Op-Amp Practical Applications: Design, Simulation and Implementation
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Lecture -39
Applications: Automatic Gain Controller using Development Board

Hi, welcome to this particular module. Now, in this module we will see a circuit that is known as Automatic Gain Controller is also called automatic volume controller. So, as a name suggest automatic volume controller so, what does it mean that if us if a person is speaking right and suddenly his voice is too high, that should not affect tremendously to our loudspeaker right should not like bust right. So, how can you control that change in input signal, we want to have constant output signal right or let us take another example where you have a sensor and you know that for a particular range of input signal, your output should be x value.

And, if there is a change in input signal which is not required is unwanted change in input signal, we do not want our output to be distorted or output to get changed because, that output is connected to for the electronic modules. So, in that how can we make sure that even there is a random change input signal which is undesired the output should not get affected right. So, for this kind of application we can use automatic gain controller.

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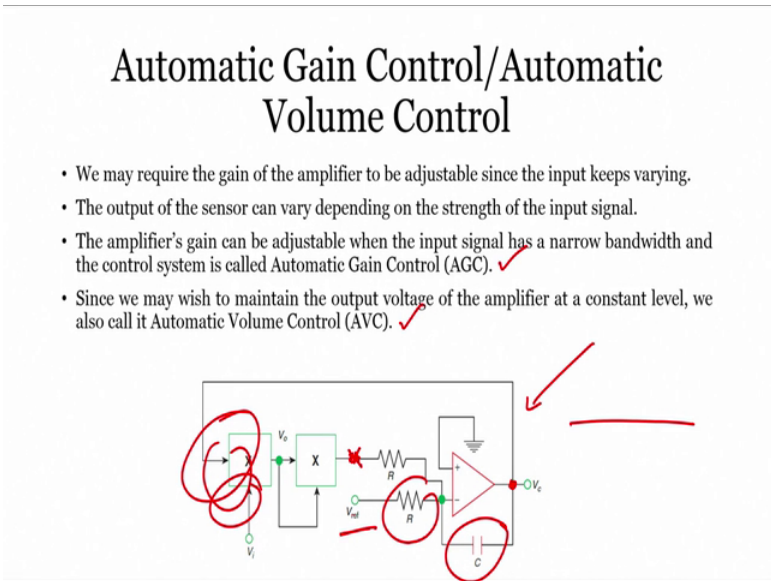

So, if you see the slide, the slide shows that like I said we required the gain of amplifier to be adjustable since a input keeps varying. The output of sensor can vary depending on the strength of input signal that we know right. The amplifier's gain can be adjustable when the input signal narrow bandwidth and the control system is called Automatic Gain Controller AGC or we since we maybe instrument and output amplifier constant level, we also can call it as a voltage automatic volume controller.

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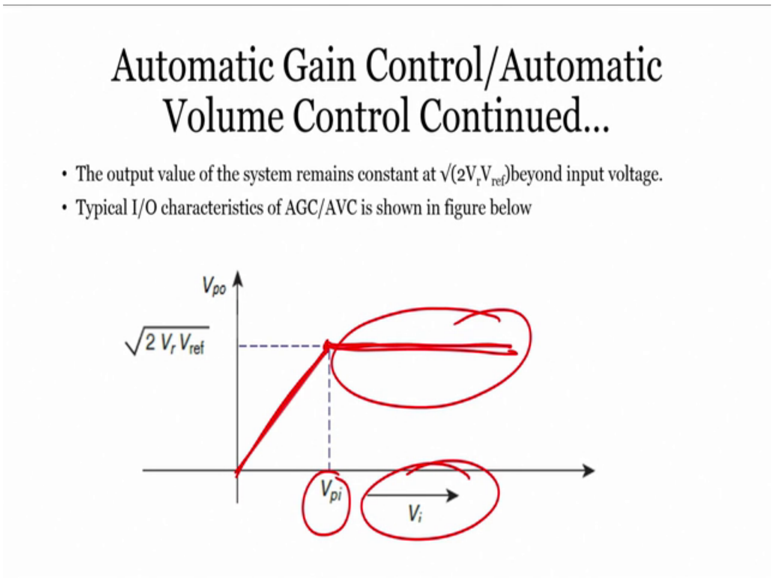

