KISSsoft-Hirnware LZ0
File name : Z:/JohnDeere_S/2009_07_20_2Synchro_Gearbox/Analysis/KISS/synchro-djh-5sat-ET_Bend.Z14
Project :
Date : 25.01.2011/07:12:30 User : example
Description : No.:

## CYLINDRICAL GEAR CALCULATION (Planetary gears)

Drawing or article number:
Gear 1: 0.000.0
Gear 2: 0.000.0
Gear 3: 0.000.0

Calculation-method ISO 6336 Method B (YF Method C)

| | | Gear 1 | Gear 2 | Gear 3 |
|---|---|---|---|---|
| Number of planets/intermediate wheels | [No.wheel] | (1) | 5 | (1) |
| Nominal power (kW) | [P] | | 218.74 | |
| Speed (UpM) | [n] | 625.0 | -709.2 | 0.0 |
| Speed Pl.-Carrier (1/min) | [nSteg] | | 194.4 | |
| Torque (Nm) | [T] | 3342.1 | 0.0 | 7400.4 |
| Torque Pl.-Carrier (Nm) | [TSteg] | | 10742.468 | |
| Application factor | [KA] | | 1.20 | |
| Power distribution factor | [Kgam] | | 1.00 | |
| Service life in hours | [H] | | 75.00 | |
| Gear driving (+) / driven (-) | | + | -/+ | - |

### 1. TOOTH GEOMETRY AND MATERIAL

(Geometry calculation according DIN 3960)

| | | Gear 1 | Gear 2 | Gear 3 |
|---|---|---|---|---|
| Centre distance (mm) | [a] | | 89.500 | |
| Centre distance tolerances | | | ISO 286 Measure js7 | |
| Normal module (mm) | [mn] | | 4.0000 | |
| Pressure angle at normal section (°) | [alfn] | | 20.0000 | |
| Helix angle at Pitch diameter (°) | [beta] | | 0.0000 | |
| Number of teeth | [z] | 28 | 17 | -62 |
| Facewidth (mm) | [b] | 76.00 | 75.00 | 74.60 |
| Chamfer Facewidth (mm) | [Faseb] | 2.00 | 2.00 | 2.00 |
| Accuracy grade | [Q-ISO1328] | 8 | 8 | 8 |
| Inner diameter of ring (mm) | [dRing] | 0.00 | 0.00 | |
| Outer diameter ring (mm) | [dRing] | | | 0.00 |
| Internal diameter gearbody di (mm) | [di] | 0.00 | 0.00 | |
| Outer diameter gearbody di (mm) | [di] | | | 270.00 |

Material
Gear 1: 18CrNiMo7-6 (1) (>=28HRC core), Case-hardening steel, case-hardened
DIN 3990-5 Figure 4a/4b (MQ), core strength >=28HRC
Gear 2: 18CrNiMo7-6 (1) (>=28HRC core), Case-hardening steel, case-hardened
DIN 3990-5 Figure 4a/4b (MQ), core strength >=28HRC
Gear 3: 31 CrMoV9, Nitriding steel, gas-nitrided
DIN 3990-5 Figure 5a/5b (MQ)

| | | Gear 1 | Gear 2 | Gear 3 |
|---|---|---|---|---|
| Surface hardness | | HRC 61 | HRC 61 | HV 800 |
| Material treatment according to ISO 6336: ML (normal) | | | | |
| Fatigue str. tooth root tension (N/mm²) | [sigFlim] | 430.00 | 430.00 | 425.00 |
| Fatigue str. Hertzian stress (N/mm²) | [sigHlim] | 1500.00 | 1500.00 | 1250.00 |
| Yield point (N/mm²) | [sigs] | 850.00 | 850.00 | 900.00 |
| Youngs modulus (N/mm²) | [E] | 206000 | 206000 | 206000 |
| Poisson number | [ny] | 0.300 | 0.300 | 0.300 |
| Mean roughness tooth flank (µm) | [RZH] | 6.30 | 6.30 | 23.00 |
| Mean roughness tooth root (µm) | [RZF] | 23.00 | 23.00 | 23.00 |
| Dedendum reference profile (module) | [hfP*] | 1.25 | 1.25 | |

