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Design and Hardware Implementation of Buck, Boost Converter and Sine Wave Inverter

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Abstract: This project deals with the Design and hardware implementation of buck and boost converter and sine wave inverter. A simulation model of the design of buck and boost converter and Sine wave inverter has been developed, and the results have been compared with those of hardware results of this project. The results show the performance of the buck and boost as well as sine wave inverter for industrial and domestic loads. The simulation results have been further aided and confirmed by experimental results obtained on a hardware prototype of a buck and boost converter fed DC motor drive and Sine wave inverter fed AC load.

I. INTRODUCTION

Nowadays, modern power electronics and drives are used in electrical as well as mechanical industry. The power converter or power modulator circuits are used with electrical motor drives, providing either DC or AC outputs, or working from either a DC (battery) supply or from the conventional AC supply. Here we will highlight the most important aspects which are common to all types of drive converters. Although there are many different types of converters, all except very low-power ones are based on some form of electro An electrical drive can be defined as an Electro mechanical device for converting electrical energy into mechanical energy to impart motion to different machines and mechanics for various kinds of process control.

II. CLASSIFICATION OF CONVERTERS

The converter topologies are classified as

A. Buck Converter

A buck converter is shown in figure. The buck converter is step down converter and produces a lower average output voltage than the dc input voltage.

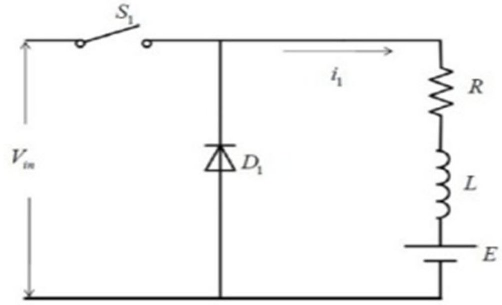

Fig 2.1 Simple Buck Converter circuit

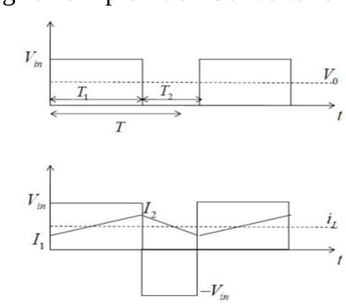

Fig 2.2 Output voltage and current waveform across the load

B. Boost Converter

A boost converter is shown in figure. In a boost converter, the output voltage is always greater than the input voltage.

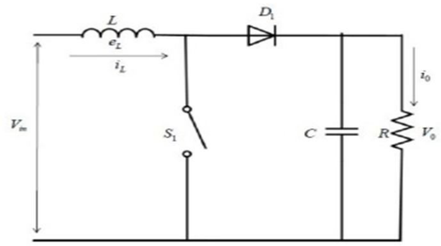

Fig 2.3 Boost converter circuit

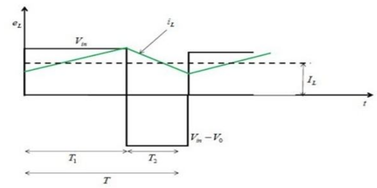

Fig 2.4 Current waveform

C. Buck-Boost Converter

Buck-Boost converter: A buck-boost converter is shown. The output voltage can be either higher or lower than the input voltage.

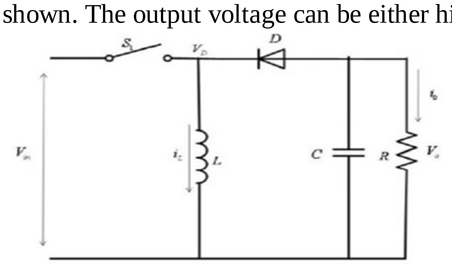

Fig 2.5 simple Buck-Boost Converter circuit

The buck and boost converter is a type of DC-to-DC converter that has an output voltage magnitude that is either greater than or less than the input voltage magnitude. It is equivalent to a fly-back converter using a single inductor instead of transformer.

D. Sine Wave Inverter

An inerter is an electronic device or circuitry that changes direct current (DC) to alternating current (AC).

The input voltage, output voltage and frequency, and overall power handling depend on the design of the specific device or circuitry. The inverter does not produce any power; the power is provided by the DC source.

