# Renewable Energy Lab

- Power electronics are extensively used in controlling renewable energy sources.
- Maximum Power Point Tracking, Synchronizing with grid supply, integrating numbers of sources, battery integration etc. are important aspect while integrating renewable sources.
- NITech has designed trainers for maximum power point tracking and interfacing generated power in grid or storing in battery.
- Possible integration of Solar, Wind, Battery sources are experimented.

# National InfoTech

A way to Power Electronics and Embedded Systems Solutions...


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**: Authorized Distributor :**

# NIRE01 40 Wp MPPT Boost Converter for Solar PV

The distinct features of the MPPT Boost Converter Trainer are:

❖ System embedded with following components”

- Nitech STM32F4-WJ Micro-Controller Board.
- IGBT/MOSFET Gate Driver Board.
- Boost Converter.
- Non-Isolated DC sensing for Input and Output DC voltage/current Measurement.
- Nitech Signal Conditioning Card to interface with Micro-controller.
- Resistive bulb load bank for testing.

❖ Solar Panel: 40 Wp

❖ Boost Converter:

- 40 W, input 12-22 V, output 17-36 V, Switching frequency 40 kHz

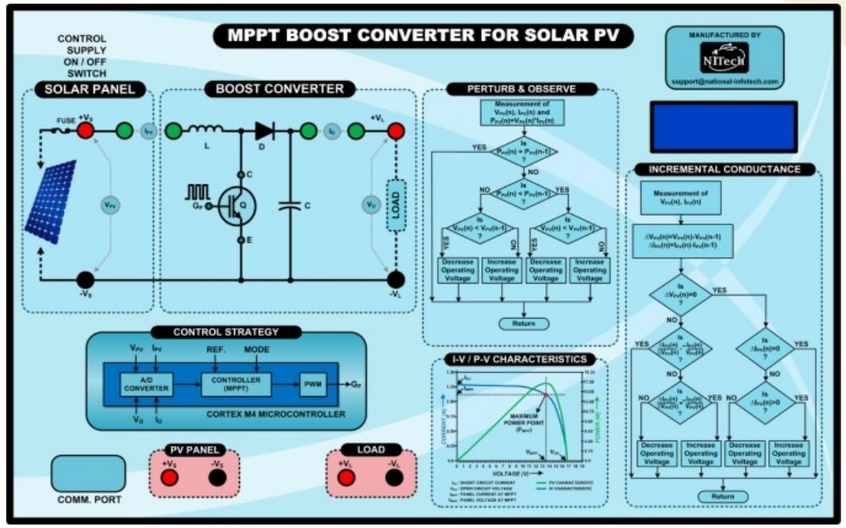
❖ Boost Converter operation in open loop and close loop mode is experimented.

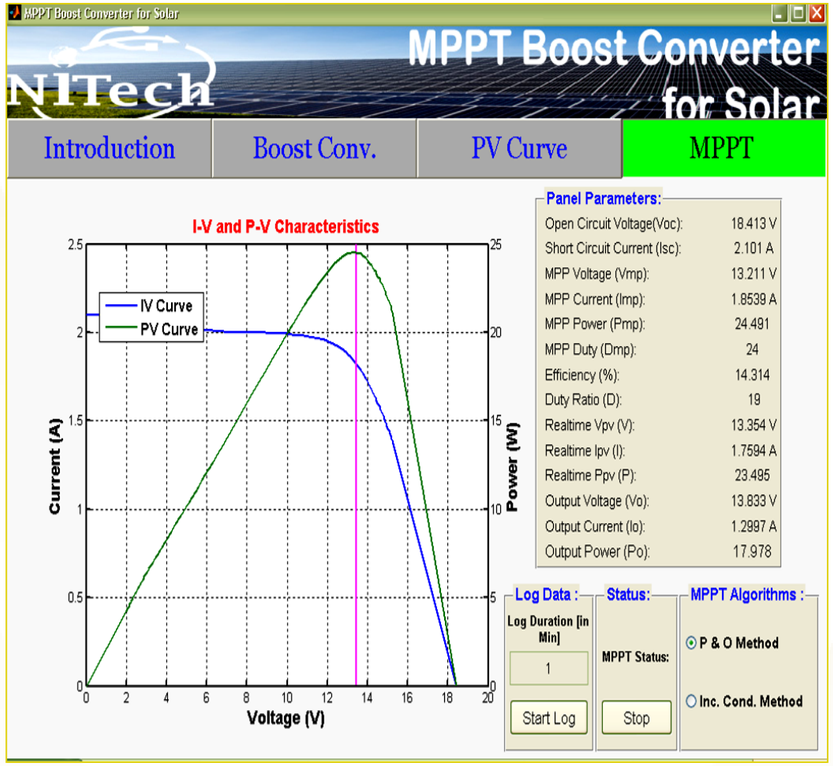
❖ Real time P-V and I-V curve can be capture and can be analyze.

