CHAPTER-2

HARDWARE DESCRIPTION OF TRAINER MODULES

2.1. INTRODUCTION:

The following modules are developed to conduct and study various experiments based on power MOSFET and IGBT.

1. Switching Characteristics Module [ITB-PEC16 M1]
2. MOSFET Module [ITB-PEC16M2].
3. IGBT Module [ITB-PEC16M3].
4. Inverter Control Module [ITB-PEC16M4]
5. Single phase single pulse Inverter control module.[ITB-PEC 16M4#2]
6. Chopper Control Module [ITB-PEC16M5]

The hardware involved in these modules are explained in the following.

2.2 SWITCHING CHARACTERISTICS MODULE

This module consists of power semi conductor devices and their base drive circuits. They are BJT, MOSFET and IGBT. The voltage and current ratings of those devices are 600V and 8A respectively. The dc power supply required for conducting various experiments is built-in.

The terminals of all the devices and base drive circuits are brought out to banana connectors mounted at the front panel. An oscillator provided for producing square wave which is shown in the front panel. The turn on time in square wave is equal to turn-off time The square wave is given as input to the base drive circuit of power transistors. The primary function of a drive circuit is to switch a power semiconductor device from the off state to the on state and vice versa. In the on-state the drive circuit must provide adequate drive power to keep the power switch in the onstate where the conduction losses are low. The separate drive circuit for each device is provided.

The switching characteristics configurations can be made by proper interconnection of the drive circuit and device terminals at the front panel. A diode is provided current to a current sensing resistor which is internally connected in between the device and ground. The mimic diagram showing the inter connection of device terminals is screen printed on the panel and is as shown in the figure (2.1).

