Drivetrain Design Solutions **KISSsoft**

KISSsoft
Release 2021

Product Description

Sharing Knowledge

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Product Description

1 Hardware and software requirements

You will need this computer configuration to run the program:

- Operating system: Windows 64-bit, Windows 8 or above
- Windows N and KN require the installation of Microsoft Media Feature Pack
- Processor: at least SSE2-compatible
- RAM: At least 4 GByte RAM
- Screen resolution: at least 1280 x 960 pixels
- OpenGL 3.2
- Printer: Windows printer
- Memory: Approx. 800 to 3000 MB space on the hard disk (depending on the scope of the license)
- Server requirements for network licenses: Windows Server 2012 and above
- Windows Server requires the installation of Microsoft Media Foundation
- Do not change the hard disk's hardware code for network installations.

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2 Program Versions

Test installation: a full version of the program that runs for 30 days and contains all modules, which can be deactivated if required. You can use the test installation to test our programs in a real-life working environment. The software must not be used for commercial purposes.

Single user license: The software can be installed on any number of computers. A USB protection key (sometimes known as a "dongle"), which protects the software against unauthorized access, is supplied. It is inserted in the computer's USB, to enable the software to run on that computer.

Multi-user network installation with access directory: We offer network installation for any number of users, but the number of simultaneous users is limited to the number of access rights. To manage the current user accesses, one directory with full rights must be created on a server with general access rights for KISSsoft users.

Multi-user network installation with USB port protection device: Alternatively, the network installation with USB port protection device can also run on the server. To do this, 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.

3 Calculation Modules

The following abbreviations are used for the individual calculation modules:

Z011	Single Cylindrical Gear Calculation
Z012	Cylindrical Gear Pair Calculation
Z013	Cylindrical Gear Pinion with Rack
Z014	Cylindrical Gear Planetary Gear Stage
Z015	Cylindrical Gear Three Gears Train
Z016	Cylindrical Gear Four Gears Train
Z070	Bevel and Hypoid Gear Calculation
Z060	Face Gears
Z080	Worms with Enveloping Worm Wheel
Z170	Crossed Helical Gears and Precision Mechanics Worm Gears
Z050	Beveloid Gears
Z040	Non-Circular Gears
W010	Shaft Calculation
W050	Rolling Bearing Calculation
W051	Rolling Bearing Calculation with Internal Geometry
W070	Hydrodynamic Plain Journal Bearings
W07c	Hydrodynamic Plain Thrust Bearings
M010	Cylindrical Interference Fit
M01b	Conical Interference Fit
M01c	Clamped Connections

M02a	Keys
M02b	Straight-Sided Splines
M02c	Splines (Strength)
Z09a	Splines (Strength and Geometry)
M02d	Polygons
M02e	Woodruff Keys
M03a	Bolts and Pins
M040	Bolt Calculation According To VDI 2230
M080	Welded Joints
M090	Glued and Soldered Joints
M050	Snap Rings
F010	Compression Springs and Conical Compression Springs
F020	Tension Springs
F030	Leg Springs
F040	Disc Springs
F050	Torsion-Bar Springs
Z090	V-Belts
Z091	Toothed Belts
Z092	Chain Drives
A010	Synchronization
A020	Friction Clutches
K010	Tolerance Calculation

K120	Proof of Strength with Local Stresses
K140	Hertzian Pressure
K150	Linear Drive Train
K160	Gear Body Deformation
K170	Plastics Manager

4 General: K rights

Import and export functions, and databases, for use everywhere in the program, and calculations for use in any module

4.1 K02 Languages

The user interface, messages and reports including graphics can be processed and created in KISSsoft in the following languages:

- German
- English
- French
- Italian
- Spanish
- Portuguese
- Russian
- Chinese

4.2 K04 COM interface

KISSsoft includes the option of remote control via a COM interface (no matter what operating system or programming language).

This enables KISSsoft to be addressed with Visual BASIC from Excel, for example.

Using this right you can load files, set and read variables, perform calculations and generate reports.

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

4.3 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.

4.4 K05a DXF interfaces

Enables 2D graphics to be output in DXF format, version R12 and R14. A layer can be defined.

4.5 K05e IGES interface

Use this interface to output all 2D graphics in IGES format.

4.6 K05f GDE (Gear Data Exchange) format

The GDE XML format is described in VDI guideline 2610 and defines splines, cylindrical gears and beveloid gears.

In KISSsoft, GDE format is written to a special report.

4.7 K05g GAMA format (Gleason)

Extension for these calculation modules: Z011 to Z016, and Z0170

GAMA XML format is used for Gleason measuring machines and written to a special report.

The following parameters, which are present in KISSsoft, are currently supported by the GAMA code:

- Normal module
- Number of teeth
- Helix angle
- Facewidth
- Profile shift
- Root diameter
- Start of the involute
- Reference diameter
- Normal tooth thickness, arc

4.8 K05d Solid Edge interface

This interface creates the direct integration between the Solid Edge 3D CAD system and KISSsoft. This enables you to start all KISSsoft calculation modules directly from Solid Edge. Cylindrical or bevel gears calculated in KISSsoft can be generated as a 3D part with a real tooth form in Solid Edge. You can run Solid Edge with a single click from the tooth form calculation function in KISSsoft. A new part is then opened and the appropriate element is generated for it. You can create cylindrical gears with straight or helical teeth, which are external or internal, racks, or straight-toothed bevel gears, as defined in DIN 3971, Figure 1, and shafts (conus and cylinder elements).

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 on the drawing automatically. as a text field. The gear manufacturing data is attached to the relevant cutout (tooth space).

4.9 K05k SolidWorks interface

The interface between SolidWorks and KISSsoft creates the 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 element. You can create cylindrical gears with straight or helical teeth, which are external or internal, racks, straight-toothed bevel gears, as defined in DIN 3971 (Figure 1), as well as shafts (conical and cylindrical elements).

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).

4.10 K05m Autodesk Inventor interface

The interface between Autodesk Inventor and KISSsoft creates the 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, simply click on 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 internal or external, racks, or straight-toothed bevel gears, as defined in DIN 3971, Figure 1, and shafts (conus and cylinder elements).

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).

4.11 K05n NX interface

The interface between NX and KISSsoft creates the direct integration in the 3D CAD system. Use this to start all KISSsoft calculation modules directly from within NX. Cylindrical 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 internal or external, racks and shafts (conical and cylindrical elements).

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).

4.12 K05o* 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 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.

This interface is being developed by SWMS.

4.13 K05q* Creo Parametric interface

Cylindrical or bevel gears calculated in KISSsoft can be generated directly in Creo Parametric as a 3D part with a real tooth form. You must open Creo Parametric before you start generating a 3D model in KISSsoft. In Creo Parametric, 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.

This interface is being developed by Applisoft.

4.14 K05a 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.

4.15 K05u STEP format export (Parasolid)

Right 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.

4.16 K07 user database

Database right for administering different technical data such as materials, tolerances, reference profiles, bolt standards etc. Using a database tool you can add, add data to, or modify your own, data records, and also move, display or hide them in sequence.

4.17 K7a Material management

Right to input additional materials in the database and change specific data for materials that are already present.

4.18 K09 Hardness conversion

Right to convert hardness data in accordance with Vickers, Brinell and Rockwell for different material groups according to DIN EN ISO 18265:2014. You can call The hardness conversion function in the 'Extras' menu.

4.19 K10 Tolerances calculation

Use this to 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 2768:1991, DIN 7168:1991 (withdrawn)) 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.

4.20 K12 Strength Verification using Local stresses (FKM Guideline)

The static and proof of fatigue strength (time or endurance) with elastically calculated local stresses as specified in the FKM Guideline [1] 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 with safety against fatigue failure. You can also perform this calculation with load spectra.

4.21 K14 Hertzian Pressure

Calculation of the Hertzian pressure of two bodies. The Hertzian equations are used to help calculate the maximum pressure (Hertzian pressure) and the proximity of the two bodies (ball, cylinder, ellipsoid, plane (convex and concave)). In addition, the stress curve, normal to the surface, is determined.

The calculation of the contact and the proximity of the two bodies is based on this literature: Boresi/Schmidt 2002 [2], Weber/Banaschek 1955 [3] and Norden 1973 [4].

4.22 K14a Any Contact

Use this to calculate the line contact between two bodies with an arbitrary profile (line load on an elastic hemisphere). The results include deformations and loads in the contact area and under the surface along the profiles. Plasticity and friction are ignored. The calculations are based on Johnson 2003 [5].

4.23 K15 Linear Drive Train

Use this right to calculate drive screws. Drive screws are used to convert rotational movement into longitudinal movement or to generate powerful forces. Almost exclusively, trapezoidal screws (selectable, DIN 103) are used as drive screws. The information provided in Roloff Matek 2001 [6] is used to calculate linear drive trains (drive screws).

4.24 K16 Gear body deformation

Use this right to calculate the deformation due to a 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 or a stiffness matrix under unit load. The stiffness matrix can be added to a shaft calculation for cylindrical gears or to the face load factor calculation/contact analysis 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 (Right W10).

4.25 K17 Plastics Manager

Requirement: Rights Z14 and Z14a (if the permissible root and/or contact stress are to be calculated)

Use these rights to add new plastic materials to the KISSsoft material database, if the material characteristics are available. When a material is added to the database, KISSsoft generates its associated .DAT material file. 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 safety factors via the total service life.

4.26 K18 Reliability

Requirement: a suitable strength calculation right for the machine element

Calculation of reliability of gears, shafts and bearings according to Bernd Bertsche 2008 [7] with the use of 3-parameter Weibull distribution. System stiffness within KISSsys. The f_{tb} and b coefficients can be entered (preset values in accordance with Bertsche).

4.27 K20 Import a stiffness matrix

Extension for calculation right K16 and right K11j

Imports 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)

5 Gears: Z rights

5.1 Z01 Gear Basic Right

This right permits you to start these calculation modules:

- Single Cylindrical Gear Z011
- Cylindrical Gear Pair Z012

and includes the gear geometry calculation for cylindrical gears as specified in ISO 21771 (and DIN 3960).
The calculations are valid for internal and external teeth:

- Straight and helical gear teeth, double helical gearing
- Reference profiles as 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 (as specified in DIN 3972 and your own tool lists) and pinion type cutters (as 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
- Tip alteration, length correction, chamfer, tip chamfer, profile modification, etc. can be taken into account.
- Check for undercut, a pointed tooth, meshing interference, tip clearance, ease of assembly, tip and root form circle, active tip and root diameter (active involutes) contact outside the meshing area, etc.
- The test mass, base tangent length, tooth thickness, effective radial measurement over one and two balls and measurement over one and two pins can be calculated. The test mass is calculated separately for each lower and upper allowance.
- Tooth thickness allowances:
    - according to DIN 3967 (e.g. e25), database tables installed
    - according to ISO 1328 (e.g. 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
- User-defined tables for tooth thickness allowances
- For precision mechanics: tip circle (with tolerances) for a topping tool
- Calculates the circumferential backlash area (and normal backlash area) of the gear pairing while taking into account tooth thickness allowances and center distance tolerance
- Calculates all relevant values, such as contact ratio, specific sliding, etc.
- Calculates and verifies the effective contact ratios and root circles (taking into account the tooth thickness allowances). Calculates all the most important data for the smallest center distance and greatest tooth thickness, and for the largest center distance and smallest tooth thickness
- Angles can be input as decimal numbers, with a decimal point, or as minutes and seconds
- Modules can be input either in mm or as a diametral, transverse diametral, transverse or normal pitch
- Different accuracy grade for individual gears
- The interval can be increased for permitted profile shifts
- You can also define power loss, moment of inertia and weight for all types of strength calculations (for cylindrical gears, bevel gears and 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 supplied with more than 200 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. KISSsoft also supports the use of stainless steels, aluminum, bronzes, and plastics with right Z14.

