Laboratory Manual

for

Power Electronics & Drives (EEP-613)

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List of Experiments

DOs and DON'Ts in Power Electronics Laboratory

Dos

- Come prepared and on time for laboratory experiments.
- Read all the instructions of the experiment carefully.
- Select the measuring instruments for the designated range of the equipments.
- Always wear tight dresses and rubber shoes in the laboratory.
- Make all the connections neat and tight.
- Always increase the voltage or current gradually.
- Use additional safety precautions for particular experiment, if any.

DON'Ts

- Never touch any live terminal by bare hands.
- Never turn on the main switches of any experiment without getting checked the circuit by laboratory instructor.
- Never turn on any circuit at full supply voltage, even if the reading is desired at rated voltage.

Experiement-1

Aim:

To draw V-I Characteristics of SCR.

Apparatus Required:

S. No.	Apparatus/Accessories	Specifications	Quantity
1	SCR Kit	As available in lab	1
2	Ammeter	0-10 mA, DC	1
3	Ammeter	0-50 mA, DC	1
4	Voltmeter	0-50 V, DC	1
5	Connecting Leads		12

Circuit Diagram:

Schematic circuit diagram for V-I characteristics of SCR is given in Fig.1.1

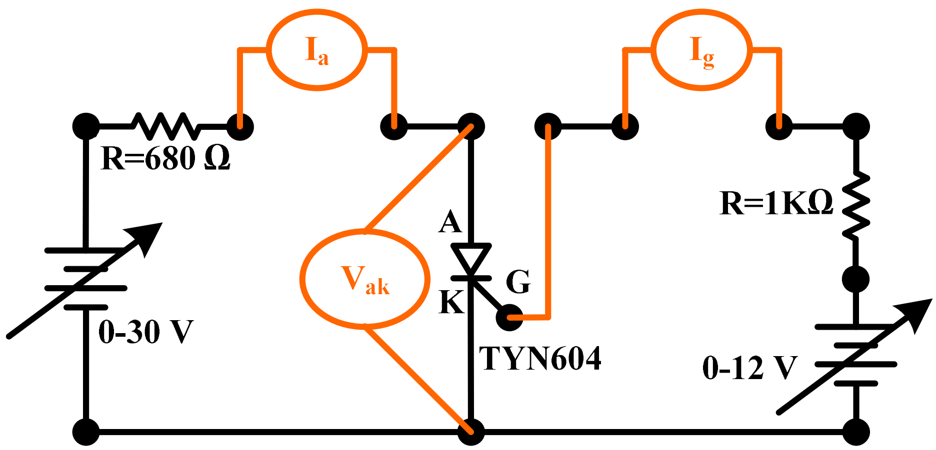

Fig.1.1Schematic Circuit Diagram for V-I Characteristics of SCR.

Theory:

Silicon Controlled Rectifier (SCR) is a four layer PNPN (three junction) semiconductor switching device. It has three terminals namely anode (A), cathode (K) and gate (G). According to the polarity of voltages applied, its characteristics can be divided into three modes as described below:

Reverse blocking mode:

When cathode is made positive with respect to anode and no gate current is applied, the device behaves as if two diodes are connected in series with reverse voltage applied across them. In this state, a small value of leakage current in the range of few microamperes flows in the circuit.

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Forward blocking mode:

When anode is made positive with respect to cathode with gate open, a small current called forward leakage current flows. In this case, when forward voltage is increased to a value called forward break over voltage then the revers biased junction J_2 has avalanche breakdown.

Forward conduction mode:

In this mode, the Thyristor conducts and current from anode to cathode with a very small voltage drop across it.

Procedure:

Steps to perform experiment.

1. Connect the circuit as shown in the Fig.1.1.
2. Switch on the power supply.
3. Fix the value of gate current to a certain value by adjusting the gate voltage and note the reading for I_g.
4. Now increase the anode cathode voltage V_{AK} in steps form minimum value and note the value of V_{AK} and corresponding value of I_A.
5. Carefully note the anode cathode voltage V_{AK} when there is sudden increase in anode current I_A and hence decrease in the anode cathode voltage V_{AK}.
6. With further increase in anode voltage, anode current increase sharply. Carefully note the values of V_{AK} and I_A.
7. Repeat from step 3 to step 6 for various value of gate current I_G.

Observations:

S. No.	I_G		I_G		I_G	
	V_{AK}	I_A	V_{AK}	I_A	V_{AK}	I_A
1						
2						
3						
4						
5						

Result:

Draw the graph between $\mathbf{V_{AK}}$ and $\mathbf{I_A}$, and comment on it.

Precautions:

1. Slowly increase the voltage and note the readings carefully.
2. Connect the ammeter and voltmeter with correct polarity.

Pre-Experiment Questions:

1. What do you understand by forward and reverse biasing?
2. What is depletion layer in any PN junction?
3. What do you understand by SCR?
4. Why SCR is known as semi controlled device?
5. What is the advantage of SCR?

Viva-Voce Questions:

1. What is forward break over voltage?
2. Why the forward break over voltage reduces with gate current?
3. What do you mean by finger voltage?
4. What is the significance of finger voltage?
5. What is reverse break down voltage?
6. What is gate trigger current?
7. Why a SCR regains its forward blocking capabilities even after reaching forward break over voltage, however cannot regain after reverse break down voltage?
8. What is thermal triggering?

Experiement-2

Aim:

To draw V-I Characteristics of DIAC.

