PSR500

Inspection of worm gears by a retrofitted single flank testing machine

INITIALLY PRODUCED BY KLINGELNBERG

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Why single flank testing?

Main requirements in worm gear production

- quality (DIN standard)
- defined backlash
- low noise / high lifetime
- influence of assembly precision
- contact pattern
- pitch deviation of worm gear

All these parameters are measured by single flank testing machine PSR500

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PSR500 Single flank testing machine

Retrofitted by GEARTEC.CZ

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Machine can measure

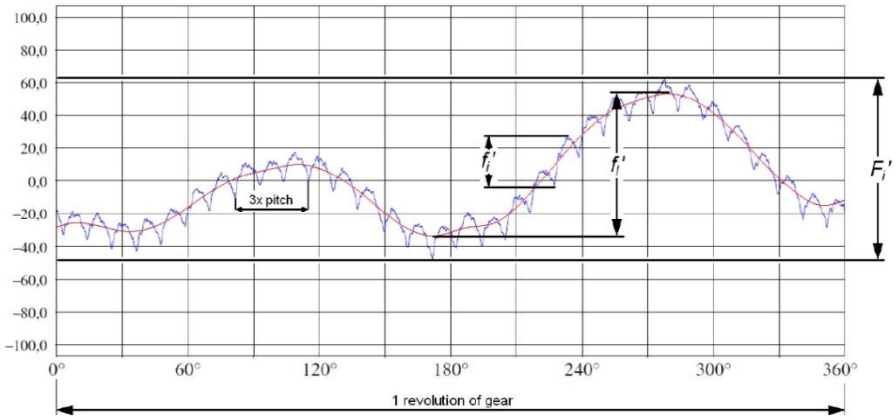
Standards: DIN 3974, ISO 1328 and free tolerances

Single flank deviations of worm gears

F_i' - Tangential composite deviation
f_i' - Tooth to tooth composite deviation
f_l' - Long wave component of tangential composite deviation
f_k' - Short wave component of tangential composite deviation
j - backlash

Pitch deviations of gear and worm

F_p - Total pitch error
f_{pt} - Adjacent pitch error
f_u - Diff. between adjacent pitches
F_r -Radial runout



Contact pattern
FFT analysis
Roundness, eccentricity of gear and worm

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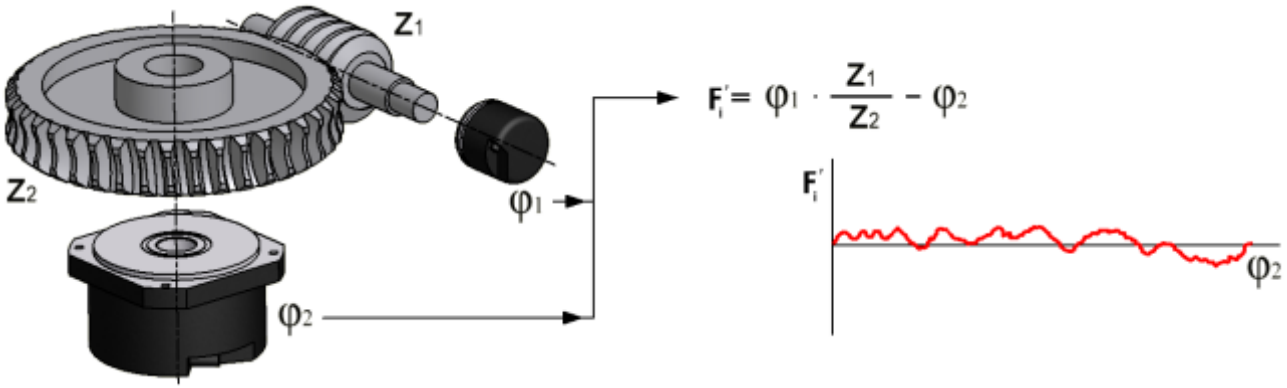
Principle of single flank testing



- mounting distance during testing is static
- left and right flanks are tested separately
- two accurate angle encoders
- accuracy up to 1 arc second (5 micro rad)
  ~ 1 µm on radius 200 mm
- results is transmission error
- deviation and tolerances according to DIN 3974 standard

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Inspection certificates (header)

Workpiece data

Customer's logo

Single flank composite measurement, Schneckenräder

PSR 500

Meister-geartec

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Worm	schnecke m 2.118		Wormgear		Rad m 2.118	Measured points	4000
Number of teeth	z	1 / R	Number of teeth	z	72	Serial No.	1
Axial modul	m_x	2,118	Middle diameter	d_m	152,496 mm	Contract No.	
Pressure angle	α_n	15°00'00"	Angle of crossbar	w	00°00'00"	Machine No.	
Middle diameter	d_m	47,764 mm	Worm position	M'_y	0,000 mm	Date	8.3.2011 16:04
Centre distance	a'	100,000 mm	Worm position	M'_z	----------	Checked by	
Measuring speed		50rpm	Load torque		----------	Note	

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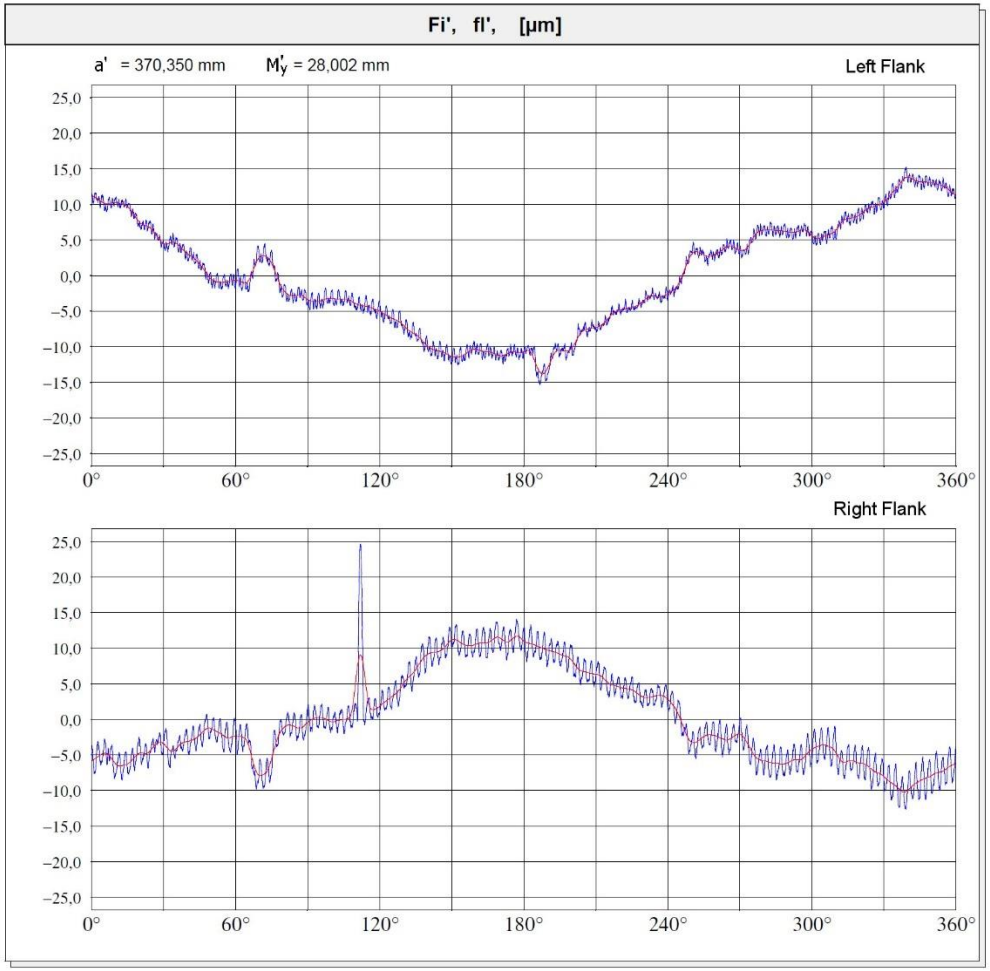
Inspection certificates - chart



