



Technologies for ToT & Power Electronics Test Facility

under NaMPET-II

CDAC, Thiruvananthapuram



OUTLINE

- Technologies for ToT
- Power Electronics Test Facility (PETF)

Technology Developed

1. Miniature Model of Full Spectrum Simulator for Power Electronics & Power Systems
2. Full Spectrum Simulator for Power Electronics & Power Systems
3. High Speed Reconfigurable Power Electronics Controller
4. 400 Hz Inverters for Airborne Applications
5. Non - Linear Load
6. Medical Electrical Safety Analyser
7. Grid Interactive Solar Photo Voltaic System
8. ON Line Double conversion UPS System for Medium / High Capacity range
9. Single-Phase STATCOM
10. DC-DC converter for SPV applications

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Miniature Model of Full Spectrum Simulator for Power Electronics & Power Systems

- Indigenously developed
- Consists of two 19" rack systems – Processing & I/O interfaces
- Provides both off-line and real-time simulation capabilities at an affordable cost
- easily configurable for custom applications
- HIL feature for PE & PS with simulation environment in SEQUEL



Miniature Model of Full Spectrum Simulator for Power Electronics & Power Systems



- GUI for circuit development
- Analog & Digital I/O for HIL are integrated to effectively utilize simulation to optimize the systems under development
- Extensive libraries for PE & PS are built-in
- Users can incorporate new circuit elements
- Development implemented under NaMPET through Institute – R&D interaction by CDAC & IITs



Miniature Model of Full Spectrum Simulator for Power Electronics & Power Systems

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Full Spectrum Simulator for Power Electronics & Power Systems



- Cost effective simulator for offline, real time & hardware-in-loop(HIL) simulation for PE & PS
- SEQUEL/MATLAB Simulink for offline simulation
- Analog/Digital I/O for HIL simulation
- Time compensation hardware for external PWM signals
- GUI for real-time simulator

Full Spectrum Simulator for Power Electronics & Power Systems



- TI DSP based low cost hardware
- C language based real-time software environment



Full Spectrum Simulator for Power Electronics & Power Systems

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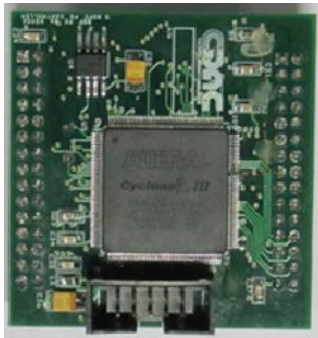
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Technology Developed

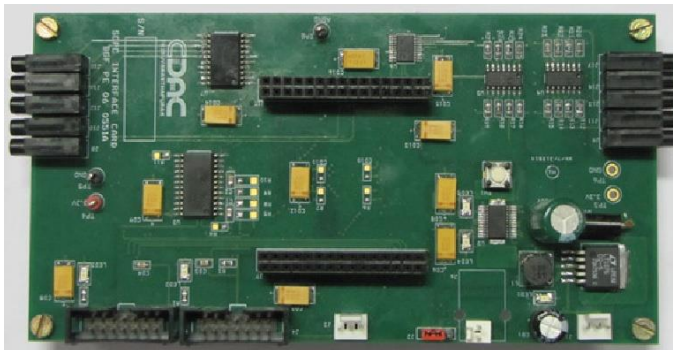
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High Speed Reconfigurable Power Electronics Controller

