

TTS: Tormach Tooling System®

Operator's Manual



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I Preface

I.1 Safety

This brief manual reviews the unique properties of the Tormach Tooling System (TTS) and provides some suggestions for operation. It does not cover general machine shop practices. Operators should be versed in safe milling machine operations before attempting to use any milling machine. Tool holders by themselves are not dangerous, but the combination of a sharp cutting tool, a powerful machine, and an untrained or inattentive operator can be extremely dangerous. Users and operators are ultimately responsible for safe setup and operation. Wear safety glasses and observe safe shop practices at all times.

I.2 Principles of Operation

Each TTS holder has a shoulder that is undercut so it contacts the spindle itself, not the end of the collet. As the drawbar is tightened the collet will simultaneously squeeze the shank and be pulled upward into the spindle taper. This simultaneous action, grasping while moving up, pulls the toolholder tightly against the spindle face. The high-pressure contact between the shoulder of the toolholder and the spindle is the equivalent of a zero tolerance fit; the vertical location (Z-height) of the tool is exact. The initial placement, created by simply sliding the toolholder up until it stops, is normally within a few thousandths of an inch. The final location, after tightening the collet, is exact, highly repeatable, and not affected by the variable tension of the drawbar or wear on the collet.

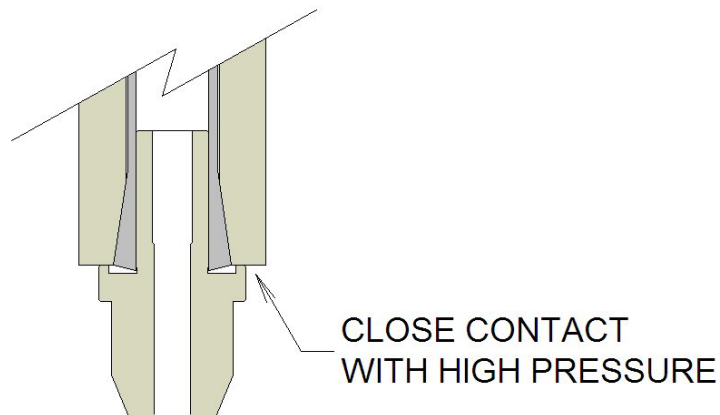


Figure 1. Contact pressure is created between the spindle face and the TTS shoulder

I.3 Performance Expectations

Metal cutting operations with tooling of cutting diameters greater than 1/2" should be limited to light finish operations only. Plastic and wood cutting operations should be limited to cutters no greater than 1.5" in diameter. Never use unbalanced cutters. Tool holders and collets should be dry when mounted. Remove any oil with alcohol and a clean cloth.

Check drawbar tension frequently. Collet tension is created by a slight stretch of the drawbar. Only a few thousandths of an inch of stretch is needed to generate hundreds of pounds of force by a steel drawbar. As the machine is operated, the spindle bearings will generate heat, resulting in an increasing temperature of the spindle and drawbar. This increases the natural length of the drawbar and reduces the force that the drawbar exerts on the collet. Checking tension is particularly important when

beginning a long cutting process with a cold machine. Pause the process as the machine begins to come up to temperature and re-tension the drawbar.

2 Preparing the Machine for TTS

2.1 Truing the Spindle Nose

It is important to check the spindle face before beginning to use TTS holders. Any collision with a vise or spindle crash with a workpiece in the prior history of the machine may have left marks on the surface of the spindle face which will affect the accuracy of TTS. Because most tooling references the spindle taper only, and not the face of the machine spindle, it is unlikely that any such damage will have been noticed prior to first use of TTS.

If a TTS holder is mounted in a spindle with a face that is not flat and perpendicular to the axis of rotation, the TTS holder will cock slightly as it is drawn tightly against the spindle face. This will cause significant eccentricity in the motion of the cutting tool.

