Op-Amp Practical Applications: Design, Simulation and Implementation
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Lecture – 22
Op-amp with Positive Feedback: Monostable Multivibrator

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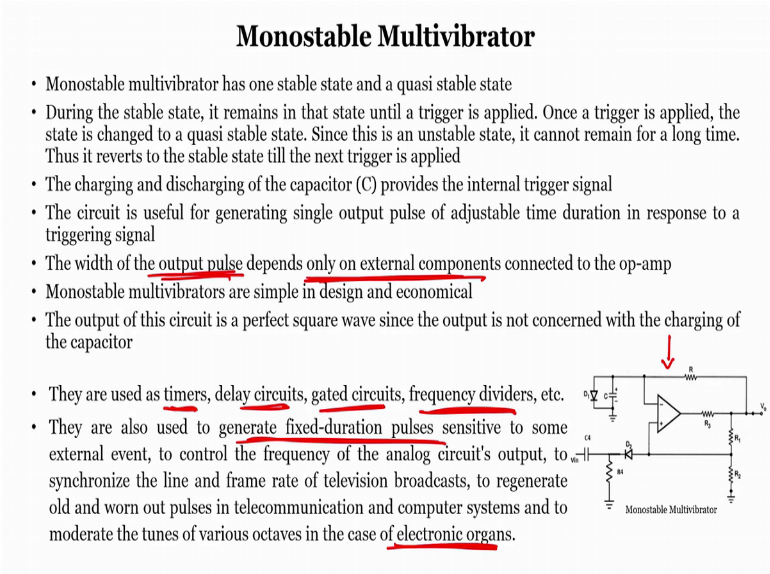

Hi, welcome to this module. In this module, we will see monostable multivibrators. If you talk about astable multivibrator, both state unstable. Now, if we talk about monostable, then a one state should be stable right. So, let us see what are monostable multivibrators. So, if you see this slide, monostable multivibrator right, you can see, it right over here, the circuit is shown here right, has one stable and one quasi stable state right.

During the stable state, it remains in that state until a trigger is applied. Once the trigger is applied, the state is changed to a quasi stable state. Since this is an unstable state, it cannot remain for a long time. And thus it reverts to the stable state till the next trigger is applied. So, as soon as it is a constant voltage and when you apply a spike or a or a or a trigger right, then it goes to the unstable state. Now, since it is a unstable or quasi stable state, it cannot remain for a long time. And thus it reverts to a stable state.

So, this charging and discharging of the capacitor in this case right, provide the internal trigger signal. The circuit is useful for generating single output pulse of adjustable time duration in response to trigger signal. Whenever you apply a trigger signal, there will be a pulse generated. Now, width of the output pulse depends only on external components connected to the operational amplifier.

The advantage of monostable multivibrator is, it is simple in design, and it is economical. The output of the circuit is perfect square wave since the output is not concerned with the charging of the capacitor that is a advantage right. They are used as timers or you can say, it is used as timers, delay circuits, gate circuits, frequency dividers, etcetera.

It is also used as a fixed-duration pulse sensitive or to generate a fixed-duration pulse sensitive to some external event, to control the frequency of analogue circuits output, and use of this is to synchronize the line and frame rate of television broadcast, to regenerate old and worn out pulses in telecommunication and computer systems and to moderate the tune of various octaves in the case of electronic organs. So, the use of monostable multivibrator are many as we have seen.

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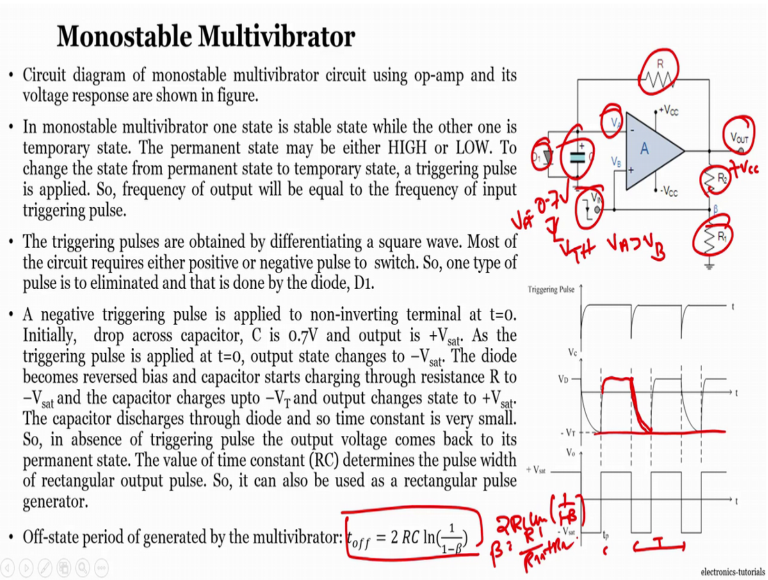

Now, let us see, how it operates how it operates ok. So, the circuit diagram monostable multivibrator circuit is using operational amplifier and its voltage response is shown here. This is the circuit, this is the triggering pulse, voltage response is this one fine. And let us see, how this how this particular circuit works. So, in monostable multivibrator one stable state is one state is stable while the other state is temporary state or quasi stable state. The permanent state may be either high or low. To change the state from permanent state to temporary state, a triggering pulse is applied. So, frequency of output will be equal to the frequency of input triggering pulse.

The triggering pulse are obtained by differentiating a square wave right, you can see here. The most of the circuit requires either a positive or a negative pulse to switch. So, one type of pulse is eliminated and that is done by diode, D1 right. So, we just require pulse, which is either positive or negative. And one of the pulses, can be easily eliminated, if I use diode in this particular configuration.

A negative triggering pulse is applied to a non-inverting terminal at time t equals to 0. Now, we can see, here this is a non-inverting terminal and at time t equals to 0. If I apply a triggering pulse, what will happen, initially drop across capacitor C equals to 0.7. And output is plus V saturation right. This is a 0.7, and that is why, this is at plus V saturation, because the drop initially is a drop is this one. And the output is at plus V saturation. As the triggering pulse is applied 0.7 volts. And if I apply this, plus V saturation correct. So, as a triggering pulse is applied at t equals to 0, output changes to minus V saturation right.

If I apply here triggering pulse, then my output will changes to minus V saturation. Diode becomes reverse bias here, becomes a reverse bias and capacitor charge discharging through the resistor right. So, to minus V saturation the capacitor charge on till minus V T, and output changes to plus V saturation. Thus the capacitor discharges through diodes and so the time constant is very small. So, in absence of triggering pulse output voltage comes back to its permanent state. The value of time constant RC determines the pulse width of rectangular pulse right.

