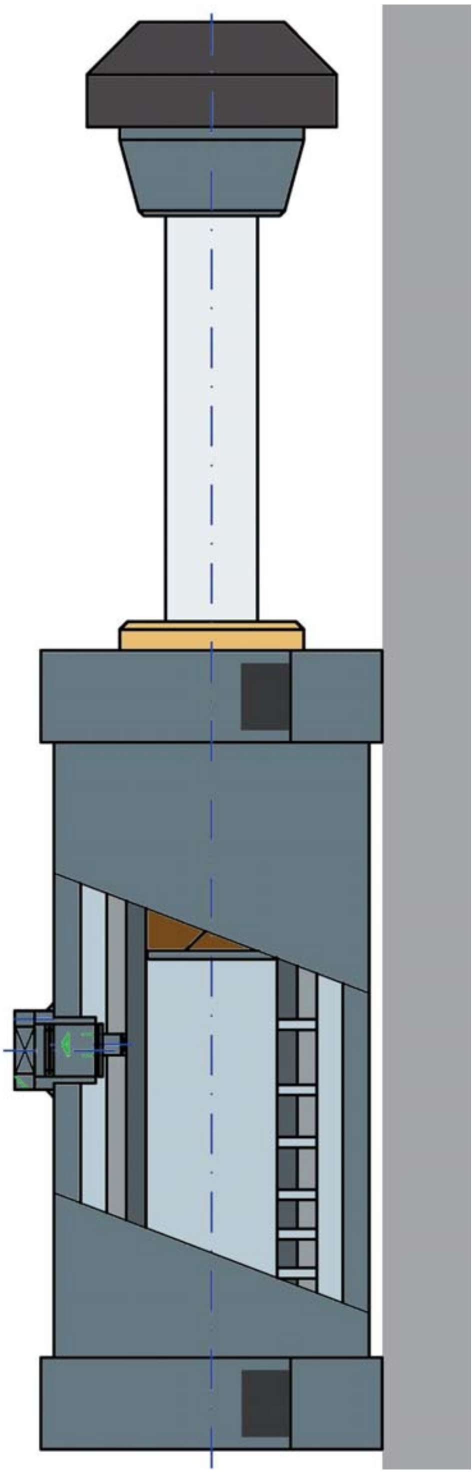
Working principle of adjustable shock absorbers STD

During operation the piston rod travels through the stroke, the piston forces the hydraulic oil through the orifice holes. The total orifice area decreases at a rate consistent with the stroke. Speed is reduced, pressure and braking force remain nearly constant. This eliminates destructive shock forces which can cause damage to products and machines.

In order to adapt the shock absorber to different operating situations, the total orifice area can be adjusted. A rotation of the adjusting screw causes a shift betweeen damping and cylinder tube. The adjustable shock absorber offers more flexibility in application design and selection procedure. When an effective weight change is required, you can simply adjust the setting.

The basic characteristics will be preserved, since the total orifice area changes, providing true linear deceleration. Adjustable models offer a wide range of effective weight. One model is capable of handling numerous applications.

The return spring (not shown) pushes the piston rod to the start position for the next cycle. A check valve supports the rapid extension so the shock absorber is ready for a working stroke in the shortest possible time.



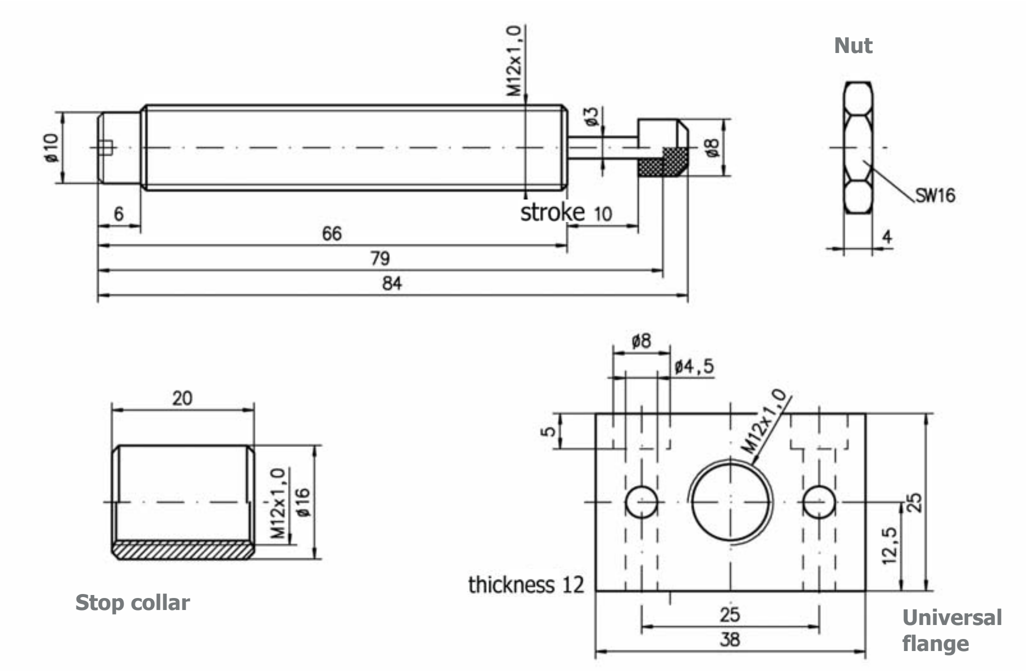
Summary STD

Product	Stroke [mm]	Thread	Energy capacity [Nm/stroke]	Effective mass [kg]	Page
STD 7 x 10	10	M12x1,0	4	5 - 60	18
STD 7 x 12	12	M14x1,5	16	1 - 100	18
STD 10 x 12	12	M16x1,5	18	1,5 - 160	19
STD 10 x 20	20	M20x1,5	30	2,5 - 240	19
STD 1.0 M	25	M25x1,5 or M27x3,0	78	8 - 1360	20
STD 1.0 M x 40	40	M25x1,5	116	13 - 1980	20
STD 1.25 M x 1	25	M33x1,5 or 1 ¼" – 12UNF	112	10 - 1800	21
STD 1.25 M x 1 NG	25	M33x1,5 or 1 ¼" – 12UNF	112	330 - 48000	21
STD 1.25 M x 2	50	M33x1,5 or 1 ¼" – 12UNF	224	15 - 2400	21
STD 1.25 M x 2 NG	50	M33x1,5 or 1 ¼" – 12UNF	224	470 - 77000	21
STD 1.2 M x 1	25	M36x1,5	195	10 - 1250	22
STD 1.2 M x 1 NG	25	M36x1,5	195	350 - 51000	22
STD 1.2 M x 2	50	M36x1,5	390	15 - 1850	22
STD 1.2 M x 2 NG	50	M36x1,5	390	450 - 81000	22
STD 1.5 M x 1	25	M42x1,5	250	27 - 3600	23
STD 1.5 M x 1 NG	25	M42x1,5	250	3000 - 110000	23
STD 1.5 M x 2	50	M42x1,5	500	43 - 6350	23
STD 1.5 M x 2 NG	50	M42x1,5	500	5000 - 175000	23
STD 1.5 M x 3	75	M42x1,5	750	55 - 9500	23
STD 2.0 M x 1	25	M64x2,0	570	40 - 7500	24
STD 2.0 M x 1 NG	25	M64x2,0	570	10000 - 250000	24
STD 2.0 M x 2	50	M64x2,0	1140	70 - 12000	24
STD 2.0 M x 2 NG	50	M64x2,0	1140	11000 - 460000	24
STD 2.0 M x 4	100	M64x2,0	2280	115 - 12000	24
STD 2.0 M x 4 NG	100	M64x2,0	2280	12000 - 460000	24
STD 2.0 M x 6	150	M64x2,0	3420	130 - 23000	24
STD 3.0 M x 2	50	M85x2,0	2100	190 - 31000	25
STD 3.0 M x 3,5	90	M85x2,0	3600	220 - 35000	25
STD 3.0 M x 5	125	M85x2,0	5100	230 - 40000	25
STD 3.0 M x 6,5	165	M85x2,0	6500	310 - 43000	25
STD 3.0 M x 8	200	M85x2,0	10000	330 - 48000	25
STD 4.0 M x 2	50	M115x2,0	4500	200 - 70000	26
STD 4.0 M x 4	100	M115x2,0	9000	220 - 75000	26
STD 4.0 M x 6	150	M115x2,0	13500	240 - 84000	26
STD 4.0 M x 8	200	M115x2,0	19000	270 - 90000	26
STD 4.0 M x 10	250	M115x2,0	23500	300 - 110000	26

