BAPATLA ENGINEERING COLLEGE :: BAPATLA

(Autonomous)

POWER ELECTRONICS LAB MANUAL (18EEL602 & 20EEL602)

Department of Electrical and Electronics Engineering

Bapatla Engineering College::Bapatla-522101

(Autonomous)

(Affiliated to Acharya Nagarjuna University)

E-mail: bec_principal@yahoo.com; Website:becbapatla.ac.in

Phone: 08643-224244,224266,225234; Fax: 08643-224246

BAPATLA ENGINEERING COLLEGE :: BAPATLA

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College Vision

To build centers of excellence, impart high quality education and instill high standards of ethics and professionalism through strategic efforts of our dedicated staff, which allows the college to effectively adapt to the ever changing aspects of education.

College Mission

Our Mission is to impart the quality education at par with global standards to the students from all over India and in particular those from the local and rural areas. We continuously try to maintain high standards so as to make them technologically competent and ethically strong individuals who shall be able to improve the quality of life and economy of our country

Department Vision

The Department of Electrical & Electronics Engineering will provide programs of the highest quality to produce globally competent technocrats who can address challenges of the millennium to achieve sustainable socio-economic development.

Department Mission

1. To provide quality teaching blended with practical skills.
2. To prepare the students ethically strong and technologically competent in the field of Electrical and Electronics Engineering.
3. To motivate the faculty and students in the direction of research and focus to fulfil social needs.

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PROGRAM EDUCATIONAL OBJECTIVES (PEO'S)

PEO1	Have a strong foundation in the principles of Basic Sciences, Mathematics and Engineering to solve real world problems encountered in modern electrical engineering and pursue higher studies/placement/research.
PEO2	Have an integration of knowledge of various courses to design an innovative and cost effective product in the broader interests of the organization & society.
PEO3	Have an ability to lead and work in their profession with multidisciplinary approach, cooperative attitude, effective communication and interpersonal skills by participating in team oriented and open-ended activities.
PEO4	Have an ability to enhance in career development, adapt to changing professional and societal needs by engage in lifelong learning.

PROGRAM OUTCOMES (PO'S)

Program Outcomes		**Engineering Graduates will be able to**
PO1	Engineering knowledge	Apply the knowledge of mathematics, science, Engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	Problem analysis	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	Design/development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Conduct investigations of com plex problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern tool usage	Create, select, and apply appropriate techniques, Resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	The engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and teamwork	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10	Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to com prehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PROGRAM SPECIFIC OUTCOMES (PSO'S)

PSO1	The Electrical and Electronics Engineering graduates are capable of applying the Knowledge of mathematics and sciences in modern power industry.
PSO2	Analyse and design efficient systems to generate, transmit, distribute and utilize electrical energy to meet social needs using power electronic systems.
PSO3	Electrical Engineers are capable to apply principles of management and economics for providing better services to the society with the technical advancements in renewable and sustainable energy integration.

Safety Precautions

1. Care in handling all electrical apparatus and equipment is the only effective safe guard against injury and death.
2. Never use appliances etc. that have damaged or frayed leads.
3. Replace immediately broken switches and plugs etc.
4. Check that all metallic parts of electric equipment are effectively earthed.
5. Never place bare wires of leads in plug fit a plug top.
6. Check proper working of safety devices.
7. Keep proper condition of electrical hand tools.
8. Use correct rating of fuses.
9. Never tamper unnecessarily with any live apparatus.

Following precautions should be observed before using the electrical appliances and equipment.

10. Always be careful, donot think of others while working on electricity.
11. You should not energize any conductor unless you are sure that all is clear and there is none working on it.
12. You should not tamper unnecessarily with any live electrical gear.
13. You should not disconnect any plug by pulling the flexible cable.
14. Before replacing a blown fuse always remember to put the main switch off.
15. Safety demands a good earthing; hence always keep earth connections in good condition.
16. Before using portable electrical things see that these are well earthed.
17. While handling an electrical appliance like table fan, iron box, heaters etc. be sure that they are disconnected from the supply. Switching off is not enough. Insulation failure leads to sever Shock.
18. Live wires should always be connected through the switch.
19. Do not use a Cutting plier as a hammer.
20. Do not put a sharp-edged tool in your pocket.
21. If you want to hand over any sharp tool-like knife, screw driver, file, hand saw etc. to someone else, give it from handle side otherwise it can injure the hand.
22. Do not use tools like file, knife, screwdriver etc. without handle otherwise it can injure your hand.
23. In rainy season apply grease on tools to avoid rust.

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POWER ELECTRONICS LAB

III B.Tech – VI Semester (Code: 18EEL602/20EEL602)

Lectures	0	Tutorial	0	Problem Solving	0	Practical	3	Credits	1.5
Continuous Internal Assessment				30	Semester End Examination (3 Hours)				70

Prerequisites: Semiconductor Physics and Nano Materials (20EE202/PH03).

Course Objectives: To make the students

CO1: Conduct the Turning ON and OFF of Transistor and Power Electronics Devices.

CO2: Illustrate AC to DC Conversion circuits on R, RL, Back emf Loads.

CO3: Categorise the operation of inverters PWM techniques on R, Motor Loads.

CO4: Outline the operation of DC-DC choppers and AC Voltage controllers on R Load.

Course Outcomes: Students will be able to

CLO1: Test the basic operation and compare performance of various power semiconductor devices, passive components and switching circuits.

CLO2: Justify the performance of AC to DC Conversion circuits with different loads.

CLO3: Measure the operation of inverters and PWM techniques.

CLO4: Assess the operation of DC-DC choppers and AC Voltage controllers.

LIST OF EXPERIMENTS:

A- Essential Experiments

1. Static characteristics of SCR, TRIAC.
2. Characteristics of MOSFET & IGBT.
3. Gate triggering methods for SCR (R, RC, UJT).
4. 1- phase Half & Full controlled rectifier with R, RL & RLE load.
5. Voltage commutated DC chopper with R load.
6. 1-phase modified series inverter with R load.
7. 1-phase parallel inverter with R & RL loads.

B- List of Optional Experiments:

(i) Chose one Experiment

8. 1-phase Cyclo-converter (Center tapped or Bridge) with R load.
9. 1- phase IGBT based inverter with R, RL loads.
10. 1-phase Dual converter with R, RL & RLE loads (Circulating and Non-circulating modes).

(ii) Chose one Experiment

11. 3-phase Half & Full controlled Rectifier with R, RL and RLE loads.

12. 3-phase IGBT based inverter with R, RL loads.

13. Buck Boost Converter with R load.

(iii) Chose one Experiment

14. DSP based speed control of BLDC motor.

15. DSP based speed control of 3-phae Induction motor.

16. Study of 1-phase full wave Mc-Murray Bedford Inverter with R, RLE load.

Note: Minimum 10 experiments should be conducted.

CLO, PO and PSO Mapping:

Circuit Theory Lab (20EEL202)		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO1	Demonstrate the basic operation and compare performance of various power semiconductor devices, passive components and switching circuits.	3	3	1	3	0	0	0	0	3	2	0	0	3	2	2
CLO2	Categorize the performance of AC to DC Conversion circuits with different loads	3	3	2	3	0	0	0	0	3	2	0	0	3	3	3
CLO3	Outline the operation of inverters and PWM techniques.	3	3	3	3	3	0	0	0	3	2	0	0	3	3	3
CLO4	Illustrate the operation of DC-DC choppers and AC Voltage controllers.	3	3	3	3	1	0	0	0	3	2	0	0	3	3	3

1. Static Characteristics of SCR & TRIAC

a). Characteristics of SCR: -

AIM: To plot the characteristics of an SCR and to find the holding current and latching current.

APPARATUS:

1) Characteristics Study unit.
2) Meter Unit (3 ½ digit voltmeter -2Nos) 200V,20V-1No.each
   (3 ½ digit Ammeters-2Nos) 2A,20mA-1No.each

PROCEDURE:

(a) V-I Characteristics :-

1) Make the connections as given in the circuit diagram including meters.
2) Now switch ON the mains supply to the unit and initially keep V_1 & V_2 at minimum.
3) Set load potentiometer R1 in the minimum position.
4) Adjust $I_G = I_{G1}$ say 8 mA by varying V_2 or gate current potentiometer R_2.
5) Slowly vary V_1 and note down V_{AK} and I_L readings for every 2 volts and entered the readings in the tabular column.
6) Further vary V_1 till SCR conducts, this can be noticed by sudden drop of V_{AK} and rise of I_L readings note down this readings and tabulated.
7) Vary V_1 Further and note down I_L and V_{AK} readings. Draw the graph of $\mathbf{V_{AK}}$ V/S $\mathbf{I_L}$. Repeat the same for $I_G = I_{G2}$ and draw the graph.

(b) To find latching current:-

1) Apply about 20V between Anode and cathode by varying V_1.
2) Keep the load potentiometer R_1 at minimum position.
3) The device must be in the OFF state with gate open.
4) Gradually increase Gate voltage - V_2 till the device turns ON.
5) This is the minimum gate current (Igmin) required to turn ON the device.
6) Adjust the gate voltage to a slightly higher.
7) Set the load potentiometer at the maximum resistance position.
8) The device should come OFF state, otherwise decrees V_1 till device comes to OFF state.
9) The gate voltage should be kept constant in this experiment. By varying R_1, gradually increase load current 1A in steps.
10) Open and close the Gate voltage V_2 switch after each step.

11) If the anode current is greater the latching current of the device, the device stays on even after the gate switch is opened. Otherwise the device goes into blocking mode as soon as the gate switch is opened.

12) Note the latching current. Obtain the more accurate value of the latching current by taking small steps of 1A near the latching current value.

(c)To find the Holding current:-

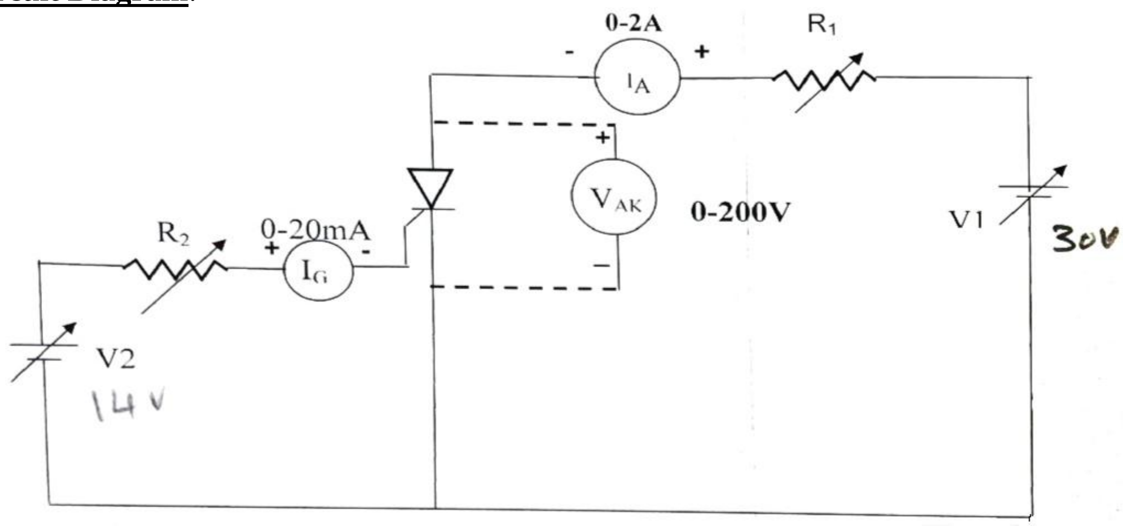
1) Increase the load current from the latching current level by load pot R_1 or V_1.
2) Open the gate switch permanently. The Thyristor must be fully ON.
3) Now start reducing the load current gradually by adjusting R_1 . If the SCR does not turn OFF even after the R_1 at maximum position, then reduce V_1.
4) Observe when the device goes to Blocking mode. The load current through the device at this instant, is the holding current of the device.,
5) Repeat the steps again to accurately get the Ih. Normally $I_H<I_L$.

IG-8.3mA approximately
IL-30mA.
Ih-22mA.

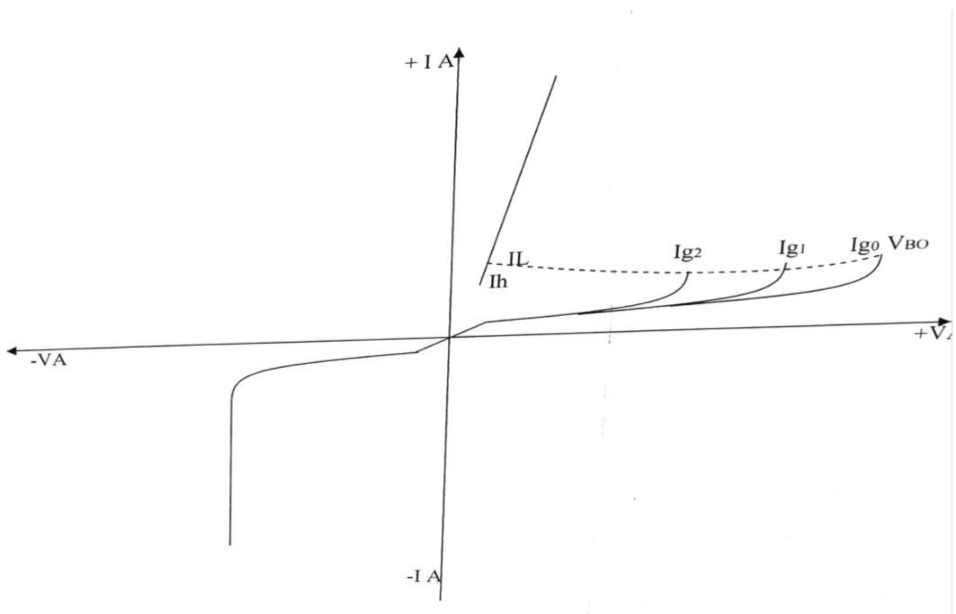
Gate Current $I_G=I_{G1}$=8.1mA	
Anode Voltage V_{AK} (Volts)	Anode Current I_A (Amperes)

Gate Current $I_G=I_{G1}$=7.2mA	
Anode Voltage V_{AK} (Volts)	Anode Current I_A (Amperes)

Circuit Diagram: -



Output Waveform: -



ANSWER THE FOLLOWING QUESTIONS:
1. What is thyristor family?
2. What are the different family members of thyristor devices?
3. What are the different modes of an SCR?
4. Define Latching current (IL).
5. Define Holding current (IH). Which will be larger either IL or IH?
6. What are the conditions for „Turn-ON" of an SCR.

b) Characteristics of TRIAC:-

AIM: To plot the characteristics of an TRIAC and to find the holding current and latching current.

APPARATUS:

3) Characteristics Study unit.
4) Meter Unit (3 ½ digit voltmeter -2Nos) 200V,20V-1No.each
   (3 ½ digit Ammeters-2Nos) 2A,20mA-1No.each

PROCEDURE:

a) **V-I Characteristics** :-

8) Make the connections as given in the circuit diagram including meters.
9) Now switch ON the mains supply to the unit and initially keep V1 & V2 at minimum.
10) Set load potentiometer R1 in the minimum position.
11) Adjust IG =IG1 say 10mA by varying V2 or gate current potentiometer R2.
12) Slowly vary V1 and note down VT2 T1 and IL readings for every 5 volts and entered the readings in the tabular column.
13) Further vary V1 till TRIAC conducts, this can be noticed by sudden drop of VT2 T1 and rise of IL readings note down this readings and tabulated.
14) Vary V1 Further and note down IL and VT2 T1 readings .Draw the graph of VT2 T1 V/s IL.Repeat the same for IG=IG2/IG3 and draw the graph.

(b) To find latching current:

1)Apply about 20V between MT2 and MT1 by varying V1.
2)Keep the load potentiometer R1 at minimum position.The device must be in the OFF state with gate open.
3)Gradually increase Gate voltage - V2 till the device turns ON.This is the minimum gate current (Igmin) required to turn ON the device.
4)Adjust the gate voltage to a slightly higher.Set the load potentiometer at the maximum resistance position.
5)The device should comes to OFF state, otherwise decrese V1 till the device comes to OFF state.
6)The gate voltage should be kept constant in this experiment. By varying R1, gradually increase load current 1A in steps.
7)Open and close the Gate voltage V2 switch after each step.
8)If the anode current is greater the latching current of the device, the device stays on even after the gate switch is opened.
9) Otherwise the device goes into blocking mode as soon as the gate switch is opened.
10)Note the latching current. Obtain the more accurate value of the latching current by taking small steps of 1A near the latching current value.

C) To find the Holding current:-

1) Increase the load current from the latching current level by load pot R1 or v1.

