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PROJECT REPORT
ON

TIMER CONTROLLED LIGHT SWITCH

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ABSTRACT

Timer-Controlled Light Switch is constructed by using step-down transformer, full-wave center-tapped rectifier, 555 timer ICs and CD 4017 Decade counter ICs. It consists of power supply automatically switch-off circuit, resetting circuit, oscillator circuit, counter circuit and relay driver circuit. As we mount separately push button switches in Timer-Controlled Light Switch, we open or close this circuit. It is controlled on-off time interval by users. Light emitting diodes (LEDs) indicate how to operate the whole parts of Timer-Controlled Light Switch. LDR (Light Dependent resistor which consists of Timer-Controlled Light Switch is light sensor with varies light. This is used at home and factory. When we forget to shut down the electric bulb or lamp, this circuit makes automatically switch off. This is also used for security system.

CONTENTS

CHAPTER 1

In this project we introduce you to a circuit which has wide application in our daily lives; Timer-Controlled Light Switch. When it is sunset (6 p.m.), this circuit makes automatically switch on. After the duration of the time is half past four o'clock (10:30 p.m.), it makes automatically switch off. Then it makes automatically operating at 4:30 a.m.

When the sun rises, this circuit will automatically shut-down. Timer-Controlled Light Switch is very simple but you can see variations of this circuit in such as street light switches, safe alarms, etc. if this circuit is being used as part of a security system, it uses the contacts that best suit the system.

CHAPTER 2

RECTIFIER CIRCUITS

Rectifier circuits are found in all dc power supplies that operate from an ac voltage source. They convert the ac input voltage to a pulsating dc voltage. The most basic type of rectifier circuit is the half-wave rectifier. Although half-wave rectifiers have some applications, the full-wave rectifiers are the most commonly used type in dc power supplies. These two types of full-wave rectifiers:

(1) Full-wave center-tapped rectifier

(2) Full-wave bridge rectifier

2.1 The Full-Wave Center-Tapped Rectifier

The full-wave center-tapped rectifier use two diodes connected to the secondary of a centered-tapped transformer, as shown in Figure (2.1). The input voltage is coupled through the transformer to the center-tapped secondary. Half of the total secondary voltage appears between the center-tap and each end of the secondary winding.

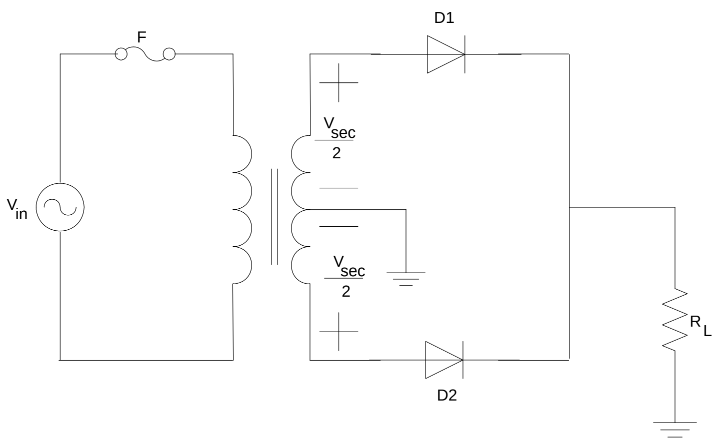


Figure (2.1) A full-wave center-tapped rectifier

For a positive half-cycle of the input voltage, the polarities of the secondary voltages are as shown in Figure (2.2(a)). This condition is forward-biases the upper diode D1 and reverse-biases the lower diode D2. The current path is through D1 and the load resistor R_L, as indicated.

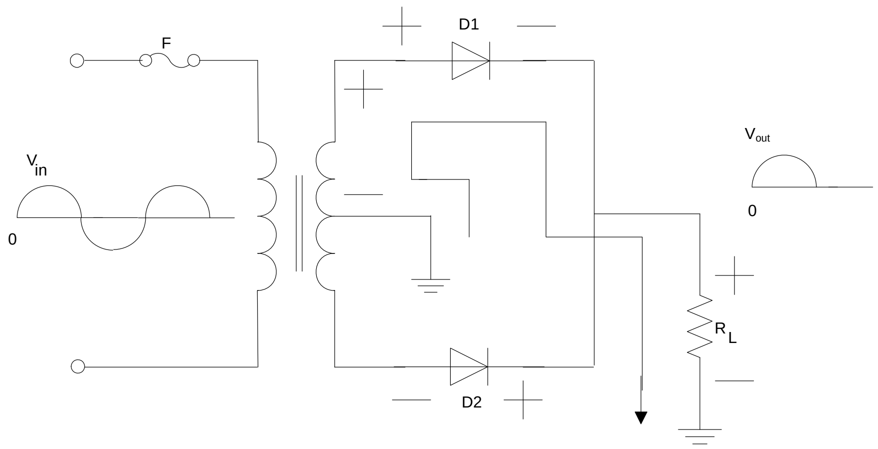


Figure (2.2(a)) During positive half-cycles, D1 is forward-biased and D2 is reversed-biased.