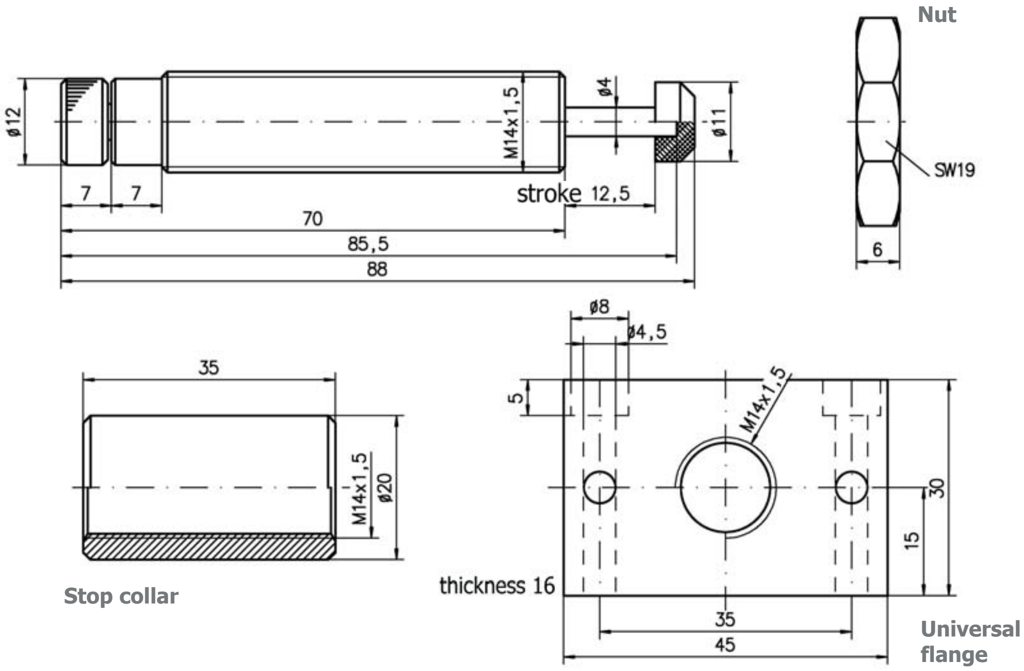
Please note that this review is only for pre-selection. In any case, please use our example calculations (page 32 and 33) to check whether the selected damper is suitable.

- Fully adjustable.
- Temperature range from – 10 °C to + 80 °C (higher temperature up to + 120 °C on request).
- Fitting according to your requirements.
- Nylon cap optional.
- Install a mechanical stop 1 mm before end of the stroke, do not bottoming under load to prevent damage.