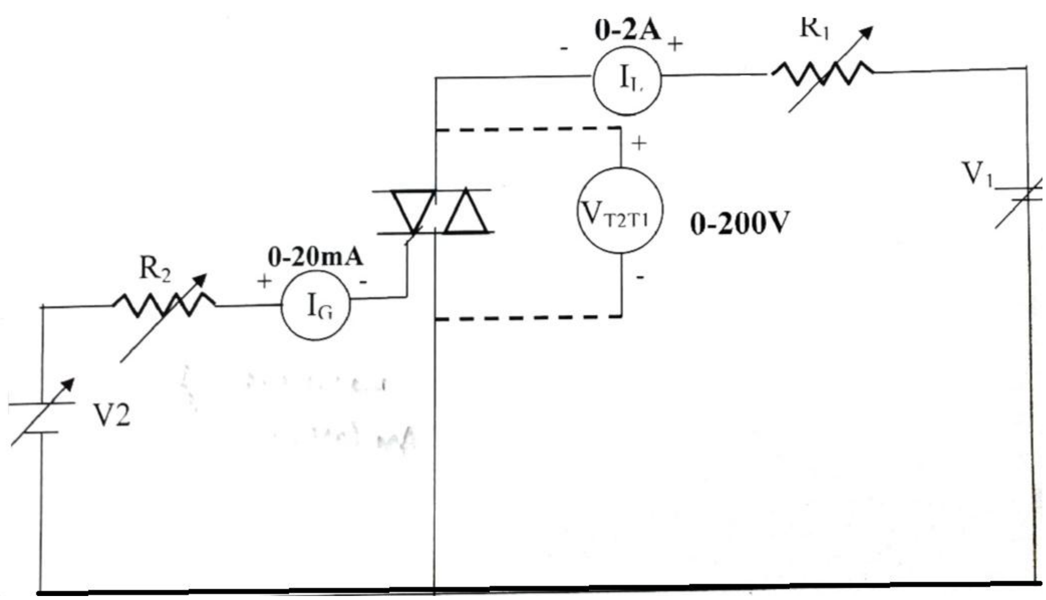
2) Open the gate switch permanently. The TRIAC must be fully ON.Now start reducing the load current gradually by adjusting R1 . If the TRIAC does not turns OFF even after the R1 at maximum position, then reduce V1.

3) Observe when the device goes to Blocking mode. The load current through the device at this instant , is the holding current of the device. Repeat the steps again to accurately get the Ih. Normally Ih<IL.

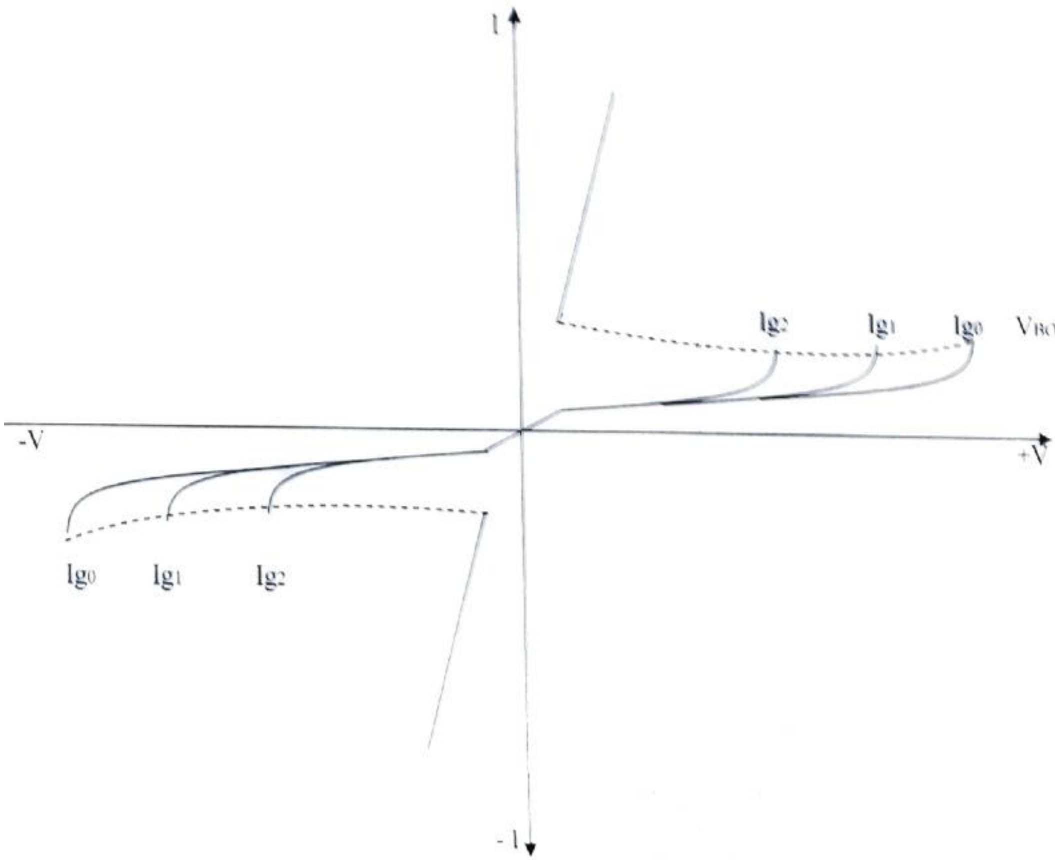
IG-10mA approximately
IL-14mA. approximately
Ih-12mA. approximately

IG=IG1=7Ma	
V T2 T1	I L

IG=IG1=7.1mA	
V T2 T1	I L



OUTPUT WAVEFORM:-



2. Firing Schemes of SCR (R , RC, UJT)

AIM:- To study the difference firing schemes of an SCR.

APPARATUS :- Firing scheme module kit, Ammeter , Wattmeter,
Bulb load, Patch cards, CRO.

PROCEDURE :-

1. Connect the CKT as per the circuit diagram.
2. Switch ON the power supply.
3. By varying the pot R, Observe the waveform in CRO.
4. Measure the firing angle from waveform in CRO.
5. Calculate the average and RMS values of load output voltages.

For RC Firing Schemes:-

1. Connect the CKT as per the circuit diagram.
2. Switch ON the power supply.
3. By varying the pot R, Observe the waveform in CRO.
4. Measure the delay angle in CRO.
5. The value of Iavg, Irms, Vavg ,Vrms and alfa are calculated in The tabular column.
6. Calculate the average and RMS value of load voltage and load current.

For UJT Firing schemes:-

1. Connect the circuit as per the circuit diagram.
2. Switch on the power supply
3. Slowly vary the pot R, Observe the waveform in CRO.
4. Note down the value of Irms, Iavg, Vavg, Vrms & alfa in a tabular column.
5. Measure the value of alfa and tabulated in the tabular form.

Formulae:-

$$\text{Form Factor} = V_{rms}/V_{av}$$

$$\text{Form Factor} = \frac{I_{rms}}{I_{av}}$$

$$\textit{Ripple Factor}, \gamma = \frac{\sqrt{(Irms)^2 - (Idc)^2}}{Idc}$$

$$= \frac{\sqrt{(Vrms)^2 - (Vdc)^2}}{Vdc}$$

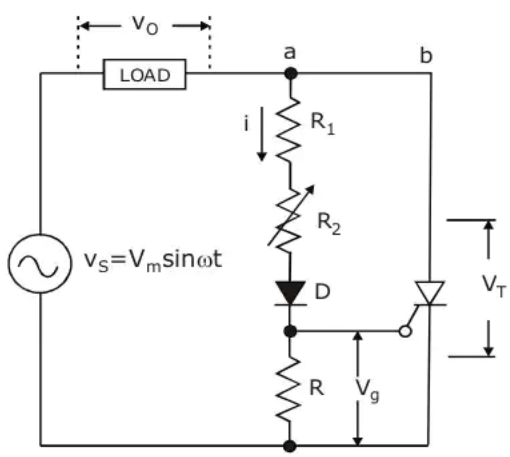
$$V_{RMS} = \frac{1}{\sqrt{2}} \times V_{pk} = 0.7071 \times V_{pk}$$

$$V_{RMS} = \frac{1}{2\sqrt{2}} \times V_{p\text{-}p} = 0.3536 \times V_{p\text{-}p}$$

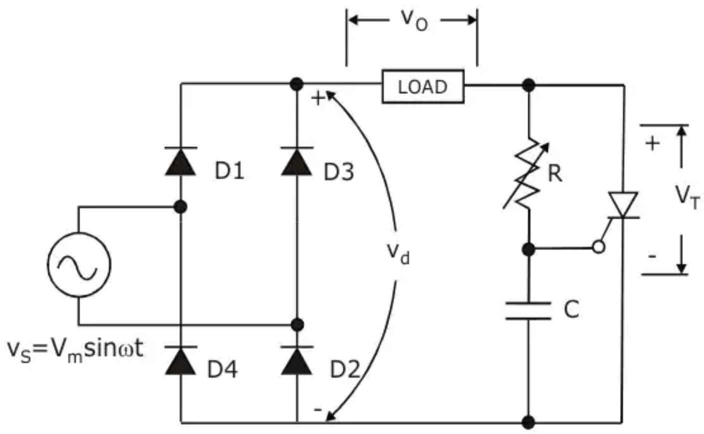
$$V_{RMS} = \frac{\pi}{2\sqrt{2}} \times V_{avg} = 1.11 \times V_{avg}$$

CIRCUIT DIAGRAM:-

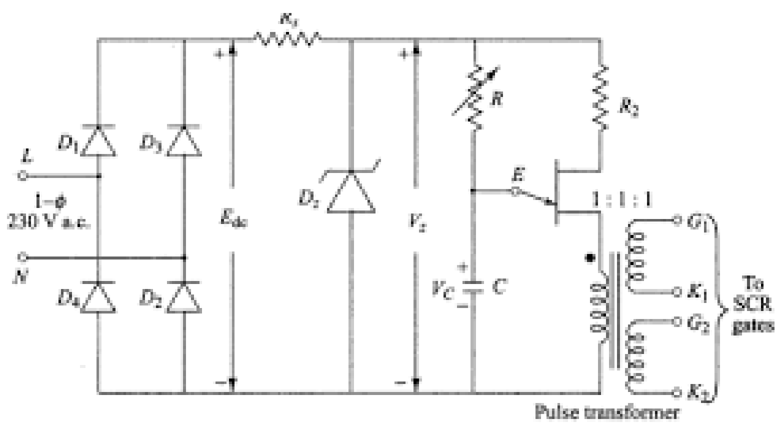
R Triggering Circuit



RC Full Wave Circuit



UJT TRIGGERING CIRCUIT



Synchronized UJT trigger-circuit

TABULAR FORM:-

FOR R-TRIGGERING

S.NO	V0	Vag(th)	Vrms(p)	Vrms(th)	Iavg(p)	Iavg(th)	Firing angle	Ripple factor(p)	Ripple factor (th)

FOR RC-TRIGGERING

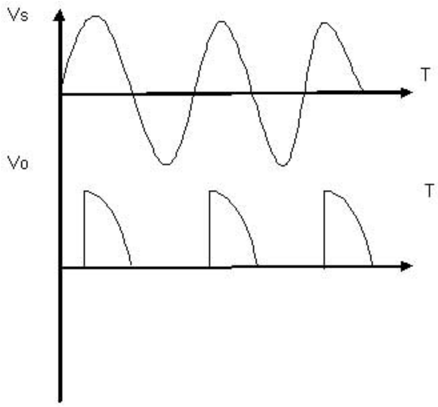
S.NO	V0	Vag(th)	Vrms(p)	Vrms(th)	Iavg(p)	Iavg(th)	Firing angle	Ripple factor(p)	Ripple factor (th)

FOR UJT-TRIGGERING

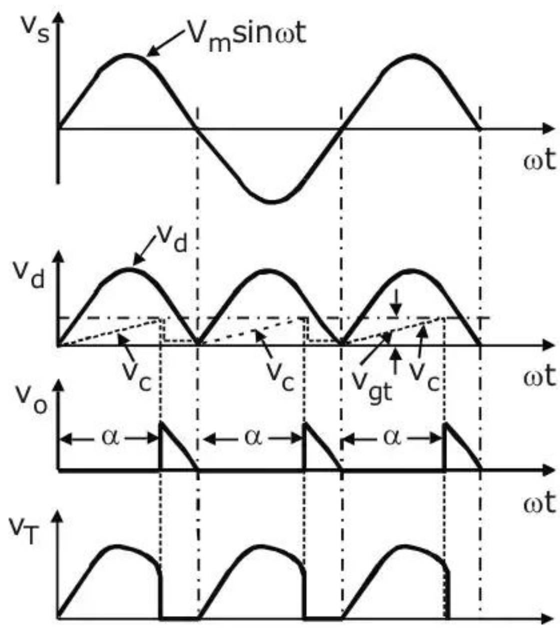
S.NO	V0	Vag(th)	Vrms(p)	Vrms(th)	Iavg(p)	Iavg(th)	Firing angle	Ripple factor(p)	Ripple factor (th)

MODEL GRAPHS:-

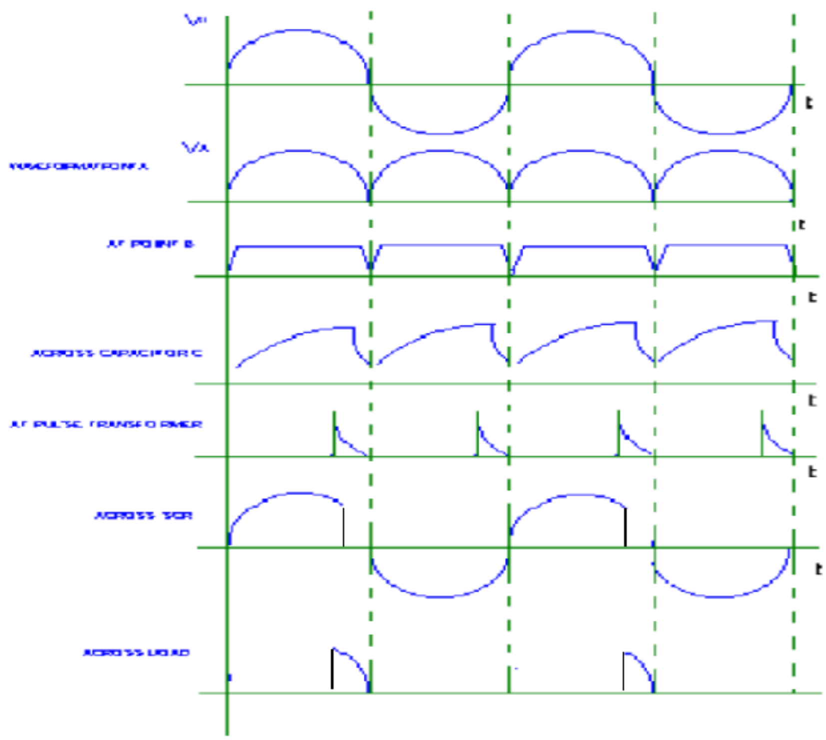
FOR R TRIGGERING:-



FOR RC TRIGGERING:-



FOR UJT TRIGGERING:-



3. 1-Phase Fully Controlled Bridge Rectifier With R-Load

AIM:- To conduct 1-phase fully controlled bridge rectifier and to obtain output voltage waveform.

APPARATUS:- Pulse converter, CRO, Ammeter, Voltmeter, Bulb, Patchcards.

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Switch ON the power supply to the circuit and switch ON pulse converter switch SW3.
3. Vary the firing angle switch step by step using firing angle knob.
4. At each stage note down the readings of CRO.
5. After taking the readings bring the firing angle knob to min .position.

FORMULAE:-

Its rms value = $\frac{V_m}{\sqrt{2}}$

and average value = $\frac{2V_m}{\Pi}$

Therefore, FF = $\frac{rms}{average} = \frac{\frac{V_m}{\sqrt{2}}}{\frac{2V_m}{\Pi}} = 1.11$

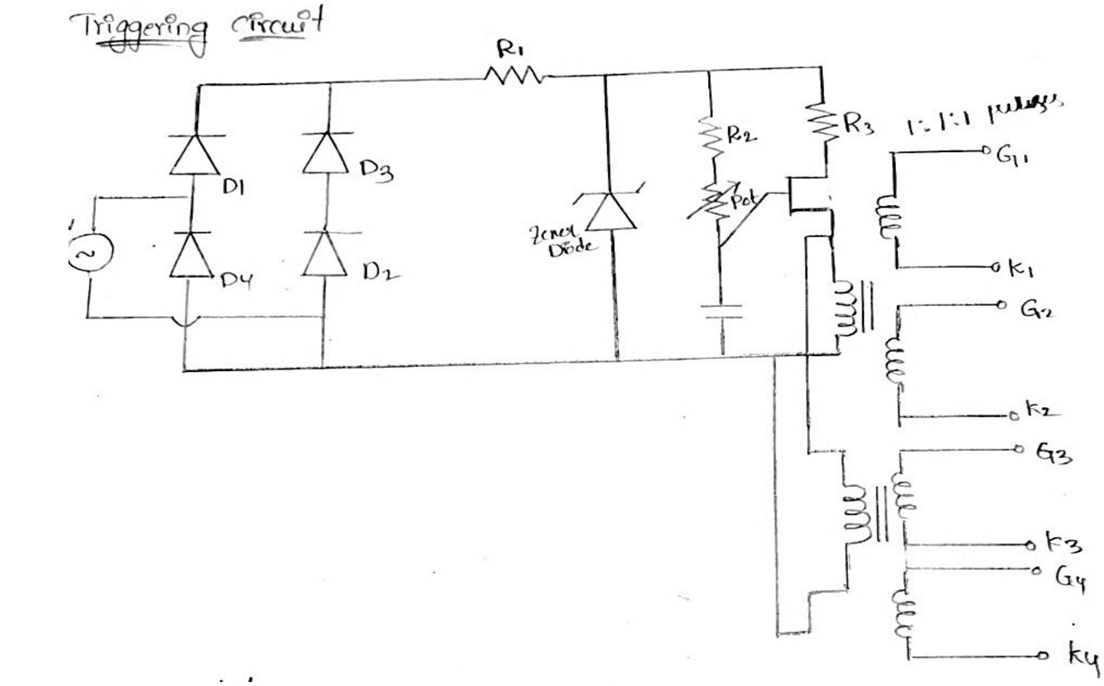
$$Ripple\ Factor = \frac{\sqrt{(Irms)^2 - (Idc)^2}}{Idc}$$

