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KISSsoft evaluation

File

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CALCULATION OF A HELICAL GEAR PAIR

Drawing or article number:
Gear 1: z3(GearPair_const1)
Gear 2: z2(GearPair_const1)

Load spectrum

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

Bin	Frequency	Power	Speed	Torque	Coefficients					
No.	[%]	[kW]	[1/min]	[Nm]	KV	KHβ	KHα	Kγ	YM1	YM2
1	10.00000	756.2500	31023.0	232.7839	1.5894	1.1204	1.2160	1.0000	1.0000	1.0000
2	10.00000	680.6250	31023.0	209.5055	1.6630	1.1278	1.2334	1.0000	1.0000	1.0000
3	10.00000	665.5000	34125.3	186.2271	1.7549	1.1391	1.2519	1.0000	1.0000	1.0000
4	10.00000	582.3125	34125.3	162.9487	1.8730	1.1533	1.2721	1.0000	1.0000	1.0000
5	10.00000	544.5000	37227.6	139.6704	2.0000	1.1732	1.2997	1.0000	1.0000	1.0000
6	10.00000	453.7500	37227.6	116.3920	2.0000	1.2139	1.3503	1.0000	1.0000	1.0000
7	10.00000	423.5000	43432.2	93.1136	2.0000	1.2670	1.4100	1.0000	1.0000	1.0000
8	10.00000	317.6250	43432.2	69.8352	2.0000	1.3489	1.4944	1.0000	1.0000	1.0000
9	10.00000	211.7500	43432.2	46.5568	2.0000	1.4968	1.6260	1.0000	1.0000	1.0000
10	10.00000	105.8750	43432.2	23.2784	2.0000	1.9531	1.9186	1.0000	1.0000	1.0000

Numbers of load cycles

Bin	Frequency	Load cycles	
1	10.00000	3350484000	1276374857
2	10.00000	3350484000	1276374857
3	10.00000	3685532400	1404012343
4	10.00000	3685532400	1404012343
5	10.00000	4020580800	1531649829
6	10.00000	4020580800	1531649829
7	10.00000	4690677600	1786924800
8	10.00000	4690677600	1786924800
9	10.00000	4690677600	1786924800
10	10.00000	4690677600	1786924800

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.

Notice:

Calculation with methods ISO6336 and AGMA 2001 results in a reduction of resistance in the domain of fatigue resistance (from circa 10^7 to 10^10 cycles).
The lifetime calculation takes this into account (also with the S-N curve (Woehler Curve) of the Miner type).

Results

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

Safeties, calculated with load spectrum:		
Root safety	3.880	3.369
Flank safety	1.223	1.263

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

Scuffing safety (integral temperature)	3.045
Scuffing safety (flash temperature)	3.601

Analysis of critical elements in load spectrum: See section 10

ONLY AS INFORMATION: CALCULATION WITH REFERENCE POWER

Calculation method ISO 6336:2006 Method B

		------- GEAR 1	-------- GEAR 2 --
Power (kW)	[P]	756.250	
Speed (1/min)	[n]	31023.0	11818.3
Torque (Nm)	[T]	232.8	611.1
Application factor	[KA]	1.25	
Required service life (h)	[H]	18000.00	
Gear driving (+) / driven (-)		+	-

