Test Bench for Electrical Drives

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Abstract. *Testing equipment is an integral part of every development department. This article presents the bench for testing and measurement of electrical drives parameters and their control algorithms. With its design and versatility, it is different from known commercial products such as various dynamometers, mechanical brakes, etc. Control of the whole measurement process is realized by the EVA processor system (designed by UNIS, a.s. as well), which provides detailed display on the integrated graphical LCD unit. Maximal parameters of tested electrical drives are up to 40 000 rpm and up to 2 N·m torque.*

Keywords: BLDC Motor Test Bench, Electrical Brake, Mechanical Brake, EVA Processor System, CAN Communication Bus

1. Introduction

The described measuring system, designed by UNIS, a.s. [1], is mainly intended for the testing of the electrical drives' mechanical characteristics and their control algorithms. The prime area of interest in the Mechatronic systems division is the development of control electronics and software algorithms for driving sensor and sensor-less electronic commutated motors (BLDC motors) in the power range up to 1.5 kW and in the voltage range up to 48 V DC. Usage of these electrical drives is mainly in the aerospace industry and other safety critical applications.

The new test bench has been created on the basis of these requirements. Its block schematic is in Fig. 1 and graphical model in Fig. 2. For easier orientation it can be separated into several parts – mechanical brake, electrical brake, processor control system, graphical and operating panel. Individual parts are connected to a common CAN bus, which controls whole test bench, data collects and displays the actual physical values on an LCD panel.

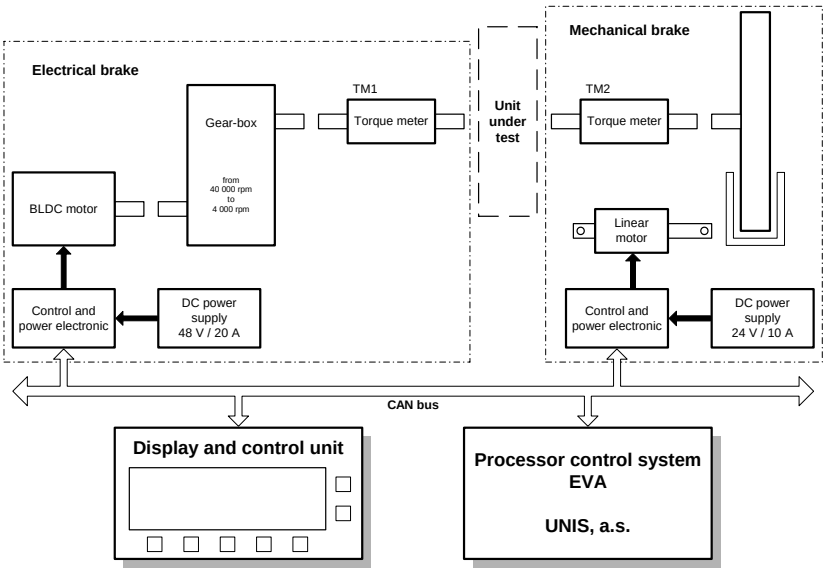

Fig. 1. Block schematic of the test bench.

The following chapters contain a more detailed description of particular part of the test bench, their parameters, and possibilities. Graphical model of several parts, e.g. Fig. 2, created in AutoDesk Inventor environment is also enclosed.

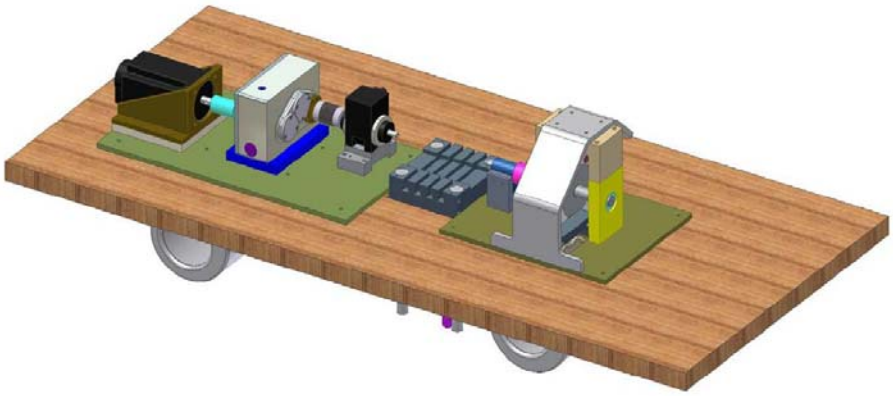

Fig. 2. Graphical model of the whole test bench.

2. Electrical Brake

The electrical brake, Fig. 3, consists firstly of the torque meter (the first black box in Fig. 3), which is a product of Magtrol, with maximal parameter range up to 40 000 rpm and up to 2 N·m torque. The next component is the two-stage gear-box, each stage having the same gear ratio. The gearbox consists of helical gears immersed in oil for permanent lubrication and cooling. The gear ratio of the whole gearbox is 1 to 10 and maximal transferred power up to 1.5 kW. The gearbox output is connected to the BLDC motor (black one, Fig. 3) with a nominal power of 1 kW. Its principle is similar to that of the active electric brake and produces the negative torque to tested device. The braking torque, thanks to smart control, is continuously variable over a whole range according to requirements. Information about torque and angular speed are available from the torque meter in analog values that are converted to digital form and processed in the processor system.

