CSEE223 Lab

Name: ___________________________

Multivibrator Circuits (Multisim)

Date:_______________

Reading

Lecture on the Astable Multivibrator and Monostable Multivibrator

Objectives

After performing this experiment, you will be able to construct and understand the operation of the Astable Multivibrator (Pulse Generator) and Monostable Multivibrator (One-Shot) Circuits. **<u>Circuit construction will be accomplished via Multisim 2001.</u>**

Materials Needed

1 – IC 555
4 – Resistors 4.7kΩ and 10kΩ
2 – Capacitors .01 μF and .001μF
1 – DC power supply
1 – Oscilloscope
1 – Function Generator
1 – Windows PC with Multisim 2001

Summary of Theory and Operation

The 555 timer has two basic operational modes: **one shot and astable**. In the one-shot mode, the 555 acts like a monostable multivibrator. A monostable is said to have a single stable state--that is the off state. Whenever it is triggered by an input pulse, the monostable switches to its temporary state. It remains in that state for a period of time determined by an RC network. It then returns to its stable state. In other words, the monostable circuit generates a single pulse of a fixed time duration, each time it receives an input trigger pulse. Thus, the name, “One-Shot” is given to describe it.

Some of the applications for Monostable multivibrator, it can be a half astable multivibrator, can be used as a missing pulse detector , it can be used for speed control and measurement , it can be modified into a linear ramp generator and it can be used as frequency divider using square wave generator.

The other basic operational mode of the 555 is as an **astable multivibrator**. An astable multivibrator is simply an oscillator. The astable multivibrator generates a continuous stream of rectangular off-on pulses that switch between two voltage levels. The frequency of the pulses and their duty cycle are dependent upon the RC network values.