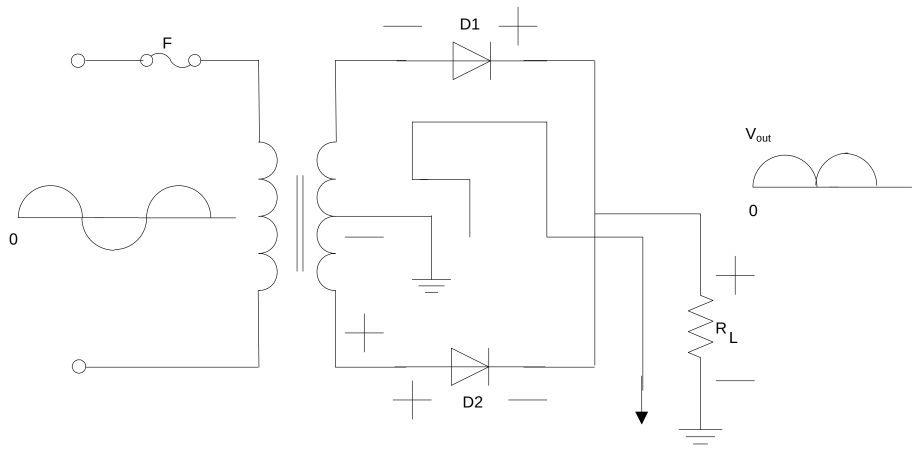


Figure (2.2(b)) During negative half-cycles, D2 is forward-biased and D1 reversed-biased

Figure (2.2) Basic operation of a full-wave center-tapped rectifier

For a negative cycle of the input voltage, the voltage polarities on the secondary are as shown in Figure (2.2(b). this condition reverse-biases D1 and forward-biases D2. the current path is through D2 and R_L, as indicated. Because the output current during both the positive and negative portions of the input cycle in the same direction through the load, the output voltage developed across the load resistor is a full-wave rectified dc voltage.

Peak value of output voltage for the full-wave center-tapped rectifier,

$$V_{P(out)} = V_{P(sec)} /2 - 0.7\ V$$

Average value of output voltage of the full-wave center tapped rectifier:

$$V_{AVG} = 2V_{P(out)} / \pi$$

Diode peak inverse voltage for the full-wave center-tapped rectifier:

$$PIV = 2V_{P(out)} + 0.7$$

CHAPTER 3

POWER SUPPLY FILTER

A power supply filter ideally eliminates the fluctuations in the output voltage of the half-wave or full rectifier and produces a constant-level dc voltage. The 60 Hz pulsating dc output of a half-wave rectifier or the 120 Hz pulsating output of a full-wave rectifier must be filtered to reduce the large voltage variations. Figure (3.1) illustrates the filtering concept showing a nearly smooth dc output voltage from the filter. The small amount of fluctuation in the filter output voltage is called ripple.

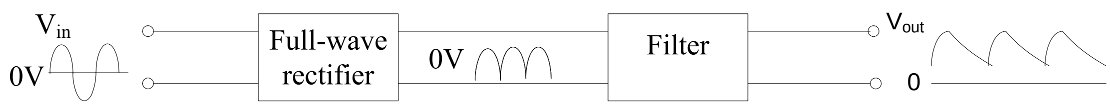
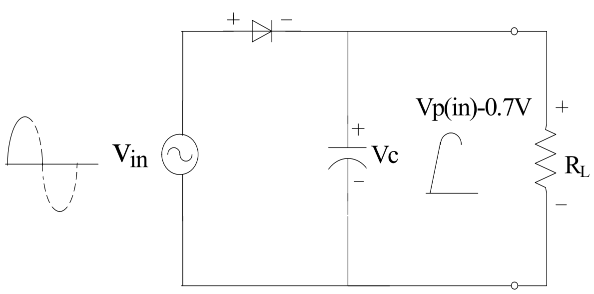


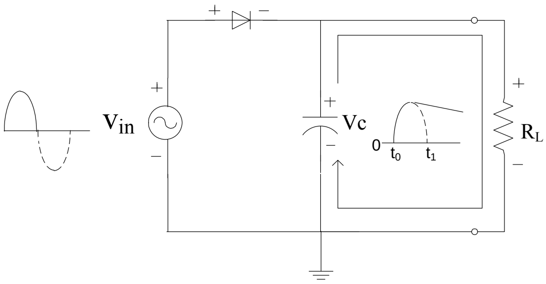
Figure (3.1) Power supply filtering

3.1 Capacitor Filter

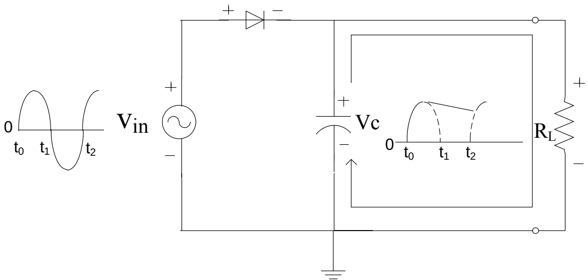
A half-wave rectifier with a capacitor filter is shown in Figure (3.2). During the positive first quarter-cycle of the input, the diode is forward-biased and presents a low resistance path, allowing the capacitor to charge to within 0.7V of the input peak. When the input begins to decrease below its peak, the capacitor retains its charge and the diode becomes reversed biased since the cathode is more positive than the diode. During the remaining part of the cycle, the capacitor can discharge only through the load resistor at a rate determined by the RLC time constant.



