MAVILOR EXPRESS
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INFRANOR GROUP COMPANY

Introduction

Introduction

This month we are pleased to publish an interesting article from Dr. Bernard Eberdhing on Servodrivers. We are sure you will find his discussion extremely helpful.
We are also very happy to announce our investment in new, cutting-edge technology for our Quality Control department. With this new equipment, Mavilor can continue to ensure that our clients recieve products of the highest quality.

Mavilor Motors and Infranor Spain is proud to collaborate with the Musseum of Salamanca in their new project: the creation of a solar panel electronic vehicle. The vehicle, which will use a Mavilor motor and drive, is being prepared to enter the World Solar Challenge competition in Australia. We wish them much success in their endeavor.

Please your participation is important to us - this publication serves as a forum of ideas regarding both Mavilor products and the entire automation industry, and your input is highly appreciated.

Thank you very much,

Mavilor Team.

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SERVODRIVES

Servo motor selection and dynamic points of view

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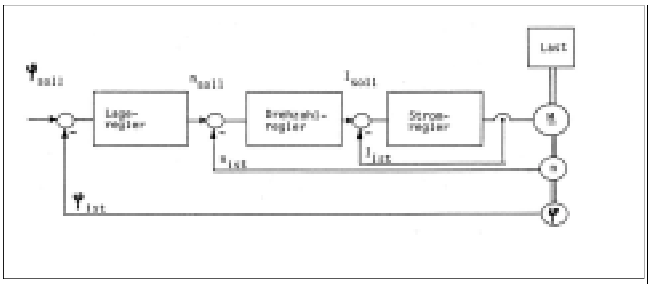

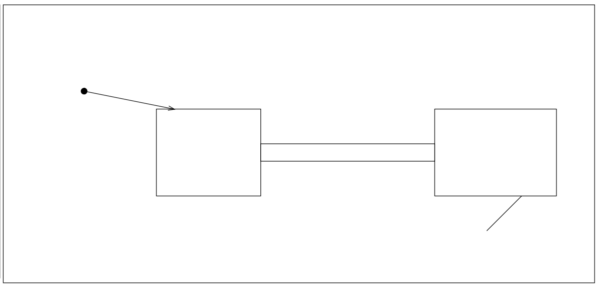

Machine manufacturers are increasingly called upon to design systems for optimal time utilization. However, there are often conflicts between shortening the acceleration and positioning time and the limits of the mechanical system. The resulting torsional resonances represent greater mechanical force and must be avoided. This article attempts to clarify the influence of servo motor design on the dynamic behaviour of the drive, by comparing disc motors and DC conventional electric motors.

The following parameters are of interest in this study:

- o Constructed length
- o Shaft diameter
- o Moment of inertia
- o Electrical time constant

Key data on the motors compared are listed in the table. Figure 1 shows the simplified structure of a position controller circuit via current cascade adjustment and speed control.

Motor Type	NN Nm	PN kW	La mH	Ra Ω	large mm	Shafts mm	Jm Kg cm2	Te ms	fres Hz
Disc motors	3.8	1.2	0.2	0.7	127.5	24	24.4	0.27	140
Conventional electric motors	3.6	1.2	1.5	0.25	230	19	20.5	6.8	80

Table: Key technical data of comparable disc motors and conventional electric motors

Controller theory states that the maximum step frequency of the loop cascade controller is w = w. Therefore, the step frequency of the internal controller loop must be maximized. This is also necessary when the exterior controller loop has less stringent requirements, as this will reduce the force exerted on all components, provide better suppression of interference and increase the stability - all of which make the system easier to handle.

As the internal controller loop, the current controller circuit should have the widest possible bandwidth. Modern servo amplifiers have values of 1-2 kHz, which depend not only on the switching frequency used (*fs* preferably ³ 8 kHz), but also on the load. A comparison of the time constants clearly shows lower values (see table) for the disc motors (ironless rotor). This allows current controller circuits with larger bandwidths to be designed.

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SolarZep Project

MAVILOR MOTORS AND INFRANOR SPAIN COLLABORATION MUSSEUM OF SALAMANCA

"How do you design a car?"
"Whom do you design a car or motorcycle for?"
With each new exhibition, The Museum of Automobile History of Salamanca seeks to bring a new aspect of the world of automation to the public. Automobile design is an important part of the museum's focus, so it is fundamental to educate the public about the creative process involved in bringing a new car into the market. The multiple possibilities of an electronic vehicle are shown in our new project: the design and construction of an electronic vehicle powered by solar panels. The specifications of the vehicle are quite high, starting with a chassis made of computer-optimised steel tubes. It has a body surface of 1 m2, comprised of laminated aluminium that alternates with eight solar modules.

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The new digital microscope will allow us to carry out visual verifications with a significant improvement in presentation quality.

At the same time, we will be able to save the images in a digital format, which we can then send to suppliers or clients via e-mail.

This equipment serves to implement optical measurement and quality control programs for all our products.

The speed control circuit is the second controller loop, and the high bandwidth of the current controller can be utilized in this case. Figure 2 shows the simplified mechanical structure of a servo motor.

