

TAS
SCHÄFER



Friction Springs Industrial Buffers



Damping technology

Function and structure

Friction springs Type TAS

The primary function of a friction spring is the damping / absorbing of introduced energy. A friction spring consists of closed outer and inner rings which intermesh with their conical surfaces. As a result of the energy introduced axially, the outer and inner rings on the conical surfaces are shifted apart from each other so that the spring column is shortened. This has the effect that the outer rings stretch and the inner rings reduce in diameter. As a result of the friction arising on the conical surfaces, the introduced energy is absorbed and converted into heat which is to be removed. Resonance effects are suppressed completely.

energy absorption depend on the number of elements. The necessary element number is calculated from the required spring travel s or the required spring work W_e

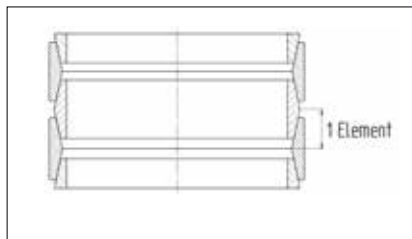
$$W_e = s_{total} / s_e = W_{total} / W_e$$


Fig. 1: Friction spring with 4 elements

Principle of the friction spring

Friction springs consist of outer and inner rings which contact each other on their conical surfaces, with the application of a special lubricant.

If an axial load acts on the friction spring, the conical surfaces slide over one another and cause the outer rings to be lengthened (stretched) and the inner rings to be shortened (compressed). The conical surfaces cause a force and path translation. As a result, a linear spring diagram is plotted.

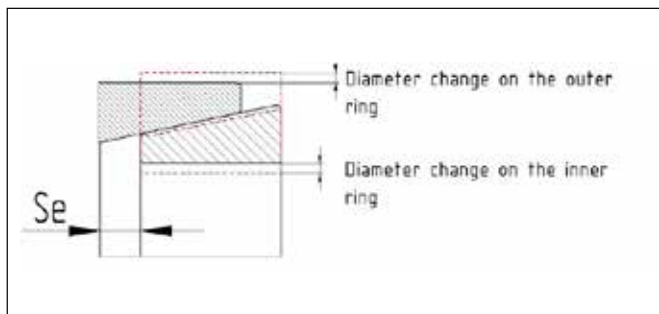


Fig. 2: Friction spring with diameter deviation

An effective conical surface is designated as a spring element, i.e. half an outer ring and half an inner ring.

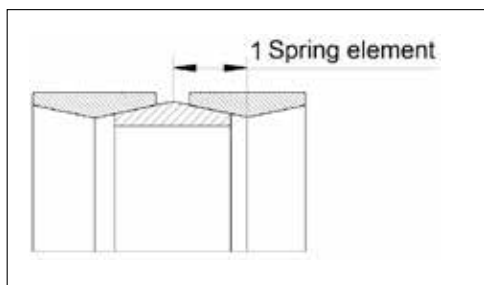


Fig 3: Drawing 2 outer rings and 1 inner ring

Friction springs are structured from similar-type outer and inner rings. As a result of changing the element number, any arbitrary spring travel can be achieved and, as a result, every level of spring stiffness. However, the end force always remains identical in case of different element numbers. Only the spring travel, as well as the spring length, change.

With the selection of the ring type, the outer and inner diameter, as well as the spring end force, are stipulated. On the other hand, the length spring, spring travel and work

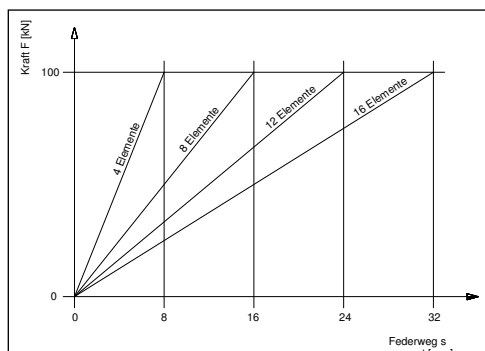


Fig. 4: Characteristic curve changeable by selection of ring number

Function and structure

Friction springs Type TAS

The friction spring should be designed as far as possible so that it comes to its end with half an inner rings on both sides. This is the most favorable variant. Thus the friction spring consists of:

- 2 Outer rings
- 1 Inner ring
- 2 Half inner rings

If, for construction-technical reasons, the friction spring must end with an uneven element number, it is composed as follows.

- 1 Outer ring
- 1 Inner ring
- 1 Half outer ring
- 1 Half inner ring

Alternatively, a friction spring can also end with 2 half outer rings or whole rings. If friction springs end with one or even two whole rings then, for the calculation of L_0 , half the ring width or twice the half ring width are to be added.

Check: For all correctly composed friction springs, the following applies:

Element number $e = \text{sum of all spring rings} - 1$

Also nothing changes here if the friction springs are closed off with whole spring rings instead of with half spring rings. The friction spring in Fig. 8 consists of 7 spring rings and accordingly has $7 - 1 = 6$ elements. With the calculation of the spring length, half the ring width is also to be added.

