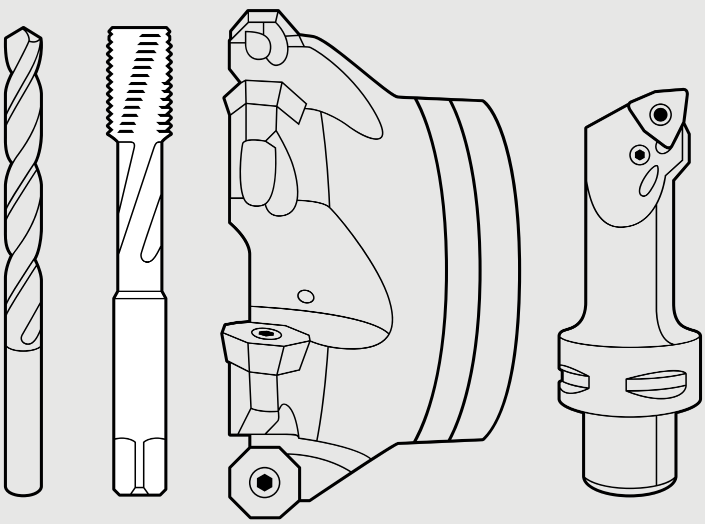
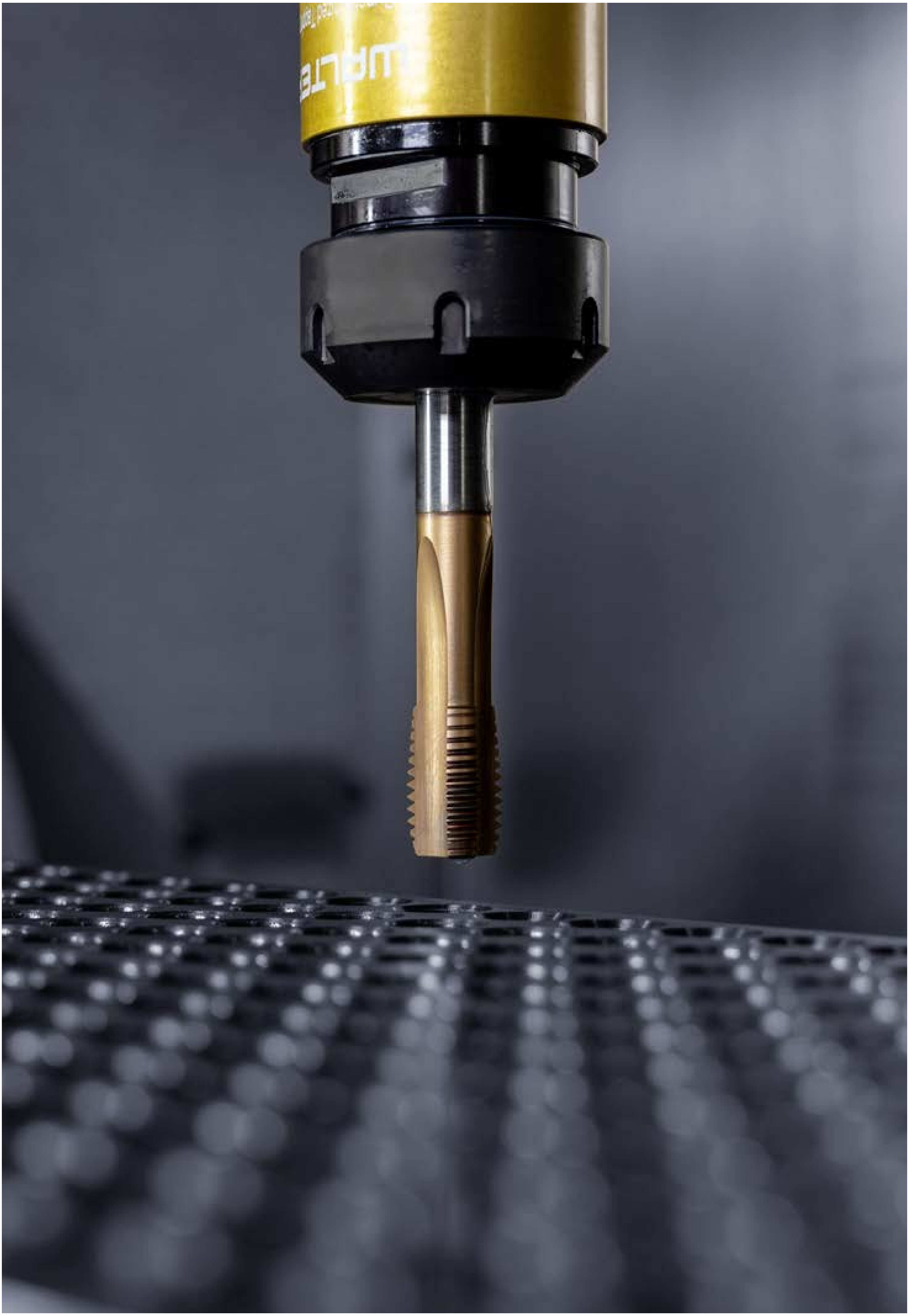
Tapping, thread forming, thread milling

Technical Compendium – Threading
Edition 2024

_ METAL IS OUR WHOLE WORLD

Technical Compendium
Threading





Technical Compendium – Threading

Tapping

Thread forming

Technical Compendium – Threading (continued)

Thread milling

General information – Solid carbide thread milling

General information – Indexable insert thread milling

Thread milling strategies

Application information

Designation key

General

WALTER
Engineering Kompetenz

Technologies at Walter

Accure·tec®

The patented Walter Accure·tec® technology ensures maximum vibration damping on boring bars for turning and adaptors for milling. Ideal for turning, milling and drilling operations involving extended tool applications.

Drion·tec™

Drion·tec™ is the name for Walter's drilling and reaming tool solutions with a replaceable cutting edge – both with indexable inserts and exchangeable inserts. Drion·tec™ drills are set apart by their cost-efficiency, high precision and versatility. Thanks to a wide product range, they are suitable for specialised mass production as well as for specific applications and mixed-mode manufacturing.

Krato·tec™

Krato·tec™ is a unique Walter coating technology for solid carbide tools. The core of this consists of an extraordinarily fracture-resistant AlTiN multi-layer coating with a textured top layer. The special layer architecture is highly wear- and adhesion-resistant, even at high cutting speeds, and ensures the tools have universal application.

Tiger·tec® Gold

Tiger·tec® Gold, the new Walter generation platform for unique indexable insert coatings, enables maximum tool life and process reliability. The new grades are based on PVD, CVD or ULP technology, depending on the application. Unique coating properties, protected by multiple patents, guarantee the best protection against tool life-limiting types of wear and ensure outstanding performance.

Tiger·tec® Silver

With Tiger·tec® Silver, Walter is offering a world first in coating technology for indexable inserts. The special aluminium oxide layer with optimised microstructure reduces wear during turning, milling and drilling operations, and increases toughness and temperature resistance for significantly higher cutting data.

Thrill·tec™

Thrill·tec™ circular drill/thread mills combine three functions in one tool and operation: Chamfering, drilling core holes and producing threads. The tools boast a special combination of substrate, coating and geometry, resulting in long tool life. Bringing together multiple machining steps makes incredibly short machining times possible and reduces the number of tools used and machine slots required.

Walter BLAXX

Walter BLAXX is the benchmark for a new generation of milling cutters: The milling bodies are extremely robust thanks to their special surface treatment. The milling systems, which are mainly positioned tangentially, are equipped with Tiger·tec® indexable inserts. Tools with the "Walter BLAXX" designation combine high wear resistance with unbeatable performance data.

Walter Green

Walter Green: Sustainability and responsible use of resources are central components of our company principles. We use our "Walter Green" seal to show how we implement these principles – such as by offsetting our CO_2 emissions with environmental conservation projects.

Walter Xpress

Walter Xpress is the rapid ordering and delivery service offered by Walter Multiply for high-quality special tools. It is available for around 10,000 tool varieties, with a maximum delivery time of two to four weeks from the order date. The ordering process is clearly structured and guarantees absolute planning security. Quotations for all enquiries are calculated and provided within 24 hours.

Technologies at Walter (continued)

Walter Precision XT

Precision boring tools are always used to finish an existing bore or to improve the precision of existing bores, for instance by correcting their position, narrowing the hole tolerance, or enhancing the surface quality. Precision boring is typically performed using a depth of cut < 0.5 mm (0.02 inches).

Walter Boring XT

Tools for rough boring are used to expand existing bores. Material removal is a key element of this process. The bore to be enlarged is machined in advance or created using casting or forging processes. The rough boring tools themselves can also be used for radial offsetting and multi-edge boring.

XD Technologie

Walter Titex solid carbide drilling and reaming tools stand for precision, high performance and cost-efficiency when drilling in practically any material. Walter Titex XD Technology offers the greatest precision and cost-efficiency in deep-hole drilling operations up to $70 \times D_c$ without pecking.

Xill·tec®

With Xill·tec®, the solid carbide milling cutters from the MC230 Advance product range, Walter offers a uniquely wide range, with different dimensions, numbers of teeth and shank versions. This means that users are well-equipped for all conceivable milling operations and ISO materials. Universal use – with excellent quality.

Xtra·tec®

Xtra·tec® indexable insert milling cutters and drills guarantee extremely soft cutting action and optimal surface quality on almost all materials. Indexable inserts with highly positive geometries and the Tiger·tec® coating have a particularly beneficial hardness/toughness ratio. For maximum productivity and process reliability.

Xtra·tec®XT

Xtra·tec® XT is the latest generation of Walter milling tools. As the “Xtended” Xtra·tec® technology, it offers a completely new perspective on productivity and process reliability. It can cover nearly all milling operations in every common material group: More reliable, productive, cost-efficient than ever before – all while compensating for the CO_2 emissions through Walter Green.

X·treme Evo

For Walter, the X·treme Evo DC260 & DC160 Advance solid carbide drills as well as the X·treme Evo Plus DC180 Supreme and X·treme Evo 3 DC183 Supreme are the embodiment of the “next generation of drilling”, offering versatility for a wide range of materials and machine concepts – with outstanding tool life, productivity and process reliability.

Technologies at Walter (continued)

Walter Capto™ is a modular tool adaptor system. It is suitable for all turning, milling, drilling and threading processes. Its ISO-standardised polygon taper absorbs torsional moments and bending moments extremely well and ensures optimal repeat accuracy.

Walter ConeFit is an extremely flexible solid carbide milling system with a wide range of high-performance exchangeable heads and shaft variants. Its conical thread can self-centre, thereby guaranteeing maximum stability and concentricity.

Walter ScrewFit users benefit from maximum flexibility. Its modular interface is suitable for a wide variety of boring bars and adaptors and a wide range of tool diameters and lengths for milling and drilling.

The precision-ground QuadFit interface with taper and support face characterises the precision of the vibration-damped boring bars for turning and thread turning with Walter Accure·tec® technology. The exchangeable head system, which can be rotated by 180°, makes it possible to rapidly replace tools with high indexing accuracy.

In turning and grooving operations, the Walter precision cooling system provides cooling at the centre of the chip formation. Its dual coolant jets are directed precisely onto the flank and rake faces. In drilling operations, the coolant jets exit close to the cutting edge. This system provides significantly increased tool life, improved chip breaking and chip removal, greater efficiency and higher quality.

“Flash” refers to specialised solid carbide milling cutters for high-feed milling. Their end-face geometry reduces the chip thickness “h” and therefore enables an extremely high feed per tooth. Forces that occur are diverted axially towards the centre of the tool, which helps to stabilise the machining process.

On Walter turning toolholders with “SmartLock”, the clamping screw can be operated from the side of the tool. This makes it possible to index the inserts **in** the machine quickly and easily. Tool change times are reduced as a result. Ideal for use on CNC lathe and multi-spindle machines.

Walter tools for threading

Threading solutions from the Walter and Walter Prototyp competence brands are extremely innovative.
They reduce costs, increase productivity and provide decisive competitive advantages.
In our comprehensive range of catalogue products, you can find the right tool for any machining method or process:
HSS-E(-PM) and solid carbide taps, thread formers and thread milling cutters.

1 **TC610/TC611 Supreme**
thread milling cutter

This product line covers a wide range of profiles and dimensions.
The thread milling cutters can be used universally and are cost-efficient in most applications.

2 **TC630 Supreme**
orbital thread milling cutter

This orbital thread milling cutter can be used to produce small and deep threads from dimension M1.6 with precision and process security. For hard workpiece machining, Walter currently offers you the TC685 Supreme lines.

3 **TC620 Supreme**
multi-row thread milling cutter

With this thread milling cutter, less is more. This tool boasts DeVibe technology and fewer cutting edges, which dramatically reduces the cutting pressure and vibration. This allows you to work with higher cutting parameters – and achieve significantly more cost-efficient machining.

4 **T2710–T2713**
indexable insert thread milling cutters

This thread milling cutter is the ultimate benchmark for large threads. The robust design of the body and the indexable inserts makes the tool unbeatable in terms of speed and process reliability. The product line starts from just M16 and is available in the standard range for thread depths of $1.5 \times D_N$–$3 \times D_N$.

5 Specialist: TC130 Supreme machine tap

Whenever process reliability has top priority in tapping, the TC130 Supreme machine tap is used. This is because it produces short chips and the best surface quality in high-strength steels.

6 TC420 Supreme universal machine tap

Anyone who forms threads benefits from many different advantages. Thread forming is non-cutting, stable, reliable – and extremely cost-efficient. Walter's portfolio includes the right solution for every application, e.g. the TC420 Supreme.

7 Paradur® Eco Plus universal machine tap

The Eco Plus tools are the epitome of a threading success story. They are suitable for universal application and guarantee outstanding process reliability.

8 Prototex® HSC solid carbide machine tap

HSC stands for "High-Speed Cutting". The solid carbide tools are therefore mainly used in mass production. For blind-hole machining, Walter also offers the Paradur® HSC.

Cutting data for tapping

= Cutting data for wet machining

E = Emulsion
O = Oil
v_c = Cutting speed

Overview of the main material groups and code letters

Material group	Material	Sub-group	Condition	Brinell hardness HB	Tensile strength R_m [N/mm²]	Machining group[1]	HSS-E(-PM) taps, Uncoated, v_c [m/min] 1,5 × D_N	2 × D_N	2,5 × D_N	
P	Non-alloyed steel	C ≤ 0,25 %	Annealed	125	430	P1	16	13	12	E
		C > 0,25… ≤ 0,55 %	Annealed	190	640	P2	20	17	14	E
		C > 0,25… ≤ 0,55 %	Heat-treated	210	710	P3	10	9	7	E
		C > 0,55 %	Annealed	190	640	P4	10	9	7	E
		C > 0,55 %	Heat-treated	300	1010	P5	6	5	4	E
		Free-machining steel (short-chipping)	Annealed	220	750	P6	10	9	7	E
	Low-alloy steel	Annealed		175	590	P7	20	17	14	E
		Heat-treated		285	960	P8	5	4	4	E
		Heat-treated		380	1280	P9	3	3	2	E
		Heat-treated		430	1480	P10	3	2	2	O
	High-alloy steel and high-alloy tool steel	Annealed		200	680	P11	10	9	7	E
		Hardened and tempered		300	1010	P12	6	5	4	E
		Hardened and tempered		380	1280	P13	3	3	2	O
	Stainless steel	Ferritic/martensitic, annealed		200	680	P14	3	2	2	E
		Martensitic, heat-treated		330	1110	P15	3	2	2	E
M	Stainless steel	Austenitic, quench hardened		200	680	M1	4	3	3	E
		Austenitic, precipitation hardened (PH)		300	1010	M2	2	2	1	E
		Austenitic/ferritic, duplex		230	780	M3	2	2	2	E
K	Malleable cast iron	Ferritic		200	400	K1	10	9	7	E
		Pearlitic		260	700	K2	7	5	5	E
	Grey cast iron	Low strength		180	200	K3	19	16	13	E
		High strength/austenitic		245	350	K4	13	10	9	E
	Cast iron with spheroidal graphite	Ferritic		155	400	K5	10	9	7	E
		Pearlitic		265	700	K6	7	5	5	E
	CGI			230	400	K7	6	5	4	E
N	Wrought aluminium alloys	Not hardenable		30	–	N1	10	8	7	E
		Hardenable, hardened		100	340	N2	19	16	13	E
	Cast aluminium alloys	≤ 12% Si, not hardenable		75	260	N3	17	14	12	E
		≤ 12% Si, hardenable, hardened		90	310	N4	17	14	12	E
		> 12% Si, not hardenable		130	450	N5	16	13	11	E
	Magnesium-based alloys			70	250	N6	26	21	19	O
	Copper and copper alloys (bronze/brass)	Non-alloyed, electrolytic copper		100	340	N7	9	7	6	E
		Brass, bronze, red brass		90	310	N8	24	21	18	E
		Copper alloys, short-chipping		110	380	N9	31	25	21	E
		High tensile, Ampco		300	1010	N10	2			E
S	Heat-resistant alloys	Fe-based	Annealed	200	680	S1	3	3	2	E
			Hardened	280	940	S2	2	2	2	E
		Ni- or Co-based	Annealed	250	840	S3	3	3	2	E
			Hardened	350	1180	S4	2	2	2	O
			Cast	320	1080	S5	2	2	2	O
	Titanium alloys	Pure titanium		200	680	S6	10	8	7	E
		α and β alloys, hardened		375	1260	S7	3	2	2	O
		β alloys		410	1400	S8	3	2	2	O
	Tungsten alloys			300	1010	S9	2	2	2	O
	Molybdenum alloys			300	1010	S10	5	5	4	O
H	Hardened steel	Hardened and tempered		50 HRC	–	H1				O
		Hardened and tempered		55 HRC	–	H2				O
		Hardened and tempered		60 HRC	–	H3				O
	Hardened cast iron	Hardened and tempered		55 HRC	–	H4				O
O	Thermoplastics	Without abrasive fillers				O1	28	23	19	E
	Thermosetting plastics	Without abrasive fillers				O2	11	9	8	E
	Plastic, glass-fibre reinforced	GFRP				O3	6	5	4	E
	Plastic, carbon-fibre reinforced	CFRP				O4	6	5	4	E
	Plastic, aramid-fibre reinforced	AFRP				O5	6	5	4	E
	Graphite (technical)			80 Shore		O6	13	11	9	E

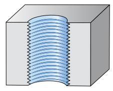
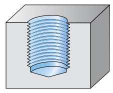
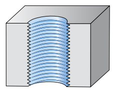
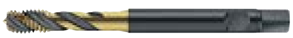
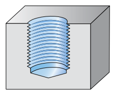
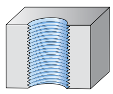
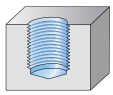
[1] The assignment of the machining groups can be found in the "General" section of the Technical Compendium, page F7.

HSS-E(-PM) taps			Solid carbide taps						
Coated			Uncoated			Coated			
v_c [m/min]									
1,5 × D_N	2 × D_N	2,5 × D_N	1,5 × D_N	2 × D_N	2,5 × D_N	1,5 × D_N	2 × D_N	2,5 × D_N	
37	30	26							E
37	31	26				64			E
23	19	17				64	52		E
23	19	16				64	52		E
14	12	10				56	46		E
23	19	16				64	52		E
37	30	26				64	52		E
12	10	9				49	40		E
7	6	5				37	30		E
5						26	21		O
23	19	16				64	52		E
14	12	10				56	46		E
7	6	5				37	30		O
7	6	5							E
5	4	3							E
8	7	6							E
5	4	3							E
6	5	4							E
22	18	16	29	24	20	50	41	33	E
11	9	8	17	14	12	34	28	22	E
44	36	32	46	38	33	73	60	51	E
17	14	12	17	14	12	45	37	31	E
22	18	16	29	24	20	42	34	28	E
12	10	9	17	14	12	41	33	27	E
10	8	7	14	11	10	33	27	23	E
8	7	6							E
32	26	22							E
22	18	16	41	33	28	89	73	63	E
22	18	16	41	33	28	89	73	63	E
25	21	18	35	29	24	70	57	49	E
34	28	24	44	36	31	90	74	63	O
14	12	10							E
36	29	25							E
48	40	34	58	48	41	58	48	41	E
			11	9	8	11	9	8	E
									E
3									E
									E
3									O
3									O
8	7	6							E
4	4								O
4	4								O
2	2		5	4	3	6	5	4	O
7	5		12	10	9	17	14	12	O
						18	15	13	O
						4	3		O
						4	3		O
						4	3		O
22	18	15							E
13	10	9	27	22	19	25	21	18	E
8	6	5	16	13	11	15	12	11	E
8	6	5	16	13	11	15	12	11	E
8	6	5	16	13	11	15	12	11	E
19	16	13	24	20	17	24	20	17	E

The specified cutting data represents average standard values.
For specific applications, adjustment is recommended.

Type description

Taps for universal applications

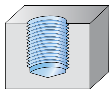
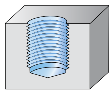
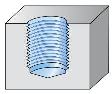
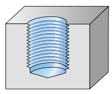
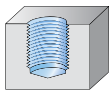
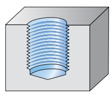
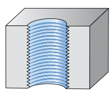
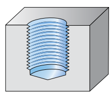
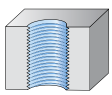
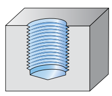
Type description		Machining	Material groups: P Steel	M Stainless steel	K Cast iron	N NF metals	S Materials with difficult cutting properties	H Hard materials	O Other	Helix angle	Thread depth
Prototex® Eco Plus 	– For wet and MQL machining		●●	●●	●●	●●				0°	$3{,}0 \times D_N$
Paradur® Eco Plus 	– For wet and MQL machining		●●	●●	●●	●●				45°	$3{,}0 \times D_N$
Prototex® Synchrospeed 	– Synchronous machining – Shank tolerance h6		●●	●●	●●	●●	●●		●●	0°	$3{,}0 \times D_N$
Paradur® Synchrospeed 	– Synchronous machining – Shank tolerance h6		●●	●●	●●	●●	●		●	40°	$2{,}5 \times D_N$
TC216 Perform 	– Particularly cost-effective for small to medium batch sizes		●●	●●	●●	●●				0°	$3{,}5 \times D_N$
TC115 Perform 	– Particularly cost-effective for small to medium batch sizes		●●	●●	●●	●				45°	$3{,}0 \times D_N$

●● Primary application
● Additional application

Type description

(continued)

Taps for special applications

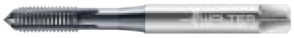
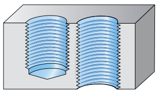
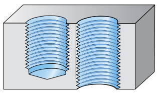
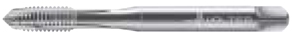
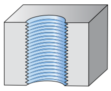
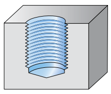
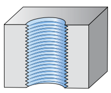
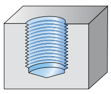
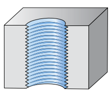
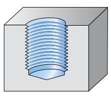
Type description		Machining	Material groups P Steel	M Stainless steel	K Cast iron	N NF metals	S Materials with difficult cutting properties	H Hard materials	O Other	Helix angle	Thread depth
TC120 Supreme 	– High reliability in soft steel and medium-strength steel		●●			●				45°	$3{,}0 \times D_N$
TC121 Supreme 	– Maximum performance in medium-strength steel		●●	●	●	●				40°	$2.5 \times D_N$
TC122 Supreme 	– Maximum tool life in medium-strength to high-strength steel		●●			●				15°	$1{,}5 \times D_N$ $2{,}5 \times D_N$
TC130 Supreme 	– For medium-strength to high-strength steels and short-chipping materials – Internal coolant required		●●		●●	●			●	0°	$3{,}5 \times D_N$
Paradur® Short Chip HT 	– For long-chipping materials		●●		●	●				15°	$4{,}0 \times D_N$
TC142 Supreme 	– For stainless and high-strength steels with very high performance		●	●●						50°	$3{,}0 \times D_N$
Prototex® X·pert P 	– For low-strength to medium-strength materials		●●			●			●	0°	$3{,}0 \times D_N$
Paradur® X·pert P 	– For low-strength to medium-strength materials		●●			●			●	45°	$3{,}5 \times D_N$
Prototex® X·pert M 	– For stainless and high-strength steels		●	●●						0°	$3{,}0 \times D_N$
Paradur® X·pert M 	– For stainless and high-strength steels		●	●●						40°	$2{,}5 \times D_N$

●● Primary application
● Additional application

Type description

(continued)

Taps for special applications

Type description		Machining	Material groups							Helix angle	Thread depth
			P	M	K	N	S	H	O		
			Steel	Stainless steel	Cast iron	NF metals	Materials with difficult cutting properties	Hard materials	Other		
Paradur® Eco CI 	– For short-chipping materials – For wet and MQL machining				●●	●●			●	0°	3,0 × D_N
Paradur® X·pert K 	– For cast iron workpieces				●●	●				0°	3,0 × D_N
Prototex® X·pert N 	– For long-chipping aluminium materials					●●	●		●	0°	3,0 × D_N
Paradur® X·pert N 	– For long-chipping aluminium materials					●●	●		●	35°	3,0 × D_N
Prototex® TiNi Plus 	– For machining high-strength titanium materials that tend to cause jamming when used with emulsion						●●			0°	2,0 × D_N
Paradur® Ti Plus 	– For machining high-strength titanium and nickel materials that tend to cause jamming when used with emulsion						●●			15°	2,0 × D_N
Prototex® HSC 	– For high-strength and extremely high-strength steel materials up to 55 HRC – Shank tolerance h6 – Internal coolant required – Solid carbide		●●		●●					0°	2,0 × D_N
Paradur® HSC 	– For high-strength and extremely high-strength steel materials up to 55 HRC – Shank tolerance h6 – Internal coolant required – Solid carbide		●●		●●			●●		15°	2,0 × D_N

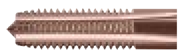
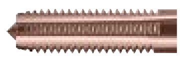
●● Primary application
● Additional application

Product families

Tap	
TC115 Perform	Blind-hole tap for universal application – Perform line
TC120 Supreme	Blind-hole tap for soft steels
TC121 Supreme	Blind-hole tap for medium-strength steels
TC122 Supreme	Blind-hole tap for high-strength steels
TC130 Supreme	Blind-hole tap for ISO P and ISO K, produces short chips
TC142 Supreme	Blind-hole tap for stainless steels – Supreme line
TC216 Perform	Through-hole tap for universal application – Perform line
TC388 Supreme	Blind-hole and through-hole tap for ISO H materials with 50–58 HRC
TC389 Supreme	Blind-hole and through-hole tap for ISO H materials with 55–65 HRC
AP	For Ampco materials
Eco CI	For short-chipping cast iron and aluminium materials
Eco Plus	Product range for particularly cost-effective wet or minimum quantity lubrication (MQL) machining
Engine	For short-chipping cast iron and aluminium materials, made from solid carbide
FT	For titanium carbide hard materials
H	For soft materials
H24	Tool with higher number of flutes
HS	For abrasive, short-chipping materials
HSC	"High-Speed Cutting", for high cutting speeds
HT	For steel with a tensile strength of 700–1400 N/mm^2
Inox 25	Designed specifically for manufacturing cap nuts
Insert	For manufacturing thread inserts
MS	For short-chipping copper-zinc alloys
N	For steel with a tensile strength of 200–1000 N/mm^2
NH	For steel with a tensile strength of 400–1200 N/mm^2
Ni	For nickel alloys and similar materials
Ni 10	For difficult-to-cut materials
OS	For thin steel and aluminium sheets
Short Chip HT	Problem-solver for birds nesting and swarf packing in steel with a tensile strength of 850–1200 N/mm^2
STE	For steel with a tensile strength of 350–1200 N/mm^2 and chamfer form E
Synchrospeed	Product range for synchronous machining
Ti	For titanium alloys and similar materials
Ti Plus	Specially developed for titanium alloys with emulsion
TiNi	For titanium alloys and nickel alloys
TiNi Plus	Specially developed for titanium alloys and nickel alloys with emulsion
X·pert K	For grey cast iron and cast iron with spheroidal graphite
X·pert M	For stainless and high-strength steels
X·pert N	For long-chipping aluminium alloys
X·pert P	For steel materials from 200–1000 N/mm^2

Grade description

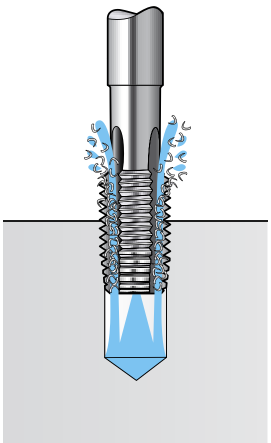
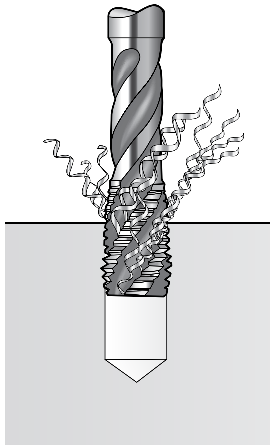
Tap

Walter grade description	Standard designation	P Steel	M Stainless steel	K Cast iron	N NF metals	S Materials with difficult cutting properties	H Hard materials	O Other	Application range (01 10 20 30 40 50 60 70 80 90)	Coating process	Coating composition	Tool example
WY80FC	HSS-E	●●	●●	●●	●●					—	Vaporised	
WY80AA	HSS-E	●●	●●	●●	●					PVD	TiN	
WW60AG	HSS-E-PM	●●			●					PVD	TiNK / vap	
WY80BD	HSS-E	●●	●	●	●					PVD	TiCN	
WW60BC	HSS-E-PM	●●		●						PVD	TiCN	
WW60RB	HSS-E-PM	●	●●							PVD	TiAlN	
WW60RG	HSS-E-PM	●●	●	●	●					PVD	TiAlN	
WY80EH	HSS-E	●●		●●	●			●		PVD	AlCrTiN	
WJ30TU	Solid carbide					●	●●			PVD	AlTiSiN	
WE10TU	Solid carbide					●	●●			PVD	AlTiSiN	

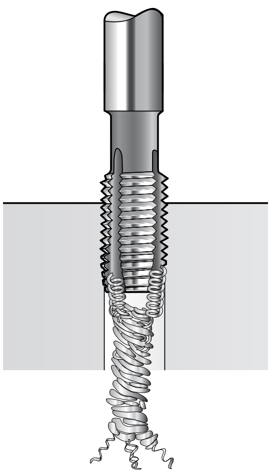
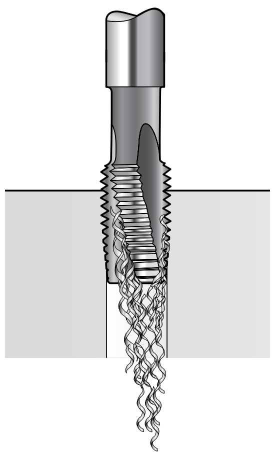
●● Primary application
● Additional application

Basic types

Blind-hole threads

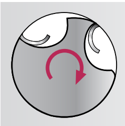
Straight-fluted taps – short-chipping materials	Right-hand spiral taps – long-chipping materials
Straight-fluted taps do not transport chips. For this reason, they can only be used with short-chipping materials or short threads. **Remark:** The chips accumulate at the bottom of the hole if internal coolant is not used. If the safety margin at the bottom of the hole is too small, the tool can run up against the chips and break. Deeper threads are possible with straight-fluted tools if the tap has an axial coolant supply, because the chips are flushed out against the direction of feed. However, the chips must be broken short (e.g. TC130 Supreme, thread depth of up to $3.5 \times D_N$). In comparison to helical tools, straight-fluted taps have longer tool life. Some straight-fluted tools can also be used for through-hole threads in materials with good chip breaking properties (e.g. Paradur® Eco CI, Paradur® X·pert K, TC388/TC389 Supreme). 	Right-hand spiral taps transport chips towards the shank. The tougher the material to be machined (and/or the longer the chips it produces) and the deeper the thread, the greater the helix angle required (e.g. TC142 Supreme, Paradur® Eco Plus). 

Through-hole threads

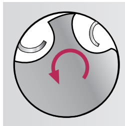
Taps with spiral point – long-chipping materials	Left-hand spiral taps – long-chipping materials
Taps with a spiral point transport the chips forward in the direction of feed. Taps with a spiral point are the first choice for creating through-hole threads in long-chipping materials (e.g. TC216 Perform, Prototex® Eco Plus). 	Left-hand spiral taps (and taps with a spiral point) transport the chips forward in the direction of feed. Tools with left-hand helix are practical if chips cannot be removed reliably with a spiral point alone. Tool example: Paradur® N of type 20411 and 20461 

Thread cutting process

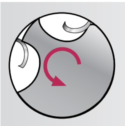
Cutting process for blind-hole threads



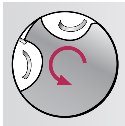
1. The cutting tap comes to a stop. At the point at which it comes to a stop, all cutting edges in the chamfer are in the process of forming chips.



2. The tool begins to reverse. The resulting chips remain where they are for the time being. The reverse torque at this point is virtually zero.



3. When the tap reverses, the chips come into contact with the back of the trailing land. The reverse torque increases sharply. The chips now have to be shorn off. As the chamfer of the tap has a clearance angle and the conical chamfer withdraws from the thread axially when it backs out of the hole, the purchase point is no longer directly at the chip root. For this reason, the chips require a certain level of stability (thickness) to ensure a clean break.

