Gen-2 SPEC

Gen-2 SPEC Tester (System Power Extended Cycling)

ELECOMP Capstone Design Project 2017-2018

Sponsoring Company:

Infineon Technologies Americas Corp.
Rhode Island Design Center
200 Crossings Blvd, Suite 100
Warwick, RI 02886
https://www.infineon.com

Company Overview:

We make life easier, safer and greener

Infineon Technologies is a global leader in semiconductor solutions with worldwide headquarters located in Neubiberg, Germany, near Munich. Infineon Technologies Americas is headquartered in El Segundo, CA, near Los Angeles. Infineon Technologies reported sales of about €6.5 billion in 2017, and has 36,300 employees worldwide.

Semiconductor and system solutions from Infineon contribute to a better future – making our world easier, safer and greener. These tiny, barely visible electronic components have become an indispensable part of our daily lives.

Infineon acquired the Rhode Island design center with the purchase of International Rectifier in 2015. The Rhode Island design center opened in 2001 and has since been developing power management digital controller ICs, integrated power stages and point-of-load solutions. These products power high performance and artificial intelligence servers, internet datacenter and network backbones, high end desktops, laptops, graphics, gaming computers, and cellular telecommunication systems. Our local team of 35 engineers and technicians solve Power Electronic system needs for the world's most advanced microprocessors, GPUs and ASICs.

Technical Directors:

Denis Galipeau, MSEE, PMP (URI College of Engineering Class of 1988)
Senior Staff Engineer, Product Engineering
denis.galipeau@infineon.com
www.linkedin.com/in/denis-galipeau-msee-pmp-95b2b211

Mark Rodrigues (URI College of Engineering Class of 2010)
Senior Staff Engineer, Applications Engineering
Mark.Rodrigues@infineon.com
https://www.linkedin.com/in/mark-rodrigues-8b0b8625/

Project Motivation:

As Infineon continues to drive advancements in Power Electronics efficiencies and power densities, we need to ensure these state-of-the-art devices can withstand the test of time without degradation or failure. For example, our 5x6 mm Powerstage devices can provide 100 A dc, powering high performance computer and artificial intelligence processors with up to 800 A dc when paralleled with our Digital Multiphase controllers. Our products are used in ultra-reliable server systems which are the backbone of our financial, internet and mission-critical infrastructures.

Our project goal is to create a flexible 2nd Generation long term reliability test system to ensure we provide the world's most robust power conversion systems. We would like to define, develop and validate a test system with a team of talented EE and CE students to increase system flexibility and capabilities.

All project work will be carried out at the Infineon Rhode Island Design Center in Warwick, RI. Students interested in the project must have a means of transportation to and from the facility.

Anticipated Best Outcome:

A functional system able to test 60 individual voltage converters under 100 A dc load transients. Thermal management, fan control, transient load control, and complete system telemetry for all 60 devices will be managed in 6 individual "neighborhoods". Each neighborhood will consolidate telemetry and transfer to a local system terminal where data will be processed. The common terminal will be able to manage system faults, set system environments such as supply voltages, loads, switching frequencies, output voltages and thermal management settings.

Project Details:

A second generation long- term system reliability tester will be designed and developed to enable the testing of various voltage regulator systems. The main focus of this new Capstone effort is to upgrade the 6x mainboards with increased flexibility through improved telemetry management, monitoring and control. An onboard microcontroller or other processing system is envisioned to manage the local neighborhood. The 6x mainboards will interface with a rack terminal laptop connected to an internal network for remote monitoring and data transfers.

Much of the following hardware description is reuse of our Gen-1 system which supports up to 60 individually controlled and monitored voltage regulators under loads up to 100 A each. The system will be housed in a standard 42U server rack and will include

- 6x 1000 W remotely adjustable dc-dc power supplies,
- 2x triple output dc-dc power supplies which will also be remotely controlled,
- 6x 36-channel data acquisition systems with telemetry,
- 60x electronic loads capable of static and transient loading up to 100 A. Onboard fan control, temperature telemetry, fault detection/communication/management may be improved in this project.
- 6x main "neighborhood" boards which will act as the main interface for 10x systems under test. Each mainboard will accommodate 10 channels of the following:
    - E-fuse isolation of a faulty channel
    - Flexible Controller Device Under Test (DUT) card
    - Flexible Powerstage or Point of Load (POL) DUT card
    - Accurate current sensing (<0.5% if possible)
    - DUT fan with control
    - Programmable 100 A transient/dc load with onboard fan and control

Figure 1: Front View of test system rack. 6 main boards will be mounted to the front for easy DUT (device under test) accesibilty. Test equiment such as dc-dc supplies and data acquisition equipment will be mounted in the rear.

