MESYS Ball Screw Calculation 12-2024

File name:	BallScrewExample.mBSC
Project name:	**Protocol Example**
Description:	**Ball Screw Calculation**
Date:	Monday, 24. February 2025

Ball Screw Calculation

Input data

Geometry

Number of starts	ns	1	
Number of turns	nt	5	
Lead	Ph	10.000	mm
Lead direction		right	
Ball diameter	Dw	5.0000	mm
Pitch diameter	Dpw	25.000	mm
Contact angle	α	40.000	°
Conformity ball screw	frs	0.52	
Conformity ball nut	frn	0.52	
Axial clearance	Pa	0.0000	mm
Clearance generation		axial direction	
Tolerance class		5	
Inner diameter ball screw	dsi	0.0000	mm
Outer diameter nut	dhe	40.000	mm
Ball screw lead error	ΔPh	0.0000	mm

Loading

Speed of inner ring	ni	100.000	rpm
		inner ring rotates relative to load	
Speed of outer ring	ne	0.0000	rpm
		outer ring is stationary relative to load	
Axial force	Fx	5000.0	N
Radial force Y	Fy	0.0000	N
Radial force Z	Fz	0.0000	N
Rotation around Y	ry	0.0000	mrad
Moment Z	Mz	50.000	Nm
Reliability	reliability	90.000	%

Material

Material ball screw	Steel	
Material treatment ball screw	Air-melt	
Hardness ball screw	HV_s	660
Material ball nut	Steel	
Material treatment ball nut	Air-melt	
Hardness ball nut	HV_n	660
Material ball	Steel	

Results

Reliability factor calculated according ISO 281

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Static load rating analog ISO 76

Dynamic load rating calculated using exponents of ISO 281

Geometry

Number of starts	ns	1	
Number of turns	nt	5	
Lead	Ph	10.000	mm
Lead angle	phi	7.2561	°
Lead direction		right	
Number of loaded balls per turn	zl	15	
Ball diameter	Dw	5.0000	mm
Pitch diameter	Dpw	25.000	mm
Contact angle	α	40.000	°
Free contact angle	α0	40.000	°
Conformity ball screw	frs	0.52	
Conformity ball nut	frn	0.52	
Radius inner race	rs	2.6000	mm
Radius outer race	rn	2.6000	mm
Axial clearance	Pa	0.0000	mm
Radial clearance	Pd	0.0000	mm
Extension contact ellipse inner ring	dCiMax	22.426	mm
Extension contact ellipse outer ring	dCeMin	27.604	mm
Ellipse length ratio inner race	eLR_i	121.893	%
Ellipse length ratio outer race	eLR_e	123.635	%

Forces and displacements

Axial force	Fx	5000.0	N
Radial force Y	Fy	0.0000	N
Radial force Z	Fz	0.0000	N
Moment Y	My	15.193	Nm
Moment Z	Mz	50.000	Nm
Displacement X	ux	8.5089	µm
Displacement Y	uy	3.1493	µm
Displacement Z	uz	0.2163	µm
Rotation around Y	ry	0.0000	mrad
Rotation around Z	rz	0.3487	mrad
Maximal pressure	pmax	2246.9	MPa
Static safety factor	S0eff	6.55585	

Life

Modification factor for tolerance class	fac	1
Modification factor for reliability	far	1
Modification factor for steel treatment (ball screw)	fm_i	1
Modification factor for steel treatment (ball nut)	fm_e	1
Modification factor for surface hardness (static, ball screw)	fh0_i	1
Modification factor for surface hardness (static, ball nut)	fh0_e	1

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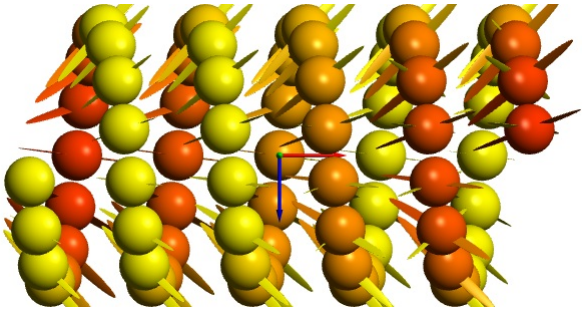
Modification factor for surface hardness (dynamic, ball screw)	fh_i	1	
Modification factor for surface hardness (dynamic, ball nut)	fh_e	1	
Dynamic load rating	Ca	26821.2	N
Static load rating	C0a	90171.4	N
Reference rating life	L10r	59.4193	
Reference rating life	Lnr	59.4193	
Reference rating life	L10rh	9903.2	h
Reference rating life	Lnrh	9903.2	h

