

InvoMilling™

AGILE GEAR MANUFACTURING

Cutting lead times in gear manufacturing

Machining gears normally requires dedicated tools for the specific gear profile. With the patented InvoMilling process it is possible to use the same cutters for different gear profiles. By changing the CNC program instead of changing the tool, the time from receiving an order for a component and delivering it can be greatly reduced.

Since multi-task machines or five-axis machining centres are used, complete components can be machined in one set-up. For manufacturers that move components between different machines or outsource the gear operation, InvoMilling can reduce lead times and shorten total manufacturing time significantly.

In-house gear milling in standard machines

- Flexibility – same tools for many gear profiles
- Gear machining in multi-task machines and five-axis machining centres
- Complete components in one machine and one set-up
- More environmentally-friendly - runs dry, does not use cutting oil

See how it works on www.sandvik.coromant.com/invomilling



Success story

Gear wheel data

Module, mn/diametral pitch, DP:	6 mm/4.23 inch ⁻¹
Number of teeth, z:	27
Helix angle, β:	17 degrees
Face width, b:	130 mm/5.12 inch
Pitch circle, d:	170 mm/6.69 inch

Result:

1 pass HSS hob stable hobbing machine	2 passes HSS hob "old" hobbing machine
31.5 minutes	57 minutes

New method on
multi-task machine
23 minutes

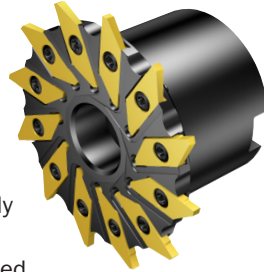
*The preferred
solution for small
to medium batch
sizes!*

First choice for large batch
sizes - CoroMill® 176.

Tools for different module sizes

CoroMill® 161

CoroMill 161 cutter is for manufacturing smaller module gears. High-precision insert seats ensure low tool run-out plus excellent component quality. Furthermore, modules from 2 to 4 can be efficiently covered with only a limited range of inserts. CoroMill 161 cutter is supplied in various diameters, starting at 66 mm, in both Coromant Capto® and arbor coupling configurations.



CoroMill® 162

CoroMill 162 cutter uses a unique i-Lock interface between the insert and tool body to ensure both stability and precision. CoroMill 162 comes in two sizes. Size 4 is ideal for the efficient manufacturing of module 4 to 8 gears starting with a diameter of 90 mm, while size 6 performs equally well for manufacturing module 6 to 12 gears. Tools are available with different arbor coupling sizes.



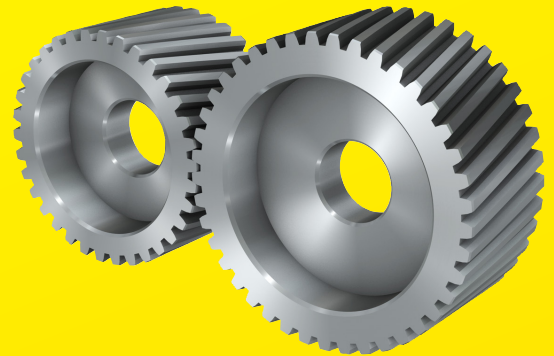
Cutter	Ideal module range	Possible module range
CoroMill 161	2–4	>2
CoroMill 162	4–12	>4

For more information see www.sandvik.coromant.com/coromill161 and www.sandvik.coromant.com/coromill162

Measuring example:

Produce a high quality gear

To precise machine movements and a high precision cutter, InvoMilling yields a high quality gear both regarding dimensional accuracy and surface finish. A gear measurement report for helical gear manufacture using InvoMilling is shown on pages 4 and 5.