Now, if you see this circuit right so, first let us see a plot, here what you see until this V pi the output almost changes linearly right. And, above V pi if there an and then we reach this particular point where your output is kind of constant right. So, how to get this constant in even there is change in V pi signal, as you can see here we changing signal is there, we can we are not looking at the change in the output right. How can we obtained this constant output? So, for that what we need to do, we need to use this circuit. And, in this circuit there is a reference voltage, input voltage is a assign wave and assign wave is further multiplied by once again multiplied becoming sin square right.

So, when you have sin square it is like a ripples or you can say full way rectifier kind of signal. And since there is a integrator right over here, if you can R and C forms are integrator what their output will be almost constant right, that is what we see here at the output is constant right. So, using this circuit we can control the output voltage, again there is a feedback signal. So, if there is an error that error signal goes here and then you can compare it with this input voltage right which is further rectified. And, further the error is subtracted to make sure that output voltage remains constant. So, the signal that is obtained here is always compared with the reference voltage which is given over here ok. In terms of operation it is very simple and the output of the system remains constant at under root of 2 V r V ref.

We will see how we can get this particular equation or a formula and after certain input voltage. That means output voltage will be constant at that this particular point and typical output input output characteristic is shown here in the figure, where you see a V V i versus V o or we can say V pi versus V po. So, let us see how we can implement this particular circuit using a TI board and then we will see the output voltage also; how the output voltage changes with respect to input. And, we will see that even there is unwanted change in input signal, the output voltage remains constant ok. So, let us see this I will ask Anil to show us the implementation of the circuit on the TI board.

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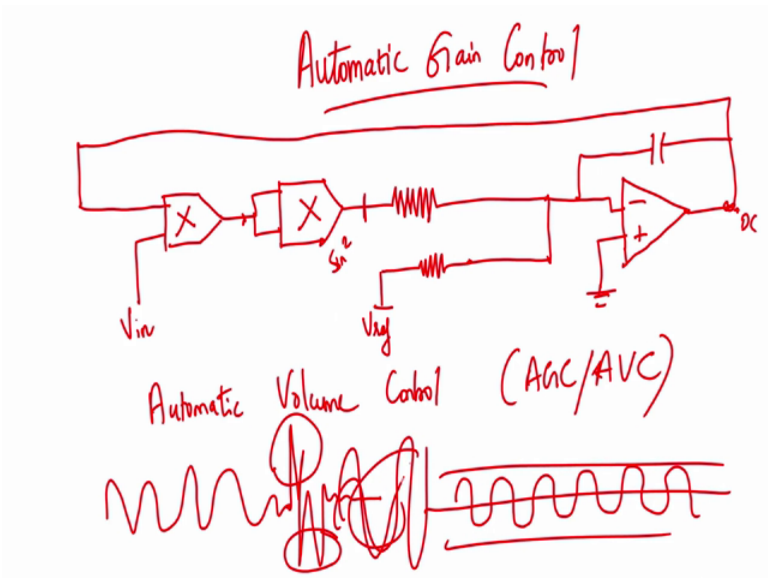

We will be doing the experiment on the board for the automatic gain controller circuit which you have just seen in theory. So, just quickly recap doing recap what is the automatic gain control? The this circuit is mainly used so, as you can see on the screen this the circuit that we will be trying out on the board today. So, what basically means what is this automatic gain control? Automatic gain control also called as you would be aware now it is also called automatic volume control. So, AGC or AVC what it does is basically whatever; so, input voltage like a specially, in the practical applications input voltage might be having a particular pattern but, occasionally there might be fluctuations like this.