5.2 Z01a Planets, Three- and Four-Gear Train

Permits you to run these calculation modules:

- Planetary Gear Z014: Sun, planet, internal gear
- Three-Gear Train Z015: Power distribution level or position of contact (pinion, idler gear/idler gears, gear)

- Four-Gear Train Z016: dual position of contact (pinion, idler gear/idler gears I, idler gear/ gears II, gear) and double-planet configuration (sun, planet I, planet II, internal gear)

The total clearance between the sun and the planet carrier is also calculated for planetary stages (Z014). Notes that are relevant to the selected calculation method are taken into account during strength analysis. For example, the special notes included in ISO 6336 or DIN 3990 for planetary stages or for positions of contact are used when calculating the dynamic factor and the face load factor.

The 2D display (right Z05) shows the individual meshings. 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 these 3 speeds: the speed of the sun, rim, and web.

5.3 Z01b Pinion with Rack

Permits you to run this calculation module:

- Pinion with rack Z013

Input the distance from the pinion center to the lower edge of 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.

5.4 Z01x Extension for Cylindrical Gear Geometry

Extension for these calculation modules: Z011 to Z016, Z070, Z080 and Z170

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

Determine the form diameters from the tooth form
The tip and root form diameters are usually calculated according to the theoretical equations in ISO 21771. 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 that the start of the modification is displayed for toothing with profile modifications. For this reason, the transverse contact ratio displayed might be too small.

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

5.5 Z01y Asymmetrical Gears

Requirement: Rights Z02a, Z14 or Z14a

Extension for these calculation modules: Z011 to Z016

Calculates geometry and strength for asymmetrical gears (only possible according to ISO 6336, VDI 2545 and VDI 2736). A few functions, such as pre-machining, rough sizing and fine sizing, etc. are not currently available.

5.6 Z01z Individual Modifications per Tooth

Extension for these calculation modules: Z011 to Z016

Use of different modifications separately for each individual tooth. Only the geometry calculation is possible.

5.7 Z02 Strength Calculation as specified in DIN 3990

Extension for these calculation modules: Z012 to Z016

According to DIN 3990 [8] (most recent valid edition), you can also use the DIN 3990, Part 41 method for vehicle gears.

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

- Face load factors for cylindrical gear pairs according to Method C2 with graphical display of the load configurations if this is selected. Option for taking into account stiffening and the contact pattern check.
- Face load factors for planetary stages according to Method C1.
- Face load factors according to Method B, determined by the exact verification of production tooth trace deviation as the result of deformation with shaft calculation (right W10)
- Calculates the tooth flank load-bearing capacity (pitting: DIN 3990, Part 2) according to Method B.
- Calculates tooth root load capacity (DIN 3990, Part 3) according to Method B, tooth form and stress correction factor, optionally also using Method C.
- Calculates scuffing safety (DIN 3990, Part 4) with both calculation procedures (flash temperature and integral temperature criterion) according to Method B.
- Materials specified in DIN 3990, Part 5.
- Take into account the influence of grinding notches. Input the ratio t_g/ϱ_g (t_g: depth of grinding notch, ϱ_g: radius of grinding notch) according to figure in DIN 3990, Part 3, Section 4.4 or ISO 6336, Part 3, Figure 33. Calculates Y_g' (coefficient with which YS is multiplied). If pre-machining and final machining tools are input, t_g/ϱ_g is calculated automatically.

5.8 Z02a Strength Calculation as Specified in ISO 6336

Extension for these calculation modules: Z012 to Z016

The calculation according to ISO 6336 [9] 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, Right Z02.

Calculates the internal temperature and the flash temperature as specified in ISO/TR 13989-1 and ISO/TR 13989-2.

Corrigendum ISO 6336-2/Cor1:2008: You can activate the change to helix angle coefficient Zβ if required.

5.9 Z02b Strength Calculation as Specified in BV RINA

Extension for these calculation modules: Z012 to Z016

Strength Calculation of Cylindrical Gears. Special calculation method for ships' engines (primarily for France and Italy), similar to ISO 6336 but with a few additions. Special documentation is available on request.

5.10 Z02e Strength calculation according to GOST

Extension for these calculation modules: Z012 to Z016

Strength Calculation according to the Russian GOST-21354-87 guideline (latest edition, 1987).

5.11 Z02f Strength calculation according to ISO 13691

Extension for these calculation modules: Z012 to Z016

ISO 13691 is a calculation guideline for cylindrical gears. This calculation method is based on ISO 6336, in which some factors have been defined so that the calculation method can be used for high-speed gear units. This calculation method can only be used for gear pairs.

5.12 Z02x Static Strength of the Tooth Root

Requirement: Right Z02, Z02a, Z13 or Z14
Extension for these calculation modules: Z012 to Z016

Calculates the tooth root static strength of cylindrical gears:
Determination of tooth root stress according to ISO 6336 with and without stress correction factor YS. Calculates the safety against overload failure and safety against plastic deformation (yield point). The tensile strength and yield point depending on temperature are determined for metallic materials and for plastics.

5.13 Z03 Rough Sizing Cylindrical Gear

Requirement: Right Z02, Z02a, Z13 or Z14
Extension for these calculation modules: Z012, Z014

Rough sizing automatically determines the most important tooth parameters (center distance, module, number of teeth, width) from the power that is to be used and the required ratio. This is followed by optimization performed by the strength calculation program. We recommend you use the minimum safeties.

The ISO, AGMA or DIN methods can be used for strength calculation, and VDI 2545 and VDI 2736 can also be used for plastics. A list of solutions with the possible center distance, facewidth and module ranges is then output as the result. 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 any particular solution is also displayed. If the strength values are the same, the weight is an indicator of how expensive a particular solution might be.

5.14 Z04 Fine Sizing Cylindrical Gear

Extension for these calculation modules: Z012, Z014, Z015 and Z016

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 input a fixed center distance or specify an interval for the center distance.

All the variants the system finds are then output in a list, classified by different criteria (generation of vibrations, accuracy of ratio, weight, strength, variation in tooth contact stiffness etc.). Depending on your requirements, 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. 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 insert it in the basis window. You can check and refine it there. As long as the fine sizing window remains open, you can access alternative solutions at any time.

5.15 Z04a Additional Strength Calculation for All Variants

Requirement: Right Z04 and either Z02, Z02a, 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 the results 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.
A graphic in which you can vary the data that is displayed is very useful when you want to find the best possible range of solutions. All the results can also be displayed as graphics.

5.16 Z05 Tooth Form Calculation and Display

For all gear types except:

- Bevel gears: Calculates the tooth form on the basis of the virtual cylindrical gear gear teeth
- Hypoid gears: No tooth form calculation
- Crossed helical gears: 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 (reference profile, hobbing 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 axial section
- Checking the practicality of manufacture (usable involute etc.): Precise checks to see whether the gear teeth can be manufactured using the selected tool
- 2D tooth form display: Gears can be displayed either individually or as pairs: Transfer of the tooth form (of one or more teeth) and the gear view in transverse and axial section to CAD systems, if the appropriate rights such as K05a etc. are present.
- 3D gear display: Use the appropriate rights (K05u etc.) to transfer 3D solids to CAD systems or via 3D interfaces.

5.17 Z05a Input Any Cutter Form or Tooth Form

Extension for these calculation modules: Z011 to Z016, Z070, Z080, Z170 and 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, rights Z24, Z25, Z26 and Z27) and used to analyze meshing behavior and strengths.

5.18 Z05b Tooth Form Export used as Coordinates Points

Extension for these calculation modules: Z011, Z016, Z040, Z050, Z060, Z070, Z080, Z170 and Z09A
Exports the tooth form to a text file, as coordinates. You can export the production stages for the gear and tool in different sections. You can export the data using X- and Y-coordinates, X- and Y-coordinates with normal angle or with additional curvature. You can also use several other options such as Number of points or Position of tooth form.

5.19 Z05c Reference Profile Calculation for Gears with Involutes or Special Profiles

Extension for these calculation modules: Z011 to Z016, Z070, Z080, Z170 and 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 most often 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.

5.20 Z05d Calculate the Tooth Form from the Paired Gear (Generate with Other Gear in the Pair)

Extension for these calculation modules: Z012, Z013, Z014, Z015 and 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 (the other gear in the pair) and gear 2 is the gear whose tooth form is generated from gear 1 by the generating process. The tooth form from the other gear in the pair is calculated automatically in two steps:

- Step 1: Calculates the tooth form of the gear to be generated. To do this, KISSsoft calculates the generating gear (gear 1) and the tooth contour is increased accordingly by the allowance from gear 2. Gear 1 is then used as the pinion type cutter to generate gear 2. As a usable toothing always requires a certain amount of tip clearance, 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 appropriate root clearance and an optimum root rounding.
- Step 2: Calculate gear 2 without allowance (the allowance has already been taken into account in step 1) with the tool defined in step 1. This produces the effective tooth form for gear 1 and gear 2.

5.21 Z05e Addition for Mold Making

Extension for right: Z05

Calculates the tooth form, taking into account the:

- Radial strain (tooth tip and root)
- Tangential strain (tooth thickness)
- Inlay body made of steel

The contour of the spray-casting mold is taken from the contour calculated using this method.

Calculates the electrodes used to manufacture the spray-casting mold:

- Calculation as before, but also taking into account the spark gap.
- You can calculate the hobbing cutter used to manufacture the electrode with right Z05c, if required

5.22 Z05f Arc-Shaped Start of Entry Curve on the Tooth Tip

Extension for right: 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 of circle to arc of circle, so that the final arc of circle is tangential to the tip circle.

Possible tip modifications for a gear are: tip chamfer, running-in curve from arc of circle (according to H. Hirn [10]), running-in curve with progressive profile modification and tip rounding, linear profile modification, progressive profile modification. You can use coefficients to specify the curve of the tip modification. In addition, KISSsoft can use its sizing function to suggest a suitable starting point (diameter) for the entry curve and for the tip relief value. Use the profile modification calculation (right Z01x) to do this.

5.23 Z05g Optimum Tooth Root Rounding

Extension for right: Z05

The tooth root created on the basis of the selected tool may not necessarily have the best possible rounding. If the root radius 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, right 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 diameter. This is useful for specific purposes, for example, to install measuring pins 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, then size the best possible tool for this: This option must be enabled to do this. The toothing reference profile is also calculated from the tooth form (right Z05c). This profile is then used to manufacture the appropriate tool.

Checking with strength calculation: Optimized root rounding can be taken into account in the strength calculation if you select the "using graphical method" option (right Z19i) under Details in the Rating tab for tooth form factors (YF, YS). You can also size the "Modification starting at diameter" for elliptical root modifications in the Tooth form tab. The suggested value is dmod = dNf.i+0.02*mn.

5.24 Z05h Cycloid and Arc of Circle Toothings

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

The KISSsoft basic data window is where you enter cycloid and circular arc teeth (cylindrical gears), such as involute cylindrical gears. You can also select either "Cycloid" or "Circular arc teeth" as the flank shape in a tooth form calculation and enter the appropriate data to define them. 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 right Z24).

You can perform the calculations listed below with data that has been defined using these methods:

- A transmission error, a temporary transmission change, temporary power loss etc. (with right Z24)
- Lubrication gap EHD and flash temperature (with right Z30)
- Wear (with right Z31)
- Sliding velocity, specific sliding (with right Z27)
- Hertzian pressure and tooth root stresses (with right Z25)

5.25 Z05i Arc of Circle Approximation

Extension for right: Z05

Convert tooth flank into circular arcs. You can specify the degree of accuracy. As some eroding machines have problems processing a polygonal course, you can make the process easier by outputting the data with arcs of circle.

5.26 Z05j Display Collisions during Generation (Cylindrical Gears)

Extension for these calculation modules: Z012 to Z016 and right Z05

When generating two gears (in the graphical display), you can activate the collision display option. The points at which contact or a collision occurs are then highlighted with squares.

Black square: Contact (between 0.005 * module distance and 0.001 * module penetration)

Red square: Collision (greater than 0.001 * module penetration)

Collisions are identified on all the contacting teeth, and are marked accordingly. 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.

5.27 Z05k Display Collisions during Generation (Worms/Crossed Helical Gears)

Extension for this calculation module: Z170 and right Z05

Same function as right Z05j.

