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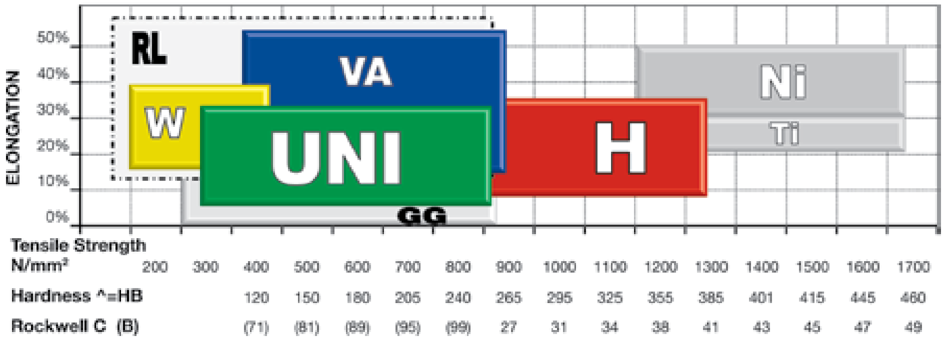

Material	Type	AISI / USA (Common examples)	JIS	DIN	Material #
Steel	<500 N/mm²	Leaded Steels	Leaded Steels	RFFeb60, RFe100	1.1015, 1.1013
	<750 N/mm²	1010, 1012, 1020	S10C, S12C, S20C	St37-2, 16MnCr5, St50-2	1.0112, 1.1053, 1.7131
	<900 N/mm²	1025, 1060	S25C, S45C, S55C	CK45, C60	1.1191, 1.0601
	<1100 N/mm²	4140, A2, 4340, M42, M2	SCM4, SCM5, SCM440	42CrMo4, 100Cr6 34CrNiMo6, S2-10-1-8	1,7225, 1.3505, 1.6582, 1.3247
	<1400 N/mm²	01, L6, M42, D3	SKD1, SNCM439	100MnCrW12, X210Cr12, S2-10-1-8	1.2510, 1.271
	>55 HR$_c$	02, A2, D2, D3, M2	SKD12, SKD11, SKD1	90MnCrV8 X100CrMoV5-1	1.2842, 1.2379, 1.2363, 1.2080
Stainless Steel	Austenitic <900 N/mm²	303, 416 430F	SUS304L SUS430F	X10CrNiS189, X12CrMoS17	1.4305 1.4104 1.4301 1.4541 1.4571
	Austenitic >900 N/mm²	304, 316, 321	SUS304 SUS316 SUS321	X10CrNiMoTi1810, X5CRNi189, X210CrNiTi189	
	Martensitic, Ferritic >900 N/mm²	410S, 430, 436, 420, Stavax	SUS29, SUS33, SUS43	X4CrNiMoN6257, XBCrNiMo275 X5CrTi12	14460, 1.4512, 1.4582
Ti	>850 N/mm²	4901, 4902, 4921, 4941		Ti 99.5, Ti 99.7,Ti 99.8	3.7024, 3.7034, 3.7065
Cast Iron	>850 N/mm²	Grade 150, Grade 400	FC10, FC25, FC40	GG10, GG25, GG40	0.6025, 0.6040
	<850 N/mm²	S.G. iron, Mehanite Black & White Heart	FCD40, FCD70 GGG40, GGG70	GTS45-06, GTW45-07	0.0740, 0.7070 0.08145, 0.8045
Copper	<350 N/mm²	101	C1020, C1011	E-Cu57, SE-Cu	2.0060, 2.0070
Brass	Long Chipping <700 N/mm²	C24000, C26800, C34800		CuZn37, CuZn33	2.0321, 2.0260
	Short Chipping <1500 N/mm²	40A, B124, C28000		CuZn39Pb2, CuZn40	2.0360
Aluminium	Long Chipping	LMO, 1B (1050A) Magnesium, Extruded Aluminium	IN90, IN99	A199.5	3.0255
	Short Chipping	5083, 2024, 6061, 7075 Low silicon wrought & cast aluminium	A7075, A6061	AlCuMg2, A1Mg2Mn0.8	3.1355, 3.3525
	Cast > 10% Si	4043, 380, 355.1, A356.2	ADC10, AC2B, AC4A, AC4D	GD-A1Ci8Cu G-A1Si5Mg	3.2162.05 3.2341.01
Plastics	Soft	Polyurethane PVC		ABS, Polycarbonate PUR-elastomer	

Sutton Tools

for universal materials	for aluminiums	for soft materials	for hard materials	for tough materials	for cast iron materials	for copper materials	for titaniums
UNI	Al	W	H	VA	GG	Cu	Ti
							Ti
●		●					
●		●					
●		●					
●			●				
●			●				
			●				
●		●		●			
		●		●			
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●		●	●			●	
●	●	●				●	

Sutton Tools

Coolant
Oil - O
Soluble Oil - S
Air - A

STUB

		Drilling Depth	≤ 3xØ														**Spotting**	
		Discount Group	A1002		A1004		A1006		A1130		A1502		A1502		A1502		A1124	
		Material	HSS		HSS Co		HSS Co		HSS Co		HSS Co		SPM		PM-HSS Co		HSS Co	
		Surface Finish	St. Ox		Brt		TiN		TiAlN		TiAlN		TiAlN		TiAlN		TiN	
		Colour Ring & Application	Ferrous Mat.		General Purpose						VA		UNI		H		General Purpose	
		Geometry	30º Helix		40º Helix		40º Helix		40º Helix		40º Helix		40º Helix		25º Helix		-	
		Metal Removal Volume	Low		Medium		Medium		Medium		Medium/High		Medium/High		High		High	
Materials	**Material examples**	**Coolant**	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.
Steels																		
Free-cutting steels	S1214L, Leaded Steels	S	25	5	20	5	25	5	30	5	64	6	77	7	-	-	35	4
Structural steels		S	20	5	17	5	20	5	25	5	64	6	55	7	-	-	25	4
Carbon steels	1020, 1024, 1045, 1060	S	15	5	12	5	15	5	25	5	62	5	55	7	40	6	20	4
Alloy steels 850 - 1200 N/mm^2	4140, 01, A2, D3, M42, P20	S	12	4	10	4	12	4	15	4	-	-	45	6	30	5	15	3
Alloy steels hard./temp. 1200 - 1400 N/mm^2	EN26, 01, L6, M42, D3, 4140	S	-	-	-	-	-	-	-	-	-	-	10	4	10	4	10	3
Alloy steels hard./temp. > 1400 N/mm^2		S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stainless Steels																		
Free machining stainless steel	416, 430F	O	10	4	10	4	10	4	15	4	30	6	18	4	-	-	10	3
Austentic stainless steels	303, 304, 316, 317,321	O	8	4	7	4	10	4	10	4	20	5	13	4	-	-	15	2
Ferritic + martensitic < 1000 N/mm^2	409, 430, 436, Duplex Alloys	O	-	-	11	4	15	3	15	3	-	-	16	3	-	-	10	2
Cast Irons																		
Cast iron ≤ 240 HB	GG10, GG20	S/A	25	6	20	6	25	6	30	6	-	-	44	6	40	6	30	5
Cast iron < 240 HB	GG25, GG40	S/A	20	5	18	5	25	5	25	5	-	-	39	6	35	6	20	4
Spheroidal graphite + Malleable cast iron	GGG50, GGG70	S	20	6	18	6	25	6	25	6	-	-	44	5	30	5	20	4
Titaniums																		
Titaniums unalloyed	Ti99.8	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Titanium alloys	TiA164V4, TiA155n2	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickels																		
Nickels unalloyed	Nickel 200, Ni99.6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel alloys < 850 N/mm^2	Nickel 400, Hastalloy C, Inconel 600	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel alloys 850 - 1150 N/mm^2	Nimonic 80A Waspalloy, Inconel 718	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coppers																		
Copper unalloyed		S	-	-	30	5	30	5	30	5	80	3	33	4	-	-	50	4
Shortchip brass + phosphor bronze + gun metal		S	-	-	28	5	40	5	40	5	-	-	44	5	-	-	30	4
Long chip brass		O	-	-	25	5	60	5	60	5	50	5	39	4	-	-	40	4
Aluminiums																		
Al/Mg unalloyed		S	-	-	42	6	60	6	60	6	112	8	88	5	-	-	50	5
Al alloyed Si < 5%		S	-	-	35	6	50	6	50	6	80	7	70	6	-	-	50	4
Al alloyed Si > 1.5% < 10%		S	-	-	28	5	40	5	40	5	70	7	53	5	-	-	35	4
Al alloyed Si > 10%, Mg - Alloys		S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes on Drilling

1. Step feeding or pecking is required for drilling greater than 3 x diameter
2. When drilling cast surface & black (ie.not machined surface), reduce drilling speed by 20%
3. For optimal positional accuracy and hole size, the use of spot drills is recommended prior to drilling desired hole, refer to our standard range (Discount Group A1124).
4. For hole depths greater than 7 x Ø, pre-drill initially to pilot start for more accurate hole position and eliminate drill wandering. The pilot can be drilled with short rigid drill, approx. 3 x Ø in depth and reduced feed to ensure accurate pilot hole

JOBBER																LONG SERIES				EXTRA LENGTH					
≤ 5xØ																≤ 7xØ				≤ 10xØ		≤ 12xØ		≤ 14xØ	
A0402		A0404		A1112		A1114		A1130		A1130		A1502		A1502		A0502		A0504		A0420					
HSS		HSS Co		HSS Co		HSS Co		HSS Co		HSS Co		HSS Co		SPM		HSS		HSS Co		HSS Co		HSS Co		HSS Co	
St. Ox		Colour Tempered		Brt		TiN		TiAlN		TiAlN		TiAlN		TiAlN		St. Ox		TiAlN		TiN		TiN		TiN	
General Purpose				General Purpose		General Purpose		General Purpose		UNI		VA		UNI				General Purpose		General Purpose					
30º Helix		25º Helix		40º Helix		40º Helix		40º Helix		40º Helix		40º Helix		40º Helix		30º Helix		40º Helix		40º Helix		40º Helix		40º Helix	

Low		Medium		Medium		Medium		Medium				Medium/High		Medium/High		Low		Medi um		Medium		Medium		Medium	
Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.
20	5	20	5	20	5	24	5	24	5	29	4	58	6	70	7	16	5	30	5	25	5	20	5	20	5
16	5	20	5	17	5	20	5	20	5	25	4	58	6	50	7	13	5	16	5	13	5	10	5	10	5
12	5	15	5	12	5	20	5	20	5	25	4	58	5	50	7	10	5	16	5	13	5	10	5	10	5
10	4	12	4	10	4	12	4	12	4	17	3	-	-	40	6	-	-	-	-	-	-	-	-	-	-
-	-	10	4	-	-	-	-	-	-	-	-	-	-	12	4	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	4	10	4	10	4	12	4	12	4	12	3	25	6	16	4	7	4	10	4	10	4	10	4	10	4
6	4	8	4	8	4	8	4	8	4	8	4	14	5	12	4	-	-	7	4	7	4	7	4	7	4
-	-	-	-	12	4	12	4	12	4	12	4	-	-	14	3	-	-	10	4	10	4	10	4	10	4
20	6	25	6	20	6	24	6	24	6	29	5	-	-	40	6	16	6	19	6	15	6	12	6	12	6
16	5	20	5	20	5	20	5	20	5	20	5	-	-	35	6	13	5	16	5	13	5	10	5	10	5
16	6	20	6	20	6	20	6	20	6	20	6	-	-	40	5	13	6	16	6	13	6	10	6	10	6
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	40	5	70	3			-	-	-	-	-	-	-	-	-	-
-	-	25	6	32	5	32	5	32	5	32	5	-	-	40	5	-	-	26	5	20	5	16	5	16	5
-	-	-	-	48	5	48	5	48	5	48	5	40	5	35	4	-	-	38	5	31	5	25	5	25	5
-	-	-	-	48	6	48	6	48	6	48	6	112	8	80	5	27	6	38	6	31	6	25	6	25	6
-	-	-	-	40	6	40	6	40	6	40	6	80	7	64	6	22	6	32	6	26	6	20	6	20	6
-	-	-	-	32	5	32	5	32	5	32	5	70	6	48	5	18	5	26	5	20	5	16	5	16	5
-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	5	-	-	-	-	-	-	-	-	-	-

Feed Table (f)

Drill Ømm	Feed No. (mm/rev) 1	2	3	4	5	6	7	8	9
2.0	0.020	0.025	0.030	0.040	0.050	0.060	0.080	0.100	0.120
3.0	0.030	0.040	0.050	0.060	0.080	0.100	0.120	0.150	0.180
4.0	0.040	0.050	0.060	0.080	0.100	0.120	0.150	0.180	0.200
5.0	0.045	0.055	0.065	0.085	0.110	0.135	0.165	0.190	0.220
6.0	0.050	0.060	0.080	0.100	0.120	0.150	0.180	0.200	0.250
8.0	0.060	0.080	0.100	0.120	0.150	0.200	0.250	0.300	0.350
10.0	0.080	0.100	0.120	0.150	0.200	0.250	0.300	0.350	0.400
12.0	0.080	0.100	0.120	0.150	0.200	0.250	0.300	0.400	0.500
16.0	0.100	0.120	0.150	0.200	0.250	0.300	0.400	0.500	0.600
20.0	0.150	0.200	0.250	0.300	0.400	0.500	0.600	0.700	0.800

Calculations

RPM = $\frac{\text{Vc x 318}}{Ø}$

Feedrate (mm/min) = **RPM x f**

Vc = m/min **Ø** = Dia. **f** = mm/rev

Example

Drilling Ø10mm, 40mm deep in P20 steel, using R40-UNI drill

Vc = = **40m/min**

RPM = $\frac{40 \times 318}{10}$ = **1272**

Feed No. = 5 (refer feed table) = 0.20mm/rev

Feedrate (mm/min) = 1272 x 0.20 = **254mm/min**

Sutton Tools

	STUB					JOBBER				LONG	
Drilling Depth	≤ 3xØ					≤ 5xØ		≤ 6xØ		≤ 8xØ	≤ 12xØ
Discount Group	A0202	A0206	A0202	A0202	A0202	A0202	A0202	A0202	A0202	A0202	A0202
Material	VHM	VHM	VHM	VHM	VHM	VHM	VHM	VHM	VHM	VHM	VHM
Surface Finish	TiCN	TiCN	TiAlN + TiN	TiAlN + TiN	TiAlN + TiN	TiCN	TiAlN + TiN	TiAlN	TiAlN	TiAlN	TiAlN
Colour Ring & Application	SS & Tough Mat.	Hardened Steels	General Purpose		UNI	Non Ferrous	UNI	UNI	W	UNI	UNI
Geometry	15º Helix	Str. Flute	30º Helix	-	IK	20º Helix	IK	Type FS	IK	IK	IK

Coolant
Oil - O
Soluble Oil - S
Air - A

Materials	Material examples	Coolant	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.	Vc (m/min)	Feed No.
Steels																								
Free-cutting steels	S1214L, Leaded Steels	S	100	5	-	-	100	6	90	7	130	7	100	4	130	7	85	7	-	-	60	6	60	6
Structural steels		S	100	5	-	-	100	6	90	7	140	7	90	4	140	7	85	7	-	-	60	6	60	6
Carbon steels	1020, 1024, 1045, 1060	S	100	5	-	-	85	6	75	7	90	7	80	4	90	7	75	7	-	-	50	5	40	5
Alloy steels 850 - 1200 N/mm²	4140, 01, A2, D3, M42, P20	S	85	1	-	-	75	6	65	7	70	7	-	-	70	7	65	7	-	-	65	4	55	7
Alloy steels hard./temp. 1200 - 1600 N/mm²	EN26, 01, L6, M42, D3, 4140	S	70	2	-	-	60	5	50	6	55	6	-	-	55	6	50	6	-	-	40	5	40	5
Alloy steels hard./temp. > 1600 N/mm²		S	-	-	55	2	65	3	25	4	30	4	-	-	30	4	-	-	-	-	-	-	-	-
High tensile alloy steels		S	-	-	40	2	50	5	40	6	45	6	-	-	45	6	40	6	-	-	40	6	30	6
Stainless Steels																								
Free machining stainless steel	416, 430F	O	40	3	-	-	40	3	-	-	50	4	-	-	50	4	-	-	-	-	45	3	35	3
Austentic stainless steels	303, 304, 316, 317,321	O	40	3	-	-	40	3	-	-	35	4	-	-	35	4	-	-	-	-	35	3	25	3
Ferritic + martensitic < 1000 N/mm²	409, 430, 436, Duplex Alloys	O	85	2	-	-	30	3	-	-	30	3	-	-	30	3	-	-	-	-	40	3	30	3
Cast Irons																								
Cast iron ≤ 240 HB	GG10, GG20	S/A	-	-	-	-	110	3	90	6	-	-	60	6	-	-	80	7	90	6	60	6	60	6
Cast iron < 240 HB	GG25, GG40	S/A	85	3	-	-	100	3	80	6	-	-	-	-	-	-	70	7	80	6	50	5	50	5
Spheroidal graphite + Malleable cast iron	GGG50, GGG70	S	85	2	-	-	90	3	80	5	-	-	-	-	-	-	70	6	75	5	50	5	50	5
Titaniums																								
Titanium unalloyed	Ti99.8	O	45	1	-	-	40	5	40	5	40	6	-	-	40	6	35	1-2	-	-	30	4	-	-
Titanium alloys	TiA164V4, TiA155n2	O	20	1	-	-	35	4	35	4	35	5	-	-	35	5	25	1-2	-	-	25	4	-	-
Nickels																								
Nickel unalloyed	Nickel 200, Ni99.6	O	45	1	-	-	45	4	40	4	45	4	-	-	45	4	-	-	-	-	35	3	-	-
Nickel alloys < 850 N/mm²	Monel 400, Hastelloy C, Inconel 600	O	20	1	-	-	30	4	25	4	30	4	-	-	30	4	-	-	-	-	25	3	-	-
Nickel alloys 850 - 1150 N/mm²	Nimonic 80A Waspalloy, Inconel 718	O	20	1	-	-	-	-	-	-	25	3	-	-	25	3	-	-	-	-	20	2	-	-
Coppers																								
Copper unalloyed		S	-	-	-	-	180	4	-	-	100	9	200	5	100	9	140	6	140	6	-	-	-	-
Shortchip brass + phosphor bronze + gun metal		S	-	-	100	5	160	4	-	-	-	-	70	5	-	-	160	6	160	6	-	-	-	-
Long chip brass		O	-	-	-	-	140	3	-	-	150	8	120	5	150	8	120	6	120	6	-	-	-	-
Aluminiums																								
Al/Mg unalloyed		S	-	-	-	-	260	5	-	-	240	9	200	5	240	9	180	7	200	7	200	5	-	-
Al alloyed Si < 5%		S	-	-	-	-	180	4	-	-	-	-	170	5	-	-	160	7	180	7	180	5	-	-
Al alloyed Si > 1.5% < 10%		S	-	-	-	-	180	4	-	-	-	-	140	5	-	-	140	7	170	7	160	5	-	-
Al alloyed Si > 10%, Mg - Alloys		S	-	-	100	5	180	4	-	-	-	-	120	7	-	-	130	7	140	7	140	5	-	-

Feed Table (f)

Drill Ømm	Feed No. (mm/rev) 1	2	3	4	5	6	7	8	9
2.0	0.020	0.025	0.030	0.040	0.050	0.060	0.080	0.100	0.120
3.0	0.030	0.040	0.050	0.060	0.080	0.100	0.120	0.150	0.180
4.0	0.040	0.050	0.060	0.080	0.100	0.120	0.150	0.180	0.200
5.0	0.045	0.055	0.065	0.085	0.110	0.135	0.165	0.190	0.220
6.0	0.050	0.060	0.080	0.100	0.120	0.150	0.180	0.200	0.250
8.0	0.060	0.080	0.100	0.120	0.150	0.200	0.250	0.300	0.350
10.0	0.080	0.100	0.120	0.150	0.200	0.250	0.300	0.350	0.400
12.0	0.080	0.100	0.120	0.150	0.200	0.250	0.300	0.400	0.500
16.0	0.100	0.120	0.150	0.200	0.250	0.300	0.400	0.500	0.600
20.0	0.150	0.200	0.250	0.300	0.400	0.500	0.600	0.700	0.800

Calculations

$$\text{RPM} = \frac{\text{Vc} \times 318}{Ø}$$

$$\text{Feedrate (mm/min)} = \text{RPM} \times f$$

Vc = m/min **Ø** = Dia. **f** = mm/rev

Example

Drilling Ø10mm, 40mm deep in P20 steel, using 122310 drill

Vc = = **65m/min**

RPM = $\frac{65 \times 318}{10}$ = **2067**

Feed No. = 7 (refer feed table) = 0.30mm/rev

Feedrate (mm/min) = 2067 x 0.30 = **620mm/min**

Sutton Tools

GARANT carbide high-performance drills

The use of carbide high-performance drills (Fig. 1) requires both high concentricity of the machine and rigid tool clamping, and also performance machine technology to achieve high feed rate values.

Fig. 1 Garant Carbide High Performance Drill

Example of application drilling through holes:

Material:	GG 25 (cast iron <240HB)	
	CS1045 (carbon steels)	
	hole diameter:	10.0 mm
	hole depth:	110 mm (11 x d_1)
Tool:	Carbide high-performance drill (123100 10)	
	For drilling up to 12 x d_1 in cast iron, spheroidal graphite iron, malleable cast iron, short-chipping as well as corrosion and acid resistant steels	

Cutting data:

	GG 25	**CS1045**
Cutting speed:	vc = 50 m/min	vc = 40 m/min
Speed:	n = 1600 rpm	n = 1200 rpm
Feed rate:	f = 0.2 mm/rev.	f = 0.2 mm/rev.
Feed rate speed:	vf = 320 mm/min	vf = 240 mm/min

Influences on the drilling result

The actual quality of the completed bore hole depends on various factors.
A **strong** influence on the hole tolerance is exerted by the **radial run-out** of the drill in the spindle. Fig. 2 shows the relationship between concentricity tolerance of the clamping holder and the life of the drilling tool.
A **medium** influence on the drilling result is exerted by the general machine condition as well as drill tip wear. On the other hand, the feed rate speed and the material only influence the bore hole tolerance very **slightly**.

