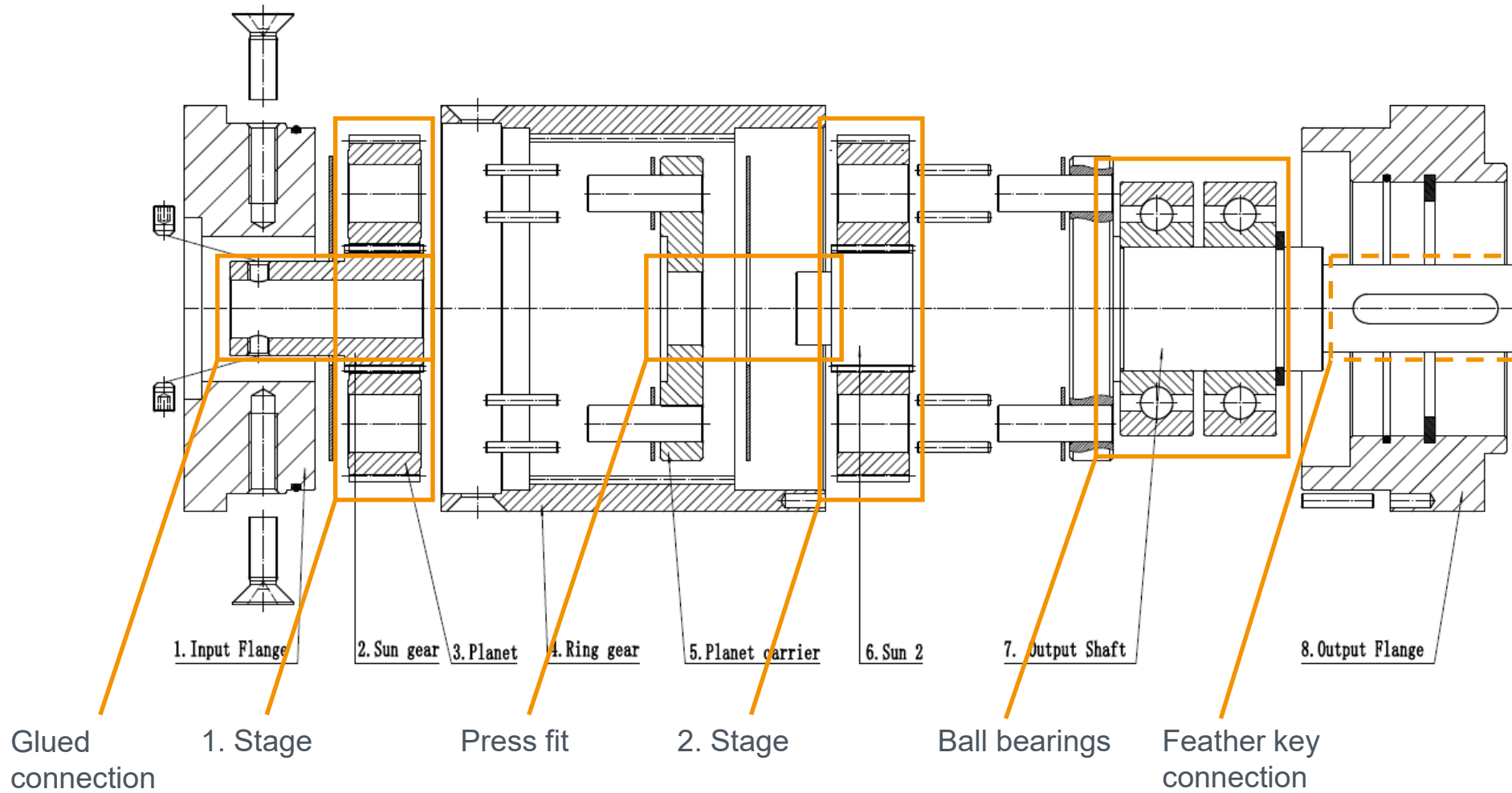


Dimensioning of Gearboxes



Dimensioning



Dimensioning

Glued connection of the first sun gear (Henkel, technical books)