(a) Initial charging of capacitor (diode is forward-biased) happens only once when power is turned on



(b) Discharging through after peak of positive alternation (diode is forward-biased)



(c) Charging back to peak of input (diode is forward-biased)

Figure (3.2) Operation of a half-wave rectifier with a capacitor filter

3.2 Ripple Voltage

The capacitor charges quickly at the beginning of a cycle and showing discharges after the positive peak. The variation in the output voltage due to charging and discharging is called the ripple voltage.

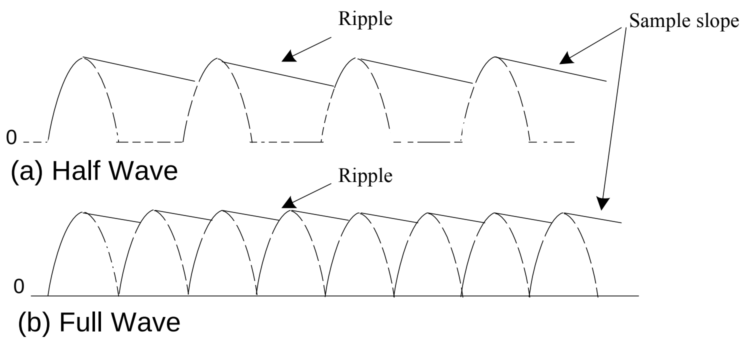


Figure (3.3) Comparison of ripple voltage for half-wave and full-wave signals with the same filter capacitor and load and derived from the same sine wave input.

CHAPTER 4

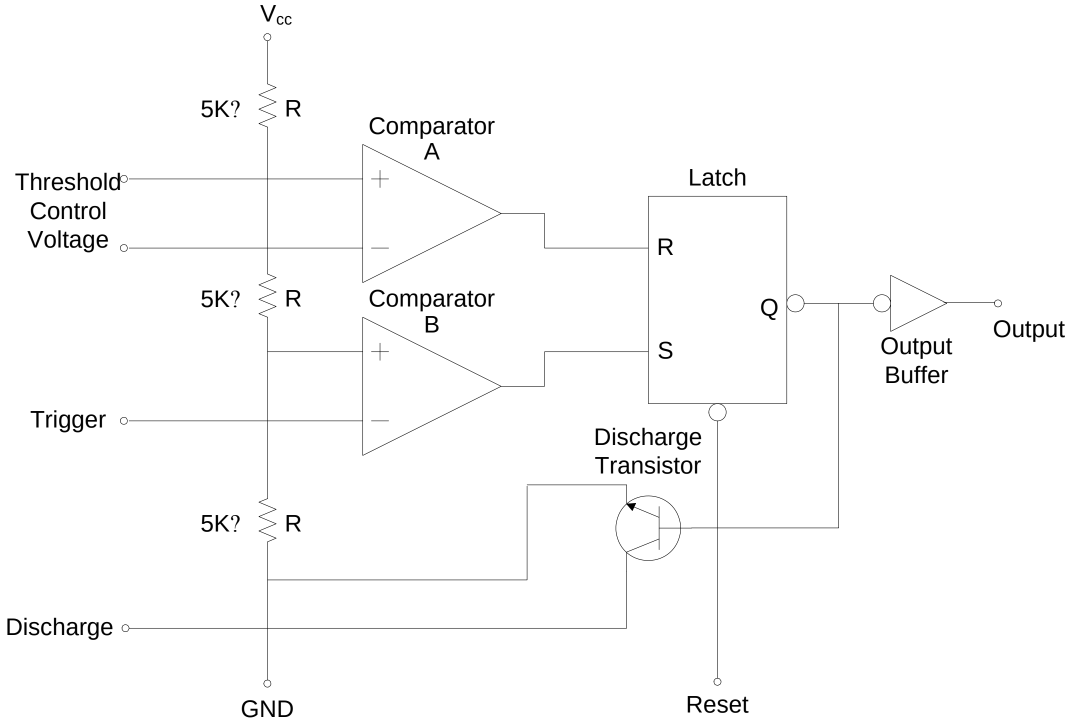
INTEGRATED CIRCUITS

An integrated circuit is a single functional block with contains many individual devices (transistors, resistors, capacitors, etc). In an IC, many interconnections between transistors and other components have been made internally with only those terminals that are necessary being made3 available externally. Integrated circuits offer higher reliability, simply because only given function can be implemented with fewer components. Probably one of the most important advantages of ICs is the high level of circuit complexity made contemplate and relatively easily implement complex systems.

4.1 The 555 Timer

The 555 Timer is an integrated circuit that can be used as an astable or monostable multibivarator for many other applications. Figure (4.1) shows a functional diagram of a 555 Timer.

