AC-DC-AC DUAL CONVERTER IN THE EXISTING LOAD

Aswin Thomas Joseph[1], A. Nalini[2], E. Sheeba Percis[3] and L. Madheshwaran[4]

[1]*PG Scholar*

[2,3]*Professor- Electrical and Electronics Engineering*

[4]*Product Engineer- Dr. APJ Abdul Kalam COE*

Dr. M.G.R Educational and Research Institute, Maduravoyal, Chennai-600095, India

Abstract: *The greatest danger to the earth in the last 20 years has been the global warming phenomenon. An International agreement was reached to combat global warming and make up for the insufficient production of electrical power by boosting the use of Renewable Energy Sources (RES). Improved modulation and control methods for the used converters are still needed, as the necessity to combine energy storage devices with renewable energy sources.*

Low DC output voltage is characteristic of contemporary electrical devices. The utility's alternating current supply needs to be transformed and stepped down to a suitable DC voltage. In the past, converters were large and expensive. Size and cost were greatly reduced because to the invention of the switch mode power supply. This goal is attained via boosting power density, which is done by shrinking the size of passive/energy storage components like inductors, capacitors and transformers. The entire power system needs to be operated at high efficiency in order to make greater use of the available electric energy.

The demand for electricity has recently increased. Some existing products consume a high load of electricity, resulting in demand and electricity production. We are becoming smarter by purchasing the latest energy-saving devices and consuming less load by paying more money. However, we are simply wasting and discarding the existing product. So, a solution to reduce the high load to a low load in the existing device.

The uniqueness of the idea and future product will aid in lowering the high load consumption in heavy load appliances by simply adding this small device to existing electrical products. It balances the load based on the appliances' requirements and rated current. From a practical standpoint, the AC/DC/AC converter's implementation has been discussed.

Keywords: **AC to DC Converter, DC to AC Converter, Transformer and Output Waveform.**

1. INTRODUCTION

Currently, there is an increasing demand for efficient systems whenever we discuss electricity consumptions, and in order to meet those needs, engineers have been developing efficient conversion strategies as well as being capable of designing circuits with high

performance. Nonetheless, technology in this discipline is constantly improving in response to new and challenging situations.

The conversion of electrical power is a remarkable field of electrical engineering. Power electronics is the use of solid-state devices to control and transform electricity.

There are various linear component types, including inductors, transformers and capacitors, which are used for current and voltage filtering as well as intermediate energy storage. These elements are primarily responsible for determining the converter's size, weight and price. But alternating current (AC) or direct current (DC) can be used as a classification for power conversion systems (DC). One of the often-utilized conversions in power electronics systems is from Alternative Current (AC) to Direct Current (DC). The rectifier's key characteristic is that it must manage the output current (load). The rectifier's output is then connected to the filter following that. As is common knowledge, a filter is nothing more than advice that transforms unidirectional ac voltage back into pure dc voltage by filtering away ripples. The circuit uses both an inductor and a capacitor as filters. The most common filter is a capacitor. Theoretically, using a high voltage capacitor with an output voltage of around 150% is advised to reduce ripple and provide a smooth graph. We are using a 230V/50Hz AC supply that is connected to a step-down transformer, which steps down and provides a DC voltage based on the transformer rating. The rectifier circuit then transforms the AC to pulsing DC and we connect a capacitor after that (filter). Then it transforms the pulsing AC into pure DC. Today's electrical power disruptions are driving the need for extremely reliable and efficient DC to AC inverters, to transform DC output from renewable energy systems, storage batteries and green and solar energy sources into completely sinusoidal steady AC. Due to its simple nature, low cost of energy conversion and minimal complexity, this method of collecting electrical is preferred. Later, this transformed energy can be injected into the grid or utility supply on a big scale for load balancing purposes as well.

