Experiment: 6

Study of 1-phase full-bridge Inverter

Objectives:

1. **To study unipolar and bipolar SPWM technique for single phase inverter. The amplitude modulation index is 0.4, 0.6, 0.8 and 3.0.**
2. **To study the performance of single-phase inverter for square wave modulation for 180° conduction mode.**

Introduction: The process of conversion of a dc power into an ac power at a desired output voltage and frequency is called an inversion. For low and medium power inverters, gate controlled turn off devices such as power BJT, MOSFET, IGBT, GTO etc. are used. Inverters are used in various applications requiring variable voltage, variable frequency ac supply.

In the lab our setup for single phase inverter is IGBT based. The control strategy i.e., modulation technique, is developed in the MATLAB/Simulink environment and that is interfaced with the dSPACE board1104. The output of the dSPACE board is of TTL level. The IGBT in our setup needs a driver circuit (Skyper 32) whose input voltage level should be of +15Volts. Now to convert the TTL output from the dSPACE board to that level, a non-inverting amplifier circuit is used. The output of the amplifier circuit is given to the driver circuit which in turn generates the required gate signal for the IGBT.

The power switches used here are IGBT and they are in module of two. Each module is suitable for each leg in the inverter circuit. Each driver circuit is capable to handle two switches in a module.

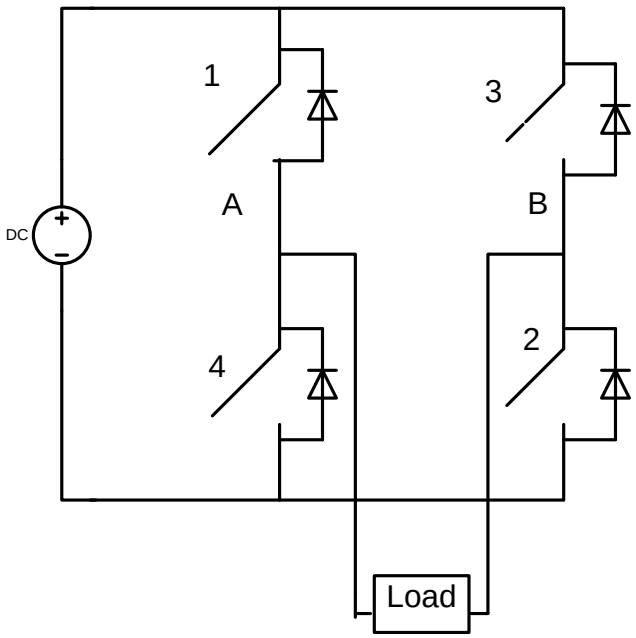

Fig. 1. Circuit diagram of full bridge single phase inverter

Procedures:

The procedure for performing the experiment is categorized as under.

1. **Development of control signal in MATLAB/SIMULINK environment.**
   a. Gate signal for Square wave modulation technique with 180 deg conduction mode should be developed in MATLAB/SIMULINK environment and it should be modified according to dSpace requirements. The frequency for the fundamental voltage should be 50Hz.
   b. Unipolar and bipolar SPWM signal for single phase inverter should also be developed in two different files of the MATLAB/Simulink environment and it should be modified according to the dSpace 1104 board requirements. The frequency for the fundamental should be 50Hz. The Frequency modulation index should be 20 and amplitude modulation index should be 0.4, 0.6 0.8. and 3.1. (The experiment related to it should be carried out once the whole experiment for the square wave modulation is finished.)
   c. Ensure that the gate signals for the switches of the same leg should not be in the ON position simultaneously.
   d. The four signals for four 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.

2. **Amplification of the signals from the dspace board**
    a. One board of non-inverting amplifier circuit has two amplifier circuits in it. (see fig3). It has an inbuilt power supply of ±15V. Two signals for the switches (switches 1 and 4 or 3 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.
    b. One Skyper 32 board is capable to drive the two IGBT of the same module.
    c. 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 inverter circuit.**
    a. Connect the dc link voltage supply and load to the inverter circuit.
    b. Before giving the dc link voltage (which is given through single phase autotransformer fed ac to dc rectifier) to the power circuit first check all the switching signals at the respective gates of the IGBT. It should vary between +15V and -7V.
    c. Now gradually increase the dc link voltage using single phase autotransformer and set the dc link voltage up to 300V. Care should be taken that if any unusual thing happens then the dc link voltage should be made off instantly.
    d. Now observe the voltage across the load using differential probe.
    e. Then Load the inverter gradually and observe the load current using current probes. Load should be RL type. And it should be varied in steps upto 5 Amps of current.
    f. Save the different waveforms of voltages and current.
    g. 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.

