_O.GB.gp1.GP1

KISSsoft Release 03/2015 F

KISSsoft evaluation

File

Name : Unnamed
Changed by: kspl on: 07.03.2016 at: 10:58:15

Important hint: At least one warning has occurred during the calculation:

1-> Gear 1: The specific sliding at the root [zetaf] is less than -3.00.

2-> Calculation of scuffing:
The entered gear pair data is outside the boundary of the calculation method!

The application of ISO/TR 13989-2 has following limitations:
wBt (=77.1 N/mm) >= 150.0 N/mm

3-> Notice concerning gear 2:
Dimension over balls is not measurable (facewidth is too small)!

CALCULATION OF A HELICAL GEAR PAIR

Drawing or article number:
Gear 1: 0.000.0
Gear 2: 0.000.0

Calculation method ISO 6336:2006 Method B

		------- GEAR 1	-------- GEAR 2 --
Power (kW)	[P]	2.094	
Speed (1/min)	[n]	2000.0	1142.9
Torque (Nm)	[T]	10.0	17.5
Application factor	[KA]	1.25	
Required service life (h)	[H]	3000.00	
Gear driving (+) / driven (-)		+	-

Working flank gear 1: Right flank

1. TOOTH GEOMETRY AND MATERIAL

(geometry calculation according to
DIN 3960:1987)

		------- GEAR 1	-------- GEAR 2 --
Center distance (mm)	[a]	55.000	
Centre distance tolerance	ISO 286:2010 Measure js7		
Normal module (mm)	[mn]	2.0000	
Pressure angle at normal section (°)	[alfn]	20.0000	
Helix angle at reference circle (°)	[beta]	10.0000	
Number of teeth	[z]	20	35
Facewidth (mm)	[b]	15.00	15.00
Hand of gear		right	left
Accuracy grade	[Q-ISO 1328:1995]	6	6
Inner diameter (mm)	[di]	0.00	0.00
Inner diameter of gear rim (mm)	[dbi]	0.00	0.00

Material

Gear 1: 18CrNiMo7-6, Case-carburized steel, case-hardened
ISO 6336-5 Figure 9/10 (MQ), core strength >=25HRC Jominy J=12mm<HRC28

Gear 2: 18CrNiMo7-6, Case-carburized steel, case-hardened
ISO 6336-5 Figure 9/10 (MQ), core strength >=25HRC Jominy J=12mm<HRC28

		------- GEAR 1	-------- GEAR 2 --
Surface hardness		HRC 61	HRC 61
Material quality according to ISO 6336:2006 Normal (Life factors ZNT and YNT >=0.85)			
Fatigue strength. tooth root stress (N/mm²)	[sigFlim]	430.00	430.00
Fatigue strength for Hertzian pressure (N/mm²)	[sigHlim]	1500.00	1500.00
Tensile strength (N/mm²)	[Rm]	1200.00	1200.00
Yield point (N/mm²)	[Rp]	850.00	850.00
Young's modulus (N/mm²)	[E]	206000	206000
Poisson's ratio	[ny]	0.300	0.300
Roughness average value DS, flank (µm)	[RAH]	0.60	0.60
Roughness average value DS, root (µm)	[RAF]	3.00	3.00
Mean roughness height, Rz, flank (µm)	[RZH]	4.80	4.80
Mean roughness height, Rz, root (µm)	[RZF]	20.00	20.00

Gear reference profile	1 :	
Reference profile	1.25 / 0.38 / 1.0 ISO 53.2:1997 Profil A	
Dedendum coefficient	[hfP*]	1.250
Root radius factor	[rhofP*]	0.380 (rhofPmax*= 0.472)
Addendum coefficient	[haP*]	1.000
Tip radius factor	[rhoaP*]	0.000

Protuberance height factor	[hprP*]	0.000
Protuberance angle	[alfprP]	0.000
Tip form height coefficient	[hFaP*]	0.000
Ramp angle	[alfKP]	0.000
	not topping	

Gear reference profile	2 :	
Reference profile	1.25 / 0.38 / 1.0 ISO 53.2:1997 Profil A	
Dedendum coefficient	[hfP*]	1.250
Root radius factor	[rhofP*]	0.380 (rhofPmax*= 0.472)
Addendum coefficient	[haP*]	1.000
Tip radius factor	[rhoaP*]	0.000
Protuberance height factor	[hprP*]	0.000
Protuberance angle	[alfprP]	0.000
Tip form height coefficient	[hFaP*]	0.000
Ramp angle	[alfKP]	0.000
	not topping	

Summary of reference profile gears:

Dedendum reference profile	[hfP*]	1.250	1.250
Tooth root radius Refer. profile	[rofP*]	0.380	0.380
Addendum Reference profile	[haP*]	1.000	1.000
Protuberance height factor	[hprP*]	0.000	0.000
Protuberance angle (°)	[alfprP]	0.000	0.000
Tip form height coefficient	[hFaP*]	0.000	0.000
Ramp angle (°)	[alfKP]	0.000	0.000

Type of profile modification:
none (only running-in)

Tip relief (µm)	[Ca]	2.0	2.0

Lubrication type	oil bath lubrication	
Type of oil	Oil: ISO-VG 150	
Lubricant base	Mineral-oil base	
Kinem. viscosity oil at 40 °C (mm²/s)	[nu40]	150.00
Kinem. viscosity oil at 100 °C (mm²/s)	[nu100]	13.00
FZG test A/8.3/90 (ISO 14635-1:2006)	[FZGtestA] 12	
Specific density at 15 °C (kg/dm³)	[roOil]	0.892
Oil temperature (°C)	[TS]	70.000

		------- GEAR 1 -------- GEAR 2 --
Overall transmission ratio	[itot]	-1.750
Gear ratio	[u]	1.750
Transverse module (mm)	[mt]	2.031
Pressure angle at pitch circle (°)	[alft]	20.284

Working transverse pressure angle (°)	[alfwt]	17.738	
	[alfwt.e/i]	17.787 / 17.689	
Working pressure angle at normal section (°)	[alfwn]	17.493	
Helix angle at operating pitch circle (°)	[betaw]	9.851	
Base helix angle (°)	[betab]	9.391	
Reference centre distance (mm)	[ad]	55.848	
Sum of profile shift coefficients	[Summexi]	-0.3993	
Profile shift coefficient	[x]	0.1082	-0.5074
Tooth thickness (Arc) (module) (module)	[sn*]	1.6495	1.2014
Tip alteration (mm)	[k*mn]	-0.050	-0.050
Reference diameter (mm)	[d]	40.617	71.080
Base diameter (mm)	[db]	38.098	66.672
Tip diameter (mm)	[da]	44.950	72.950
(mm)	[da.e/i]	44.950 / 44.950	72.950 / 72.950
Tip diameter allowances (mm)	[Ada.e/i]	0.000 / 0.000	0.000 / 0.000
Tip form diameter (mm)	[dFa]	44.950	72.950
(mm)	[dFa.e/i]	44.950 / 44.950	72.950 / 72.950
Active tip diameter (mm)	[dNa]	44.950	72.950
Active tip diameter (mm)	[dNa.e/i]	44.950 / 44.950	72.950 / 72.950
Operating pitch diameter (mm)	[dw]	40.000	70.000
(mm)	[dw.e/i]	40.011 / 39.989	70.019 / 69.981
Root diameter (mm)	[df]	36.050	64.050
Generating Profile shift coefficient	[xE.e/i]	0.0711/ 0.0505	-0.5555/ -0.5830
Manufactured root diameter with xE (mm)	[df.e/i]	35.901 / 35.819	63.858 / 63.748
Theoretical tip clearance (mm)	[c]	0.500	0.500
Effective tip clearance (mm)	[c.e/i]	0.666 / 0.581	0.630 / 0.559
Active root diameter (mm)	[dNf]	38.298	67.368
(mm)	[dNf.e/i]	38.308 / 38.288	67.382 / 67.354
Root form diameter (mm)	[dFf]	38.286	67.065
(mm)	[dFf.e/i]	38.246 / 38.226	67.007 / 66.976
Reserve (dNf-dFf)/2 (mm)	[cF.e/i]	0.041 / 0.021	0.203 / 0.173
Addendum (mm)	[ha=mn*(haP*+x)]	2.166	0.935
(mm)	[ha.e/i]	2.166 / 2.166	0.935 / 0.935

Dedendum (mm)	[hf=mn*(hfP*-x)]	2.284		3.515
(mm)	[hf.e/i]	2.358 /	2.399	3.611 / 3.666
Roll angle at dFa (°)	[xsi_dFa.e/i]	35.873 /	35.873	25.443 / 25.443
Roll angle to dNa (°)	[xsi_dNa.e/i]	35.873 /	35.873	25.443 / 25.443
Roll angle to dNf (°)	[xsi_dNf.e/i]	6.024 /	5.727	8.386 / 8.217
Roll angle at dFf (°)	[xsi_dFf.e/i]	5.057 /	4.699	5.752 / 5.480
Tooth height (mm)	[H]	4.450		4.450
Virtual gear no. of teeth	[zn]	20.864		36.512
Normal-tooth thickness at tip circle (mm)	[san]	1.382		1.704
(mm)	[san.e/i]	1.323 /	1.290	1.632 / 1.591
Normal-tooth thickness on tip form circle (mm)	[sFan]	1.382		1.704
(mm)	[sFan.e/i]	1.323 /	1.290	1.632 / 1.591
Normal space width at root circle (mm)	[efn]	0.000		0.000
(mm)	[efn.e/i]	0.000 /	0.000	0.000 / 0.000
Max. sliding velocity at tip (m/s)	[vga]	1.920		1.363
Specific sliding at the tip	[zetaa]	0.769		0.769
Specific sliding at the root	[zetaf]	-3.330		-3.321
Mean specific sliding	[zetam]		0.769	
Sliding factor on tip	[Kga]	0.458		0.325
Sliding factor on root	[Kgf]	-0.325		-0.458
Pitch on reference circle (mm)	[pt]		6.380	
Base pitch (mm)	[pbt]		5.984	
Transverse pitch on contact-path (mm)	[pet]		5.984	
Lead height (mm)	[pz]	723.668		1266.419
Axial pitch (mm)	[px]		36.183	
Length of path of contact (mm)	[ga, e/i]		9.973 (10.023 /	9.924)
Length T1-A, T2-A (mm)	[T1A, T2A]	1.953(1.904/	2.003)	14.803(

14.803/		14.803)				
Length T1-B (mm)	[T1B, T2B]	5.942(	5.942/	5.942)	10.815(	
10.765/		10.864)				
Length T1-C (mm)	[T1C, T2C]	6.093(	6.075/	6.111)	10.663(	
10.632/		10.695)				
Length T1-D (mm)	[T1D, T2D]	7.938(	7.889/	7.987)	8.819(	
8.819/		8.819)				
Length T1-E (mm)	[T1E, T2E]	11.927(	11.927/	11.927)	4.830(	
4.781/		4.879)				
Length T1-T2 (mm)	[T1T2]			16.757 (	16.707 /	16
.806)						
Diameter of single contact point B (mm)	[d-B]	39.909(	39.909/	39.909)	70.093(	
70.062/		70.123)				
Diameter of single contact point D (mm)	[d-D]	41.274(	41.236/	41.312)	68.966(	
68.966/		68.966)				
Addendum contact ratio	[eps]	0.975(	0.978/	0.972)	0.692(	
0.697/		0.687)				
Minimal length of contact line (mm)	[Lmin]			18.178		
Transverse contact ratio	[eps_a]			1.667		
Transverse contact ratio with allowances	[eps_a.e/m/i]			1.675 /	1.667 /	1.658
Overlap ratio	[eps_b]			0.415		
Total contact ratio	[eps_g]			2.081		
Total contact ratio with allowances	[eps_g.e/m/i]			2.089 /	2.081 /	2.073

2. FACTORS OF GENERAL INFLUENCE

		------- GEAR 1 -------- GEAR 2 --
Nominal circum. force at pitch circle (N)	[Ft]	492.4
Axial force (N)	[Fa]	86.8
Radial force (N)	[Fr]	182.0
Normal force (N)	[Fnorm]	532.1
Nominal circumferential force per mm (N/mm)	[w]	32.83
Only as information: Forces at operating pitch circle:		
Nominal circumferential force (N)	[Ftw]	500.0
Axial force (N)	[Faw]	86.8
Radial force (N)	[Frw]	159.9
Circumferential speed reference circle (m/s)	[v]	4.25
Circumferential speed operating pitch circle (m/s)	[v(dw)]	4.19
Running-in value (µm)	[yp]	0.5
Running-in value (µm)	[yf]	0.5
Correction coefficient	[CM]	0.800
Gear body coefficient	[CR]	1.000

Reference profile coefficient	[CBS]		0.975
Material coefficient	[E/Est]		1.000
Singular tooth stiffness (N/mm/µm)	[c']		9.411
Meshing stiffness (N/mm/µm)	[cgalf]		14.115
Meshing stiffness (N/mm/µm)	[cgbet]		11.998
Reduced mass (kg/mm)	[mRed]		0.00415
Resonance speed (min-1)	[nE1]		27855
Resonance ratio (-)	[N]		0.072
Subcritical range			
Running-in value (µm)	[ya]		0.5
KHb calculated according to ISO 6336-1:2006, Annex E (takes into account K_A*K_V)			
Axis alignment (µm)	[$f_{\Sigma\beta}$ / $f_{\Sigma\delta}$]		
0.0/	0.0		

Torque (0: -, 1: <I, 2: <II)		0	0
(For intermediate results refer to file: KHbeta_calc12.tmp)			

Dynamic factor	[KV]	1.079

Face load factor - flank	[KHb]		1.000
- Tooth root	[KFb]		1.000
- Scuffing	[KBb]		1.000

Transverse load factor - flank	[KHa]		1.742
- Tooth root	[KFa]		1.742
- Scuffing	[KBa]		1.742

Helical load factor scuffing	[Kbg]		1.097

Number of load cycles (in mio.)	[NL]	360.000	205.714

3. TOOTH ROOT STRENGTH

Calculation of Tooth form coefficients according method: B

		------- GEAR 1 --------	GEAR 2 --
Calculated with manufacturing profile shift	[xE.e]	0.07	-0.56
Tooth form factor	[YF]	1.37	1.94
Stress correction factor	[YS]	1.95	1.56
Working angle (°)	[alfFen]	17.73	15.36
Bending lever arm (mm)	[hF]	1.80	2.22
Tooth thickness at root (mm)	[sFn]	4.00	3.75
Tooth root radius (mm)	[roF]	1.09	1.46

(hF* = 0.902/ 1.112 sFn* = 1.999/ 1.876 roF* = 0.546/ 0.732 dsFn = 36.665/ 64.877 alfsFn = 30.00/ 30.00)

Helix angle factor	[Ybet]	0.965

Deep tooth factor	[YDT]		1.000	
Gear rim factor	[YB]	1.00		1.00
Effective facewidth (mm)	[beff]	15.00		15.00
Nominal stress at tooth root (N/mm²)	[sigF0]	42.38		48.18
Tooth root stress (N/mm²)	[sigF]	99.55		113.17
Permissible bending stress at root of Test-gear				
Notch sensitivity factor	[YdrelT]	0.993		0.987
Surface factor	[YRrelT]	0.957		0.957
size factor (Tooth root)	[YX]	1.000		1.000
S-N curve (Woehler line) in the range of endurance limit				
	Haibach			
Finite life factor	[YNT]	0.760		0.785
[YdrelT*YRrelT*YX*YNT]		0.723		0.741
Alternating bending factor (mean stress influence coefficient)				
	[YM]	1.000		1.000
Stress correction factor	[Yst]		2.00	
Yst*sigFlim (N/mm²)	[sigFE]	860.00		860.00
Permissible tooth root stress (N/mm²)	[sigFP=sigFG/SFmin]	443.88		455.43
Limit strength tooth root (N/mm²)	[sigFG]	621.43		637.61
Required safety	[SFmin]	1.40		1.40
Safety for Tooth root stress	[SF=sigFG/sigF]	6.24		5.63
Transmittable power (kW)	[kWRating]	9.34		8.43

4. SAFETY AGAINST PITTING (TOOTH FLANK)

		------- GEAR 1 --------	GEAR 2 --
Zone factor	[ZH]		2.648
Elasticity coefficient (√N/mm)	[ZE]		189.812
Contact ratio factor	[Zeps]		0.839
Helix angle factor	[Zbet]		1.008
Effective facewidth (mm)	[beff]		15.00
Nominal flank pressure (N/mm²)	[sigH0]		478.94
Surface pressure at operating pitch circle (N/mm²)			
	[sigHw]		734.05
Single tooth contact factor	[ZB,ZD]	1.00	1.00
Flank pressure (N/mm²)	[sigHB, sigHD]	736.43	734.05
Lubrication coefficient at NL	[ZL]	0.992	0.992
Speed coefficient at NL	[ZV]	0.979	0.979
Roughness coefficient at NL	[ZR]	0.939	0.939
Work hardening factor at NL	[ZW]	1.000	1.000
S-N curve (Woehler line) in the range of endurance limit			

	Haibach		
Finite life factor	[ZNT]	0.928	0.948
	[ZL*ZV*ZR*ZNT]	0.846	0.864
Small no. of pittings permissible:	no		
Size factor (flank)	[ZX]	1.000	1.000
Permissible surface pressure (N/mm²)	[sigHP=sigHG/SHmin]	1269.17	1296.32
Limit strength pitting (N/mm²)	[sigHG]	1269.17	1296.32
Required safety	[SHmin]	1.00	1.00
Safety for surface pressure at operating pitch circle			
	[SHw]	1.73	1.77
Safety for stress at single tooth contact	[SHBD=sigHG/sigHBD]	1.72	1.77
(Safety regarding transmittable torque)	[(SHBD)^2]	2.97	3.12
Transmittable power (kW)	[kWRating]	6.22	6.53

4b. MICROPITTING ACCORDING TO ISO/TR 15144-1:2014

Calculation did not run. (Lubricant: Load stage micropitting test is unknown.)

