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KISSsoft evaluation

File

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CALCULATION OF A HELICAL GEAR PAIR

Drawing or article number:
Gear 1: z1(GearPair_const2)
Gear 2: z4(GearPair_const2)

Load spectrum

Example with file (with factors)
Number of bins in the load spectrum: 10
Reference gear: 1

Bin No.	Frequency [%]	Power [kW]	Speed [1/min]	Torque [Nm]	Coefficients KV	KHβ	KHα	Kγ	YM1	YM2
1	10.00000	756.2500	11818.3	611.0578	1.2950	1.1115	1.1035	1.0000	1.0000	1.0000
2	10.00000	680.6250	11818.3	549.9520	1.3328	1.1203	1.1179	1.0000	1.0000	1.0000
3	10.00000	665.5000	13000.1	488.8462	1.3800	1.1307	1.1346	1.0000	1.0000	1.0000
4	10.00000	582.3125	13000.1	427.7405	1.4406	1.1431	1.1540	1.0000	1.0000	1.0000
5	10.00000	544.5000	14181.9	366.6347	1.5215	1.1581	1.1770	1.0000	1.0000	1.0000
6	10.00000	453.7500	14181.9	305.5289	1.6348	1.1766	1.2045	1.0000	1.0000	1.0000
7	10.00000	423.5000	16545.6	244.4231	1.8046	1.2067	1.2362	1.0000	1.0000	1.0000
8	10.00000	317.6250	16545.6	183.3173	1.8962	1.2363	1.2460	1.0000	1.0000	1.0000
9	10.00000	211.7500	16545.6	122.2116	1.8962	1.2590	1.2397	1.0000	1.0000	1.0000
10	10.00000	105.8750	16545.6	61.1058	1.8962	1.2818	1.2337	1.0000	1.0000	1.0000

Numbers of load cycles

Bin	Frequency	Load cycles	
1	10.00000	1276374857	674655282
2	10.00000	1276374857	674655282
3	10.00000	1404012343	742120810
4	10.00000	1404012343	742120810
5	10.00000	1531649829	809586338
6	10.00000	1531649829	809586338
7	10.00000	1786924800	944517394
8	10.00000	1786924800	944517394
9	10.00000	1786924800	944517394
10	10.00000	1786924800	944517394

S-N curve (Woehler line) in the endurance domain according: according to standard

Notice:
Calculation-method according to:
- ISO 6336-6 / DIN3990-6
During the calculation all the load factors (ISO6336/DIN3990: KV, KHb, KFb; AGMA2001: Knu, Km, ..) for each load spectrum bin are calculated separately.

Results

Calculation for load spectra:
The application factor should be set to 1.0!

Safeties, calculated with load spectrum:

Root safety	4.212	3.711
Flank safety	1.459	1.472

Safeties against scuffing/micropitting/EHT/TFF are indicated for the most critical element of the load spectrum:

Scuffing safety (integral temperature)	3.949
Scuffing safety (flash temperature)	3.800

Analysis of critical elements in load spectrum: See section 10

ONLY AS INFORMATION: CALCULATION WITH REFERENCE POWER

Calculation method DIN 3990:1987 Method B

		------- GEAR 1	-------- GEAR 2 --
Power (kW)	[P]	756.250	
Speed (1/min)	[n]	11818.3	6246.8
Torque (Nm)	[T]	611.1	1156.1
Application factor	[KA]	1.25	
Required service life (h)	[H]	18000.00	
Gear driving (+) / driven (-)		+	-

Working flank gear 1: Left flank
Sense of rotation gear 1 clockwise

1. TOOTH GEOMETRY AND MATERIAL

(geometry calculation according to ISO 21771:2007, DIN ISO 21771)

			------- GEAR 1	-------- GEAR 2 --
Center distance (mm)	[a]		250.000	
Center distance tolerance	ISO 286:2010 Measure js7			
Normal module (mm)	[mn]		4.5000	
Pressure angle at normal section (°)	[alfn]		20.0000	
Helix angle at reference circle (°)	[beta]		15.0000	
Number of teeth	[z]		37	70
Facewidth (mm)	[b]		36.00	32.00
Hand of gear			right	left
Accuracy grade	[Q-DIN 3961:1978]		6	6
Inner diameter (mm)	[di]		0.00	32.00
Inner diameter of gear rim (mm)	[dbi]		0.00	0.00

