Power Supply Design Project in Electrical Systems Laboratory Course

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Keywords

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Introduction

Engineering Design is an important element of engineering curriculum to prepare future engineers in implementation of engineering design cycle by creating a new product or process to meet a defined need under cost, practicality, and safety constraints. The primary goal is to train the engineers through a 7-step iterative process: (1) understand cost and performance requirements, (2) analyze functions, (3) plan tasks, (4) model and prototype, (5) fabrication, and integration, (6) testing and evaluation, and (7) documenting and reporting progress. To train students in this process, the electrical engineering curriculum includes an Electrical Systems Laboratory as a 2-credit final semester course. A design project is an important element of the course and constitutes 50% of overall grade in the course. The topics include discrete components, integrated circuits (ICs), programmable logic controllers, and LabVIEW for test, measurement, and control.

Methodology

As a first step, students are grouped in teams of 2 to 3 members. Careful consideration is given to ensure diversity in teams with respect to strengths, experience, and background. Considering that power supply (PS) as a standalone integrated system plays a very important role in electronic and embedded systems, the teams are assigned two types of PS design projects with multiple output voltages: a linear PS design with excellent regulation and relatively low-efficiency, and a high-efficiency switching PS design. The student teams design and build a variable and fixed voltage DC power supply utilizing linear and switching voltage regulator ICs and create a LabView based automated test to verify fixed PS parameters. To ensure safety of students and avoid the need to work with 120 VAC, a portable center-tapped fuse-protected step-down transformer is provided to the teams with an output of 15.2 VAC (RMS). The teams are given a set of requirements for both designs. The requirements include project objectives, laboratory parts and equipment available for the project, PS specifications as inputs and outputs, design verification parameters in terms of output voltage, load regulation, LED status indicators, details of automated test station utilizing LabVIEW, and project report and presentation details along with rubrics. The student teams go over the requirement documents and present the SRR which demonstrates their complete and proper understanding of system requirements. The student teams also learn soldering theory and training which prepares them for building of prototype PS. The students develop skills in the use of Autodesk EAGLE, PSpice, and ExpressPCB to create the circuit schematic and circuit board design layout. The teams build the circuit on breadboards to verify the design meets the load

regulation requirements. After the creation of the power supply design, the board is produced with the CNC PCB Milling Machine. The teams transfer the design to the PCB by soldering the components per the PCB layout. The teams install the PCBs into a 3D printed boxes with switches to control the DC voltage outputs and LED indicator lights.

The student teams work with NI USB 6009 Data Acquisition (DAQ) System to create a testing environment for the PS outputs. The block diagrams use two DAQ Assistant blocks to collect the data from the power supply, calculate the load regulation, and display the results. A two-member faculty team assesses the quality of student design output through laboratory testing of the PS, team presentation of the project including deficiencies, and a written narrative of the project activities and outcomes.

Conclusion

The students appreciate the opportunity to go over PS design project during the course. They learn valuable skills that help them find suitable career opportunities during the final semester. Sample student comments include: “The design of the power supply was very helpful. We hope to use this information at our future jobs”, and “The project provided me with hands-on experience to apply my knowledge”. To improve the project, student also suggested to have more time for it, access to laboratory after hours, and more practice with LabVIEW.

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