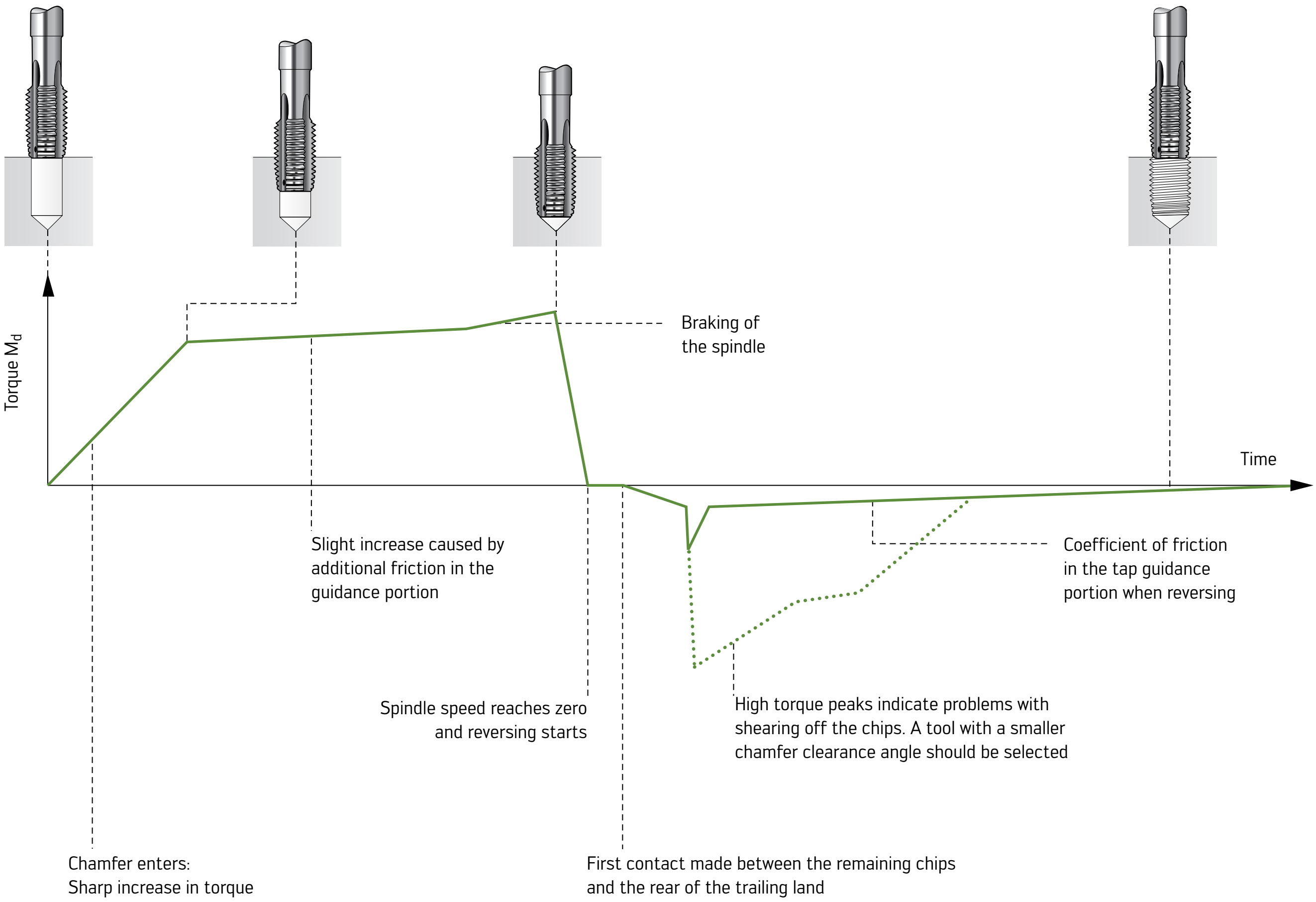


4. The chips have been shorn off and reverse torque decreases to the level of friction between the guidance portion and the cut thread.

Remark:
Through-hole taps cannot be used for blind-hole machining, as these have a large chamfer clearance angle. The result: The chips may not be shorn off, and may instead become jammed between the chamfer and the thread. This could lead to fractures in the chamfer and, in extreme cases, to tap breakage.

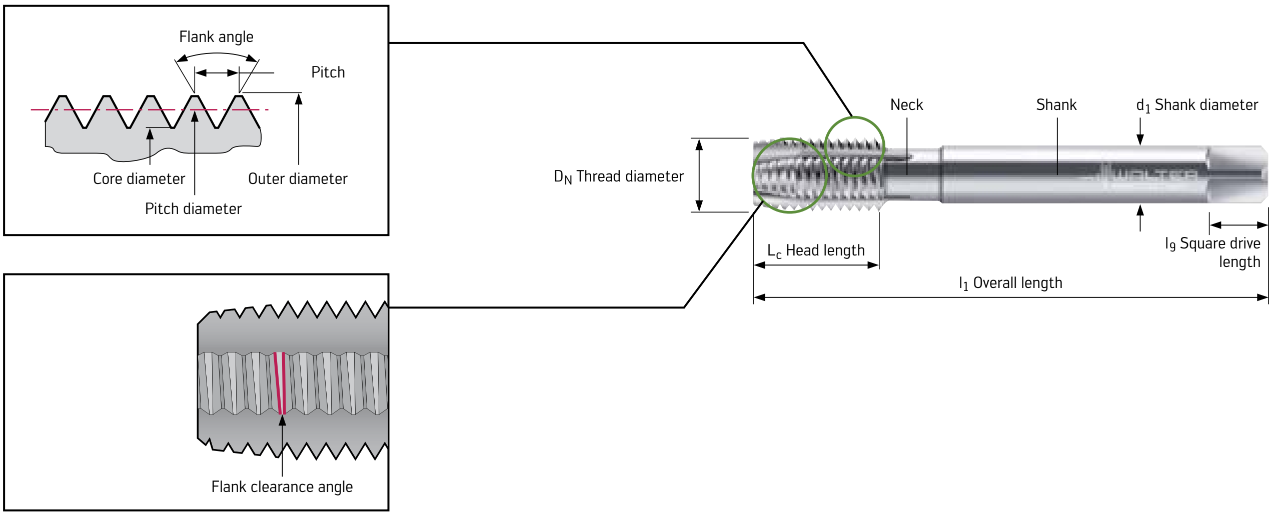
The chamfer clearance angle of blind-hole taps is always smaller than that of through-hole taps, because blind-hole taps must shear off the chip root when reversing.

Torque curve during the blind-hole thread tapping process

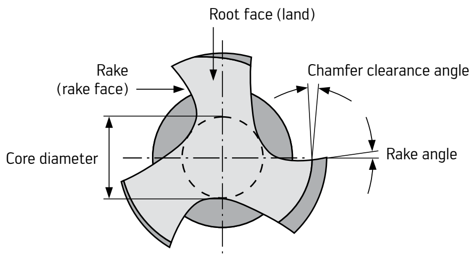


Angles and features

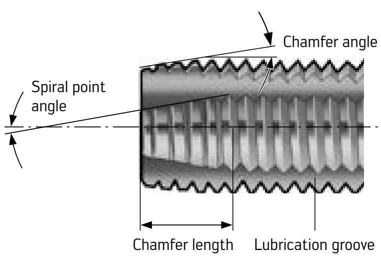
Features (side view)



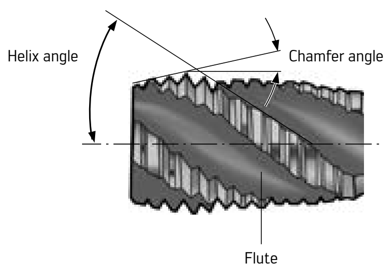
Features (view from above)



Through-hole tap with spiral point



Blind-hole tap with a right-hand helix

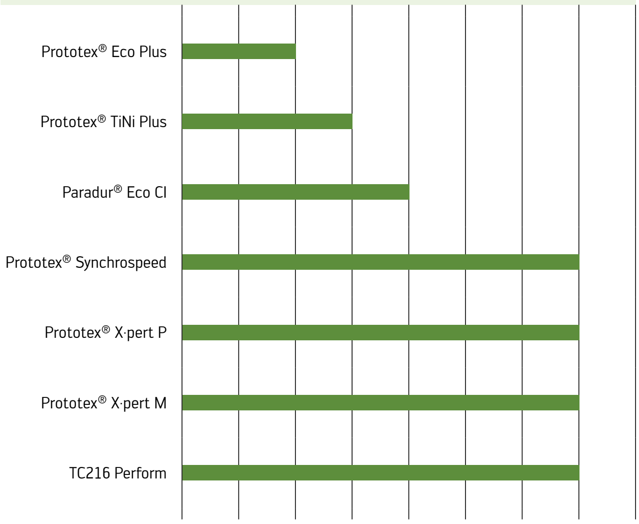


Angles and features

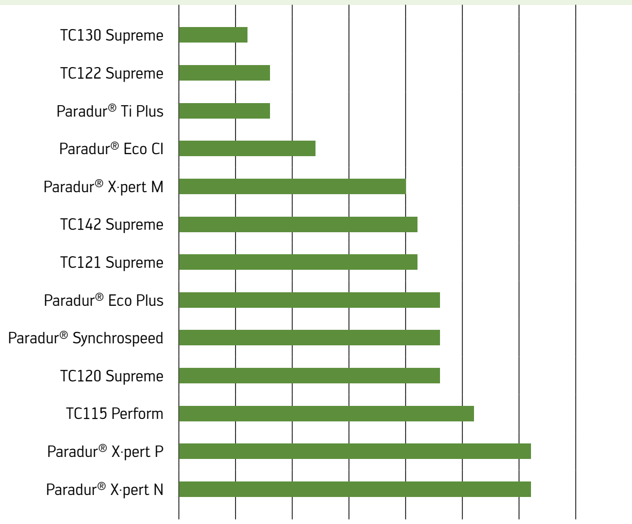
(continued)

Comparison of geometry data

Rake angle of through-hole taps



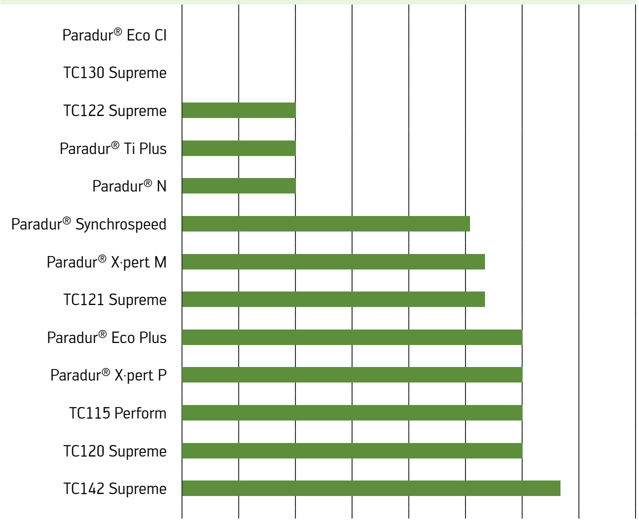
Rake angle of blind-hole taps



A smaller **rake angle**:

- Increases the stability of the cutting edges (large rake angles could cause fractures around the chamfer)
- Generally produces more controllable chips
- Produces poorer-quality surfaces on the component
- Increases the cutting forces and the cutting torque
- Is required for machining hard and abrasive materials
- Increases the tendency to compress the material to be machined, i.e. the tap cuts less freely and therefore creates slightly narrower threads

Helix angle of blind-hole taps



A larger **helix angle**:

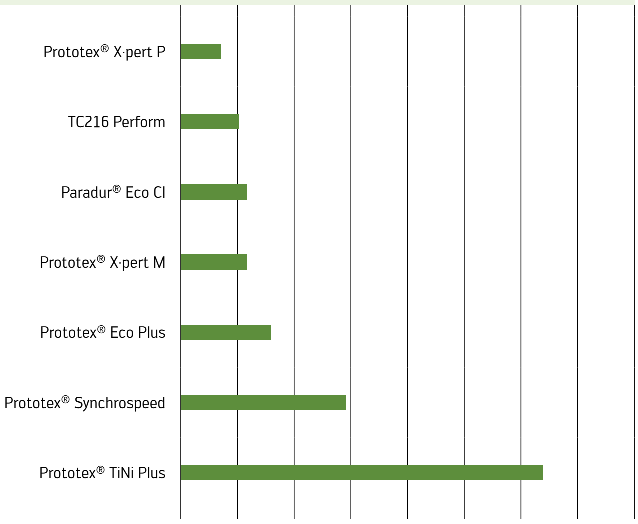
- Facilitates chip removal
- Reduces the stability of the tool and thereby limits the maximum cutting torque
- Reduces the stability of the teeth
- Reduces tool life
- Enables deeper threads

Angles and features

(continued)

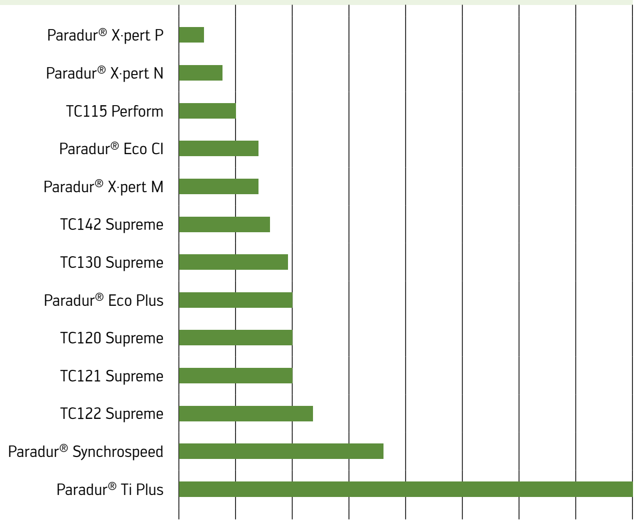
Comparison of geometry data

Flank clearance angle of through-hole taps



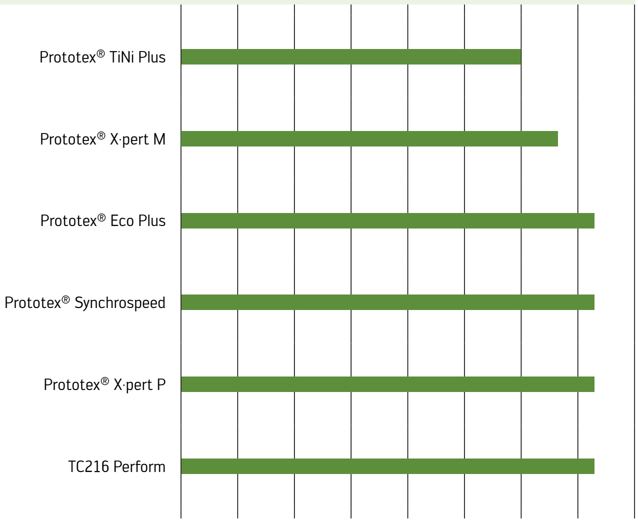
The **flank clearance angle** must be matched to the material to be machined. High-strength materials and materials that tend to cause jamming require a larger flank clearance angle.

Flank clearance angle of blind-hole taps



The guidance characteristics of the tool worsen as the clearance angle is increased, which is why miscutting occurs in soft materials if compensating chucks are used.

Spiral point angle of through-hole taps

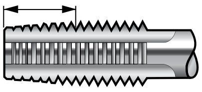
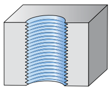
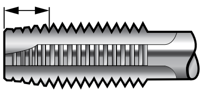
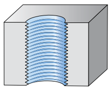
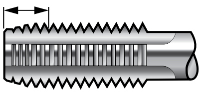
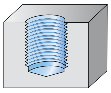
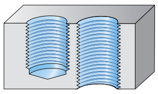
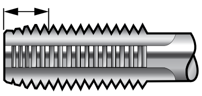
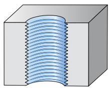
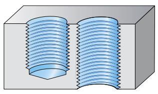
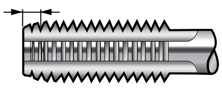
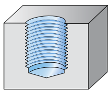
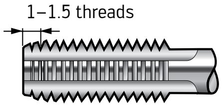
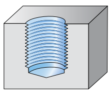


The **spiral point angle** is limited by the chamfer length and the number of flutes, because a larger spiral point angle causes the land width in the first thread of the chamfer to be reduced.
The result: The stability of the cutting edge decreases (the risk of fractures around the chamfer increases). However, a larger spiral point angle facilitates chip removal in the direction of feed. If the spiral point angle is too small, chip removal can become problematic. Left-hand helical tools provide a solution for this.

Chamfer clearance angle:
Through-hole taps have a chamfer clearance angle approx. three times larger than blind-hole taps.

Chamfer forms

Chamfer forms based on DIN 2197

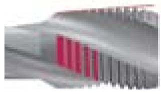
Form	Number of threads in the chamfer	Design of the flutes	Blind-hole/ through-hole machining	Used predominantly for
A	6–8 threads 	Straight-fluted		Short-chipping materials
				Short through-hole threads in medium-chipping and long-chipping materials
B	3.5–5 threads 	Straight-fluted with spiral point		Medium-chipping and long-chipping materials
C	2–3 threads 	Right-hand helical		Medium-chipping and long-chipping materials
		Straight-fluted		Short-chipping materials
D	3.5–5 threads 	Left-hand helical		Long-chipping materials
		Straight-fluted		Short-chipping materials
E	1.5–2 threads 	Right-hand helical		Short thread run-out in medium-chipping and long-chipping materials
		Straight-fluted		Short thread run-out in short-chipping materials
F	1–1.5 threads 	Right-hand helical		Very short thread run-out in medium-chipping and long-chipping materials
		Straight-fluted		Very short thread run-out in short-chipping materials

Please note:

Longer chamfers:
– Increase tool life
– Reduce the load on the cutting edge
– Increase the required torque

Shorter chamfers:
– Enable the thread to almost reach the bottom of the hole
– Facilitate chip formation

Modifications

	Negative chamfer	Shortened chamfer	Reduced helix in the chamfer	Inclined thread	Uncoated rake
					
Chip formation	Chips are rolled more tightly, shorter chips	Chips are rolled more tightly, fewer chips	Chips are rolled more tightly, shorter chips	No change	Chips are rolled more tightly, shorter chips
Tool life	+	- -	Uncoated: - Coated: +	+	-
Thread quality	-	-	Uncoated: - - Coated: □	□	-
Chip thickness	□	+	□	□	□
Torque	+	-	-	-	□
Application example	Prevention of birds nesting in soft steels such as St52, C45, etc.	Thread nearly to the bottom of the hole, improved chip control	Optimised chip formation in steels and wrought aluminium alloys	Problems with fractures or weld formations in the guidance portion	Optimised chip formation in steels, crankshaft machining
Standard tools with appropriate modification	Paradur® HSC Prototex® HSC	All tools with E/F chamfer form	Paradur® Short Chip HT Paradur® Ni 10 Paradur® HSC	TC130 Supreme TC142 Supreme Paradur® Eco Plus Paradur® X·pert M Paradur® Synchrospeed	All uncoated tools as well as Paradur® Synchrospeed (TiN-VAP)

+ increases   □ remains unchanged   - decreases   - - decreases sharply

Solutions

Thread surface

The thread surface is determined by:
– The production process: Drilling, forming, milling
– The wear on the tool
– The geometry
– The coating
– The material to be machined
– The cooling lubricant and its availability in the operating area of the tool

Remark:
In tapping and thread forming, there is almost no possibility to influence the surface quality via the cutting data. In contrast to this, the cutting speed and feed rate can be selected independently of each other for thread milling.

Optimisation of the thread surface during thread cutting

– Use thread forming or thread milling instead of tapping
– Increase the rake angle
– Decrease the chip thickness by using a longer chamfer or an increased number of flutes (with blind-hole taps, this nevertheless worsens the chip formation)
– In general, TiN and TiCN produce the best surfaces in steel (uncoated tools or CrN and DLC layers produce the best surfaces in aluminium)
– Increase the oil content of the emulsion or only use oil
– Supply cooling lubricant directly to the operating area
– Replace the tool with a new one earlier

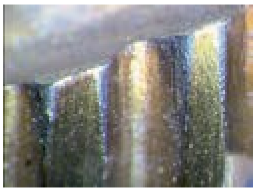
Some of the suggested measures might lead to an improvement in the surface quality, but they are associated with poorer chip control – which is problematic with deep blind holes in particular. It is therefore important to select a compromise that takes the customer's requirements into account.

Tap
with TiCN layer in AlSi7

Tap
with DLC layer in AlSi7

Wear

A high level of hardness ensures high resistance to wear – and therefore long tool life. At the same time, increasing the hardness generally also leads to reduced toughness.
However, small dimensions and high-spiralled tools require a high level of toughness, because otherwise total breakage can occur.
The hardness of the tool can normally be increased without difficulty for thread formers, straight-fluted tools or tools with a shallow helix angle, as well as for machining low-strength abrasive materials.
Solid carbide tools are characterised by a particularly high degree of hardness.



Example of abrasive wear

Weld formations on the tool

Special coatings and surface treatments are recommended to solve problems depending on the material to be machined:
– Aluminium and aluminium alloys: Uncoated, CrN, DLC
– Soft steels and stainless steels: VAP
– Soft structural steels: CrN

Example of weld formations

Designation key
for HSS-E(-PM) and solid carbide taps

Example:

T	C	1	20	–	M10	–	C	1	–	W	W	60	AG
1	2	3	4	5	6		7	8		Grade			

1	2	3	4
Tool group	**Generation**	**Tool type**	**Tool type**
T Threading		**1** Blind-hole tap **2** Through-hole tap **3** Blind-hole and through-hole tap	**15** Universal, Perform 45° helix angle 300–1 000 N/mm² **16** Universal, Perform Straight-fluted, spiral point 300–1000 N/mm² **20** ISO P, Supreme 45° helix angle 350–800 N/mm² **21** ISO P, Supreme 40° helix angle 800–1250 N/mm² **22** ISO P, Supreme 15° helix angle 1000–1 400 N/mm² **30** ISO P Straight-fluted 700–1 400 N/mm² **42** ISO M, Supreme 50° helix angle < 1000 N/mm **88** ISO H, Supreme Straight-fluted 50–58 HRC **89** ISO H, Supreme Straight-fluted 55–65 HRC

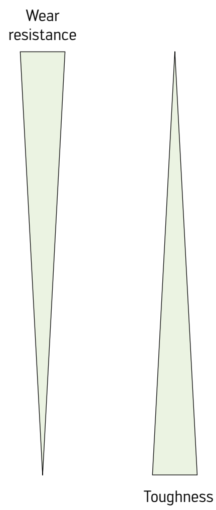
5	6	7	8
1. Delimiters	**Thread dimension**	**Tolerance/shank type**	**Modification**
– Metric		**B** 4HX, 3B Reinforced shank **C** 6HX, 2B Reinforced shank **K** 4HX, 3B Reduced shank **L** 6HX, 2B Reduced shank	**0** External coolant **1** Axial internal coolant **D** Chamfer form D **E** Chamfer form E **G** Long version

Grade designation key
for solid carbide and HSS-E(-PM) cutting tool materials

Example:

W	W	60	AG
Walter	1	2	3

1	2	3
Substrate	**Application range**	**Coating**
Solid carbide: **E**, **J** HSS-E-PM: **W** HSS-E: **Y**	05 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95	**AA** TiN **AG** TiNK/vap **BA** TiCN **BD** TiCN **BC** TiCN **FC** vap **RB** TiAlN **RG** TiAlN



Cutting data for thread forming

= Cutting data for wet machining

E = Emulsion
O = Oil
v_c = Cutting speed

Material group	Overview of the main material groups and code letters			Brinell hardness HB	Tensile strength R_m [N/mm²]	Machining group[1]	HSS-E thread formers, Uncoated, v_c [m/min] 1,5 × D_N	2 × D_N	2,5 × D_N
P	Non-alloyed steel	C ≤ 0,25 %	Annealed	125	430	P1	17	14	12
		C > 0,25… ≤ 0,55 %	Annealed	190	640	P2	15	12	10
		C > 0,25… ≤ 0,55 %	Heat-treated	210	710	P3	10	9	7
		C > 0,55 %	Annealed	190	640	P4	10	9	7
		C > 0,55 %	Heat-treated	300	1010	P5			
		Free-machining steel (short-chipping)	Annealed	220	750	P6	10	9	7
	Low-alloy steel	Annealed		175	590	P7	15	12	10
		Heat-treated		285	960	P8			
		Heat-treated		380	1280	P9			
		Heat-treated		430	1480	P10			
	High-alloy steel and high-alloy tool steel	Annealed		200	680	P11	10	9	7
		Hardened and tempered		300	1010	P12			
		Hardened and tempered		380	1280	P13			
	Stainless steel	Ferritic/martensitic, annealed		200	680	P14			
		Martensitic, heat-treated		330	1110	P15			
M	Stainless steel	Austenitic, quench hardened		200	680	M1			
		Austenitic, precipitation hardened (PH)		300	1010	M2			
		Austenitic/ferritic, duplex		230	780	M3			
K	Malleable cast iron	Ferritic		200	400	K1			
		Pearlitic		260	700	K2			
	Grey cast iron	Low strength		180	200	K3			
		High strength/austenitic		245	350	K4			
	Cast iron with spheroidal graphite	Ferritic		155	400	K5			
		Pearlitic		265	700	K6			
	CGI			230	400	K7			
N	Wrought aluminium alloys	Not hardenable		30	–	N1	25	20	17
		Hardenable, hardened		100	340	N2	28	23	19
	Cast aluminium alloys	≤ 12% Si, not hardenable		75	260	N3			
		≤ 12% Si, hardenable, hardened		90	310	N4			
		> 12% Si, not hardenable		130	450	N5			
	Magnesium-based alloys			70	250	N6			
	Copper and copper alloys (bronze/brass)	Non-alloyed, electrolytic copper		100	340	N7	10	8	7
		Brass, bronze, red brass		90	310	N8			
		Copper alloys, short-chipping		110	380	N9			
		High tensile, Ampco		300	1010	N10			
S	Heat-resistant alloys	Fe-based	Annealed	200	680	S1			
			Hardened	280	940	S2			
		Ni- or Co-based	Annealed	250	840	S3			
			Hardened	350	1180	S4			
			Cast	320	1080	S5			
	Titanium alloys	Pure titanium		200	680	S6			
		α and β alloys, hardened		375	1260	S7			
		β alloys		410	1400	S8			
	Tungsten alloys			300	1010	S9			
	Molybdenum alloys			300	1010	S10			
H	Hardened steel	Hardened and tempered		50 HRC	–	H1			
		Hardened and tempered		55 HRC	–	H2			
		Hardened and tempered		60 HRC	–	H3			
	Hardened cast iron	Hardened and tempered		55 HRC	–	H4			
O	Thermoplastics	Without abrasive fillers				O1			
	Thermosetting plastics	Without abrasive fillers				O2			
	Plastic, glass-fibre reinforced	GFRP				O3			
	Plastic, carbon-fibre reinforced	CFRP				O4			
	Plastic, aramid-fibre reinforced	AFRP				O5			
	Graphite (technical)			80 Shore		O6			

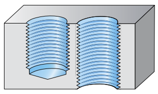
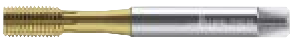
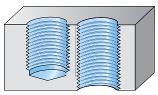
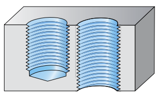
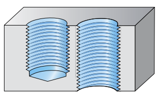
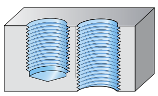
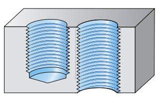
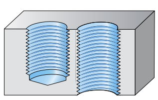
[1] The assignment of the machining groups can be found in the “General” section of the Technical Compendium, page F7.

	HSS-E thread formers			Solid carbide thread formers			
	Coated			Coated			
	v_c [m/min]			v_c [m/min]			
	1,5 × D_N	2 × D_N	2,5 × D_N	1,5 × D_N	2 × D_N	2,5 × D_N	(coolant)
	46	37	32	58	48	41	**E**
	47	38	33	58	48	41	**E**
	29	23	20	47	38	33	**E**
	29	23	20	47	38	33	**E**
	17	14	12	28	23	19	**E**
	29	23	20	47	38	33	**E**
	47	38	33	58	48	41	**E**
	15	12	11	24	20	17	**E**
	29	23	20	47	38	33	**E**
	17	14	12	28	23	19	**E**
	13	10	9	26	21	18	**E O**
	5	4	3	15	12	10	**O**
	15	12	11	31	25	21	**E O**
	5	4	4	15	13	11	**O**
	5	4	4	15	13	11	**E O**
	29	23	20	52	43	37	**E**
	14	12	10	45	37	32	**E**
	56	45	39	81	67	57	**E**
	52	43	37	70	57	49	**E**
	48	39	34	70	57	49	**E**
	48	39	34	70	57	49	**E**
	21	17	15	46	38	33	**E**
	8	6	5				**E**
	8	6	5				**O**

The specified cutting data represents average standard values.
For specific applications, adjustment is recommended.

Type description

Thread forming

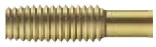
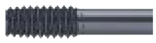
Type description		Machining	Material groups							Thread depth
			P	M	K	N	S	H	O	
			Steel	Stainless steel	Cast iron	NF metals	Materials with difficult cutting properties	Hard materials	Other	
TC410 Advance 	– For universal application		●●	●●		●●	●			3,5 × D_N
TC420 Supreme 	– High-tech thread former for universal application – For wet and MQL machining		●●	●●		●●	●			3,5 × D_N
TC430 Supreme 	– Specialist in the ISO P range		●●	●	●	●				3,5 × D_N
TC440 Supreme 	– Specialist in the ISO M range – Specially designed for machining stainless steels with emulsion		●	●●		●	●			3,5 × D_N
TC470 Supreme 	– Specialist in the ISO P and ISO N ranges – For universal application – Solid carbide thread former – For high forming speeds and long tool life – Shank tolerance h6		●●	●		●●	●			3,5 × D_N
Protodyn® S Synchrospeed 	– For universal application – Specially designed for synchronous machining – Shank tolerance h6 – Weldon clamping surface		●●	●●		●●	●			3,5 × D_N
Protodyn® Eco LM 	– For soft materials with tendency to cause jamming		●			●●	●●			2,0 × D_N

●● Primary application
● Additional application

Product families

Thread formers	
TC410 Advance	For universal application
TC420 Supreme	High-tech thread former for universal application
TC430 Supreme	Specially for machining steels in the ISO P range
TC440 Supreme	Specially designed for machining stainless steels with emulsion
TC470 Supreme	Solid carbide thread former for high forming speeds and long tool life
Synchrospeed	Specially designed for synchronous machining
Eco LM	For soft materials with tendency to cause jamming

Grade description

Walter grade description	Standard designation	P Steel	M Stainless steel	K Cast iron	N NF metals	S Materials with difficult cutting properties	H Hard materials	O Other	Application range (01 10 20 30 40 50 60 70 80 90)	Coating process	Coating composition	Tool example
WW60AD	HSS-E-PM	●●	●	●	●●	●				PVD	TiN	
WW60BA	HSS-E-PM	●●	●●	●	●●	●				PVD	TiCN	
WW60EL	HSS-E-PM	●●	●	●	●					PVD	AlCrN	
WY80AD	HSS-E	●●	●●	●	●●	●				PVD	TiN	
WG20EL	Solid carbide	●●		●	●					PVD	AlCrN	

●● Primary application
● Additional application

Thread forming process

Basic principles

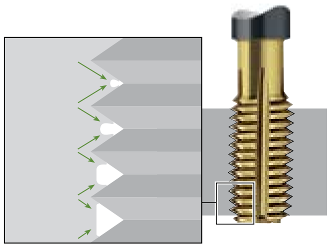
Thread forming is a non-cutting process that uses cold forming to create internal threads. Displacement of the material forces the material to yield. This creates a compressed thread profile. This process does not require the flutes that would be needed for thread cut tapping, which increases the stability of the tool.

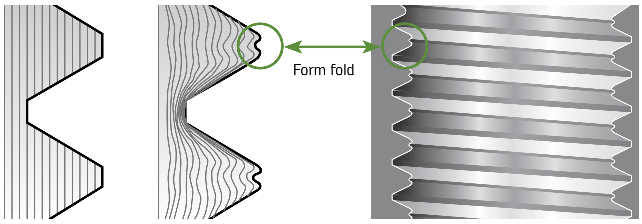
The combination of cold forming and the uninterrupted chamfer profile of formed threads (compare the image on the right) significantly increases both the break-out resistance under static load and the fatigue strength under dynamic load.
In contrast, the interrupted chamfer profile is used in thread tapping and thread milling (compare the image on the right).

Please note that there is always a form fold in the area of the crest on formed threads. For this reason, thread forming is not permitted in all industries. Specific restrictions are listed below:
– Food industry and medical technology (germ formation around the form fold)
– Automatic component screw connections (screw may jam in the form fold)
– Generally not permitted for use in aircraft construction

Thread forming is perfectly suited for mass production – for example in the automotive industry. Extremely reliable processes can be implemented as a result of the non-cutting creation of threads in combination with high tool stability due to the closed polygon profile. In addition, in contrast to tapping, higher cutting parameters can often be achieved while also improving tool life.
Thread forming requires a higher torque compared to tapping.

Remark:
In thread forming, the pilot hole diameter is subject to smaller tolerances than in tapping and thread milling. For this reason, thread forming is not always the most cost-efficient alternative. It is therefore essential to consider the circumstances of each individual case.





