



Ball screws

i Calculation without errors.

ii Project information

?

Input section

1.0 Preliminary design. Units selection

1.1 Calculation units	SI Units (N, mm, kW...)		
1.2 Calculation of screw revolutions, feed and pitch			
1.3 Lead	Ph	20.000	[mm] ● 20 ▼
1.4 Travel speed	v	800.00	[mm/s] ●
1.5 Ball screw rotational speed	ns	2400.00	[/min] ●
1.6 Transmission ratio	$i=(z2/z1)$	0.6250	[~] ●
1.7 Engine speed	ne	1500.00	[/min] ●

1.8 Preliminary calculation of dynamic load capacity and screw diameter

1.9 Equivalent axial load	Fm	1000.0	[N]
1.10 Equivalent rotational speed	nm	2400.0	[/min] ✓
1.11 Load factor	fw	1.20	[~]
1.12 Desired service life	Lh-req	20000	Lh [h] ▼
1.13 Required dynamic load rating (ISO)	Ca-req	17073.1	[N]
1.14 Required dynamic load rating (ANSI)	Pi-req	15765.6	[N]
1.15 Preliminary design of the ball screw diameter	d1-req	20(5) - 50(1)	[mm]

1.16 Check values

1.17 Ball Screw mounting (ends)	B. Fixed - Supported ▼		
1.18 Unsupported length of ball screw shaft	Ls [mm]	1200.00	< 1280
1.19 Ball screw nominal diameter	d1 [mm]	32.0000	> 20
1.20 Dn - characteristic speed (d1*ns)	Dn	76800	< 110000
1.21 Buckling - permissible axial load on screw	Fmax	42400.1	[N]
1.22 Maximum allowable speed	nmax	2972.9	[/min]
1.23 Screw and nut friction coefficient	f	0.01	[~]
1.24 Efficiency (rotational force / axial force)	η	0.9484	[~]
1.25 Torsional moment	Mk	3.3564	[Nm]
1.26 Engine power	Pw	0.844	[kW]

1.27 Tolerance class (ISO 3408)

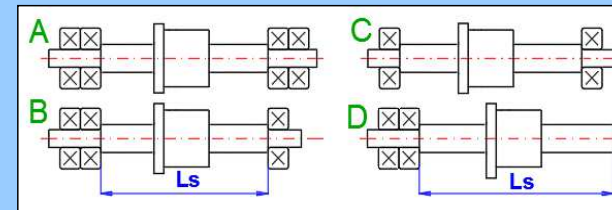
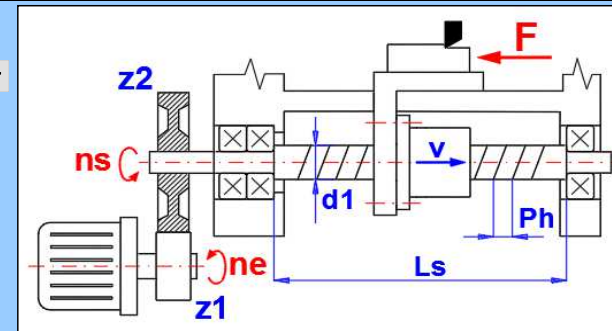
1.28 Tolerance on specified travel	$\pm ep$	9	13	24	47	208	840	---	---	[μm]
1.29 Tolerance on travel variation	uu	6	9	16	30	52	210	---	---	[μm]
1.30 Tolerances on travel variation	u300p	3.5	6	12	23	52	210	---	---	[μm]
1.31 Tolerances on travel variation	u2pp	3	4	6	8	---	---	---	---	[μm]

2.0 Material parameters

2.1 Ball screw shaft material

2.2 Modulus of elasticity	Es	210000	[MPa]
2.3 Yield strength in tension	Rp0.2	350.0	[MPa]
2.4 Poison's Ratio	ms	0.300	[~]
2.5 Density	ros	7850.0	[kg/m ³]
2.6 Linear expansion coefficient	α	11.50	[10 ⁻⁶ /°C]

2.7 Ball material



1.32 Table of diameters and leads

d1 = 10 ;	Ph = 1, 2, 2.5, 3, 4, 5, 6
d1 = 12 ;	Ph = 2, 2.5, 3, 4, 5, 6, 8, 10, 12
d1 = 14* ;	Ph = 3, 4, 5
d1 = 15* ;	Ph = 10, 20
d1 = 16 ;	Ph = 2, 2.5, 3, 4, 5, 6, 8, 10, 12, 16
d1 = 20 ;	Ph = 3, 4, 5, 6, 8, 10, 12, 16, 20
d1 = 25 ;	Ph = 4, 5, 6, 8, 10, 12, 16, 20, 25
d1 = 28* ;	Ph = 6, 10
d1 = 32 ;	Ph = 4, 5, 6, 8, 10, 12, 16, 20, 25, 32
d1 = 36* ;	Ph = 5, 8, 10

2.8 Modulus of elasticity	Eb	210000	[MPa]
2.9 Poisson's Ratio	mb	0.300	[~]
2.10 Nut material			
2.11 Modulus of elasticity	En	210000	[MPa]
2.12 Poisson's Ratio	mn	0.300	[~]

