Op-Amp Practical Applications: Design, Simulation and Implementation

Prof. Hardik Jeetendra Pandya
Department of Electronic Systems Engineering
Indian Institute of Science, Bangalore

Lecture – 11
Op-amp Applications: Clipper

So, welcome to this particular module. And in this module, we will be understanding what are the application of Op-Amp in terms of wave shaping circuits. So, what kind of wave shaping circuits you can use and what kind of circuits you can implement to shape the wave, alright. So, one of the circuit, that is used for shaping the signal is called clipper alright. So, clip; what does clip do? It will kind of cut right, clipping. It will cut the signal or you can shape the wave.

So, either the signal; we are shaping the positive part of the signal is called positive clipper. If we are going to shape the negative part of the signal is called negative clipper. So, very easy to understand, very easy to identify which kind of clippers we should use for shaping what kind of waveforms right.

So, how a operational amplifier can be used as a clipper circuit, alright. How operational amplifier can be used as a clipper circuit? We will see and then, we will implement, will implement this clipper circuit using our favorite 3 equipment right. DC power supply function generator and oscilloscope alright. 3 things and we have a simple thing called breadboard right. We have our operational amplifier ICs, we have some resistors, we have some we have some diodes and we will see that how we can implement this particular circuit.

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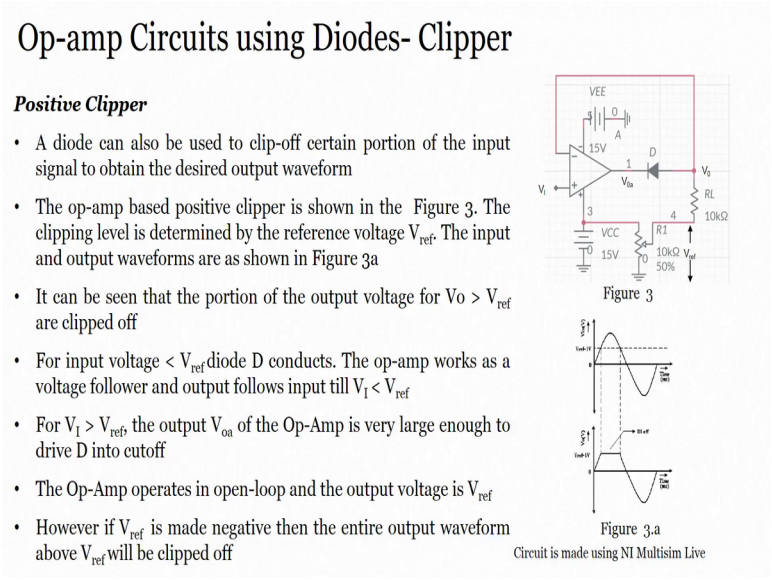

So, let us see on the screen, the opamp circuits that using diodes, opamp circuits using diodes and that will act as a clipper that will act as a clipper.

Now, we have seen the opamp circuits with diodes which act as a rectifier's right. We have used half wave rectifier; we have used full wave rectifier. Now, we are looking at the clippers alright. So, what exactly clipper means and how we can implement this circuit? So, this particular circuit that you see here right, what is it? This is minus 15 volts alright. Plus, ok. Now, we have V C C right. And we have we are applying a reference voltage through to your anode of the diode. We are applying some voltage to the anode of diode.

Now, to conduct this diode, the anode should be more positive compared to cathode right. The anode voltage should be higher than cathode voltage or the cathode voltage should be lower than anode voltage, right. That we already know.

So, here the reference voltage right, this voltage, reference voltage, this one is given through the potentiometer. What is it? Potentiometer, alright. So, potentiometer is a component right, using which we can change the resistance, using which we can change the resistance. We have seen the potentiometer in earlier lectures.

So, using a potentiometer, what I can do? I can set my reference voltage V reference. I can set my reference voltage V reference. This is my load resistor R L. This is my diode

which is my P N junction diode. This is connected in connected in this particular way N P right. This is C, this is diode which is anode, this is cathode right is an diode is P right. This anode is P cathode is N.

