2.1 SELECTION PROCEDURE

The electromechanical linear actuators transform a rotary movement into a linear motion.
Due to the SCREW – NUT efficiency, there is a loss of energy which depends on the screw and nut type. The loss of energy is higher with 1-start acme screw and nut than with 2-starts acme screw and nut or ball screw and ball nut.
Therefore, to choose the right actuator for an application it is necessary to consider the DUTY CYCLE REQUIRED BY THE APPLICATION, which has to be compared to the WORKING DUTY CYCLE that the actuator can perform.

APPLICATION DUTY CYCLE Fu [%]: working time under load required by the application during 10 min., related to 10 minutes by percentage.

$$\mathbf{Fu}\ [\%] = \frac{\text{Working time in 10 minutes}}{\text{10 minutes}} \times 100$$

ACTUATOR DUTY CYCLE Fi [%]: working time under load that the actuator can perform during 10 minutes in environment temperature 25 °C, according to the performances stated in this catalogue, without risk of internal parts overheating, which is the main limit to the working time of an actuator.

To make the right selection of an actuator we recommend and advise to follow the SELECTION PROCEDURE as indicated below:

HOW TO SELECT A LINEAR ACTUATOR

1. **Application Duty Cycle Fu [%]**

   Application data to be known:

   1.1 Linear speed
   1.2 Push or pull load
   1.3 Working cycle
   1.4 Stroke length
   1.5 Electric motor type

   Calculate the application duty cycle Fu [%] on 10 minutes

2. **Selection of actuator series**

   2.1 Fu ≤ 30%: Select acme screw actuators Series ATL or Series UAL
   2.2 Fu ≥ 50%: Select ball screw actuators Series BSA or Series UBA
   2.3 30% < Fu < 50%: There are 2 possibilities:
   - Either select a ball screw series to avoid overheating risks
   - Or select an acme screw series after having checked the admitted load for a duty cycle higher than 30%. Refer to FORCE – DUTY CYCLE graphs on page 22.

   Generally, the ball screw series is more expensive than the equivalent acme screw one, but note that the choice of the acme screw series will give (with Fu > 30%) reduced performance, so it may be necessary to select a larger (and more expensive) size.

   The ball screw actuators are not self-locking, so they require a brake motor to ensure static load holding. Furthermore, brake motor is also necessary whenever a precise positioning and repeatability are required, with both ball and acme screw actuators.

   High linear speeds require a brake motor to stop and to avoid overrunning.
   In such conditions the selection between ball screw or acme screw actuators is therefore influenced not only by technical factors but also by economical reasons.

3. **Starting size selection**

   Based on the given load and linear speed required by the application, refer to graphs on page 17 to make the selection of the actuator size.

2.1 SELECTION PROCEDURE

4. Mechanical checks

Make following mechanical checks on the selected size:

4.1 Push load: to check buckling risks refer to graphs on page 18 and 19.

It is recommended that this check is made based on the maximum load and stroke requirements.

4.2 Critical rotational speed for bending and whipping risks of acme or ball screw.

It is recommended that this check is made based on the maximum linear speed and stroke requirements.

Refer to graphs on page 20 and 21, where for each actuator size it is stated the linear speed limit referred to the actuator stroke length.

Either selected size can be confirmed if not select the next larger size.

4.3 Lifetime: acme screw and ball screw lifetime.

- Acme screw linear actuators

  The performances stated in this catalogue (from page 26 to page 33) are related to duty cycle 30% in 10 min and environment temperature of 25°C.

  For applications with duty cycle between 30% and 50% refer to graphs on page 22.

  The screw nut lifetime calculation is complex, and is dependent on load, linear speed, temperature and duty cycle. For lifetime figures on individual applications contact Servomech's Technical Dpt.

- Ball screw linear actuators

  The performances stated in this catalogue (from page 34 to page 41) are related to duty cycle 100%, environment temperature 25°C and minimum lifetime L_{10} = 2000 hours.

  For lifetime longer or shorter than 2000 hours refer to graphs on page 23.

5. Final size selection

Based on the required motor type and on the actuator selected series and size, find in the performance tables the ratio which gives the required performance in terms of load and linear speed. Choose the performance nearest to those required.

6. Selection check point

With the performances (load – linear speed) achievable with the selected actuator and based on the duty cycle required by the application, calculate the working duty cycle.

Compare the resulting working duty cycle (Fu %) to the duty cycle allowed by the selected actuator (Fi %).

It must be Fu $\leq$ Fi, otherwise repeat the actuator type selection starting from point 2.

7. Accessories selection

7.1 Front and rear attachment
7.2 Stroke limit device
7.3 Input versions
7.4 Other accessories

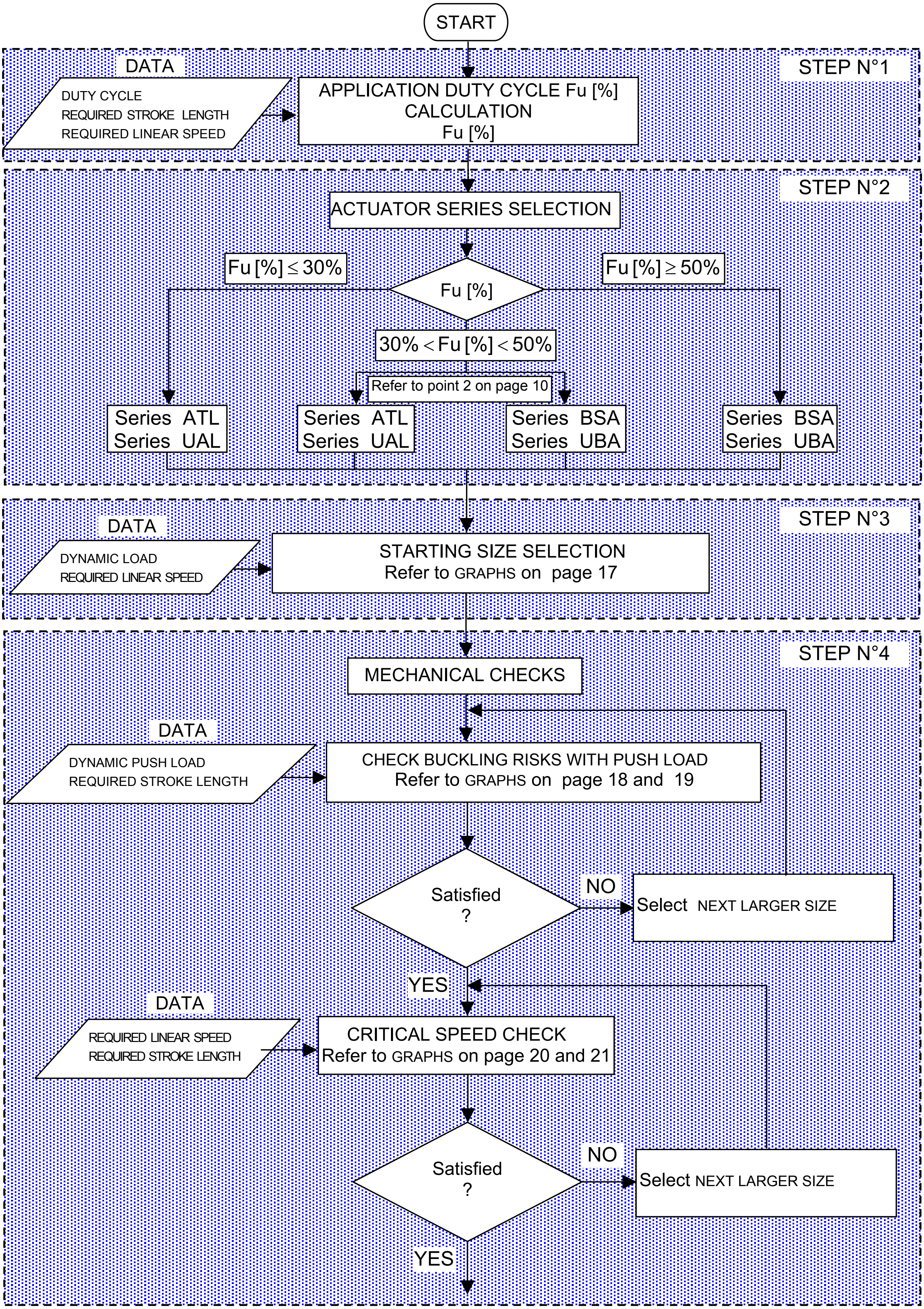
8. Actuator dimensions and fixing accessories

Refer to the dimensional tables to know the over-all dimensions of the actuator and relevant accessories and verify if they suit the application.