3.0 Definition of mechanism, load and screw parameters

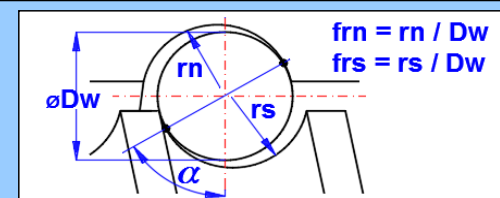
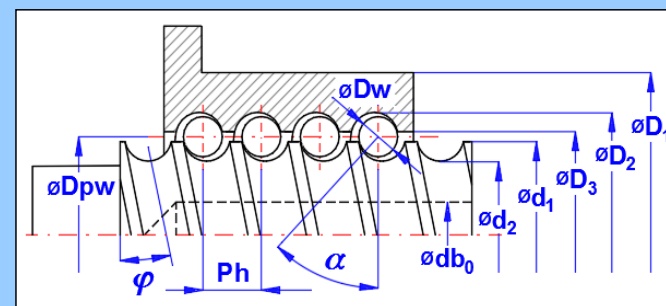
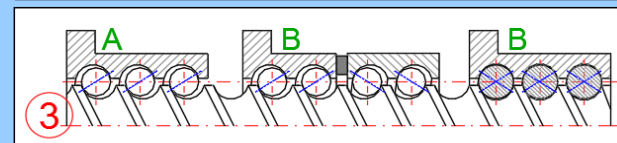
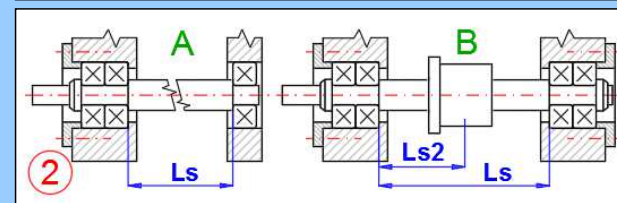
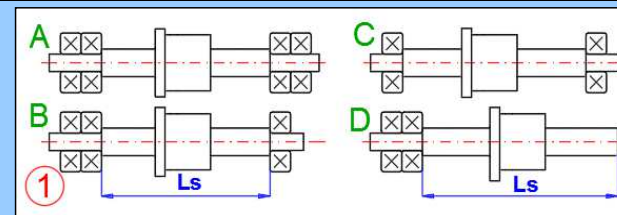
3.1 Transfer of values from preliminary design [1]

3.2 Definition of accuracy, design, load, life ...

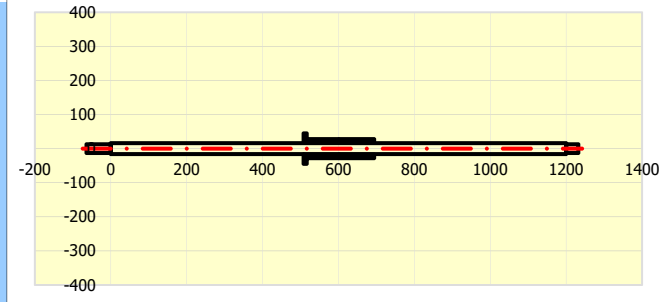
3.3 Tolerance class		IT 3	
3.4 Required reliability		90 % (1)	
3.5 1. Ball Screw mounting (ends)	B. Fixed - Supported		
3.6 2. Ball Screw mounting (stiffness)	A. Rigid mounting of ball screw shaft at one end		
3.7 3. Nut type	B. With preload (double nut, ball size, different lead ...)		
3.8 Equivalent axial load, direction 1	Fma1	1374.10	[N]
3.9 Equivalent axial load, direction 2	Fma2	888.30	[N]
3.10 Maximum axial load	Fmax	1624.21	[N]
3.11 Equivalent rotational speed, direction 1	nm1	1273.47	[/min]
3.12 Equivalent rotational speed, direction 2	nm2	1273.47	[/min]
3.13 Maximal rotational speed	nmax	2400.00	[/min]
3.14 Ball nut preload	Fpr [N]	1700.00	A. 10% Ca (2023)
3.15 Load factor	fw	1.20	[~]
3.16 Desired service life	Lh-req	20000	Lh [h]
3.17 Required dynamic load rating (ISO)	Ca-req	20227.5	[N]
3.18 Required dynamic load rating (ANSI)	Pi-req	18678.4	[N]

3.19 Selection, definition of ball screw and nut parameters

3.20 Unsupported length of ball screw shaft	Ls	1200.00	[mm]
3.21 Unsupported length of ball screw shaft	Ls2	600.00	[mm]
3.22 Number of loaded turns (nut)	i	3.00	[~]
3.23 Number of unloaded balls in the recirculation system	zu	0	
3.24 Reduction factor of dynamic load rating Ca	exp	0.86 (ISO, ANSI)	
3.25 Table of ball screws		1. ISO - Light	
3.26 Dimensions of ball screw (d1 x Ph)		32 x 20 (Dw=5.556; Ca=22041; C0a=52810)	[mm,N]
3.27 Nominal diameter	d1	32.000	[mm]
3.28 Diameter of the inside hole	db0	0.000	[mm]
3.29 Ball diameter	Dw	5.556	[mm]
3.30 Lead	Ph	20.0000	[mm]
3.31 Pitch circle diameter	Dpw	33.3890	[mm]
3.32 Lead angle	φ	10.7949	[°]
3.33 Nominal contact angle	α	45.00	[deg]
3.34 Conformity ratio (rn/Dw)	frn	0.550	0.550 - According the ISO 3408
3.35 Conformity ratio (rs/Dw)	frs	0.550	0.550 - According the ISO 3408
3.36 Dynamic axial load rating (ISO)	Ca	22041.0	[N]
3.37 Static axial load rating	C0a	52810.0	[N]
3.38 Ball screw shaft root diameter	d2	27.833	[mm]
3.39 Ball nut body diameter	D1	56.0	[mm]



3.40	Ball nut root diameter	D2	38.945	[mm]
3.41	Ball nut internal diameter	D3	34.778	[mm]
3.42	Preload created by double nut		Yes	
3.43	Ball nut approximate length	Ln	184	[mm] <input checked="" type="checkbox"/>
3.44	Approximate useful travel	Lu	1016	[mm]
3.45 Listing of important results				
3.46	Dn - characteristic speed (d1*ns)	Dn	76800	< 110000 [~]
3.47	Resulting life with reliability factor	Lrhr	25876	> 20000 [h]
3.48	Total Rigidity with the preloaded nut unit	R,pr	95	[N/μm]
3.49	Elastic deformation for maximum force and maximum screw length	Δmax	17	[μm]
3.50	Tolerances on specified travel (Lu = 1016 [mm])	±ep	24	[μm]
3.51	Deflection (dead weight load)	y _{max}	0.08481	< 0.36 [mm]
3.52	Safety factor (tension, compression, torsion)	SF _c	100.72	> 2.00 [~]
3.53	Safety factor (buckling)	SF _b	52.21	> 3.50 [~]
3.54	Static safety factor	SF _s	32.51	> 1.4 [~]
3.55	Critical speed	n _{cr}	3680	[/min]
3.56	Rate of Permissible operating speed to Critical speed	r (n _{max} /n _{cr})	0.652	< 0.80 [~]
3.57	Efficiency	η	0.951	[~]



