

KISSsys 2019 – Instruction 010

Positioning of shafts and groups

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Sharing Knowledge

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1 Introduction

Machine elements must be positioned in space correctly to assure a proper positioning of the forces and the correct layout in 3D representation. This instruction will explain how to position the most important elements. There are several ways to set, create or evaluate the positions in a KISSsys model. There is no right and wrong way to do it. The approach depends on the model itself, but also on the user.

2 Summary

There are mainly two kinds of positioning procedures: The positioning of the shafts in the layout and the positioning of the machine elements on the shafts.

Every KISSsys main element (shaft, group and casing) can be positioned manually in space. This method is not very user-friendly and should be avoided if possible. Although now it is the only possibility to position a casing in a model. It is either possible to define a parallel orientation of two shafts or to define the position with the meshing e.g. the coaxial shaft elements can be moved on the parent shaft either by drag and drop in the shaft editor or by using the variable "position" in KISSsys.

3 Positioning techniques

This section describes the positioning of single elements and the difference in positioning complete coaxial shaft groups and their integrated elements.

4 Coordinate system

4.1 Main coordinate system

The main coordinates system can be shown / hidden in the icon bar:



Figure 1. Show coordinate system

The representation in the kSys3DView looks as shown in the following figure. Right-click -> properties window; will show the default position $[x/y/z] \rightarrow [0/0/0]$ and the default orientation of the unit vectors of the axis system (x-axis = [1,0,0], y-axis = [0,1,0]). Generally, this definition will remain unchanged while building a model in KISSsys.



Figure 2. Definitoin of the golbal position of the main coordinate system

The size of the coordinates system can be adjusted with a click on the following icon:



4.2 Group coordinate system

Once you enter a group into the tree structure in KISSsys e.g. named "GroupBox" the positioning of this group will be according to the default definition of the main coordinates system (can be changed; will be shown later).



Figure 4.

Positioning of the group "GroupBox" according to main coordinate system

5 Example 1: Helical gearbox

To start, add the helical gear box from the templates according to the following figure.



Figure 5. Opening the helical gearbox template

5.1 Orientation of the group

The position of the group can be set according to the main coordinates system. As default the position corresponds to the default definition of the group "gearbox". To change the orientation, either the displaycement in x-, y- and z-direction can be entered manually. In the following figure e.g. the group is displaced in positive y-direction.



Figure 6. Axial displacement of the group "Groupbox"

To change the orientation of the group according to the main coordinates system, the definition of the unit-vector can be adjusted.



Figure 7. Inverted unit vector of the group

For this example, the position and orientation of the group coordinates system will correspond to the definition of the the main coordinates system.

Hint: To show the immediate changes while positioning the elements in the 3DViewer in KISSsys, press the following icon in the icon-bar:



5.2 Shaft coordinate systems

Selecting a shaft in the tree structure e.g. "Shaft1" will highlight the corresponding element in the 3DViewer with red and the local shaft coordinate system will appear.



Figure 9. Shaft coordinate system

Right click on "Shaft1" in the tree structure -> properties; will show the position and the orientation of the local coordinate system of the shaft.



Figure 10. Positioning «Shaft1» according to the group

To start positioning the shafts inside the groups, one shaft always must be defined as a "reference shaft". In our example, the reference shaft will be "Shaft1". To do so, "right-click" on "Shaft1" and choose: "reset position" -> "own input" ("own input" is the command, which <u>activates the manual positioning</u>).

Model	đ	×			
× 🗆	1				
	🦑 System				
	睯 kSys3DView				
~	📗 GroupBox				
	SearPairConst1	1			
	SearPairConst2	2			
	> D Shaft1				
	> 🗇 Shaft2	Properties window			
	> 🗇 Shaft3	Variables overview			
	😵 ThreeGears	New variable			
		Cut (Ctrl+X)			
		Copy (Ctrl+C)			
		Paste (Ctrl+V)			
		Delete (Del)			
		Rename			
		Hide			
		Find references	K Shaft positioning		×
			Position for _O.GroupBox.Shaft1		
		Dialog	Definition Own input		•
		Merge		OK	Cancel
		ResetPosition			Curree

Figure 11. Manual positioning of the shaft

We now e.g. define an offset of +50 mm in positive y-direction for this reference "shaft1":