1.25
Tooth root radius Refer. profile (module)
[rofP*] 0.38 0.38
0.38
Addendum Reference profile (module) [haP*] 1.00 1.00
0.80
Minimum root height of the tool (module) [hf0P*.i] > 1.064 > 1.064 >
0.884
Protuberance height (module) [hk*] 0.00 0.00
0.00
Protuberance angle (°) [alfPro] 0.00 0.00
0.00
Shaping cutter, Number of teeth [z0]
20
Shaping cutter, Addendum modification [x0]
0.0000
Shaping cutter, tip circle (mm) [da0]
90.000
Shaping cutter, Radius at tip (mm) [ra0]
0.976
Type of profile modification: No
Tip relief (µm) [Ca] 2 2
3

Type of lubrication oil bath lubrication
Type of oil Oil: ISO-VG 68
Lubricant base Mineral-oil base
Kinem. viscosity oil at 40 °C (mm²/s) [nu40] 68.00
Kinem. viscosity oil at 100 °C (mm²/s) [nu100] 8.80
FZG-Test A/8.3/90 step [FZGtestA] 12
Specific density at 15 °C (kg/dm³) [roOil] 0.885
Oil temperature (°C) [theOil] 70.000

ambient temperature (°C) [theUmg] 20.000

------- Gear 1 ---------- Gear 2 ---------- Gear
3 ---
Overall transmission ratio [itot] 3.214
Gear ratio [u] 0.607 -3.647
Transverse module (mm) [mt] 4.000
Pressure angle at Pitch circle (°) [alft] 20.000
Working transverse pressure angle (°) [alfwt] 19.101 19.101
[alfwt.e/i] 19.133 / 19.069 19.069 / 19.133
Base helix angle (°) [betab] 0.000
Reference centre distance (mm) [ad] 90.000 -90.000
Sum of the Addendum modification [Summexi] -0.1223 0.1223
Addendum modification coefficient [x] -0.2447 0.1223
0.0000
Tooth thickness (Arc) (module) [sn*] 1.3927 1.6598
1.5708
Tooth thickness (Arc) (mm) [sn] 5.5708 6.6394
6.2832
(mm) [sn.e/i] 5.486 / 5.386 6.554 / 6.454 6.168 /
6.038

Modification of tip diam. (mm) [k*mn] 0.000 0.000
0.000
Reference diameter (mm) [d] 112.000 68.000
-248.000
Base diameter (mm) [dB] 105.246 63.899
-233.044
Tip diameter (mm) [da] 118.043 76.979
-241.600
(mm) [da.e/i] 118.043 / 117.943 76.979 / 76.879 -241.600 /
-241.700
Tip diameter tolerance (mm) [Ada.e/i] 0.000 / -0.100 0.000 / -0.100 0.000 /
-0.100
Chamfer (1) / Tip rounding (2) / pointed tooth (3) 1 1 1
Tip chamfer/ tip rounding (mm) [Fased] 0.100 0.100
0.100
Tip form circle (mm) [dFa.e/i] 117.843 / 117.743 76.779 / 76.679 -241.800 /
-241.900
Operating pitch diameter (mm) [dw] 111.378 67.622/67.622
-246.622
[dw.e/i] 111.400 / 111.356 67.635 / 67.609 67.609 /
67.635
Root diameter (mm) [df] 100.043 58.979
-258.000
Manufacturing addendum modification [xE.e/i] -0.2738 / -0.3082 0.0931 / 0.0588 -0.0395 /
-0.0841
Manufactured root diameter with xE (mm) [df.e] 99.81 58.75
-258.32
Manufactured root diameter with xE (mm) [df.i] 99.53 58.47
-258.67
Theoretical tip clearence (mm) [c] 0.989 0.989/1.011

