CLAP ACTIVATED ADJUSTABLE DUAL SEQUENCER

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Components Used:

Required for the Project:

COMPONENT	QUANTITY
IC555	2
CONDENSER MICROPHONE	1
TRANSISTOR BC547	2
RESISTORS	1K (x4), 10K (x4), 4.7K (x1)
10K POTENTIOMETER	2
CAPACITORS	1000uF (x1), 10nF (x3), 100uF (x1)
LED	2
DIODE (IN4007)	4

Required for the Power Supply Circuit:

COMPONENT	QUANTITY
IN 4007 DIODE	4
TRANSFORMER	1
1000uF CAPACITOR	1
10nF CAPACITOR	1
IC7812	1

ABSTRACT

• Industrial process automation is an upcoming field aiming at automating complex tasks or processes. Sequencing is a major aspect of industrial automation, whose fundamental task is to synchronise the processes precisely.

In the industrial sector, sequence is crucial as it facilitates effective planning and scheduling of the production process. Manufacturers employ production sequencing, a meticulous scheduling procedure, to arrange the manufacturing of purchase orders. Manufacturers can achieve mix flexibility production using this method and a common manufacturing resource. Manufacturing in sequence is the process of manufacturing components according to an Original Equipment Manufacturers' (OEM) prescribed sequence. By coordinating the supply of components with the production line, this method has various advantages in terms of shortening the product cycle time, boosting productivity, and minimising inventory levels.

•A Dual Sequencer is an electronic device which can coordinate the functioning of two processes in a required sequence. The dual sequencer is usually used in industrial automation where the manufacturing processes have to be precisely timed and sequenced. One application of the dual sequencer is in microsurgical documentation, where it can simplify the operation of a movable mirror type of dual camera adapter, allowing efficient production of high-quality images.

•The current project 'Clap Activated Adjustable Dual Sequencer' aims at implementing a dual process sequencer with precise adjustable timings of each of the process. Moreover, the sequencer is activated or is started through a clap or any noise in the similar frequency, thereby enabling a hands free and easier activation.

INTRODUCTION

•A dual sequencer performs the function of synchronising two processes to take place one after the other for precise amount of time. Evidently that a timer circuit has to be used in the sequencing device.

•Monostable multivibrators are circuits which stay in a particular voltage state by default and transit to another voltage, with the application of trigger, for a calculated time period and fall back to the default voltage state. And essentially these monostable circuits can be used for precisely timing the processes for short time intervals. The time period of the circuit depends primarily on the resistance and capacitance values present, and hence the time periods of the multivibrators can be controlled and configured by using variable resistance.

•The dual sequencer uses two monostable multivibrators to time both the sequences. And these multivibrators are designed in such a way that the second one is triggered at the instant the first multivibrator falls to the stable state from the unstable state, thereby establishing the sequencing of the process.

•Also, the very first timer is activated through a sound signal, the condenser microphone, with the necessary circuitry is capable of generating a trigger when a clap or a noise of equivalent frequency is detected.

COMPONENT DESCRIPTION

1. NE555

The 555 timer IC is an integrated circuit (chip) used in a variety of timer, delay, pulse generation, and oscillator applications.

The 555 Timer IC got its name from the three 5KΩ resistors that are used in its voltage divider network. The IC is capable of generating extremely accurate time delays and very high frequency oscillations (upto 500KHz with duty cycle varying from 50% to 100%).

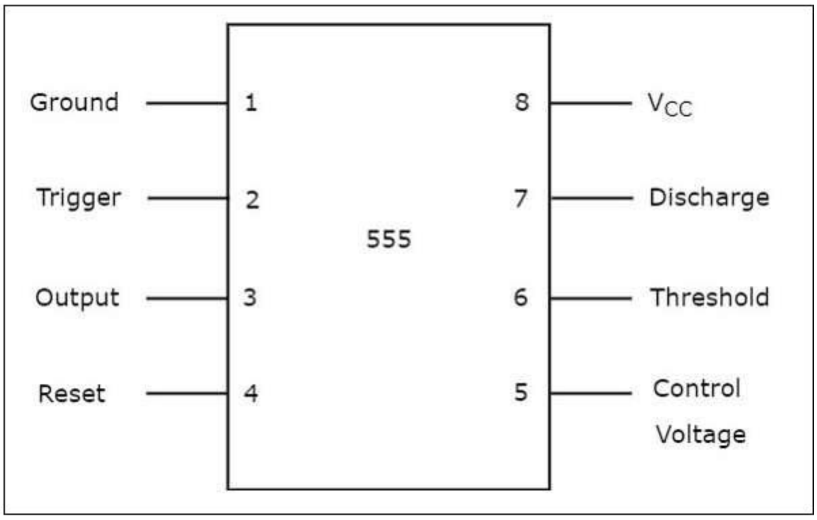


Fig. Pin diagram of IC 555

Working:

The following is the working of the IC 555 in monostable mode (the mode which we need here):

