Experiments 07 & 08

Experiment 07: Study of 3-phase full-bridge Inverter for resistive load by operating in 120° and 180° conduction modes.

Objective:

To study the performance of three phase inverter for square wave modulation for 120° and 180° conduction mode for fundamental frequency of 50Hz.

Brief Introduction: Inverter is used to convert DC power to AC power. Three phase inverter has wide application for medium power and high power applications where we need variable voltage variable frequency power supply.

The set up in our laboratory has AC to DC rectifiers and then DC to AC inverters. The ac to dc rectifiers is used to generate dc link voltage. To vary the dc link voltage, we can feed the ac power using three phase autotransformer. The inverter has inbuilt driver Circuit (Skyper32R) in it, which needs the +15V power supply and the gate signal for the switches should have voltage level of 0/15V. The setup has facility that we can give the control signal from the outside which can be generated from dSPACE board. The output of dSPACE board is of TTL logic i.e., 0/5V, so we need to amplify the signal using non inverting amplifier circuit. The non-inverting amplifier (fig.3) circuit needs a ac input of 18-0-18 Volts from center-tapped transformer, to generate the power supply of ±15V which is needed for the non-inverting amplifier circuit. The non-inverting amplifier circuit is given input of 5Volts and it is amplified to the level of 15V. The schematic for the entire setup for three phase inverter is given in the Fig.1.

