School of Computing and Electrical Engineering, Indian Institute of Technology Mandi

Advanced Power Laboratory

The Advanced Power Laboratory, supported majorly by **Department of Science and Technology-Fund for Improvement of S&T Infrastructure ((DST-FIST), New Delhi**. The facility is located in the Stable Complex at IIT Mandi. Following facilities are created:

- Real-time Digital Simulation
- Smart Energy Test Bed
- Wind Turbine with Hardware-in-loop

The facility is being/will be utilized by the researchers, students, Faculty members and some of the industries to carry out research related to operation of the various power and control systems and equipments in a real time simulated environment.

Experts Involved:

- **Dr. Bharat Singh Rajpurohit**, bsr@iitmandi.ac.in, **Specialisation**: Power Electronics Application to Power Systems
- **Dr. Pratim Kundu**, pratim@iitmandi.ac.in, **Specialisation**: Power systems protection, Wide Area Measurement Systems (WAMS)
- **Dr. Narsa Reddy,** tummru@iitmandi.ac.in, Specialisation: Hybrid Energy Storage Applications in Future Microgrids, Efficient Power Ec. Interfaces in Renewable Energy App.
- **Dr. Himanshu Misra**, himanshumisra@iitmandi.ac.in, Electric Drives & Control, DC Microgrid, E. Machines
- **Dr. Moumita Das**, moumita@iitmandi.ac.in , Application of Wide Bandgap Devices, EVs.
- **Dr. Amit Singha,** amit@iitmandi.ac.in, Control Systems, DC-DC Converters.
- **Dr. Samar**, samar@iitmandi.ac.in, **Specialisation:** smart grid communication, information theory.
- **Prof. Ramesh Oruganti**, ramesho@iitmandi.ac.in, **Specialisation**: Power Electronics, Solar photovoltaic energy systems

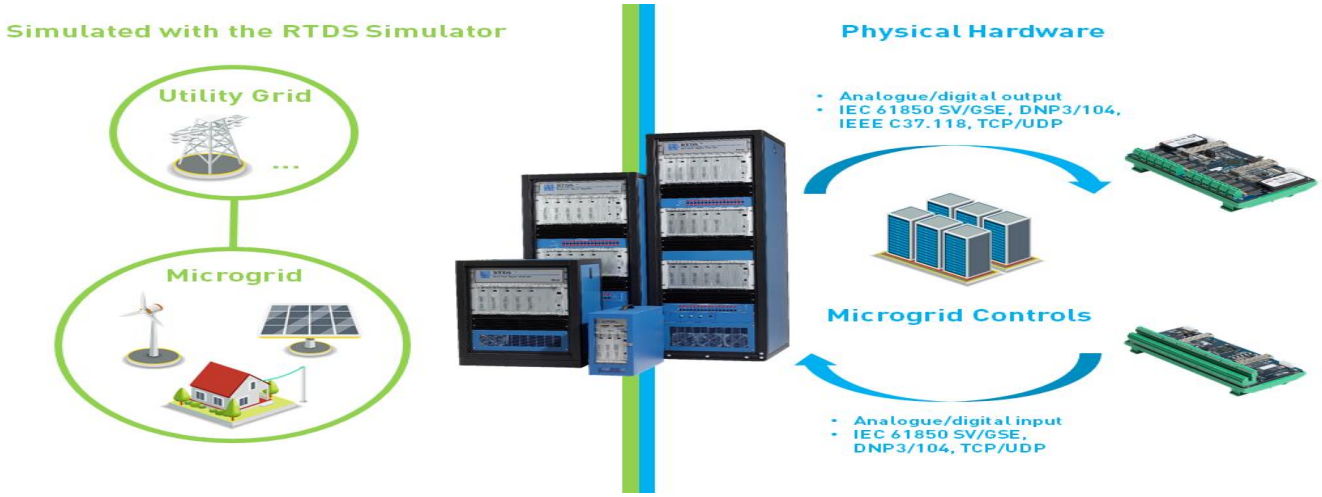
REAL-TIME DIGITAL SIMULATION

The real time digital simulation lab is setup to perform development, validation and testing operations for the various power and control models and the hardware equipments. In the Lab, the RTDS has been integrated with the hardware equipments such as amplifiers, relays, converters, electric drives, etc.