5.28 Z05n Straight Line Flank

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

The KISSsoft basic data window is where you enter straight line flanks (cylindrical gears), such as involute cylindrical gears. 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.

5.29 Z05o Measurement grid points for measuring topologies

Extension for these calculation modules: Z011 to Z016

Using this right, the measurement grid points for the gear flank and root can be output and used for measuring topologies. This applies for cylindrical, bevel and crossed helical gears, worms and worm wheels, and splines.

5.30 Z05q Special Functions for the Watch-Making Industry

Extension for these 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.

5.31 Z05x Animate 2D Display

Extension for right: Z05

By turning the gear step-by-step on screen, you can monitor how the gear pair is being generated, 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, crossed helical gears and worms in normal section in the graphic.

5.32 Z06 Face Gears Calculation

Permits you to run this calculation module:

- Face Gears Z060

Calculation module that calculates the geometry of face gears mated with cylindrical pinion gears. The presence of undercut and pointed teeth can be checked in the graphic in the 2D display. You can input modified tip heights to prevent the generation of pointed teeth. The 2D tooth form display can display the inside, middle and outside of the face gear at the same time. 3D view with export option (right K05u). Simulates manufacture using a pinion type cutter to calculate the tooth form.

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

5.33 Z06a Strength Calculation Based on ISO 6336/Literature

Extension for this calculation module: Z060

This calculation method is based on the approach described in the technical literature produced by the company Crown Gear [11]. The method is similar to right Z06b, but uses the shortest length of contact as the effective facewidth for calculating Hertzian pressure. The formulae used here are listed in the report.

5.34 Z06b Strength Calculation based on Crown Gear/DIN 3990

Extension for this calculation module: Z060

This calculation method returns the same results as the Crown Gear software developed by the company Crown Gear itself [11]. The method is similar to right Z06a, but always uses the shared facewidth of the pinion and the gear as the effective facewidth for calculating Hertzian pressure, even if the length of contact is shorter. The formulae used here are listed in the report.

5.35 Z06c Strength Calculation Based on ISO 10300, Method B

Extension for this calculation module: Z060

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 [12].

5.36 Z06d Strength Calculation Based on DIN 3991, Method B

Extension for this calculation module: Z060

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 DIN 3991 [13].

5.37 Z6e Static Strength

Extension for this calculation module: Z060

Calculates the static strength of face gears.

5.38 Z06f 3D Display

Extension for this calculation module: Z060

3D view of the geometry of face gears with any shaft angle and offset in the Parasolid viewer with the option of exporting data in STEP format (right K05u).

5.39 Z07 Bevel and Hypoid Gears Calculation

Permits you to run this calculation module:

- Bevel and hypoid gears Z070

Calculates 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. Calculates all dimensions necessary to create the bevel gear drawing (tip and active root diameter on the outer and inner bevel). Applies to all types of bevel gears and manufacturing process, such as Gleason, Klingelnberg and Oerlikon. The bevel gears are also shown as graphics.

Input the geometry using the reference diameter (d_{e2}) or normal module (m_{nm}) with a sizing suggestion for the profile shift and the cutter radius.

The rough sizing is a simple pre-sizing of bevel and hypoid gears. After you input the gear reduction, the helix angle, and design parameters b/mn and Re/b, the system generates a proposal that is calculated for the module, number of teeth, facewidth and external diameter.

5.40 Z07a Bevel Gears with Cyclo-Palloid and Palloid Toothing

Extension for this 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 for 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 and KNC60 with all relevant cutters, cutter radii 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 shortening on the inside diameter, transverse contact and overlap ratio, tooth form factor and stress correction factor
- Calculation of all toothing dimensions

- Calculates 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 value necessary to avoid undercut
    - Balanced sliding

5.41 Z07b Hypoid Gears with Cyclo-Palloid Toothing

Extension for this calculation module: Z070

The geometry of hypoid gears (bevel gears with offset), their ease of manufacturing, and performing a strength calculation for them according to 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 and KNC60 with all relevant cutters, cutter radii 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 shortening on the inside diameter, transverse contact and overlap ratios, tooth form factor and stress correction factor either for the driving or driven flank
- Calculation of all toothing dimensions
- Calculates 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 of suitable pressure angles on the driving and driven flank
- Sizing of the profile shift for the minimum value required to prevent undercut

5.42 Z07d Gleason Bevel Gear Toothing

Extension for this 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-compliant 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"

5.43 Z07e Strength Calculation Based on ISO 10300, Methods B and C

Extension for this calculation module: Z070

ISO 10300 enables the proof against tooth fracture and micropitting to be calculated. Scuffing safety (integral temperature criterion) is calculated according to DIN 3991. An extension to the method, to include hypoid bevel gears, is currently under discussion. A proposal according to FVA is already implemented in KISSsoft.

5.44 Z07g Strength Calculation Based on DIN 3991

Extension for this calculation module: Z070

Strength calculation as specified in DIN 3991 (virtual cylindrical gear toothing method) with proof against tooth fracture, micropitting and scuffing (integral temperature criterion).

5.45 Z07h Strength Calculation for Plastics

Extension for this calculation module: Z070

Strength calculation for plastics, for tooth root fracture and flank strength, as specified in Niemann, VDI 2545 and VDI 2736. The calculation is performed using the virtual cylindrical gear toothing method described in right Z14.

5.46 Z07i Calculation of Bevel Gear Differentials

Extension for this calculation module: Z070

Calculates bevel gear differentials and the static strength of bevel gears. The static strength of the tooth root is calculated as described in right Z02x.

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.

5.47 Z07j Strength Calculation Based on AGMA 2003

Extension for this calculation module: Z070

Calculates the strength of bevel gears on the basis of AGMA 2003.

5.48 Z07m Rough Sizing

Extension for these calculation modules: Z012, Z014, Z070, Z080 and Z170

Rough sizing proposes possible gear teeth configurations based on the data entered for the ratio and the load. The purpose of rough sizing is to determine the possible range of suitable solutions, all sized for the specified torque, according to all the specified required safeties.

5.49 Z07n Fine Sizing

Extension for these calculation modules: Z012, Z014, Z015, Z070, Z080 and Z170

In fine sizing, all possible geometry variants (module, number of teeth, etc.) are generated, documented and displayed as a graphic for the specified facewidth and center distance. For planetary gear stages, the gear rim diameter is usually set, and the center distance is varied.

5.50 Z07p 3D Display

Extension for this calculation module: Z070

3D view of geometry of bevel and hypoid gears in the Parasolid viewer with options for exporting the data in STEP format (right K05u). Straight, helical, and spiral toothed gear types are available (but not hypoid gears). The basic geometry and the tooth form are calculated according to ISO 23509. The final tooth form, along the facewidth, is defined according to the "Face milling" or "Face hobbing" manufacturing process.

5.51 Z7o Optimization of Flanks and Profile Modifications with Contact Analysis under Load

Extension for this calculation module: Z070

Contact analysis for a range of profile modification variants and partial loads. The contact analysis details are the same as those in contact analysis under load for cylindrical gear pairs (right Z32). The exact sizing of flanks and profile modifications is not only available for specific load cases, but also for a load range.

5.52 Z7s3 Sizing of Topological Modifications

Extension for this calculation module: Z070

Only sold together with engineering services performed by KISSsoft AG. Specific instructions on how to use this tool are supplied with this package.

5.53 Z08 Worm Gear Analysis

Permits you to run this calculation module:

- Worms with enveloping worm wheel Z080

Use this calculation module to size and verify worm gears (cylindrical worms or enveloping worm gears) that have a double enveloping worm wheel. Use calculation module Z170 to verify worm gears that have a cylindrical worm wheel.

- Calculates worm geometry according to ISO/TR 14521 and DIN 3975 [14]. Tooth thickness and control measurement values (base tangent length, rollers and

measurement over balls of the worm gear) as specified in DIN 3960 [15]. 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), ZK, ZN. 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.

5.54 Z08a Strength Calculation Based on DIN 3996

Extension for this calculation module: Z080

- Sizing of the facewidth, center distance, lead angle etc.
- Strength calculation as specified in DIN 3996:1998 or according to DIN 3996:2012 with: temperature, pitting, wear, tooth fracture and deflection safeties, and also efficiency.
- Calculates the starting torque under load, which can be very important if you are sizing drives.

5.55 Z08b Strength Calculation Based on ISO/TR 14521

Extension for this calculation module: Z080

Strength calculation according to ISO/ST 14521:2010 with calculation of wear, pitting, tooth fracture, temperature and deflection safety, and also efficiency.

5.56 Z08c Strength Calculation Based on AGMA 6034 and AGMA 6135

Extension for this calculation module: Z080

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

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

It also determines bending safety as defined in AGMA 6135, Annex B.

5.57 Z08n Fine Sizing for Worm Gear Pairs

Extension for this calculation module: Z080

Use the fine sizing method to find the best variants for worm gear pairs with preset, definable boundary conditions. If you input the nominal ratio, theoretical stress concentration factor, pressure angle, reference circle, center distance and number of teeth, the system calculates and displays all the possible solutions.

All the variants the system finds are then output in a list, classified by the most varied 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.

5.58 Z08p 3D Display

Extension for this calculation module: Z080

3D view of the geometry of enveloping worm wheels in the Parasolid viewer with options for exporting the data in STEP format (right K05u). The worm wheel model is generated in the simulated cutting process, which uses the best possible tool to generate the worm.

5.59 Z08s 3D Generation, Special Settings

Extension for this calculation module: Z080

This module has a range of different setting options which particularly affect how the 3D data for the worm wheel is generated. This gives you the option of modifying the simulated cutting process. For example, if you want to modify the oversize factor for the worm wheel cutter, change the angle of the milling cutter's shaft, or modify the assigned flank shape of the worm wheel cutter. Using the skin model, you can then perform a visual examination of the tooth contact when not under load.

5.60 Z09 Spline (Strength and Geometry)

Use this to run this calculation module:

- Z09A Spline (geometry and strength)

Calculation of geometry with tolerance system and strength verification using three different methods (Niemann [16], DIN 5466 or AGMA 6123).

The geometry and control measurement values of splines and hubs are calculated as specified in these standards:

- DIN 5480:2006

  Part 2 of the standard contains the nominal and test measurement values.
- DIN 5481:2019

  Right Z05h is required, to output straight line tooth flanks. All standard geometries are

  supplied in files for reading.
- DIN 5482:1973

  All standard geometries are supplied in files for reading.
- ISO 4156:1991

  All standard geometries for designing gauges are calculated according to ISO 4156,

  Amendment 1, with data for GO und NO GO gauges.
- ANSI B92.1:1992 and ANSI B92.2:1992

Lists are provided, to make selection easier. They contain recommended dimensions and all possible dimensions. The "Own Input" option can be selected to enable an unlimited number of additional dimensions to be defined. The system includes all the tolerance systems (allowances and manufacturing tolerances) listed in the standards, in full. The data includes control measurement values for "Actual" and "Effective". The "Actual" data contains the dimensions for an individual measurement (e.g. base tangent length). The "Effective" data contains the dimensions that take into account manufacturing errors when checks are performed with gauges.

5.61 Z10 Cylindrical Gear Calculation Using the FVA Method

Extension for these calculation modules: Z012 to Z016

Gear strength is calculated using the method in the gear calculation program developed by the Forschungsvereinigung Antriebstechnik (Germany). The calculation procedure follows the one described in DIN 3990. All variations are taken into account so that this calculation option returns the

same results as the FVA program. As the FVA calculation program is used as the reference program, the FVA calculation can be used as a reference if problems arise when comparing calculations performed using different programs.

5.62 Z12 Operating Backlash

Extension for these calculation modules: Z012 to Z016, Z08 and Z170

In addition to calculating the theoretical backlash (integrated in basic right Z01), the backlash after mounting and operating backlash is calculated for cylindrical gears, according to DIN 3967. When calculating the backlash after mounting, the toothing deviations and the deviation error of axis as specified in ISO 10064 or DIN 3964, and also the profile and mounting deviations, are also taken into account. The calculation for operating backlash also takes into account the differences in temperature between the gears and the housing. The effect of the swelling is also taken into consideration if plastic gears are involved. The increase in pitch error and the reduction in tip clearance due to thermal expansion is also documented.