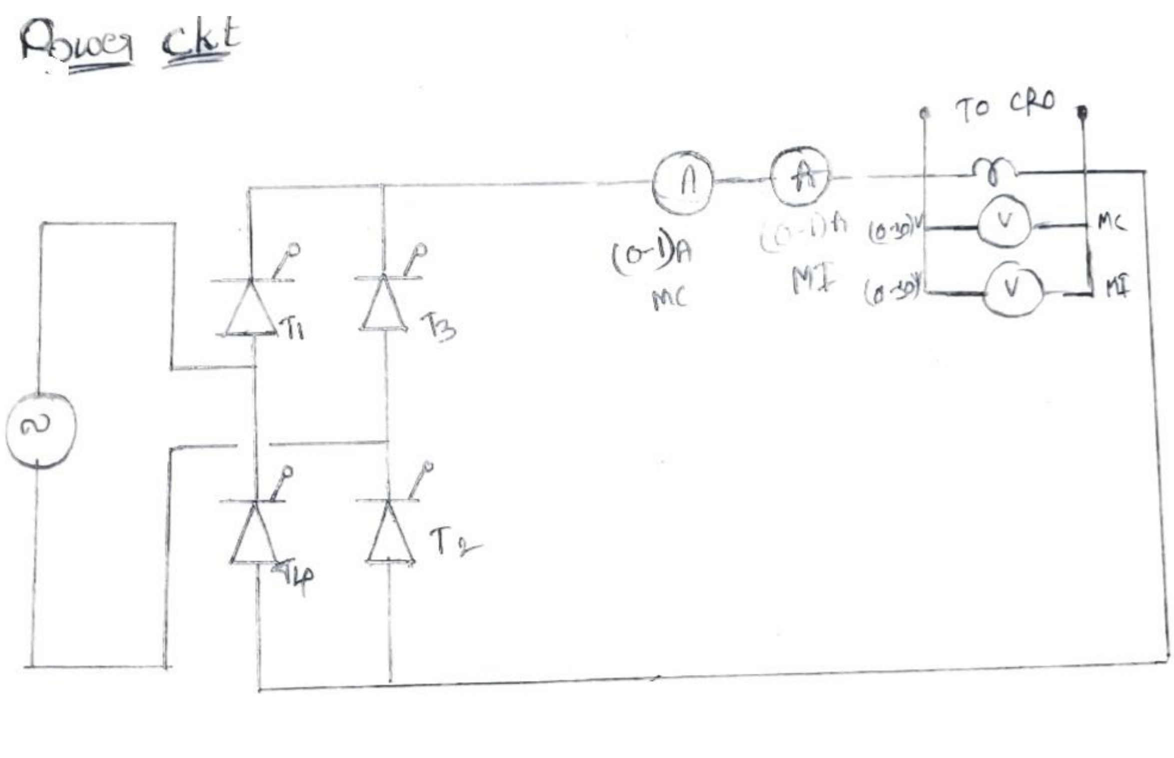
$$= \frac{\sqrt{(0.707Im)^2 - (0.637Im)^2}}{(0.637Im)}$$

$$= \frac{\sqrt{(0.707Im)^2 - (0.637Im)^2}}{(0.637Im)}$$

$$= 0.482$$

Circuit Diagram:-

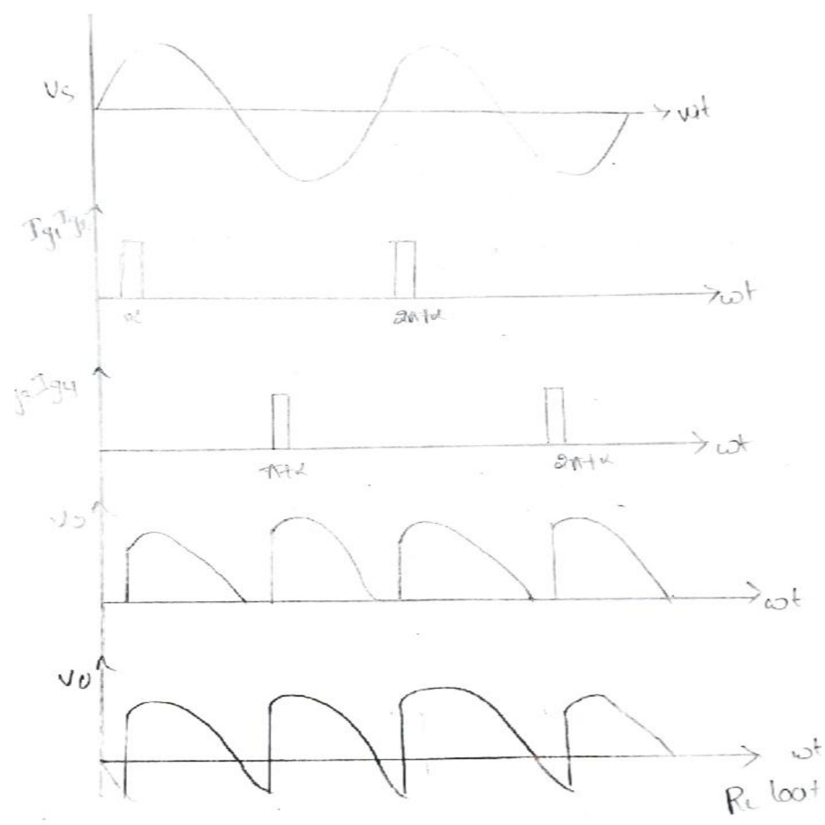




Tabular Form:-

S.NO	V avg(p)	V avg (th)	V rms (p)	V rms(th)	I avg(p)	I rms (p)	Firing angle	Ripple factor(p)	Ripple factor(th)

Wave forms:-



PRECAUTIONS:- 1.Connections should me tight.
2.Avoid parallax error while taking the readings.

4. Speed Control of Dc Shunt Motor Using Three Phase Full Controlled Converter

Aim: To study speed control of DC shunt motor using three phase full controlled converter.

APPARATUS REQUIRED:

A) Three phase converter firing circuit.
B) Three phase full controlled converter Power circuit.
c) Power scope or CRO.
D) DC Shunt motor-1 H.P./220V.with mechanical loading arrangement.
E) Rheostat-350 ohms/2A.
F) Digital Tachometer.

PROCEDURE:

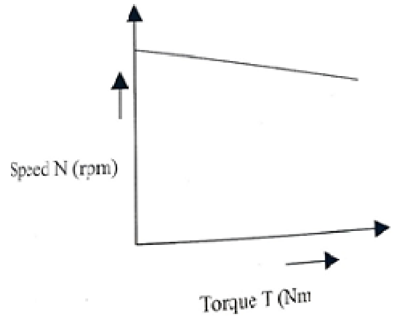
1) Connect R Y B and Neutral to the respective terminals provided in the unit. Switch ON the Mains supply. The display indicates
   WELCOME
   THREE PHASE CONVERTER FIRING
   F.A-180degrees

2)The LCD display shown F.A-180 degrees and the trigger output are at OFF state.
3)Now switch ON the 3ph supply for synchronization.
4)Set the F.A foe any degree by incrementing and decrementing the F.A . using INC and DEC key.
5) Now press RUN/Stop key, the trigger outputs are available at T1 to T6 trigger o/p terminals. We can also vary the firing angle when it is in ON condition also. Soft start and soft stop feature is provided for the firing pulses.

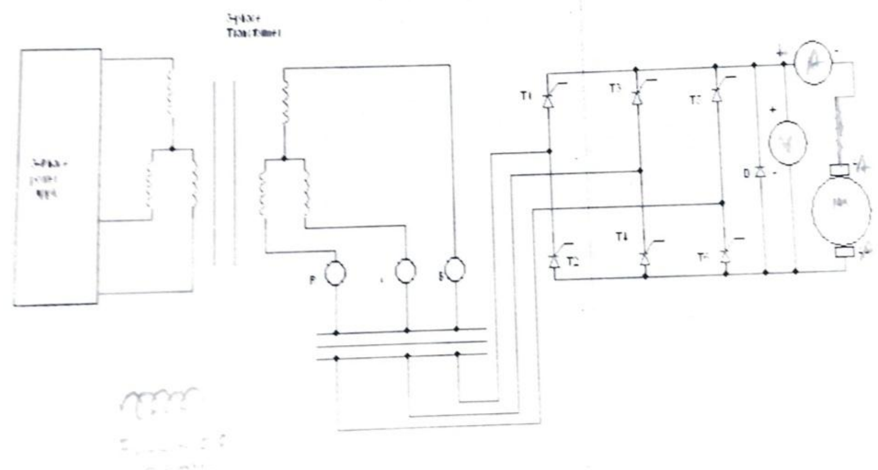
TABULAR COLOUMN FOR ARMATURE CONTROL:

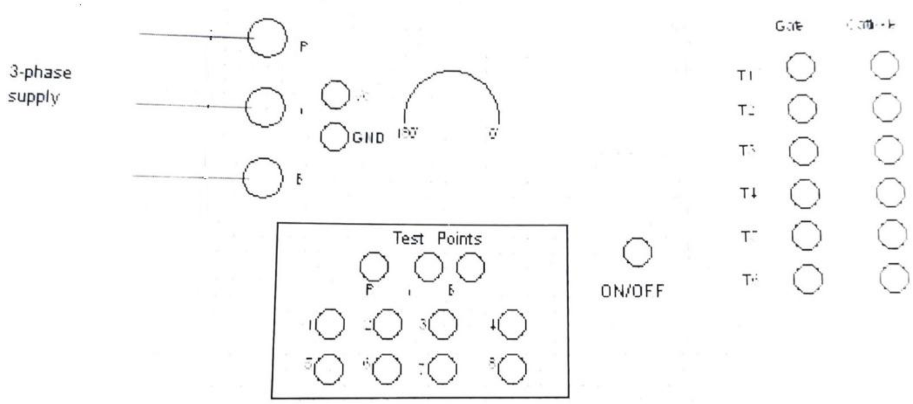
Sl No	Field voltage	Vin volts	Firing angle	Va Volts	Ia amps	Speed in RPM	Load in W in kg.	Torque (N-M)

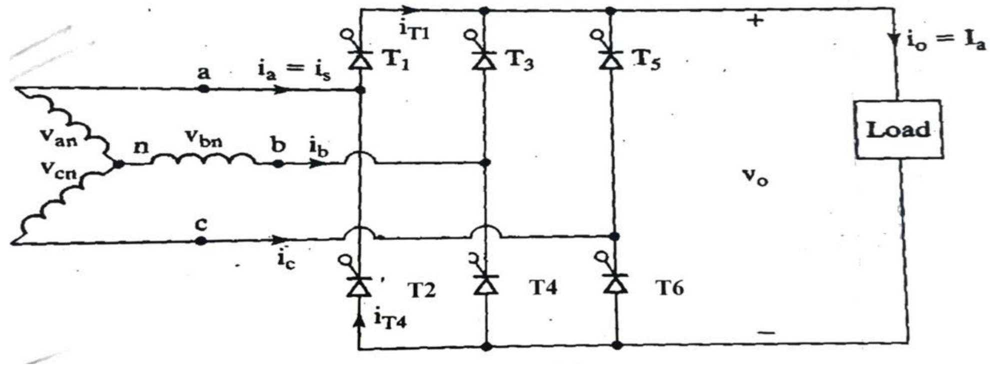
W=W1-W2 Kgs..
Torque = 9.81*R*(w1-W2) N-m. Where R= radius of the brake drum = m.
MODEL GRAPH:



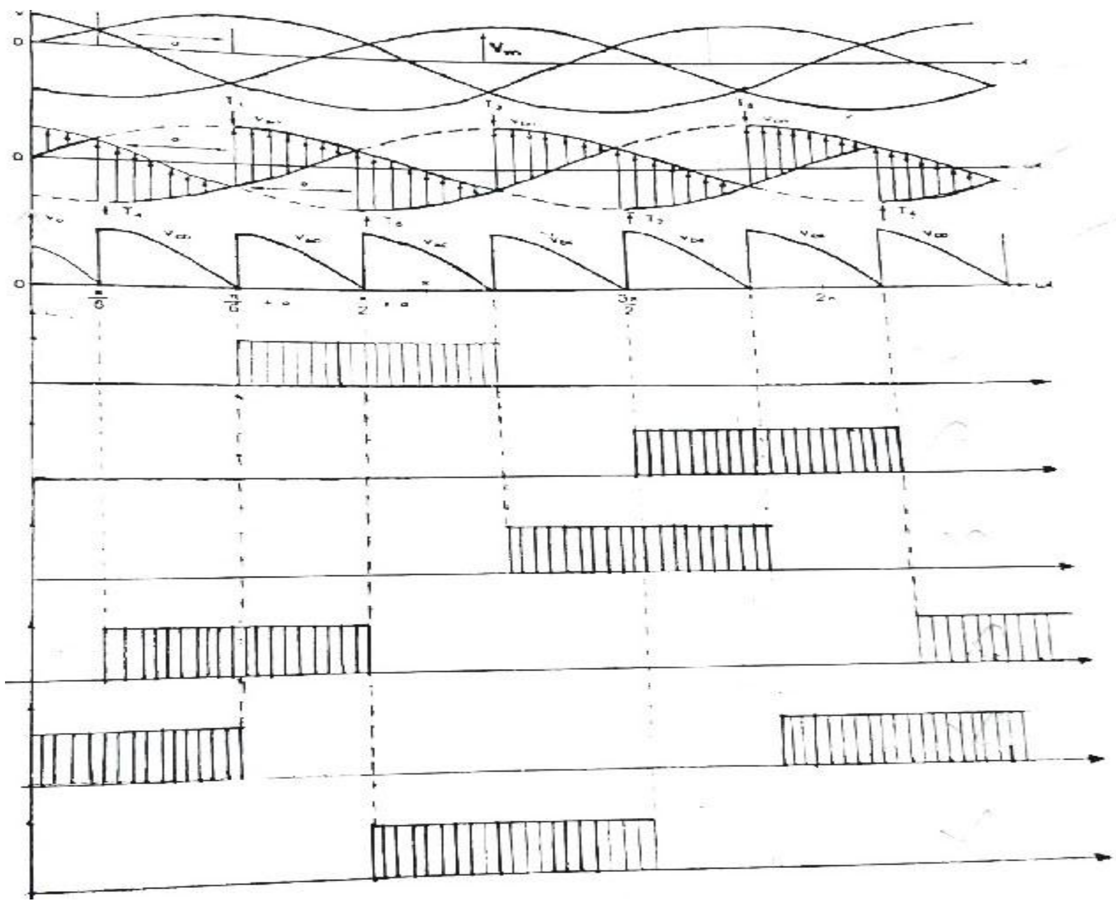
CIRCUIT DIAGRAM:







(a) Circuit



(b) Wave forms

Figure 2.6 Three-phase Fully Controlled Bridge Converter

RESULT:- SPEED CONTROL OF DC MOTOR USING 3PHASE FULL CONTROLLED CONVERTER IS STUDIED.

5. Speed Control Of Dc Motor Using Single Phase Dual Converter In Circulatory Current Mode

AIM: To control the speed of DC motor using single phase Dual Converter in Circulatory current mode.

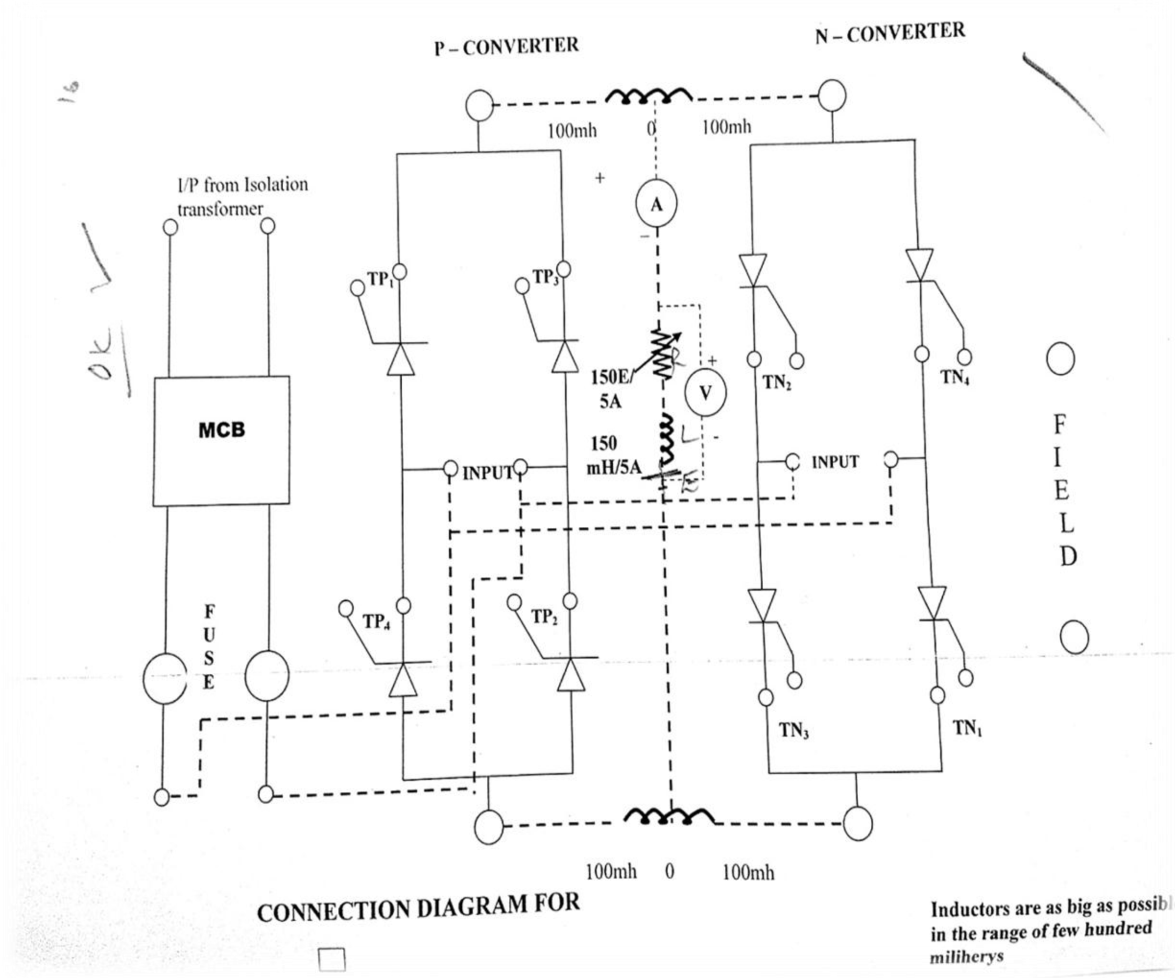
APPARATUS :

a)Single phase dual converter power circuit-230V/5 Amps
b)Single phase dual converter firing unit.
c)DC Shunt motor 1 H.P/220 V with mechanical loading arrangement.
d)Digital tachometer.
e)CRO – 20 Mhz.

