June, 2005

Technical Release Note

Out-Gassing Nanomotion Vacuum Motors

Introduction

Overview

Nanomotion's high resolution precision vacuum motors are specifically designed for high vacuum (HV) and ultra high vacuum (UHV) environment applications. Nanomotion offers two vacuum motor series:

- **High vacuum motors** (HR-V and HR-VN) that are compatible with pressures down to 10^{-7} torr.
- **Ultra high vacuum motors** (HR-U) that are compatible with pressures down to 10^{-10} torr.

Both vacuum motor series can be baked to remove (out-gas) residual contaminants.

This technical release note describes the recommended bake-out processes and explains the effects that bake-out might have on the performance of the motors.

Conventions

Important information is presented in the following formats:

Notes	Hints and recommendations for working efficiently.

Cautions	Actions requiring special attention to avoid possible damage to equipment.

Warnings	**Actions requiring special attention to avoid injury**

Abbreviations

EOP	Envelope of Performance
HV	High Vacuum
MCOT	Maximal Continuous Operation Time
Torr	Units of vacuum
UHV	Ultra High Vacuum

Bake-out Procedures

Bake-out procedures are conducted in a vacuum oven, with a vacuum of 10^{-3} to 10^{-4} Torr. Bake-out may be conducted on motors detached from their systems or on whole systems, without detaching the motors.

There are two bake-out procedures:

- Standard-Temperature Bake-out
- High Temperature Bake-out

Caution	Before baking motors that are detached from their systems, short-circuit the wire leads. See *Short-Circuiting* on page 4 for details.

Standard-Temperature Bake-out

Use the standard bake-out procedure to remove most contaminants from vacuum motors and other system components. The temperature used in the bake-out depends on the vacuum motor type, as shown in the following table:

Motor	Vacuum (Torr)	Temperature (ºC)
Vacuum	10^{-7}	120º
Ultra-High Vacuum	10^{-10}	140º

Warning	**To avoid injury, operate the vacuum oven according to the instructions of the manufacturer and use appropriate precautions when removing the items from the vacuum oven.**

To perform a Standard Temperature Bake-out:

1. If the motor is detached from the system, short circuit the connecting wires (see *Short-Circuiting* for details).
2. Place the vacuum motor (or system) in the vacuum oven.
3. Gradually raise the temperature (at a typical rate of 2ºC/min) to the required temperature (see table above).
4. Bake for 24 hours at the required temperature.
5. Gradually cool down the vacuum oven at a typical rate of 2°C/min.

After the vacuum oven has reached room temperature, the vacuum motor is ready for use.

High-Temperature Bake-out

Use the High-Temperature Bake-out procedure to remove contaminants that would not bake out in the Standard-Temperature Bake-out.

To perform High-Temperature Bake-out:

1. If the motor is detached from the system, short circuit the connecting wires (see *Short-Circuiting* for details).
2. Place the vacuum motor in the vacuum oven.
3. Gradually raise the temperature to 160ºC (at a typical rate of 2ºC/min).
4. Bake for 24 hours at 160ºC with at least 10^{-4} torr vacuum.
5. Gradually cool down the vacuum oven (at a typical rate of 2ºC/min).

After the vacuum oven has reached room temperature, the vacuum motor is ready for use.

Short-Circuiting

If the motor is detached from the amplifier, the wire leads of the vacuum motor must be short-circuited before the bake-out process.

The following table displays the wire colors and the corresponding D-type pin numbers for short-circuiting:

Wire	Pin
White	3
Black	4
Red	5

Short-Circuiting Fixture

A fixture is available for easy short-circuiting (see figure below).

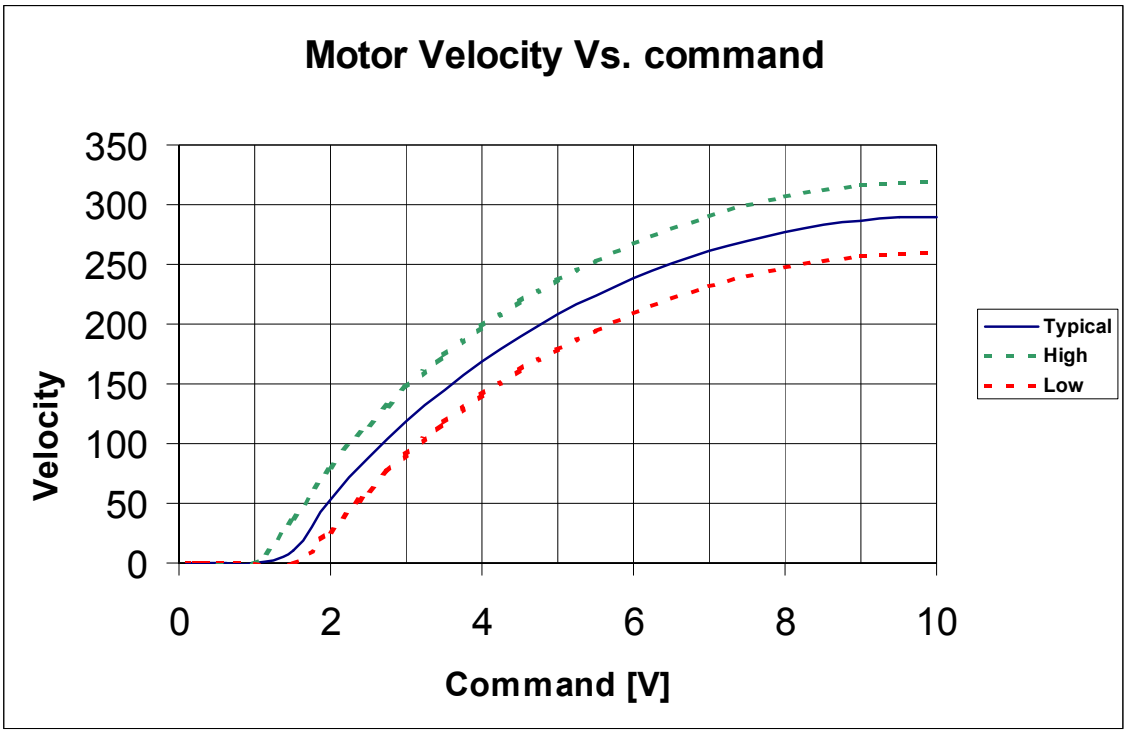
Connect the wire leads to the appropriate inlets in the device.