- Safety factor: $S = C \cdot \frac{\tau_{zul}}{\tau_T}$
- τ_{zul} : permitted torsional stress (26.5 N/mm², Loctite 648)
- τ_T : working torsional stress
- C: constant factor (clearance, temperature, materials, alternating stress,...)
- Datasheet: max. torque for one-stage gearboxes

Press fit of the second sun gear (KISSsoft, DIN 7190)

- Definition of the tolerances
- Dimensioning for plastic deformation of shaft and hub
 - Tightest fit: smallest hole of the carrier and biggest shaft diameter
 - Calculation of the safety factors for both parts
- Dimensioning for slide through
 - Loosest fit: biggest hole of the carrier and smallest shaft diameter
 - Calculation of the safety factor
- Datasheet: max. torque of two-stage gearboxes



Failed motor shaft connection



Failed press fit

Dimensioning

Lifetime calculation of ball bearings (KISSsys, ISO 281)

Known:

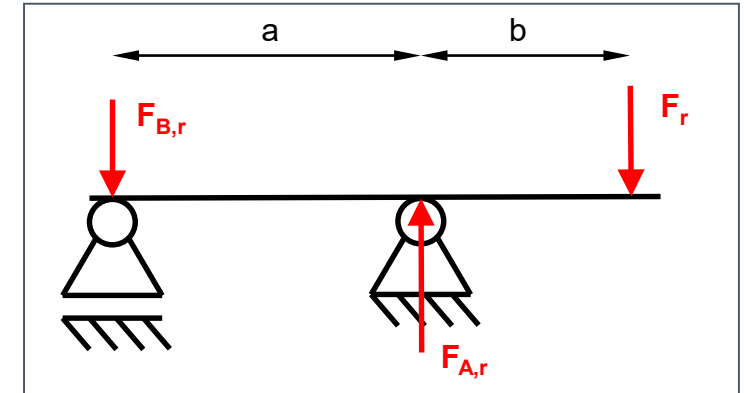
- Radial load: $F_r = 306 \text{ N}$
- Speed of output shaft: $n = 100 \text{ rpm}$
- Distance between ball bearings: $a = 8 \text{ mm}$
- Distance between ball bearing A and radial load: $b = 14 \text{ mm}$
- Ball bearing NSK 608 DU:
 - dynamic load rating $C = 3300 \text{ N}$
 - static load rating $C_0 = 1370 \text{ N}$

Unknown:

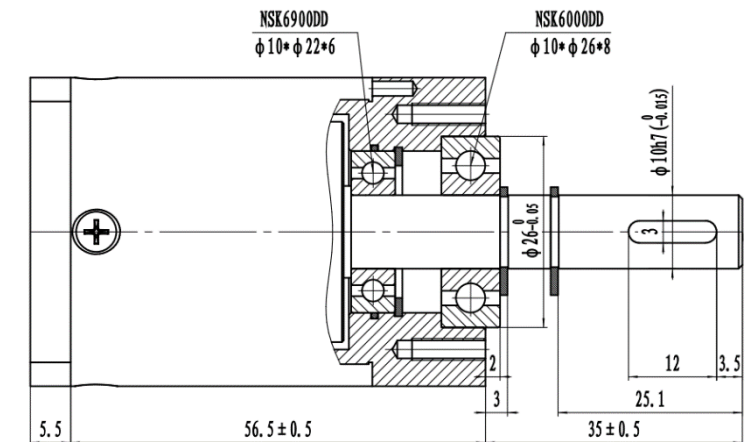
- Lifetime L_{10h}

Calculation:

- Radial load @ A: $F_{A,r} = F_r \cdot (a+b)/a = 306 \cdot 22/8 = 841.5 \text{ N}$
 - Equivalent load: $P = F_{A,r} = 841,5 \text{ N}$
 - Lifetime: $L_{h10} = (C/P)^3 \cdot 10^6/n/60 = (3300/841,5)^3 \cdot 10^6/100/60 = \underline{\underline{10.000 \text{ h}}}$
- Datasheet: max. radial load F_r