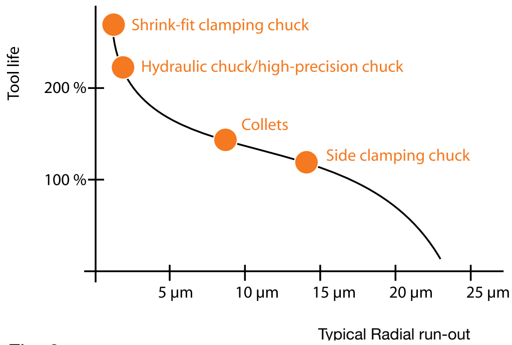
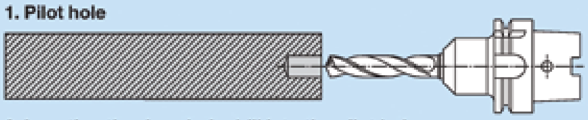


Fig. 2
Influence of the radial run-out on the life of the drill related to the clamping method

Garant **Use the deep hole drill correctly:** Information

1. Pilot hole

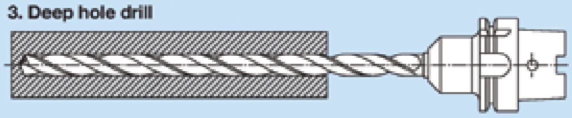


- Pilot drill must have the same diameter + 0.01 / + 0.03 as the deep hole drill.
- Minimum depth of pilot hole **3×D** (recommend 5×D).

2. Inserting the deep hole drill into the pilot hole

- At insertion, run at low speed (n = 300 rpm) and low feed rate (v_f = 400 mm/min)
- Shortly before reaching pilot hole depth, stop the feed and steadily increase the speed to cycle speed.

3. Deep hole drill

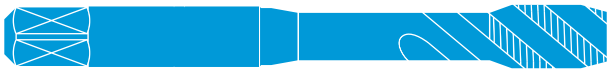


- Increase the feed to cycle feed rate.
- Drill to the desired depth without clearing the chips.

4. Withdrawing the drill

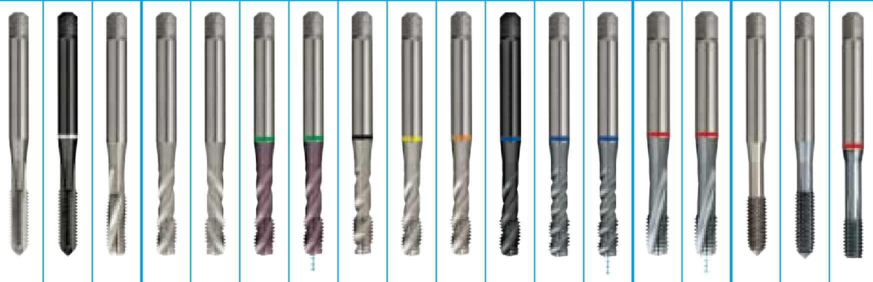
- Back out to about pilot hole depth
- Steadily reduce speed to about 300 rpm
- Withdraw from hole at normal rate of withdrawal (v_f = 1000 mm/min)
- For through holes, reduce feed rate by about 50 % when approaching break-through

Sutton Tools



FOR TAPPING BLIND HOLES

			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Thread Depth			≤1.5xØ	≤3xØ	≤1.5xØ	≤3xØ										≤1.5xØ		≤3xØ		
Discount Group			D0402			D0402	C10120/1	D0410		D0404	D0402	D0404	D0408	D0408		D0408		D0402	D0408	D0402
Material			HSSE V3			HSSE V3		PM-HSSE V3		HSSE V3	HSSE V3	HSSE V3	HSSE V3	PM-HSSE V3		PM-HSSE V3		HSSE V3		SPM
Surface Finish			Brt	St. Ox	Brt	Brt		TiAIN		Brt	Brt	CrN	St. Ox	TiCN		TiCN		Brt	TiCN	TiCN
Colour Ring & Application			General Purpose			General Purpose		UNI		Al	W	Cu	VA	VA PM		H		General Purpose		H
Geometry			-	Low Relief	15º Helix	40º Helix	40º Helix LH	40º Helix	40º Helix IK	45º Helix 2 Flute	45º Helix	45º Helix	45º Helix	50º Helix	50º Helix IK	15º Helix	15º Helix IK	No Groove	Multi-Coolant Groove	
Materials	**Material examples**	**Coolant**	**Vc (m/min)**			**Vc (m/min)**														
Steels																				
Free-cutting steel		S	6	-	6	6	6	12	15	-	15	-	10	12	15	-	-	5	8	10
Structural steels		S	6	-	6	6	6	12	15	-	15	-	10	12	15	-	-	5	8	10
Carbon steels	1020, 1024, 1045, 1060	S	6	-	6	6	6	12	15	-	15	-	10	12	15	-	-	-	-	10
Alloy steels 850 - 1200 N/mm²	4140, 01, A2, D3, M42, P20	S	4	-	4	4	4	10	12	-	12	-	8	10	12	8	8	-	-	5
Alloy steels hard./temp. 1200 - 1400 N/mm²	EN26, 01, L6, M42, D3, 4140	S	-	-	-	-	-	-	-	-	-	-	-	-	-	6	6	-	-	-
High tensile alloy steels		O	-	-	-	-	-	-	-	-	-	-	-	-	-	8	8	-	-	-
Stainless Steels																				
Free machining stainless steel	416, 430F	O	-	-	-	3	3	5	10	-	-	-	8	10	12	-	-	10	10	10
Austenitic stainless steels	303, 304, 316, 317, 321	O	-	-	-	3	3	3	8	-	-	-	5	8	10	-	-	8	8	10
Ferritic + martensitic < 1000 N/mm²	409, 430, 436, Duplex Alloys	O	-	-	-	3	3	3	5	-	-	-	-	-	-	5	5	-	-	6
Cast Irons																				
Cast iron ≤ 240 HB	GG10, GG20	S/A	15	15	10	10	10	20	20	-	-	-	-	-	-	-	-	-	-	-
Cast iron < 240 HB	GG25, GG40	S/A	10	10	8	8	8	15	15	-	-	-	-	-	-	-	-	-	-	-
Spheroidal graphite + Malleable cast iron	GGG50, GGG70	S	10	10	8	8	8	15	15	-	-	-	-	-	-	-	-	-	-	-
Titaniums																				
Titanium unalloyed	Ti99.8	O	-	-	-	-	-	-	-	-	-	-	-	-	-	8	8	-	-	-
Titanium alloys	TiA164V4, TiA155n2	O	-	-	-	-	-	-	-	-	-	-	-	-	-	6	6	-	-	-
Nickels																				
Nickel unalloyed	Nickel 200, Ni99.6	O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel alloys < 850 N/mm²	Monel 400, Hastelloy C, Inconel 600	O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel alloys 850 - 1150 N/mm²	Nimonic 80A Wasp alloy, Inconel 7 18	O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coppers																				
Copper unalloyed		S	8	-	-	-	-	-	-	8	5	15	-	-	-	-	-	20	20	-
Short chip brass + phosphor bronze + gun metal		S	6	-	-	8	8	10	12	-	-	-	-	-	-	12	12	-	-	10
Long chip brass		O	6	-	-	10	10	12	15	15	15	20	-	-	-	-	-	15	15	-
Aluminiums																				
Al / Mg unalloyed		S	10	-	10	15	15	18	25	40	25	30	-	30	30	-	-	30	30	-
Al alloyed Si < 5%		S	40	-	10	15	15	18	25	30	25	30	-	30	30	-	-	30	30	-
Al alloyed Si > 1.5% < 10%		S	7	-	8	10	10	12	20	10	20	25	-	25	25	-	-	15	15	-



Coolant
Oil - O
Soluble Oil - S
Air - A

Notes on Tapping

1. The speeds listed above are a recommendation only, and are based on depth of thread listed, speeds can be be adjusted on application. As a general rule;
   -If hole depth required is less than above mentioned = increase speed
   -If hole depth required is more than above mentioned = reduce speed
2. For coated tools, speeds may be increased by 20%
3. Taps must be driven by the square to eliminate slippage, eg, ER-GB collets (square drive)
4. When using spiral flute taps with length compensation tapping attachment, it is recommended to short pitch the feed 95%, to eliminate tap cutting oversize, eg. M6x1 @ 1000RPM, Feedrate= 950mm/min

* Denotes for use on fully computer controlled synchro machines, with rigid tapping holder

FOR TAPPING THROUGH HOLES

≤ 1.5xØ	≤ 3xØ	≤ 1.5xØ		≤ 3xØ												≤ 3xØ			
D0402	D0402	D0408		D0402		D0410		D0402	D0404	D0402	D0402	D0408		D0408	D0408/5	D0402	D0408	D0404	D0410
HSSE V3	HSSE V3	SPM	VHM	HSSE V3		PM-HSSE V3		HSSE V3		HSSE V3	HSSE V3	PM-HSSE		PM-HSSE	PM-HSSE	HSSE V3		HSSE V3	SPM
Brt	St. Ox	TiCN		Brt		TiAlN		Ni	CrN	Brt	St. Ox	TiCN		TiCN	TiCN	Brt	TiCN	CrN	TiCN
General Purpose		XH	VH	General Purpose		UNI		W	Cu		VA	VA PM		VADH	H	General Purpose		Cu	H
-	Low Relief	Special Relief		-	LH					Interrupted Threads						No Groove	Multi-Coolant Groove	Multi-Coolant Groove	Multi-Coolant Groove
				Vc (m/min)															
6	-	-	-	10	10	18	25	18	-	20	12	15	25	20	-	5	8	-	10
6	-	-	-	10	10	18	25	18	-	20	12	15	25	20	-	5	8	-	10
6	-	-	-	10	10	18	25	18	-	20	12	15	25	20	12	-	-	-	10
4	-	-	-	8	8	15	20	15	-	15	10	12	20	15	10	-	-	-	5
-	-	8	8	-	-	6	6	-	-	-	-	-	-	-	8	-	-	-	-
-	-	5	5	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-
-	-	-	-	3	3	12	12	-	-	8	10	12	12	12	-	10	10	-	10
-	-	-	-	3	3	10	10	-	-	8	8	10	10	10	-	8	8	-	10
-	-	-	-	3	3	8	8	-	-	5	-	-	-	-	8	-	-	-	6
15	15	-	-	15	15	25	20	-	-	-	-	-	-	-	-	-	-	-	-
10	10	-	-	10	10	18	15	-	-	-	-	-	-	-	-	-	-	-	-
10	10	-	-	10	10	18	15	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	8	15	10	-	-	-	-	-	20	20	40	-
6	-	10	10	12	12	15	18	-	-	-	-	-	-	-	18	-	-	-	10
6	-	-	-	15	15	18	20	18	20	20	-	-	-	-	-	15	15	20	-
10	-	-	-	18	18	30	30	30	30	35	-	30	35	35	-	30	30	40	-
10	-	-	-	18	18	30	30	30	30	35	-	30	35	35	-	30	30	40	-
7	7	-	-	15	15	25	25	25	25	30	-	25	30	30	15	15	15	20	20

Calculations

$$RPM = \frac{Vc \times 318}{Ø}$$

$$Feedrate\ (mm/min) = RPM \times Thread\ Pitch$$

Vc = m/min **Ø** = Dia.

Example

Tapping M6x1,18mm deep blind hole, in 4140 (annealed) steel, using R40 UNI spiral flute tap, with length compensation tapping attachment.

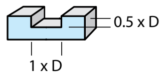
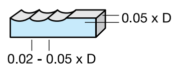
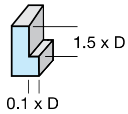
Vc = = 10m/min

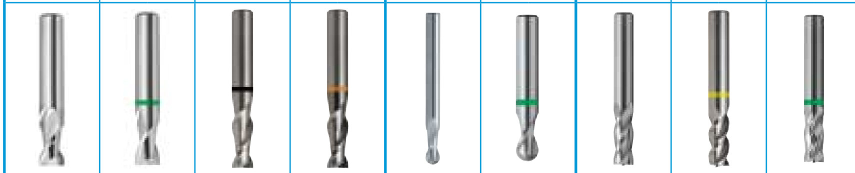
RPM = $\frac{10 \times 318}{6}$ = **530**

Feedrate (mm/min) = 530 x 1mm Pitch = 530mm/min

Short pitching allowance (length compensation attachment) = 530 x 0.95 = **503mm/min**

Sutton Tools

			SLOTTING								PROFILING				FINISHING					
																				
Discount Group			B0502		B0610		B0402		B0602		B0502		B0610		B0502		B0610		B0610	
Material			HSS Co.8		SPM		HSS Co		HSS Co		HSS Co.8		SPM		HSS Co.8		SPM		SPM	
Surface Finish			Brt		Brt		Brt		CrN		Brt		Brt		Brt		Brt		Brt	
Colour Ring & Application			General Purpose		UNI		Al		Cu		General Purpose		UNI		General Purpose		W		UNI	
Geometry			30º Helix		30º Helix		40º Helix		40º Helix		30º Helix		30º Helix		30º Helix		45º Helix		Unequal	
Materials	**Material examples**	**Coolant**	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #
Steels																				
Free-cutting steel	S1214L, Leaded Steels	S	30	6	40	6	-	-	-	-	45	5	80	6	35	5	96	7	40	6
Structural steels		S	30	6	40	6	-	-	-	-	45	5	80	6	35	5	96	7	40	6
Carbon steels	1020, 1024, 1045, 1060	S	25	5	35	5	-	-	-	-	40	4	70	5	30	4	84	6	35	5
Alloy steels 850 - 1200 N/mm²	4140, 01, A2, D3, M42	S	20	5	25	5	-	-	-	-	20	4	35	5	22	4	-	-	25	5
Alloy steels hard./temp. 1200 - 1600 N/mm²	EN26, 01, L6, M42, D3, 4140	S	-	-	20	4	-	-	-	-	17	3	30	4	17	3	-	-	20	4
High tensile alloy steels		O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stainless Steels																				
Free machining stainless steel	416, 430F	O	15	5	20	5	-	-	-	-	20	4	35	5	17	4	-	-	20	5
Austenitic stainless steels	303, 304, 316, 317,321	O	12	3	15	3	-	-	-	-	17	2	30	3	13	2	-	-	15	3
Ferritic + martensitic < 1000 N/mm²	409, 430, 436, Duplex Alloys	O	10	4	12	4	-	-	-	-	14	4	25	4	10	3	-	-	12	4
Cast Irons																				
Cast iron ≤ 240 HB	GG10, GG20	S,A	30	5	40	5	-	-	-	-	40	4	70	5	35	4	-	-	40	5
Cast iron < 240 HB	GG25, GG40	S,A	25	4	30	4	-	-	-	-	28	3	50	4	25	3	-	-	30	4
Spheroidal graphite + Malleable cast iron	GGG50, GGG70	S	20	3	25	3	-	-	-	-	23	2	40	3	22	2	-	-	25	3
Titaniums																				
Titanium unalloyed	Ti99.8	O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Titanium alloys	TiA164V4, TiA155n2	O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickels																				
Nickel unalloyed	Nickel 200, Ni99.6	O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel alloys < 850 N/mm²	Monel 400, Hastelloy C, Inconel 600	O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel alloys 850 - 1150 N/mm²	Nimonic 80A Waspalloy, Inconel 718	O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coppers																				
Copper unalloyed		S	50	6	60	6	72	6	86	6	50	6	60	6	70	6	72	8	80	6
Short chip brass + phosphor bronze + gun metal		S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Long chip brass		O	25	5	30	5	48	5	58	5	25	5	30	5	40	5	48	7	50	5
Aluminiums																				
Al / Mg unalloyed		S	70	6	80	6	96	6	115	6	85	6	150	6	70	6	96	7	80	6
Al alloyed Si < 5%		S	60	5	70	5	84	5	101	5	70	6	120	6	60	6	84	7	70	6
Al alloyed Si > 1.5% < 10%		S	50	5	60	5	72	5	86	5	60	5	100	5	55	5	72	6	60	5
Al alloyed Si > 10%, Mg - Alloys		S	30	6	40	6	48	6	48	6	-	-	-	-	-	-	-	-	-	-



Coolant
Oil - O
Soluble Oil - S
Air - A

Notes on Milling

1. Above values are guidelines for the size and type of cut nominated.
2. For coated tools, speeds may be increased by 20%.
3. For long series tools, reduce speed by 40% and feed by 20%.

Calculations

RPM = $\frac{Vc \times 318}{Ø}$

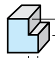
Feedrate (mm/min) = **RPM x f x Z**

Vc = m/min **Ø** = Dia. **f** = mm/tooth
Z = No. of teeth

Example

Slotting Ø10mm, 5mm deep in 1020 steel, using S2 type R30 UNI Endmill (2 flutes)

Vc	=		= 42m/min
RPM	=	$\frac{42 \times 318}{10}$	= **1335**
Feed No.	=	5 (refer feed table)	= 0.024mm/tooth
Feedrate (mm/min)	=	1335 x 0.024 x 2	= **64mm/min**

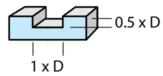
FINISHING		ROUGHING															
		 1.5 x D / 0.5 x D															
B0610		B0402		B0402		B0610		B0610		B0610		B0610		B0610		B0610	
SPM		HSS Co.8				SPM		SPM		SPM		SPM		SPM		SPM	
TiAlN		Brt		Brt		Brt		TiAlN		Brt		TiAlN		TiAlN		TiAlN	
VA		General Purpose				W		VA		Ti		UNI		UNI		H	
50º Helix		25º Helix (Coarse Pitch)		25º Helix (Fine Pitch)		30º Helix (Coarse Pitch)		55º Helix		30º Helix		30º Helix (Coarse Pitch)		30º Helix (Fine Pitch)		30º Helix (Fine Pitch)	
Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #
70	7	36	5	-	-	-	-	-	-	-	-	40	5	70	9	-	-
70	7	36	5	-	-	-	-	-	-	-	-	40	5	70	9	-	-
62	6	32	4	38	3	-	-	-	-	-	-	35	4	60	8	-	-
40	6	20	4	25	3	-	-	15	4	-	-	30	4	40	7	40	4
-	-	-	-	25	2	-	-	-	-	-	-	25	2	30	7	30	2
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	6
30	6	-	-	30	4	-	-	30	6	-	-	-	-	35	4	-	-
25	4	-	-	20	2	-	-	20	6	-	-	-	-	25	2	-	-
20	5	-	-	15	3	-	-	20	6	-	-	-	-	20	3	25	6
-	-	45	8	50	8	-	-	-	-	-	-	-	-	60	8	-	-
-	-	25	8	30	8	-	-	-	-	-	-	-	-	40	8	60	6
-	-	18	8	20	8	-	-	-	-	-	-	-	-	25	8	-	-
-	-	-	-	-	-	-	-	-	-	32	9	-	-	-	-	30	5
-	-	-	-	-	-	-	-	-	-	20	9	-	-	-	-	15	4
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	5
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	4
-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-	15	4
-	-	-	-	-	-	58	8	49	7	-	-	55	7	-	-	-	-
-	-	-	-	25	5	-	-	-	-	-	-	-	-	-	-	30	6
-	-	-	-	-	-	38	8	33	7	-	-	37	7	-	-	-	-
100	7	80	9	-	-	77	6	52	5	-	-	70	5	120	9	-	-
90	7	80	9	-	-	67	6	48	5	-	-	65	5	120	9	-	-
80	6	55	8	-	-	58	5	40	4	-	-	55	4	80	8	-	-
-	-	-	-	-	-	40	7	-	-	-	-	38	6	-	-	-	-

Feed Table (f)

Mill Ømm	Feed No. (mm/tooth)															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2.0	0.001	0.001	0.001	0.002	0.002	0.004	0.005	0.006	0.007	0.008	0.010	0.012	0.014	0.016	0.018	0.020
3.0	0.002	0.002	0.003	0.003	0.004	0.007	0.010	0.010	0.010	0.012	0.015	0.017	0.019	0.022	0.024	0.027
5.0	0.005	0.006	0.007	0.009	0.010	0.014	0.020	0.020	0.022	0.025	0.026	0.026	0.028	0.030	0.032	0.038
6.0	0.006	0.008	0.009	0.011	0.013	0.017	0.020	0.024	0.027	0.029	0.031	0.033	0.035	0.036	0.039	0.043
8.0	0.010	0.012	0.014	0.016	0.019	0.024	0.029	0.032	0.034	0.036	0.038	0.041	0.045	0.048	0.052	0.063
10.0	0.013	0.015	0.018	0.021	0.024	0.030	0.036	0.039	0.044	0.049	0.053	0.058	0.063	0.067	0.071	0.075
12.0	0.016	0.018	0.022	0.026	0.030	0.036	0.046	0.048	0.052	0.059	0.063	0.072	0.079	0.085	0.090	0.100
16.0	0.020	0.023	0.027	0.031	0.038	0.045	0.052	0.059	0.063	0.071	0.079	0.087	0.095	0.100	0.110	0.120
20.0	0.022	0.028	0.033	0.038	0.045	0.056	0.065	0.073	0.080	0.090	0.096	0.100	0.110	0.120	0.130	0.140

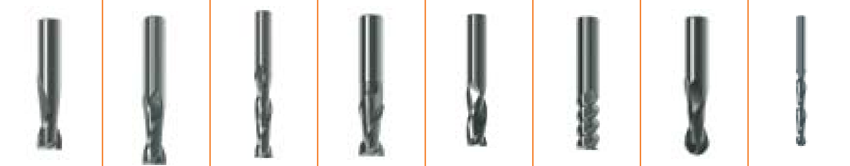
Sutton Tools

SLOTTING



Cutting Depth	0.5 x D							
Discount Group	B0202	B0202	B0202	B0202	B0202	B0202	B0202	B0202
Type	Slot drill	Slot drill	Slot drill	AlCarb	Unimill	Hi-Helix Unimill	Ballnose	Ballnose
Length	Stub	Regular	Long	Regular	Regular	Regular	Regular	Long
No. of Flutes	2	2	2	2	3	3	2	2
Geometry	30° Helix	30° Helix	30° Helix	40° Helix	30° Helix	60° Helix	30° Helix	30° Helix