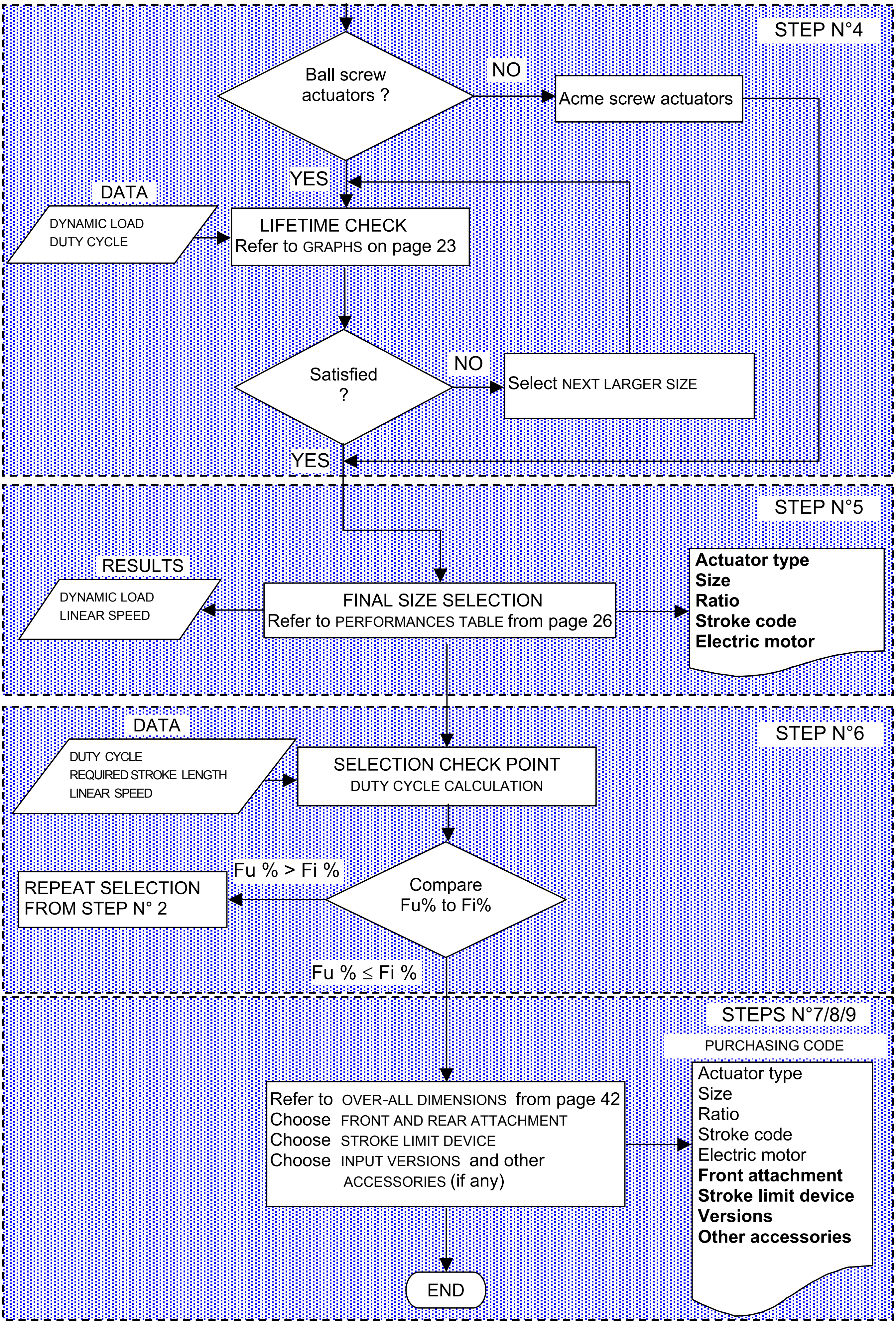
9. Purchasing code

Refer to example on page 24.

SELECTION PROCEDURE FLOW-CHART



SELECTION PROCEDURE FLOW-CHART



2.2 EXAMPLE OF LINEAR ACTUATOR SELECTION

1st EXAMPLE Application data

Required stroke length	300 mm
Required linear speed	20 mm/s
Dynamic push load	4500 N
Static load	4500 N
Duty Cycle	5 complete double travels every 10 min.
Motor	Alternate Current 3-phases

STEP N° 1

Calculate the DUTY CYCLE (FU) required by the application:

$$Fu\% = \frac{2 \times \text{Stroke}}{\text{Speed}} \times \frac{\text{N° complete double travels in 10 minutes}}{\text{10 minutes}} \times 100 = \frac{2 \times 300\ [\text{mm}]}{20\ [\text{mm/s}]} \times \frac{5}{10\ [\text{min}]} \times \frac{1\ [\text{min}]}{60\ [\text{s}]} \times 100 = 25\ \%$$

STEP N° 2

With the DUTY CYCLE lower than 30%, select an acme screw actuator. Furthermore, with the REQUIRED LINEAR SPEED of 20 mm/s choose the actuator **TYPE** ATL (refer to INITIAL SELECTION GRAPHS on page 17).

STEP N° 3

Referring to the SELECTION GRAPHS, which state the main performances of the actuator series ATL (page 17), select **SIZE** ATL 30.

STEP N° 4

4.1 Based on the DYNAMIC PUSH LOAD and referring to the BUCKLING PUSH LOAD GRAPHS (page 18), check if the actuator size ATL 30 is suitable.

4.2 Check the critical rotational speed referring to GRAPHS on page 20: size ATL 30 with STROKE LENGTH 300 [mm] is OK.

STEP N° 5

Now you can proceed to the final selection of the linear actuator. Referring to the performance table of the actuator ATL 30 with AC 3-phase motor, **RATIO** RN2 performs linear speed and load very near to those required:

LINEAR SPEED: 23 [mm/s] **DYNAMIC LOAD:** 5200 [N]
With a AC 3-phase **MOTOR** 0.25 kW 2 poles

STEP N° 6

To confirm the selection made, calculate the working DUTY CYCLE (FU) replacing in the formulae the real achievable linear speed:

$$Fu\ \% = \frac{2 \times 300\ [\text{mm}]}{23\ [\text{mm/s}]} \times \frac{5}{10\ [\text{min}]} \times \frac{1\ [\text{min}]}{60\ [\text{s}]} \times 100 = 21.7\ \%$$

Value lower than 30 % therefore admitted by the selected actuator.

STEPS N° 7 – 8 – 9

Select stroke limit device and mounting attachments shown on dimensional pages before completing the actuator ordering code by referring to page 24.

2.2 EXAMPLE OF LINEAR ACTUATOR SELECTION

2nd EXAMPLE Application data:

Required stroke length	600 mm
Required linear speed	60 mm/s
Dynamic push and pull load	900 N
Static push load	900 N
Duty Cycle	13 complete double travels every 10 min.
Motor	Direct Current 24 V

STEP N° 1

Calculate the DUTY CYCLE (FU) required by the application:

$$Fu\,\% = \frac{2 \times \text{Stroke}}{\text{Speed}} \times \frac{\text{N° complete double travels in 10 minutes}}{\text{10 minutes}} \times 100 = \frac{2 \times 600\,[\text{mm}]}{60\,[\text{mm/s}]} \times \frac{13}{10\,[\text{min}]} \times \frac{1\,[\text{min}]}{60\,[\text{s}]} \times 100 = 43\,\%$$

STEP N° 2

With the DUTY CYCLE higher than 30 % and lower than 50 % both acme or ball leadscrew can be chosen.
Choosing a ball leadscrew a duty cycle 43 % would be surely performed. This example is done and explained choosing an acme leadscrew actuator.
With the REQUIRED LINEAR SPEED of 60 mm/s, referring to the SELECTION GRAPHS on page 17, an actuator **TYPE** ATL can be chosen.

STEP N° 3

3.1 Referring to the SELECTION GRAPHS which state the main performances of the actuators series ATL (page 17) select **SIZE** ATL 20.

3.2 Referring to the performance table of the actuator ATL 20 with DC motor, **RATIO** RV2 achieves performances very near to those required:
LINEAR SPEED: 64 [mm/s] **DYNAMIC LOAD:** 920 [N]
With a DC **MOTOR** 24 V 100 W 3000 rpm

3.3 Referring to FORCE - DUTY CYCLE GRAPHS (page 22) the actuator ATL 20, with a DUTY CYCLE of 43%, can sustain only the 70 % of the nominal dynamic load: 0.7 × 920 = 640 N. This load does not satisfy the application requirement: choose NEXT LARGER SIZE ATL 25.

