WHISPERLINE

ANTI-VIBRATION

Reference Guide

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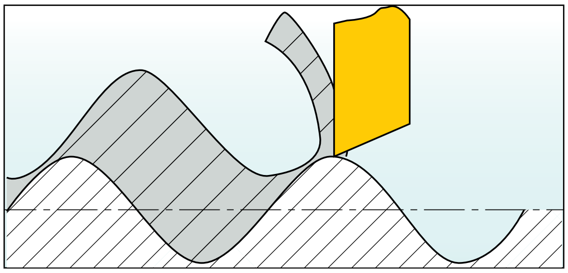
Chatter Suppression Method of ISCAR's Anti-Vibration Tools

Cutting tool vibration is a well-known problem in machining. The most common issue is that of self-excited vibrations, also known as "chatter."

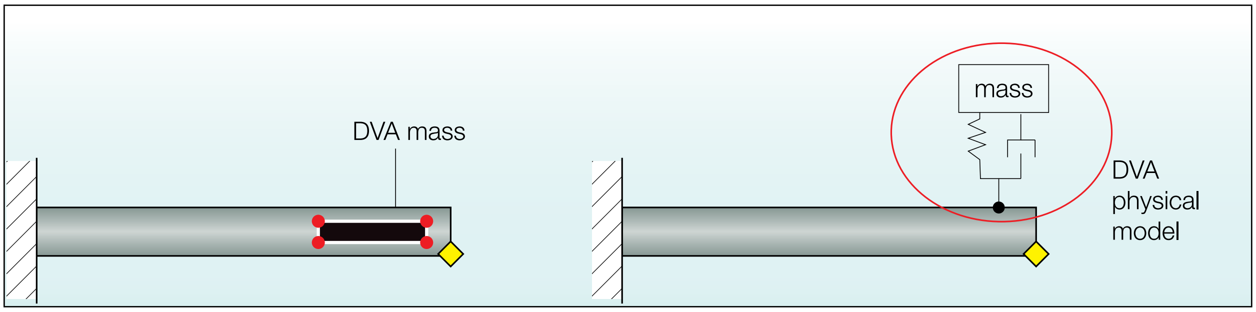
During machining, a vibrating tool generates undulation on a workpiece surface. In a subsequent tool pass, the cutting edge would then be machining the previously generated wavy surface - leaving behind a newly generated wavy pattern, as shown in the figure below. The chip thickness and therefore the cutting forces vary with time. This phenomenon can greatly amplify vibrations and develop chatter.



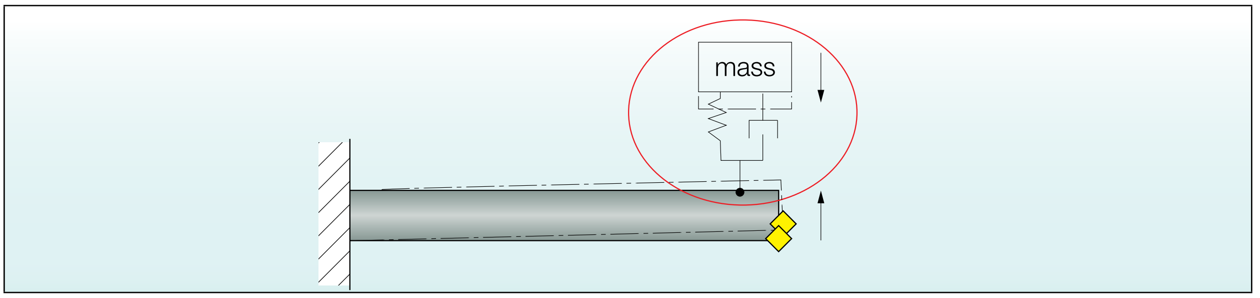
Chatter vibrations are detrimental to the safety and quality of machining operations. They cause a rough surface finish, increase cutting forces, reduce tool and machine life, decrease productivity, and create irritating high noises.

During internal turning, the tool usually has a large overhang (large L/D). In general, where L/D>3, chatter vibrations become apparent due to high tool flexibility and low damping.

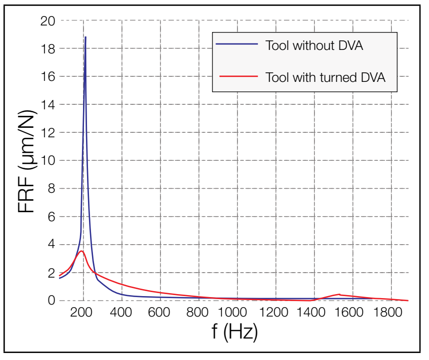
ISCAR's anti-vibration tools are designed for operations in which large overhangs are required. These tools include Dynamic Vibration Absorber (DVA) systems to increase damping and therefore stability during machining – see figure below. The DVA is a heavy Tungsten mass supported by elastomeric components and located in an internal cavity at the furthest available position in the tool.



A mechanism is designed to preload the elastomers and therefore to modify the stiffness of their equivalent spring. Modification of the spring stiffness causes a change of the DVA natural frequency. The DVA system is tuned such that its natural frequency is brought close to that of the tool without DVA. This is done in order to introduce a phase shift between the tool and the DVA mass vibration, eventually causing attenuation of the oscillation amplitude of the tool.



