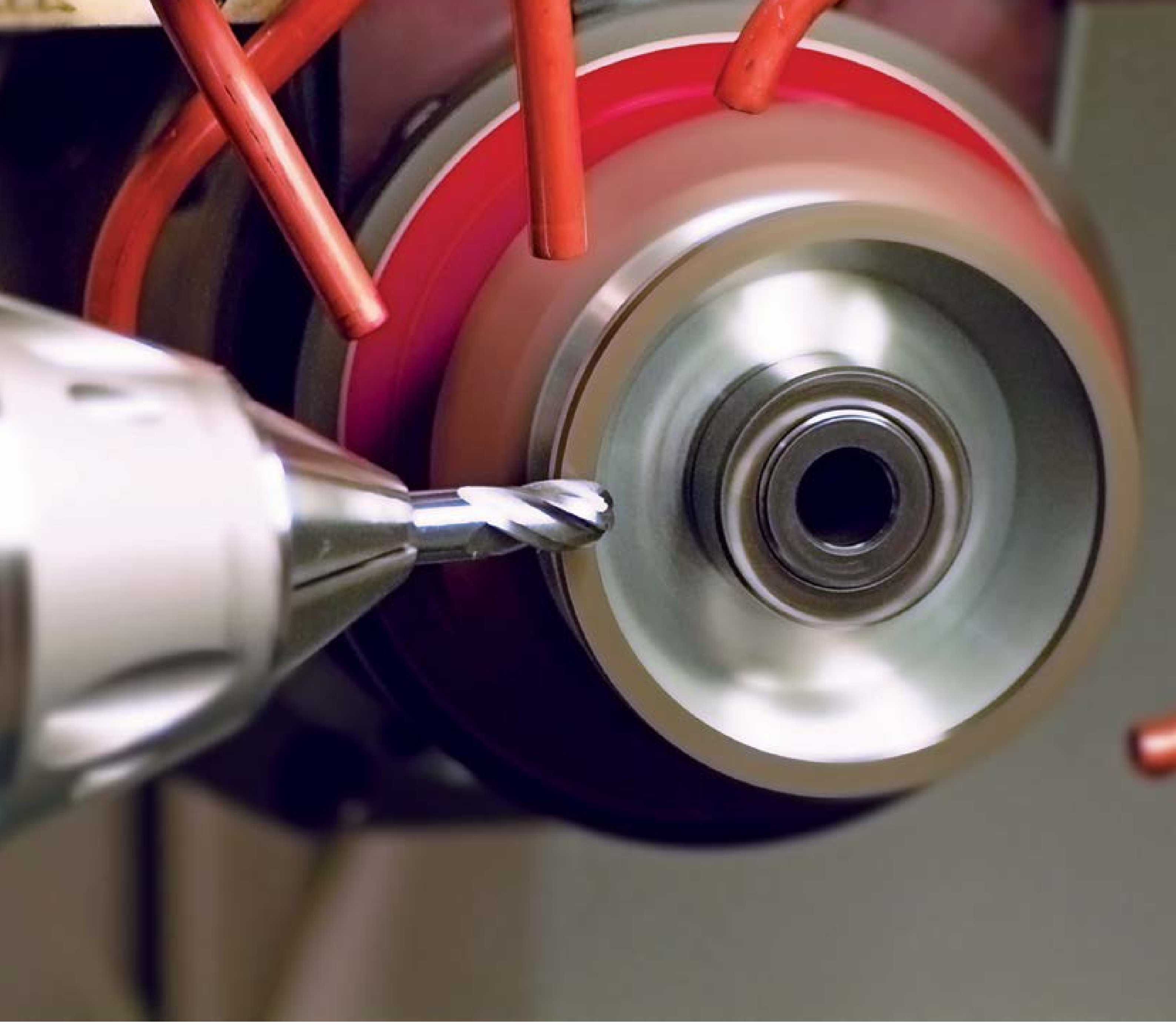
TECHNICAL INFO

• Speeds & Feeds Charts • Troubleshooting
• General • Drills • Taps • Endmills • Reamers



Regrinding Service... Reduce your production costs

Sutton Tools continue to reinvest to provide a 'complete' range in cutting tool products and services. Our regrinding service returns tools to 'as new' condition. Quality is guaranteed from the CNC grinding machines which are operated by highly experienced personnel, using advanced technology. A full regrinding service is offered in Europe. HSS and carbide tooling can be reconditioned by our highly experienced personnel, with reproducible, high quality results, every time.

We regrind HSS Powdered Metallurgy and grades of Solid Carbide, complemented by fifth generation thin film coatings.

Sutton Tools Recoating Service
In Europe we provide a full regrinding service for Sutton Tools distributors. Using world-leading technology, coatings are available to solve a wide range of problems relating to friction and wear, thereby improving tool performance and increasing tool life, up to 300-1000% compared to uncoated.

Send & Return Service
Sutton Tools re-sharpening boxes will be provided for safe shipment of your tools for servicing. Simply fill in the request form, and we will return the tools to 'as new' condition as instructed. Contact us for your Sutton Tools re-sharpening box and request form.

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Application Guide Materials - Workpiece

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ISO	VDI 3323	Germany	Germany	U.K.	U.K.	France	Italy	Spain	Sweden	Japan	USA
	1	1.0402	C 22	050 A 20	2C	CC20	C 20 , C 21	F.112	1450		1020, G 10200
	1	1.0715	9 SMn 28	230 M 07		S250	CF 9 SMn 28	11SMn28	1912	SUM 22	1213, G 12130
	1	1.0722	10 SPb 20			10PbF2	CF 10 SPb 20	10SPb20			11 L 08
	1	1.0736	9 SMn 36	240 M 07	1B	S300	CF 9 SMn 36	12SMN35			1215, G 12150
	1	1.0737	9 SMnPb 36			S300Pb	CF 9 SMnPb 36	12SMnP35	1926		12 L 14, G 12144
	1	1.0401	C 15	080 M 15	CS	CC12	C16	F.111	1350	S 15 CK	1015, G 10170
	1	1.0718	9 SMnPb 28			S250Pb	CF 9 SMnPb 28	11SMnPb28	1914	SUM 22 L	12 L 13, G 12134
	1	1.1141	Ck 15	080 M 15	32C	XC12 , XC15 , XC18	C15		1370	S15C	1015, G 10170
	2	1.1170	28 Mn 6	150 M 28	14A	20M5	C 28 Mn			SCMn 1	1330
	2 / 3	1.0501	C 35	060 A 35		CC35	C 35	F.113	1550	S 35 C	1035, G 10350
	2 / 3	1.0503	C 45	080 M 46		CC45	C 45	F.114	1650	S45C	1045, G 10430
	2 / 3	1.1191	Ck 45	080 M 46			C 45	F.1140	1672	S48C	1045, G 10420
	2 / 3	1.0726	35 S 20	212 M 36	8M	35 MF 4		F.210.G	1957		1140, G 11400
	2 / 3	1.1157	40 Mn 4	150 M 36	15	35 M 5					1039, G10390
	2 / 3	1.1167	36 Mn 5	150 M 36		40 M 5		F.411	2120	SMn438(H)	1335, G 13350
	4 / 5	1.0535	C 55	070 M 55			C 55	F.1150	1655	S 55 C	1055
	4 / 5	1.0601	C 60	080 A 62	43D	CC 55	C 60			S 58 C	1060, G 10600
	4 / 5	1.1203	Ck 55	070 M 55		XC 55	C 50		1655	S 55 C	1055
	4 / 5	1.1221	Ck 60	080 A 62	43D	XC 60	C 60	F.1150	1665; 1678	S 58 C	1060, G 10640
	4 / 5	1.1545	C 105 W1	BW 1A			C 100 KU	F.5118	1880	SK 3	W 110, T 72301
	4 / 5	1.1274	Ck 101	060 A 96				F.5117	1870	SUP 4	1095, G 10950
	5 / 9	1.5120	38 MnSi 4								
	6 / 7	1.6657	10 NiCrMo 13-4	832 M 13	36C		15 NiCrMo 13	14NiCrMo131			
	6 / 7	1.5423	16 Mo 5	1503-245-420			16 Mo 5	16Mo5		SB 450 M	4520, G 45200
	6 / 7	1.7131	16 MnCr 5	527 M 17		16 MC 5	16 MnCr 5	F.1516	2511	SCR 415	5115, G 51170
	6 / 7	1.5622	14 Ni 6			16 N 6	14 Ni 6	15Ni6			A350LF5
	6 / 7	1.5415	15 Mo 3	1501-240		15 D 3	16 Mo 3	16Mo3	2912		A204GrA
	6 / 7	1.5752	14 NiCr 14	655 M 13	36A	12 NC 15				SNC 815 (H)	3310, 3415, 9314, G 33106
	6 / 7	1.6587	17 CrNiMo 6	820 A 16		18 NCD 6	18 NiCrMo 7				
	6 / 7	1.7262	15 CrMo 5			12 CD 4	12 CrMo 4	12CrMo4	2216		
P	6 / 7	1.7335	13 CrMo 4-4	1501-620 Gr. 27		15 CD 3.5	14 CrMo 4 5	14CrMo45	2216		A 182-F11, F12
	6 / 7	1.7380	10 CrMo 9-10	1501-622 Gr. 31, 45		10 CD 9.10	12 CrMo 9 10	F.155	2218		A 182-F22, J 21890
	6 / 7	1.7715	14 MoV 6-3	1503-660-440							
	6 / 7	1.7015	10 Cr 3	523 M 15		12 C 3				SCr 415 (H)	5015, G 50150
	6 / 8	1.7033	34 Cr 4	530 A 32	18B	32 C 4	34 Cr 4 (KB)			SCr 430 (H)	5132, G 51320
	6 / 8	1.7218	25 CrMo 4	1717 CDS 110		25 CD 4 S	25 CrMo 4 (KB)	F.1251	2225	SCM 420, SCM 430	4130, G 41300
	6 / 8	1.6523	21 NiCrMo 2	805 M 20	362	20 NCD 2	20 NiCrMo 2	F.1522	2506	SNCM 220 (H)	8620, G 86170
	6 / 9	1.7220	34 CrMo 4	708 A 37		35 CD 4	35 CrMo 4		2234	SCM 432, SCCrM 3	4135, 4137, G 41350
	6 / 9	1.7225	42 CrMo 4	708 M 40		42 CD 4	42 CrMo 4		2244	SCM 440 (H)	4140, 4142, G 41400
	6 / 9	1.8509	41 CrAlMo 7	905 M 39	41B	40 CAD 6.12	41 CrAlMo 7			SACM 645	A355GrA, K 24065
	6 / 9	1.0961	60 SiCr 7			60 SC 7	60 SiCr 8				9262
	6 / 9	1.2067	100 Cr 6	BL 3							L 3, T 61203
	6 / 9	1.2419	105 WCr 6			105 WC 13	107 WCr 5 KU		2140	SKS 31	
	6 / 9	1.2542	45 WCrV 7	BS 1			45 WCrV 8 KU		2710		S 1, T 41901
	6 / 9	1.2713	55 NiCrMoV 6			55 NCDV 7		F.520.S		SKT 4	L 6, T 61206
	6 / 9	1.7035	41 Cr 4	530 M 40	18	42 C 4	41 Cr 4			SCr 440 (H)	5140, G 51400
	6 / 9	1.7176	55 Cr 3	527 A 60	48	55 C 3	55 Cr 3		2253	SUP 9 (A)	5155, G 51550
	6 / 9	1.6546	40 NiCrMo 2-2	311-Type 7		40 NCD 2	40 NiCrMo 2 (KB)			SNCM 240	8740, G 87400
	6 / 9	1.6511	36 CrNiMo 4	816 M 40	110	40 NCD 3	38 NiCrMo 4 (KB)				9840, G 98400
	6 / 9	1.6582	34 CrNiMo 6	817 M 40	24	35 NCD 6	35 NiCrMo 6 (KW)		2541	SNCM 447	4340
	6 / 9	1.7361	32 CrMo 12	722 M 24	40B	30 CD 12	32 CrMo 12		2240		
	6 / 9	1.8159	50 CrV 4	735 A 50	47	50 CV 4	51 CrV 4	51CrV4	2230	SUP 10	6145, 6150
	6 / 9	1.8523	39 CrMoV 13-9	897 M 39	40C		36 CrMoV 13 9				
	6 / 9	1.8161	58 CrV 4								
	10 /11	1.5680	12 Ni 19			Z 18 N 5					2515
	10 /11	1.2363	X100 CrMoV 5-1	BA 2		Z 100 CDV 5	X 100 CrMoV 5 1 KU	F.5227	2260	SKD 12	A 2, T 30102
	10 /11	1.2436	X210 CrW 12				X 215 CrW 12 1 KU	F.5213	2312	SKD 2	D 4
	10 /11	1.2601	X165 CrMoV 12				X 165 CrMoW 12 KU		2310		
	10 /11	1.3343	S 6-5-2	BM 2		Z 85 WDCV 06.05.04.02	HS 6-5-2		2722	SKH 51	M 2, T 11302
	10 /11	1.2344	X40 CrMoV 5-1	BH 13		Z 40 CDV 5	X 40 CrMo 5 1 1 KU	F.5318	2242	SKD 61	H 13, T 20813

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ISO	VDI 3323	Germany	Germany	U.K.	U.K.	France	Italy	Spain	Sweden	Japan	USA
	10 /11	1.2581	X30 WCrV 9-3	BH 21		Z 30 WCV 9	X 30 WCrV 9 3 KU			SKD 5	H 21, T 20821
	10 /11	1.2080	X210 Cr 12	BD 3		Z 200 C 12	X 210 Cr 13 KU			SKD 1	D 3, T 30403
	10 /11	1.3243	S 6-5-2-5	BM 35		Z 85 WDKCV 06.05.05.04.02	HS 6-5-2-5	HS 6-5-2-5	2723	SKH 55	M35
	10 /11	1.3348	S 2-9-2			Z 100 DCWV 09.04.02.02	HS 2-9-2	HS 2-9-2	2782		M 7, T 11307
	10 /11	1.3255	S 18-1-2-5	BT 4		Z 80 WKCV 18.05.04.0	HS 18-1-1-5	HS 18-1-1-5		SKH 3	T 4, T 12004
	10 /11	1.3355	S 18-0-1	BT 1		Z 80 WCV 18.04.01	HS 18-0-1	HS 18-0-1		SKH 2	T 1, T 12001
	10 /11	1.4718	X45 CrSi 9-3	401 S 45	52	Z 45 CS 9	X 45 CrSi 8			SUH 1	HNV 3, S 65007
	12 /13	1.4104	X12 CrMoS 17	420 S 37		Z 10 CF 17	X 10 CrS 17	F.3117	2383	SUS 430 F	430 F, S 43020
P	12 /13	1.4000	X6 Cr 13	403 S 17		Z 6 C 13	X 6 Cr 13	F.3110	2301	SUS 403	403, S 40300
	12 /13	1.4016	X6 Cr 17	430 S 15	60	Z 8 C 17	X 8 Cr 17	F.3113	2320	SUS 430	430, S 43000
	12 /13	1.4113	X6 CrMo 17	434 S 17		Z 8 CD 17.01	X 8 CrMo 17			SUS 434	434, S 43400
	12 /13	1.4006	X12 Cr 13	410 S 21	56A	Z10 C 13	X 12 Cr 13	F.3401	2302	SUS 410	410 S, S 41000
	12 /13	1.4001	X7 Cr 14					F.8401		SUS 429	429
	12 /13	1.4871	X53 CrMnNiN 21-9	349 S 52		Z 52 CMN 21.09	X 53 CrMnNiN 21 9			SUH 35	EV 8, S 63008
	12 /13	1.4034	X46 Cr 13	420 S 45	56D	Z 40 C 14	X 40 Cr 14	F.3405	2304	SUS 420J2	
	12 /13	1.4057	X19 CrNi 17-2	431 S 29	57	Z 15 CN 16.02	X 16 CrNi 16	F.3427	2321	SUS 431	431, S 43100
	12 /13	1.4313	X3 CrNi 13-4	425 C 11		Z 5 CN 13.4	X 6 CrNi 13 04		2385	SCS 5	CA 6-NM, J 91540
	12 /13	1.4027	G-X20Cr14	420 C 24	56B	Z 20 C 13 M				SCS 2	
	14.1	1.4436	X3 CrNiMo 17-13-3	316 S 33		Z 6 CND 18.12.03	X 5 CrNiMo 17 13 2		2343	SUS 316	316, S 31600
	14.1	1.4310	X10 CrNi 18-8	301 S 21		Z 12 CN 17.07	X2CrNi18 07	F.3517	2331	SUS 301	301, S 30100
	14.1	1.4401	X5 CrNiMo 17-12-2	316 S 31	58J	Z 6 CND 17.11	X 5 CrNiMo 17 12	F.3543	2347	SUS 316	316, S 31600
	14.1	1.4429	X2CrNiMoN 17-13-3	316 S 62		Z 2 CND 17.13 Az	X 2 CrNiMoN 17 13 3		2375	SUS 316 LN	316 LN, S 31653
	14.1	1.4583	X6 CrNiMoNb 18-12				X 6 CrNiMoNb 17 13				318
	14.1	1.4305	X10 CrNiS 18-10	303 S 21	58M	Z 10 CNF 18.09	X 10 CrNi 18 09	F.3508	2346	SUS 303	303, S 30300
	14.1	1.4301	X5 CrNi 18-10	304 S 15	58E	Z 6 CN 18.09	X 5 CrNi 18 11	F.3504	2332 , 2333	SUS 304	304 , 304 H, S 30400
	14.1	1.4571	X6 CrNiMoTi17-12-2	320 S 31	58J	Z 6 CNT 17.12	X 6 CrNiMoTi 17 12	F.3535	2350	SUS 316 Ti	316 Ti, S 31635
	14.1	1.4311	X2 CrNiN 18 10	304 S 62		Z 2 CN 18 .10	X2CrNiN18 10	F.3541	2371	SUS 304 LN	304 LN, S 30453
M	14.1	1.4308	G-X6CrNi 18-9	304 C 15	58E	Z 6 CN 18.10 M			2333	SCS 13	CF-8, J 92590
	14.1	1.4408	G-X6CrNiMo 18-10	316 C 16					2343	SCS 14	CF-8M, J 92900
	14.1	1.4581	G-X5CrNiMoNb 18	318 C 17		Z 4 CNDNb 18.12	GX5CrNiMoNb19 11 2			SCS 22	
	14.2	1.4845	X12 CrNi 25-21	310 S 24		Z 12 CN 25.20	X 6 CrNi 25 20	F.331	2361	SUH 310; SUS 310 S	310 S
	14.2	1.4878	X12 CrNiTi 18-9	321 S 51	58B	Z6CNT18.12B		F.3523	2337	SUS 321	321
	14.2	1.4541	X14 CrNiTi 18-10	321 S 12		Z 6 CNT 18.10	X 6 CrNiTi 18 11	F.3523	2337	SUS 321	321 H, S 32100
	14.2	1.4550	X6 CrNiNb 18-10	347 S 17	58F	Z 6 CNNb 18.10	X 6 CrNiNb 18 11	F.3524	2338	SUS 347	347, S 34700
	14.3	1.4545	X5CrNiCuNb15-5-4			EZ5CNU15-05					S15500, 15-5 PH
	14.3	1.4542	X5CrNiCuNb16-4			Z6CNU17-04					S17400, 17-4 PH; 630
	15 /16	0.6020	GG 20	180, 200/220, 220, Grade180, Grade260		FGL200, Ft20D	G 20	FG20	120	FC200	200/225, 25B, 30, 30B
	15	0.6010	GG-10		100	FT 10 D	G10		0110-00	FC100	
	15	0.6015	GG 15	Grade 150		FT 15 D	G 15	FG 15	0115-00	FC150	NO 25 B
	15	0.6660	GGL-NiCr202	L-NiCuCr202		L-NC 202			0523-00		A436 Type 2
	15	0.7040	GGG 40	SNG 420/12		FCS 400-12	GS400-12	FGE 38-17	0717-02	FCD400	60-40-18
	16	0.6030	GG30	Grade 300		Ft 30 D	G30	FG30	01 30-00	FC300	300/325, 40B, 45/50, 45B
	16	0.6035	GG-35	GRADE 350		Ft35D	G 35	FG 35	135	FC350	A48-50
	16	0.6040	GG40	GRADE400		Ft 40 D			140		A48-60 B
	16	0.7070	GGG-70	SNG700/2	EN-JS1070	FGS 700-2	GGG 70	GGG 70	07 37-01	FCD700, FCD700-2	100-70-03
	17	0.7033	GGG35.3						07 17-15		Ni-ResistD-5B, S-NiCr35-3
	17	0.7043	GGG-40.3	370/7	EN-JS1025	FGS 370/17			0717-15	FCD400-18L	60/40/18
K	17	0.7050	GGG50	SNG500/7	EN-JS1050	FGS 500/7	GGG 50	FGE50-7	0727-02	FCD500, FCD500-7	65-45-12, 70-50-05, 80-55-06
	17	0.7652	GGG-NiMn 13 7	S-NiMn 137		S-Mn 137					
	17	0.7660	GGG-NiCr 20 2	Grade S6		S-NC 202			0772-00		A43D2, Ni-ResistD-2, S-NiCr20-2
	18	0.6025	GG25	Grade260		Ft 25 D	G25	FG25	0717-12		250/275, 35, 35B, 40
	18	0.7060	GGG60	SNG600/3	EN-JS1060	FGS600-3	G 25	FG 25	07 32-03	FC250	100-70-03, 80-55-06, 80-60-03
	18								0727-03	FCD600	A48 40 B
	19	0.8055	GTW55								
	19	0.8135	GTS-35-10	B 340/2		Mn 35-10		GTS 35	810		
	19	0.8145	GTS-45-06	P 440/7		Mn 450-6			0815-00		A220-40010
	19		GTS-35	B 340/12			0852-00	GMN 45			
	19			8 290/6		MN 32-8					
	19		GTS-35	B340/12		MN 35-10			0810-00		32510