| | | | | |
|---|---|---|---|---|
| 1.811 | | | | |
| Tip clearence upper allowance (mm) | [c.e] | 1.311 | 1.311/1.415 | |
| 2.132 | | | | |
| Tip clearence lower allowance (mm) | [c.i] | 1.089 | 1.089/1.151 | |
| 1.910 | | | | |
| Active root diameter (mm) | [dNf] | 106.456 | 64.141/64.171 | |
| -254.045 | | | | |
| | [dNf.e] | 106.500 | 64.170/64.218 | |
| -253.931 | | | | |
| | [dNf.i] | 106.440 | 64.132/64.162 | |
| -254.088 | | | | |
| Root form circle (mm) | [dFf] | 105.646 | 63.957 | |
| -256.942 | | | | |
| | [dFf.e/i] | 105.589 / 105.527 | 63.932 / 63.911 | -257.332 |
| / -257.777 | | | | |
| Reserve (dNf-dFf)/2 (mm) | [rNf-rFf.e/i] | 0.486 / 0.426 | 0.130 / 0.100 | 1.923 / |
| 1.622 | | | | |
| Addendum (mm) | [ha] | 3.021 | 4.489 | |
| 3.200 | | | | |
| (mm) | [ha.e/i] | 3.021 / 2.971 | 4.489 / 4.439 | 3.200 / |
| 3.150 | | | | |
| Dedendum (mm) | [hf] | 5.979 | 4.511 | |
| 5.000 | | | | |
| (mm) | [hf.e/i] | 6.095 / 6.233 | 4.627 / 4.765 | 5.158 / |
| 5.337 | | | | |
| Profile angle to dFa (°) | [alf_dNa_t.e/i] | 26.734 / 26.638 | 33.669 / 33.557 | 15.466 / |
| 15.552 | | | | |
| Profile angle to dFf (°) | [alf_dNf0_t.e/i] | 4.624 / 4.189 | 1.834 / 1.115 | 25.094 / |
| 25.304 | | | | |
| Tooth depth (mm) | [H] | 9.000 | 9.000 | |
| 8.200 | | | | |
| Virtual gear no. of teeth | [zn] | 28.000 | 17.000 | |
| -62.000 | | | | |
| Normal Tooth thickness at Tip cyl. (mm) | [san] | 3.150 | 2.486 | |
| 4.097 | | | | |
| (mm) | [san.e/i] | 3.109 / 2.956 | 2.454 / 2.277 | 4.014 / |
| 3.858 | | | | |
| (without consideration of tip chamfer/ tip rounding) | | | | |
| Normal Tooth space as Tip cylinder (mm) | [efn] | 0.000 | 0.000 | |
| 2.241 | | | | |
| (mm) | [efn.e/i] | 0.000 / 0.000 | 0.000 / 0.000 | 2.212 / |
| 2.180 | | | | |
| Max. sliding speed at tip (m/s) | [vga] | 0.989 | 1.220 | |
| 0.551 | | | | |
| Max. sliding speed at tip (m/s) | [vga] | 0.989 | 1.220/0.551 | 0.437 |
| Specific sliding at the tip | [zetaa] | 0.827 | 0.772/0.348 | 0.666 |
| Specific sliding at the root | [zetaf] | -3.379 | -4.785/-1.994 | -0.535 |
| Sliding factor on tip | [Kga] | 0.394 | 0.486 | |
| 0.219 | | | | |
| Sliding factor on root | [Kgf] | -0.486 | -0.394 | |
| -0.174 | | | | |
| Pitch (mm) | [pt] | | 12.566 | |
| Base pitch (mm) | [pbt] | | 11.809 | |
| Transverse pitch on contact-path (mm) | [pet] | | 11.809 | |
| Axial pitch (mm) | [px] | 0.000 | 0.000 | |
| 0.000 | | | | |
| Length of path of contact (mm) | [ga] | | 18.501 | 18.330 |
| (mm) | [ga.e/i] | | 18.555 / 18.246 | 18.383 / 17.999 |
| Length T1-A (mm) | [T1A] | | 8.005 | 2.953 |
| Length T1-B (mm) | [T1B] | | 14.698 | 9.474 |
| Length T1-C (mm) | [T1C] | | 18.223 | 11.064 |
| Length T1-D (mm) | [T1D] | | 19.813 | 14.761 |
| Length T1-E (mm) | [T1E] | | 26.506 | 21.283 |
| | | | | |
| Transverse contact ratio | [Eps.a] | | 1.567 | 1.552 |
| Transverse contact ratio, effective | [Eps.aEffe/i] | | 1.571 / 1.545 | 1.557 / 1.524 |
| Overlap ratio | [Eps.b] | | 0.000 | 0.000 |
| Total contact ratio | [Eps.G] | | 1.567 | 1.552 |
| Total contact ratio, effective | [Eps.gEffe/i] | | 1.571 / 1.545 | 1.557 / 1.524 |