Material

Gear 1:	34 CrAlNi 7-10, Nitriding steel, gas-nitrided
	ISO 6336-5 Figure 13a/14a (MQ)
Gear 2:	31 CrMoV9, Nitriding steel, gas-nitrided
	ISO 6336-5 Figure 13a/14a (MQ)

	------- GEAR 1	-------- GEAR 2 --

Surface hardness		HV 950	HV 800
Fatigue strength. tooth root stress (N/mm²)	[σFlim]	425.00	425.00
Fatigue strength for Hertzian pressure (N/mm²)	[σHlim]	1250.00	1250.00
Tensile strength (N/mm²)	[σB]	900.00	1100.00
Yield point (N/mm²)	[σS]	680.00	900.00
Young's modulus (N/mm²)	[E]	206000	206000
Poisson's ratio	[v]	0.300	0.300
Roughness average value DS, flank (µm)	[RAH]	3.00	3.00
Roughness average value DS, root (µm)	[RAF]	3.00	3.00
Mean roughness height, Rz, flank (µm)	[RZH]	20.00	20.00
Mean roughness height, Rz, root (µm)	[RZF]	20.00	20.00

Gear reference profile	1 :		
Reference profile	1.25 / 0.38 / 1.0 ISO 53:1998 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 coefficient	[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 53:1998 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 coefficient	[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 coefficient	[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]	3.2	3.2

Lubrication type		Oil injection lubrication
Type of oil (Own input)		Mobil Jet Oil II
Lubricant base		Synthetic oil based on polyether
Kinem. viscosity oil at 40 °C (mm²/s)	[nu40]	25.30
Kinem. viscosity oil at 100 °C (mm²/s)	[nu100]	5.00
Specific density at 15 °C (kg/dm³)	[roOil]	1.004
Oil temperature (°C)	[TS]	70.000

		------- GEAR 1 --------	GEAR 2 --
Overall transmission ratio	[itot]	-1.892	
Gear ratio	[u]	1.892	
Transverse module (mm)	[mt]	4.659	
Pressure angle at pitch circle (°)	[alft]	20.647	
Working transverse pressure angle (°)	[alfwt]	21.103	
	[alfwt.e/i]	21.116 / 21.089	
Working pressure angle at normal section (°)	[alfwn]	20.440	
Helix angle at operating pitch circle (°)	[betaw]	15.044	
Base helix angle (°)	[betab]	14.076	
Reference center distance (mm)	[ad]	249.243	
Sum of profile shift coefficients	[Summexi]	0.1701	
Profile shift coefficient	[x]	0.0810	0.0890
Tooth thickness (Arc) (module) (module)	[sn*]	1.6298	1.6356
Tip alteration (mm)	[k*mn]	-0.008	-0.008
Reference diameter (mm)	[d]	172.373	326.112
Base diameter (mm)	[db]	161.302	305.166
Tip diameter (mm)	[da]	182.087	335.897
(mm)	[da.e/i]	182.087 / 182.041	335.897 / 335.840
Tip diameter allowances (mm)	[Ada.e/i]	0.000 / -0.046	0.000 / -0.057
Tip form diameter (mm)	[dFa]	182.087	335.897
(mm)	[dFa.e/i]	182.087 / 182.041	335.897 / 335.840
Active tip diameter (mm)	[dNa]	182.087	335.897
Active tip diameter (mm)	[dNa.e/i]	182.087 / 182.041	335.897 / 335.840
Operating pitch diameter (mm)	[dw]	172.897	327.103
(mm)	[dw.e/i]	172.913 / 172.881	327.133 / 327.073
Root diameter (mm)	[df]	161.853	315.663
Generating Profile shift coefficient	[xE.e/i]	0.0520/ 0.0368	0.0494/ 0.0310
Manufactured root diameter with xE (mm)	[df.e/i]	161.592 / 161.454	315.306 / 315.141
Theoretical tip clearance (mm)	[c]	1.125	1.125
Effective tip clearance (mm)	[c.e/i]	1.432 / 1.281	1.376 / 1.232
Active root diameter (mm)	[dNf]	166.107	319.772
(mm)	[dNf.e/i]	166.170 / 166.076	319.840 / 319.734
Root form diameter (mm)	[dFf]	165.564	318.657
(mm)	[dFf.e/i]	165.399 / 165.313	318.367 / 318.234
Reserve (dNf-dFf)/2 (mm)	[cF.e/i]	0.428 / 0.339	0.803 / 0.683
Addendum (mm)	[ha=mn*(haP*+x+k)]	4.857	4.893
(mm)	[ha.e/i]	4.857 / 4.834	4.893 / 4.864
Dedendum (mm)	[hf=mn*(hfP*-x)]	5.260	5.224
(mm)	[hf.e/i]	5.391 / 5.460	5.403 / 5.485
Roll angle at dFa (°)	[xsi_dFa.e/i]	30.009 / 29.973	26.353 / 26.327
Roll angle to dNa (°)	[xsi_dNa.e/i]	30.009 / 29.973	26.353 / 26.327
Roll angle to dNf (°)	[xsi_dNf.e/i]	14.182 / 14.043	17.980 / 17.914
Roll angle at dFf (°)	[xsi_dFf.e/i]	12.995 / 12.857	17.034 / 16.946
Tooth height (mm)	[h]	10.117	10.117
Virtual gear no. of teeth	[zn]	40.713	77.025
Normal tooth thickness at tip circle (mm)	[san]	3.367	3.551
(mm)	[san.e/i]	3.290 / 3.215	3.442 / 3.356
Normal tooth thickness on tip form circle (mm)	[sFan]	3.367	3.551
(mm)	[sFan.e/i]	3.290 / 3.215	3.442 / 3.356
Normal space width at root circle (mm)	[efn]	3.860	3.356
(mm)	[efn.e/i]	3.926 / 3.963	3.388 / 3.403
Max. sliding velocity at tip (m/s)	[vga]	21.029	21.366
Specific sliding at the tip	[zetaa]	0.402	0.465
Specific sliding at the root	[zetaf]	-0.871	-0.673
Mean specific sliding	[zetam]	0.434	