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Measurment evaluation

Allowed values according to DIN 3974

Left and right flank

Standard: DIN 3974	F-factor 25%		Allowed	Measured	
Total composite deviation	F'_i	[µm]	17.8 | 3	11.3 | 2	10.9 | 2
Single flank composite dev.	f'_i	[µm]	6.7 | 3	4.4 | 2	5.6 | 3
Mean value	$f'_{i,m}$	[µm]		3.5 | 1	4.4 | 2
Max value	$f'_{i,max}$	[µm]		4.6 | 2	6.8 | 4
Long wave component	f'_l	[µm]	10.0	7.1	6.3
Short wave component	f'_k	[µm]	5.0	4.2	5.1
Backlash - tangential	j	[mm]			

Ver. 2.6.9.1

Measured values

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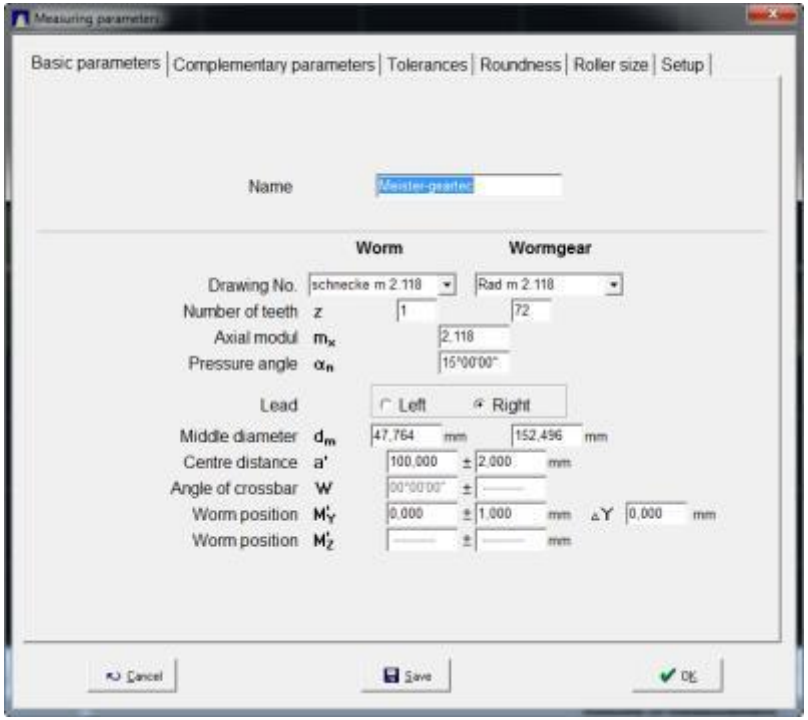
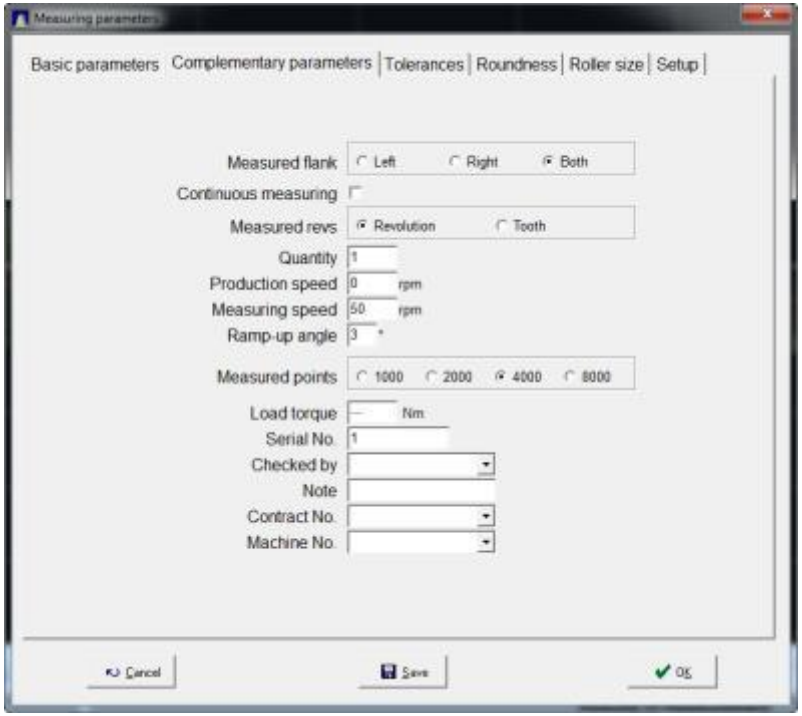
Software interface



Basic object parameters



Complementary object parameters

Measuring software is user-friendly requiring no special or advanced PC knowledge. It can communicate in many languages and runs under Windows.

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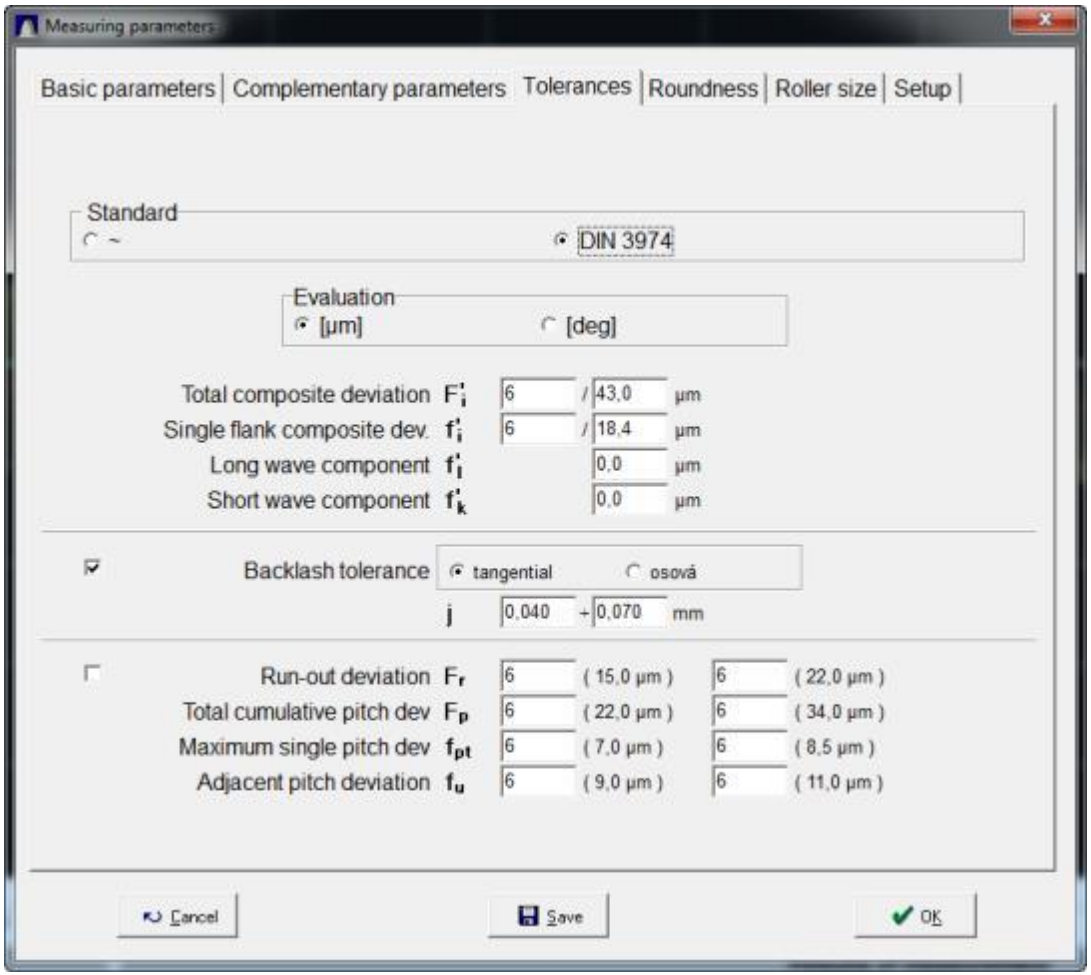
Tolerances