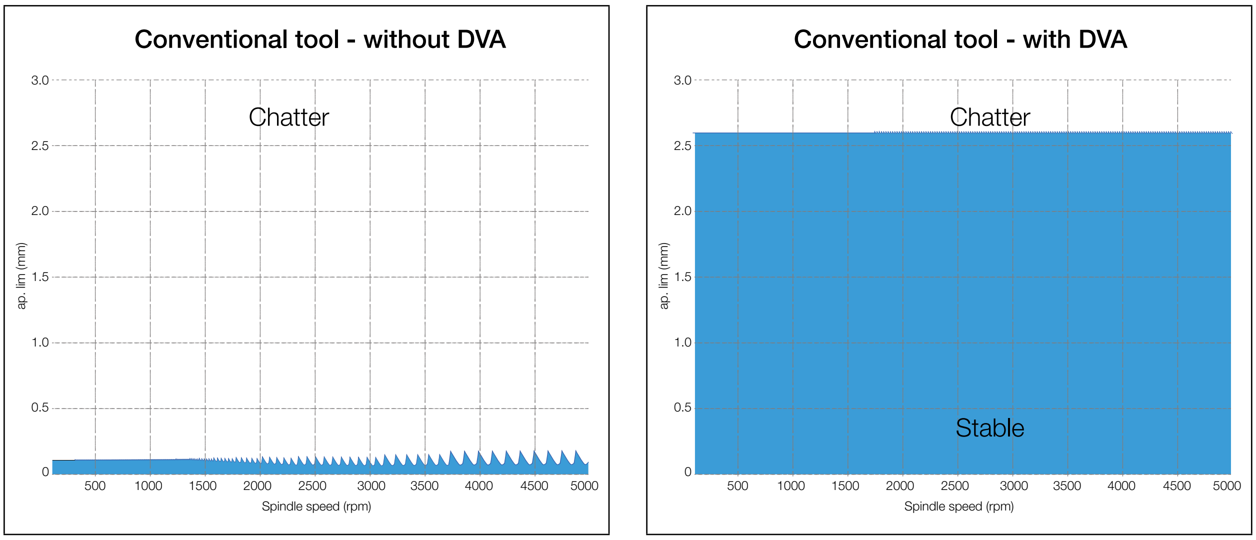
The tuning procedure is performed by experimental modal analysis as shown in the figure below. A modal hammer is used for applying and measuring impact forces and an accelerometer is used for measuring the resulting acceleration. Using these signals, the Frequency Response Function (FRF) which reflects the tool dynamic flexibility is obtained.
The FRF of ISCAR's anti-vibration tools may be compared to those of conventional ones without DVA at the same overhang length – see figure below. Due to the high damping, ISCAR'S anti-vibration tools have relatively a very low FRF peak magnitude.



The border between a stable cut and an unstable one can be demonstrated in the plane of depth of cut (ap) and spindle speed and it is known as the Stability Lobe Diagram (SLD). The SLD can be used to find the machining parameters that result in the maximum chatter-free material removal rate. The SLD can be obtained using a tool FRF and machining conditions.

Decreasing the FRF peak magnitude, via increasing the tool damping, yields an enhancement in its stability limit. The SLD's of ISCAR's anti-vibration tools and corresponding conventional tools are compared in the figure below, where ISCAR's anti-vibration tools show a considerably higher stability limit than that of conventional tools.

Tool stiffness and mounting rigidity also affect the FRF and the stability limit of the tool. Increasing the mentioned stiffness will cause improvement in the FRF and stability limit.



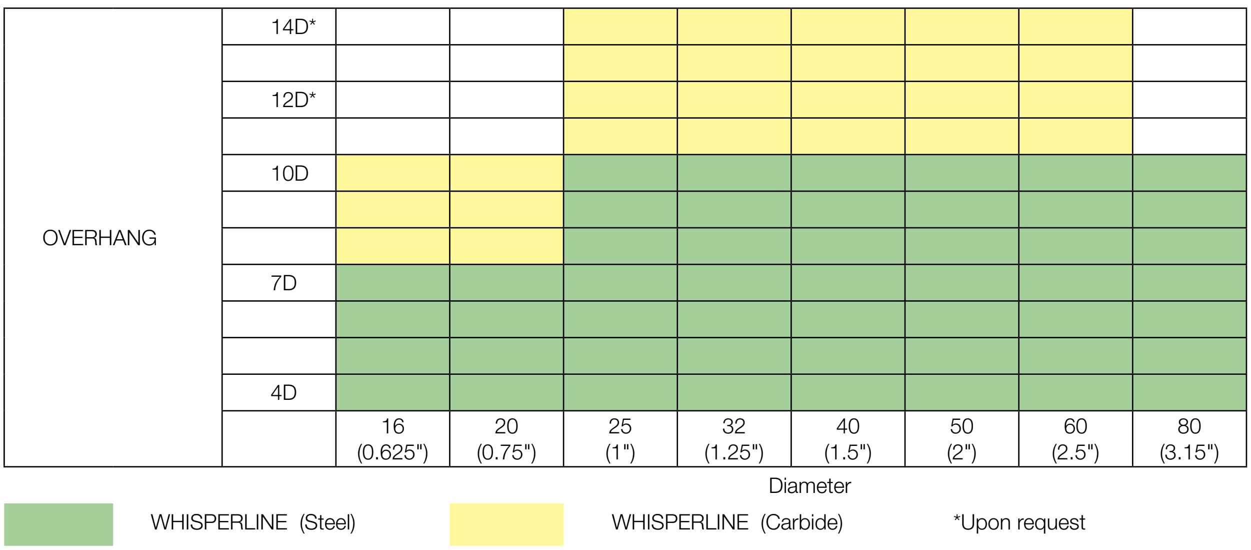
User Guide
WHISPERLINE – Vibration Damping Tools for Lathe Machines

Vibrations are one of the most common problems that limit machining. In more severe cases an operation becomes impossible due to excessive vibrations. In other cases, machining is possible, but at the cost of reduced cutting conditions. Additional effects of vibration include worse surface quality and a decrease in insert tool life.

