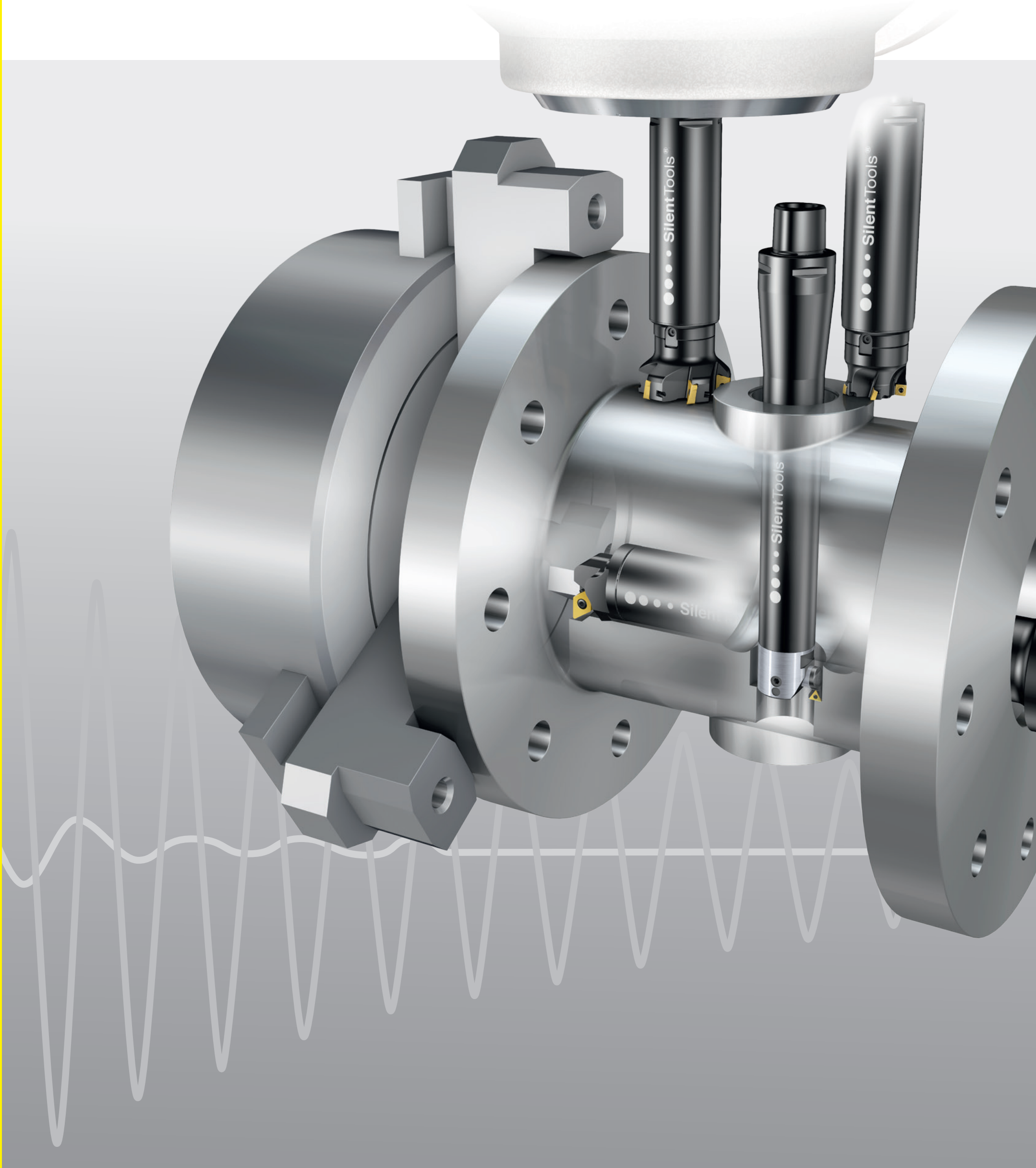
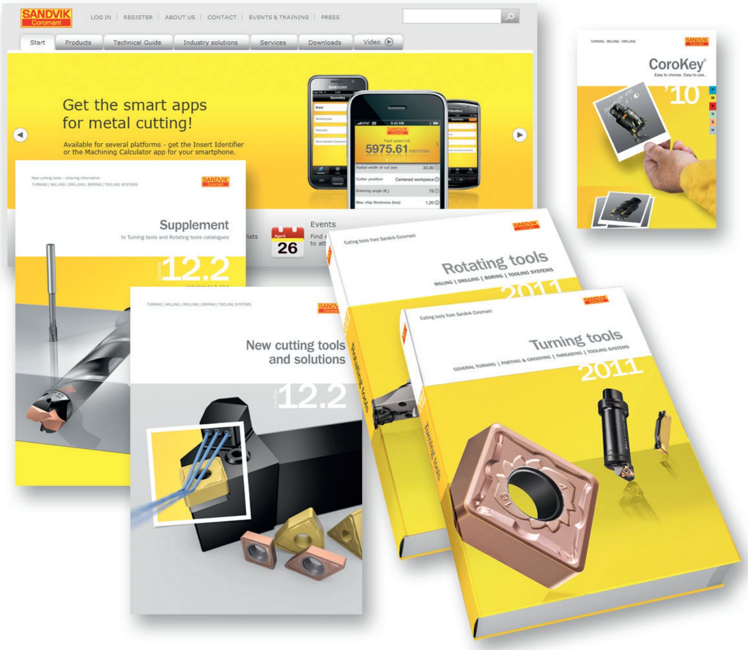
APPLICATION GUIDE

Silent Tools





More information

Useful information and application techniques can be found in our catalogues, handbooks, application guides and on the Sandvik Coromant website.

Visit our website for the latest news!

www.sandvik.coromant.com

Content

1. Introduction

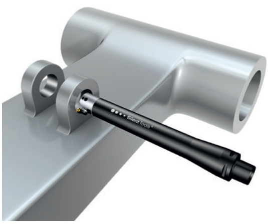
Silent Tools has long been the trademark for tool holders, designed to minimize vibration with a dampening system inside the tool body. The majority of Silent Tools customers use them for long overhangs and poor accessibility. However, great productivity increases and surface quality improvements are to be gained, even for shorter overhangs.

It is not possible to avoid vibration entirely in metal cutting operations, but there are various ways of reducing it. This application guide will help you reach productive machining with minimized vibration.

We will go through application techniques, how to avoid costly mistakes when machining with long overhangs and machining principles, as well as recommendations and troubleshooting for the most common operations and applications in the areas of turning, milling and boring.

Vibration is often the limiting parameter in gaining high output in the machine; e.g. turn down speed, feed, and depth of cut. By using dampened Silent Tools you can increase the cutting parameters and at the same time get a more secure and vibration free process with close tolerances, good surface and much higher metal removal rate, which in summary gives you a lower cost per component.

Enjoy the silence!



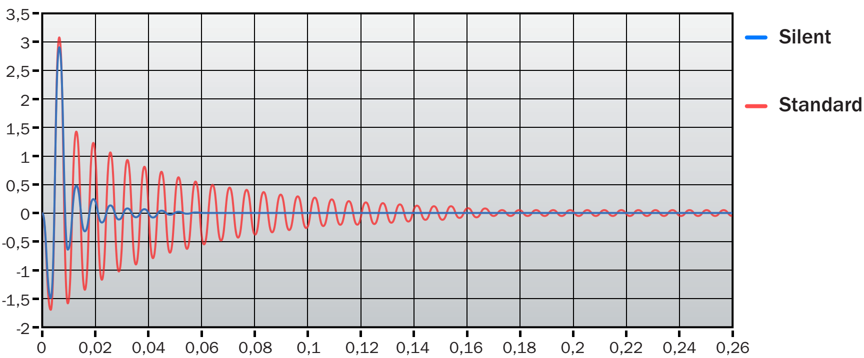

SilentTools®

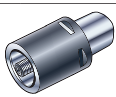
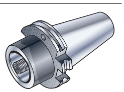
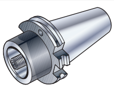
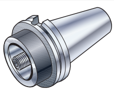
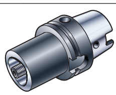
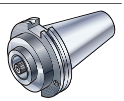
Review of fundamentals

Inside a dampened tool is a pre-tuned dampening system that consists of a heavy mass, supported by rubber spring elements. Oil is added to increase the dampening.

The graph shows the difference in vibration dampening between an undampened and a dampened solution.

For long tool overhang and flanges, two-face contact between the spindle and the tool holder is recommended.



Two face contact		Single face contact	
Coromant Capto®		ISO/CAT	
BIG PLUS		MAS BT	
HSK		CAT-V	

Coromant Capto® coupling - two face contact

It is important to respect the limits marked on the product (load, temperature, rotation, min/ max overhang and pressure):

- Temperature is highlighted to save the rubber elements in the dampening system
- Maximum temperature limit depends on type of product and is marked on the tool, eg. 75-120°C (167-248 F)

The dampening system consists of a heavy mass, supported on rubber spring elements.

Choose the right tool

Choosing the correct tool is important to achieve best possible productivity and results. There is always an optimized solution for each length/diameter overhang and the dampening system is tuned to run optimally in specified conditions.

Each dampened tool has a defined range of reach (bandwith) for optimum tool function and it is important that the right range for each tool is applied. Using a short tool with an extension will not deliver desired results.

Increasing the static stiffness of the cutting tool will make it possible to increase chip removal rate and productivity, without facing vibration problems. Look for standard tools giving you an assembly with minimum lengths and maximum diameter. Both parameters are equally important.

If it is a modular tool; build it so that the biggest diameter is closest to the machine side.

Working area specification

There is a potential to increase productivity by using dampened tools from 3 x BD (Body diameter) and up.

For 4 x BD, cutting data can usually be increased by more than 50% by using a dampened tool and from 6 x BD, dampened solutions are the only choice to achieve good productivity, hole quality and surface finish.

When your application requires lengths, diameters, couplings and other specifications outside the standard, off the shelf-tools, ask for an engineered solution for best performance.

Reduce the cutting forces

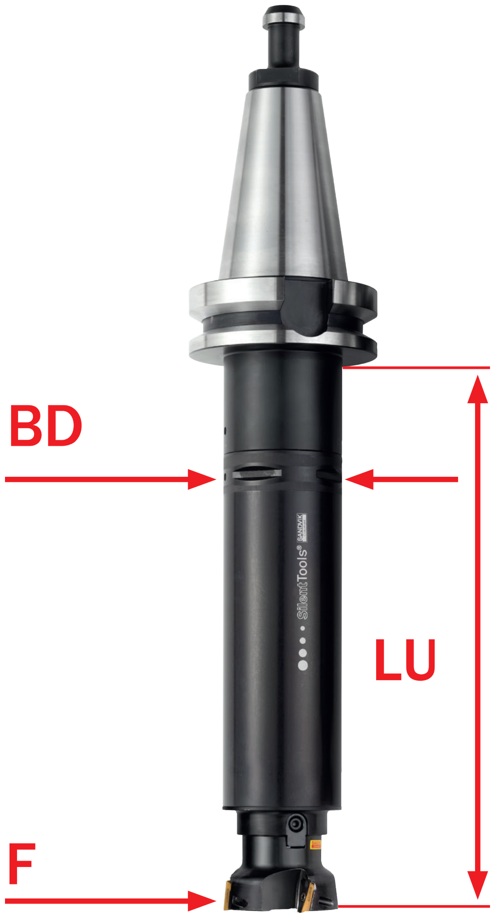
Start out by choosing the best available cutting solution. Then, choose the largest possible diameter and shortest possible overhang to minimize deflection.

The next thing to have in mind is that the dampening system should be as close to the cutting edge as possible, and that the weight in front of the damper should be as light as possible. Reduced weight on the cutting tool will minimize the kinetic energy in a potential vibration. This will make it easier for the tool to dampen vibration, and thus stretch the maximum overhang for both solid and damped tools.

By implementing these strategies, you will reduce the force variations and vibration.

$$\textbf{Deflection } (\delta) = \frac{64 \times F \times LU^3}{3 \times E \times \pi \times BD^4}$$

E: Young's modulus
F: Force
LU: Usable length
BD: Body diameter



In summary:

1. Reduce cutting forces by choosing the right cutting tool and insert
2. Minimize deflection by increasing the static stiffness through largest possible shank diameter and minumum length
3. Reduced weight on cutting units will minimize the kinetic energy in a potential vibration
4. When extending modular tools, build large diameters
5. For engineered products, consider optimized shapes and material reinforcements

Vibration basics

Mechanical structures tend to vibrate with one or more resonance frequencies determined by geometry and material. Each resonance frequency corresponds to a ”vibration mode”. The dampening determines how fast the vibration settles after being triggered. With increased deflection, the energy in the oscillation increases.

The force variations in machining will trigger the self-induced vibration at the natural frequencies of the machine tool. Once the vibration is triggered, it will feed on the forced vibration and grow larger and larger, unless you can reduce the force variations.

Variations in machining forces can depend on a number of things, and if nothing is done to reduce the cutting forces, the vibration will increase.

- Chip segmenting process
- Interrupted cut
- Inclusions in the material
- Ovality in the workpiece
- Formation of built-up edge

k = spring constant
m = object mass
f = vibration frequenzy
δ = tool deflection
F = force on the tool

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

Typical components

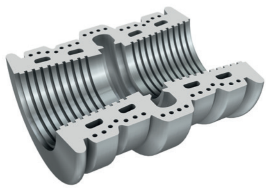
There is a big potential for increased productivity using Silent Tools in all type of industrial segments. For components requiring long tools (~6-14 x BD) Silent Tools is the only choice for vibration-free machining.

General Engineering

Typical components: Shafts, brackets, hydraulic components (cylinders, sleeves), pumps and valve housings etc.

Power Generation

Typical components: Gas turbines, gas turbine discs etc.

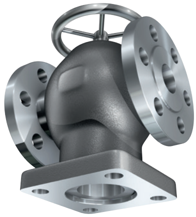


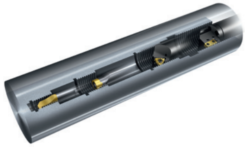
Aerospace

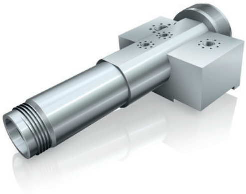
Typical components: landing gears, shafts, titanium components, turbine discs etc.

Oil & Gas

Typical components: Pump houses, threading components, body spools etc.

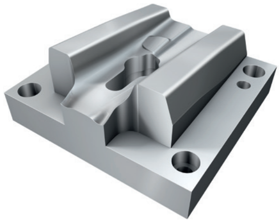






Automotive

Typical components: Cylinder blocks, stamping die components, engine components etc.



Economics, ROI calculator

A Silent Tool investment almost always has a short pay-back time, thanks to increased productivity and less scrap. There are three Sandvik Coromant calculators available that cover the areas of boring, milling and turning, helping you calculate return on investment (ROI) of your Silent Tools. With limited input, you will instantly see the outcome and payback time for a Silent Tool investment, compared to undampened tools.