Results section

4.0 Nominal life, modified life (ISO 3408-5)

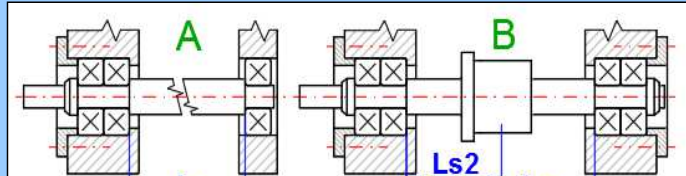
4.1	Required reliability		90 % (1)	
4.2	Reliability factor	far	1.00	[~]
4.3 Unidirectional external axial load				
4.4	Life in revolution	L	2388334360	[rev]
4.5	Life in hours	Lh	31257.56607	[h]
4.6	Life in path	Lm	47766687.2	[m]
4.7	Life in hours with reliability factor	Lhr	31257.56607	[h]
4.8	Life in path with reliability factor	Lmr	47766687.2	[m]

4.9 Bidirectional external axial load and ball screw with preloaded ball nuts

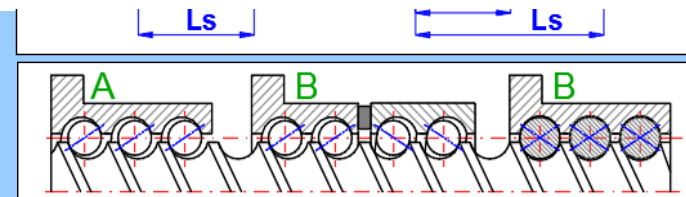
4.10	Life in revolution	L1	2388334360	[rev]
4.11	Life in hours	Lh1	31257.56607	[h]
4.12	Life in revolution	L2	8840384597	[rev]
4.13	Life in hours	Lh2	115699.4223	[h]
4.14	Resulting life in revolution	Lr	1977144917	[rev]
4.15	Resulting life in hours	Lrh	25876.0829	[h]
4.16	Resulting life in path	Lrm	39542898.34	[m]
4.17	Resulting life with reliability factor	Lrhr	25876.0829	[h]
4.18	Resulting life in path with reliability factor	Lrmr	39542898.34	[m]

5.0 Static axial rigidity. Ball screw, ball nut unit... (ISO 3408-4)

5.1 Static axial rigidity				
5.2	Ball Screw mounting (ends)		A. Rigid mounting of ball screw shaft at one end	
5.3	Ball Screw mounting (stiffness)		B. With preload (double nut, ball size, different lead ...)	
5.4	Unsupported length of ball screw shaft	Ls	1200.000	[mm]
5.5	Unsupported length of ball screw shaft	Ls2	600.000	[mm]
5.6	Diameter of load application on the ball screw shaft	dc	29.460	[mm]



5.7 Diameter of load application on the ball nut	Dc	37.318	[mm]
5.8 Rigidity of ball screw shaft (Rs)			
5.9 Rigidity (Rigid mounting at one end)	Rs1	119.3	[N/μm]
5.10 Rigidity (Rigid mounting at both ends)	Rs2	477.2	[N/μm]
5.11 Rigidity of ball screw shaft for $Ls2=Ls/2$	Rs2,min	477.2	[N/μm]
5.12 Rigidity of nut body and screw shaft under resulting radial components of load (Rn/s)			
5.13 Rigidity of the nut body and screw shaft	Rn/s	22005.9	[N/μm]
5.14 Rigidity of nut body and screw shaft under preload	Rn/s,pr	44011.8	[N/μm]
5.15 Rigidity of the ball/balltrack area (Rb/t)			
5.16 Rigidity of the ball/balltrack area	Rb/t	435.8	[N/μm]
5.17 Rigidity of the ball/balltrack area under preload	Rb/t,pr	882.2	[N/μm]
5.18 Rigidity of ball nut unit (Rnu)			
5.19 Rigidity of ball nut unit with backlash	Rnu	427.4	[N/μm]
5.20 Rigidity of preloaded ball nut unit	Rnu,pr	864.9	[N/μm]
5.21 Rigidity of ball nut unit with the correction factor (Rnu*far)			
5.22 Correction factor for the selected tolerance class	far	0.55	IT 3
5.23 Rigidity of the ball nut unit with the correction factor	Rnu,ar	235.0	[N/μm]
5.24 Rigidity of the preloaded ball nut unit with the correction factor	Rnu,pr,ar	475.7	[N/μm]
5.25 Total Rigidity of Linear Motion system			
5.26 Rigidity of screw bearings	RS	10000000.0	[N/μm]
5.27 Rigidity of nut mounting	RB	10000000.0	[N/μm]
5.28 Total Rigidity with the nut unit with backlash	R	79.1	[N/μm]
5.29 Total Rigidity with the preloaded nut unit	R,pr	95.4	[N/μm]
5.30 Elastic deformation for maximum force and maximum screw length	Δmax	17	[μm]



5.31 Auxiliary calculations (ISO 3408-4)

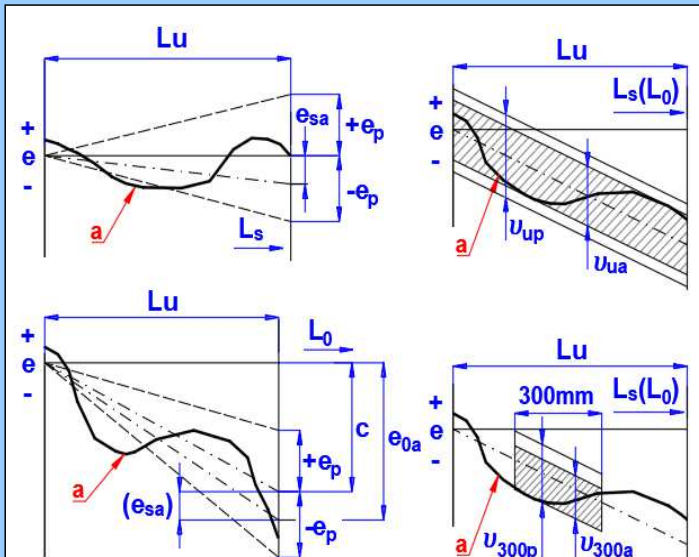
$\Sigma\cos\alpha$	$\Sigma\cos\alpha_n$	$\cos\alpha_{\text{Taus}}$	$\cos\alpha_{\text{Taun}}$	$\sin\alpha_{\text{Taus}}$	$\sin\alpha_{\text{Taun}}$
0.4407	0.354799	0.851488	0.815531	0.524374	0.578713
Y_s	Y_n	c_{Es}	c_{En}	z_1	z_2
0.952987	0.998521	0.464314	0.464314	19	0
FN	ck	k			
34.71	1.432106	44.533197			