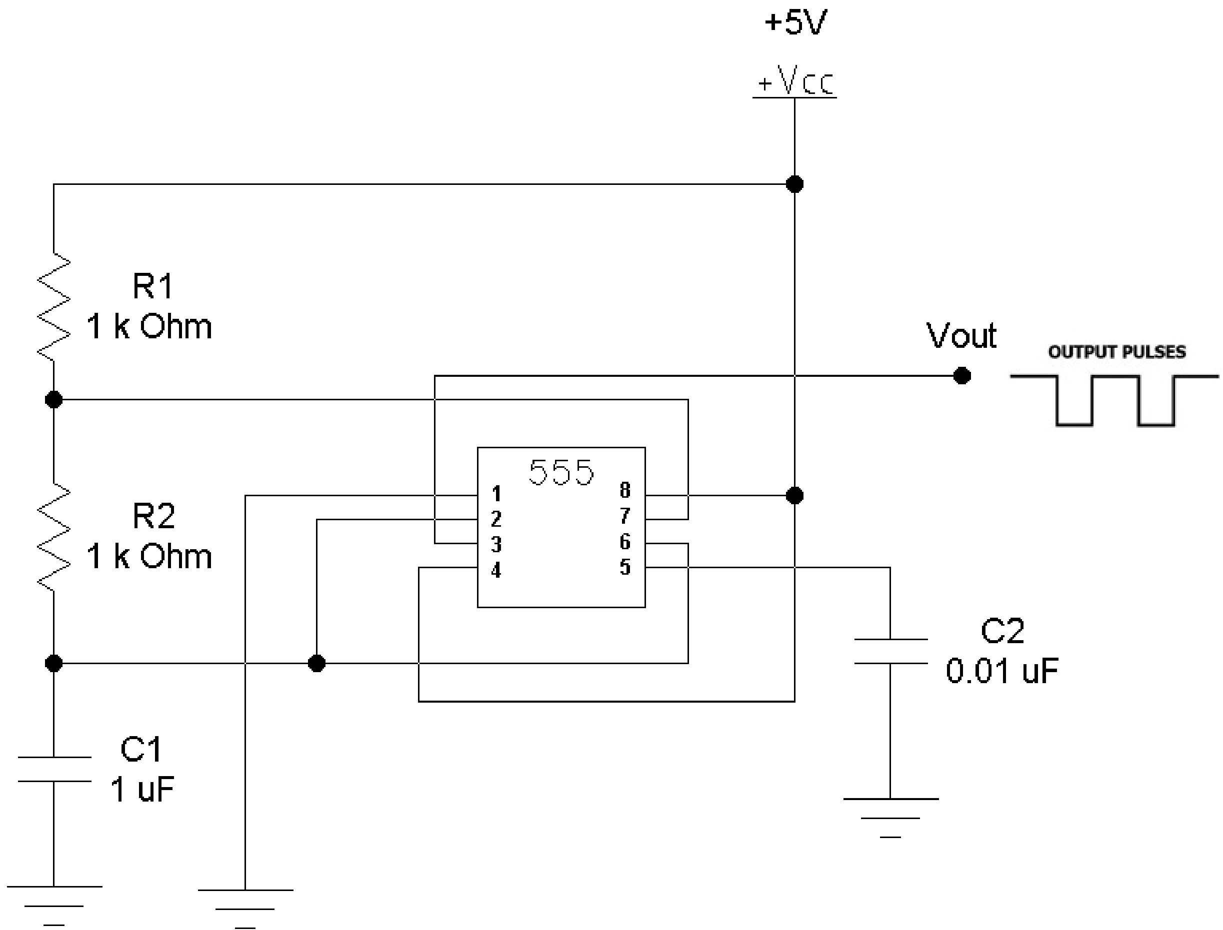


FIG 3
Astable

An astable multivibrator is a timing circuit whose 'low' and 'high' states are both unstable. As such, the output of an astable multivibrator toggles between 'low' and 'high' continuously, in effect generating a train of pulses. This circuit is therefore also known as a 'pulse generator' circuit.

The classic multivibrator circuit is also called a plate coupled multivibrator is first described by Henri Abraham and Eugene Bloch

In the circuit of FIG 3, capacitor C1 charges through R1 and R2, eventually building up enough voltage to trigger an internal comparator to toggle the output flip-flop. Once toggled, the flip-flop discharges C1 through R2 into pin 7, which is the discharge pin. When C1's voltage becomes low enough, another internal comparator is triggered to toggle the output flip-flop. This once again allows C1 to charge up through R1 and R2 and the cycle starts all over again.

The amplifying elements in the circuit of an stable multivibrator are FET, JFET, OP-AMP or all of the above

□

- ☐ **charge-up time(t_1) for C1 is given by: $t_1 = 0.693(R1+R2)C1$. (in seconds).**
- ☐ **discharge time (t_2) for C1 is given by: $t_2 = 0.693(R2)C1$. (in seconds).**
- ☐ **total period (T) of one cycle is $t_1 + t_2 = 0.693\ C1(R1+2R2)$. (in seconds)**
- ☐ **frequency (*f*) of the output wave is the reciprocal of this period, and is can be calculated by $f = 1.44/(C1(R1+2R2))$ or 1/T. (in Hertz)**

Note: Charge-up time is also known as "ON" time; Discharge time is also known"OFF''time

