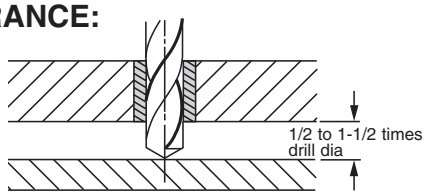
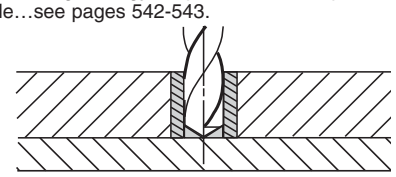
INSTALLATION AND TECHNICAL DATA

RECOMMENDED CHIP CLEARANCE:

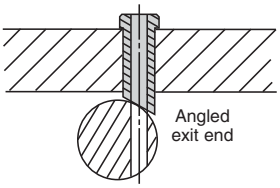


To minimize drill bending and maximize hole accuracy, mount drill bushings as close to the workpiece as possible while still allowing adequate chip clearance. The necessary clearance depends on workpiece material and chip stringiness. For example, cast iron, with fine chips requires about 1/2 times drill diameter for chip clearance. Materials that produce long, stringy chips, such as cold-rolled steel and aluminum, require at least one-drill-diameter clearance. To reduce clearance even with long, stringy chips, exit-end chip breakers are available…see pages 542-543.



Direct workpiece contact is usually not recommended. Chips can escape only up through the drill's flutes, drill-bearing length is shortened by the drill point's length, and drill-withdrawal burrs can raise the jig plate. Direct contact may be necessary, though, for maximum bearing length when drilling sloped surfaces (see below). Also, reamer bushings can be mounted much closer than drill bushings, due to much finer chips, for more-accurate hole finishing.

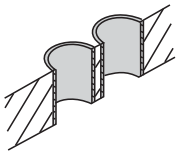
SLOPED WORKPIECE SURFACES:

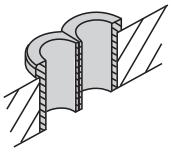


Whenever the drilling axis is not perpendicular to the workpiece surface, locate the exit end as close to the part as possible. Otherwise the drill will tend to wander. For maximum drill guiding, we recommend specifying bushings with an angle milled on the exit end, tangent to the workpiece surface at point of entry.

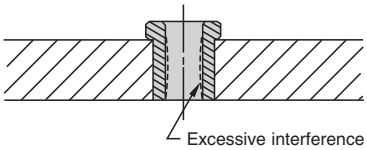
SPECIAL BUSHINGS FOR CLOSE HOLE SPACING:

When holes are located close together, special bushings are sometimes required. Thinwall bushings, where the bushing ID is larger than the normal ID range for a given OD, are often a good solution. Holes for thinwall bushings must be very accurate and round, because these bushings are more easily distorted. For very-close hole spacing, especially with headed bushings, specify bushings with ground flats.





INSTALLATION-HOLE PREPARATION:



To avoid jig-plate or bushing distortion, do not use excessive interference fits on press-fit bushings. See table below for recommended hole sizes in unhardened steel or cast iron jig plates. Always prepare installation holes using a jig borer or reamer. Standard chucking reamers (with a plus tolerance) usually produce installation holes to the tolerances shown in the table. Other factors to consider are: (1) headed bushings require less interference to resist drilling thrust; (2) longer bushings in thick plates require less interference; (3) bushings with thinner walls are more prone to distortion; (4) less-ductile jig-plate materials require less interference.

