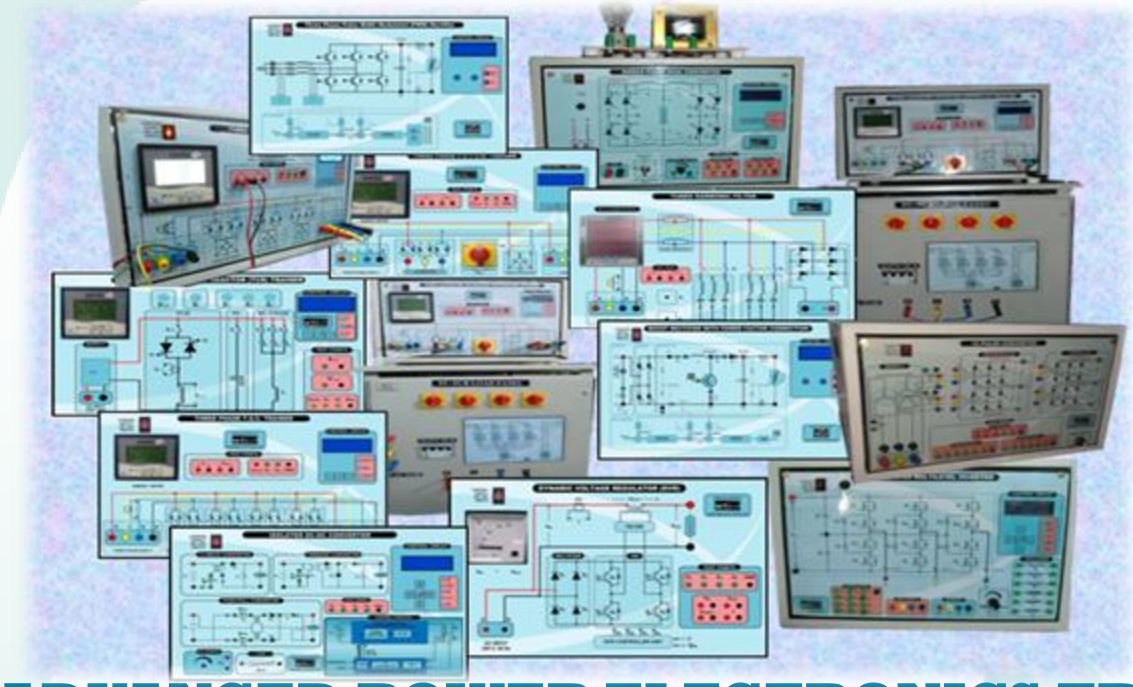

# ADVANCED POWER ELECTRONICS TRAINER

Power electronics is the engineering study of converting electrical power from one form to another. World-wide, at anaverage rate of 12 billion kilowatts of electrical energy is generated in every hour of every day of every year. The power generated is being reprocessed or recycled through some form of power electronic systems. It is expected that this power processing will increase up to 80% in near future.Increased use of Power electronics demanded new power converters which do not pollute the grid. Accordingly many new power converters are developed.

The use of power electronics in power system control and power quality improvements are also increased extensively.

**NITech** offers a wide range of advance power electronics converter kits for studying new power converters and for studyingapplication of power electronics in power system. Kits like multi-pulse converter, PWM rectifier, PFC using boost converter, multi-level inverters are designed.


: **Developed By:**

National Infotech

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**: Authorized Distributor:**

NATIONAL INFOTECH

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

# NIAPE01THREE PHASE DIODE CLAMPED MULTILEVEL INVERTER

Trainer for studying IGBT based 3 level diode clamped multilevel inverter with popularly used modulation techniques.

## Specifications:

- 3-level diode clamped multilevel inverter power module.
- Cortex M4 32-bit Microcontroller based gate/base circuit.
- Different control technique:
  - Square wave mode
  - Sinusoidal Pulse Width Modulation (SPWM)
  - Space Vector Modulation (SVM)
- Different mode of control:
  - Only Voltage control
  - Only frequency control
  - Voltage – frequency (v/f) control
- Input Voltage: Step down supply voltage of 48 V DC.
- Load: Three load resistance of 100 E, three-phase inductance 120 mH.
- Three CTs to observe the inverter output current waveforms
- 12 IGBTs with proper heat sink and snubber circuit, 6 power diodes.
- 12 nos. of high speed opto-isolator provided for IGBT PWM inverter.
- 12 nos. of IGBT gate driver IC provided for IGBT gate driving.
- One no of input DC power supply for gate driver card.
- 3 phase outputs andDC input terminals are terminated on the front panel.
- All are mounted on a nice cabinet with stickered front panel.