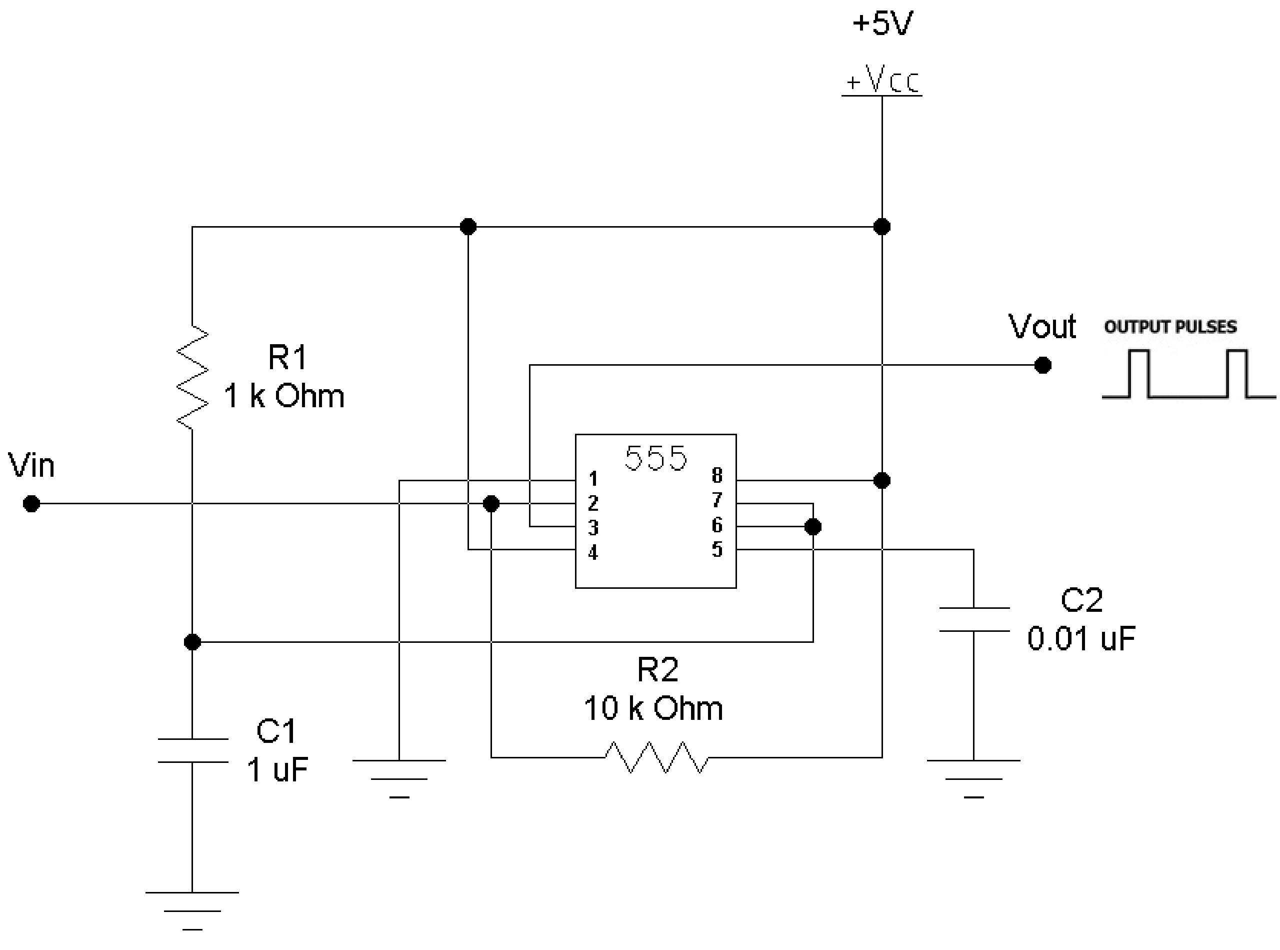


FIG 4
One Shot

In FIG 4, only two components to make up a timer, a capacitor (C1) and a resistor (R1). And for noise immunity maybe a capacitor on pin 5. Due to the internal latching mechanism of the 555, the timer will always time-out once triggered, regardless of any subsequent noise (such as bounce) on the input trigger (pin 2). This is a great asset in interfacing the 555 with noisy sources. Just in case you don't know what *'bounce'* is: bounce is a type of fast, short term noise caused by a switch, relay, etc. and then picked up by the input pin.

The trigger input is initially high (about 1/3 of +V). When a negative-going trigger pulse is applied to the trigger input (see fig. 9a), the threshold on the lower comparator is exceeded. The lower comparator, therefore, sets the flip-flop. That causes T1 to cut off, acting as an open circuit. The setting of the flip-flop also causes a positive-going output level which is the beginning of the output timing pulse.

The capacitor (C1) now begins to charge through the external resistor (R1). As soon as the charge on the capacitor equal 2/3 of the supply voltage, the upper comparator triggers and resets the control flip-flop. That terminates the output pulse which switches back to zero. At this time, T1 again conducts thereby discharging the capacitor. If a negative-going pulse is applied to the reset input while the output pulse is high, it will be terminated immediately as that pulse will reset the flip-flop.

Whenever a trigger pulse is applied to the input, the 555 will generate its single-duration output pulse. Depending upon the values of external resistance and capacitance used, the output timing pulse may be adjusted from approximately one millisecond to as high as on hundred seconds. For time intervals less than approximately 1-millisecond, it is recommended that standard logic one-shots designed for narrow pulses be used instead of a 555 timer. IC timers are normally used where long output pulses are required. In this application, the duration of the output pulse (T_{pulse}) in seconds is approximately equal to:

$$T_{pulse} = 1.1 \text{ x R1 x C1 (in seconds)}$$

The output pulse width is defined by the above formula and with relatively few restrictions, timing components R(t) and C(t) can have a wide range of values. There is actually no theoretical upper limit on T (output pulse width), only practical ones. The lower limit is 10uS. You may consider the range of T to be 10uS to infinity, bounded only by R and C limits. Special R(t) and C(t) techniques allow for timing periods of days, weeks, and even months if so desired.