Tolerances

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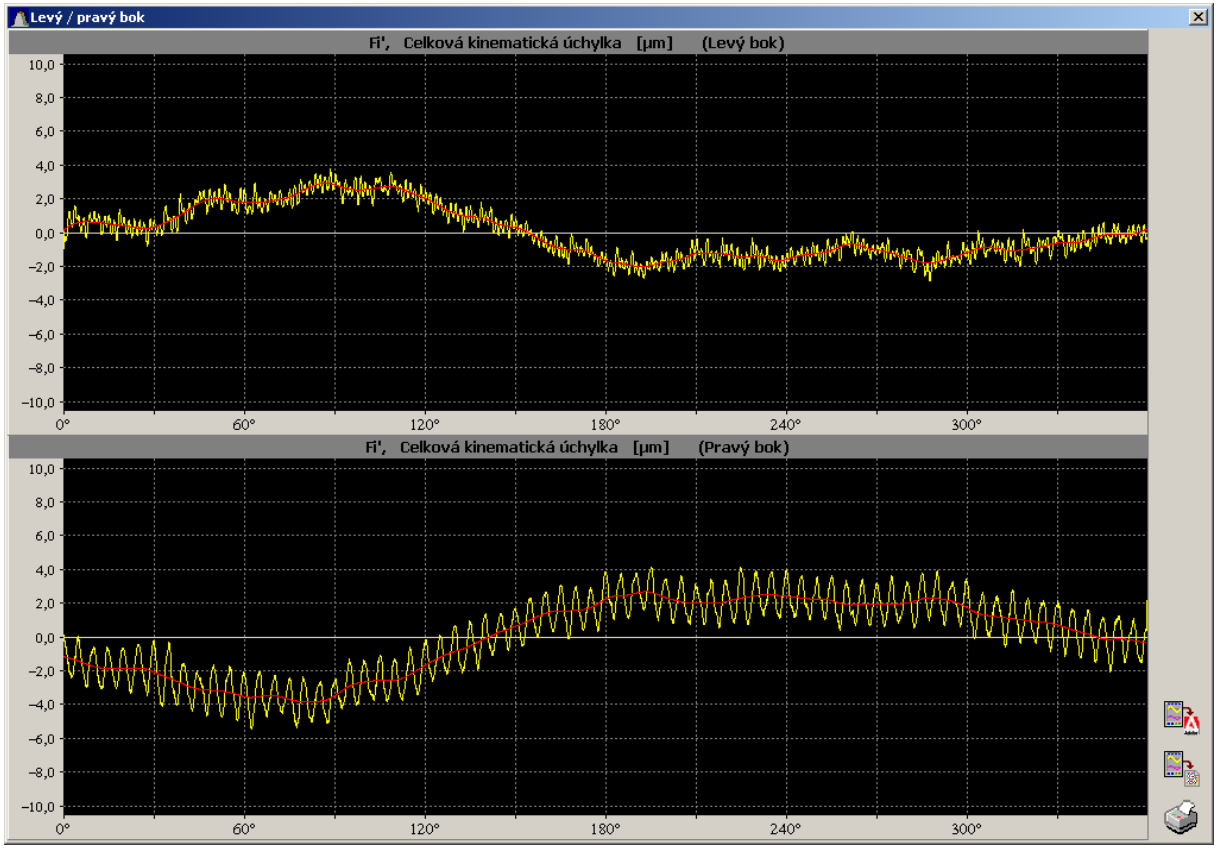
Example 1: perfect gears

Worm gear set, gear ratio 1:72

- Tooth to tooth deviation 0.003 mm on right flank
- Left flank is DIN1, right flank is DIN2



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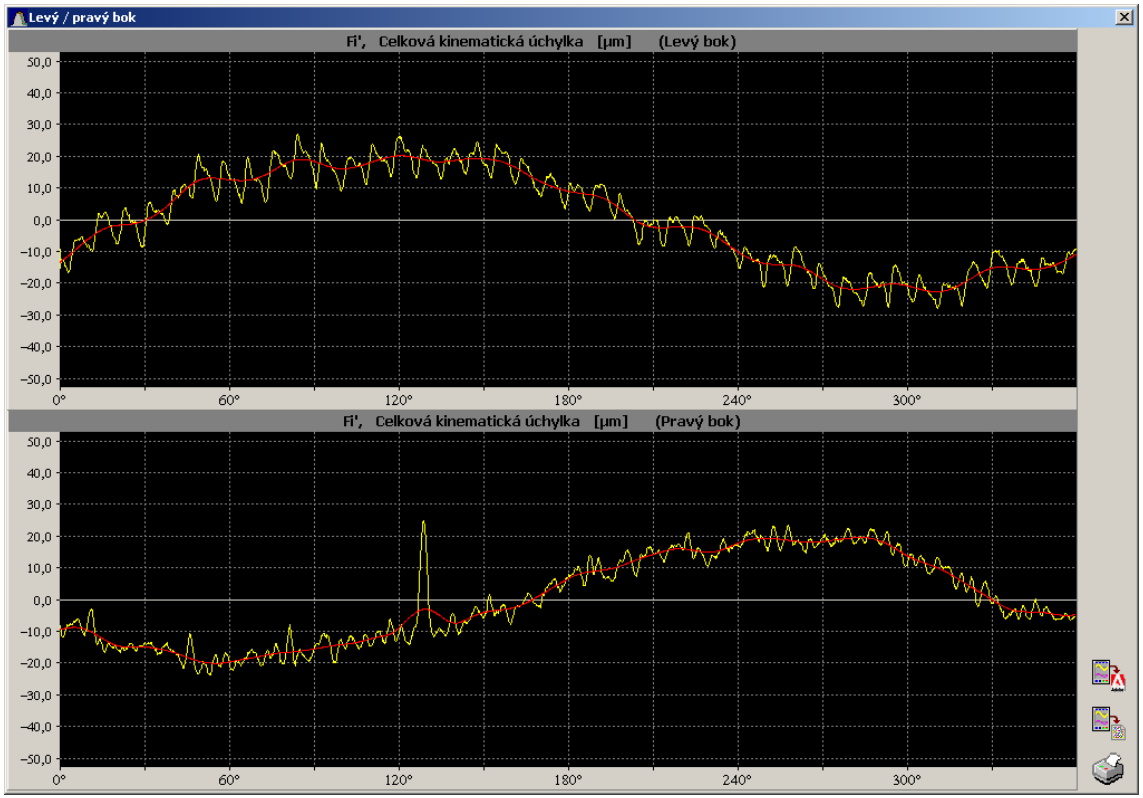
Example 2: Run-out & nick

