ENHANCED VOLTAGE DOUBLER CIRCUIT USING IC555 TIMER: DESIGN AND APPLICATION

ECB1204 - ANALOG INTEGRATED CIRCUIT

A PROJECT REPORT

Submitted by

SHAKTHIVISESH N

THANISHKUMAR K

VISHAL A

in partial fulfillment for the award of the degree

of

BACHELOR OF ENGINEERING

in

ELECTRONICS AND COMMUNICATION ENGINEERING

K. RAMAKRISHNAN COLLEGE OF TECHNOLOGY

(An Autonomous Institution, Affiliated to Anna University Chennai and Approved by AICTE, New Delhi)

SAMAYAPURAM, TIRUCHIRAPPALLI – 621 112

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BONAFIDE CERTIFICATE

Certified that this project report titled "**ENHANCED VOLTAGE DOUBLER CIRCUIT USING IC555 TIMER: DESIGN AND APPLICATION"** is the bonafide work of **SHAKTHIVISESH N** (**2303811710621100**), **THANISHKUMAR K** (**2303811710621112), VISHAL A (2303811710621124)** who carried out the project under my supervision. Certified further, that to the best of my knowledge the work reported herein does not from part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate**.**

SIGNATURE	**SIGNATURE**
Dr. S. SYEDAKBAR, M.E., Ph.D.,	Mrs. G. KEERTHANA, M.E.,
HEAD OF THE DEPARTMENT	**SUPERVISOR**
Assistant Professor	Assistant Professor
Department of Electronics and Communication Engineering	Department of Electronics and Communication Engineering
K Ramakrishnan College of Technology (Autonomous)	K Ramakrishnan College of Technology (Autonomous)
Samayapuram – 621 112	Samayapuram – 621 112

Submitted for the viva-voce examination held on ………………

INTERNAL EXAMINER **EXTERNAL EXAMINER**

DECLARATION

We jointly declare that the project report on "**ENHANCED VOLTAGE DOUBLER CIRCUIT USING IC555 TIMER: DESIGN AND APPLICATION"** is the result of original work done by us and best of our knowledge, similar work has not been submitted to "ANNA UNIVERSITY CHENNAI" for the requirement of Degree of BACHELOR OF ENGINEERING. This project report is submitted on the partial fulfillment of the requirement of the award of Degree of BACHELOR OF ENGINEERING.

Signature

SHAKTHIVISESH N

THANISHKUMAR K

VISHAL A

Place : Samayapuram

Date :

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CHAPTER 1
PROBLEM STATEMENT

The DC voltage doubler circuit is a versatile design used in electronics to increase a DC input voltage to nearly twice its original value. Using the popular and low-cost 555 Timer IC, this circuit combines ease of implementation with practical functionality. Voltage doubling is achieved by exploiting the characteristics of capacitors, diodes, and the square wave signal generated by the 555 Timer IC.

A voltage doubler is a type of charge pump circuit that increases a DC voltage without requiring inductors or transformers. Instead, it relies on capacitors to store and transfer electrical charge, along with diodes to direct current flow appropriately. When paired with a 555 Timer IC, the circuit generates a periodic square wave signal that drives the charge pump network, producing a DC output voltage approximately double the input voltage. Such circuits are widely used in battery-operated devices, low-power electronics, and situations where compact, lightweight solutions are preferred over bulky transformers. The proposed system is designed to address specific problems:

Charging Phase: During the high state of the square wave generated by the 555 Timer, the first capacitor charges to the input voltage through a diode. The diode prevents the capacitor from discharging back to the source when the square wave toggles. Charge Pump (Voltage Doubler Network): Two diodes and two capacitors are arranged to form a voltage doubler. The first capacitor charges during the positive half of the square wave, and its charge is transferred to the second capacitor during the negative half.

Reliability: While cost-effective, the system is designed to provide accurate and consistent detection of intrusions. Discharge and Transfer Phase: When the square wave transitions to its low state, the charged capacitor transfers its stored energy to the second capacitor via another diode. This transfer effectively adds the capacitor's voltage to the input voltage, resulting in an output voltage approximately twice the input value.

1.1 BACKGROUND OF THE WORK

Voltage multipliers, including voltage doublers, have long been an essential part of electronics for applications where higher DC voltage is required but cannot be sourced directly due to limitations of the input power supply. These circuits, typically relying on passive components like diodes and capacitors, have been used in devices ranging from CRT televisions to modern-day portable gadgets.

