ISSN: 2278-4632
Vol-12 Issue-01 No.01: 2022

# DESIGN OF OZONISED AIR PURIFICATIONSYSTEM WITH VOLTAGE MULTIPLIER CIRCUIT

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**Abstract:** The Paper is designed to develop a voltage multiplier circuit for step up of voltage from a supply source of 230V AC based on ozonized air purification system. The indoor environment is affected by pollutants, such as gases and particles. Pollutants can be removed from the indoor environment in various ways. Air-cleaning devices are commonly marketed as benefiting the removal of air pollutants and, consequently, improving indoor air quality. So this project is used for air pollution control particularly for removing particles from waste gases at industrial facilities and power-generating stations High voltage DC is indispensable for testing of dielectric strength of different electrical appliances and equipment's. In this project, single phase AC to high voltage DC generation circuit is developed. Ladder network of capacitors and diodes on the basics of Cockcroft–Walton circuit is used for generation of high DC voltage.. Temperature and short circuit current protection feature is added to the designed circuit. Therefore, if the high voltage generation circuit exceeds a 0temperature range or occur a short circuit then the system will disconnect the input source and save from possible damage to the system. Consequently, the designed circuit will be reliable and save.

**Keywords:** Multiplexer, Spark filter, Step up transformer, High voltage converter.

## I. Introduction

The Cockcroft–Walton (CW) generator or half wave voltage doubler is an electric circuit that generates a high DC voltage from a low-voltage AC or pulsing DC input. It was named after the British and Irish physicists John Douglas Cockcroft and Ernest Thomas Sinton Walton, who in 1932 used this circuit design to power their particle accelerator, performing the first artificial nuclear disintegration in history. They used this voltage multiplier cascade for most of their research, which in 1951 won them the Nobel Prize in Physics for "Transmutation of atomic nuclei by artificially accelerated atomic particles". Less well

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known is the fact that the circuit was discovered much earlier, in 1919, by Heinrich Greinacher, a Swiss physicist [2], [10]. For this reason, this doubler cascade is sometimes also referred to as the Greinacher multiplier. Cockcroft–Walton circuits are still used in particle accelerators. They also are used in everyday electronic devices that require high voltages.

## II. Conventional methods for high voltage DC generation

Voltage multiplier power supplies have been used for many years. Some of the most commonly applied methods for producing a voltage larger than the power supply voltage include step-up transformers, voltage doubler, multiplier circuits, charge pump circuits, switched-capacitor circuits, and boost or step-up converters. Among these methods, diode capacitor topologies are more suitable [23]. In 1932, Cock crofand Walton introduced a complex cascade voltage-doubler that is shown in Figure 2.1 [24] and they received the Nobel Prize in 1951 for this work. Tis circuit could produce a steady potential of about 700 kV that was three times greater than the applied input voltage. However, due to existence of series connected coupling capacitances, the high coupling voltage drop happens in this configuration. Tis phenomenon causes a small voltage gain for the circuit of Figure 2. Furthermore, series connected output capacitor causes a low output capacitance. In this circuit, except Cs1, other output capacitors were holding a floating voltage. Therefore, employing the stored electrical charge in each capacitor, individually, for other applications was complex.

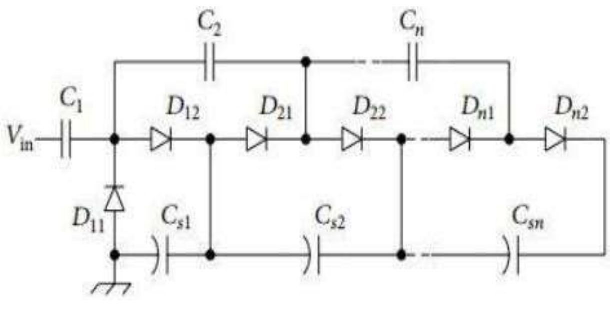


Fig 2.1: Cockcrof-Walton cascade voltage-doubler circuit

In 1976, Dickson proposed a cascade diode-capacitor circuit, which was an improvement for the Cockcrof-Walton circuit (Figure 2.1) [25]. Tis circuit configuration, known as “charge pump,” required clock pulses as the input of the coupling capacitors. The presented topology of the Dickson circuit was simpler than the Cockcrof-Walton circuit.

