VARGUS

Thread Milling Handbook

VARDEX

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Introduction

The most ingenious invention of the last millenium was actually the screw.
The industrial production of the screw only began in the 1850's. It was invented by Vitold Reabchinsky.

In the distant past, the tools were activated by muscle power and were very similar to today's tools. The ancient hammers looked like their modern counterparts and so did the drills, planes, saws and files. The nails already served mankind in ancient times, mainly by joining parts together (mostly from wood). For that reason, man needed the hammer.

The screw, however, is a relatively modern invention. The principle of the screw had already been invented in the third century B.C. by Archimedes and screw-shaped fixtures were used in ancient times for water pumping or compression, for example, for squeezing olives or for torture instruments.

But screws for joining parts appeared only in the 16th century.

The early screws had a screwing head with one slot and the screwdriver only became popular with carpenters after 1800. Back then, screws were regarded as expensive luxury articles. The reason: production took place manually. Industrial production of the screw started only after 1850.

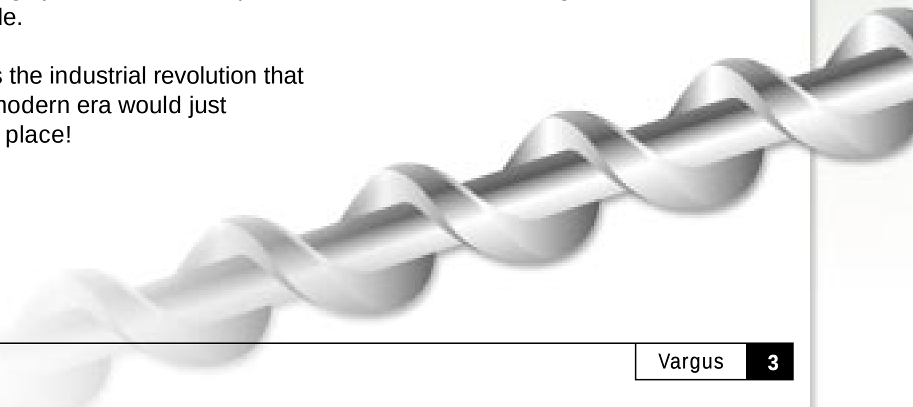
Cheap screws are actually a modern creation. Not only screws for wood serve modern civilization, but also screws designed for other materials, for example, steel that is used in modern building.

Steel screws used in the building industry obtain their strength from the friction between the screw and the nut. The screw presses the two workpieces together, and the more the screw is fastened – the more the pressure is increased.

This invention enabled the building of ships and houses, cupboards and tables, and also various domestic appliances.

The very accurate screw also enabled the building of amazingly accurate measuring instruments such as microscopes with an accuracy of up to a hundredth of a millimeter and transforming systems for telescopes that make accurate tracing of the planets possible.

Without screws the industrial revolution that rushed in the modern era would just not have taken place!

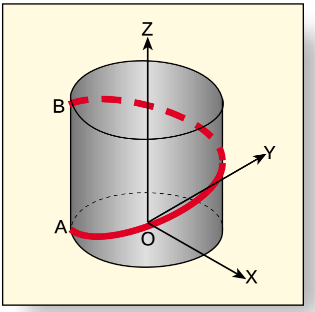


About Thread Milling (general)

Thread Milling is a method for producing a thread by a milling operation.

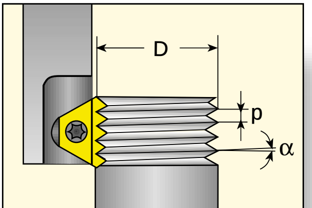
The most common way to produce a thread is still by tapping and turning but today we see more and more milling and this is because CNC milling machines with three simultaneous axes are very popular. These can now be found in every small workshop.

To perform a Thread Milling operation, a helical interpolation movement is required. Helical interpolation is a CNC function producing tool movement along a helical path. This helical motion combines circular movement in one plane (x,y coordinate) with a simultaneous linear motion in a plane perpendicular to the first (z coordinate).



Vargus Thread Milling system

Vargus thread milling tools are based on indexable multitooth inserts. The cutter rotates around itself at high speed and at the same time moves along the helical path. All the teeth are machined simultaneously so every tooth creates one pitch. At the end of the operation all pitches are combined into one complete thread and that by one pass only. This result is achieved with Vardex high accuracy inserts and use of a CNC milling machine.

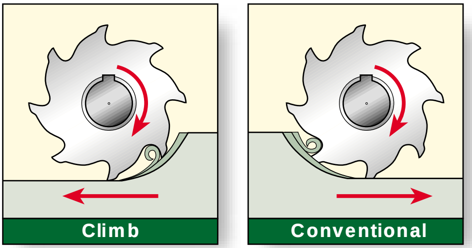


α: helix angle
D: external diameter
p: pitch

Advantages of the system and field of application

- Enables machining of large work pieces which cannot be easily mounted on a lathe
- Non-rotatable and non-symmetrical parts easily machined
- Complete operation in one clamping
- Threading of large diameters requires less power than threading by taps
- No upper limits to bore diameter
- Chips are short
- Blind holes without a thread relief groove can be machined
- Thread relief groove unnecessary
- One holder used for both internal and external threads
- One tool used for both right hand and left hand thread
- Tooling inventory can be reduced to a minimum as small range of tooling covers a wide range of thread profiles
- Interchangeable inserts
- Suitable for machining of hard materials
- Threads have a high surface finish
- Allows for correction of tool diameter and length
- Interrupted cuts easily machined
- One tool for a wide range of materials
- A better thread quality in soft materials where taps normally tear the material
- Short machining time due to high cutting speed and rapid feed rates
- Small cutting forces allow machining of parts with thin walls

Climb and conventional



There are two methods for the milling operation - climb milling and conventional milling.

For many years it was common practice to mill against the direction of the feed due to the absence of backlash eliminating devices and the use of high speed steel cutters. This method is called conventional milling.

In conventional milling, friction and rubbing occur as the insert enters into the cut, resulting in chip welding and heat dissipation into the insert and workpiece.

Climb milling, the second method, is now generally recommended. The insert enters the workpiece material with some chip load and proceeds to produce a chip that thins as it progresses towards the finish. This reduces the heat by dissipating it into the chip.

Based on the above, Vargus recommends using the climb operation which will give you:
- reduced load from the cutting corner
- better tool life
- better surface finish

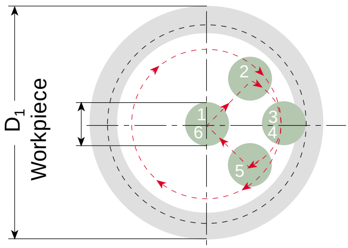
Infeed method

How does the thread milling cutter enter and exit the workpiece?

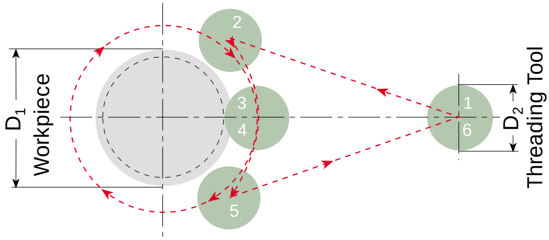
Tangential arc approach - The best method ! ! !

With this method, the tool enters and exits the workpiece smoothly. No marks are left on the workpiece and there is no vibration, even with harder materials.
Although it requires slightly more complex programming than the radial approach (see below), this is the method recommended for machining the highest quality threads.

Internal Thread



External Thread



1-2: rapid approach
2-3: tool entry along tangential arc, with simultaneous feed along z-axis
3-4: helical movement during one full orbit (360⁰)
4-5: tool exit along tangential arc, with continuing feed along z-axis
5-6: rapid return

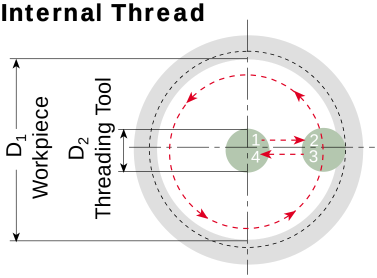
Radial approach

This is the simplest method. There are two characteristics worth noting about the radial approach:

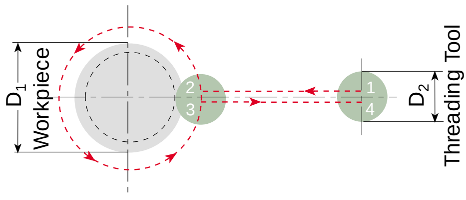
- a small vertical mark may be left at the entry (and exit) point. This is of no significance to the thread itself.
- when using this method with very hard materials, the tool may have a tendency to vibrate as it approaches the full cutting depth.

Note: Radial feed during entry to the full profile depth should only be 1/3 of the subsequent circular feed!...

Internal Thread



External Thread



1-2: radial entry
2-3: helical movement during one full orbit (360⁰)
3-4: radial exit

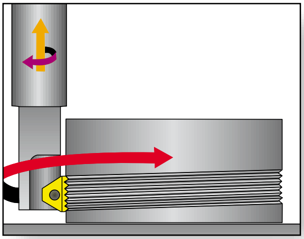
External/Internal RH. LH.

Vardex TM tools can produce external and internal,
RH or LH threads depending only on the tool path which is programmed.
The following drgs. will clarify it very easily.

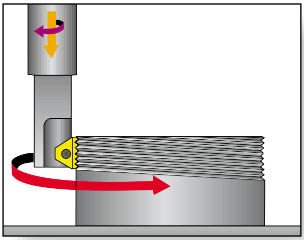
For conical applications such as NPT or BSPT, left hand tools can be used.
In such a case the tool must be moved in the opposite direction.

