Actuator range

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Linear actuator definition and type

Definition: Electro-mechanical linear actuators enable precise, controlled, and repeatable push/pull movement in linear drive applications (see illustrations below).

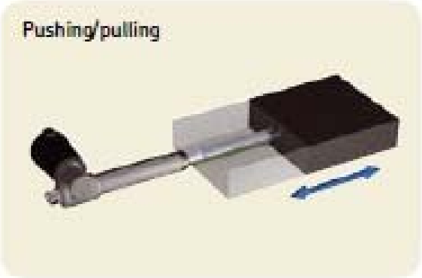
Linear actuators serve as efficient, virtually maintenance-free, and environmentally friendly alternatives to hydraulic or pneumatic types.

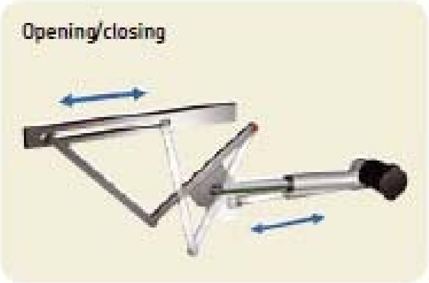
Standard versions can handle loads as great as 12 kN, deliver speeds up to 150 mm/s, and travel as far as 1 500 mm. They can be self-contained in aluminum, zinc, or polymer housings and ready-to-mount for easy plug-in operation.

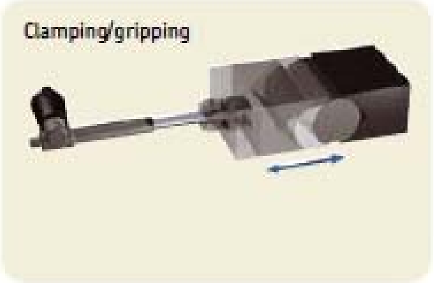
Actuators with modular design and open architecture offer opportunities to choose and integrate components to achieve customized solutions within existing envelopes. Application potential expands with the introduction of technologies for specific purposes, such as hall sensors, limit switches, potentiometers, friction clutches, or back-up nuts.

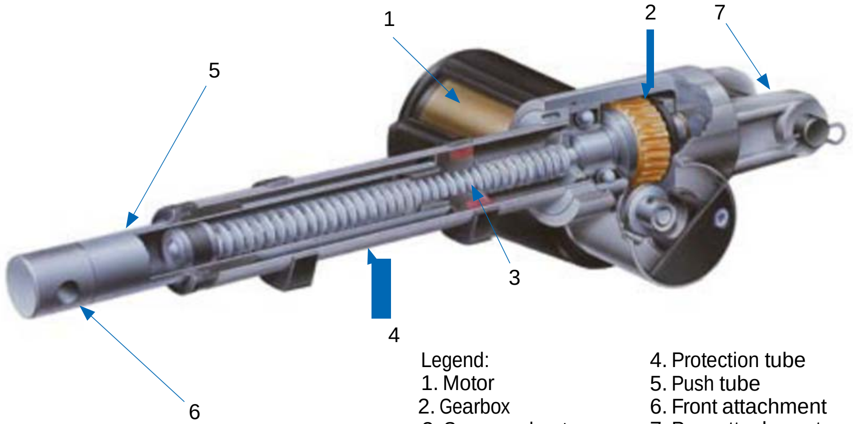
Screw-type linear actuators powered by an electric AC or DC motor basically consist of a lead screw (threaded shaft/spindle) with drive nut and push tube. In 90 % of the cases, a gearbox between the motor and the screw is also present.

When power is supplied, the motor rotates the lead screw, which causes the drive nut to travel and extend the push tube. Reversing the motor rotation retracts the push tube.









Legend:
1. Motor
2. Gearbox
3. Screw and nut
4. Protection tube
5. Push tube
6. Front attachment
7. Rear attachment