STD 7 x 10



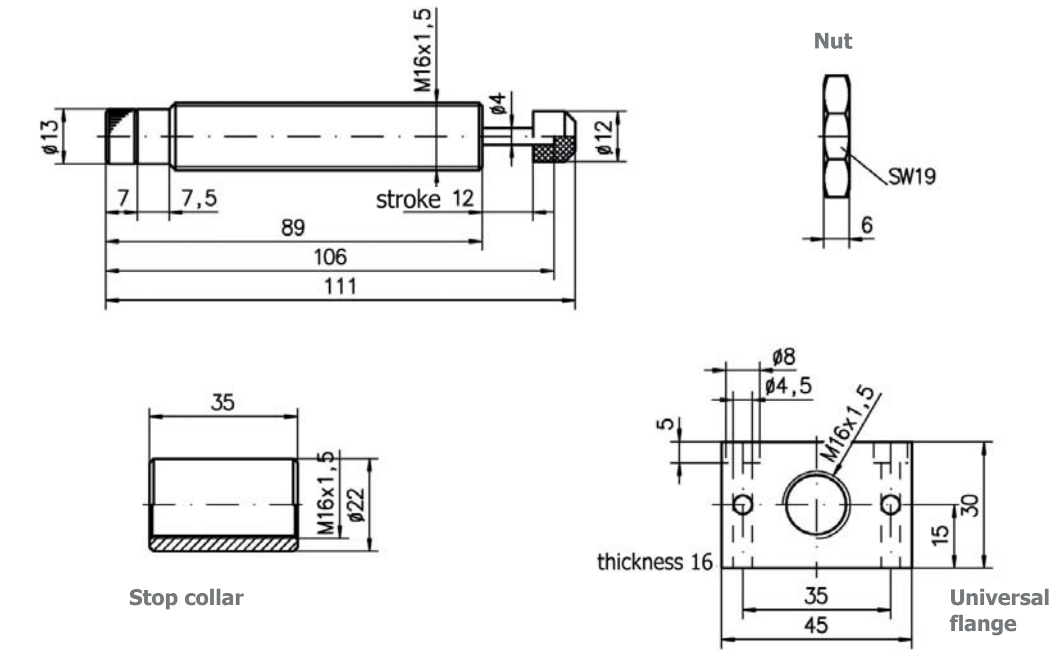
STD 7 x 12



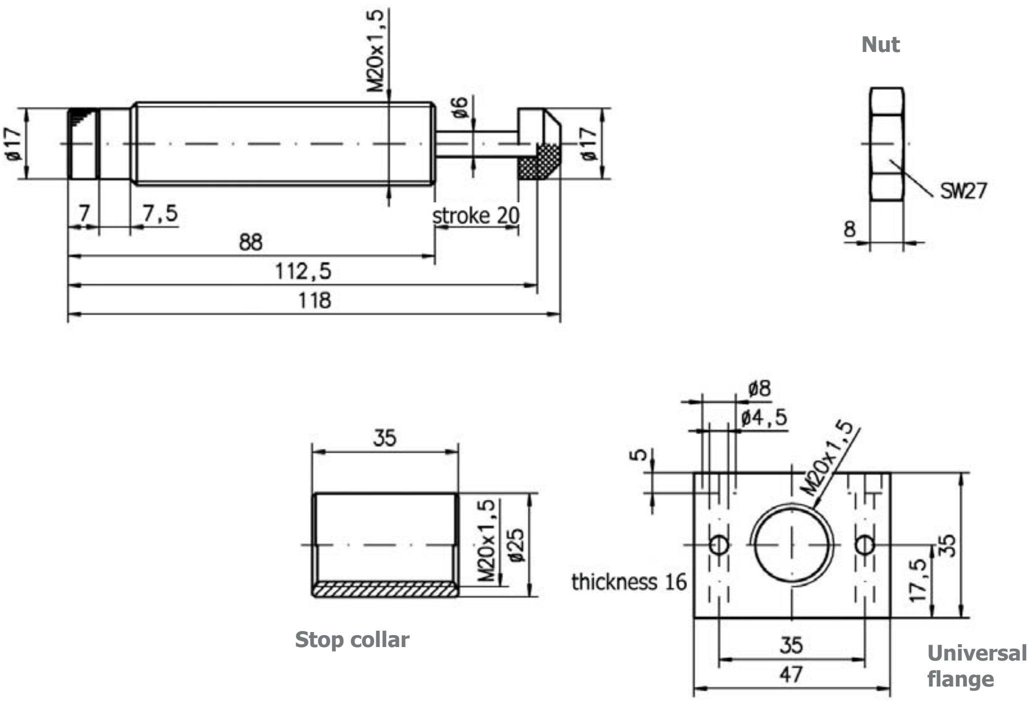
Type	Stroke [mm]	Thread	Energy capacity [Nm/stroke]	[kNm/h]	Effective mass [kg]	Spring force [N]	Weight [g]
STD 7 x 10	10	M12x1,0	4	6	5 - 60	6 - 11	50
STD 7 x 12	12,5	M14x1,5	16	25	1 - 100	5 - 15	70

- Fully adjustable.
- Temperature range from – 10 °C to + 80 °C (higher temperature up to + 120 °C on request).
- Fitting according to your requirements.
- Nylon cap optional.
- Install a mechanical stop 1 mm before end of the stroke, do not bottoming under load to prevent damage.

STD 10 x 12



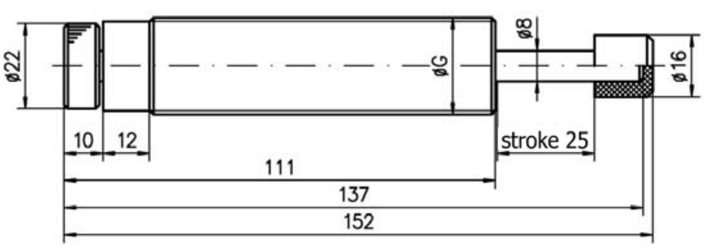
STD 10 x 20



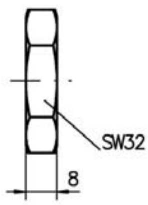
Type	Stroke [mm]	Thread	Energy capacity [Nm/stroke]	Energy capacity [kNm/h]	Effective mass [kg]	Spring force [N]	Weight [g]
STD 10 x 12	12	M16x1,5	18	26	1,5 - 160	4 - 11	90
STD 10 x 20	20	M20x1,5	30	46	2,5 - 240	7 - 20	130

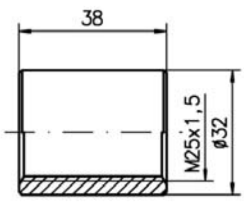
- Fully adjustable.
- Temperature range from – 10 °C to + 80 °C (higher temperature up to + 120 °C on request).
- Fitting according to your requirements.
- Nylon cap optional.
- Install a mechanical stop 1 mm before end of the stroke, do not bottoming under load to prevent damage.

STD 1.0 M

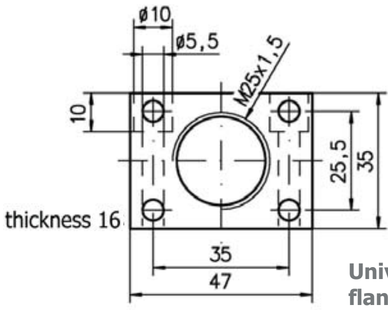


Nut



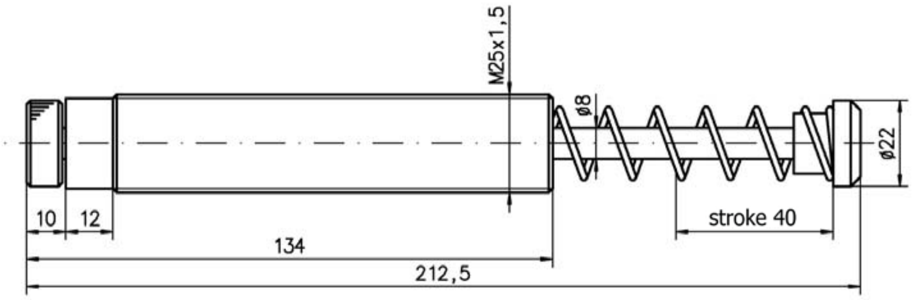


Stop collar

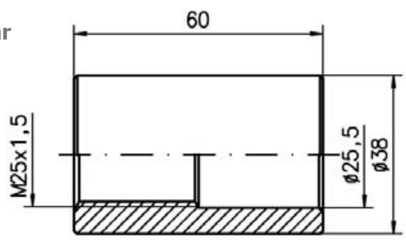


Universal flange

STD 1.0 x 40



Stop collar

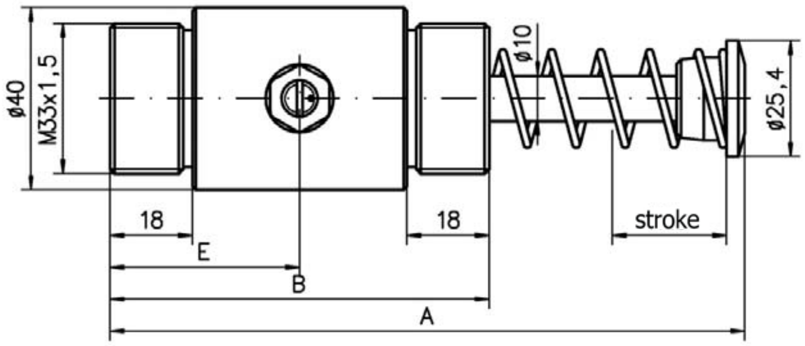


(for accessories see STD 1.0 M)

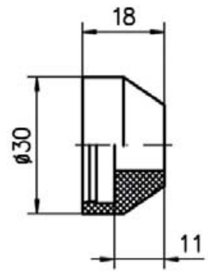
Type	Stroke [mm]	Options	Thread	Energy capacity [Nm/stroke]	Energy capacity [kNm/h]	Effective mass [kg]	Spring force [N]	Weight [g]
STD 1.0 M	25	---	M27x3,0	78	66	8 - 1360	25 - 50	390
STD 1.0 MB	25	Nylon cap	M27x3,0	78	66	8 - 1360	25 - 50	310
STD 1.0 M-S	25	---	M25x1,5	78	66	8 - 1360	25 - 50	400
STD 1.0 MB-S	25	Nylon cap	M25x1,5	78	66	8 - 1360	25 - 50	320
STD 1.0 M x 40	40	---	M25x1,5	116	106	13 - 1980	20 - 70	390

- Fully adjustable.
- Temperature range from – 10 °C to + 80 °C (higher temperature up to + 120 °C on request).
- Fitting according to your requirements.
- Polyurethane cap optional.
- Install a mechanical stop 1 mm before end of the stroke, do not bottoming under load to prevent damage.

