

Position and Timing Control with DC Motor Using 555 Timer

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Abstract

There are several of control circuits controlling motor, any programmable timers could control the motor, it can be simple to very complicate depending on the requirement by user. However, the main advantage of using 555 timer is because that it does not require coding. User can adjust position and timer control by picking up different Resistors and Capacitors. It is widely used in many applications and widely available. In addition, the 555 timer has lots of uses such as mark space adjustment, and inductive current Detection.

Key Word

555 Timer, DC motor, flipper

Introduction

555 timer is widely used in various field, there are two main models in the data sheet Mono stable mode and astable model, the main difference between them in our design is depend on if you want the initial setting to be high or low. It can also operate in high voltage (5-15v) range, it is high powered and at the same time able to be triggered by small current.

Objective

The purpose of develop 555 timer control is to set the position and timing of a flipper which is attached to DC Motor as picture below. The reason to build that is to avoid jam occurred the cutting machine operating and a lot of times, it is due to the ribbon stuck in the clipper, if a flipper is attached underneath clipper and rotate only once after the clipper open, it could successfully reduce the times jam occur.



3. Implementation

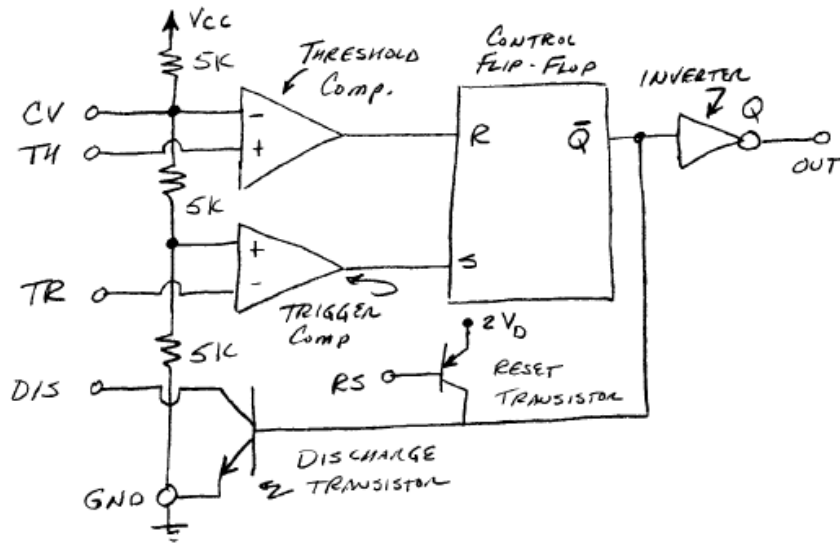


Figure 1.1 Timer function block diagram

3.1) Basic description of how 555 timer works

R-S flip-flop states:

R	S	Q	Q'
Low	Low	No change	No change
Low	High	High	Low
High	Low	Low	High
High	High	High	Low

According to figure 1.1 and the table above (1) when Q' is low, discharge transistor is cut-off, when Q' is high, discharge transistor is saturated. (2) When the reset pin is high, the reset resistor is cut-off and when the reset is low, the discharge transistor is saturated and Q' is forced high, Q is then low. (3) Threshold comparator is low when $V_{th} < 2/3V_{cc}$ and threshold

comparator is high when $V_{th} > 2/3 V_{cc}$. (4) trigger comparator is low when $V_{tr} > 1/3 V_{cc}$ and trigger comparator is high when $V_{tr} < 1/3 V_{cc}$. (5) The CV pin allows us to change the voltage divider preference. When a voltage V_{cv} is applied, $2/3 V_{cc}$ becomes V_{cv} and $1/3 V_{cc}$ becomes $1/2 V_{cv}$.