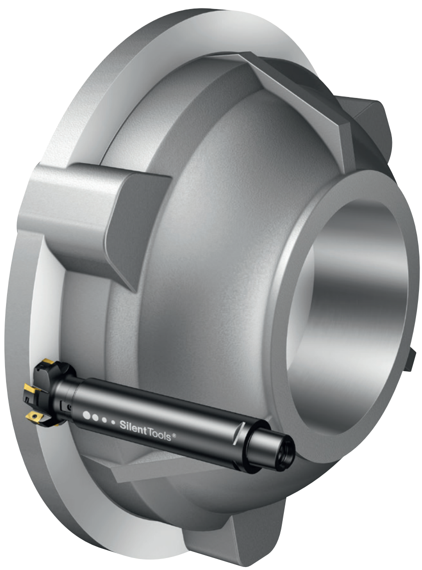
Find the calculators on the website: www.sandvik.coromant.com

2. Milling

Main considerations

Working with rotating tools differ from turning, where you have a boring bar in a rigid tool post, but most of the conditions for successful operations are the same:

- Rigid clamping
- Shortest possible tool length
- Largest possible assembly diameter
- Minimum weight of the cutter to reduce the kinetic energy in a potential vibration



Reduce vibration

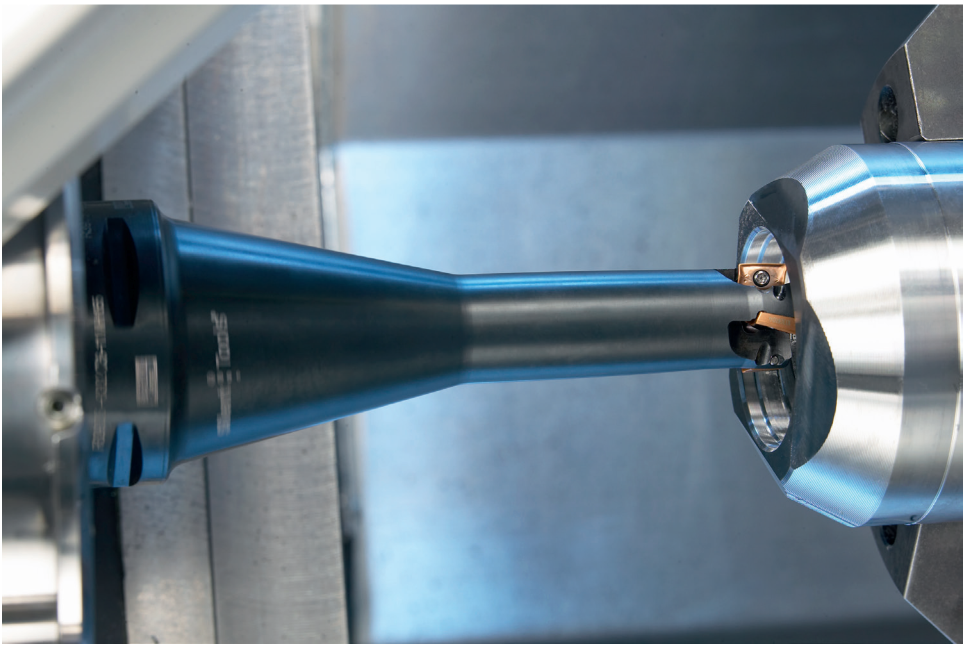
Workpiece set up and machine stability are two important things to consider carefully to minimize vibration.

Workpiece

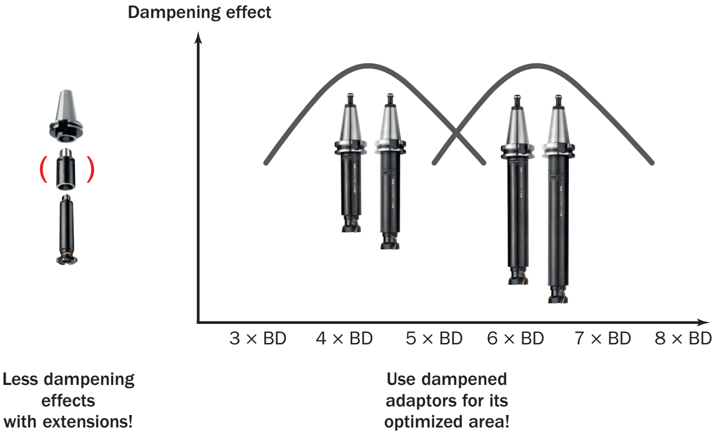
- Affix the workpiece in the most favourable way to support the cutting forces which arise during the machining process
- Use milling concepts with design and entering angle that generate cutting forces in the most stable direction of the workpiece
- Optimize the machining strategy and direction to obtain the most stable cutting condition as possible

Machine

- Machine condition have a large influence on vibration. Excessive wear of the spindle bearing or feed mechanism will result in poor machining properties.



All Silent Tools dampened adaptors are designed for different overhangs, and with differently tuned dampers. The best performance will be achieved by using the optimized length instead of adding extension adaptors. If there is a need for more than 7–8 x BD, ask for an engineered adaptor.



Factors that influence vibration

There are four basic factors that have a major influence on vibration:

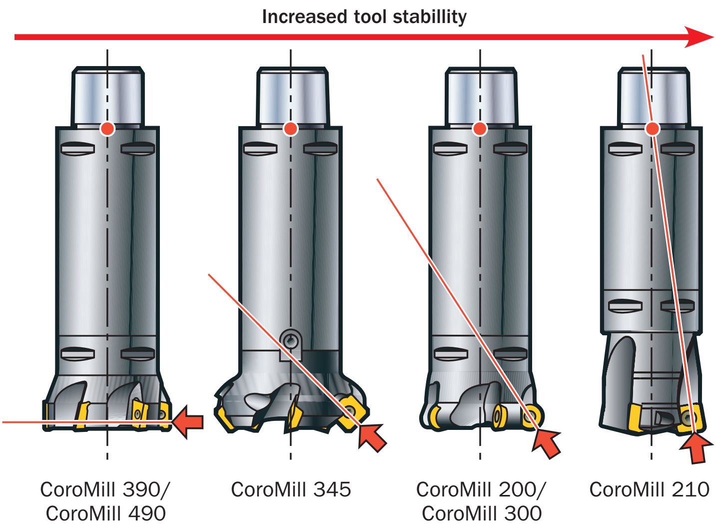
- Entering/lead angle and cutting forces
- Cutter diameter relative to radial depth of cut
- Insert geometry
- Cutter pitch

Entering angle

The entering angle is important as it determines the direction of the cutting forces. The larger the kappa angle (KAPR), the larger the radial cutting forces. Choose cutter concept according to process and application.

When the radial cutting forces increase, you can see the difference in functionality between dampened and undampened tools.

With a small entering angle combined with shorter overhang, the maximum depth of cut on the cutter could be reached before vibration occure.



Cutter diameter relative to radial depth of cut

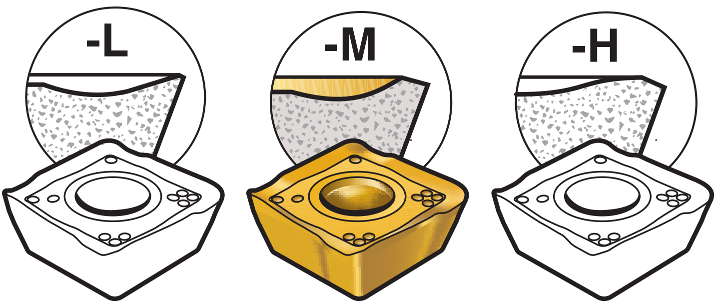
A smaller tool diameter will reduce the power and torque requirements as well as the deflective cutting forces. The ratio of the milling cutter diameter in relation to the radial engagement needs to be kept smaller than any maximum value.

Insert geometry

The cutting tool geometry should be light or medium.

Silent tools limits

High temperatures can change the function of the dampening system. Use air or through coolant when possible. Extreme n (rpm) can also reduce the function of the dampening system.



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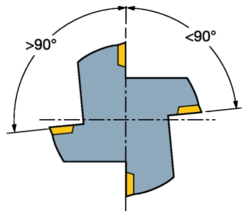
Cutter pitch

When multiple inserts are in contact with the material, the risk of vibration increases. As long as you are working with cutting depths under the critical depth for vibration, an increased number of inserts is more productive however. Work with both radial engagement and the pitch of the cutter to find the best performance. In most cases a coarse pitch is the best choice for productive machining with dampened tools.

Differentially pitched cutter

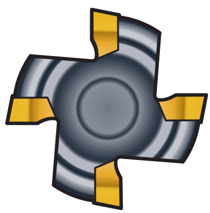
Harmonic forces cause vibration and a differentially pitched cutter is therefore an effective way to minimize vibration. It breaks the harmonic forces and therefore increases stability and is especially useful when a_e is high and you have long overhangs.



Coarse pitch – L

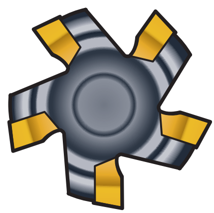
Differentially pitched cutter with reduced number of inserts. First choice for unstable operations due to the lowest cutting forces.

Close pitch – M



Evenly or differentially pitched cutter, depending on concept, with medium number of inserts. First choice for roughing in stable conditions.

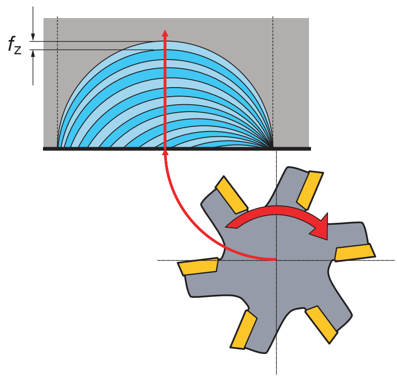
Extra close pitch – H



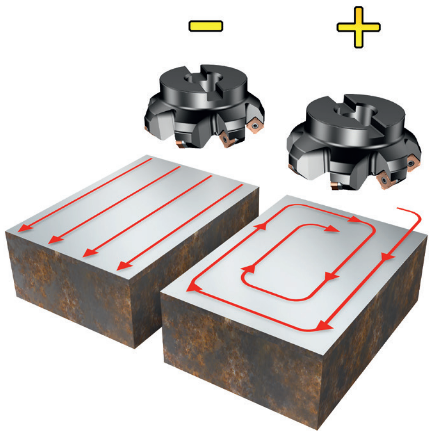
Evenly pitched cutter with maximum number of inserts. First choice for high productivity with low a_e (more than one edge in contact).

Programming guidelines

A general rule for face milling is to keep the milling cutter constantly in cut, instead of running several length way passes. This minimizes the number of entries and exits and keeps the inserts from disadvantageous loads that could lead to vibration.



Roll into cut



Keep the cutter constantly engaged

Roll into cut

Roll into the cut clockwise to get thin chips, approaching zero at the exit. This approach will avoid vibration tendencies that can originate from a thick-chip-at-exit approach.

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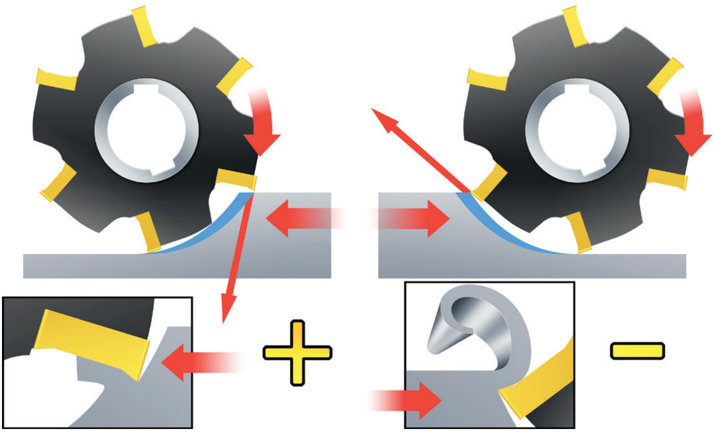
Milling direction

Down-milling is the first choice for most milling operations. In some cases, when the machine has insufficient power or the workpiece is very pliable, up-milling is preferred. Remember however that the cutting force tends to lift the workpiece when up-milling. This must be carefully counteracted when clamping the workpiece.

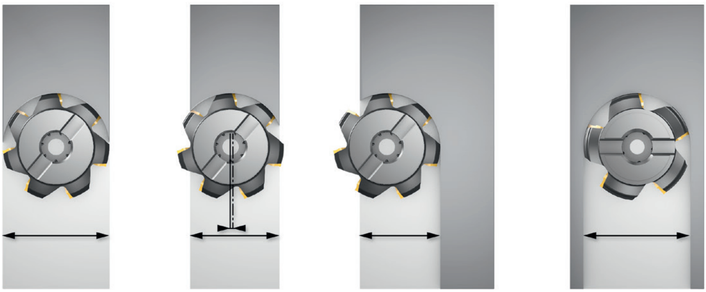


Position and diameter

In general face milling, the cutter diameter should be 20-50% larger than the cutting width and the cutter should be positioned slightly off-centre. Do not position the cutter exactly in the centre.

When the cutter diameter is smaller than the workpiece, it is recommended that maximum width of cut is 60-70% of the cutter diameter.

In full slot milling, it is very important to reduce the number of engaged inserts to avoid vibration.



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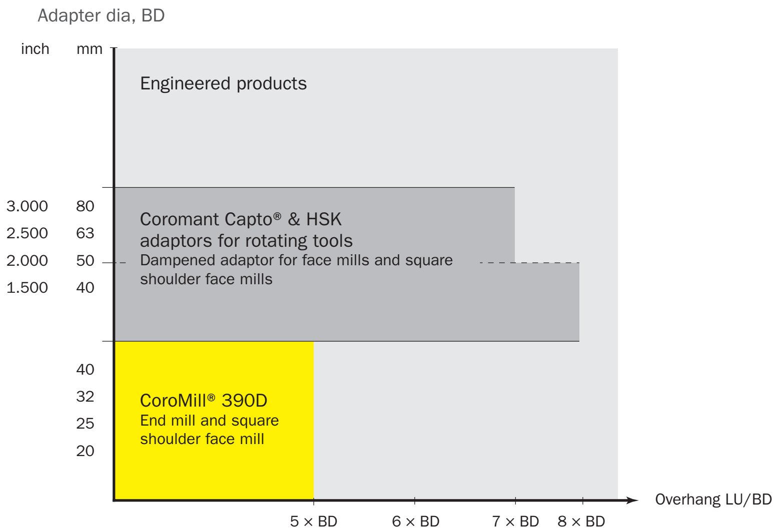
Product overview

There is a wide range of Silent Tools milling adaptors available off the shelf, with HSK or modular Coromant Capto couplings.

If none of our standard adapters are suitable, inquire for an engineered solution. Adaptors for slitting cutters, built-in dampeners in large side mills and long-edge cutters are also available as engineered solutions.