However, requiring the clock pulses can limit utilizing this circuit for high-voltage applications. Figure 2.2 shows the Dickson charge pump,which is a kind of cascade voltage doubler.

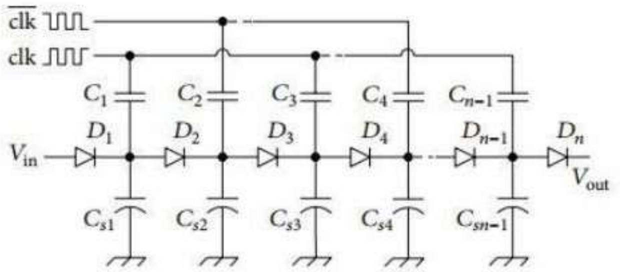


Fig. 2.2: Dickson charge pump circuit

In 2003, Karthaus and Fischer have simplified and improved circuit of the Cockcrof Walton (Figure 2.1) as shown in Figure 2.3. Tis improved circuit configuration was modifying the Dickson circuit [26] transformation. However, in Karthaus-Fischer cascade voltage doubler, the clock pulses were eliminated, as the numbers of coupling and stray capacitors were reduced. Therefore, the essential requirements of the circuit became less than the Dickson circuit (Figure 2.2). Based on the achievement, the Karthaus Fischer circuit can even be utilized for high-voltage applications. In addition, the input impedance of the Cockcroft Walton circuit was reduced by changing the connection of the coupling capacitors, and its output capacitance is increased by using an independent grounded stray capacitor for each stage, in Karthaus Fischer circuit [23].

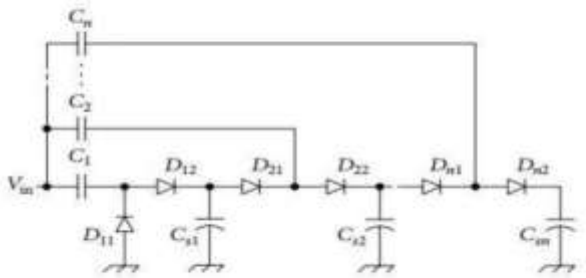

Fig 2.3: Karthaus-Fischer cascade voltage-doubler circuit.

## III MULTIPLIETR AND COCKCROFT WALTON VOLTAGE PULSE WIDTH MODULATION

One of the cheapest and popular ways of generating high voltages at relatively low currents is the classic multistage diode/capacitor voltage multiplier, known as Cockcroft Walton multiplier, named after the two men who used this circuit design to be the first to succeed in performing the first nuclear disintegration in 1932. James Douglas Cockcroft and Ernest Thomas Sinton Walton, in fact have used this voltage multiplier cascade for the research which later made them winners of the 1951 Nobel Prize in physics for "Transmutation of atomic nuclei by artificially accelerated atomic particles". Less known is the fact that the circuit was first discovered much earlier, in 1919, by Heinrich Greinacher, a Swiss physicist. For this reason, this doubler cascade is sometimes also referred to as the Greinacher multiplier. Unlike transformers this method eliminates the requirement for the heavy core and the bulk of insulation/potting required. By using only capacitors and diodes, these voltage multipliers can step up relatively low voltages to extremely high values, while at the same time being far lighter and cheaper than transformers. The biggest advantage of such circuit is that the voltage across each stage of this cascade, is only equal to twice the peak input voltage, so it has the advantage of requiring relatively low cost components and being easy to insulate. One can also tap the output from any stage, like a multi tapped transformer. They have various practical applications and find their way in laser systems, CRT tubes, hv power supplies, LCD backlighting, power supplies, x-ray systems, travelling wave tubes, ion pumps, electrostatic systems, air ionizers, particle accelerators, copy machines, scientific instrumentation, oscilloscopes.