**2. FACTORS OF GENERAL INFLUENCE**

| | | ------- Gear 1 | ---------- Gear 2 | ---------- Gear |
|---|---|---|---|---|
| 3 --- | | | | |
| Nominal circum. force at pitch circle (N) | | | | |
| | [Ft] | 11936.075 | 11936.075 | |
| Axial force (N) | [Fa] | 0.0 | 0.0 | |
| 0.0 | | | | |
| Axial force (total) (N) | [Fa_ges] | 0.0 | | |
| 0.0 | | | | |
| Radial force (N) | [Fr] | 4344.4 | 4344.4 | |
| 4344.4 | | | | |
| Normal force (N) | [Fnorm] | 12702.1 | 12702.1 | |
| 12702.1 | | | | |
| Tangent.load at p.c.d.per mm (N/mm) (N/mm) | | | | |

| | | | | |
|---|---|---|---|---|
| | [w] | | 168.11 | 169.07 |
| Circumferential speed pitch d.. (m/sec) | [v] | | | 2.52 |
| Running in value y.a (µm) | [ya] | | 1.6 | 1.7 |
| Gear body coefficient CR | [CR] | | 1.00 | 1.00 |
| Correction coefficient CM | [CM] | | 0.80 | 0.80 |
| Reference profile coefficient CBS | [CBS] | | 0.98 | 0.98 |
| Singular tooth stiffness (N/mm/µm) | [c'] | | 11.686 | 14.223 |
| Meshing spring stiffness (N/mm/µm) | [cg] | | 16.653 | 20.114 |
| Reduced mass (kg/mm) | [mRed] | | 0.0053 | 0.0134 |
| Resonance speed (min-1) | [nE1] | | 19163 | 21762 |
| Nominal speed (-) | [N] | | 0.033 | 0.033 |
| Subcritical range | | | | |
| Planets are on a bearing on a fixed restraint bolt | | | | |
| Tooth trace deviation (active) (µm) | [Fby] | | 24.48 | 17.85 |
| from deformation of shaft (µm) | [fsh] | | 8.80 | 0.00 |
| Tooth trace | | | 0 | 0 |
| (0:without, 1:crowned, 2:Tip relief, 3:full modification) | | | | |
| from production tolerances (µm) | [fma] | | 20.00 | 21.00 |
| Running in value y.b (µm) | [yb] | | 4.32 | 3.15 |
| Dynamic coefficient | [KV] | | 1.03 | 1.04 |
| Face coefficient - flank | [KHb] | | 1.98 | 1.85 |
| - Tooth root | [KFb] | | 1.82 | 1.72 |
| - Scuffing | [KBb] | | 1.98 | 1.85 |
| Transverse coefficient - flank | [KHa] | | 1.00 | 1.04 |
| - Tooth root | [KFa] | | 1.00 | 1.04 |
| - Scuffing | [KBa] | | 1.00 | 1.04 |
| Helix angle coefficient scuffing | [Kbg] | | 1.00 | 1.00 |
| No of load changes (in mio.) | [NL] | 9.7 | 3.2 | 4.4 |