The setup will consist of following cards:

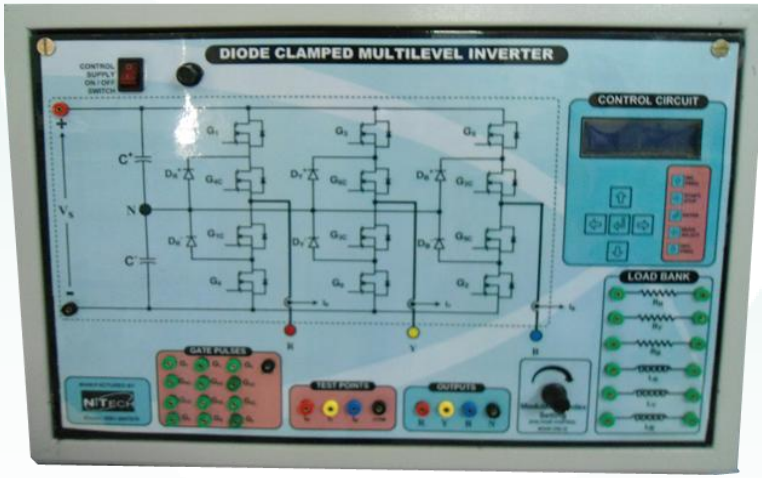
## 1. 32 bit ARM-Cortex controller card:

- STM32F407VGT MCU @168MHz
- Buffered I/O Ports using 74HC573
- 2 DAC outputs
- 9 ADC input channels with buffering using LM324 IC
- On board QEI (Quadrature Encoder Interface) section
- 5 Keys push to ground
- 16*2 LCD (JHD162A) display
- UART section (RS-232)(IC Max 232)
- RS-485 serial communication port

## 2. IGBT based power card and driver card:

- 12 Nos. of IGBTs - STGW30NC120HD
- 06 Nos. of fast acting diodes MUR460
- Optical Isolation and driving through TLP 250
- Bipolar driving + 16 / -8 V
- 15 V DC excitation supply for driver card
- 12 Numbers of SMPS transformer for deriving power supply for opto-isolator.

## 3. 48 V, 4.5 A DC supply using SMPS

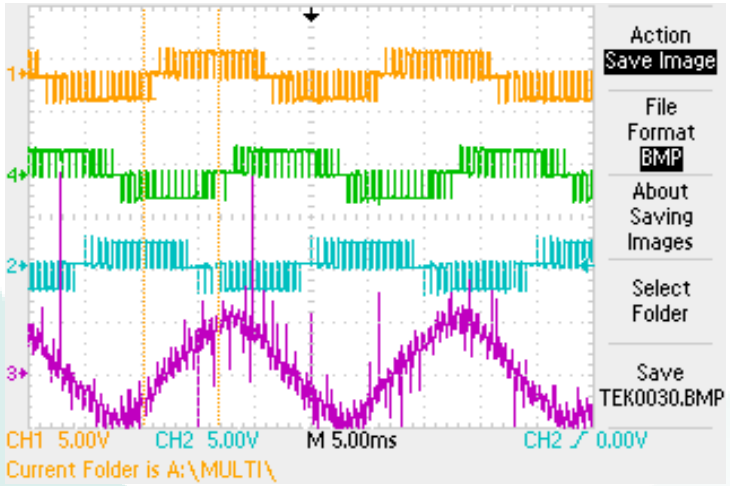


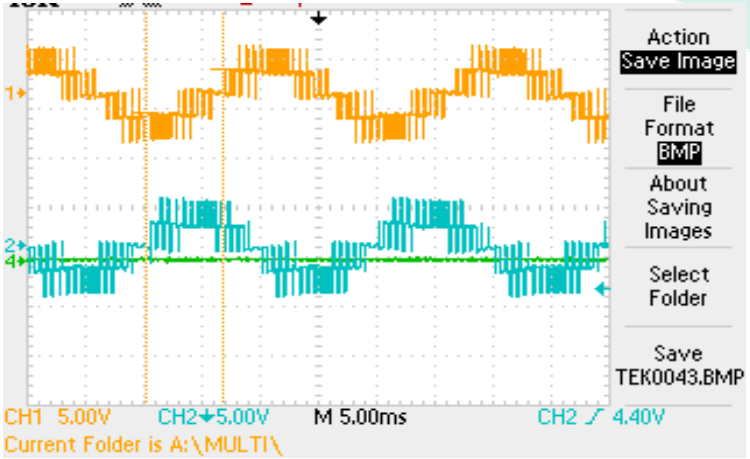
## List of Experiments:

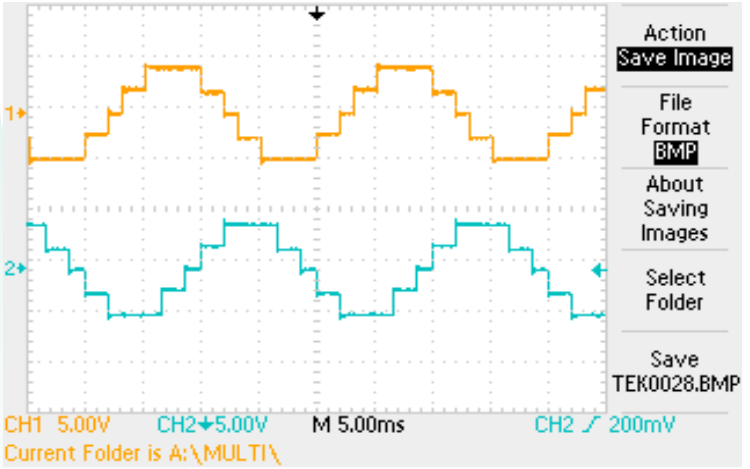
- Study of gate pulse generating circuit for multilevel inverters.
- Study of multilevel inverter in square wave mode with R-load.
- Study of multilevel inverter in square wave mode with R-L load.
- Study of voltage control in multilevel inverter controlled with SPWM inverter.
- Study of voltage control in multilevel inverter controlled with SVM inverter.
- Study of v/f control in multilevel inverter controlled with SPWM inverter.
- Study of v/f control in multilevel inverter controlled with SVM inverter.
- Comparative study of SPWM and SVM control in multilevel inverter