Using ISCAR's WHISPERLINE tools can greatly reduce the above problems, leading to a substantial increase in productivity, surface finish and insert tool life.

Vibration issues occur more drastically at large overhangs where, in many cases, machining becomes impossible with conventional tools. However, improvements in all machining parameters can be achieved also at shorter overhangs by implementing WHISPERLINE tools.

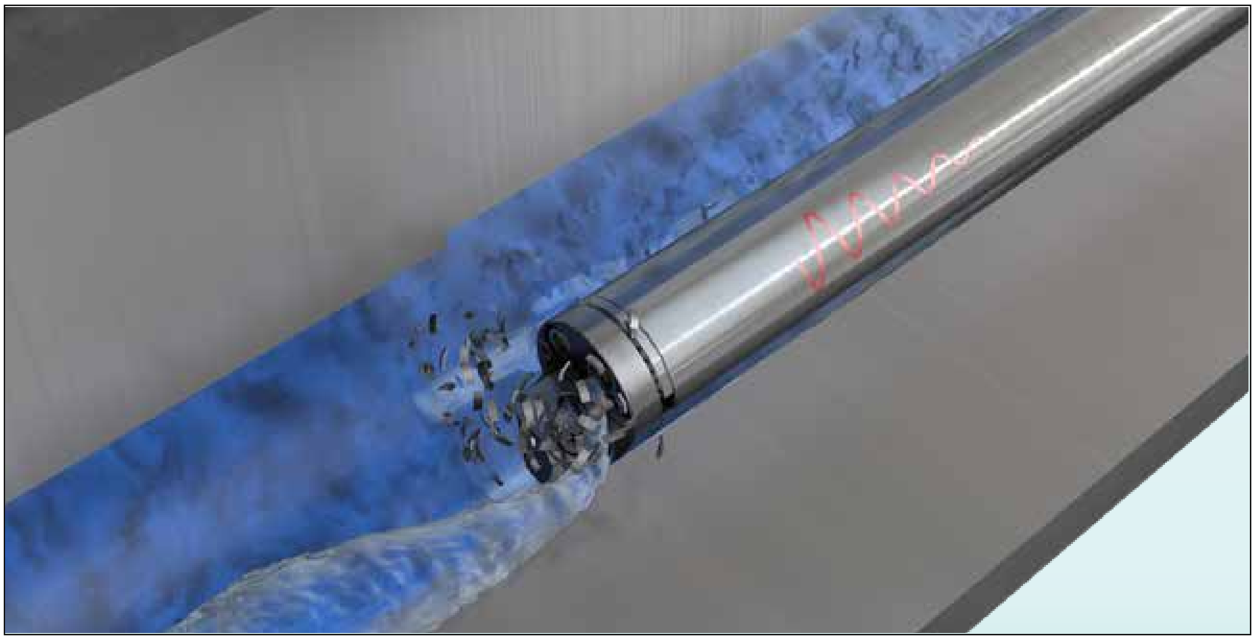
Availability of Tools Per Shank Diameter and Machining Depth



Basic Considerations

Following all the recommendations below (as closely as possible) will greatly improve WHISPERLINE tool performance.

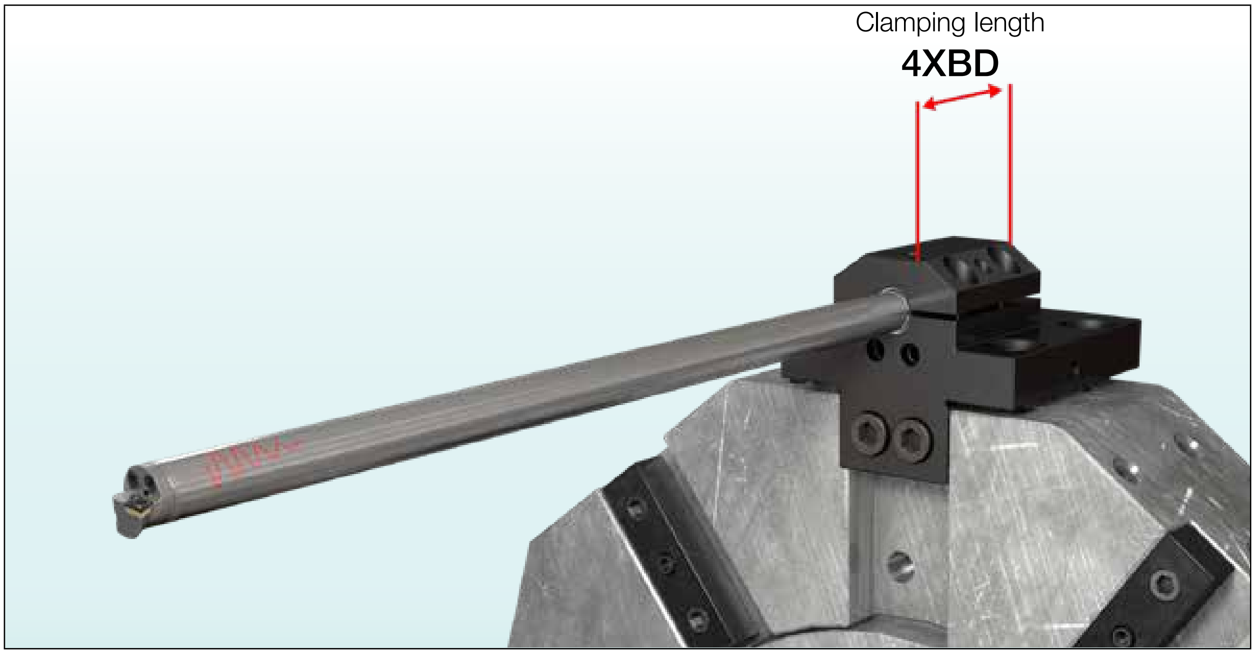
1. Bar D-min parameter should be 10%- 20% smaller than the machined bore to allow for chip evacuation and deflection.