Checking the face is a simple matter of running a 0.0005" or 0.0001" indicator across the face, near the spindle taper, while the machine spindle is turned slowly. The spindle face should show less than 0.001" (0.025 mm) deviation.

Correcting the face is just as easy. Clamp a lathe tool in the milling machine vise. A new carbide tool is recommended. With the spindle turning at a few hundred RPM, take a very light surface cut. There is no need to remove much more than a few thousandths of an inch.

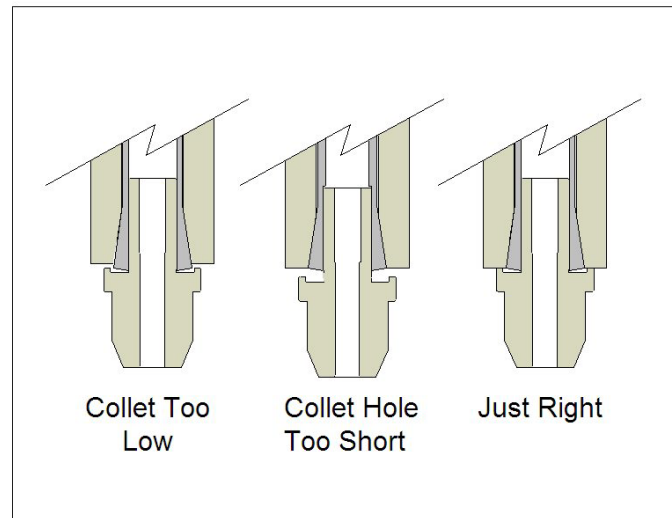
If there is a large ding in the spindle face, there will be a recessed area where it was hit, and a raised area to one side where the displaced material is proud of the surface. It is not necessary to cut away the recessed area, only to remove the raised area.

2.2 Checking the Spindle Collet

The recessed area between the shank of the holder and the shoulder will allow the tool holder to make contact with the spindle face even though the collet extends beyond the face of the spindle.

Most machines can use TTS without modification, but sometimes the geometry of the machine or a collet creates some additional issues.

The diagram shows two possible problems. On the left (collet too low) the taper geometry is not very deep in the spindle. This results in the collet extending too far beyond the spindle. If the collet extends



beyond the spindle farther than the recessed area on the TTS holder can accommodate, then the shoulder of the holder will not contact the face of the spindle. The center diagram shows a collet where the 3/4" section inside the collet is less than the length of the TTS shank. This will also prevent the shoulder from contacting the face of the spindle. If the shoulder cannot make contact with the spindle face, then the unique benefits of TTS (rigidity and exact Z height) will not be seen.

If you find these geometry issues on a machine that has an R8 spindle taper, the best solution is to use the Tormach TTS-R8 collet. This is a special variation of a precision R8 collet with the end of the collet ground flat and the overall length slightly less than the standard length. The TTS-R8 collet is included with each TTS kit, or it can be purchased separately.

If your machine exhibits the geometry problems mentioned above and does not use R8, or if you wish to use your existing R8 collet, the solution is to modify the collet. Using a disk sander or bench grinder, a hardened collet can easily be shortened about 1/8". Be sure to avoid overheating the collet by grinding lightly. Pause the grinding process occasionally and dunk the collet in water to keep the temperature low. Grinding open the internal diameter is more time consuming, but not really more difficult. A small die grinder (Dremel tool or similar) with a long shank grinding wheel can be used, but be careful not to grind the precision section of the collet that will grasp the shank of the TTS holder.

3 General Operating Guidelines

3.1 Clean Tools and Collets before each use

Tool holders and collets should be dry when mounted. Remove any oil with alcohol and a clean cloth.

3.2 Cutters greater than 1/2" diameter

Metal cutting operations with tooling of cutting diameters greater than 1/2" should be limited to light finish operations only. Plastic and wood cutting operations should be limited to cutters no greater than 1.5" in diameter. Never use unbalanced cutters. Tool holders and collets should be dry when mounted. Remove any oil with alcohol and a clean cloth.