So, we can see very clearly, that it the charging and discharging of the capacitor right. When it discharges, and it discharges through D1 the it is very fast. And it comes back to the stable state. Whenever you apply a pulse, this is a stable state. Whenever you apply a pulse like this, goes to its non- stable state comes back, and again stable right, like this goes back here. And in return the output will go to plus V saturation and minus V saturation. Whenever is here is minus V saturation. Whenever is stable, plus V saturation, minus V saturation, plus V saturation, minus V saturation, plus V saturation. So, this is a generation of square wave.

This square wave depends on whenever you apply a triggering pulse. The stable state is like I said V D, and when you apply a pulse, it goes to minus V T, and since it is a quasi stable state. It will not remain for long time, it will come back to its stable state right. So, in the absence of triggering pulse the output voltage remain back to its permanent state. The value of time constant RC determines the pulse width of the rectangular output. So, it can also be used as a rectangular pulse wave generator right, that is another application of your monostable multivibrator.

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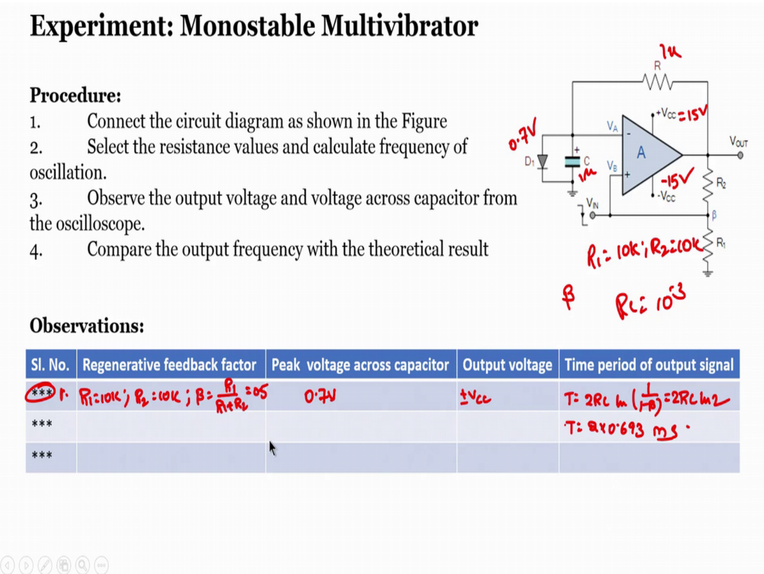

So, if I want to perform an experiment for monostable multivibrator, I will use the circuit shown here. And I will connect the circuit select the resistance values and calculate the frequency. Observe the output voltage and voltage across capacitor. And compare the output frequency with the theoretical result. So, what I will do, I will have a regenerative feedback, peak across peak voltage across capacitor, output voltage, and time period of output signal.

So, again we will see how the monostable multivibrator can be designed in your experiment class. Now, to do that, the things that we have seen a particularly about circuit designing, my t a Sitaram and Suman discussed about circuit design, and perform simulation. Then they will discuss about how the circuit operates, we have seen in theory in detail, but we just need to have a quick recall of how circuit operates. So, they will show you about that circuit operation. And compare it with the simulation.

So, simulation we use multisim and then, we do not stop at simulation. We also go further and perform experiments. So, we will compare theory with simulation, we compare theoretical results with our experimental results. So, this is the complete idea. And now, what I will do is, I will request t a to join us, and show us how the experiment procedure can be carried out. And I will request him to join us.

Now, we will look into a monostable multivibrator. In case of an astable multivibrator, we do not require any kind of a triggering input. So, once the power is on to the operational amplifier directly the op-amp gives an output square wave. And the frequency of the square wave, entirely depends upon the charging and discharging rate of a capacitor, so which is nothing but our beta value or beta into V S S value that is nothing but your higher threshold and lower threshold values of our symmetry curve.

In this case, in case if we want in our application, if we require to generate a pulse for particular duration, only when we require at some triggering point that means, when I give a triggering point, only then it should generate a pulse. Then such a cases, a astable multivibrator cannot be used. So, we require to have some kind of modification in the circuit. In the same similar kind of a circuit, some kind of a modification such that only whenever a triggering input is received. Then, it has to generate a pulse for a particular duration for a particular frequency.

Now, we will look into how a monostable this is called a monostable multivibrator. We will look into how the monostable multivibrator can be you know can give the output high for a particular frequency based upon the input triggering pulse, and based upon the resistors, and capacitors resistors that we use; resistors and capacitors that we use.

And in this session, what we are going to discuss is one thing is brief explanation, as we are following in the previous video lectures in the same way. Even in this model, we will briefly discuss about a monostable multivibrator working of the circuit, then their connections, then we will see the theoretical calculations. Then we will look into simulation, compare theoretical with the simulation, then with a practical results. So, as professor discussed in the module, so I may not go in deep into the complete explanation of the circuit.

Now, when we go to the monostable multivibrator, so this is how the monostable multivibrator design is of. So, if you compare, we can see that the monostable multivibrator and a stable multivibrator looks similar is not it, and also even for monostable as well as for astable multivibrator. The design uses a positive feedback is not it. Even our previous circuit, it has a positive feedback that positive feedback that means, nothing but the resistors that we use in the positive feedback decides the value of beta right.

If we want to understand about the circuit, how exactly it works, remember recall our previous you know astable multivibrator. We understood that because of the positive feedback, since because it looks similar to our Schmitt trigger, it gives some thresholds, positive thresholds and a negative thresholds. And since the output is connected to RC filter right. And the junction of RC is given to negative. Whenever the input voltage is greater than the threshold, then either it goes to plus V C C or minus V C C based upon the input signal.

But, the only difference that we observe in monostable multivibrator is that along with RC filter, there is one more diode, which is connected in this fashion right, anode to positive and cathode to our ground. Now, so that what will be the implication of a diode in the system, so one thing it is clear that, whenever the output is positive; whenever the output signal is positive, in case the capacitor cannot charge to 15 volts right. The reason is because of the diode whenever capacitor initially starts charging, once the value is equal to the cutoff value of D1 right.

So, generally it will be 0.7 volts right. Whenever it reaches to 0.7, then the diode will switch on, then the complete voltage will be connected to the ground, so that means, capacitor will charge only till cutoff value of D1 right. Now, if it is a case, when the output is positive, it will never go back to the negative signal right. Why the reason is, when we see imagine that initially we are getting V OUT as plus V C C right. Only two states either plus V C C state or minus V C C state.