Example: For a bore diameter of 80 mm (3") it is recommended to use a 60 mm (2.5") bar rather than a 80 mm (3") bar. Although the 80 mm bar is stiffer, the lack of space for chip evacuation will decrease the surface finish and can cause breakages.

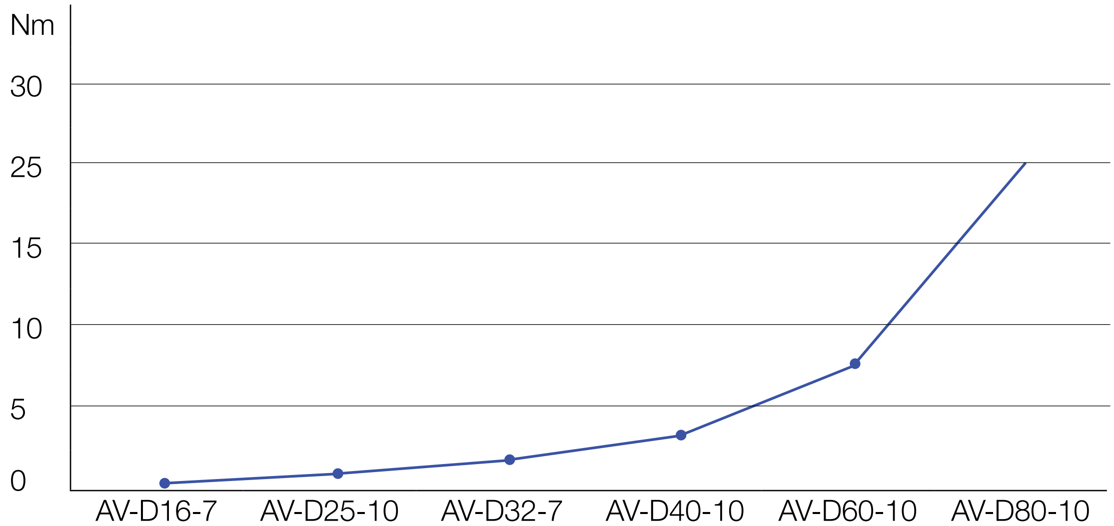
2. Clamping stability is crucial! Please follow the guidelines below as strictly as possible:

a Increase clamping length as much as possible.
The minimum recommended length is 4 X bar diameter.



b Flat-bed lathe with a tool post provides higher rigidity compared to turret clamping. When using larger diameter bars, the moment exerted on the clamping tool (just by the bars weight) is increased dramatically.

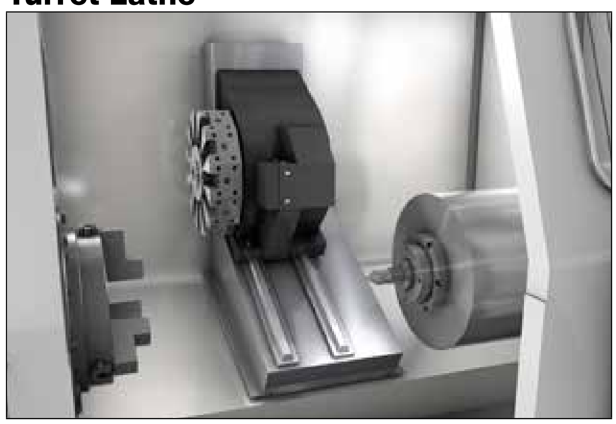
Movement Created From Bar Weight



c Choose a machine that is in proportion to the tool size and overhang.
Use a flat bed lathe if possible.

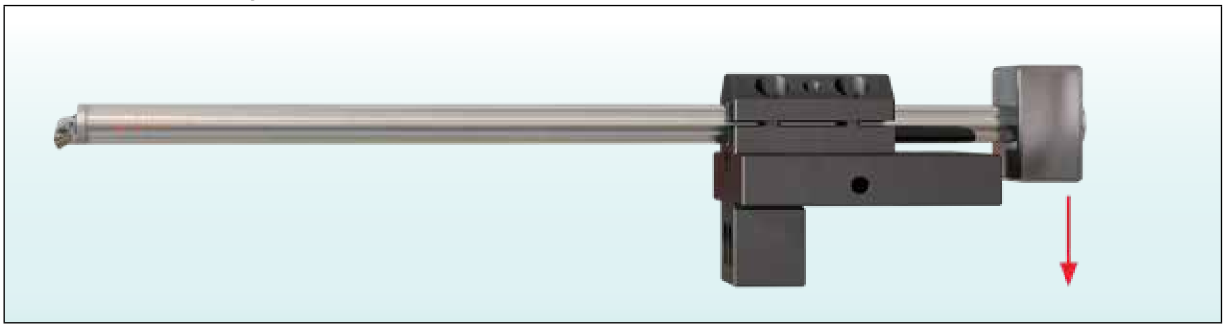
Flat Bed Lathe

Turret Lathe



d You can employ several methods to decrease the negative effect of the moment:

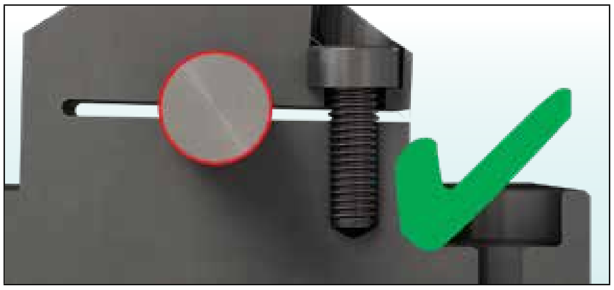
- Install a counterweight:



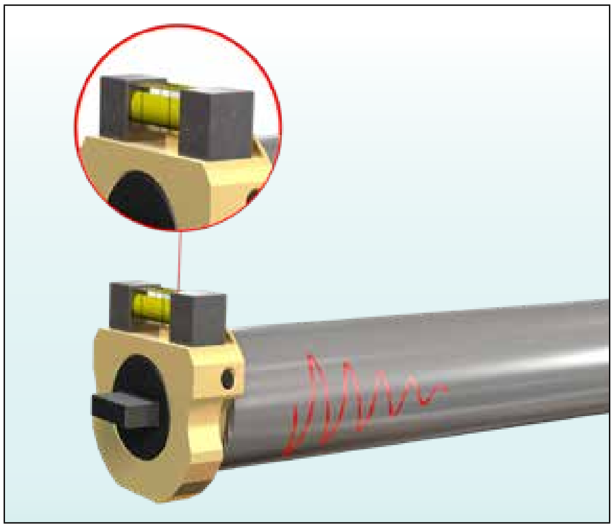
• Work with the bar upside down:

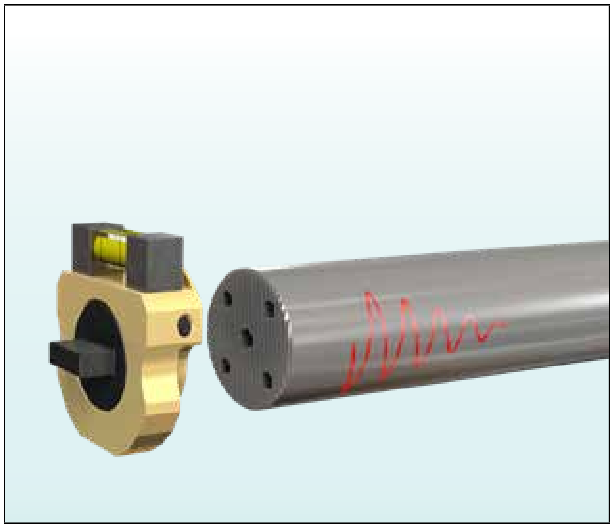
• Both methods create forces in opposite direction to the bars weight and thus reduce the moment that is exerted on the tool post.

e Split sleeve vs screw.
Choose a tool post with peripheral and uniform clamping forces

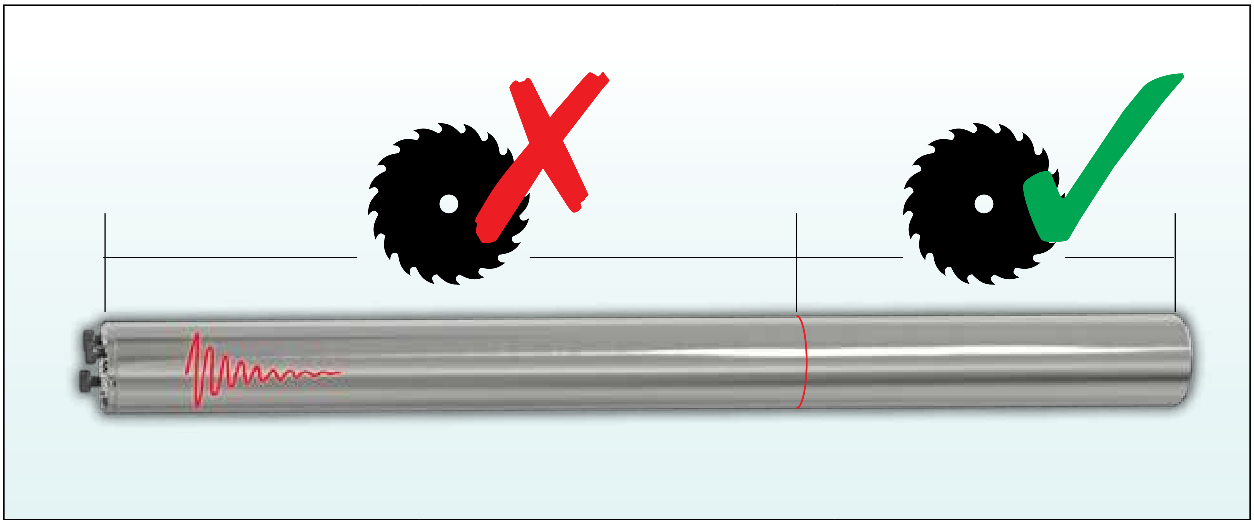


3 Zero Setting:
Use the AV-set device (sold separately) to ensure center height of the cutting edge.





4 Shortening the bar:
In case the bar is too long for your machine or application, it is possible to shorten it.
Each bar has a red marking that shows the minimum length to which the bar can be shortened.