With this, the non-stressed length L_0 of the friction spring in Fig. 8 is $L_0 = 6 \times h_e + b/2$
Values from friction spring table on page 9

For the verification of the spring length, it is not appropriate to measure the non-stressed spring length L_0 .

Because of certain non-circularity values of the spring rings without a load and grease between the tapered surfaces, a spring length L_0 which is too large is mostly measured.

So that the spring rings make complete contact on the tapered surfaces, measuring should be carried out under test load only.

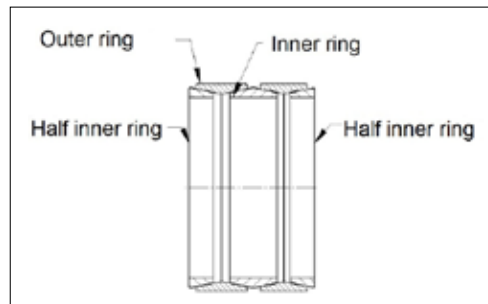


Fig. 5: Friction spring with two HIR

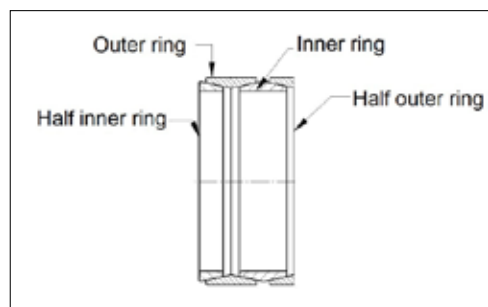


Fig. 6: Friction spring with HOR + HIR

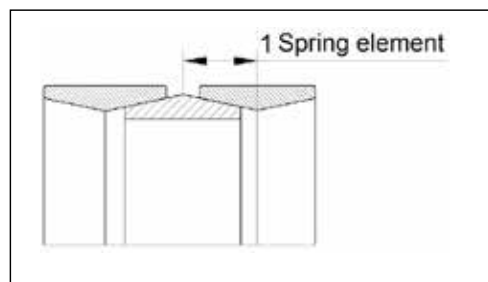


Fig. 7: Friction spring with whole rings at the end

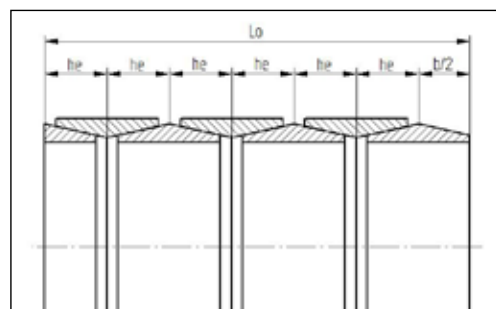


Fig. 8: Friction spring with 6 elements, ends 1 IR + 1 HIR

Construction notes

Pre-stressing:

Friction springs are to be pre-stressed with at least 5%, preferably with 10%, of the spring end force. The pre-stressing has the objective of bracing the spring rings against each other and of fixing their location with respect to each other and this has as result that a spring column is aligned in the axial direction.

In order not to impair the lubrication film on the tapered surfaces, the pre-stressing force should not be more than 50% of the later end force.

Guide:

Friction springs require an inner or outer guide. In the case of short

friction springs ($L_v \leq 1.5 \times D_1$) which are loaded between pressure plates guided parallel, a guide can be dispensed with. In case of long friction springs, it is recommended to brace these with two pre-stressed pots as friction spring cartridges.

Lubrication:

The selection of the lubricant has a large influence on the service life of the friction spring. Optimal spring characteristic values are achieved by the utilization of special lubricants. Therefore only authorized special lubricants should be used to ensure reliable function. On delivery, the friction springs are already lubricated. Since the service life of a friction

spring is in the order of magnitude of the fatigue strength of a friction spring, a later lubrication is dispensed with.

Sealing:

In order not to impair the lubrication film in case of friction springs, these are to be installed protected against moisture and dust. Simple sliding guides mostly suffice. Otherwise we recommend the installation of a flexible bellows.

Characteristics

High level of spring work with low weight and volume:

Since the spring material is fully utilized by the friction spring, the dimensions and the weight can be reduced to a minimum. The spring work per element is the decisive variable here.

High damping:

As a result of the good damping of a friction spring, where this is 66% as standard, the energy introduced is absorbed quickly and reliably. Furthermore, resonance effects are suppressed completely.

Overload-secure in block setting:

As a result of their construction as block springs, it is ensured that the friction springs do not exceed their permissible stresses. This prevents damage to the friction springs.

Independent of the loading rate:

The loading rate is independent of the force-travel diagram. Even with small loading rates, friction springs offer full spring work and damping.