6.0 Tolerances, accuracy (ISO 3408-3, ANSI B5.48)

6.1 Tolerance class	IT 3	
6.2 Useful travel	Lu	1016.00 [mm] <input checked="" type="checkbox"/> (~Lu = 1016.00 mm)

6.3 Tolerance on specified travel (±ep) and travel variation (±uup)

Lu [mm]		IT0		IT1		IT3		IT5	
>	<=	±ep [μm]	±uup [μm]	±ep [μm]	±uup [μm]	±ep [μm]	±uup [μm]	±ep [μm]	±uup [μm]
0	315	4	3.5	6	5	12	8	23	18
315	400	5	3.5	7	5	13	10	25	20
400	500	6	4	8	5	15	10	27	20
500	630	6	4	9	6	16	12	32	23
630	800	7	5	10	7	18	13	36	25
800	1000	8	6	11	8	21	15	40	27
1000	1250	9	6	13	9	24	16	47	30
1250	1600	11	7	15	10	29	18	55	35
1600	2000	-	-	18	11	35	21	65	40
2000	2500	-	-	22	13	41	24	78	46
2500	3150	-	-	26	15	50	29	96	54
3150	4000	-	-	32	18	62	35	115	65
4000	5000	-	-	-	-	76	41	140	77
5000	6300	-	-	-	-	90	50	170	93
6300	8000	-	-	-	-	110	60	213	115
8000	10000	-	-	-	-	-	-	265	140

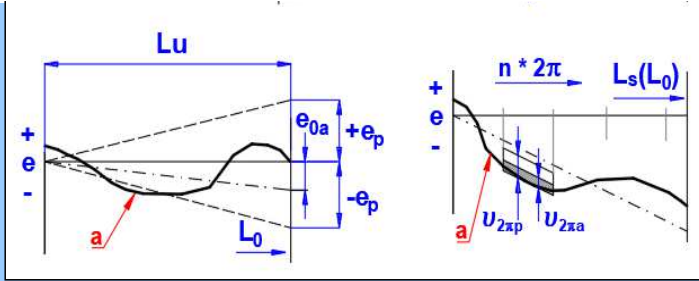


10000	12500	-	-	-	-	-	-	320	170
							ISO	+JIS	+NSK

6.4 Travel deviation and variation

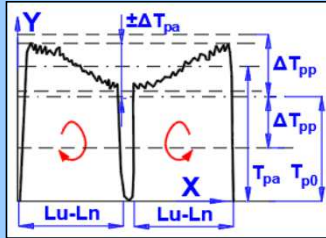
6.5 Tolerance class		IT0	IT1	IT3	IT5	IT7 (x)	IT10 (x)
6.6 Tolerances on specified travel	$\pm e_p$ [μm]	9	13	24	47	---	---
6.7 Tolerances on specified travel (x)	$\pm e_p$ [μm]	11.9	20.3	40.6	77.9	176.1	711.2
6.8 Tolerances on travel variation	v_{up} [μm]	6	9	16	30	---	---
6.9 Tolerances on travel variation	v_{300p} [μm]	3.5	6	12	23	52	210
6.10 Tolerances on travel variation	$v_{2\pi}$ [μm]	3	4	6	8	---	---

(x) Only for transport ball screws

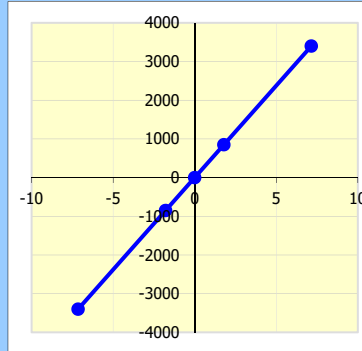


6.11 Limiting deviation ΔT_{pp} for the dynamic drag torque T_{p0}

6.12 Dynamic drag torque with preload	T_{p0}	0.6196	[Nm]
6.13 Permissible deviation	$\pm \Delta T_{pp}$	30	[%]
6.14 Permissible deviation	$\pm \Delta T_{pp}$	0.1859	[Nm]

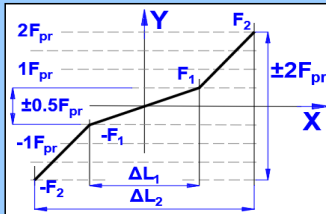


X - Travel
Y - Preload drag torque



6.15 Measurement of preloaded nut axial rigidity: R_{nu}

6.16 Axial load	F_1 [N]	850	[N]	<input checked="" type="checkbox"/>
6.17 Axial load	F_2 [N]	3400	[N]	
6.18 Elastic deformation	ΔL_1 [μm]	3.57	[μm]	
6.19 Elastic deformation	ΔL_2 [μm]	14.30	[μm]	
6.20 Rigidity in the range +- F_1	R_{nu1}	475.7	[N/ μm]	
6.21 Rigidity in the range + F_1 to + F_2 and - F_1 to - F_2	R_{nu2}	475.7	[N/ μm]	

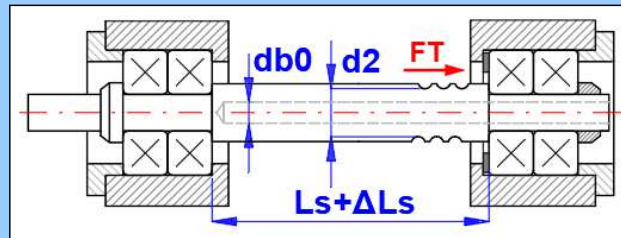


6.22 Tolerance class and Deviations (ANSI B5.48)

6.23 Tolerance class	Class1	Class2	Class3	Class4	Class5	Class6	Class7	Class8	
6.24 Maximum permissible lead error (Inch)	0.000472	0.000472	---	0.001181	0.001181	---	---	---	[inch]
6.25 Maximum permissible lead error (Micrometer)	11	11	---	28.6	28.6	---	---	---	[μm]
6.26 Maximum rate error (inch / 12inch)	---	0.0002	0.0002	---	0.0005	0.0005	0.001	0.006	[inch]
6.27 Maximum rate error (μm / 300 mm)	---	5	5	---	13	13	25	150	[μm]
6.28 Wobble error peak to peak (Inch)	0.0002	0.0002	0.0002	0.0004	0.0004	0.0004	0.0004	0.0015	[inch]
6.29 Wobble error peak to peak (Micrometer)	5	5	5	10	10	10	10	38	[μm]