Working flank gear 1: Right 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]	4.0000	
Pressure angle at normal section (°)	[alfn]	20.0000	
Helix angle at reference circle (°)	[beta]	20.0000	
Number of teeth	[z]	32	84
Facewidth (mm)	[b]	28.00	24.00
Hand of gear		left	right
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: 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
Material quality according to ISO 6336:2006 Normal (Life factors ZNT and YNT >=0.85)			
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]	-2.625	
Gear ratio	[u]	2.625	
Transverse module (mm)	[mt]	4.257	
Pressure angle at pitch circle (°)	[alft]	21.173	
Working transverse pressure angle (°)	[alfwt]	22.943	
	[alfwt.e/i]	22.956 / 22.931	
Working pressure angle at normal section (°)	[alfwn]	21.662	
Helix angle at operating pitch circle (°)	[betaw]	20.232	
Base helix angle (°)	[betab]	18.747	
Reference center distance (mm)	[ad]	246.889	
Sum of profile shift coefficients	[Summexi]	0.8091	
Profile shift coefficient	[x]	0.1776	0.6315
Tooth thickness (Arc) (module) (module)	[sn*]	1.7001	2.0305
Tip alteration (mm)	[k*mn]	-0.126	-0.126
Reference diameter (mm)	[d]	136.215	357.564
Base diameter (mm)	[db]	127.020	333.426
Tip diameter (mm)	[da]	145.383	370.364
(mm)	[da.e/i]	145.383 / 145.343	370.364 / 370.307
Tip diameter allowances (mm)	[Ada.e/i]	0.000 / -0.040	0.000 / -0.057
Tip form diameter (mm)	[dFa]	145.383	370.364
(mm)	[dFa.e/i]	145.383 / 145.343	370.364 / 370.307
Active tip diameter (mm)	[dNa]	145.383	370.364
Active tip diameter (mm)	[dNa.e/i]	145.383 / 145.343	370.364 / 370.307
Operating pitch diameter (mm)	[dw]	137.931	362.069
(mm)	[dw.e/i]	137.944 / 137.918	362.102 / 362.036
Root diameter (mm)	[df]	127.635	352.616
Generating Profile shift coefficient	[xE.e/i]	0.1449/ 0.1278	0.5869/ 0.5663
Manufactured root diameter with xE (mm)	[df.e/i]	127.374 / 127.237	352.259 / 352.094
Theoretical tip clearance (mm)	[c]	1.000	1.000
Effective tip clearance (mm)	[c.e/i]	1.304 / 1.156	1.251 / 1.108
Active root diameter (mm)	[dNf]	131.408	355.801
(mm)	[dNf.e/i]	131.472 / 131.378	355.871 / 355.760
Root form diameter (mm)	[dFf]	130.744	354.698
(mm)	[dFf.e/i]	130.574 / 130.487	354.362 / 354.208
Reserve (dNf-dFf)/2 (mm)	[cF.e/i]	0.493 / 0.402	0.832 / 0.699
Addendum (mm)	[ha=mn*(haP*+x+k)]	4.584	6.400
(mm)	[ha.e/i]	4.584 / 4.564	6.400 / 6.372
Dedendum (mm)	[hf=mn*(hfP*-x)]	4.290	2.474
(mm)	[hf.e/i]	4.420 / 4.489	2.652 / 2.735
Roll angle at dFa (°)	[xsi_dFa.e/i]	31.903 / 31.866	27.706 / 27.684
Roll angle to dNa (°)	[xsi_dNa.e/i]	31.903 / 31.866	27.706 / 27.684
Roll angle to dNf (°)	[xsi_dNf.e/i]	15.302 / 15.137	21.374 / 21.319
Roll angle at dFf (°)	[xsi_dFf.e/i]	13.650 / 13.478	20.620 / 20.542
Tooth height (mm)	[h]	8.874	8.874
Virtual gear no. of teeth	[zn]	37.976	99.688
Normal tooth thickness at tip circle (mm)	[san]	3.004	3.055
(mm)	[san.e/i]	2.923 / 2.850	2.946 / 2.859
Normal tooth thickness on tip form circle (mm)	[sFan]	3.004	3.055
(mm)	[sFan.e/i]	2.923 / 2.850	2.946 / 2.859
Normal space width at root circle (mm)	[efn]	3.331	2.697