2. LITERATURE SURVEY

Electrical circuits called AC-DC converters transforms the alternating current (AC) input into direct current (DC) output. They are utilised in power electronic applications where a 50Hz/60Hz sine-wave AC voltage input needs to be converted into power for a DC output. In our daily lives, whether at home, at work, or in a mechanical setting, we use control electronic converters. Due to their great power handling capacity and higher efficiency, converters are now a standard component of industrial electric drives, power supply and other automotive equipment.

The main purpose of the converter is to offer power that is customised for a particular application. Electric current that occasionally reverses direction is known as alternating current (AC). Sinusoidal, Square, Complex, and Triangular waves are the four types of variable AC wave shapes that are used commercially. Rectification is the term used to describe the process of changing AC current to DC current. Alternating current is used in our home, but it is not always possible to use it everywhere. On occasion, we must change this into a direct current source. An AC to DC converter is referred to as a "rectifier". By permitting the signal to travel in only one direction, the circuit transforms an alternating current signal into a direct current signal.

The power in electrification systems that are employed have three different types of power converters: AC-DC converters (rectifiers), DC-DC converters, and DC-AC converters (inverters). A lower power DC-AC inverter or a DC-DC converter is needed for auxiliary units

such pressure pumps, air conditioners, and auxiliary batteries. A DC-AC power converter changes a DC input voltage into an AC output voltage with the necessary magnitude and frequency. In many commercial, home and industrial applications, such as the renewable energy system (RES), motor drives system (MDS), and uninterruptible power supply (UPSs). To function as a forced-commutated rectifier, the AC-DC converter must act as a voltage boost. AC power is more effective, dependable and frequently used.

The DC output voltage of contemporary electrical equipment is low. A suitable DC voltage must be created by converting and stepping down the utility's alternating current supply. At one time, converters were quite expensive and very large. Size and cost were significantly reduced because to the invention of the switch mode power supply. This goal is attained via boosting power density, which is done by shrinking the size of energy-storage passive components like inductors, capacitors, and transformers. The current use of various types of converters stems from the need for the entire power system to operate at high efficiency in order to make greater use of the available electric energy.

3. WORKING PRINCIPLE

An electrical or electromechanical device designed specifically to convert one set of electrical characteristics (voltage, current, or frequency) at the input to another set of values at the output is known as a converter.

A device that changes an AC voltage into a DC voltage is called an AC-DC converter. One of the most crucial components in power electronics is the AC to DC Converter. This is due to the fact that many real-world applications rely on these transformations.

Rectification is the process of converting AC current to DC current. At the load end connection, the rectifier will change the AC supply into a DC supply. The inverter handles the reverse process. Rectification is the name given to the process since it "straightens" the current's direction. Similar to this, transformers are frequently used to modify AC sources to lower the voltage level for improved DC supply functioning range.

A power electrical device called a converter is used to change DC into AC. These devices make use of switches. DC to AC conversions from 12V, 24V, and 48V to 110V, 120V, 220V, 230V, and 240V with supply frequency 50Hz or 60Hz can be carried out.

Changing a DC power supply to an AC power supply is the main purpose of DC to AC converters. In this context, a DC power source is a relatively steady source of positive voltage while an AC power source oscillates around a base voltage of 0V, often in a sinusoidal, square or mode.

A battery's voltage source is converted into an AC signal using the typical inverter technique used in electronics. They typically run on 12 volts and are employed in a variety of applications, including those related to lead-acid technology, automotive, and solar systems.

An inverter's basic circuit consists of a switch and a transformer coil arrangement. In order to fast oscillate back, a conventional transformer can be linked to the input of the DC signal through a switch.

Because the primary coil of the transformer's current flow is bidirectional, an alternating current signal is output throughout the secondary coils.

An inverter circuit's principal purpose is to produce oscillations with the desired DC and apply them to the transformer's primary winding by raising the current. Based on the number of twists in the main and minor coils, this primary voltage is then increased to a high voltage. These can be used to send power to loads in dc transmission lines.