The development of the **555 Timer IC** in 1972 revolutionized the field of electronics by providing a versatile, cost-effective, and easy-to-use component for generating oscillations, delays, and pulse-width modulated signals. Its widespread adoption in a variety of applications highlighted its utility as a reliable square wave generator, making it an ideal candidate for driving charge pump circuits like voltage doublers.

Voltage doublers, when paired with a 555 Timer, eliminate the need for bulky transformers or inductors traditionally used in voltage conversion, offering a compact and lightweight solution. This capability is particularly relevant in battery-powered and portable systems, where space and weight constraints are critical, and efficiency remains a high priority.

The concept of combining a **555 Timer** with a **charge pump network** of capacitors and diodes allows designers to create a simple yet effective circuit for voltage doubling. Such designs are invaluable in applications like powering high-brightness LEDs, low-current DC motors, and portable devices, where increasing the available voltage without significant size or cost increases is essential.

This work builds on these established principles by leveraging the simplicity and versatility of the 555 Timer IC to create an efficient DC voltage doubler. It aims to address the growing need for lightweight, cost-effective, and compact voltage conversion solutions in modern electronics, bridging the gap between low-voltage power sources and the requirements of higher-voltage systems.

CHAPTER 2

DESIGN PROCEDURE OF VOLTAGE DOUBLER

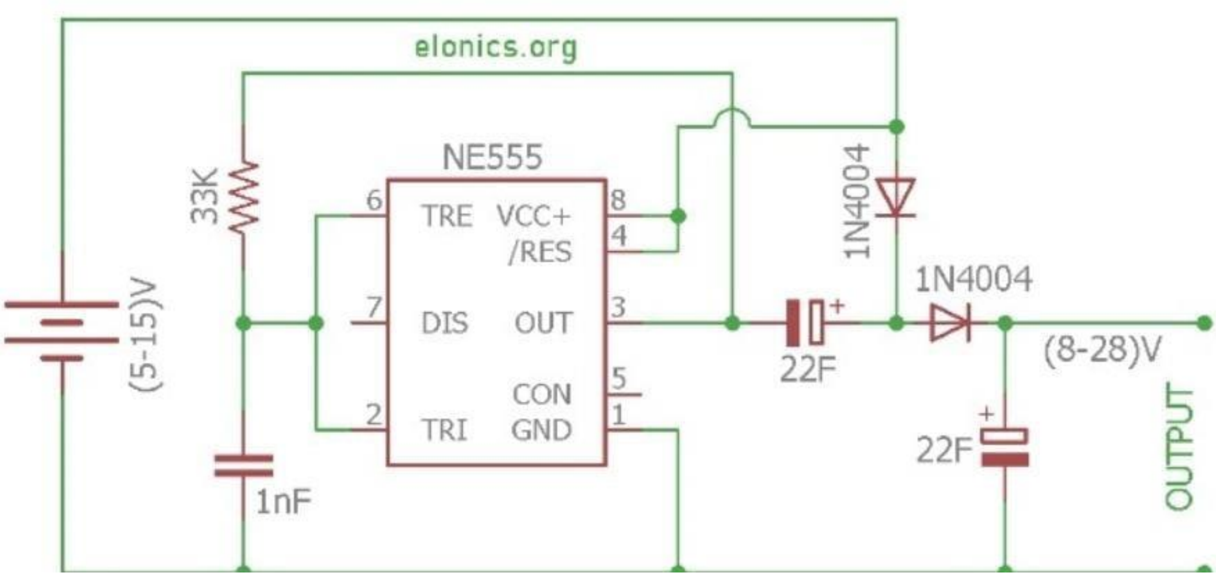

Figure 1 Circuit Diagram of Voltage Doubler

2.1 COMPONENTS USED

2.1.1 555 TIMER IC

IC 555 is a precision timing IC that provides time delays or oscillations. 555 Timer IC has three modes of operation: Astable, Monostable and Bi-stable. In this project, we are going to use the IC 555 in Bi-stable mode.

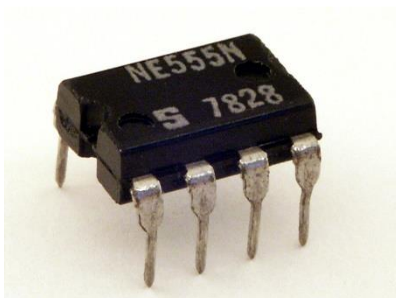

Figure 2.1 NE555

2.1.2 DIODE

The IN4007 is a widely used general-purpose rectifier diode. It is part of the popular 1N400x series of diodes, designed for low-cost, medium-current rectification applications. These diodes are typically used in AC-to-DC conversion circuits, protection circuits, and other applications where unidirectional current flow is required.