Apparatus Required:

S. No.	Apparatus/Accessories	Specifications	Quantity
1	DIAC Kit	As available in lab	1
2	Ammeter	0-50 mA, DC	1
3	Voltmeter	0-50 V, DC	1
4	Connecting Leads		6

Circuit Diagram:

Schematic circuit diagram for V-I characteristics of DIAC is given in Fig.2.1

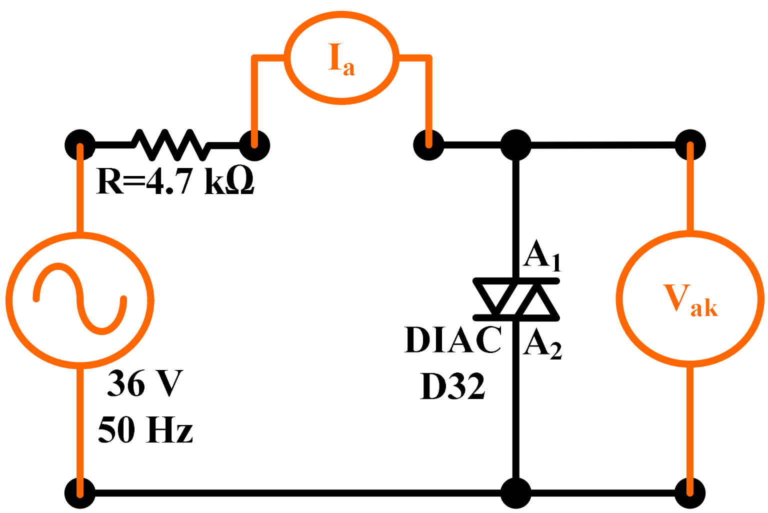

Fig.2.1 Schematic Circuit Diagram for V-I Characteristics of DIAC.

Theory:

DIAC is a two terminal three layer semiconductor devices. It is a bi-directional diode i.e., it can be made to conduct in either direction. It has no gate terminal. Switching from off state to on state may done by simply exceeding the avalanche breakdown voltage in either direction. The two p-regions have similar doping characteristics resulting in symmetrical switching characteristic for both positive and negative voltages.

When the applied voltage exceeds the avalanche breakdown voltage, the DIAC current rises sharply. In this ON condition, the voltage across the DIAC decreases with increasing current and the device therefore offers negative resistance. Its turn on voltages is approximately 32 V.

Procedure:

Steps to perform experiment.

1. Connect the circuit as shown in the Fig.2.1.
2. Connect positive terminal of the variable supply to point A and negative terminal to point B.
3. Switch on the power supply to the circuit.
4. Now vary the input voltage with the help of pot from its minimum value and note down the values of V and their corresponding values of I.
5. Repeat step 3 and step 4 with reverse supply connection across the DIAC.

Observations:

S. No.	Voltages across DIAC (Volts)	Current through DIAC (mA)
1		
2		
3		
4		
5		

Result:

Draw the graph between $\mathbf{V_{AK}}$ and $\mathbf{I_A}$, and comment on it.

Precautions:

1. Slowly increase the voltage and note the readings carefully.
2. Connect the ammeter and voltmeter with correct polarity.

Pre-Experiment Questions:

1. What do you understand by DIAC?
2. How the DIAC differs from a Diode?
3. What is the application of DIAC?

Viva-Voce Questions:

1. Can a DIAC be simulated by two anti-parallel connected diodes?
2. What do you understand by negative resistance characteristic?
3. What is silicon bi-lateral switch?
4. Can a DIAC be used as a rectifier?

Experiement-3

Aim:

To draw V-I Characteristics of TRIAC.

Apparatus Required:

S. No.	Apparatus/Accessories	Specifications	Quantity
1	TRIAC Kit	As available in lab	1
2	Ammeter	0-10 mA, DC	1
3	Ammeter	0-50 mA, DC	1
4	Voltmeter	0-50 V, DC	1
5	Connecting Leads		10

Circuit Diagram:

Schematic circuit diagram for V-I characteristics of TRIAC is given in Fig.3.1

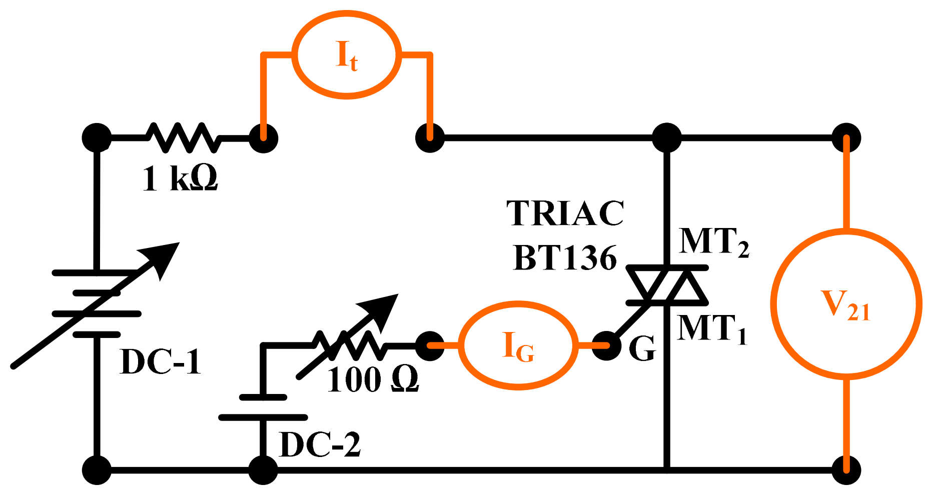

Fig.3.1 Schematic Circuit Diagram for V-I Characteristics of TRIAC.

Theory:

TRIAC has three terminals namely MT_1, MT_2, and G. The TRIAC can be turned on with positive or negative gate current by keeping the MT_2 terminal at positive or negative voltage w.r.t. MT_1. It is bilateral device and equivalent to two thyristor connected in anti parallel.

A TRIAC can be triggered in four modes:

Mode-1: MT_2 terminal positive w.r.t. MT_1 and positive gate current

After triggering the TRIAC in this mode, it conducts in Ist quadrant. The device is more sensitive in this mode.

Mode-2: MT_2 terminal negative w.r.t. MT_1 and positive gate current

After triggering the TRIAC in this mode, it conducts in IIIrd quadrant. The device is less sensitive in this mode.

Mode-3: MT_2 terminal negative w.r.t. MT_1 and negative gate current

After triggering the TRIAC in this mode, it conducts in IIIrd quadrant. The device is more sensitive compared to Mode-2 because in this mode less gate current is required for triggering the device with the same supply voltage and same load compared to the positive gate current as in mode-2.

