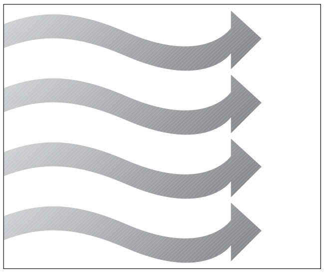
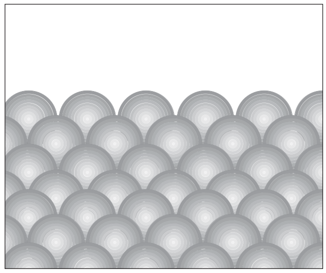
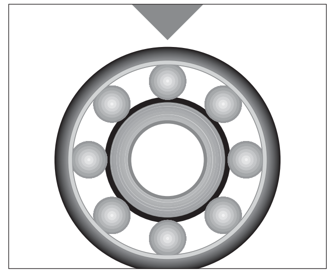
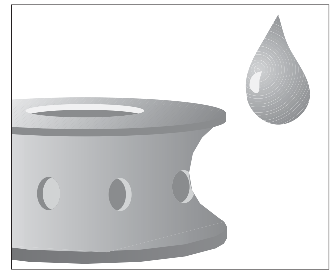
The New Class defines the performance limits of screw jacks









The design

The cubic shape with integrated cooling fins permits a longer duty cycle, as the heat is dissipated more effectively, thus extending the service life of the lubricant. The surface coating simultaneously protects the jack against corrosion.

The housing material

The mechanical strength of the housing has been improved, particularly at high temperature, through the use of spheroidal graphite iron instead of the former cast iron. This ensures greater reliability, even in tough service conditions.

The bearings

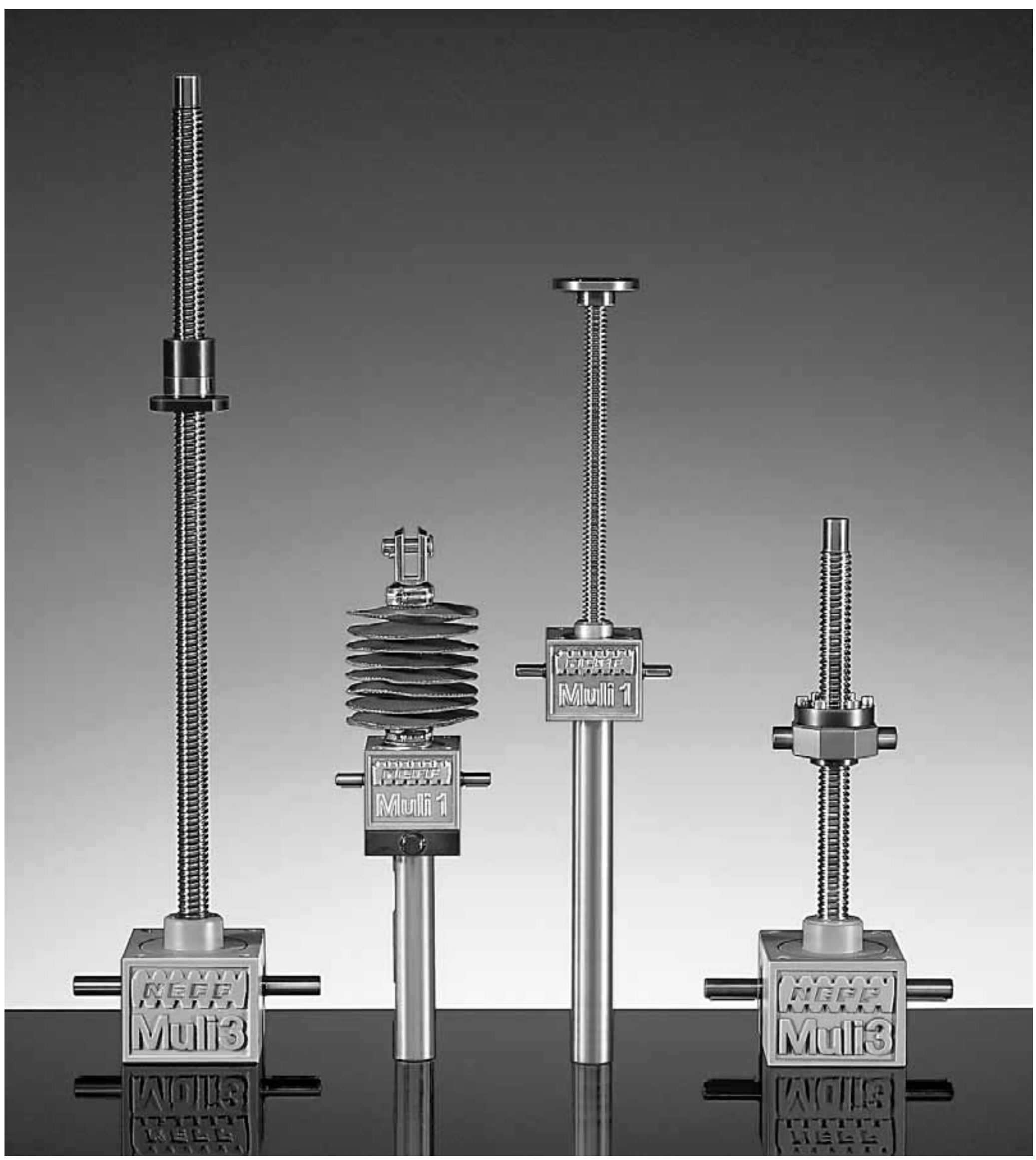
Taper roller bearings on the worm shaft and heavy-duty ball bearings as the main thrust bearings make it possible to move higher loads, increase the safety reserve and extend the service life.

The lubrication

The trapezoidal screw (version N) is greased by radial lubrication holes on the worm wheel. The resultant lower friction and temperature extends the service life, particularly when operating with longer stroke lengths.

The range of NEFF worm gear screw jacks comprises ten models with lifting capacities from 5 to 500 kN. All versions are designed for both tensile and compressive loads and will operate in any orientation or mounting position.
They meet the most demanding technical standards:

- Wide range of load capacities
- High and low speeds
- Cubic shape of the housing with predrilled flange bores allows ideal attachment of a motor, gearbox or rotary encoder
- Standard mounting parts and end fittings
- Easy synchronization of several worm gear screw jack units
- With ball screw or trapezoidal screw, as required for the application concerned
- Extensive variations, also for special requirements (e.g. safety nut)
- Complete range of accessories

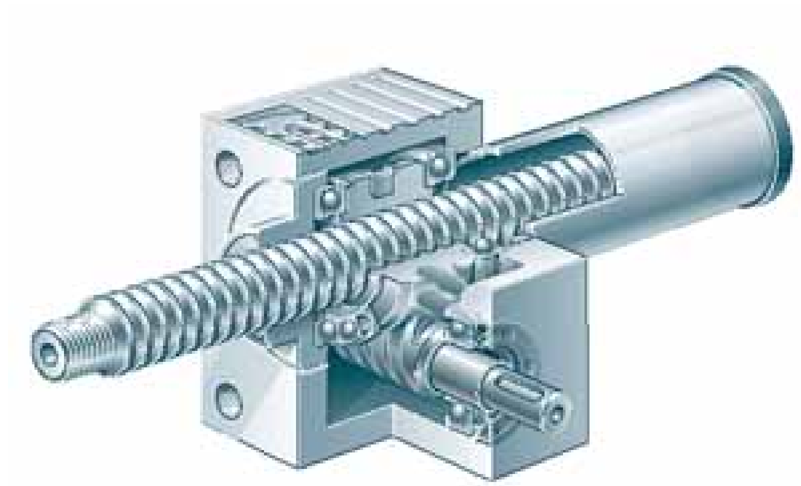


Worm gear screw jacks
Design versions

MULI® 1
to
MULI® 5
(5–100 kN)

Axially translating screw **Version N or V**

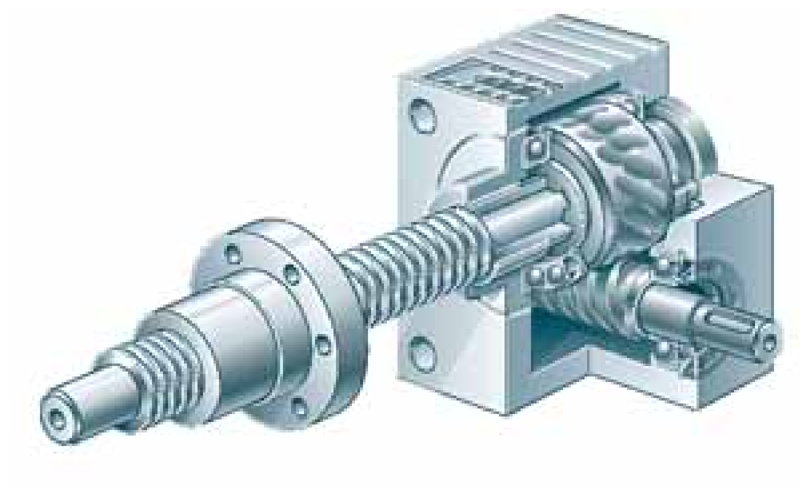
The rotary motion of precision worm gearing (worm shaft and internally threaded worm wheel) is converted into axial linear motion of the screw, which travels/translates through the gearbox housing.
The load is attached to the end of the screw.



JUMBO® 1
to
JUMBO® 5
(150–500 kN)

Rotating screw **Version R**

Driven by a precision worm gearing (screw keyed to the worm wheel), the rotary motion of the screw is translated into linear motion of the travelling nut on the screw.



Version N

Rotation of the screw is prevented by its permanent attachment to the guided load.

Version V

Version V with anti-rotation device is recommended if the screw cannot be secured externally to prevent rotation.

Version R

Note:
The travelling nut must be ordered separately.

Gear ratio H

One full turn of the worm shaft produces a stroke of 1 mm (see page 10/11).

Gear ratio L

One full turn of the worm shaft produces a stroke of 0.25 mm (see page 10/11).

Trapeziodal screw

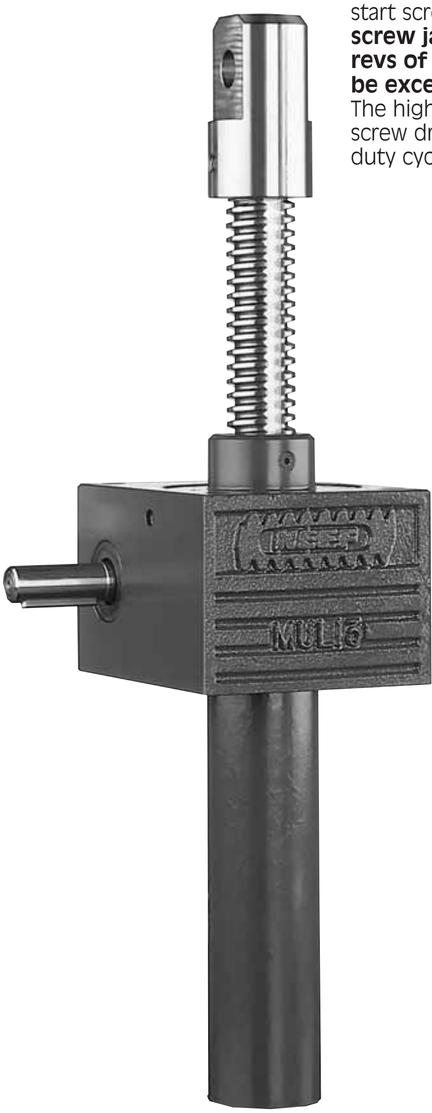
For tough conditions, good price/performance ratio.

Ball screw

For longer duty cycles, with higher efficiency, high positional accuracy.

Technical data
Worm gear screw jacks

The range includes a total of ten worm gear screw jack models in two series: MULI® 1 to MULI® 5 with lifting capacities up to 100 kN and JUMBO® 1 to JUMBO® 5 with lifting capacities from 150 kN to 500 kN statically.