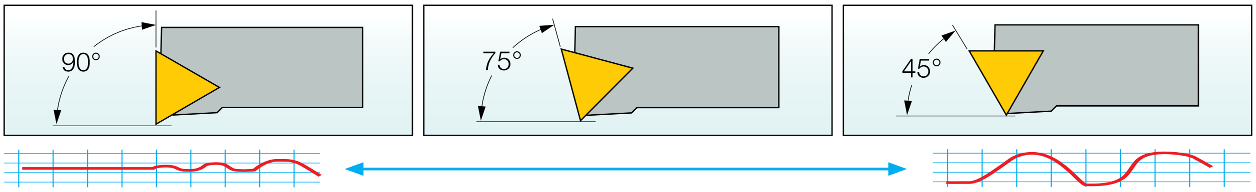


Bar Diameter	Maximum Length After Shortening	
DCONMS (mm)	**OAL 7D** (mm)	**OAL 10D** (mm)
16 (0.625")	100 (3.9")	Not Recommended
20 (0.75")	125 (4.9")	Not Recommended
25 (1")	158 (6.2")	255 (10")
32 (1.25")	190 (7.5")	320 (12.5")
40 (1.5")	240 (9.5")	410 (16")
50 (2")	305 (12")	520 (20")
60 (2.5")	380 (15")	630 (25")

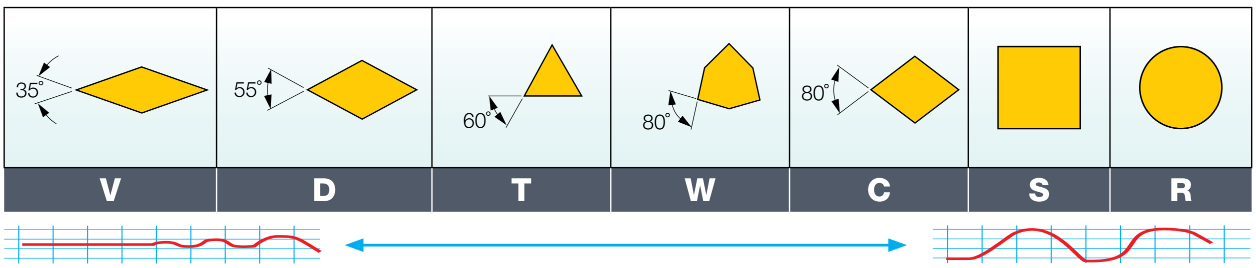
Choosing the Correct Insert

Choosing the correct insert can have a big influence on the overall success of vibration damping. The main way the insert can improve the machining stability is by minimizing the cutting forces. Following the guidelines below should be your first step to eliminate vibrations:

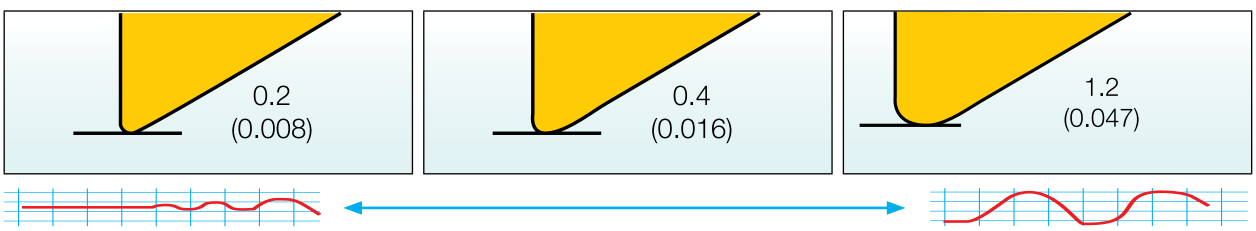
1. Choose an entry angle that is as close as possible to 90° to reduce the radial forces to a minimum.



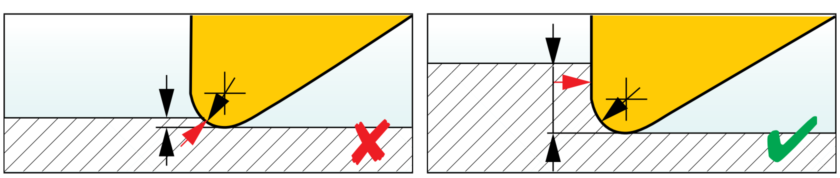
2. Choose the smallest insert head angle possible. This will reduce overall cutting forces and increase the clearance.



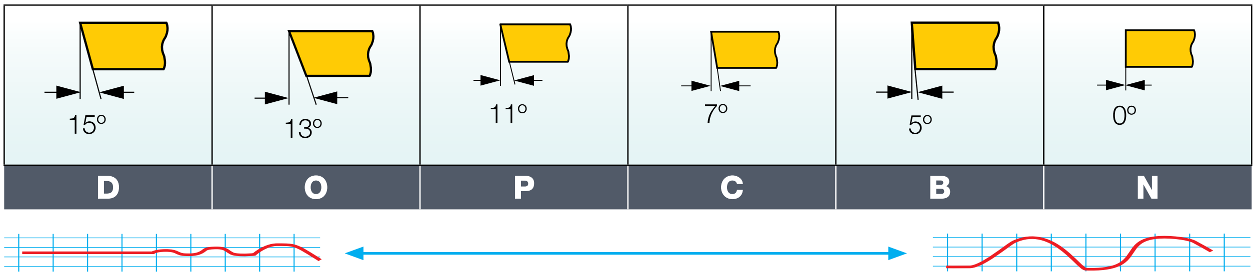
3. Choose a small nose radius to reduce the cutting forces and to enable machining in a lower depth of cut. (Depth of cut should be larger than the nose radius)