Coolant
Oil - O
Soluble Oil - S
Air - A



Materials	Material examples	Coolant	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #
Steels																		
Free-cutting steel	S1214L, Leaded Steels	S	70-90	8	60-80	8	30-50	7	-	-	60-80	8	90-110	10	60-80	8	35-45	7
Structural steels		S	50-70	8	45-55	8	25-35	7	-	-	45-55	8	70-80	10	45-55	8	25-35	7
Carbon steels	1020, 1024, 1045, 1060	S	30-50	8	30-40	8	20-30	7	-	-	35-45	8	35-45	10	35-45	8	20-30	7
Alloy steels 850 - 1200 N/mm^2	4140, 01, A2, D3, M42	S	22-32	4	20-30	4	15-25	3	-	-	25-35	4	25-35	8	25-35	4	15-25	3
Alloy steels hard./temp. 1200 - 1600 N/mm^2	EN26, 01, L6, M42, D3, 4140	S	10-20	3	10-20	3	5-15	2	-	-	10-20	3	10-20	6	10-20	3	5-15	2
Hardened materials 46-54Rc	4140, 01, A2, D3, M42	S	-	-	-	-	-	-	-	-	-	-	10-20	3	-	-	-	-
Hardened materials 54-62Rc	4140, 01, A2, D3, M42	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
High tensile alloy steels		O	10-20	3	10-20	3	5-15	2	-	-	10-20	3	10-20	6	10-20	3	5-15	2
Stainless Steels																		
Free machining stainless steel	416, 430F	O	30-40	4	25-35	4	15-25	3	-	-	25-35	4	40-50	8	25-35	4	15-25	3
Austenitic stainless steels	303, 304, 316, 317,321	O	25-35	4	20-30	4	10-20	3	-	-	20-30	4	35-45	8	20-30	4	10-20	3
Ferritic + martensitic < 1000 N/mm^2	409, 430, 436, Duplex Alloys	O	15-25	3	15-25	3	5-15	2	-	-	15-25	3	25-35	6	15-25	3	5-15	2
Cast Irons																		
Cast iron ≤ 240 HB	GG10, GG20	S,A	70-80	14	65-75	14	35-45	13	-	-	65-75	14	-	-	65-75	14	35-45	13
Cast iron < 240 HB	GG25, GG40	S,A	50-60	10	45-55	10	25-35	9	-	-	45-55	10	-	-	45-55	10	25-35	9
Spheroidal graphite + Malleable cast iron	GGG50, GGG70	S	85-95	8	75-85	8	45-55	7	-	-	75-85	8	-	-	75-85	8	45-55	7
Titaniums																		
Titanium unalloyed	Ti99.8	O	40-50	8	35-45	8	20-30	7	-	-	35-45	8	45-55	8	35-45	8	20-30	7
Titanium alloys	TiA164V4, TiA155n2	O	30-40	4	25-35	4	15-25	3	-	-	25-35	4	30-40	4	25-35	4	15-25	3
Nickels																		
Nickel unalloyed	Nickel 200, Ni99.6	O	40-50	6	35-45	6	20-30	5	-	-	35-45	6	45-55	6	35-45	6	20-30	5
Nickel alloys < 850 N/mm^2	Monel 400, Hastelloy C, Inconel 600	O	30-40	4	25-35	4	15-25	3	-	-	25-35	4	30-40	4	25-35	4	15-25	3
Nickel alloys 850 - 1150 N/mm^2	Nimonic 80A Waspalloy, Inconel 718	O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coppers																		
Copper unalloyed		S	120-140	10	110-130	10	60-80	9	110-130	14	110-130	10	-	-	110-130	9	60-80	8
Short chip brass + phosphor bronze + gun metal		S	80-100	8	70-90	8	40-60	7	-	-	70-90	8	-	-	70-90	8	40-60	7
Long chip brass		O	100-120	10	90-110	10	50-70	9	90-110	13	90-110	10	-	-	90-110	9	50-70	8
Aluminiums																		
Al / Mg unalloyed		S	90-110	10	70-90	10	60-80	9	110-130	14	70-90	10	-	-	70-90	9	60-80	8
Al alloyed Si < 5%		S	80-100	10	70-90	10	60-80	9	100-120	14	70-90	10	-	-	70-90	9	60-80	8
Al alloyed Si > 1.5% < 10%		S	70-90	10	60-80	10	50-70	9	90-110	13	60-80	10	-	-	60-80	8	50-70	7
Al alloyed Si > 10%, Mg - Alloys		S	50-70	10	50-70	10	40-60	9	70-90	13	50-70	10	-	-	50-70	8	40-60	7

Notes on Tapping

1. Above speeds & feeds are a guide only, based on type of cut illustrated
2. Above speeds & feeds are based on UNCOATED tools
3. For COATED tools, speeds may be increased

Calculations

$$RPM = \frac{Vc \times 318}{Ø}$$

$$\text{Feedrate (mm/min)} = RPM \times f \times Z$$

Vc = m/min **Ø** = Dia. **f** = mm/tooth
Z = No. of teeth

Example

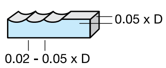
Finishing cut in 1020 steel, using Ø10mm dia. 4 flute endmill, regular length, uncoated depth = 15mm width = 1mm

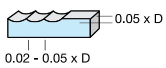
Vc = = 45m/min

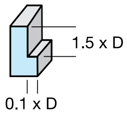
RPM = $\frac{45 \times 318}{10}$ = 1431

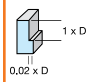
Feed No. = 9 (refer feed table) = 0.044mm/tooth

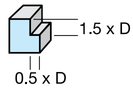
Feedrate (mm/min) = 1431 x 0.044 x 4 = 252mm/min

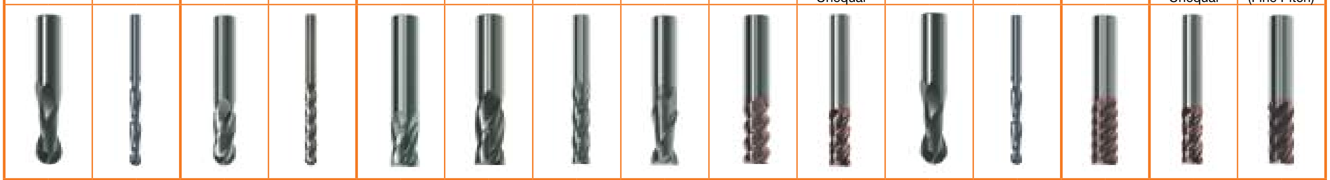












PROFILING				PROFILING				FINISHING																SUPER		ROUGHING			
0.05 x D				1 x D				1.5 x D																1 x D		1.5 x D			
B0202		B0202		B0202		B0202		B0202		B0202		B0202		B0202		B0204		B0206		B0202		B0202		B0204		B0206		B0206	
Ballnose		Ballnose		Ballnose		Ballnose		Endmill		Endmill		Endmill		AlCarb		Hi-Helix Unimill		Semi Rougher		Ballnose		Ballnose		Rocket Mill		Semi Rougher		Rougher	
Regular		Long		Regular		Long		Stub		Regular		Long		Regular		Regular		Regular		Regular		Long		Regular		Regular		Regular	
2		2		4		4		4		4		4		2		3		4		4		4		4/6		4		3/4/5/6	
30° Helix		30° Helix		30° Helix		30° Helix		30° Helix		30° Helix		30° Helix		40° Helix		60° Helix		45° Helix Unequal		30° Helix		30° Helix		50° Helix		45° Helix Unequal		45° Helix (Fine Pitch)	
Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #	Vc (m/min)	Feed #
160-180	10	90-110	9	160-180	10	90-110	9	70-90	9	60-80	9	35-45	8	-	-	70-90	10	80-100	10	60-80	9	35-45	8	-	-	80-100	6	120-140	6
150-170	10	90-110	9	150-170	10	90-110	9	50-60	9	45-55	9	25-35	8	-	-	50-70	10	60-80	10	45-55	9	25-35	8	-	-	60-80	6	80-100	6
140-160	10	80-100	9	140-160	10	85-95	9	40-50	9	35-45	9	20-30	8	-	-	45-55	10	45-55	10	35-45	9	20-30	8	110-130	15	45-55	6	65-75	6
130-150	9	70-90	8	130-150	9	80-90	8	30-40	5	25-35	5	15-25	4	-	-	30-40	6	35-45	6	25-35	5	15-25	4	90-110	14	35-45	4	50-60	4
45-55	9	25-35	8	45-55	9	25-35	8	15-25	4	10-20	4	5-15	3	-	-	15-25	5	15-25	5	10-20	4	5-15	3	75-85	14	15-25	3	30-40	3
-	-	-	-	-	-	-	-	10-20	4	10-20	4	5-15	3	-	-	10-20	5	10-20	5	10-20	4	5-15	3	30-40	8	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15-25	7	-	-	-	-
45-55	9	25-35	8	45-55	9	25-35	8	15-25	4	10-20	4	5-15	3	-	-	15-25	5	15-25	5	10-20	4	5-15	3	30-40	8	15-25	3	25-35	3
65-75	5	35-45	4	65-75	5	35-45	4	30-40	5	25-35	5	15-25	4	-	-	30-40	6	35-45	6	25-35	5	15-25	4	-	-	35-45	4	50-60	4
55-65	5	30-40	4	55-65	5	30-40	4	25-35	5	20-30	5	10-20	4	-	-	25-35	6	30-40	6	20-30	5	10-20	4	-	-	30-40	4	40-50	4
45-55	5	25-35	4	45-55	5	25-35	4	15-25	4	15-25	4	5-15	3	-	-	20-30	5	20-30	5	15-25	4	5-15	3	15-25	7	20-30	3	30-40	3
150-170	14	90-110	13	150-170	14	90-110	13	70-90	15	65-75	15	35-45	14	-	-	-	-	-	-	65-75	15	35-45	14	115-125	15	-		95-105	
90-110	12	50-70	11	90-110	12	50-70	11	50-70	11	45-55	11	25-35	10	-	-	-	-	-	-	45-55	11	25-35	10	95-105	15	-		65-75	
170-190	13	100-120	12	170-190	13	100-120	12	80-100	9	75-85	9	45-55	8	-	-	-	-	-	-	75-85	9	45-55	8	85-95	15	-		105-115	
75-85	7	45-55	6	75-85	7	45-55	6	40-50	9	35-45	9	20-30	8	-	-	45-55	10	45-55	10	35-45	9	20-30	8	65-75	14	45-55	6	50-60	6
60-70	4	35-45	3	60-70	4	35-45	3	30-40	5	25-35	5	15-25	4	-	-	30-40	6	35-45	6	25-35	5	15-25	4	45-55	15	35-45	4	35-45	4
65-75	5	35-45	4	65-75	5	35-45	4	40-50	7	35-45	7	20-30	6	-	-	45-55	8	45-55	8	35-45	7	20-30	6	45-55	7	45-55	6	50-60	6
55-65	5	30-40	4	55-65	5	30-40	4	30-40	5	25-35	5	15-25	4	-	-	30-40	6	35-45	6	25-35	5	15-25	4	25-35	7	35-45	4	35-45	4
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25-35	6	30-40	6	-	-	-	-	15-25	7	30-40	4	30-40	4
220-270	12	130-150	11	220-270	12	130-150	11	120-140	11	110-130	11	60-80	10	120-140	15	130-150	12	150-170	12	110-130	11	60-80	10	-	-	150-170	8	160-180	8
140-190	10	90-110	9	140-190	10	90-110	9	70-90	9	70-90	9	40-60	8	-	-	90-110	10	90-110	10	70-90	9	40-60	8	-	-	90-110	6	100-120	6
180-230	12	110-130	11	180-230	12	110-130	11	100-120	11	90-110	11	50-70	10	100-120	14	110-130	12	120-140	12	90-110	11	50-70	10	-	-	120-140	8	130-150	8
220-270	13	130-150	12	220-270	13	130-150	12	120-140	11	110-130	11	60-80	10	120-140	15	130-150	12	150-170	12	110-130	11	60-80	10	-	-	150-170	8	160-180	8
200-250	13	120-140	12	200-250	13	120-140	12	110-130	11	100-120	11	60-80	10	110-130	15	120-140	12	130-150	12	100-120	11	60-80	10	-	-	130-150	8	140-160	8
180-230	12	110-130	11	180-230	12	110-130	11	100-120	11	90-110	11	50-70	10	100-120	14	110-130	12	120-140	12	90-110	11	50-70	10	-	-	120-140	8	130-150	8
140-190	11	90-110	10	140-190	11	90-110	10	80-100	11	70-90	11	40-60	10	80-100	14	90-110	12	90-110	12	70-90	11	40-60	10	-	-	90-110	8	100-120	8

Feed Table (f)

Mill Ømm	Feed No. (mm/tooth)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2	0.001	0.001	0.001	0.002	0.002	0.004	0.005	0.006	0.007	0.008	0.010	0.012	0.014	0.016	0.03
3	0.002	0.002	0.003	0.003	0.004	0.007	0.010	0.010	0.010	0.012	0.015	0.017	0.019	0.022	0.04
5	0.005	0.006	0.007	0.009	0.010	0.014	0.020	0.020	0.022	0.025	0.026	0.026	0.028	0.030	0.06
6	0.006	0.008	0.009	0.011	0.013	0.017	0.020	0.024	0.027	0.029	0.031	0.033	0.035	0.036	0.07
8	0.010	0.012	0.014	0.016	0.019	0.024	0.029	0.032	0.034	0.036	0.038	0.041	0.045	0.048	08
10	0.013	0.015	0.018	0.021	0.024	0.030	0.036	0.039	0.044	0.049	0.053	0.058	0.063	0.067	0.12
12	0.016	0.018	0.022	0.026	0.030	0.036	0.046	0.048	0.052	0.059	0.063	0.072	0.079	0.085	0.15
16	0.020	0.023	0.027	0.031	0.038	0.045	0.052	0.059	0.063	0.071	0.079	0.087	0.095	0.100	0.18
20	0.022	0.028	0.033	0.038	0.045	0.056	0.065	0.073	0.080	0.090	0.096	0.100	0.110	0.120	0.21

Sutton Tools

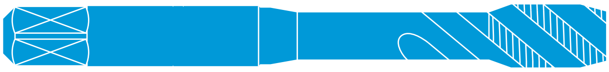
Code	Problem
1	Breaking of drill
2	Outer corner breaks down
3	Cutting edges chip
4	Lands chip
5	Drill splits up centre
6	Drill will not enter work
7	Hole rough
8	Hole oversize
9	Tang Breaks

1	2	3	4	5	6	7	8	9	Solution
●					●	●			Dull point
●									Drill has front taper due to wearing
●				●	●				Insufficient lip clearance on point
●		●							Lip clearance too great
●									Drill in incorrectly point ground
●	●								Flutes clogged with chips
●									Spring or backlash in drill press, fixture or work
●		●		●		●			Feed too heavy
	●								Cutting speed too high
	●					●			Dry cutting, no lubricant at cutting edges
	●								Hard spots in workpiece material
			●						Oversize jig bushing
					●				Drill web (core) diameter too big
						●			Fixture/Clamping not rigid
							●		Unequal angle or Uneven length of cutting edges
							●		Spindle run-out/Loose spindle
								●	Bad fit between shank taper & socket. The drive & alignment is controlled by the taper fit.

Sutton Tools

Code	Problem
1	Chisel point wear
2	Major cutting edge wear
3	Cutting edge wear
4	Chamfered edge wear
5	Cutter breakout
6	Tip breakout
7	Chip congestion on drill spine
8	Tool breaking
9	Rattling or similar noises
10	Chip congestion
11	Workpiece hardening
12	Fluctuating accuracy
13	Burr formation at the drill hole exit

1	2	3	4	5	6	7	8	9	10	11	12	13	Sollution
●													The clearance angle at the drill centre should be greater than the relief (Feed rate)
●			●	●			●	●			●		Flute length as short as possible
	●												Enlargement of the clearance angle at the outer cutting edges
	●	●	●		●								Sharpen more frequently
						●							Enlarging the point angle
			●	●		●	●					●	The cutting edge difference should be a maximum of 0.02 mm
				●							●		The edge prep should be greater
				●									Clearance angle should be smaller
						●	●		●				Extension of the groove width
						●							Smaller point diameter
						●							Smaller flute helix
			●	●	●		●	●	●	●			Greater tapering and smaller chamfered edge width
												●	Smaller edge preperation
●	●	●		●	●	●	●	●			●	●	Lower feed rate
	●				●	●		●	●		●		Lower cutting speed
									●				Greater feed rate



Code	Problem
1	Thread is oversize
2	Axial miscutting of thread
3	Thread is undersize
4	Thread has bellmouthed entry
5	Thread surface is rough and unclean
6	Low tool life
7	Partial or complete tap breakage on FORWARD or BACKWARD movement

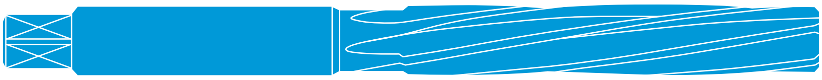
1	2	3	4	5	6	7	Possible reason	Solution
●		●	●	●	●	●	Wrong tap, cutting geometry of the tap is not suitable for this operation	Use correct tap for the material group (see Expert Tool System, at www.sutton.com.au)
●				●	●		Tap hole diameter is undersize	Tap hole diameter should be in accordance to DIN336 or respective standard. For cold forming taps, a special hole diameter is needed.
●			●			●	Misalignment - tap hole position, or angle is not correct	a) check workpiece clamping b) check machine settings
●							The axial machine spindle movement is not free and easy	a) use mechanical feed b) use tap holder with length compensation
●							Cold welding on the thread flanks of the tap	a) use a new tap b) improve and check lubrication c) remove cold welding area from tap d) use tap with surface treatment or coatings
●							Poor guidance of the tap because of little thread depth	a) use mechanical feed b) use tap that has better guiding characteristics
●				●	●		Speed is too high	a) improve lubrication b) lower speed
●				●	●		Chip clogging	a) use tap with different flute form b) use coated taps c) use tap set
●				●	●		The lubrication wrong, additives or the coolant supply is not sufficient	Make sure that the coolant is correct and that the supply is sufficient
	●						Spiral fluted taps are over pressured in the initial cutting phase (retracting pulling force)	Spiral fluted taps should only be lightly pushed into the tap hole until it begins to cut. The tap holder should immediately begin to apply tension to the tap.
	●						Spiral pointed taps (gun taps) are not receiving enough pressure in the initial cutting phase	Spiral pointed taps and even left hand spiral flute taps must have a stronger pressure until they begin to cut. The tap holder should immediately begin to apply pressure to the tap (pushing force)
●		●					Tolerance on the tap is not identical to the tolerance on the drawing or on the gauge	Use a tap which has a correct tolerance
			●				Wrong initial cutting pressure has been used or the machine spindle is not moving along its axis free and easy	a) use mechanical feed b) use tap holder with length compensation
				●	●		Tap is over loaded, either from coarse pitch and/or tough material	Use set of taps
					●		Cold welding, material build-up (pick-up)	a) improve coolant supply, use taps with surface treatments or coatings b) check if surface treatment is correct for this application
					●	●	Hardened walls in drilled hole	a) use drill best suited to material being drilled b) use new drill or boring tool c) resharpen drilling or boring tools d) if possible, heat treatment and coatings should only be made after threading
						●	Over loading of teeth in the chamfer area	a) use a longer chamfer (check if the tap hole is blind hole or through) b) use increased number of teeth in the chamfer area by selecting tap with increased number of flutes
						●	Tap hole chamfer is missing or wrong	countersink tap hole chamfer with correct angle
						●	Tap crashed against the bottom of tap hole	Use tap holder with length compensation and over load clutch

Sutton Tools

Code	Problem	Possible reason
1	Poor Workpiece Finish	Cutting edge wear, cutter radial run-out
2	Splintering of workpiece edge	Unsuitable cutting conditions, unsuitable shape of cutting edge
3	Non-parallel or uneven surface	Low stiffness of the cutter or of the workpiece (loose)
4	Extreme flank wear	Unsuitable cutting conditions, unsuitable shape of cutting edge
5	Extreme crater wear	
6	Breaks and shelling due to thermal shock	
7	Formation of built-up edges	
8	Poor chip clearance, chip blockage	
9	Lack of Rigidity	Difficult cutting conditions, clamping of the workpiece
10	End mill cutter breaks	Unsuitable cutting conditions, flute length of the cutter

1	2	3	4	5	6	7	8	9	10	Solution
●						●	●			Increase cutting speed
			●	●				●		Reduce cutting speed
						●	●			Increase feed rate
●	●	●		●	●		●	●	●	Reduce feed rate
●	●	●		●	●			●	●	Reduce cutting depth
							●	●	●	Change cutter diameter and cut width
●			●	●		●	●			Check use of cooling lubricant, flush swarf away
	●	●	●	●	●	●	●	●		Increase clearance angle (Radial relief)
	●			●	●					Increase wedge angle (Rake angle)
	●									Increase number of teeth
		●					●	●	●	Reduce number of teeth
							●			Select larger chip space (Cutter)
●	●	●	●		●					Change shape of minor cutting edge
		●			●					Cutter - change radial run-out
	●	●			●			●	●	Change cutter stiffness, flue length (l/D ratio)
	●	●			●			●		Select machine with higher power and stiffness

Application Guide Trouble Shooter - Reamers



Code	Problem
1	Breakage
2	Excessive wear
3	Chattering
4	Poor surface Finish

1	2	3	4	Possible reason	Solution
●		●		Dirt or burrs in spindle or socket in which reamer is held	clean spindle
●	●			Misalignment of two or more parts of the set-up. This condition can cause a bell-mouthed hole	align holes or use bridge style reamer
●	●	●	●	Too fast or too slow speeds.	adjust
●	●	●	●	Too much or too little feed.	adjust
	●			Wrong type of coolant.	refer to lubricant supplier's literature
●				No lubricant between guide bushing and reamer.	apply
	●		●	Lack of lubricant.	increase
●				Bottoming in blind holes.	reduce depth travel of reamer
		●		Lack of sufficient stock to ream.	drill smaller hole
●	●		●	Too much stock to ream.	drill larger hole
●		●		Entering work too fast.	slow down the approach feed, until all cutting edges are located in the hole
●	●	●	●	Badly drilled holes – too rough, tapered or bell-mouthed. Bell-mouthed holes may cause the reamer to wedge rather than cut.	replace drill
●		●		Oversize or undersize bushings.	Use suitable bush
●		●		Lack of rigidity in machine or work holder.	improve rigidity
●	●		●	Improperly designed reamer for the job.	