- By connecting the trigger input to VCC through a resistor, the trigger input is kept high. In other words, the trigger comparator will output 0 to the flip-flop's S input. On the other hand, when the Threshold pin is low, the Threshold comparator also returns a value of 0. The Threshold pin is actually Low because the flip-flop's Q-bar output is High, keeping the discharge transistor active and allowing the voltage from the source to pass through it on its way to ground.
- Pressing the pushbutton on the trigger pin is what converts the 555 Timer's output state from Low to High. As a result, the trigger pin will

ground or the input state will be 0, in which case the comparator will output 1 to the flip-flip's S input. The 555 Timer output will become High and the Q-bar output will become Low as a result. As a result, the capacitor C1 will now begin charging through the resistor R1 at the same time that the discharge transistor has been turned off. (R1 and C1 being connected between the pin 6 and Vcc and 6 and GND respectively)

- The 555 Timer will remain in this state until the voltage across the capacitor reaches 2/3 of the supplied voltage. In that case, the Threshold input voltage will be higher and the comparator will output 1 to the R input of the flip-flip. This will bring the circuit into the initial state. The Q-bar output will become High, which will activate the discharge transistor as well as make the IC output Low again.

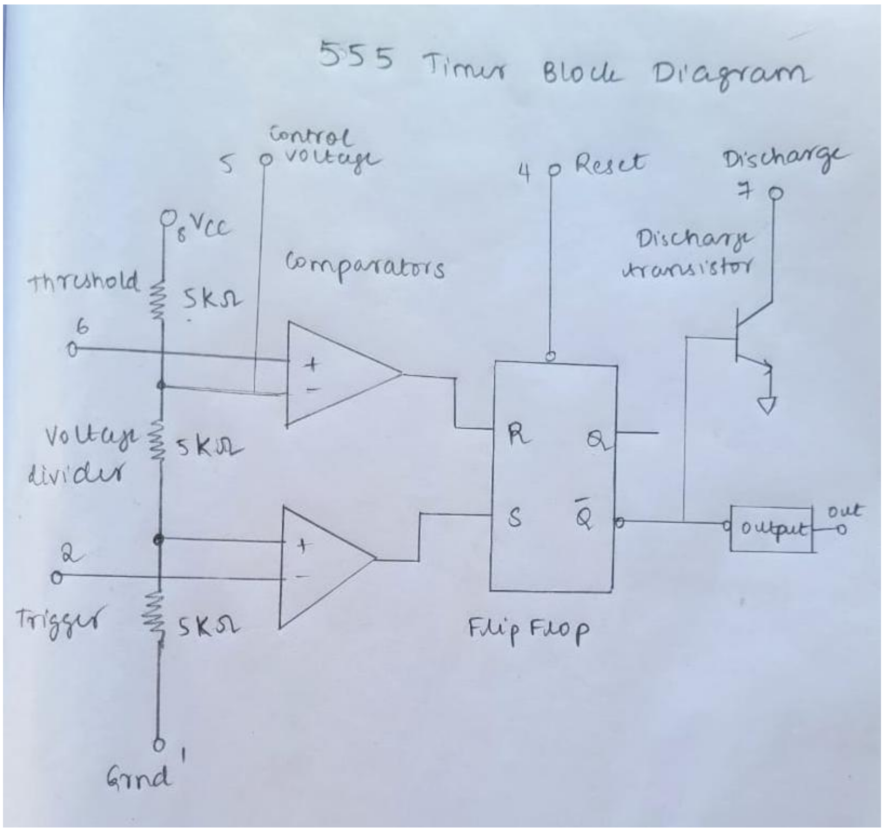


Fig. Internal circuit of IC 555

2. Condenser Microphone

A condenser microphone, also known as a capacitor microphone, is a type of microphone that converts sound waves into electrical signals through the use of a vibrating diaphragm and a capacitor. It offers high sensitivity and accuracy, making it suitable for a wide range of applications such as recording studios, broadcasting, and live performances. Here's how a condenser microphone typically works:

- Diaphragm and Backplate: The key components of a condenser microphone are a thin diaphragm and a backplate. The diaphragm is typically made of a conductive material, such as metal-coated plastic or metalized film, and is located close to the backplate.
- Capacitor Principle: The diaphragm and the backplate form a capacitor, where the diaphragm acts as one plate, and the backplate acts as the other plate. The air gap between them serves as the dielectric of the capacitor. The capacitance of the microphone changes with the displacement of the diaphragm in response to sound waves.
- Polarization Voltage: To operate a condenser microphone, a polarizing voltage is applied between the diaphragm and the backplate. This voltage creates an electric field between the plates of the capacitor, causing a fixed charge on the diaphragm.
- Sound Wave Interaction: When sound waves reach the diaphragm, they cause it to vibrate in response to the changes in air pressure. The diaphragm's movement alters the capacitance between the diaphragm and the backplate, resulting in a varying electrical signal.
- Capacitance Variation: As the diaphragm moves inward or outward, the capacitance changes accordingly. When the diaphragm moves closer to the backplate, the capacitance increases, and when it moves away, the capacitance decreases. These variations in capacitance generate a corresponding electrical signal.
- Output Circuit: The varying capacitance signal is then sent to an output circuitry. The output circuit typically includes a preamplifier that amplifies the weak electrical signal from the condenser element to a usable level. The signal can then be further processed, amplified, and recorded or transmitted as desired.