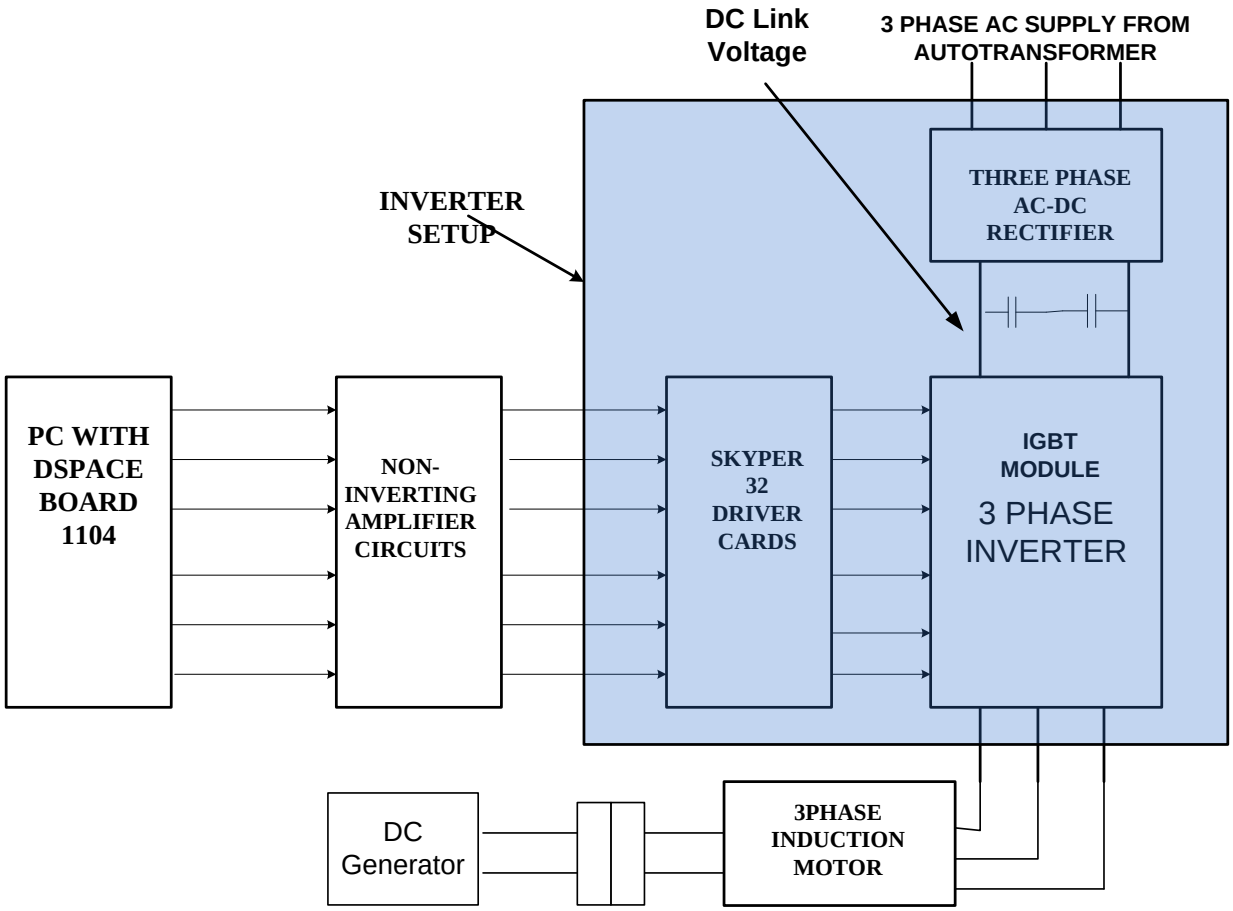

Fig. 1. The schematic for three phase inverter system

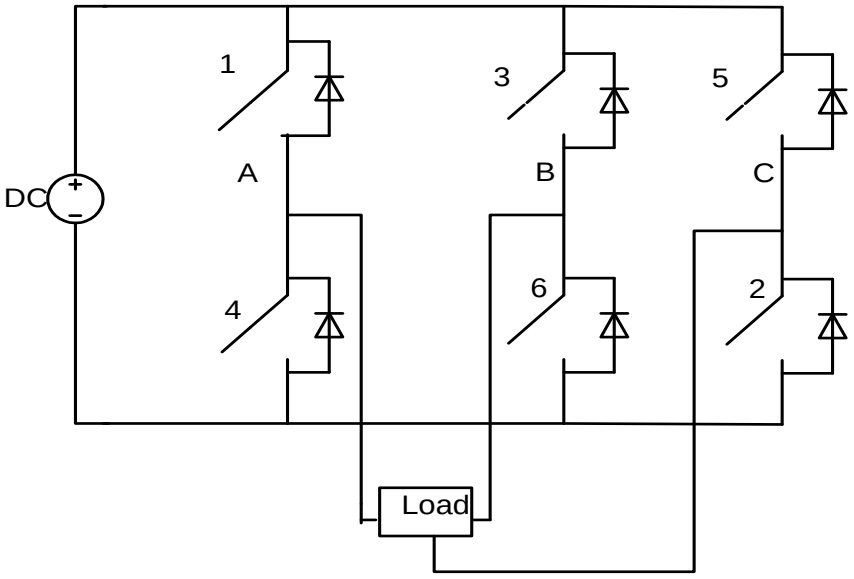

Fig. 2. Circuit diagram for three phase inverter.