Sketch for lifetime calculation (GP42)



Custom solution (GP42)

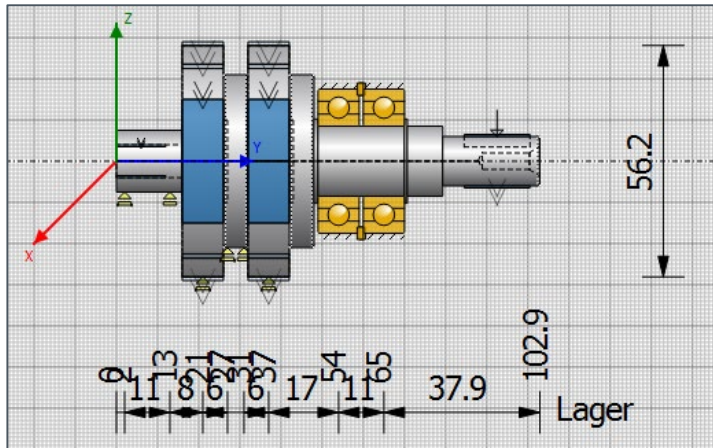
Dimensioning

Calculations in KISSsys

- Set structure of gearbox and define calculations
- Optimisation of gear parameters
- ➔ Datasheet: efficiency, ratios, inertia, backlash, rated torque (for given lifetime and speed)

Basisdaten		Bezugsprofil		Toleranzen		Belastung		Faktoren	
Systemdaten									
Normalmodul	m _n	0.5000	mm	Sonne		geradverzahnt			
Normaleingriffswinkel	α _n	20.0000	°	Schrägungswinkel am Teilkreis		β		0.0000 °	
Achsabstand	a	15.8800	mm	Anzahl Planeten				3	
Geometrie									
		Sonne	Planeten	Hohlrade				Details...	
Zähnezahl	z	32	29	-94					
Zahnbreite	b	10.0000	10.0000	10.0000		mm			
Profilverschiebungsfaktor	x*	0.7628	0.6705	0.0000					
Qualität (ISO 1328:1995)	Q	8	8	8					
Werkstoffe und Schmierung									
Sonne		20CrMnTi, Einsatzstahl, einsatzgehärtet, ISO 6336-5 Bild 9/10 (MQ), Kernhärte >=25HRC Jominy J=12mm <HRC28_NEW							
Planeten		20CrMnTi, Einsatzstahl, einsatzgehärtet, ISO 6336-5 Bild 9/10 (MQ), Kernhärte >=25HRC Jominy J=12mm <HRC28_NEW							
Hohlrade		32CrMo12, Nitrierstahl, nitriert, ISO 6336-5 Bild 13a/14a (MQ)							
Schmierung		Fett: Klübersynth G 34-130							

Planetary stage calculation



Shaft calculation

GEARBOX SPECIFICATION		Speed / rpm	Torque / Nm	Lifetime for	Lifetime for	Lifetime for max.
Reduction Ratio	-	15.504		Input	Planetary_calc1 / h	torque calc. / h
No. of Stages	-	2		Output	Planetary_calc2 / h	5.168
Rated Output Torque	Nm	24.6			10000	10000
Max. Output Torque	Nm	39.4		Root Safety	Radial Forces / N	Axial Forces / N
Rated Input Speed	rpm	3500		2. Sun Gear	430	0
Max. Input Speed	rpm	5968		2. Planet Gear		50.5
Backlash	°	0.52186		2. Ring Gear		
Efficiency	%	0.94483			Lifetime / h	
Lifetime	h	10000		1. Sun Gear	Bearing B1	40320.83332
Max. Axial Forces	N	430		1. Planet Gear	Bearing B2	10110.684
Max. Radial Forces	N	1080		1. Ring Gear		
Gearbox Inertia	kg mm ²	5.4002				
Ambient Temperature	°C	-15...+90				
Protection Class	-	IP40				

User interface



 High-torque
Planetary Gearboxes