Speed of travel

Gear ratio H (high speed)
For worm gear screw jacks fitted with standard trapezoidal screws, one full turn of the worm shaft produces a stroke of 1 mm and therefore a **linear speed of 1500 mm/minute at 1500 rpm.** The figures for units fitted with ball screws range from 1071 mm/minute to 2142 mm/minute depending on size and pitch.

Gear ratio L (low speed)
For worm gear screw jacks fitted with standard trapezoidal screws, one full turn of the worm shaft produces a stroke of 0.25 mm and therefore a linear speed of 375 mm/minute at 1500 rpm. The figures for units fitted with ball screws range from 312 mm/minute to 535 mm/minute depending on size and pitch.

Please note that higher speeds of travel can be achieved with larger screw pitches or multiple start screws. **The worm gear screw jack's maximum drive revs of 1500 rpm must not be exceeded.**
The higher efficiency of the ball screw drive also permits a longer duty cycle.

Tolerances and backlash

- The gearbox housings are machined on the four mounting sides. The tolerances conform to DIN ISO 2768-mH. The sides that are not machined (the cooling ribs) conform to DIN 1685, GTB 18.

- The axial backlash of the jack screw under alternating load is as follows:
  - Trapezoidal screws: up to 0.4 mm
  - Ball screws: 0.2 mm

- The lateral play between the outside diameter of the screw and the guide diameter is 0.2 mm.

- The backlash in the worm gears is ±4° of the input shaft. A predetermined axial float is built into the input shaft bearing assembly of all models from MULI® 4 upwards to accommodate thermal expansion during operation.

- Trapezoidal screws are manufactured to a straightness of 0.3-1.5 mm/m, ball screws to a straightness of 0.08 mm/m over a length of 1000 mm and to the following pitch accuracies:
  MULI® 1–MULI® 5:
  0.05 mm/300 mm length
  JUMBO® 1–JUMBO® 5:
  0.2 mm/300 mm length

Lateral forces on the jack screw.
Any lateral forces that may occur should be taken by an external guide rail.

Stop collar A

Prevents the screw from being removed from the jack gearbox. Fitted as standard on ball screw versions N and V. Optionally available for screw jacks with trapezoidal screws.
The stop collar cannot be used as a fixed stop.

Self-locking

The self-locking function depends on a variety of parameters:

- Large pitches
- Different gear ratios
- Lubrication
- Friction parameters
- Ambient influences, such as high or low temperatures, vibrations, etc.
- The mounting position

Versions with ball screw and large pitches are consequently **not self-locking.** Suitable brakes or braking motors (on request) must therefore be considered in such cases. **Limited self-locking** is available for smaller pitches (single-start).

Special versions

In addition to the extensive standard range, NEFF can also supply anticlockwise, multi-start and special material worm gear screw jacks on request.

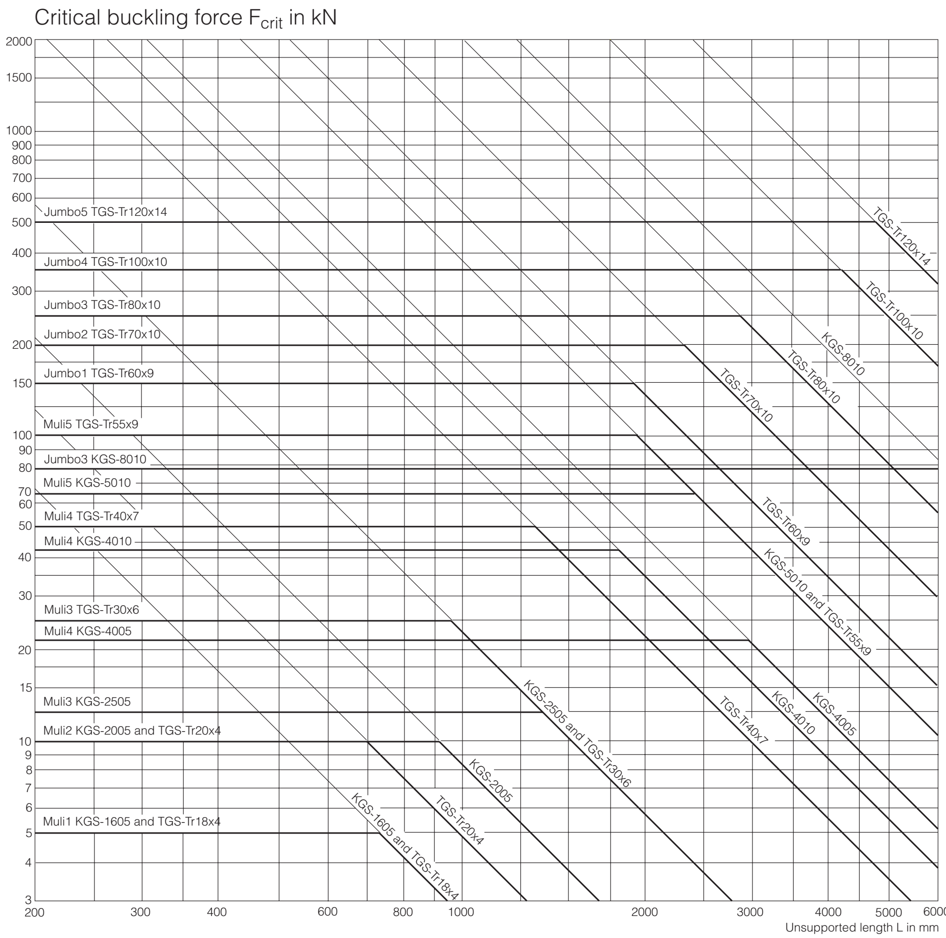
Selection and calculation

Critical buckling force of a screw jack under compressive loads

Thin lifting screws may buckle sideways when subjected to compressive loads. Before the permissible compressive force is defined for the screw. allowance must be made for safety factors as appropriate to the installation.

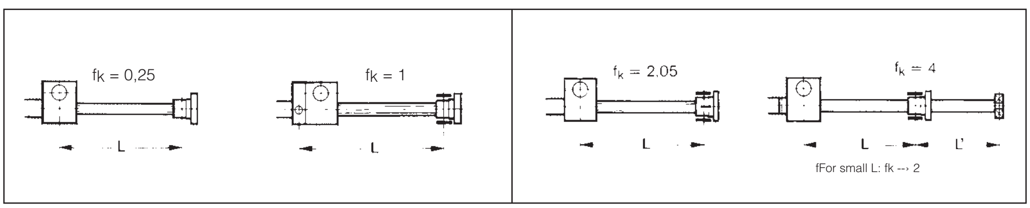
$$F_{eff} \leq f_k \cdot F_{crit} \cdot 1/S_k$$

- F_{eff} is the actual axial force (compressive force) acting on the jack screw in kN.
- f_k is a correction factor which makes allowance for the type of screw bearing. Sufficiently rigid mounting of the worm gear screw jack is consequently a prerequisite for cases 2. 3 and 4.
- F_{crit} is the critical buckling force as a function of the unsupported length L.
- S_k is the safety factor and depends on the application in question. Values between 3 and 6 are customary in general mechanical engineering.



TGS = Trapezoidal screw
KGS = Ball screw

Case 1 **Case 2** **Case 3** **Case 4**



Selection and calculation

Critical speed of jack screws

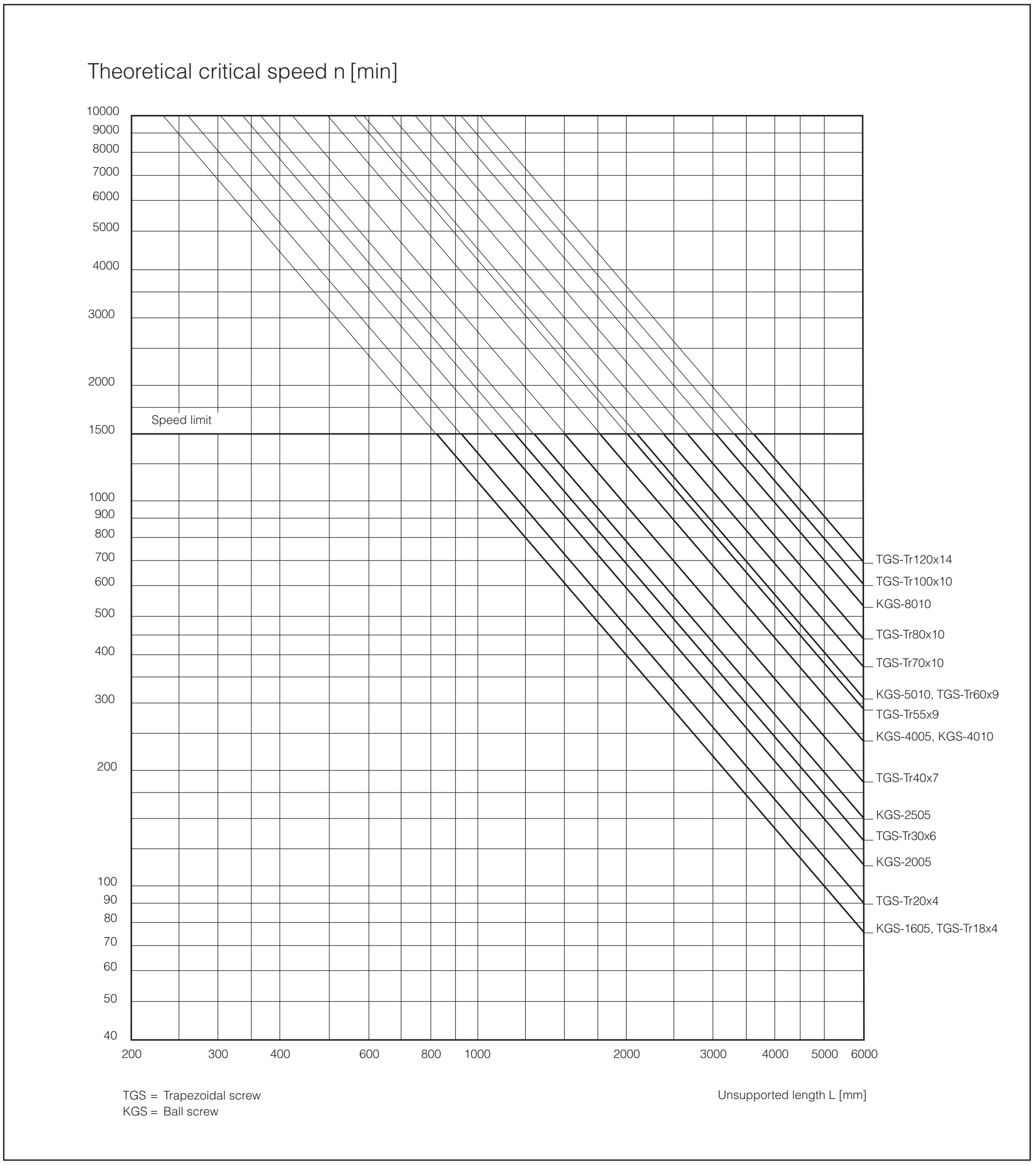
(Version R only)
Resonant bending vibration may develop with thin screws rotating at high speed. Assuming a sufficiently rigid assembly. the resonant frequency can be estimated with the aid of the following method.

$$n_{perm} = f_{kr} \cdot n_{crit} \cdot 0.8$$

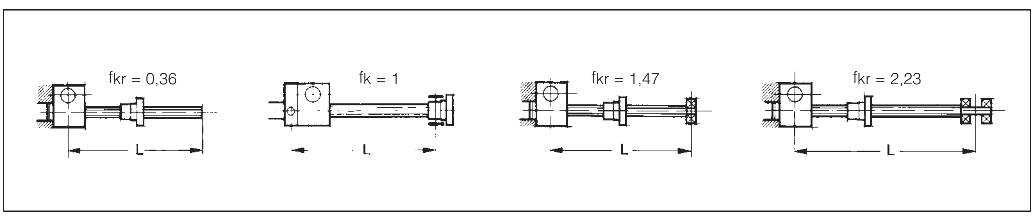
n_{perm} is the maximum permissible screw speed in rpm.

f_{kr} is a correction factor which makes allowance for the type of screw bearing. Sufficiently rigid mounting of the worm gear screw jack and bearing is consequently a prerequisite for cases 2. 3 and 4.

n_{crit} is the critical screw speed; it corresponds to the basic bending vibration of the screw and leads to resonance effects.



