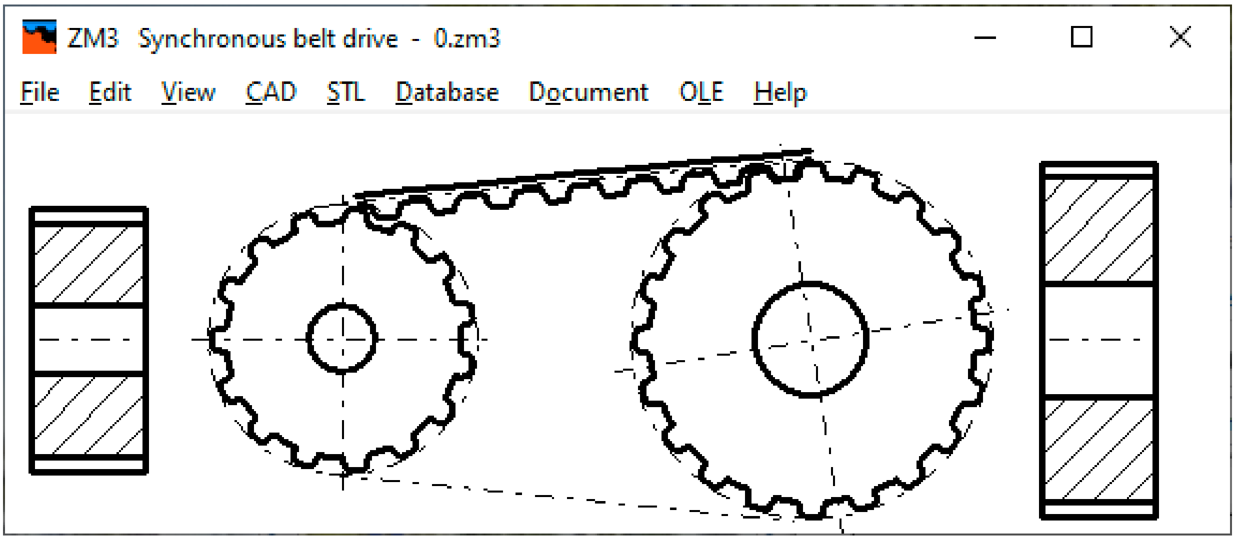
HEXAGON Newsletter 186 March / April 2021

by Fritz Ruoss

ZM3: New Software for Synchronous Belt Drives



There are many different profile shapes for synchronous belts. These have been summarized and standardized in ISO 17396 (T and AT profile, 2017) and ISO 13050 (profile G, H, R, S) from 2014. Before that, every belt manufacturer had its own standards and designations. Unfortunately, only the dimensions have been standardized. For the calculation of load and strength, each provider continues to use its own standards. There are a multitude of different factors, tables, diagrams and graphs. For synchronous belts made of rubber, polyurethane or neoprene, with tension cords made of steel, fiberglass, carbon, kevlar.

In ZM3, the strength is therefore only approximately calculated using the following data:

1. Tensile force and tension of the toothed belt
2. Surface pressure on the tooth flanks
3. Shear stress on the tooth

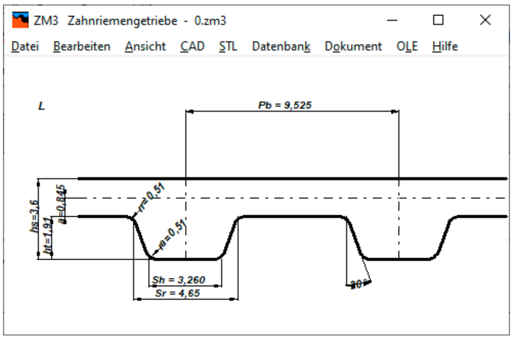
In ZM3 we use a breaking force FB similar to that of chain drives. In the case of synchronous belts, this depends on the incorporated tension cords (made of steel, fiberglass, carbon). As a default for FB, we use FB = 50 * (hs-ht) * b, which corresponds to an average tension of 50 MPa in the belt cross-section. If the proportion of tensile cords in the cross section is 20%, this corresponds to a tensile stress of 250 MPa.

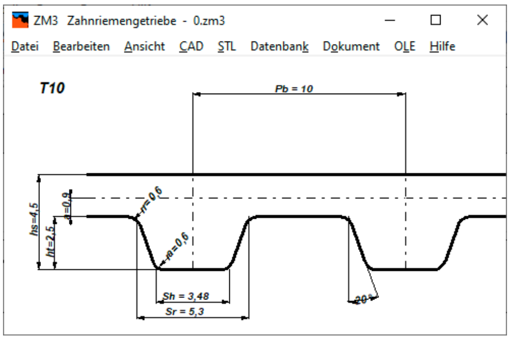
The load-bearing portion of the remaining belt cross-section made of PU or neoprene can be neglected, if only because of the different elongation. The elongation of steel = sigma / modulus of elasticity is 0.12% at 250 MPa (for tensile cord made of glass fiber or carbon approx. 0.35% at 250 MPa)

Then a check of the permissible surface pressure on the tooth flanks. The surface pressure depends on the load (torque), application factor, height and width of the teeth and the number of teeth in mesh. The permissible surface pressure of the tooth flanks depends on the material and shape of the synchronous belt.

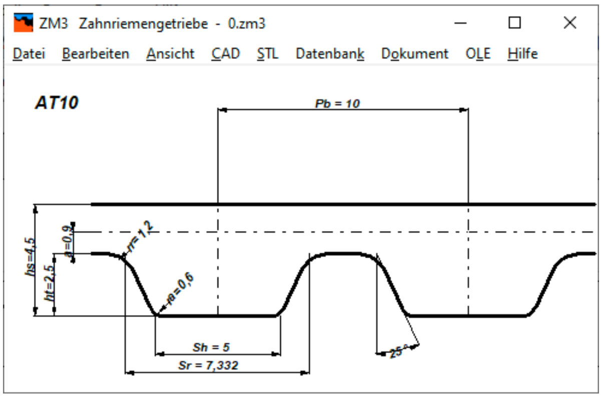
And finally, a shear stress for shearing off the teeth on the synchronous belt. As with the surface pressure, it depends on the load, the application factor, the number of teeth in mesh, the tooth width and the face width.