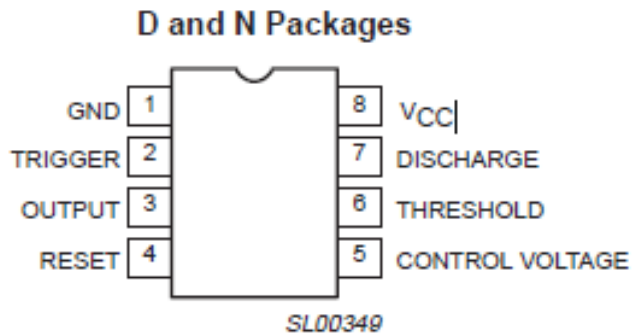


Figure 1.2 Pin configuration

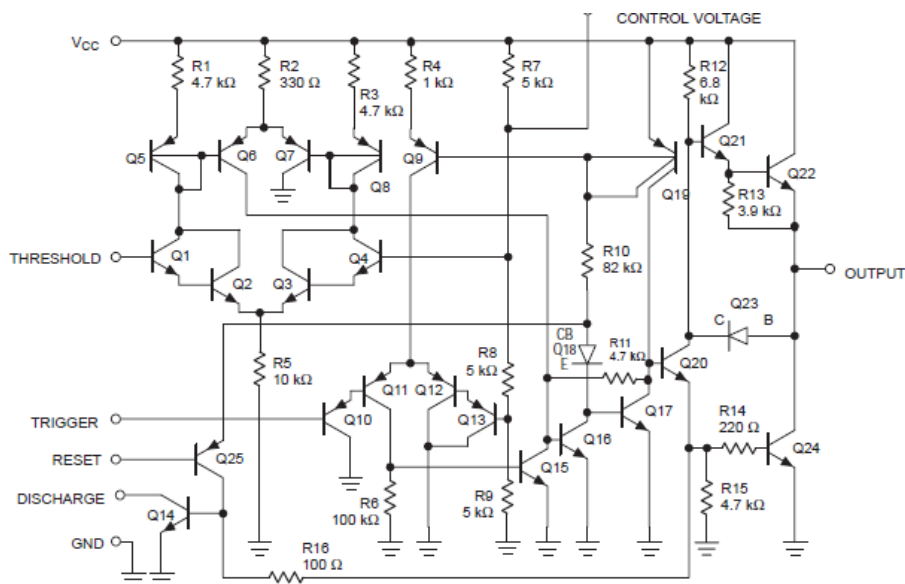


Figure 1.3 equivalent schematic

3.2) Application

When the output voltage is high, the DC motor will rotate once and turned off when output is low. Based on the experiment we did, the time duration for flipper rotates for 360 degree is about half second. So the period for output goes to high is 0.5 second. The duration of next operation is depend on the length user input, however, based on the experiments, the maximum length and time for one operation could be precisely measured, as well as the shortest length. For the maximum length, the duration is approximately 8.92 seconds and approximately 4.25 seconds for minimum length. In addition, the machine may take ten seconds to set up initial position, thus the first ten seconds of DC motor should be turned off. A potentiometer will build in the control circuit to control for different time.

3.2) Astable mode

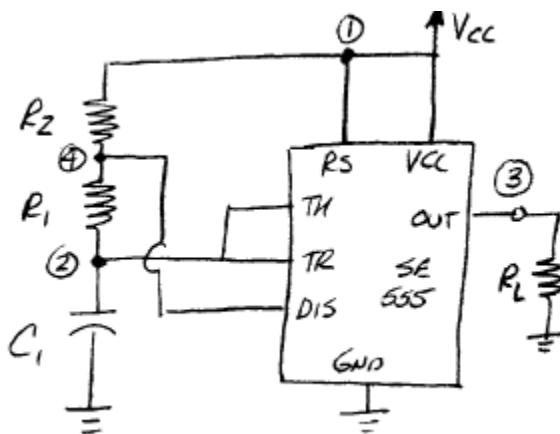


Figure 2 astable mode

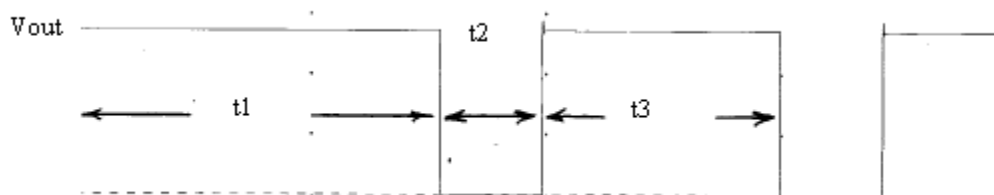


Figure 3 Output (V3) of astable mode

Equation for astable mode.