Case 1 **Case 2** **Case 3** **Case 4**



Worm gear screw jacks with multi-start screws are also available for applications with high lifting speeds. These versions run at a considerably lower screw speed and better efficiency for the same lifting speed. They are generally not self-locking.

Selection and calculation

Required drive torque for a worm gear screw jack

The required drive torque for a worm gear screw jack is governed by the axial load acting on the jack screw. the transmission ratio and the efficiency. It should be noted that the breakaway torque may be considerably higher than the torque required for continuous running. This applies in particular to worm gear screw jacks with low efficiency after a long standstill period. The acceleration torque should be checked if necessary in cases with large screw pitches and very short run-up times.

$$M_T = \frac{F_{eff}}{2 \cdot \pi \cdot \eta} \cdot \frac{P}{i} + M_0$$

M_T is the required drive torque of the worm gear screw drive at the worm shaft in Nm.

F_{eff} is the actual force acting on the jack screw in N.

η is the efficiency of the worm gear screw jack in decimal notiation. e.g. 0.32 instead of 32% (for values. see table on page 11). η is an average value determined by measurement.

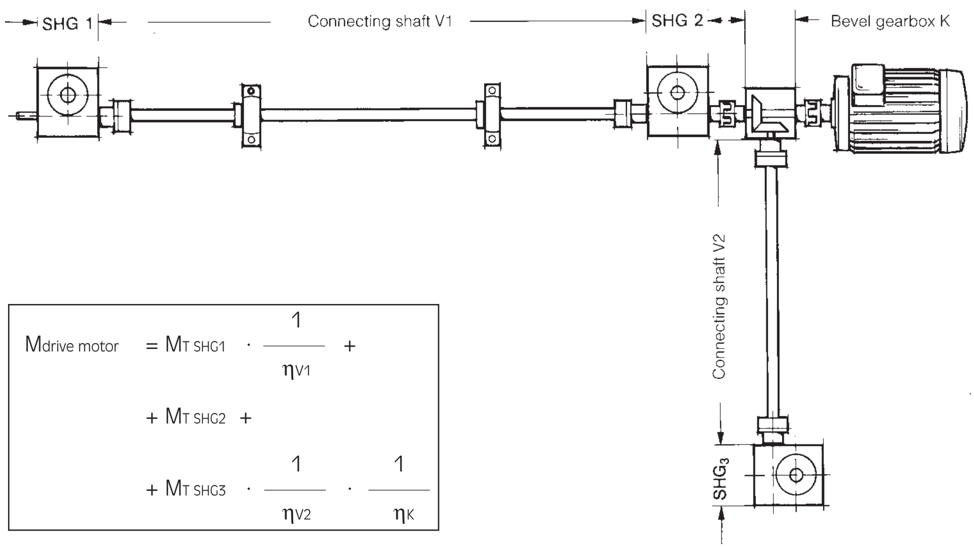
$\frac{p}{i}$ is the transmission ratio of the worm gear screw drive in mm stroke length per revolution of the worm shaft.

M_0 is the idle torque of the worm gear screw drive in Nm. Mo is determined by measurements undertaken after a brief running-in period with liquid grease lubrication at room temperature. It represents an average value which may vary to a greater or lesser extent. depending on the running-in state. lubricant and temperature. For values. see table on page 11

Required drive torque for a worm gear screw jack system

The required drive torque for a worm gear screw jack system is governed by the drive torque values for the individual jacks. with allowance for the static and dynamic frictional losses in transmission components (coupling. connecting shafts. pedestal bearings. angle gearboxes. etc.). It is useful to draw a diagram illustrating the flow of forces.

Example



$$M_{drive\ motor} = M_{T\,SHG1} \cdot \frac{1}{\eta_{V1}} + M_{T\,SHG2} + M_{T\,SHG3} \cdot \frac{1}{\eta_{V2}} \cdot \frac{1}{\eta_K}$$

$M_{T\,SHG1}$ is the required drive torque for the worm gear screw jack SHG 1. It should be noted that the start-up torque (breakaway torque and possibly acceleration torque) may be considerably higher than the torque required for continuous running. This applies in particular to worm gear screw jacks with low efficiency after a long standstill period.

η_{V1} is the efficiency of connecting shaft V1

η_{V2} (V2) includes the static and dynamic frictional losses in the pedestal bearings and couplings.

η_V = 0.75...0.95 depending on the length of the shaft and number of pedestal bearings.

η_K is the efficiency of the bevel gearbox (only for the force flow via the toothing. i.e. between connecting shaft V2 and the drive motor).

$\eta_K = 0.90$

Selection and calculation

Maximum drive torque

If the worm gear screw jack jams as a result of the screw coming into contact with an obstacle. the toothing can still absorb the following maximum torque values M_T at the drive shaft.
In the case of screw jacks connected in series. the screw jack closest to the drive can absorb this torque at its drive shaft.

Size	$M_{T\,max}$ [Nm]
MULI 1	3.4
MULI 2	7.1
MULI 3	18
MULI 4	38
MULI 5	93
JUMBO 1	148
JUMBO 2	178
JUMBO 3	240
JUMBO 4	340
JUMBO 5	570

Forces and torque values acting on the drive shaft

If worm gear screw jacks are not driven free of lateral forces by means of a coupling connected to the motor shaft. but are instead driven by chains or belts. care must be taken to ensure that the radial force acting on the drive shaft does not become excessive. The values are specified in the following table.
In the worst case. the worm shaft will bend under radial force F_R and lift off the worm gear. This must be avoided. since it impairs the engagement between worm shaft and worm gear and leads to higher wear.

Size	$F_{R\,max}$ [kN]
MULI 1	0.1
MULI 2	0.2
MULI 3	0.3
MULI 4	0.5
MULI 5	0.8
JUMBO 1	0.8
JUMBO 2	1.3
JUMBO 3	1.3
JUMBO 4	2.1
JUMBO 5	3.1

Selection of drive motor

A suitable drive motor can be selected when the required drive torque and drive speed are known. After selecting a drive motor. check that it will not overload any of the worm gear screw jacks or transmission components. This risk may occur. in particular. in installations with several screw jacks if they are loaded unevenly. It will generally be necessary to install limit switches or torque-limiting couplings to protect the installation against impacting against end positions and obstacles.

Forces and torque values on the motor shaft

Toothed-belt or chain drives may exert considerable radial forces on the motor shaft if a very small sprocket is used. Please consult the motor manufacturer in cases of doubt.

Selection of a bevel gearbox

Selection of a bevel gearbox is governed by the following factors:

- Drive torque
- Drive speed (see dimensional tables)
- Duty cycle and drive power
- Forces and torque values acting on the ends of the shaft (please consult us in cases of doubt)

Required drive speed

The required drive speed is governed by the desired lifting speed. the transmission ratio of the jack and the transmission ratio of the other transmission components. A particular lifting speed can normally be achieved in several ways. Correct selection depends on the following criteria:

- Favourable efficiency
- Minimum load on transmission components in order to achieve compact. low-cost design
- Avoiding critical speeds for jack screws and connecting shafts.

Jack screw nut torques

The nut torque (M) of the jack screw is the torque that the jack screw exerts on the mounting plate (all N versions except V), or the torque that the screw applies to the travelling nut (R Version). It is not to be confused with the dirve torque (MT) of the screw jack gears on the worm shaft.

$$M\ [\mathrm{Nm}] = F_{eff}\ [\mathrm{kN}] \cdot f_M$$

(applicable in the areas of moderate and high loads)

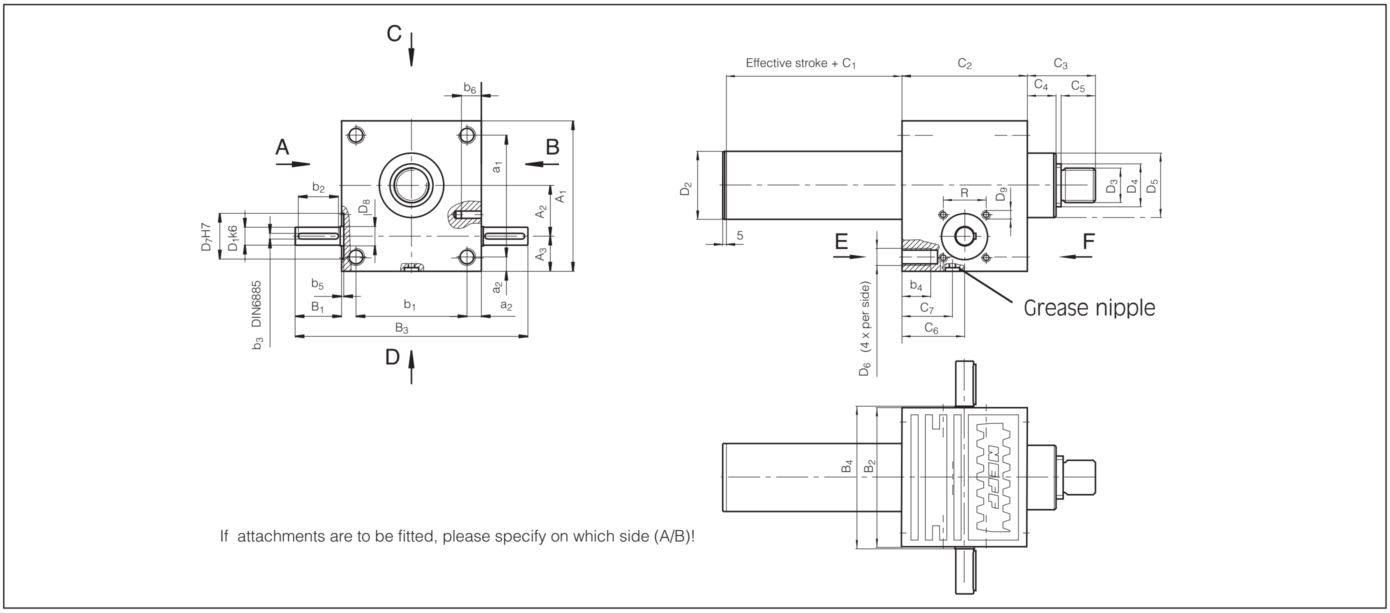
M is the jack screw nut torque in Nm for the “Lift under Load” movement.

F_{eff} is the actual supported axial force in kN.

f_M is a conversion factor that accounts for screw geometry and friction. The value is applicable under normal lubrication conditions. In the case of ball screw dirves, f_M is practically constant.

Size	f_M (trapezoidal)	f_M (ball screw)
MULI 1	1.6	1.6
MULI 2	1.8	1.6
MULI 3	2.7	1.6
MULI 4	3.4	1.6/3.2
MULI 5	4.6	3.2
JUMBO 1	5.5	–
JUMBO 2	6.4	–
JUMBO 3	7.2	3.2
JUMBO 4	8.0	–
JUMBO 5	10.6	–

Technical data
Dimensions, versions N, V



If attachments are to be fitted, please specify on which side (A/B)!

