

KISSSOFT
Calculation programs for machine design

KISSSOFT RELEASE 03/2017 PRODUCT\ DESCRIPTION

Issue 1.5

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Table of Contents

I Product Description I-13

1 Hardware and software requirements I-14

1.1 Program versions I-14
1.2 Computer configuration I-15

2 Base K module I-16

2.1 K1 Base module I-16
2.2 K02 report text and interface I-18
2.3 K04 COM interface I-18
2.4 K04a extended COM interface I-18
2.5 K05 CAD interfaces I-18
2.6 K05a DXF interfaces I-18
2.7 K05e IGES interface I-19
2.8 K05d Solid Edge interface I-19
2.9 K05k SolidWorks interface I-20
2.10 K05m Inventor interface I-20
2.11 K05n NX interface I-21
2.12 K05o* CATIA interface I-21
2.13 K05q* ProEngineer interface I-21
2.14 K05s Parasolid display window I-22
2.15 K05u Export STEP format (parasolid) I-22
2.16 K07 User database (materials etc.) I-22
2.17 K7a Material management (always present) I-22
2.18 K7b Smith-Haigh diagram I-22
2.19 K09 Hardness Conversion (in the Extras menu) I-22
2.20 K10 Calculating tolerances I-22
2.21 K11i Dynamic analysis of shaft systems I-24
2.22 K11k Export of KISSsys model data I-25
2.23 K12 Strength verification using local design (FKM guideline) I-25

2.24 K14 Hertzian pressure I-25
2.25 K14a Any contact I-26
2.26 K15 Linear Drive I-26
2.27 K16 Gear body deformation I-27
2.28 K17 Plastics Manager I-28
2.29 K18 Reliability I-29
2.30 K20 Import a reduced stiffness matrix from different FEM programs I-30

3 Shafts, axes, bearing - W-module I-31

3.1 General I-31
3.2 W01 Shafts base module I-33
3.3 W01a Input data for several shafts I-34
3.4 W01b Bearing offset, Bearing clearance I-34
3.5 W01c Take into account contact angle I-35
3.6 W01a Load spectra I-35
3.7 W03 Calculate deflection and bearing forces I-35
3.8 W03a Take into account deformation due to shearing I-36
3.9 W03b Non-linear shaft I-36
3.10 W03c Thermal expansion I-36
3.11 W03d Non-linear stiffness I-36
3.12 W04 Calculation of the critical speed I-36
3.13 W04x Effect of spinning I-37
3.14 W05 Ball and cylindrical roller bearing and roller bearing service life I-37
3.15 W05b reference service life specified in ISO/TS 16281 ..... I-38
3.16 W05a Bearing load spectra I-39
3.17 W05c Load distribution in the bearing I-40
3.18 W51 Verification of rolling bearings according to ISO/TS 16281 ..... I-41
3.19 W06 Calculate the service life and static calculation of cross sections I-41
3.20 W06a Hänchen + Decker calculation method I-42
3.21 W06b Calculation method DIN 743 ..... I-42
3.22 W06c Calculation methods in the FKM Guideline I-42
3.23 W06d Calculation method AGMA 6101/6001 ..... I-44
3.24 W06s Strength calculation with load spectra I-44

3.25 W07 Hydro-dynamic plain radial bearings I-44
3.26 W07a Calculation in accordance with Niemann I-44
3.27 W07b Calculation according to ISO 7902 ..... I-44
3.28 W07b Calculation according to ISO 31657 ..... I-46
3.29 W07e Calculation according to DIN 31652 ..... I-47
3.30 W08 Grease lubricated plain radial bearings I-47
3.31 W07c Hydrodynamic plain thrust bearing I-47
3.32 W10 Calculation of deformation in the axial direction I-47
3.33 W10 tooth trace modification with additional FEM displacement matrix... I-49
3.34 W12 Shaft arrangement (integrated design tool) I-49
3.35 W13 Buckling I-50
3.36 W14 Forced responses in KISSsoft shaft calculation I-51
3.37 W51a Rolling bearing fine sizing I-52

4 Machine elements - M module I-53

4.1 M01a Cylindrical interference fit I-53
4.2 M01b Conical interference fit connections I-53
4.3 M01x Additional function for a press fit I-54
4.4 M01c Clamped connections I-54
4.5 M02a Key I-54
4.6 M02b Spline shaft/Multi-groove profile I-55
4.7 M02c Spline I-56
4.8 M02d Polygon I-56
4.9 M02e Woodruff key I-57
4.10 M03a Bolt calculation I-57
4.11 M04 Bolt calculation I-57
4.12 M04a Eccentric clamping and load, configurations (for M04) I-58
4.13 M04b Bolt calculation at high and low temperatures (for M04) I-58
4.14 M08 Welded joints I-59
4.15 M09a Glued and Soldered Joints I-59
4.16 M050 Snap ring I-61

5 Springs - F-module I-62

5.1 F01 compression springs calculation I-62
5.2 F03 Leg spring calculation I-62
5.3 F04 Disc spring calculation I-62
5.4 F02 Tension spring calculation I-62
5.5 F05 Torsion-bar spring calculation I-62

6 Gears - Z-modules.....I-63

6.1 Z01 Gear - Base module I-63
6.2 Z01x extension of cylindrical gear geometry I-64
6.3 Z19h Sizing of deep toothing I-65
6.4 Z15 Calculate the details used to modify the profile of cylindrical gears .. I-66
6.5 Z19a Calculation with operating center distance and profile shift according to manufacture I-66
6.6 Z19d Optimize axis center distance with respect to balanced sliding I-66
6.7 Z19e Representation of specific sliding I-66
6.8 Z19f Suggestion of sensible tooth trace modifications I-67
6.9 Z19j Profile modifications with worm grinding wheels/dressing wheels ... I-68
6.10 Z19l Conversion of profile shift coefficient and tooth thickness allowance .. I-68
6.11 Z19n Profile and tooth trace diagrams }..... I-68
6.12 Z02 Strength calculation as specified in DIN 3990 ..... I-68
6.13 Z02a Strength calculation as specified in ISO 6336 ..... I-69
6.14 Z02x Static strength of the tooth root I-70
6.15 Z13 Calculation using the AGMA standard (USA standard) I-70
6.16 Z13b Calculation according to AGMA 6011/AGMA 6014 (US standard) I-71
6.17 Z02b Strength calculation as specified in BV RINA I-71
6.18 Z10 Cylindrical gear calculation using the FVA method I-71
6.19 Z14 Plastic gears I-72
6.20 Z19i Tooth form factor calculation using the graphical method I-72
6.21 Z19m Flash temperature progression I-73
6.22 Z01a Planets, 3- and 4-gear I-73
6.23 Z19g Calculate the center points of planets or idler gears I-75
6.24 Z01b Rack I-75

6.25 Z03 Cylindrical gear-Rough sizing I-75
6.26 Z04 Cylindrical gear-fine sizing I-76
6.27 Z04a Additional strength calculation of all variants I-77
6.28 Z05 Tooth form calculation and display I-78
6.29 Z05x Animate the 2D display I-79
6.30 Z05a Input any cutter form or tooth form I-80
6.31 Z05c Reference profile calculation for gears with involutes or special profiles I-80
6.32 Z05d Calculate the tooth form from the paired gear (generate with other gear in the pair) I-80
6.33 Z05e Addition for mold making I-81
6.34 Z05f Arc shaped start of entry curve on the tooth tip I-82
6.35 Z05g Optimum tooth root rounding I-82
6.36 Z05h Cycloid and arc of circle toothings..... I-83
6.37 Z05i Arc of circle approximation I-83
6.38 Z05j Display collisions in the generation process (cylindrical gears) I-83
6.39 Z05k Displaying collisions during generation (worms/crossed axis helical gears) I-84
6.40 Z05l Using the same tool type multiple times I-84
6.41 Z05m Non-symmetrical gears I-84
6.42 Z05n Straight line flank I-84
6.43 Z05q Special functions for the watch-making industry I-85
6.44 Z19k Lubrication gap EHD/ Scoring I-85
6.45 Z23 Calculate the tooth root load capacity of internal teeth with the influence of the ring gear in accordance with VDI 2737 and calculate the deformation of gear rings I-85
6.46 Z24 Meshing stiffness of the gear pair and transmission error..... I-87
6.47 Z25 Graphical representation of Hertzian pressure and tooth root strain along the actual tooth form I-87
6.48 Z26 Displacement volumes for gear pumps I-88
6.49 Z26a Additional option for gear pumps Z26 ..... I-88
6.50 Z27 Kinematics based on the actual tooth form I-89
6.51 Z29 Sizing and checking of master gears I-89

6.52 Z30 Micropitting (frosting) and flash temperature I-89
6.53 Z31 Wear I-90
6.54 Z31a Iterative calculation of wear I-90
6.55 Z32 Calculate contact analysis under load for cylindrical gear pairs I-91
6.56 Z34 Calculate contact analysis under load for planetary systems I-93
6.57 Z35 Calculate contact analysis under load for bevel gears..... I-94
6.58 Z37 Calculate the deformation of the planet carrier with FEM (z37). I-95
6.59 Z33 Profile modification optimization with contact analysis under load ... I-95
6.60 Z38 Use FEM to calculate stress in the gear root I-96
6.61 Z06 Face gear calculation (Z060) I-96
6.62 Z06a Strength calculation based on ISO 6336/Literature I-96
6.63 Z06b Strength calculation based on CrownGear/DIN 3990 ..... I-97
6.64 Z06c Strength calculation based on ISO 10300, Method B I-97
6.65 Z06d Strength calculation based on DIN 3991, Method B I-97
6.66 Z6e Static strength I-97
6.67 Z6f 3-D display I-97
6.68 Z07 Bevel gear calculation (Z070) I-98
6.69 Z07d Gleason bevel gear toothing I-98
6.70 Z07e Strength calculation based on ISO 10300, Methods B and C I-99
6.71 Z07g Strength calculation based on DIN 3991 ..... I-99
6.72 Z07h Strength calculation for plastics I-99
6.73 Z07i Calculation of bevel gear differentials I-99
6.74 Z07j Strength calculation based on AGMA 2003 ..... I-100
6.75 Z07a bevel gears with cyclo-palloid and palloid toothing I-100
6.76 Z07b Hypoid gears with cyclo-palloid gear teeth I-101
6.77 Z07p 3D display I-102
6.78 Z7o Flank and profile modifications with contact analysis under load..... I-103
6.79 Z08 Worm gear calculation (Z080) I-103
6.80 Z08a Strength calculation based on DIN 3996 ..... I-103
6.81 Z08b Strength calculation based on ISO 14521 ..... I-104
6.82 Z08c Strength calculation based on AGMA 6034 and AGMA 6135 ..... I-104
6.83 Z08p 3D display I-105

6.84 Z19b Worm calculation with sizing using the normal module (worm sizing tool module) I-105
6.85 Z17 Calculate crossed axis helical gear pairs I-105
6.86 Z17a Strength calculation according to ISO 6336/Hirn I-106
6.87 Z17b Strength calculation according to Niemann/VDI 2545 ..... I-106
6.88 Z17c Strength calculation according to Hoechst I-106
6.89 Z17d Static strength calculation: Deformation and shear I-107
6.90 Z17e Strength calculation according to VDI 2736-3 ..... I-108
6.91 Z17n Fine sizing for crossed helical gear I-109
6.92 Z09 Splines I-109
6.93 Z12 Operating backlash I-110
6.94 Z22 Hardening depth I-110
6.95 Z16 Sizing of torque I-110
6.96 Z18 Service life calculation I-111
6.97 Z16a Sizing of torque for load spectra I-111
6.98 Z18a Calculate service life for load spectra I-111
6.99 Z40 Non-circular gears I-112
6.100 Z50 Beveloid gears I-113

7 Belt/chain drives Z module I-115
7.1 Z90 V-belts (Z090) I-115
7.2 Z91 Toothed belts (Z091) I-115
7.3 Z92 Chain gears (Z092) I-116

8 Automotive - A-Module I-117
8.1 A10 Synchronization (A010) I-117
8.2 A20 Friction clutches (A020) I-117

9 KISSsys - K11 module I-118
9.1 Overview I-118
9.2 Modules I-118
9.2.1 K11h Efficiency calculation I-118
9.2.2 K11i Modal analysis of shaft systems (k11i) I-119

9.2.3 K11j Take into account housing deformation in static KISSsys calculations (k11j) I-119
9.3 Different views of the data I-120
9.4 Modeling I-120
9.5 Variants I-120
9.6 Example applications I-121

II Index II-123

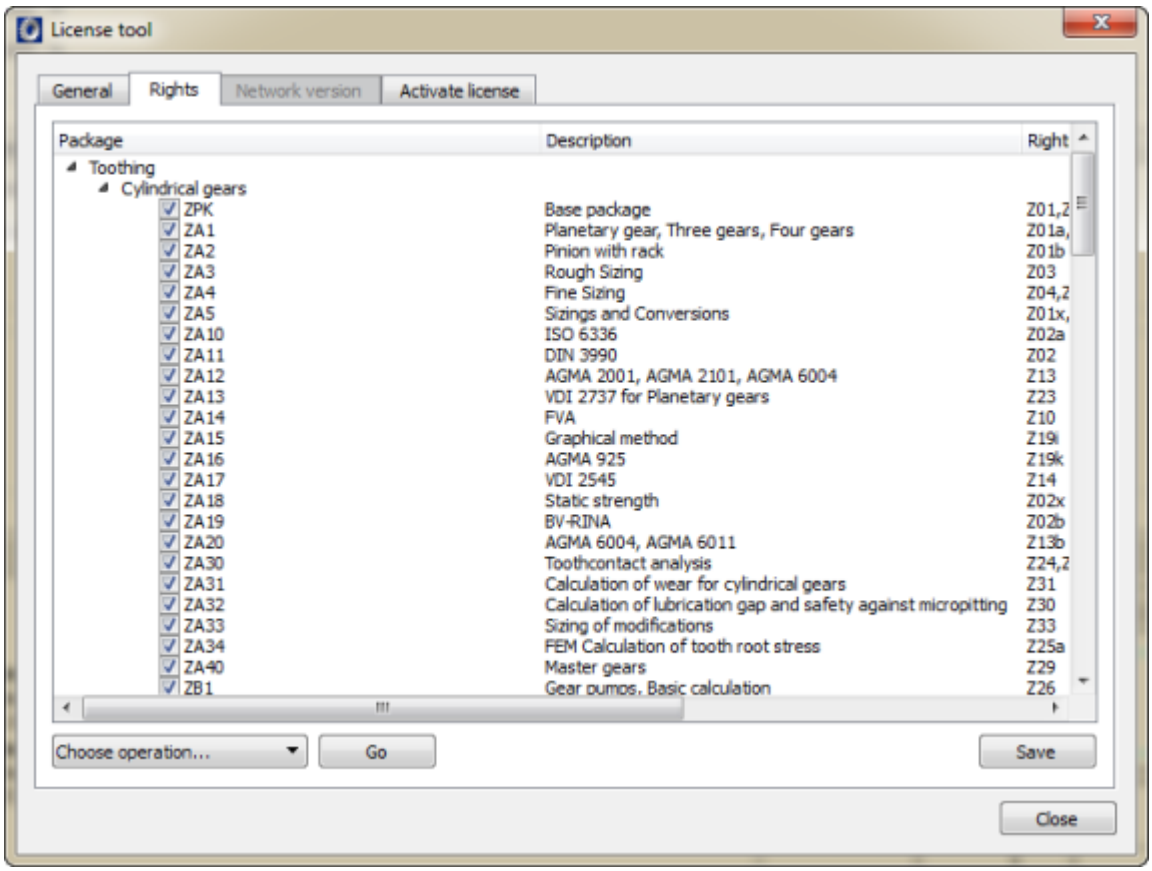
Chapter 1
Product Description

Description of characters:

* Programs from other manufacturers. We guarantee to provide support and implement a compatible installation.

K02a Short description of the calculation module. You will also find this abbreviation again in the price list.

(M02a) Module ID as found in the software and in the Rights tab in the KISSsoft License tool.



1.1 Program versions

- **Demo program:** All the program modules can be tested in a demonstration program. The scope of the demo version is the same as the full version, apart from a few restrictions (listed below):
  - You cannot save calculation files and results
  - You can only select the first item in the lists
  - You cannot export graphics (DXF, IGES, etc.)
  - The text "This license is for non-commercial use only" appears when you print graphics.

Programs from other suppliers, which we also provide, are not included in the demo version. The demo program gives you a good insight into how to work with the KISSsoft system.

- **Test installation:** Furthermore, starting on a date which you specify, you can also test a full version of our programs for a period of 30 days. You will then have unrestricted access to all our currently available calculation modules. The test installation gives you the opportunity to test our programs in a practical environment.
- **Single user version:** Copying protection: For security reasons, the programs can be copied at any time. To limit the illegal distribution of these programs, a software USB port protection device "dongle" is supplied along with the single user version. This is then inserted into the computer's USB port.
- **Multi-user network installation with access directory:** We can supply a network installation, in which any number of users can work with the software, but at the same time only a limited number (depending on the number specified on the license) of users have authorization. This makes KISSsoft extremely flexible and easy to integrate into any network structure. To manage these licenses, you only need to install one directory with full rights on a server with general access rights for KISSsoft users. This does not start any server processes or similar processes. The license file contains the path of the access directory and the logical serial number of the network drive.
- **Multi-user network installation with USB port protection device:** Alternatively, you can also run the network installation on the server, with a USB protection dongle. To do so, you need a server with a Windows operating system and a USB port, and a directory to which both the server and clients have read and write access.

1.2 Computer configuration

To run the programs, you require the following computer configuration:

- Operating system: Windows VISTA, Windows 7, Windows 8 or Windows 10
- Processor: at least SSE2-compatible
- RAM: at least 4 GB RAM
- Screen resolution: at least 1280 x 960 pixels
- OpenGL compatible
- Printer: Windows printer
- Memory: Space required on hard disk: approximately 800 to 3000 MB (depending on amount of data required)

2.1 K1 Base module

This module represents the administration module which is the basis for all calculation modules. The following points are covered:

- **KISSsoft in different languages:** KISSsoft is available in five languages. While the program is running, you can switch language separately for calculation reports and the user interface (see also K02).
- **Data storage:** The KISSsoft system stores the data input by users and the results of calculations in a freely-definable storage medium (diskette, local hard disk, network server). Use the project management functions to create project-specific directories.
- **Recording the results:** You can select where the results are output (printer or file) and how they are displayed to suit your own requirements. Additional Properties:
  - The report file is in RTF format. Although an internal editor is available, you can also select an external editor. If you use an RTF editor (for example, KISSedit which is supplied with the system, Workpad or MS Word) the relevant graphics are displayed in the report.
  - You can also select the scope of the printout (detailed variant and summary, to 9 levels of detail)
  - The content and appearance of the report templates can easily be modified using a text editor. Here, you can predefine formatting, such as font size, bold, italic or underlined.
  - You can select the language of the printout (see option K2).
  - Automatic page breaks and numbering.
  - User-specific print header (for example, to comply with the quality assurance requirements of ISO 900x).
  - Display in a report editor. This enables you to add comments quickly and easily. In the report editor (KISSedit), you can select the header and footer format. You can include your company logo. The report you generate can be viewed directly. The report is displayed in a Word processing program, usually in the editor supplied with the system. You can use the KISSsoft settings to specify which word processing program you want to use.
- **Graphical representations and plotter:** To help you input and check data, at some points in the program, the inputs are shown in a scale graphic. Simply click a button to print out images, store them in graphics formats, or output

them via a CAD interface (DXF, IGES, see modules K05a and K05e). You can also define your own system of coordinates, line types and colors.

- **Help function:** KISSsoft has a powerful help system. Press function key F1 at any time to request information about the current situation in the program. In addition, you can call other topics in the help system by selecting them from the table of contents or by clicking a cross-reference. As you can also display graphics, you no longer have to keep the manual close by when you are working with the KISSsoft system.
- **Toggling units:** In KISSsoft, you can toggle units at any time. You can also store your own tailored configurations alongside the pre-prepared default settings.
- **Input parameter as formula:** In the interface you can perform simple calculations to help your work, directly when you input the data. This is useful if, for example, you must calculate a torque from the force and the lever arm, or work out a length from several masses.
- **Calculator:** You can activate a calculator program at any time, and use it to perform simple calculations.
- **Data exchange between different program sections:** At different places in the program you can refer back to the results of data that has already been calculated in other program modules. As a consequence, you can, for example, access data from the gear calculation when defining the external forces in the shaft.
- **Public data interface:** The freely definable formatting of this data interface gives you a very effective communications tool for interacting with external programs. It has been specially designed to enable KISSsoft to be integrated into CAD programs. All input and output data can be exported in ASCII format. The scope and format of this data is freely definable. To enable this, each calculation module contains an editable report file. External programs can, in addition, transfer input data (also in ASCII format) to the calculation modules. These files are imported automatically during start-up and the data is displayed on screen.
- **Calculation server, KISSsoft API:** You can use KISSsoft as a calculation server for your own program developments. You can do this either via the public data interface (see above) or via a COM interface.

2.2 K02 report text and interface

The program is currently available in the following languages:

- Right K02 German (always present)
- Right K02a English
- Right K02b French
- Right K02c Italian
- Right K02d Spanish
- Right K02f Portuguese
- Right K02e Russian

2.3 K04 COM interface

You can use the COM interface to start the software from an external program, load files, set and read variables, run calculations, or generate reports.

You will find a detailed description of its functions in the manual.

2.4 K04a extended COM interface

Use the "CallFunc" and "CallFuncNParam" functions to call a multitude of sizing and optimization functions. A list of these functions is available on request.

2.5 K05 CAD interfaces

KISSsoft's public interface is a powerful tool, designed to create CAD integrations. The modular structure of KISSsoft programs enables them to be integrated smoothly into the CAD system, as individual calculation functions. Detailed instructions about how to create interfaces in the CAD system are provided in the manual.