The frequency of the trigger pulse waveform should have the same period length as the output pulse width $T_{(pulse)}$. Therefore the trigger pulse frequency (f) should be

$f \leq 1 \div T_{pulse}$
$f \leq 1 \div T_{pulse}$

Procedure

1. Using the Astable multivibrator circuit of Fig 5 below, calculate the following:

a.	ON time (t_1) with the given values of R1, R2, and C1: $t_1 = 0.693(R1+R2)C1=$
b.	Off time (t_2) with the given values of R2, and C1: $t_2 = 0.693(R2)C1=$
c.	Period (T) of the pulses with the calculated values of t_1 and t_2: $T = t_1 + t_2 =$
d.	Expected frequency(f): $f = 1/T =$

2. Using Multsim, construct the Astable multivibrator circuit below, set your DC voltage source (Vcc) to 5V and adjust your oscilloscope settings to display the output waveform at Pin3.

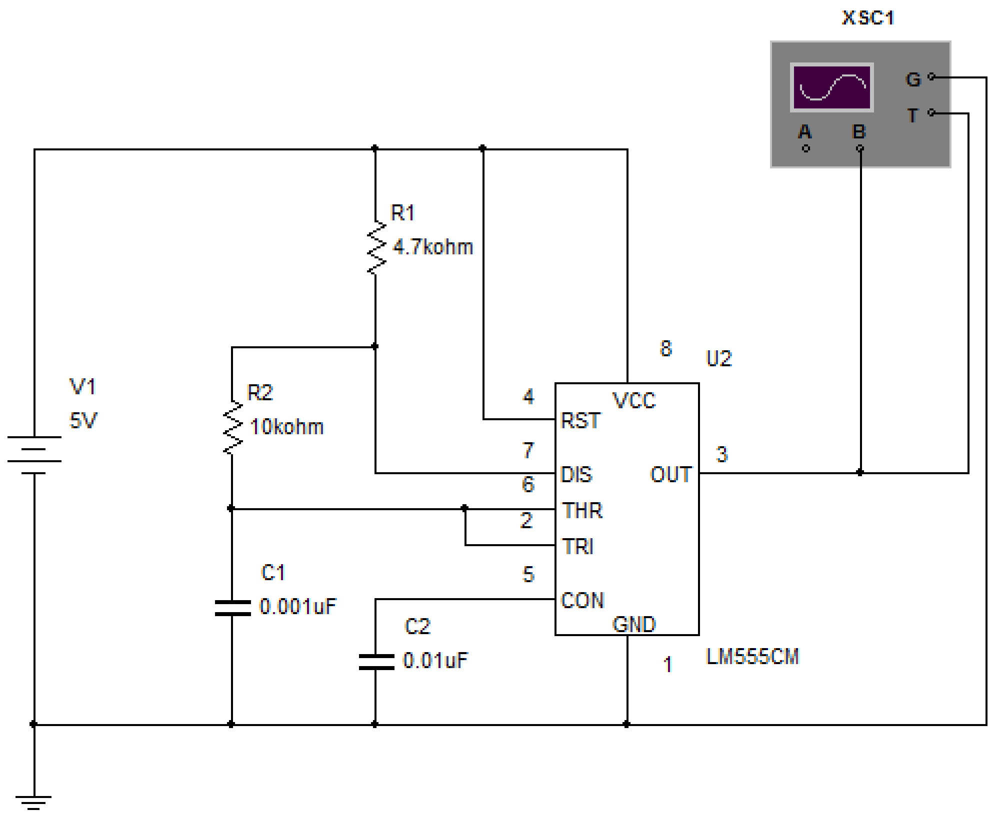
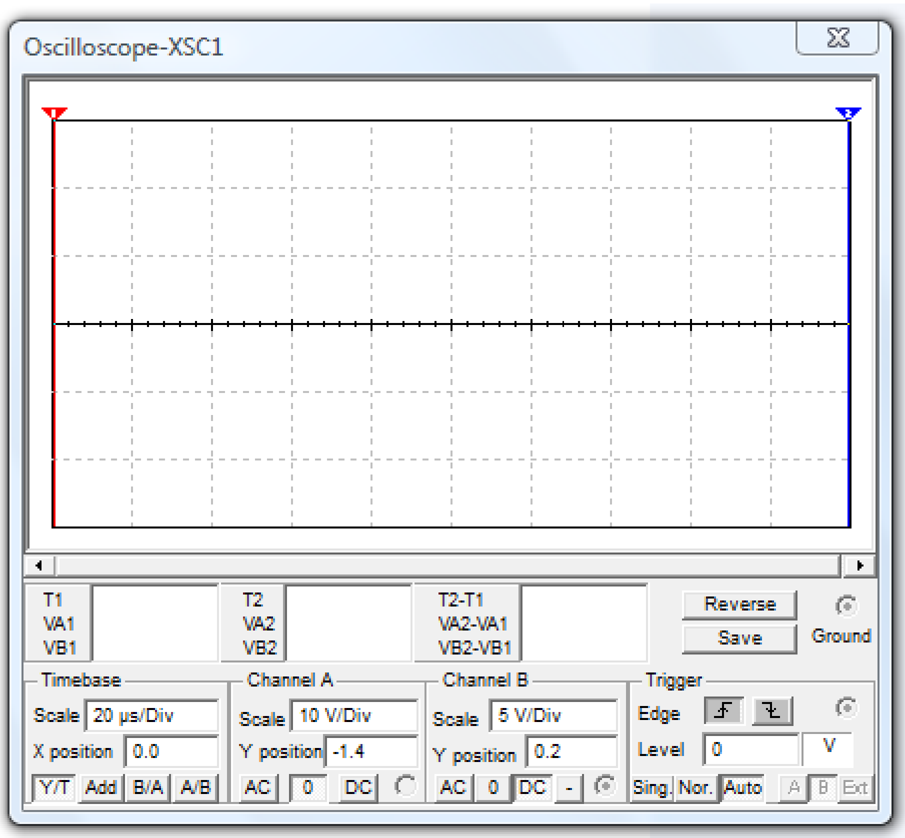
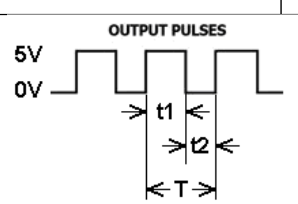