Thread Milling methods

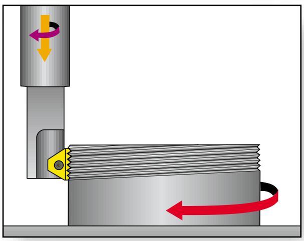
External



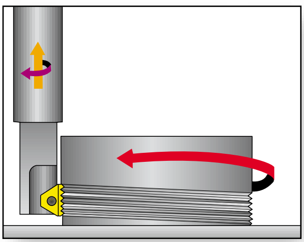
Right Hand Thread - Conventional Milling



Left Hand Thread - Conventional Milling

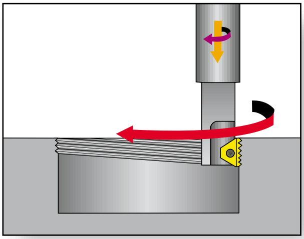


Right Hand Thread - Climb Milling

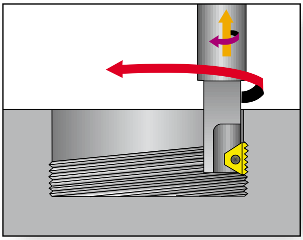


Left Hand Thread - Climb Milling

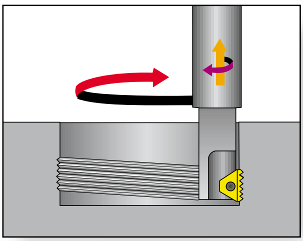
Internal



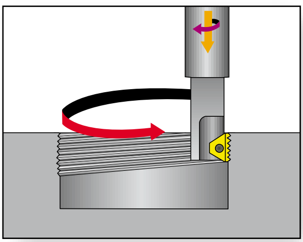
Right Hand Thread - Conventional Milling



Left Hand Thread - Conventional Milling



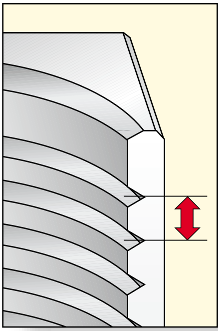
Right Hand Thread - Climb Milling



Left Hand Thread - Climb Milling

Coarse pitch threads

Internal



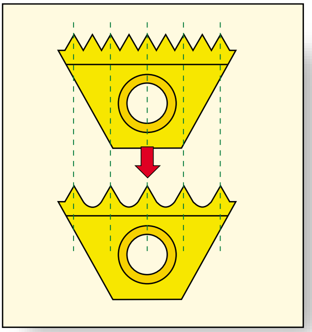
Coarse pitch threads are a combination of small thread dia. and relatively large pitches. The thread milling operation is based on three-axes simultaneous movement so the profile shape on the workpiece is not a copy of the insert profile. In other words the profile is generated and not copied which is contrary to the thread turning operation.
This fact causes a profile distortion, especially when machining coarse pitch internal threads.
The profile distortion depends on four main parameters:
• Thread dia. • Tool cut. dia. • Thread pitch • Profile angle

For internal threads, as a general rule, when the ratio between cutting tool dia. (D_2) and the thread dia. (minor dia.) is below 70% the profile distortion is neglected.
Above this ratio, however, the standard inserts will not give the correct profile.
We in Vargus have developed tools which correct the profile distortion and by that give a solution for the coarse pitch threads.
The inserts are identified in the catalogue by the no. 028/... and the toolholders by the number 124/... In our new catalog, tables can be found which indicate exactly which tools to use for every standard thread.
E.g.: For M24x3.0 (coarse pitch thread) the right toolholder is TMC 25-4 124/002 + insert 4I3.0ISOTM 028/007.
But for M42x3.0 (non-coarse pitch thread) the right tool is TMC 25-5 holder + 5I3.0ISOTM2 insert.

External

In general, for external thread (such as ISO, UN, W) the profile distortion is neglected.
For small profile angle such as ACME (29 deg.) and TRAPEZ (30 deg.) every case should be examined separately.

Fine pitch threads



Fine pitch threads are threads with small pitches.
It is dificult to produce multitooth inserts for small pitches because of the small radius between the teeth.
Vargus developed inserts where every second tooth was dropped to enlarge the radius between the teeth.

Important!

• All the fine pitch inserts are partial profile type (as a result of the enlarged radius).
• Two orbits are required to complete the thread because we dropped every second tooth.

How to find the correct toolholder?

In general, Vargus recommends using the largest possible toolholder with the shortest overhang and with max. possible cutting edges. The inserts selection will be determined according to the toolholder size and the thread type.
For that, and in order to avoid profile distortion, we have three methods:

1 Largest tool table method (p. 10-13)

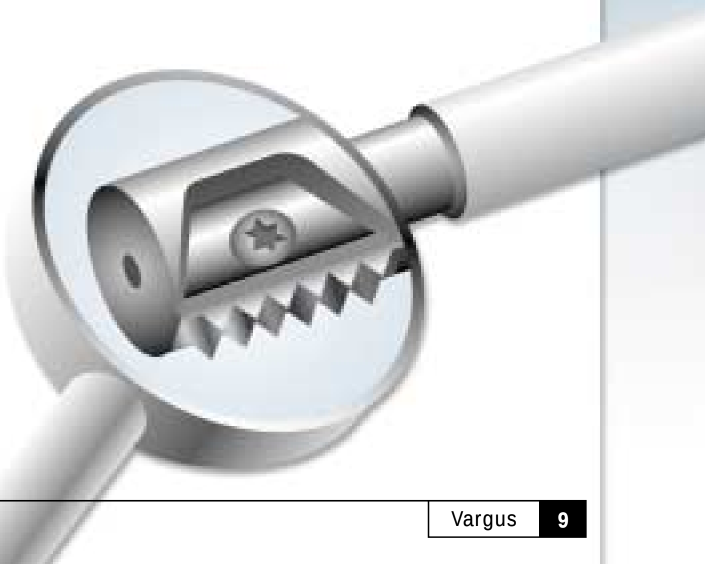
These new and friendly tables located at the begining of our catalogue are your guide and indicate the correct tool to use for every standard thread - coarse pitch and non-coarse pitch threads.
The recommended toolholder is the largest (largest cutting dia.) for a given thread application, smaller or equal dia. can also be used.
E.g.: For M25XI.5 (no need for bore dia. calculation) the largest offered tool is TMC 20-3 which means that every tool that has a smaller cutting dia. e.g. TMC 16-3 can also give a suitable solution.
We recommend using the largest tool tables as they give you a quick answer on the right tool for every std. thread covered by Vardex tools.

2 Minimum bore diameters for thread milling table (p. 14)

On page 14 of this handbook you will find a large table which gives you the minimum bore diameter for any combination of thread pitch and toolholder.
Every dia. below that should be treated as a coarse pitch thread.
For coarse pitch threads, please see the insert section in our catalogue.
E.g.: M25x1.5 (bore diameter 23.37, should be calculated).
When you use TMC 20-3 holder, the table will show a min. bore dia. of 23.0, hence the tool is suitable.
For BTMWC 25-3B holder, however, the min. bore dia. is 25.0 so the tool is not suitable.

3 TM Gen software (p. 15)

This perfect software developed by Vardex engineers gives you the right tools (all suitable tools) for each application and also automatically the CNC program.



VARDEX

Tooling recommendation for given internal thread specification (Largest tool table method)

ISO

Pitch mm	Nominal Dia. mm	Holder	Insert	L_1-Toolholder overhang	D_2-Tool cutting dia.*	$h_{min.}$ - Thread Profile depth
0.75	10	TMMC12-6.0	6.0I0.75ISOTM...028/001	12.0	9.0	0.43
	11	TMMC12-6.0	6.0I0.75ISOTM...	12.0	9.0	
1.0	12-14	TMMC12-6.0	6.0I1.0ISOTM..	12.0	9.0	0.58
	15-18	TMMC12-2	2I1.0ISOTM2...	12.0	11.5	
	20	TMC16-3	3I1.0ISOTM2...	22.0	17.0	
	22	BTMC20-3B	3BI1.0ISOTM2...	29.0	19.0	
	24	TMC20-3	3I1.0ISOTM2...	43.0	20.0	
	25-28	TMLC25-3	3I1.0ISOTM2...	25.0	22.0	
	30	TM2C25-3	3I1.0ISOTM2...	43.0	26.0	
1.25	12	TMMC12-6.0	6.0I1.25ISOTM...028/002	12.0	9.0	0.72
	14	TMMC12-6.0	6.0I1.25ISOTM...	12.0	9.0	
1.5	14-15	TMMC12-6.0	6.0I1.5ISOTM...	12.0	9.0	0.87
	16-20	TMC12-2	2I1.5ISOTM2...	12.0	11.5	
	22	TMC16-3	3I1.5ISOTM2...	22.0	17.0	
	24	BTMC20-3B	3BI1.5ISOTM2...	29.0	19.0	
	25-26	TMC20-3	3I1.5ISOTM2...	43.0	20.0	
	27-30	TMLC25-3	3I1.5ISOTM2...	25.0	22.0	
	32-33	TM2C25-3	3I1.5ISOTM2...	43.0	26.0	
	35-42	TMC25-5	5I1.5ISOTM2...	52.0	30.0	
	45	TMC32-5	5I1.5ISOTM2...	58.0	37.0	
	48-55	TM2C32-5	5I1.5ISOTM2...	45.0	42.0	
	56-68	TMSH-D50-22-3	3I1.5ISOTM2...		50.0	
	70-80	TMSH-D63-22-5	5I1.5ISOTM2...		63.0	
1.75	12	TMMC20-6.0 124/003	6.0I1.75ISOTM...028/003	15.0	9.0	1.01
2.0	14-20	TMC12-2	2I2.0ISOTM...028/004	12.0	11.5	1.15
	22	TMNC16-3	3I2.0ISOTM2...	22.0	15.5	
	24	TMC16-3	3I2.0ISOTM2...	22.0	17.0	
	25	BTMC20-3B	3BI2.0ISOTM2...	29.0	19.0	
	27	TMC20-3	3I2.0ISOTM2...	43.0	20.0	
	28-32	TMLC25-3	3I2.0ISOTM2...	25.0	22.0	
	33-36	TM2C25-3	3I2.0ISOTM2...	43.0	26.0	
	39-42	TMC25-5	5I2.0ISOTM2...	52.0	30.0	
	45-48	TMC32-5	5I2.0ISOTM2...	58.0	37.0	
	50-56	TM2C32-5	5I2.0ISOTM2...	45.0	42.0	
	58-68	TMSH-D50-22-3	3I2.0ISOTM2...		50.0	
	70-85	TMSH-D63-22-5	5I2.0ISOTM2...		63.0	
	90-105	TMSH-D80-27-5	5I2.0ISOTM2...		80.0	
	110-130	TMSH-D100-32-5	5I2.0ISOTM2...		100.0	
	135-150	TMSH-D125-40-5	5I2.0ISOTM2...		125.0	
2.5	20	TMC16-3 124/001	3I2.5ISOTM...028/005	20.5	15.50	1.44
	22	TMC25-4 124/002	4I2.5ISOTM...028/006	30.0	18.0	