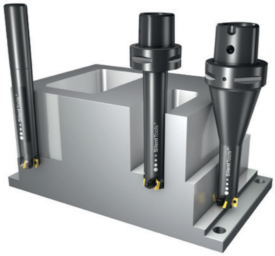
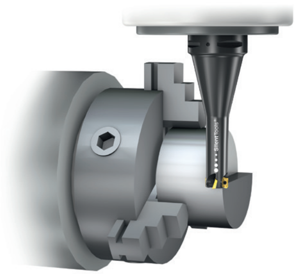
End mills and square shoulder face mills	**Dampened adaptors for face mills and square shoulder face mills**	
CoroMill® 390D	Dampened adaptors – Coromant Capto	Dampened adaptors – HSK
		
Cylindrical shank or Coromant Capto back-end coupling	Coromant Capto back-end coupling (C4, C5, C6 and C8)	HSK back-end coupling (HSK 63 and HSK 100)
Coarse, close and extra close pitch	Wide range of exchangeble cutting heads	Wide range of exchangeble cutting heads
DC: 20-40 mm (0.787-1.575 inch)	Coolant through	Coolant through
Overhang: ≤ 5 x BD	BD: 40-80 mm (1.575-3.150 inch)	BD: 63-100 mm (2.480-3.937 inch)
	DMM: 16-32 mm (0.750-1.500 inch)	DMM: 16-27 mm (0.750-1.000 inch)
	Overhang: ≤ 8 x BD	Overhang: ≤ 8 x BD

- Dampened solutions from 20–40 mm (0.787-1.575 inch) with integrated CoroMill 390 milling cutters are available in the standard assortment
- From 40 mm (1.575 inch) and above, there are dampened adaptors with Coromant Capto sizes C4–C8, with coolant through arbor mounting available as standard. Combined with a basic holder, the adaptor can be an assembled dampened tool for most machine interfaces
- For machines with HSK couplings; integrated adaptors are available



CoroMill® 390D – application area

CoroMill 390D is a real productivity booster for long and slender tools and works well in both vertical and horizontal machines. The cutters are designed for reach and at the same time efficient when machining close to chucks in multi-task machines.

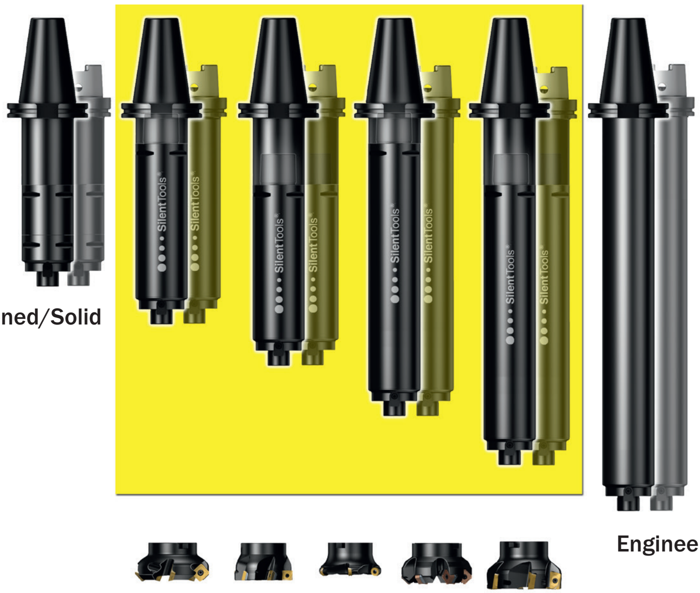




The program consists of Coromant Capto sizes C6, C5 and cylindrical shanks in diameter 20, 25, 32 and 40 mm (0.787, 0.984, 1.260 and 1.575 inch) with a reach of 3–5 times the cutting diameter, DC.

- Coromant Capto® C5
  - High stability
  - Large programme of basic holders
  - First choice for closed reach
- Coromant Capto® C6
  - High stability
  - Large programme of basic holders
  - Integrated multi-task spindles
  - First choice for open reach
- Cylindrical shanks
  - Hydraulic Chucks, e.g. CoroChuck 930, for accurate holding of the cutter.
  - Collet chucks

Short and long basic holders

With a combination of arbor mounting on the adaptors and basic holders with different lengths, solutions for most applications up to 8 x BD are available. For overhangs above 8 x BD, or when you have other specific requirements, engineered solutions are the best alternative.

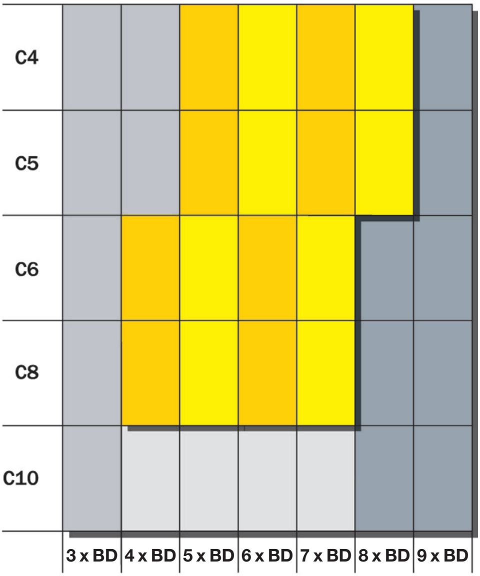


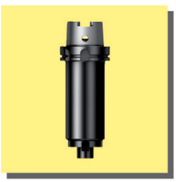
Undampened/Solid

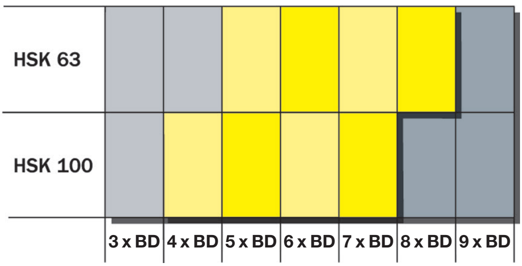
Engineered solution

Dampened adaptors for face mills and square shoulder face mills

- Cx-391.05CD
- 392.41005CD







Application examples

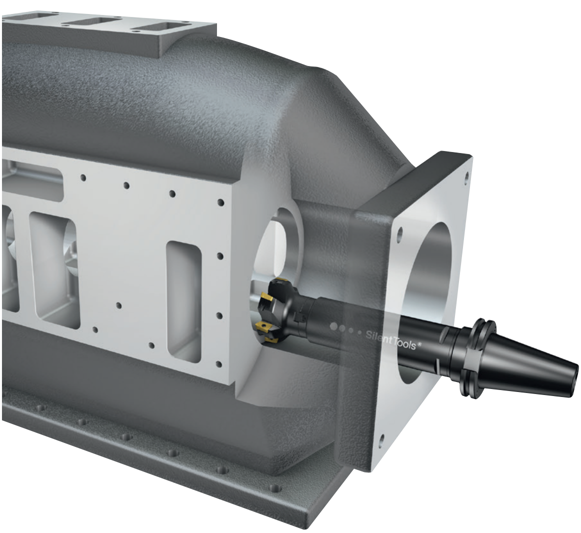
Case one: Valve house

Operation	Shoulder milling – circular interpolation	
Workpiece material	CMC 09.1, K3.2.C.UT, Nodular cast iron	
Machine cost	195 EUR/hour	
Machined volume	179 (10.92)/pc cm^3 ($inch^3$)	
ZEFF	5	
Assembly length	280 mm (11.024 inch)	
	Reference	**Silent Tools**
Adaptor		C6-391.05 CD-22 200
Cutting head		R390-066 Q22-18M
Cutting data		
n (r/min)	700	1352
v_c (m/min (ft/min))	176 (577)	280 (918)
f_z (mm (inch))	0.31 (0.012)	0.27 (0.010)
v_f (mm/min (inch/min))	687 (27.05)	1 156 (45.52)
v_{fa} (mm/min (inch/min))	8.0 (0.315)	19.0 (0.748)
AP (mm (inch))	4.0 (0.158)	6.0 (0.236)
a_e (mm (inch))	18.59 (0.732)	18.59 (0.732)
Tot. cycle time	30.07 min	12.08 min
Tool life (no of comp.)	10	20

Applying Silent Tools to a shoulder milling operation in a valve housing resulted in increased metal removal and improved surface finish. Even with the increase in speed, depth of cut and spindle speed, there were no vibration tendencies. The results are conclusive: 149 % increase in productivity and return on investment after nine weeks!

Case two: Valve house

Operation	Circular interpolation
Workpiece material	CMC 09.1
Machine cost	Euro 195
Machined volume	Q=182 cm^3/min (11.11 $inch^3$/min)
ZEFF	6
Assembly length	480 mm (18.9 inch)
Recommended cutting data	
a_e, mm (inch)	17.56 (0.691)
n (r/min)	900
v_c (m/min (ft/min))	238 (780)
f_z (mm (inch))	0.32 (0.013)
v_{fa} (mm/min (inch/min))	24 (0.945)
AP (mm (inch))	6.0 (0.236)
Total cycle time, min	27.58
Tool life (no of comp.)	10



Step machining from one side		
	Reference	**Recommended**
Step 1	Rough boring to diameter 135 mm (5.31 inch)	Circular interpolation to diameter 139.8 mm (5.50 inch)
Step 2	Rough boring to diameter 139.8 mm (5.50 inch)	Finishing boring to diameter 140 mm (5.51 inch) H7
Step 3	Flushing	
Step 4	Finishing boring to diameter 140 mm (5.51 inch) H7	

The valve housing has a total length of 850 mm (33.46 inch) and a production volume of 300 units per year. In January 2012 the valve housing underwent a small process change. The length of the valve housing demanded processing from both sides and the modification involved finishing of the internal diameter of 140 mm (5.51 inch) with a maximum cutting length of 425 mm (16.73 inch).

The process was rationalized from two rough boring cuts, followed by a flushing operation to remove chips before the final finishing to Ø140 H7, to one circular interpolation and the final boring finish. The milling adaptor, C8-391.05CD-27 360 was combined with a basic holder and an oversized CoroMill 390, acquiring an assembly length of 480 mm (18.9 inch).

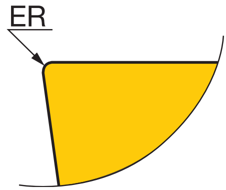
By changing the process the customer saves EUR 22,000 per year. This equals a payback time of nine weeks, or 64 produced components. Another great bonus was that tool life increased from two produced units to ten!

Operation	Deep pocket milling	
Component	Hollow chamber	
Workpiece material	CMC 01.2	
Machine cost	Euro 90	
Machined volume	132 cm^3/min (8.06 $inch^3$/min)	
ZEFF	4	
Assembly length	360 mm (14.17 inch)	
Cutting data	**Competitor**	**Silent Tools**
n (r/min)	1100	1550
v_c (m/min (ft/min))	176 (578)	249 (817.3)
f_z (mm (inch))	0.46 (0.018)	0.41 (0.016)
v_f (mm/min (inch/min))	2030 (80)	2540 (100)
AP (mm (inch))	0.50 (0.02)	1.02 (0.04)
a_e (mm (inch))	51 (2.00)	51 (2.00)
Tot. cycle time	900 min	400 min
Tool life (no of comp.)	0.1	0.25

The pocket measures 457 x 457 x 406 mm (18 x 18 x 16 inch). The pocket has 25.4 mm (1.0 inch) radii in the corners, which required a 50 mm (2.0 inch) cutter. The existing process was unproductive and as deep pocket machining was getting more and more common in the workshop, a productivity increase was the main goal.

By implementing a dampened milling adaptor with an extension, along with a CoroMill® 210 and grade GC1040, the productivity goals were met. Result: The reference solution took 15 hours, while the Silent Tools solution took under seven hours.

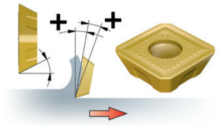
Tips and hints, summary



Insert grades and geometries

Choose a small edge rounding (ER). Go from thick coating to a thin one. If necessary, use uncoated inserts. Use sharp and positive inserts with chip forming capacity.

Entering angle



The smaller the entering angle, the thinner the chip, and the further away it will spread along the cutting edge. This allows for higher feed per tooth. A smaller entering angle will also direct more of the cutting force in axial direction and reduce the risk of vibration.

Cutter pitch

In most cases a coarse pitch is the best choice for productive machining with dampened tools. Use a coarse pitch cutter to slow down changes in the cutting force directions. Reducing the number of inserts will often enable a significant increase in the axial depth of cut.

Feed per tooth

A higher feed per tooth may give a constant preload on the machine tool spindle and prevent it from using the play in its bearings.

Achieve maximum Q

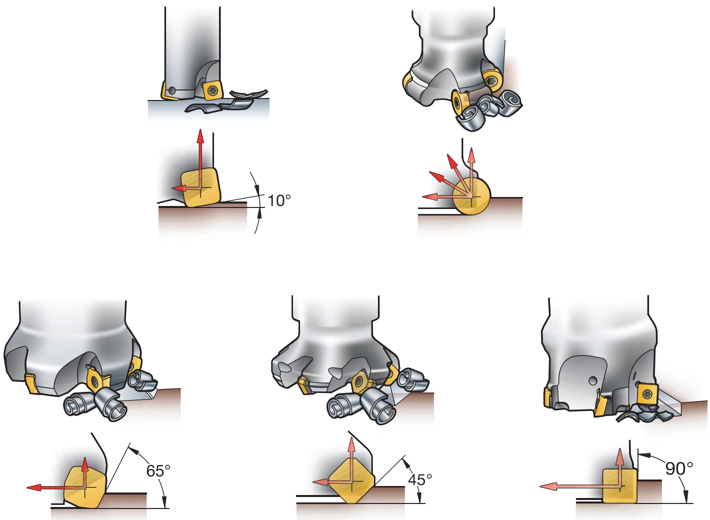
Choose a_e between 60%–80% as a starting value if possible. Reduce the number of inserts to maximize Q. This is particularly important when using full slot engagement.

Chip evacuation

Use compressed air to prevent re-cutting of the chips. This is especially important in deep-cavity milling. Notice that a coarse pitch cutter will have more space to evacuate the chips.

Entry and exit

Avoid situations where the centre line or the cutter is in line with the workpiece edge. In situations like that, the insert is leaving cut when the chip thickness is at its maximum, which gives very high shock-loads at entry and exit.



SANDVIK Coromant

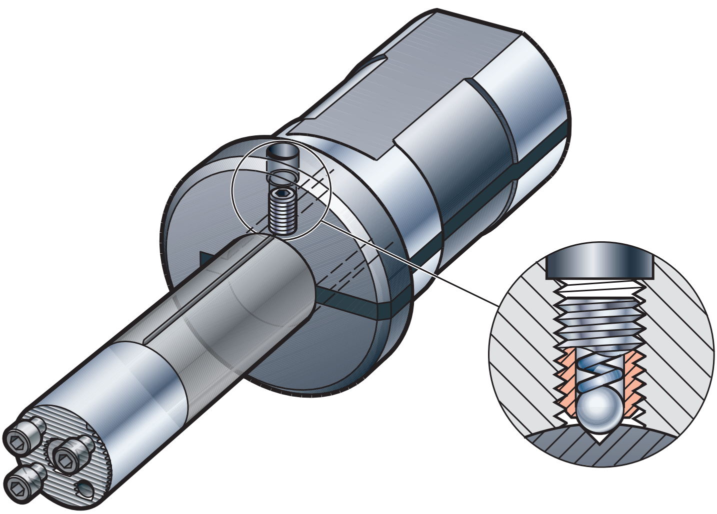
3. Turning

Main considerations

Clamping stability and correct centre height are two important factors in order to achieve the right dimension tolerances and surface finish of your component. Clamp the cylindrical boring bar in a split sleeve holder, to achieve maximum contact area. With EasyFix sleeves you will achieve the most stable clamping and exact centre height positioning. The centre height affects both the rake angle and cutting force on the tool.