Helical gear

Data	
Normal module, mn/diametral pitch, DP:	4.15 mm/6.12 inch ⁻¹
Number of teeth, z:	22
Helix angle, β:	-22.5 degrees
Profile shift, x (high profile):	0.41
Pressure angle:	20 degrees
Tip diameter, d _a :	112.8 mm/4.44 inch
Root diameter, d _f :	87.4 mm/3.44 inch
Face width, b:	30 mm/1.18 inch
Material:	42CrMo4 (260 HB)

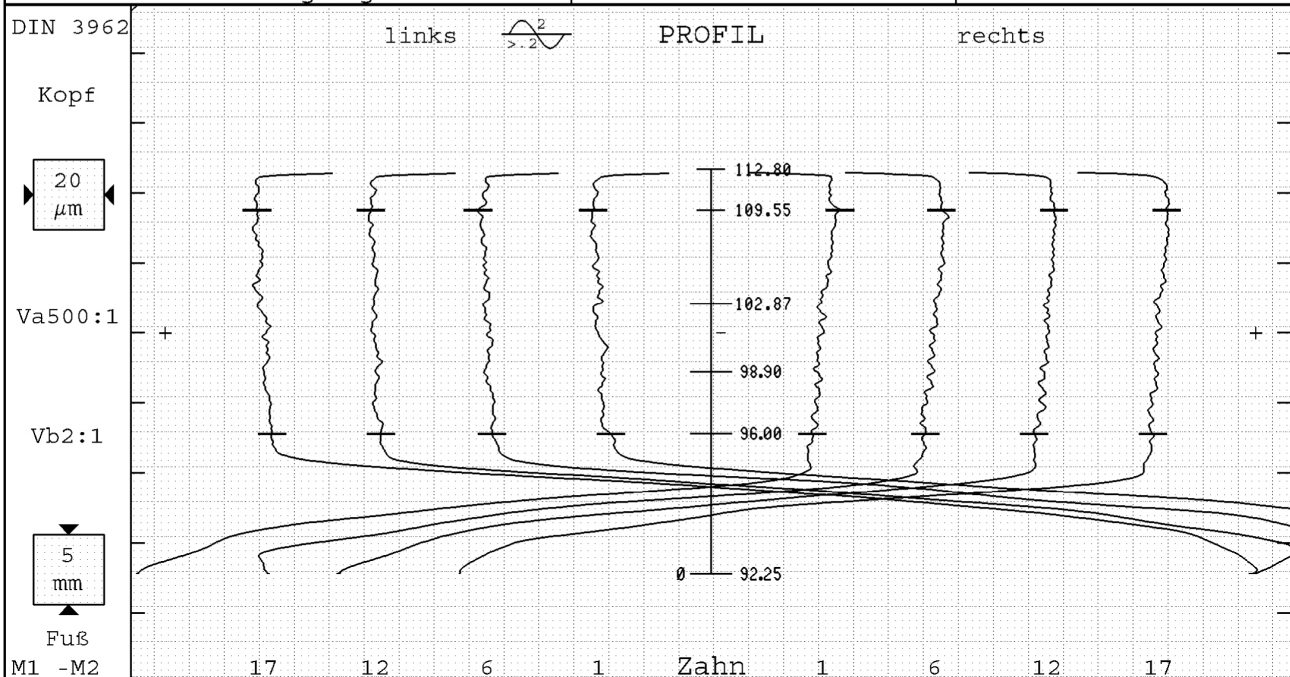
Example of a helical gear produced using the InvoMilling method.