Tooling recommendation for given internal thread specification (Largest tool table method)

ISO

Pitch mm	Nominal Dia. mm	Holder	Insert	L_1-Toolholder overhang	D_2-Tool cutting dia.*	$h_{min.}$ - Thread Profile depth
3.0	24-33	TMC25-4 124/002	4I3.0ISOTM...028/007	30.0	18.0	1.73
	36-40	TMC25-5	5I3.0ISOTM...028/009	52.0	30.0	
	42-48	TMC25-5	5I3.0ISOTM2...	52.0	30.0	
	50-52	TMC32-5	5I3.0ISOTM2...	58.0	37.0	
	55-72	TM2C32-5	5I3.0ISOTM2...	45.0	42.0	
	75-90	TMSH-D63-22-5	5I3.0ISOTM2...		63.0	
	95-110	TMSH-D80-27-5	5I3.0ISOTM2...		80.0	
	115-135	TMSH-D100-32-5	5I3.0ISOTM2...		100.0	
	140-250	TMSH-D125-40-5	5I3.0ISOTM2...		125.0	
3.5	30-33	TMC25-5 124/004	5I3.5ISOTM...028/008	40.0	25.0	2.02
4.0	36-42	TMC25-5	5I4.0ISOTM...028/010	52.0	30.0	2.31
	45-52	TMC25-5	5I4.0ISOTM2...	52.0	30.0	
	55	TMC32-6B	6BI4.0ISOTM2...	55.0	35.0	
	56-58	TMC32-5	5I4.0ISOTM2...	58.0	37.0	
	60-65	TMC40-6B	6BI4.0ISOTM2...	65.0	46.0	
	68-76	TM2C40-6B	6BI4.0ISOTM2...	65.0	52.0	
	80-90	TMSH-D63-22-6B	6BI4.0ISOTM2...		63.0	
	95-110	TMSH-D80-27-6B	6BI4.0ISOTM2...		80.0	
	115-135	TMSH-D100-32-6B	6BI4.0ISOTM2...		100.0	
	140-300	TMSH-D125-40-6B	6BI4.0ISOTM2...		125.0	
4.5	42-45	TMC25-5	5I4.5ISOTM...028/011	52.0	30.0	2.60
5.0	48-52	TMC25-5	5I5.0ISOTM...028/075	52.0	30.0	2.89
		TMC32-6B	6BI5.0ISOTM2...	55.0	35.0	
5.5	56	TMC32-6B	6BI5.5ISOTM2...	55.0	35.0	3.17
	60	TMC40-6B	6BI5.5ISOTM2...	65.0	46.0	
6.0	64-68	TMC40-6B	6BI6.0ISOTM2...	65.0	46.0	3.46
	70-80	TM2C40-6B	6BI6.0ISOTM2...	65.0	52.0	
	85-100	TMSH-D63-22-6B	6BI6.0ISOTM2...		63.0	
	105-120	TMSH-D80-27-6B	6BI6.0ISOTM2...		80.0	
	125-145	TMSH-D100-32-6B	6BI6.0ISOTM2...		100.0	
	150-300	TMSH-D125-40-6B	6BI6.0ISOTM2...		125.0	

Please note: those are just a few of the tables. You will find the complete range in our catalogue.

Tooling recommendation for given internal thread specification (Largest tool table method)

UN

Pitch tpi	Nominal Dia. inch	Holder	Insert	L_1-Toolholder overhang	D_2-Tool cutting dia.*	$h_{min.}$ - Thread Profile depth
32	7/16-1/2	TMMC12-6.0	6.0I32UNTM...	12.0	9.0	0.46
	9/16-11/16	TMC12-2	2I32UNTM2...	12.0	11.5	
	3/4-13/16	TMC16-3	3I32UNTM2...	22.0	17.0	
	7/8-15/16	TMC20-3	3I32UNTM2...	43.0	20.0	
	1	TMLC25-3	3I32UNTM2...	25.0	22.0	
28	7/16-1/2	TMMC12-6.0	6.0I28UNTM...	12.0	9.0	0.52
	9/16-3/4	TMC12-2	2I28UNTM2...	12.0	11.5	
	13/16-7/8	TMC16-3	3I28UNTM2...	22.0	17.0	
	15/16	TMC20-3	3I28UNTM2...	43.0	20.0	
	1-1 1/8	TMLC25-3	3I28UNTM2...	25.0	22.0	
	1 3/16-1 1/2	TM2C25-3	3I28UNTM2...	43.0	26.0	
24	9/16-11/16	TMC12-2	2I24UNTM2...	12.0	11.5	0.61
20	7/16	TMMC12-6.0	6.0I20UNTM...028/012	12.0	9.0	0.73
	1/2-9/16	TMMC12-6.0	6.0I20UNTM...	12.0	9.0	
	5/8-13/16	TMC12-2	2I20UNTM2...	12.0	11.5	
	7/8	TMC16-3	3I20UNTM2...	22.0	17.0	
	15/16-1	TMC20-3	3I20UNTM2...	43.0	20.0	
	1 1/16-1 1/8	TMLC25-3	3I20UNTM2...	25.0	22.0	
	1 3/16-1 5/16	TM2C25-3	3I20UNTM2...	43.0	26.0	
	1 3/8-1 5/8	TMC25-5	5I20UNTM2...	52.0	30.0	
	1 11/16-1 13/16	TMC32-5	5I20UNTM2...	58.0	37.0	
	1 7/8-2 1/8	TM2C32-5	5I20UNTM2...	45.0	42.0	
	2 1/4-2 5/8	TMSH-D50-22-3	3I20UNTM2...		50.0	
	2 3/4-3	TMSH-D63-22-5	5I20UNTM2...		63.0	
18	9/16	TMC12-2	2I18UNTM...028/017	12.0	11.5	0.81
	5/8	TMC12-2	2I18UNTM2...	12.0	11.5	
	1 1/16-1 3/16	TMLC25-3	3I18UNTM2...	25.0	22.0	
	1 1/4-1 3/8	TM2C25-3	3I18UNTM2...	43.0	26.0	
	1 7/16-1 5/8	TMC25-5	5I18UNTM2...	52.0	30.0	
	1 11/16	TMC32-5	5I18UNTM2...	58.0	37.0	
16	7/16-5/8	TMMC12-6.0	6.0I16UNTM...028/014	12.0	9.0	0.92
	11/16-13/16	TMC12-2	2I16UNTM2...	12.0	11.5	
	7/8-15/16	TMC16-3	3I16UNTM2...	22.0	17.0	
	1	TMC20-3	3I16UNTM2...	43.0	20.0	
	1 1/16-1 3/16	TMLC25-3	3I16UNTM2...	25.0	22.0	
	1 1/4-1 3/8	TM2C25-3	3I16UNTM2...	43.0	26.0	
	1 7/16-1 5/8	TMC25-5	5I16UNTM2...	52.0	30.0	
	1 11/16-1 7/8	TMC32-5	5I16UNTM2...	58.0	37.0	
	1 15/16-2 3/16	TM2C32-5	5I16UNTM2...	45.0	42.0	
	2 1/4-2 5/8	TMSH-D50-22-3	3I16UNTM2...		50.0	
	2 3/4-3 3/8	TMSH-D63-22-5	5I16UN TM2...		63.0	

Tooling recommendation for given internal thread specification (Largest tool table method)

