



# Planetary gearing

i	Calculation without errors.	Sun	Planet	Ring gear
ii	<input type="checkbox"/> Project information			

## Input section

### 1.0 Options of basic input parameters

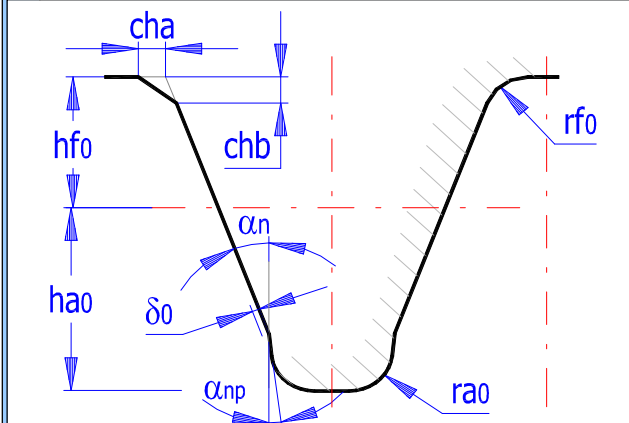
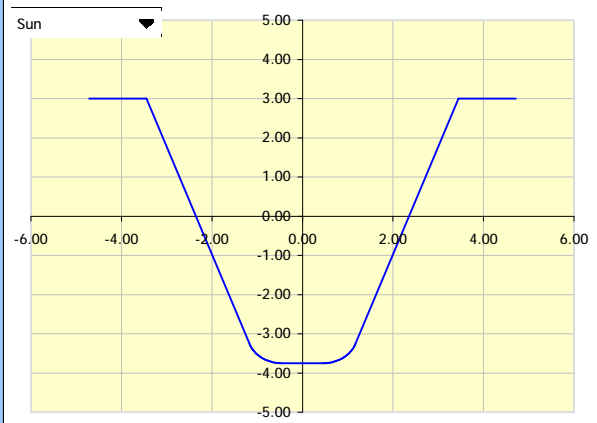
1.1 Calculation units	SI Units (N, mm, kW...)			
1.2 Transmission type (input/output)	Sun => Planet Carrier			
1.3 Transferred power	Pw [kW]	19.51	-19.51	0.00
1.4 Speed (Sun, Planet Carrier, Ring Gear)	n	3000.00	548.39	0.00
1.5 Requested speed for the: Planet Carrier	n	400.00	253.73	~ 750
1.6 Torsional moment (Sun, Planet Carrier, Ring Gear)	Mk	62.11	-339.79	277.68
1.7 Speed (Planet in Planet Carrier)	n		-1389.25	
1.8 Transmission ratio $z1/z0$ , $z2/z1$ , $(z2/z0)$	i	1.765	-2.533	(-4.471)

### 2.0 Options of material, loading conditions, operational and production parameters

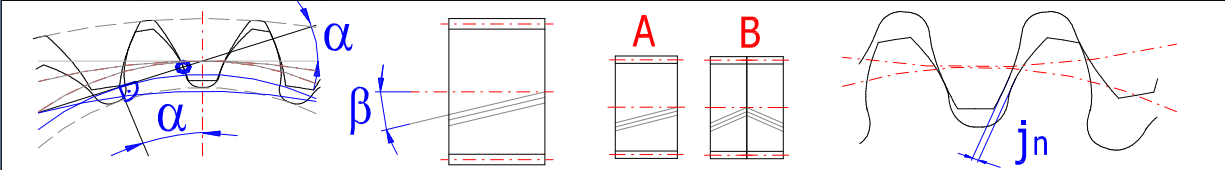
2.1 Material identification according standard :	DIN		
2.2 Material of the sun :	C...Alloy structural steel 37 Cr 4 (Rm=883 MPa) heat treated		
2.3 Material of the planet :	C...Alloy structural steel 37 Cr 4 (Rm=883 MPa) heat treated		
2.4 Material of the ring gear :	C...Alloy structural steel 37 Cr 4 (Rm=883 MPa) heat treated		
2.5 Loading of the gearbox, driving machine - examples	A...Continuous		
2.6 Loading of gearbox, driven machine - examples	A...Continuous		
2.7 Type of gearing mounting	Double-sided symmetrically supported gearing - type 1		
2.8 Accuracy grade - ISO1328  Ra max v max	6.....(Ra max. = 1.6 / v max. = 30)		
2.9 Desired service life	Lh	20000 [h]	
2.10 Coefficient of safety (contact/bend)	SH / SF	1.30	1.60
2.11 Automatic design			