Applications and limits of thread forming

Approx. 65% of all materials to be machined in industry are formable.
The limits are illustrated below:
– Brittle materials with elongation lower than 7% such as:
  • GJL (GG – grey cast iron)
  • Silicon alloys with a silicon content of > 12%
  • Short-chipping copper-zinc alloys
  • Thermosetting plastics
– Thread pitch > 3 mm (forming at pitches ≤ 1.5 mm is particularly cost-effective)
– Tensile strength > 1200–1400 N/mm²

Typical materials used in thread forming are:
– Steel
– Stainless steel
– Soft copper alloys
– Wrought aluminium alloys

Rule of thumb:

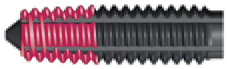
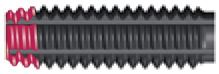
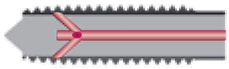
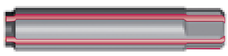
Pilot hole diameter = nominal diameter – f* × pitch

* 6H tolerance: f = 0.45
6G tolerance: f = 0.42

Example: M10 dimension
Pilot hole diameter → 10,0 mm – 0,45 × 1,5 mm = 9,325 mm = **9,33 mm**

Modifications

Thread formers

		Effect	Side effect
Chamfer form D		Improved tool life	Slightly increased cycle time
Chamfer form E		Threads nearly to the bottom of the hole and slightly reduced cycle time	Shorter tool life
Radial coolant outlets		Increased tool life due to improved cooling and lubrication conditions (for deep threads and difficult materials)	Higher purchase price
Lubrication grooves on the shank		Increased tool life due to improved cooling and lubrication conditions (not as efficient as radial coolant outlets)	Cost-effective alternative to radial coolant outlets
Increased overall length		Enables machining of areas that are difficult to access	–
Coatings and surface treatments		Increased performance	Potentially higher purchase price

Solutions

Thread forming is extremely reliable. The benefits of this method come to the fore in particular for deep blind holes in soft or tough materials, as these applications are the most likely to cause problems relating to chip removal when carrying out tapping.
Thread forming is the method of choice for such applications. Furthermore, the very materials that most frequently cause chipping problems (such as St52, 16MnCr5 or C15) are extremely well-suited to forming.

Thread forming is also beneficial for applications that require an extremely high surface quality, as the depths of surface roughness of formed threads are generally much lower than those of cut threads.

Despite the benefits of non-cutting creation of threads, there are certain points that should be borne in mind for thread forming as well in order to guarantee a reliable process:

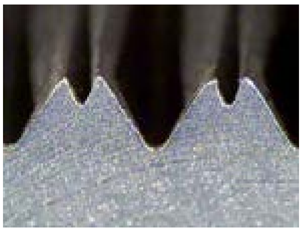
- The pilot hole diameter has a smaller tolerance (e.g. ±0.05 mm for M6) in comparison to tapping
- It must be ensured that no chips resulting from drilling remain in the core hole. This can be achieved using a twist drill with internal coolant or using a thread former with an axial coolant outlet. In the latter case, the thread former should be positioned over the pilot hole for a short period before forming starts.
- The torque is generally higher compared to tapping. This means that the drive power of the machine must be taken into account, especially for larger threads.
- The required torque for thread forming is higher than for tapping; it may be necessary to increase the chuck setting value as a result.
- Greater attention must be paid to the cooling lubricant and the cooling lubricant supply when carrying out forming; the tool running dry, even for a short period, could result in rejects and tool breakage. This is due to the effect of higher surface pressure on the forming edges and the narrower cross section of the lubrication grooves used in forming compared to the flutes of taps. The smaller lubrication grooves give the thread former greater stability, which in turn is required due to the increased torque. Larger lubrication grooves would cause the forming edges to crack due to the higher forces applied.
- The coefficient of friction decreases with each coating as the temperature increases. Higher forming speeds can therefore lead to improved tool life.
- Well-known automotive manufacturers often stipulate that the threads must comply with a specific thread overlap, which can be achieved using special solutions – the most important factor is ensuring a precise pilot hole diameter (e.g. via reaming).

Borderline cases for thread forming

It is difficult to set clear limits for forming, because there are always exceptions where limits have been exceeded successfully or not reached at all.

- **Tensile strength**
  Depending on the material and lubrication conditions, the limit range is approx. 1200–1400 N/mm^2. However, there have been cases where forming was performed successfully in stainless steel using HSS-E thread formers and in Inconel 718, which is considered to have difficult cutting properties, using solid carbide thread formers. Both materials had a strength of 1450 N/mm^2.
- **Elongation**
  In general, a minimum value of 7% is specified for the elongation. Nevertheless, there have also been cases here where, for instance, GGG-70 has been formed with an elongation of only approx. 2%. However, in this case, tiny cracks were clearly visible in the flanks, which were considered acceptable by the user. In such cases, it should not be assumed that the forming process will result in increased strength.
- **Pitch and thread profile**
  For pitches greater than 3 mm, the limits for the tensile strengths specified above must be adjusted downwards. Thread types with steep flanks (e.g. 30° for trapezoidal threads) must be assessed on a case-by-case basis.
- **Si content**
  AlSi cast alloys can be formed if the silicon content does not exceed 12%. Nevertheless, there are have also been cases in which the silicon content was higher than 12%. However, this reduces the surface finish quality and the break-out resistance of the thread.
- **Form fold**
  The unavoidable form fold occurring on the crest of the thread may become problematic if automated processes are used to insert screws. The first threads sometimes thread into the form fold.
  Formed threads are also avoided in components used in the food industry and medical technology, because it is not possible to reliably clean away contamination in the form fold by washing.

  Remark:
  Walter Prototyp is able to design special tools in which the form fold can be closed under specific conditions. There have been cases in which customers who were initially opposed to using thread forming decided to permit it for this reason.



Thread profile made with a standard former

Thread profile made with a special former

- **Aerospace industry**
  Thread forming is generally not permitted in the aerospace industry. Changes to the microstructure that occur during thread forming or welding are mainly avoided for applications in this industry.

Designation key
for HSS-E(-PM) and solid carbide thread formers

Example:

T	C	4	40	–	M10	–	C	1	–	W	W	60	AD
1	2	3	4	5	6		7	8		Grade			

1
Tool group
T Threading

2
Generation

3
Tool type
4 Thread former

4			
Tool type			
10	Universal, Advance	30	ISO P, Supreme
20	Universal, Supreme	40	ISO M, Supreme
		70	ISO P, Supreme

5
1. Delimiters
– Metric

6
Thread dimension

7		
Tolerance/shank type		
C	6HX, 2BX	Reinforced shank
E	6GX	Reinforced shank
F	7GX	Reinforced shank
L	6HX, 2BX	Reduced shank
N	6GX	Reduced shank
P	7GX	Reduced shank

8			
Modification			
0	External coolant without lubrication grooves	D	Chamfer form D
1	Axial internal coolant, without lubrication grooves	E	Chamfer form E
2	Radial internal coolant	F	Chamfer form E, axial internal coolant without lubrication grooves
5	Axial internal coolant, with lubrication grooves	L	Left-hand thread
6	External coolant with lubrication grooves	H	Extended shank XL

Grade designation key
for solid carbide and HSS-E(-PM) cutting tool materials

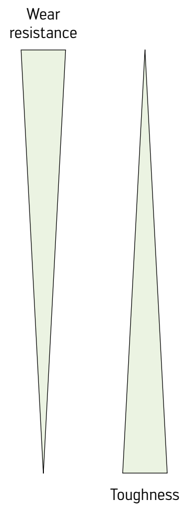
Example:

W	W	80	AD
Walter	1	2	3

1	
Substrate	
G	Solid carbide
W	HSS-E-PM
Y	HSS-E

2 – Application range

05, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95



3	
Coating	
AD	TiN
BA	TiCN
EL	AlCrN

Cutting data for solid carbide thread milling (continued)

= Cooling lubricant recommended ***

E = Emulsion
M = MQL
A = Compressed air

v_c = Cutting speed
f_z = Feed per tooth
f = Feed per revolution

Material group	Overview of the main material groups and code letters			Brinell hardness HB	Tensile strength R_m [N/mm²]	Machining group [1]	Cooling lubricant
P	Non-alloyed steel	C ≤ 0,25 %	Annealed	125	430	P1	**E M A**
		C > 0,25… ≤ 0,55 %	Annealed	190	640	P2	**E M A**
		C > 0,25… ≤ 0,55 %	Heat-treated	210	710	P3	**E M A**
		C > 0,55 %	Annealed	190	640	P4	**E M A**
		C > 0,55 %	Heat-treated	300	1010	P5	**E M A**
		Free-machining steel (short-chipping)	Annealed	220	750	P6	**E M A**
	Low-alloy steel	Annealed		175	590	P7	**E M A**
		Heat-treated		285	960	P8	**E M A**
		Heat-treated		380	1280	P9	**E M A**
		Heat-treated		430	1480	P10	**E M A**
	High-alloy steel and high-alloy tool steel	Annealed		200	680	P11	**E M A**
		Hardened and tempered		300	1010	P12	**E M A**
		Hardened and tempered		380	1280	P13	**E M A**
	Stainless steel	Ferritic/martensitic, annealed		200	680	P14	**E M A**
		Martensitic, heat-treated		330	1110	P15	**E M A**
M	Stainless steel	Austenitic, quench hardened		200	680	M1	**E**
		Austenitic, precipitation hardened (PH)		300	1010	M2	**E**
		Austenitic/ferritic, duplex		230	780	M3	**E**
K	Malleable cast iron	Ferritic		200	400	K1	**E M A**
		Pearlitic		260	700	K2	**E M A**
	Grey cast iron	Low strength		180	200	K3	**E M A**
		High strength/austenitic		245	350	K4	**E M A**
	Cast iron with spheroidal graphite	Ferritic		155	400	K5	**E M A**
		Pearlitic		265	700	K6	**E M A**
	CGI			230	400	K7	**E M A**
N	Wrought aluminium alloys	Not hardenable		30	–	N1	**E M A**
		Hardenable, hardened		100	340	N2	**E M A**
	Cast aluminium alloys	≤ 12% Si, not hardenable		75	260	N3	**E M A**
		≤ 12% Si, hardenable, hardened		90	310	N4	**E M A**
		> 12% Si, not hardenable		130	450	N5	**E M A**
	Magnesium-based alloys			70	250	N6	**A**
	Copper and copper alloys (bronze/brass)	Non-alloyed, electrolytic copper		100	340	N7	**E M A**
		Brass, bronze, red brass		90	310	N8	**E M A**
		Copper alloys, short-chipping		110	380	N9	**E M A**
		High tensile, Ampco		300	1010	N10	**E M A**
S	Heat-resistant alloys	Fe-based	Annealed	200	680	S1	**E**
			Hardened	280	940	S2	**E**
		Ni- or Co-based	Annealed	250	840	S3	**E**
			Hardened	350	1180	S4	**E**
			Cast	320	1080	S5	**E**
	Titanium alloys	Pure titanium		200	680	S6	**E**
		α and β alloys, hardened		375	1260	S7	**E**
		β alloys		410	1400	S8	**E**
	Tungsten alloys			300	1010	S9	**E**
	Molybdenum alloys			300	1010	S10	**E**
H	Hardened steel	Hardened and tempered		50 HRC	–	H1	**M A**
		Hardened and tempered		55 HRC	–	H2	**M A**
		Hardened and tempered		60 HRC	–	H3	**M A**
	Hardened cast iron	Hardened and tempered		55 HRC	–	H4	**M A**
O	Thermoplastics	Without abrasive fillers				O1	**E M A**
	Thermosetting plastics	Without abrasive fillers				O2	**E M A**
	Plastic, glass-fibre reinforced	GFRP				O3	**E M A**
	Plastic, carbon-fibre reinforced	CFRP				O4	**E M A**
	Plastic, aramid-fibre reinforced	AFRP				O5	**E M A**
	Graphite (technical)			80 Shore		O6	**E M A**

[1] The assignment of the machining groups can be found in the “General” section of the Technical Compendium, page F7.

* The feed per tooth is valid for a thread depth of $1 \times D_N$. If deeper threads are machined, it may be necessary to increase the number of radial cuts.
** The feed per tooth for $3 \times D_N$ tools with D_c < 1.6 mm must be reduced by 30–50%.
*** Emulsion must always be used for drill/thread mills.

TC610 / 611						TC630				
v_c [m/min]		f_z [mm]				v_c [m/min]		f_z [mm]**		
Uncoated	Coated	$D_c \leq 3$ mm	$D_c > 3$ and ≤ 7 mm	$D_c > 7$ and ≤ 9 mm	$D_c > 9$ mm	Uncoated	Coated	$D_c \leq 1{,}5$ mm	$D_c > 1{,}5$ and ≤ 3 mm	$D_c > 3$ mm
	115	0,015	0,045	0,070	0,1		95	0,015	0,045	0,100
	155	0,012	0,045	0,070	0,1		105	0,015	0,045	0,100
	130	0,02 (2)	0,045	0,070	0,1		95	0,015	0,045	0,100
	130	0,02 (2)	0,045	0,070	0,1		95	0,015	0,045	0,100
	95	0,02 (2)	0,045	0,070	0,1		95	0,015	0,045	0,100
	130	0,012	0,045	0,070	0,1		95	0,015	0,045	0,100
	130	0,012	0,045	0,070	0,1		86	0,015	0,045	0,100
	80	0,02 (2)	0,040	0,070	0,1		100	0,015	0,045	0,100
	75	0,02 (2)	0,040	0,070	0,1		90	0,015	0,045	0,100
	65	0,02 (2)	0,040	0,070	0,1		70	0,015	0,045	0,100
	150	0,025 (3)	0,065 (2)	0,070	0,1		95	0,015	0,045	0,100
	110	0,03 (3	0,065 (2)	0,070	0,1		95	0,015	0,045	0,100
	90	0,03 (3)	0,065 (2)	0,070	0,1		80	0,015	0,045	0,100
	55	0,02 (2)	0,065 (2)	0,070	0,1		80	0,015	0,045	0,100
	45	0,03 (3)	0,075 (3)	0,095 (2)	0,1 (2)		65	0,015	0,045	0,100
	55	0,015 (2)	0,030	0,050	0,1		90	0,010	0,035	0,075
	40	0,02 (4)	0,04 (2)	0,050	0,1 (2)		60	0,010	0,035	0,075
	45	0,013 (2)	0,030	0,050	0,1		60	0,010	0,035	0,075
45	105	0,020	0,050	0,075	0,1		130	0,017	0,050	0,100
45	100	0,025 (2)	0,050	0,075	0,1		130	0,017	0,050	0,100
60	130	0,020	0,050	0,075	0,1		125	0,017	0,050	0,100
45	110	0,025 (2)	0,050	0,075	0,1		130	0,017	0,050	0,100
45	105	0,020	0,050	0,075	0,1		115	0,017	0,050	0,100
45	100	0,02 (2)	0,040	0,075	0,1		120	0,017	0,050	0,100
40	85	0,025 (2)	0,050	0,075	0,1		115	0,017	0,050	0,100
	210	0,030	0,075	0,100	0,1		135	0,020	0,055	0,100
	210	0,030	0,075	0,100	0,1		130	0,020	0,055	0,100
	165	0,030	0,075	0,100	0,1		120	0,020	0,055	0,100
	165	0,030	0,075	0,100	0,1		120	0,020	0,055	0,100
	145	0,030	0,075	0,100	0,1		125	0,020	0,055	0,100
	220	0,030	0,075	0,100	0,1		130	0,020	0,055	0,100
	140	0,030	0,075	0,100	0,1		125	0,020	0,055	0,100
	190	0,030	0,075	0,100	0,1		115	0,020	0,055	0,100
	160	0,030	0,075	0,100	0,1		125	0,020	0,055	0,100
	50	0,030	0,075	0,100	0,1		60	0,020	0,055	0,100
	35	0,015 (2)	0,030	0,050	0,1		40	0,012	0,033	0,075
	25	0,015 (2)	0,05 (2)	0,050	0,085		30	0,012	0,033	0,075
	40	0,015 (2)	0,05 (2)	0,050	0,09		40	0,012	0,033	0,075
	25	0,02 (3)	0,05 (2)	0,050	0,1 (2)		25	0,012	0,033	0,075
	25	0,013 (2)	0,05 (2)	0,050	0,1 (2)		25	0,012	0,033	0,075
	40	0,011	0,035	0,050	0,1		65	0,012	0,033	0,075
	40	0,015 (2)	0,035	0,050	0,1		40	0,012	0,033	0,075
	20	0,015 (2)	0,035	0,050	0,1		30	0,012	0,033	0,075
	50	0,015 (2)	0,030	0,050	0,09		40	0,012	0,033	0,075
	60	0,015 (2)	0,05 (2)	0,050	0,09		40	0,012	0,033	0,075
	55	0,02 (3)	0,065 (2)	0,070	0,1					
	35	0,011	0,045	0,070	0,1					
	30	0,011	0,060 (3)	0,08 (3)	0,1 (3)					
	60	0,011	0,065 (2)	0,070	0,1					
	290	0,011	0,035	0,050	0,1		285	0,011	0,032	0,075
90	145	0,011	0,035	0,050	0,1		140	0,011	0,032	0,075
30	65	0,011	0,035	0,050	0,1		65	0,011	0,032	0,075
30	65		0,035	0,050	0,1		65	0,011	0,032	0,075
30	65		0,035	0,050	0,1		65	0,011	0,032	0,075
175	215		0,035	0,050	0,1		215	0,011	0,032	0,075

The specified cutting data are average standard values. For specific applications, adjustment is recommended.
The values in brackets define the number of radial cuts. If no value in brackets is provided, one radial cut is recommended.

Cutting data for solid carbide thread milling (continued)

[cooling lubricant symbol] = Cooling lubricant recommended
E = Emulsion
M = MQL
A = Compressed air
v_c = Cutting speed [m/min]
f_z = Feed per tooth [mm]

●● = Recommended strategy
● = Possible strategy

Material group	Overview of the main material groups and code letters			Brinell hardness HB	Tensile strength R_m [N/mm²]	Machining group [1]	[cooling lubricant symbol]	TC620 / TC620 DeVibe – Strategy: Climb milling	Conventional milling	Non-cutting pass
P	Non-alloyed steel	C ≤ 0,25 %	Annealed	125	430	P1	E M	●	●●	●
		C > 0,25 ... ≤ 0,55 %	Annealed	190	640	P2	E M	●	●●	●
		C > 0,25 ... ≤ 0,55 %	Heat-treated	210	710	P3	E M	●	●●	●
		C > 0,55 %	Annealed	190	640	P4	E M	●	●●	●
		C > 0,55 %	Heat-treated	300	1010	P5	E M	●	●●	●
		Free-machining steel (short-chipping)	Annealed	220	750	P6	E M	●	●●	●
	Low-alloy steel	Annealed		175	590	P7	E M	●	●●	●●
		Heat-treated		285	960	P8	E M	●	●●	●
		Heat-treated		380	1280	P9	E M	●	●●	●
		Heat-treated		430	1480	P10	E M	●	●●	●
	High-alloy steel and high-alloy tool steel	Annealed		200	680	P11	E M	●	●●	●●
		Hardened and tempered		300	1010	P12	E M	●	●●	●
		Hardened and tempered		380	1280	P13	E M	●	●●	●
	Stainless steel	Ferritic/martensitic, annealed		200	680	P14	E M	●	●●	●●
		Martensitic, heat-treated		330	1110	P15	E M	●	●●	●
M	Stainless steel	Austenitic, quench hardened		200	680	M1	E	●●	●	●●
		Austenitic, precipitation hardened (PH)		300	1010	M2	E	●●	●	●●
		Austenitic/ferritic, duplex		230	780	M3	E	●●	●	●●
K	Malleable cast iron	Ferritic		200	400	K1	E M	●	●●	●
		Pearlitic		260	700	K2	E M	●	●●	●
	Grey cast iron	Low strength		180	200	K3	E M	●	●●	●
		High strength/austenitic		245	350	K4	E M	●	●●	●
	Cast iron with spheroidal graphite	Ferritic		155	400	K5	E M	●	●●	●
		Pearlitic		265	700	K6	E M	●	●●	●
	CGI			230	400	K7	E M	●	●●	●
N	Wrought aluminium alloys	Not hardenable		30	–	N1	E M	●●	●	●
		Hardenable, hardened		100	340	N2	E M	●●	●	●
	Cast aluminium alloys	≤ 12% Si, not hardenable		75	260	N3	E M	●●	●	●
		≤ 12% Si, hardenable, hardened		90	310	N4	E M	●●	●	●
		> 12% Si, not hardenable		130	450	N5	E M	●●	●	●
	Magnesium-based alloys [3]			70	250	N6	A	●●	●	●
	Copper and copper alloys (bronze/brass)	Non-alloyed, electrolytic copper		100	340	N7	E M	●●	●	●●
		Brass, bronze, red brass		90	310	N8	E M	●●	●	●
		Copper alloys, short-chipping		110	380	N9	E M	●●	●	●
		High tensile, Ampco		300	1010	N10	E M	●●	●	●
S	Heat-resistant alloys	Fe-based	Annealed	200	680	S1	E	●●	●	●●
			Hardened	280	940	S2	E	●●	●	●●
		Ni- or Co-based	Annealed	250	840	S3	E	●●	●	●●
			Hardened	350	1180	S4	E	●●	●	●●
			Cast	320	1080	S5	E	●●	●	●●
	Titanium alloys	Pure titanium		200	680	S6	E	●●	●	●●
		α and β alloys, hardened		375	1260	S7	E	●●	●	●
		β alloys		410	1400	S8	E	●●	●	●
	Tungsten alloys			300	1010	S9	E	●●	●	●
	Molybdenum alloys			300	1010	S10	E	●●	●	●
H	Hardened steel	Hardened and tempered		50 HRC	–	H1	M A	●	●●	●
		Hardened and tempered		55 HRC	–	H2	M			
		Hardened and tempered		60 HRC	–	H3	M			
	Hardened cast iron	Hardened and tempered		55 HRC	–	H4	M A			
O	Thermoplastics	Without abrasive fillers				O1	E M	●●	●	●
	Thermosetting plastics	Without abrasive fillers				O2	E M	●●	●	●
	Plastic, glass-fibre reinforced	GFRP				O3	E M	●●	●	●
	Plastic, carbon-fibre reinforced	CFRP				O4	E M	●●	●	●
	Plastic, aramid-fibre reinforced	AFRP				O5	E M	●●	●	●
	Graphite (technical)			65		O6	E M	●●	●	●

[1] The assignment of the machining groups can be found in the "General" section of the Technical Compendium, page F7.
[3] Water-miscible cooling lubricants must not be used when machining magnesium-based alloys.

TC620				TC620 DeVibe				TC685*				TC645*			
v_c [m/min]	f_z [mm]			v_c [m/min]	f_z [mm]			v_c [m/min]	f_z [mm]			v_c [m/min]	f_z [mm]		
WB10TJ	$D_c \leq 6$ mm	$D_c > 6$ mm and ≤ 12 mm	$D_c > 12$ mm	WB10TJ	$D_c \leq 6$ mm	$D_c > 6$ mm and ≤ 12 mm	$D_c > 12$ mm	WB10RC	$D_c \leq 4$ mm	$D_c > 4$ mm and ≤ 8 mm	$D_c > 8$	WB10TJ	$D_c \leq 4$ mm	$D_c > 4$ mm and ≤ 8 mm	$D_c > 8$
115	0,07	0,11	0,15	136	0,07	0,11	0,15					250	0,05	0,08	0,12
155	0,07	0,11	0,15	183	0,07	0,11	0,15					250	0,05	0,08	0,12
130	0,07	0,11	0,15	153	0,07	0,11	0,15					250	0,05	0,08	0,12
130	0,07	0,11	0,15	153	0,07	0,11	0,15					250	0,05	0,08	0,12
95	0,07	0,11	0,15	112	0,07	0,11	0,15					250	0,04	0,07	0,1
130	0,07	0,11	0,15	153	0,07	0,11	0,15					250	0,05	0,08	0,12
130	0,07	0,11	0,15	153	0,07	0,11	0,15					250	0,05	0,08	0,12
80	0,05	0,09	0,13	94	0,05	0,09	0,13					250	0,05	0,08	0,12
75	0,05	0,09	0,13	89	0,05	0,09	0,13					250	0,04	0,07	0,1
65	0,05	0,09	0,13	77	0,05	0,09	0,13	70	0,015	0,030	0,050	250	0,04	0,08	0,12
150	0,07	0,11	0,15	177	0,07	0,11	0,15					250	0,05	0,08	0,12
110	0,07	0,11	0,15	130	0,07	0,11	0,15					250	0,04	0,07	0,1
90	0,07	0,11	0,15	106	0,07	0,11	0,15					250	0,04	0,07	0,1
55	0,07	0,11	0,15	65	0,07	0,11	0,15					250	0,05	0,08	0,12
45	0,07	0,11	0,15	53	0,07	0,11	0,15					250	0,05	0,08	0,12
70	0,05	0,09	0,13	83	0,05	0,09	0,13					150	0,025	0,04	0,08
40	0,05	0,09	0,13	47	0,05	0,09	0,13					150	0,02	0,035	0,07
45	0,04	0,07	0,10	53	0,04	0,07	0,10					150	0,025	0,04	0,08
105	0,07	0,12	0,17	124	0,07	0,12	0,17	90	0,020	0,045	0,070	300	0,05	0,1	0,15
100	0,07	0,12	0,17	118	0,07	0,12	0,17	90	0,020	0,045	0,070	300	0,05	0,1	0,15
130	0,07	0,12	0,17	153	0,07	0,12	0,17	100	0,020	0,045	0,070	300	0,05	0,1	0,15
110	0,07	0,11	0,15	130	0,07	0,11	0,15	90	0,020	0,045	0,070	300	0,05	0,1	0,15
105	0,07	0,11	0,15	124	0,07	0,11	0,15	90	0,020	0,045	0,070	300	0,05	0,1	0,15
100	0,07	0,11	0,15	118	0,07	0,11	0,15	90	0,020	0,045	0,070	300	0,05	0,1	0,15
85	0,07	0,11	0,15	100	0,07	0,11	0,15	80	0,020	0,045	0,070	300	0,05	0,1	0,15
130	0,07	0,12	0,17	155	0,07	0,12	0,17					300	0,05	0,1	0,15
140	0,07	0,12	0,17	160	0,07	0,12	0,17					300	0,05	0,1	0,15
135	0,07	0,12	0,17	155	0,07	0,12	0,17					300	0,05	0,1	0,15
135	0,07	0,12	0,17	155	0,07	0,12	0,17					300	0,05	0,1	0,15
135	0,07	0,12	0,17	155	0,07	0,12	0,17					300	0,05	0,1	0,15
140	0,07	0,12	0,17	160	0,07	0,12	0,17					300	0,05	0,1	0,15
135	0,07	0,12	0,17	155	0,07	0,12	0,17					300	0,05	0,1	0,15
125	0,07	0,12	0,17	140	0,07	0,12	0,17					300	0,05	0,1	0,15
135	0,07	0,12	0,17	155	0,07	0,12	0,17					300	0,05	0,1	0,15
65	0,05	0,09	0,13	75	0,05	0,09	0,13					300	0,04	0,08	0,12
35	0,07	0,11	0,15	41	0,07	0,11	0,15					120	0,02	0,05	0,08
25	0,07	0,11	0,15	30	0,07	0,11	0,15					120	0,02	0,05	0,08
40	0,07	0,11	0,15	47	0,07	0,11	0,15					120	0,02	0,05	0,08
25	0,05	0,09	0,13	30	0,05	0,09	0,13					120	0,016	0,04	0,06
25	0,05	0,09	0,13	30	0,05	0,09	0,13					120	0,016	0,04	0,06
40	0,07	0,11	0,15	47	0,07	0,11	0,13					120	0,02	0,05	0,08
40	0,05	0,09	0,13	47	0,05	0,09	0,13					120	0,016	0,04	0,06
20	0,05	0,09	0,13	24	0,05	0,09	0,13					120	0,016	0,04	0,06
50	0,05	0,09	0,13	59	0,05	0,09	0,13	30	0,010	0,020	0,050	120	0,02	0,05	0,08
60	0,05	0,09	0,13	71	0,05	0,09	0,13	30	0,010	0,020	0,050	120	0,02	0,05	0,08
55	0,05	0,09	0,13	65	0,05	0,09	0,13	55	0,012	0,030	0,050				
								50	0,010	0,022	0,040				
								45	0,008	0,020	0,030				
								50	0,010	0,022	0,040				
290	0,06	0,1	0,14	342	0,06	0,1	0,14								
145	0,06	0,1	0,14	177	0,06	0,1	0,14								
65	0,06	0,1	0,14	77	0,06	0,1	0,14								
65	0,06	0,1	0,14	77	0,06	0,1	0,14								
65	0,06	0,1	0,14	77	0,06	0,1	0,14								
215	0,06	0,1	0,14	254	0,06	0,1	0,14								

* The TC645 and TC685 are left-hand cutting versions.
Climb milling is therefore always used for the machining operation.

The specified cutting data are average standard values.
For specific applications, adjustment is recommended.

Cutting data for solid carbide thread milling (continued)

= Cooling lubricant recommended ***

E = Emulsion
M = MQL
A = Compressed air

v_c = Cutting speed
f_z = Feed per tooth
f = Feed per revolution

Material group	Overview of the main material groups and code letters			Brinell hardness HB	Tensile strength R_m [N/mm²]	Machining group [1]	Cooling lubricant
P	Non-alloyed steel	C ≤ 0,25 %	Annealed	125	430	P1	**E M A**
		C > 0,25… ≤ 0,55 %	Annealed	190	640	P2	**E M A**
		C > 0,25… ≤ 0,55 %	Heat-treated	210	710	P3	**E M A**
		C > 0,55 %	Annealed	190	640	P4	**E M A**
		C > 0,55 %	Heat-treated	300	1010	P5	**E M A**
		Free-machining steel (short-chipping)	Annealed	220	750	P6	**E M A**
	Low-alloy steel	Annealed		175	590	P7	**E M A**
		Heat-treated		285	960	P8	**E M A**
		Heat-treated		380	1280	P9	**E M A**
		Heat-treated		430	1480	P10	**E M A**
	High-alloy steel and high-alloy tool steel	Annealed		200	680	P11	**E M A**
		Hardened and tempered		300	1010	P12	**E M A**
		Hardened and tempered		380	1280	P13	**E M A**
	Stainless steel	Ferritic/martensitic, annealed		200	680	P14	**E M A**
		Martensitic, heat-treated		330	1110	P15	**E M A**
M	Stainless steel	Austenitic, quench hardened		200	680	M1	**E**
		Austenitic, precipitation hardened (PH)		300	1010	M2	**E**
		Austenitic/ferritic, duplex		230	780	M3	**E**
K	Malleable cast iron	Ferritic		200	400	K1	**E M A**
		Pearlitic		260	700	K2	**E M A**
	Grey cast iron	Low strength		180	200	K3	**E M A**
		High strength/austenitic		245	350	K4	**E M A**
	Cast iron with spheroidal graphite	Ferritic		155	400	K5	**E M A**
		Pearlitic		265	700	K6	**E M A**
	CGI			230	400	K7	**E M A**
N	Wrought aluminium alloys	Not hardenable		30	–	N1	**E M A**
		Hardenable, hardened		100	340	N2	**E M A**
	Cast aluminium alloys	≤ 12% Si, not hardenable		75	260	N3	**E M A**
		≤ 12% Si, hardenable, hardened		90	310	N4	**E M A**
		> 12% Si, not hardenable		130	450	N5	**E M A**
	Magnesium-based alloys			70	250	N6	**A**
	Copper and copper alloys (bronze/brass)	Non-alloyed, electrolytic copper		100	340	N7	**E M A**
		Brass, bronze, red brass		90	310	N8	**E M A**
		Copper alloys, short-chipping		110	380	N9	**E M A**
		High tensile, Ampco		300	1010	N10	**E M A**
S	Heat-resistant alloys	Fe-based	Annealed	200	680	S1	**E**
			Hardened	280	940	S2	**E**
		Ni- or Co-based	Annealed	250	840	S3	**E**
			Hardened	350	1180	S4	**E**
			Cast	320	1080	S5	**E**
	Titanium alloys	Pure titanium		200	680	S6	**E**
		α and β alloys, hardened		375	1260	S7	**E**
		β alloys		410	1400	S8	**E**
	Tungsten alloys			300	1010	S9	**E**
	Molybdenum alloys			300	1010	S10	**E**
H	Hardened steel	Hardened and tempered		50 HRC	–	H1	**M A**
		Hardened and tempered		55 HRC	–	H2	**M A**
		Hardened and tempered		60 HRC	–	H3	**M A**
	Hardened cast iron	Hardened and tempered		55 HRC	–	H4	**M A**
O	Thermoplastics	Without abrasive fillers				O1	**E M A**
	Thermosetting plastics	Without abrasive fillers				O2	**E M A**
	Plastic, glass-fibre reinforced	GFRP				O3	**E M A**
	Plastic, carbon-fibre reinforced	CFRP				O4	**E M A**
	Plastic, aramid-fibre reinforced	AFRP				O5	**E M A**
	Graphite (technical)			80 Shore		O6	**E M A**

[1] The assignment of the machining groups can be found in the "General" section of the Technical Compendium, page F7.