PROCEDURE :

1) Make the connections in the power circuit as shown in the power circuit as shown in the circuit diagram for non circulatory current mode.
2) Connect firing pulses from the firing circuit to the respective SCR'S Gate/Cathode terminals in the power circuit .
3) Connect input AC supply to the power circuit through an isolation transformer .
4) Connect the FIELD supply from the power circuit to the FIELD of the DC Shunt motor connect the ARMATURE terminals between the output terminal of dual converter in series with ammeter provided in the power circuit.
5) Connect voltmeter across output of the dual converter as shown.
6) Switch ON the firing circuit. Select CC mode . Select P converter . Switch ON the MCB.
7) Vary the firing angle by dec key and press ON/OFF key to ON .
8) Note down the voltmeter and ammeter reading and speed of the DC motor for different values of firing angle .Note down the reading in the tabular column.
9) Keep the firing angle at 0^0 and apply the load till the rated current of the DC motor with mechanical loading setup and Note down the voltmeter and ammeter reading and speed of DC motor and enter the reading in the tabular column.
10) Select N converter in firing unit by press key P/N Key.
11) Repeat the above procedure for N converter also.
12)You can observe the speed of the motor reverse in N converter.
13)Switch off the trigger pulses by press ON/OFF key to OFF in the firing unit and switch off the MCB in power circuit and field supply to the motor at the end.
16) Remove Connections.

CIRCUIT DIAGRAM:1



CIRCUIT DIAGRAM:2

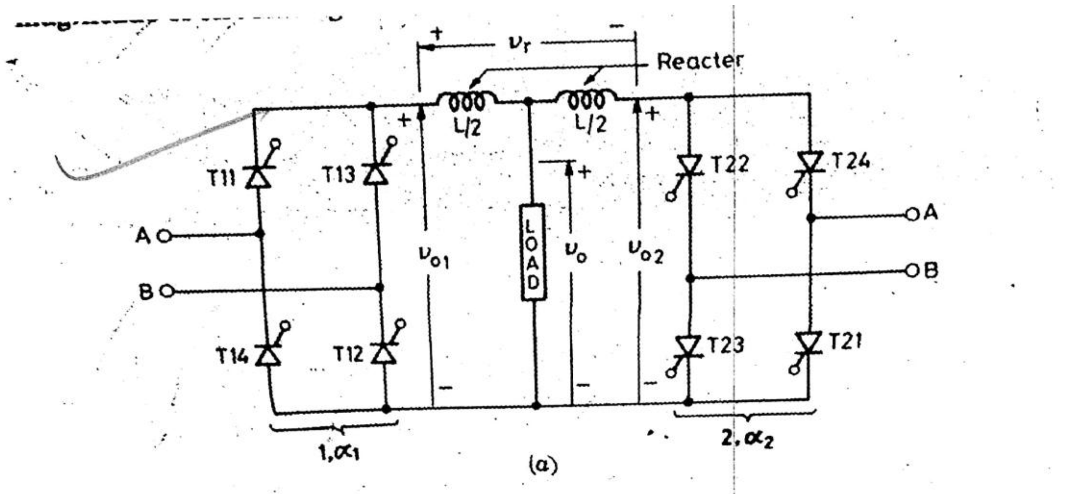


Fig. 2 Circuit diagram for Circulating current type dual converter

DIAGRAM:3

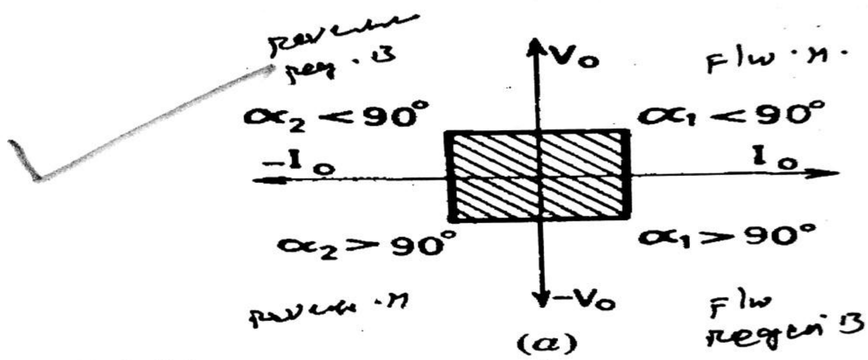


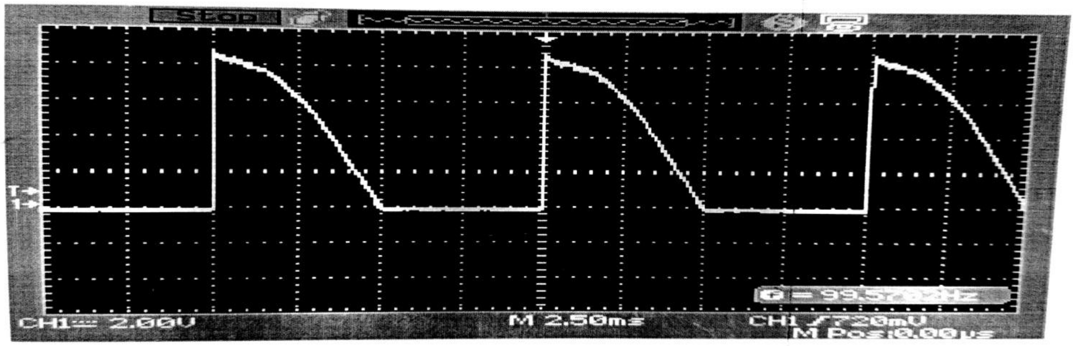
FIG 1.(b)

Four quadrant diagram

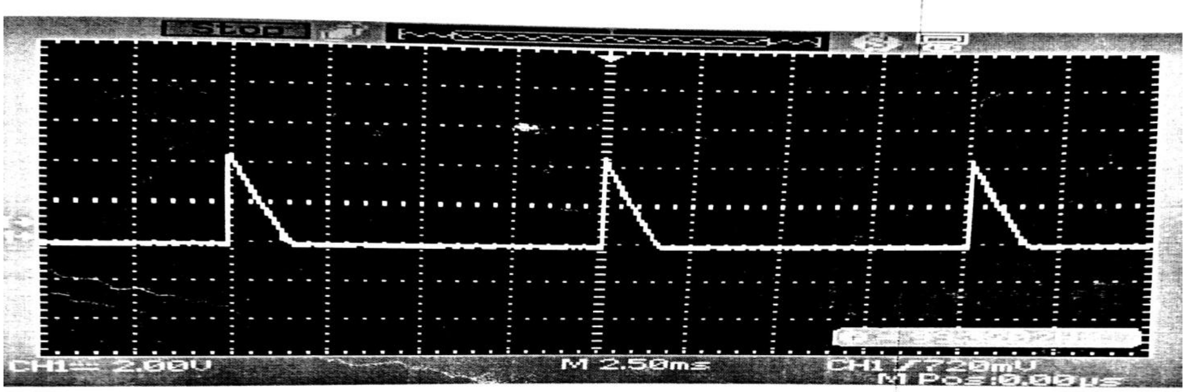
WAVE FORMS FOR SINGLE PHASE DUAL CONVERTER

P CONVERER :

P CONVERTER ON



OUTPUT WAVEFORM FOR R LOAD (α=90°)



OUTPUT WAVEFORM FOR R LOAD (α=150°)

Tabular form for MOTOR LOAD for P CONVERTER

SI.NO	Input voltage Vin	Firing angle	Output voltage Vo	Output current Io	Speed in RPM

PRECUATIONS:

1. Connections are made as per the circuit diagram.

2. Reading should be taken without parallax error.

RESULT: Performance of speed control of DC motor using single phase dual converter in circulatory current mode is studied.

6.Single Phase Cyclo Converter

AIM: To study single phase cycloconverter for R load.

APPARATUS:

a) Single phase cycloconverter firing circuit.
b) Single phase cycloconverter power circuit.
c) Single phase centre tap isolation transformer 15-0-15V/1KVA.
d) Power scope or CRO.
e) Resistive load-150ohms /5A Rheostat.

PROCEDURE:

1) Switch ON the mains supply to the firing circuit. Observe test points and trigger outputs by changing frequency division and by varying the firing angle. Make sure that the firing pulse are proper before connecting to the power circuit.
2) Next make the power circuit connections as given in the circuit. Include voltmeter and ammeter in power circuits.
3) Connect the firing pulses from the firing circuit to the respective SCR'S in the power circuit. Connect Rheostat -150 ohms /5A at the output. Initially connect input supply of 15V-0-15V from the centre tap transformer.
4) Switch ON the MCB, switch ON triggering pulse. Set the different frequency division Vary the firing angle and observe the waveform across load. Note down the output voltage, output current readings from digital voltmeter and digital ammeter in the tabular column.
5) Draw the input and output voltage wave forms for different firing angle.
6) Bring firing angle to 180^0 in the firing unit. Switch off trigger pulses and switch OFF MCB in the power circuit and switch off main supply to firing circuit unit.

PRECAUTIONS:

1) If the output is zero even after all proper connections, switch OFF the MCB and interchange AC input connections to the power circuit. This is to make the firing circuit and power circuit to synchronize.
2) Change the frequency division only when the triggering pulse switch at OFF position.
3) Avoid loose connections, reading are to be taken without parallax error.

TABULAR COLUMN:

S.No	Input supply voltage(v) in Volts	Frequency division in Hz	Firing angle (α)in deg.	Output voltage (V_o) in volts	Output current(I_o) in Amps

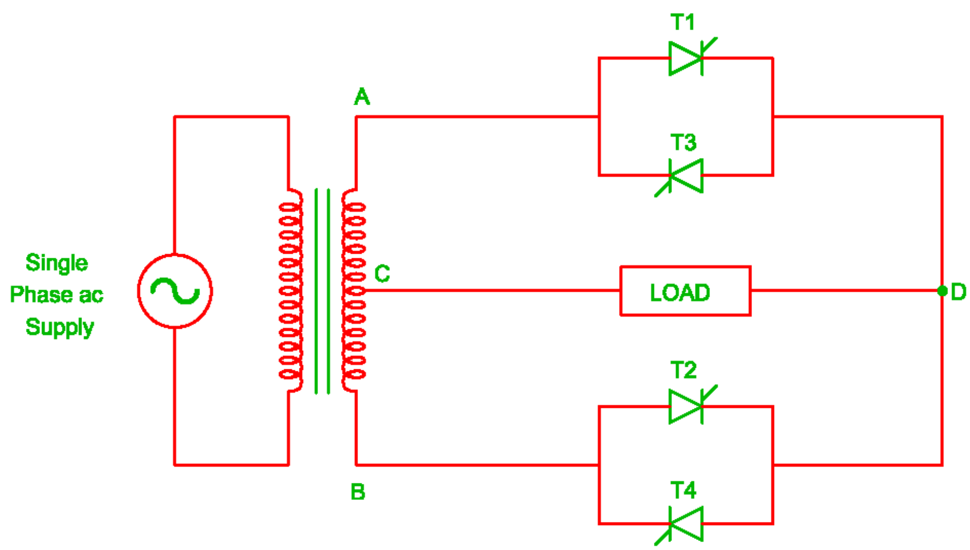
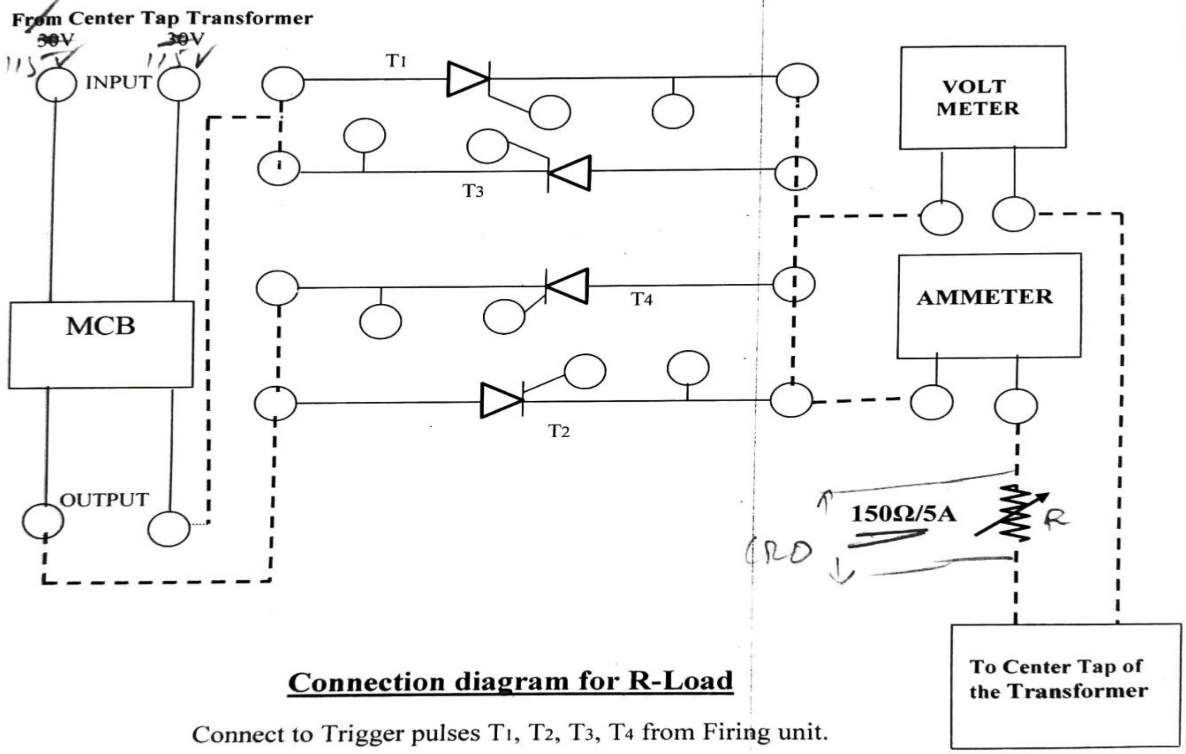


