

DM50: From 4000 rpm to – 4000 rpm in 3 ms

Introduction

Some applications, such as textiles machines or the semiconductor industry, require motors capable of running at constant high speeds and able to change their direction of rotation as quickly as possible. Here is an example which shows the DM50's impressive ability to accelerate. The motor is capable of changing its directional speed from 4000 rpm to – 4000 rpm in 3 ms¹.

Kinematics

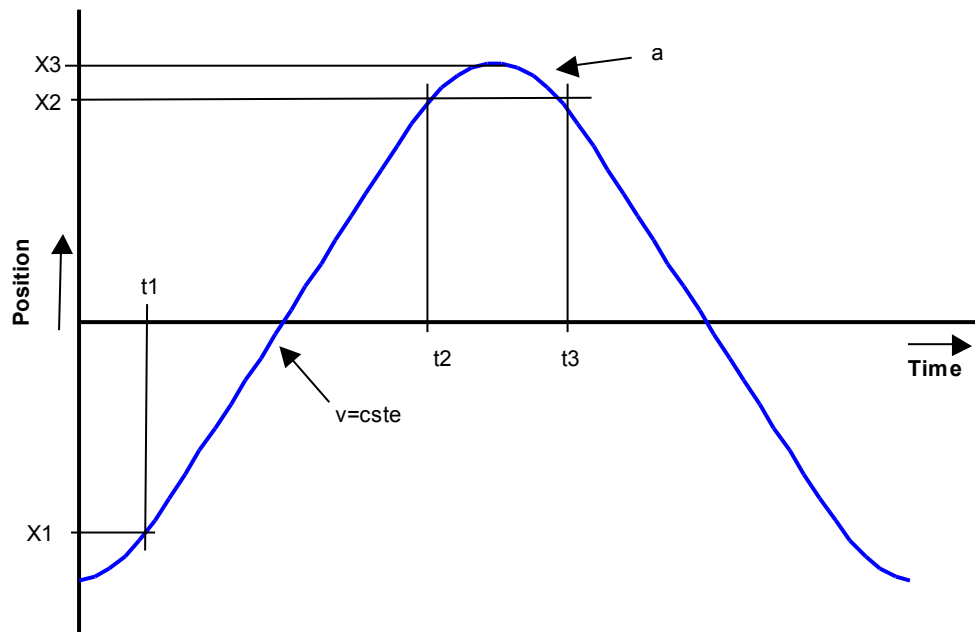


Figure 1: Movement profile

From t1 to t2, the movement takes place at a constant speed. Then, from t2 to t3 the rotor decelerates and accelerates in the opposite direction.

The problem is simple: What must the torque be to provide this acceleration?

Data:

Motor: DM50

Motor inertia: $J_m = 10 \text{ gcm}^2$

Load inertia: $J_l = 10 \text{ gcm}^2$

Speed: $s = 4000 \text{ rpm}$

Speed inversion time: $t_3 - t_2 = 3 \text{ ms}$

Calculations:

Where: $T_a = (t_3 - t_2)/2$, $X_a = (x_3 - x_2)$

The acceleration is deduced from kinematic equations: $a = \frac{1}{2} X_a * T_a^{-2}$ or $a = v / T_a$

If $T_a = 1.5 \text{ ms}$, and $v = 4000 \text{ rpm}$, then **$a = 280000 \text{ rad/s}^2$**

The torque required to provide this acceleration is: $T = J * a = 20e^{-7} * 167500 = \mathbf{0.560 \text{ Nm}}$

¹ With load inertia = 10 gcm²

We will see that the DM50 motor is capable of providing the torque required to perform the requested movement.

Practical application



Figure2: Device used in the experiment

To demonstrate the capabilities of the DM50, we have used the following elements:

- DM50 motor, coil A in //
- HP 500 line encoder, for the negative feedback loop
- Base: The motor is securely attached on top.
- Wheel: To simulate the load inertia
- Technosoft IDS 640 driver, 72 V-15 A

The IDS 640 driver is capable of operating in closed loop. The movement is programmed externally using a computer, then is downloaded into the driver's memory. During the execution of the movement, the driver can save certain pertinent parameters such as the actual position, the speed or the line current. These parameters are then transmitted from the driver to the computer for analysis and comparison with the reference movement.

Description of the reference movement:

- a) Start in position 0: Acceleration at 300,000 rad/s² from 0 to 4000 rpm
- b) For 3 revolutions, the speed is constant: 4000 rpm
- c) After 3 revolutions, deceleration and acceleration to invert the speed. This takes place in 3 ms.
- d) For 6 revolutions in the opposite direction, the speed is constant: - 4000 rpm
- e) Then, deceleration and acceleration to invert the speed, as in point c.
- f) End of the movement, return to the start position.

Result and analysis

The following figures show a comparison between the setpoint (in red) and the reality (in blue), for both the position (figure 3 and 4) and the speed (figure 5 and 6).