❖ Two MPPT algorithms: (i) Perturb & Observe; and (ii) Incremental Conductance are experimented.

❖ Control algorithms are developed using ARM Cortex M4 series 32-bit Microcontroller from ST Microelectronics under KEIL IDE from micro vision with embedded C code.

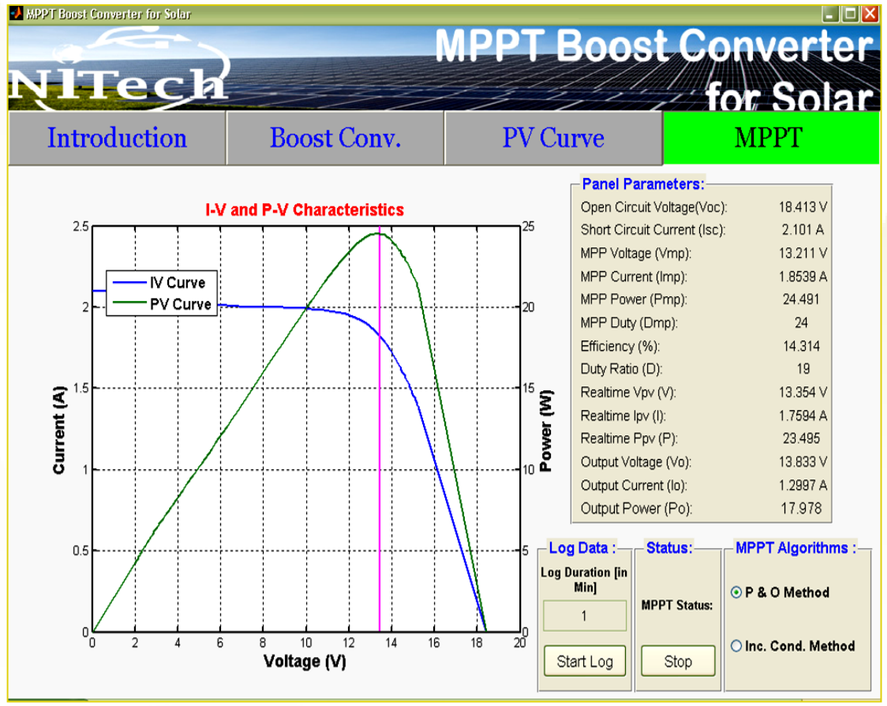
❖ MATLAB based serial utility for visual observations and user interface with the trainer.



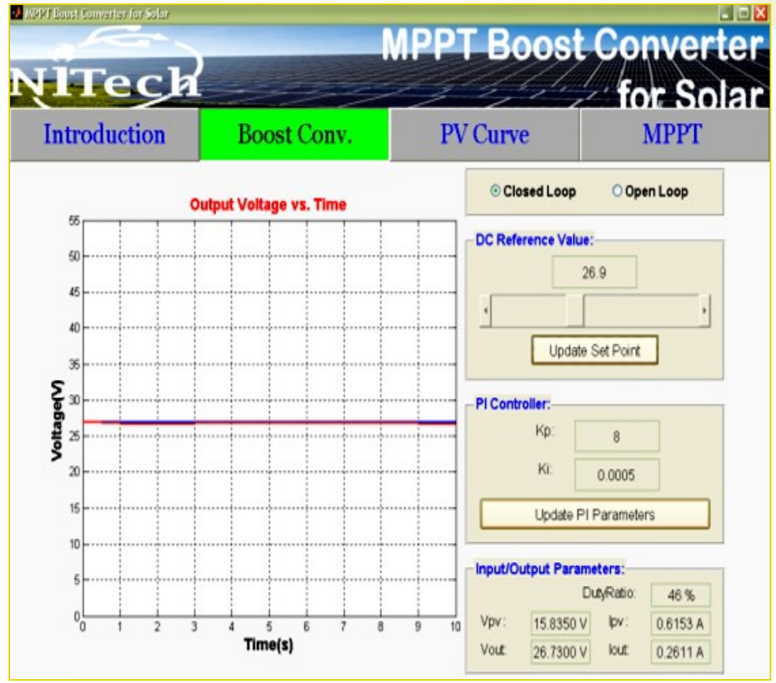
# NIRE02 450 Wp MPPT Boost Converter for Solar PV