Envelope of Performance (EOP)

EOP refers to the set of operating parameters (force, velocity, duty cycle, and maximal continuous operation time).

The EOP of motors operating in a vacuum is lower than that of motors that run in atmospheric pressure conditions. This is due to the fact that heat is not dissipated by convection in a vacuum, heat is dissipated only by conduction and radiation.

The chart below illustrates the EOP regarding motor velocity and command.

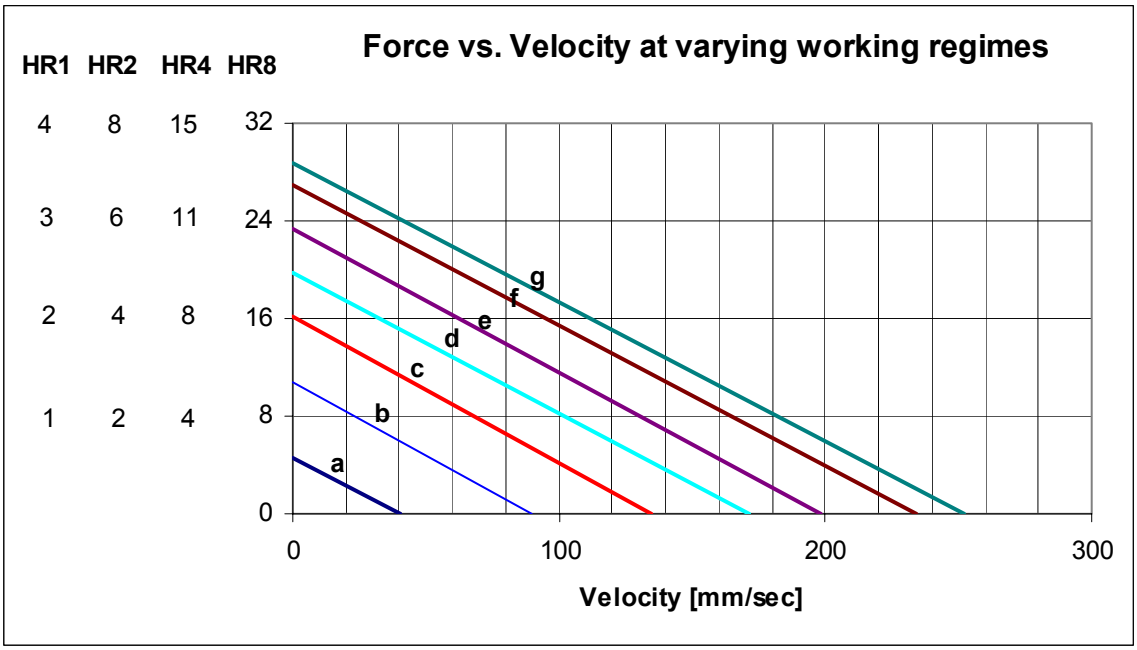


Performance Derating

Baking at 160° derates the performance of the vacuum motor by 10%. This means that the duty cycle and maximum continuous operation time (MCOT) are reduced.

To determine EOP for a baked-out vacuum motor:

1. Plot motor settings on the Force vs. Velocity chart below (the Y-axis shows force values for four motor types).



2. Locate the curve that is on or directly above the plotted point.

3. Use the table below to determine the appropriate Duty Cycle and Maximum Continuous Operation Time for the plotted curve.

Curve	Duty Cycle	MCOT* (sec)
a	100%	-
b	44%	184
c	26%	107
d	17%	72
e	13%	55
f	9%	39
g	8%	35

* Maximum Continuous Operation Time

Note The above graph and table apply to motors driven by AB1A, AB2 or AB4 drivers at an operating temperature of 25°C.

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