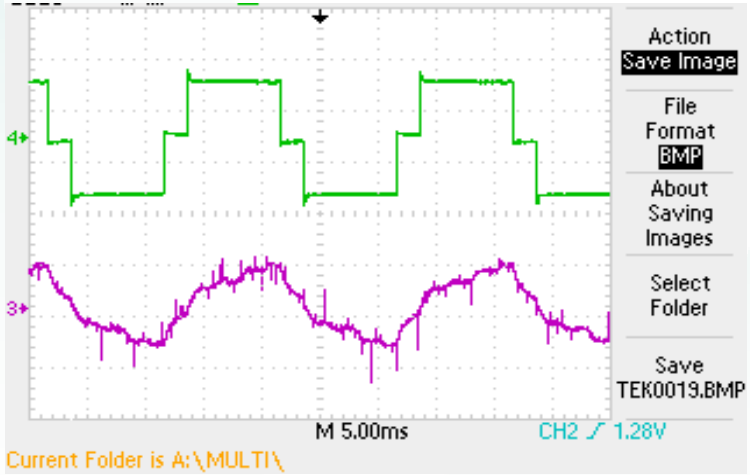
## Typical waveforms:

Following are the waveforms observed during the operation.



# NIAPE02Multi Pulse Converter (12 Pulse)

Trainer for studying principle operation of 12-pulse converter.

## Specifications:

- Star – Star / Delta supply Transformer (415 V: 30V: 30V, 500 VA).
- 02 numbers of six pulse diode rectifier to form 12-pulse diode rectifier configuration.
- 02 numbers of six pulse thyristor rectifier to form 12-pulse thyristor rectifier configuration.
- 12-pulse rectifier with provision to study output voltage, transformer secondary currents and transformer primary current.
- Firing module - 12 nos. of isolated gate pulses for thyristor converter.
- Firing angle control:
  - Potentiometer to vary firing angle in analog mode
  - 8051 controller to vary firing angle in digital mode.
- Necessary test points provided for intermediate stage control circuit waveform observations.
- Power circuit – 12 nos. of diode, 12 nos. of SCR with snubber.

The setup will consist of following cards:

## 1. Power Cards:

- Three-phase diode bridge – 12 numbers of. Diode 1N5408
- Three-phase Thyristor Bridge – 12 numbers of SCR 25TT12 (25A, 1200V)
- Snubber circuits
- Three CTs for isolated currer waveform observation.

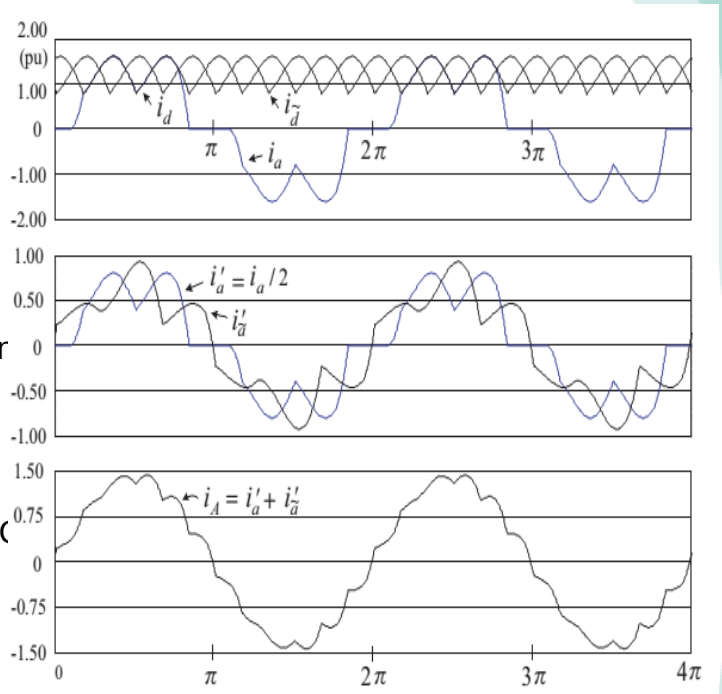
## 2. Thyristor Firing card:

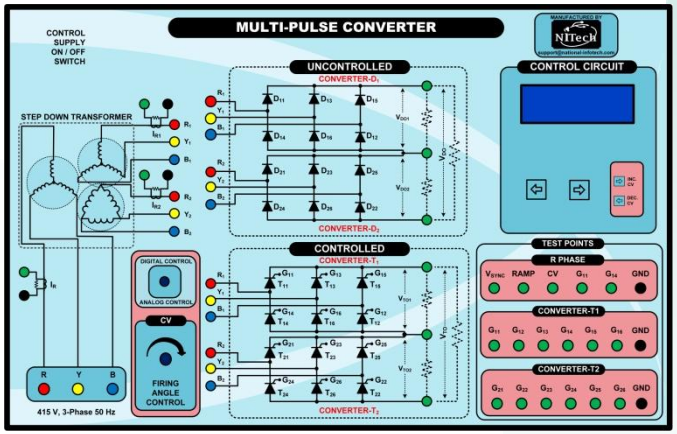
- +ZCD and –ZCD using diodes
- on board 5 kHz carrier using RC circuit
- Pulse Transformer based driving
- Gate resistor with anti-parallel diode

## List of Experiments:

- Study of firing pulse generation for 12-pulse converter.
- Study of 12-pulse uncontrolled converter.
- Study 12-pulse controlled converter.
- Study of source voltagewaveform of 12-pulse uncontrolled converter.
- Study of source currentwaveform of 12 Pulse controlled converter.
- Comparison of supply Power Factor of 6-pulse and 12-pulse converter.

