 250HV, 238HB or 99.5HRB or less.
* *6: The surface hardness of products of 8.8 to 12.9 in strength category must not produce a difference of more than 30 points at Vickers hardness HV0.3 compared with inner hardness. The surface hardness of products of 10.9 in strength category must not exceed 390HV.
* *7: Where the lower yield point ReL cannot be measured, 0.2% bearing force Rp0.2 shall be used. ReL values for strength categories 4.8, 5.8 and 6.8 are for calculation purposes only and are not values for testing.
* *8: The yield stress ratio and minimum 0.2% bearing force Rp0.2 in accordance with the method for expressing strength categories shall be used in tests of cut test pieces. These values may vary when products themselves are tested to obtain these values, due to the manufacturing method of the products, nominal screw diameter, or other factor.

■Evaluation of Condition of Carbon on Surface



H1: Height of screw thread in a maximum substantive condition

Values of H1 and E (Minimum)

Unit [mm]

Pitch of screw (P)			0.5	0.6	0.7	0.8	1	1.25	1.5	1.75	2	2.5	3	3.5	4
H1			0.307	0.368	0.429	0.491	0.613	0.767	0.920	1.074	1.227	1.534	1.840	2.147	2.454
E (Min.)	Strength category	8.8,9.8	0.154	0.184	0.215	0.245	0.307	0.384	0.460	0.537	0.614	0.767	0.920	1.074	1.227
		10.9	0.205	0.245	0.286	0.327	0.409	0.511	0.613	0.716	0.818	1.023	1.227	1.431	1.636
		12.9	0.230	0.276	0.322	0.368	0.460	0.575	0.690	0.806	0.920	1.151	1.380	1.610	1.841

● Mechanical Properties and Maximum Tightening Torque of Hexagon Socket Head Cap Screw (For coarse pitch thread of strength categories of 10.9 and 12.9)

Supplementary information

Nominal d	Effective sectional area [mm2]	Minimum tensile load [N]		Yield load [N]		Proof load [N]		Permissible maximum axial force F [N]		(Tf max.) Maximum tightening torque [N·m] When K=0.17		When K=0.25	
		10.9	12.9	10.9	12.9	10.9	12.9	10.9	12.9	10.9	12.9	10.9	12.9
M1.6	1.27	1,320	1,550	1,190	1,390	1,050	1,230	832	976	0.23	0.27	0.33	0.39
M2	2.07	2,150	2,530	1,940	2,270	1,720	2,010	1,360	1,590	0.46	0.54	0.68	0.80
M2.5	3.39	3,530	4,140	3,170	3,720	2,810	3,290	2,220	2,610	0.94	1.11	1.39	1.63
M3	5.03	5,230	6,140	4,710	5,520	4,180	4,880	3,300	3,870	1.68	1.97	2.47	2.90
M4	8.78	9,130	10,700	8,220	9,640	7,290	8,520	5,750	6,750	3.91	4.59	5.75	6.75
M5	14.2	14,800	17,300	13,300	15,600	11,800	13,800	9,300	10,900	7.91	9.28	11.6	13.6
M6	20.1	20,900	24,500	18,800	22,100	16,700	19,500	13,200	15,400	13.4	15.8	19.8	23.2
M8	36.6	38,100	44,600	34,300	40,200	30,400	35,500	24,000	28,100	32.6	38.3	48	56.3
M10	58.0	60,300	70,800	54,300	63,700	48,100	56,300	38,000	44,600	64.6	75.8	95	111
M12	84.3	87,700	103,000	78,900	92,600	70,000	81,800	55,200	64,800	113	132	166	194
M14	115	120,000	140,000	108,000	126,000	95,500	112,000	75,300	88,400	179	210	264	309
M16	157	163,000	192,000	147,000	172,000	130,000	152,000	103,000	121,000	280	328	411	483
M18	192	200,000	234,000	180,000	211,000	159,000	186,000	126,000	148,000	385	452	566	664
M20	245	255,000	299,000	229,000	269,000	203,000	238,000	161,000	188,000	546	640	803	942
M22	303	315,000	370,000	284,000	333,000	252,000	294,000	199,000	233,000	742	871	1,090	1,280
M24	353	367,000	431,000	330,000	388,000	293,000	342,000	231,000	271,000	944	1,110	1,390	1,630
M27	459	477,000	560,000	430,000	504,000	381,000	445,000	301,000	353,000	1,380	1,620	2,030	2,380
M30	561	583,000	684,000	525,000	616,000	466,000	544,000	368,000	431,000	1,870	2,200	2,760	3,230

K: Torque coefficient

Remarks

1. The minimum tensile load and proof load given in the above table are derived from JIS B 1051-2000.
2. Yield load = Bearing force (lower yield point) × Effective sectional area
3. Value calculated by permissible maximum axial force
   ≈ 0.7 × Yield stress, maximum tightening torque (Tfmax) = Torque coefficient (K) × Permissible maximum axial force (F) × Nominal diameter (d)
4. Value of torque coefficient
   Value of K = 0.17
   For oil lubrication, clamped material SS400, finish of clamped surface about 25S, internal thread material SS400, internal thread accuracy 6g or class 2
   Value of K = 0.25
   For electrogalvanizing, clamped material SS400, finish of clamped surface about 25S, internal thread material SCM, internal thread accuracy 6g or class 2
   Supplementary information
   Value of K = 0.35 will result in the table shown above if the internal thread material is SS400.

Recommended tightening torque (Tf)

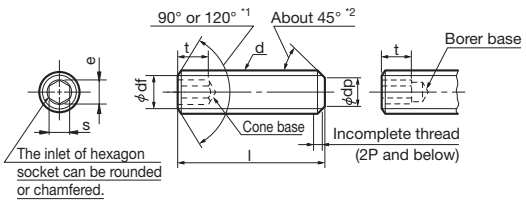
Recommended tightening torque (Tf) varies due to dispersion of the initial tightening force depending on the tool used.
Recommended tightening torque (Tf) = Value for each tool × Maximum tightening torque (Tfmax)

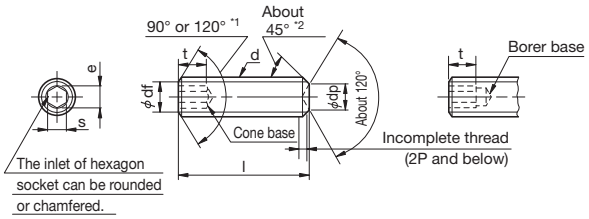
Value for each tool

1) When clamped by hand : 0.65 Tfmax.
2) By an impact driver or an electric driver : 0.75 Tfmax.
3) By a torque wrench or by a wrench with limit on torque : 0.85 Tfmax.
4) By a torque wrench : 0.9 Tfmax.

