

ADVANCED POWER ELECTRONICS & DRIVES SETUP

DIGITAL PWM CONTROLLERS:

- MATLAB – REAL TIME CONTROLLER
- SPARTAN 6/CYCLONE-IV/VIVADO FPGA PWM CONTROLLER
- DSP TMS2812/TMS28335/C2000 FLOATING POINT CONTROLLER
- DSPIC 18F4011 MICROCONTROLLER

POWER MODULES:

- SEMIKRON BASED 1KVA/3KVA/3KVA/10KVA/20KVA/30KVA IGBT POWER CIRCUIT
- SEMIKRON ASYMMETRIC/SYMMETRIC IGBT BASED SR POWER CIRCUIT 3KVA/5KVA
- SIC POWER CIRCUIT -1KW
- 3Ø-9Ø CONFIGURABLE MATRIX CONVERTER-3KVA (INDIRECT & DIRECT)
- 3Ø-3Ø MATRIX CONVERTER-3KVA (INDIRECT & DIRECT)
- 3Ø – 3 LEVEL ANPC POWER CIRCUIT – 3KVA/5KVA/10KVA/15KVA
- 3Ø – 5 LEVEL ANPC POWER CIRCUIT – 3KVA/5KVA/10KVA
- 3Ø – 3 LEVEL NPC POWER CIRCUIT – 3KVA/5KVA/10KVA/15KVA
- 3Ø – 5 LEVEL NPC POWER CIRCUIT – 3KVA/5KVA/10KVA
- 3Ø – 2/3/5/7/9/11/13 LEVEL CASCADED H -BRIDGE POWER CIRCUIT – 3KVA/5KVA/10KVA
- 5Ø – 5 LEVEL CIRCUIT CASCADED H -BRIDGE POWER CIRCUIT – 3KVA/5KVA
- 5Ø – 5 LEVEL CIRCUIT CASCADED H -BRIDGE POWER CIRCUIT – 3KVA/5KVA
- 3Ø – 3 LEVEL VIENNA POWER CIRCUIT 3KVA/5KVA
- BI DIRECTIONAL CONVERTER DC-DC BUCK-BOOST POWER CIRCUIT 1000W/2000W
- 3Φ /5Φ CURRENT SOURCE INVERTER -3KVA
- Z SOURCE 5 PHASE INVERTER – 3KVA
- QUASI –Z SOURCE-5 PHASE INVERTER-3KVA
- 1Φ - 6Φ CONFIGURABLE IGBT BASED INVERTER-3KVA
- 3Φ – 3 LEVEL FLYING CAPACITOR POWER CIRCUIT -1KVA

LOADS:-

- 1HP/3HP/5HP/7.5HP/10HP 3Φ AC INDUCTION MOTOR + EDDY CURRENT+ DC GENERATOR LOAD
- 1HP 5Φ AC INDUCTION MOTOR+ EDDY CURRENT+ DC GENERATOR LOAD
- 1HP/3HP/5HP/7.5HP/ DC SHUNT MOTOR + EDDY CURRENT+ DC GENERATOR LOAD
- 1HP/3HP BLDC MOTOR + EDDY CURRENT+ DC GENERATOR LOAD
- 1HP/3HP PMSM MOTOR+ EDDY CURRENT+ DC GENERATOR LOAD
- 1HP/3HP SWITCHED RELUCTANCE MOTOR+ EDDY CURRENT+ DC GENERATOR LOAD

SPECIAL PRODUCTS:-

- DFIG
- PMSG
- FACTS-STATCOM-UPQC/SSSC
- DC/AC MICRO GRID
- IoT SMART GRID

CONTROL TECHNIQUES:-

- SPACE VECTOR MODULATION WITH V/F CONTROL
- DIRECT TORQUE CONTROL IMPLEMENTATION HARDWARE AC/PMSM MOTOR
- VECTOR CONTROL (FOC) IMPLEMENTATION AC MOTOR
- SENSOR LESS CONTROL FOR AC / BLDC MOTOR
- POWER QUALITY IMPROVEMENT IN DC/AC MICRO GRID
- ACTIVE POWER FILTER – SHUNT
- HYBRID WIND AND SOLAR POWER GENERATION TECHNOLOGY
- MATLAB –IMPLEMENTATION

POWER ELECTRONICS APPLICATION SOFTWARE

The application program is written in VHDL language using XILINX-ISE foundation software Sample programs provided for the following experiments.

- Single phase SCR AC Voltage regulator with R-RL load.
- Single phase triac AC voltage regulator with R-RL load.
- Single phase half-fully controlled converter with R, RL load.
- IGBT/MOSFET based Single/Two/Four quadrant chopper with R, RL load.
- IGBT/MOSFET based single phase sine PWM inverter with RL load.
- MOSFET based Fly-back & Forward converter.
- Buck, Boost, Buck-Boost Converter.
- 1st, IInd, IVth Quadrant chopper control of DC Motor controller
- Open loop speed control of three phase AC induction motor using V/F control (SPWM)
- Closed loop speed control of three phase AC induction motor using V/F control
- Open / Closed loop control of BLDC, SR Motor.



VHDL

I. SCR PROJECT CARD

- One number of TYN612 SCR with snubber circuit & heat sink provided for power circuit
- One number of pulse transformer provided for SCR pulse.
- One 2 pin Screw type phoenix connector for SCR terminals Anode & Cathode and another 2 pin connector for SCR pulse input from FPGA Controller.
- One number of step down transformer with ZCD circuit for supply synchronization.
- PWM input : 0-5 V/0-3V level.
- Power input : 0-24V AC/DC @ 1A



II. DUAL IGBT PROJECT CARD

- Two number of IRGBC20S IGBT with snubber circuit & heat sink power circuit to form one Leg.
- One number of IR2110 driver IC used for IGBT driver with opto-isolation.
- 3pin phoenix connector for Cathode, Emitter, center point of one Leg and another 3 pin connector for PWM input from FPGA Controller.
- PWM inputs: 0-5V/0-3V level./Power input:0-24V DC @ 2Amp



III. MOSFET BUCK BOOST CONVERTER CARD

- One number MOSFET used as power switch.
- Opto provided for PWM isolation.
- Driver IC IR2110 & Filter circuit provided.
- PWM input level +5v/+3v @ max 10khz frequency
- I/P voltage : 15V DC, Output voltage: 24V
- Voltage feedback circuit and resistive load provided.
- Connectors provided for PWM input (PWM given from FPGA Controller)

DC POWER SUPPLY (OPTIONAL)

- **SINGLE LINEAR VARIABLE 0-30V, 2 AMPS DC POWER SUPPLY**
 - Input Voltage Range : AC 230V, + 10%
 - Output Voltage :
- One Nos of 0-30V Source Provided with banana connector Terminations at front Panel
- Current Range 0-2 Amps
- 1 Nos of 3.5 Digit Digital Display with a switch provided to indicate either Voltage or Current
- 2 Nos of panel Potentiometer provided to adjust coarse and fine control
- One Separate Adjustable potentiometer provided to set the current Range from 0-2A.

DC -DC BUCK CONVERTER TRAINER

This set-up is designed to study the working principle of buck dc-dc converter. It consists of

- **Buck-converter PWM control circuit.**
- **Buck- converter power circuit.**
- **0-30v dc power supply for power converter input.**

Buck-converter PWM control circuit:

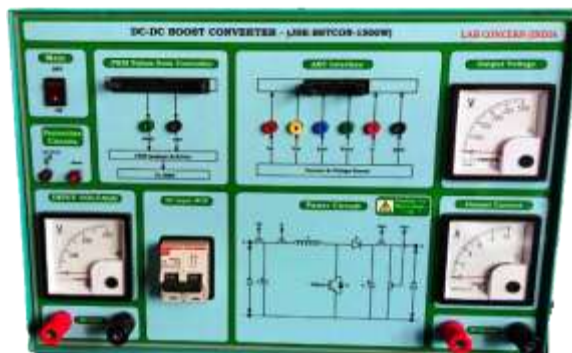
- TL494 based PWM controller for converter PWM generation.
- One number potentiometer provided for set voltage adjustment.
- One number of dpdt switch provided for open loop/closed loop selection.
- One number of pulse socket provided for feedback voltage-interface
- One number of pulse socket provided for PWM output- interface.
- Varies test points provided for wave form measurement.
- Circuit diagram printed in the front panel PCB.
- One number of power on/off switch with indicator.

Buck- converter power circuit:

- One number of IRF250 power MOSFET provided for power device.
- High speed opto provided for MOSFET PWM isolation.
- IR2110 IC provided for MOSFET PWM driver.
- One number of high-frequency inductor and capacitor and diode provided for power circuit.
- One number of output voltage divider circuit provided for feed -back voltage.
- One number of pulse socket provided for feedback voltage-output.
- One number of pulse socket provided for PWM input.
- One number of fixed R-provided for load resistor.
- Low value (0.2e) resistor provided in varies sections of power circuits for current wave-form measurement.
- Banana connectors provided for power circuit input and outputs.
- Fuse provided for output side for over load protections.
- Specifications:
 - ❖ Input : 0-25v dc
 - ❖ Output: 0-5VDC@1Amp

0-30v dc power supply for power converter input.

- Lm723 based variable dc power supply.
- 0-30v dc output @ 2amp capacity.
- One number of potentiometer provided for output voltage variation.
- One number of potentiometer provided for output current variation.
- One number of led display provided for o/p voltage / current measurement.
- Built in over-current limit facility.



DC -DC -BOOST CONVERTER TRAINER

This set-up is designed to study the working principle of -boost dc-dc converter. it consists of

- ❖ Boost converter PWM control circuit.
- ❖ Boost converter power circuit.
 - 0-30v dc power supply for power converter input.

BOOST CONVERTER PWM CONTROL CIRCUIT:

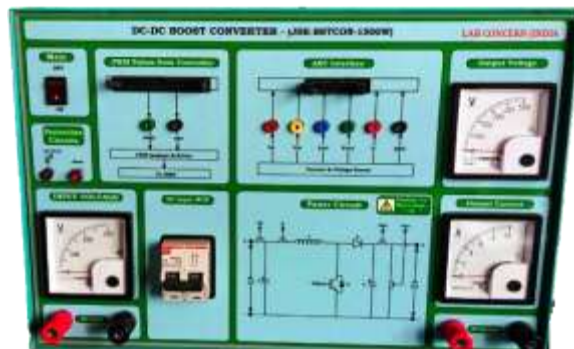
- TL494 based PWM controller for converter PWM generation
- One number potentiometer provided for set voltage adjustment.
- One number of dpdt switch provided for open loop/closed loop selection.
- One number of pulse socket provided for feed back voltage-interface
- One number of pulse socket provided for PWM output- interface.
- Varies test points provided for waveform measurement.
- Circuit diagram printed in the front panel PCB
- One number of power on/off switch with indicator.

BOOST CONVERTER POWER CIRCUIT:

- One number of IRF250 power MOSFET provided for power device.
- High speed opto provided for MOSFET PWM isolation.
- IR2110 IC provided for MOSFET PWM driver.
- One number of high-frequency inductor and capacitor and diode provided for power circuit.
- One number of output voltage divider circuit provided for feed -back voltage.
- One number of pulse socket provided for feed back voltage-output.
- One number of pulse socket provided for PWM input.
- One number of fixed R-provided for load resistor.
- Low value (0.2e) resistor provided in varies sections of power circuits for current wave-Form measurement.
- Banana connectors provided for power circuit input and outputs.
- Fuse provided for output side for over load protections.
- Specifications:
 - input : 0-15v dc@
 - output : 0-30v dc @ 0.5amp

0-30V VARIABLE DC SUPPLY FOR POWER CIRCUIT INPUT:

- LM723 based variable dc power supply.
- 0-30v dc output @ 2amp capacity.
- One number of potentiometer provided for output voltage variation.
- One number of potentiometer provided for output current variation.
- One number of led display provided for o/p voltage / current measurement.
- Built in over-current limit facility.



DC -DC BUCK-BOOST CONVERTER TRAINER

This set-up is designed to study the working principle of buck-boost dc-dc converter. It consists of

- Buck-boost converter PWM control circuit.
- Buck-boost converter power circuit.
- 0-30v dc power supply for power converter input.

BUCK-BOOST CONVERTER PWM CONTROL CIRCUIT:

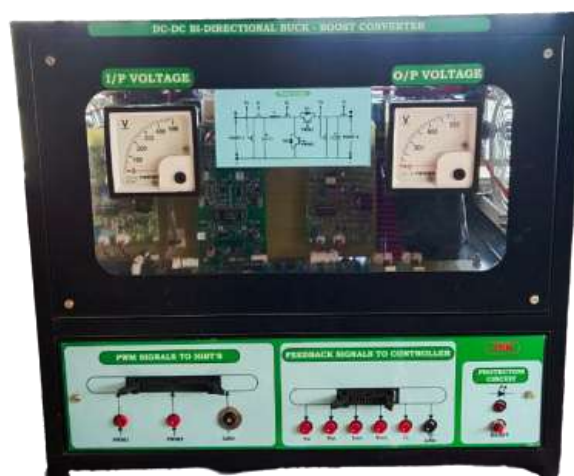
- TL494 based PWM controller for converter PWM generation.
- One number potentiometer provided for set voltage adjustment.
- One number of dpdt switch provided for open loop/closed loop selection.
- One number of dpdt switch provided for buck-boost mode selection.
- One number of pulse socket provided for feed back voltage-interface
- One number of pulse socket provided for PWM output- interface.
- Varies test points provided for waveform measurement.
- Circuit diagram printed in the front panel PCB.
- One number of power on/off switch with indicator.

BUCK-BOOST CONVERTER POWER CIRCUIT:

- One number of IRF250 power MOSFET provided for power device.
- High speed opto provided for MOSFET PWM isolation.
- IR2110 IC provided for MOSFET PWM driver.
- One number of high-frequency inductor and capacitor and diode provided for power circuit.
- One number of output voltage divider circuit provided for feed -back voltage.
- One number of pulse socket provided for feed back voltage-output.
- One number of pulse socket provided for PWM input.
- One number of fixed R-provided for load resistor.
- Low value (0.2e) resistor provided in varies sections of power circuits for current waveform measurement.
- Banana connectors provided for power circuit input and outputs.
- Fuse provided for output side for over load protections.
- Specifications:
 - Input : 0-15v dc
 - Output: 0-30v dc (boost) @ 0.5A
 - 5VDC@1Amp (buck).

0-30V VARIABLE DC SUPPLY FOR POWER CIRCUIT INPUT:

- LM723 based variable dc power supply.
- 0-30v dc output @ 2amp capacity.
- One number of potentiometer provided for output voltage variation.
- One number of potentiometer provided for output current variation.
- One number of led display provided for o/p voltage / current measurement.
- Built in over-current limit facility.



DC -DC FLY BACK CONVERTER TRAINER

This set-up is designed to study the working principle of isolated type fly back- dc-dc converter. It consists of

- Fly back converter PWM control circuit.
- Fly back converter power circuit.
- 0-30V DC power supply for power converter input.

FLY BACK CONVERTER PWM CONTROL CIRCUIT:

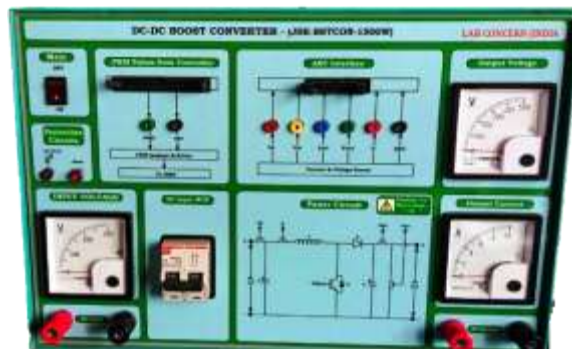
- TL494 based PWM controller for converter PWM generation.
- One number potentiometer provided for set voltage adjustment.
- One number of dpdt switch provided for open loop/closed loop selection.
- One number of pulse socket provided for feed back voltage-interface
- One number of pulse socket provided for PWM output- interface.
- Varies test points provided for waveform measurement.
- Circuit diagram printed in the front panel PCB.
- One number of power on/off switch with indicator.