Figure 2.2 LM358

1.2.3 33 KΩ RESISTORS

The 33 kΩ resistors are essential components in configuring the 555 Timer IC in astable mode. They determine the frequency and duty cycle of the square wave output by controlling the charging and discharging cycles of the timing capacitor. These resistors, in conjunction with the timing capacitor, dictate the oscillation speed, which is critical for the proper functioning of the voltage doubler circuit. Their fixed resistance ensures a stable and predictable operation of the timer.

Figure 2.3 33 KΩ Resistors

2.1.4 470 µF CAPACITOR

The 470 µF capacitor is a key component in the voltage doubler circuit, where it functions as a charge storage element. During the oscillation cycle, it alternately charges and discharges to transfer energy and double the input voltage. Its large capacitance value helps to minimize voltage ripple, ensuring a stable output for powering loads. This capacitor is critical for maintaining the efficiency and reliability of the voltage multiplication process.

Figure 2.4 470 µF capacitor

2.1.5 10 µF CAPACITOR

The 10 µF capacitor is part of the timing network of the 555 Timer and plays a vital role in generating oscillations. It charges and discharges at a rate determined by the resistors, producing a continuous square wave. This capacitor is crucial for setting the timing intervals, directly impacting the frequency of the output signal. Its value is carefully chosen to ensure optimal performance of the circuit while maintaining stability.

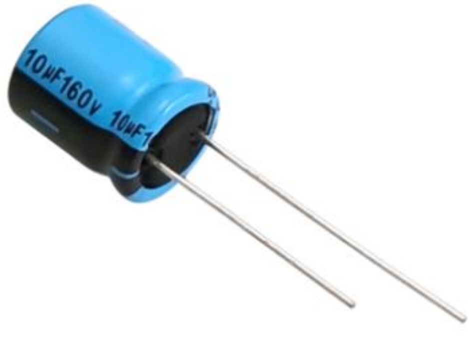

Figure 2.5 10 µF Capacitor

2.1.6 9V BATTERY

The **9V battery** powers the entire circuit. It supplies the necessary voltage for the **LM358**, **NE555**, and other components. The 9V battery makes the system portable and allows it to operate even in environments without a direct power source. This feature is especially useful for mobile or temporary security setups.

Figure 2.6 9V Battery

2.1.7 12V LED

The 12V LED is used as the load to demonstrate the circuit's ability to provide a stable, doubled voltage output. It serves as a practical test device, indicating whether the voltage doubler is functioning correctly. By lighting up, the LED visually confirms that the circuit can handle real-world applications. Additionally, the LED's operation provides a way to evaluate the output voltage and current stability under load conditions.

Figure 2.7 12V LED light

2.2 WORKING PRINCIPLE OF VOLTAGE DOUBLER

A capacitor charge pump is an ingenious circuit design used to increase voltage without requiring inductive components like transformers or inductors. It works by using capacitors and diodes in combination with an oscillating input signal, such as the square wave generated by a 555 timer IC. The 555 timer output alternates between 0V and the positive rail voltage, creating the necessary switching action for the charge pump operation.

When the timer output is at 0V, a 22µF capacitor connected to the output charges through a diode to a voltage close to the supply voltage minus the diode's forward voltage (~0.7V). When the timer output switches to the positive rail voltage, the previously charged capacitor acts like a secondary voltage source in series with the timer output. This configuration effectively doubles the output voltage, as the voltage across the capacitor adds to the voltage of the timer output.

To ensure stability and prevent charge loss, a second diode is used to block current from flowing back into the capacitor. Additionally, a second capacitor at the output smooths the voltage, minimizing fluctuations and ensuring a steady, higher voltage output. This simple yet efficient design is widely used in applications where low power and compact circuits are essential, such as in portable electronics or situations where inductors would be impractical.