5. STRENGTH AGAINST SCUFFING

Calculation method according to
ISO TR 13989:2000

Lubrication coefficient (for lubrication type)	[XS]		1.000	
Multiple meshing factor	[Xmp]		1.000	
Relative structure coefficient (Scuffing)	[XWrelT]		1.000	
Thermal contact factor (N/mm/s^.5/K)	[BM]	13.780		13.780
Relevant tip relief (µm)	[Ca]	2.00		2.00
Optimal tip relief (µm)	[Ceff]		2.91	
Ca taken as optimal in the calculation (0=no, 1=yes)		0		0
Effective facewidth (mm)	[beff]		15.000	
Applicable circumferential force/facewidth (N/mm)				
	[wBt]		77.113	
(Kbg = 1.097, wBt*Kbg = 84.616)				
Angle factor	[Xalfbet]		0.941	
(ε1:0.975, ε2:0.692)				
Flash temperature-criteria				
Lubricant factor	[XL]		0.844	
Tooth mass temperature (°C)	[theMi]		74.24	
theM = theoil + XS*0.47*Xmp*theflm	[theflm]		9.03	
Scuffing temperature (°C)	[theS]		353.42	
Coordinate gamma (point of highest temp.)	[Gamma]		0.941	

[Gamma.A]=-0.679 [Gamma.E]=0.957

Highest contact temp. (°C)	[theB]	94.23
Flash factor (°K*N^-.75*s^.5*m^-.5*mm)	[XM]	50.058
Approach factor	[XJ]	1.000
Load sharing factor	[XGam]	0.637
Dynamic viscosity (mPa*s)	[etaM]	29.80 (70.0 °C)
Coefficient of friction	[mym]	0.059
Required safety	[SBmin]	2.000
Safety factor for scuffing (flash temperature)	[SB]	11.698

Integral temperature-criteria

Lubricant factor	[XL]	1.000
Tooth mass temperature (°C)	[theM-C]	74.28
theM-C = theoil + XS*0.70*theflaint	[theflaint]	6.12
Integral scuffing temperature (°C)	[theSint]	361.99
Flash factor (°K*N^-.75*s^.5*m^-.5*mm)	[XM]	50.058
Running-in factor (well run in)	[XE]	1.000
Contact ratio factor	[Xeps]	0.230
Dynamic viscosity (mPa*s)	[etaOil]	29.80 (70.0 °C)
Mean coefficient of friction	[mym]	0.080
Geometry factor	[XBE]	0.550
Meshing factor	[XQ]	1.000
Tip relief factor	[XCa]	1.649
Integral tooth flank temperature (°C)	[theint]	83.46
Required safety	[SSmin]	1.800
Safety factor for scuffing (intg.-temp.)	[SSint]	4.337
Safety referring to transferred torque	[SSL]	21.691

6. MEASUREMENTS FOR TOOTH THICKNESS

		------- GEAR 1 --------	GEAR 2 --
Tooth thickness deviation		DIN 3967 cd25	DIN 3967 cd25
Tooth thickness allowance (normal section) (mm)	[As.e/i]	-0.054 / -0.084	-0.070 / -0.110
Number of teeth spanned	[k]	3.000	4.000
Base tangent length (no backlash) (mm)	[Wk]	15.494	20.995
Actual base tangent length ('span') (mm)	[Wk.e/i]	15.443 / 15.415	20.929 / 20.892
(mm)	[ΔWk.e/i]	-0.051 / -0.079	-0.066 / -0.103
Diameter of contact point (mm)	[dMWk.m]	41.027	69.791
Theoretical diameter of ball/pin (mm)	[DM]	3.530	3.288
Eff. Diameter of ball/pin (mm)	[DMeff]	3.750	3.500
Theor. dim. centre to ball (mm)	[MrK]	23.356	37.071
Actual dimension centre to ball (mm)	[MrK.e/i]	23.300 / 23.269	36.969 / 36.909
Diameter of contact point (mm)	[dMMr.m]	41.262	69.350

Diametral measurement over two balls without clearance (mm)			
	[MdK]	46.712	74.071
Actual dimension over balls (mm)	[MdK.e/i]	46.600 / 46.538	73.867 / 73.748
Diametral measurement over rolls without clearance (mm)			
	[MdR]	46.712	74.142
Actual dimension over rolls (mm)	[MdR.e/i]	46.600 / 46.538	73.938 / 73.819
Chordal tooth thickness (no backlash) (mm)	['sn]	3.296	2.402
Actual chordal tooth thickness (mm)	['sn.e/i]	3.242 / 3.212	2.332 / 2.292
Reference chordal height from da.m (mm)	[ha]	2.231	0.955
Tooth thickness (Arc) (mm)	[sn]	3.299	2.403
(mm)	[sn.e/i]	3.245 / 3.215	2.333 / 2.293
Backlash free center distance (mm)	[aControl.e/i]	54.803 / 54.688	
Backlash free center distance, allowances (mm)	[jta]	-0.197 / -0.312	
dNf.i with aControl (mm)	[dNf0.i]	38.141	67.098
Reserve (dNf0.i-dFf.e)/2 (mm)	[cF0.i]	-0.053	0.046
Tip clearance	[c0.i(aControl)]	0.284	0.262
Centre distance allowances (mm)	[Aa.e/i]	0.015 / -0.015	
Circumferential backlash from Aa (mm)	[jtw_Aa.e/i]	0.010 / -0.010	
Radial clearance (mm)	[jrw]	0.327 / 0.182	
Circumferential backlash (transverse section) (mm)			
	[jtw]	0.204 / 0.114	
Rotation angle when gear 1 is fixed (°)		0.3333 / 0.1873	
Normal backlash (mm)	[jnw]	0.188 / 0.106	

7. GEAR ACCURACY

		------- GEAR 1 --------	GEAR 2 --
According to ISO 1328:1995			
Accuracy grade	[Q-ISO1328]	6	6
Single pitch deviation (µm)	[fptT]	7.00	7.50
Base circle pitch deviation (µm)	[fpbT]	6.60	7.00
Sector pitch deviation over k/8 pitches (µm)	[Fpk/8T]	9.50	12.00
Profile form deviation (µm)	[ffaT]	5.50	6.50
Profile slope deviation (µm)	[fHaT]	4.60	5.50
Total profile deviation (µm)	[FaT]	7.50	8.50
Helix form deviation (µm)	[ffbT]	7.00	7.50
Helix slope deviation (µm)	[fHbT]	7.00	7.50
Total helix deviation (µm)	[FbT]	10.00	11.00
Total cumulative pitch deviation (µm)	[FpT]	20.00	26.00
Runout (µm)	[FrT]	16.00	21.00
Single flank composite, total (µm)	[FisT]	32.00	39.00
Single flank composite, tooth-to-tooth (µm)	[fisT]	12.00	13.00

Radial composite, total (µm)	[FidT]	26.00	31.00
Radial composite, tooth-to-tooth (µm)	[fidT]	9.50	9.50

Axis alignment tolerances (recommendation acc. ISO TR 10064:1992, Quality 6)

Maximum value for deviation error of axis (µm)	[fSigbet]	11.00 (Fb= 11.00)
Maximum value for inclination error of axes (µm)	[fSigdel]	22.00

8. ADDITIONAL DATA

Maximal possible centre distance (eps_a=1.0)	[aMAX]	56.344	
Weight - calculated with da (kg)	[Mass]	0.186	0.491
Total weight (kg)	[Mass]	0.677	

Moment of inertia (System referenced to wheel 1):
calculation without consideration of the exact tooth shape

single gears ((da+df)/2...di) (kg*m²)	[TraeghMom]	3.073e-005	0.000252
System ((da+df)/2...di) (kg*m²)	[TraeghMom]	0.000113	
Torsional stiffness (MNm/rad)	[cr]	0.1	0.2
Mean coeff. of friction (acc. Niemann)	[mum]	0.090	
Wear sliding coef. by Niemann	[zetw]	1.281	
Gear power loss (kW)	[PVZ]	0.036	
(Meshing efficiency (%)	[etaz]	98.282)	

Indications for the manufacturing by wire cutting:

Deviation from theoretical tooth trace (µm)	[WireErr]	43.0	24.6
Permissible deviation (µm)	[Fb/2]	5.0	5.5

9. DETERMINATION OF TOOTH FORM

Data for the tooth form calculation :

Calculation of Gear 1
Tooth form, Gear 1, Step 1: Automatic (final machining)
haP*= 1.022, hfP*= 1.250, rofP*= 0.380

Calculation of Gear 2
Tooth form, Gear 2, Step 1: Automatic (final machining)
haP*= 1.037, hfP*= 1.250, rofP*= 0.380

10. SERVICE LIFE, DAMAGE, LOAD DISTRIBUTION

Required safety for tooth root	[SFmin]	1.40
Required safety for tooth flank	[SHmin]	1.00

Service life (calculated with required safeties):

System service life (h)	[Hatt]	> 1000000	
Tooth root service life (h)	[HFatt]	1e+006	1e+006
Tooth flank service life (h)	[HHatt]	1e+006	1e+006

Note: The entry 1e+006 h means that the Service life > 1,000,000 h.

Damage calculated on basis of required service life

[H] (3000.0 h)

F1%	F2%	H1%	H2%
0.00	0.00	0.00	0.00

Load distribution (ISO6336-1, Annex E)

$K_{H\beta}$	w_m (N/mm)	w_I (N/mm)	w_{II} (N/mm)	w_{max} (N/mm)	σ_{Hm} (N/mm^2)	σ_{HI} (N/mm^2)	σ_{HII} (N/mm^2)	σ_{Hmax} (N/mm^2)
1.000	46.5	46.5	46.5	46.5	556.2	556.2	556.2	556.2

Index m, I, II stand for: Middle of facewidth, Side I and Side II

REMARKS:

- Specifications with [.e/i] imply: Maximum [e] and Minimal value [i] with consideration of all tolerances
  Specifications with [.m] imply: Mean value within tolerance
- For the backlash tolerance, the center distance tolerances and the tooth thickness deviation are taken into account. Shown is the maximal and the minimal backlash corresponding the largest resp. the smallest allowances
  The calculation is done for the Operating pitch circle..
- Calculation of Zbet according Corrigendum 1 ISO 6336-2:2008 with Zbet = 1/(COS(beta)^0.5)
- Details of calculation method:
  cg according to method B
  KV according to method B
- For the coefficients ZL, ZV, ZR, ZW, ZX, YdrelT, YRrelT and YX, the logarithmically interpolated value taken from the values for the fatigue strength and the static strength based on the number of load cycles is used..

End of Report lines: 521

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KISSsoft Release 03/2015 F

KISSsoft evaluation

File

Name : Unnamed
Changed by: kspl on: 07.03.2016 at: 10:58:16

Important hint: At least one warning has occurred during the calculation:

1-> Gear pair 1 - 2 :
The transverse load factor KHa is very high.
The formulae in the standard probably do not suit this case.

2-> Calculation of scuffing:
The entered gear pair data is outside the boundary of the calculation method!

The application of ISO/TR 13989-2 has following limitations:
wBt (=82.9 N/mm) >= 150.0 N/mm

CALCULATION OF A HELICAL GEAR PAIR

Drawing or article number:
Gear 1: 0.000.0
Gear 2: 0.000.0

Calculation method ISO 6336:2006 Method B

		------- GEAR 1	-------- GEAR 2 --
Power (kW)	[P]	2.053	
Speed (1/min)	[n]	1142.9	584.1
Torque (Nm)	[T]	17.2	33.6
Application factor	[KA]	1.25	
Required service life (h)	[H]	3000.00	
Gear driving (+) / driven (-)		+	-

Working flank gear 1: Left flank

1. TOOTH GEOMETRY AND MATERIAL

(geometry calculation according to
DIN 3960:1987)

		------- GEAR 1 --------	GEAR 2 --
Center distance (mm)	[a]	74.000	
Centre distance tolerance	ISO 286:2010 Measure js7		
Normal module (mm)	[mn]	2.0000	
Pressure angle at normal section (°)	[alfn]	20.0000	
Helix angle at reference circle (°)	[beta]	20.0000	
Number of teeth	[z]	23	45
Facewidth (mm)	[b]	20.00	21.00
Hand of gear		right	left
Accuracy grade	[Q-ISO 1328:1995]	6	6
Inner diameter (mm)	[di]	0.00	0.00
Inner diameter of gear rim (mm)	[dbi]	0.00	0.00

Material

Gear 1: 18CrNiMo7-6, Case-carburized steel, case-hardened
ISO 6336-5 Figure 9/10 (MQ), core strength >=25HRC Jominy
J=12mm<HRC28

Gear 2: 18CrNiMo7-6, Case-carburized steel, case-hardened
ISO 6336-5 Figure 9/10 (MQ), core strength >=25HRC Jominy
J=12mm<HRC28

		------- GEAR 1 --------	GEAR 2 --
Surface hardness		HRC 61	HRC 61
Material quality according to ISO 6336:2006 Normal (Life factors ZNT and YNT >=0.85)			
Fatigue strength. tooth root stress (N/mm²)	[sigFlim]	430.00	430.00
Fatigue strength for Hertzian pressure (N/mm²)	[sigHlim]	1500.00	1500.00
Tensile strength (N/mm²)	[Rm]	1200.00	1200.00
Yield point (N/mm²)	[Rp]	850.00	850.00
Young's modulus (N/mm²)	[E]	206000	206000
Poisson's ratio	[ny]	0.300	0.300
Roughness average value DS, flank (µm)	[RAH]	0.60	0.60
Roughness average value DS, root (µm)	[RAF]	3.00	3.00
Mean roughness height, Rz, flank (µm)	[RZH]	4.80	4.80
Mean roughness height, Rz, root (µm)	[RZF]	20.00	20.00

Gear reference profile	1 :		
Reference profile	1.25 / 0.38 / 1.0 ISO 53.2:1997 Profil A		
Dedendum coefficient		[hfP*]	1.250
Root radius factor		[rhofP*]	0.380 (rhofPmax*= 0.472)
Addendum coefficient		[haP*]	1.000
Tip radius factor		[rhoaP*]	0.000
Protuberance height factor		[hprP*]	0.000

Protuberance angle	[alfprP]	0.000
Tip form height coefficient	[hFaP*]	0.000
Ramp angle	[alfKP]	0.000
	not topping	

Gear reference profile	2 :	
Reference profile	1.25 / 0.38 / 1.0 ISO 53.2:1997 Profil A	
Dedendum coefficient	[hfP*]	1.250
Root radius factor	[rhofP*]	0.380 (rhofPmax*= 0.472)
Addendum coefficient	[haP*]	1.000
Tip radius factor	[rhoaP*]	0.000
Protuberance height factor	[hprP*]	0.000
Protuberance angle	[alfprP]	0.000
Tip form height coefficient	[hFaP*]	0.000
Ramp angle	[alfKP]	0.000
	not topping	

Summary of reference profile gears:

Dedendum reference profile	[hfP*]	1.250	1.250
Tooth root radius Refer. profile	[rofP*]	0.380	0.380
Addendum Reference profile	[haP*]	1.000	1.000
Protuberance height factor	[hprP*]	0.000	0.000
Protuberance angle (°)	[alfprP]	0.000	0.000
Tip form height coefficient	[hFaP*]	0.000	0.000
Ramp angle (°)	[alfKP]	0.000	0.000

Type of profile modification:
none (only running-in)