STD 1.25 M



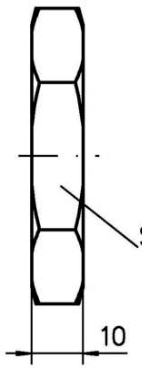
Polyurethane cap



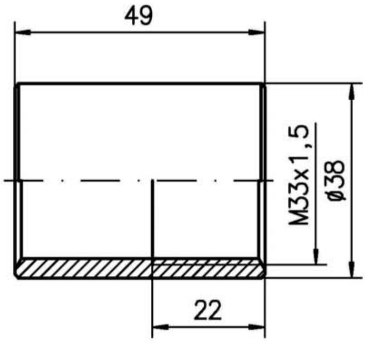
Dimensions:

Type	Stroke	A	B	E
		[mm]		
STD 1.25 M x 1	25	139	83	41,5
STD 1.25 M x 2	50	189	108	66,5

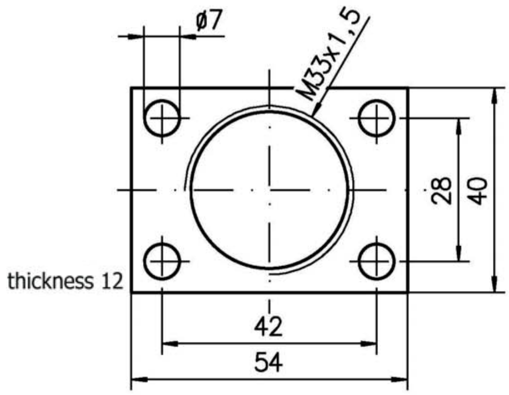
Nut



Stop collar



Rectangular flange

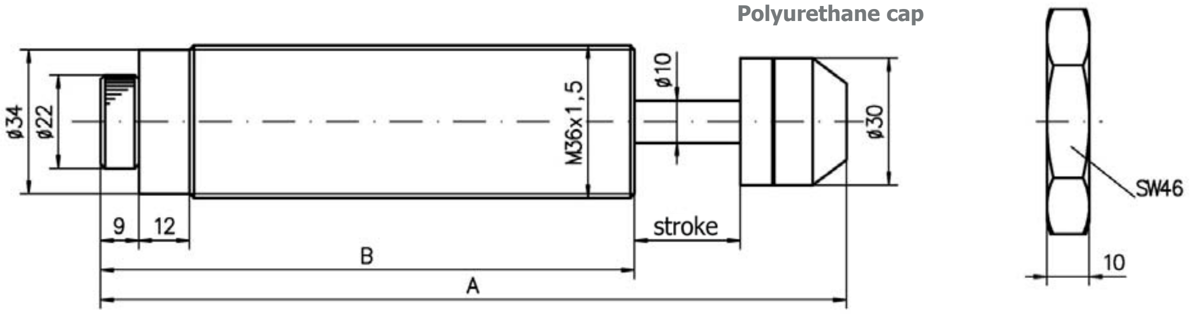


Technical data:

Type	Stroke [mm]	Thread	Energy capacity [Nm/stroke]	Energy capacity [kNm/h]	Effective mass [kg]	Spring force [N]	Weight [g]
STD 1.25 M x 1	25	M33x1,5 or	112	76	10 - 1800	40 - 70	640
STD 1.25 M x 1 NG	25	1 ¼" – 12 UNF	112	76	330 - 48000	40 - 70	640
STD 1.25 M x 2	50	M33x1,5 or	224	86	15 - 2400	45 - 80	730
STD 1.25 M x 2 NG	50	1 ¼" – 12 UNF	224	86	470 - 77000	45 - 80	730

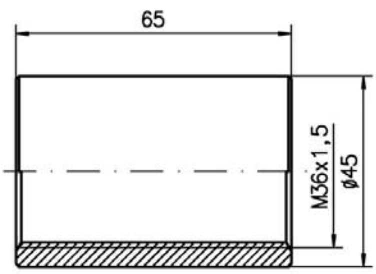
- Fully adjustable.
- Temperature range from – 10 °C to + 80 °C (higher temperature up to + 120 °C on request).
- Fitting according to your requirements.
- Polyurethane cap standard.
- Install a mechanical stop 1 mm before end of the stroke, do not bottoming under load to prevent damage.

STD 1.2 M

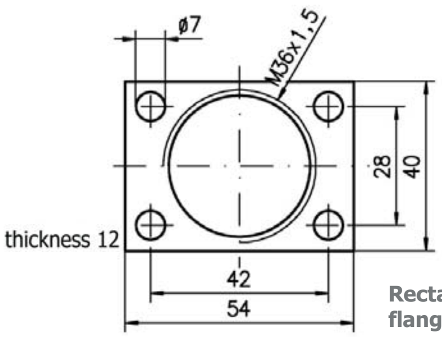


Dimensions:

Type	Stroke	A [mm]	B
STD 1.2 M x 1	25	176	126
STD 1.2 M x 2	50	248	172



Stop collar



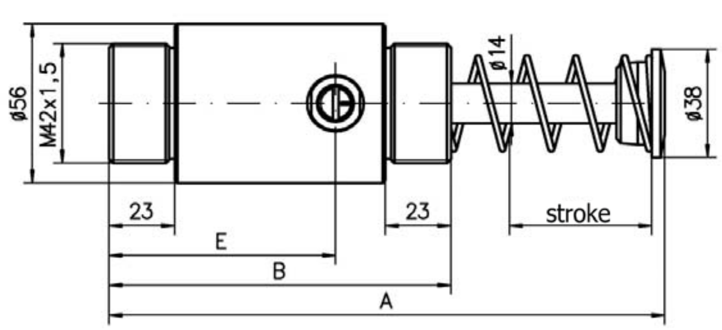
Rectangular flange

Technical data:

Type	Stroke [mm]	Thread	Energy capacity [Nm/stroke]	Energy capacity [kNm/h]	Effective mass [kg]	Spring force [N]	Weight [g]
STD 1.2 M x 1	25	M36x1,5	195	94	10 - 1250	35 - 80	650
STD 1.2 M x 1 NG	25	M36x1,5	195	94	350 - 51000	35 - 80	650
STD 1.2 M x 2	50	M36x1,5	390	188	15 - 1850	35 - 85	820
STD 1.2 M x 2 NG	50	M36x1,5	390	188	450 - 81000	35 - 85	820

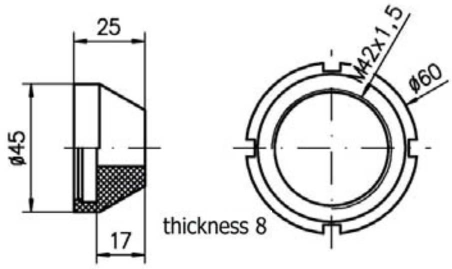
- Fully adjustable.
- Temperature range from – 10 °C to + 80 °C (higher temperature up to + 120 °C on request).
- Fitting according to your requirements.
- Polyurethane cap optional.
- Install a mechanical stop 1 mm before end of the stroke, do not bottoming under load to prevent damage.