Mode-4: MT_2 terminal positive w.r.t. MT_1 and negative gate current

After triggering the TRIAC in this mode, it conducts in Ist quadrant. The device is less sensitive in this mode compared to the mode-1 of operation because the device requires more gate current in this mode.

Procedure:

Step to perform the experiment.

1. Connect the circuit as shown in the Fig.3.1.
2. Switch on the power supply.
3. Fix the value of gate current to a certain value and note the reading for I_G.
4. Now increase the voltage with the help of pot P_1 from minimum value and note the value of V and corresponding value of I.
5. Carefully note the voltage V when there is sudden increase in current I.
6. With further increase in voltage, current increases rapidly. Carefully note the voltage and current I.
7. Repeat from step 3 to step 6 for various values of gate current.
8. Now reverse the supply voltage across MT_1 and MT_2, also reverse gate supply.
9. Repeat from step3 to step 7 for various values of gate current.

Observations:

S. No.	**I_G**		**I_G**		**I_G**	
	V	**I**	**V**	**I**	**V**	**I**
1						
2						
3						
4						
5						

Result:

Draw the graph between **V** and **I**, and comment on it.

Precautions:

1. Slowly increase the voltage and note the readings carefully.
2. Connect the ammeter and voltmeter with correct polarity.

Pre-Experiment Questions:

1. Why should the two trigger sources be isolated?
2. How does the TRIAC differ from SCR?
3. What are the advantages of bidirectional controllers?
4. What is meant by duty cycle in ON-OFF control method?
5. Amongst SCR, DIAC and TRIAC, which devices are voltage or current controlled?

Viva-Voce Questions:

1. How the TRIAC conducts in both directions?
2. Can negative signal be given to the gate of TRIAC?
3. Can a TRIAC be simulated by two anti-parallel connected SCRs?
4. How does the TRIAC differ from DIAC?
5. What is phase control?
6. What are the advantages and disadvantages of phase control?
7. What is the need of heat sinks in power electronic devices?
8. Can a TRIAC be used as a rectifier?

Experiement-4

Aim:

To measure the values of I_G, I_L, and I_H for a given SCR.

Apparatus Required:

S. No.	Apparatus/Accessories	Specifications	Quantity
1	SCR Kit	As available in lab	1
2	Ammeter	0-10 mA, DC	1
3	Ammeter	0-50 mA, DC	1
4	Voltmeter	0-50 V, DC	1
5	Connecting Leads		10

Circuit Diagram:

Schematic circuit diagram for the measurement of gate current, latching current and holding current of SCR is given in Fig.4.1

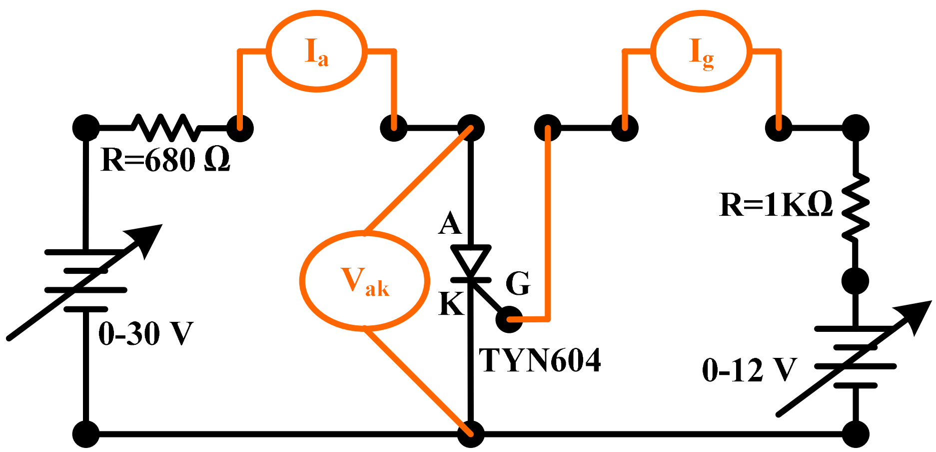

Fig.4.1 Schematic Circuit Diagram of SCR.

Theory:

Silicon Controlled Rectifier (SCR) is a four-layer PNPN (three junction) semiconductor switching device with three terminals named as anode (A), cathode (K) and gate (G). To make the SCR conducting, the anode is made positive with respect to cathode and certain gate pulse is applied to make the reverse biased junction J_2 forward biased. It is necessary that the anode current should be more that latching value. Once the SCR start conducting, the gate pulse can be removed. Thereafter if the SCR is required to attain the blocking mode again the forward anode current should go below the holding value. This gate pulse actually reduces the anode to cathode voltage required for conduction. In this mode, the thyristor conducts current form anode to cathode with a very small voltage drop across it.

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Procedure:

Please follow below mentioned Steps for measurement of I_G.

1. Connect the circuit as shown in the Fig.4.1.
2. Switch on the power supply.
3. Adjust the anode voltage and gate voltage and note the reading of V_{AK}.
4. Now slowly increase the gate current by varying P_2 and note the value of anode current.
5. Carefully note the ammeter reading (I_G) when there is sudden decrease in voltage V_{AK} i.e. when SCR is switched ON.
6. Repeat from step 2 to step 4 for different values of anode voltage and gate voltage.

Please follow below mentioned Steps for the measurement of I_L and I_H.