5.63 Z13 Calculation According to AGMA Standards

Extension for these calculation modules: Z012 to Z016

Calculation using a wide range of AGMA standards:

You can use either the USA standards ANSI/AGMA 2001-B88, 2001-C95, 2001-D04 (all in US customary units) or 2101-D04 (metric units of measurement) to calculate the strength of cylindrical gears. Proposals for the dynamic and face load factors are calculated according to AGMA, but you can also enter your own factors here. Geometry factors (for tooth root and flank) are fully calculated according to ANSI/AGMA 908-B89, and the values for Pitting Resistance Power Rating, Contact Load Factor, Bending Strength Power Rating, Unit Load for Bending Strength, Service Factor and others, are output. This calculation can be used for all gear configurations, including planetary stages. However, it is worth noting that the AGMA standard does not permit the calculation of tooth root strength in internal gear pairs. Despite this, you can use right Z19j (graphical method) to perform this calculation.

The strength calculation specified in AGMA 6004-F88 can be used for open gear rims (for example, in 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 single tooth contact point). 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.

5.64 Z13b Calculation according to AGMA 6011/AGMA 6014

Extension for these calculation modules: Z012 to Z016

- Strength calculation for high-speed gear units according to AGMA 6011-I03.
- Strength calculation for large open gear rims according to AGMA 6014-A06. AGMA 6014 replaces AGMA 6004-F88.

These calculation methods can only be used for gear pairs.

5.65 Z14/Z14a Strength calculation according to VDI 2545 and VDI 2736 (Plastic gears)

Extension for these calculation modules: Z012 to Z016

Calculates the tooth root and tooth flank safeties for plastic cylindrical gears according to VDI 2545 (right Z14) or VDI 2736 (right Z14a).

The calculation methods used for plastics take special account of the different ways that these materials perform at different temperatures. The types of lubrication used here include oil, grease or dry run (no lubrication).

The calculation method defines the local temperature at the tooth flank and tooth root, and uses these values to determine the permitted loads depending on the number of load cycles. The calculation is performed for plastic/plastic and steel/plastic combinations. 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 (Victrex, Sabic, Dupont), are added on an on-going basis. The appropriate material data is based on measurements taken by the manufacturers. As no data is available for certain calculation methods, depending on the material involved, not all calculation variants can be performed.

All specific material properties are stored in text tables (material strength depending on temperature and number of load cycles).

If no S-N curve (Woehler lines) is known for the permissible Hertzian pressure, a service life calculation can be performed using the wear values if the plastic's wear properties are known. This calculation can be performed in addition to, or instead of, the tooth flank safety calculation specified in VDI 2545 or VDI 2736.

5.66 Z15 Calculating Details Used to Modify the Profile for Cylindrical Gears

Extension for these calculation modules: Z012 to Z016

Calculates points A to E along the path of contact with the appropriate 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 according to the different methods used to calculate tip relief. A proposal for the tool for generating the profile modification is calculated. Data such as the short or long modification length, tip and/or root relief, or the specified load for which the sizing is to be performed, can be included in the tooth form calculation.

5.67 Z16 Torque Sizing

Extension for these calculation modules: Z011 to Z016, Z070, Z080 and Z170

For cylindrical gears, bevel gears, crossed axis helical gears and worm gears, the maximum transmittable torque to achieve the predefined safeties 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.

5.68 Z16a Torque Sizing for Load Spectra

Extension for right: Z16

Use this right to calculate load spectra. Enter the frequency, power/torque and speed to define any load spectra. The system includes all load spectra as defined in DIN 15020 (crane construction). The calculation is performed according to ISO 6336-6:2006 [9] and is based on 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

5.69 Z17 Crossed Helical Gear Calculation

Permits you to run this calculation module:

- Crossed helical gears and precision mechanics worms Z170

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

Calculates the geometry of crossed helical gears (cylindrical gears with crossed axes) as specified by G. Niemann, [17]. The current version of this standard describes methods used to calculate and check the geometry of crossed helical 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 POM, PEEK, PEEK+30%CF and PA46 greased worm gears according to Pech [18].

5.70 Z17a Strength Calculation According to ISO 6336/Hirn

Extension for this calculation module: Z170

Strength calculation for metallic materials:

The method according to Niemann [17], combined with the ISO 6336 method [9], permits you to perform a comprehensive strength calculation for crossed helical gears (root, flank or wear resistance and also scuffing safety). Niemann's calculation of pressure ellipses takes the special geometry of crossed helical 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, such as steel/bronze, steel/aluminum and also for different steel/steel combinations. This is a simplified method, which is no longer recommended.

5.71 Z17b Strength Calculation According to Niemann/VDI 2545

Extension for this calculation module: Z170

The method defined by Niemann [17] 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 right Z14 for cylindrical gears).

5.72 Z17c Strength Calculation According to Hoechst

Extension for this calculation module: Z170

Use the strength calculation procedure defined by Hoechst [19] to calculate load coefficients and shear strength for steel/Hostaform material combinations.

5.73 Z17d Static Strength Calculation

Extension for this calculation module: Z170

Use this right 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 [20].

5.74 Z17e Strength Calculation According to VDI 2736-3

Extension for this calculation module: Z170

Use this right to calculate the root and flank safety of crossed helical gears as defined in VDI 2736-3 [20], which provides the data for a range of different plastics for the calculation.

5.75 Z17f Wear calculation according to Pech

Extension for this calculation module: Z170

With this right, the wear for worm wheels according to Pech [18] can be calculated for steel/plastic combinations (only for POM, PEEK, PEEK+30%CF and PA46).

5.76 Z17g Crossed Helical Gear with Rack

Extension for this calculation module: Z170

A pinion/rack configuration (geometry and strength) can be calculated. You can assess the contact pattern in the 3D view.
Here, rough sizing and fine sizing are not available. You cannot make corrections to the rack.

5.77 Z17h Meshing graphics with slices for crossed helical gears

Extension for this calculation module: Z170

Meshing graphics can be shown for different slices (parallel to the middle slice) for the worm/worm wheel configuration. Meshing graphics are also displayed for axis angle <>90°.

5.78 Z17n Fine Sizing for Crossed Helical Gears

Extension for this calculation module: Z170

Use the fine sizing method to find the best variants for crossed helical gear stages with preset, definable boundary conditions. If you input the nominal ratio, normal module, pressure angle, helix angle, center distance and 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 the most varied 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.

5.79 Z18 Service Life Calculation

Extension for right: 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. The service life is calculated according to ISO 6336-6:2006 [9] 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 system service life is also output for every gear in the configuration.

5.80 Z18a Service Life Calculation for Load Spectra

Extension for right: Z18

You can define any load spectra by inputting their frequency, power/torque and speed. The system includes all load spectra as defined in DIN 15020 (crane construction). The calculation is based on ISO 6336-6:2006 [9] using the Palmgren-Miner rule.

If you input the target service life, the application factor load (usually 1.0 for classic load spectra) and a load spectrum, KISSsoft calculates the resulting safeties for the tooth root and tooth flank, and also the scuffing safety for the critical element of the spectrum. It then outputs the results in a report.

5.81 Z18b/Z18br Determination of a load spectrum for gears from the measured torque curve

Extension for these calculation modules: Z012 through Z016, Z050, Z060, Z070, Z170

Use this calculation option to generate a load spectrum from a measured torque curve. An extended "simple count" method is used if all torque measuring points are positive (right Z18b). The "Rainflow" method is used for more complex torque curves with positive and negative values (in addition, right Z18br) and a load spectrum with alternating bending factors Y_M is determined to take load bending torque components into account.

5.82 Z19a Calculation with Operating Center Distance and Profile Shift According to Manufacture

Extension for these calculation modules: Z012 to Z016 and Z09A

The cylindrical gear specified in ISO 21771 or DIN 3960 is based on the calculation of the (theoretically) backlash-free toothing. This enables the total profile shift for the individual gears over the center distance to be specified. Using this right, you can enter the profile shifts independently of the center distance.

5.83 Z19b Worm Calculation with Sizing Using the Normal Module

Extension for this calculation module: Z080

The geometry of worm pairings is usually calculated with the axial module. With this right, 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.

5.84 Z19d Axis Center Distance Optimization with Respect to Balanced Sliding

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

To optimize the center distance if you have a fixed profile shift on a selected gear, the center distance for cylindrical gears is calculated in such a way as to balance out the specific sliding of the gear pair.

5.85 Z19e Represent Specific Sliding

Extension for these calculation modules: Z012 to Z016 and Z070

Progression of specific sliding (sliding speed and tangential speed) during meshing. The calculation is performed for involute cylindrical gear toothing. This shows specific sliding for the smallest center distance and greatest tooth thickness, and also 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 or for involute gears with profile modifications.

5.86 Z19g Calculation of Center Points of Planets or Idler Gears

Requirement: Right Z01a
Extension for these calculation modules: Z014 and Z015

Planets:
Calculate the center points of the planet so that the planets can be mounted.

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 gear(s) (taking into account the practical aspects of assembly).

5.87 Z19h Sizing of Deep Tooth Forms

Extension for these calculation modules: Z012 to Z016

Special reference profiles with larger addendums and dedendums are used for deep tooth forms. Use this right to size the reference profile needed to generate the required transverse contact ratio. This function is also available in the gear fine sizing function.

5.88 Z19i Calculate Tooth Form Factor Using Graphical Method

Requirement: Right Z02, Z02a, Z13 or Z14
Extension for these calculation modules: Z012 to Z016

As defined in ISO 6336 [9] or DIN 3990 [8], the tooth form is calculated, and the stress correction factor is determined, 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 tooth forms or gears with pressure angles that differ greatly from 20°). An improved approach is the one specified by Obsieger [21]. In this approach, the product of the tooth form and the stress correction factor is calculated for all the points in the entire root area, for the tooth form determined by the manufacturing process, and the maximum value is then determined. The strength calculation is then performed with this maximum value.

AGMA provides a method for calculating tooth form factor Y for external gears. No calculation methods are available for internal teeth. In this case, according to AGMA, the internal toothing can only be calculated using the graphical method (right Z19j). Here, the exact tooth form must be described, and the main values must be 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 calculates 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. This method is similar to the process specified by Obsieger. In this case, the specific point of tooth root at which the coefficient I(=Y/Kf*) is at its lowest, is defined. This point is where the greatest stress is present.

This is the recommended method, particularly for unusual tooth forms and internal teeth (for verifications according to AGMA and DIN). It is applied both in the strength calculation for metals according to ISO 6336, DIN 3990, AGMA 2001 or AGMA 2101 and for plastics according to VDI 2545 [22] or VDI 2736 [20], and also in fine sizing (right Z04a).

5.89 Z19j Profile Modifications with Grinding Worms/Dressing Wheels

Extension for these calculation modules: Z011 to Z016

The purpose of this right is to check whether an existing grinding worm with the associated dressing wheel is suitable for a newly sized toothing.

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, the system displays a second window in which you can check whether a better approximation of the theoretically optimal modification could be achieved 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.

5.90 Z19k Lubrication Gap

Requirement: Right Z02, Z02a or Z13
Extension for these calculation modules: Z012 to Z016

Use this right to determine probability of wear and scuffing and vulnerability to micropitting as defined in AGMA 925-A03 "Effect of Lubricant On Gear Surface Distress". This standard uses the meshing to

describe the conditions in the lubrication gap so that you can calculate the lubrication gap height while taking into account the flank deformation, lubricant properties, sliding velocity, and local Hertzian stress. The results can be output in a report or displayed in a graphic.

5.91 Z19l Convert Profile Shift Coefficient and Tooth Thickness Allowance

Extension for these calculation modules: Z011 to Z016, Z080, Z170 and Z09A

Use this right to convert the profile shift coefficient from the base tangent length, measurement over balls etc. and also to convert the tooth thickness allowances in the tolerance screen.