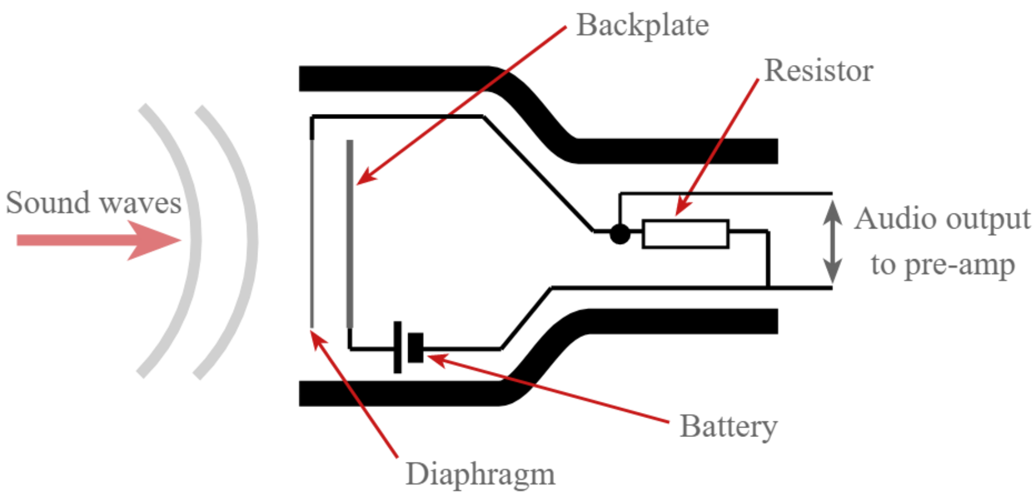


Fig. The schematic diagram of condenser microphone

Condenser microphones are highly sensitive, providing excellent frequency response and transient accuracy, which makes them well-suited for capturing vocals, acoustic instruments, and capturing detailed audio in professional audio settings.

3. IC 7812

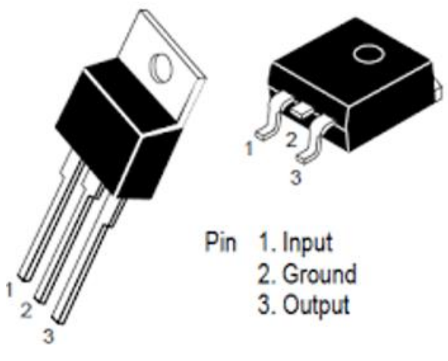


Fig. Pin diagram of IC 7812

The IC 7812 is a popular voltage regulator integrated circuit that provides a fixed output voltage of +12 volts DC. It is part of the 78xx series of voltage regulators, where the xx represents the specific output voltage. Here's an overview of how the IC 7812 works:

1. Input Voltage: The IC 7812 requires an input voltage that is higher than the desired output voltage. Typically, the input voltage can range from 14 volts to 35 volts DC. However, it is important to ensure that the input voltage does not exceed the maximum specified input voltage for the IC to prevent damage.

2. Voltage Regulation: The IC 7812 utilizes a three-terminal positive voltage regulator configuration. It contains a built-in voltage reference, error amplifier, pass transistor, and current limiting circuitry. These components work together to regulate the output voltage at a constant +12 volts.

3. Pin Configuration: The IC 7812 has three pins: input (Vin or Input), ground (GND), and output (Vout or Output). The input pin is connected to the higher input voltage source, the ground pin is connected to the common ground, and the output pin provides the regulated +12 volts DC.

4. Voltage Drop: When the input voltage is applied to the IC 7812, the internal components compare the reference voltage with the input voltage. If the input voltage exceeds the desired output voltage, the error amplifier drives the pass transistor to adjust the output voltage and maintain it at the specified value.

5. Heat Dissipation: The IC 7812 may generate some heat during operation due to the voltage drop across the pass transistor. To dissipate this heat, it is recommended to use a heat sink or ensure proper ventilation if the power dissipation is high.

6. Current Limiting: The IC 7812 also incorporates a current limiting feature to protect against excessive current flow. If the load connected to the output exceeds the maximum current rating of the IC, the current limiting circuitry reduces the output current to a safe level, preventing damage to the IC.