Surface finish, from root to tip, Rz: 2 microns

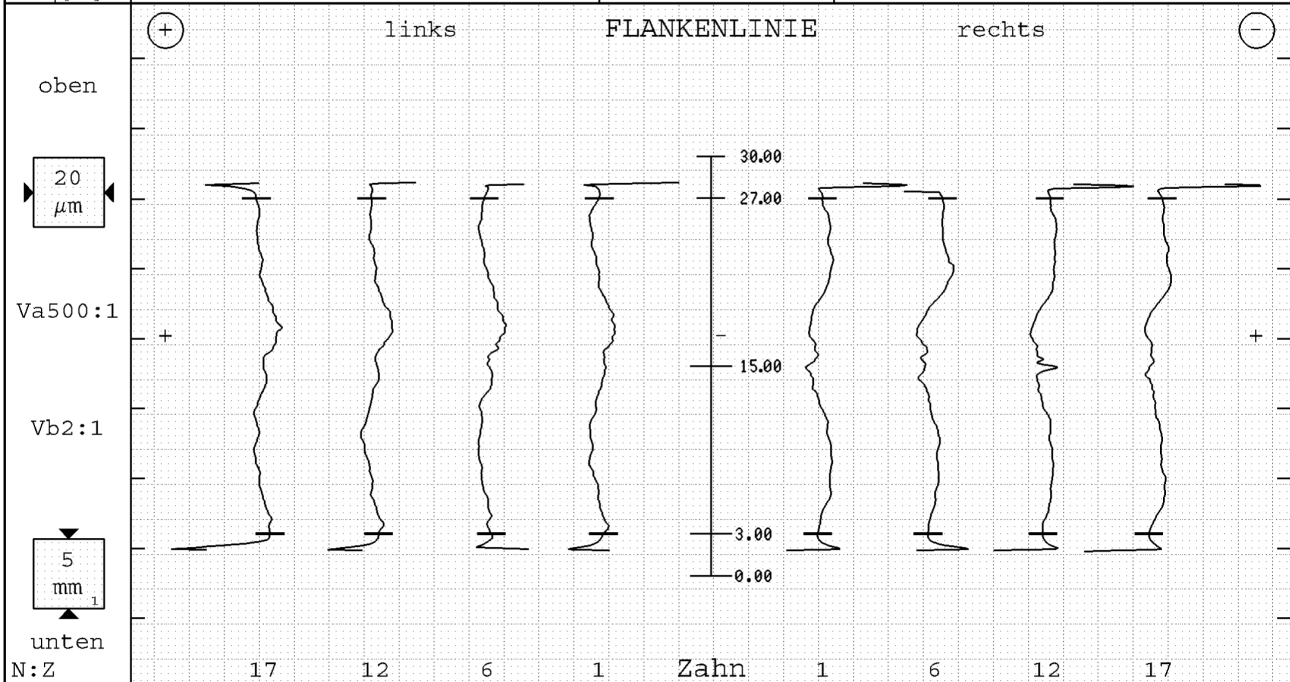
Profile example of a helical gear produced using the InvMilling method.

Stirnrad Profil/Flankenlinie

0409j19 0	P100	Prüfer:		Datum:	07.03.2011~15:21
Zahnrad Nr.1		Zähnezahl z	22	Zahnbreite b	30mm
Zeichnungsnr.: 5 Achsentest		Modul m	4.15mm	Prof.-Prüfber. La	15.98mm
Auftr./Seriennr.: Sandvik1		Eingriffswinkel	20°	Flnk.-Prüfber. LB	24mm
Kunde/Masch. Nr.:		Schrägungswinkel	-22.5°	Ausw.-Anfang M1	13.8mm
Messplatz: P100		Grundkreis-Ø db	91.9446mm	Taster Ø	(#7)2mm
Zustand: Fertigdiagramm		Grundschr.winkel	-21.076°	Pr.versch.F. x	.01



	Meßwert [µm]Qualität				zul. Wert Qual				Meßwert [µm]Qualität						
fH _{tot}	3.3	4	V 2.3		±7	6	±7	6	5.9	6	V 1.6				
fH _α	4.4	5	2.1	3.3	3.4	±7	6	±7	6	6.4	6	5.0	5.4		
F _α	5.5		4.1	5.1	5.8	4	12	6	12	6	8.2	5	8.0	6.4	6.0
f f _α	4.3	4	3.2	3.0	3.6		10	6	10	6	3.6	3	2.9	2.9	3.1
F/K-φ[mm]									112.176		[112.5/113.1]				



	V 1.7				V 4.2									
fH _{βm}	-0.5	1			-1.9	1	V 4.2							
fH _β	0.2	-1.5	1	-1.0	0.2	±9	6	±9	6	0.1	-4.1	4	-1.4	-2.1
F _β	7.8	9.1	6	7.7	7.4	10	6	10	6	7.9	10.5	7	7.8	7.5
f f _β	7.9	8.7	7	7.9	7.5	7	6	7	6	7.9	9.9	8	7.9	7.3

TW: 20°C

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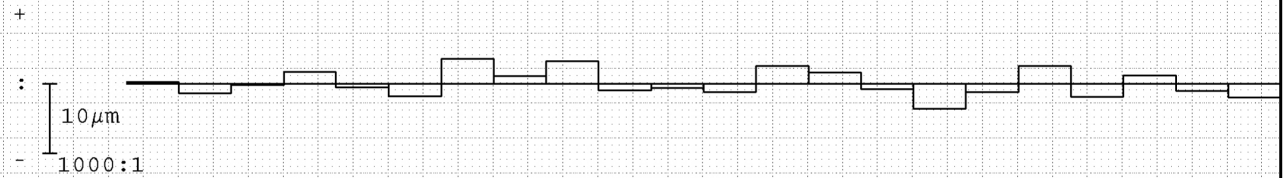