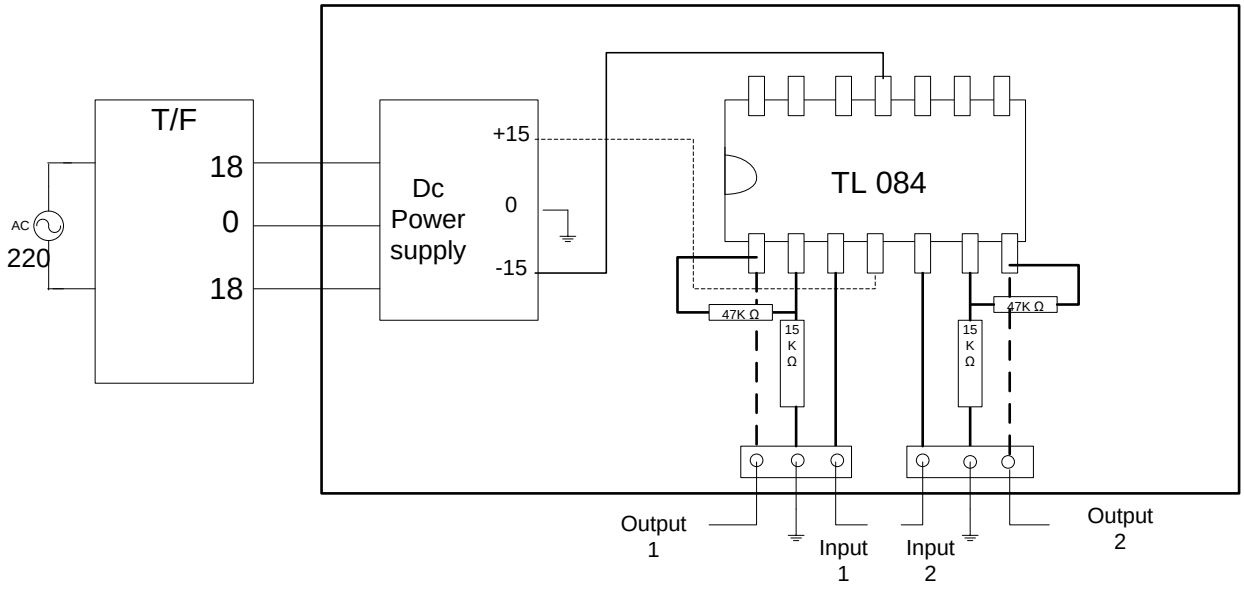

Fig. 3. Non-inverting Amplifier circuit

Procedures:

1. **Generation of Control signal**
    a) Models for Square wave modulation technique for 180° conduction mode and 120° conduction mode technique is developed in different files of Matlab/Simulink environment. And each model is modified according to the need of dSpace1104 board. Each model is simulated one by one to perform the experiments.
    b) Each model will give six gate signals which can be checked at the Digital IO pins.
    c) Ensure that the gate signals corresponding to the switches of the same leg should not be in the ON position simultaneously. Also ensure that the gate signals corresponding to legs A. B and C should be 120° out of phase.

2. **Amplification of the signals from the dspace board**

    a) The six signals for six switches of the inverter should be taken out from the dspace board and should be given to the inputs of the non inverting amplifier circuit. (say for leg A top switch, output of the dSpace board should be given to V_{AT} and for bottom switch give to V_{Ab}. Similarly for other legs)
    b) One board of non inverting amplifier circuit has two amplifier circuits in it (See Fig. 3). It has an inbuilt power supply of ±15V. Two signals for the switches (switches 1 and 4 or 3 and 6 or 5 and 2) of same leg should be given in the same board. The output of the amplifier should be fed to driver circuits. And the same board should be used to give the power supply to the driver circuit (Skyper32). Care should be taken that before switching on the ac power given to the amplifier board, signals from the dSpace board is given to the respective tagged wires of the circuit.

c) One Skyper 32 board is capable to drive the two IGBT of the same module. (see datasheet for skyper 32)
d) If the driver circuit is getting power supply above 13V then Red led will glow. If LED goes off then this indicates that there is some error in the circuit.

3. Handling of Inverters

a) Connect the three phase resistive load to the inverter. Also connect the three phase supply from the auto transformer to terminals marked on the setup. Also provide 220 V ac supply to terminals marked for the fan.
b) Before giving the dc link voltage to the inverter setup first ensure that all the LED of gate driver circuits should be on. And ensure that all the driver circuit should be receiving the amplified control signal is reaching.
c) Then gradually increase the dc link voltage using three phase autotransformer.
d) If everything goes fine then set the dc link voltage at 500 V DC.
e) Note down the phase voltage, line voltages and load current also save the voltages and current waveform of the inverter.
f) If you want to turn off the inverter then you need first switch off the load and then reduce the dc link voltage gradually, then switch off the control signal power supply then stop the simulation.
g) Take the readings in the following tabular form

Observation Table:

120-degree conduction mode				
S.no	V_{RMS} (phase)	V_{RMS} (line)	I_{RMS}	THD %

180-degree conduction mode				
S.no	V_{RMS} (phase)	V_{RMS} (line)	I_{RMS}	THD %

Precautions

1. This experiment should be not be performed if you are not with your shoes on.
2. Get familiar with the different circuit boards before starting with the experiment.
3. Do not touch the live part with your hands, it may be fatal.

4. Before giving power to the circuit be sure that your circuit has been checked by one of the instructors in the lab.
5. Always give the control signal first and then switch on the power supply.
6. Always switch off the power supply first then switch off the control signal otherwise it may damage the switches.

Lab Report

1. Calculate the THD and plot the harmonic spectrum of the voltage waveform for 180^0 and 120^0 techniques.

<u>Experiment 8:</u> Study of 3-phase full-bridge Inverter for induction motor by using SPWM.