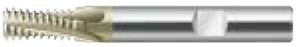
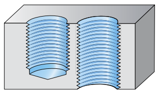
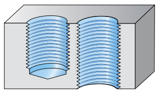
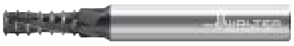
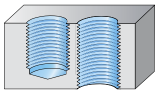
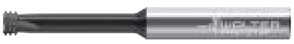
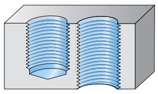
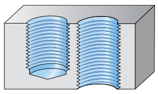
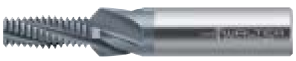
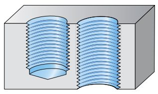
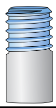
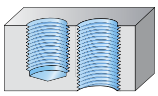
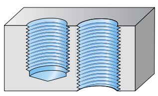
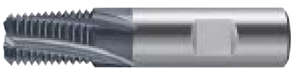
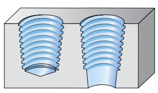
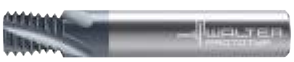
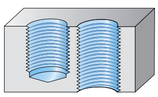
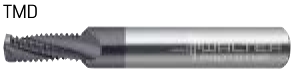
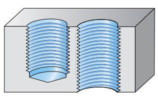
* The feed per tooth is valid for a thread depth of 1 × D_N. If deeper threads are machined, it may be necessary to increase the number of radial cuts.
** The feed per tooth for 3 × D_N tools with D_c < 1.6 mm must be reduced by 30–50%.
*** Emulsion must always be used for drill/thread mills.

Thread milling cutters*						Orbital thread milling cutters					Drill/thread mills*						
v_c [m/min]		f_z [mm]				v_c [m/min]		f_z [mm]**			v_c [m/min]	$D_c \le 5$ mm		$D_c > 5$ and ≤ 10 mm		$D_c > 10$ mm	
Uncoated	Coated	$D_c \le 3$ mm	$D_c > 3$ and ≤ 7 mm	$D_c > 7$ and ≤ 9 mm	$D_c > 9$ mm	Uncoated	Coated	$D_c \le 1{,}5$ mm	$D_c > 1{,}5$ and ≤ 3 mm	$D_c > 3$ mm	Coated	f_z [mm]	f [mm/rev]	f_z [mm]	f [mm/rev]	f_z [mm]	f [mm/rev]
	115	0,015	0,045	0,070	0,1		85	0,025	0,040	0,100							
	155	0,012	0,045	0,070	0,1		115	0,020	0,040	0,100							
	130	0,02 (2)	0,045	0,070	0,1		100	0,020	0,040	0,100							
	130	0,02 (2)	0,045	0,070	0,1		100	0,015	0,040	0,100							
	95	0,02 (2)	0,045	0,070	0,1		70	0,015	0,040	0,100							
	130	0,012	0,045	0,070	0,1		100	0,020	0,040	0,100							
	130	0,012	0,045	0,070	0,1		100	0,020	0,040	0,100							
	80	0,02 (2)	0,040	0,070	0,1		60	0,010	0,040	0,100							
	75	0,02 (2)	0,040	0,070	0,1		55	0,010	0,040	0,100							
	65	0,02 (2)	0,040	0,070	0,1		45	0,010	0,040	0,100							
	150	0,025 (3)	0,065 (2)	0,070	0,1		100	0,007	0,040	0,100							
	110	0,03 (3	0,065 (2)	0,070	0,1		70	0,004	0,040	0,100							
	90	0,03 (3)	0,065 (2)	0,070	0,1		55	0,004	0,040	0,100							
	55	0,02 (2)	0,065 (2)	0,070	0,1		30	0,009	0,040	0,100							
	45	0,03 (3)	0,075 (3)	0,095 (2)	0,1 (2)		25	0,004	0,040	0,100							
	55	0,015 (2)	0,030	0,050	0,1		35	0,008	0,030	0,095							
	40	0,02 (4)	0,04 (2)	0,050	0,1 (2)		20	0,004	0,030	0,095							
	45	0,013 (2)	0,030	0,050	0,1		30	0,007	0,030	0,095							
45	105	0,020	0,050	0,075	0,1	40	70	0,030	0,050	0,100	85	0,040	0,120	0,060	0,200	0,095	0,300
45	100	0,025 (2)	0,050	0,075	0,1	40	70	0,015	0,050	0,100	85	0,040	0,120	0,060	0,200	0,095	0,300
60	130	0,020	0,050	0,075	0,1	50	90	0,030	0,050	0,100	105	0,040	0,120	0,060	0,200	0,095	0,300
45	110	0,025 (2)	0,050	0,075	0,1	40	75	0,020	0,050	0,100	90	0,040	0,120	0,060	0,200	0,095	0,300
45	105	0,020	0,050	0,075	0,1	40	70	0,030	0,050	0,100	85	0,040	0,120	0,060	0,200	0,095	0,300
45	100	0,02 (2)	0,040	0,075	0,1	40	65	0,010	0,050	0,100	85	0,040	0,120	0,060	0,200	0,095	0,300
40	85	0,025 (2)	0,050	0,075	0,1	30	60	0,015	0,050	0,100	75	0,040	0,120	0,060	0,200	0,095	0,300
	400	0,030	0,075	0,100	0,1		400	0,050	0,065	0,100	400	0,070	0,200	0,120	0,300	0,170	0,400
	400	0,030	0,075	0,100	0,1		400	0,050	0,065	0,100	400	0,070	0,200	0,120	0,300	0,170	0,400
	400	0,030	0,075	0,100	0,1		360	0,050	0,065	0,100	400	0,070	0,200	0,120	0,300	0,170	0,400
	400	0,030	0,075	0,100	0,1		360	0,050	0,065	0,100	400	0,070	0,200	0,120	0,300	0,170	0,400
	170	0,030	0,075	0,100	0,1	95	130	0,050	0,065	0,100	195	0,070	0,200	0,120	0,300	0,170	0,400
	400	0,030	0,075	0,100	0,1		360	0,050	0,065	0,100	480	0,070	0,200	0,120	0,300	0,170	0,400
	360	0,030	0,075	0,100	0,1		205	0,050	0,065	0,100							
	360	0,030	0,075	0,100	0,1		205	0,045	0,065	0,100							
	360	0,030	0,075	0,100	0,1		205	0,050	0,065	0,100							
	50	0,030	0,075	0,100	0,1		30	0,050	0,065	0,100							
	35	0,015 (2)	0,030	0,050	0,1		20	0,011	0,030	0,095							
	25	0,015 (2)	0,05 (2)	0,050	0,085		15	0,009	0,030	0,095							
	40	0,015 (2)	0,05 (2)	0,050	0,09		20	0,010	0,030	0,095							
	25	0,02 (3)	0,05 (2)	0,050	0,1 (2)		15	0,007	0,030	0,095							
	25	0,013 (2)	0,05 (2)	0,050	0,1 (2)		15	0,007	0,030	0,095							
	40	0,011	0,035	0,050	0,1		20	0,020	0,030	0,095							
	40	0,015 (2)	0,035	0,050	0,1		25	0,008	0,030	0,095							
	20	0,015 (2)	0,035	0,050	0,1		10	0,008	0,030	0,095							
	50	0,015 (2)	0,030	0,050	0,09		30	0,011	0,030	0,095							
	60	0,015 (2)	0,05 (2)	0,050	0,09		30	0,009	0,030	0,095							
	55	0,02 (3)	0,065 (2)	0,070	0,1		40	0,005	0,040	0,075							
	35	0,011	0,045	0,070	0,1		30	–	0,040	0,075							
	30	0,011	0,060 (3)	0,08 (3)	0,1 (3)		25	–	0,006	0,060							
	60	0,011	0,065 (2)	0,070	0,1		45	–	0,040	0,075							
	290	0,011	0,035	0,050	0,1		155	0,020	0,030	0,090							
90	145	0,011	0,035	0,050	0,1	70	105	0,020	0,030	0,090							
30	65	0,011	0,035	0,050	0,1	25	40	0,020	0,030	0,090							
30	65		0,035	0,050	0,1	25	40	0,020	0,030	0,090							
30	65		0,035	0,050	0,1	25	40	0,020	0,030	0,090							
175	215		0,035	0,050	0,1	150	155	0,020	0,030	0,090	175	0,025	0,1	0,045	0,15	0,06	0,2

The specified cutting data are average standard values. For specific applications, adjustment is recommended.
The values in brackets define the number of radial cuts. If no value in brackets is provided, one radial cut is recommended.

Type description

Thread milling cutters

Type description			Machining	P Steel	M Stainless steel	K Cast iron	N NF metals	S Materials with difficult cutting properties	H Hard materials	O Other	Helix angle	Thread depth
TC610		– Universal thread milling cutter		●●	●●	●●	●●	●●		●	20°	1,5 × D_N
TC611		– Universal thread milling cutter		●●	●●	●●	●●	●●		●	20°	2,0 × D_N
TC620		– Universal multi-row thread milling cutter		●●	●●	●●	●●	●●		●	15°/ 20°	2,0 × D_N 2,5 × D_N
TC630		– Universal orbital thread milling cutter		●●	●●	●●	●●	●●		●	15°	2,0 × D_N 2,5 × D_N 3,0 × D_N 4,0 × D_N
TC685		– Drill/thread mill for hardened materials from 44 to 63 HRC		●		●		●	●●		–15°	2,0 × D_N 2,5 × D_N
TMC		– Universal thread milling cutter with countersink		●●	●●	●●	●●	●●		●	27°	2,0 × D_N
TME		– Universal thread milling cutter for external threads		●●	●●	●●	●●	●●		●	20°	2,0 × D_N
TMG HRC		– Thread milling cutter for hardened materials from 48 to 63 HRC		●●		●●		●	●●	●	10°	1,5 × D_N
TMO HRC		– Orbital thread milling cutter for hardened materials from 48 to 63 HRC		●●		●●		●	●●	●	15°	2,0 × D_N
TMG		– Universal thread milling cutter		●●	●●	●●	●●	●●		●	10°	—
TMG Ni		– Thread milling cutter for nickel alloys		●●	●●		●	●●		●	27°	1,5 × D_N
TMD		– Drill/thread mill for short-chipping aluminium and grey cast iron materials				●●	●●				27°	2,0 × D_N

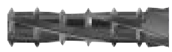
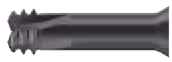
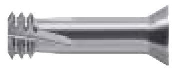
●● Primary application
● Additional application

Product families

Thread milling cutters	
TC610 / TC611 Supreme	Universal thread milling cutter
TC620 Supreme	Universal multi-row thread milling cutter
TC630 Supreme	Universal orbital thread milling cutter
TC685 Supreme	Drill/thread mill for hardened materials
TMC	Universal thread milling cutter with countersink
TMD	Drill/thread mill
TME	Universal thread milling cutter for external threads
TMG HRC	Thread milling cutter for hardened materials from 48 to 63 HRC
TMG	Universal thread milling cutter
TMG Ni	Thread milling cutter for nickel alloys
TMO HRC	Orbital thread milling cutter for hardened materials from 48 to 63 HRC

Grade description

Thread milling cutters

Walter grade description	Standard designation	Material groups: P Steel	M Stainless steel	K Cast iron	N NF metals	S Materials with difficult cutting properties	H Hard materials	O Other	Application range (01 05 10 15 20 25 30 35 40 45)	Coating process	Coating compo- sition	Tool example
WB10TJ	HC – 10	●●	●●	●●	●●	●●		●	01 – 20	PVD	AlTiN	
WB10RC	HC – 10	●		●		●	●●		01 – 20	PVD	TiAlN	
WB10RA	HC – 10	●	●●	●	●	●●		●	01 – 20	PVD	TiAlN + TiAl	
WB10RD	HC – 10	●●	●●	●●	●●	●●		●	01 – 20	PVD	TiAlN + ZrN	
WJ30RC	HC – 30	●●	●●	●●	●●	●●		●	20 – 40	PVD	TiAlN	

HC = Coated carbide

●● Primary application
● Additional application

Cutting data for indexable insert thread milling

= Cooling lubricant recommended

E = Emulsion
M = MQL
A = Compressed air
$\mathbf{v_c}$ = Cutting speed [m/min]
$\mathbf{f_z}$ = Feed per tooth [mm]

Overview of the main material groups and code letters

Material group	Material			Brinell hardness HB	Tensile strength R_m [N/mm²]	Machining group[1]	Cooling lubricant	T2710 / T2711 / T2712 / T2713 v_c [m/min]	f_z [mm] Insert size 06	f_z [mm] Insert size 09/11/14/22
P	Non-alloyed steel	C ≤ 0,25 %	Annealed	125	430	P1	E M	200	0,3	0,4
		C > 0,25 ... ≤ 0,55 %	Annealed	190	640	P2	E M	200	0,3	0,4
		C > 0,25 ... ≤ 0,55 %	Heat-treated	210	710	P3	E M	200	0,3	0,4
		C > 0,55 %	Annealed	190	640	P4	E M	200	0,3	0,4
		C > 0,55 %	Heat-treated	300	1010	P5	E M	200	0,3	0,4
		Free-machining steel (short-chipping)	Annealed	220	750	P6	E M	200	0,3	0,4
	Low-alloy steel	Annealed		175	590	P7	E M	200	0,3	0,4
		Heat-treated		285	960	P8	E M	200	0,3	0,4
		Heat-treated		380	1280	P9	E M	150	0,25	0,35
		Heat-treated		430	1480	P10	E M	100	0,2	0,3
	High-alloy steel and high-alloy tool steel	Annealed		200	680	P11	E M	200	0,3	0,4
		Hardened and tempered		300	1010	P12	E M	200	0,3	0,4
		Hardened and tempered		380	1280	P13	E M	150	0,3	0,4
	Stainless steel	Ferritic/martensitic, annealed		200	680	P14	E M	200	0,25	0,35
		Martensitic, heat-treated		330	1110	P15	E M	150	0,25	0,35
M	Stainless steel	Austenitic, quench hardened		200	680	M1	E	200	0,2	0,3
		Austenitic, precipitation hardened (PH)		300	1010	M2	E	150	0,2	0,3
		Austenitic/ferritic, duplex		230	780	M3	E	80	0,2	0,3
K	Malleable cast iron	Ferritic		200	400	K1	E M	200	0,3	0,4
		Pearlitic		260	700	K2	E M	200	0,3	0,4
	Grey cast iron	Low strength		180	200	K3	E M	250	0,3	0,4
		High strength/austenitic		245	350	K4	E M	200	0,3	0,4
	Cast iron with spheroidal graphite	Ferritic		155	400	K5	E M	200	0,3	0,4
		Pearlitic		265	700	K6	E M	200	0,3	0,4
	CGI			230	400	K7	E M	200	0,3	0,4
N	Wrought aluminium alloys	Not hardenable		30	–	N1	E M	200	0,3	0,4
		Hardenable, hardened		100	340	N2	E M	200	0,3	0,4
	Cast aluminium alloys	≤ 12% Si, not hardenable		75	260	N3	E M	200	0,3	0,4
		≤ 12% Si, hardenable, hardened		90	310	N4	E M	200	0,3	0,4
		> 12% Si, not hardenable		130	450	N5	E M	200	0,3	0,4
	Magnesium-based alloys[3]			70	250	N6	A	250	0,3	0,4
	Copper and copper alloys (bronze/brass)	Non-alloyed, electrolytic copper		100	340	N7	E M	200	0,3	0,4
		Brass, bronze, red brass		90	310	N8	E M	200	0,3	0,4
		Copper alloys, short-chipping		110	380	N9	E M	200	0,3	0,4
		High tensile, Ampco		300	1010	N10	E M	50	0,3	0,4
S	Heat-resistant alloys	Fe-based	Annealed	200	680	S1	E	40	0,25	0,25
			Hardened	280	940	S2	E	25	0,15	0,15
		Ni- or Co-based	Annealed	250	840	S3	E	40	0,25	0,25
			Hardened	350	1180	S4	E	25	0,15	0,15
			Cast	320	1080	S5	E	30	0,2	0,2
	Titanium alloys	Pure titanium		200	680	S6	E	40	0,25	0,25
		α and β alloys, hardened		375	1260	S7	E	40	0,25	0,25
		β alloys		410	1400	S8	E	30	0,2	0,2
	Tungsten alloys			300	1010	S9	E	40	0,25	0,25
	Molybdenum alloys			300	1010	S10	E	40	0,25	0,25
H	Hardened steel	Hardened and tempered		50 HRC	–	H1	M A	45	0,2	0,3
		Hardened and tempered		55 HRC	–	H2	M	–	–	–
		Hardened and tempered		60 HRC	–	H3	M	–	–	–
	Hardened cast iron	Hardened and tempered		55 HRC	–	H4	M A	45	0,2	0,3
O	Thermoplastics	Without abrasive fillers				O1	E M	200	0,3	0,4
	Thermosetting plastics	Without abrasive fillers				O2	E M	150	0,3	0,4
	Plastic, glass-fibre reinforced	GFRP				O3	E M	50	0,3	0,4
	Plastic, carbon-fibre reinforced	CFRP				O4	E M	50	0,3	0,4
	Plastic, aramid-fibre reinforced	AFRP				O5	E M	50	0,3	0,4
	Graphite (technical)			80 Shore		O6	E M	200	0,3	0,4

[1] The assignment of the machining groups can be found in the "General" section of the Technical Compendium, page F7.
[3] Water-miscible cooling lubricants must not be used when machining magnesium-based alloys.

The specified cutting data represents average standard values.
For specific applications, adjustment is recommended.

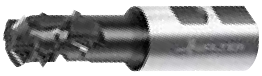
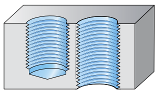
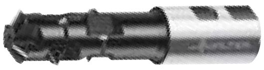
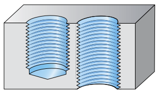
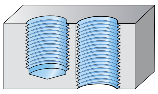
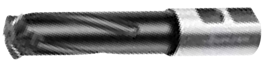
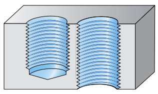
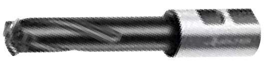
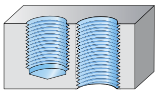
Climb milling must therefore be used for the machining operation. The specified cutting data represents target values under good machining conditions.

Solution for vibration:
– Use indexable inserts with D61 geometry
– Reduce v_c by 25–50% and/or increase f_z by 25–50%
– Radial cutting pass

T2710/T2711/T2712: One radial cut is recommended
T2713: Radial cutting pass may be required.

Type description

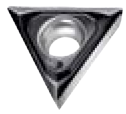
Thread milling cutters

Type description		Machining	Material groups P Steel	M Stainless steel	K Cast iron	N NF metals	S Materials with difficult cutting properties	H Hard materials	O Other	Thread depth
T2710 	– Multi-row thread milling cutter with indexable inserts		●●	●●	●●	●	●●	●	●	1,5 × D_N
T2711 	– Multi-row thread milling cutter with indexable inserts		●●	●●	●●	●	●●	●	●	2,0 × D_N
T2712 	– Multi-row thread milling cutter with indexable inserts		●●	●●	●●	●	●●	●	●	2,5 × D_N
T2712 	– Single-row thread milling cutter with indexable inserts		●●	●●	●●	●	●●	●	●	2,5 × D_N
T2713 	– Single-row thread milling cutter with indexable inserts		●●	●●	●●	●	●●	●	●	3,0 × D_N

●● Primary application
● Additional application

Grade description

Indexable inserts

Walter grade description	Standard designation	Material groups: P Steel	M Stainless steel	K Cast iron	N NF metals	S Materials with difficult cutting properties	H Hard materials	O Other	Application range 01 05 10 15 20 25 30 35 40 45	Coating process	Coating composition	Tool example
WSM37S	HC – 35	●●	●●	●●	●	●●	●	●		PVD	TiAlN + Al_2O_3 (Al)	

HC = Coated carbide

●● Primary application
● Additional application

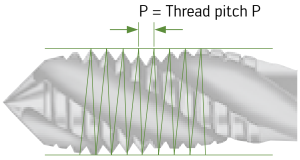
Process principles

Basic aspects of thread milling

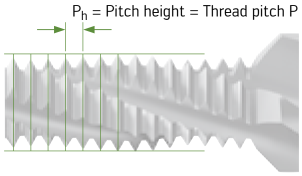
- A machine tool with a 3D CNC control system is required (largely standard today)
- Conventional thread milling is cost-effective up to approx. 2.5 × D_N, while orbital thread milling is beneficial for larger thread depths
- For larger thread dimensions, thread milling is generally quicker than tapping and thread forming

In contrast to tapping and thread forming, the pitch is created by the CNC control system when carrying out thread milling.

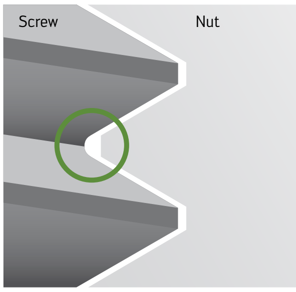
Theoretically, an internal thread milling cutter can also be used to create an external thread. However, because the external threads are rounded to minimise the notch effect in the core and the outer diameter created is too small, the threads produced in this way will not comply with the standard.
The gauge accuracy will nevertheless be maintained, as the thread ring gauge tests the pitch diameter.

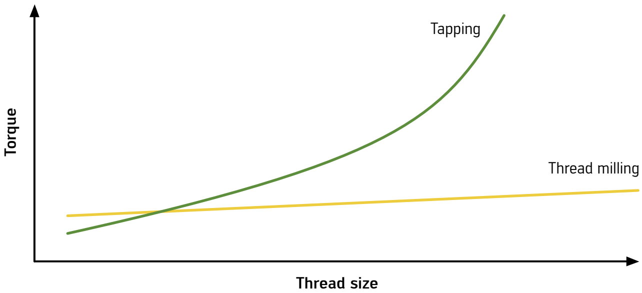


Tapping: The thread pitch P is created by the tap/thread former.



Thread milling: The thread pitch P is created by the CNC control system (circular program).





It is also possible to create large threads on machines with lower drive power, as, in contrast to tapping and thread forming, the torque required for thread milling only increases moderately as the thread size increases.

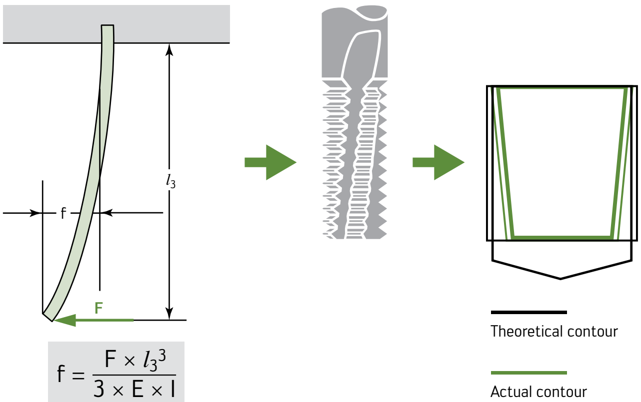
Thread milling is an extremely reliable production process. Chip removal is generally unproblematic, as the process produces short chips. In addition, thread milling does not require any special chucks; almost all common milling chucks can be used for thread milling as well.

The laws of physics mean that thread milling cutters are subject to less deflection at the shank than at the front cutting edge. As shown in the adjacent curve formula, this leads to conical threads when using conventional thread milling cutters.
In order to counteract this physical law, the geometric design of thread milling cutters is slightly conical. Problems with this resulting from difficult machining conditions (e.g. deep threads) can be rectified using one of the following measures:

- (Multiple) radial cutting pass(es)
- Using conventional milling for all radial cuts
- Reducing the cutting pressure by omitting teeth
- Carrying out a non-cutting pass without additional feed at the end of the process (radial cutting passes are preferable to carrying out a non-cutting pass due to their wear behaviour)

Remark:
Orbital thread milling cutters (TC630) are a good alternative, as they can be used to create parallel threads right to the bottom of the hole. With orbital thread milling cutters, the relevant projection length for the curvature does not change across the entire length of the thread, as only one row of cutting edges is engaged at any given time. This means that the curvature remains constant.

The measures listed above increase the cycle time, but are unavoidable in some cases where it is not otherwise possible to ensure that the thread remains true to gauge. Measures for reducing the conicity must often be implemented in particular for threads with small tolerances and when working with materials with difficult cutting properties (such as Inconel).



$$f = \frac{F \times l_3^3}{3 \times E \times I}$$

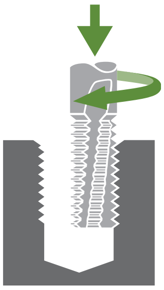
f = Curvature	E = Modulus of elasticity
F = Cutting force	I = Grade 2 surface torque
l_3 = Projection length	L_c = Cutting edge length

Machining strategies

Thread milling processes

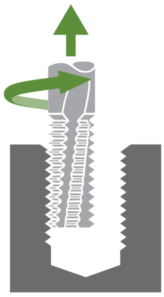
There are two fundamentally different thread milling processes:

Conventional milling



Conventional milling is preferred when machining hardened materials, or as a solution for conical threads.
(from top to bottom in right-hand threads)

Climb milling



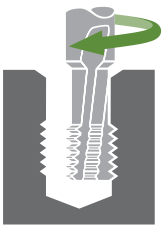
Climb milling increases tool life and prevents chatter marks, while facilitating thread conicity.
(from top to bottom in right-hand threads)

Remark:
Walter GPS automatically determines the right process for the relevant application and takes into account the specific details relating to the tool and the machining process.

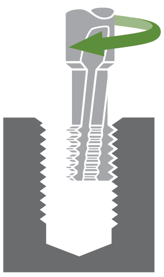
Cutting pass

The cuts can be made in a number of passes in order to reduce the forces acting on the tool:

Axial cutting pass



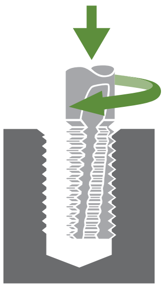
First cut



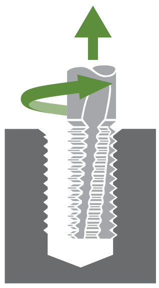
Second cut

Remark:
Ensure that the thread milling cutter is always moved by a multiple of the pitch when making axial cutting passes.

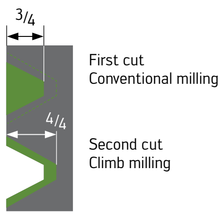
Radial cutting pass



First cut



Second cut

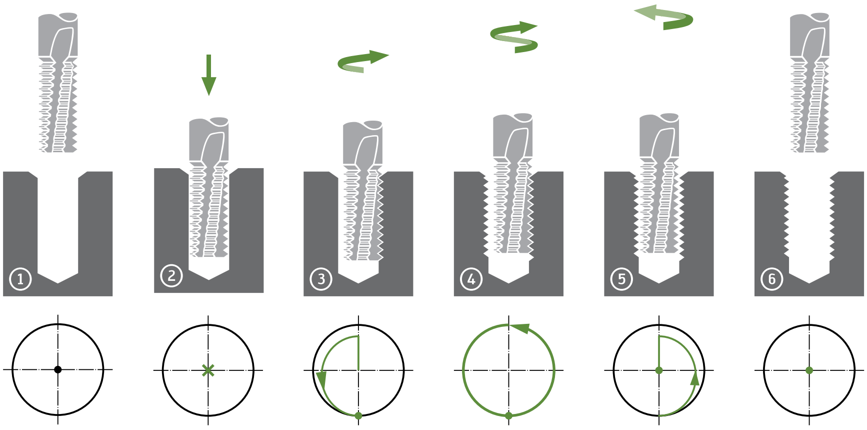


Advantages:
- Greater thread depths can be created
- Reduced risk of tool breakage
- Thread milling is possible even with a relatively unstable clamping arrangement
- Counteracts conical threads

Disadvantages:
- Increased tool wear
- Longer production time
- Axial cutting passes can result in a burr at the transition

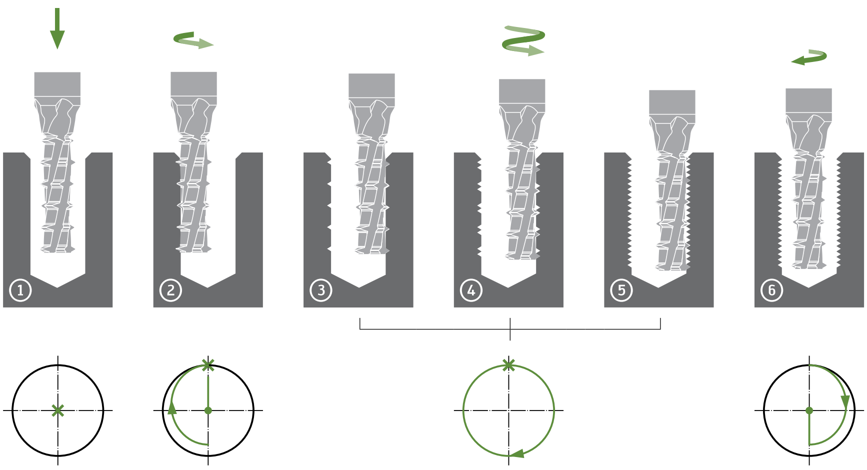
Machining strategies
Basic strategies

Thread milling



1. Positioning over core hole
2. Plunging
3. Entry loop
4. Creating the thread using 360° helical interpolation
5. Exit loop
6. Returning the tool to the start position

Multi-row thread milling



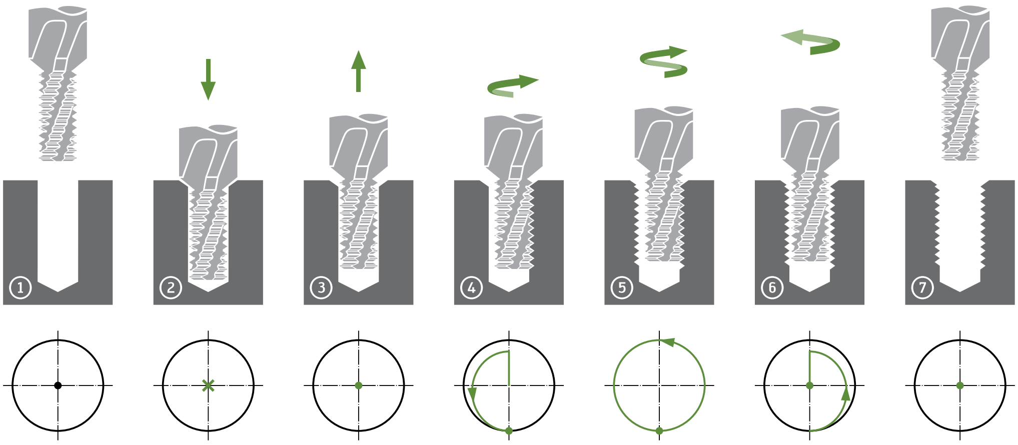
1. Positioning the milling cutter over core hole and plunging
2. Entry loop
3. – 5. Producing the thread using helical interpolation until the row spacing is bridged
6. Exit loop

- ● Start position
- ● Movement out of the level (green)
- × Movement into the level
- → Direction of movement on the x-axis and y-axis

Machining strategies

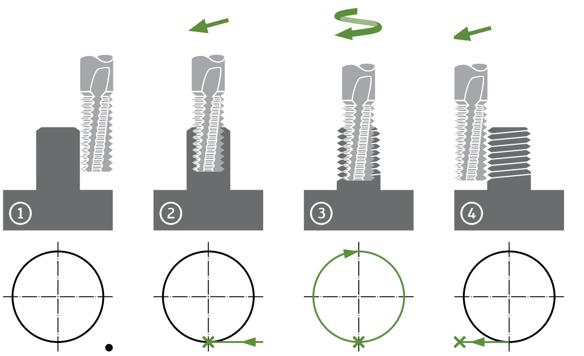
Basic strategies (continued)

Thread milling with countersink



Positioning over core hole	Plunging and countersinking	Feeding back	Entry loop	Creating the thread using 360° helical interpolation	Exit loop	Returning the tool to the start position

External thread milling



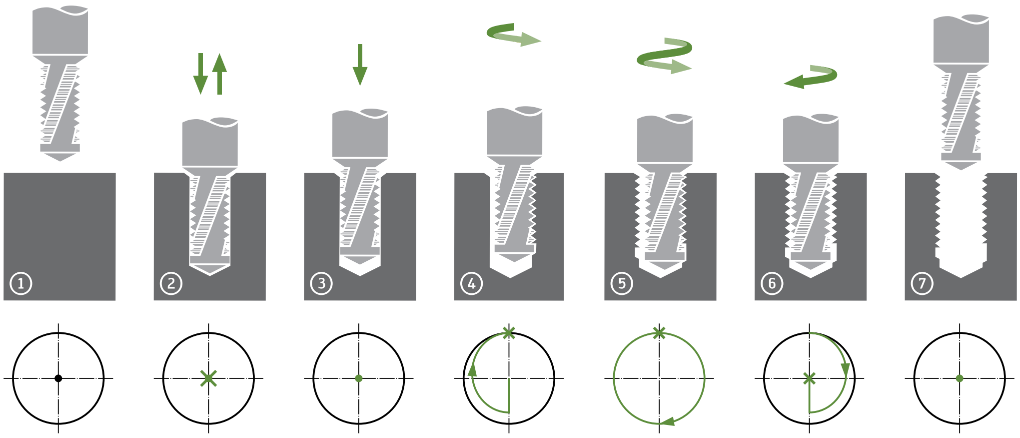
Positioning	Approaching in the inclination angle	Thread milling using 360° helical interpolation	Withdrawing in the inclination angle

- ● Start position
- ● Movement out of the level
- × Movement into the level
- → Direction of movement on the x-axis and y-axis