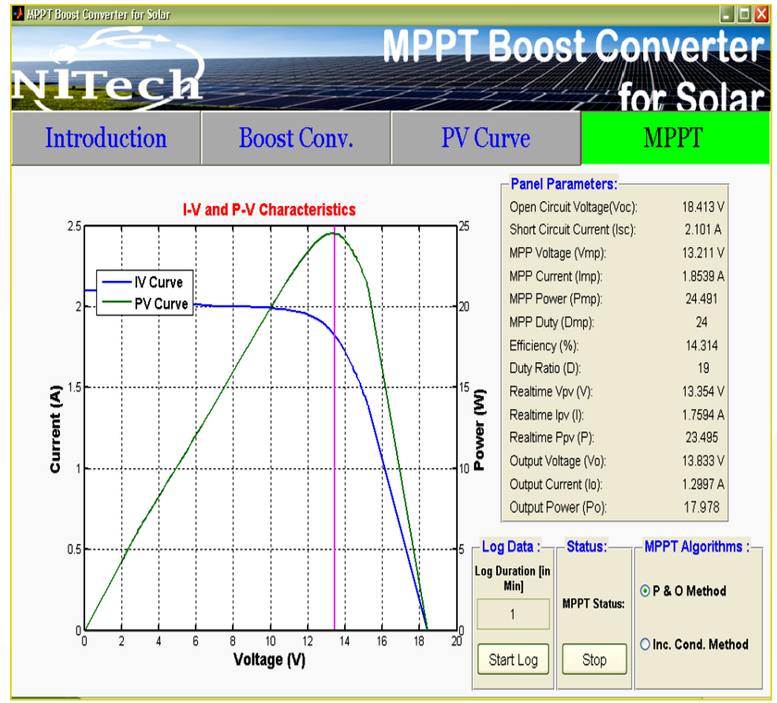
- ❖ MPPT Boost Converter Test Bench in open form to experiment existing MPPT method.
- ❖ System embedded with following components”
  - Nitech STM32F4-WJ Micro-Controller Board.
  - IGBT/MOSFET Gate Driver Board.
  - Boost Converter.
  - Isolated DC sensing for Input and Output DC voltage/current Measurement.
  - NITech’s sensor card (V4) to interface with Micro-controller.
  - Resistive bulb load bank for testing.
- ❖ Solar Panel: 450 Wp; Three numbers of 150Wp panels connected in series.
- ❖ Boost Converter:
  - 450 W, input 96-120 V, output 200-250V, Switching frequency 40 kHz
- ❖ Boost Converter operation in open loop and close loop mode is experimented.
- ❖ Real time P-V and I-V curve can be capture and can be analyze.
- ❖ Two MPPT algorithms: (i) Perturb & Observe; and (ii) Incremental Conductance are experimented.
- ❖ Control algorithms are developed using ARM Cortex M4 series 32-bit Microcontroller from ST Microelectronics under KEIL IDE from micro vision with embedded C code.
- ❖ MATLAB based serial utility for visual observations and user interface with the trainer.
- ❖ All measured quantities are accessible by user in software where new algorithm can be implemented.