7.0 Calculation of warming, expansion and compensating force

7.1 Ball screw length	L_s	1200.00	[mm]
7.2 Ball screw shaft root diameter	d_2	27.833	[mm]
7.3 Diameter of the inside hole	db_0	0.000	[mm]
7.4 Linear expansion coefficient	α	11.50	[$10^{-6}/^\circ\text{C}$]
7.5 Temperature increase	Δt	10.0	[$^\circ\text{C}$]
7.6 The thermal elongation of the screw	ΔL_s	0.138000	[mm]
7.7 Requested screw preload	ΔL_p	0.138000	[mm]
7.8 The pretensioning force	FT	14693.6	[N]



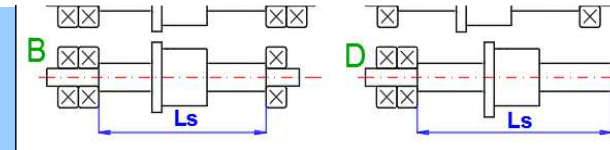
8.0 Check for buckling, tension, compression, torsion, critical speed, efficiency....

8.1 Ball screw input parameters

8.2 Ball Screw mounting (ends)	B. Fixed - Supported	
8.3 Additional load force (preload, temp. dilatation...)	F_{add}	0.000 [N]



8.4	Unsupported length of ball screw shaft	Ls	1200.000	[mm]
8.5	Ball screw shaft root diameter	d2	27.8330	[mm]
8.6	Ball screw shaft root area	A	608.43	[mm^2]
8.7	Quadratic moment of inertia	Ix	29458.46	[mm^4]
8.8	Ball screw weight	m	5.731	[kg]
8.9	Deflection (dead weight load)	y _{max}	0.08481	< 0.36 [mm]
8.10 Check - tension, compression, torsion				
8.11	Sum of loading forces	F _{max} +F _{add}	1624.21	[N]
8.12	Torsional moment (max.)	M _k	5.4380	[N/m]
8.13	Tensile stress / Compressive stress	σ	2.67	< 350 [MPa]
8.14	Torsional stress	τ	1.28	< 210 [MPa]
8.15	Equivalent stress	σ _{red}	3.48	< 350 [MPa]
8.16	Safety factor (tension, compression, torsion)	SF _c	100.71793	> 2.00 [~]
8.17 Check - buckling				
8.18	Buckling factor	Coeff _b	2.00	[~]
8.19	Load force	F _{max} +F _{add}	1624.21	[N]
8.20	Limiting slenderness ratio (short / intermediate / long)	SR _{cs} /SR _c	17.3 108.8	[~]
8.21	Slenderness ratio	SR	138.0	
8.22	Permissible buckling load	F _b	84800.13	[N]
8.23	Safety factor (buckling)	SF _b	52.21016	> 3.50 [~]
8.24 Check - Critical speed				
8.25	Critical speed factor	Coeff _{ncr}	3.93	[~]
8.26	Permissible operating speed	n _{crp}	2400.0	[/min]
8.27	Critical speed	n _{cr}	3680.5	[/min]
8.28	Rate of Permissible operating speed to Critical speed	r (n _{crp} /n _{cr})	0.65209	< 0.80
8.29 Static safety factor				
8.30	Maximum axial load	F _{max}	1624.21	[N]
8.31	Basic static axial load rating C _{0a}	C _{0a}	52810.00	[N]
8.32	Static safety factor	SF _s	32.51	> 1.4 [~]
8.37 Oil lubrication - efficiency calculation				
8.38	Recommended min. oil quantity	ov	2.7	[mm³/min]
8.39	Operating temperature	T	30.0	[°C]
8.40	Oil type	Gear oil		
8.41	Recommended oil viscosity grade (ISO)	grade	VG46	VG46
8.42	Kinematic viscosity of the lubricant at operating temperature		79.8	[cSt]
8.43	Efficiency calculation	Screw+bearings		
8.44	Friction coefficient	f	0.00952	0.00952
8.45	Efficiency (normal operation)	η	0.9507	[~]
8.46	Efficiency (reverse operation)	η _r	0.9484	[~]



? Additions section

9.0 Formulas for calculation: acceleration, forces, moments, revolutions, friction...

1. Cylinder - Moment of inertia; Mass: $I = 0.5 * Ro * 3.14 * r^4 * H$; $m = 3.14 * Ro * r^2 * H$ [I-Moment of inertia; r-Radius; H-High; Ro-Density; m-Weight]	8. Screw speed: $n = 60 * v / Ph$ $n = 1000 * v / Ph$																						
<table border="1"> <tr><th>I [kg*m²]</th><th>r [m]</th><th>H [m]</th><th>Ro[kg/m³]</th><th>m [kg]</th></tr> <tr><td>0.003196</td><td>0.06</td><td>0.02</td><td>7850</td><td>1.775628</td></tr> </table>	I [kg*m²]	r [m]	H [m]	Ro[kg/m³]	m [kg]	0.003196	0.06	0.02	7850	1.775628	<table border="1"> <tr><th>n [/min]</th><th>v [mm/s]</th><th>Ph [mm]</th><th>n [/min]</th><th>v [m/min]</th><th>Ph [mm]</th></tr> <tr><td>600</td><td>10</td><td>1</td><td>10000</td><td>10</td><td>1</td></tr> </table>	n [/min]	v [mm/s]	Ph [mm]	n [/min]	v [m/min]	Ph [mm]	600	10	1	10000	10	1
I [kg*m²]	r [m]	H [m]	Ro[kg/m³]	m [kg]																			
0.003196	0.06	0.02	7850	1.775628																			
n [/min]	v [mm/s]	Ph [mm]	n [/min]	v [m/min]	Ph [mm]																		
600	10	1	10000	10	1																		