Machining strategies

Basic strategies (continued)

Drilling and thread milling



Positioning over core hole

Drilling, countersinking the core hole and chip removal

Plunging

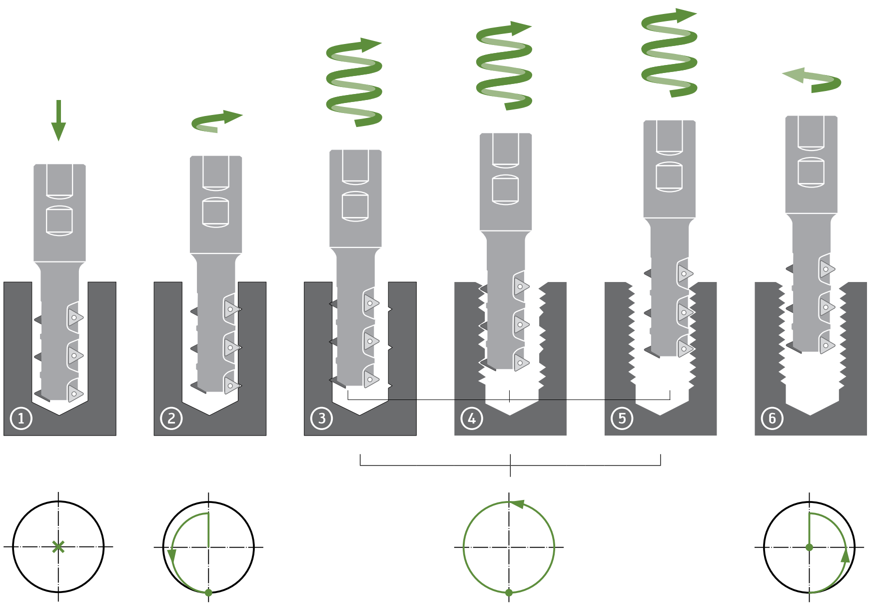
Entry loop

Creating the thread via conventional milling using 360° helical interpolation

Exit loop

Returning the tool to the start position

Indexable insert thread milling



Positioning the milling cutter over core hole and plunging

Entry loop

Producing the thread using helical interpolation until the row spacing is bridged

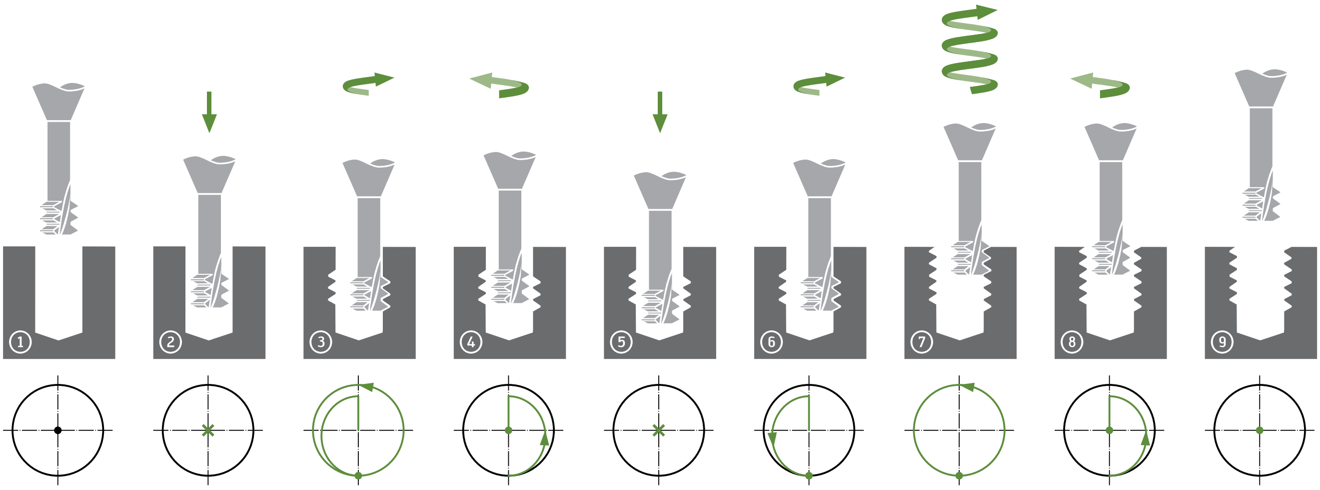
Exit loop

- ● Start position
- ● Movement out of the level
- ✕ Movement into the level
- → Direction of movement on the x-axis and y-axis

Machining strategies

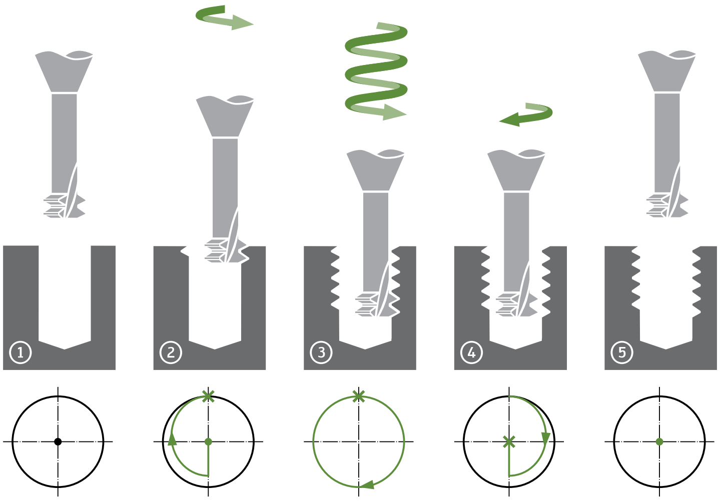
Basic strategies (continued)

Orbital thread milling



1. Positioning over core hole
2. Plunging
3. Entry loop + 360° helical interpolation
4. Exit loop
5. Plunging
6. Entry loop
7. Creating the thread using helical interpolation
8. Exit loop
9. Returning the tool to the start position

Orbital thread milling in hardened materials



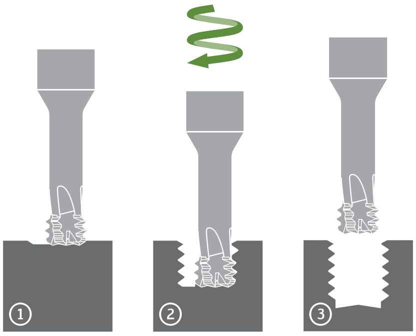
1. Positioning over core hole
2. Entry loop
3. Creating the thread via conventional milling using helical interpolation
4. Exit loop
5. Returning the tool to the start position

- ● Start position
- ● Movement out of the level
- × Movement into the level
- → Direction of movement on the x-axis and y-axis

Machining strategies

Basic strategies (continued)

Circular drilling/threading



Chamfering	Creating the thread and core hole using helical interpolation	Returning the tool to the start position

- Start position
- Movement out of the level
- × Movement into the level
- → Direction of movement on the x-axis and y-axis

CNC programming for solid carbide thread milling Walter TC610/TC611/TC620/TC630/TC685

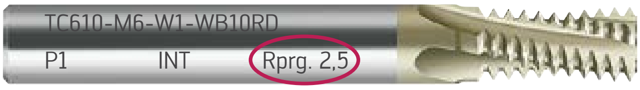
It is generally recommended to use Walter GPS to generate the CNC program for thread milling. Unlike predefined machine cycles, Walter GPS takes into account the stability of the tool and the material to be machined. On the basis of this information, it automatically selects the optimum cutting parameters and includes radial cutting passes in the program sequence if necessary. CNC programs can normally be generated for all commonly used control systems. Every line of the program includes comments, enabling users to understand the program sequence and to adjust individual values, which is not possible with machine cycles. In addition, using Walter GPS enables the required thread tolerance to be achieved with the very first thread – eliminating the need to carry out time-consuming gradual adjustment to achieve suitable correction values.

Every thread milling cutter is measured during production and labelled with the programming radius ("Rprg."). The programming radius is calculated on the basis of the actual pitch diameter measured. As the thread is gauged on the pitch diameter, it is vital that this is taken into account in the programming. Not all users are able to measure the pitch diameter of a thread milling cutter and calculate the Rprg. The labelling of the tools with the Rprg. as standard therefore offers significant advantages for ensuring optimum programming processes, as users can simply read the Rprg. on the shank of the tool and input it directly into the tool memory of the machine. If the Rprg. is entered without correction, the thread milling cutter will move along the path of the smallest permitted pitch diameter.

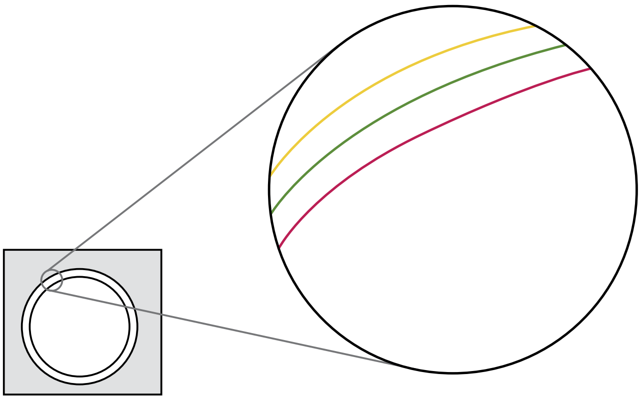
As using the Rprg. by itself only achieves the minimum permitted pitch diameter, the value entered must be corrected on the basis of the selected tolerance. The top line of the CNC program generated by Walter GPS can be used to do so. Reducing the Rprg. by the specified correction value (in the adjacent example, this is 0.038 mm) results in a movement sequence in which the pitch diameter of the milled thread is situated in the middle of the tolerance range.

If the tool becomes worn during machining, the deflection increases and the pitch diameter is reduced. This can be offset by correcting the Rprg. It is recommended to use correction increments of 0.01 mm.

Remark: If the tool memory uses diameters instead of radii, the Rprg. must be doubled before it is entered. Failing to do so will result in a collision, breaking the tool.



Comment	Code
Tool radius presetting	;Tol. 6H: R='Rprg'-0.038 mm
Tool request	N01 M6 T
Selection of working plane	N02 G90 G17



Maximum permitted pitch diameter

Middle of the tolerance range
(achieved using the correction value calculated by Walter GPS)

Minimum permitted pitch diameter
(achieved if the Rprg. is entered without correction)

Radius correction values for solid carbide thread milling Walter TC610/TC611/TC620/TC630/TC685

Metric thread in accordance with DIN 13

Thread nominal diameter D_N [mm]	P [mm]	Radius correction: Minimum dimension for H tolerances	Radius correction: Middle of the tolerance range for a 6H tolerance [mm]	Radius correction: Middle of the tolerance range for a 6G tolerance [mm]
≥ 3 and ≤ 22	0,50	Rprg.	–0,025	–0,035
	0,70	Rprg.	–0,030	–0,041
	0,80	Rprg.	–0,031	–0,043
	1,00	Rprg.	–0,038	–0,051
	1,25	Rprg.	–0,040	–0,054
	1,50	Rprg.	–0,045	–0,061
	1,75	Rprg.	–0,050	–0,067
	2,00	Rprg.	–0,053	–0,072
	2,50	Rprg.	–0,056	–0,077

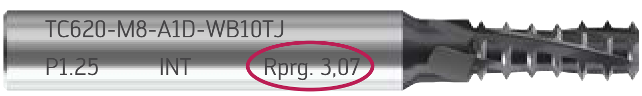
Based on the pitch diameter tolerances in accordance with DIN ISO 965-1.

UN/UNC/UNF/UNEF thread in accordance with ASME B1.1

Thread nominal diameter D_N [inches]	P [TPI]	Radius correction: Minimum dimension for H tolerances	Radius correction: Middle of the tolerance range for a 2B tolerance [mm]	Radius correction: Middle of the tolerance range for a 3B tolerance [mm]
≥ 0.164" and ≤ 0.75"	32	Rprg.	–0,023	–0,017
	24	Rprg.	–0,027	–0,020
	20	Rprg.	–0,031	–0,023
	18	Rprg.	–0,034	–0,025
	16	Rprg.	–0,036	–0,027
	13	Rprg.	–0,041	–0,030
	11	Rprg.	–0,046	–0,034
	10	Rprg.	–0,049	–0,036

Based on the pitch diameter tolerances in accordance with ASME B1.1.

The programming radius (abbreviated to "Rprg.") can be read from the tool shank and is to be entered in the tool table of the CNC control system. The milled thread is then in the lower tolerance range and is usually too narrow. If the thread has to be milled to bring it to the middle of the tolerance range, the Rprg. must be reduced by the value stated in the "Middle of the tolerance range" column. The thread is then generally true to gauge. The radius correction values can also be determined using Walter GPS.

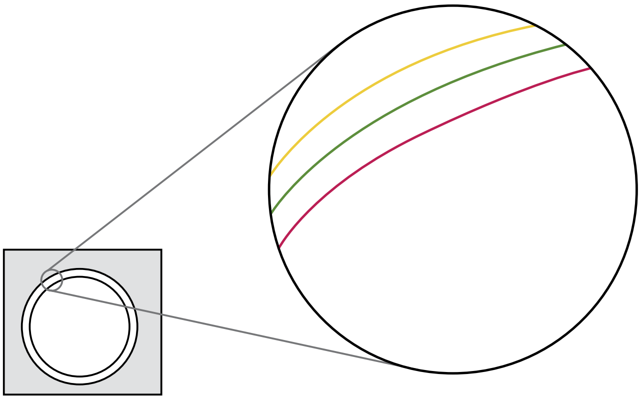


Example of an M8 – 6H thread with P = 1.25 mm	
Programming radius (Rprg.)	3,07 mm
Radius correction in the middle of the 6H tolerance range	– 0,04 mm
Tool radius to be used	**= 3.03 mm**

CNC programming for indexable insert thread milling Walter T2710/T2711/T2712/T2713

The programming radius (abbreviated to “Rprg.”) can be found in the radius correction tables. Only the tool radius has to be measured and the corresponding correction value taken from the table.

If the measured tool radius is reduced by the value stated in the “Minimum dimension” column, the thread is still in the lower tolerance range after machining and is usually too narrow.
If the thread has to be milled to bring it to the middle of the tolerance range, the measured tool radius must be reduced by the value stated in the “Middle of the tolerance range” column. The thread is generally true to gauge after machining.
Radius correction values can also be determined in Walter GPS.



Maximum permitted pitch diameter

Middle of the tolerance range
(achieved using the correction value calculated by Walter GPS)

Minimum permitted pitch diameter
(achieved if the Rprg. is entered without correction)

Radius correction values for indexable insert thread milling Walter T2710/T2711/T2712/T2713

Metric thread in accordance with DIN 13

Thread nominal diameter D_N	P	r	Radius correction: Minimum dimension for H tolerances	Radius correction: Middle of the tolerance range for a 6H tolerance	Radius correction: Middle of the tolerance range for a 6G tolerance
[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
≥ 16	1,5	0,1	−0,05	−0,10	−0,12
	2	0,1	−0,10	−0,15	−0,17
	2,5	0,1	−0,15	−0,20	−0,22
	3	0,2	−0,10	−0,16	−0,19
	3,5	0,2	−0,15	−0,22	−0,24
	4	0,2	−0,20	−0,27	−0,30
	4,5	0,2	−0,25	−0,33	−0,36
	5*	0,2	−0,30	−0,38	−0,42
		0,4	−0,10	−0,18	−0,22
	5,5	0,4	−0,15	−0,24	−0,27
	6	0,4	−0,20	−0,29	−0,33
	8	0,4	−0,40	−0,51	−0,56
	10	0,4	−0,59	−0,71	–

Based on the pitch diameter tolerances in accordance with DIN ISO 965-1. Valid from M20.
* IMPORTANT: For P = 5 mm, we recommend an insert radius r = 0.2 mm. Please take this into account when selecting the radius correction values.

UN/UNC/UNF/UNEF thread in accordance with ASME B1.1

Thread nominal diameter D_N	P	r	Radius correction: Minimum dimension	Radius correction: Middle of the tolerance range for a 2B tolerance	Radius correction: Middle of the tolerance range for a 3B tolerance
[inches]	[TPI]	[mm]	[mm]	[mm]	[mm]
≥ 3/4"	18	0,1	−0,04	−0,08	−0,07
	16	0,1	−0,06	−0,10	−0,09
	14	0,1	−0,08	−0,12	−0,11
	12	0,1	−0,11	−0,16	−0,15
	9	0,1	−0,18	−0,23	−0,22
	8	0,2	−0,12	−0,17	−0,16
	7	0,2	−0,16	−0,22	−0,21
	6	0,2	−0,22	−0,29	−0,27
	5*	0,2	−0,31	−0,38	−0,36
		0,4	−0,11	−0,18	−0,16
	4,5	0,4	−0,16	−0,24	−0,22
	4	0,4	−0,23	−0,32	−0,30

Based on the pitch diameter tolerances in accordance with ASME B1.1. Valid from UNC 7/8.
* IMPORTANT: For P = 5 TPI, we recommend an insert radius r = 0.2 mm. Please take this into account when selecting the radius correction values.

Pipe thread G (BSP) in accordance with DIN EN ISO 228

Thread nominal diameter D_N	P	r	Radius correction: Minimum dimension	Radius correction: Middle of the tolerance range
[inches]	[TPI]	[mm]	[mm]	[mm]
≥ 1" and < 2 1/4"	11	0,2	−0,11	−0,16
≥ 2 1/4"	11	0,2	−0,11	−0,17

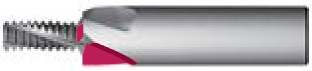
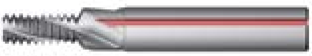
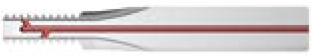
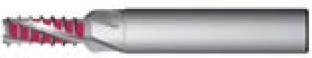
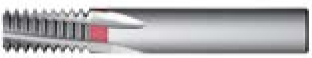
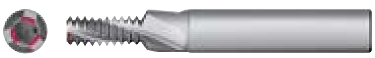
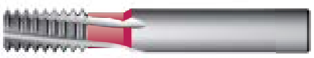
Based on the pitch diameter tolerances in accordance with DIN ISO 228. Valid from D_N 1".

If the measured tool radius is reduced by the value stated in the "Minimum dimension" column, the thread is still in the lower tolerance range after machining and is usually too narrow.
If the thread has to be milled to bring it to the middle of the tolerance range, the measured tool radius must be reduced by the value stated in the "Middle of the tolerance range" column. The thread is generally true to gauge after machining.
Radius correction values can also be determined in Walter GPS.

Example of an M36 – 6H thread	P	4 mm
	r	0,2 mm
Measured tool radius		14,53 mm
Radius correction in the middle of the 6H tolerance range		– 0,27 mm
Tool radius to be used		**= 14.26 mm**

Modifications

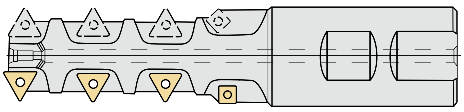
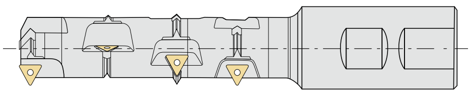
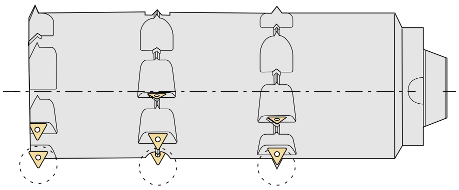
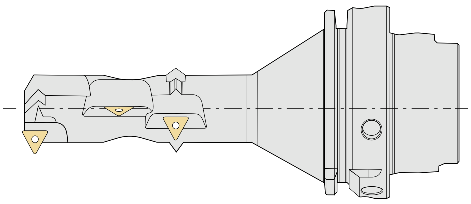
Thread milling cutters

	Modification	Effect
	Countersink and facing step	Countersinking and facing step in one tool
	Coolant grooves on the shank	Targeted cooling without weakening the tool cross section in the cutting area
	Radial coolant outlets	Targeted cooling for through-hole threads
	Threads removed	Reduced cutting forces, as fewer teeth are engaged at once. Machining time is not increased despite the multiple passes as higher cutting parameters are possible.
	Deburring cutting edge	Removal of the incomplete thread at the thread start area without an additional operation
	First thread profile lengthened on the face	Chamfering of the core hole
	Grinding of the neck	Enables axial cutting passes to be made (useful for deep threads)

Modifications

(continued)

Thread milling cutters with indexable insert

	Modification	Effect
	Indexable insert thread milling cutter with deburring cutting edge	Removal of the incomplete thread at the thread start area without an additional operation
	Indexable insert thread milling cutter with countersunk cutting edge	Countersinking in a single tool
	Indexable insert thread milling cutter with four rows	Multi-row tools usually reduce the machining time. Increases the cutting forces on long tools (not always suitable).
 	Indexable insert thread milling cutters with NCT/HSK/Capto adaptors	Different clamping options allow the tools to be used on different machine tools.

Solutions

		Thread milling problems					
		Chatter marks	Short tool life	Cutting edge breakaway	Conical threads*	Tool breakage	True to gauge
Cutting data/strategy/settings	f_z in [mm/tooth]	+	+	☐	–	–	
	v_c in [m/min]	–	–	☐		☐	
	Programming			☐		☐	☐
	Climb milling	■	■				
	Conventional milling				■		■
	Cutting pass	■		■	■	■	■
	Programming radius [Rprg.]						☐
	Cooling		+	+			
Workpiece	Clamping arrangement	☐	+	+	☐	☐	☐
	Pilot hole diameter	☐	+	☐	☐	☐	+
	Chip removal		+	+	☐	☐	
Tool	Stability/geometry	☐	+	+	☐	☐	+
	Projection length	–	–	–	–	–	–
	Coating		☐				
	Concentricity	☐	☐	☐		☐	☐

☐ check ■ preferably use – reduce + improve/increase

* Using tools in the TC630 Supreme family is an excellent alternative for creating parallel threads.

TC630 – Specialists for challenging tasks:

Tools from the TC630 family are often used as problem-solvers where

– deep threads need to be created

– conventional thread milling cutters create conical threads

Cooling and lubrication:
Problems caused by the cooling and lubrication and the corresponding measures for rectifying these problems are located in the "Cooling and lubrication" section.

T2710–T2713 – The indexable insert specialists for large threads:

– For short and long threads

– D61 geometry with anti-vibration land to reduce vibration

– D67 geometry for longest tool life

– With restricted machining conditions (limited speed), f_z can be significantly increased and v_c reduced

Hard workpiece machining:

– Only use tools specially designed for hard workpiece machining (TC685, TMO HRC or TMG HRC)

– Use conventional machining where possible (see Walter GPS recommendation)

– If the TC685 mills the hole and the thread, then climb milling is used (left-hand cutting geometry)

– Select the largest permitted pilot hole diameter

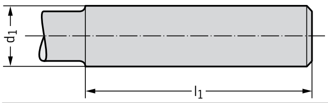
– If problems with the cylindricity of threads occur, carry out several radial cuts or use tools from the TC685/TMO HRC family

– Do not use cooling lubricant. Instead, remove the hard chips from the hole with compressed air or MQL

Shank dimensions in accordance with DIN 6535

Cylindrical shank
DIN 6535 HA

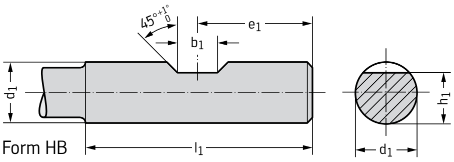
Form HA
for d_1 = 2–32 mm



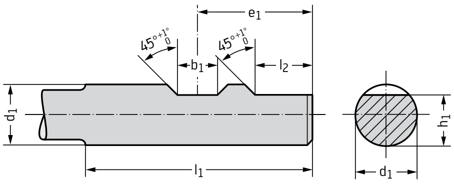
d_1 h6 [mm]	2	6	10	12	16	20	25	32
l_1 +2 [mm]	28	36	40	45	48	50	56	60

Cylindrical shank
DIN 6535 HB

Form HB
with a pulling face for d_1 = 6–20 mm



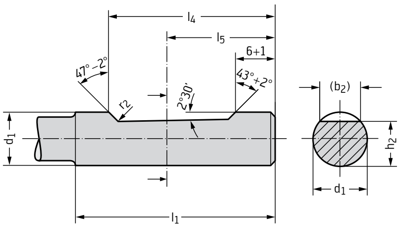
Form HB
with two pulling faces for d_1 = 25 and 32 mm



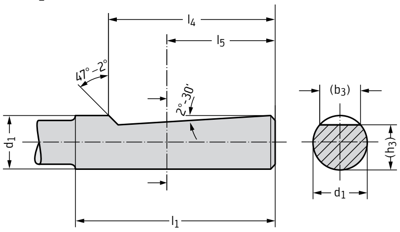
d_1 h6 [mm]	b_1 +0,05 [mm]	e_1 −1 [mm]	h_1 h11 [mm]	l_1 +2 [mm]	l_2 +1 [mm]
6	4,2	18	5,1	36	–
8	5,5	18	6,9	36	–
10	7	20	8,5	40	–
12	8	22,5	10,4	45	–
14	8	22,5	12,7	45	–
16	10	24	14,2	48	–
18	10	24	16,2	48	–
20	11	25	18,2	50	–
25	12	32	23,0	56	17
32	14	38	30,0	60	19

Cylindrical shank
DIN 6535 HE

Form HE
for d_1 = 6–20 mm

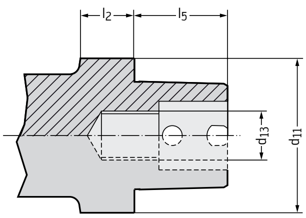


Form HE
for d_1 = 25 and 32 mm



d_1 h6 [mm]	(b_2) ≈ [mm]	(b_3) [mm]	h_2 h11 [mm]	(h_3) [mm]	l_1 +2 [mm]	l_4 −1 [mm]	l_5 Nominal dimension [mm]	r_2 min. [mm]
6	4,3	–	5,1	–	36	25	18	1,2
8	5,5	–	6,9	–	36	25	18	1,2
10	7,1	–	8,5	–	40	28	20	1,2
12	8,2	–	10,4	–	45	33	22,5	1,2
14	8,1	–	12,7	–	45	33	22,5	1,2
16	10,1	–	14,2	–	48	36	24	1,6
18	10,8	–	16,2	–	48	36	24	1,6
20	11,4	–	18,2	–	50	38	25	1,6
25	13,6	9,3	23,0	24,1	56	44	32	1,6
32	15,5	9,9	30,0	31,2	60	48	35	1,6

Walter Capto™ tool adaptor
ISO 26623



Walter Capto™	d_{11} mm	l_2 mm	l_5 mm	d_{13}
C3	32	15	19	M12 × 1,5
C4	40	20	24	M14 × 1,5
C5	50	20	30	M16 × 1,5
C6	63	22	38	M20 × 2,0
C8	80	30	48	M20 × 2,0

Tool selection for indexable insert thread milling cutters

Metric threads			Coarse-pitch threads									
Family	Body designation	l_3 [mm]	M16	M18	M20 / M22	M24 / M27	M30 / M33	M36 / M39	M42 / M45	M48 / M52	M56 / M59	M64 / M68
T2710	T2710-17-W16-3-06-2-15	33,0			0601							
	T2710-19-W20-3-06-3-12	39,1				0602						
	T2710-24-W25-3-09-3-14	49,5					0902					
	T2710-29-W32-3-09-3-16	58,5						0902				
	T2710-35-W32-3-11-3-18	68,5							1102			
	T2710-40-W40-3-14-3-20	79,0								1402		
	T2710-44-W40-3-14-3-22	91,0									1404	
	T2710-52-W40-4-14-3-24	103,0										1404
T2711	T2711-13-W16-1-06	35,0	0601									
	T2711-15-W16-2-06	39,0		0601								
	T2711-17-W16-3-06-2-20	43,0			0601							
	T2711-19-W20-3-06-2-24	51,0				0602						
	T2711-24-W25-3-09-2-31.5	64,5					0902					
	T2711-29-W32-3-09-3-24	76,5						0902				
	T2711-35-W32-3-11-3-27	89,5							1102			
	T2711-40-W40-3-14-3-30	103,0								1402		
	T2711-44-W40-3-14-3-33	119,0									1404	
	T2711-52-W40-4-14-2-60	135,0										1404
T2712	T2712-24-W25-3-09-2-31.5	79,5					0902					
	T2712-29-W32-3-09-2-36	94,5						0902				
	T2712-35-W32-3-11-2-40.5	110,5							1102			
	T2712-40-W40-3-14-2-50	127,0								1402		
	T2712-13-W16-1-06	43,0	0601									
	T2712-17-W16-3-06	53,0			0601							
	T2712-19-W20-3-06	63,0				0602						
	T2712-24-W25-3-09	79,5					0902					
	T2712-29-W32-3-09	94,5						0902				
	T2712-35-W32-3-11	110,5							1102			
	T2712-40-W40-3-14	127,0								1402		
	T2712-44-W40-3-14	147,0									1404	
	T2712-52-W40-4-14	167,0										1404
T2713	T2713-17-W16-3-06	63,0			0601							
	T2713-19-W20-3-06	75,0				0602						
	T2713-24-W25-3-09	94,5					0902					
	T2713-29-W32-3-09	112,5						0902				
	T2713-35-W32-3-11	131,5							1102			
	T2713-40-W40-3-14	151,0								1402		
	T2713-44-W40-3-14	175,0									1404	
	T2713-52-W40-4-14	199,0										1404
	T2713-60-C5-4-14	115,0										
	T2713-73-C6-5-14	125,0										
	T2713-94-C8-5-22	140,0										

Example: With the T2710-35-W32-3-11-3-18 body and the size 11 indexable insert with 0.2 mm radius (1102 → P26300-1102..), an M42 or M45 thread can be produced. Additionally, this body/indexable insert combination can be used to produce fine-pitch threads with a pitch of 3 and 4.5 mm, when the nominal diameter is ≥ 42 mm.

WALTER PROTOTYP

Tool selection for indexable insert thread milling cutters

(continued)

Metric threads				Fine-pitch threads P [mm]													
Family	Body designation	l_3 [mm]	D_N [mm]	1,5	2	2,5	3	3,5	4	4,5	5	5,5	6	7	8	9	10
T2710	T2710-17-W16-3-06-2-15	33,0	≥ 20	0601		0601											
	T2710-19-W20-3-06-3-12	39,1	≥ 24	0601			0602										
	T2710-24-W25-3-09-3-14	49,5	≥ 30		0901			0902									
	T2710-29-W32-3-09-3-16	58,5	≥ 36		0901				0902								
	T2710-35-W32-3-11-3-18	68,5	≥ 42	1101			1102			1102							
	T2710-40-W40-3-14-3-20	79,0	≥ 48		1401				1402		1402						
	T2710-44-W40-3-14-3-22	91,0	≥ 56		1401							1404					
	T2710-52-W40-4-14-3-24	103,0	≥ 64	1401			1402		1402				1404				
T2711	T2711-13-W16-1-06	35,0	≥ 16	0601													
	T2711-15-W16-2-06	39,0	≥ 18		0601												
	T2711-17-W16-3-06-2-20	43,0	≥ 20		0601												
	T2711-19-W20-3-06-2-24	51,0	≥ 24	0601			0602										
	T2711-24-W25-3-09-2-31.5	64,5	≥ 30	0901				0902									
	T2711-29-W32-3-09-3-24	76,5	≥ 36	0901			0902		0902								
	T2711-35-W32-3-11-3-27	89,5	≥ 42	1101			1102			1102							
	T2711-40-W40-3-14-3-30	103,0	≥ 48	1401			1402				1402						
	T2711-44-W40-3-14-3-33	119,0	≥ 56	1401			1402					1404					
	T2711-52-W40-4-14-2-60	135,0	≥ 64	1401			1402		1402		1402		1404				
T2712	T2712-24-W25-3-09-2-31.5	79,5	≥ 30	0901				0902									
	T2712-29-W32-3-09-2-36	94,5	≥ 36	0901			0902		0902								
	T2712-35-W32-3-11-2-40.5	110,5	≥ 42	1101						1102							
	T2712-40-W40-3-14-2-50	127,0	≥ 48		1401						1402						
	T2712-13-W16-1-06	43,0	≥ 16	0601													
	T2712-17-W16-3-06	53,0	≥ 20	0601													
	T2712-19-W20-3-06	63,0	≥ 24	0601			0602										
	T2712-24-W25-3-09	79,5	≥ 30	0901			0902										
	T2712-29-W32-3-09	94,5	≥ 36	0901			0902										
	T2712-35-W32-3-11	110,5	≥ 42	1101			1102										
	T2712-40-W40-3-14	127,0	≥ 48	1401			1402										
	T2712-44-W40-3-14	147,0	≥ 56	1401			1402					1404					
	T2712-52-W40-4-14	167,0	≥ 64	1401			1402					1404					
T2713	T2713-17-W16-3-06	63,0	≥ 20	0601													
	T2713-19-W20-3-06	75,0	≥ 24	0601			0602										
	T2713-24-W25-3-09	94,5	≥ 30	0901			0902										
	T2713-29-W32-3-09	112,5	≥ 36	0901			0902										
	T2713-35-W32-3-11	131,5	≥ 42	1101			1102										
	T2713-40-W40-3-14	151,0	≥ 48	1401			1402										
	T2713-44-W40-3-14	175,0	≥ 56	1401			1402					1404					
	T2713-52-W40-4-14	199,0	≥ 64	1401			1402					1404					
	T2713-60-C5-4-14	115,0	≥ 72	1401			1402					1404					
	T2713-73-C6-5-14	125,0	≥ 85	1401			1402					1404					
	T2713-94-C8-5-22	140,0	≥ 125									2204					

Example: With the T2710-35-W32-3-11-3-18 body and the size 11 indexable insert with 0.2 mm radius (1102 → P26300-1102..), an M42 or M45 thread can be produced. Additionally, this body/indexable insert combination can be used to produce fine-pitch threads with a pitch of 3 and 4.5 mm, when the nominal diameter is ≥ 42 mm.