The recommended clamping tolerance is ISO H7 and we also recommend using split bushing material with a minimum 45 HRC to avoid permanent deformation. Never use screws in direct contact with the bar shank as they may damage the bar.

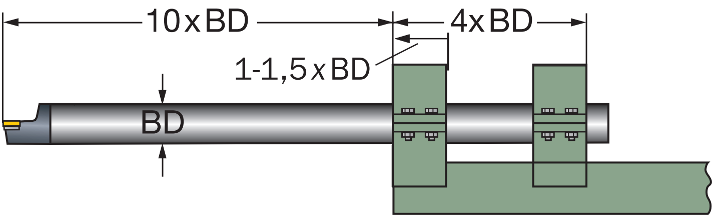
When machining with long overhangs, correct clamping can not be overvalued.

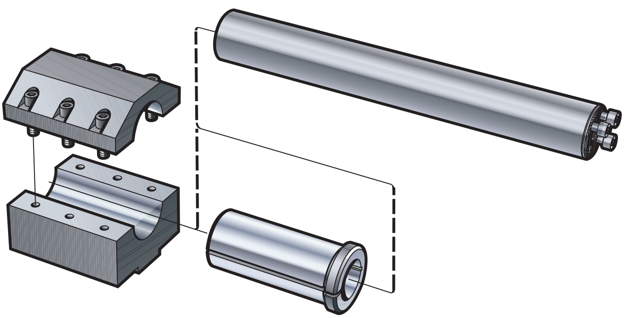


Boring bars – general

- Surface finish of ~1 µm is required to ensure sufficient clamping contact
- Recommended clamping length is 4 × BD. If possible, we recommend using a clamping length of 6 × BD for boring bars over 200 mm (7.87 inch)
- Cylindrical boring bars in split sleeves. Recommended clamping tolerance is ISO H7
- Split bushing material, minimum 45 HRC to avoid permanent deformation
- If a large bar, use a double bearing cap
- For best clamping stability use a split boring bar holder

Let the design and dimensions of the component decide the diameter and length of the boring bar. For best clamping stability, first choice is Coromant Capto coupling or split sleeves. The diameter of the bore and the length needed to reach the bottom will indicate what type of boring bar to use.

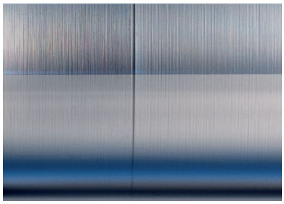




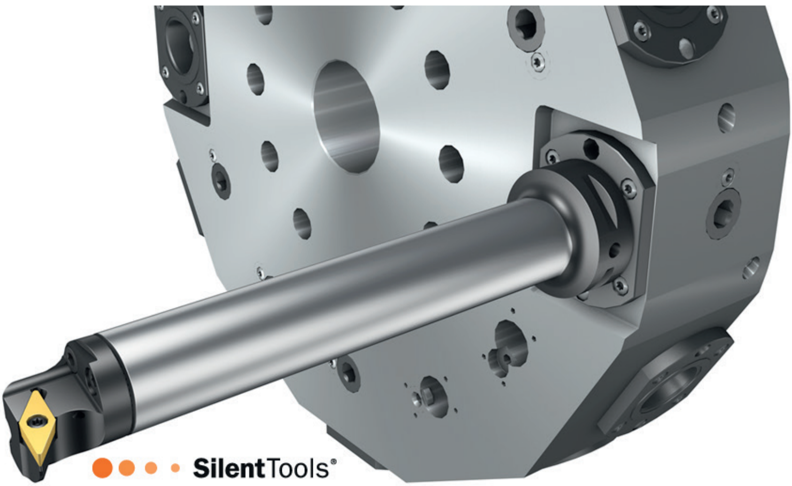
Clamping of Silent Tools bars

Due to the design of the turret in a CNC lathe or the flexibility of a multi-task machine, the rigidity is usually reduced. Small turret widths reduce the ratio between the clamping length and the bar diameter on larger cylindrical boring bars and consequently reduce the set-up stability.

The Coromant Capto coupling can also be a solution on a turret lathe machine. This minimizes the need for long sleeves and will result in a stable set-up with additional quick-change benefits.



The importance of correct clamping can not be underestimated. The pictures show surface finish with 1) incorrect clamping and 2) split holder clamping.



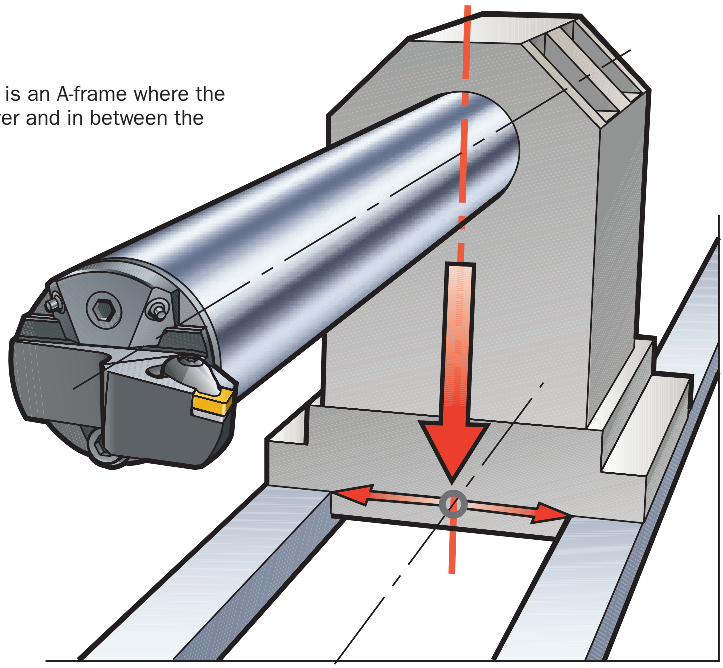
Flat bed lathes

Compared to turret lathes, a flat-bed lathe with a tool post is often more rigid and stable and can hold larger and longer boring bars. The limitation of the machine in this case can be the tool post, the size of the machine and the rigidity in the design.

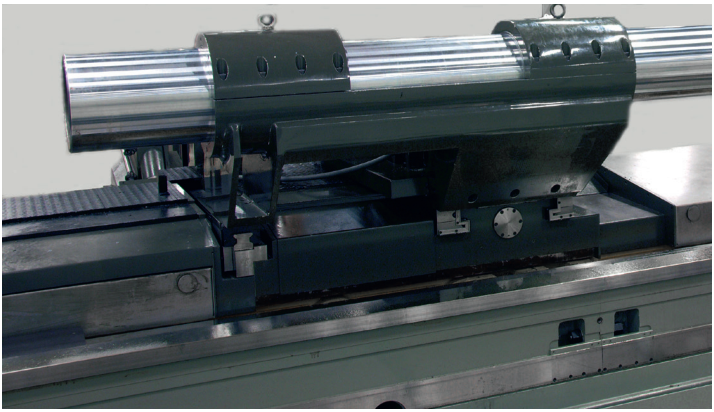
The stability of the machine slides and gibs are important factors in order to achieve good results when holding Silent Tools boring bars with long overhangs. For best results, the tool post clamping should be with large gibs designed with the cross gibs spread widely apart, equal or wider than the clamping length, 4 x BD. Remember that the weight increases dramatically with increased bar size:

- Diameter 100 mm (3.94 inch) = 88 kg (194.0 lb)
- Diameter 120 mm (4.72 inch) = 140 kg (308.7 lb)

The best tool post design is an A-frame where the bar is mounted directly over and in between the slides of the machine.



For best performance of the boring bar, the contact, design, and dimensional tolerance between tool and tool holder are important factors. The best stability is obtained with a holder that completely encases the bar. V-type bar holder and cylindrical holder with screws are not recommended.



Split holder for 300 mm (11.81 inch) bar diameter. The distance between the cross slides is 1,200 mm (47.24 inch) (4 x BD).

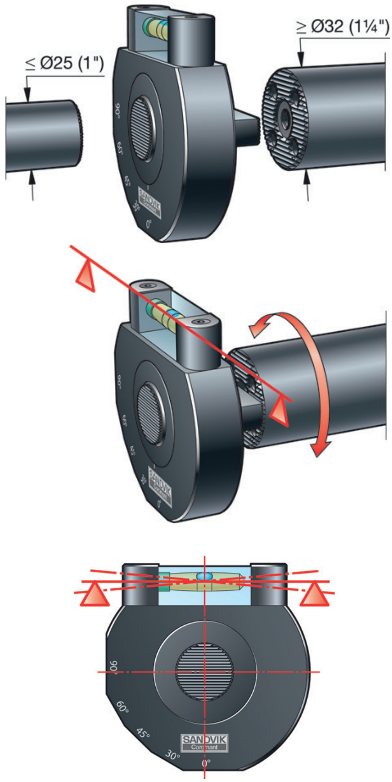
Centre height setting tool

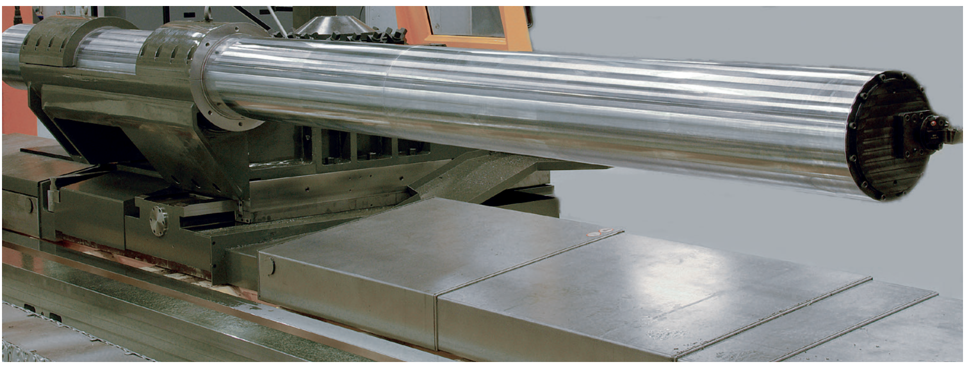
For all cylindrical CoroTurn SL bars, there is a quick and simple method to accurately ensure correct centre height setting of the cutting edge:

1. Attach the setting tool to the serrated edge of the cylindrical boring bar
2. Twist the boring bar to the right position
3. The bar is parallel when the bubble is in the centre position

Even though the bar will deflect slightly below centre during the machining operation, the correct mounting of the bar is on centre line.

Alternative setting tools are height gauge and cross test lever.





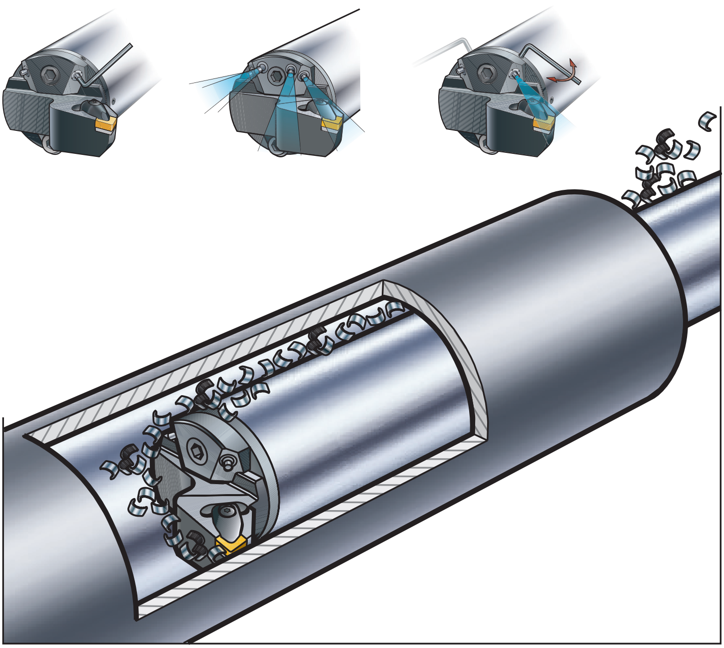
Dampened 300 mm (11.81 inch) CoroTurn SL quick change boring bar with overhang 10 x BD.

Pressure and direction

For best tool life and process security, use coolant directed to the cutting zone. For tools equipped with SL quick change heads, adjustment of the coolant nozzles needs to be done manually, to ensure that the coolant hits the cutting zone. For best results, use tools with integrated coolant and several nozzles. This is equally important for internal turning with long overhangs. To turn on and off the coolant flow, use a hexagon key.

Clearance between the boring bar and the inside of the bore is extremely important for chip evacuation and to avoid radial deflection. For a bore diameter of 100 mm (3.94 inch), the applicable bar is 80 mm (3.15 inch). This gives enough clearance for chip evacuation and will eliminate any damage to the tool and component.

Coolant can be applied through the rear of the boring bar using common size connectors with British Standard Pipe (BSP) threaded fittings. Sandvik Coromant dampened boring bars are equipped with a pre-threaded coolant intake hole.



Advanced cooling technology

The Sandvik Coromant advanced cooling technology is a unique concept that optimizes the use of coolant in all wet machining. By directing the coolant with precision to the cutting zone, the generated heat is efficiently removed from the cutting zone, giving excellent chip breaking, also in difficult materials, regardless of what pressure you use.

- When using low pressure (up to ~30 bars/435 PSI) – the Sandvik Coromant HP holders will outrun regular tool holders thanks to the exactly directed coolant jets
- When using high pressure (above 30 bars/435 PSI), the most productive solution is a combination of the Sandvik Coromant HP holders and insert geometries dedicated for high pressure coolant. The higher the pressure, the more demanding materials can be machined with excellent results. Sometimes a high coolant flow is required to wash the chips from the bore.

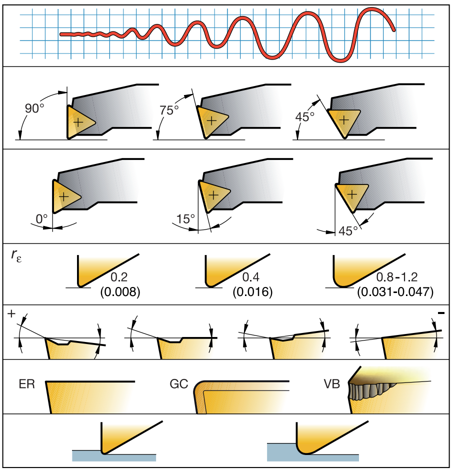
Silent Tools adapters are designed for 70 bars (1015 PSI) pressure with the exception of the diameter 100 mm (3.94 inch) boring bar, which has a capacity of 50 bars (725 PSI).

Factors that influence vibration

To minimize vibration tendencies:

- Use a large entering angle and positive rake angle
- Use big nose radii and point angle
- Use a positive macro geometry
- Control the wear pattern and ER-treatment on the micro geometry
- Depth of cut should be larger than the nose radius.

Lower radial force gives less radial deflection and fewer problems with vibration. For best results; use a radial depth of cut that is larger than the nose radius when using a 90° entering angle (0° lead angle). If the radial depth of cut is smaller, a 45° entering angle will give you equal results.