FLY BACK CONVERTER POWER CIRCUIT:

- One number of IRF250 power MOSFET provided for power device.
- High speed opto provided for MOSFET PWM isolation.
- IR2110 IC provided for MOSFET PWM driver.
- One number of high-frequency fly-back transformer provided for power circuit
- One number of output voltage divider circuit provided for feed -back voltage.
- One number of pulse socket provided for feed back voltage-output.
- One number of pulse socket provided for PWM input.
- One number of fixed R-provided for load resistor.
- Low value (0.2e) resistor provided in varies sections of power circuits for current waveform measurement.
- Banana connectors provided for power circuit input and outputs.
- Fuse provided for output side for over load protections.
- Specifications:
 - Input : 0-20VDC
 - Output: 0-5V @ 1 amp

0-30V VARIABLE DC SUPPLY FOR POWER CIRCUIT INPUT:

- LM723 based variable DC power supply.
- 0-30v dc output @ 2amp capacity.
- One number of potentiometer provided for output voltage variation.
- One number of potentiometer provided for output current variation.
- One number of led display provided for o/p voltage / current measurement.
- Built in over-current limit facility.



DC -DC FORWARD CONVERTER TRAINER

This set-up is designed to study the working principle of isolated type Forward- dc-dc converter. It consists of

- Forward converter PWM control circuit.
- Forward converter power circuit.
- 0-30v dc power supply for power converter input.

FORWARD CONVERTER PWM CONTROL CIRCUIT:

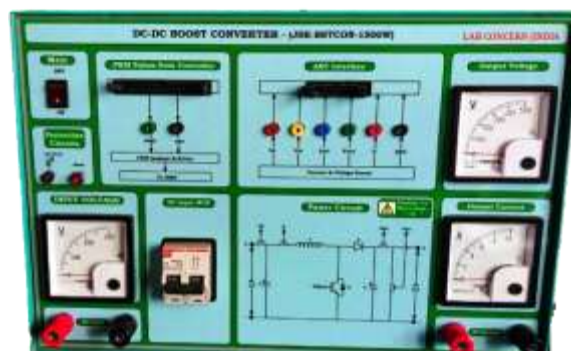
- TL494 based PWM controller for converter PWM generation.
- One number potentiometer provided for set v oltag e adjustment.
- One number of dpdt switch provided for open loop/closed loop selection.
- One number of pulse socket provided for feed back v oltag e-interface
- One number of pulse socket provided for PWM output- interface.
- Varies test points provided for wave form measurement.
- Circuit diagram printed in the front panel PCB.
- One number of power on/off switch with indicator.

FORWARD CONVERTER POWER CIRCUIT:

- One number of IRF250 power MOSFET provided for power device.
- High speed opto provided for MOSFET PWM isolation.
- IR2110 IC provided for MOSFET PWM driver.
- One number of high-frequency forward transformer provided for power circuit
- One number of high frequency diode & inductor, capacitor provided for filter
- One number of output v oltag e divider circuit provided for feed -back v oltag e.
- One number of pulse socket provided for feed back v oltag e-output.
- One number of pulse socket provided for PWM input.
- One number of fixed R-provided for load resistor.
- Low v alue (0.2e) resistor provided in varies sections of power circuits for current waveform measurement.
- Banana connectors provided for power circuit input and outputs.
- Fuse provided for output side for over load protections.
- Specifications:
 - Input : 0-20v dc
 - Output: 0-5v @ 1 amp

0-30V VARIABLE DC SUPPLY FOR POWER CIRCUIT INPUT:

- Lm723 based v ariable DC power supply.
- 0-30V DC output @ 2amp capacity.
- One number of potentiometer provided for output v oltag e variation.
- One number of potentiometer provided for output current variation.
- One number of led display provided for o/p v oltag e / current measurement.
- Built in over-current limit facility.



DC-DC PUSH-PULL CONVERTER

This set-up is designed to study the working principle of -boost dc-dc converter. it consists of

- Push pull converter PWM control circuit.
- Push Pull converter power circuit.
- 0-30v dc power supply for power converter input.

PUSH PULL CONVERTER PWM CONTROL CIRCUIT:

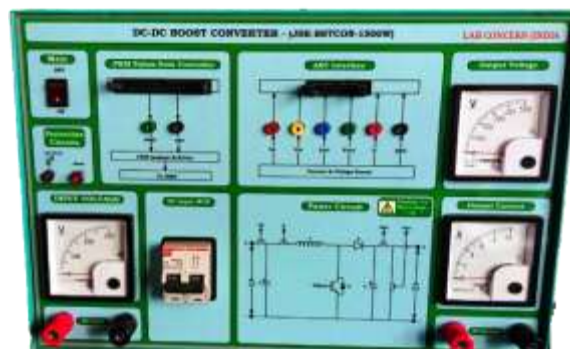
- TL494 based PWM controller for converter PWM generation.
- One number potentiometer provided for set voltage adjustment.
- One number of dpdt switch provided for open loop/closed loop selection.
- One number of pulse socket provided for feed back voltage-interface
- Two number of pulse sockets provided for PWM output- interface.
- Varies test points provided for wave form measurement.
- Circuit diagram printed in the front panel PCB.
- One number of power on/off switch with indicator.

PUSH PULL CONVERTER POWER CIRCUIT:

- Two number of IRF250 power MOSFET provided for power device.
- High speed opto provided for MOSFET PWM isolation.
- IR2110 IC provided for MOSFET PWM driver.
- One number of high-frequency transformer, inductor and capacitor and diode provided for power circuit.
- One number of output voltage divider circuit provided for feed -back voltage.
- One number of pulse socket provided for feed back voltage-output.
- One number of pulse socket provided for PWM input.
- One number of fixed R-provided for load resistor.
- Low value (0.2e) resistor provided in varies sections of power circuits for current wave-Form measurement.
- Banana connectors provided for power circuit input and outputs.
- Fuse provided for output side for over load protections.
- Specifications:
 - input : 0-20VDC
 - output : 0-5V DC @1amp

0-30V VARIABLE DC SUPPLY FOR POWER CIRCUIT INPUT:

- Lm723 based variable dc power supply.
- 0-30v dc output @ 2amp capacity.
- One number of potentiometer provided for output voltage variation.
- One number of potentiometer provided for output current variation.
- One number of led display provided for o/p voltage / current measurement.
- Built in over-current limit facility.



DC-DC SERIES RESONANT CONVERTER TRAINER

This set-up is designed to study the working principle of isolated type dc-dc Series Resonant converter. It consists of

- Resonant converter PWM control circuit.
- Resonant converter power circuit.
- 0-30v dc power supply for power converter input.

RESONANT CONVERTER PWM CONTROL CIRCUIT:

- IC based PWM controller for converter PWM generation.
- One number potentiometer provided for PWM frequency adjustment.
- Two number of pulse socket provided for PWM-interface
- Varies test points provided for wave form measurement.
- Circuit diagram printed in the front panel PCB.
- One number of power on/off switch with indicator.

RESONANT CONVERTER POWER CIRCUIT:

- Two number of IRF250 power MOSFET provided for power device.
- High speed opto provided for MOSFET PWM isolation.
- IR2110 IC provided for MOSFET PWM driver.
- One number of high-frequency transformer provided for power circuit
- One number of high frequency inductor & capacitor provided for tank circuit.
- Two number of pulse socket provided for PWM input
- One number of fixed R-provided for load resistor.
- Low value (0.2e) resistor provided in varies sections of power circuits for current waveform measurement.
- Banana connectors provided for power circuit input and outputs.
- Fuse provided for output side for over load protections.
- One number of analog dc voltmeter provided for output voltage measurement
- Specifications:
 - Input : 0-20V DC
 - Output: 0-5V @ 1 amp

0-30V VARIABLE DC SUPPLY FOR POWER CIRCUIT INPUT:

- Lm723 based variable dc power supply.
- 0-30V DC output @ 2amp capacity.
- One number of potentiometer provided for output voltage variation.
- One number of potentiometer provided for output current variation.
- One number of led display provided for o/p voltage / current measurement.
- Built in over-current limit facility.

UJT, R & RC Firing circuit for SCR

- One number of **UJT , R & RC Firing circuit** is provided
- 2N2646 UJT used as a triggering device
- Potentiometer is provided for firing angle adjustments (10-170 degree)
- 1:1 Pulse transformer is provided for pulse isolations
- One number R FIRING circuit with Potentiometer for firing angle adjustments
- One number RC FIRING circuit with Potentiometer for firing angle adjustments
- Pulse Outputs for all 3 firing circuits are terminated by connectors for SCR inputs
- One number of TYN612 SCR with proper heat sink & snubber circuit is provided
- 230/24V @0.5A Transformer is provided for UJT Firing circuit input
- 230/24V @1A Transformer is provided for power circuit input
- One number of Toggle switch for Power circuit 24V AC ON/OFF
- One number of Power Resistor of 100E/20W is provided as R load
- Power ON/OFF Switch with Indication



Single Phase AC Voltage Controller with R and RL Loads

This trainer is designed to study the working principle of single phase AC regulator circuit using SCR & TRIAC. This trainer consists of

- Two number of TYN612 SCR with heat-sink is provided for Power circuit
- One number of TRIAC is provided for Power circuit
- One number of TCA785 IC based Firing circuits with firing angle adjustments (180-0degree)
- One number of potentiometer is provided for firing angle adjustments
- Pulse outputs are terminated in the Front panel for external Patching.
- 24v, 1Amp AC is provided for power circuit inputs
- One number of power resistor is provided as fixed R Load
- All necessary test points are provided for external patching
- All are mounted on a nice cabinet with sticker front panel with mimic diagram
- 230VAC input with power ON/OFF Switch & Power circuit Input is 24VAC



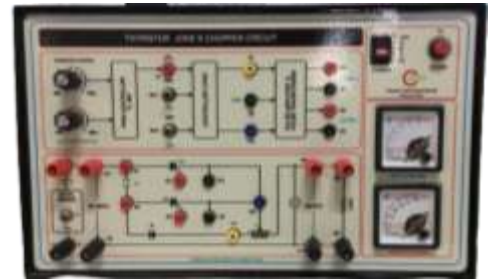
DC Jones Chopper with R and RL Loads

This trainer is designed to study the principle of SCR Based DC-DC Chopper circuit (Jones Chopper).

1. SCR Chopper Firing circuit
2. Power circuit

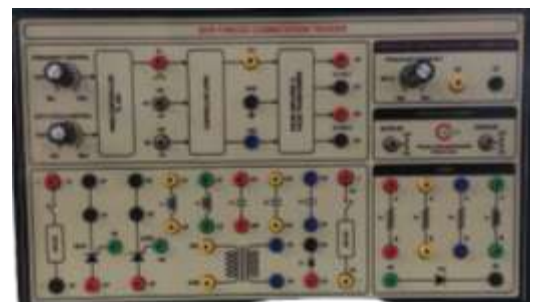
SCR Chopper firing circuit and Power circuit

- Two number of TYN1225 SCR with heat-sink is provided for Power circuit
- One number of Power diode & Inductor is provided for Power circuit
- Necessary Commutating components (L&C) are provided to form JONES CHOPPER
- One number of Digital / IC based Firing circuits with duty cycle ratio & Frequency Adjustment
- Two number of potentiometer / digital key is provided for duty cycle ratio/freq. adjustments
- Toggle switches are provided for pulse ON/OFF
- 2 Numbers of Pulse outputs are terminated in the front panel for external Patching.
- 200v DC is provided for power circuit inputs & DC Voltmeter is provided for input/output dc voltage measurement
- One no of fixed Loads will be provided.



Forced Commutation Circuits (Class A, Class B, Class C, Class D and Class E)

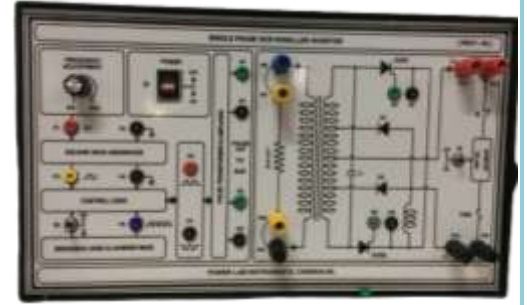
- Study the forced commutation circuits like Class A, Class B, Class C, Class D & Class E
- 2 number of TYN612 SCR with heat-sink is provided for Power circuit
- Two number of Power diode is provided for Power circuit
- One number of IC based Firing circuits with duty cycle & frequency adjustments
- One number of potentiometer is provided for firing angle adjustments & frequency adjustments
- 2 Numbers of Pulse outputs are terminated in the PCB for external Patching.
- 24v, 1Amp DC is provided for power circuit inputs
- One number of power resistors is provided as fixed R Load with for external patching
- One number of 100Mh inductor & Capacitor is provided commutation circuits
- All necessary test points are provided for external patching
- All are mounted on a nice cabinet with sticker front panel with mimic diagram



Single Phase Parallel, Inverter with R and RL Loads

This trainer is designed to study the working principle of SCR Based PARALLEL INVERTER circuits. This set up consists of

- 2 number of TYN612 SCR with heat-sink is provided for Power circuit
- Two number of Power diode is provided for Power circuit
- One number of IC based Firing circuits with frequency adjustments
- One number of potentiometer is provided for firing pulse frequency adjustments
- 2 Numbers of Pulse outputs are terminated in the PCB for external Patching.
- 24v, 1Amp DC is provided for power circuit inputs
- One number of power resistor is provided as fixed R Load with terminations for External patching
- One number of Capacitor is provided commutation circuits
- One number of Parallel inverter transformer (24V, 1A) capacity is provided
- All necessary test points are provided for external patching
- All are mounted on a nice cabinet with sticker front panel with mimic diagram
- 230VAC input with power ON/OFF Switch
- Power circuit Input is 24V DC & Output 24VAC @1A



SCR Based Series Inverter

- This trainer is designed to study the working principle of SCR Based SERIES INVERTER circuits . This set up consists of
- 2 number of TYN612 SCR with heat-sink is provided for Power circuit
- Power diode is provided for Power circuit
- One number of IC based Firing circuits with frequency adjustments
- One number of potentiometer is provided for firing pulse frequency adjustments
- 2 Numbers of Pulse outputs are terminated in the PCB for external Patching.
- 24v, 1Amp DC is provided for power circuit inputs
- One number of power resistor is provided as fixed R Load with terminations for External patching
- Two number of Capacitor is provided commutation circuits
- One number of Series inverter inductor is provided
- All necessary test points are provided for external patching
- All are mounted on a nice cabinet with sticker front panel with mimic diagram
- 230VAC input with power ON/OFF Switch
- Power circuit Input is 24VDC



Single phase Cyclo-converter with R and RL loads

This setup designed to study the working principle of single-phase step-down

1. Single phase cyclo converter firing circuit
 2. SCR power circuit
- 4 number of SCRs (600V @ 25Amp) With necessary Heat sink & Snubber circuit is provided to Form single phase Mid-Point Type Cyclo-converter ckt
 - Digital IC based SCR Firing pulse generation with Firing angle adjustment of 180-0 degree & Frequency selection of 50Hz , 50/2 Hz , 50/3Hz , 50/4 Hz, 50/5Hz & 50/6 Hz
 - Digital Keys are provided to select Output Frequency & Firing angle adjustment
 - Pulse transformer & Transistor based Pulse amplifier is provided in all Four SCR's
 - IC based ZCD Circuit is provided for Synchronized SCR Pulse generation
 - Input 230V \pm 10%, 50Hz single phase AC & \pm 15V DC @ 0.5A regulated op trigger ckt.
 - One number of Center tape transformer of 230 /24-0-24VAC@2A is provided for power circuit input
 - One number of Fixed Resistor is provided as R- load



Single Phase Dual Converter with RL Loads

- Built-in FPGA based Firing pulse controller.
- 4 Number of SCR rating @ 1200V , 25A with proper heat sink & snubber circuit is provided for P Group Converter
- 4 Number of SCR rating @ 1200V , 25A with proper heat sink & snubber circuit is provided for N Group Converter
- Numbers of 1:1 Pulse transformer is provided for Pulse Isolation with test point connector for waveform measurement
- SCR outputs are terminated by banana connectors for external load connection
- 3 Numbers of 25A Hall effect current sensor is provided with signal conditioner circuit input DC & Output AC
- Designed Output Capacity @ 5A
- Single Phase 0-230VAC Input & 0-200vdc Output @5A Capacity
- Dual Converter power module for fixed RL Load
- Suitable for DC Motor load.



CHOPPER FED DC DRIVE

- Built-in FPGA based Firing pulse controller.
- 4 Number of SCR rating @ 600V , 75A with proper heat sink & snubber circuit is provided for Converter
- Numbers of 1:1 Pulse transformer is provided for Pulse Isolation with test point connector for waveform measurement
- SCR outputs are terminated by banana connectors for external load connection
- 3 Numbers of 25A Hall effect current sensor is provided with signal conditioner circuit input DC & Output AC
- Designed Output Capacity @ 5A
 - Single Phase 0-230VAC Input & 0-200v dc Output @5A Capacity Suitable for DC Motor load.