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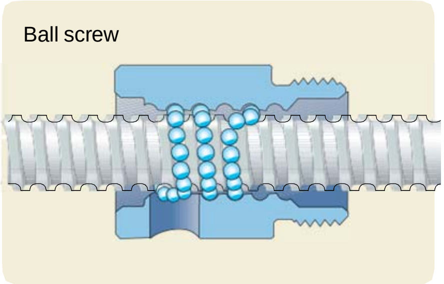
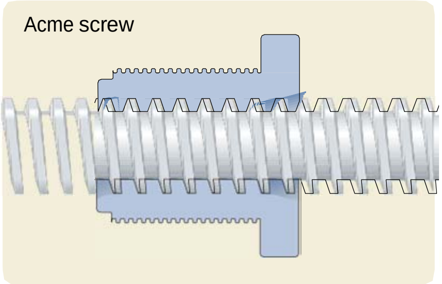
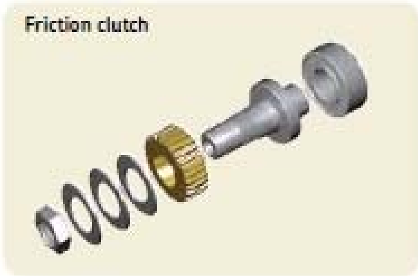






Ball screw vs. acme screw: Traditional types of lead screws include ball screws and acme screws, whose specification will be influenced by an actuator's configuration and load requirements.

Ball screws: All-steel ball screws consist of a screw shaft, ball nut with a ball recirculation system to convert rotary motion into smooth, accurate, and reversible linear motion (or torque to thrust). The row of circular rolling elements is self-contained in a closed system between the nut and screw for a design exhibiting extremely low friction coefficients. The low frictional resistance minimizes wear, improves efficiency, and reduces operating temperature for longer service life.

Ball screws can handle extreme loads, achieve high duty cycles, operate over a wide temperature range, and deliver the precision necessary to equip actuators performing over long periods at high speeds and requiring high dynamic capability. Brakes usually will be specified for ball screw actuators to prevent back-drive.

Acme screws: These screws transmit torque into linear motion through direct sliding friction. A typical assembly consists of a steel screw and plastic nut.

Some of the products are equipped with acme screws with a relatively high friction coefficient that makes them well suited for self-locking application. Acme screw actuators accommodate high static load, withstand excessive vibration, operate quietly, and represent cost-effective solutions.

Performance considerations

Beyond the basic fundamentals of actuator operation, applications may require feedback on position and/or direction, limits on motion or travel in a particular direction, or protection against dynamic overload. Enabling technologies have been developed for these purposes.

Limit switch: Its purpose is to limit actuator motion or travel in a particular direction. When activated, the switch opens or closes an electrical contact. When the contact is closed, current will flow through the switch; when the contact is open, no current will flow through the switch. These devices prevent actuators from running into the mechanical ends and may allow for the adjustment of stroke length.

Hall sensors: These rotary or linear sensing devices determine the relative position of an actuator. Two sensors detect the changing magnetic field created by a rotating magnet and then relay corresponding output pulses to a control unit to provide the position feedback.

Potentiometer: A potentiometer is an analouge feedback device. The potentiometer is considered as an absolute sensor with unique value in each position. Sometimes it is called a variable resistance that can be read and feed into a controller for positioning control of the application.

Friction clutch: This function will protect the actuator from mechanical damage when it reaches either of its mechanical end positions or when the maximum dynamic load is momentarily exceeded. A friction clutch consists of a series of steel plates engaging a hub and a series of friction rings engaging a housing. Pressure is exerted on the plates and rings by an adjuster acting through a spring and pressure plate. The friction clutch is not intended for use as a load limiter, but only for protection of the actuator and end-use equipment in the event of dynamic overload.

Ball detent clutch: A ball detent type clutch transmits force through hardened balls which rest in detents on the shaft and are held in place with springs. An overtorque/load condition pushes the balls out of their detents, thereby decoupling the lead-screw from the motor.

Back-up nut: This prevents an actuator from collapsing if a drive nut fails. The back-up nut is usually in metal, exhibits greater anti-shear strength than the drive nut, and only makes contact with the threads of the spindle when the threads of the drive nut fail. The back-up nut carries the load and may be able to lower the load (signaling need for repair).

Slip stick effect: The cycle of alternating slipping and sticking as two surfaces rub against each other. The effect is vibration and noise. Resonances within other materials can occur. This effect can sometimes be heard, felt or seen. With linear actuators, Slip stick has been witnessed between the Delrin and aluminum or steel, such as between drive nut and spindle, and glide pad and extrusion.