(mm)	[efn.e/i]	3.393 /	3.428		2.708 /	2.713		
Max. sliding velocity at tip (m/s)	[vga]	38.042			45.071			
Specific sliding at the tip	[zetaa]	0.331			0.452			
Specific sliding at the root	[zetaf]	-0.824			-0.495			
Mean specific sliding	[zetam]		0.397					
Sliding factor on tip	[Kga]	0.170			0.201			
Sliding factor on root	[Kgf]	-0.201			-0.170			
Pitch on reference circle (mm)	[pt]		13.373					
Base pitch (mm)	[pbt]		12.470					
Transverse pitch on contact-path (mm)	[pet]		12.470					
Lead height (mm)	[pz]	1175.732			3086.295			
Axial pitch (mm)	[px]		36.742					
Length of path of contact (mm)	[ga, e/i]	18.526 (	18.585 /	18.360)				
Length T1-A, T2-A (mm)	[T1A, T2A]	16.838(	16.779/	16.962)	80.617(	80.617/	80.551)	
Length T1-B (mm)	[T1B, T2B]	22.893(	22.893/	22.852)	74.561(	74.502/	74.661)	
Length T1-C (mm)	[T1C, T2C]	26.884(	26.868/	26.900)	70.570(	70.528/	70.613)	
Length T1-D (mm)	[T1D, T2D]	29.308(	29.249/	29.432)	68.147(	68.147/	68.081)	
Length T1-E (mm)	[T1E, T2E]	35.364(	35.364/	35.322)	62.091(	62.032/	62.191)	
Length T1-T2 (mm)	[T1T2]	97.454 (	97.395 /	97.513)				
Diameter of single contact point B (mm)	[d-B]	135.020(	135.020/	134.992)	365.254(	365.206/	365.336)	
Diameter of single contact point D (mm)	[d-D]	139.892(	139.842/	139.996)	360.207(	360.207/	360.157)	
Addendum contact ratio	[eps]	0.680(	0.681/	0.675)	0.806(	0.809/	0.797)	
Minimal length of contact line (mm)	[Lmin]		30.732					
Transverse contact ratio	[eps_a]		1.486					
Transverse contact ratio with allowances	[eps_a.e/m/i]	1.490 /	1.481 /	1.472				
Overlap ratio	[eps_b]		0.653					
Total contact ratio	[eps_g]		2.139					
Total contact ratio with allowances	[eps_g.e/m/i]	2.144 /	2.135 /	2.126				

2. FACTORS OF GENERAL INFLUENCE

		------- GEAR 1 -------- GEAR 2 --
Nominal circum. force at pitch circle (N)	[Ft]	3417.9
Axial force (N)	[Fa]	1244.0
Radial force (N)	[Fr]	1323.9
Normal force (N)	[Fnorm]	3870.7
Nominal circumferential force per mm (N/mm)	[w]	142.41
Only as information: Forces at operating pitch circle:		
Nominal circumferential force (N)	[Ftw]	3375.4
Axial force (N)	[Faw]	1244.0
Radial force (N)	[Frw]	1428.8
Circumferential speed reference circle (m/s)	[v]	221.26
Circumferential speed operating pitch circle (m/s)	[v(dw)]	224.05
Running-in value (µm)	[yp]	0.8
Running-in value (µm)	[yf]	1.0
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']	14.548
Meshing stiffness (N/mm/µm)	[cgalf]	19.847
Meshing stiffness (N/mm/µm)	[cgbet]	16.870
Reduced mass (kg/mm)	[mRed]	0.05805
Resonance speed (min-1)	[nE1]	5518

Resonance ratio (-)	[N]		5.622
Overcritical range			
Running-in value (µm)	[ya]		0.8
Bearing distance l of pinion shaft (mm)	[l]		56.000
Distance s of pinion shaft (mm)	[s]		5.600
Outside diameter of pinion shaft (mm)	[dsh]		28.000
Load in accordance with Figure 13, ISO 6336-1:2006	[-]	4	
0:a), 1:b), 2:c), 3:d), 4:e)			
Coefficient K' according to Figure 13, ISO 6336-1:2006	[K']	-1.00	
Without support effect			
Tooth trace deviation (active) (µm)	[Fby]		4.04
from deformation of shaft (µm)	[fsh*B1]		1.83
(fsh (µm) = 1.83, B1= 1.00, fHb5 (µm) = 7.00)			
Tooth without tooth trace modification			
Position of Contact pattern: favorable			
from production tolerances (µm)	[fma*B2]		13.09
(B2= 1.00)			
Tooth trace deviation, theoretical (µm)	[Fbx]		4.75
Running-in value (µm)	[yb]		0.71
Dynamic factor	[KV]		1.589
Face load factor - flank	[KHb]		1.120
- Tooth root	[KFb]		1.082
- Scuffing	[KBb]		1.120
Transverse load factor - flank	[KHa]		1.216
- Tooth root	[KFa]		1.216
- Scuffing	[KBa]		1.216
Helical load factor scuffing	[Kbg]		1.126
Number of load cycles (in mio.)	[NL]	33504.840	12763.749