Tool selection for indexable insert thread milling cutters

(continued)

<table>
<tr><th colspan="3">UN threads</th><th colspan="9">UNC</th></tr>
<tr><th>Family</th><th>Body designation</th><th>l_3 [mm]</th><th>3/4–10</th><th>7/8–9</th><th>1–8</th><th>1 1/4–7</th><th>1 1/2–6</th><th>2 1/4–4,5</th><th>≥ 2 3/4–4</th><th>≥ 3–4</th><th>≥ 3 1/2–4</th></tr>
<tr><td rowspan="5">T2710</td><td>T2710-18-W16-3-06-2-11.3</td><td>36,5</td><td></td><td>0601</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>T2710-20-W20-3-06-3-12.7</td><td>41,1</td><td></td><td></td><td>0602</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>T2710-26-W25-3-09-3-12.7</td><td>52,2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>T2710-31-W32-3-09-3-19.1</td><td>63,7</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>T2710-43-W40-4-09-3-25.4</td><td>80,7</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="5">T2711</td><td>T2711-16-W16-2-06</td><td>41,0</td><td>0601</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>T2711-18-W16-3-06-2-25.4</td><td>47,5</td><td></td><td>0601</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>T2711-26-W25-3-09-2-32.7</td><td>68,0</td><td></td><td></td><td></td><td>0902</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>T2711-31-W32-3-09-3-25.4</td><td>80,7</td><td></td><td></td><td></td><td></td><td>0902</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="10">T2712</td><td>T2712-26-W25-3-09-2-32.7</td><td>84,0</td><td></td><td></td><td></td><td>0902</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>T2712-31-W32-3-09-2-38.1</td><td>99,8</td><td></td><td></td><td></td><td></td><td>0902</td><td></td><td></td><td></td><td></td></tr>
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<tr><td>T2712-44-W40-3-14</td><td>147,0</td><td></td><td></td><td></td><td></td><td></td><td>1404</td><td></td><td></td><td></td></tr>
<tr><td>T2712-52-W40-4-14</td><td>167,0</td><td></td><td></td><td></td><td></td><td></td><td></td><td>1404</td><td></td><td></td></tr>
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<tr><td>T2713-19-W20-3-06</td><td>75,0</td><td></td><td></td><td>0602</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>T2713-73-C6-5-14</td><td>125,0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>1404</td></tr>
<tr><td>T2713-94-C8-5-22</td><td>140,0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

<table>
<tr><th colspan="3">UN threads</th><th colspan="6">UNF</th><th colspan="11">UN</th></tr>
<tr><th colspan="3"></th><th colspan="6"></th><th></th><th colspan="10">TPI</th></tr>
<tr><th>Family</th><th>Body designation</th><th>l_3 [mm]</th><th>7/8–14</th><th>1–12</th><th>11/8–12</th><th>11/4–12</th><th>13/8–12</th><th>11/2–12</th><th>D_N</th><th>18*</th><th>16</th><th>14</th><th>12</th><th>9</th><th>8</th><th>6</th><th>5</th><th>4,5</th><th>4</th></tr>
<tr><td rowspan="5">T2710</td><td>T2710-18-W16-3-06-2-11.3</td><td>36,5</td><td></td><td></td><td></td><td></td><td></td><td></td><td>≥ 0,87</td><td>0601</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>T2710-26-W25-3-09-3-12.7</td><td>52,2</td><td></td><td></td><td></td><td colspan="3">0901</td><td>≥ 1,25</td><td colspan="4">0901</td><td></td><td>0902</td><td></td><td></td><td></td><td></td></tr>
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<tr><td>T2710-43-W40-4-09-3-25.4</td><td>80,7</td><td></td><td></td><td></td><td></td><td></td><td></td><td>≥ 2,00</td><td colspan="4">0901</td><td></td><td colspan="2">0902</td><td></td><td></td><td></td></tr>
<tr><td rowspan="5">T2711</td><td>T2711-16-W16-2-06</td><td>41,0</td><td></td><td></td><td></td><td></td><td></td><td></td><td>≥ 0,75</td><td colspan="4">0601</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>T2712-52-W40-4-14</td><td>167,0</td><td></td><td></td><td></td><td></td><td></td><td></td><td>≥ 2,75</td><td colspan="5">1401</td><td colspan="3">1402</td><td colspan="2">1404</td></tr>
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<tr><td>T2713-19-W20-3-06</td><td>75,0</td><td></td><td colspan="5">0601</td><td>≥ 1,00</td><td colspan="5">0601</td><td>0602</td><td></td><td></td><td></td><td></td></tr>
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<tr><td>T2713-52-W40-4-14</td><td>199,0</td><td></td><td></td><td></td><td></td><td></td><td></td><td>≥ 2,75</td><td colspan="5">1401</td><td colspan="3">1402</td><td colspan="2">1404</td></tr>
<tr><td>T2713-60-C5-4-14</td><td>115,0</td><td></td><td></td><td></td><td></td><td></td><td></td><td>≥ 3,00</td><td colspan="5">1401</td><td colspan="3">1402</td><td colspan="2">1404</td></tr>
<tr><td>T2713-73-C6-5-14</td><td>125,0</td><td></td><td></td><td></td><td></td><td></td><td></td><td>≥ 3,50</td><td colspan="5">1401</td><td colspan="3">1402</td><td colspan="2">1404</td></tr>
<tr><td>T2713-94-C8-5-22</td><td>140,0</td><td></td><td></td><td></td><td></td><td></td><td></td><td>≥ 5,00</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">2202</td></tr>
</table>

Example: With the T2710-20-W20-3-06-3-12.7 body and the size 06 indexable insert with 0.2 mm radius (0602 → P26300-0602…), a UNC 1" thread can be produced. Additionally, this body/indexable insert combination can be used to produce UN threads with 8 TPI, when their nominal diameter is ≥ 1".

* UNEF

Tool selection for indexable insert thread milling cutters

(continued)

G threads (BSP)

Family	Body designation	Insert	l_3 [mm]	G 1"	G 1 1/8"	G 1 1/4"	G 1 1/2"	G 1 3/4"	G 2"	G 2 1/4"	G 2 1/2"	G 2 3/4"	G 3"	≥ G 3 1/2"
T2712	T2712-24-W25-3-09	09G11	79,5	●●	●●	●●	●●	●	●	●	●	●	●	●
	T2712-29-W32-3-09		94,5		●●	●●	●●	●●	●	●	●	●	●	●
	T2712-40-W40-3-14	14G11	127				●●	●●	●●	●●	●	●	●	●
	T2712-44-W40-3-14		147					●●	●●	●●	●	●	●	●
	T2712-52-W40-4-14		167						●●	●●	●●	●	●	●
T2713	T2713-24-W25-3-09	09G11	94,5	●●	●●	●●	●●	●	●	●	●	●	●	●
	T2713-29-W32-3-09		112,5		●●	●●	●●	●●	●	●	●	●	●	●
	T2713-40-W40-3-14	14G11	151				●●	●●	●●	●●	●	●	●	●
	T2713-44-W40-3-14		175					●●	●●	●●	●	●	●	●
	T2713-52-W40-4-14		199						●●	●●	●●	●	●	●
	T2713-60-C5-4-14		115							●●	●●	●●	●	●
	T2713-73-C6-5-14		125									●●	●●	●●

Example: With the T2712-29-W32-3-09 body and the P26310-09G11.. indexable insert, G threads from G 1 1/8" can be produced.

●● **Primary application:** High level of cost-efficiency for small and large batch sizes

● **Additional application:** Cost-effective for small batch sizes
(In order to achieve a good surface quality, the feed per tooth must be reduced. This results in longer machining times.)

Designation key
for solid carbide thread milling cutters

Example:

T	C	6	45	-	M10	-	A	1	F	-	W	B	10	TJ
1	2	3	4	5	6		7	8	9		Grade			

1	2	3	4	
Tool group	**Generation**	**Tool type**	**Tool type**	
T Threading		**6** Solid carbide thread milling cutter	**10** Universal, 1.5 × D_N	**30** Universal, orbital thread milling cutter
			11 Universal, 2.0 × D_N	**45** Universal, orbital drill/thread mill
			20 Universal, multi-row	**85** ISO H, orbital drill/thread mill

5	6	7	8	9
1. Delimiters	**Thread dimension**	**Shank type**	**Cooling/geometry**	**Thread depth/ useable length**
– Metric		**A** Cylindrical shank	**0** External coolant	**D** 2,0 × D_N
		W Weldon shank	**1** Axial internal coolant	**E** 2,5 × D_N
			5 Walter DeVibe, axial internal coolant	**F** 3,0 × D_N
				H 4,0 × D_N

Grade designation key
for solid carbide and HSS cutting tool materials

Example:

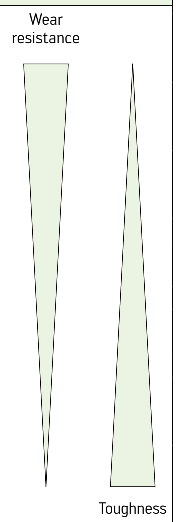
W	B	10	TJ
Walter	1	2	3

1 – Substrate

Solid carbide	B
	J
HSS	

2 – Application range

05, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95



3 – Coating

RA	TiAIN + TiAl
RC	TiAIN
RD	TiAIN (+ ZrN)
TJ	AITiN

Designation key for indexable insert thread milling cutters

Example tool:

T	2	7	11	–	29	-	W	32	-	3	-	09	-	3	-	24
1	2	3	4	5	6		7	8		9		10		11		12

1	2	3	4	5	6
Tool group	**Generation**	**Tool type**	**Tool type**	**1. Delimiters**	**Cutting diameter**
T Threading		**7** Indexable insert thread milling cutters	**10** Universal with triangular insert 1,5 × D_N **11** Universal with triangular insert 2,0 × D_N **12** Universal with triangular insert 2,5 × D_N **13** Universal with triangular insert 3.0 × D_N/ modular	**–** Metric **.** Inch	

7	8	9	10	11	12
Adaptor type	**Adaptor size**	**Number of teeth**	**Insert size**	**Number of cutting rows**	**Cutting row spacing**
W Weldon shank **C** Walter Capto™					

Designation key for indexable insert thread milling cutters

(continued)

Example indexable insert:

P26300	-	09	02	-	D	6	7		W	SM	37	G
1		2	3		4	5	6		Walter	7	8	9

1 – Family

P26300 Positive triangular thread milling cutter insert

P26310 Positive triangular thread milling cutter insert, for single-row tools

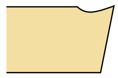
2 – Insert size

06
09
11
14
22

3 – Insert radius/ thread specification

01 = 0,1 mm
02 = 0,2 mm
04 = 0,4 mm
G11 = G thread, 11 TPI

4 – Chip breaker groove

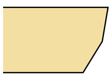


D = 10°

5 – Cutting edge

6

6 – Flank face design



1

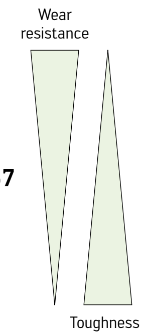
7

7 – Application

SM Universal application with ISO P, M, K, N, S and H materials

8 – ISO application range

37



Cutting tool materials for:

7 thread milling

9 – Generation

S Tiger·tec® Silver

G Tiger·tec® Gold

Surface treatments and coatings

Surface treatment and hard material coatings for improved performance

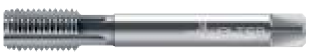
Surface coating has developed into a proven technological process for improving the performance of machining tools. In contrast to surface treatment, the tool surface remains chemically unaltered and a thin layer is applied.

For Walter Prototyp high-speed steel and carbide tools, the coating is applied using PVD processes, which work at process temperatures of below 600 °C and therefore do not result in any change to the base material. Hard material layers have a greater hardness and wear resistance than the substrate itself.

In addition
– they separate the substrate and the material to be cut from each other
– they act as a thermal insulation layer

Remark:
This also means that coated tools have longer tool life – even at higher cutting speeds.

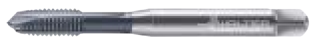
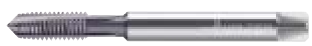
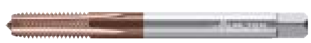
Tapping

Surface treatment/ coating	Coating code	Description	Areas of use	Properties	Tool example
BLK	UU	Uncoated	– Ideal for soft steels	– Lower cutting speed and shorter tool life compared to coated tools – Tightly rolled chips – Very good chip formation	
VAP	FC	Vaporised	– Ideal for stainless materials – In materials that are soft, tough or tend to cause weld formations – For very deep blind-hole threads	– Better coolant adhesion and therefore fewer built-up edges – Lower cutting speed and shorter tool life compared to coated tools – Optimum chip removal – Reduces birds nesting	
NIT	FB	Plasma nitrided	– Through hole: Steel up to 1200 N/mm^2 – Materials: Grey cast iron (GJL) – Aluminium alloys with 6–18% silicon content – Ampco	– Improved wear resistance thanks to increased surface hardness	
NID	FD	Nidamised = plasma nitrided + vaporised	– Through-hole threads: Steel up to 1200 N/mm^2, machining of cast iron and aluminium – Blind-hole threads: Only short-chipping materials (grey cast iron (GJL), AlSi alloys with > 7% silicon content, C70)	– Improved wear resistance due to increased surface hardness – Better chip formation due to VAP	
TiN	AA	Titanium nitride	– Steel and stainless materials – Suitable for nickel alloys	– Universal coating: Suitable for many materials	

Surface treatments and coatings

(continued)

Tapping

Surface treatment/ coating	Coating code	Description	Areas of use	Properties	Tool example
TiN / VAP	AB	Titanium nitride + vaporised	– Suitable for very deep blind holes – General steels	– Better chip formation compared to fully TiN-coated tools	
TiNK / VAP	AG	Titanium nitride (tip coating) + vaporised	– Suitable for very deep blind holes – Soft steels – better chip formation compared to fully TiN-coated tools	– Reduces weld formations in the guidance portion	
TiCN	BA	Titanium carbo-nitride	– Alloyed and non-alloyed steels – Abrasive materials such as grey cast iron, AlSi alloys (> 5% silicon content), copper alloys and bronze alloys – Suitable for nickel alloys – Not suitable for titanium alloys	– Resistant to wear caused by abrasive materials	
THL	RG	Titanium aluminium nitride + sliding layer	– General steels, especially stainless steels – Deep blind-hole threads possible – MQL machining	– Better chip formation than TiN and TiCN – Tends to cause built-up edges in materials containing manganese	
CrN	CB	Chromium nitride	– Tapping in aluminium and copper alloys – Machining of self-lubricating steels	– Reduces the formation of built-up edges – High degree of hardness	
TiAlN	RB	Titanium aluminium nitride	– Stainless steels – ISO K materials	– Good chip formation – Minimises the formation of built-up edges	
ACN	EA	Aluminium chromium nitride	– Nickel alloys	– No chemical affinity with titanium alloys as it is a titanium-free coating	
AlTiSiN	TU	Aluminium titanium silicon nitride	– Use in hardened steels	– Improved tool edge life and surface quality	

Surface treatments and coatings

(continued)

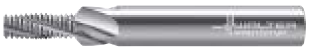
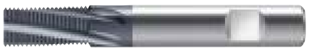
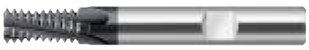
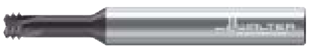
Thread forming

Surface treatment/ coating	Coating code	Description	Areas of use	Properties	Tool example
TiN	AD	Titanium nitride	– All formable materials (ISO P, ISO M, ISO N)	– Universal coating	
TiCN	BA	Titanium carbo-nitride	– Advantages compared to TiN in carbon steels and cast aluminium (> 7%–12% silicon content)	– Resistant to wear caused by abrasive materials	
CrN	CB	Chromium nitride	– ISO N materials – Titanium alloys (only with oil) – For materials with tendency to cause jamming	– Reduces the formation of built-up edges – High degree of hardness	
AlCrN	EL	Aluminium chromium nitride	– ISO P materials – ISO N materials – Solid carbide: Outstanding performance	– Very smooth coating – High level of hardness	

Surface treatments and coatings

(continued)

Thread milling

Surface treatment/ coating	Coating code	Description	Areas of use	Properties	Tool example
Uncoated	UU	–	– For use in aluminium and titanium alloys	– Sharp cutting edges	
TiCN	BA	Titanium carbon nitride	– Universal application up to 48 HRC	– Average performance in many materials	
TAM	RC	Titanium aluminium nitride	– Universal application up to 48 HRC	– Good performance in many materials	
TAZ	RD	Titanium aluminium nitride + zirconium	– Universal application up to 48 HRC	– Good performance in many materials	
LTM	TJ	Aluminium titanium nitride	– Universal application up to 48 HRC	– Very good performance in many materials	
TAX	RC	Titanium aluminium nitride	– For hardened and abrasive materials	– Higher temperature resistance than TiCN	
NHC	DD	Diamond coating	– ISO N materials	– High temperature resistance – Reduced tendency to adhere – Resistant to abrasive wear – High layer hardness – Sharp cutting edges	
TAA	RA	Titanium aluminium nitride + titanium aluminium	– ISO S/ISO M up to 48 HRC	– Very good performance in many materials	

WALTER PROTOTYP

Cooling and lubrication

It is common to talk about "coolant" in this context, although for thread cutting and thread forming in particular, lubrication is more important than cooling.
The following different methods are used:

- External coolant supply
- External coolant supply via outlets parallel to the axis on the chuck
- "Internal" coolant supply via flutes on the shank
- **I**nternal **c**oolant supply (**IC**) with **a**xial **c**oolant outlet (**AC**)
- Internal coolant supply with **r**adial **c**oolant outlet (**RC**)

An external coolant supply is the most widely used method. It works in most cases. When machining blind-hole threads vertically, the core hole fills with coolant (with the exception of very small drill diameters) and this facilitates the thread machining process.

When producing through-hole threads, the core hole is unable to be filled, however, because the chips are transported in the direction of feed and no chips are created in the first place during thread forming. The coolant may still be able to penetrate right to the chamfer even with deep threads. The coolant jet should be set so that it is as parallel as possible to the tool axis.

An external coolant supply becomes difficult when machining deep threads with the spindle in a horizontal position, as the coolant is not always able to penetrate through to the cutting edge. During blind-hole tapping, the removal of chips also hinders the coolant supply.

Supplying coolant parallel to the axis via coolant grooves on the shank boasts significant advantages, as the coolant is always reliably transported to the cutting edge, regardless of the tool length. The only thing that should be borne in mind with this method is that the coolant will be ejected radially as the speed increases if the coolant pressure is too low.

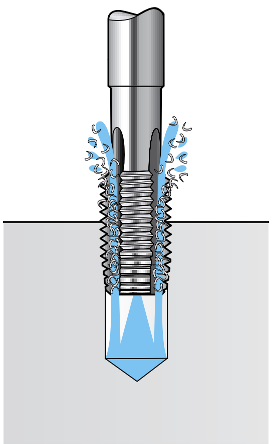
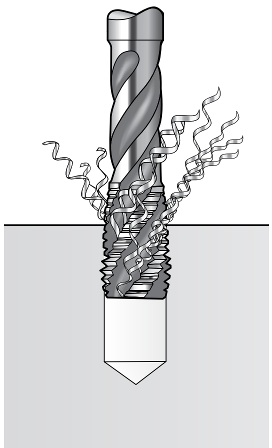
The internal coolant supply ensures that the coolant is continuously supplied to the cutting edge, ensuring optimum cooling and lubrication of the cutting edge at all times. It also promotes chip evacuation where necessary.

Material groups	Material	Thread cutting	Thread forming	Thread milling
P	Steel	Emulsion 5%	Emulsion 5–10%	Emulsion/MQL/compressed air
	Steel 850–1200 N/mm^2	Emulsion 5–10%	Emulsion 10% or oil (Protofluid)	Emulsion/MQL/compressed air
	Steel 1200–1400 N/mm^2	Emulsion 10% or oil (Protofluid)	Emulsion 10% or oil (Protofluid or Hardcut 525)	Emulsion/MQL/compressed air
	Steel 1400–1600 N/mm^2 Equivalent to 44–49 HRC	Oil (Protofluid or Hardcut 525)	Forming is generally not possible	Emulsion/MQL/compressed air
M	Stainless steel	Emulsion 5–10% or oil (Protofluid)	Oil (Protofluid) [Emulsion 5–10% only possible with special tools, e.g. Protodyn® S Eco stainless steel]	Emulsion
K	GJL grey cast iron (GG)	Emulsion 5%	Forming is not possible	Emulsion/MQL/compressed air
	GJS ductile cast iron (GGG)	Emulsion 5%	Emulsion 10%	Emulsion/MQL/compressed air
N	Aluminium up to max. 12% Si	Emulsion 5–10%	Emulsion 5–15%	Emulsion/MQL/compressed air
	Aluminium over 12% Si	Emulsion 5–10%	Emulsion 5–10% Forming only practical in exceptional cases	Emulsion/MQL/compressed air
	Magnesium	Oil (Protofluid)	Forming is not possible at room temperature	Dry
	Copper	Emulsion 5–10%	Emulsion 5–10%	Emulsion/MQL/compressed air
S	Titanium alloys	Emulsion 10% or oil (Protofluid or Hardcut 525)	Oil (Hardcut 525)	Emulsion
	Nickel alloys	Emulsion 10% or oil (Protofluid or Hardcut 525)	Oil (Protofluid or Hardcut 525)	Emulsion
H	Steel > 49 HRC	Oil (Hardcut 525) possible only with carbide tools	Forming is not possible	Dry/MQL
O	Plastics	Emulsion 5%	Threads produced by means of forming do not keep their dimensions	Emulsion/MQL

Cooling and lubrication

(continued)

Tapping

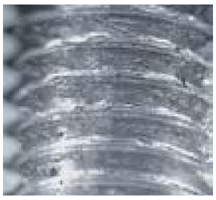
Short chips	**Long chips** (chips cannot be broken)
The best results in terms of performance and process reliability are attained if the chips can be broken short. These short chips can then be easily flushed out of the thread by the coolant. The best way to break the chips short is with straight-fluted taps (e.g. Paradur® HT). Internal coolant with axial outlet is recommended for blind-hole threads. **Remark:** When creating blind-hole threads in short-chipping materials without internal coolant, the chips collect at the bottom of the hole. If the safety margin at the bottom of the hole is too small, the tool can run up against the chips and break. 	When working with steels below 1000 N/mm² or with stainless steels and other extremely tough materials, it is generally not possible to break the chips short. In these cases, the chips must be removed using helical tools. If internal coolant is available, the coolant only helps with chip evacuation. In some cases, taps with a shallower helix angle can be used, which extends tool life. 

Cooling and lubrication

(continued)

Thread forming

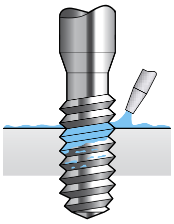
Cooling and, in particular, lubrication are of central importance for thread forming. Insufficient lubrication causes a sharp drop in the surface quality of the thread, as these photographs show:



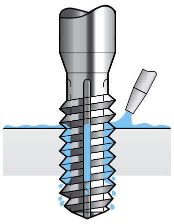
Flaky surface due to insufficient lubrication; solution: Lubrication grooves

Smooth surface due to excellent lubrication

There are two different basic tool types:
Thread formers with lubrication grooves and **thread formers without lubrication grooves**. The different application ranges are explained below.



Without lubrication grooves



With lubrication grooves

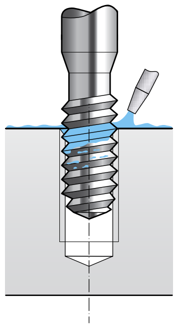
The area of application for tools without lubrication grooves is limited to:

- Sheet metal extrusions
- Through-hole threads up to 1.5 × D_N (because coolant cannot collect in the core hole)
- Blind-hole threads when machining vertically (internal coolant is recommended for extremely deep blind-hole threads)

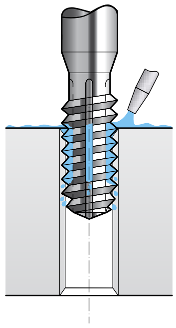
Lubrication grooves ensure uniform lubrication even at the bottom of deep threads, which is why thread formers with lubrication grooves can be used universally.
Vertical through-hole threads up to approx. 3.5 × D_N can be created with lubrication grooves even without internal coolant.

There are four different cases to consider for the tool design:

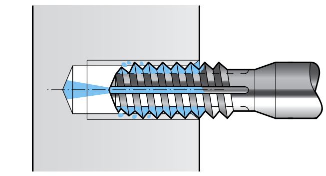
Vertical blind-hole machining
Lubrication grooves and internal coolant supply are not required; external coolant supply is sufficient (internal coolant is recommended for very deep threads, though an axial coolant outlet is sufficient).



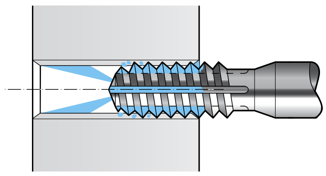
Vertical through-hole machining (> 1.5 × D_N)
Lubrication grooves are required; internal coolant supply is not necessary. Cooling lubricant supplied externally can penetrate through to the forming edges via the lubrication grooves (for extremely deep threads, internal coolant with radial outlet is recommended).



Horizontal blind-hole machining
Lubrication grooves and internal coolant supply are necessary. Axial coolant outlet is sufficient.



Horizontal through-hole machining
Lubrication grooves are required. Internal coolant supply with radial outlet is recommended.



Cooling and lubrication

(continued)

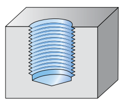
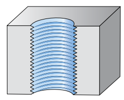
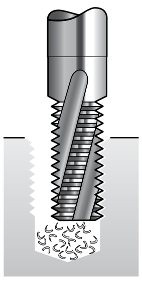
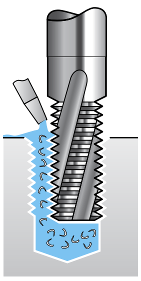
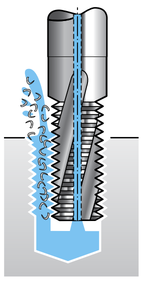
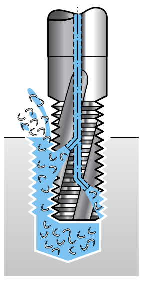
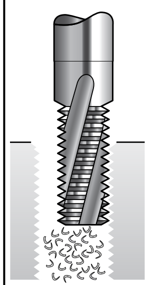
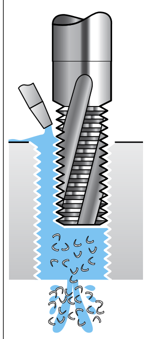
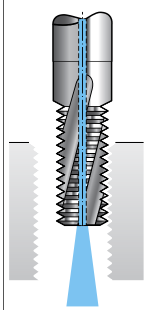
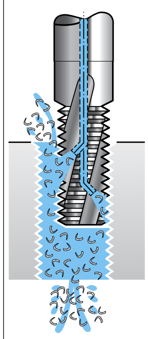
Thread milling

Wet machining is generally recommended for **thread milling**, however it should only be used if evenly distributed coolant can be guaranteed, as otherwise thermal shocks could occur, encouraging the formation of microcracks, which in turn result in fractures and thereby reduce tool life.

For blind-hole machining, it is generally recommended to use a tool with an axial coolant outlet. In this case, the best option is to use emulsion. No thermal shocks occur, because the tool is cooled over its entire surface. In addition, the coolant jet facilitates chip removal and therefore ensures that the process is reliable. Alternatively, internally supplied compressed air or MQL can also be used here, but this results in shorter tool life.
Using externally supplied emulsion is not recommended when creating blind-hole threads, as doing so can cause chips to collect in the core hole, which negatively affects tool life. Externally supplied cooling lubricant also increases the risk of thermal shocks.

For creating through-hole threads, it is recommended to use emulsion or MQL, supplied externally. Alternatively, compressed air can be used. Wet machining may lead to problems in some circumstances, as it is not always possible to guarantee evenly distributed cooling of the tool with an external coolant supply. With smaller thread dimensions in particular, there is the risk that externally supplied coolant may not completely penetrate the small hole. This means that evenly distributed cooling of the tool is not ensured, leading to an increased risk of thermal shocks.

Remark:
When carrying out thread milling, having no cooling is less of a problem than having intermittent cooling.

								
Machining	Dry	External	KA[1]	KR[2]	Dry	External	KA[1]	KR[2]
Recommen-dation	—	●	●●	●	●●	●●	—	●●
Illustration								
Reasoning	Chips remain in the hole and could cause fracture	Chips partially remain in the hole	Chips are optimally flushed out	Chips are partly flushed out	Chips fall downwards out of the hole	Chips are flushed out downwards	No cooling effect	Chips are flushed out

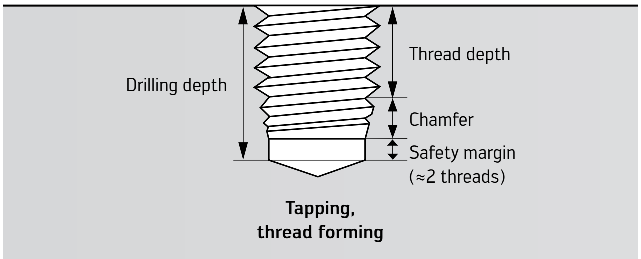
●● Primary application
● Additional application

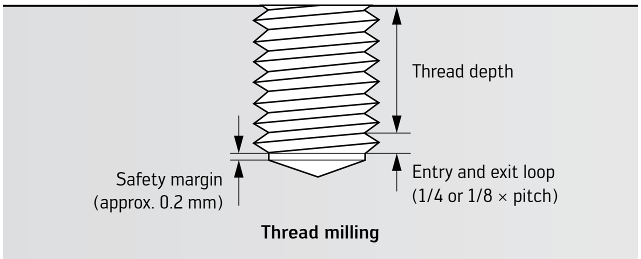
[1] Internal coolant supply with axial outlet
[2] Internal coolant supply with radial outlets

Information on the core hole and pilot hole diameter

Depth of the core hole for tapping, thread forming and thread milling

Drilling depth ≥ useable thread depth (+ chamfer length) + safety margin





Please note: Any existing tip on the threading tool must be taken into account when calculating the required depth of the core hole. In doing so, it is important to make a distinction between a full point and a reduced point.

Unlike taps and thread formers, thread milling cutters do not have a chamfer area or a tip – the drilling length can be used as effectively as possible. This means that they only require a very small axial safety margin.

Diameter of the core hole for tapping and thread milling

Rule of thumb: **Hole diameter = nominal diameter – pitch**

Example: M10 dimension
Hole diameter → 10,0 mm – 1,5 mm = **8,5 mm**

Pilot hole diameter for thread forming

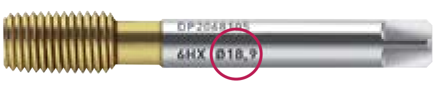
Rule of thumb: **Hole diameter = nominal diameter – f* × pitch**

* 6H tolerance: f = 0.45
6G tolerance: f = 0.42

Example: M10 dimension
Hole diameter → 10,0 mm – 0,45 × 1,5 mm = 9,325 mm = **9,33 mm**

Specific information on the core hole in thread forming

Remark:
The recommended pilot hole diameter is marked on the shank of Walter Prototyp thread formers.



When selecting the drilling and reaming tool, the permissible tolerances for the pilot hole diameter listed in the adjacent table must be taken into account in order to ensure a reliable forming process and adequate tool life.

Due to these tolerances, which are smaller than the tolerances for tapping, thread forming is not always more cost-effective than tapping.

In thread forming, the core diameter of the thread is created during the forming process. It is therefore dependent on the flow characteristics of the material.
In contrast to this, the core diameter for tapping and thread milling is already determined by the core hole. It is therefore essential to test the thread core diameter after the forming process to ensure that it is true to gauge.

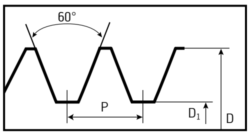
Tolerances of the pilot hole diameter

Pitch	Pilot hole diameter tolerance
≤ 0,3 mm	± 0,01 mm
> 0.3 mm to < 0.5 mm	± 0,02 mm
≥ 0.5 mm to < 1 mm	± 0,03 mm
≥ 1 mm	± 0,05 mm

Remark:
The Walter Titex product range is designed to match the pilot hole diameters for tapping and thread forming.