STD 1.5 M



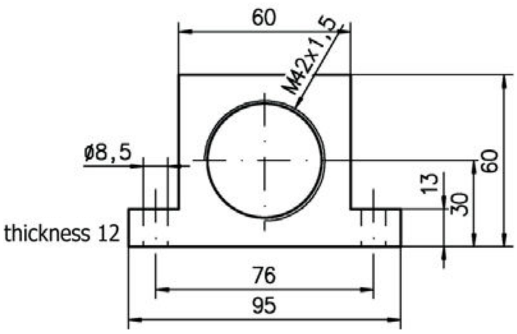
Polyurethane cap

Nut

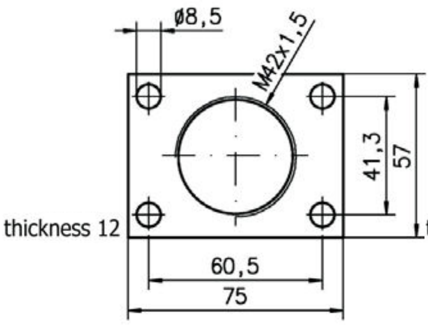


Dimensions:

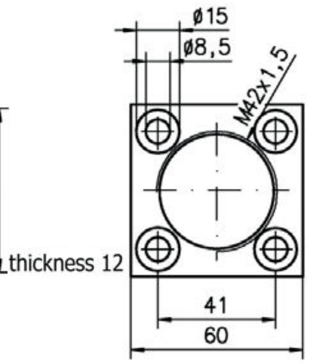
Type	Stroke	A	B	E
	[mm]			
STD 1.5 M x 1	25	144	94	53
STD 1.5 M x 2	50	195	120	79,5
STD 1.5 M x 3	75	246	145	104,5



Foot mounting



Rectangular flange



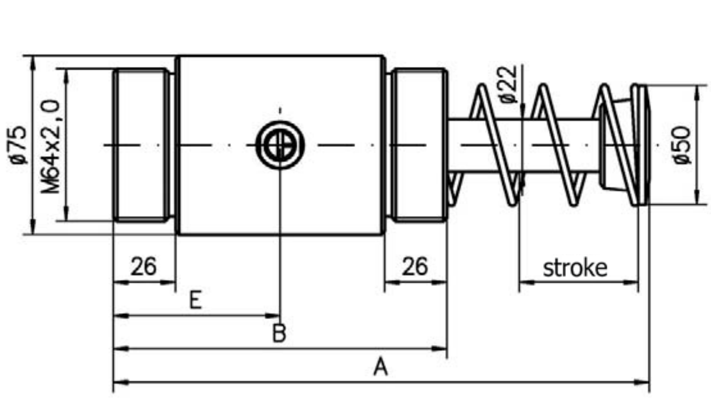
Square flange

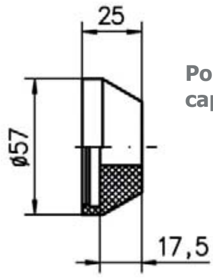
Technical data:

Type	Stroke [mm]	Thread	Energy capacity [Nm/stroke]	Energy capacity [kNm/h]	Effective mass [kg]	Spring force [N]	Weight [kg]
STD 1.5 M x 1	25	M42x1,5	250	125	27 - 3600	60 - 90	1,4
STD 1.5 M x 1 NG	25	M42x1,5	250	125	3000 - 110000	60 - 90	1,4
STD 1.5 M x 2	50	M42x1,5	500	148	43 - 6350	70 - 150	1,7
STD 1.5 M x 2 NG	50	M42x1,5	500	148	5000 - 175000	70 - 150	1,7
STD 1.5 M x 3	75	M42x1,5	750	182	55 - 9500	60 - 130	2,1

- Fully adjustable.
- Temperature range from – 10 °C to + 80 °C (higher temperature up to + 120 °C on request).
- Fitting according to your requirements.
- Polyurethane cap optional.
- Install a mechanical stop 1 mm before end of the stroke, do not bottoming under load to prevent damage.

STD 2.0 M

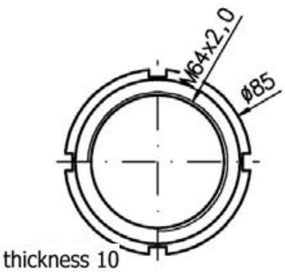




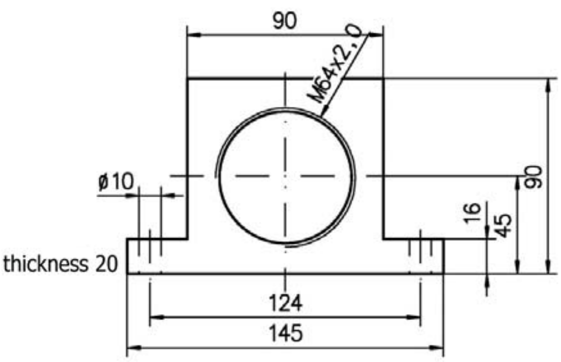
Polyurethane cap

Dimensions:

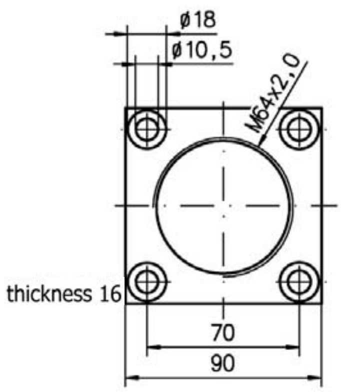
Type	Stroke	A	B	E
			[mm]	
STD 2.0 M x 1	25	175	115	57,5
STD 2.0 M x 2	50	225	140	70
STD 2.0 M x 4	100	327	190	95
STD 2.0 M x 6	150	455	240	120



Nut



Foot mounting



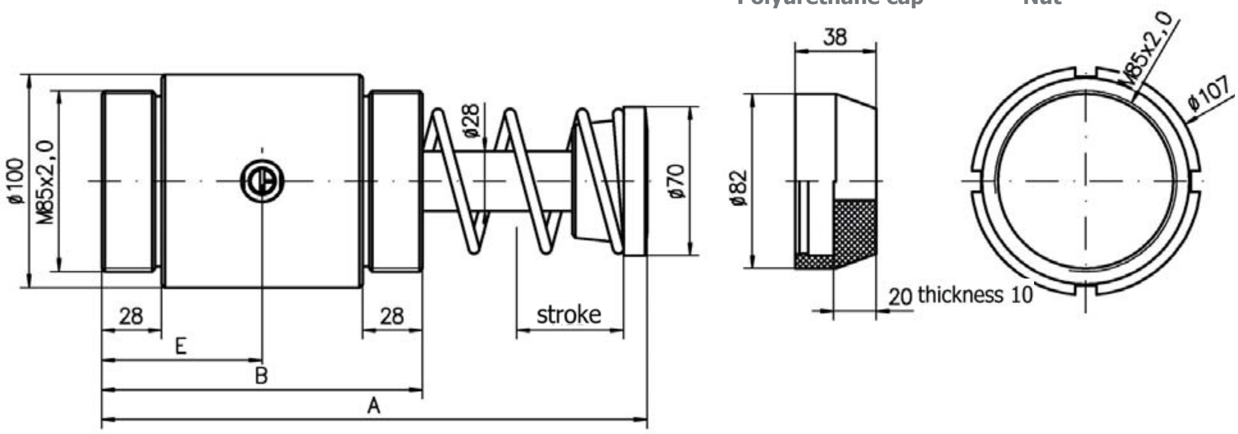
Square flange

Technical data:

Type	Stroke [mm]	Thread	Energy capacity [Nm/stroke]	[kNm/h]	Effective mass [kg]	Spring force [N]	Weight [kg]
STD 2.0 M x 1	25	M64x2,0	570	150	55 - 8000	60 - 90	3,2
STD 2.0 M x 1 NG	25	M64x2,0	570	150	10000 - 250000	60 - 90	3,2
STD 2.0 M x 2	50	M64x2,0	1140	171	70 - 12000	60 - 130	3,6
STD 2.0 M x 2 NG	50	M64x2,0	1140	171	11000 - 460000	60 - 130	3,6
STD 2.0 M x 4	100	M64x2,0	2280	228	115 - 17000	60 - 180	4,8
STD 2.0 M x 4 NG	100	M64x2,0	2280	228	12000 - 460000	60 - 180	4,8
STD 2.0 M x 6	150	M64x2,0	3420	287	130 - 23000	55 - 270	6,0

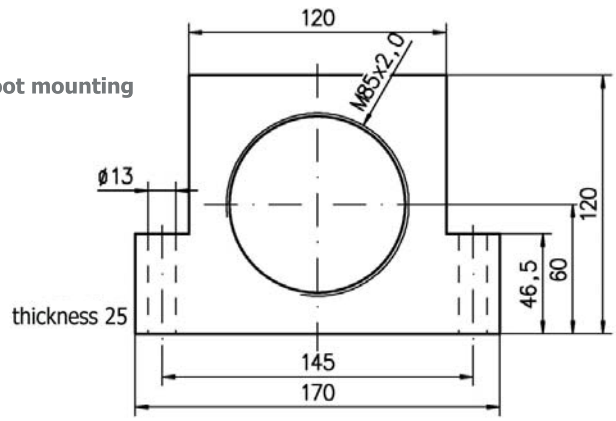
- Fully adjustable.
- Temperature range from – 10 °C to + 80 °C (higher temperature up to + 120 °C on request).
- Fitting according to your requirements.
- Polyurethane cap optional.
- Install a mechanical stop 1 mm before end of the stroke, do not bottoming under load to prevent damage.

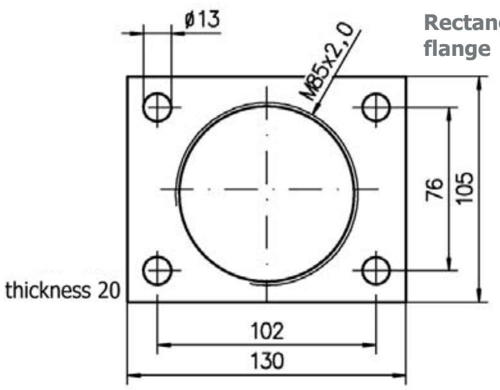
STD 3.0 M



Dimensions:

Type	Stroke	A	B	E
		[mm]		
STD 3.0 M x 2	50	255	150	75
STD 3.0 M x 3.5	90	335	190	95
STD 3.0 M x 5	125	410	225	112
STD 3.0 M x 6.5	165	505	265	132
STD 3.0 M x 8	200	600	300	150



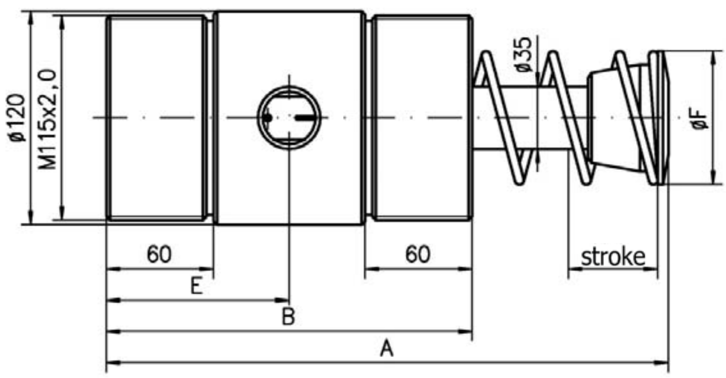


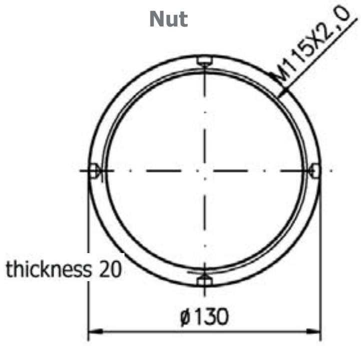
Technical data:

Type	Stroke	Thread	Energy capacity		Effective mass	Spring force	Weight
	[mm]		[Nm/stroke]	[kNm/h]	[kg]	[N]	[kg]
STD 3.0 M x 2	50	M85x2,0	2100	720	190 - 31000	140 - 265	7,5
STD 3.0 M x 3.5	90	M85x2,0	3600	1030	220 - 35000	110 - 200	9,0
STD 3.0 M x 5	125	M85x2,0	5100	1250	228 - 40000	105 - 290	11,0
STD 3.0 M x 6.5	165	M85x2,0	6500	1550	310 - 43000	120 - 350	13,2
STD 3.0 M x 8	200	M85x2,0	10000	2100	330 - 48000	170 - 580	16,0

- Fully adjustable.
- Temperature range from – 10 °C to + 80 °C (higher temperature up to + 120 °C on request).
- Fitting according to your requirements.
- Polyurethane cap optional.
- Install a mechanical stop 1 mm before end of the stroke, do not bottoming under load to prevent damage.

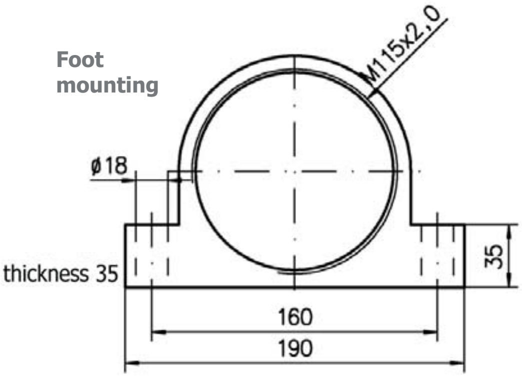
STD 4.0 M

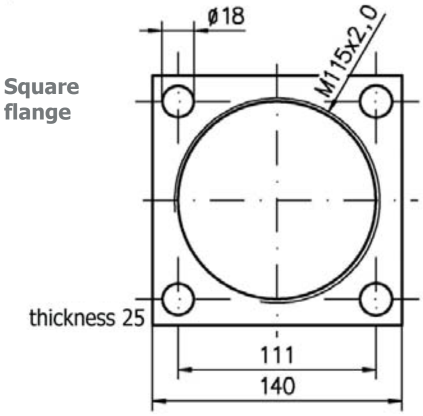




Dimensions:

Type	Stroke	A	B [mm]	E	ØF
STD 4.0 M x 2	50	315	205	102	75
STD 4.0 M x 4	100	415	255	127	75
STD 4.0 M x 6	150	516	305	152	90
STD 4.0 M x 8	200	642	355	177	90
STD 4.0 M x 10	250	745	405	202	110





Technical data:

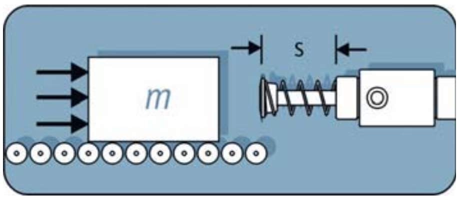
Type	Stroke [mm]	Thread	Energy capacity [Nm/stroke]	 [kNm/h]	Effective mass [kg]	Spring force [N]	Weight [kg]
STD 4.0 M x 2	50	M115x2,0	4500	1000	200 - 70000	200 - 290	14
STD 4.0 M x 4	100	M115x2,0	9000	1250	220 - 75000	170 - 290	16
STD 4.0 M x 6	150	M115x2,0	13500	1450	240 - 84000	170 - 390	18
STD 4.0 M x 8	200	M115x2,0	19000	1700	270 - 90000	240 - 600	21
STD 4.0 M x 10	250	M115x2,0	23500	2000	300 - 110000	170 - 460	25