Size	Dimensions [mm]															
	A_1	A_2	A_3	a_1	a_2	B_1	B_2	B_3	B_4	b_1	b_2	b_3	b_4	b_5	C_1	C_2	C_3 1)
MULI 1	80	25	24	60	10	24	72	120	77	52	18	3	13	1.5	20	62	35(46)
MULI 2	100	32	28	78	11	27.5	85	140	90	63	20	5	15	1.5	30	75	45(48.5)
MULI 3	130	45	31	106	12	45	105	195	110	81	36	5	15	2	30	82	50
MULI 4	180	63	39	150	15	47.5	145	240	150	115	36	6	16	2	45	117	65
MULI 5	200	71	46	166	17	67.5	165	300	170	131	56	8	30	2.5	55	160	95
JUMBO 1	210	71	49	170	20	65	195	325	200	155	56	8	40	8	55	175	95
JUMBO 2	240	80	60	190	25	67.5	220	355	225	170	56	8	45	8	55	165	110
JUMBO 3	240	80	60	190	25	67.5	220	355	225	170	56	8	45	8	55	165	110
JUMBO 4	290	100	65	230	30	65	250	380	255	190	56	10	54	8	65	220	140
JUMBO 5	360	135	75	290	35	100	300	500	305	230	90	14	80	8	90	266	200

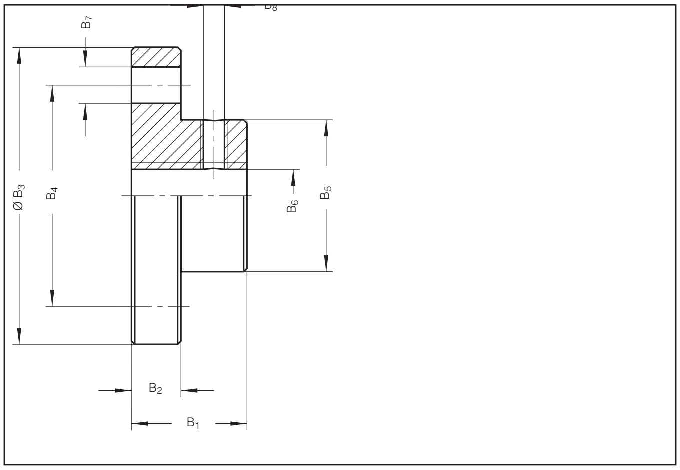
Size	Dimensions [mm]														
	C_4 2)	C_5	C_6	C_7	D_{1k6} 4)	D_2 3)	D_3 6)	D_4Tr	D_4KGT	D_5 2)	D_6	D_{7H7}	D_8	D9xb6 7)	□R (TK) 7)	V-KGT
MULI 1	12(23)	19	31	22	10 x 21.5	33	M12 x 1.75	Tr18 x 4	1605	29.6(48)	M8	28	12	M5x10	32 (45.25)	30x30
MULI 2	18(21.5)	20	37.5	27	14 x 25	40	M14 x 2.0	Tr20 x 4	2005	38.7(61)	M8	35	15	M6x12	35 (49.5)	40x40
MULI 3	23	22	41	29	16 x 42.5	50	M20 x 2.5	Tr30 x 6	2505	46	M10	35	17	M8x12	44 (62.2)	50x50
MULI 4	32	29	58.5	42.5	20 x 45	60	M30 x 3.5	Tr40 x 7	4005/4010	60	M12	52	25	M10x15	55 (77.8)	60x60
MULI 5	40	48	80	53	25 x 65	82	M36 x 4	Tr55 x 9	5010	85	M20	52	28	M12x18	60 (84.85)	80x80
JUMBO 1	40	48	87.5	60	25 x 62.5	90	M48 x 2	Tr60 x 9	–	90	M24	52	28	M12x18	60 (84.85)	–
JUMBO 2	40	58	82.5	60	30 x 65	115	M56 x 2	Tr70 x 10	–	105	M30	58	32	M12x18	(80)	–
JUMBO 3	40	58	82.5	60	30 x 65	115	M64 x 3	Tr80 x 10	8010	120	M30	58	32	M12x18	(80)	120x120
JUMBO 4	50	78	110	86	35 x 62.5	133	M72 x 3	Tr100 x 10	–	145	M36	72	40	M16x30	(100)	–
JUMBO 5	60	118	133	109	48 x 97.5	153	M100 x 3	Tr120 x 14	–	170	M42	80	50	M16x40	(115)	–

1) This dimension refers to the closed height and represents a minimum. It must be increased if bellows are used (see page 22).
2) The values in brackets refer to version with ball screw.
3) Square tube for version with ball screw and anti-rotation device.
4) Diameter and length to shoulder.
5) Dimension A_1 in accordance to DIN 1685 GTB 18.
6) In accordance to DIN 13 screw thread: MULI.
In accordance to DIN 13 fine pitch thread: JUMBO.
7) JUMBO 2-5 only 3 holes

Accessories
Attachments

Top plate BP

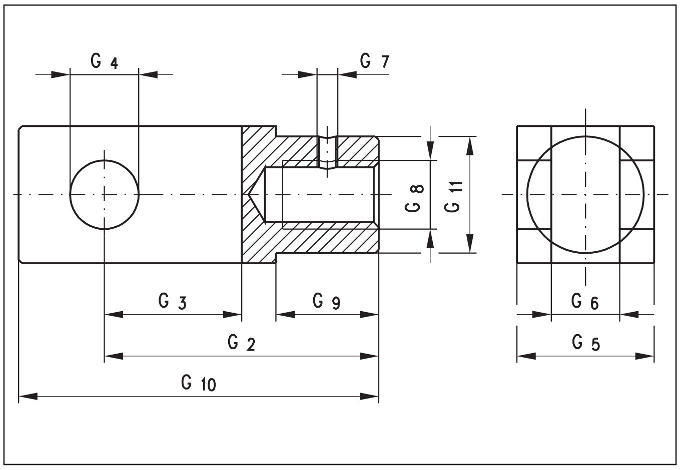
Screwed onto the mounting thread of the jack screw and protected against rotation.



Size	Dimensions [mm]								Weight [kg]	Ident No.
	B_1	B_2	ø B_3	B_4	B_5	B_6	B_{7x4}	B_8		
BP MULI 1	20	7	65	48	29.3	M12	9	M5	0.2	9204400008
BP MULI 2	21	8	80	60	38.7	M14	11	M6	0.3	9204400009
BP MULI 3	23	10	90	67	46	M20	11	M8	0.6	9204400010
BP MULI 4	30	15	110	85	60	M30	13	M8	1.2	9204400011
BP MULI 5	50	20	150	117	85	M36	17	M10	4.8	9204400012
BP JUMBO 1	50	25	170	130	90	M48x2	21	M10	5	9204400013
BP JUMBO 2	60	30	200	155	105	M56x2	25	M12	7.7	9204400014
BP JUMBO 3	60	30	220	170	120	M64x3	25	M12	9.8	9204400015
BP JUMBO 4	80	40	260	205	145	M72x3	32	M12	18.4	9204400016
BP JUMBO 5	120	40	310	240	170	M100x3	38	M12	29.6	9204400017

Fork end GA

Screwed onto the mounting thread of the jack screw and protected against rotation. Supplied with split pins and collar pins. Galvanized.

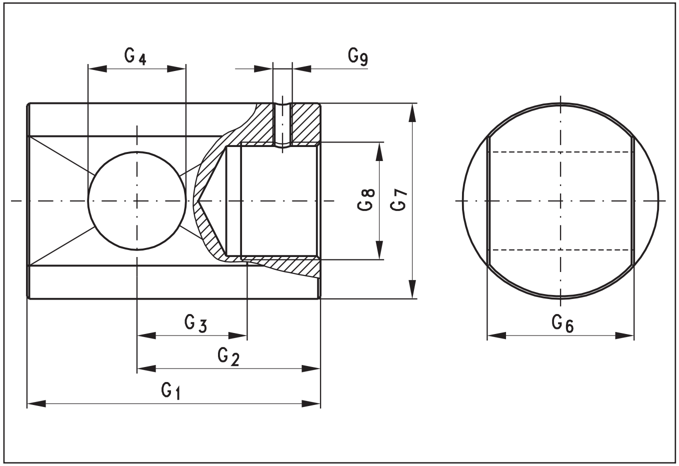


Size	Dimensions [mm]										Weight [kg]	Ident No.
	G_2	G_3	G_4H9	G_5□	G_6B12	G_7	G_8	G_9	G_{10}	G_{11}		
GA MULI 1	48	24	12	24	12	115	M12	18	62	20	0,15	9204350023
GA MULI 2	56	28	14	28	14	116	M14	22	72	24,5	0,2	9204350024
GA MULI 3	80	40	20	40	20	118	M20	30	105	34	0,8	9204350025
GA MULI 4	120	60	30	60	30	118	M30	43	160	52	2,5	9204350026
GA MULI 5	144	72	35	70	35	1110	M36	40	188	60	3,8	9204350027

Accessories
Attachments

Clevis end GK

Screwed onto the mounting thread of the jack screw and protected against rotation.



Size	Dimensions [mm]								Weight [kg]	Ident.-No.
	G_1	G_2	G_3	G_4H8	G_6H10	G_7	G_8	G_9		
GK MULI 1	55	40	15	10	15	30	M12	115	0,2	9204350016
GK MULI 2	63	45	18	12	20	39	M14	116	0,3	9204350017
GK MULI 3	78	53	20	16	30	45	M20	118	0,6	9204350018
GK MULI 4	100	70	30	20	35	60	M30	118	1,2	9204350019
GK MULI 5	130	97	33	22	40	85	M36	1110	2,5	9204350020
GK JUMBO 1	120	75	45	40	60	90	M48x2	1110	4,8	9204350028
GK JUMBO 2	130	90	50	50	70	105	M56x2	1112	4,8	9204350029
GK JUMBO 3	155	105	60	60	80	120	M64x3	1112	8,0	9204350030
GK JUMBO 4	220	135	85	80	110	145	M72x3	1112	22,5	9204350031
GK JUMBO 5	300	200	100	90	120	170	M100x3	1112	31,5	9204350032

Accessories
Protection

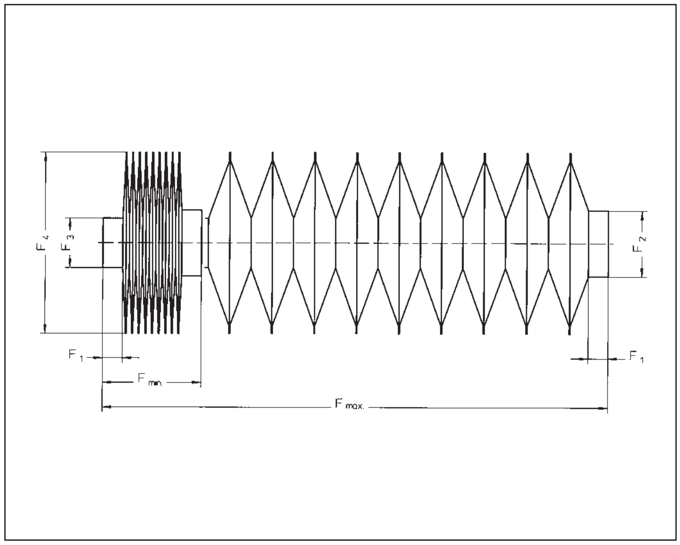
Bellows F

Length: For each 150 mm of open length up to 1.80 m, allow 8 mm when calculating the closed length. Allow 10 mm for each 150 mm over 1.80 m. The calculated length is added to value C_3 (see page 12) as screw extension.
Diameter F_2 may differ on the opposite side, depending on the attachment fitted.

Important: The installation position must be specified, as internal support rings must be fitted when the jack is operated in a horizontal position. When installed vertically, bellows over 2 meters have textile tapes.
The same information is also required for the second bellows when ordering version R (rotating screw).
Material: PVC-coated polyester, stitched construction. Temperature range -30 °C to 70 °C. Secured in position by clamping rings. Special versions on request.

Flat spiral spring covers SF

Available on request (refer also to the catalog Screw drives GT, KOKON.