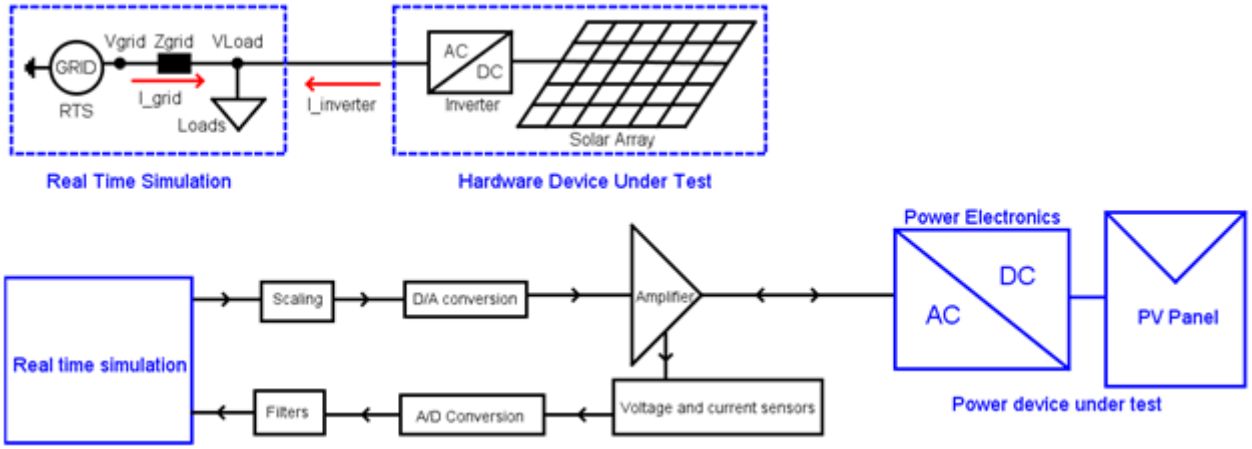
The real time digital simulation facility is equipped with 1 racks of Real Time Digital Simulator (RTDS) System procured from RTDS Technologies, Canada. Each rack of RTDS consists of a number of parallel processing cards, including cards for running the simulation as well as inter-rack communications (IRC), workstation interface (WIF), and the I/O cards. The PB5 processor card is the latest generation of processor card developed for RTDS. Each PB5 has two PowerPC RISC processors operating at a clock frequency of 1.7 GHZ. The PB5 has eight Gigabyte Trans receiver (GT) fibre ports. Two GT ports are reserved for connecting to the I/O and the other six ports can be used to communicate directly to other PB5 cards. The increased number of ports simplifies the modelling of large scale systems using small timestamp sub-networks.

The RTDS is also equipped with the GTSYNC and GTNET-PMU cards. The GTSYNC card is used to connect GPS clock to the RTDS for time synchronization of the RTDS with the GPS clock. The GTNET-PMU card is used to connect the software PMUs of the RTDS to the Phasor Data Concentrators (PDC) by implementing IEEEC37.118-2011 protocol.

The lab facility is also equipped with one amplifier (Omicron CMS 356), few converters from SEMIKRON and few electric drives to support the real time simulation process.



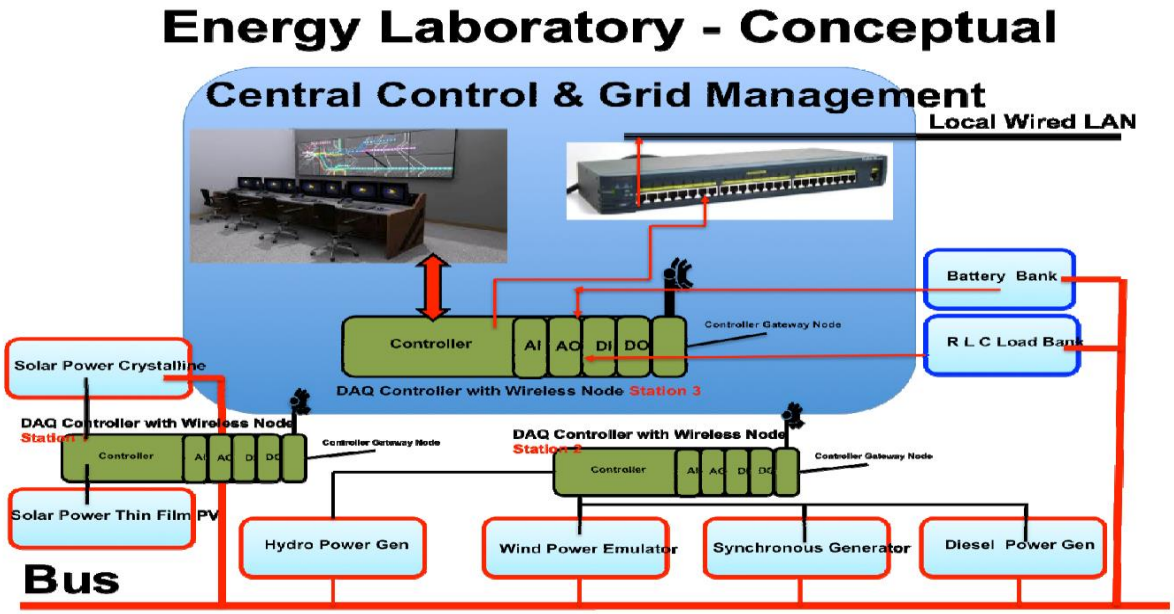
Microgrid Simulation and Testing, courtesy RTDS™ Technologies