Sliding factor on tip	[Kga]		0.197			0.200		
Sliding factor on root	[Kgf]		-0.200			-0.197		
Pitch on reference circle (mm)	[pt]			14.636				
Base pitch (mm)	[pbt]			13.696				
Transverse pitch on contact-path (mm)	[pet]			13.696				
Lead height (mm)	[pz]		2021.007			3823.527		
Axial pitch (mm)	[px]			54.622				
Length of path of contact (mm)	[ga, e/i]		22.410 (	22.474 /	22.229)			
Length T1-A, T2-A (mm)	[T1A, T2A]	19.831(	19.767/	19.963)	70.179(	70.179/	70.111)	
Length T1-B (mm)	[T1B, T2B]	28.545(	28.545/	28.495)	61.465(	61.401/	61.578)	
Length T1-C (mm)	[T1C, T2C]	31.125(	31.103/	31.147)	58.885(	58.843/	58.927)	
Length T1-D (mm)	[T1D, T2D]	33.526(	33.463/	33.659)	56.484(	56.484/	56.415)	
Length T1-E (mm)	[T1E, T2E]	42.241(	42.241/	42.191)	47.769(	47.705/	47.883)	
Length T1-T2 (mm)	[T1T2]		90.010 (	89.946 /	90.074)			
Diameter of single contact point B (mm)	[d-B]	171.107(	171.107/	171.074)	328.996(	328.948/	329.081)	
Diameter of single contact point D (mm)	[d-D]	174.684(	174.635/	174.786)	325.404(	325.404/	325.357)	
Addendum contact ratio	[eps]	0.812(	0.813/	0.806)	0.825(	0.828/	0.817)	
Minimal length of contact line (mm)	[Lmin]			45.499				

Transverse contact ratio	[eps_a]		1.636	
Transverse contact ratio with allowances	[eps_a.e/m/i]	1.641 /	1.632 /	1.623
Overlap ratio	[eps_b]		0.586	
Total contact ratio	[eps_g]		2.222	
Total contact ratio with allowances	[eps_g.e/m/i]	2.227 /	2.218 /	2.209