Diagram independence of the temperature:

In the temperature range -40°C to $+80^\circ\text{C}$ the characteristic curve of the friction spring is constant. This is different than in the case of hydraulic dampers or synthetic springs, where the force-travel diagram is influenced by fluctuations of temperature and self-heating. The self-heating due to damping is to be considered.

Zero maintenance:

A relubrication of the spring in operation is generally not necessary. The utilization of other lubricants can even lead to failure of the friction spring.

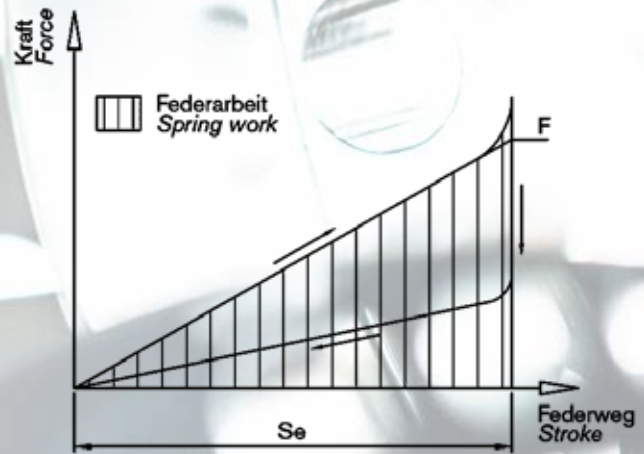
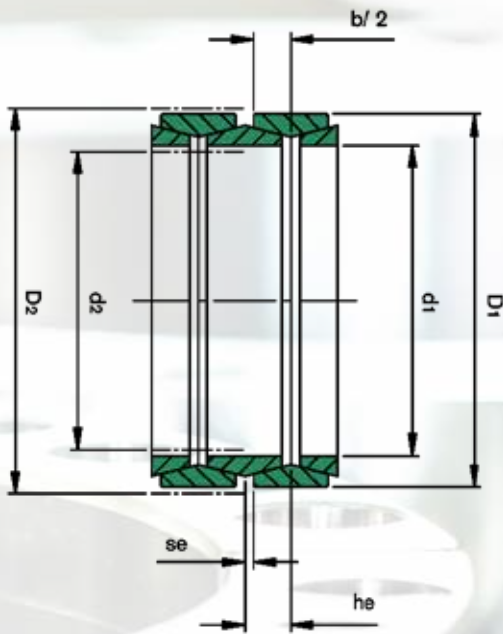
Can be individually arranged to suit the case of application:

As well as our standard friction springs, we are also glad to offer you solutions individually tailored to your requirements.

Parallel and series switching:

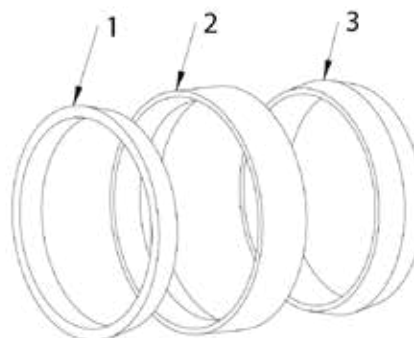
Given the option to arrange the spring column in 2 different ways, it is possible to use the installation space even more effectively.

Friction springs



Used symbols

F [kN]	Spring end force
se [mm]	Spring travel for one element
he [mm]	Element height
We [J]	Energy absorption (work of one element)
D1 [mm]	Outer diameter
d1 [mm]	Inner diameter
b/2 [mm]	Half width of the ring
D2 [mm]	Outer diameter of guide components
d2 [mm]	Inner diameter of guide components



Order specification:

Type-Number of spring elements.Index

(e.g.: 06300-4.xxxx*)

*Sequential number:

includes references to further product data

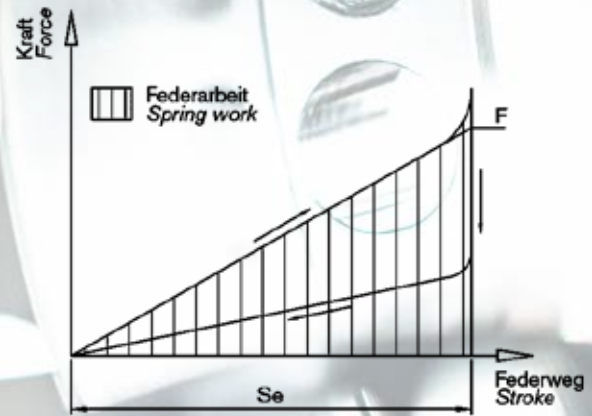
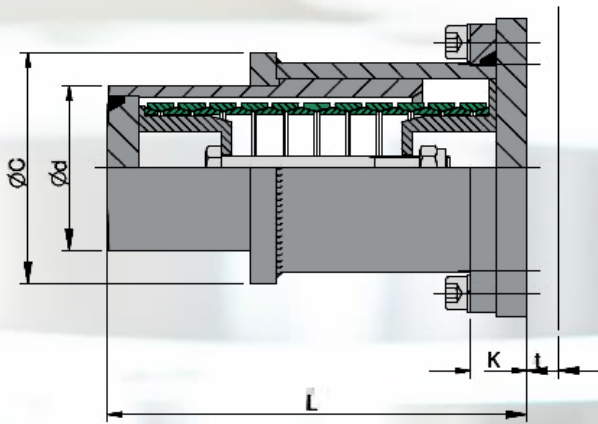
Friction Springs