PHIL Interface between a RTDS and a Device Under Test (Inverter) , courtesy RTDS™ Technologies

SMART ENERGY TEST BED

The smart energy test bed provides facility to analyse integration of conventional and renewable sources together with smart controller for smart operation and smart control of the power system network.



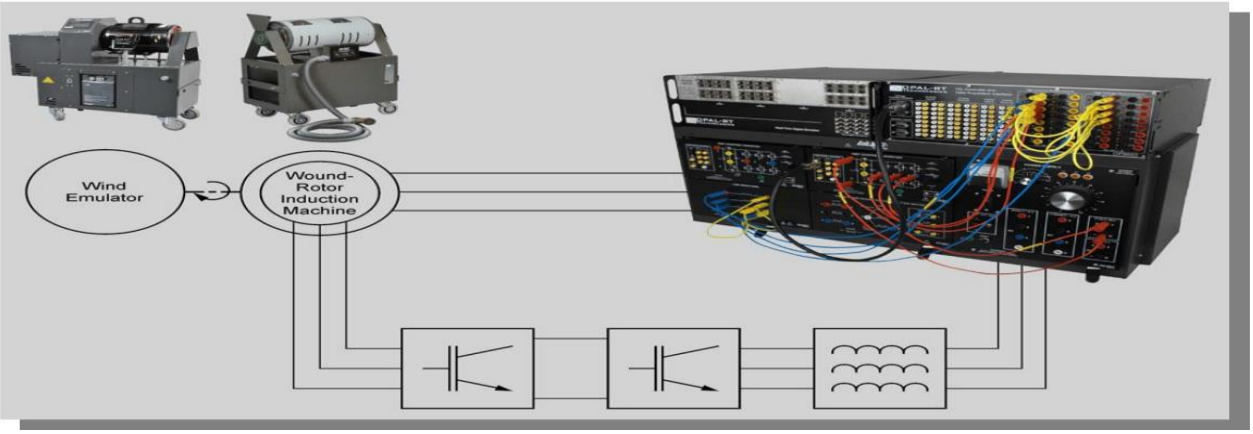
Test bed includes:

- Solar power generation by mono polycrystalline solar panel (2kW) and thin film silicon hybrid solar panel (2kW)
- Hydro power generation with 3.5kW series centrifugal pump working as turbine
- A 2 kWwind turbine emulator with variable frequency drive
- Diesel generator system of 5kVA and Battery bank
- Synchronous generator of 2kW
- Controllable & variable loads (R,L,C)

Integrated Smart Energy Test Bed is controlled centrally/remotely to create different scenarios in real-time by wired/wireless communication channels. To operate in real time, a GPS module is connected to each controller and data acquisition system.

WIND TURBINE WITH HARDWARE-IN-LOOP

- 2-kw DFIG Laboratory kit from LABVOLT, USA consists of (2kW wound motor, 2× IGBT Module, Four Quadrant Dynamometer of Speed Range = 0 to 3000 rpm & Nominal Torque Range = 0 to 12.18 N•m) and, Opal-RT OP4500 HIL Controller & Interface (8 high current (15 A channels) and 8 high voltage (500 V) Channels)



Opal-RT simulators can easily be interfaced with actual control and protection system equipment using commercial voltage and power amplifiers to conduct traditional HIL simulation and testing. Furthermore, sub-microsecond FPGA models can be integrated with power interfaces to emulate complex power equipment in real-time, enabling testing of control algorithms, as well as fast protection systems and power electronic component power handling capabilities.

Domains: microgrids, windfarms, active power filters, converter control for electric drives applications
Typical use case: Rapid Control Prototyping & HIL for power electronics control

Future Research Works

- Micro-grids
- Advanced Electric Drives
- Power Quality Analysis
- E-mobility
- Hardware in the loop (HIL) and Software in loop (SIL) testing

Contact:
Dr. Bharat Singh Rajpurohit,
Program Coordinator and Associate Professor,
School of Computing and Electrical Engineering,
Indian Institute of Technology Mandi
bsr@iitmandi.ac.in, 01905-267046, 088954580096, Fax: 1905-267009