Integration of the KISSsoft system:

In addition to this general solution, the system also has a wide range of standard formats for graphical displays. You can also request CAD integrations for numerous other CAD systems.

2.6 K05a DXF interfaces

All two-dimensional graphical data is described in AutoCAD DXF data format. As this interface is used in many CAD systems, this option can therefore also be used for other CAD systems. If necessary, you can also specify the layer to which inputs and outputs are to apply.

2.7 KO5e IGES interface

Outputs all two dimensional graphical data in IGES format.

2.8 KO5d Solid Edge interface

The interface between Solid Edge and KISSsoft is created by direct integration in the 3D CAD system. This enables you to start all KISSsoft calculation modules directly from Solid Edge. Cylindrical or bevel gears calculated in KISSsoft can then be generated directly in Solid Edge as a 3D part with a real tooth form. From the KISSsoft system, in the tooth form calculation module, simply press a button to start Solid Edge. This opens a new part and generates the appropriate part. You can create cylindrical gears with straight or helical teeth, which are external or internal, or straight-toothed bevel gears, as defined in DIN 3971, Figure 1. Furthermore, you have the option of adding toothing to existing shafts at a later point in time. If you insert a reference layer to a side face of an existing shaft and then select it, the tooth form is cut out there on the shaft blank. In the 2D area, the interface also gives you the option of adding gear manufacturer data automatically as a text field on the drawing. The gear manufacturing data is attached to the relevant cutout (tooth space).

2.9 K05k SolidWorks interface

The interface between SolidWorks and KISSsoft is created by direct integration in the 3D CAD system. Use this to start all KISSsoft calculation modules directly from within SolidWorks. Transverse or bevel gears calculated in KISSsoft can be generated directly in SolidWorks as a 3D part with real tooth form. From the KISSsoft system, in the tooth form calculation module, simply press a button to start SolidWorks. This opens a new part and generates the appropriate part. You can create cylindrical gears with straight or helical teeth, which are external or internal, or straight-toothed bevel gears, as defined in DIN 3971, Figure 1. You also have the option of adding toothing to existing shafts at a later point in time. If you insert a reference layer to a side face of an existing shaft and then select it, the tooth form is cut out there on the shaft blank. In the 2D area, the interface also gives you the option of adding gear manufacturer data automatically as a text field on the drawing. The gear manufacturing data is attached to the relevant cutout (tooth space).

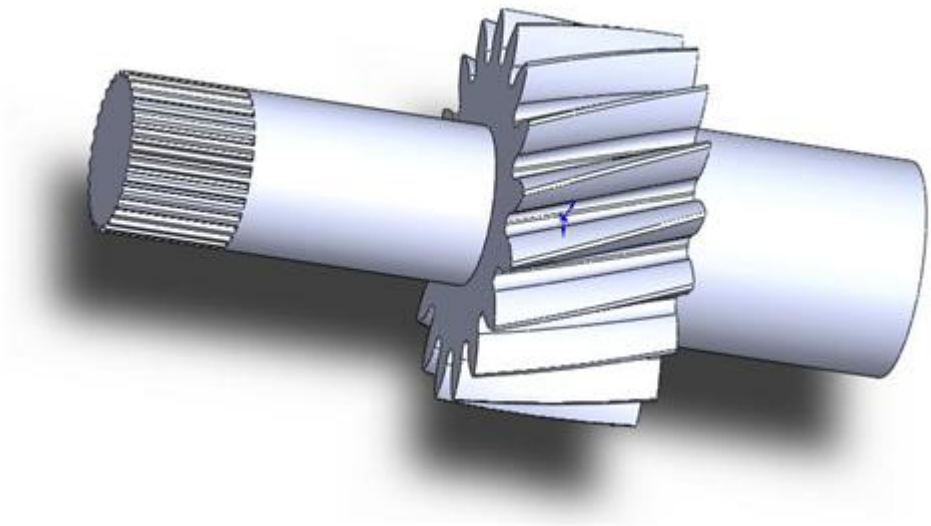


Figure 1.1: Pinion shaft generated in KISSsoft

2.10 K05m Inventor interface

The interface between Inventor and KISSsoft is created by direct integration in the 3D CAD system. Use this to start all KISSsoft calculation modules directly from within Inventor. Cylindrical or bevel gears calculated in KISSsoft can then be generated directly in Inventor as a 3D part with a real tooth form. From the KISSsoft system, in the tooth form calculation module, you simply press a button

to start Inventor. This opens a new part and generates the appropriate part. You can create cylindrical gears with straight or helical teeth, which are external or internal, or straight-toothed bevel gears, as defined in DIN 3971, Figure 1. Furthermore, you have the option of adding toothing to existing shafts at a later point in time. If you insert a reference layer to a side face of an existing shaft and then select it, the tooth form is cut out there on the shaft blank. In the 2D area, the interface also gives you the option of adding gear manufacturer data automatically as a table on the drawing. The gear manufacturing data is attached to the relevant cutout (tooth space).

2.11 KO5n NX interface

The interface between NX and KISSsoft is created by direct integration in the 3D CAD system. Use this to start all KISSsoft calculation modules directly from within NX. Cylindrical or bevel gears calculated in KISSsoft can be generated directly in NX as a 3D part with a real tooth form. You can create cylindrical gears with straight or helical teeth, which are external or internal. You also have the option of adding toothing to existing shafts at a later point in time. If you insert a reference layer to a side face of an existing shaft and then select it, the tooth form is cut out there on the shaft blank. In the 2D area, the interface also gives you the option of adding gear manufacturer data automatically as a table on the drawing. The gear manufacturing data is attached to the relevant cutout (tooth space).

2.12 KO5o* CATIA interface

Cylindrical or bevel gears calculated in KISSsoft can be generated directly in CATIA V5 as a 3D part with a real tooth form. You must open CATIA V5 before you start generating a 3D model in KISSsoft. In CATIA V5, this then opens a new part and the appropriate part is generated. You can create cylindrical gears with straight or helical teeth, which are external or internal. In the 2D area, the interface also gives you the option of adding gear manufacturer data automatically as a text field on the drawing.

2.13 KO5q* ProEngineer interface

Cylindrical or bevel gears calculated in KISSsoft can be generated directly in ProEngineer as a 3D part with a real tooth form. You must open ProEngineer before you start generating a 3D model in KISSsoft. In ProEngineer, this then opens a new part,, and the appropriate part is generated. You can create cylindrical gears with straight or helical teeth, which are external or internal, or straight-toothed bevel gears, as defined in DIN 3971, Figure 1. In the 2D area, the interface also gives you the option of adding gear manufacturer data automatically as a text field on the drawing.

2.14 K05s Parasolid display window

The cylindrical gears, racks, bevel gears, face gears, crossed helical gears and worm gears calculated in KISSsoft can be displayed directly in this parasolid 3D display window.

2.15 K05u Export STEP format (parasolid)

Module for exporting the 3D models displayed in the Parasolid view window in STEP format.

3D models of cylindrical gears, racks, bevel gears, face gears, helical gears, and worm gears, can be generated and exported.

2.16 K07 User database (materials etc.)

You can extend or change any data, such as materials, geometry data or the toothing profile, via the user database. One of the KISSsoft system's more useful features is that changes to material data also automatically become active in every calculation that has already been saved.

2.17 K7a Material management (always present)

Module in which you input additional materials and where you change specific data of materials that are already present.

2.18 K7b Smith-Haigh diagram

Prerequisite: right W03, W06

This right permits you to display a Smith and Haigh diagram for a specific material. It can only be displayed as part of a shaft calculation. You can display a notched part. In the graphic you can select the cross section as well as the stress components bending, tension/compression or torsion.

2.19 K09 Hardness Conversion (in the Extras menu)

Conversion of hardness data according to Vickers, Brinell and Rockwell for different material groups according to DIN EN ISO 18265.

2.20 K10 Calculating tolerances

Calculate the total allowance for the measurement chains for the elements you input. You can define the tolerances either as a general tolerance (DIN ISO 2768, DIN 7168) with inputs specified in ISO in the tolerance field or use your own values. This calculation uses a constant distribution (arithmetical sum) and the square

root of the tolerance squares (standard distribution) to define the whole tolerance field.

2.21 K11i Dynamic analysis of shaft systems

Performing dynamic analyses in complete shaft systems.

This module enables you to:

- perform a modal analysis of a complete KISSsys model. You can select either pure torsional vibrations or linked torsional, axial and flexural vibrations. The result is displayed in a 3D animation of the vibrating shaft system, and is also exported as a table. A detailed report is also provided. Damping is ignored, and the amplitudes of the eigenmodes are standardized at 1.
- Calculation of the Campbell diagram. The shaft system's eigenfrequencies are calculated for an operating speed range on one of the shafts. The results are output as a plot, report and table .
- Calculation of forced responses. Calculates how the shaft system reacts to dynamic stimulation. The dynamic excitation of concentrated unbalance masses is used to dynamically excite the system. The dynamic excitation of gears (caused by transmission error and stiffness fluctuations in the meshing) is not taken into account. Both the (structural) material damping and the viscous damping can be defined. The resulting responses from different dynamic excitations are added in the time range, and the final result is given as the maximum value for this superposition. Transient phenomena are not taken into account.

The transfer matrices method is used for the calculation in every case. A number of different models are available for meshing stiffness as defined in ISO 6336, contact analysis (if the necessary license is present), infinite stiffness and zero stiffness.

2.22 K11k Export of KISSsys model data

This module is used to export data from any KISSsys model in XML format. The input data and the model's kinematics are exported together with a range of different calculation results (for example, bearing stiffness, meshing stiffness etc.).

2.23 K12 Strength verification using local design (FKM guideline)

The static and proof of fatigue strength (time or endurance) with elastically calculated local stresses as specified in the FKM Guideline (6th Edition) for non-welded parts.

Starting from stresses in critical points that are calculated using an FE program, you can use this method to calculate a complete strength verification with safety against fracture or against the yield point and the safety against fatigue failure. You can also perform this calculation with load spectra.

2.24 K14 Hertzian pressure

Calculating the Hertzian pressure of two bodies. Hertzian equations are used to help calculate the maximum pressure (Hertzian pressure) and also the proximity of the two bodies (ball, cylinder, ellipsoid, plane; convex or concave). They also calculate the normal stress curve to the surface.

The calculation formulae have been taken from "Advanced Mechanics of Materials, 6th Edition".

2.25 K14a Any contact

Calculates the line contact between two bodies with an arbitrary profile (line load on an elastic hemisphere). The results include deformation and loads in the contact area and under the surface along the profiles. Plasticity and friction are ignored. These calculations are based on "Contact Mechanics" by K. L. Johnson, Cambridge University Press, 2003.

2.26 K15 Linear Drive

Use this calculation module to calculate drive screws. Drive screws are used to convert rotational movement into longitudinal movement or to generate great forces. Trapezoidal screws (DIN 103 selectable) are used almost exclusively as drive screws.

The information provided in Roloff Matek [62] is used to calculate linear drives (drive screws).

2.27 K16 Gear body deformation

This calculation module is designed to calculate the deformation due to line load on the operating pitch diameter of a gear body with a web mounted on a shaft. The gear body is defined by parameters. The results are the deformation of the operating pitch diameter and a stiffness matrix under unit load. The stiffness matrix can be added to the shaft calculation (module W10a) for cylindrical gears to ensure that gear body deformations are taken into account in the meshing when the load distribution is calculated. The deformation due to the gear body is added to the shaft bending and is used to define gaping and the tooth trace modification (WA2).

2.28 K17 Plastics Manager

This module can be used to add new plastic materials to the KISSsoft material database, if the material characteristics are available. When a material is added to the database, a corresponding material .DAT file is generated. If results from gear tests (gear geometry, torque, speed, number of cycles to failure, temperature) are available, the permissible root and/or flank fatigue can be calculated and evaluated statistically. The fatigue data is automatically added to the appropriate .DAT files. These files can be used to calculate the lifetime safety factors.

2.29 K18 Reliability

Calculation of reliability according to Bernd Bertsche [105] with the use of 3-parameter Weibull distribution. The reliability R of a machine element is calculated as a function of the number of load cycles t using the following equation.

$$R(t) = e^{-\frac{t-t_0}{(T-t_0)}^{\beta}} * 100\%$$

The reliability results for the gear teeth (bending, pitting) are output in the reports (Service life section) and in a graphic. Results for rolling bearings are displayed in a graphic.

The reliability of the entire drive train is calculated in KISSsys. The system displays the reliability over the service life for all gears, bearings and shafts, individually or in the overall system. The display can be done via a linear, logarithmic or dual logarithmic scale. Aditionally, the service life of the drive system for a reliability of 90, 99 and 99.9% is dispayed.

2.30 K20 Import a reduced stiffness matrix from different FEM programs

This is used to import a reduced stiffness matrix based on the following formats:

- Standard KISSsoft format (K20a)
- Abaqus format (K20b)
- Nastran format (K20c)
- code_aster format (K20d)
- ANSYS format (K20e)

3.1 General

The program is made up of individual modules, all of which are controlled via the base module, which contains input, modification, and output, options. Data that has been input once (geometry, material, forces, etc.) can therefore be used in all calculation modules and does not have to be entered again and again.

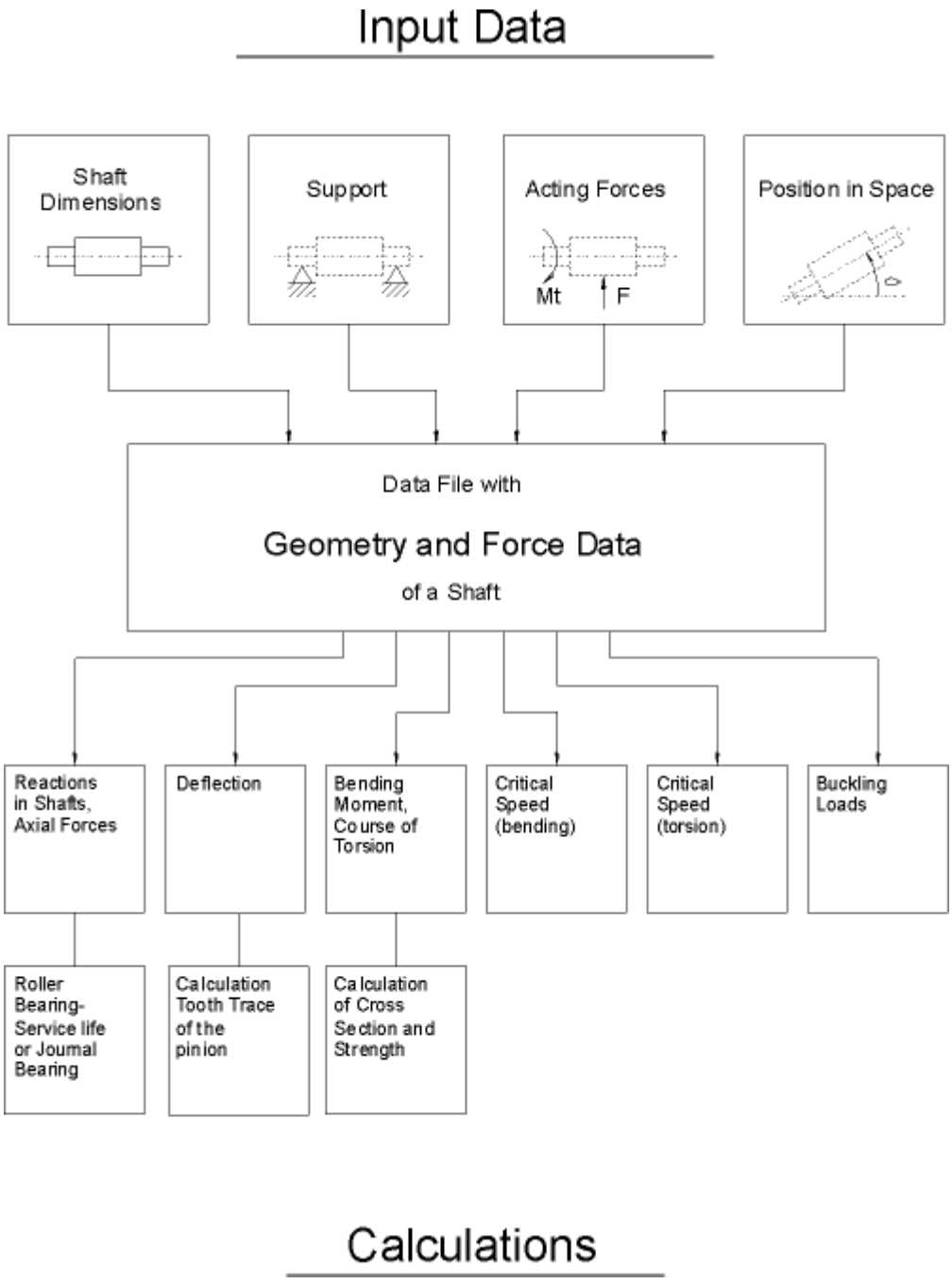


Figure 1.2: Flow-chart of the modules for shaft and bearing calculation in KISSsoft

3.2 W01 Shafts base module

Use this to start the calculation module:

- Shaft calculation [W010]

In this module, you can input and correct geometry and material data, shaft specifications, drawing numbers, support, peripheral conditions, external forces and moments (simplified input for couplings, spur and bevel gears, worms, worm gears, belt sheaves), and it has an interface to CAD. Graphical interface: The shaft contour and bearing are shown in a scale diagram.

Additional properties of the base module are:

- Any dimensions (cylindrical and conical), axial symmetric cross section, solid and hollow shafts, beams (H-, I-,L-profiles etc.)
- Integrated drawing tool that enables simple corrections to be made to the shaft contour (diameter, lengths). You can change any of these elements by simply clicking on them with the mouse.
- List functions: The elements you input are output as a list and can be changed as required (change, insert, delete)
- You can enter these values for force and moment in any spatial positions. However, the following values are already predefined:
  - Cylindrical gear
  - Bevel gear
  - Worm
  - Worm wheel
  - Coupling / Motor
  - Rope or belt sheave
  - Individual radial and axial forces, bending and torsional moments
  - External masses with moment of inertia
  - Eccentric load
  - Power loss
  - Interface used to import data from gear calculations
  - Forces can also apply outside the shaft
  - You can also specify your own power or torque
- Statically undefined bearings

- Calculation of:
  - Shaft weight
  - Moment of inertia
  - Gyroscopic moment
  - Resulting, axial force
  - Static torsion of the shaft
  - Torsional moment progression
- All force elements (external force, cylindrical gear, coupling etc.) can be assigned load spectra. This information is evaluated accordingly (deflection, strength, rolling bearing) in the calculations. Calculation with a load spectrum requires W01s
- The geometric data and the calculated bearing forces are displayed in an easy to understand form on screen and on paper.
- Interface to different CAD systems for transferring (importing and exporting) shaft geometry in different formats (see options for K05).
- The results of the base calculation, the deflection (W03), critical speed (W04) and strength calculation (W06), including the specific relevant graphical representations, are grouped together in a collective report.

3.3 W01a Input data for several shafts

Use this calculation module to input and calculate data for several coaxial shafts. You can link the shafts with rolling bearings or general connections.

You may need to use several coaxial shafts, for example, for moveable gears for speed change gear units where the deformation of the shaft and the moveable gear can be taken into account when you size the tooth trace modifications.

At present, you can define a maximum of 15 coaxial shafts.

3.4 W01b Bearing offset, Bearing clearance

If you have this right you can take the bearing offset and the bearing clearance into account in the calculation. You can specify the bearing offset both for general bearings and for rolling bearings.

In the case of rolling bearings, you can define a radial clearance and a displacement in both the X and Z directions. In the case of general bearings, you can define clearance or displacement for all six degrees of freedom.

3.5 W01c Take into account contact angle

Use this calculation module to take the bearing pressure angle into account in the calculation. For this purpose, the bearing force from the average pressure point is moved along the line of action to the bearing center. The resulting bending moment is then effective at the bearing.

3.6 W01a Load spectra

Use this calculation module to define load spectra that can then be taken into account in the calculation. You can either select a spectrum element, which enables you to perform all the calculations, or perform the calculation with the entire spectrum to calculate either the bearing service life (W05) or its strength (W06s).

3.7 W03 Calculate deflection and bearing forces

- Calculate the diagrams of bending, course of transverse force, and torque diagram, in the X-Y and the Z-Y plane (shaft axes always along the Y-axis), with or without taking into account the dead weight
- Calculate the axial force while taking into account the mass (depending on the length of the shaft)
- Calculate the axial strain of the shaft
- Graphical display of all critical results on screen and as a printout: course of deflection, shearing force, bending moment in different planes, torsional moment, axial force and static comparative stress
- Calculate the forces and torques in bearings (and ends of shafts) for an unlimited number and any type of bearing
- Output the bearing reaction forces for an unlimited number of bearings
- Calculate the inclination of the diagrams of bending in bearings, e.g. when calculating cylindrical roller bearings. The progression of the angle of inclination can also be displayed on screen and printed out.
- If you input a shaft with load spectra, you can also calculate the bending lines individually for the load on each load spectrum bin (right W1s).
- Calculate all stress components (tension/compression, bending, shearing, torsion) and equivalent stress. Display the equivalent stress progression as well as stress components.
- Calculate the deflection with or without taking into account deformation due to shearing (right W3a)

Calculate deflection and cut sizes using finite element calculation with one-dimensional beam elements. This calculation is based on a CM2 FEM library of Computing Objects (http://www.computing-objects.com)

3.8 W03a Take into account deformation due to shearing

Deformations due to shearing can be taken into account when you calculate deformations. You can specify the shear correction coefficient for that purpose. However, there is only one shear correction coefficient for the shaft system.

3.9 W03b Non-linear shaft

You can activate a calculation with a geometric non-linear beam model. A shaft calculation with two fixed bearings under shearing force then also supplies axial force due to elongation along the length. If you perform the calculation with a non-linear shaft model, you must take the deformations due to shearing into account. In standard shafts, the linear and non-linear calculations return the same results. The non-linear method supplies good results in cases that do not occur in mechanical engineering, such as, for two fixed bearings or for the calculation of the diagrams of bending for thin wires.