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Material Group		WKR	DIN	BS	EN	AFNOR	UNI	UNE	SS	JIS	AISI / SAE / UNS
ISO	VDI 3323	Germany	Germany	U.K.	U.K.	France	Italy	Spain	Sweden	Japan	USA
K	20	0.8035	GTM-35	W340/3		MB35-7			814	AC4A	
	20	0.8040	GTW-40	W410/4		MB40-10			08 15	FCMW330	
	20	0.8045						GTM 35	852		
	20	0.8065	GTMW-65				GMB40	GTM 40			
	20	0.8155	GTS-55-04	P 510/4		Mn 550-4	GMB45	GTM 45			A220-50005
	20	0.8165	GTS-65-02	P 570/3		Mn 650-3			0854-00		70003
	20	0.8170	GTS-70-02	P 690/2		Mn 700-2	GMN 55, 65		0854-00	FCMP490	90001
	20		GTS-45	P440/7			20 Mn 7	F.1515-20 Mn 6		SMnC 420	400 10
	20		GTS-65	P 570/3		MP 60-3	C 36; C 38		1572	S 35 C	70003
N	21	3.0205							08 52		Al99
	21	3.0255	Al99.5	L31/34/36		A59050C	P-Al99.5		Al99.5	FCMP540	1000
	21	3.3315	AlMg1								
	21	3.0505	AlMn0.5Mg0.5								
	21	3.0275	Al99.7	4508, 9001-3, P-Al99.7		1070A	Al99.7			1070, A1070	1070A
	21	3.0285	Al99.8	1080A		1080A	4590, 9001-4, P-Al99.8			1080A, 1080A	1080A, 1080A
	22	3.1325	AlCuMg 1			2017A	P-AlCu4MgMnSi			2017	A92017
	22	3.1655	AlCuSiPb								
	22	3.2315	AlMgSi1								
	22	3.4345	AlZnMgCuO,5	L 86		AZ 4 GU/9051					7050
	22	3.1305	AlCuMg0.5	L86		A-U2G2117	P-AlCu2.5MgSi			2117	2117
	22	3.0517	AlMnCu								
	23	3.2381	G-AlSi 10 Mg	G-AlSi9Mg		A-S10G			AlSi10Mg	AC4A, ADC3	A03590
	23	3.2382	GD-AlSi10Mg						811-04	ADC3	
	23	3.2581	G-AlSi12	LM20		A-S12U	G-AlSi13CuMn		AlSi12Cu	AC3A	A04130
	23	3.3561	G-AlMg 5							AC7A, ADC5, Al-Mg6	
	23	3.5101	G-MgZn4sE1Zr1	MAG 5							ZE 41
	23	3.5103	MgSE3Zn27r1	MAG 6		G-TR3Z2					EZ 33
	23	3.5812	G-MgAl8Zn1	NMAG 1							AZ 81
	23	3.5912	G-MgAl9Zn1	MAG 7							AZ 91
	23	3.3549	AlMg5Mn								
	23	3.3555	AlMg5								
	23	3.3547	AlMg4.5, AlMg4.5Mn	5083		5183	P-AlMg4.4		AlMg4.5Mn	5082	A95083
	23-24	3.2383	G-AlSi0Mg(Cu)	LM9					4253		A360.2
	23-24			2789;1973		NF A32-201					A356-72
	23-24			LM25					4244	A5052	356.1
	23-24		G-AlSi12	LM 6					4261		A413.2
	23-24		G-AlSi 12 (Cu)	LM 20					4260	ADC12	A413.1
	23-24		GD-AlSi12						4247	A6061	A413.0
	23-24		GD-AlSi8Cu3	LM24					4250	A7075	A380.1
	24	2.1871	G-AlCu 4 TiMg								
	24	3.1754	G-AlCu5Ni1,5								
	24	3.2163	G-AlSi9Cu3							ADC10	
	24	3.2371	G-AlSi 7 Mg							AC4CH	4218 B
	24	3.2373	G-AlSI9MGWA			A-S7G			4251	C4BS	SC64D
	24	3.5106	G-MgAg3SE2Zr1	mag 12							QE 22
	24		G-ALMG5	LM5		A-SU12			4252		GD-AlSI12
	26	2.1090	G-CuSn 7 5 pb			U-E 7 Z 5 pb 4					C93200
	26	2.1096	G-CuSn5ZnPb	LG 2							c 83600
	26	2.1098	G-CuSn 2 Znpb								C 83600
	26	2.1182	G-CuPb15Sn	LB1		U-pb 15 E 8					C23000
	27	2.0240	CuZn 15								
	27	2.0321	CuZn 37	cz 108		CuZn 36, CuZn 37	C 2700				C27200
	27	2.0590	G-CuZn40Fe								
	27	2.0592	G-CuZn 35 Al 1	U-Z 36 N 3		HTB 1					C 86500
	27	2.1293	CuCrZr	CC 102		U-Cr 0.8 Zr					C 18200
	28	2.0060	E-Cu57								
	28	2.0375	CuZn36Pb3								
	28	2.0966	CuAl 10 Ni 5 Fe 4	Ca 104		U-A 10 N					C 63000
	28	2.0975	G-CuAl 10 Ni								B-148-52
	28	2.1050	G-CuSn 10	CT1							c 90700
	28	2.1052	G-CuSn 12	pb 2		UE 12 P					C 90800
	28	2.1292	G-CuCrF 35	CC1-FF							C 81500
	28	2.4764	CoCr20W15Ni								

Material Group		WKR	DIN	BS	EN	AFNOR	UNI	UNE	SS	JIS	AISI / SAE / UNS
ISO	VDI 3323	Germany	Germany	U.K.	U.K.	France	Italy	Spain	Sweden	Japan	USA
S	31	1.4558	X 2 NiCrAlTi 32 20	NA 15							N 08800
	31	1.4562	X 1 NiCrMoCu 32 28 7								N 08031
	31	1.4563	X 1 NiCrMoCuN 31 27 4						2584		N 08028
	31	1.4864	X 12 NiCrSi 36 16	NA 17		Z 12 NCS 35.16				SUH 330	INCOLOY DS,, N08330
	31	1.4865	G-X40NiCrSi38 18	330 C 40			XG50NiCr39 19			SCH15	N 08004
	31	1.4958	X 5 NiCrAlTi 31 20								
	31	2.4668	NiCr19NbMo			NC20K14					AMS 5544
	32	1.4977	X 40 CoCrNi 20 20			Z 42 CNKDWNb					
	33	2.4360	NiCu30Fe	NA 13		NU 30					Monel 400
	33	2.4603				NC22FeD					5390A
	33	2.4610	NiMo16cR16Ti								Hastelloy C-4
	33	2.4630	NiCr20Ti	HR 5,203-4		NC 20 T					Nimonic 75
	33	2.4642	NiC29Fe			Nnc 30 Fe					Inconel 690
	33	2.4856	NiCr22Mo9Nb	NA 21		NC 22 FeDNb					INCONEL 625, N 26625
	33	2.4858	NiCr21Mo	NA 16		NC 21 Fe DU					Incoloy 825
	34	2.4375	NiCu30 Al	NA 18		NU 30 AT					Monel k-500
	34	2.4631	NiCr20TiAl	Hr40;601, NA 20		NC20TA					N 07080
	34	2.4668	NiCr19FeNbMo			NC 19 Fe Nb					Inconel 718
	34	2.4694	NiCr16fE7TiAl								Inconel
	34	2.4955	NiFe25Cr20NbTi								
	34	2.4668	NiCr19Fe19NbMo	HR8		NC19eNB					5383
	34	2 4670	S-NiCr13A16MoNb	3146-3		NC12AD					5391
	34	2.4662	NiFe35Cr14MoTi			ZSNCDT42					5660
	34	2.4964	CoCr20W15Ni			KC20WN					5537C
	34		C0Cr22W14Ni			KC22WN					AMS 5772
	34										N07725, Inconel 725
	35	2.4669	NiCr15Fe7TiAl			NC 15 TNb A					Inconel X-750
	35	2.4685	G-NiMo28								Hastelloy B
	35	2.4810	G-NiMo30								Hastelloy C
	35	2.4973	NiCr19Co11MoTi			NC19KDT					AMS 5399
	35	3.7115	TiAl5Sn2								
	36	3.7025	Ti 1	2 TA 1							R 50250
	36	3.7225	Ti 1 pd	TP 1							R 52250
	36	2 4674	NiCo15Cr10MoAlTi								AMS 5397
	37	3.7124	TiCu2	2 TA 21-24							
	37	3.7145	TiAl6Sn2Zr4Mo2Si								R 54620
	37	3.7165	TiAl6V4	TA 10-13;TA 28		T-A 6 V					
	37	3.7185	TiAl4Mo4Sn2	TA 45-51; TA 57							
	37	3.7195	TiAl 3 V 2.5								
	37		TiAl4Mo4Sn4Si0.5								
	37		TiAl5Sn2.5	TA14/17		T-A5E					AMS R54520
	37		TiAl6V4	TA10-13/TA28		T-A6V					AMS R56400
	37		TiAl6V4ELI	TA11							AMS R56401
H	38	1.1545	C 105 W1	BW 1A		Y1 105	C 100 KU	F-5118	1880	SK 3	W 1
	38	1.2762	75 CrMoNiW 6 7								
	38	1.4125	X105 CrMo 17			Z 100 CD 17					440C
	38	1.6746	32 nlcRmO 14 5	832 M 31		35 NCD 14					
	40	0.9620	G-X 260 NiCr 4 2	Grade 2 A			0512-00				Ni- Hard 2
	40	0.9625	G-X 330 Ni Cr 4 2	Grade 2 B							Ni- Hard 1
	40	0.9630	G-X 300 CrNiSi 9 5 2				0513-00				Ni-Hard 4
	40	0.9640	G-X 300 CrMoNi 15 2 1								
	40	0.9650	G-X 260 Cr 27	Grade 3 D							A 532 III A 25% Cr
	40	0.9655	G-X 300 CrNMo 27 1	Grade 3 E							A 532 III A 25% Cr
	40	1.2419	105 WCr 6	105WC 13			0466-00				
	40	1.4841	X15 CrNiSi 25 20	314 S31		Z 15 CNS 25-20					310
	41	0.9635	G-X 300 CrMo 15 3								
	41	0.9645	G-X 260 CrMoNi 20 2 1					107 WCr 5 KU			

ISO	VDI	Material Group	Sutton	
P	A	Steel	N	UNI
M	R	Stainless Steel	VA	
K	F	Cast Iron	GG	
N	N	Non-Ferrous Metals, Aluminiums & Coppers	Al | W	
S	S	Titaniums & Super Alloys	Ti	Ni
H	H	Hard Materials (≥ 45 HRC)	H	

∧ VDI 3323 material groups can also be determined by referring to the workpiece material cross reference listing. Refer to main index of this section.

For expert tooling recommendations, go to:
www.suttonhps.com


							STUB		JOBBER													
		Catalogue Code					D186 / D100		D101		D102		D103		D179		D109		D180		D202	
		Material					HSS		HSS								HSS Co		HSS		HSS Co	
		Surface Finish					*Blu*		*Brt*		*Blu*		*TiN*		*TiAlN Tip*		Colour Temp		*TiAlN Tip*		Colour Temp	
		Sutton Designation					N		N								Hard Materials		VA		N	
		Geometry					R30		R30								R25		R40		L30	
		Drilling Depth					≤ 3xØ		≤ 5xØ								-		≤ 3xØ		≤ 5xØ	
ISO	VDI∧ 3323	Material		Condition	HB	N/mm²	Vc	Feed #	Vc	Feed #	Vc	Feed #	Vc	Feed #	Vc	Feed #	Vc	Feed #	Vc	Feed #	Vc	Feed #
P	1	Steel - Non-alloy, cast & free cutting	~ 0.15 %C	A	125	440	**25**	**5**	**12**	**5**	**20**	**5**	**24**	**5**	**24**	**5**	-	-	**20**	**4**	**12**	**5**
P	2		~ 0.45 %C	A	190	640	**20**	**5**	**10**	**5**	**16**	**5**	**20**	**5**	**20**	**5**	-	-	**16**	**4**	**10**	**5**
P	3			QT	250	840	**15**	**4**	8	5	**12**	**5**	**18**	**5**	**18**	**5**	**15**	**5**	12	4	8	5
P	4		~ 0.75 %C	A	270	910	**15**	**4**	8	5	**12**	**5**	**18**	**5**	**18**	**5**	15	5	12	4	8	5
P	5			QT	300	1010	10	4	-	-	10	4	12	4	12	4	**12**	**4**	-	-	-	-
P	6	Steel - Low alloy & cast < 5% of alloying elements		A	180	610	**15**	**4**	**8**	**5**	**12**	**5**	**18**	**5**	**18**	**5**	-	-	**12**	**4**	**8**	**5**
P	7			QT	275	930	**15**	**4**	8	4	**12**	**4**	**18**	**4**	**18**	**4**	**15**	**4**	12	4	8	4
P	8			QT	300	1010	10	4	-	-	10	4	12	4	12	4	**12**	**4**	-	-	-	-
P	9			QT	350	1180	-	-	-	-	8	3	10	3	10	3	10	4	-	-	-	-
P	10	Steel - High alloy, cast & tool		A	200	680	**10**	**4**	8	5	**10**	**4**	**12**	**4**	**12**	**4**	12	4	-	-	8	5
P	11			HT	325	1100	-	-	-	-	8	3	10	3	10	3	10	4	-	-	-	-
P	12	Steel - Corrosion resistant & cast	Ferritic / Martensitic	A	200	680	-	-	-	-	-	-	10	3	10	3	-	-	7	4	-	-
P	13		Martensitic	QT	240	810	-	-	-	-	8	3	10	3	10	3	-	-	7	4	-	-
M	14.1	Stainless Steel	Austenitic	AH	180	610	10	4	-	-	8	4	10	4	10	4	10	4	**12**	**4**	-	-
M	14.2		Duplex		250	840	8	4	-	-	6	4	8	4	8	4	8	4	**10**	**4**	-	-
M	14.3		Precipitation Hardening		250	840	-	-	-	-	-	-	-	-	10	3	-	-	7	3	-	-
K	15	Cast Iron - Grey (GG)	Ferritic / Pearlitic		180	610	25	6	12	6	20	6	**25**	**6**	**25**	**6**	25	6	-	-	12	6
K	16		Pearlitic		260	880	20	5	-	-	16	5	20	5	20	5	20	5	-	-	-	-
K	17	Cast Iron - Nodular (GGG)	Ferritic		160	570	20	6	12	6	16	6	**18**	**6**	**18**	**6**	20	6	-	-	12	6
K	18		Pearlitic		250	840	20	6	-	-	16	6	18	6	18	6	20	6	-	-	-	-
K	19	Cast Iron - Malleable	Ferritic		130	460	20	6	-	-	16	6	**18**	**6**	**18**	**6**	20	6	-	-	-	-
K	20		Pearlitic		230	780	20	6	-	-	16	6	18	6	18	6	20	6	-	-	-	-
N	21	Aluminum & Magnesium - wrought alloy	Non Heat Treatable		60	210	40	6	**25**	**5**	30	6	-	-	-	-	-	-	**50**	**6**	**25**	**5**
N	22		Heat Treatable	AH	100	360	40	6	**25**	**5**	30	6	-	-	-	-	-	-	**50**	**6**	**25**	**5**
N	23	Aluminum & Magnesium - cast alloy ≤12% Si	Non Heat Treatable		75	270	-	-	18	4	-	-	30	4	30	4	-	-	**40**	**5**	18	4
N	24		Heat Treatable	AH	90	320	-	-	18	4	-	-	30	4	30	4	-	-	**40**	**5**	18	4
N	25	Al & Mg - cast alloy >12% Si	Non Heat Treatable		130	460	-	-	12	6	-	-	20	6	20	6	-	-	30	5	12	6
N	26	Copper & Cu alloys (Brass/Bronze)	Free cutting, Pb > 1%		110	390	-	-	20	4	-	-	30	4	30	4	-	-	50	5	20	4
N	27		Brass (CuZn, CuSnZn)		90	320	-	-	15	4	-	-	25	4	25	4	**25**	**6**	-	-	15	4
N	28		Bronze (CuSn)		100	360	-	-	15	4	-	-	25	4	25	4	-	-	30	5	15	4
N	29	Non-metallic - Thermosetting & fiber-reinforced plastics					30	4	25	3	30	4	35	4	35	4	-	-	50	4	25	3
N	30	Non-metallic - Hard rubber, wood etc.					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S	31	High temp. alloys	Fe based	A	200	680	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S	32			AH	280	950	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S	33		Ni / Co based	A	250	840	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S	34			AH	350	1180	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S	35			C	320	1080	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S	36	Titanium & Ti alloys	CP Titanium		400 MPa		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S	37.1		Alpha alloys		860 MPa		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S	37.2		Alpha / Beta alloys	A	960 MPa		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S	37.3			AH	1170 MPa		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S	37.4		Beta alloys	A	830 MPa		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S	37.5			AH	1400 MPa		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
H	38.1	Hardened steel		HT	45 HRC		-	-	-	-	-	-	-	-	-	-	10	4	-	-	-	-
H	38.2			HT	55 HRC		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
H	39.1			HT	58 HRC		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
H	39.2			HT	62 HRC		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
H	40	Cast Iron	Chilled	C	400	1350	20	5	10	5	16	5	20	5	20	5	20	5	-	-	10	5
H	41			HT	55 HRC		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Condition: **A** (Annealed), **AH** (Age Hardened), **C** (Cast), **HT** (Hardened & Tempered), **QT** (Quenched & Tempered)
Bold = Optimal | Regular = Effective