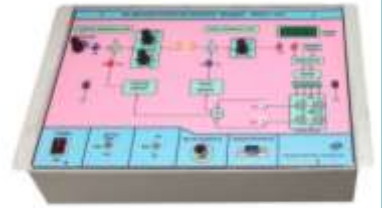


CONTROL SYSTEMS LAB

1. DC Motor Position Control Trainer (JIPC -103)

DC Position Control System provides the students an opportunity to study and operate a practical electro mechanical angular-position-control system.

- The system is built using a good quality permanent magnet DC motor.
- Potentiometric using special 360° revolution servo potentiometers
- High quality MOSFET based DC driver circuit to drive the DC motor.
- Necessary Patch chords and cables
- Position control of a 12V gear motor
- Mimic diagram with multicolor test points in the front panel
- Digital display to display the set point & real position
- Regulated power supplies for electronic circuits
- All components are fixed in attractive powder coated metal cabinet



2. Synchro Transmitter and Receiver (JIST-104)

This unit consists of high torque synchro (Transmitter & Receiver), Digital panel Meter, Transformer etc. to study the characteristics of synchro transmitter & receiver

- Synchro transmitter to generate the stator voltage
- Synchro receiver rotate based on transmitter stator voltage
- Synchro transmitter-receiver pair with calibrated dials (0-360°)
- Digital panel meter provided to measure the generator voltage
- Step down transformer (Input:230V AC /Output:50v AC) to connect the rotor supply
- Necessary panel connectors provided
- All components are mounted in attractive powder coated metal cabinet



3. Lead Lag compensation (JILL -102)

This unit has been designed to enable the students to go through the complete design procedure and finally verify the performance improvements provided by compensation.

- Square and sine wave generators for transient and frequency response studies
- Compensation network implementation through built-in variable gain amplifier
- Error detector, lead, lag, inverter blocks
- Provision for connect external RC values
- RC source with variable range.
- Regulated power supply, Frequency adjustment potentiometer provided
- Mimic diagram with test points provided
- All components are mounted in attractive powder coated cabinet



4. DC Motor Speed Control System

FEATURES

- One F/V converter provided to convert the pulses voltage output,
- Speed controller provided to select # Proportional circuit # proportional plus integral circuit
- One 3½ digit display to the speed of DC Servo motor / set value

- A Switch provided to select the reference or actual Speed.
- All Important signals are terminated at sockets so that the student can monitor / measure the signals using CRO, DVM, Frequency counter etc. POWER AMPLIFIER:
- PWM based MOSFET



Power Amplifier

- One MOSFET as power device
- Rating: 500V @ 8 Amp
- Control circuitry with opto-coupler Isolation.
- One potentiometer provided to control the duty cycle of the chopper

DC SERVO MOTOR WITH EDDY LOAD:

- One 12V, PM DC Motor, mounted on a open frame
- Speed Range: 0 to 1500 RPM
- Speed Sensor fixed on the frame # Photon interrupter with optical Encoders.
- Eddy Current Magnetic Loading Arrangement.

POWER SUPPLY:

Input 230V +10%, 50Hz, Single phase AC * 15V at 0.5A DC regulated output for control circuitry output

5. AC Servo Motor Speed control System (JIAS-106)

This unit consists of AC servo motor, power driver, feedback sensor with motor setup etc., to study the AC motor speed control.

- The system is good quality AC servo motor is permanent split capacitance induction motor.
- Thyristor based power driver circuit to drive the AC servo motor
- Fan with disc fixed on AC motor.
- Opto coupler sensor to sense the motor speed.
- Motor with feedback sensor fixed in a separate setup
- Digital display to display the motor speed and set point.
- IC regulated power supply.
- PI controller with P, I potentiometer provided..
- Setpoint potentiometer and test points provided for each stage .
- Open loop/ closed loop provision.
- All components are fixed in attractive powder coated metal cabinet.

6. PLC (Siemens) Study Trainer

This PLC trainer consists of Demonstration panel, PLC software to study the concepts, and programming of programmable logic controller. Demonstration panel consists of PLC, Switches and LEDs to demonstrate input, output functions, etc.

PLC Make

: Siemens

- Model : SIMATIC S71200 (**\$7 200 model is Absolute**)
- Analog Inputs : 2 (0-10 V DC)
- Analog Outputs : 2 (0-20 mA DC)
- Digital Inputs : 14 (24 V DC)
- Digital Outputs : 10 (24 V DC)
- Power supply voltage: 24 V DC
- Interface Communication: PROFINET- 2 PORT
- Memory Program/data : 125 KB
- Fast counters : 6 (three with max. 100 kHz; 3 with max. 30 kHz)
- SIMATIC STEP 7 TIA-Portal Basic License Software for Programming

Demonstration Panel:

- 12 SPDT Switches/Push button provided to simulate the Digital inputs.
- 10 LEDs provided with fuse protection to simulate the digital outputs
- Voltage source (0-10) V with indicator provided.



- Power supply (+24V DC / 2 A) communication cable provided.
- Connectors provided for external interface application.
- Mimic diagram with sticker provided in the panel.
- PLC integrated with Demonstration panel for compact size.
- The components are mounted on an attractive powder coated cabinet.



Programming Software:

Windows (7/8/10) 32 bit based programming software.

Note :

PC should be provided by the institution at the time of installation.

7. Stepper Motor Control System

This unit consists of stepper motor, feedback sensor, PWM based power driver, Power supply etc., to study and control the stepper motor position.

- Highly torque stepper motor.
- Position feedback sensor fixed
- PWM based intelligent power driver to drive the motor supply.
- Digital Controller to control motor position
- Regulated power supply.
- Digital display to display the motor position.
- All components are fixed in attractive powder coated metal cabinet.

8. DSP Trainer

- Input : 230VAC 50Hz
- Power supply: 5VDC

Hardware overview:

- A Texas instruments TMS 320C6748 device with a DSP floating
- Point processor and processor operating up to 300 MHz
- 8user LED/8 position user DIP Switch
- 2 channel spi based 1 MSPS ADC
- 14 Pin TI JTAG for external programme interfaces
- Tlv320aic3106 stereo code
- Configurable boot load options
- Single voltage power supply 5v
- 2 channel spi based DAC
- Embedded JTAG Emulation
- Cabinet: wooden box

Experiment:

- ADC loop back
- Wave form generator(sine, square, triangle, cosine)
- Design FIR filter
- Sampling theorem
- CODEC loop back
- N point DFT&FFT
- Design IIR filter
- Noise removal
- Convolution & correlation



9. PID Controller (JIPID-101)

The PID Controller unit consists of simulated building blocks like error detector, dead time, integrator and time constants, which may be configured into a variety of systems.

- Simulated 1st, 2nd order system of type 0 and type 1 system
- PID section with adjustable proportional gain, derivative and integral time constants provide the control action.
- Simulated blocks – dead time (transportation lag), integrator, time constants, error detector and gain.
- Signal Generator for sine & square waveforms, the students to study the response on CRO
- Set value pot meter and disturbance source provided
- IC regulated Power Supply
- Multicolor test points with mimic diagram in front panel
- Necessary flexible patch chords with detailed documentation
- Attractive powder coated metal cabinet.

Function Generator - 3MHz

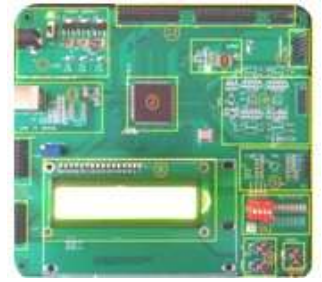
- **Sine, Square, Triangle, Pulse, TTL, DC, Sweep output**
- LCD display for 16 character by 2 line shows frequency and output wave form
- Direct digital synthesizer IC based design with crystal oscillator give exception a frequency accuracy
- Variable DC offset with on/off control
- Output amplifier protected against short circuit
- Standard 50 ohms output impedance
- Frequency range: 0.33Hz to 3.33MHz selected in 6 decade steps
- DC offset: +/- 5v continuously adjustable
- 20V peak to peak Amplitude
- 0db, 20db, 40db, 60db Attenuator
- Powder coated sleek cabinet.



DIGITAL PULSE / TRIGGER/PWM CONTROLLERS:

dsPIC30F4011 PWM CONTROLLER

- dsPIC30F4011 MICRO CONTROLLER
- Oscillator/Reset
- Low Voltage Detect/Watchdog Timer and Power Saving Modes
- Flash and EEPROM Programming
- 16x2 LCD display.
- Operating Voltage: +5v
- Operating Frequency: 40MHz
- On chip 48k flash Memory
- Four compare unit
- 6 PWM pulses to control the switching devices that are connected with 34pin FRC connector.
- 4 Channel ADC/ 5 Channel DAC are connected with 26 pin FRC cable.



FPGA PWM CONTROLLER-DEVELOPMENT BOARD

- **Xilinx SPARTAN-6** Processor speed 20 MHz
- 100 inputs/output lines are in 3.3/5V level
- Isolated serial communication interface through USB connector
- 4MB PROM for code execution memory.
- External JTAG header for programming
- 20x4 (or 16x2) LCD interface header.
- 8 user LEDs/4 position user DIP switch/2 up & down input push switch/Up to 100 GPIO Pins



VHDL

ADC

- **No of ADC input : 16 Channels/32 Channel (Bi-Polar type)**
- Resolution : 12 bit
- Sampling rate : 1MSPS
- Analog input range: ±10V
- Buffer section for voltage protection



DAC

- **No of DAC output : 4 Channels /8 Channel**
- Resolution : 12 bit
- Settling time : 6µs
- Analog input range: -5v to +5V
- 16 pin header for ADC input/16 pin header for PWM OUTPUT
- 2nos 50pin headers for GPIO line termination/External Programming header/100pwm signals

DSP Development Board specification

- **TMS320F28335** Processor speed up to 150 MHz.
- Isolated serial communication interface through USB connector and 9-Pin male header.
- On board Isolated USB emulator for programming, debugging.
- 16 PWM Output/6 capture input for read external inputs.
- 20x4 (or 16x2) LCD interface header/On chip flash for programming 512KB/On chip RAM 68KB
- 16 output lines for LEDs/8 input lines for Read switch inputs/2 no of input push switches.



ADC

- ADC :16 Ch., Resolution : 12 bit, Samp./ Rate : 12.5MSPS
- Analog input range : ±3.3V with buffered input

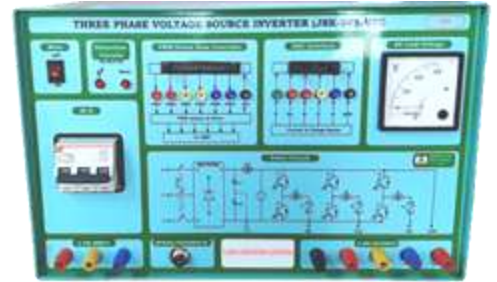
DAC

- DAC output : 8 Channels, Resolution : 12 bit, S. time : 6µs, Analog o/p: 0 to +3.3V/5V

IGBT INVERTERS/DC-DC CONVERTERS/RECTIFIERS

THREE PHASE VOLTAGE SOURCE INVERTER

- IGBT 600V/75A based power circuit.
- Gate Driver circuit for Device protection
- Input AC Voltage (for Rectifier) = 415V or 300Vdc
- DC Link Voltage $V_{dc} = 300Vdc$
- Output AC Voltage $V_{ac} = 0-415V$ 3- ϕ (line to line volt)
- Output Load Current $I_{ac} = 5A$ max
- Output Frequency = 0-50 Hz
- IGBT Switching Frequency $F_{sw} = 10$ KHz MAX



3 PHASE DIODE RECTIFIER + 3 PHASE INVERTER 3 LEG/4 LEG/6 LEG CONFIGURATION'S

- SEMIKRON –IGBT 1200V/70A
- SKYPER 32/AGILENT gate Drivers
- Input AC Voltage (for Rectifier) = 415V Line to line volt
- DC Link Voltage $V_{dc} = 650Vdc$
- Output AC Voltage $V_{ac} = 0-415V$ 3- ϕ (line to line volt)
- Output Load Current $I_{ac} = 30A$ max
- Output Frequency = 0-50 Hz
- IGBT Switching Frequency $F_{sw} = 20$ KHz MAX
- Ambient Temperature $T_{amb} = 40$ dec C.
- Cooling Method Forced Air Cooled.
- OPAL-RT/dSPACE/DSP/FPGA-compatible



MULTI LEVEL INVERTER-3 LEVEL (ANPC) TYPE -20kva

- SEMIKRON –IGBT 1200V/70A
- SKYPER 32/AGILENT gate Drivers
- Input AC Voltage (for Rectifier) = 415V (L - L volt)
- DC Link Voltage $V_{dc} = 650Vdc$
- Output AC Voltage $V_{ac} = 0-415V$ 3- ϕ (L to L volt)
- Output Load Current $I_{ac} = 25A$ max
- Output Frequency = 0-50 Hz
- IGBT Switching Frequency $F_{sw} = 20$ KHz MAX
- Ambient Temperature $T_{amb} = 40$ dec C.
- Cooling Method Forced Air Cooled.
- OPAL-RT/dSPACE/DSP/FPGA compatible
- *AVAILABLE POWER RATING---1KVA to 25KVA



5PHASE 5-LEVEL CASCADED H-BRIDGE MULTI LEVEL INVERTER

- FPGA based PWM controller
- 5KVA IGBT based 5PH -5LEVEL Power Circuit
- 1HP - 5PH & 3PH induction motor with spring balance/Eddy current Load/Generator Loads.
- OPAL-RT/dSPACE/DSP/FPGA compatible



AC/DC/BLDC/PMSM/SWITCHED RELUCTANCE/MULTIPHASE-MOTOR DRIVES

AC MOTOR:

Power : 1HP/2HP/5HP/10HP/15HP
 Speed : 1500rpm
 Voltage : 412V
 Current : 4.2A
 Frequency : 50Hz/60Hz
 Loading : Mechanical/Electrical
 Feedback : Proximity/QEP

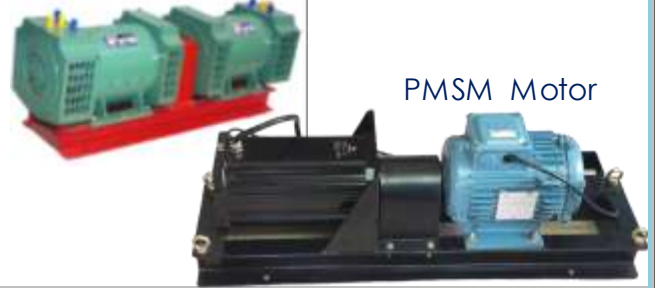
Ac Motor Generator



DC MOTOR:

Power : 2Kw/3Kw/10Kw
 Speed : 1500rpm/2000rpm
 Voltage : 220V
 Current : 2A
 Frequency : 50Hz/60Hz
 Loading : Mechanical/Electrical
 Feedback : Proximity/QEP

Dc Motor Alternator



PMSM Motor

BLDC MOTOR:

Power : 0.75Kw/1.4Kw/3.7KW
 Speed : 1500rpm
 Voltage : 180vDC
 Current : 2A
 Frequency : 50Hz
 Loading : Mechanical/Electrical
 Feedback : 3-HALL sensor with 120 degree apart



3.7kW BLDC

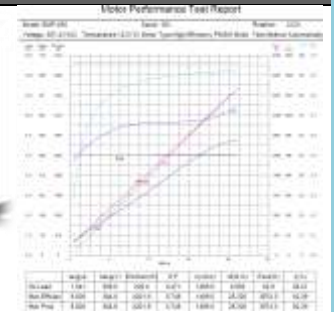
BLDC motor with GEAR arrangement

PMSM Motor:

Power : 0.75Kw/1.4Kw/3.7Kw
 Speed : 1500rpm/4000rpm
 Voltage : 180vDC
 Current : 2A
 Frequency : 50Hz
 Loading : Mechanical/Electrical
 Feedback : Position sensor



5kW PMSM



Switched Reluctance Motor:

Power : 1HP/3HP
 Speed : 2000rpm
 Voltage : 310V
 Current : 4.2A
 Frequency : 50Hz
 Phase : 4Ph 8/6 Type
 Loading : Mechanical/Electrical
 Feedback : Positions sensor

Eddy current dynamo load



Multi Phase Motor(5/6/9phase):

Type : 5 Phase Sq. Cage Induction motor
 Power : 1 hp (750W)
 Stat. Voltage : 5 phase, 180V
 Current : 2A
 Speed : 1500 RPM
 Loading : Mechanical/Electrical
 Feedback : Positions sensor

5-Phase Induction Motor



Synchronous Reluctance motor

***special customized motors are available: -PMSG/SYNCHRONOUS RELUCTANCE/POLY-PHASE**

1. FPGA driven IGBT based DC motor Drive.(DC DRIVE).



FPGA based Generalize PWM controller (Re-programmable):1no.