Selection criteria

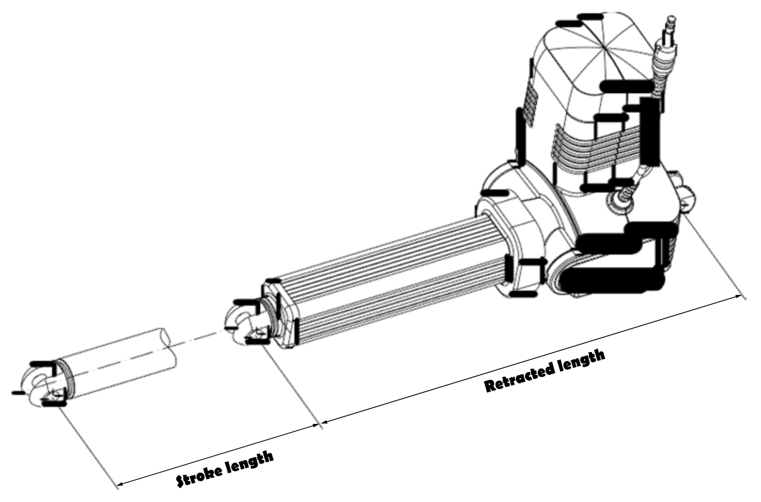
An actuator's performance will be influenced by a variety of factors intrinsic to an application. An understanding of these factors can help you select the most suitable actuator design and solution. Relevant factors to evaluate include push/pull force, static and dynamic load capacity, speed, stroke and retracted length, duty cycle, and life calculation.

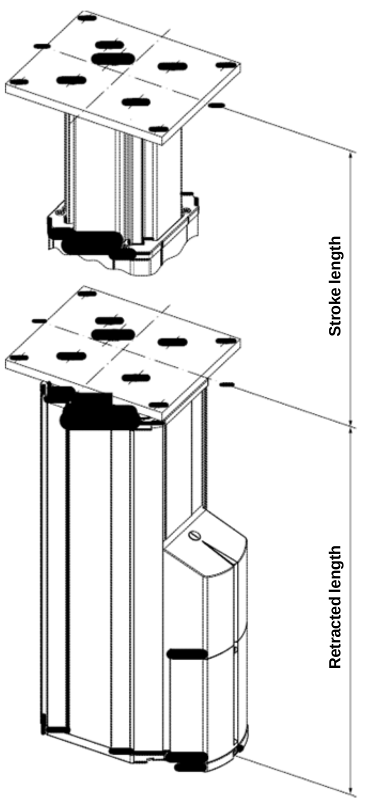
Force: Push force is the maximum extending force that an electric linear actuator can produce in Newtons (N). Pull force is the maximum retracting force. Some actuators do not produce equal push and pull forces, while others do not permit pull force.

Load capacity: Maximum static load refers to the weight or mass that an actuator can handle when standing still without causing permanent damage or causing the actuator to start "going backwards." (Subjecting an actuator to loads in excess of stated values can increase the risk of permanent deformation to some parts.) Maximum dynamic load represents the maximum total weight or mass that the actuator can move. The decisive factor for this value is the size of the motor and the type of gearing. Some versions feature an integral mechanical safety device similar to a clutch to protect the motor and gears from damage.

Speed: This represents the rate of travel (when extending or retracting) and is usually measured in mm/s or in./s. Speed can vary under different loads, often depending on the motor. Actuators with DC motors exhibit a speed variation inversely proportional to the load. Actuators with AC motors move at more consistent speed, which is only slightly affected by the load. Other factors impacting the speed will include the magnitude and/or frequency of the applied voltage, the ambient temperature, and how well an actuator is integrated into the end-use application.

Stroke and retracted length: The stroke describes the length (in millimeters or inches) that an electro-mechanical linear actuator or telescopic pillar will extend or retract. The retracted length is the shortest distance between the two fixed points on an actuator when the actuator is in its innermost position. The dimensions reflect a measurement from the center of the rear and front mounting holes.





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Calculations

Duty cycle and duty factor: This defines the maximum period during actuator operation without interruption. The corollary duty factor expresses how long an actuator can handle non-stop operation before it overheats or is otherwise damaged. Many variables will affect the duty cycle, including running time, application, design, installation, and components. It is necessary for you to assess the type of task, its duration, frequency, and repetitiveness when evaluating expected duty cycle.

SKF linear actuators are designed for intermittent operation. Permitted load is related to the duty factor i.e. load must be reduced, when the duty factor is increased. Duty cycle is defined as the relation between operational time, load and rest time. In the diagrams, maximum load is shown as a function of duty cycle. If the recommended duty factor is exceeded, the actuator may overheat and be damaged.