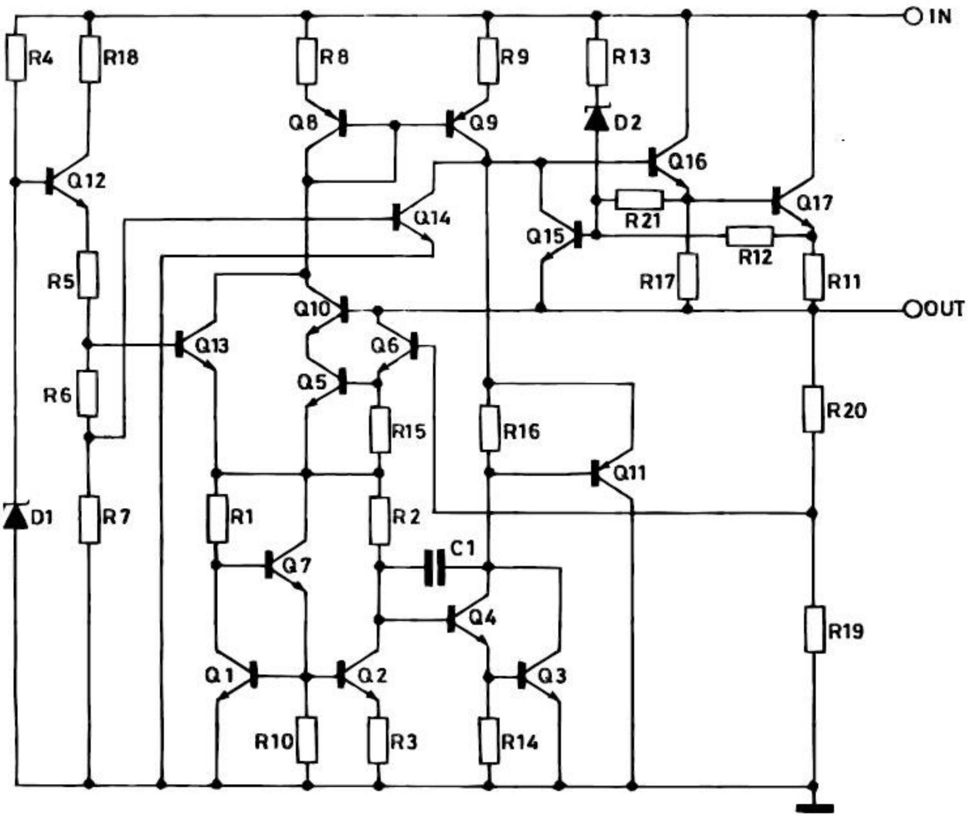
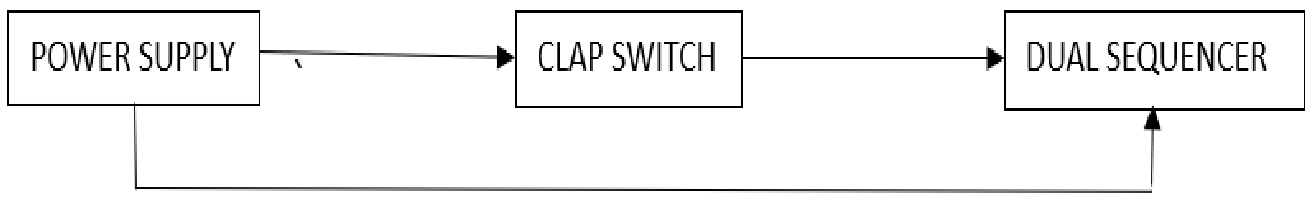


Fig. Internal circuitry of IC 7812

Overall, the IC 7812 provides a stable and regulated +12 volts DC output voltage from a higher input voltage source. It is commonly used in various electronic circuits and power supply applications where a reliable and constant voltage is required.

THE COMPLETE PICTURE



WORKING

1. MONOSTABLE MULTIVIBRATOR

In essence, a monostable multivibrator is an electrical component with only one stable logic state—HIGH or LOW—out of two potential states. An external trigger causes a monostable multivibrator to produce a single output pulse in the "unstable" state for a brief period of time before returning to the stable state.

By simply connecting a resistor, a capacitor, and a triggering switch as illustrated in the below diagram, we can easily make our 555 timers act as a monostable multivibrator which can generate a high voltage pulse for the calculated amount of time.

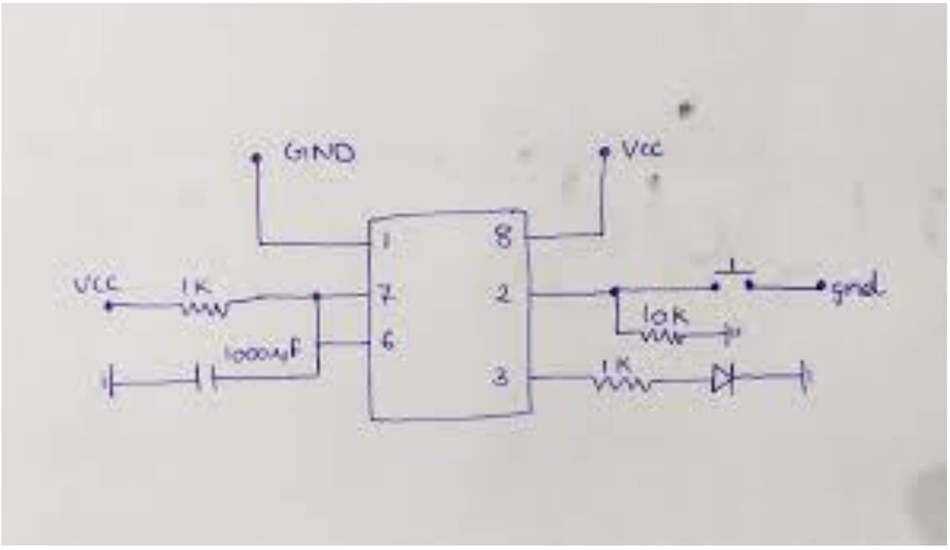


Fig. Circuit of the monostable multivibrator

Simple operation

OUPUT at PIN 3 is low since the 555 is initially in a steady state. We know that the non-inverting end of the lower comparator is at 1/3Vcc, so when we connect the trigger pin 2 to ground using a pushbutton switch to supply negative (1/3Vcc) voltage, two things happen:

I. The flip flop is set, the lower comparator becomes HIGH, and pin 3 receives a HIGH output as a result.

II. The timing capacitor C1 disconnects from the ground and begins charging through the resistor R1 as the transistor Q1 turns off.

