Help-Function

Selection of Help Topics

a (acceleration)
Angles
Angle α
Angle ß
Angle γ
Average velocity v_m (in the phase)
Back
Ball Screw Assembly system
Bearing side 1: Not usable length of the spindle L_{S1}
Bearing side 2: Not usable length of the spindle L_{S2}
C_0/F_{max} and/or $C_{0,red}/F_{max}$
Calculation assumptions and/or calculation conditions
Continue
Customer data
Data
Dimensions
Distance of the spindle bearings L_1
Drive rigidity of Ball Screw Assembly without consideration of the spindle bearings R_{tot}
Drive Unit with Ball Srew Unit AGK
Drive Unit with Ball Srew Unit AOK
Drive Unit with Ball Srew Unit FAR
Dyn. equi. external force loads
Dyn. equi. total load
File
File close
File open
File new
File save
File save as
Force
Forces
General references
Input via dynamic cycle
Input via percentages of time
Input via strokes
Kind of spindle bearing
Lead of the screw P
L_{10} (theoretical lifetime)
L_{h10} (theoretical lifetime)
L_{na}
Load capacity reduction, e.g. with short stroke
Mass
Mass active in
Masses
Maximum moment M_{max}
Maximum load F_{max}

a (acceleration)

The value „a“ indicates the acceleration and/or deceleration value from an initial speed at the beginning of a dynamic phase to a terminal velocity at the end of the phase during a movement.

Angles

The rotation of the system around the X-, Y- and Gravitation-axis can be entered in the **input mask angles**.

Angle α

The rotation of the system around the X-axis can be entered in the **input mask angles** in the input field angle α.

Angle ß

The rotation of the system around the Y-axis can be entered in the **input mask angles** in the input field angle ß.

Angle γ

The rotation of the system around the Gravitation-axis can be entered in the **input mask angles** in the input field angle γ.

Average velocity v_m (in a particular phase)

This characteristic is necessary **for the input of dynamic cycles** with the **masks input via percentages of time** or **input via strokes**. It is to be considered that v_m conforms neither to the velocity at the beginning of a particular phase nor to the terminal velocity. It represents the average speed in a particular phase. It comprises of the devision of the distance by the time ($v_m=\Delta s/\Delta t$).

Back

Using the back button you can return to the previous input mask.

Ball Screw Assembly system

The Ball Screw Assembly can be selected in the **input mask data** by using the pull down menu “Types of Screw Assemblies”.

Bearing side 1: Not usable length of the spindle L_{S1}

The not usable length on the left side of the spindle L_{S1} indicates the distance/length, which is not available for the stroke. Reference point is the centre of the left bearing.

Bearing side 2: Not usable length of the spindle L_{S2}

The not usable length on the right side of the spindle L_{S2} indicates the distance/length, which is not available for the stroke. Reference point is the centre of the right bearing.

C_0/F_{max} and/or $C_{0,red}/F_{max}$

This value indicates the ratio between the static load capacity and the maximum occurring load F_{max}. In the calculation oscillations, dirt and/or temperature influences are not considered. Therefore, this value should be at least ≥ 4. For the respective application this ratio with consideration of the valid safety regulations must be met. Here substantially higher values can be necessary.

Calculation assumptions and/or calculation conditions

(see **input mask tips** and **the printout**)

Continue

Using this button the next input mask can be achieved. Each input mask has to be accomplished, in order to prevent neglection of input masks and also to avoid mistakes.

Customer data

In the **input mask printout** the specific customer data, e.g. name, address and project can be entered and saved.

Data

In the **input mask data** you can select the Screw Assembly system and you get information about theoretical lifetime expectancy of the Screw Assembly system.

Dimensions

In the **input mask dimensions,** the system dimensions e.g. screw bearing, distance of spindle bearings, lead of screw and the spindle support - if existing - are entered.

Distance of the spindle bearings L_1

The distance of the spindle bearings L_1 indicates the centre to centre distance of the bearings. This input size is necessary for the calculation of the permissible critical speed and the permissible axial load.

Drive rigidity of Ball Srew Assembly without consideration of the spindle bearings R_{tot}

The drive rigidity of the Screw Assembly without consideration of the spindle bearings R_{tot} indicates the rigidity in moving direction. This value neither contains the rigidity of the rotation bearings nor of the construction. Hence the total rigidity of the drive is lower.

