

Bushing Selection Chart

For Use with Precision Shoulder Bolts

Tip: Set your PDF viewer to "Actual size" before printing to maintain scale.

Bushing Material Comparison

Material	Pros	Cons	Best Applications
Bronze (SAE 660)	Excellent wear resistance, Good load capacity, Moderate cost, Machinable	Requires lubrication, Can gall if run dry, Heavier than plastic	General industrial machinery, Moderate to heavy loads, Indoor equipment
Oilite (Sintered Bronze)	Self-lubricating, Low maintenance, Good wear resistance, Oil-impregnated	Limited relubrication, Can dry out over time, Lower load than solid	Low maintenance applications, Light to moderate loads, Hard to access areas
PTFE (Teflon)	Very low friction, Chemical resistant, Self-lubricating, Food safe	Lower load capacity, Can cold flow, Higher cost	Chemical processing, Food equipment, Clean rooms, Corrosive environments
Acetal (Delrin)	Low friction, Quiet operation, Good wear resistance, Dimensional stability	Moisture sensitive, Moderate load only, Temperature limited	Light loads, Quiet operation critical, Consumer products, Office equipment
Nylon	Excellent wear, Quiet, Good impact strength, Chemical resistant	Absorbs moisture, Dimensional changes, Limited temperature	Light to moderate loads, Moist environments, Budget applications
Graphite (Impregnated)	Self-lubricating, High temperature, Chemical resistant, No oil needed	Brittle, Higher cost, Limited availability	High temperature, Clean environments, No lubrication permitted
Needle Bearing	Highest load capacity, Low friction, Compact design, Precise operation	Higher cost, Requires lubrication, More complex install	Heavy loads in compact spaces, Precision machinery, High-speed rotation

Clearance Fit Guidelines

Application Type	Clearance Range	Description
Precision Positioning	0.0005" - 0.001"	Minimal play, accurate location, may require hand fitting
Close Running Fit	0.001" - 0.002"	Very little play, smooth operation, most common for pivot points
Standard Running Fit	0.002" - 0.004"	Good balance of smooth operation and easy assembly, general purpose
Free Running Fit	0.003" - 0.005"	More clearance, easy assembly, some play acceptable
Loose Sliding Fit	0.005" - 0.010"	Significant clearance, for rough alignment or temporary assemblies

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Calculating Bushing ID from Shoulder Diameter

Formula: $\text{Bushing ID} = \text{Shoulder Diameter} + (2 \times \text{Desired Clearance})$

Example 1: 1/2" (0.500") shoulder with standard running fit

- Desired clearance: 0.003" per side
- Bushing ID = $0.500" + (2 \times 0.003") = 0.506"$
- Specify: 0.506" ID bushing or 1/2" +0.006" oversize

Example 2: 3/4" (0.750") shoulder with close running fit for precision

- Desired clearance: 0.0015" per side
- Bushing ID = $0.750" + (2 \times 0.0015") = 0.753"$
- Specify: 0.753" ID bushing or 3/4" +0.003" oversize

Press Fit Interference Recommendations

Base Material	Bushing OD Interference	Installation Method
Aluminum	0.0005" - 0.001"	Light press, arbor press recommended
Steel or Cast Iron	0.001" - 0.002"	Standard press, arbor press or driver
Stainless Steel	0.001" - 0.003"	Firm press, may require heating base
Plastic/Composite	0.0005" - 0.0015"	Very light press or adhesive bond

Common Bushing Sizes for Standard Shoulder Bolts

Shoulder	Close Fit ID	Standard Fit ID	Free Fit ID	Typical OD
1/4"	0.2515"-0.252"	0.253"-0.254"	0.255"-0.256"	3/8"-1/2"
5/16"	0.3135"-0.314"	0.315"-0.316"	0.318"-0.320"	1/2"-5/8"
3/8"	0.3765"-0.377"	0.378"-0.379"	0.380"-0.383"	1/2"-3/4"
1/2"	0.5015"-0.502"	0.503"-0.504"	0.505"-0.508"	5/8"-7/8"
5/8"	0.6265"-0.627"	0.628"-0.629"	0.630"-0.633"	3/4"-1"
3/4"	0.7515"-0.752"	0.753"-0.754"	0.755"-0.758"	7/8"-1-1/4"
1"	1.0015"-1.002"	1.003"-1.004"	1.005"-1.008"	1-1/4"-1-1/2"

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Load Capacity Estimates

Bushing Type	Max PV (psi-ft/min)	Max Load (psi)	Max Speed (ft/min)
Bronze (SAE 660)	50,000	4,000	1,000
Oilite (Porous)	10,000	2,000	400
PTFE Composite	4,000	2,000	300
Acetal (Delrin)	3,000	1,500	300
Nylon	2,500	1,000	250
Needle Bearing	N/A (rolling)	20,000+	3,000+

Note: $PV = \text{Pressure (load/projected area)} \times \text{Velocity}$. Values are general guidelines - consult manufacturer for specific applications.

Bushing Maintenance and Replacement Criteria

When to Replace Bushings:

- Radial clearance exceeds 0.010" (0.005" per side)
- Visible wear grooves or scoring in bushing ID
- Increased noise or vibration during operation
- Binding or sticking in rotation or sliding
- Excessive heat generation at bearing surface
- Bushing material transfer to shoulder bolt surface

Relubrication Guidelines:

- **Bronze bushings:** Every 50-100 hours or monthly
- **Oilite bushings:** Minimal - relubricate only if operation becomes rough
- **Plastic bushings:** Typically dry-running - lubricate only if specified
- **Needle bearings:** Follow manufacturer schedule, typically every 500-1000 hours

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