5.92 Z19m Flash Temperature Progression

Requirement: Right Z02, Z02a, Z13 or Z14
Extension for these calculation modules: Z012 to Z016 and Z070

Displays the flash temperature progression during meshing as specified in DIN 3990-4 [8].

5.93 Z19n Profile and Tooth Trace Diagrams

Extension for these calculation modules: Z011 to Z016, Z050, Z060, Z070, Z170 and Z09A

Use this right to display profile and tooth trace diagrams.

5.94 Z19v Backlash calculation from tooth form

Extension for these calculation modules: Z012 - Z016, Z170

This right enables the load-free backlash to be calculated from the tooth form, taking into account profile and tooth trace modifications. For crossed helical gears, the crossed helical gear calculation only covers worm wheels with an axial crossing angle of 90°.

5.95 Z19w Specific functions for watch manufacturing

Extension for these calculation modules: Z011 to Z016

Using this right makes it easier to use KISSsoft for applications suitable for the watch-making industry. Dry-running steel gears can be calculated. In addition, since the watch-making industry generally uses non-involute tooth forms, error messages about involute gears are not displayed. With it, gear definitions in watch manufacturing format (CH) can be loaded.

5.96 Z19p Power Skiving Check

Using this right enables you to check whether different kinds of toothing can be manufactured by power skiving.

5.97 Z22 Hardening Depth

Extension for these calculation modules: Z012 to Z016 and 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 [9], AGMA 2001 and Niemann [23] is also documented.

5.98 Z23 Calculate the Tooth Root Load Capacity of Internal Teeth with the Influence of the Ring Gear According to VDI 2737 and Calculate the Deformation of Gear Rings

Extension for these calculation modules: Z012 to Z016

VDI 2737 starts from the basic structure and basic equations detailed in DIN 3990 or ISO 6336 and provides details about 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.

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, and the radial deformation, for the conditions at the tooth contact point and in the middle between the points of contact on two neighboring planets.

5.99 Z24 Contact stiffness of the tooth pair and transmission errors

Requirement: Right Z32, Z34 or Z35
Extension for these calculation modules: Z012 to Z016, and Z070

Calculation of meshing under load, taking into account tooth deformation, and determination of the transmission error.

The contact stiffness curves for a gear pair are calculated, on the basis of the effective tooth form, taking into account tooth deformation and gear body deformation, and Hertzian flattening, and then output as a graphic, according to the literature from Weber/Banaschek [3]. The average change in stiffness (variance) is also determined. This calculation is also integrated in the Fine sizing module (Right Z04). There, the stiffness variance is output for every variant.

5.100 Z25 Graphical Representation of Hertzian Pressure and Tooth Root Stress Along Actual Tooth Form

Requirement: Rights Z32, Z34 or Z35
Extension for these calculation modules: Z012 to Z016 and Z070

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 pressure and the tooth root stress, and displays this as a graphic.

The normal force diagram and the torque on both gears are also displayed in a graphic. This graphic assumes that the bearings are arranged symmetrically on both sides, and takes into account the progression of the magnitude and direction of the force affecting the bearing (rights Z32 and Z34). In addition, the Hertzian pressure, normal force curve, and tooth root stress, can be represented on the tooth as stress distribution (rights Z32 and Z34).

5.101 Z26 Displacement Volumes for Gear Pumps

Extension for this calculation module: Z012

Calculates the displacement volume, without taking into account loss due to returns in pinched volumes (select under Settings), due to the effective tooth form. These values are then printed in a report. This calculation function is included in the fine sizing (right Z04).

5.102 Z26a Gear Pumps, Additional Right

Requirement: Right Z32 and Z01 (for straight-toothed cylindrical gear pairs)

You can use this right to perform an extremely detailed analysis for gear pumps. Calculation for external and internal gear pumps (with or without sunk key). Using this calculation, you can analyze any type of cylindrical gear with involute and non-involute teeth forms.
Changes to important pump parameters during meshing are calculated and displayed as a graphic. 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) and 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 the pump's design under input or output pressure. Enter an appropriate value to determine this. This value then has a significant influence on the torque curve.

The pinched volume depends on the pump's design, isolated (enclosed) or affected by input or output pressure due to pressure release grooves. Enter an appropriate value to determine this. This value then has a significant influence on the torque curve. When the pinched volume is reduced, you see a significant increase in pressure 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.

5.103 Z27 Kinematics Based on Actual Tooth Form

Requirement: Right Z32, Z34 or Z35
Extension for these calculation modules: Z012 to Z016 and Z070

Calculates and displays the progression of sliding velocity, specific sliding and sliding factors for any two gears. In contrast to right Z19e, this is a generally applicable calculation which takes all of the profile modifications into account.

5.104 Z29 Size and Check Master Gears

Extension for these calculation modules: Z011 to Z016, Z170

To perform a test for a 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. Once you have calculated the gear, you can start sizing the master gear. When you run this calculation, the system proposes

suitable standard master gears from DIN 3970, and checks whether an existing master gear can be used. You can also size an optimum master gear to check a test gear. This application is available for cylindrical and worm gears that have more than 6 teeth.

5.105 Z30 Micropitting (Frosting) and Flash Temperature

Requirement: Rights Z02, Z02a or Z13 and Z24, Z25, Z26
Extension for these calculation modules: Z012 to Z016

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

- ISO/TS 6336-22
- AGMA 925

Both methods are based on Blok's theory and deliver similar results. They are based on calculating meshing under load and use the local parameters for the sliding and rolling speed, Hertzian pressure, line load and bending radii. The (minimum) gap height that results from this calculation is then shown as a graphic and output.

Calculates the specific lubricant film thickness λGF as specified in ISO/TR 6336-22. The specific lubricant film thickness $\lambda GFmin$ is then shown as a graphic and output. The specific lubricant film thickness λGFP is required to determine the safety against micropitting. This is calculated if the lubricant's load stage for micropitting as specified in FVA info sheet 54/7, C-GF/8.3/90 [24] is known. The safety against micropitting is then shown as a 2D diagram (middle of the facewidth) and in a 3D diagram (path of contact and facewidth).

5.106 Z31 Wear

Requirement: Rights Z14 and Z32
Extension for these calculation modules: Z012, Z013, Z014, Z015, Z016

Tooth flank wear is the main damage criterion that affects dry-running plastic gears (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, dependent on temperature, in the polymer data file, for example Z014-100.DAT for POM. The data is input in 10-6 mm3/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.

5.107 Z31a Iterative Wear Calculation

Requirement: Rights Z14, Z32, Z31
Extension for these calculation modules: Z012, Z013, Z014, Z015, Z016

The functions are the same as in Z31, but wear is now calculated in several steps. The wear calculation iteration makes it possible to determine wear along the tooth flank more accurately. This is because more contact analysis steps are performed with the worn tooth flank.

5.108 Z32 Calculation of Contact Analysis Under Load for Cylindrical Gear Pairs

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

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.

Use right Z24 to calculate gear stiffness accurately for each particular contact point. The results match well with the much more extensive FEM verifications. If right Z24 is not available, the average tooth stiffness stated in ISO 6336 is used.

5.109 Z32a Contact analysis with asymmetrical toothing

Requirement: Right Z32

Extension for these calculation modules: Z012 to Z016

This right extends the stiffness calculation for meshing gear pairs. It now takes into account asymmetrical toothings in accordance with Langheinrich [25].

5.110 Z32b Contact analysis with conical profile shift

Requirement: Right Z32
Extension for this calculation module: Z012

The Contact analysis module can perform calculations with conical profile shift. The conical profile shift is defined according to the profile shift coefficient side I and side II on gear 1. It overwrites the profile shift coefficients in the **Basic data** tab.

5.111 Z33 Profile Modification Optimization with Contact Analysis Under Load

Requirement: Right Z32, Z34 or Z02c
Extension for these calculation modules: Z012, Z014, Z070

Calculate contact analysis for an area of profile modification variants and partial loads. The contact analysis details are the same as for the description given in right Z32. This right can be used to size flank and profile modifications accurately, not only for a specific load case, but also for a load range.

5.112 Z34 Calculation of Contact Analysis Under Load for Planetary Systems

Extension for these calculation modules: Z014

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 planet carrier transmission error and load distribution on individual planets for each cylindrical gear pair in each system (sun/planet and planet/internal gear).

Use right Z24 to calculate gear stiffness accurately for each particular contact point. The results match well with the much more extensive FEM verifications. If right Z24 is not available, the average tooth stiffness stated in ISO 6336 is used.

5.113 Z35 Calculation of Contact Analysis Under Load for Bevel Gear Pairs

Extension for this calculation module: Z070

Use this right to calculate 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 virtual 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 teeth).

5.114 Z37 Calculation of Planet Carrier Deformation with FEM

Requirement: Right Z34 or Z02c
Extension for this calculation module: Z014

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

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

Use this right to define a parametric model of the planet carrier and its load. The software then performs an automatic FEM analysis of the planet carrier deformation to determine 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 planetary system tooth geometry.

KISSsoft uses the open source Code_Aster 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 for the planet carrier.

5.115 Z38a/Z38b Tooth root stress Calculation with FEM

Extension for these calculation modules: Z012

Calculates tooth root stress using the Code_Aster FEM Solver and the Salome FEM preprocessor, both supplied along with KISSsoft. A 2D or 3D FEM model of the gear is created and analyzed (2D: right Z38a, 3D: right Z38b). The load is calculated in the 2D analysis and applied to the load direction

angle at the single tooth contact point. In a 3D analysis, the total length of path of contact and the associated load distribution from the contact analysis calculation is used. The fixed 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 on the side of the gear segment that is being analyzed. In the 2D analysis for helical gears, the equivalent spur gear is calculated and used, according to ISO 6336-3 [9].

5.116 Z39a Contact Analysis Noise Graphics Group

Requirement: Right Z32, Z34 or Z35
Extension for these calculation modules: Z012 to Z016 and to some extent Z070

This contains the following graphical contact analysis outputs:

- Meshing
- Transmission error
- Amplitude spectrum of transmission error
- Transmission error acceleration
- Speed curve
- Excitation force
- Torque curve
- Single contact stiffness
- Stiffness curve
- Amplitude spectrum of the contact stiffness
- Kinematics

5.117 Z39b Contact Analysis Efficiency Graphics Group

Requirement: Right Z32, Z34 or Z35
Extension for these calculation modules: Z012 to Z016 and to some extent Z070

This contains the following graphical contact analysis outputs:

- Overall power loss
- Specific power loss 2D/3D
- Efficiency progression
- Specific sliding along the tooth flank, gear A/B

- Heat development 2D/3D
- Heat development along the tooth flank, gear A/B
- Contact temperature 2D/3D
- Lubricant film 2D/3D
- Specific thickness of film 2D/3D

5.118 Z39c Contact Analysis Forces and Stresses Graphics Group

Requirement: Right Z32, Z34 or Z35
Extension for these calculation modules: Z012 to Z016 and to some extent Z070

This contains the following graphical contact analysis outputs:

- Contact lines on tooth flank
- Contact pattern on the tooth flank (only Z070)
- Load distribution on operating pitch circle
- Normal force curve (line load, length of path of contact) 2D/3D
- Normal force distribution on tooth (line load, length of path of contact)
- Bearing force curve
- Bearing force curve in %
- Direction of the bearing forces
- Stress curve (Hertzian pressure) 2D/3D
- Tooth root stress, gear A/B 2D/3D
- Tooth root stress over facewidth, gear A/B
- Bending stress in the root area, gear A/B 2D/3D
- Stress distribution on tooth, gear A/B

5.119 Z39d Contact Analysis Safeties Graphics Group

Requirement: Right Z32, Z34 or Z35
Extension for these calculation modules: Z012 to Z016 and to some extent Z070

This contains the following graphical contact analysis outputs:

- Safety against scuffing 2D/3D
- Safety against micropitting 2D/3D
- Safety against micropitting at the tooth
- Wear along the tooth flank, gear A/B 2D/3D
- Wear progress along the tooth flank, gear A/B
- Safety against tooth flank fracture, gear A/B 2D/3D

5.120 Z40 Non-Circular Gears

Permits you to run this calculation module:

- Non-circular gears Z040

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

- Center distance and ratio progression (momentary transmission ratio of the rotating position of Gear 1)
- 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 on "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 on-going momentary transmission ratio is displayed.