Drive Unit AGK

Structure of drive unit AGK:

- Rexroth Precision Ball Screw Assembly (BSA) with screw of various tolerance grades**.**
- Variable number of optional screw supports, to increase the linear speed with even long strokes – (critical speed). [Please check the maximal number of spindle supports in the catalogue].
- Steel or polyurethane sealing strip combined with aluminium extrusion profile encapsulation.
- Ball nut enclosure made of aluminium extrusion profile finished on all sides with reference edges on both sides.
- Pillow block units made of robust extruded aluminum profile with reference edges on both sides and mounting holes as well as locating feature for motor mounting.

Choice of drive elements:

- Motor with motor mounting bracket and coupling connector can be provided complete as an assembly.
- Belt side-drive attachments with selectable ratios and mountig arrangements complete with attached motor as an assembly.
- Maintenance-free digital AC servomotor with integrated brake and attached feedback.

The Ball Screw Assemblies can be selected in the **input mask data** under the pull-down-menu “Types of Ball Screw Assemblies”.

Drive Unit AOK

Ball Screw Assembly nuts of the drive unit AOK are completely contained in the product data base standard - Ball Screw Assemblies. Structure of drive unit AOK:

- Rexroth Precision Ball Screw Assemby (BS) with screw of various tolerance grades.
- Ball nut enclosure made of aluminium extrusion profile finished on all sides with reference edges on both sides.

- Pillow block units made of robust extruded aluminum profile with reference edges on both sides and mounting holes as well as locating feature for motor mounting.

Choice of drive elements:

- Motor with motor mounting bracket and coupling connector can be provided complete as an assembly.
- Belt side-drive attachments with selectable ratios and mountig arrangements complete with attached motor as an assembly.
- Maintenance-free digital AC servomotor with integrated brake and attached feedback.

The nut types of the drive unit AOK are completely in the Standard Ball Screw Assembly catalogue. The Ball Screw Assemblies can be selected in the **input mask data** under the pull-down-menu types of Ball Screw Assemblies.

Drive Unit FAR

The driven nut assembly consists of:

- A Single ball nut
- Two row angular contact ball bearing with integrated mounting hole and lube ports
- A slotted nut

The matching side drive timing belt can be supplied along with the assembly, if required. Suitable AC servo motors and drive controllers are also shown. The Ball Screw Assemblies can be selected in the **input mask data** under the pull-down-menu types of Ball Screw Assemblies.

Dyn. equi. external force loads

The dynamic equivalent external force load on the Screw Assembly exclusively develops due to external forces, e.g. for masses -, acceleration -, deceleration -, working and process forces. This indication does not consider the influence of the preload.

Dyn. equi. total load

The dynamic equi. total load indicates the resulting total load, the theoretical lifetime of the Screw Assembly is calculated with. The influence of the preload is considered in the dynamic equivalent total load.

In case of "highly" preloaded Screw Assembly systems (preload classes 3%, 5 %, 7 % and 10 %) following two cases are differentiated with the calculation of the total load on the Screw Assembly in the respective phase (stroke). With a preloading of 2 % the total load for each phase is calculated exclusively per case b:

a.) External Loading $F_{external} \leq 2,828 \times F_V$ (preload force)

In this case, the total load F_{total} can be calculated according to formula (1).

$$F_{total,phase} = \left(\frac{F_{external,Phase}}{2,828 * F_V} + 1 \right)^{\frac{3}{2}} \times F_V \qquad (1)$$

with:

$F_{external,Phase}$	=	loading on the Screw Assembly resulting from mass, acceleration, deceleration, machining and process forces [N]
F_V	=	preload of the Screw Assembly without external load in the individual phase [N]

Due to the high dynamics, it must be ensured that all raceways are within the preload range when subjected to the operating load.