You have operational amplifier. You are applying signal through the non-inverting terminal of the operational amplifier, non-inverting terminal of the operational amplifier. Now, let us see if I have this circuit, how it will act how it will act hm. So, this is your positive clipper circuit, positive clipper alright. So, a diode can be a diode can also be used to clip off certain portion of input signal to obtain the desired output waveform.

That means, that if you see this particular signal, which is your input signal you see this signal which is your output signal. What we observe is, by using this circuit which is your positive clipper, you can clip off, you can clip off certain portion of your signal. You see here, this signal is clipped off right. That is what we are looking at. A diode, the diode can also be used to clip of certain portion of the input signal to obtain the desired waveform.

The opamp based positive clipper is shown in figure 3. This is your figure for positive clipper. This is a figure for your positive clipper. The clipping level is determined by the reference voltage V reference. That is, by changing the V reference, how much clipping I want, how much clipping I want in this signal, in this particular signal. I can change it. You see, there is a here you see, it is dash line. This one, this is your V reference is your V reference right.

If I change this V reference, I can change this clipping. You see this clipping, I can change this clipping. If I change the V reference; that means, if I put V reference here, then I will have waveform which is like this right.

If I keep my V reference here, then I will have waveform which looks like this right. That means, if by changing V reference I can change the clipping, I can change the clipping ok. Excellent. So, what we have seen? We have seen that a diode can be used for as a positive clipper. Then, we have seen these circuit for positive clipper is shown here.

Then, we have seen the clipping can be determined or is determined by the reference voltage right, V reference. The input and output waveforms as shown in figure 3 a. You can see the input and output waveforms. These the circuit is made using N I multisim life

alright. The circuit you can design using multisim. The circuit you can design using multisim alright.

Now, it can be seen that the portion of the output voltage V 0 greater than V reference. V 0 greater than V reference are clipped off you see here the output voltage which is this voltage right. This is your V in right and this is your V out. So, what is clipped? What is clipped? This signal that you applied which was V out is greater than this line, this line alright, is greater than V reference voltage.

So, the only portion of the output voltage which is greater than V reference is clipped of alright. For the input, see for the input voltage less than V reference diode D conducts. So, how this operates? Now, let us see. Now, this was easy right. We this much is easy we understand how the clipping is occurring in the signal.

Let us see the how this circuit works and why this circuit helps us to clip off certain portion of the signal. So, if you see here, for the input voltage less than this input voltage is less than V reference voltage. That means, V 1 less than V reference voltage right. D conducts diode will conduct why because, V is less right. That means, a output would be, this will be more positive compared to this terminal.

Anode will be more positive compared to cathode. That is why, this diode will start conducting. When diodes are conducting right, the opamp works as a voltage follower right. Because, see diodes are conducting, then it is like this. So now, the your opamp becomes a voltage follower right. Your voltage follower circuit is this one.

When you have diode in a conducting situation, in a conducting situation this diode will conduct when your V 1 or V in is less than V reference voltage right. So, for the input voltage less than V reference voltage, diode D conducts. The opamp works as voltage follower and the output voltage follows till V I is less than V reference, you got it. So, the output voltage will follow until V I is less than V reference. Now, let us consider another case. Another case is, for V I greater than V reference. What will happen for V I greater than V reference? What will happen right?

So, for the voltage V I, which is input voltage greater than reference voltage greater than reference voltage. The output V o a, the output V o a. That is, here output voltage of the

opamp is very large enough to drive D into cutoff to drive diode in to cut off. Diode will not start. It will not conduct. Diode will not conduct right.

In this case, the opamp operates in open loop and the output voltage is V reference right. When it does not conduct, opamp is like open loop because, is not connected. It is not connected. It is a open loop. Feedback is not connected because diode is not conducting. Becomes a open loop circuit. When it becomes open loop circuit, the output is nothing but your V reference voltage. Output will be your V reference voltage.

So now, now our output is V reference excellent. However, if V reference is made negative, then the entire output waveform V reference would be clipped off. That means, that if I have V reference right, V reference as negative like here right. If I make V reference equals to minus, let us say 5 volts and the signal is signal is 5 volts, then the entire signal would be clipped off right. This entire signal would be my output here in this particular case.