3.3 Draw Bar Tension

The drawbar tension necessary to avoid tool pullout varies with the work. Experienced operators quickly gain a feel for the torque needed. The worst case is usually a large spiral fluted high helix end mill, running under heavy load and vibrating while cutting. Without a very tight drawbar tension TTS can pull out under those conditions. In that sort of instance we would recommend as much as 25 to 35 foot lbs of torque on the drawbar. Under standard operating conditions most people will tighten about 12 to 20 foot lbs of torque.

Be aware that both the drawbar and the collet are wear items. Check the internal and external threads occasionally to make sure they are in good condition. A worn thread will provide excessive friction in turning while under load, providing less pulling force on the collet for a given amount of torque on the drawbar. Replace worn items as needed and remember that a little grease on the threads will extend the life of both drawbar and collet.

Unlike other power drawbar systems, the Tormach Power Drawbar system does not rotate the drawbar. The drawbar as used in the Tormach Power Drawbar is not normally a wear item.

4 Offline Measurement

4.1 Basic Technique

Tool measurement is made using a height gauge with the tool supported by the precision ground outer rim. This is best done by placing the shank of the tool into the hole in the surface plate of the TTS granite block. If your granite block does not have a hole, you can use the TTS measurement fixture on any standard surface plate. Alternatively, you can set the tool on a pair of 1-2-3 blocks. It really doesn't matter which method you use as long as you keep a few issues in mind:

- Enter the measurements from the height gauge directly into your tool table. Don't try to add or subtract the height of the measurement fixture from the recorded tool length or do any other analysis relative to some other datum. Just enter the numbers as you read them from the height gauge. The software of your controller will automatically calculate the necessary compensations based on differences between tools, not based on their absolute length.
- Use the same method for all tools. Don't measure some on a 1-2-3 block and then measure other tools on the TTS measurement fixture.
- Always make sure the tools are resting on the precision surface of the outer ring. Do not allow a tool to be supported by the end of the shank when measuring.



Figure 2. Touching off tools on a surface plate, using the TTS measurement fixture to support the ground precision ring.

4.2 Measuring Oversize Tools

Occasionally a very long drill bit will exceed the reach of the height gauge. The easiest solution is to stand the height gauge on the 2" side of a set of 1-2-3 blocks, but don't forget to add the block offset to your measurement.

5 Touch Tools

5.1 Overview

The Tormach Touch Tool provides a simple and safe method for setting height of your work offset consistent with the tool length offsets, thus allowing use of multiple tools with a single touch. For an instructional video on proper operation of the touch tool, please see :

http://www.tormach.com/videos/20112_Tool_Change/20112_ToolChange.wmv

5.2 Basic Operation

Using the Touch Tool is a simple three step process:

1. Mount the Touch Tool and select its tool number as the active tool in the machine controller
2. Bring the spindle down to the work until your Touch Tool indicates to its zero reference
3. Enter zero into the Z axis DRO

Figure 3. TTS touch tools



5.3 Zeroing the Touch Tool

The digital indicator has a special recessed zero/reset button to avoid accidental reset. We recommend setting the zero at the mid-stroke of the indicator plunger and then using zero as your Z reference point.

The mechanical indicator is used in a similar manner; however, the zero reference should be set at .250" (watch the small needle dial). At this position, both needles point in the same direction. This makes for a visually distinctive position that is easy to recognize at a glance.

5.4 Centering the Touch Tools

The Touch Tool holds the indicator approximately on the spindle centerline making it convenient to touch off inside pockets or cavities if needed. A set of spacer washers is included in case a more accurate center position is needed.

6 Set Screw Holders

6.1 Overview

Set screw holders are suitable for general milling operations. The setscrew holders are intended to be used with end mills that have a Weldon flat on them. They can also be used with certain Silver & Deming style drill bits.

6.2 Operating Tips

Make certain that the set screw is on the flat of the tool and never attempt to hold tooling without a flat.