This ensures that the rolling elements will not slide.

b.) External loading $F_{external} > 2,828 \times F_V$ (preload force)

In this case the total load F_{total} in a discrete step is determined according to formula (2).

$$F_{total,phase} = F_{external,phase} \qquad (2)$$

The equivalent total load $F_{equi,total}$ is determined according to formula (3).

$$F_{equi,total} = \sqrt[3]{F_{total,1}{}^3 \times \frac{q_1}{100} + F_{total,2}{}^3 \times \frac{q_2}{100} + ... + F_{total,l}{}^3 \times \frac{q_l}{100}} \qquad (3)$$

with:

$F_{total,1}..F_{total,l}$	=	total load on the Screw Assembly per phase [N]
$q_1 ...... q_l$	=	stroke percentage of individual phases [%]
l	=	number of phases per cycle

The theoretical lifetime (90% lifetime probability) is determined according to formula (4).

$$L_{10} = \left(\frac{C}{F_{Equi,total}} \right)^3 * 10^6 \qquad (4)$$

with:

L_{10}	=	nominal lifetime in revolutions
$F_{Equi,total}$	=	equivalent total load [N]
C	=	dynamic load capacity [N]

File

In this listing following functions are available: **File new**, **file open**, **file close**, **file save**, **file save as** and **Exit**.

File close

Via this function in the listing file, an **open file** (application) can be closed.

File open

Via this function in the listing file, a **stored file** (application) can be loaded into the program and the data can be changed later.

File new

Via this function in the listing file, a **new file** can be started.

File save

Via this function in the listing file, a **file** (application) can be stored.

File save as

Via this function in the listing file, a **file** (application) can be stored under a name.

Force

In the **input mask forces** the force component in moving direction can be entered. These forces are activated for the individual phases of the total procedure stroke (see **input mask of forces**).

Forces

In the **input mask forces** the force component in moving direction can be entered. These forces are activated for the individual phase(s) of the total procedure stroke (see **input mask of forces**).

General references

(see imprint)

Input via dynamic cycle

With this input method the total stroke is entered as a dynamic cycle. This input method is the most exact input, since for each individual phase e. g. the starting and/or terminal velocity and stroke distance are precisely defined in this case. Only with this input method all the program integrated control inquiries, e.g. maximum permissible speed etc., can be used.

Input via percentages of time

With this input method for the individual phases, the respective average speed v_m, the respective allocated time, and/or cyclic duration are entered. From this data the average speed for the total cycle and the stroke percentage are then calculated.

Input via strokes

With this input method, the total stroke is entered through individual stroke distances. Here the indication of the average speed v_m per phase is necessary in addition to the individual stroke. For the calculation of the average speed for the total cycle, the total switch on time of the axis [%] must be entered.

Kind of spindle bearing

In the **input mask dimensions** the kind of the spindle bearing can be selected. The selection of the spindle bearing influences the critical speed and the permissible axial load. The following kinds of spindle bearing can be selected:

- Fixed - Fixed
- Fixed - Floating
- Fixed - Free

Lead of the screw P

The lead of the screw P indicates the linear distance in mm, which the screw nut moves while a complete rotation of the ball screw spindle.

L_{10}

The nominal life L_{10} is understood as being the achievable calculated liefe expectany with a probability of survival of 90%. This means that 90% of a sufficiently large quantity of identical bearings achieve or exceed the theoretical life expectancy before material faigue occurs. This size is represented in the **input mask data**.

L_{h10}

The 90%-reliable lifetime in hours of a single bearing or of a group of apparently identical bearings operating in identical conditions (according to DIN 636 part of 2). This value is represented in the **mask data**.

L_{na}

If this probability is too low the calculated life expectancy must be reduced by a certain factor, this being the life expectancy coefficient a_1 for the probability of survival. This results in the modified life expectancy L_{na}.

$$L_{na} = a_1 * \left(\frac{C}{F_{Equi,total}} \right)^q * 10^5 \qquad (1)$$

with:

L_{na}	=	nominal lifetime (m)
a_1	=	lifetime probability
$F_{Equi,total}$	=	equivalent total load (N)
C	=	dynamic load capacity (N)
q	=	10/3 for Roller-Runner Blocks
q	=	3 for Ball-Runner-Blocks

table 1: Dependence of the factor a_1 from the lifetime probability

Lifetime Probability %	90	95	96	97	98	99
Factor a_1	1,00	0,64	0,55	0,47	0,37	0,25