### 3.0 Parameters of the cutting tool and tooth profile

3.1 Standardized tool	2. DIN 867 (a=20deg, ha0=1.25, hf0=1.0, ra0=0.25, d0=0deg, anp=0deg, ca=0.25)				
3.2 Addendum of tool	ha0*	1.2500	1.2500	1.2500	[modul]
3.3 Dedendum of tool	hf0*	1.0000	1.0000	1.2000	[modul]
3.4 Fillet radius of tool	ra0*	0.2500	0.2500	0.0000	[modul]
3.5 Root fillet radius of tool	rf0*	0.0000	0.0000	0.3800	[modul]
3.6 Chamfer of root	cha*	0.0000	0.0000	0.0000	[modul]
3.7 Chamfer of root	chb*	0.0000	0.0000	0.0000	[modul]
3.8 Protuberance height	δ0*	0.0000	0.0000	0.0000	[modul]
3.9 Protuberance angle	αnp	0.0000	0.0000	0.0000	[°]
3.10 Min. unit head clearance	ca*min	0.2500	0.2500	0.1000	[modul]
3.11 Unit head clearance	ca*	0.2500	0.3047		<input type="radio"/> [modul]
3.12 Unit head clearance	ca*		0.3047	0.2500	<input checked="" type="radio"/> [modul]
3.13 Number of Teeth of the cutting tool	z0			30	<input checked="" type="checkbox"/>
3.14 Addendum modification coefficient	x0*			0.00	[modul]
3.15 Tip diameter of the tool	da0			103.276	[mm]



### 4.0 Design of a module and geometry of toothing

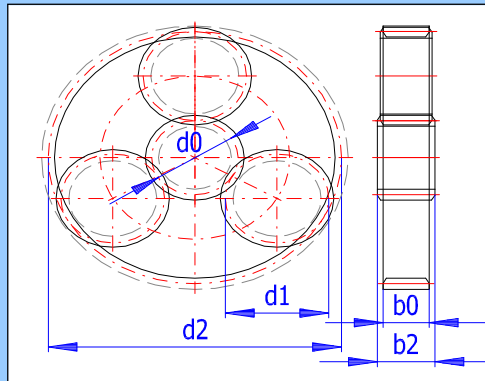
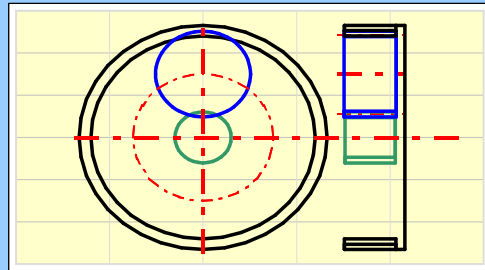
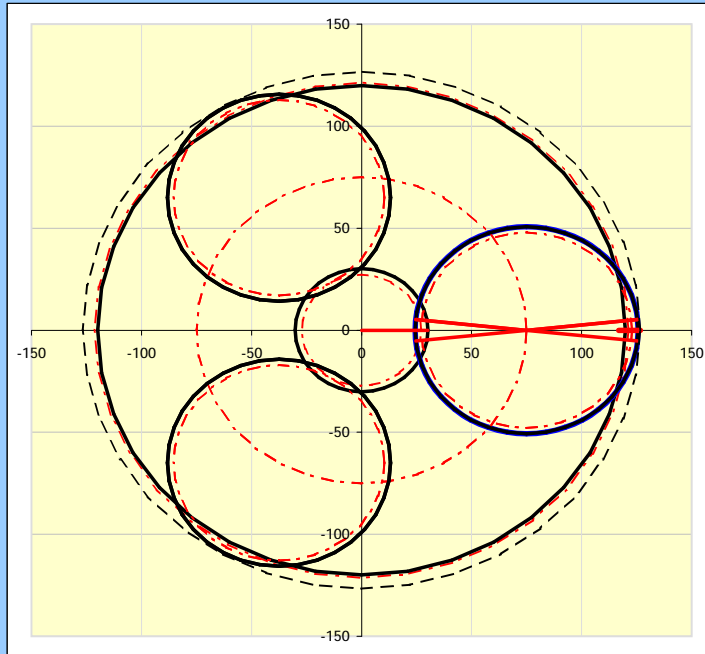