# NIRE03 900 Wp MPPT Boost Converter for Solar PV

- ❖ MPPT Boost Converter Test Bench in open form to experiment existing MPPT method.
- ❖ System embedded with following components:
  - Nitech STM32F4-WJ Micro-Controller Board.
  - IGBT/MOSFET Gate Driver Board.
  - Boost Converter.
  - Isolated DC sensing for Input and Output DC voltage/current Measurement.
  - NITech's sensor card (V4) to interface with Micro-controller.
  - Resistive bulb load bank for testing.
- ❖ Solar Panel: 900W p; Three numbers of 330 Wp panels connected in series.
- ❖ Boost Converter:
  - 900 Wp, input 96-120 V, output 200-250 V, Switching frequency 40 kHz.
- ❖ Boost Converter operation in open loop and close loop mode is experimented.
- ❖ Control algorithms are developed using ARM Cortex M4 series 32-bit Microcontroller from ST Microelectronics under KEIL IDE from micro vision with embedded C code.
- ❖ All measured quantities accessible by user in software where new algorithm can be implemented.



# NIRE04 450Wp Two-Stage Solar PV Single-Phase Grid Inverter (Boost Converter & Inverter)

Single-phase grid synchronized inverter trainer for studying PV fed solar inverted and for studying intermediate control algorithm development.

❖ System embedded with following components:

- 450 Wp solar panels
- Nitech STM32F4-WJ Micro-Controller Board.
- IGBT based single-phase inverter with necessary driver and protection circuit.
- Isolated AC/DC sensing for voltage/current Measurement.
- NITech's sensor card (V4) to interface with Micro-controller.

❖ Solar Panel: 450 Wp; Three numbers of 150 Wp panels connected in series.

❖ Boost Converter:

- 450 W, input 96-120 V, output 200-250 V, Switching frequency 40 kHz.

❖ Specifications: AC output voltage: 230 ± 5% V, Single Phase, 50 Hz ± 5 Hz, Transformer Power rating: 600 VA, 230 V / 110 V

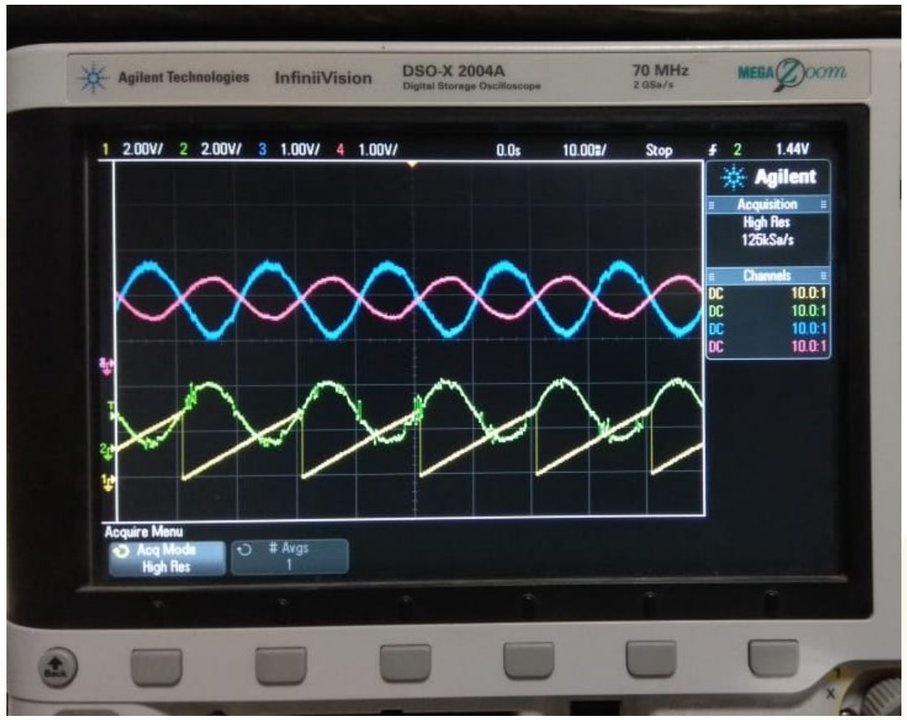
❖ Control algorithm development based on instantaneous power theory; and operation of grid-synchronized inverter is studied.

❖ PLL development for grid synchronization is studied.