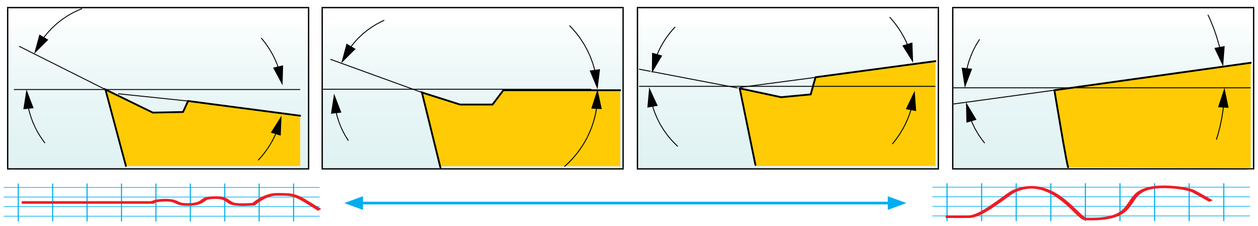
4. Machining depth (ap) should be larger than the nose radius.



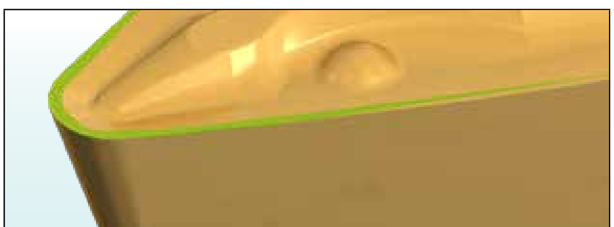
5 Use an insert with an overall positive geometry to reduce the cutting forces:



6 Choose a positive top rake geometry:



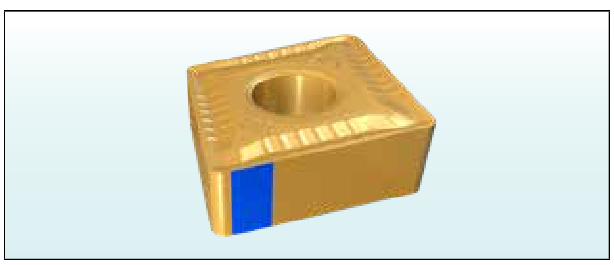
7 Use an insert with a small honing size. This can usually be achieved by choosing ground inserts and /or inserts with thin coating.



Small Honing

Big Honing

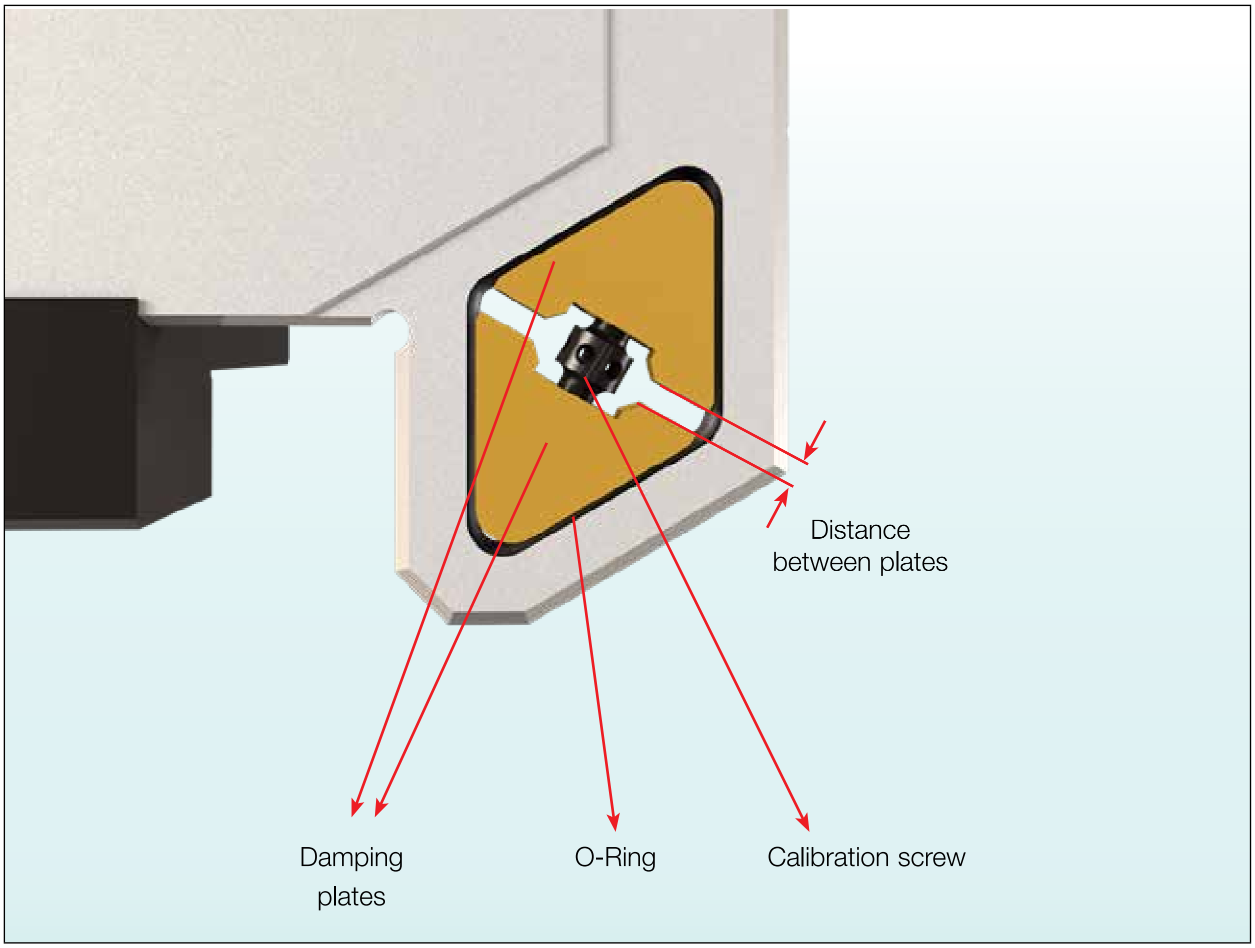
8 Avoid using wiper inserts. These types of inserts improve surface finish but this is achieved at the expense of increasing the cutting forces



Each one of these steps reduces the cutting forces. You can use all or a combination of some of them depending on the limitations of your application.