Permitted load for DC-actuators at a specific duty factor is expressed in percentage of maximum dynamic load capacity (→ fig. 1).

$$\text{Duty factor \%} = \frac{N}{N+R}\,100$$

where

N = running period under load

R = rest period

N+R = total cycle time

Example:

An actuator is running with the following cycle, 5 seconds running, 5 seconds rest, 5 seconds running, 15 seconds rest, and so on.

Calculate duty factor and maximum load for this working cycle.

$$\text{Duty factor} = \frac{5+5}{(5+5)+(5+15)}\,100 = 33\%$$

Max. dynamic load = 5 000 N

Permitted load = 0,73 ¥ 5 000 = 3 650 N

Life calculation: An actuator's life expectancy is divided into two types: its life and its service (or operational) life. The actuator's life is defined as the time the actuator can live without being derated due to age. The actuator's service life is defined as the time (or how many cycles) the actuator can operate. For example, an actuator is installed to operate once a day for 10 years. Its expected life is 10 years and its required service life is 10 ¥ 365 cycles.

The service life of a ball screw actuator normally will be determined by the L_{10} life of the ball screw. In most cases, there is less wear on the worm gear and bearings than on the ball screw.

Under certain circumstances, the life of the motor is shorter than that of the ball screw. Generally, the life of DC-motors is reduced when load and number of starts/stops are increased.

To calculate the basic rating life L_{10} of a ball screw, all you need to know is the dynamic load and actual stroke. L_{10} is defined as the life that 90% of a sufficiently large group of apparently identical ball screws can be expected to attain or exceed.

$$L_{10\,ds} = \frac{500\,000\,p}{S}\left(\frac{C}{F_M}\right)^3$$

where

$L_{10\,d\,s}$ = basic rating life in double strokes i.e. a stroke from one end position to the other and back again.

p = lead of the ball screw (mm).

S = actual stroke (mm).

C = ball screw basic dynamic load rating (N).

F_M = cubic mean load (N).

In many cases, the magnitude of the load fluctuates. In order to calculate the equivalent screw load, it is first necessary to determine a constant mean load F_m which would have the same influence on the ball screw as the actually fluctuating load. A constant mean load can be obtained from the formula below.

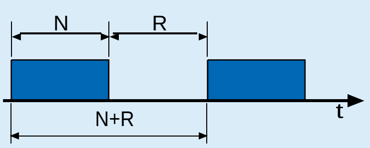
$$F_M = \sqrt[3]{\frac{F_1^3\,S_1+F_2^3\,S_2+F_3^3\,S_3+...}{S_1+S_2+S_3+...}}$$

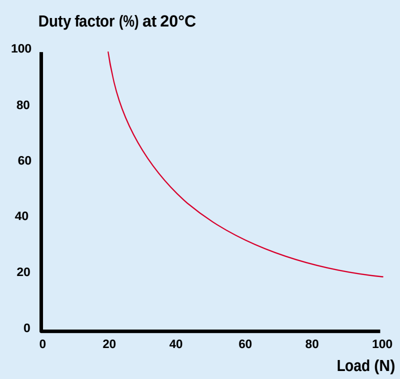
Example:

An actuator with a stroke of 500 mm has a load of 2 800 N in one direction of movement and 2 100 N in the other. The entire stroke of the actuator is utilized.

$$F_M = \sqrt[3]{\frac{2\,800^3 \times 500+2\,100^3 \times 500}{500+500}} = 2\,500$$

Fig. 1





Application checklist

Designing and specifying an electro-mechanical linear actuator begins by assessing as many application factors as possible to make the most appropriate and educated technology choices.

- How much force and in what directions (push, pull, vertical, and/or horizontal) will the actuator need to move?
- How far and how fast will the actuator need to travel?
- How often will the actuator operate and how much time will elapse between operations?
- What is the desired lifetime for the application?
- How will the actuator be mounted and will front and/or back mounts require special configurations?
- Does the application suggest a need for safety mechanisms?
- Will environmental factors (temperature variations, moisture, or vibration) pose a challenge to operation?
- Is space limited?
- What are the power supply options?
- If a motor is used, what type (AC, DC, or special) and what voltage?
- Is feedback required for speed and/or position?
- Are revised specifications likely or anticipated in the future?