FIG A : SINGLE PHASE TO SINGLE PHASE CYCLOCONVERTER

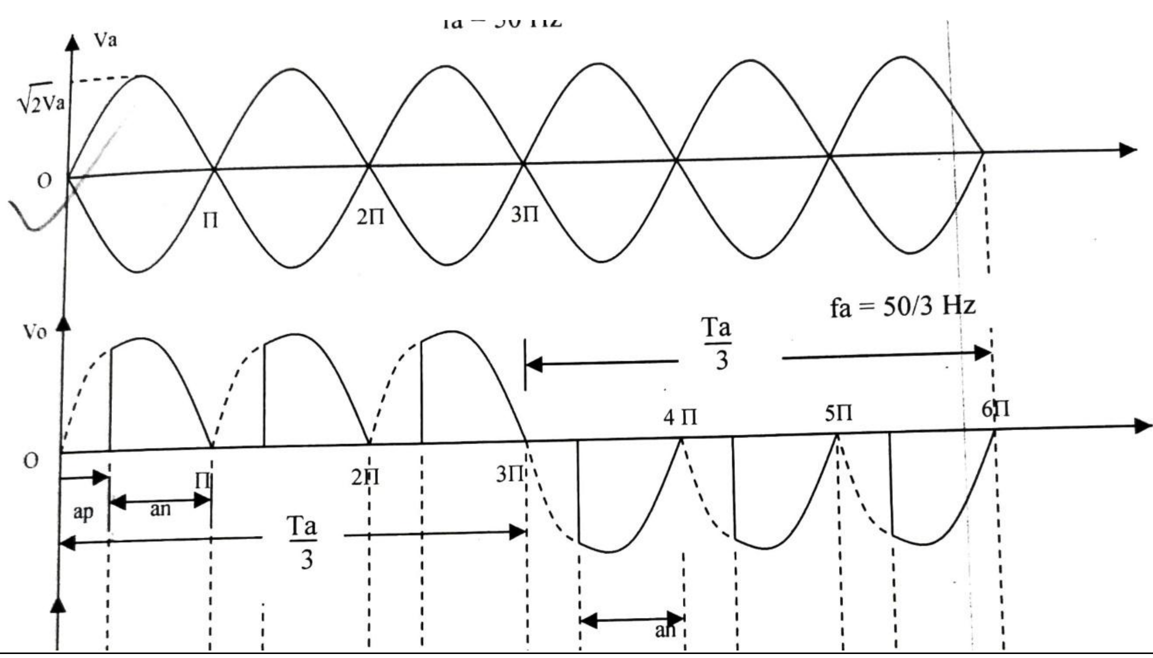
SINGLE PHASE CYCLO CONVERTER



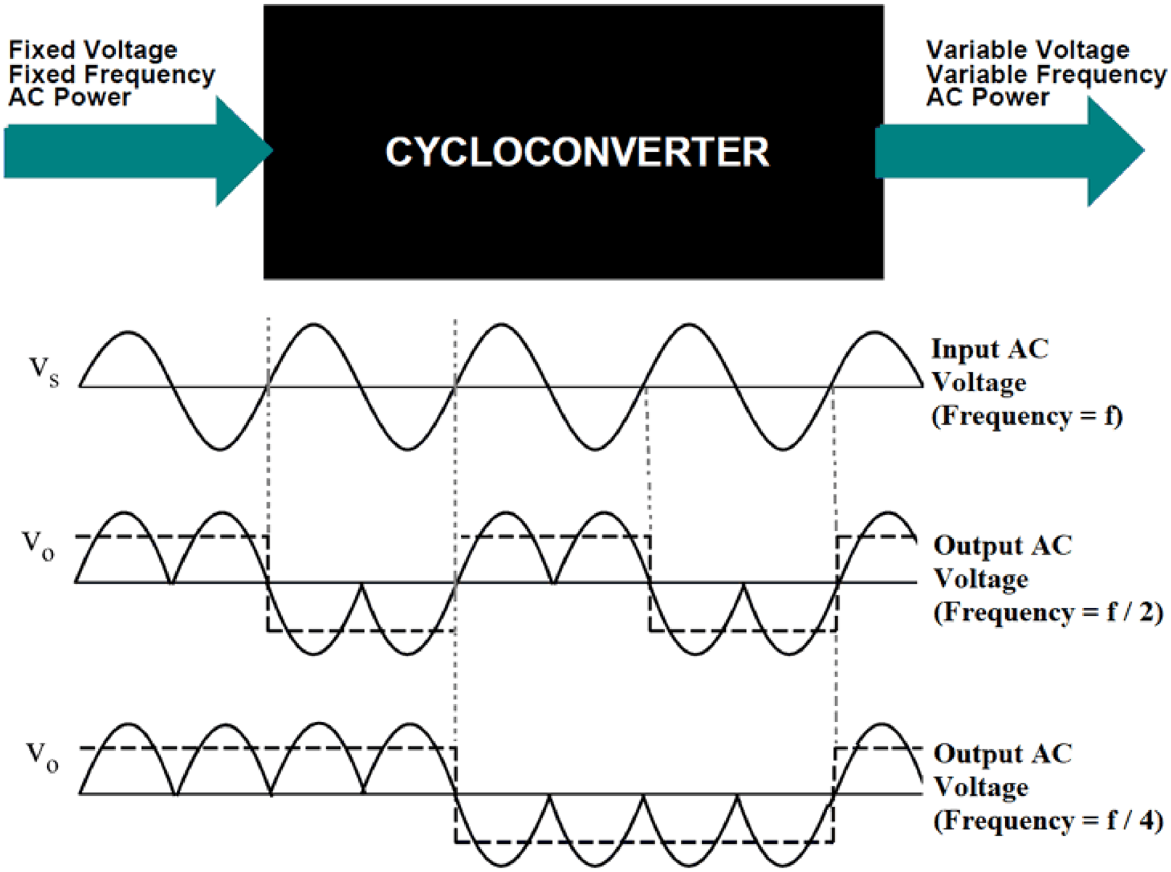
Connection diagram for R-Load

Connect to Trigger pulses T1, T2, T3, T4 from Firing unit.

8



Dr.P.Sampath Kumar/Asst.Professor/EEE Dept/BEC,Bapatla-522101.



Results: Single phase cycloconverter is constructed and drawn the waveforms across load.

7. Study Of Jones Chopper

AIM: To study the various control strategies of jones chopper.

APPARATUS:

1) Jones chopper module
2) Pulse firing circuit
3) Resistive load-10 ohms/5A
4) CRO
5) Patch cards

PROCEDURE:

1)The connection are made as per the circuit diagram.
2) Take the power supply and switch on the chopper module.
3) switch ON pulse circuit.
4) observe the waveforms in CRO.
5)By varying duty ratio pot, measure on time and total time in CRO. Tabulate in the tabular form.
Calculate duty ratio and tabulate into tabular column.
6)Measure the same values on the time and the total time from CRO by varying pot in chopper circuit module.
7)Tabulate the values in the tabular column.

TABULAR COLUMN 1:
CONSTANT FREQUENCY

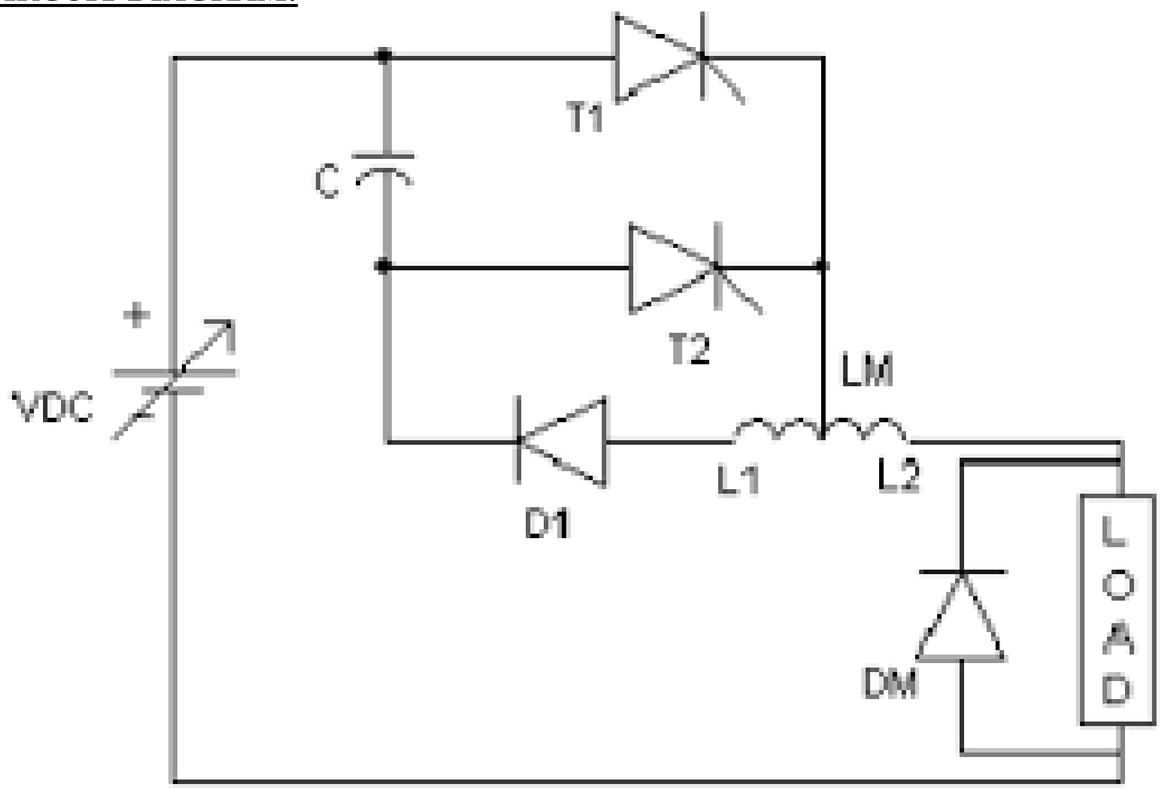
S.NO	T_{ON}(m sec)	T_{OFF}(m sec)	Duty cycle	Vo in volts

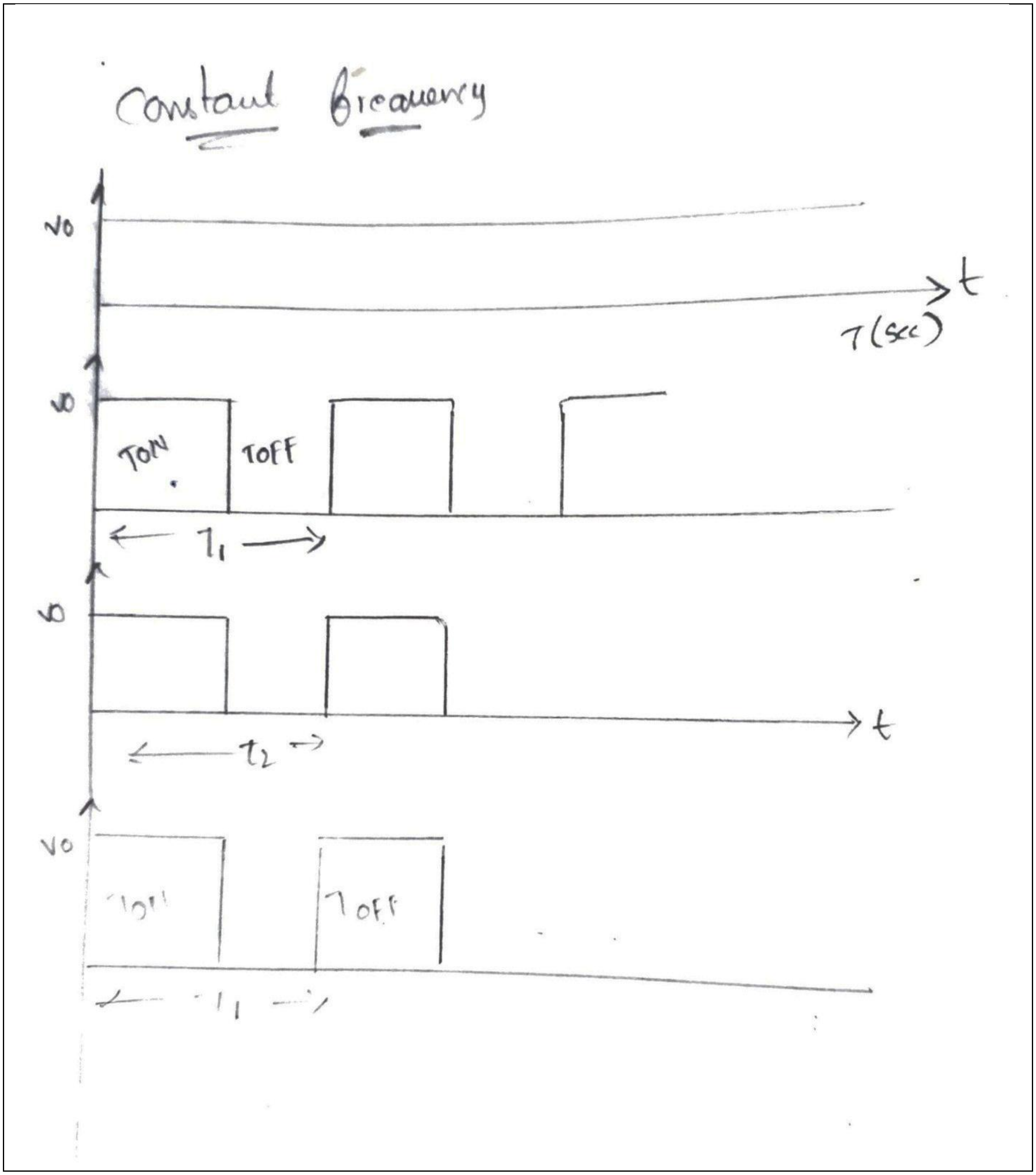
$T=T_{ON}+T_{OFF}$
$V_O=V_{OUTPUT} \times T_{ON}/T_{OFF}$

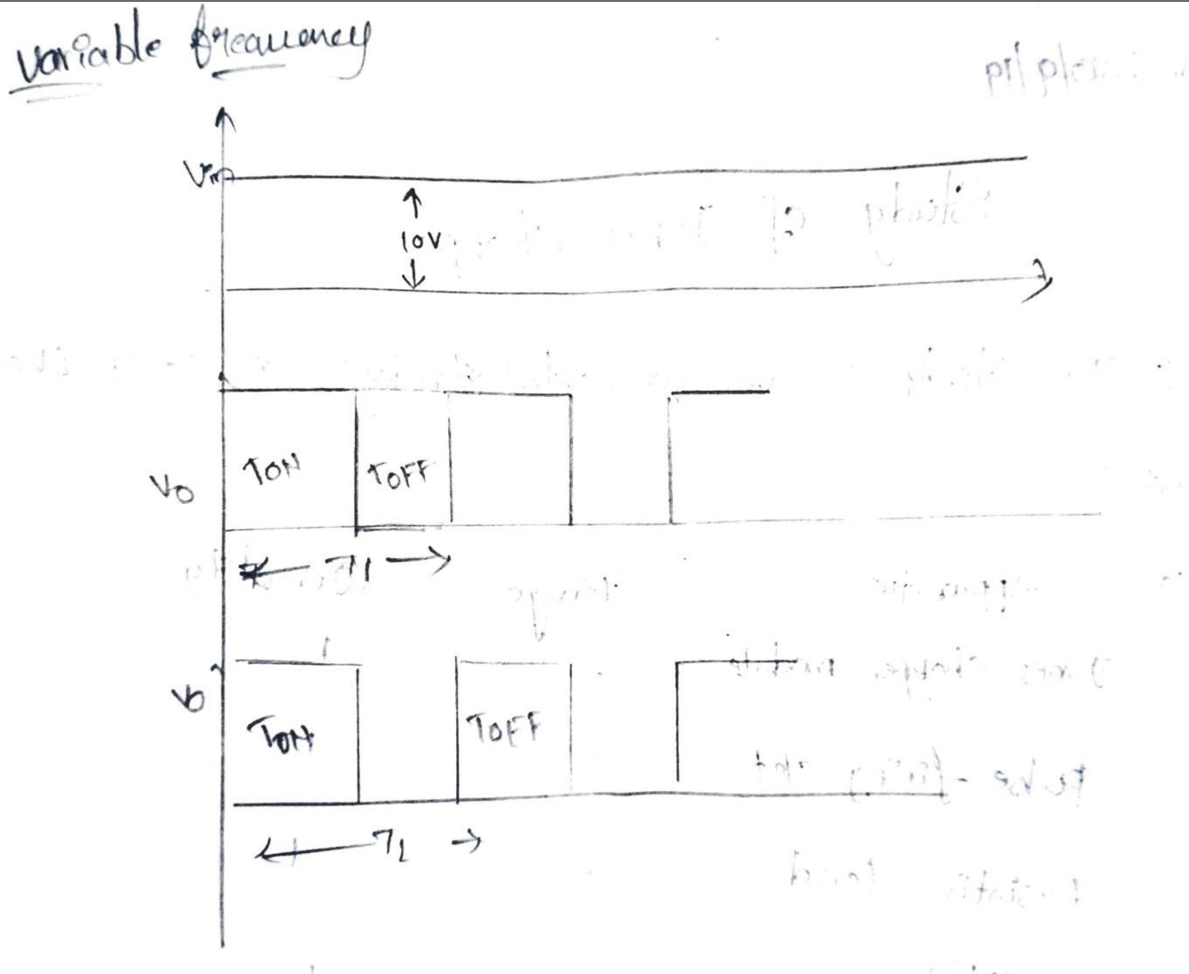
TABULAR COLUMN 2:
VARIABLE FREQUENCY

S.NO	T_{ON}(m sec)	T_{OFF}(m sec)	FREQUENCY	Vo in volts

CIRCUIT DIAGRAM:




Constant frequency
Vo
t
T(sec)
Vo
TON
TOFF
T1
Vo
t
T2
Vo
TOFF
T1



PRECAUTIONS:

1)All connections are must be tight.

2)Avoid parallax error.

RESULTS: The various control strategies of jones chopper is studied and values are tabulated and observed the graph.

8.Single Phase Series Inverter

AIM: To study working of series inverter.

Apparatus:

1) Series inverter kit.
2) Dc power supply unit- 30V/2A
3) Rheostat-100 ohms/2A
4) CRO-20 Mhz.

Procedure:

1) To begin with switch on the power supply to the firing circuit. Check that trigger pulses by varying the frequency.
2) Make the interconnections of the power circuit as shown in the circuit diagram.
3) Now connect trigger outputs from the firing circuits to gate and cathode of SCR's T1and T2.
4) Connect input from a 30v/2A regulated power supply. Switch On the input DC supply. Now apply trigger pulse to the SCR's and observe voltage wave from across load.
5) Vary the frequency and observe the wave forms.
6) If the inverter frequency increases above the resonant frequency of the power circuit commutation will fail.
7) Then switch OFF the DC supply, reduce the inverter frequency and try again if you will not get the result. check the input fuse and try again.
8) Repeat the same with different values of L, C and load.
9) And observe the waveforms with and without flywheel diodes. The output wave form is entirely depending on load.
10) Plot a graph of frequency verses output voltage .
11) Tabulate the reading in the table.
12) Draw the load voltage waveforms.