Processor & its speed: FPGA Spartan-6 LXT_9 FPGA: High-speed (20MHz or more)

Front End Software support: USB/JTAG Enabled by ISE® Design Suite Linux and Windows

Number of Digital I/Os: 200 or more with voltage level 3.3v/5V Level

No of ADC Channel: 8 isolated – Bi-Polar Resolution:12Bit Sampling Rate:1MSPS

No of DAC Channel: 4 isolated Resolution:12Bit S/Time-6 μ s Analogue :-5v to +5V

Types of PWM: Open Loop /Closed Loop speed control of separately excited DC Shunt motor.

IGBT based 3-ph Voltage Source Inverter Stack(AC/DC)-10kVA:1 no

IGBT rating: 1200V/100A or more with switching frequency 20 kHz or more

Input AC Voltage (for Rectifier): 415V_{L-L}

DC Link Voltage: 600V

Output Voltage & current: 0-415V, 3- ϕ (line to line volt), 15A max

Output Frequency & Minimum motor speed: 0-50 Hz

Gate Driver: Skyper32/HCPL316J Based smart driver with inverting, non-inverting, auto-reset, shutdown capabilities and “Soft” turn-on/turn-off features.

Sensors: 4 Nos. of H-Effect current sensor LA25-P SC circuit-1 No Voltage Sensor ACPL-C870 with Signal circuit measurable DC Links.

Measuring Element of DC Link: Galvanized Voltmeter 0-600V

Protections: Protections: Over-voltage, over-current, under-voltage etc.

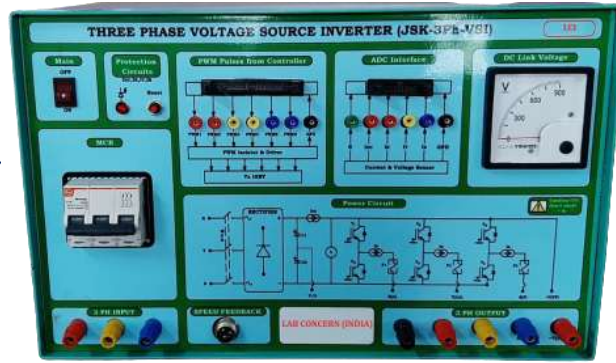
DC Motor with Spring Balance Load (standard make): 1KW, 220v DC, 1500rpm, Field voltage 512 pulse QEP sensor.

Measurable components at front panel & Software based: Gate pulses, converter parameters, motor speed, motor parameters, Voltage, act. Speed, Ref Speed from PC, Motor can run In both direction, V_d, V_q, I_d, I_q references displayed through VEE-PRO software in PC.

Accessories: 1 no. of single phase Isolation transformer (230/110-0-110v ac)-1KVA, 1 no. of single phase Autotransformer-2KVA.

Compatibility: compatible to other real-time controller(OPAL-RT/dSPACE/Typhoon-HIL)

2. DSP driven IGBT based AC Induction motor drive. (AC DRIVE)



DSP based Generalize PWM controller (Re-programmable):1no.

Processor & its speed: TMS320F28335: High-speed (150MHz or more)

Front End Software support: USB/JTAG Enabled by CCS® Design Suite for Windows

Number of Digital I/Os: 200 or more with voltage level 3.3v/5V Level

Memory: On chip flash for programming 512KB, On chip RAM 68KB

No of ADC Channel: 16 isolated – Bi-Polar Resolution:12Bit Sampling Rate:1MSPS

No of DAC Channel: 4 isolated Resolution:12Bit S/Time-6µs Analogue :-5v to +5V

Types of PWM: Open Loop /Closed Loop speed control of Induction motor pulse pattern.

IGBT based 3-ph Voltage Source Inverter Stack-10kVA:1 no

IGBT rating:1200V/100A or more with switching frequency 20 kHz or more

Input AC Voltage (for Rectifier): 415V_{L-L}

DC Link Voltage: 600V

Output Voltage & current: 0-415V, 3-φ (line to line volt), 15A max

Output Frequency & Minimum motor speed: 0-50 Hz

Gate Driver: Skyper32/HCPL316J Based smart driver with inverting, non-inverting, auto-reset, shutdown capabilities and "Soft" turn-on/turn-off features.

Sensors: 4 Nos. of H-Effect current sensor LA25-P SC circuit-1 No Voltage Sensor ACPL-C870 with Signal circuit measurable DC Links.

Measuring Element of DC Link: Galvanized Voltmeter 0-600V

Protections: Over-voltage, over-current, under-voltage etc.

AC Induction Motor with Spring Balance Load (standard make): 1kW open-end winding, 415, 50HZ, 1440rpm, stator current 3A with 512 pulse QEP sensor.

Measurable components at front panel & Software based: Gate pulses, converter parameters, motor speed, motor parameters, Voltage, act. Speed, Ref Speed from PC, Motor can run in both direction, V_d, V_q, I_d, I_q references displayed through VEE-PRO software in PC.

Accessories: 1 no. of single phase Isolation transformer (230/110-0-110vac)-1KVA, 1 no. of single phase Autotransformer-2KVA.

Compatibility: compatible to other real-time controller(OPAL-RT/dSPACE/Typhoon-HIL)

3. FPGA driven IGBT based BLDC motor Drive PMBLDC. (BLDC DRIVE)



FPGA based Generalize PWM controller (Re-programmable):1no.

Processor & its speed: FPGA Spartan-6 LXT_9 FPGA: High-speed (20MHz or more)

Front End Software support: USB/JTAG Enabled by ISE® Design Suite Linux and Windows

Number of Digital I/Os: 200 or more with voltage level 3.3v/5V Level

No of ADC Channel: 8 isolated – Bi-Polar Resolution:12Bit Sampling Rate:1MSPS

No of DAC Channel: 4 isolated Resolution:12Bit S/Time-6 μ s Analogue :-5v to +5V

Types of PWM: Open Loop /Closed Loop speed control of BLDC motor pulse pattern.

IGBT based 3-ph BLDC Inverter Stack-10kVA:1 no

IGBT rating:1200V/100A or more with switching frequency 20 kHz or more

Input AC Voltage (for Rectifier): 415V_{L-L}

DC Link Voltage: 600V

Output Voltage & current: 0-415V, 3- ϕ (line to line volt), 15A max

Output Frequency & Minimum motor speed: 0-50 Hz

Gate Driver: Skyper32/HCPL316J Based smart driver with inverting, non-inverting, auto-reset, shutdown capabilities and "Soft" turn-on/turn-off features.

Sensors: 4 Nos. of H-Effect current sensor LA25-P SC circuit-1 No Voltage Sensor ACPL-C870 with Signal circuit measurable DC Links.

Measuring Element of DC Link: Galvanized Voltmeter 0-600V

Protections: Protections: Over-voltage, over-current, under-voltage etc.

PMBLDC Motor with Spring Balance Load (standard make): Rated Voltage:Three-

phase300v DC, RatedCurrent:2.5A, Power:1000Watts, Torque:3.3N-m, RPM:3000 rpm, Feed back:3-Hall sensor standard with 120 Degree apart, DemagnetizationTemperature \geq 150°C, Protection Grades:IP54, Noise Control: \leq 62 dB (Self-cooling), Vertical Installation:B14, IP54

Measurable components at front panel & Software based: Gate pulses, converter parameters, motor speed ,motor parameters, Voltage, act. Speed ,Ref Speed from PC, Motor can run In both direction , Vd,Vq,Id,Iq references displayed through VEE-PRO software in PC.

Accessories:1 no. of single phase Isolation transformer (230/110-0-110vac)-1KVA , 1 no. of single phase Autotransformer-2KVA .

Compatibility: compatible to other real-time controller(OPAL-RT/dSPACE/Typhoon-HIL)

4. FPGA driven IGBT based PMSM motor Drive (PMSM DRIVE)



FPGA based Generalize PWM controller (Re-programmable):1no.

Processor & its speed: FPGA Spartan-6 LXT_9 FPGA: High-speed (20MHz or more)

Front End Software support: USB/ JTAG Enabled by ISE® Design Suite Linux and Windows

Number of Digital I/Os: 200 or more with voltage level 3.3v/5V Level

No of ADC Channel: 8 isolated – Bi-Polar Resolution:12Bit Sampling Rate:1MSPS

No of DAC Channel: 4 isolated Resolution:12Bit S/Time-6µs Analogue :-5v to +5V

Types of PWM: Open Loop /Closed Loop speed control of PMSM motor pulse pattern.

IGBT based 3-ph PMSM Inverter Stack-10kVA:1 no

IGBT rating:1200V/100A or more with switching frequency 20 kHz or more

Input AC Voltage (for Rectifier): 415V_{L-L}

DC Link Voltage: 600V

Output Voltage & current: 0-415V, 3-φ(line to line volt), 15A max

Output Frequency & Minimum motor speed: 0-50 Hz

Gate Driver: HCPL316J Based smart driver with inverting, non-inverting, auto-reset, shutdown capabilities and "Soft" turn-on/turn-off features.

Sensors: 4 Nos. of H-Effect current sensor LA25-P SC circuit-1 No Voltage Sensor ACPL-C870 with Signal circuit measurable DC Links.

Measuring Element of DC Link: Galvanized Voltmeter 0-600V

Protections: **Protections:** Over-voltage, over-current, under-voltage etc.

PMSM Motor with Spring Balance Load (standard make): Rated Voltage:Three-

phase230Vac2, RatedCurrent:2.5A, Power:1000Watts, Torque:3.3N-m, RPM:3000 rpm, Feed

back:2024PPR Position Encoder, DemagnetizationTemperature≥150°C, Protection

Grades:IP54, Noise Control:≤62 dB(Self-cooling), Vertical Installation:B14, IP54

Measurable components at front panel & Software based: Gate pulses, converter parameters,

motor speed, motor parameters, Voltage, act. Speed ,Ref Speed from PC, Motor can run In both direction , Vd, Vq, Id, Iq references displayed through VEE-PRO software in PC.

Accessories:1 no. of single phase Isolation transformer (230/110-0-110v ac)-1KVA , 1 no. of single phase Autotransformer-2KVA .

Compatibility: compatible to other real-time controller(OPAL-RT/dSPACE/Typhoon-HIL)

5. FPGA driven IGBT based SR motor(SWITCHED RELUCTANCE DRIVE)



Generalize PWM controller (Reconfigurable): 1 no.

Processor & its speed: Spartan-6 LXT FPGA: High-speed connectivity (20MHz or more)

Front End Software support: JTAG Enabled by ISE® Design Suite Linux and Windows user

Number of Digital I/Os: 200 or more with voltage level 3.3v/5V Level

No of ADC Channel: 8 isolated – Bi-Polar Resolution:12Bit S/R:1MSPS

No of DAC Channel: 4 isolated Resolution:12Bit S/Time-6µs Analog :-5v to +5V

Types of PWM: At least SPWM&SVPWM, Modified SVPWM

IGBT based Front End SR Inverter Stack-5KW :1 no.,

IGBT rating: 600V/70A or more with switching frequency 40 kHz or more

Input AC Voltage (for Rectifier): 230V_{L-L}

DC Link Voltage: 350V

Output Voltage & current: 0-300V, 4-φ(line to line volt), 5A max

Gate Driver: HCPL316J Based smart driver with inverting, non-inverting, auto-reset, & shutdown capabilities and "Soft" turn-on/turn-off features.

Sensors: 5 Nos. of Smart current sensor LA25-P SC circuit-1 No Voltage Sensor ACPL-C870 with Signal circuit measurable DC Links. Galvanized Voltmeter 0-500V

Protections: Over-voltage, over-current, under-voltage etc.

Motor: 1HP, 4-phases, 8/6 pole SR motor with 310V, 2000rpm at full load and 3000RPM at No Load coupled with spring balance load & optical position sensors (2nos.). Should operate in Open/closed-loop and current control technique may be extra.

Measurable components at front panel: Gate pulses, converter parameters etc. and Motor parameters, reference & actual speed displayed through VEE-PRO software in PC.

Accessories: 1 no. of single phase Isolation transformer (230/110-0-110v ac)-1KVA, 1 no. of single phase Autotransformer-2KVA .

Compatibility: compatible to other real time controller(OPAL-RT/dSPACE/Typhoon-HIL)

6. FPGA driven IGBT based Multi Phased(5PH) motor Drive



Generalize PWM controller (Reconfigurable):1no.

Processor & its speed: Spartan-6 LXT_9 FPGA: High-speed connectivity (20MHz or more)

Front End Software support: USB/JTAG Enabled by ISE® Design Suite Linux and Windows

Number of Digital I/Os: 200 or more with voltage level 3.3v/5V Level

No of ADC Channel: 8 isolated – Bi-Polar Resolution:12Bit S/R:1MSPS

No of DAC Channel: 4 isolated Resolution:12Bit S/Time-6µs Analogue :-5v to +5V

Types of PWM: SPWM & SVPWM based open & Closed-Loop speed control (up to 6-ph operations)

IGBT based 6-ph Inverter Stack-10kVA:1 no

IGBT rating:1200V/100A or more with switching frequency 40 kHz or more

Input AC Voltage (for Rectifier): 415V_{L-L}

DC Link Voltage: 600V

Output Voltage & current: 0-415V, 6-φ (line to line volt), 15A max

Output Frequency: 0-50 Hz

Gate Driver: Skyper32/HCPL316J Based smart driver with inverting, non-inverting, auto-reset, shutdown capabilities and “Soft” turn-on/turn-off features.

Sensors: 6 Nos. of H-Effect current sensor LA25-P SC circuit-1 No Voltage Sensor ACPL-C870 with Signal circuit measurable DC Links. Galvanized Voltmeter 0-600V

Protections: Over-voltage, over-current, under-voltage etc.

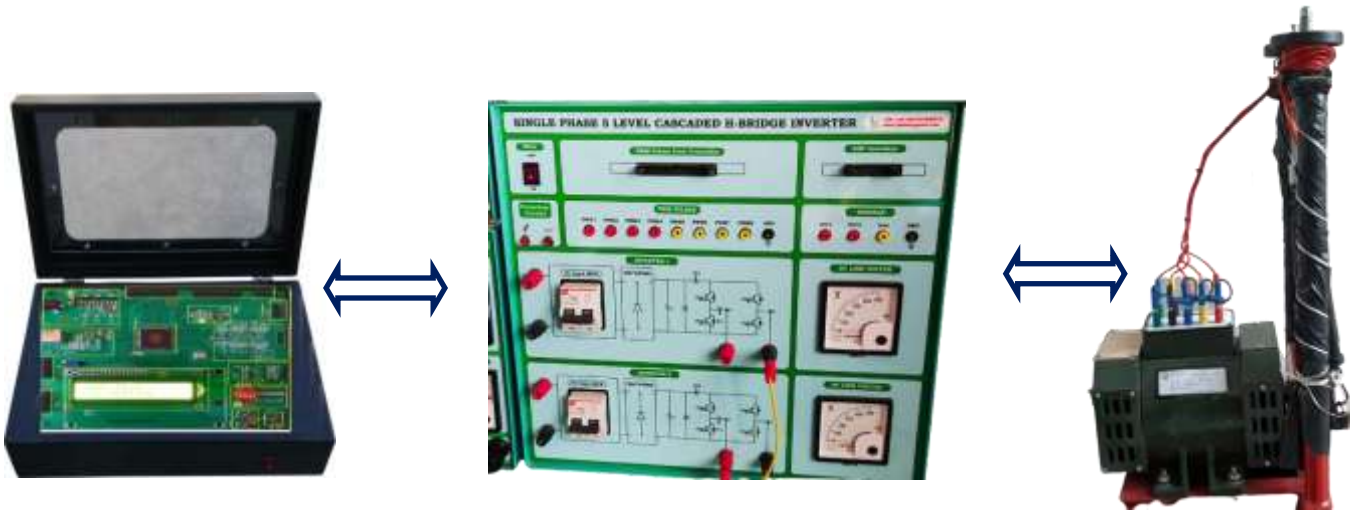
Motor(Standard make):1kW open-end winding, 415, 50HZ, 1440rpm,2A with 512 pulse QEP sensor Elastomeric Jaw Coupled with Generator

Generator(Standard make): 1HP, DC Generator, Armature volt 220V, Current 5A, 1500RPM,Field Voltage 220VDC.