By nature, set screw holders will slightly push the end mill to one side of the clearance hole diameter when the screw is tightened. This offset from center is small, but significant for end mills smaller than 5/16" in diameter. Consider using an ER collet holder for small diameter tools and close tolerance finishing applications.

This is not significant in 1/2" and 3/8" tooling, but begins to become important on smaller cutters. The ER20 collet holders will mount tooling on center, without the offset inherent to a set screw holder. The ER20 collet holders are recommended if you are using 1/4" or smaller cutters that are based on a larger shank diameter, even if the shank offers a Weldon flat for mounting. The set screw holders will work for this application, but the tool will last longer and the machined finish will be better when using an ER20 holder.

7 Jacobs Taper and Drill Chucks

7.1 Overview

Jacob's taper adaptors are used for mounting drill chucks. Drill Chucks are not designed to support side loads and should never be used to hold endmills or any other side cutting tools. The vibration, in combination with side loads from a milling operation, will generally shake the drill chuck off the mount. This has the potential for a very dangerous situation.

7.2 Installing a Drill Chuck

Mounting a chuck on a taper adaptor is a simple matter of pushing the adaptor onto the chuck. It is important to remove any oil or grease on both the taper adaptor and the socket in the chuck before putting them together. A cotton swab and a little rubbing alcohol is all that is needed to degrease each end. Heating the chuck and/or cooling the taper adaptor before putting them together can provide a more secure connection. Do not go crazy with a blowtorch; a halogen desk lamp held over the chuck until it is quite warm is plenty of heat. The heating technique is not necessary, but it does help the connection resist vibration.

7.3 Removing a Drill Chuck

If you want to reuse a chuck that is mounted on a different taper adaptor, all you need is a long punch and a vise. Set the chuck on top of a vise with the taper adaptor pointing down. When the chuck jaws are fully open, the small circular part you will see in the center, down inside the chuck, is actually the end of the taper adaptor. Using a punch placed directly in the center, drive the punch with a good sharp hammer blow and the taper adaptor should drop free. Be prepared with a rag or something below the chuck in order to catch the taper adaptor. The ground surfaces of an adaptor are likely to be damaged if it is dropped onto a concrete floor.



Figure 4. Even the side loads from a small engraving tool can catastrophically damage the Jacob's Taper

8 ER 20 Tool Holders

8.1 Overview

ER20 holders are suitable for milling and drilling operations. They will center the tool spindle and are desirable for operations which require a high degree of concentricity: drilling, reaming, precision finishing, etc. Make sure to choose the correct collet size for the tool; collets are available in both inch and metric sizes.

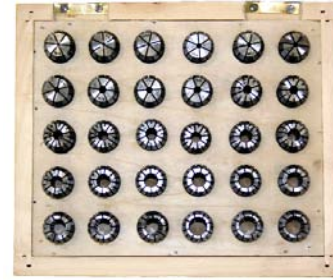
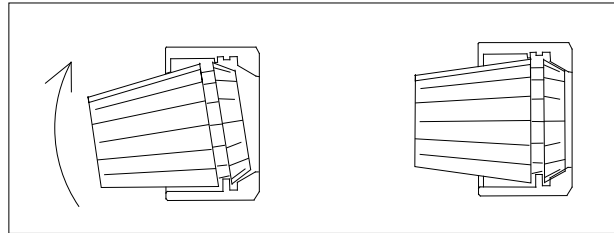


Figure 5. Collets come in 1/32" sizes

8.2 Operation

The ER20 collet is a self-extracting style. This means that the collet must be mounted into the nut first, then the nut and collet assembly are put into the collet holder. If these steps are not taken the collet and/or nut may be damaged and there will be very little holding capacity of the collet. A close inspection of the collet nut will reveal that it is not symmetrical. An area of the retaining ring is cut away. With the collet held at an angle, it is tipped into the cut-out area and will snap into place. With the collet correctly mounted in the nut, the collet will be pulled forward and out of the collet holder taper when the nut is slightly loosened, resulting in self-extraction.