5.3 Relative positioning of shafts

To define the position of "Shaft2" there are several options. Right-click on "Shaft 2" -> "ResetPosition" will open the following dialog:



Figure 13. Selection menu for the position of "Shaft2"

The user can choose between the following options:

- 1) Default value
- 2) According to calculation
- 3) Parallel to one shaft / group
- 4) Parallel to two shafts / groups

5.3.1 «Default value»

This option can be used, if the exact position of the gear is known. The coordinates can be manually entered directly in the field "position":



Figure 14. Manual positioning of «Shaft2»

5.3.2 "According to calculation"

5.3.2.1 Positioning of "Shaft2"

Once the gear-pair connection is defined the shafts can be positioned according to the gear-pair calculation. "Rightclick" on "Shaft2" -> ResetPosition; The following dialog will appear.

Model Korrent		Shaft positioning Position for _O.GroupBox.Shaft2 Definition According to calculation Shaft positioning	Х ОК Cancel Х
> 42 Shaft1 > 1 Shaft2 > 1 Shaft3 * ThreeGearsCalc1	Properties window Variables overview New variable Cut (Ctrl+X) Copy (Ctrl+C) Paste (Ctrl+V) Delete (Del) Rename Hide Find references Dialog Merge ResetPosition	Position for _O.GroupBox.Shaft2 Calculation Definition Rotational offset No	hreeGearsCalc1
		Position for _O.GroupBox.Shaft2 Element on shaft Reference element Center distance [mm] Position of contact [°] Direction of shaft Axial offset [mm]	Gear2

Figure 15. Function «According to calculation»

The "Shaft2" is positioned according to the "ThreegearsCalc". In the dialog above the corresponding element will be selected (Gear2). The Reference element is "Gear1" from "Shaft1". The centerdistance will be taken from the gearpair calculation (path is inserted automatically).

Properties							
Variables Functions Variables Functions	Type Name Reference Value Path MISS Expression	Real					

Figure 16. Centerdistance from the the gear calculation

The position of contact can be entered with reference to "Gear1" and the coordinate system of the reference element.



Figure 17. Position of contact

5.3.2.2 Positioning of "Shaft3"

After defining «Shaft2», «Shaft3» will be defined with reference to "Shaft2". Right-click on "Shaft3" and select "RestPosition".

Model & X			
× 🗐	Properties window	K Shaft positioning	\times
🦑 System	Variables overview	Position for _O.GroupBox.Shaft3	
睯 kSys3DView	New variable	Definition According to calculation	-
Y 퉬 GroupBox	Cut (Ctrl+X)		OK Cancel
SearPairConst1	Copy (Ctrl+C)		Carteer
SearPairConst2	Paste (Ctrl+V)	K Shaft positioning	×
✓ III Shaft1	Delete (Del)	Position for _O.GroupBox.Shaft3	
🖉 Bearing1	Rename	Calculation O.GroupBox.Thr	eeGearsCalc1
Bearing2	Hide	Definition	
	Find references	Portidias	
ShaftCalc1	Dialog	Rotational offset No	→
✓ III Shaft2	Merge		OK Cancel
🗟 Bearing1	ResetPosition	K Shaft positioning from belical	gear calculation
Bearing2	SetColor		
- Gear2	ShowCoordinates		
ShaftCalc2	Split	Element on shaft	Gear3
> up Shaft3		Reference element	^.Shaft2.Gear2 ▼
		Center distance [mm]	^.ThreeGearsCalc1.a2
		Position of contact [°]	-45
		Direction of shaft	Standard 👻
		Axial offset [mm]	^.ThreeGearsCalc1.bv2
			OK Cancel





Figure 19. Negative value for «position of contact"

The position of contact for both meshings will be transferred to the KISSsoft shaft calculations. For e.g. "Gear2" contains meshings with "Gear1" and "Gear3". This definition will be shown in the shaftcalculation (ShaftCalc2) as well.



5.3.2.3 Rotational offset

The rotational offset can be used in order to rotate the positioned, local shaft coordinate system as shown in the following figure.

