LINEAR ACTUATORS AND GEAR BOXES SELECTION CRITERIA

GENERAL WARNING

Actuators and gear boxes are devices meant to be installed into larger machines therefore **they cannot be considered as safety devices** (see EC law CE 89/392 and further CE 91-368,93/44,93/68). They are not elements that shall discriminate, with their use or with their fault, safeguard of people's safety and health.

INSTALLATION, USE, MAINTENANCE AND WASTE GUIDELINES

Recommendations:

- Actuators and gear boxes being installed by qualified and authorised technicians
- Electrical connections done by qualified personnel; during installation main electric power supply shall be turned off so to run safely all these operations (wearing also protection suits, gloves and glasses)
- Actuators and gear boxes need very few maintenance operations: cleaning and eventually greasing (according to instruction manuals)
- Scheduled inspections to working actuator or gear box in order to detect in time possible problems: in case of doubts contact our technical service
- Ilf something wrong is detected do not try to fix it without technical advise: its after-sales dept. will be at your complete disposal to solve it out

All products are delivered with proper packing, according to customer needs and goods dimensions / weight. We recommend a safe product handling, using for example forklifts, safety belts….
Package, as well as the actuators themselves, shall be disposed / wasted according to laws in force in the user's Country.

INTRODUCTION

Linear actuators are independent systems used to obtain linear movements: basically, they are made up by an electric motor, rotating a lead screw directly or by means of a gearbox.
A nut is then allowed to move along the lead screw carrying in and out a push rod connected to the nut itself.
Load shall be axial only, but it can be tensile or pushing, no matter what push rod direction is. Actuators can work both with or without load. Self-locking or not self-locking behaviour depend on the gearing ratio and load value. In any case, self-locking is always possible with additional components.
According to type of actuator and driving / control system used with it, we can have a simple ON / OFF device (pushing and/or pulling) or a servo-mechanism.
Electric actuators main advantages towards pneumatic and hydraulic ones are basically following:
they can easily stop in intermediate positions all along their stroke,
the power consumption happens only while the actuator is working (not necessary to keep it in position for example), the power supply is clean and easy to find, with no need of tubes.
Thus, wirings on applications frameworks will be easier to build and no fluids (i.e. oil) can accidentally be spared. This last feature is necessary in food and textile environments.

ACTUATOR MAIN COMPONENTS

Linear actuators consist in an electric motor directly connected to lead-screw/nut or by means of a worm gearbox, a belt/pulleys system or planetary gearings (1 or 2 stages).
The system turns out to be a rigid chain.

Running against mechanical stops causes serious damages to actuator's internal parts!

Motors
Actuators can host different kinds of motors: AC three or single phase, with brake, inverter-friendly, DC, brushless and stepper-motors. Many options are available such as second shafts, manual brake release and so on.
Selection of motor performances (torque, speed, service...) is done according to duty cycle requested to actuators.

Gear-boxes

Two kinds of gear-boxes are basically used on actuators too:
• Steel worm-screw (1 or 2 stages) and plastic or bronze worm-wheel: wheel's material is chosen according to needed main performances such as low noise, lifetime, reduced backlash
• Planetary gear-box (ALI5-AP, L and EC series): due to its high efficiency this kind is often used when duty cycles are high.
They can have 1 stage with plastic satellites or 2 stages where first one has plastic satellites and second stage has steel ones

Lead screw

Basically steel made and featuring cold-rolled profile, they are coupled with bronze or plastic polymer in order to grant safety and sturdiness against loads.
In ball-screw versions (VRS), lead screws are cold-rolled and tempered and coupled with hardened-grinded ball-nuts.

Push rod
Push rods can be aluminium made for actuators whose loads are low, thick chrome-plated steel for those who stand high loads or stainless steel for special applications like in food industries.

ACTUATOR AND GEAR BOX APPLICATION FIELDS

Actuators and gear boxes can be used in several fields and various machineries. To give an example of how different can be the applications needing actuators we can list a few like: adjusting brushes height in floor-sweeping machines, positioning blades for wood-cutting machines, textile industries, paint and chemical plants, medical equipment (different movements in X-ray machines) equipments for disable / aged people, solar panels, etc..

PARAMETERS FOR ACTUATOR OR GEAR BOX SELECTION PROCESS

The main features for actuator or gear box selection are:
• load dynamics (load trend along stroke)
• speed (linear speed trend along stroke)
• duty cycle
• environmental conditions
• stroke length
• power supply
• output rpm (gear box)
• output torque (gear box)
The configuration we get will be self-locking or non-self-locking according to its global efficiency.