FIG 5

3. Set your oscilloscope Timebase, Channel B, and Trigger to the following settings:



4. Adjust your Timebase until you get 1 to 3 cycles on your screen.
5. Adjust your X position so you can measure the number of horizontal squares accurately.
6. Measure the ON (t_1), OFF (t_2) time, and Period (T). Calculate the frequency (ƒ) based on the measured period.

ON (t_1)	OFF (t_2)	Period (T)	Frequency (ƒ)
note:			

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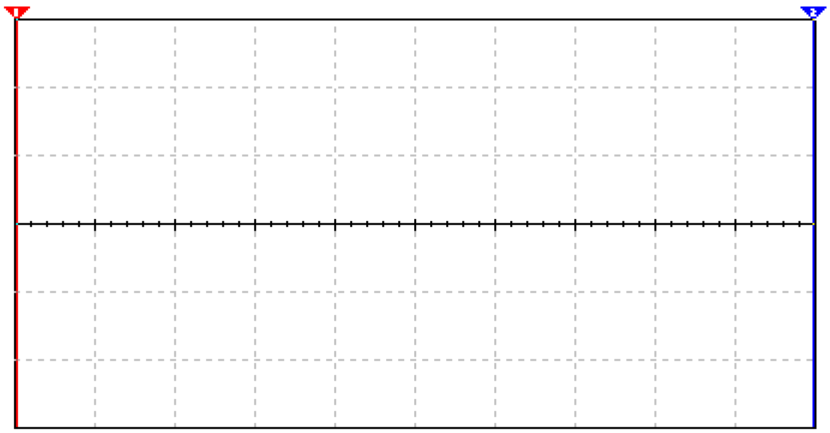
6. On the next diagram, draw the waveform viewed on your scope. <u>You need to ONLY display 2 or 3 pulses only</u>. Pick any single pulse and label the output pulses for measured ON time (t_1), OFF time (t_2), and Period (T).



7. Using the Monostable multivibrator circuit of Fig 6 below, calculate the ON time of the output pulses.

a.	ON time (t_1) with the given values of R1and C1: t_1 =1.1(R1)C1 =

8. Using Multsim, construct the One Shot multivibrator circuit below, set your DC voltage source (Vcc) to 5V and adjust your oscilloscope settings to display the output waveform at Pin3.