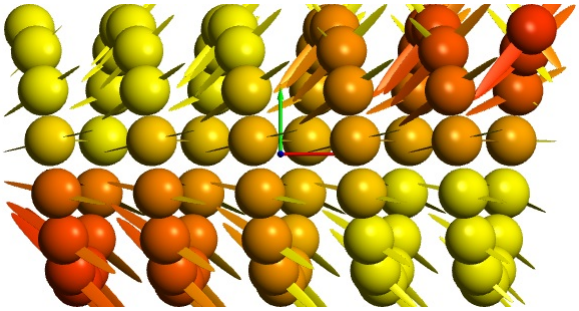
Stiffness matrix

	ux [µm]	uy [µm]	uz [µm]	ry [mrad]	rz [mrad]
Fx [N]	899.425	-100.133	4.050	969.750	1340.797
Fy [N]	-101.533	606.621	29.208	1258.060	-3005.524
Fz [N]	3.791	-76.634	560.806	5169.276	286.656
My [Nm]	1.367	0.446	5.141	190.368	25.455
Mz [Nm]	1.161	-3.035	-0.560	7.306	220.763

Compliance matrix

	Fx [N]	Fy [N]	Fz [N]	My [Nm]	Mz [Nm]
ux [µm]	0.001150	0.000185	0.000056	-0.008471	-0.003557
uy [µm]	0.000198	0.001830	0.000077	-0.016171	0.025480
uz [µm]	0.000130	0.000425	0.002403	-0.069116	0.009846
ry [mrad]	-0.000012	-0.000021	-0.000067	0.007298	-0.000963
rz [mrad]	-0.000003	0.000026	0.000009	-0.000595	0.004956