UN

Pitch tpi	Nominal Dia. inch	Holder	Insert	L_1-Toolholder overhang	D_2-Tool cutting dia.*	$h_{min.}$ - Thread Profile depth
16	3 1/2-4	TMSH-D80-27-5	5I16UNTM2...		80.0	0.92
14	7/16	TMC20-6.0 124/003	6.0I14UNTM...028/013	15.0	9.0	1.05
	7/8	TMC12-2	2I14UNTM2...	12.0	11.5	
13	1/2	TMC20-2 124/005	2I13UNTM...028/015	15.5	10.0	1.13
12	9/16-11/16	TMC20-2 124/005	2I12UNTM...028/016	15.5	10.0	1.22
	3/4	TMNC16-3	3I12UNTM...028/020	22.0	15.5	
	13/16	TMC16-3	3I12UNTM...028/020	22.0	17.0	
	7/8	TMNC16-3	3I12UNTM2...	22.0	15.5	
	15/16	TMC16-3	3I12UNTM2...	22.0	17.0	
	1	BTMC20-3B	3BI12UNTM2...	29.0	19.0	
	1 1/16	TMC20-3	3 I12UNTM2...	43.0	20.0	
	1 1/8-1 1/4	TMLC25-3	3I12UNTM2...	25.0	22.0	
	1 5/16-1 7/16	TM2C25-3	3 I12UNTM2...	43.0	26.0	
	1 1/2-1 11/16	TMC25-5	5I12UNTM2...	52.0	30.0	
	1 3/4-1 15/16	TMC32-5	5I12UNTM2...	58.0	37.0	
	2-2 1/4	TM2C32-5	5I12UNTM2...	45.0	42.0	
	2 3/8-2 3/4	TMSH-D50-22-3	3I12UNTM2...		50.0	
	2 7/8-3 3/8	TMSH-D63-22-5	5I12UNTM2...		63.0	
	3 1/2-4	TMSH-D80-27-5	5I12UNTM2...		80.0	
11	5/8	TMC20-2 124/006	2I11UNTM...028/018	15.5	12.0	1.33
10	3/4	TMC16-3 124/001	3I10UNTM...028/019	20.5	15.5	1.47
9	7/8	TMC25-4 124/002	4I9UNTM...028/021	30.0	18.0	1.63
8	1-1 3/16	TMC25-4 124/007	4I8UNTM...028/022	40.0	20.0	1.83
	1 1/4-1 3/8	TMC25-5 124/004	5I8UNTM...028/024	40.0	25.0	
	1 7/16-1 5/8	TMC25-5	5I8UNTM...028/024	52.0	30.0	
	1 11/16-1 15/16	TMC25-5	5I8UNTM2...	52.0	30.0	
	2-2 1/8	TMC32-5	5I8UNTM2...	58.0	37.0	
	2 1/4-2 7/8	TM2C32-5	5I8UNTM2...	45.0	42.0	
	3-3 5/8	TMSH-D63-22-5	5I8UNTM2...		63.0	
	3 3/4-4	TMSH-D80-27-5	5I8UNTM2...		80.0	
7	1 1/8-1 1/4	TMC25-4 124/002	4I7UNTM...028/023	30.0	18.0	2.09
6	1 3/8-1 9/16	TMC25-5 124/004	5I6UNTM...028/025	40.0	25.0	2.44
	1 5/8-1 15/16	TMC25-5	5I6UNTM...028/025	52.0	30.0	
	2-2 1/8	TMC25-5	5I6UNTM2...	52.0	30.0	
	2 1/4	TMC32-5	5I6UNTM2...	58.0	37.0	
	2 3/8-2 1/2	TMC40-6B	6BI6UNTM2...	65.0	46.0	
	2 5/8-3 1/8	TM2C40-6B	6BI6UNTM2...	65.0	52.0	
	3 1/4-3 3/4	TMSH-D63-22-6B	6BI6UNTM2...		63.0	
	3 7/8-4	TMSH-D80-27-6B	6BI6UNTM2...		80.0	
5	1 3/4	TMC25-5	5I5UNTM...028/077	52.0	30.0	2.93
4.5	2-2 1/4	TMC32-6B	6BI4.5UNTM2...	55.0	35.0	3.26
4	2 1/2	TMC40-6B	6BI4UNTM2...	65.0	46.0	3.67
	2 3/4-3	TM2C40-6B	6BI4UNTM2...	65.0	52.0	
	3 1/4-4	TMSH-D63-22-6B	6BI4UNTM2...		63.0	

Minimum bore diameters for thread milling

Pitch mm		0.5	0.6	0.7	0.75 0.80	0.9	1.0	1.25	1.5	1.75	2.0		2.5	3.0	3.5	4.0	4.5	5.0	5.5		6.0	
Pitch tpi		48	44	36	32	28	26 24	20 19	18 16	14	13 12	11.5 11	10	9 8	7	6		5		4.5		4
Toolholder	D_2	Minimum Bore Diameter Di mm																				
TMMC 12-6.0	9.0	9.5	9.7	9.9	10.0	10.4	10.7	11.4	12.0													
TMMC 20-6.0	9.0	9.5	9.7	9.9	10.0	10.4	10.7	11.4	12.0													
TMMC 20-6.0 124/003	9.0	9.5	9.7	9.9	10.0	10.4	10.7	11.4	12.0													
TMC 12-2	11.5	12.0	12.2	12.4	12.5	12.9	13.2	13.9	14.5	15.1												
TMC 20-2	11.5	12.0	12.2	12.4	12.5	12.9	13.2	13.9	14.5	15.1												
TMLC 25-2	11.5	12.0	12.2	12.4	12.5	12.9	13.2	13.9	14.5	15.1												
TMSC 10-2	12.5	13.0	12.6	13.6	13.5	13.9	14.2	14.9	15.5	16.1												
TMOC 20-2	14.5	15.1	15.2	15.3	15.4	16.0	16.4	17.0	17.8	18.6												
TMNC 16-3	15.5	16.0	16.2	16.4	16.5	16.9	17.2	17.9	18.5	19.0	19.5	20.0										
TMC 16-3 124/001	15.5	16.0	16.2	16.4	16.5	16.9	17.2	17.9	18.5	19.0	19.5	20.0										
TMC 16-3	17.0	17.6	17.8	18.0	18.2	18.70	19.0	19.6	20.0	20.5	21.0	21.5										
BTMC 16-3B	17.0	17.6	17.8	18.0	18.2	18.7	19.0	19.6	20.0	20.5	21.0	21.5										
TM2C 20-2	17.0	17.6	17.8	18.0	18.2	18.7	19.0	19.6	20.0	20.5												
BTMC 20-3B	19.0	19.7	20.0	20.2	20.4	20.8	21.0	21.6	22.0	22.5	23.0	23.5										
TMNC 20-3	19.0	19.7	20.0	20.2	20.4	20.8	21.0	21.6	22.0	22.5	23.0	23.5										
TMC 20-3	20.0	20.7	21.0	21.2	21.4	21.8	22.0	22.6	23.0	23.5	24.0	24.5										
TMOC 20-3	20.0	20.7	21.0	21.2	21.4	21.8	22.0	22.6	23.0	23.5	24.0	24.5										
BTMWC 25-3B	22.0	22.7	23.0	23.2	23.4	23.8	24.0	24.6	25.0	25.5	26.0	26.5										
BTMLC 25-3B	22.0	22.7	23.0	23.2	23.4	23.8	24.0	24.6	25.0	25.5	26.0	26.5										
TMLC 25-3	22.0	22.7	23.0	23.2	23.4	23.8	24.0	24.6	25.0	25.5	26.0	26.5										
TMC 25-5 124/004	25.0	25.7	26.0	26.2	26.4	26.8	27.0	27.7	28.2	28.7	29.2	29.7	31.3	33.7	36.7	39.7	42.7					
TM2C 25-3	26.0	26.7	27.0	27.2	27.4	27.8	28.0	28.7	29.3	29.8	30.3	30.8										
BTM2C 25-3B	26.0	26.7	27.0	27.2	27.4	27.8	28.0	28.7	29.3	29.8	30.3	30.8										
TMC 25-5	30.0	30.7	31.0	31.2	31.4	31.8	32.0	32.8	33.5	34.1	34.6	35.6	36.6	39.0	42.0	45.0	48.0					
TMLC 25-5	30.0	30.7	31.0	31.2	31.4	31.8	32.0	32.8	33.5	34.1	34.6	35.6	36.6	39.0	42.0	45.0	48.0					
TMOC 25-5	30.0	30.7	31.0	31.2	31.4	31.8	32.0	32.8	33.5	34.1	34.6	35.6	36.6	39.0	42.0	45.0	48.0					
TMC 32-6B	35.0															50.0	53.4	42.5	50.0	44.6	57.5	56.6
TMC 32-5	37.0	38.0	38.2	38.4	38.6	39.1	39.5	40.4	41.0	41.5	42.0	43.0	44.0	46.5	49.0	52.0	55.5					
TMLC 32-5	37.0	38.0	38.2	38.4	38.6	39.1	39.5	40.4	41.0	41.5	42.0	43.0	44.0	46.5	49.0	52.0	55.5					
TMNC 32-5	37.0	38.0	38.2	38.4	38.6	39.1	39.5	40.0	41.0	41.5	42.0	43.0	44.0	46.5	49.0	52.0	55.5					
TMSH D38-16-2	38.0	38.5	38.7	38.9	39.0	39.6	40.0	41.0	42.0	43.0												
TM2C 32-5	42.0	43.2	43.4	43.6	43.8	44.5	45.0	46.0	46.5	47.0	47.4	48.2	49.0	52.0	54.5	57.5	61.0					
TMVC 32-5	46.0																				62.5	
TMC 40-6B	46.0															55.6	55.0	52.5	54.0	54.5	57.5	56.6
TMLC 40-6B	46.0															55.6	55.0	52.5	54.0	54.5	57.5	56.6
TMSH D50-22-2	50.0	50.5	50.7	50.9	51.0	51.6	52.0	53.0	54.0	54.5												
TMSH D50-22-3	50.0	50.5	50.7	50.9	51.0	51.6	52.0	53.0	54.0	54.5	55.0	55.5										
TM2C 40-6B	52.0															63.0	64.0	66.0	67.0	67.6	69.0	70.0
TMSH D63-22-3B	63.0	63.5	63.7	63.9	64.0	64.6	65.0	66.0	67.0	67.5	68.0	69.0										
TMSH D63-22-5	63.0	63.5	63.7	63.9	64.0	64.6	65.0	66.0	67.0	67.5	68.0	69.0	70.0	72.0	73.0	74.0	75.0					
TMSH D63-22-6B	63.0															74.0	75.0	77.0	78.0	78.6	80.0	81.0
TMSH D80-27-5	80.0	80.5	80.7	80.9	81.0	81.6	82.0	83.0	84.0	84.5	85.0	86.0	87.0	89.0	90.0	91.0	92.0					
TMSH D80-27-6B	80.0															91.0	92.0	94.0	95.0	95.6	97.0	98.0
TMSH D100-32-5	100.0	100.5	100.7	100.9	101.0	101.6	102.0	103.0	104.0	104.5	105.0	106.0	107.0	109.0	110.0	111.0	112.0					
TMSH D100-32-6B	100.0															111.0	112.0	114.0	115.0	115.6	117.0	118.0
TMSH D125-40-5	125.0	125.5	125.7	125.9	126.0	126.6	127.0	128.0	129.0	129.5	130.0	131.0	132.0	134.0	135.0	136.0	137.0					
TMSH D125-40-6B	125.0															136.0	137.0	139.0	140.0	140.6	142.0	143.0