Sutton Tools

Recommended Cutting Speeds (RPM) - Standard Length Burs

Diameter	Double Cut		Aluminium Cut	Max RPM
	Steels, alloys & non-ferrous	Stainless Steel	Aluminium	
1/16	33,000	50,000	-	78,000
3/32	26,000	40,000	-	60,000
1/8	23,000	35,000	-	53,000
3/16	17,000	25,000	-	38,000
1/4	15,000	22,000	30,000	33,000
5/16	13,000	20,000	25,000	30,000
3/8	12,000	18,000	20,000	27,000
7/16	11,500	17,000	18,000	26,000
1/2	11,000	16,000	15,000	24,000
5/8	10,000	15,000	12,000	23,000
3/4	9,000	14,000	10,000	21,000
7/8	8,500	13,000	-	20,000
1	8,000	12,000	-	18,000

Note: Recommend reduce speeds by 50% when using long shank carbide burs.

Safety Tips

- Eye protection must be worn at and around bur application
- For use in air & electric die grinders, do not use in conventional electric drills as insufficient speed can cause breakage.
- Chuck carbide bur to full capacity of machine chuck.
- Do not use driving tool with worn bearings.
- Endeavour to use double cut wherever possible as standard cut can produce harmful slivers.

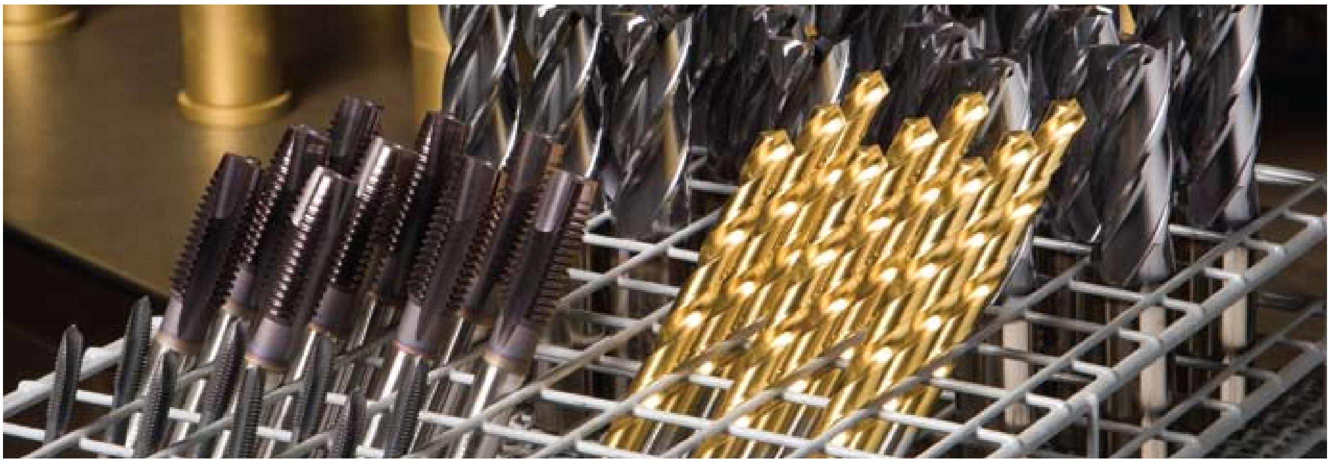
Hints for Use

- Position bur in drive as close as possible to head of collet.
- Allow tool to do its own cutting – do not force the cut or use excessive pressure.
- Allow tool to be running at full speed before making contact with the work piece.
- To prevent loading on aluminium burs – coat bur with bees wax or oven cleaner before use.
- If sparks are evident in use, either bur is dull and should be replaced or material is too hard.

Sutton Tools

Trade Name	Coating	Coating Structure	Coating Thickness	Micro-hardness	Coeff. of Friction vs Steel	Thermal Stability	Colour	Application & Benefits
Brt	-	-	-	-	0.8 - 1.0	-	-	• Non-ferrous metals and plastics
St. Ox	Steam Oxide	-	-	-	0.8 - 1.0	-	Blue - Black	• Ferrous metals e.g. HSS • Prevents chip build-up on the cutting edges • Cutting sticky ferrous materials • Increased corrosion resistance
Ni	Plasma Nitride	-	-	-	0.8 - 1.0	-	-	• Abrasive materials - cast iron and aluminium alloys
Futura Nano (TiAlN)	TiAlN	Nano Layer	4 µm	3300 HV	0.3 - 0.35	up to 900°C	Violet - Grey	• Abrasive materials - cast iron and heat treated steel • Difficult to machine materials, such as stainless steel • Higher speeds and feeds • Reduces or eliminates use of coolants
Alcrona	AlCrN	Mono Layer	4 µm	3200 HV	0.35	up to 1,100°C	Blue - Grey	• Low alloy steels and high tensile steels • Hardened steels up to 54 HRC • Ideal for carbide endmills
TiCN	TiCN	Gradient Coating	2 - 4 µm	3000 HV	0.4	up to 400°C	Blue - Grey	• High performance applications • Difficult to machine materials • Abrasive materials - cast iron and aluminium alloys • Adhesive materials - copper and copper based alloys
TiN	TiN	Mono Layer	1-3 µm	2300 HV	0.4	up to 600°C	Gold - Yellow	• General purpose use • Wide range of materials • 3 to 8 times longer tool life than uncoated tools • Higher tool speeds and feeds than uncoated tools
CrN	CrN	Gradient Coating	3 - 5 µm	1750 HV	0.5	up to 700°C	Silver - Grey	• Cutting and forming of copper, nickel, & monel metal • Enhanced thermal stability and oxidation resistance • Excellent corrosion resistance • Low internal stress of coating results in excellent adhesion under high loads

Latest advances in thin film coatings to optimise your machining application



Sutton Tools

Abbreviations	Type	Application	Description
HSS	Conventional high speed steel	Standard tool material for most common applications	Used for the manufacturing of cutting tools such as twist drills, end mills and taps. Yields consistent hardness levels following heat treatment providing for a reputable tool life.
HSS Co	5% cobalt grade of high speed steel	High-heat resistance, especially suited for roughing or when coolant insufficient	Cobalt alloyed, tungsten-molybdenum high speed steel possessing high hardness, excellent cutting properties, high-red hardness and good toughness.
HSSE Co8%	8% cobalt grade of high speed steel	Increased heat resistance & hardness, suitable for difficult-to-machine materials	Available for applications that require a strong resistance to softening at elevated cutting temperatures. The ability of the steel to maintain its “red-hot hardness” is provided by the addition of cobalt. The high hot hardness is required for machining difficult materials such as nickel-base, titanium and highly alloyed steel.
HSSE V3	Premium grade of high speed steel	Wide range of machine taps.	Vanadium grade gives high wear resistance and toughness for most tapping applications.
PM-HSSE V3	Powdered metallurgy - vanadium grade of high speed steel	Materials with hardness up to $40HR_c$. Difficult to machine materials eg. stainless steels.	PM-HSS V3 for higher performance tools, incorporates very fine and uniform grain structure allowing a high hardness to be achieved, whilst maintaining good toughness.
PM-HSS Co	Powdered metallurgy - 8% Cobalt grade of high speed steel	Materials with hardness up to $45HR_c$.	The addition of cobalt provides this material with the ability to maintain its strength and hardness level when exposed to extremely high cutting temperatures. This makes PM-HSS Co suitable for heavy duty tapping, in materials such as high alloyed steels to non-ferrous metals like Ni-base alloys & Ti-alloys.
SPM	Powdered metallurgy - 11% Cobalt grade of high speed steel	Special applications, requiring very high edge hardness. Cutting tools with the appropriate geometry can be applied to workpiece materials with hardness upto $55HR_c$.	An excellent bridge material between high speed steel and carbide. SPM offers very high red hardness, wear resistance and the highest compressive strength of any high speed steel.
VHM	Solid carbide	Materials with hardness up to $62HR_c$ & also used in materials with very high abrasion, such as Al Si >10%	Ultra fine grain type with maximum toughness combine with high hardness, therefore especially reccommended for rotating tools to machine hardened parts.

Computer controlled vacuum heat treatment ensures consistent high quality

Metric	Imperial	Inch	Gauge
0.010		0.0004	
0.100		0.0039	
0.150		0.0059	97
0.160		0.0063	96
0.170		0.0067	95
0.180		0.0071	94
0.190		0.0075	93
0.200		0.0079	92
0.210		0.0083	91
0.220		0.0087	90
0.230		0.0091	89
0.240		0.0094	88
0.254		0.0100	87
0.270		0.0106	86
0.280		0.0110	85
0.290		0.0114	84
0.300		0.0118	
0.305		0.0120	83
0.317		0.0125	82
0.330		0.0130	81
0.343		0.0135	80
0.368		0.0145	79
0.397	1/64	0.0156	
0.400		0.0157	
0.406		0.0160	78
0.457		0.0180	77
0.500		0.0197	
0.508		0.0200	76
0.533		0.0210	75
0.572		0.0225	74
0.600		0.0236	
0.610		0.0240	73
0.635		0.0250	72
0.660		0.0260	71
0.700		0.0276	
0.711		0.0280	70
0.742		0.0292	69
0.787		0.0310	68
0.794	1/32	0.0313	
0.800		0.0315	
0.813		0.0320	67
0.838		0.0330	66
0.889		0.0350	65
0.900		0.0354	
0.914		0.0360	64
0.940		0.0370	63
0.965		0.0380	62
0.991		0.0390	61
1.000		0.0394	
1.016		0.0400	60
1.041		0.0410	59

Metric	Imperial	Inch	Gauge
1.067		0.0420	58
1.092		0.0430	57
1.181		0.0465	56
1.191	3/64	0.0469	
1.321		0.0520	55
1.397		0.0550	54
1.511		0.0595	53
1.588	1/16	0.0625	
1.613		0.0635	52
1.702		0.0670	51
1.778		0.0700	50
1.854		0.0730	49
1.900		0.0748	
1.930		0.0760	48
1.984	5/64	0.0781	
1.994		0.0785	47
2.000		0.0787	
2.057		0.0810	46
2.083		0.0820	45
2.184		0.0860	44
2.261		0.0890	43
2.375		0.0935	42
2.381	3/32	0.0938	
2.438		0.0960	41
2.489		0.0980	40
2.527		0.0995	39
2.578		0.1015	38
2.642		0.1040	37
2.705		0.1065	36
2.778	7/64	0.1094	
2.794		0.1100	35
2.819		0.1110	34
2.870		0.1130	33
2.946		0.1160	32
3.000		0.1181	
3.048		0.1200	31
3.100		0.1220	
3.175	1/8	0.1250	
3.200		0.1260	
3.264		0.1285	30
3.300		0.1299	
3.400		0.1339	
3.454		0.1360	29
3.500		0.1378	
3.569		0.1405	28
3.572	9/64	0.1406	
3.600		0.1417	
3.658		0.1440	27
3.700		0.1457	
3.734		0.1470	26
3.797		0.1495	25

Metric	Imperial	Inch	Gauge
3.800		0.1496	
3.861		0.1520	24
3.900		0.1535	
3.912		0.1540	23
3.969	5/32	0.1563	
3.988		0.1570	22
4.000		0.1575	
4.039		0.1590	21
4.089		0.1610	20
4.100		0.1614	
4.200		0.1654	
4.216		0.1660	19
4.300		0.1693	
4.305		0.1695	18
4.366	11/64	0.1719	
4.394		0.1730	17
4.400		0.1732	
4.496		0.1770	16
4.500		0.1772	
4.572		0.1800	15
4.600		0.1811	
4.623		0.1820	14
4.700		0.1850	13
4.762	3/16	0.1875	
4.800		0.1890	12
4.851		0.1910	11
4.900		0.1929	
4.915		0.1935	10
4.978		0.1960	9
5.000		0.1969	
5.055		0.1990	8
5.100		0.2008	
5.105		0.2010	7
5.159	13/64	0.2031	
5.182		0.2040	6
5.200		0.2047	
5.220		0.2055	5
5.300		0.2087	
5.309		0.2090	4
5.400		0.2126	
5.410		0.2130	3
5.500		0.2165	
5.556	7/32	0.2188	
5.600		0.2205	
5.613		0.2210	2
5.700		0.2244	
5.791		0.2280	1
5.800		0.2283	
5.900		0.2323	
5.944		0.2340	A
5.953	15/64	0.2344	

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Metric	Imperial	Inch	Gauge
6.000		0.2362	
6.045		0.2380	**B**
6.100		0.2402	
6.147		0.2420	**C**
6.200		0.2441	
6.248		0.2460	**D**
6.300		0.2480	
6.350	**1/4**	0.2500	**E**
6.400		0.2520	
6.500		0.2559	
6.528		0.2570	**F**
6.600		0.2598	
6.629		0.2610	**G**
6.700		0.2638	
6.747	**17/64**	0.2656	
6.756		0.2660	**H**
6.800		0.2677	
6.900		0.2717	
6.909		0.2720	**I**
7.000		0.2756	
7.036		0.2770	**J**
7.100		0.2795	
7.137		0.2810	**K**
7.144	**9/32**	0.2813	
7.200		0.2835	
7.300		0.2874	
7.366		0.2900	**L**
7.400		0.2913	
7.493		0.2950	**M**
7.500		0.2953	
7.541	**19/64**	0.2969	
7.600		0.2992	
7.671		0.3020	**N**
7.700		0.3031	
7.800		0.3071	
7.900		0.3110	
7.938	**5/16**	0.3125	
8.000		0.3150	
8.026		0.3160	**O**
8.100		0.3189	
8.200		0.3228	
8.204		0.3230	**P**
8.300		0.3268	
8.334	**21/64**	0.3281	
8.400		0.3307	
8.433		0.3320	**Q**
8.500		0.3346	
8.600		0.3386	
8.611		0.3390	**R**
8.700		0.3425	
8.731	**11/32**	0.3438	

Metric	Imperial	Inch	Gauge
8.800		0.3465	
8.839		0.3480	**S**
8.900		0.3504	
9.000		0.3543	
9.093		0.3580	**T**
9.100		0.3583	
9.128	**23/64**	0.3594	
9.200		0.3622	
9.300		0.3661	
9.347		0.3680	**U**
9.400		0.3701	
9.500		0.3740	
9.525	**3/8**	0.3750	
9.576		0.3770	**V**
9.600		0.3780	
9.700		0.3819	
9.800		0.3858	
9.804		0.3860	**W**
9.900		0.3898	
9.922	**25/64**	0.3906	
10.000		0.3937	
10.084		0.3970	**X**
10.200		0.4016	
10.262		0.4040	**Y**
10.319	**13/32**	0.4063	
10.490		0.4130	**Z**
10.500		0.4134	
10.716	**27/64**	0.4219	
10.800		0.4252	
11.000		0.4331	
11.112	**7/16**	0.4375	
11.200		0.4409	
11.500		0.4528	
11.509	**29/64**	0.4531	
11.800		0.4646	
11.906	**15/32**	0.4688	
12.000		0.4724	
12.200		0.4803	
12.303	**31/64**	0.4844	
12.500		0.4921	
12.700	**1/2**	0.5000	
12.800		0.5039	
13.000		0.5118	
13.097	**33/64**	0.5156	
13.494	**17/32**	0.5313	
13.500		0.5315	
13.891	**35/64**	0.5469	
14.000		0.5512	
14.288	**9/16**	0.5625	
14.500		0.5709	
14.684	**37/64**	0.5781	

Metric	Imperial	Inch	Gauge
15.000		0.5906	
15.081	**19/32**	0.5938	
15.478	**39/64**	0.6094	
15.500		0.6102	
15.875	**5/8**	0.6250	
16.000		0.6299	
16.272	**41/64**	0.6406	
16.500		0.6496	
16.669	**21/32**	0.6563	
17.000		0.6693	
17.066	**43/64**	0.6719	
17.462	**11/16**	0.6875	
17.500		0.6890	
17.859	**45/64**	0.7031	
18.000		0.7087	
18.256	**23/32**	0.7188	
18.500		0.7283	
18.653	**47/64**	0.7344	
19.000		0.7480	
19.050	**3/4**	0.7500	
19.447	**49/64**	0.7656	
19.500		0.7677	
19.844	**25/32**	0.7813	
20.000		0.7874	
20.241	**51/64**	0.7969	
20.500		0.8071	
20.638	**13/16**	0.8125	
21.000		0.8268	
21.034	**53/64**	0.8281	
21.431	**27/32**	0.8438	
21.500		0.8465	
21.828	**55/64**	0.8594	
22.000		0.8661	
22.225	**7/8**	0.8750	
22.500		0.8858	
22.622	**57/64**	0.8906	
23.000		0.9055	
23.019	**29/32**	0.9063	
23.416	**59/64**	0.9219	
23.500		0.9252	
23.812	**15/16**	0.9375	
24.000		0.9449	
24.209	**61/64**	0.9531	
24.500		0.9646	
24.606	**31/32**	0.9688	
25.000		0.9843	
25.003	**63/64**	0.9844	
25.400	**1**	1.0000	

Sutton Tools

Approx Tensile Strength vs Hardness

Tensile Strength			Hardness	
N/mm²	Kg/mm²	Tons/Inch²	Brinell Hb	Rockwell HR
400	40.8	26.0	119	69 HR_B
450	45.9	29.0	133	75 HR_B
500	50.1	32.4	149	81 HR_B
550	56.0	35.6	163	85.5 HR_B
600	61.0	38.9	178	89 HR_B
650	66.2	42.1	193	92 HR_B
700	71.4	45.3	208	95 HR_B
750	76.5	48.5	221	97 HR_B
800	81.6	51.8	238	22 HR_C
850	86.7	55.1	252	25 HR_C
900	91.8	58.3	266	27 HR_C
1000	102.0	64.7	296	31 HR_C
1100	112.2	71.2	325	35 HR_C
1200	122.4	77.7	354	38 HR_C
1300	132.6	84.1	383	41 HR_C
1400	142.8	90.5	408	44 HR_C
1500	152.9	97.0	444	47 HR_C
1600	163.1	103.5	461	49 HR_C
1700	173.3	109.9	477	50 HR_C
1800	183.5	116.4	514	52 HR_C
1900	193.7	122.9	549	54 HR_C
2000	203.9	129.3	584	56 HR_C
2100	214.1	135.8	607	57 HR_C
2200	224.3	142.2	622	58 HR_C
2300	233.1	148.7	653	60 HR_C

Conversion of values depends on the actual alloy content; this chart therefore indicates a general conversion only.

Manufacturing Tolerances

Nominal Diameter in mm above	up to and including	Tolerance Grade in Microns							1 Micron = 0.001mm	
		h6	h7	h8	h9	h10	k9	k10	js10	js12
0	3	+0 -6	+0 -10	+0 -14	+0 -25	+0 -40	+25 -0	+40 -0	+20 -20	+50 -50
3	6	+0 -8	+0 -12	+0 -18	+0 -30	+0 -48	+30 -0	+48 -0	+24 -24	+60 -60
6	10	+0 -9	+0 -15	+0 -22	+0 -36	+0 -58	+36 -0	+58 -0	+29 -29	+75 -75
10	18	+0 -11	+0 -18	+0 -27	+0 -43	+0 -70	+43 -0	+70 -0	+35 -35	+90 -90
18	30	+0 -13	+0 -21	+0 -33	+0 -52	+0 -84	+52 -0	+84 -0	+42 -42	+105 -105
30	50	+0 -16	+0 -25	+0 -39	+0 -62	+0 -100	+62 -0	+100 -0	+50 -50	+125 -125
50	80	+0 -19	+0 -30	+0 -46	+0 -74	+0 -120	+74 -0	+120 -0	+60 -60	+150 -150
80	120	+0 -22	+0 -35	+0 -54	+0 -87	+0 -140	+87 -0	+140 -0	+70 -70	+175 -175

Conversion: 1 micron equals .00004 inches

Sutton Tools

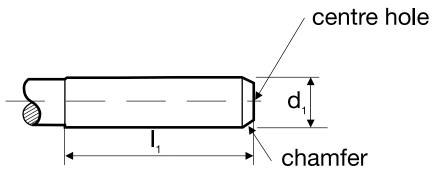
High Speed Steel Straight Shanks

DIN 1835

Form A (plain)

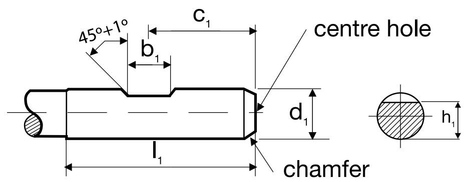
d_1 h6	l_1 +2 -0
3	28
4	28
5	28
6	36
8	36
10	40
12	45

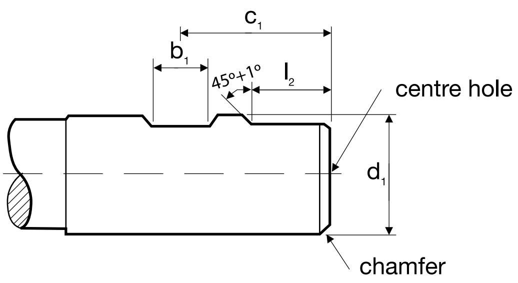
d_1 h6	l_1 +2 -0
16	48
20	50
25	56
32	60
40	70
50	80
63	90



Form B (with drive flat)

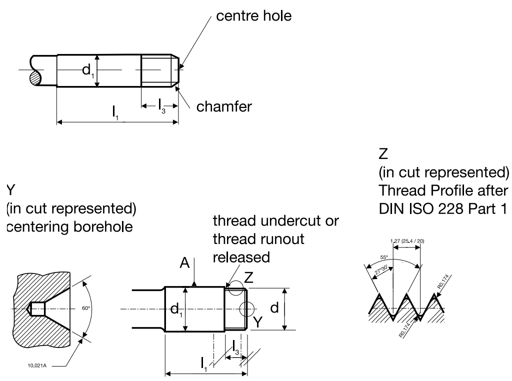
d_1 h6	b_1 +0.05 -0	c_1 0 -1	h_1 h13	l_1 +2 -0	l_2 +1 -0	centre hole form R DIN 332 part b
6	4.2	18	4.8	36	-	1.6 x 2.5
8	5.5	18	6.6	36	-	1.6 x 3.35
10	7	20	8.4	40	-	1.6 x 3.35
12	8	22.5	10.4	45	-	1.6 x 3.35
16	10	24	14.2	48	-	2.0 x 4.25
20	11	25	18.2	50	-	2.5 x 5.3
25	12	32	23	56	17	2.5 x 5.3
32	14	36	30	60	19	3.15 x 6.7
40	14	40	38	70	19	3.15 x 6.7
50	18	45	47.8	80	23	3.15 x 6.7
63	18	50	60.8	90	23	3.15 x 6.7