## Observed waveform for 12-Pulse converter



# NIAPE03Single Phase Dual Converter

Trainer for studying single phase dual converter working in circulating and non-circulating current mode of operation.

## Specifications:

- Microcontroller based gate pulse generation circuit.
- Observation of intermediate stage waveforms of gate pulse generation.
- Selection switch for circulating and non-circulating mode of operation.
- Experimentation with R and R-L load.
- Firing module - 8 nos. of isolated gate pulses for positive and negative group of thyristors.
- Inbuilt connection of inductor for circulating current mode.
- Keyboard and LCD display as user interface for adjusting firing angle.
- One DPDT switch for selection of Dual converter with circulating non-circulating current mode of operation.
- MCB protection for input power ON/OFF and protection.
- Potentiometer to vary the firing angle.

The setup will consist of following cards:

## 1. Controller Card:

- SST89E516RD 8-bit MCU clocked @18.432MHz
- Buffered I/O Ports using 74HC573
- 5 Interface Keys
- 16x2 LCD (JHD162A) display
- UART section (IC Max 232)

## 2. Thyristorfiring card:

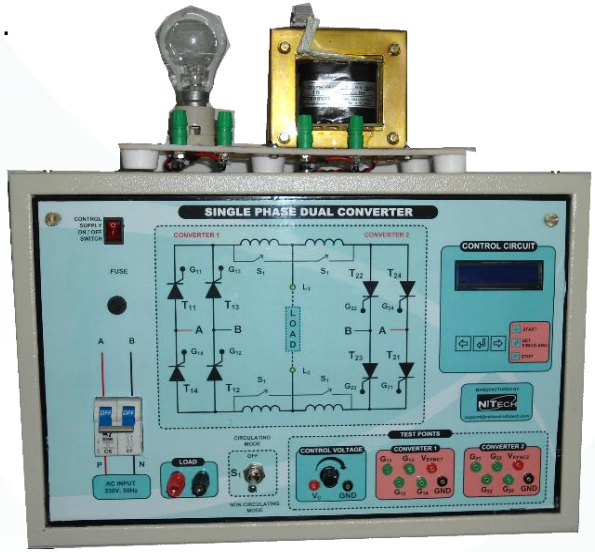
- +ZCD and –ZCD using diodes
- on board 5 kHz carrier using RC circuit
- Pulse Transformer based driving
- Gate resistor with anti-parallel diode

## 3. Power card:

- Rating: 300V, 5A
- Thyristor 25TT12 (25A, 1200V) (8 Nos.)
- Snubber circuit

## List of Experiments:

- Study of gate pulse generating circuit for dual converters.
- Study of non-circulating mode of operation of dual converter with R load.
- Study of circulating mode of operation of dual converter with R load.
- Study of non-circulating mode of operation of dual converter with R-L load.
- Study of circulating mode of operation of dual converter with R-L load.



# NIAPE04Isolated DC-DC Converter Trainer

Trainer is for studying 03 numbers of different configurations of isolated switch mode DC-DC converters.

## The kit includes:

- Three topologies of isolated DC-DC converters:
  - Flyback converter
  - Forward converter
  - Push-Pull converter
- Microcontroller based gate pulse generation circuit.
- Variable resistive load for open-loop and closed loop control demonstration.
- Stabilized DC supply 24 V DC. ( Variation 21 to 27 V)

The kit works directly with 230V, 50Hz AC supply. Step down supply voltage of 24 V DC and variable load rheostat of 50 E is provided for experimentation.

The setup will consist of following cards:

## 1. 32 bit ARM-Cortex controller card:

- STM32F407VGT MCU @168MHz
- Buffered I/O Ports using 74HC573
- 2 DAC outputs
- 9 ADC input channels with buffering using LM324 IC
- On board QEI (Quadrature Encoder Interface) section
- 5 Keys push to ground
- 16*2 LCD (JHD162A) display
- UART section (RS-232)(IC Max 232)
- RS-485 serial communication port