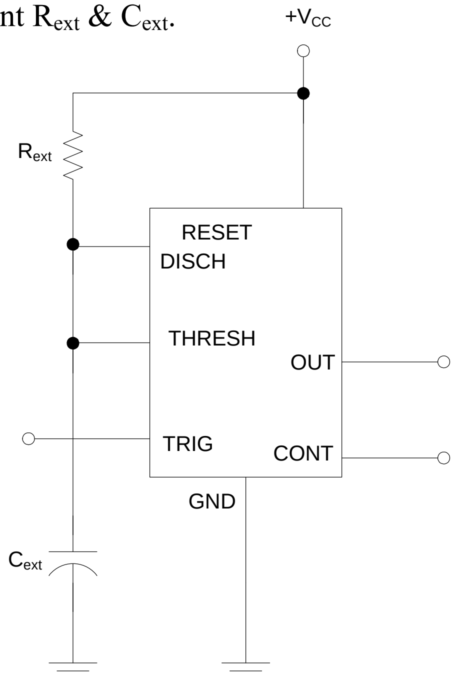
The comparators are devices whose outputs are HIGH when the voltage on the positive (+) input is greater than the on the negative (-) input and LOW when the negative (-) input voltage is greater than the positive (+) input voltage. The voltage divider consisting of three 5KΏ resistors provides a trigger level of (1/3) VCC and a threshold level of (2/3)VCC. The control voltage input (pin5) can be used to externally adjust the trigger and threshold levels to other values if necessary. When the normally high trigger input momentarily goes below (1/3)V_{CC}, the output of comparator B switches from LOW to HIGH and SETS the S-R latch, causing the output(pin3) to go HIGH and turning the discharge transistor Q1 off. The output will stay HIGH until the normally LOW threshold input goes above (2/3)V_{CC} and causes the output of comparator A to switch from LOW to HIGH. This RESETS the latch causing the output to go back LOW and turning the discharge transistor on. The external reset input can be used to RESET the latch independent of the threshold circuit. The trigger and threshold inputs (Pin2 and pin6) are controlled by external components connected to produce either monostable or astable action.



Figure(4.1) Internal functional diagram of a 555 Timer

4.1.1 Monostable (One –Shot) Operation

By connecting an external resistor and capacitor to the 555 Timer, monostable operation is achieved. If a short during negative pulse is applied to the trigger input, a single positive pulse is produced on the output. The pulse width of the output is determined by the time constant R_{ext} & C_{ext}.



Figure(4.2) the 555 Timer connected as one-shot

The flip-flop is initially set, causing the device output to be LOW. When the trigger input goes below (1/3) V_{CC},.the lower comparator triggers and reset the flip-flop, thus causing the device output to jump to the high level. During this time Q_d is turned off and the external capacitor Cext charges through R_{ext}. When the threshold voltage reaches(2/3) V_{CC}, the upper comparator triggers and set the flip-flop, thus causing the device output to switch back to its low level. At the same time, Q_d is turn on and C_{ext} discharging rate of C_{ext} determines how the output is HIGH. The length of time is determined by the following formula.