Measurable components at front panel: Gate pulses, converter parameters, motor speed etc. and motor parameters, Vd,Vq,Id,Iq references displayed through VEE-PRO software in PC.

Compatibility: compatible to other real-time controller(OPAL-RT/dSPACE/Typhoon-HIL)

7. Speed control of 1 Ø, FIVE-LEVEL MULTI LEVEL Inverter based AC motor Drive



FPGA based Generalize PWM controller (Re-programmable):1no.

Processor & its speed: FPGA Spartan-6 LXT_9 FPGA: High-speed (20MHz or more)

Front End Software support: USB/JTAG Enabled by ISE® Design Suite Linux and Windows

Number of Digital I/Os: 200 or more with voltage level 3.3v/5V Level

No of ADC Channel: 8 isolated – Bi-Polar Resolution:12Bit Sampling Rate:1MSPS

No of DAC Channel: 4 isolated Resolution:12Bit S/Time-6µs Analogue :-5v to +5V

Types of PWM: Open/Closed Loop speed control of MLI SPWM, SPM, SVPWM method.

1 Ø, FIVE-LEVEL MULTI LEVEL INVERTER

4 No's of 600V/ 50A, SEMIKRON IGBT module , with One no of 600V/25A Common emitter Bidirectional IGBT's mounted in Proper Heat-sink with cooling Fan provision

INPUT DC LINK VOLT : 350v DC maximum

OUTPUT AC : 230V AC voltage

O/P FREQUENCY : 10-50HZ

SWITCHING FREQUENCY : 20KHZ MAX.

Recommended : 15khz max.

LOAD CURRENT MAX : 5A PEAK

4 no's TLP250 driver circuit used for all individual IGBTs.

All the collector and emitter & Gate Emitter terminals are to be brought out into the front panel proper connector for power circuit connection & Fault Output with reset circuit

Temperature Protection, Over current protection and short circuit protection provided for all individual IGBT module

Current & Voltage sensor for DC link current, Voltage and Output line current

Reset circuit provided and terminated to clear the fault

0.5HP 1PH AC MOTOR WITH SPRING BALANCE LOAD

AC MOTOR WITH SPRING BALANCE LOAD

POWER:0.5HP, VOLTAGE:200Vac, CURRENT:4A, SPEED:1430rpm, LOAD:spring balance load

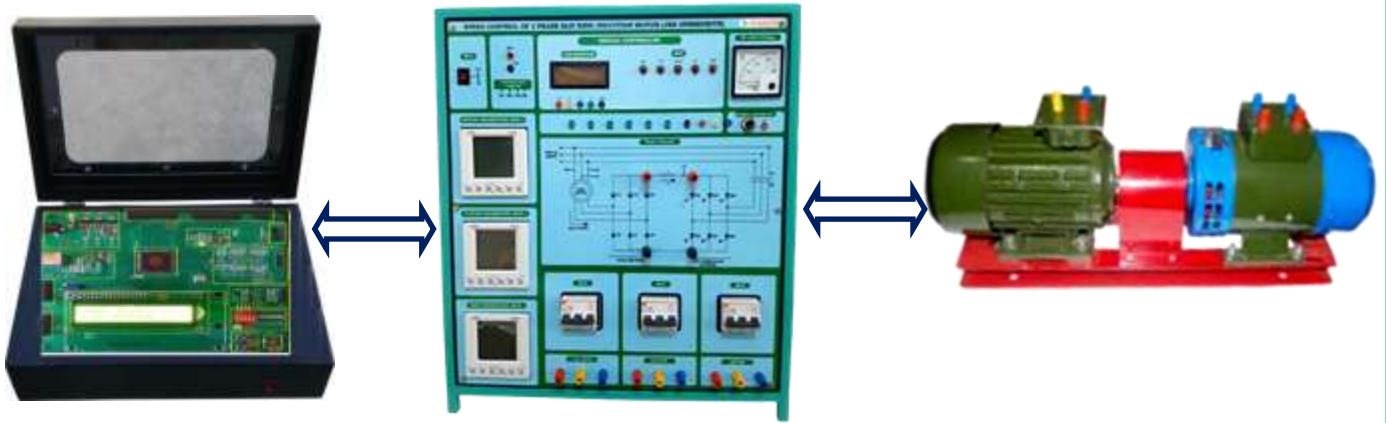
Speed sensor: Proximity Sensor Used to sense the Rotor speed.

Measurable components at front panel & Software based: Gate pulses, converter parameters, motor speed ,motor parameters, Voltage, act. Speed ,Ref Speed from PC, Motor can run In both direction , Vd,Vq,Id,Iq references displayed through VEE-PRO software in PC.

Accessories:1 no. of single phase Isolation transformer (230/110-0-110vac)-1KVA , 1 no. of single phase Autotransformer-2KVA .

Compatibility: compatible to other real-time controller(OPAL-RT/dSPACE/Typhoon-HIL)

8. speed control of 3 Phase Slip ring Induction Motor(STATIC KRAMMER DRIVE)



FPGA based Generalize PWM controller (Re-programmable):1no.

Processor & its speed: FPGA Spartan-6 LXT_9 FPGA: High-speed (20MHz or more)

Front End Software support: USB/ JTAG Enabled by ISE® Design Suite Linux and Windows

Number of Digital I/Os: 200 or more with voltage level 3.3v/5V Level

No of ADC Channel: 8 isolated – Bi-Polar Resolution: 12Bit Sampling Rate: 1MSPS

No of DAC Channel: 4 isolated Resolution: 12Bit S/Time-6 μ s Analogue :-5v to +5V

Types of PWM: Open Loop /Closed Loop speed control of **STATIC KRAMMER DRIVE.**

1 \emptyset , FIVE-LEVEL MULTI LEVEL INVERTER

3PH SCR POWER CIRCUIT:

6 Nos **SEMIKRON SCRs (SKKT 106B16E) Rating @1200v/100A** with Snubber Capacitors Used to form Power circuit and mounted on suitable heat sinks cabinet

6nos Pulse isolation Transformer with Transistor based Pulse Driver circuit will be used.

Each SCR Snubber circuit will be used

Over load Fuse protection available

Various circuit configurations like half and fully controlled bridge can be wired by Interconnecting the devices using patch cords.

6 nos. Pulse amplifier and isolator circuit will be used.

3ph AC Synchronizing circuit will be used to generate synchronized pulse for 3ph scr.

Input---3PH,415VAC

O/P Power---2.2KW

3HP 3PH SLIPRING INDUCTION MOTOR WITH DC GENERATORLOAD

Power: 3HP, Stator voltage: Three phase 415V AC, Rotor voltage: Three phase 210V AC, Speed: 1410 RPM,.

Generator(Standard make): 2.5kW DC Generator, Armature volt 220V, Current 9A, 1500RPM,Field Voltage 220VDC

Speed sensor: Proximity Sensor Used to sense the Rotor speed

Measurable components at front panel & Software based: Gate pulses, converter parameters, motor speed, motor parameters, Voltage, act. Speed ,Ref Speed from PC, Motor can run In both direction , V_d, V_q, I_d, I_q references displayed through VEE-PRO software in PC.

One no 5A, 5mH inductor will be used as dc link reactor.

One no Multi function meter (MFM) used to measure the Slip Power .It will show active power Reactive Power, Apparent Power, PF, Voltage and Current

Accessories: 1 no. of single phase Isolation transformer (230/110-0-110vac)-1KVA , 1 no. of single phase Autotransformer-2KVA .

Compatibility: compatible to other real-time controller(OPAL-RT/dSPACE/Typhoon-HIL)

1 KW MPPT Boost Converter for Solar PV

- MPPT Boost Converter for the development of new MPPT method and for using with grid synchronized inverter:
- System embedded with following components:
 - SPARTAN-6 FPGA Board.
 - IGBT/MOSFET Gate Driver Board.
 - Boost Converter.
 - 1 kW, Input 100-140 V, Output 200-250 V, Switching frequency 40 kHz.
 - Non-Isolated DC sensing for Input and Output DC voltage/current Measurement.
 - Signal Conditioning Card to interface with PWM controller.
 - Resistive bulb load bank for testing.
- Solar Panel: 1 kW: Four numbers of 250 kWp panels connected in series.
- Boost Converter operation in open loop and close loop mode is experimented.
- Control algorithms are developed using SPARTAN – 6 development board
- FPGA controller with re-writable VHDL code.
- All measured quantities are accessible by user in software where new algorithm can be implemented.
- The unit can be used as an input stage for matching rating grid synchronized inverter
- **VEEpro front end software for data analysis.**



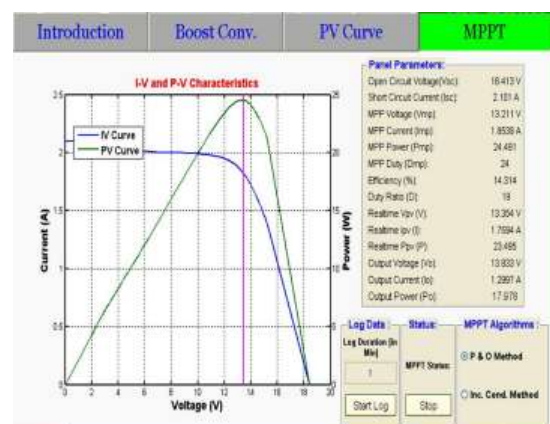
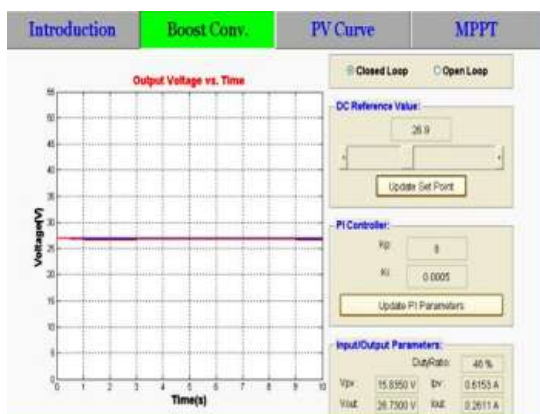
BOOST CONVERTER



INTER LEAVED BOOST CONVERTER



DC-DC CONVERTER



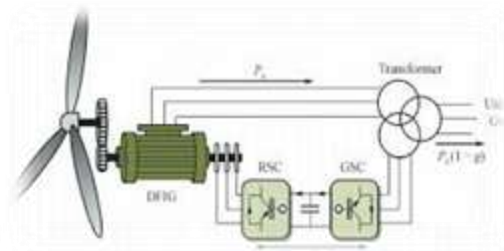
1 KW SINGLE PHASE GRID SYNCHRONIZED INVERTER FOR SOLAR PV

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

- System embedded with following components:
 - 1 kW solar panels (Four numbers of 250 kWp panels connected in series)
 - Spartan-6 FPGA based PWM Controller Board.
 - IGBT based single phase inverter with necessary driver and protection circuit.
 - Sensing circuit for AC voltage and AC current sensing.
 - Sensing circuit for DC voltage sensing
- Specifications: AC output voltage: $230 \pm 5\%$ V, Single Phase, $50 \text{ Hz} \pm 5 \text{ Hz}$,
- Power rating: 1kVA.
- Control algorithm development based on instantaneous power theory; and
- Operation of grid synchronized inverter is studied.
- PLL development for grid synchronization is studied.
- 08 ADC channels and 02 DAC channels for analogue acquisition and debugging
- LIS302DL, ST MEMS motion sensor, 3-axis digital output accelerometer
- Single phase grid synchronized inverter trainer for studying PV fed solar inverted and for studying intermediate control algorithm development.
- Control algorithm development based on instantaneous power theory; and operation of grid synchronized inverter is studied.
- PLL development for grid synchronization is studied.
- SPARTAN-6 FPGA microcontroller specifications:
 - Processor speed 20 MHz
 - 100 output lines / inputs lines are in 3.3/5V level
 - Isolated serial communication interface through USB connector
 - 4MB PROM for code execution memory.
 - External JTAG header for programming
 - 20x4 (or 16x2) LCD interface header.
 - 8 user LEDs/4 position user DIP switch
 - 2 up & down input push switch
 - Up to 100 Individually Programmable GPIO Pins
- ADC
 - No of ADC input : 16 Channels/32 Channel
 - Resolution : 12 bit
 - Sampling rate : 1MSPS
 - Analog input range: $\pm 10\text{V}$
 - Buffer section for voltage protection
- DAC
 - No of DAC output : 4 Channels /8 Channel
 - Resolution : 12 bit
 - Settling time : $6\mu\text{s}$
 - Analog input range: -5v to +5V
- Connectors
 - 16 pin header for ADC input
 - 16 pin header for PWM OUTPUT
 - 2 no's of 50 pin headers for GPIO line termination
 - External Programming header
- All pins are buffered and are 5V tolerance.
- Test points for intermediate signal observations are provided.



WIND EMULATOR USING DOUBLY FED INDUCTION GENERATOR (DFIG) TRAINING SETUP



DFIG – SYSTEM:-

- 3HP DC Motor Coupled With 2.2KW Slip Ring Induction Motor (DFIG)
- FPGA Based DC Drive for Prime Mover(DC MOTOR)
- Single Quadrant Chopper FED DC Drive
 - INPUT VOLTAGE-----1PH 230V AC OR 300V DC
 - OUTPUT VOLTAGE-----0-220V VARIABLE DC
 - O/P POWER -----2.2KW
- 3PH Power Module for MOTOR SIDE (ROTOR) SIDE CONVERTER.
 - INPUT VOLTAGE-----3PH 230V AC OR 600V DC max
 - OUTPUT VOLTAGE-----0-415V VVVF method
 - O/P POWER -----5KVA
- 3PH Power Module for GRID SIDE CONVERTER.
- IGBT Based Power Module
 - INPUT VOLTAGE-----3PH 230V AC OR 600V DC max
 - OUTPUT VOLTAGE-----0-415V VVVF
 - O/P POWER -----5KVA
- DFIG STUFFS:-
 - Direct Power Control Scheme Will Be Provided For Control Active And Reactive Power
 - In Super Synchronous Mode Power Will Generate In Rotor Side Above 1800rpm Speed
 - In Sub Synchronous Mode Power Will Generate In Stator Side Above 1200rpm Speed
 - Chopper Fed DC Drive Will Work As Wind Emulator.
- OPAL-RT/dSPACE/DSP/FPGA compatible

WIND SOLAR HYBRID SETUP

HYBRID WIND & SOLAR SYSTEM:

- 2kw /5kw PMSG Based Wind Emulator
- 2kw/5kw Solar Panel/Simulator
- Dc-Dc Boost Converter With MPPT
- IGBT Based 3ph Voltage Source Inverter
- FPGA SPARTAN6 Based Controller- Reprogrammable
- Grid Side Interface Stuffs-Reprogrammable
- OPAL-RT/DSPACE/DSP/FPGA Compatible



POWER QUALITY IMPROVEMENT IN DC MICROGRID

- 2kw /5kw DFIG Based Wind Emulator
- 2kw/5kw Solar Panel/Simulator
- Dc-Dc Boost Converter With MPPT
- IGBT Based 3ph Voltage Source Inverter
- FPGA SPARTAN6 Based Controller- Reprogrammable
- Grid Side Interface Stuffs-Reprogrammable
- OPAL-RT/DSPACE/DSP/FPGA Compatible



BLDC –AC MOTOR DRIVE BASED GRID INTEGRATION

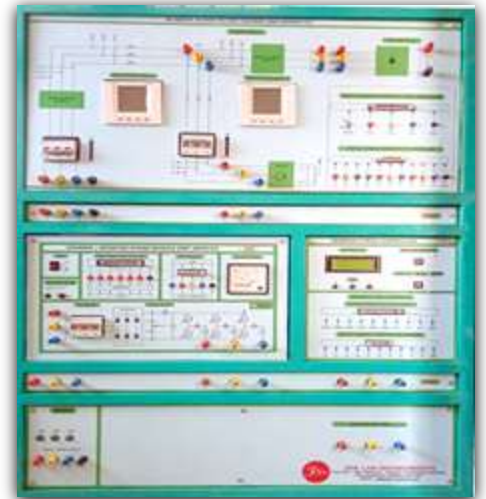
- FPGA SPARTAN6LX25 Controller
- 20KVA IGBT Back To Back Inverters (**4modules**)
- 3HP-BLDC MOTOR coupled with AC Induction motor with **DYNAMOMETER** SETUP
- Grid Side Interface Stuffs