Standard dimensions

Type	F kN	S _e mm	h _e mm	W _e J	D ₁ mm	d ₁ mm	b/2 mm	D ₂ mm	d ₂ mm	Weight kg
01800	5	0,4	2,2	1,0	18,1	14,4	1,8	18,7	13,9	0,002
02500	9	0,6	3,1	2,7	25,0	20,8	2,5	25,9	20,1	0,004
03200	14	0,8	4,0	5,6	32,0	27,0	3,2	33,1	26,1	0,007
03800	20	0,9	4,7	9,0	38,0	31,7	3,8	39,3	30,6	0,012
04200	27	1,0	5,2	13,5	42,2	34,6	4,2	43,6	33,4	0,017
04800	35	1,1	5,9	19,3	48,2	39,4	4,8	49,8	38,1	0,026
05500	42	1,3	6,8	27,3	55,0	46,0	5,5	56,7	44,5	0,035
06300	55	1,4	7,7	38,5	63,0	51,9	6,3	64,9	50,3	0,056
07000	67	1,6	8,6	53,6	70,0	58,2	7,0	72,1	56,4	0,074
08000	84	1,8	9,8	75,6	80,0	67,0	8,0	83,0	64,0	0,105
09000	100	2,0	11,0	100,0	90,0	75,5	9,0	93,0	72,5	0,145
10000	125	2,2	12,2	137,5	100,0	83,6	10,0	103,0	81,0	0,203
12400	200	2,6	15,0	260,0	124,0	102,0	12,4	127,0	99,0	0,410
13000	160	2,6	15,0	208,0	130,0	111,5	12,4	133,0	108,5	0,376
14000	250	3,0	17,0	375,0	140,0	116,0	14,0	143,0	113,0	0,576
16600*	350	3,7	20,0	648,0	166,0	134,0	16,0	170,0	130,0	0,870
19600	600	4,4	23,4	1320	194,0	155,0	19,0	199,0	150,0	1,680
20000	510	3,9	22,4	995,0	198,0	161,0	18,5	202,0	157,0	1,570
22000	720	4,4	26,4	1584,0	220,0	174,0	22,0	224,0	170,0	2,600
26200	860	4,8	25,8	2064,0	262,0	208,0	21,0	266,0	204,0	3,426
30000	1.000	5,8	35,8	2900,0	300,0	250,0	30,0	305,0	245,0	5,530
32000	1.250	6,2	38,2	3875,0	320,0	263,0	32,0	326,0	258,0	7,100

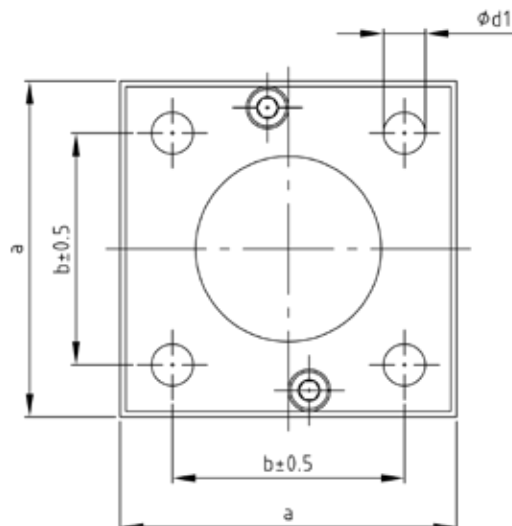
*Type 16600 is not a block spring and a separate stroke limit must be provided

IPA 1



Used symbols

m	[kg]	Weight
Fv	[kN]	Pretensioning force
F	[kN]	Spring force
s	[mm]	Spring travel
W	[J]	Spring work
L	[mm]	Total length
d	[mm]	Plunger diameter
C	[mm]	Case diameter
K	[mm]	Flange thickness
a	[mm]	Flange dimension
b	[mm]	Hole size
d1	[mm]	Flange boring
t	[mm]	Support wall thickness



Order specification:

IPA1-Sz.-Type.Index

(e.g.: IPA1-1-06300.xxxx*)

*Sequential number:

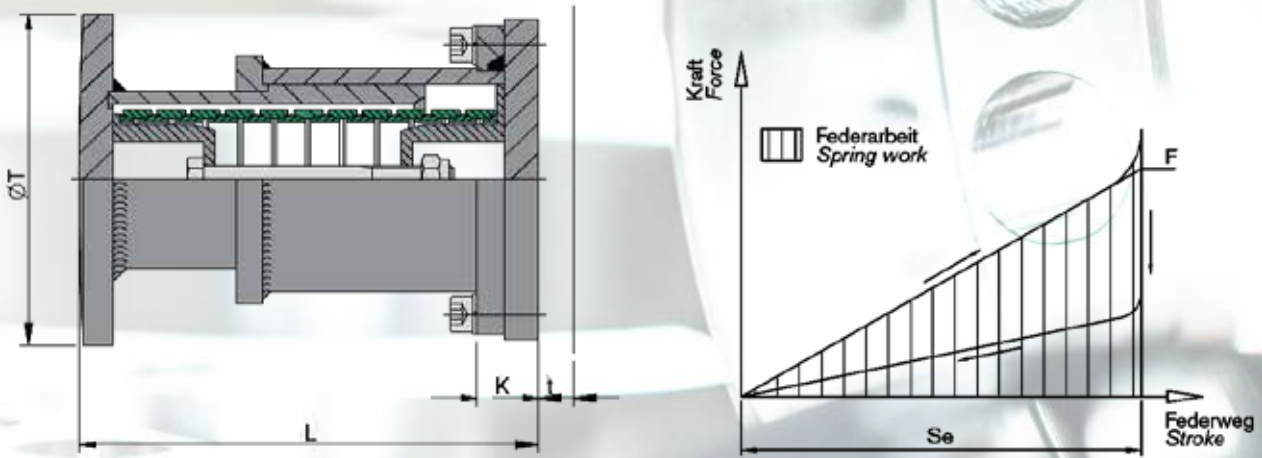
includes references to further product data

IPA 1

Standard dimensions

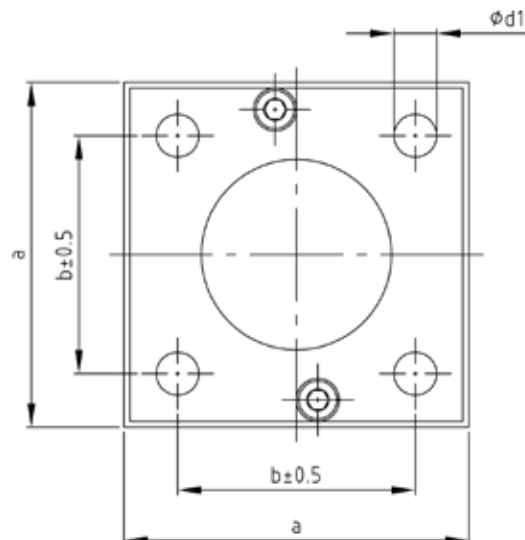
Sz.	Type	Diagram values				Dimensions of the buffer					Connection dimensions			
		F_V kN	F kN	s mm	W J	L mm	d mm	C mm	K mm	a mm	b mm	d_1 mm	t mm	m kg
1	06300	6	55	27,4	830	202	80	112	27	145	100	18	15	10,5
2		6	55	37,0	1120	262	80	112	27	145	100	18	15	12,5
3		6	55	54,8	1670	374	80	112	27	145	100	18	15	16,7
4		6	55	64,4	1960	434	80	112	27	145	100	18	15	19,2
5		6	55	74,0	2250	494	80	112	27	145	100	18	15	20,2
6	08000	7	84	33,0	1500	230	96	122	27	160	110	18	15	13,4
7		7	84	46,0	2090	306	96	122	27	160	110	18	15	16,5
8		7	84	66,0	3000	428	96	122	27	160	110	18	15	22,5
9		7	84	79,0	3590	505	96	122	27	160	110	18	15	26,2
10		7	84	92,0	4180	582	96	122	27	160	110	18	15	28,0
11	10000	10	125	44,0	2970	300	114	142	31	185	130	23	20	22,2
12		10	125	60,5	4080	397	114	142	31	185	130	23	20	26,0
13		10	125	89,0	6000	571	114	142	31	185	130	23	20	37,1
14		10	125	105,0	7080	667	114	142	31	185	130	23	20	41,8
15		10	125	121,0	8160	763	114	142	31	185	130	23	20	48,1
16	12400	20	200	51,2	5630	365	142	178	34	215	155	23	20	39,0
17		20	200	64,8	7120	454	142	178	34	215	155	23	20	46,0
18		20	200	102,4	11260	696	142	178	34	215	155	23	20	64,0
19		20	200	116,0	12760	784	142	178	34	215	155	23	20	75,0
20		20	200	130,0	14300	872	142	178	34	215	155	23	20	78,0
21	16600	20	360	75,0	14250	500	184	230	47	270	200	27	25	98,0
22		20	360	95,0	18050	630	184	230	47	270	200	27	25	124,0
23		20	360	142,0	26980	880	184	230	47	270	200	27	25	147,0
24		20	360	170,0	32300	1040	184	230	47	270	200	27	25	150,0
25		20	360	190,0	36100	1200	184	230	47	270	200	27	25	175,0