$$t_w = 1.1R_{ext}\,C_{ext}$$

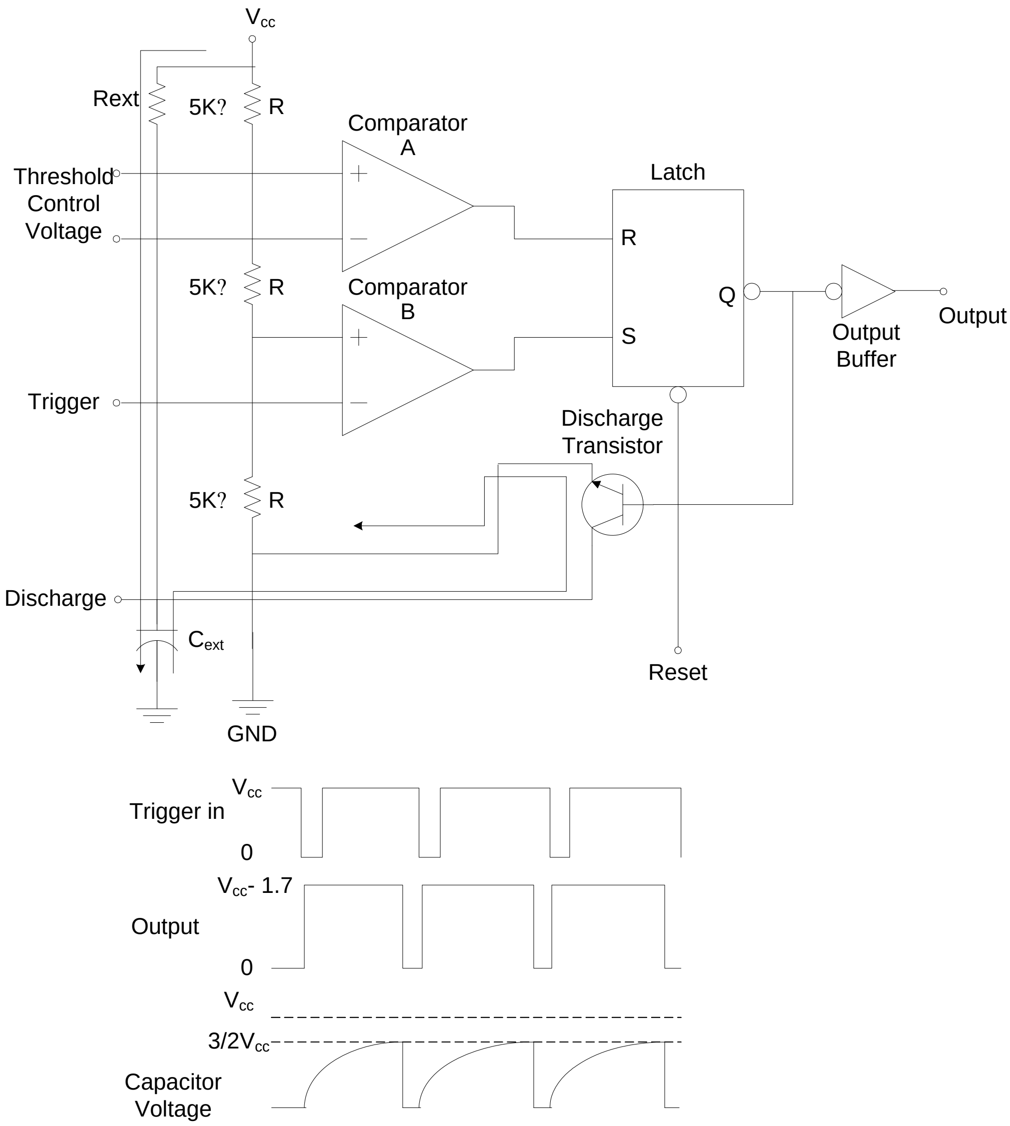


Figure (4.3) Monostable operation of the 555 Timer

4.1.2 Astable Operation

The threshold input is connected to the trigger input. When the dc power is initially turned on, the capacitor is discharge and holds the trigger voltage which is lower than (1/3) V_{CC}. This level triggers the lower comparator: causing the output to switch high and Q_d turn off. Then C_{ext} begins charging through R_1 and R_2. When the capacitor voltage reaches (2/3) V_{CC}, the output switch low and Q_d turns on. The C_{ext} discharges through R2 and Q_d. When the capacitor voltage decreases to (1/3)V_{CC}, the lower comparator again triggers, causing the output to switch back high and turn off Q_d. The cycle repeats itself and the device oscillates.

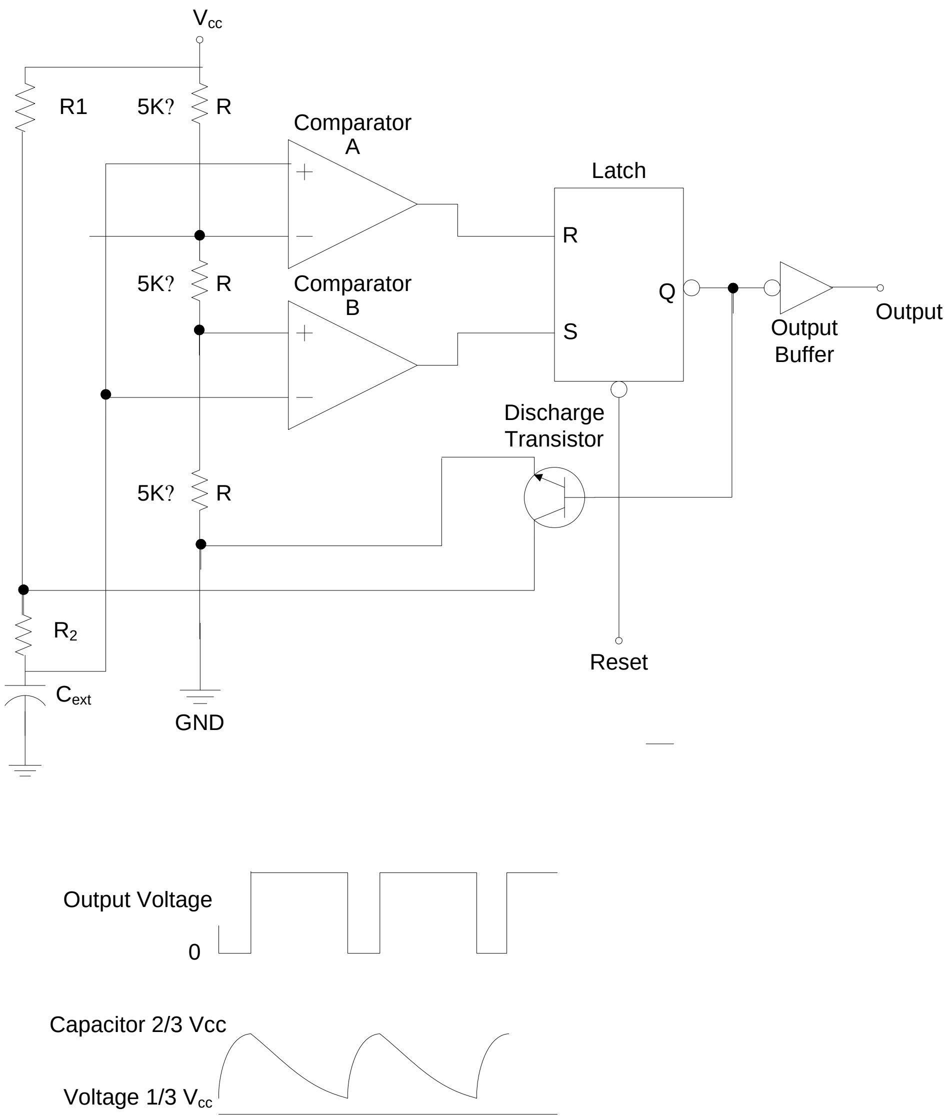


Figure (4.4) Astable operation of the 555 Timer

The frequency of oscillation is given by

$$f = 1.44/(R_1+R_2)C_{ext}$$

By selecting R1and R2, the duty cycle of the output can be adjusted. Capacitor (C_{ext}) charges through $R_1$and R_2, then discharges only through R_2.