3.10 W03c Thermal expansion

Input the temperature and heat expansion coefficient to predefine the axial expansion of temperature and housing. In this case, a shaft has a homogenous temperature.

3.11 W03d Non-linear stiffness

The stiffness of rolling bearings is calculated according to ISO/TS 16281 (DIN ISO 281 supplement 4). The internal geometry data is taken from the rolling bearing database or approximated from the load numbers, if not otherwise specified. This calculation option supplies a changed deflection and load distribution on the bearing, but no additional results. For more information, see W05b and W05c.

You can take into account the non-linear bearing stiffness for double row self-aligning roller bearings, single-row cylindrical roller bearings, taper roller bearings, deep groove thrust ball bearings, angular contact ball bearings, radial four-point contact bearings, and single-row deep groove thrust ball bearings and angular contact thrust ball bearings.

3.12 W04 Calculation of the critical speed

Calculate the eigenfrequencies for the system of coaxial shafts, with or without additional mass.

- Calculate any number of eigenfrequencies
- Taking into account bending, torsion and axial movements
- Coupling of axial and bending movements by angular contact ball bearings and taper roller bearings
- Display on screen and print out natural frequencies for deflections and displacement
- In the case of beam profiles, eigenfrequencies are defined in both main levels.
- Gears can be included automatically and handled like masses. In this situation, KISSsoft takes into account the mass and the moment of inertia of the gear sited on the shaft.

3.13 W04x Effect of spinning

Prerequisite: right W04

Addition used to calculate eigenfrequencies: This takes into account the gyro effect of large momentums of mass. The critical frequencies (bending mode) are calculated for the forward and backward whirl. In a synchronous parallel run, an unbalance increases the bending oscillations, because the angular speed of the rotating shaft and angular speed of the shaft's peripheral center point are the same. However, the synchronous counter run is, in most cases, not technically important.

The effect of spinning is taken into account for the predefined speed.

3.14 W05 Ball and cylindrical roller bearing and roller bearing service life

Use this to start the calculation module:

- Rolling bearing calculation [W050]

- Calculation of:
  - Deep groove ball bearing (single and double row)
  - Angular contact ball bearing (single and double row)
  - Cylindrical roller bearing (single and double row)
  - Needle roller bearing
  - Double row self-aligning roller bearing, double row self-aligning ball bearing
  - Taper roller bearing

- Paired taper roller bearing
- Four-point contact bearing (QJ)
- Axial spherical roller bearings
- Axial cylindrical roller bearing
- Thrust needle roller bearing
- Deep groove thrust ball bearing
- Angular contact thrust ball bearing
- Axial tilted roller bearings
- Cross roller bearings
- Hybrid bearings (deep groove ball bearings, cylindrical roller bearings with ceramic rolling bodies)

- All data (approximately 40,000 different bearings) is stored. It is transferred directly from data from FAG, SKF, Koyo, Timken, IBC and KRW bearings.
- Integrating bearings using the database tool
- Selecting a bearing by inside or external diameter
- Taking into account radial and axial forces
- Calculate service life and static safety factor
- Check the bearing speed limit (oil and grease lubrication)
- Simultaneous calculation of up to 8 bearings (any number of bearings in the shaft calculation).
- Bearing clearance: Normal / C3 / C4 for deep groove ball bearings
- Bearing arrangement: Single, back-to-back or face-to-face arrangement.
- Calculate the axial forces for angular contact ball bearings and taper roller bearings

3.15 W05b reference service life specified in ISO/TS 16281

Prerequisite: right W03d

- In the shaft calculation, in the enhanced version of module W03d, you can also calculate and output the reference service life specified in ISO/TS 16281. This method performs a detailed calculation of the bearing service life and takes into account the internal bearing geometry (rolling bodies, clearance, etc.).

This calculates the reference service life Lnrh. With authorization W05a you can also calculate the modified reference service life.

As before, you can still analyze the following bearing types while taking their internal geometry into account:

- Deep groove ball bearing
- Angular contact ball bearing
- Cylindrical roller bearing
- Taper roller bearing
- Double row self-aligning roller bearing
- Needle roller bearing/Needle cage
- Axial cylindrical roller bearing
- Axial spherical roller bearings
- Deep groove ball bearing (single row)
- Angular contact ball bearing (single row)
- Four-point contact bearing
- Deep groove thrust ball bearing (single row)
- Cylindrical roller bearing (single row, single row (full complement), double row, double row (full complement)
- Axial cylindrical roller bearing
- Needle roller bearing/Needle cage
- Thrust needle cage
- Taper roller bearing (single row)
- Double row self-aligning roller bearing
- Axial spherical roller bearings

3.16 W05a Bearing load spectra

Calculate the service life as specified in ISO 281 for any load spectra. Modified rating life calculation (influence of working conditions and lubricant): Rolling bearing calculation is performed using the aISO coefficient (ISO 281-2007), in accordance with the modified service life criterion. KISSsoft uses data about lubricant viscosity, cleanliness, operating temperature, the speed, the bearing geometry, and the bearing type, to define the aISO coefficient and then includes this in the calculation. Alternatively, you can also perform this calculation without the aISO coefficient.

You can also use this module to perform an enhanced bearing service life calculation in the shaft calculation.

The reference thermal limit of the operating speed, as specified in DIN 15312 and DIN 732, can be calculated from the heat level of the rolling bearing.

3.17 W05c Load distribution in the bearing

Prerequisite: right W03d

In the shaft calculation in the enhanced version of modules W03d and W05b you can also calculate and output the pressure on the individual rolling bodies as specified in ISO/TS 16281. You can output this data either as a report or a graphic.

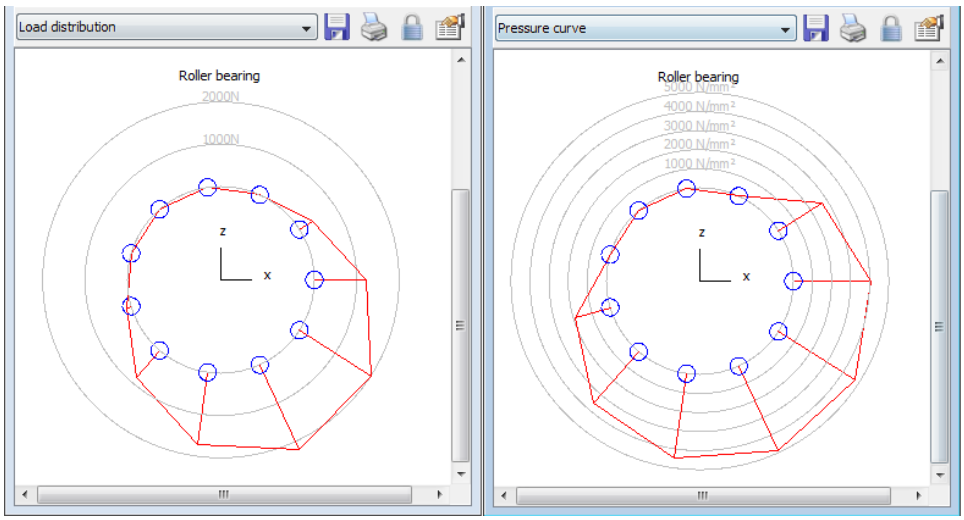


Figure 1.3: Load distribution in the bearing

3.18 W51 Verification of rolling bearings according to ISO/TS 16281

Bearing rings can now be handled as elastic. To do so, external loads are defined on the outside or inside ring, and the deformation of the bearing ring is determined iteratively with the deflection of the rolling bodies. Bearing rings can now also be tilting, as well as having constant deformation.

Extension to module WB4

3.19 W06 Calculate the service life and static calculation of cross sections

- You can select the following cross section types (automatic calculation of notch factors, notch effect on the outside or inside diameter):
  - Smooth shaft
  - Shoulder
  - Shoulder with relief groove
  - Conical shoulder
  - Press fit
  - Key
  - Spline
  - Straight-sided spline
  - Square groove
  - Circumferential groove
  - V-notch
  - Thread
  - Cross hole
  - Define your own definition notch factors
- Supplied materials: around 100 materials, such as Ck 45, Ck 60, St 52, 16 MnCr 5, 18 CrNiMo7, GG 20, stainless steels, steel castings, malleable iron and many more
- Showing the progression of the equivalent stress as a graphic makes it easier to locate the cross sections that are at risk.
- Input the values for surface roughness and quality values as defined in ISO 1302 and output roughness Rz.

- Influence of surface treatments (shot peening etc.) and heat treatment.
- Wedge tables for cross sections with wedges are pre-installed. The data is imported from a data file that contains the ISO 773, DIN 6885.1, DIN 6885.2 and DIN 6885.3 standards. You can also specify other standards, or input them directly while the program is running.
- Calculate safety for fatigue failure; Static safety against yield point and fracture With W06s, finite life calculation and load spectra.

3.20 W06a Hänchen + Decker calculation method

Calculate in accordance with "Neue Festigkeitsberechnung für den Maschinenbau " by Hänchen + Decker. Very reliable calculation method although it no longer corresponds to the latest research results (accepted by TÜV).

3.21 W06b Calculation method DIN 743

Calculate according to DIN 743 (2012 edition) "Tragfähigkeit von Wellen und Achsen" (similar to the calculation in accordance with the FKM Guideline): Strength calculation for shafts and axes with safety verification against residual deformation.and failure due to fatigue The strains that occur here (at average and deflection stress) are evaluated on the basis of a simplified Smith diagram.

Important features of this method:

- applies only to shafts and axes.
- Tension/compression, bending and torsion are included in the calculation. However, shearing is not taken into account.
- Take into account surface factor (nitriding, case hardening, carbonitriding, rolling, shot peening, induction and flame hardening).
- As the service life is not calculated (fatigue strength range), the load spectra are therefore also not calculated
- Temperature range: -40 to 150 degrees Celsius.
- Only applies to steel.

3.22 W06c Calculation methods in the FKM Guideline

The FKM Guideline is the most comprehensive currently-available calculation method. It goes far beyond the application areas of DIN 743, but requires more time and effort to interpret its results. The calculation algorithm performs both a static

and a finite life calculation. This calculation algorithm was developed by Professor Haibach.

3.23 W06d Calculation method AGMA 6101/6001

In this calculation method, the calculation is performed using von Mises stresses.

The 7 reference coefficients (ka to kg) are used to determine a whole coefficient with which you can calculate the static safety and safety against fatigue.

Restrictions to the strength calculation method:

- In KISSsoft, no load spectra can be taken into consideration in the calculation according to AGMA 6101.
- The standard only contains diagrams of the notch factors for 3 different notches (shoulder, circumferential groove and cross hole).
- Separate fixed notch factors are entered for the press fit and the key. A range is defined in the standard for the press fit with key combination.

3.24 W06s Strength calculation with load spectra

Prerequisite: right W06b or W06c

The calculations specified in the FKM Guideline, DIN 743 with the FVA proposal, or the new draft, enable you to calculate strength with load spectra. If you input a shaft with load spectra, you can use it to perform the calculation directly. However, the calculation method specified by Hänchen/Decker do not take load spectra into account because the standard does not permit this.

3.25 W07 Hydro-dynamic plain radial bearings

Calculation of hydro-dynamic plain radial bearings in stationary operation. Different oil types are predefined (ISO VG) and you can also input data for special lubricants. The calculation is performed for cylindrical bore plain bearings (however, using different construction types only gives a small variation in results).

3.26 W07a Calculation in accordance with Niemann

You can use this module to calculate the power loss, oil flow, oil temperature, minimum lubricant gap thickness as defined in G. Niemann, Maschinenelemente I, Springer, and O. R. Lang, Gleitlager, Springer. This calculation can only be used for pressure lubricated bearings (circulatory lubrication) when the service reliability is also tested.

3.27 W07b Calculation according to ISO 7902

Calculation according to ISO 7902: Complete calculation according to ISO 7902, Part 1 (2013 edition), and Parts 2 and 3 (1998 edition) for pressure-less and

pressure lubricated bearings. This takes into account the way in which lubricant is applied (lubrication holes, lubrication groove, lubrication glands). It calculates all the operating data as defined in ISO 7902, including the operating temperature, minimum lubrication gap width, power loss, oil flow etc. It also checks service reliability. The spring stiffness (radial stiffness) of the bearing at the operating point is also calculated. This value can then be included in the shaft calculation.

3.28 W07b Calculation according to ISO 31657

Calculation according to DIN 31657: Complete calculation according to DIN 31657, Parts 1 to 4 (1996 edition) for pressure-less and pressure-lubricated plain bearings. Two types of bearing are described in this standard: multi-lobed plain bearings and tilting pad plain bearings. It calculates all the operating data according to DIN 31657, including the operating temperature, minimum lubrication gap width, power loss, oil flow etc. It also checks service reliability. The spring stiffness (radial stiffness) of the bearing at the operating point is also calculated. This value can then be included in the shaft calculation.

3.29 W07e Calculation according to DIN 31652

Calculation according to DIN 31652: Complete calculation according to DIN 31652, Parts 1 to 3 (2017) for pressure-less and pressure lubricated bearings. This takes into account the way in which lubricant is applied (lubrication holes, lubrication groove, lubrication glands). It calculates all the operating data according to DIN 31652, including the operating temperature, minimum lubrication gap width, power loss, oil flow etc. It also checks service reliability. The spring stiffness (radial stiffness) of the bearing at the operating point is also calculated. This value can then be included in the shaft calculation.

3.30 W08 Grease lubricated plain radial bearings

Calculates the bearing data in operation, and during the transfer to mixed friction, on the basis of the calculation method used for oil lubricated plain bearings when insufficient lubricant is present. A wide range of different greases are predefined here.

3.31 W07c Hydrodynamic plain thrust bearing

Calculation of hydrodynamic plain thrust bearings in stationary operation. Different oil types are predefined (ISO VG) and you can also input data for special lubricants.

- Calculation according to DIN 31653: Complete calculation of axial segment bearings as defined in DIN 31653, Parts 1 to 3 (1991 edition) for pressure-less and pressure lubricated bearings. It calculates all the operating data according to DIN 31653, including the operating temperature, minimum lubrication gap width, power loss, oil flow etc.
- Calculation according to DIN 31654: Complete calculation of axial segment bearings as defined in DIN 31654, Parts 1 to 3 (1991 edition) for pressure-less and pressure lubricated bearings. This takes into account the way in which lubricant is applied (lubrication holes, lubrication groove, lubrication glands). It calculates all the operating data according to DIN 31654, including the operating temperature, minimum lubrication gap width, power loss, oil flow etc.

3.32 W10 Calculation of deformation in the axial direction

Calculates the displacement of a cross section point from its home position due to torsion and deflection. For various purposes, for example, for grinding off crowning (also called length modification or tooth trace modification) on toothing, it is important that you know how much a specific point in the shaft cross section moves in a particular direction due to elastic deformation. This program calculates

the displacement in a specific interval along the length of the axis and prints out the data. The tooth trace deviation due to deformation is also calculated for toothing. This value is needed for face gear calculations. Graphical display of deformation components on screen (and printer). You can transfer this data to any CAD program via the graphic interface.

3.33 W10 tooth trace modification with additional FEM displacement matrix

Use this module to take into account the deformation of the gear bodies of cylindrical gears in tooth trace modifications. To do this, you must use a FE (Finite Element) calculation to generate a displacement matrix under unit load. You will find a example file for this (deviation.dat) in the dat directory.

3.34 W12 Shaft arrangement (integrated design tool)

(See also illustration)

Shaft arrangement

The system has two functions which you can use to size shafts (of any diameter):

- Sizing for strength: The KISSsoft system arranges the shaft contour so that the equivalent stress has the same (definable) value in all the cross sections.
- Sizing for deflection: The KISSsoft system changes the diameters of the default shaft contour proportionally to achieve a predefined maximum deflection.

Procedure for shaft optimization:

The "traditional" method of design leads from the idea to the design; from rough-sizing and then to the optimized final design. This can be replicated very effectively by the KISSsoft system when it is implemented in a CAD environment. As soon as a design concept is available, the next step usually involves dimensioning the load bearing elements, such as couplings, gears, belts etc. The KISSsoft system provides a wide range of sizing programs for this. The dimensions of the load bearing elements then result in the bearing distances and the shaft lengths. The KISSsoft system has a sizing module that you use to dimension shafts with support. Start the shaft calculation program, enter the approximate shaft length, the bearing mid-points and elements with external forces. The system then returns a first suggestion for the diameter. You can then define the type of bearing and, depending on the required service life, you can modify the shaft diameter. You can easily exit from, or correct the appropriate diameter change in the graphical display on the screen.

In the next step, you calculate the exact strength (check for strength against overload failure and failure due to fatigue). As part of the strength calculation process, the outside shaft diameter is optimized automatically to achieve the required level of safety. You can, of course, also check the shaft-hub connections (press fit, key, couplings with toothing) at the same time.

You can now output this quickly and optimally sized shaft via the CAD interface and, without any additional effort, you will now have the finished shaft contour, together with the bearings, in your CAD design drawing.

3.35 W13 Buckling

You use this function to calculate the safety against buckling of shafts and supports. All peripheral conditions, bearings and effective axial forces (point or line loads) are taken into account in the calculations. It outputs the safety for a number of buckling cases. However, only the first one is usually relevant. You must input the loads for this calculation.

3.36 W14 Forced responses in KISSsoft shaft calculation

This is used to calculate forced responses in shafts that have been defined in KISSsoft. The dynamic excitation of concentrated unbalance masses is used to dynamically excite the shaft. The dynamic excitation of gears (caused by transmission error and stiffness fluctuations in the meshing) are not taken into account. Both the (structural) material damping and viscous damping can be defined. The resulting responses from different dynamic forces are added in the time range, and the final result is determined using the maximum value for this superposition. Transient phenomena are not taken into account. Transfer matrices are used in this calculation.

3.37 W51a Rolling bearing fine sizing

You can use variation calculation to optimize the internal geometry of bearings. The variants are then either displayed in a list or as a graphic.

Module: WB5

4.1 M01a Cylindrical interference fit

Cylindrical interference fits and bindings influenced by centrifugal force

- Load in the circumferential and axial directions
- Calculating the maximum torque for a non-slipping fit. If slip occurs in the fit, micro gliding will cause corrosion due to friction.
- The calculation includes the entirety of the DIN 7190 standard (elastics) with longitudinal, radial and oil interference fits

You must also calculate the safety of the interference fit to gliding and the safety of the shaft material and the hub against the breaking and yield point. The tolerance system according to DIN 7151 (e.g. with diameter input 60 H7/f6), has been implemented to make it easier to input data.

4.2 M01b Conical interference fit connections

Calculation methods in accordance with Kollmann or DIN 7190-2.

Conical interference fit connection: Calculation and sizing of a conical interference fit connection for transferring torque in an elastic working state. Conical interference fits are normally joined axially with a bolt (only Kollmann) or by pressing them on.

The method as specified by F. G. Kollmann is for connections with the same Young's modulus and with a solid internal component. The permitted range of the set angle is sized (for the upper contact). The delay and pretension force for joints and in operation under maximum torque is also calculated.

In the case of the calculation method in accordance with E. DIN 7190-2, connections with a hollow shaft are also possible. In this method, the sliding moment, the joining force, and the axial force during operation, are defined. In addition the equivalent stresses for joints are determined for the specified joining pressure.

Sizings:

- Permitted cone angle (for self-locking)
- Length of interference fit for transmitting the maximum torque
- Maximum transmissible torque

Also, for verifications according to Kollmann:

- either pressing distance for mounting or mounting pressing force

4.3 M01x Additional function for a press fit

Extension of the press fit calculation:

- The calculation also takes into account the effect of centrifugal force on the expansion of the interference fit and on the stress in the shaft and hub.
- You can either enter the tolerance manually, or use an automatic option to calculate the tolerance pairing based on the required safety against gliding and the permissible material stress. Input the values for surface roughness with qualities defined in ISO 1302.
- The hub's external diameter can vary if you use the KISSsoft system to calculate cylindrical and taper interference fits. In such cases, input the external diameter section by section with the diameter and length. The system then derives an equivalent diameter from these values (as specified by V. Gross) and includes it in the calculation.

4.4 M01c Clamped connections

There are two different configurations of clamped connections that can be calculated:

- Slotted hub
- Split hub

The surface pressure and safety against sticking are calculated in accordance with the classic literature (Roloff Matek, Machine elements, 15th Edition, 2001). Bending is calculated as specified by Decker, Machine elements, 15th Edition, 2000.

4.5 M02a Key

For keys as defined in:

- DIN 6885.1
- DIN 6885.1 Form G, H, J
- DIN 6885.2
- DIN 6885.3
- ANSI B17.1 Square
- ANSI B17.1 Rectangular
- Own input

a calculation is performed to find the load on the shaft and hub (surface pressure) and the key (shearing) and also defines the safeties (calculation method: DIN 6892 (2012) Method C). The calculation takes into account the tolerances of the key radii and the direction of force. You can also enter your own value for the number of keys, the contact coefficient and the application factor. Scale graphic representation.

Key calculation as specified by DIN 6892 (2012) Method B:

This standard uses very clearly defined calculations for keys under constant and peak load. For example, it also includes the situation where an interference fit is present. You can input this data in a subdialog: Chamfer on shaft and the hub; smaller and larger external diameter of the hub; width to external diameter; distance; torque curve; frequency of load direction change.

Sizings:

- Determine the load bearing length of the shaft or hub on the basis of target safety and
- determine the transmissible torque.

4.6 M02b Spline shaft/Multi-groove profile

For multi-groove profiles specified in:

- DIN ISO 14 (light series)
- DIN ISO 14 (medium series)
- DIN 5464 (vehicles, heavy series)
- DIN 5471 (machine tools, with 4 keys)
- DIN 5472 (machine tools, with 6 keys)

a calculation is performed to find the load placed on the shaft and hub (surface pressure). You can also add additional standards. The calculation of the load placed on the shaft and hub (surface pressure), together with determining the safeties, is performed in accordance with the "classic technical literature" (Niemann, Maschinenelemente I, 4th Edition, 2005). Scale graphic representation.