IPA 2



Used symbols

m	[kg]	Weight
Fv	[kN]	Pretensioning force
F	[kN]	Spring force
s	[mm]	Spring travel
W	[J]	Spring work
L	[mm]	Total length
T	[mm]	Baffle diameter
K	[mm]	Flange thickness
a	[mm]	Flange dimension
b	[mm]	Hole size
d1	[mm]	Flange boring
t	[mm]	Support wall thickness



Order specification:

IPA2-Sz.-Type.Index

(e.g.: IPA2-1-06300.xxxx*)

*Sequential number:

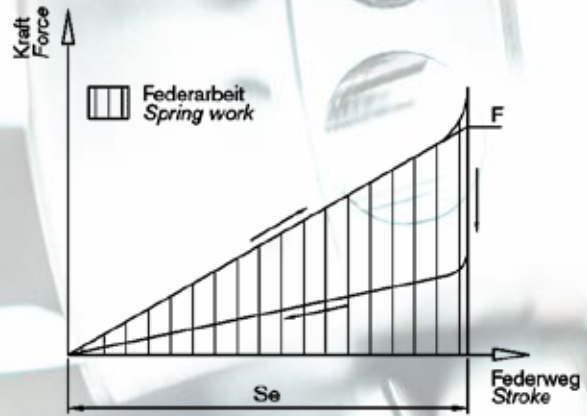
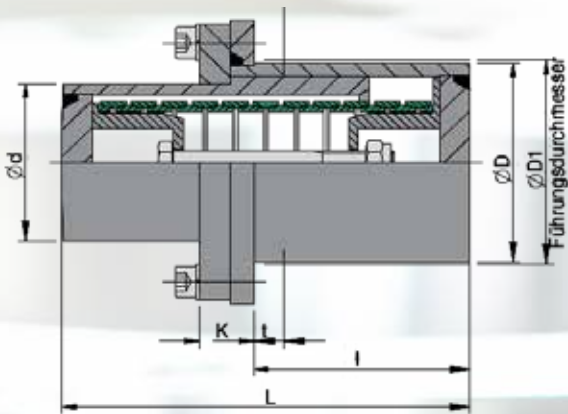
includes references to further product data

IPA 2

Standard dimensions

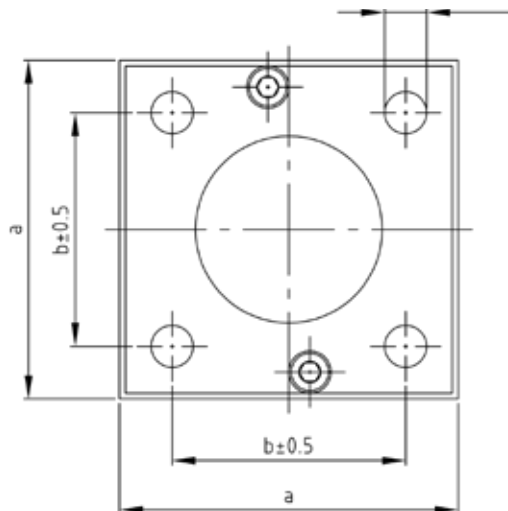
Sz.	Type	Diagram values				Dimensions of the buffer				Connection dimensions			
		F_v kN	F kN	s mm	W J	L mm	T mm	K mm	a mm	b mm	d_1 mm	t mm	m kg
1	06300	6	55	27,4	830	202	150	27	145	100	18	15	12,0
2		6	55	37,0	1120	262	150	27	145	100	18	15	13,8
3		6	55	54,8	1670	374	150	27	145	100	18	15	18,2
4		6	55	64,4	1960	434	150	27	145	100	18	15	20,8
5		6	55	74,0	2250	494	150	27	145	100	18	15	21,5
6	08000	7	84	33,0	1500	230	200	27	160	110	18	15	16,3
7		7	84	46,0	2090	306	200	27	160	110	18	15	19,5
8		7	84	66,0	3000	428	200	27	160	110	18	15	25,5
9		7	84	79,0	3590	505	200	27	160	110	18	15	29,6
10		7	84	92,0	4180	582	200	27	160	110	18	15	31,0
11	10000	10	125	44,0	2970	300	250	31	185	130	23	20	30,0
12		10	125	60,5	4080	397	250	31	185	130	23	20	30,5
13		10	125	89,0	6000	571	250	31	185	130	23	20	38,2
14		10	125	105,0	7080	667	250	31	185	130	23	20	44,8
15		10	125	121,0	8160	763	250	31	185	130	23	20	52,1
16	12400	20	200	51,2	5630	365	250	34	215	155	23	20	45,0
17		20	200	64,8	7120	454	250	34	215	155	23	20	48,0
18		20	200	102,4	11260	696	250	34	215	155	23	20	66,0
19		20	200	116,0	12760	784	250	34	215	155	23	20	77,0
20		20	200	130,0	14300	872	250	34	215	155	23	20	79,0
21	16600	20	360	75,0	14250	500	250	47	270	200	27	25	101,0
22		20	360	95,0	18050	630	250	47	270	200	27	25	126,0
23		20	360	142,0	26980	880	250	47	270	200	27	25	149,0
24		20	360	170,0	32300	1040	250	47	270	200	27	25	152,0
25		20	360	190,0	36100	1200	250	47	270	200	27	25	177,0