Worm gear set, gear ratio 1:41

- Run-out of gear about 0.020mm
- Righ flank has a nick 0.035 mm on tooth no. 15



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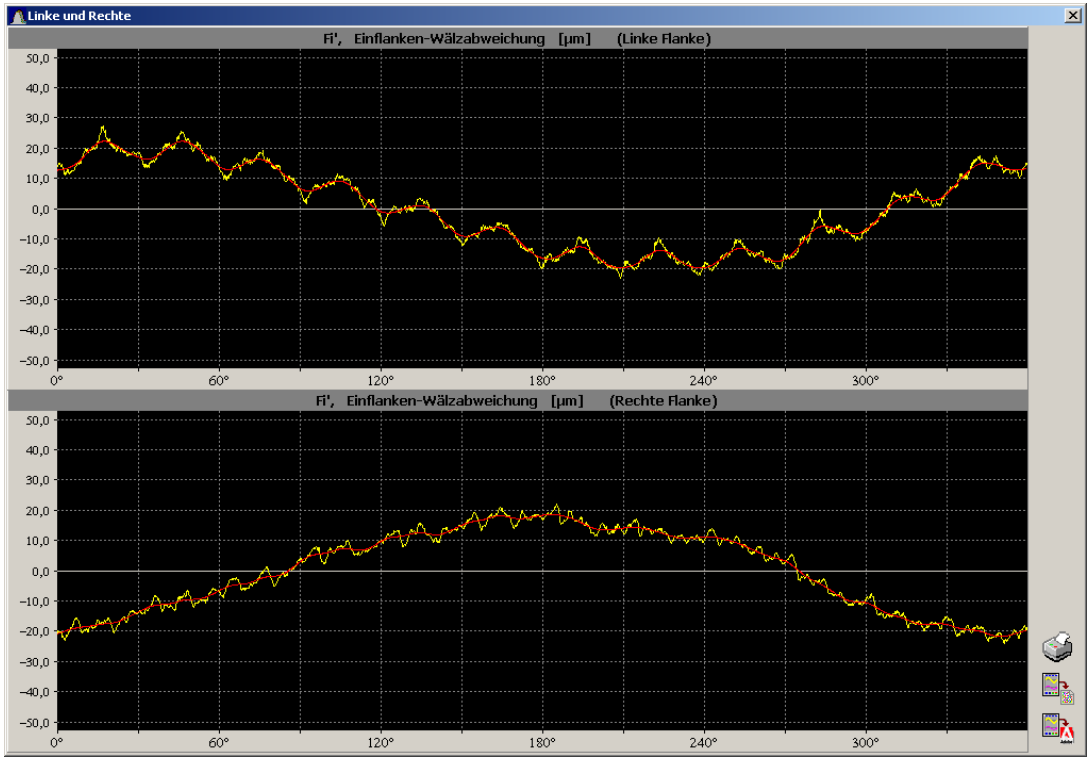
Example 3: Different flanks

Worm gear set, gear ratio 5:61

- Run-out of gear about 0.020 mm
- Worm´s left flank has run-out 0.010 mm



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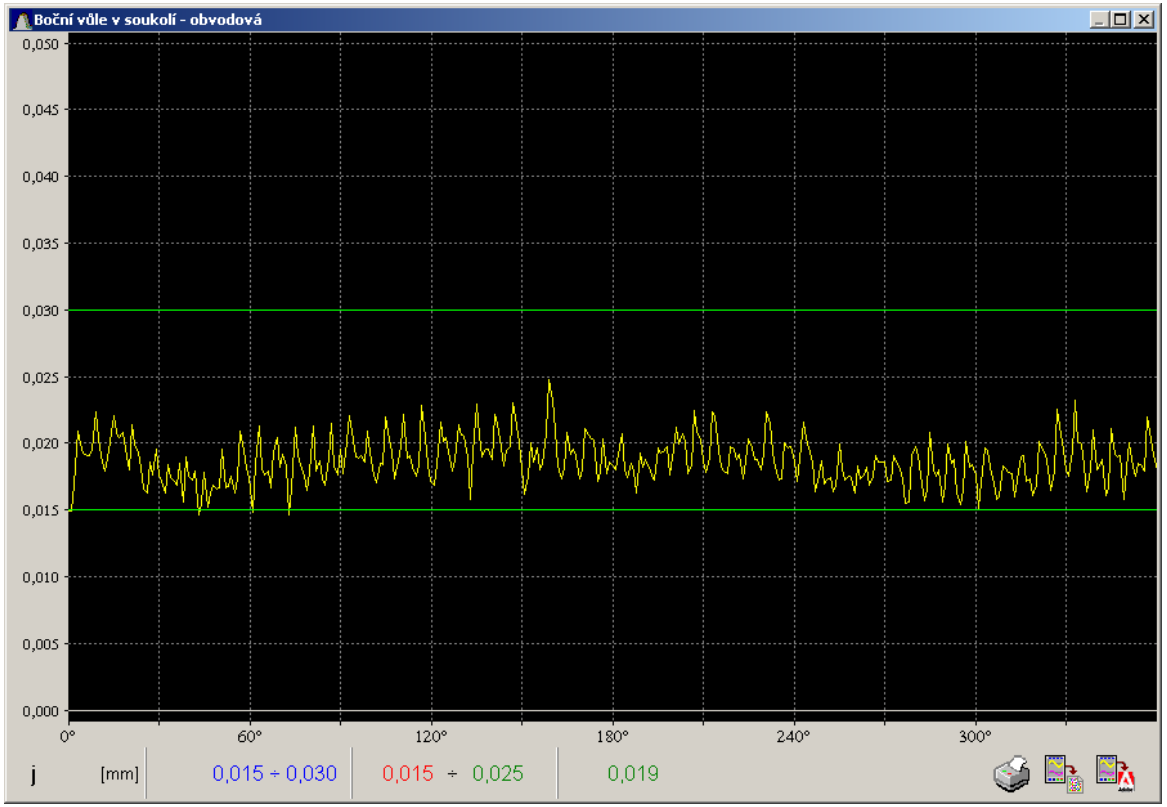
Example 4: Backlash

Continuous measuring of backlash

- Chart of backlash for 1 revolution of gear
- Backlash is changing over tooth contact



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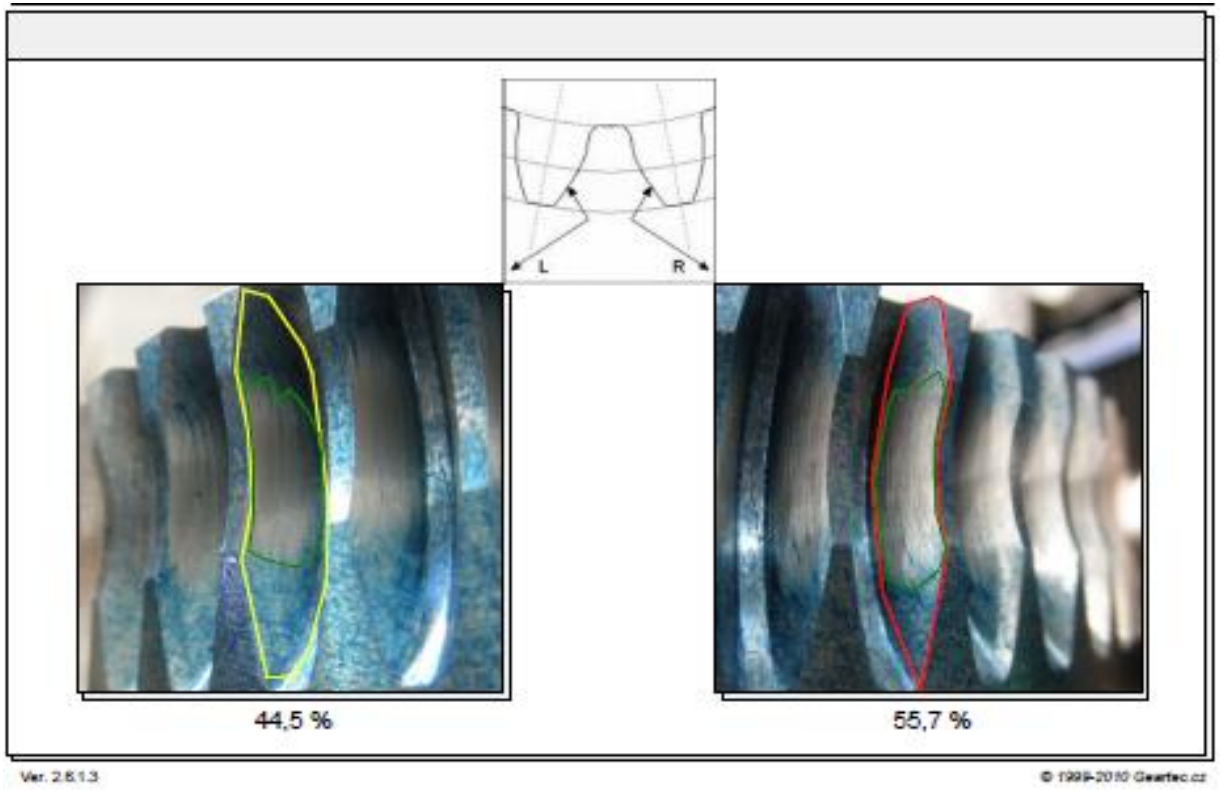
Example 5: Contact pattern