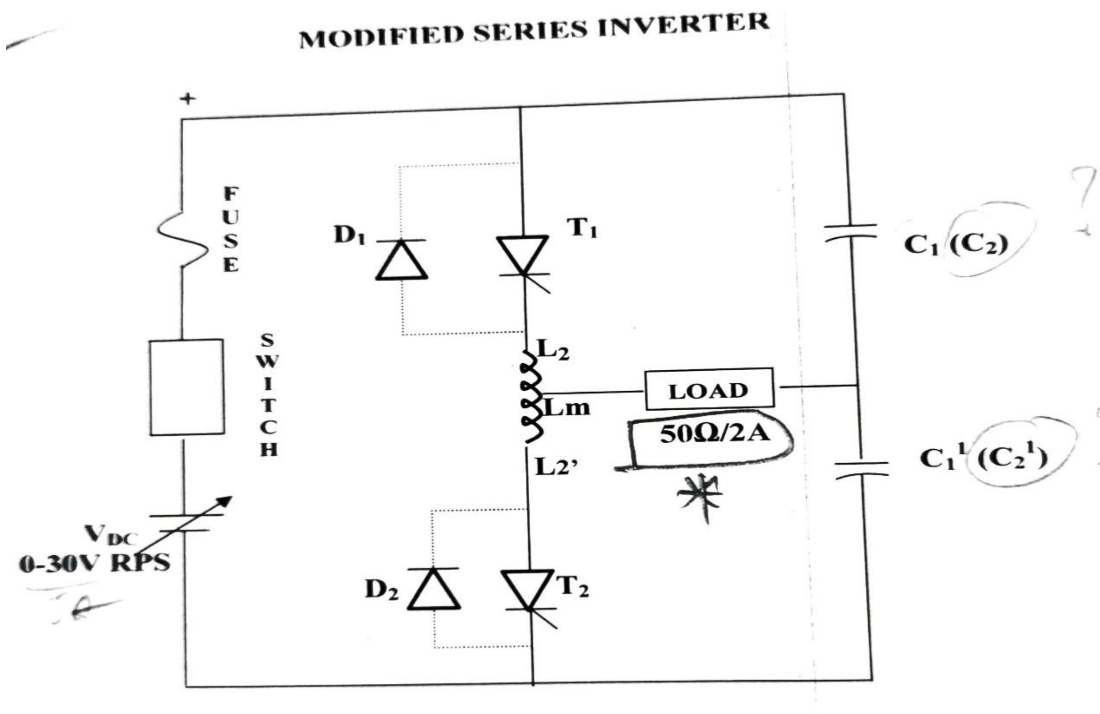
To switch OFF the inverter .switch OFF The input supply first and then trigger pulse.

Resonance frequency f_r : $\frac{1}{2\pi}\sqrt{\frac{1}{LC} - R^2/4L^2}$

TABULAR COLUMN:

S.NO	Frequency in Hz	Load voltage volts using multimeter

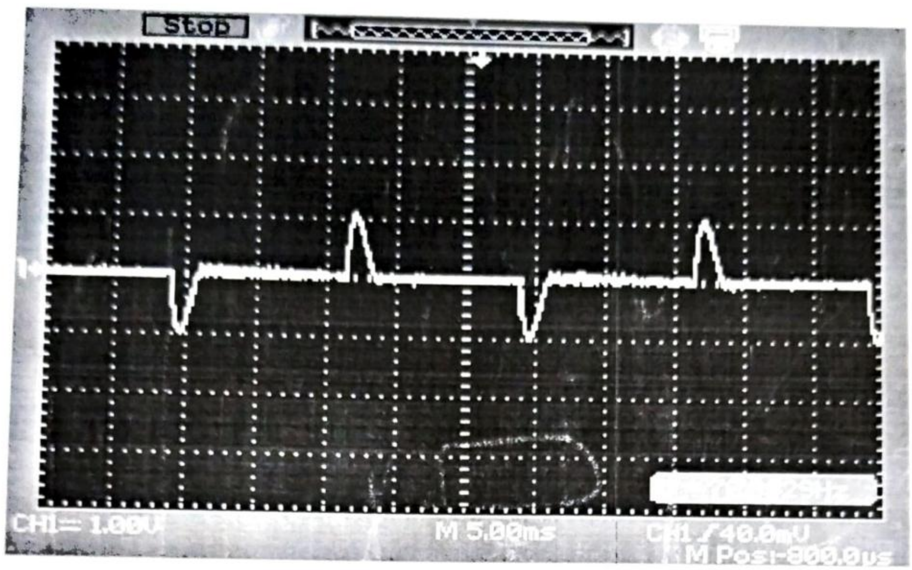
CIRCUIT DIAGRAM:



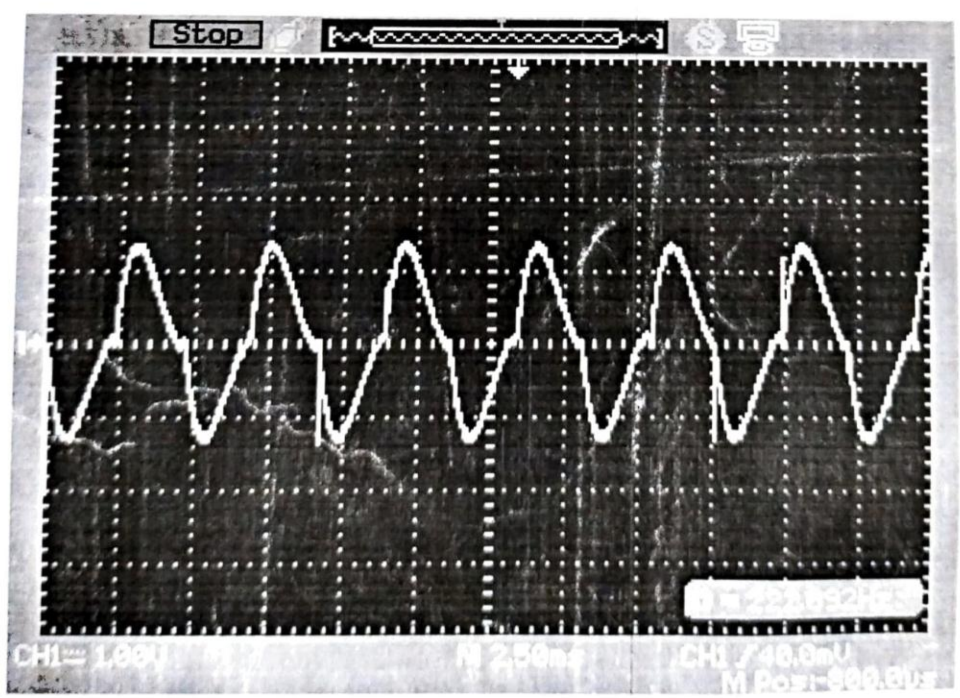
CIRCUIT DIAGRAM

DIFFERENT WAVEFORMS FOR SERIES INVERTER AS OBSERVED ON DIGITAL STORAGE OSCILLOSCOPE

Capacitor-10Microfarad L= 10mh R=15 Ohms app.

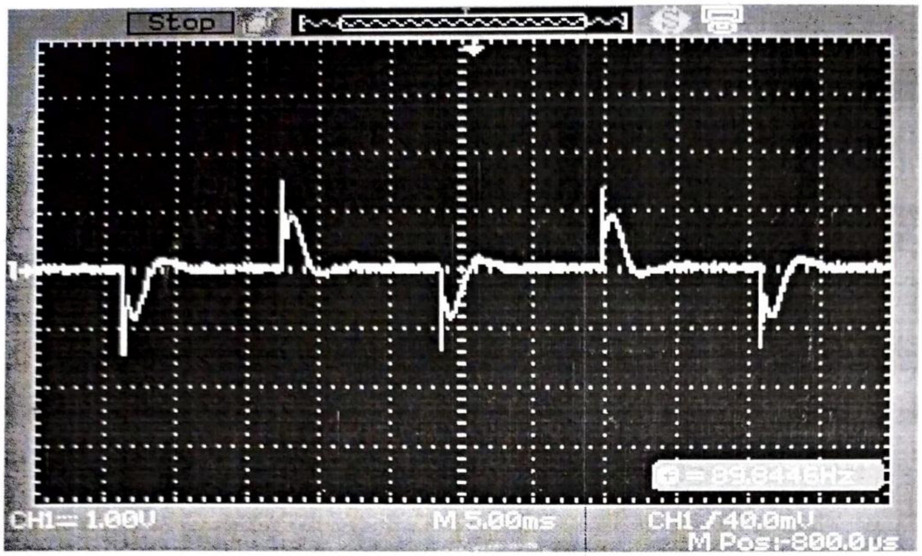


WAVEFORM ACROSS LOAD (AT LOW FREQUENCY WITH OUT FLY WHEEL DIODES)

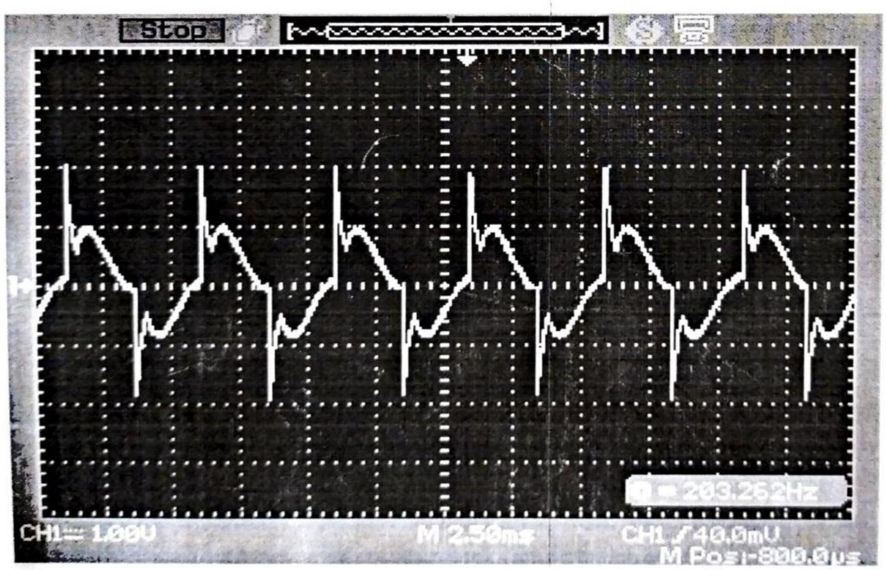


WAVEFORM ACROSS LOAD (AT HIGH FREQUENCY

WITH OUT FLY WHEEL DIODES



WAVEFORM ACROSS LOAD (AT LOW FREQUENCY WITH FLY WHEEL DIODES)



WAVEFORM ACROSS LOAD (AT HIGH FREQUENCY WITH FLY WHEEL DIODES)

Results: Series inverter is constructed and its performance is studied.

9. Single Phase Parallel Inverter

1.AIM: To study the working of parallel inverter.

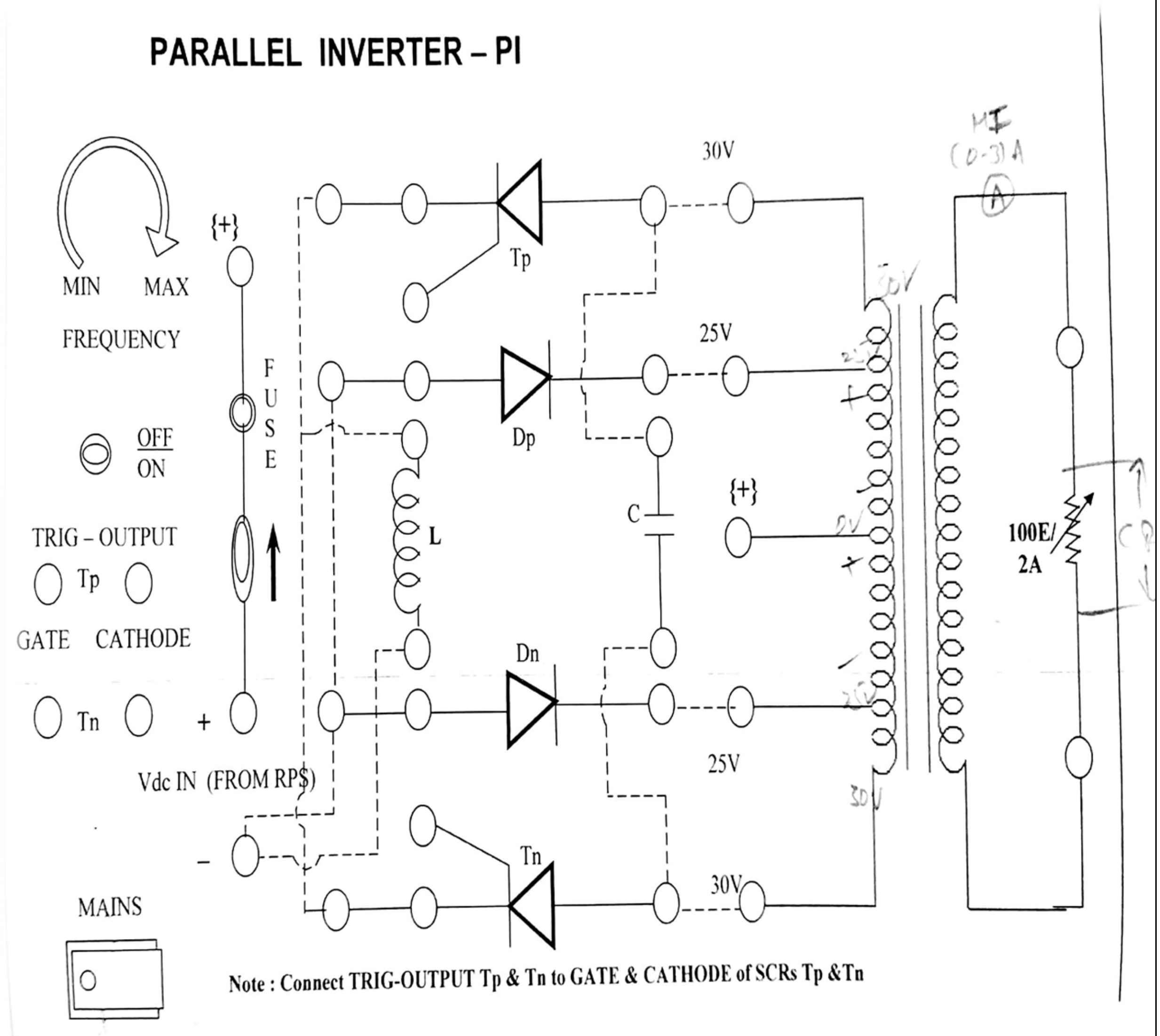
2.APPARATUS REQUIRED:

a) Parallel inverter kit
b) Rheostat – 100 ohms/2 A
c) DC Power supply unit-30v/2a
d) CRO – 20Mhz.

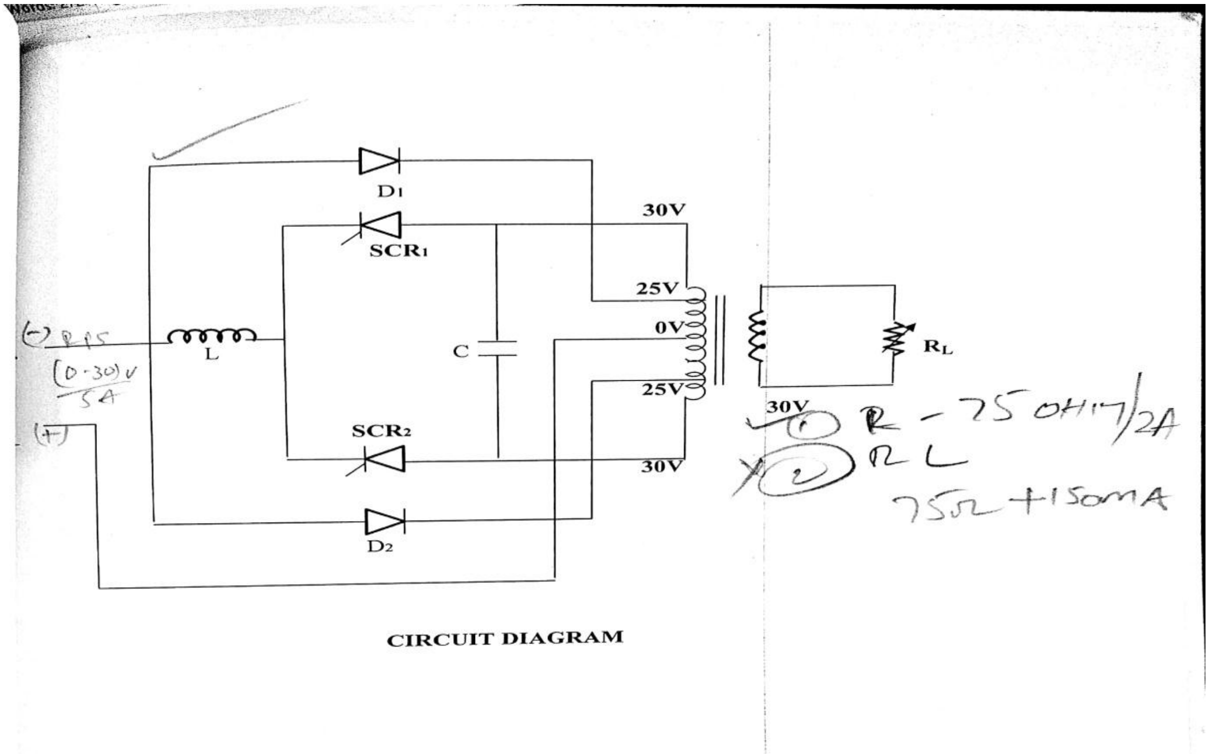
PROCEDURE :-

1.Switch on the firing circuit .observe the trigger outputs **Tp** and **Tn** by varying frequency potentiometer and by operating ON/OFF switch.
2.Then connect input DC supply to the power circuit from DC Regulated power supply (30v/5A)
3.Connect trigger output to gate and cathode of SCR **Tp** & **Tn**.
4) Make the interconnections as shown in the circuit diagram.
5) Connect the load between load terminals (100 ohms/2A)
6) Connect free wheeling diodes in the circuit.
7) To begin with set input voltage to 15V. Apply trigger pulses to SCR and observe voltage waveforms across load.
8) Output voltage is square wave only .Then remove freewheeling diode connections and observe waveform.
9)Then vary the load .vary the frequency and observe waveform . To switch OFF the inverter switch OFF DC input supply only .Switch OFF the trigger pulses will lead to short circuit.
10) Since the parallel inverter works on forced commutations, there is a chance of commutation failures.
11) If the commutation fails ,there is a dead short circuit in the input DC supply,Which will leads to the blown off the input fuse .please check the fuse if the commutation fails. Preferably connect the input DC supply from the 30V/2A regulated DC power supply unit which has over current tripping facility thereby protect the DC supply unit.
12) If the commutation fails, switch off the DC supply first and then trigger outputs. Check the connection again.