4.1 Number of Planets	3	<= 4	3
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- 4.2 Number of teeth - setting
- 4.3 Number of teeth (Sun, Planet, Ring Gear)
- 4.4 Speed (Sun, Planet Carrier, Ring Gear)
- 4.5 Normal pressure angle
- 4.6 Helix angle
- 4.7 Setting of the ratio of the width of the sun to its diameter
- 4.8 The ratio of the sun width to its diameter
- 4.9 Module / Standardized value
- 4.10 Diametral Pitch (Circular Pitch)
- 4.11 Reference diameter
- 4.12 Recommended width of gearing
- 4.13 Face width (Sun, Planet, Ring Gear)
- 4.14 Working face width
- 4.15 The ratio of the gear width to its diameter
- 4.16 Working center distance
- 4.17 Approximate weight of the gearing
- 4.18 Minimum coefficient of safety
- 4.19 Movement of gears (step and current angle)

Optimal (30) ▼

z	17	30	-76	
n	3000.00	548.39	0.00	[/min]
$\alpha$	20			[°]
$\beta$	20			[°]
$\Psi_d / \max$	1.00	< 1.4		
mn	3			[mm]
P	32.0000			
d0/d1/d2	54.273	95.776	-242.633	[mm]
	30.4 - 76			[mm]
b0/b1/b2	54.000	56.000	55.000	[mm]
bw	54.000	55.000		[mm] <input checked="" type="checkbox"/>
$\Psi_d$	0.99	0.58	0.23	
aw	75.025	-75.025		[mm]
m	0.956	9.345	3.574	[kg]
SH / SF	1.42	10.24		
	10	0		[°]



4.20 Normal backlash

4.21 - Recommended min. | max. value

	0.0520	0.2079	[mm]
4.22 - Selected normal backlash jn	0.0000	0.0000	[mm]

5.0  Correction of toothing (Addendum modification)

5.1 Types

5.2 - Permissible undercutting of teeth (min. value)

	-0.235	-0.567	[modul]
5.3 - Preventing undercutting of teeth (min. value)	-0.118	-0.500	[modul]
5.4 - Prevents tapering of teeth (min. value)	0.219	-0.731	[modul]

5.5 Planet addendum modification coefficient setting

			x1min
5.6 Addendum modification coefficient (Sun, Planet, Ring Gear) x0,x1,x2	0.0000	0.0000	>-2.2619

5.7 Sum of addendum modification coefficients - limit  $\Sigma x$  [modul]

	>-1.1488	<1.1244
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5.8 Sum of addendum modification coefficients (x0+x1, x1+x2)  $\Sigma x$  [modul]

	0.0000	-0.5682
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5.9 Center distance (working) aw [mm]

	75.0245	-75.0246
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5.10 Required axis distance aw [mm]

	150.0491	72.02 ~ 78.02
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5.11 Transverse contact ratio  $\epsilon\alpha$

	1.4251	1.5993
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5.12 Total contact ratio  $\epsilon\gamma$

	3.3847	3.5952
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5.13 Unit tooth thickness on the tip diameter sa\* [modul]