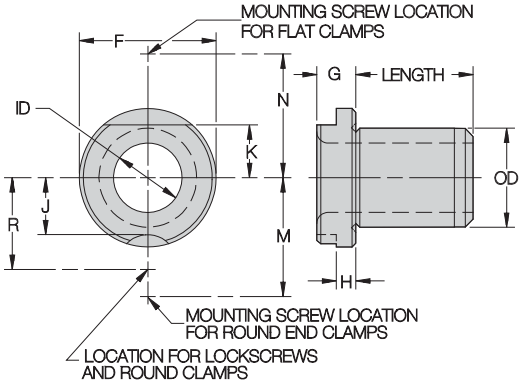
USA

PRESS-FIT BUSHING OD		RECOMMENDED HOLE SIZE
NOM.	ACTUAL	
5/32	.1578-.1575	.1565-.1570
3/16	.1891-.1888	.1880-.1883
13/64	.2046-.2043	.2037-.2040
1/4	.2516-.2513	.2507-.2510
5/16	.3141-.3138	.3132-.3135
3/8	.3766-.3763	.3757-.3760
13/32	.4078-.4075	.4069-.4072
7/16	.4392-.4389	.4382-.4385
1/2	.5017-.5014	.5007-.5010
9/16	.5642-.5639	.5632-.5635
5/8	.6267-.6264	.6257-.6260
3/4	.7518-.7515	.7507-.7510
7/8	.8768-.8765	.8757-.8760
1	1.0018-1.0015	1.0007-1.0010
1-1/8	1.1270-1.1267	1.1257-1.1260
1-1/4	1.2520-1.2517	1.2507-1.2510
1-3/8	1.3772-1.3768	1.3757-1.3760
1-1/2	1.5021-1.5018	1.5007-1.5010
1-3/4	1.7523-1.7519	1.7507-1.7510
2-1/4	2.2525-2.2521	2.2507-2.2510
2-3/4	2.7526-2.7522	2.7507-2.7510

METRIC

PRESS-FIT BUSHING OD		RECOMMENDED HOLE SIZE
NOM.	ACTUAL (s6)	(H7)
3mm	3.020-3.014mm	3.000-3.010mm
4mm	4.027-4.019mm	4.000-4.012mm
5mm	5.027-5.019mm	5.000-5.012mm
6mm	6.027-6.019mm	6.000-6.012mm
7mm	7.032-7.023mm	7.000-7.015mm
8mm	8.032-8.023mm	8.000-8.015mm
10mm	10.032-10.023mm	10.000-10.015mm
12mm	12.039-12.028mm	12.000-12.018mm
15mm	15.039-15.028mm	15.000-15.018mm
18mm	18.039-18.028mm	18.000-18.018mm
22mm	22.048-22.035mm	22.000-22.021mm
26mm	26.048-26.035mm	26.000-26.021mm
30mm	30.048-30.035mm	30.000-30.021mm
35mm	35.059-35.043mm	35.000-35.025mm
42mm	42.059-42.043mm	42.000-42.025mm
48mm	48.059-48.043mm	48.000-48.025mm
55mm	55.072-55.053mm	55.000-55.030mm
62mm	62.072-62.053mm	62.000-62.030mm
70mm	70.078-70.059mm	70.000-70.030mm
78mm	78.078-78.059mm	78.000-78.030mm
85mm	85.093-85.071mm	85.000-85.035mm
95mm	95.093-95.071mm	95.000-95.035mm
105mm	105.101-105.079mm	105.000-105.035mm
115mm	115.101-115.079mm	115.000-115.035mm
125mm	125.117-125.092mm	125.000-125.040mm

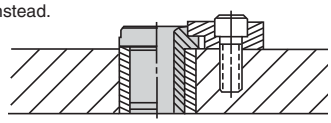
FM FLAT MILLED RENEWABLE



BODY OD	F	G	H	J	K	M	N	R	FLAT CLAMP	LOCK SCREW
5/16	35/64	1/4	1/8	11/64	11/64	5/8	11/16	1/2	FC-01 FC-10	LS-1
1/2	51/64			19/64	17/64	3/4	25/32	5/8		
3/4	1-3/64			27/64	25/64	7/8	57/64	3/4		
1	1-27/64	3/8	3/16	19/32	1/2	1-7/64	1-9/64	59/64	FC-02 FC-12	LS-2
1-3/8	1-51/64			25/32	11/16	1-19/64	1-21/64	1-7/64		
1-3/4	2-19/64	3/8	3/16	1	7/8	1-41/64	1-33/64	1-25/64	FC-03 FC-14 FC-15	LS-3
2-1/4	2-51/64			1-1/4	1-1/8	1-57/64	1-49/64	1-41/64		

APPLICATIONS:

Replaceable bushing used for extra resistance to rotational forces under harsh conditions. This bushing, generally used with a liner, has a milled locking flat to allow fastening securely with a flat clamp. FM bushings also have a standard recess on the other side to allow using a lockscrew instead.