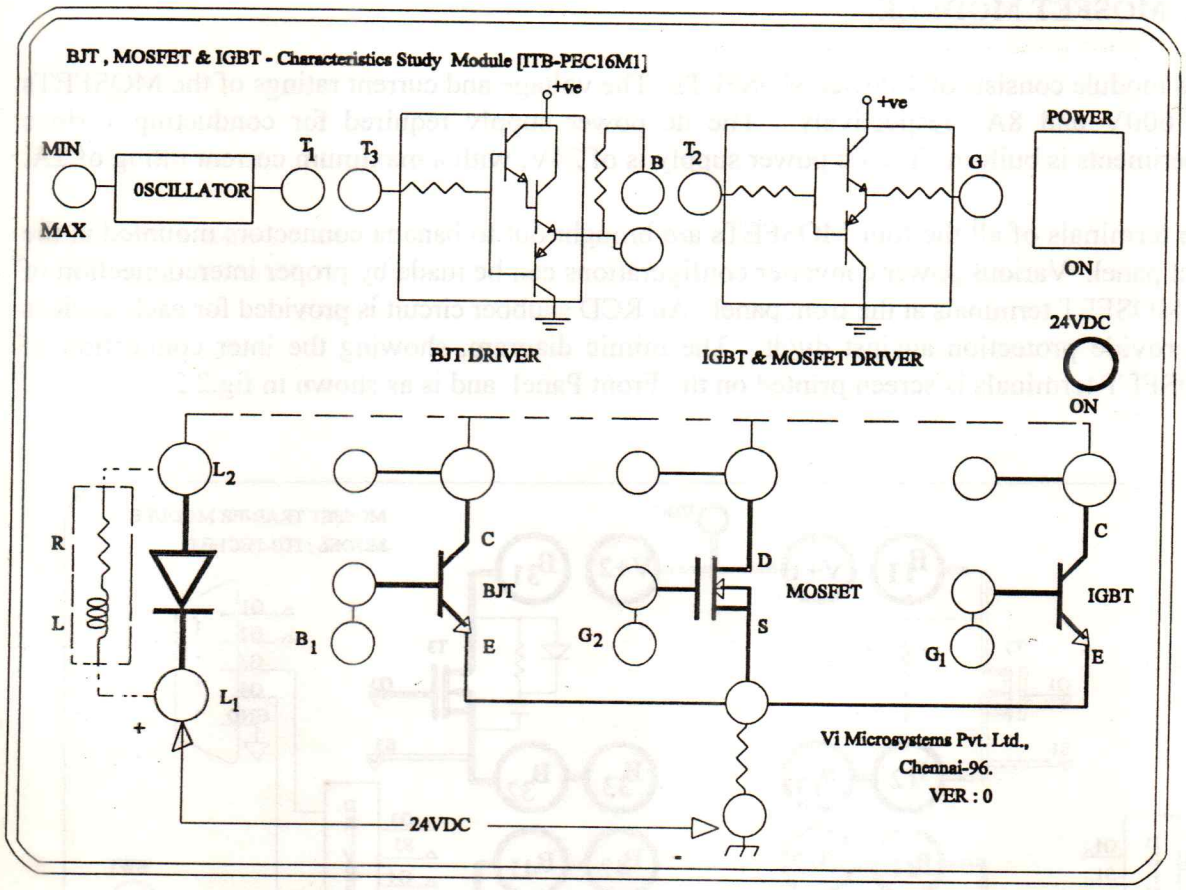

Fig - 2.1. Mimic Diagram at the front panel of Switching Characteristics Module

CIRCUIT DESCRIPTION :

The d.c. link voltage is obtained through a step down transformer and a full-wave diode bridge rectifier. The d.c. power supply is of 24V, with a maximum current rating of 2A. The step down transformer is kept at the outside. A main power switch is provided with indicator to switch ON ac power supply. A toggle switch SW1 provided on the input side of an oscillator to give the minimum (or) maximum frequency of the square wave.

The banana connectors for BJT drive circuit, IGBT & MOSFET drive circuit are mounted on the front panel. The darlington arrangement of two transistors are used for BJT base drive circuit. The totem-pole arrangement of transistors are used for IGBT & MOSFET drive circuit. Which provides positive gave pulse to the devices. The current sensing resistor connected across a device and the ground. Which sense the current through the ground.

2.3. MOSFET MODULE:

This module consists of 4 Power MOSFETs. The voltage and current ratings of the MOSFETs are 600V and 8A respectively. The dc power supply required for conducting various experiments is built-in. The dc power supply is of 24V, with a maximum current rating of 2A.

The terminals of all the four MOSFETs are brought out to banana connectors mounted at the front panel. Various power converter configurations can be made by proper interconnection of the MOSFET terminals at the front panel. An RCD snubber circuit is provided for each devices to provide protection against dv/dt. The mimic diagram, showing the inter connection of MOSFET terminals is screen printed on the Front Panel and is as shown in fig.2.2.

