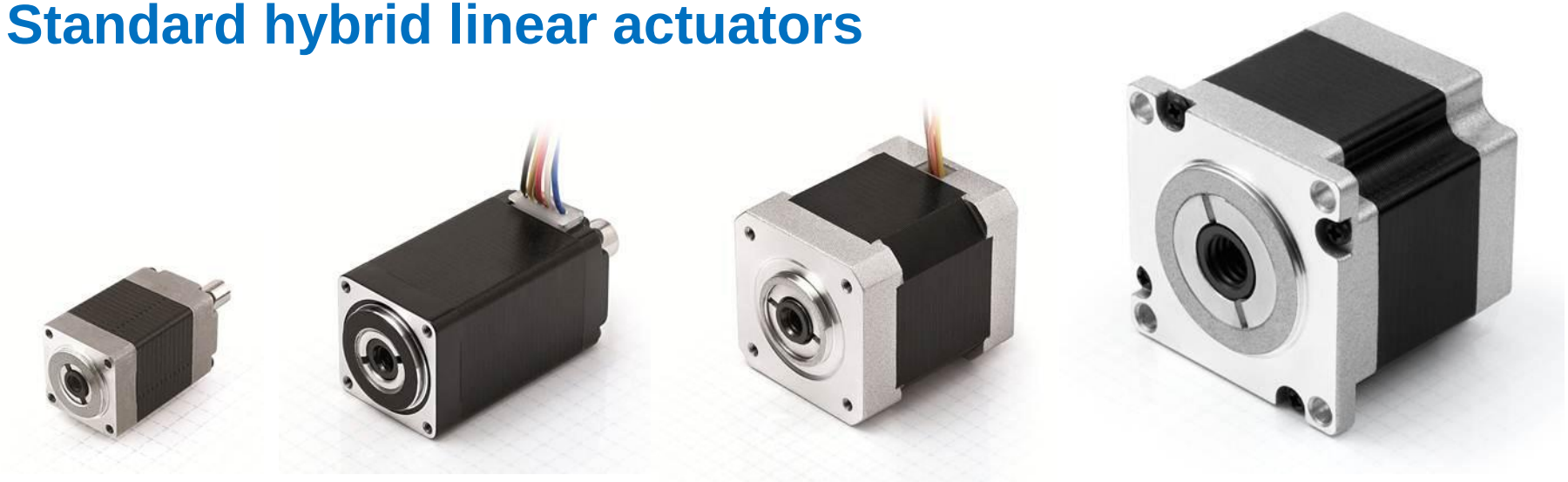
Linear actuators

- Types
- Applications
- Calculations
- Problems

Standard hybrid linear actuators

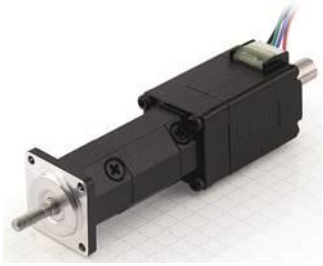


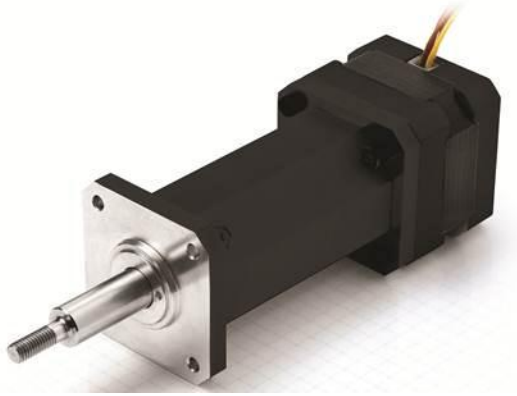
Specifications

Name	Size/NEMA	Max. speed*	Max. thrust*	Thread pitch	Max. resolution
L2018..	20mm / 8	40mm/s	40N	1mm	5µm/step
L2818..	28mm / 11	140mm/s	60N	5mm	25µm/step
L3518..	35mm / 14	100mm/s	140N	2mm	10µm/step
L4118..	42mm / 17	250mm/s	400N	1 / 2 / 5mm	5/10/25µm/step
L5918..	56mm / 23	70mm/s	1000N	2mm	10µm/step