Digital image of contact pattern

- stored in database with measuring results



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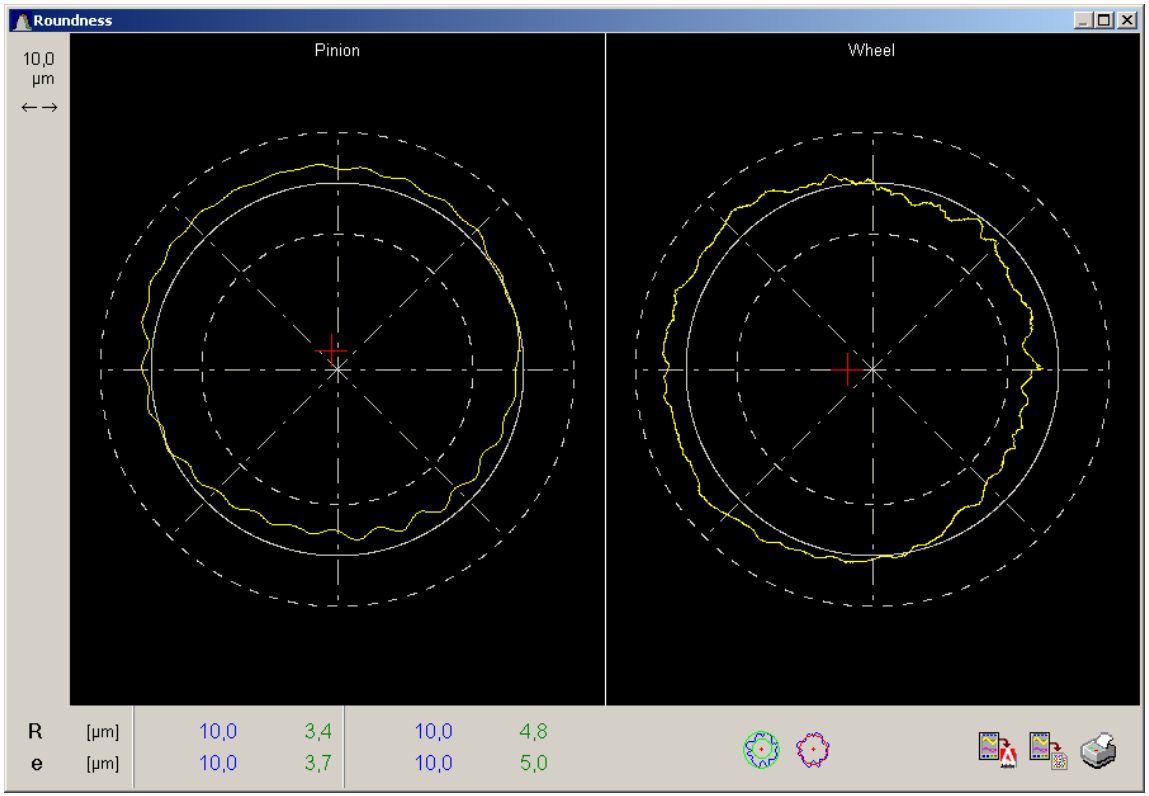
Example 6: Run-out and roundness

Measuring of bearings surfaces

- run-out of worm shaft and worm wheel
- elimination of run-out error



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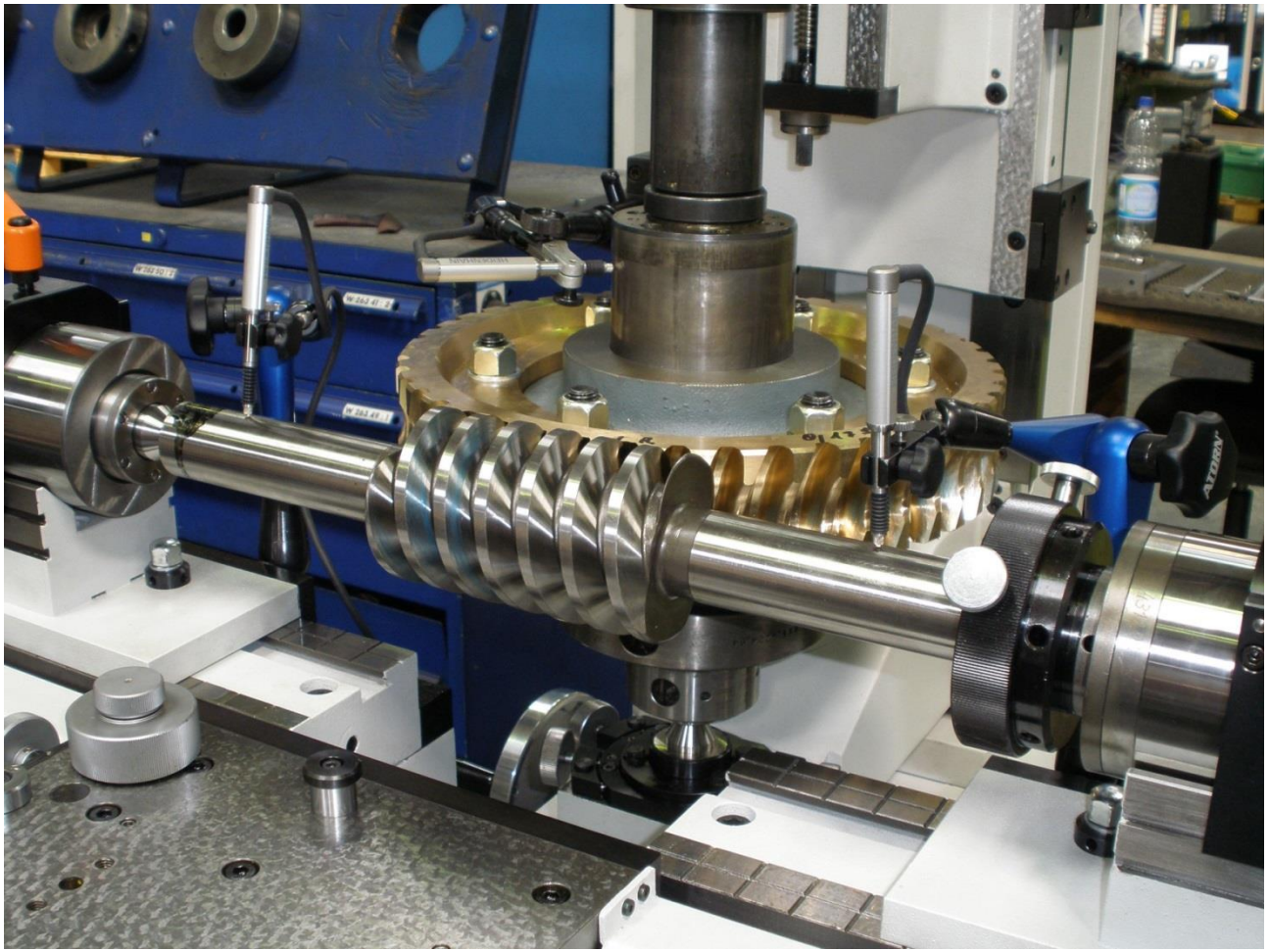
Example 6: Measuring of run-out



