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Forming a transistor test circuit by using 555 timer

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Abstract

* In this research we have formed a circuit to exam the transistors of the types npn and pnp and detect the transistors that work from the damage .

* We used the formation of this circuit on the basic component is the 555 timer , and we used several other pieces of electronic will come to mention later.

* We tested many transistors by the previous circuit.

key words : The 555 Timer - AStable - Transistor - Operational amplifier - Comparator - Optical LEDs.

الملخص :

* لقد قمنا في هذا البحث بتشكيل دائرة لفحص الترانزستورات من النوعين npn و pnpوكشف الترانزستورات التي تعمل من العاطلة .

* اعتمدنا في تشكيل هذه الدائرة على مكون أساسي وهو المؤقت 555 ، كما استخدمنا عدة قطع الكترونية أخرى سوف نأتي على ذكرها لاحقاً .

* فحص العديد من الترانزستورات بواسطة الدارة السابقة .

الكلمات المفتاحية : المؤقت 555 – عديم الإستقرار – الترانزستور – المضخم العملياتي – المقارن – ليدات ضوئية .

1. Introduction:

The transistor is one of the most important electronic elements that have been discovered, consist of two in front of or opposite diodes in the direction and two components in one chip are the transistor[2].

Since the transistor is important in the design of electronic circuits, we must before using it to know whether it works or not, and to know if there is within the circuit any a defect, we have to exam the elements, especially transistors which are essential elements of the most important in electronic circuits[3,5].

Transistor damage occurs due to several factors such as temperature, sudden (height or down) of electric current, electrical and magnetic fields, corrosion of printed circuits, or due to fault in bias efforts which are coming to it by resistant which connected to it, Also, maybe a short circuit in the transistor load circuit causes damage, but to make sure the transistor is damaged or not we must test this transistor, where there are many ways to test this component and one of these methods is how we were able to apply by using the 555 timer.

Where it was used as an Astable oscillator [4],Figure.1 shows how to connect the 555 timer to work in AStable mode or called "Free running", The waveforms shown in Fig. 2 show us how to charge and discharge the capacitor C connected externally to the chip, and how the output voltage varies between the values +Vcc (the values of source voltage) and (0).

To explain how the circuit works, We assume that the output of the S-R circuit is in the high state (the time T_1 in the output form). This output of the S-R circuit will reflect to the low state, thus making the internal discharge transistor in OFF state .

With this transistor in OFF state, the outer capacitor (C) starts charging in +Vcc direction through the R_A and R_B resistors and at time T_2, the charge on the capacitor is up to 2/3 Vcc and the output of comparator circuit A will be (High), because the voltage on the other side is 1/3 Vcc and makes the S-R circuit in the state (RESET) and becomes Q=0, This makes the output (pin 3) of the 555 timer at the level (LOW), so the base of the discharge transistor becomes (High) , Making it in ON mode.

With this transistor in position (ON), the capacitor C begins to discharge its charge at time T_3, the charge has reached 1/3Vcc, and as a result, the output of the comparator B will be at the High level and the R-S circuit in (SET) and Q = 1, or return to the original state and the

discharge transistor is again in OFF state and the capacitor C is allowed to charge and the cycle is repeated.

As shown in Fig. 1, capacitor C is charged through R_A and R_B resistors to 2/3Vcc and is discharged through the R_B resistance to 1/3 Vcc voltage, the time t_p (positive time) can be calculated by the relationship [1] :

$$t_p = 0.693*(R_A + R_B)*C$$

And time t_n (Negative time) can be calculated by relationship:

$$t_n = 0.693*R_B*C$$

The time T (full cycle time) is the total time t_p and the time t_n:

$$T = t_p + t_n = 0.693*(R_A + 2R_B)*C.$$

The output frequency can be calculated for 555 timer by the relationship:

$$F = 1 / T = 1 / 0.693*(R_A + 2R_B)*C$$

The previous relationship can be written as :