9 Boring Tools

9.1 Overview

Boring is for precision finishing on large diameter holes and cylinders. The TTS adaptor fits to 7/8-20 UNF mounted heads or other tooling with the 7/8-20 thread. The Tormach boring head is compatible with 1/2" shank boring bars. Boring tools should only be operated in a clockwise rotation as the cutting forces will tighten, rather than loosen the head on the threaded stem in this configuration.



Figure 6. Adjusting the boring head

9.2 Adjusting the Boring Head

To adjust the boring head, slightly back off each of the 3 set screws and then carefully turn the adjustment dial with an allen wrench. Retighten the set screws and verify that the tool is positioned correctly using a dial indicator or similar method. Because of backlash inherent in the adjustment mechanism, it is crucial to verify actual position after each adjustment if a high level of precision is desired.

10 Tapping Heads

10.1 Tapping Overview

Tapping is the most common way to thread holes, especially small diameter holes. Larger holes are often threaded with a thread milling or thread turning process.

Effective tapping requires synchronization of the spindle speed with feed rate. For a given spindle RPM, the corresponding feed rate is determined by the thread pitch of the tap. If not synchronized, the tap will not cut in a true helical path and will double cut or damage the threads as well as potentially break off inside the workpiece.

A tap will spin faster or slower as it engages more or less material. The effect is especially noticeable when the tap enters or exits the hole. Additionally, the acceleration and deceleration of both the axes and spindle drive systems in CNC mills will affect synchronization, especially when the tap reverses direction. For this reason, a method is needed to allow the tap to adjust position as it threads.

- For small holes, there are three tapping methods:
- Reversing Tapping Head
- Tension/Compression (or *floating*) Tapping Head
- Rigid Tapping

Both Reversing and Tension/Compression Tapping heads are built with vertical compliance, or *float*, to aid in maintaining the desired thread pitch as the spindle RPM fluctuates, greatly improving the quality of the threads.

- A) A Reversing Tapping Head uses an internal gear/clutch mechanism to 1) provide float, and 2) reverse rotation when the head withdraws. They are more complicated mechanically, but are simpler to program.
- B) A Tension/Compression tapping head has a built-in spring mechanism that allows the head to float to adjust the position of the tap as needed. Programming is slightly more complex, but they are considered robust and highly reliable. The spindle drive system must also be able to quickly accelerate and decelerate.
- C) Rigid tapping uses specialized spindle control with feedback to very accurately maintain feed rate - spindle speed coordination. Rigid tapping is typically found on expensive mills and dedicated hole making CNC centers. Rigid tapping is not feasible on mills without sophisticated and specialized spindle control.



Figure 7. Reversing Tapping Head with Brake Rod installed.

10.2 Basic Operation, Reversing Tapping Head:

The Tormach reversing head comes in two sizes, small and large. The Small Tapping Head (PN 30613) covers #0 to 1/4" threads and the Large Tapping Head (PN 30612) ranges from #8 to 1/2". The shank is TTS geometry, and the heads can be used in any mill or drill press capable of holding a 3/4" shank.

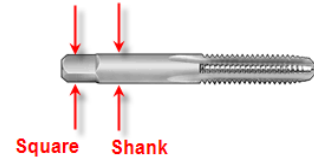


Figure 8. Tap with Square and Shank indicated.

The tap is held by a rubberflex collet locked by the nut on the nose of the head's spindle and prevented from rotating in the head by using its squared end. The small head accepts a fixed square but the larger head, which covers a bigger range of sizes, has a set of alternative blocks which fit into a square hole above the collet nut.



Figure 9. Collet sizes are displayed as Hole Diameter (mm) x Square Size (mm)

To install a tap in the head, first choose the correct size square block (not applicable for the small head) and insert it into the head. Place the rubberflex collet around the shank of the tool and tighten the nut with the included wrenches to secure the tap

After securing the head in the spindle, install the brake rod and insert the end so it is inside of the hole on the underside of the column (Figure 7).