Sizings:

- Determine the load bearing length of the shaft or hub on the basis of target safety and
- determine the transmissible torque.

4.7 M02c Spline

For splines defined in:

- DIN 5480
- DIN 5481
- DIN 5482
- ISO 4156 (1991)
- ANSI B92.1 and ANSI B92.2 (1992).

a calculation is performed to find the load placed on the shaft and hub (surface pressure). You can also add additional standards. Toothing data is defined in the database and therefore you can make the use of in-house profiles mandatory. You can use gear calculation module Z09a to calculate the manufacturing mass and the tolerances. The calculation of the load placed on the shaft and hub (surface pressure), together with determining the safeties, is performed in accordance with the "classic technical literature" (Niemann, Maschinenelemente I, 4th Edition, 2005).

Sizings:

- Determine the load bearing length of the shaft or hub on the basis of target safety and
- determine the transmissible torque.

4.8 M02d Polygon

For polygon shafts specified in:

- DIN 32711-1 (P3G profile)
- DIN 32712-1 (P4C profile)

a calculation is performed to find the load placed on the shaft and hub (surface pressure). You can also add additional standards. The calculation of the load placed on the shaft and hub (surface pressure), together with determining the safeties, is performed either according to DIN standards 32711-2 (for P3G profiles)/DIN 32712-2 (for P4C profiles) or as described in the "classic technical literature" (Niemann, Maschinenelemente I, 4th Edition, 2005).

Scale graphic representation according to DIN standards

Sizings:

- Determine the load bearing length of the shaft or hub on the basis of target safety and determine the transmissible torque

4.9 M02e Woodruff key

For Woodruff keys specified in:

- DIN 6888, series A (high pinion groove)
- DIN 6888, series B (low pinion groove)

a calculation is performed to find the load placed on the shaft and hub (surface pressure). You can also add additional standards. The calculation of the load placed on the shaft and hub (surface pressure), together with determining the safeties, is performed in accordance with the "classic technical literature" (Niemann, Maschinenelemente I, 4th Edition, 2005).

Sizings:

- Determine the load bearing length of the shaft or hub on the basis of target safety

4.10 M03a Bolt calculation

Bolt/pin connections are split into five calculations types, depending on where

they are used:

- Cross pin under torque
- Longitudinal pin under torque
- Guide pin under bending force
- Bolt connection subjected to transverse load
- Bolts in a circular layout

The calculation of the load placed on the bolts, shaft, and hub (or part), together with determining the safeties, is performed in accordance with the "classic technical literature" (Niemann, Maschinenelemente I, 4th Edition, 2005),

apart from bolts in a circular layout.

You can therefore select solid pins/bolts, grooved dowel pins, as well as spiral pins as specified in DIN EN ISO 8748, DIN EN ISO 8750, DIN EN ISO 8751 and locking pins as specified in DIN EN ISO 8752, DIN EN ISO 13337, as required.

4.11 M04 Bolt calculation

The calculation permits the use of the entire scope of VDI 2230, 2015 Edition. If used together with the M04a option, you can, for example, calculate the complex examples of VDI 2230 quickly and effectively. Tables have been integrated for all the elements concerned, such as bolts specified in DIN ISO 4762, 4014, 4016,

4017 and 949, and ASME 18.2.1, and standards for bores, washers, nuts etc. You can also define your own bolts, with up to 8 sections, and hollow bolts. You can define plates, bushes, annulus segments or prismatic bodies as clamped elements. The program is able to suggest values for the reference diameter and thread length. The default pretension force is 90% of the yield point. However, you can use the setting options to modify this. You can also perform calculations with a predefined starting torque or pretension force. Data is output for the state with the minimum pretension force (tightening factor 1.0), with the maximum pretension force and for the selected utilization of the yield point. The tension diagram and bolt geometry are shown as a graphic on screen and can then either be printed out or transferred to a CAD program.

4.12 M04a Eccentric clamping and load, configurations (for M04)

This also enables you to take into account an eccentric load and clamping. It checks for gaping in the interface. Configurations: Using this option, you can also input bolt configurations with axial, transverse and bending moment loads. Minimum length of engagement and stripping strength: To determine the necessary minimum length of engagement, you can (as specified in section 5 of VDI 2230) calculate the stripping strength of bolts and nut threads while taking into account the nut expansion and plastic deformation.

4.13 M04b Bolt calculation at high and low temperatures (for M04)

Bolts are usually mounted at ambient temperature. However, the operating temperature has a significant influence on the pretension state of the bolt and therefore also on the safety and security of the connection. For example, if steel bolts are inserted into light metal materials the conditions change dramatically, even at an operating temperature of 70 degrees! The extension to KISSsoft's bolt calculation function enables it to apply the calculation guideline specified in VDI 2230, which also calculates bolted joints for operating temperatures between -200 and +1000 degrees Celsius. You can specify different temperatures for bolts and clamped parts. You can also take into account the temperature-dependent changes in the Young's modulus, in the thermal expansion coefficients, in the yield point and in the pressures permitted for the materials. All the criteria for the bolted joint are checked in the assembled state at ambient temperature, and also in a stationary or non-stationary state at operating temperature (according to VDI 2230: pretension force, bolt load, fatigue life, and surface pressure).

4.14 M08 Welded joints

Calculation basis: DIN 18800, Part 1, November 1990 Edition, especially Section 8.4. Calculation and sizing of welded joints (joints with electric arc welds) with welded seam types:

- Butt seam through welded
- Double HV seam, counter welded
- HV welded seam, cap position counter welded/root through welded
- HY seam with or without fillet weld, not through welded
- Double HY seam with or without fillet weld, not through welded
- Double I seam, not through welded
- Fillet weld, not through welded
- Double-fillet weld, not through welded

Input the load (normal force, shearing forces) of the part safety coefficient and weld seam boundary coefficient, integrated material database. Calculate the stresses, the weld seam boundary stress and safety.

4.15 M09a Glued and Soldered Joints

Glued joint:

Calculation basis: G. Niemann, Maschinenelemente, Volume I, 1981. The calculation of glued joints is performed for connections that are subject to shear.

Two different load cases are treated:

- Shearing force: transmission of shear force between two surfaces
- Torque: shaft-hub connection with a torque load

The joint can be subject either to static or dynamic (usually pulsating) load. You can select adhesives (extendable database) that harden at room temperature or at higher temperatures.

Sizings:

- Sizing the adhesion width (for shaft hub), or the adhesion length (for brackets), on the basis on the strength of the base material The tear resistance of the joint is sized so that it equals the tear resistance of the underlying material or the fatigue strength under pulsating stress of the shaft.

- Sizing the adhesion width on the basis of stress: the tear resistance of the joint is sized so that it can withstand the forces it is subjected to without compromising the required safety.

Soldered joint:

Calculation basis: G. Niemann, Maschinenelemente, Volume I, 1981. The calculation is performed for soldered connections that are subject to shear.

Two different load cases are treated:

- Shearing force: transmission of shear force between two surfaces
- Torque: shaft-hub connection with a torque load

The joint can be subject either to static or dynamic (usually pulsating) load. You can select any material (extendable database):

- Soft solder LSn40, LSn60 short time load
- Soft solder LSn40 for a permanent load
- Brass solder: Steel NE heavy metals
- New silver solder, copper: Steel
- Silver solder: Steel NE heavy metals

Sizings:

- Sizing the weld width (for shaft hubs), or the weld length (for brackets), on the basis on the strength of the base material. The tear resistance of the joint is sized so that it equals the tear resistance of the underlying material or the fatigue strength under pulsating stress of the shaft.
- Sizing the solder width on the basis of stress: the tear resistance of the joint is sized so that it can withstand the forces it is subjected to without compromising the required safety.

4.16 M050 Snap ring

Calculation method as specified in the Seeger manual. Shaft rings and bore rings are treated separately. Sharp-cornered abutments or components with chamfer, and a corner distance/radius can be specified for them. The calculation in both cases (shaft/bore ring) includes the following:

- load bearing capacity of the keyway, load bearing capacity of the Seeger ring (retaining ring), lever arm of the dishing moment, bending stress of the ring, plier force

In addition to the above, the following calculations are available for shaft rings:

- detaching speed of the shaft, retaining force of the ring

Sizing functions:

- Sizing of load factor based on the ratio of the shoulder length to the groove depth
- Sizing the dishing angle using the nominal diameter

5.1 F01 compression springs calculation

Calculation of cylindrical stressed compression springs, as specified in EN 13906-1. Includes the sizing (by inputting the compression forces and assembly masses) and the verification of compression springs. Database with the most important spring materials. Displays the spring characteristic line, the relaxation, the progression of relaxation over time, the progression of spring force over time and the Goodman diagram for dynamically loaded springs. Tolerances and main dimensions, as specified in DIN 2076, 2077, DIN 2096, DIN EN 15800, DIN EN 10270-1, DIN EN 10270-2, DIN EN 10270-3 and DIN EN 10218. Integrated database with spring geometries specified in DIN 2098 Sheet 1 (withdrawn).

5.2 F03 Leg spring calculation

Calculation of cylindrical rotating springs in accordance with EN 13906-3. Contains the sizing (by inputting the compression forces and assembly masses) and the verification of leg springs. Database with the most important spring materials. Database with wire diameters, as specified in DIN 2076, 2077, DIN EN 10270-1, DIN EN 10270-2, DIN EN 10270-3 and DIN EN 10218. Display the spring characteristic line. The leg can either be clamped in a fixed position, supported, tangential or bent. Tolerances specified in DIN 2076, 2077, 2194, EN 10270-1.

5.3 F04 Disc spring calculation

Calculation of disc springs and spring packages as specified in DIN 2092. Contains the sizing (by inputting the compression forces and assembly masses) and the verification of disc springs. Database with material properties and dimensions as specified in DIN 2093. Display the spring characteristic line, Goodman diagram.

5.4 F02 Tension spring calculation

Calculation of cylindrical tension springs in accordance with EN 13906-2. Contains the sizing (by inputting the compression forces and assembly masses) and the verification of tension springs. Database with the most important spring materials. Database with wire diameters, as specified in DIN 2076, 2077, DIN EN 10270-1, DIN EN 10270-2, DIN EN 10270-3 and DIN EN 10218. Display the spring characteristic line, Goodman diagram for dynamically stressed springs. Tolerances, main dimensions, eyes specified in DIN 2076, 2077, 2096, 2097, EN 10270-1.

5.5 F05 Torsion-bar spring calculation

Calculation of torsion-bar springs with round cross section according to DIN 2091. Contains the sizing (by inputting the compression moments and assembly masses) and the verification of torsion-bar springs. Material properties according to DIN 17221. Main dimensions specified by DIN 2091. Display the spring characteristic line.

6.1 Z01 Gear - Base module

Use this to start the calculation module:

- Single gear [Z011]
- Gear pair [Z012]

Gear geometry calculation for cylindrical gears as specified in ISO 21771 (and DIN 3960)

Valid for: Internal and external teeth

- Straight and helical gear teeth, double helical gearing
- Reference profiles specified in ISO 53, DIN 867, DIN 3972 profiles I, II, III and IV, DIN 58400 and free choice (for precision mechanics: topping tools); protuberance, buckling root flank.
  - Input of hobbing cutters (specified in DIN 3972 and your own tool lists) and pinion type cutters (specified in DIN 1825, 1826, 1828 and your own tool lists).
  - Alternatively, you can also determine the tooth form as a theoretical involute without inputting tool data.
- Taking into account tip alteration, length correction, chamfer, tip chamfer, profile modification, etc.
- Check for undercut, a pointed tooth, meshing interference, tip clearance, ease of assembly, tip and root form diameter, active tip and root diameter (active involutes) contact outside the meshing area, etc.
- Calculate the test mass, base tangent length, tooth thickness, effective radial measurement over one and two balls, measurement over one and two pins. The test mass is calculated separately for each lower and upper allowance.
- If necessary, you can also determine the tooth thickness allowance:
  - according to DIN 3967 (for example, e25) (database tables installed)
  - according to ISO 1328 (for example, GJ)(1980 edition, these details are not included in the current edition)
  - according to ISO 23509 (for bevel gears)
  - according to DIN 58405 (e.g. 8g) for precision mechanics (database tables installed)
  - from the target circumferential backlash or from the normal backlash

- You can also create your own tooth thickness allowance tables. These tables are then processed automatically by the program.
- For precision mechanics: tip circle (with tolerances) for a topping tool
- Calculate the circumferential backlash area (and normal backlash) of the gear pairing while taking into account tooth thickness allowances and center distance tolerance.
- Calculate all relevant values, such as contact ratio, specific sliding etc.
- Calculate and check the effective contact ratios and root circles (taking into account the tooth thickness allowances); calculate all the important data for the smallest center distance and greatest tooth thickness, as well as for the greatest center distance and smallest tooth thickness
- Angles can be input either as decimal numbers with decimal points or with minutes and seconds.
- Modules can be input either in mm or as diametral pitch or transverse diametral pitch, transverse or normal pitch.
- Different accuracy grade for individual gears.
- Increase the interval for permitted profile shifts: With this right the band width of the usually performable profile shifts can be significantly increased. This is very useful for special cases.
- You can also define power loss, moment of inertia and weight for all types of strength calculations (for cylindrical gears, bevel gears, worm gears).

Materials and reference profiles are taken from the database

You can define any number of different materials and reference profiles in special database entries. At present, the system is shipped with approximately 150 different materials and a wide and varied range of reference profile, hobbing cutter and pinion type cutter lists. All the hardening techniques specified in DIN 3990 are taken into account. This system also supports the use of stainless steels, aluminum, bronzes etc. Plastics with module Z14.

6.2 Z01x extension of cylindrical gear geometry

Extension for calculation modules: Z011, Z012, Z013, Z014, Z015, Z016

Profile shift sizing (optimum area, balanced sliding etc.). High and involute short cut meshings, topping tool. Special expression with all manufacturer tolerances

ISO 1328, DIN 3961, AGMA 2015, AGMA 2001, DIN 58405, BS 436; Calculate tolerances/allowances from measured values

Pre-machining tool and input for pre-machining: Pre-machining tool and input for pre-machining. Input the pre-machining tool with processing input, along with the grinding wheel (tip rounding and grinding depth: up to the form diameter or active tip and root diameters, or own input). All the control measurement values for pre-machining and final machining, the tooth form for pre-machining and final machining, and the grinding notch (if one is produced and if this reduces the strength for the strength calculation as specified in ISO 6336 or DIN 3990), are calculated and documented. Manufacturing processes involving more than two processing steps (for example, two milling processes plus a grinding process) are performed with right Z05l.

Define form diameters from the tooth form: The tip and root form diameters are usually calculated in accordance with the theoretical equations in ISO21771. However, this does not take into account the effective undercut. If you activate the "Calculate tip and/or root form circles from tooth form" option, the form diameter is determined on the basis of the effective tooth form. In the case of toothing with an undercut, this option determines the starting point of the undercut and includes it in the calculation used to determine the transverse contact ratio etc.

NOTE:

In the case of toothing with profile modifications, the starting point of the modification is displayed, to enable the transverse contact ratio to be displayed as being too small.

Determine the tooth thickness in any diameter: Report containing tooth thickness (chord and arc with deviation) at any diameter.

6.3 Z19h Sizing of deep toothing

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Special reference profiles with larger addendums and dedendums are used for deep toothing. This sizing function calculates the required reference profile on the basis of the required transverse contact ratio. If this function is active in gear fine sizing, the reference profile for every solution is calculated so that precisely the required transverse contact ratio is achieved.

6.4 Z15 Calculate the details used to modify the profile of cylindrical gears

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Calculation of points A to E along the path of contact with the corresponding involute lengths. Output the diameter, radii and involute and roll lengths for the involute test diagram (for the gear and its paired opposing gear). Input all reference values in accordance with the different methods used to calculate tip relief. The system proposes a tool that can be used to generate the profile modification. You can then use the data directly in the tooth form calculation. Short or long modification length, tip and/or root relief, specify the load for which the sizing is to be calculated.

6.5 Z19a Calculation with operating center distance and profile shift according to manufacture

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

The cylindrical gear specified in ISO 21771 or DIN 3960 is based on the calculation of a (theoretically) backlash-free toothing. This enables the total profile shift for the individual gears over the center distance to be specified. With this right, you can input the profile shifts independently of the center distance. This is very useful as it provides a way to check the limits of a toothing (clearance, contact ratio etc.) if there are major variations in the center distance (e.g. in the case of large center distance tolerance zones).

6.6 Z19d Optimize axis center distance with respect to balanced sliding

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Optimize axis center distance with respect to balanced sliding: For a specified profile shift of a (selectable) gear, this right calculates the axis center distance in such a way as to balance gear pair specific sliding (for cylindrical gears).

6.7 Z19e Representation of specific sliding

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016, Z070

The progression of specific sliding (sliding speed and tangential speed) during the meshing can be shown as a graphic. The calculation is performed for involute cylindrical gear toothing. This shows specific sliding for the smallest center distance and greatest tooth thickness, as well as for the largest center distance and smallest tooth thickness.

(See right Z27 for details on how to calculate specific sliding and the sliding movements for any tooth form and involute gears with profile modifications.)

6.8 Z19f Suggestion of sensible tooth trace modifications

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

For calculations specified in ISO (Z02a) or DIN (Z02).

The ISO 6336 or DIN 3990 standards specify that tooth trace modifications are performed in a reasonable manner. This additional program generates reasonable sizings for tooth trace modifications as specified in ISO 6336.

6.9 Z19j Profile modifications with worm grinding wheels/dressing wheels

The purpose of this module is to check whether an existing grinding worm with the associated dressing wheel is suitable for a newly sized toothing. Dressing wheels are very expensive, that's why it is an interesting idea to use existing dressing wheels for other toothings too.

All available grinding worms are recorded in one file, each grinding worm with its associated dressing wheel. The system displays the grinding worms/dressing wheels that are suitable for a particular toothing (with the specified module and pressure angle), in a table. The system calculates and displays the tip relief actually achieved with the grinding worm and the length of the modification. You can check whether a required tip relief can be generated with an available grinding worm/dressing wheel.

When you have selected a grinding worm, a second window is displayed in which you can check whether it would be possible to achieve a better approximation of the theoretically optimal modification by changing the dressing wheel's depth of immersion in the grinding worm, or by changing the dressing wheel's lifting amount, to adjust the tip modification created during grinding.

6.10 Z19l Conversion of profile shift coefficient and tooth thickness allowance

Extension for calculation modules: Z011, Z012, Z013, Z014, Z015, Z016, Z080, Z170, Z09A

In this right, you can convert the profile shift coefficient from the base tangent length, measurement over balls etc. The tooth thickness allowance can also be converted in the tolerance screen.

6.11 Z19n Profile and tooth trace diagrams }

Extension for calculation modules: Z011, Z012, Z013, Z014, Z015, Z016, Z080, Z170, Z09A

Use this authorization to display profile and tooth trace diagrams.

6.12 Z02 Strength calculation as specified in DIN 3990

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

In accordance with DIN 3990, December 1987 edition (most recent, valid edition)

Comprehensive, very detailed calculation using the most precise methods (Method B) with the option of influencing all the most critical values.

You can also use the Method in DIN 3990, Part 41, for vehicle gears.

Calculate general influencing values (DIN 3990, Part 1) with dynamic and face load factors and transverse coefficients:

- Face load factor for cylindrical gear pairs in accordance with Method C2 with:
  Load configurations shown as graphics when selected.
  - Optionally taking into account the support effect and contact pattern check.
  - Load coefficients for planetary stages in accordance with Method C1
  -Load coefficients in accordance with Method B by the exact verification of tooth trace deviation as the result of deformation with shaft calculation (right W10).
- Calculate tooth flank-load capacity (pitting; DIN 3990, Part 2) in accordance with Method B.
- Calculate tooth root load capacity (DIN 3990, Part 3) in accordance with Method B, tooth form and stress correction factor, optionally also using Method C.
- Calculate scuffing safety (DIN 3990, Part 4) with both calculation procedures (flash temperature and integral temperature criterion) in accordance with Method B.
- Materials specified in DIN 3990, Part 5
- Taking into account the influence of grinding notches. Here, you input the ratio tg/ρg (tg: depth of grinding notch, ρg: radius of grinding notch) according to the Figure in DIN 3990, Part 3, section 4.4 or ISO 6336, Part 3, Fig. 33. This calculates Yg' (coefficient, which with YS is multiplied). If you input the pre-machining and final machining tools, tg/ρg is calculated automatically.

6.13 Z02a Strength calculation as specified in ISO 6336

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

The ISO 6336 standard for calculating the strength of cylindrical gears first appeared in 1996. The current edition, ISO 6336:2006, includes useful innovations. The calculation includes all the general factors (Part 1), flank safety (Part 2), root safety (Part 3), materials (Part 5) and scuffing safety (as specified in DIN 3990-4)

Grinding notches are taken into account as specified in DIN 3990, (Z02). ISO 6336 corresponds to a great extent to DIN 3990. However, it does have a few significant differences (primarily in the range of endurance limit).

Calculate the internal temperature and the flash temperature as specified in ISO TR 13989-1 and ISO TR 13989-2

Corrigendum ISO 6336-2 (2008): You can activate the change to helix angle coefficient Zβ if required.