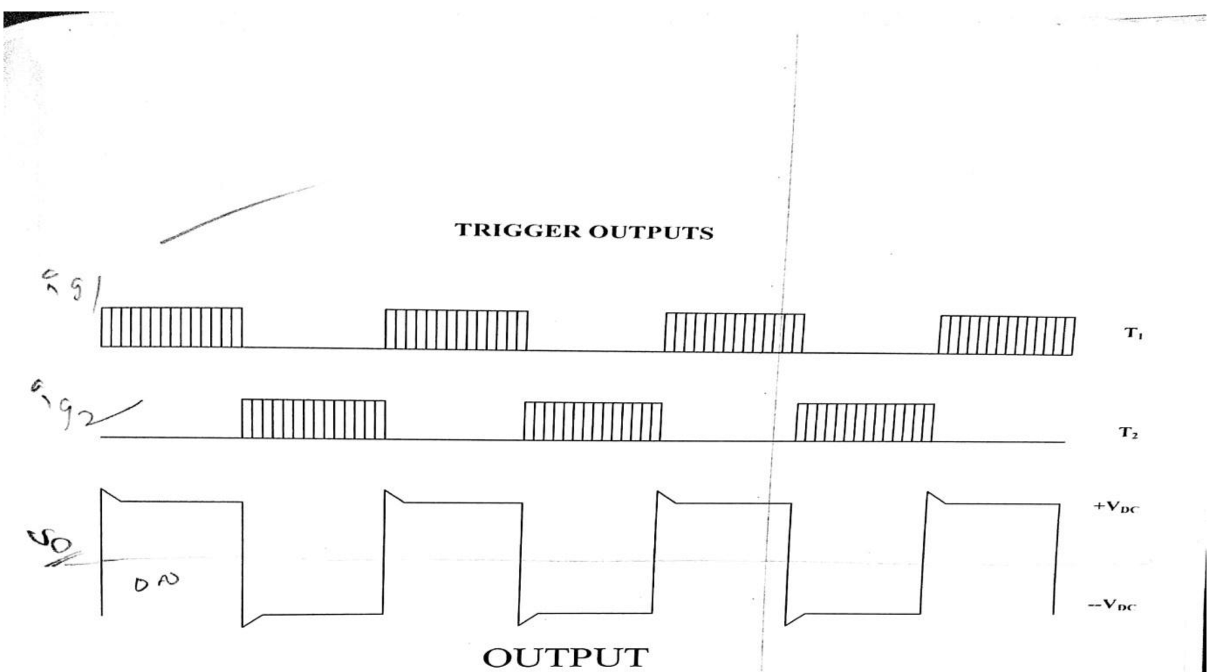
CIRCUIT DIAGRAM : 1



CIRCUIT DIAGRAM: 2



TRIGGERING OUTPUTS :



Precautions:
1.Connections are made as per the circuit diagram.
2. Reading should be taken without parallax error.

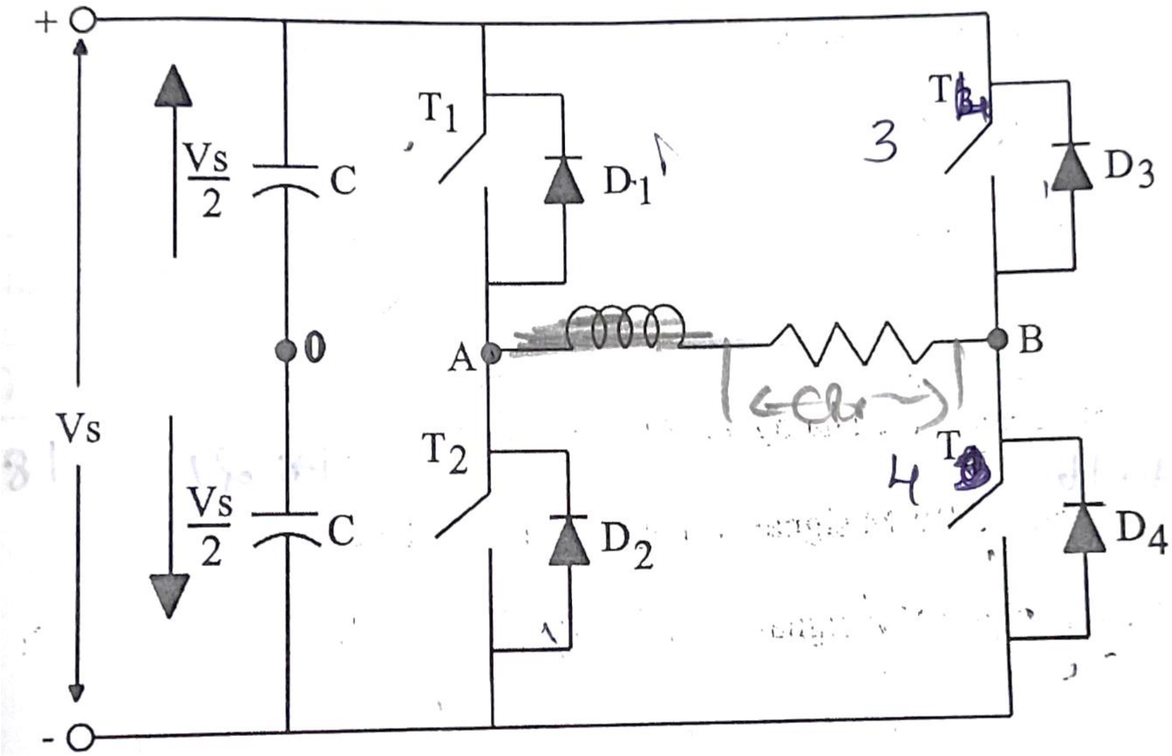
RESULT: PARALLEL INVERTER using SCR is constructed and its performance is studied.

10.Single Phase Pwm Inverter Control Module

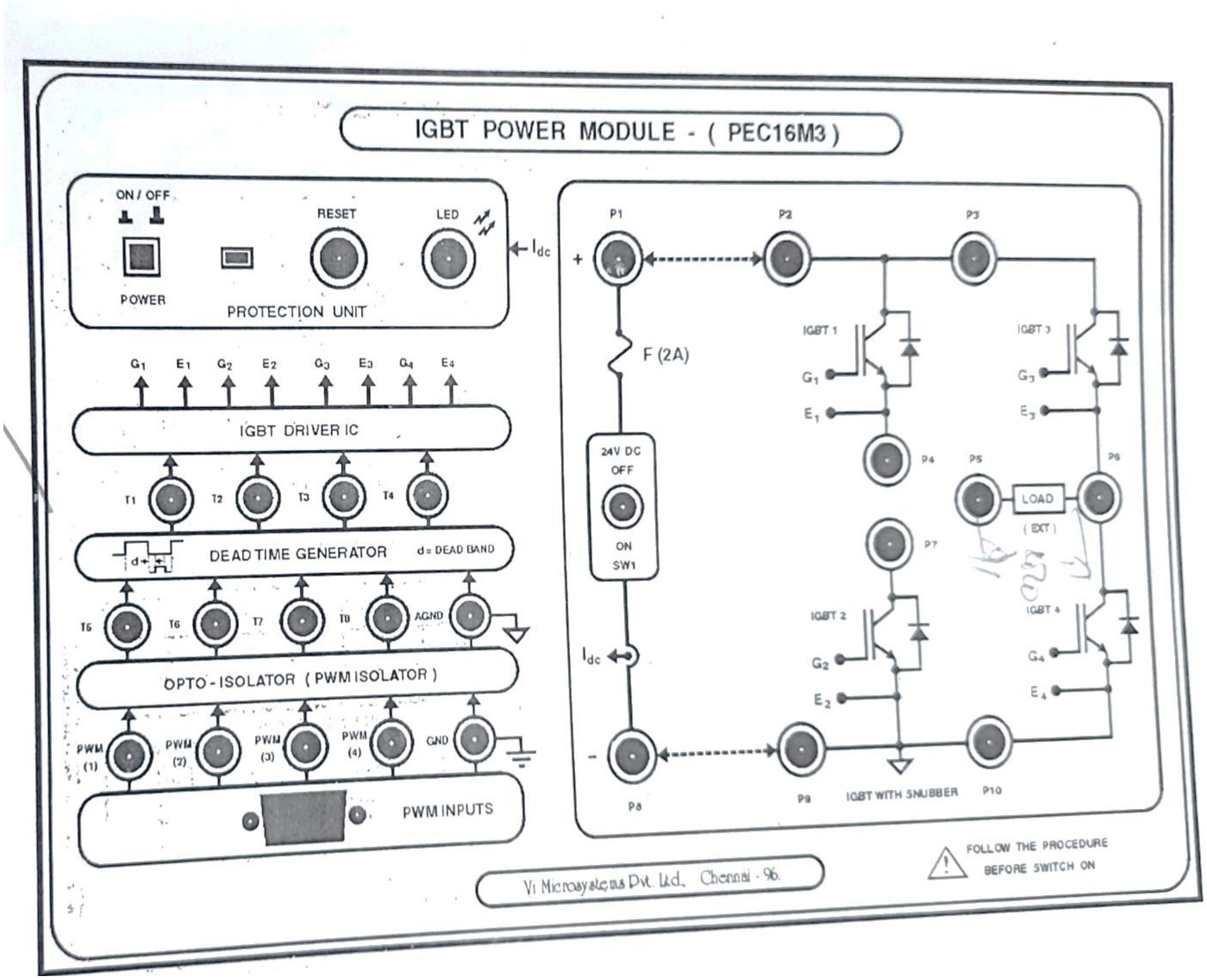
AIM:
To study the operation of single phase sine PWM inverter operation using PEC16M4#1.
APPARATUS REQUIRED:

- PEC16M4#1
- PEC16M2/M3
- CRO
- R-L-Load

CIRCUIT DIAGRAM:



Front Panel View:



CONNECTION PROCEDURE:

1. Connect P1 of 24V DC to P2 of IGBT 1.
2. Connect P4 of IGBT 1 to P7 of IGBT 2.
3. Connect External Load between P4 of IGBT 1 an P6 of IGBT 3.
4. Connect P8 of 24V DC to P9 of IGBT 2.
5. Connect 9-pin connector of inverter control module to 9-pin connector of power module.

EXPERIMENTAL PROCEDURE:

1. Switch ON power supply to power module. LED in the protection unit glows. Now press reset pulse button and LED switches OFF.
2. Switch ON power supply to inverter control module.

3. Set the reference sine wave using reference wave selection switch and set its amplitude and frequency.
4. Set the PWM pulse amplitude and frequency of carrier wave.
5. Switch ON SPDT switch to release PWM pulse to power module.
6. Check for the test waveform in every test points using CRO.
7. Output AC voltage is obtained across the load.

Table: 1

Switching frequency = Hz

S.No	Sine Wave Amplitude (V)	Reference Frequency (Hz)	Carrier Frequency (Hz)	Measured V_0(V)	Calculated O/P Voltage (V)

Precautions:

1.Connections are made as per the circuit diagram.

2. Reading should be taken without parallax error.

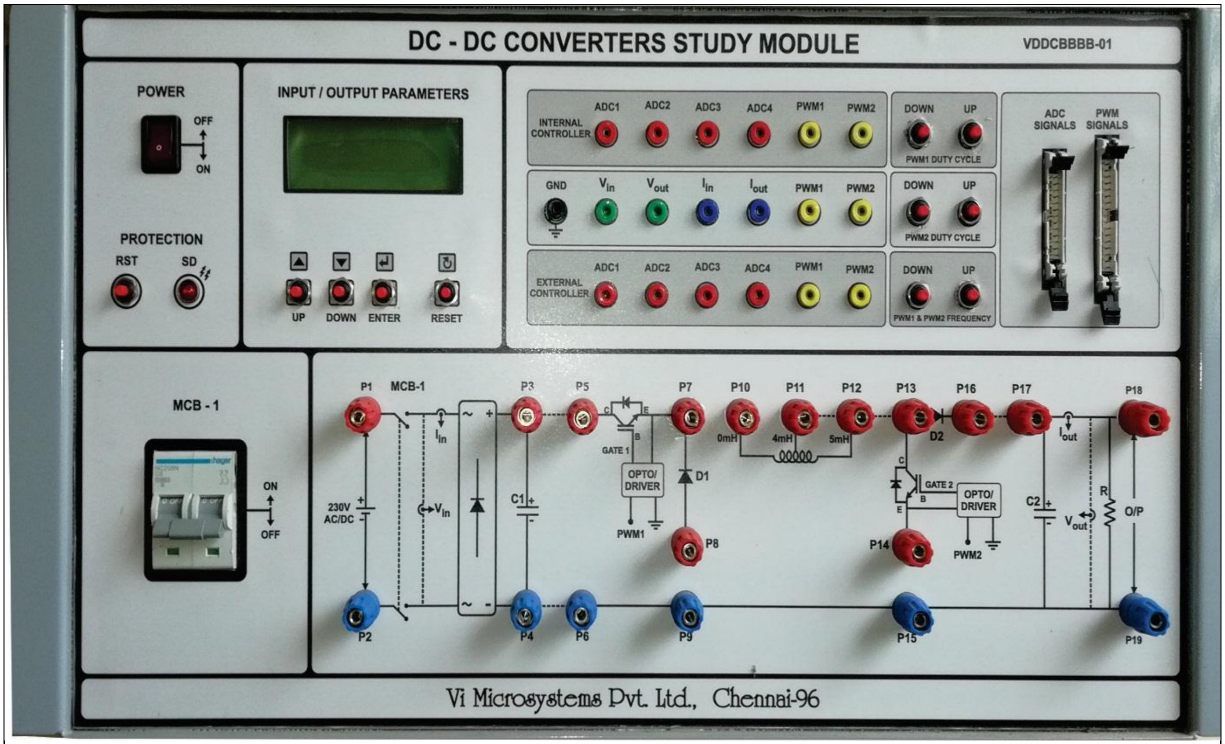
RESULT: PARALLEL INVERTER using SCR is constructed and its performance is studied.

11. 1KW IGBT Based DC-DC Buck-Boost Converter

AIM:

To study the operation of 1KW IGBT Based DC-DC Buck-Boost Converter.

- Microcontroller based DC-DC buck converter operation , boost converter and buck boost converter operation are available.
- Input voltage range =(0-325V) DC Output Voltage =(0-325V)DC
- Power – 1000W
- Maximum current 10A
- Isolated Voltage and current sensor : Hall Effect sensor are used to monitoring input /output voltage and current
- MCB protection is provided
- Over Voltage and over current protection is provided
- LCD Display :Duty cycle , Input Voltage , input current , output voltage, output current ,etc;
- DV/DT protection is available for IGBT (Snubber circuit)



- **Controller Unit :**

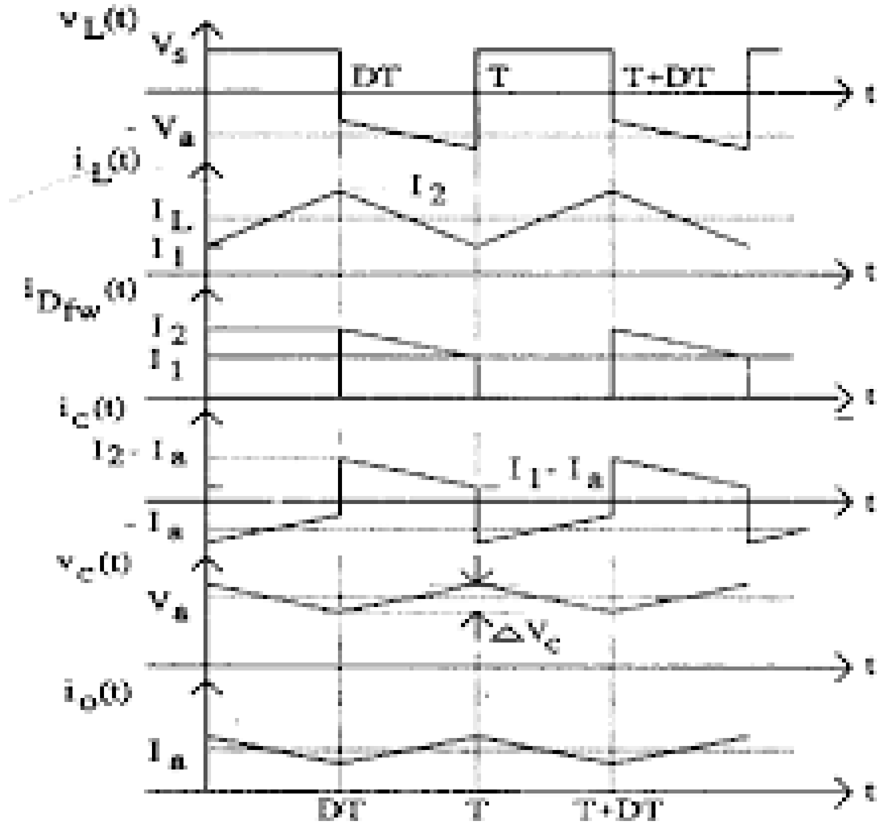
  - ➔ Internal Microcontroller is provided for generating PWM & ADC reading (Internal controller)
  - ➔ Option for by passing the internal controller for applying user generated PWM(External controller)
- Open loop and closed loop operations can be done.
- 26pin FRC and 34Pin FRC connector is provided for external controller interface.
- Test points :4 Nos sensor and one ground, signals and 2 PWM Signal.