	0.7537	0.8646	0.8733
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5.14 Specific sliding on tooth root  $\partial A0/\partial E1$

	-3.4858	-1.6917
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5.15 Specific sliding on tooth tip  $\partial E0/\partial A1$

	0.6285	0.7771
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5.16 Specific sliding on tooth root  $\partial A1/\partial E2$

		-0.7247	-0.1137
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5.17 Specific sliding on tooth tip  $\partial E1/\partial A2$

		0.1021	0.4202
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5.18 Sum of all specific slidings Sum| $\partial$ |

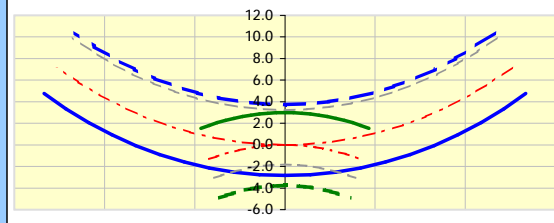
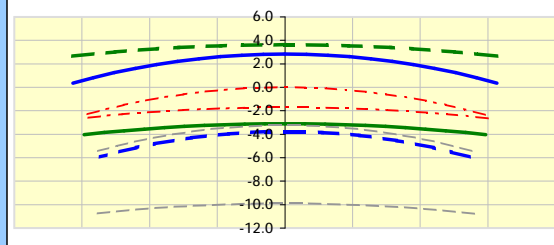
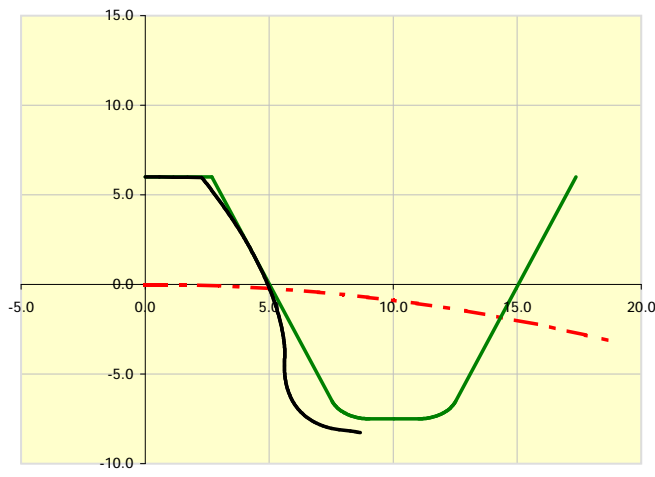
	6.5830	1.3608	Sum = 7.9439
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5.19 Safety coefficient for surface durability SH

	1.42	1.42	3.15
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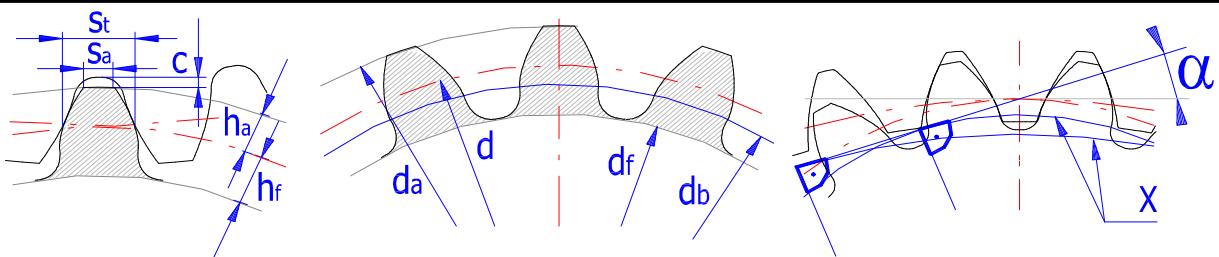
5.20 Safety coefficient for bending durability SF

	14.90	10.24	15.05
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Results section