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Typical applications

Off-highway

Hood lifter

Highway mobile sign

Food and beverage

Grill

Tilting pan

Medical

Imaging system

Incubator

Healthcare

Treadmill

Massage table

Solar tracking

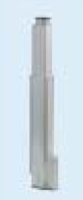
Solar tracker

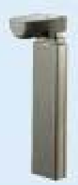
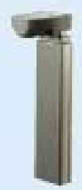
Factory automation

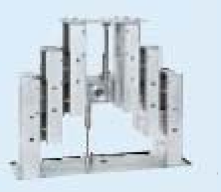
Adjustable workstation

Frame gripper

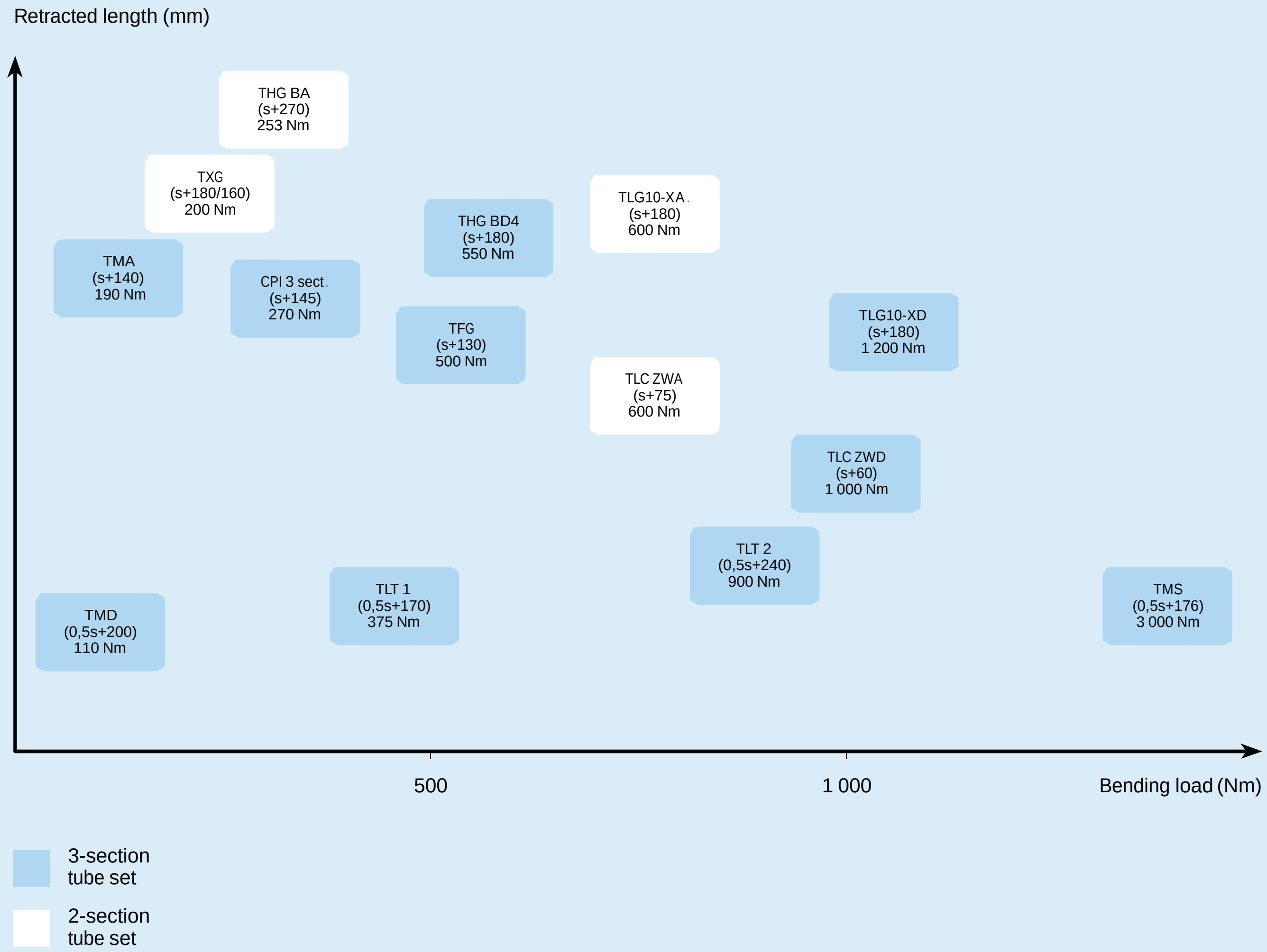
Telescopic pillars AC versions	Type	Voltage	Max rated load push	Max rated load pull	Max speed full load	Max speed no load	Stroke (S)	Page
	–	V	N	N	mm/s	mm/s	mm	No.
	TLC	120 or 230 AC	4 000	4 000	15	22	100 to 700	38
	TFG 50	120 AC	2 500	2 500	15	19	200 to 700	42
	TFG 90	230 AC	2 500	2 500	15	19	200 to 700	42
	THC	120 or 230 AC	1 800	1 800	15	20	200 to 700	46
	TXG	120 or 230 AC	1 500	0	17	23	200 to 600	50
	TGC	120 or 230 AC	1 000	1 000	11	12	200 to 700	54