Objective:

> **To study the performance of three phase inverter for SPWM technique for 0.4, 0.6, 0.8 and 3.3 modulation index. The frequency modulation index is 21 and fundamental frequency is 50Hz on three phase induction motor as load.**

Brief Introduction: Inverter is used to convert DC power to AC power. Three phase inverter has wide application for medium power and high power applications where we need variable voltage variable frequency power supply.

The set up in our laboratory has AC to DC rectifiers and then DC to AC inverters. The ac to dc rectifiers is used to generate dc link voltage. To vary the dc link voltage, we can feed the ac power using three phase autotransformer. The inverter has inbuilt driver Circuit (Skyper32R) in it, which needs the +15V power supply and the gate signal for the switches should have voltage level of 0/15V. The setup has facility that we can give the control signal from the outside which can be generated from dSPACE board. The output of dSPACE board is of TTL logic i.e., 0/5V, so we need to amplify the signal using non inverting amplifier circuit. The non-inverting amplifier (fig.3) circuit needs an ac input of 18-0-18 Volts from center-tapped transformer, to generate the power supply of ±15V which is needed for the non-inverting amplifier circuit. The non-inverting amplifier circuit is given input of 5Volts and it is amplified to the level of 15V. The schematic for the entire setup for three phase inverter is given in the fig.1.