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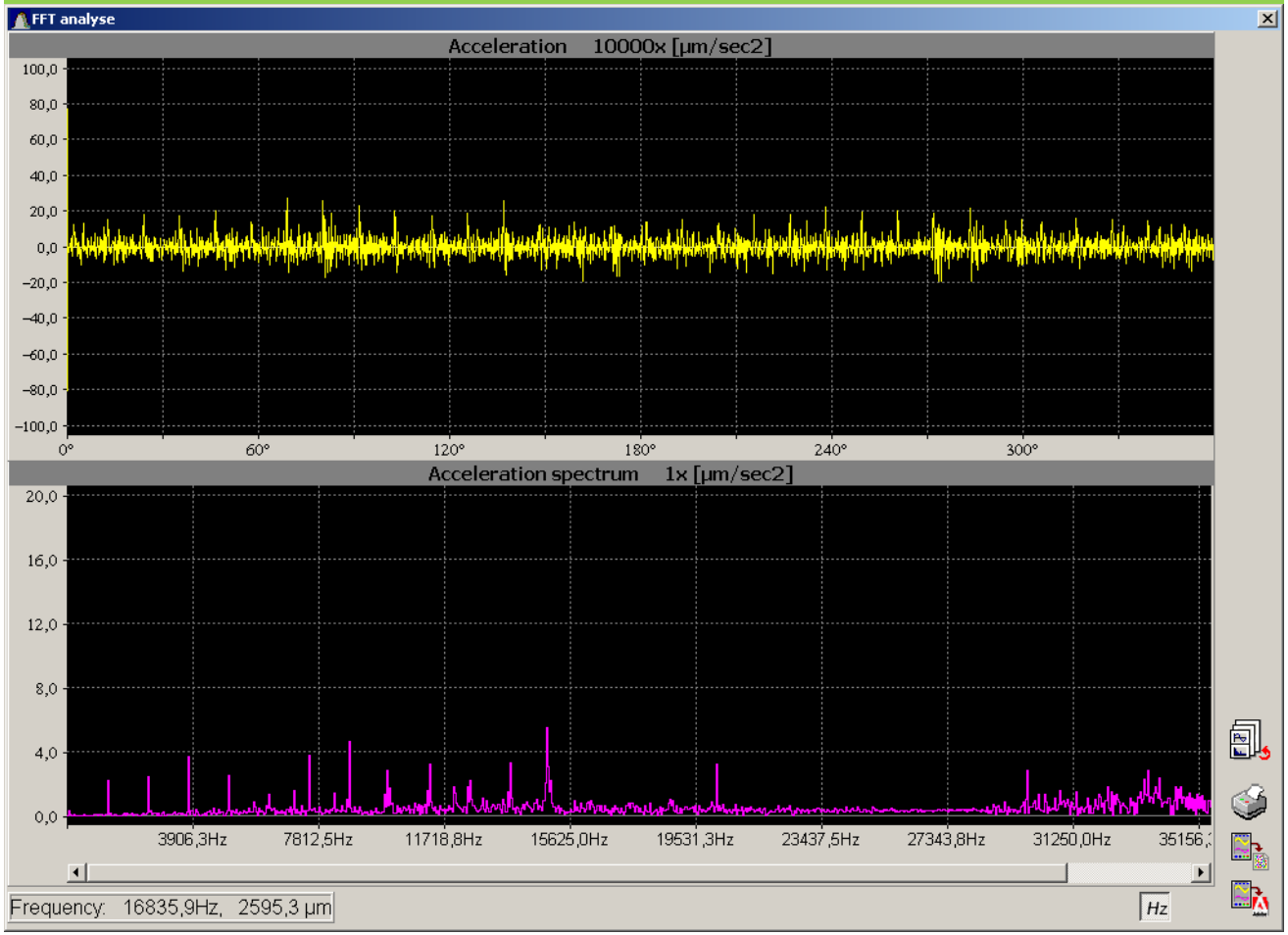
Example 7: FFT analysis and noise

Calculated acceleration spectrum of signal



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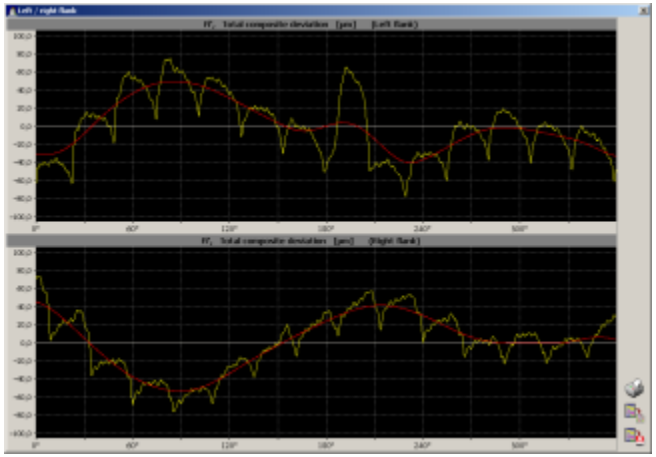
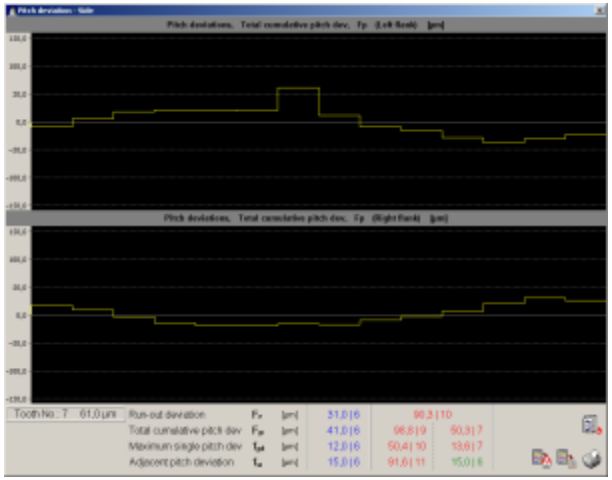
Example 8: Pitch deviation of gear

Calculated diagram of pitch deviation

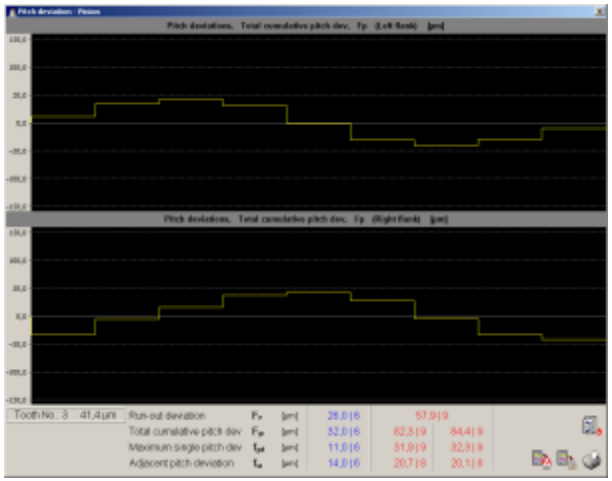


Wromgear



Decomposition of single flank test

Worm



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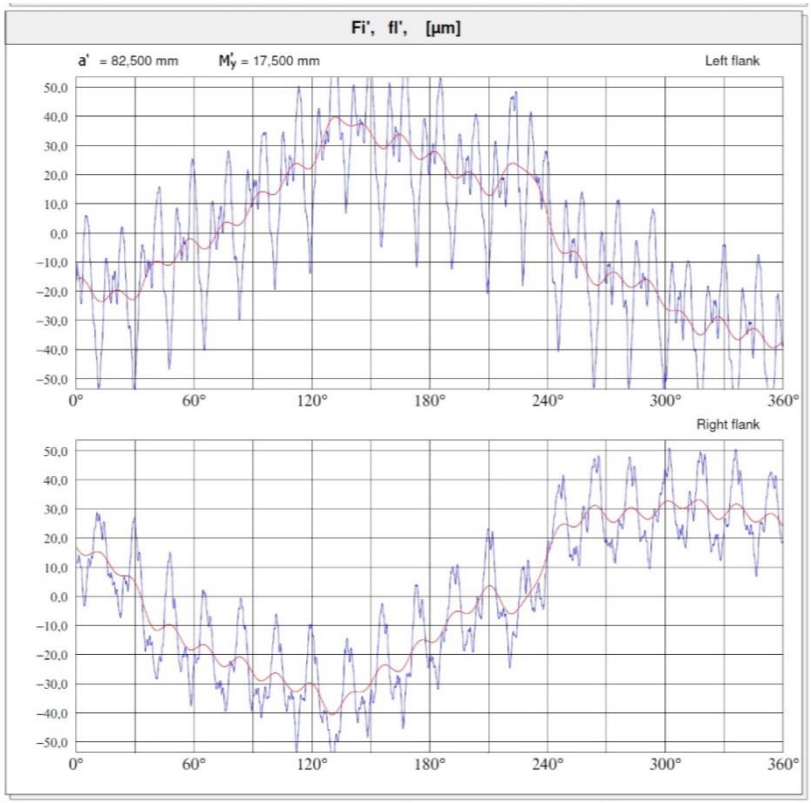
Example 9: Worm with a pitch error



Standard: DIN 3974	F-factor 25%		Allowed	Measured	
Total composite deviation	F'_i	[µm]	84,6 | 8	136,9 | 10	110,4 | 9
Single flank composite dev.	f'_i	[µm]	36,1 | 8	64,5 | 10	46,1 | 9
Mean value	f'_{im}	[µm]		48,1 | 9	30,3 | 8
Max value	f'_{imax}	[µm]		72,4 | 10	49,7 | 9
Long wave component	f'_l	[µm]	45,0	79,2	73,7
Short wave component	f'_k	[µm]	30,0	58,2	37,6
Backlash - tangential	j	[mm]	0,100 ÷ 0,150	0,097 ÷	0,198

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There is not 180 deg.
between tooth Nr. 1 and Nr. 2,
but
180 deg and
cca 99 wsec.