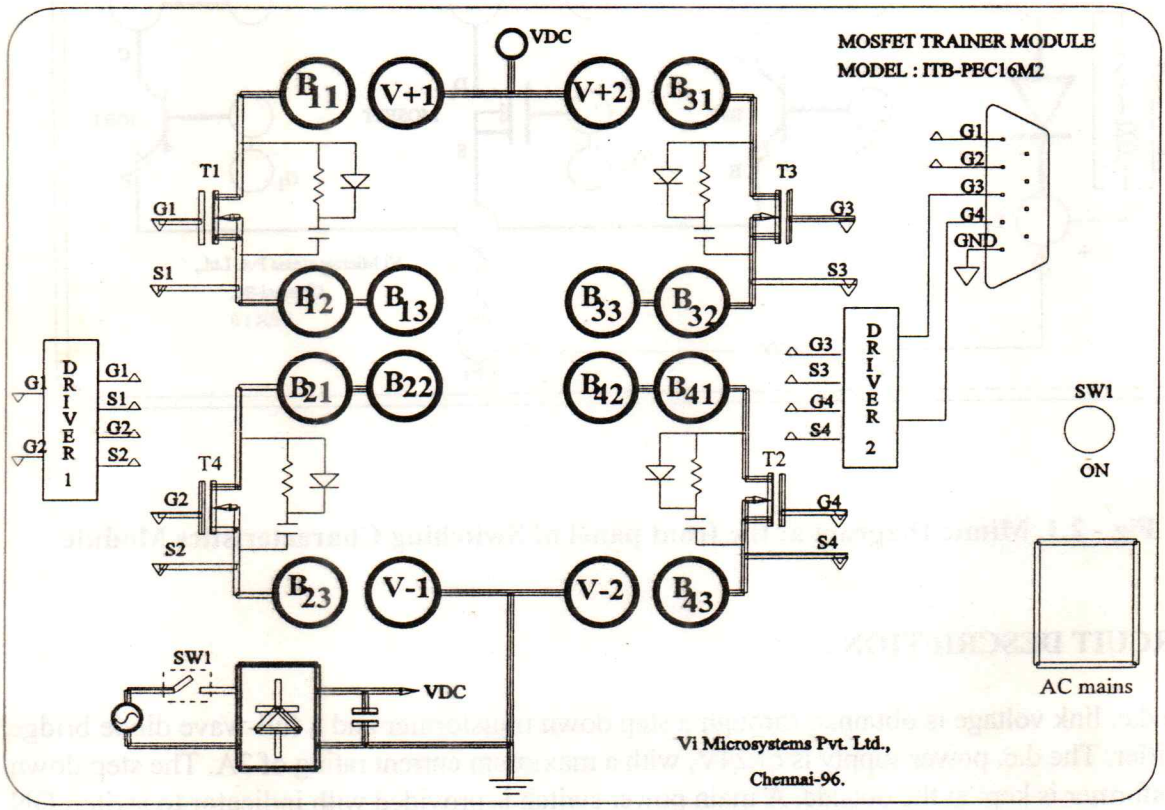

Figure 2.2 Mimic Diagram at the Front Panel of the MOSFET Module.

2.3.1 CIRCUIT DESCRIPTION:

The dc link voltage is obtained through a step-down transformer and a full-wave diode bridge rectifier. A mains power switch (with indicator) is provided to switch ON/OFF ac power (230V) to the input transformer. This will also provide ±15V dc supply to the gate Driver IC IRF2110. A toggle switch SW1 provided on the secondary side switch ON or OFF ac supply to the bridge rectifier. Once SW_1 is switched on, v_{dc}, (DC Link Voltage) will be available between the banana connectors V+1(V+2) and V-1(V-2).

The gating signals from the control module is to be connected at the 9 pin D connector through the signal cable provided. The gating signals are isolated from control power supply by means of high-speed opto couplers. The isolated gating signals are then applied to the MOSFET Driver IC, IRF 2110, Two such Driver Ics are used; one driver IC provides gating signals to the devices in one leg.

Each MOSFET can be used independently to study the switching characteristics or it may be inter connected with others depending on the required converter topology.

2.4. IGBT MODULE:

This module consists of 4 IGBTs. The voltage and current ratings of the IGBTs are 600V and 8A respectively. The dc power supply required for conducting various experiments is built-in. The dc power supply is of 24V, with a maximum current rating of 2A.

The terminals of all the four IGBTs are brought out to banana connectors mounted at the front panel. Various power converter configurations can be made by proper interconnection of the IGBT terminals at the front panel. An RCD snubber circuit is provided for each devices to provide protection against dv/dt. The mimic diagram showing the interconnection of the IGBT terminals is screen printed on the front panel and is as shown in Fig.2.3.