Tip relief (µm)	[Ca]	2.0	2.0

Lubrication type	oil bath lubrication	
Type of oil	Oil: ISO-VG 150	
Lubricant base	Mineral-oil base	
Kinem. viscosity oil at 40 °C (mm²/s)	[nu40]	150.00
Kinem. viscosity oil at 100 °C (mm²/s)	[nu100]	13.00
FZG test A/8.3/90 (ISO 14635-1:2006)	[FZGtestA] 12	
Specific density at 15 °C (kg/dm³)	[roOil]	0.892
Oil temperature (°C)	[TS]	70.000

		------- GEAR 1 --------	GEAR 2 --
Overall transmission ratio	[itot]		-1.957
Gear ratio	[u]		1.957
Transverse module (mm)	[mt]		2.128
Pressure angle at pitch circle (°)	[alft]		21.173
Working transverse pressure angle (°)	[alfwt]		24.233

	[alfwt.e/i]	24.259 / 24.208	
Working pressure angle at normal section (°)	[alfwn]	22.872	
Helix angle at operating pitch circle (°)	[betaw]	20.415	
Base helix angle (°)	[betab]	18.747	
Reference centre distance (mm)	[ad]	72.364	
Sum of profile shift coefficients	[Summexi]	0.8756	
Profile shift coefficient	[x]	0.4425	0.4331
Tooth thickness (Arc) (module) (module)	[sn*]	1.8929	1.8860
Tip alteration (mm)	[k*mn]	-0.115	-0.115
Reference diameter (mm)	[d]	48.952	95.776
Base diameter (mm)	[db]	45.648	89.311
Tip diameter (mm)	[da]	54.492	101.278
(mm)	[da.e/i]	54.492 / 54.482	101.278 / 101.268
Tip diameter allowances (mm)	[Ada.e/i]	0.000 / -0.010	0.000 / -0.010
Tip form diameter (mm)	[dFa]	54.492	101.278
(mm)	[dFa.e/i]	54.492 / 54.482	101.278 / 101.268
Active tip diameter (mm)	[dNa]	54.492	101.278
Active tip diameter (mm)	[dNa.e/i]	54.492 / 54.482	101.278 / 101.268
Operating pitch diameter (mm)	[dw]	50.059	97.941
(mm)	[dw.e/i]	50.069 / 50.049	97.961 / 97.921
Root diameter (mm)	[df]	45.722	92.508
Generating Profile shift coefficient	[xE.e/i]	0.4054/ 0.3848	0.3850/ 0.3575
Manufactured root diameter with xE (mm)	[df.e/i]	45.574 / 45.491	92.316 / 92.206
Theoretical tip clearance (mm)	[c]	0.500	0.500
Effective tip clearance (mm)	[c.e/i]	0.671 / 0.581	0.635 / 0.559
Active root diameter (mm)	[dNf]	47.460	94.533
(mm)	[dNf.e/i]	47.486 / 47.440	94.563 / 94.510
Root form diameter (mm)	[dFf]	47.076	93.691
(mm)	[dFf.e/i]	46.977 / 46.924	93.532 / 93.442
Reserve (dNf-dFf)/2 (mm)	[cF.e/i]	0.281 / 0.231	0.561 / 0.489
Addendum (mm)	[ha=mn*(haP*+x)]	2.770	2.751
(mm)	[ha.e/i]	2.770 / 2.765	2.751 / 2.746
Dedendum (mm)	[hf=mn*(hfP*-x)]	1.615	1

.634				
(mm)	[hf.e/i]	1.689 /	1.730	1.730 /
1.785				
Roll angle at dFa (°)	[xsi_dFa.e/i]	37.355 /	37.332	30.639 /
30.625				
Roll angle to dNa (°)	[xsi_dNa.e/i]	37.355 /	37.332	30.639 /
30.625				
Roll angle to dNf (°)	[xsi_dNf.e/i]	16.422 /	16.212	19.938 /
19.832				
Roll angle at dFf (°)	[xsi_dFf.e/i]	13.928 /	13.641	17.823 /
17.628				
Tooth height (mm)	[H]	4.385		4
.385				
Virtual gear no. of teeth	[zn]	27.296		53
.404				
Normal-tooth thickness at tip circle (mm)	[san]	1.307		1
.514				
(mm)	[san.e/i]	1.254 /	1.215	1.445 /
1.398				
Normal-tooth thickness on tip form circle (mm)	[sFan]	1.307		1
.514				
(mm)	[sFan.e/i]	1.254 /	1.215	1.445 /
1.398				
Normal space width at root circle (mm)	[efn]	1.583		1
.431				
(mm)	[efn.e/i]	0.000 /	0.000	1.448 /
1.458				
Max. sliding velocity at tip (m/s)	[vga]	0.833		0
.683				
Specific sliding at the tip	[zetaa]	0.468		0
.468				
Specific sliding at the root	[zetaf]	-0.879		-0
.879				
Mean specific sliding	[zetam]		0.468	
Sliding factor on tip	[Kga]	0.278		0
.228				
Sliding factor on root	[Kgf]	-0.228		-0
.278				
Pitch on reference circle (mm)	[pt]		6.686	
Base pitch (mm)	[pbt]		6.235	
Transverse pitch on contact-path (mm)	[pet]		6.235	
Lead height (mm)	[pz]	422.528		826
.686				
Axial pitch (mm)	[px]		18.371	
Length of path of contact (mm)	[ga, e/i]		8.386 (8.422 /	8.330)
Length T1-A, T2-A (mm)	[T1A, T2A]	6.494(6.458/	6.542)	23.879(
23.879/	23.869)			

Length T1-B (mm)	[T1B, T2B]	8.645(	8.645/	8.636)	21.729(	21.692/ 21.774)
Length T1-C (mm)	[T1C, T2C]	10.273(	10.261/	10.286)	20.100(	20.076/ 20.124)
Length T1-D (mm)	[T1D, T2D]	12.729(	12.693/	12.777)	17.644(	17.644/ 17.634)
Length T1-E (mm)	[T1E, T2E]	14.880(	14.880/	14.871)	15.493(	15.457/ 15.539)
Length T1-T2 (mm)	[T1T2]			30.374 (	30.337 /	30.410)
Diameter of single contact point B (mm)	[d-B]	48.813(	48.813/	48.806)	99.322(	99.290/ 99.362)
Diameter of single contact point D (mm)	[d-D]	52.267(	52.232/	52.313)	96.030(	96.030/ 96.022)
Addendum contact ratio	[eps]	0.739(	0.741/	0.735)	0.606(	0.610/ 0.601)
Minimal length of contact line (mm)	[Lmin]			27.813		
Transverse contact ratio	[eps_a]			1.345		
Transverse contact ratio with allowances	[eps_a.e/m/i]			1.351 /	1.343 /	1.336
Overlap ratio	[eps_b]			1.089		
Total contact ratio	[eps_g]			2.434		
Total contact ratio with allowances	[eps_g.e/m/i]			2.440 /	2.432 /	2.425

2. FACTORS OF GENERAL INFLUENCE

		------- GEAR 1 --------	GEAR 2 --
Nominal circum. force at pitch circle (N)	[Ft]		700.7
Axial force (N)	[Fa]		255.0
Radial force (N)	[Fr]		271.4
Normal force (N)	[Fnorm]		793.5
Nominal circumferential force per mm (N/mm)	[w]		35.03
Only as information: Forces at operating pitch circle:			
Nominal circumferential force (N)	[Ftw]		685.2
Axial force (N)	[Faw]		255.0
Radial force (N)	[Frw]		308.4
Circumferential speed reference circle (m/s)	[v]		2.93
Circumferential speed operating pitch circle (m/s)	[v(dw)]		3.00
Running-in value (µm)	[yp]		0.5
Running-in value (µm)	[yf]		0.5
Correction coefficient	[CM]		0.800
Gear body coefficient	[CR]		1.000
Reference profile coefficient	[CBS]		0.975

Material coefficient	[E/Est]	1.000	
Singular tooth stiffness (N/mm/µm)	[c']	11.547	
Meshing stiffness (N/mm/µm)	[cgalf]	14.534	
Meshing stiffness (N/mm/µm)	[cgbet]	12.354	
Reduced mass (kg/mm)	[mRed]	0.00730	
Resonance speed (min-1)	[nE1]	18522	
Resonance ratio (-)	[N]	0.062	
Subcritical range			
Running-in value (µm)	[ya]	0.5	
KHb calculated according to ISO 6336-1:2006, Annex E (takes into account K_A*K_V)			
Axis alignment (µm)	[$f_{\Sigma\beta}$ / $f_{\Sigma\delta}$]		
0.0/	0.0		
Torque (0: -, 1: <I, 2: <II)		0	0
(For intermediate results refer to file: KHbeta_calc12.tmp)			
Dynamic factor	[KV]	1.067	
Face load factor - flank	[KHb]	1.000	
- Tooth root	[KFb]	1.000	
- Scuffing	[KBb]	1.000	
Transverse load factor - flank	[KHa]	1.775	
- Tooth root	[KFa]	1.775	
- Scuffing	[KBa]	1.775	
Helical load factor scuffing	[Kbg]	1.211	
Number of load cycles (in mio.)	[NL]	205.714	105.143

3. TOOTH ROOT STRENGTH

Calculation of Tooth form coefficients according method: B

		------- GEAR 1 --------	GEAR 2 --
Calculated with manufacturing profile shift	[xE.e]	0.41	0.38
Tooth form factor	[YF]	1.29	1.35
Stress correction factor	[YS]	2.18	2.18
Working angle (°)	[alfFen]	23.74	22.59
Bending lever arm (mm)	[hF]	2.16	2.36
Tooth thickness at root (mm)	[sFn]	4.42	4.55
Tooth root radius (mm)	[roF]	0.88	0.85
(hF* = 1.082/ 1.182 sFn* = 2.211/ 2.274 roF* = 0.439/ 0.425 dsFn = 46.284/ 93.060 alfsFn = 30.00/ 30.00)			

Helix angle factor	[Ybet]	0.833
Deep tooth factor	[YDT]	1.000

Gear rim factor	[YB]	1.00		1.00
Effective facewidth (mm)	[beff]	20.00		21.00
Nominal stress at tooth root (N/mm²)	[sigF0]	41.10		40.88
Tooth root stress (N/mm²)	[sigF]	97.25		96.73
Permissible bending stress at root of Test-gear				
Notch sensitivity factor	[YdrelT]	1.000		1.002
Surface factor	[YRrelT]	0.957		0.957
size factor (Tooth root)	[YX]	1.000		1.000
S-N curve (Woehler line) in the range of endurance limit				
	Haibach			
Finite life factor	[YNT]	0.785		0.816
[YdrelT*YRrelT*YX*YNT]		0.751		0.782
Alternating bending factor (mean stress influence coefficient)				
	[YM]	1.000		1.000
Stress correction factor	[Yst]		2.00	
Yst*sigFlim (N/mm²)	[sigFE]	860.00		860.00
Permissible tooth root stress (N/mm²)	[sigFP=sigFG/SFmin]	461.49		480.26
Limit strength tooth root (N/mm²)	[sigFG]	646.08		672.37
Required safety	[SFmin]	1.40		1.40
Safety for Tooth root stress	[SF=sigFG/sigF]	6.64		6.95
Transmittable power (kW)	[kWRating]	9.74		10.19

4. SAFETY AGAINST PITTING (TOOTH FLANK)

		------- GEAR 1 --------	GEAR 2 --
Zone factor	[ZH]	2.200	
Elasticity coefficient (√N/mm)	[ZE]	189.812	
Contact ratio factor	[Zeps]	0.862	
Helix angle factor	[Zbet]	1.032	
Effective facewidth (mm)	[beff]	20.00	
Nominal flank pressure (N/mm²)	[sigH0]	386.24	
Surface pressure at operating pitch circle (N/mm²)			
	[sigHw]	594.13	
Single tooth contact factor	[ZB,ZD]	1.00	1.00
Flank pressure (N/mm²)	[sigHB, sigHD]	594.13	594.13
Lubrication coefficient at NL	[ZL]	0.992	0.992
Speed coefficient at NL	[ZV]	0.971	0.971
Roughness coefficient at NL	[ZR]	0.953	0.953
Work hardening factor at NL	[ZW]	1.000	1.000
S-N curve (Woehler line) in the range of endurance limit			
	Haibach		

Finite life factor	[ZNT]	0.948	0.972
	[ZL*ZV*ZR*ZNT]	0.870	0.893
Small no. of pittings permissible:		no	
Size factor (flank)	[ZX]	1.000	1.000
Permissible surface pressure (N/mm²)	[sigHP=sigHG/SHmin]	1305.60	1339.16
Limit strength pitting (N/mm²)	[sigHG]	1305.60	1339.16
Required safety	[SHmin]	1.00	1.00
Safety for surface pressure at operating pitch circle			
	[SHw]	2.20	2.25
Safety for stress at single tooth contact	[SHBD=sigHG/sigHBD]	2.20	2.25
(Safety regarding transmittable torque)	[(SHBD)^2]	4.83	5.08
Transmittable power (kW)	[kWRating]	9.91	10.43

4b. MICROPITTING ACCORDING TO ISO/TR 15144-1:2014

Calculation did not run. (Lubricant: Load stage micropitting test is unknown.)

5. STRENGTH AGAINST SCUFFING

Calculation method according to
ISO TR 13989:2000

Lubrication coefficient (for lubrication type)	[XS]	1.000	
Multiple meshing factor	[Xmp]	1.000	
Relative structure coefficient (Scuffing)	[XWrelT]	1.000	
Thermal contact factor (N/mm/s^.5/K)	[BM]	13.780	13.780
Relevant tip relief (µm)	[Ca]	2.00	2.00
Optimal tip relief (µm)	[Ceff]	3.01	
Ca taken as optimal in the calculation (0=no, 1=yes)		0	0
Effective facewidth (mm)	[beff]	20.000	
Applicable circumferential force/facewidth (N/mm)			
	[wBt]	82.899	
(Kbg = 1.211, wBt*Kbg = 100.390)			
Angle factor	[Xalfbet]	1.027	
(ε1:0.739, ε2:0.606)			
Flash temperature-criteria			
Lubricant factor	[XL]	0.844	
Tooth mass temperature (°C)	[theMi]	72.00	
theM = theoil + XS*0.47*Xmp*theflm	[theflm]	4.25	
Scuffing temperature (°C)	[theS]	353.42	
Coordinate gamma (point of highest temp.)	[Gamma]	0.448	
[Gamma.A]=-0.368 [Gamma.E]=0.448			

Highest contact temp. (°C)	[theB]	82.34
Flash factor (°K*N^-.75*s^.5*m^-.5*mm)	[XM]	50.058
Approach factor	[XJ]	1.000
Load sharing factor	[XGam]	0.967
Dynamic viscosity (mPa*s)	[etaM]	29.80 (70.0 °C)
Coefficient of friction	[mym]	0.054
Required safety	[SBmin]	2.000
Safety factor for scuffing (flash temperature)	[SB]	22.975
Integral temperature-criteria		
Lubricant factor	[XL]	1.000
Tooth mass temperature (°C)	[theM-C]	72.13
theM-C = theoil + XS*0.70*theflaint	[theflaint]	3.05
Integral scuffing temperature (°C)	[theSint]	361.99
Flash factor (°K*N^-.75*s^.5*m^-.5*mm)	[XM]	50.058
Running-in factor (well run in)	[XE]	1.000
Contact ratio factor	[Xeps]	0.299
Dynamic viscosity (mPa*s)	[etaOil]	29.80 (70.0 °C)
Mean coefficient of friction	[mym]	0.064
Geometry factor	[XBE]	0.235
Meshing factor	[XQ]	1.000
Tip relief factor	[XCa]	1.394
Integral tooth flank temperature (°C)	[theint]	76.71
Required safety	[SSmin]	1.800
Safety factor for scuffing (intg.-temp.)	[SSint]	4.719
Safety referring to transferred torque	[SSL]	43.524

6. MEASUREMENTS FOR TOOTH THICKNESS

		------- GEAR 1 --------	GEAR 2 --
Tooth thickness deviation		DIN 3967 cd25	DIN 3967 cd25
Tooth thickness allowance (normal section) (mm)	[As.e/i]	-0.054 / -0.084	-0.070 / -0.110
Number of teeth spanned	[k]	4.000	7.000
Base tangent length (no backlash) (mm)	[Wk]	22.039	40.475
Actual base tangent length ('span') (mm)	[Wk.e/i]	21.989 / 21.961	40.409 / 40.372
(mm)	[ΔWk.e/i]	-0.051 / -0.079	-0.066 / -0.103
Diameter of contact point (mm)	[dMWk.m]	50.167	97.156
Theoretical diameter of ball/pin (mm)	[DM]	3.734	3.530
Eff. Diameter of ball/pin (mm)	[DMeff]	3.750	3.750
Theor. dim. centre to ball (mm)	[MrK]	28.069	51.588
Actual dimension centre to ball (mm)	[MrK.e/i]	28.014 / 27.983	51.508 / 51.463
Diameter of contact point (mm)	[dMMr.m]	50.615	97.726
Diametral measurement over two balls without clearance (mm)			

