EXPERIMENT NO.10

OBJECT: To perform the control of 3-phase induction motor using IGBT based 3-phase inverter capable of driving a 0.5-hp AC motor.

APPARATUS REQUIRED:-

1. 3 – Phase IGBT based PWM inverter and V/F control trainer.
2. 25~60 Watt bulb.
3. 3 ph. ½ hp Induction Motor.

THEORY:-

An **Inverter** is an electrical device that converts **Direct current** (DC) to **Alternating current** (AC); the converted AC can be at any required voltage and frequency with the use of appropriate transformers, switching, and control circuits. Some industrial applications of inverters are for adjustable speed ac drives, induction-heating, stand by air craft power supplies, UPS for computers, HV dc transmission lines etc.

The variable frequency converter which acts as interface between utility power System and induction motor must satisfy following basic requirement:

1) Ability to adjust frequency according to the desired output speed.

2) Ability to adjust output voltage so as to maintain a constant air gap flux in a constant torque region.

3) Ability to supply rated current on a continuous basis at any frequency.

Variable frequency drives illustrates the basic concept where utility input is converted into dc by means of either controlled or uncontrolled rectifier and then inverted to provide three phase voltages and currents to the motor. These converters are classified based on the type of rectifier and inverter.

1) Pulse-width-modulated voltage-source inverters (PWM-VSI) with a diode rectifier.

2) Square-wave voltage-source inverter (square-wave-VSI) with a thyristor rectifier.

3) Current-source inverter (CSI) with thyrister rectifier.

PWM-VSI scheme is implemented here. PWM inverter controls both the frequency and magnitude of the voltage output. One possible method of generating the inverter Switch control signals is by comparing three sinusoidal control voltages(at the desired output frequency and proportional to the output voltage magnitude)with a triangular waveform at a selected switching frequency.

In VSI dc voltage applied to the inverter is constant and a quick change in the voltage is not possible. The load current will not affect the voltage. Such an operation is achieved when a capacitor is connected across the inverter terminals. On the other hand, in case of CSI, the current drawn by the inverter does not change in its magnitude if there is a change in the inverter voltage. An inductance connected in series with the inverter makes it possible. In a VSI the output voltage is decided by the conduction of inverter devices and the current waveform depends on the load.

For providing adjustable frequency power to industrial applications, three phase inverters are more common than single-phase inverters. A basic three-phase inverter is a six-step bridge inverter. It uses a minimum of six power devices. In inverter terminology, a step is defined as a change in the firing from one device to the next device in proper sequence. For one cycle of 360 deg., each step would be of 60 deg. Interval for a six-step inverter. This means that the devices would be gated regular intervals of 60 deg. In proper sequence so that a 3 phase ac voltage is synthesized at the output terminals of a six-step inverter.

There are two possible patterns of gating the devices. In one pattern a device conducts for 180 deg. And in other, each device conducts for 120 deg. But in both the patterns, gating signals are applied and removed at 60 deg. Intervals of the O/P voltage waveforms.

PWM inverters are gradually taking over other types of inverters in industrial applications. PWM techniques are characterized by constant amplitude pulses. The width of these pulses is however, modulated to obtain inverter output voltage control and to reduce its harmonic contents. Single pulse modulation, multiple pulse modulations and sinusoidal pulse modulation are the basic PWM techniques.

TEST POINTS:

Control Test points:-

TP1 w.r.t. GND :- Control ckt power supply + 5V DC.

TP2 w.r.t. GND :- Clock signal.

TP3 w.r.t. GND :- Enabling signal (i.e. : A7 line)

TP4 w.r.t. GND :- 0 TO 10V Soft Start.

TP5 w.r.t. GND :- Ramp

TP6 w.r.t. GND :- Duty Cycle.

TP7 w.r.t. GND :- Drive for Q1

TP8 w.r.t. GND : - Drive for Q2

TP9 w.r.t. GND : - Drive for Q3

TP10 w.r.t GND : - Drive for Q4.

TP 11 w.r.t. GND : - Drive for Q5.

TP12 w.r.t GND : - Drive for Q6.

GND :- Control ckt GND.

Power Test Points:-

TP 13 w.r.t TP14 : -230VAC i/p

TP 15 w.r.t TP16 : - DC voltage.

TP17 w.r.t. TP18 :- Output voltage waveform across lamp load.

(0 - 200 V) Phase to Phase

TP18 w.r.t. TP19 :- Output voltage waveform across lamp load.

(0 - 200 V) Phase to phase

TP19 w.r.t. TP17 :- Output voltage waveform across lamp load.

(0 - 200 V) Phase to phase

PROCEDURE :-

[USE UNEARTHED CRO ONLY]

A] To study the control circuit:-

1. Connect the 3 pin Top to 230 V mains.
2. Switch on the mains, Rocker switch & see that all the LED's inside the units are glowing to show supply status.

NOTE: -Don’t give the START to unit.

3. Observe the waveform from TP1 to TP12 w.r.t. GND on CRO & refer to block diagram as well as waveforms.
4. Measure the min. frequency of clock (TP2) & enabling signal (TP3) & freq. pot position at zero [enabling signal freq = O/P Freq.]
5. Measure the period of pulse in terms of degrees
6. Switch off the unit.

Note: - The unit will not start only on Resistive load, it will start only on motor.

B] Study of Power ckt. [Motor load only]

1. Repeat steps 1 to 3 from Expt.B
2. Connect motor plug to the 4 pin John's connector of the unit.
3. Switch on the unit.
4. Increase the frequency pot from min to max slowly.(wait for motor response).
5. Vary the frequency pot from min to max and measure the speed of the motor.
6. Plot the graphs of frequency Vs O/P voltage and frequency Vs speed on the graph paper.

OBSERVATION TABLE:-

LOAD	V(AC)	A(AC)	V(DC)	A(DC)	R.P.M.