Linear motion – Maximal axial loads

Introduction

When used in combination with a lead screw to provide a linear motion, the stepper motor faces axial loads on its shaft.
We will differentiate two cases:

1. the push-mode: generates a load which pushes the shaft towards the inside of the motor.
2. the pull-mode: generates a load which pulls the shaft outside the motor.

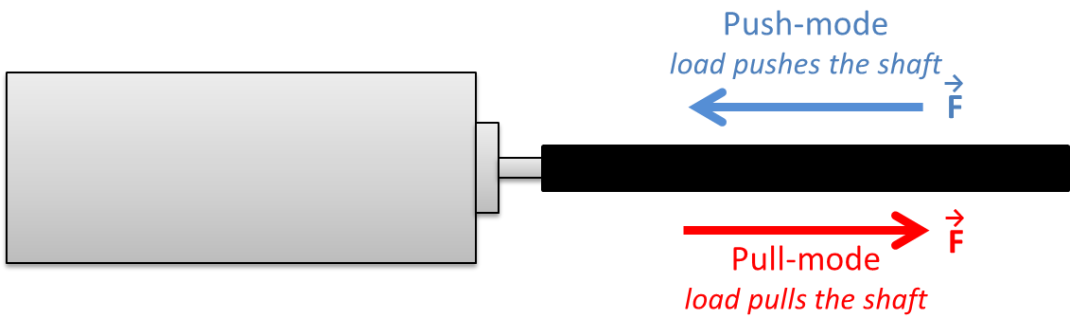

Figure 1 - Illustration of a shaft load depending on actuation mode

This memo aims to provide the reader a good understanding of what maximal load the motor can overcome while actuating a linear motion.

Datasheet limits

When defining the limit of your linear actuator, there are 2 main data to keep in mind:

1. the maximal axial load the chosen motor can bear. Please note that ball-bearings are required when using the motor as a linear actuator.

Shaft bearings [1] [2]	sintered bearings (Bearing code: SB)	ball bearings, preloaded (Bearing code: 2R)	
Shaft load max.:			
– with shaft diameter	1,2	1,2	mm
– radial at 5 000 min⁻¹ (3 mm from bearing)	0,3	4	N
– axial at 5 000 min⁻¹	0,3	3	N
– axial at standstill	0,3	11	N

Figure 2 - Extract of AM1020 datasheet.

2. The linear component datasheet curve:

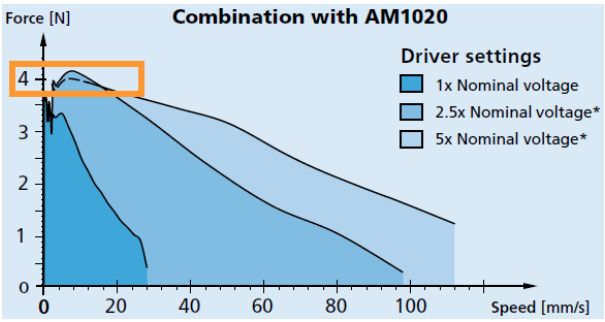

Figure 3 - Extract of M1.6 x 0.35 lead screw datasheet

Push- vs Pull-mode

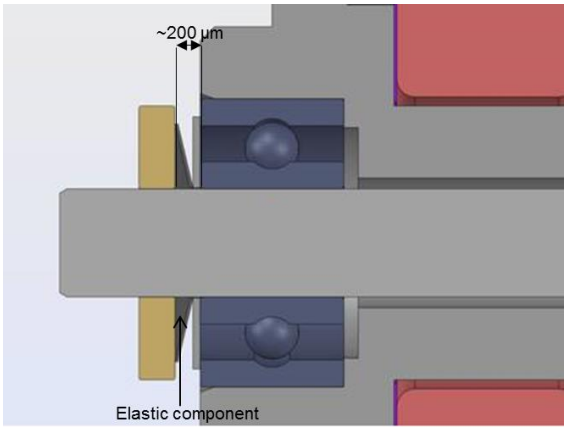

Figure 4 - Illustration of the elastic component providing the ball bearing preload.

A. Pull-mode

The maximal load the motor can pull is limited by the shaft maximal axial load indicated in the datasheet (line 19). Indeed, this value represents the limit before which, in pull-mode, the axial play is ensured. If this limit is exceeded, the elastic component that imposes a preload on the bearing will be elastically (and reversibly) deformed, and the shaft will move forward of about 200µm. When the load is relaxed, the shaft moves back to its original position. This does not affect the proper operation of the motor.
If this displacement of 200µm is not critical for the application, the maximum force the motor can pull is defined by the linear component datasheet curve.
If the axial play is critical in pull-mode and not in push mode, special execution with the elastic component placed at the front is available on request. For more information, please contact your point of sales.

B. Push-mode

The maximal load the motor can push is directly calculated from the motor Torque/speed curve, with a security factor of 40% and a conservative lead screw efficiency ratio. You can find this calculated force in function of the speed on the linear component datasheet. Please note that this maximal load is, at low speed, greater than the maximal shaft axial load indicated in the motor datasheet.

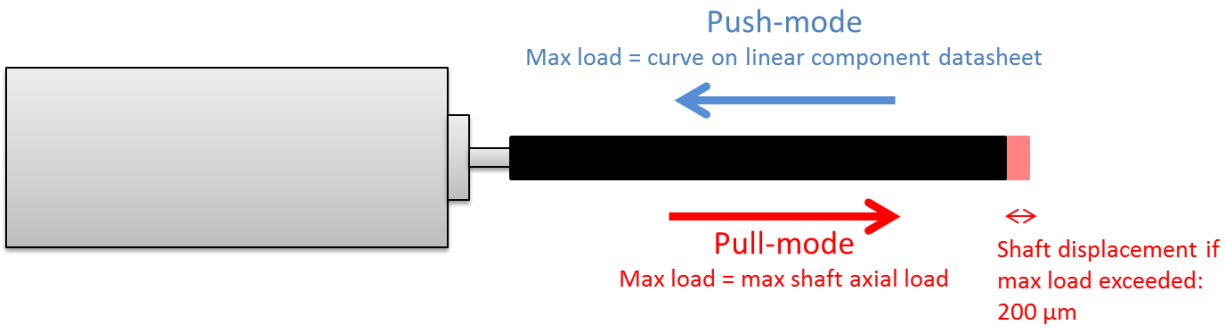

Figure 5 - limits for axial forces the motor can overcome

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