Vibration tendency

Entering/lead angle and rake angle

Nose radius and point angle, mm (inch)

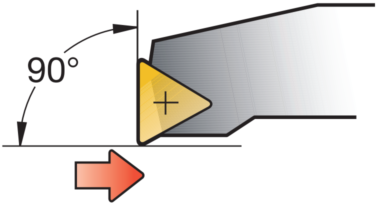
Macro geometry

Micro geometry

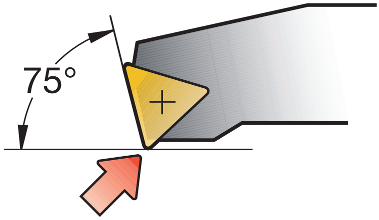
Depth of cut related to nose radius

Be aware that re-directing forces can reduce deflection:

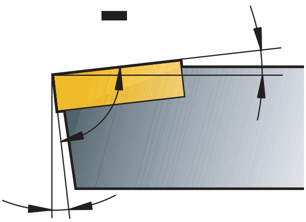
- Entering angle as close to 90° as possible (lead angle 0°) will maximize the portion of feed force coming back from the work-piece in the axial direction. A force in the axial direction will give less tool deflection than equal forces in the radial direction.
- For internal turning the entering angle should never be less than 75° (lead angle 15°).
- The more positive the rake angle, the less cutting forces are needed to machine the component. Less cutting forces means less deflection.
- Less force in the radial direction giving less radial deflection



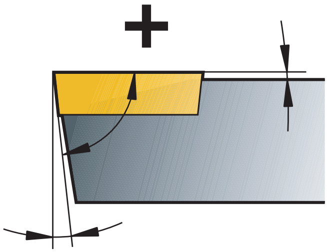
Force direction: mainly axial



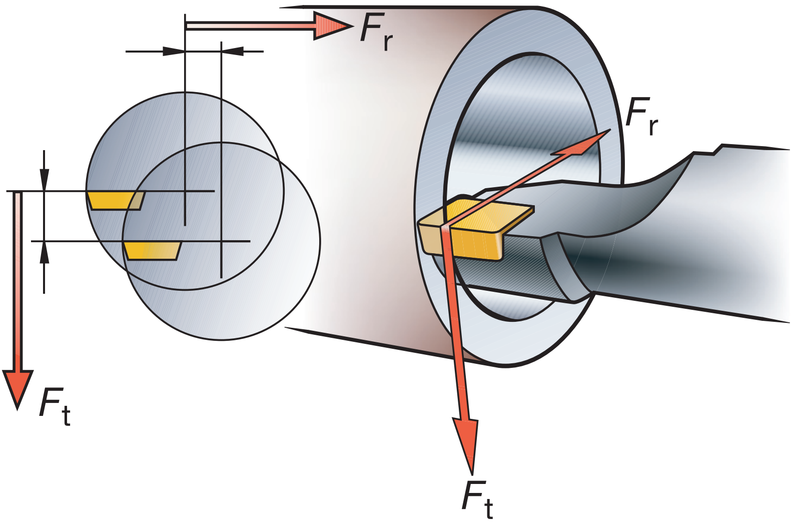
Force direction: both axial and radial



Negative rake angle increases cutting forces



Positive rake angle gives less cutting forces

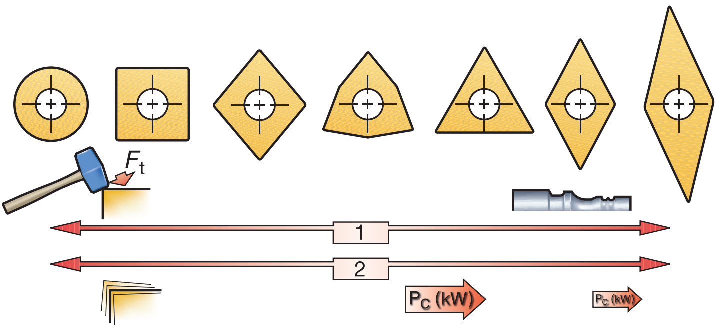


F_t = tangential forces and F_r = radial forces

Insert point angle

Select an insert shape relative to the entering angle and accessibility requirements of the tool. One rule of thumb is to always choose the smallest possible nose radius to reduce vibration tendencies. When it comes to point angle, there are two paths to choose:

- A small insert point angle will improve tool stability, give good clearance of a trailing surface, and small chip area variations if the tool starts vibrating in a radial direction
- A large insert point angle gives insert strength and reliability but requires more machining power, since a larger cutting edge is engaged in the cut



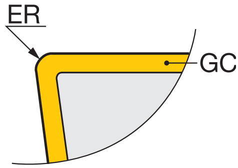
Positive geometries

Positive geometries and positive rake angles generate less cutting forces and less deflection of the tool. Therefore, choose the most positive geometry you can, with a chip-breaker suitable for your cutting data. This may decrease the wear resistance and edge strength somewhat, as well as the chip-control, so vibration control is always a balance.

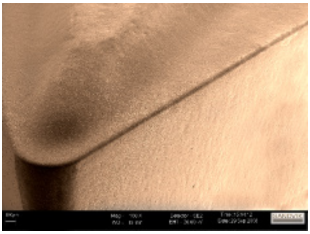
Wiper inserts

Wipers are usually not first choice when it comes to avoiding vibration, as the increased cutting forces and radial deflection are difficult to overcome. In very stable conditions, however, wiper inserts can provide true benefits in surface finish and increased cutting data.

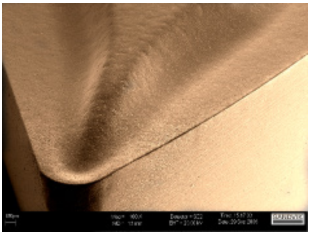
Edge rounding



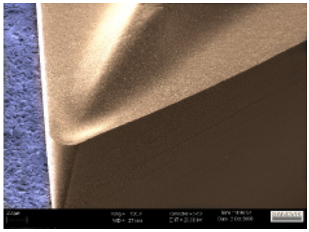
A small edge rounding (ER) gives lower cutting forces in all directions. This means easier cutting action and less deflection of the tool. Ground inserts have smaller edge rounding than direct pressed inserts, which is true also for uncoated or thin-coated inserts.



M = Direct pressed inserts



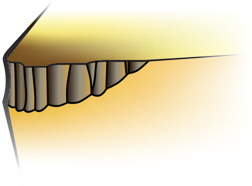
G = Ground insert, normally with smaller ER



E = Ground insert for closer tolerances and sharp edge

Cutting data

Excessive insert wear, such as flank wear must be avoided, as it changes the clearance between the tool and the component wall, which can cause vibration problems.



Cutting speed, v_c

Correct cutting speed will avoid built-up edge, which influences surface finish, cutting forces and tool life.

- Excessive cutting speed can generate flank wear, which reduces security and reliability, due to chip jamming, poor chip evacuation and insert breakage, especially when machining deep holes
- Cutting speeds which are too low will generate built-up edge
- Uneven wear pattern will decrease tool life and surface finish, so pay careful attention to wear pattern
- Workpiece material has a great impact on what cutting speed you can apply

Depth of cut, AP, and feed, f_n

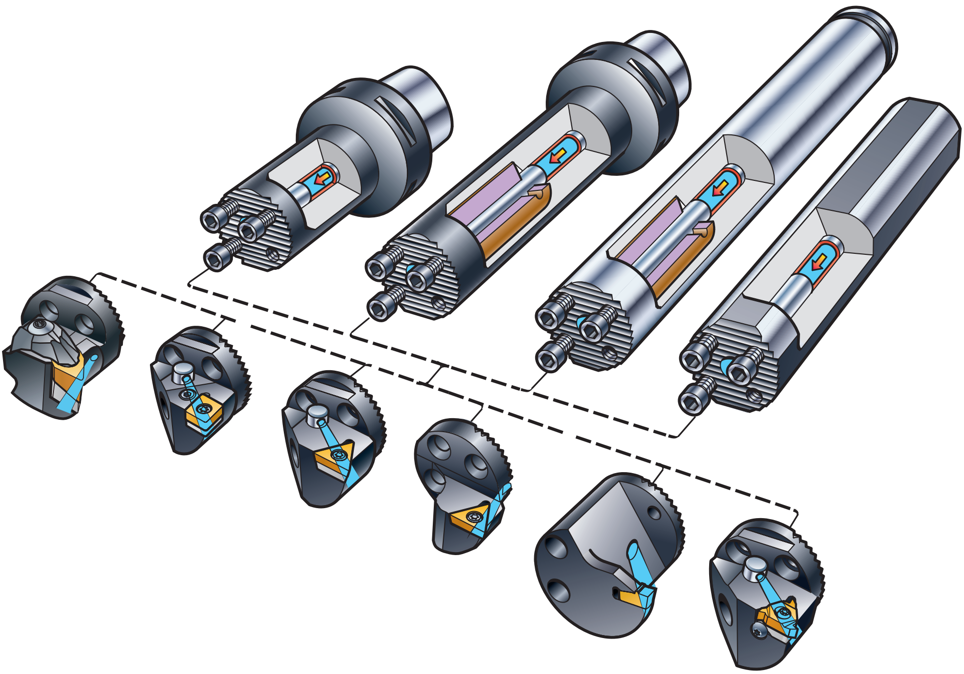
The combination of AP and f_n is important to achieve the best possible chip areas. Two rules of thumb:

- Program AP larger than the nose radius
- Program for an f_n that is a minimum of 25% of the nose radius, depending on what surface finish is required

One of the first things to consider if you experience vibration when machining with long overhangs is to increase the feed and a second remedy, change the cutting speed. Usually, the best results are achieved with higher cutting speed.

Chip area

- If the chip area is too large, the cutting forces are too large
- If the chip area is too small, the friction between tool and work-piece is too great and a rubbing effect can occur



Case one: Turning mud screws

An oil & gas company machining mud screws invited Sandvik Coromant to the workshop to test Silent Tools as the existing solution was not stable enough. By utilizing the stability of the Silent Tools bar and the possibilities of using higher cutting data, the machining time was reduced by nine minutes per component.

Operation	Turning	
Component	Mud screws	
Workpiece material	CMC 20.32 (Stellite Grade 6)	
Machine cost	Euro 94	
	Reference	**Silent Tools**
Adaptor	A24T-DTFNR3	A570-4C D28-15 40
Insert	TNMG 332-MS VP-05RT	SNMG 432-SM
Grade	VP05RT	GC 1105
Cutting data		
n, r/min:	171.98	275.17
D_m mm (inch):	56 (2.20)	56 (2.20)
v_c m/min (ft/min)	30 (100)	49 (160)
f_n mm/r (inch/r)	0.08 (0.003)	0.10 (0.004)
AP mm (inch)	2.5 (0.10)	2.5 (0.10)
Tool life (no of comp.)	1	2
Tot. cycle time, min	21.51	10.08 min
Productivity increase		113%

Application examples

Case two: Turning internal hole

Internal turning is sensitive to vibration. Tool choice is restricted by the component's hole diameter and length, as the depth of the hole determines the overhang.

Minimize the tool overhang and select the largest possible bar diameter in order to obtain optimum stability and accuracy. For internal turning, a dampened Silent Tools boring bar is the first choice.

A customer with a typical internal light roughing operation of a process flange benefitted greatly from a Silent Tools boring bar. By getting rid of the vibration, the spindle speed could be more than doubled, the cycle time reduced by a third and the productivity increased by 188%.

Operation	General internal machining, light roughing	
Component	Process flange	
Workpiece material	CMC 01.1, P1.1.Z.AN, Low alloy steel	
Machine cost	EUR/hour: € 75	
Working hour/week	80	
Dampened adaptors usage	44%	
Machined volume/pc cm^3 ($inch^3$)	54 (3.295)	
Assembly length mm (inch)	406 (15.984)	
	Reference	**Silent tools**
Adaptor		C6-570-3C 40 368
Cutting head		570-DCLNL-40-12-L
Cutting data		
n, r/min:	424	955
D_m mm (inch):	60 (2.360)	60 (2.360)
v_c m/min (ft/min)	80 (263)	180 (591)
f_n mm/r (inch/r)	0.1 (0.004)	0.15 (0.006)
AP mm (inch)	1.0 (0.040)	2.0 (0.079)
Tot. cycle time	91.63 min	31.84 min
Tool life (no of comp.)	1.5	2.65
Productivity increase		188%

Case three: Bearing case, flanged

The customer struggled with vibration and asked Sandvik Coromant for a productive solution. By implementing an A570-3C D32 27-40 boring bar, one of the two boring operations was removed and the productivity could be increased substantially. One comment from the customer:

"Not only did the bar silence my boring operation. It also silenced all the people in the workshop who told me that the Sandvik Coromant tool would not work."

Material	CMC 02.1	
Machine	Dainichi	
Component	Bearing case, flanged	
Operation	Rough boring	
	Reference	**Silent Tools**
Adaptor		A570-3CD3227-40
Cutting head		SL-PTFNL-40-16HP
Insert		TNMG 332-QM GC4215
Cutting data		
n, r/min	227	340
D_m mm (inch)	94 (3.7)	94 (3.7)
v_c m/min (ft/min)	67 (220)	99 (325)
f_n mm/r (inch/r)	0.36 (0.014)	0.41 (0.016)
AP mm (inch)	3.2 (0.125)	3.2 (0.125)
Tot. cycle time, min	28	15
Tool life (no of comp.)	3	8
Productivity increase		**132%**

Case four: Spindle

The spindle production involves mainly internal processing and the existing process included two operations – turning from both sides. The customer experienced two issues: vibration and a need for a simplified process. By implementing a Silent Tools boring bar of 5.3xBD, the turning could be performed from one side, saving time for the customer.