2. FACTORS OF GENERAL INFLUENCE

		------- GEAR 1	-------- GEAR 2 --
Nominal circum. force at pitch circle (N)	[Ft]	7089.9	
Axial force (N)	[Fa]	1899.7	
Radial force (N)	[Fr]	2671.6	
Normal force (N)	[Fnorm]	7811.1	
Nominal circumferential force per mm (N/mm)	[w]	221.56	
Only as information: Forces at operating pitch circle:			
Nominal circumferential force (N)	[Ftw]	7068.5	
Axial force (N)	[Faw]	1899.7	
Radial force (N)	[Frw]	2727.9	
Circumferential speed reference circle (m/s)	[v]	106.67	
Circumferential speed operating pitch circle (m/s)	[v(dw)]	106.99	
Running-in value (µm)	[yp]	0.8	
Running-in value (µm)	[yf]	0.8	
Correction factor	[CM]	0.800	
Gear blank factor	[CR]	1.000	
Basic rack factor	[CBS]	0.975	
Material coefficient	[E/Est]	1.000	
Singular tooth stiffness (N/mm/µm)	[c']	14.149	
Meshing stiffness (N/mm/µm)	[cg]	20.901	
Reduced mass (kg/mm)	[mRed]	0.08088	
Resonance speed (min-1)	[nE1]	4149	
Resonance ratio (-)	[N]	2.849	
Overcritical range			
Running-in value (µm)	[ya]	0.8	
Bearing distance l of pinion shaft (mm)	[l]	72.000	
Distance s of pinion shaft (mm)	[s]	7.200	
Outside diameter of pinion shaft (mm)	[dsh]	36.000	

Load according to Figure 6.8, (0:6.8a, 1:6.8b, 2:6.8c, 3:6.8d, 4:6.8e)	DIN 3990-1:1987	[-]	4
Coefficient K' according to Figure 6.8,	DIN 3990-1:1987	[K']	-1.00

Without support effect

Tooth trace deviation (active) (µm)	[Fby]	3.83
from deformation of shaft (µm)	[fsh*B1]	2.49

(fsh (µm) = 2.49, B1= 1.00, fHb5 (µm) = 6.50)
Tooth without tooth trace modification
Position of Contact pattern: favorable

from production tolerances (µm)	[fma*B2]	9.00

(B2= 1.00)

Tooth trace deviation, theoretical (µm)	[Fbx]	4.50
Running-in value (µm)	[yb]	0.67
Dynamic factor	[KV]	1.295
Face load factor - flank	[KHb]	1.111
- Tooth root	[KFb]	1.077
- Scuffing	[KBb]	1.111
Transverse load factor - flank	[KHa]	1.103
- Tooth root	[KFa]	1.103
- Scuffing	[KBa]	1.103
Helical load factor scuffing	[Kbg]	1.157

Number of load cycles (in mio.)	[NL]	12763.749	6746.553

3. TOOTH ROOT STRENGTH

Calculation of Tooth form coefficients according method: B

		------- GEAR 1	-------- GEAR 2 --
Calculated with profile shift	[x]	0.0810	0.0890
Tooth form factor	[YF]	1.18	1.15
Stress correction factor	[YS]	2.13	2.24
Load application angle (°)	[alfFen]	19.31	19.94
Bending moment arm (mm)	[hF]	4.12	4.34
Tooth thickness at root (mm)	[sFn]	9.72	10.12
Tooth root radius (mm)	[roF]	2.27	2.09

(hF* = 0.915/ 0.966 sFn* = 2.161/ 2.248 roF* = 0.505/ 0.465)
(den (mm) =
184.894/ 348.890 dsFn(mm) = 163.644/ 317.443 alfsFn(°) = 30.00/ 30.00 qs = 2.138/ 2.416)

Contact ratio factor	[Yeps]	1.000	
Helix angle factor	[Ybet]	0.927	
Effective facewidth (mm)	[beff]	36.00	32.00
Nominal stress at tooth root (N/mm²)	[sigF0]	102.20	117.47
Tooth root stress (N/mm²)	[sigF]	196.60	225.96

Permissible bending stress at root of Test-gear

Notch sensitivity factor	[YdrelT]	0.984	0.996
Surface factor	[YRrelT]	0.990	0.990
size factor (Tooth root)	[YX]	1.000	1.000
Finite life factor	[YNT]	1.000	1.000
	[YdrelT*YRrelT*YX*YNT]	0.974	0.986