$$F = 1.43 / (R_A + 2R_B)*C$$

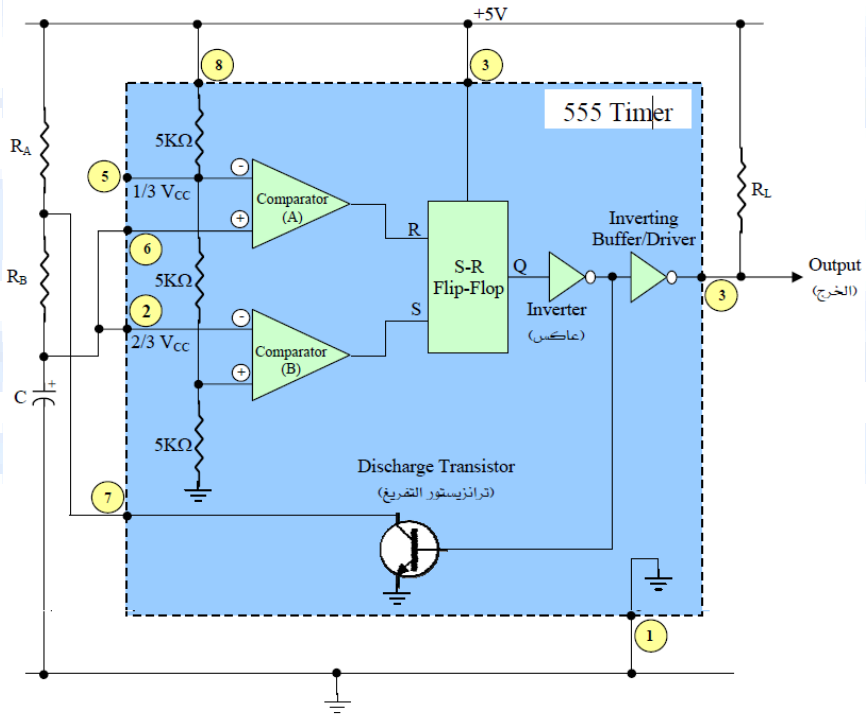

Figure. 1. AStable 555 timer

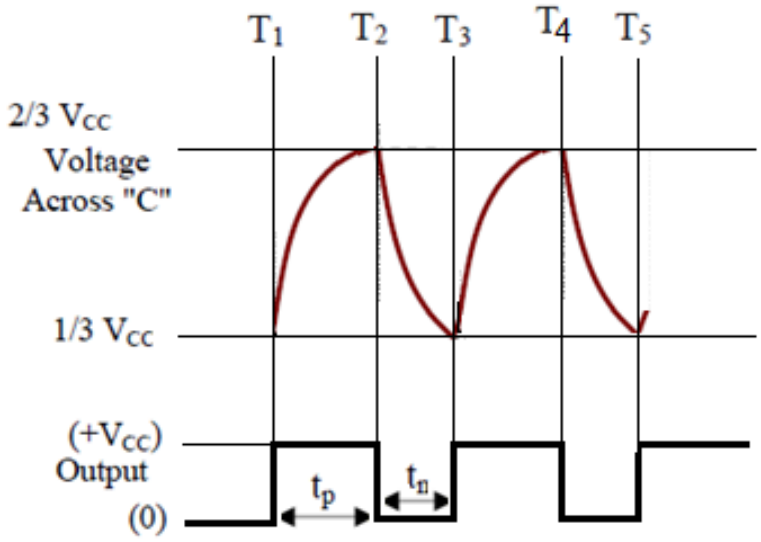

Figure. 2. The output signal for the AStable 555 timer

2. Material and Methods :

In the electronic lab located in the Physics Department of (Faculty of Arts and Sciences /Almarj) - University of Benghazi has formed a transistor test circuit and test it , and Fig.3 shows the circuit.