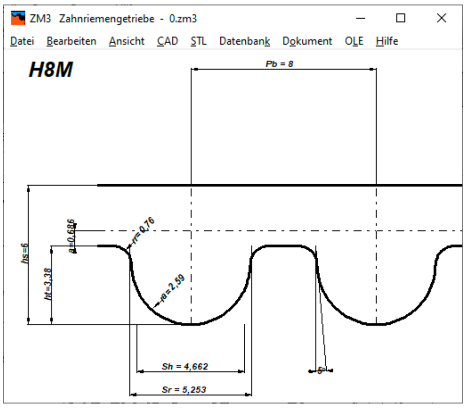
In ZM3, all tooth profiles are converted into a trapezoidal profile with transition radii.



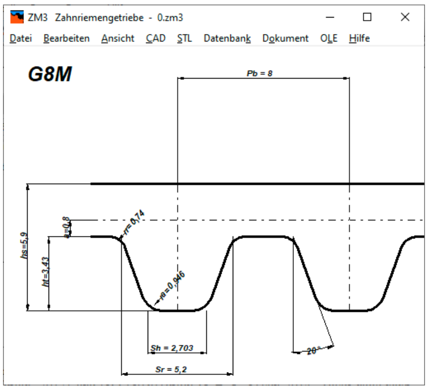


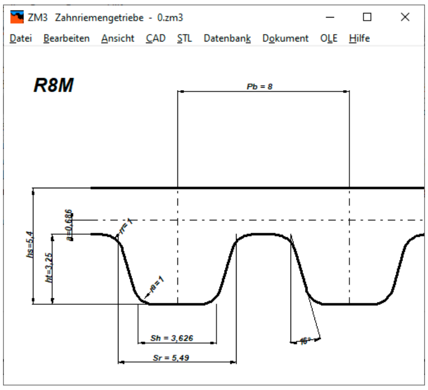
Trapezoidal profile fits exactly for inch profiles X, L, H and metric profiles T and AT.



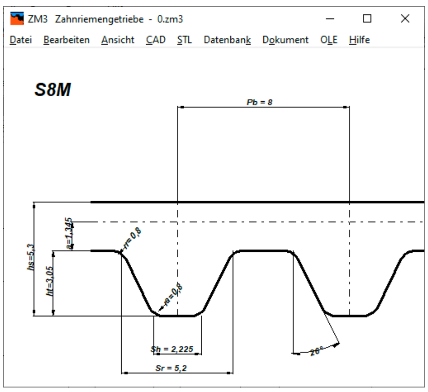


An H-profile according to ISO 13050 can also be constructed quite precisely in this way, even if a trapezoidal profile is no longer recognizable due to the large radii.

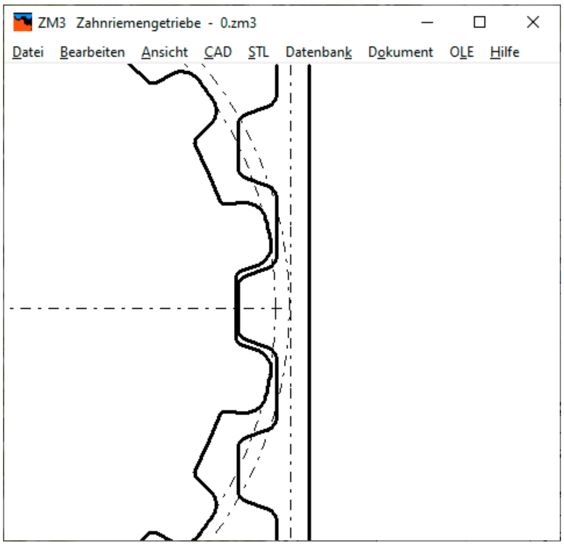


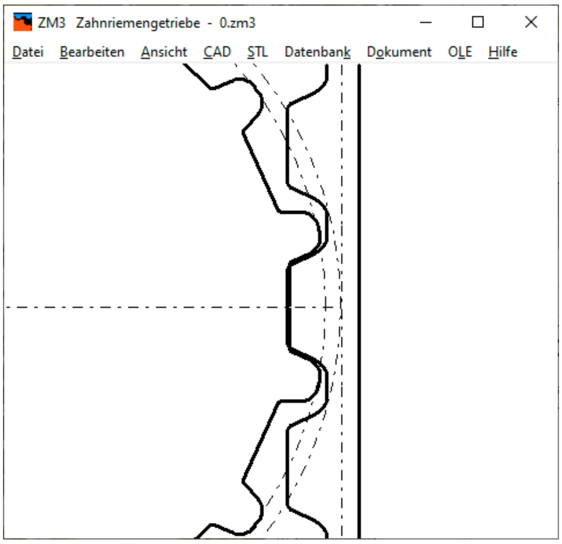


Profiles G, R and S according to ISO 13050 have involute flanks, the construction is complex.
In ZM3 these profiles are only shown imprecisely as a trapezoidal profile.



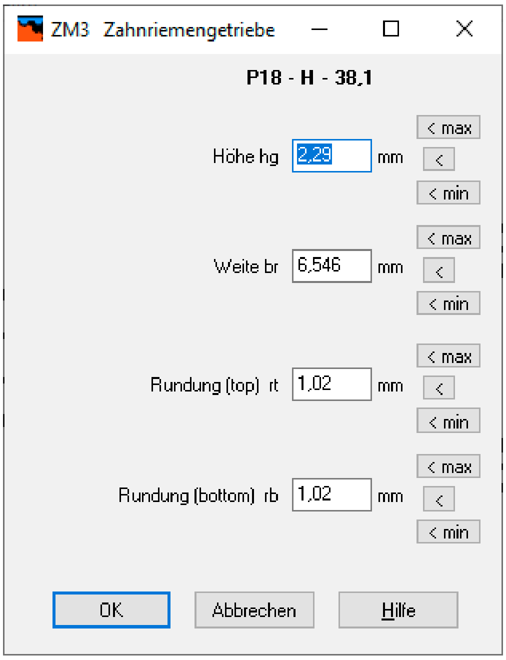
ZM3 also generates an image of the meshing of the synchronous belt with the pulley. With the T-profile it is noticeable that the backlash is very large. The T-profile should not be used for drives with reversal of the direction of rotation, unless the tooth profile of the pulley is changed.