Load and linear speed

These two parameters shall be evaluated both separately and together since they may affect each other during actuator working cycle, especially if additional elements like inertial phenomena, vibrations … are involved.
For example, if an heavy load has to be moved with changing speeds involving sharp accelerations and slowdowns, inertial load has to be added to physical load, thus affecting actuator choice.
In these cases please contact our Technical Dept

Temperature working range can also be widened using special materials for some of the actuator components, special lubricants and seals (the same happens for aggressive environments).Of course under-rating of actuator and duty cycle must also be taken under consideration.
In general, ball-screw units are non-self-locking therefore additional devices, such as brakes, can be necessary to lock actuators

Duty cycle and environmental conditions

These parameters also need to be analyzed as linked together.
Duty cycle is defined as percentage rate between on-time and idle-time, on a timeframe of 5 min.
Environment is mainly related to temperature and occasional aggressive agents affecting materials (humidity, dust, acids…). Standard actuators duty cycle is rated in S3-30%, at 30°C ambient temp.
Working temperature range allowed for standard actuators is -10°C / +60°C.
However duty cycle can be raised building up high-efficiency actuators featuring ball-screws and planetary gearboxes, or over sizing the actuator whose ratings will therefore become higher.
Temperature working range can also be widened using special materials for some of the actuator components, special lubricants and seals (the same happens for aggressive environments).Of course under-rating of actuator and duty cycle must also be taken under consideration.
In general, ball-screw units are non-self-locking therefore additional devices, such as brakes, can be necessary to lock actuators.

Actuator working stroke

This feature (standard each 50 mm step) shall be chosen taking under consideration:
- limits tied to high rotation speeds of internal lead screw and to its own weight (in case the actuator is mounted horizontally) (critical Speed diagram is available on any acme screws technical documentation)
- limits linked to lead screw length to avoid buckling problems (see diagram 1 page 10).

Actuator shall than perform its job within its nominal stroke: while designing application / framework, 10mm extra-stroke on both stroke-ends (in and out) shall be included to decrease possibility of going at mechanical stroke.

Running against actuator's mechanical stops causes serious damages to its internal components! In case of strokes 20 times longer than lead screw diameter, 150mm extra stroke shall be included in the design of the actuator so that, when push rod is completely extracted, it has still 150mm more to go: this will give more stiffness to the unit preventing radial backlash.

Excessive radial backlashes lead to side-forces on actuator's axis, thus unexpected wear and lubricant loss, non regular workouts.

Power supply

To choose a suitable actuator it is important to start finding out which kind of electric power supply is available. Not all actuators are prepared for all voltages.

SELF-LOCKING

There is not a sharp threshold between self locking and non-self locking conditions, because this feature is affected by gears wear, type of load, presence of vibrations, mounting position etc …When in doubt the only way of being sure of actuator behaviour is testing it on the application.When actuator is not self-locking, its positioning precision and repeatability features are lower: in this case, some additional elements are required, such as brakemotors, control/feedback systems or motor short-circuit to achieve magnetic braking effect (for DC motors without brake only)

ACTUATOR AND GEAR BOX INSTALLATION

During machine designing it is extremely important to forsee proper mounting points so that actuator won't have to stand radial forces but axial ones only.
Than, when physically installing actuator into machinery, an accurate alignment of the connecting points is very important to avoid grease losses and nut wear due to radial forces.
Axis of front and back connecting points must always be parallel.
Actuators shall work within their nominal stroke.
When framework is being designed, 10mm extra stroke (in both directions) must be considered to have less possibilities of mechanical end-stops.
Also, when stroke is 20 times longer than lead screw diameter, at least 150mm extra stroke (in extracted position) shall be included in order to prevent the actuator from having radial forces when push rod is completely out.

Running against mechanical stop causes serious damages to actuator components!

Off-set load lead to side-forces on actuator axis causing unexpected wear, lubricant loss and non-regular operation.

Before starting the actuators or gear box up, following checkings shall be performed:

- If actuator is equipped with limit switches devices, before starting the motor, ensure they are connected and working, in order to avoid any mechanical end-stops.

- Make sure push rod will start travelling in the correct direction and limit switches are correctly adjusted. Start motor "step-by-step" to check all this.

All wirings of actuator (motor and stroke control devices) must be done with power switched off. If not, both operator and actuator are at risk.

When actuators are equipped with single-phase motors, capacitors must be discharged before any operation.

In case limit switches are already adjusted, be careful because manual rotation of push-rod will cause adjustment loss!

For a correct selection of actuators it is absolutely necessary to refer to above reported instructions and technical advises.
We decline any responsibility releted to demanges caused to things and persons due to not proper use of the technical information given on this catalogue or incorrect use of actuators and gear boxes.
More information about installation of the actuators are reported in the use and maintenance manual.

SERVICE

All actuators with max load lower then ALI5 are long-life lubricated:
no relubrication is needed in case actuators workout is regular.
Other models are equipped with lubricators and schedules for service are advised into user manual for each actuator.