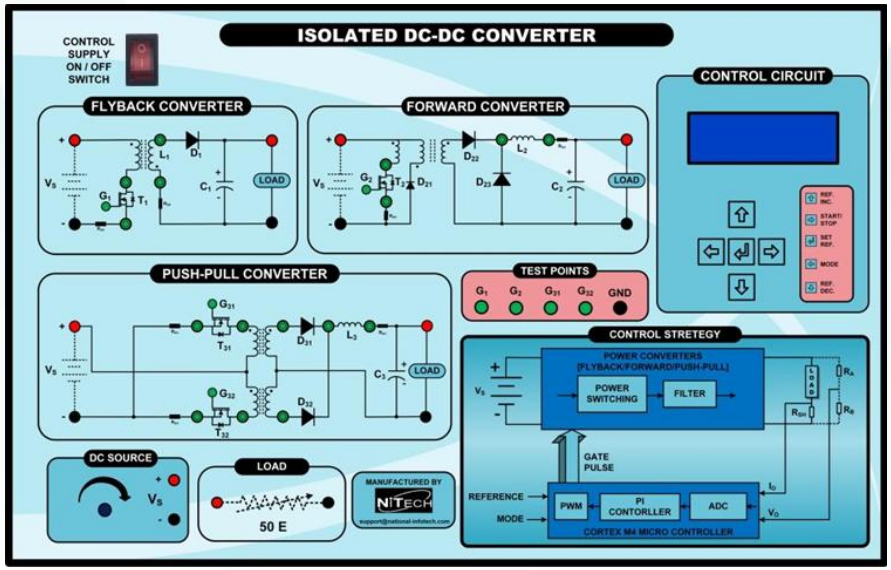
## 2. MOSFET based converter card:

- Optical Isolation through TLP 250
- MOSFET IRF840 (400V, 8A)
- Diode MUR 460
- 15 V AC excitation supply
- Fuse for over current trip

## 3. 24V, 4.5 A DC supply using SMPS

## List of Experiments:

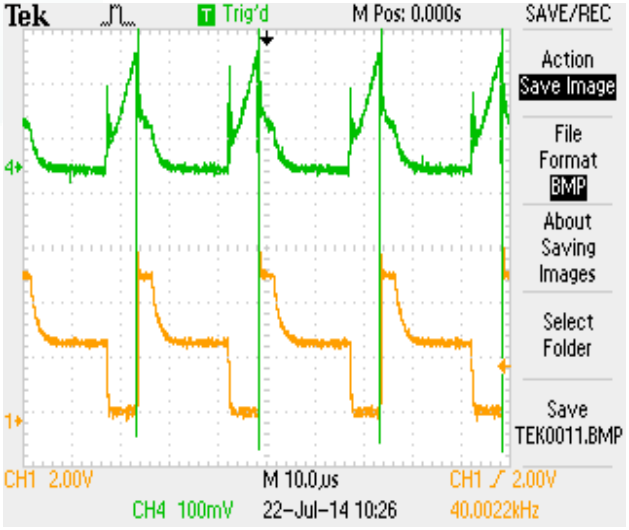
- Study of gate pulses of Flyback, Forward, and push-pulls converter.
- Study of Flyback converter designing.
- Study of Flyback converter circuit operation.
- Study of Forward converter designing.
- Study of Forward converter circuit operation.
- Study of push-pull converter designing.
- Study of push-pull converter circuit operation.

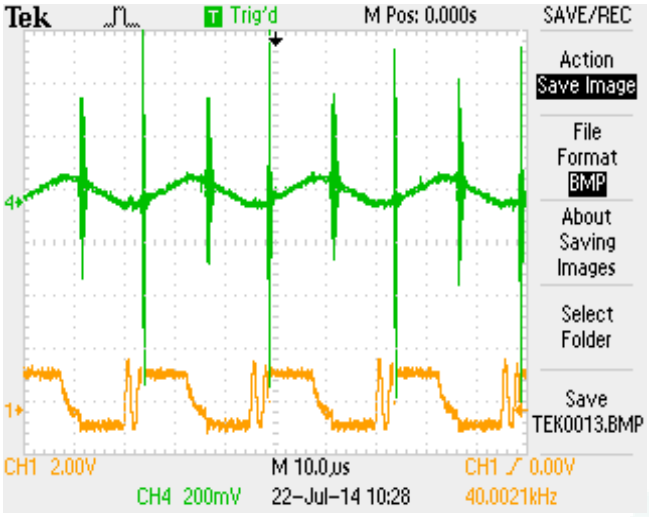


## Typical waveforms:

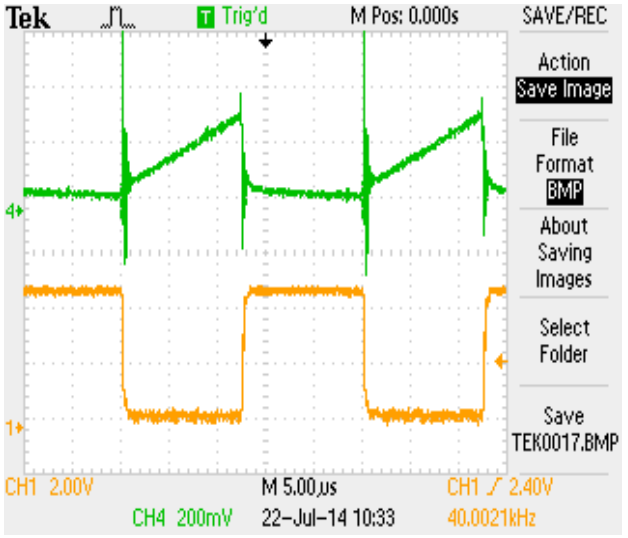
Following are the waveforms observed during the operation.