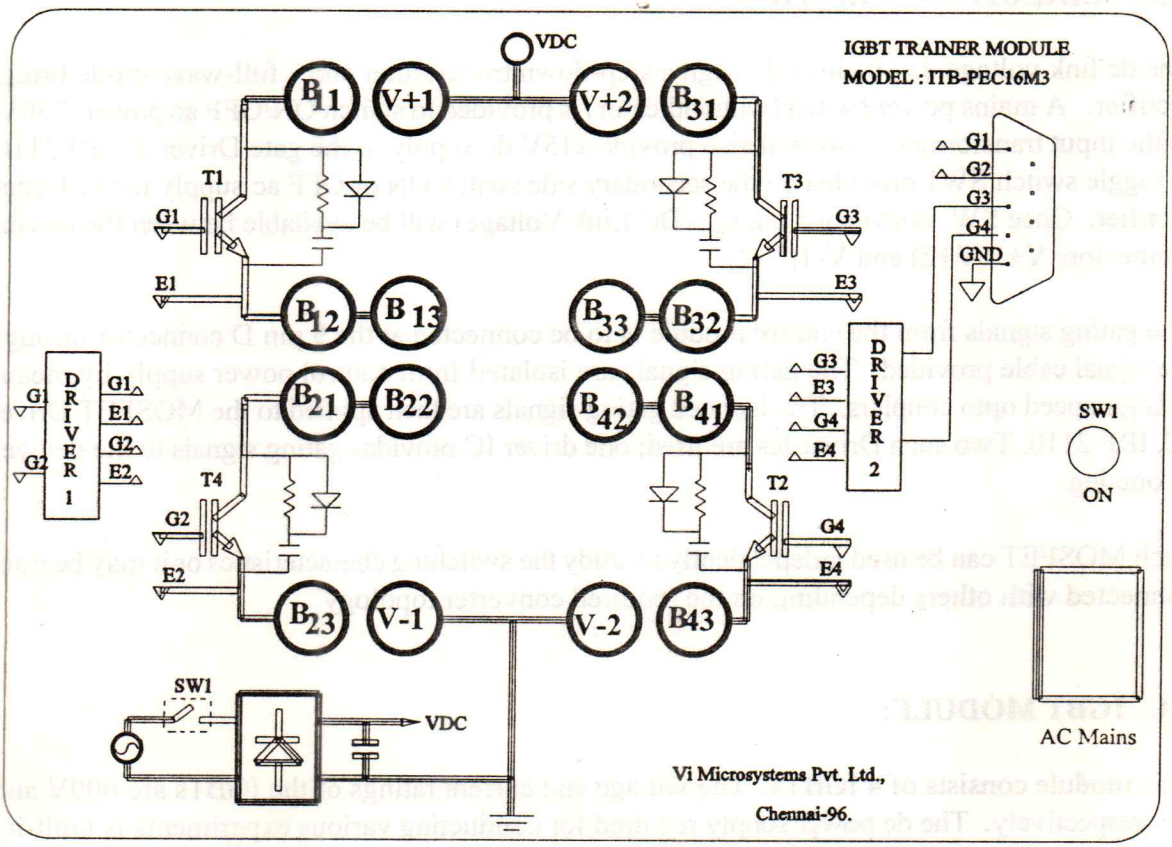

Figure 2.3 Mimic diagram at the Front Panel of the IGBT Module.

2.4.1. CIRCUIT DESCRIPTION:

The dc link voltage is obtained through a step-down transformer and a full-wave diode bridge rectifier. A mains power switch (with indicator) is provided to switch ON or OFF ac power (230V) to the input transformer. This will also provide ±15V dc supply to the gate Driver IC IRF2110. A toggle switch SW1 provided on the secondary side switch ON/OFF ac supply to the bridge rectifier. Once SW_1 is switched on, $v_{dc,}$ (DC Link Voltage) will be available between the banana connectors V+1 (V+2) and V-1 (V-2).

The gating signals from the control module is to be connected at the 9 pin D connector through the signal cable provided. The gating signals are isolated from control power supply by means of high-speed opto couplers. The isolated gating signals are then applied to the IGBT Driver IC, IRF 2110, Two such Driver Ics are used; one driver IC provides gating signals to the devices in one leg. Each IGBT can be used independently to study the switching characteristics or it may be inter connected with others depending on the required converter topology.

2.5.1. INVERTER CONTROL MODULE

This module provides the gating signals required for a single phase bridge inverter. The gating signals are obtained with sine-triangle modulation. The frequency and the amplitude of the reference sine wave can be varied. The triangular carrier frequency can be varied from 1 Khz to 4 Khz. A selector switch is provided to select the maximum carrier frequency of 2 Khz and 4 Khz. Test points are provided in the front panel to observe the waveforms at various stages of the control circuitry and to study its operation. The power supply required (+5V, ±15V) for the control circuitry is built-in.

The various stages involved in generating the gating signals for the bridge inverter is depicted in a mimic diagram at the front panel and is as shown in fig.2.4.1.