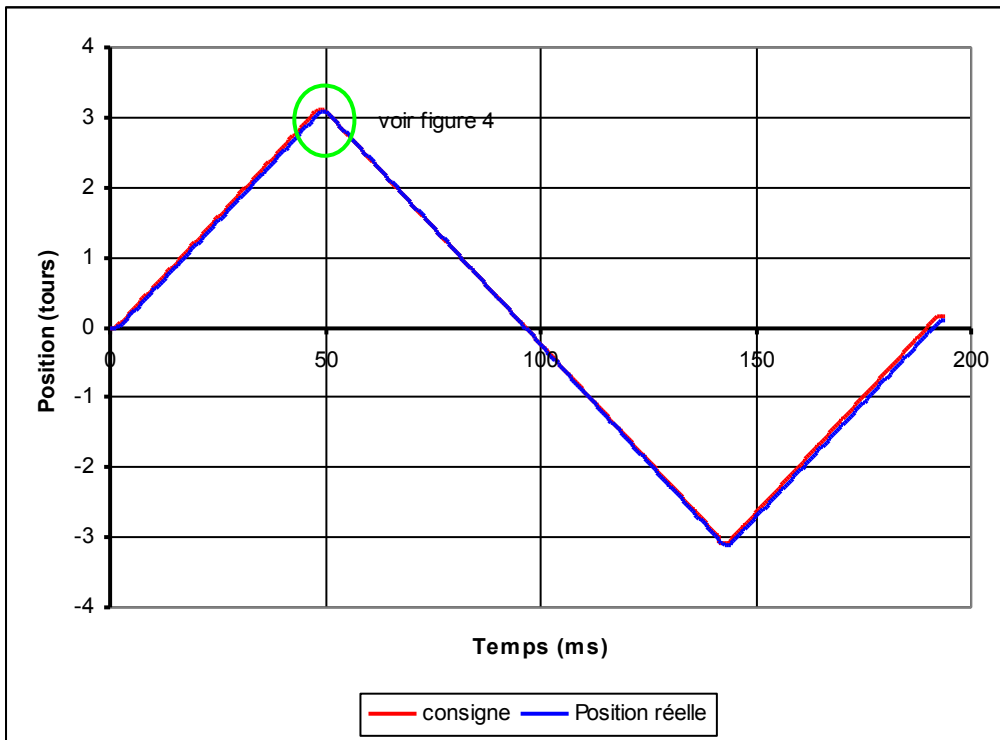


Figure 3: Movement reading

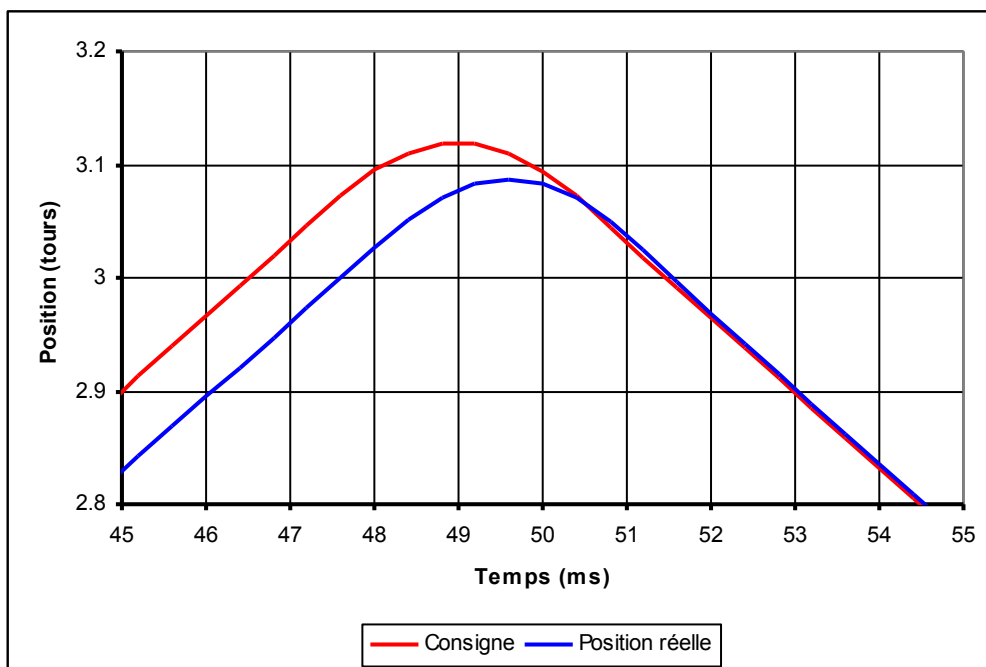


Figure 4: Inversion of the direction

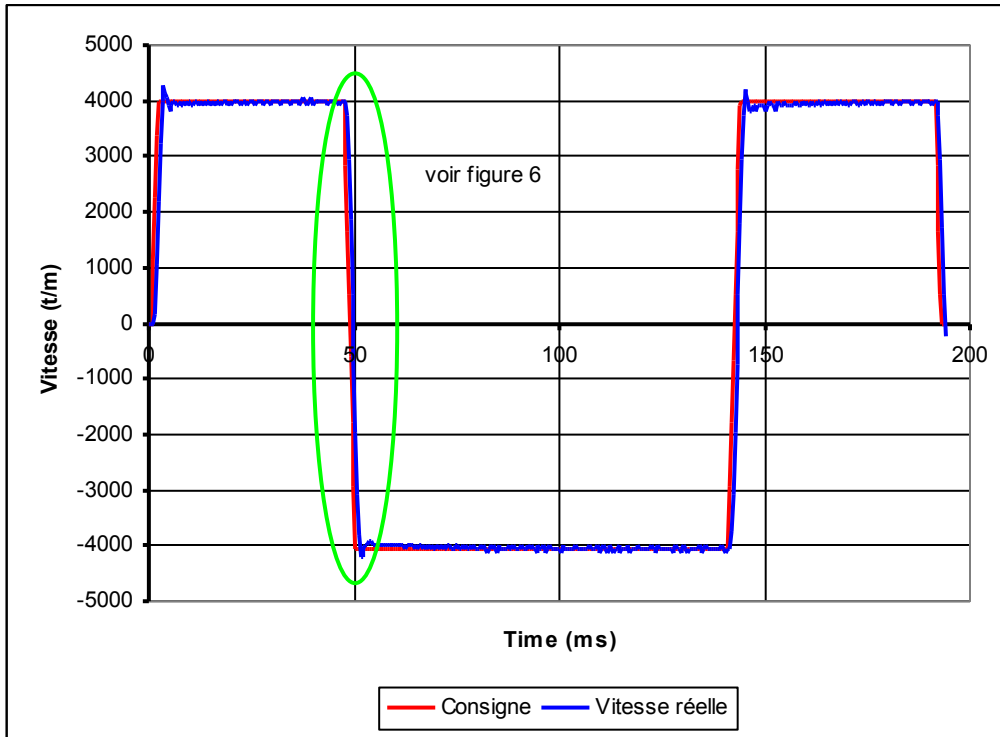


Figure 5: Speed reading

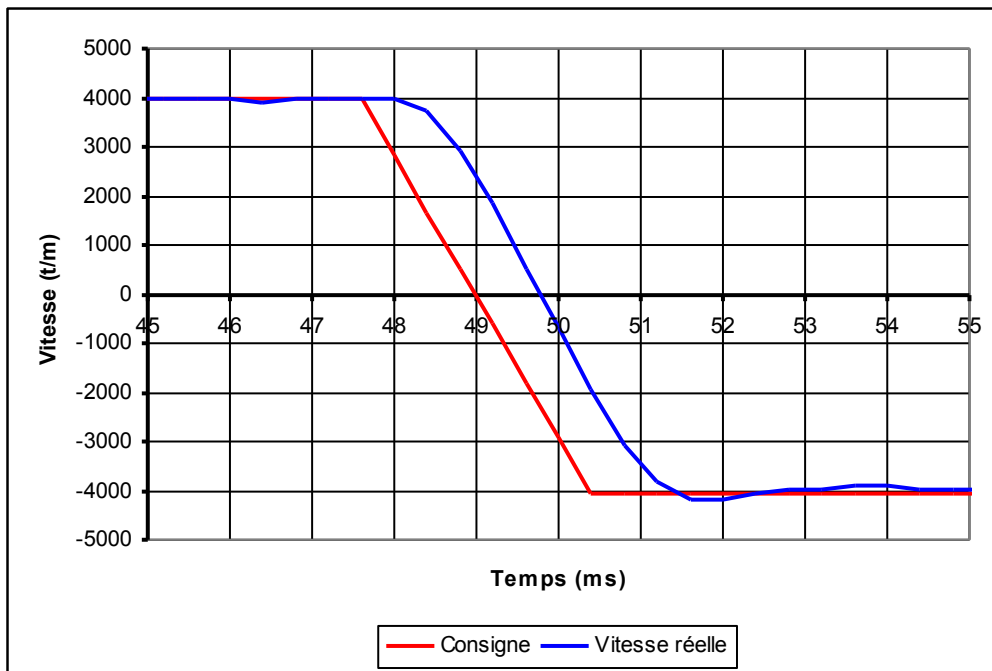


Figure 6: Speed transition

Conclusion

Thanks to the great performance offered by the motor and by the Technosoft driver, the transition between 4000 rpm and -4000 rpm can take place in 3 ms. Note that the difference between the setpoint and the actual curve is less than one ms during the transition, which is very low. The **DM50** motor is therefore particularly well suited to applications where speed and acceleration are critical factors.