Notes on Drilling

1. Step feeding or pecking is required for drilling greater than 3 x Ø.
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 (D175).
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, approximately. 3 x Ø in depth and reduced feed to ensure accurate pilot hole.

LONG SERIES		TAPER SHANK						REDUCED SHANK		NC SPOTTING		COUNTERBORES & COUNTERSINKS											
D113		D141		D115		D140		D188		D175 / D176		C105		C106		C107		C108		C100			
HSS		HSS Co		HSS		HSS		HSS		HSS Co		HSS				HSS Co		HSS Co		HSS Co			
Blu		*Colour Temp*		*Blu*		*Blu*		*Blu*		*TiN*		*Brt*		*TiN*		*Brt*		*TiAlN*		*Brt*			
N		Tough Mat		N		N		N		N		Machine Use				N		UNI		N			
R30		R30		R30		R30		R30		90° / 120°		90°				90°				-			
≤ 7xØ		≤ 5xØ		≤ 5xØ		≤ 8xØ		≤ 5xØ		-		-				-				-			
Vc	Feed #	Vc	Feed #	Vc	Feed #	Vc	Feed #	Vc	Feed #	Vc	Feed #	Vc	Feed #	Vc	Feed #	Vc	Feed #	Vc	Feed #	Vc	Feed #	VDI 3323	ISO
16	**5**	**38**	**5**	**32**	**5**	**5**	**5**	**32**	**5**	**35**	**4**	**25**	**3**	**31**	**3**	**36**	**3**	**44**	**3**	**30**	**3**	1	
13	**5**	**38**	**5**	**32**	**5**	**5**	**5**	**32**	**5**	**25**	**4**	**21**	**3**	**25**	**3**	**30**	**3**	**36**	**3**	**30**	**3**	2	
10	**5**	**30**	**5**	25	5	5	5	25	5	**20**	**4**	21	2	**25**	**2**	**30**	**2**	**36**	**2**	30	3	3	
10	**5**	**30**	**5**	25	5	5	5	25	5	**20**	**4**	21	2	**25**	**2**	**30**	**2**	**36**	**2**	30	3	4	
-	-	18	4	15	4	4	4	15	4	15	3	-	-	11	1	14	1	16	1	12	1	5	
10	**5**	**30**	**5**	25	5	5	5	**25**	**5**	**20**	**4**	**21**	**2**	**25**	**2**	**30**	**2**	**36**	**2**	**30**	**3**	6	
10	4	**30**	**4**	25	4	4	4	25	4	**15**	**4**	12	2	**15**	**2**	**18**	**2**	**22**	**2**	15	2	7	P
-	-	18	4	15	4	4	4	15	4	15	3	-	-	11	1	14	1	**16**	**1**	12	1	8	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	1	10	1	9	
10	5	18	4	15	4	4	4	15	4	15	3	10	1	**11**	**1**	14	1	**16**	**1**	12	1	10	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	1	10	1	11	
-	-	10	4	-	-	-	-	-	-	10	2	-	-	-	-	10	1	**12**	**1**	14	1	12	
-	-	-	-	-	-	-	-	-	-	12	3	-	-	-	-	-	-	**10**	**1**	10	1	13	
7	4	**12**	**4**	8	4	4	4	8	4	**10**	**3**	-	-	**10**	**2**	**12**	**2**	**14**	**2**	16	2	14.1	
-	-	**10**	**4**	-	-	-	4	6	4	**15**	**2**	-	-	**8**	**1**	**10**	**1**	**12**	**1**	12	1	14.2	M
-	-	10	4	-	-	-	-	-	-	10	2	-	-	8	1	10	1	**12**	**1**	14	1	14.3	
16	6	**38**	**5**	32	5	5	5	32	5	**30**	**5**	**17**	**2**	**20**	**2**	**24**	**2**	**28**	**2**	**25**	**2**	15	
13	5	30	5	25	5	5	5	-	-	20	4	17	2	20	2	24	2	**28**	**2**	16	2	16	
13	6	**25**	**5**	20	5	5	5	20	5	**20**	**4**	15	2	**15**	**2**	**20**	**2**	**25**	**2**	20	2	17	K
13	6	25	5	20	5	5	5	-	-	20	4	15	2	15	2	**20**	**2**	**25**	**2**	20	2	18	
13	6	**25**	**5**	20	5	5	5	20	5	20	4	15	2	**15**	**2**	20	2	**25**	**2**	20	2	19	
13	6	25	5	20	5	5	5	-	-	20	4	15	2	15	2	-	-	**25**	**2**	20	2	20	
20	5	96	6	-	-	-	-	**80**	**6**	**50**	**5**	**34**	**4**	41	4	**48**	**4**	58	4	80	4	21	
20	5	96	6	-	-	-	-	**80**	**6**	**50**	**5**	**34**	**4**	41	4	**48**	**4**	58	4	80	4	22	
-	-	72	5	-	-	-	-	60	5	**35**	**4**	25	3	**31**	**3**	**36**	**4**	**44**	**4**	60	3	23	
-	-	72	5	-	-	-	-	60	5	**35**	**4**	25	3	**31**	**3**	**36**	**4**	**44**	**4**	60	3	24	
-	-	-	-	-	-	-	-	-	-	30	4	-	-	-	-	30	4	**44**	**4**	-	-	25	
-	-	30	6	-	-	-	-	25	6	**40**	**4**	55	2	**66**	**2**	**78**	**2**	**94**	**2**	80	2	26	N
-	-	19	3	-	-	-	-	16	3	30	4	34	2	40	2	48	2	**58**	**2**	-	-	27	
-	-	38	6	-	-	-	-	32	6	**50**	**4**	42	2	50	2	60	2	**72**	**2**	80	2	28	
-	-	-	-	-	-	-	-	-	-	30	4	-	-	-	-	30	4	44	4	-	-	29	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	
-	-	-	-	-	-	-	-	-	-	9	2	-	-	-	-	5	2	8	2	-	-	31	
-	-	-	-	-	-	-	-	-	-	8	2	-	-	-	-	4	2	5	2	-	-	32	
-	-	-	-	-	-	-	-	-	-	9	2	-	-	-	-	5	2	8	2	-	-	33	
-	-	-	-	-	-	-	-	-	-	8	2	-	-	-	-	-	-	5	2	-	-	34	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	2	-	-	35	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	3	10	3	-	-	36	S
-	-	-	-	-	-	-	-	-	-	8	2	-	-	-	-	7	3	9	3	-	-	37.1	
-	-	-	-	-	-	-	-	-	-	8	2	-	-	-	-	7	3	9	3	-	-	37.2	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	2	-	-	37.3	
-	-	-	-	-	-	-	-	-	-	8	2	-	-	-	-	7	3	9	3	-	-	37.4	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	2	-	-	37.5	
-	-	-	-	-	-	-	-	-	-	10	3	-	-	-	-	-	-	-	-	-	-	38.1	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	38.2	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39.1	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39.2	H
13	5	**30**	**5**	25	5	5	5	25	5	20	4	17	2	20	2	**24**	**2**	**28**	**2**	16	2	40	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	41	

Feed Table (f) (mm/rev)

Ø	Feed # 1	2	3	4	5	6	7	8	9	10
2.0	0.020	0.025	0.030	0.040	0.050	0.060	0.075	0.095	0.120	0.15
3.0	0.030	0.035	0.045	0.055	0.070	0.090	0.110	0.135	0.17	0.21
4.0	0.040	0.045	0.060	0.075	0.090	0.115	0.140	0.18	0.22	0.27
5.0	0.045	0.055	0.070	0.090	0.110	0.135	0.17	0.21	0.26	0.32
6.0	0.055	0.065	0.080	0.100	0.125	0.16	0.19	0.24	0.30	0.37
8.0	0.070	0.085	0.105	0.130	0.16	0.20	0.25	0.31	0.38	0.47
10.0	0.085	0.105	0.125	0.16	0.19	0.24	0.30	0.37	0.46	0.56
12.0	0.095	0.120	0.15	0.18	0.23	0.28	0.34	0.42	0.52	0.64
16.0	0.125	0.15	0.19	0.23	0.29	0.36	0.44	0.54	0.66	0.82
20.0	0.15	0.18	0.23	0.28	0.34	0.42	0.52	0.64	0.80	0.98
25.0	0.18	0.22	0.27	0.33	0.41	0.50	0.60	0.74	0.90	1.10
32.0	0.23	0.27	0.33	0.41	0.50	0.60	0.74	0.88	1.10	1.30
38.0	0.26	0.32	0.38	0.46	0.56	0.68	0.82	1.00	1.20	1.45
45.0	0.30	0.36	0.43	0.52	0.64	0.76	0.92	1.10	1.35	1.60
52.0	0.33	0.40	0.48	0.58	0.70	0.84	1.00	1.20	1.45	1.75
63.0	0.39	0.47	0.56	0.67	0.80	0.96	1.14	1.35	1.65	1.95

METRIC DRILLS (mm size)

Ø = nominal tap size (mm)
n = spindle speed (RPM)
V_c = cutting speed (m/min)
f = feed (mm/rev)
V_f = feed rate (mm/min)

$$n = \frac{V_c \times 1000}{Ø \times \pi} \simeq \frac{V_c}{Ø} \times 318$$

$$V_c = \frac{n \times Ø \times \pi}{1000} \simeq \frac{n \times Ø}{318}$$

$$V_f = f \times n$$

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ISO	VDI	Material Group	Sutton	
P	A	Steel	N	UNI
M	R	Stainless Steel	VA	
K	F	Cast Iron	GG	
N	N	Non-Ferrous Metals, Aluminiums & Coppers	Al | W	
S	S	Titaniums & Super Alloys	Ti	Ni
H	H	Hard Materials (≥ 45 HRC)	H	

^ VDI 3323 material groups can also be determined by referring to the workpiece material cross reference listing. Refer to main index of this section.

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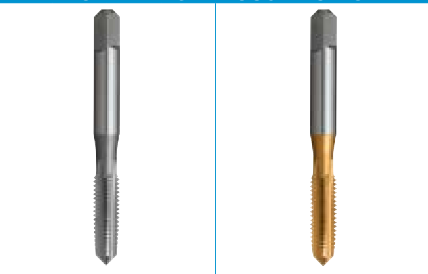
	FOR BLIND & THROUGH HOLES		FOR THROUGH HOLES		
					
Catalogue Code M	T384 / T385 / T386 / T901		T393	T394	T395
MF	T401 / T402 / T403 / T902	T404	T406	T407	T408
UNC	T414 / T415 / T416 / T903		T422	T423	T424
UNF	T431 / T432 / T433 / T904		T439	T440	T441
BSW	T451 / T452 / T453 / T905		T457	T458	T459
BSF, BA, BSB (Brass)	T466 / T467 / T468 / T906	-	-	-	-
G (BSPF)	T479 / T480 / T481 / T909	T482 / T483	T484	-	-
BSPT	T475	T476	-	-	-
Material	HSS		HSSE		
Surface Finish	*Brt*	*TiN*	*Brt*	*Blu*	*TiN*
Sutton Designation	N		N		
Geometry					
Thread Depth	≤ 1xØ		≤ 3xØ		

ISO	VDI^ 3323	Material		Condition	HB	N/mm²	Vc (m/min)		Vc (m/min)		
P	1	Steel - Non-alloy, cast & free cutting	- 0.15 %C	A	125	440	**7**	**11**	**12**	**13**	**18**
	2		- 0.45 %C	A	190	640	**7**	**11**	**12**	**13**	**18**
	3			QT	250	840	**6**	**9**	10	**11**	**15**
	4		- 0.75 %C	A	270	910	**7**	**10**	11	**12**	**17**
	5			QT	300	1010	5	8	-	-	14
	6	Steel - Low alloy & cast < 5% of alloying elements		A	180	610	**7**	**11**	**12**	**13**	**18**
	7			QT	275	930	5	7	8	**9**	**12**
	8			QT	300	1010	4	5	-	-	9
	9			QT	350	1180	-	-	-	-	-
	10	Steel - High alloy, cast & tool		A	200	680	5	7	8	9	12
	11			HT	325	1100	-	-	-	-	-
	12	Steel - Corrosion resistant & cast	Ferritic / Martensitic	A	200	680	-	-	-	6	8
	13		Martensitic	QT	240	810	-	-	-	-	-
M	14.1	Stainless Steel	Austenitic	AH	180	610	-	-	-	7	9
	14.2		Duplex		250	840	-	-	-	4	6
	14.3		Precipitation Hardening		250	840	-	-	-	3	5
K	15	Cast Iron - Grey (GG)	Ferritic / Pearlitic		180	610	7	11	12	13	18
	16		Pearlitic		260	880	6	9	-	-	15
	17	Cast Iron - Nodular (GGG)	Ferritic		160	570	7	11	12	13	18
	18		Pearlitic		250	840	6	9	-	-	15
	19	Cast Iron - Malleable	Ferritic		130	460	9	14	15	17	23
	20		Pearlitic		230	780	7	11	12	13	18
N	21	Aluminum & Magnesium - wrought alloy	Non Heat Treatable		60	210	7	11	**12**	-	**18**
	22		Heat Treatable	AH	100	360	9	14	**15**	-	**23**
	23	Aluminum & Magnesium - cast alloy ≤12% Si	Non Heat Treatable		75	270	9	14	15	-	23
	24		Heat Treatable	AH	90	320	9	14	15	-	23
	25	Al & Mg - cast alloy >12% Si	Non Heat Treatable		130	460	-	-	-	-	-
	26	Copper & Cu alloys (Brass/Bronze)	Free cutting, Pb > 1%		110	390	5	7	8	-	**12**
	27		Brass (CuZn, CuSnZn)		90	320	11	16	18	-	27
	28		Bronze (CuSn)		100	360	8	13	-	-	-
	29	Non-metallic - Thermosetting & fiber-reinforced plastics					-	-	-	-	-
	30	Non-metallic - Hard rubber, wood etc.					-	-	-	-	-
S	31	High temp. alloys	Fe based	A	200	680	-	-	-	-	-
	32			AH	280	950	-	-	-	-	-
	33		Ni / Co based	A	250	840	-	-	-	-	-
	34			AH	350	1180	-	-	-	-	-
	35			C	320	1080	-	-	-	-	-
	36	Titanium & Ti alloys	CP Titanium		400 MPa		-	-	-	-	-
	37.1		Alpha alloys		860 MPa		-	-	-	-	-
	37.2		Alpha / Beta alloys	A	960 MPa		-	-	-	-	-
	37.3			AH	1170 MPa		-	-	-	-	-
	37.4		Beta alloys	A	830 MPa		-	-	-	-	-
	37.5			AH	1400 MPa		-	-	-	-	-
H	38.1	Hardened steel		HT	45 HRC		-	-	-	-	-
	38.2			HT	55 HRC		-	-	-	-	-
	39.1			HT	58 HRC		-	-	-	-	-
	39.2			HT	62 HRC		-	-	-	-	-
	40	Cast Iron	Chilled	C	400	1350	-	-	-	-	-
	41			HT	55 HRC		-	-	-	-	-

Condition: **A** (Annealed), **AH** (Age Hardened), **C** (Cast), **HT** (Hardened & Tempered), **QT** (Quenched & Tempered)
Bold = Optimal | Regular = Effective

FOR BLIND HOLES			FOR BLIND & THROUGH HOLES			
						
T397	T396	T398	T399	T400		
T409	-	T411	-	-		
T425	T426	T427	T428	T429		
T442	-	T443	T444	-		
T460	T461	T462	T463	T464		
-	-	-	-	-		
T485	-	-	-	-		
-	-	-	-	-		
HSSE			HSSE			
Brt	*Blu*	*TiN*	*Brt*	*TiN*		
N			N			
R40						
≤2.5xØ			≤1.5xØ			
Vc (m/min)			Vc (m/min)		VDI 3323	ISO
10	**11**	**14**	12	**18**	1	P
10	**11**	**14**	12	**18**	2	
8	**9**	**12**	-	15	3	
9	**10**	**13**	-	**17**	4	
-	-	11	-	-	5	
10	**11**	**14**	-	18	6	
6	**7**	**10**	-	-	7	
-	-	7	-	-	8	
-	-	-	-	-	9	
6	**7**	**10**	-	-	10	
-	-	-	-	-	11	
-	4	6	-	-	12	
-	-	-	-	-	13	
-	5	7	-	**9**	14.1	M
-	4	5	-	6	14.2	
-	3	4	-	-	14.3	
10	11	14	-	-	15	K
-	-	12	-	-	16	
10	11	14	-	-	17	
-	-	12	-	-	18	
12	13	18	-	-	19	
10	11	14	-	-	20	
10	-	**14**	**12**	**18**	21	N
12	-	**18**	**15**	**23**	22	
12	-	18	15	23	23	
12	-	18	15	23	24	
-	-	-	-	-	25	
6	-	**10**	**8**	**12**	26	
14	-	22	-	-	27	
-	-	-	14	21	28	
-	-	-	-	-	29	
-	-	-	-	-	30	
-	-	-	-	-	31	S
-	-	-	-	-	32	
-	-	-	-	-	33	
-	-	-	-	-	34	
-	-	-	-	-	35	
-	-	-	-	-	36	
-	-	-	-	-	37.1	
-	-	-	-	-	37.2	
-	-	-	-	-	37.3	
-	-	-	-	-	37.4	
-	-	-	-	-	37.5	
-	-	-	-	-	38.1	H
-	-	-	-	-	38.2	
-	-	-	-	-	39.1	
-	-	-	-	-	39.2	
-	-	-	-	-	40	
-	-	-	-	-	41	

Condition: A (Annealed), **AH** (Age Hardened), **C** (Cast), **HT** (Hardened & Tempered), **QT** (Quenched & Tempered)
Bold = Optimal | Regular = Effective

Notes on Tapping

1. The speeds listed above are a recommendation only, and are based on depth of thread listed, speeds can 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. Taps must be driven by the square to eliminate slippage, eg, ER-GB collets (square drive).
3. 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.