So, for these fluctuations you do not want the output to go follow the input in these fluctuations and you want the output to be having a defined gain. And, it is gain needs to be controlled to set values, no matter how the input changes. So, this is the essence of automatic gain control that you have studied. So, let us we will not go into the full details of this because that is already covered. So, in the circuit what we are trying to do it today that only will see right now. So, what we have the circuit we have 2 multipliers here and a amplifier op-amp based amplifier so, what happens is basically this is your input voltage ok.

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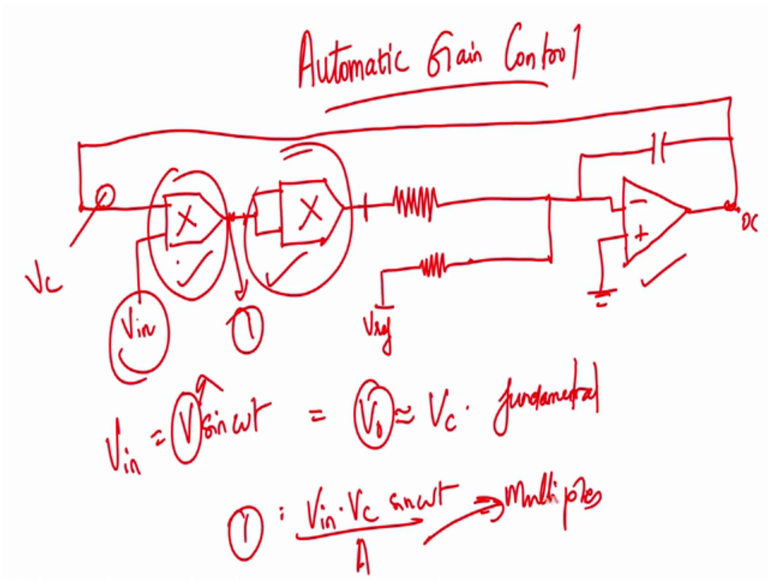

And so, let us say you in apply an input voltage of V sin omega t as the V in. So, you want your V in if your V fluctuates your output should be a read, the amplitude of your output should be reasonably constant let say V c. So, this is your fundamental aim of designing the circuit. So, what happens in this in these blocks are so, V in has a one component there are two multipliers. There are two multipliers this and this and this multipliers has a in one input has a feedback from the output ok.

So, what then the next multiplier is there; what this next multiply does is it is like a multiplication operation and let us say after the multiplication. So, this is a this is the this has a this input as a measure of the amplitude of the output as a measure of the amplitude of the output that is V c. And so, here the output the output of the multiplier will be V in into V c sin omega t by A, where A is the amplification factor of the multiplier ok. So, this is the output at this point 1. Now, at two what happens is this same signal is multiplied again with itself. So, what happens is you will get some voltage which is V in V c by A whole square into sin square omega t at here 2 so, this is 2.

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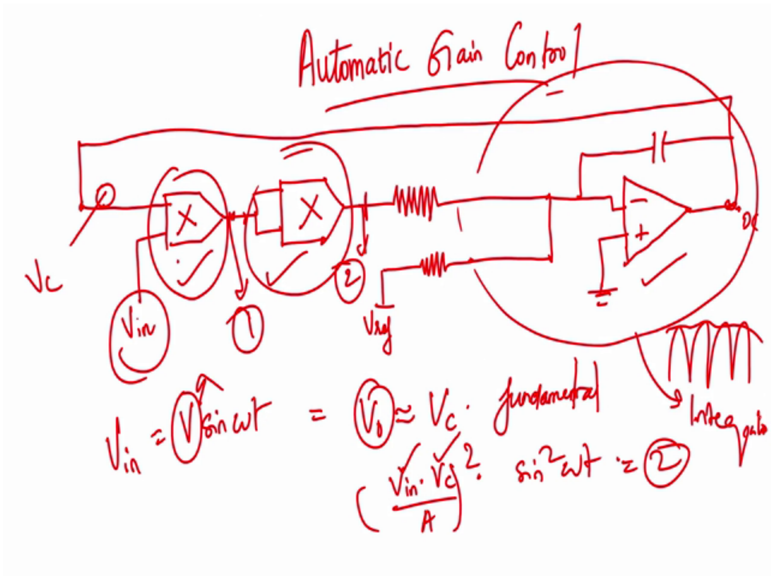