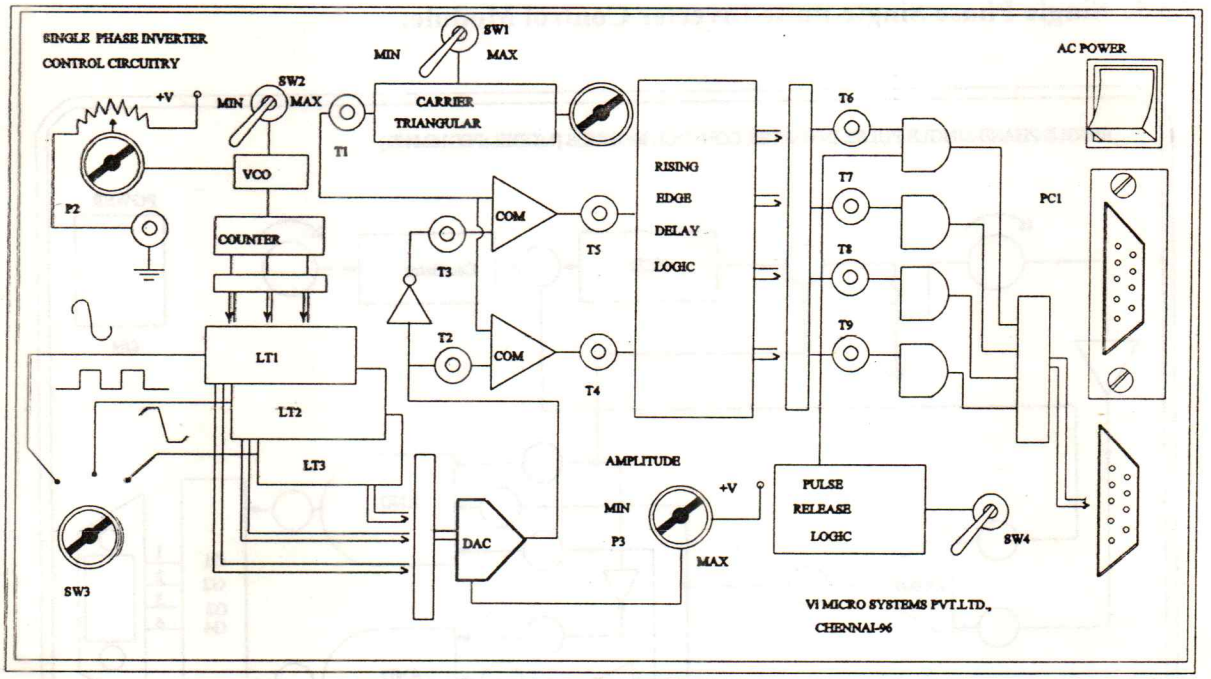

Fig. 2.4.1. Mimic diagram showing the various stages in the Inverter Control Module

2.5.1a. CIRCUIT DESCRIPTION:

The ac power required to provide dc supply to the control circuitry is switched ON or OFF through the mains power switch SW with indicator. 5V power supply is used for EPROM and DAC circuitries. ±15V is used for other linear Ics and logic circuits.

The triangular carrier frequency can be selected either at 2.2 Khz or 4.2 Khz by means of the toggle switch SW1. It can be varied upto these maximum limits using the control pot P1.

The reference sine wave frequency can be varied by varying the VCO frequency. It can be selected between two levels of frequency through the toggle switch SW_2. For each level, the frequency can be varied by means of the control pot P2. The amplitude of the sine wave is controlled by means of the control pot P3. The modulating wave can be either sine, Trapezoidal or Square wave. It can be selected through the selector switch SW_3.

The gating signals generated by means of pulse width modulation, are applied to logic circuits, to decide the desired switching sequence and to provide the necessary delay before applying the signals at the gate. The gating signals are terminated at 9 pin D connector PC1. The gating signals can be blocked or released by means of the switch SW4. The gating signals to the inverter switches are connected from the control module to the inverter module through the cable provided.