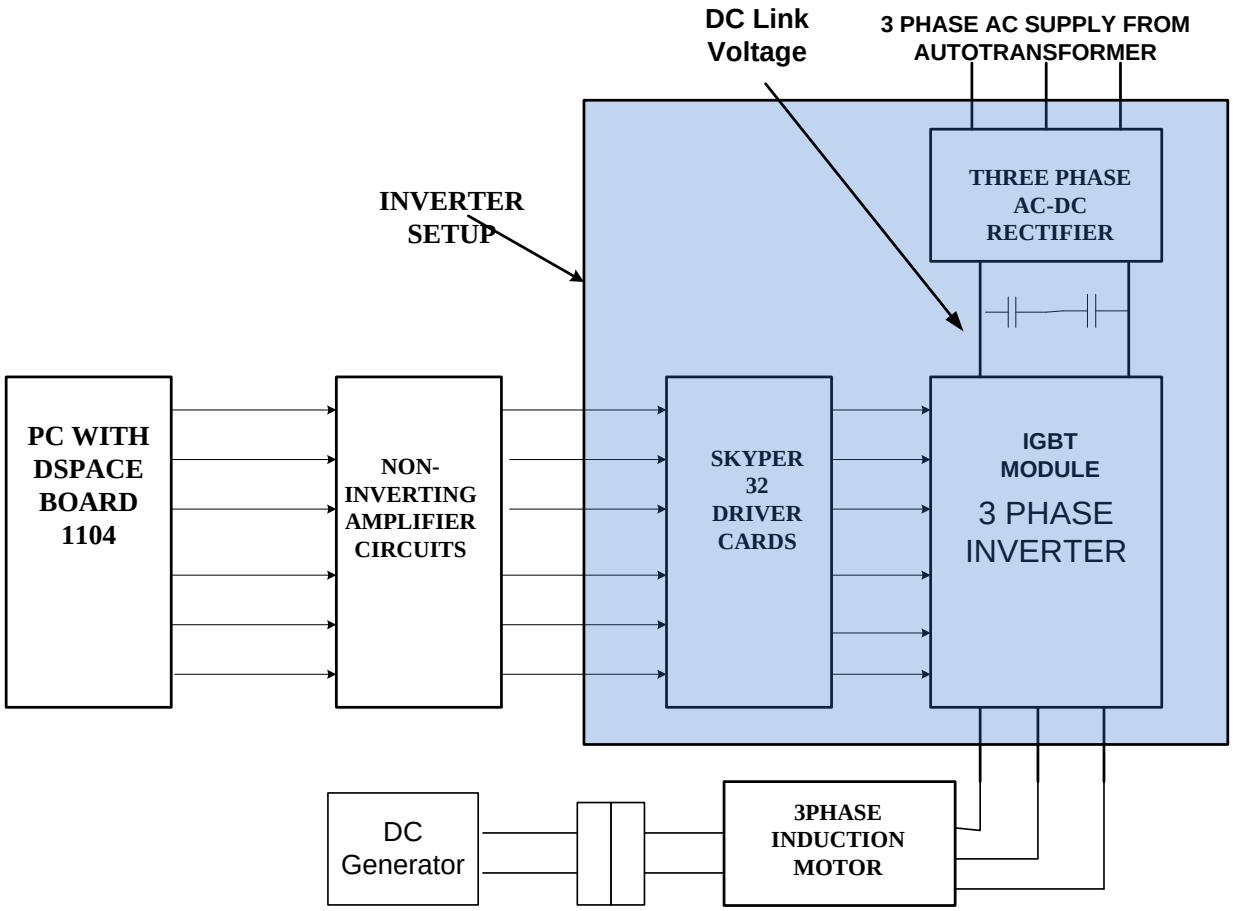

Fig. 1. The schematic for three phase inverter system.

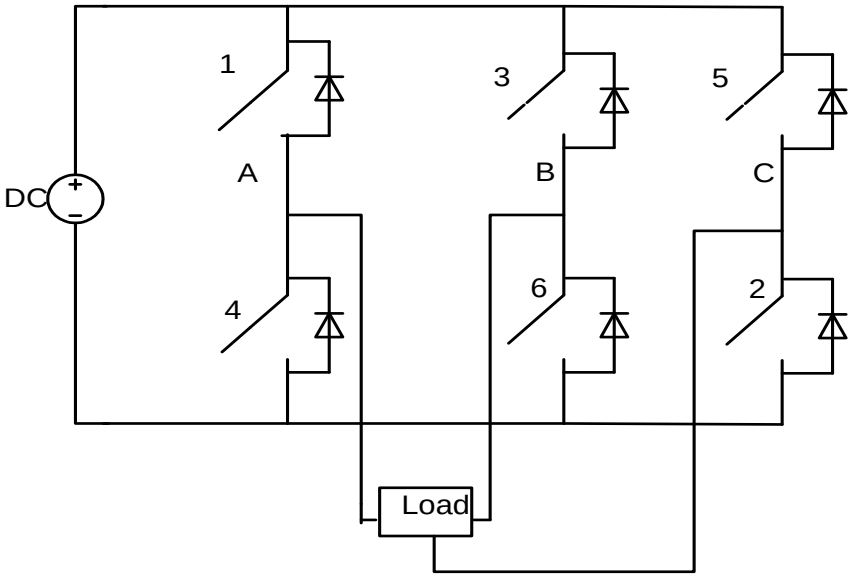

Fig. 2. Circuit diagram for three phase inverter.