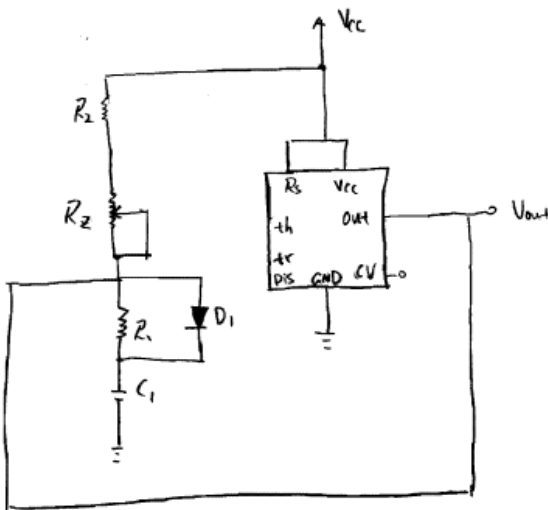
$$t_1 = (1.0986) * (R_1 + R_2) * (C_1)$$

$$t_2 = (0.693) * (R_1) * (C_1)$$

$$t_3 = (0.693) * (R_1 + R_2) * (C_1)$$

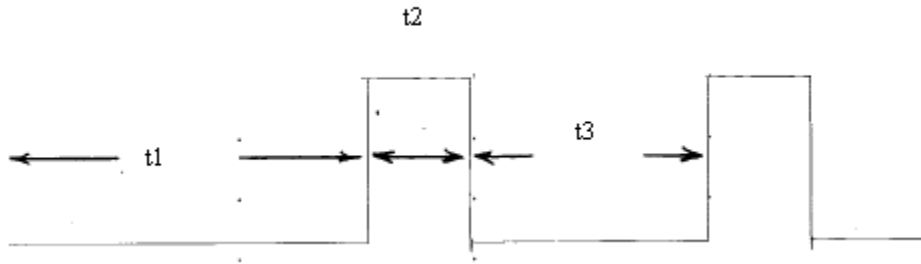
However, as figure 3, the output is working reversely as expected result and hence an inversed astable mode has to be designed.

3.3) Inversed astable mode.



Note: R_z here is controlling the time depending on the length of ribbon user input.

Output Result



$$T1 = (1.0986) * (R1 + R2 + Rz) * (C1)$$

$$T2 = (0.693) * (R1) * (C1)$$

$$T3 = t3 = (0.693) * (R1 + R2) * (C1)$$

The key to this application is D1 is reverse biased when $V_{c1} = V_{tr} = 1.3V_{cc}$. $S=1$. If the input pulse has returned to zero then $R=0$.

Conclusion

This application note describes how to control DC motor using 555 timer. Overall, there may be better way to control DC motor with precise timing and position for example microcontroller, unfortunately, some of them are tedious, some of them are not applicable in our project. The reason I pick 555 timer is that it is non-programmable and still could provide accurate timing and position. Also, in our project particularly, we do not really care where the flipper going to stop as long as it is not above 180 degree, so the only thing that I pay more attention is timing control. However, there are still some issues to bear in mind as the modifications advance. Changes will make to this document accordingly.

Reference

Wierzba, Gregory M. "ECE 402 Application of analog integrated circuit". 2010

LM-555 timer datasheet :

<http://www.national.com/mpf/LM/LM555.html#Overview>

RONALD, CHOY."THE 555 TIMER AND ITS APPLICATIONS" Ronald Choy N.p,

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