2.5.2. Single Phase Single Pulse Inverter Control Module:

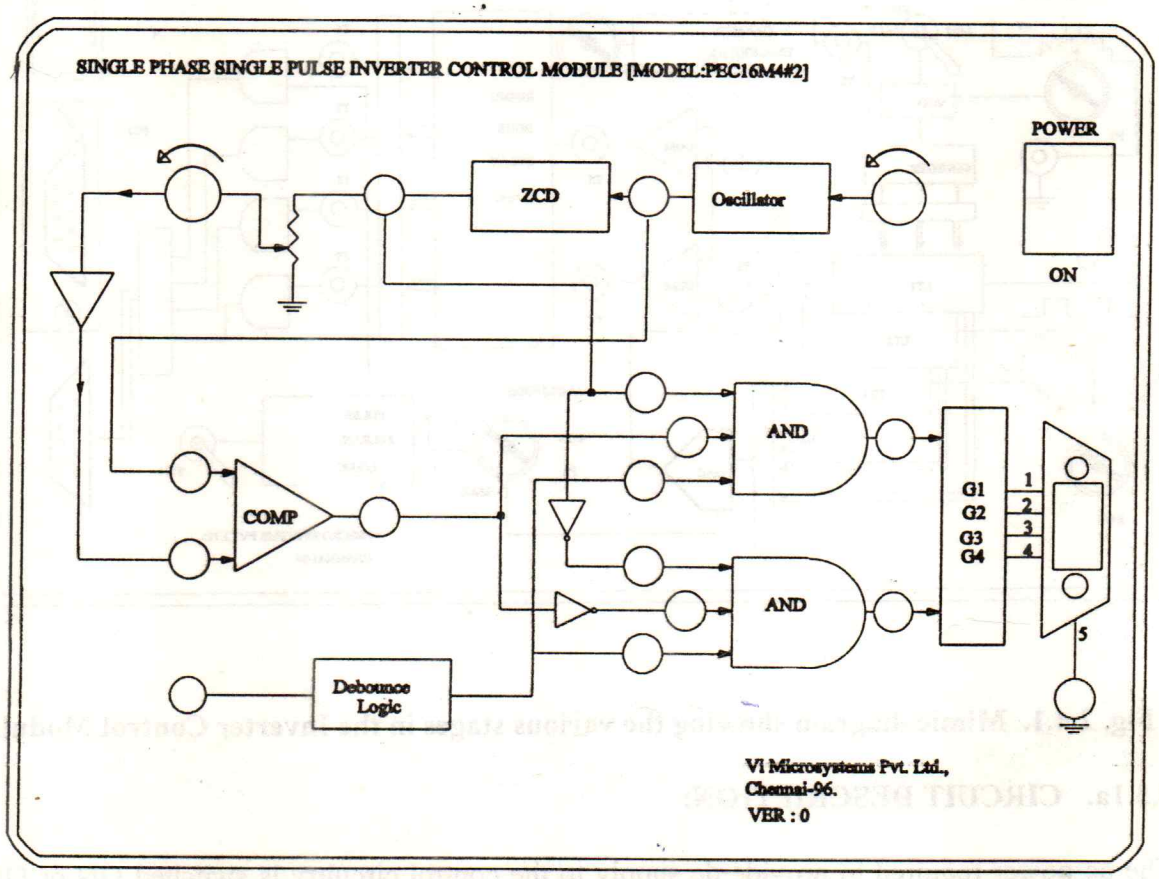

Fig. 2.4.2. Mimic Diagram of Single Phase Single Pulse Inverter Control Module

This module provides single pulse required for single phase bridge inverter. This signal is obtained with square-triangle modulation. The frequency and the amplitude of the reference square wave can be varied. Square wave and the triangle wave can be compared by using comparator. Test points are provided in the front panel to observe the waveforms at various stages of control circuit trainer and to study its operation. The power supply required (+5V, ±15V) for the control circuitry is built-in. The mimic diagram at the front panel is shown in fig.2.4.2.

2.6. Chopper Control Module.

This module generates the gating signals required for (i) single quadrant (ii) Two quadrant chopper (iii) Four Quadrant Chopper circuits. The gating signals are generated by comparing a triangular carrier with a reference dc control voltage level. The carrier frequency can be selected between two limits minimum (2.2 Khz) and a maximum (4.2 KHz). Within the selected maximum frequency it possible to vary the carrier frequency. The power supply required for the control circuitry is built in. Test point are provided in the front panel to study the operation of various stages in the control circuitry.

The mimic diagram showing the various stages in the control circuitry is screen printed in the front panel and is shown in Fig.2.5.

2.6.1. CIRCUIT DESCRIPTION:

The power supply to the control circuitry is switched ON or OFF by means of the ac main switch SW with indicator. The carrier frequency can be selected between a minimum and a maximum by means of the toggle switch SW1 and it can be adjusted through the control pot P1. The dc control voltage level, which controls the duty cycle ratio, can be adjusted by means of the pot P2. The gating signals can be either blocked on released by means of the switch SW4.