A power inverter can be entirely electronic or may be a combination of mechanical effects (such as a rotary apparatus) and electronic circuitry. Static inverters do not use moving parts in the conversion process.

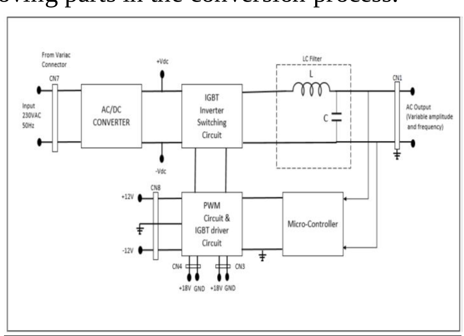

Fig.2.6 Block diagram of the sine wave inverter

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III. EXISTING YSTEM

A. Single-Phase Unidirectional AC/DC Buck Converter Fed DC Motor Drive

DC motors with their limited yet indispensable applications in electric traction, vehicles, and other high starting torque applications, call for the design of modern DC motor drives which not only provide a wide range of speed control but also cater to the power quality constraints that a power system puts forth. However, conventional phase controlled converters used for exercising control over the speed of DC motors often introduce harmonics in the source current besides imparting a poor input power factor.

B. Single Phase Variable Voltage Variable Frequency Pure Sine Wave Inverter

Energy is stored in form of Direct Current (DC) so inverter is required. An inverter device coverts DC into AC. Single phase inverter and three phase inverter are two types of inverters. Single phase inverter has again classified as half bridge and full bridge inverter. Square wave, modified sine wave and pure sine wave are single phase inverter techniques. Square wave and modified-sine wave inverter has strong power harmonics and low quality AC output. Pure sine wave inverter generates good quality AC power and has less harmonic distortion. So the single phase pure sine wave inverter is design and implemented

C. Three-Phase Improved Power Quality AC–DC Converters

Three-phase ac–dc conversion of electric power is widely employed in adjustable-speeds drive (ASDS), uninterruptible power supplies (UPSS), HVDC systems, and utility interfaces with nonconventional energy sources such as solar photovoltaic systems (PVS), etc., battery energy storage systems (BESSS), in process technology such as electroplating, welding units, etc., battery charging for electric vehicles, and power supplies for telecommunication systems traditionally, ac–dc converters, which are also known as rectifiers, are developed using diodes and thyristors to provide controlled and uncontrolled unidirectional and bidirectional dc power.

various applications are available like

1) Three phase improved power quality ac to dc converter.
2) Single phase closed loop pure sine wave inverter.
3) Pure sine wave inverter for PV Applications.

IV. PROBLEM FORMULATION

A. Problem with DC Drives

DC motors with their limited yet indispensable applications in electric traction, vehicles, and other high starting torque applications, call for the design of modern DC motor drives which not only provide a wide range of speed control but also cater to the power quality constraints that a power system puts forth. However, conventional phase controlled converters used for exercising control over the speed of DC motors often introduce harmonics in the source current besides imparting a poor input power factor

B. Problems with Motor Drives

The use of motors has increased tremendously since the day of its invention. They are being used as actuators in various industrial processes, robotics, house appliances and other similar applications. The reason for its day by day increasing popularity can be primarily attributed to its robust construction, simplicity in design and cost effectiveness. Speed control is one of the application imposed constraints for the choice of a motor. Out of all the speed control mechanisms, the Volts/Hertz control scheme is very popular because it provides a wide range of speed control with good running and transient performance. This control mechanism is referred to as sclar control mode

C. Traditional Methods

1) Voltage Source Inverter: The traditional adjustable speed drives system is based on the voltage source inverter (VSI), which consists of a diode rectifier front end, dc link capacitor, and an inverter bridge. VVI is the simplest adjustable frequency drive and most economical. However, it has the poorest output waveform. It requires the most filtering to the inverter

2) Current Source Inverter (CSI): AC current transformers are used to adjust the controlled rectifier. Input converter is similar to the VSI drive. A current regulator presets DC bus current. The inverter delivers six step current frequency pulse, which the voltage waveform follows. Switches in the inverter can be transistors, SCR thyristors or gate turnoff thyristors (GTOs).