This condition, known as the quasi-stable state, lasts for some period (T). Now, when the capacitor begins to charge and reaches a voltage that is just a little bit higher than 2/3 Vcc. Again, two things happen when Threshold PIN 6 exceeds the voltage at the inverting end (2/3Vcc) of the Upper comparator:

I. First, the output of the chip at pin 3 changes from HIGH to LOW and the upper comparator and flip flop are reset.
II. And secondly, Transistor Q2 turns ON, causing the capacitor to begin discharging through Discharge PIN 7.

As a result, following the time period set by the RC network, the 555 IC automatically return to the stable condition (LOW). The following formulas provide the duration of the quasi-stable state:

$$T=1.1 * R * C \text{ Seconds}$$

Where R would be the resistance connected between the Vcc line and the line shorting the pins 6 and 7. And C would be the capacitor connected between the 6 and 7 shorting line and the ground.

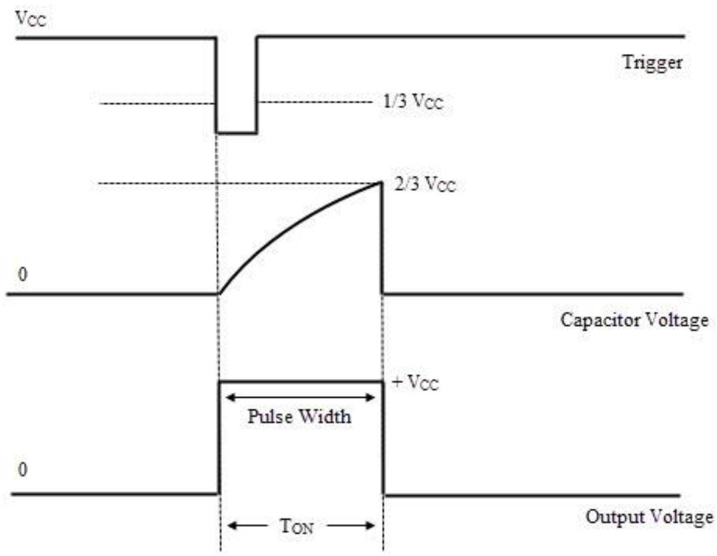


Fig. The waveform

2. SEQUENCER CIRCUIT

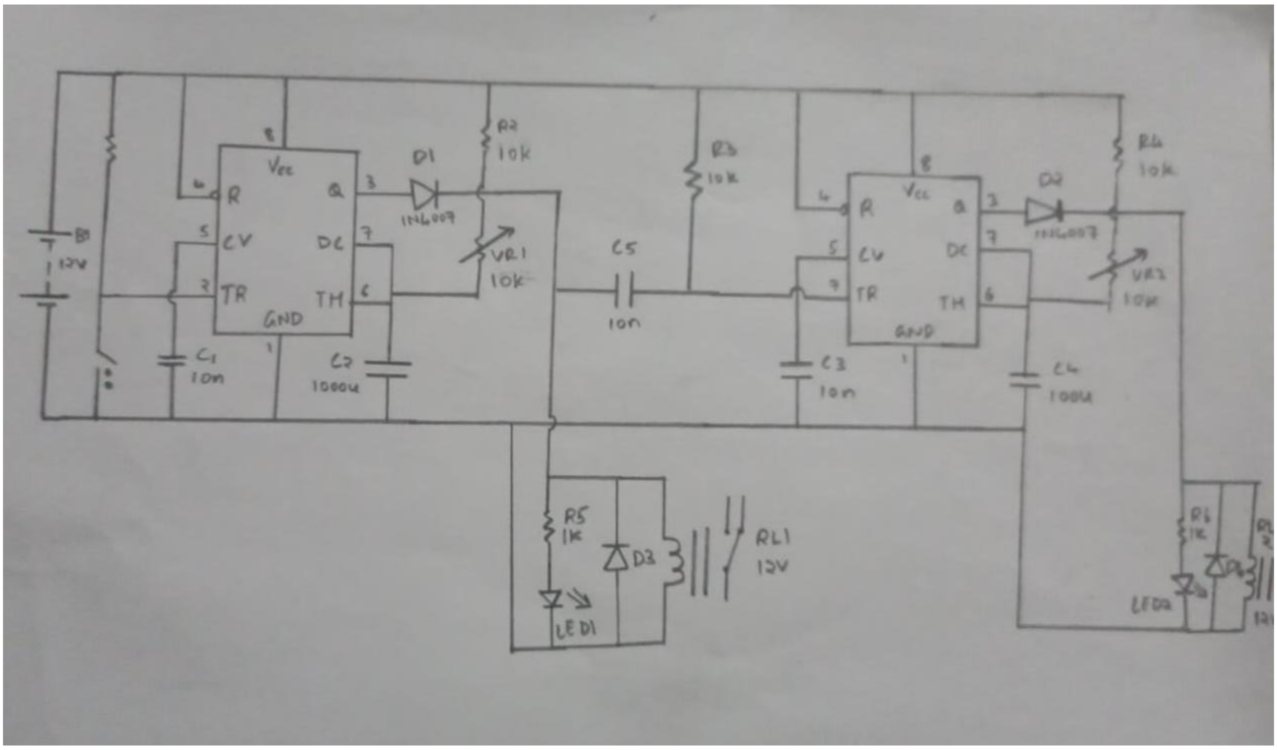


Fig. Circuit diagram of the dual sequencer

The dual sequencer circuit is essentially two timers which need to start in a sequence, i.e., the second timer should turn on once the output of the first timer falls down to the stable after staying in the unstable state for the required time period. Hence we connect a capacitor between the output of the first and the trigger pin of the second monostable multivibrator.

