Electromechanical Actuation Systems

ROSNER-TDL

R/C Servos for Mechatronic Applications

Part 1: Introduction

Overview:

Servos used in radio controlled (R/C) models (planes, cars, ships) are compact electro-mechanical actuation systems. Their versatile performance data and simple availability make them a good choice for other technical areas, too. But for some applications the available catalog data is not sufficient to find the right servo. This report (and more to come) shows our ability to get just these information by experiments.

Construction and operating principle

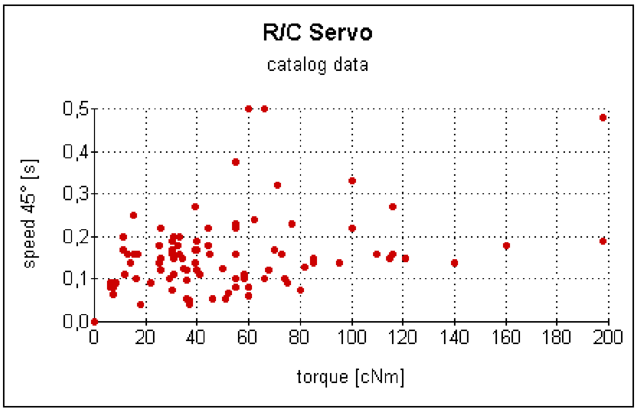
A servo has a direct current (DC) motor, which drives the output by a multistage gear train. In most cases the output is rotary (typical stroke: ± 90 deg), while linear output become rare. The position of the output is fed back by a position sensor (mostly a potentiometer) to be compared with the command signal. Any difference will be eliminated. The command signal is a pulse length coded (PLC) signal with a rate of repetition of about 50 Hz. In the last years a more digital approach for the electronics became available. Here the data rate is internally augmented to about 300 Hz. So a higher dynamic is possible, also the load stiffness is improved, but at the expense of a higher power consumption. The typical supply voltage is 5 V, by a moderate increase (to 6 V) the performance data improve a bit. To cope with the increased heat in the motor aluminum cases for retrofit are available.

Catalog data

The most important data given by catalogs are:

- holding torque: peak static torque
- actuation torque: typical dynamic torque
- speed or actuation time: time to move a typical angle (40°, 45°, 60°)
- power supply voltage and current
- mass or weight
- size (length, width, height)

We have data sheets of more than 400 servos available. Some are shown in the graph.

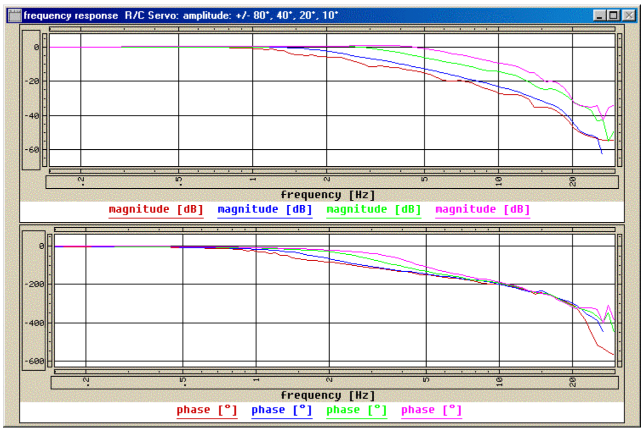


Catalog data: speed or actuation time for 45° and actuation torque. Typical selection of available servos.

Limits of catalog data

Especially in typical mechatronic applications, when a permanent dynamic motion is required (e.g. to compensate disturbing torques) the catalog data are not enough for the right choice. Here we can help with experiments and measurements.

In our laboratory we can evaluate any electro-mechanical performance data, even under external loads. Here the command signals come from programmable digital signal generators, so we can command any type of signal.

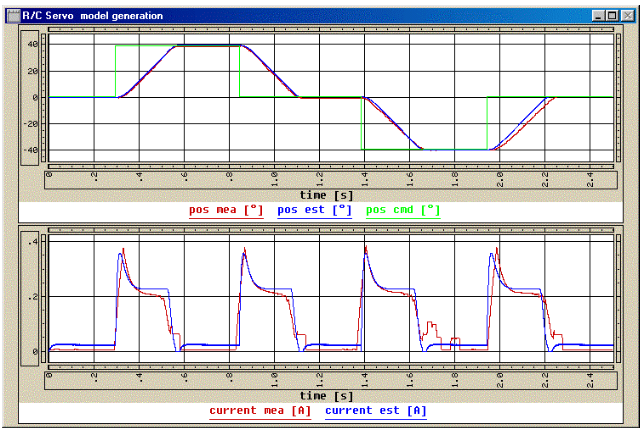


Frequency response at different amplitudes: the results at different amplitudes (± 10°to ± 80°) show the strong non-linear behaviour.

Model generation

For many simulations, we need the analytic relationship between command signal and the motion and the current. Here a mathematical model with experimentally estimated parameters is the solution. Because of the very special construction of the servos the model must be significantly non-linear.

The adaptation of the model to measurements (i.e. the identification or estimation of the relevant physical parameters as motor data, internal friction, control dynamic) leads to precise and powerful models.



Step response: Comparison of measurement an model. The upper diagram shows the various positions (measured red, estimated blue, command green). The lower diagram shows the currents. The model used here has 9 parameters: 3 for the motor, 3 for the electronics and 3 for the gear train.

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