6.0  Basic dimensions of gearing



- 6.1 Number of teeth (Sun, Planet, Ring Gear)
- 6.2 Face width (Sun, Planet, Ring Gear)
- 6.3 Normal module
- 6.4 Transverse module
- 6.5 Circular pitch
- 6.6 Transverse circular pitch
- 6.7 Base circular pitch
- 6.8 Center distance (pitch)
- 6.9 Center distance (production)
- 6.10 Center distance (working)
- 6.11 Pressure angle
- 6.12 Transverse pressure angle
- 6.13 Pressure angle at the pitch cylinder
- 6.14 Transverse pressure angle at the pitch cylinder
- 6.15 Helix angle
- 6.16 Base helix angle
- 6.17 Tip diameter
- 6.18 Reference diameter
- 6.19 Base diameter
- 6.20 Root diameter
- 6.21 Operating pitch diameter
- 6.22 Operating pitch diameter
- 6.23 Addendum
- 6.24 Dedendum
- 6.25 Tooth thickness on the tip diameter
- 6.26 Tooth thickness on the tip diameter (transverse)
- 6.27 Tooth thickness on the pitch diameter
- 6.28 Tooth thickness on the pitch diameter (transverse)
- 6.29 Tooth thickness on the root diameter
- 6.30 Unit tooth thickness on the tip diameter
- 6.31 Unit head clearance
- 6.32 Hlavová vůle
- 6.33 Unit correction
- 6.34 Sum of addendum modification coefficients
- 6.35 Addendum modification coefficient

z	17	30	-76	
b	54.0000	56.0000	55.0000	[mm]
mn	3.0000	3.0000		[mm]
mt	3.1925	3.1925		[mm]
p	9.4248	9.4248		[mm]
pt	10.0296	10.0296		[mm]
ptb	9.3526	9.3526		[mm]
a	75.0245	-73.4283		[mm]
av	75.0245	-75.1329		[mm]
aw	75.0245	-75.0246		[mm]
$\alpha$	20.0000	20.0000		[°]
$\alpha_t$	21.1728	21.1728		[°]
$\alpha_{wn}$	20.0000	23.2660		[°]
$\alpha_{wt}$	21.1729	24.1252		[°]
$\beta$	20.0000	20.0000		[°]
$\beta_b$	18.7472	18.7472		[°]
da	60.2731	101.4476	-239.8251	[mm]
d	54.2731	95.7760	-242.6325	[mm]
db	50.6094	89.3107	-226.2537	[mm]
df	46.7731	88.2760	-253.3251	[mm]
dw	54.2731	95.7760		[mm]
dw		97.8581	-247.9072	[mm]
ha	3.0000	2.8358	1.4037	[mm]
hf	3.7500	3.7500	5.4546	[mm]
sna	2.0963	2.4201	2.4652	[mm]
sta	2.2611	2.5937	2.6198	[mm]
sn	4.7124	4.7124	3.4715	[mm]
st	5.0148	5.0148	3.6943	[mm]
sb	5.1541	6.1929	8.7423	[mm]
sa*	0.7537	0.8646	0.8733	[modul]
ca*	0.2500	0.305 / 0.305	0.2500	[modul]
ca	0.7500	0.914 / 0.914	0.7500	[mm]
$\Delta Y$		0.0000	-0.0361	[modul]
$\Sigma x_{01} / \Sigma x_{12}$		0.0000	-0.5682	[modul]
x	0.0000	0.0000	-0.5682	[modul]

7.0  Supplemental parameters of gearing

7.1	Number of teeth	z	17	30	-76
7.2	Virtual number of teeth of a helical gear	zn	20.175	35.603	-90.194
<b>Minimum number of teeth:</b>					
7.3	- Permissible undercutting	zmin1	13	13	15
7.4	- Without undercutting	zmin2	15	15	18
7.5	- Without tapering	zmin3	20	20	23