10.2.1 Adjusting the Slip

Both the large and small tapping heads include an adjustable slip clutch to help avoid breaking taps when using the tapping head on a drill press. This feature is only for manual operation. The clutch should be turned to maximum torque (setting = 4) whenever the tapping heads are used in a CNC operation.



Figure 10. To install the collet into the tapping head, press firmly and twist until teeth engage and the collar snaps in place.

10.3 Basic Operation, Tension/Compression Tapping Head:

The Tension/Compression tapping head set (PN 31163) is a modular tool holding system consisting of a TTS (Tormach Tooling System) tapping chuck and quick-change collets. Like all TTS accessories, it can be used with any machine capable of holding a 3/4" tool shank. The Tapping range for the set is #0 - 1/2" (M1.6-M12). The total distance of float built into the tap is approximately 0.75 in.



Figure 11. Once the spring clip has been removed, the spanner can be used to tighten or loosen the adjustable nut.

We recommend using the Tension/Compression Tapping Set only with PCNC 1100 Series II machines or Pre-Series II machines that have been installed with the spindle upgrade kit (PN 31090).

Each collet is marked with in the following manner: Hole diameter (mm) × Square size (mm) (Figure 8, Figure 9). The set is compatible with both metric and inch taps manufactured to the ANSI standard.

Choose a collet that most closely matches your tap's shank and square size. The tap should seat firmly and securely in the collet. Consult

Table I for collet/tap compatibility.

Simply depress the locator sleeve and insert the tap into the collet. When the locator sleeve is

PN	Hole diameter (mm)	Square Size (mm)	ANSI Inch Tap	ANSI Metric Tap
31164	3.58	2.79	#0-#6	M1.6-M3.5
31165	4.27	3.33	#8, 5/32"	M4
31166	4.93	3.86	#10, 3/16"	M4.5, M5
31167	5.59	4.19	#12, 7/32"	
31168	6.48	4.85	1/4"	M6, M6.3
31169	8.08	6.05	5/16"	M7, M8
31170	9.68	7.26	3/8"	M10
31171	8.20	6.15	7/16"	M11
31172	9.32	6.99	1/2"	M12, M12.5

Table I. Collet sizes included in Tension/Compression Tapping Head Kit

released, the tap will be held firmly in the collet. To remove the tap, simply depress the locator sleeve and pull out the tool.

The collet can then be inserted into the Tapping Head by firmly pressing and twisting the collet against the head until it snaps into place. To remove the collet, simply slide the sleeve collar against the body of the collet (Figure 10).

10.3.1 Adjusting the Slip

Before using each collet for the first time, ensure that the slip adjustment is as tight as possible. If the tap becomes loose as it is being fed into a hole, it can be driven into the back of the Tapping head and damage the unit.

To tighten the slip adjustment, carefully remove the spring clip from the collet and use the included pin spanner wrench to tighten or loosen the adjustable nut (Figure 11). Replace the spring clip to secure the nut in place, taking care to ensure that the one of the slots in the nut aligns with a hole in the collet body so the clip can be replaced.

For manual tapping operations where the operator is in control of the feed rate, it is possible to tune the slip compensation to allow the tap to slip if over torqued. When used correctly, this may save the tap and preserve the integrity of the threads.

10.4 Tips for Tapping

Tap manufacturers produce many styles of taps in many different materials and geometries. You should always refer to the tap suppliers' recommendations when choosing or using a tap. Tapping charts are available from many tap suppliers and are often freely available for download. You should consult these as needed to aid with tap and drill selection.

Always use high quality taps designed for CNC operation. A hand tap is more likely to break when used in a CNC application. A spiral tap is often a better choice.