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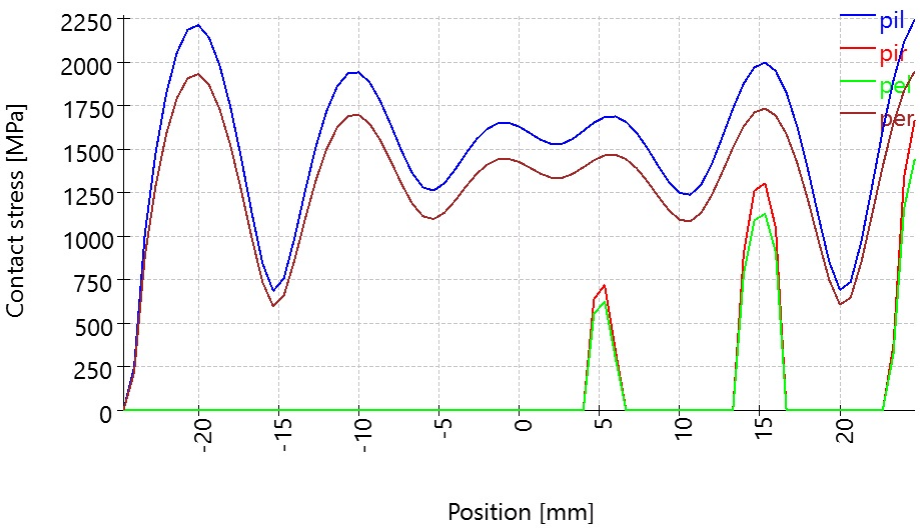
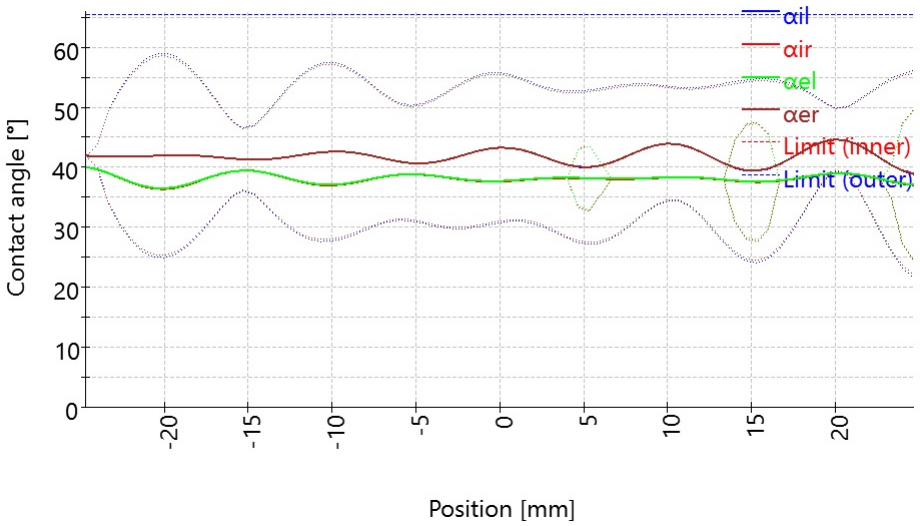
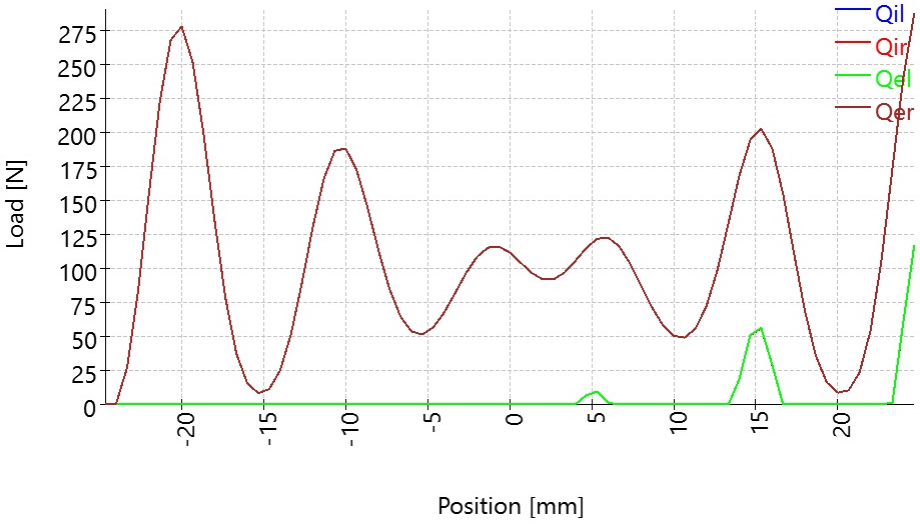
Contact stress