The recent technological developments have made it possible to design a voltage multiplier that efficiently converts the low AC voltage into high DC voltage comparable to that of the more conventional transformer-rectifier-filter-circuit. The voltage multiplier is made up of capacitors and diodes that are connected in different configurations. Voltage multiplier has different stages. Each stage is made up of one diode and one capacitor. These arrangements of diodes and capacitors make it possible to produce rectified and filtered output voltage whose amplitude (peak value) is larger than the input AC voltage.Based on the review, theexisting cascade voltage doublers can produce an output voltage higher than the applied input voltage.

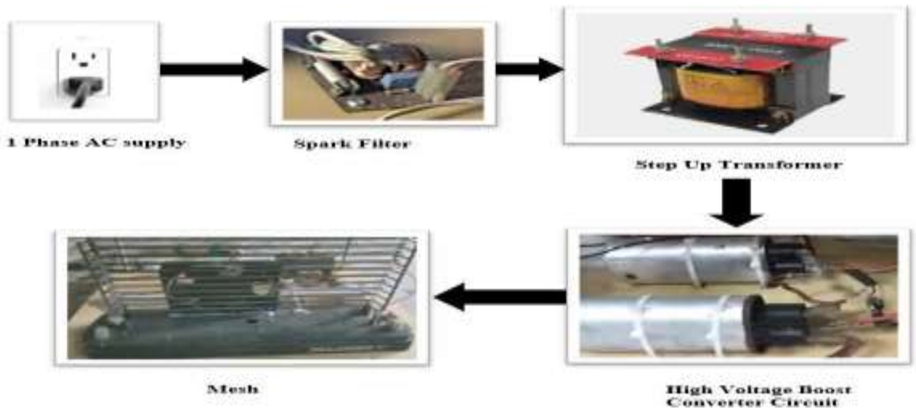


Figure:3.1 Block diagram of High Voltage DC using Voltage Multiplier circuit

Fortunately, there is an IC (Integrated circuit) called a comparator: these come usually 4 sections in a single package. and filtered output voltage whose amplitude (peak value) is larger than the input AC voltage.Based on the review, theexisting cascade voltage doublers can produce an output voltage higher than the appliedinput voltage.