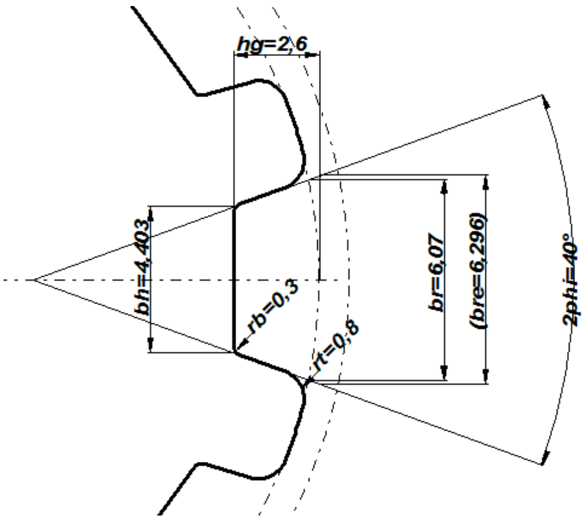




With the AT profile, on the other hand, the teeth of the toothed belt are literally pressed into the tooth gap of the pulley. Wide teeth on the toothed belt and thin teeth on the pulley reduce the shear stress on the toothed belt.

In ZM3 you can generate the tooth profile of synchronous belt pulleys with trapezoidal profile as true-scale DXF file. Or generate an STL file straight away and create a 3D model of the pulley on a 3D printer. For variations, you can change the most important parameters for the tooth profile.

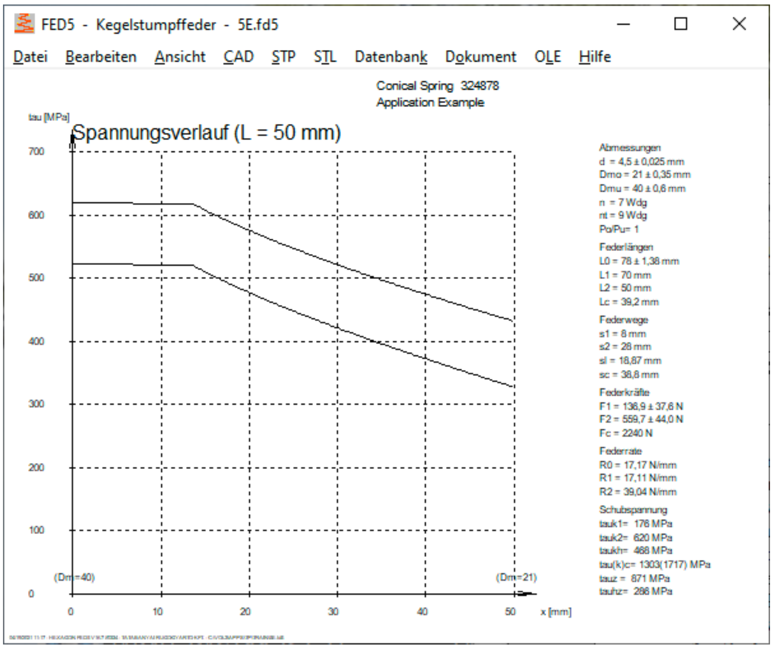




For profiles according to ISO 5296, ISO 17396 profile T and ISO 13050 profile S, the outer tooth width “br” is specified. For profiles according to ISO 17396 profile AT and ISO 13050 profile H, the inner tooth width “bh” is specified. For profiles according to ISO 13050 profile G and R, both tooth width “bh” and tooth width “bh” are specified (but they have different names), the tooth angle is calculated. ZM3 converts br and bh, the designation "bre" is the tooth width on the tangent to the outer diameter d0.

ZM3 is available now at a price of 224 euros for a single user license.

FED5: shear stress distribution diagram tau-x reversed



In FED5, FED6 and FED7 you can display the course of the tension along the spring body as a diagram, and that for every spring length between L0 and Lc. The x-axis is then the compressed spring body from 0 to the specified spring length. Which side corresponds to which side was not displayed, which is why a conical spring calculated with FED7 was shown reversed compared to the spring calculated with FED5. Therefore, the tau-x diagram in FED5 has been reversed, and the mean coil diameter of the spring ends is given in brackets.

WN5: Table to ISO 4156 and ANSI B92.2M: WN5 V5.1 Bugfixed

WN5 - Involute Splines - iso415...

File Edit View CAD STL Document OLE Help

External Spline ISO 4156:2021		
EXT 25z x 1m x 30P x 5js ISO 4156		
No. of teeth	z	25
module	m	1,00000
Pressure angle	alphaD	30 °
Pitch circle diameter	D	25,0000
Base diameter	Db	21,6506
Major diameter	Dee	26,00 h11
Form diameter	DFe	23,93 max.
Minor diameter	Die	23,31 min.
Tooth thickness		
max.effective	Svmax	1,598
max.actual	Smax	1,576
min.effective	Svmin	1,566
min actual	Smin	1,543
Measurement over pins	MRe	27,878 max.aux.
Measurement over pins	MRe	27,827 min.
Pin/ball diameter	DRe	1,900
Root fillet radius	rho fe	0,200

WN5 - Involute Splines - iso415...

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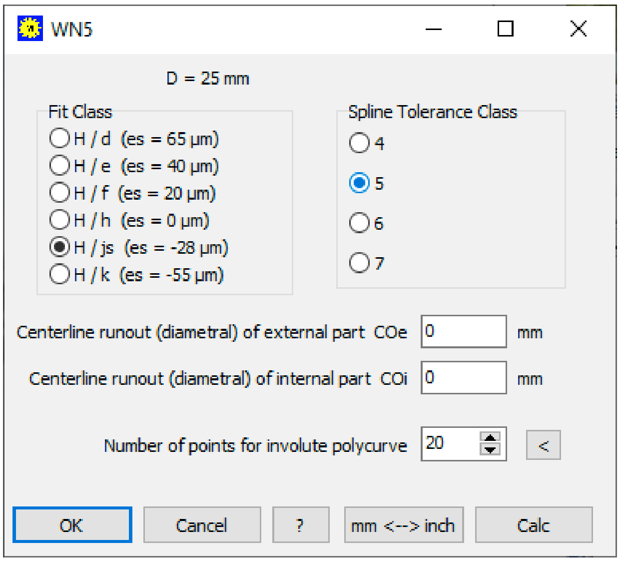
External Involute Spline Data 000001	
EXT 25Z x 1m x 30P x 5js ANSI B92.2M-1980	
Flat Root Side Fit	Tolerance Class-5
No. of teeth	25
module	1,000
Pressure angle	30 deg
Base diameter	21,651 ref
Pitch diameter	25,000 ref
Major diameter DEE	26,00 max
Form diameter DFE	23,89
Minor diameter DIE	23,31 / 23,55
Circular tooth thickness	
Max effective	1,598
Min actual	1,543
Measurement over two pins	27,827 / 27,878
Pin Diameter	1,90
Fillet Radius	0,20

New in WN5 V5.1 was a Quick4 view in the A3 drawing frame. Unfortunately, since this change, the old ANSI B92.2M table had been displayed in the manufacturing drawing even though ISO 4156 was selected. And the greatest dimension of the tooth thickness “Max effective” of the splined shaft was always displayed for H / h, even if H / d, H / e, H / f was selected. In the Quick3 and Quick4 view, however, the correct table was displayed. Affected customers with WN5 V5.1 will receive a free update, they have already been informed.