2. Acceleration: $a = (v2 - v1) / (t2 - t1)$

[a-Acceleration; v1-Initial velocity; v2-Final velocity; t1-Start time; t2-End time]

a [m/s ²]	v1 [m/s]	v2 [m/s]	t1 [s]	t2 [s]
1.0000	0	1	0	1

3. Acceleration: $a = 0.5 * (v2^2 - v1^2) / s$

[a-Acceleration; v1-Initial velocity; v2-Final velocity; s-Displacement]

a [m/s ²]	v1 [m/s]	v2 [m/s]	s [m]
0.5000	0	1	1

4. Angular acceleration: $a = 0.1047198 * n / t$

[a-Angular acceleration; n-Speed; t-Time]

a [rad/s ²]	n [rpm]	t [s]
10.4720	100	1

5. Force: $F = m * a$

[F-Force; m-Weight; a-Acceleration]

F [N]	m [kg]	a [m/s ²]
10	1	10

6. Force: $F = 0.5 * m * (v2^2 - v1^2) / s$

[F-Force; m-Weight; v1-Initial velocity; v2-Final velocity; s-Displacement]

F [N]	v1 [m/s]	v2 [m/s]	m [kg]	s [m]
150.0000	10	20	1	1

7. Torque: $Mk = 0.10472 * (n2 - n1) * I / t$

[Mk-Torque; n1-Initial speed; n2-Final speed; I-Moment of inertia; t-Time]

Mk [Nm]	n1 [/min]	n2 [/min]	I [kg*m ²]	t [s]
10.47198	10	20	10	1

9. Lead: $Ph = 60 * v / n$ $Ph = 1000 * v / n$

[n-Screw speed; v-Velocity; Ph-Lead]

Ph [mm]	v [mm/s]	n [/min]	Ph [mm]	v [m/min]	n [/min]
1	10	600	100	1	10

10. Shear friction - force: $F = Q * f$; $FI = atan(f)$

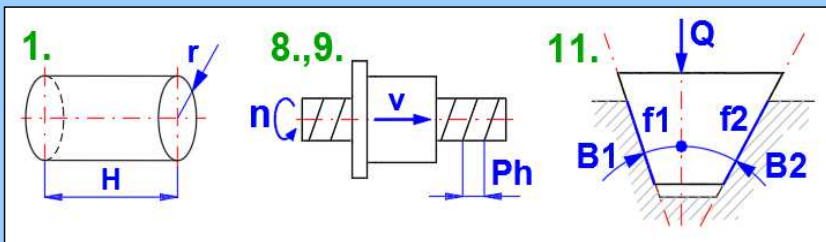
[F-Force; Q-Normal force; f-Friction coefficient; FI-Angle of friction cone]

F [N]	Q [N]	f [~]	FI [°]
100	1000	0.1	5.710593

11. Friction in V-groove - force: $F = Q * (f1*cos(B2) + f2*cos(B1)) / sin(B1+B2)$

[F-Force; Q-Normal force; f1-Friction coefficient; f2-Friction coefficient; B1-Angle; B2-Angle]

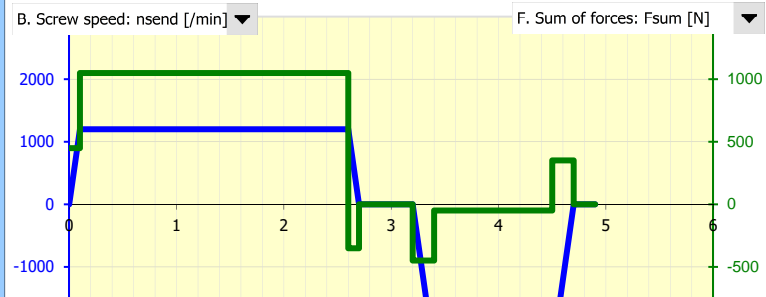
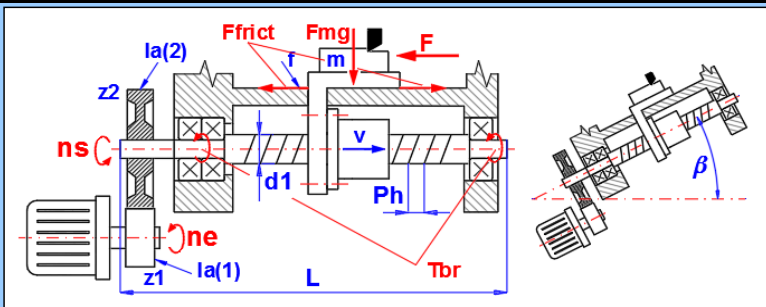
F [N]	Q [N]	f1 [~]	f2 [~]	B1 [°]	B2 [°]
141.42	1000	0.1	0.1	45	45



10.0 Design of the load spectrum table

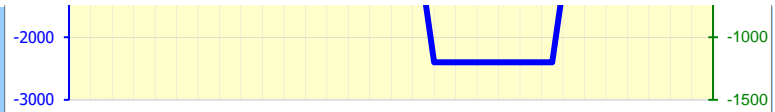
10.1 Definition of the mechanism

10.2 Lead	Ph	20.000	[mm]	<input checked="" type="checkbox"/>
10.3 Nominal diameter	d1	32.000	[mm]	
10.4 Pitch circle diameter	Dpw	33.389	[mm]	
10.5 Screw shaft full length	L	1520.00	[mm]	
10.6 Vertical rotation of the mechanism	β	0.00	Horizontal (0°)	<input type="checkbox"/>
10.7 Mass of moving object (table, workpiece ...)	m	100.00	[kg]	
10.8 Moment of inertia converted from the linear motion to rot:	Iw	0.001013212	[kg*m ²]	
10.9 Inertia moment of Screw	Is	0.001228324	[kg*m ²]	
10.10 Inertia moment of gears on screw side	Ia(2)	0.0006	[kg*m ²]	
10.11 Inertia moment of gears on motor side	Ia(1)	0.003	[kg*m ²]	
10.12 Transmission ratio	$i=(z2/z1)$	0.6250	[~]	
10.13 Inertia moment for acceleration torque	Iacc	0.010274333	[kg*m ²]	
10.14 Ball nut preload	Fpr	1700.00	[N]	
10.15 Preload dynamic drag torque	Tpr	0.619627519	[Nm]	
10.16 Sliding surface friction coefficient (table, workpiece ...)	f	0.05	[~]	
10.17 Frictional force created by the movement of the table, wor	Ffrict	49.050	[N]	
10.18 Force from own weight (table, workpiece...)	Fmg	0.000	[N]	
10.19 Efficiency	η	0.97	0.97	<input checked="" type="checkbox"/>
10.20 Torque from the friction (table, workpiece)	Tfrict	0.2575	[Nm]	