CHAPTER 3

COST OF COMPONENTS

COMPONENT	**QUANTITY**	**COST (APPROX.)**
NE555 (Timer IC)	1	15
1N4007 Diode	2	15
33 KΩ Resistors	1	10
470 µF Capacitor	2	20
10 µF Capacitor	1	10
12V LED light	3	25
9V Battery	1	25
Connecting Wires	As Required	10
Breadboard	1	50

Table 3.1 Cost and Quantity of the Components

CHAPTER 4
RESULT AND DISCUSSION

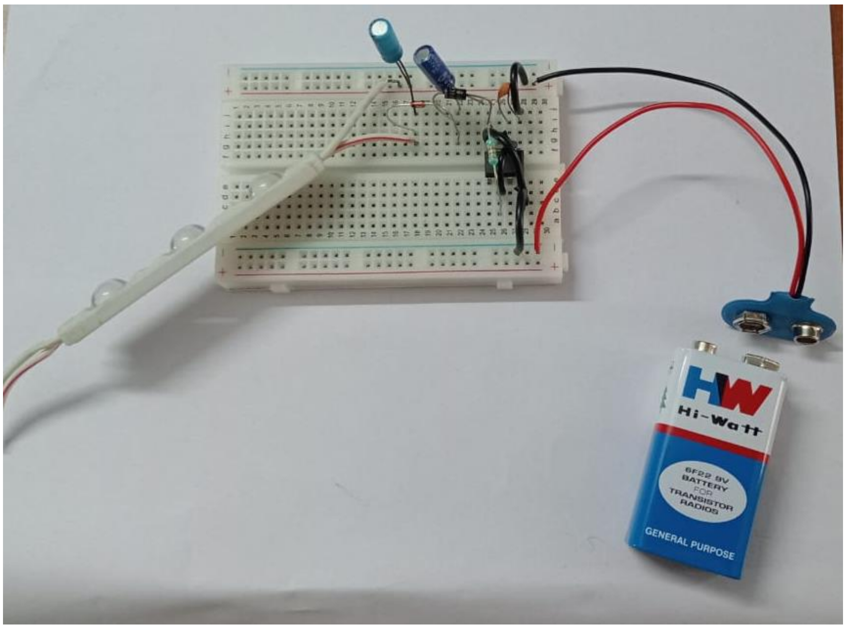

Figure 4.1 Demo of Voltage Doubler Circuit

4.1 FUNCTIONALITY

The DC voltage doubler circuit using a 555 Timer IC is designed to increase the input DC voltage to approximately double its value. The 555 Timer operates in astable mode, generating a continuous square wave signal. This oscillating signal drives a diode-capacitor charge-pump network, which alternately charges and discharges the capacitors to accumulate energy and boost the voltage. The doubled voltage output is used to power a 12V LED, demonstrating the circuit's ability to provide a stable and efficient output for practical applications. This setup is suitable for low-power devices requiring higher voltage from limited input sources.

4.2 ADVANTAGES

The DC voltage doubler circuit using a 555 Timer IC offers several benefits. It provides an efficient solution for boosting a low input voltage to approximately double its value, enabling the operation of devices requiring higher voltage from limited power sources. The design is simple and cost-effective, relying on readily available components like the 555 Timer IC, resistors, capacitors, and diodes. Its compact and lightweight nature makes it suitable for portable and space-constrained applications. Additionally, the circuit is versatile, capable of working across various input voltage ranges, and demonstrates good energy efficiency by minimizing losses, especially when using components like Schottky diodes. This functionality is ideal for powering small loads, such as LEDs or other low-power devices, in practical applications.

4.3LIMITATIONS

The DC voltage doubler circuit has some inherent limitations. First, it is not suitable for high-current applications, as the diodes and capacitors used in the charge-pump network have limited current-handling capabilities. The output voltage may experience significant ripple and instability under heavy loads, requiring additional filtering for smoother operation. Furthermore, the circuit's efficiency decreases as the input voltage or load increases due to energy losses in diodes (forward voltage drop) and switching components. Lastly, the design is sensitive to component tolerances, and improper selection of resistors, capacitors, or diodes can affect performance, making careful design and testing crucial.

4.1 APPLICATIONS

The DC voltage doubler circuit using a 555 Timer IC is widely used in various low-power applications. It is commonly employed in portable devices to step up voltage from small batteries to power components like LEDs, sensors, or microcontrollers. In laboratories and educational settings, it serves as a useful tool for testing, prototyping, and understanding voltage-doubling principles. The circuit is also used in LED drivers, providing the necessary voltage to operate LEDs requiring a higher input than the available supply. Additionally, it is valuable in energy harvesting applications, boosting low voltages from sources like solar panels or thermoelectric generators to drive small devices. Its simplicity and versatility make it a popular choice for learning and experimenting with basic power circuits.