$$\text{Duty Cycle} = (R_1+R_2)/(R_1+2R_2)$$

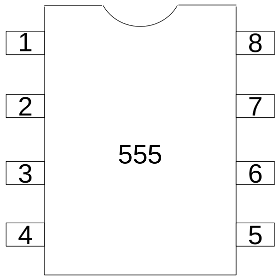


Figure (4.5) Pinout diagram for the 555 Timer

PIN 1 = Ground pin

PIN 2 = Trigger pin

PIN 3 = Output pin

PIN 4 = Reset pin

PIN 5 = Control voltage pin

PIN 6 = Threshold pin

PIN 7 = Discharge pin

PIN 8 = Supply pin

<u>Rating for 555 Timer IC</u>

Supply Voltage (V_{CC}) ---------4.5 to 15 V

Output Current ---------200 mA(maximum)

Power Dissipation ---------0.6 W

Working Temperature ---------0 ˚C to 70˚C

4.2 4017 Decade Counter IC

4017 IC is a digital IC. It is also called divided by 10 counters. Counters with ten states in their sequences are called decade counters.

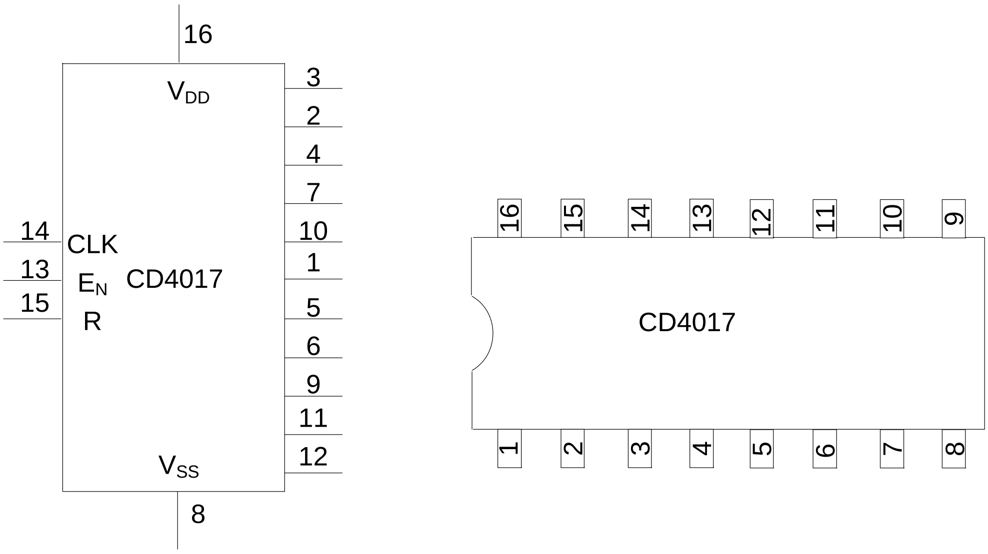


Figure (4.6) Pinout diagram and Logic diagram for CD 4017 IC

Input Pins

CLK – Clock input (Pin 14)

It performs square wave input pin. If the supply voltage gives 10V for 4017 IC, the frequency of the square wave input is below 5 MHz.

EN – Clock Enable input (Pin 13)

To perform counting, it must be connected with negative terminal of the supply voltage. If it is connected with positive terminal of the supply voltage, the counting function will stop.

R – Reset input (Pin 15)

When it is connected with positive terminal of the supply voltage, Q0 becomes high (1) and then pins (Q1 to Q9) becomes low (0). To alternate high level from Q0 to Q9, pin 15 is ground.

VDD, VSS – Supply pins (Pin 16 and Pin 8)

VDD (Pin 16) is connected with positive terminal of the supply voltage and VSS (Pin 8) is connected with negative terminal.

Output Pins

Output pins are from Q0 to Q9. When output pins (Q0 to Q9) alternate to high level.

C_0 – Carry Out

C_0 is the output pin. The square wave frequency if this pin is one-tenth of the frequency of pin 14.

Table 4.1 Decade Counter Sequence

Count	**Clock Pulse**	**Output States**									
		Q_0	Q_1	Q_2	Q_3	Q_4	Q_5	Q_6	Q_7	Q_8	Q_9
0	↑	**1**	0	0	0	0	0	0	0	0	0
1	↑	0	**1**	0	0	0	0	0	0	0	0
2	↑	0	0	**1**	0	0	0	0	0	0	0
3	↑	0	0	0	**1**	0	0	0	0	0	0
4	↑	0	0	0	0	**1**	0	0	0	0	0
5	↑	0	0	0	0	0	**1**	0	0	0	0
6	↑	0	0	0	0	0	0	**1**	0	0	0
7	↑	0	0	0	0	0	0	0	**1**	0	0
8	↑	0	0	0	0	0	0	0	0	**1**	0
9	↑	0	0	0	0	0	0	0	0	0	**1**

Rating for 4071 IC

Supply Voltage (V_{CC}) ------------------ 3 V to 15 V
Maximum Output Current ------------------- 10 mA
Power Dissipation for each output pin ------------------- 10 mW

CHAPTER 5

CONCLUSION

5.1 Working Principle of each part of Timer-Controlled Light Switch

Timer Controlled Light Switch consists of seven parts.

1. Power Supply

Power supply is the full-wave centered-tapped rectifier. The step-down transformer is reduced AC voltage from AC 220 volts to AC 12 volts. Diode D6 and D7 converted to DC voltage. C11 is the filter capacitor.