10.21 Torque from the dead weight

Tmg 0.0000 [Nm]
 Tbr [Nm] 0.0925 0.0925



10.22 Bearing frictional torque

10.23 Move values to equivalent load table [11.0]

10.24 Definition table

i	ne_start [1/min]	ne_end [1/min]	dt [s]	t_end [s]	ns_end [1/min]	α [rad/s ²]	a [m/s ²]	v_start [m/s]	v_end [m/s]	ds [mm]	s [mm]	F [N]	F_acc [N]	F_sum [N]	T_acc [N/m]	T_sum [N/m]	Power [kW]
1	0	750	0.1	0.1	1200	785.3982	4	0	0.4	20.00	20.00		400.0	449.1	8.069	9.502	0.373
2	750	750	2.5	2.6	1200	0	0	0.4	0.4	1000.00	1020.00	1000.0	0.0	1049.1	0.000	6.683	0.525
3	750	0	0.1	2.7	0	-785.3982	-4	0.4	0	20.00	1040.00		-400.0	-351.0	-8.069	-6.637	-0.261
4	0	0	0.5	3.2	0	0	0	0	0	0.00	1040.00		0.0	0.0	0.000	0.000	0.000
5	0	-1500	0.2	3.4	-2400	-785.3982	-4	0	-0.8	-80.00	960.00		-400.0	-449.1	-8.069	-9.502	0.746
6	-1500	-1500	1.1	4.5	-2400	0	0	-0.8	-0.8	-880.00	80.00		0.0	-49.1	0.000	-1.432	0.225
7	-1500	0	0.2	4.7	0	785.3982	4	-0.8	0	-80.00	0.00		400.0	351.0	8.069	6.637	-0.521
8	0	0	0.2	4.9	0	0	0	0	0	0.00	0.00		0.0	0.0	0.000	0.000	0.000
9	0			4.9	0	0	0	0	0	0.00	0.00		0.0	0.0	0.000	0.000	0.000
10	0			4.9	0	0	0	0	0	0.00	0.00		0.0	0.0	0.000	0.000	0.000
11	0			4.9	0	0	0	0	0	0.00	0.00		0.0	0.0	0.000	0.000	0.000
12	0			4.9	0	0	0	0	0	0.00	0.00		0.0	0.0	0.000	0.000	0.000
13	0			4.9	0	0	0	0	0	0.00	0.00		0.0	0.0	0.000	0.000	0.000
14	0			4.9	0	0	0	0	0	0.00	0.00		0.0	0.0	0.000	0.000	0.000
15	0			4.9	0	0	0	0	0	0.00	0.00		0.0	0.0	0.000	0.000	0.000
16	0			4.9	0	0	0	0	0	0.00	0.00		0.0	0.0	0.000	0.000	0.000
17	0			4.9	0	0	0	0	0	0.00	0.00		0.0	0.0	0.000	0.000	0.000
18	0			4.9	0	0	0	0	0	0.00	0.00		0.0	0.0	0.000	0.000	0.000
19	0			4.9	0	0	0	0	0	0.00	0.00		0.0	0.0	0.000	0.000	0.000
20	0			4.9	0	0	0	0	0	0.00	0.00		0.0	0.0	0.000	0.000	0.000

11.0 Equivalent rotational speed and equivalent axial load (ISO3408-5)

11.1 Transfer of values to paragraph [3.0]

11.2 Number of different load conditions

8

11.3 Nut type

B. With preload (double nut, ball size, different lead ...)

11.4 Ball nut preload

Fpr [N] 1700.00 ~ 750

11.5 Limiting axial load

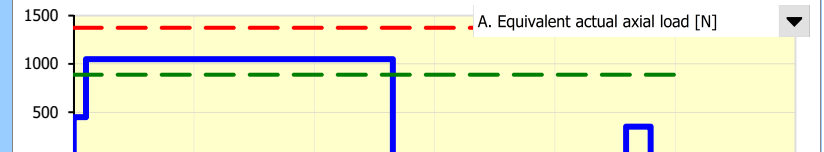
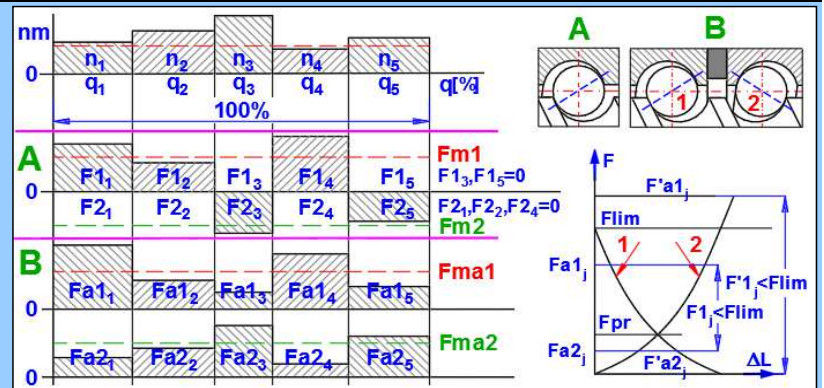
Flim [N] 4808.33

11.6 Operational preload factor

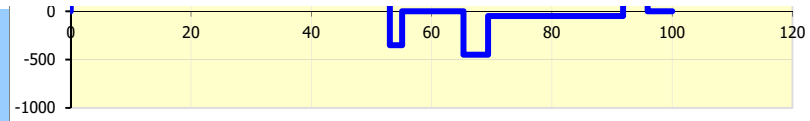
fop [~] 0.60

11.7 Table of loads

i	F1,2j [N]	Fa1j [N]	Fa2j [N]	nj [1/min]	q [%]	tj [s]	Description
1	449.1	1267.2	818.1	600.0	2.0	0.10	
2	1049.1	1624.2	575.2	1200.0	51.0	2.50	
3	-351.0	860.7	1211.7	600.0	2.0	0.10	
4	0.0	1020.0	1020.0	0.0	10.2	0.50	
5	-449.1	818.1	1267.2	1200.0	4.1	0.20	
6	-49.1	997.1	1046.1	2400.0	22.4	1.10	
7	351.0	1211.7	860.7	1200.0	4.1	0.20	
8	0.0	1020.0	1020.0	0.0	4.1	0.20	
9		0	0				