	[MdK]	56.015	103.115
Actual dimension over balls (mm)	[MdK.e/i]	55.906 / 55.845	102.956 / 102.865
Diametral measurement over rolls without clearance (mm)			
	[MdR]	56.137	103.175
Actual dimension over rolls (mm)	[MdR.e/i]	56.028 / 55.967	103.017 / 102.926
Chordal tooth thickness (no backlash) (mm)	['sn]	3.783	3.771
Actual chordal tooth thickness (mm)	['sn.e/i]	3.729 / 3.699	3.701 / 3.661
Reference chordal height from da.m (mm)	[ha]	2.832	2.781
Tooth thickness (Arc) (mm)	[sn]	3.786	3.772
(mm)	[sn.e/i]	3.732 / 3.702	3.702 / 3.662
Backlash free center distance (mm)	[aControl.e/i]	73.849 / 73.764	
Backlash free center distance, allowances (mm)	[jta]	-0.151 / -0.236	
dNf.i with aControl (mm)	[dNf0.i]	47.155	94.159
Reserve (dNf0.i-dFf.e)/2 (mm)	[cF0.i]	0.089	0.314
Tip clearance	[c0.i(aControl)]	0.360	0.338
Centre distance allowances (mm)	[Aa.e/i]	0.015 / -0.015	
Circumferential backlash from Aa (mm)	[jtw_Aa.e/i]	0.014 / -0.014	
Radial clearance (mm)	[jrw]	0.251 / 0.136	
Circumferential backlash (transverse section) (mm)			
	[jtw]	0.225 / 0.121	
Rotation angle when gear 1 is fixed (°)		0.2628 / 0.1421	
Normal backlash (mm)	[jnw]	0.198 / 0.107	

7. GEAR ACCURACY

		------- GEAR 1 --------	GEAR 2 --
According to ISO 1328:1995			
Accuracy grade	[Q-ISO1328]	6	6
Single pitch deviation (µm)	[fptT]	7.00	7.50
Base circle pitch deviation (µm)	[fpbT]	6.50	7.00
Sector pitch deviation over k/8 pitches (µm)	[Fpk/8T]	9.50	12.00
Profile form deviation (µm)	[ffaT]	5.50	6.50
Profile slope deviation (µm)	[fHaT]	4.60	5.50
Total profile deviation (µm)	[FaT]	7.50	8.50
Helix form deviation (µm)	[ffbT]	7.00	8.50
Helix slope deviation (µm)	[fHbT]	7.00	8.50
Total helix deviation (µm)	[FbT]	10.00	12.00
Total cumulative pitch deviation (µm)	[FpT]	20.00	26.00
Runout (µm)	[FrT]	16.00	21.00
Single flank composite, total (µm)	[FisT]	31.00	38.00
Single flank composite, tooth-to-tooth (µm)	[fisT]	11.00	12.00
Radial composite, total (µm)	[FidT]	26.00	31.00

Radial composite, tooth-to-tooth (µm)	[fidT]	9.50	9.50

Axis alignment tolerances (recommendation acc. ISO TR 10064:1992, Quality 6)

Maximum value for deviation error of axis (µm)	[fSigbet]	11.00 (Fb= 11.00)
Maximum value for inclination error of axes (µm)	[fSigdel]	22.00

8. ADDITIONAL DATA

Maximal possible centre distance (eps_a=1.0)	[aMAX]	74.908	
Weight - calculated with da (kg)	[Mass]	0.365	1.325
Total weight (kg)	[Mass]	1.690	

Moment of inertia (System referenced to wheel 1):
calculation without consideration of the exact tooth shape

single gears ((da+df)/2...di) (kg*m²)	[TraeghMom]	9.616e-005	0.001415
System ((da+df)/2...di) (kg*m²)	[TraeghMom]	0.0004659	
Torsional stiffness (MNm/rad)	[cr]	0.2	0.6
Mean coeff. of friction (acc. Niemann)	[mum]	0.077	
Wear sliding coef. by Niemann	[zetw]	0.629	
Gear power loss (kW)	[PVZ]	0.020	
(Meshing efficiency (%)	[etaz]	99.042)	

Indications for the manufacturing by wire cutting:

Deviation from theoretical tooth trace (µm)	[WireErr]	270.1	138.3
Permissible deviation (µm)	[Fb/2]	5.0	6.0

9. DETERMINATION OF TOOTH FORM

Data for the tooth form calculation :

Calculation of Gear 1
Tooth form, Gear 1, Step 1: Automatic (final machining)
haP*= 0.989, hfP*= 1.250, rofP*= 0.380

Calculation of Gear 2
Tooth form, Gear 2, Step 1: Automatic (final machining)
haP*= 1.003, hfP*= 1.250, rofP*= 0.380

10. SERVICE LIFE, DAMAGE, LOAD DISTRIBUTION

Required safety for tooth root	[SFmin]	1.40	
Required safety for tooth flank	[SHmin]	1.00	

Service life (calculated with required safeties):

System service life (h)	[Hatt]	> 1000000	
Tooth root service life (h)	[HFatt]	1e+006	1e+006
Tooth flank service life (h)	[HHatt]	1e+006	1e+006

Note: The entry 1e+006 h means that the Service life > 1,000,000 h.

Damage calculated on basis of required service life

[H] (3000.0 h)

F1%	F2%	H1%	H2%
0.00	0.00	0.00	0.00

Load distribution (ISO6336-1, Annex E)

$K_{H\beta}$	w_m	w_I	w_{II}	w_{max}	σ_{Hm}	σ_{HI}	σ_{HII}	σ_{Hmax}
	(N/mm)	(N/mm)	(N/mm)	(N/mm)	(N/mm^2)	(N/mm^2)	(N/mm^2)	(N/mm^2)
1.000	51.2	51.2	51.2	51.2	446.0	446.0	446.0	446.0

Index m, I, II stand for: Middle of facewidth, Side I and Side II

REMARKS:

- Specifications with [.e/i] imply: Maximum [e] and Minimal value [i] with consideration of all tolerances
  Specifications with [.m] imply: Mean value within tolerance
- For the backlash tolerance, the center distance tolerances and the tooth thickness deviation are taken into account. Shown is the maximal and the minimal backlash corresponding the largest resp. the smallest allowances
  The calculation is done for the Operating pitch circle..
- Calculation of Zbet according Corrigendum 1 ISO 6336-2:2008 with Zbet = 1/(COS(beta)^0.5)
- Details of calculation method:
  cg according to method B
  KV according to method B
- For the coefficients ZL, ZV, ZR, ZW, ZX, YdrelT, YRrelT and YX, the logarithmically interpolated value taken from the values for the fatigue strength and the static strength based on the number of load cycles is used..

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ROLLING BEARING ANALYSIS

Calculation method: ISO 281:2007 und Herstellerangaben
- With enhanced bearing service life according to ISO 281:2007

General data:	
Speed (1/min)	2000.000
Axial force (N)	86.824
Required service life (h)	20000.000
Operating temperature (°C)	70
Type of oil	Oil: ISO-VG 150
Lubricant base	Mineral-oil base
Kinematic viscosity oil at 40 °C (mm²/s)	150.00
Specific density oil at 15 °C (kg/dm³)	0.892
Oil lubrication with filtering, Lubricant with additive	ISO 4406:1999 -/19/16, beta40=75

Rolling bearing No. 1:

Bearing type	SKF *6004	
Type	Deep groove ball bearing (single row)	
Bearing clearance: normal		
Only radial load		
Radial force (N)	[Fr]	363.750
Axial force (N)	[Fa]	0.000
Inner diameter (mm)	[d]	20.000
External diameter (mm)	[D]	42.000
Width (mm)	[B]	12.000
Basic dynamic load rating (kN)	[C]	9.950
Basic static load rating (kN)	[C0]	5.000

Speed limit (oil) (1/min)	[n.max]	24000
Dynamic equivalent load (N)	[P]	363.750
Static equivalent load (N)	[P0]	363.750
Operating viscosity (mm²/s)	[nu]	34.884
Reference viscosity (mm²/s)	[nu1]	18.072
Fatigue load limit (kN)	[Cu]	0.212
Impurity characteristic quantity	[ec]	0.057
Service life coefficient	[aISO]	1.112
Rolling moment of friction (Nmm)	[Mrr]	6.302
Sliding moment of friction (Nmm)	[Msl]	1.437
Moment of friction, seals (Nmm)	[Mseal]	0.000
Mseal according to SKF Main Catalog 10000/1 EN:2013		
Moment of friction flow losses (Nmm)	[Mdrag]	0.000
Total moment of friction (Nmm)	[M]	7.739
Service life (h)	[Lh]	189607.274
Static safety factor	[S0]	13.746

Rolling bearing No. 2:

Bearing type	SKF *6004	
Type	Deep groove ball bearing (single row)	
Bearing clearance:	normal	
Radial and axial load		
Radial force (N)	[Fr]	158.909
Axial force (N)	[Fa]	86.824
Inner diameter (mm)	[d]	20.000
External diameter (mm)	[D]	42.000
Width (mm)	[B]	12.000
Basic dynamic load rating (kN)	[C]	9.950
Basic static load rating (kN)	[C0]	5.000
Speed limit (oil) (1/min)	[n.max]	24000
Dynamic equivalent load (N)	[P]	267.577
Static equivalent load (N)	[P0]	158.909
Operating viscosity (mm²/s)	[nu]	34.884
Reference viscosity (mm²/s)	[nu1]	18.072
Fatigue load limit (kN)	[Cu]	0.212
Impurity characteristic quantity	[ec]	0.057
Service life coefficient	[aISO]	1.502
Rolling moment of friction (Nmm)	[Mrr]	11.298
Sliding moment of friction (Nmm)	[Msl]	1.146
Moment of friction, seals (Nmm)	[Mseal]	0.000
Mseal according to SKF Main Catalog 10000/1 EN:2013		

Moment of friction flow losses (Nmm)	[Mdrag]	0.000
Total moment of friction (Nmm)	[M]	12.445
Service life (h)	[Lh]	643706.154
Static safety factor	[S0]	31.465

Notice:
The modified rating life according ISO 281 contains only approximate formulae
for the calculation of the fatigue load boundary and the resulting values for a23 are sometimes very high..
The moment of friction is calculated according to the details in SKF Catalog 2013..
This is always calculated with a coefficient for additives in the lubricant mybl=0.15.

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101

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Analysis of shafts, axle and beams

Input data

Coordinate system shaft: see picture W-002

Label		s1
Drawing		
Initial position (mm)		0.000
Length (mm)		135.000
Speed (1/min)		2000.00
Sense of rotation: clockwise		
Material		C45 (1)
Young's modulus (N/mm²)		206000.000
Poisson's ratio nu		0.300
Density (kg/m³)		7830.000
Coefficient of thermal expansion	(10^-6/K)	11.500
Temperature (°C)		20.000
Weight of shaft (kg)		0.517
Weight of shaft, including additional masses (kg)		0.517
Mass moment of inertia (kg*mm²)		46.584
Momentum of mass GD2 (Nm²)		0.002

Weight towards (0.000, 0.000, -1.000)
Deformations due to shearing are not considered
Contact angle of rolling bearings is not considered
Tolerance field: Mean value
Reference temperature (°C) 20.000

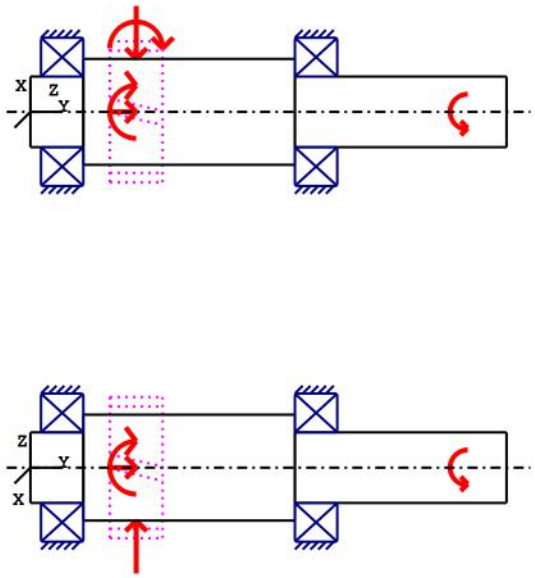


Figure: Load applications

Shaft definition (s1)

Outer contour

Cylinder (Cylinder)		0.000mm ... 15.000mm
Diameter (mm)	[d]	20.0000
Length (mm)	[l]	15.0000
Surface roughness (µm)	[Rz]	8.0000

Relief groove right (Relief groove right)
r=0.50 (mm), t=1.00 (mm), l=2.00 (mm), Rz=8.0, Turned (Ra=3.2µm/125µin)
Own Input, Form B, FKM

Cylinder (Cylinder)		15.000mm ... 75.000mm
Diameter (mm)	[d]	30.0000
Length (mm)	[l]	60.0000
Surface roughness (µm)	[Rz]	8.0000

Cylinder (Cylinder)		75.000mm ... 135.000mm

Diameter (mm)	[d]	20.0000
Length (mm)	[l]	60.0000
Surface roughness (µm)	[Rz]	8.0000

Relief groove left (Relief groove left)
r=0.50 (mm), t=1.00 (mm), l=2.00 (mm), Rz=8.0, Turned (Ra=3.2µm/125µin)
Own Input, Form B, FKM

Forces

Type of force element

		Coupling
Label in the model		cIn(Input)
Position on shaft (mm)	[y_{local}]	124.0000
Position in global system (mm)	[y_{global}]	124.0000
Effective diameter (mm)		20.0000
Radial force factor (-)		0.0000
Direction of the radial force (°)		0.0000
Axial force factor (-)		0.0000
Length of load application (mm)		20.0000
Power (kW)		2.0944 driven (Input)
Torque (Nm)		10.0000
Axial force (N)		0.0000
Shearing force X (N)		0.0000
Shearing force Z (N)		0.0000
Bending moment X (Nm)		0.0000
Bending moment Z (Nm)		0.0000
Mass (kg)		0.0000
Mass moment of inertia Jp (kg*m²)		0.0000
Mass moment of inertia Jxx (kg*m²)		0.0000
Mass moment of inertia Jzz (kg*m²)		0.0000
Eccentricity (mm)		0.0000

Type of force element

		Cylindrical gear
Label in the model		z1(gp1)
Position on shaft (mm)	[y_{local}]	30.0000
Position in global system (mm)	[y_{global}]	30.0000
Operating pitch diameter (mm)		40.0000
Helix angle (°)		9.8511 right
Working pressure angle at normal section (°)		17.4928
Position of contact (°)		0.0000
Length of load application (mm)		15.0000
Power (kW)		2.0944 driving (Output)

Torque (Nm)		-10.0000
Axial force (N)		86.8241
Shearing force X (N)		-159.9381
Shearing force Z (N)		500.0000
Bending moment X (Nm)		-0.0000
Bending moment Z (Nm)		1.7365

Bearing

Label in the model		b1
Bearing type		SKF *6004
Bearing type		Deep groove ball bearing (single row)
Bearing position (mm)	[y_{lokal}]	9.000
Bearing position (mm)	[y_{global}]	9.000
Attachment of external ring		Free bearing
Inner diameter (mm)	[d]	20.000
External diameter (mm)	[D]	42.000
Width (mm)	[b]	12.000
Corner radius (mm)	[r]	0.600
Basic static load rating	[C_0]	5.000
Basic dynamic load rating	[C]	9.950
Fatigue load rating	[C_U]	0.212
Values for approximated geometry:		
Basic dynamic load rating (kN)	[C_{theo}]	0.000
Basic static load rating (kN)	[C_{0theo}]	0.000

Label in the model		b2
Bearing type		SKF *6004
Bearing type		Deep groove ball bearing (single row)
Bearing position (mm)	[y_{lokal}]	81.000
Bearing position (mm)	[y_{global}]	81.000
Attachment of external ring		Fixed bearing
Inner diameter (mm)	[d]	20.000
External diameter (mm)	[D]	42.000
Width (mm)	[b]	12.000
Corner radius (mm)	[r]	0.600
Basic static load rating	[C_0]	5.000
Basic dynamic load rating	[C]	9.950
Fatigue load rating	[C_U]	0.212
Values for approximated geometry:		
Basic dynamic load rating (kN)	[C_{theo}]	0.000
Basic static load rating (kN)	[C_{0theo}]	0.000

Results

Shaft

Maximum deflection (mm)	0.001
Position of the maximum (mm)	135.000
Mass center of gravity (mm)	59.464
Total axial load (N)	86.824
Torsion under torque (°)	0.027

Bearing

Probability of failure	[n]	10.00	%
Axial clearance	[u_A]	10.00	µm

Rolling bearings, classical calculation (contact angle not considered)

Shaft 's1' Rolling bearing 'b1'

Position (Y-coordinate)	[y]	9.00	mm
Equivalent load	[P]	0.36	kN
Equivalent load	[P_0]	0.36	kN
Life modification factor for reliability	[a_1]	1.000	
Service life	[L_{nh}]	170560.03	h
Static safety factor	[S_0]	13.75	
Bearing reaction force	[Fx]	0.089	kN
Bearing reaction force	[Fy]	0.000	kN
Bearing reaction force	[Fz]	-0.353	kN
Bearing reaction force	[Fr]	0.364	kN (-75.81°)
Oil level	[H]	0.000	mm
Load-independent moment of friction	[M_0]	0.011	Nm
Load-dependent moment of friction	[M_1]	0.002	Nm
Torque of friction	[M_{loss}]	0.013	Nm
Power loss	[P_{loss}]	2.697	W

The moment of friction is calculated according to the details in SKF Catalog 1994.