Telescopic pillars DC versions	Type	Voltage	Max rated load push	 pull	Max speed full load	 no load	Stroke (S)	Page
	–	V	N	N	mm/s	mm/s	mm	No.
	CPI	24 DC	4 000	4 000	31	38	200 to 700	60
	TLG	24 DC	4 000	0	25	33	200 to 700	64
	TLT	24 DC	4 000	0	25	42	300 to 700	68
	TFG 10	24 DC	2 500	2500	15	19	200 to 700	72
	THG	24 DC	2 000	0	12	15	200 to 700	76
	CAWA	24 DC	1 650	0	14	22	500 to 1 000	80

Telescopic pillars DC versions	Type	Voltage	Max rated load push	pull	Max speed full load	no load	Stroke (S)	Page
	–	V	N	N	mm/s	mm/s	mm	No.
	TXG	24 DC	1 500	0	17	23	200 to 600	84
	TMA	24 DC	1 000	0	35	55	500	88
	TMD	24 DC	800	0	35	60	700	92

Telescopic pillars No motor	Type	Voltage	Max load push	pull	Max speed full load	no load	Stroke (S)	Page
	–	V	N	N	mm/s	mm/s	mm	No.
	FRE	No motor	N/A	N/A	N/A	N/A	200 to 700	98
	TMS	No motor	4 000	4 000	N/A	N/A	250 to 700	102

Telescopic pillars – retracted length/bending load ratio



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Linear actuators
AC versions

	Type	Voltage	Max rated load push	Max rated load pull	Max speed full load	Max speed no load	Stroke (S)	Page
	–	V	N	N	mm/s	mm/s	mm	No.
	SLS	3™400 AC	50 000	50 000	74	88	100 to 700	110
	SKS/SKA	3™400 AC	30 000	30 000	45	54	100 to 700	114
	SKD	3™400 AC	15 000	15 000	25	33	100 to 700	118
	STD	3™400 AC	15 000	15 000	10	14	100 to 700	122
	STW	230 AC	15 000	15 000	12	13	100 to 700	126
	MAX 6	120 or 230 AC	8 000	6 000	13	18	50 to 700	130

Linear actuators
AC versions

	Type	Voltage	Max rated load push	pull	Max speed full load	no load	Stroke (S)	Page
	–	V	N	N	mm/s	mm/s	mm	No.
	CAR 40	120 or 230 AC	6 000	6 000	40	40	100 to 700	134
	CAHB–31	115 or 230 AC	6 000	6 000	48	57	102 to 610	138
	SJ	115 or 230 AC	5 000	5 000	6,6	7,2	100 to 600	142
	DSP	3™400 AC	4 500	4 500	50	58	100 to 700	146
	CAP 32	120 or 230 AC	3 500	3 500	32	32	50 to 700	150
	CAR 32	120 or 230 AC	3 500	3 500	32	32	50 to 700	154

Linear actuators
AC versions

	Type	Voltage	Max rated load push	pull	Max speed full load	no load	Stroke (S)	Page
	–	V	N	N	mm/s	mm/s	mm	No.
	CAT 32B	120, 230 or 400 AC	3 500	3 500	32	32	50 to 700	158
	CAT 33	120, 230 or 400 AC	3 000	3 000	24	24	100 to 400	162
	WSP	230 AC	2 600	2 600	50	50	100 to 700	166
	CAHB–30	115 or 230 AC	2 300	2 300	25	26	102 to 610	170
	CAT 33H	120, 230 or 400 AC	1 200	1 200	90	90	100 to 400	174