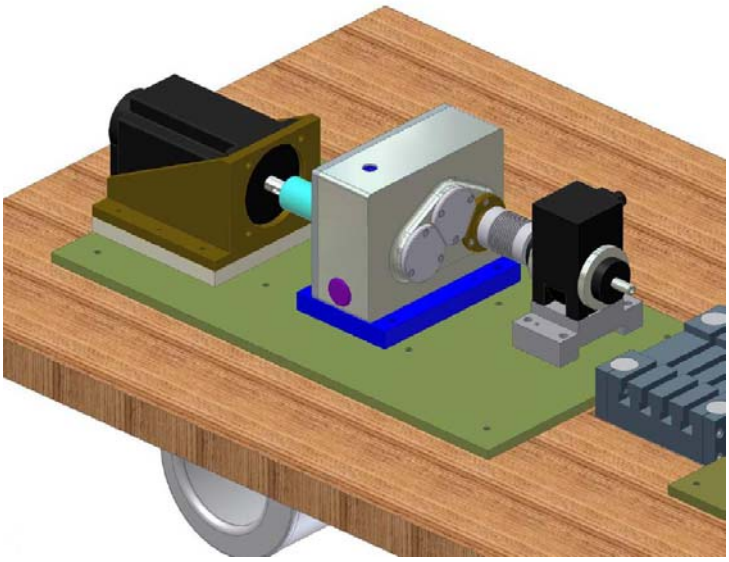

Fig. 3. Model of electrical brake, part of the test bench.

3. Mechanical Brake

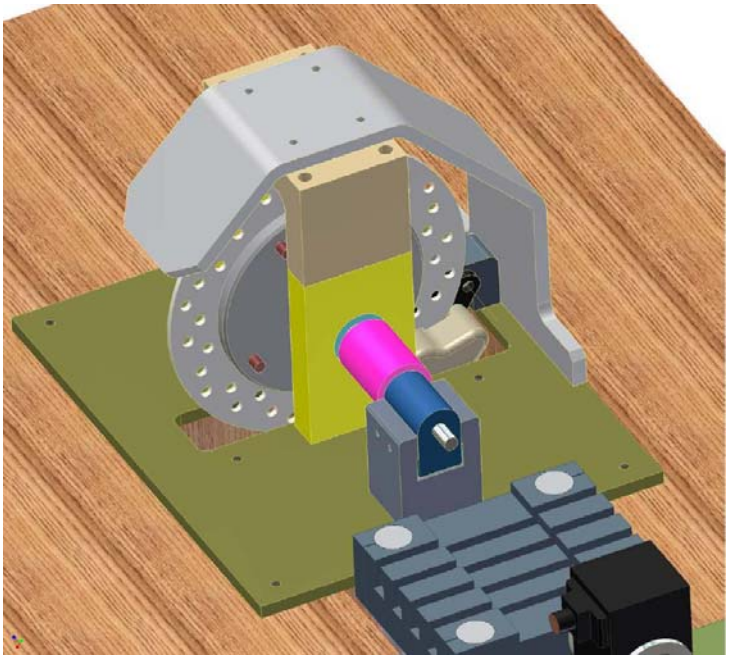

Fig. 4. Model of mechanical brake, part of the test bench.

The input stage of the mechanical part, Fig. 4, of the test bench is also includes an independent torque meter with maximal parameter range up to 10 000 rpm and up to 10 N·m torque. Its mechanical brake consists of a wheel-brake disk that is usually used in the automotive industry. To enable continuous variable control of braking torque, the brake caliper is actuated by a special linear electric motor. The temperature of the wheel-brake disk is measured by a contactless infrared thermometer (pyrometer). Angular speed of the disk is sensed by an inductive sensor, which responds to movement of the disk's clamping screws. The processor unit again processes analog information from the sensors.

Several parts of the test bench are connected together by elastic couplings, which if necessary can be used to couple shafts of different diameters. Alignment of the tested motor and torque meter in the mechanical and electrical part is by means of a height-adjustable central fixture, to which the tested motor is fastened.

4. Control and Display Unit

The control and display unit consists of the graphical monochromatic LCD display and the set of control buttons. The unit is connected to the central CAN bus and receives physical values from the individual parts for display. According to user requirements, the unit sends control commands to the processor unit, which makes appropriate changes. The basic displayed values are – torques from both torque meters, angular speed, temperature of the wheel-disk brake, voltage and current generated by the electric motor in the electrical part of the test bench, etc. The basic parameters for setting are – percent of braking effect for brake caliper, percent of braking effect for electric brake and e.g. settings of the internal protective bonding circuits against overload of individual parts and sensors.

5. Conclusions

The test bench described above is used to perform testing of the mechanical parameters of electrical drives, mainly low and middle power electrically commutated (BLDC) motors. The use of the processor measuring system enables presentation of obtained results in digital form on personal computer or directly on the graphical unit integrated in the test bench. Through the use of the height-adjustable central fixture it is possible to adapt almost any electric drive with compatible dimensions.

During the development work on the control algorithms, several electrically commutated motors by reputable producers, such as Maxon Motor [2], Anaheim Automation [3], Dunkermotor [4], were tested on this stand in UNIS a.s.

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References

[1] Company web pages, division of Mechatronic System. *UNIS, a.s.* http://www.mechsys.cz

[2] Electrical drives producer web pages. *Maxon Motor*. http://www.maxonmotor.com

[3] Electrical drives producer. *Anaheim Automation.* http://www.anaheimautomatiom.com

[4] Electrical drives producer web pages. *Dunkermotoren*. http://www.dunkermotoren.de