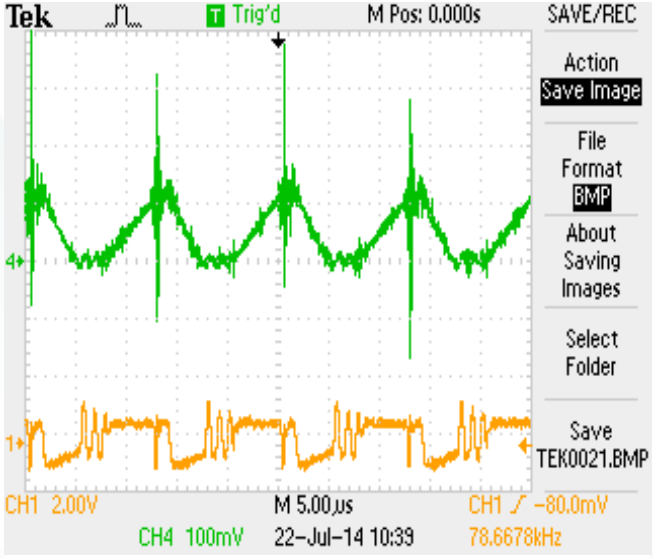
### (i) Waveforms of forward converter operation:




### (ii) Waveforms ofpush-pull converter operation:



# NIAPE05Isolated DC-DC Bridge Converter Trainer

This trainer is for studying isolated bridge configurations of switch mode DC-DC converter.

## The kit includes:

- Two topologies of isolated bridgeconverter:
  - Half-bridge converter
  - Full-bridge converter
- Microcontroller based gate pulse generation circuit.
- Fixed and variable resistive load for open loop and closed loop control demonstration.
- Stabilized DC supply 24 V DC. ( Variation 21 to 27 V)

The kit works directly with 230V, 50Hz AC supply. Step down supply voltage of 24 V DC and variable load rheostat of 50 E is provided for experimentation.

The setup will consist of following cards:

### 1. 32 bit ARM-Cortex controller card:

- STM32F407VGT MCU @168MHz
- Buffered I/O Ports using 74HC573
- 2 DAC outputs
- 9 ADC input channels with buffering using LM324 IC
- On board QEI (Quadrature Encoder Interface) section
- 5 Keys push to ground
- 16*2 LCD (JHD162A) display
- UART section (RS-232)(IC Max 232)
- RS-485 serial communication port

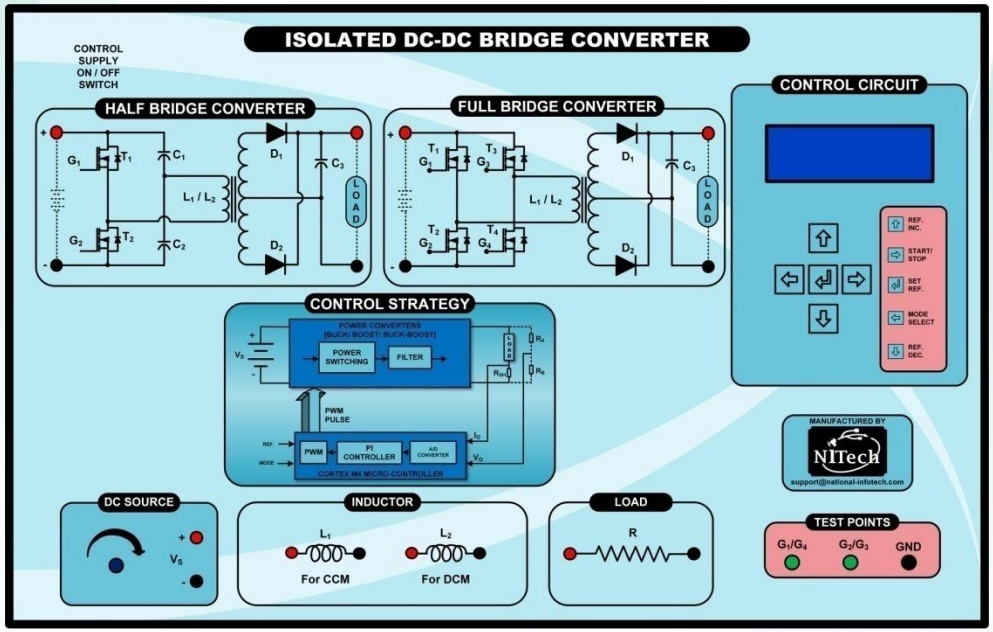
### 2. MOSFET based inverter card:

- Optical Isolation through TLP 250
- MOSFET IRF840 (400V, 8A)
- Diode MUR 460
- 15 V AC excitation supply
- Fuse for over current trip

### 3. 24V, 4.5 A DC supply using SMPS.

## List of Experiments:

- Study of Gate pulses of half-bridge and full-bridge converter.
- Study of half-bridge converter designing.
- Study of half-bridge converter circuit operation.
- Study of full-bridge converter designing.
- Study of full-bridge converter circuit operation.



# NIAPE06Three Phase PWM Rectifier

This trainer is for studying Three Phase PWM Rectifier Operation.

