

Power Program at Cleveland State University

In 2001, Power Electronics and Electric Machines program was fully developed in electrical and computer engineering department at Cleveland State University. To support newly developed curriculum, state of the art Power Electronics and Electric Machines Laboratory has been established. This effort has been supported by National Science Foundation (award # 0410912), Nasa Glen Research Center and Fenn College of Engineering. The old Electric Machines Laboratory that consisted of line-fed motor generator sets has been completely dismantled and replaced with seven modern test benches.

New Laboratory Workstations

Power Laboratory at Cleveland State University consists of three Lab Volt test benches, four Power Board test benches and four DSPACE test benches.

Lab-Volt Test Benches

The Lab-Volt Power Electronics Training System is a versatile, flexible, modular, and complete teaching system [1]. It consists of all different types of modules including power supplies, power electronics circuits and variable-speed drive modules, AC and DC machines and transformers, wiring cables, control panels, power meters and various measuring instruments [2]. Following a discussion of theoretical concepts in each laboratory exercise, the student is guided through a step-by-step, hands-on exercise procedure to build and operate a real power electronics or electromechanical system with all these modules. Each module has a top-opening bell housing that permits visual inspection of its internal construction. This feature gives students a chance to observe each device thoroughly. The Lab-Volt training system has protection circuit in most modules, which makes it is not only convenient and effective but also essentially safe to work on.



Figure 2 Dr. Stankovic next to the Lab Volt test bench

Power-Pole board Test Benches

The Power-pole boards shown on Fig.3 is a building-block-based power electronics reconfigurable circuit board which contains power-pole circuit as well as on-board isolated drive circuits, PWM generation, fault protection, output filter, and switched load. The corresponding experiments using the power pole board are developed at University of Minnesota [3].

The main feature of the Power-pole Board is the reconfigurable power-pole consisting of two MOSFETs and two diodes. The drive circuits for the MOSFETs are incorporated on the board, and so are the various protection circuits for over current and over voltage. PWM signals to control the MOSFETs can be generated onboard or supplied from an external source. The power-pole can be configured to work in various topologies using three magnetic boards which plug into the Power-pole board. In addition, there is an option of doing frequency analysis of each topology by injecting a small-signal sinusoidal control voltage. The board can also be operated in voltage/current feedback mode using an external control circuit mounted on a daughter board which plugs into the Power-pole board [4].

The experiments related to DC/DC choppers in the lab course are partially adopted from those developed at the University of Minnesota. By using such well-

designed and more industrial-style Power-pole board, students avoid many unnecessary difficulties to get familiar with practical devices and gain more experience.

