

KISSsoft evaluation

File

Name : Unnamed

Changed by: J on: 25.01.2019 at: 20:34:54

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

1-> Undercut Gear 1

(Underneath of the active flank - no reduction of transverse contact ratio)

2-> Your tooth thickness tolerance (DIN 3967 cd25) is not suitable for small gears.

Choose a tolerance for precision mechanics!

3-> Your tooth thickness tolerance (DIN 3967 cd25) is not suitable for small gears.

Choose a tolerance for precision mechanics!

CALCULATION OF A CYLINDRICAL SPUR GEAR PAIR

Drawing or article number:

Gear 1: z1(SunPlanet1)

Gear 2: z3(SunPlanet1)

Calculation method DIN 3990:1987 Method B

| | ----- GEAR 1 ----- | ----- GEAR 2 -- |
|------------------------------------|--------------------|-----------------|
| Power (W) | [P] | 427.257 |
| Speed (1/min) | [n] | 6000.0 1074.6 |
| Torque (Nm) | [T] | 0.680 3.797 |
| Application factor | [KA] | 1.25 |
| Required service life (h) | [H] | 2000.00 |
| Gear driving (+) / driven (-) | + | - |
| Working flank gear 1: Right flank | | |
| Sense of rotation gear 1 clockwise | | |

1. TOOTH GEOMETRY AND MATERIAL

(geometry calculation according to DIN 3960:1987)

| | ----- GEAR 1 ----- | ----- GEAR 2 -- |
|--------------------------------------|--------------------------|-----------------|
| Center distance (mm) | [a] | 20.348 |
| Center distance tolerance | ISO 286:2010 Measure js7 | |
| Normal module (mm) | [mn] | 0.5000 |
| Pressure angle at normal section (°) | [alfn] | 20.0000 |
| Helix angle at reference circle (°) | [beta] | 0.0000 |
| Number of teeth | [z] | 12 67 |
| Facewidth (mm) | [b] | 6.00 6.00 |
| Hand of gear | Spur gear | |
| Accuracy grade | [Q-DIN 3961:1978] | 6 6 |
| Inner diameter (mm) | [di] | 0.00 29.37 |
| Inner diameter of gear rim (mm) | [dbi] | 0.00 0.00 |

Material

Gear 1: Steel, Grade 3, HRC58-64(AGMA), Case-carburized steel, case-hardened

AGMA 2001-C95

Gear 2:

Steel, Grade 3, HRC58-64(AGMA), Case-carburized steel, case-hardened

AGMA 2003, only for BEVEL GEARS

| | | ----- GEAR 1 ----- | GEAR 2 -- |
|---|---------|--------------------|-----------|
| | | HRC 60 | HRC 60 |
| Surface hardness | | | |
| Fatigue strength. tooth root stress (N/mm ²) | [σFlim] | 515.00 | 275.00 |
| Fatigue strength for Hertzian pressure (N/mm ²) | [σHlim] | 1895.00 | 1720.00 |
| Tensile strength (N/mm ²) | [σB] | 1035.00 | 1035.00 |
| Yield point (N/mm ²) | [σS] | 887.00 | 887.00 |
| Young's modulus (N/mm ²) | [E] | 206843 | 206843 |
| Poisson's ratio | [ν] | 0.300 | 0.300 |
| Roughness average value DS, flank (μm) | [RAH] | 0.63 | 0.63 |
| Roughness average value DS, root (μm) | [RAF] | 2.40 | 2.40 |
| Mean roughness height, Rz, flank (μm) | [RZH] | 5.00 | 5.00 |
| Mean roughness height, Rz, root (μm) | [RZF] | 16.00 | 16.00 |

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] | 1.6 | 1.5 |
|-----------------|------|-----|-----|

