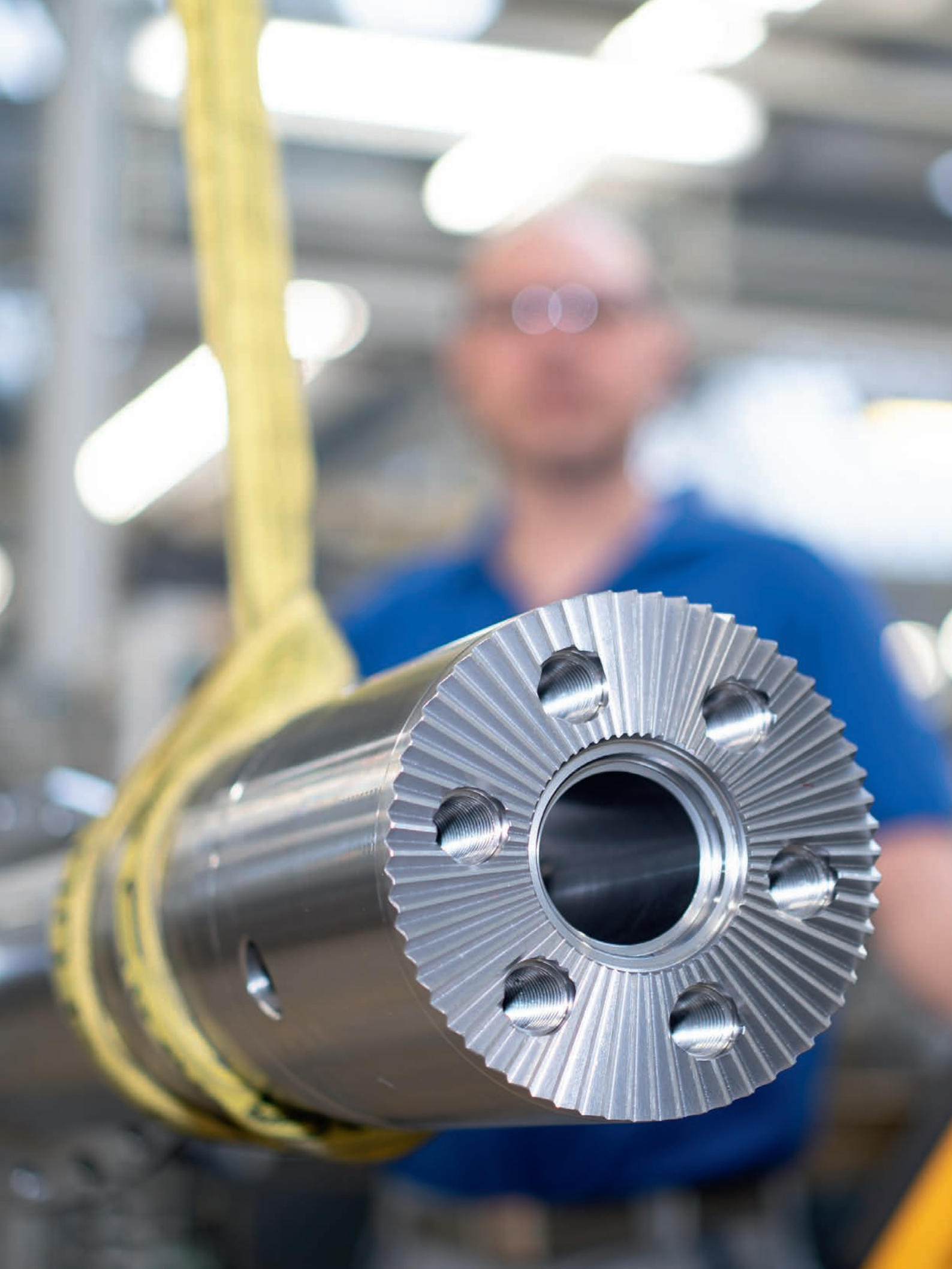
voith.com

VOITH

Voith Hirth serrations

Rings, parts and specialized serration services



The original – Invented decades ago but still perfect today

Hirth rings

This form-locking, self-centering and easily detachable connection component connects shafts, disks, rotors, wheels and cranks with remarkable precision and maximum torque capacity. The design facilitates backlash-free operation and is suitable when changing forces. Furthermore, this connection component is also easy to release and transmits torque wear-free with a positional accuracy of 1 – 2 angle seconds.