BLDC –AC MOTOR

SHUNT - ACTIVE POWER FILTER (SAF)

- I/P source voltage -230AC RMS – (Phase to ground)
- I/P Source Current -10A(peak)
- Power Rating - 5KVA
- Before compensation source current THD will be greater than 25%
- After compensation source current THD will be less than 5%
- All equipments are covered by a industrial type cabinet
- OPAL-RT/dSPACE/DSP/FPGA compatible



SOLAR BASED GRID-TIED INVERTER

- 2KW SOLAR BASED GRID TIED INVERTER:
- 2KW Solar Panel with Stand-MNRE approved
- 2KW DC-DC BOOST Converter with MPPT
- 5KVA IGBTBased 3PH Voltage Source Inverter
- FPGA SPARTAN6 based PWM controller-reprogrammable
- GRID SIDE INTERFACE STUFFS-reprogrammable
- OPAL-RT/dSPACE/DSP/FPGA compatible



WIND TURBINE EMULATOR USING -PMSG

- Digital PWM controller: FPGA
- Inverters: **VSI/VIENNA/NPC/H-BRIDGE** types
- PMSG SETUP
- 6KW DC Motor Coupled With 2.2KW PMSG

DC Motor Specifications:

- Power : 2.2KW
- Armature voltage : 220V DC
- Field voltage : 220V DC
- Speed : 1500 RPM
- Make : Benn/OMAX
- Double side shaft extension

PMSG (Generator)

- Type : Three phase PMSG
- Power : 2.2KW
- Stator voltage : Three phase 230V
- Speed : 1500 RPM
- Make : Benn /OMAX
- DIRECTPOWER CONTROL SCHEME FOR ACTIVE AND REACTIVE POWER
- OPAL-RT/dSPACE/DSP/FPGA compatible



SMART GRID SIMULATOR

2KW SOLAR BASED GRID TIED INVERTER: - G1-GENERATING STATION-1

- 2KW Solar Panel with Stand-MNRE approved
- 2KW DC-DC BOOST Converter with MPPT
- 5KVA IGBT Based 3PH Voltage Source Inverter
- FPGA SPARTAN6 based PWM controller-reprogrammable
- GRID SIDE INTERFACE STUFFS-reprogrammable
- OPAL-RT/dSPACE/DSP/FPGA compatible

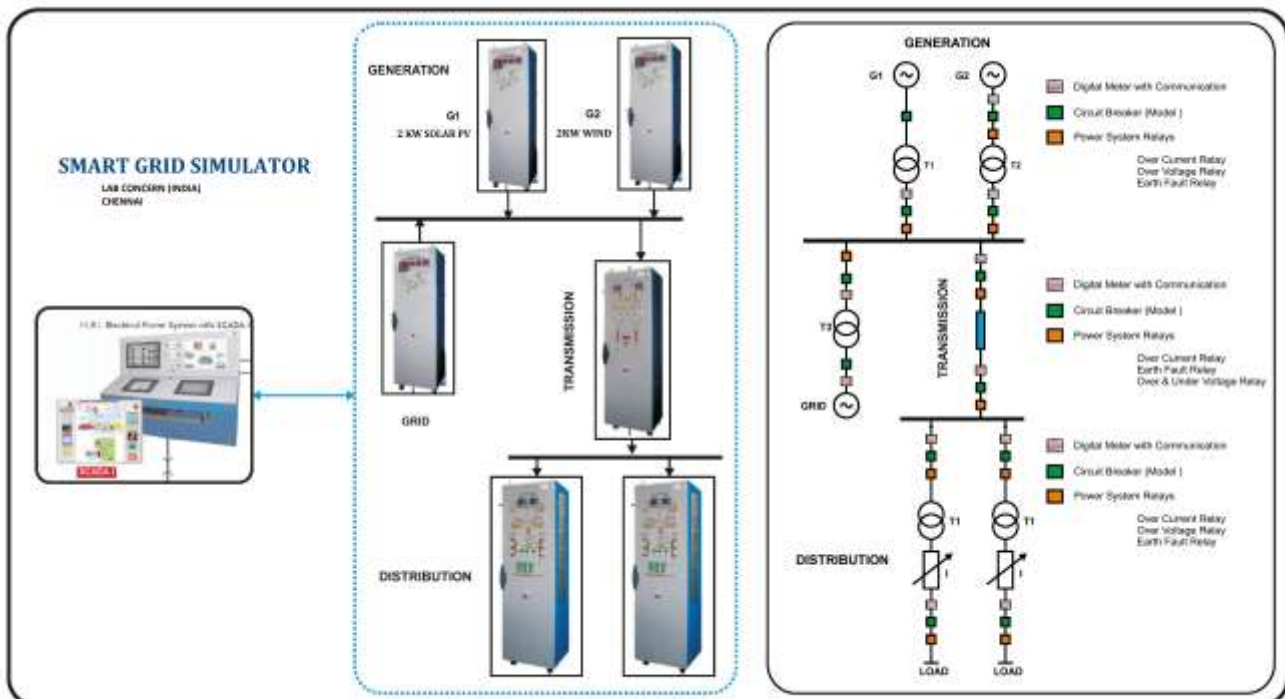
2KW PMSG/DFIG BASED WIND EMULATOR: G2-GENERATING STATION-2

DC Motor Specifications:

- Power : 2.2KW
- Armature voltage : 220V DC
- Field voltage : 220V DC
- Speed : 1500 RPM
- Make : Benn
- Double side shaft extension

PMSG (Generator)/DFIG

- Type : Three phase PMSG
- Power : 2.2KW
- Stator voltage : Three phase 230V AC,
- Speed : 1500 RPM
- Make : Benn
- DIRECT POWER CONTROL SCHEME FOR ACTIVE AND REACTIVE POWER
- OPAL-RT/dSPACE/DSP/FPGA compatible





Generator Load



(Optional)

Eddy Current Load



(Optional)

Spring Balance



POWER SYSTEMS LAB

PC BASED DIGITAL TYPE OVER/UNDER VOLTAGE RELAY WITH TEST KIT

Microcontroller type over/under voltage relay test set-up consists of

1. **One no voltage source set up.**
2. **One no microcontroller based over/under voltage relay.**

voltage source test setup:

- ❖ One no of voltage Source provided (0 to 270V).
- ❖ Continuous variable.
- ❖ 300v digital voltmeter provided for measure voltage.
- ❖ One no of 1 phase auto transformer provided.
- ❖ One no of fuse provided.
- ❖ Output terminals terminated in panel front side.

Micro controller-based relay:

Features:

- Single phase over/under voltage relay with inverse definite minimum time (IDMT), DMT & Instantaneous characteristics.
- One no of LCD provided for show the digital values.
- Five nos. of key's used for selecting options.
- One no of 300/9V PT provided for measure the voltage.
- Choice of 5 inverse time characteristics curve for phase over/under voltage fault.

Selectable like:

- ❖ Very inverse
- ❖ Normal inverse
- ❖ Restricted inverse
- ❖ 3 seconds
- ❖ 1.3 seconds

Specification:

- Auxiliary voltage range :200v -245v ac
- Relay rated voltage 300V.
- Contact rating : AC 250v @10A

PC interface:

- **VEEPRO front end software will be provided for PC connectivity.**

PRODUCT'S MODEL



PC BASED DIGITAL TYPE OVER CURRENT RELAY WITH TEST SETUP

Microcontroller type over current relay test set-up consists of

1. One no current source set up.
2. One no microcontroller based over current relay.

Current source test setup:

- ❖ One no of current Source provided(0 to 20A).
- ❖ continuous variable.
- ❖ 20A ammeter provided for measure relay current.
- ❖ One no of 1 phase auto transformer provided.
- ❖ One no of fuse provided.

Micro controller-based relay:

Features:

- Single phase low set non over current relay with inverse definite minimum time (IDMT) characteristics.
- One no of LCD provided for show the digital values.
- Five no's of key's used for select options.
- One no of 20A CT provided for measure the current.
- Single phase non directional over current relay with instantaneous or definite minimum time(DMT) characteristics.
- Choice of 5 inverse time characteristics curve for phase fault.

Selectable like:

- ❖ Very inverse
- ❖ Normal inverse
- ❖ Restricted inverse
- ❖ 3 seconds
- ❖ 1.3 seconds

Specification:

- Auxiliary voltage range :200v -245v ac
- Relay rated current: 5A
- Contact rating :ac 250v @10A

PC interface:

- ❖ VEEPRO front end software for PC connectivity.

PRODUCT'S MODEL



PC BASED DIGITAL TYPE 1ph %BIASED DIFFERENTIALRELAY WITH TEST SETUP

Microcontroller type single phase % biased DIFFERENTIAL relay test set-up consists of

1. One no of TRANSFORMER set up.
2. One no microcontroller based differential relay.

Transformer test setup:

- ❖ Two nos. of isolation transformer Transformer provided. (230/24v, 5A)/(12-0-12/12-0-12,5A).
- ❖ 2 nos. of digital ammeter provided for measure primary, secondary current.
- ❖ One no of single-phase load provided.
- ❖ One no of fuse provided.
- ❖ One no of rheostat provided for short circuit purpose.
- ❖ Output terminals terminated in panel front side.

Micro controller based differential relay:

Features:

- Single phase differential relay with inverse definite minimum time (IDMT), DMT characteristics.
- One no of LCD provided for show the digital values.
- Five nos. of key's used for select options.
- Two no's of 5A/5A CT provided for measure the current.

Specification:

- Auxiliary voltage range :200v -245v Ac
- Relay rated current 5A.
- contact rating : AC 250v @10A

PC Connectivity.

- ❖ VEEPRO Front end software for PC Interface.



PC BASED DIGITAL TYPE 3ph %BIASED DIFFERENTIAL RELAY WITH TEST SETUP

Microcontroller type THREE PHASE % biased DIFFERENTIAL relay test set-up consists of

1. Two nos. of 3 phase TRANSFORMER set up.
2. One no microcontroller based THREE PHASE % biased differential relay.

Transformer test setup:

- ❖ Two no's of isolation Transformer provided (230/24v, 5A, 3 phase), (12-0-12/12-0-12, 5A, 3 phase).
- ❖ 6 nos. of digital ammeter provided for measure primary, secondary current.
- ❖ One no of three phase lamp load provided.
- ❖ One no of rheostat provided for short circuit purpose.
- ❖ Output terminals terminated in panel front side.

Micro controller based THREE PHASE % biased differential relay:

Features:

- Single phase differential relay with inverse definite minimum time (IDMT), DMT characteristics.
- One no of LCD provided for show the digital values.
- Five nos. of key's used for select options.
- six no's of 5A/5v CT provided for measure the current.

Specification:

- Auxiliary voltage range 200v -245v Ac
- Relay rated current 5A.
- contact rating :ac 250v @10A

PC Connectivity.

- ❖ **VEEPRO Front end software for PC Interface.**



PC BASED DIGITAL TYPE OVER/UNDER FREQUENCY RELAY WITH TEST SETUP

Microcontroller type over/under frequency relay test set-up consists of

1. One no frequency source set up.
2. One no microcontroller based over/under frequency relay.

Frequency source test setup:

- ❖ One no of frequency Source provided (35 to 70 Hz).
- ❖ Continuous variable.
- ❖ One no of microcontroller based 1 phase H-bridge inverter provided.
- ❖ One no of fuse provided.
- ❖ Output terminals terminated in panel front side.

Micro controller-based relay:

Features:

- Single phase over/under frequency relay with inverse definite minimum time (IDMT), DMT & Instantaneous characteristics.
- One no of LCD provided for show the digital values.
- Five nos. of key's used for select options.
- One no of 300/9V PT provided for measure the frequency.
- Choice of 5 inverse time characteristics curve for phase over/under frequency fault.

Selectable like:

- ❖ Very inverse
- ❖ Normal inverse
- ❖ Restricted inverse
- ❖ 3 seconds
- ❖ 1.3 seconds

Specification:

- Auxiliary frequency range :200v -245v Ac
- Relay rated frequency 35 to 65Hz.
- Contact rating : AC 250v @10A

PC Connectivity.

- ❖ VEEPRO Front end software for PC Interface.



PC BASED DIGITAL TYPE REVERSE POWER RELAY WITH TEST SETUP

Microcontroller based Reverse power relay test set-up consists of

1. One no of microcontroller based Reverse power relay with test set up.



Test setup:

- ❖ One number of **1HP 3 phase induction motor** coupled with **1kva single phase alternator** provided for source - 1.
- ❖ One no of multi-function meter (MFM) provided for measure voltage, current, Kw, KVar, frequency...etc (electrical parameters).
- ❖ One no of digital speed indicator provided.
- ❖ One no of digital **synchroscope** provided.
- ❖ One no of proximity sensor provided for sense the motor speed.
- ❖ One no of 6A single phase Auto transformer provided for source 2.
- ❖ One no of **1 Hp VFD drive** provided for drive the induction motor.
- ❖ Two nos. of fuse provided.
- ❖ One no of 2A variable DC source provided for alternator excitation voltage.

Micro controller based reverse power relay:

Features:

- One no of LCD provided for show the digital values.
- Five nos. of key's used for select options.
- One no of 5A/5A CT provided for measure the current.
- One no of 270/9v PT provided for measure the voltage.
- Single phase reverse power relay with definite minimum time (DMT) characteristics.
- current setting 0-2A.
- Time setting 0-50 sec.

Specification:

- Auxiliary voltage range :230v ac/dc
- Relay rated current: 1A
- Contact rating: AC 250v @10A

PC Connectivity.

- ❖ **VEEPRO Front end software for PC Interface.**



PC BASED DIGITAL TYPE EARTH FAULT RELAY WITH TEST SETUP

Microcontroller type Earth fault relay test set-up consists of

1. One no of current source set up.
2. One no microcontroller-based Earth fault relay.

Current source test setup:

- ❖ One no of current Source provided (0 to 20A).
- ❖ Continuous variable.
- ❖ 20A ammeter provided for measure relay current.
- ❖ One no of 1 phase auto transformer provided.
- ❖ One no of fuse provided.
- ❖ One no of 0.5hp 3 phase induction motor provided.

Micro controller-based relay:

Features:

- Earth fault relay with inverse definite minimum time (IDMT) characteristics.
- One no of LCD provided for show the digital values.
- Five nos. of key's used for select options.
- One no of 5A CT provided for measure the current.
- Earth fault relay with instantaneous or definite minimum time (DMT) characteristics.
- Choice of 5 inverse time characteristics curve for phase fault.

Selectable like:

- ❖ Very inverse
- ❖ Normal inverse
- ❖ Restricted inverse
- ❖ 3 seconds
- ❖ 1.3 seconds

Specification:

- Auxiliary voltage range :200v -245v ac/dc
- Relay rated current: 2A
- Contact rating : AC 250v @10A

PC Connectivity.

- ❖ **VEEPRO Front end software for PC Interface.**



ELECTRO-MECHANICAL TYPE IDMT EARTH FAULT RELAY WITH TEST SETUP

Electromechanical type IDMT Earth fault relay test set-up consists of

1. One no current source set up.
2. One no Electromechanical based IDMT Earth fault relay.

Current source test setup:

- ❖ One no of 3 phase 0.5HP AC induction motor provided.
- ❖ One no of 750 ohm rheostat provided for create short circuit.
- ❖ 5A ammeter provided for measure relay current.
- ❖ Automatic relay trip circuit provided.

Electromechanical based IDMT Earth fault relay:

Features:

- Single phase non directional Earth fault relay with inverse definite minimum time (IDMT) characteristics.
- Current rating :1A
- Current Multiplier plug setting.
- Time multiplier setting provided.
- One no of 5A/1A CT provided for measure the current.
- Single phase non directional Earth fault relay with inverse definite minimum time (IDMT) characteristics.
- One no of digital timer provided.

Specification:

- Auxiliary voltage range :230v AC
- Relay make: ALSTOM/MEGAWIN
- Relay rated current: 1A
- Contact rating : AC 250v @10A

Experiment details:

- ❖ Study & testing of Earth fault relay IDMT type with different current & time setting multiplier.
- ❖ Plotting of IDMT characteristics of Earth fault relay.