Note: The foregoing values are for reference purposes only. When in use, calculate an appropriate tightening torque in accordance with JIS B 1083, JIS B 1084 or other standard.

Configuration and Dimension of Hexagon Socket Set Screw (Excerpts from JIS B 1177-1997)





Nominal designation of screw (d)		M1.6	M2	M2.5	M3	M4	M5	M6	M8	M10	M12	M16	M20	M24
Pitch (P)		0.35	0.4	0.45	0.5	0.7	0.8	1	1.25	1.5	1.75	2	2.5	3
dp	Maximum	0.80	1.00	1.5	2.00	2.50	3.5	4	5.5	7.00	8.50	12.00	15.00	18.00
	Minimum	0.55	0.75	1.25	1.75	2.25	3.2	3.7	5.2	6.64	8.14	11.57	14.57	17.57
dz	Maximum	0.80	1.00	1.20	1.40	2.00	2.50	3.00	5.0	6.0	8.00	10.00	14.00	16.00
	Minimum	0.55	0.75	0.95	1.15	1.75	2.25	2.75	4.7	5.7	7.64	9.64	13.57	15.57
df		Almost the diameter of screw groove												
e*3	Minimum	0.803	1.003	1.427	1.73	2.3	2.87	3.44	4.58	5.72	6.86	9.15	11.43	13.72
s*4	Designation	0.7	0.9	1.3	1.5	2	2.5	3	4	5	6	8	10	12
	Maximum	0.724	0.902	1.295	1.545	2.045	2.560	3.071	4.084	5.084	6.095	8.115	10.115	12.142
	Minimum	0.711	0.889	1.270	1.520	2.020	2.520	3.020	4.020	5.020	6.020	8.025	10.025	12.032
t	Minimum*5	0.7	0.8	1.2	1.2	1.5	2	2	3	4	4.8	6.4	8	10
	Minimum*6	1.5	1.7	2	2	2.5	3	3.5	5	6	8	10	12	15

	ℓ			(Reference) Outline mass per 1000 units / kg (Density:7.85kg/dm³)												
	Nominal length	Min.	Max.													
Flat point	2	1.8	2.2	0.021	0.029	0.05	0.059									
	2.5	2.3	2.7	0.025	0.037	0.063	0.08	0.099								
	3	2.8	3.2	0.029	0.044	0.075	0.1	0.14	0.2							
	4	3.76	4.24	0.037	0.059	0.1	0.14	0.22	0.32	0.41						
	5	4.76	5.24	0.046	0.074	0.125	0.18	0.3	0.44	0.585	0.945					
	6	5.76	6.24	0.054	0.089	0.15	0.22	0.38	0.56	0.76	1.26	1.77				
	8	7.71	8.29	0.07	0.119	0.199	0.3	0.54	0.8	1.11	1.89	2.78	4			
	10	9.71	10.29		0.148	0.249	0.38	0.7	1.04	1.46	2.52	3.78	5.4	8.5		
	12	11.65	12.35			0.299	0.46	0.86	1.28	1.81	3.15	4.78	6.8	11.1	15.8	
	16	15.65	16.35				0.62	1.18	1.76	2.51	4.41	6.78	9.6	16.3	24.1	30
	20	19.58	20.42					1.49	2.24	3.21	5.67	8.76	12.4	21.5	32.3	42
	25	24.58	25.42						2.84	4.09	7.25	11.2	15.9	28	42.6	57
	30	29.58	30.42							4.94	8.82	13.7	19.4	34.6	52.9	72
	35	34.5	35.5								10.4	16.2	22.9	41.1	63.2	87
	40	39.5	40.5								12	18.7	26.4	47.7	73.5	102
	45	44.5	45.5									21.2	29.9	54.2	83.8	117
	50	49.5	50.5									23.7	33.4	60.7	94.1	132
	55	54.4	55.6										36.8	67.3	104	147
	60	59.4	60.6										40.3	73.7	115	162
Con-cave point	2	1.8	2.2	0.019	0.029	0.05										
	2.5	2.3	2.7	0.025	0.037	0.063	0.079									
	3	2.8	3.2	0.029	0.044	0.075	0.1	0.155								
	4	3.76	4.24	0.037	0.059	0.1	0.14	0.23	0.3							
	5	4.76	5.24	0.046	0.074	0.125	0.18	0.305	0.42	0.565						
	6	5.76	6.24	0.054	0.089	0.15	0.22	0.38	0.54	0.74	1.25					
	8	7.71	8.29	0.07	0.119	0.199	0.3	0.53	0.78	1.09	1.88	2.71				
	10	9.71	10.29		0.148	0.249	0.38	0.68	1.02	1.44	2.51	3.72	5.3			
	12	11.65	12.35			0.299	0.46	0.83	1.26	1.79	3.14	4.73	6.7	10.5		
	16	15.65	16.35				0.62	1.13	1.74	2.49	4.4	6.73	9.5	15.7	22.9	
	20	19.58	20.42					1.42	2.22	3.19	5.66	8.72	12.3	20.9	31.1	40.2
	25	24.58	25.42						2.82	4.07	7.24	11.2	15.8	27.4	41.4	55.2
	30	29.58	30.42							4.94	8.81	13.7	19.3	33.9	51.7	70.3
	35	34.5	35.5								10.4	16.2	22.7	40.4	62	85.3
	40	39.5	40.5								12	18.7	26.2	46.9	72.3	100
	45	44.5	45.5									21.2	29.7	53.3	82.6	115
	50	49.5	50.5									23.6	33.2	59.8	92.6	130
	55	54.4	55.6										36.6	66.3	103	145
	60	59.4	60.6										40.1	72.8	114	160

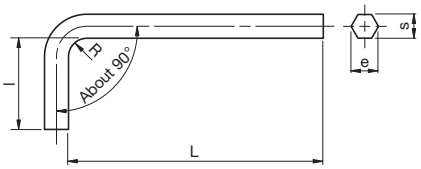
**1 For the nominal length (ℓ) that is shorter than the stepped double line, perform a 120° of chamfering.
**2 The angle of approx. 45° corresponds to the slope portion below the core diameter.
**3 e minimum= 1.14 x s minimum. Nominal diameter M1.6, M2 and M2.5 are excluded.
**4 For s, use the specified hexagon socket gauge to examine.