TM Gen software

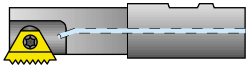
To use the Thread Milling tools a CNC program is required.
Unfortunately most CNC milling machines today do not provide this option as a standard in their controllers.
Vargus has developed new software (suitable for win95/98/nt) for CNC programming.
All the operator has to do is enter the basic thread parameters:
Thread type, thread standard, pitch, dia., thread length and workpiece material then follow the computer instructions which will lead you to the correct choice of tool for the job in hand.
The software then generates the helical interpolation for the CNC program.
Vargus supplies this software at no charge to their end-users through their local agents.

Toolholder styles

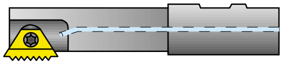
Vargus has a wide range of standard toolholders and every style has been developed for a specific application. All toolholders have a coolant through channel.
The cooling is used for two purposes:

- to reduce the temperature from the cutting edge
- to help the chip flow.

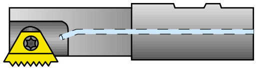
Toolholder: TMC - toolholders for std. thread application - using TM2 inserts



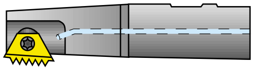
Toolholder: TMLC - long series for long threads - using TM2 inserts



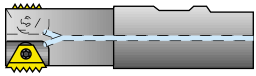
Toolholder: TMC 124/... - toolholders with reduced cut. dia. for coarse pitch applications - using coarse pitch 028/... TM inserts



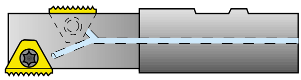
Toolholder: TMNC - toolholders for conical threads - using BSPT, NPT, NPTF inserts
Note: L.H. toolholders are avaiable for the second cutting edge of the insert



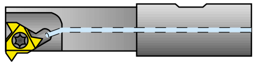
Toolholder: TM2C - twin flute toolholders with two cut. edges for fast operation - using TM2 inserts



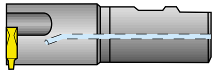
Toolholder: TMOC - twin flute offset toolholders to complete long thread in one cycle - using TM2 inserts



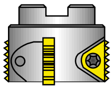
Toolholder: TMSC - single point toolholders - using thread turning IC 1/4” std. inserts



Toolholder: TMVC - single point toolholders for large pitches - using thread turning IC 5/8” vertical std. inserts



Toolholder: TMSH - Shell Mill toolholders with multi cut. edges for fast machining of large threads - using TM2 inserts.



Toolholder: TMS - full Solid Carbide tool for small diameters

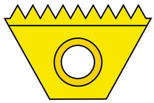
Insert styles

Vargus provides the largest range of thread profiles:
ISO, UN, UNJ, W, BSPT, NPT, NPTF, NPS, PG, TRAPEZ and ACME.

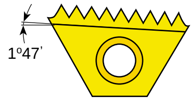
All Vargus inserts are adapted for toolholders with one cut. edge or with multi cutting edges. We have a wide range of insert types.

The right insert for the job

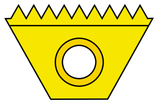
Insert: TM2
For standard threads



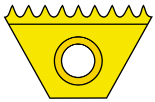
Insert: TM (BSPT, NPT, NPTF)
For tapered threads



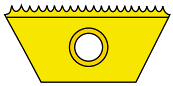
Insert: Coarse Pitch 028/...TM2
For thread milling large pitch to bore diameter ratio



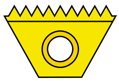
Insert: TM2F
For fine thread pitches



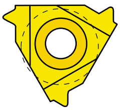
Insert: TM2 IC $^{3}/_{8}$”B, IC $^{3}/_{4}$”B
For long threads extra vibration resistance



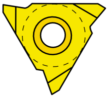
Insert: TM IC 6.0 mm
For small bore diameters min 9.5 mm



Insert: IC 1/4” Laydown Thread Turning
Single point thread milling with laydown thread turning inserts
For very short thread or material with high hardness



Insert: IC 5/8”V (T=6) Vertical Thread Turning
Single point thread milling with vertical thread turning inserts, for large pitches



PROGRAMMING

CNC program sample
(Thread: M60 x 1.5 x 20)

%

O0001 (TMINRH CLIMB CYCLES = 1)
Program no.

(Fanuc 11M Controller.)
Remark

G90 G00 G57 X0 Y0
Home (origin) set

G43 H10 Z0 M3 S946
Tool length compensation-on and RPM set

G91 G00 X0 Y0 Z-20.272
Go down in Z-axis

G41 D60 X9.459 Y-20.595 Z0
Tool diameter compensation-on

G91 G03 X20.595 Y20.595 Z0.272 R20.595 F36
Entrance by tangential arc

G91 G03 X0 Y0 Z1.500 I-30.054 J0
Thread machining-HELICAL interpolation movement

G91 G03 X-20.595 Y20.595 Z0.272 R20.595
Exit by tangential arc

G00 G40 X-9.459 Y-20.595 Z0
Tool diameter compensation-off

G90 G49 G57 G00 Z200.000 M5
Tool length compensation-off and RPM close

M30
End of program

%

List of "G" Codes (ISO)

Code	Description
G00	Fast feed linear positioning
G01	linear interpolation
G02	Circular/Helical interpolation CW
G03	Circular/Helical interpolation CCW
G40	Cutter radius compensation-cancel
G41	Cutter radius compensation-left
G42	Cutter radius compensation-right
G43	Tool length compensation +
G49	Tool length compensation-cancel
G57	Work coordinate system selection
G90	Absolute command relative to work coordinate origin
G91	Incremental command relative to tool position
F	Feed inch/min or mm/min
S	Spindle speed RPM
H	Tool length compensation number
D	Tool radius compensation number
X	X coordinate
Y	Y coordinate
Z	Z coordinate
R	Radius of travel
I	X coordinate to centre of arc travel
J	Y coordinate to centre of arc travel
M3	Spindle forward rotation
M5	Spindle stop
M30	Program end & rewind
O	Program number
N	Block number (can be avoided)
%	Recognition code (ISO or EIA), +End of tape
(	Start of comment
)	End of comment

Program check

After generating the program with the TM Gen software the program can be tested on the machine itself. It is very important that the program is very carefully tested in order to avoid any errors.
Following, our recommendation, step by step :

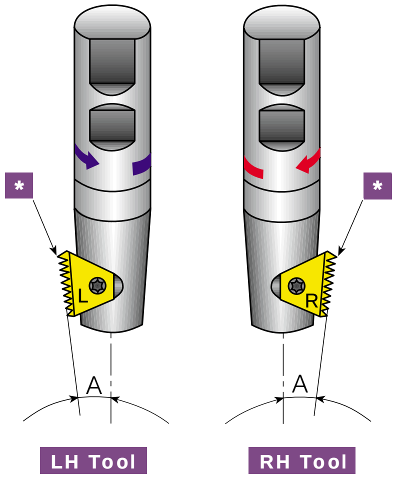
- Run the TM Gen with your thread data. As a general rule please first key in V=100 and f=0.05. This data should be changed after the first thread.
- Check the TM data to be sure that all input data is correct.
- Where possible send the program direct from your PC to the CNC machine controller in order to avoid any copying mistakes.
- Check the program without axis movement (not possible for every machine).
- Check the program above the workpiece in order to identify any tool route failures.
- Check the program inside the material in a single block option and reduce speed by 50%.
- Cancel the single block option and run the program at a normal speed.
- Check the component with a standard gauge and compensate the tool radius if necessary.

Conical threads

Our TM Gen also gives a solution for conical threads.
A parallel thread such as ISO, UN or Whitworth have thread constant radius, while the conical thread has a radius which changes all the time.
Only a few controllers can handle this conical helical interpolation.
In view of this Vargus developed software which gives a solution to this complicated movement. Vargus TM Gen divides the circle into eight sections and changes the radius for every section and with this the conical movement can be described.
It is not necessary to drill the pre-bore drill with the conical shape. It can be drilled parallel as our inserts cut the full profile and machine the minor dia.