❖ ARM-cortex M4 microcontroller specifications:

- STM32F407VGT6 microcontroller featuring 32-bit ARM Cortex-M4F core, 1 MB Flash, 192 KB RAM in an LQFP100 package
- Microcontroller running at 168 MHz and providing peak throughput of 210 MIPs
- On-board ST-LINK/V2 for programming and debugging
- LIS302DL, ST MEMS motion sensor, 3-axis digital output accelerometer
- MP45DT02, ST MEMS audio sensor, Omni-directional digital microphone
- CS43L22, audio DAC with integrated class D speaker driver
- USB OTG FS with micro-AB connector
- GPIO ports are routed to header on mother board for easy connection
- All pins are buffered and are 5V tolerance.

❖ Test points for intermediate signal observations are provided.



# NIRE05 900 Wp Two-Stage Solar PV Single-Phase Grid Inverter (Boost Converter & Inverter)

Single-phase grid synchronized inverter trainer for studying PV fed solar inverted and for studying intermediate control algorithm development.

❖ System embedded with following components:

- 900 Wp solar panels
- NITech's STM32F4-WJ Micro-Controller Board.
- IGBT based single-phase inverter with necessary driver and protection circuit.
- Isolated AC/DC sensing for voltage/current Measurement.
- NITech's sensor card (V4) to interface with Micro-controller.

❖ Solar Panel: 900 Wp; Three numbers of 330 Wp panels connected in series.

❖ Boost Converter:

- 900 W, input 96-120 V, output 200-250 V, Switching frequency 40 kHz.

❖ Specifications: AC output voltage: 230 ± 5% V, Single Phase, 50 Hz ± 5 Hz

❖ Transformer Power rating: 1200 VA., 230 V / 110 V

❖ Control algorithm development based on instantaneous power theory; and operation of grid-synchronized inverter is studied.

❖ PLL development for grid synchronization is studied.

❖ ARM-cortex M4 microcontroller specifications:

- STM32F407VGT6 microcontroller featuring 32-bit ARM Cortex-M4F core, 1 MB Flash, 192 KB RAM in an LQFP100 package
- Microcontroller running at 168 MHz and providing peak throughput of 210 MIPs
- On-board ST-LINK/V2 for programming and debugging
- Board power supply: through USB bus or from an external 12V AC supply
- 09 ADC channels and 02 DAC channels for analogue acquisition and debugging
- LIS302DL, ST MEMS motion sensor, 3-axis digital output accelerometer
- MP45DT02, ST MEMS audio sensor, Omni-directional digital microphone
- CS43L22, audio DAC with integrated class D speaker driver
- USB OTG FS with micro-AB connector
- GPIO ports are routed to header on mother board for easy connection
- All pins are buffered and are 5V tolerance.

❖ Test points for intermediate signal observations are provided.

# NIRE06 900 Wp Two-Stage Solar PV Three-Phase Grid Inverter (Boost Converter & Inverter)

Three - phase grid synchronize inverter trainer for studying PV fed solar inverted and for studying intermediate control algorithm development.

❖ System embedded with following components:

- 900 Wp solar panels
- NITech's STM32F4-WJ Micro-Controller Board.
- IGBT based single-phase inverter with necessary driver and protection circuit.
- Isolated AC/DC sensing for voltage/current Measurement.
- NITech's sensor card (V4) to interface with Micro-controller.

❖ Solar Panel: 900 Wp; Three numbers of 330 Wp panels connected in series.

❖ Boost Converter:

- 900 W, input 96-120 V, output 200-250 V, Switching frequency 40 kHz.

❖ Specifications: AC output voltage: 415 ± 5% V, Three Phase, 50 Hz ± 5 Hz

❖ Transformer Power rating: 1200 VA., 415 V / 110 V, Three Phase

❖ Control algorithm development based on instantaneous power theory; and operation of grid-synchronized inverter is studied.

❖ PLL development for grid synchronization is studied.

❖ ARM-cortex M4 microcontroller specifications:

- STM32F407VGT6 microcontroller featuring 32-bit ARM Cortex-M4F core, 1 MB Flash, 192 KB RAM in an LQFP100 package
- Microcontroller running at 168 MHz and providing peak throughput of 210 MIPs
- On-board ST-LINK/V2 for programming and debugging
- 09 ADC channels and 02 DAC channels for analogue acquisition and debugging
- LIS302DL, ST MEMS motion sensor, 3-axis digital output accelerometer
- MP45DT02, ST MEMS audio sensor, Omni-directional digital microphone
- CS43L22, audio DAC with integrated class D speaker driver
- USB OTG FS with micro-AB connector
- GPIO ports are routed to header on mother board for easy connection
- All pins are buffered and are 5V tolerance.