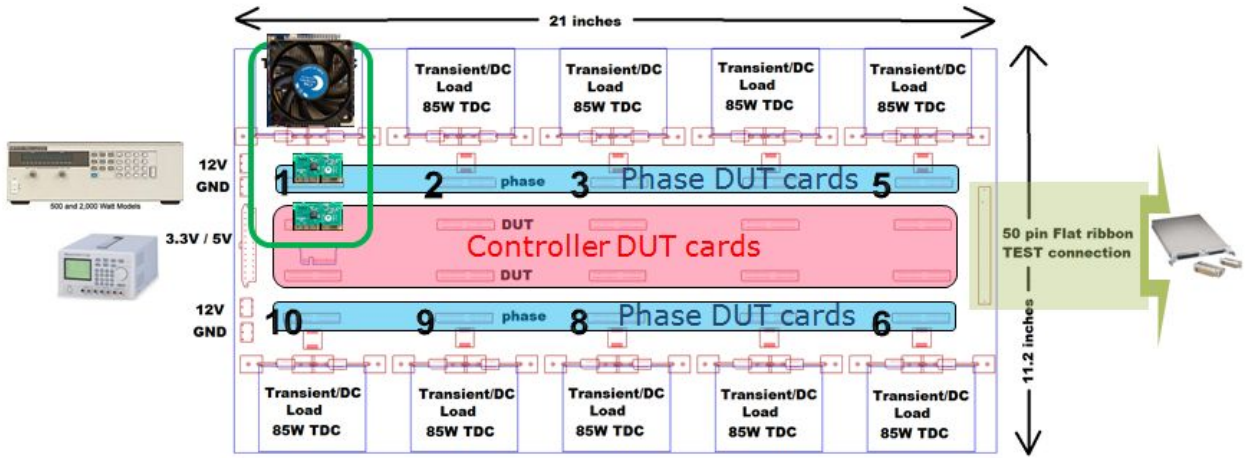

Figure 2: One of six main "neighborhood" boards. Concept showing load, phase DUT, voltage regulator controller at voltage regulator site #1. 10 voltage regulator systems can be tested on one main board.

Hardware/Electrical Tasks:

The hardware goal of this project is the addition of an onboard microcontroller or other processing system to manage the local mainboard "neighborhood".

- Manage telemetry data consolidation
  - There are 60+ I2C devices to control and read.
  - Desire local main board management of all I2C based telemetry including currents, voltages, temps, faults
- Manage local thermal management of fans
  - closed loop control of DUT temp and load temps to achieve equal temperatures across all 10 DUT
  - Manage average fan speeds to match between six different mainboards
- Manage local power supply, channel enabling/disabling, and load control
  - Support different cycling modes for input power, channel enabling/disabling under various loads
  - Manage independent system tests such as per-channel efficiency sweeps, current sense accuracy sweeps
- Fault management
  - Manage boundary conditions to isolate a bad channel and report faults to systems.
  - Enable email or text alerts of system issues.

Firmware/Software/Computer Tasks:

- GUI control of mainboard
  - Create a flexible environment for different DUT tests and different types of tests
    - Long term reliability environments
    - Transient and static load environments
    - Power cycling
    - Efficiency testing
    - Trim correlation
    - Target DUT: Power stage, Point-of-Load, µPOL, µPhase and Digital Controllers
  - Control, settings, data collection and selection
  - Manage output telemetry files for easier post processing.
  - Ensure ease of software modifications after the project is completed for added system reconfiguration flexibility.
  - Allow system fault alert reporting via email or text.

Composition of Team:

3 Electrical Engineers and 2 Computer Engineers.
(In addition: The 2 Infineon Technical Directors are backed by 20+ Warwick based resources including PCB Designers, Design Engineers, Applications Engineers, Test Engineers and Technicians)

Skills Required:

Electrical Engineering Skills Required:

- Switch-Mode Power Conversion
- Analog (Linear) and Digital Control Systems
- Microprocessors

Computer Engineering Skills Required:

- Analog (Linear) and Digital Control Systems
- Graphical Interface architecture and data management
- Application creation

Anticipated Best Outcome's Impact on Company's Business:

Deployment of a more flexible test system will ensure product robustness and reduction of field issues. A successful system will be reproduced and distributed to sites worldwide to enable other Infineon groups to extensively validate their products.

Broader Implications of the Best Outcome on the Company's Industry:

Our Warwick, RI team is also interested in engaging with the University of Rhode Island professors and students to build a strong and local talent base in support of our switch-mode power electronics development activities. Skills required by our team include

- Power Electronics Applications Engineering,
- Analog and Digital IC Design Engineering, and
- Test Automation Engineering.

Infineon Technologies is not alone; Rhode Island has a very strong and competitive Power Semiconductor industry including companies such as ON/Fairchild Semiconductor, Texas Instruments, IDT and the PICOR Corporation who would benefit from URI-based Power Electronics curriculum.