3. TOOTH ROOT STRENGTH

Calculation of Tooth form coefficients according method: B

		------- GEAR 1	-------- GEAR 2 --
Calculated with profile shift	[x]	0.1776	0.6315
Tooth form factor	[YF]	1.21	1.09
Stress correction factor	[YS]	2.16	2.49
Load application angle (°)	[alfFen]	20.35	21.65
Bending moment arm (mm)	[hF]	3.83	4.00
Tooth thickness at root (mm)	[sFn]	8.72	9.35
Tooth root radius (mm)	[roF]	1.93	1.55

(hF* = 0.957/ 0.999 sFn* = 2.181/ 2.336 roF* = 0.483/ 0.387)
(den (mm) =
154.501/405.384 dsFn(mm) =129.190/354.090 alfsFn(°) = 30.00/ 30.00 qs = 2.256/ 3.015)

Helix angle factor	[Ybet]		0.891
Deep tooth factor	[YDT]		1.000
Gear rim factor	[YB]	1.00	1.00
Effective facewidth (mm)	[beff]	28.00	24.00
Nominal stress at tooth root (N/mm²)	[sigF0]	70.75	85.74
Tooth root stress (N/mm²)	[sigF]	184.91	224.10

Permissible bending stress at root of Test-gear				
Notch sensitivity factor	[YdrelT]	0.989	1.021	
Surface factor	[YRrelT]	0.982	0.982	
size factor (Tooth root)	[YX]	1.000	1.000	
Finite life factor	[YNT]	0.850	0.850	
[YdrelT*YRrelT*YX*YNT]		0.826	0.852	
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]	501.33	517.52	
Limit strength tooth root (N/mm²)	[sigFG]	701.86	724.53	
Required safety	[SFmin]	1.40	1.40	

4. SAFETY AGAINST PITTING (TOOTH FLANK)

		------- GEAR 1	-------- GEAR 2 --
Zone factor	[ZH]	2.268	
Elasticity factor (√N/mm²)	[ZE]	189.812	
Contact ratio factor	[Zeps]	0.855	
Helix angle factor	[Zbet]	1.032	
Effective facewidth (mm)	[beff]	24.00	
Nominal contact stress (N/mm²)	[sigH0]	456.09	
Contact stress at operating pitch circle (N/mm²)	[sigHw]	750.37	
Single tooth contact factor	[ZB,ZD]	1.02	1.00
Contact stress (N/mm²)	[sigHB, sigHD]	764.48	750.37
Lubrication coefficient at NL	[ZL]	0.919	0.919
Speed coefficient at NL	[ZV]	1.074	1.074
Roughness coefficient at NL	[ZR]	0.875	0.875
Material pairing coefficient at NL	[ZW]	1.000	1.000
Finite life factor	[ZNT]	0.850	0.850
	[ZL*ZV*ZR*ZNT]	0.733	0.733
Limited pitting is permitted:	No		
Size factor (flank)	[ZX]	1.000	1.000
Permissible contact stress (N/mm²)	[sigHP=sigHG/SHmin]	916.74	916.74
Pitting stress limit (N/mm²)	[sigHG]	916.74	916.74
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 ISO/TS 6336-20/21:2017