STEP N° 4

4.1 Based on the DYNAMIC PUSH LOAD and referring to the BUCKLING PUSH LOAD GRAPHS (page 18) check if the actuator size ATL 25 is suitable.

4.2 Check the critical speed referring to GRAPHS on page 20: size ATL 25 with STROKE LENGTH 600 [mm] is OK.

STEP N° 5

Referring to the performance table of the actuator ATL 25 with DC motor, **RATIO** RV2 performs linear speed and load very near to those required :
LINEAR SPEED: 64 [mm/s] **DYNAMIC LOAD:** 1330 [N]
With a DC **MOTOR** 150 W 3000rpm
0.7 × 1330 = 930 N: this actuator size satisfies the application requirements.

STEP N° 6

To confirm the selection made, calculate the working DUTY CYCLE (Fu) replacing in the formulae the linear speed achievable:

$$Fu\,\% = \frac{2 \times 600\,[\text{mm}]}{64\,[\text{mm/s}]} \times \frac{13}{10\,[\text{min}]} \times \frac{1\,[\text{min}]}{60\,[\text{s}]} \times 100 = 41\%$$

Working duty cycle lower than the duty cycle accepted by the actuator with load 900 N: Fu = 41 %; Fi = 43 %, so the selection is right.

2.2 EXAMPLE OF LINEAR ACTUATOR SELECTION

STEPS N° 7 – 8 – 9

Select stroke limit device and mounting attachments shown on dimensional pages, before completing the actuator ordering code by referring to page 24.

3rd EXAMPLE Application data:

Required stroke length	1000 mm
Required linear speed	120 mm/s
Dynamic push and pull load	1700 N
Static load	0 N
Duty Cycle	28 complete double travels every 10 min.
Required Lifetime	2500 working hours under load
Motor	Alternate Current 3-phases

STEP N° 1

Calculate the DUTY CYCLE (FU) required by the application:

$$Fu\% = \frac{2 \times \text{Stroke}}{\text{Speed}} \times \frac{\text{N° complete double travels in 10 minutes}}{\text{10 minutes}} \times 100 = \frac{2 \times 1000\,[\text{mm}]}{120\,[\text{mm/s}]} \times \frac{28}{10\,[\text{min}]} \times \frac{1\,[\text{min}]}{60\,[\text{s}]} \times 100 = 78\,\%$$

STEP N° 2

With the DUTY CYCLE higher than 50%, select a ball screw actuator. Furthermore, with the REQUIRED LINEAR SPEED of 120 mm/s, choose an actuator **TYPE** UBA (see graphs on page 17).

STEP N° 3

Referring to the SELECTION GRAPHS which state the main performances of the actuators series UBA (page 17) select **SIZE** UBA 2.

STEP N° 4

4.1 Based on the DYNAMIC PUSH LOAD and referring to the BUCKLING PUSH LOAD GRAPHS (page 19) check if the actuator size UBA 2 is suitable.

4.2 Check the critical rotational speed for bending and whipping problems of the ball screw referring to GRAPHS on page 21. Size UBA 2 with STROKE LENGTH 1000 [mm] is not suitable: choose NEXT LARGER SIZE UBA 3. UBA 3 with STROKE LENGTH 1000 [mm] is OK.

4.3 Check if the required ball screw lifetime (2500 hours under load 1700 N) is achievable by UBA 3 referring to GRAPHS on page 23: the selected actuator size UBA 3 is OK.

STEP N° 5

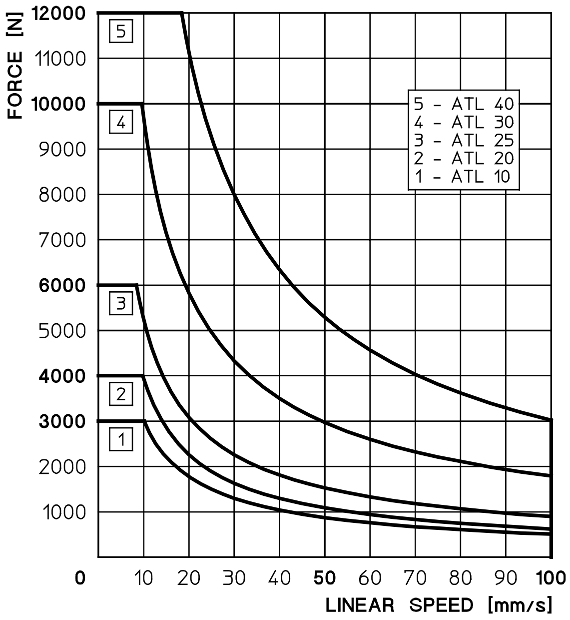
Now you can proceed to the final selection of the linear actuator. Referring to the performance table of the actuator UBA 3 with AC 3-phase motor, **RATIO** RV1 performs linear speed and load very near to those required:

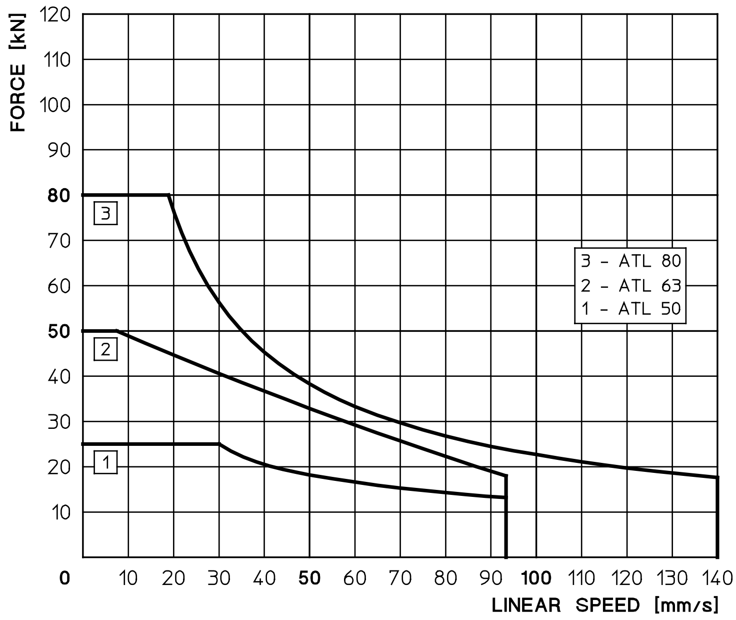
LINEAR SPEED: 110 [mm/s] **DYNAMIC LOAD:** 2300 [N]
With AC 3-phase **BRAKE MOTOR** 0.37 kW 4 poles

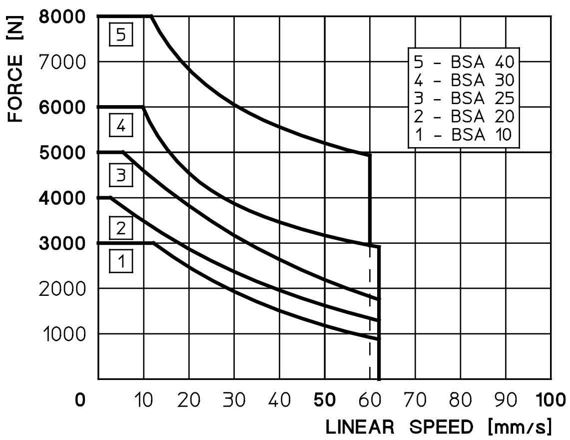
STEPS N° 7 – 8 – 9

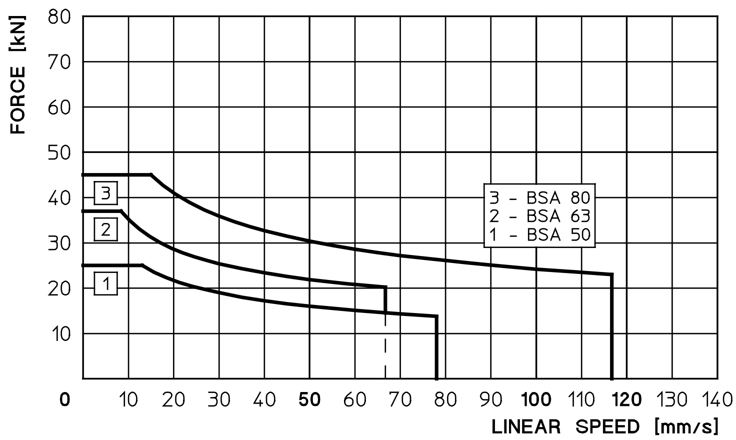
Select stroke limit device and mounting attachments shown on dimensional pages, before completing the actuator ordering code by referring to page 24.