### 8.0 Qualitative indices of gearing

8.1	Transverse contact ratio	$\epsilon_\alpha$	1.4251	1.5993	
8.2	Transverse overlap ratio	$\epsilon_\beta$	1.9596	1.9959	
8.3	Total contact ratio	$\epsilon_\gamma$	3.3847	3.5952	
8.4	Coefficient of gear unloading	Cdi/df	0.00	0.70	1.00 <input checked="" type="checkbox"/>
8.5	Resonance speed	nE	32404.15	11710.70	[ /min]
8.6	Resonance speed		6948.05	2742.65	
8.7	Resonance ratio	N	0.0757	0.1999	
8.8	Approximate weight of the gearing	m	0.96	3.11	3.57 [kg]
8.9	Losses in the gearing	$\zeta$	1.43%	0.77%	
8.10	Losses (gearing, bearings, total)	$\zeta$	0.351	0.047	0.398 [kW]
8.11	Recommended lubricant viscosity	v50	81	81	<input checked="" type="checkbox"/> [mm <sup>2</sup> /sec]

### 9.0 Coefficients for safety calculation

#### Common for the gearing

9.1	Stiffness of a tooth pair	c'	7.412	8.611	
9.2	Meshing stiffness per unit face width	C $\gamma$	9.775	12.480	
9.4	Application factor	KA	1.000		
9.5	Dynamic factor	KV	1.146	1.275	
9.6	Number of cycles	NK	8.83E+09	1.67E+09	1.97E+09

#### For pitting safety calculation

9.7	Face load factor (contact stress)	$K_{H\beta}$	1.097	1.077	
9.8	Transverse load factor (contact stress)	$K_{H\alpha}$	1.589	1.783	
9.9	Total factor of additional loads	KH	1.998	2.449	
9.10	Elasticity factor	ZE	189.81	189.81	
9.11	Zone factor	ZH	2.371	2.205	
9.12	Helix angle factor	Zbeta	0.969	0.969	
9.13	Contact ratio factor	Zeps	0.838	0.791	
9.14	Work hardening factor	ZW	1.000	1.000	
9.15	Lubricant factor	ZL	0.972	0.972	0.972 Mineral oil ▼
9.16	Peripheral speed factor	ZV	0.979	0.979	0.979
9.17	Roughness factor affecting surface durability	ZR	0.840	0.840	0.840 Automatic ▼
9.18	Life factor for contact stress	ZN	0.850	0.850	0.850 n=∞; ZN=0.85 ▼
9.19	Single pair tooth contact factor	ZB	1.000	1.000	
	Single pair tooth contact factor	ZD	1.000	1.000	

#### For bending safety calculation

9.20	Face load factor (root stress)	$K_{F\beta}$	1.086	1.068	
9.21	Transverse load factor (root stress)	$K_{F\alpha}$	1.589	1.783	
9.22	Total factor of additional loads	KF	1.978	2.429	
9.23	Helix angle factor	Ybeta	0.833	0.833	
9.24	Contact ratio factor	Yeps	0.722	0.671	
9.25	Notch sensitivity factor	Ydelta	0.990	0.996	1.072
9.26	Size factor	YX	1.000	1.000	1.000
9.27	Tooth-root surface factor	YR	0.931	0.931	0.931
9.28	Alternating load factor	YA	1.000	0.700	1.000
9.29	Production technology factor	YT	1.000	1.000	1.000
9.30	Life factor	YN	0.850	0.850	0.850 n=∞; YN=0.85 ▼
9.31	Stress correction factor	YST	1.000		
9.32	Form factor (bending)	YFa	3.072	2.647	1.489
9.33	Stress correction factor	YSa	1.563	1.689	3.087
9.34	Tip factor, equal (Yfa x YSa)	YFS	4.802	4.472	4.597