Lubrication type Oil bath lubrication

Type of oil Oil: ISO-VG 220

Lubricant base Mineral-oil base

Kinem. viscosity oil at 40 °C (mm²/s) [nu40] 220.00

Kinem. viscosity oil at 100 °C (mm²/s) [nu100] 17.50

| | | | |
|--|--------------------|------------------------------|-----------------------|
| Specific density at 15 °C (kg/dm³) | [roOil] | 0.895 | |
| Oil temperature (°C) | [TS] | 70.000 | |
| | | ----- GEAR 1 ----- GEAR 2 -- | |
| Overall transmission ratio | [itot] | -5.583 | |
| Gear ratio | [u] | 5.583 | |
| Transverse module (mm) | [mt] | 0.500 | |
| Pressure angle at pitch circle (°) | [alft] | 20.000 | |
| Working transverse pressure angle (°) | [alfwt] | 24.208 | |
| | [alfwt.e/i] | 24.274 / 24.142 | |
| Working pressure angle at normal section (°) | [alfwn] | 24.208 | |
| Helix angle at operating pitch circle (°) | [betaw] | 0.000 | |
| Base helix angle (°) | [betab] | 0.000 | |
| Reference center distance (mm) | [ad] | 19.750 | |
| Sum of profile shift coefficients | [Summexi] | 1.3210 | |
| Profile shift coefficient | [x] | 0.4720 | 0.8490 |
| Tooth thickness (Arc) (module) (module) | [sn*] | 1.9144 | 2.1888 |
| Tip alteration (mm) | [k*mn] | -0.062 | -0.062 |
| Reference diameter (mm) | [d] | 6.000 | 33.500 |
| Base diameter (mm) | [db] | 5.638 | 31.480 |
| Tip diameter (mm) | [da] | 7.348 | 35.225 |
| (mm) | [da.e/i] | 7.348 / 7.338 | 35.225 / 35.215 |
| Tip diameter allowances (mm) | [Ada.e/i] | 0.000 / -0.010 | 0.000 / -0.010 |
| Tip form diameter (mm) | [dFa] | 7.348 | 35.225 |
| (mm) | [dFa.e/i] | 7.348 / 7.338 | 35.225 / 35.215 |
| Active tip diameter (mm) | [dNa] | 7.348 | 35.225 |
| Active tip diameter (mm) | [dNa.e/i] | 7.348 / 7.338 | 35.225 / 35.215 |
| Operating pitch diameter (mm) | [dw] | 6.182 | 34.515 |
| (mm) | [dw.e/i] | 6.185 / 6.179 | 34.533 / 34.497 |
| Root diameter (mm) | [df] | 5.222 | 33.099 |
| Generating Profile shift coefficient | [xE.e/i] | 0.3621/ | 0.3072 0.7006/ 0.6182 |
| Manufactured root diameter with xE (mm) | [df.e/i] | 5.112 / 5.057 | 32.951 / 32.868 |
| Theoretical tip clearance (mm) | [c] | 0.125 | 0.125 |
| Effective tip clearance (mm) | [c.e/i] | 0.256 / 0.189 | 0.223 / 0.169 |
| Active root diameter (mm) | [dNf] | 5.707 | 33.681 |
| (mm) | [dNf.e/i] | 5.718 / 5.699 | 33.704 / 33.662 |
| Root form diameter (mm) | [dFf] | 5.661 | 33.352 |
| (mm) | [dFf.e/i] | 5.641 / 5.638 | 33.211 / 33.135 |
| Reserve (dNf-dFf)/2 (mm) | [cF.e/i] | 0.040 / 0.029 | 0.285 / 0.226 |
| (undercut taken into account) | | | |
| Addendum (mm) | [ha=mn*(haP*+x+k)] | 0.674 | 0.862 |
| (mm) | [ha.e/i] | 0.674 / 0.669 | 0.862 / 0.857 |
| Dedendum (mm) | [hf=mn*(hfP*-x)] | 0.389 | 0.201 |
| (mm) | [hf.e/i] | 0.444 / 0.471 | 0.275 / 0.316 |
| Roll angle at dFa (°) | [xsi_dFa.e/i] | 47.886 / 47.727 | 28.768 / 28.727 |
| Roll angle to dNa (°) | [xsi_dNa.e/i] | 47.886 / 47.727 | 28.768 / 28.727 |
| Roll angle to dNf (°) | [xsi_dNf.e/i] | 9.708 / 8.440 | 21.918 / 21.703 |
| Roll angle at dFf (°) | [xsi_dFf.e/i] | 1.905 / 0.290 | 19.261 / 18.822 |
| Tooth height (mm) | [h] | 1.063 | 1.063 |
| Virtual gear no. of teeth | [zn] | 12.000 | 67.000 |
| Normal tooth thickness at tip circle (mm) | [san] | 0.256 | 0.380 |
| (mm) | [san.e/i] | 0.215 / 0.183 | 0.329 / 0.292 |
| Normal tooth thickness on tip form circle (mm) | [sFan] | 0.256 | 0.380 |
| (mm) | [sFan.e/i] | 0.215 / 0.183 | 0.329 / 0.292 |
| Normal space width at root circle (mm) | [efn] | 0.000 | 0.333 |
| (mm) | [efn.e/i] | 0.000 / 0.000 | 0.338 / 0.341 |
| Max. sliding velocity at tip (m/s) | [vqa] | 0.807 | 0.612 |