* The upper value of *5 t minimum is applicable to the nominal length (ℓ) shorter than the stepped double line.
* The lower value of *6 t minimum is applicable to the nominal length (ℓ) longer than the stepped double line.

Remarks

1. The recommended nominal length (ℓ) for nominal designation is indicated within the gray portion.
2. Dimensional symbols correspond to the JIS B 0143.
3. The configuration of hexagon socket base can be either cone or borer base. For a borer base, the bore depth must not be 1.2 times or more than the hexagon socket depth t.

Configuration and Dimension of Hexagon Bar Wrench (Spanner) (Excerpts from JIS B 4648-1994)



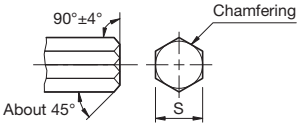
Nominal designation of spanner	Configuration/Dimension [mm]							Mechanical properties		
	s		e		L	l	R	Hardness (Min.)*1		Proof torque*2 [N·m]
	Max.	Min.	Max.	Min.	About	About	About	Rockwell hardness	Vickers hardness	
0.7	0.711	0.698	0.79	0.76	32	6	1.5	52HRC	545HV	0.08
0.9	0.889	0.876	0.99	0.96	32	10	1.5			0.18
1.3	1.270	1.244	1.42	1.37	40	12	1.5			0.53
1.5	1.500	1.475	1.68	1.63	45	14	1.5			0.82
2	2.00	1.960	2.25	2.18	50	16	2			1.9
2.5	2.50	2.460	2.82	2.75	56	18	2.5			3.8
3	3.00	2.960	3.39	3.31	63	20	3			6.6
4	4.00	3.952	4.53	4.44	70	25	4			16
5	5.00	4.952	5.67	5.58	80	28	5			30
6	6.00	5.952	6.81	6.71	90	32	6			52
8	8.00	7.942	9.09	8.97	100	36	8	50HRC	513HV	120
10	10.00	9.942	11.37	11.23	112	40	10	48HRC	485HV	220
12	12.00	11.89	13.65	13.44	125	45	12			370
14	14.00	13.89	15.93	15.70	140	56	14			590
17	17.00	16.89	19.35	19.09	160	63	17	45HRC	446HV	980
19	19.00	18.87	21.63	21.32	180	70	19			1360
22	22.00	21.87	25.05	24.71	200	80	22			2110
24	24.00	23.87	27.33	26.97	224	90	24			2750
27	27.00	26.87	30.75	30.36	250	100	27			3910
32	32.00	31.84	36.45	35.98	315	125	32			6510
36	36.00	35.84	41.01	40.50	355	140	36			9260

**1 The hardness corresponds to either Rockwell hardness or Vickers hardness.
**2 A spanner will not be damaged by the torque or below. Avoid any abnormality such as unendurable torsion, deformation of hexagon shape or bending.

Remarks

Chamfering of spanner edge is not necessary if it can be inserted easily into the hexagon socket. If chamfering is required, leave the width across bolt (s) as shown in the right figure. Besides, the side surfaces of long and short shafts are at right angle to respective shafts.
Therefore, it must not lean more than ±4°. (Refer to the right figure.)

Chamfering of spanner edge



Proof torque of strength class 45H (Reference)

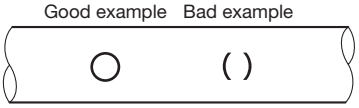
Nominal designation of screw (d)	Proof torque [N·m]	Recommended tightening torque [N·m]	Spanner size
M1.6	0.07	0.04	0.7
2	0.15	0.09	0.9
2.5	0.44	0.26	1.3
(2.6)	0.44	0.26	1.3
3	1.17	0.69	1.5
4	2.74	1.67	2
5	5.88	3.53	2.5
6	9.8	5.9	3
8	23.5	14.2	4
10	45.1	27.5	5
12	77.5	47.1	6
(14)	88.3	53.0	6
16	186	118	8
(18)	211	128	8
20	363	216	10

How to Use Hexagon Socket Set Screws

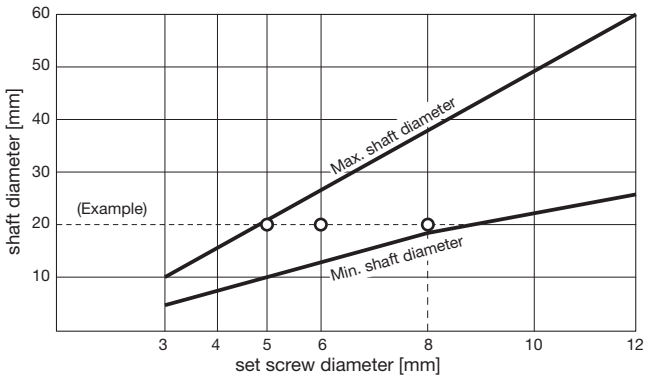
● Shaft Diameter and Set Screw Size

The impression of screw tip should clearly appear on the shaft cylinder surface. A correlation between non-tightening shaft diameter and set screw is shown as below.

Screw tip impression



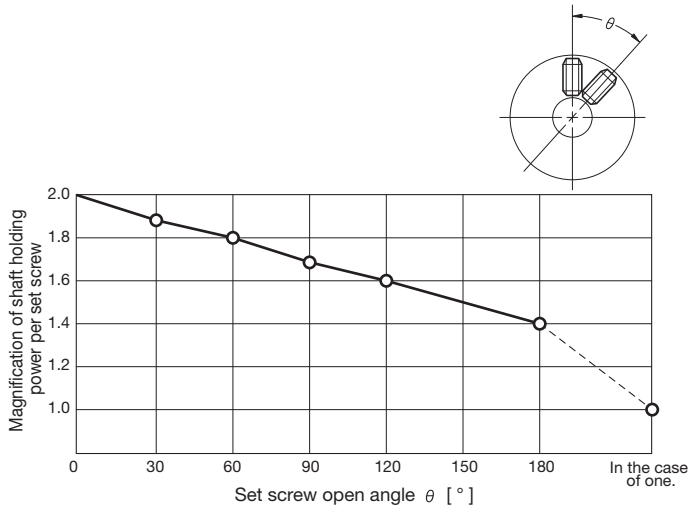
Correlation between set screw and shaft diameter



● If the Size of Set Screw Cannot be Enlarged

Two set screws are sometimes used when a large shaft holding power is required. However, using two set screws does not necessarily mean that the shaft holding power becomes double. This is because shaft holding power is different depending on the open angle (alignment) between two set screws. The following diagram indicates the relationship between set screw open angle and shaft holding power.