❖ Test points for intermediate signal observations are provided.

# NIRE07 900 Wp Single-Stage Solar PV Single Phase Grid Inverter

Three-phase grid synchronized inverter trainer for studying PV fed solar inverted and for studying intermediate control algorithm development.

❖ System embedded with following components:

- 900Wp solar panels
- NITech's STM32F4-WJ Micro-Controller Board.
- IGBT based single-phase inverter with necessary driver and protection circuit.
- Isolated AC/DC sensing for voltage/current Measurement.
- NITech's sensor card (V4) to interface with Micro-controller.

❖ Solar Panel: 900 Wp; six numbers of 150 Wp panels connected in series.

❖ Specifications: AC output voltage: 230 ± 5% V, Single Phase, 50 Hz ± 5 Hz

❖ Transformer Power rating: 1200 VA., 230 V / 110 V

❖ Control algorithm development based on instantaneous power theory; and operation of grid-synchronized inverter is studied.

❖ PLL development for grid synchronization is studied.

❖ ARM-cortex M4 microcontroller specifications:

- STM32F407VGT6 microcontroller featuring 32-bit ARM Cortex-M4F core, 1 MB Flash, 192 KB RAM in an LQFP100 package
- Microcontroller running at 168 MHz and providing peak throughput of 210 MIPs
- On-board ST-LINK/V2 for programming and debugging
- Board power supply: through USB bus or from an external 12V AC supply
- 09 ADC channels and 02 DAC channels for analogue acquisition and debugging
- LIS302DL, ST MEMS motion sensor, 3-axis digital output accelerometer
- MP45DT02, ST MEMS audio sensor, Omni-directional digital microphone
- CS43L22, audio DAC with integrated class D speaker driver
- USB OTG FS with micro-AB connector
- GPIO ports are routed to header on mother board for easy connection
- All pins are buffered and are 5V tolerance.

❖ Test points for intermediate signal observations are provided.

# NIRE08 900 Wp Signle-Stage Solar PV Three Phase Grid Inverter

Three-phase grid synchronized inverter trainer for studying PV fed solar inverted and for studying intermediate control algorithm development.

❖ System embedded with following components:

- 900Wp solar panels
- NITech's STM32F4-WJ Micro-Controller Board.
- IGBT based single-phase inverter with necessary driver and protection circuit.
- Isolated AC/DC sensing for voltage/current Measurement.
- NITech's sensor card (V4) to interface with Micro-controller.

❖ Solar Panel: 900 Wp; six numbers of 150 Wp panels connected in series.

❖ Specifications: AC output voltage: 415 ± 5% V, Three Phase, 50 Hz ± 5 Hz

❖ Transformer Power rating: 1200 VA., 415 V / 110 V, Three Phase

❖ Control algorithm development based on instantaneous power theory; and operation of grid-synchronized inverter is studied.

❖ PLL development for grid synchronization is studied.

❖ ARM-cortex M4 microcontroller specifications:

- STM32F407VGT6 microcontroller featuring 32-bit ARM Cortex-M4F core, 1 MB Flash, 192 KB RAM in an LQFP100 package
- Microcontroller running at 168 MHz and providing peak throughput of 210 MIPs
- On-board ST-LINK/V2 for programming and debugging
- 09 ADC channels and 02 DAC channels for analogue acquisition and debugging
- LIS302DL, ST MEMS motion sensor, 3-axis digital output accelerometer
- MP45DT02, ST MEMS audio sensor, Omni-directional digital microphone
- CS43L22, audio DAC with integrated class D speaker driver
- USB OTG FS with micro-AB connector
- GPIO ports are routed to header on mother board for easy connection
- All pins are buffered and are 5V tolerance.

❖ Test points for intermediate signal observations are provided.