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 gear pair with the cylindrical gear calculation 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 processed here.

Restriction: Center distance > 0 (no pairs with internal toothing)

5.121 Z50 Beveloid Gears

Permits you to run this calculation module:

- ▪ Beveloid gears Z050

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 Roth [26] and Tsai [27].

5.122 Z50p 3D Display

Extension for this calculation module: Z050

3D view of geometry of beveloid gears in the Parasolid viewer with options for exporting the data in STEP format (right K05u).

6 Shafts and Bearings: W rights

6.1 W01 Shaft Basic Right

This right permits you to run this calculation module:

- Shaft calculation W010

In this module, you can input and modify geometry and material data, bearings, peripheral conditions, external forces and moments (simplified input for couplings, spur and bevel gears, worms, worm gears and belt sheaves). The graphical interface permits you to display shaft contours and bearings to scale.

Additional properties are:

- Any dimensions (cylindrical and conical), axially symmetrical cross-sections, solid and hollow shafts, beams (H-, I- and L-profiles etc.)
- Use the integrated drawing tool to make modifications to the shaft contour (diameters, lengths). You can change any of these elements simply by clicking on them with the mouse.
- List functions: The elements you input are output as a list and can be changed (inserted, deleted etc.) as required.
- You can enter any values for forces and moments in any spatial position:
    - Cylindrical gear
    - Bevel gear
    - Worm
    - Worm wheel
    - Coupling/motor
    - Rope or belt sheave
    - Single 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
    - Applied forces, including forces applied outside of the shaft
    - Alternative values for power or torque
- Statically undefined bearings

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

6.2 W01a Input data for Several Shafts

Use this to input and calculate several coaxial shafts. You can link the shafts with rolling bearings, plain bearings or general connections.

6.3 W01b Bearing Offset, Bearing Tilting, Bearing Clearance

Use this right to input values for bearing offset, bearing tilting and bearing clearance, and take them into account in the calculation. For rolling bearings, where applicable, you can input radial clearance based on ISO 5753-1:2009, or as an absolute value. You can input radial clearance as an absolute value for plain bearings. You can specify clearance for all six degrees of freedom in Cartesian space for general bearings. For rolling bearings, you can also specify an initial offset and a tilting of the external ring.

6.4 W01c Take Contact Angle into Account

Use this right to take the bearing contact angle into account in the calculation. In this case, the bearing force from the average pressure point is moved to the bearing center, along the line of action. An equivalent bending moment is then effective at the bearing.

6.5 W1f Shaft - Rough Sizing

Use this to automatically perform a rough sizing for shafts, based on equivalent stress. You can also automatically size the rolling bearing in the same step.

6.6 W01s Load Spectra

Use this right to define and then take into account user-defined or standardized load spectra. When used together with right W05, you can calculate the bearing service life. When used together with W06s, you can calculate the strength.

6.7 W03 Calculation of Deflection and Bearing Forces

Use this right to perform the following calculations:

- Calculate the diagrams of bending, course of transverse force, and torque diagram, in the X-Y and Z-Y plane (shaft axes are always calculated 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
- Calculate forces and moments in bearings for any number and type of bearings
- Calculate the inclination of the diagrams of bending in bearings, e.g. when calculating cylindrical roller bearings
- If you input a shaft with load spectra, you can also calculate the diagrams of bending individually for the load on each load bin (right W01s)
- Calculate all stress components (tension/compression, bending, shearing, torsion) and equivalent stress. Display the progression of equivalent stress and also the stress components

- Calculate deflection, with or without taking into account deformation due to shearing (right W03a)

6.8 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 factor for that purpose. However, there is only one shear correction factor for the shaft system.

6.9 W03b Nonlinear Shaft Calculation

Calculation with a geometric non-linear beam model. A shaft calculation with two fixed bearings under shearing force then also supplies the axial force due to elongation along the length, for example. If you use a non-linear shaft model in the calculation, you must take deformation due to shearing (right W03a) into account.

6.10 W03c Thermal Expansion

Input the temperature and heat expansion coefficient to predefine the axial thermal expansion for shafts and housings. An even temperature distribution is assumed.

6.11 W03d Non-Linear Stiffness

Use this right to take non-linear stiffness into account for most rolling bearing types. The calculation is performed according to ISO/TS 16281 (DIN ISO 281 Supplement 4). If the internal geometry data in the rolling bearing database is present and plausible, this data is used in the calculation. If not, these values are approximated from the load numbers. This calculation option returns a modified deflection and load distribution on the bearing, but no other results (see rights W05b and W05c).

6.12 W04 Calculation of the Critical Speed

Calculates any number of eigenfrequencies in coaxially arranged shaft systems while taking into account bending, torsional and axial vibrations. Gears can automatically be handled like masses. You can also enter additional masses if required. Links between axial and bending vibrations are taken into account for suitable rolling bearing types with a known internal geometry.

6.13 W04x Gyroscopic Effect

Extension for right: W04

Use this right to calculate eigenfrequencies while also taking into account the gyroscopic effect of large spinning masses for the predefined speed. The critical frequencies are calculated for the forward and backward whirl.

6.14 W05 Service Life of Ball Bearings and Roller Bearings

You can select one of these calculations:

- Deep groove ball bearing (single row, double row)
- Double row self-aligning ball bearing
- Angular contact ball bearing (single row, in pairs)
- Four-point contact bearing
- Angular contact thrust ball bearings (one-sided and double direction)
- Deep groove thrust ball bearings, (one-sided and double direction)
- Radial cylindrical roller bearing (single row, double row)
- Radial cylindrical roller bearing full complement (single row, double row)
- Cylindrical roller thrust bearings
- Axial angular contact roller bearing
- Needle roller bearing with/without internal ring
- Needle cage
- Thrust needle cages
- Taper roller bearing (single row, paired (X, TDI) or (O, TDO))
- Barrel-shaped bearings
- Double row self-aligning roller bearing
- Axial spherical roller bearings

Most bearing data from a variety of different manufacturers is available directly in the database. You can also use the database tool to define your own bearings. The calculation can take both radial and axial forces into account. You can also use this right to define the service life and static safety factor, and to check the bearing's speed limit (oil and grease lubrication).

6.15 W05a Bearing Load Spectra

Calculate the service life as specified in ISO 281 for any load spectra. The extended service life and the operating speed thermal limit, as specified in DIN 15312 and DIN 732, can be calculated from the heat level of the rolling bearing.

6.16 W05b Reference Service Life According to ISO/TS 16281

Extension for right: W03d

Use right W05b in bearing calculations to calculate and output the reference service life according to 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 right W05a, you can also calculate the modified reference service life. At present, the internal geometry calculation is implemented for:

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

6.17 W05c Load Distribution in the Bearing

Extension for rights: W03d and W05b

Use this right to calculate the pressure on individual rolling bodies according to ISO/TS 16281.

6.18 W05d Link to external interfaces for stiffness and reference rating life calculations

Extension for these rights: W03d and W05b
This right enables external interfaces to be used, with which, similar to ISO/TS 16281, the non-linear stiffness of rolling bearings can be taken into consideration. Provided that a suitable interface also enables the reference rating life to be calculated, this function can also be used, with this right (provided W05b is assigned too).

6.19 W06 Perform Endurance Limit and Static Calculation for Cross-Sections

Use this right to verify the strength (static and endurance) at any cross-section. The following values can be taken into account as notch factors:

- Smooth shaft
- Shoulder
- Shoulder with relief groove
- Conical shoulder
- Interference fit
- Key
- Spline
- Straight-sided splines
- Square groove
- Circumferential groove
- V-notch
- Thread
- Cross hole

You can also define your own notch factors and enter surface roughness with qualities according to ISO 1302, to include surfaces and heat treatment in the calculation.

6.20 W06a Hänchen and Decker Calculation Method

The strength calculation described in Hänchen and Decker [28] is a very tried and tested, but no longer very up-to-date, calculation method for verifying the strength of shafts (accepted by TÜV).

6.21 W06b Calculation Method DIN 743

The method described in DIN 743:2012 for calculating the load capacity of shafts and axles is similar to the calculation according to the FKM Guideline in that it determines the strength for shafts and axles with a safety verification against plastic deformation and failure due to fatigue. The strains that occur here (under average and deflection stress) are evaluated on the basis of a simplified Smith diagram.

6.22 W06c Calculation Method in the FKM Guideline

Use this to calculate static strength and fatigue strength as defined in the FKM Guideline [1].

6.23 W06d Calculation method AGMA 6101/6001

Enables the safety against fracture and fatigue to be calculated for shafts and axes, according to AGMA 6101-F19/AGMA 6001-F19.

6.24 W06s Strength Calculation with load Spectra

Extension for rights: W06b and W06c

This strength calculation also takes load spectra into account.

6.25 W06t Rotational degrees of freedom in load spectra

Extension for these rights: W01s

This right enables the rotational degree of freedom of general and connecting bearings to be configured, on a load-case-specific basis, as well as their power and temperature data.

6.26 W07a Calculation According to Niemann

Use this right to calculate the power loss, oil flow, oil warming and minimum lubrication gap size according to G. Niemann [16] and O. R. Lang [29]. This calculation can only be used for pressure-lubricated bearings (circulatory lubrication) when the service reliability is also tested.

6.27 W07b Calculation According to ISO 7902

Complete calculation according to ISO 7902 [30] for pressure-free lubricated and pressure-lubricated bearings. This takes into account the way in which lubricant is applied (lubrication holes, lubrication groove, lubrication glands). All operating data, such as operating temperature, minimum lubrication gap width, power loss, oil flow etc., is calculated according to ISO 7902. Service reliability is checked, and the spring constant (radial stiffness) of the bearing at the point of operation are also calculated. This value can then be included in the shaft calculation.

6.28 W07d Calculation According to ISO 31657

Calculation according to DIN 31657 [31]:
Complete calculation according to DIN 31657:1996 Parts 1 to 4, for pressure-lubricated plain hydrodynamic bearings with high circumferential speeds. Two types of bearing are described in this standard: multi-lobed plain bearings and tilting pad plain bearings. All operating data, such as operating temperature, minimum lubrication gap width, lubricating film pressure, oil flow etc. are calculated according to DIN 31657. Service reliability is checked and the spring constant (radial stiffness) of the bearing at the point of operation are also calculated. This value can then be included in the shaft calculation.

6.29 W07e Calculation According to DIN 31652

Calculation according to DIN 31652 [32]:
Complete calculation for pressure-free lubricated and pressure-lubricated bearings. This takes into account the way in which lubricant is applied (lubrication holes, lubrication groove, lubrication glands). All operating data, such as operating temperature, minimum lubrication gap width, power loss, oil flow etc., is calculated according to DIN 31652. Service reliability is checked and the spring constants (radial stiffness) of the bearing at the point of operation are also calculated. This value can then be included in the shaft calculation.

6.30 W07 Hydro-Dynamic Plain Journal Bearings

Calculates hydro-dynamic plain journal 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).

6.31 W07c Hydrodynamic Plain Thrust Bearing

Calculates 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 [33]:
  Complete calculation of pad thrust bearings for pressure-less and pressure lubricated bearings. All operating data, such as operating temperature, minimum lubrication gap width, power loss, oil flow etc. are calculated according to DIN 31653.
- ▪ Calculation according to DIN 31654 [34]:
  Complete calculation of tilting pad thrust bearings for pressure-less and pressure lubricated bearings. This takes into account the way in which lubricant is applied (lubrication holes, lubrication groove, lubrication glands). All operating data, such as operating temperature, minimum lubrication gap width, power loss, oil flow etc. are calculated according to DIN 31654.