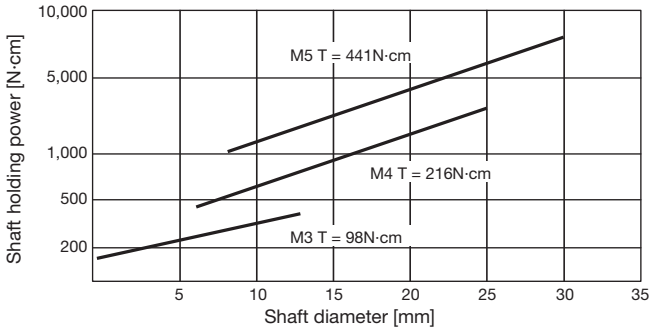
Set screw open angle and shaft holding power



● Shaft Diameter and Shaft Holding Power

The fixation limit (shaft holding power) of shaft and hub or flange is related to the friction factor between the tip of set screw and shaft. The fixation limit based on the data of examination results is described below.

Non-tightening shaft diameter and shaft holding power (concave point)

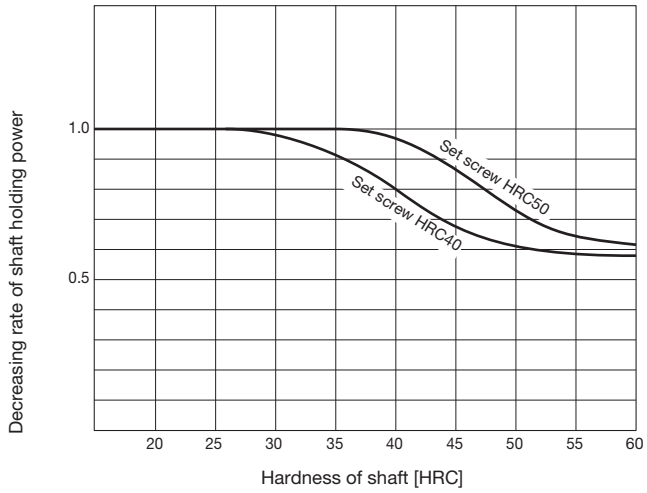


* Shaft holding power of set screw is related to the size of non-tightening shaft diameter.

● Hardness and Shaft Holding Power

Shaft holding power decreases as hardness of non-tightening shaft increases. The relationship between hardness and shaft holding power is described below.

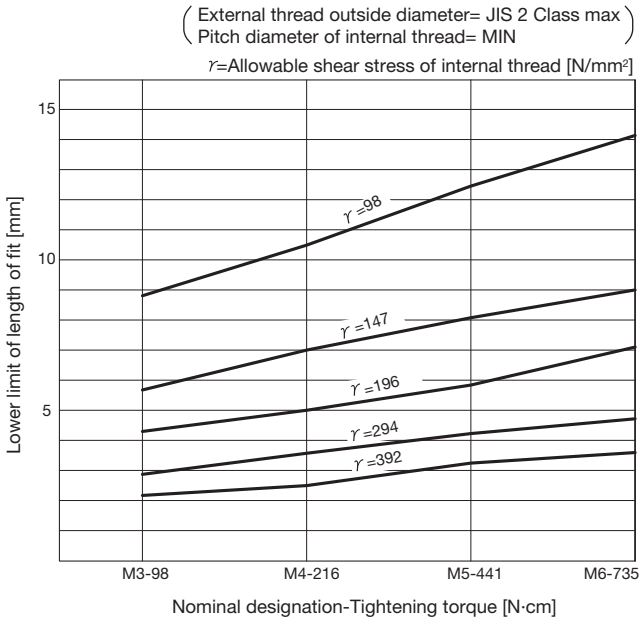
Set screw and shaft hardness and shaft holding power



● Set Screw and Length of Fit

Because of the widespread use of zinc die casting or iron sintered alloy as internal thread material, the allowable load of internal thread decreases, and which can be a source of trouble. However, it can be solved by increasing the thickness of internal thread part. The relationship between length of fit and material strength is described below.

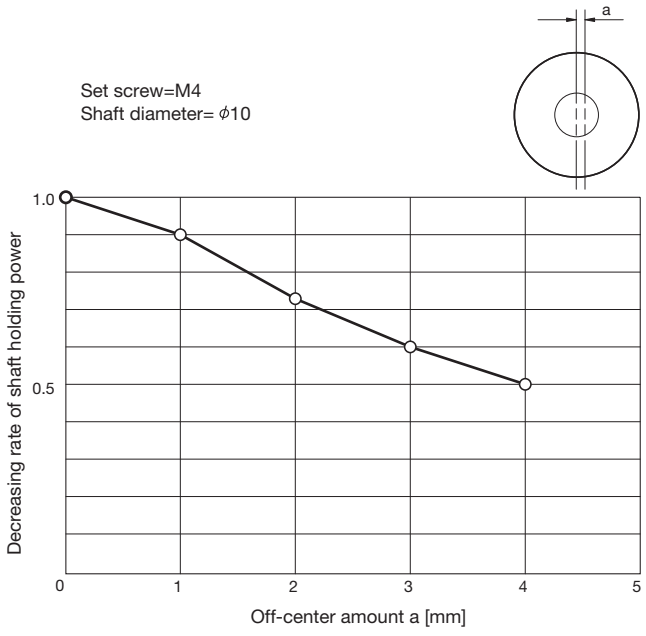
Strength of internal thread and set screw length of fit



● Off-center Amount of Internal Thread Bore

If the internal thread bore is not centered from the shaft center, the shaft holding power may decrease. The following is the examination results using M4 set screw.

