NANOMOTION LTD.

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Application Note NM 5

Considerations in Applying Nanomotion Motors for a Vacuum Environment

- **Vacuum and Ultra High Vacuum grades**
- **Non-magnetic version available**
- **Unlimited travel**
- **High resolution**

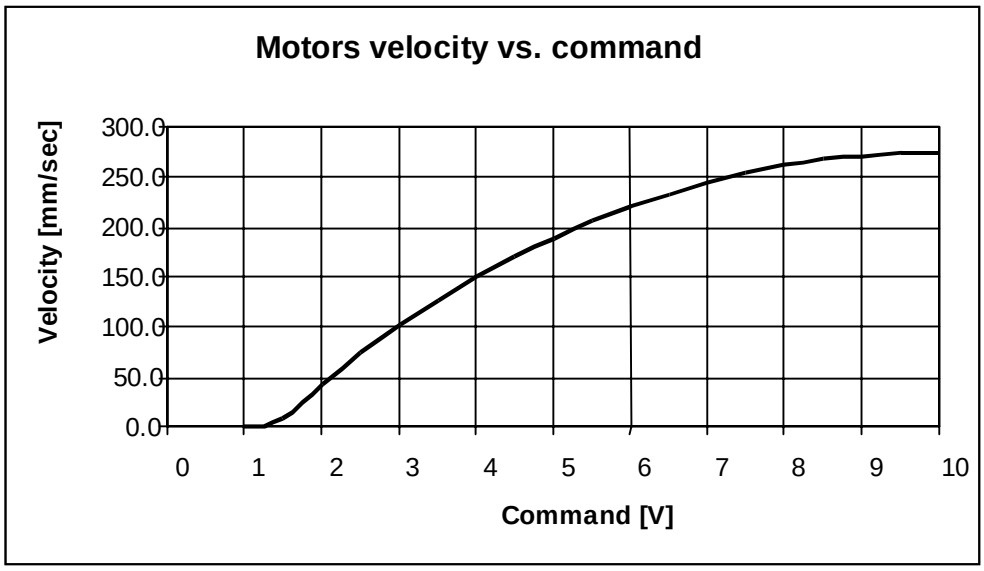
Nanomotion's high resolution precision vacuum motors are specifically designed for high vacuum and ultra high vacuum environment applications. Nanomotion offers two types of vacuum motors: high vacuum motors that are compatible with pressures down to 10^{-7} torr, and ultra high vacuum motors that are compatible with pressures down to 10^{-10} torr. The Piezo-Ceramic based, non-magnetic, vacuum compatible motors are ideal for applications such as E-Beam writers, SEM, TEM, or any application that requires a vacuum and/or E-Beam or Ion-Beam environment.

There are several factors to be considered when designing an application using Nanomotion's vacuum motors.

Performance Envelope (EOP)

There is a major difference between the nature of heat dissipation in a vacuum environment and the nature of heat dissipation in atmospheric pressure environments. In a high vacuum environment, convection does not exist at all and the major heat dissipation mechanisms are conduction and radiation. Consequently, the envelope of operating parameters (command, duty cycle and continuous operation time) is modified. The actual EOP for each motor is shown in the motor specifications.