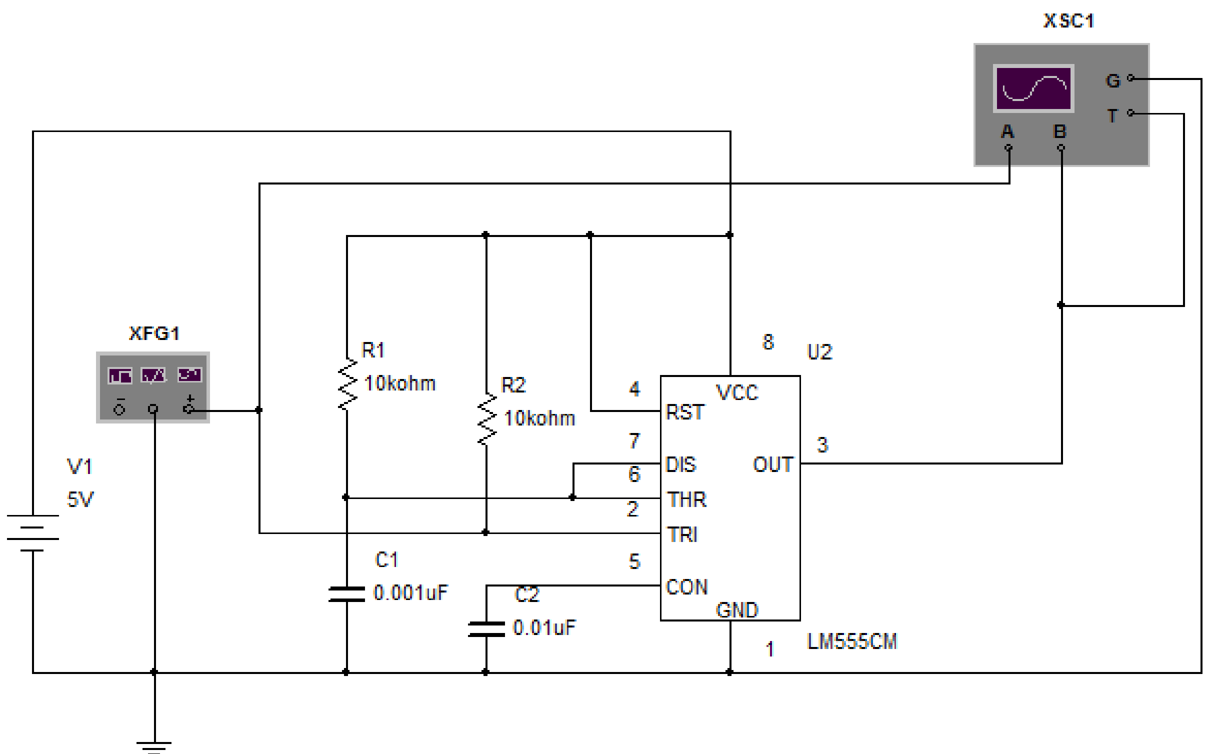
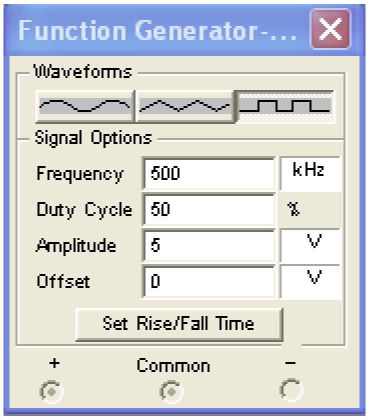
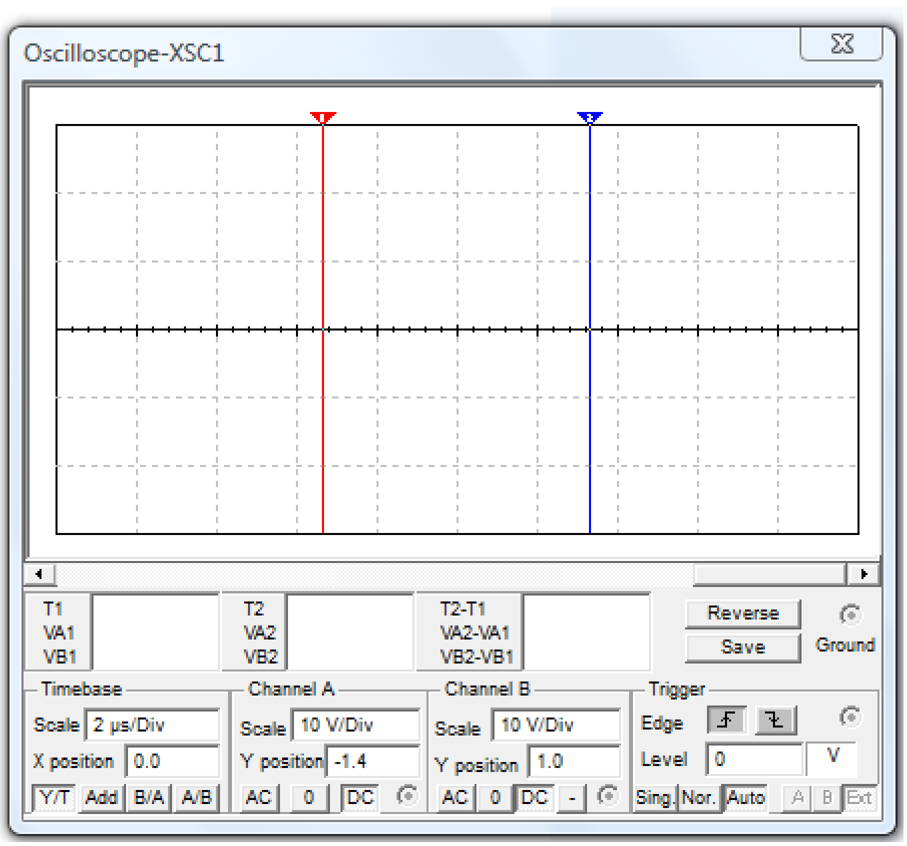