10.5 Dialing in your Process

10.5.1 Verify Spindle Speed:

Confirm that the commanded spindle speed is at or near the actual spindle speed. Use a tachometer such as a PN 30527 or similar to verify that the observed spindle RPMs match those commanded with the S word (Figure 12). A close match will provide the best tapping results, especially when tapping longer thread lengths.

For PCNC 1100 owners, the procedure to calibrate the digital VFD is found

10.5.2 Calculating feed rate:

It is very important to use the correct feed rate. The feed rate for a specific tap is calculated in the following manner:

For Inch Taps: Feed Rate (IPM) = Spindle Speed (RPM)/Threads per Inch (TPI)

For Example, 1/4×20 tap programmed for 500 RPM will need to be feed at 25 IPM

For Metric Taps: Feed Rate (mm/min) = Spindle Speed (RPM) × Metric Pitch



Figure 12. Use a Tachometer to accurately measure spindle RPMs. Mark the spindle with reflective tape and aim the tachometer at the mark with the spindle running to measure RPMs.

For Example, M5×0.8 tap programmed for 500 RPM will need to be fed at 400 mm/min

10.5.3 Chip Clearance/Chip Evacuation:

Make sure there is room for chip evacuation. This is especially important when bottom threading blind holes and/or threading deep holes. Consider using a *spiral tap* for blind tapping.

10.5.4 Hard vs. Soft materials:

It can be much more difficult to tap hard materials. Use sharp tools and consult tap manufacturer’s guidelines for recommended geometries.

10.5.5 Lubrication:

It is important to keep the tap lubricated while it is cutting. Ensure that the tap receives plenty of cutting fluid. Dry tapping is generally not recommended – consult your tap manufacturer’s recommendations when in doubt.

10.6 Choosing the Correct Drill

The size and concentricity of a drilled hole prior to tapping can have great effect on the strength of a threaded connection.

Table 2 illustrates how thread quality changes can change with different drilled hole diameters.

Drilled holes will generally have some amount of oversize resulting from the wandering of the drill tip during entry. This can be reduced by A) using high quality precision drills, and B) drilling twice; that is, drilling first with a slightly smaller pilot drill and then re-drilling with the correct sized hole will eliminate most oversize error associated with drill wandering.

Tap Size	Drill Size	Decimal Drill Size (in.)	Theoretical Thread %	Probable Oversize (in.)	Probable Hole Size (in.)	Probable Thread %
¼ - 20	9	.1960	83	.0038	.1998	77
	8	.1990	79		.2028	73
	7	.2010	75		.2048	70
	13/64	.2031	72		.2069	66
	6	.2040	71		.2078	65
	5	.2055	69		.2093	63
	4	.2090	63		.2128	57

Table 2. Different Drill combinations with the same tap will produce different threads

11 Modular Insert Cutters

11.1 Tool Wear

The actual width of a cut for an insert cutter depends on a number of factors. As insert cutting edges wear, the cutting diameter will become slightly smaller. Additionally, worn inserts will increase the cutting force exerted on the tool, causing increased cutter deflection. Cutter deflection is also a more pronounced effect when using longer cutter bodies. If you plan to use insert cutters for precision work, measure the actual width of cut by taking a test cut and measuring slot width.

11.2 Measuring and touching off Insert Cutters

To accurately touch-off an insert cutter, spin the cutter slowly by hand as you approach the surface you are referencing. You will notice that one insert may be slightly lower than the others; this insert should be used for referencing the cutter.

11.3 Anti-seize

Always use anti-seize when securing inserts to the cutter head. The screws will tighten as the cutter is used, and it can be very difficult to remove screws without destroying the cutter head if anti-seize is not used.

11.4 Tool Projection

Use the shortest cutter mount possible. This will be the stiffest tool configuration and provide the best results in terms of precision. If a longer cutter mount must be used, reduce cutting forces by decreasing feedrate and depth of cut.

12 Electronic Touch Probe and Tool Setter

12.1 Interfacing with the PCNC

For complete information on using the Touch probe or tool setter with the PCNC mill, refer to the PCNC Operator's Manual.