Controller Card



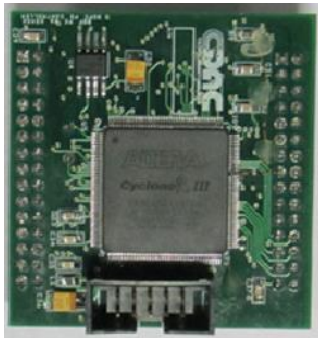
Interface Card



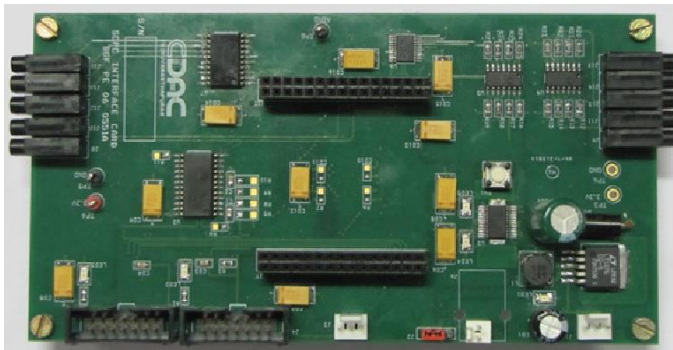
- Reconfigurable controller architecture [on FPGA] that can replace the conventional embedded microcontroller / DSP based controller
- Soft processor integrated reconfigurable PE controller
- Based on SOPC design methodology
- Eclipse based software development environment
- Custom made instructions / functions

High Speed Reconfigurable Power Electronics Controller

Controller Card



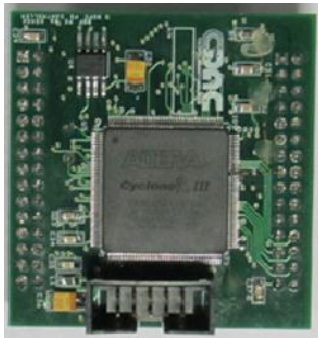
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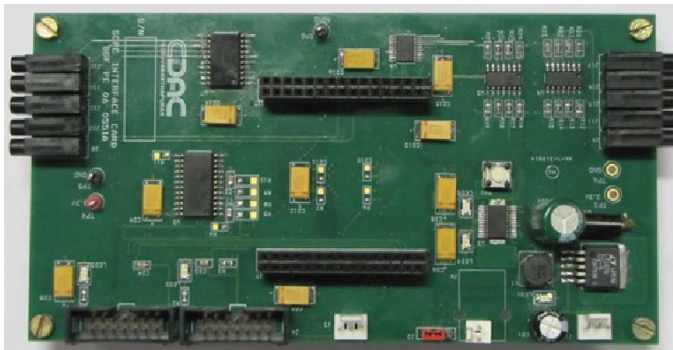
- Exclusive PE library provides PE specific IPs – PWM generator, PI controller, ADC controller, DAC controller etc
- Explores the idea of hardware parallel processing than software pipelining
- Custom made instructions / functions

High Speed Reconfigurable Power Electronics Controller

Controller Card



Interface Card



- Targeted Applications of Interface Card:
 - DC-DC converter control & Solar SPV MPPT control
 - Inverter control for AC drive applications

High Speed Reconfigurable Power Electronics Controller

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400 Hz Inverters for Airborne Applications

Single-Phase Inverter



- Ideal for mission critical on-board airborne applications
- 400 Hz single-phase / three-phase output
- Suitable for low capacity applications
- Superior performance compared to conventional rotary inverters

Three-Phase Inverter



- High efficiency & stringent frequency regulation
- MOSFET based full-bridge inverter
- FPGA based controller
- Short circuit protection



400 Hz Inverters for Airborne Applications

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Non - Linear Load



- For testing of UPS, inverter etc
- Comprises parallel combination of rectifier modules
- Load can be configured for 1 Φ & 3 Φ operation in steps of 0.5, 1, 2 and 5 kVA
- Thermostat protection when cooling system fails
- Protection against short circuit, over-current, over-voltage & over-temperature
- Emergency stop facility

Non - Linear Load



- Alarm indication during fault condition
- Hand-held remote panel operation
- Switch-on status for each step load
- Digital meter for measuring important test parameters



Non - Linear Load

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Medical Electrical Safety Analyser



- Electro-medical equipment used for diagnosis or treatment
- Based on International standard IEC 62353
- 22000 counts measurement
- USB & Bluetooth interfaces
- Graphical LCD / Keypad interfaces
- Windows / Linux compatible GUI
- Testing of medical electrical equipment following routine maintenance
- Electrical safety compliance testing of medical electrical equipment