Displacement of bearing	[u_x]	-0.000	µm
Displacement of bearing	[u_y]	10.035	µm
Displacement of bearing	[u_z]	0.000	µm
Displacement of bearing	[u_r]	0.000	µm
Misalignment of bearing	[r_x]	0.021	mrad (0.07')
Misalignment of bearing	[r_y]	-0.000	mrad (0')
Misalignment of bearing	[r_z]	0.008	mrad (0.03')
Misalignment of bearing	[r_r]	0.023	mrad (0.08')

Shaft 's1' Rolling bearing 'b2'

Position (Y-coordinate)	[y]	81.00	mm	
Equivalent load	[P]	0.27	kN	
Equivalent load	[P_0]	0.16	kN	
Life modification factor for reliability	[a_1]	1.000		
Service life	[L_{nh}]	428491.30	h	
Static safety factor	[S_0]	31.46		
Bearing reaction force	[Fx]	0.071	kN	
Bearing reaction force	[Fy]	-0.087	kN	
Bearing reaction force	[Fz]	-0.142	kN	
Bearing reaction force	[Fr]	0.159	kN	(-63.56°)
Oil level	[H]	0.000	mm	
Load-independent moment of friction	[M_0]	0.011	Nm	
Load-dependent moment of friction	[M_1]	0.001	Nm	
Torque of friction	[M_{loss}]	0.012	Nm	
Power loss	[P_{loss}]	2.470	W	
The moment of friction is calculated according to the details in SKF Catalog 1994.				
Displacement of bearing	[u_x]	-0.000	µm	
Displacement of bearing	[u_y]	10.000	µm	
Displacement of bearing	[u_z]	0.000	µm	
Displacement of bearing	[u_r]	0.000	µm	
Misalignment of bearing	[r_x]	-0.015	mrad	(-0.05')
Misalignment of bearing	[r_y]	0.120	mrad	(0.41')
Misalignment of bearing	[r_z]	-0.007	mrad	(-0.02')
Misalignment of bearing	[r_r]	0.017	mrad	(0.06')

Utilization, with reference to the required service life

[H] (10000.000)

B1	B2
0.39	0.29

B1: b1
B2: b2

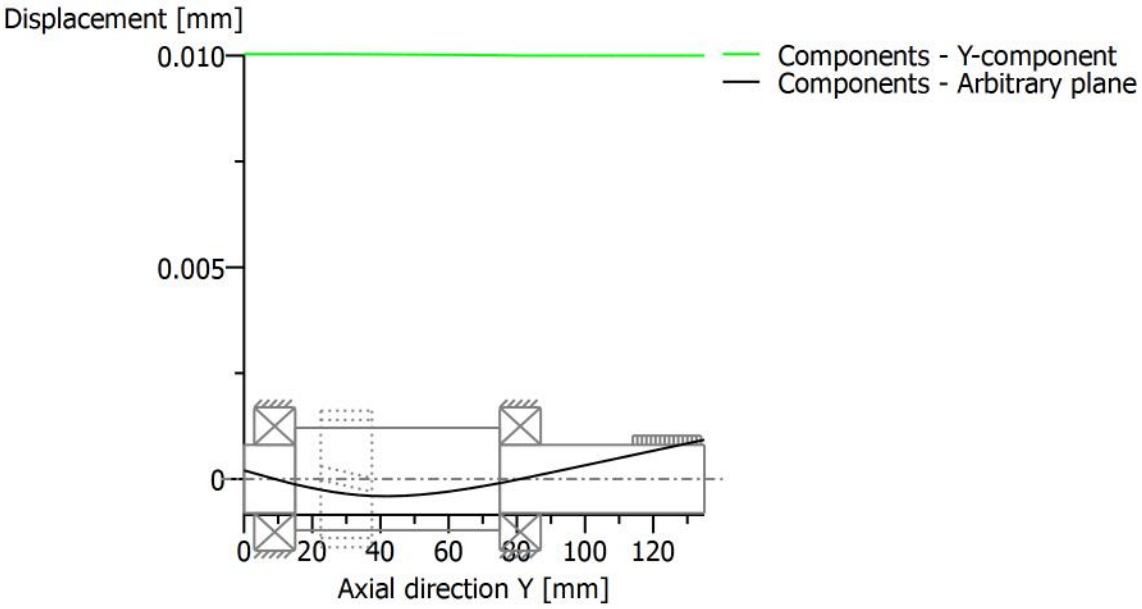
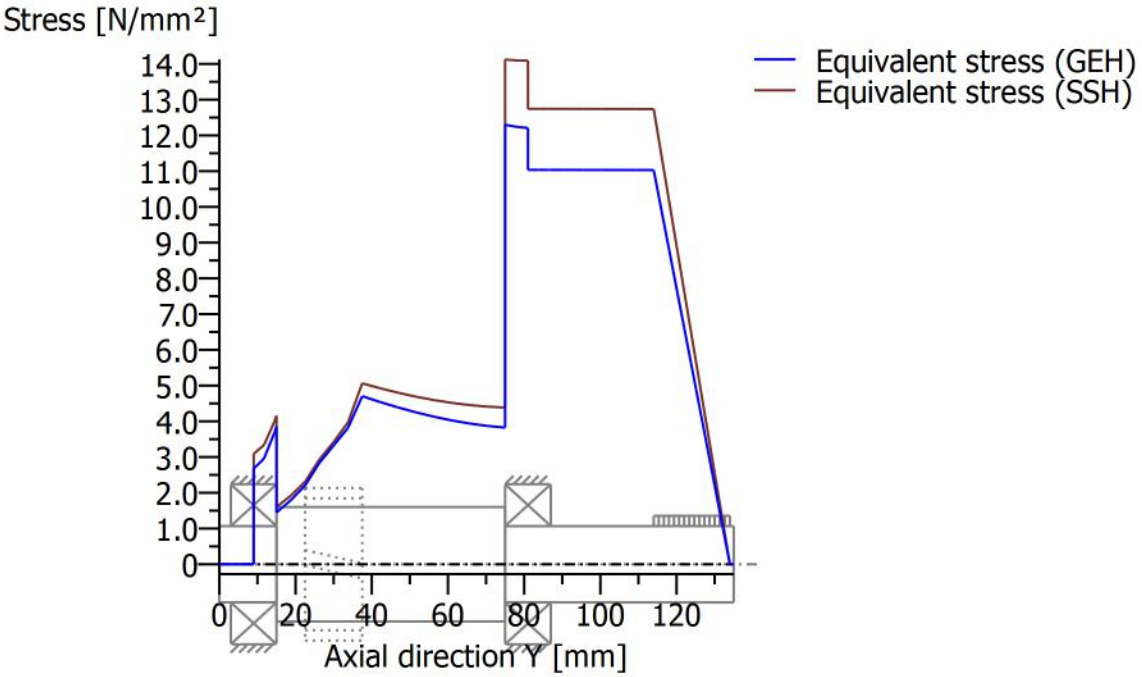


Figure: Deformation (bending etc.) (Arbitrary plane 293.922226 120)



GEH(von Mises): sigV = ((sigB+sigZ,D)^2 + 3*(tauT+tauS)^2)^1/2SSH(Tresca): sigV = ((sigB-sigZ,D)^2 + 4*(tauT+tauS)^2)^1/2

Figure: Equivalent stress

Eigenfrequencies/Critical speeds

1. Eigenfrequency: 0.00 Hz, Critical speed: 0.00 1/min Rigid body rotation Y 's1'

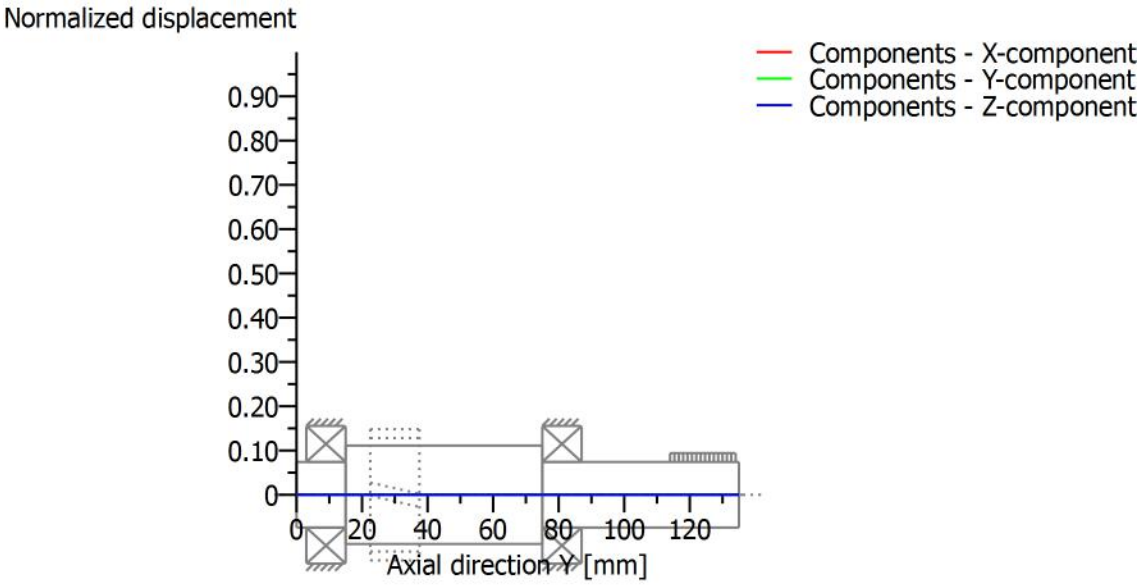


Figure: Eigenfrequencies (Normalized rotation) (Eigenfrequency: 1. (0 Hz))

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KISSsoft Release 03/2015 F

KISSsoft evaluation

File

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ROLLING BEARING ANALYSIS

Calculation method: ISO 281:2007 und Herstellerangaben
- With enhanced bearing service life according to ISO 281:2007

General data:	
Speed (1/min)	1142.857
Axial force (N)	-340.116
Required service life (h)	20000.000
Operating temperature (°C)	70
Type of oil	Oil: ISO-VG 150
Lubricant base	Mineral-oil base
Kinematic viscosity oil at 40 °C (mm²/s)	150.00
Specific density oil at 15 °C (kg/dm³)	0.892
Oil lubrication with filtering, Lubricant with additive	ISO 4406:1999 -/19/16, beta40=75

Rolling bearing No. 1:

Bearing type	SKF *6205	
Type	Deep groove ball bearing (single row)	
Bearing clearance: normal		
Only radial load		
Radial force (N)	[Fr]	400.844
Axial force (N)	[Fa]	0.000
Inner diameter (mm)	[d]	25.000
External diameter (mm)	[D]	52.000
Width (mm)	[B]	15.000
Basic dynamic load rating (kN)	[C]	14.800
Basic static load rating (kN)	[C0]	7.800

Speed limit (oil) (1/min)	[n.max]	18000
Dynamic equivalent load (N)	[P]	400.844
Static equivalent load (N)	[P0]	400.844
Operating viscosity (mm²/s)	[nu]	34.884
Reference viscosity (mm²/s)	[nu1]	21.453
Fatigue load limit (kN)	[Cu]	0.335
Impurity characteristic quantity	[ec]	0.069
Service life coefficient	[aISO]	1.767
Rolling moment of friction (Nmm)	[Mrr]	7.050
Sliding moment of friction (Nmm)	[Msl]	1.534
Moment of friction, seals (Nmm)	[Mseal]	0.000
Mseal according to SKF Main Catalog 10000/1 EN:2013		
Moment of friction flow losses (Nmm)	[Mdrag]	0.000
Total moment of friction (Nmm)	[M]	8.584
Service life (h)	[Lh]	1000000.000
Static safety factor	[S0]	19.459

Rolling bearing No. 2:

Bearing type	SKF *6205	
Type	Deep groove ball bearing (single row)	
Bearing clearance:	normal	
Radial and axial load		
Radial force (N)	[Fr]	546.723
Axial force (N)	[Fa]	-340.116
Inner diameter (mm)	[d]	25.000
External diameter (mm)	[D]	52.000
Width (mm)	[B]	15.000
Basic dynamic load rating (kN)	[C]	14.800
Basic static load rating (kN)	[C0]	7.800
Speed limit (oil) (1/min)	[n.max]	18000
Dynamic equivalent load (N)	[P]	897.709
Static equivalent load (N)	[P0]	546.723
Operating viscosity (mm²/s)	[nu]	34.884
Reference viscosity (mm²/s)	[nu1]	21.453
Fatigue load limit (kN)	[Cu]	0.335
Impurity characteristic quantity	[ec]	0.069
Service life coefficient	[aISO]	0.825
Rolling moment of friction (Nmm)	[Mrr]	22.446
Sliding moment of friction (Nmm)	[Msl]	9.180
Moment of friction, seals (Nmm)	[Mseal]	0.000
Mseal according to SKF Main Catalog 10000/1 EN:2013		

Moment of friction flow losses (Nmm)	[Mdrag]	0.000
Total moment of friction (Nmm)	[M]	31.626
Service life (h)	[Lh]	53942.104
Static safety factor	[S0]	14.267

Notice:
The modified rating life according ISO 281 contains only approximate formulae
for the calculation of the fatigue load boundary and the resulting values for a23 are sometimes very high..
The moment of friction is calculated according to the details in SKF Catalog 2013..
This is always calculated with a coefficient for additives in the lubricant mybl=0.15.