V. PROBLEM SOLVING

To overcome all the above disadvantages, we are going to design a new model which is helpful in controlling of both ac and dc drives in industrial and domestic applications in the aspects like speed control with help of buck, boost converter and Sine wave inverter.

A. Operation

The block diagram as drawn consists of a single DC source, a Buck converter, a Boost converter and a sine wave inverter. The basic concept of the project is to run the loads provided by using a single DC source. So a 12v battery is used as the source for the equipment. The converters used in the project are made to change over manually i.e., for charging a mobile or a 5v battery the buck converter is operated, for running a DC drive the boost converter is connected and to use for domestic appliances such as an LED lamp as used in the project. The battery is connected to buck converter that is used to step down the voltage fed from the battery source. This stepped down voltage is now used to run any applications within the output range i.e., 5V. Whenever the battery output is connected to boost converter, the voltage will raise to a maximum value i.e., up to 22V which can be used to run a low rated DC drive. If the range of boost converter is further increased, we can increase the load rating. So as to run the AC load, a sine wave inverter is being used. This sine wave inverter has a DC input of 12V which will be then converted to AC 230V with low current rating that can be used to run home appliances like LED la etc., in order to utilize maximum power, the sine wave inverter rating has to be manipulated with respect to the load requirement. The output from sine wave inverter can be used in turn to recharge the supply battery through a capacitor filter.

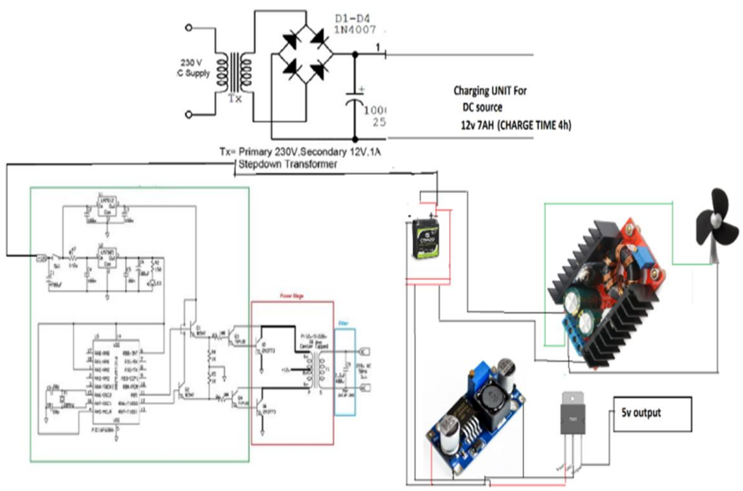

Fig 5.1 Schematic diagram

B. Hardware Implementation

The main motivation behind this project is to design a prototype that is introduced by conventional converter based drives providing a wide range of speed control. For this purpose, a Buck and Boost Converter model, which generates voltages lower or greater than the input voltage at its output, is an obvious choice for speed control. To more clearly distinguish the inverters with outputs of much less distortion than the modified sine wave (three step) inverter designs, the manufacturers often use the phrase pure sine wave inverter. Almost all consumer grade inverters that are sold as a "pure sine wave inverter" do not produce a smooth sine wave output at all, just a less choppy output than the square wave (two step) and modified sine wave (three step) inverters. However, this is not critical for most electronics as they deal with the output quite well. Where power inverter devices substitute for standard line power, a sine wave output is desirable because many electrical products are engineered to work best with a sine wave AC power source Sine wave inverters with more than three steps in the wave output are more complex and have significantly higher cost than a modified sine wave, with only three steps, or square wave (one step) types of the same power handling. Switch-mode power supply (SMPS) devices, such as personal computers or DVD players, function on quality modified sine wave power. AC motors directly operated on non-sinusoidal power may produce extra heat, may have different speed-torque characteristics, or may produce more audible noise than when running on sinusoidal power.