Medical Electrical Safety Analyser

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Grid Interactive Solar Photo Voltaic System



- Consists of PE interface made of 3 Φ grid interactive inverter modules with capability of exporting power to grid
- Power extraction with MPPT of SPV system
- Reduced ITHD
- Anti-islanding protection
- Power rating: 10kW \times 3
- Control: DSP-FPGA based digital controller
- Inverter: IGBT based



Grid Interactive Solar Photo Voltaic System

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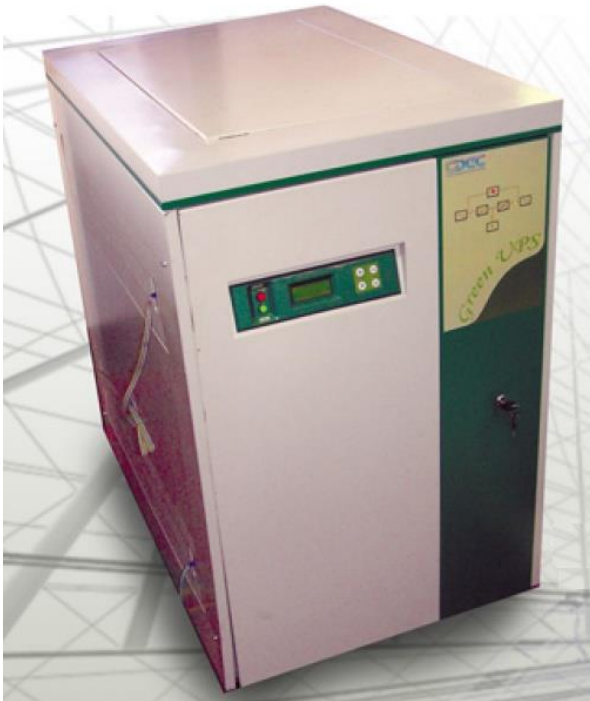
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ON Line Double conversion UPS System for Medium / High Capacity range



- Double conversion on-line design philosophy
- 3 Φ input - 3 Φ output
- Input p.f near unity
- Controlled I/P current harmonics
- High overall efficiency
- Superior dynamic response less than 5 ms
- DSP based controller
- IGBT/IPM based power modules
- LCD display
- Optional paralleling, RS232C, TCP/IP



ON Line Double conversion UPS System for Medium / High Capacity range

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Static Compensators (STATCOM)

- Single Phase
- 3 Phase 3 Wire
- 3 Phase 4 Wire

Static Compensators (STATCOM)

Single Phase STATCOM



- Rating: 5A @ 230V, 50 Hz AC input
- Configuration: Single Phase, full bridge IPM/IGBT PWM controlled inverter
- Switching frequency: 10 kHz
- Control : Using DSP based digital controller
- Cooling: Forced air cooling
- Protections : Over current, short circuit, over voltage(AC/DC), over temperature

Static Compensators (STATCOM)

3 Phase 3 Wire STATCOM



- Rating(typical): 500 kVA, 415V 3 Phase, 3 Wire
- Configuration: 3 Phase, full bridge IGBT PWM controlled inverter
- Switching frequency: 10 kHz
- Control: Using DSP/FPGA based digital controller
- Cooling: Forced air cooling
- Panel fabrication : Suitable for indoor deployment
- User interface : Graphic LCD and Keypad

Static Compensators (STATCOM)

3 Phase 3 Wire STATCOM



- Protections: Over current, short circuit, over voltage(AC/DC), over temperature
- Functions:
 - Reactive power compensation upto 250 kVAR to maintain grid side PF
 - Harmonic current compensation as per IEEE 519-1992 standard within the current rating of the STATCOM

Static Compensators (STATCOM)