So, this is like a diode based rectification operation. So, sin square omega t would have information like this. And, you will try you will we can get the actually, we can get the what is the amplitude of it has information about the amplitude of the output as also the amplitude of the input correct. So, then it goes to an op-amp based amplifier section. So, this amplifier acts as an integrator here ok, acts in integrator and what it does is it tries to see how much the output voltage is fluctuation fluctuating from his reference voltage and it will give you an error voltage.

And that error voltage so, the accumulation will be will be there in the output and that gets that gets feedback to the multipliers multiplier section as a result of which whatever be the fluctuation of the input the output voltage remains same. So, it to put it simply let us say here your output is V in into V c by A sin omega t.

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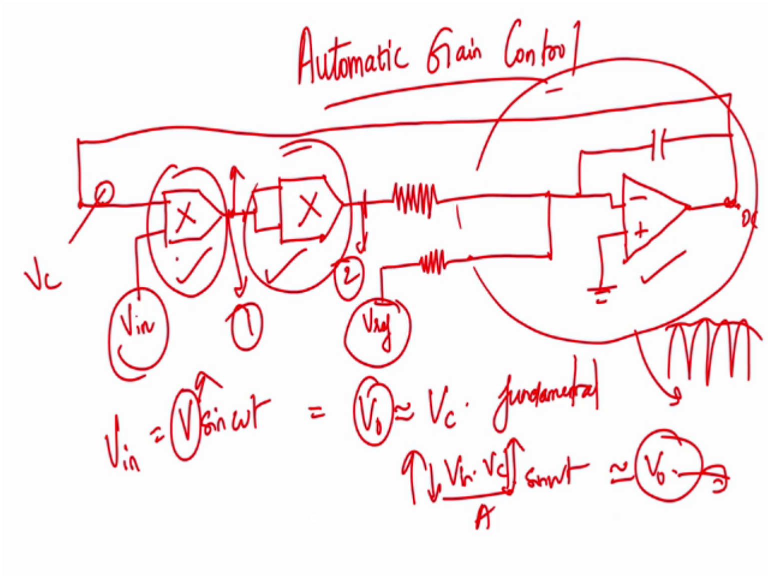

And, let say your output is proportion to this, if your V in goes down your V c has to go up to maintain this output voltage constant. Let us say or if your V in goes up your V c has to go down to retain your output voltage constant. So, that is what the whole circuit does, this is the essence and the theory has already been covered. So, now, in the experiment what we will do is, we will have this will have connected this circuit on their board.

And, then we will apply a sin wave and show you what is the output and how the output is changing? So, now so this is the whole a whole circuit, we have 2 multipliers and then an op-amp section. And, as a result of which with the changes in V in input voltage with even minor changes input voltage amplitude the output voltage is remains reasonably constant so, now let us see the board.

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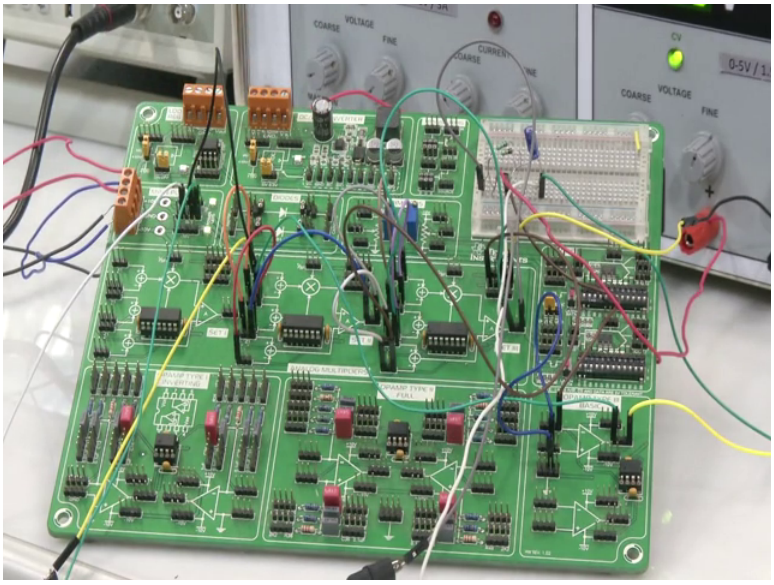