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101

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KISSsoft Release 03/2015 F

KISSsoft evaluation

File

Name : Unnamed
Changed by: kspl on: 07.03.2016 at: 10:58:19

Analysis of shafts, axle and beams

Input data

Coordinate system shaft: see picture W-002

Label		s2
Drawing		
Initial position (mm)		0.000
Length (mm)		80.000
Speed (1/min)		1142.86
Sense of rotation: counter clockwise		
Material		C45 (1)
Young's modulus (N/mm²)		206000.000
Poisson's ratio nu		0.300
Density (kg/m³)		7830.000
Coefficient of thermal expansion	(10^-6/K)	11.500
Temperature (°C)		20.000
Weight of shaft (kg)		0.307
Weight of shaft, including additional masses (kg)		0.307
Mass moment of inertia (kg*mm²)		24.022
Momentum of mass GD2 (Nm²)		0.001
Weight towards	(0.000, 0.000, -1.000)	
Deformations due to shearing are not considered		
Contact angle of rolling bearings is not considered		
Tolerance field: Mean value		
Reference temperature (°C)		20.000

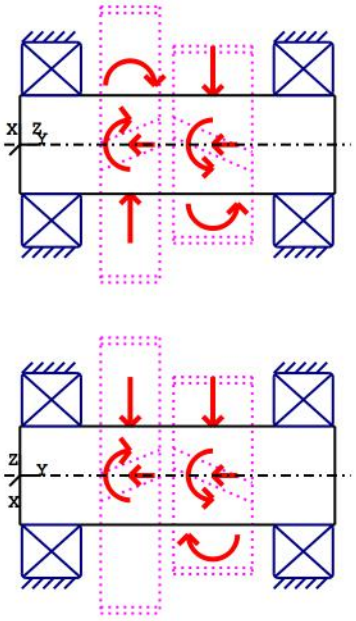


Figure: Load applications

Shaft definition (s2)

Outer contour

Cylinder (Cylinder)		0.000mm ... 80.000mm
Diameter (mm)	[d]	25.0000
Length (mm)	[l]	80.0000
Surface roughness (µm)	[Rz]	8.0000

Forces

Type of force element

		Cylindrical gear
Label in the model		z2(gp1)
Position on shaft (mm)	[y_{local}]	28.0000
Position in global system (mm)	[y_{global}]	28.0000
Operating pitch diameter (mm)		70.0000
Helix angle (°)		9.8511 left
Working pressure angle at normal section (°)		17.4928
Position of contact (°)		180.0000
Length of load application (mm)		15.0000
Power (kW)		2.0525 driven (Input)

Torque (Nm)		-17.1500
Axial force (N)		-85.0876
Shearing force X (N)		156.7394
Shearing force Z (N)		-490.0000
Bending moment X (Nm)		0.0000
Bending moment Z (Nm)		2.9781

Type of force element

		Cylindrical gear
Label in the model		z3(gp2)
Position on shaft (mm)	[y_{local}]	49.0000
Position in global system (mm)	[y_{global}]	49.0000
Operating pitch diameter (mm)		50.0588
Helix angle (°)		20.4152 right
Working pressure angle at normal section (°)		22.8723
Position of contact (°)		-45.0000
Length of load application (mm)		20.0000
Power (kW)		2.0525 driving (Output)
Torque (Nm)		17.1500
Axial force (N)		-255.0282
Shearing force X (N)		-702.5907
Shearing force Z (N)		-266.4197
Bending moment X (Nm)		-4.5136
Bending moment Z (Nm)		-4.5136

Bearing

Label in the model		b1
Bearing type		SKF *6205
Bearing type		Deep groove ball bearing (single row)
Bearing position (mm)	[y_{lokal}]	8.000
Bearing position (mm)	[y_{global}]	8.000
Attachment of external ring		Free bearing
Inner diameter (mm)	[d]	25.000
External diameter (mm)	[D]	52.000
Width (mm)	[b]	15.000
Corner radius (mm)	[r]	1.000
Basic static load rating	[C_0]	7.800
Basic dynamic load rating	[C]	14.800
Fatigue load rating	[C_U]	0.335
Values for approximated geometry:		
Basic dynamic load rating (kN)	[C_{theo}]	0.000
Basic static load rating (kN)	[C_{0theo}]	0.000

Label in the model	b2

Bearing type		SKF *6205
Bearing type		Deep groove ball bearing (single row)
Bearing position (mm)	[y_{lokal}]	72.000
Bearing position (mm)	[y_{global}]	72.000
Attachment of external ring		Fixed bearing
Inner diameter (mm)	[d]	25.000
External diameter (mm)	[D]	52.000
Width (mm)	[b]	15.000
Corner radius (mm)	[r]	1.000
Basic static load rating	[C_0]	7.800
Basic dynamic load rating	[C]	14.800
Fatigue load rating	[C_U]	0.335
Values for approximated geometry:		
Basic dynamic load rating (kN)	[C_{theo}]	0.000
Basic static load rating (kN)	[C_{0theo}]	0.000

Results

Shaft

Maximum deflection (mm)	0.001
Position of the maximum (mm)	39.000
Mass center of gravity (mm)	40.000
Total axial load (N)	-340.116
Torsion under torque (°)	0.007

Bearing

Probability of failure	[n]	10.00	%
Axial clearance	[u_A]	10.00	µm

Rolling bearings, classical calculation (contact angle not considered)

Shaft 's2' Rolling bearing 'b1'

Position (Y-coordinate)	[y]	8.00	mm
Equivalent load	[P]	0.40	kN
Equivalent load	[P_0]	0.40	kN
Life modification factor for reliability[a_1]		1.000	
Service life	[L_{nh}]	734033.57	h
Static safety factor	[S_0]	19.46	

Bearing reaction force	[Fx]	0.169	kN
Bearing reaction force	[Fy]	0.000	kN
Bearing reaction force	[Fz]	0.364	kN
Bearing reaction force	[Fr]	0.401	kN (65.11°)
Oil level	[H]	0.000	mm
Load-independent moment of friction	[M_0]	0.017	Nm
Load-dependent moment of friction	[M_1]	0.003	Nm
Torque of friction	[M_{loss}]	0.020	Nm
Power loss	[P_{loss}]	2.373	W

The moment of friction is calculated according to the details in SKF Catalog 1994.

Displacement of bearing	[u_x]	-0.000	µm
Displacement of bearing	[u_y]	-10.095	µm
Displacement of bearing	[u_z]	0.000	µm
Displacement of bearing	[u_r]	0.000	µm
Misalignment of bearing	[r_x]	-0.037	mrad (-0.13')
Misalignment of bearing	[r_y]	-0.000	mrad (0')
Misalignment of bearing	[r_z]	0.038	mrad (0.13')
Misalignment of bearing	[r_r]	0.053	mrad (0.18')

Shaft 's2' Rolling bearing 'b2'

Position (Y-coordinate)	[y]	72.00	mm
Equivalent load	[P]	0.90	kN
Equivalent load	[P_0]	0.55	kN
Life modification factor for reliability	[a_1]	1.000	
Service life	[L_{nh}]	65348.34	h
Static safety factor	[S_0]	14.27	
Bearing reaction force	[Fx]	0.377	kN
Bearing reaction force	[Fy]	0.340	kN
Bearing reaction force	[Fz]	0.396	kN
Bearing reaction force	[Fr]	0.547	kN (46.39°)
Oil level	[H]	0.000	mm
Load-independent moment of friction	[M_0]	0.017	Nm
Load-dependent moment of friction	[M_1]	0.010	Nm
Torque of friction	[M_{loss}]	0.026	Nm
Power loss	[P_{loss}]	3.168	W

The moment of friction is calculated according to the details in SKF Catalog 1994.

Displacement of bearing	[u_x]	-0.000	µm
Displacement of bearing	[u_y]	-10.000	µm
Displacement of bearing	[u_z]	-0.000	µm
Displacement of bearing	[u_r]	0.000	µm
Misalignment of bearing	[r_x]	0.037	mrad (0.13')
Misalignment of bearing	[r_y]	0.119	mrad (0.41')
Misalignment of bearing	[r_z]	-0.045	mrad (-0.15')
Misalignment of bearing	[r_r]	0.058	mrad (0.2')

Utilization, with reference to the required service life

[H] (10000.000)

B1	B2
0.24	0.53

B1: b1

B2: b2

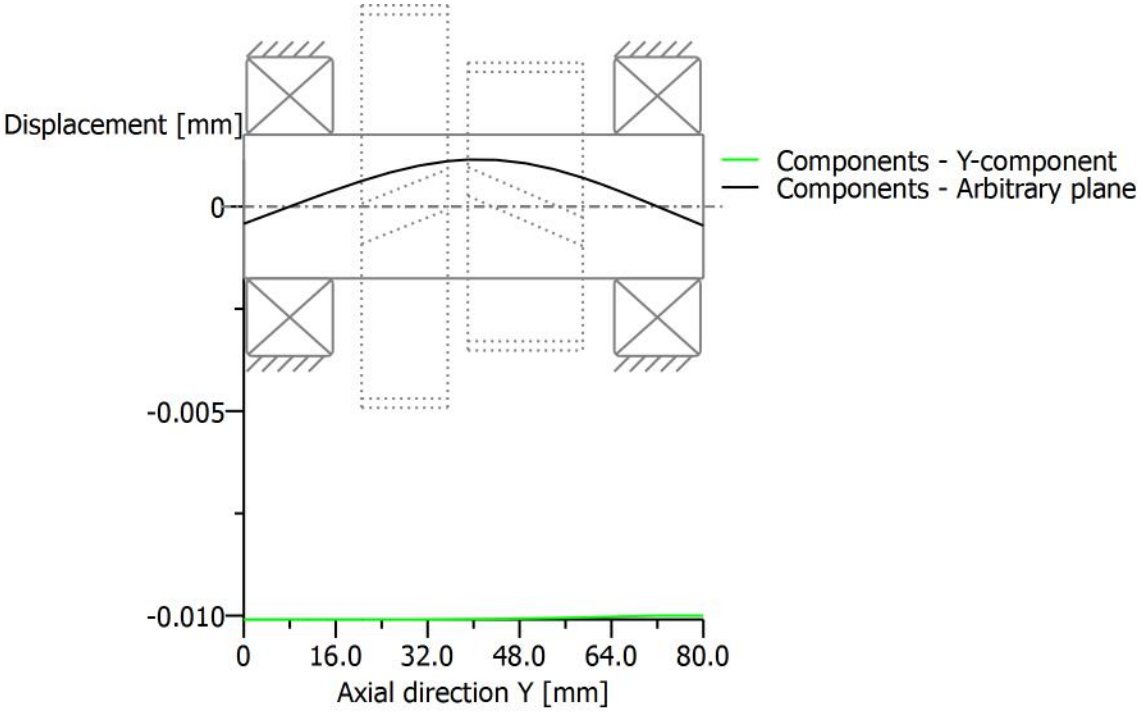
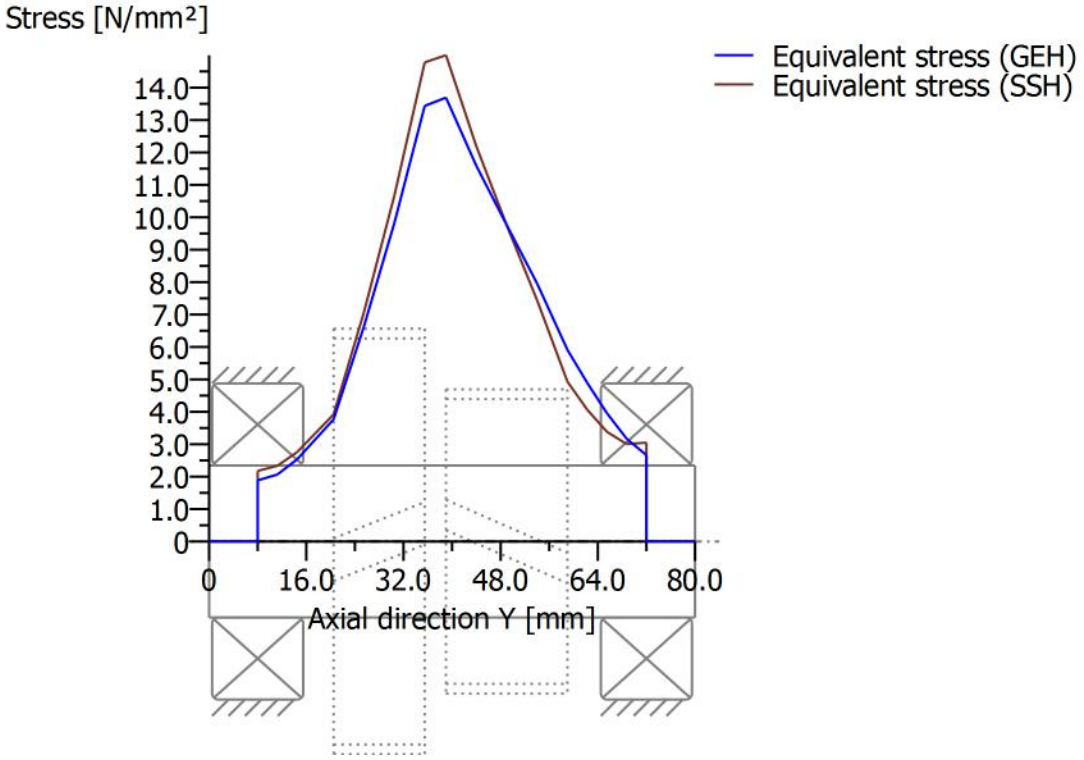


Figure: Deformation (bending etc.) (Arbitrary plane 218.8561812 120)



GEH(von Mises): sigV = ((sigB+sigZ,D)^2 + 3*(tauT+tauS)^2)^1/2SSH(Tresca): sigV = ((sigB-sigZ,D)^2 + 4*(tauT+tauS)^2)^1/2

Figure: Equivalent stress

Eigenfrequencies/Critical speeds

1. Eigenfrequency: 0.00 Hz, Critical speed: 0.00 1/min Rigid body rotation Y 's2'

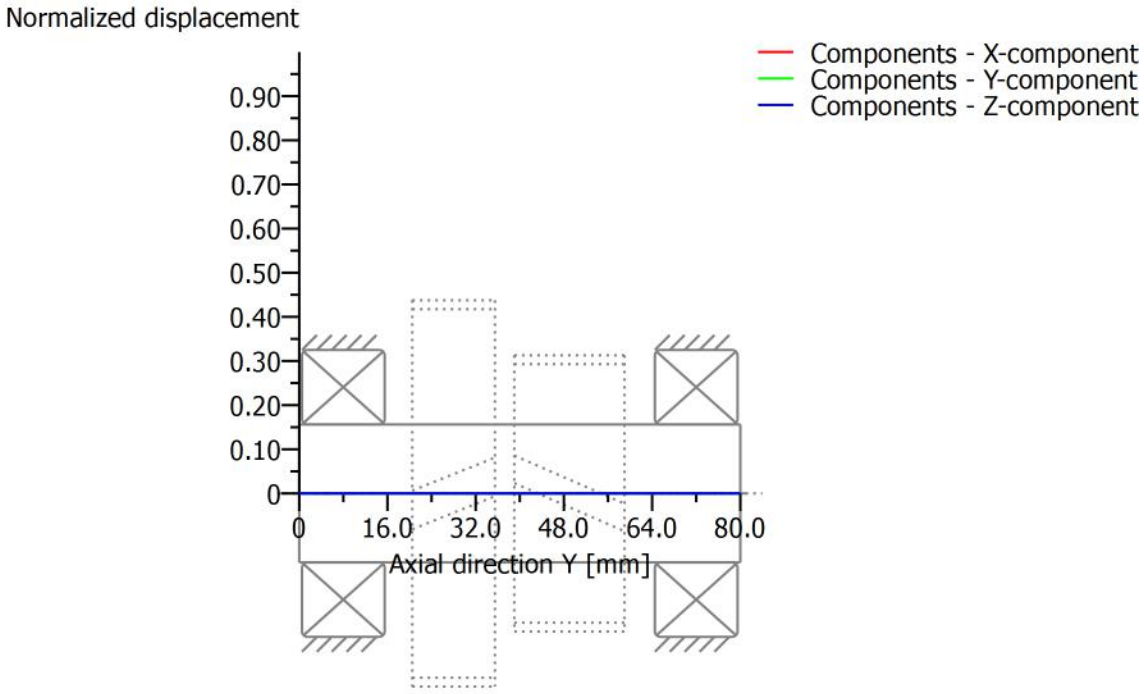


Figure: Eigenfrequencies (Normalized rotation) (Eigenfrequency: 1. (0 Hz))

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KISSsoft Release 03/2015 F

KISSsoft evaluation

File

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ROLLING BEARING ANALYSIS

Calculation method: ISO 281:2007 und Herstellerangaben
- With enhanced bearing service life according to ISO 281:2007

General data:	
Speed (1/min)	584.127
Axial force (N)	249.928
Required service life (h)	20000.000
Operating temperature (°C)	70
Type of oil	Oil: ISO-VG 150
Lubricant base	Mineral-oil base
Kinematic viscosity oil at 40 °C (mm²/s)	150.00
Specific density oil at 15 °C (kg/dm³)	0.892
Oil lubrication with filtering, Lubricant with additive	ISO 4406:1999 -/19/16, beta40=75

Rolling bearing No. 1:

Bearing type	SKF *6004	
Type	Deep groove ball bearing (single row)	
Bearing clearance: normal		
Only radial load		
Radial force (N)	[Fr]	243.926
Axial force (N)	[Fa]	0.000
Inner diameter (mm)	[d]	20.000
External diameter (mm)	[D]	42.000
Width (mm)	[B]	12.000
Basic dynamic load rating (kN)	[C]	9.950
Basic static load rating (kN)	[C0]	5.000

Speed limit (oil) (1/min)	[n.max]	24000
Dynamic equivalent load (N)	[P]	243.926
Static equivalent load (N)	[P0]	243.926
Operating viscosity (mm²/s)	[nu]	34.884
Reference viscosity (mm²/s)	[nu1]	40.863
Fatigue load limit (kN)	[Cu]	0.212
Impurity characteristic quantity	[ec]	0.033
Service life coefficient	[aISO]	0.592
Rolling moment of friction (Nmm)	[Mrr]	2.535
Sliding moment of friction (Nmm)	[Msl]	1.337
Moment of friction, seals (Nmm)	[Mseal]	0.000
Mseal according to SKF Main Catalog 10000/1 EN:2013		
Moment of friction flow losses (Nmm)	[Mdrag]	0.000
Total moment of friction (Nmm)	[M]	3.872
Service life (h)	[Lh]	1000000.000
Static safety factor	[S0]	20.498

Rolling bearing No. 2:

Bearing type	SKF *6007	
Type	Deep groove ball bearing (single row)	
Bearing clearance:	normal	
Radial and axial load		
Radial force (N)	[Fr]	569.506
Axial force (N)	[Fa]	249.928
Inner diameter (mm)	[d]	35.000
External diameter (mm)	[D]	62.000
Width (mm)	[B]	14.000
Basic dynamic load rating (kN)	[C]	16.800
Basic static load rating (kN)	[C0]	10.200
Speed limit (oil) (1/min)	[n.max]	15000
Dynamic equivalent load (N)	[P]	801.898
Static equivalent load (N)	[P0]	569.506
Operating viscosity (mm²/s)	[nu]	34.884
Reference viscosity (mm²/s)	[nu1]	32.669
Fatigue load limit (kN)	[Cu]	0.440
Impurity characteristic quantity	[ec]	0.069
Service life coefficient	[aISO]	0.923
Rolling moment of friction (Nmm)	[Mrr]	23.406
Sliding moment of friction (Nmm)	[Msl]	8.899
Moment of friction, seals (Nmm)	[Mseal]	0.000
Mseal according to SKF Main Catalog 10000/1 EN:2013		

Moment of friction flow losses (Nmm)	[Mdrag]	0.000
Total moment of friction (Nmm)	[M]	32.305
Service life (h)	[Lh]	242250.149
Static safety factor	[S0]	17.910

Notice:
The modified rating life according ISO 281 contains only approximate formulae
for the calculation of the fatigue load boundary and the resulting values for a23 are sometimes very high..
The moment of friction is calculated according to the details in SKF Catalog 2013..
This is always calculated with a coefficient for additives in the lubricant mybl=0.15.