Load capacity reduction, e.g. with short-stroke

With strokes ≤ 3,5 x lead of the screw x i (number of ball track turns) the special lubricating and servicing instructions in the catalog for short-stroke must be considered. With extreme short-stroke sometimes a reduction of the dynamic load capacity C is necessary. In the calculation program there is an input size reduction [%]. The load capacity reduction determines the proportional reduction of the dynamic load capacity C for short-stroke. To define this value for a Screw Assembly system, in each case an exact analysis of the stroke and the loads is necessary. Therefore no or only very general recommendations for this value can be indicated. I.e. this load capacity reduction must be individually specified for each case. With questions you please contact the field representative and/or distribution center responsible for your account (**see input mask data**).

Mass

The respective mass is entered into the **input mask masses**. Furthermore the activity of the mass in certain phases has to be defined. Moreover the acceleration in moving direction has to be assigned.

Mass active in

The line “mass active in” – contained in the **input mask masses** – determines if the respective mass affects the Screw Assembly in the particular phase or not.

Masses

In the **input mask masses** the mass and/or masses are entered. Furthermore it is defined whether the mass in the individual phases is active or not. Moreover the acceleration in moving direction has to be assigned.

Maximum moment M_{max}

a.) Drive moment, which has to be transferred directly over the spindle end in the case of a driven spindle (Occurring moments due to the mass inertia and friction of the spindle end bearings have to be considered separately).
b.) Drive moment, which has to be transfered directly over the driven ball srew nut.

Note for the calculation of the maximum moment: With the calculation of the required total moment always one drive moment and no transmitted moment is set. As a simplification all amouts of the single moments (occurring due to external forces, friction and mass intertia of the revolving items) are always added as a direction-independent value. This means that the actually required moment may be lower and the respective moments in the indivudal phases are just conditionally suitable for engine/automatic controller interpretations.

Maximum load F_{max}

The field maximum load in the **mask data** indicates in which phase the maximum load affects the Screw Assembly.

Miniature Ball Screw Assembly system

The Ball Screw nuts of miniature Ball Screw Assembly systems are completely contained in the standard Ball Screw Assembly product data base. In the mask data the type of the minature Ball Screw Assemblies can be selected under the pull-down menue types of nuts.

Moved mass of the drive BSA/PLSA

The moved mass of the drive BSA/PLSA indicates the additional load, that affects the Screw Assembly system beside the external masses. By causing additional loads onto the Screw Nut it influences the lifetime calculation.

Operating Factor k_f

Via the operating factor k_f the lifetime reducing influences and factors can be considered. The theoretical lifetime is affected by the operating factor k_f according to formula (1).

$$L_{10} = \left(\frac{C}{k_f * F_{Equi,total}} \right)^3 * 10^6 \qquad (1)$$

with:

L_{10}	=	nominal lifetime in revolutions
k_f	=	operating factor
$F_{Equi,total}$	=	equivalent total load [N]
C	=	dynamic load capacity [N]

Phase T

A total cycle can consist of several phases. For the calculation of the equivalent total loads – and thus the theoretical lifetime – a determination of the total loads in the individual phases (stroke distances) is necessary. According to formula (1) the total equivalent load is computed under reference to the loads in the individual phases.

$$F_{Equi,total} = \sqrt[3]{F_{total,1}{}^3 \times \frac{q_1}{100} + F_{total,2}{}^3 \times \frac{q_2}{100} + ... + F_{total,l}{}^3 \times \frac{q_l}{100}} \qquad (1)$$

with:

$F_{total,1}..F_{total,l}$	=	total load on the Screw Assembly in the individual phase [N]
$q_1 ...... q_l$	=	stroke percentage of each phase [%]
l	=	number of phases per cycle

Planetary Screw Assembly system

The Planetary Screw Assembly can be selected in the **input mask data** by using the pull down menu “Types of Screw Assemblies”.

Preload

The Screw Assemblies are manufactured in different preload classes. With high dynamic processes the preload should not be cancelled by the external load; otherwise the rolling elements can slide and a premature failure of the Screw Assembly may occure.

Preload with high dynamic processes

During high dynamic processes the preload of the Screw Assembly should not be cancelled. Otherwise intensified wear may occoure due to sliding of the rolling elements. Hence premature damage or defects of the Screw Assembly may occure.