Stirnrad Teilung

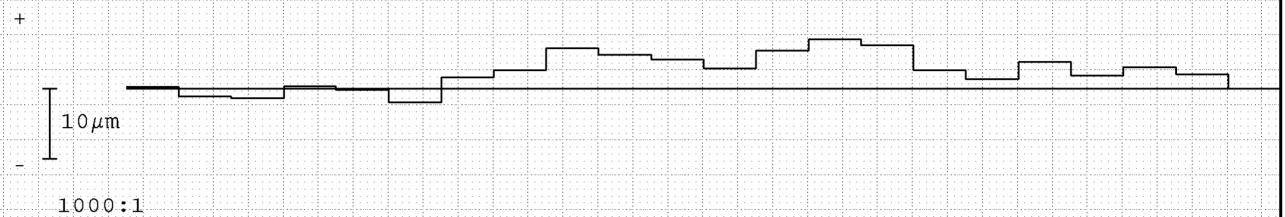
Prog.Nr.: GST0409j19 0 P100	Prüfer:	Datum: 07.03.2011~15:21
Benennung: Zahnrad Nr.1	Zähnezahl z: 22	Eingriffswinkel: 20°
Zeichnungsnr.: 5 Achsentest	Modul m: 4.15mm	Schrägungswinkel: -22.5°
Auftr./Serienr.: Sandvik1	Messplatz: P100	
Kunde/Masch. Nr.:	Zustand: Fertigdiagramm	

DIN 3962

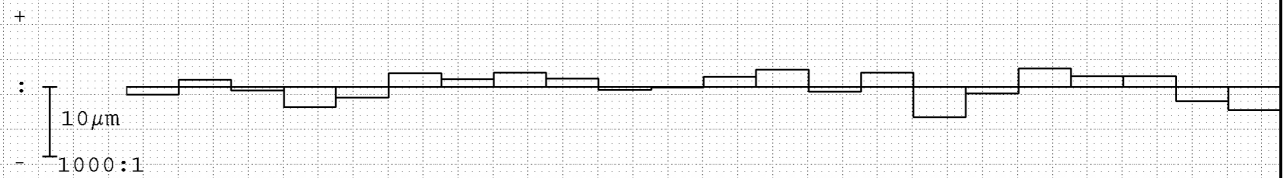
Teilungs-Einzelabweichungen fp linke Flanke



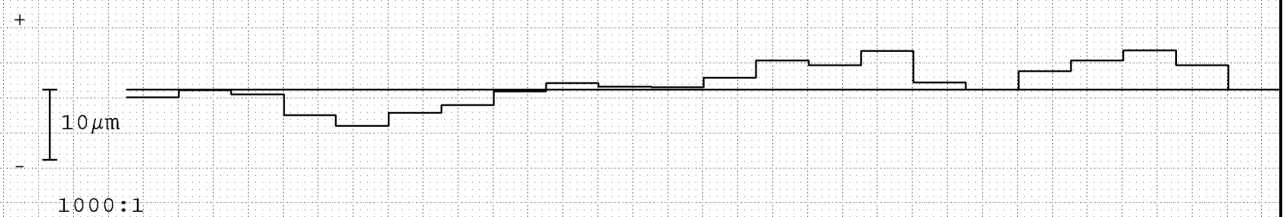
Teilungs-Summenabweichungen Fp linke Flanke



Teilungs-Einzelabweichungen fp rechte Flanke



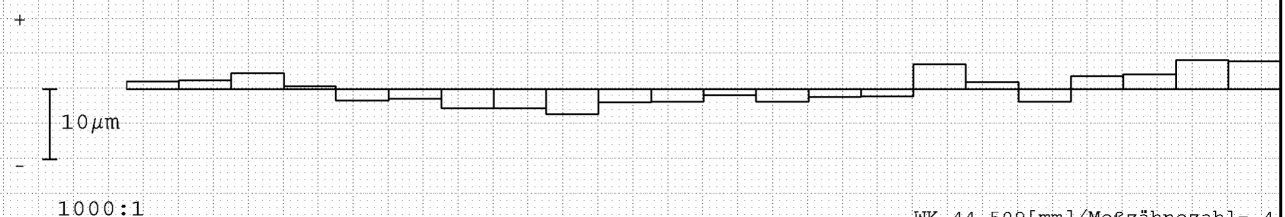
Teilungs-Summenabweichungen Fp rechte Flanke