| | | | |
|--|---------------|------------------------|-------------------------|
| Specific sliding at the tip | [zetaa] | 0.545 | 0.689 |
| Specific sliding at the root | [zetaf] | -2.211 | -1.197 |
| Mean specific sliding | [zetam] | 0.607 | |
| Sliding factor on tip | [Kga] | 0.415 | 0.315 |
| Sliding factor on root | [Kgf] | -0.315 | -0.415 |
| Pitch on reference circle (mm) | [pt] | 1.571 | |
| Base pitch (mm) | [pbt] | 1.476 | |
| Transverse pitch on contact-path (mm) | [pet] | 1.476 | |
| Length of path of contact (mm) | [ga, e/i] | 1.915 (1.941 / 1.871) | |
| Length T1-A, T2-A (mm) | [T1A, T2A] | 0.441(0.415/ 0.478) | 7.903(7.903/ 7.892) |
| Length T1-B (mm) | [T1B, T2B] | 0.880(0.880/ 0.872) | 7.464(7.438/ 7.497) |
| Length T1-C (mm) | [T1C, T2C] | 1.267(1.264/ 1.271) | 7.076(7.055/ 7.098) |
| Length T1-D (mm) | [T1D, T2D] | 1.917(1.891/ 1.954) | 6.427(6.427/ 6.416) |
| Length T1-E (mm) | [T1E, T2E] | 2.356(2.356/ 2.348) | 5.988(5.962/ 6.021) |
| Length T1-T2 (mm) | [T1T2] | 8.344 (8.318 / 8.369) | |
| Diameter of single contact point B (mm) | [d-B] | 5.906(5.902) | 34.840(34.818/ 34.868) |
| Diameter of single contact point D (mm) | [d-D] | 6.818(6.789/ 6.860) | 34.003(34.003/ 33.994) |
| Addendum contact ratio | [eps] | 0.738(0.740/ 0.730) | 0.560(0.575/ 0.538) |
| Minimal length of contact line (mm) | [Lmin] | 6.000 | |
| Transverse contact ratio | [eps_a] | 1.297 | |
| Transverse contact ratio with allowances | [eps_a.e/m/i] | 1.315 / 1.291 / 1.267 | |
| Overlap ratio | [eps_b] | 0.000 | |
| Total contact ratio | [eps_g] | 1.297 | |
| Total contact ratio with allowances | [eps_g.e/m/i] | 1.315 / 1.291 / 1.267 | |