1. Connect the circuit as shown in the Fig.4.1.
2. Apply about 30V between anode and cathode.
3. Keep P_2 at minimum resistance position. The device must be in the off state with open gate.
4. Gradually increase the gate current by adjusting P_2. Observe the minimum gate current required to turn-on the device.
5. Further the gate voltage/current should be kept constant.
6. With the help of P_1, gradually increase the anode current in steps, each step may be of 3mA. Open and close the gate switch after each step. If anode current is greater than the latching current of the device, then the device stays on even after the gate switch is opened. Otherwise device goes into blocking mode as soon as the gate switch is opened. Note the value of latching current. Obtain more accurate value of latching current (I_L) by taking 1mA/0.25mA steps of the anode current near the latching current value already obtained.
7. To measure holding current (I_H). Increase the anode current form latching current level with P_1 or by increasing supply voltage slightly.
8. Open the gate switch permanently. The thyristor must be fully ON. Now start reducing the anode current gradually by adjusting P_1. If thyristor does not turn off even after the P_1 is at the highest resistance value. Then reduce the anode supply voltage. Observe when device goes into blocking mode. The anode current through the device at this instant is the holding (I_H) of the device.

Observations:

For measurement of I_G:

S. No.	V_{AK}	I_G
1		
2		
3		

For measurement of I_L and I_H:

I_L		I_H	

Result:

1. For higher values of gate current the break over voltage decreased.
2. I_L is higher than I_H by ______mA.

Precautions:

1. Slowly increase the voltage and note the readings carefully.
2. While measuring gate current do not change anode voltage and gate voltage.
3. Change the resistance gradually and observe.
4. Note the reading after repeating at least three times.

Pre-Experiment Questions:

1. What do you understand by holding current of SCR?
2. What do you understand by latching current of SCR?
3. What do you understand by forward breakover voltage of SCR?
4. What is commutation in SCR?
5. What are the methods to turn ON a SCR?

Viva-Voce Questions:

1. Why the latching current is more that holding current?
2. What will happen if holding current is more than latching current?
3. Why commutation circuit is required of SCR?
4. What is voltage commutation?
5. What is current commutation?
6. Can a thyristor conduct even after the voltage across its anode and cathode is reverse biased? Justify your answer with example.

Experiement-5

Aim:

To study the operation of a single-phase half-controlled bridge converter.

Apparatus Required:

S. No.	Apparatus/Accessories	Specifications	Quantity
1	Bridge converter Kit	As available in lab	1
2	Firing kit	As available in lab	1
3	CRO	As available in lab	1
4	Load (Resistive/Inductive)	As per requirement	1
5	Connecting Leads		12

Circuit Diagram:

Schematic circuit diagram for single phase half controlled rectifier is given in Fig.5.1

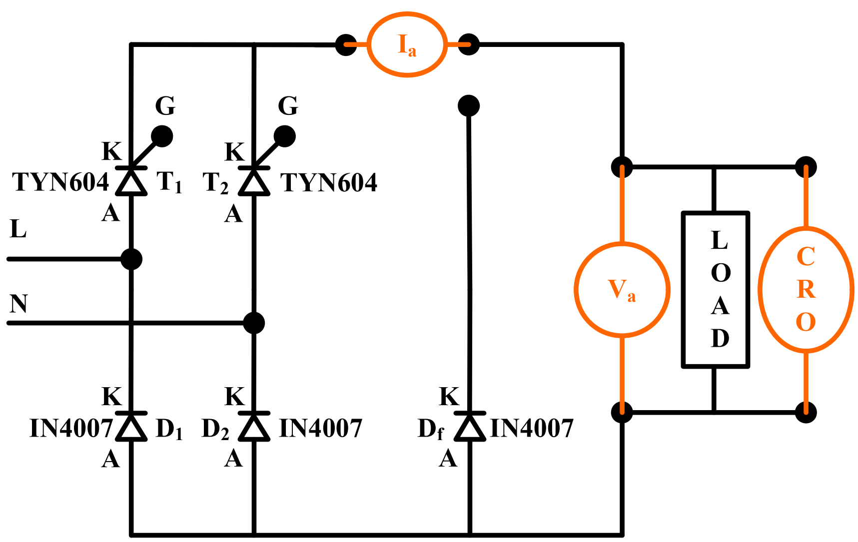

Fig.5.1 Schematic Circuit Diagram of single phase half controlled rectifier.

Theory:

The circuit arrangement of a single phase semi converter is shown in Fig. 5.1. In this circuit, two arms included in two arms of bridge rectifier and a constant voltage power supply is obtained at the secondary by controlling the firing time of each SCR's during each half cycle. During positive half cycle, thyristor T_1 is forward biased. When thyristor T_1 is fired at ωt (angle), the load is connected to the input supply through T_1 and diode D_2 during the period. During the period from the thyristor T_1 and diode D_2 are turned off, the input voltage is negative and the freewheeling diode D_f is forward biased. D_f conducts to provide the continuity of current in case

 Prepared by Dr Sanjeev Singh, Associate Professor (EIE Department), SLIET Longowal of inductive loads. During the negative half cycle of the input voltage, thyristor T_2 at ωt (angle), will reverse bias D_f. the diode D_f is turned off and the load is connected to the supply through T_2 and D_1.

Procedure:

Please follow the below mentioned to perform experiment:

1. Connect the circuit as shown in the Fig.5.1.
2. Switch on the power supply
3. Connect a load across the bridge output point.
4. Connect CRO across load and adjust so that the waveform is clearly visible.
5. Keep the firing pot at minimum value and observe waveform on CRO.
6. Gradually vary the firing angle α and observe waveform.

Simulate this circuit in MATLAB-SIMULINK and record the simulated waveforms.

Observations:

Comment on the waveforms for different loads and operating conditions obtained in simulated performance and laboratory results.

Precautions:

If the power circuit does not respond to the trigger pulses, reverse the phase neutral connection to the power circuit else interchange T_1 and T_2 connections. Make sure the power input to the power circuit is disconnected while you do this.

Pre Experiment Questions:

1. What is conduction angle?
2. What do you understand by converter and inverter?
3. What can be the maximum conduction angle for a Diode and when?
4. What is inversion mode of converters?
5. What is phase control?

Viva-Voce Questions:

1. What do you understand by uncontrolled and controlled rectifier?
2. What do you understand by semi converter?
3. What is the purpose of freewheeling diode?
4. What do you understand by firing angle and extinction angle?
5. What are the advantages and disadvantages of half controlled converter?
6. What shall be the output equation for this converter?
7. What is inversion mode of operation of a converter?
8. Can this converter work in inversion mode?