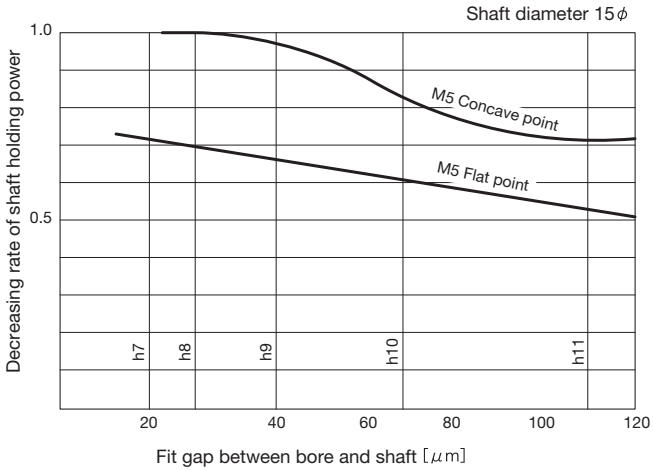
Off-center amount of set screw bore and shaft holding power



● Accuracy of Fit Between Shaft and Hub or Flange Bore

As indicated below, shaft holding power does not decrease until shaft accuracy of h9. However, the effect of fit accuracy is expected in the actual use environment.

Fit accuracy with bush bore and shaft holding power



Reference: Socket screw group technology
"How to select and use hexagon socket set screw"

Torque Wrench

● SFC-□ SA2/DA2 (Clamp bolt)

Nominal bolt size	Tightening torque [N·m]	Torque driver (preset type)	Hexagon bit	Coupling size
M2	0.4 to 0.5	N6LTDK	SB 1.5mm	005,010
M2.5	1.0 to 1.1	N12LTDK	SB 2mm	010,020
M3	1.5 to 1.9	N20LTDK	SB 2.5mm	030
M4	3.4 to 4.1	N50LTDK	SB 3mm	035,040
M5	7.0 to 8.5	N100LTDK	SB 4mm	050
Nominal bolt size	Tightening torque [N·m]	Torque wrench (preset type)	Hexagon head	Coupling size
M6	14 to 15	N230LCK	230HCK 5mm	060
M8	27 to 30	N450LCK	450HCK 6mm	080,090,100

● SFS-□ S/W/G (Pressure bolt)

Nominal bolt size	Tightening torque [N·m]	Torque wrench (single function type)	Spanner head	Coupling size
M5	8	N120SPCK×8N·m	230SCK 8mm	05
M6	14	N230SPCK×14N·m	230SCK 10mm	06,08,09,10
M8	34	N450SPCK×34N·m	450SCK 13mm	12,14

● SFS-□ S/W/G (Reamer bolt)

Nominal bolt size	Tightening torque [N·m]	Torque wrench (single function type)	Spanner head	Coupling size
M5	8	N120SPCK×8N·m	230SCK 8mm	05
M6	14	N230SPCK×14N·m	230SCK 10mm	06,08
M8	34	N450SPCK×34N·m	450SCK 13mm	09,10
M10	68	N900SPCK×68N·m	900SCK 17mm	12
M12	118	N1800SPCK×118N·m	1800SCK 19mm	14

● SFS-□ S/W/G-C (Reamer bolt)

Nominal bolt size	Tightening torque [N·m]	Torque wrench (single function type)	Spanner head	Coupling size
M5	6	N60SPCK×6N·m	230SCK 8mm	05
M6	11	N120SPCK×11N·m	230SCK 10mm	06,08
M8	26	N450SPCK×26N·m	450SCK 13mm	09,10
M10	51	N900SPCK×51N·m	900SCK 17mm	12
M12	90	N900SPCK×90N·m	900SCK 19mm	14

● SFS-□ SS/DS (Pressure bolt)

Nominal bolt size	Tightening torque [N·m]	Torque wrench (single function type)	Spanner head	Coupling size
M6	14	N230SPCK×14N·m	230SCK 10mm	080,090,100,120
M8	34	N450SPCK×34N·m	450SCK 13mm	140

● SFF-□ SS/DS (Pressure bolt)

Nominal bolt size	Tightening torque [N·m]	Torque wrench (single function type)	Spanner head	Coupling size
M6	10	N120SPCK×10N·m	230SCK 10mm	070,080,090,100

● SFM-□ SS/DS (Pressure bolt)

Nominal bolt size	Tightening torque [N·m]	Torque wrench (single function type)	Hexagon head	Coupling size
M6	14	N230SPCK×14N·m	230HCK 5mm	090,100,120
M8	34	N450SPCK×34N·m	450HCK 6mm	140

● SFH-□ S/G (Reamer bolt)

Nominal bolt size	Tightening torque [N·m]	Torque wrench (single function type)	Spanner head	Coupling size
M8	34	N450SPCK×34N·m	450SCK 13mm	150
M10	68	N900SPCK×68N·m	900SCK 17mm	170
M12	118	N1800SPCK×118N·m	1800SCK 19mm	190
M16	300	N4400SPCK×300N·m	4400SCK 24mm	210,220
Nominal bolt size	Tightening torque [N·m]	Torque wrench (preset type)	Spanner head	Coupling size
M20	570	N7000LCK	7000SCK 30mm	260

● ALS-□ R/Y/B (Set screw)

Nominal set screw size	Tightening torque [N·m]	Torque driver (preset type)	Hexagon bit	Coupling size
M3	0.7	N12LTDK	SB 1.5mm	–
M4	1.7	N20LTDK	SB 2mm	–
M5	3.6	N50LTDK	SB 2.5mm	–
M6	6.0	N100LTDK	SB 3mm	–
Nominal set screw size	Tightening torque [N·m]	Torque wrench (preset type)	Hexagon head	Coupling size
M8	14.5	N230LCK	230HCK 4mm	–
M10	28.0	N450LCK	450HCK 5mm	–

● ALS-□ R/Y/B (Clamp bolt)