2. FACTORS OF GENERAL INFLUENCE

| | | ----- GEAR 1 ----- | GEAR 2 -- |
|--|---------|--------------------|-----------|
| Nominal circum. force at pitch circle (N) | [Ft] | 226.7 | |
| Axial force (N) | [Fa] | 0.0 | |
| Radial force (N) | [Fr] | 82.5 | |
| Normal force (N) | [Fnorm] | 241.2 | |
| Nominal circumferential force per mm (N/mm) | [w] | 37.78 | |
| Only as information: Forces at operating pitch circle: | | | |
| Nominal circumferential force (N) | [Ftw] | 220.0 | |
| Axial force (N) | [Faw] | 0.0 | |
| Radial force (N) | [Frw] | 98.9 | |
| Circumferential speed reference circle (m/s) | [v] | 1.88 | |
| Circumferential speed operating pitch circle (m/s) | [v(dw)] | 1.94 | |
| Running-in value (μm) | [yp] | 0.4 | |
| Running-in value (μm) | [yf] | 0.3 | |
| Correction factor | [CM] | 0.800 | |
| Gear blank factor | [CR] | 1.000 | |
| Basic rack factor | [CBS] | 0.975 | |
| Material coefficient | [E/Est] | 1.004 | |
| Singular tooth stiffness (N/mm/μm) | [c'] | 6.818 | |
| Meshing stiffness (N/mm/μm) | [cg] | 8.339 | |
| Reduced mass (kg/mm) | [mRed] | 0.00014 | |
| Resonance speed (min-1) | [nE1] | 194277 | |
| Running-in value (μm) | [ya] | 0.4 | |
| Bearing distance l of pinion shaft (mm) | [l] | 12.000 | |
| Distance s of pinion shaft (mm) | [s] | 1.200 | |
| Outside diameter of pinion shaft (mm) | [dsh] | 5.455 | |
| Load according to Figure 6.8, DIN 3990-1:1987 [-] | | 4 | |
| (0:6.8a, 1:6.8b, 2:6.8c, 3:6.8d, 4:6.8e) | | | |

Coefficient K' according to Figure 6.8,

| | | | |
|---|----------------------|----------|---------|
| | DIN 3990-1:1987 [K'] | -1.00 | |
| Without support effect | | | |
| Tooth trace deviation (active) (μm) | [Fby] | 4.56 | |
| from deformation of shaft (μm) | [fsh*B1] | 0.48 | |
| (fsh (μm) = 0.48, B1= 1.00, fHb5 (μm) = 6.00) | | | |
| Tooth without tooth trace modification | | | |
| Position of Contact pattern: favorable | | | |
| from production tolerances (μm) | [fma*B2] | 8.00 | |
| (B2= 1.00) | | | |
| Tooth trace deviation, theoretical (μm) | [Fbx] | 5.37 | |
| Running-in value (μm) | [yb] | 0.81 | |
| User specified factor KV: | | | |
| Dynamic factor | [KV] | 1.056 | |
| Face load factor - flank | | | |
| | [KHb] | 1.382 | |
| - Tooth root | [KFb] | 1.301 | |
| - Scuffing | [KBb] | 1.382 | |
| Transverse load factor - flank | | | |
| | [KHa] | 1.000 | |
| - Tooth root | [KFα] | 1.000 | |
| - Scuffing | [KBα] | 1.000 | |
| Helical load factor scuffing | | | |
| | [Kbg] | 1.000 | |
| Number of load cycles (in mio.) | [NL] | 2160.000 | 128.955 |

3. TOOTH ROOT STRENGTH

Calculation of Tooth form coefficients according method: B

| | | ----- GEAR 1 ----- | GEAR 2 -- |
|---|------------------------|--------------------|-----------|
| Calculated with manufacturing profile shift | [xE.ε] | 0.3621 | 0.7006 |
| Tooth form factor | [YF] | 1.81 | 1.59 |
| Stress correction factor | [YS] | 1.85 | 2.12 |
| Load application angle (°) | [αFen] | 29.35 | 24.54 |
| Bending moment arm (mm) | [hF] | 0.66 | 0.75 |
| Tooth thickness at root (mm) | [sFn] | 1.00 | 1.17 |
| Tooth root radius (mm) | [roF] | 0.23 | 0.19 |
| (hF* = 1.312/ 1.497 sFn* = 2.008/ 2.336 roF* = 0.468/ 0.385) | | | |
| (den (mm) = 6.818/ 34.840 dsFn(mm) = 5.253/ 33.129 αfsFn(°) = 30.00/ 30.00 qs = 2.144/ 3.032) | | | |
| Contact ratio factor | [Yeps] | 1.000 | |
| Helix angle factor | [Ybet] | 1.000 | |
| Effective facewidth (mm) | [beff] | 6.00 | 6.00 |
| Nominal stress at tooth root (N/mm²) | [sigF0] | 253.50 | 255.30 |
| Tooth root stress (N/mm²) | [sigF] | 435.13 | 438.21 |
| Permissible bending stress at root of Test-gear | | | |
| Notch sensitivity factor | [YdrelT] | 0.997 | 1.005 |
| Surface factor | [YRrelT] | 0.972 | 0.972 |
| size factor (Tooth root) | [YX] | 1.000 | 1.000 |
| Finite life factor | [YNT] | 1.000 | 1.000 |
| | [YdrelT*YRrelT*YX*YNT] | 0.968 | 0.976 |
| Alternating bending factor (mean stress influence coefficient) | [YM] | 1.000 | 1.000 |
| Stress correction factor | [Yst] | 2.00 | |