IPA 3



Used symbols

m	[kg]	Weight
Fv	[kN]	Pretensioning force
F	[kN]	Spring force
s	[mm]	Spring travel
W	[J]	Spring work
L	[mm]	Total length
l	[mm]	Dimple length
D	[mm]	Outer diameter
d	[mm]	Plunger diameter
K	[mm]	Flange thickness
a	[mm]	Flange dimension
b	[mm]	Hole size
d1	[mm]	Flange boring
D1	[mm]	Installation diameter
t	[mm]	Support wall thickness



Order specification:
IPA3-Sz.-Type.Index
 (e.g.: IPA3-1-06300.xxxx*)

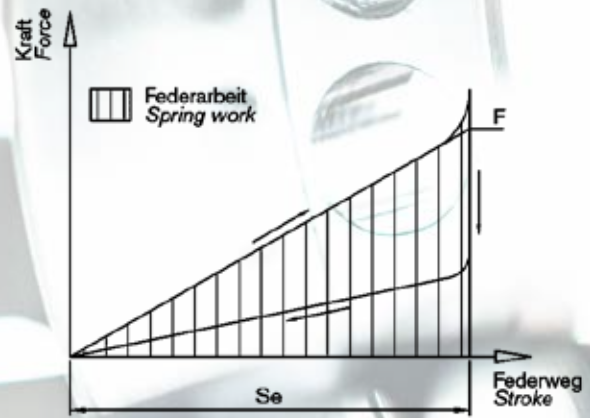
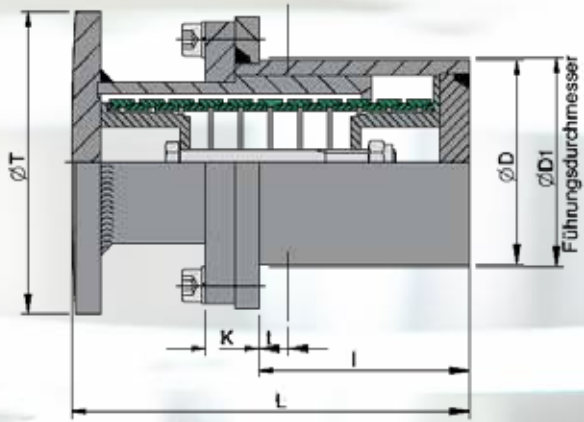
*Sequential number:
 includes references to further product data

IPA 3

Standard dimensions

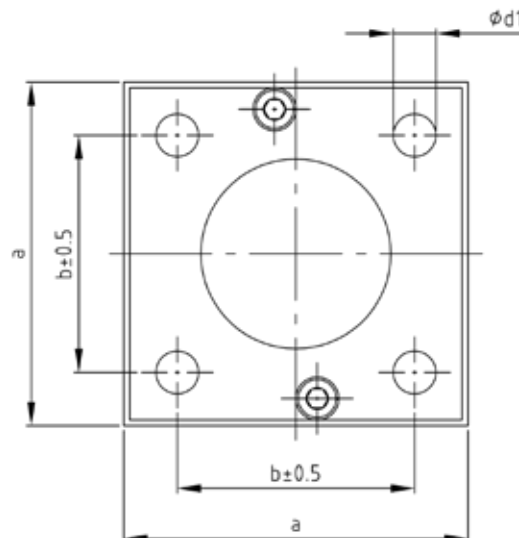
Sz.	Type	Diagram values				Dimensions of the buffer						Connection dimensions				
		F_V kN	F kN	s mm	W J	L mm	I mm	D mm	d mm	K mm	a mm	b mm	d_1 mm	D_1 mm	t mm	m kg
1	06300	6	55	27,4	830	202	107	102	80	27	145	100	18	104	15	10,2
2		6	55	37,0	1120	262	156	102	80	27	145	100	18	104	15	12,5
3		6	55	54,8	1670	374	225	102	80	27	145	100	18	104	15	16,5
4		6	55	64,4	1960	434	293	102	80	27	145	100	18	104	15	19,1
5		6	55	74,0	2250	494	293	102	80	27	145	100	18	104	15	20,1
6	08000	7	84	33,0	1500	230	125	114	96	27	160	110	18	117	15	13,5
7		7	84	46,0	2090	306	170	114	96	27	160	110	18	117	15	16,2
8		7	84	66,0	3000	428	258	114	96	27	160	110	18	117	15	21,7
9		7	84	79,0	3590	505	355	114	96	27	160	110	18	117	15	25,8
10		7	84	92,0	4180	582	360	114	96	27	160	110	18	117	15	27,5
11	10000	10	125	44,0	2970	300	165	133	114	31	185	130	23	135	20	21,5
12		10	125	60,5	4080	397	230	133	114	31	185	130	23	135	20	26,0
13		10	125	89,0	6000	571	350	133	114	31	185	130	23	135	20	36,7
14		10	125	105,0	7080	667	470	133	114	31	185	130	23	135	20	41,3
15		10	125	121,0	8160	763	470	133	114	31	185	130	23	135	20	45,3
16	12400	20	200	51,2	5630	365	216	165	142	34	215	155	23	167	20	35,5
17		20	200	64,8	7120	454	275	165	142	34	215	155	23	167	20	45,0
18		20	200	102,4	11260	696	456	165	142	34	215	155	23	167	20	64,0
19		20	200	116,0	12760	784	574	165	142	34	215	155	23	167	20	74,0
20		20	200	130,0	14300	872	550	165	142	34	215	155	23	167	20	78,0
21	16600	20	360	75,0	14250	500	328	219	184	47	270	200	27	222	25	83,0
22		20	360	95,0	18050	630	450	219	184	47	270	200	27	222	25	106,0
23		20	360	142,0	26980	880	660	219	184	47	270	200	27	222	25	148,0
24		20	360	170,0	32300	1040	687	219	184	47	270	200	27	222	25	151,0
25		20	360	190,0	36100	1200	850	219	184	47	270	200	27	222	25	176,0