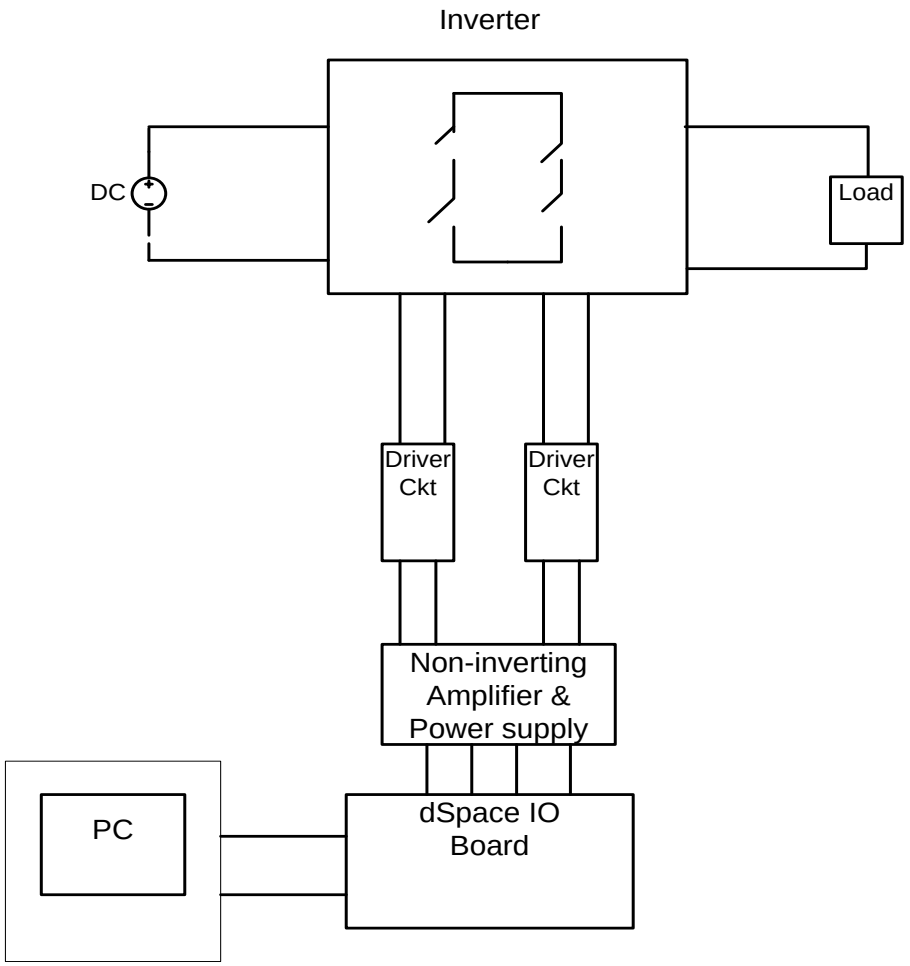

Fig. 2. Configuration for the entire setup for single phase inverter.

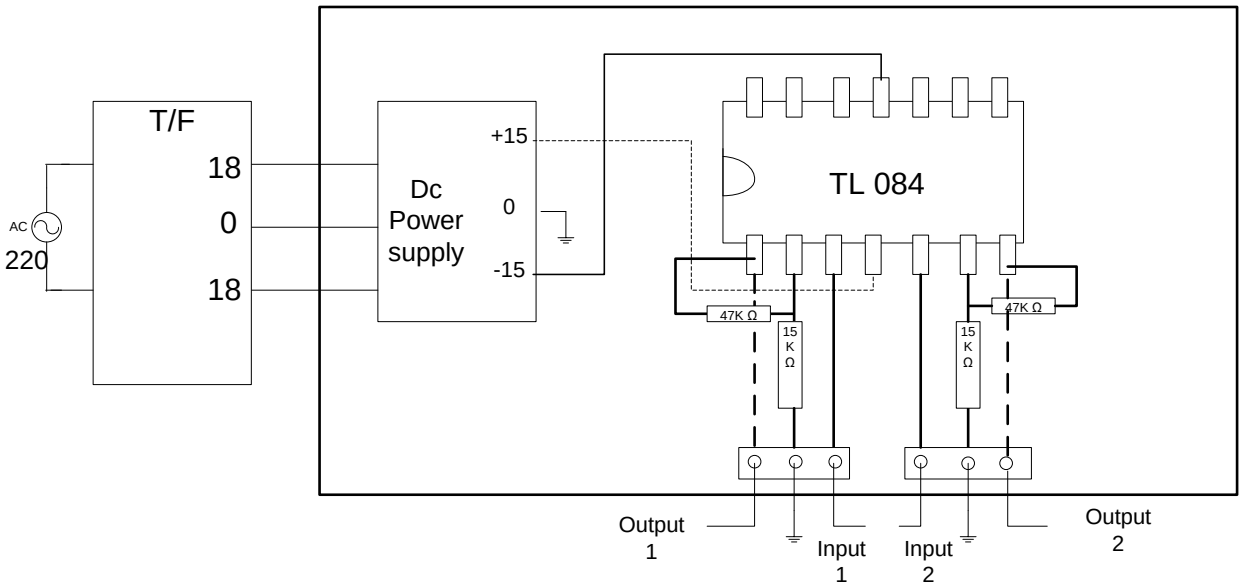

Fig. 3. Details of Non inverting amplifier circuit board.

Take the readings in the following tabular form

Vdc =
Fundamental frequency =
Carrier frequency =

Modulation technique: Bipolar				
S.no	Modulation Index	V_{RMS}	I_{RMS}	

Modulation technique: Unipolar				
S.no	Modulation Index	V_{RMS}	I_{RMS}	

Modulation technique: Square wave 180 deg conduction mode				
S.no	V_{RMS}	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.
7. After performing the experiment discharge the dc link capacitor voltage on a rheostat

Lab Report

1. Calculate the THD and plot the harmonic spectrum of the voltage waveform for unipolar, bipolar and square wave modulation.