Linear actuators
DC versions

	Type	Voltage	Max rated load push	pull	Max speed full load	no load	Stroke (S)	Page
	–	V	N	N	mm/s	mm/s	mm	No.
	SKG	24 DC	15 000	15 000	55	73	100 to 700	180
	STG	24 DC	15 000	15 000	14	20	100 to 700	184
	RU	24 DC	12 000	8 000	8	15	100 to 700	188
	MAX 3	12 or 24 DC	8 000	6 000	12,7	18	50 to 700	192
	CAR 40	24 DC	6 000	6 000	40	60	100 to 700	196
	ECO	24 DC	6 000	4 000	9	13	50 to 300	200

Linear actuators
DC versions

	Type	Voltage	Max rated load push	pull	Max speed full load	no load	Stroke (S)	Page
	–	V	N	N	mm/s	mm/s	mm	No.
	FD	24 DC	6 000	4 000	6,2	8,2	50 to 300	204
	Magdrive	24 DC	6 000	6 000	8,5	15	50 to 700	208
	CAHB–21	12 or 24 DC	4 500	4 500	45	65	102 to 610	212
	ASM	12 or 24 DC	4 000	4 000	50	70	100 to 700	216
	CAP 43B	24 DC	4 000	4 000	52	65	50 to 700	220
	CAT 32B	12 or 24 DC	4 000	4 000	52	67	50 to 700	224

Selection guide

Linear actuators
DC versions

	Type	Voltage	Max rated load push	pull	Max speed full load	no load	Stroke (S)	Page
	–	V	N	N	mm/s	mm/s	mm	No.
	MAX 1	24 DC	4 000	4 000	12,7	18	50 to 700	228
	CAR 32	12 or 24 DC	3 500	3 500	40	60	50 to 700	232
	CAP 32	12 or 24 DC	3 500	3 500	40	60	50 to 700	236
	CAP 43A	24 DC	3 000	3 000	40	52	100 to 400	240
	CAT 33	12 or 24 DC	3 000	3 000	40	52	100 to 400	244
	CAHB–20	12 or 24 DC	2 500	2 500	27	33	102 to 610	248

Linear actuators DC versions	Type	Voltage	Max rated load push	Max rated load pull	Max speed full load	Max speed no load	Stroke (S)	Page
	–	V	N	N	mm/s	mm/s	mm	No.
	CARE 33	24 DC	2 000	2 000	32	45	50 to 500	252
	CAR 22	12 or 24 DC	1 500	1 500	20	30	50 to 300	256
	CAT 33H	12 or 24 DC	1 200	1 200	150	190	100 to 400	260
	CAHB–10	12 or 24 DC	1 000	1 000	45	56	50 to 300	264
	CALA 36A	12 or 24 DC	600	600	17	31	50 to 200	268
	CAT 21B	24 DC	600	600	8,1	9,7	50 to 300	272

Linear actuators
No motor

	Type	Voltage	Max rated load push	pull	Max speed full load	no load	Stroke (S)	Page
	–	V	N	N	mm/s	mm/s	mm	No.
	CARN 32	No motor	3 500	3 500	N/A	N/A	50 to 700	280
	CCBR 32	No motor	2 500	2 500	N/A	N/A	50 to 700	284

Rotary actuators

	Type	Max torque	Max speed	Size	Page
	–	Nm	rpm	mm	No.
	CRAB 17 CRAB 17	70 105	8 20	125 125	290 290
	CRAB 05	100	3	86	296

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Control units

	Type	Functionality	Max motor	Input	Output	Page
	–	–	n°	V	V/A	No.
	SCU	Encoder processing	6	24 DC 120 or 230 AC	24/30 24/18	302
	VCU	Basic functions	5	120 or 230 AC	24/7 or 18	306
	BCU	Basic functions	3	120 or 230 AC	24/7	310
	CB 200S	Basic functions	3	100 – 240 AC	24/3	314
	MCU	Basic functions	2	24 DC	24/7 or 18	316
	LD–014 LD–015 LD–015	Synchronous Synchronous Synchronous	4 3 2	120 or 230 AC 120 or 230 AC 120 or 230 AC	24/11 24/11 24/9	318 320 320

Control units

	Type	Functionality	Max motor	Input	Output	Page
	–	–	n°	V	V/A	No.
CAED ANR 	5–24R –PO 9–24R –PO	Analogical feedback Analogical feedback	1 1	24 DC 24 DC	24/5 24/9	322 322
CAED 	3–24R 5–24R 9–24R	Basic functions Basic functions Basic functions	1 1 1	24 DC 24 DC 24 DC	24/3 24/5 24/9	324 324 324
CAEV 	110/220	Basic functions	1	120 or 230 AC	120 or 230 AC	326