The moment of inertia of the motor, *JM*, is flexibly coupled to the moment of inertia of the tachometer, *JT*, creating a vibrating system. The natural frequency of this system must be taken into account, as it has significant influence on dynamic behaviour. For the natural frequency ω ,

$$\omega = \frac{\sqrt{C\,(JM + JT)}}{JM \cdot JT}$$

Conventional electric motors

Two options for maximizing the natural frequency can be deduced from this relationship. This has the following design-related advantages for the disc motor:

The reduced length (e.g., Factor 2) allows a 2 increase in shaft diameter with the same mass inertia. Since the polar moment of inertia increases with the 4th power of the diameter, torsional stability is increased four-fold.
The natural frequency of the system is higher, resulting in improved system properties. This is shown in Figures 3 and 4.

The same considerations should be made for the motor-load system. This allows relevant mechanical drive requirements to be taken into account. A direct relationship between the minimum positioning time achievable and the natural frequency can be established for each system.

Mavilor Motor MA

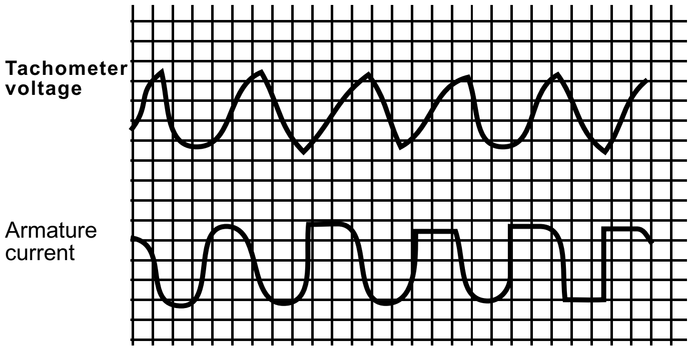

Fig. 3: Tachometer voltage and armature current of a DC disc motor
Natural frequency: ** 143 Hz

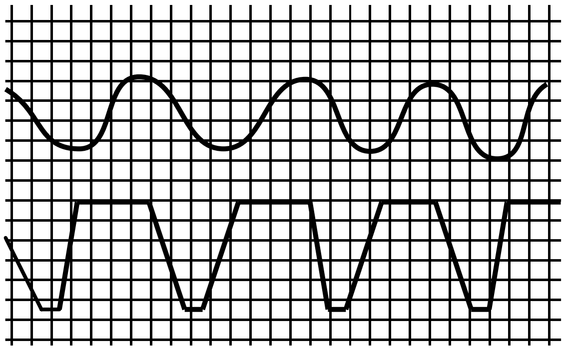

Fig. 4: Tachometer voltage and armature current of a conventional DC electric motor

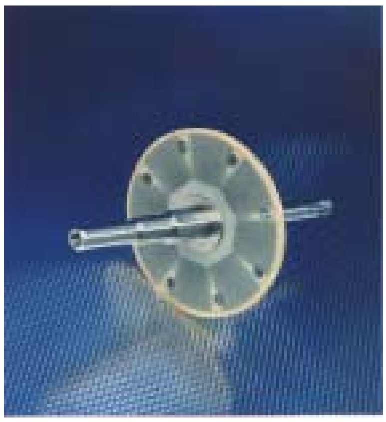

Fig. 5: Infranor disc motor, AM Series

Higher accelerations lead to resonance, increasing the positioning times. The resonance that appears is generally offset with the corresponding specification for the rated values (ramps). The measurements also showed that conventional electric motors tend to experience vibration in a wider margin of amplification, *P*, of the speed control circuit, unlike disc motors. Moreover, sudden interruption of this vibration was also not observed when the amplification, *P*, typical in disc motors, is reduced. This behaviour makes it hard to adjust the speed controller circuit and may cause unwanted vibration to appear during operation. In this context, therefore, the following selection criteria can be established for servo motors:

- Elevated torsional stability (short design, larger shaft diameter)
- Low mass inertia
- Low inductivity (and therefore larger bandwidth for the current controller circuit)
- Lower mass of the tachometer generator (measurement system in general)
- Stablest possible coupling of the measurement system to the motor shaft (hollow-bored shaft mounting)

These requirements were taken into account in the design of the disc motors of the MO, MT, MS (DC), SE and AM (AC) series (Fig. 5). Therefore, these motors meet the necessary dynamic requirements for modern drive systems, achieving lower acceleration and positioning times, greater precision and good system stability and handling.

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Mavilor modernizes its Quality analysis system.

Mavilor has invested in new verification equipment for the quality control department, including a digital microscope (power: x100). This improvement in analytical instruments allows for the visual verification of all system components in order to achieve the highest possible quality in all of our products.

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The panels provide a peak power of 1kW. The aerodynamic aspects of the vehicle have been optimised using computational methods to a coefficient of aerodynamic resistance of Cd=0.11, 1.0, giving it almost no resistance.

Technical Characteristics are:

Type: sports car
Capacity: one passenger
Dimensions: 600x200x125 mm
Weight (kg): 550 kg
Battery weight (kg): 150 kg
Type of battery: Pb-acid Orbital donated by Tudor
Maximum speed: 80 m/s
Acceleration: from 0-50 km/h in 8 seconds
Mileage with full tank: 50 km
Motor: 5kW brushless radial flow motor donated by Mavilor Motors
Drive: motor comes with its own drive
Solar panel efficiency: 10%

This unique prototype represents the first phase of an ambitious project that will optimise all of the vehicle's characteristics to compete in the World Solar Challenge in Australia.

ISO 9001 Certificate Nr. 16927