Inteligent Electric Network Laboratory

System Definitions

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International collaboration

Support:

"The opinions, hypotheses and conclusions or recommendations expressed in this material are the responsibility of the author (s) and do not necessarily reflect the vision of FAPESP".
Main Research Areas

1. Shared and multifunctional use of Power Electronics Converters;
   - Ensure stable operation for static and dynamic operation.

2. Identification of loads and sources;
   - Enable comparison of Synchronverter (no communication network) and Power Based Control (based on data communication between converters).

3. Development of photovoltaic and battery converters;
   - Analysis of grid forming systems and anti-islanding.

4. Energy quality and high frequency distortion;
   - Study the impact of high frequency on output filters of converters and interference on communication systems.

5. System communication and data aggregation;
   - Development of communication systems for the distributed operation of energy resources.
Hardware Resources

Battery
HEV
Elec. Load

PV system.

Electronic Load

AC Load and DC sources emulators

Regenerative grid simulator (100 kVA)

Transformer

High Freq. power supply
Microgrid Topology
Intelligent Platform Concept

Platform Overview

❖ Connected distributed Energy Resources;

❖ IP protocol and open standards-based publish-subscribe messaging (P2P) network;

❖ Enable third-party applications via standard APIs;

❖ Data aggregation;

❖ Monitoring and event Control;

❖ Security functions.
General topology

Allow reconfiguration;
Voltage and current data acquisition from all busses;
Data / log storage;
External access.
Data Network Diagram

Network priority:

1. Protection;
2. Equipments control and status;
3. Data acquisition;
4. User equipment control;
5. User access;
   a. Local
   b. Remote
Emulation flux validation

Characteristics:

Code validation and compilation check;

Fault protection -> disable system.
FPGA / DSP Control Board

Board characteristics:
1. Suitable for both sbRIO and DSP applications;
2. Enable 16x channels for ADC;
3. Control of 12x inverter arms;
4. 4x relay controls;
5. 5x manual inputs;
6. 4x DAC debug output (8x in sbRIO).
High Frequency Inverter

1. 4x inverter leg in a modular 2x2 leg topology;
2. Isolated driver for Mosfets or SiC devices;
3. Parallel setup for semiconductors;
4. Overvoltage, overcurrent and overtemperature protection;
5. EMI conduction optimization;
6. Ultra compact power supply;
7. Logic board for interlock and dead time.
Photovoltaic and battery converters

Board characteristics:
1. 500W, ~80% efficiency photovoltaic micro inverter;
2. High Step-up Isolated interleaved DC/DC converter;
3. 3 level DC/AC converter with LCL output filter;
4. Integrated DSP, signal acquisition, PV controls, hardware protection and EMI filter;
5. Low cost (~ 100$) BOM.
Smart Meter Project

Board characteristics:
1. Low cost BeagleBone Black based smart meter;
2. 4x voltage and 3x non intrusive current measurement;
3. 16-Bit, 500-kSPS, 8-Channel ADC;
4. PRU based signal acquisition and processing;
5. Decentralized P2P XML data communication.