10		0	0			
11		0	0			
12		0	0			
13		0	0			
14		0	0			
15		0	0			
16		0	0			
17		0	0			
18		0	0			
19		0	0			
20		0	0			



11.8 Equivalent and maximum speed and load

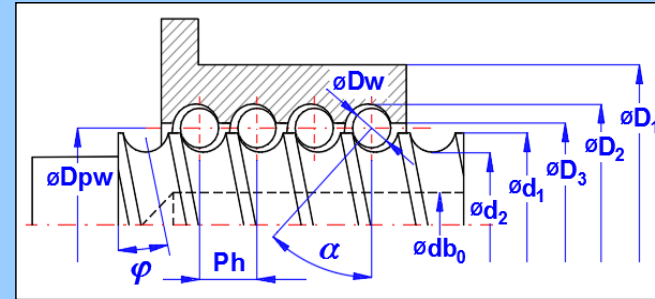
11.9	Equivalent rotational speed	nm1	1273.47	[/min]
11.10	Equivalent rotational speed	nm2	1273.47	[/min]
11.11	Maximal rotational speed	nmax	2400.0	[/min]
11.12	Equivalent axial load	Fma1	1374.1	[N]
11.13	Equivalent actual axial load	Fma2	888.3	[N]
11.14	Maximal axial load	Fmax	1624.2	[N]

12.0 Calculation of basic and modified static and dynamic load rating (ISO3408-5, ANSI B5.48)

12.1 Transfer of values to paragraph [3.0]

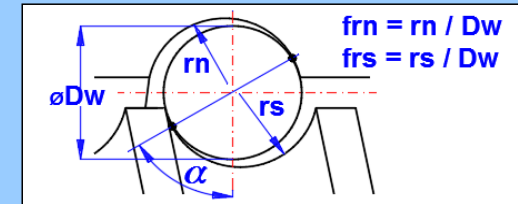
12.2 Input parameters

12.3	Number of loaded turns (nut)	i	3.00	[~]	<input checked="" type="checkbox"/>
12.4	Number of unloaded balls in the recirculation system	zu	0	[~]	
12.5	Nominal diameter	d1	32.000	[mm]	
12.6	Ball diameter	Dw	5.5560	[mm]	
12.7	Lead	Ph	20.000	[mm]	
12.8	Pitch circle diameter	Dpw	33.389	[mm]	<input checked="" type="checkbox"/>
12.9	Lead angle	φ	10.7949	[deg]	
12.10	Nominal contact angle	α	45	[deg]	
12.11	Conformity ratio (rn/Dw)	frn	0.550	0.550 - According the ISO 3408	<input type="text"/>
12.12	Conformity ratio (rs/Dw)	frs	0.550	0.550 - According the ISO 3408	<input type="text"/>
12.13	Number of effectively loaded balls per turn of thread	z1	19	[~]	



12.14 Basic static axial load rating C0a

12.15	Characteristic of basic static axial load rating	k0	43.21054944	[~]	
12.16	Reciprocal curvature radii	ro11,ro21	0.359971202	[1/mm]	
12.17	Reciprocal curvature radii	ro12	-0.327246548	[1/mm]	
12.18	Reciprocal curvature radii	ro22	0.048004021	[1/mm]	
12.19	Basic static axial load rating C0a	C0a	52810.5	[N]	



12.20 Basic dynamic axial load rating Ca

12.21	Dynamic load rating for the ball screw per single loaded turn	Ci	8568.5	[N]	
12.22	Exponent for Cs calculation	exp	0.86	0.86 ... ISO 3408-5	<input type="text"/>
12.23	Dynamic load rating for the ball screw shaft per single loaded turn	Cs	9177.4	[N]	
12.24	Dynamic load rating for the ball nut per single loaded turn	Cn	13793.3	[N]	
12.25	Geometric factor	fc	81.12787358	[~]	
12.26	Geometric factor	f1	7.642977396	[~]	
12.27	Geometric factor	f2	0.426108899	[~]	
12.28	Geometric factor	f3	0.665353986	[~]	
12.29	Geometric factor	gama	0.117664059	[~]	
12.30	Ratio Cs/Cn	Cs/Cn	0.665353986	[~]	
12.31	Basic dynamic axial load rating Ca	Ca	22040.9	[N]	

12.32 Modified static and dynamic axial load rating C0am, Cam

12.33	Surface hardness	AH	654.00	[HV10]	
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12.34	Hardness factor for static axial load rating	fh0	1.00	[~]
12.35	Correction factor for tolerance grades	fac	1.00	[~]
12.36	Modified static axial load rating	C0am	52810.5	[N]
12.37	Hardness factor for dynamic axial load rating	fh	1.00	[~]
12.38	Material processing factor	fm	1.00	[~]
12.39	Modified dynamic axial load rating	Cam	22040.9	[N]
12.40 Basic Load Rating (ANSI B5.48-1977)				
12.41	Basic Load Rating (1 000 000 Inches Rated Life)	Pi	4935.3	[lbf]
12.42	Basic Static Thrust Capacity (Imperial)	Ti	27272.9	[lbf]
12.43	Rated life for X inches	LIix	1000000	[in]
12.44	Load Rating at Other Than One Million Inches of Travel	Pix	4935.3	[lbf]
12.45	Basic Load Rating (25400 Meters Rated Life)	Pm	21956.6	[N]
12.46	Basic Static Thrust Capacity (Metric)	Tm	121320.3	[N]
12.47	Rated life for Y meters	LImy	25400	[m]
12.48	Load Rating at Other Than 25400 Meters of Travel	Pmy	21956.6	[N]
12.49	Recalculation Pi on to Ca	Ca'	23773.7	[N]
12.50 Generating ISO and ANSI ball screw tables				
12.51	Generating C0am and Cam to ISO table			100% OK
12.52	Generating Pix and Ti to ANSI table			100% OK

13.0 Graphical output, CAD systems

13.1	2D drawing output to:	DXF File		
13.2	2D drawing scale	Automatic		
13.3	Number of threads (screw) on the drawing	nts	60	60 [~] <input checked="" type="checkbox"/>
13.4	Number of threads (nut) on the drawing	ntn	3	3 [~]
13.5	Ball nut length	Ln	184	184 [mm]
13.6	Moving the nut from the left (the number of threads)	k	27	27 [~]