	linke Flanke				rechte Flanke			
	Meßwert	Qual.	zul. Wert	Qual.	Meßwert	Qual.	zul. Wert	Qual.
gr. Teilungs-Einzelabweichung fp max	3.6	4	9.0	6	4.5	5	9.0	6
gr. Teilungssprung fu max	5.4	5	11.0	6	6.5	5	11.0	6
Teilungsschwankung Rp	7.1				7.1			
Teilungs-Gesamtabweichung Fp	9.0	3	28.0	6	10.8	4	28.0	6
Teilungs-Spannenabweichung Fpz/8	7.7	4	18.0	6	6.7	3	18.0	6

DIN 3962

Rundlauf Fr



WK 44.509[mm]/Meßzähnezahl= 4

Rundlaufabweichung Fr	3	22.0	6	Soll	194.214	194.12
Zahndickenschwankung Rs				Ist	45.619	45.61

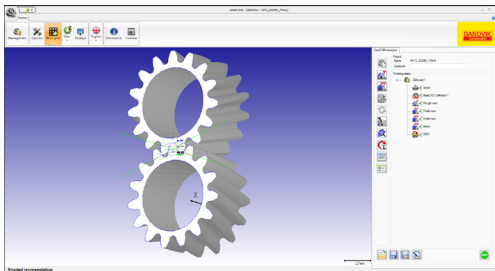
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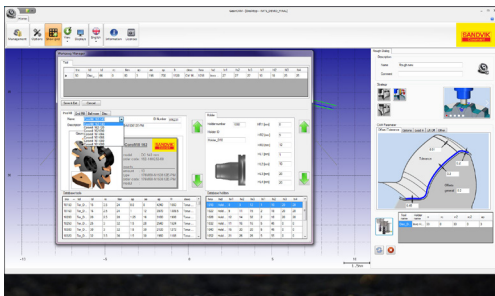


Easy to program

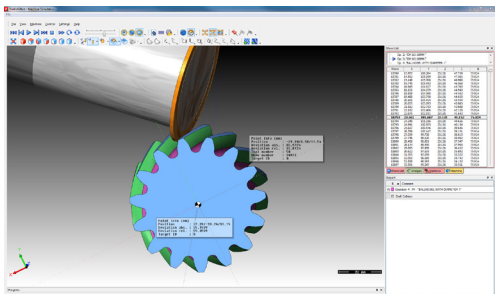
The software InvoMilling™ 1.0 is developed for quick and easy CNC programming of the patented InvoMilling process. Combine the software with our dedicated precision cutters CoroMill® 161 and CoroMill® 162 for truly flexible gear manufacturing.



1. Define your gear geometry.



2. Select your machining strategy, add roughing and finishing operations and select tools to be used from the tool library.