Capacity charts:

The following parameters will be needed in the energy absorption calculation:		
1. Mass	**m**	[kg]
2. Impact velocity	**v**	[m/s]
3. Propelling force	**F**	[N]
4. Cycles per hour	**C**	[1/h]

The load range is calculated with those parameters. Pre-determine a stroke length and verify the calculation.		
1. Total energy/stroke	E_T	[Nm]
2. Total energy/hour	E_{TC}	[Nm/h]
3. Effective mass	m_e	[kg]

Case 1: Mass without propelling force

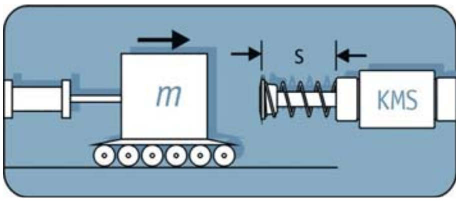


m	= 50 kg	*Mass*
v	= 1,5 m/s	*Impact velocity*
C	= 100 1/h	*Cycles per hour*

E_K/E_T	$= ½ \cdot m \cdot v^2$	$= ½ \cdot 50\ kg \cdot (1,5\ m/s)^2$	= **56 Nm**
E_{TC}	$= E_T \cdot C$	$= 56\ Nm \cdot 100\ 1/h$	= **5600 Nm/h**
m_e	$= 2 \cdot E_T / v^2$	$= 2 \cdot 56\ Nm / (1,5\ m/s)^2$	= **50 kg**

→ **SES 11 x 25 B selected**

Case 2: Mass with propelling force

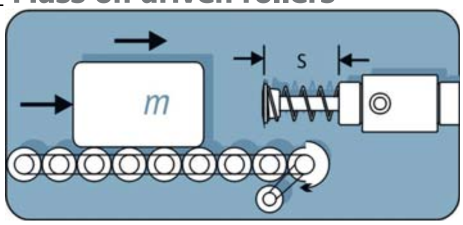


m	= 100 kg	*Mass*
v	= 1,5 m/s	*Impact velocity*
F_D	= 1000 N	*Propelling force*
C	= 200 1/h	*Cycles per hour*
s	= 0,025 m	*Stroke*

E_K	$= ½ \cdot m \cdot v^2$	$= ½ \cdot 100\ kg \cdot (1,5\ m/s)^2$	= **112,5 Nm**
E_W	$= F_D \cdot s$	$= 1000\ N \cdot 0,025\ m$	= **25 Nm**
E_T	$= E_K + E_W$	$= 112,5\ Nm + 25\ Nm$	= **137,5 Nm**
E_{TC}	$= E_T \cdot C$	$= 137,5\ Nm \cdot 200\ 1/h$	= **27500 Nm/h**
m_e	$= 2 \cdot E_T / v^2$	$= 2 \cdot 137,5\ Nm / (1,5\ m/s)^2$	= **122 kg**

→ **SES 1.1 M x 1 B selected**

Case 3: Mass on driven rollers

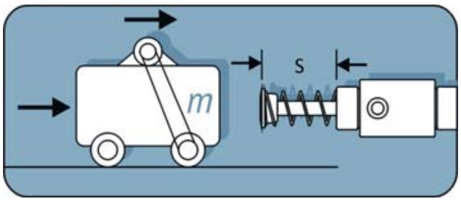


m	= 900 kg	*Mass*
v	= 1,0 m/s	*Impact velocity*
C	= 200 1/h	*Cycles per hour*
s	= 0,05 m	*Stroke*
µ	= 0,3	*Coefficient of friction steel/steel*

E_K	$= ½ \cdot m \cdot v^2$	$= ½ \cdot 900\ kg \cdot (1,0\ m/s)^2$	= **450 Nm**
E_W	$= m \cdot \mu \cdot g \cdot s$	$= 900\ kg \cdot 0,3 \cdot 9,81\ m/s^2 \cdot 0,05\ m$	= **132 Nm**
E_T	$= E_K + E_W$	$= 450\ Nm + 137,5\ Nm$	= **582 Nm**
E_{TC}	$= E_T \cdot C$	$= 582\ Nm \cdot 200\ 1/h$	= **116400 Nm/h**
m_e	$= 2 \cdot E_T / v^2$	$= 2 \cdot 582\ Nm / (1,0\ m/s)^2$	= **1164 kg**

→ **STD 2.0 M x 2 selected**

Case 4: Mass with motor drive

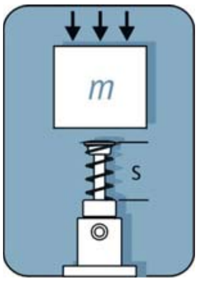


m	= 3000 kg	*Mass*
v	= 1,4 m/s	*Impact velocity*
HM	= 2,5	*Arresting torque factor for motors*
P	= 3 kW	*Drive power*
C	= 1/h	*Cycles per hour*
s	= 0,125 m	*Stroke*

E_K	$= \frac{1}{2} \cdot m \cdot v^2$	$= \frac{1}{2} \cdot 3000\ kg \cdot (1{,}4\ m/s)^2$	= **2940 Nm**
E_W	$= 1000 \cdot P \cdot s \cdot HM / v$	$= 1000 \cdot 3\ kW \cdot 0{,}125\ m \cdot 2{,}5 / 1{,}4\ m/s$	= **670 Nm**
E_T	$= E_K + E_W$	$= 2940\ Nm + 670\ Nm$	= **3610 Nm**
E_{TC}	$= E_T \cdot C$	$= 3610\ Nm \cdot 1\ 1/h$	= **3610 Nm/h**
m_e	$= 2 \cdot E_T / v^2$	$= 2 \cdot 3610\ Nm / (1{,}4\ m/s)^2$	= **3684 kg**

→ **STD 3.0 M x 5 selected**

Case 5: Free falling mass

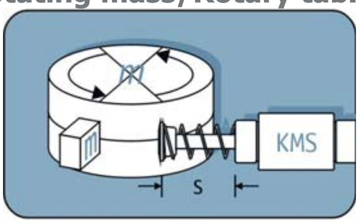


m	= 50 kg	*Mass*
h	= 0,5 m	*Height of fall*
C	= 300 1/h	*Cycles per hour*
s	= 0,05 m	*Stroke*

v	$= \sqrt{2 \cdot g \cdot h}$	$= \sqrt{2 \cdot 9{,}81\ m/s^2 \cdot 0{,}5\ m}$	= **3,1 m/s**
E_K	$= m \cdot g \cdot h$	$= 50\ kg \cdot 9{,}81\ m/s^2 \cdot 0{,}5\ m$	= **245 Nm**
E_W	$= m \cdot g \cdot s$	$= 50\ kg \cdot 9{,}81\ m/s^2 \cdot 0{,}05\ m$	= **24,5 Nm**
E_T	$= E_K + E_W$	$= 245\ Nm + 24{,}5\ Nm$	= **269,5 Nm**
E_{TC}	$= E_T \cdot C$	$= 269{,}5\ Nm \cdot 300\ 1/h$	= **80850 Nm/h**
m_e	$= 2 \cdot E_T / v^2$	$= 2 \cdot 269{,}5\ Nm / (3{,}1\ m/s)^2$	= **55 kg**