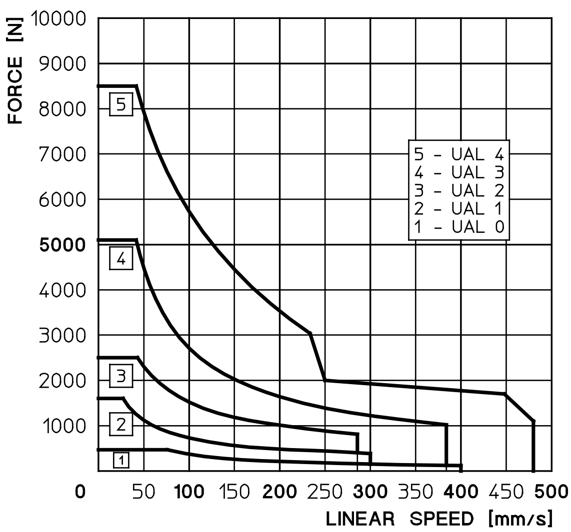
2.3 LINEAR ACTUATORS SELECTION GRAPHS

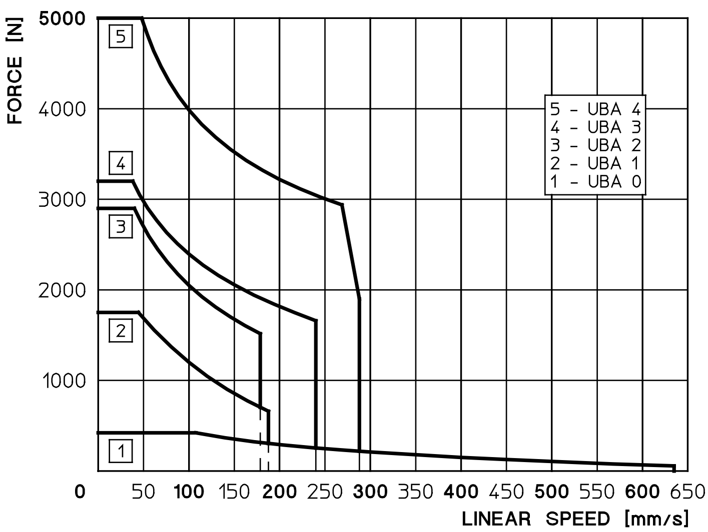






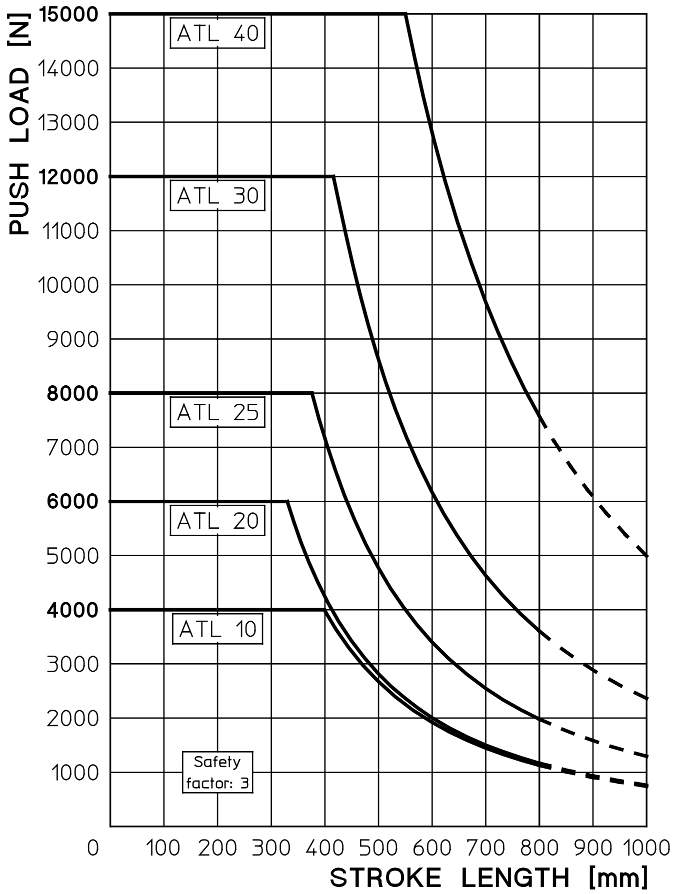


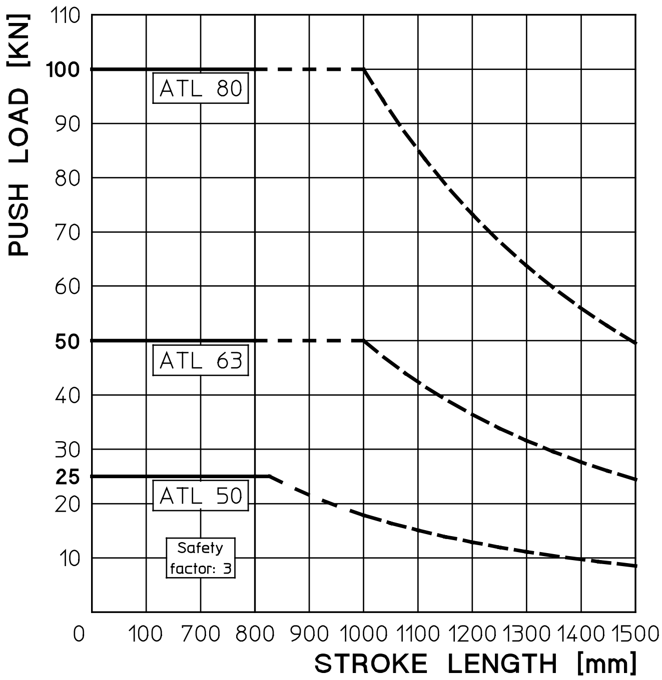




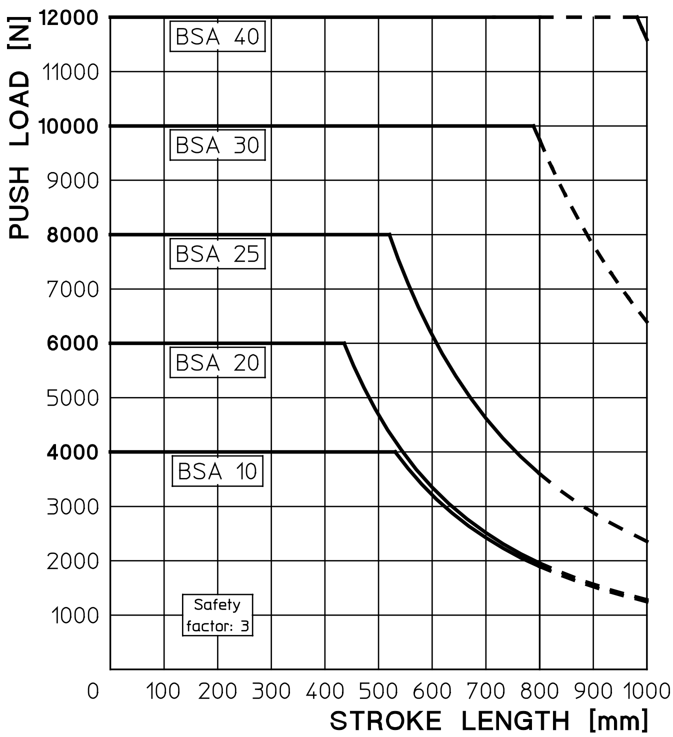
2.4 BUCKLING PUSH LOAD GRAPHS
Linear Actuators Series ATL and Series BSA