Standard lubrificant							
Brand	**Products**	**Tmin °C**	**Tmax °C**	**Tdrop °C**	**Base oil**	**Thickener**	**NLGI Class**
Vanguard	G.S. Friction 2	-45	+150	+180	Synthetic	Lithiunm hydroxide	2

Alternative lubrificants							
Brand	**Products**	**Tmin °C**	**Tmax °C**	**Tdrop °C**	**Base oil**	**Thickener**	**NLGI Class**
Klueber	Isoflex LDS 18 Special A	-50	+120	190	Synthetic	Lithiunm complex	2
Dow Corning	Molykote BG20	-45	+180	+290	Synthetic	Lithiunm complex	2

Dedicates lubricants are available for special duties or special environments (e.g. food machinaries); please contact our tech. Department.

Nut wear check-up

A scheduled check on nut wear is to be done periodically.
Wire-off motor and put load on push-rod : load value shall be according to model rating (from nominal load till 0,1 times nominal load lowering this coefficient as the actuator size increases).
Apllying both compression and tensile load, check by means of an adial-gauge that axial backlash is lower:

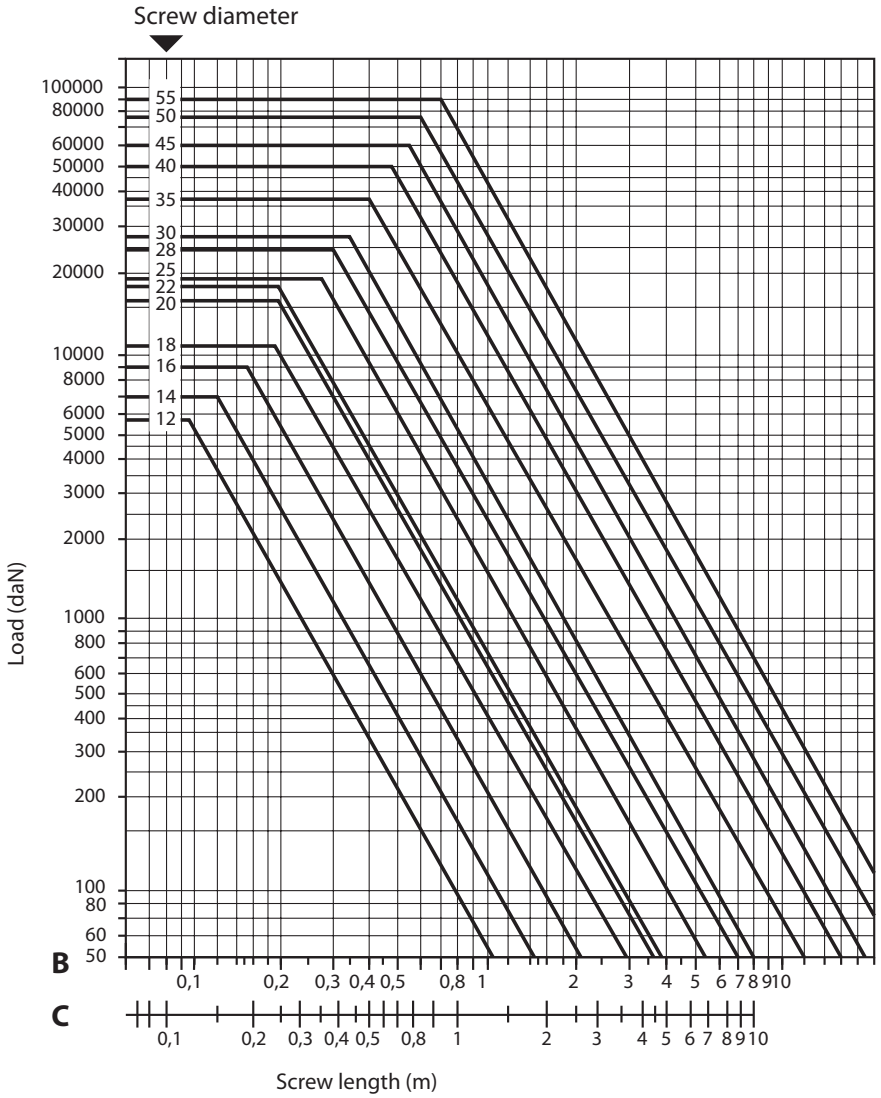
$$Backlash_{(mm)} \leq 0.25 * \frac{screwpitch_{(mm)}}{starts}$$

In case backlash is higher actuator needs to be replaced.
If actuator features ballscrew drive, nut fail first signal is noise higher than usual.
A scheduled manual check as explained above is anyway necessary to monitor regular and linear nut workout.

More information about maintenance of the actuators are reported in the use and maintenance manual.

All data contained in this catalogue are purely indicative and not binding for the company.

DIAGRAM 1



The diagram shows how to see what's max load admitted bya lead screw, basing upon its length and upon how actuator will be fixed on frame.
As a general rule, choice is:

Actuator series	***Diagram***
Actuator with stroke 15-20 time lower than lead screw diameter	**C**
Actuator with stroke 15-20 time larger than lead screw diameter	**B**