→ **STD 1.5 M x 2 selected**

Case 6: Rotating mass/Rotary table with driving torque

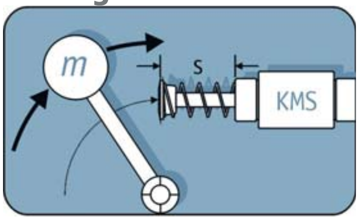


J	= 60 kgm²	*Moment of inertia*
ω	= 1,2 1/s	*Angular velocity*
r	= 0,5 m	*Radius (shock absorber)*
M	= 200 Nm	*Driving torque*
C	= 1000 1/h	*Cycles per hour*
s	= 0,025 m	*Stroke*

v	$= \omega \cdot r$	$= 1{,}2\ 1/s \cdot 0{,}5\ m$	= **0,6 m/s**
E_K	$= \frac{1}{2} \cdot J \cdot \omega^2$	$= \frac{1}{2} \cdot 60\ kgm^2 \cdot (1{,}2\ 1/s)^2$	= **43,2 Nm**
E_W	$= M \cdot s / r$	$= 200\ Nm \cdot 0{,}025\ m / 0{,}5\ m$	= **10 Nm**
E_T	$= E_K + E_W$	$= 43{,}2\ Nm + 10\ Nm$	= **53,2 Nm**
E_{TC}	$= E_T \cdot C$	$= 53{,}2\ Nm \cdot 1000\ 1/h$	= **53200 Nm/h**
m_e	$= 2 \cdot E_T / v^2$	$= 2 \cdot 53{,}2\ Nm / (0{,}6\ m/s)^2$	= **296 kg**

→ **STD 1.0 M selected**

Case 7: Swivelling mass with driving torque

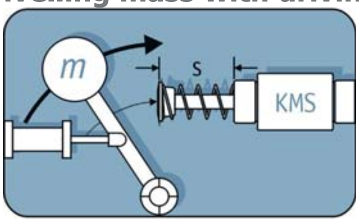


m	= 30 kg	*Mass*
v_m	= 1,0 m/s	*Impact velocity*
r	= 0,4 m	*Radius (shock absorber)*
R_m	= 0,6 m	*Radius (mass)*
M	= 40 Nm	*Driving torque*
C	= 1500/h	*Cycles per hour*
s	= 0,02 m	*Stroke*

E_K	$= \frac{1}{2} \cdot m \cdot v^2$	$= \frac{1}{2} \cdot 30\ kg \cdot (1{,}0\ m/s)^2$	**= 15 Nm**
E_W	$= M \cdot s / r$	= 40 Nm · 0,02 m / 0,4 m/s	**= 2 Nm**
E_T	$= E_K + E_W$	= 15 Nm + 2 Nm	**= 17 Nm**
E_{TC}	$= E_T \cdot C$	= 17 Nm · 1500 1/h	**= 25500 Nm/h**
v	$= v_m \cdot r / R_m$	= 1,0 m/s · 0,4 m / 0,6 m	**= 0,67 m/s**
m_e	$= 2 \cdot E_T / v^2$	$= 2 \cdot 17\ Nm / (0{,}67\ m/s)^2$	**= 76 kg**

→ SES 10 x 20 A selected

Case 8: Swivelling mass with driving force

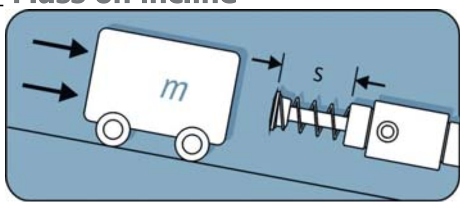


m	= 3000 kg	*Mass*
v_m	= 1,5 m/s	*Impact velocity*
r	= 1,0 m	*Radius (shock absorber)*
R_m	= 1,3 m	*Radius (mass)*
R_F	= 0,5 m	*Radius (force)*
F_D	= 4000 N	*Driving force*
C	= 150/h	*Cycles per hour*
S	= 0,1 m	*Stroke*

E_K	$= \frac{1}{2} \cdot m \cdot v^2$	$= \frac{1}{2} \cdot 3000\ kg \cdot (1{,}5\ m/s)^2$	**= 3375 Nm**
E_W	$= F_D \cdot s \cdot R_F / r$	= 4000 N · 0,1 m · 0,5 m/1,0 m	**= 200 Nm**
E_T	$= E_K + E_W$	= 3375 Nm + 200 Nm	**= 3575 Nm**
E_{TC}	$= E_T \cdot C$	= 3575 Nm · 150 1/h	**= 536,25 kNm/h**
v	$= v_m \cdot r / R_m$	= 1,5 m/s · 1,0 m/1,3 m	**= 1,15 m/s**
m_e	$= 2 \cdot E_T / v^2$	$= 2 \cdot 3575\ Nm / (1{,}15\ m/s)^2$	**= 1352 kg**

→ STD 4.0 M x 4 selected

Case 9: Mass on incline



m	= 10 kg	*Mass*
h	= 0,2 m	*Height*
α	= 20°	*Angle of inclination*
C	= 500 1/h	*Cycles per hour*
s	= 0,016 m	*Stroke*

E_K	$= m \cdot g \cdot h$	$= 10\ kg \cdot 9{,}81\ m/s^2 \cdot 0{,}2\ m$	**= 19,62 Nm**
E_W	$= m \cdot g \cdot s \cdot \sin\alpha$	$= 10\ kg \cdot 9{,}81\ m/s^2 \cdot 0{,}016\ m \cdot \sin 20°$	**= 0,54 Nm**
E_T	$= E_K + E_W$	= 19,62 Nm + 0,54 Nm	**= 20,16 Nm**
E_{TC}	$= E_T \cdot C$	= 20,16 Nm · 500 1/h	**= 53200 Nm/h**
v	$= \sqrt{2 \cdot g \cdot h}$	$= \sqrt{2 \cdot 9{,}81\ m/s^2 \cdot 0{,}2\ m}$	**= 1,98 m/s**
m_e	$= 2 \cdot E_T / v^2$	$= 2 \cdot 20{,}16\ Nm / (1{,}98\ m/s)^2$	**= 10,3 kg**

→ SES 14 S selected

Additional sizing formulas and calculations:

Effective mass m_e [kg]	Brake force F_B [N]
$m_e = 2 \cdot E_T / v^2$	$F_B = 1{,}2 \cdot E_T / s$
Deceleration a [m/s^2]	Deceleration time t_B [s]
$a = 0{,}6 \cdot v^2 / s$	$t_B = 2{,}5 \cdot s / v$

The above formulas apply to correctly selected and adjusted shock absorbers. Please take more precautions than may be necessary to be on the safe side.

Special versions are available on request:	
Description	**Application**
Shock absorber with swivelling fixing	• Clevis mounting
Shock absorber with special characteristic line	• Very high impact velocity • Very low impact velocity
Shock absorber in stainless steel	• Hostile environment • Outdoor application
Shock absorber with alternative seals	• Hostile environment • Deviating ambient temperatures
Shock absorber with special stroke length	
Shock absorber with nickel plated outside parts	• Hostile environment • Outdoor application
Shock absorber with air/oil-tank	• High frequencies requiring an increased energy capacity/h • Controlled return stroke of piston rod
Shock absorber with special fastening thread	• Pre-determined fastening elements