Let us see closely ok. It is very important point if right. Now, my V reference is right. Now, my V reference is 1 volt alright. But, what if my V reference, what if my V reference is minus 5 volt for minus 5 volt? Let us say, this is my minus 5 volt. If my signal if my signal is 5 volts, my V reference is minus 5 volts right. Then, what will I have the entire this waveform? The entire input signal right will be clipped off; that means, output will be nothing will be clipped off.

That means that, by changing V reference, by changing V reference you can you can control the shaping of the signal. You can control the shaping of the signal; you can control the clipping. When you clip it, it should it will look different. You see shaping. What is shaping? Shaping means, what does shaping means? Shaping of the signal is nothing but, you see if I have the signal right, I can clip it like this or I can clip it like this or I can clip it like this, right.

That means that, the signal which is your input signal. My output signal can be vary. It can be of different shape, can be of different shape. That is what I mean by clipping and that is what clipper does, that is what is a function of a clipper ok. So, easy. Now, this is the positive clipper; that means, it will only act on the positive. What about I want to clip just negative? Only negative right. You are the input I have interested only in this part of

the input, I want to shape the negative part of the signal. How can I design a circuit which can act for negative part of the signal.

So, in this case, what we will do in this case? What we will do? Let us see, let us see the negative. So, opamp circuits using diodes which is a clipper and this is your negative clipper. This is your negative clipper. Now, if you see the diode D 1 in the negative clipper and if you see diode D 1 in positive clipper ok. So, I am going back 1 slide, you see what is the main difference, what is the main difference? (Refer Time: 14:00).

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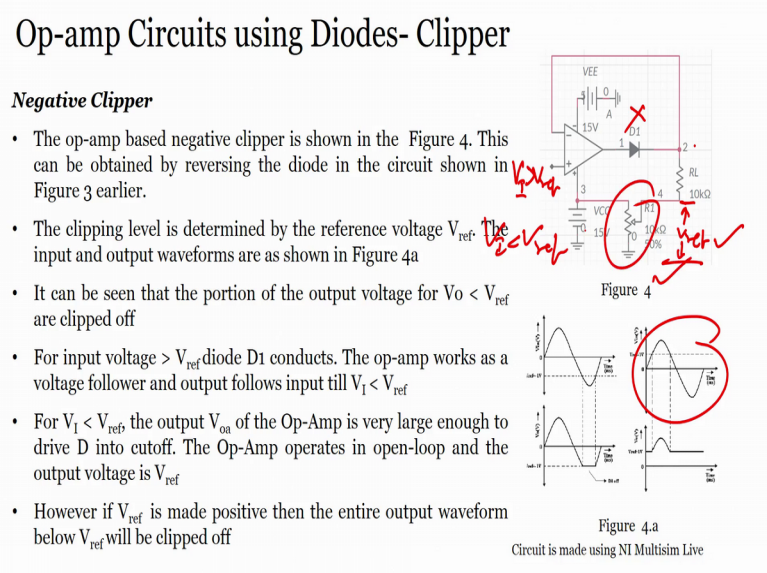

The main difference is that, when you compare diode D 1 in the in the in the in the negative clipper circuit and when you compare diode in the positive clipper circuit, the direction is opposite. The direction is opposite. You see here, here see direction is opposite.

So, negative clipper you connect the diode, the anode of the diode to the output of the opamp and the cathode to the reference voltage, anode to the output cathode to the reference voltage P to the output N to the reference voltage P N junction. Now, it is in P N configuration right. So, rest of the circuit is similar. Rest of circuit is exactly similar minus V or V E. We have V C C, we can have V reference here, V reference right. This is your load resistor R L. This is you are output is connected to the cathode of the diode; that means, reference voltage is connected to cathode. The output voltage of opamp connected to anode right, is very easy.