K Shaft positioning ×	K Shaft positioning from helical	I gear calculation $ imes$
Position for _O.GroupBox.Shaft2	Position for _O.GroupBox.Shaft2	
Calculation _O.GroupBox.ThreeGearsCalc1	Element on shaft	Gear2 👻
Definition Formulas	Reference element	^.Shaft1.Gear1 ▼
Rotational offset Yes 💌	Center distance [mm]	^.ThreeGearsCalc1.a1
OK Cancel	Position of contact [°]	45
	Direction of shaft	Standard 👻
	Rotational offset [°]	30
	Axial offset [mm]	^.ThreeGearsCalc1.bv1
		OK Cancel
		Rotational offset (+30°)

Figure 21. Rotational offset definition

5.3.2.4 Axial offset definition

In the dialog of the positioning process, an axial offset "bv" can be entered.

K Shaft positioning from helical gear calculation ×					
Position for _O.GroupBox.Shaft2					
Element on shaft	Gear2 👻				
Reference element	^.Shaft1.Gear1 👻				
Center distance [mm]	^.ThreeGearsCalc1.a1				
Position of contact [°]	0				
Direction of shaft	Standard 🗸				
Axial offset [mm]	^.ThreeGearsCalc1.bv1 OK Cancel				



P

J.

This value can either be entered directly in KISSsys or in the gear-calculation itself. To set this parameter in KISSsys; right-click on "ThreeGearsCalc" -> Properties. Be aware the flags "KISSsys -> KISSsoft" are set, if you want to set the value from KISSsys.



A <u>positive value</u> for "bv" represents the axial offset in the local + Y-direction of the shaft coordinate system. "bv1" is defined between "gear1" and "gear2". E.g. an offset of +20 mm for "bv1" results in the following displacement:



Figure 24. Graphical visualization in 3DViewer (axial displacement



Figure 25. Axial Displacement in KISSsoft interface

5.3.3 "Parallel to one shaft / group"

User can choose "parallel to one shaft / group" in order to position a shaft according to a reference element (group / shaft). In the prompting dialog user can specify the position for "shaft2". To define, he needs to select the reference element (in our case this will be "shaft1"). There is either a possibility to enter the distances to the reference coordinates system in cartesian or in polar coordinates. Furthermore, a shaft can also be inverted in its orientation (direction of shaft -> "reverserd").

Papring 1	Properties window	K Shaft positioning	×
 Bearing 1 Bearing 2 Gear 2 ShaftCalc2 Shaft3 Bearing 1 Bearing 1 Bearing 2 CentricalLo Gear 3 ShaftCalc3 	Properties window Variables overview New variable Cut (Ctrl+X) Copy (Ctrl+C) Paste (Ctrl+V) Delete (Del) Rename Hide Eind references	Position for _0.GroupBox.Shaft2 Definition Parallel to one shaft/group OK Car Shaft positioning parallel to one shaft/group Position for _0.GroupBox.Shaft2 Reference element Coordinate system	
** ThreeGearsCalc1	Dialog Merge ResetPosition	Distance along x-axis [mm] Distance along y-axis [mm] Distance along z-axis [mm] Direction of shaft Coordinate system Distance along x-axis [mm]	Standard Cartesian Cartesian Polar

Figure 26. Positioning according to "Parallel to one shaft / group"

The following figures shows the definition in polar (left image) and cartesian coordinates system (right image).



Figure 27. Position of contact in polar / cartesian coordinate system

<u>Note</u>: This solution might be necessary in some specific cases, but in general it is recommended to work with the function "according to calculation".

5.3.4 "Parallel to two shafts / groups"

One shaft can also be positioned according to two reference elements. This may be the case, when two shafts are positioned (fixed) in space and you want to position another shaft relatively to them.

To start, both shafts ("shaft1" and "shaft2") need to be defined. Selecting own input and e.g. defining shaft 1 to be fixed at the origin point [x/y/z] = [0/0/0]. Now for "shaft3" we e.g. set "own input" with the following position: [x/y/z] = [90/0/0].



Figure 28.

Positioning according to "parallel to two shafts / groups"

In this example, the middle shaft "Shaft2" will be positioned according to "Shaft1" respectively "Shaft3". As an input, user either must insert the center distance manually, or he can copy the actual center distance from the gear pair calculation.