As the multivibrator needs a negative trigger signal to get activated, the connecting capacitor produces a negative pulse once the voltage across it changes from 5v to 0v. This trigger in turn activates the second timer. A point to be noted here is that at the instance the first timer moves from the stable state to the unstable state, the capacitor produces a positive trigger, which is again incapable of activating the second timer.

Now, the time periods of the timers can be adjusted through the potentiometers (through the formula mentioned in the above section) and the circuit is ready to drive two processes sequentially for the required durations.

Calculations:

As the time period of each of the timer is

T= R*C*1.1 seconds

The range of time the first timer can operate for is,

Tmin = 1.1 * 10k * 1000u = 11 s

Tmax = 1.1 * 20k * 1000u = 22 s

The range of time the second timer can operate for is,

Tmin = 1.1 * 10k * 1000u = 11 s

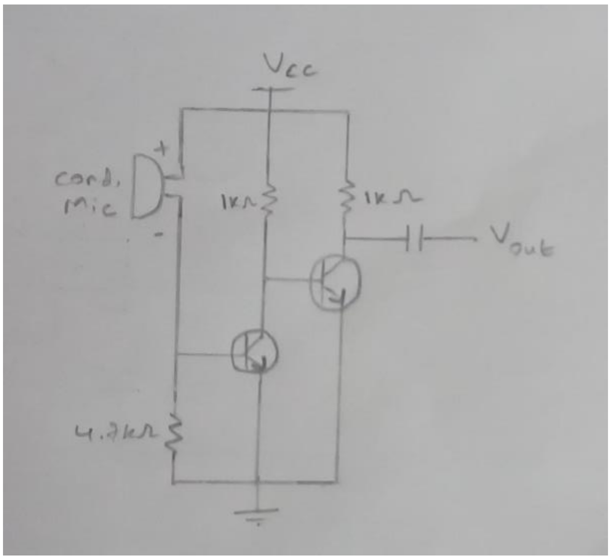
Tmax = 1.1 * 20k * 1000u = 22 s

In general, T = 1.1 * (10k+R) * 1000u

(where R is the value of the variable resistance)

3. CLAP CIRCUIT

The clap circuit's main purpose is to generate a trigger pulse upon receiving any sound input. The condenser microphone is used for taking the sound input.



The clap switch has two major parts – the sound sensor and the signal conditioning network.

The sound sensor used here is the condenser microphone (discussed in the section above).

The signal condition network, as shown in the above given diagram uses two BC547 Bi polar junction transistors and three resistors. The circuit's function is to generate a negative trigger pulse with a change in voltage across the condenser microphone, i.e., generating a trigger pulse from the Vout terminal upon receiving a clap or equivalent noise.

4. POWER SUPPLY

The power supply circuit employed uses a step down transformer to convert the 220V AC voltage from the mains supply to 12V AC. This step down transformer is followed by a bridge rectifier circuit which rectifies the stepped down voltage.

A capacitor of 1000uF has been used prior to the 12V regulator IC to filter the rippled response of the bridge rectifier.

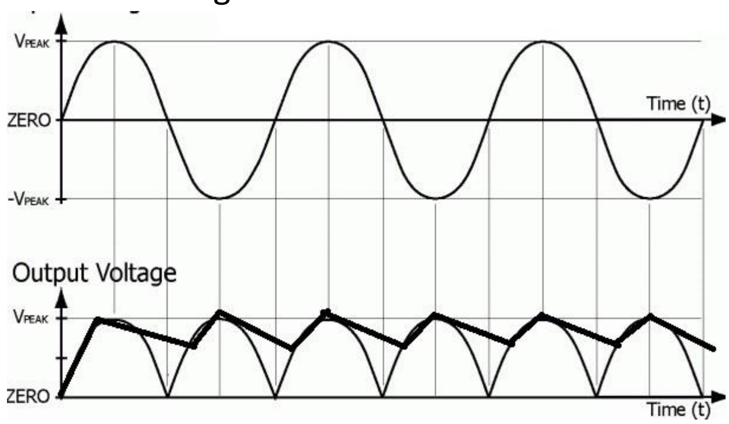


Fig. The input, full wave rectified and filtered response of the rectifier

The IC 7812 is then used to further regulate the rectified voltage to generate a stable 12V DC voltage supply.