Vibration Damping Turning Blades for Lathe Machines

While many anti-vibration tools exist in the market for internal machining applications, ISCAR is the only company that offers anti-vibration blades for external applications. The company's vast experience and unmatched designing skills have enabled ISCAR to produce an ingenious damping mechanism that is small enough to be assembled onto blades and created the optimal blade for a large range of overhangs. This unique ISCAR damping mechanism consists of two plates connected by a screw and fixed to the blade by an O-ring.



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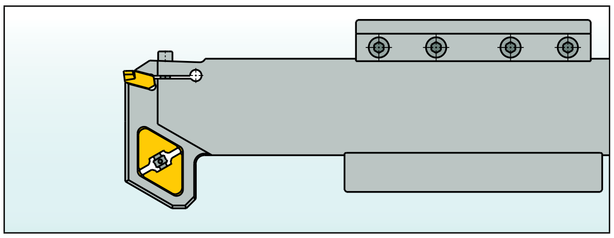
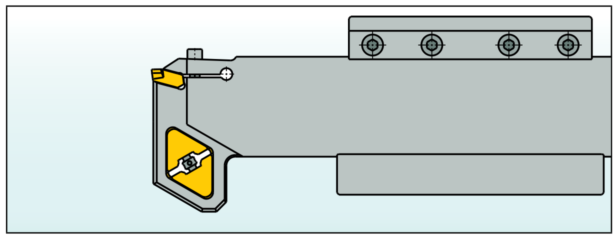
- RPM is one of the most important factors that affect vibrations. To maintain a stable and controlled machining process, use constant RPM (G97).
- Each blade is pre-calibrated in laboratory conditions for an overhang of 100mm (3.94").
- Although the pre-calibration is suitable for a wide range of overhangs, sometimes fine-tuning calibration is necessary, depending on the overhang and clamping rigidity of the machine.
- Before making fine tuning calibration, try to optimize the cutting conditions.

Fine Tuning Calibration

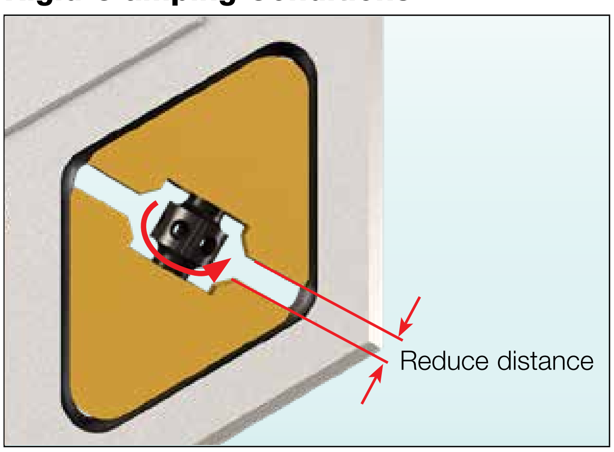
- For shorter overhangs / more rigid clamping conditions, it is recommended to increase the compression of the O-ring by rotating the calibration screw clockwise (make sure the distance between the damping plates increases).
- For longer overhangs / less rigid clamping conditions, it is recommended to decrease the compression of the O-ring by rotating the calibration screw counter clockwise (make sure the distance between the damping plates decreases).



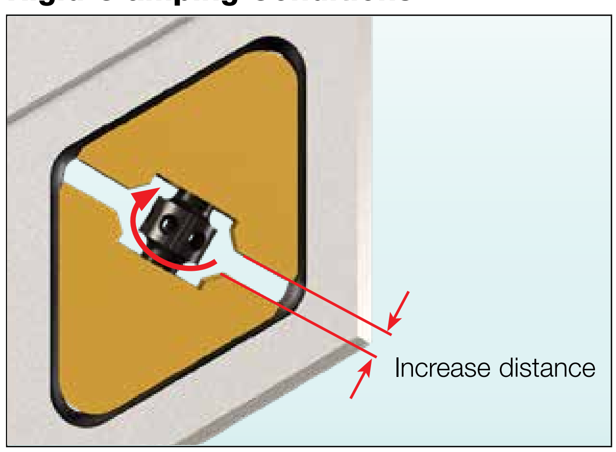


- The fine-tuning resolution should be about a half-turn for each 30mm (1.18") difference in the overhang.
- To restore the initial setup, use the distance between the damping plates imprinted on the blade.

For Longer Overhangs / Less Rigid Clamping Conditions



For Shorter Overhangs / More Rigid Clamping Conditions



Quality Standard

ISCAR has been certified by the prestigious Standards Institution, as being in full compliance to ensure delivery of the finest quality goods. Quality control facilities include the metallurgical laboratory, raw metal testing, an online testing procedure and a machining center for tool performance testing and final product inspection.
Only the finest products are packaged for entry into ISCAR's inventory.

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