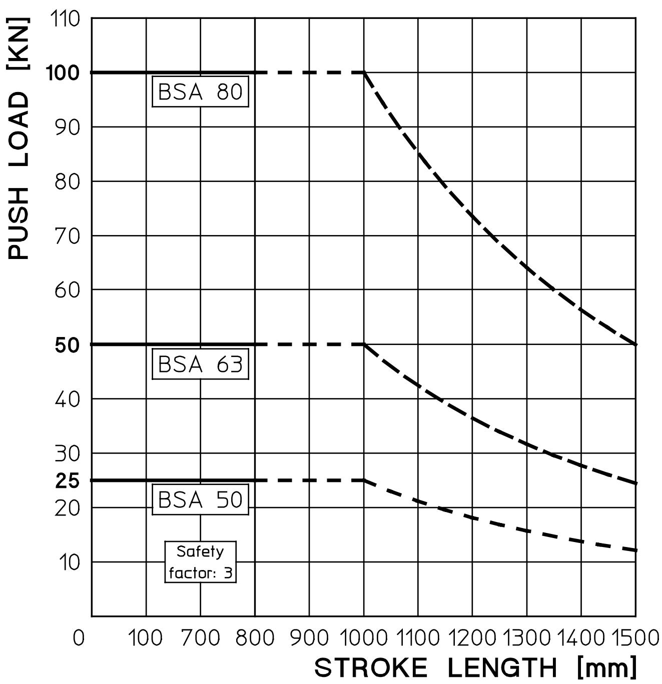
Series ATL





Series BSA

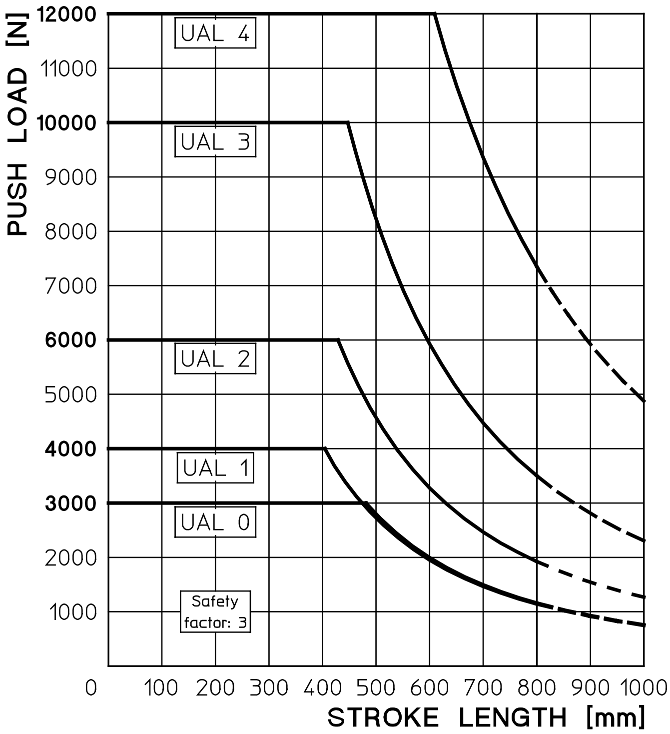


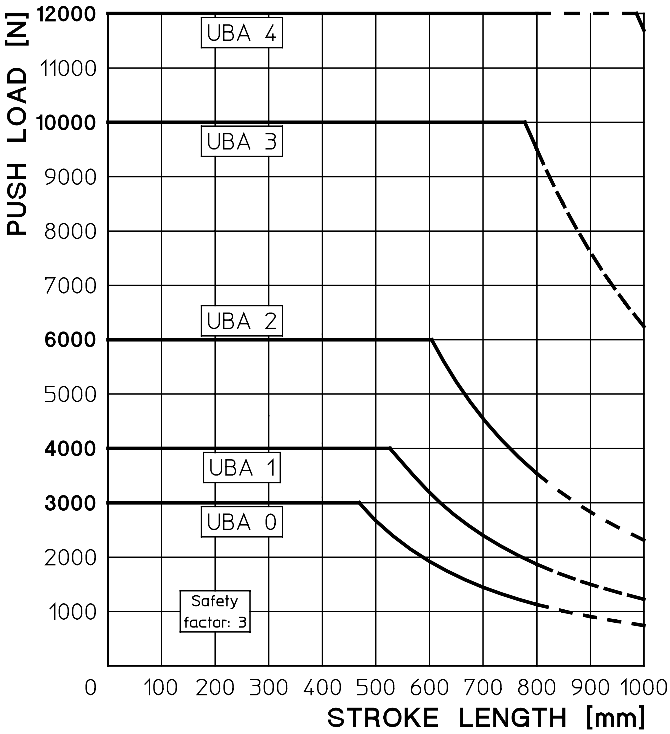


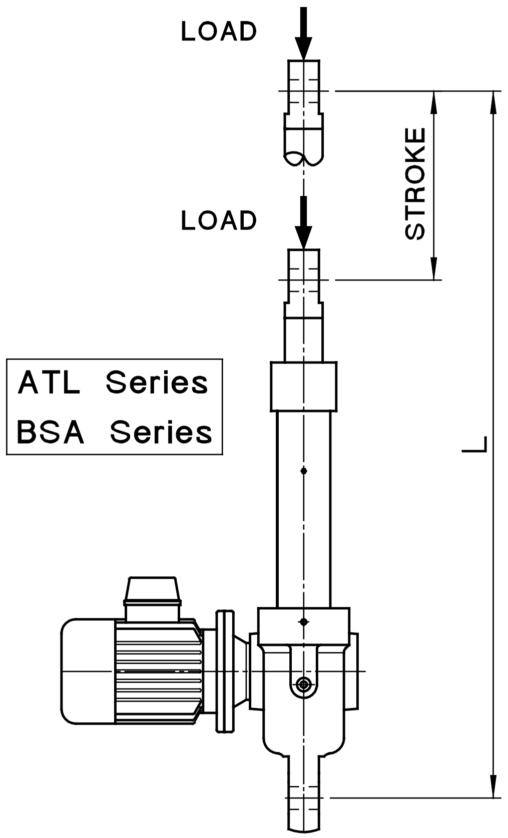
2.4 BUCKLING PUSH LOAD GRAPHS

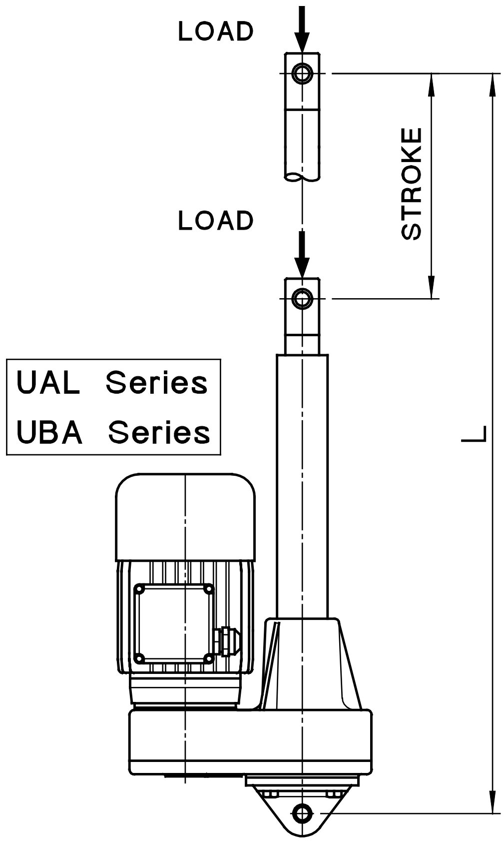
Linear Actuators Series UAL and Series UBA