Material	E200 Boehler/ 18CrNiMo7	
Machine	Mazak integrex 300	
Machine cost	EURO 150	
Component	Spindle	
Operation	Internal boring	
	Reference	**Silent Tools**
Adaptor		C6-570-3C 32 159
Cutting head		570-DWLNL-32-08-LE
Insert		WNMG 080408-PM GC4225
Cutting data		
n, r/min	509	1146
D_m mm (inch)	50 (1.97)	50 (1.97)
v_c m/min (ft/min)	80 (262)	180 (590)
f_n mm/r (inch/r)	0.1 (0.004)	0.15 (0.006)
AP mm (inch)	1 (0.039)	1 (0.039)
Tot. cycle time min	68.5	5.95
Tool life (no of comp.)	1	4
Productivity increase		**1052%**

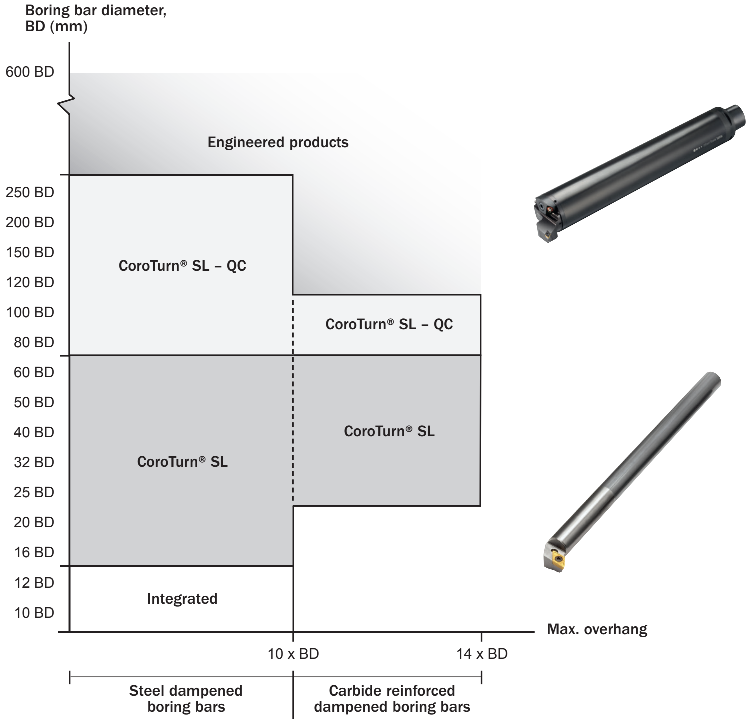
Product overview

Selection of boring bar has a big impact on production economy. The Sandvik Coromant tool program is comprehensive and covers solutions from diameter 10 to 100 millimeter (0.394 to 3.94 inch) as standard off-the-shelf tools that will be delivered within 24 hours. Outside that range, engineered tools up to diameter 600 millimeter (23.6 inch) are available.

Overhangs 3–14 x BD bars are available while for Coromant Capto, you will find sizes from diameter 16 to 100 millimeter (0.63 to 3.94 inch).

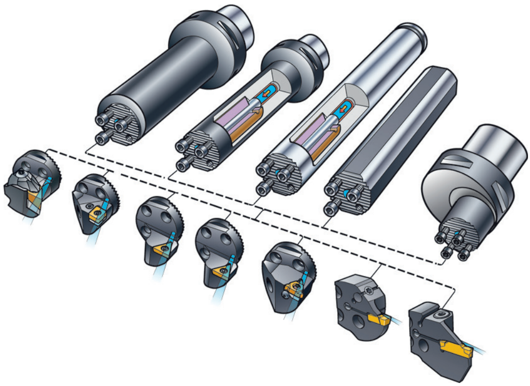
Productive for short overhangs

Generally, you can use a steel or carbide boring bar for overhangs up to 4 x BD, but even in this range, a Silent Tools bar will give you very productive advantages. Overhangs up to 10 x BD are usually solved by applying a steel dampened boring bar to accomplish a sufficient process, while overhangs over 10 x BD require a carbide reinforced dampened boring bar to deal with radial deflection and vibration.



If you work with a combination of cutting heads and Silent Tools dampened boring bars, you can easily change only the head if there is damage on the tip seat.

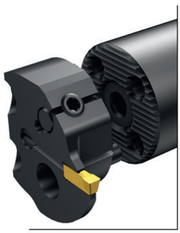
There is a comprehensive offer of around 500 different cutting heads available for general turning, parting & grooving and threading, including Quick Change QS in diameter 32 and 80 mm (1.26 and 3.15 inch). There is also a dedicated program of CoroTurn HP cutting heads available.



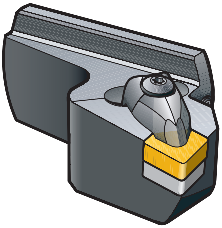
A combination of cutting heads and Silent Tools dampened boring bars gives great flexibility, with cutting heads for different applications.

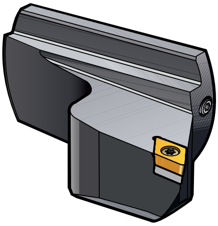
Large cylindrical boring bars come in several different couplings, such as Coromant Capto and Quick Change coupling units.

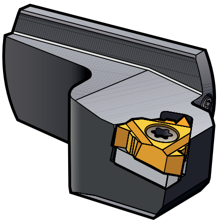
CoroTurn® SL



CoroTurn® SL







Bar types

Internal turning is very sensitive to vibration. Minimize the tool overhang and select the largest possible tool size in order to obtain the best possible stability and accuracy. For internal turning with steel dampened boring bars, the first choice is bars of type 570-3C.

For grooving and rough threading operations where the radial forces are higher than in turning, the recommended bar type is 570-4C.

The table below shows the maximum recommended overhang for different bar types.

The static stiffness of a carbide reinforced bar is improved by about 2.5 times compared to a steel bar with the same overhang.

There are different dampening systems for different overhang lengths:

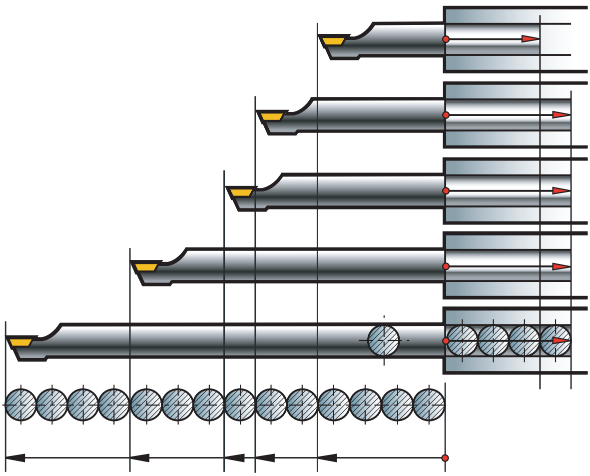
Bar type	Turning	Grooving	Threading
Steel boring bars	4 x BD	3 x BD	3 x BD
Carbide boring bars	6 x BD	5 x BD	5 x BD
Steel dampened boring bars	10 x BD	5 x BD*	5 x BD*
Carbide reinforced dampened boring bars	14 x BD	7 x BD	7 x BD

* 570-4C bars

Select boring bar material to suit the appropriate length to diameter ratio. A carbide bar has a higher static stiffness than a steel bar, which is why a larger overhang can be allowed.

As seen in the figure, the following boring bar materials can be selected to suit the appropriate length to diameter ratio.

Threading and grooving give more radial cutting forces than turning, which limits the recommended maximum overhang. A dampening mechanism increases the dynamic stiffness and allows even larger overhangs.



1 = solid steel bar

2 = carbide bars

3 = steel dampened, short version 4–7 x BD

4 = steel dampened, long version 7–10 x BD

5 = carbide reinforced dampened boring bar 10–12 x BD & 12–14 x BD

Tips and hints, summary

Reduce the risk of vibration by choosing the largest possible bar diameter with the smallest possible overhang. Use recommended clamping length, minimum 4 x BD.

Cut off of the CR boring bars above 10 x BD is not allowed. For 570-4C bars, clamping over the dampening mechanism is allowed, while it is not allowed for 3C bars. When a 570-3C short design bar is cut-off to minimum length, the clamping length must not exceed 3 x BD to avoid clamping over the dampening mechanism. Never cut-off 570-3C bars diameter >100mm (3.94 inch).

Modification of standard bars

Bar diameter	**L, min length after cut off**	
BD	Short design 4–7 × BD	Long design 7–10 × BD
mm	mm	mm
16	100	155
20	125	200
25	155	255
32	190	320
40	240	410
50	305	520
60	380	630
80	630	630
100	770	770

We recommend a min. clamping length of 4 × BD

Bar diameter	**L, min length after cut off**	
BD	Short design 4–7 × BD	Long design 7–10 × BD
inch	inch	inch
0.625	4	7
0.750	5	8
1.000	7	11
1.250	8	13
1.500	10	17
1.750	10.4	18
2.000	12	21
2.500	15	25
3	20	20
4	30.3	30.3

We recommend a minimum clamping length of 4 × BD

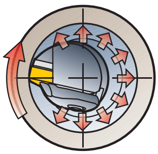
Two lines on the bar indicate minimum and maximum overhang. Make sure that the overhang is within that range. Outside this range, there is no guarantee for the dampening function.

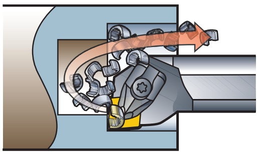
Chip evacuation

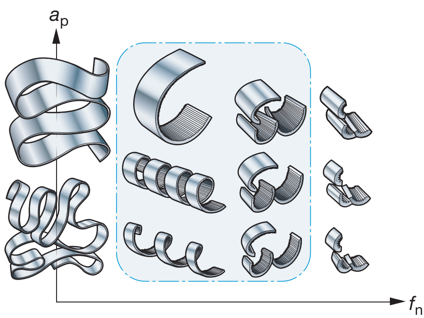
For best chip evacuation, use a tool holder with integrated coolant and an insert geometry that gives short and spiral formed chips. If you experience poor chip evacuation; try to increase the coolant flow, change the insert geometry or increase the cutting speed to get shorter chips.

Another alternative is to consider an alternative tool path. Up-side-down cutting units actually permit improved chip evacuation.

Ensure that there is enough room for the chips between bar and hole. Otherwise, the tool can press the chips onto the surface and also damage the tool body.







Adjustment of nozzles

Use a hexagon key to turn the coolant flow on or off. For SL Quick Change heads, use the same hexagon key to adjust the direction of the nozzles.

Wiper inserts

For better surface finish and higher productivity, wipers can be an optimizer in very stable conditions. General recommendations when using wipers are to increase the feed and choose a smaller nose radius.

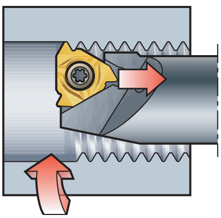
Internal threading

To reduce the risk of vibration, use the following tips:

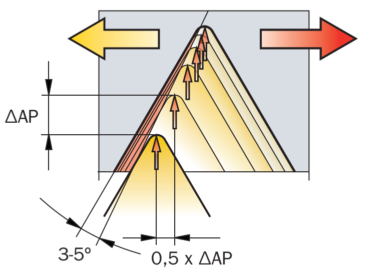
- Use modified flank feed
- Infeed per pass should not exceed 0.2 mm (0.008 inch) and never be less than 0.06 mm (0.002 inch)
- Final pass, always with reduced infeed rate
- Use a sharp geometry for lowest cutting forces

For best chip evacuation:

- Use modified flank feed to lead the spiral chips towards the opening of the hole
- Use inside-out feed direction in stable conditions. Choose left or right flank to steer the chip flow
- Use coolant for best chip evacuation



Feed direction from inside out



Modified flank infeed directs the chips out from the hole

Internal grooving and profiling

Reduce the risk of vibration by applying the following tips:

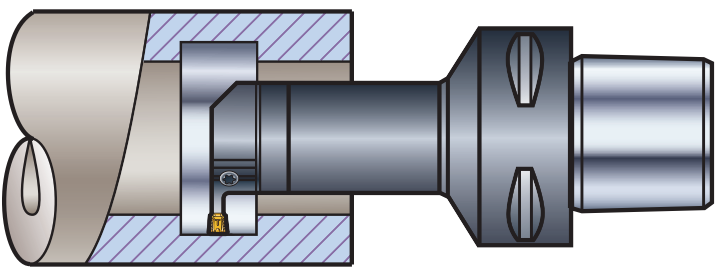
- Set-up should have the shortest possible overhang with the lightest cutting geometry possible
- Use a smaller insert and make several cuts instead of one
- Start from the outside and make overlapping cuts inwards for best chip evacuation
- A finishing operation can be a side turning motion. Start from the inside and turn outwards
- Ramping/turning can be used for improved chip control and may reduce vibration
- Use right- or left hand style inserts to direct the chips when roughing

Common set-up

Running the bar conventionally generates cutting forces that push the insert downwards.

Alternative set-up

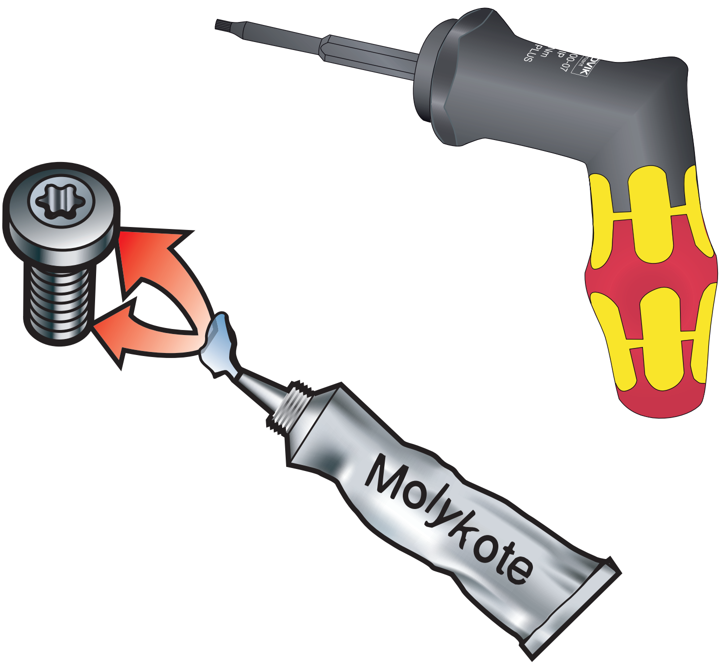
Running the bar upside down changes the direction of the cutting forces which improves the stability. This can also improve chip evacuation. This method requires careful considerations, even in small diameters. If the cutting force is reduced to 0 by interrupted cut, the bar will bounce against the workpice in turning direction and receives a larger cut force which can damage both tool and component.



Treatment

For best performance, clean all parts and lubricate with oil at least once a year. Lubricant should also be applied to the screws when needed. Replace worn or exhausted screws and washers.

Dampened bars can become deformed due to the thin wall thickness. When assembling, ensure that the bars are held correctly. Always check the clamping when working with Silent Tools products. Use a torque wrench for correct screw-tightening.



Summary: How to avoid vibration

Increase static stiffness

- Check the clamping and set-up
- Use Coromant Capto or split holder
- Minimum tool overhang and maximized diameter
- Material reinforcement (boring bars)

Increase dynamic stiffness

- Small insert point angle
- Use dampened tools
- As low weight in front of the cutting tool as possible

Reduce the cutting forces

- Use a positive cutting angle
- Use a positive insert geometry with small ER

Avoid deflection

- Change the direction of the cutting force from radial to axial
- Entering angle close to 90° (lead angle 0°)
- Depth of cut bigger than nose radius

Enable chip control

- Increase coolant flow
- Clearance between tool and workpiece
- Check that all chips have been evacuated

Note!

Be sure not to overload the dampened boring bar. Maximum load is marked on the products and you can also use the calculator available at www.sandvik.coromant.com/knowledge to find maximum load.

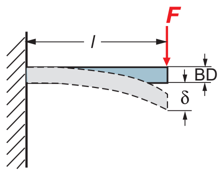
4. Boring

Main considerations

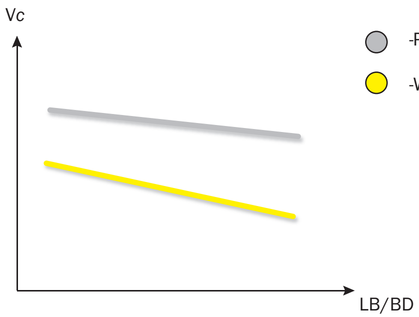
The Silent Tools boring tools reach a maximum of six times the bore diameter into your workpiece. If you need to go deeper, ask for an engineered solution.