# NIRE09 PMSG based Wind Energy Conversion System

The distinct features and components of the PMSG based wind energy conversion system are:

❖ DC shunt motor coupled with PMSG as wind source

- DC Motor Specifications: Power: 2HP, Armature voltage: 220V DC, Field voltage: 220V DC, 1500 RPM, Double side shaft extension, Make : Benn
- PMSG Specifications: Power: 1 kW, 415 or 220 V line voltage, 4 pole, 50 Hz, 1500 rpm Permanent Magnet Synchronous Generator
- Controlled rectifier for DC armature control and rheostat for field control

❖ ARM-cortex M4 microcontroller specifications:

- STM32F407VGT6 microcontroller featuring 32-bit ARM Cortex-M4F core, 1 MB Flash, 192 KB RAM in an LQFP100 package
- Microcontroller running at 168 MHz and providing peak throughput of 210 MIPs
- On-board ST-LINK/V2 for programming and debugging
- Board power supply: through USB bus or from an external 12V AC supply
- 09 ADC channels and 02 DAC channels for analogue acquisition and debugging
- LIS302DL, ST MEMS motion sensor, MP45DT02, ST MEMS audio sensor, Omni-directional digital microphone, USB OTG FS with micro-AB connector
- GPIO ports are routed to header on mother board for easy connection
- All pins are buffered and are 5V tolerance.

❖ Encoder for speed sensing

❖ Three phase power module with six IGBTs

- 5 HP Three phase rectifier and inverter module with protection and sensing circuit
- 1200 V, 25 A diode bridge for AC-DC conversion with Electrolyte DC capacitor
- Three phase 1200 V, 30 A IGBT power module with heat sink and snubber circuit
- Isolated driver circuit with inbuilt power supply and having port for connecting 06 gate pulses to drive IGBTs of the inverter circuit
- IGBTs with desaturation protection against overload and short-circuit.
- Indication of READY and FAULT with a provision to latch driver output and reset with RESET button.
- Sensor Circuit: Sensing circuit for Three AC output currents, One DC current and One DC voltage

# NIRE010 DFIG based Wind Energy Conversion System

This Module consists of following components:

**a.** ARM-cortex M4 microcontroller as Controller

**b.** DC Drive

**c.** Three phase IGBT power module

**d.** DC shunt motor coupled with Slip Ring Induction Motor and additional components

The distinct features of the components of the DFIG based wind energy conversion system are:

❖ DC shunt motor coupled with Slip Ring Induction Motor (Working as a generator)

- DC Motor Specifications: Power : 2HP, Armature voltage: 220V DC, Field voltage: 220V DC, Speed: 1500 RPM, Double side shaft extension, Make : Benn
- Slip Ring Motor (Working as a generator): Type: Three phase slip ring induction motor, Power: 1 HP, Stator voltage : Three phase 415 or 220 V, 1.4A, Rotor voltage : Three phase 415 or 220 V, Speed : 1410 RPM, Make : Benn
- Controlled rectifier for DC armature control and rheostat for field control

❖ ARM-cortex M4 microcontroller specifications:

- STM32F407VGT6 microcontroller featuring 32-bit ARM Cortex-M4F core, 1 MB Flash, 192 KB RAM in an LQFP100 package
- Microcontroller running at 168 MHz and providing peak throughput of 210 MIPs
- On-board ST-LINK/V2 for programming and debugging
- Board power supply: through USB bus or from an external 12V AC supply
- 09 ADC channels and 02 DAC channels for analogue acquisition and debugging
- LIS302DL, ST MEMS motion sensor, MP45DT02, ST MEMS audio sensor, Omni-directional digital microphone, USB OTG FS with micro-AB connector
- GPIO ports are routed to header on mother board for easy connection
- All pins are buffered and are 5V tolerance.

❖ Encoder for speed sensing

❖ Three phase power module with six IGBTs – 02 Nos.