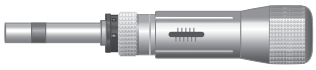
Nominal bolt size	Tightening torque [N·m]	Torque driver (preset type)	Hexagon bit	Coupling size
M2	0.4	N6LTDK	SB 1.5mm	014
M2.5	1.0	N12LTDK	SB 2mm	020
M3	1.5	N20LTDK	SB 2.5mm	030
M5	7.0	N100LTDK	SB 4mm	040
Nominal bolt size	Tightening torque [N·m]	Torque wrench (preset type)	Hexagon head	Coupling size
M6	14.0	N230LCK	230HCK 5mm	055
M8	30.0	N450LCK	450HCK 6mm	065,080

● PSL-G · G-C (Clamp bolt)

Nominal bolt size	Tightening torque [N·m]	Torque wrench (preset type)	Hexagon head	Applicable size
M6	17.0	N230LCK	230HCK 5mm	19 to 40
M8	41.0	N450LCK	450HCK 5mm	42 to 65
M10	82.0	N900LCK	900HCK 5mm	70 to 95
M12	142.0	N1800LCK	1800HCK 5mm	100 to 120

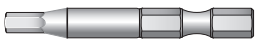
● Torque driver (preset type)

■ **N-LTDK**



● Bit

■ **SB**

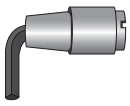


● Torque wrench (single function type)

■ **N-SPCK**

● Hexagon head

■ **HCK**

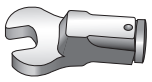


● Torque wrench (preset type)

■ **N-LCK**

● Spanner head

■ **SCK**



Technical Data

Physical and Mechanical Property of Metals

● Physical Property

Metal material	Ratio	Longitudinal elastic modulus $\times 10^3$ [N/mm^2]	Rigidity modulus $\times 10^3$ [N/mm^2]	Thermal conductivity [W/(M·k)]	Thermal expansion $\times 10^{-6}$ [1/k]
Low-carbon steel (0.08C to 0.12C)	7.86	206	79	57 to 60	11.3 to 11.6
Medium carbon steel (0.40C to 0.50C)	7.84	205	82	44	10.7
High-carbon steel (0.8C to 1.6C)	7.81 to 7.83	196 to 202	80 to 81	37 to 43	9.6 to 10.9
Chrome steel (SCr430)	7.84	—	—	44.8	12.6 (300 to 470k)
Chrome-molybdenum steel (SCM440)	7.83	—	—	42.7	12.3
Martensitic stainless steel (SUS410)	7.80	200	—	24.9	9.9
Austenitic stainless steel (SUS304)	8.03	197	73.7	15	17.3
Tool steel (SKD6)	7.75	206	82	42.2 (373k)	10.8
Gray iron (FC)	7.05 to 7.3	73.6 to 127.5	28.4 to 39.2	44 to 58.6	9.2 to 11.8
Nodular graphite cast iron (FCD)	7.10	161	78	33.5 to 37.7	10
Duralumin (A2017-T4)	2.79	69	—	201	23.4
Super duralumin (A2024-T4)	2.77	74	29	121	23.2
Extra super duralumin (A7075-T6)	2.80	72	28	130	23.6
Lautan (AC2A-T6)	2.79	72	—	121	24.0
Silumin (AC3A-F)	2.66	71	—	121	20.4
Aluminum casting alloy (AC4CH-T6)	2.68	72	—	151	21.5
Aluminum die casting alloy (ADC12)	2.70	72	—	100	21.0
Zinc die casting alloy (ZDC-2)	6.60	89	—	113	27.4

● Mechanical Property

Metal material	Yield point [N/mm^2]	Tensile strength [N/mm^2]	Hardness [HB]
S20C-N	245	402	116 to 174
S30C-N	284	471	137 to 197
S30C-H	333	539	152 to 212
S45C-N	343	569	167 to 229
S45-H	490	686	201 to 269
SS400	216	402 to 510	—
SCM420	—	932	262 to 352
SCM435	785	932	269 to 331
SUS303	206	520	187 or less
SUS304	206	520	200 or less
FC200	—	200	223 or less
FC250	—	250	241 or less
FC300	—	300	262 or less
FC350	—	350	277 or less
FCD400	250	400	201 or less
FCD450	280	450	143 to 217
FCD500	320	500	170 to 241
A2014-T4	245	412	—
A2017-T4	196	353	—
A7075-T6	471	539	—