Size		Dimensions [mm] F_1	F_2	F_3	F_4
F MULI 1	N/V TGS[1)]	12	30	30	101
	N/V KGS[1)]	12	48	30	101
	R	12	30	28	101
F MULI 2	N/V TGS[1)]	12	39	39	113
	N/V KGS[1)]	12	61	39	113
	R	12	39	32	113
F MULI 3	N/V	20	46	46	127
	R	20	46	38	127
F MULI 4	N/V	20	60	60	140
	R TGS/KGS-4010	20	60	63	140
	R KGS-4005	20	60	53	140
F MULI 5	N/V	20	85	85	152
	R	20	85	72	152
F JUMBO 1	N/V	20	90	90	165
	R	20	90	85	165
F JUMBO 2	N/V	20	105	105	175
	R	20	105	95	175
F JUMBO 3	N/V	20	120	120	191
	R	20	120	105	191
F JUMBO 4	N/V	20	145	145	201
	R	20	145	130	201
F JUMBO 5	N/V	20	170	170	245
	R	20	170	160	245

[1)] TGS = Trapezoidal screw
KGS = Ball screw

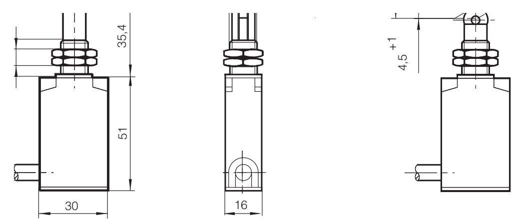
Accessories
Protection

Limit switches with roller lever

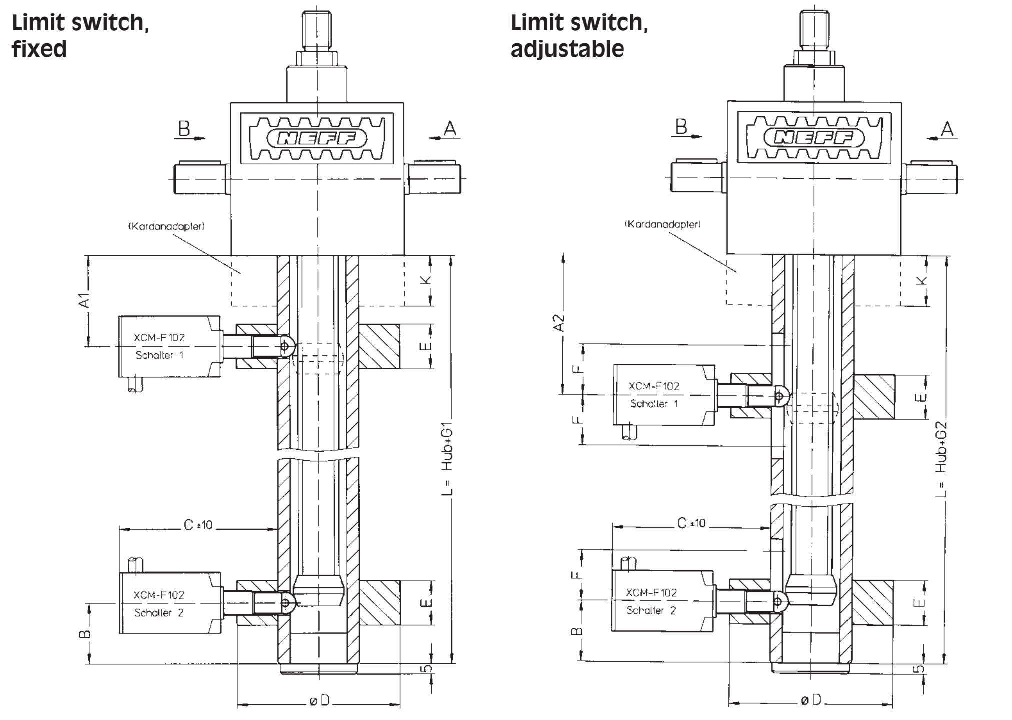
Particularly suitable for end-position shutoff (also available in explosion-proof design).

Actuating cam 30° in accordance with DIN 69 639:
A (Minimum actuating stroke): 2.6 ± 0.5 mm
B (Differential stroke): 0.85 ± 0.25 mm
F0 (Minimum switch-on force): 1 N
Ve (Approach velocity): 0.001 to 0.1 m/s

Connection:
5-core cable with PVC sheath, 1 m long
Conductor cross-section 0.75 mm²
Brown/blue: NO contact
Black/black: NC contact
Green/yellow: PE conductor
Switching capacity: NF C 63 146 (IEC 947-5-1)
Ident No. 92203259



Limit switch installation position



Size	Dimensions [mm]									
	A1	A2	B	C	ø D	E	F	G1	G2	K
MULI 1	40	65	30	80	80	20	25	82	107	20
MULI 2	45	70	30	80	80	20	25	87	112	25
MULI 3	50	75	30	80	90	20	25	92	117	30
MULI 4	60	85	30	80	100	20	25	102	127	40
MULI 5	70	95	30	80	120	20	25	112	137	50
JUMBO 1	80	105	30	80	140	20	25	122	147	60
JUMBO 2	100	125	30	80	160	20	25	142	167	80
JUMBO 3	100	125	30	80	160	20	25	142	167	80
JUMBO 4	110	135	30	80	170	20	25	152	177	90
JUMBO 5	120	145	30	80	190	20	25	162	187	100

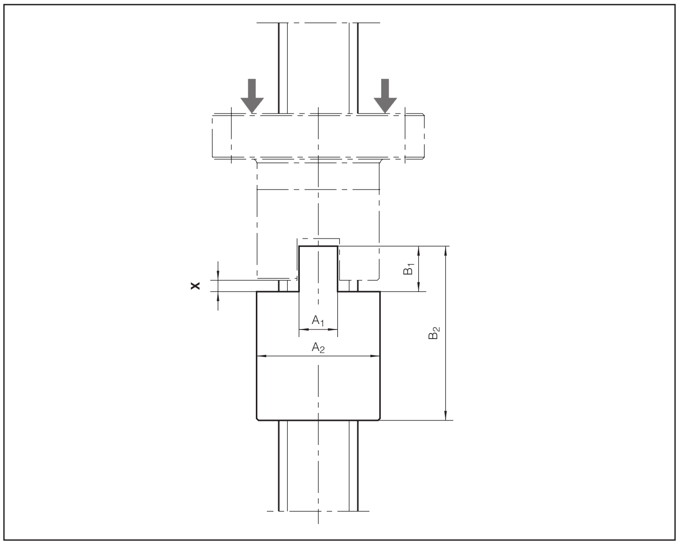
Drives and drive components
Safety nuts

Safety nuts SFM-TGS/ KGS[1)]

For version R: The safety nut is positioned below the travelling nut without axial load and is therefore not subjected to wear The functioning of the safety nuts is guaranteed only when installation and applied forces are as shown in the illustration (see right). As the travelling nut wears, the distance “x“ between the two nuts decreases, which provides a visual check of wear without the need for dismantling.
The travelling nut must be replaced when the axial play on a single-thread screw is more that 1/4 of the lead of the thread (= dimension X). Otherwise, safety cannot be guaranteed.
Wear greater than 1/4 of the lead of the thread can endanger persons and property. Dimension X must be checked regularly.

The safety nut supports the load if the thread form of the travelling nut fails as a result of excessive wear (dirt, lubrication starvation, overheating, etc.).
The safety nut can only be ordered together with the flanged nut (we reserve the right to make design changes).

For version N: The design is similar to that for version R. A visual check for wear is also possible in this case. **Please specify the load direction when ordering.**

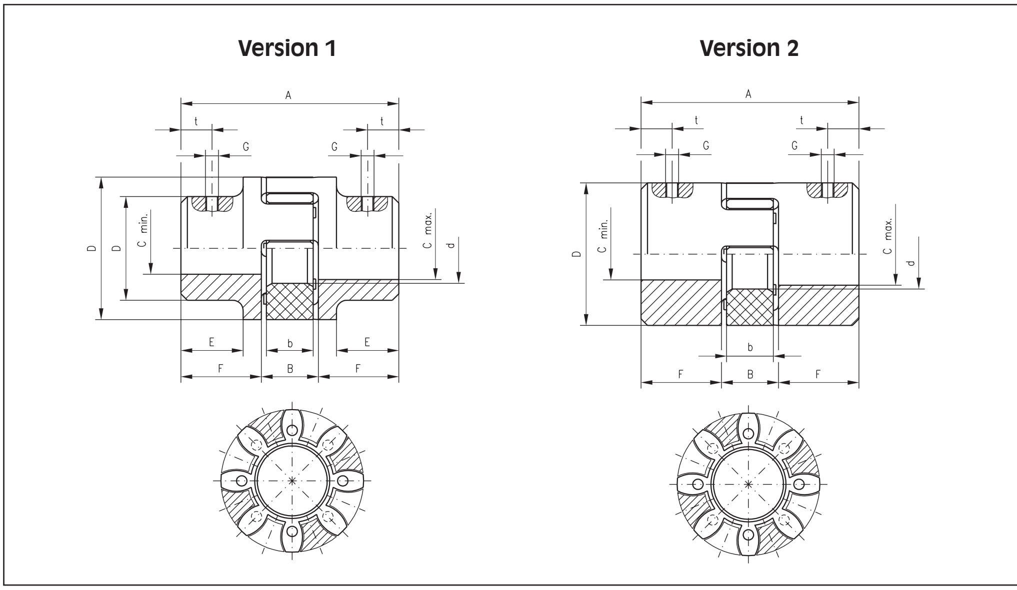


Size	Dimensions [mm] (see pages 13 and 16 for dimensions of travelling nut)					Weight [kg]
	A_1	$A_{2\,-0.5}$	B_1	B_2	X	
SFM MULI 1	10	28	10	44	1	0.45
SFM MULI 2	10	32	10	44	1	0.55
SFM MULI 3	12	38	10	46	1.5	0.70
SFM MULI 4	16	63	15	73	1.75	3.10
SFM MULI 5	20	72	16	97	2.25	4.30
SFM JUMBO 1	20	85	16	99	2.25	5.70
SFM JUMBO 2	25	95	20	100	2.5	11.30
SFM JUMBO 3	25	105	20	110	2.5	13.70
SFM JUMBO 4	30	130	25	130	2.5	23.30
SFM JUMBO 5	40	160	25	160	3.5	45.70

1) KGS on request.

Flexible couplings RA, RG

The torque is transmitted by interlocked, elastic couplings, which compensate for slight axial displacement, radial offset and angular offset. Standard gear rim 92 Shore A.

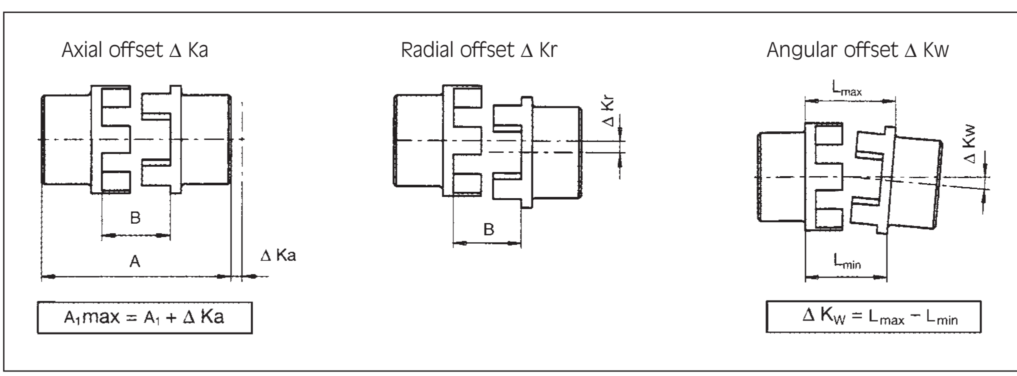


Size	Version	Max. torque	Dimensions [mm]										Offsets				Set-screw tapping		Max. weight d.
													max. axial offset	max. radial offset n=1500 1/min.	Δ Kw [degrees] max. angular offset at n = 1500 1/min		Dim.	Dim.	
		[Nm]	A_1	E	F	B	b	D_1	D	d	C_{min} 1)	C_{max} 1)	Δ Ka [mm]	Δ Kr [mm]	Δ Kw [mm]		G	t	[kg]
RA 14	2	7.5	35	–	11	13	10	–	30	10	6	15	1.0	0.17	1.2	0.67	M4	5	0.05
RA 19	1	10	66	20	25	16	12	32	40	18	10	19	1.2	0.20	1.2	0.82	M5	10	0.15
RA 19/24	2	10	66	–	25	16	12	–	41	18	19	24	1.2	0.20	1.2	0.82	M5	10	0.15
RA 24	1	35	78	24	30	18	14	40	55	27	14	24	1.4	0.22	0.9	0.85	M5	10	0.25
RA 24/28	2	35	78	–	30	18	14	–	56	27	22	28	1.4	0.22	0.9	0.85	M5	10	0.35
RA 28	1	95	90	28	35	20	15	48	65	30	14	28	1.5	0.25	0.9	1.05	M6	15	0.40
RA 28/38	2	95	90	–	35	20	15	–	67	30	28	38	1.5	0.25	0.9	1.05	M6	15	0.55
RA 38	1	190	114	37	45	24	18	66	80	38	16	38	1.8	0.28	1.0	1.35	M8	15	0.85
RA 42	1	265	126	40	50	26	20	75	95	46	28	42	2.0	0.32	1.0	1.70	M8	20	1.2
RA 48	1	310	140	45	56	28	21	85	105	51	28	48	2.1	0.36	1.1	2.00	M8	20	1.7
RG 55	1	410	160	52	65	30	22	98	120	60	30	55	2.2	0.38	1.1	2.3	M10	20	7.3
RG 65	1	625	185	61	75	35	26	115	135	68	40	65	2.6	0.42	1.2	2.70	M10	20	11.0
RG 75	1	975	210	69	85	40	30	135	160	80	40	75	3.0	0.48	1.2	3.30	M10	25	17.9
RG 90	1	2400	245	81	100	45	34	160	200	100	50	90	3.4	0.50	1.2	4.30	M12	30	28.5

1) Not all intermediate sizes are listed in this catalogue. Further sizes on request.