*See datasheet for technical details

Hybrid linear actuators with linear slide



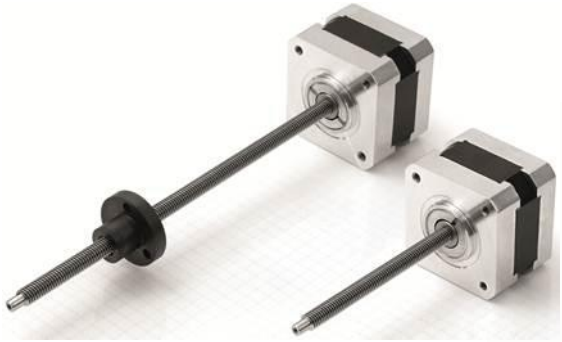



Specifications

Name	Size/NEMA	Stroke*	Thread pitch	Max. resolution
L2018..-25	20mm / 8	25mm	1mm	5µm/step
L2818..-Axx	28mm / 11	25 / 50mm	5mm	25µm/step
L3518..-Axx	35mm / 14	Coming soon	2mm	10µm/step
L4118..-Axx	42mm / 17	25 / 50mm	1 / 2 / 5mm	5/10/25µm/step
L5918..-Axx	56mm / 23	25 / 50mm	2mm	10µm/step

*Customer-specific versions are available in large quantity

Hybrid linear positioning drive



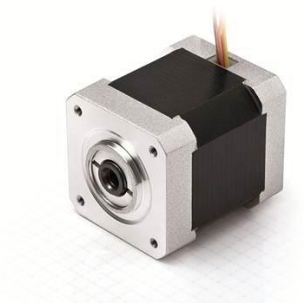
Specifications

Name	Size/NEMA	Stroke*	Thread pitch	Max. resolution
LS2018..*	20mm / 8	75 / 150mm	1mm	5µm/step
LS2818..	28mm / 11	75 / 150mm	1 / 2 / 5mm	5/10/25µm/step
LS3518..*	35mm / 14	75mm	2mm	10µm/step
LS4118..	42mm / 17	75 / 150mm	1 / 2 / 5mm	5/10/25µm/step
LS5918..	56mm / 23	75mm	2mm	10µm/step

*Customer-specific versions are available in large quantity; not all combinations are available at the moment

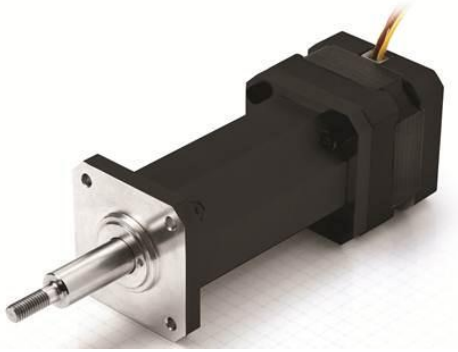
Linear actuators - applications

Hybrid linear actuators:



+ mechanical rework possible
+ large choice of lead screw lengths
+ good for price-sensitive applications
- higher mechanical expense
- lead screw moves through the motor, needs a lot of space

hybrid linear actuators with linear slide:



+ linear slide for anti-rotation is integrated
+ easy to use
- fixed stroke
- length is 2 x stroke

hybrid linear positioning drive:

+ compact size for limited space
+ low priced
+ easy to fit
- fixed stroke
- short stroke

Calculating a linear force:

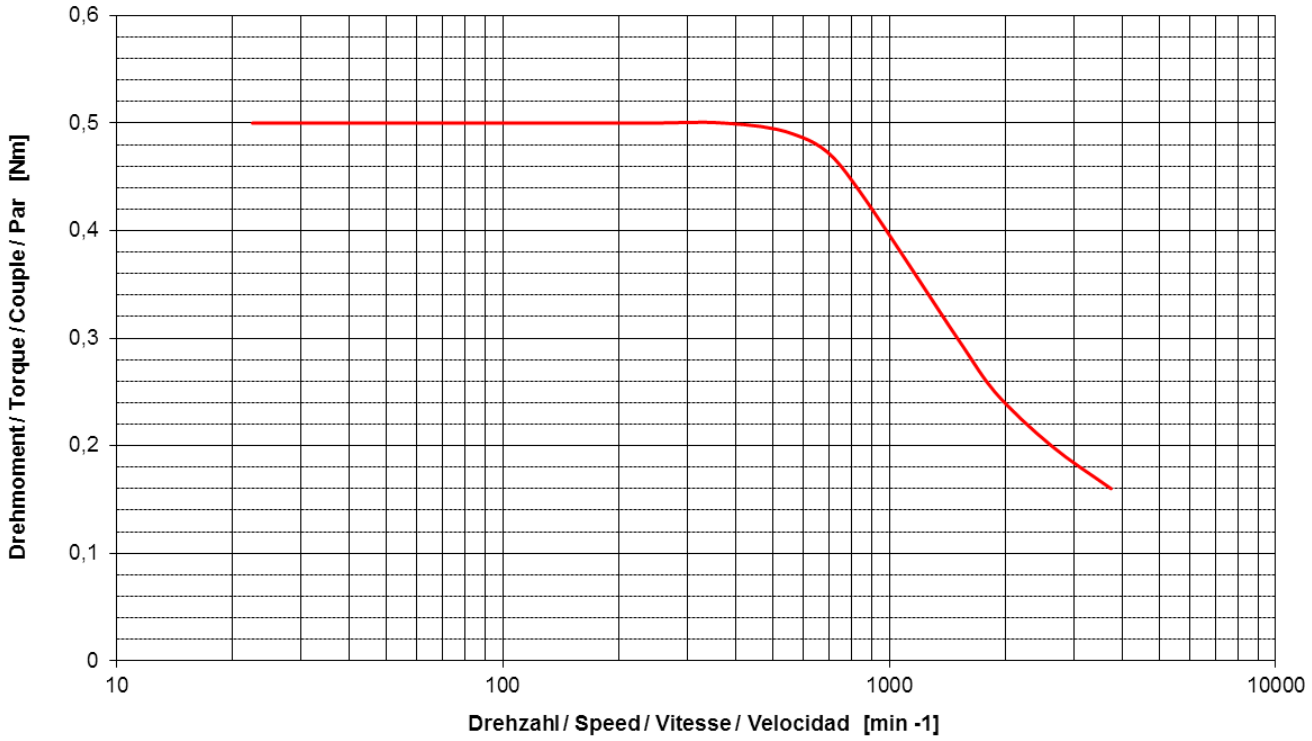
- Example – a standard ST4118L1804
- Formula to calculate the linear force: $(Md_{Mot} \times 2\pi \times \text{efficiency})/p$

  Efficiency = , pitch = 1mm/rotation
  Example: (0.5Nm x 6.28 x 1)/0.001m -> 3140N
- The linear actuators have a larger shaft
  ST4118L1804 Ø 5 mm shaft
  L4118L1804 Ø 10 mm shaft
  This results in a reduced power of about 20% compared to a standard stepper motor
- 3140N - 20% = 2512N
- The following pages will show why we have 3 different pitches for the linear actuators and why the following rules are not right:

  Double pitch -> double speed and half force
  1/5 pitch -> 1/5 speed and 5x higher force

Calculating a linear force:

The torque curve of the ST4118L1804 is calculated as follows:
(Md Mot x 2π x efficiency)/p, efficiency was set at 0.4 and pitch 1/2/5:

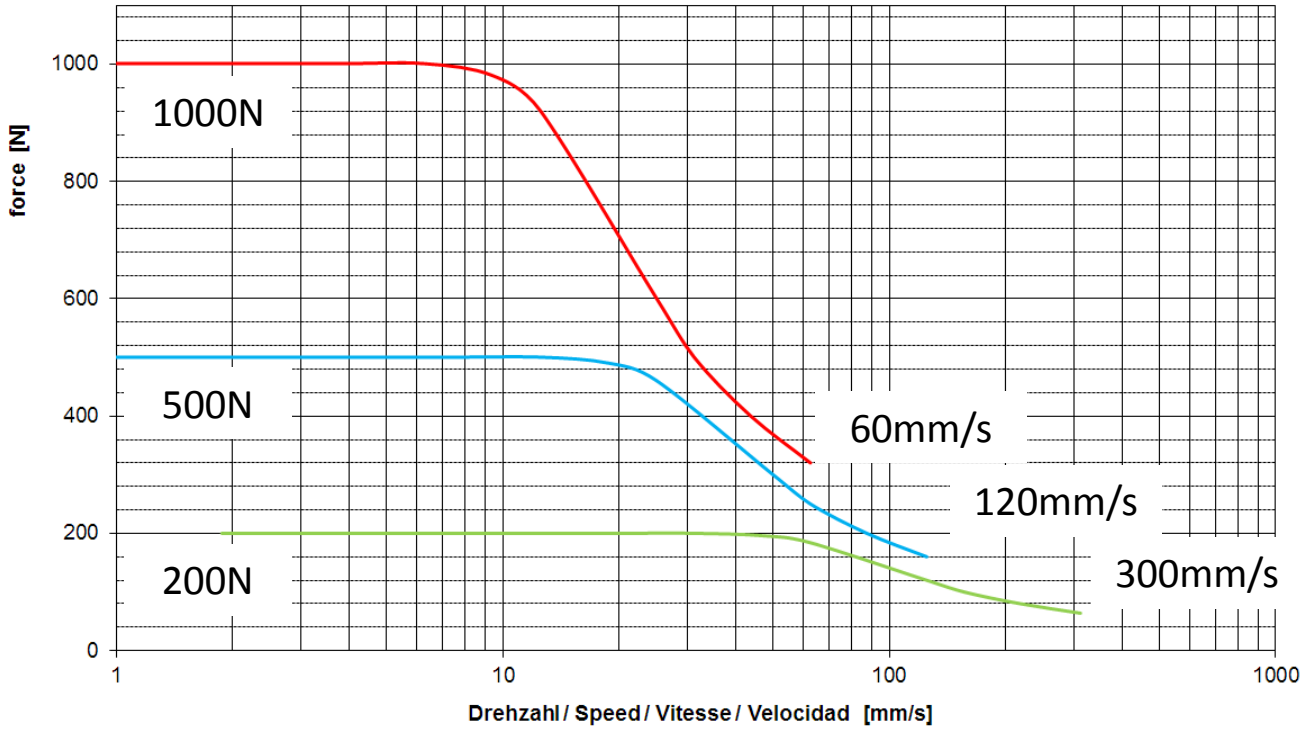


Calculating a linear force:

T6x1

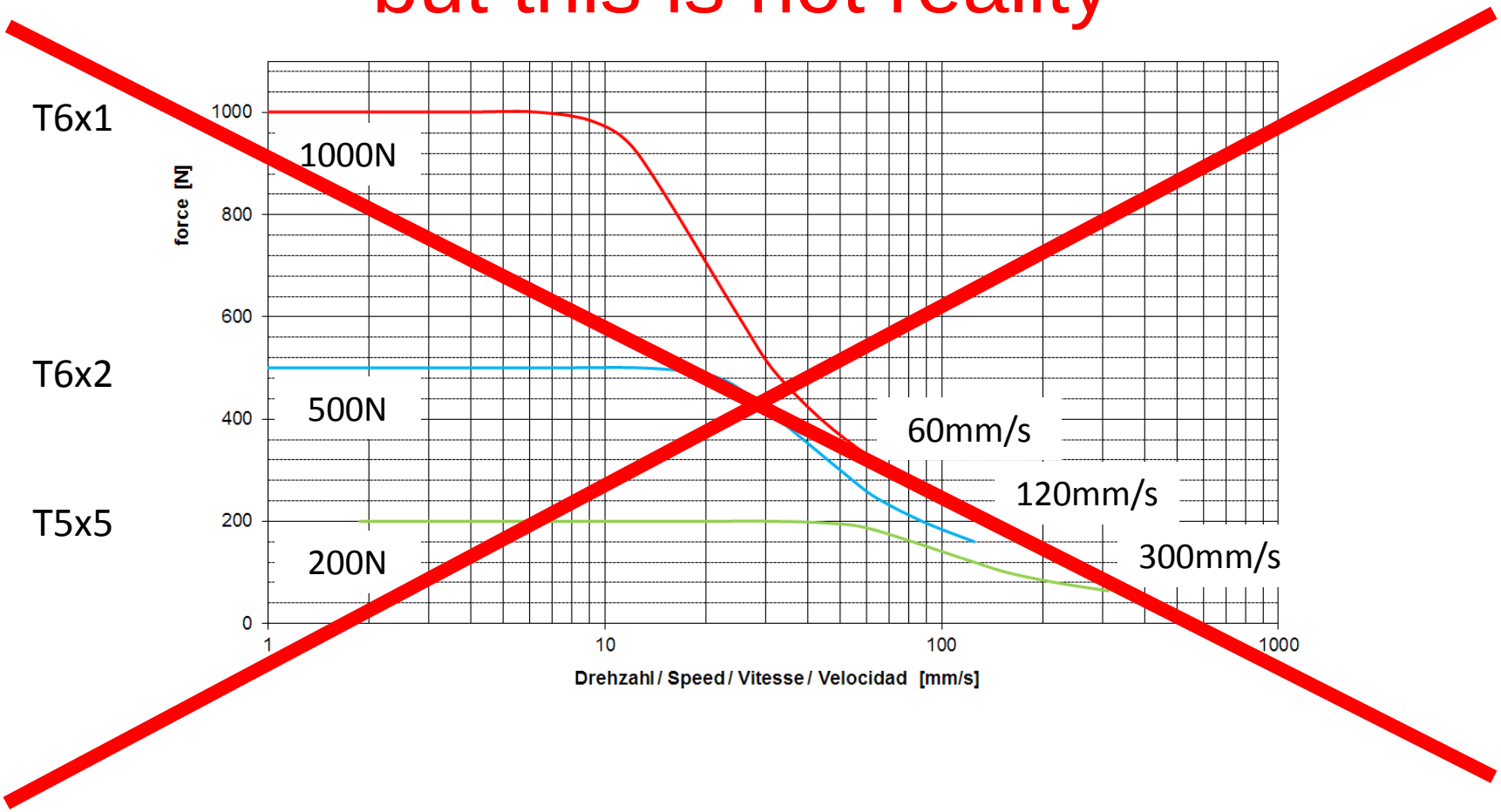
T6x2

T5x5



Calculating a linear force:

but this is not reality



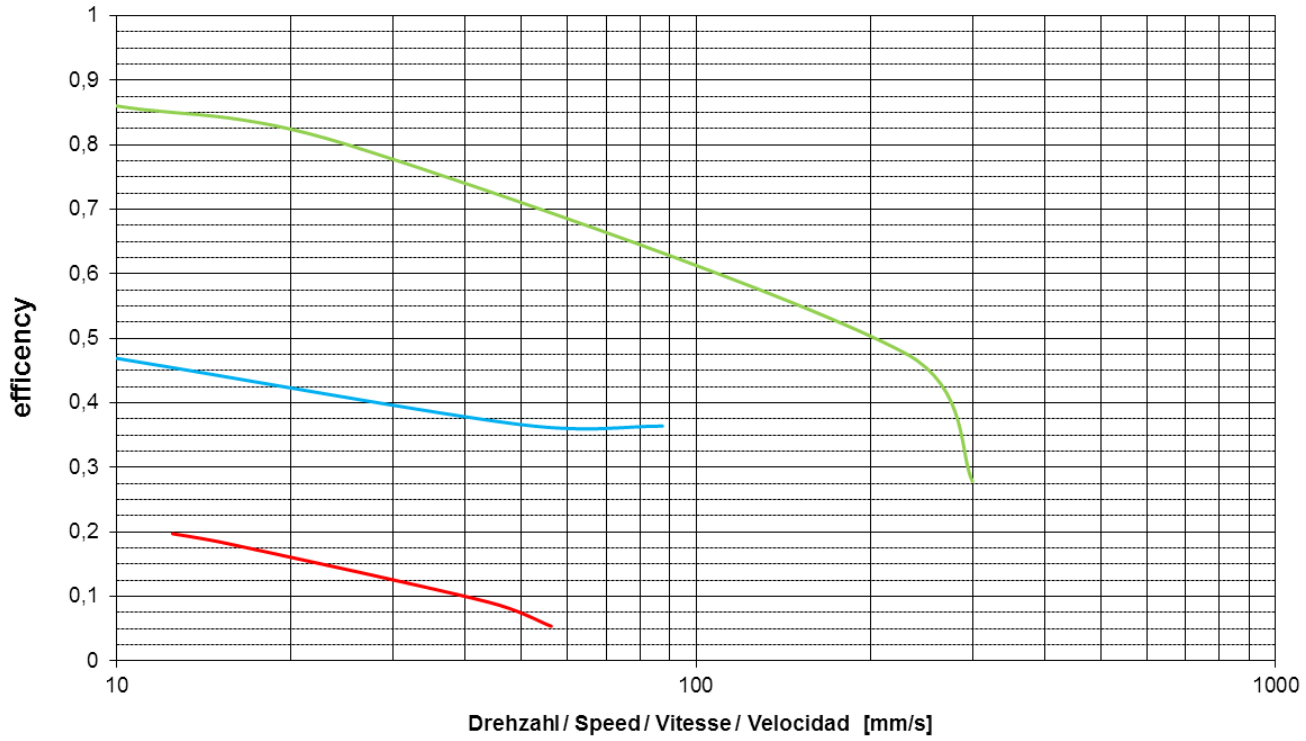
Calculating a linear force:

This graph shows the efficiency of different lead screws:

T5x5

T6x2

T6x1



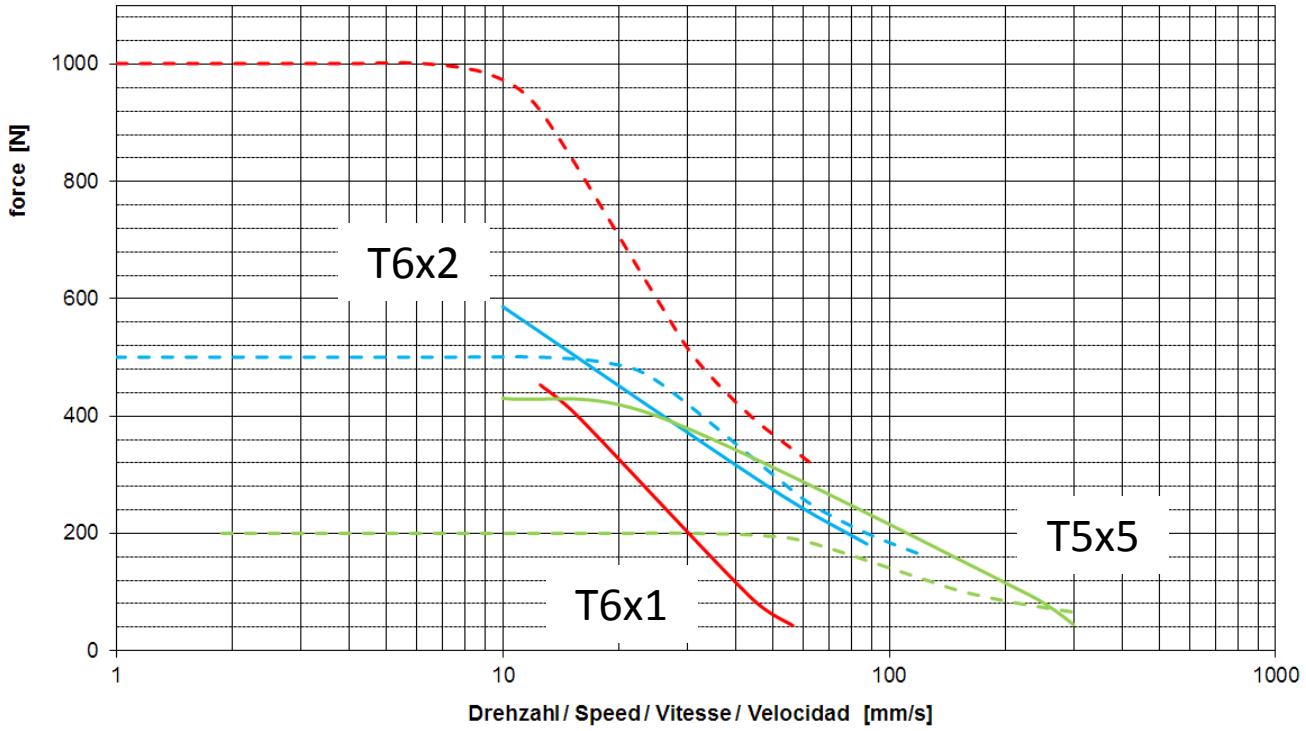
Calculating a linear force:

This is the reality: Linear actuators with different pitches calculated with the efficiency of the different lead screws