**3. TOOTH ROOT STRENGTH**

| | | ------- Gear 1 | ---------- Gear 2 | ---------- Gear 3 --- |
|---|---|---|---|---|
| Calculation of Tooth form coefficients according method: C | | | | |
| (Tooth shape coefficients are calculated using the manufacturing addendum modification xE.e for measures > 0.05*mn) | | | | |
| Tooth form factor | [YF] | 2.95 | 2.78/2.78 | 1.79 |
| Stress correction factor | [YS] | 1.49 | 1.57/1.57 | 2.87 |
| Bending lever arm (mm) | [hF] | 7.49 | 7.74/7.74 | 6.61 |
| working angle (°) | [alfen] | 25.20 | 31.79/31.79 | 20.00 |
| Tooth thickness at root (mm) | [sFn] | 7.66 | 7.78 | 9.42 |
| Tooth root radius (mm) | [roF] | 2.61 | 2.19 | 0.60 |
| Contact ratio factor | [Yeps] | 0.73 | 0.73 | |
| Helix angle factor | [Ybet] | 1.00 | 1.00 | |
| Effective facewidth (mm) | [beff] | 76.00 | 75.00/75.00 | 74.60 |
| Local Tooth root stress (N/mm²) | [sigF0] | 125.81 | 126.33/127.10 | 150.65 |
| (Effective)Tooth root stress (N/mm²) | [sigF] | 282.76 | 283.92/282.01 | 334.26 |
| Permissible bending stress at root of Test-gear | | | | |
| Support factor | [Ydrel] | 0.99 | 0.993/0.993 | 1.172 |
| Surface-factor | [YRrelT] | 0.947 | 0.947 | 0.988 |
| Size coefficient (Tooth root) | [YX] | 1.000 | 1.000 | 1.000 |
| Limited-life factor | [YNT] | 0.977 | 0.999 | 0.992 |
| Alternating bending coefficient | [Kwb] | 1.000 | 0.700 | 1.000 |
| Stress correction factor | [Yst] | | 2.00 | |
| Permissible Tooth root stress (N/mm²) | [sigFG] | 787.05 | 565.29/565.29 | 976.84 |
| ([sigFP] = [sigFG] / [SFmin]) (N/mm²) | [sigFP] | 562.18 | 403.78/403.78 | 697.74 |
| Nominal safety | [SFmin] | 1.40 | 1.40/1.40 | 1.40 |
| Transmittable power (kW) | [kWRating] | 434.89 | 311.09/313.19 | 456.60 |
| Safety for Tooth root stress | [SF=sigFG/sigF] | 2.78 | 1.99/2.00 | 2.92 |

**4. SAFETY AGAINST PITTING (TOOTH FLANK)**

| | | ------- Gear 1 | ---------- Gear 2 | ---------- Gear 3 --- |
|---|---|---|---|---|
| Zone factor | [ZH] | 2.56 | 2.56 | |
| Elasticity coefficient (N^.5/mm) | [ZE] | 189.81 | 189.81 | |
| Contact ratio factor | [Zeps] | 0.90 | 0.90 | |
| Helix angle factor | [Zbet] | 1.00 | 1.00 | |
| Effective facewidth (mm) | [beff] | 71.00 | 70.60 | |
| Nominal value Surface pressure (N/mm²) | [sigH0] | 871.42 | 589.02 | |
| Surface pressure at Operating pitch diameter (N/mm²) | [sigH] | 1363.45 | 911.86 | |
| Lubrication factor | [ZL] | 0.960 | 0.969/0.969 | 0.946 |
| Speed factor | [ZV] | 0.976 | 0.982/0.982 | 0.968 |
| Roughness-factor | [ZR] | 0.950 | 0.962/0.938 | 0.891 |
| Material mating factor | [ZW] | 1.000 | 1.000/1.000 | 1.000 |
| Limited-life factor | [ZNT] | 1.132 | 1.231 | 0.985 |
| Minimal no. of pittings permissible: | | no | | |
| Size coefficient (flank) | [ZX] | 1.000 | 1.000 | 1.000 |
| Permissible surface pressure (N/mm²) | [sigHG] | 1512.47 | 1691.90/1648.79 | 1004.49 |
| ([sigHP] = [sigHG] / [SHmin]) (N/mm²) | [sigHP] | 1512.47 | 1691.90/1648.79 | 1004.49 |
| Safety for surface pressure at pitch diameter | [SHw] | 1.11 | 1.24/1.81 | 1.10 |
| Single tooth contact factor | [ZBD] | 1.00 | 1.04/1.10 | 1.00 |
| Surface pressure single tooth con. (N/mm²) | [sigHBD] | 1363.45 | 1413.06/1005.40 | 911.86 |
| Nominal safety | [SHmin] | 1.00 | 1.00/1.00 | 1.00 |
| Transmittable power (kW) | [kWRating] | 269.17 | 313.59/588.27 | 265.44 |
| Safety for stress at single tooth contact | [SH=sigHG/sigHBD] | 1.11 | 1.20/1.64 | 1.10 |