Thread pilot hole diameters for tapping/thread milling

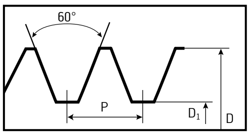
ISO metric thread



M ISO metric coarse-pitch thread
DIN 13 and DIN ISO 965-1

D Ø	P mm	D_1 Min. mm	D_1 Max. mm 5H / 6H	Ø mm
M1*	0,25	0,729	0,785	0,75
M1.1*	0,25	0,829	0,885	0,85
M1.2*	0,25	0,929	0,985	0,95
M1.4*	0,30	1,075	1,142	1,10
M1.6	0,35	1,221	1,321	1,25
M1.7	0,35	1,321	1,421	1,35
M1.8	0,35	1,421	1,521	1,45
M2	0,40	1,567	1,679	1,60
M2.2	0,45	1,713	1,838	1,75
M2.3	0,40	1,813	1,938	1,85
M2.5	0,45	2,013	2,138	2,05
M2.6	0,45	2,113	2,238	2,15
M3	0,50	2,459	2,599	2,50
M3.5	0,60	2,850	3,010	2,90
M4	0,70	3,242	3,422	3,30
M4.5	0,75	3,688	3,878	3,70
M5	0,80	4,134	4,334	4,20
M6	1,00	4,917	5,153	5,00
M7	1,00	5,917	6,153	6,00
M8	1,25	6,647	6,912	6,80
M9	1,25	7,647	7,912	7,80
M10	1,50	8,376	8,676	8,50
M11	1,50	9,376	9,676	9,50
M12	1,75	10,106	10,441	10,20
M14	2,00	11,835	12,210	12,00
M16	2,00	13,835	14,210	14,00
M18	2,50	15,294	15,744	15,50
M20	2,50	17,294	17,744	17,50
M22	2,50	19,294	19,744	19,50
M24	3,00	20,752	21,252	21,00
M27	3,00	23,752	24,252	24,00
M30	3,50	26,211	26,771	26,50
M33	3,50	29,211	29,771	29,50
M36	4,00	31,670	32,270	32,00
M39	4,00	34,670	35,270	35,00
M42	4,50	37,129	37,799	37,50
M45	4,50	40,129	40,799	40,50
M48	5,00	42,587	43,297	43,00
M52	5,00	46,587	47,297	47,00
M56	5,50	50,046	50,796	50,50
M60	5,50	54,046	54,796	54,50
M64	6,00	57,505	58,305	58,00
M68	6,00	62,505	62,305	62,00

*5H max.



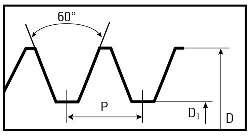
MF ISO metric fine-pitch thread
DIN 13 and DIN ISO 965-1

D Ø × P	D_1 Min. mm	D_1 Max. mm 6H	Ø mm
M2 × 0.25	1,729	1,785	1,75
M2.2 × 0.25	1,929	1,985	1,95
M2.3 × 0.25	2,029	2,085	2,05
M2.5 × 0.35	2,121	2,221	2,15
M3 × 0.25	2,729	2,785	2,75
M3 × 0.35	2,621	2,721	2,65
M3.5 × 0.35	3,121	3,221	3,15
M4 × 0.35	3,621	3,721	3,65
M4 × 0.5	3,459	3,599	3,50
M4.5 × 0.5	3,959	4,099	4,00
M5 × 0.35	4,621	4,721	4,65
M5 × 0.5	4,459	4,599	4,50
M5 × 0.75	4,188	4,378	4,20
M6 × 0.5	5,459	5,599	5,50
M6 × 0.75	5,188	5,378	5,25
M7 × 0.5	6,459	6,599	6,50
M7 × 0.75	6,188	6,378	6,25
M8 × 0.5	7,459	7,599	7,50
M8 × 0.75	7,188	7,378	7,25
M8 × 1	6,917	7,153	7,00
M9 × 0.75	8,188	8,378	8,25
M9 × 1	7,917	8,153	8,00
M10 × 0.5	9,459	9,599	9,50
M10 × 0.75	9,188	9,378	9,25
M10 × 1	8,917	9,153	9,00
M10 × 1.25	8,647	8,912	8,75
M11 × 1	9,917	10,153	10,00
M12 × 0.5	11,459	11,599	11,50
M12 × 1	10,917	11,153	11,00
M12 × 1.25	10,647	10,912	10,75
M12 × 1.5	10,376	10,676	10,50
M13 × 1	11,917	12,153	12,00
M14 × 0.75	13,188	13,378	13,20
M14 × 1	12,917	13,153	13,00
M14 × 1.25	12,647	12,912	12,75
M14 × 1.5	12,376	12,676	12,50
M15 × 1	13,917	14,153	14,00
M15 × 1.5	13,376	13,676	13,50
M16 × 0.75	15,188	15,378	15,20
M16 × 1	14,917	15,153	15,00
M16 × 1.25	14,647	14,912	14,80
M16 × 1.5	14,376	14,676	14,50
M17 × 1	15,917	16,153	16,00
M18 × 1	16,917	17,153	17,00
M18 × 1.5	16,376	16,676	16,50
M18 × 2	15,835	16,210	16,00
M20 × 1	18,917	19,153	19,00
M20 × 1.5	18,376	18,676	18,50
M20 × 2	17,835	18,210	18,00
M22 × 1	20,917	21,153	21,00
M22 × 1.5	20,376	20,676	20,50
M22 × 2	19,835	20,210	20,00

WALTER PROTOTYP

Thread pilot hole diameters for tapping/thread milling (continued)

ISO metric thread

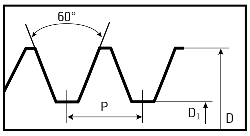


MF ISO metric fine-pitch thread
DIN 13 and DIN ISO 965-1

D Ø × P	D_1 Min. mm	D_1 Max. mm 6H	Ø mm
M24 × 1.5	22,376	22,676	22,50
M24 × 2	21,835	22,210	22,00
M25 × 1	22,917	23,153	23,00
M25 × 1.5	23,376	23,676	23,50
M26 × 1.5	24,376	24,676	24,50
M27 × 1	25,917	26,153	26,00
M27 × 1.5	25,376	25,676	25,50
M27 × 2	24,835	25,210	25,00
M28 × 1.5	26,376	26,676	26,50
M28 × 2	25,835	26,210	26,00
M30 × 1	28,917	29,153	29,00
M30 × 1.5	28,376	28,676	28,50
M30 × 2	27,835	28,210	28,00
M32 × 1.5	30,376	30,676	30,50
M32 × 2	29,835	30,210	30,00
M33 × 1.5	31,376	31,676	31,50
M33 × 2	30,835	31,210	31,00
M34 × 1.5	32,376	32,676	32,50
M35 × 1.5	33,376	33,676	33,50
M36 × 1.5	34,376	34,676	34,50
M36 × 2	33,835	34,210	34,00
M36 × 3	32,752	33,252	33,00
M38 × 1.5	36,376	36,676	36,50
M39 × 1.5	37,376	37,676	37,50
M39 × 2	36,835	37,210	37,00
M39 × 3	35,752	36,252	36,00
M40 × 1.5	38,376	38,676	38,50
M40 × 2	37,835	38,210	38,00
M40 × 3	36,752	37,252	37,00
M42 × 1.5	40,376	40,676	40,50
M42 × 2	39,835	40,210	40,00
M42 × 3	38,752	39,252	39,00
M45 × 1.5	43,376	43,676	43,50
M45 × 2	42,835	43,210	43,00
M45 × 3	41,752	42,252	42,00
M48 × 1.5	46,376	46,676	46,50
M48 × 2	45,835	46,210	46,00
M48 × 3	44,752	45,252	45,00
M50 × 1.5	48,376	48,676	48,50
M50 × 2	47,835	48,210	48,00
M50 × 3	46,752	47,252	47,00
M52 × 1.5	50,376	50,676	50,50
M52 × 2	49,835	50,210	50,00
M52 × 3	46,587	47,087	49,00
M56 × 1.5	54,376	54,676	54,50
M56 × 2	53,835	54,210	54,00
M56 × 3	52,752	53,252	53,00
M58 × 1.5	56,376	56,676	56,50
M60 × 1.5	58,376	58,676	58,50
M60 × 2	57,835	58,210	58,00
M60 × 3	56,752	57,252	57,00

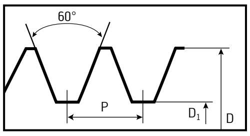
Thread pilot hole diameters for tapping/thread milling (continued)

American threads



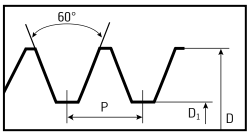
UN Eight-thread series
in accordance with ASME B1.1

D Ø P Gg/1"	D_1 Min. mm 2B/3B	 Max. mm 2B	 Ø mm
1 1/8–8 UN	25,138	25,962	25,40
1 1/4–8 UN	28,313	29,126	28,50
1 3/8–8 UN	31,488	32,123	32,00
1 1/2–8 UN	34,663	35,456	35,00
1 5/8–8 UN	37,838	38,623	38,10
1 3/4–8 UN	41,013	41,790	41,50
1 7/8–8 UN	44,188	44,957	44,45
2–8 UN	47,363	48,125	48,00
2 1/4–8 UN	53,713	54,462	54,00



UNF Fine-pitch thread
in accordance with ASME B1.1

D Ø P Gg/1"	D_1 Min. mm 2B/3B	 Max. mm 2B	 Ø mm
0–80 UNF	1,181	1,306	1,25
1–72 UNF	1,473	1,613	1,55
2–64 UNF	1,755	1,913	1,85
3–56 UNF	2,024	2,197	2,15
4–48 UNF	2,271	2,459	2,40
5–44 UNF	2,550	2,741	2,70
6–40 UNF	2,819	3,023	2,95
8–36 UNF	3,404	3,607	3,50
10–32 UNF	3,962	4,166	4,10
12–28 UNF	4,496	4,724	4,60
1/4–28 UNF	5,367	5,580	5,50
5/16–24 UNF	6,792	7,038	6,90
3/8–24 UNF	8,379	8,626	8,50
7/16–20 UNF	9,738	10,030	9,90
1/2–20 UNF	11,326	11,618	11,50
9/16–18 UNF	12,761	13,084	12,90
5/8–18 UNF	14,348	14,671	14,50
3/4–16 UNF	17,330	17,689	17,50
7/8–14 UNF	20,262	20,663	20,40
1–12 UNF	23,109	23,569	23,25
1 1/8–12 UNF	26,284	26,744	26,50
1 1/4–12 UNF	29,459	29,919	29,50
1 3/8–12 UNF	32,634	33,094	33,00
1 1/2–12 UNF	35,809	36,269	36,10

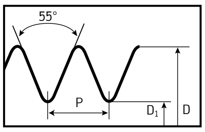


UNC Coarse-pitch thread
in accordance with ASME B1.1

D Ø P Gg/1"	D_1 Min. mm 2B/3B	 Max. mm 2B	 Ø mm
1–64 UNC	1,425	1,582	1,55
2–56 UNC	1,694	1,872	1,85
3–48 UNC	1,941	2,146	2,10
4–40 UNC	2,156	2,385	2,35
5–40 UNC	2,487	2,697	2,65
6–32 UNC	2,642	2,896	2,85
8–32 UNC	3,302	3,531	3,50
10–24 UNC	3,683	3,962	3,90
12–24 UNC	4,343	4,597	4,50
1/4–20 UNC	4,976	5,268	5,10
5/16–18 UNC	6,411	6,734	6,60
3/8–16 UNC	7,805	8,164	8,00
7/16–14 UNC	9,149	9,550	9,40
1/2–13 UNC	10,584	11,013	10,80
9/16–12 UNC	11,996	12,456	12,20
5/8–11 UNC	13,376	13,868	13,50
3/4–10 UNC	16,299	16,833	16,50
7/8–9 UNC	19,169	19,748	19,50
1–8 UNC	21,963	22,598	22,25
1 1/8–7 UNC	24,648	25,348	25,00
1 1/4–7 UNC	27,823	28,524	28,00
1 1/2–6 UNC	33,518	34,295	34,00
1 3/4–5 UNC	38,951	39,814	39,50
2–4,5 UNC	44,689	45,598	45,00

Thread pilot hole diameters for tapping/thread milling (continued)

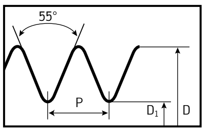
Pipe thread



G **Pipe thread in accordance with DIN EN ISO 228**

D	D_1		
Ø P Gg/1"	Min. mm	Max. mm	Ø mm DIN 336 / ISO 2306
G 1/16–28	6,561	6,843	6,80
G 1/8–28	8,566	8,848	8,80
G 1/4–19	11,445	11,890	11,80
G 3/8–19	14,950	15,395	15,25
G 1/2–14	18,632	19,173	19,00
G 5/8–14	20,588	21,129	21,00
G 3/4–14	24,118	24,659	24,50
G 7/8–14	27,878	28,419	28,25
G 1–11	30,292	30,932	30,75
G 1 1/8–11	34,940	35,580	35,50
G 1 1/4–11	38,953	39,593	39,50
G 1 3/8–11	41,366	42,006	41,90
G 1 1/2–11	44,846	45,486	45,25
G 1 3/4–11	50,789	51,429	51,00
G 2–11	56,657	57,297	57,00
G 2 1/4–11	62,753	63,393	63,00
G 2 1/2–11	72,227	72,867	72,60
G 3–11	84,927	85,567	85,00

Whitworth thread

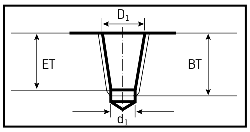


Rp **Whitworth pipe thread in accordance with DIN EN 10226-1**

D	D_1		
Ø P Gg/1"	Min. mm	Max. mm	Ø mm DIN 336 / ISO 2306
Rp 1/16–28	6,490	6,632	6,55
Rp 1/8–28	8,495	8,637	8,60
Rp 1/4–19	11,341	11,549	11,50
Rp 3/8–19	14,846	15,054	15,00
Rp 1/2–14	18,490	18,774	18,50
Rp 5/8–14	20,446	20,730	20,50
Rp 3/4–14	23,976	24,260	24,00
Rp 1–11	30,112	30,472	30,25
Rp 1 1/4–11	38,773	39,133	39,00
Rp 1 1/2–11	44,629	45,063	45,00
Rp 2–11	56,440	56,874	56,50
Rp 2 1/2–11	72,010	72,444	72,20
Rp 3–11	84,710	85,144	85,00

Thread pilot hole diameters for tapping/thread milling (continued)

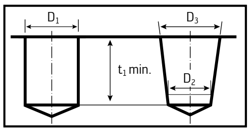
Whitworth thread



Rc Tapered pipe thread, taper 1:16 in accordance with DIN EN 10226-2

Ø P Gg/1"	d_1 mm	D_1 mm	ET mm	Min. BT mm
Rc 1/16–28	6,3	6,49	8,31	10,0
Rc 1/8–28	8,3	8,50	8,31	10,1
Rc 1/4–19	11,0	11,35	12,37	15,0
Rc 3/8–19	14,5	14,85	12,77	15,4
Rc 1/2–14	18,1	18,49	16,83	20,5
Rc 3/4–14	23,5	23,98	18,13	21,8
Rc 1–11	29,6	30,11	21,42	26,0
Rc 1 1/4–11	38,1	38,78	23,72	28,3
Rc 1 1/2–11	44,0	44,67	23,72	28,3
Rc 2–11	55,6	56,48	28,02	32,6
Rc 2 1/2–11	71,1	72,00	31,32	37,1
Rc 3–11	83,6	84,71	34,42	40,2

American pipe thread



NPT American standard pipe thread in accordance with ASME B1.20.1, taper 1:16

Ø P Gg/1"	D_1 mm	D_2 mm	D_3 mm	t_1 mm
1/16–27 NPT	6,15	5,95	6,39	10,7
1/8–27 NPT	8,40	8,31	8,74	10,8
1/4–18 NPT	11,10	10,73	11,36	15,6
3/8–18 NPT	14,30	14,15	14,80	16,0
1/2–14 NPT	17,90	17,47	18,32	20,8
3/4–14 NPT	23,30	22,79	23,67	21,3
1–11,5 NPT	29,00	28,64	29,69	25,6
1 1/4–11,5 NPT	37,70	37,37	38,45	26,1
1 1/2–11,5 NPT	43,70	43,44	44,52	26,1
2–11,5 NPT	55,60	55,45	56,56	26,5
2 1/2–8 NPT	66,30	66,14	67,62	36,3
3–8 NPT	82,30	81,90	83,52	38,5

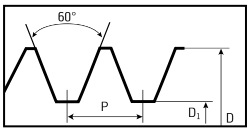
NPTF American standard pipe thread in accordance with ASME B1.20.3, taper 1:16

Ø P Gg/1"	D_1 mm	D_2 mm	D_3 mm	t_1 mm
1/16–27 NPTF	6,1	5,97	6,41	10,3
1/8–27 NPTF	8,4	8,33	8,77	10,3
1/4–18 NPTF	11,0	10,77	11,40	15,0
3/8–18 NPTF	14,5	14,19	14,84	15,3
1/2–14 NPTF	17,5	17,48	18,33	19,9
3/4–14 NPTF	23,0	22,84	23,72	20,4
1–11 1/2 NPTF	29,0	28,62	29,76	24,5
1 1/4–11,5 NPTF	37,5	37,44	38,52	25,0
1 1/2–11,5 NPTF	43,5	43,50	44,59	25,0
2–11,5 NPTF	56,0	55,51	56,62	25,4
2 1/2–8 NPTF	66,0	66,03	67,71	38,0
3–8 NPTF	82,0	81,80	83,62	40,0

WALTER PROTOTYP

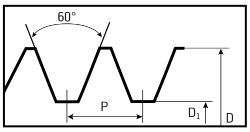
Thread pilot hole diameters for tapping/thread milling (continued)

Thread insert



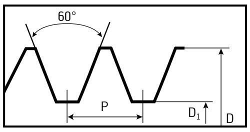
EG M
ISO metric coarse-pitch thread in accordance with DIN 8140

D		D_1		
Ø	P mm	Min. mm	Max. mm	Ø mm
EG M2,5	0,45	2,597	2,697	2,65
EG M3	0,50	3,109	3,221	3,15
EG M3,5	0,60	3,630	3,755	3,70
EG M4	0,70	4,152	4,292	4,20
EG M5	0,80	5,174	5,334	5,25
EG M6	1,00	6,217	6,407	6.30
EG M8	1,25	8,217	8,483	8,40
EG M10	1,50	10,324	10,560	10,50
EG M12	1,75	12,380	12,645	12,50
EG M14	2,00	14,433	14,733	14,50
EG M16	2,00	16,433	16,733	16,50
EG M18	2,50	18,542	18,897	18,80
EG M20	2,50	20,542	20,897	20,80
EG M22	2,50	22,542	22,897	22,80
EG M24	3,00	24,649	25,049	24,75



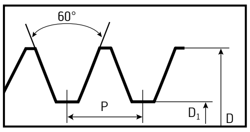
EG MF
ISO metric fine-pitch thread in accordance with DIN 8140

D	D_1		
Ø × P	Min. mm	Max. mm	Ø mm
EG M8 × 1	8,217	8,407	8,3
EG M10 × 1	10,217	10,407	10,3
EG M10 × 1.25	10,217	10,438	10,4
EG M12 × 1.25	12,217	12,438	12,4
EG M12 × 1.5	12,324	12,560	12,5
EG M14 × 1.5	14,324	14,560	14,5
EG M16 × 1.5	16,324	16,560	16,5
EG M18 × 1.5	18,324	18,560	18,5
EG M18 × 2	18,433	18,733	18,5
EG M20 × 1.5	20,324	20,560	20,5



EG UNC
Unified coarse-pitch thread for wire thread inserts

D	D_1		
Ø	Min. mm	Max. mm	Ø mm
EG Nr. 2–56	2,282	2,441	2,35
EG Nr. 3–48	2,630	2,804	2,70
EG Nr. 4–40	2,982	3,180	3,05
EG Nr. 5–40	3,312	3,487	3,40
EG Nr. 6–32	3,677	3,879	3,70
EG Nr. 8–32	4,338	4,524	4,40
EG Nr. 10–24	5,055	5,283	5,10
EG Nr. 12–24	5,715	5,944	5,80
EG 1/4–20	6,625	6,868	6,70
EG 5/16–18	8,244	8,489	8,40
EG 3/8–16	9,869	10,127	10,00
EG 7/16–14	11,505	11,783	11,70
EG 1/2–13	13,123	13,393	13,30
EG 9/16–12	14,747	15,031	15,00
EG 5/8–11	16,376	16,673	16,50
EG 3/4–10	19,598	19,908	19,75



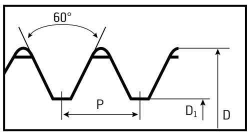
EG UNF
Unified fine-pitch thread for wire thread inserts

	D_1		
Ø	Min. mm	Max. mm	Ø mm
EG Nr. 2–64	2,270	2,405	2,30
EG Nr. 3–56	2,614	2,758	2,65
EG Nr. 4–48	2,962	3,122	3,00
EG Nr. 5–44	3,300	3,467	3,30
EG Nr. 6–40	3,644	3,818	3,70
EG Nr. 8–36	4,321	4,498	4,40
EG Nr. 10–32	4,999	5,184	5,10
EG 1/4–28	6,545	6,721	6,60
EG 5/16–24	8,166	8,351	8,20
EG 3/8–24	9,754	9,931	9,80
EG 7/16–20	11,387	11,585	11,40
EG 1/2–20	12,970	13,172	13,00

WALTER PROTOTYP

Thread pilot hole diameters for tapping/thread milling (continued)

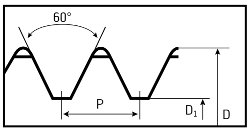
ISO metric thread



MJ Coarse-pitch thread in accordance with DIN ISO 5855

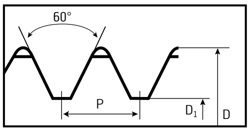
D Ø × P	D_1 Min. mm	 Max. mm	 Ø mm
MJ3 × 0.5	2,513	2,653	2,60
MJ4 × 0.7	3,318	3,498	3,40
MJ5 × 0.8	4,221	4,421	4,30
MJ6 × 1	5,026	5,215	5,10
MJ8 × 1.25	6,782	6,994	6,90
MJ10 × 1.5	8,539	8,779	8,70
MJ12 × 1.75	10,295	10,563	10,50
MJ16 × 2	14,051	14,351	14,30

American threads



UNJC Coarse-pitch thread in accordance with ASME B1.15 and ISO 3161

D Ø P Gg/1"	D_1 Min. mm 3B	 Max. mm 3B	 Ø mm
1–64 UNJC	1,467	1,570	1,50
2–56 UNJC	1,742	1,860	1,80
3–48 UNJC	1,999	2,137	2,05
4–40 UNJC	2,226	2,391	2,30
5–40 UNJC	2,556	2,721	2,65
6–32 UNJC	2,732	2,938	2,80
8–32 UNJC	3,393	3,599	3,50
10–24 UNJC	3,795	4,064	3,90
12–24 UNJC	4,455	4,704	4,60
1/4–20 UNJC	5,113	5,387	5,20
5/16–18 UNJC	6,563	6,833	6,70
3/8–16 UNJC	7,978	8,255	8,10
7/16–14 UNJC	9,344	9,637	9,50
1/2–13 UNJC	10,796	11,093	10,90
9/16–12 UNJC	12,226	12,480	12,30
5/8–11 UNJC	13,625	13,902	13,70
3/4–10 UNJC	16,575	16,880	16,75

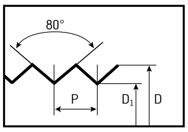


UNJF Fine-pitch thread in accordance with ASME B1.15 and ISO 3161

D Ø P Gg/1"	D_1 Min. mm 3B	 Max. mm 3B	 Ø mm
0–80 UNJF	1,215	1,297	1,25
1–72 UNJF	1,510	1,602	1,55
2–64 UNJF	1,797	1,900	1,85
3–56 UNJF	2,073	2,191	2,10
4–48 UNJF	2,329	2,467	2,40
5–44 UNJF	2,613	2,763	2,70
6–40 UNJF	2,886	3,051	2,95
8–36 UNJF	3,479	3,662	3,60
10–32 UNJF	4,053	4,253	4,15
12–28 UNJF	4,602	4,815	4,70
1/4–28 UNJF	5,466	5,662	5,60
5/16–24 UNJF	6,907	7,110	7,00
3/8–24 UNJF	8,494	8,680	8,60
7/16–20 UNJF	9,875	10,083	10,00
1/2–20 UNJF	11,463	11,660	11,50
9/16–18 UNJF	12,913	13,123	13,00
5/8–18 UNJF	14,500	14,702	14,50

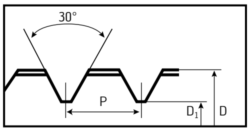
Thread pilot hole diameters for tapping/thread milling (continued)

Miscellaneous



Pg Steel pipe thread in accordance with DIN 40430

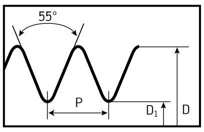
D Ø P Gg/1"	D1 Min. mm	 Max. mm	 Ø mm
Pg 7 × 20	11,29	11,43	11,40
Pg 9 × 18	13,85	14,01	14,00
Pg 11 × 18	17,25	17,41	17,25
Pg 13,5 × 18	19,05	19,21	19,00
Pg 16 × 18	21,15	21,31	21,25
Pg 21 × 16	26,79	27,03	27,00
Pg 29 × 16	35,49	35,73	35,50
Pg 36 × 16	45,49	45,73	45,50
Pg 42 × 16	52,49	52,73	52,50
Pg 48 × 16	57,79	58,03	58,00



Tr ISO metric trapezoidal thread

D Ø × P	D1 Min. mm	 Max. mm	 Ø mm
8 × 1.5	6,5	6,69	6,60
9 × 2	7,0	7,236	7,20
10 × 2	8,0	8,236	8,20
11 × 3	8,0	8,315	8,25
12 × 3	9,0	9,315	9,25
14 × 3	11,0	11,315	11,25
16 × 4	12,0	12,375	12,25
18 × 4	14,0	14,375	14,25
20 × 4	16,0	16,375	16,25
22 × 5	17,0	17,45	17,25
24 × 5	19,0	19,45	19,25
26 × 5	21,0	21,45	21,25
28 × 5	23,0	23,45	23,25
30 × 6	24,0	24,5	24,25
32 × 6	26,0	26,5	26,25
34 × 6	28,0	28,5	28,25
36 × 6	30,0	30,5	30,25
38 × 7	31,0	31,56	31,50
40 × 7	33,0	33,56	33,50
42 × 7	35,0	35,56	35,50
44 × 7	37,0	37,56	37,50
46 × 8	38,0	38,63	38,50
48 × 8	40,0	40,63	40,50
50 × 8	42,0	42,63	42,50
52 × 8	44,0	44,63	44,50

Whitworth thread



BSW Whitworth thread in accordance with BS 84

D Ø P Gg/1"	D1 Medium min. mm	 Class max. mm	 Ø mm
1/16–60	1,045	1,231	1,20
3/32–48	1,703	1,911	1,90
1/8–40	2,362	2,590	2,50
5/32–32	2,952	3,213	3,10
3/16–24	3,407	3,745	3,60
7/32–24	4,201	4,539	4,50
1/4–20	4,724	5,155	5,00
5/16–18	6,131	6,591	6,50
3/8–16	7,493	7,988	7,90
7/16–14	8,790	9,330	9,20
1/2–12	9,989	10,590	10,50
9/16–12	11,577	12,178	12,00
5/8–11	12,919	13,558	13,40
3/4–10	15,798	16,484	16,40
7/8–9	18,612	19,354	19,25
1–8	21,335	22,148	22,00
1 1/8–7	23,929	24,833	24,75
1 1/4–7	27,104	28,008	27,50
1 3/8–6	29,505	30,529	30,00
1 1/2–6	32,680	33,704	33,50
1 5/8–5	34,771	35,965	35,50
1 3/4–5	37,946	39,140	39,00
1 7/8–4,5	40,398	41,705	41,50
2–4 1/2	43,573	44,880	44,50
2 1/4–4	49,020	50,468	50,00
2 1/2–4	55,370	56,818	56,00

Thread pilot hole diameters for thread forming

M ISO metric coarse-pitch thread DIN 13 and DIN ISO 965-1

Ø	P mm	Ø mm
M1	0,25	0,88
M1.1	0,25	0,98
M1.2	0,25	1,08
M1.4	0,30	1,26
M1.6	0,35	1,45
M1.7	0,35	1,55
M1.8	0,35	1,65
M2	0,40	1,82
M2.2	0,45	2,00
M2.3	0,40	2,10
M2.5	0,45	2,30
M2.6	0,45	2,40
M3	0,50	2,80
M3.5	0,60	3,25
M4	0,70	3,70
M5	0,80	4,65
M6	1,00	5,55
M8	1,25	7,40
M10	1,50	9,30
M12	1,75	11,20
M14	2,00	13,10
M16	2,00	15,10
M18	2,50	16,90
M20	2,50	18,90
M22	2,50	20,90
M24	3,00	22,70

MF ISO metric fine-pitch thread DIN 13 and DIN ISO 965-1

Ø × P	Ø mm
M4 × 0.5	3,80
M5 × 0.5	4,80
M6 × 0.5	5,80
M6 × 0.75	5,65
M7 × 0.75	6,65
M8 × 0.75	7,65
M8 × 1	7,55
M10 × 0.75	9,65
M10 × 1	9,55
M10 × 1.25	9,40
M12 × 1	11,55
M12 × 1.25	11,40
M12 × 1.5	11,30
M14 × 1	13,55
M14 × 1.5	13,30
M16 × 1	15,55
M16 × 1.5	15,30
M18 × 1	17,55
M18 × 1.5	17,30
M20 × 1.5	19,30
M20 × 2	19,10
M22 × 1.5	21,30

UNC Coarse-pitch thread in accordance with ASME B1.1

Ø P Gg/1"	Ø mm
2–56 UNC	1,97
3–48 UNC	2,26
4–40 UNC	2,55
5–40 UNC	2,87
6–32 UNC	3,15
8–32 UNC	3,80
10–24 UNC	4,30
12–24 UNC	5,00
1/4–20 UNC	5,75
5/16–18 UNC	7,25
3/8–16 UNC	8,75
7/16–14 UNC	10,30
1/2–13 UNC	11,80
9/16–12 UNC	13,30
5/8–11 UNC	14,80
3/4–10 UNC	17,90

UNF Fine-pitch thread in accordance with ASME B1.1

Ø P Gg/1"	Ø mm
2–64 UNF	2,00
3–56 UNF	2,30
4–48 UNF	2,60
5–44 UNF	2,90
6–40 UNF	3,20
8–36 UNF	3,85
10–32 UNF	4,45
12–28 UNF	5,05
1/4–28 UNF	5,90
5/16–24 UNF	7,45
3/8–24 UNF	9,00
7/16–20 UNF	10,50
1/2–20 UNF	12,10
9/16–18 UNF	13,70
5/8–18 UNF	15,25
3/4–16 UNF	18,40
7/8–14 UNF	21,40
1–12 UNF	24,45

Thread pilot hole diameters for thread forming (continued)

UNEF Extra fine-pitch thread in accordance with ASME B1.1

Ø P Gg/1"	Ø mm
1/4–32 UNEF	6,00
5/16–32 UNEF	7,60
3/8–32 UNEF	9,10
7/16–28 UNEF	10,70
1/2–28 UNEF	12,30
9/16–24 UNEF	13,80
5/8–24 UNEF	15,40
3/4–20 UNEF	18,50
7/8–20 UNEF	21,60
1–20 UNEF	24,80

G Pipe thread in accordance with DIN EN ISO 228

Ø P Gg/1"	Ø mm
G 1/16	7,25
G 1/8–28	9,25
G 1/4–19	12,50
G 3/8–19	16,00
G 1/2–14	20,00
G 5/8–14	22,00
G 3/4–14	25,50
G 7/8–14	29,25
G 1–11	32,00

EG M ISO metric coarse-pitch thread in accordance with DIN 8140

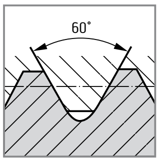
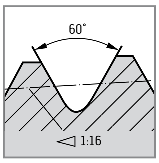
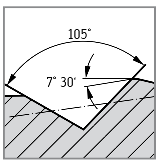
Ø	P mm	Ø mm
EG M3	0,50	3,40
EG M4	0,70	4,60
EG M5	0,80	5,65
EG M6	1,00	6,85
EG M8	1,25	9,05
EG M10	1,50	11,30
EG M12	1,75	13,50

BSW Whitworth thread in accordance with BS 84

Ø P Gg/1"	Ø mm
3/32–48	2,10
1/8–40	2,85
5/32–32	3,55
3/16–24	4,20
1/4–20	5,70
5/16–18	7,20
3/8–16	8,70
7/16–14	10,20
1/2–12	11,60
9/16–12	13,20
5/8–11	14,70
11/16–11	16,25
3/4–10	17,70
7/8–9	20,75
1–8	23,75

Thread types

DIN thread types (excerpt from DIN 202)

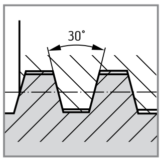
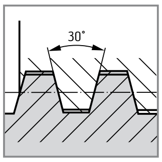
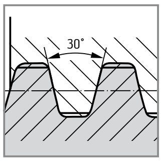
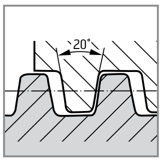
Profile (diagram)	Name	Code letters	Short designation[1] examples	Nominal size	As specified in	Application
	**ISO metric thread (single-start or multi-start)**	**M**	M0,8		DIN 14-1 – DIN 14-4	Watches and precision engineering
			M0,8[2]	1–68 mm	DIN 13-1	General purpose (coarse-pitch threads)
			M24 × 4P2		DIN 13-52	
			M6 × 0,75[2] M8 × 1 – LH[2]	1–1 000 mm	DIN 13-2 – DIN 13-11	General purpose, to be used where the pitch of the coarse-pitch thread is too large (fine-pitch thread)
			M24 × 4P2		DIN 13-52	
			M64 × 4	64 mm and 76 mm	DIN 6630	External thread for barrel joints
			M30 × 2 – 4H5H	1,4–355 mm	LN 9163-1 – LN 9163-7 LN 9163-10 and LN 9163-11	Aerospace
	ISO metric thread with transition tolerance range (formerly thread for interference fits)		M10 Sn 4 M10 Sk 6	3–150 mm	DIN 13-51	Screw-in end on studs: Non-sealing
			M10 Sn 4 sealing			Screw-in end on studs: Sealing
	Metric thread with large clearance		M36	12–180 mm	DIN 2510-2	Bolted connections with reduced shank
	ISO metric screw thread, helical coil thread for thread inserts	**EG M**	EG M20	2–52 mm	DIN 8140-2	Helical coil thread (coarse-pitch and fine-pitch thread) for wire thread inserts
	ISO metric thread for interference fits	**MFS**	MFS 12 × 1,5	5–16 mm	DIN 8141-1	Interference fits in cast aluminium alloys (coarse-pitch and fine-pitch thread)
	**Metric tapered external thread**	**M**	M30 × 2 tprd	6–16 mm	DIN 158-1	Blanking plugs and lubricating nipples
			M30 × 2 tprd short			
	**Self-forming tapered external thread**	**S**	S8 × 1	6–10 mm	DIN 71412	Tapered lubricating nipples; thread similar to DIN 158-1, but with 105° thread profile angle

[1] Full designations are given in the relevant standards.
[2] Designation in accordance with DIN ISO 965-1

Thread types

(continued)

DIN thread types (excerpt from DIN 202)

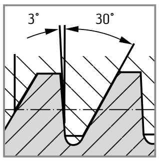
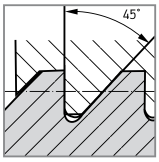
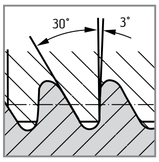
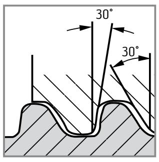
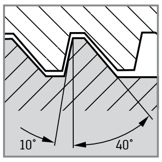
Profile (diagram)	Name	Code letters	Short designation[1] examples	Nominal size	As specified in	Application
	**ISO metric trapezoidal thread (single-start or multi-start)**	**TR**	Tr40 × 7	8–300 mm	DIN 103-1 – DIN 103-8	General
			Tr40 × 14P7			
	ISO metric flat trapezoidal thread (single-start or multi-start)		Tr40 × 7		DIN 380-1 and DIN 380-2	
			Tr40 × 14P7			
	**Trapezoidal thread (single-start or two-start) with clearance**	**TR**	Tr48 × 12	48 mm	DIN 263-1 and DIN 263-2	Rail vehicles
			Tr40 × 16P8	40 mm		
			Tr32 × 1,5	10–56 mm	DIN 6341-2	Draw-in collets
	**Rounded trapezoidal thread**	**TR**	Tr40 × 5	26–80 mm	DIN 30295-1 and DIN 30295-2	Rail vehicles
	**Trapezoidal thread**	**KT**	KT22	10–50 mm	DIN 6063-2	Plastic containers

[1] Full designations are given in the relevant standards.