IPA 4



Used symbols

m	[kg]	Weight
Fv	[kN]	Pretensioning force
F	[kN]	Spring force
s	[mm]	Spring travel
W	[J]	Spring work
L	[mm]	Total length
I	[mm]	Dimple length
D	[mm]	Outer diameter
T	[mm]	Baffle diameter
K	[mm]	Flange thickness
a	[mm]	Flange dimension
b	[mm]	Hole size
d1	[mm]	Flange boring
D1	[mm]	Installation diameter
t	[mm]	Support wall thickness



Order specification:

IPA4-Gr.-Typ.Index

(e.g.: IPA4-1-06300.xxxx*)

*Sequential number:

includes references to further product data

IPA 4

Standard dimensions

Sz.	Type	Diagram values				Dimensions of the buffer						Connection dimensions				
		F_V kN	F kN	s mm	W J	L mm	I mm	D mm	T mm	K mm	a mm	b mm	d_1 mm	D_1 mm	t mm	m kg
1	06300	6	55	27,4	830	202	107	102	150	27	145	100	18	104	15	11,7
2		6	55	37,0	1120	262	156	102	150	27	145	100	18	104	15	13,4
3		6	55	54,8	1670	374	225	102	150	27	145	100	18	104	15	18,0
4		6	55	64,4	1960	434	293	102	150	27	145	100	18	104	15	20,7
5		6	55	74,0	2250	494	293	102	150	27	145	100	18	104	15	21,4
6	08000	7	84	33,0	1500	230	125	114	200	27	160	110	18	117	15	16,3
7		7	84	46,0	2090	306	170	114	200	27	160	110	18	117	15	19,2
8		7	84	66,0	3000	428	258	114	200	27	160	110	18	117	15	24,7
9		7	84	79,0	3590	505	355	114	200	27	160	110	18	117	15	29,0
10		7	84	92,0	4180	582	360	114	200	27	160	110	18	117	15	30,4
11	10000	10	125	44,0	2970	300	165	133	250	31	185	130	23	135	20	26,6
12		10	125	60,5	4080	397	230	133	250	31	185	130	23	135	20	29,0
13		10	125	89,0	6000	571	350	133	250	31	185	130	23	135	20	37,8
14		10	125	105,0	7080	667	470	133	250	31	185	130	23	135	20	42,3
15		10	125	121,0	8160	763	470	133	250	31	185	130	23	135	20	51,6
16	12400	20	200	51,2	5630	365	216	165	250	34	215	155	23	167	20	44,5
17		20	200	64,8	7120	454	275	165	250	34	215	155	23	167	20	47,5
18		20	200	102,4	11260	696	456	165	250	34	215	155	23	167	20	65,6
19		20	200	116,0	12760	784	574	165	250	34	215	155	23	167	20	76,5
20		20	200	130,0	14300	872	550	165	250	34	215	155	23	167	20	78,4
21	16600	20	360	75,0	14250	500	328	219	250	47	270	200	27	222	25	100,5
22		20	360	95,0	18050	630	450	219	250	47	270	200	27	222	25	125,0
23		20	360	142,0	26980	880	660	219	250	47	270	200	27	222	25	148,2
24		20	360	170,0	32300	1040	687	219	250	47	270	200	27	222	25	151,2
25		20	360	190,0	36100	1200	850	219	250	47	270	200	27	222	25	177,0