6.14 Z02x Static strength of the tooth root

Prerequisite: right Z2 or Z2a or Z13 or Z14

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Calculate the tooth root static strength of cylindrical gears

Define the tooth root stress (with and without stress correction factor YS) as specified in ISO 6336, calculate safety against overload failure and against persistent deformation (yield point). For metallic materials and for plastics (tensile strength and yield point depending on temperature)

6.15 Z13 Calculation using the AGMA standard (USA standard)

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Calculation using a wide range of AGMA standards:

You can use either the USA standard ANSI/AGMA 2001-B88, 2001-C95, 2001-D04 (all in US customary units) and 2101-D04 (metric units of measurement) to calculate the strength of cylindrical gears. The standard implemented in its complete form and the dynamic factor and the face load factor are calculated according to AGMA recommendations. You can also input your own coefficients. The geometry factors (for tooth root and flank) are calculated entirely in accordance with ANSI/AGMA 908-B89. In addition to all the relevant intermediate results, the following values are also supplied: Pitting Resistance Power Rating, Contact Load Factor, Bending Strength Power Rating, Unit Load for Bending Strength, Service Factor. This calculation can also be used for every other cylindrical gear configuration (including planetary stages). However, it is worth noting that AGMA Directives do not permit the calculation of tooth root strength in internal gear pairs.

However, right Z19i (graphical method) does enable this to be calculated.

The strength calculation specified in AGMA 6004-F88 can be used for open gear rims (for example, cement mills).

Tooth form factor Y must be calculated according to AGMA 908 for each type and degree of accuracy of toothing for tip load (application of force at tip) or for HPSTC (application of force at individual point of contact). HPSTC is used in calculations for straight toothed, qualitatively high gears, otherwise, the tip load is used. However, if required, this process can be overridden and you can use either tip load or HPSTC for the majority of the calculations.

6.16 Z13b Calculation according to AGMA 6011/AGMA 6014 (US standard)

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

- Strength calculation as defined in AGMA 6011-I03 (for turbo drives).
- Strength calculation as defined in AGMA 6014-A06 (for large, open gear rings). AGMA 6014 replaces AGMA 6004-F88.

6.17 Z02b Strength calculation as specified in BV RINA

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Strength calculation of cylindrical gears. Special calculation method for ship's engines (primarily for France and Italy), similar to ISO 6336 with a few additions. Special documentation is available on request.

6.18 Z10 Cylindrical gear calculation using the FVA method

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Gear strength is calculated using the gear calculation programs developed by the Forschungsvereinigung Antriebstechnik (BRD). The calculations are performed on the basis of DIN 3990, and take into account all the variations. Therefore this option achieves exactly the same results as those given by the FVA program. FVA is used as a reference program. If problems arise when comparing calculations performed using different programs, you can use the calculation with the FVA program as a reference.

6.19 Z14 Plastic gears

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Calculate tooth root and tooth flank safeties for cylindrical gears made of plastic modified according to VDI 2545, VDI 2736 or as specified by G. Niemann, Machine elements III, 1985. The major differences between the calculation methods are detailed in the KISSsoft Help.

The calculation methods used for plastics take special account of the fact that these materials are very sensitive to extremes of temperature. The types of lubrication used here include oil, grease or none at all (dry run).

The calculation method defines the local temperature at the tooth flank and at the tooth root, and uses these values to determine the permitted loads depending on the number of load cycles. The calculation is performed for combinations of plastic/plastic and also steel/plastic. The safety against tooth deformation is also determined.

The KISSsoft database includes all the materials documented in VDI 2545 and VDI 2736:

- Polyamide (PA12, PA6, PA66, PA46)
- Polyacetal (POM)
- Polyetheretherketone (PEEK)
- Polybutylene terephthalate (PBT)
- Laminate

Materials with data from different manufacturers, such as PEEK (made by Victrex) or LUBRICOMP UCL-4036A HS (from SABIC Innovative Plastic) are added on an on-going basis. The corresponding material data is based on manufacturer measurements. As a result, data may not be present for specific calculation methods and therefore not all calculations can be performed.

All specific properties of a particular material are stored in text tables (material-strength depending on temperature and number of load cycles). You can easily add your own material data to these tables.

If you know the wear values of a particular plastic, you can also calculate the service life with regard to wear. This can be added to the tooth flank safety specified in VDI 2545 or VDI 2736 or used as a replacement value if the S-N curve (Woehler lines) for permissible Hertzian pressure are not known.

6.20 Z19i Tooth form factor calculation using the graphical method

Prerequisite: right Z2 or Z2a or Z13 or Z14

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

As defined in ISO 6336 or DIN 3990, the tooth form and the stress correction coefficient are calculated at the tooth root at the point at which the tangent and the tooth center line form an angle of 30°. However, it is generally acknowledged that this method is rather imprecise, for special forms (for example, deep meshings or gears with pressure angles that vary greatly from 20°). According to Obsieger (Konstruktion magazine 32 (1980) pages 443-447), there is a more precise approach, in which the product of the tooth form factor and the stress correction factor is calculated, and the maximum value is determined. This method is based on the process for manufacturing a specific tooth form, and is applied to all points in the whole root area. This maximum value is then used in calculating the strength.

AGMA provides a method for calculating tooth form factor Y in external teeth. No calculation methods are available for internal teeth. As specified in AGMA, internal teeth can only be calculated using the graphical method. Here, the exact tooth form must be described and the fundamental values measured (root radius etc.) KISSsoft can now calculate these values. To do this, the program first calculates the tooth form and from this, then automatically defines the required parameters (root radius, torsion arm, root width). A better method than the one used in the AGMA proposal is then used to determine tooth form factor Y and stress correction factor Kf. As in the Obsieger process, the point on the tooth root where the coefficient I(=Y/Kf*..) is at a minimum is defined. It is at this point that the greatest stress occurs.

This is the recommended method, particularly for unusual tooth forms and internal teeth (for verifications specified by AGMA and DIN). If required, this calculation procedure can also be applied in strength calculations as defined in ISO 6336, DIN 3990, AGMA 2001 or AGMA 2101 for metals, and VDI 2545 and VDO 2736 for plastics, as well as in fine sizing (Z4a).

6.21 Z19m Flash temperature progression

Prerequisite: right Z2 or Z2a or Z13 or Z14

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Display the flash temperature progression during meshing as specified in DIN 3990-4.

6.22 Z01a Planets, 3- and 4-gear

Use this to start the calculation module:

- Planetary gear (sun, planet, rim) [Z014]
- 3 gears [Z015]: power distribution level or position of contact (pinion, idler gear/idler gears, gear)
- 4 gears [Z016]: dual position of contact (pinion, idler gear/idler gears I, idler gear/idler gears II, gear)

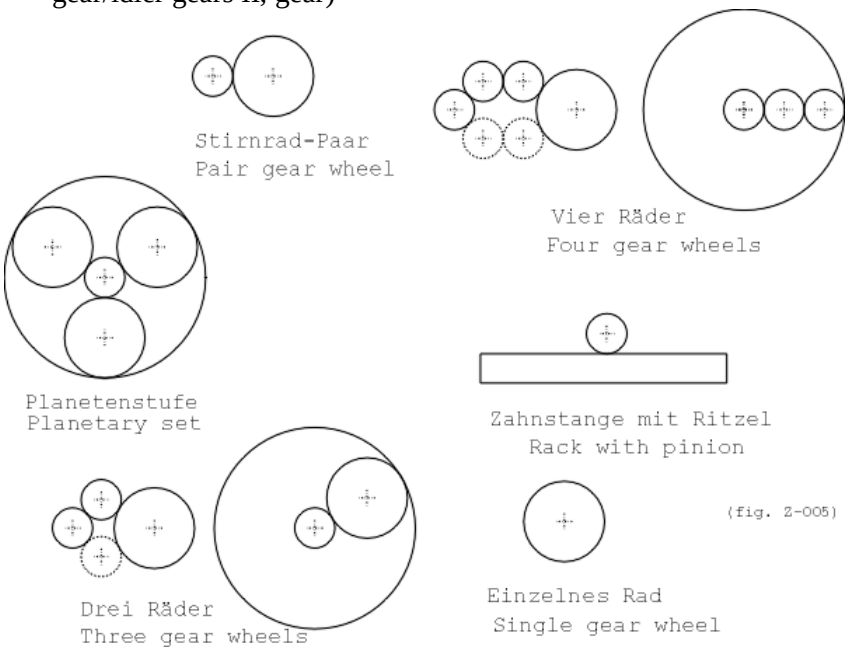


Figure 1.3: Gear configurations

The input interface has been modified to suit the appropriate configuration, as has the output data. In the program, the calculation is performed for each individual gear pair. This process also checks configuration-specific problems. For example, if you input the number of planets, the program checks whether the planets will touch each other. The overall interactions of the sun with the planet carrier are also calculated for planetary stages. In strength calculations, the method takes into account notes about the selected calculation method (for example, when calculating the dynamic factor and the face load factor, the special information provided in ISO 6336 or DIN 3990 for planetary stages or for point of contact stages is used).

The 2D display (right Z05) shows the individual meshing. In a 3D display (right Z05x), the system shows the configuration with all the gears (only one strand is shown for 3- and 4-gear configurations).

You can also switch the ease of assembly check for planets on and off (if the planet mid point is evenly pitched). If you deactivate this check, right Z19g can be used to calculate the center points. You can define any combination of speeds for a planetary configuration (you can predefine 2 of the 3 speeds: speeds of sun planet carrier, and web).

6.23 Z19g Calculate the center points of planets or idler gears

Prerequisite: right Z1a

For planets: calculate the center points of planetary gears to see how the planets can be assembled (this is very important, if the planets cannot be arranged in an even pitch because of the restrictions imposed by the number of gear teeth).

For gear wheel chains (3-gear): input the required distance between the first and the last gear in the chain to define either its position or the position of the idler gears (taking into account the practical aspects of assembly).

6.24 Z01b Rack

Allows to start the calculation module: Pinion-Rack [Z013]

The input interface is modified to suit the rack-pinion configuration. Input the rack height. Input the distance from the pinion center to the rack as the "center distance". You can then input the over-rolled rack length to determine the number of load cycles on one tooth of the rack when calculating the strength. The strength calculation for a rack is performed as specified in ISO, AGMA or DIN for an internal gear with an extremely large number of teeth. This calculates the correct rolling mass for the rack.

6.25 Z03 Cylindrical gear-Rough sizing

Prerequisite: right Z2 or Z2a or Z13 or Z14

Extension for calculation modules: Z012, Z014

Rough sizing automatically defines the most important tooth parameters (center distance, module, number of teeth, width) from the power that is to be used and the required ratio with the following optimization determined by the strength calculation program. We recommend you use the minimum safeties. Input intervals for b/mn, b/a, or b/d ratios to limit the data to the exact solution you require.

You can use either the ISO, AGMA or DIN strength calculation methods here, or VDI 2545 and VDI 2736 for plastics. The result of this is a list of solutions that display the possible center distances, facewidths and module area. You can either expand or reduce the scope of the list, if you want to display more or fewer individual results for a specific solution. The total weight of a solution is also displayed. Where the strength values are the same, this data is useful for seeing which solutions are more cost-effective or more expensive.

The aim of rough sizing is to show possible solutions to a drive problem. You can select a solution and transfer it to the basis window where you can check and refine it. As long as the rough sizing window remains open, you can access alternative solutions at any time.

6.26 Z04 Cylindrical gear-fine sizing

Extension for calculation modules: Z012, Z014, Z015

This is a very powerful tool that can be used to find the best variants for cylindrical gear stages under predefined constraints.

If you input a nominal ratio, a center distance and a module interval, the system calculates and displays all the possible suggestions for the number of teeth, module, helix angle and profile shift. It also shows the deviation from the nominal ratio, the specific sliding and the contact ratio.

It also provides variant options for the helix angle, the pressure angle and the center distance.

For planetary gear units or cylindrical gears that have an idler gear, you can:

- perform the calculation either with the predefined center distance or with the predefined internal gear reference circle.

For cylindrical gear stages, you can:

- either specify a fixed center distance or an interval.

All the variants the system finds are then output in a list, classified by the most varied criteria (generation of vibrations, accuracy of ratio, weight, strength, variation in tooth contact stiffness etc.). If necessary, you can also limit the critical parameters (tip circle, root circle, minimum number of teeth, tolerated undercut, reject variants with specific sliding 3.0 etc.)

You can use the overall summary criterion ("summary"), which you can set using parameters, to find the "optimum" variant. All variants (results) are displayed in a list. You can either expand or reduce the scope of the list, if you want to display more or fewer individual results for a specific solution.

You can select a solution and transfer it to the basis window where you can check and refine it. As long as the fine sizing window remains open, you can access alternative solutions at any time.

Graphical display of results as in Figure Graphics for fine sizing on page I-77.

6.27 Z04a Additional strength calculation of all variants

Prerequisite: right Z4

Prerequisite: right Z2 or Z2a or Z13 or Z14

KISSsoft also calculates the strength (tooth root, flank and scuffing) for every proposed variant at the same time as it calculates the geometry variants and outputs this as a printed list. If you have the appropriate rights, you can also define the angle of rotation error (transmission error), the wear, the transverse contact ratio under load and the variation in bearing forces by verifying the path of contact under load for each geometry variant. It is very useful to display this data as a graphic in which you can vary the data, to find the optimum solution. In the example, the color scale used in the figure clearly shows the tooth root safety as the X-axis, flank safety as the Y-axis and the module. This highlights how the root safety increases for larger modules (all the solutions displayed here have the same facewidth and center distance)

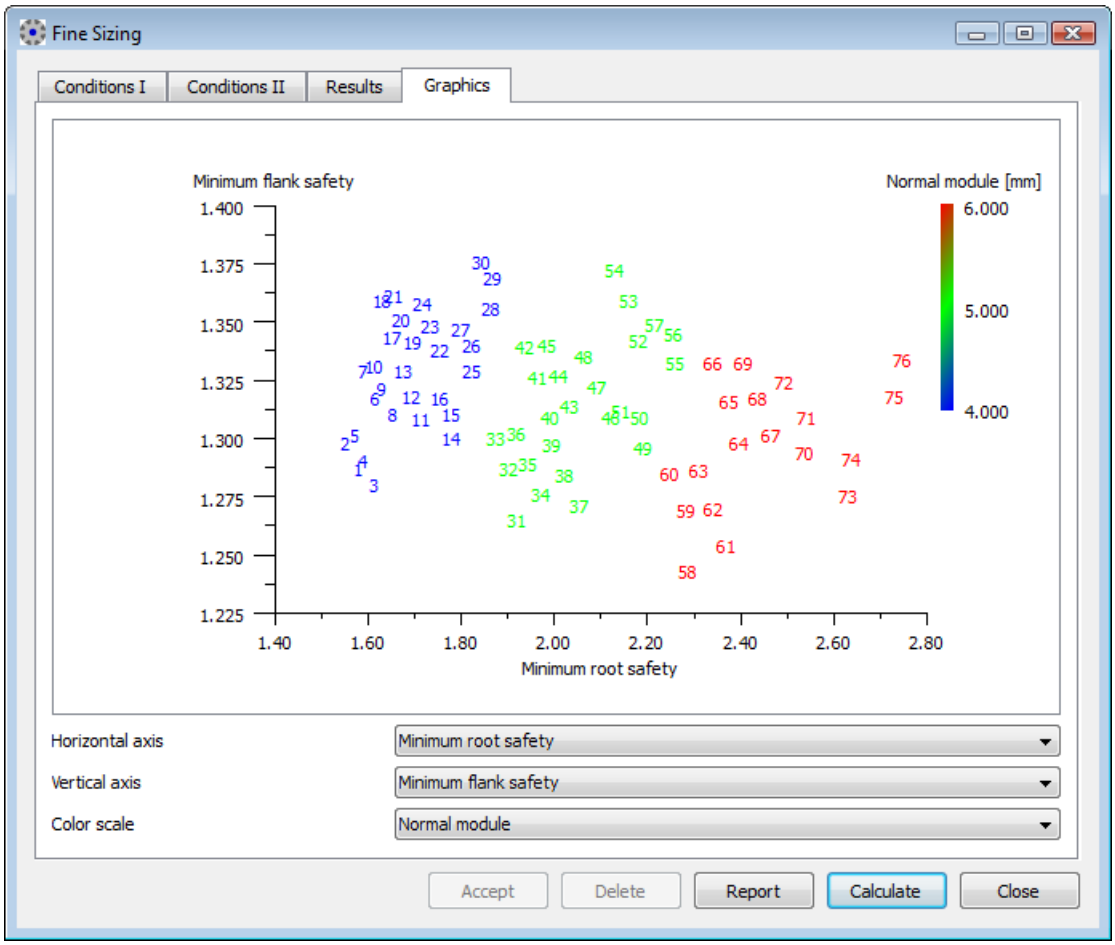


Figure 1.4: Graphics in fine sizing

6.28 Z05 Tooth form calculation and display

For all gear types except:

- Bevel gears: tooth form is calculated on the basis of the virtual cylindrical gear.
- Hypoid gears: no tooth form calculation.
- Spiral-toothed gear wheels: gear pair not shown in a 2D display (meshing) for shaft angles <> 90°.

- Exact calculation of the tooth form, taking into account the manufacturing process: hobbing cutter, rack type cutter or pinion type cutter.
- With predefined tolerance fields for tooth thickness and tip/root circle.

- Gear view: Graphic representation of the gears in transverse and axis section.
- Checking the practicality of manufacture (usable involute etc.): Precise checks to see whether the toothing can be manufactured using the selected tool.
- Display the tooth form in 2D on screen. You can display the gears either individually or in a pair here. Transfer the tooth form (of one or more teeth) and the gear view in face and axial section to CAD systems, if the corresponding options (K05a etc.) are present.

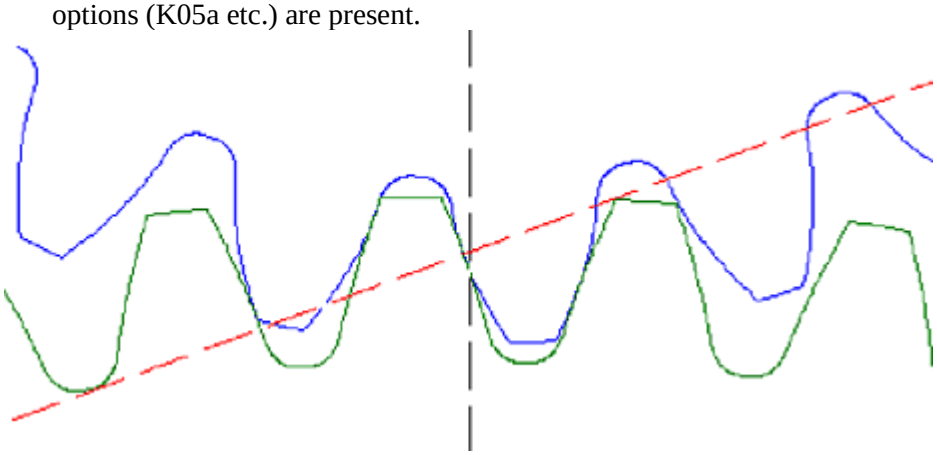


Figure 1.5: Tooth form of a cylindrical gear pair in 2D

- Graphical display of the manufacturing process.

This module is especially useful in the manufacture of internal gears because it calculates the entire manufacturing process along with all the checks on impacts, reduction of the contact ratio, start and end of the involute on the tooth, etc.

Display gears in 3D on screen. Use the corresponding options (K05G etc.) to transfer 3D solids to CAD systems or via 3D interfaces.

6.29 Z05x Animate the 2D display

Extension for option: Z05

By turning the gear step-by-step on screen, you can monitor how the gear pair is meshing and also simulate the production process. The measuring functions integrated in the graphics enable you to determine distances and angles. You can also rotate the gears relative to each other. An additional memory function enables you to compare different variants or modifications. If necessary, you can also display

the measuring ball for spur gears, worm gears and worms in normal section in the graphic.

6.30 Z05a Input any cutter form or tooth form

Extension for calculation modules: Z011, Z012, Z013, Z014, Z015, Z016, Z070, Z080, Z170, Z09A

If you cannot input special tools (hobbing cutters or pinion type cutters) in the input screen provided for them, you can import them from a DXF file and then use this data to calculate the tooth form. Alternatively, you can also import the tooth form directly from a DXF file.

The tooth form that is generated or imported in this manner can then be used in all the calculation options that reference data directly from the tooth form (for example, Z24, Z25, Z26 and Z27) and used to analyze the meshing behavior of the geometry and strengths.

6.31 Z05c Reference profile calculation for gears with involutes or special profiles

Extension for calculation modules: Z011, Z012, Z013, Z014, Z015, Z016, Z070, Z080, Z170, Z09A

You can calculate the appropriate gear-reference profile (in transverse section) of any tooth form (involute and non-involute). The profile can then also be displayed in a normal section. This is usually used to calculate the tool profile for any tooth form. This tool profile can then be used to manufacture the gear in the generating process.

The calculation process first defines the reference profile (= tool) and then generates the tooth form again for the tool that was defined in this manner. In the graphic, you can then see the original tooth form and, once again, the tooth form generated with this tool. If there are differences between these two tooth forms, this means either that the required tooth form cannot be manufactured for generated gears, or that an incorrect manufacturing operating pitch circle has been predefined.

6.32 Z05d Calculate the tooth form from the paired gear (generate with other gear in the pair)

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

When calculating the tooth form from the other gear in the pair, the gear pair is defined with the number of teeth etc. in the cylindrical gear input. Here, gear 1 is the generating gear ("paired gear") and gear 2 is the gear whose tooth form is generated from gear 1 by the generating process. The tooth form from the opposing gear is calculated automatically in two steps:

1. Step: calculate the tooth form of the gear to be generated. To do this, the KISSsoft system calculates generating gear 1 by increasing the tooth contour by the allowance of gear 2. Gear 1 is then used as the pinion type cutter to generate gear 2. A useable toothing always requires a certain amount of tip clearance. To achieve this, the tip circle of the pinion type cutter (gear 1) is increased. To do this, you can input the required tip clearance c. The tip circle of gear 1 is then increased by 2*c. A usual value is c = 0.2 * mn. The tip is also rounded off to achieve the optimum value. The calculation of gear 2 achieves the corresponding root clearance and an optimum root rounding.
2. Step: Calculate gear 2 without allowance (the allowance was already taken into account in step 1) with the tool defined in step 1. This gives the effective tooth form for gear 1 and gear 2.