Our portfolio:

We offer a complete range to meet your requirements:

- Standard rings
- Tailor-made serration rings and parts
- Serrations on customer components

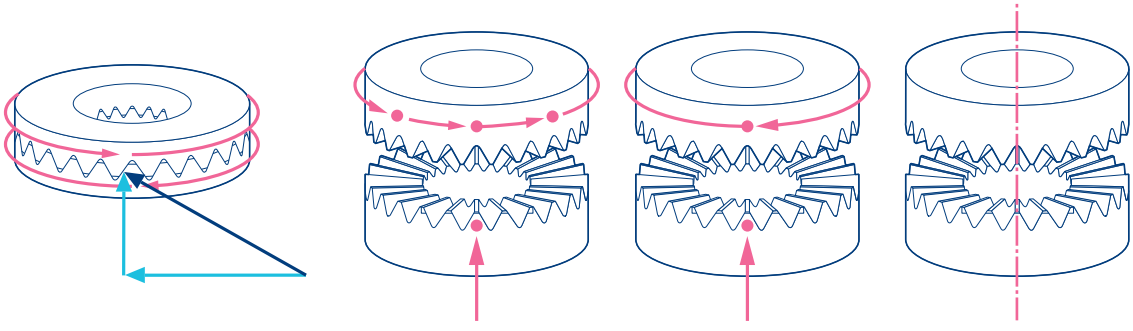
Hirth serration features:

- Angular surfaces provide positive locking transmission
- of most of the peripheral force
- High load-bearing percentage on tooth flanks
- Multiple wedge effect
- Optimized geometrical shape of teeth
- Hardened serration

Advantages:

- High torque capacity
- The bolts only absorb a small axial force
- High wear resistance
- Indexing accuracy ± 2”
- Repeat accuracy < 0.001 mm
- Self-centering
- Low axial and concentric run-out
- Long service life

Features



Voith standard serration rings

Our standard serration rings act as a compact indexing element that achieves high indexing accuracy. Additionally, it is also used as a positioning element with high repeat accuracy.

Advantages you can expect

+ Short delivery times
+ Readily available stock
+ Excellent pricing
+ Guaranteed replacement rings

Applications:

- Machine tools (particularly rotary indexing tables, turret heads and pallet changers)
- Metrology
- Robotics
- Medical technology
- General engineering

The standard range of standard rings:

- Diameter 50 – 900 mm, number of teeth 24 – 720
- Transmittable torque 340 – 98,600 Nm

Note:

Higher torques can be transmitted with custom-made rings or with specialized serration services.

Standard rings - Technical data

Ring size	Outer diameter of dimension D	Inner diameter of dimension d	Maximum transmittable torque Tmax
	[mm]	[mm]	[Nm]
N 5	50	20	340
N 10	100	60	940
N 12	125	85	1,700
N 16	160	120	2,260
N 20	200	150	3,720
N 25	250	200	6,460
N 28	280	230	7,320
N 32	320	260	8,330
N 36	360	300	15,000
N 40	400	340	16,800
N 45	450	350	25,500
N 50	500	400	28,800
N 56	560	450	46,700
N 63	630	520	53,500
N 71	710	590	60,300
N 80	800	670	87,500
N 90	900	760	98,600