## IV: SIMULATION LINK OF PROPOSED SYSTEM

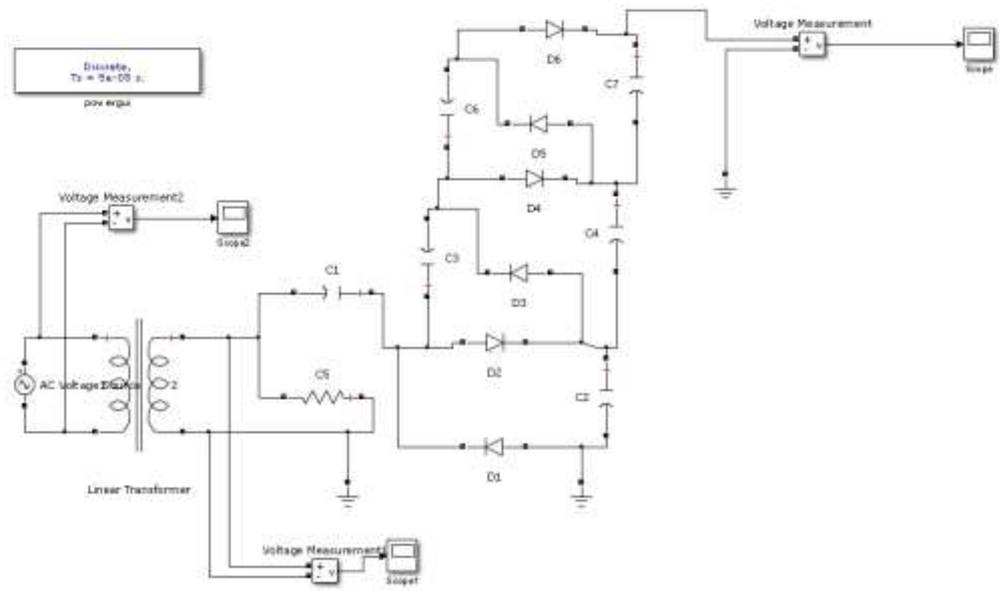


Figure :4.1 : Simulation Model of Voltage Multiplier Circuit

## V :Results:

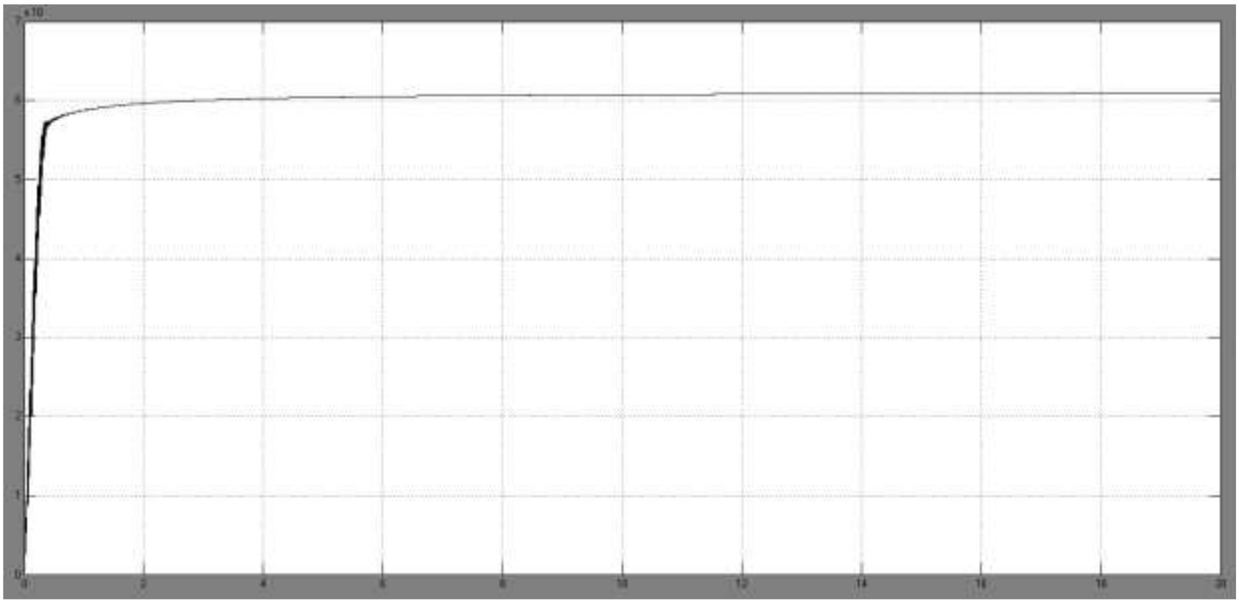

Figure:5.1:Voltage Value @ Scope1

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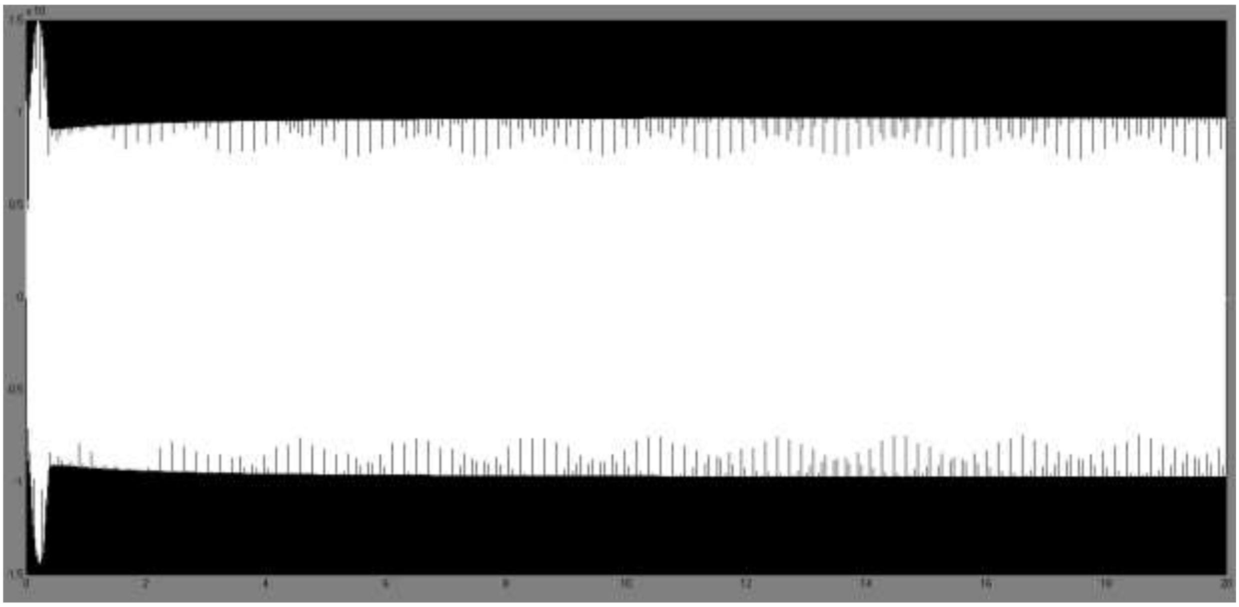

Figure:5.2.:Voltage Value @ Scope 2

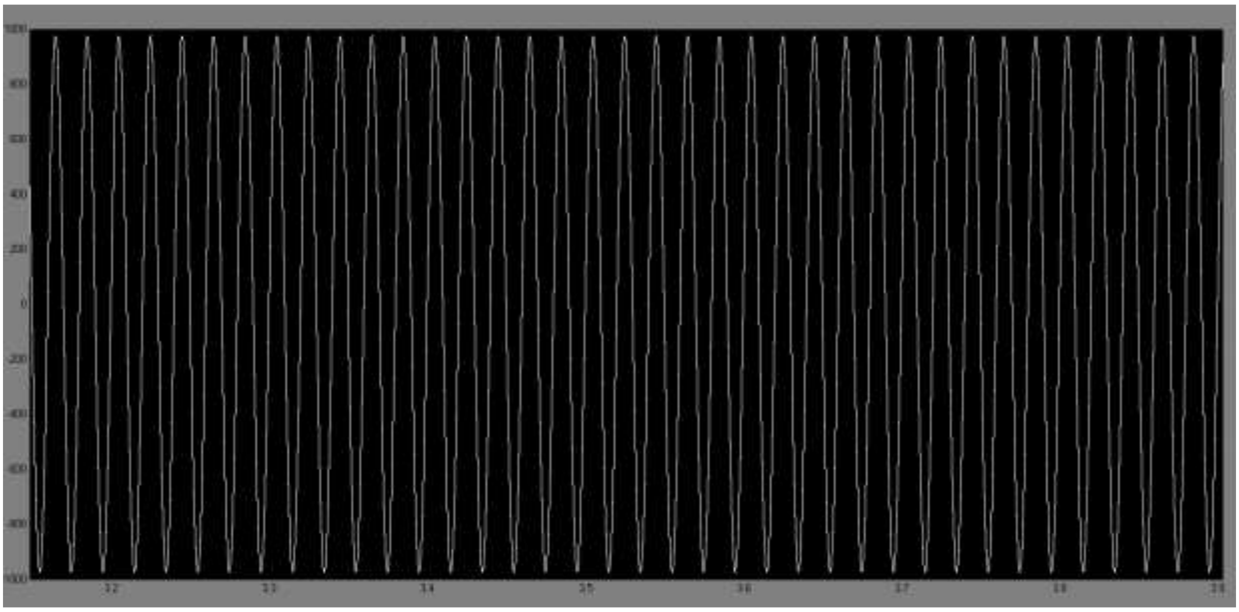

Figure:5.3:Voltage Value @ Scope3

## VI: SYSTEM DESIGN AND HARDWARE COMONENTS OF PROPOSED SYSTEM

The design aims to generate high voltage DC from single phase AC which can be monitored in real time data at a local LCD along with remotely over internet. The overall system requires a single phase step down transformer, capacitors, diodes, resistors, Arduino, GSM module, voltage sensor & a temperature sensor.