~	III shafta	1				
Ť	Bearing 1	Properties window	K Shaft positioning		×	
	Bearing2	Variables overview	Position for _O.GroupBox.Shaft2			
	Gear2	New variable	Definition Parallel to two shafts/gro	oups	•	
	ShaftCalc2	Cut (Ctrl+X)		OK	Capital	
~	🗇 Shaft3	Copy (Ctrl+C)		UK	Cancer	
	Bearing1	Paste (Ctrl+V)	K Shaft positioning parallel to tv	vo shafts/gr	oups	\times
	Bearing2	Delete (Del)	Position for _O.GroupBox.Shaft2			
	CentricalLo	Rename	Reference element 1	^.Shaft1	1	•
	Gear3	Hide	Deferrer derect 2	A Chailes		_
		Find references	Reference element 2	m.snarts		•
	 InreeGearsCalc1 		Center distance a1 [mm]			
		Dialog	Center distance a2 [mm]			
		Merge	Axial offset from element 1 [mm]			
		ResetPosition			5	
			Direction of shaft	Standard		•
			Position of shaft	Above		•
				-	ОК	Cancel

Figure 29. Positioning according to "parallel to two shafts / groups"

To get the reference from the "ThreeGearsCalc" go to properties and copy / paste the reference path into the corresponding input field.

Properties			K Shaft positioning parallel to tw	vo shafts/groups
Variables Functions	Turne	Deal	Position for _O.GroupBox.Shaft2	
^	rype	Real	Reference element 1	^.Shaft1 🔹
ThreeGearsCalc1	Name	al	Reference element 2	^.Shaft3 ▼
S _VERSION	Reference		Center distance a1 [mm]	_O.GroupBox.ThreeGearsCalc1.a1
R a2	Value	84	Center distance a2 [mm]	O.GroupBox.ThreeGearsCalc1.a2
R alpha 1	Path	_O.GroupBox.ThreeGearsCalc1.a1	Axial offset from element 1 [mm]	
R alpha2	KISSso	ft -> KISSsys 🛛 KISSsys -> KISSsoft	Direction of shaft	Standard 🗸
* * ThreeGearsCalc1	Name	a2	Position of shaft	Above
S _VERSION	Reference			OK Cancel
R a1	Value	86.86103202		OK Cancel
R alpha1	Path	_O.GroupBox.ThreeGearsCalc1.a2		

Figure 30. Centerdistance from KISSsys variable

User can select in the dialog either "position of shaft = above":

K Shaft positioning parallel to t	×	4	4	
Position for _O.GroupBox.Shaft2				
Reference element 1	^.Shaft1	•		
Reference element 2	^.Shaft3	•		L
Center distance a1 [mm]	_O.GroupBox.ThreeGearsCalc1.a1		2	
Center distance a2 [mm]	_O.GroupBox.ThreeGearsCalc1.a2		A second	
Axial offset from element 1 [mm]] 🏅	0 5	
Direction of shaft	Standard	- 1		
Position of shaft	Above OK Cancel	- _		



Figure 31. Definition "above"

or "position of shaft = below":

K Shaft positioning parallel to tv	+	
Position for _O.GroupBox.Shaft2		
Reference element 1	^.Shaft1 ▼	· · ·
Reference element 2	^.Shaft3 ▼	
Center distance a1 [mm]	_O.GroupBox.ThreeGearsCalc1.a1	
Center distance a2 [mm]	_O.GroupBox.ThreeGearsCalc1.a2	
Axial offset from element 1 [mm]		and the second second
Direction of shaft	Standard 🗸	
Position of shaft	Below	
	OK Cancel	2000

Figure 32. Definition "below"

6 Example 2: Planetary gears (Coaxial shaft groups)

The positioning of coaxial shafts must be performed in the corresponding groups they belong to. These "kSysgroups" are defined one level higher than the coaxial shafts in the model tree hierarchy.

Model 🗗 🗙	Properties		8
 ✓ Image: System ✓ System ✓ kSys3DView ✓ GroupBox ✓ GroupBox ✓ GroupBox ✓ MainLine_calc % PlanetGearPair % SunShaft > Image: SunShaft 	Variables Functions	Type kSysGroup Position]

Figure 33. Position of "GroupBox"

The positioning of these coaxial shafts inside the group is based on the variable "position", which is saved in the properties of each coaxial shaft.