Alternating bending factor (mean stress influence coefficient)	[YM]	1.000	1.000
Stress correction factor	[Yst]	2.00	
Yst*sigFlim (N/mm²)	[sigFE]	850.00	850.00
Permissible tooth root stress (N/mm²)	[sigFP=sigFG/SFmin]	591.43	598.89
Limit strength tooth root (N/mm²)	[sigFG]	828.00	838.44
Required safety	[SFmin]	1.40	1.40

4. SAFETY AGAINST PITTING (TOOTH FLANK)

		------- GEAR 1	-------- GEAR 2 --
Zone factor	[ZH]	2.396	
Elasticity factor (√N/mm²)	[ZE]	189.812	
Contact ratio factor	[Zeps]	0.827	
Helix angle factor	[Zbet]	0.983	
Effective facewidth (mm)	[beff]	32.00	
Nominal contact stress (N/mm²)	[sigH0]	518.28	
Contact stress at operating pitch circle (N/mm²)	[sigHw]	730.27	
Single tooth contact factor	[ZB,ZD]	1.01	1.00
Contact stress (N/mm²)	[sigHB, sigHD]	736.94	730.27
Lubrication coefficient at NL	[ZL]	0.919	0.919
Speed coefficient at NL	[ZV]	1.063	1.063
Roughness coefficient at NL	[ZR]	0.880	0.880
Material pairing coefficient at NL	[ZW]	1.000	1.000
Finite life factor	[ZNT]	1.000	1.000
	[ZL*ZV*ZR*ZNT]	0.860	0.860
Limited pitting is permitted:	No		
Size factor (flank)	[ZX]	1.000	1.000
Permissible contact stress (N/mm²)	[sigHP=sigHG/SHmin]	1075.06	1075.06
Pitting stress limit (N/mm²)	[sigHG]	1075.06	1075.06
Required safety	[SHmin]	1.00	1.00

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

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

5. SCUFFING LOAD CAPACITY

Calculation method according to DIN 3990:1987

Lubrication coefficient (for lubrication type)	[XS]	1.200	
Scuffing test and load stage	[FZGtest]	FZG - Test A / 8.3 / 90 (ISO 14635 - 1)	12
Relative structure coefficient (Scuffing)	[XWrelT]	1.500	
Thermal contact factor (N/mm/s^.5/K)	[BM]	13.780	13.780
Relevant tip relief (µm)	[Ca]	3.20	3.20
Optimal tip relief (µm)	[Ceff]	13.25	
Ca taken as optimal in the calculation (0=no, 1=yes)		0	0
Effective facewidth (mm)	[beff]	32.000	
Applicable circumferential force/facewidth (N/mm)	[wBt]	508.988	
Angle factor	[Xalfbet]	0.987	

(ε1:0.812, ε2:0.825)

Flash temperature-criteria		
Tooth mass temperature (°C)	[theMB]	129.39
(theMB = theoil + XS*0.47*theflamax)		
Maximum flash temperature (°C)	[theflamax]	105.30
Scuffing temperature (°C)	[theS]	695.80
Coordinate gamma (point of highest temp.)	[Gamma]	-0.363
[Gamma.A]=-0.363 [Gamma.E]=0.357		
Highest contact temp. (°C)	[theB]	234.69
Flash factor (°K*N^-.75*s^.5*m^-.5*mm)	[XM]	50.058
Geometry factor	[XB]	0.233
Load sharing factor	[XGam]	0.333
Dynamic viscosity (mPa*s)	[etaM]	2.97 (70.0 °C)
Coefficient of friction	[mym]	0.099
Integral temperature-criteria		
Tooth mass temperature (°C)	[theMC]	108.11
(theMC = theoil + XS*0.70*theflaint)		
Mean flash temperature (°C)	[theflaint]	45.37
Integral scuffing temperature (°C)	[theSint]	695.80
Flash factor (°K*N^-.75*s^.5*m^-.5*mm)	[XM]	50.058
Contact ratio factor	[Xeps]	0.262
Dynamic viscosity (mPa*s)	[etaOil]	9.44 (70.0 °C)
Mean coefficient of friction	[mym]	0.068
Geometry factor	[XBE]	0.191
Meshing factor	[XQ]	1.000
Tip relief factor	[XCa]	1.023
Integral tooth flank temperature (°C)	[theint]	176.18