Parallel pre hole for NPT

Nominal Size (in)	Pitch (tpi)	Pre hole dia. (mm)
1/16	27	6.2
1/8	27	8.5
1/4	18	11.0
3/8	18	14.5
1/2	14	17.8
3/4	14	23
1	11 1/2	29
1 1/4	11 1/2	37.5
1 1/2	11 1/2	44
2	11 1/2	56
2 1/2	8	66.5
3	8	82.5



* **Important!** Tool offset length and diameter for conical inserts should be measured on the first tooth.

Speed and feed

For initial test we always recommend starting with V=100 m/min and f=0.05 mm.

Vardex Carbide grades and recommended cutting speeds (V)

Recommended Cutting Speed V (m/min)					
Material Workpiece	VSX ISO P10-P30	V30 ISO P20-P30	VKX* ISO K05-K20	VK2 ISO K10-K20	VBX ISO P10-P20
Carbon Steel < 600 N/mm^2	160-240	160-200	150-250	-	160-250
Carbon Steel 600-800 N/mm^2	170-200	150-180	170-200	-	170-220
Alloy Steel 700-850 N/mm^2	120-170	110-150	120-180	-	120-170
Alloy Steel 850-1100 N/mm^2	110-150	100-130	110-150	-	110-190
Stainless Steel (Austenitic < 700 N/mm^2)	160-200	150-180	160-200	-	160-220
Stainless Steel (Martensitic < 1100 N/mm^2)	150-180	140-170	150-200	-	150-220
Stainless Steel (Ferritic < 800 N/mm^2)	150-200	140-170	150-200	-	150-220
Cast Steel < 500 N/mm^2	170-200	150-180	170-200	-	170-220
Cast Steel 700-1000 N/mm^2	120-180	120-150	120-180	-	120-180
Cast or Malleable Iron 150 - 240 HB	-	-	-	100-130	100-150
Cast Iron 100 - 200 HB	-	-	110-150	110-150	110-170
Bronze / Copper	-	-	120-180	120-170	-
Aluminium	-	-	200-400	200-300	-

VSX and VKX are PVD TiN coated, VBX is TiCN coated
The recommended feed per cutting edge per rotation "f" is between 0.05-0.3mm.
* For IC 3/4"B only VKX grade is available

Basic formulas for cutting conditions

Calculation of the rotational velocity

$$N = \frac{1000 \times V}{\pi \times D2} \text{ (R.P.M.)}$$

V= cutting speed (m/min), D2= tool cutting dia. (mm), N= rotation velocity (R.P.M.)

Calculation of the cutting speed

$$V = \frac{N \times \pi \times D2}{1000} \text{ (m/min)}$$

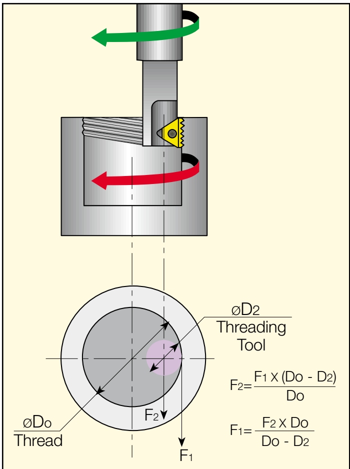
Calculation of the feed rate at the cutting edge

$$F1 = f \times Z \times N \text{ (mm/min)}$$

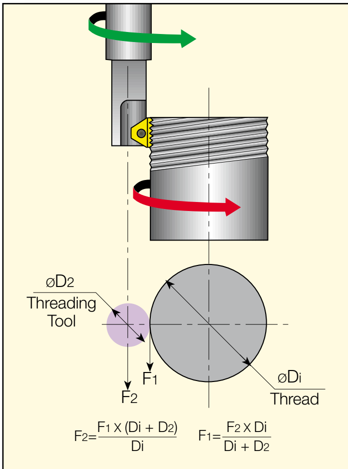
f= feeding per cutting edge per rotation, Z= number of cutting edges, N=rotational velocity (R.P.M.)

Calculation of feed rates at the tool centre line

On most CNC machines, the feed rate required for programming is that of the center-line of the tool. When dealing with linear tool movement, the feed rate at the cutting edge and the center line are identical, but with circular tool movement such is not the case.
The following equations define the relationship between feed rates at the cutting edge and at the tool centre line. (The TM Gen software automatically gives the feed rate at the tool centre).



Internal Thread

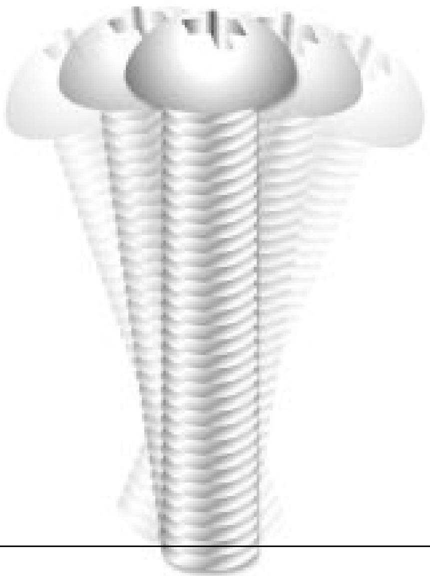


External Thread

Vibration

The cutting action of the TM tools is not continuous. During the milling operation, the cutting edge of the insert enters and exits from the material very quickly. The tool cuts only once per rotation and because of this the tool is sensitive to vibrations. Vibrations can be identified very easily by the noise which, in this case, is extremely loud.

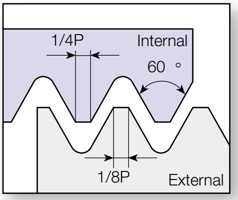
The results of the vibrations are:
- bad thread surface quality
- low tool life
- breakages on the insert teeth



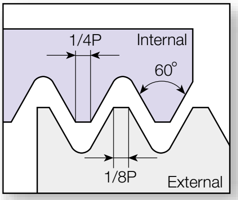
How to avoid vibrations

- Use the toolholder with the max cut. dia. (D_2).
- Use the tool with the smallest overhang (L_1).
- Use the tool with max. cutting edges - TM2 tool or shell mill.
- Don't exceed the recommended cutting speed.
- Always use cooling water during the operation.
- Component must be well fixed to the machine table.
- Divide the thread into several passes - instead of only one, by using only part of the insert length. It is also possible to use part of the profile depth but this is recommended only for large pitches.

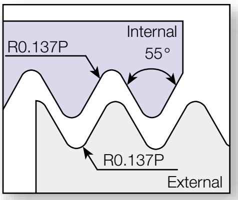
Thread milling insert standards



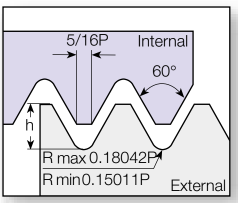
ISO Metric
Defined by:
R262 (DIN 13)
Tolerance class:
6g/6H



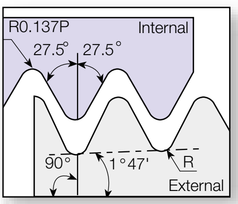
American UN
Defined by:
ANSI B1.1.74
Tolerance class:
Class 2A/2B



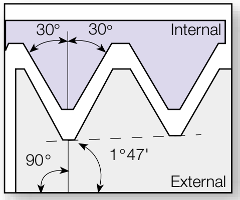
W for BSW, BSP
BSW Defined by:
B.S.84:1956, DIN 259, ISO228/1:1982
BSP Defined by:
B.S.2779:1956
Tolerance class:
BSW-Medium class A, BSP-Medium class



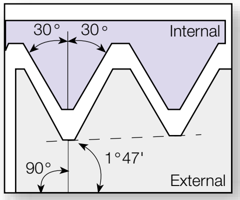
UNJ
Defined by:
MIL-S-8879C
Tolerance class:
3A/3B



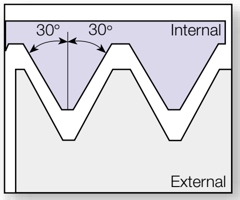
British BSPT
Defined by:
B.S. 21:1985
Tolerance class:
Standard BSPT



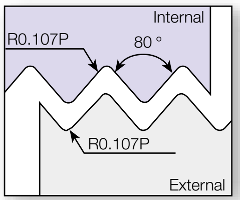
NPT
Defined by:
USAS B2.1:1968
Tolerance class:
Standard NPT



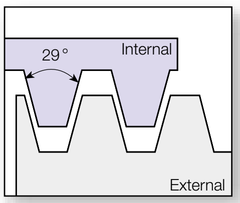
NPTF
Defined by:
ANSI 1.20.3-1976
Tolerance class:
Standard NPTF



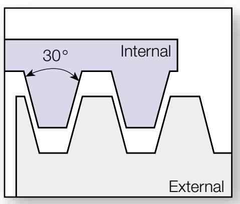
NPS
Defined by:
USA NBS H28 (1957)
Tolerance class:
Standard NPS



Pg
Defined by:
DIN 40430
Tolerance class:
Standard



ACME
Defined by:
ANSI B1/5:1988
Tolerance class:
3G



TR
Defined by:
Trapez DIN 103
Tolerance class:
7e/7H

Thread dimensions of BSP B.S.2779: 1956 medium class

Internal (Dimensions in inch)