Experiement-6

Aim:

To study the operation of a single-phase full controlled bridge converter power circuits.

Apparatus Required:

S. No.	Apparatus/Accessories	Specifications	Quantity
1	Bridge converter Kit	As available in lab	1
2	Firing kit	As available in lab	1
3	CRO	As available in lab	1
4	Load (Resistive/Inductive)	As per requirement	1
5	Connecting Leads		12

Circuit Diagram:

Schematic circuit diagram for single phase half controlled rectifier is given in Fig.6.1

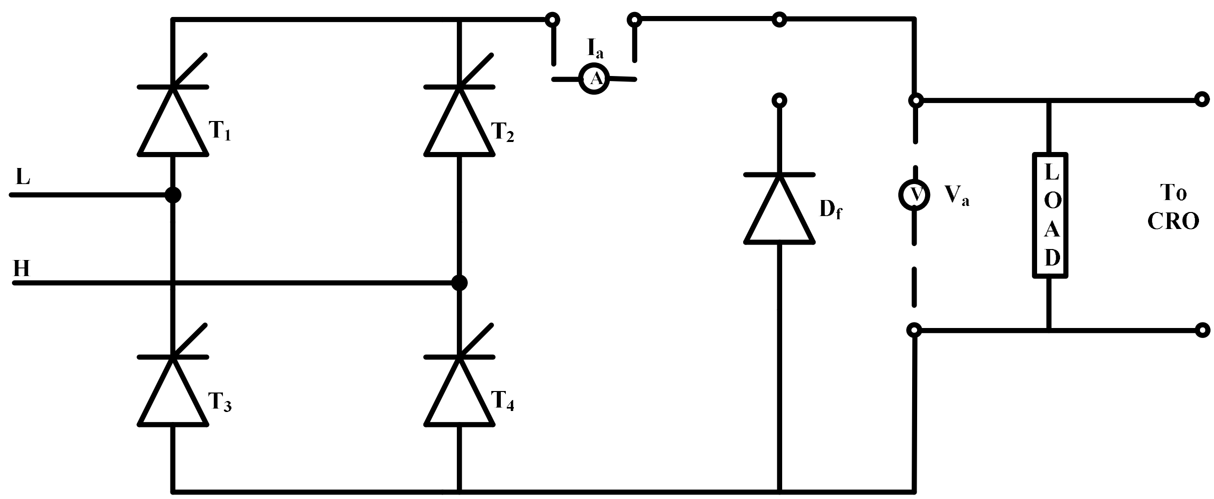

Fig.6.1 Schematic Circuit Diagram of single phase full controlled rectifier.

Theory:

The circuit arrangement of a single phase semi converter is shown in Fig. 6.1. In this circuit, two arms included in two arms of bridge rectifier and a constant voltage power supply is obtained at the secondary by controlling the firing time of each SCR's.

In a full controlled converter as compared to half controlled converter, the diode D_1 & D_2 are replaced by thyristos T_3 & T_4. The main difference between a fully controlled circuit and a half controlled circuit is that the former can operate as an inverter when the firing angle is between

$\pi/2$ and π, and later can operate only in the rectifying modes as the firing angle changes from zero to π.

Procedure:

1. Switch ON the mains supply for single- phase bridge converter & its firing unit.
2. Connect a load across the bridge output point.
3. Connect CRO across load and adjust so that the waveform is clearly visible.
4. Keep the firing pot minimum value and observe waveform on CRO.
5. Gradually vary the firing angle α and observe waveform.

Simulate this circuit in MATLAB-SIMULINK and record the simulated waveforms.

Observations:

Comment on the waveforms for different loads and operating conditions obtained in simulated performance and laboratory results.

Precautions:

If the power circuit does not respond to the trigger pulses, reverse the phase neutral connection to the power circuit else interchange thyristor connections. Make sure the power input to the power circuit is disconnected while you do this.

Pre Experiment Questions:

1. Which type of commutation is used in this experiment?
2. What will happen if the firing angle is greater than 90^o?
3. What are the performance parameters of a rectifier?
4. What are the advantages of three phase rectifier over single phase rectifier?
5. What are the difference between half wave and full wave rectifier?

Viva-Voce Questions:

1. What do you understand by full converter?
2. What is the purpose of freewheeling diode?
3. What are the advantages and disadvantages of full controlled converter?
4. What shall be the output equation for this converter?
5. Can this converter work in inversion mode?
6. How a full controlled converter can be converted to a half-controlled converter?
7. Define two quadrant and four quadrant converters.
8. What is the purpose of snubber circuit?

Experiement-7

Aim:

To study the operation of a three-phase half controlled bridge converter power circuits.

Apparatus Required:

S. No.	Apparatus/Accessories	Specifications	Quantity
1	Bridge converter Kit	As available in lab	1
2	Firing kit	As available in lab	1
3	CRO	As available in lab	1
4	Load (Resistive/Inductive)	As per requirement	1
5	Connecting Leads		12

Circuit Diagram:

Schematic circuit diagram for three phase half controlled bridge converter is given in Fig.8.1