ELECTRO-MECHANICAL TYPE IDMT OVER CURRENT RELAY WITH TEST SETUP

Electromechanical type IDMT over current relay test set-up consists of

1. One no current source set up.
2. One no Electromechanical based IDMT over current relay.

Current source test setup:

- ❖ One no of current Source provided (0 to 20A).
- ❖ Continuous variable.
- ❖ 20A ammeter provided for measure relay current.
- ❖ One no of 1 phase auto transformer provided.
- ❖ One no of fuse provided.

Electromechanical based IDMT over current relay:

Features:

- Single phase non directional over current relay with inverse definite minimum time (IDMT) characteristics.
- Current rating :5A
- Current Multiplier plug setting.
- Time multiplier setting provided.
- One no of 20/5A CT provided for measure the current.
- Single phase non directional over current relay with inverse definite minimum time (DMT) characteristics.
- One no of digital timer provided.

Specification:

- Auxiliary voltage range :230v AC
- Relay make: ALSTOM/MEGAWIN.
- Relay rated current: 5A
- Contact rating : AC 250v @10A

Experiment details:

- ❖ Study & testing of over current relay IDMT type with different current & time setting multiplier.
- ❖ Plotting of IDMT characteristics of over current relay.



PC BASED DIGITAL TYPE DIRECTIONAL OVER CURRENT RELAY

Microcontroller type over current relay test set-up consists of

1. One no current source set up.
2. One no microcontroller based Directional over current relay.



Current source test setup:

- ❖ One no of current Source provided(0 to 20A).
- ❖ continuous variable.
- ❖ 20A ammeter provided for measure relay current.
- ❖ One no of 1 phase auto transformer provided.
- ❖ One no of fuse provided.

Micro controller-based relay:

Features:

- Single phase low set non directional over current relay with inverse definite minimum time (IDMT) characteristics.
- One no of LCD provided for show the digital values.
- Five no's of key's used for select options.
- One no of 20A CT provided for measure the current.
- Single phase non directional over current relay with instantaneous or definite minimum time(DMT) characteristics.
- Choice of 5 inverse time characteristics curve for phase fault.

Selectable like:

- ❖ Very inverse
- ❖ Normal inverse
- ❖ Restricted inverse
- ❖ 3 seconds
- ❖ 1.3 seconds

Specification:

- Auxiliary voltage range :200v -245v ac
- Relay rated current: 5A
- Contact rating :ac 250v @10A

PC interface:

- ❖ VEEPRO front end software for PC connectivity.

PRODUCT'S MODEL



RELAY CO-ORDINATION SETUP

Microcontroller type over current relay test set-up consists of

1. Current source set up.
2. Microcontroller based over current relay.-2nos.



Current source test setup:

- ❖ current Source provided(0 to 20A) continuous variable.
- ❖ 20A ammeter provided for measure relay current.
- ❖ One no of 1 phase auto transformer provided.
- ❖ One no of fuse provided.

Micro controller-based relay:

Features:

- Single phase low set non over current relay with inverse definite minimum time (IDMT) characteristics.
- One no of LCD provided for show the digital values.
- Five no's of key's used for select options.
- One no of 20A CT provided for measure the current.
- Single phase non directional over current relay with instantaneous or definite minimum time(DMT) characteristics.
- Choice of 5 inverse time characteristics curve for phase fault.

Selectable like:

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- ❖ 3 seconds
- ❖ 1.3 seconds

Specification:

- Auxiliary voltage range :200v -245v ac
- Relay rated current: 5A
- Contact rating :ac 250v@10A

PC interface:

- ❖ VEEPRO front end software for PC connectivity.

GENERATOR PROTECTION SIMULATOR – PC BASED

Generator protection Simulator consists of

1. FPGA based generator protection relays with test set up.

Test setup:

- ❖ Two numbers of 2HP 3 phase induction motor coupled with 1kv a three phase alternator provided for source1 & source2.
- ❖ Three nos. of multi-function meter (MFM) provided for measure both source side voltage, current, Kw, KVar, frequency....etc(electrical parameters).
- ❖ 2 nos. of digital speed indicator provided.
- ❖ 2 nos. of proximity sensor provided for sense the motor speed.
- ❖ 2 nos. of 2 Hp VFD drive provided for drive the induction motor.
- ❖ 2 nos. of 2A variable DC source provided for alternator excitation voltage.
- ❖ One no of rheostat will be provided.

FPGA based generator protection relays:

Type of relays:

- One no of 3 phase over/under voltage relay.
- One no of 3 phase over current relay.
- One no of 3 phase reverse power relay.
- One no of 3 phase synchronizing relay.
- One no of 3 phase over/under frequency relay.
- One no of field failure relay.
- One no of Negative sequence relay.
- One no of 3 phase differential relay.
- One no of earth fault relay.

Relay features:

- Five nos. of key's used for select options for all relays.
- Three nos. of 5A/5A CT provided for measure the current.
- Three nos. of 270/9v PT provided for measure the voltage.
- Single phase generator protection relay with definite minimum time (DMT) characteristics.
- Current setting: 0 - 5A.
- Voltage rating : 0-240v (phase voltage).
- Time setting 0-50 sec.
- One no of 2KVA three phase lamp load provided.
- Three nos. of circuit breaker provided inside the module.

PC Interface:

- All relays communicate with PC.
- Pc interface software provided.
- VEE pro software for front end application.
- All relays control by manually and through PC.

FPGA specification:

AHMY_SP6_LX9_PROJECT Board is an easy to use FPGA board featuring Xilinx Spartan-6 FPGA. It is specially designed for experimenting and research system design with FPGAs.

On-Board Features:

- ❖ Programming & Memory section
- ❖ Processor speed 20 MHZ.
- ❖ 69 Individually Programmable GPIO Pins.
- ❖ 4MB On board PROM for standalone program execution memory.

Interfaces

- ❖ 8 output and 8 input lines with 5V Level.
- ❖ Isolated serial communication interface through USB connector.

- ❖ 4 position user DIP switch.
- ❖ 8 user LEDs.
- ❖ 2 no of input push switches.
- ❖ 20x4 (or 16x2) PROJECT D interface header.
- ❖ External JTAG header for programming

Headers

- ❖ 2 nos. of 26 pin and 1 no of 10 pin headers for GPIO line termination (49 Pins).
- ❖ 40 pin header for 32 GPIO for input or output with 3.3V to 5V Level.
- ❖ 10 pin External JTAG header for Programming
- ❖ 5V adapter connector for power supply (+5V, GND)
- ❖ 20 pins header used to interface 20x4 PROJECT D or 16x2 PROJECT D.

Specification:

- Auxiliary voltage range :230v Ac.
- Relay rated current: 5A
- Contact rating: ac 230v @10A.

MODEL ONLY



MOTOR-GENERATOR/ALTERNATOR-1



MOTOR-GENERATOR/ALTERNATOR-2

TRANSFORMER PROTECTION SIMULATOR

Transformer protection simulation experimental unit

1. 2KVA 3 phase TRANSFORMER set up.
2. Power systems protection relays(differential relay, over current& earth fault, UV/OV)
3. Meter panel with R loads & fault simulator.

Transformer test setup:

- ❖ Input voltage: 0-230v AC (R phase) with 25,50,75,100%.
- ❖ Input voltage: 0-230v AC (Y phase) with 25,50,75,100%.
- ❖ Input voltage: 0-230v AC (B phase) with 25,50,75,100%.
- ❖ Capacity :2KVA
- ❖ Connection: STAR/DELTA
- ❖ 6 nos. of digital ammeter provided for measure primary, secondary current
- ❖ Input, Output terminals terminated in panel front side.

Protection Relays:

- One no of 3 phase differential relay.
- One no of 3 phase over current relay.
- One no of 3 phase over voltage relay.
- One no of 3 phase under voltage relay.
- One no of Earth fault relay.

Relay specification:

- All relays should be microcontroller/FPGA based.
- DMT, IDMT mode of operation.
- LCD will be provided to indicate the parameters.
- One no of NO,NC contacts will be provided for all relays.
- Digital keys will be provided to set parameters.
- Suitable CT, PT will be provided.

Meter panel with R load:

- ❖ Three nos. of digital ammeter provided for measure primary current.
- ❖ Three nos. of digital ammeter provided for measure secondary current.
- ❖ Three nos. of digital voltmeter provided for measure primary voltage.
- ❖ Three nos. of digital voltmeter provided for measure secondary voltage.
- ❖ One no of three phase 2kv a lamp load with selector switch provided.

Fault simulator & trip time measurement set up:

- ❖ One no of 3 phase auto transformer provided for simulate the over/under voltage faults.
- ❖ One no of short circuit resistor provided.
- ❖ One no of automatic trip time measurement circuit provided.

Specification:

- Auxiliary voltage range: 245v ac @ Relay rated current 5A.
- contact rating: AC 250v @10A

List of experiments:

- Different type of IDMT Characteristics of over current relay.
- Different type of IDMT Characteristics of over voltage relay.
- Different type of IDMT characteristics of under voltage relay.
- Characteristics of differential relay.
- Operation of over current relay.
- Operation of over voltage relay.
- Operation of under voltage relay - Draw the curve all relays.



FEEDER PROTECTION SIMULATOR

Feeder Protection Simulation Experimental Unit

This Feeder Protection Simulation Study Unit used for simulating and studying the protection schemes of Radial & parallel feeder protection and various fault conditions. Protection is provided through over current + earth fault relay. Necessary Resistive /lamp load & CTs and PTs are also provided in the testing panel. Proper rating fuses and protection devices are provided in the panel, it consists of

1. Power systems Protection Relays (Digital Relays)
2. Panel with Meter arrangements

Power system Protection Relays

1. 2 Numbers of Numerical 3 phase over current relay + earth fault relay (**MAKE C&S**)
2. 2 Numbers of Numerical Directional -3 phase over current relay + earth fault relay (**MAKE C&S**)
3. Numerical over voltage / under voltage relay-**MAKE C&S/PLI**)

Numerical 3 phase over current relay + earth fault relay (non-directional relay)

Type	Digital Relay (Numerical type)
Function	3 elements over current +single element EF Relay
CT Input	1A
Current Setting	up to 120%
Time Setting	available
Function	IDMT
Output	NC&NO Contact@2A
Auxiliary supply	230VAC
Make	C&S



Numerical 3 phase directional over current relay + earth fault relay (directional relay)

Type	Digital Relay (Numerical type)
Function	3 elements over current +single element EF Relay
CT Input	1A
Current Setting	up to 120%
Time Setting	available
Function	IDMT
Output	NC&NO Contact@2A
Auxiliary supply	230VAC
Make	C&S



Numerical 3 phase over /Under Voltage relay

Type	Digital Relay (Numerical type)
Function	3 elements over /Under voltage Relay
PT Input	110VAC
Voltage Setting	up to 120%
Time Setting	available
Function	IDMT
Output	NC&NO Contact@2A



Auxiliary supply 230VAC
Make C&S

Panel with Meter arrangements

Powder coated MS panel with stickered front panel is provided to fix all the relays, Digital meters , CT & PT etc , The detailed specifications is as below

Instruments Transformers (CT & PT)

- 5/1 A CT is provided for all current relays
- CT secondary outputs are terminated in front panel with necessary terminal identification for relay interconnection by user
- 220/110V or 63V PT is provided for all voltage & frequency & synchronizing relays
- CT secondary outputs are terminated in front panel with necessary terminal identification for relay interconnection by user
- All relays specification matched with feeder panel specification using CT/PTs
- All are mounted on a nice cabinet with necessary diagram indication

Digital Meters

- 18 no. of AC digital ammeter provided for current measurement in various sections of feeder
- Three no. of ac digital voltmeter provided for ac voltage measurement.

Others features

- Nine numbers of current limiting resistor-1.5A with banana terminations is provided for short circuit fault creations
- 3 phase breakers & MCB's are provided for protection & Necessary 3 phase indicators are provided

3 phase Load

- One number of three phase Lamp load provided with diff-load selector switch is provided for loading
 - Input : 3 phase 415vac
 - Capacity : 1.5 KVA
 - Number of load ON/OFF switch: 6.

Specifications

Input : 3 Phases -415vac & Capacity: 3 Phases -3KVA

Experiments

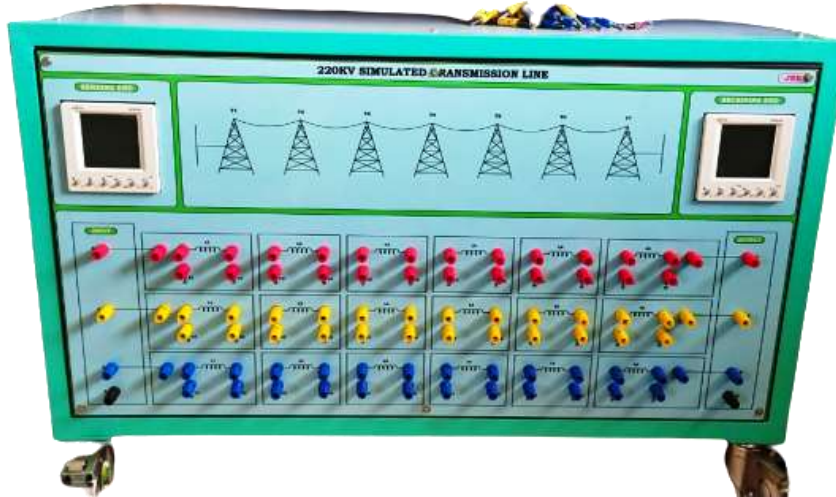
1. Study of radial feeder protection with time /current grading
2. Study of Parallel feeder protection/current grading



TRANSMISSION LINE SIMULATOR (LV MODEL)

1- phase Transmission line Integrated with the following sections: -

1. Generating station section.
2. Transmission line section (Short, Medium, Long types).
3. RLC loading section.
4. Protection relay and ABCD parameter calculating section.
5. PC interface section.



1. Generating station section:
 - Input voltage: 230v AC 1 phase.
 - Output voltage: 110v Ac/2A.
 - One no of 1 phase 2A autotransformer provided.
 - One no of digital voltmeter provided.
 - One no of digital ammeter provided.
2. Transmission line section(180kms):
 - Short , medium , long transmission line used this line .
 - Medium transmission line T network & PI network provided.
 - Long transmission line PI network provided.
3. RLC Loading section:
 - One no of lamp load provided.
 - One no of inductive load provided.
 - One no of digital voltmeter provided.
 - One no of digital ammeter provided.
4. Protection relay and ABCD parameter calculating section:
 - One no of over current relay provided.
 - One no of over voltage relay provided.
 - One no frequency relay provided.
 - Transmission line A,B,C,D values calculated using microcontroller-based system.
5. PC interface section:
 - All the above modules control by VEEpro software through PC.

Experiment details:

1. **Demonstration of Ferranti Effect.**
2. **ABCD parameter.**
3. **Determination of surge impedance load (SIL).**
4. **Line Efficiency and Losses.**
5. **Voltage regulation.**
6. **Study of over current relay.**
7. **Study of over voltage relay.**

TRANSMISSION LINE SIMULATOR (HV MODEL)

3- Phase Transmission line Integrated with the following sections: -

1. Generating station section.
2. Transmission line section (Short, Medium, Long types).
3. RLC loading section.
4. Protection relay and ABCD parameter calculating section.
5. PC interface section.



1. Generating station section:
 - Input voltage: 415v AC 3 phase.
 - Output voltage: 110v Ac/2A.
 - One no of 3 phase 5A autotransformer provided.
 - Three no of digital voltmeter provided.
 - Three no of digital ammeter provided.
2. Transmission line section(180kms):
 - Short, medium, long transmission line used this line.
 - Medium transmission line T network & PI network provided.
 - Long transmission line PI network provided.
3. RLC Loading section:
 - One no of lamp load provided.
 - One no of inductive load provided.
 - One no of digital voltmeter provided.
 - One no of digital ammeter provided.
4. Protection relay and ABCD parameter calculating section:
 - One no of over current relay provided.
 - One no of over voltage relay provided.
 - One no frequency relay provided.
 - Transmission line A,B,C,D values calculated using microcontroller-based system.
5. PC interface section:
 - All the above modules control by VEEpro software through PC.