Now, let us see how this circuit will work ok. So, the first line, first line is that the opamp based negative clipper is shown in figure 4 ok. This can be obtained by reversing. You say, reversing the diode in the circuit shown in figure 3. Earlier, we have already seen that. Now, the clipping level the clipping level; that means, how much it will clip is determined by the reference voltage. New thing to learn no. We already know that in the positive clipper that the reference voltage will determine how much clipping will happen, very easy ok. The input and output waveforms as shown in figure 4 a ok.

Let us see figure 4 a. What is figure 4 a? Figure 4 a, is here right. Again, you can see the circuit. This circuit is made using N I, national instrument multisim live ok, nice. Now, So, what we should do? We should do is; we should focus on our figures alright. So, what is that the input voltage and the correspondingly the output voltage with respect to the input voltage. That is what is given in figure 4 a right and what we can see that the portion of output voltage for V o less than V reference are clipped off; that means, that the voltage output voltage here hm.

So, the input voltage is this. Which one? This one this is your input voltage right and the output voltage, you see output voltage is clipped off; is clipped off. Output voltage should be like this right. So, the output voltage output voltage which portion is clipped off, which is less than your reference voltage, which is less than your reference voltage. This is your reference voltage, is your reference voltage.

So, if you see the output voltage, output voltage is the portion of the output voltage that is clipped is the voltage which is less than a reference voltage alright, easy. So, here, if you, we will see the next case here. So, let us see if you see figure number 4 a, then we can see that, it can be seen that the portion of the output voltage for V o less than V reference are clipped off. For V o less than V reference are clipped off, for input voltage if the input voltage is greater than V reference hm. So, let us consider this particular case, when your input voltage input voltage V in is greater than V ref; V in is greater than V ref.

In this condition, what will happen? If my V in is greater than V reference voltage; that means, my this terminal will be more positive compared to my cathode compared to my cathode right. My diodes P will be more positive. A anode will be more positive

compared to my cathode. And that is why, my diode D 1 will start conducting my D 1 will start conducting right.

Now, in this case, in this case the opamp works as a voltage follower why because, if my D 1 starts conducting, then it means that it is a short circuit like this; that means, this is nothing but, if I see the circuit, I will find that it is the thing but, your nothing but your voltage follower. This is voltage follower. This is the case when your V in is greater than V reference.

So, the opamp works as a voltage follower and the output voltage follows input till V is V I is less than V reference alright. Now, if what if I have V I less than V reference? That means, the next condition next condition where I have V in or V I less than V reference voltage, what happens if this is the condition? In this condition, the output voltage of the opamp is very large enough to drive D 2 cut off; that means, that this diode will be cut off. Diode will be cut off in this case. What will happen if the diode is cut off?.

That means, it is output is not connected to this 2 right. If I say, A and this is B, then A is not connected to B. Why because, my diode is not conducting, my diode is not connecting. When my diode conducts, then I can write like this.

When my diode is not conducting, I cannot draw like right; that means, a A and B is not connected. If A and B is not connected; that means, my opamp would be in open loop when my A and B is not connected; that means, my opamp can be or it will come into open loop situation or open loop mode and the voltage output voltage is nothing but your reference voltage.

So, if my opamp is open loop mode, then what will happen? If my opamp is open loop, then this is not connected; that means, whatever my output voltage is there, is nothing but here my reference voltage that I am creating here right. Super easy, extremely easy. There cannot be easier things than this kind of circuits.

So, easy. Just you understand the operation of diode and rest becomes a history right. Very easy diode, how diodes acts, positive, this is negative, if anode is greater than cathode, then it will start conducting. If anode is less than cathode, then it will not start conducting. When I say anode is greater, that means, the voltage at the anode is less than

voltage at the cathode alright. Then, the diode will not start conducting and if you know this, then you can understand the clipper. You can understand the clipper alright.

So, however, if V reference is made positive and then the entire waveform entire waveform will clip. If my V reference is made positive, you see if right. Now, V reference is here then you can see the entire waveform. This is my input signal.

But you see the output, see the output, almost entire waveform is gone except the voltage which was above the V reference voltage which was above the V reference voltage. But, if I have reference voltage V reference voltage, if I have this V reference voltage somewhere set here, then what I will get? The output I will get. The output would be this. Everything will be clipped off. Everything, whole signal, whole signal will be clipped off. That is what it says that if V reference is made positive, then the entire output waveform below V ref will be clipped off. Easy, super easy.