Model	ē×	Pr	operties			
× 🖻	 System ksys3DView GroupBox CarrierShaft MainLine_calc PlanetGearPair PlanetGearPair PlanetGearPair PlanetaryCalc1 RingShaft SunShaft 		Variables	Functions ierShaft _VERSION deflection diam diamInt Drawing ElementData3D innerGeometry kSys_3DColor kSys_3DColor kSys_3DTransparency length mass material materialInfo outerGeometry position	Type Name Reference Value Path Expression	Real position ce 150 _O.GroupBox.CarrierShaft.position XISSsoft -> KISSsys KISSsys -> KISSsoft on

Figure 34. Axial position of the variable "position"

The "position value" zero (0) means that the shaft is starting at the same global position where the group is defined.

<u>Note</u>: If the flag "KISSsoft-KISSsys" is activated, the adjusted position in the shaft editor will influence the value in KISSsys as well.

When opening the ShaftCalculation "MainLine_calc" and selecting the shaft e.g. "CarrierShaft" in the element tree, the global position resp. the starting point of this shaft according to the group is shown.

Model 🗗 >	Element Tree	Shaft		
✓ □	Overview	Designation	CarrierShaft	
2 kSys3DView	CarrierShaft Cuter contour Zylinder	Drawing number	Input	
V 🍌 GroupBox		Position in global system Y	150.0000	mm
> 과 CarrierShaft	Zylinder	Operating temperature T	20.0000	°C
	> D Zylinder	Ambient density p	1.2000	kg/m³
	Zylindrische Bo	Speed n	1000.0000	1/min 🗹

Figure 35. Position in the global system

Loading a "group template" (Planetary gearbox).

Open a "new" model and add the below group template of a planetary gearbox to the root of the tree structure hierarchy.



Then, activate the coordinates system with clicking the following icon in the icon bar.



Figure 37. Show axis system in 3DViewer

Activate the 3DViewer from the model tree (double-click on the element). Choose the following representation mode "in the front".



Figure 38. Position of planet gear in 3DViewer

In this example the position of the planet is already defined.

To show you the positioning procedure in a planetary gear, right-click on the planet-group and choose "reset position" and then select "own input". After set the position at origin point of the main group.



Figure 39. Reset the position of the planet group and set back to [0/0/0]

To position this coaxial planetary group, right-click again on the planetary group "Planet" and select "ResetPosition".

Model & ×	K	K Shaft positioning	×
 ✓ ■ <i>*</i> System [*] kSys3DView ✓ → GroupBox ✓ → CarrierShaft ☑ Bearing1 ☑ Bearing2 〖 CarrierElement 		Position for _0.GroupBox.CarrierSha Definition According to calculation K Shaft positioning Position for _0.GroupBox.CarrierSha Calculation _0.GroupBox.Pla	ft.Planet OK Cancel X anetaryCalc1
		Definition Formulas Rotational offset No	Cancel I gear calculation
> 과 RingShaft > 과 SunShaft		Position for _O.GroupBox.CarrierSha Element on shaft Reference element Center distance [mm] Position of contact [°] Direction of shaft	Planet PlanetGear.PlanetGear A.^.SunShaft.SunGear A.^.PlanetaryCalc1.a Standard A. PlanetaryCalc4 but
	ResetPosition	Axiai offset [mm]	OK Cancel

Figure 40. Set the planetary group "according to calculation"

As default, the position of contact is defined to 0°. selecting e.g. 45° results in the following change of display.

K Shaft positioning from helical	Position des Eingriffs	
Position for _O.GroupBox.CarrierSha	ft <mark>.Planet</mark>	z†
Element on shaft	PlanetGear	
Reference element	^.^.SunShaft.SunGear ▼	
Center distance [mm]	^.^.PlanetaryCalc1.a	
Position of contact [°]	45	
Direction of shaft	Standard 👻	
Axial offset [mm]	^.^.PlanetaryCalc1.bv1	
	OK Cancel	i

Figure 41. position of contact



Figure 42. Position of contact in 3DViewer

To set the number of planets, "right-click" on the "PlanetaryGearPairConst" and select "dialog". Then set the required number of planets (in this example npl. = 3)

Figure 43. Definition of number of planets

To show all 3 planets in the 3DView; right-click on kSys3DView and select "ShowPlanets".



Figure 44. Function "show planets"

7 Positioning according to other gear calculations

The relative positioning process of bevel gears, face gears, worm gears etc. is similar to the procedure described in chapter 5.3.