So, here we have the circuit so, the as we have seen in previous sessions we have the multiplier section here ok. Since, we have to use 2 multipliers so, we have used 2 multiplier sections this and this and then we have to use op-amp section. So, we have used the op-amp section also here so, we have used this op-amp section ok. So, the input voltage is applied from the function generator at a sin wave of let us say 50 kilohertz is applied and, this voltages are and this amplitude can be changed and the connections are made accordingly for the multiplier.

So, as we did before also the multiplier has x 1 x 2 y 1 y 2 z 1 z 2 inputs; the x 2 y 2 and z 2 inputs of the multipliers both multipliers are grounded and the input first input is applied to x 1. So, this yellow wire here is x 1 which is your input from your function generator and you have your y 1, this y 1 is this green wire, y 1 is coming from where y 1 is coming from this op-amp here. So, that is the feedback which we saw that is coming from the output of the op-amp, this green wire which we are holding up here. So, this green wire is there so, this what the first multiplier which we saw that connection. The output of that multiplier as we have seen before has to be fed back for the negative feedback to work for the multiplier.

So, that is this wire, this blue wire here, this blue wire here, the output of the multiplier is fed back to the z 1 input that goes to the negative terminal of the multiplier op-amp ok. Then the output of this multiplier again goes to goes as the input one of the inputs through this wire you can see this wire right. So, it again goes as the input to the next multiplier section here, x 1 again x 2 is grounded like this. Then x 2 is grounded as so, is y 2 and y 1, what we will have y 1 because a second multiplier has the same signal right, we had seen. We use a same signal at both the input terminals of the second multiplier so, that is what this brown wire does, this brown wire which I am holding up which we are showing with the pen here.

So, this brown shots or connects the same output of the previous multiplier as the input, both the inputs of the second multiplier. And, as usual set 2 terminal is grounded and z 1 is fed back from the output through this long brown wire. This wire which I am holding, the output is fed back as well to the x 2 terminal to the x 1 terminal through this green wire, output is fed back through this green wire not the brown wire. The brown wire is basically ground for the probes, this a green wire. And, then what has to happen the output from the second multiplier through this gray wire here has to go to the resistor network, which is shown in the small breadboard.

We saw 2 resistors right, one resister goes through a capacitor to the output terminal of the op-amp and another resister comes in through the reference voltage which we apply. The concepts of the reference voltage etcetera have been discussed to you. And so, this one resister comes in through the reference voltage and capacitor goes to output of the op-amp. And, again the inputs of the op-amp are that those and positive terminal of the op-amp is grounded through this blue wire.

And, the negative terminal is connected to the other end of the resistor pair, these two resistors. And, the capacitor connects across the output and the negative terminal of the op-amp, here so this is the output. So, this is the whole connection of the circuit and output of the op-amp finally, as we have seen before again goes back all the way back to the input of the first multiplier so, this completes the circuit.

So, now what will happen? So, we have here we will give input to the first multipliers input through this yellow wire and we will see the output from where, we will see the output from the red wire. And, we will see the red wire is a actually giving the supply for the reference voltage here this red wire. And, this white where here is there we will see the output which is the output of the op-amp, it is connected there itself because it is connected to the other end of the capacitor correct. So, now let us see the function generator first on our right yes.