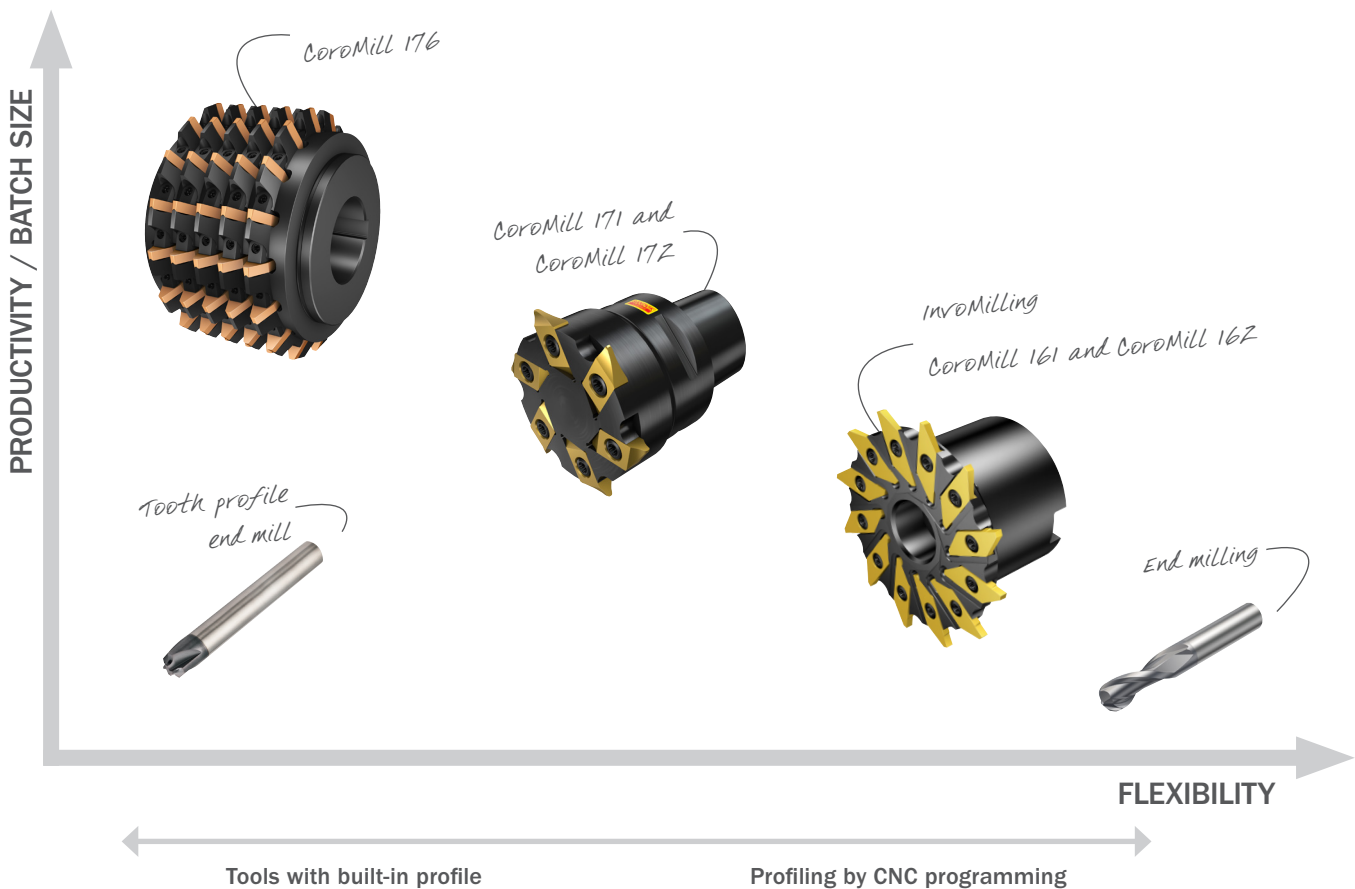
3. Simulate the machining process to verify tool paths.

Comparison of methods

Sandvik Coromant has an extensive portfolio of gear manufacturing tools and methods. For large batch production of spur and helical gears, where high productivity is paramount, we offer a range of competitive disc cutters and hobs, e.g. CoroMill® 170 and CoroMill 176. Both offer much higher productivity than HSS tools.

First choice cutters for medium batch sizes are CoroMill 171 and CoroMill 172. These disc cutters are easily applied in machining centres, multi-task machines and turning centres, making it possible to machine complete components in one set-up.

InvoMilling with CoroMill 161 or CoroMill 162 cutters is the natural choice for small to medium batches when the focus is on greater flexibility. The productivity of InvoMilling is nevertheless comparable to HSS hobbing. What's more, all the advantages of using a multi-task machine still apply.



Gear cutters for your demands



Sandvik Coromant has developed a new assortment of indexable insert gear milling cutters, an initiative that has taken place in close cooperation with our customers and MTM partners. Unrivalled engineering know-how together with extensive metal cutting experience ensures a tool solution that suits your needs.

Over recent years, we have introduced a completely new insert generation. Developments in insert substrates, coating materials, coating manufacturing, and post processes provide higher metal-removal rates with longer tool-life. These new gear milling tools deliver all the performance and benefits you need to take your production to levels not possible with conventional HSS cutters.

With Sandvik Coromant as your partner, you gain all the experience to optimize your overall manufacturing and reduce your cost per component.

www.sandvik.coromant.com

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