Lubrication coefficient (for lubrication type)	[XS]	1.200	
Scuffing test and load stage	[FZGtest]	FZG - Test A / 8.3 / 90 (ISO 14635 - 1)	12
Multiple meshing factor	[Xmp]	1.000	
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]	8.97	
Ca taken as optimal in the calculation (0=no, 1=yes)		0	0
Effective facewidth (mm)	[beff]	24.000	
Applicable circumferential force/facewidth (N/mm)	[wBt]	385.476	
Kbg = 1.126, wBt*Kbg = 434.068			
Angle factor	[Xalfbet]	1.008	
(ε1:0.680, ε2:0.806)			

Flash temperature-criteria		
Lubricant factor	[XL]	0.894
Tooth mass temperature (°C)	[theMi]	105.54
(theMi = theoil + XS*0.47*Xmp*theflm)		
Average flash temperature (°C)	[theflm]	63.01
Scuffing temperature (°C)	[theS]	775.90
Contact time (µsec)	[tc]	6.29
theS increased because of short contact time by (°C)		316.20
Coordinate gamma (point of highest temp.)	[Gamma]	-0.374
[Gamma.A]=-0.374 [Gamma.E]=0.315		
Highest contact temp. (°C)	[theB]	266.00
Flash factor (°K*N^-.75*s^.5*m^-.5*mm)	[XM]	50.058
Approach factor	[XJ]	1.018
Load sharing factor	[XGam]	0.805
Dynamic viscosity (mPa*s)	[etaM]	9.44 (70.0 °C)
Coefficient of friction	[mym]	0.054

Integral temperature-criteria		
Lubricant factor	[XL]	1.000
Tooth mass temperature (°C)	[theMC]	97.94
(theMC = theoil + XS*0.70*theflaint)		
Mean flash temperature (°C)	[theflaint]	33.27
Integral scuffing temperature (°C)	[theSint]	450.16
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]	0.318
Dynamic viscosity (mPa*s)	[etaOil]	9.44 (70.0 °C)
Mean coefficient of friction	[mym]	0.048
Geometry factor	[XBE]	0.154
Meshing factor	[XQ]	1.000
Tip relief factor	[XCa]	1.273
Integral tooth flank temperature (°C)	[theint]	147.84

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		13.000	
Base tangent length (no backlash) (mm)	[Wk]	55.764		154.953	
Actual base tangent length ('span') (mm)	[Wk.e/i]	55.675 /	55.628	154.830 /	154.774
(mm)	[ΔWk.e/i]	-0.089 /	-0.136	-0.122 /	-0.179
Diameter of measuring circle (mm)	[dMWk.m]	137.518		364.227	

> Base tangent length Gear 2 is not measurable (Gear to thin)

Theoretical diameter of ball/pin (mm)	[DM]	6.939	6.984
Effective diameter of ball/pin (mm)	[DMeff]	7.000	7.000
Radial single-ball measurement backlash free (mm)	[MrK]	73.720	186.149
Radial single-ball measurement (mm)	[MrK.e/i]	73.609 / 73.550	185.990 / 185.917
Diameter of measuring circle (mm)	[dMMr.m]	137.489	362.265
Diametral measurement over two balls without clearance (mm)	[MdK]	147.440	372.297
Diametral two ball measure (mm)	[MdK.e/i]	147.218 / 147.101	371.981 / 371.834
Diametral measurement over pins without clearance (mm)	[MdR]	147.440	372.297
Measurement over pins according to DIN 3960 (mm)	[MdR.e/i]	147.218 / 147.101	371.981 / 371.834
Measurement over 3 pins (axial) according to AGMA 2002 (mm)	[dk3A.e/i]	147.218 / 147.101	371.981 / 371.834

Chordal tooth thickness (no backlash) (mm)	[sc]	6.798	8.122
Actual chordal tooth thickness (mm)	[sc.e/i]	6.703 / 6.653	7.992 / 7.932
Reference chordal height from da.m (mm)	[ha]	4.649	6.427
Tooth thickness (Arc) (mm)	[sn]	6.800	8.122
(mm)	[sn.e/i]	6.705 / 6.655	7.992 / 7.932