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]	-0.095 /	-0.145	-0.130 /	-0.190
Number of teeth spanned	[k]	5.000		9.000	
Base tangent length (no backlash) (mm)	[Wk]	62.604		118.063	
Actual base tangent length ('span') (mm)	[Wk.e/i]	62.515 /	62.468	117.941 /	117.885
(mm)	[ΔWk.e/i]	-0.089 /	-0.136	-0.122 /	-0.179
Diameter of measuring circle (mm)	[dMWk.m]	172.315		325.895	
Theoretical diameter of ball/pin (mm)	[DM]	7.699		7.617	
Effective diameter of ball/pin (mm)	[DMeff]	8.000		8.000	
Radial single-ball measurement backlash free (mm)	[MrK]	92.358		169.334	
Radial single-ball measurement (mm)	[MrK.e/i]	92.245 /	92.185	169.170 /	169.094
Diameter of measuring circle (mm)	[dMMr.m]	173.431		327.376	
Diametral measurement over two balls without clearance (mm)	[MdK]	184.557		338.669	
Diametral two ball measure (mm)	[MdK.e/i]	184.331 /	184.211	338.341 /	338.189
Diametral measurement over pins without clearance (mm)	[MdR]	184.716		338.669	
Measurement over pins according to DIN 3960 (mm)	[MdR.e/i]	184.490 /	184.370	338.341 /	338.189
Measurement over 2 pins (free) according to AGMA 2002 (mm)					
	[dk2f.e/i]	184.318 /	184.198	0.000 /	0.000
Measurement over 2 pins (axial) according to AGMA 2002 (mm)					
	[dk2t.e/i]	184.646 /	184.526	0.000 /	0.000
Measurement over 3 pins (axial) according to AGMA 2002 (mm)					

	[dk3A.e/i]	184.490 / 184.370	338.341 / 338.189
Chordal tooth thickness (no backlash) (mm)	[sc]	7.332	7.360
Actual chordal tooth thickness (mm)	[sc.e/i]	7.237 / 7.187	7.230 / 7.170
Reference chordal height from da.m (mm)	[ha]	4.918	4.917
Tooth thickness (Arc) (mm)	[sn]	7.334	7.360
(mm)	[sn.e/i]	7.239 / 7.189	7.230 / 7.170
Backlash free center distance (mm)	[aControl.e/i]	249.696 /249.547	
Backlash free center distance, allowances (mm)	[jta]	-0.304 / -0.453	
dNf.i with aControl (mm)	[dNf0.i]	165.520	319.024
Reserve (dNf0.i-dFf.e)/2 (mm)	[cF0.i]	0.060	0.328
Tip clearance (mm)	[c0.i(aControl)]	0.850	0.802
Center distance allowances (mm)	[Aa.e/i]	0.023 / -0.023	
Circumferential backlash from Aa (mm)	[jtw_Aa.e/i]	0.018 / -0.018	
Radial clearance (mm)	[jrw.e/i]	0.476 / 0.281	
Circumferential backlash (transverse section) (mm)	[jtw.e/i]	0.366 / 0.216	
Normal backlash (mm)	[jnw.e/i]	0.332 / 0.196	
Torsional angle at entry with fixed output:			
Entire torsional angle (°)	[j.tSys]	0.2423/ 0.1431	

7. GEAR ACCURACY

		------- GEAR 1	-------- GEAR 2 --
According to DIN 3961:1978			
Accuracy grade	[Q-DIN3961]	6	6
Profile form deviation (µm)	[ff]	10.00	10.00
Profile slope deviation (µm)	[fHa]	7.00	7.00
Total profile deviation (µm)	[Ff]	13.00	13.00
Helix form deviation (µm)	[fbf]	5.50	5.50
Helix slope deviation (µm)	[fHb]	9.00	9.00
Total helix deviation (µm)	[Fb]	10.00	10.00
Normal base pitch deviation (µm)	[fpe]	9.00	10.00
Single pitch deviation (µm)	[fp]	9.00	10.00
Adjacent pitch difference (µm)	[fu]	11.00	12.00
Total cumulative pitch deviation (µm)	[Fp]	34.00	40.00
Sector pitch deviation over z/8 pitches (µm)	[Fpz/8]	22.00	25.00
Runout (µm)	[Fr]	25.00	28.00
Tooth Thickness Variation (µm)	[Rs]	15.00	16.00
Single flank composite, total (µm)	[Fi']	38.00	42.00
Single flank composite, tooth-to-tooth (µm)	[fi']	15.00	16.00
Radial composite, total (µm)	[Fi"]	28.00	32.00
Radial composite, tooth-to-tooth (µm)	[fi"]	12.00	14.00