| | | | |
|--|---------------------|---------|--------|
| Yst*sigFlim (N/mm ²) | [sigFE] | 1030.00 | 550.00 |
| Permissible tooth root stress (N/mm ²) | [sigFP=sigFG/SFmin] | 712.44 | 383.59 |
| Limit strength tooth root (N/mm ²) | [sigFG] | 997.42 | 537.03 |
| Required safety | [SFmin] | 1.40 | 1.40 |
| Safety for tooth root stress | [SF=sigFG/sigF] | 2.29 | 1.23 |
| Transmittable power (W) | [WRating] | 699.56 | 374.00 |

4. SAFETY AGAINST PITTING (TOOTH FLANK)

| | | ----- GEAR 1 ----- | GEAR 2 -- |
|---|---------------------|--------------------|-----------|
| Zone factor | [ZH] | | 2.245 |
| Elasticity factor ($\sqrt{N/mm^2}$) | [ZE] | | 190.200 |
| Contact ratio factor | [Zeps] | | 0.949 |
| Helix angle factor | [Zbet] | | 1.000 |
| Effective facewidth (mm) | [beff] | | 6.00 |
| Nominal contact stress (N/mm ²) | [sigH0] | | 1104.01 |
| Contact stress at operating pitch circle (N/mm ²) | [sigHw] | | 1490.73 |
| Single tooth contact factor | [ZB,ZD] | 1.17 | 1.00 |
| Contact stress (N/mm ²) | [sigHB, sigHD] | 1741.98 | 1490.73 |
| Lubrication coefficient at NL | [ZL] | 1.020 | 1.020 |
| Speed coefficient at NL | [ZV] | 0.963 | 0.963 |
| Roughness coefficient at NL | [ZR] | 0.920 | 0.920 |
| Material pairing coefficient at NL | [ZW] | 1.000 | 1.000 |
| Finite life factor | [ZNT] | 1.000 | 1.000 |
| | [ZL*ZV*ZR*ZNT] | 0.904 | 0.904 |
| Limited pitting is permitted: | No | | |
| Size factor (flank) | [ZX] | 1.000 | 1.000 |
| Permissible contact stress (N/mm ²) | [sigHP=sigHG/SHmin] | 1712.93 | 1554.74 |
| Pitting stress limit (N/mm ²) | [sigHG] | 1712.93 | 1554.74 |
| Required safety | [SHmin] | 1.00 | 1.00 |
| Safety factor for contact stress at operating pitch circle | | | |
| | [SHw] | 1.15 | 1.04 |
| Safety for stress at single tooth contact | [SHBD=sigHG/sigHBD] | 0.98 | 1.04 |
| (Safety regarding transmittable torque) | [(SHBD)^2] | 0.97 | 1.09 |
| Transmittable power (W) | [WRating] | 413.13 | 464.74 |

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] | 1.000 | |
| Scuffing test and load stage | [FZGtest] | FZG - Test A / 8.3 / 90 (ISO 14635 - 1) | 12 |
| Relative structure coefficient (Scuffing) | [XWrelT] | 1.000 | |
| Thermal contact factor (N/mm/s ^{0.5} /K) | [BM] | 13.780 | 13.780 |
| Relevant tip relief (μm) | [Ca] | 1.60 | 1.50 |
| Optimal tip relief (μm) | [Ceff] | 6.93 | |