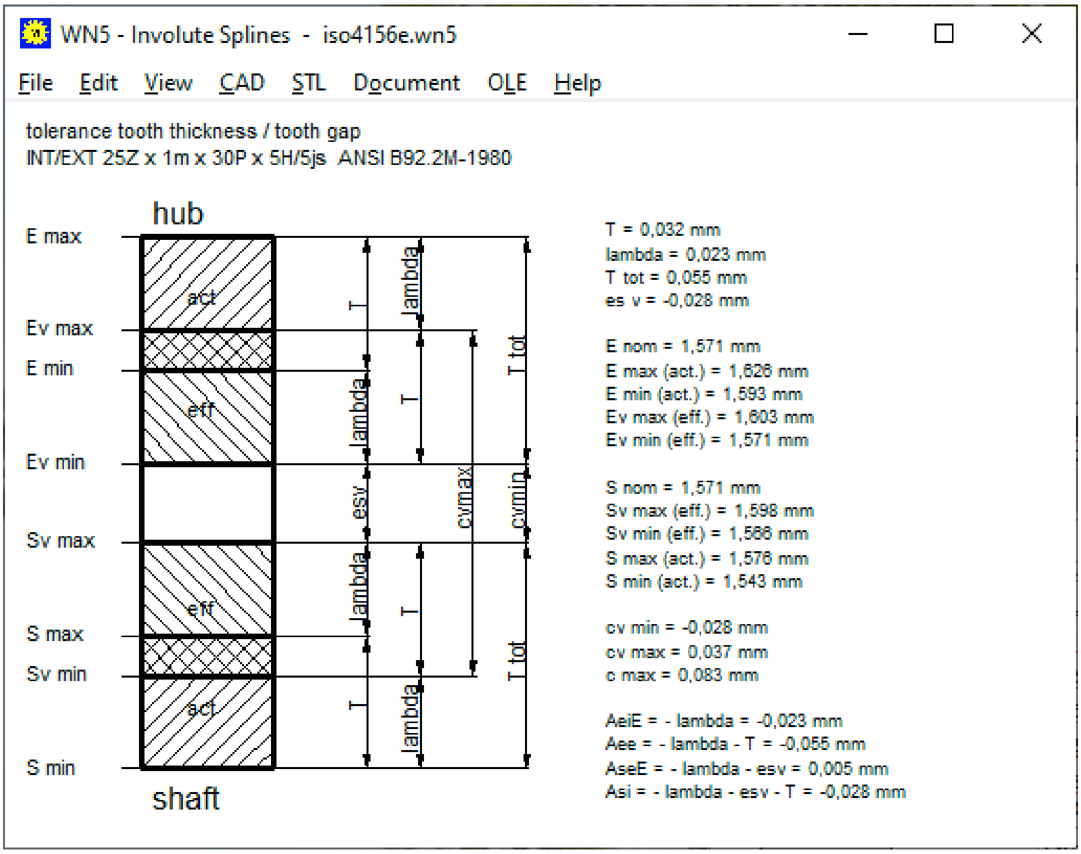
WN5: Fit Class H/js and H/k



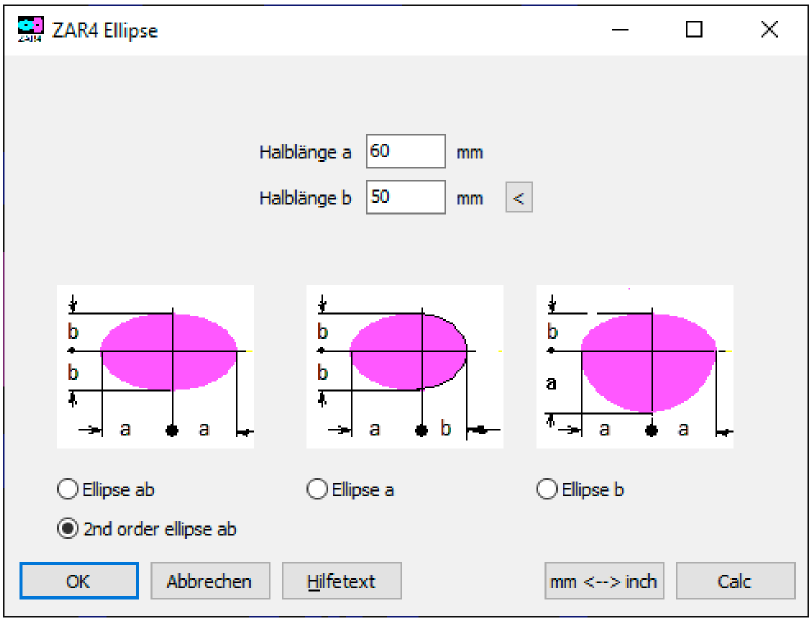
In the latest ISO 4156: 2021 (also already in ISO 4156: 2005) there are not only the clearance fits H / d, H / e, H / f and H / h but also the transition fits H7 / js and H / k for a tight fit, in WN5 since V4.9. When calculating the dimensions of “js” and “k” for esv (fundamental deviation), the ISO dimensions according to the fit table do not apply, but rather the clauses “esv = (T + lambda) / 2” for “js” and “esv = (T + lambda) ”for“ k ”. In the last version 5.1 of WN5, the dimensions according to ISO 286 were used. The pairings H / js and H / k are now significantly tighter.