## The kit includes:

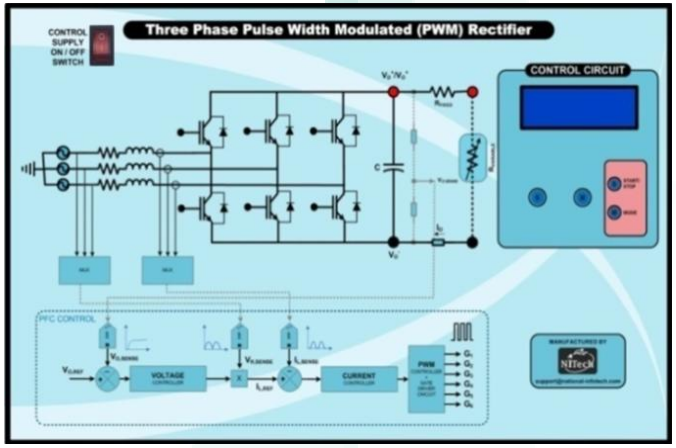
The experiment setup consists of three-phase PWM rectifier, 32-bit Cortex M4 ARM microcontroller based controller for gate pulse generation, and load. Test points for current and voltage waveform observation across different elements are provided. Detailed features and specifications are as listed below:

- Isolated 110V, 50Hz three-phase AC input voltage.
- Boost Converter with 220V, 2.0A capacity.
- Current Transformer for current waveform observation.
- Digital control circuit implementation using latest Cortex M4 ARM 32-bit microcontroller (STM32F407VG).
- Slow outer voltage control loop working at 100 µSec and fast inner current loop working at 10 µSec.
- Two different current control method, Average Current Control and Hysteresis Current Control can be studied.
- Accessibility to monitor the gate pulses of the boost converter.
- Rugged packaging with plug and socket type banana connector.

## 1. 32 bit ARM-Cortex controller card:

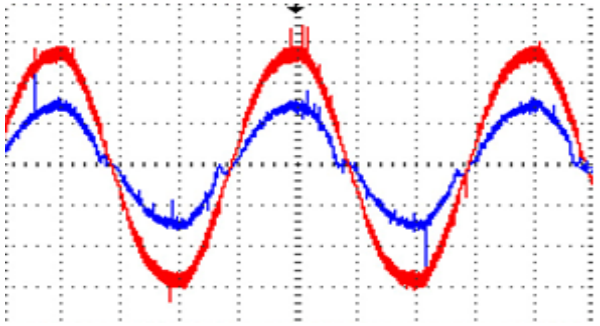
- STM32F407VGT MCU @168MHz
- Buffered I/O Ports using 74HC573
- 2 DAC outputs
- 9 ADC input channels with buffering using LM324 IC
- On board QEI (Quadrature Encoder Interface) section
- 5 Keys push to ground
- 16*2 LCD (JHD162A) display
- UART section (RS-232)(IC Max 232)
- RS-485 serial communication port

The pictorial view of the front panel of the kit is shown below.

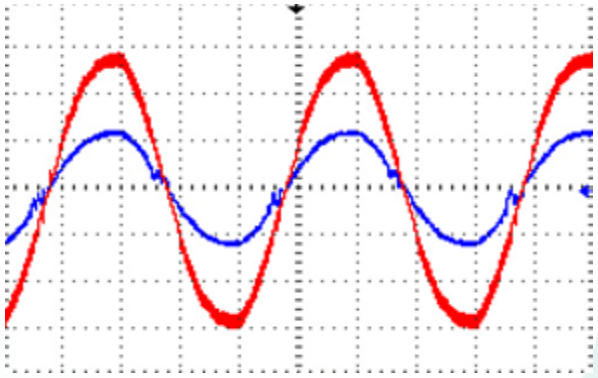



## Typical Waveforms:

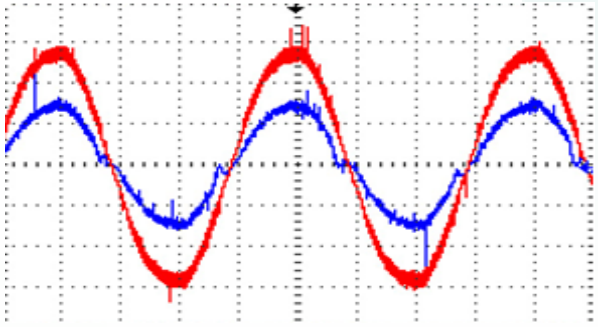
$V_S$ (Source Voltage) and $I_S$(Source Current)Boost Rectifier in Average Current Control Mode



$V_S$ (Source Voltage) and $I_S$(Source Current)Boost Rectifier in Hysteresis Control Mode



$V_S$ (Source Voltage) and $I_S$(Source Current)Boost Rectifier in Peak Current Control Mode



# NIAPE07Boost Rectifier with Power Factor Correction (PFC)

This trainer is for studying operation of Boost Rectifier with Power Factor Correction.