Circuit diagram:

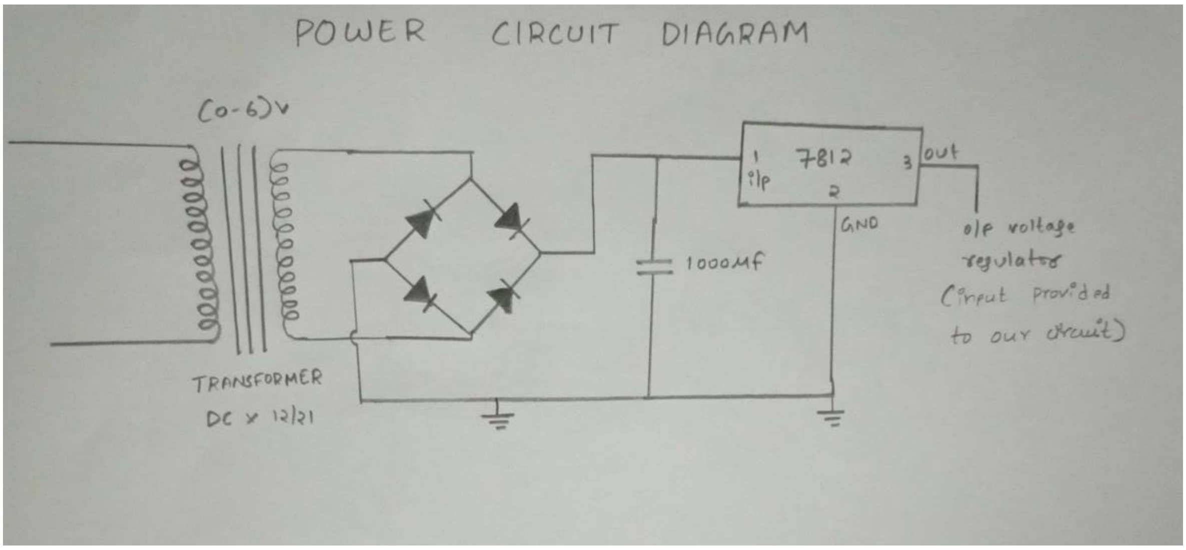
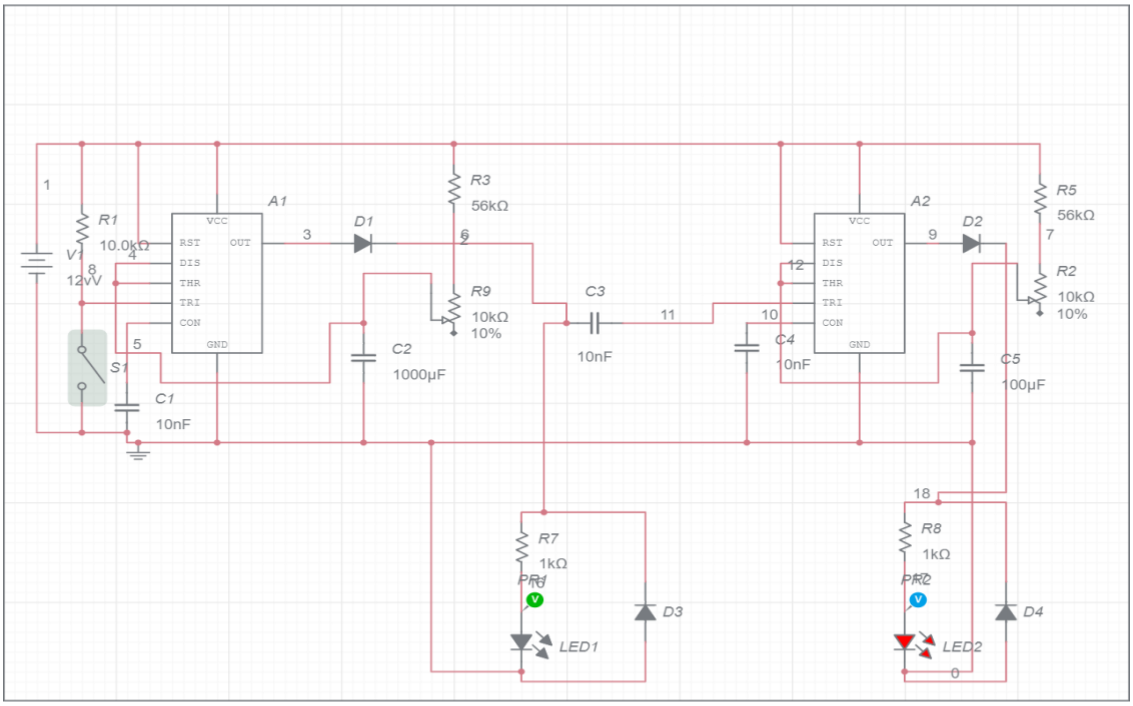