Form D (screwed shank)

d_1	l_1 +2 -0	l_3 +1 -0
6	36	10
10	40	10
12	45	10
16	48	10
20	50	15
25	56	15
32	60	15



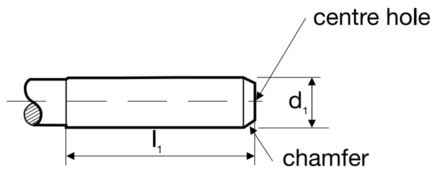
* All measurements in millimetres

Sutton Tools

Carbide Straight Shanks

Form HA (plain)

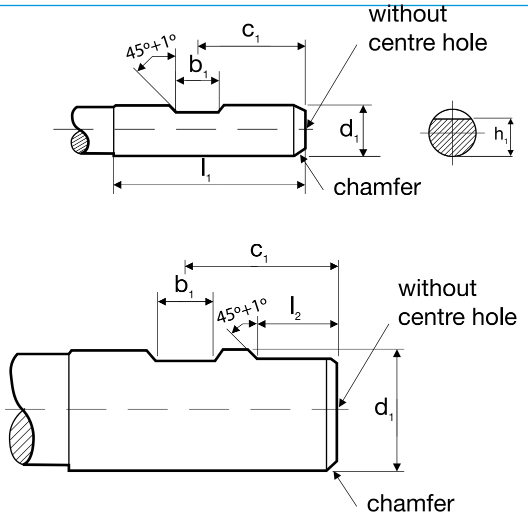
d_1 h6	l_1 +2 -0	d_1 h6	l_1 +2 -0
2	28	12	45
3	28	14	45
4	28	16	48
5	28	18	48
6	36	20	50
8	36	25	56
10	40	32	60



Form HB (with drive flat)

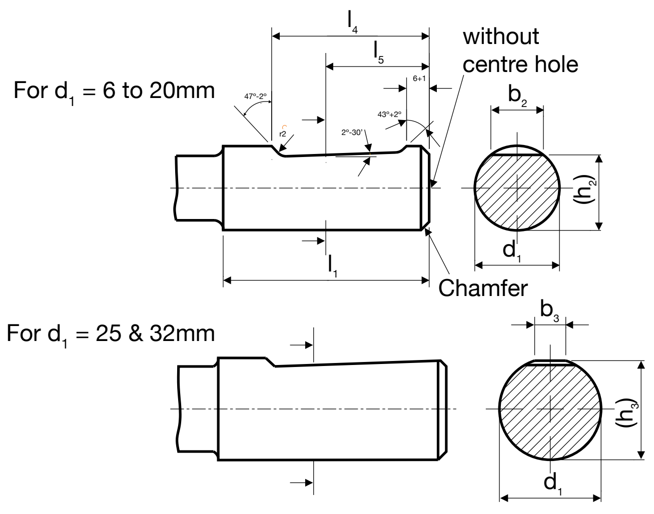
d_1 h6	b_1 +0.05 -0	c_1 0 -1	h_1 h11	l_1 +2 -0	l_2 +1 -0
6	4.2	18	4.8	36	-
8	5.5	18	6.6	36	-
10	7	20	8.4	40	-
12	8	22.5	10.4	45	-
14	8	22.5	12.7	45	-
16	10	24	14.2	48	-
18	10	24	16.2	48	-
20	11	25	18.2	50	-
25	12	32	23	56	17
32	14	36	30	60	19

6mm to 20mm = One Drive Flat
25mm & 32mm = Two Drive Flats



Form HE (with whistle notch flat)

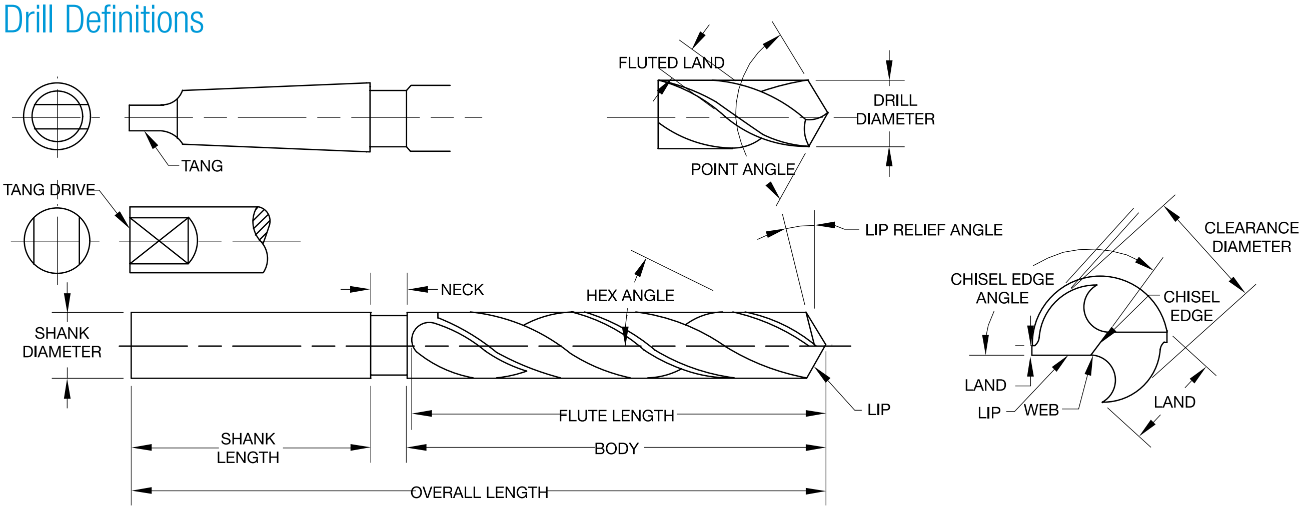
d_1 h6	b_1 +0.05 -0	c_1 0 -1	h_1 h11	l_1 +2 -0	l_2 +1 -0
6	4.2	18	4.8	36	-
8	5.5	18	6.6	36	-
10	7	20	8.4	40	-
12	8	22.5	10.4	45	-
14	8	22.5	12.7	45	-
16	10	24	14.2	48	-
18	10	24	16.2	48	-
20	11	25	18.2	50	-
25	12	32	23	56	17
32	14	36	30	60	19



* All measurements in millimetres

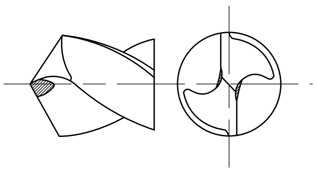
Sutton Tools

Drill Definitions

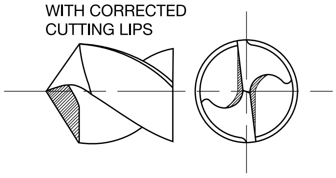


Drill Point Types (DIN1412)

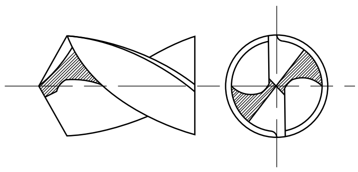
TYPE A
THINNED CHISEL EDGE



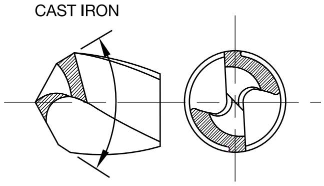
TYPE B
THINNED CHISEL EDGE WITH CORRECTED CUTTING LIPS



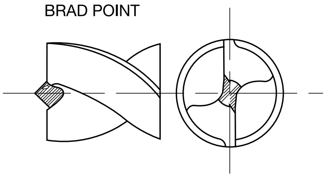
TYPE C
SPLIT POINT



TYPE D
POINT GROUND FOR CAST IRON



TYPE E
BRAD POINT



Drill Tolerances DIN / ISO 286, Part 2

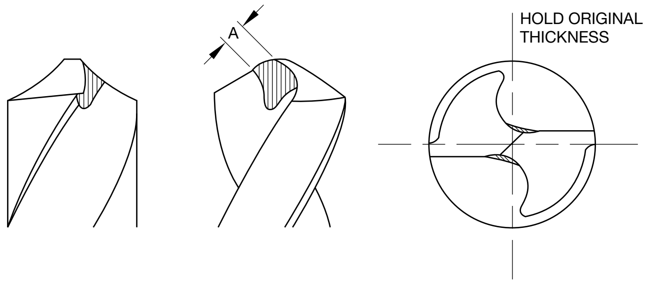
Drill Diameter at Point (mm)		Diameter Tolerance h8 (mm)		Back Taper (mm)		
Over	Inclusive	Plus (+)	Minus (-)	(Tapering of Diameter)†		
0.20	3.00	0.000	0.014	0.000	to	0.008
3.00	6.00	0.000	0.018	0.002	to	0.008
6.00	10.00	0.000	0.022	0.002	to	0.009
10.00	18.00	0.000	0.027	0.003	to	0.011
18.00	30.00	0.000	0.033	0.004	to	0.015
30.00	50.00	0.000	0.039	0.004	to	0.015

† The Drill diameter usually reduces towards the shank end; tolerance per 10mm of flute length.

Sutton Tools

Web Thinning

On most drills the web increases in thickness towards the shank with the result that, as the drill is shortened by repeated sharpening, the chisel edge will become wider. As the chisel edge does not cut but forces the metal out of the way, too wide a chisel edge will result in more pressure required for penetration, leading to greater heat generation and a resultant loss of life.



Cutting Fluids

The use of cutting fluids is an advantage in most drilling operations and an essential in some.
The two main functions of the cutting fluid are lubrication and cooling.
The purpose of lubrication is to reduce friction by lubricating the surfaces tool and work, to facilitate easier sliding of the chips up the flute and to prevent the chips welding to the cutting edges.
In production work, particularly when drilling deep holes, the cooling action of the fluid is often more important than the lubrication. Overheating will shorten the life of the drill. Intermittent feed on deep holes, where possible, not only clears the chips but permits more effective cooling.

Speeds

The speed of a drill is the rate at which the periphery of the drill moves in relation to the work being drilled.
As a rule, with a drill working within its speed range for a specific material, more holes between sharpenings will be achieved if the speed is reduced and less holes if the speed is increased. Thus, for each production run, a speed must be established which will result in the highest rate of production without excessive breakdown time or drill usage.
The factors governing speed are: Component material, hardness of material, depth of hole, quality required, condition of drilling machine, efficiency of cutting fluid.

Feeds

The feed of the drill is governed by the drill size and the component material.
As with speeds, an increase in feed will lessen the number of holes produced sharpening but it is essential that a constant feed be maintained. If a drill is allowed to dwell, breakdown of the cutting edges will result.

Small Drill Feeds and Speeds

Breakdown of small drills can most often be attributed to two faults: speed too high and feed too low.
A feed which will produce CHIPS not POWDER, coupled with a speed compatible with the strength of the drill is essential for small hole drilling.
Feeds must be based on thickness of chip, not mm/min, and speeds adjusted accordingly. EXAMPLE: A 1mm drill is to operate at a feed of 0.013mm /rev, drilling steel. While the material may permit a speed of 30m/min or 9,500 RPM it is obvious that the drill could not withstand a load of 0.013mm feed at this speed; a penetration rate of 124mm/min.
The correct procedure is to retain the feed but reduce the speed to obtain a penetration within the capacity of the strength of the drill.

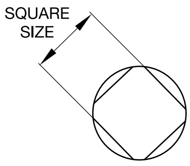
Deep Hole Drilling

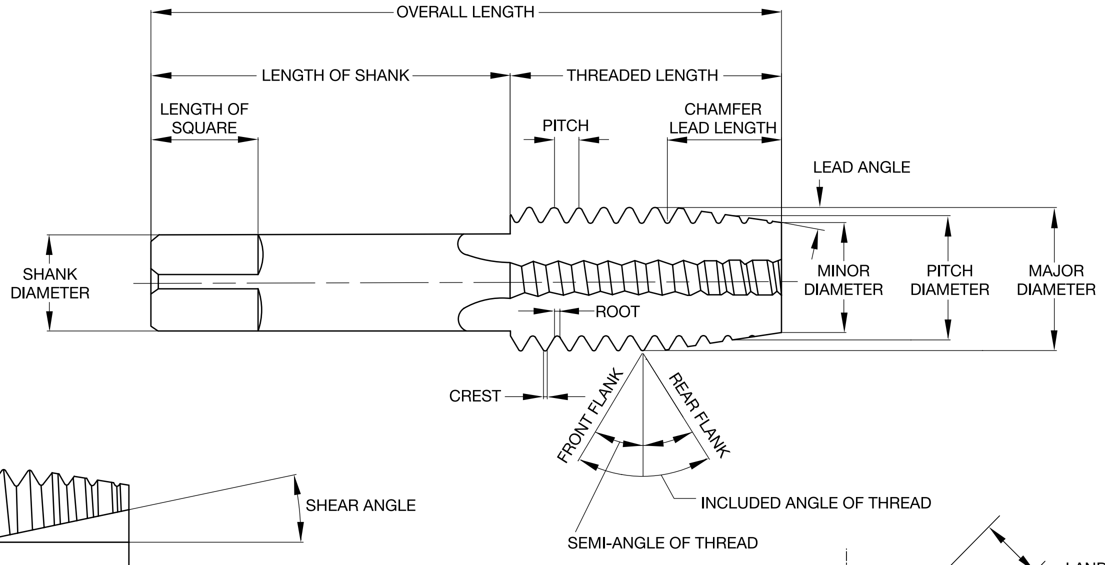
When drilling deep holes, speeds and feeds should be reduced as follows:

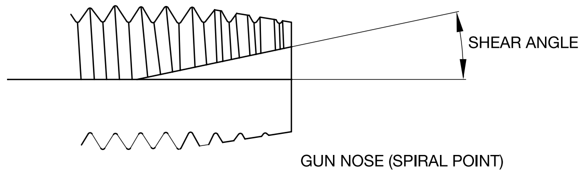
Depth of hole	Reduction per cent %	
	Speed	**Feed**
3 times drill diameter	10	10
4 times drill diameter	30	10
5 times drill diameter	30	20
6 to 8 times drill diameter	35 to 40	20

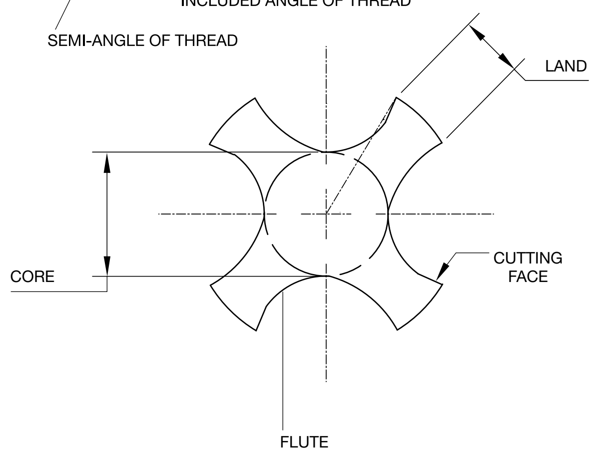
Sutton Tools

Tap Definitions

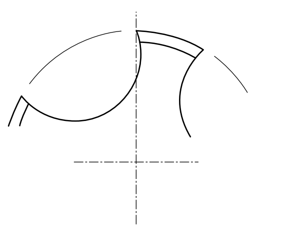




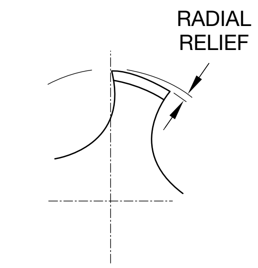




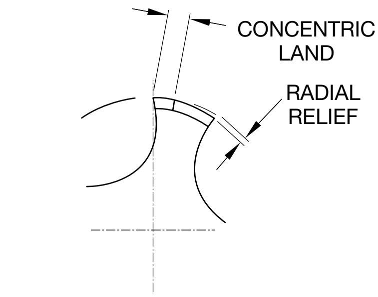
Thread Relief Types



CONCENTRIC THREADS
(No radial relief)

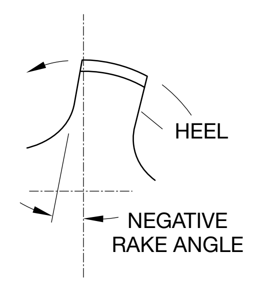


ECCENTRIC THREADS
(Relieved to cutting edge)

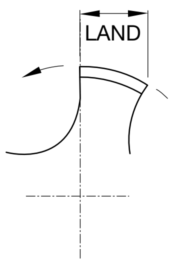


CON-ECCENTRIC THREADS
(Relieved to a land)

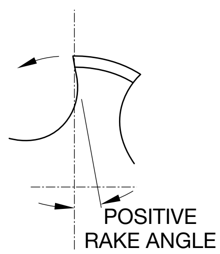
Cutting Faces



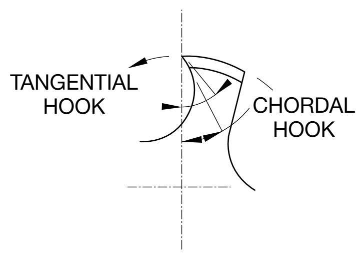
NEGATIVE RAKE



RADIAL RAKE



POSITIVE RAKE

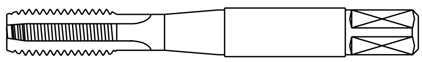
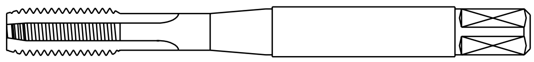
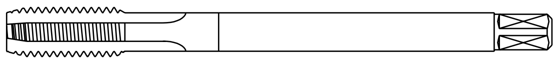


HOOK

Sutton Tools

Construction dimensions / designs

The construction dimensions & designs of our taps, are manufactured in accordance to the various international standards listed below. The dimensions can be found in our catalogues, respective leaflets & our Expert Tool System situated on our website.

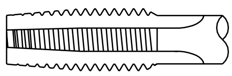
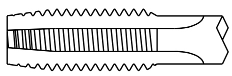
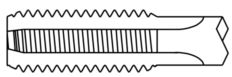
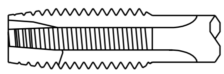
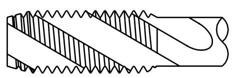
Style	Standard	Illustration
Short Machine & Hand Taps	ISO 529 JIS (J TYPE)	
Reinforced Shank Taps	DIN371	
Reduced Shank Taps	DIN374 / DIN376	

Exceptions are:

Pipe taps - Rc (BSPT), G (BSPF), Rp (BSPPL)	ISO2284 Standard
Pipe taps - NPT, NPTF, NPSF	ANSI B949 Standard
Machine Nut Taps	ANSI B949 Standard

Chamfer Type / Length

Table below is in accordance with ISO8830 / DIN2197

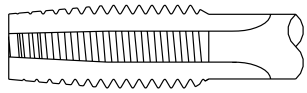
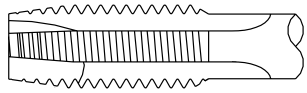
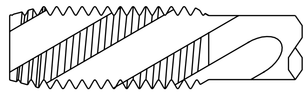
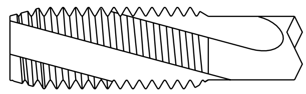
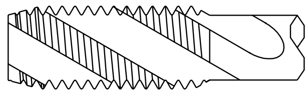
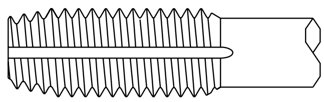
Terminology	Form	Number of threads on lead	Approx. chamfer angle	Type of flute	Main area of application	Illustration
TAPER	A	6 to 8	5°	Hand or straight flutes	Short through holes	
INTERMEDIATE	D	3.5 to 5	8°	Hand or straight	Generally for Through holes	
BOTTOMING	E*	1.5 to 2	23°	Hand or straight flutes	Blind holes with very short thread runout	
INTERMEDIATE	B	3.5 to 5	10°	Straight, with spiral point	Through holes in medium & long chipping materials	
BOTTOMING	C	2 to 3	15°	Spiral fluted	Generally for blind holes	

* Use of this type is not recommended

Sutton Tools

Tap Types - Helix direction/ Helical pitch / Fluteless

The helix angle depends primarily upon the hole form, eg. Through hole , blind hole, deep blind hole, etc., but the material, eg short chips, long chips, also has a strong influence on the direction of the helix. The following basic forms have derived during the development of taps:

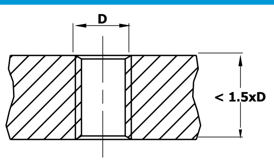
Description	Illustration
Straight Flutes (Hand) - Suitable for through or blind holes. The flutes only have room for a small amount of chips. The chips are not transported axially. Therefore, it is not advisable to cut deep through or blind holes (except in short chipping materials), with this type.	
Straight Flutes with spiral point (Gun) – Suitable for through holes, the spiral point curls the chip forward ahead of the tap & out of the hole. Therefore, chip clogging is avoided and coolant can flow without problems.	
Spiral Flutes (LH Spiral) – Suitable for interrupted through holes, where cross-holes exist. The direction of the flutes, curls & transports the chips forward of the tap, similar to Gun taps (also, opposite to RH spiral flutes). However, in applications where another hole intersects with the tapped hole, the helical flutes maintain the pitching of the thread.	
15º Spiral Flutes (RH Spiral) – Suitable for blind holes, best suited to tough short chipping materials, upto 1.5 x D in depth. This particular tap design has no advantages for soft, and long chipping materials, especially over 1.5 x d_1 in depth. Due to the slow helix angle not transporting the chips well, clogging is possible.	
40º to 50º Spiral Flutes (RH Spiral) – Suitable for blind holes, best suited to long chipping materials, the high helix angle & the direction of the flutes, curls & transports the chips back out of the hole. This particular tap style is required to cut on reversal; therefore flute rake is required on the both front & back flute faces.	
Thredflo/Roll taps (fluteless) - Suitable for blind & through holes. This type of tap internally rolls a thread, therefore displacing the metal rather than cutting, like the above mentioned styles. Due to torque generated when producing roll threads, much higher machine power is required. Roll threads also produce much stronger threads than cut threads, as the grain structure of the thread remains uniform through the thread form profile. Note! Tapping drill size is not the same as a cut thread tap	

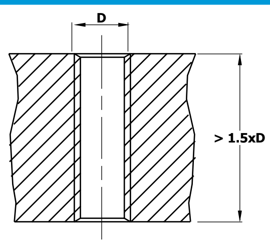
The above basic tool types are available in different variations, which have been designed & developed in respect to the specific materials and working conditions.