FIG 6

9. It is important to understand that the function generator (XFG1) is the trigger source for the One Shot and its output is monitored on Channel A. Its waveform looks like that of an Astable circuit.



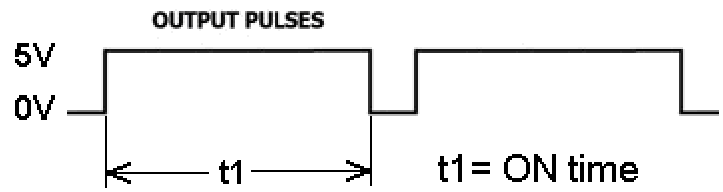
10. Channel B will monitor the output of the One Shot and the ON time should be longer than the OFF time.
11. You will see that the One Shot will trigger on the Fall time of the triggering waveform.
12. Set your oscilloscope Timebase, Channel A, Channel B, and Trigger to the following settings:



13. Adjust your Timebase until you get 1 to 3 cycles on your screen.
14. Adjust your X position so you can measure the number of horizontal squares accurately.

15. Measure the ON (t_1), and Period (T). Calculate the frequency (f) based on the measured period.

ON (t_1)	Period (T)	Frequency (f)
Note:		



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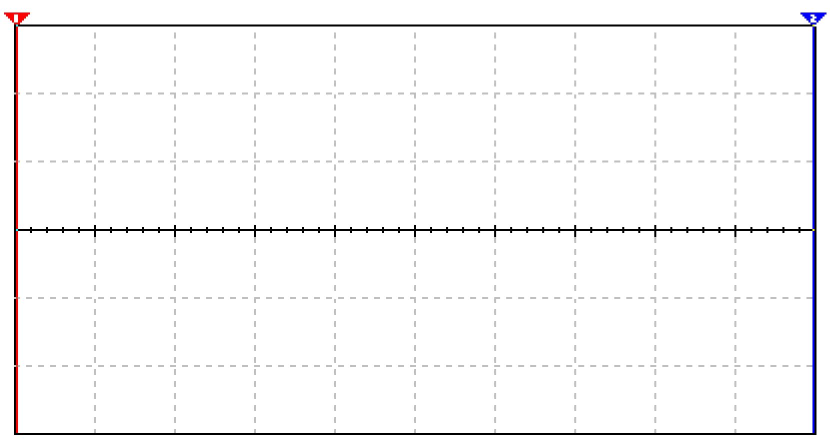
16. On the next diagram, draw the waveform viewed on your scope. <u>You need to ONLY display 2 or 3 pulses only</u>. Pick any single pulse and label the output pulses for measured ON time (t_1) and Period (T).



Questions

1. Explain the basic function of the monostable multivibrator. What does it do?

2. Explain the basic function of the astable multivibrator. What does it do?