6.33 Z05e Addition for mold making

Extension for option: Z05

Calculate the tooth form, taking into account the:

- Target total deviation of tooth thickness allowance
- Radial elongation (tooth tip and root)
- Tangential elongation (tooth thickness)
- Inlay body made of steel

The contour of the spray-casting mold is taken from the contour calculated using this method. Calculate the electrodes used to manufacture the spray-casting mold.

- Calculation as before, but while also taking into account the spark gap
- With option Z05c you can also calculate the hobbing cutter used to manufacture the electrode if necessary.

6.34 Z05f Arc shaped start of entry curve on the tooth tip

Extension for option: Z05

An entry curve that passes into the involute tangentially is applied to the tooth tip, starting from the specific diameter. This entry curve consists of three arcs of circle. The bend in the curve increases from arc to arc of circle, so that the final curve is tangential to the tip circle. This modified tooth form (also called a hybrid tooth) has significant benefits, because it results in extremely quiet running, despite relatively imprecise production methods. For this reason, the modification is applied for plastic products, for preference. An entry curve is usually only applied to deep toothing with transverse contact ratios of greater than 2.1. Tip modification of the calculated gear with: no tip modification, tip chamfer, tip relief from arc of circle (as stated by H. Hirn), tip relief with progressive profile modification and tip rounding, linear profile correction, progressive profile correction. Use factors to set the tip modification progression. In addition, KISSsoft can use its sizing function to suggest a suitable starting point (diameter) for the entry curve and the tip relief value. To do this, it uses the profile modification calculation (Z01x).

6.35 Z05g Optimum tooth root rounding

Extension for option: Z05

The tooth root created on the basis of the selected tool may not necessarily have the best possible rounding. If the radius of the root is too small, this may lead to the notch effect being too high and therefore reduce the strength of the tooth root. For this reason, option Z05g calculates an ellipse in the root area, starting from a defined diameter (usually the active root diameter). This ellipse has the largest possible tooth root radius. The system then modifies the tooth form accordingly. You can also add a definable length on the root circle diameter. This is useful for specific purposes, for example, to install measuring rollers correctly. You can use this option for the following purposes:

1. The tooth form is then eroded: If you want to erode the tooth form, the root form should be manufactured to be as strong as possible.
2. if you want to mill the gear and size the best possible tool for this. In this case, you must activate this option and also calculate the toothing reference profile from the tooth form (Z05c) to manufacture the required tool.

Checking with strength calculation: Optimized root rounding can be included in the strength calculation if you select the "Tooth form calculation using graphical

method (Z19i)" variant when selecting the calculation settings. The sizing function in the input window prompts the root diameters as suggestions for the start of the modification. 0.02 * module is suggested as the arc length.

6.36 Z05h Cycloid and arc of circle toothings

Extension for calculation modules: Z011 to Z016, Z070, Z09A, Z170

Input cycloid and arc of circle meshings (cylindrical gears) as involute cylindrical gears in the KISSsoft base screen. In the tooth form calculation, they can then be defined as the "Cycloid" or "Arc of circle" flank shapes, with the corresponding data. The following applies to all non-involute (or modified involute) tooth forms: The effective path of contact is defined on the basis of the tooth form (by simulating the generating process)(with option Z24).

You can use the data defined in this manner to calculate:

- Transmission errors, temporary transmission changes, temporary power loss etc. (with option Z24)
- Lubrication gap EHD and flash temperature (with option Z30)
- Wear (with option Z31)
- Sliding velocity, specific sliding (with option Z27)
- Hertzian pressure and tooth root stress (with option Z25)

6.37 Z05i Arc of circle approximation

Extension for option: Z05

Convert tooth flank into an arc of circle. You can specify the degree of accuracy. Several eroding machines find it difficult to process polylines. You can help them by outputting the data as arcs of circle.

6.38 Z05j Display collisions in the generation process (cylindrical gears)

Extension for option: Z05; for calculation module: Z012 to Z016

When generating two gears (in the graphical display) you can activate the collision display option. In the graphic, this shows (with squares) the points where the gears touch or where collisions may occur.

shown in brown: touch (between 0.005 * module distance and 0.001 * module penetration)

shown in red: collision (greater than 0.001 * module penetration)

The system identifies and marks collisions in all the meshing teeth. This option is particularly useful for analyzing the generation of non-involute tooth forms or measured tooth forms (using a 3D measuring machine) with a theoretical single flank generation check.

6.39 Z05k Displaying collisions during generation (worms/crossed axis helical gears)

Extension for option: Z05; for calculation module: Z170

Same function as Z05j.

6.40 Z05l Using the same tool type multiple times

Extension for all calculation modules:

Use this option to use the same tool type more than once.

Example application: In large-scale production runs, a roughing hob (usually with another pressure angle and module) is often used, followed by a fine hob and then the grinding or honing process.

6.41 Z05m Non-symmetrical gears

Extension for calculation modules: Z012

Use this module to import and process non-symmetrical gears.

(Still in development)

6.42 Z05n Straight line flank

Extension for calculation modules: Z011 to Z016, Z070, Z09A, Z170

Input straight line flank (cylindrical gears) as involute cylindrical gears in the KISSsoft base screen. As part of the tooth form calculation, you can then define the flank shape as "straight line", using the appropriate data.

The "straight line flank" shape is primarily used for spline profiles as defined in DIN 5481.

6.43 Z05q Special functions for the watch-making industry

Extension for calculation modules: Z011 to Z016

When a cylindrical gear, cutter, or pinion type cutter is imported from a .dxf file, you can now predefine a scaling to give the .dxf file a different normal module from the one used in the calculation.

Additional functions are being planned.

6.44 Z19k Lubrication gap EHD/ Scoring

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Prerequisite: right Z2 or Z2a or Z13

As specified in AGMA 925, you can use this calculation module to define the probability of scuffing and wear, as well as susceptibility to micro pitting (frosting). AGMA 925-A03, "Effect of Lubricant on Gear Surface Distress", describes the relationships in the lubrication gap above the meshing point. AGMA 925 defines how to calculate the lubrication gap height while taking into account the flank deformation, lubricant properties, sliding velocity, and local Hertzian stress.

Graphical display of results and comprehensive report.

6.45 Z23 Calculate the tooth root load capacity of internal teeth with the influence of the ring gear in accordance with VDI 2737 and calculate the deformation of gear rings

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

VDI 2737 fulfills the following task:

The usual tooth root load capacity verification for cylindrical gears requires an important addition when internal teeth are involved. In most cases, a significant

gear rim stress value is usually present. This can have a critical effect on load capacity. Fractures can run both through the tooth root ("thick" gear rims) and also through the gear rim ("thin" gear rims).

This guideline also takes into account the stress on the gear rim and the influences associated with this. Here, the crucial aspects are the determination and summarization of local stress in the tooth root. This starts from the basic structure and basic equations detailed in DIN 3990 or ISO 6336 and defines the calculation of the stress that runs outwards from the area of the tooth root transition curve for the tooth root or the gear rim transverse section.

Calculate deformation:

If, for design reasons, the gear rims of hollow gears must be made relatively thin, they may be deformed significantly by the force imposed when the tooth meshes with the gear. This program calculates the bending and tangential stress along with the radial deformation for the conditions at the tooth contact point and in the middle between these points of contact (of two neighboring planetary stages).

6.46 Z24 Meshing stiffness of the gear pair and transmission error

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016, Z070

Prerequisite: Right Z32 or Z34 or Z35

Calculate meshing under load while taking into account tooth deformation and defining the transmission error)

The different positions of the teeth to each other and the shape of the teeth have a constant and changing effect on tooth contact stiffness during generation. The progression of the contact stiffness of a pair of gears is calculated on the basis of the effective tooth form and displayed as a graphic. Take into account tooth deformation, gear body deformation and Hertzian flattening (calculation according to Weber/Banaschek, FVA reports 129 and 134, FVA 1955). The average change in stiffness (variant) is also calculated. This value is important for evaluating the generation of vibration. The more the stiffness changes, the greater the transmission error, and the more vibrations are generated. These are then transferred along the shaft and generate noise in the shaft and housing. This calculation is also integrated as part of fine sizing (Z04). Here the variance of stiffness is output for each variant.

6.47 Z25 Graphical representation of Hertzian pressure and tooth root strain along the actual tooth form

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016, Z070

Prerequisite: Right Z32 or Z34 or Z35

Representation of Hertzian pressure and tooth root strain using the effective tooth form:

The effective path of contact of two gears with any tooth form (calculated or imported; involute, cycloid or arc of circle) is calculated and displayed. To do this, the system calculates the progression of Hertzian flattening pressure as well as the tooth root strain, and displays this as a graphic.

In addition, the system displays the progression of normal force and torque on both gears. Also, (assuming a two-sided, symmetrical bearing layout), it displays the progression of the size and direction of the force to which the bearing is subjected (Z32 and Z34). Both the amount and changes in direction to the bearing force can generate vibrations in the bearing, which are then transmitted to the housing.

In addition, the Hertzian pressure, normal force curve, and tooth root stress, can be represented on the tooth as stress distribution (Z32 and Z34).

6.48 Z26 Displacement volumes for gear pumps

Automatic calculation of the displacement volume (however without taking into account loss due to returns in pinched volumes) (select under Settings) due to the effective tooth form and printed out in the report. This also includes the calculation function used in fine sizing (Z04).

6.49 Z26a Additional option for gear pumps Z26

Prerequisite: right Z32

For cylindrical gears: gear pairs (right Z01)

Restriction: Only for straight-toothed cylindrical gears

You can use this option to perform an extremely detailed analysis of gear pumps. Calculation for external gear pumps and for internal gear pumps (with or without round ended sunk key). This calculation enables you to analyze any type of cylindrical gear with involute and non-involute teeth forms. As a result, you can also verify the internal gear pumps of the "Gerotor" construction type. The system calculates and displays the changes to the critical parameters of a pump that occur during meshing. These include geometric parameters such as the pinched volume (between two meshed tooth pairs, return volume), the volume with a critical inflow area (if possible, the flow of oil should be kept constant), the narrowest point (minimum distance between the first tooth pair without contact), inflow speed, oil inflow at the entry point (with Fourier analysis to evaluate the noise levels), volume under pressure at input. Other important information is the progression of torque on the two gears, the progression of the Hertzian pressure sigH, the sliding velocity vg and the wear value sigH*vg. Hertzian flattening can be included when calculating forces because this effect has a significant influence. The pinched volume depends on how the pump construction functions under pressure at input or output. This is defined by the appropriate input value and has a considerable effect on the torque curve.

The pinched volume depends on how the pump construction functions either if it is insulated (enclosed) or has pressure release grooves under pressure at input or output. This is defined by the appropriate input value and has a considerable effect on the torque curve. When the pinched volume is reduced, you see a significant momentary increase in compression in this volume. This produces strong pulsing forces on the support and therefore generates noise. A pressure release groove must

be installed to avoid this increase in pressure. For this reason, it is very useful to calculate and display the pressure flow in the pinched volume.

6.50 Z27 Kinematics based on the actual tooth form

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016, Z070

Prerequisite: Right Z32 or Z34 or Z35

Calculate and display the progression of sliding velocity, specific sliding and sliding factors of any two gears. In contrast to option Z19e, this calculation is generally applicable because it includes all the profile modifications and is also well suited to defining the sliding conditions of cycloid gears.

6.51 Z29 Sizing and checking of master gears

Extension for calculation modules: Z011 to Z016, Z170

To perform a test for double flank composite transmission, you require one master gear which is then rotated on a test device together with the gear you want to test. After you have calculated a gear, you can start this master gear sizing option. When you start this option, the system prompts you with a suitable standard master gear as defined in DIN 3970. You use this option to check whether an existing master gear can be used. You can also size a master gear so that it can be used as the optimum gear to check a test gear. This module is available for cylindrical and worm gears that have more than 6 teeth.

6.52 Z30 Micropitting (frosting) and flash temperature

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Prerequisite: right Z2 or Z2a or Z13, Z24, Z25, Z26

Calculate the local lubrication gap (thickness h) during meshing and the local flash temperature using one of two methods:

- Draft ISO TR 15144
- AGMA 925

Both methods are based on Blok's theory and deliver similar results. The calculation is based on calculating meshing under load and uses the local parameters for sliding and rolling speed, Hertzian pressure, line load and bending radii that

result from this calculation. The gap height and minimum gap height are shown as a graphic.

Calculate specific lubricant film thickness λGF as specified in ISO TR 15144 with the graphical display and output of the specific lubricant film thickness λGFmin. The specific lubricant film thickness λGFP is required to determine the risk of micro pitting.

This is calculated if the lubricant's load stage for micropitting as specified in FVA info sheet 54/7 (C-/8.3/90 test) is known. Safety against micropitting is then shown as a 2D diagram (middle of the facewidth) and in a 3D diagram (by the path of contact and the facewidth).

6.53 Z31 Wear

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Prerequisite: right Z14, Z32

Restriction: only for plastics

Tooth flank wear is the main damage criterion that affects plastic gears that run without lubrication. The wear, and how it is distributed across the tooth flank, can vary greatly depending on the geometry and load.

Local wear can only be calculated if the wear coefficient k_W for the relevant material is known. You can input the wear coefficient k_w for plastics in the polymer data file, depending on the temperature (for example, Z014-100.DAT for POM). The data is input in 10^{-6} mm^3/Nm.

It produces a graphical representation of the local wear (in the relative scale with rays in the normal direction on the tooth flank) and the worn flank in real coordinates.

6.54 Z31a Iterative calculation of wear

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Prerequisite: Right Z14, Z32, Z31

The functions are the same as in Z31, but now wear is calculated in several steps. You can use the wear iteration function to define wear along the tooth flank in more detail, because it performs several steps of the contact analysis with the worn tooth flank.

6.55 Z32 Calculate contact analysis under load for cylindrical gear pairs

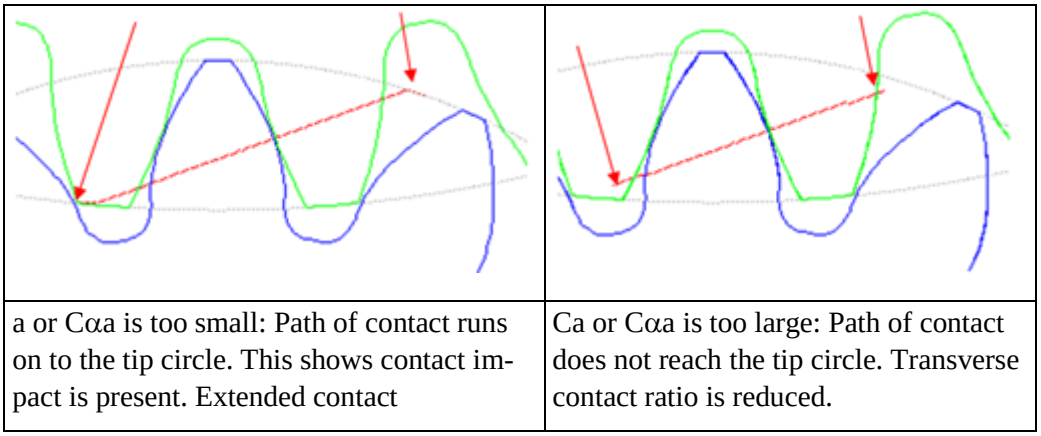
Extension for calculation modules: Z012, Z013, Z015, Z016

Use this option to calculate the path of contact for any tooth form. In theory, the path of contact between two involute meshings is straight. For any (non-involute) gear, the path of contact in each case can be any curve. However, the load placed on the teeth of involute gears will also cause these gears to deform. As a result, in practice, the path of contact is never an exactly straight line. In particular, this may cause meshing to start earlier and continue beyond the usual point. The progression of the path of contact, and therefore the characteristic parameters of gears defined by it, such as the transmission error, is a critical aspect when estimating the risk of vibration, losses, local warming, and wear characteristics of a pair of gears.

You can predefine the accuracy (calculation time). Depending on the level of accuracy you select, the number of slices (into which the facewidth is divided) and the precision of the iteration are set for the calculation. You can also take the influence of manufacturing errors (pitch) and the misalignment of the axes (deviation/inclination error of axis) into account.

Use option Z24 (see contact stiffness (see section "Z24 Meshing stiffness of the gear pair and transmission error" on page I-87)) to calculate the stiffness of the gears. The results achieved with this method are very similar to those achieved with much more complicated verifications using FEM. Without option Z24, the average tooth stiffness stated in ISO 6336 is used.

Defining meshing under load is an important tool in helping you check the effect of profile and width modifications. The transmission error will increase or decrease, depending on the sizing of the modification. In addition, the meshing graphic shows whether an impact of contact is present.



a or Cαa is too small: Path of contact runs on to the tip circle. This shows contact impact is present. Extended contact	Ca or Cαa is too large: Path of contact does not reach the tip circle. Transverse contact ratio is reduced.

Figure 1.3: Display of path of contact under load in meshing graphic. Left: entry impact if tip relief Ca or Cαa is too small. Right: shortened contact if tip relief Ca or Cαa is too large

6.56 Z34 Calculate contact analysis under load for planetary systems

Extension for calculation modules: Z014

Use this option to calculate the path of contact for any tooth form. In theory, the path of contact between two involute meshings is straight. For any (non-involute) gear, the path of contact in each case can be any curve. However, the load placed on the teeth of involute gears will also cause these gears to deform. As a result, in practice, the path of contact is never an exactly straight line. In particular, this may cause meshing to start earlier and continue beyond the usual point. The progression of the path of contact, and therefore the characteristic parameters of gears defined by it, such as the transmission error, is a critical aspect when estimating the risk of vibration, losses, local warming, and wear characteristics of a pair of gears.

The calculation for planetary systems also involves the calculation of the transmission error of the planet carrier and load distribution on individual planets for each cylindrical gear pair in each system (sun/planet and planet/internal gear).

You can predefine the accuracy (calculation time). Depending on the level of accuracy you select, the number of slices (into which the facewidth is divided) and the precision of the iteration are set for the calculation. You can also take the influence of manufacturing errors (pitch) and the misalignment of the axes (deviation/inclination error of axis) into account.

Use option Z24 (see contact stiffness (see section "Z24 Meshing stiffness of the gear pair and transmission error" on page I-87)) to calculate the stiffness of the gears. The results achieved with this method are very similar to those achieved with much more complicated verifications using FEM. Without option Z24, the average tooth stiffness stated in ISO 6336 is used.

Defining meshing under load is an important tool in helping you check the effect of profile and width modifications. The transmission error will increase or decrease, depending on the sizing of the modification. In addition, the meshing graphic shows whether an impact of contact is present.

6.57 Z35 Calculate contact analysis under load for bevel gears

Extension for calculation modules: Z070

In the Bevel and Hypoid gears module, the contact analysis calculates the path of contact under load for bevel gears with straight, helical, and spiral teeth. Hypoid gears are not supported. A pair of bevel gears with a substitute cylindrical gear toothing are approximated for the analysis. Each one of the gears in this cylindrical gear pair has a number of teeth that varies across the facewidth, an operating pitch diameter, and a helix angle (spiral toothing).

6.58 Z37 Calculate the deformation of the planet carrier with FEM (z37).

Extension for calculation module: Z014.

☼ Prerequisite: z34 or z2c.

Calculate axis alignment for the planet bolts of the planet carrier when the face load factor is calculated according to ISO 6336-1 Annex E or contact analysis.

Tilting of planet bolts relative to the planet pin axis has a significant effect on sizing a planetary stage.

Using this module, you can define a parametric model of the planet carrier and its load. The software can then perform an automatic FEM analysis of the planet carrier deformation, deriving the resulting tilting of the planet bolts relative to the planet pin axis. Both single-walled and double-walled planet carriers can be defined. The resulting 3D model of the parametric planet carrier can be viewed in the 3D view of the tooth geometry of the planetary system.

KISSsoft uses the Code Aster open source FEM Solver. This can be selected when KISSsoft is being installed. If necessary, this FEM tool can also be used to access all the 3D modeling functions and the FEM analysis results of the planet carrier.

6.59 Z33 Profile modification optimization with contact analysis under load

Extension for calculation modules: Z012, Z014

Prerequisite: Right Z32 or Z34 or Z2c

Calculate contact analysis for an area of profile modification variants and partial loads. The contact analysis details are the same as in the description of the Contact analysis calculation (see section "Z32 Calculate contact analysis under load for cylindrical gear pairs" on page I-91). This module can be used to size flank and profile modifications accurately, not only for a specific load case, but also for a load range.

6.60 Z38 Use FEM to calculate stress in the gear root

Calculates stress in the gear roof using the Code_Aster FEM Solver and the Salome FEM preprocessor that are supplied along with KISSsoft. A 2D FEM model of the gear is generated and analyzed. In this case, the load at the point of contact of each gear is applied in the working angle. The fixing area of the gear tooth (necessary boundary condition for the FEM analysis) can be either the inside/external diameter of the gear (for internal or external gears), or the sides of the gear segment that is being analyzed. For the case of helical gears, the equivalent spur gear is calculated and used, according to ISO 6336-3.

Module: ZA24

6.61 Z06 Face gear calculation (Z060)

Use this to start the calculation module:

☼ Face gear [Z060]

Calculation module that calculates the geometry of face gears mated with cylindrical pinion gears. This 2D display displays the inside, middle and outside of the face gear tooth form all at the same time. You can check for undercut and pointed teeth in the 2D graphic. You can then alter the tip to prevent the creation of pointed teeth. 3D display with export option (option K05u). Simulate generating using a pinion type cutter to calculate the tooth form.

This applies to straight and sloping toothed gears without hypoid offset and with a 90° shaft angle.

6.62 Z06a Strength calculation based on ISO 6336/Literature

Extension for calculation module: Z060

Strength calculation based on ISO 6336/ Literature

We recommend you use this calculation method. It is based on the technical literature produced by the company Crown Gear. Crown Gear was a Dutch company which specialized in the production of face gears between 1990 and 2002. The method is similar to option Z06b, but implements the smallest line of contact length as the effective facewidth for calculating Hertzian flattening. The formulae used here are listed in the report.