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KISSsoft Release 03/2015 F

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Important hint: At least one warning has occurred during the calculation:

1-> Normally the force is absorbed in the middle of the notch.
a0 would then be the supporting length/2 = 10.50 mm.
Your entry is probably incorrect.

Keys [M02a]

Calculation method: DIN 6892-B:2012

Label		DIN 6885.1:1968 Default
Key width (mm)	[b]	10.00
Key height (mm)	[h]	8.00
Chamfer (mean value) (mm)	[r]	0.50
Shaft diameter (mm)	[d]	35.00
Nominal torque (Nm)	[T]	32.88
Application factor	[KA]	1.00
equivalent torque (Nm)	[Teq]	32.88
Maximum torque (Nm)	[Tmax]	328.83
Minimal frictional torque for interference fit (Nm)	[TRmin]	0.00
Torque curve: No alternating torque		
Number of load peaks	[NL]	100
Number of change of load direction	[NW]	1
Load direction changing coefficient	[fw]	1.00
Number of keys	[i]	1
Load factor	[phi]	1.00
equivalent circumferential stress (N)	[Feq]	1879.04

Maximal circumferential force (N)	[Fmax]	18790.43
Contact coefficient for equivalent surface pressure	[Kneq]	1.00
Contact coefficient for maximal surface pressure	[Knmax]	1.00
Help coefficient	[Kle]	1.050
Load distribution coefficient	[Kl]	1.050
Friction factor	[KReq]	1.000
Friction factor	[KR]	1.000

Shaft

Material	C45 (1)	
Type	Through hardened steel	
Treatment	unalloyed, through hardened	
Tensile strength (N/mm²)	[Rm]	650.00 (d=16-40mm)
Yield point (N/mm²)	[Re]	430.00 (d=16-40mm)

Groove depth shaft (minimal value) (mm)	[t1]	5.00
Chamfer on shaft (mm)	[s1]	0.01
Supporting key length (mm)	[ltr]	21.00
Supporting key height (mm)	[t1tr]	3.76
Pressure stress (N/mm²)	[peq]	25.00
Pressure stress (N/mm²)	[pmax]	250.04
Support factor	[fs]	1.30
Hardness influence coefficient	[fH]	1.00
Permissible surface pressure (N/mm²)	[pzul]	559.00
Load peak frequency coefficient	[fL]	1.50
Load direction changing coefficient	[fw]	1.00
Required safety against flow (fw * pzul / peq)	[SFeq]	22.36
Required safety against flow (fL * pzul / pmax)	[SFmax]	3.35
Minimal safety	[SF]	3.35

Hub

Material	18CrNiMo7-6	
Type	Case-carburized steel	
Treatment	case-hardened	
Tensile strength (N/mm²)	[Rm]	1100.00 (d=16-40mm)
Yield point (N/mm²)	[Re]	745.00 (d=16-40mm)

Groove depth hub (minimal value) (mm)	[t2]	3.30
Chamfer on hub (mm)	[s2]	0.01
Supporting key length (mm)	[ltr]	21.00

Supporting key height (mm)	[t2tr]	3.22
Small outside diameter of hub (mm)	[D1]	95.00
Big outside diameter of hub (mm)	[D2]	95.00
Width of hub-part with D2 (mm)	[c]	21.00
Equivalent diameter hub (mm)	[D]	95.00
Distance a0 (Figure 2, DIN 6892) (mm)	[a0]	0.00
Pressure stress (N/mm²)	[peq]	29.16
Pressure stress (N/mm²)	[pmax]	291.55
Support factor	[fs]	1.50
Hardness influence coefficient	[fH]	1.15
Permissible surface pressure (N/mm²)	[pzul]	1285.13
Load peak frequency coefficient	[fL]	1.50
Load direction changing coefficient	[fw]	1.00
Required safety against flow (fw * pzul / peq)	[SFeq]	44.08
Required safety against flow (fL * pzul / pmax)	[SFmax]	6.61
Minimal safety	[SF]	6.61

Key

Material	C45 (1)	
Type	Through hardened steel	
Treatment	unalloyed, through hardened	
Tensile strength (N/mm²)	[Rm]	700.00 (d= 0-16mm)
Yield point (N/mm²)	[Re]	490.00 (d= 0-16mm)
Pressure stress (N/mm²)	[peq]	25.00 / 29.16
Pressure stress (N/mm²)	[pmax]	250.04 / 291.55
Support factor	[fs]	1.10
Hardness influence coefficient	[fH]	1.00
Permissible surface pressure (N/mm²)	[pzul]	539.00
Load peak frequency coefficient	[fL]	1.50
Load direction changing coefficient	[fw]	1.00
Required safety against flow (fw * pzul / peq)	[SFeq]	18.49
Required safety against flow (fL * pzul / pmax)	[SFmax]	2.77
Minimal safety	[SF]	2.77
Cross section area (mm²)	[b*ltr]	210.00
Shear stress (N/mm²)	[tau]	8.95

Remarks:

Safety = Minimum (fw*pzul/peq, fL*pzul/pmax)
Condition according to DIN 6892 Safety >= 1.0
Chamfer on key: Mean value as in examples in DIN 6892
Groove depth: Minimum value as in examples in DIN 6892

End of Report lines: 127

Name : Unnamed
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Analysis of shafts, axle and beams

Input data

Coordinate system shaft: see picture W-002

Label		s3
Drawing		
Initial position (mm)		0.000
Length (mm)		145.000
Speed (1/min)		584.13
Sense of rotation: clockwise		
Material		C45 (1)
Young's modulus (N/mm²)		206000.000
Poisson's ratio nu		0.300
Density (kg/m³)		7830.000
Coefficient of thermal expansion	(10^-6/K)	11.500
Temperature (°C)		20.000
Weight of shaft (kg)		0.763
Weight of shaft, including additional masses (kg)		0.763
Mass moment of inertia (kg*mm²)		100.278
Momentum of mass GD2 (Nm²)		0.004

Weight towards (0.000, 0.000, -1.000)
Deformations due to shearing are not considered
Contact angle of rolling bearings is not considered
Tolerance field: Mean value
Reference temperature (°C) 20.000

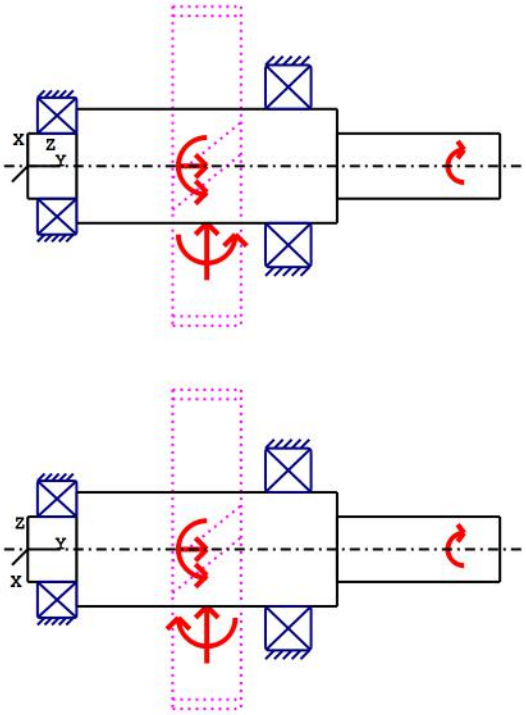


Figure: Load applications

Shaft definition (s3)

Outer contour

Cylinder (Cylinder)		0.000mm ... 15.000mm
Diameter (mm)	[d]	20.0000
Length (mm)	[l]	15.0000
Surface roughness (µm)	[Rz]	8.0000

Relief groove right (Relief groove right)
r=0.50 (mm), t=0.50 (mm), l=2.00 (mm), Rz=8.0, Turned (Ra=3.2µm/125µin)
Own Input, Form B, FKM

Cylinder (Cylinder)		15.000mm ... 95.000mm
Diameter (mm)	[d]	35.0000
Length (mm)	[l]	80.0000
Surface roughness (µm)	[Rz]	8.0000

Cylinder (Cylinder)		95.000mm ... 145.000mm

Diameter (mm)	[d]	20.0000
Length (mm)	[l]	50.0000
Surface roughness (µm)	[Rz]	8.0000

Radius left (Radius left)
r=2.00 (mm), Rz=8.0, Turned (Ra=3.2µm/125µin)

Forces

Type of force element

		Coupling
Label in the model		cOut(Output)
Position on shaft (mm)	[y_{local}]	134.0000
Position in global system (mm)	[y_{global}]	134.0000
Effective diameter (mm)		20.0000
Radial force factor (-)		0.0000
Direction of the radial force (°)		0.0000
Axial force factor (-)		0.0000
Length of load application (mm)		20.0000
Power (kW)		2.0115 driving (Output)
Torque (Nm)		-32.8833
Axial force (N)		0.0000
Shearing force X (N)		0.0000
Shearing force Z (N)		0.0000
Bending moment X (Nm)		0.0000
Bending moment Z (Nm)		0.0000
Mass (kg)		0.0000
Mass moment of inertia Jp (kg*m²)		0.0000
Mass moment of inertia Jxx (kg*m²)		0.0000
Mass moment of inertia Jzz (kg*m²)		0.0000
Eccentricity (mm)		0.0000

Type of force element

		Centric force
Label in the model		f1
Position on shaft (mm)	[y_{local}]	134.0000
Position in global system (mm)	[y_{global}]	134.0000
Length of load application (mm)		0.0000
Power (kW)		0.0000
Torque (Nm)		-0.0000
Axial force (N)		0.0000
Shearing force X (N)		0.0000
Shearing force Z (N)		0.0000
Bending moment X (Nm)		0.0000

Bending moment Z (Nm)		0.0000

Type of force element

		Cylindrical gear
Label in the model		z4(gp2)
Position on shaft (mm)	[y_{local}]	55.0000
Position in global system (mm)	[y_{global}]	55.0000
Operating pitch diameter (mm)		97.9412
Helix angle (°)		20.4152 left
Working pressure angle at normal section (°)		22.8723
Position of contact (°)		135.0000
Length of load application (mm)		21.0000
Power (kW)		2.0115 driven (Input)
Torque (Nm)		32.8833
Axial force (N)		249.9276
Shearing force X (N)		688.5389
Shearing force Z (N)		261.0913
Bending moment X (Nm)		-8.6544
Bending moment Z (Nm)		-8.6544

Bearing

Label in the model		b1
Bearing type		SKF *6004
Bearing type		Deep groove ball bearing (single row)
Bearing position (mm)	[y_{lokal}]	9.000
Bearing position (mm)	[y_{global}]	9.000
Attachment of external ring		Free bearing
Inner diameter (mm)	[d]	20.000
External diameter (mm)	[D]	42.000
Width (mm)	[b]	12.000
Corner radius (mm)	[r]	0.600
Basic static load rating	[C_0]	5.000
Basic dynamic load rating	[C]	9.950
Fatigue load rating	[C_U]	0.212
Values for approximated geometry:		
Basic dynamic load rating (kN)	[C_{theo}]	0.000
Basic static load rating (kN)	[C_{0theo}]	0.000

Label in the model		b2
Bearing type		SKF *6007
Bearing type		Deep groove ball bearing (single row)
Bearing position (mm)	[y_{lokal}]	80.000
Bearing position (mm)	[y_{global}]	80.000
Attachment of external ring		Fixed bearing

Inner diameter (mm)	[d]	35.000
External diameter (mm)	[D]	62.000
Width (mm)	[b]	14.000
Corner radius (mm)	[r]	1.000
Basic static load rating	[C_0]	10.200
Basic dynamic load rating	[C]	16.800
Fatigue load rating	[C_U]	0.440
Values for approximated geometry:		
Basic dynamic load rating (kN)	[C_{theo}]	0.000
Basic static load rating (kN)	[C_{0theo}]	0.000

Results

Shaft

Maximum deflection (mm)	0.001
Position of the maximum (mm)	145.000
Mass center of gravity (mm)	63.185
Total axial load (N)	249.928
Torsion under torque (°)	-0.065

Bearing

Probability of failure	[n]	10.00	%
Axial clearance	[u_A]	10.00	µm

Rolling bearings, classical calculation (contact angle not considered)

Shaft 's3' Rolling bearing 'b1'

Position (Y-coordinate)	[y]	9.00	mm	
Equivalent load	[P]	0.24	kN	
Equivalent load	[P_0]	0.24	kN	
Life modification factor for reliability	[a_1]	1.000		
Service life	[L_{nh}]	> 1000000	h	
Static safety factor	[S_0]	20.50		
Bearing reaction force	[Fx]	-0.121	kN	
Bearing reaction force	[Fy]	0.000	kN	
Bearing reaction force	[Fz]	-0.212	kN	
Bearing reaction force	[Fr]	0.244	kN	(-119.62°)
Oil level	[H]	0.000	mm	

Load-independent moment of friction	[M_0]	0.005	Nm
Load-dependent moment of friction	[M_1]	0.001	Nm
Torque of friction	[M_{loss}]	0.006	Nm
Power loss	[P_{loss}]	0.361	W

The moment of friction is calculated according to the details in SKF Catalog 1994.

Displacement of bearing	[u_x]	0.000	µm
Displacement of bearing	[u_y]	10.032	µm
Displacement of bearing	[u_z]	-0.000	µm
Displacement of bearing	[u_r]	0.000	µm
Misalignment of bearing	[r_x]	0.010	mrad (0.04')
Misalignment of bearing	[r_y]	-0.000	mrad (0')
Misalignment of bearing	[r_z]	-0.008	mrad (-0.03')
Misalignment of bearing	[r_r]	0.013	mrad (0.05')

Shaft 's3' Rolling bearing 'b2'

Position (Y-coordinate)	[y]	80.00	mm
Equivalent load	[P]	0.80	kN
Equivalent load	[P_0]	0.57	kN
Life modification factor for reliability	[a_1]	1.000	
Service life	[L_{nh}]	262368.24	h
Static safety factor	[S_0]	17.91	
Bearing reaction force	[Fx]	-0.568	kN
Bearing reaction force	[Fy]	-0.250	kN
Bearing reaction force	[Fz]	-0.042	kN
Bearing reaction force	[Fr]	0.570	kN (-175.82°)
Oil level	[H]	0.000	mm
Load-independent moment of friction	[M_0]	0.018	Nm
Load-dependent moment of friction	[M_1]	0.006	Nm
Torque of friction	[M_{loss}]	0.024	Nm
Power loss	[P_{loss}]	1.485	W

The moment of friction is calculated according to the details in SKF Catalog 1994.