So, let us consider, the V OUT we are getting into plus V C C state. So, what are the threshold at that point. So, in order to go to minus V C C, the input voltage should be always, the input voltage should be greater than the greater than higher threshold value V T H. In this case, what is V T H beta into R1 by R1 plus R2 right. Only when the input voltage is greater than this value, it goes to minus V C C. Now, what now because of that now if I say, we will assume that V OUT is plus V C C. If V OUT is plus V C C the capacitor will charge, it will try to charge till plus V C C, but because of the diode, it will charge only till 0.7 volts, it will charge only till 0.7 volts right.

Since, if this V A value so that means, V A will be equal to 0.7. Suppose if this V A value is lesser than V B that means, input voltage is lower than your threshold value right. Threshold is nothing but V T H, which we have already seen previously higher threshold value. If this value is lower than V T H, then diode cannot go to minus V C C, diode sorry the op-amp cannot go to minus V C C, it will be always a plus V C C. If it is always a plus V C C, diode will be the capacitor will be in a charging state because of the diode.

Diode can only reach up to 0.7 volts, so that is why when you look into the the figure, we can see that whenever the output is positive, whenever the output is positive right the capacitor charges till V D, then it will constant. Now, when it goes to negative V C C, if the output has to go to negative minus V C C, the only condition is that the input voltage should be greater than input voltage should be greater than our V T H.

Now that condition will not happen until unless, we give some external triggering pulse. What if I give some negative pulse at the positive, when I give a negative pulse at the positive, obviously the V A value is greater than V B, the condition is satisfying. So, whenever I give a negative pulse, the V A value will be greater than V B as a result the output will go to minus V C C.

When output goes to minus V C C, then that then since the diode will be in reversed bias condition. The capacitor will starts discharge, till what? Till to our threshold value is not it. Why not to minus V C C, the reason is that, we know that even from the astable multivibrator or even from the schmitt trigger. When the input voltage is smaller than; input voltage is smaller than our negative threshold value, it goes to plus V C C again right, so that means, it will discharge only till minus V C C right, so that decides right, so the complete frequency of the signal.

But, we will get the signal only when right this discharges are complete frequency right. Once our once it is reached to plus V C C, it continues at the same, what we have seen further a positive cycle. So, this decides the complete frequency, when to on, when to when to off, that entirely depends upon entirely depends upon R and C the charging value of a capacitor. And depends upon R 1 and R 2 values right, but in order to generate in order to get, so in order to get our you know negative pulse. The only thing is we have to provide one triggering input, that is why reason it is called monostable multivibrator.

So, and this complete the pulse duration entirely depends upon the equation this one. The period is completely depends upon 2 RC log 1 by 1 minus beta, where beta is nothing but beta is R 1 by R 1 plus R 2 right, that is what we are seeing even from our previous sessions itself.

Now, we will see, how do we do our connections, how do we do our connections, and we will try to derive the theoretical, and then we will look into the simulation point of view. Now, we will take a op-amp, we will connect a plus V C C as well as minus V C C right with plus 15 and minus 15. So, I am taking this as plus 15 volts, and I am taking this as minus 15 volts, right. We will take a diode, so we will find out what is a diode cutoff frequency.

So, generally in a simulation, we will consider diode the value is of 0.7 cutoff value. So, whenever the capacitor reaches to 0.7, that diode will be forward biased condition. Whenever the input voltage is greater than 0.7, the capacitor value right the diode will be forward condition, then the capacitor will go to saturation. Then what values of R 1, R 2 we select, we select R 1 and R 2 as R 1 as 10 kilo as we have seen in the previous from a stable as well as from schmitt triggers.

We are considering R 1 the as 10 kilo as well as R 2 as 10 kilo right. So, R 1, R 2; 10 kilo meaning the beta value. So, we will say the regeneration factor, so this is 1. When I say regenerative factor feedback factor, so I am considering R 1 as 10 kilo, and R 2 as 10 kilo, so that the beta value will become R 1 by R 1 plus R 2, so which is nothing but 1 by 2, which is 0.5 volt 0.5 value right.

Now, what will be the peak voltage across capacitor, the peak voltage will be equal to diode cutoff, so which is nothing but 0.7 right. So, what will be the output voltage, the positive output voltage will be 0.7, this is the output voltage. So, output voltage will be always plus or minus V C C, because output can only saturate from plus V C C to minus V C C, but the period or the duty cycle depends upon depends upon our R and C right.

And what about the time period of the signal so, in order to calculate, so how to derive this particular value. So, similar to that of our previous astable multivibrator explanation what we can do is that, we can consider this 0.7 to till this value. And calculate the discharge time, discharge rate, and we can easily understand, what is the time taken for this two discharge. And in order to compute our complete discharge charging, now previous case we have consider from higher threshold to lower threshold.

In this case, you have to consider from lower threshold to V D, which is nothing but 0.7. What is the time it takes, that if I can calculate, this gives us complete the on time or this gives us complete time right. And if I know at what frequency this is switching on and off, this complete frequency, we can understand clear. So, this depends upon the capacitor value and the beta value right, whereas this value depends upon, when we are giving this peak.

Now, so when we do the calculation similar to that of what we have done in astable multivibrator, the T value the period value will be equal to 2 times of RC into log 1 by 1 minus beta 2 times RC into log 1 by 1 minus beta, so where beta is nothing but 0.5. I can write it as 2 RC right into 1 by 1 minus 1 by 2, it is a 0.5, 1 minus 0.5. 0.5 is 1 by 2 it is nothing but log 2 right. Now, what is the value of log 2? 0.693. So, it is nothing but it is T is nothing but 2 into 0.693 into RC.

Now, what values of R and C we will consider, we will consider R is 1 kilo and 1 microfarad even in this case 1 micro, and 1 kilo. So, the value will become RC value will become 10 power minus 3 into 10 power. So, I can remove RC, and I can write it as millisecond clear. Now, we will see the simulation, how does it work right.