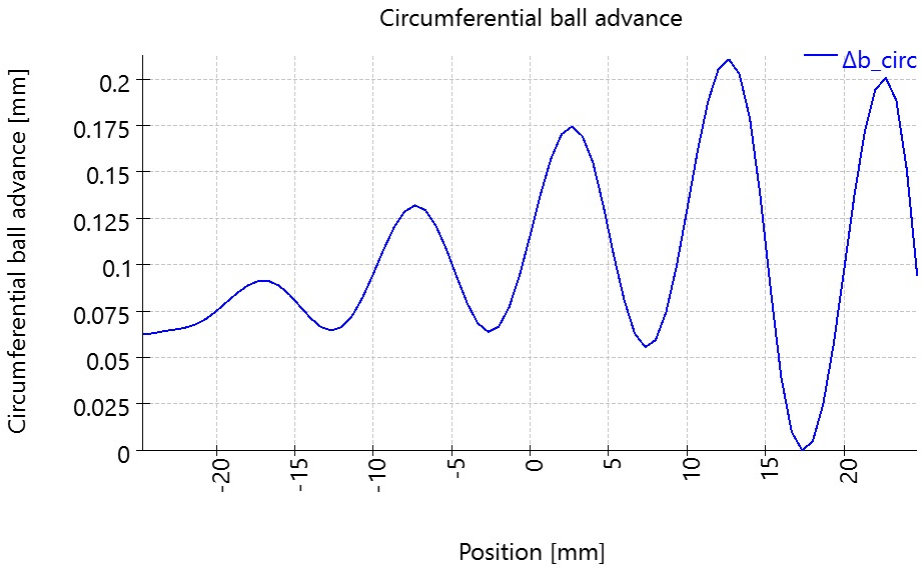


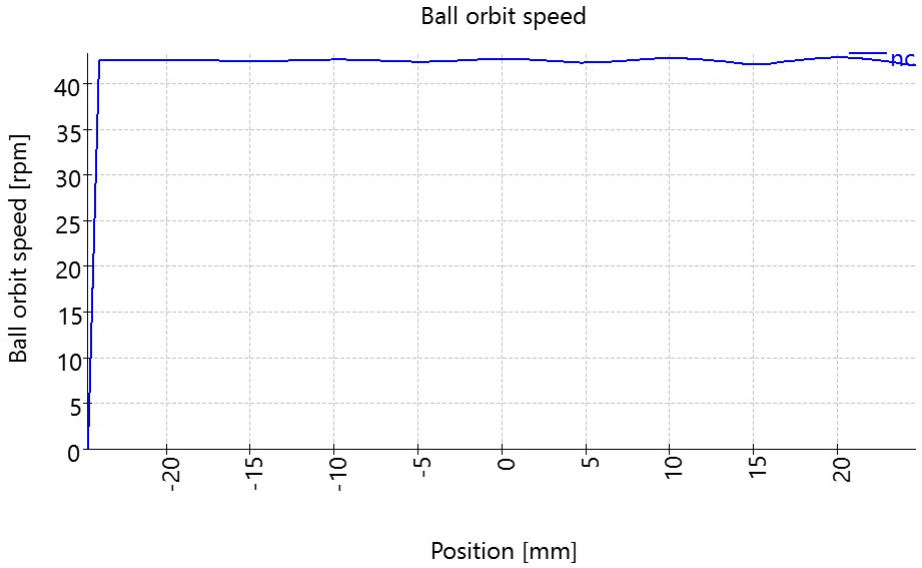
Contact angle

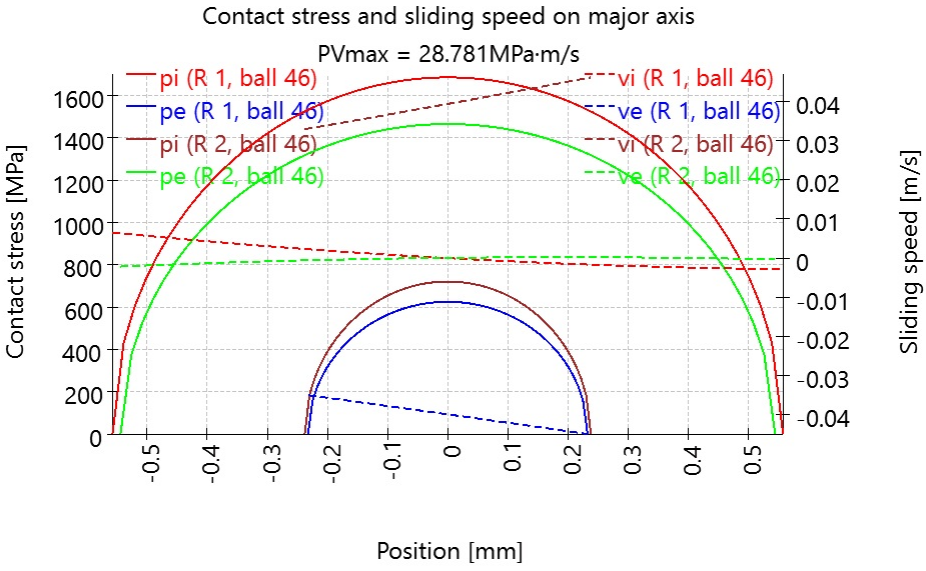


Ball loads




Circumferential ball advance
Δb_circ
Circumferential ball advance [mm]
0.2
0.175
0.15
0.125
0.1
0.075
0.05
0.025
0
-20
-15
-10
-5
0
5
10
15
20
Position [mm]


Ball orbit speed
nc
Ball orbit speed [rpm]
40
35
30
25
20
15
10
5
0
-20
-15
-10
-5
0
5
10
15
20
Position [mm]


Contact stress and sliding speed on major axis
PVmax = 28.781MPa·m/s
pi (R 1, ball 46)
pe (R 1, ball 46)
pi (R 2, ball 46)
pe (R 2, ball 46)
vi (R 1, ball 46)
ve (R 1, ball 46)
vi (R 2, ball 46)
ve (R 2, ball 46)
Contact stress [MPa]
1600
1400
1200
1000
800
600
400
200
0
Sliding speed [m/s]
0.04
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
Position [mm]

MESYS Shaft and Rolling Bearing Calculation

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