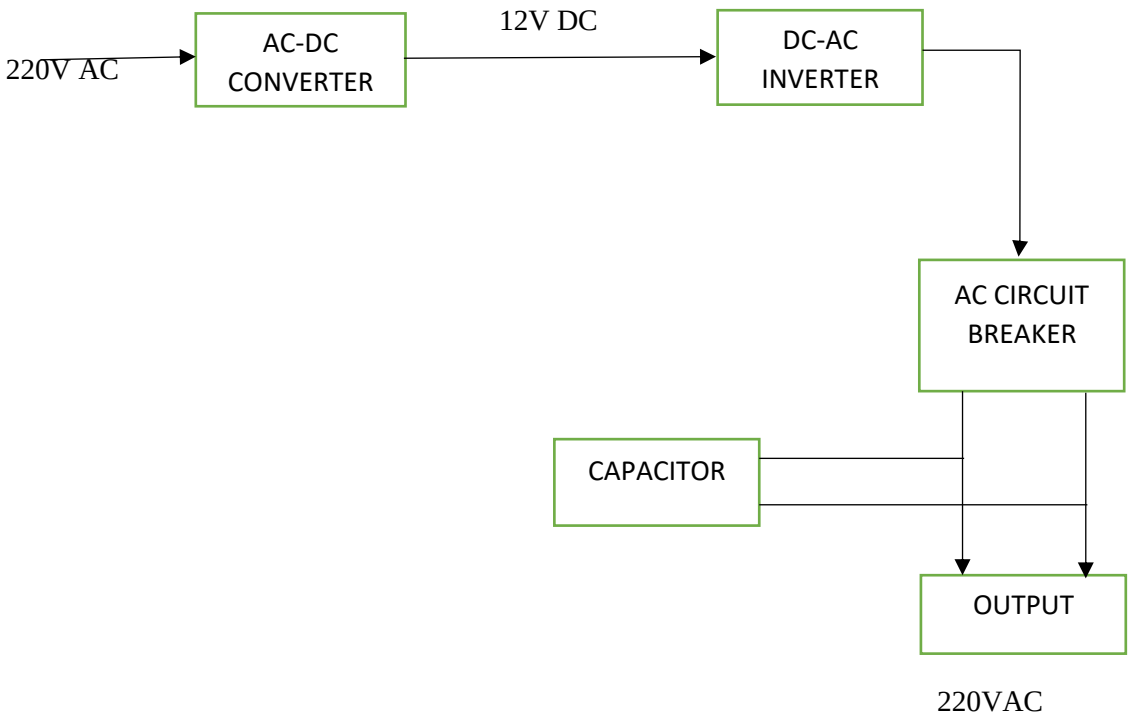

Fig 3.1 Working of the Project

Main components used in AC-DC-AC Conversion:

3.1. Transformer:

A transformer is a passive part that moves electrical energy from one electrical circuit to another electrical circuit or to several electrical circuits. The electromotive force (EMF) across any other coils wound around the same core will change as a result of a changing magnetic flux caused by a changing current in any one of the transformer's coils. A metallic (conductive) link between the two circuits is not necessary for the transfer of electrical energy between distinct coils.

Depending on the load in the system, this steps up or down the grid power to a useful value. The output voltage and current to the diode bridge and capacitor are determined by the transformer turns ratio.

3.2. Bridge Diode Rectifier:

A diode bridge is a bridge rectifier circuit made up of four diodes that is used to convert alternating current (AC) from the input terminals to direct current (DC) on the output terminals.

Its purpose is to change the negative AC pulses into positive pulses, which may then be smoothed into DC via a low-pass filter.

It is referred to as a bridge rectifier when used in its most typical application, which is to convert an alternating-current (AC) input into a direct-current (DC) output. In comparison to a rectifier with a three-wire input from a transformer with a center-tapped secondary winding, a bridge rectifier offers full-wave rectification from a two-wire AC input, which results in a cheaper cost and weight.