### 10.0 Stress and safety coefficients

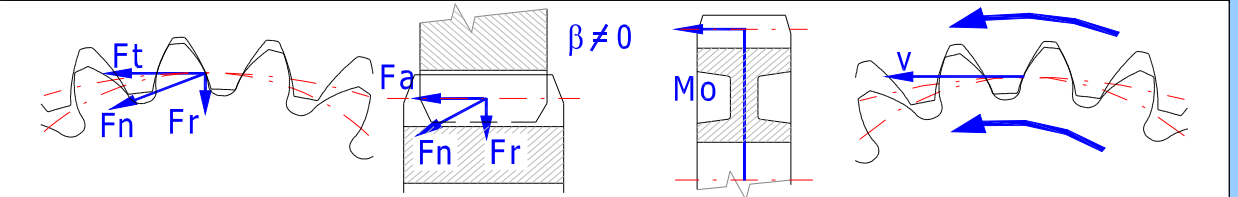
10.1	Safety coefficient for surface durability	SH (S-P)	1.42	1.42	
10.2	Safety coefficient for surface durability	SH (P-R)		3.15	3.15
10.3	Safety coefficient for bending durability	SF (S-P)	14.90	11.68	
10.4	Safety coefficient for bending durability	SF (P-R)		10.24	15.05
10.5	Nominal contact stress	SigmaH0	233.42	95.00	[MPa]
10.6	Contact stress	SigmaH	329.96	329.96	[MPa]
10.7	Contact stress			148.67	148.67 [MPa]
10.8	Pitting stress limit	SigmaHG	468.71	468.71	[MPa]

10.9	Pitting stress limit		468.71	468.71	[MPa]
10.10	Permissible contact stress	SigmaHP	360.55	360.55	[MPa]
10.11	Permissible contact stress		360.55	360.55	[MPa]
10.12	Nominal tooth-root stress	SigmaFO	13.61	12.22	[MPa]
10.13	Nominal tooth-root stress		11.35	11.88	[MPa]
10.14	Tooth-root stress	SigmaF	26.91	24.17	[MPa]
10.15	Tooth-root stress		27.57	28.85	[MPa]
10.16	Tooth-root stress limit	SigmaFG	400.89	282.30	[MPa]
10.17	Tooth-root stress limit		282.30	434.15	[MPa]
10.18	Permissible bending stress	SigmaFP	250.56	176.44	[MPa]
10.19	Permissible bending stress		176.44	271.35	[MPa]

**11.0**  Check dimensions of gearing

11.1	Number of measured teeth	zw	3	5	9	
11.2	Number of measured teeth	zw	3	5	9	<input checked="" type="checkbox"/>
11.3	Chordal dimension	W	22.9937	41.3586	80.2576	[mm]
11.4	Pin/Ball diameter	dt	5.2500	5.2500	5.2500	[mm]
11.5	Pin/Ball diameter	dt	5.2500	5.2500	5.2500	<input checked="" type="checkbox"/> [mm]
11.6	Dimension over pins/balls	M	61.4317	103.2660	238.3757	[mm]

**12.0**  Force conditions (forces acting on the toothing)



12.1	Tangential force	Ft	762.96	762.96	[N]	
12.2	Normal force	Fn	864.03	864.03	[N]	
12.3	Axial force	Fa	833.08	0.00	-833.08	[N]
12.4	Radial force	Fr	295.52	-295.52	[N]	
12.5	Force planet carrier -> planet	Fc-p		1509.69	[N]	
12.6	Centrifugal force on the planet	Fc		338.91	[N]	
12.7	Radial force on the bearing in planet	Fb		1547.26	[N]	
12.8	Rated torque	Mk	20.70	36.15	92.56	[Nm]
12.9	Rated rotational speed	n	2451.6	-1389.2	548.4	[/min]
12.10	Bending moment (planet gear)	Mo	0.00	28.17	0.00	[Nm]
12.11	Peripheral speed on the pitch diameter	v   vmax	6.967	< 30	[m/s]	
12.12	Specific load	wt	14.129	13.87	[N/mm]	
12.13	Unit load	wt*	4.71	4.62	[MPa]	