**5. STRENGTH AGAINST SCUFFING**

| | | | | |
|---|---|---|---|---|
| Calculation method according DIN3990 | | | | |
| Lubrication coefficient (Scoring) | [XS] | 1.000 | | |
| Relative structure coefficient (Scoring) | [XWrelT] | 1.000 | 1.000 | |
| Angle factor | [Xalfbet] | 0.964 | 0.964 | |
| (eps1: 0.701/0.865, eps2: 0.865/0.687) | | | | |
| Therm. contact factor (N/mm/s^.5/K) | [BM] | 13.795 | 13.795 | 13.795 |
| Average roughness, Ra, tooth flank (µm) | [RAH] | 0.80 | 0.80 | 3.60 |
| Applicable circumferential force/tooth width | [wbt] | 411.550 | 405.187 | |
| Flashtemperature-criteria | | | | |
| Tooth mass temperature (°C) | [them] | 132.600 | 107.017 | |
| theM-B = theoil + XS*0.47*theflamax | [theflamax] | 133.19 | 78.76 | |
| Scuffing temperature (°C) | [thes] | 444.866 | 444.866 | |
| Coordinate gamma (point of highest temp.) | [Gamma] | -0.749 | -0.733 | |
| Highest contact temp. (°C) | [theB] | 265.791 | 185.776 | |
| Flash factor | [XM] | 50.002 | 50.002 | |
| Geometry-factor | [XB] | 0.664 | 0.333 | |
| Distribution factor | [XGam] | 0.333 | 0.333 | |
| Coefficient of friction | [mymy] | 0.265 | 0.315 | |
| Nominal safety | [SBmin] | 2.000 | | |
| Safety coefficient for scuffing (flash-temp) | [SB] | 1.915 | 3.238 | |
| Integraltemperature-criteria | | | | |
| Tooth mass temperature (°C) | [theMC] | 100.180 | 77.339 | |
| theM-C = theoil + XS*0.70*theflaint | [theflaint] | 43.11 | 10.48 | |
| Scuffing temperature (°C) | [theSint] | 444.866 | 444.866 | |
| Flash factor | [XM] | 50.002 | 50.002 | |
| Contact ratio factor | [XE] | 0.251 | 0.252 | |
| Mean coefficient of friction | [mym] | 0.137 | 0.144 | |
| Geometry-factor | [XBE] | 0.553 | 0.129 | |
| Meshing factor | [XQ] | 1.000 | 1.000 | |
| Tip relief-factor | [XCa] | 1.000 | 1.000 | |
| Integral-tooth flank temperature (°C) | [theint] | 164.852 | 93.065 | |
| Nominal safety | [SSmin] | 1.80 | | |
| Safety coefficient for scuffing (intg.-temp.) | [SSint] | 2.70 | 4.78 | |
| Safety referring to transfered torque | [SSL] | 3.95 | 16.25 | |

**6. TOOTH THICKNESS DIMENSIONS**

| | | ------- Gear 1 | ---------- Gear 2 | ---------- Gear 3 --- |
|---|---|---|---|---|

| Tooth thickness tolerance | | DIN3967 c27 | DIN3967 c27 | DIN3967 c27 |
|---|---|---|---|---|
| Tooth thickness allowance (normal section) (mm) | [As.e/i] | -0.085/-0.185 | -0.085/-0.185 | -0.115/-0.245 |
| No of teeth over which to measure | [k] | 3.000 | 3.000 | -7.000 |
| Diameter of contact point (mm) | [dMWk] | 109.554 | 70.938 | -246.467 |
| Base tangent length ('span') (no backlash) (mm) | [Wk] | 30.421 | 30.808 | -80.229 |
| Effective base tangent length ('span') (mm) | [Wk.e/i] | 30.341/30.247 | 30.729/30.635 | -80.337/-80.459 |
| Theor. ball/roller diameter (mm) | [dm] | 6.628 | 7.192 | 6.627 |
| Eff. ball/roller diameter (mm) | [DMeff] | 7.000 | 7.500 | 7.000 |
| Diameter of contact point (mm) | [dMMr] | 110.813 | 69.399 | -246.830 |
| Theor. dim. centre to ball (mm) | [MrK] | 60.100 | 40.077 | -118.806 |
| Real dimension centre to ball (mm) | [MrK.e/i] | 59.991/59.861 | 39.993/39.893 | -118.983/-119.180 |
| Theor. dimension over two balls (mm) | [MdK] | 120.200 | 79.844 | -237.612 |
| Real dimension over balls (mm) | [MdK.e/i] | 119.981/119.721 | 79.676/79.477 | -237.966/-238.359 |
| True dimension over rolls (mm) | [MdR.e/i] | 119.981/119.721 | 79.676/79.477 | -237.966/-238.359 |
| Effective dimensions over 3 rolls (mm) | [Md3K.e/i] | 0.000/0.000 | 79.368/79.170 | 0.000/0.000 |
| Chordal tooth thickness without play (mm) | [smn] | 5.569 | 6.629 | 6.283 |
| Effective chordal tooth thickness (mm) | [smn.e/i] | 5.484/5.384 | 6.544/6.444 | 6.168/6.038 |
| Reference chordal height (mm) | [ha] | 3.091 | 4.651 | 3.160 |
| Axial Distance Without Backlash (mm) | [aControl.e/i] | 89.255/88.966 | -89.789/-90.121 | |
| Centre distance deviation (mm) | [Aa.e/i] | 0.018/-0.018 | 0.018/-0.018 | |
| Circumferential backlash (mm) | [jt] | 0.382/0.158 | 0.442/0.188 | |
| Normal backlash (mm) | [jn] | 0.359/0.148 | 0.415/0.177 | |
| entire torsion angle (°) | [j.tSys] | 0.1178/0.2546 | | |