Right flank has wavy surface,
cca 5 µm

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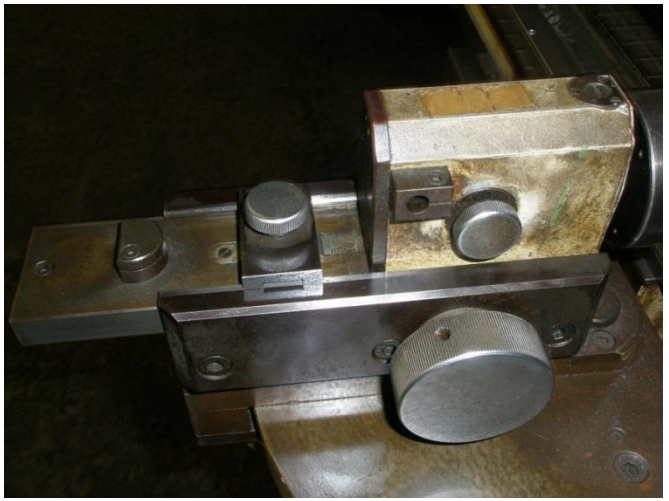
Before retrofit



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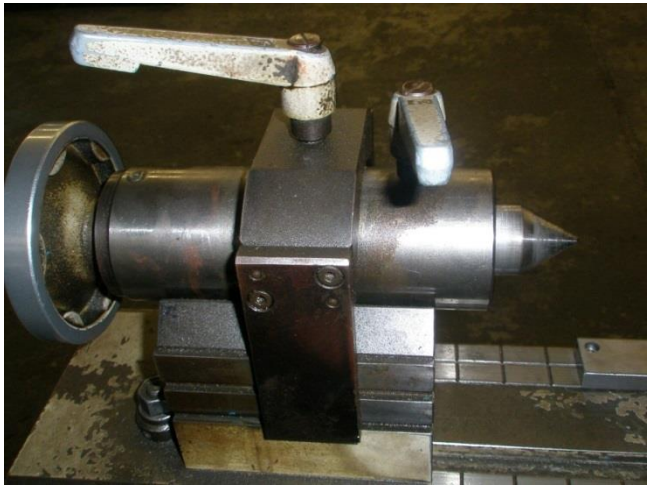
Before retrofit



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Complete dismantling

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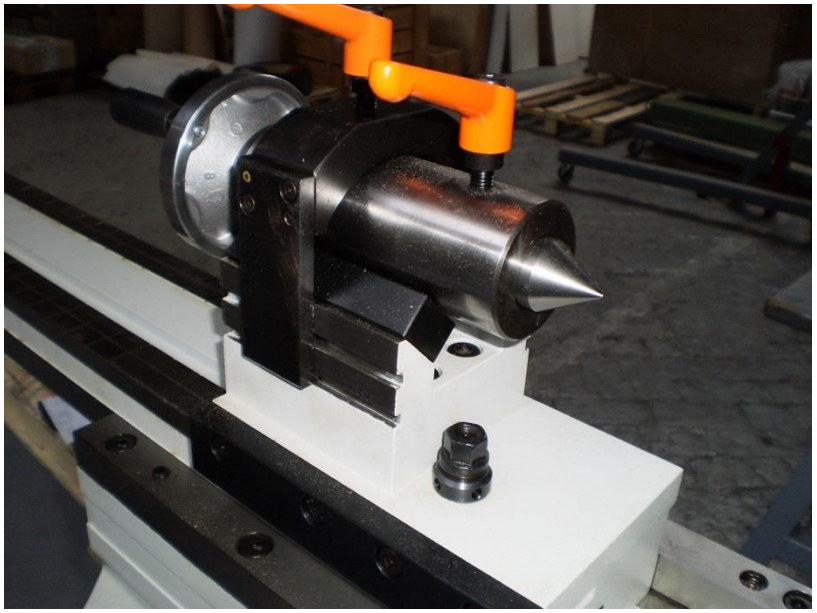
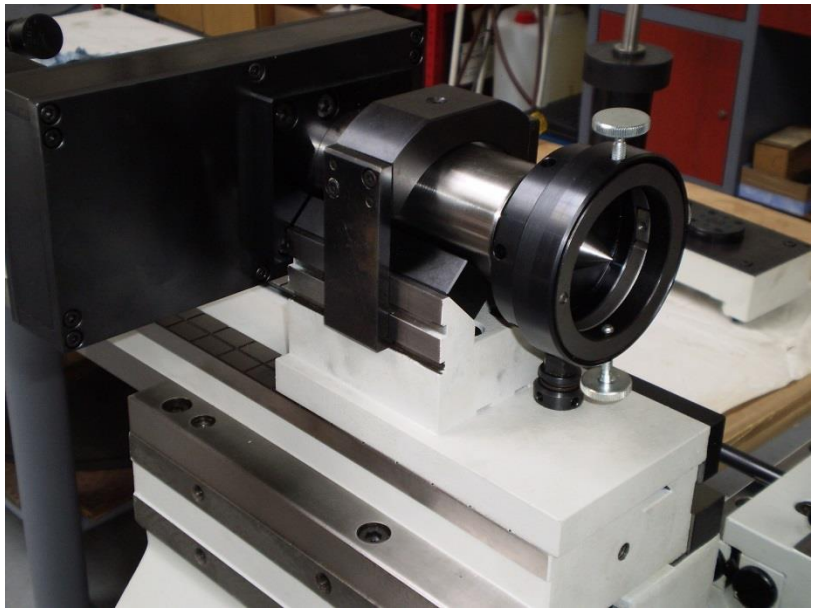
We modernize