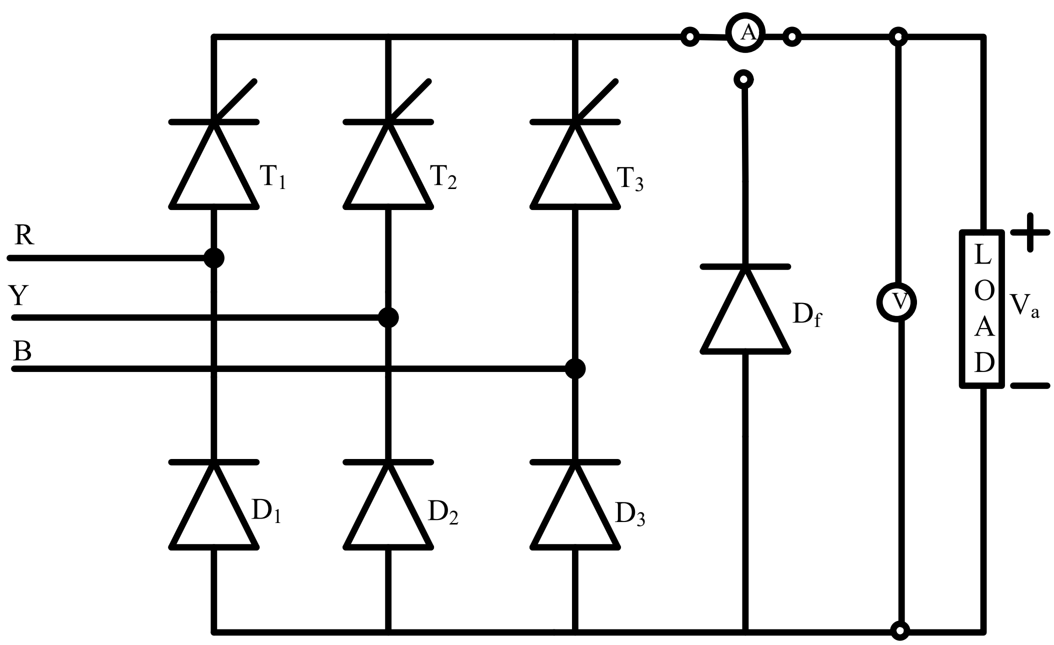

Fig.5.1 Schematic Circuit Diagram of three phase half controlled bridge converter.

Theory:

The three- phase half controlled converter has three thyristors and three diodes. In a half-controlled converter either of the top three or the bottom three thyristors are replaced by the diodes. The asymmetrical configuration is not used as it introduces imbalance in line currents on A>C side. In a three- phase half controlled converters free wheeling action will take place when the firing angle α is more than $\pi/3$ and the output voltage will become zero during this period (α-$\pi/3$).

In a two- quadrant bridge converter, if half the total numbers of thyristors are replaced by diodes, the converter circuit so formed is called the "Half- controlled"converter. Thiss name is derived owing to half the number of thyristors used in the circuit arrangement compared to the fully controlled converter. Half- controlled converters are also know as "semiconverter". The advantages of half- controlled converters over fully controlled converters are:

1. Since half the thyristors are replaced by diodes, the half- controlled converter coasts less than the fully controlled converter.
2. The mean DC terminal voltage can be continuously controlled from maximum to virtually zero with an increased control range of the firing angle.
3. The reactive power requirement for the same mean DC output voltage is less than for a fully controlled converter especially for lower output voltages. As a result, the power factor is improved with half – controlled converters.

Half- controlled converters are widely used in main line A.C. traction where large DC motors are supplied from a single- phase AC supply. The supply power factor is an important quantity since the supply system is week with low short – circuit capacity.

Procedure:

Please follow the below mentioned to perform experiment:

1. Connect the circuit as shown in the Fig.8.1.
2. Switch ON the power supply for three-phase bridge converter and its firing unit.
3. Connect a load across the bridge output point.
4. Connect CRO across load and adjust so that the waveform is clearly visible.
5. Keep the firing pot at minimum value and observe waveform on CRO.
6. Gradually vary the firing angle α and observe waveform.

Simulate this circuit in MATLAB-SIMULINK and record the simulated waveforms.

Observations:

Comment on the waveforms for different loads and operating conditions obtained in simulated performance and laboratory results.

Precautions:

The firing scheme should be properly checked before starting the operation.

Pre Experiment Questions:

1. What is conduction angle?
2. What are the effects of adding freewheeling diode in this circuit?
3. What is the effect of removing the freewheeling diode in three phase semi converter?

4. Why the power factor of semi converters is better than that of full converters?
5. What is inversion mode of converters?

Viva-Voce Questions:

1. What do you understand by semi converter?
2. What is the purpose of freewheeling diode?
3. Define firing angle?
4. Define extinction angle?
5. What shall be the output equation for this converter?
6. What is inversion mode of operation of a converter?
7. Can this converter work in inversion mode?
8. Define two quadrant and four quadrant converter.
9. What is the purpose of snubber circuit?

Experiement-8

Aim:

To study the operation of a three-phase full controlled bridge converter power circuits.

Apparatus Required:

S. No.	Apparatus/Accessories	Specifications	Quantity
1	Bridge converter Kit	As available in lab	1
2	Firing kit	As available in lab	1
3	CRO	As available in lab	1
4	Load (Resistive/Inductive)	As per requirement	1
5	Connecting Leads		12

Circuit Diagram:

Schematic circuit diagram for three phase full controlled rectifier is given in Fig.7.1

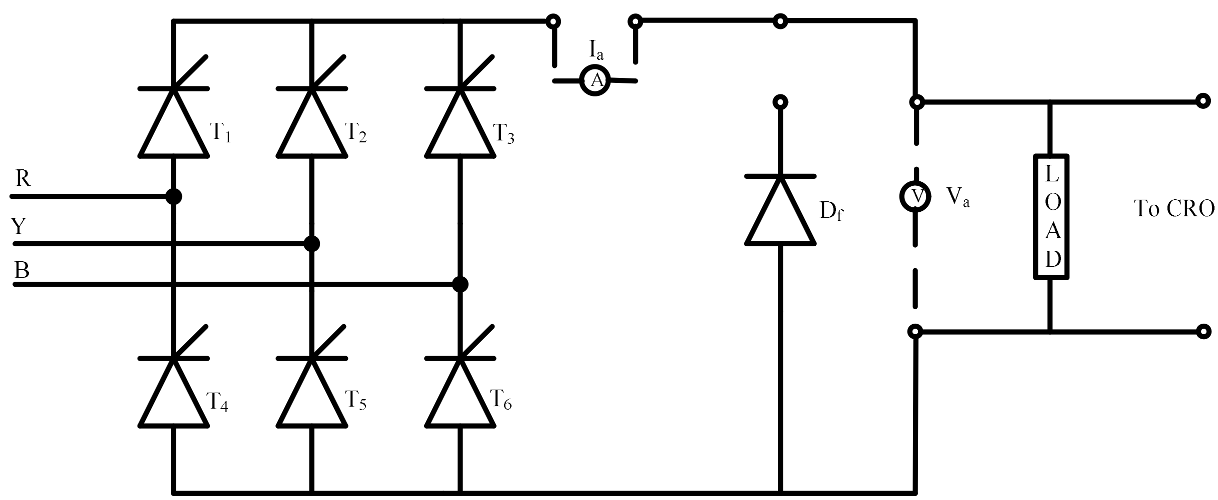

Fig.7.1 Schematic Circuit Diagram of three phase full controlled rectifier.