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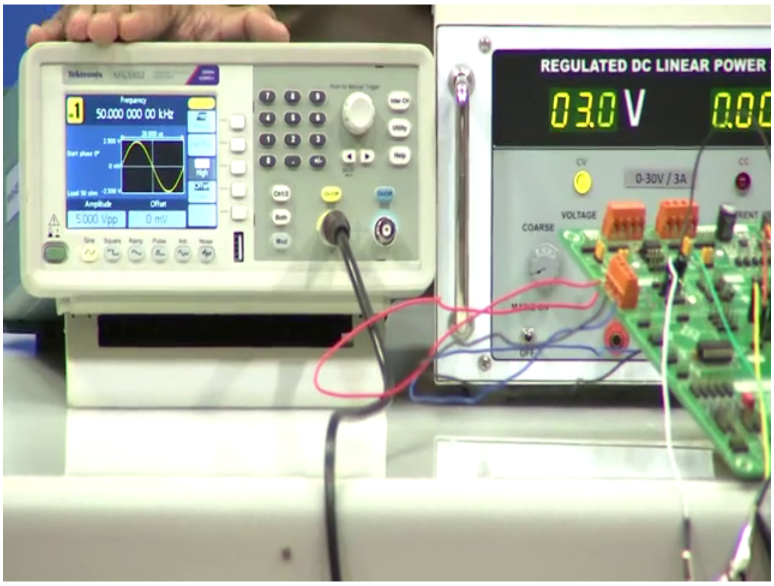

So, in the function generator we can see we are applying 50 kilohertz sin wave at 5 volt peak to peak, at 5 volt peak to peak sin wave 50 kilohertz at sin volt 5 volt peak to peak ok. Now, let us see the output voltage in the oscilloscope. So, we have shown the output voltage, output signal and the input signal. So, let us see the oscilloscope.

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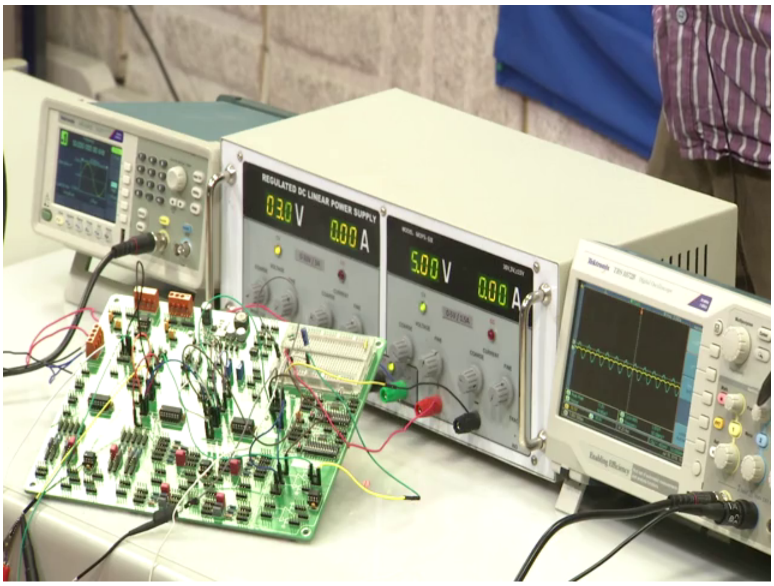