Backlash free center distance (mm)	[aControl.e/i]	249.713 /249.572
Backlash free center distance, allowances (mm)	[jta]	-0.287 / -0.428
dNf.i with aControl (mm)	[dNf0.i]	130.859 355.036
Reserve (dNf0.i-dFf.e)/2 (mm)	[cF0.i]	0.142 0.337
Tip clearance (mm)	[c0.i(aControl)]	0.750 0.702
Center distance allowances (mm)	[Aa.e/i]	0.023 / -0.023

Circumferential backlash from Aa (mm)	[jtw_Aa.e/i]	0.019 / -0.019
Radial clearance (mm)	[jrw.e/i]	0.451 / 0.264
Circumferential backlash (transverse section) (mm)	[jtw.e/i]	0.380 / 0.223
Normal backlash (mm)	[jnw.e/i]	0.336 / 0.197
Torsional angle at entry with fixed output:		
Entire torsional angle (°)	[j.tSys]	0.3161/0.1853

7. GEAR ACCURACY

		------- GEAR 1	-------- GEAR 2 --
According to ISO 1328-1:1995, ISO 1328-2:1997			
Accuracy grade	[Q]	6	6
Single pitch deviation (µm)	[fptT]	10.00	11.00
Base circle pitch deviation (µm)	[fpbT]	9.30	10.30
Sector pitch deviation over k/8 pitches (µm)	[Fpk/8T]	18.00	26.00
Profile form deviation (µm)	[ffaT]	12.00	13.00
Profile slope deviation (µm)	[fHaT]	9.50	11.00
Total profile deviation (µm)	[FaT]	15.00	17.00
Helix form deviation (µm)	[ffbT]	9.00	9.50
Helix slope deviation (µm)	[fHbT]	9.00	9.50
Total helix deviation (µm)	[FbT]	13.00	13.00
Total cumulative pitch deviation (µm)	[FpT]	36.00	47.00
Runout (µm)	[FrT]	29.00	38.00
Single flank composite, total (µm)	[FisT]	54.00	66.00
Single flank composite, tooth-to-tooth (µm)	[fisT]	18.00	19.00
Radial composite, total (µm)	[FidT]	43.00	52.00
Radial composite, tooth-to-tooth (µm)	[fidT]	15.00	15.00

Axis alignment tolerances (recommendation acc. to ISO TR 10064-3:1996, Quality)		6)
Maximum value for deviation error of axis (µm)	[fSigbet]	15.17 (Fb= 13.00)

Maximum value for inclination error of axes (µm)	[fSigdel]	30.33

8. ADDITIONAL DATA

Mass (kg)	[m]	3.209	19.287
Total mass (kg)	[m]	22.495	
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]	0.00747	0.31503
System ((da+df)/2...di) (kg*m²)	[TraeghMom]	0.05319	
Torsional stiffness on input for stopped output:			
Torsional stiffness (MNm/rad)	[cr]	1.613	
Torsion when subjected to nominal torque (°)	[delcr]	0.008	
Mean coeff. of friction (acc. Niemann)	[mum]	0.044	
Wear sliding coef. by Niemann	[zetw]	0.589	
Gear power loss (kW)	[PVZ]	2.995	
(Meshing efficiency (%)	[etaz]	99.604)	
Sound pressure level (according to Masuda, without contact analysis)			
	[dB(A)]	106.9	
Oil requirement for injection lubrication (l/min)			
	[Voil]	9.348	
(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	2270884	1.7	1.178e+030	1.81e+030	100.00
1	Tooth flank	2270884	1.3	1.1e+030	5.239e+030	100.00
2	Tooth root	865099	1.7	1.178e+030	1.81e+030	100.00
2	Tooth flank	865099	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	232.8	KA,F	1	1.000
1	Tooth flank	5.709	232.8	KA,H	1	1.000
2	Tooth root	17.035	611.1	KA,F	2	1.000
2	Tooth flank	5.709	611.1	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.
- 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
  KHb, KFb according method C
  fma following equation (64), fsh following (57/58), Fbx following (52/53/57)
  KHa, KFa according to method B
- 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 for coefficients ZL, ZV, ZR, ZW, ZX, YdrelT, YRrelT and YX..

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