T6x1

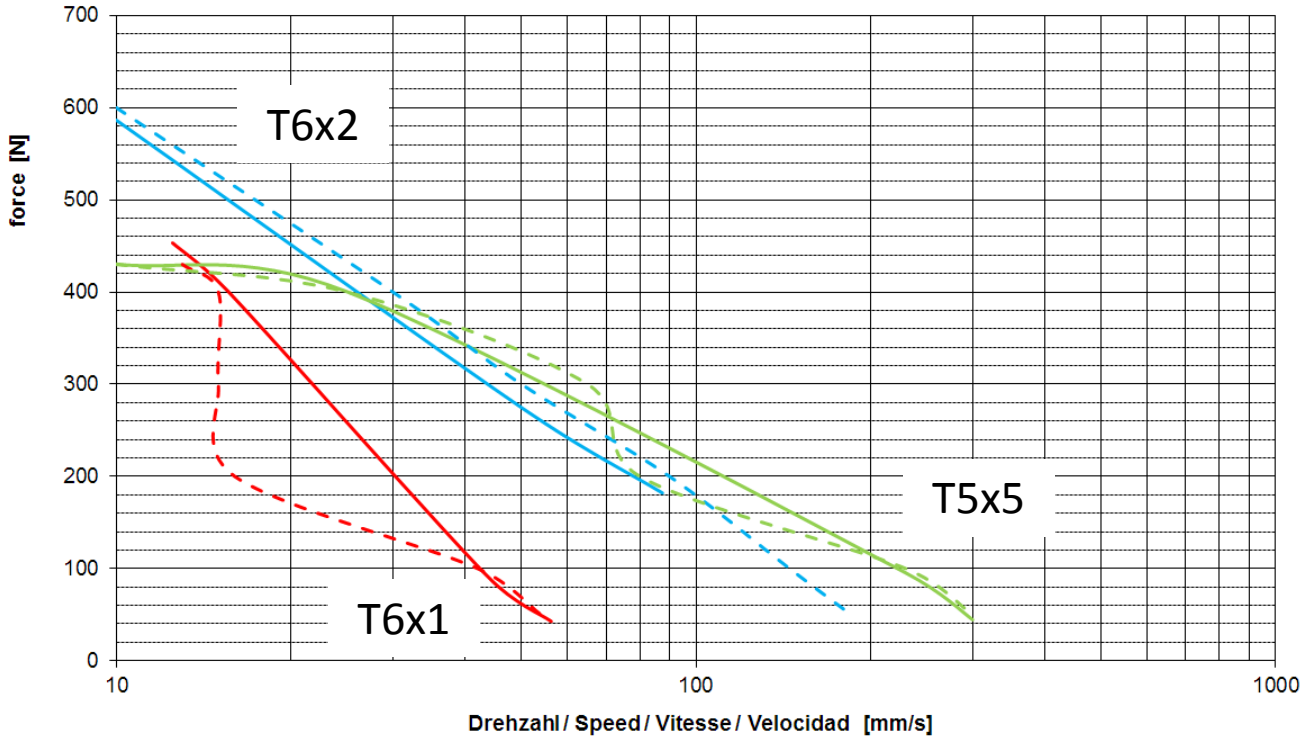
T6x2

T5x5



Calculating a linear force:

This graph compares the calculated and the measured characteristic curves; the calculated curve is without system resonances



Calculating a linear force:

But why do we have these three pitches?

T6x1:
- for high resolution (5µm for every full-step)
- for self-locking without current (>300N)

T6x2:
- good resolution (10µm for every full-step)
- high force (max. 600N)
- high speed (max. 150mm/s)
- good efficiency

T5x5:
- high speed (max. 300mm/s)
- very good efficiency

Life span of linear actuators:

The first durability test was accomplished with the following parameters:

- motor L4118L1804-T6x2
- force 400N
- start speed 2 mm/s
- speed 5 mm/s
- ramp 30Hz/s
- stroke 30 mm
- 1 x lubricated with Nanolub
- repetitions 473.618
- overall track 28.417 km

Possible problems and limitations when using Nanotec linear actuators:

- The radial force on the lead screw is strongly reducing the motor‘s force
- Perpendicularity  and concentricity  are very important for good results
- Resonances occur at a certain speed
- Max. length of the lead screw. If the lead screw is too long, there is no stability
- Durability of nut (peek)
- Periodic use of grease
- Periodic cleaning of the nut and the lead screw because of dust
- High temperature destroys the nut very quickly (peek)
- Different results in push and pull (example: z-axis)

Some of these problems will subsequently be demonstrated on the test stand

Thanks for your attention!

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