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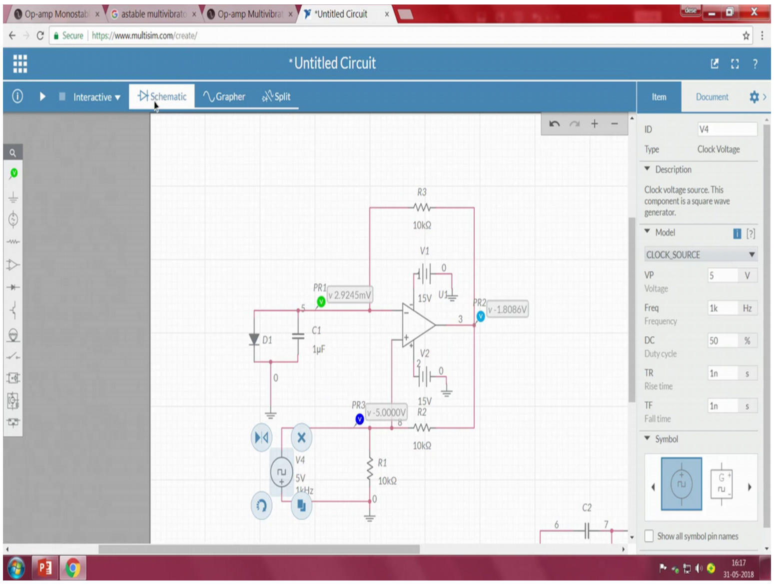

And we will go back to our experimental tool. So, I will go with simulation now. So, how the circuit will be first, now what I will do is that, I will go to op-amp. I will select a op-amp right. And I need to give the power supplies to that, so I will go to DC voltage connect negative here. Then take a ground connect it here. Then go to another power supply right. So, positive all some connecting. And taking ground connected here.

So, the supply that we require is 15 volts. So, I will make it as 15, even in this case and even here as 15. Then what next, I have to take R1 and R2 resistors as well as R and C as well as the diode 2. So, I will place everything. This is let us take, this one as R 1. So, this is R1, so which has to be connected to the positive terminal, so little bit down. Then, I will take one more resistor, which is R2, which is a feedback resistor that too positive feedback.

And the both value should be of 10 k. So, I will replace this with 10 kilo ohms resistance, even this one 10 kilo ohm. So, there would not be much difference between whether we take 10 kilo or one kilo, because as long as the beta remains same for the chosen resistor values, the system works similar way right. And we require a negative feedback with a 1 kilo resistors which decides our charging rate of our capacitor. So, we also require a capacitor, if we do not have a capacitor, this complete astable monostable cannot work, because that entirely depends upon, when to switch on, when to switch off depends upon the charging and capacitor discharging rate of our capacitor, and we also need a diode right.

So, I will go with a diode. And this should be connected in this fashion. So, we have made all the connection sorry, we have put whatever the components that we required, in order to build it. Now, what we have to do is we have to connect it, how do we have to connect. So, the output has to be connected to one of this terminal. And the other terminal has to be connected to the positive. And this terminal has to be connected to here and take a ground, I will paste it here right.

So, the positive side, which give provides the schmitt trigger operation, which decides the higher threshold value and the lower threshold value part is done. What is the next one? We have to connect RC charging and discharging to our output. So, I am going to this part. I will go here, I will go connect from here to here, and diode also has to be connected right. So, what I will do, this part of diode, I will be connecting it here. So, our circuit is done right.

Now, I want to measure, how the capacitor know the charging and discharging decides. Since, we have a diode and the output voltage ok. So, I will go to the grapher. So, let me check whether everything is right or wrong, D1, C1 right, 15, 15, 10 k, 10 k, 1 k, 1 microfarad, D 1, plus 15 and minus plus 15 and minus 15 yes.

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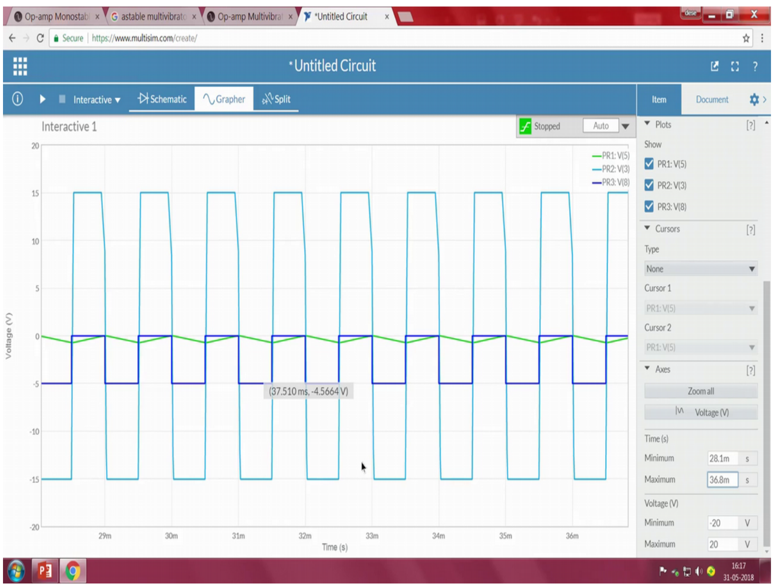

So, go to grapher and just run it. So, what is happening, so which is red, which is green. Green is nothing by input. So, voltage across the capacitor right and this is output voltage. Now, see when we see the output across the capacitor, it is only 643.83 milli, which is approximately of 0.7 volts right that is the diode you know cutoff voltage.

Now, in order to make it as monostable I have to provide some triggering input at the positive terminal is not it, so which makes the you know the positive terminal to go below that means, it makes the negative value is higher than the V B value V A value will be higher than the V A value, so that the output will goes to minus V C C. As a result, the capacitor will discharged from 0.7 volts to 0.68643 volts to what you say it is minus threshold value.

So, what is the minus threshold value in this case, it is nothing but 0.75 minus 0.75 is a minus threshold value. So, how can I do, so I can create any pulse. So, what I do is that, I will take some DC voltage some clock voltage or some clock voltage, I will do. Now, I need negative, so what I will do is that I will reverse it. After reversing it, this I will be connecting it here. And this should be grounded, so I am grounding it.

So, since it is a 5 volts I will get minus 5 volts as an output. So, if I want to understand, what we can do is that, we can take one more voltage and we connect it, at this point. And we can observe the blue color, the dark blue color. So, we can understand at what you know the value of it.

Now, when I go to grapher, and when I run the system. So, for our understanding what I will do is that, I just stop it and I will zoom all voltage. Then this I will make it as 100 milli it is like you know zooming on X axis or 10 milli 10 millisecond, still zooming on X axis or still more zooming. So, what is happening? So this is nothing but our voltage across the negative pulse that we are giving. And the duty cycle of the pulse is 50 percent duty cycle.