METRIC TAPS (mm size)

Ø = nominal tap size (mm)
P = thread pitch (mm)
n = spindle speed (RPM)
V_c = cutting speed (m/min)
V_f = feed rate (mm/min)
V_r = feed rate per rev (mm/rev)

$$n = \frac{V_c \times 1000}{Ø \times \pi} \simeq \frac{V_c}{Ø} \times 318$$

$$V_c = \frac{n \times Ø \times \pi}{1000} \simeq \frac{n \times Ø}{318}$$

$$V_f = n \times P$$

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ISO	VDI	Material Group	Sutton	
P	A	Steel	N	UNI
M	R	Stainless Steel	VA	
K	F	Cast Iron	GG	
N	N	Non-Ferrous Metals, Aluminiums & Coppers	Al | W	
S	S	Titaniums & Super Alloys	Ti	Ni
H	H	Hard Materials (≥ 45 HRC)	H	

^ VDI 3323 material groups can also be determined by referring to the workpiece material cross reference listing. Refer to main index of this section.

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	E100	E102 / E225	E184	E125	
Catalogue Code	E100	E102 / E225	E184	E125	
Material	HSS Co.8	HSS Co.8		HSS Co.8	
Surface Finish	*Brt*	*Brt*	*TiAlN*	*Brt*	
Sutton Designation	N	N		N	
Geometry	R30	R30		R30	
Type of Cut: *Slotting*	●	●	●		
Finishing				●	
Universal					●
Roughing					
Profiling					
↕ ap × Ø	0.5	0.5	0.5	1.5	1.5
↔ ae × Ø	1.0	1.0	1.0	0.1	0.25

ISO	VDI^ 3323	Material		Condition	HB	N/mm²	E100 Vc	E100 Feed #	E102 / E225 Vc	E102 / E225 Feed #	E184 Vc	E184 Feed #	E125 Vc	E125 Feed #	E125 Vc	E125 Feed #
P	1	Steel - Non-alloy, cast & free cutting	~ 0.15 %C	A	125	440	**30**	**6**	**18**	**5**	**22**	**5**	**40**	**4**	**40**	**5**
	2		~ 0.45 %C	A	190	640	**30**	**6**	**18**	**5**	**22**	**5**	**40**	**4**	**40**	**5**
	3			QT	250	840	30	6	18	5	**22**	**5**	40	4	40	5
	4		~ 0.75 %C	A	270	910	30	6	18	5	**22**	**5**	40	4	40	5
	5			QT	300	1010	20	5	12	4	15	4	25	3	25	4
	6	Steel - Low alloy & cast < 5% of alloying elements		A	180	610	**30**	**6**	**18**	**5**	**22**	**5**	**40**	**4**	**40**	**5**
	7			QT	275	930	25	5	15	4	18	4	30	3	30	4
	8			QT	300	1010	20	5	12	4	15	4	25	3	25	4
	9			QT	350	1180	-	-	-	-	-	-	-	-	-	-
	10	Steel - High alloy, cast & tool		A	200	680	20	5	12	4	**15**	**4**	25	3	25	4
	11			HT	325	1100	-	-	-	-	-	-	-	-	-	-
	12	Steel - Corrosion resistant & cast	Ferritic / Martensitic	A	200	680	-	-	-	-	11	4	10	2	10	3
	13		Martensitic	QT	240	810	15	4	9	3	11	3	22	3	22	4
M	14.1	Stainless Steel	Austenitic	AH	180	610	-	-	-	-	11	4	-	-	-	-
	14.2		Duplex		250	840	-	-	-	-	9	2	-	-	-	-
	14.3		Precipitation Hardening		250	840	-	-	-	-	-	-	-	-	-	-
K	15	Cast Iron - Grey (GG)	Ferritic / Pearlitic		180	610	30	5	18	4	**21**	**4**	35	3	35	4
	16		Pearlitic		260	880	25	4	15	3	18	3	25	2	25	3
	17	Cast Iron - Nodular (GGG)	Ferritic		160	570	20	3	12	2	**15**	**2**	22	2	22	3
	18		Pearlitic		250	840	20	3	12	2	15	2	22	2	22	3
	19	Cast Iron - Malleable	Ferritic		130	460	20	3	12	2	15	2	22	2	22	3
	20		Pearlitic		230	780	20	3	12	2	15	2	22	2	22	3
N	21	Aluminum & Magnesium - wrought alloy	Non Heat Treatable		60	210	**70**	**6**	**42**	**5**	51	5	**70**	**5**	**70**	**6**
	22		Heat Treatable	AH	100	360	**70**	**6**	**42**	**5**	51	5	**70**	**5**	**70**	**6**
	23	Aluminum & Magnesium - cast alloy ≤12% Si	Non Heat Treatable		75	270	50	5	30	4	33	4	55	4	55	5
	24		Heat Treatable	AH	90	320	50	5	30	4	33	4	55	4	55	5
	25	Al & Mg - cast alloy >12% Si	Non Heat Treatable		130	460	30	6	18	5	21	5	-	-	-	-
	26	Copper & Cu alloys (Brass/Bronze)	Free cutting, Pb > 1%		110	390	25	5	15	4	18	4	40	4	40	5
	27		Brass (CuZn, CuSnZn)		90	320	-	-	-	-	-	-	-	-	-	-
	28		Bronze (CuSn)		100	360	50	6	30	5	33	5	70	5	70	6
	29	Non-metallic - Thermosetting & fiber-reinforced plastics					-	-	-	-	-	-	-	-	-	-
	30	Non-metallic - Hard rubber, wood etc.					-	-	-	-	-	-	-	-	-	-
S	31	High temp. alloys	Fe based	A	200	680	-	-	-	-	-	-	-	-	-	-
	32			AH	280	950	-	-	-	-	-	-	-	-	-	-
	33		Ni / Co based	A	250	840	-	-	-	-	-	-	-	-	-	-
	34			AH	350	1180	-	-	-	-	-	-	-	-	-	-
	35			C	320	1080	-	-	-	-	-	-	-	-	-	-
	36	Titanium & Ti alloys	CP Titanium		400 MPa		-	-	-	-	-	-	-	-	-	-
	37.1		Alpha alloys		860 MPa		-	-	-	-	-	-	-	-	-	-
	37.2		Alpha / Beta alloys	A	960 MPa		-	-	-	-	-	-	-	-	-	-
	37.3			AH	1170 MPa		-	-	-	-	-	-	-	-	-	-
	37.4		Beta alloys	A	830 MPa		-	-	-	-	-	-	-	-	-	-
	37.5			AH	1400 MPa		-	-	-	-	-	-	-	-	-	-
H	38.1	Hardened steel		HT	45 HRC		-	-	-	-	-	-	-	-	-	-
	38.2			HT	55 HRC		-	-	-	-	-	-	-	-	-	-
	39.1			HT	58 HRC		-	-	-	-	-	-	-	-	-	-
	39.2			HT	62 HRC		-	-	-	-	-	-	-	-	-	-
	40	Cast Iron	Chilled	C	400	1350	-	-	-	-	-	-	25	-	25	3
	41			HT	55 HRC		-	-	-	-	-	-	-	-	-	-

Condition: A (Annealed), **AH** (Age Hardened), **C** (Cast), **HT** (Hardened & Tempered), **QT** (Quenched & Tempered)

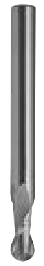
Bold = Optimal | Regular = Effective

Feed Table (f_z) (mm/tooth)

Ø	Feed # 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2	0.001	0.002	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.010	0.011	0.013	0.014	0.016	0.018	0.020	0.022	0.024	0.026	0.030
3	0.002	0.003	0.004	0.005	0.006	0.008	0.009	0.010	0.012	0.014	0.016	0.018	0.020	0.023	0.025	0.028	0.032	0.034	0.038	0.042
4	0.004	0.005	0.006	0.007	0.009	0.010	0.012	0.014	0.016	0.018	0.021	0.023	0.026	0.030	0.032	0.036	0.040	0.044	0.045	0.050
5	0.005	0.006	0.008	0.009	0.011	0.013	0.015	0.017	0.020	0.023	0.025	0.030	0.032	0.036	0.040	0.044	0.050	0.055	0.060	0.065
6	0.006	0.008	0.009	0.011	0.013	0.016	0.018	0.021	0.024	0.028	0.030	0.034	0.038	0.042	0.045	0.050	0.055	0.060	0.070	0.075
8	0.010	0.012	0.014	0.017	0.019	0.022	0.025	0.028	0.032	0.036	0.040	0.045	0.050	0.055	0.060	0.065	0.075	0.080	0.085	0.095
10	0.013	0.015	0.018	0.021	0.024	0.028	0.032	0.036	0.040	0.045	0.050	0.055	0.060	0.070	0.075	0.085	0.090	0.100	0.11	0.12
12	0.016	0.019	0.022	0.026	0.030	0.034	0.038	0.044	0.050	0.055	0.060	0.065	0.075	0.080	0.090	0.100	0.11	0.12	0.13	0.14
16	0.020	0.024	0.028	0.034	0.038	0.044	0.050	0.055	0.060	0.070	0.080	0.085	0.095	0.11	0.12	0.13	0.14	0.16	0.17	0.18
20	0.022	0.028	0.032	0.038	0.044	0.050	0.060	0.065	0.075	0.085	0.095	0.11	0.12	0.13	0.15	0.16	0.18	0.19	0.21	0.23
25	0.025	0.032	0.038	0.045	0.055	0.060	0.070	0.080	0.090	0.10	0.12	0.13	0.15	0.16	0.18	0.20	0.22	0.24	0.26	0.29

Notes on Milling

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

							
E192		E113		E146			
HSS Co.8		HSS Co.8		HSS Co.8			
TiAlN		***Brt***		***Brt***			
N		N		NR			
R30		R30		R30 NR (Long)			
●							
				●			
		●					
1.5		0.05		1.5			
0.1		0.02-0.05		0.25			
Vc	Feed #	Vc	Feed #	Vc	Feed #	VDI 3323	ISO
50	**4**	**40**	**5**	**30**	**5**	1	P
50	**4**	**40**	**5**	**30**	**5**	2	P
50	4	40	5	30	5	3	P
50	4	40	5	30	5	4	P
30	3	30	4	30	5	5	P
50	**4**	**40**	**5**	**30**	**5**	6	P
40	4	35	4	30	5	7	P
30	3	30	4	30	5	8	P
25	3	-	-	-	-	9	P
30	**3**	30	4	-	-	10	P
25	3	-	-	-	-	11	P
12	2	-	-	-	-	12	P
25	3	-	-	-	-	13	P
20	3	20	4	-	-	14.1	M
15	1	15	2	-	-	14.2	M
12	2	-	-	-	-	14.3	M
40	**3**	40	4	40	8	15	K
30	2	30	3	-	-	16	K
-	-	25	2	10	8	17	K
-	-	25	2	-	-	18	K
-	-	25	2	10	8	19	K
-	-	25	2	-	-	20	K
75	5	80	6	80	9	21	N
75	5	80	6	80	9	22	N
60	4	55	5	55	8	23	N
60	4	55	5	55	8	24	N
50	4	50	5	-	-	25	N
40	4	25	5	25	6	26	N
-	-	-	-	-	-	27	N
75	5	50	6	40	6	28	N
-	-	-	-	-	-	29	N
-	-	-	-	-	-	30	N
-	-	-	-	-	-	31	S
-	-	-	-	-	-	32	S
-	-	-	-	-	-	33	S
-	-	-	-	-	-	34	S
-	-	-	-	-	-	35	S
-	-	-	-	-	-	36	S
-	-	-	-	-	-	37.1	S
-	-	-	-	-	-	37.2	S
-	-	-	-	-	-	37.3	S
-	-	-	-	-	-	37.4	S
-	-	-	-	-	-	37.5	S
-	-	-	-	-	-	38.1	H
-	-	-	-	-	-	38.2	H
-	-	-	-	-	-	39.1	H
-	-	-	-	-	-	39.2	H
-	3	-	-	-	-	40	H
-	-	-	-	-	-	41	H

METRIC ENDMILLS (mm size)

Ø = nominal tool diameter (mm)
n = Spindel speed (RPM)
v_c = Cutting speed (m/min)
f_z = Feed rate per tooth (mm/tooth)
v_f = Feed rate (mm/min)
z = No. cutting edges
Q = Metal removal rate (cm³/min)
a_p = Cutting depth (mm)
a_e = Cutting width (mm)

$$n = \frac{v_c \times 1000}{Ø \times \pi} \simeq \frac{v_c}{Ø} \times 318$$

$$v_c = \frac{n \times Ø \times \pi}{1000} \simeq \frac{n \times Ø}{318}$$

$$f_z = \frac{V_f}{z \times n} \qquad v_f = f_z \times z \times n$$

$$Q = \frac{a_p \times a_e \times v_f}{1000}$$

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

1	2	3	4	5	6	7	8	Possible Reason	Solution
●				●	●			Dull point	Sharpen
●								Drill has front taper due to wearing	Sharpen
●			●	●				Insufficient lip clearance on point	Grind correctly
●		●						Lip clearance too great	Regrind to correct clearance angle
●								Drill in incorrectly point ground	Regrind correctly
●	●							Flutes clogged with chips	Remove drill from hole and to clear flutes
●								Spring or backlash in drill press, fixture or work	Check each item for rigidity and alignment
●		●	●		●			Feed too heavy	Reduce Feed
	●							Cutting speed too high	Reduce speed
	●				●			Dry cutting, no lubricant at cutting edges	Apply cutting fluid
				●				Drill web (core) diameter too big	Thin web to original size
					●			Fixture/Clamping not rigid	Secure job firmly
						●		Unequal angle or uneven length of cutting edges	Regrind to same lip lengths and angles
						●		Spindle run-out/Loose spindle	Check machine
							●	Bad fit between shank taper & socket. The drive & alignment is controlled by the taper fit	Remove dirt, nicks or burrs, or replace worn socket

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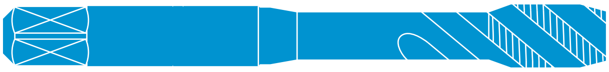

Code	Problem
1	Thread is oversize
2	Axial miscutting of thread
3	Thread is undersize
4	Thread has bellmouthed entry
5	Thread surface is rough and unclean
6	Low tool life
7	Partial or complete tap breakage on FORWARD or BACKWARD movement

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 Selector, at www.suttontools.com/expert-tool-selector
●				●	●		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

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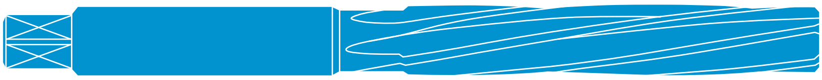
Code	Problem	Possible Reason
1	Poor workpiece finish	Cutting edge wear, cutter radial run-out
2	Splintering of workpiece edge	Unsuitable cutting conditions, unsuitable shape of cutting edge
3	Non-parallel or uneven surface	Low stiffness of the cutter or of the workpiece (loose)
4	Extreme flank wear	Unsuitable 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	Endmill 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, flute length (l/D ratio)
	●	●			●			●		select machine with higher power and stiffness