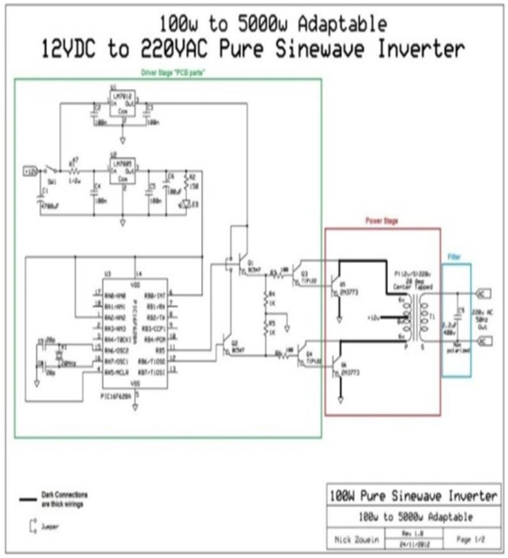

Fig. 5.2 Circuit diagram of Sine Wave Inverter

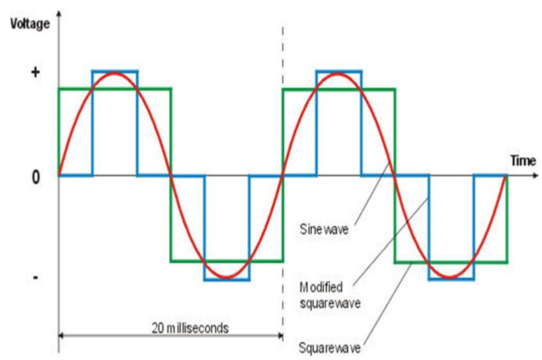

Fig. 5.3 Output wave form of Modified sine wave

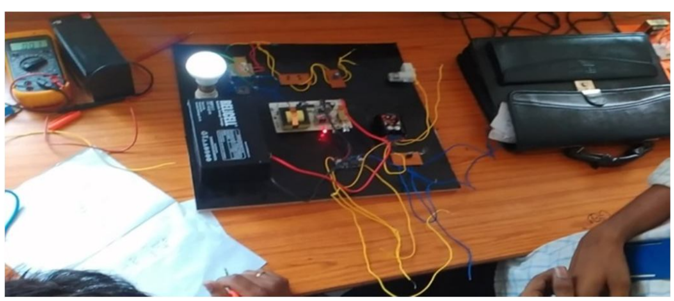

Fig. 5.4 Driving AC load using a DC source through Sine wave inverter

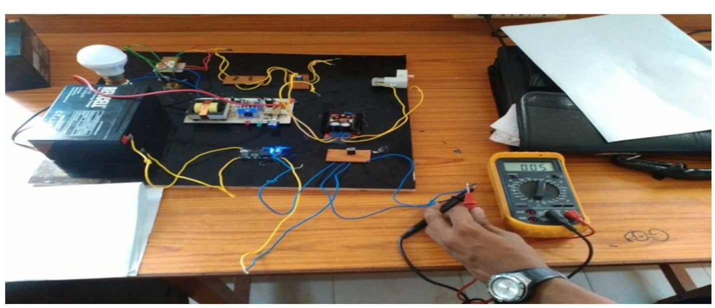

Fig. 5.4 Driving AC load using a DC source through Sine wave inverter

VI. RESULTS

The boost converter used in the project gives an output voltage of 22V which can be used for running small dc motor and other conventional applications

The buck converter gives an output of 4.9v which can be used for charging the mobile and batteries etc.,

The sine wave inverter used converts 12v DC supply to 230v AC output. The 230v supply can be used for any domestic applications like lighting purposes and other home appliances

Table 6.1 Hardware output results:

Hardware Parameter	Input voltage	Output Voltage
Boost converter	12V DC	22V DC
Buck converter	12V DC	5V DC
Sine wave inverter	12V DC	230V AC

VII. CONCLUSION

The industrial and domestic loads can be effectively operated with the help of conventional methods such as Buck, Boost converters and sine wave inverter. In this project, we had designed and implemented a DC-DC converter i.e., a buck converter and a boost converter is for DC drives here we are using a 12V DC shunt drive.