6.32 W08 Grease-Lubricated Plain Journal 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.

6.33 W10 Tooth trace Modification

Displacement in the axial direction is determined by moving a cross-section point from its home position in the axial direction, due to torsion and deflection. For various purposes, for example, for grinding off flankline crowning (also called length modification or tooth trace modification) on toothing, it is important to know how much a specific point in the shaft cross-section moves in a particular direction due to elastic deformation. This right calculates the displacement at definable intervals along the axis. The tooth trace deviation due to deformation is also calculated for toothing. This value is needed for a precise face gear calculation.

6.34 W12 Shaft Sizing

The system has two functions which you can use to size shafts:

- Sizing for strength: The KISSsoft system sizes 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.

6.35 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 value is usually relevant. You must specify the loads for this calculation.

6.36 W14 Forced Vibrations

Calculates forced vibrations in shafts 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 errors 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 domain, 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.

6.37 W51 Verification of Rolling Bearings According to ISO/TS 16281

Used to verify rolling bearings according to ISO/TS 16281. The bearing rings can also be taken into account as elastic rings, and also with tilting.

6.38 W51a Rolling Bearing Fine Sizing

You can use variation calculations to optimize the internal geometry of bearings.

7 Connections: M rights

7.1 M01a Cylindrical Interference Fit

Use this right to calculate cylindrical interference fits and gear rim thicknesses influenced by centrifugal force. You can define multiple interference fits in which the occurring forces (from outside to inside) are passed onto the next internal ring. You can then verify the innermost interference fit.

You can select these calculations:

- Loads in circumferential and axial directions.
- Calculate the maximum torque for a non-slipping fit. If slip occurs in the fit, micro gliding will cause corrosion due to friction.
- This calculation includes the entire DIN 7190-1:2017 standard (elastic range) with longitudinal, radial and oil interference fits.
- Verifies an elastic-plastic loaded interference fit as specified in DIN 7190-1:2017 with predefined interference (stresses and elongations are only calculated for the purely elastic case).

The stress curves (equivalent, tangential and radial stresses) can be displayed in a graphic. Tolerance fields with allowances can be displayed in a second graphic, taking into account the temperature and centrifugal force, with or without considering the pressure.

The stresses (radial and tangential stress) are calculated according to the theory of "ring-shaped slices with constant thickness", as described in [35]. You must also calculate the safety of the interference fit against slipping and the safety of the shaft and hub material against the breaking and yield point. To make entering these values easier, the tolerances system according to DIN EN ISO 286-1:2010 has been integrated (e.g. with an input diameter of 60 H7/f6).

7.2 M01b Conical Interference Fits

Uses the calculation methods for conical interference fits (conical interference fit connection) according to Kollmann 1984 or DIN 7190-2:2017.

Use this right to calculate and size a conical interference fit connection for transferring torque in an elastic working state. You can mount the interference fit connection either by axial clamping using a bolt (Kollmann) or by pressing it 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 pressing distance and pretension force for joints, and in operation under maximum torque, is also calculated.

The calculation method according to DIN 7190-2:2017 can also be used for connections with a hollow shaft. In this method, the sliding moment, joining force and axial force during operation are defined. In addition, the equivalent stresses for joints are determined for the specified joining pressure.

Possible sizing functions:

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

During verification according to Kollmann, you can also select:

- the pressing distance for mounting or mounting pressing force

7.3 M01x Enhanced Calculation for Interference Fit

Extension for rights M01 and M01b

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 on the basis of the required safety against sliding and the permitted material stress. Input the surface roughness with qualities according to DIN EN ISO 1302:2002.

When you calculate cylindrical and taper interference fits, the hub's external diameter can vary. In such cases, input the external diameter with the diameter and length, section by section. KISSsoft then derives an equivalent diameter from these values (as specified by Gross 1996) and includes it in the calculation.

7.4 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 according to Roloff/Matek [36]. Bending is determined according to Decker 2000.

7.5 M02a Key

Select the key geometry from the standards:

- DIN 6885.1:1968 Standard
- DIN 6885.1:1968 Form G, H, J
- DIN 6885.2:2012
- DIN 6885.3:1956
- ANSI B17.1:1967 Square
- ANSI B17.1:1967 Rectangular
- Own input

Use this right to perform a calculation according to calculation method DIN 6892 Method B or Method C.

In DIN 6892:2012 Method C, a calculation is performed using the load on the shaft, on the hub (surface pressure) and the key (shearing) with the definition of the safeties. 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, contact coefficient and application factor. The shaft and hub, with the key, can then be displayed to scale in a graphic.

The key calculation method described in DIN 6892:2012 Method B has a very different approach for calculating duration and peak load for the key. The calculation standard takes into account the fact that an interference fit will be present at the same time.

In a subscreen, you can also enter the chamfer for the shaft and the hub, the smallest and largest external diameter for the hub, the width for the external diameter, the distance, torque curve and frequency of change of load direction.

Possible sizing functions:

- Determine the load bearing length of the shaft or hub on the basis of required safety
- Determine the transmissible torque

7.6 M02b Straight-Sided Splines/Multi-Groove Profiles

The calculation is for straight-sided splines/multi-groove profiles as defined in:

- DIN ISO 14:1986 (Light series)

- DIN ISO 14:1986 (Medium series)
- DIN 5464:2010 (Vehicles, heavy series)
- DIN 5471:1974 (Machine tools, with 4 keys)
- DIN 5472:1980 (Machine tools, with 6 keys)
- Own Input

A calculation is performed to find the load placed on the shaft and hub (surface pressure). You can also add additional standards. The load placed on the shaft and hub (surface pressure) is calculated, and the safeties are determined, as described in Niemann [16]. The connection can be displayed to scale in a graphic.

Sizing functions:

- Determine the load bearing length of the shaft or hub on the basis of required safety
- Determine the transmissible torque

7.7 M02c Spline

Use this right to perform the following calculations for splines:

- DIN 5480:1991
- DIN 5480:2006
- DIN 5481:2018
- DIN 5482:1973
- ISO 4156:2005
- ANSI B92.1:1996
- ANSI B92.2:1989
- Own Input

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. You can use gear calculation right Z09a to calculate the manufacturing mass and the tolerances. The load placed on the shaft and hub (surface pressure) is calculated, and the safeties are determined, as described in Niemann [16].

Sizing functions:

- Determine the load bearing length of the shaft or hub on the basis of required safety
- Determine the transmissible torque

7.8 M02d Polygon

This calculation is for polygon shafts as specified in:

- DIN 32711-1:2009 (P3G profile)
- DIN 32712-1:2009 (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 load placed on the shaft and hub (surface pressure) is calculated, and the safeties are determined, either according to DIN standards 32711-2:2009 (for P3G profiles) or DIN 32712-2:2009 (for P4C profiles) or as described in Niemann [16].

The connection can be displayed to scale in a graphic according to the DIN standards.

Sizing functions:

- Determine the load bearing length of the shaft or hub on the basis of required safety
- Determine the transmissible torque

7.9 M02e Woodruff Key

Use this right to perform the calculation for Woodruff keys as specified in:

- DIN 6888:1956, series A (high pinion groove)
- DIN 6888:1956, 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 load placed on the shaft and hub (surface pressure) is calculated, and the safeties are determined, as described in classic technical literature, see [16].

Sizing function:

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

7.10 M03a Bolt Calculation

Bolt/pin connections are split into five calculations types, according to the application case:

- 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 load placed on the bolts, shaft and hub (or part), together with determining the safeties, is calculated as described in classic technical literature Niemann, 2005, with the exception of bolts that are in a circular layout.

You can therefore select solid pins/bolts, grooved dowel pins or spiral pins, as specified in DIN EN ISO 8748:2007, DIN EN ISO 8750:2007 or DIN EN ISO 8751:2007 and locking pins as specified in DIN EN ISO 8752:2009 or DIN EN ISO 13337:2009, as required.

7.11 M04 Bolt Calculation

The calculation permits you to use the full scope of VDI 2230 Sheet 1, 2015 edition and to perform calculation using FE results according to VDI 2230 Sheet 2 (2014). The examples in VDI 2230 Sheet 1 can be calculated together with right M04a. Tables for all the elements affected are integrated in the system, for example, bolts as defined in:

- DIN EN ISO 4762:2004
- DIN EN ISO 7984:2009
- DIN EN ISO 4014:2011
- DIN EN ISO 4017:2011
- DIN EN ISO 1207:1994
- DIN EN ISO 8765:2001
- DIN EN ISO 8766:2001
- DIN EN 1662:1998
- DIN EN 1665:1998
- ASME 18.2.1:1996
- Own Input

The standards for holes, washers, nuts etc. are also stored in the database. You can also define your own bolts with up to 9 sections, and also hollow bolts. You can define plates, bushes, annulus segments or prismatic bodies as clamped elements. The software can also generate suggested values for the reference diameter and the thread length. The default pretension force is sized to 90% of the yield point, but can be modified as necessary. You can also perform calculations with a predefined tightening 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 bolt geometry, tension diagram and the pretension force/tightening torque ratio can be shown as a graphic on screen.

7.12 M04a Eccentric Clamping and Load

Requirement: Right M04

Use this right to take eccentric loading and clamping into account and also to check the interface for gaping. You can also select other bolted joint configurations with axial, transverse and bending moment loads, and also calculate the 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 Sheet 1) calculate the stripping strength of bolt and nut threads while taking into account the nut expansion and plastic deformation.

7.13 M04b Bolt Calculation with Influence of Temperature

Requirement: Right M04

Use this right to calculate bolted joints for operating temperatures between –200 °C and +1000 °C as described by Wiegand, Kloos and Thomala 1988, using the calculation guideline specified in VDI 2230. You can specify different temperatures for bolts and clamped parts (connecting solids). You can also take into account the temperature-dependent changes to the Young's modulus, the thermal expansion coefficients, the yield point and 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 sheet 1: pretension force, bolt load, fatigue life, and surface pressure).

7.14 M08 Welded Joints

Calculation basis: DIN 18800, Part 1, November 1990 Edition, especially Section 8.4. Calculation and sizing of welded joints (joints produced 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

You can enter values for loads (normal force, shearing forces). The part safety coefficient and boundary safety coefficient are defined according to the configuration you select. The material data is embedded in the KISSsoft database. The stresses, weld seam boundary stress and safety are calculated as the results.

7.15 M09a Glued and Soldered Joints

Glued and soldered joints, which are subject to shear, are calculated as defined in G. Niemann 1981. Two different load cases are possible here:

- Shearing force: Transmission of shearing force between two surfaces
- Torque: Shaft-hub connection with a torque load

The joint can be either subject to static or dynamic (usually pulsating) load.

You can select adhesives (expandable database) that harden at room temperature or at higher temperatures. You can select the following materials for soldered joints:

- Soft solder LSn40 or LSn60 for a temporary load
- Soft solder LSn40 for a permanent load
- Brass solder: Steel NE heavy metals
- German silver solder
- Copper: Steel
- Silver solder: Steel NE heavy metals

Sizing options:

- Size the adhesion width/solder width (for shaft/hub), or the adhesion length/solder 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 of the shaft under pulsating stress.
- Size the adhesion width/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.

7.16 M05 Snap Ring

This calculation method is based on the Seeger-Orbis catalog. Shaft rings and bore rings are treated separately. Sharp-cornered abutments or components with chamfers (a corner distance/radius) can

be specified for them.

The following calculations can be used both for shaft rings and for bore rings:

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

You can also calculate the following for shaft rings:

- shaft detaching speed, ring retaining force

These sizing functions are available here:

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

7.17 M06 Hirth coupling

This calculation method is extended from the manual published by Voith. It calculates the tooth geometry, loads and safety factors. You can select an existing design from the Voith manual or select "Own input" to enter your own geometry.

8 Springs: F rights

8.1 F01 Calculation of Compression Springs

Cylindrical compression springs are calculated as specified in DIN EN 13906-1:2013.