Series UAL	Series UBA

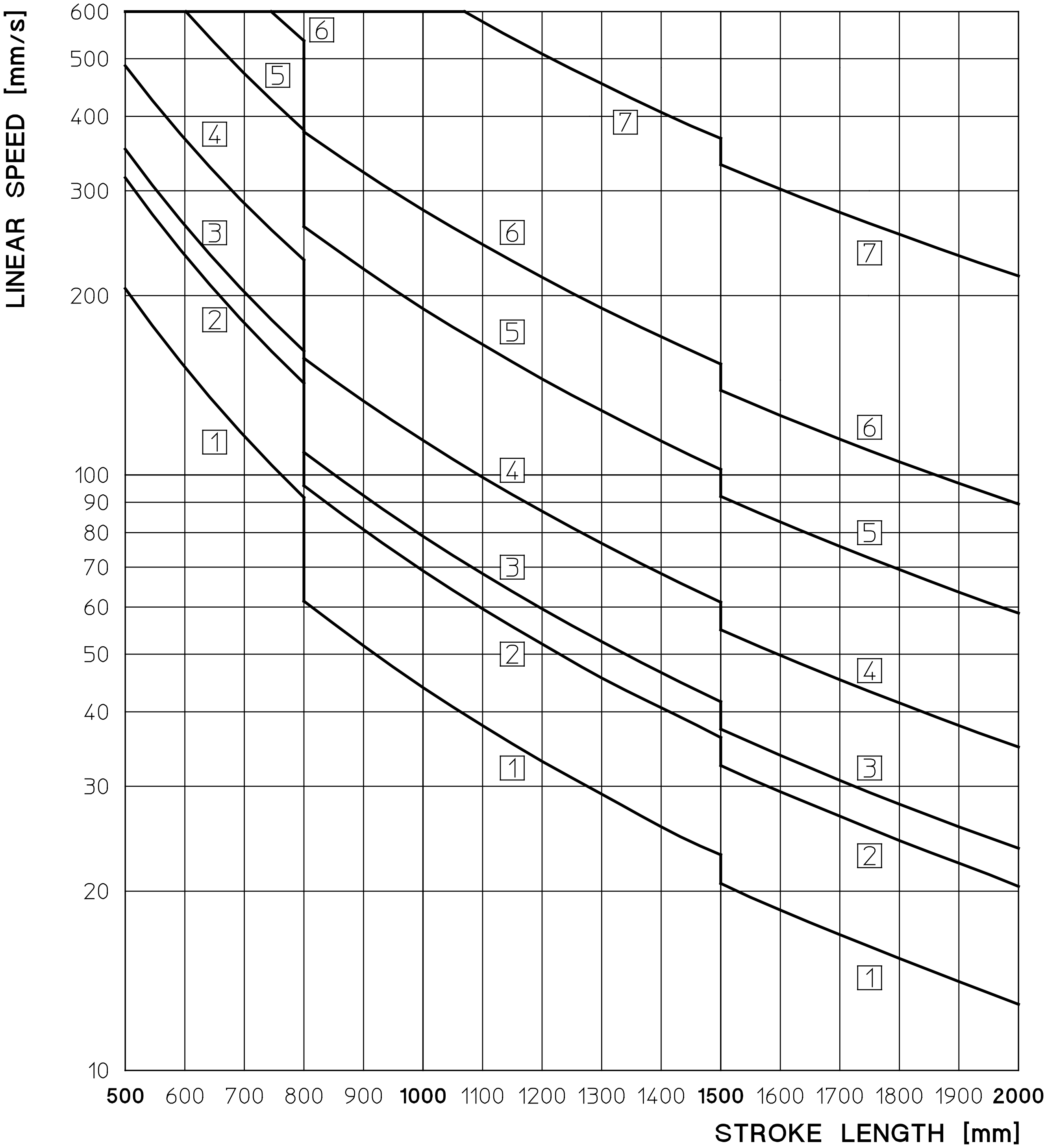








2.5 CRITICAL SPEED FOR BENDING AND WHIPPING RISKS
Acme screw linear actuators Series ATL and Series UAL



LEGEND	
7	ATL 80
6	ATL 63
5	ATL 50
4	ATL 40 UAL 4
3	ATL 30 UAL 3
2	ATL 25 UAL 2
1	ATL 10 ATL 20 UAL 0 UAL 1

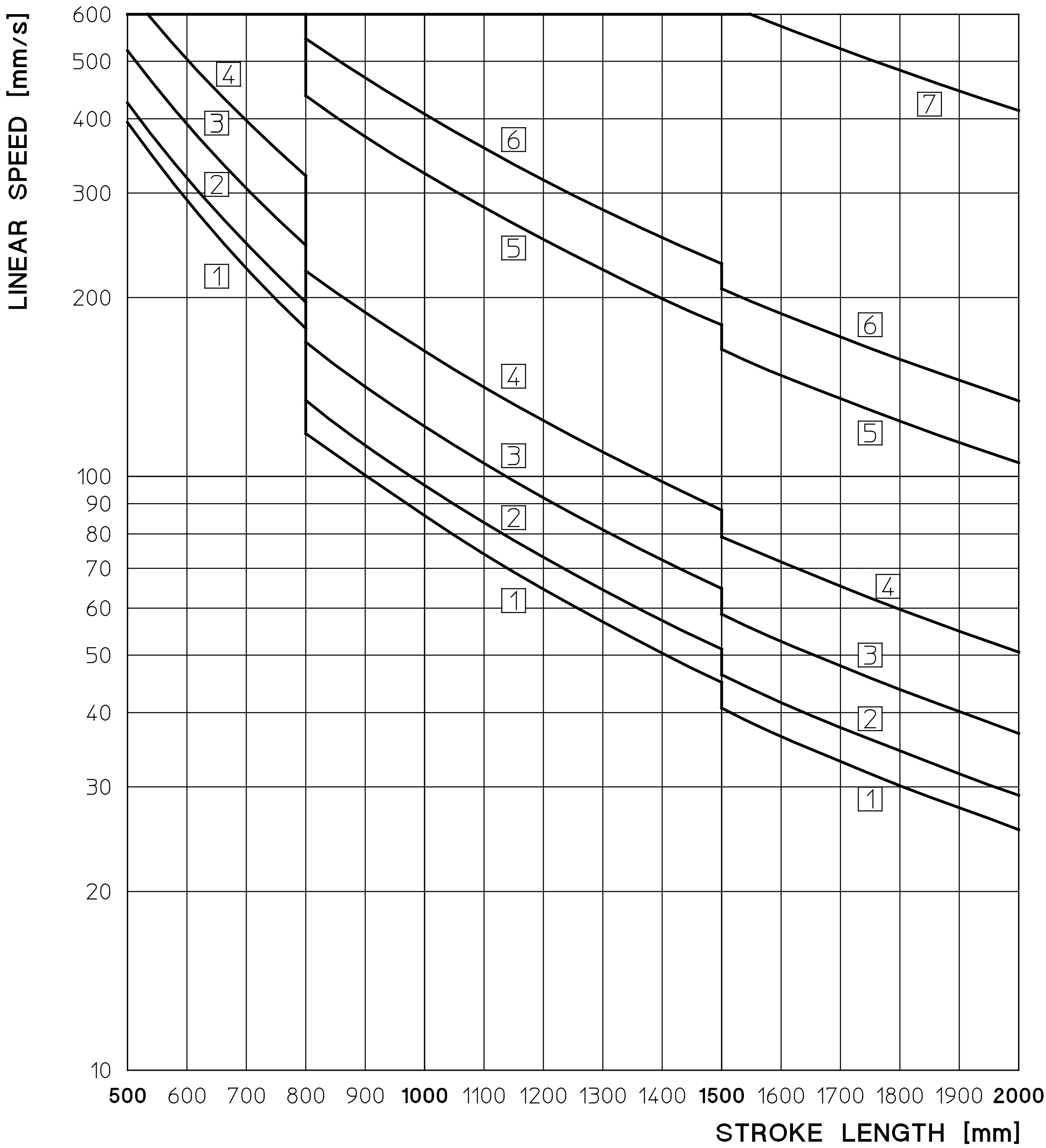
NOTE 1: ONLY FOR ACME LEADSCREW ACTUATORS

The data stated in the above graph refers to 1-start acme screw, more precisely to actuators with ratio R–1, where "–" is one of the different ratios available: H, V, N, L, XL.

2-starts acme screw actuators, identified with ratio R–2, with same linear speed admit double stroke length than the ones given in the above graph.

2.5 CRITICAL SPEED FOR BENDING AND WHIPPING RISKS

Ball screw linear actuators Series BSA and Series UBA



LEGEND	
7	BSA 80
6	BSA 63
5	BSA 50
4	BSA 40 UBA 4
3	BSA 30 UBA 3
2	BSA 25 UBA 2
1	BSA 10 BSA 20 UBA 0 UBA 1

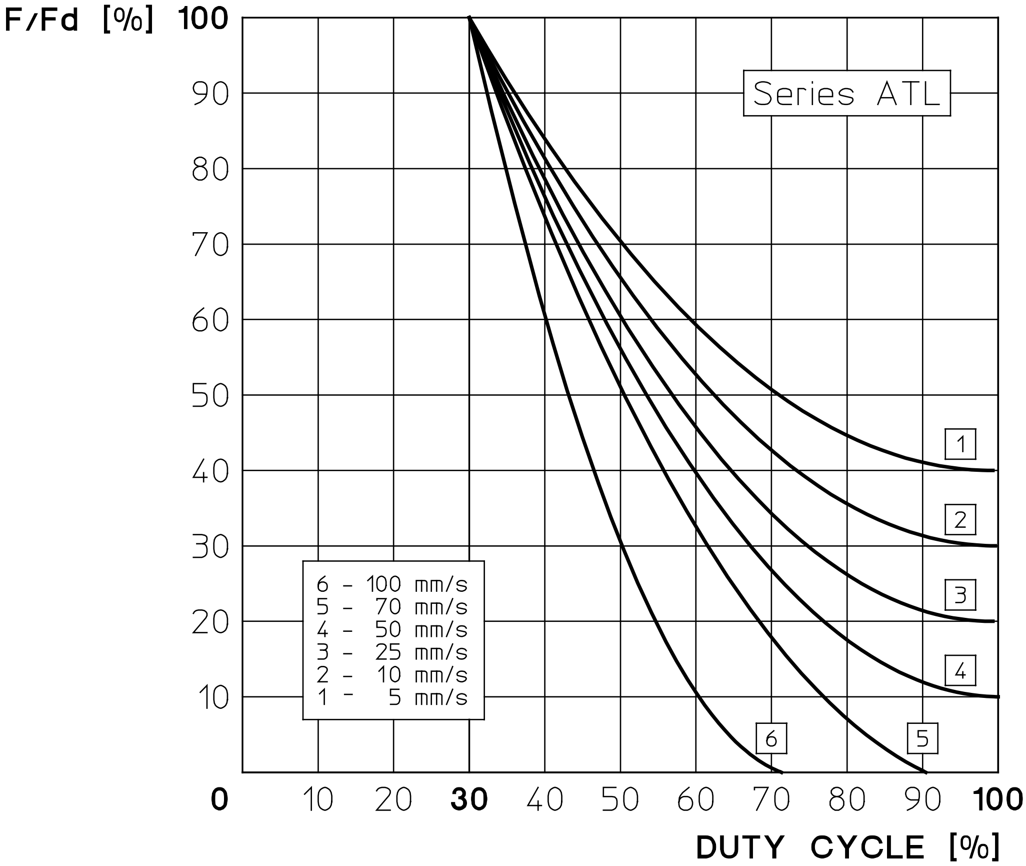
NOTE 2: FOR BOTH ACME AND BALL LEADSCREW ACTUATORS