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	use a different reamer

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Trade Name	Coating	Coating Structure	Micro-hardness	Coeff. of Friction vs Steel	Thermal Stability	Colour	Application & Benefits
Alcrona (AlCrN)	Aluminium Chromium Nitride	Mono Layer	3200 HV	0.35	up to 2012°F	Blue - Grey	• Low alloy steels and high tensile steels • Hardened steels up to 54 HRC • Ideal for carbide tools
Aldura	TiAlN + AlCrN	Multi Layer	3300 HV	<0.4	>1100°C	Blue - Grey	• High speed machining • Suitable for minimum quantity lubrication (MQL) and dry machining • Machining of hardened steels (>60HRC) • Ideal for carbide tools
AlNova	Alcrona based	Multi Layer	3200 HV	0.35	>1100°C	Light Grey	• Even high thermal stresses hardly effect the superior hardness of the coating • Its high hot hardness results in excellent abrasion resistance even at high cutting speeds
Blu	Steam Oxide	-	-	0.8 - 1.0	-	Blue - Black	• For ferrous metals • Prevents chip build-up on the cutting edges, especially in low carbon steels • Oxide layer protects surface • Good carrier of lubricants
Brt	-	-	-	0.8 - 1.0	-	-	• For general purpose applications
CrN	Chromium Nitride	Gradient Coating	1750 HV	0.5	up to 1292°F	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
Futura Nano (TiAlN)	Titanium Aluminium Nitride	Nano Layer	3300 HV	0.3 - 0.35	up to 1652°F	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
Hardlube	TiAlN + WC/C	Nano Layer	3000 HV	0.15-0.20	up to 1472°F	Dark Grey	• Excellent friction and lubricating properties of the coating provide optimal chip flow • Tapping and drilling of hard to machine materials • Suitable for minimum quantity lubrication (MQL) and dry machining
Helica	Alcrona based	Multi Layer	3000 HV	0.25	up to 1100°C	Copper	• Longer tool life • Higher cutting speeds and feeds • Superb chip evacuation • Greater number of regrinds • Improved drill hole quality • Excellent performance in abrasive material
Ni	Plasma Nitride	-	-	0.8 - 1.0	-	-	• Increases surface hardness • Better lubricant carrying properties • Abrasive materials - cast iron and Aluminium alloys
TiN	Titanium Nitride	Mono Layer	2300 HV	0.4	up to 1112°F	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
TiCN	Titanium Carbonitride	Gradient Coating	3000 HV	0.4	up to 752°F	Blue - Grey	• High performance applications • Difficult to machine materials • Abrasive materials - cast iron and Aluminium alloys • Adhesive materials - copper and copper based alloys
TiSiN	TiSi based	Multi Layer	3600 HV	0.3	<1200°C	Copper	• Suitable for high speed (wet / dry) and hard machining for difficult materials above 52 HRC. • Suitable for high speed machining with hardened steels above 60 HRC to maximum of 63 HRC • Vc & Vf = +50%

Latest advances in thin film coatings to optimise your machining application

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, endmills and taps.
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 Co 8%	8% cobalt grade of high speed steel	Increased heat resistance and 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	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 40 HRC 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 45 HRC	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 up to 55 HRC	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	Sub-micron grade of solid Carbide (ISO K15-K30)	Tapping hardened steel	Ultra fine grain type (0.8μm) with maximum toughness & high hardness, therefore especially recommended for rotating tools to machine hardened parts.
VHM	Sub-micron grade of solid Carbide (ISO K40)	Sutton standard grade for endmills & drills	Ultra fine grain type (0.6μm) offers the ideal combination of hardness & toughness for high performance drilling & general milling applications
VHM-ULTRA	Sub-micron grade of solid Carbide (ISO K40-K50)	High performance grade for endmills	Ultra fine grain type (0.5μm) offers the best wear resistance for high performance milling applications.

Computer controlled vacuum heat treatment ensures consistent high quality

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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**
1.067		0.0420	**58**

Metric	Imperial	Inch	Gauge
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**
1.500		0.0591	
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**
2.500		0.0984	
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	
6.000		0.2362	

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Metric	Imperial	Inch	Gauge
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	
8.800		0.3465	
8.839		0.3480	**S**

Metric	Imperial	Inch	Gauge
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	
15.000		0.5906	
15.081	**19/32**	0.5938	
15.478	**39/64**	0.6094	

Metric	Imperial	Inch	Gauge
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	

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Tensile Strength vs Hardness (≈)

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

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			
		e8	**h5**	**h6**	**h7**	**h8**	**h9**	**h10**	**js12**	**js14**	**k8**	**k9**	**k10**	**m7**
0	3	-14	0	0	0	0	0	0	+50	+125	+14	+25	+40	+12
		-18	-4	-6	-10	-14	-25	-40	-50	-125	0	0	0	+2
3	6	-20	0	0	0	0	0	0	+60	+150	+18	+30	+48	+16
		-38	-5	-8	-12	-18	-30	-48	-60	-150	0	0	0	+4
6	10	-25	0	0	0	0	0	0	+75	+180	+22	+36	+58	+21
		-47	-6	-9	-15	-22	-36	-58	-75	-180	0	0	0	+6
10	18	-32	0	0	0	0	0	0	+90	+215	+27	+43	+70	+25
		-59	-8	-11	-18	-27	-43	-70	-90	-215	0	0	0	+7
18	30	-40	0	0	0	0	0	0	+105	+260	+33	+52	+84	+29
		-73	-9	-13	-21	-33	-52	-84	-105	-260	0	0	0	+8
30	50	-50	0	0	0	0	0	0	+125	+310	+39	+62	+100	+34
		-89	-11	-16	-25	-39	-62	-100	-125	-310	0	0	0	+9
50	80	-60	0	0	0	0	0	0	+150	+370	+46	+74	+120	+41
		-106	-13	-19	-30	-46	-74	-120	-150	-370	0	0	0	+11
80	120	-72	0	0	0	0	0	0	+175	+435	+54	+87	+140	+48
		-126	-15	-22	-35	-54	-87	-140	-175	-435	0	0	0	+13

Conversion: 1 micron equals .00004 inches

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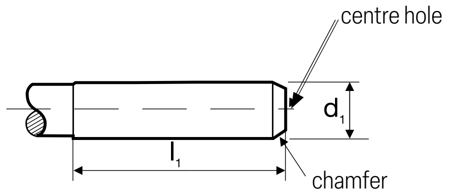
High Speed Steel Straight Shanks

DIN 1835

Form A (plain)

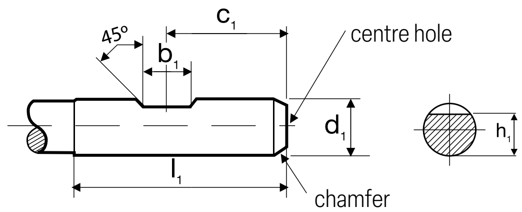
d_1 h6	l_1 +2 -0
3	28
4	28
5	28
6	36
8	36
10	40
12	45

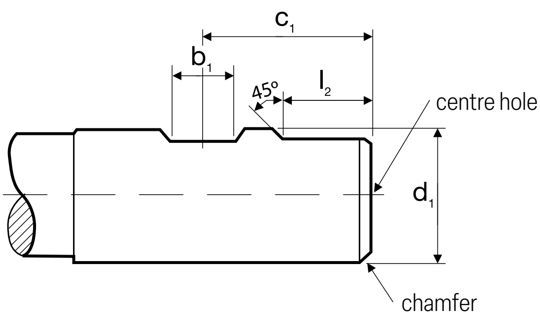
d_1 h6	l_1 +2 -0
16	48
20	50
25	56
32	60
40	70
50	80
63	90



Form B (with drive flat)

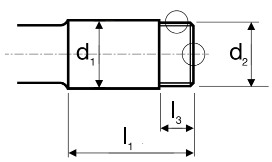
d_1 h6	b_1 +0.05 -0	c_1 0 -1	h_1 h13	l_1 +2 -0	l_2 +1 -0
6	4.2	18	4.8	36	-
8	5.5	18	6.6	36	-
10	7	20	8.4	40	-
12	8	22.5	10.4	45	-
16	10	24	14.2	48	-
20	11	25	18.2	50	-
25	12	32	23	56	17
32	14	36	30	60	19
40	14	40	38	70	19
50	18	45	47.8	80	23
63	18	50	60.8	90	23



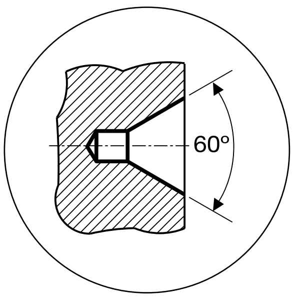


Form D (screwed shank)

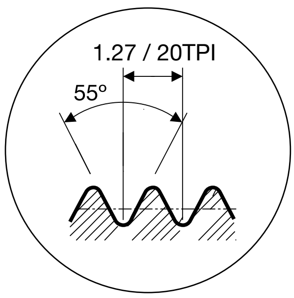
d_1	l_1 +2 -0	l_3 +1 -0	d_2
6	36	10	5.9
10	40	10	9.9
12	45	10	11.9
16	48	10	15.9
20	50	15	19.9
25	56	15	24.9
32	60	15	31.9



thread undercut or
thread run out released



centring hole



thread profile
DIN ISO 228
Whitworth Form

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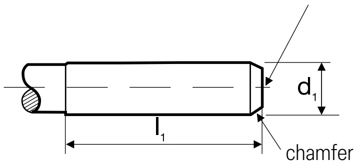
Carbide Straight Shanks

Form HA (plain)

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

DIN6535

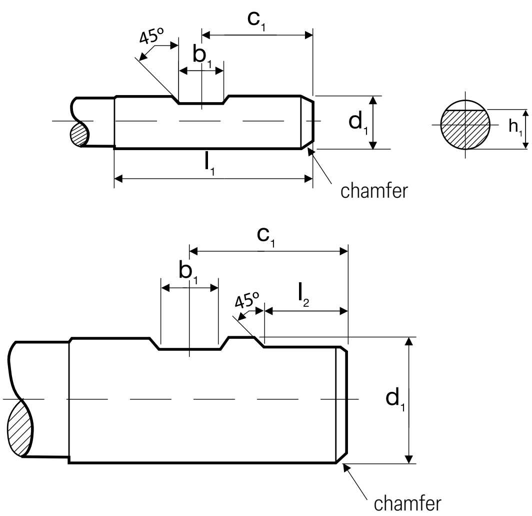
d_1 h6	l_1 +2 -0
12	45
14	45
16	48
18	48
20	50
25	56
32	60



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	5.1	36	-
8	5.5	18	6.9	36	-
10	7	20	8.5	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

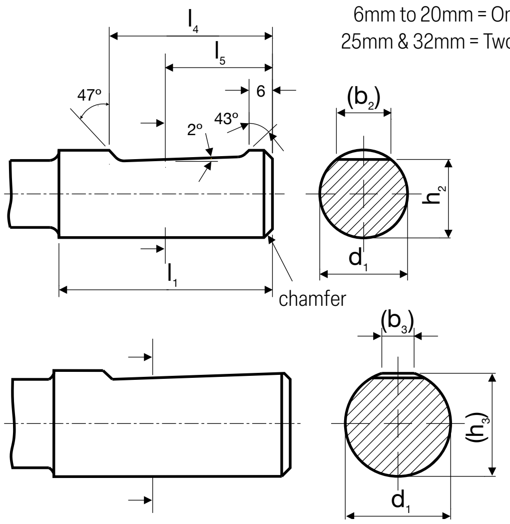
6mm to 20mm = One Drive Flat
25mm & 32mm = Two Drive Flats



Form HE (with whistle notch flat)

d_1 h6	b_2	b_3	h_2 h11	h_3	l_1 +2 0	l_4 0 -1	l_5
6	4.3	-	5.1	-	36	25	18
8	5.5	-	6.9	-	36	25	18
10	7.1	-	8.5	-	40	28	20
12	8.2	-	10.4	-	45	33	22.5
14	8.1	-	12.7	-	45	33	22.5
16	10.1	-	14.2	-	48	36	24
18	10.8	-	16.2	-	48	36	24
20	11.4	-	18.2	-	50	38	25
25	13.6	9.3	23	24.1	56	44	32
32	15.5	9.3	30	31.2	60	48	35

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



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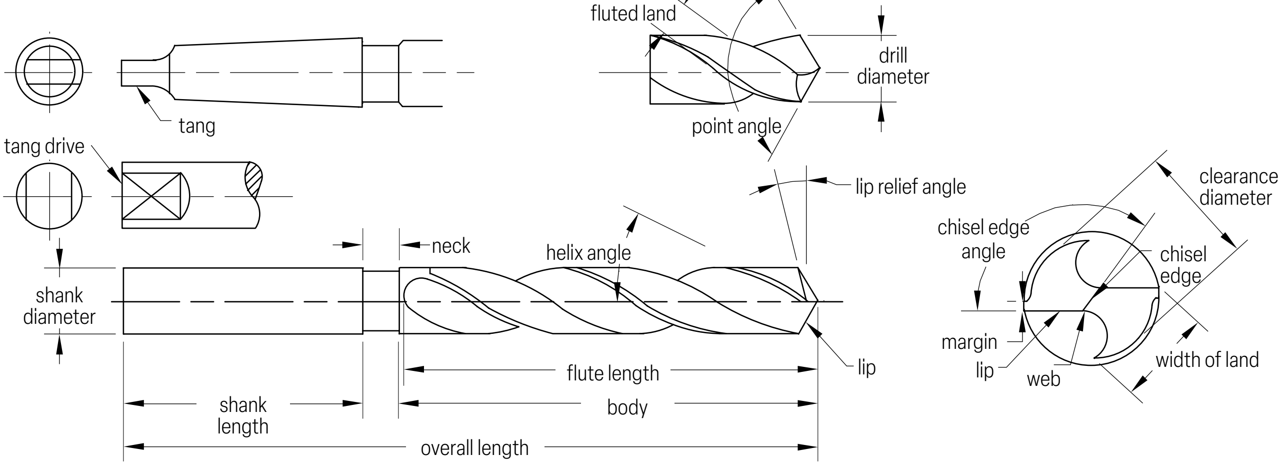
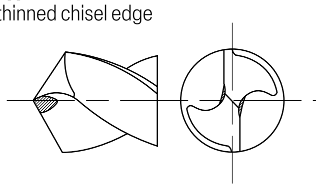
Drill Definitions



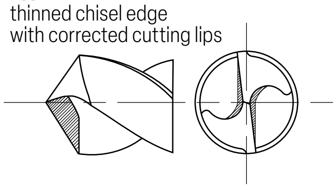
*Drills manufactured to ANSI B94-11. The overall length and flute length are measured to the corner of the outer lip.

Drill Point Types (DIN1412)

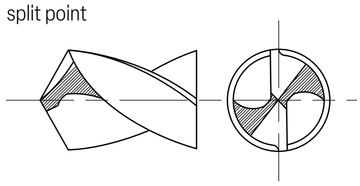
Type A
thinned chisel edge



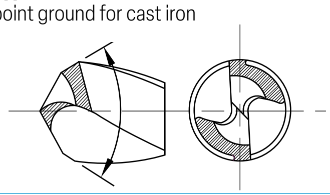
Type B
thinned chisel edge
with corrected cutting lips



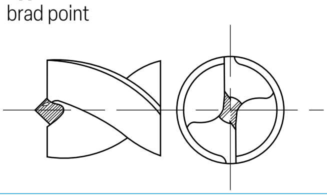
Type C
split point



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.

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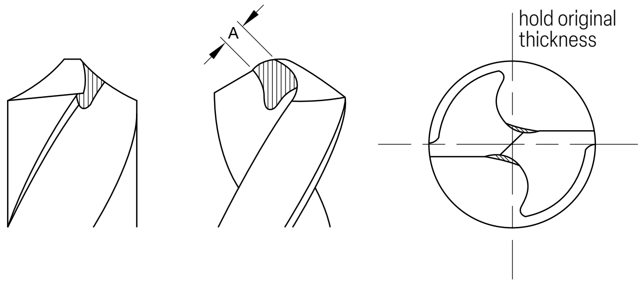
Web Thinning

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 sharpening 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 percent %	
	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

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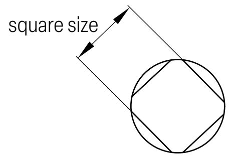
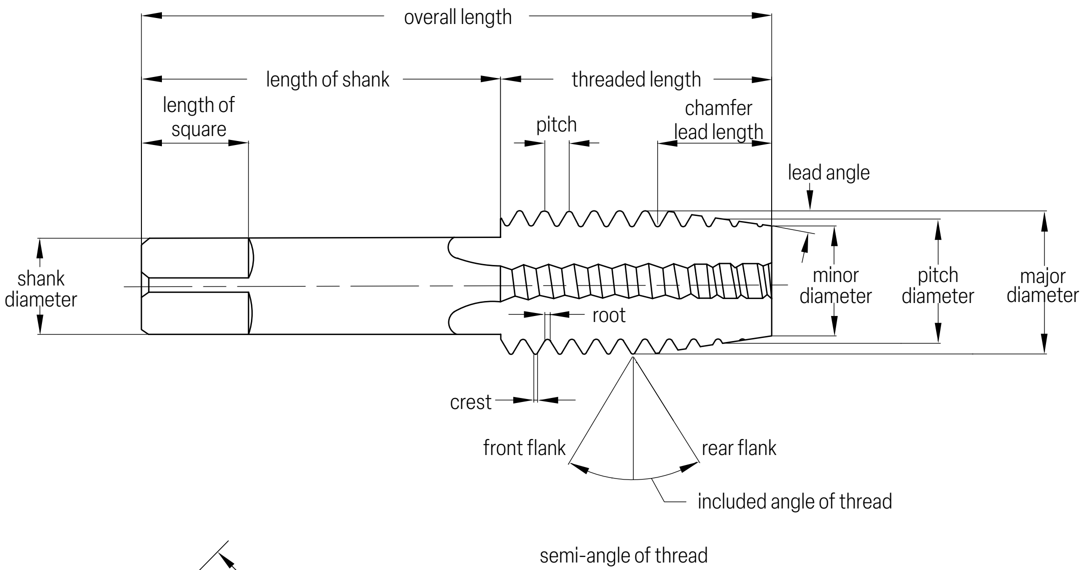
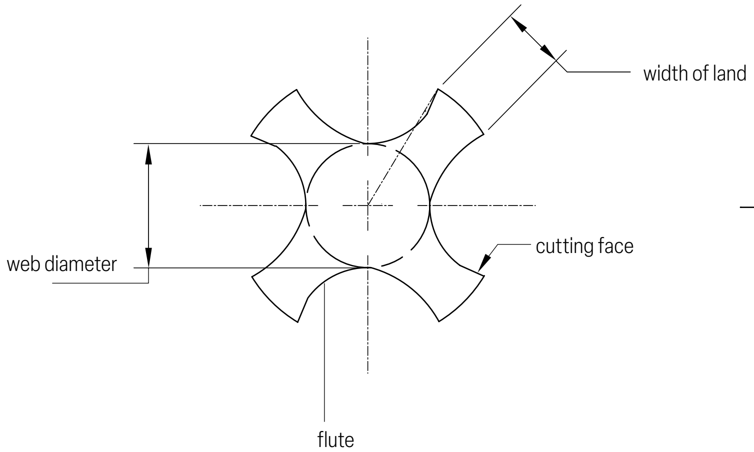
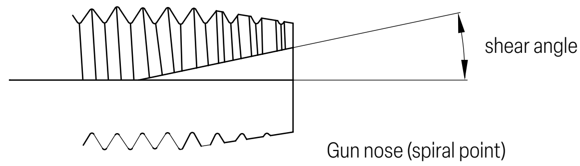
Tap Definitions