6.63 Z06b Strength calculation based on CrownGear/DIN 3990

Extension for calculation module: Z060

Strength calculation based on CrownGear/DIN 3990.

This calculation method delivers the same results as the SoftwareCrown Gear that was developed by Crown Gear. This was a Dutch company which specialized in manufacturing face gears from 1990 to 2000. The method is similar to option Z06a, but always uses the shared facewidth of the pinion and the gear as the effective facewidth for calculating Hertzian flattening, even if the contact line length is smaller. The formulae used here are listed in the report.

6.64 Z06c Strength calculation based on ISO 10300, Method B

Extension for calculation module: Z060

Strength calculation based on ISO 10300, Method B

Face gears belong to the class of bevel gears, where the pinion has a cone angle of 0° and the face gear has a cone angle of 90°. For this reason, you can also use a bevel gear strength calculation such as ISO 10300 or DIN 3991.

6.65 Z06d Strength calculation based on DIN 3991, Method B

Extension for calculation module: Z060

Strength calculation based on DIN 3991, Method B

Face gears belong to the class of bevel gears, where the pinion has a cone angle of 0° and the face gear has a cone angle of 90°. For this reason, you can also use a bevel gear strength calculation such as ISO 10300 or DIN 3991.

6.66 Z6e Static strength

Extension for calculation module: Z060

Calculate the static strength of face gears.

6.67 Z6f 3-D display

Extension for calculation module: Z060

Display face gear geometry with any shaft angle and offset in 3D in the parasolid viewer with the option of exporting data in STEP format (K05u option).

6.68 Z07 Bevel gear calculation (Z070)

Use this to start the calculation module:

- Bevel gear [Z070]

Calculate the geometry and strength of straight-, helical- and spiral-toothed bevel gears. Geometry and control measurement values as stated in ISO 23509. The calculation includes the geometry of bevel gears for all currently used manufacturing techniques. Compare this with the calculation example in the documentation. Calculate all necessary data required to create the bevel gear drawing (tip and active root diameter on the outer and inner bevel) and tooth thickness. Applies to all types of bevel gears and manufacturing process, such as Gleason, Klingelnberg, Oerlikon. The bevel gears are also shown as graphics.

Input geometry by predefining the reference diameter (d_{e2}) or the normal module (m_{nm}). Dimensioning suggestion for the profile shift and the cutter radius.

Bevel gear-Rough sizing

Simple pre-sizing of bevel gears: After you input the gear reduction, the helix angle, and design parameters b/mn and Re/b, the system produces a proposal that is calculated for the module, the facewidth and external diameter.

6.69 Z07d Gleason bevel gear toothing

Extension for calculation module: Z070

The input data required to calculate geometry according to ISO 23509 is often missing from data sheets for Gleason calculations. For this reason, a special input window has been designed, in which you can enter data that is present on all the Gleason data sheets. The software then checks these entries and converts them into ISO 23509 geometry.

In a second input window you can define the bevel gear geometry and achieve a good approximation of the basic data defined in the Gleason data sheets for the following types of bevel gears:

- Constant helix angle (straight or helical)
- Duplex (constant slot width)
- Spiral bevel, standard (modified slot width)

- Zerol "Duplex taper"
- Zerol "Standard"

6.70 Z07e Strength calculation based on ISO 10300, Methods B and C

Extension for calculation module: Z070

ISO 10300 for verifying the strength of bevel gears first appeared in 2001. This standard is currently the most up-to-date strength verification for bevel gears, which is why it is recommended.

Applying ISO 10300, you can prove safety against tooth fracture and pitting, and calculate scuffing safety (integral temperature criterion) as specified in DIN 3991.

An extension of the method to include hypoid bevel gears is currently being discussed. A suggestion in accordance with FVA is already implemented in KISSsoft.

6.71 Z07g Strength calculation based on DIN 3991

Extension for calculation module: Z070

Calculation according to DIN 3991 (replacement cylindrical gear toothing method)

Applying DIN 3991, you can to prove safety against tooth fracture, pitting and scuffing (integral temperature criterion)

6.72 Z07h Strength calculation for plastics

Extension for calculation module: Z070

Strength calculation for plastics: on tooth root fracture and flank strength, as specified in Niemann, VDI 2545 and VDI 2736. The calculation is performed using the process described in option Z14 for the replacement cylindrical gear.

6.73 Z07i Calculation of bevel gear differentials

Extension for calculation module: Z070

Calculate the static strength of bevel gears and calculate bevel gear differentials.

Calculate the static strength of the tooth root. The calculation is performed in accordance with the process described in option Z2x for the replacement cylindrical gear.

Bevel gears in differentials are usually only subject to a static load and are therefore only checked for static fracture safety at the tooth root. To calculate a differential gear, input the torque at the differential and the number of strands.

6.74 Z07j Strength calculation based on AGMA 2003

Extension for calculation module: Z070

Calculate the strength of bevel gears based on AGMA 2003.

6.75 Z07a bevel gears with cyclo-palloid and palloid toothing

Extension for calculation module: Z070

Geometry, manufacturability and strength calculation of bevel gears as defined in the Klingelnberg process. As stated in the Klingelnberg in-house standards KN 3028 (geometry and manufacture of cyclo-palloid gears) or KN 3025 (strength calculation of cyclo-palloid gears) and KN 3030 (strength calculation), a complete calculation is performed for cyclo-palloid toothing:

- Machine types FK41B, AMK400, AMK635, AMK855, AMK1602, KNC25, KNC40, KNC60 with all corresponding cutters, cutter radiuses and numbers of blade groups
- You can specify any shaft angle, or angle modification here
- Overall geometry with machine distance, modules (inside, middle, outside), pitch of helix, checks on the cut back, undercut space, calculation of the profile shift for balanced sliding, checks on the backwards cut, control and calculation of the necessary tip reduction on the inside diameter, profile and overlap ratio, tooth form factor and stress correction factor
- Calculation of all toothing dimensions
- Calculation of pitting, tooth root and scuffing load capacity (as defined by the integral temperature criterion) with all modifications in the KN 3030 in-house standard

Sizings:

- Sizing of profile shift for:

- Minimum necessary value to avoid undercut
- Balanced sliding

6.76 Z07b Hypoid gears with cyclo-palloid gear teeth

Extension for calculation module: Z070

The geometry of hypoid gears (bevel gears with offset), their ease of manufacturing, and performing a strength calculation for them in accordance with the Klingelnberg process. As stated in the Klingelnberg in-house standards KN 3029 (geometry and manufacture of cyclo-palloid gears) or KN 3026 (palloid-hypoid gears) and KN 3030 (strength calculation), a complete calculation is performed for cyclo-palloid toothing:

- Machine types FK41B, KNC40, KNC60, AMK855, AMK1602, KNC25, KNC40, KNC60 with all corresponding cutters, cutter radiuses and numbers of blade groups
- You can use any value as the shaft angle, angle modification, pressure angle for the driving and driven flank
- Overall geometry with calculation of the pitch of helix, facewidths, machine distance, modules (inside, middle, outside), checks on the cut back, undercut space, calculation of gap widths, checks on backwards cut, checking and calculating the necessary tip reduction on the inside diameter, transverse contact and overlap ratios, tooth form factor stress and correction factor either for the driving or driven flank
- Calculation of all toothing dimensions
- Calculation of pitting, tooth root and scuffing load capacity (as defined by the integral temperature criterion for the replacement crossed helical gear) with all modifications in the KN 3030 in-house standard

Sizings:

- Suggestion for suitable pressure angles on the driving and driven flank
- Sizing of the profile shift for the minimum value required to prevent undercut

6.77 Z07p 3D display

Extension for calculation module: Z070

Display bevel gear geometry in 3D in the Parasolid viewer with the option of exporting data in STEP format (K05u option). Straight, helical, and spiral tooth types are available, except hypoid gears. The basic geometry and the tooth form are calculated according to ISO 23509 and the final facewidth across the toothwidth is calculated in accordance with the manufacturing process ("face milling" or "face hobbing" process).

6.78 Z7o Flank and profile modifications with contact analysis under load

Calculate contact analysis for an area of profile modification variants and partial loads. The contact analysis details are the same as in the description for Contact analysis calculation (see the "Z32 Calculate contact analysis under load for cylindrical gear pairs" section on page 1-83). This module can be used to size flank and profile modifications accurately, not only for a specific load case, but also for a load range.

Module ZC33

6.79 Z08 Worm gear calculation (Z080)

Use this to start the calculation module:

- Worms with double enveloping worm wheels [Z080]

Use this calculation module to size and verify worm gears (cylindrical worms or globoid worms) with enveloping worm gears. Use calculation module [Z170] to verify worm gears with cylindrical worm wheels.

- Calculate worm geometry according to ISO 14521 and DIN 3975. Tooth thickness and control measurement values (base tangent length, rollers and measurement over balls of the worm gear) as specified in DIN 3960. Manufacturing tolerances as stated in DIN 3974-1 and 3974-2 (1995).
- Various different worm wheel materials with special data for calculating wear and efficiency. Flank forms: ZA, ZE, ZH, ZI, ZK, ZN, ZC.
- Control measurement values are calculated for worms with shape of flank ZA, ZI (or ZE). This calculation takes into account the tooth thickness allowance: the three wire measurement and tooth thickness for the worm, measurement over balls for the worm wheel and center distance for the worm wheel pair.

6.80 Z08a Strength calculation based on DIN 3996

Extension for calculation module: Z080

- Sizing the facewidth, center distance, lead angle etc.

- Strength calculation according to DIN 3996 (1998 edition) or in accordance with the Draft DIN 3996:2005 with: efficiency, temperature safety, pitting safety, wear safety, tooth fracture and deflection safety.
- You can also calculate the starting torque under load, which is a critical value when sizing gear drives.

6.81 Z08b Strength calculation based on ISO 14521

Extension for calculation module: Z080

Strength calculation according to ISO TR 14521, 2008 edition, with calculation of efficiency, wear safety, pitting safety, tooth fracture, temperature and bending safety.

6.82 Z08c Strength calculation based on AGMA 6034 and AGMA 6135

Extension for calculation module: Z080

The method stated in AGMA 6034 applies to steel worms with bronze double enveloping worm wheels. It calculates the transmissible power of the gear pair. This is a simplified method which is suitable for empirical sizing.

The method stated in AGMA 6135 applies to steel globoid worms with bronze double enveloping worm wheels. It calculates the transmissible power of the gear pair. This is also a simple method which is suitable for empirical sizing.

It also defines bending safety as stated in AGMA 6135, Annex B.

6.83 Z08p 3D display

Extension for calculation module: Z080

Display the enveloping worm wheel geometry in 3D in the Parasolid viewer, with the option of exporting data in STEP format (K05u option). The worm wheel model is generated from the cutting simulation, which uses the ideal hob tool to generate the worm.

6.84 Z19b Worm calculation with sizing using the normal module (worm sizing tool module)

Extension for calculation module: Z080

The geometry of worm pairings is usually calculated with the axial module. With this option, you can also perform sizing using the normal module (tool module). This has a particular influence on the tip and root circle, and the profile shift.

6.85 Z17 Calculate crossed axis helical gear pairs

Use this to start the calculation module:

- Crossed helical gears and precision mechanics worms with a cylindrical worm wheel [Z170]

Use this calculation module to size and verify crossed axis helical gear pairs and worm gear units with a cylindrical worm wheel.

Calculate the geometry of crossed helical gears (cylindrical gears with crossed axes) as specified by G. Niemann, [66]. The current version of this standard describes methods used to calculate and check the geometry of spiral toothed gears for any shaft angle. This module calculates the checking and manufacturing masses.

The calculation permits both the usual combination of slopes in gear pairs that point in the same direction (left-left or right-right) and also left-right combinations. The service life of worm gears with plastic-gears and steel-worms can be significantly increased by increasing the tooth thickness in the gear and reducing it in the worm. Special functions are available for sizing this type of gear.

Wear is calculated for greased worm gears for POM, PEEK, PEEK+30%CF and PA46 according to Pech [101].

6.86 Z17a Strength calculation according to ISO 6336/Hirn

Extension for calculation module: Z170

Strength calculation for metallic materials:

Using the method developed by G. Niemann [66], combined with the ISO 6336 method, you can perform a comprehensive strength calculation for worm gears (root strength, flank strength, or wear strength and scuffing safety). Niemann's calculation of pressure ellipses takes the special geometry of worm gears into account. The effective load-bearing facewidth is then derived from this. The tooth root calculation is performed in the same way as in ISO 6336. Flank strength calculation as specified by Niemann also includes the service life factors stated in ISO 6336. Scuffing safety, integral temperature process, as stated in Niemann (corresponds to DIN 3990).

The calculation method according to Hirn is used for special material pairs: steel/bronze, steel/aluminum, and various different steel/steel combinations. This is a simplified method developed in 1965, which is no longer recommended.

6.87 Z17b Strength calculation according to Niemann/VDI 2545

Extension for calculation module: Z170

The method defined by G. Niemann is the same as for steel gears, but includes the verification specified in VDI 2545 and the other processes for plastic gears (such as the one given in option Z14 for cylindrical gears).

6.88 Z17c Strength calculation according to Hoechst

Extension for calculation module: Z170

Use the strength calculation procedure defined by Hoechst to calculate load coefficients and blocking safety (shear strength) for steel/Hostaform material combinations.

6.89 Z17d Static strength calculation: Deformation and shear

Extension for calculation module: Z170

Use this module to calculate the static tooth root safety factor against overload failure and yield point (as for cylindrical gears). Also use it to calculate the static safety against shearing, for worm wheels, as specified in VDI 2736-3.

6.90 Z17e Strength calculation according to VDI 2736-3

Extension for calculation module: Z017

The method in VDI 2736-3 makes it possible to calculate the root and flank safety for crossed helical gears. VDI 2736-3 details a number of plastic materials that are available for this calculation.

6.91 Z17n Fine sizing for crossed helical gear

This is a very powerful tool that can be used to find the best variants for crossed helical gear stages under predefined constraints. If you input the ranges of the nominal ratio, the normal module, the pressure angle, the helix angle, the center distance and the profile shift coefficient, the system calculates and displays all the possible suggestions.

All the variants the system finds are then output in a list, classified by a great variety of criteria (accuracy of ratio, contact ratio, safety factors, weight, axial forces, etc.). You can either expand or reduce the scope of the list, if you want to display more or fewer individual results for a specific solution.

6.92 Z09 Splines

Use this to start the calculation module:

- Splines [Z09A]

Calculating geometry with the tolerance system and strength verification according to three different methods (Niemann, DIN 5466 or AGMA 6123).

The geometry and control measurement values of splines and pinion centers is calculated according to:

- DIN 5480 (edition 2006)
- DIN 5481 (edition 2005)*[1] *[2]
- DIN 5482 (edition 1973)*[2]
- ISO 4156 (1991)
- ANSI B92.1 and ANSI B92.2 (1992).

. Selection lists with recommended dimensions, as well as all possible dimensions, make it easier for you to select the one you want. In the "Own input" option, you can also define any other dimensions you require. The system includes all the tolerance systems (allowances and manufacturing tolerances) listed in the standards. Control measurement values for "Actual dimensions" and for "Effective dimensions". The "Actual" data contains the dimensions for individual measurements (for example, base tangent length). The "Effective" data has the dimensions that include manufacturing errors when checked against templates.

For splines that conform to ISO 4156, this method calculates all the data required to design gauges as specified in ISO 4156, Amendment 1, with details for go and not-go gauges.

For splines according to DIN 5480, the data for the design of the gauges is calculated on the basis of Part 15. In addition, the allowances are shown for go and not-go gauges (new, or on the wear limit).

Their strength is calculated by 3 different methods: Niemann/Winter, AGMA 6123 and Draft DIN 5466.

*[1] : DIN 5481 also requires right Z5h to output straight line tooth flanks

*[2] : all the standard geometries for DIN 5481 and DIN 5482 are supplied as files that can be read.

6.93 Z12 Operating backlash

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016, Z080, Z170

In addition to calculating the theoretical backlash (integrated in Z01) for cylindrical gears, as defined in DIN 3967, the backlash after mounting (including toothing deviations, the deviation error of axis according to ISO 10064 or DIN 3964, and form and mounting deviations) and the operating backlash (including the temperature differences between the gears and the housings) can also be calculated. The influence of the increase in thickness due to water absorption is also taken into account for plastic gears. The increase in pitch error and the reduction in tip clearance due to thermal expansion is also documented.

6.94 Z22 Hardening depth

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016, Z070

This calculates the optimum hardening depth (for case hardened or nitrite hardened gears). It shows the stress curve in the depth vertical to the flank surface. Displays the stress curve in the depth (vertical to the flank surface) and the hardening progression accompanied by a warning message that an insufficient number of ratios is present. The recommended hardening depth specified in ISO 6336-5, AGMA 2001 and Niemann is also documented.

6.95 Z16 Sizing of torque

Extension for calculation modules: Z011, Z012, Z013, Z014, Z015, Z016, Z070, Z080, Z170

For cylindrical gears, bevel gears, crossed axis helical gears and worm gears, the maximum transmissible torque required to achieve the predefined safety levels is calculated based on the required service life and required safeties (for tooth

fracture, pitting, scuffing, and, for worm gears, also for wear and temperature safety).

6.96 Z18 Service life calculation

Extension for option: Z16

After you input or confirm the minimum safeties for tooth root and flank safety, the service life (in hours) for the specified load is calculated for all gears, apart from splines (Z09). Service life is calculated according to ISO 6336, Part 6 (2006) using the Palmgren-Miner Rule. In the range of endurance limit, you can select a modified form of the S-N curve (Woehler lines) as an alternative to ISO 6336:

- According to Miner (corresponds to ISO 6336 or DIN 3990)
- According to Corten/Dolan
- According to Haibach

The service life of the system (every gear in the configuration) is also output.

6.97 Z16a Sizing of torque for load spectra

Extension for option: Z16

This is an addition to Z16 for calculating load spectra. You can define any load spectra by inputting the frequency, power/torque and speed. The system includes all load spectra as defined in DIN 15020 (crane construction). The calculation is based on ISO 6336, part 6 (2006) using the Palmgren-Miner Rule. In the range of endurance limit, you can select a modified form of the S-N curve (Woehler lines) as an alternative to ISO 6336:

- According to Miner (corresponds to ISO 6336 or DIN 3990)
- According to Corten/Dolan
- According to Haibach

6.98 Z18a Calculate service life for load spectra

Extension for option: Z18

This is an addition to Z18 for calculating load spectra. You can define any load spectra by inputting the frequency, power/torque and speed. The system includes all load spectra as defined in DIN 15020 (crane construction). The calculation is

based on ISO 6336, part 6 (2006) using the Palmgren-Miner Rule. Calculate safeties with load spectra: If you input the target service life, the load, the application factor (usually 1.0 for classic load spectra) and a load spectrum, KISSsoft calculates the resulting safeties for the tooth root and tooth flank, as well as the scuffing safety for the critical element of the load. It then outputs the results in a report.

6.99 Z40 Non-circular gears

Use this to start the calculation module:

- Non circular gears [Z040]

Calculate the entire tooth contour of non-circular gears. You may be required to input:

- Center distance and ratio progression (momentary conversion of the rotating position of Gear1)
- Center distance and operating pitch line of Gear 1 (in polar coordinates)
- Operating pitch line of Gear 1 and Gear 2 (each in polar coordinates)

The center distance can be fixed or variable. The software first defines the operating pitch lines and then adds teeth to the operating pitch lines in the pinion type cutter simulation. This produces very precise and elegant toothing both on outer contours and "bosses" that run in one direction. After this, both gears can be generated in opposition to each together to check that they function correctly. The current ratio is displayed in real time.

There are instructions about how to estimate strength. These are used to convert the critical areas of a non-circular gear pair into the same, circular gear pair and then verify this with the cylindrical gear module [Z012].

Both open non-circular contours (for example, a pinion with an angle of rotation of 330° to a gear with an angle of rotation of 60°) and non-circular gears with an overall reduction of 1:2 to 1:10 (for example, a pinion with an angle of rotation of 720° to a gear with an angle of rotation of 360°) can be created here.

Restriction: Center distance > 0 (no internal toothed pairs)

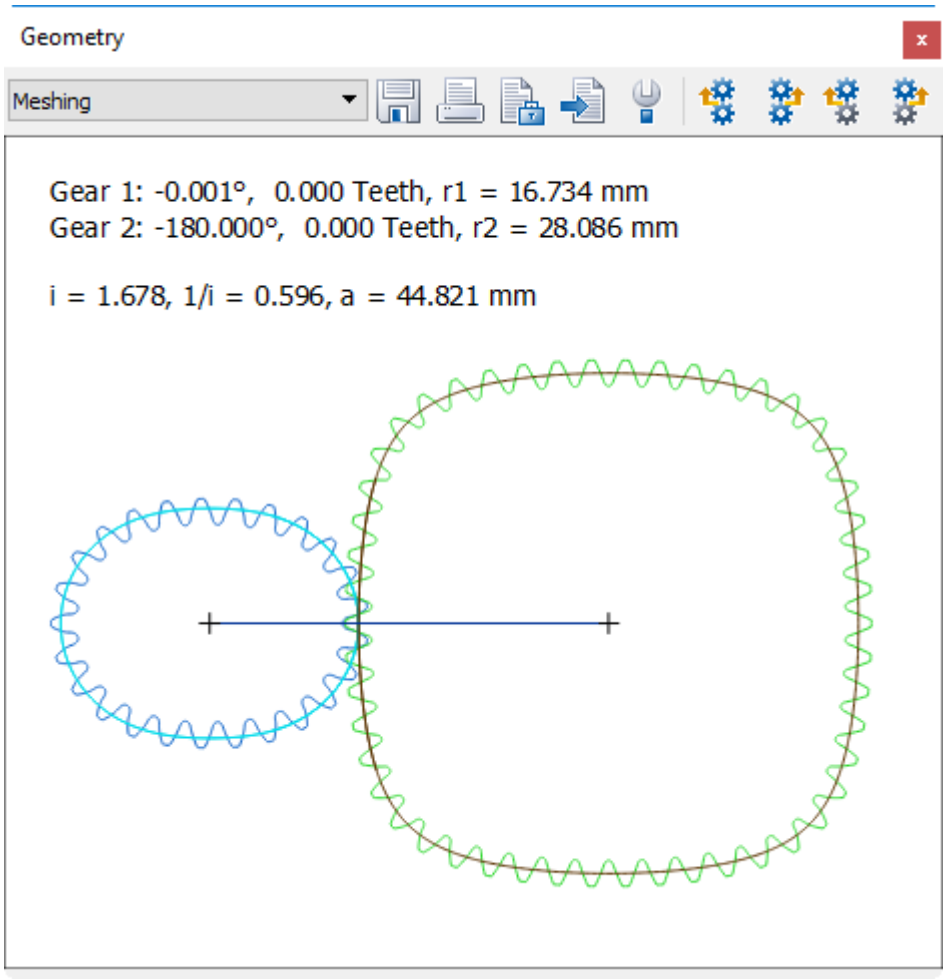


Figure 1.5: Display of non-circular gears

6.100 Z50 Beveloid gears

Beveloid gears (also known as "conical gears") are generated using a slightly tilted, rack-shaped cutter. This makes it possible to generate a gear pairing with a small shaft angle.