BSP. Nominal Size	Threads per Inch	Lenght of Engagement	Major Diametor	Effective Diameter			Minor Diameter		
			Min.	Max.	Tol.	Min.	Max.	Tol.	Min.
1/8	28	3/8	0.3830	0.3643	0.0042	0.3601	0.3483	0.0111	0.3372
1/4	19	1/2	0.5180	0.4892	0.0049	0.4843	0.4681	0.0175	0.4506
3/8	19	1/2	0.6560	0.6273	0.0050	0.6223	0.6051	0.0175	0.5886
1/2	14	5/8	0.8250	0.7849	0.0056	0.7793	0.7549	0.0213	0.7336
5/8	14	5/8	0.9020	0.8619	0.0056	0.8563	0.8319	0.0213	0.8106
3/4	14	3/4	1.0410	1.0013	0.0060	0.9953	0.9709	0.0213	0.9496
7/8	14	3/4	1.1890	1.1494	0.0061	1.1433	1.1189	0.0213	1.0976
1	11	7/8	1.3090	1.2573	0.0065	1.2508	1.2718	0.0252	1.1926
1 1/4	11	1	1.6500	1.5987	0.0069	1.5918	1.5588	0.0252	1.5336
1 1/2	11	1 1/8	1.8820	1.8310	0.0072	1.8238	1.7908	0.0252	1.7656
1 3/4	11	1 1/8	2.1160	2.0651	0.0073	2.0578	2.0248	0.0252	1.9996
2	11	1 1/8	2.3470	2.2961	0.0073	2.2888	2.2558	0.0252	2.2306
2 1/4	11	1 1/8	2.5870	2.5362	0.0074	2.5288	2.4958	0.0252	2.4706
2 1/2	11	1 1/8	2.9600	2.9094	0.0076	2.9018	2.8688	0.0252	2.8436
2 3/4	11	1 1/8	3.2100	3.1594	0.0076	3.1518	3.1188	0.0252	3.0936
3	11	1 1/8	3.4600	3.4095	0.0077	3.4018	3.3688	0.0252	3.3436
3 1/2	11	1 1/8	3.9500	3.8997	0.0079	3.8918	3.8588	0.0252	3.8336
4	11	1 1/8	4.4500	4.3998	0.0080	4.3918	4.3588	0.0252	4.3336
5	11	1 1/8	5.4500	5.4000	0.0082	5.3918	5.3588	0.0252	5.3336
6	11	1 1/8	6.4500	6.4502	0.0084	6.4418	6.3588	0.0252	6.3336

External (Dimensions in inch)

BSP. Nominal Size	Threads per Inch	Lenght of Engagement	Major Diameter			Effective Diameter			Minor Diameter		
			Max.	Tol.	Min.	Max.	Tol.	Min.	Max.	Tol.	Min.
1/8	28	3/8	0.3830	0.0061	0.3769	0.3601	0.0042	0.3559	0.3372	0.0080	0.3292
1/4	19	1/2	0.5180	0.0072	0.5108	0.4843	0.0049	0.4794	0.4506	0.0095	0.4411
3/8	19	1/2	0.6560	0.0073	0.6487	0.6223	0.0050	0.6173	0.5886	0.0096	0.5790
1/2	14	5/8	0.8250	0.0083	0.8167	0.7793	0.0056	0.7737	0.7336	0.0109	0.7227
5/8	14	5/8	0.9020	0.0083	0.8937	0.8563	0.0056	0.8507	0.8106	0.0109	0.7997
3/4	14	3/4	1.0410	0.0087	1.0323	0.9953	0.0060	0.9893	0.9496	0.0113	0.9383
7/8	14	3/4	1.1890	0.0088	1.1802	1.1433	0.0061	1.1372	1.0976	0.0114	1.0862
1	11	7/8	1.3090	0.0095	1.2995	1.2508	0.0065	1.2443	1.1926	0.0125	1.1801
1 1/4	11	1	1.6500	0.0099	1.6401	1.5918	0.0069	1.5849	1.5336	0.0129	1.5207
1 1/2	11	1 1/8	1.8820	0.0102	1.8718	1.8238	0.0072	1.8156	1.7656	0.0132	1.7524
1 3/4	11	1 1/8	2.1160	0.0103	2.1057	2.0578	0.0073	2.0505	1.9996	0.0133	1.9863
2	11	1 1/8	2.3470	0.0104	2.3366	2.2888	0.0073	2.2815	2.2306	0.0134	2.2172
2 1/4	11	1 1/8	2.5870	0.0105	2.5765	2.5288	0.0074	2.5214	2.4706	0.0135	2.4571
2 1/2	11	1 1/8	2.9600	0.0106	2.9494	2.9018	0.0076	2.8942	2.8436	0.0136	2.8300
2 3/4	11	1 1/8	3.2100	0.0107	3.1993	3.1518	0.0076	3.1442	3.0936	0.0137	3.0799
3	11	1 1/8	3.4600	0.0107	3.4493	3.4018	0.0077	3.3941	3.3436	0.0137	3.3299
3 1/2	11	1 1/8	3.9500	0.0109	3.9391	3.8918	0.0079	3.8839	3.8336	0.0139	3.8197
4	11	1 1/8	4.4500	0.0110	4.4390	4.3918	0.0080	4.3838	4.3336	0.0140	4.3196
5	11	1 1/8	5.4500	0.0112	5.4388	5.3918	0.0082	5.3836	5.3336	0.0142	5.3194
6	11	1 1/8	6.4500	0.0114	6.4386	6.3918	0.0084	6.3834	6.3336	0.0144	6.3192

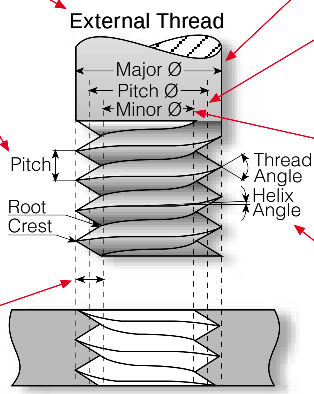
Thread terminology

External thread
A thread on the external surface of a cylinder screw or cone

Pitch
The distance between corresponding points on adjacent thread forms measured parallel to the axis. This distance can be defined in millimeters or by the tpi (threads per inch) which is the reciprocal of the pitch.

Depth of Thread
The distance between crest and root measured normal to the axis.

Nominal diameter
The diameter from which the diameter limits are derived by the application of deviation allowances and tolerances.



Internal Thread
A thread on the internal surface of a cylinder or cone.

Major diameter
The largest diameter of a screw thread.

Pitch diameter
On a straight thread, the diameter of an imaginary cylinder, the surface of which cuts the thread forms where the width of the thread and groove are equal.

Minor diameter
The smallest diameter of a screw thread.

Helix angle
For a straight thread, where the lead of the thread and the pitch diameter circle circumference form a right angled triangle, the helix angle is the angle opposite the lead.

Straight Thread
A thread formed on a cylinder

Taper Thread
A thread formed on a cone

Specials

Vargus offers special toolholders and inserts according to customer design or gives solution for special applications.
In order to send fast and reliable answers Vargus asks for the following details for every inquiry:

- Thread dias.: major, minor and effective
- Thread profile angle
- Radii of the profile (Root and Crest)
- Pitch
- Thread length
- Workpiece material
- Tolerances for all above (where possible)

Vargus is aware of the fact that in many cases the end user does not have all the thread details as listed above but the min. info should include the major and minor dia. profile angle, pitch, thread length - all the missing details - will be completed according to Vargus design standards. Drawing for approval and confirmation will be sent to the customer.

Vargus manufactures a large quantity of special holders every year and most of them with extra overhang (L_1) for long thread machining, or for threads located at the bottom of a deep bore.
In most cases Vargus gives a solution for the extra long toolholders but sometimes it is not possible to offer because of expected vibration problems.

Manual CNC Programming

Thread: M30 X 1.5 X 20 INTERNAL on Alloy Steel
Cutting data: V = 150 m/min, f = 0.1 mm

Insert: 3BI 1.5 ISO TM2
Holder: BTMC 20 - 3B (D_2=19)

Step by step:

- Calculate the feed rates.
  First find the R.P.M.

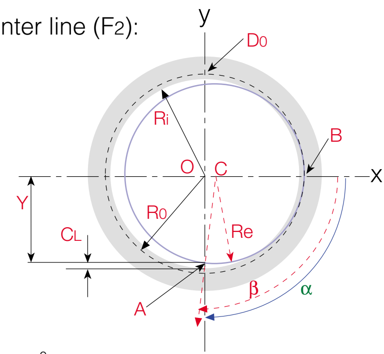
$$N = \frac{1000 \text{ X } V}{\pi \text{ X } D_2} = \frac{1000 \text{ X } 150}{3.14 \text{ X } 19} = 2512 \text{ R.P.M.}$$

- Select the feed per tooth: choose 0.1 mm
- Next, calculate the feed rate at the insert cutting edge (F_1):

$$F_1 = f \text{ X } Z \text{ X } N = 0.1 \text{ X } 1 \text{ X } 2512 = 251.2 \text{ mm/min}$$

- Finally, calculate the feed rate at the toolholder center line (F_2):

$$F_2 = \frac{D_1 \text{ X } (D_0 - D_2)}{D_0} = \frac{251.2 \text{ X } (30 - 19)}{30} = 92.1 \text{ mm/min}$$



- Choose the thread milling method
  Chosen method: Climb milling
- Calculate of the radius of the tangential arc Re
  Assume a clearance C_L = 0.5 mm

$$Re = \frac{(Ri - C_L)^2 + Ro^2}{2Ro} = \frac{(14.19 - 0.5)^2 + 15^2}{2 \text{ X } 15} = 13.747 \text{ mm}$$