Theory:

The three phase half and full controlled converters differ in construction only. The former has three thyristors and three diodes whereas the latter has all six thyristors. In a half - controlled converter either of the top three or the bottom three thyristors are replaced by the diodes. The asymmetrical configuration is not used as it introduces imbalance in line currents on A.C side. In a three- phase half controlled converters freewheeling action will take place when the firing angle α is more than $\pi/3$ and the output voltage will become zero during this period(α $-\pi/3$).

Procedure:

1. Switch ON the mains supply for three-phase bridge converter and its firing unit.
2. Connect a load across the bridge output point.
3. Connect CRO across load and adjust so that the waveform is clearly visible.
4. Keep the firing pot at minimum value and observe waveform on CRO.
5. Gradually vary the firing angle α and observe the waveform.

Simulate this circuit in MATLAB-SIMULINK and record the simulated waveforms.

Observations:

Comment on the waveforms for different loads and operating conditions obtained in simulated performance and laboratory results.

Precautions:

The firing scheme should be properly checked before starting the operation.

Pre Experiment Questions:

1. State the type of commutation used in this circuit?
2. What will happen if the firing angle is greater than 90^o?
3. What are the performance parameters of rectifier?
4. What are the advantages of three phase rectifier over single phase rectifier?
5. What are the difference between half wave and full wave rectifier?

Viva-Voce Questions:

1. What do you understand by full converter?
2. What is the purpose of freewheeling diode?
3. What shall be the output equation for this converter?
4. What is inversion mode of operation of a converter?
5. Can this converter work in inversion mode?
6. How half controlled converter is different from full controlled converter?
7. Define two quadrant and four quadrant converter.
8. What is the purpose of snubber circuit?

Experiement-9

Aim:

To study the operation of a single-phase half bridge inverter.

Apparatus Required:

S. No.	Apparatus/Accessories	Specifications	Quantity
1	Bridge converter Kit	As available in lab	1
2	Firing kit	As available in lab	1
3	CRO	As available in lab	1
4	Load (Resistive/Inductive)	As per requirement	1
5	Connecting Leads		12

Circuit Diagram:

Schematic circuit diagram for single phase half bridge inverter is given in Fig.9.1

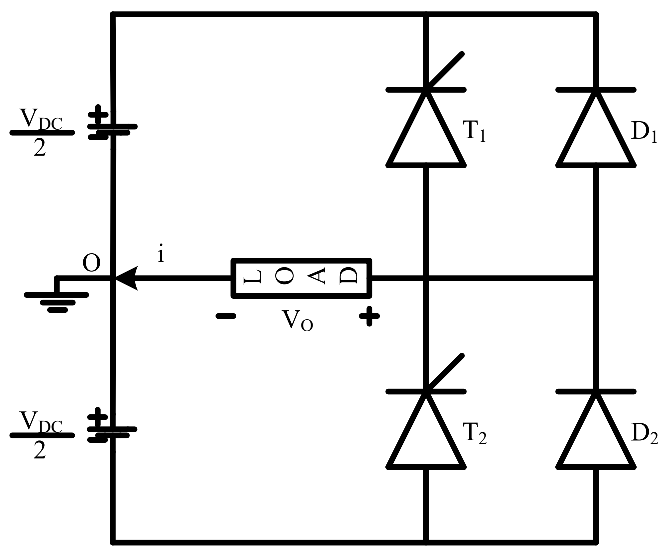

Fig.5.1 Schematic Circuit Diagram of single phase half bridge inverter.

Theory:

Inverters are mainly used to convert DC power into AC power at desired output voltage and frequency. Some of the important applications of inverters are variable frequency AC drives, Induction Heating, Standby Aircraft and UPS etc. The half- bridge inverter has two thyristors and two diodes connected. During the period $0< t< T/2$ thyristor T_1 conducts and the load is subjected to a voltage V/2. At $t= T/2$, thyristors T_1 is commutated OFF and then thyristor T_2 is gated ON. During the period $T/2 < t< T$, thyristor T_2 conducts and the load is subjected to a voltage – V/2. Thus the load voltage is an alternating rectangular voltage waveform of frequency(1/T). By controlling T, we can control the frequency of inverter output voltage.

For a pure resistive load, thyristors will be enough. But load may be inductive or capacitive. Furthermore, even the resistive load will have some inductance or capacitance. Thus for all types of loads, output currents will not necessarily reverse at the same instant as does the load voltage. The diodes D_1 and D_2 connected in anti- parallel with the thyristors will then permit load current to flow. These diodes are called feedback diodes.

Procedure:

Please follow the below mentioned to perform experiment:

7. Connect the circuit as shown in the Fig.9.1.
8. Switch ON the power supply for single-phase half- bridge inverter and its firing unit.
9. Connect a load across the bridge output point.
10. Connect CRO across load and adjust so that the waveform is clearly visible.
11. Keep the firing pot at minimum value and observe waveform on CRO.
12. Gradually vary the firing angle α and observe waveform.

Simulate this circuit in MATLAB-SIMULINK and record the simulated waveforms.

Observations:

Comment on the waveforms for different loads and operating conditions obtained in simulated performance and laboratory results.

Precautions:

Make the connections tight and check the circuit before switching On the power supply.