New spindles to clamp gears between centers

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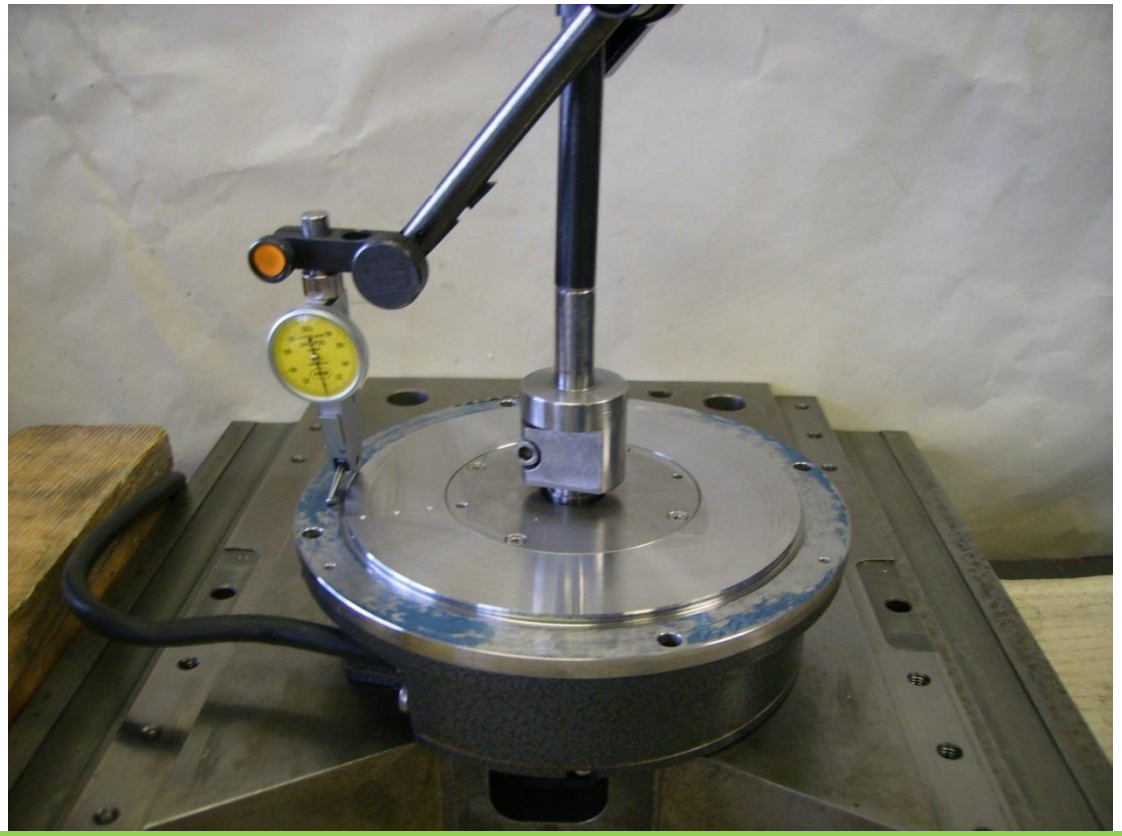
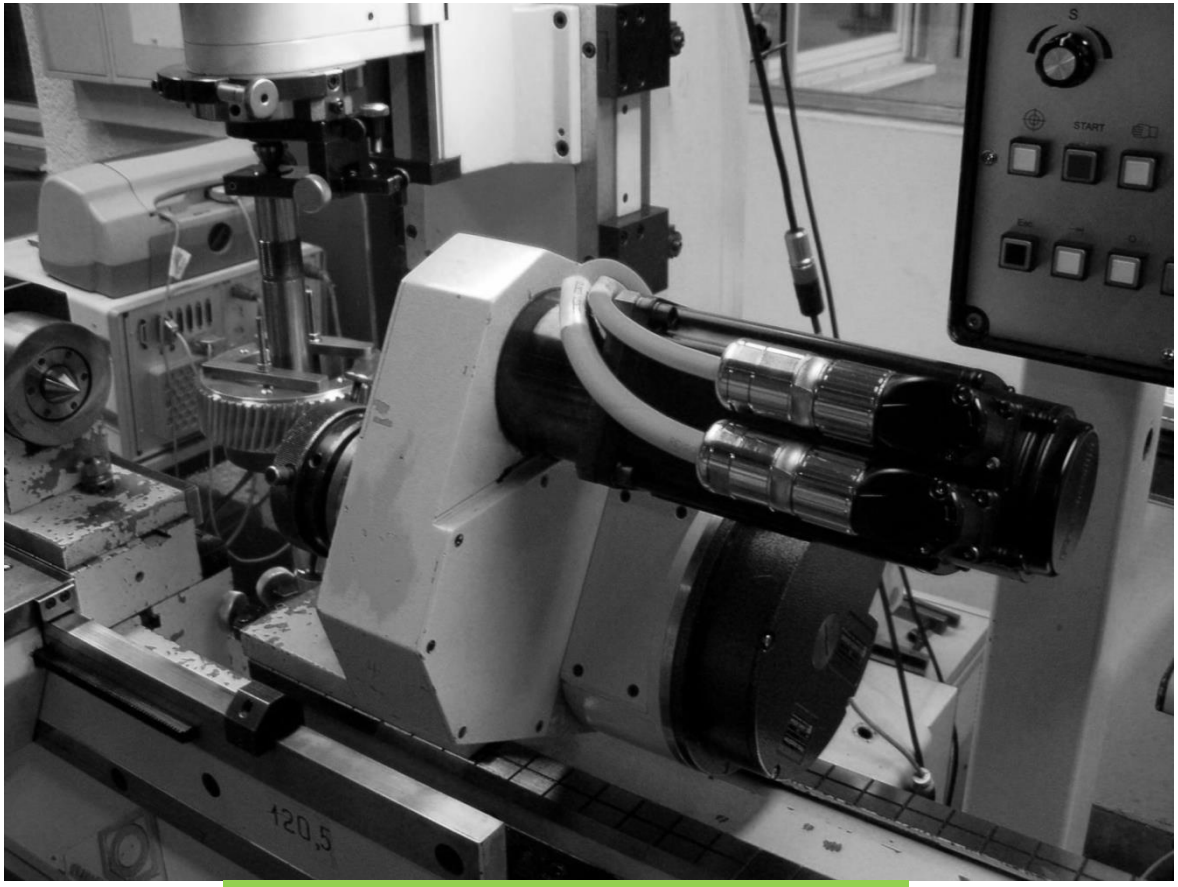
We modernize



Checking accuracy of rotary encoders placed in the table for a worm

We modernize



New motor unit

We modernize

New control panel

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We modernize

Completely new wiring box

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Before and after

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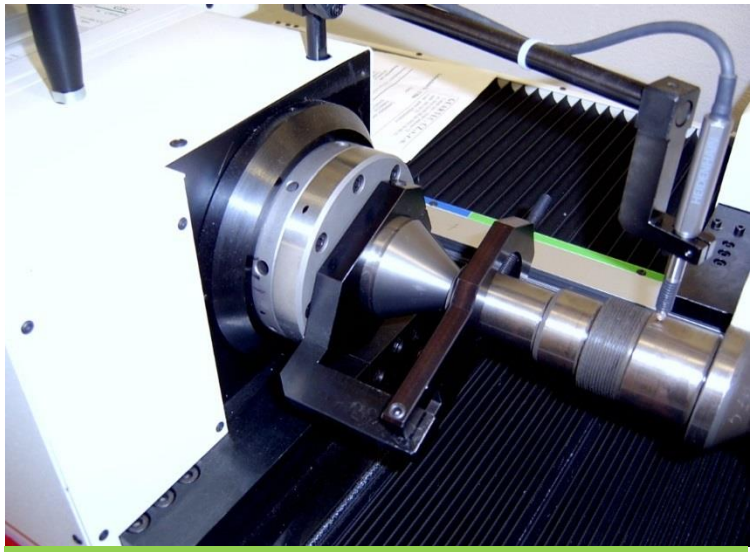
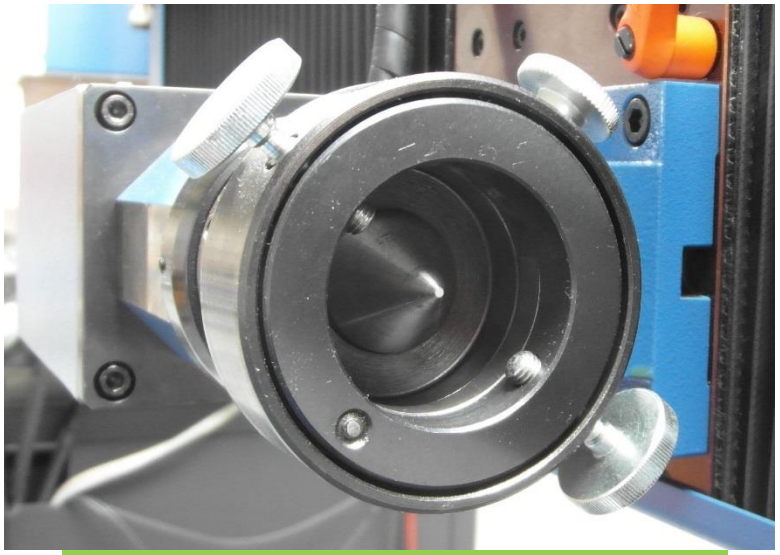
Accessories - Clamping

Two standard fixtures



Clamping range 0 – 20, 0- 40 mm
Intended for users with common accuracy measurement

Special fixtures



Clamping range 0 – 40 mm
Intended for users with higher accuracy measurements

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Accessories – Calibration

Calibration arbor and Master worm gears (DIN3)

Thank you.

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