3.3. Capacitor:

A capacitor is made up of two conductors and a non-conductive area. A vacuum or an electrical insulator substance known as a dielectric might serve as the non-conductive zone.

The rectified AC signal is stabilised using a big capacitor, which also serves as a filter to create a DC voltage with some residual ripple. The best component to ensure a high charge capacity and quick discharge rate is a larger capacitor with a reduced effective series resistance.

3.4. Resistor:

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. Resistors have a variety of functions in electronic circuits, including lowering current flow, adjusting signal levels, dividing voltages, biassing active components and terminating transmission lines.

Resistors are widely used in electronic devices and are common components of electrical networks and electronic circuits. Practical resistors can be made of a variety of materials and forms when used as discrete components. The integrated circuits incorporate resistors as well.

3.5. Battery:

A battery is a type of electric power source that consists of one or more electrochemical cells with external connections that may be used to power electrical equipment. When a battery is delivering electricity, the positive terminal is referred to as the cathode, and the negative end is referred to as the anode.

Primary batteries, sometimes known as primary cells, may generate current immediately after being assembled. These are most typically employed in portable devices with minimal current draw, that are only used occasionally, or that are utilised far away from a backup power source.

Secondary batteries, also known as secondary cells or rechargeable batteries, must be charged before they may be used for the first time. They are typically constructed using discharged active materials.

4. METHODOLOGY

Voltages must sometimes be increased, when sending power over long distances. Similarly, voltages must be reduced for equipment that consumes less power. Step-up transformers are used to increase the voltage levels, while step-down transformers are used to decrease the voltage levels.

At the load end connection, the rectifier converts the alternating current supply into a direct current supply. The input alternating current power is rectified to produce direct current power. The issue is that DC output power is comprised of pulses and is not pure DC.

The pulsing DC must be transformed into pure DC. Most of the circuit relies on capacitors to accomplish it. As the input voltage rises from zero to its maximum value, the capacitor is used to store energy. As the input voltage falls from its highest value to zero, the capacitor's energy can be released. So, using this charging and discharging of the capacitor, we can transform the pulsing DC into pure DC.

5. CONCLUSION

By this process of innovation, the inverter and converter method are combined together in a single device. The AC current 220V is converted to 12V DC by rectification process and the converted 12V DC is step up and again converted to 220V AC. This implementation method helps to reduce at least 10% of input load compared to the output load in the high current consuming existing devices. It saves the electricity and reduces the demand in future.

Fig.5.1 Developed Prototype

ACKNOWLEDGMENTS:

My Project Advisors Dr. E. Sheeba Percis, Dr. A. Nalini and Er. L. Madheshwaran made it possible for me to complete this work. I would like to express my gratitude to them. I was able to complete this assignment at all levels because to their ideas, involvement, efforts and counsel.

REFERENCES

[1] Design and Construction of a 12v DC to 230v AC Power Inverter: C A Quarcoo, B K Banini, Henry Kwame Obeng.

[2] A Review of DC-AC Converters for Electric Vehicle Applications: Khairy Sayed- Department of Electrical Engineering, Faculty of Engineering, Sohag University, Sohag 82524, Egypt;, Abdulaziz Almutairi- Department of Electrical Engineering, College of Engineering, Majmaah University, Al Majma'ah 11952, Saudi Arabia;, Naif Albagami- Department of Electrical Engineering, College of Engineering, Majmaah University, Al Majma'ah 11952, Saudi Arabia;, Omar Alrumayh- Department of Electrical Engineering, College of Engineering, Qassim University, Unaizah 56452, Saudi Arabia, Ahmed G. Abo-Khalil- Department of Sustainable and Renewable Energy Engineering, College of Engineering, University of Sharjah, Sharjah P.O. Box 27272, United Arab Emirates and Hedra Saleeb- Electrical Department, Faculty of Technology and Education, Sohag University, Sohag 82524, Egypt.

[3] Study of AC to DC Converter: Sayed Mahmud, Anika Bushra, Tamanna Sumaiya, Hossain Md Arafat, Rahman Md Asiqur.