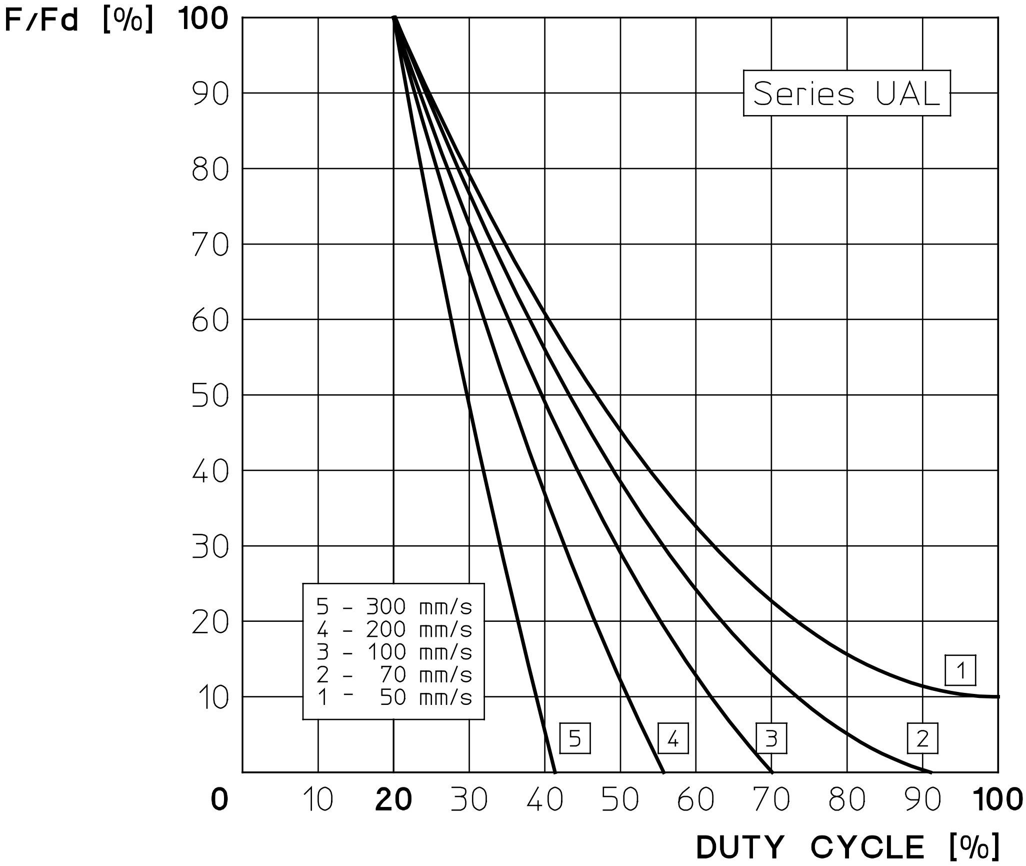
Whipping refers to the natural resonance which will occur when an acme or ball screw of a given diameter and length is rotated at a particular speed. The speed of the screw at which natural resonance will occur is known as the CRITICAL SCREW SPEED.

The acme or ball screw rotational speed is related to the actuator linear speed by the lead pitch of the screw.

The actuator linear speed, referred to the stroke length, should be therefore checked to be below the critical linear speed limit shown in the above graphs.

2.6 FORCE – DUTY CYCLE GRAPHS
ACME SCREW LINEAR ACTUATORS

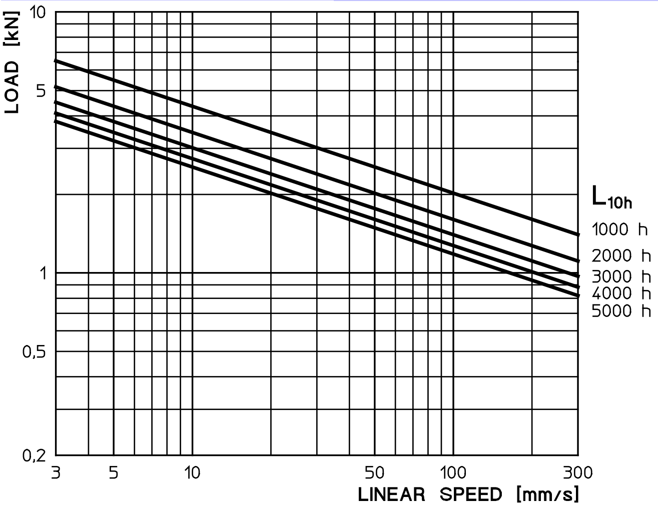


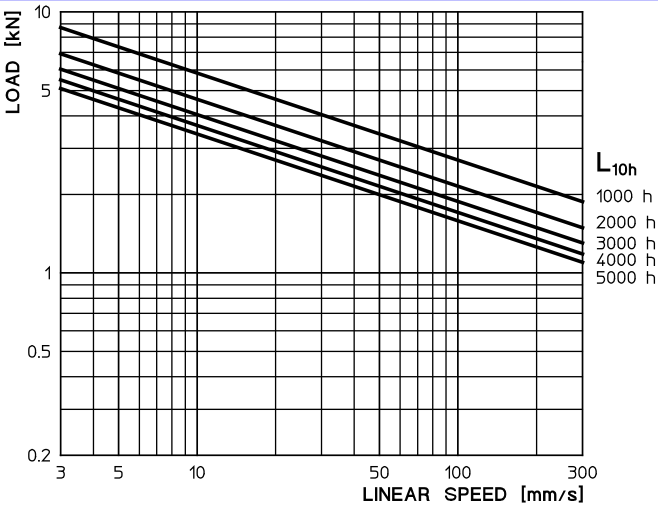


F – Dynamic load required by the application
Fd – Dynamic load performed by the actuator (see Performances Tables from page 26 to page 41)

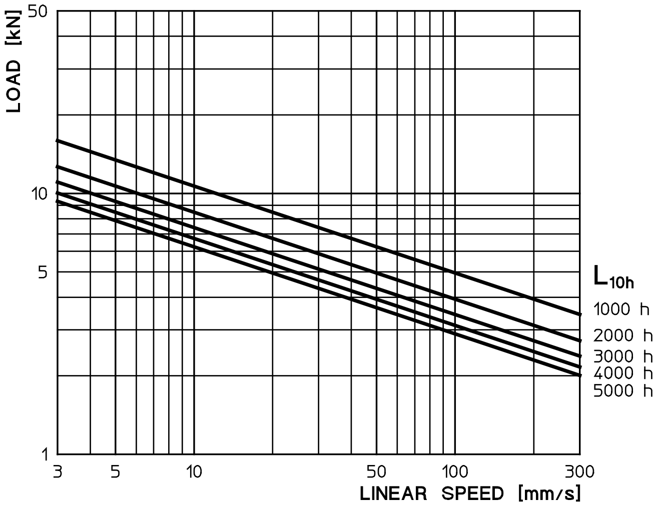
2.7 BALL SCREWS LIFETIME GRAPHS

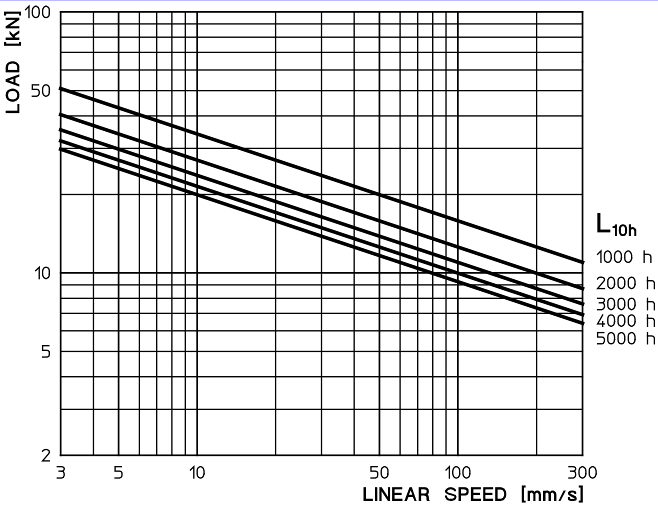
Bs 14 × 5	BSA 10 - BSA 20 UBA 0 - UBA 1	Bs 16 × 5 Bs 20 × 5	BSA 25 - UBA 2 BSA 30 - UBA 3