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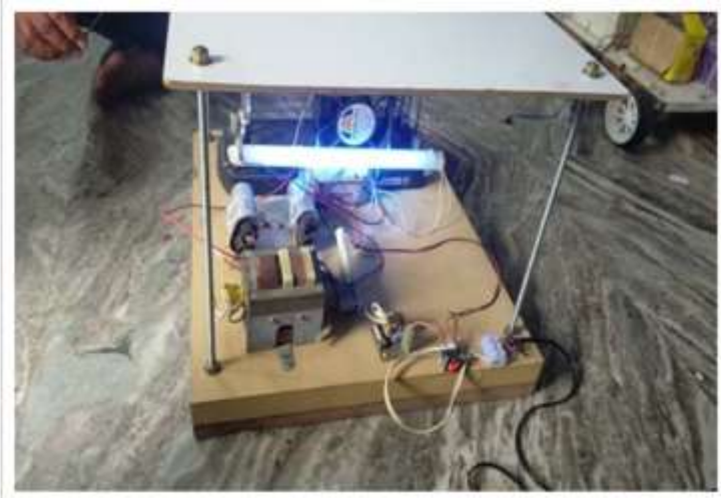

Figure 6.1 High Voltage DC generation circuit hardware prototype installation

## CASE-1

Figure:6.2 Flue gases passed through mesh

Figure::6.3: Removal of bacteria

**CASE-2:**

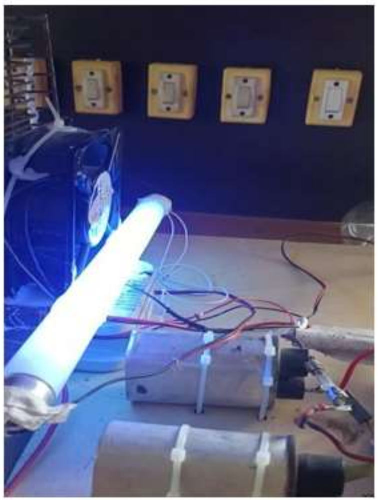

Figure:6.4:Testing with Match Stick

Figure:6.5: Released purified air

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| SI. No | Number of Stage | Input Voltage | Output Voltage |
|---|---|---|---|
| **1** | Stage 1 | 230V | 5000V |
| **2** | Stage 2 | 5000V | 15000V |

**VII :Conclusion**

A single phase AC to high voltage DC generation circuit is designed and implemented in this project. Simple Cockcroft–Walton voltage doubler circuit is used to design the implemented circuit. For monitoring the output voltage, a local LCD Arduino Uno(ATmega328P microcontroller) is used. The microcontroller sense the voltage by voltage divider & sensor and display into LCD display.

This project generates around 1000 V DC using 14 stages of diode capacitor cascade circuit. Itis possible to take various DC voltage outputs by using external probe from different stages aseach stage generates a particular DC voltage. Due to the electrical and mechanical effects of the materials used in the assembly construction, use of temperature protection is imperative. In this project the over temperature protection system is designed for the high voltage DC generation circuit. The maximum allowable operating temperature can be set to a desirable value by programming. In addition no high temperature protection, the over current protectionis also incorporated into the proposed circuit. If the input current exceeds a predetermined value due to short circuit or others faults, microcontroller will disconnect the circuit from source by relay.

A special feature scheme is the facility of remote monitoring with long distance wireless transmission of real-time data such as input voltage, output voltage, devicetemperature and trip signal. Such feature is enabled using a GSM/GPRS module.

The effectiveness of the developed system is tested experimentally in the laboratory and a good accuracy is confirmed. This project will be helpful to developed high voltage DC generation circuit locally, which will save foreign currency.

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