(j.tSys: Torsion angle of planet carrier for blocked shaft)

## 7. TOLERANCES

| | | ------- Gear 1 | ---------- Gear 2 | ---------- Gear 3 --- |
|---|---|---|---|---|
| According ISO 1328: | | | | |
| Accuracy grade | [Q-ISO1328] | 8 | 8 | 8 |
| Single pitch deviation (µm) | [fpb] | 17.0 | 17.0 | 19.0 |
| Profile deviation (µm) | [ffa] | 21.0 | 21.0 | 23.0 |
| Profile angular deviation (µm) | [fHa] | 17.0 | 17.0 | 19.0 |
| Profile total deviation (µm) | [Fa] | 27.0 | 27.0 | 30.0 |
| Helix form deviation (µm) | [ffb] | 20.0 | 20.0 | 21.0 |
| Helix slope deviation (µm) | [fHb] | 20.0 | 20.0 | 21.0 |
| Tooth helix deviation (µm) | [Fb] | 28.0 | 28.0 | 29.0 |
| Total cumulative pitch deviation (µm) | [Fp] | 55.0 | 55.0 | 72.0 |
| Runout tolerance (µm) | [Fr] | 44.0 | 44.0 | 58.0 |
| Total radial composite tolerance (µm) | [Fi"] | 72.0 | 72.0 | 86.0 |
| Tooth-to-tooth radial composite tolerance (µm) | [fi"] | 29.0 | 29.0 | 29.0 |
| Total tangential composite deviation (µm) | [Fi'] | 97.0 | 97.0 | |

117.0
Tooth-to-tooth tangential composite deviation (µm)
[fi'] 42.0 42.0
45.0

**8. ADDITIONAL DATA**

| | | | |
|---|---|---|---|
| Medium coef. of friction (acc. Niemann) | [mum] | 0.088 | 0.097 |
| Wear sliding coef. by Niemann | [zetw] | 1.257 | 0.759 |
| Meshpower (kW) | | 150.688 | 150.688 |
| Power loss from gear load (kW) | | 0.530 | 0.261 |
| Total power loss (kW) | | 3.958 | |
| Total efficiency | | 0.982 | |

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

| | | | | |
|---|---|---|---|---|
| single gears | ((da+df)/2...di) (kgm²) | [TraeghMom] | 0.00820 | 0.00122 |
| | | | | 0.08049 |
| System | ((da+df)/2...di) (kgm²) | [TraeghMom] | 0.01602 | |

Remarks:
- Specifications with [.e/i] imply: Maximum [e] and Minimul value [i] with consideration of all tolerances
- For the flank backlash the center-distance tolerances and the tooth thickness deviation are taken into account. Shown is the maximal and the minimal backlash corresponding to the largest resp. smallest measure.
- Details of calculation method:
  cg according to method B
  KV according to method B
  KHb, KFb according to method C1
  KHa, KFa according to method B

End report lines : 414