WN5: Tolerance Graphic: E nom, S nom, c max added

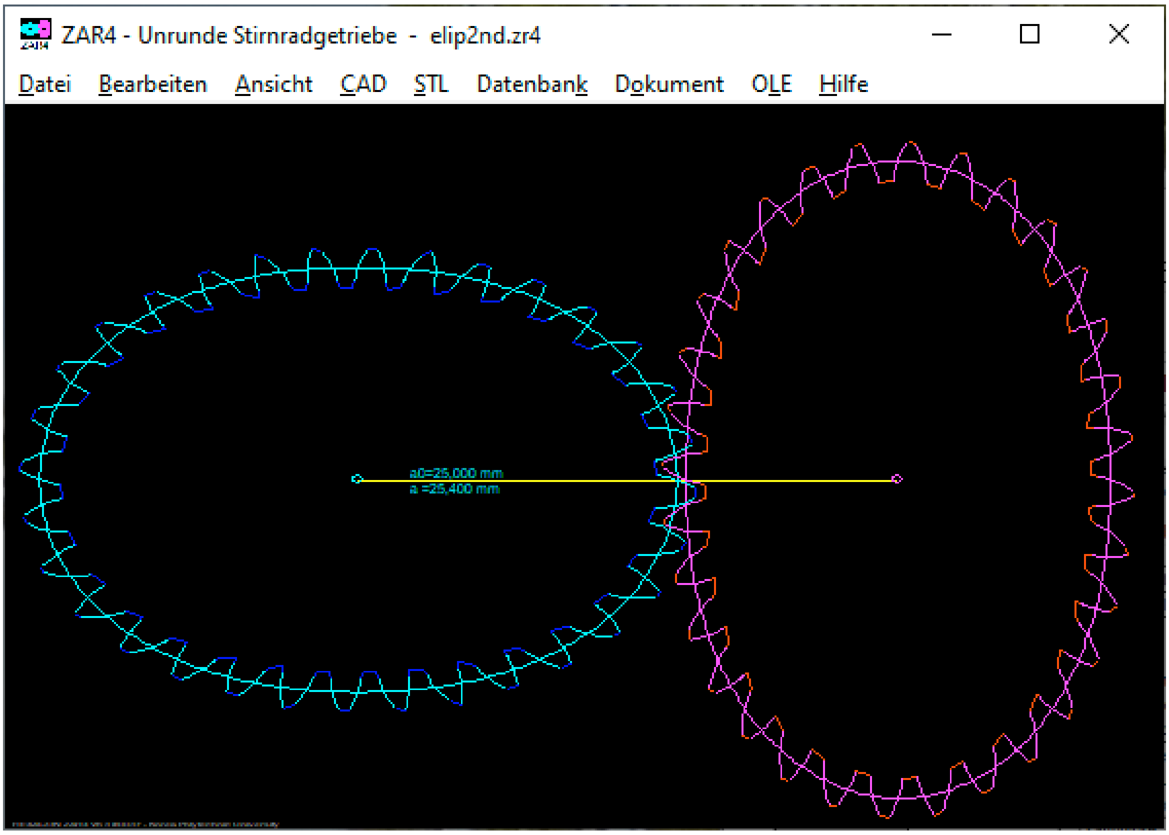
The nominal value of the tooth width and gap width Snom and Enom is the pitch P = m * pi / 2.
In addition, the largest possible clearance of a single tooth cmax has been added.
cmax = Emax-Smin = cvmax+2*lambda = cvmin+2*Ttot



ZAR4, GEO4: 2nd order Ellipse added



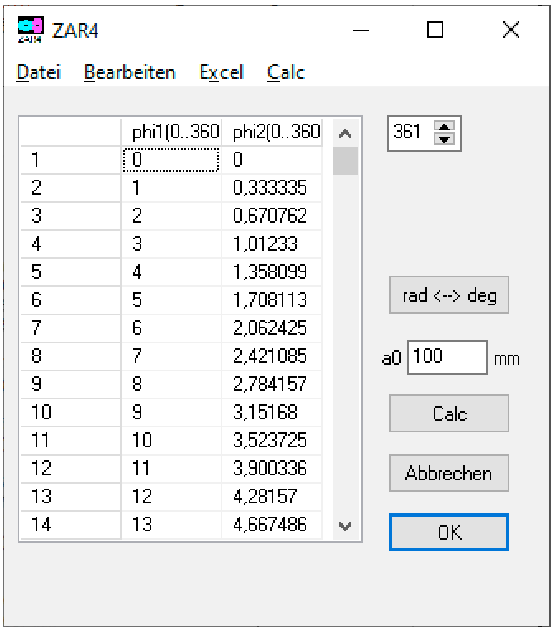
A 2nd order ellipse can be described very easily:
r = 2 * a * b / ((a-b) - (a-b) * cos (2 * phi))
When used as a non-circular gear, the second-order ellipse has the advantage that the gear and mating gear can have the same contour. To do this, the number of teeth must be divisible by 4 because the meshing is offset by 90 °. In the case of a “correct” ellipse, the contour of the mating gear must be calculated, the pitch curves of the elliptical non-circular gear and mating gear are different.
In ZAR4 and GEO4, as alternative to an ellipse, you can now select a second-order ellipse as pitch curve (ZAR4) or as a cam shape (GEO4).



ZAR4: Tooth contact drawings

Use the arrow keys to move the non-circular gear through the specified angle. The step angle delta phi can now be entered. Previously it was set to 180 ° / z1.

ZAR4: Calculate pitch curve from pitch angles of driving gear and driven gear



As a new option for the pitch curve, you can now enter the angle of the drive gear and the corresponding angle of the driven gear. To do this, enter the angle phi1 in 1 ° steps or less and the associated angle phi2 of the mating gear phi2. ZAR4 then calculates the pitch curves of gear 1 and gear 2:

r1 = a0 / (1 + dphi1 / dphi2) or r2 = a0 / (1 + dphi2 / dphi1)

Where dphi is the angle difference dphi1 = phi1 (i + 1) - phi1 (i)

WN2: Radial Runout Fr

Measurement Mi (DM=6) max	*126,017*
Measurement Mi (DM=6) min	*125,956*
Add. data Fr	*0,060*