ORDERING EXAMPLES:

FM-20-16-.1250	Standard USA Bushing, inch ID
FM-20-16-.1772	Standard USA Bushing, mm ID (.1772 = 4.50mm)
FM-20-16-.1250 REAMER	Reamer Tolerance on ID
FM-20-16-.1250 NCB	No counterbore on long bushings marked with * (no counterbore is standard on all other bushings)
FMC-20-16-.1250	Carbide Bushing

Standard prices apply only to bushings with a standard-drill-size ID with the stated ID range. See catalog back cover for standard drill sizes and their decimal equivalents. For prices on non-standard ID sizes, including reamer-tolerance and tap-guide bushings, please contact factory.

STANDARD ID TOLERANCES:

From #80 to 1/4"	+.0001/+.0004	From .35 to 3mm	+.002/+.008mm
Over 1/4 to 3/4"	+.0001/+.0005	Over 3 to 6mm	+.004/+.012mm
Over 3/4 to1-1/2"	+.0002/+.0006	Over 6 to 10mm	+.005/+.014mm
Over 1-1/2 to 2-3/4"	+.0003/+.0007	Over 10 to 18mm	+.006/+.017mm
		Over 18 to 30mm	+.007/+.020mm
		Over 30 to 50mm	+.009/+.025mm
		(G6 tolerance)	

REAMER ID TOLERANCES:

From #60 to 1/4"	+.0005/+.0008	From 1 to 3mm	+.006/+.012mm
Over 1/4 to 1"	+.0006/+.0010	Over 3 to 6mm	+.010/+.018mm
Over 1" to 1-1/2"	+.0008/+.0012	Over 6 to 10mm	+.013/+.022mm
		Over 10 to 18mm	+.016/+.027mm
		Over 18 to 30mm	+.020/+.033mm
		(F6 tolerance)	

ID RANGE	OD	LENGTH	ANSI PART NO.	PRICE 1-5	CLAMP
.0135-.0291 #80-#70 .35-.70mm	5/16 .3125-.3123	*1/4	FM-20-4	Please see our web catalog for pricing.	FC-01 FC-10 LS-1 RC-01 RK-01 RK-10
		*5/16	FM-20-5		
		*3/8	FM-20-6		
		*1/2	FM-20-8		
		*3/4	FM-20-12		
.0292-.0519 #69-3/64 .75-1.30mm		*5/16	FM-20-5		
		*3/8	FM-20-6		
		*1/2	FM-20-8		
		*3/4	FM-20-12		
.0520-.0634 #55-1/16 1.35-1.60mm		*5/16	FM-20-5		
		*3/8	FM-20-6		
		*1/2	FM-20-8		
		*3/4	FM-20-12		
.0635-.0934 #52-#43 1.65-2.35mm		5/16	FM-20-5		
		*3/8	FM-20-6		
		*1/2	FM-20-8		
		*3/4	FM-20-12		
		*1	FM-20-16		
.0935-.1249 #42-#31 2.40-3.15mm		5/16	FM-20-5		
		3/8	FM-20-6		
		*1/2	FM-20-8		
		*3/4	FM-20-12		
		*1	FM-20-16		
		*1-3/8	FM-20-22		
.1250-.1935 1/8-#10 3.20-4.90mm		5/16	FM-20-5		
		3/8	FM-20-6		
		1/2	FM-20-8		
		5/8	FM-20-10		
		*3/4	FM-20-12		
		*1	FM-20-16		
		*1-3/8	FM-20-22		

* Counterbored, leaving correct drill-bearing length and clearance (see page 514 for bearing length).