SWITCH GEAR AND PROTECTION LAB

Air Circuit Breaker (3 ϕ , 440V, 3pole, 50Hz ACB 3 ϕ fixed type 400 A) with Test Setup

This set up is designed to study the working principle of ACB and to test the ACB (Air circuit breaker) under over current fault and Earth Fault conditions. This set up consists of

1. ACB (Air Circuit Breaker)
2. ACB Test Kit with Panel set up

Specification

Features:

- ❖ A range to meet every customer's need
- ❖ Ratings : 400A
- ❖ Breaking Capacities : 50kA
- ❖ 3 Pole Versions with Fix configuration
- ❖ High Short time withstand capacity, $I_{cu}=I_{cs}=I_{cw}$ for 1 sec for total selectivity
- ❖ Different terminal orientations : Flat, Horizontal and Vertical
- ❖ Common door cut-out for entire range
- ❖ Left aligned cut-out for all ratings
- ❖ Uniform height and depth for ACBs upto 4000 Amp

User Friendly Features

- ❖ Safety
- ❖ Superior quality engineering grade plastics used for insulation purpose; conforms to Glow wire test (Ref: IEC 60695-2-1)
- ❖ In built Safety shutters prevent accidental contact with live cradle terminals
- ❖ Transparent safety shutter offers easy inspection of cradle contacts & reduces the maintenance time
- ❖ Wide Band Shunt Release to ensure intentional tripping even during voltage fluctuations
- ❖ Easily removable arc chutes without use of any tool – Reduces downtime
- ❖ Conformance to Standards
- ❖ IEC - 60947 (Part 1 & 2)
- ❖ IS/IEC - 60947 (Part 1 & 2)
- ❖ IEC 60695 - 2 - 1
- ❖ BS EN 60947 – 2
- ❖ **Make : L&T**

Other Features

Housing: The ACB is housed in M.S. Cubicle box with conduit plugs are provided with side entry of cables. Provision for termination of contacts is made inside the cable box.

Panel with ACB Test set up (current injection source)

This panel consists of the following components

- a. Meter with Relays (Electro Mechanical Type OC,EF)
- b. Variable ac current source with trip time indicator /meter
- c. Earth Fault SIMULATOR

Meter with Relays (Electro Mechanical Type OC,EF)

Electromechanical Type IDMT Over Current RELAY:

Features:

- Single phase non directional over current relay with inverse definite minimum time (IDMT) characteristics.
- Current rating :5A



- Current Multiplier plug setting.
- Time multiplier setting provided.
- One no of 20/5A CT provided for measure the current.
- Single phase non directional over current relay with inverse definite minimum time (DMT) characteristics.
- One no of digital timer provided.

Specification:

- Auxiliary voltage range :230v AC
- Relay make: ALSTOM/MEGAWIN.
- Relay rated current: 5A
- Contact rating : AC 230v@10A

Electromechanical type IDMT Earth fault relay:

Features:

- Single phase non directional Earth fault relay with inverse definite minimum time (IDMT) characteristics.
- Current rating :1A
- Current Multiplier plug setting.
- Time multiplier setting provided.
- One no of 5A/1A CT provided for measure the current.
- Single phase non directional Earth fault relay with inverse definite minimum time (IDMT) characteristics.
- One no of digital timer provided.

Specification:

- Auxiliary voltage range :230v AC
- Relay make: ALSTOM/MEGAWIN
- Relay rated current: 1A
- Contact rating : AC 230v@10A



2. Variable ac current source with trip time indicator /meter

- One number of Variable current source of 0-30A is provided to test ACB
- One number of digital AC Ammeter is provided to indicate the Fault current in Amp.
- Autotransformer is provided to adjust the current output.
- One number of Automatic trip time measurement circuit (ATM Circuit) is provided
- One number START push button is provided in ATM Circuit
- One number STOP push button is provided in ATM Circuit
- One number LCD - Digital stop Clock is provided in ATM Circuit to measure relay trip time in S , S/10 , S/100
- One number reset switch is provided in front panel to restart the digital stop clock.
- provision of ACB busbar with suitable CT , input & output indicator
- Provision of Breaker trip status indicator with manual on/off switch
- Mimic diagram is printed on panel front plate for easy understandir
- Make – LAB CONCERN INDIA



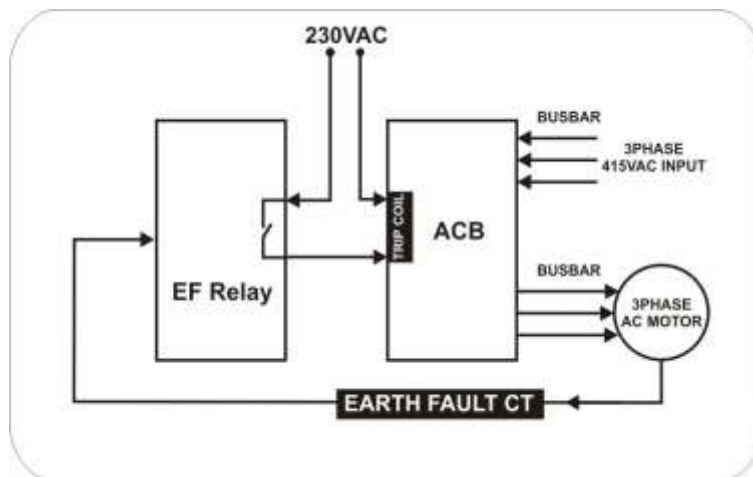
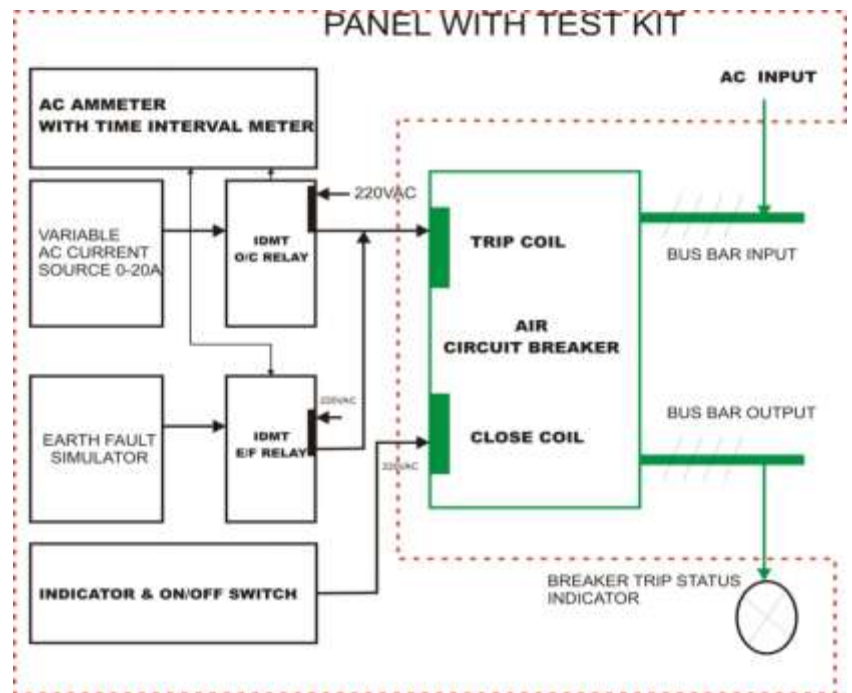
Earth fault Simulator: -

- One no of 3 phase 0.5HP AC induction motor provided.
- One no of 750 Ohm rheostat provided for create shot circuit.

EXPERIMENT DETAILS:

- ❖ **Testing of ACB under Over current fault conditions (under different fault current & study the tripping characteristics)**

- ❖ Testing of ACB under Earth fault conditions (under different fault current & study the tripping characteristics)
- ❖ Study the construction & operation of ACB (AIR CIRCUIT BREAKER)



Vacuum Circuit Breaker. 3Ø, 3pole, 400A

This set up is designed to study the working principle of VCB and to test the VCB (Vacuum circuit breaker) under over current fault and Earth Fault conditions. This set up consists of

1. **VCB (Vacuum Circuit Breaker)-11KV**
2. **VCB Test Kit with Panel set up**

VCB (Vacuum circuit Breaker)

Specification

Name	VCB
Capacity	11KV
Type	Draw out Type
Rated Current	400A
Rated Voltage	415V, 3 Phase, 50HZ
Rated Insulated Voltage	690 V
Rated S.C Breaking	36.6 KA
No. of Pole	Three Pole



Other Features

Housing: The VCB is housed in M.S. Cubicle box with conduit plugs are provided with side entry of cables. Provision for termination of contacts is made inside the cable box

Panel with VCB Test set up (current injection source)

This panel consists of the following components

1. Meter with Relay
2. Variable ac current source with trip time indicator /meter
3. Earth Fault SIMULATOR

Specification

- One number of IDMTOC Relay with necessary CT
- One number of Electromechanical Type Earth Fault Relay with necessary CT

Over Current Relay

- **Type** Single Pole /element Over Current Relay
- **CT Input** 5A
- **PMS** 50% -200% in steps of 25%
- **TMS** 0.1 to 1 in steps of 0.1s
- **Function** IDMT
- **Curve** IDMT curve of 3sec as per IEC-255
- **Features** Self powered Hand reset type-Mechanical Flag Indicator
- **Make** MEGAWIN (MCDG11)/AREVA (CDG11)
- One number of IDMT E/F Relay with necessary CT



E/F Current Relay

- **Type** Single Pole /element E/F Relay
- **CT Input** 2A
- **PMS** 50% -200% in steps of 25%
- **TMS** 0.1 to 1 in steps of 0.1s
- **Function** IDMT
- **Curve** IDMT curve of 3sec as per IEC-255
- **Features** Self powered



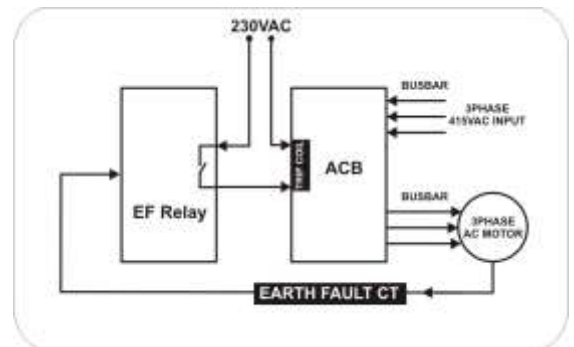
- Hand reset type-Mechanical Flag Indicator
- **Make** MEGAWIN (MCDG11)/AREVA (CDG11)

Variable ac current source with trip time indicator /meter

- One number of **Variable current source of 0-30A** is provided to test VCB
- One number of digital AC Ammeter is provided to indicate the Fault current in Amp
- Autotransformer is provided to adjust the current output.
- One number of Automatic trip time measurement circuit (ATM Circuit) is provided
 - One number START push button is provided in ATM Circuit
 - One number STOP push button is provided in ATM Circuit
 - One number LCD - Digital stop Clock is provided in ATM Circuit to measure relay trip time in S , S/10 , S/100
 - One number reset switch is provided in front panel to restart the digital stop clock

Earth Fault Simulator

This set up is designed to simulate the Earth Fault for ACB testing, This set up consists of



- One number of 3 phase induction motor /0.5HP/CG Make/3 PHASE 415VAC/ is provided to simulate Earth Fault
- Necessary Earth side CT & all necessary terminals are terminated in motor for Earth Fault simulation
- One number of Current limit resistor is provided to adjust/limit the Earth Fault current

Other Features

- VCB bus-bar input & output indicator is provided
- Necessary CT With suitable rating is provided
- Breaker trip status indicator with manual on/off switch
- All are mounted on a nice cabinet with diagram stickered on front panel.&230VAC@50Hz AC Input with power ON/OFF Switch
- Mimic diagram is printed on panel front plate for easy understanding
- Make – POWER LAB

EXPERIMENTS

1. **Testing of VCB under Over current fault conditions (under different fault current & study the tripping characteristics)**
2. **Testing of VCB under Earth fault conditions (under different fault current & study the tripping characteristics)**
3. **Study the construction & operation of VCB**

Oil Circuit Breaker. 3Ø, 3pole,400A(OCB)

This set up is designed to study the working principle of OCB and to test the OCB (Oil circuit breaker) under over current fault and Earth Fault conditions. This set up consists of

1. OCB (Oil Circuit Breaker)-11KV
2. OCB Test Kit with Panel set up

OCB (Oil circuit Breaker)

Specification

Name	OCB
Capacity	11KV
Type	Draw out Type
Rated Current	400A
Rated Voltage	415V, 3 Phase, 50HZ
Rated Insulated Voltage	690 V
Rated S.C Breaking	36.6 KA
No. of Pole	Three Pole

Other Features

Housing: The OCB is housed in M.S. Cubicle box with conduit plugs are provided with side entry of cables. Provision for termination of contacts is made inside the cable box



Panel with VCB Test set up (current injection source)

This panel consists of the following components

1. Meter with Relay
2. Variable ac current source with trip time indicator /meter
3. Earth Fault SIMULATOR

Specification

- One number of IDMTOC Relay with necessary CT
- One number of Electromechanical Type Earth Fault Relay with necessary CT

Over Current Relay

- **Type** Single Pole /element Over Current Relay
- **CT Input** 5A
- **PMS** 50% -200% in steps of 25%
- **TMS** 0.1 to 1 in steps of 0.1s
- **Function** IDMT
- **Curve** IDMT curve of 3sec as per IEC-255
- **Features** Self powered Hand reset type-Mechanical Flag Indicator
- **Make** MEGAWIN (MCDG11)/AREVA (CDG11)
- One number of IDMTE/F Relay with necessary CT

E/F Current Relay

- **Type** Single Pole /element E/F Rela
- **CT Input** 2A
- **PMS** 50% -200% in steps of 25%
- **TMS** 0.1 to 1 in steps of 0.1s



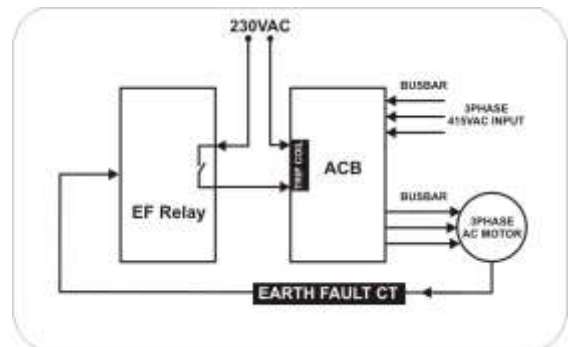
- **Function** IDMT
- **Curve** IDMT curve of 3sec as per IEC-255
- **Features** Self powered Hand reset type-Mechanical Flag Indicator
- **Make** MEGAWIN (MCDG11)/AREVA (CDG11)

Variable ac current source with trip time indicator /meter

- One number of **Variable current source of 0-30A** is provided to test OCB
- One number of digital AC Ammeter is provided to indicate the Fault current in Amp
- Autotransformer is provided to adjust the current output.
- One number of Automatic trip time measurement circuit (ATM Circuit) is provided
 - One number START push button is provided in ATM Circuit
 - One number STOP push button is provided in ATM Circuit
 - One number LCD - Digital stop Clock is provided in ATM Circuit to measure relay trip time in S , S/10 , S/100
 - One number reset switch is provided in front panel to restart the digital stop clock

Earth Fault Simulator

This set up is designed to simulate the Earth Fault for ACB testing, This set up consists of



- One number of 3 phase induction motor /0.5HP/CG Make/3 PHASE 415VAC/ is provided to simulate Earth Fault
- Necessary Earth side CT & all necessary terminals are terminated in motor for Earth Fault simulation
- One number of Current limit resistor is provided to adjust/limit the Earth Fault current

Other Features

- OCB bus bar input & output indicator is provided
- Necessary CT With suitable rating is provided
- Breaker trip status indicator with manual on/off switch
- All are mounted on a nice cabinet with diagram stickered on front panel.&230VAC@50Hz AC Input with power ON/OFF Switch
- Mimic diagram is printed on panel front plate for easy understanding
- Make – LAB CONCERN INDIA

EXPERIMENTS

1. **Testing of OCB under Over current fault conditions (under different fault current & study the tripping characteristics)**
2. **Testing of OCB under Earth fault conditions (under different fault current & study the tripping characteristics).**
3. **Study the construction & operation of VCB**

SF6 Circuit Breaker with Test Kit

This test panel can be used to understand the basic working principle of SF6 circuit breaker under over current and earth fault conditions. This set up consist of



Breaker Specification

Type	SF6-12KV
Rated Voltage	12kv
Rated Frequency	50 Hz
Basic Insulation Level	28KVRMS
Short time withstand current for 3 sec	40KA
Operating sequence	0-0.3s-co-3min-co
Operating time	36-55ms
Closing Time	65-95ms
Auxiliary supply	220v ac

Make

KIRLOSKAR ELECTRIC COMPANY

Panel with SF6 Breaker Test set up (current injection source)

This panel consists of the following components

1. Meter with Relay
2. Variable ac current source with trip time indicator /meter
3. Earth Fault SIMULATOR