Now, but one thing, we can see is that capacitor is discharging to till what value, it is not discharging to minus 7.5. It is discharging, but as long as it is ready to you know discharge the pulse is becoming higher, meaning the pulse is going again back to the 0 right because of that reason again the capacitor starts charging, again discharging starts discharging, so that we cannot expect the same thing, whatever we require.

So, in such cases, what we require is we require whenever, we give a negative whenever we give a negative triggering pulse, it should on or it should be a negative at particular duration of time right at particular duration, then it should go to you know 0. So, how do we create it? I need only a short duration pulse, short duration pulse of minimum of one milliseconds or even smaller than one millisecond, but with this it is not possible, it will be keep on changing it.

So, one way to do is that by using by using, when a pulse connected to a differentiator, we will get a spike, I need only a spike. So, what we do is that, we will create a spike. So, just to understand about, how does it exactly works. What we do is that, we will take this particular circuit. So, this if we observe the same input voltage, that we are using it here right. And now what we do is that at this point, we will connect one voltage source. So, we can understand that what type of voltage we are giving. And we will get connect one more output voltage here. So, I will remove this diode. So, just for our understanding right now, so how exactly it works how exactly it works right.

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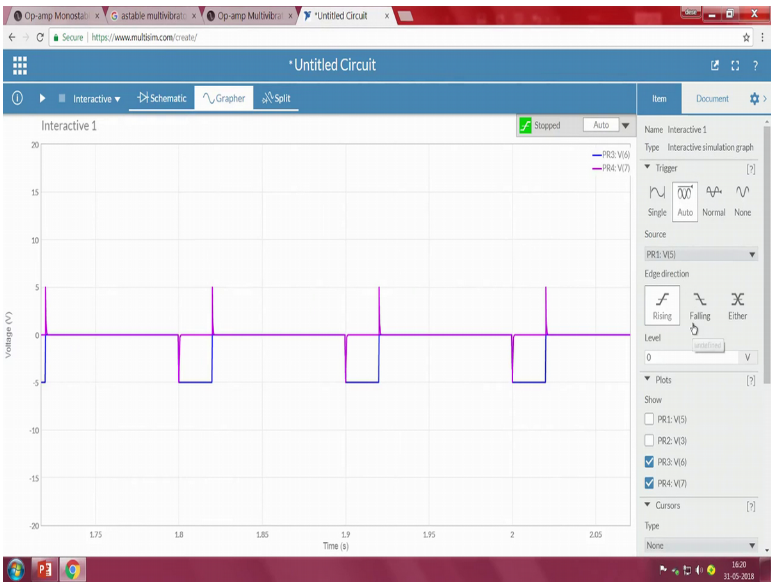

Now, let me run this. And see the working of this particular portion. So, why we are doing it, we require a only negative spike negative spike. And when the input is even becoming positive, I do not need to see any output right. It still should remain the same no influence on that. So, what I do is that observe here. So, I do not need the other two. So, I will make other two as 0.

So, when we observe, so one is input PR3 is input. PR3 is nothing but sorry PR4 is input right. So, the blue color is input, and pink color is output. So, whenever we have a spike positive spike, so whenever you know the we have a negative pulse because of the negative pulse we are getting some spike. And again, when there is a change from negative to ground, again we are getting a spike. But, if I get this spike, there will be a problematic.

Again, it makes it allows the op-amp to go to plus V C C state, but that should not happen. It should happen only, when the capacitor is discharged to or the capacitor voltage is lesser than minus 7.5 or lesser than minus V C C value sorry minus V lower threshold value. So, in order to happen that this particular spike, I should, we should not pass through the system. How can we do that one ways, if I use simple diode, what I will do is that this particular part, I will connect it to diode. So, just to visualize this value, what we will do is that, we will take one more resistor connect across this.

So, I just reverse this, connect this resistor, and this particular portion to ground. Now, I will sorry this particular portion to ground connect it. I will take one more voltage source. So, we will check it, this point. Now, I will go to grapher and in this case, let me run. I do not need PR1 and PR2. Again I am removing PR1 and PR2 ok. So, what are all PR3, PR4 and PR5; I need PR3, PR4 and PR5. PR1 I do not need. So, when I zoom this this off, when I zoom it, this is input signal blue color right. So, blue color, when you see blue color is input.

Now, output from the differentiator is PR4 pink color. Now, when I remove both the things, we can see that, now it has given only a positive only a one spike right. So, whenever this spike is there, then it make it allows it allows V B right. It makes the op-amp to be at minus V C C the reason is that the V A value that means, the voltage across negative terminal is higher than the voltage across your positive terminal. So, whenever that happens the op-amp goes to negative V C C right, so this is ok. Since, it goes to negative V C C.

Now, once it goes to negative V C C, the influence of the input is not there to the op-amp circuit. As a result, when the capacitor is below minus lower threshold value till that time the output will be at minus V C C. Again if it happens, it goes to positive V C C. Now, we will connect this particular circuit by replacing this with this, so what do is that, we will select this complete part, move from here to here. So, now I already have a resistor, I do not need any of this resistor here. This is just for the load resistance, and this value has to be connected here, so I am connecting it here.

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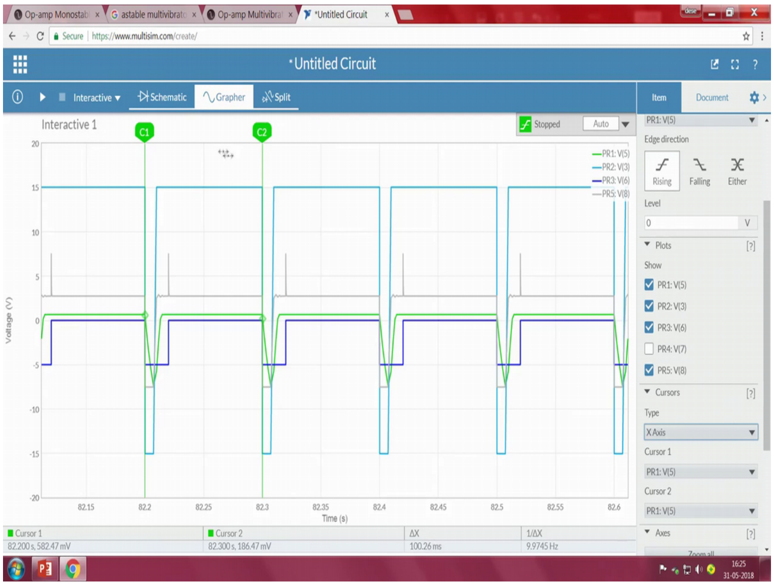

Now, if I run the value, have a look, when I zoom value right, we can see so whichever is not required, I just remove it, so I do not need, we will see one by one. This is my input voltage across the capacitor meaning and this is output voltage And the PR3 is the pulse that we are giving. PR4 is the output across that across differentiator, now I do not need it right.