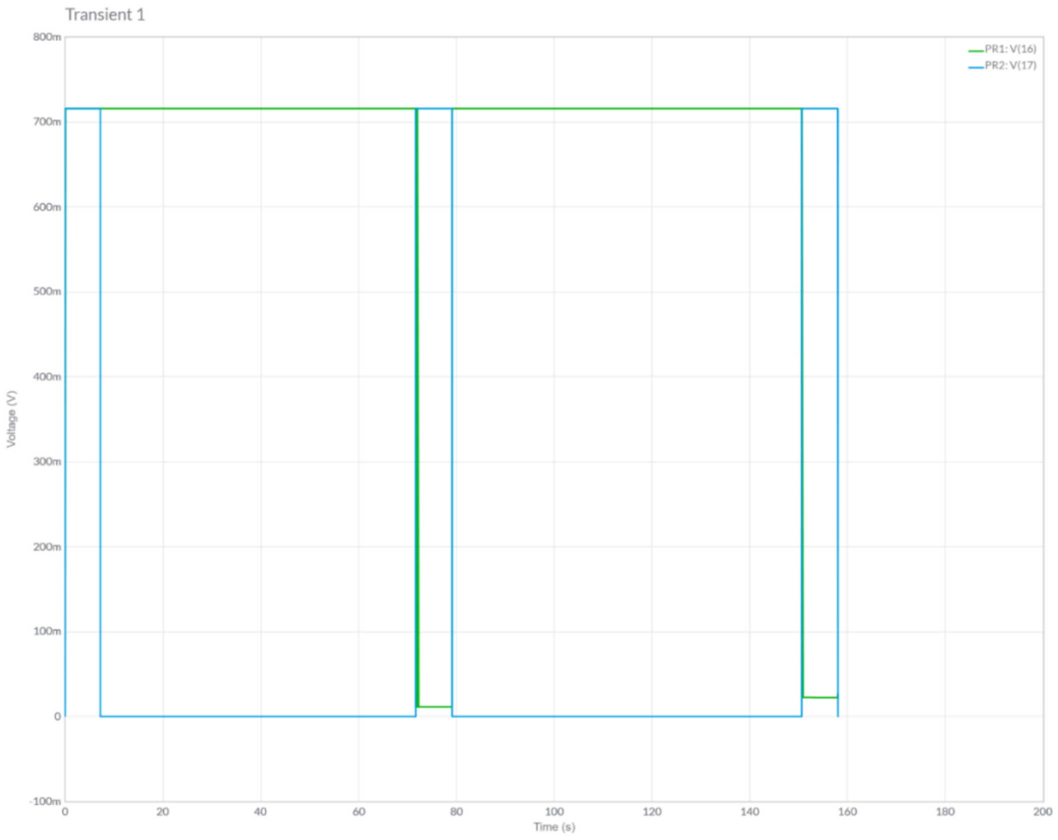
Fig. Circuit of power supply

VIRTUAL SIMULATION RESULTS

The dual sequencer circuit has been simulated in MultiSim and the real time analysis had been performed to obtain the output waveforms.



The above was the schematic circuit simulated in MultiSim and below is the obtained result



APPLICATIONS

A dual timer sequencer, also known as a dual time-based sequencer or dual-channel timer sequencer, is a device or system that controls the sequencing of events or processes based on multiple timers or time intervals. It can be implemented using various technologies, including digital logic circuits, microcontrollers, or software programs. The application of a dual timer sequencer depends on the specific requirements and can vary across different industries and fields. Here are a few examples:

Industrial Automation: Dual timer sequencers are extensively used in industrial automation systems to control the timing and sequencing of various processes. For instance, in a manufacturing assembly line, a dual timer sequencer can coordinate the movement of robotic arms, conveyor belts, and other equipment, ensuring precise timing and synchronization of operations.

Lighting Control Systems: Dual timer sequencers find applications in lighting control systems, such as stage lighting for performances, architectural lighting for buildings, or even automated lighting setups for residential or commercial spaces. The sequencer can control the timing and intensity of different lights, creating dynamic lighting effects or programmed sequences.

Traffic Signal Control: Dual timer sequencers play a crucial role in traffic signal control systems. They help regulate the timing and sequencing of traffic lights at intersections, ensuring safe and efficient traffic flow. By coordinating the green, yellow, and red signals for different directions, the sequencer optimizes traffic movement and minimizes congestion.

Irrigation Systems: In agriculture and landscaping, dual timer sequencers are used in automated irrigation systems. They control the activation and duration of sprinklers or drip irrigation systems based on specific schedules or time intervals. The sequencer ensures that the plants receive water at appropriate times, optimizing water usage and plant health.

Laboratory Equipment: In scientific laboratories, dual timer sequencers are utilized to automate experiments or analytical processes. They can control the timing of different steps, such as sample injections, temperature changes, or data acquisition intervals. The sequencer helps ensure precise timing and repeatability of experiments, enhancing research efficiency.

Home Automation: Dual timer sequencers can be employed in home automation systems to automate various tasks based on time triggers. For example, they can control the opening and closing of motorized curtains or blinds, turning on and off appliances or lights at specific times, or managing the timing of home security systems.

These are just a few examples, and the application of a dual timer sequencer can extend to various other fields and industries wherever precise timing and sequencing of events or processes are required. The flexibility of programming and customization allows the sequencer to adapt to specific needs in different applications.

FUTURE SCOPE

As seen in the applications, the dual sequencer is one of the fundamental blocks of many applications. As an extension to the project here, the following can be done:

- Connecting relays to the outputs of the timers to driver components requiring higher power values.
- Extending the number of sequencers by cascading the same architecture in series.
- Change the mode of activation from noise/clap to an input from any sensor, input from a button/switch, input from any previous system, etc.
- Also the range of timing can be varies by changing the values of the potentiometers used, the required values can be calculated through the aforementioned formulae.

CONCLUSION

An adjustable clap activated dual sequencer had been designed to operate for time periods varying from 10 seconds to 20 seconds (for one of the timers). The circuit can be activated through the sound of the clap of hands or any signal of equivalent amplitude and frequency.

The estimated cost of the circuit without the power supply circuit is equal to Rs. 150 and the cost including the power supply circuit can be approximates to Rs. 300. Hence, the circuit is overall quite economical.

Also, due to the compact size and low power requirements of the circuit, it can be used in many application .

The sequencer is capable of synchronising processes extremely accurately and can be used in a wide range of application – from industrial process automation to medical operations.

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