Pre-Experiment Questions:

1. What do you understand by an ideal and a practical voltage source?
2. What do you understand by an ideal and a practical current source?
3. What is the application of inverter?
4. What do you mean by conduction mode of inverter?

Viva-Voce Questions:

1. What is an inverter?
2. What do you understand by Current Source Inverter (CSI)?
3. What do you understand by Voltage Source Inverter (VSI)?
4. Define gain of an inverter?

Experiement-10

Aim:

To study the operation of Jones and Morgan's Chopper circuits.

Apparatus Required:

S. No.	Apparatus/Accessories	Specifications	Quantity
1	SCR Chopper kit	As available in lab	1
2	Ammeter	As available in lab	1
3	Voltmete	As available in lab	1
4	Load (Resistive/Inductive)	As per requirement	1
5	Connecting Leads		12

Circuit Diagram:

Schematic circuit diagram for Jones and Morgan's Chopper circuits is given in Fig10.1& 10.2

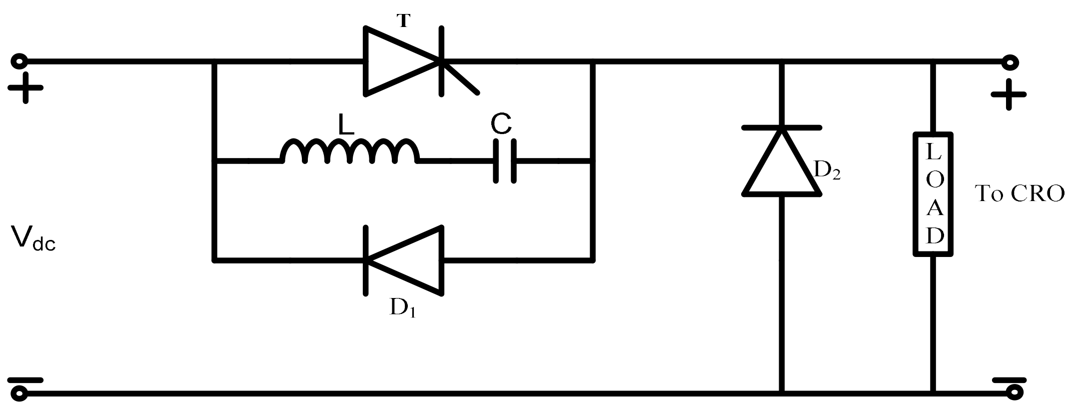

Fig.10.1 Schematic Circuit Diagram of Morgan's Chopper circuit.

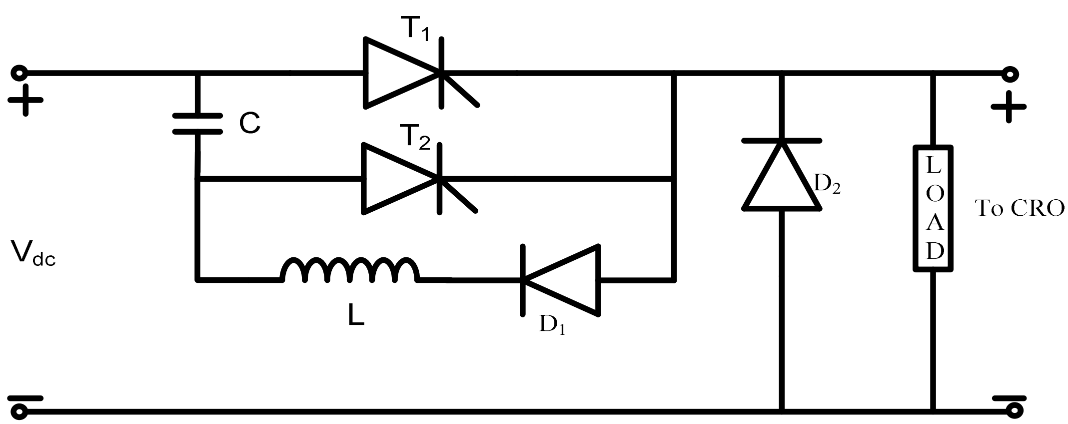

Fig.10.2 Schematic Circuit Diagram of Jones Chopper circuit.

Theory:

Speed control of DC motors using thyristor voltage chopper is needed whenever the DC supply is already available from AC supply. The choppers are circuits which convert power between a constant voltage DC input and a variable voltage DC output. The power is controlled by the method of ON- OFF. The voltage is applied to the load for a specified period called on- time (T_{ON}), and the load is open – circuited or the applied voltage is removed for a duration know as off- time (T_{OFF}). The load power can be controlled by varying the on- and off- time. The ratio T to (T_{ON} + T_{OFF}) is known as the duty cycle.

The circuit shown in Fig.10.1 is called Morgan chopper, which uses self-commutation, by a resonant circuit aided by a saturable reactor. Its major advantage is that it uses only one thyristor. The circuit shown in Fig.10.2 is called Jones Chopper, which uses class D commutation.

Procedure:

Please follow the below mentioned to perform experiment:

1. Connect the circuit as shown in the Fig.10.1
2. Switch ON the power supply of the chopper circuit and its firing unit.
3. Connect a load across the bridge output point.
4. Connect CRO across load and adjust so that the waveform is clearly visible.
5. Keep the firing pot at minimum value and observe waveform on CRO.
6. Gradually vary the firing angle α and observe waveform.
7. Repeat the steps 1 to 6 for Fig.10.2.

Simulate these circuits in MATLAB-SIMULINK and record the simulated waveforms.

Observations:

Comment on the waveforms for different loads and operating conditions obtained in simulated performance and laboratory results.

Precautions:

1. Make the connections tight and check the circuit before switching ON the power supply.
2. Never test a chopper without load.

Pre Experiment Questions:

1. What are methods to get a variable dc voltage from a constant dc voltage source?
2. What is the application of chopper circuit?

Viva-Voce Questions:

1. What do you mean by dc transformer?
2. What do you understand by Step up chopper?
3. What do you understand by Step down chopper?