But, we can observe one thing that, when I give spike, till I give a spike the negative voltage is at somewhere around 664 millivolt, which is almost equal 0.7 volts diode cut in voltage right. Whenever I give a negative spike, the blue color one is a negative spike for somewhere around 10 milliseconds right, so this one since it is passed to a differentiator, it has generated one positive spike of 10 seconds 10 milliseconds, sorry it generated a negative spike. Because of this negative spike the V A value is greater than V B value, the voltage across V A is higher than the voltage across V B.

So, it allows it makes it makes the output of op-amp to go to minus V C C state, we can see here minus V C C state. Then what we did, so what we did in the sense, then how it is going to plus V C C again, because of the negative voltage because of minus V C C. Now, the capacitor starts discharging to minus 15 volts right. Now, the capacitor started discharging, now since the threshold value is 7.5, when you observe that minus 7.5 whenever the V A value is reaching below minus 7.5 that is our lower threshold value. Then it makes this particular value to go to plus V C C, output to plus V C C that is what we can see right.

So, when you observe this value, so we can take the cursor X axis cursor. And when you see, what is the time duration to go from this, and when you calculate based upon that. And the value is somewhere around ok, this value right cursor 2 somewhere around 4 7.5 7 point somewhere nearby, so the value the on time is somewhere around 6.8259 milliseconds right. So, this is the on time, whereas the complete cycle if I see from here to here, sorry this is a off time. So, we can see 100.26. So, this is the case, when we use 10 kilo ohm resistor.

So, what happens, if I use 100 kilo ohm or 50 kilo ohm resistor higher value, since it is a 50 k, the discharging rate will be little slower, because the load value smaller so it takes lesser time to discharge sorry more time to discharge it. Since, it takes more time, we can see the change in the width this particular width. Now, this will this should increase, because the capacitor will discharge very slowly right. So, right now the value is somewhere around 6.8 milliseconds, now it will be even more. So, what I will do is that, I will replace this 10 k with 50 k resistance 50 k, and we run it.

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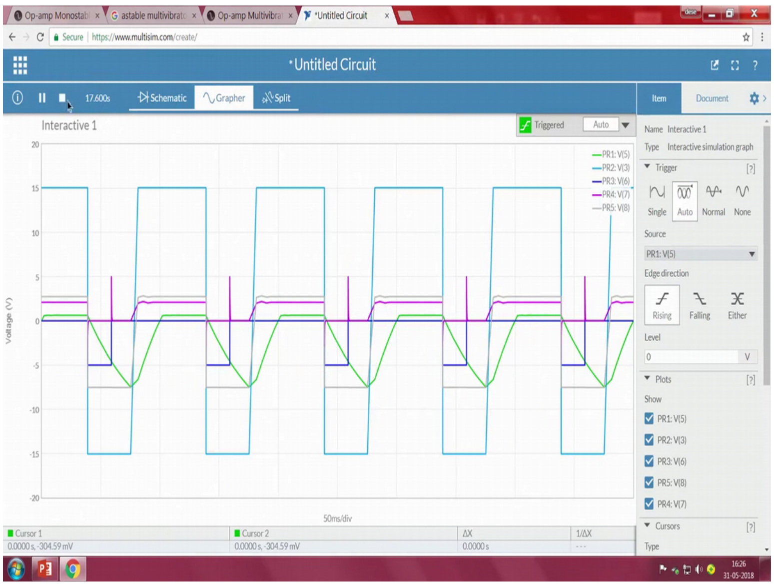

Now, when we look into the grapher, see observe, what happened, now the width this cycle maybe same, but the width of this changed the duty cycle of your pulse is changed, this is because of this is because of the capacitor the capacitor discharge rate is different compared to the capacitor you know capacitor discharge rate of the previous resistance value. As a result the discharge rate is smaller, in this case because of a higher resistance value it will it makes the output to stay at minus V C C for a longer duration that duration you can calculate based upon your RC discharge time.

So, whatever we have seen, whatever the calculations we have made during a restable you know module, what we have calculated. If you do the same calculation, we can even see the voltage from here to here, right or if you want to compare, what we can see that, I can put one value at here and one more. So, previously if I remember right, it is a 6 point millisecond 6.9 millisecond.

Now, if you see 37.5 milliseconds, what if I decrease my resistance value, if I decrease my resistance value it consumes lot of current, so that the discharge will be little faster. So, faster the discharge, faster the ramp, right. It discharge somewhere here, even see lesser than 6.9 milliseconds, if we can see 6.9 milliseconds right. So, depends upon when you provide a triggering pulse, if I delay the triggering pulse. So, if this triggering pulses the frequency is a little higher right, we will get different frequency again right.

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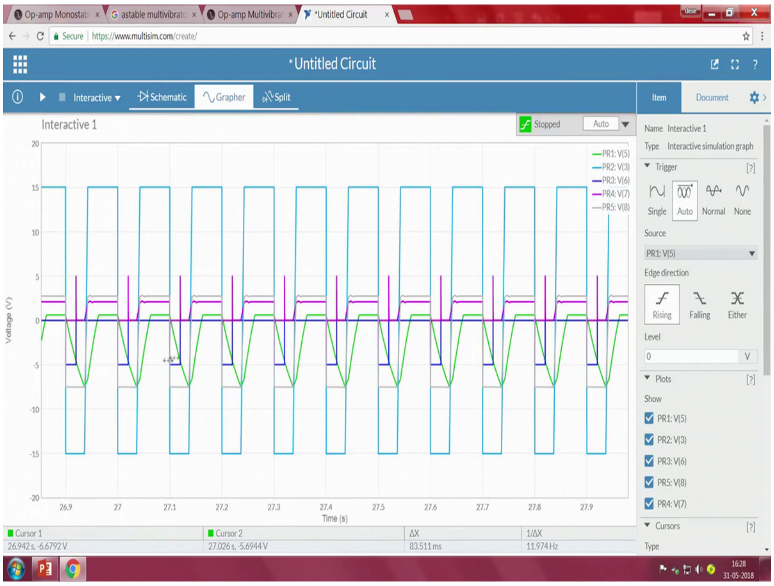

So, it entirely depends upon when you give a triggering pulse, so that means, a monostable multivibrator what we can see is that, it is not you know continuously generating sinusoidal sorry a square wave signal, but the user has to provide a triggering input to the system only then, it goes to the minus V C C state. Then once it goes to a once then when the capacitor starts discharging, whenever the voltage value is smaller than minus you know reference value again it goes back to its a original state.