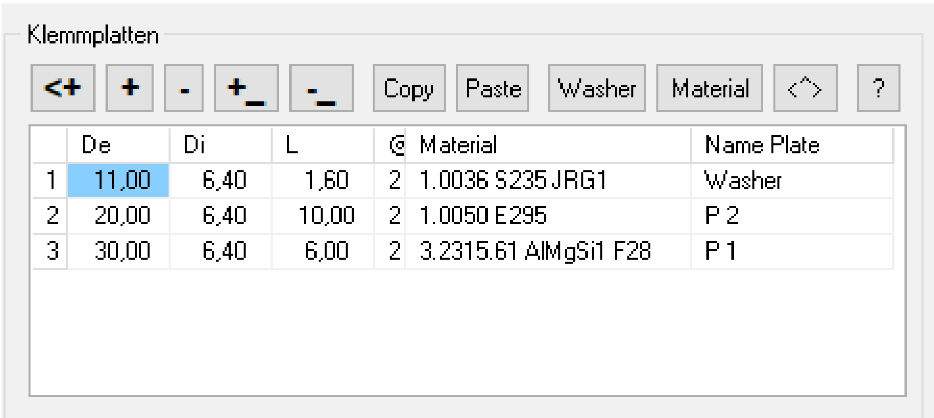
Measurement Mi (DM=5,25) max	*109,265*
Measurement Mi (DM=5,25) min	*109,169*
Add. data Fr	*0,020*

In the table DIN5480: 1991 the permissible radial runout deviation of the hub under “Additional information Fr” was not correct. The radial runout of the internal and external gears are the same, but the runout of the hub was specified too small. Fr has been corrected.
In the new table DIN5480: 2006, however, no concentricity deviation Fr is given.

SR1 Quick Input: Additional text (line 4)

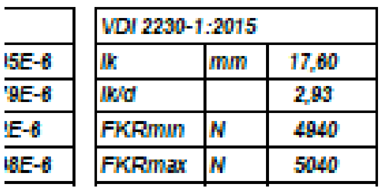
If the 3 lines of text are not enough for you, you can now write a fourth line (max. 100 characters). The 4th line is output in the table drawing and the quick views, but not in the text printout.

SR1 Quick input: take over the clamping plate data from the previous element
With the “<+” button, the data of the previous plate are adopted for the next clamping plate. Only the material had to be selected again from the database in order to take over the material data. In future, the material data will also be adopted.



Reverse the SR1 clamping plate assembly
If you swap screw and nut, you also have to reverse the arrangement of the clamping plates. There is now a new button “<^>” in the quick input.

SR1 Quick3,4, table drawing: clamping length ratio Lk / d
The clamping length ratio Lk / d is added to the views.

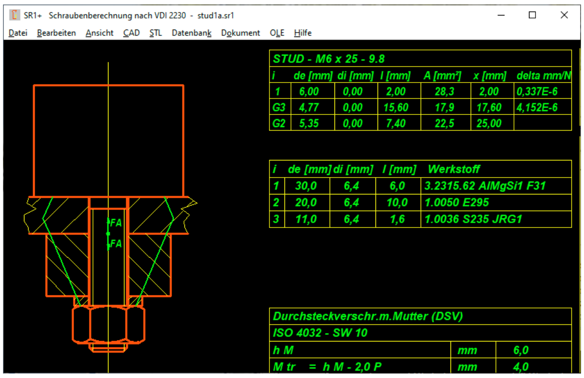


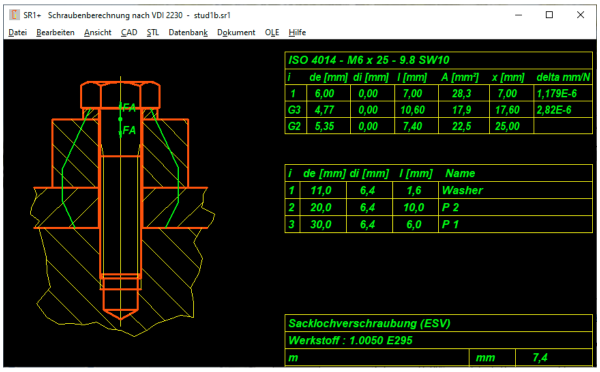
SR1: M1.4 screw
Thread M1.4 has been added to the database, plus a hexagon socket screw M1.4 according to DIN 912 and nut 1.4 DIN 934

SR1 Tip: bolted joint with stud bolts

It is often asked how one can calculate a stud bolt with nut. If the thread screwed in first does not have to be calculated, that's easy: The screwed-in bolt is defined as a bolt with a large special head. If the stripping safety of both thread sides is to be calculated, 2 calculations must be carried out:

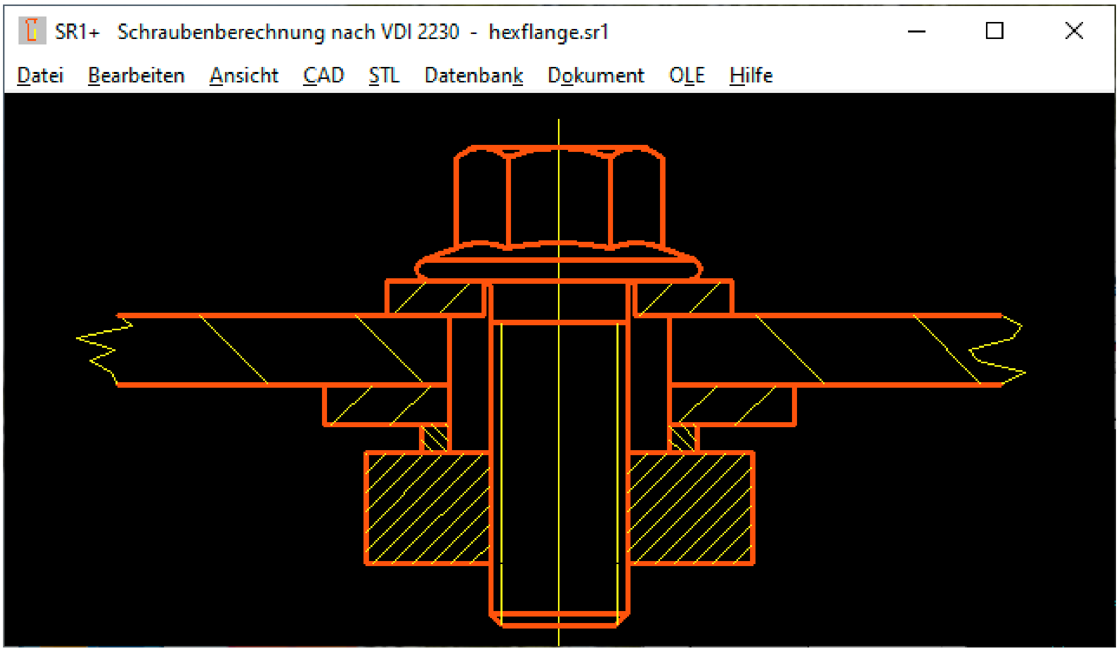
1. bolt as a screwed-in threaded bolt with a large special head as DSV
2. bolt with nut-screw head as ESV





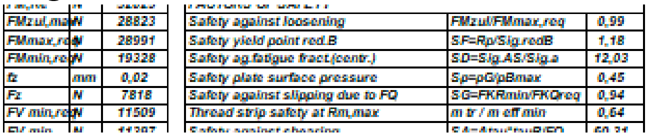
The nut is then defined as a screw head and the arrangement of the clamping plates must be reversed for this. To automate this, there is a new button “<^>”. The assembly preload FM, max (FMzul according to VDI 2230) must be taken over from the first calculation.