QUANTITY DISCOUNTS

Quantity	1 -5	6 -11	12 -23	24 -49	50 -99	100 -199	200 -499	500 Up
Discount %	Net	18%	29%	34%	42%	48%	50%	52%
Multiplier	1.00	.82	.71	.66	.58	.52	.50	.48

FLAT MILLED RENEWABLE FM

ID RANGE	OD	LENGTH	ANSI PART NO.	PRICE 1-5	CLAMP
.1405-.1889 #28-3/16 3.60-4.75mm	**1/2** .5000-.4998	5/16	FM-32-5	Please see our web catalog for pricing.	FC-01 FC-10 LS-1 RC-01 RK-01 RK-10
		3/8	FM-32-6		
		1/2	FM-32-8		
		*3/4	FM-32-12		
		*1	FM-32-16		
		*1-3/8	FM-32-22		
		*1-1/2	FM-32-24		
		*1-3/4	FM-32-28		
.1890-.3438 #12-11/32 4.80-8.70mm		5/16	FM-32-5		
		3/8	FM-32-6		
		1/2	FM-32-8		
		3/4	FM-32-12		
		*1	FM-32-16		
		*1-3/8	FM-32-22		
		*1-1/2	FM-32-24		
		*1-3/4	FM-32-28		
		*2-1/8	FM-32-34		
.2812-.5625 9/32-9/16 7.20-14.00mm	**3/4** .7500-.7498	3/8	FM-48-6		FC-01 FC-11 LS-1 RC-01 RK-01 RK-11
		1/2	FM-48-8		
		3/4	FM-48-12		
		1	FM-48-16		
		1-3/8	FM-48-22		
		1-1/2	FM-48-24		
		1-3/4	FM-48-28		
		2-1/8	FM-48-34		
		*2-1/2	FM-48-40		
		*3	FM-48-48		
.4688-.7812 15/32-25/32 12.00-19.50mm	**1** 1.0000-.9998	1/2	FM-64-8		FC-02 FC-12 LS-2 RC-02 RK-02 RK-12
		3/4	FM-64-12		
		1	FM-64-16		
		1-3/8	FM-64-22		
		1-1/2	FM-64-24		
		1-3/4	FM-64-28		
		2-1/8	FM-64-34		
		2-1/2	FM-64-40		
		3	FM-64-48		
.7188-1.0625 23/32 – 1-1/16 18.50-27.00mm	**1-3/8** 1.3750-1.3747	3/4	FM-88-12		FC-02 FC-12 LS-2 RC-02 RK-02 RK-12
		1	FM-88-16		
		1-3/8	FM-88-22		
		1-1/2	FM-88-24		
		1-3/4	FM-88-28		
		2-1/8	FM-88-34		
		2-1/2	FM-88-40		
		3	FM-88-48		

ID RANGE	OD	LENGTH	ANSI PART NO.	PRICE 1-5	CLAMP
.9688-1.4062 31/32 – 1-13/32 25.00-35.00mm	**1-3/4** 1.7500-1.7497	3/4	FM-112-12	Please see our web catalog for pricing.	FC-03 FC-14 FC-15 LS-3 RC-03 RK-03 RK-14
		1	FM-112-16		
		1-3/8	FM-112-22		
		1-1/2	FM-112-24		
		1-3/4	FM-112-28		
		2-1/8	FM-112-34		
		2-1/2	FM-112-40		
		3	FM-112-48		
1.3438-1.8750 1-11/32 – 1-7/8 35.00-47.00mm	**2-1/4** 2.2500-2.2496	3/4	FM-144-12		FC-03 FC-14 FC-15 LS-3 RC-03 RK-03 RK-14
		1	FM-144-16		
		1-3/8	FM-144-22		
		1-1/2	FM-144-24		
		1-3/4	FM-144-28		
		2-1/8	FM-144-34		
		2-1/2	FM-144-40		
		3	FM-144-48		

* Counterbored, leaving correct drill-bearing length and clearance (see page 514 for bearing length).

QUANTITY DISCOUNTS

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