**13.0**  Parameters of the chosen material

13.1	Density	Ro	7870.00	7870.00	7870.00	[kg/m^3]
13.2	Young's Modulus (Modulus of Elasticity)	E	206.00	206.00	206.00	[GPa]
13.3	Tensile Strength, Ultimate	Rm	883.00	883.00	883.00	[MPa]
13.4	Tensile Strength, Yield	Rp0.2	637.00	637.00	637.00	[MPa]
13.5	Poison's Ratio		0.30	0.30	0.30	
13.6	Contact Fatigue Limit	SHlim	690.00	690.00	690.00	[MPa]
13.7	Bending Fatigue Limit	SFlim	512.00	512.00	512.00	[MPa]
13.8	Tooth Hardness - Side	VHV	285	285	285	[HV]
13.9	Tooth Hardness - Core	JHV	285	285	285	[HV]
13.10	Base Number of Load Cycles in Contact	NHlim	5.00E+07	5.00E+07	5.00E+07	
13.11	Wohler Curve Exponent for Contact	qH	10	10	10	
13.12	Base Number of Load Cycles in Bend	NFlim	3.00E+06	3.00E+06	3.00E+06	
13.13	Wohler Curve Exponent for Bend	qF	6	6	6	

**Additions section**

**14.0**  Design of the exact transmission ratio

14.1	Number of teeth (Sun, Planet, Ring Gear)	z	17	30	-76		
14.2	Speed (Sun, Planet Carrier, Ring Gear)	n [/min]	3000.00	548.39	0.00		
14.3	Number of teeth from:	z	15	15			
14.4	Number of teeth to:	z	50	50			
14.5	Requested speed for the: Planet Carrier	n [/min]	400.00	700.000	z0=22	z1=35	z2=-92
14.6	Run calculation, transmitting values						

**15.0**  Preliminary design of shaft diameters (steel)

Recommended shaft diameter for:

16.1	- Main power-transmitting shafts	DA	48.46	85.33	79.78	[mm]
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16.2 - Small, short shafts DB 

37.66	66.31	62.00
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 [mm]

16.0  Approximate module calculation from the existing gear

16.1 Number of teeth	z	24	35	96	
16.2 Tip diameter	da	131.85	187.70	94.70	[mm]
16.3 Distance between teeth edges	u	0.00	0.00	14.13	[mm]
16.4 Helix angle	$\beta$	10.00	10.00	10.00	[°]
16.5 Module of tooth	mn	5.0000	5.0000	0.9973	[mm]

17.0  Graphical output, CAD systems


17.1 2D drawing output to: DXF File 

17.2 2D Drawing scale: Automatic

17.3 Detail: Planet

$\beta$  [°]... 30  
a [modul]... 1

17.4 Detailed drawing of tooth and wheel

17.5 Number of drawn teeth	4		
17.6 Number of points of tooth tip	5		
17.7 Number of points of tooth flank	30		
17.8 Rolling (turning) of a tool between the bite	0.5	[°]	<input type="checkbox"/> Drawing without axes
17.9 Number of tooth copies in the picture of engagement check	12		
17.10 Turning of pinion during engagement check	0.5	[°]	
17.11 Gear angle	168.7500	[°]	

17.12 Text description (Information for BOM)

<b>Sun</b>		
Row 1 (BOM attribute 1)	Planet gear - Sun gear	<input checked="" type="checkbox"/>
Row 2 (BOM attribute 2)	z0=17, mn=3, beta=20	
Row 3 (BOM attribute 3)	Material: 37 Cr 4	
<b>Planet</b>		
Row 1 (BOM attribute 1)	Planet gear - Planet gear	<input checked="" type="checkbox"/>
Row 2 (BOM attribute 2)	z1=30, mn=3, beta=20	
Row 3 (BOM attribute 3)	Material: 36 Mn 5	
<b>Ring gear</b>		
Row 1 (BOM attribute 1)	Planet gear - Ring gear	<input checked="" type="checkbox"/>
Row 2 (BOM attribute 2)	z2=76, mn=3, beta=20	
Row 3 (BOM attribute 3)	Material: 37 Cr 4	

17.13 Table of parameters 

Table of sun gear parameters
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