| | | | |
|--|-------------|------------------|---|
| Ca taken as optimal in the calculation (0=no, 1=yes) | | 0 | 0 |
| Effective facewidth (mm) | [beff] | 6.000 | |
| Applicable circumferential force/facewidth (N/mm) | [wBt] | 68.879 | |
| Angle factor (ϵ_1 :0.738, ϵ_2 :0.560) | [Xalfbet] | 1.038 | |
| Flash temperature-criteria | | | |
| Tooth mass temperature (°C) (theMB = theoil + XS*0.47*theflamax) | [theMB] | 80.21 | |
| Maximum flash temperature (°C) | [theflamax] | 21.71 | |
| Scuffing temperature (°C) | [theS] | 408.58 | |
| Coordinate gamma (point of highest temp.) [Gamma.A]=-0.652 [Gamma.E]=0.859 | [Gamma] | -0.652 | |
| Highest contact temp. (°C) | [theB] | 101.92 | |
| Flash factor ($^{\circ}\text{K} \cdot \text{N}^{-1} \cdot 75 \cdot \text{s}^{-1} \cdot \text{m}^{-1} \cdot 5 \cdot \text{mm}$) | [XM] | 50.109 | |
| Geometry factor | [XB] | 0.504 | |
| Load sharing factor | [XGam] | 0.333 | |
| Dynamic viscosity (mPa*s) | [etaM] | 28.41 (70.0 °C) | |
| Coefficient of friction | [mym] | 0.161 | |
| Required safety | [SBmin] | 2.000 | |
| Safety factor for scuffing (flash temperature) | [SB] | 10.604 | |
| Integral temperature-criteria | | | |
| Tooth mass temperature (°C) (theMC = theoil + XS*0.70*theflaint) | [theMC] | 76.16 | |
| Mean flash temperature (°C) | [theflaint] | 8.81 | |
| Integral scuffing temperature (°C) | [theSint] | 408.58 | |
| Flash factor ($^{\circ}\text{K} \cdot \text{N}^{-1} \cdot 75 \cdot \text{s}^{-1} \cdot \text{m}^{-1} \cdot 5 \cdot \text{mm}$) | [XM] | 50.109 | |
| Contact ratio factor | [Xeps] | 0.307 | |
| Dynamic viscosity (mPa*s) | [etaOil] | 41.90 (70.0 °C) | |
| Mean coefficient of friction | [mym] | 0.107 | |
| Geometry factor | [XBE] | 0.337 | |
| Meshing factor | [XQ] | 1.000 | |
| Tip relief factor | [XCa] | 1.007 | |
| Integral tooth flank temperature (°C) | [theint] | 89.37 | |
| Required safety | [SSmin] | 1.800 | |
| Safety factor for scuffing (intg.-temp.) | [SSint] | 4.572 | |
| Safety referring to transmittable torque | [SSL] | 17.478 | |

6. MEASUREMENTS FOR TOOTH THICKNESS

| | | ----- Gear 1 ----- | Gear 2 -- |
|---|-----------|--------------------|-----------------|
| | | DIN 3967 cd25 | DIN 3967 cd25 |
| Tooth thickness deviation | | | |
| Tooth thickness allowance (normal section) (mm) | [As.e/i] | -0.040 / -0.060 | -0.054 / -0.084 |
| Number of teeth spanned | [k] | 2.000 | 9.000 |
| Base tangent length (no backlash) (mm) | [Wk] | 2.460 | 13.306 |
| Actual base tangent length ('span') (mm) | [Wk.e/i] | 2.422 / 2.403 | 13.255 / 13.227 |
| (mm) | [ΔWk.e/i] | -0.038 / -0.056 | -0.051 / -0.079 |
| Diameter of measuring circle (mm) | [dMWk.m] | 6.133 | 34.151 |
| Theoretical diameter of ball/pin (mm) | [DM] | 1.117 | 0.919 |
| Effective diameter of ball/pin (mm) | [DMeff] | 1.250 | 1.000 |
| Radial single-ball measurement backlash free (mm) | [MrK] | 4.276 | 17.958 |
| Radial single-ball measurement (mm) | [MrK.e/i] | 4.246 / 4.231 | 17.899 / 17.866 |
| Diameter of measuring circle (mm) | [dMMr.m] | 6.518 | 34.352 |
| Diametral measurement over two balls without clearance (mm) | [Mdk] | 8.552 | 35.907 |