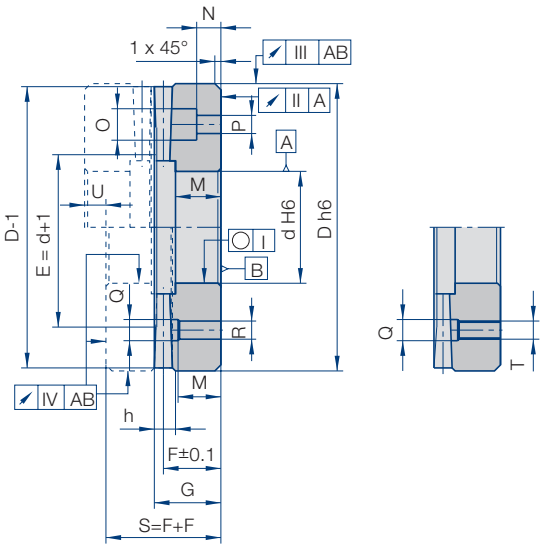
Requirements:

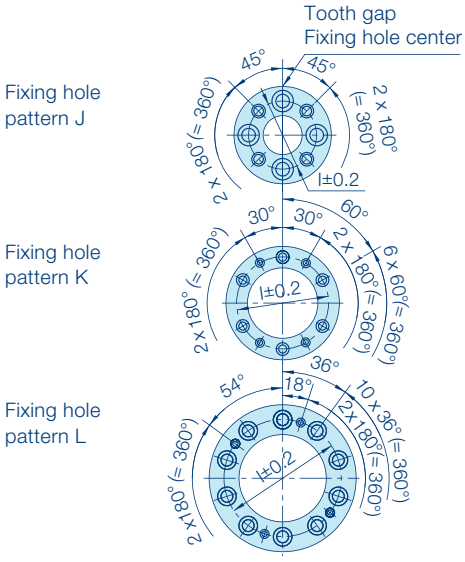
- No safety allowance
- Fully tightened bolts, material class 10.9 in compliance with ISO 898-1
- Hardened locating pins with solid cross-section in compliance with ISO 8734

Dimensions and part numbers
Ring sizes N5 to N40

On all standard rings, the center of the tooth gap is identical to the center of the fixing hole for the bolts. This means that the fixing holes are offset by half a spacing when paired.

Standard rings – dimensions and part numbers





Order example

Ring size	Number of teeth	Part number
N 20	96	H15.093220

When ordering, always specify the ring size, number of teeth and order number.

Technical data
Ring sizes N5 to N40

Ring size	N5			N10			N12			N16			N20		
ø D	50			100			125			160			200		
Number of teeth	G	h	U	G	h	U	G	h	U	G	h	U	G	h	U
24	11.6	3.8	3.5	14.5	5.91	4.2									
	H15.093010			H15.092040											
36	11.2	2.72	2.5	14.5	4.81	4.0	17.3	5.8	4.6						
	H15.093020			H15.092010			H15.093140								
48	10.7	1.78	1.4	14.1	3.82	3.5	16.7	4.34	3.6	17.1	5.43	4.3	19.5	5.9	4.1
	H15.093040			H15.092020			H15.093110			H15.092140			H15.093240		
60	10.4	1.2	0.9	13.6	2.69	2.3	16.6	3.83	3.5	16.8	4.5	3.8	19.6	5.4	4.3
	H15.093050			H15.092030			H15.093120			H15.092110			H15.093250		
72				13.7	2.74	2.4	16.6	3.69	3.5	16.8	4.21	3.8	19.5	4.83	4.2
				H15.092050			H15.093130			15.092120			H15.093210		
96							16.1	2.52	2.2	16.6	3.51	3.4	19.1	3.84	3.5
							H15.093130			H15.092130			H15.093220		
120										16.1	2.61	2.3	19.1	3.51	3.3
										H15.092160			H15.093230		
144													18.7	2.76	2.4
													H15.093270		
180															
240															
288															
360															

d	20	60	85	120	150
F	10	12.5	15	15	17.5
I	35	80	105	140	175
J	●				
K		●	●	●	●
L					
M	7.5	8.6	11.6	10.6	13.1
N	3	4.1	4.6	4.6	5.1
O	11	11	11	11	15
P	7	7	7	7	9.5
Q	7	7	10	10	9.5
R	5	5	7	7	6.8
T	M6	M6	M6	M6	M8
I/II/III	0.005				
IV	0.01				