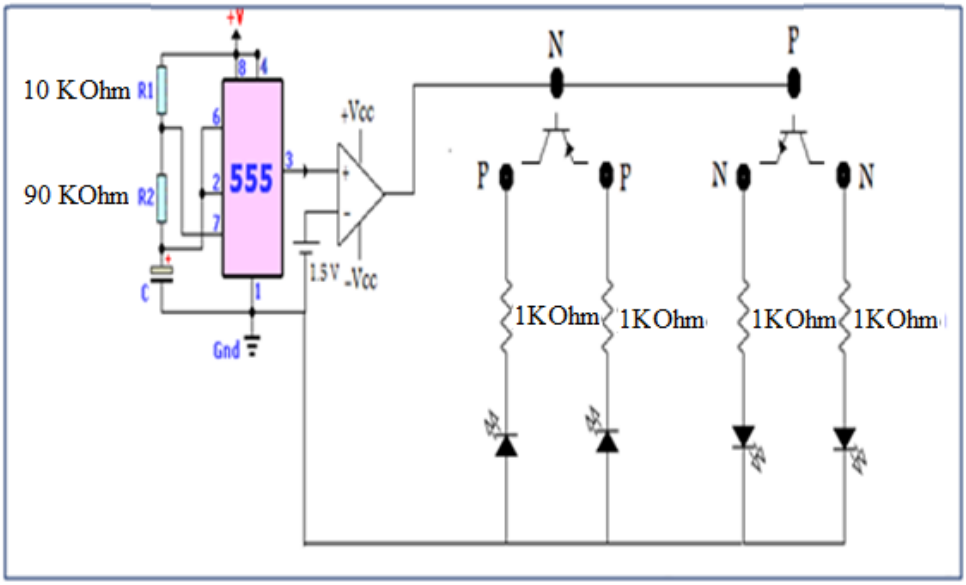

Figure. 3. The operation circuit of a transistor test by 555 timer

2.1.Circuit elements :

1. Integrated circuit IC 555.
2. Operational amplifier IC 741.
3. Set of resistors [90 KΩ, 10 KΩ, 1 KΩ] .
4. Two capacitors (10 µF, 1 µF).
5.Optical LEDs (number 4).
6. Battery 1.5 V.
7. Several transistors (npn, pnp) for testing.

3- Results and Discussion:

The integrated circuit IC555 has been connected to work as an AStable oscillator in times given with the following relationship:

$$t_{on} = 0.693 * (R_1 + R_2) * C$$

$$t_{on} = 0.693 * [(10 + 90) * 10^{+3}] * 10 * 10^{-6} = 693 * 10^{-3} \text{ Sec}$$

$$t_{off} = 0.693 * R_2 * C$$

$$t_{off} = 0.693 * 90 * 10^{+3} * 10 * 10^{-6} = 623.7 * 10^{-3} \text{ Sec}$$

The output of this circuit gives a square signal of (1 and 0) as explained above, to achieve the previous test circuit, the previous signal must be made positive and negative, to achieve this, we placed the output of the integrated circuit IC 555 comparator .

The comparator works as follows:

From the operational amplifier (IC 741)[6], the non inverter input was connected to the 555 output and the inverter input was connected to the 1.5 V battery (Which we consider here to be a reference signal where it is compared with the signals applied to the non inverter input), the operational amplifier was fed (±5V) when the input signal value is greater than the reference signal value, the output voltage is positive $V_O=+V_{CC}$ When the input signal value is less than the reference signal value, the output voltage is negative $V_O = -V_{CC}$, Thus we will obtain the output of the comparator on the positive and negative pulse signal, including the transistors for the examination and the examination is as follows:

3.1. First: (npn transistor):

It is known that the transistor of whatever type, it consists of two diode are connected to each other from the positive side we get the npn transistor as in Fig.4 :

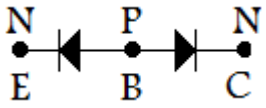

Figure. 4. The npn transistor

Note from the figure that the transistor consist of two junction, the first junction is (B-E) mean that (base - emitter) and the second junction (B-C) mean that (base - collector) and thus:

*** When positive pulse:**

(B-E) and (B-C) will be directly bias, meaning that both diodes are (on) state, and the current will be pass through the diodes and the optical LEDs will be light up .

*** When negative pulse:**

(B-E) and (B-C) will be reverse bias, meaning that both diodes are (off) state,and the current will be not pass through the diodes in it and the optical LEDs will be not light.

In the end, the transistor works, but if the above does not happen, the transistor is damaged or maybe not npn.

3.2.Second: (pnp transistor):

In the same way, if the two diodes are connected to each other from the negative side, we obtain an pnp transistor as in fig.5 :

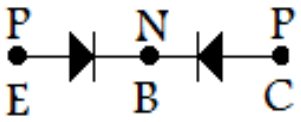

Figure. 5. The pnp transistor

*** When positive pulse:**

(B-E) and (B-C) will be reverse bias, meaning that both diodes are (off) state, and the current will be not pass through the diodes in it and the optical LEDs will be not light.

*** When negative pulse:**

(B-E) and (B-C) will be directly bias, meaning that both diodes are (on) state, and the current will be pass through the diodes and the optical LEDs will be light up .

In the end, the transistor works, but if the above does not happen, the transistor is damaged or maybe not pnp.

4.Conclusion:

We have done several tests by a circuit that has been formed on many transistors of both types to detect whether they work or are damaged. We have obtained 100% correct results. All transistors were either damaged or working.

We also detected transistor damage in a device in laboratory by this circuit and replaced the transistor to return the device to work again.

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