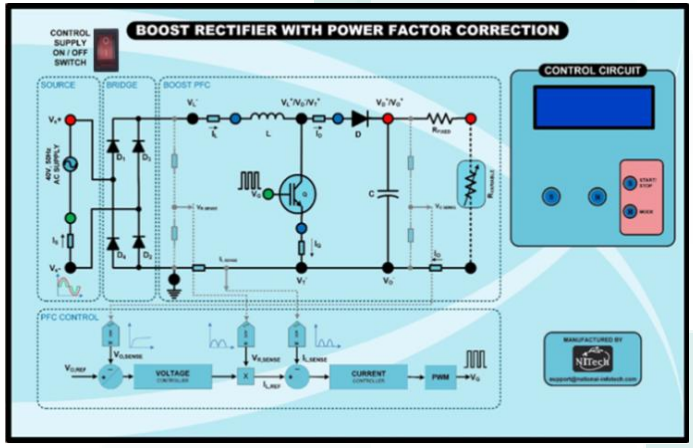
## The kit includes:

The experiment setup consists of low voltage boost rectifier with PFC, 32-bit Cortex M4 ARM microcontroller based controller for gate pulse generation, and load. Test points for current and voltage waveform observation across different elements are provided. Detailed features and specifications are as listed below:

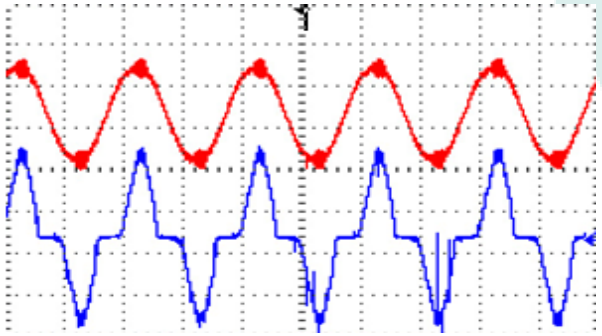
- Isolated 40V, 50Hz ACinput voltage.
- Boost Converter with 70V, 1.5A capacity.
- Series shunt resistor across source, inductor, switch, diode and load for current waveform observation.
- Digital control circuit implementation using latest Cortex M4 ARM 32-bit microcontroller (STM32F407VG).
- Slow outer voltage control loop working at 100 µSec and fast inner current loop working at 10 µSec.
- Two different current control method, Average Current Control and Hysteresis Current Control can be studied.
- Accessibility to monitor the gate pulses of the boost converter.
- Rugged packaging with plug and socket type banana connector.

## 2. 32 bit ARM-Cortex controller card:

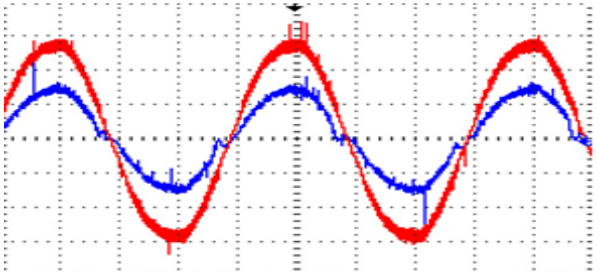
- STM32F407VGT MCU @168MHz
- Buffered I/O Ports using 74HC573
- 2 DAC outputs
- 9 ADC input channels with buffering using LM324 IC
- On board QEI (Quadrature Encoder Interface) section
- 5 Keys push to ground
- 16*2 LCD (JHD162A) display
- UART section (RS-232)(IC Max 232)
- RS-485 serial communication port



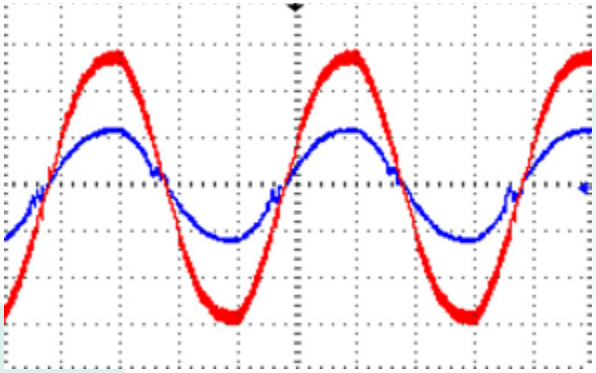

## Typical Waveforms:



$V_S$(Source Voltage) and $I_S$(Source Current) with Boost Rectifier in Voltage Control Mode



$V_S$ (Source Voltage) and $I_S$(Source Current)Boost Rectifier in Average Current Control Mode



$V_S$ (Source Voltage) and $I_S$(Source Current)Boost Rectifier in Hysteresis Current Control Mode

# NIAPE08 Cascaded Multilevel Inverter

- Trainer for studying 5-level cascaded multilevel inverter formed by cascading two H-bridges.

- The experiment setup consists of:
  1. ARM Cortex M4 32-bit Microcontroller Kit;
  2. Two cascaded H-Bridges with required Power & Driver Circuit; and
  3. Step-down DC source and R, R-L Load Bank for laboratory experiments.

- Test points for current and voltage waveform observation across different elements are provided.

- Rugged packaging with plug and socket type banana connector.

## The setup will consist of following cards:

### 1. 32 bit ARM-Cortex controller card:

- STM32F407VGT MCU @168MHz
- Buffered I/O Ports using 74HC573
- 2 DAC outputs
- 9 ADC input channels with buffering using LM324 IC
- On board QEI (Quadrature Encoder Interface) section
- 5 Keys push to ground
- 16*2 LCD (JHD162A) display
- UART section (RS-232)(IC Max 232)
- RS-485 serial communication port

### 2. IGBT based power card and driver card:

- 08 Nos. of IGBTs - STGW30NC120HD
- 08Nos. of fast acting diodes MUR460
- Optical Isolation and driving through TLP 250
- Bipolar driving + 16 / -8 V
- 15 V DC excitation supply for driver card
- 12 Numbers of SMPS transformer for deriving power supply for opto-isolator.

### 3. 48 V, 4.5 A DC supply using SMPS