Dimensions in mm

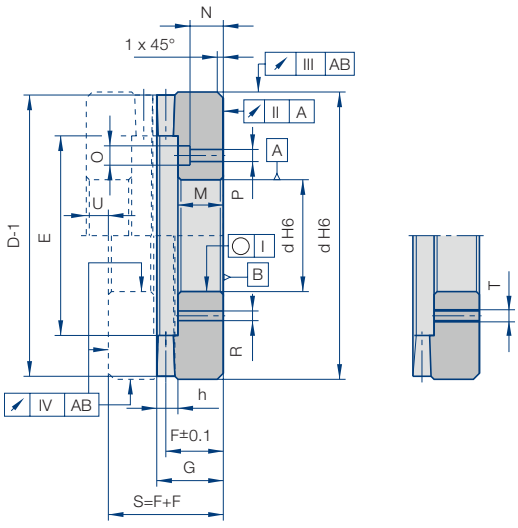
■ Available from stock, subject to prior sale

● Fixing hole pattern

N25			N28			N32			N36			N40		
250			280			320			360			400		
G	h	U	G	h	U	G	h	U	G	h	U	G	h	U
19.5	5.91	4.2	22.7	7.27	5.7									
H15.092240			H15.093340											
19.8	5.82	4.7	22.8	6.95	5.8	22.4	6.66	4.9	26.2	8.18	6.4			
H15.092250			H15.093350			H15.092340			H15.093440					
19.2	4.36	3.7	22.5	5.21	4.5	22.1	5.45	4.5	25.2	6.58	5.4	25.0	5.91	4.2
H15.092210			H15.093310			H15.092310			H15.093450			H15.092450		
19.1	3.85	3.5	21.4	3.63	3.0	22.4	5.43	5.0	24.7	5.4	4.6	24.6	5.45	4.3
H15.092220			H15.093320			H15.092320			H15.093470			H15.092470		
18.7	2.91	2.5	21.4	3.47	3.2	21.8	4.23	4.0	24.7	4.98	4.5	24.5	4.84	4.2
H15.092230			H15.093330			H15.092330			H15.093410			H15.092410		
18.7	2.76	2.4	21.4	3.22	2.9	21.7	3.82	3.4	24.0	3.63	3.5	24.3	4.23	4.0
H15.092270			H15.093370			H15.092360			H15.093420			H15.092420		
						21.1	2.62	2.3	23.8	3.07	3.0	23.6	2.72	2.4
						H15.092370			H15.093430			H15.092430		
									23.5	2.39	2.0	23.6	2.77	2.4
									H15.093480			H15.092480		
									23.15	1.71	1.4	23.4	2.02	1.7
									H15.093490			H15.092440		
200			230			260			300			340		
17.5			20			20			22.5			22.5		
225			255			290			330			370		
●			●			●			●			●		
13.7			15			15.3			17.8			17.6		
5.2			7.2			7.3						9		
15			15			15			18			18		
9.5			9.5			9.5			11.5			11.5		
9.5			9.5			9.5			11.5			11.5		
6.8			6.8			6.8			9			9		
M8			M8			M8			M8			M8		
												0.01		
												0.02		

Dimensions and part numbers
Standard ring sizes N45 to N90

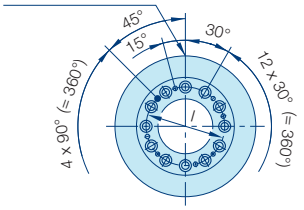
Dimensions and data



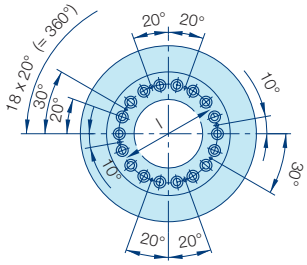
Tooth gap

Fixing hole centre

Fixing hole pattern J



Fixing hole pattern K



Note:
On all standard rings, the center of the tooth gap is identical to the center of the fixing hole for the bolts This means that the fixing holes are offset by half a spacing when paired.