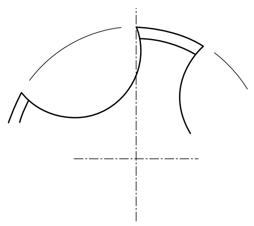




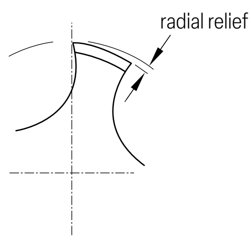


Gun nose (spiral point)

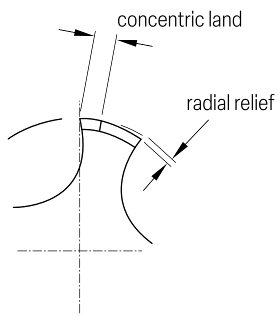
Thread Relief Types



Concentric threads
(no radial relief)

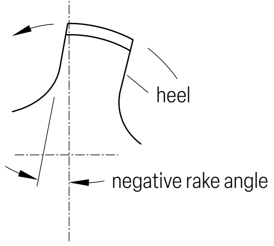


Eccentric threads
(relieved to cutting edge)

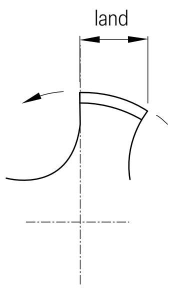


Con-eccentric threads
(relieved to a land)

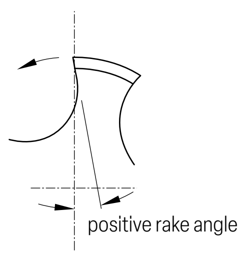
Cutting Faces



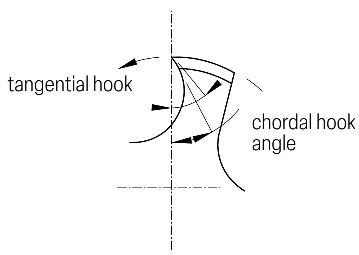
Negative rake



Radial rake



Positive rake



Hook

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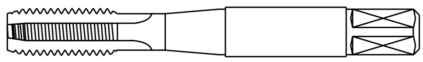
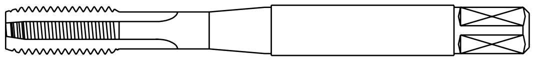
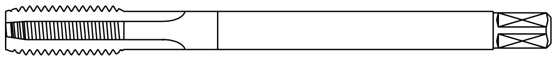
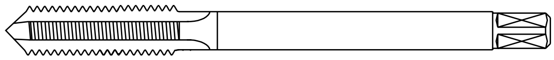
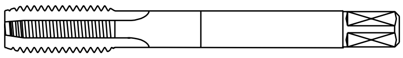
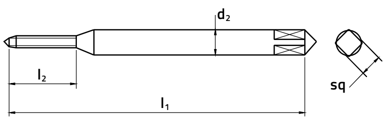
Construction dimensions / designs

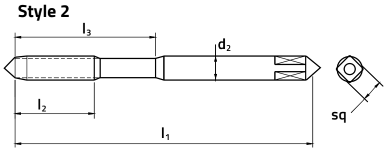
Short Machine & Hand Taps	ISO 529 JIS (J TYPE)	
Reinforced Shank Taps	DIN371	
Reduced Shank Taps	DIN374 / DIN376 / DIN5156	
Machine Nut Taps	ANSI B949 Standard	
Pipe Taps	Rc(BSPT), G (BSPF), Rp (BSPPL) - ISO2284 Standard NPT, NPTF, NPSF - ANSI B949 Standard	

Tap Styles

Style 1



Style 2



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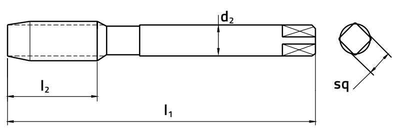

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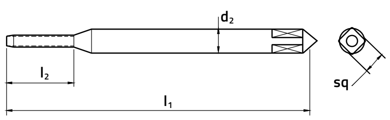
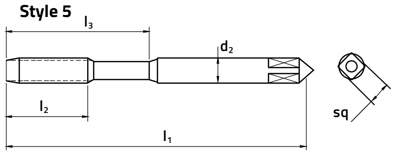
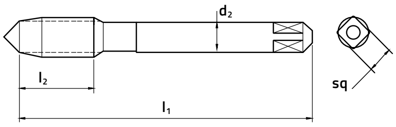


Style 5

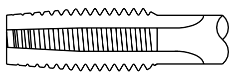
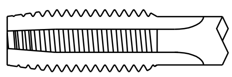
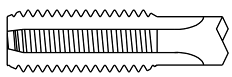
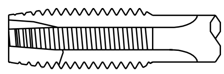
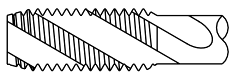


Style 6



Chamfer Type / Length

Table below is in accordance with ISO8830 / DIN2197

Terminology	Form	Number of threads on lead	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 run out	
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

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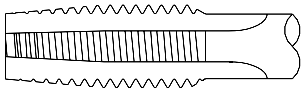
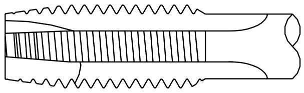
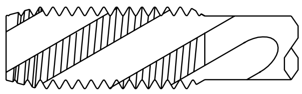
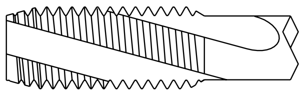
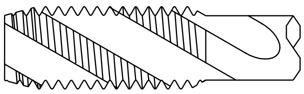
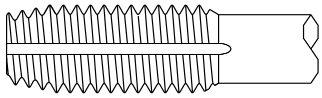
Tap Types - Helix direction/ Helical pitch / Fluteless

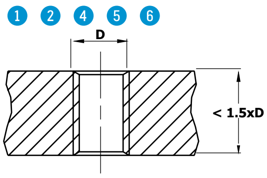
The helix angle depends primarily upon the hole form, eg. Through hole , blind hole, deep blind hole, etc., but the material, eg short chips, long chips, also has a strong influence on the direction of the helix. The following basic forms have derived during the development of taps:

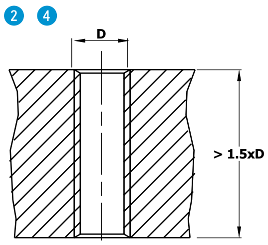
Description	Illustration
1 Straight Flutes (Hand) - Suitable for through or blind holes. The flutes only have room for a small amount of chips. The chips are not transported axially. Therefore, it is not advisable to cut deep through or blind holes (except in short chipping materials), with this type.	
2 Straight Flutes with (Gun) – Suitable for through holes, the gun point curls the chip forward ahead of the tap & out of the hole. Therefore, chip clogging is avoided and coolant can flow without problems.	
3 Spiral Flutes (LH Spiral, right hand cutting) – 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.	
4 15° Spiral Flutes (RH Spiral) – Suitable for blind holes, best suited to tough short chipping materials, up to 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.	
5 40° to 50° 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.	
6 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.	

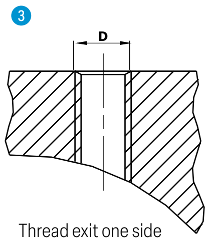
The above basic tool types are available in different variations, which have been designed & developed in respect to the specific materials and working conditions.

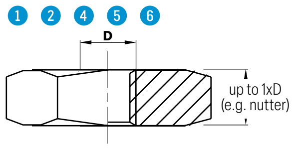
Tap Hole Types

Through Holes

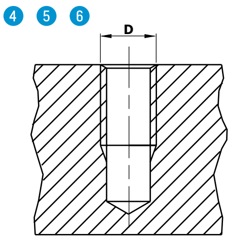


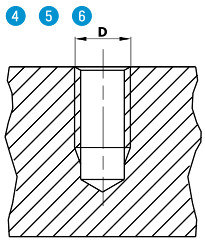


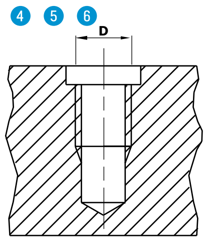


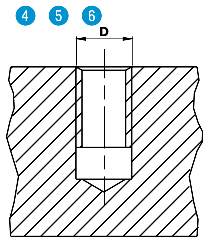


Blind Holes









For blind holes, there are generally two thread run out 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 run out. 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.

Geometry

Sutton Designation	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 tolerance 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 Tools has historically manufactured.	Normal rake angle & normal thread relief	Bright Blu 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 (PM-HSS), which due to its finer grain structure than that of conventional HSS, higher hardness can be achieved with excellent toughness, along with TiAlN surface coating allowing for better tool life than normal taps.	Normal rake angle & high thread relief	Bright TiAlN
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 Blu
VAPM	For stainless and tough steels – geometry similar to VA range, however tap material is powder metal high speed steel (PM-HSS), 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

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Lubricants

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:
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 × 1 = 5.00mm drill
Whitworth Form Threads (inch calculation)	Drill Size = Nom, Tap Dia, $-\frac{1.28}{TPI} \times$ % of thread depth	1/4 BSW 75% thread required: Drill Size = 0.250 – $\frac{1.28}{20} \times \frac{75}{100}$ = 0.250 – 0.048 Therefore Drill Size = 0.202 Nearest Standard Drill = 5.1mm = 0.2007 inch
Unified Form Threads (inch calculation)	Drill Size = Nom, Tap Dia, $-\frac{1.30}{TPI} \times$ % of thread depth	1/4 UNC 75% thread required: Drill Size = 0.250 – $\frac{1.30}{20} \times \frac{75}{100}$ = 0.250 – 0.049 Therefore Drill Size = 0.201 Nearest Standard Drill = 5.1mm = 0.2007 inch

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All sizes are "suggested sizes" only and may be varied to suit individual requirements

M ISO Metric Coarse (60°)

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 (60°)

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 (60°)

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 (60°)

Tap Size	T.P.I.	Tapping Drill mm
#2 (0.086)	56	1.85
#3 (0.099)	48	2.1
#4 (0.112)	40	2.3
#5 (0.125)	40	2.6
#6 (0.138)	32	2.8
#8 (0.164)	32	3.4
#10 (0.190)	24	3.8
#12 (0.216)	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 (60°)

Tap Size	T.P.I.	Tapping Drill mm
#3 (0.099)	56	2.1
#4 (0.112)	48	2.35
#5 (0.125)	44	2.65
#6 (0.138)	40	2.9
#8 (0.164)	36	3.5
#10 (0.190)	32	4.1
#12 (0.216)	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 (60°)

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 (55°)

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 (55°)

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 (55°)

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 (55°)

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 (55°)

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 (55°)

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 (80°)

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 (60°)

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 (60°)

Tap Size	T.P.I.	Tapping Drill mm
1/8	27	8.6
1/4	18	11.3
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 Tools Taper Pipe Reamers.

Thread forming
(Fluteless taps)

Tap Size	T.P.I.	Tapping Drill mm
UNC		
#1 (0.073)	64	1.7
#2 (0.086)	56	2.0
#3 (0.099)	48	2.3
#4 (0.112)	40	2.6
#5 (0.125)	40	2.9
#6 (0.138)	32	3.2
#8 (0.164)	32	3.8
#10 (0.190)	24	4.4
#12 (0.216)	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 (0.073)	72	1.7
#2 (0.086)	64	2.0
#3 (0.099)	56	2.3
#4 (0.112)	48	2.6
#5 (0.125)	44	2.9
#6 (0.138)	40	3.2
#8 (0.164)	36	3.9
#10 (0.190)	32	4.5
#12 (0.216)	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
(47.5°)

Tap Size	Pitch mm	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

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

- Higher speeds and tool life
- Reduced possibility of breakage due to no cutting edges and robust tool construction

Figure 1. No chips produced

Figure 2. Higher tensile strength threads produced due to grain structure following the thread form

Figure 3. For use in through and blind holes applications

What's New?

Figure 4. New polygon profile

Figure 5. New radiused blend on polygon profile

Figure 6. Thread profile with radius crest

Figure 7. Polished tool surface, surface finish

Figure 1.

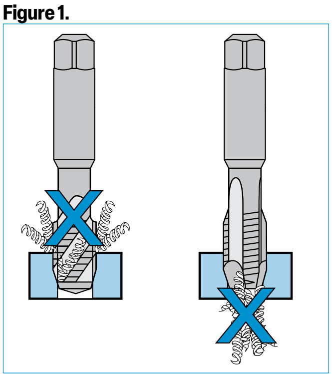


Figure 2.

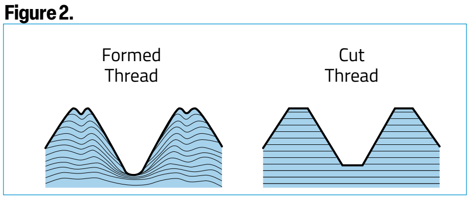


Figure 3.

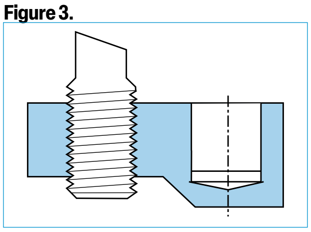


Figure 4.

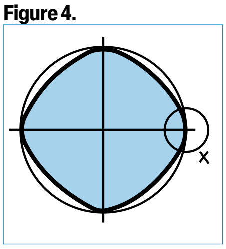


Figure 5.

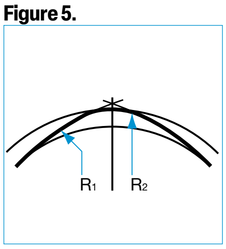


Figure 6.

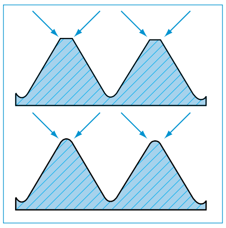
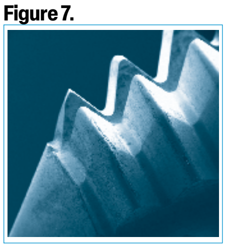


Figure 7.



Suitable for wide range materials

-Low carbon steels
-Leaded steels
-Austenitic stainless steels
-Alloy steels; typically up to 1200 N/mm^2, (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

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 minimum 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
Drill size = nominal thread dia. (in mm)– (0.007 x % of thread x pitch)	Drill size for 65% of thread in a M6 x 1.0 threaded hole would be: Drill size = 6 – (0.007 x 65 x 1.0 (pitch)) = 5.54mm (Use 5.50mm drill (Stockable drill) = 71%)

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. **Figure 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. **Figure 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

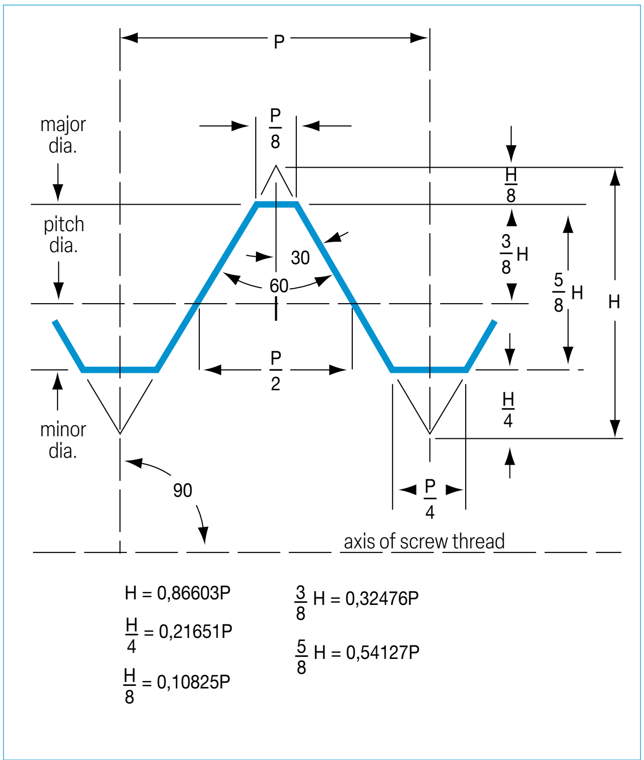
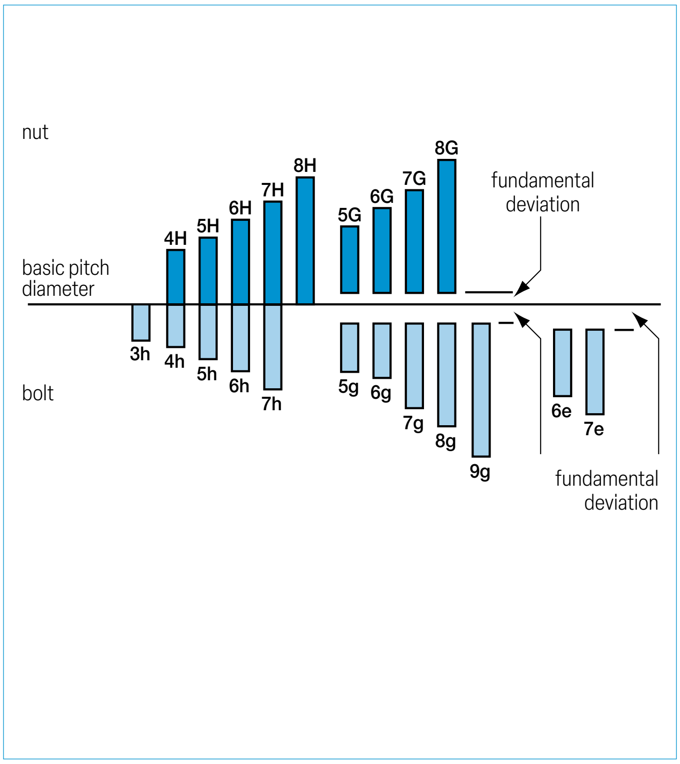