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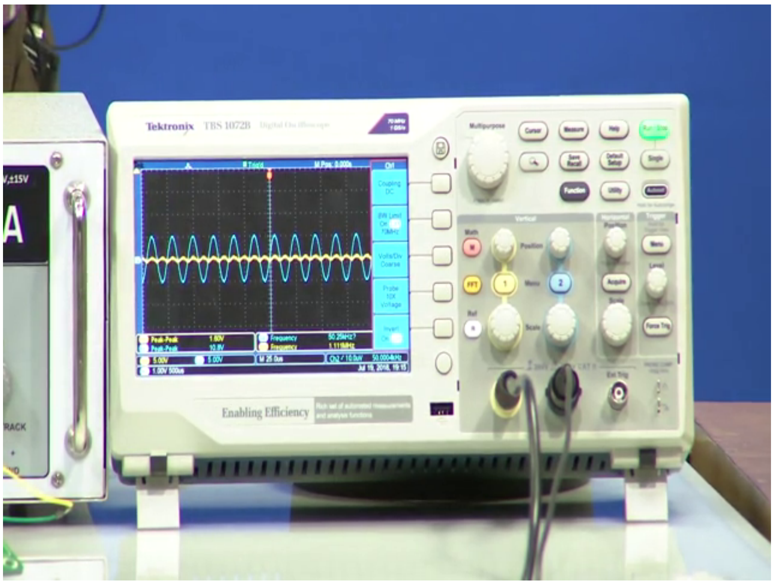

Yes, now you can see the oscilloscope so, the blue is the input signal and yellow is the gain controlled output. So, we have adjusted the scales now so, that you can see the output and the input on the same reference level. So, let us see we have kept the input voltage at 5 volt peak to peak. So, let us just increase the voltage ranges and you will see that even when the input voltage is going from 5 volt peak to peak swing to 10 volt peak to peak swing, you will still see that the output voltage is reasonably constant which is what we want in an automatic gain controlled or automatic volume control environment.

So, let us just increase the input voltage now. So, through function generator I will be increase in the input voltage, but just focus on the oscilloscope to see how the output is changing. So, we are just seeing the circuit again so, we are seeing the oscilloscope again. So, this is now 6 volt earlier it was 5 volt so, still if you see the output voltage is constant it is sinusoid of a reasonably low amplitude because, that is what we have designed for. So, this is 6 volt peak to peak still the output voltage you can see that it is remaining constant. This is 7 volt peak to peak, 8 volt peak to peak, 9 volt peak to peak, 10 volt peak to peak.

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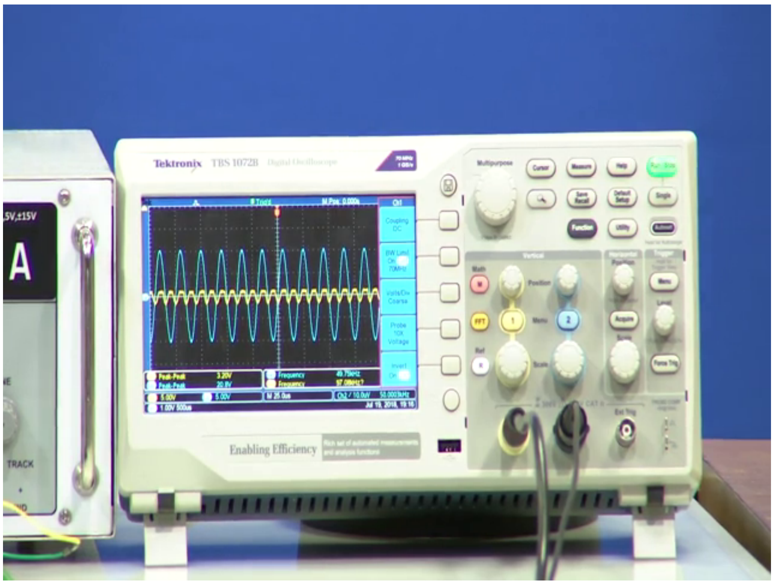

Still you can see the output voltage is reasonably remaining constant. If you go beyond this what happens is that, if like will it take to cross 10 volt peak to peak or 12 volt peak to peak. We have used 3 sections of circuits in the circuit right, we have 2 levels of multipliers and an op-amp. In one of these circuits many of the intermediate stages, they can reach saturation levels because of which your out output voltage need not necessarily follow the input.

But, you can see very clearly that when we swing from 5 volt to 10 volt peak to peak which is a very huge swing; here output voltage is remaining constant so, which is the yellow. This is the automatic gain control operation which we have demonstrated through this experiment.

Thank you.