Our recommendation is to always use Silent Tools for long overhangs, over 4 x BD.

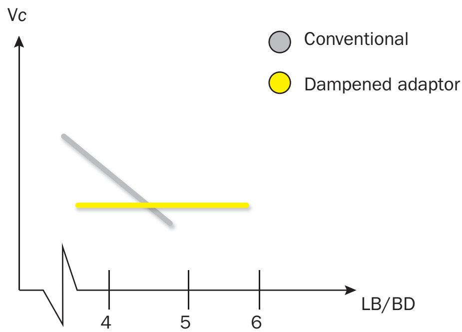
Tool overhang and diameter of tool



- Choose largest Coromant Capto size possible
- Choose shortest possible basic holder
- If possible, use a heavy duty basic holder
- For overhangs over 4 x BD, use dedicated tools, e.g Silent Tools.



Cutting speed in relation to overhang, with different geometries



Cutting speed in relation to overhang, with conventional and dampened adaptors

Insert shape and entering angle/lead angle

Use entering angle 90° (0°) for roughing and 92°(-2°) for finishing. Less force in the radial direction gives less radial deflection and vibration. Triangular-shaped inserts (T-style) are first choice for boring operations. CoroTurn® 107 inserts meet these requirements and are first choice.

Nose radius

The nose radius, RE, on the insert is a key factor in turning operations. Selection of nose radius depends on the:

- Depth of cut, AP
- Feed, f_n

and influences the:

- Surface finish
- Chip breaking
- Insert strength

Small nose radius

- Ideal for small cutting depths
- Reduces vibration
- Less insert strength

Large nose radius

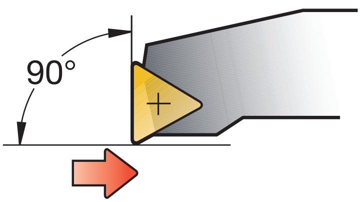
- Heavy feed rates
- Large depths of cut
- Stronger edge
- Increased radial forces

Nose radius in relation to depth of cut

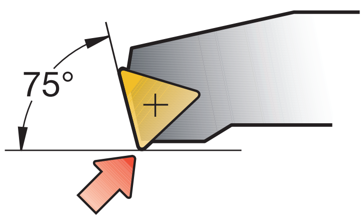
The radial forces that push the insert away from the cutting surface become more axial as the depth of cut increases. The nose radius also affects the chip formation. Generally, chip breaking improves with a smaller radius. As a general rule of thumb, the depth of cut should be greater than or equal to 2/3 of the nose radius or half the nose radius in the feed direction.

Feed starting values depending on nose radius

Nose radius size *(mm)*	0.4	0.8	1.2
Feed *(mm/r)*	0.17	0.22	0.27



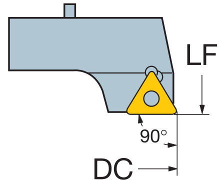
Force direction mainly axial



Force direction both axial and radial

Rough boring

Choose a roughing geometry unless a small depth of cut is needed. For smaller cutting depths, use a medium geometry. Recommended nose radius: 0.8 mm (0.031 inch) and if you experience problems, try 0.4 mm (0.016 inch). For severe problems, try to use only one insert.



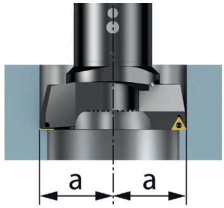
Rough boring slide and insert

With Sandvik Coromant dampened rough boring tools three different tool set-ups are possible:

- Productive boring: two inserts with the same length and diameter
- Step boring: Additional shim under one of the slides
- Single-edge boring: Replace one of the slides with a cover

Productive boring

Involves two cutting edges and is employed for roughing operations of holes, with tolerance IT9 or larger, where metal removal rate is the first priority. Feed rate is obtained by multiplying the feed by the number of inserts. ($f_n=f_z$ x ZEFF)

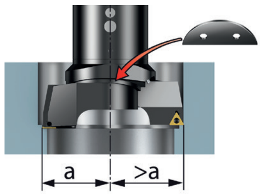


Productive boring

Step boring

When adding a shim under one of the slides, the insert will only take the inner half of the desired radial cut, and the result is a step-boring tool. Select this method if you want to take a larger radial cut than one insert can take, but remember to reduce the axial feed to what is normal for a tool with only one cutting edge.

If the two inserts are set to take the same radial depth of cut, the outer one will always take the largest cutting force, due to higher speed and more chip removal. By doing this right, vibration can easily be avoided and a smooth surface is guaranteed. This set-up will produce a stepped shoulder if it is not going through the work-piece.



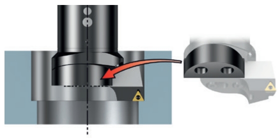
Step boring

The feed rate and the produced surface finish is the same as if only one insert is used ($f_n=f_z$). Produced hole tolerance is IT9 or larger.

Single-edge boring

Single-edge boring is the best option when:

- You need to reduce cutting forces due to a low power machine
- You have problems with vibration
- Close tolerances, accurate roundness or good surface finish is required



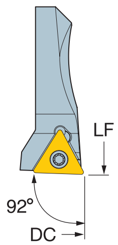
Single-edge boring

Produced hole tolerance is IT9 or larger.

Finish boring

The finish boring tools are single-edge tools with radial micrometer adjustment on the cutting unit head. Finishing is used when close hole tolerances and excellent surface finish are needed.

Choose a light cutting insert with a positive cutting geometry. First choice is knife-edge inserts (TCGT L-K). Use a small nose radius of 0.2 mm (0.008 inch), maximum 0.4 mm (0.016 inch).



Finish boring cartridge and insert

Tolerance of hole diameter

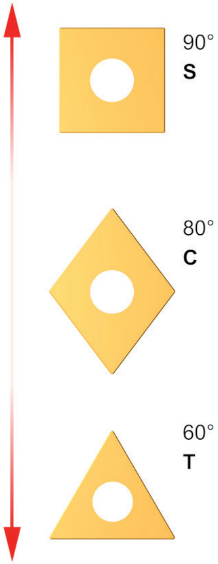
For finishing with one insert, a tolerance of IT7 can be achieved in good conditions. The tolerance will be influenced by the clamping of the tool holder, fixtures of the component and wear of insert. We recommend a measuring cut to decide what adjustments are needed to compensate for tool deflection. To achieve good surface finish and close hole tolerances, it is also important to use cutting fluids to prevent recutting of chips and heat expansion of the tool and workpiece.

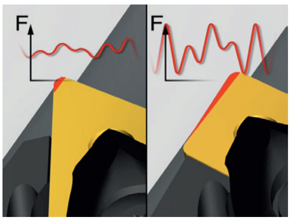
Vibration influence factors

To reduce vibrations, choose a light cutting insert with a positive cutting geometry and small nose radius. T-style inserts are first choice for boring operations.

High vibration tendency

– Heavy feeds
– Large depth of cut
– Strong edge security





Less vibration tendency

– Ideal for small depth of cut
– Reduces vibration

Information about other vibration influence factors such as the following can be found in the application guide on page 41-47.

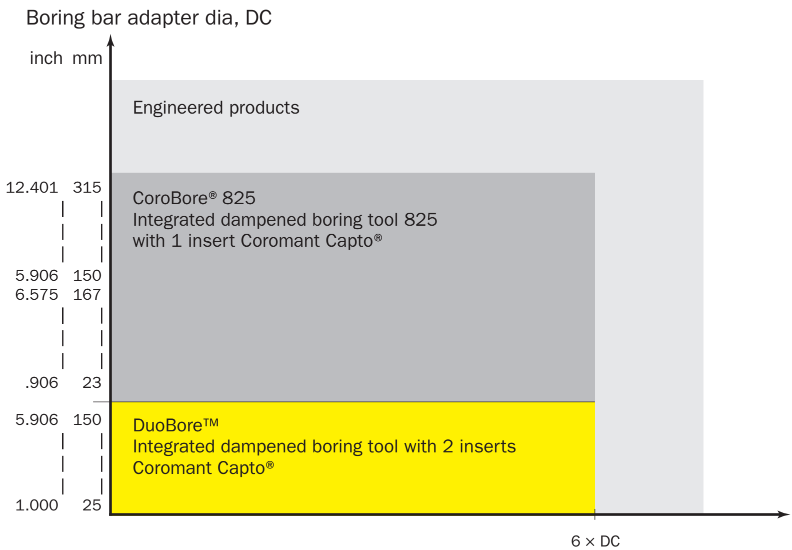
- Insert point angle
- Positive geometries
- Wiper inserts
- Edge rounding
- Cutting data and cutting speed.

Product overview

Sandvik Coromant offers dampened boring tools for rough and finish boring. The adapters are designed with Coromant Capto back-end couplings for best possible clamping and flexibility. This gives you unique flexibility and modularity to build desired tool assemblies. Coromant Capto basic holders are available in all common machine interfaces.

Silent Tools finish and rough boring tools give increased productivity and close tolerances from lengths of 3–10 x BD. When using Silent Tools, you have the opportunity to double the depth of cut. Through coolant is a feature for precise direction of jets to the cutting zone.

Using extension and reduction adaptors are possible on dampened boring tools, but the tool will no longer be optimized. However, a dampened tool with extension or reduction still performs better than an undampened tool.



Rough boring	Fine boring	
Boring range mm (inch) Ø25-150 (0.98–5.9)	Boring range mm (inch) Ø23-167 (0.90–6.6)	Boring range mm (inch) Ø150-315 (5.9–12.4)
Dampened DuoBore™	Dampened CoroBore® 825/826	
		
Coromant Capto® back-end coupling Coolant through		

DuoBore™ 821 rough boring tools

Dampened DuoBore adapters for roughing are designed with two inserts for high productivity in boring applications against shoulders and through holes. The tool can be assembled in three different tool setups: Productivity, step-boring and single edge boring. Read more on page 71.

Boring range	25-150 mm (0.984–5.906 inch)
Boring depth	6 x DC (23.6–27.6 inch)
Hole tolerance	IT9
Cutting fluid	Internal
Insert size/types:	90°(0°) CoroTurn 107°, 75°(15°) CoroTurn 107°

CoroBore® 825/826 – finish boring tools

Dampened CoroBore 825 and CoroBore 826 are designed for finishing operations with excellent surface finish and close tolerances even in long overhangs, with possibilities to double the depth of cut and still obtain the same excellent surface finish.

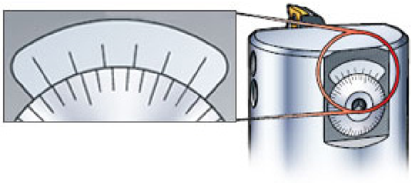
Boring range	23-315 mm (.906-12.402 inch)
Boring depth	6 x BD
Hole tolerance	IT6
Cutting fluid	Internal
Diameter adjustment:	0.002 mm (0.000079 inch)
Insert types	92°(-2) CoroTurn 107°, 92°(-2) CoroTurn 111°

Radial adjustment of fine boring head:

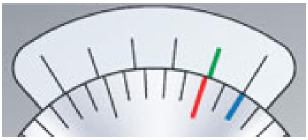
- Diameter adjustment of 2 microns
- Two different diameter setting mechanisms
  - 825 - Nonie scale (dia 23–315 mm, 0.90–12.4 inch)
  - 826 - A click for each diameter increment (dia 150–315 mm, 5.90– 12.4 inch)

How to use CoroBore® 825

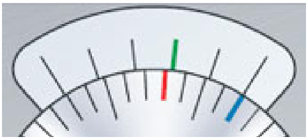
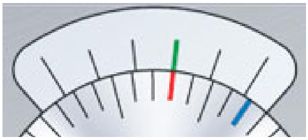
Example of setting: In this example the blue line on the scale disc is a reference since it is aligned to a line on the vernier in the starting position.



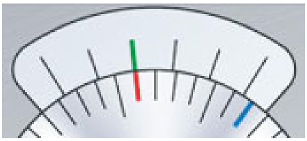
Start position | **Adjusted position**



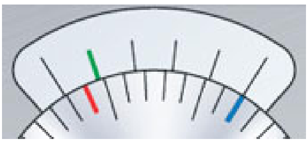
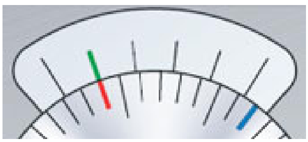

Scale disc turned clockwise until the line of scale (red) lines up with the second line (green) of the vernier. Diameter increased by 0.002 mm (0.00008")

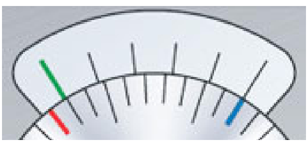
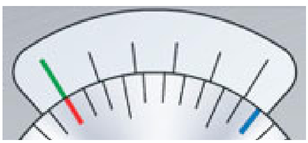
Scale disc turned clockwise until the line of scale (red) lines up with the third line (green) of the vernier. Diameter increased by 0.004 mm (0.00016")

Scale disc turned clockwise until the line of scale (red) lines up with the fourth line (green) of the vernier. Diameter increased by 0.006 mm (0.00024")

Scale disc turned clockwise until the line of scale (red) lines up with the fifth line (green) of the vernier. Diameter increased by 0.008 mm (0.00032")

Scale disc turned clockwise until the line of scale (red) lines up with the sixth line (green) of the vernier. Diameter increased by 0.010 mm (0.0004") = 1 division of scale.

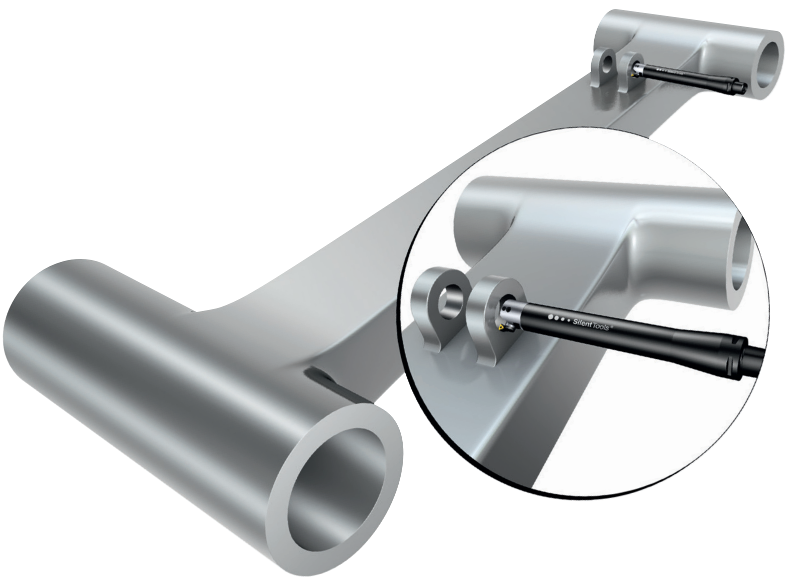
Application examples

Case one: Lug holes, landing gear

Machining of an aerospace part, with a length of 2.1 m (7 ft) and width of 0.91 m (3 ft) was an accessibility challenge. The component has two lug holes in line on the outside and the process consisted of semi-roughing both lugs from one side. Then followed a finish pass and a ream pass of one lug hole from one side, followed by a set-up of the part to the opposite side, dialing it in to centre, completing with a new finish- and ream pass.