- 5 HP Three phase rectifier and inverter module with protection and sensing circuit
- 1200 V, 25 A diode bridge for AC-DC conversion with Electrolyte DC capacitor
- Three phase 1200 V, 30 A IGBT power module with heat sink and snubber circuit
- Isolated driver circuit with inbuilt power supply and having port for connecting 06 gate pulses to drive IGBTs of the inverter circuit
- IGBTs with desaturation protection against overload and short-circuit.
- Indication of READY and FAULT with a provision to latch driver output and reset with RESET button.
- Sensor Circuit: Sensing circuit for Three AC output currents, One DC current and One DC voltage

# NIRE11 BLDC Machine based Hydro Power System

The distinct features and components of BLDC machine Hydro energy conversion system are:

❖ DC shunt motor coupled with Brushless DC Machine

- 1.5 HP / 180 V Armature / 220 V Field / 3000 RPM / DC Shunt wound dynamo meter type Motor coupled with 1 HP / 120 V / 3000 RPM / BLDC Machine.
- Complete with Load cell type torque sensor and digital torque indicator.
- Controlled rectifier for DC armature control and rheostat for field control.
- Load bank for DC motor armature when working as generator
- Controlled rectifier for DC armature control and rheostat for field control

❖ ARM-cortex M4 microcontroller specifications:

- STM32F407VGT6 microcontroller featuring 32-bit ARM Cortex-M4F core, 1 MB Flash, 192 KB RAM in an LQFP100 package
- Microcontroller running at 168 MHz and providing peak throughput of 210 MIPs
- On-board ST-LINK/V2 for programming and debugging
- Board power supply: through USB bus or from an external 12V AC supply
- 09 ADC channels and 02 DAC channels for analogue acquisition and debugging
- LIS302DL, ST MEMS motion sensor, MP45DT02, ST MEMS audio sensor, Omni-directional digital microphone, USB OTG FS with micro-AB connector
- GPIO ports are routed to header on mother board for easy connection
- All pins are buffered and are 5V tolerance.

❖ Encoder for speed sensing

❖ Three phase power module with six IGBTs

- 5 HP Three phase rectifier and inverter module with protection and sensing circuit
- 1200 V, 25 A diode bridge for AC-DC conversion with Electrolyte DC capacitor
- Three phase 1200 V, 30 A IGBT power module with heat sink and snubber circuit
- Isolated driver circuit with inbuilt power supply and having port for connecting 06 gate pulses to drive IGBTs of the inverter circuit
- IGBTs with desaturation protection against overload and short-circuit.
- Indication of READY and FAULT with a provision to latch driver output and reset with RESET button.

❖ Sensor Circuit: Sensing circuit for Three AC output currents, One DC current and One DC voltage

# NIRE12 Grid Synchronised Inverter for Integrating Three Energy Sources

The distinct features of the grid-synchronised inverter for integrating three different energy sources are as listed below:

- ❖ DC link voltage: 250 V
- ❖ Three ports at DC link for connecting different energy source outputs with indicator and sensing circuit to measure input power (Source may be Solar, Wind and Hydro)
- ❖ DC link voltage control to fed varying power coming from different source to the grid
- ❖ Three phase power module with six IGBTs as Grid Synchronized Inverter
  - 5 HP Three phase rectifier and inverter module with protection and sensing circuit
  - 1200 V, 25 A diode bridge for AC-DC conversion with Electrolyte DC capacitor
  - Three phase 1200 V, 30 A IGBT power module with heat sink and snubber circuit
  - Isolated driver circuit with inbuilt power supply and having port for connecting 06 gate pulses to drive IGBTs of the inverter circuit
  - IGBTs with desaturation protection against overload and short-circuit.
  - Indication of READY and FAULT with a provision to latch driver output and reset with RESET button.
  - Sensor Circuit: Sensing circuit for Three AC output currents, One DC current and One DC voltage
- ❖ Coupling inductor – three phase and step-up three phase transformer 120:415 V between inverter and 415 V three-phase grid voltage

# NIRE13 Bidirectional Converter for Integrating Battery Storage System

Bidirectional DC-DC converter for integrating Battery Energy Storage system at the DC link:

- ❖ Intelligent Power Module for DC-DC convertor
- ❖ Buck, Boost, Buck-Boost Operation
- ❖ Output Power: 1 kW Maximum
- ❖ Input Voltage: 100-200 V,
- ❖ Output Voltage: 300 V, Current: 5-10 A
- ❖ Switching Frequency: 50 kHz, Voltage Ripple 5 %, Current Ripple 5%
- ❖ Inbuilt isolated gate driving circuits and terminal to connect gate pulse generated by controller.