- Calculate the angle ß

$$\beta = 180^0 - \arcsin\left(\frac{Ri - C_L}{Re}\right) = 180^0 - \arcsin\left(\frac{14.19 - 0.5}{13.747}\right) = 95.22^0$$

- Calculate the movement along the Z-axis during the entry approach (Za)

$$Z\alpha = P\,[mm] \text{ X } \frac{\alpha^0}{360^0} = 1.5 \text{ X } \frac{90}{360} = 0.375 \text{ mm}$$

- Calculate X and Y values of the start of the entry approach

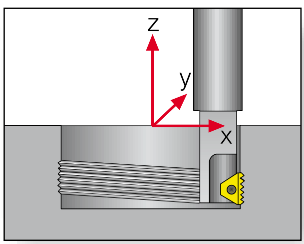
$X = 0$ $\quad$ $Y = Ri + C_L = -14.19 + 0.5 = -13.69$ mm

- Define Z-axis location at the start of the entry approach

$Z = -(L + Z\alpha) = -(20+0.375) = -20.375$ mm

- Define the starting point

$Xa = 0$ $\quad$ $Ya = 0$



The CNC Program (Fanuc 11M)

```
%
N10 G90 G00 G57 X0. Y0.
N20 G43 H10 Z0. M3 S2512
N30 G91 G00 X0. Y0. Z-20.375
N40 G41 D60 X0. Y-13.690 Z0.
N50 G03 X15. Y13.69 Z0.375 R13.747 F92
N60 G03 X0. Y0. Z1.5I-15. J0.
N70 G03 X-15. Y13.69 Z0.375 R13.747
N80 G00 G40 X0. Y-13.690 Z0.
N90 G49 G57 G00 Z200. M5
N100 M30
%
```

Classic Questions

- **Is it possible to produce more than two starts with Vargus thread milling tools?**

Yes it is possible! You just have to insert the pitch in the TM Gen as pitch multiplied by the no. of starts.
E.g.: Pitch 3.0 mm with two starts should be inserted as 6.0 mm pitch.

- **Why does the non-cutting edge of the insert sometimes break?**

This is a result of a vibration problems. Change the cutting conditions.

- **Which tool is recommended for long threads TMO or TM2?**

TM2!
TMO can machine long threads in one cycle but it is still one cut. edge tool.
TM2 can machine shorter thread but as it has two cutting edges you can increase the speed.
We recommend TMO for light jobs like aluminum as the second pocket reduces toolholder stability, and TM2 for heavy duty.

- **What happens if I use larger tool (larger cut. dia.) than recommended by Vargus tables?**

A profile distortion will occur.

- **Why is the CNC program for conical threads so long?**

Vargus TM gen divides the circle into 8 sections in order to describe the conical helical interpolation.

- **What infeed method does Vargus use in the TM Gen?**

We recommend and use the tangential ARC method.

- **Which coordinate system does Vargus use in the TM Gen?**

Incremental for parallel threads and absolute for conical threads.

- **How can you machine several threads in the same component using absolute program?**

You have to move the program origin axis and locate it at the center of the hole for each thread.

- **How can a thread longer than the insert itself be machined?**

You make one cycle then move the tool in a “z” direction and machine a second cycle.

- **What is the purpose of the carbide core in the TM toolholders?**

The carbide core is used as an anti-vibration system.

- **Is it necessary to produce a relief groove when using TM tools?**

Not necessary, the tool can reach the bottom of a blind hole.

- **I used std. inserts for coarse pitch thread and in spite of this I got the correct thread, or I used a larger tool than recommended in your tables and I got the correct thread?**

When you follow Vargus recommendations, we can guarantee the thread form exactly acc. to standard as Vargus take into consideration the std. tolerances with relation to the tool tolerances. In many cases the customer demand is not for high accuracy and that is why he can accept the thread even with profile distortion. Also many customers check the thread with a home-made gauge and hence the thread is not measured correctly.

- **What is the max. length for special tools?**

It is difficult to give a general answer because it depends on workpiece material, machine conditions, pitch and clamping system.

- **I have a three axes machine, why can't I run the TM program?**

Your machine does not have the option to control 3 axes at same time, you have to ask your machine dealer to open this option (normally it exists in the machine software but is protected by a code).

- **How much does the TM Gen cost and how can I get it?**

Free of charge from your local dealer.

- **How much excess do I have to leave on the pre-drilled hole?**

About 0.2 mm on the dia..

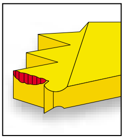
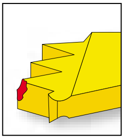
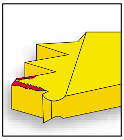
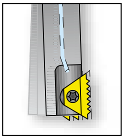
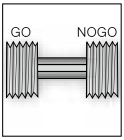
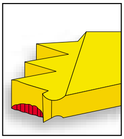
- **Can I use the same insert for TM holder, TM2 holder and Shell Mill?**

Yes!

- **What is thread distortion?**

The difference between the theoretical thread form and the actual thread form on the workpiece.

Trouble Shooting

	Problem	Possible Cause	Solution
	**Increased insert flank wear**	Cutting speed too high	reduce cutting speed/use coated insert
		Chip is too thin	increase feed rate
		Insufficient coolant	increase coolant flow rate
	**Chipping of cutting edge**	Chip is too thick	reduce feed rate/use the tangential arc method/ increase rpm
		Vibration	check stability
	**Material build up on the cutting edge**	Incorrect cutting speed	change cutting speed
		Unsuitable carbide grade	use a coated carbide grade
	**Chatter / Vibration**	Feed rate is too high	reduce the feed
		Profile is too deep	execute two passes, each with increased cutting depth/ execute two passes, each cutting only half the thread length
		Thread length is too long	execute two passes, each cutting only half the thread length
	**Insufficient thread accuracy**	Tool deflection	reduce feed rate/execute a “zero” cut
	**Chipping of the non cutting edge**	Vibration	check stability

VARDEX

Worldwide

Australia
Vargus-Neumo
Australia Pty. Ltd.
Tel: +61 (0) 357 843 690
Fax: +61 (0) 357 843 533

Denmark
Damstahl Tooling a/s
Tel: +45 (0) 86 52 2800
Fax: +45 (0) 86 51 0099

France
Vargus France sarl
Tel: +33 (0) 1 46 60 82 20
Fax: +33 (0) 1 46 60 90 99

Germany
Neumo GmbH
Tel: +49 (0) 7043 36 0
Fax: +49 (0) 7043 36 160

Israel
Neumo-Vargus Ltd.
Tel: +972 (0) 3 537 3275
Fax: +972 (0) 3 537 2190

Poland
Neumo-Vargus Ltd.
Tel: +48 (0) 46 833 4306
Fax: +972 (0) 46 832 5626

Switzerland
Vargus Werkzeug-
Technik SNEL AG
Tel: +41 (0) 41 784 21 21
Fax: +41 (0) 41 784 21 39

United Kingdom
Damstahl Tooling
Tel: +44 (0) 1952 58 32 22
Fax: +44 (0) 1952 58 33 83

United States
V.N.E. Corp. Ltd.
Tel: + 1 800 828 8765
+ 1 608 756 4930
Fax: +1 608 741 7125

Belgium
N.V. van Maele
Tel: +32 (0) 9 386 55 92
Fax: +32 (0) 9 386 09 51

Czechia
ALBA Precision spol. s.r.o.
Tel: +420 (0) 5 4522 6400
Fax: +420 (0) 5 4853 2689

Croatia/Slovenia
Okret d.o.o.
Tel: +385 2122 8449
Fax: +385 2122 8464

Greece
Carbocut Ltd.
Tel: +30 (0) 1 34 75 111
Fax: +30 (0) 1 34 25 621

Holland
Cerametal & Co.
Tel: +31 (0) 165 550 800
Fax: +31 (0) 165 556 176

India
Hemant Tools
Tel: +91 (0) 22 342 1174
Fax: +91 (0) 22 342 8095

Italy
Novatea S.p.A.
Tel: +39 015 582 1893, 5, 6
Fax: +39 015 582 1909

Japan
Fuji Koeki Co. Ltd.
Tel: +81 (0) 6531 5631
Fax: +81 (0) 6531 5606

New Zealand
Alpine Industrial
Tel: +64 (0) 9 262 3545
Fax: +64 (0) 9 262 2798

Singapore
JEP Industrades Pte. Ltd.
Tel: +65 5454 222
Fax: +65 5452 823

South Africa
Pilot Tools (PTY) Ltd.
Tel: +27 (0) 11 616 8130
Fax: +27 (0) 11 616 7758

Spain
Trans Inter S.A.
Tel: +34 (0) 93 261 81 10
Fax: +34 (0) 93 335 81 86

Taiwan
Hung Chih Ltd. Co.
Tel: +886 (0) 6 225 2216
Fax: +886 (0) 6 220 5993

Thailand
P.S.C. Cutting Tools
Tel: +66 (0) 2427 4535
Fax: +66 (0) 2427 4534

Turkey
Teknik Hirdevat Evi
Tel: +90 (0) 212 210 2796
Fax: +90 (0) 212 210 2961

Venezuela
Tuvenca
Tel/Fax: +58 (0) 993 3037

Your VARDEX dealer:

Vargus Ltd.
1 Hayotsrim St.
Nahariya 22311, Israel
Tel. +972 (0)4 985-5111
Fax. +972 (0)4 982-5810
Web. http:\\www.vargus.co.il
E-mail: mrktg@vargus.co.il

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