Printout

A printout contains all necessary calculation parameters and results. It can be generated in this **input mask**. A complete examination of used calculation parameters by the application engineer or customer is absolutely necessary. Further customized data (e.g. name, address etc.), the address of the design engineer and the designation of the individual masses can be entered.

q_s (stroke percentages)

The stroke percentages of q_s indicate the distance percentage of a respective phase for all considered dynamic phases.

q_t (time percentages)

The time percentages q_t indicate for all phases (stroke distances) the allocated (assigned) time of a respective phase.

Quit

Quit is located in the listing file. Hereby the calculation can be cancelled or closed.
(Attention: The calculation file is not saved yet!)

Rights to use

(see imprint)

s (stroke distance)

The stroke distance s indicates for each phase the covered distance (within the total stroke). The stroke distance s is required for calculating the stroke percentages of qs. Thus the equivalent total load is computed according to formula (1).

$$F_{Equi,total} = \sqrt[3]{F_{total,1}{}^3 \times \frac{q_1}{100} + F_{total,2}{}^3 \times \frac{q_2}{100} + ... + F_{total,l}{}^3 \times \frac{q_l}{100}} \qquad (1)$$

with:

$F_{total,1}..F_{total,l}$	=	Total load for the Screw Assembly per stroke [N]
$q_1 ...... q_l$	=	stroke percentage of each phase [%]
l	=	number of phases per cycle

Selection of language

The calculation program offers both a German and English-language version. The language can be selected under the menu item language.

Short stroke

Short stroke exists when the stroke is less than 3,5 x (srew lead) lead of the screw P x i (number of ball track turns). In this case special maintenance and lubrication references in the catalog must be considered.

With short stroke sometimes a reduction of the load capacity is necessary (see load capacity reduction, e.g. with short stroke in the **mask data**).

Start position of the BSA/PLSA-Nut with stroke movement Dx

The start position of the Nut with stroke movement Dx indicates the distance of the screw nut displacement to the left side (actual start position for the stroke).

Stroke distance percentages q_s

The stroke percentages q_s indicate the distance percentages of the respective phase for all phases (strokes). Thus the equivalent total load is calculated according to formula (1).

$$F_{Equi,total} = \sqrt[3]{F_{total,1}{}^3 \times \frac{q_1}{100} + F_{total,2}{}^3 \times \frac{q_2}{100} + ... + F_{total,l}{}^3 \times \frac{q_l}{100}} \qquad (1)$$

with:

$F_{total,1}..F_{total,l}$	=	total load for the Screw Assembly per stroke [N]
$q_1 ...... q_l$	=	stroke percentage of individual phases [%]
l	=	number of phases per cycle

Switch on time in the phase q_t

The switch on time in the phase q_t indicates the proportional cyclic duration of an individual phase in comparison to the total period.

Switch on time of the axis

The switch on time indicates the total cyclic actuation of the axis with the input via strokes. This information is necessary for calculation of the average speed and the theoretical lifetime.

System requirements

- MS Windows 98, ME, XP, or Windows NT, Win7, Win8
- Actual PC, Performance as Pentium IV 1 GHz
- RAM $\geq$ 128 MB
- MS Internet Explorer $\geq$ 5.5 and actual Word

T (Phase)

t indicates the period of a respective phase (stroke distance). It can be assigned in all three dynamic cycle set masks “**input via dynamic cycle**”, “**input via percentages of time**” and “**input via strokes**”.

Thermal balance at PLSA

Due to the friction during high dynamic processes the temperature is higher at the PLSA nut. An alignment of the total friction power to the convection power is necessary. Is the total friction power higher than the convection power the switch on time must be lower.

Training

courses on request

Type of Screw Assembly system

In the pull-down menu of the same title, the type of the Screw Assembly system can be selected in the **input mask data**.
Following types are selectable:

- Standard Ball Screw Assembly system (The BSA nut types of eLINE, Miniature and the drive unit AOK are completely contained)
- Drive Unit with Ball Screw Assembly Unit AGK
- Drive Unit with Ball Screw Assembly Unit FAR
- Standard PLSA

Type of nut

In the pull-down menu of the same title, the type of nut can be selected in the input mask data (see mask data).