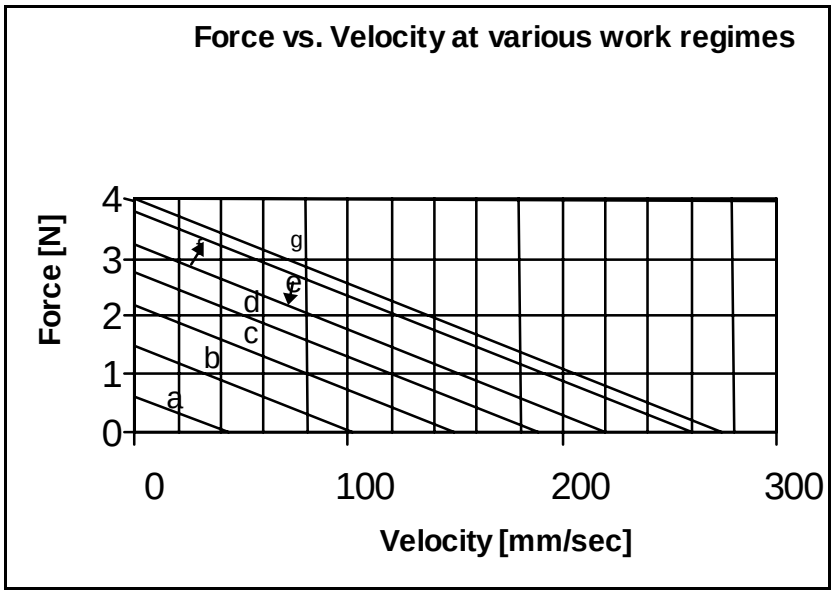
The following graph illustrates motor velocity as a function of the applied driver command voltage. Allowing up to 30 mm/sec variations, use it as a reference and as a guideline for expected motor performance.



Motor Velocity vs. Command[1]

[1]The motor operates horizontally at room temperature and low duty cycle (<10%). It interfaces a Ceramic Strip (according to Nanomotion Specifications) and a cross-roller high quality slide.

The following graph and table are designed to help the user determine the correct performance envelope of operation so as not to overheat and damage the motor.



Curve	25 ^{0}C		50 ^{0}C		Vacuum	
	Duty Cycle	max.continuou operation ti	Duty Cycle	max.continuou operation ti	Duty Cycle	max.continuou operation ti
a	100%	-	100%	-	100%	-
b	100%	-	100%	-	44%	184
c	100%	-	92%	137	26%	107
d	100%	-	62%	93	17%	72
e	78%	87 seconds	47%	70	13%	55
f	56%	62 seconds	33%	50	9%	39
g	50%	56 seconds	30%	45	8%	35

Performance envelope at various work regimes

How to define a performance envelope

An example for using the above graph and table:

A *vacuum* application requires *1N* at a velocity of *40mm/sec*. The graph shows that this point of operation corresponds to curve "*b*".

The table shows that curve "b" and a vacuum environment require that a duty cycle of 44% will not be exeeded while maintaining a maximum continuous operation time of 184 seconds.

It is important to ensure good thermal conductivity between the domed motor finger tips and the stage, as one of the heat dissipation mechanisms for the motor in vacuum is conduction through the finger tips.

We recommend running the stage at atmospheric pressure for two hours at 50% command and 50% duty cycle for conditioning, after which the system must be cleaned without disassembly of the motor and placed into the vacuum environment.

Outgassing

Nanomotion's vacuum motors are made of vacuum compatible materials and undergo special processes that make them compatible for vacuum environments. They can be baked at temperatures of 120°C. A baking temperature of 140°C can be applied for the UHV series upon special request.

Corona Region

It is imperative that the motor is not operated during the transition from atmospheric pressure to vacuum. Operating the motor at ambient pressures between 10 and 1 torr may cause plasma discharge that can damage the motor.

Efficient Use of Control

The motor features an inherent braking mechanism. The motor stiffness and position are therefore maintained even when non-energized. Use advanced controllers that are capable of de-energizing (or disabling) the motor when it reaches the target. Otherwise, even though the motor may be at standstill, it is still energized, with the result that the motor is working at 100% duty cycle. De-energizing (disabling) the motor is essential to avoid heat build-up.

Cable Length

Reducing the length of the cable may damage the motor. Extending the cable length will not damage the motor; however, it will affect motor performance. Always be sure to maintain the safety connection (pins 1 and 6) along all the cable, up to the last connector of the motor.

Motor Mount

For heavy duty applications, protect the system's bearing from sedimenting residual particles that may result from extensive operation of the motor. For clean room compatibility please refer to the Scan and Step New Product Announcement.

For further information please consult Nanomotion Customer Support Division.

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