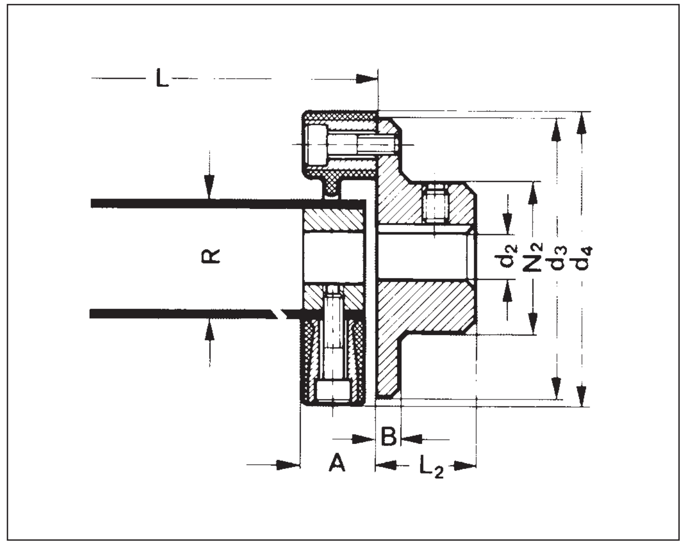
Offsets

On the standard and large hubs, RA 14–48, the tapped hole (G) for the set screw is opposite the groove.
Set screws conform to DIN 916, with serrated, annular cutting edge.



Universal joint shafts GX

Universal joint shafts are used to connect several worm gear screw jacks together. The shafts attenuate noise, vibrations and impacts and compensate for axial, radial and angular errors. They offer exceptional torsional rigidity, high temperature and oil resistance and are particularly suitable where long lengths and/or high speeds are a factor. Elastic articulated shafts are maintenance-free; the central section can be removed radially (to the side) without axial displacement of the connected units. They are supplied as a length of tube (dimension L to be specified by customer) fitted with coupling assemblies at both ends. Pillow blocks are generally not required, except for very long connections.

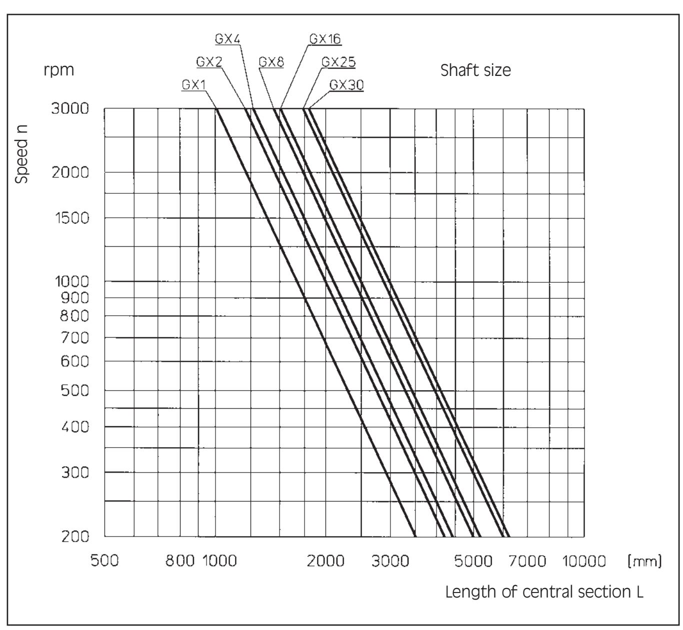


Size	Dimensions [mm]										Weight	
	M[1] [Nm]	A	B	$d_{2\,min}$	$d_{2\,max}$	d_3	d_4	L_2	N_2	R	m_1[2] [kg]	m_2[3] [kg/m]
GX 1	10	24	7	10	25	56	56	24	36	30	0.47	1.05
GX 2	30	24	8	14	38	85	88	28	55	40	1.06	1.42
GX 4	60	28	8	16	45	100	100	30	65	45	2.31	1.61
GX 8	120	32	10	20	55	120	125	42	80	60	3.55	2.16
GX 16	240	42	12	22	70	150	155	50	100	70	6.16	2.53
GX 25	370	46	14	22	85	170	175	55	115	85	9.5	3.09
GX 30	550	58	16	28	100	200	205	66	140	100	15.21	3.64

1) Transmittable torque in Nm
2) m_1 = Weight without central section
3) m_2 = Weight of central section per metre

Shaft diagramm

as a function of length and speed

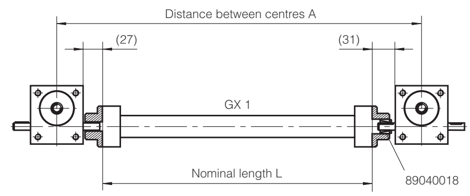


Drives and drive components

Length of the universal joint shaft for MULI® with companion flange

MULI® 1

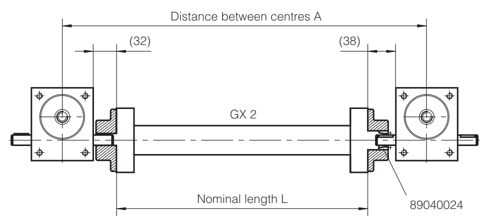
with DKWN companion flange (10–20)
Starting torque of the tensioning element 1.2 Nm



L = A - 130

MULI® 2

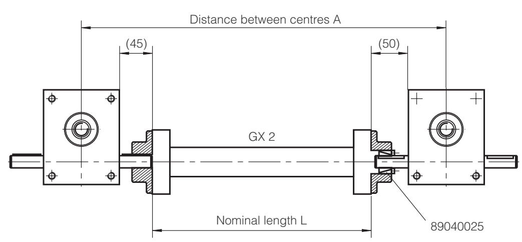
with DKWN companion flange (14–26)
Starting torque of the tensioning element 2.1 Nm



L = A - 155

MULI® 3

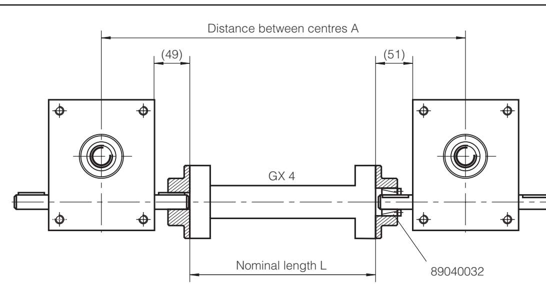
with DKWN companion flange (16–32)
Starting torque of the tensioning element 4.9 Nm



L = A - 200

MULI® 4

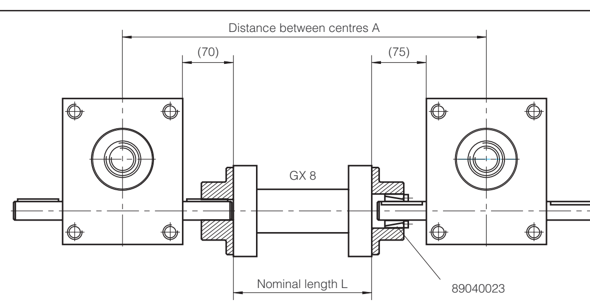
with DKWN companion flange (20–38)
Starting torque of the tensioning element 9.7 Nm



L = A - 245

MULI® 5

with DKWN companion flange (25–47)
Starting torque of the tensioning element 16.5 Nm



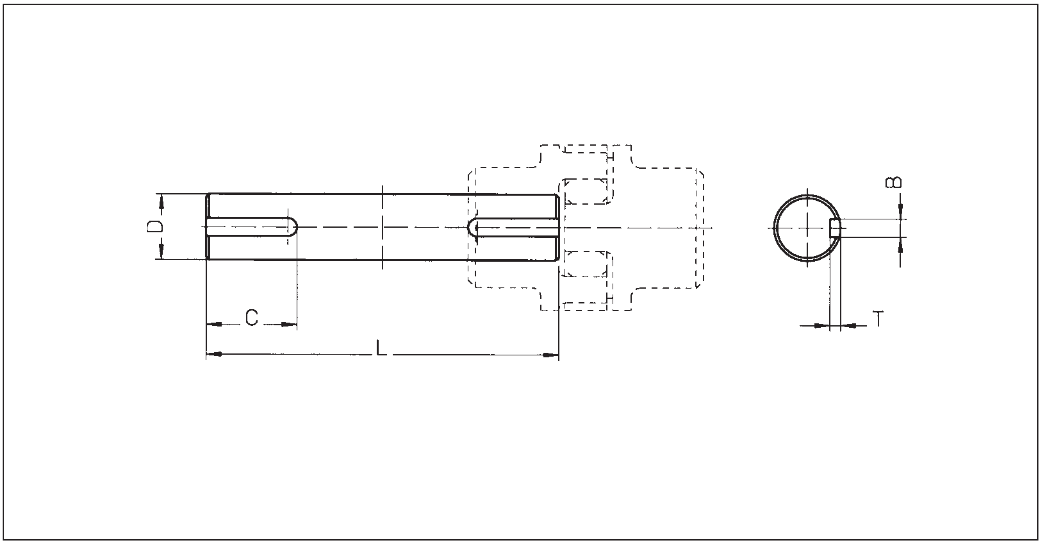
L = A - 310

Drives and drive components

Connecting Shafts, Series VW

Connecting shafts Series VW

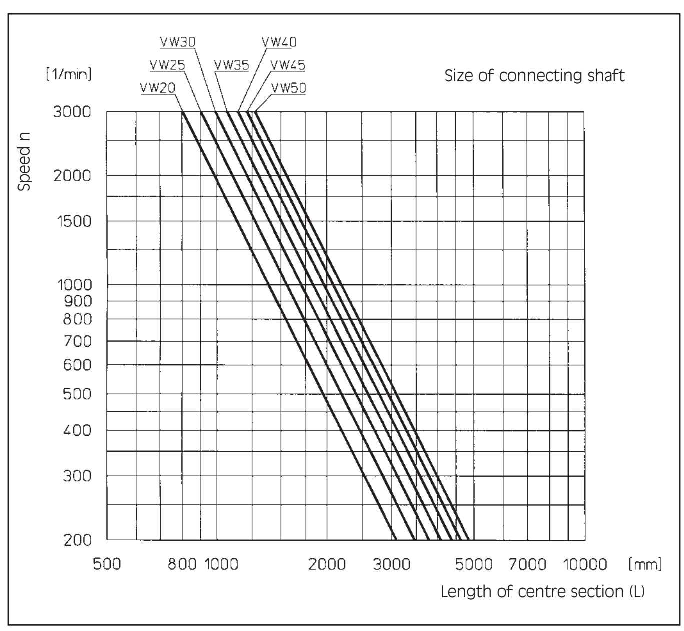
The Series VW connecting shafts are rigid shafts with an engaging groove at each end. For greater distances and diameters of axle, some of these shafts are available as tubular shafts.
The holes in the couplings must be drilled to fit the diameter of the shaft.
(Torques see chart "couplings" on page 29).