3 Phase 4 Wire STATCOM



- Rating(typical) : 500 kVA, 415V 3 Phase, 4 Wire
- Configuration: 3 Phase, 4 leg IGBT PWM controlled inverter
- Switching frequency: 10 kHz
- Control: Using DSP/FPGA based digital controller
- Cooling: Forced air cooling
- Panel fabrication: Suitable for indoor deployment
- User interface : Graphic LCD and Keypad

Static Compensators (STATCOM)

3 Phase 4 Wire STATCOM



- Protections: Over current, short circuit, over voltage(AC/DC), over temperature
- Functions :
 - Reactive power compensation upto 250 kVAr to maintain grid side PF
 - Harmonic current compensation as per IEEE 519-1992 standard within the current rating of the STATCOM
 - Unbalance current compensation
 - Neutral current compensation

Static Compensators (STATCOM)

- Applications:
 - For limiting THD in 1 Φ non-linear loads
 - For improved power factor



Static Compensators (STATCOM)

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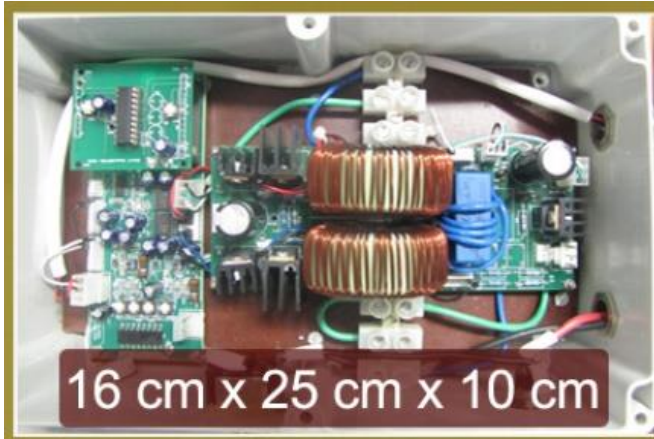
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DC-DC Converter for SPV Applications



- Interleaved boost converter
- Energy management system to provide uninterrupted power supply to the DC loads
- Self-sufficient in generation with bare minimum consumption from the grid



- **Specifications**

Input : 35 - 45V

Output : 60V, 200W

Battery : 60V, 48AH

PV module : 200W,

V_{mpp} 35.5V, I_{mpp} 7.6A



OUTLINE

- Technologies for ToT
- Power Electronics Test Facility

Power Electronics Test Facility

- Technology Transfer Centre, Vellayambalam
- Green Power Lab, Technopark Campus

Technology Transfer Centre (Vellayambalam)



- 250 kVA Test bay for testing the Proto models with maximum rating of 250 kVA
- 100 kW Test bay for testing of DC units of maximum rating 100 kW
- 50 kVA Test bay for testing the Proto models with maximum rating of 50 kVA
- 250 kVA Auto Transformer with maximum output current of 300A
- 50 kVA Auto Transformer with maximum output current of 100A

Technology Transfer Centre (Vellayambalam)



- 100 kW DC Power source
- Testing of battery operated Power Electronic Modules, in charging and discharging mode
- 50 kVA Non-linear Load for testing Single phase and Three phase prototypes
- 3 x 20 kW Linear Load for testing of Single phase and Three phase prototypes
- 2 x 4.5 kW AC/DC Programmable Load suitable for the testing of prototypes with Sine, Square and Step Wave output

Technology Transfer Centre (Vellayambalam)



- **External Agency Testing**
- M/s. Methode Electronics Pvt Ltd, Bangalore
- 100 kW DC-AC Inverter
- 11.50 kW loaded as on 11-05-2015
- 3 weeks continuous testing

Power Electronics Test Facility

- Technology Transfer Centre, Vellayambalam
- Green Power Lab, Technopark Campus

Green Power Lab (Technopark Campus)



- 25 KW Solar Power Plant
- 5 KW Wind Power Plant
- Simulation Lab
- Test set up for conducting EMI / EMC pre-compliance tests
- Environmental Test Chamber (Thermal & Humidity)

Green Power Lab (Technopark Campus)



CONTACT

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Advanced Computing For Human Advancement

Thank You