Compact Resistive Load Bank Assembly

ELECOMP Capstone Design Project 2026-2027

Sponsoring Entity:

Naval Undersea Warfare Center (NUWC) Division Newport
1176 Howell Street, Newport, RI 02841
https://www.navsea.navy.mil/Home/Warfare-Centers/NUWC-Newport/

Entity Overview:

The Naval Undersea Warfare Center (NUWC) Division Newport, headquartered in Newport, Rhode Island, is the Navy's full-spectrum research, development, test and evaluation, engineering, and fleet support center for submarines, autonomous underwater systems, and offensive and defensive undersea weapon systems. Division Newport is responsible, cradle to grave, for all aspects of systems under its charter, engaged in efforts ranging from fundamental research to the support of evolving operational capabilities in the U.S. Navy fleet.

NUWC Division Newport is the oldest warfare center in the country, tracing its heritage to the Naval Torpedo Station established on Goat Island in Newport Harbor in 1869. Today its scientific and engineering staff of approximately 3,000 makes it one of the largest employers in Rhode Island, providing expertise in science and technology, technical direction, and system design, development, test, and evaluation in support of undersea superiority.

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Project Description Submitted by NUWC Technical Director:

Load banks, which simulate an electrical load on a power source, are important pieces of test equipment used for verifying the performance of power supplies and other high-power circuitry. They are vital to ensuring power circuitry can drive its designed load prior to use. However, many load banks are large, heavy, and take up significant room in space-constrained laboratories. Owing to their simple design, many are also not equipped with monitoring features that allow insight into their internal temperature and power dissipation.

A compact resistive load bank system will be a versatile tool that allows laboratory staff to verify the performance of power circuitry as well as allow product designers access to a valuable tool for prototyping new systems. This concept combines a standard resistive load bank design with display, monitoring, and safety features in addition to compact packaging. These new features will be important for allowing users to monitor the performance of this system and ensure that it is always operating within its design boundaries. A compact package will allow laboratory staff to store and deploy this system without sacrificing floor space in their facilities.

This system would be composed of two components:

1. An enclosure that integrates the resistive loads, cooling and thermal management subsystems, user display, and electronics package into a compact system.
2. An electronics package to implement user interface, control, sensing, and safety features.

Project Requirements / Technological Challenges:

1. Design a compact load bank enclosure capable of dissipating the heat generated by a set of resistive loads energized by a single input voltage.
2. Perform thermal analysis to inform design of enclosure, heatsink, and cooling systems.
3. Package all required modules and subsystems in a compact enclosure.
4. Implement multiple user-selectable load profiles per load bank system.
5. Design an electronics package to implement the following features:
    - Cooling, safety features, user interface, monitoring of input voltage, input current, and internal temperature.
6. Create a user interface to:
    - Select the desired load value in watts.
    - Display the current, voltage, and power dissipation of the load bank.
    - Display the current temperature inside the load bank. ? Configure setpoints used for safety features.
7. Implement user and system safety features, such as protections against:
    - Overcurrent, overvoltage, overheating, and reverse polarity.

Further Details Provided by Consulting Technical Directors:

Professor Yeonho Jeong and Mike Smith

Anticipated Best Outcomes:

The expected outcome of this project is the development of a functional prototype of a compact resistive load bank consisting of four main components: 1) resistive loads, 2) a forcedair cooling system, 3) sensors, and 4) a controller. The prototype will be designed to meet a wide range of electrical specifications and required dynamic responses while satisfying the associated thermal and environmental requirements across the specified operating conditions.

Detailed design requirements, including the voltage range, slew rate, maximum allowable component temperature, and other electrical, thermal, and environmental specifications, will be provided during the early stage of the project.

Project Details:

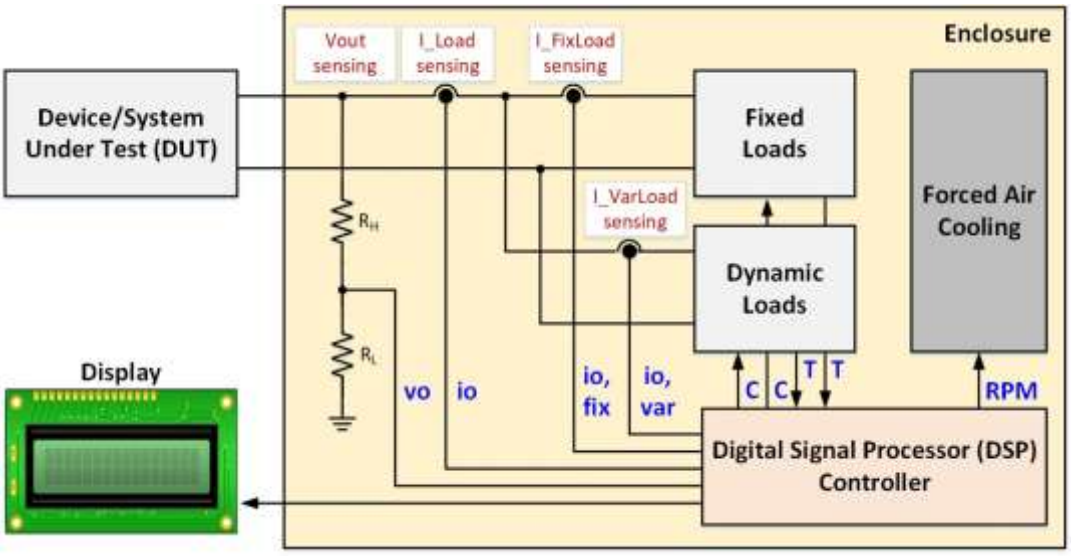

Figure 1. Overall framework of resistive load bank system.

The resistive load bank framework is presented in Fig. 1. The major hardware and software development tasks are summarized below:

[Hardware Tasks]

- Select and size input terminals, wire gauges, and resistive elements based on the target voltage, current, and power ratings.
- Design fixed and dynamic load circuits, including switching devices, fuses/breakers, and protection components.
- Design and integrate voltage, current, and temperature sensing circuits.
- Design and fabricate the enclosure with appropriate ventilation and a forced-air cooling system.
- Assemble and bench-test each load stage individually prior to full system integration, followed by comprehensive system-level evaluation.

[Software Tasks]

- Develop and program the DSP-based controller, including ADC configuration, protection functions, and load-control logic.
- Implement real-time monitoring, basic display, and data logging, including load conditions and temperature through an LCD or serial interface.

Composition of Team:

Two Electrical Engineers. (One should have the skills needed for the software tasks; preference given)

Skills Required:

Electrical/Computer Engineering Skills Required:

- Electrical fundamentals (Ohm's Law, series/parallel, power calculation.)
- Thermal management and cooling method (fans and heatsink)
- Resistive elements and switching/staging (relays/contactors)
- Sensing & safety, such as current sensing, temperature sensing, correct wire gauge, fuse/breaker protection, grounding/insulation
- Hands-on skills in electrical circuit assembly and testing
- Knowledge of using lab equipment, such as oscilloscopes, DC supplies, & E-loads.

AI Usage:

AI usage guidance for this project will be provided verbally by the Technical Directors during your first meeting.