| | | | | | |
|---|------------------|---------|----------|----------|--------|
| Diametral two ball measure (mm) | [MdK.e/i] | 8.492 / | 8.462 | 35.788 / | 35.722 |
| Diametral measurement over pins without clearance (mm) | [MdR] | | 8.552 | | 35.907 |
| Measurement over pins according to DIN 3960 (mm) | [MdR.e/i] | 8.492 / | 8.462 | 35.788 / | 35.722 |
| Measurement over 3 pins (axial) according to AGMA 2002 (mm) | | | | | |
| | [dk3A.e/i] | 8.492 / | 8.462 | 35.788 / | 35.722 |
| Dimensions over 3 pins without clearance (mm) | [Md3R] | | 0.000 | | 35.897 |
| Effective dimensions over 3 pins (mm) | [Md3R.e/i] | 0.000 / | 0.000 | 35.779 / | 35.712 |
| Chordal tooth thickness (no backlash) (mm) | [sc] | | 0.953 | | 1.094 |
| Actual chordal tooth thickness (mm) | [sc.e/i] | 0.913 / | 0.893 | 1.040 / | 1.010 |
| Reference chordal height from da.m (mm) | [ha] | | 0.710 | | 0.869 |
| Tooth thickness (Arc) (mm) | [sn] | | 0.957 | | 1.094 |
| (mm) | [sn.e/i] | 0.917 / | 0.897 | 1.040 / | 1.010 |
| Backlash free center distance (mm) | [aControl.e/i] | | 20.239 / | 20.180 | |
| Backlash free center distance, allowances (mm) | [jta] | | -0.109 / | -0.169 | |
| dNf.i with aControl (mm) | [dNf0.i] | | 5.638 | | 33.391 |
| Reserve (dNf0.i-dFf.e)/2 (mm) | [cF0.i] | | -0.001 | | 0.090 |
| Tip clearance (mm) | [c0.i(aControl)] | | 0.030 | | 0.011 |
| Center distance allowances (mm) | [Aa.e/i] | | 0.011 / | -0.011 | |
| Circumferential backlash from Aa (mm) | [jtw_Aa.e/i] | | 0.009 / | -0.009 | |
| Radial clearance (mm) | [jrw.e/i] | | 0.179 / | 0.099 | |
| Circumferential backlash (transverse section) (mm) | [jtw.e/i] | | 0.158 / | 0.087 | |
| Normal backlash (mm) | [jnw.e/i] | | 0.148 / | 0.082 | |
| Torsional angle at entry with fixed output: | | | | | |
| Entire torsional angle (°) | [j.tSys] | | | 2.9252 / | 1.6203 |

7. GEAR ACCURACY

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

According to DIN 3961:1978

One or several gear data (mn, b or d) lay beyond the limits covered by the standard.

The tolerances are calculated on the basis of the formulae in the standard.

However, their values are outside the official range of validity!

| | | | |
|--|-------------|-------|-------|
| Accuracy grade | [Q-DIN3961] | 6 | 6 |
| Profile form deviation (μm) | [ff] | 4.50 | 4.50 |
| Profile slope deviation (μm) | [fHa] | 4.50 | 4.50 |
| Total profile deviation (μm) | [Ff] | 6.00 | 6.00 |
| Helix form deviation (μm) | [fbf] | 4.00 | 4.00 |
| Helix slope deviation (μm) | [fHb] | 8.00 | 8.00 |
| Total helix deviation (μm) | [Fb] | 9.00 | 9.00 |
| Normal base pitch deviation (μm) | [fpe] | 6.00 | 6.00 |
| Single pitch deviation (μm) | [fp] | 6.00 | 6.00 |
| Adjacent pitch difference (μm) | [fu] | 8.00 | 8.00 |
| Total cumulative pitch deviation (μm) | [Fp] | 13.00 | 17.00 |
| Sector pitch deviation over z/8 pitches (μm) | [Fpz/8] | 8.00 | 10.00 |
| Runout (μm) | [Fr] | 9.00 | 10.00 |
| Tooth Thickness Variation (μm) | [Rs] | 5.00 | 6.00 |
| Single flank composite, total (μm) | [Fi'] | 15.00 | 18.00 |
| Single flank composite, tooth-to-tooth (μm) | [fi'] | 9.00 | 9.00 |
| Radial composite, total (μm) | [Fi''] | 12.00 | 14.00 |
| Radial composite, tooth-to-tooth (μm) | [fi''] | 4.00 | 5.50 |