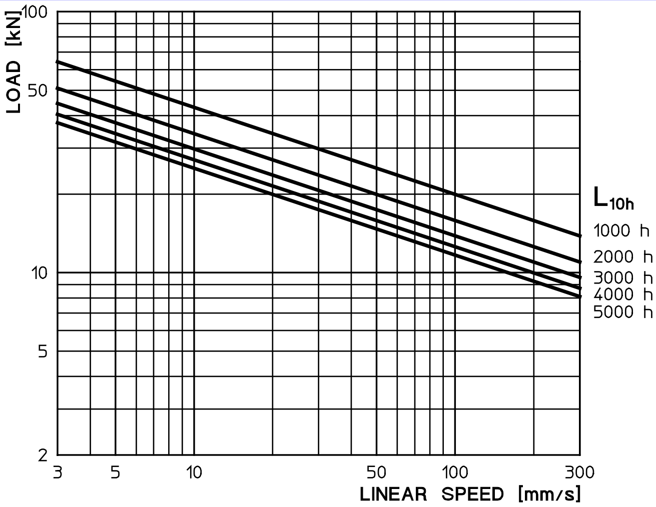


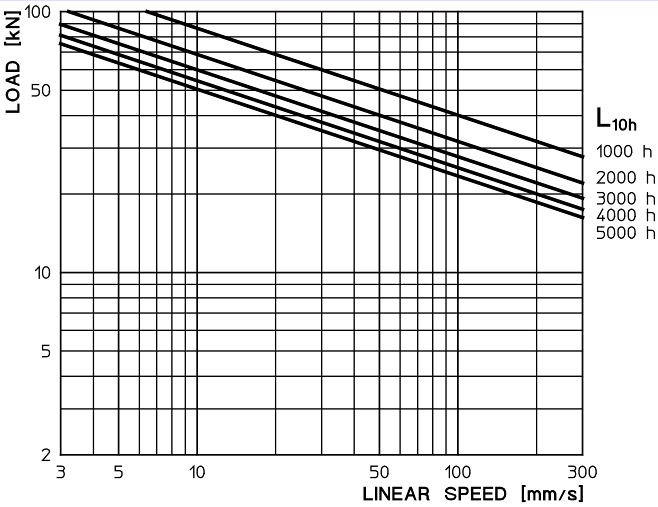
Bs 25 × 6	BSA 40 - UBA 4	Bs 32 × 10	BSA 50





Bs 40 × 10	BSA 63	Bs 63 × 20	BSA 80





2.8 CODING

ATL	30	RN2	C300	FO	FCE	VERS.3	RH
1	2	3	4	5	6	7.A	7.B

MOTOR	0,25 KW 2 POLES 3-PH.	230/400 V 50 Hz	IP55 F	BRAKE	W
8	8.A	8.B	8.C	8.D	8.E

ACCESSORIES	SP	FI	FS	AR	EH 53	MSB	BELLOW	OTHER
9	9.A	9.B	9.C	9.D	9.E	9.F	9.G	9.H

1.	Actuator Series	ATL; UAL; BSA; UBA	
2.	Size	ATL / BSA	10, 20, 25, 30, 40, 50, 63, 80
		UAL / UBA	0, 1, 2, 3, 4
3.	Ratio	RH1, RV1, RN1, RL1, RXL1	
		RH2, RV2, RN2, RL2, RXL2	
4.	Stroke Code	C100, C200, C300, C400, C500, C600, C700, C800 (or special strokes available on request)	
5.	Front attachment	BA standard threaded head end; ROE rod end; FO clevis end;	
		TS ball joint FL flange end; TF hinged head	
	Rear attachment	Standard :	See over-all dimensions
	Housing pivot	On request:	turned at 90°, code RPT 90°
6.	Stroke length limit device	FCE	electric switches
		FCM (NC)	magnetic reed switches normally closed
		FCM (NO)	magnetic reed switches normally open
		FCP	inductive proximity switches
7.A	Input versions	Vers.1	single input shaft
		Vers.2	double input shaft
		Vers.3	motor flange European standard IEC B5 or IEC B14
		Vers.4	motor flange and extended input shaft
		Vers.5	motor flange adapter European standard IEC B5 + coupling
		Vers.6	motor flange adapter + coupling + extended input shaft
7.B	Input shaft position	RH	right hand, standard as per dimensional sheets
		LH	left hand, on request input shaft at 180°

MOTOR

8.	Electric motor	Alternate Current	AC 3-phase
		Alternate Current	AC 1-phase
		Direct Current	DC
8.A	Power and number of poles	2 poles	
		4 poles	
8.B	Voltage	3-phase	standard multivoltage 230/400 V 50 Hz - 255/440 V 60 Hz
		1-phase	230 V 50 Hz - 260 V 60 Hz
		DC	24 V, 12 V
		Other voltages available on request	
8.C	Protection	IP 55	standard for 3-phase or 1-phase motors without brake
		IP 54	standard for AC motors with brake and DC motors
	Insulation Class	F	standard; on request special protections and insulation classes
8.D	Motor brake	Directly wired or separately wired	
8.E	Motor terminal box position	W	standard
		N, S ,E	on request, see page 90

ACCESSORIES

9.A	SP	Rear bracket
9.B	FI	Intermediate support flange, see page 93
9.C	FS	Safety clutch
9.D	AR	Anti-turn device
9.E	Encoder	EH 53 or ENC.4
9.F	MSB	Safety nut for push load
9.G	B	Protective bellows
9.H		Special devices on request

2.9 SELF - LOCKING CONDITIONS

A linear actuator is self-locking when:

- Applying a push or pull load when the actuator is in still position, the actuator does not start moving (statically self-locking)
- Switching off the electric motor of an actuator in motion, the actuator stops even under push or pull load (dynamically self-locking)

Self-locking and non self-locking conditions are defined in following 4 different situations:

1. **<u>Statically self-locking</u>:**

   Actuator in still position without vibrations: when applying a push or pull load (up to the maximum load allowed) the actuator does not start moving.

   This self-locking condition occurs whenever the self-locking coefficient is lower than 0.35 NOTE (1).

2. **<u>Dynamically self-locking:</u>**

   2.1 Actuator in motion with an opposite load to its movement: switching off the motor, the actuator stops (self-lock).
   This self-locking condition occurs whenever the self-locking coefficient is lower than 0.30 NOTE (1).

   2.2. Actuator in motion with a load acting on the same motion direction: switching off the motor, the actuator stop is not guaranteed. The actuator stops only if its self-locking coefficient is lower than 0.25 NOTE (1) and in any case not always in the same position.
   In the above condition we recommend to use a brake motor to stop the actuator under load and to lock it on that position, avoiding an unexpected start in case of vibrations or load shocks.

3. **<u>Uncertain locking:</u>**

   With self-locking coefficient between 0.35 and 0.55 NOTE (1), the actuators are in an uncertain locking condition. Increasing the applied load the actuator can start moving.

   We suggest to use a brake motor to ensure a locking condition or contact SERVOMECH Technical Dpt. for a better evaluation of the application.

4. **<u>Non self-locking:</u>**

   With self-locking coefficient higher than 0.55 NOTE (1) the actuators are never self-locking.

   Note that even non self-locking actuators require a minimal push or pull force to start moving. This force value shall be checked and given by SERVOMECH Technical Dpt.

NOTE (1) To know the self-locking coefficient value of each actuator refer to the PERFORMANCES TABLES.

Self-locking coefficient table