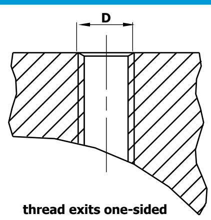
Tap Hole Type

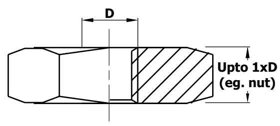
The two basic types of tapping holes are blind holes and through holes.

Through Holes

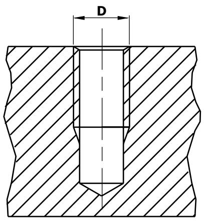


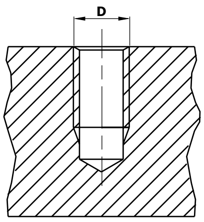


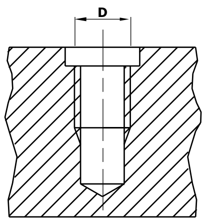


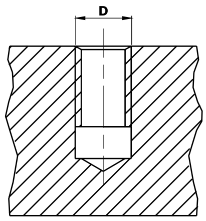


Blind Holes









For blind holes, there are generally two thread runout forms used at the bottom of the tap hole. One form has a recessed diameter at the bottom of the hole, and the other form has a standard runout. Other types of holes are respective to construction designs, eg.

a) The bore is smaller than the tap hole diameter (typical for pipes)
b) As step hole, where the following diameter (second step), is smaller than the tap hole diameter.

Sutton Tools

Geometry

Abbrev.		Description	Tap geometry	Surface
GG		For cast iron – iron is a very abrasive material, therefore to increase tool life the taps are always surface treated or coated to resist the abrasion. The thread limit for this range is 6HX, which is high limit of the 6H tolerancte allowing for longer wear life.	Straight flutes with low rake angle.	TiCN Plasma Nitride Ni
N		For normal, general purpose type materials – suited to a wide range of materials, with normal rakes & relief's. This is existing geometry that Sutton has historically manufactured.	Normal rake angle & Normal thread relief	Bright Steam Oxide TiN
UNI		For normal, general purpose type materials – suited to a wide range of materials, with normal rakes & high relief's. However tap material is powder metal high speed steel (PMHSS), which due to its finer grain structure than that of conventional HSS, higher hardness can be achieved with excellent toughness, along with Teclube surface coating allowing for better tool life than normal taps.	Normal rake angle & High thread relief	Bright TiAIN
VA		For stainless and tough steels – to avoid clogging in tough, long chipping materials such as stainless steel, it is essential that the chip flows continuously in an axial direction. Best suited to rigid tapping applications due to high thread relief. TiCN & TiN coating has proven to be best suited for these materials.	High rake angle & thread relief	TiCN Steam Oxide
VAPM		For stainless and tough steels – geometry similar to VA range, however tap material is powder metal high speed steel (PMHSS), which due to its finer grain structure than that of conventional HSS, higher hardness can be achieved with excellent toughness, allowing for better tool life than VA taps.	High rake angle & thread relief	TiCN
H		For hard materials forming short chips – the low rakes & relief's combined with a hard surface coating, allow excellent tool life.	Low rake angle & thread relief	TiCN
W		For soft materials – due to the very high rake angle with a low thread relief, allows for excellent chip flow & gauging in soft materials.	High rake angle & Low thread relief	Bright CrN
AI		For malleable aluminium with long chips – to avoid clogging when threading in aluminium which forms long chips, it is essential that the chip flows continuously in an axial direction. Generally these taps have 1 less flute than normal taps & therefore have larger flute space, which more adequate for large volumes of chips to help avoid clogging.	High rake angle High helix, 2 Flutes Low thread relief	Bright Plasma Nitride

Sutton Tools

Use

Use of a suitable lubricant or cutting compound is necessary on most tapping operations. The type of lubricant as well as the method of application is often of extreme importance and can be responsible for the success or failure of a tapping operation.

Recommendation

The table on page 130 lists general recommendations for the type of lubricant. However, better results can sometimes be obtained by the use of one of the many modified or specialised lubricants recommended by cutting oil specialists.
The general principle is to have more EP (Extreme Pressure) additives added with the degree of difficulty, usually hardness increase. Oils stick, and improve frictional properties essential in tapping tough applications.

Application

Proper application of the lubricant is just as important as the type used. To be effective, ample quantities of lubricant must reach the chamfer or cutting portion of the tap during the entire tapping operation. In many cases, the lubricant must also aid in controlling or disposing of the chips.

Flow

The flow of lubricant should be directed into the hole rather than at the tap and should have sufficient pressure to wash the chips away from the hole as much as possible. Also, if the flow is not continuous, it should start before the tap enters the hole and continue until the tap is completely reversed out of the hole. In this way, ample oil is provided at the start of the cut and loose chips will be suspended in the oil so that they do not interfere with the tap backing out of the hole. On machines where the work revolves and the tap is stationary, it is desirable to use several streams of lubricant on opposite sides of the tap, especially on horizontal tapping.

Cleanliness

Tapping lubricants must always be clean. If filter equipment is not used, the lubricant must be replaced periodically to eliminate fine chips, grit and foreign matter that accumulate in the tank. Also, it is very important that the piping and tank are thoroughly flushed and cleaned before filling with new lubricant. The dilution of lubricants often changes during use so that additions may be necessary to maintain the recommended proportion of active materials.

Tapping drill

The tapping drill hole diameter should be drilled as large as possible, within the respective fitting just under the upper permissible dimension of the tolerance.
If the tapping drill hole diameter is too small, then this will cause the thread root diameter (minor diameter) to cut the material. This should be avoided, because the small chips which derive from the root of thread, clog the normal chip flow and rip pieces of material out of the finished thread. Consequently, the tap is overloaded and often breaks because of the high torque.
Another problem which occurs in certain materials due to thread root diameter cutting, is when a chip-bulge has been formed around the root radius. The minor diameter of the tap is clogged with small chips, which leads to a clamping of the tool teeth are ripped out, which leads to tool breakage. It is therefore, necessary that the material which is to be tapped, be taken into account when determining the tap hole diameter. Typical materials which do not squeeze or clamp are iron, brass and bronze and materials which squeeze are steels, steel castings and malleable steels. The tap cuts more economically, when the tap drill hole diameter is within the upper range of the permissible tolerance.

Warning: When drilling holes in materials which tend to work harden, care is needed to ensure the drills are sharp otherwise tap life is decreased.

Tapping drill formula

The correct size of drill to give the desired percentage of thread can be calculated by using the following formula:

Thread Type	Formula	Example
Metric (ISO)	Drill Size = Nom. Tap Dia. in mm – Pitch	M6 x 1 = 5.00mm drill
Whitworth Form Threads (inch calculation)	Drill Size = Nom. Tap Dia. – $\frac{1.28}{\text{TPI}}$ x % of thread depth	1/4 BSW 75% thread required: Drill Size = .250 – $\frac{1.28}{20}$ x $\frac{75}{100}$ = .250 – .048 Therefore Drill Size = .202 Nearest Standard Drill = 5.1mm = .2007 inch
Unified Form Threads (inch calculation)	Drill Size = Nom. Tap Dia. – $\frac{1.30}{\text{TPI}}$ x % of thread depth	1/4 UNC 75% thread required: Drill Size = .250 – $\frac{1.30}{20}$ x $\frac{75}{100}$ = .250 – .049 Therefore Drill Size = .201 Nearest Standard Drill = 5.1mm = .2007 inch

Sutton Tools

ALL SIZES ARE "SUGGESTED SIZES" ONLY AND MAY BE VARIED TO SUIT INDIVIDUAL REQUIREMENTS

M
ISO METRIC COARSE (60º)

Tap Size	Pitch mm	Tapping Drill mm
M1.6	0.35	1.25
M2	0.4	1.6
M2.5	0.45	2.05
M3	0.5	2.5
M3.5	0.6	2.9
M4	0.7	3.3
M4.5	0.75	3.7
M5	0.8	4.2
M6	1.0	5.0
M8	1.25	6.8
M10	1.5	8.5
M12	1.75	10.2
M14	2.0	12.0
M16	2.0	14.0
M18	2.5	15.5
M20	2.5	17.5
M22	2.5	19.5
M24	3.0	21.0
M27	3.0	24.0
M30	3.5	26.5
M33	3.5	29.5
M36	4.0	32.0
M42	4.5	37.5
M45	4.5	40.5
M48	5.0	43.0
M52	5.0	47.0
M56	5.5	50.5

MF
ISO METRIC FINE (60º)

Tap Size	Pitch mm	Tapping Drill mm
M4	0.5	3.5
M5	0.5	4.5
M6	0.75	5.3
M8	1.0	7.0
M10**	1.0	9.0
M10	1.25	8.8
M12**	1.25	10.8
M12	1.5	10.5
M14**	1.25	12.8
M14	1.5	12.5
M16*	1.5	14.5
M18**	1.5	16.5
M20*	1.5	18.5
M22	1.5	20.5
M24	2.0	22.0
M25*	1.5	23.5
M32*	1.5	30.5
M40*	1.5	38.5
M50*	1.5	48.5

*Metric Conduit **Spark Plug

8UN (8 TPI)
UNIFIED NATIONAL FORM (60º)

Tap Size	T.P.I.	Tapping Drill mm
1-1/8	8	25.5
1-1/4	8	28.5
1-3/8	8	31.75
1-1/2	8	35.0
1-5/8	8	38.0
1-3/4	8	41.5
1-7/8	8	44.5
2	8	47.5

UNC
UNIFIED NATIONAL COARSE (60º)

Tap Size	T.P.I.	Tapping Drill mm
#2 (.086)	56	1.85
#3 (.099)	48	2.1
#4 (.112)	40	2.3
#5 (.125)	40	2.6
#6 (.138)	32	2.8
#8 (.164)	32	3.4
#10 (.190)	24	3.8
#12 (.216)	24	4.5
1/4	20	5.1
5/16	18	6.6
3/8	16	8.0
7/16	14	9.4
1/2	13	10.8
9/16	12	12.2
5/8	11	13.5
3/4	10	16.5
7/8	9	19.5
1	8	22.2
1-1/8	7	25.0
1-1/4	7	28.0
1-3/8	6	31.0
1-1/2	6	34.0
1-3/4	5	39.5
2	4.5	45.0

UNF
UNIFIED NATIONAL FINE (60º)

Tap Size	T.P.I.	Tapping Drill mm
#3 (.099)	56	2.1
#4 (.112)	48	2.35
#5 (.125)	44	2.65
#6 (.138)	40	2.9
#8 (.164)	36	3.5
#10 (.190)	32	4.1
#12 (.216)	28	4.6
3/16*	32	4.0
1/4	28	5.5
5/16	24	6.9
3/8	24	8.5
7/16	20	9.8
1/2	20	11.5
9/16	18	12.8
5/8	18	14.5
3/4	16	17.5
7/8	14	20.5
1	12	23.5
1*	14	24.0
1-1/8	12	26.5
1-1/4	12	29.5
1-3/8	12	33.01
1-1/2	12	36.0

*UNS

UNEF
UNIFIED NATIONAL FORM (60º)

Tap Size	T.P.I.	Tapping Drill mm
1/4	32	5.6
5/16	32	7.2
3/8	32	8.8
1/2	28	11.8
5/8	24	14.75
3/4	20	18
1	20	24.2

BSW
BRITISH STANDARD WHITWORTH (55º)

Tap Size	T.P.I.	Tapping Drill mm
1/16*	60	1.2
3/32*	48	1.85
1/8	40	2.55
5/32*	32	3.2
3/16	24	3.7
7/32*	24	4.5
1/4	20	5.1
5/16	18	6.5
3/8	16	7.9
7/16	14	9.3
1/2	12	10.5
9/16	12	12.1
5/8	11	13.5
3/4	10	16.25
7/8	9	19.25
1	8	22.0
1-1/8	7	24.75
1-1/4	7	28.0
1-1/2	6	33.5
1-3/4	5	39.0
2	4-1/2	44.5

*WHIT. Form

BSF
BRITISH STANDARD FINE (55º)

Tap Size	T.P.I.	Tapping Drill mm
3/16	32	4.0
7/32	28	4.6
1/4	26	5.3
5/16	22	6.8
3/8	20	8.3
7/16	18	9.8
1/2	16	11.0
9/16	16	12.7
5/8	14	14.0
11/16	14	15.5
3/4	12	16.75
7/8	11	19.75
1	10	22.75
1-1/8	9	25.5
1-1/4	9	28.5
1-1/2	8	34.5
1-3/4	7	41.0

BSB
BRITISH STANDARD BRASS (55º)

Tap Size	T.P.I.	Tapping Drill mm
1/4	26	5.2
5/16	26	6.8
3/8	26	8.4
7/16	26	10.0
1/2	26	11.6
9/16	26	13.2
5/8	26	14.8
3/4	26	18.0
7/8	26	20.8
1	26	24.3

Rc (BSPT)* ISO Rc TAPER SERIES 1:16 (55º)

Tap Size	T.P.I.	Drill Only*	Drill & Reamer
Rc 1/16	28	6.4	6.2
Rc 1/8	28	8.4	8.4
Rc 1/4	19	11.2	10.8
Rc 3/8	19	14.75	14.5
Rc 1/2	14	18.25	18.0
Rc 3/4	14	23.75	23.0
Rc 1	11	30.0	29.0
Rc 1-1/4	11	38.5	38.0
Rc 1-1/2	11	44.5	44.0
Rc 2	11	56.0	55.0

G (BSPF) ISO G PARALLEL SERIES (55º)

Tap Size	T.P.I.	Tapping Drill mm
G 1/16	28	6.8
G 1/8	28	8.8
G 1/4	19	11.8
G 3/8	19	15.3
G 1/2	14	19.0
G 5/8	14	21.0
G 3/4	14	24.5
G 7/8	14	28.5
G 1	11	31.0
G 1-1/4	11	39.5
G 1-1/2	11	45.5
G 1-3/4	11	51.5
G 2	11	57.5
G 2-1/2	11	72.5

Rp (BSPPL) SEALING PIPE THREAD PARALLEL (55º)

Tap Size	T.P.I.	Tapping Drill mm
Rp 1/8	28	8.6
Rp 1/4	19	11.5
Rp 3/8	19	15.0
Rp 1/2	14	18.5
Rp 3/4	14	24.0
Rp 1	11	30.2
Rp 1-1/4	11	39.0
Rp 1-1/2	11	45.0
Rp 2	11	56.4

Pg STEEL CONDUIT (80º)

Tap Size	T.P.I.	Tapping Drill mm
Pg7	20	11.3
Pg9	18	13.9
Pg11	18	17.3
Pg13.5	18	19.1
Pg16	18	21.2
Pg21	15	26.8

THREAD FORMING (FLUTELESS TAPS)

Tap Size	T.P.I.	Tapping Drill mm
METRIC COARSE		
M1	0.25	0.9
M1.1	0.25	1.0
M1.2	0.25	1.1
M1.4	0.3	1.28
M1.6	0.35	1.45
M1.7	0.35	1.55
M1.8	0.35	1.65
M2.0	0.40	1.8
M2.2	0.45	2.0
M2.3	0.4	2.1
M2.5	0.45	2.3
M2.6	0.45	2.4
M3	0.5	2.8
M3.5	0.6	3.2
M4	0.7	3.7
M5	0.8	4.6
M6	1.0	5.5
M8	1.25	7.4
M10	1.5	9.3
M12	1.75	11.2
BSW		
1/8	40	2.9
5/32	32	3.6
3/16	24	4.3
1/4	20	5.8
5/16	18	7.3
3/8	16	8.8

NPT-NPTF* NATIONAL PIPE TAPER 1:16 (60º)

Tap Size	T.P.I.	Drill Only*	Drill & Reamer
1/16	27	6.3	6.0
1/8	27	8.5	8.2
1/4	18	11.0	10.8
3/8	18	14.5	14.0
1/2	14	18.0	17.5
3/4	14	23.0	23.0
1	11-1/2	29.0	28.5
1-1/4	11-1/2	37.5	37.0
1-1/2	11-1/2	44	43.5
2	11-1/2	55.5	55.0

NPSF NATIONAL PIPE STRAIGHT (60º)

Tap Size	T.P.I.	Tapping Drill mm
1/8	27	8.6
1/4	18	11.0
3/8	18	14.5
1/2	14	18.0

*Taper pipe threads of improved quality are obtained when taper is pre-formed using Sutton Taper Pipe Reamers.

THREAD FORMING (FLUTELESS TAPS)

Tap Size	T.P.I.	Tapping Drill mm
UNC		
#1 (.073)	64	1.7
#2 (.086)	56	2.0
#3 (.099)	48	2.3
#4 (.112)	40	2.6
#5 (.125)	40	2.9
#6 (.138)	32	3.2
#8 (.164)	32	3.8
#10 (.190)	24	4.4
#12 (.216)	24	5.0
1/4	20	5.8
5/16	18	7.3
3/8	16	8.8
7/16	14	10.2
1/2	13	11.7
UNF		
#1 (.073)	72	1.7
#2 (.086)	64	2.0
#3 (.099)	56	2.3
#4 (.112)	48	2.6
#5 (.125)	44	2.9
#6 (.138)	40	3.2
#8 (.164)	36	3.9
#10 (.190)	32	4.5
#12 (.216)	28	5.1
1/4	28	6.0
5/16	24	7.5
3/8	24	9.0
7/16	20	10.6
1/2	20	12.1
G (BSPF)		
1/8	28	9.25
1/4	19	12.5
3/8	19	16.0
1/2	14	20.0
5/8	14	22.0
3/4	14	25.5
7/8	14	29.25
1	11	32.0

BA (47.5º)

Tap Size	T.P.I.	Tapping Drill mm
0	1	5.1
1	0.9	4.5
2	0.81	4.0
3	0.73	3.4
4	0.66	3.0
5	0.59	2.65
6	0.53	2.3
7	0.48	2.05
8	0.43	1.8
9	0.39	1.55
10	0.35	1.4
11	0.31	1.2
12	0.28	1.05
13	0.25	0.98
14	0.23	0.8
15	0.21	0.7
16	0.19	0.6

Sutton Tools

Fluteless taps

Fluteless taps do not cut threads in the same manner as conventional taps – but actually FORM and FLOW the threads with an absence of chips. Used under suitable conditions, these taps produce threads with a high degree of finish not possible with ordinary taps. Ductile materials are most appropriate for forming of threads and must have a minimum 10% elongation.

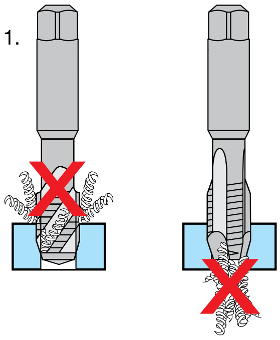
Benefits of thread forming

1. No chips produced
2. Higher tensile strength threads produced due to grain structure following the thread form
3. For use in through and blind holes applications
4. Higher speeds and tool life
5. Reduced possibility of breakage due to no cutting edges and robust tool construction

Suitable for wide range materials

-Low carbon steels
-Leaded steels
-Austenitic stainless steels
-Alloy steels; typically up to 1200 N/mm², (36 Rc) with a minimum 10% elongation
-Aluminium die castings alloys (low silicon, 10% max;)
-Wrought aluminium alloys (Ductile)
-Zinc die casting alloys
-Copper and copper alloys

1.



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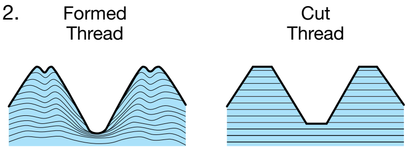

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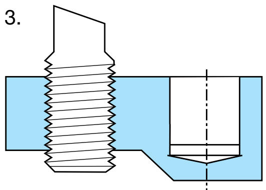
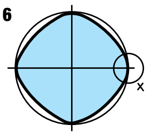


Whats New?

- New polygon profile 6
- New radiused blend on polygon profile 7
- Thread profile with radius crest 8
- Polished tool surface, surface finish 9

6



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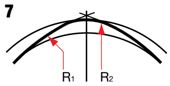

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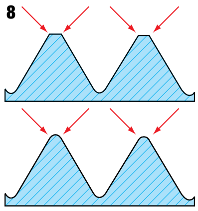

9

Percentage of thread required

Because the thread produced by a fluteless tap is substantially stronger than a conventional thread, greater tool life and efficiency may be obtained when forming up to 65% thread. Threads may be formed up to 80% of depth, but tool life will be reduced and work clamping pressure necessarily increased. Greater tapping speeds allow the metal to flow far more readily, so 60 feet per minute minium may be used as a guide, but this could increase with the type of material being tapped. A depth of 65% is recommended for the ductile materials mentioned, but this percentage will be reduced for less ductile materials to maintain all-round efficiency.

Tapping drill formula for fluteless taps

Refer Tapping Drill Size Chart for recommended sizes (Suitable for Unified, Whitworth and Metric sizes only).
The formula to calculate the theoretical hole size for a required percentage of thread is:

Formula	Example
$$\text{Drill size} = \text{nominal thread dia. inch} - \frac{.007 \times \%\ \text{of thread}}{\text{TPI}}$$	Drill size for 65% of thread in a M6 x 1.0 threaded hole would be: Drill size = 6 – (.007 x 65 x 1.0 (pitch)) = 5.54m (Use 5.50mm drill (Stockable drill) = 76%)

It is to be noted that the drill size for fluteless tapping is always larger than the P.D. of the thread. A drill size equal to the P.D. of the thread would produce 100% of thread, but this is NOT recommended.

As the additional driving torque is only up to 50% increase, any conventional driving equipment using the square as a drive is suitable for fluteless tapping.

Lubrication

In general it is best to use a good cutting oil or lubricant rather than a coolant for fluteless tapping. Sulphur base and mineral oils, along with most friction reducing lubricants recommended for use in cold extrusion or metal drawing, have proven best for this work. Make sure lubricant is clean, free from chips swarf and filings in suspension, which produce a poor finish and jamming, sometimes breakage – extra filtration may be required.

Countersinking

Because the fluteless tap displaces metal, some metal will be displaced above the mouth of the hole during tapping, countersink or chamfer the hole prior to tapping will reduce the extrusion within the countersink and not interfere with the mating part.