So, till next triggering pulse received, it will always be at that particular state right. So, you can even change the different values of resistance, and you can even observe that, so or even you can change the a capacitance value no matter what, because RC entirely depends upon R and C. So, the multiplication factor is what a responsible there. And I hope it is clear, why we have used this differentiator. So, the purpose of the differentiator is the square will be converted to spike, which is a triggering input.

And the purpose of this diode is since when you do a spike, spike will happen even at a positive pulse. Whenever change in the duration whenever there is a change in you know amplitude from 0 to 5, 5 to 0 min, 0 to minus 5, minus 5 to 0, whenever this happens, we will get a spike because of the differentiator right. When you differentiate a pulse, you will get a spike right. So, since we do not need any spike at the at you know, when the ramp is when the input is going from minus 5 to 0, if you use a diode, so which will block all the positive signals right.

So, we will get only one spike, during the negative pulse. So, this negative pulse will responsible to discharge my you know the discharger capacitor till, it goes to minus V C C. As a result, we can see the period a complete signal. So, what we do now is that, we will develop the same thing using our T A board. And we will see whether we got the you know we got whether we are getting the same thing or not.

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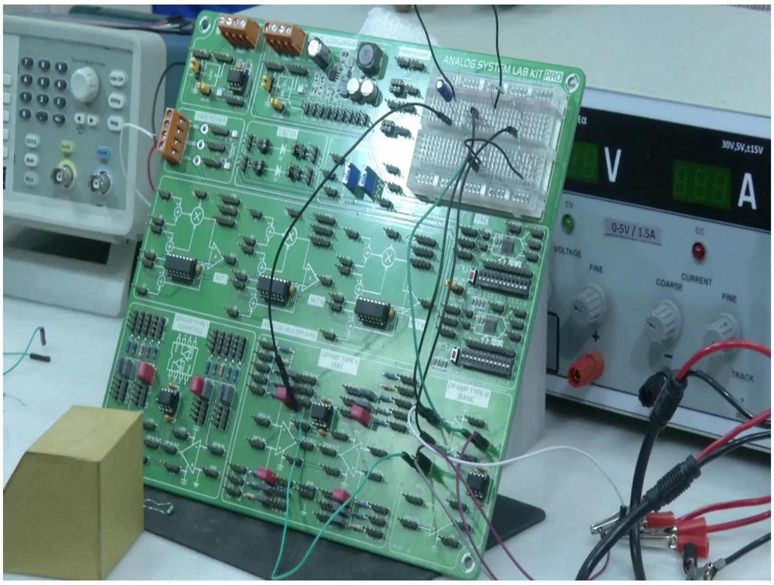

Now, when we look into the T A board. So, when we look into the T A board right, so this is a T A board right. So, even in this case we are going to use this particular portion right, as we have already seen the last time. So, we will connect in a similar fashion, so, all the diodes and everything. And we will see what response we get as we have seen even in simulation right.

Later on we will connect input source, we will see how the response will be, then we will connect you know triggering pulse that differentiator everything, and we will see the response of the system right. So, we will disconnect the previous circuit. So, the previous circuit is astable multivibrator. So, we do not even have to disconnect everything the wirings are everything same only thing is across our capacitor, we have to connect a diode.

So, now we are doing we are taking a diode, so that is our capacitor. The capacitor, we will use is one microfarad there. So, we can see across the capacitor right, we can see here we have connected right. So, how it how the connections are to the ground. The cathode is there, and other the other side it is connected to positive you know like a negative terminal of our this is going to the negative terminal of our operational amplifier right. So, this is as per our circuit now. Now, what we have to do, now we will switch on the circuit, we will see what is a response that we get in our oscilloscope.

So, we do not need any input in this case. Why do we do not require any input, because this is an astable multivibrator, it should automatically or monostable multivibrator. Since, we are using a diode, but since there is a diode, it cannot go to the other state meaning, the input voltage when the output is positive. The voltage across the capacitor will be at 0.7 right, we can even see.

So, here when we see the signal, when we see the signal the blue color indicates what our output right. So, the scale if I see, when you see the scale, this is at one box is equal to 5 volts. So, when we look into the scale, so one box is equal to 5 volts. So, if we zoom into the oscilloscope right, the second one is a 5 volts. And whereas the first one, which is yellow color the box is of 500 milli volts one box is 500 right, so that means, a voltage output is of somewhere around 15 and the input is 0.7 that means, the voltage across the capacitor.

The yellow is voltage across the capacitor, which is so we are aligning both the things to the same point, so that easy to understand. So, the blue color one is 5 volts, we can see here. So, we can see this is 5 volts. And whereas this one is 500 milli volts, so that the blue that which is nothing but output. So, it will be 5, 10 and more than its somewhere around 12 point something. Whereas, the output if I see, so that means it is already at the positive V C C. What about the output, output is somewhere around 700 milli volt right, so that is a cut in voltage of our diode right.

So, when I take a diode, diode will be always cut in voltage that means, it is not allowing the capacitor to charge more than 0.7, the voltage across the capacitor is 0.7. Now, since it is at 0.7 it cannot go to the negative state. If it cannot go to the negative state, again it cannot discharge it right. So, the capacitor is always at this stage, until and unless when we provide a negative triggering pulse. So, what we do is that in order to generate a negative triggering pulse, we will take a function generator, we will generate some pulse output. So, we will generate some pulse output.

When we look into the function generator, so we will take the same frequency 10 hertz frequency we will take. And a duty cycle as 10 percent, 10 h frequency and duty cycle as 10 percent, but we need a negative pulse. But, it is giving a positive pulse, what we can do is that, so we can create an offset. And amplitude is a 5 volts we will take, 5 volts peak value or since we have given peak to peak we can say offset as minus 2.5 sorry offset as plus 2.5. So, we will create an offset 2.5 volts. So, we can see we got 5, but we need a minus 5 positive input terminal, we will connect it in a reverse way.