Order example

Ring size	Number of teeth	Part number
N 20	96	H15.093220

When ordering, always specify the ring size, number of teeth and order number.

Technical data
Ring sizes N45 to N90

Ring size	N45			N50			N56		
ø D	450			500			560		
Number of teeth	G	h	U	G	h	U	G	h	U
96	26.5	5.53	3.2						
	H15.093540								
120	27.7	6.58	5.4	27	5.92	4.2			
	H15.093560			H15.092540					
144	26.8	4.89	4.0	27.3	5.83	4.7	29.1	5.16	3.5
	H15.093510			H15.092550			H15.092940		
180	26.6	4.09	3.5	27.6	5.74	5.4	29.3	4.85	3.7
	H15.093520			H15.092510			H15.092950		
240	26.6	3.29	3.0	26.7	3.86	3.5	29.5	4.54	4.2
	H15.093530			H15.092520			H15.092910		
288	26.4	3.24	2.9	26.15	2.91	2.4	29	3.48	3.2
	H15.093570			H15.092560			H15.092920		
360	26	2.39	2.1	26.2	2.78	2.6	29	3.22	3.2
	H15.093580			H15.092530			H15.092930		
720							27.85	1.11	0.8
							H15.092960		

d	350	400	450
E	400	450	502
F	25	25	27.5
I	380 ± 0.2	430 ± 0.2	480 ± 0.5
J	●	●	●
K			
M	20.8	20.2	24
N	9.8	9.2	11
O	18	18	20
P	11.5	11.5	14
R	9	9	11
T	M8	M8	M10
I/II/III			0.01
IV			0.02