Displacement of bearing	[u_x]	-0.000	µm
Displacement of bearing	[u_y]	10.000	µm
Displacement of bearing	[u_z]	-0.000	µm
Displacement of bearing	[u_r]	0.000	µm
Misalignment of bearing	[r_x]	-0.007	mrad (-0.02')
Misalignment of bearing	[r_y]	-0.070	mrad (-0.24')
Misalignment of bearing	[r_z]	0.012	mrad (0.04')
Misalignment of bearing	[r_r]	0.014	mrad (0.05')

Utilization, with reference to the required service life

[H] (10000.000)

B1 B2

0.22 0.34

B1: b1
B2: b2

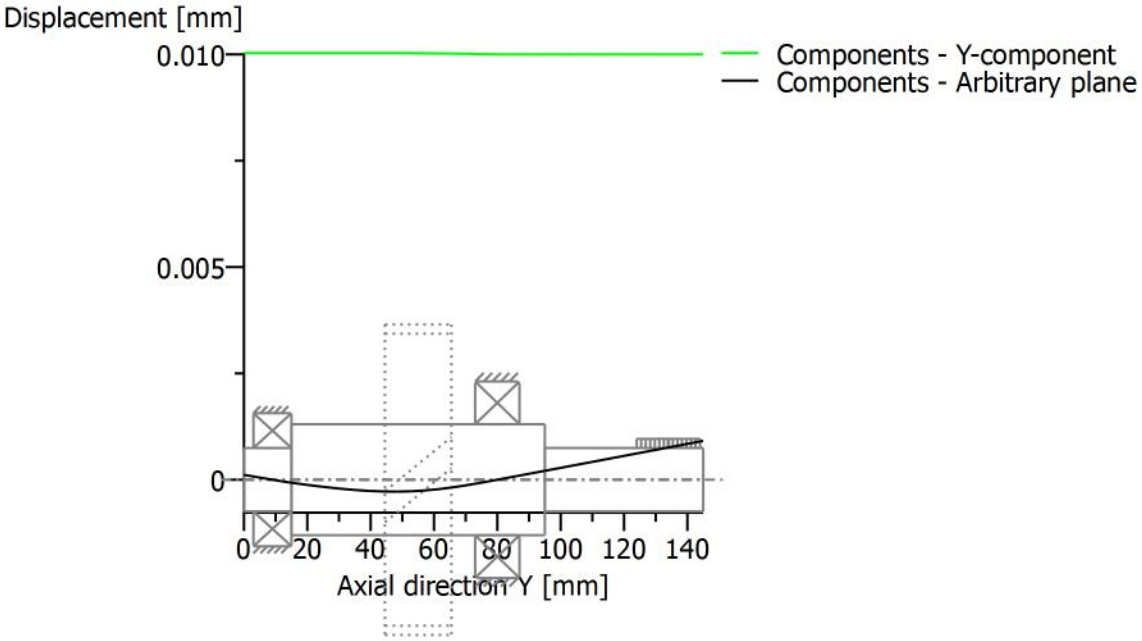
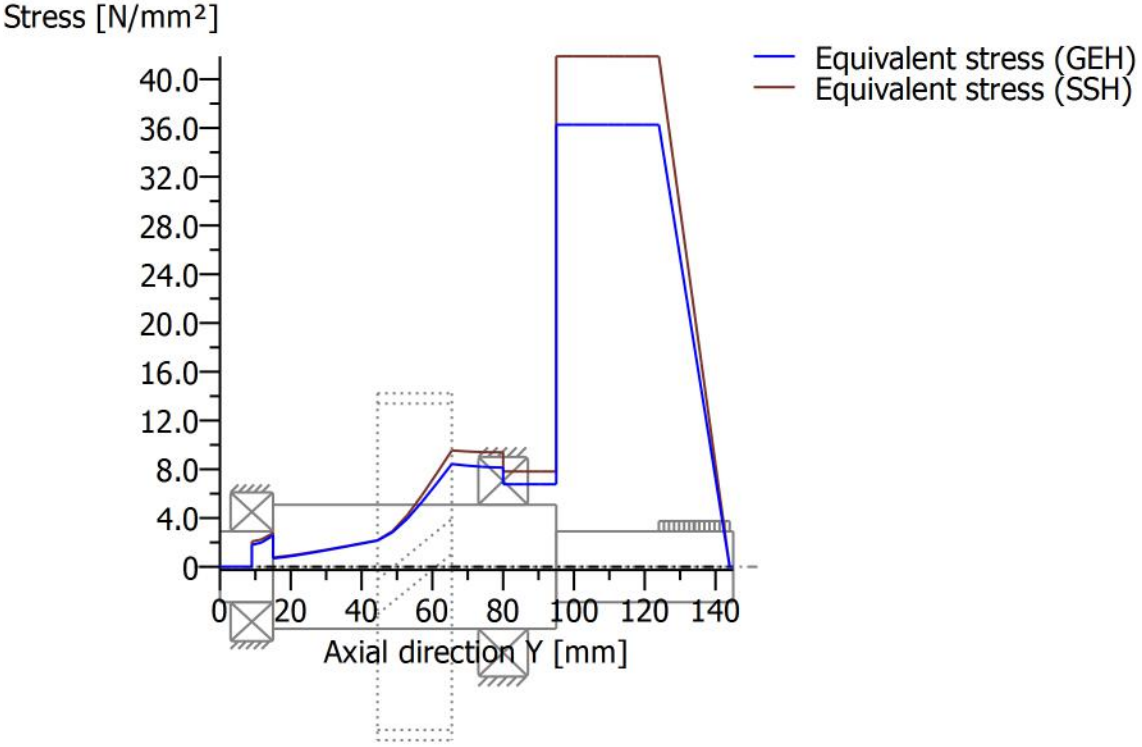


Figure: Deformation (bending etc.) (Arbitrary plane 212.0428163 120)



GEH(von Mises): sigV = ((sigB+sigZ,D)^2 + 3*(tauT+tauS)^2)^1/2SSH(Tresca): sigV = ((sigB-sigZ,D)^2 + 4*(tauT+tauS)^2)^1/2

Figure: Equivalent stress

Eigenfrequencies/Critical speeds

1. Eigenfrequency: 0.00 Hz, Critical speed: 0.00 1/min Rigid body rotation Y 's3'

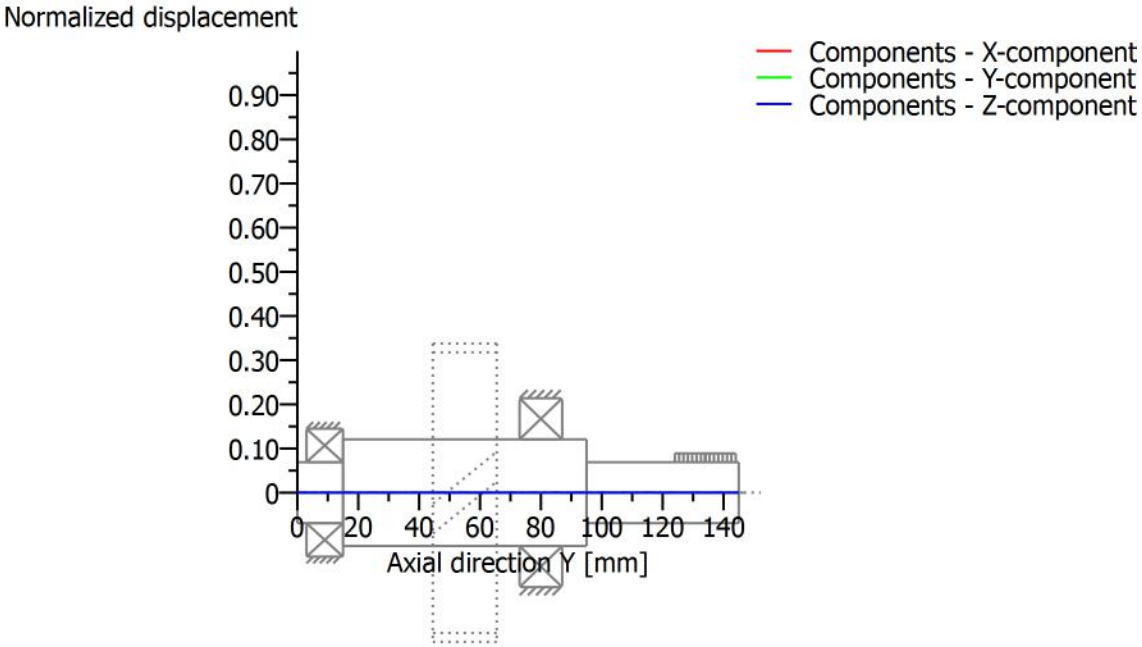


Figure: Eigenfrequencies (Normalized rotation) (Eigenfrequency: 1. (0 Hz))

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_O.GB.s3.Spline

KISSsoft Release 03/2015 F

KISSsoft evaluation

File

Name : Unnamed
Changed by: kspl on: 07.03.2016 at: 10:58:23

Important hint: At least one warning has occurred during the calculation:

1-> The tooth tip of Hub will probably collide with the root area of Shaft. Please check this in the 2D graphic.

SPLINED JOINTS DIN 5480:2006

Shaft DIN5480 - W 20.00*0.80*24*6h
Hub DIN5480 - N 20.00*0.80*24*7H

Drawing or article number:
Shaft: 0.000.0
Hub: 0.000.0

1. TOOTH GEOMETRY AND MATERIAL

Normal module (mm)	[mn]	0.8000	
Nominal diameter DIN (mm)	[dB]	20.00	
Pressure angle at normal section (°)	[alfn]	30.000	
		------- SHAFT ---------	HUB --------
Number of teeth	[z]	24	-24
Helix angle at reference circle (°)	[beta]	0.0000	
Facewidth (mm)	[b]	20.00	20.00
Hand of gear	Spur gear		

Material
Gear 1: C45 (1), Through hardened steel, unalloyed, through hardened
ISO 6336-5 Figure 5/6 (MQ)
Gear 2: C45 (1), Through hardened steel, unalloyed, through hardened
ISO 6336-5 Figure 5/6 (MQ)

		SHAFT	HUB
Surface hardness		HBW 186	HBW 186

Gear reference profile	1 :		
Reference profile	DIN 5480:2006 0.55 / 0.16 / 0.45 Broaching		
Dedendum coefficient	[hfP*]		0.550
Root radius factor	[rhofP*]		0.160 (rhofPmax*= 0.810)
Addendum coefficient	[haP*]		0.450
Tip radius factor	[rhoaP*]		0.000
Protuberance height factor	[hprP*]		0.000
Protuberance angle	[alfprP]		0.000
Tip form height coefficient	[hFaP*]		0.000
Ramp angle	[alfKP]		0.000
		not topping	

Gear reference profile	2 :		
Reference profile	DIN 5480:2006 0.55 / 0.16 / 0.45 Broaching		
Dedendum coefficient	[hfP*]		0.550
Root radius factor	[rhofP*]		0.160 (rhofPmax*= 0.810)
Addendum coefficient	[haP*]		0.450
Tip radius factor	[rhoaP*]		0.000
Protuberance height factor	[hprP*]		0.000
Protuberance angle	[alfprP]		0.000
Tip form height coefficient	[hFaP*]		0.000
Ramp angle	[alfKP]		0.000
		not topping	

Summary of reference profile gears:

Dedendum reference profile	[hfP*]	0.550	0.550
Tooth root radius Refer. profile	[rofP*]	0.160	0.160
Addendum Reference profile	[haP*]	0.450	0.450
Protuberance height factor	[hprP*]	0.000	0.000
Protuberance angle (°)	[alfprP]	0.000	0.000
Tip form height coefficient	[hFaP*]	0.000	0.000
Ramp angle (°)	[alfKP]	0.000	0.000

Transverse module (mm)	[mt]	0.800
Pressure angle at pitch circle (°)	[alft]	30.000
Base helix angle (°)	[betab]	0.000
Sum of profile shift coefficients	[Summexi]	0.0000

SHAFT	HUB

Profile shift coefficient	[x]	-0.0500	0.0500
Profile shift (x*m) (mm)	[x*m]	-0.0400	0.0400
Reference diameter (mm)	[d]	19.200	-19.200
Base diameter (mm)	[db]	16.628	-16.628
Tip diameter (mm)	[da]	19.840	-18.400
Effective tip diameter (mm)	[da.e/i]	19.840 / 19.710	-18.400 / -18.530
Tip diameter allowances (mm)	[Ada.e/i]	0.000 / -0.130	0.000 / -0.130
Root diameter (mm)	[df]	18.240	-20.000
Effective root diameter (mm)	[df.e/i]	18.226 / 18.205	-20.017 / -20.048
Root diameter allowances (mm)	[Adf.e/i]	-0.014 / -0.035	-0.017 / -0.048

Root diameter allowances Adf.e/i and df.e/i only as indication.
In accordance to DIN5 480 other allowances are valid according to the manufacturing process..

Generating Profile shift coefficient	[xE.e/i]	-0.0587 / -0.0717	0.0392 / 0.0197
Root form diameter (mm)	[dFf.e/i]	18.413 / 18.395	-19.773 / -19.827

(dFf2 calculated with virtual pinion type cutter (circa): z= 15 x= 0.200 rhoaP0*=0.1)

Tooth height (mm)	[H]	0.800	0.800
Theoretical tip clearance (mm)	[c]	0.080	0.080
Effective tip clearance (mm)	[c.e/i]	0.169 / 0.089	0.162 / 0.087
Normal-tooth thickness at tip circle (mm)	[san]	0.851	0.836
(mm)	[san.e/i]	0.921 / 0.830	0.895 / 0.809
Normal space width at root circle (mm)	[efn]	0.755	0.752
(mm)	[efn.e/i]	0.756 / 0.757	0.751 / 0.750
Pitch on reference circle (mm)	[pt]	2.513	
Base pitch (mm)	[pbt]	2.177	
Transverse pitch on contact-path (mm)	[pet]	2.177	

2. MEASUREMENTS FOR TOOTH THICKNESS

		------- SHAFT	--------- HUB --------
Accuracy grade		6	7
Tooth thickness deviation		DIN 5480 h	DIN 5480 H
Number of teeth spanned	[k]	4.0000	-4.0000
Base tangent length (no backlash) (mm)	[Wk]	8.4717	-8.4717
Diameter of contact point (mm)	[dMWk.m]	18.6599	-18.6634
Theoretical diameter of ball/pin (mm)	[dm]	1.4971	1.3890
Eff. Diameter of ball/pin (mm)	[DMeff]	1.5000	1.4000
Theor. dimension over two balls (mm)	[MRe/Mri-ball]	21.4070	-17.0486
Diametral measurement over rolls without clearance (mm)	[MRe/Mri-pin]	21.4070	-17.0486

Data for Actual Dimensions (DIN 5480:2005)

Tooth thickness / Spacewidth (mm)	[Smax/Smin, Emax/Emin]	1.2024 / 1.1904	1.2384 / 1.2204
Tooth thickness tolerance, normal section (mm)	[Tol.Smax/min]	-0.0080 / -0.0200	

Tooth space tolerance, normal section (mm)	[Tol.Emax/min]			0.0280 / 0 .0100
Base tangent length (mm)	[Wk.Smax/Smin]	8.4648 /	8.4544	-8.4960 / -8 .4804
Diametral two ball measure (mm)	[MRe/Mri-ball]	21.3944 /	21.3754	17.1042 / 17 .0685
Diametral measurement over rolls (mm)	[MRe/Mri-pin]	21.3944 /	21.3754	17.1042 / 17 .0685

Data for Effective Dimensions (DIN 5480:2005)

Tooth thickness / Spacewidth (mm)	[Svmax/min, Evmax/min]	1.2104 /	1.2024	1.2204 / 1 .2104
Tooth thickness tolerance, normal section (mm)	[Tol.Svmax/min]	0.0000 /	-0.0080	
Tooth space tolerance, normal section (mm)	[Tol.Evmax/min]			0.0100 / 0 .0000
Base tangent length (mm)	[Wk.Svmax/min](	8.4717 /	8.4648)	(-8.4804 / -8 .4717)
Diametral two ball measure (mm)	[MRe/Mri-ball](	21.4070 /	21.3944)	(-17.0685 / -17 .0486)
Diametral measurement over rolls (mm)	[MRe/Mri-pin] (	21.4070 /	21.3944)	(-17.0685 / -17 .0486)

Circumferential backlash (transverse section):

-Theoretical (without form errors) (mm)	[jt.th]	0.0480 /	0.0180
-Effective (with form errors) (mm)	[jt.eff]	0.0180 /	0.0000
Normal backlash theoretical (mm)	[jn.th]	0.0416 /	0.0156
Normal backlash (mm)	[jn.eff]	0.0156 /	0.0000

Notice: When controlling splines with individual measurements (base tangent length/pin diameter) respect the values in 'Actual dimensions'.

3. GEAR ACCURACY

		------- SHAFT ---------	HUB --------
According to DIN 5480:2005:			
Accuracy grade	[Q-DIN5480]	6	7
Total profile deviation (µm)	[Fa]	7.0	10.0
Total helix deviation (µm)	[Fb]	6.0	7.0
Single pitch deviation (µm)	[fp]	5.5	8.0
Total cumulative pitch deviation (µm)	[Fp]	12.0	18.0
Runout (µm)	[Fr]	30.0	30.0

5. ADDITIONAL DATA

Moment of inertia (System referenced to wheel 1):

calculation without consideration of the exact tooth shape				
single gears	((da+df)/2...di) (kg*m²)	[TraeghMom]	2.002e-006	3.705e-006
System	((da+df)/2...di) (kg*m²)	[TraeghMom]	5.707e-006	

6. TOOTH FORM DEFINITION

Data for the tooth form calculation :
Data not available.

End of Report lines: 172