SR1 Tip: Calculate clamping plates with a large bore or elongated hole



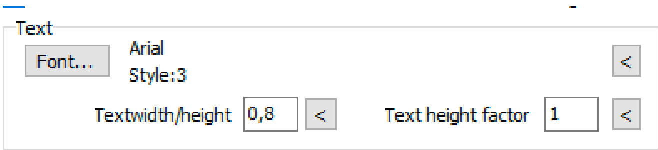
If the bore of a clamping plate is larger than the bearing diameter dw of the screw head or nut, the screw connection according to VDI 2230 cannot be calculated. Fatal error, calculation not possible. Even thick washers or sleeves are of no use. According to VDI 2230, only the change in length of the clamping plates due to tension and pressure is calculated, but not the bending and curvature of washers and sleeves. The only thing that helps is to enlarge the head of the screw and nut: use flange screws and flange nuts.

Fit text into tables and diagrams



FMzul,max	N	28823	Safety against loosening	FMzul/FMmax,req	0,99
FMmax,req	N	28991	Safety yield point red.B	SF=Rp/Sig.redB	1,18
FMmin,req	N	19328	Safety ag.fatigue fract.(centr.)	SD=Sig.AS/Sig.a	12,03
fz	mm	0,02	Safety plate surface pressure	Sp=pG/pBmax	0,45
Fz	N	7818	Safety against slipping due to FQ	SG=FKRmin/FKQreq	0,94
FV min,req	N	11509	Thread strip safety at Rm,max	m tr / m eff min	0,64

The text size on the graphics screen does not change continuously according to the window size and resolution, but in steps. Therefore it can happen that text in tables is displayed too big or too small. This can be adjusted under File \ Settings \ Graphics: Change text height factor or text width factor, the standard setting is 1 for the text height factor and 0.8 for the text width coefficient.



Old HEXAGON Software running on new hardware and new operating system

Some customers are still using 20-year-old versions with new hardware and a new PC. Most of them run without any problems, although the current operating systems at that time were called Windows 95, Windows 98 and Windows 2000. And a hard drive partition couldn't be larger than 2 GB. Older versions sometimes cause problems with database access if the storage space is larger than 2 TB (2000 GB). In 2006 and 2015 the database problems with the old and new database module were fixed.

1 Year Corona

If you look back today on the first corona wave in the first half of 2020, the numbers for Germany look harmless compared to today: fewer than 200,000 infected people, 9,000 deaths, and the highest 7-day incidence was 45. When shops and schools were closed and airports in March 2020, the 7-day incidence was just 10. In the second wave from September 2020 to February 2021, 2 million infected people, 60,000 deaths, the highest incidence over 200. The second wave in Germany was triggered in by people returning from vacation. This will probably be repeated in 2021, when there will be the fourth wave. The third wave began in March 2021, triggered by international mutations of the virus. Corona will probably be with us for a long time. The vaccine manufacturers are counting on the fact that their products will be needed for a long time due to their diminishing effectiveness and new mutations.

EU President in the Corona shopping frenzy

Von der Leyen is negotiating with Biontech-Pfizer about the delivery of a further 1.8 billion vaccine doses for the period from 2021 to 2023. In return, she will receive 50 million of the vaccine doses already ordered earlier than expected. 1.8 billion vaccine doses for 450 million EU citizens? Another 4 syringes for each for 2022 and 2023? If 33% of the population refuses vaccination, every EU citizen willing to vaccinate receives 6 syringes from Biontech.

Spring Poem

Spring lets its blue ribbon
Again fluttering through the air;
Sweet, well-known fragrances
Forebodingly strip the land.
Corona flowers are already dreaming
Want to come soon.
Listen, a loud exhaust sound from afar!
Spring, yes it's you!
I heard you!
After Eduard Mörike, Ochsenwang 1829. Translated by Google Translator.