Figure 2



Metric Taps; Comparison Tap Limits & Product Classes and Grades

Product Tolerance					Tap Limits					
Tap Size mm	Pitch	ISO Tolerance Class	6H Upper Deviation Tolerance µm	JIS 2 Old/JIS Product Tolerance µm	ISO Tap Grade	ISO Tap Limits Microns µm	Recommended Limit P 1 µm	P 2 µm	P 3 µm	P 4 µm
M1.0	x 0.25	5H	56	60	ISO 1	+ 6 / 17	+ 10 / 25			
M1.1	x 0.25	5H	56	60	ISO 1	+ 6 / 17	+ 10 / 25			
M1.2	x 0.25	5H	56	60	ISO 1	+ 6 / 17	+ 10 / 25			
M1.4	x 0.3	5H	60	60	ISO 1	+ 6 / 18	+ 10 / 25			
M1.6	x 0.35	5H	67	85	ISO 1	+ 7 / 20	+ 10 / 25	+ 25 /40		
M1.7	x 0.35	6H	85	85	ISO 2	+ 20 / 34	+ 10 / 25	+ 25 /40		
M1.8	x 0.35	6H	85	85	ISO 2	+ 20 / 34	+ 10 / 25	+ 25 /40		
M2.0	x 0.4	6H	90	70	ISO 2	+ 21 / 36	+ 10 / 25	+ 25 /40		
M2.2	x 0.45	6H	95	95	ISO 2	+ 23 / 38	+ 10 / 25	+ 25 /40		
M2.3	x 0.4	6H	90	95	ISO 2	+ 21 / 36	+ 10 / 25	+ 25 /40		
M2.5	x 0.45	6H	95	95	ISO 2	+ 23 / 38	+ 10 / 25	+ 25 /40		
M2.6	x 0.45	6H	95	95	ISO 2	+ 23 / 38	+ 10 / 25	+ 25 /40		
M3.0	x 0.5	6H	100	100	ISO 2	+ 24 / 40	+ 10 / 25	+ 25 /40		
M3.5	x 0.6	6H	112	90	ISO 2	+ 27 / 45	+ 10 / 25	+ 25 /40		
M4.0	x 0.7	6H	118	118	ISO 2	+ 29 / 48		+ 20 /40		
M5	x 0.8	6H	125	125	ISO 2	+ 30 / 50		+ 20 /40		
M6	x 1.0	6H	150	120	ISO 2	+ 35 / 59		+ 20 /40		
M7	x 1.0	6H	150	120	ISO 2	+ 35 / 59		+ 20 /40		
M8	x 1.25	6H	160	130	ISO 2	+ 38 / 63		+ 20 /40	+ 40 / 60	
M10	x 1.5	6H	180	140	ISO 2	+ 42 / 70		+ 20 /40	+ 40 / 60	
M12	x 1.75	6H	200	160	ISO 2	+ 48 / 80			+ 40 / 60	+ 60 / 80
M14	x 2.0	6H	212	170	ISO 2	+ 51 / 85			+ 40 / 60	+ 60 / 80
M16	x 2.0	6H	212	170	ISO 2	+ 51/ 85			+ 40 / 60	+ 60 / 80
M18	x 2.5	6H	224	190	ISO 2	+ 54 / 90			+ 40 / 60	+ 60 / 80
M20	x 2.5	6H	224	190	ISO 2	+ 54 / 90			+ 40 / 60	+ 60 / 80
M22	x 2.5	6H	224	190	ISO 2	+ 54 / 90			+ 40 / 60	+ 60 / 80
M24	x 3.0	6H	265	200	ISO 2	+ 64 / 106			+ 40 / 60	+ 60 / 80

P limits; they stock the smaller P limit for SP Taps, and the larger P limit for PO taps.
Where there is only the one “P” limit; it is the same limit for both SP & PO Taps

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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**):

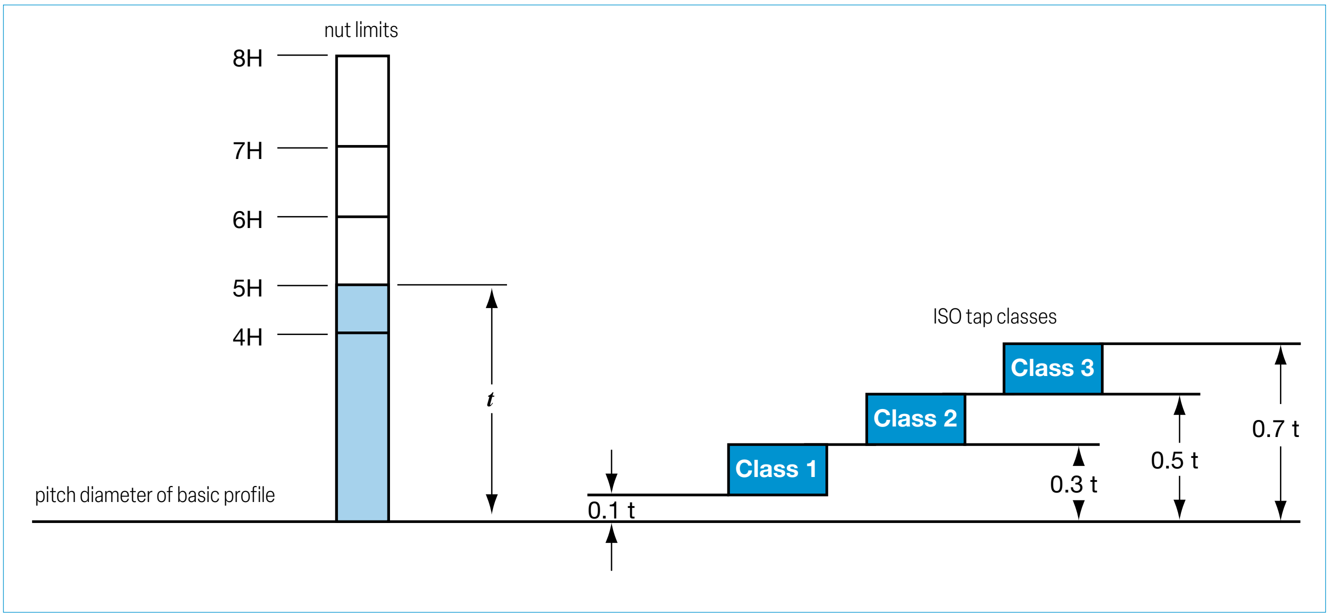
for tap class 1: + 0.1 t
for tap class 2: + 0.3 t
for tap class 3: + 0.5 t

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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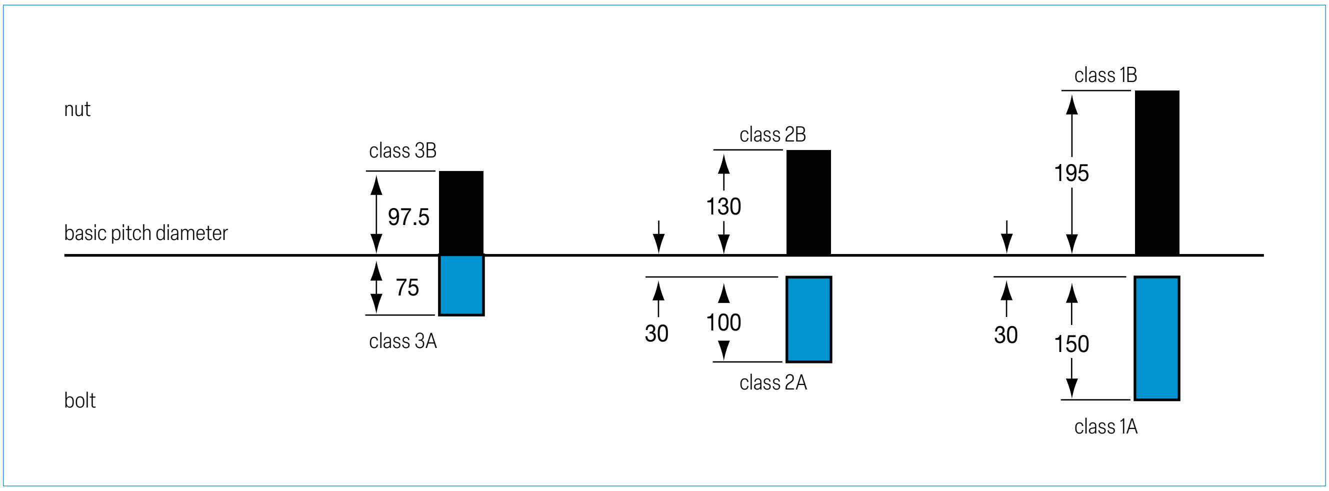
This system is well known. It has now been accepted by ISO as the recommended tolerance for ISO inch threads down to 0.06 inch nominal diameter.
The arrangement of the allowance and the various classes of pitch diameter tolerance for a normal length of engagement of the mating threads is shown in this 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. **Figure 4**.

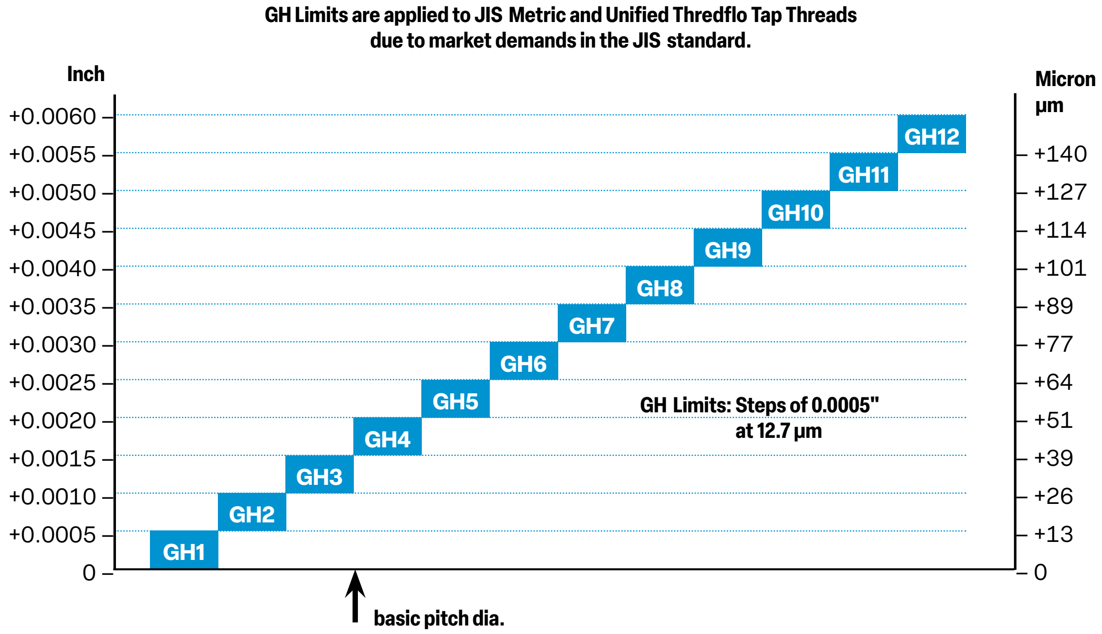
Figure 4



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



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

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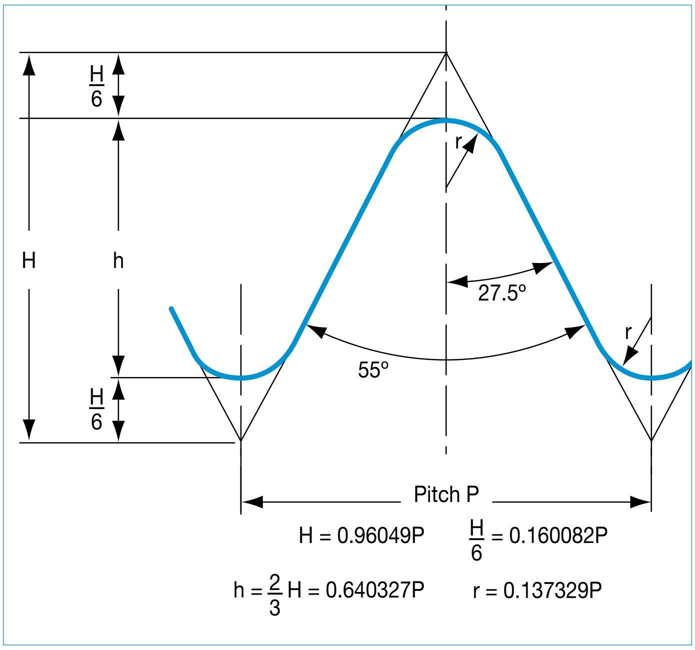
Basic Profile for Whitworth (BSW, BSF and WHIT.) Thread forms

British Standard Whitworth Form

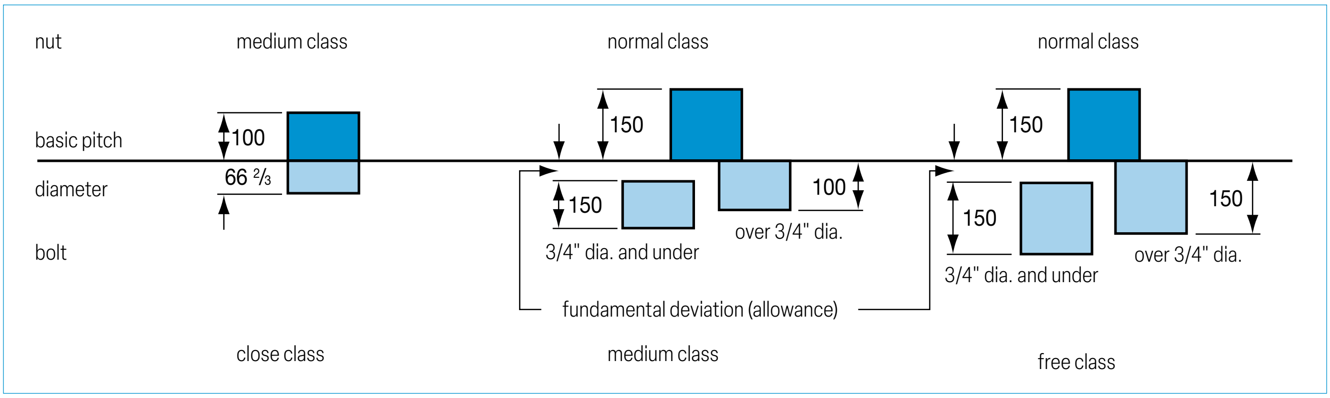
The sides of the thread form an angle of 55° with one another, and the top and bottom of the full triangle are truncated one-sixth of the height. The actual depth of the thread is equal to two-thirds of the height of the generating triangle and is equal to 0.6403 times the pitch. The crests and roots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

Figure 5



The Whitworth Screw Thread Tolerance System

Figure 6

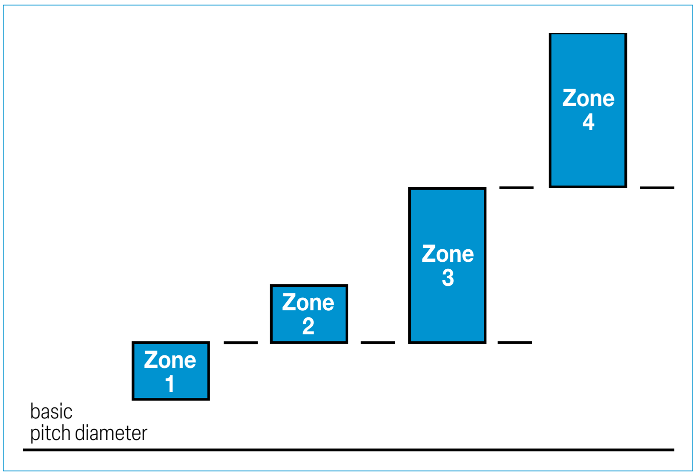


Pitch diameter tolerance zones of recommended combinations of classes of bolts and nuts having Whitworth screw threads. **Figure 6**.

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. **Figure 7**.

Figure 7



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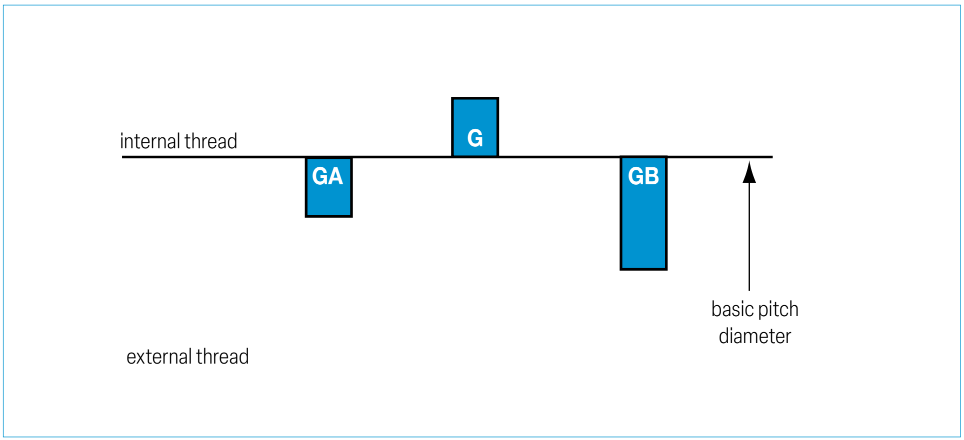
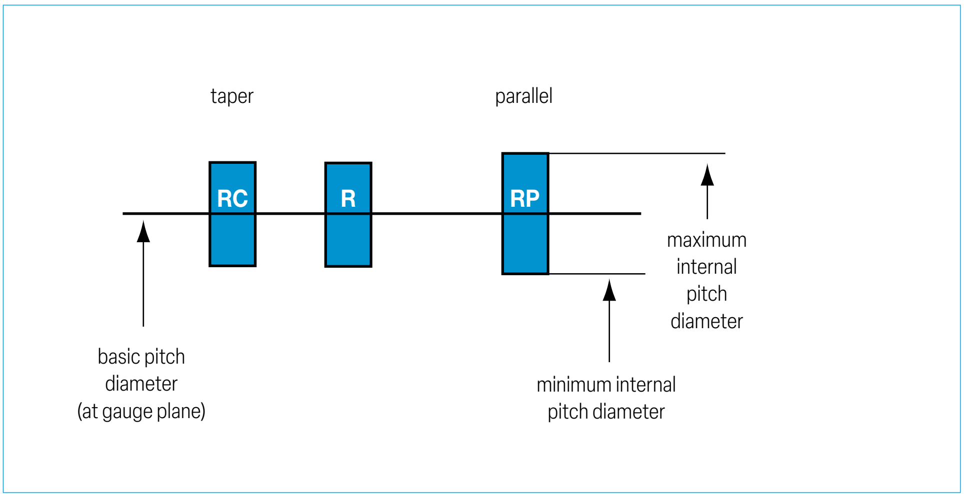
The International Standard Pipe Tap Thread System (ISO) has been derived from the original Whitworth gas and water pipe tap threads, formerly known as BSPF (Fastening) and BSPT (Taper), these systems have been so widely used throughout Europe and the United Kingdom that they have been metricated, whilst 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.