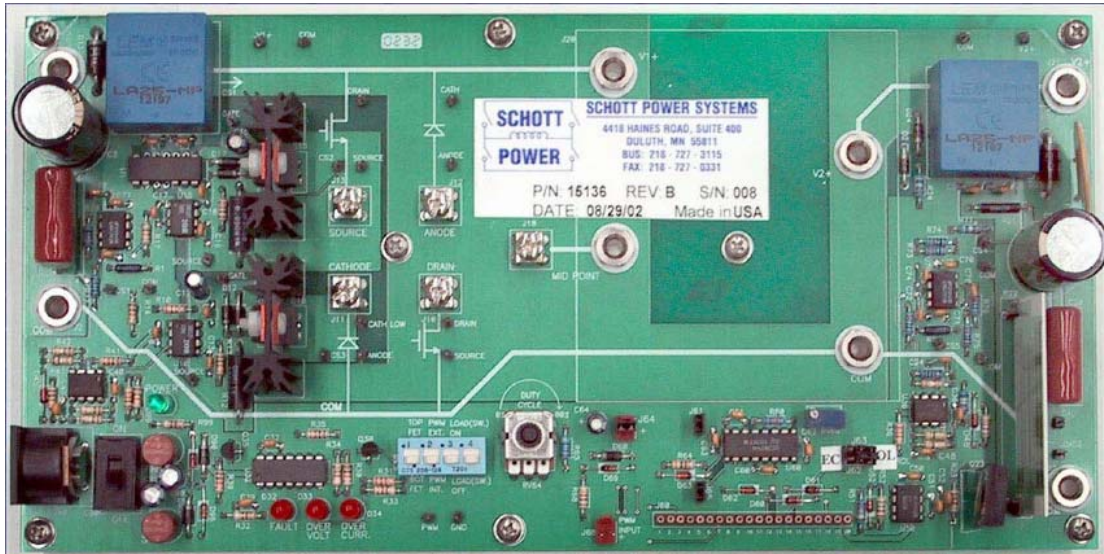


Figure 3 Power Pole Board

DSPACE Test Benches

DSPACE DSP controller board shown on Fig.4 is an interface between the host computer, the driving circuit, and the motor drive system, including PWM inverters, transducers, serial interfaces, sensors, etc. One of the best features of the dSPACE package is the ease of building real-time applications [5]. DSPACE has a software interface to the controller board based on MATLAB-SIMULINK. Since SIMULINK is a block-oriented, graphical interface based simulation package that works within MATLAB environment, students need not to write code at all [6]. Once the model in SIMULINK is completed, DSPACE software can convert it into real-time DSP code. Then it downloads the code to the controller board, and execute the hardware in real-time. DSPACE software also has tools to display, store data, and change parameters.

After the procedure of getting acquainted with SIMULINK, students can build and operate a real-time motor drive system. DSPACE related experiments will allow students to observe and comprehend the operation adjustable speed drives.

Power Laboratory at CSU consists of three DSPACE Test Benches. In addition, all test benches are equipped with Tectronics oscilloscopes, voltage and current probes, power supplies, digital meters etc.

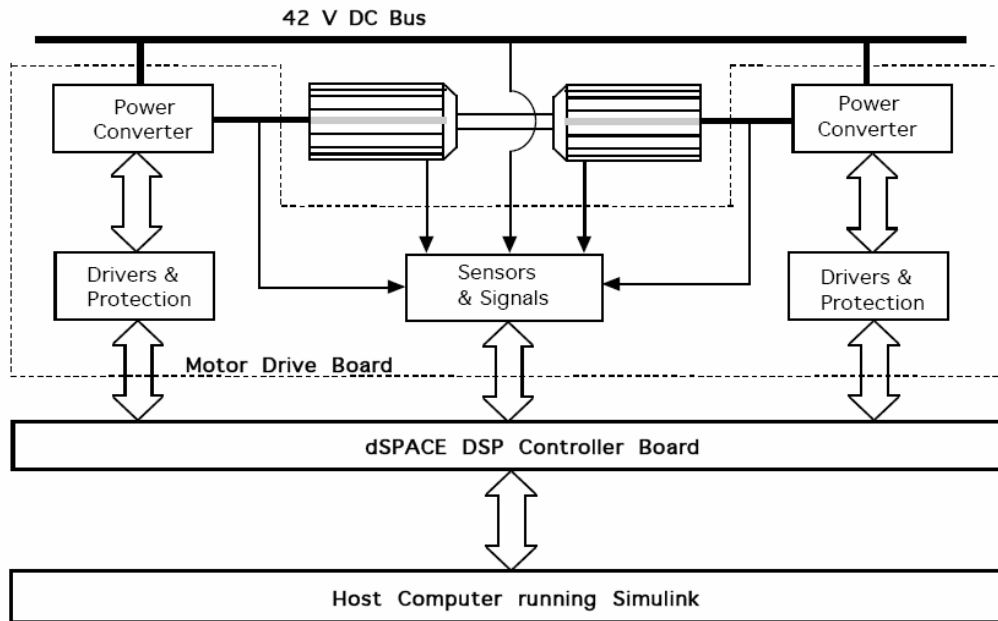


Figure 4

- [1] Lab-Volt Systems, Inc., < <http://www.labvolt.com> >
- [2] Youakim Al Kalaani and Abul K M Azad, "Teaching Electric Machines and Power electronics: Emphasis and challenges," *Proceedings, 2002 ASEE Annual Conference & Exposition, 2002*.
- [3] William Robbins and Ned Mohan, "A Building-Block-Based Power Electronics Instructional Laboratory," in *Proc. IEEE power electron. Spec. Conf.*, vol. 2, Cairns, Australia, 2002, pp. 467-472.
- [4] Department of Electrical and Computer Engineering University of Minnesota, "Power Electronics Laboratory user manual," July. 2004.
- [5] Shuhui Li, "Laboratory Restructuring and Development for the Course of Electric Machinery Using Software and Hardware IT tools," *Proceedings, 2005 ASEE Annual Conference & Exposition, 2005*.
- [6] Ahmed Rubaai, James H. Johnson, Jr. and Donatus Cobbinah, "The New Motors and Controls Laboratory at Howard University," *Proceedings, 2005 ASEE Annual*.