HEXAGON PRICE LIST 2021-05-01

Base price for single licences (perpetual)	**EUR**
DI1 Version 2.1 O-Ring Seal Software	190.-
DXF-Manager Version 9.1	383.-
DXFPLOT V 3.2	123.-
FED1+ V31.2 Helical Compression Springs incl. spring database, animation, relax., 3D,..	695.-
FED2+ V21.9 Helical Extension Springs incl. Spring database, animation, relaxation, ...	675.-
FED3+ V21.4 Helical Torsion Springs incl. prod.drawing, animation, 3D, rectang.wire, ...	600.-
FED4 Version 7.8 Disk Springs	430.-
FED5 Version 16.7 Conical Compression Springs	741.-
FED6 Version 17.2 Nonlinear Cylindrical Compression Springs	634.-
FED7 Version 14.3 Nonlinear Compression Springs	660.-
FED8 Version 7.4 Torsion Bar	317.-
FED9 Version 6.4 Spiral Spring	394.-
FED10 Version 4.4 Leaf Spring	500.-
FED11 Version 3.6 Spring Lock and Bushing	210.-
FED12 Version 2.7 Elastomer Compression Spring	220.-
FED13 Version 4.2 Wave Spring Washers	228.-
FED14 Version 2.6 Helical Wave Spring	395.-
FED15 Version 1.6 Leaf Spring (simple)	180.-
FED16 Version 1.3 Constant Force Spring	225.-
FED17 Version 2.1 Magazine Spring	725.-
GEO1+ V7.5 Cross Section Calculation incl. profile database	294.-
GEO2 V3.3 Rotation Bodies	194.-
GEO3 V3.3 Hertzian Pressure	205.-
GEO4 V5.3 Cam Software	265.-
GEO5 V1.0 Geneva Drive Mechanism Software	218.-
GEO6 V1.0 Pinch Roll Overrunning Clutch Software	232.-
GEO7 V1.0 Internal Geneva Drive Mechanism Software	219.-
GR1 V2.2 Gear construction kit software	185.-
GR2 V1.1 Eccentric Gear software	550,-
HPGL-Manager Version 9.1	383.-
LG1 V6.6 Roll-Contact Bearings	296.-
LG2 V3.1 Hydrodynamic Plain Journal Bearings	460.-
SR1 V23.8 Bolted Joint Design	640.-
SR1+ V23.8 Bolted Joint Design incl. Flange calculation	750.-
TOL1 V12.0 Tolerance Analysis	506.-
TOL2 Version 4.1 Tolerance Analysis	495.-
TOLPASS V4.1 Library for ISO tolerances	107.-
TR1 V6.3 Girder Calculation	757.-
WL1+ V21.6 Shaft Calculation incl. Roll-contact Bearings	945.-
WN1 V12.3 Cylindrical and Conical Press Fits	485.-
WN2 V10.4 Involute Splines to DIN 5480	250.-
WN2+ V10.4 Involute Splines to DIN 5480 and non-standard involute splines	380.-
WN3 V 6.0 Parallel Key Joints to DIN 6885, ANSI B17.1, DIN 6892	245.-
WN4 V 5.1 Involute Splines to ANSI B 92.1	276.-
WN5 V 5.2 Involute Splines to ISO 4156 and ANSI B 92.2 M	255.-
WN6 V 4.1 Polygon Profiles P3G to DIN 32711	180.-
WN7 V 4.1 Polygon Profiles P4C to DIN 32712	175.-
WN8 V 2.5 Serration to DIN 5481	195.-
WN9 V 2.4 Spline Shafts to DIN ISO 14	170.-
WN10 V 4.3 Involute Splines to DIN 5482	260.-
WN11 V 2.0 Woodruff Key Joints	240.-
WN12 V 1.2 Face Splines	256.-
WN13 V 1.0 Polygon Profiles PnG	238.-
WN14 V 1.0 Polygon Profiles PnC	236.-
WNXE V 2.3 Involute Splines – dimensions, graphic, measure	375.-
WNXK V 2.2 Serration Splines – dimensions, graphic, measure	230.-
WST1 V 10.2 Material Database	235.-
ZAR1+ V 26.7 Spur and Helical Gears	1115.-
ZAR2 V8.1 Spiral Bevel Gears to Klingelnberg	792.-

ZAR3+ V10.4 Cylindrical Worm Gears	620.-
ZAR4 V6.3 Non-circular Spur Gears	1610.-
ZAR5 V12.3 Planetary Gears	1355.-
ZAR6 V4.2 Straight/Helical/Spiral Bevel Gears	585.-
ZAR7 V2.2 Plus Planetary Gears	1380.-
ZAR8 V1.8 Ravigneaux Planetary Gears	1950.-
ZAR9 V1.0 Cross-Helical Screw Gears	650.-
ZARXP V2.6 Involute Profiles - dimensions, graphic, measure	275.-
ZAR1W V2.5 Gear Wheel Dimensions, tolerances, measure	450.-
ZM1.V3.0 Chain Gear Design	326.-
ZM2.V1.0 Pin Rack Drive Design	320.-
ZM3.V1.0 Synchronous Belt Drive Design	224.-

PACKAGES	EUR
HEXAGON Mechanical Engineering Package (TOL1, ZAR1+, ZAR2, ZAR3+, ZAR5, ZAR6, WL1+, WN1, WN2+, WN3, WST1, SR1+, FED1+, FED2+, FED3+, FED4, ZARXP, TOLPASS, LG1, DXFPLOT, GEO1+, TOL2, GEO2, GEO3, ZM1, ZM3, WN6, WN7, LG2, FED12, FED13, WN8, WN9, WN11, DI1, FED15, GR1)	8,500.-
HEXAGON Mechanical Engineering Base Package (ZAR1+, ZAR3+, ZAR5, ZAR6, WL1+, WN1, WST1, SR1+, FED1,+, FED2+, FED3+)	4,900.-
HEXAGON Spur Gear Package (ZAR1+ and ZAR5)	1,585.-
HEXAGON Planetary Gear Package (ZAR1+, ZAR5, ZAR7, ZAR8, GR1)	3,600.-
HEXAGON Involute Spline Package (WN2+, WN4, WN5, WN10, WNXE)	1,200.-
HEXAGON Graphic Package (DXF-Manager, HPGL-Manager, DXFPLOT)	741.-
HEXAGON Helical Spring Package (FED1+, FED2+, FED3+, FED5, FED6, FED7)	2,550.-
HEXAGON Complete Spring Package (FED1+, FED2+, FED3+, FED4, FED5, FED6, FED7, FED8, FED9, FED10, FED11, FED12, FED13, FED14,, FED15, FED16, FED17)	4,985.-
HEXAGON Tolerance Package (TOL1, TOL1CON, TOL2, TOLPASS)	945.-
HEXAGON Complete Package (All Programs)	14,950.-

Quantity Discount for Individual Licenses

Licenses	2	3	4	5	6	7	8	9	>9
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Network Floating License

Licenses	1	2	3	4	5	6	7..8	9..11	>11
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Language Version:
- **German and English :** all Programs
- **French**: FED1+, FED2+, FED3+, FED4, FED5, FED6, FED7, FED9, FED10, FED13, FED14, FED15, TOL1, TOL2.
- **Italiano**: FED1+, FED2+, FED3+, FED4, FED5, FED6, FED7, FED9, FED13, FED14, FED17.
- **Swedish**: FED1+, FED2+, FED3+, FED5, FED6, FED7.
- **Portugues**: FED1+, FED17
- **Spanish**: FED1+, FED2+, FED3+, FED17

Updates:

Software Update (software Win32/64 + pdf manual)	40 EUR
Software Update (software 64-bit Win + pdf manual)	50 EUR

Update Mechanical Engineering Package: 800 EUR, Update Complete Package: 1200 EUR
Maintenance contract for free updates: annual fee: 150 EUR + 40 EUR per program

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General packaging and postage costs for delivery on CD-ROM: EUR 60, (EUR 25 inside Europe)
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