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(Fluteless) Roll Taps:

THREAD SIZE			ISO COARSE		UNC		BSW	
Metric	Fraction	M/C Screw Gauge	Pitch mm	Tapping Drill mm	T.P.I.	Tapping Drill mm	T.P.I.	Tapping Drill mm
M1.0			0.25	0.90				
M1.1			0.25	1.00				
M1.2			0.25	1.10				
M1.4			0.3	1.25				
M1.6			0.35	1.45				
M1.7			0.35	1.55				
M1.8			0.35	1.65				
M2.0			0.4	1.80				
M2.2			0.45	2.00				
M2.3			0.4	2.10				
M2.5			0.45	2.30				
M2.6			0.45	2.40				
M3.0			0.5	2.75				
	1/8						40	2.90
M3.5			0.6	3.20				
		#6			32	3.10		
	5/32						32	3.60
M4			0.7	3.70				
		#8			32	3.80		
	3/16						24	4.30
		#10			24	4.30		
M5			0.8	4.60				
M6			1.0	5.55				
	1/4				20	5.80	20	5.80
	5/16				18	7.30	18	7.30
M8			1.25	7.40				
	3/8				16	8.80	16	8.80
M10			1.50	9.30				

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Thread Systems

The ISO standard is the international standard intended to be adopted throughout the world to unify and rationalise screw threads at an international level. The ISO standard recognises two groups of screw threads, (a) ISO metric, a complete thread system in metric units and (b) ISO inch Unified which is covered by British Standard BS 1580 and American Standard ANSI – B1-1 – Unified screw thread systems. The Whitworth and BA screw threads are obsolete but still widely used during the period of transition.
All measurements must have a controlling point or base from which to start. In the case of a screw thread, this control point is called BASIC or theoretically correct size, which is calculated on the basis of a full thread form. Thus, on a given screw thread, we have the Basic Major Diameter, the Basic Pitch Diameter, and the Basic Minor Diameter. The Basic Profile is the profile to which the deviations, which define the limits of the external and internal threads, are applied.
While it is impossible in practice to form screw threads to their precise theoretical or BASIC sizes, it is possible and practical to establish limits to which the deviation must not exceed. These are called the "Maximum" and "Minimum" Limits. If the product is no smaller than the "Minimum Limit" and no larger than the "Maximum Limit", then it is within the size limits required. This difference between the Maximum and Minimum Limits is the TOLERANCE. In actual practice, the Basic size is not necessarily between Maximum and Minimum Limits. In most cases, the Basic Size is one of the Limits.
In general, tolerances for internal threads will be above Basic and for external threads, below Basic.

Basic Profile for ISO Inch (Unified) and ISO Metric

The basic form is derived from an equilateral triangle which is truncated 1/8 of the height at the major diameter and 1/4 of the height at the minor diameter. The corresponding flats have a width of P/8 and P/4 respectively. Fig. 1.
In practice major diameter clearance is provided by the tap beyond the P/8 flat on internal threads and beyond the P/4 flat on external threads. These clearances are usually rounded.

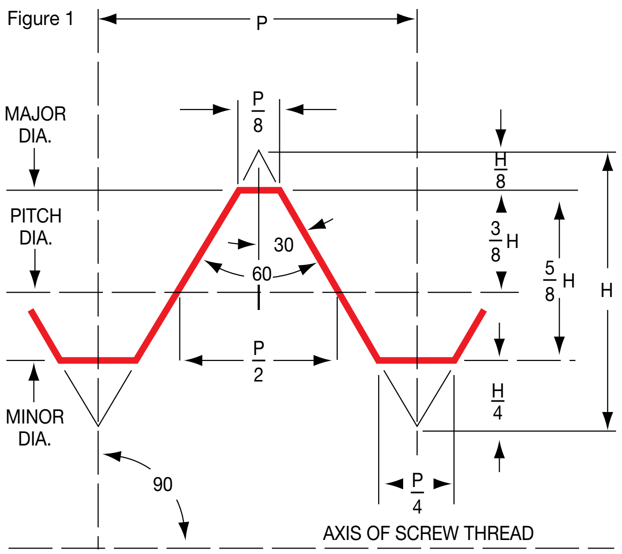
ISO Metric Tolerance Positions

Three tolerance positions are standardised for bolts and two for nuts. These are designated e, g and h for bolts and G and H for nuts. As in the ISO System for limits and fits, small letters are used to designate tolerance positions for bolts and capital letters are used for nut tolerance positions. Also the letters h and H are used for tolerance positions having the maximum metal limit coincided with the basic size, i.e., with a fundamental deviation of zero. Fig. 2.

ISO Metric Tolerance Grades

A series of tolerance grades designated 4, 5, 6, 7
and 8 for nut pitch diameters. An extended series of tolerance grades, designated 3, 4, 5, 6, 7,8 and 9, for bolt pitch diameters.
An important factor here is that for the same tolerance grade the nut pitch diameter tolerance is 1.32 x the corresponding bolt pitch diameter tolerance.
Size and recommendations of fits can be obtained from the Australian Standards AS 1275 or AS 1721.

Figure 1



$H = 0.86603P$

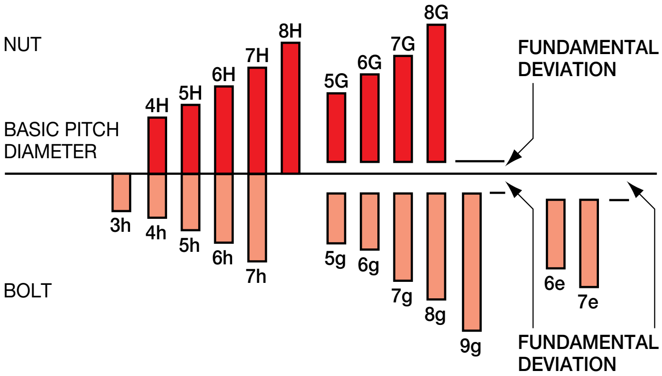
$\frac{H}{4} = 0.21651P$

$\frac{H}{8} = 0.10825P$

$\frac{3}{8}H = 0.32476P$

$\frac{5}{8}H = 0.54127P$

Figure 2



The ISO metric system of tap tolerances comprises three classes of tap sizes which are calculated from the Grade 5 nut tolerance, irrespective of the nut grade to be cut as follows:

ISO, Class 1 – Class 2 – Class 3

The tolerances of these three classes are determined in terms of a tolerance unit t, the value of which is equal to the pitch tolerance value TD2 grade 5 of nut (extrapolated up to pitch 0.2mm):

$t = TD_2$ grade 5

The value of the tap pitch diameter tolerance is the same for all three classes 1, 2 and 3: it is equal to 20% of t.

The position of the tolerance of the tap with respect to the basic pitch diameter results from the lower deviation the values of which are (see figure 3):

for tap class 1: + 0.1 t

for tap class 2: + 0.3 t

for tap class 3: + 0.5 t

Choice of tolerance class of the tap with respect to the class of thread to be produced.

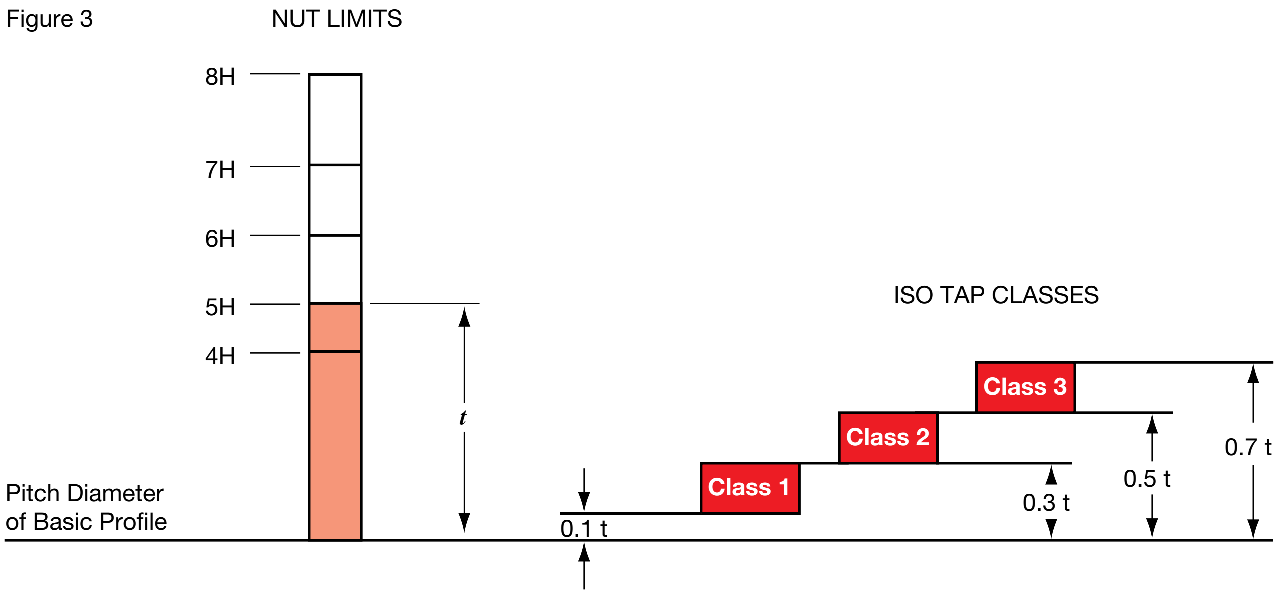
Unless otherwise specified, the taps of classes 1 to 3 will generally be used for the manufacture of nuts of the following classes:

ISO, Class 1: for nuts of limits 4H and 5H

ISO, Class 2: for nuts of limits 6H and 5G

ISO, Class 3: for nuts of limits 7H – 8H and 6G.

Figure 3



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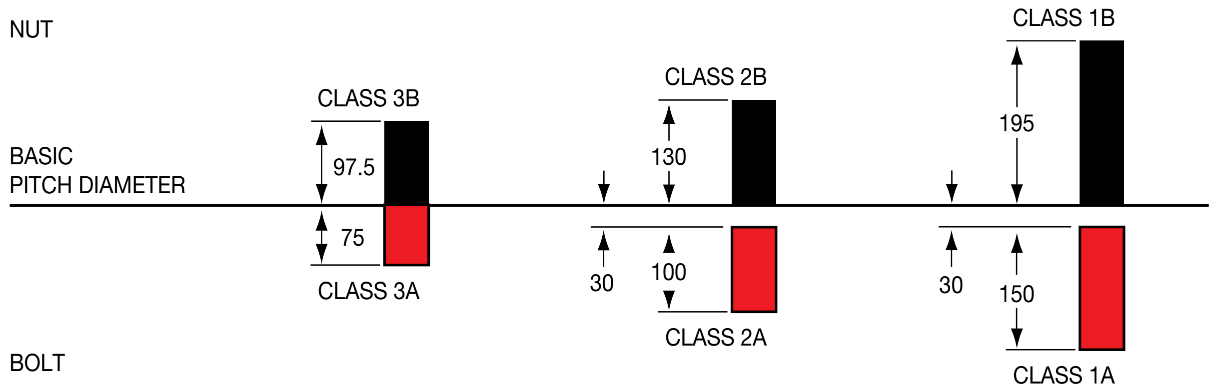
This system is well known. It has now been accepted by ISO as the recommended tolerancing for ISO inch threads down to 0.06 inch nominal diameter. The arrangement of the allowance and the various classes of pitch diameter tolerance for a normal length of engagement of the mating threads is shown in this diagram.
The pitch diameter tolerance for Class 2A bolts is shown as 100 units, and the fundamental deviation and other tolerances are shown as percentages of the Class 2A tolerance. Fig. 4.

Figure 4

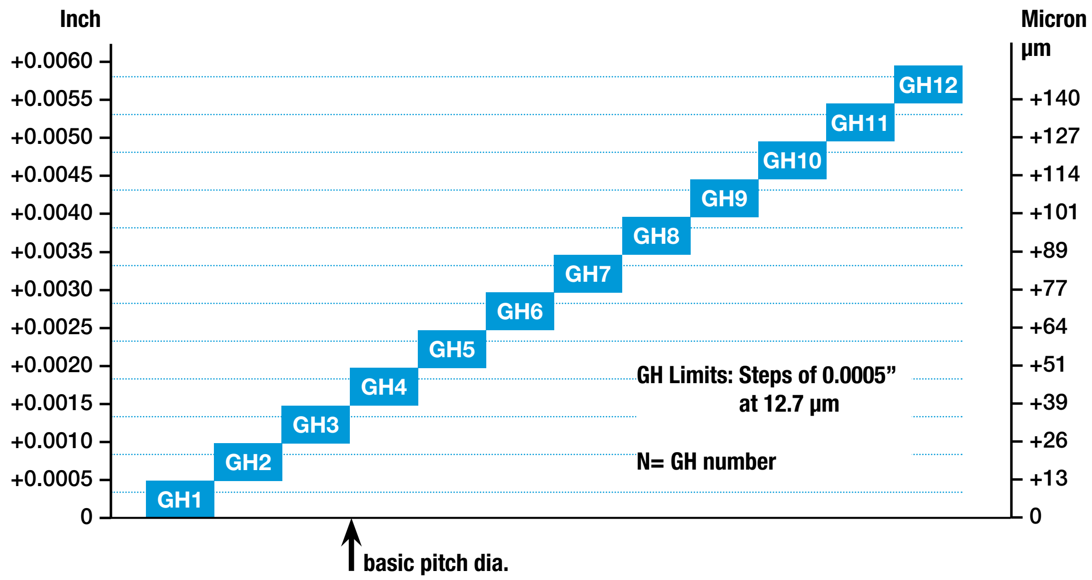


Unified Taps
The "GH" System

This system provides for a range of pitch diameters for each size of tap: the height limit of pitch diameters being the basic pitch diameter plus increments or units of .0005". It is designated by the letter "GH" followed by a numeral indicating the number or units applying to the particular "GH" size. The tap manufacturer's tolerance is applied as minus.
This is the limit which will normally be supplied. Alternative "GH" limits other than those shown in the price list can be made to special order.

GH Limits for JIS Roll Taps

GH Limits are applied to JIS Metric and Unified Thredflo Tap Threads due to market demands in the JIS standard.



For Sutton Tools Metric (mm) Roll / Fluteless Taps (Limit same as the "RH" & "G" Limits)
GH Limits: Steps of 0.0127 mm
N = GH number

GH LIMITS

Upper limit: 0.0005" x N
Lower limit: (0.0005" x N) – 0.0005

Basic Profile for Whitworth (BSW, BSF and WHIT.) Thread forms

British Standard Whitworth Form

The sides of the thread form an angle of 55° with one another, and the top and bottom of the full triangle are truncated one-sixth of the height. The actual depth of the thread is equal to two-thirds of the height of the generating triangle and is equal to 0.6403 times the pitch. The crests and roots are rounded to a radius of 0.137329 times the pitch. Fig. 5.

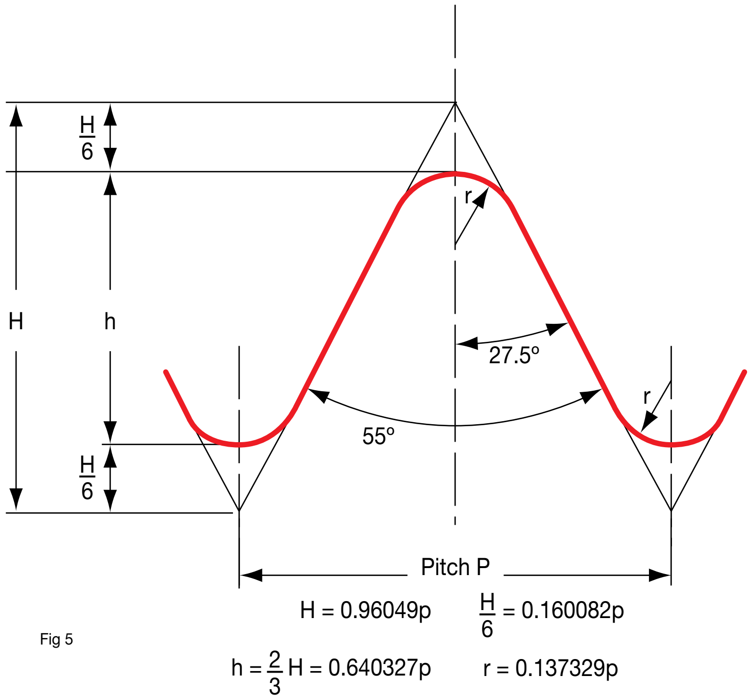
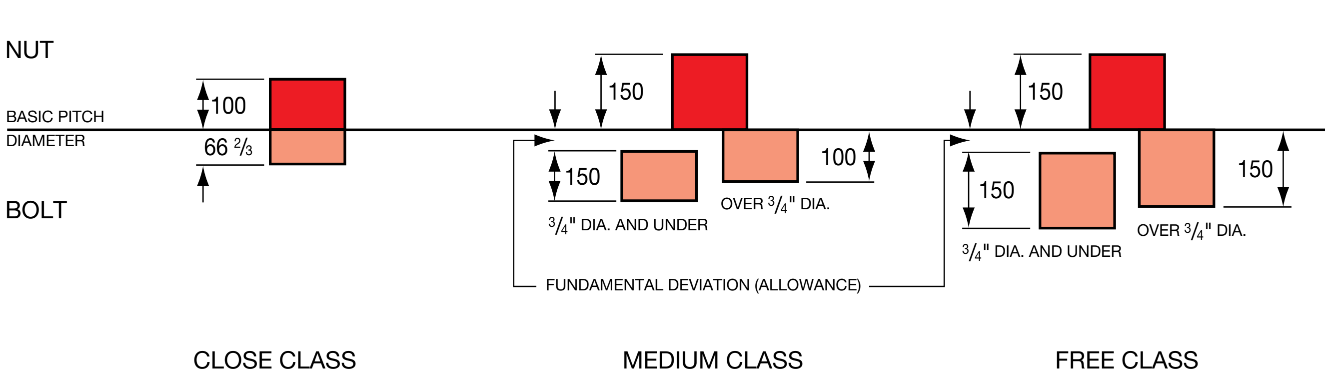


Fig 5

The Whitworth Screw Thread Tolerance System

Figure 6



Pitch diameter tolerance zones of recommended combinations of classes of bolts and nuts having Whitworth screw threads. Fig. 6

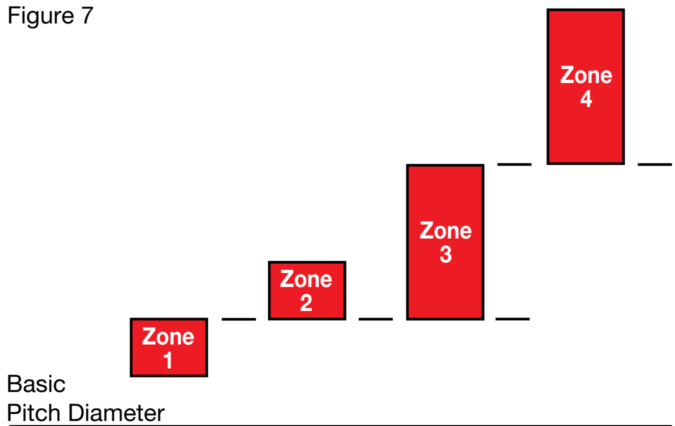
British Tap Size Zone Limits

British Standard Zone 3 and Zone 4 limits are normally applied to Whitworth and BA taps.

The values for position and tolerances are formulated and must be obtained from the standard's tables.

The accompanying chart shows the zone limits relationship for ground threads. Fig. 7.

Figure 7



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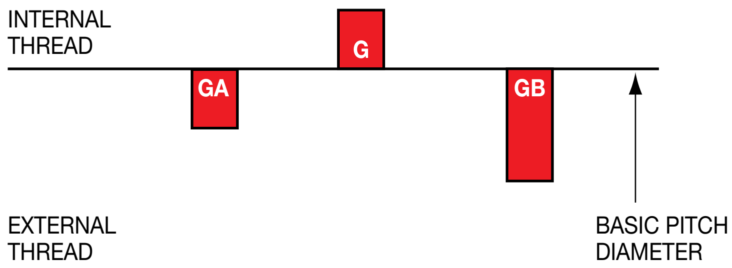
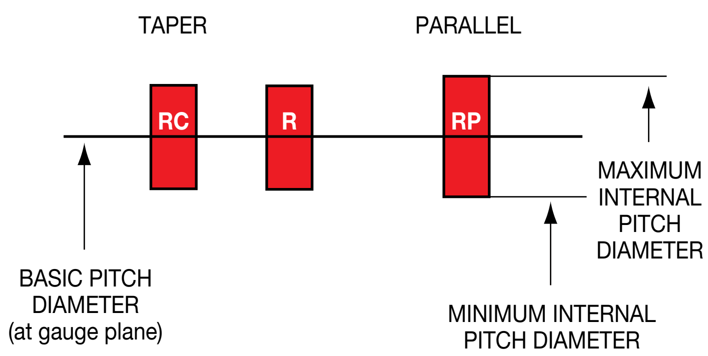
The International Standard Pipe Tap Thread System (ISO) has been derived from the original Whitworth gas and water pipe tap threads, formerly known as BSPF (Fastening) and BSPT (Taper), these systems have been so widely used throughout Europe and the United Kingdom that they have been metricated, whilst still retaining the whitworth thread form. These popular thread systems are the basis for the ISO parallel "G" series and the taper "R" series, these systems are endorsed and in agreement with the current British and Australian standards. For comparison, the pitch diameter tolerance zones are given for both the parallel and taper systems.

"G" Fastening Parallel Pipe Threads – ISO 228, AS1722 PT2 and BS2779.
This parallel thread system has only one positive internal thread tolerance and two classes of external tolerances. This series constitutes a fine series of fastening connecting pipe threads for general engineering purposes, the assembly tolerances on these threads are such as to make them unsuitable for pressure tight seal by the threads themselves. For the conveying of fluids, the seal may be produced by gaskets, flanges, or "O" rings etc.



"R" Sealing Taper Pipe Threads – ISO 7, AS1722 PT1 and BS21. The taper rate is 1-16 on diameter.
This series is for tubes and fittings where pressure tight joints are made by threads, these threads therefore must have a full form profile (no truncations). The series include a taper external thread (R) for assembly with either taper internal (Rc) or parallel internal (Rp) threads. The Rp series has a unilateral tolerance (+/–) which normally requires a special below basic low limit tap, to allow for sizing deviations at the start of the internal thread, the size is gauged at this position, with an Rc taper gauge. The low limit Rp tap size, allows a minimum accommodation length to be machined, with an equivalent material saving possible.