Dimensions in mm

■ Available from stock, subject to prior sale

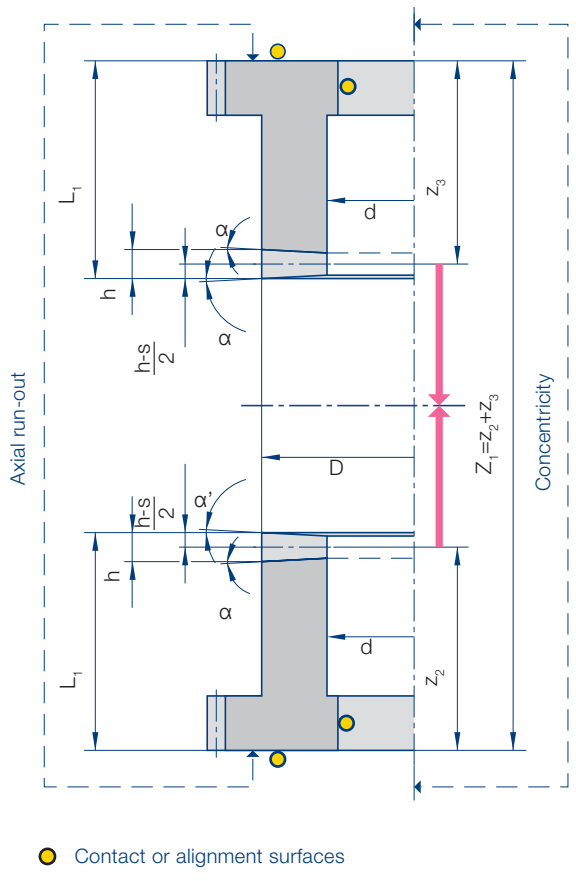
● Fixing hole pattern

N63			N71			N80			N90		
630			710			800			900		
G	h	U	G	h	U	G	h	U	G	h	U
29.8	6.48	4.7	31.9	6.2	4						
	H15.092640			H15.092740							
29.8	5.91	4.8	31.75	5.32	3.5	37.4	6.68	4.9			
	H15.092650			H15.092750			H15.092840				
29.9	5.33	5.0	32.2	5.34	4.7	37.1	5.47	4.5	42.3	6.59	5.4
	H15.092610			H15.092710			H15.092810			H15.097630	
29.3	4.14	3.8	32.2	4.90	4.5	37	4.85	4.3	41.8	4.85	3.8
	H15.092620			H15.092720			H15.092820			H15.097640	
29.2	3.75	3.6	31.5	3.56	3.2	36.8	4.24	4.0	42.2	4.99	4.7
	H15.092630			H15.092730			H15.092830			H15.097610	
28	1.38	1.0	30.6	1.68	1.4	35.8	2.02	1.7	41	2.4	2.5
	H15.092660			H15.092760			H15.092850			H15.097620	
520			590			670			760		
580			650			740			840		
27.5			30			35			40		
550 ± 0.5			620 ± 0.5			710 ±0.5			800 ± 0.5		
●			●								
						●			●		
23			25.5			31			35		
10			12.5			18			22		
20			20			20			20		
14			14			14			14		
11			11			11			11		
M10			M10			M10			M10		
0.015											
0.03											

Tailor-made serration rings and parts

If our standard serration rings are not suitable for your application, no problem. We can produce custom-made Hirth toothed rings and parts. Needless to say, we will also support you in the design process and with the calculations for the Voith Hirth serration. We have access to effective simulation tools for performing the calculations. Take advantage of this opportunity and benefit from our years of experience.

Schematic drawing:



Contact or alignment surfaces

To produce custom-made rings and parts, we require the following information:

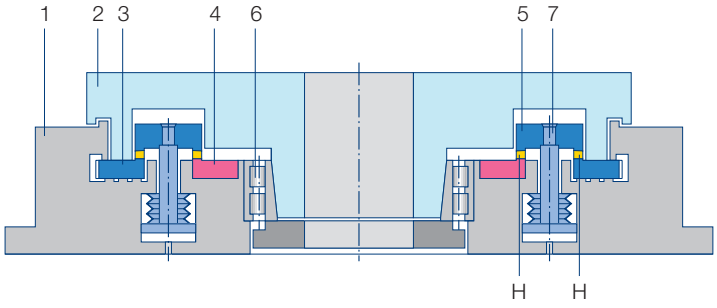
- Number of teeth z
- Outer diameter of teeth D
- Inner diameter of teeth d
- Position of teeth in respect of any fixing holes, keyways etc. (e.g. tooth gap center to center of fixing hole)
- Assembly dimension Z_1 of toothed parts
- Indication of prepared concentricity checking surface (diameter) and contact surface(s) [○]
- Details of material and type of any treatment
- Machining and positional tolerance
- Surface quality of teeth

Advantages of 3–part Voith Hirth toothed rings in non-lifting rotary indexing table tool holders

+ Minimal force required to rotate the workpiece
+ Incursion of coolant can easily be prevented
+ Cost-optimized design
+ High positioning accuracy (indexing accuracy ±2”)
+ Short travel distances when changing tools
+ Quick tool changes

The idea of using 3 toothed rings enables hugely advantageous designs to be realized, particularly in machine tool engineering. Frequent applications include non-lifting rotary index tables and tool holders.

Three-part coupling design – invented by Voith Turbo



Schematic diagram of non-lifting rotary indexing table with Voith Hirth serration in 3 toothed ring design

1 Housing
2 Upper section of indexing table
3 Rotating toothed ring
4 Fixed toothed ring
5 Closing toothed ring
6 Radial bearing
7 Lifting cylinder

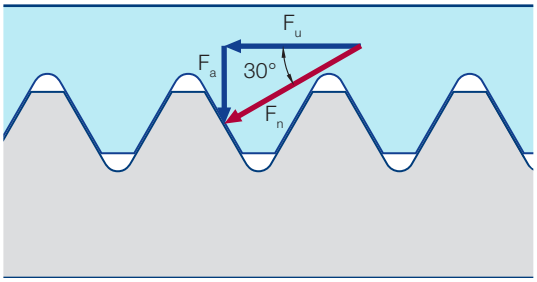
H Hirth serration

Design and calculation information

Calculation:

- Voith Hirth serrations are not calculated in the same way as involute toothing.
- The transmitted torque T is proportional to the circumferential force F_u
- The inclination of the tooth flanks results in an axial force F_a
- When compressed together, the teeth support each other if the pre-load Fva is sufficient. This means that the teeth do not bend.
- The varying loads on the tooth flanks result merely in a slightly irregular distribution of the pressure pre-load in the tooth root cross-section

Force diagram:



F_u Circumferential force

F_a Axial force

F_n Normal force

Note:

These calculations are purely estimations. For an accurate calculation, please contact our office.