So, when we see the connections, so now we will connect it. We will switch on the output of function generator. The negative pulse of the negative terminal of the function generator, we are connecting it to the positive terminal, the junction or positive terminal of an op-amp. And the positive terminal, we will connect it to ground right. So, we made a connections now. What is the response we are getting, so we will make it auto scale CRO right. So, what we do is that, we will create same differentiator even here, we will create same differentiator, and we will try to provide a spike as an input to the system.

So, we will switch off everything and we will provide we will give we will connect a differentiator circuit on the breadboard on the breadboard of our t a board. So, what values we will take, we will take 2.2 k and 0.1 microfarad capacitor. So, we are connecting 2.2 k resistor on the breadboard. So, the input should be connected to this particular point, so that is a reason right. First is capacitor, then resistor right there is a differentiator circuit. Now, we will take 0.1 microfarad capacitor right. So, we made a connections, so that capacitor value is 0.1 microfarad capacitor, and the resistor that we are using is 2.2 kilo ohms sorry 2.2 kilo ohms, so 0.1 microfarad, and 2.2.

So, what we do is that the input from function generator right. So, the negative should be connected, because we require a negative spike. Negative should be connected to the capacitor, and the positive should be grounded. So, now if you observe the ground is connected to the other part of a resistor, and the white color wire, which is the ground of our you know function generator is connected to the capacitor input. Now, we will observe what is a response we get, so we will take the two probes of the CRO, and we will connect one at the input, other one at the input of the capacitor, other one at the junction of capacitor and resistor wire.

Since, it is a passive differentiator, we may not required any supply voltage to this. So, we can see that the red color wire is connecting to the input right. Now, we connected one channel positive input to at the capacitor place the capacitor input. Other the ground will be connected to the reference value, made the frequency has 10 hertz high level to 0, low level to minus 5, and the duty cycle to 90 percent. So, since it is 90 percent duty cycle. So, on time is so on time is more and off time is smaller. And directly since the low level is minus 5, so minus 5 on time is little smaller right. So, this is connected using this BNC probes to the input of the capacitor at this point.

So, we have connected to this point, observe they have connected here right. The positive is connected there, and the negative is grounded the negative wire is grounded to this point. And one channel of oscilloscope, one channel of oscilloscope is connected here, this is the first channel of oscilloscope connected here with the positive one, whereas the negative terminal is grounded.

So, this is the negative terminal, where both the negatives oscilloscope as well as function generator is grounded to this particular point. Then another channel oscilloscope another channel the positive input is connected at the common at the output of junction of our resistor and capacitor. So, this is the junction of this is our capacitor point one microfarad right, this is resistor at this junction, whereas the negative is grounded.

So, when we look into oscilloscope when we see the oscilloscope, we can see that both are at both channels are at 5, but you have a little offset in the second channel. But, one thing we can observe that, the input is negative for duration small percent that percent is you know 10 percent. If I consider in a negative side, if I consider with respect to the positive side, it is a 90 percent right, and going again higher, lower. So, since this signal is passing through a differentiator, we are getting a spikes.

When I zoom it little more right, whenever there is a change in the change from 0 to 5 or 5 to 0, we can see the spike. Because of the negative changeover you get a negative spike; because of the negative to 0, it is we are getting a positive spike here. But we require only this spike, when we are giving a triggering pulse as an input to our monostable multivibrator. Otherwise, if we pass even the signal, it again get it comes back to the previous stage, which is unwanted are unnecessary in our case.

So, how do we avoid this signal? Since, we do not need this particular signal, what we do is that we take a diode, we connect this particular and we connect a diode such a way that it will pass only the negative signals and the positive pulses should not passed. So, we will connect in connect it in the cathode output. So, we will take a diode. We will take a diode and this diode we will connect it to the cathode of the diode will be connected to the junction point, and we will connect anode to the positive terminal.

So, positive terminal in the sense, so I will take another wire and I will connect both the things or this particular terminal I will use some bug connectors and connect it to the positive terminal right. So, this terminal I am connecting it to. So, positive terminal right, this is what we require. Now, when I measure output across this point, and when you look into the oscilloscope ok, so what we do is that this we will see the complete output voltage. So, output voltage should be. So, this is our output voltage, we will connect it.

So, we can see from the oscilloscope, it was very small. So, what I will do is that I will change this 1 k with 10 k resistance and let me switch on the main. So, since it is 15, what I do is that both to be at the same point second output channel as well as input channel I am keeping little down. And let me zoom little bit right. Let me stop and here we can observe that right. Whenever there is a ok, since we have not connected across the capacitor, but if I connect the input the yellow color to the output across a capacitor. So, we can even see the response with respect to the capacitor change, I am connecting across the capacitor right.

So, what we can see, the capacitor is somewhere around 5 volts. So, 1 volt is somewhere around 5 right or I can take a cursor and channel 1 ok, channel 1 type amplitude. So, I will make it 0. So, I will take the cursor. The value is somewhere around 1.8. So, here we can observe that whenever that whenever we are giving a negative pulse right, so what is happening because of this negative pulse because of the negative pulse from the function generator, it the capacitor starts discharging right. So, whenever it goes to minus 7.5, then it goes to minus V C C so, it is going to the minus V C C.

And again when the value is greater than 7.5, it is again going back to the plus V C C and the spike we can see because this is the voltage we are observing before the diode when we pass through after the diode even that we cannot see right. So, when we measure this value when we use a cursor and when we take cursor type is of time and when we take this. So, the value the value somewhere around 500 the difference between is 800 microseconds.

So, we can compare this results with our simulation results and we can verify it, so that means, we can understand that in order to generate a triggering pulse in until unless we generate a triggering pulse for a monostable multivibrator, we cannot see any change in our output because of our diode which makes a capacitor to go to you know stay at 0.7

volts which allow which will not allow the capacitor to charge more than that. Since, it cannot charge the capacitor the output voltage the voltage across the V A which is nothing but negative terminal is smaller than that of you know higher threshold value as a result the output will be always stays at plus V C C right.

So, in order to make it, when we provide a negative pulse, then the V A value is higher than the higher threshold value allow making it the op amp to go at minus V C C level then capacitor starts to discharging. So, because of the discharging state the output will be at minus V C C until when the voltage across the capacitor is below the negative threshold value it will be always at minus V C C. When the capacitor voltage is even below 7.5 volts minus 7.5 volts, then it go back goes backs to plus V C C state. So, till then it will be always at minus V C C, so that discharging rate is responsible for the time duration at which the you know the output voltage will be at minus V C C right. So, this is a difference between an astable and monostable multivibrator.

Thank you.