● Approximate Converted Values of Steels to Rockwell Hardness of C Scale

Rockwell C scale hardness (HRC)	Vickers hardness (HV)	Brinell hardness (HB) 10mm sphere Load 3000kgf		Rockwell hardness			Rockwell superficial hardness Diamond conical penetrator			Shore hardness (HS)	Tensile strength [MPa] Approximate value) 1MPa= 1N/mm²	Rockwell C scale hardness (HRC)
		Standard sphere	Tungsten carbide sphere	A scale (HRA) Load 60kgf Diamond conical penetrator	B scale (HRB) Load 100kgf Diameter 1.6mm (1/16in) sphere	D scale (HRD) Load 100kgf Diamond conical penetrator	15-N scale Load 15kgf	30-N scale Load 30kgf	45-N scale Load 45kgf			
68	**940**	–	–	**85.6**	–	**76.9**	**93.2**	**84.4**	**75.4**	97	–	**68**
67	**900**	–	–	**85.0**	–	**76.1**	**92.9**	**83.6**	**74.2**	95	–	**67**
66	**865**	–	–	**84.5**	–	**75.4**	**92.5**	**82.8**	**73.3**	92	–	**66**
65	**832**	–	(739)	**83.9**	–	**74.5**	**92.2**	**81.9**	**72.0**	91	–	**65**
64	**800**	–	(722)	**83.4**	–	**73.8**	**91.8**	**81.1**	**71.0**	88	–	**64**
63	**772**	–	(705)	**82.8**	–	**73.0**	**91.4**	**80.1**	**69.9**	87	–	**63**
62	**746**	–	(688)	**82.3**	–	**72.2**	**91.1**	**79.3**	**68.8**	85	–	**62**
61	**720**	–	(670)	**81.8**	–	**71.5**	**90.7**	**78.4**	**67.7**	83	–	**61**
60	**697**	–	(654)	**81.2**	–	**70.7**	**90.2**	**77.5**	**66.6**	81	–	**60**
59	**674**	–	(634)	**80.7**	–	**69.9**	**89.8**	**56.6**	**65.5**	80	–	**59**
58	**653**	–	**615**	**80.1**	–	**69.2**	**89.3**	**75.7**	**64.3**	78	–	**58**
57	**633**	–	**595**	**79.6**	–	**68.5**	**88.9**	**74.8**	**63.2**	76	–	**57**
56	**613**	–	**577**	**79.0**	–	**67.7**	**88.3**	**73.9**	**62.0**	75	–	**56**
55	**595**	–	**560**	**78.5**	–	**66.9**	**87.9**	**73.0**	**60.9**	74	2075	**55**
54	**577**	–	**543**	**78.0**	–	**66.1**	**87.4**	**72.0**	**59.8**	72	2015	**54**
53	**560**	–	**525**	**77.4**	–	**65.4**	**86.9**	**71.2**	**58.5**	71	1950	**53**
52	**544**	(500)	**512**	**76.8**	–	**64.6**	**86.4**	**70.2**	**57.4**	69	1880	**52**
51	**528**	(487)	**496**	**76.3**	–	**63.8**	**85.9**	**69.4**	**56.1**	68	1820	**51**
50	**513**	(475)	**481**	**75.9**	–	**63.1**	**85.5**	**68.5**	**55.0**	67	1760	**50**
49	**498**	(464)	**469**	**75.2**	–	**62.1**	**85.0**	**67.6**	**53.8**	66	1695	**49**
48	**484**	**451**	**455**	**74.7**	–	**61.4**	**84.5**	**66.7**	**52.5**	64	1635	**48**
47	**471**	**442**	**443**	**74.1**	–	**60.8**	**83.9**	**65.8**	**51.4**	63	1580	**47**
46	**458**	**432**	**432**	**73.6**	–	**60.0**	**83.5**	**64.8**	**50.3**	62	1530	**46**
45	**446**	**421**	**421**	**73.1**	–	**59.2**	**83.0**	**64.0**	**49.0**	60	1480	**45**
44	**434**	**409**	**409**	**72.5**	–	**58.5**	**82.5**	**63.1**	**47.8**	58	1435	**44**
43	**423**	**400**	**400**	**72.0**	–	**57.7**	**82.0**	**62.2**	**46.7**	57	1385	**43**
42	**412**	**390**	**390**	**71.5**	–	**56.9**	**81.5**	**61.3**	**45.5**	56	1340	**42**
41	**402**	**381**	**381**	**70.9**	–	**56.2**	**80.9**	**60.4**	**44.3**	55	1295	**41**
40	**392**	**371**	**371**	**70.4**	–	**55.4**	**80.4**	**59.5**	**43.1**	54	1250	**40**
39	**382**	**362**	**362**	**69.9**	–	**54.6**	**79.9**	**58.6**	**41.9**	52	1215	**39**
38	**372**	**353**	**353**	**69.4**	–	**53.8**	**79.4**	**57.7**	**40.8**	51	1180	**38**
37	**363**	**344**	**344**	**68.9**	–	**53.1**	**78.8**	**56.8**	**39.6**	50	1160	**37**
36	**354**	**336**	**336**	**68.4**	(109.0)	**52.3**	**78.3**	**55.9**	**38.4**	49	1115	**36**
35	**345**	**327**	**327**	**67.9**	(108.5)	**51.5**	**77.7**	**55.0**	**37.2**	48	1080	**35**
34	**336**	**319**	**319**	**67.4**	(108.0)	**50.8**	**77.2**	**54.2**	**36.1**	47	1055	**34**
33	**327**	**311**	**311**	**66.8**	(107.5)	**50.0**	**76.6**	**53.3**	**34.9**	46	1025	**33**
32	**318**	**301**	**301**	**66.3**	(107.0)	**49.2**	**76.1**	**52.1**	**33.7**	44	1000	**32**
31	**310**	**294**	**294**	**65.8**	(106.0)	**48.4**	**75.6**	**51.3**	**32.7**	43	980	**31**
30	**302**	**286**	**286**	**65.3**	(105.5)	**47.7**	**75.0**	**50.4**	**31.3**	42	950	**30**
29	**294**	**279**	**279**	**64.7**	(104.5)	**47.0**	**74.5**	**49.5**	**30.1**	41	930	**29**
28	**286**	**271**	**271**	**64.3**	(104.0)	**46.1**	**73.9**	**48.6**	**28.9**	41	910	**28**
27	**279**	**264**	**264**	**63.8**	(103.0)	**45.2**	**73.3**	**47.7**	**27.8**	40	880	**27**
26	**272**	**258**	**258**	**63.3**	(102.5)	**44.6**	**72.8**	**46.8**	**26.7**	38	860	**26**
25	**266**	**253**	**253**	**62.8**	(101.5)	**43.8**	**72.2**	**45.9**	**25.5**	38	840	**25**
24	**260**	**247**	**247**	**62.4**	(101.0)	**43.1**	**71.6**	**45.0**	**24.3**	37	825	**24**
23	**254**	**243**	**243**	**62.0**	100.0	**42.1**	**71.0**	**44.0**	**23.1**	36	805	**23**
22	**248**	**237**	**237**	**61.5**	99.0	**41.6**	**70.5**	**43.2**	**22.0**	35	785	**22**
21	**243**	**231**	**231**	**61.0**	98.5	**40.9**	**69.9**	**42.3**	**20.7**	35	770	**21**
20	**238**	**226**	**226**	**60.5**	97.8	**40.1**	**69.4**	**41.5**	**19.6**	34	760	**20**
(18)	230	219	219	–	96.7	–	–	–	–	33	730	(18)
(16)	222	212	212	–	95.5	–	–	–	–	32	705	(16)
(14)	213	203	203	–	93.9	–	–	–	–	31	675	(14)
(12)	204	194	194	–	92.3	–	–	–	–	29	650	(12)
(10)	196	187	187	–	90.7	–	–	–	–	28	620	(10)
(8)	188	179	179	–	89.5	–	–	–	–	27	600	(8)
(6)	180	171	171	–	87.1	–	–	–	–	26	580	(6)
(4)	173	165	165	–	85.5	–	–	–	–	25	550	(4)
(2)	166	158	158	–	83.5	–	–	–	–	24	530	(2)
(0)	160	152	152	–	81.7	–	–	–	–	24	515	(0)

* Boldface figures are derived from ASTM E 140. (Adjusted jointly by SAE, ASM and ASTM)
* The figures in parentheses ( ) in the table are the ranges that are not frequently used and are shown for reference purposes only.