2. Automatically Switch-Off Circuit

This circuit is basically constructed on the 555 Timer IC. When the voltage of pin 2 (trigger voltage) of IC 1 goes below (1/3) V_{CC}, the output (pin3) becomes supply voltage. When threshold voltage exceeds (2/3) V_{CC}, the output pin is equal zero volt. By using voltage-divider circuit (R2 and R3), pin 6 is given about 4V (less than (2/3) V_{CC}).

If switch 1(S1) is pressed, the output (pin 3) of IC 1 reaches high-state. Pin 3 keeps this level until the voltage (pin 4) is not zero. Output pin of IC 1 (pin 3) gives as supply voltage to IC 2. When switch 2 (S2) is pressed, pin 4 becomes zero volt and IC 1 will be rest. Therefore IC 2 does not get supply voltage. By pressing S1, we can give supply voltage to IC 2 and by pressing S2, we can out supply voltage to IC2.

LED 1 displays whether the circuit gets the power or does not.

3. Trigger Circuit

IC2 is used as a monostable circuit. LDR is used as light sensor. The resistance of LDR varies with light intensity. This is inversely proportional light intensity.

LDR and VR_1 works as voltage-divider. When it becomes dark, the resistance of LDR will increase. So pin2 voltage will decrease. When pin2 voltage below $(1/3)V_{CC}$, pin3 gets high-state. This voltage is used as supply voltage to IC 3, IC 4, IC 5, IC 6. When Pin 3 of IC 2 is high state LED to will be on.

4. Resetting Circuit

IC 3 is used as monostable. When pin 3 of IC 2 becomes zero, supply voltage for IC 3 will be zero. When pin 3 voltage of IC 2 converts low state to high state, IC3 gets supply voltage. In this situation, C_4 has no voltage. So pin 2 is 0V, and pin 3 of IC3 gets high state. Pin 15 (Reset pin) of IC 5 and IC6 gets this high voltage. In 4017 IC, when pin 15 gets high states, reset the IC.

After 0.1 sec ($R_7 \times C_4 = 2.2M \times 0.047\mu F = 0.1$ sec), C_4 is full with charging and pin 2 gets high state. At the time, C_5 is charged through R_8.After the time reaches 4 minutes, C_5 reaches $(2/3)V_{CC}$.

$$
\begin{aligned}
T &= 1.1\, R_8\, C_5 \\
&= 1.1 \times 470K \times 470\mu F \\
&= 1.1 \times 470 \times 10^3 \times 470 \times 10^{-6} \\
&= 243 \text{ seconds} \\
&= 4 \text{ min } 3 \text{ s}
\end{aligned}
$$

After the time reaches 4 minutes, C_5 voltage (pin 6 of IC 3) is greater than $(2/3)V_{CC}$, Pin 3 of IC3 (pin 15 of IC 5 and IC 6) is back to its low level.

5. Oscillator Circuit

IC 4 is used as astable circuit. IC 4 will produce square wave.

The frequency of oscillation is

$$
\begin{aligned}
f &= \frac{1.44}{(R_9 + 2R_{10})C_7} \\
&= \frac{1.44}{(120K + (2 \times 330K)) \times 1000\mu F} \\
&= \frac{1.44}{780 \times 10^3 \times 1000 \times 10^{-6}} \\
&= 0.00185 \text{ Hz}
\end{aligned}
$$

For 1 cycle,

$$T = \frac{1}{f}$$

$$= \frac{1}{0.00185}$$

$$= 541.7 \text{ seconds}$$

6. Counter Circuit

When the base voltage of transistor is greater than 0.6 V, the relay pulls in.

7. Relay Driver Circuit

When the base voltage of transistor is greater than 0.6 V, the relay pulls in.