The calculation is based on well known technical documentation, and on more recent publications. The geometry is calculated on the basis of these two sources:

K. Roth; Zahnradtechnik – Evolventen-Sonderverzahnungen zur Getriebeverbesserung, Springer DE, 1998

S.-J. Tsai, S.-H. Wu; Geometrical Design of Conical Gear Drives with Profile-shifted Transmission; 12th IFToMM World Congress, 2007

This module is currently in development.

7.1 Z90 V-belts (Z090)

Fully automated calculation, including standard V-belt lengths and standard effective diameters. Determining transmittable power per belt while taking into account the speed, effective diameter, transmission ratio and belt length. All the data for each type of belt is saved to text files, whose names indicate their purpose. These contain the data from technical catalogs produced by the relevant manufacturer (e.g. Fenner). This also includes a belt stress calculation module that uses data from belt-bending tests. This calculates the end of rope force and axle load at standstill and in operation for optimum setting as well as for setting in accordance with data in the catalogs.

V-belt profiles:

- SPZ, SPA, SPB, SPC
- XPZ, XPA, XPB, XPC
- XPZ, XPA, XPB, XPC narrow V-belts DIN 7753/ISO 4184 (Conti-FO-Z brand)
- 3V/9N, 5V/15N, 8V/25N
- 3V/9J, 5V/15J, 8V/25J
- Dayco RPP (Panther)
- Further profiles on request

Rough dimensioning (suggests a V-belt that would be suitable for solving your drive problem), sizing of the number of belts, calculating belt length from the center distance and vice versa. As a variant, the calculation can also be performed with a third roller (tensioning pulley). You specify its position interactively on the graphical screen. This roller can be positioned outside or inside as required. The changed length of loop is then taken into account in the subsequent calculation.

7.2 Z91 Toothed belts (Z091)

Use this method to calculate and size all aspects of toothed belt drives, including the tooth number and belt length, while taking into account standard numbers of teeth. When you enter the required nominal ratio and/or the nominal axis distance, the program calculates the best possible positions. You can also calculate the required belt width, taking into account the correction factors, the minimum tooth numbers and the number of meshing teeth. You can also print out assembly details

(belt bending test). The data for each type of belt is saved to text files, whose names indicate their purpose, which can be edited as required.

Toothed belt profiles:

- XL, L, H, 8m, 14mm ISORAN (FENNER)
- 8mm, 14mm ISORAN-RPP-GOLD, ISORAN-RPP-SILVER (Megadyne)
- 8mm, 14mm RPP-HRP (Pirelli)
- 3mm, 5mm, 8mm, 14mm PowerGrip HTD (Gates)
- 8mm RPP (Marke DAYCO, Panther)
- 8mm, 14mm MGT Poly Chain GT2 (Gates)
- 8mm, 14mm MGT Poly Chain GT Carbon (Gates)
- AT5mm, AT10mm, AT20mm BRECOflex (BRECO)
- AT3mm, AT3mm GEN III, AT5mm GEN III, AT10mm GEN III SYNCHROFLEX (CONTITECH)
- Other types of toothed belt are available on request

Rough dimensioning (suggests a toothed belt that would be suitable for solving your drive problem), sizing of the belt width, calculating belt length from the center distance and vice versa. You can also perform calculations for stress-resistant toothed belts with integrated steel ropes (e.g. AT5). You can also include a tensioning pulley in the same way as in V-belt module Z90. Additional profiles: AT 5mm, AT10mm, AT20mm (Breco).

7.3 Z92 Chain gears (Z092)

Calculation of chain gears with roller chains as specified in ISO 606 (DIN 8187 and DIN 8188) with standard roller chains taken from a database. The chain geometry (center distance, number of chain elements) for simple and multiple chains and the transmissible power, axial forces, variation in speed are calculated by the polygon effect, etc. Basis: DIN ISO 10823 (2006), Dubbel, Taschenbuch für den Maschinenbau, and G. Niemann, Maschinenelemente. Checking permitted highest number of rotations, suggestion for the required lubrication. In the same way as in V-belt module Z90, you can add a third gear (tensioning pulley) to the graphic displayed on screen, and include it in the calculation.

Sizing: Using the drive data as a starting point, the program displays a list of suggested values for suitable chain drives. Calculating the chain length from center distance and vice versa; inside/outside tensioning pulley with graphical positioning.

8.1 A10 Synchronization (A010)

Calculation of synchronization time for engaging/disengaging two gears, based on geometry, working conditions and materials input.

8.2 A20 Friction clutches (A020)

Calculation of friction clutches and brakes as specified in VDI 2241 sheet 1 and 2. Contains the sizing and calculation of friction clutches (by predefining moments of inertia and torques as well as speeds).

- Speed curve at sliding time t3
- Torque diagram at sliding time t3
- Curve for coefficient of sliding friction at sliding velocity at average radius rm (if defined)

9.1 Overview

In the KISSsys system, you can create a system of machine elements. To do this, you can calculate the power flow and manage the links between the various different elements. KISSsys uses KISSsoft routines to calculate the strength of the machine elements. The results of the calculations are then made available in KISSsys, both as tables and as graphics. With the KISSsys system, you can get a clear overview of the strength and service life of all the elements in your design at any time.

9.2 Modules

- **K11a:** KISSsys Administrator License
- **K11c:** 3D core, Export functions

9.2.1 K11h Efficiency calculation

You can use the efficiency calculation in KISSsys to calculate the heat level in a particular gearbox. Several different methods are implemented. The user can select how the calculation is to be performed, according to the ISO/TR 14179 standard, Part 1 and Part 2 (together with AGMA 6123-B06).

Thermal analysis can be defined in two sections: power loss and heat dissipation. An external cooler can also be taken into account. The power loss and heat dissipation can be divided up into several sections to enable the effect of all the individual gear unit components to be taken into consideration.

Power losses can be separated into two main losses, load-dependent and non-load-dependent. Both types of loss are usually present when a gear unit is operating. Power loss can also be subdivided into gear unit elements, such as gears, bearings and seals. Losses due to meshing (according to Niemann) and churning (according to ISO/ST 14179) are considered for gears. Rolling and sliding friction (according to SKF), seal friction (according to SIO/TR 14179) and drag friction are considered for bearings, and seal friction for seals. For example, to calculate losses due to churning, the standard provides a solution for cylindrical gears that is extended to cover bevel gears. AGMA 6123-B06 includes a solution for planetary gear units with a fixed internal gear. All other types or configurations of gears are not considered.

In some cases, the results have to be treated with special care, because the calculation methods used may not fully support the type of geometry.

9.2.2 K11i Modal analysis of shaft systems (k11i)

Extension of calculation module: k11.

Prerequisite:

- Perform modal analysis in complete shaft systems.

It is not realistic to produce a modal analysis for a gearbox if you do so for each shaft, individually. Instead it must be based on the complete shaft system topology.

Using this module, you can perform modal analysis for a complete KISSsys model. Different models for calculating meshing stiffness are available: according to ISO 6336, contact analysis (if the required license is present), infinite stiffness, and zero stiffness. The user can either select pure torsional vibrations or linked torsional, axial and flexural vibrations. The result is displayed in a 3D animation of the vibrating shaft system. A detailed report is also provided. Damping is ignored, and the amplitudes of the eigenmodes are standardized at 1.

9.2.3 K11j Take into account housing deformation in static KISSsys calculations (k11j)

Extension of calculation module: k11.

Prerequisite:

- Take into account the housing stiffness in static KISSsys calculations.

As gearbox power increases, and gearbox size decreases, it becomes even more important to include housing stiffness in gearbox calculations.

Using this module, you can perform KISSsys static calculations, including housing stiffness. This is achieved inserting the reduced stiffness matrix of an FEM model of the housing, having as master nodes the nodes at the center of support bearings. It should be noted here that only bearings without clearance can be considered in the "classic" calculation methods. The resulting bearing offset has a direct effect on all the subsequent calculations.

9.3 Different views of the data

In KISSsys, a model of the system you are monitoring is stored as base data. Users can then access different views of this data:

- In the table view, the machine element data is presented in an easy-to-understand format. You can input your own data quickly and easily in this view.
- A freely-configurable user interface, in table format, groups together the most important input and output values and you can call other functions in it.
- Use the flexible dialogs to configure the templates. You can also easily change these dialogs to suit your own templates.
- A tree view gives a clear overview of the assembly structure.
- The 2D schematic diagram illustrates the power flow.
- In the 3D view you can check your input visually. Here, you can, of course, also rotate, move and zoom in on or out from the graphic.

9.4 Modeling

The systems modeled in KISSsys are extremely flexible and can be modified to suit your own requirements. You can manage the KISSsys templates to help complete your daily tasks more efficiently. To do this, simply combine already defined elements, from single parts up to entire assemblies. Using the integrated programming language you can write very powerful case-specific applications. For example, in rough sizing, you can automate a drive train within KISSsys. A range of effective plotting functions are available to represent the results of variations.

9.5 Variants

Most designs in mechanical engineering occur in variants. KISSsys uses special data formats to support these variants, so that you can, at any time, easily toggle between different device types in a series, switch settings or similar.

9.6 Example applications

The system is extremely flexible, making it suitable for a wide range of applications. However, three main applications stand out from the others:

- Designing machines: When designing machines, the sizing of each individual machine element depends on the others. KISSsys can manage and display these interrelationships. Typical applications are, for example, the sizing of multi-stage drives for assembly in confined spaces, or for the well-balanced sizing of drive trains. By using the programming options, you can also define company-specific applications which can then be sent to drawing offices and used to automate specific sizing functions.
- Handling variants: By managing variants, KISSsys can, for example, extract transmissible power data that can then be used to create catalogs of gear sets or gear series. Alternatively, it can perform observations for an entire series of variants for one design.
- Sales support: If required, the sales team can be given a special variant of KISSsys which does not include any options for changing the basic models, but which does enable them to input specific data in the appropriate dialogs. This not only speeds up the quotation process but also makes it more precise, because the sales team members can explain certain technical aspects without having to refer back to the design team.

A

A10 Synchronization (A010) - I-118
A20 Friction clutches (A020) - I-118
Automotive - A-Module - I-118

B

Base K module - I-16
Belt/chain drives Z module - I-116

C

Computer configuration - I-15

D

Different views of the data - I-121

E

Example applications - I-122

F

F01 compression springs calculation - I-62
F02 Tension spring calculation - I-62
F03 Leg spring calculation - I-62
F04 Disc spring calculation - I-62
F05 Torsion-bar spring calculation - I-62

G

Gears - Z-modules - I-64
General - I-31

H

Hardware and software requirements - I-14

K

K02 report text and interface - I-18
K04 COM interface - I-18
K04a extended COM interface - I-18
K05 CAD interfaces - I-18
K05a DXF interfaces - I-18
K05d Solid Edge interface - I-19
K05e IGES interface - I-19
K05k SolidWorks interface - I-20
K05m Inventor interface - I-20
K05n NX interface - I-21
K05o* CATIA interface - I-21
K05q* ProEngineer interface - I-21
K05s Parasolid display window - I-22
K05u Export STEP format (parasolid) - I-22
K07 User database (materials etc.) - I-22
K09 Hardness Conversion (in the Extras menu) - I-22
K1 Base module - I-16
K10 Calculating tolerances - I-22
K11h Efficiency calculation - I-119
K11i Dynamic analysis of shaft systems - I-24
K11i Modal analysis of shaft systems (k11i) - I-120
K11j Take into account housing deformation in static KISSsys calculations (k11j) - I-120
K11k Export of KISSsys model data - I-25
K12 Strength verification using local design (FKM guideline) - I-25
K14 Hertzian pressure - I-25
K14a Any contact - I-26
K15 Linear Drive - I-26
K16 Gear body deformation - I-27
K17 Plastics Manager - I-28
K18 Reliability - I-29
K20 Import a reduced stiffness matrix from different FEM programs - I-30
K7a Material management (always present) - I-22
K7b Smith-Haigh diagram - I-22
KISSsys - K11 module - I-119

M

M01a Cylindrical interference fit - I-53
M01b Conical interference fit connections - I-53
M01c Clamped connections - I-54
M01x Additional function for a press fit - I-54
M02a Key - I-54
M02b Spline shaft/Multi-groove profile - I-55
M02c Spline - I-56
M02d Polygon - I-56
M02e Woodruff key - I-57

M03a Bolt calculation - I-57
M04 Bolt calculation - I-57
M04a Eccentric clamping and load, configurations (for M04) - I-58
M04b Bolt calculation at high and low temperatures (for M04) - I-58
M050 Snap ring - I-61
M08 Welded joints - I-59
M09a Glued and Soldered Joints - I-59
Machine elements - M module - I-53
Modeling - I-121
Modules - I-119

O

Overview - I-119

P

Product Description - I-13
Program versions - I-14

S

Shafts, axes, bearing - W-module - I-31
Springs - F-module - I-62

V

Variants - I-121

W

W01 Shafts base module - I-33
W01a Input data for several shafts - I-34
W01a Load spectra - I-35
W01b Bearing offset, Bearing clearance - I-34
W01c Take into account contact angle - I-35
W03 Calculate deflection and bearing forces - I-35
W03a Take into account deformation due to shearing - I-36
W03b Non-linear shaft - I-36
W03c Thermal expansion - I-36
W03d Non-linear stiffness - I-36
W04 Calculation of the critical speed - I-36
W04x Effect of spinning - I-37
W05 Ball and cylindrical roller bearing and roller bearing service life - I-37
W05a Bearing load spectra - I-39
W05b reference service life specified in ISO/TS 16281 - I-38
W05c Load distribution in the bearing - I-40

W06 Calculate the service life and static calculation of cross sections - I-41
W06a Hänchen + Decker calculation method - I-42
W06b Calculation method DIN 743 - I-42
W06c Calculation methods in the FKM Guideline - I-42
W06d Calculation method AGMA 6101/6001 - I-44
W06s Strength calculation with load spectra - I-44
W07 Hydro-dynamic plain radial bearings - I-44
W07a Calculation in accordance with Niemann - I-44
W07b Calculation according to ISO 31657 - I-46
W07b Calculation according to ISO 7902 - I-44
W07c Hydrodynamic plain thrust bearing - I-47
W07e Calculation according to DIN 31652 - I-47
W08 Grease lubricated plain radial bearings - I-47
W10 Calculation of deformation in the axial direction - I-47
W10 tooth trace modification with additional FEM displacement matrix - I-49
W12 Shaft arrangement (integrated design tool) - I-49
W13 Buckling - I-50
W14 Forced responses in KISSsoft shaft calculation - I-51
W51 Verification of rolling bearings according to ISO/TS 16281 - I-41
W51a Rolling bearing fine sizing - I-52

Z

Z01 Gear - Base module - I-64
Z01a Planets, 3- and 4-gear - I-74
Z01b Rack - I-76
Z01x extension of cylindrical gear geometry - I-65
Z02 Strength calculation as specified in DIN 3990 - I-69
Z02a Strength calculation as specified in ISO 6336 - I-70
Z02b Strength calculation as specified in BV RINA - I-72
Z02x Static strength of the tooth root - I-71
Z03 Cylindrical gear-Rough sizing - I-76
Z04 Cylindrical gear-fine sizing - I-77
Z04a Additional strength calculation of all variants - I-78
Z05 Tooth form calculation and display - I-79
Z05a Input any cutter form or tooth form - I-81
Z05c Reference profile calculation for gears with involutes or special profiles - I-81
Z05d Calculate the tooth form from the paired gear (generate with other gear in the pair) - I-81
Z05e Addition for mold making - I-82
Z05f Arc shaped start of entry curve on the tooth tip - I-83
Z05g Optimum tooth root rounding - I-83
Z05h Cycloid and arc of circle toothings - I-84
Z05i Arc of circle approximation - I-84
Z05j Display collisions in the generation process (cylindrical gears) - I-84
Z05k Displaying collisions during generation (worms/crossed axis helical gears) - I-85
Z05l Using the same tool type multiple times - I-85
Z05m Non-symmetrical gears - I-85
Z05n Straight line flank - I-85

Z05q Special functions for the watch-making industry - I-86
Z05x Animate the 2D display - I-80
Z06 Face gear calculation (Z060) - I-97
Z06a Strength calculation based on ISO 6336/Literature - I-97
Z06b Strength calculation based on CrownGear/DIN 3990 - I-98
Z06c Strength calculation based on ISO 10300, Method B - I-98
Z06d Strength calculation based on DIN 3991, Method B - I-98
Z07 Bevel gear calculation (Z070) - I-99
Z07a bevel gears with cyclo-palloid and palloid toothing - I-101
Z07b Hypoid gears with cyclo-palloid gear teeth - I-102
Z07d Gleason bevel gear toothing - I-99
Z07e Strength calculation based on ISO 10300, Methods B and C - I-100
Z07g Strength calculation based on DIN 3991 - I-100
Z07h Strength calculation for plastics - I-100
Z07i Calculation of bevel gear differentials - I-100
Z07j Strength calculation based on AGMA 2003 - I-101
Z07p 3D display - I-103
Z08 Worm gear calculation (Z080) - I-104
Z08a Strength calculation based on DIN 3996 - I-104
Z08b Strength calculation based on ISO 14521 - I-105
Z08c Strength calculation based on AGMA 6034 and AGMA 6135 - I-105
Z08p 3D display - I-106
Z09 Splines - I-110
Z10 Cylindrical gear calculation using the FVA method - I-72
Z12 Operating backlash - I-111
Z13 Calculation using the AGMA standard (USA standard) - I-71
Z13b Calculation according to AGMA 6011/AGMA 6014 (US standard) - I-72
Z14 Plastic gears - I-73
Z15 Calculate the details used to modify the profile of cylindrical gears - I-67
Z16 Sizing of torque - I-111
Z16a Sizing of torque for load spectra - I-112
Z17 Calculate crossed axis helical gear pairs - I-106
Z17a Strength calculation according to ISO 6336/Hirn - I-107
Z17b Strength calculation according to Niemann/VDI 2545 - I-107
Z17c Strength calculation according to Hoechst - I-107
Z17d Static strength calculation
Deformation and shear - I-108
Z17e Strength calculation according to VDI 2736-3 - I-109
Z17n Fine sizing for crossed helical gear - I-110
Z18 Service life calculation - I-112
Z18a Calculate service life for load spectra - I-112
Z19a Calculation with operating center distance and profile shift according to manufacture - I-67
Z19b Worm calculation with sizing using the normal module (worm sizing tool module) - I-106
Z19d Optimize axis center distance with respect to balanced sliding - I-67
Z19e Representation of specific sliding - I-67
Z19f Suggestion of sensible tooth trace modifications - I-68
Z19g Calculate the center points of planets or idler gears - I-76
Z19h Sizing of deep toothing - I-66

Z19i Tooth form factor calculation using the graphical method - I-73
Z19j Profile modifications with worm grinding wheels/dressing wheels - I-69
Z19k Lubrication gap EHD/ Scoring - I-86
Z19l Conversion of profile shift coefficient and tooth thickness allowance - I-69
Z19m Flash temperature progression - I-74
Z19n Profile and tooth trace diagrams npb - I-69
Z22 Hardening depth - I-111
Z23 Calculate the tooth root load capacity of internal teeth with the influence of the ring gear in accordance with VDI 2737 and calculate the deformation of gear rings - I-86
Z24 Meshing stiffness of the gear pair and transmission error - I-88, I-92, I-94
Z25 Graphical representation of Hertzian pressure and tooth root strain along the actual tooth form - I-88
Z26 Displacement volumes for gear pumps - I-89
Z26a Additional option for gear pumps Z26 - I-89
Z27 Kinematics based on the actual tooth form - I-90
Z29 Sizing and checking of master gears - I-90
Z30 Micropitting (frosting) and flash temperature - I-90
Z31 Wear - I-91
Z31a Iterative calculation of wear - I-91
Z32 Calculate contact analysis under load for cylindrical gear pairs - I-92, I-96
Z33 Profile modification optimization with contact analysis under load - I-96
Z34 Calculate contact analysis under load for planetary systems - I-94
Z35 Calculate contact analysis under load for bevel gears - I-95
Z37 Calculate the deformation of the planet carrier with FEM (z37). - I-96
Z38 Use FEM to calculate stress in the gear root - I-97
Z40 Non-circular gears - I-113
Z50 Beveloid gears - I-114
Z6e Static strength - I-98
Z6f 3-D display - I-98
Z7o Flank and profile modifications with contact analysis under load - I-104
Z90 V-belts (Z090) - I-116
Z91 Toothed belts (Z091) - I-116
Z92 Chain gears (Z092) - I-117