Here: $$F_u = \frac{4\,T}{D + d}$$

and $$F_a = F_u \cdot \tan 30°$$

The axial force must be absorbed by pre-loading tensioning devices of adequate dimensions. These tensioning devices could be disk springs, hydraulic cylinders and, in special cases, bolts.

The required pre-load Fva is:

$$F_{va} = v \cdot F_a$$

with the safety factor

$$v = 1.8\ldots3.0$$

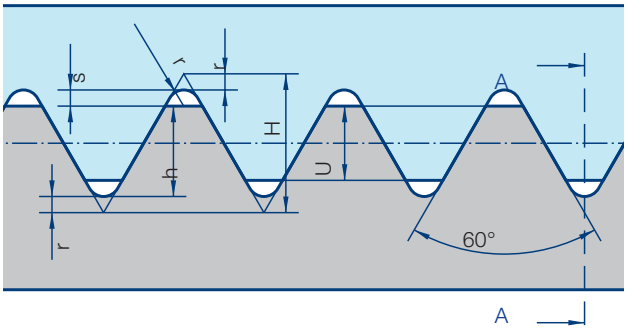
The maximum surface pressure pmax is calculated as follows:

$$p_{max} = \frac{F_{va} + F_a}{A_z}$$

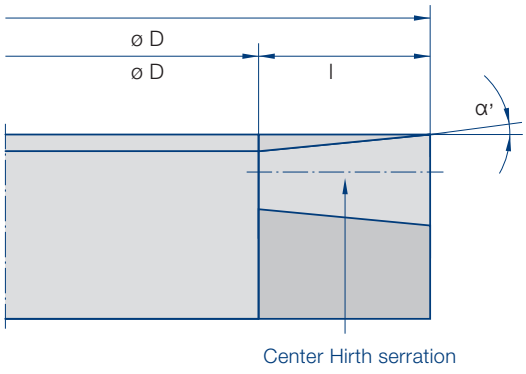
with the effective tooth flank area

$$A_z = \left(D - d - \frac{n \cdot d_L^{\,2}}{D + d} \right) \cdot \left[\frac{\pi}{4} (D + d) - 1.155 \cdot z \cdot (r + s) \right] \cdot \eta_z$$

Geometry



Section A-A



Center Hirth serration

Symbols

A_z	Effective tooth flank area
b	Factor
c	Factor
D	Outer diameter of teeth
d	Inner diameter of teeth
d_L	Fixing hole diameter
F_a	Axial force
F_u	Circumferential force
F_{va}	Pre-load
h	Actual tooth height
l	Tooth width
T	Transmitted torque
n	Number of bolts in serration surface
p_{max}	Maximum surface pressure
r	Tooth root radius
s	Crown clearance
z	Number of teeth
v	Safety factor
η_z	Load bearing percentage (0.65 if milled, 0.75 if ground)

The number of teeth and the theoretical tooth height:

The number of teeth z and the theoretical tooth height H depend on the outer tooth diameter D.

A reference value for the tooth length l is:

$$l = \frac{D - d}{2} = b \cdot D \quad \text{where} \quad b = 0.05...0.3$$

The formula for the actual tooth height h is:

$$h = c \cdot D - (2r + s)$$

Number of teeth z	12	24	36	48	60	72	96	120	144	180	240	288	360	720
Factor c	0.234	0.114	0.075	0.056	0.045	0.037	0.028	0.022	0.018	0.015	0.011	0.009	0.007	0.003

Tooth root radius r [mm]	0.3	0.6	1	1.6	2.5
Crown clearance s [mm]	0.4	0.6	1	1.6	2.5

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