Size	D	C	B	T	Ident No. connecting shaft
VW 20	20	30	6	3.5	9204200003
VW 25	25	35	8	4	9204200006
VW 30	30	40	8	4	9204200007
VW 35	35	40	10	5	9204200008
VW 40	40	50	12	5	9204200009
VW 45	45	50	14	5.5	9204200010
VW 50	50	70	14	5.5	9204200011

Connecting shaft diagram

as a function of length and revs.



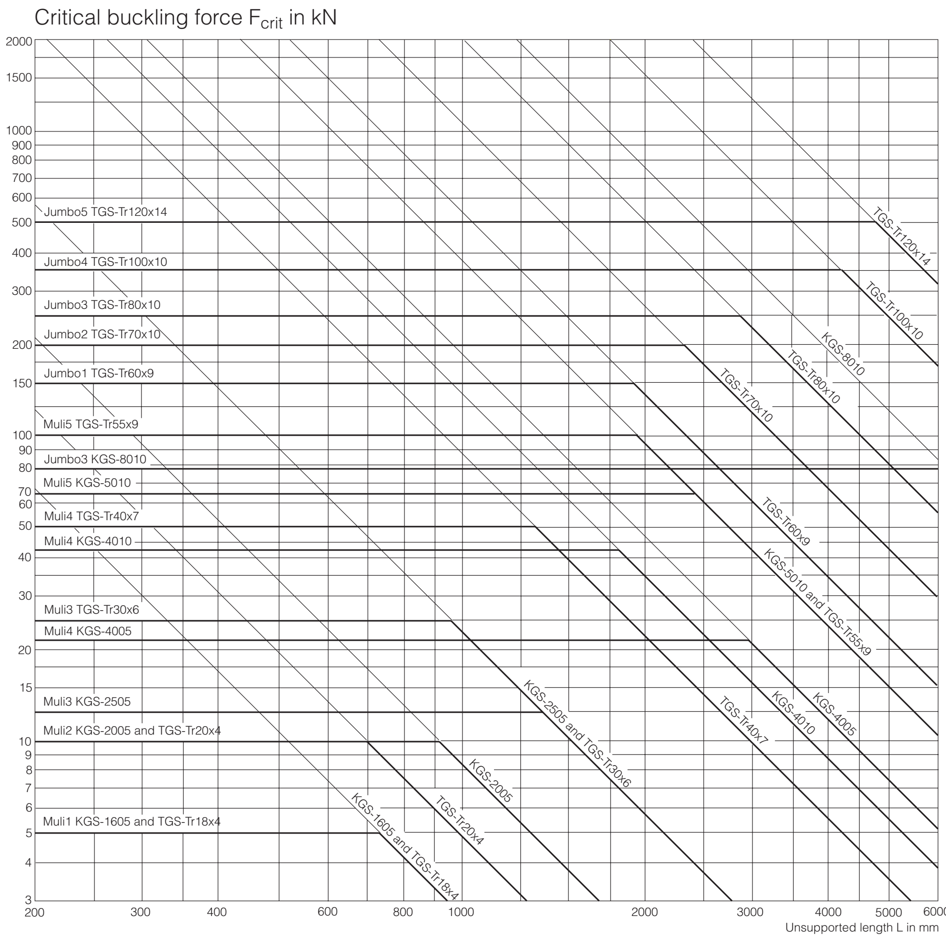
Selection and calculation

Critical buckling force of a screw jack under compressive loads

Thin lifting screws may buckle sideways when subjected to compressive loads. Before the permissible compressive force is defined for the screw. allowance must be made for safety factors as appropriate to the installation.

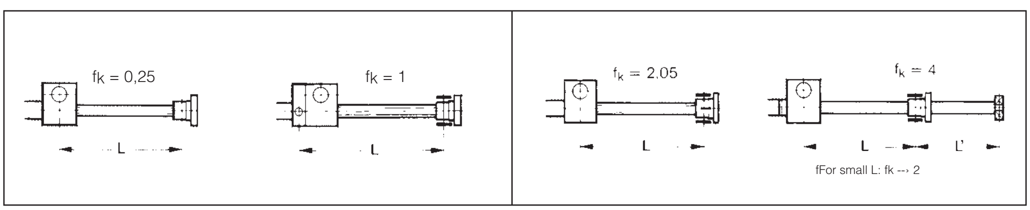
$$F_{eff} \leq f_k \cdot F_{crit} \cdot 1/S_k$$

- F_{eff} is the actual axial force (compressive force) acting on the jack screw in kN.
- f_k is a correction factor which makes allowance for the type of screw bearing. Sufficiently rigid mounting of the worm gear screw jack is consequently a prerequisite for cases 2. 3 and 4.
- F_{crit} is the critical buckling force as a function of the unsupported length L.
- S_k is the safety factor and depends on the application in question. Values between 3 and 6 are customary in general mechanical engineering.



TGS = Trapezoidal screw
KGS = Ball screw

Case 1 **Case 2** **Case 3** **Case 4**



Selection and calculation

Critical speed of jack screws

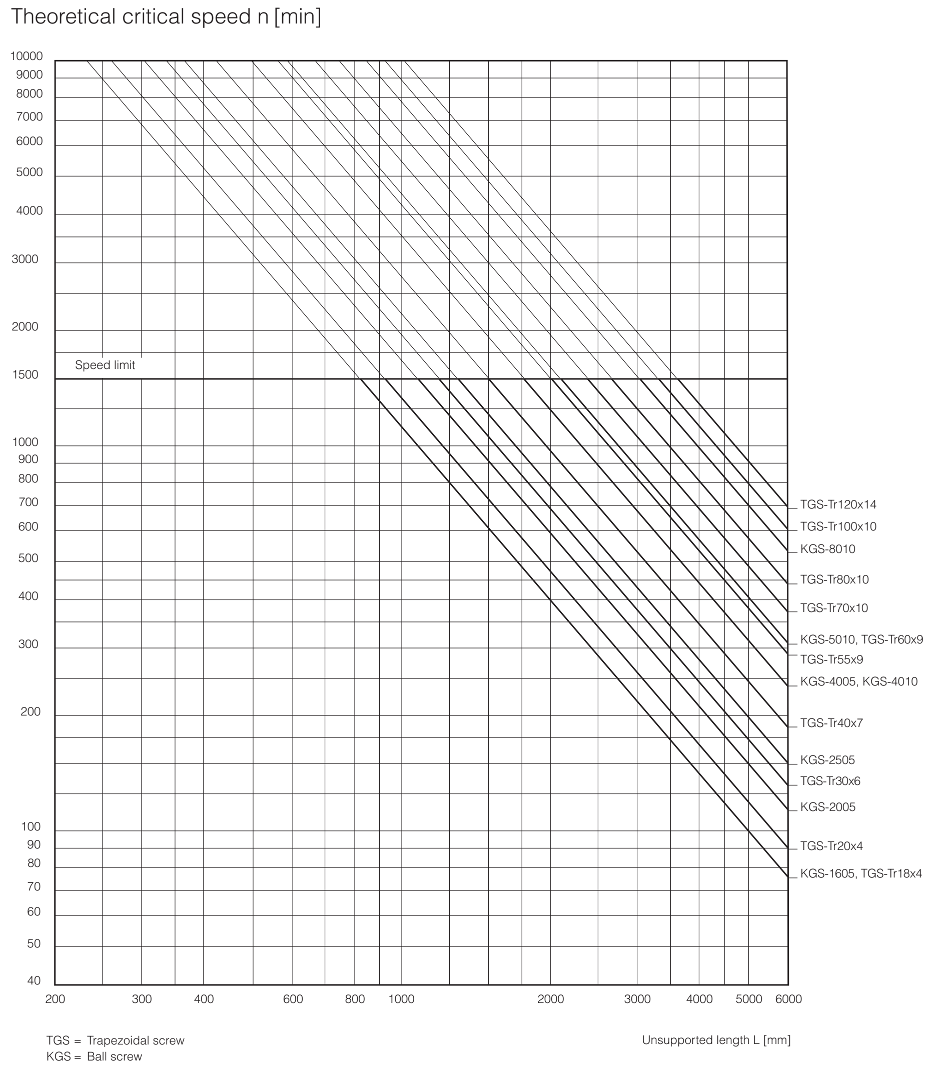
(Version R only)
Resonant bending vibration may develop with thin screws rotating at high speed. Assuming a sufficiently rigid assembly. the resonant frequency can be estimated with the aid of the following method.

$$n_{perm} = f_{kr} \cdot n_{crit} \cdot 0.8$$

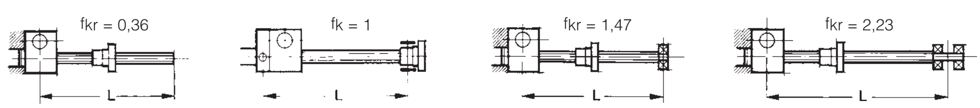
n_{perm} is the maximum permissible screw speed in rpm.

f_{kr} is a correction factor which makes allowance for the type of screw bearing. Sufficiently rigid mounting of the worm gear screw jack and bearing is consequently a prerequisite for cases 2. 3 and 4.

n_{crit} is the critical screw speed; it corresponds to the basic bending vibration of the screw and leads to resonance effects.



Case 1 **Case 2** **Case 3** **Case 4**



Worm gear screw jacks with multi-start screws are also available for applications with high lifting speeds. These versions run at a considerably lower screw speed and better efficiency for the same lifting speed. They are generally not self-locking.

Selection and calculation

Required drive torque for a worm gear screw jack

The required drive torque for a worm gear screw jack is governed by the axial load acting on the jack screw. the transmission ratio and the efficiency. It should be noted that the breakaway torque may be considerably higher than the torque required for continuous running. This applies in particular to worm gear screw jacks with low efficiency after a long standstill period. The acceleration torque should be checked if necessary in cases with large screw pitches and very short run-up times.

$$M_T = \frac{F_{eff}}{2 \cdot \pi \cdot \eta} \cdot \frac{P}{i} + M_o$$

M_T is the required drive torque of the worm gear screw drive at the worm shaft in Nm.

F_{eff} is the actual force acting on the jack screw in N.

η is the efficiency of the worm gear screw jack in decimal notiation. e.g. 0.32 instead of 32% (for values. see table on page 11). η is an average value determined by measurement.

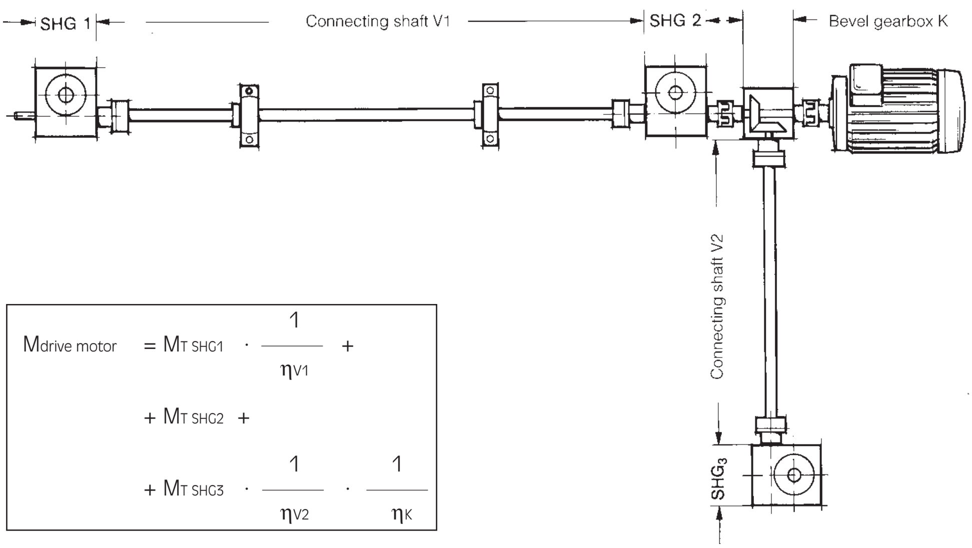
$\frac{p}{i}$ is the transmission ratio of the worm gear screw drive in mm stroke length per revolution of the worm shaft.