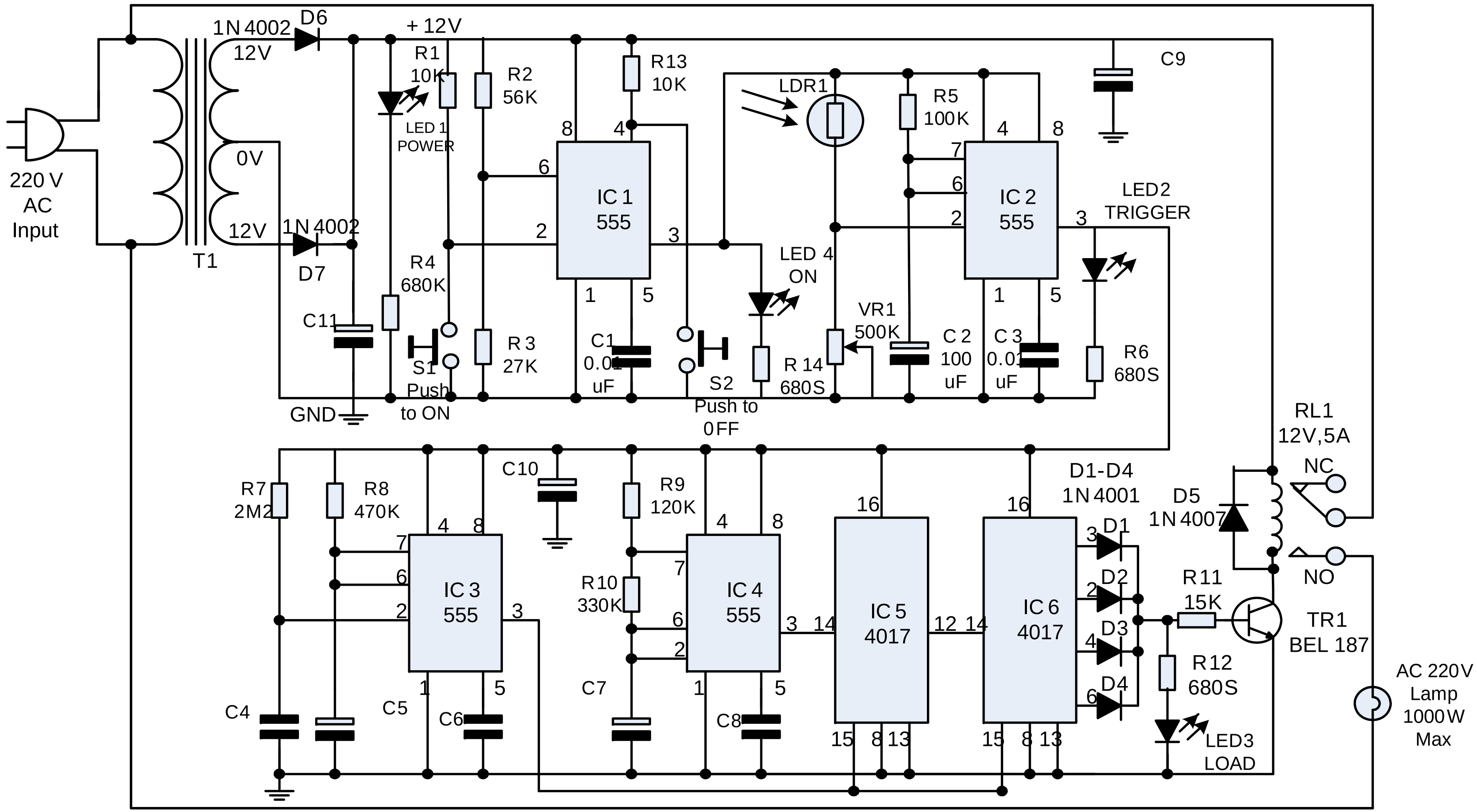


Figure (5.1) Circuit Diagram of Timer-Controlled Light Switch

5.2. The Whole operation of Timer-Controlled Light Switch

If S1 is pressed, the output pin of IC 1 gets 12V and trigger circuit IC2 gets supply voltage.

When it is dark, the resistance of LDR increases. Therefore the voltage across on LDR will increase. The voltage across of VR 1 will decrease. And the pin 2 voltage below (1/3)V_{CC}. So pin 3 of IC 2 will keep high level till morning.

So IC3, IC 4, IC5, IC6 gets 12 V. at this time, C_4 has not charged. So pin of IC3 is 0V, therefore the output of IC 3 V becomes 12V. output pin of IC 3 is connected with pin 15 of IC5 and IC 6, they will be low. Then reset pin (pin 15) of IC5 and IC6 is zero and the output pins of these IC will convert high state alternatively according to output wave of IC4.

Output pins of IC6 will charge to high state alternatively 90 minutes last.

541.7 sec	=	9 minutes (Time period of IC4)
9 minutes $\times 10$	=	90 minutes

Components List of Timer-Controlled Light Switch

Resistors

R_1, R_{13}	10 KΩ
R_2	56KΩ
R_3	27KΩ
R_4, R_6, R_{12}, R_{14}	680Ω
R_5	100KΩ
R_7	2M2Ω
R_8	470KΩ
R_9	120KΩ
R_{10}	330KΩ
R_{11}	15KΩ
VR_1	500KΩ

Output	The time at high state	Condition of Lamp
Q0(pin 3)	6:00 pm to 7:30 pm	On
Q1(pin 2)	7:30 pm to 9:00 pm	On
Q2(pin 4)	9:00 pm to 10:30 pm	On
Q3(pin 7)	10:30 pm to 12:00 midnight	Off
Q4(pin 10)	12:00 pm to 1:30 am	Off
Q5(pin 1)	1:30 am to 3:00 am	Off
Q6(pin 5)	3:00 am to 4:30 am	Off
Q7(pin 6)	4:30 am to 6:00 am	On

Switch S2 is manual switch.

Capacitors

C_1, C_3, C_6, C_8	0.01 μF
C_2	100 μF(16V)
C_4	47nF(0.047 μF)
C_5	470 μF(16V)
C_7	1000 μF(16V)
C_9	100 μF(25V)
C_{10}	10 μF(16V)
C_{11}	1000 μF(25V)

Diodes

D_1-D_4	1N4001
D_5	1N4007
D_6, D_7	1N4002
LED_1-LED_4	(Power, ON, Load, Trigger)
LDR_1	

Transistor

TRI	C1384

Transformer

T_1	12V-0-12V

Electric Bulb	220 V AC, 60 W

Relay

RL_1	12V, 5A

ICs

IC1, IC2, IC3, IC4	555 Timers
IC5, IC6	CD 4017 Decade Counter IC

Miscellaneous Switch

Push-button switch

PCB, Solder, Wires & Sockets etc.

REFERENCES

(1) Floyd, Thomas L.
“Electronic Devices”
Fourth Edition, Prentice Hall, Inc., 1996.

(2) **U Maung Maung Myat**
Applied Electronic Circuit Manual (Volume 2)