Thread types

(continued)

DIN thread types (excerpt from DIN 202)

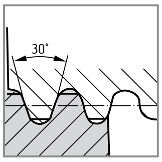
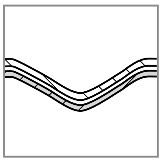
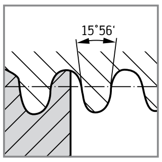
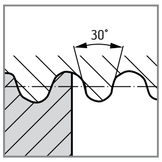
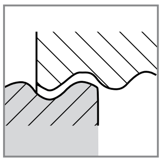
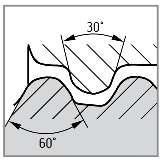
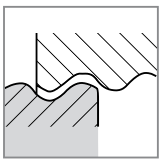
Profile (diagram)	Name	Code letters	Short designation[1] examples	Nominal size	As specified in	Application
	**Metric buttress thread (single-start or multi-start)**	**S**	S 48 × 8	10–640 mm	DIN 513-1 – DIN 513-3	Absorbing forces acting in one direction
			S 40 × 14P7			
	**45° buttress thread**	**S**	S 630 × 20	100–1 250 mm	DIN 2781	Hydraulic presses
	**Buttress thread**	**S**	S 25 × 1,5	6–40 mm	DIN 20401-1 and DIN 20401-2	Mining
			S 22	10–50 mm	DIN 55525	Plastic and glass containers in packaging
		GS	GS 22			
		KS	KS 22			
			KS 22	10–50 mm	DIN 6063-1	Plastic containers in packaging

[1] Full designations are given in the relevant standards.

Thread types

(continued)

DIN thread types (excerpt from DIN 202)

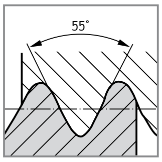
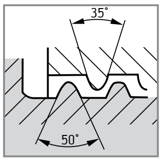
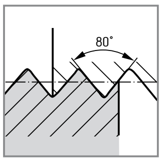
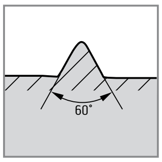
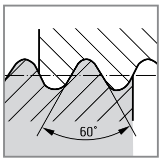
Profile (diagram)	Name	Code letters	Short designation[1] examples	Nominal size	As specified in	Application
	**Parallel knuckle thread (single-start or multi-start)**	**Rd**	Rd 40 × $^1/_6$ Rd 40 × $^1/_3$ P $^1/_6$	8–200 mm	DIN 405-1 and DIN 405-2	General
	Parallel knuckle thread		Rd 40 × 5	10–300 mm	DIN 20400	Mining, with increased load-bearing depth
			Rd 80 × 10	50–320 mm	DIN 15403	Lifting hooks
			Rd 70	20–100 mm	DIN 7273-1	Steel sheet pieces and associated couplings
	**Parallel knuckle thread clearance**	**Rd**	Rd 59 × 7	34–79 mm	DIN 262-1 and DIN 262-2	Rail vehicles
			Rd 59 × 7 left			
			Rd 50 × 7	50 mm	DIN 264-1 and DIN 264-2	Rail vehicles
			Rd 50 × 7 left			
	**Parallel knuckle thread**	**Rd**	Rd 40 × $^1/_7$	40 mm, 80 mm and 110 mm	DIN 3182-1	Respiratory protective equipment
		**GL**	GL 25 × 3	8–40 mm	DIN 168-1	Glass containers
	**Edison thread**	**E**	E27	14 mm 16 mm 18 mm 27 mm 33 mm	DIN 40400	D-type fuses; E14 and E27 also for lamp caps and holders
			E5	5 mm	DIN EN 60061-1	Lamp caps
			E10	10 mm		
			E40	40 mm		
		–	28 × 2	28 mm and 40 mm	DIN EN 60399	External thread for lampholders and internal thread for shade holder rings

[1] Designations are given in the relevant standards.

Thread types

(continued)

DIN thread types (excerpt from DIN 202)

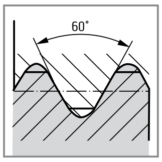
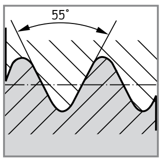
Profile (diagram)	Name	Code letters	Short designation[1] examples	Nominal size	As specified in	Application
	**Parallel Whitworth thread**	**W**	W 3/16	3/16	DIN 49301	D-type screw-in gauge rings; DII and DIII in electrical engineering
	**Glass thread**	**Glasg**	Glasg 74,5	74,5 mm 84,5 mm 99 mm 123,5 mm 158 mm 188 mm	DIN 40450	Electrical engineering for glass guards and caps
	**Steel pipe thread**	**Pg**[2]	Pg 21	7–48 mm	DIN 40430	Electrical engineering
	**Tapping screw thread**	**ST**	ST 3,5	1,5–9,5 mm	DIN EN ISO 1478	Tapping screws
	Wood screw thread	–	4	1,6–20 mm	DIN 7998	Wood screws
	**Bicycle thread**	**FG**	FG 9,5	2–34,8 mm	DIN 79012	Bicycles and mopeds
		–	1,375–24 6H/6g	1,375 mm	DIN EN ISO 6698	Assembly of freewheels on bicycle hubs

[1] Full designations are given in the relevant standards.
[2] With DIN notice 04/99, it was announced that the DIN standards relating to screw connections with steel pipe threads have been withdrawn and are superseded by metric cable glands in accordance with DIN EN 50262.

Thread types

(continued)

Thread types in accordance with standards of other countries

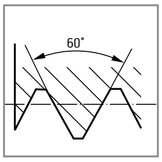
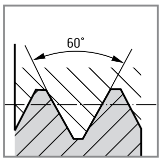
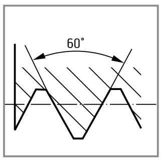
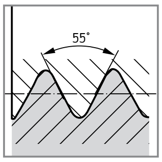
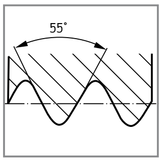
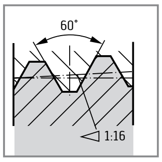
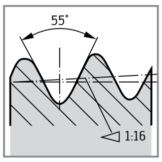
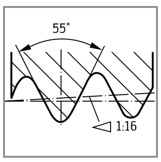
Profile (diagram)	Name	Code letters	Short designation examples	As specified in	Application
	**Unified screw thread**	**UNC** **UNF** **UNEF** [1]	Nr. 6 (0.138)– 32 UNC-2A	ASME B1.1	USA United Kingdom
		UN **UNC** **UNF** **UNEF** **UNS**	$^{1}/_{4}$–20 UNC-2A or 0.250–20 UNC-2A	ASME B1.1 BS 1580	USA United Kingdom
		UNR **UNRC** **UNRF** **UNREF** **UNRS** [2]	$^{7}/_{16}$–20 UNRF-2A or 0.4375–20 UNRF-2A	ASME B1.1	USA
		UNJ **UNJC** **UNJF** **UNJEF**	0.250–28 UNJF-3A	ASME B1.15 BS 4084	USA United Kingdom
	**Whitworth thread**	**BSW** **BSF**	$^{1}/_{4}$ in.–20 BSW	BS 84	United Kingdom
	B.A. thread	**B.A.**	11 B.A.	BS 93	

[1] For thread diameters of less than $^{1}/_{4}$ inch
[2] External thread with rounded thread root

Thread types

(continued)

Thread types in accordance with standards of other countries

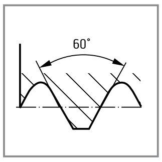
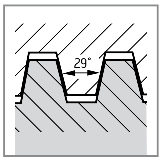
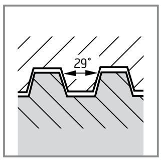
Profile (diagram)	Name	Code letters	Short designation examples	As specified in	Application
	**Parallel pipe thread**	**NPSC**	1/8–27 NPSC	ANSI / ASME B1.20.1	USA
		**NPSM** **NPSL**			
		NPSH **NH**	1/2–14 NPSH 3/4–11.5 NH	ASME B1.20.7	
		**Dryseal** **NPSF** **Dryseal** **NPSI**	1/8–28 NPSF	ASME B1.20.3	
		**G ≙ BSP ≙ PF**	G 1 1/4	DIN EN ISO 228-1 BS 2779	United Kingdom
		**Rp ≙ BSPP ≙ PF**	Rp ¼	DIN EN 10226-1 BS 21 ISO 7/1	
 [2]	**Tapered pipe thread**	**NPT** **NPTR**	3/8–18 NPT	ASME B1.20.1	USA
		Dryseal **NPTF** **Dryseal** **PTF-SAE-** **SHORT**	1/8–27 NPTF-1 [3]	ANSI B1.20.3	
 [2]		**R**[1]	R ½	DIN EN 10226-1 BS 21 ISO 7/1	United Kingdom
 [2]		**Rc ≙ BSPT ≙ PT**	Rc 1/2		

[1] External thread
[2] Profile perpendicular to the axis.
[3] -1 or -2 is the NPTF thread class; -1 is the gauging system without a check of the bottom or point flat.
-2 is the gauging system **with** a check of the bottom or point flat (= new gauging system in accordance with ANSI B1.20.5).

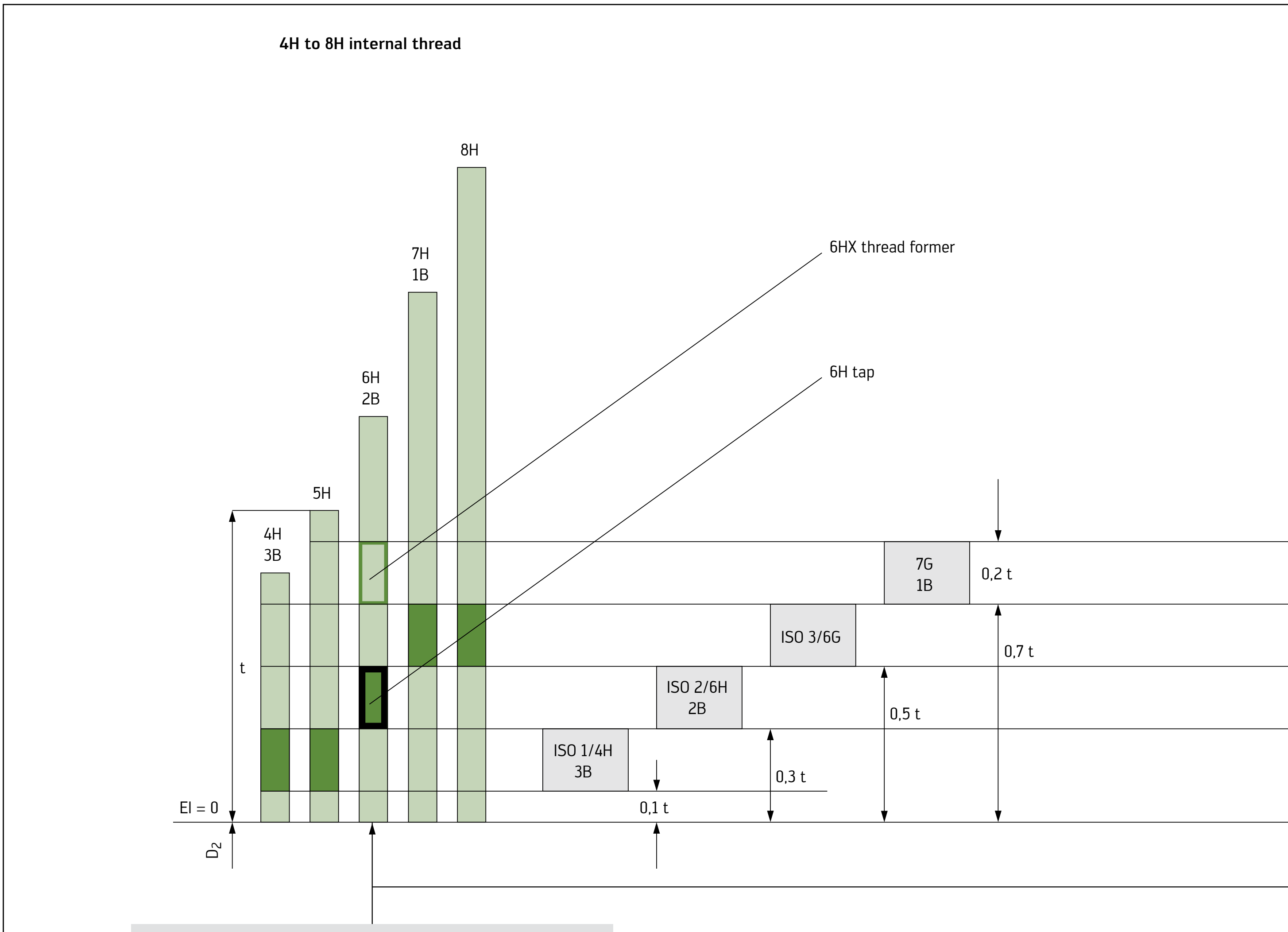
Thread types

(continued)

Thread types in accordance with standards of other countries

Profile (diagram)	Name	Code letters	Short designation examples	As specified in	Application
	**Wire thread insert**	**UNC-STI** **UNF-STI**	$^{1}/_{4}$–20 UNC-2B-STI or 0.125–20 UNC-2B-STI	ASME B18.29.1	USA
	**Trapezoidal thread**	**ACME**	$1^{3}/_{4}$–4 ACME-2G	ASME B1.5	USA
				BS 1104	United Kingdom
		**Stub-ACME**	0.500–20 STUB ACME	ANSI B1.8	USA

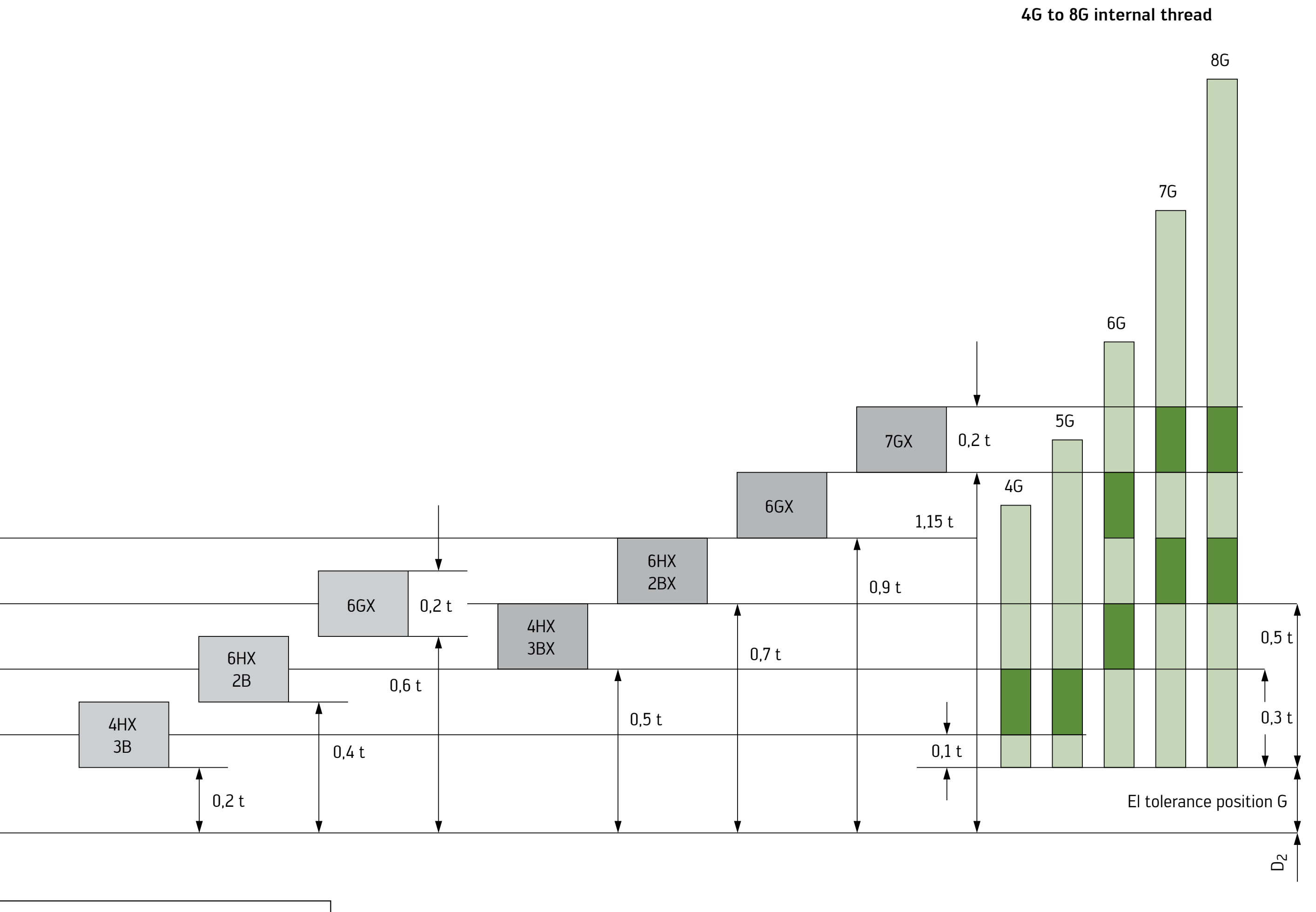
Tolerance units



Example of 6HX thread former:
The thread former has a significantly higher pitch diameter than the tap. It is also in the X-position.

Tolerance classes

Tool tolerance class				Achievable tolerance classes					Technical application
ISO	DIN	ASME	Factory standard						
ISO 1	4H		4BX	ISO 1/4H	5H				Screw connection with little clearance
ISO 2	6H		6HX	4G	5G	ISO 2/6H			H-position: Normal screw connection G-position: For electroplated coatings
ISO 3	6G		6GX			ISO 3/6G	7H	8H	H-position: Screw connection with a lot of clearance G-position: For electroplated coatings
	7G		7GX				7G	8G	To prevent distortion during heat treatment, for electroplated coatings
		3B	3BX	3B			2B		Screw connection with little clearance
		2B	2BX				2B		Normal screw connection



Example of 6H tap:
The average pitch diameter for the tap is approximately in the bottom third of the tolerance range for the female thread.

- Taps
- Taps with specific P.D. (pitch dia.)
- Thread formers

D_2 = Pitch diameter of the basic profile
t = Tolerance unit in accordance with DIN 13 Part 15 ANSI/ASME B1.1

Remark:
All tolerance positions can be created with the same thread milling cutter.
For more information, see the "Thread milling – CNC programming and radius correction values" section.

Calculation formulae for threading

Calculation formulae for tapping and thread forming:

Speed

$$n = \frac{v_c \times 1\,000}{D_N \times \pi} \qquad [\text{min}^{-1}]$$

Cutting speed

$$v_c = \frac{D_N \times \pi \times n}{1\,000} \qquad [\text{m/min}]$$

Specific cutting force

$$k_c = k_{c1.1}{}^{*} \times \left[\frac{p^2}{2 \times Z \times L_f}\right]^{m_c{}^{*}}$$

Tap torque

$$M_d = \frac{k_c \times D_N \times p^2}{8\,000} \times \left[\frac{L_c}{D_N}\right]^{\delta} \times \left[1.12 - \frac{\gamma}{100}\right] \qquad [\text{Nm}]$$

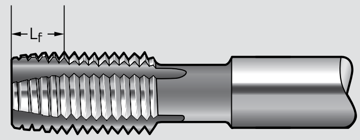
Thread former torque

$$M_d = \frac{k_c \times D_N \times p^2}{4\,000} \times \left[\frac{L_c}{D_N}\right]^{0.15} \qquad [\text{Nm}]$$

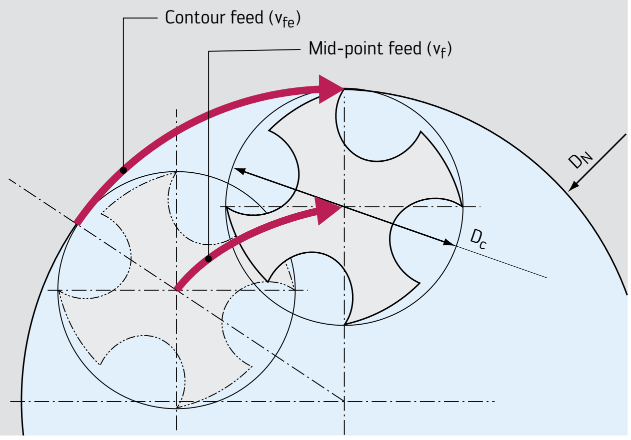
Power at the tap

$$P = \frac{M_D \times n}{9\,500 \times \eta} \qquad [\text{kW}]$$

Taps and thread formers



Thread milling



Thread milling calculation formulae:

Speed

$$n = \frac{v_c \times 1\,000}{D_c \times \pi} \qquad [\text{min}^{-1}]$$

Cutting speed

$$v_c = \frac{D_c \times \pi \times n}{1\,000} \qquad [\text{m/min}]$$

Contour feed

$$v_{fe} = n \times f_z \times z \qquad [\text{mm/min}]$$

Mid-point feed for internal thread milling

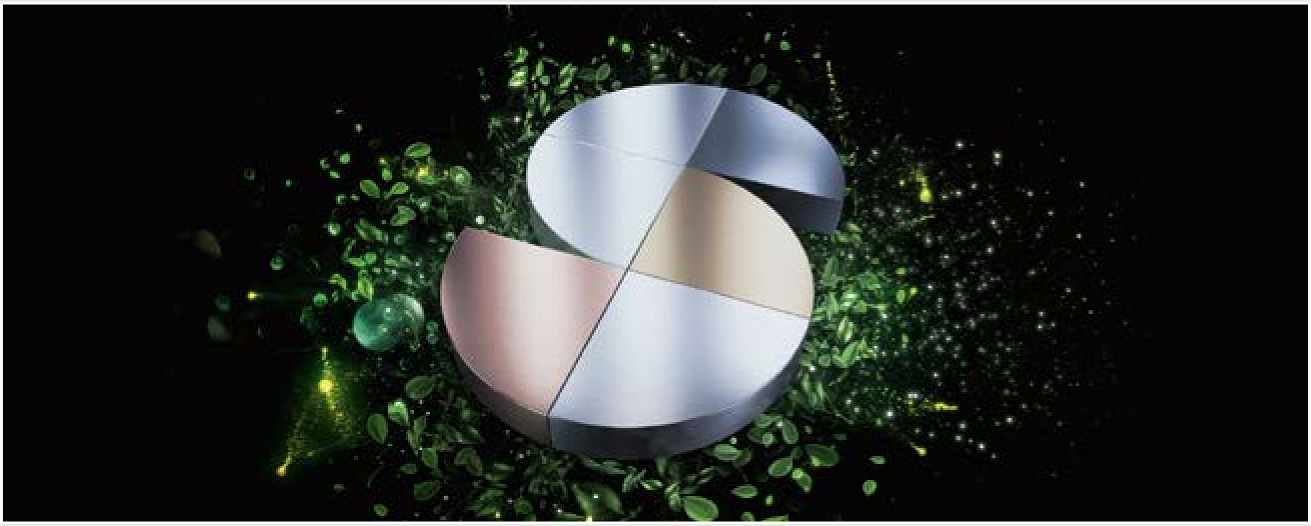
$$v_f = \frac{v_{fe}\,(D_N - D_C)}{D_N} \qquad [\text{mm/min}]$$

Mid-point feed for external thread milling

$$v_f = \frac{v_{fe}\,(D_N + D_C)}{D_N} \qquad [\text{mm/min}]$$

Tool diameter	D_c	[mm]
Thread nominal diameter	D_N	[mm]
Cutting speed	v_c	[m/min]
Mid-point feed	v_f	[mm/min]
Contour feed	v_{fe}	[mm/min]
Speed	n	[rpm]
Thread pitch	P	[mm]
Number of flutes	z	
Thread depth	L_c	[mm]
Chamfer length	L_f	[mm]
Rake angle	γ	
Chip thickness	hm	[mm]
Correction factor	δ (0.55 to 0.25)	
Specific cutting force	k_c	[N/mm²]
Cutting force	F_c	[N]
Torque	M_d	[Nm]
Power at the tap	P	[kW]
Power requirement	P_{mot}	[kW]
Machine efficiency (< 1)	η	

* For m_c and $k_{c1.1}$: see the "General" section of the Technical Compendium, page F 7.
Not applicable to multi-start, trapezoidal and conical taps



Sustainable products and services – certified and transparent

Walter is a company that takes responsibility for people and the environment. Sustainability is a central component of our corporate strategy. It pervades our products and business divisions and is reviewed and certified by independent third parties on a regular basis.

Proven to be produced to high standards

All processes, procedures, methods and instruments that we use are checked and certified by an independent body according to strict criteria. Occupational health and safety, quality assurance and environmentally friendly actions (for example through resource-saving, energy-efficient and CO_2-offset production) are examples of this. Our social commitment shows that Walter has a broader definition of responsibility.

Transparency throughout the entire process chain – for your peace of mind

The integrated management system at Walter includes the sustainable use of resources and production equipment as well as of people – our customers, partners and employees. So that you can count on all of our products meeting these requirements throughout the entire process chain, we apply our own benchmarks to our suppliers too.

Certification

The integrated management system at Walter includes certification in accordance with:

- ISO 9001 (Quality management)
- VDA 6.4 (Production equipment for the automotive industry)
- ISO 14001 (Environmental management)
- ISO 45001 (Occupational health and safety management)
- ISO 50001 (Energy management)

You can find more information on Walter certification here:

Occupational health and safety
Walter protects its employees against health hazards. To prevent accidents, we continuously review our processes and take proactive measures as a precaution.

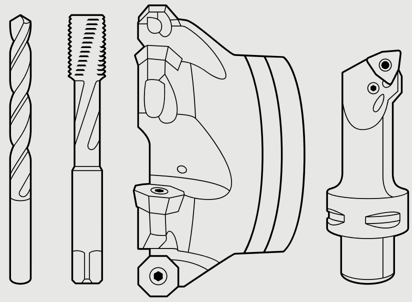
Environmental and energy management
Environmental protection is an important company objective for Walter. We use energy efficiently and deploy practical methods to sustainably reduce the consumption of energy, water and resources.

Quality management
Walter is continuously improving its products and processes. We ensure our product quality using effective measures and procedures – and check it on a regular basis with our comprehensive quality management system.

Walter AG

Derendinger Straße 53, 72072 Tübingen
Postfach 2049, 72010 Tübingen
Germany

walter-tools.com



Europe

Walter Austria GmbH
Wien, Österreich
+43 1 5127300-0, service.at@walter-tools.com

Walter Benelux N.V./S.A.
Zaventem, Belgique
(B) +32 (02) 7258500
(NL) +31 (0) 900 26585-22
service.benelux@walter-tools.com

Walter (Schweiz) AG
Solothurn, Schweiz
+41 (0) 32 617 40 72, service.ch@walter-tools.com

Walter CZ s.r.o
Kurim, Czech Republic
+420 (0) 541 423352, service.cz@walter-tools.com

Walter Deutschland GmbH
Frankfurt, Deutschland
+49 (0) 69 78902-100, service.de@walter-tools.com

Walter France
Soultz-sous-Forêts, France
+33 (0) 3 88 80 20 00, service.fr@walter-tools.com

Walter Hungária Kft.
Budapest, Magyarország
+36 1 464 7160, service.hu@walter-tools.com

Walter Tools Ibérica S.A.U.
El Prat de Llobregat, España
+34 934 796760, service.iberica@walter-tools.com

Walter Italia s.r.l.
Via Volta, s.n.c., 22071 Cadorago - CO, Italia
+39 031 926-111, service.it@walter-tools.com

Walter Norden AB
Halmstad, Sweden
+46 (0) 35 16 53 00, service.norden@walter-tools.com

Walter Polska Sp. z o.o.
Warszawa, Polska
+48 (0) 22 8520495, service.pl@walter-tools.com

Walter Tools SRL
Timisoara, România
+40 (0) 256 406218, service.ro@walter-tools.com

Walter Tools d.o.o.
Maribor, Slovenija
+386 (2) 629 01 30, service.si@walter-tools.com

Walter Slovakia, s.r.o.
Nitra, Slovakia
+421 (0) 37 3260 910, service.sk@walter-tools.com

Walter Kesici Takımlar Sanayi ve Ticaret Ltd. Şti.
Bursa, Türkiye
+90 (0) 224 909 5000 Pbx, service.tr@walter-tools.com

Walter GB Ltd.
Bromsgrove, England
+44 (1527) 839 450, service.uk@walter-tools.com

Asia

Walter Wuxi Co. Ltd.
Wuxi, Jiangsu, P.R. China
+86 (510) 853 72199, service.cn@walter-tools.com

Walter Wuxi Co. Ltd.
中国江苏省无锡市新区新畅南路 3 号
电话：+86-510-8537 2199 邮编：214028
客服热线：400 1510 510
邮箱：service.cn@walter-tools.com

Walter Tools India Pvt. Ltd.
Pune, India
+91 (20) 6773 7300, service.in@walter-tools.com

Walter Japan K.K.
Nagoya, Japan
+81 (52) 533 6135, service.jp@walter-tools.com

ワルタージャパン株式会社
名古屋市中村区名駅二丁目 45 番 7 号
+81 (0) 52 533 6135, service.jp@walter-tools.com

Walter Korea Ltd.
Anyang-si Gyeonggi-do, Korea
+82 (31) 337 6100, service.wkr@walter-tools.com

한국발터(주)
경기도 안양시 동안구 학의로 282
금강펜테리움 106호 14056
+82 (0) 31 337 6100, service.wkr@walter-tools.com

Walter Malaysia Sdn. Bhd.
Selangor D.E., Malaysia
+60(3)-5624 4265, service.my@walter-tools.com

Walter AG Singapore Pte. Ltd.
+65 6773 6180, service.sg@walter-tools.com

Walter (Thailand) Co., Ltd.
Bangkok, 10120, Thailand
+66 2 687 0388, service.th@walter-tools.com

America

Walter do Brasil Ltda.
Sorocaba – SP, Brasil
+55 15 32245700, service.br@walter-tools.com

Walter Canada
Mississauga, Canada
service.ca@walter-tools.com

Walter Tools S.A. de C.V.
El Marqués, Querétaro, México
+52 (442) 478-3500, service.mx@walter-tools.com

Walter USA, LLC
Greer, SC, USA
+1 800-945-5554, service.us@walter-tools.com