Axis alignment tolerances (recommendation acc. to ISO TR 10064-3:1996, Quality 6)

Maximum value for deviation error of axis (µm)	[fSigbet]	14.63 (Fb= 13.00)
Maximum value for inclination error of axes (µm)	[fSigdel]	29.25

8. ADDITIONAL DATA

Mass (kg)	[m]	6.547	20.684
Total mass (kg)	[m]	27.232	
Moment of inertia (system with reference to the drive):			

calculation without consideration of the exact tooth shape				
single gears ((da+df)/2...di) (kg*m²)	[TraeghMom]	0.02420		0.27706
System ((da+df)/2...di) (kg*m²)	[TraeghMom]		0.10161	
Torsional stiffness on input for stopped output:				
Torsional stiffness (MNm/rad)	[cr]		4.337	
Torsion when subjected to nominal torque (°)	[delcr]		0.008	
Mean coeff. of friction (acc. Niemann)	[mum]		0.046	
Wear sliding coef. by Niemann	[zetw]		0.710	
Gear power loss (kW)	[PVZ]		3.272	
(Meshing efficiency (%)	[etaz]		99.567)	
Sound pressure level (according to Masuda, without contact analysis)				
	[dB(A)]		101.7	
Oil requirement for injection lubrication (l/min)				
	[Voil]		10.214	
(with oil cooler, for assumed difference in temperature of oil (°C):				
		10)		

9. MODIFICATIONS AND TOOTH FORM DEFINITION

Data for the tooth form calculation :
Data not available.

10. SERVICE LIFE, DAMAGE

Calculation with load spectrum

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 the basis of the required service life [H] (18000.0 h)

No.	F1%	F2%	H1%	H2%
1	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000
3	0.0000	0.0000	0.0000	0.0000
4	0.0000	0.0000	0.0000	0.0000
5	0.0000	0.0000	0.0000	0.0000
6	0.0000	0.0000	0.0000	0.0000
7	0.0000	0.0000	0.0000	0.0000
8	0.0000	0.0000	0.0000	0.0000
9	0.0000	0.0000	0.0000	0.0000
10	0.0000	0.0000	0.0000	0.0000
Σ	0.0000	0.0000	0.0000	0.0000

Most critical duty cycle elements for Scoring (SB, Sint), Tooth Flank Fracture (SFF), hardened layer (SEHT) and Micropitting (Slam)
SB: 1
SInt: 1

Calculation of the factors required to define reliability R(t) according to B. Bertsche with Weibull distribution; t in (h):

R(t) = 100 * Exp(-((t*fac - t0)/(T - t0))^b) %

Gear		fac	b	t0	T	R(H)%
1	Tooth root	865099	1.7	1.178e+030	1.81e+030	100.00
1	Tooth flank	865099	1.3	1.1e+030	5.239e+030	100.00
2	Tooth root	457266	1.7	1.178e+030	1.81e+030	100.00
2	Tooth flank	457266	1.3	1.1e+030	5.239e+030	100.00

Reliability of the configuration for required service life (%) 100.00 (Bertsche)

Application factor , calculated according to ISO6336-6, Annex A.3

(The slope of the S-N curve (Woehler lines) in the fatigue strength range according to ISO6336-6, table A.1 is used.)

Gear		p	Teq			KA
1	Tooth root	17.035	611.1	KA,F	1	1.000
1	Tooth flank	5.709	611.1	KA,H	1	1.000
2	Tooth root	17.035	1156.1	KA,F	2	1.000
2	Tooth flank	5.709	1156.1	KA,H	2	1.000

Application factor, ISO 6336-6 A.3 [KAmax] 1.000

[KA,Fmax / KA,Hmax] 1.000 / 1.000

Classification according to F.E.M. (Edition 1.001, 1998)

Spectrum factor	[km]	0.303
Spectrum class	[L]	3
Application class (predefined service life)	[T]	7
Machine class (predefined service life)	[M]	8
Application class (achievable service life)	[T]	9
Machine class (achievable service life)	[M]	8

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.
- Details of calculation method:
  cg according to method B
  KV according to method B
  KHb, KFb according method C
  KHa, KFa according to method B

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