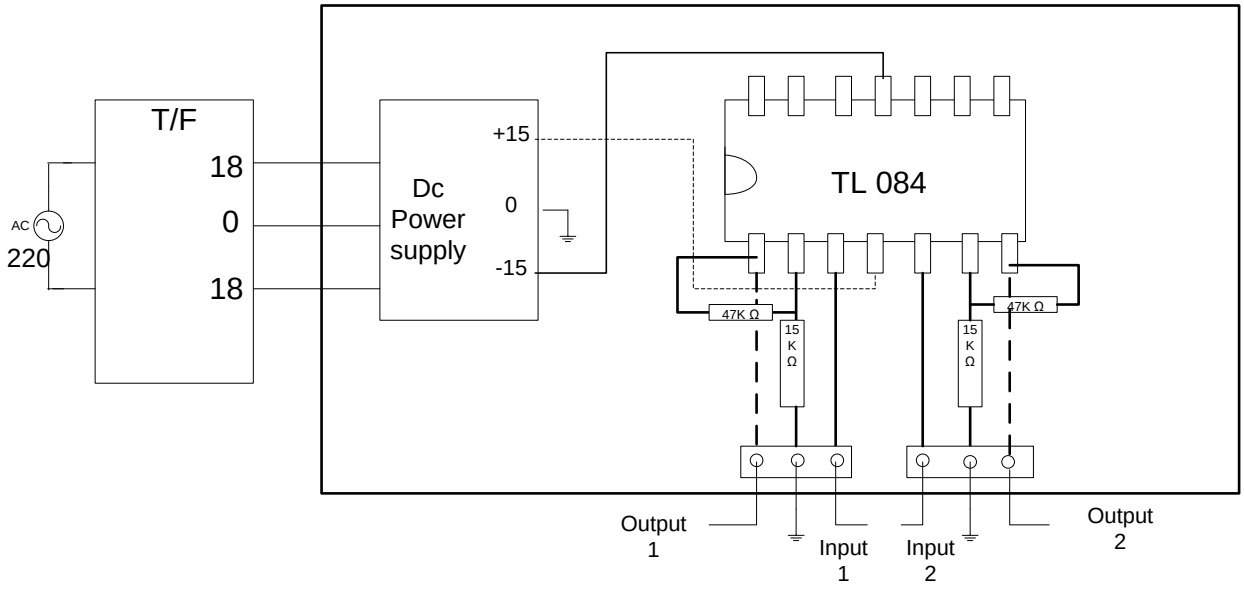

Fig. 3. Non-inverting Amplifier circuit

Procedures:

4. Generation of Control signal

d) First, three models for Square wave modulation technique for Sinusoidal Pulse Width Modulation (SPWM) technique is developed in three different files of MATLAB/Simulink environment. And each model is modified according to the need of dSpace1104 board. Each model is simulated one by one to perform the experiments.

e) Each model will give six gate signals which can be checked at the Digital IO pins.

f) Ensure that the gate signals corresponding to the switches of the same leg should not be in the ON position simultaneously. Also ensure that the gate signals corresponding to legs A. B and C should be 120° out of phase.

5. Amplification of the signals from the dSPACE **board**

e) The six signals for six switches of the inverter should be taken out from the dSPACE board and should be given to the inputs of the non-inverting amplifier circuit. (say for leg A top switch, output of the dSPACE board should be given to V_{AT} and for bottom switch give to V_{Ab}. Similarly for other legs)

f) One board of non-inverting amplifier circuit has two amplifier circuits in it. (see fig3). It has an inbuilt power supply of ±15 V. Two signals for the switches (switches 1 and 4 or 3 and 6 or 5 and 2) of same leg should be given in the same board. The output of the amplifier should be fed to driver circuits. And the same board should be used to give the power supply to the driver circuit (Skyper32). Care should be taken that before switching on the ac power given to the amplifier board,

signals from the dSPACE board is given to the respective tagged wires of the circuit.

g) One Skyper 32 board is capable to drive the two IGBT of the same module. (see datasheet for Skyper 32)
h) If the driver circuit is getting power supply above 13V then Red led will glow. If LED goes off then this indicates that there is some error in the circuit.

6. Handling of Inverters

h) Connect the three phase induction motor load to the inverter. Also connect the three phase supply from the auto transformer to terminals marked on the setup. Also provide 220 V ac supply to terminals marked for the fan. At the DC generator side which is coupled with the motor, connect the field winding to the dc supply at the terminals on the front panel of the table. Also connect a resistive load at the armature of the dc generator.
i) Before giving the dc link voltage to the inverter setup first ensure that all the LED of gate driver circuits should be on. And ensure that all the driver circuit should be receiving the amplified control signal is reaching.
j) Then gradually increase the dc link voltage using three phase autotransformer.
k) If everything goes fine then set the dc link voltage at 500dc Volts and this will make the induction motor to rotate.
l) Now give 220V dc supply to field of the generator coupled with the motor. This will generate the voltage at the armature terminals of the dc generator and now start loading the generator and make the load current of the motor at 5Amps.
m) Note down the phase voltage, line voltages and load current also save the voltages and current waveform of the inverter.
n) If you want to turn off the inverter then you need first switch off the load and then reduce the dc link voltage gradually, then switch off the control signal power supply then stop the simulation.
o) Take the readings in the following tabular form

Observation table

Vdc =
fundamental frequency=
Carrier frequency=

Modulation technique: SPWM				
S.no	Modulation Index	V_{RMS} (phase)	V_{RMS} (line)	I_{RMS}

Precautions

7. This experiment should be not be performed if you are not with your shoes on.
8. Get familiar with the different circuit boards before starting with the experiment.
9. Do not touch the live part with your hands, it may be fatal.
10. Before giving power to the circuit be sure that your circuit has been checked by one of the instructors in the lab.
11. Always give the control signal first and then switch on the power supply.
12. Always switch off the power supply first then switch off the control signal otherwise it may damage the switches.

Lab Report

2. Calculate the THD and plot the harmonic spectrum of the voltage waveform for SPWM techniques.