PROCEDURE:

1)The connection are made as per the circuit diagram.
2) Take the power supply and switch on the chopper module.
3) switch ON pulse circuit.
4) observe the waveforms in CRO.
5)By varying duty ratio pot, measure on time and total time in CRO. Tabulate in the tabular form.
Calculate duty ratio and tabulate into tabular column.
6)Measure the same values on the time and the total time from CRO by varying pot in chopper circuit module.
7)Tabulate the values in the tabular column.

Tabular Form:

S.NO	T_{ON}(m sec)	T_{OFF}(m sec)	Duty cycle	Vo in volts



Result: Buck Boost converter with different duty ratios are done in experimentally and wave forms of respective values are taken from the CRO.

12. DSP based speed control of BLDC and 3-phae Induction motor.

Aim:
To study DSP based speed control of BLDC and 3-phae Induction motor.

Hardware Structure
The entire control system includes: host computer, motor driving part, parameter storage and signal sampling and processing part. The structure diagram of the system is illustrated in Fig.1. The function of the host computer is sending instructions via RS485 Bus to the controller in order to modify the parameters or run the motor; The core part of the controller is the minimum system based on a DSP chip TMS320LF2407A, which is specially developed by TI company for the application of motor; The motor driving part is a H-bridge driving circuit made up of a driving chip(IR2184) and four power MOSFETs(LR7843); a photoelectric encoder is used as the signal sampling unit which measures the speed of the motor; A data memory chip(FM24CL32) is utilized to save parameters like speed, position, accelerator and PID parameters.

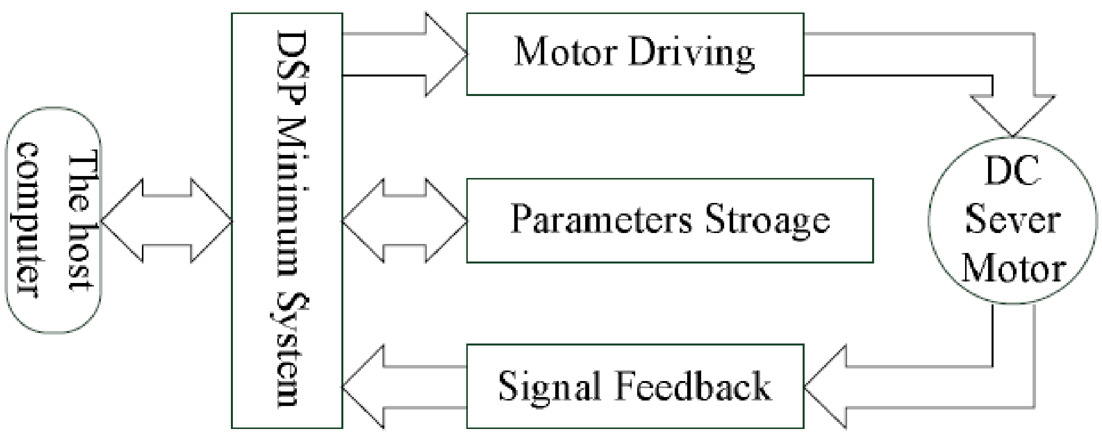


Fig.1. The Structure Diagram of the Control System

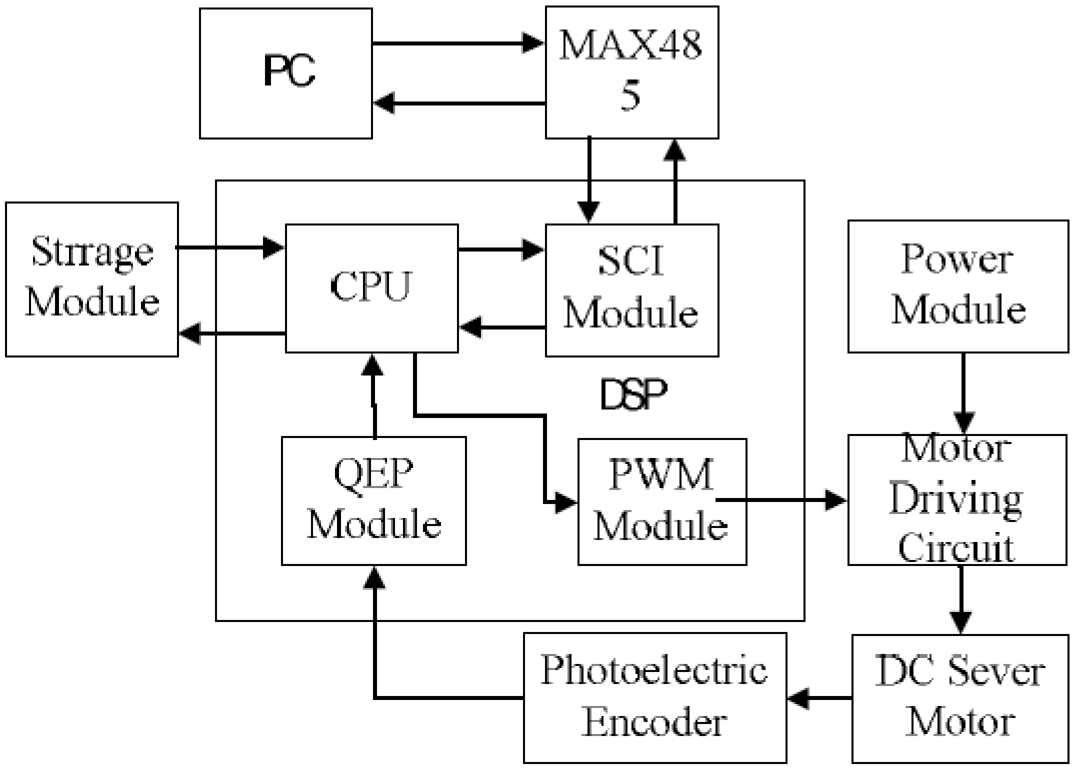


Fig.2. Overall Structure of Hardware

The DSP minimum system is the core of the control system, which generates control signals calculated according to the feedback signal and control algorithm. The circuit of minimum system includes: power supply unit, timer unit, SRAM and JTAG interface. The peripheral circuits compromise a storage unit and a communication interface unit. A nonvolatile ferroelectric memory (FM24CL32) is used to store the parameters that system needs to run correctly. The RS485 bus is one of the widely used buses in industrial site for its mature technology and easy manipulation. So the RS485 bus is used in this system to communicate with the host PC. At the same time, the circuit of CAN bus is reserved as another way to communicate.

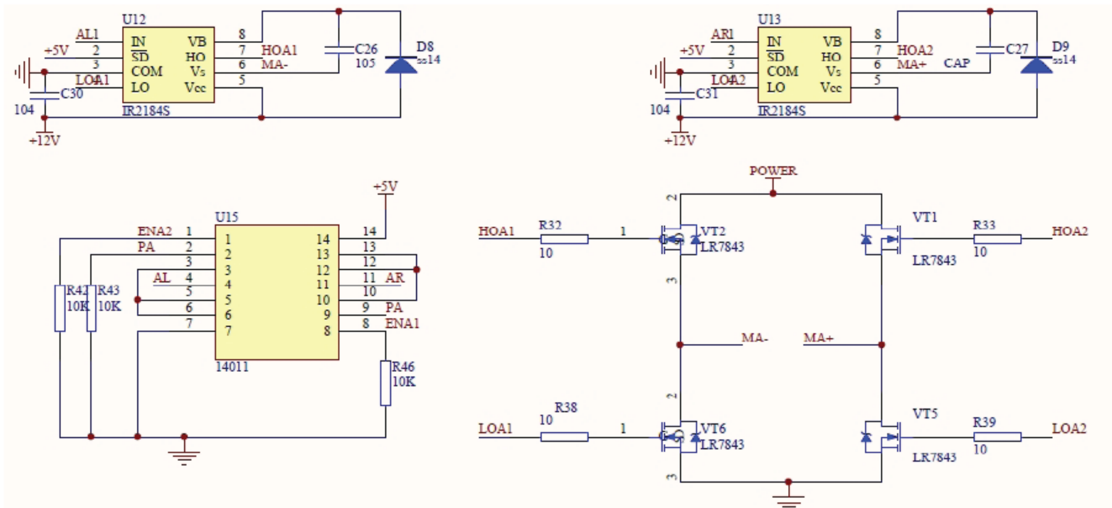
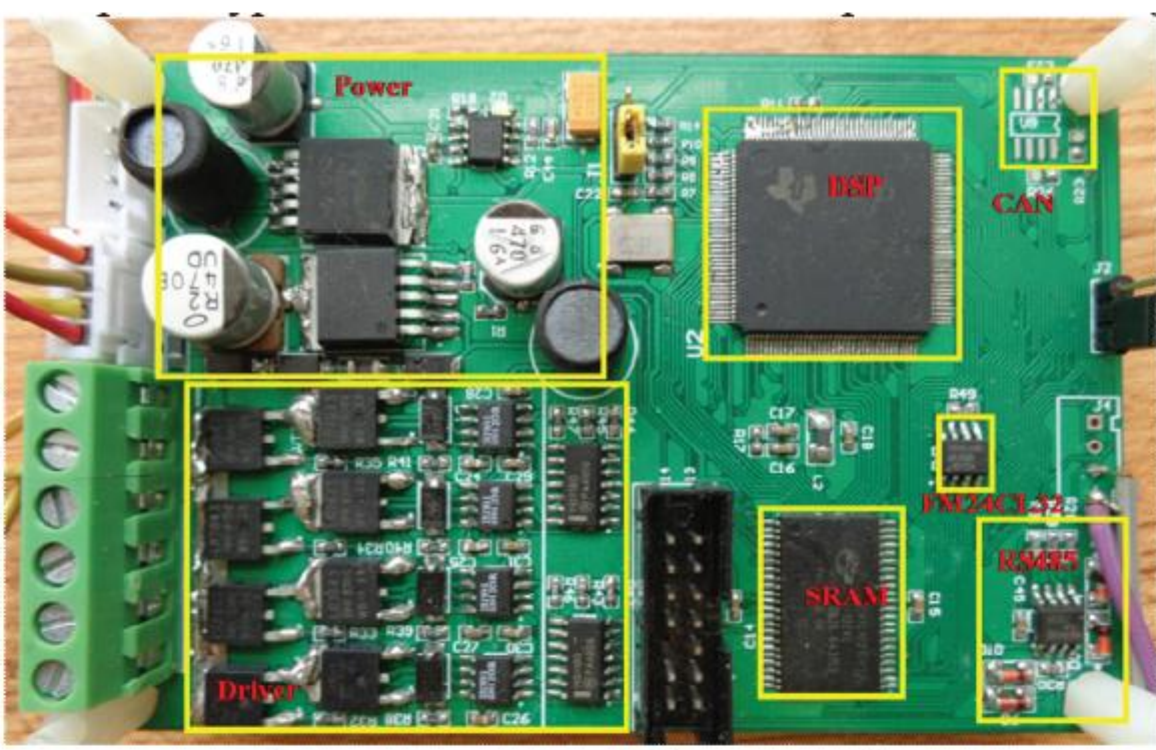


Figure.3. The Schematic of the Driving Circuit



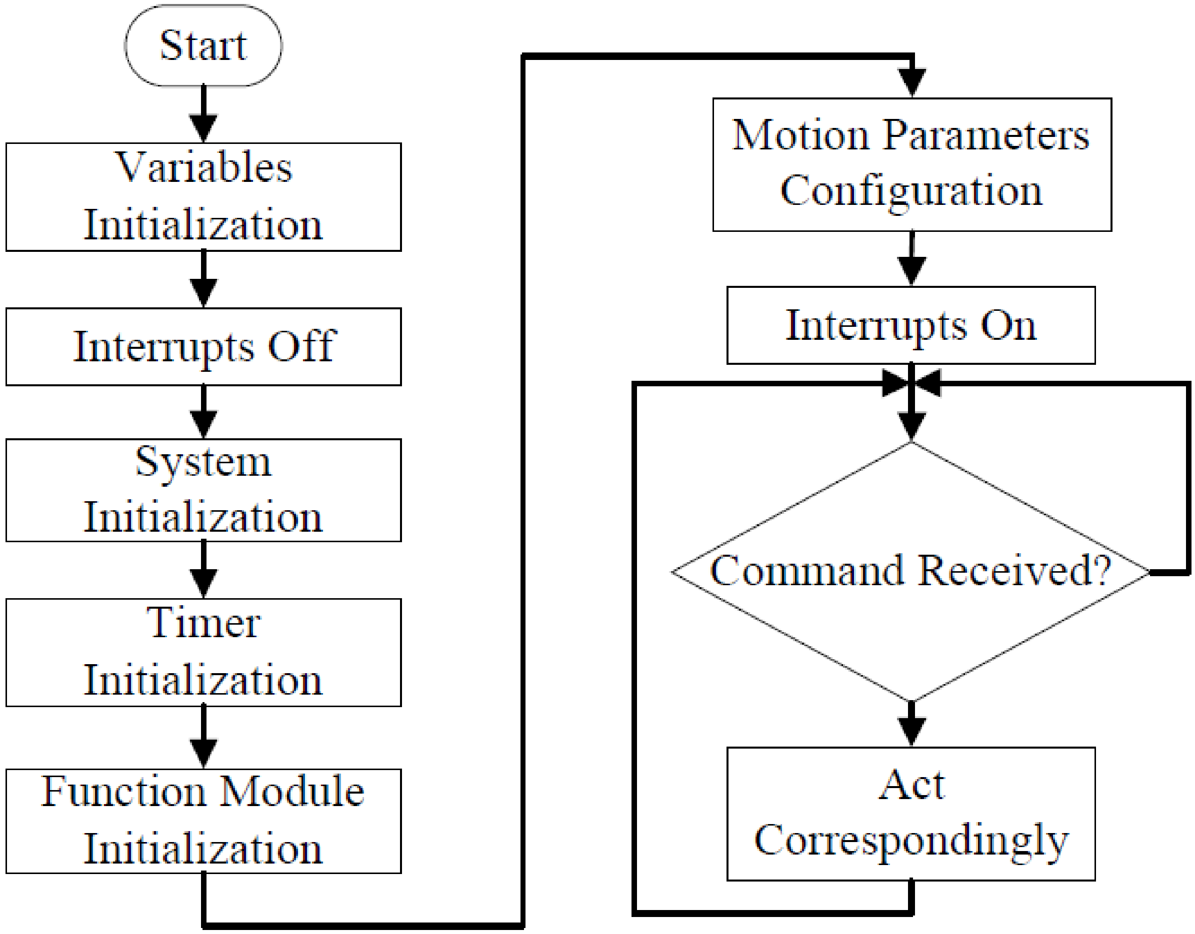


Fig.7. Flowchart of the system's main program

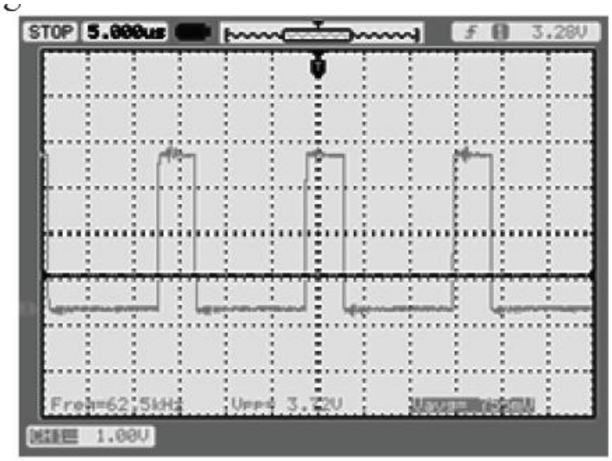


Figure 9 PWM wave

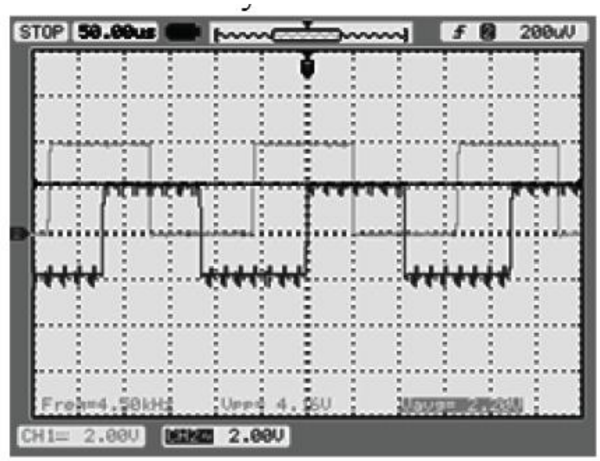


Figure 10 Pulse returned from encoder