According to DIN 58405:1972 (Feinwerktechnik):

| | | | |
|-------------------------------------|--------|-------|-------|
| Tooth-to-tooth composite error (μm) | [fi''] | 4.50 | 6.00 |
| Composite error (μm) | [Fi''] | 12.00 | 18.00 |

| | | | |
|----------------------------|-----------|-------|-------|
| Axis alignment error (µm) | [fp] | 3.46 | 3.46 |
| Flank direction error (µm) | [fbeta] | 5.00 | 5.00 |
| Runout (µm) | [Trk, Fr] | 16.00 | 21.00 |

8. ADDITIONAL DATA

| | | | |
|--|-------------|------------|------------|
| Maximal possible center distance (eps_a=1.0) | [aMAX] | 20.532 | |
| Mass (g) | [m] | 1.46 | 11.24 |
| Total mass (g) | [m] | 12.70 | |
| calculation without consideration of the exact tooth shape | | | |
| single gears ((da+df)/2...di) (kg*m²) | [TraeghMom] | 7.197e-009 | 2.851e-006 |
| Torsional stiffness on input for stopped output: | | | |
| Torsional stiffness (MNm/rad) | [cr] | 0.000 | |
| Torsion when subjected to nominal torque (°) | [delcr] | 0.101 | |
| Mean coeff. of friction (acc. Niemann) | [mum] | 0.200 | |
| Wear sliding coef. by Niemann | [zetw] | 0.787 | |
| Gear power loss (W) | [PVZ] | 14.772 | |
| (Meshing efficiency (%)) | [etaz] | 96.543 | |
| Sound pressure level (according to Masuda, without contact analysis) | | | |
| | [dB(A)] | 39.7 | |

9. MODIFICATIONS AND TOOTH FORM DEFINITION

Data for the tooth form calculation :

Data not available.

10. SERVICE LIFE, DAMAGE

| | | |
|---------------------------------|---------|------|
| 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] | 15.889 |
|-------------------------|--------|--------|

| | | | |
|------------------------------|---------|--------|--------|
| Tooth root service life (h) | [HFatt] | 1e+006 | 15.89 |
| Tooth flank service life (h) | [HHatt] | 38.56 | 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] (2000.0 h)

| F1% | F2% | H1% | H2% |
|------|-----------|-----------|--------|
| 0.00 | 9999.9900 | 5187.1451 | 0.0000 |

Damage calculated on basis of system service life [Hatt] (15.9 h)

| F1% | F2% | H1% | H2% |
|------|----------|---------|--------|
| 0.00 | 100.0000 | 41.2101 | 0.0000 |

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

$$R(t) = 100 * \exp(-((t^{*fac} - t_0)/(T - t_0))^b) \%$$

| Gear | | fac | b | t0 | T | R(H)% |
|------|-------------|---------|-----|------------|------------|--------|
| 1 | Tooth root | 1080000 | 1.7 | 9.654e+029 | 1.484e+030 | 100.00 |
| 1 | Tooth flank | 1080000 | 1.3 | 3.754e+007 | 1.788e+008 | 0.00 |
| 2 | Tooth root | 64478 | 1.7 | 9.89e+005 | 1.52e+006 | 0.00 |

| | | | | | | |
|---|-------------|-------|-----|------------|------------|--------|
| 2 | Tooth flank | 64478 | 1.3 | 9.014e+029 | 4.295e+030 | 100.00 |
|---|-------------|-------|-----|------------|------------|--------|

Reliability of the configuration for required service life (%) 0.00 (Bertsche)

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
 - KHb, KFb according method C
 - KHa, KFa according to method B

End of Report

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