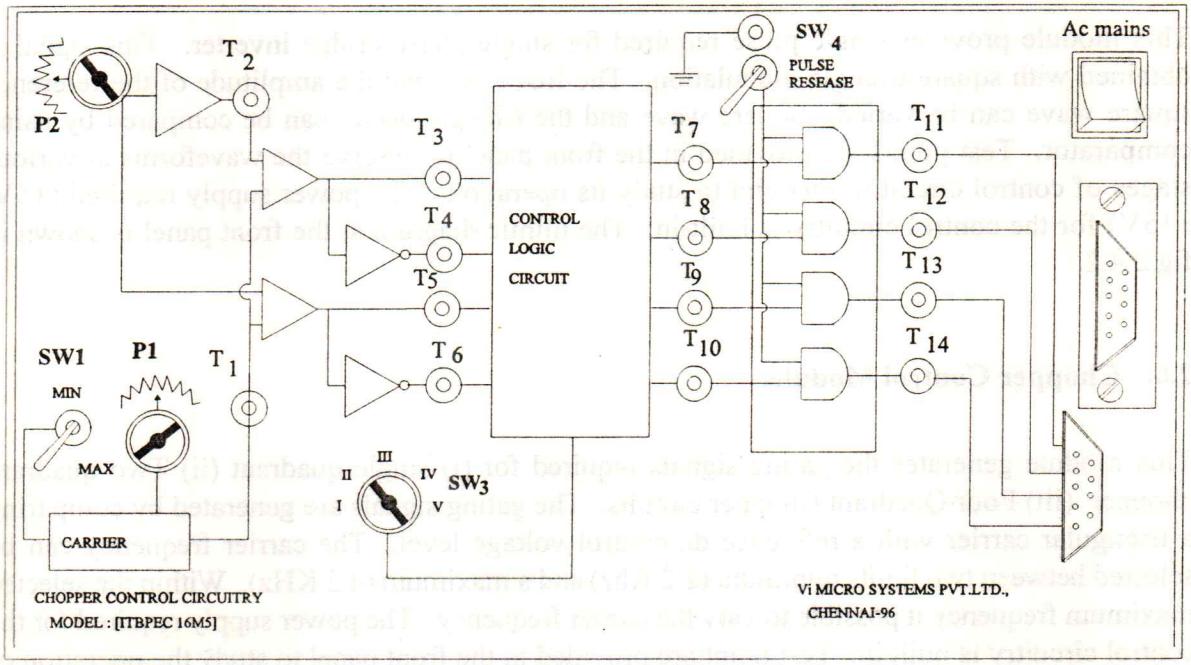

Fig.2.5 Mimic diagram at the Front Panel of the Chopper Control Module.

The gating signals can be selected to various power switches T_1, T_2, T_3 and T_4 in the chopper circuit shown in fig. 2.6 by means of the selector switch SW_3 as in table 2.1.

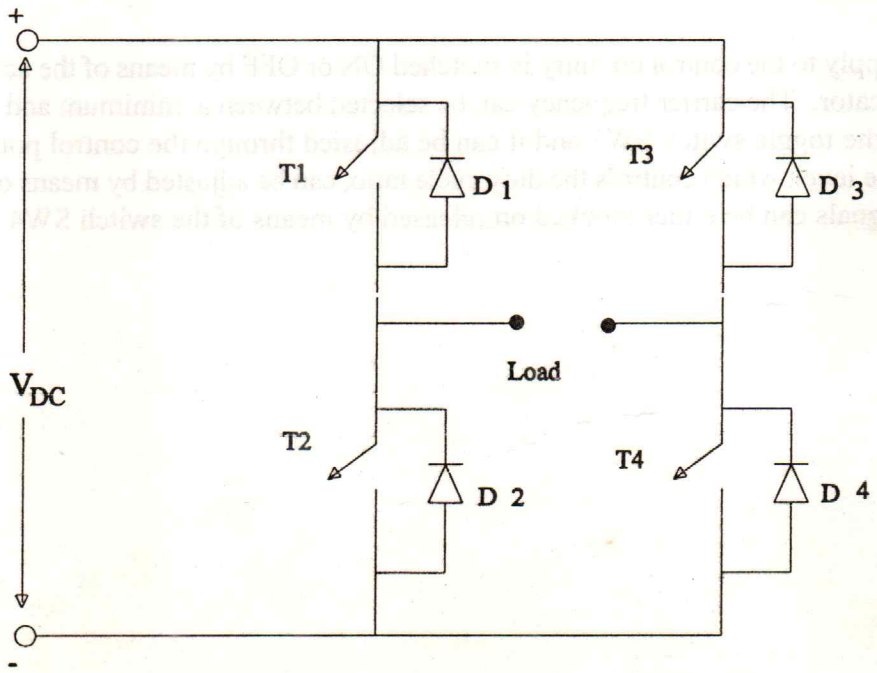

Fig.2.6 Four Quadrant Chopper Circuit.

Table 2.1

SWITCH POSITION	GATING SIGNALS To
I	T_2
II	T_1 & T_4
III	T_1, T_2 & T_3, T_4
IV	T_1, T_4 & T_3, T_2
V	T_2 & T_1, T_4
VI	T_4 & T_3, T_2

The gating signals are terminated at 9 pin D connector PC1 and is to be connected to chopper module through the cable provided.