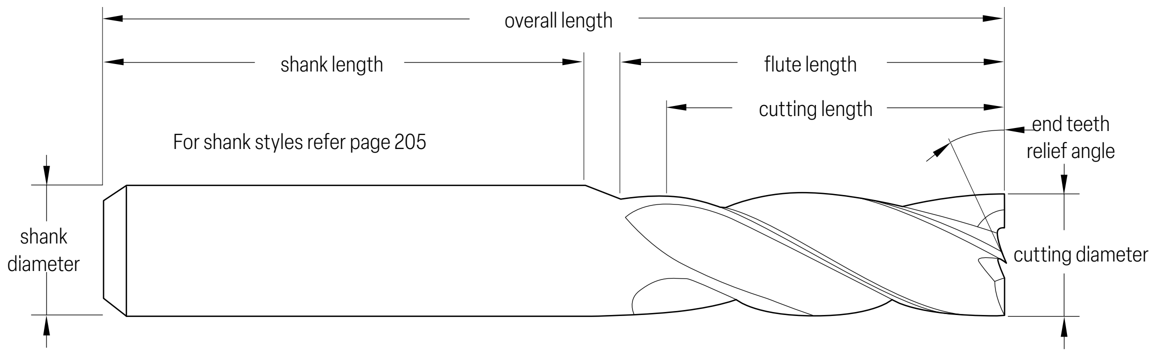
"G" Fastening Parallel Pipe Threads – ISO 228, AS1722 PT2 and BS2779.
This parallel thread system has only one positive internal thread tolerance and two classes of external tolerances. This series constitutes a fine series of fastening connecting pipe threads for general engineering purposes, the assembly 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.

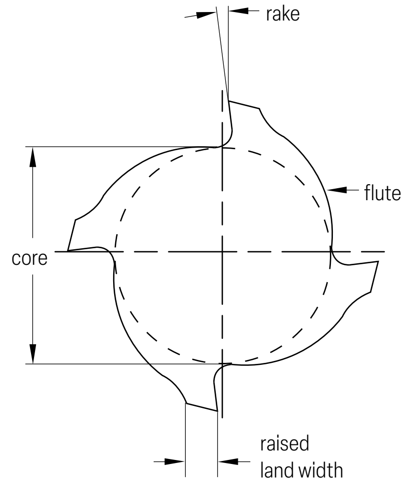


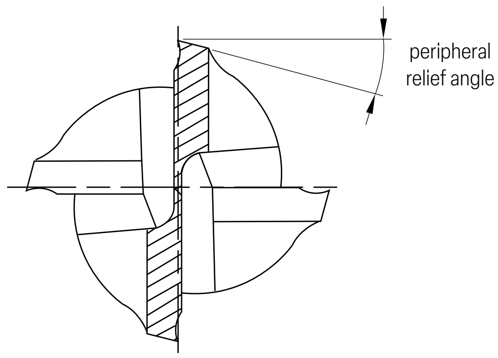
"R" Sealing Taper Pipe Threads – ISO 7, AS1722 PT1 and BS21. The taper rate is 1-16 on diameter.
This series is for tubes and fittings where pressure tight joints are made by threads, these threads therefore must have a full form profile (no truncations). The series include a taper external thread (R) 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.



Endmill Definitions





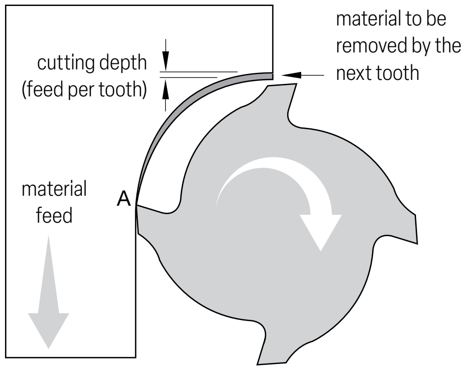


Conventional milling versus climb milling

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

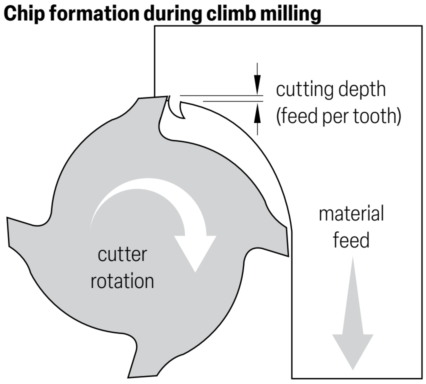
Conventional milling: The depth of the cut starts at zero thickness, and increases up to the maximum. The cut is so light at the beginning that the tool does not cut, but slides across the surface of the material, until sufficient pressure is built up and the tooth suddenly bites and begins to cut. This 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 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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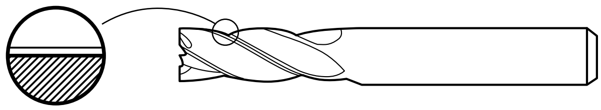
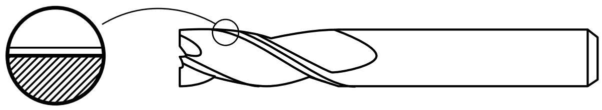
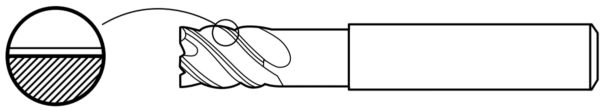
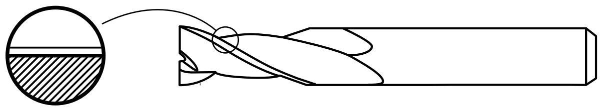
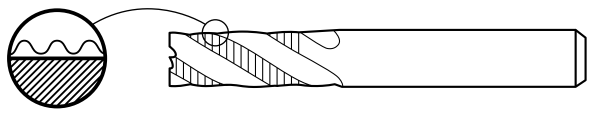
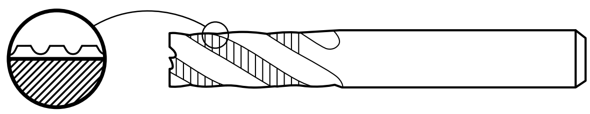
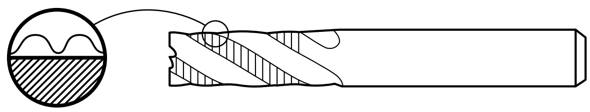
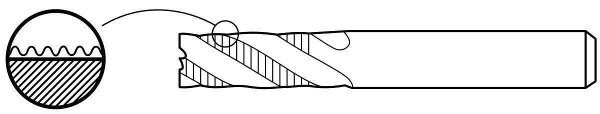
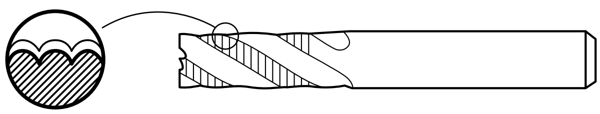
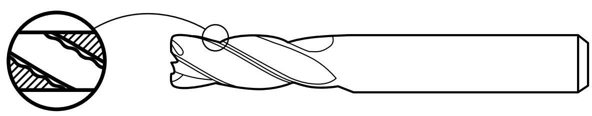
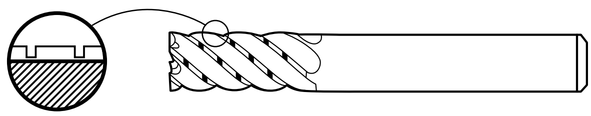
Type	Description	Application	Illustration
N	Finishing Form		
W	Slotting & Finishing - Use in soft materials, quick spiral 45° up to 600 N/mm^2		
VA	Optimised geometry for Austentic Stainless Steels & other long chipping materials up to 1000 N/mm^2		
Al & CU	For slotting wrought aluminium alloys with efficient chip evacuation, due to high relief angles and 40° spiral		
NR	Normal Roughing Form - general purpose		
NF	Semi Roughing Form - Ideally suited to soft, long chipping materials.		
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 up to 1400 N/mm^2		

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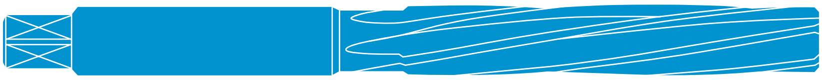

Hints on use

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 meter per minute values which may be used as a basis from which to start.

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

Company:

Contact:

Address:

Phone:

State / Province:

Fax:

Country:

Email:

Tap Details

Quantity:

Basic Geometry

☐ Thread Cutting
☐ Thread Forming

Size: ________________

Thread Limit: __________

NB: 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 ________________

Tool Material

☐ HSS
☐ HSSE
☐ PM-HSSE V3
☐ PM-HSS Co
☐ SPM
☐ VHM

Coating

☐ Uncoated
☐ Steam Oxide
☐ TiN
☐ TiAlN
☐ TiCN
☐ other ______________

Existing Method

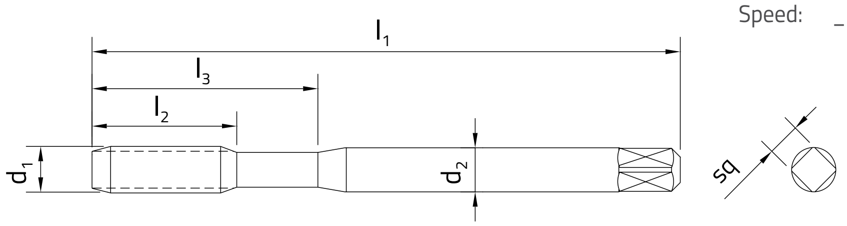
Manufacturer: ___________
____

Dimensions: ___________

Tolerance: ___________

Product No: ___________

Speed: _____________



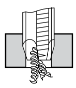
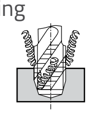
Workpiece Details

Component: ________________________________

Material Group: ________________________________

Material Grade: ________________________________

Characteristics of Material:
☐ Short Chipping ☐ Long Chipping

Hole Type:
☐ Through Hole  ☐ Blind Hole 

Tapping Hole Size: ___________ ☐ Drilled ☐ Cast ☐ Punched

Hole Depth: ________________________________

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)

Drawing / Notes

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

Company: ______

Contact: ______

Address: ______

Phone: ______

State / Province: ______

Fax: ______

Country: ______

Email: ______

Drill Details

Quantity:

Basic Geometry

Tool Type:

- ☐ Drill
- ☐ Step Drill
- ☐ Countersinks
- ☐ Subland Drills
- ☐ Core Drills
- ☐ Centre Drills

Total Length (mm): ______________________________

Number of Steps:

- ☐ Without
- ☐ With ____________________________________ steps

Step Diameter (mm):

- ☐ d_1 _________________ ☐ d_2 _________________
- ☐ d_3 _________________ ☐ d_4 _________________
- ☐ d_5 _________________ ☐ d_6 _________________

Tool Material:

- ☐ HSS
- ☐ HSSE
- ☐ PM-HSSE V3
- ☐ other ____________________________________

Plus Coating:

☐ Yes ☐ No

- ☐ TiN
- ☐ TiCN
- ☐ TiAIN
- ☐ Steam Oxide
- ☐ other ____________________________________

Plus Internal Cooling:

☐ Yes ☐ No

Point Design

Point Geometry:

- ☐ Relieved Cone
- ☐ For Grey Cast Iron
- ☐ Centre Point
- ☐ Facet Point Grind
- ☐ other ____________________________________

Special Point Grind, Form: ☐ A ☐ B ☐ C

Spiral: ☐ RH ☐ LH

Shank Design:

- ☐ Reinforced
- ☐ Without Flat
- ☐ With Flat
- ☐ Parallel Straight Shank
- ☐ Morse Taper
- ☐ other ____________________________________

Drawing / Notes

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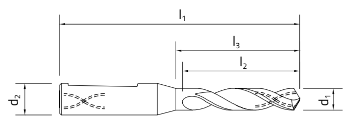
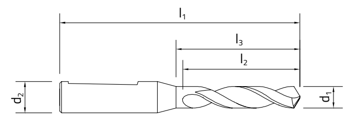
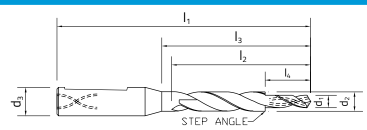
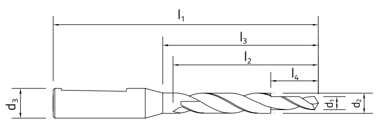
APPLICATION CARBIDE DRILL - SPECIAL ENQUIRY

Customer No.:	**New Customer** ☐	**Order No.**	
Company:		**Contact:**	
Address:		**Phone:**	
State / Province:		**Fax:**	
Country:		**Email:**	

SOLID CARBIDE DRILL WITHOUT STEP

	WITH Internal Cooling — Quantity:	WITHOUT Internal Cooling — Quantity:
		
Carbide grade	(specify if known)	(specify if known)
Norm-Ø d_1	(4 – 20mm)	(3 – 20mm)
Shank-Ø d_2	(DIN 6535)	(DIN 6535)
Shank length l_3	(DIN 6535)	(DIN 6535)
Shank form	☐ HA ☐ HE (DIN 6535)	☐ HA ☐ HE (DIN 6535)
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	☐ 120° ☐ 130° ☐ 140°	☐ 120° ☐ 130° ☐ 140°
Point geometry	(specify if known)	(specify if known)
Surface finish/coating	☐ Uncoated ☐ TiN ☐ TiCN ☐ TiAN ☐ AlCrN	☐ Uncoated ☐ TiN ☐ TiCN ☐ TiAN ☐ AlCrN
Cost per tool	$	$

SOLID CARBIDE STEP DRILL

	WITH Internal Cooling — Quantity:	WITHOUT Internal Cooling — Quantity:
		
Carbide grade	(specify if known)	(specify if known)
Step-Ø d_1	(4 – 20mm)	(3 – 20mm)
Body-Ø d_2	(4 – 20mm)	(3 – 20mm)
Shank-Ø d_3	(DIN 6535)	(DIN 6535)
Shank length l_3	(DIN 6535)	(DIN 6535)
Shank form	☐ HA ☐ HE (DIN 6535)	☐ HA ☐ HE (DIN 6535)
Step length l_4	(3 – 100mm)	(3 – 100mm)
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	☐ 120° ☐ 130° ☐ 140°	☐ 120° ☐ 130° ☐ 140°
Step angle	☐ 60° ☐ 90° ☐ 120°	☐ 60° ☐ 90° ☐ 120°
Point geometry	(specify if known)	(specify if known)
Surface finish/coating	☐ Uncoated ☐ TiN ☐ TiCN ☐ TiAN ☐ AlCrN	☐ Uncoated ☐ TiN ☐ TiCN ☐ TiAN ☐ AlCrN
Cost per tool	$	$

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Customer No.: ______ **New Customer** ☐ | **Order No.** | | | | | | | | | | | | |
Company: ______ | **Contact:** ______
Address: ______ | **Phone:** ______
State / Province: ______ | **Fax:** ______
Country: ______ | **Email:** ______

Endmill Details

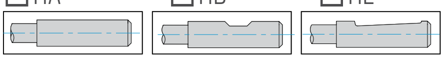
Quantity:

Basic Geometry

		Range
Norm-Ø d_2		(3 – 20mm)
Shank-Ø d_2 to DIN 6535		(4 – 20mm)
Shank length l_3 to DIN 6535		mm
Total length	l_1 Ø 3 – 10mm	(28 – 100mm)
	from Ø 10 – 20mm	(56 – 150mm)
Cutting length	l_2 Ø 3 – 10mm	(3 – 40mm)
	from Ø 10 – 20mm	(10 – 65mm)
Helix angle	w_2 Ø 3 – 6mm	(20° – 45°)
	from Ø 6 – 20mm	(20° – 55°)
No. of cutting edges	Ø 3 – 6mm	(2 – 4mm)
	from Ø 6 – 20mm	(2 – 6mm)
	from Ø 16 – 20mm	(2 – 8mm)

Shank Design

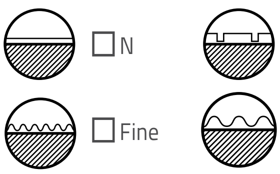
Straight Shank (DIN 6535) ☐ HA ☐ HB ☐ HE



Peripheral Geometry

Finishing endmills (Ø 3 – 20mm) ☐ N ☐ with Chip Breaker

Roughing endmills (Ø 6 – 20mm) ☐ Fine ☐ Coarse



Face Geometry

Point angle w_s ______ (180° + 5°)

Cutting to Centre ☐ Yes ☐ No

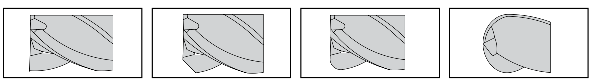
Corner Preparation

Sharp edge ☐ Yes ☐ No

Corner protection ______ mm x 45° (Ø 0.03 – 1.5mm)

Corner radius ______ mm x d_1 (Ø 0.3 – 2/3mm)

Ballnose ☐ Yes ☐ No



Plus Internal Cooling ☐ Yes ☐ No

(Ø 4 – 20mm)

Plus Coating ☐ Yes ☐ No

☐ TiN ☐ TiCN ☐ TiAN ☐ AICrN (Ø 4 – 20mm)

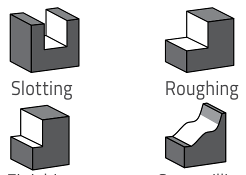
Tool Material

Specify grade (if known)

☐ Carbide ______
☐ PM-HSSE ______
☐ HSS-Co ______
☐ HSS ______

Detail Regarding Application

Range of applications ______
Material description ______
Material hardness ______ (N/mm² or HRC)
Application types
☐ Slotting
☐ Roughing
☐ Finishing
☐ Copy milling



Drawing / Notes

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