[4] Implementation and Control of an AC/DC/AC Converter for Double Wound Flywheel Application: J. G. Oliveira,1 H. Schettino,2 V. Gama,2 R. Carvalho,2 and H. Bernhoff- Division for Electricity, Uppsala University, 751 05 Uppsala, Sweden 2Electrical Engineering Department, Federal University of Juiz de Fora, 36036-900 Juiz de Fora, MG, Brazil.

[5] Modulation and Control of a DC-AC Converter with High-Frequency Link Transformer for Grid-Connected Applications: Mahmoud A. Sayed- Department of Electrical Power and Machines Engineering, Faculty of Engineering, South Valley University, Qena 83523, Egypt, T. Takeshita- Dept. of Electrical and Mechanical Engineering, Nagoya Institute of Technology, Japan, Atif Iqbal- Dept. of Electrical Engineering, Qatar University, Doha, Qatar, Zuhair Muhammed Alaas- Electrical Engineering Dept., Jazan University, Saudi Arabia, M. M. R. Ahmed- Electrical Engineering Dept., Jazan University, Saudi Arabia, Sherif M. Dabour- Department of Electrical Power Eng., Faculty of Engineering, Tanta University, Tanta 31111, Egypt.

[6] Rashid, M. H.(2008). Power Electronics - Circuits, Devices and Applications. New Jersey, U.S.A: PearsonEducation.

[7] Luo, F.; Ye, H. Advanced DC/AC Inverters: Applications in Renewable Energy (Power Electronics, Electrical Engineering, Energy, and Nanotechnology; CRC Press: Boca Raton, FL, USA, 2017.

[8] Babaei, E.; Gowgani, S. Hybrid multilevel inverter using switched capacitor units. IEEE Trans. Ind. Electron. 2013, 61, 4614–4621.

[9] Sanchis, P.; Ursúa, A.; Gubía, E.; Marroyo, L. Design and experimental operation of a control strategy for the buck-boost DC-AC inverter. IEE Proc. Electr. Power Appl. 2005, 152, 660–668.

[10] Almazan, J.; Vazquez, N.; Hernandez, C.; Alvarez, J.; Arau, J. A comparison between the buck, boost, and buck-boost inverters. In Proceedings of the IEEE VII International Power Electronics Congress, Acapulco, Mexico, 15–19 October 2000; Volume 2000, pp. 341–346.

[11] Caceres, R.; Barbi, I. A boost DC-AC converter: Analysis, design, and experimentation. IEEE Trans. Power Electron. 1999, 14, 134–141.

[12] BK Banini, GK Quashigah, BE Mensah, M. Obeng (2016). Designed power inverter producing 240V AC output. Merit Res. J. Eng. Pure and Appl. Sci. Vol. 4(1) pp. 001-003, September.

[13] Y. Fujishima, W. Kitagawa, and T. Takeshita, "Discharge operation of single-stage buck bi-directional ac/dc converter," in Future Energy Electronics Conference (IFEEC), 2013 1st International, pp. 12–17, Nov 2013.

[14] B. Veerasamy, W. Kitagawa, and T. Takeshita, "Input power factor control of bi-directional ac/dc converter," in Power Electronics and Drive Systems (PEDS), 2013 IEEE 10th International Conference on, pp. 1103–1108, April 2013.

[15] M. A. Sayed, K. Suzuki, T. Takeshita, and W. Kitagawa, "PWM switching technique for three-phase bidirectional grid-tie dc-ac-ac converter with high-frequency isolation," IEEE Transactions on Power Electronics, vol. 33, pp. 845–858, Jan 2018.

[16] S. A. Q. Mohammed and J. -W. Jung, "A State-of-the-Art Review on Soft-Switching Techniques for DC-DC, DC-AC, AC-DC, and AC-AC Power Converters," in IEEE Transactions on Industrial Informatics, 2021.