VIII. FUTURE SCOPE

This project can be implemented for better usage of the industrial and domestic loads with the help of soft computing techniques such as neural network, fuzzy logic and traditional algorithms to improve its performance. By the usage of a micro controller at DC load end, the swapping for buck and boost converter can be made easily without manual interference with respect to load. Similarly, by using a controller at source side, load equalization can be made irrespective of changes in load at any end i.e., either AC or DC.

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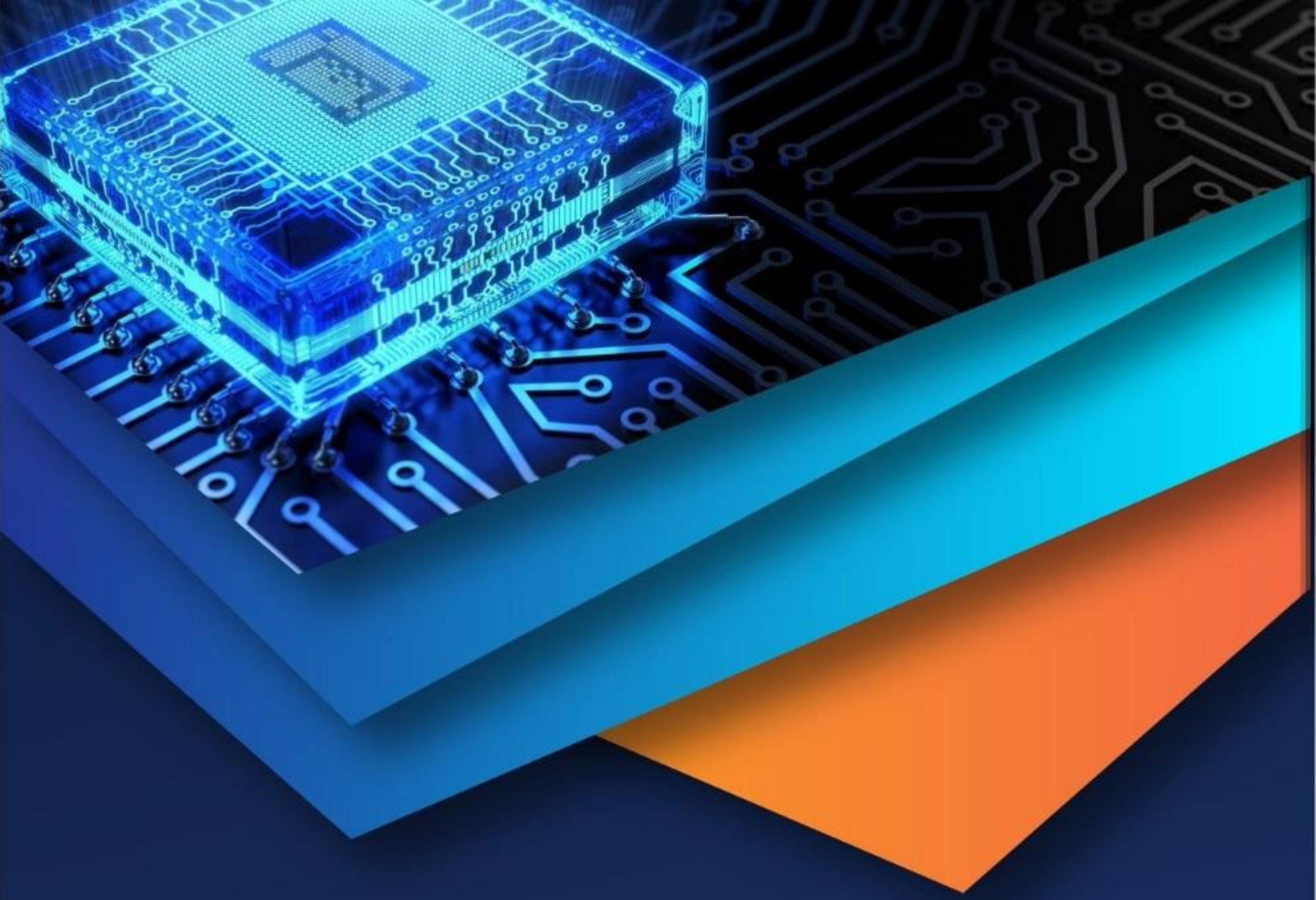

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