M_o is the idle torque of the worm gear screw drive in Nm. Mo is determined by measurements undertaken after a brief running-in period with liquid grease lubrication at room temperature. It represents an average value which may vary to a greater or lesser extent. depending on the running-in state. lubricant and temperature. For values. see table on page 11

Required drive torque for a worm gear screw jack system

The required drive torque for a worm gear screw jack system is governed by the drive torque values for the individual jacks. with allowance for the static and dynamic frictional losses in transmission components (coupling. connecting shafts. pedestal bearings. angle gearboxes. etc.). It is useful to draw a diagram illustrating the flow of forces.

Example



$$M_{drive\ motor} = M_{T\ SHG1} \cdot \frac{1}{\eta_{V1}} + M_{T\ SHG2} + M_{T\ SHG3} \cdot \frac{1}{\eta_{V2}} \cdot \frac{1}{\eta_K}$$

$M_{T\ SHG1}$ is the required drive torque for the worm gear screw jack SHG 1. It should be noted that the start-up torque (breakaway torque and possibly acceleration torque) may be considerably higher than the torque required for continuous running. This applies in particular to worm gear screw jacks with low efficiency after a long standstill period.

η_{V1} is the efficiency of connecting shaft V1

η_{V2} (V2) includes the static and dynamic frictional losses in the pedestal bearings and couplings.

η_V = 0.75...0.95 depending on the length of the shaft and number of pedestal bearings.

η_K is the efficiency of the bevel gearbox (only for the force flow via the toothing. i.e. between connecting shaft V2 and the drive motor).

$\eta_K = 0.90$

Selection and calculation

Maximum drive torque

If the worm gear screw jack jams as a result of the screw coming into contact with an obstacle. the toothing can still absorb the following maximum torque values M_T at the drive shaft.
In the case of screw jacks connected in series. the screw jack closest to the drive can absorb this torque at its drive shaft.

Size	$M_{T\,max}$ [Nm]
MULI 1	3.4
MULI 2	7.1
MULI 3	18
MULI 4	38
MULI 5	93
JUMBO 1	148
JUMBO 2	178
JUMBO 3	240
JUMBO 4	340
JUMBO 5	570

Forces and torque values acting on the drive shaft

If worm gear screw jacks are not driven free of lateral forces by means of a coupling connected to the motor shaft. but are instead driven by chains or belts. care must be taken to ensure that the radial force acting on the drive shaft does not become excessive. The values are specified in the following table.
In the worst case. the worm shaft will bend under radial force F_R and lift off the worm gear. This must be avoided. since it impairs the engagement between worm shaft and worm gear and leads to higher wear.

Size	$F_{R\,max}$ [kN]
MULI 1	0.1
MULI 2	0.2
MULI 3	0.3
MULI 4	0.5
MULI 5	0.8
JUMBO 1	0.8
JUMBO 2	1.3
JUMBO 3	1.3
JUMBO 4	2.1
JUMBO 5	3.1

Selection of drive motor

A suitable drive motor can be selected when the required drive torque and drive speed are known. After selecting a drive motor. check that it will not overload any of the worm gear screw jacks or transmission components. This risk may occur. in particular. in installations with several screw jacks if they are loaded unevenly. It will generally be necessary to install limit switches or torque-limiting couplings to protect the installation against impacting against end positions and obstacles.

Forces and torque values on the motor shaft

Toothed-belt or chain drives may exert considerable radial forces on the motor shaft if a very small sprocket is used. Please consult the motor manufacturer in cases of doubt.

Selection of a bevel gearbox

Selection of a bevel gearbox is governed by the following factors:

- Drive torque
- Drive speed (see dimensional tables)
- Duty cycle and drive power
- Forces and torque values acting on the ends of the shaft (please consult us in cases of doubt)

Required drive speed

The required drive speed is governed by the desired lifting speed. the transmission ratio of the jack and the transmission ratio of the other transmission components. A particular lifting speed can normally be achieved in several ways. Correct selection depends on the following criteria:

- Favourable efficiency
- Minimum load on transmission components in order to achieve compact. low-cost design
- Avoiding critical speeds for jack screws and connecting shafts.

Jack screw nut torques

The nut torque (M) of the jack screw is the torque that the jack screw exerts on the mounting plate (all N versions except V), or the torque that the screw applies to the travelling nut (R Version). It is not to be confused with the dirve torque (MT) of the screw jack gears on the worm shaft.

$$M\,[Nm] = F_{eff}\,[kN] \cdot f_M$$

(applicable in the areas of moderate and high loads)

M is the jack screw nut torque in Nm for the “Lift under Load” movement.

F_{eff} is the actual supported axial force in kN.

f_M is a conversion factor that accounts for screw geometry and friction. The value is applicable under normal lubrication conditions. In the case of ball screw dirves, f_M is practically constant.

Size	f_M (trapezoidal)	f_M (ball screw)
MULI 1	1.6	1.6
MULI 2	1.8	1.6
MULI 3	2.7	1.6
MULI 4	3.4	1.6/3.2
MULI 5	4.6	3.2
JUMBO 1	5.5	–
JUMBO 2	6.4	–
JUMBO 3	7.2	3.2
JUMBO 4	8.0	–
JUMBO 5	10.6	–

Selection and calculation
Examples: Direction of rotation

Fig. 1:
Illustration of direction of rotation

Fig. 2:
Direction of rotation of a worm gear screw jack (N) for "lifting" motion, top view.

Fig.: 1

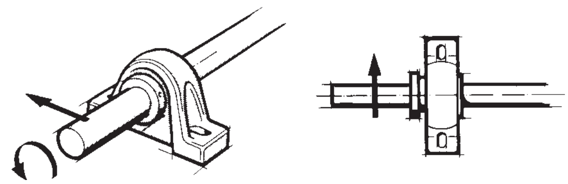


Fig.: 2

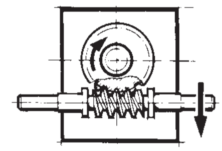


Fig. 3:
Jack system with four worm gear screw jacks and two bevel gearboxes

Fig.: 3

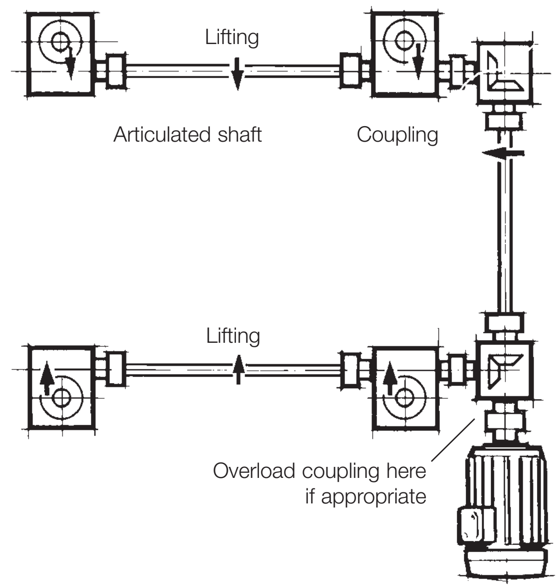


Fig. 4:
Jack system, variant 1:
Different position of drive motor, but only ratio 1:1 possible.
Overload coupling also possible.

Fig. 5:
Jack system, variant 2:
Very economical, but overload coupling not possible.

Fig.: 4

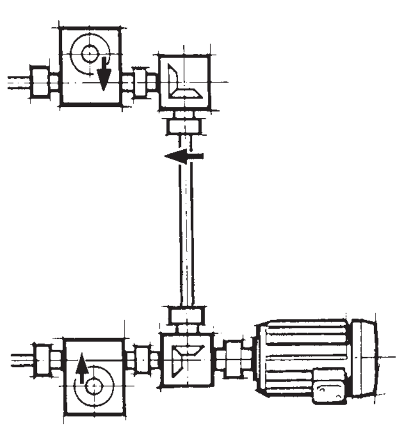
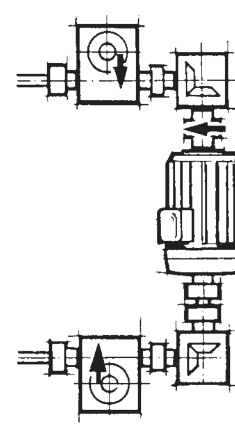


Fig.: 5



Assembly and maintenance

Assembly of worm gear screw jack systems

Direction of rotation: Before starting assembly work. the direction of rotation of all worm gear screw jacks. bevel gearboxes and the drive motor must be checked with regard to the feed direction of each individual worm gear screw jack.

Alignment errors: All components must be carefully aligned during assembly. Alignment errors and stresses increase power consumption and lead to overheating and premature wear. Before a drive unit is attached. each worm gear screw jack should be turned through its entire length by hand without load. Variations in the amount of force required and/or axial marks on the outside diameter of the screw indicate alignment errors between the worm gear screw jack and its additional guides. In this case. the relevant mounting bolts must be loosened and the worm gear screw jack turned through by hand again. If the amount of force required is now constant throughout. the appropriate components must be aligned. If not. the alignment error must be localized by loosening additional mounting bolts.

Test run: The direction of rotation of the complete system and correct operation of the limit switches must be checked again before attaching the drive motor. In the case of version N (translating screw jack). check that the screw is lubricated with grease from the interior of the gearbox and relubricate if necessary. In the case of version R (rotating screw jack). the jack screw should be coated with suitable grease to provide lubrication for lifting operation. The first test runs can then be carried out without load.
A maximum operating time of 30 % can not be exceeded at trial runs under weight for worm gear screw jacks with trapezoidal screws.

Operation: The loads. speeds and operating conditions specified for the worm gear screw jacks and transmission components must not be exceeded even briefly. Failure to observe this condition will invalidate all claims under guarantee.

Maintenance of worm gear screw jacks

Safety: All mounting bolts must be retightened after a short period of operation. The wear of the screw nut (worm gear) must be checked by measuring the thread backlash after approx. 200 hours of operation or sooner if operating conditions are harsh. The screw nut (worm gear) must be replaced if the axial backlash with a single-start thread is more than one-quarter of the thread pitch.

Lubrication: The worm gear screw jacks are lubricated by the manufacturer and are ready for operation on delivery. They version N/V must be lubricated via their grease nipples with one of the greases specified below at intervals of 30 - 50 operating hours. The screw should be cleaned and greased at the same time. The service life of screw and screw nut can be extended by applying screw spray. particularly before being greased for the first time. We recommend that the gearbox be cleaned to remove old grease and refilled with fresh grease after approx. 700 operating hours or 18 months. The worm gear screw jacks can be dismantled relatively easily:

- Unscrew the two threaded pins securing the bearing cover.
- Unscrew the screw and remove the screw protection if necessary.
- Unscrew the bearing cover with the aid of an open-ended spanner.

Proceed as follows to refit the bearing cover: fit the bearing cover firmly (using approx. ten times the force shown in the table of "Guideline values for fitting bearing cover"). Then release it and refit it with the guideline value from the table. checking the axial backlash and smooth running.

Standard grease:

Lithogrease G 421
Zeller + Gmelin, Aalen

Recommended greases:

Castrol Spheerol BM2
Mobil Mobilgrease XHP
Shell retinax HD2

Guideline values for fitting bearing cover

Type	Torque [Nm]
MULI 1	5
MULI 2	9
MULI 3	13
MULI 4	32
MULI 5	60
JUMBO 1	70
JUMBO 2	150
JUMBO 3	150
JUMBO 4	220
JUMBO 5	300