The Sandvik Coromant solution was to combine finishing and reaming operations and use a Silent Tool to bore both lug holes in one operation. This improved the process by eliminating the set-up time to move the part and dial in. All machining was performed from one side and the reaming operation was eliminated.

As shown in the data below, both cutting speed and feed could be increased and after nine manufactured components, the return on investment was achieved! A staggering productivity increase of 228% for the complete component.



Operation	Finishing	
Workpiece material	300M, high alloy steel	
Machine cost EUR/hour	€ 75	
Dampened adaptors usage	6%	
Machined volume/pc cm^3 (inch^3)	0.07 (0.004)	
ZEFF	1	
Assembly length mm (inch)	332 (13.071)	
	Reference	**Silent tools**
Adaptor		C5-R825B-FAD315A
Cutting data:		
n, r/min	203.7	254.6
v_c m/min (ft/min)	30.5 (100)	38.1 (125)
D_m mm (inch)	47.6 (1.874)	47.6 (1.874)
f_n mm/r (inch/r):	0.005 (0.0002)	0.038 (.0015)
AP mm (inch)	0.05 (0.002)	0.05 (0.002)
Tot. cycle time (min)	219.82 min	66.93 min
Tool life (no of components)	1	1
Productivity increase		228%

Case two: Boom bracket

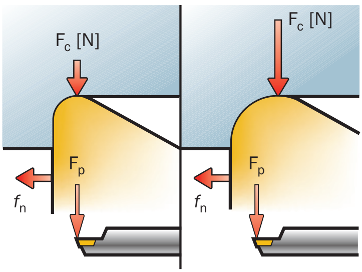
A customer producing boom brackets used a tailored boring bar with positive inserts for his application. He experienced vibration, poor surface finish and short insert tool life, even with low cutting data. The component was positioned horizontally and the operation included interrupted cuts.

By changing to a CoroBore 825 finish tool, the cutting data could be increased as well as the component quality. The customer could double his output, going from 600 components in 2011 to 1,200 in 2012.

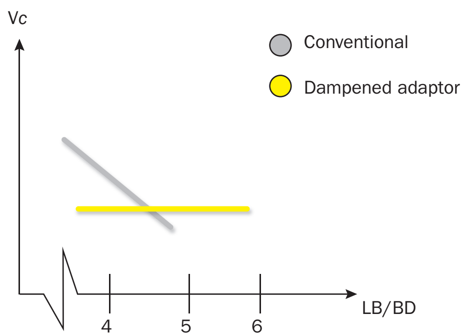
Operation	Boring	
Workpiece material	CMC 09.1/ GGG50	
	Reference	**Silent tools**
Adaptor		C5-R825C-FAE237A
Cartridge		R825C-AF23STUP1103A
Insert		TPMT 110304-KF
Cutting data:		
n, r/min	424	955
v_c m/min (ft/min)	80 (262)	180 (590)
D_m mm (inch)	60 (2.36)	60 (2.36)
f_n mm/r (inch/r)	0.06 (0.0023)	0.10 (0.004)
AP mm (inch)	1.5 (0.059)	1.5 (0.059)
Depth of hole	190	190
Tot. cycle time (min)	15.32 min	3.99 min
Tool life (no of components)	1	31
Productivity increase		**284%**

Tips and hints, summary

- Choose the largest possible tool diameter with the shortest possible basic holder
- The entering angle should be close to 90 degrees to give more axial cutting forces and less radial/tangential forces
- A small nose radius is ideal for small depths of cut and decreases the risk of vibrations. Large nose radii have strong edge security and allow for heavy feeds and large depths of cut. The risk of vibration gets higher the larger nose radius you use. Therefore, triangular, positive style inserts are first choice for dampened boring operations
- In stable conditions, use wiper inserts for high productivity or when high quality surfaces are required

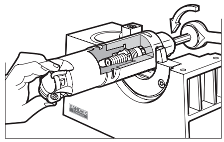


Less radial forces (Fc) with small radii

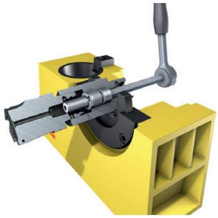


Cutting speed in relation to overhang, with conventional and dampened adaptors

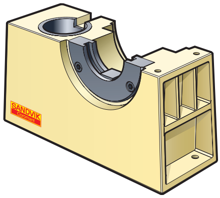
Tool assembly and maintenance



When using dampened tools in assemblies, care should be taken to hold the tool bodies correctly to make sure that the adaptors are not damaged. These are easily deformed due to the thin wall thickness.



- Use assembly mounting fixture
- Check that all units are assembled correctly, with the correct torque
- Check machine spindle, run-out, wear and clamping force
- Always use a torque wrench and apply recommended torque on screws for insert and tool assembly
- Check inserts and insert seats regularly
- Replace worn or exhausted screws and washers
- Clean all assembly items before assembly
- Lubricate all assembly items with oil at least once a year
- Lubricate the fine adjustment mechanism for fine boring regularly



5. Engineered solutions

Offer

The standard off-the-shelf boring bar offer represents a good platform for optimized solutions and high productivity. When a tailor made solution is needed, engineered versions of dampened boring bars are available for order.

The engineered dampened boring bars are often tapered, elliptical and/or curved, with the mounting adapted to the machine. Bars with overhangs of up to 14 x BD are available.

Silent Tools – engineered solutions

Turning-, milling- and boring adapters can be engineered with most of the common back- and front-end couplings.

Back-ends:

- Coromant Capto
- HSK
- MAS BT
- VDI
- VTL
- DIN 2080
- ISO 7388/1
- Cylindrical

Front-ends:

- CoroTurn SL
- CoroTurn SL quick change
- DuoBore
- CoroBore 825
- Arbor

Engineered adapters come with diameters ranging from 10–600 mm (0.394–23.62 inch). For turning adapters, the overhang ratio is up to 14 x BD, while the milling and boring adaptors have overhang ratios up to 10 x BD.

Optimized design

For best performance and highest possible static stiffness in the bar body and a damping system, the tools are are designed for defined applications.

Special solutions for multi-task machine tools

As multi-task machines are equipped with all the necessary tooling when performing a complete machining in one set-up, they have to store both short and long tool holders in the tool magazine, plus all the cutting units needed for performing the complete operations.

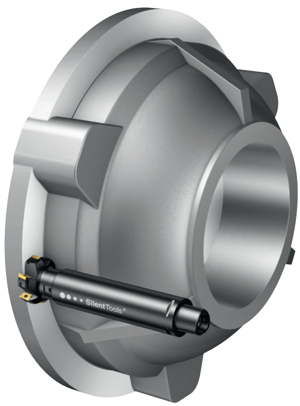
A range of long boring bars, with a manual or an automatic front-clamp system is available for the most common machines supplied by Mazak, WFL, Mori-Seiki, Niles–Simmons, Weingärtner, DMG and Okuma.

Ask your yellow coat representative to help you order your engineered solution.

Application example

Operation	Face milling	
Component	Upper body steering unit	
Workpiece material	CMC 09.1, K3.2.C.UT, Nodular cast iron	
Machine cost	125 EUR/hour	
Machined volume	122 (7.45)/pc cm^3 (inch^3)	
ZEFF	6	
Assembly length	300 mm (11.81 inch)	
	Reference	**Silent Tools**
Adaptor		S-391.06-22 260//ISO50
Cutting head		R390-063Q22-18H
Cutting data		
n (r/min)	760	1197
v_c (m/min (ft/min))	150 (492)	237 (778)
f_z (mm (inch))	0.32 (.013)	0.18 (.007)
v_f (mm/min (inch/min))	1.200 (47.25)	1.320 (52.00)
AP (mm (inch))	1.0 (.040)	3.0 (.120)
a_e (mm (inch))	31.5 (1.240)	31.5 (1.240)
Tot. cycle time	59.75 min	22.77 min
Tool life (no of comp.)	1	3

Changing a machining process that actually worked well, to a Silent Tools engineered solution, saved the customer 185 hours of production time per year. The upper body steering unit for a ship required a special dampened milling adaptor to achieve a greater depth of cut and to speed up the whole process. This face-milling operation isolated, increased the productivity of the component by 162%!



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6. Formulas and definitions

Milling – METRIC

Table feed, mm/min

$$v_f = f_z \times n \times ZEFF$$

Cutting speed, m/min

$$v_c = \frac{\pi \times DC_{ap} \times n}{1000}$$

Spindle speed, r/min

$$n = \frac{v_c \times 1000}{\pi \times DC_{ap}}$$

Feed per tooth, mm

$$f_z = \frac{v_f}{n \times ZEFF}$$

Feed per revolution, mm/rev

$$f_n = \frac{v_f}{n}$$

Metal removal rate, cm³/min

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

Net power, kW

$$P_c = \frac{a_e \times AP \times v_f \times k_c}{60 \times 10^6}$$

Torque, Nm

$$M_c = \frac{P_c \times 30 \times 10^3}{\pi \times n}$$

Milling – INCH

Table feed, inch/min

$$v_f = f_z \times n \times ZEFF$$

Cutting speed, ft/min

$$v_c = \frac{\pi \times DC_{ap} \times n}{12}$$

Spindle speed, rpm

$$n = \frac{v_c \times 12}{\pi \times DC_{ap}}$$

Feed per tooth, mm

$$f_z = \frac{v_f}{n \times ZEFF}$$

Feed per revolution, inch/rev

$$f_n = \frac{v_f}{n}$$

Metal removal rate, inch³/min

$$Q = AP \times a_e \times v_f$$

Net power, HP

$$P_c = \frac{a_e \times AP \times v_f \times k_c}{396 \times 10^3}$$

Torque, lbf ft

$$M_c = \frac{P_c \times 16501}{\pi \times n}$$

Symbol	Designation/ defination	Metric	Inch
a_e	Working engagement	mm	inch
AP	Cutting depth	mm	inch
DC_{ap}	Cutting diameter at cutting depth AP	mm	inch
D_m	Machined diameter (component diameter)	mm	inch
f_z	Feed per tooth	mm	inch
f_n	Feed per revolution	mm/r	inch
n	Spindle speed	rpm	rpm
v_c	Cutting speed	m/min	ft/min
v_f	Table feed	mm/min	inch/min
ZEFF	Number of effective teeth	pcs	pcs
h_{ex}	Maximum chip thickness	mm	inch
h_m	Average chip thickness	mm	inch
k_c	Specific cutting force	N/mm^2	$N/inch^2$
P_c	Net power	kW	HP
M_c	Torque	Nm	lbf ft
Q	Metal removal rate	cm^3/min	$inch^3/min$
KAPR	Entering angle	degree	
PSIR	Lead angle		degree
BD	Body diameter	mm	inch
DC	Cutting diameter	mm	inch
LU	Usable length	mm	inch

Turning – METRIC

Cutting speed, m/min

$$v_c = \frac{\pi \times D_m \times n}{1000}$$

Spindle speed, r/min

$$n = \frac{v_c \times 1000}{\pi \times D_m}$$

Machining time, min

$$T_c = \frac{l_m}{f_n \times n}$$

Metal removal rate, cm³/min

$$Q = v_c \times AP \times f_n$$

Penetration rate, mm/min

$$P_c = \frac{v_c \times AP \times f_n \times k_c}{60 \times 10^3}$$

Turning – INCH

Cutting speed, ft/min

$$v_c = \frac{\pi \times D_m \times n}{12}$$

Spindle speed, rpm

$$n = \frac{v_c \times 12}{\pi \times D_m}$$

Machining time, min

$$T_c = \frac{l_m}{f_n \times n}$$

Metal removal rate, inch³/min

$$Q = v_c \times AP \times f_n \times 12$$

Penetration rate, in/min

$$P_c = \frac{v_c \times AP \times f_n \times k_c}{33 \times 10^3}$$

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Symbol	Designation/ defination	Metric	Inch
D_m	Machined diameter	mm	inch
f_n	Feed per revolution	mm/r	inch/r
AP	Cutting depth	mm	inch
v_c	Cutting speed	m/min	ft/min
n	Spindle speed	rpm	rpm
P_c	Net power	kW	HP
Q	Metal removal rate	cm^3/min	$inch^3$/min
h_m	Average chip thickness	mm	inch
h_{ex}	Maximum chip thickness	mm	inch
T_c	Period of engagement	min	min
l_m	Machined length	mm	mm
k_c	Specific cutting force	N/mm^2	$N/inch^2$
KAPR	Entering angle	degree	
PSIR	Lead angle		degree
BD	Body diameter	mm	inch
DC	Cutting diameter	mm	inch
LU	Usable length	mm	inch

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Turning – METRIC

Tangential force, F_t

$$F_t = k_{c\,0,4} \times \left(\frac{0,4}{f_n \times \sin KAPR}\right)^{m_c} \times f_n \times AP$$

$k_{c\ 0,4}$: Specific cutting force at feed 0,4 mm/r
m_c Constant, depending on the material. Use 0,29 as general value.

When the entering angle. KAPR, is 75 degrees or longer, sin KAPR ~1. Use the simplified formula:

Tangential force, F_t

$$F_t = k_{c\,0,4} \times \left(\frac{0,4}{f_n}\right)^{0,29} \times f_n \times AP$$

Rule of thumb: F_t should not exceed 90% of maximum load stated for the bar used.

3-pass method

Method for achieving high accuracy in internal turning with slender boring bars where the deflection of the bar affects the obtained diameter.

1. Enter the desired finished diameter: **40.000**
2. Measure the diameter before the first pass: 37.000
3. Run the first pass. The programmed diameter is:
   37.000 + (40.000 – 37.000)/3=38.000
4. Measure the diameter before second pass: 37.670
5. Run the second pass. The programmed diameter is:
   38.000+(40.000-37.670)/2=39.165
6. Measure the diameter before the third pass: 38.825
7. Run the third pass. The programmed diameter is:
   40.000+39.165-38.825=40.340
8. Measure the final diameter: **40.020**. Deviation: 0.020

Boring – METRIC

Cutting speed, m/min

$$v_c = \frac{\pi \times D_m \times n}{1000}$$

Spindle speed, r/min

$$n = \frac{v_c \times 1000}{\pi \times D_m}$$

Machining time, min

$$T_c = \frac{l_m}{f_n \times n}$$

Metal removal rate, cm^3/min

$$Q = v_c \times AP \times f_n$$

Penetration rate, mm/min

$$V_f = f_n \times n$$

Feed per revolution, mm/r

$$f_n = ZEFF \times f_z$$

Boring – INCH

Cutting speed, ft/min

$$v_c = \frac{\pi \times D_m \times n}{12}$$

Spindle speed, rpm

$$n = \frac{v_c \times 12}{\pi \times D_m}$$

Machining time, min

$$T_c = \frac{l_m}{f_n \times n}$$

Metal removal rate, $inch^3$/min

$$Q = v_c \times AP \times f_n \times 12$$

Penetration rate, in/min

$$V_f = f_n \times n$$

Feed per revolution, in/r

$$f_n = ZEFF \times f_z$$

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