12.2 Determining Effective Diameter

The effective diameter of the probe tip is indicated on the inspection certificate supplied with the probe. The standard tip diameter is around 4mm (0.1575"). The geometry of probing is complex and the certified effective diameter will be different than the actual diameter you can measure.

12.3 Practice Tips

The stylus with the ruby tipped sphere is very accurate and wear resistant, but not inexpensive. We offer a less expensive steel stylus training kit with a breakaway section called the Practice Probe Tip (PN 30695) that can be useful when learning how to work with the probe. The Probe Wrench Set (PN 30673) is necessary to replace a stylus, swap probes or replace breakaway sections.

12.4 Ensuring Repeatability

It is advised that you mark the spindle pulley with a dot of paint and always insert the probe with the spindle in the same position. This eliminates any errors caused by random positioning.

12.5 Lock the spindle during use

Keep the spindle lock ON when the probe is in the spindle. This will prevent any accidental startup of the spindle motor which would rip the cable out of the probe body.

12.6 Measurement Accuracy

Measurement accuracy will not be better than machine accuracy. Expect about 0.001" in the PCNC

12.7 Calibrating the Probe

For the probe readings to be meaningful the center of the probing tip ball needs to lie on the centerline of the spindle. The Tormach probe has three set screws which are used to adjust this alignment.

To align the probe tip you need a hole about 1/2" diameter and 3/4" or so deep machined in a block of material so that it is perpendicular to the bottom face of the block.

The hole should be as circular as possible so ideally be reamed or bored on a lathe. If it is produced on a lathe then having a through hole and facing the end provides the accurate bottom face. A rough setting can be made using the TTS Measurement Fixture although its bore is not finish machined.

A complete description of the specific procedure for calibrating the probe with the PCNC can be found in the PCNC Operator's manual.

13 TTS Conversion Kit

13.1 Overview

The TTS Tool Conversion Kit (can be used to convert many conventional tools into Tormach Tooling System tools. It will work with most tools that have a 3/4" shank and a shoulder wider than 3/4", such as face mills, fly cutters and boring heads. Conversion to TTS provides exact Z height repeatability. It allows a tool to be used in the tool offset table of your CNC controller with other TTS tools for consistent and accurate cutting.



Figure 13. The TTS conversion kit includes a ground conversion ring and epoxy



Figure 14. Lightly sand the tool in preparation for conversion



Figure 15. Mix the epoxy. Avoid skin contact

13.2 Recommended Procedure

Gather the TTS Tool Conversion Kit and the tool you wish to convert. You will also need a disposable mixing stick, small disposable cup for mixing, sandpaper and disposable shop towels. You may want to wear gloves and/or face mask during this procedure.

The first step is to lightly sand your tool and TTS conversion ring (Figure 14). This will allow the epoxy to adhere better. Next, use your mixing stick to blend the epoxy per the package instructions (Figure 15). Once the epoxy has been mixed, apply a moderate amount of the glue to the epoxy ring using the mixing stick (Figure 16). You will not use all the epoxy in the package. If you would like to use the epoxy for another project, you should do so quickly before it hardens.

Lightly add the ring to the tool holder (Figure 17). At this time, some of the epoxy may ooze out and you may wish to do some initial clean-up. Lastly, you will want to put the tool in the machine and clamp it firmly in place. This is an essential step in the process and insures that the surface of the reference ring will be perfectly perpendicular to the axis of rotation of the spindle.

As the drawbar is tightened, the thin film of glue between the ring and the tool body will be slightly reduced. The capillary forces of the glue film will hold the ring tight against the spindle until the glue cures. It is likely that more epoxy will leak during this last step, so keep your shop towels handy (Figure 18). Leave the tool holder in the machine until the epoxy has fully set.



Figure 16. Spread the Epoxy on the conversion ring



Figure 17. Place the conversion ring on the tool



Figure 18. Clean the epoxy residue the tool