This right includes the sizing and verification of compression springs, using default values for spring forces and mounting distances. The tolerances and main dimensions specified in DIN 2076:1984 (withdrawn), DIN 2077:1979 (withdrawn), DIN 2096:1981, DIN EN 15800:2009, DIN EN 10270-1:2017, DIN EN 10270-2:2012, DIN EN 10270-3:2012 and DIN EN 10218:2012 are included.

The database includes the most important spring materials and spring geometries specified in DIN 2098 Sheet 1 (withdrawn).
The spring characteristic line, relaxation, the time-based curve of relaxation, the time-based curve of spring force and the Goodman diagram for dynamically stressed springs can be displayed in graphics.

8.2 F06 Calculation of Conical Compression Springs

The calculation for conical compression springs is performed according to Meissner, Schorcht 2007. Tolerances and materials, and also relaxation, are calculated according to DIN EN 13906-1:2013.

This right includes the sizing and verification of conical compression springs, using default values for spring forces and assembly dimensions. The tolerances and main dimensions specified in DIN 2076:1984 (withdrawn), DIN 2077:1979 (withdrawn), DIN 2096:1981, DIN EN 15800:2009, DIN EN 10270-1:2017, DIN EN 10270-2:2012, DIN EN 10270-3:2012 and DIN EN 10218:2012 are included.
The database includes the important spring materials.
The spring characteristic line, relaxation, the time-based curve of relaxation, the time-based curve of spring force and the Goodman diagram for dynamically stressed springs can be displayed in graphics.

8.3 F02 Calculation for Tension Springs

Cylindrical tension springs are calculated as specified in DIN EN 13906-2.

This right includes the sizing and verification of tension springs, using default values for spring forces and mounting distances. Tolerances, main dimensions and eyes are calculated according to DIN 2076:1984 (withdrawn), 2077:1979 (withdrawn), DIN 2096:1981, DIN 2097:1973, DIN 2194:2002 and DIN EN 10270-1:2017.
The database includes the important spring materials and also the wire diameter according to DIN

2076:1984 (withdrawn), 2077:1979 (withdrawn), DIN EN 10270-1:2017, DIN EN 10270-2:2012, DIN EN 10270-3:2012 and DIN EN 10218:2012.

The spring characteristic line and the Goodman diagram for dynamically loaded springs can be displayed as graphics.

8.4 F03 Calculation for Leg Springs

Cylindrical turn springs are calculated as specified in DIN EN 13906-3.

This right includes the sizing and verification of leg springs, using default values for spring forces and mounting distances. The stored tolerances are according to DIN 2076:1984 (withdrawn), DIN 2077:1979 (withdrawn), DIN 2194:2002 and DIN EN 10270-1:2017.

The database includes the important spring materials and also the wire diameter according to DIN 2076:1984 (withdrawn), 2077:1979 (withdrawn), DIN EN 10270-1:2017, DIN EN 10270-2:2012, DIN EN 10270-3:2012 and DIN EN 10218:2012.

The spring characteristic line can be displayed in a graphic. The leg can either be clamped in a fixed position, supported, tangential or bent.

8.5 F04 Calculation of Disc Springs

Disc springs and spring packets are calculated as specified in DIN EN 16984:2017.

This right includes functions for sizing and verifying disc springs, using default values for spring forces and mounting distances.
The database contains material property values and dimensions according to DIN EN 16983:2017.
The spring characteristic line and the Goodman diagram can be displayed as graphics.

8.6 F05 Calculation for Torsion-Bar Springs

Torsion-bar springs with a round cross-section are calculated according to DIN 2091:1981.

This right includes the sizing and verification of torsion-bar springs, using default values for spring forces and assembly dimensions.
It includes material properties as specified in DIN EN 10089:2003 and the main dimensions as defined in DIN 2091:1981.

The spring characteristic line can be displayed as a graphic.

9 Belt and chain drives: Z rights

9.1 Z90 V-Belts

Fully automated calculation with provision of standard V-belt lengths and standard effective diameters. Determines 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 in text files whose names indicate their purpose. These contain the data from technical catalogs produced by the relevant manufacturer (e.g. Fenner). The belt tension is determined by a belt-bending test. This calculates the end of rope force and axle load at standstill and in operation, to determine optimum settings and also for making settings according to data in catalogs.

V-belt profiles:

- SPZ, SPA, SPB, SPC
- XPZ, XPA, XPB, XPC
- 3V/9N, 5V/15N, 8V/25N
- 3V/9J, 5V/15J, 8V/25J
- Dayco RPP (Panther)
- Other profiles on request

The rough dimensioning included in this right generates a proposal for V-belts that would suit your particular drive problem.

Other sizing options:

- number of belts
- belt length from center distance and vice versa

As a variant, the calculation can also be performed with a third pulley (tensioning pulley). You can input the pulley position by moving it with the mouse in a graphic. This pulley can be positioned outside or inside as required. The changed length of loop is then taken into account in the subsequent calculation.

9.2 Z91 Toothed Belts

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. The required belt width is calculated and takes into account the correction factors, the minimum

number of teeth, and the number of meshing teeth. You can also print out assembly details (belt tension test) in the report. The data for each type of belt is saved to text files, whose names indicate their purpose, and 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 (DAYCO brand, 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

The rough dimensioning included in this right generates a proposal for toothed belts that would suit your particular drive problem.

Other sizing options:

- Belt width
- Number of teeth on belt from center distance and vice versa

You can also perform calculations for special stress-resistant toothed belts with integrated steel ropes (e.g. AT5).

You can also include a tensioning pulley in the same way as in right Z90 for V-belts.

9.3 Z92 Chain Drives

The calculation of chain drives with roller chains is performed according to DIN ISO 606:2012, using standardized roller chains from the database. The chain geometry (center distance, number of chain elements) for single and multiple chains, and the transmittable power, radial forces and variation in speed, are calculated using the polygon effect, etc.

The calculations are based on DIN ISO 10823: 2006, [37] and [16]. The permitted maximum speed is also checked and a proposal is output for the required lubrication. In the same way as in V-belt right

Z90, you can add a third gear (tensioning pulley) to the graphic displayed on screen, and include it in the calculation.

Possible sizings:

- Using the drive data as a starting point, the program displays a list of suggested values for suitable chain drives
- Calculates the chain length from the center distance and vice versa
- Inside/outside tensioning pulley with graphical positioning (by moving it with the mouse)

10 Automotive: A rights

10.1 A10 Synchronization

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

10.2 A20 Friction Clutches

Use this right to calculate friction clutches and brakes according to VDI 2241 sheet 1:1982 and VDI 2241 sheet 2:1984. It includes the sizing and calculation of friction clutches by specifying moments of inertia, torques and speed.

These results can also be displayed as graphics:

- Speed curve at sliding time t_3
- Torque diagram at sliding time t_3
- Curve for coefficient of sliding friction for the sliding velocity at average radius r_m (if defined)

11 KISSsys: K11 rights

11.1 Overview

In KISSsys system, you can create a machine elements system. You can then calculate the power flow for this system, and manage the links between the various different elements in it. 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. This ensures that you always have an overview of the strength and service life of all of the elements in your design.

11.2 K11 KISSsys GPK

Requirement: appropriate KISSsoft rights

This right permits you to use KISSsys without administrator rights. You can open existing models and perform all the calculations, but only if the appropriate rights for the KISSsoft calculations are present. You can perform all the functions in the model. However, you cannot make changes to the model tree structure or to existing functions.

11.3 K11a KISSsys Administrator

Extension for these rights: K11 and K11c

This right permits you to use KISSsys in administrator mode and so make changes to the KISSsys model tree structure and generate a new structure if required. You can add in any of the elements. You can also use the Classcad interpreter language to generate, modify and run your own functions.

11.4 K11e Eclipse Debug Classes

Use this right to enable communications between KISSsys and the Eclipse debugger. Eclipse uses the Classcad interpreter language to create, modify, and most importantly, debug user code. You can view the entire model tree structure, with all of its elements and associated variables and functions, if it is successfully integrated in Eclipse. You can then search the entire model and the entire library for individual functions or words. You can also use breakpoints to check the generated Classcad code step by step for errors, after you call a function in KISSsys.

11.5 K11f Industrial Gear Unit Variant Generator

This is a special KISSsys model with enhanced functionality. If you input the range for the number of stages, the gear-set ratio steps, the overall transmission ratio and the output torque, this model can automatically generate entire gearing solutions. It can size the gear stages, shafts and bearings. The relevant KISSsoft files for all the variants generated by this model are stored in the project folder, and can be imported into the overall KISSsys system for further investigation.

The gear units sized by this model are typical industrial gear units. You can define the following stages as the first gear stage:

- Cylindrical gear stage
- Bevel gear stage
- Worm gear stage
- Crossed helical gear stage
- Planetary stage

Only cylindrical gears are taken into account when you generate the other stages.

11.6 K11h Efficiency Calculation

Extension for right: K11

You can use the efficiency calculation functions in KISSsys to calculate the heat level in a particular gearbox. A number of different methods have been implemented in it. You can decide which calculation to use, according to ISO/ST 14179, 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 loss 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 ISO/TR 14179) and drag friction are considered for bearings, and seal friction is considered for seals. For example, to calculate losses due to churning, the standard provides a solution for cylindrical gears that has been 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 particular caution, because the calculation methods used may not fully support the type of geometry.

11.7 K11i1 Modal Analysis

Extension for right: K11, K11a, K11c

Use this right to perform dynamic analyses in entire shaft systems and to run a modal analysis on a complete KISSsys model. You can select options for purely torsional vibrations, linked torsional, axial or bending 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. The amplitudes of the eigenmodes are standardized at 1.

In each case, the method in the transfer matrix is used in the calculation. Different models for calculating contact stiffness are available: according to ISO 6336, contact analysis (if the required license is present), infinite stiffness, and zero stiffness.

11.8 K11i2 Campbell Diagram

Extension for rights: K11, K11a, K11c

Calculates the Campbell diagram when performing dynamic analyses in complete shaft systems. The shaft system's eigenfrequencies are calculated for an operating speed range on one of the shafts. The results are output together with the shaft's excitation frequencies and the toothing as a plot, a report and in a table.

11.9 K11i3 Forced Vibrations

Extension for rights: K11, K11a, K11c

Calculates forced vibrations when you perform dynamic analyses in complete shaft systems. This right calculates how the shaft system behaves when subjected to dynamic excitation. The dynamic excitation of concentrated unbalance masses is used to dynamically excite the system. The dynamic excitation of gears (caused by transmission errors 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 domain, and the final result is determined using the maximum value for this superposition. Transient phenomena are not taken into account.

11.10 K11j Take Into Account Housing Deformation

Extension for rights: k11, K11a and k11c

As gear units become ever more powerful, but ever smaller in size, it is increasingly important that

housing stiffness is taken into account in gear unit calculations. Use this right to perform KISSsys static calculations, including housing stiffness. This is achieved by using the reduced stiffness matrix of an FEM model of the housing, with the nodes at the center of support bearings representing the master nodes. The "classic" method can then be used to include the bearing in the calculation, but without taking clearance into account. The resulting bearing offset has a direct effect on all subsequent calculations.

11.11 K11k Export Model Data

Use this right to export the data from any KISSsys model into XML format. The input data and the kinematics of the model are exported together with different calculation results (e.g. bearing stiffness, meshing stiffness etc.).

11.12 K11k1 MSC Interface

Use this right to export a model's geometry data to MSC Adams Gear AT, in a readable format. It exports the system data, information about bearings, shaft geometries, connections, loads and gear geometries, along with their modifications.

11.13 K11k6 GEMS Interface

Use this right to import a bevel gear stage's geometry from GEMS to KISSsys. KISSsys can then use the defined loads to calculate the bevel gear displacements in the E-, P- and G-directions and export them for GEMS. GEMS can then use this data to perform the contact analysis for the bevel gear stage, taking the misalignments into account. The results, such as the progress of the transmission error, meshing stiffness and Hertzian pressure, can then be imported into KISSsys and displayed in individual graphics (plots).

11.14 Data views

In KISSsys, a model of the system you are investigating 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 tailor 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.

11.15 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.

11.16 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 jump between different device types in a series, switch settings or similar.

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