Technical Data

Balance Quality of Rotation Equipment

According to JIS B 0513-1985, balance quality is defined as a "quantity that shows the balance of a rigid rotor and is a product between a specific unbalance and specified angular velocity."

● Procedure for Deciding a Permissible Unbalance

The following information (numerical values) on the rotor is required to determine a permissible unbalance.

- Maximum rotation speed at which the rotor will be used n_{max}
- Rotor mass m
- Rotor bearing position
- Position of balancing plane

For more detailed calculations:

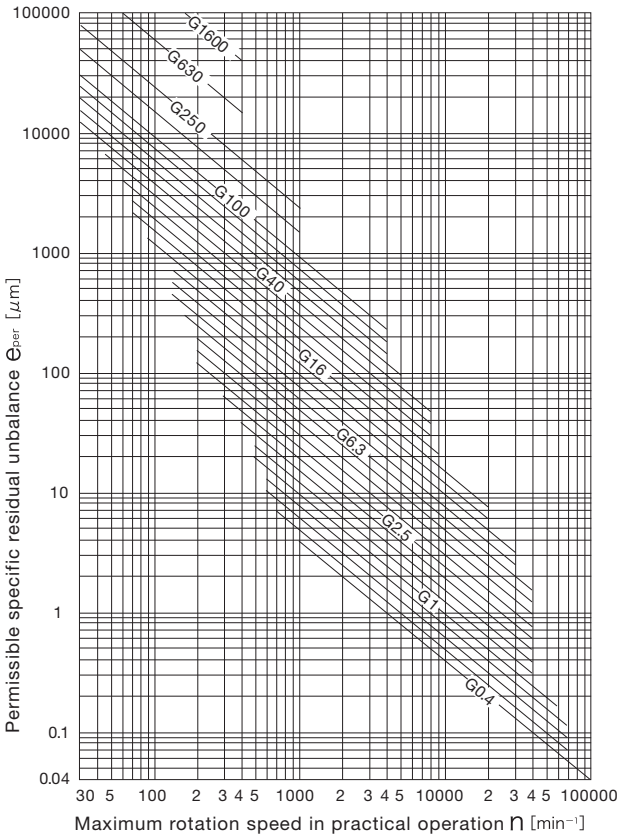
- Position of rotor mass center (center of gravity) is required.

1. A grade for balance quality is set based on the rotor type. The smaller the grade for balance quality, the higher the balancing accuracy. As explained in JIS, however, G1 and G0.4 require particular caution.
2. The permissible specific residual unbalance e_{per} is calculated based on the maximum rotation speed at which the rotor will actually be used. e_{per} can be calculated from the following calculation formula or from the diagram on the right.

$$\text{Balance quality} = e \cdot \omega$$
$$\omega = 2\pi n/60 = n/9.55$$
n [min^{-1}]
ω [rad/s]

$$\text{Balance quality} = \frac{e \cdot n}{9.55}$$

3. The permissible specific residual unbalance is calculated based on the permissible specific residual unbalance and rotor mass.
   Permissible specific residual unbalance $U_{per} = e_{per} m$ [g · mm]
4. Distribute actually the permissible specific residual unbalance to the unbalance of the balancing plane. (The distribution calculation method varies in accordance with the relationship among the bearing position, position and mass of balancing plane and position of the center of mass. For more information, refer to the explanation in JIS.)



● Recommended Grade for Balance Quality for Various Rotating Machines (JIS B 0905-1992)

Balance quality grade	Upper limit of balance quality mm/s ($e_{per} \times \omega$)	Examples of rotor type
G4000	4000	● Rigidly-supported crank shafting*2 of low-speed diesel engine for ship*1 with odd number of cylinders
G1600	1600	● Rigidly-supported crank shafting*2 of large two-cycle engine
G630	630	● Rigidly-supported crank shafting*2 of large four-cycle engine ● Rigidly-supported crank shafting*2 of diesel engine for ship*1
G250	250	● Rigidly-supported crank shafting*2 of high-speed four-cylinder diesel engine*1
G100	100	● Crank shafting of high-speed diesel engine*1 with 6 cylinders or more for completed products of engines for automobiles, trucks and rolling stock (gasoline or diesel).
G40	40	● Automotive wheels, rims, wheel sets and drive shafts ● Rigidly-supported high-speed four-cycle diesel engines*1 with 6 cylinders or more ● Crank shafting*2 of (gasoline or diesel) engines ● Crank shafting for automotive, truck and rolling stock engines*2
G16	16	● Drive shafts with special requirement (propeller shaft, Cardan shaft) ● Crusher parts ● Parts for agricultural machinery ● Parts for engines (gasoline and diesel) for automobiles, trucks and rolling stock and crank shafting*2 with 6 cylinders or more with special requirement
G6.3	6.3	● Equipment for process plants ● Main-engine turbine wheels for ships (For merchant marine) ● Centrifugal separator drums ● Papermaking rolls, printing rolls ● Fans ● Aircraft gas turbine rollers after assembly ● Flywheels ● Pump impellers ● Parts for machine tools and general machinery ● Medium and large armatures of motors with a shaft center height of at least 80cm or more without special requirement ● Small armatures mainly for high-volume production for use in an environment less sensitive to vibration or with vibration isolation ● Parts for engines with special requirement
G2.5	2.5	● Gas turbines, steam turbines and main turbines for ships (For merchant marine) ● Rigid turbo generator rotors ● Memory drums for computers and disc turbo compressors ● Main shafts for machine tools ● Medium and large armatures with special requirement ● Small armatures (Except for G6.3 and G1 conditions) ● Turbine drive pumps
G1	1	● Rotating parts of tape recorders and acoustic equipment ● Abrasive wheel shafts of grinding machines ● Small armatures with special requirement
G0.4	0.4	● Abrasive wheel shafts, abrasive wheels and armatures of precision grinding machines ● Gyroscopes

* *1: Low-speed diesel engines are engines with a piston speed of 9m/s or less. High-speed diesel engines are engines with a piston speed of 10m/s or more.
* *2: Crank shafting is an entire unit consisting of a crank shaft, flywheel, clutch, pulley, damper, rotating part of a connecting rod and other parts.
*: The rotor mass of a completed engine product is the total mass of the entire crank shafting.

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