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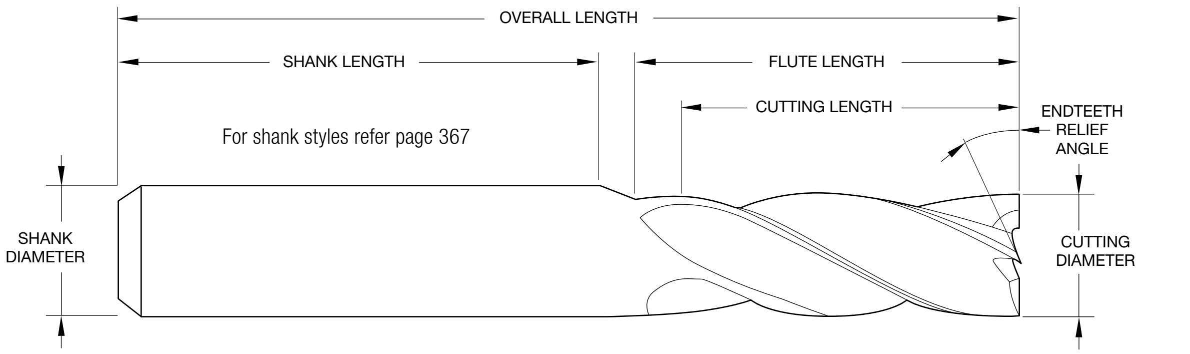
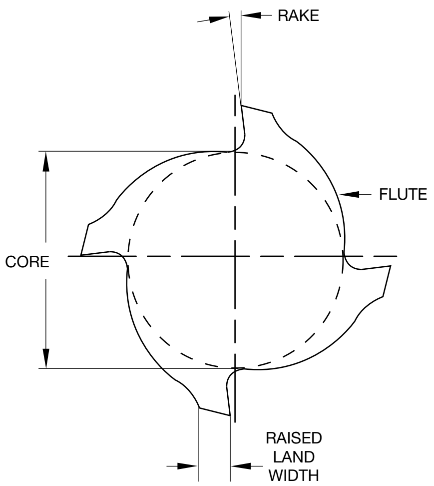
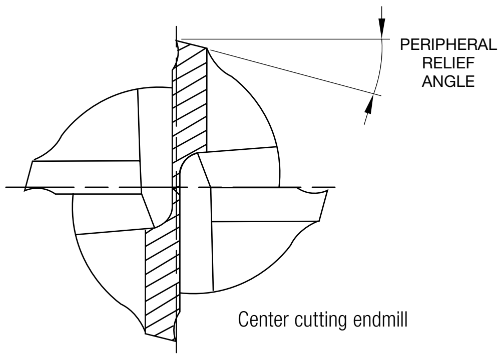
Endmill Definitions







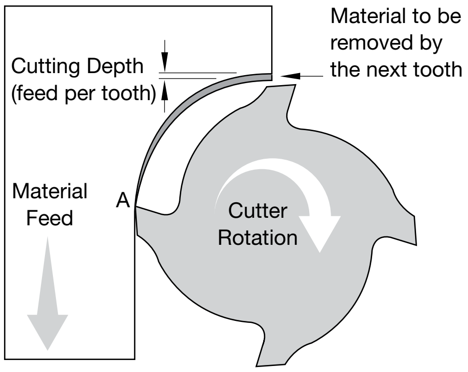
Center cutting endmill

Conventional milling versus climb milling

A milling cutter can cut in two directions, sometimes known as climb or conventional.

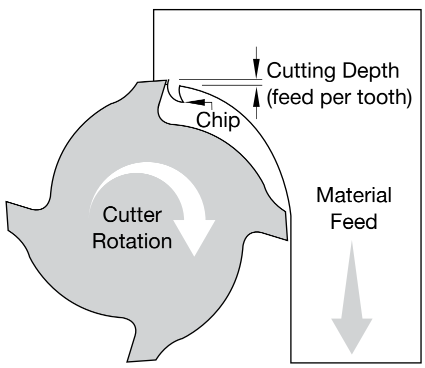
Conventional milling: The depth of the cut starts at zero thickness, and increases up to the maximum. The cut is so light at the beginning that the tool does not cut, but slides across the surface of the material, until sufficient pressure is built up and the tooth suddenly bites and begins to cut. This deforms the material (at point A on the diagram, left), work hardening it, and dulling the tool. The sliding and biting behaviour leaves a poor finish on the material.

Conventional milling. Point A may become work hardened



Climb milling: Each tooth engages the material at a definite point, and the width of the cut starts at the maximum and decreases to zero. The chips are disposed behind the cutter, leading to easier swarf removal. The tooth does not rub on the material, and so tool life may be longer. However, climb milling can apply larger loads to the machine, and so is not recommended for older milling machines, or machines which are not in good condition. This type of milling is used predominantly on mills with a backlash eliminator.

Chip formation during climb milling



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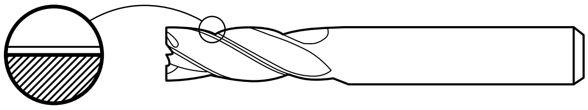
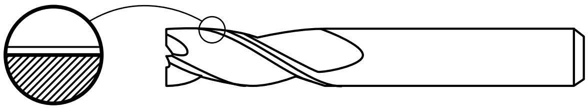
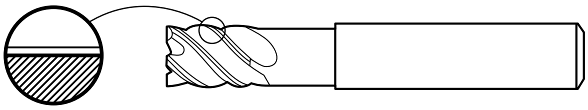
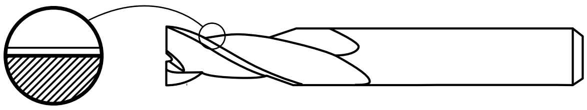
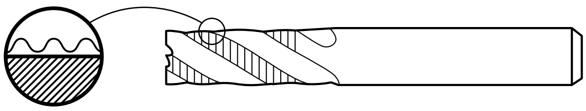
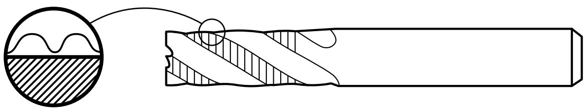
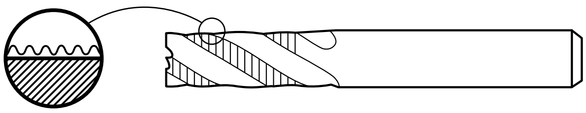
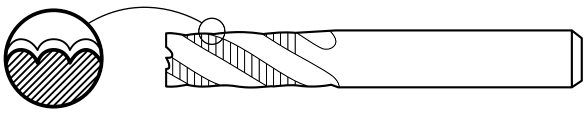
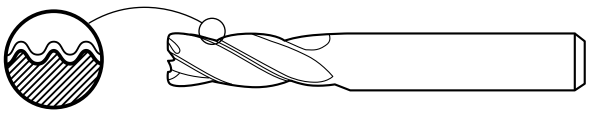
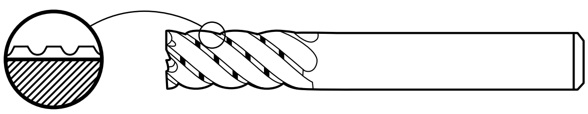
Type	Description	Application	Illustration
N	Finishing Form		
W	Slotting & Finishing - Use in soft materials, quick spiral 45° upto 600 N/mm^2		
VA	Optimized geometry for Austentic Stainless Steels & other long chipping materials upto 1000 N/mm^2		
Al & CU	For slotting wrought aluminium alloys with efficient chip evacuation, due to high relief angles and 40° spiral		
NR	Normal Roughing Form - general purpose		
WR	Coarse Form - ideally suited to soft, non-ferrous materials.		
HR	Fine Pitch Roughing Form - ideally suited to hard, short chipping materials		
HRS	Special Fine Pitch Roughing Form - Universal use		
Ti	Wave Form - ideally suited to titanium & nickel alloys		
STF	Special tooth form - Semi Roughing Form, ideally suited to materials upto 1400 N/mm^2		

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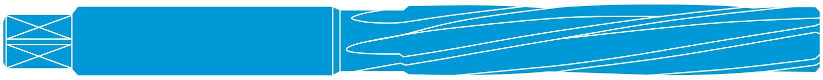

Feeds

In reaming, feeds are usually much higher than those used for drilling. The amount per feed may vary with the material, but a good starting point would be between 0.038mm and 0.10mm per flute per revolution. Too low a feed may result in glazing, excessive wear, and occasionally chatter. Too high a feed tends to reduce the accuracy of the hole and may lower the quality of the finish.The basic idea is to use as high a feed as possible and still produce the required accuracy and finish.

Stock to be removed

For the same reason, insufficient stock for reaming may result in a burnishing rather than a cutting action. It is very difficult to generalise on this phase as it is closely tied with the type of material the finish required, depth of hole, and chip capacity of the reamer. For machine reaming 0.20mm for a 6mm hole, 0.30mm for a 12mm hole, and 0.50mm for a 50mm hole, would be a typical starting point guide. For hand reaming, stock allowances are much smaller, partly because of the difficulty in hand forcing the reamer through greater stock.
A common allowance is 0.08mm to 0.13mm.

Speeds

The most efficient speed for machine reaming is closely tied in with the type of material being reamed, the rigidity of the set-up, and the tolerance or finish required. Quite often the best speed is found to lie around two-thirds the speed used for drilling the same material.
A lack of rigidity in the set-up may necessitate slower speeds, while occasionally a very compact, rigid operation may permit still higher speeds.
When close tolerances and fine finish are required it is usually found necessary to finish the reamer at considerably lower speeds.
In general, reamers do not work well when they chatter. Consequently, one primary consideration in selecting a speed is to stay low enough to eliminate chatter. Other ways of reducing chatter will be considered later, but this one rule holds: SPEEDS MUST NOT BE SO HIGH AS TO PERMIT CHATTER.

The following charts gives recommended surface feet per minute values which may be used as a basis from which to start.

Material	m/min
Aluminium and its alloys	20 – 35
Brass and Bronze, ordinary	20 – 35
Bronze, high tensile	18 – 22
Monel Metal	8 – 12
Cast Iron, soft	22 – 35
Cast iron, hard	18 – 22
Cast Iron, chilled	7 – 10
Malleable Iron	18 – 20
Steel, Annealed	13 – 18
Steel, Alloy	12 – 13
Steel, Alloy 300-400 Brinell	7 – 10
Stainless Steel	5 – 12

Chatter

The presence of chatter while reaming has a very bad effect on reamer life and on the finish of the hole. Chatter may be the result of several causes, some of which are listed:

1. Excessive speed.
2. Too much clearance on reamer.
3. Lack of rigidity in jig or machine.
4. Insecure holding of work.
5. Excessive overhang of reamer in spindle.
6. Excessive looseness in floating holder.
7. Too light a feed.

Correcting the cause can materially increase both reamer life and the quality of the reamed holes.

Coolants for Reaming

In reaming, the emphasis is usually on finish and a lubricant is normally chosen for this purpose rather than for cooling. Quite often this means a straight cutting oil.

Limit of tolerance on cutting diameter

The tolerance on the cutting diameter measured immediately behind the bevel or taper lead for parallel reamers listed is M6 as specified in BS122-PT2-1964. It is not practicable to standardise reamer limits to suit each grade of hole and the limits chosen are intended to produce H7 holes.

Nominal Diameter Range				Cutting Edge Diameter			
Inch		mm		Inch		mm	
Over	Up to and including	Over	Up to and including	High +	Low +	High +	Low +
0.0394	0.1181	1	3	0.0004	0.0001	0.009	0.002
0.1181	0.2362	3	6	0.0005	0.0002	0.012	0.004
0.2362	0.3937	6	10	0.0006	0.0002	0.015	0.006
0.3937	0.7087	10	18	0.0007	0.0003	0.018	0.007
0.7087	1.1181	18	30	0.0008	0.0003	0.021	0.008
1.1811	1.9085	30	50	0.0010	0.0004	0.025	0.009
1.9085	3.1496	50	80	0.0012	0.0004	0.030	0.011

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- ◊ Animated demonstrations of machining processes

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Sutton Tools

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APPLICATION HSS DRILLS - SPECIAL ENQUIRY

Customer No.: ______ **New Customer** ☐ **Order No.** | | | | | | | | | | | |

Company: ______ **Contact:** ______

Address: ______ **Phone:** ______

State / Province: ______ **Fax:** ______

Country: ______ **Email:** ______

Drill Details

Tool Material:	☐ HSS ☐ HSS-E	☐ PM HSS-E	☐ Other
Tool Type:	☐ Drill	☐ Step Drill	☐ Subland Drills
	☐ Core Drills	☐ Countersinks	☐ Centre Drills
Internal Cooling:	☐ Without	☐ With	
Shank Design:	☐ Reinforced	☐ Without Flat	☐ With Flat
	☐ Parallel Straight Shank	☐ Morse Taper	☐ Other
Number of Steps:	☐ Without	☐ With________ Steps	
Total Length:	☐ ____________ mm		
Step Diameter:	☐ d_1__________ mm	☐ d_2__________ mm	☐ d_3__________ mm
	☐ d_4__________ mm	☐ d_5__________ mm	☐ d_6__________ mm
Point Geometry	☐ Relieved Cone	☐ For Grey Cast Iron	☐ Centre Point
	☐ Facet Point Grind	☐ Other	
Special Point Grind, Form:	☐ A ☐ B	☐ C	
	☐ Without	☐ Other	
Coating:	☐ Uncoated	☐ TiN	☐ TiCN
	☐ TiAIN	☐ TeClube	☐ Steam Oxide
	☐ Other		
Spiral:	☐ RH	☐ LH	
Quantity Required:	______________ Tools		

Drawing / Notes

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Item No. 499980185A

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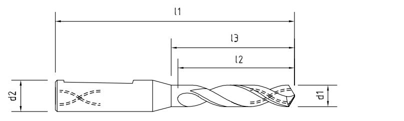
APPLICATION TWIST DRILL - SPECIAL ENQUIRY

Customer No.:	New Customer ☐	Order No.														
Company:		Contact:	
Address:		Phone:	
		Fax:	
Date:		Signature:	

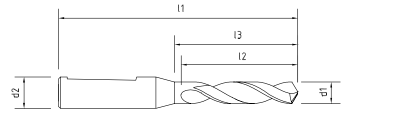
Solid Carbide Drill Without Step

Carbide grade
(specify if known)

WITH Internal Cooling



WITHOUT Internal Cooling

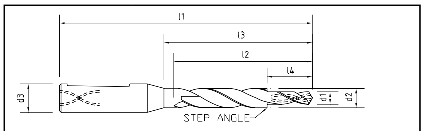


	WITH Internal Cooling: Range	WITH Internal Cooling: Complete	WITHOUT Internal Cooling: Range	WITHOUT Internal Cooling: Complete
Norm-Ø d_2	4.0 - 20.0mm		3.0 - 20.0mm	
Shank-Ø d_2 to DIN 6535				
Shank length l to DIN 6535				
Shank form to DIN 6535	HA HE		HA HE	
Drilling depth l_3	Maximum 7 x D		Maximum 7 x D	
Flute length l_2	9.5 - 155mm		9.5 - 155mm	
Total length l_1	60 - 205mm		60 - 205mm	
Point angle	120º / 130º / 140º		120º / 130º / 140º	
Point geometry (specify if known)				
Surface finish/coating	Uncoated / TiN		Uncoated / TiN	
	/ TiCN / TiALN / TeClube		/ TiCN / TiALN / TeClube	
Quantity				
Cost per tool				

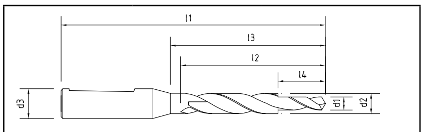
Solid Carbide Step Drill

Carbide grade
(specify if known)

WITH Internal Cooling



WITHOUT Internal Cooling



	WITH Internal Cooling: Range	WITH Internal Cooling: Complete	WITHOUT Internal Cooling: Range	WITHOUT Internal Cooling: Complete
Step-Ø d_1	4.0 - 20.0mm		3.0 - 20.0mm	
Body-Ø d_2	4.0 - 20.0mm		3.0 - 20.0mm	
Shank-Ø d_3 to DIN 6535				
Shank length l_3 to DIN 6535				
Shank form to DIN 6535	HA HE		HA HE	
Step length l_4	3 - 100 mm		3 - 100 mm	
Drilling depth l_3	Maximum 7 x D		Maximum 7 x D	
Flute length l_2	9.5 - 155mm		9.5 - 155mm	
Total length l_1	60 - 205mm		60 - 205mm	
Point angle	120º / 130º / 140º		120º / 130º / 140º	
Step angle	60º / 90º / 120º		60º / 90º / 120º	
Point geometry (specify if known)				
Surface finish/coating	Uncoated / TiN		Uncoated / TiN	
	/ TiCN / TiALN / TeClube		/ TiCN / TiALN / TeClube	
Quantity				
Cost per tool				

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Item No. 499980185 c

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APPLICATION TAP - SPECIAL ENQUIRY

Customer No.: **New Customer** ☐ **Order No.** | | | | | | | | | | | | |

Company:

Address:

State/Province:

Country:

Contact:

Phone:

Fax:

Email:

Tap Details

☐ Thread Cutting ☐ Thread Forming

Size:

Thread Limit:

Please Note: If special thread form, please supply details on separate drawing

d_1

d_2

l_1

l_2

l_3

l_4

sq a/f

Existing Method

Manufacturer:

Dimensions:

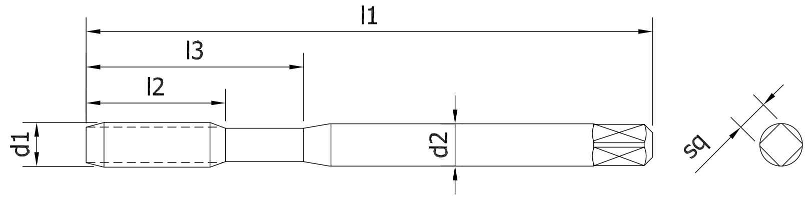
Tolerance:

Product No.:

Tool Material:

Coating: ☐ Uncoated ☐ Steam Oxide ☐ TiN ☐ TiAlN ☐ TiCN ☐ TeClube

Speed:



Workpiece Details

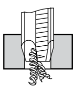
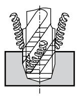
Component:

Material Group:

Material Grade:

Characteristics of Material: ☐ Short Chipping ☐ Long Chipping

Tapping Hole Size: ☐ Drilled ☐ Cast ☐ Punched

Hole Type:  ☐ Through Hole  ☐ Blind Hole

Hole Depth:

Drawing / Notes

Machine Details

Machine Type: ☐ CNC ☐ Semi Auto ☐ Manual

Machine Direction: ☐ Vertical ☐ Horizontal ☐ Oblique

Work Piece Holder: ☐ Stationary ☐ Rotating

Coolant: ☐ Neat Oil ☐ Mist / Dry ☐ Emulsion >5% ☐ Emulsion >10%

Feed: ☐ CNC ☐ Mechanical ☐ Pneumatic ☐ Hydraulic ☐ Manual

Tapping Attachment:

☐ Tapping Chuck ☐ Tension ☐ Compression

☐ Tapping Attachment

☐ Tapping Chuck (rigid)

☐ Collet Chuck (length compensating)

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Item No. 499980185B

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APPLICATION MILLING - SPECIAL ENQUIRY

Customer No.: New Customer ☐

Company:

Address:

Date:

Order No. | | | | | | | | | | | | |

Contact:

Phone:

Fax:

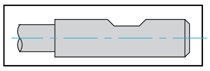
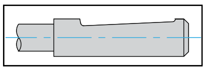
Signature:

Basic Geometry

	Range	Complete
Norm-Ø d_2	3.0 - 20.0mm	Ø mm
Shank-Ø d_2 to DIN 6535	4.0 - 20.0mm	Ø mm
Shank length l_3	to DIN 6535	mm
Total length l_1		
Ø 3.0 to 10.0	28.0 - 100mm	mm
from Ø 10.0 to 20.0	56.0 - 150mm	mm
Cutting length l_2		
Ø 3.0 to 10.0	3.0 - 40.0mm	mm
from Ø 10.0 to 20.0	10.0 - 65.0mm	mm
Helix angle w_1		
Ø 3.0 to 6.0	20º - 45º	
from Ø 6.0 to 20.0	20º - 55º	
No. of cutting edges		
Ø 3.0 to 6.0	2 - 4	
from Ø 6.0 to 20.0	2 - 6	
from Ø 16.0 to 20.0	2 - 8	

Shank Design

Straight Shank	Choice DIN 6535	☐ HA ☐ HB ☐ HE


HA

HB

HE

Peripheral Geometry

Finishing and Mills	Ø 3.0 - 20.0mm	☐ N ☐ Chip Breaker
Roughing and Mills	Ø 6.0 - 20.0mm	☐ Coarse ☐ Fine

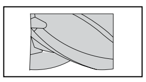
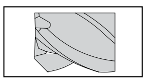
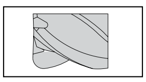
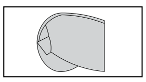
N w chip breaker Coarse Fine

Face Geometry

Point angle w_s	180º + 5º	
Cutting to centre	Choice	☐ Yes ☐ No

Corner Prep/ ...

Sharp edge	Choice	☐ Yes ☐ No
Corner protection	Ø 0.03 - 1.5mm x 45º	mm x 45º
Corner radius	Ø 0.3mm - 2/3 x d_1	mm
Ball nosed	Choice	☐ Yes ☐ No


Sharp edge

Corner protection

Corner radius

Ball-nosed

Pluse Internal Cooling

Diameter range	Ø 4.0 - 20.0mm	☐ Yes	☐ No

Pluse Coating

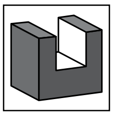
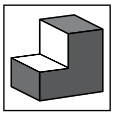
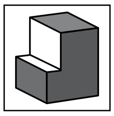
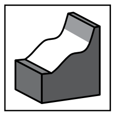
Coating	Ø 4.0 - 20.0mm	☐ TiN	☐ TiCN
	☐ Uncoated	☐ TeClube	☐ TiAlN

Tool Material

Carbide (specify grade, if known)	
PM-HSSE (specify grade, if known)	
HSS-Co	
HSS	

Detail Regarding Application

Range of applications		
Material description		
Material hardness	(N/mm^2 or HR_c)	
Application Types	☐ Slotting	☐ Roughing op.
	☐ Finishing op.	☐ Copy


Slotting

Roughing op.

Finishing op.

Copy milling

Drawing / Notes

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