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Hand switches

	Type	Operating power	Max operating channels	Type of protection	Color	Page
	–	V DC/mA	n°	IP	–	No.
EHA 	EHA 1 EHA 3	12/50 12/50	2 5	67 67	Grey Grey	332 334
	EHE 1	38/50	2	™7	Grey	336
HS 	HS 112 HS 124 HS 126 HS 138	40/50 40/50 40/50 40/50	1 2 2 3	– – – –	Black Black Black Black	338 338 338 338
	PHC	–	4	66	Grey	340
	CAES 31C	30/33	1	54	Black	342

Selection guide

Foot switches

	Type	Operating power	Max operating channels	Type of protection	Color	Page
	–	V DC/mA	n°	IP	–	No.
	ST	12/50	3	™5	Blue/anthracite	344
	PFP 1K PFP 1	– –	1 1	21 21	Grey Anthracite	346 346

Desk switches

	Type	Operating power	Max operating channels	Type of protection	Color	Page
	–	V DC/mA	n°	IP	–	No.
	ST	12/50	3	™0	Black	348
	LD	5/50	2	32	Black	350

Desk switch (pneumatic)	Type	Max operating channels	Air tube	Color	Page
	–	n°	–	–	No.
	PAM	1	1,5 m straight	Anthracite	352

Project sales

Rotary actuators

	Type	Torque	Max speed	Size	Features	Page
	–	Nm	rpm	mm	–	No.
CRAB	CRAB 12	200	20	120	Compact	356
	CRAB 20	400	15	155	Zero backlash	356
	CRAB 30	1 000	10	228	Zero backlash	356
	CRAB 40	1 700	8	286	Zero backlash	356

Compact electro-mechanical cylinder	Type	Screw lead	Nominal force[1])	Speed	Stroke	Page
	–	mm	kN	mm/s	mm	No.
CEMC	1804–145–1–42J	3,75	4,7	350	145	359
	2404–•••–•–62L	4,00	8,7	300	125–135–170	359
	2406–125–•–62L	6,00	5,8	450	125	359
	2404–•••–•–63I	4,00	13,1	300	125–135–170	359
	2406–125–•–63I	6,00	8,7	450	125	359
	2104–170–•–D63L	4	9,0	353	170	360
	2404–•••–2–D82P	4	14,1	320	90–170	360
	2406–•••–2–D82P	6	9,4	480	90–170	360
	3004–•••–2–D82P	4	14,1	266	90–170	360
	3006–•••–2–D82P	6	9,4	400	90–170	360
	3004–•••–2–D84H	4	27,4	266	90–170	360
	3006–•••–2–D84H	6	18,3	400	90–170	360
	3004–•••–2–D86F	4	39,5	266	90–170	360
	3006–•••–2–D86F	6	26,3	400	90–170	360

[1]) Nominal force: can be used 100 % of time at low speed (10 % of maximum speed)

Modular electro-mechanical cylinder	Type	Nominal force	Linear speed	Page
	–	kN	mm/s	No.
SRSA	2505	40,7	333	362
	2510	37,5	450	362
	3005	52,9	325	362
	3010	49,9	650	362
	3905	63,3	279,2[1)]	362
	3910	61,0	350	362
	3915	61,5	650	362
	4805	106,5	220,8[1)]	362
	4810	95,3	350	362
	4815	130,4	412,5	362
	4820	86,3	550	362
	6010	161,9	275	362
	6015	162,3	462,5	362
	6020	142,7	666,7	362
	7510	255,5	250[1)]	362
	7515	240,2	357[1)]	362
	7520	199,4	466,7[1)]	362
SVSA	3201	40,6	10,4[1)]	362
	4001	62,3	8,3[1)]	362
	5001	110,2	6,7[1)]	362
SLSA	2525	8,2	1 500[1)]	362
	4040	12,4	1 500[1)]	362

[1)] Peak force to be used only in static phases. For dynamic ones, this value must be limited inside the motion controller at 80 % of the dynamic load by the user. Please contact SKF.

Drive by wire

	Type	Force	Stroke	Max. speed	Page
	–	N	mm	mm/s	No.
	EPB	4 000	65	18	366

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