Let us quickly see, quickly see your clipper. Let us quickly see your clipper and let us see if I can understand what we have done.

Let us again see very quickly the positive clipper. Positive clipper diode is in this fashion right and cathode is connected to the output of opamp. Anode is connected to the V reference. V reference is the voltage across here. Your plus minus V C C and V is already given signal is given to the non-inverting terminal right. And then, what we have the if you see the see if you see the waveform, you can see that for all the signals V (Refer Time: 23:26), then V reference the signal is the signal is clipped off in the output in the output the signal is clipped off.

Now, we have for the for first case, when your input voltage is less than reference voltage, input voltage is less than reference voltage right. In this case, my diode will conduct my diode will conduct and the opamp works as a voltage follower.

If my diode works, conducts, then my opamp works as a voltage follower when the case when my V I is greater than V ref my diode will not conduct and diode when does not conduct. This becomes open loop and becomes open loop. My output voltage is nothing but V reference voltage. If my if I keep my V reference voltage negative, then the entire waveform entire waveform would be clipped off. Now, you go to the negative clipper. When you go to the negative clipper, the diode is in this particular fashion; that means,

the anode is connected to the output of the opamp, the cathode is connected to the reference voltage. Your reference voltage is here, reference voltage right.

And now, if I have a first condition when my input voltage is greater than reference voltage, my input voltage is greater than reference voltage, my diode will conduct. When my diode conducts, my opamp becomes nothing but a voltage follower. My input voltage is less than my reference voltage, then this diode will not conduct because, this because the voltage across the cathode is more than voltage across the anode. And that is why, when it does not conduct, the opamp becomes open loop. When it becomes open loop, then my voltage at the output is nothing but my V reference voltage right.

And then, if I make my V reference voltage positive, then I can entirely clip off my signal; that means, that in both the cases the reference voltage that we generate with the help of potentiometer is extremely important factor to control the clipping of the signal, good.

Now, let us move to the experiment. Experiment right.

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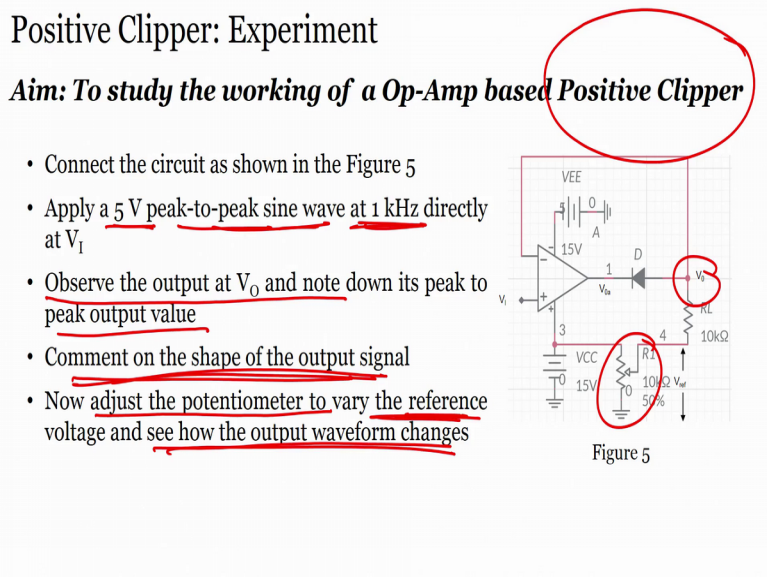

We have to see the experiment for the clipper. First, we will see positive clipper and then we will see negative clipper ok. So, first if, if you want to make a positive clipper, we all now know we all are expert now right. Because, all now know how diode works. By understanding how diode works, we can understand how the clipper works right.

So, we draw the circuit as shown in figure 5. We show we have we have we can draw the circuit as shown in figure 5. We apply voltage at the non-inverting terminal of the operational amplifiers. How much voltage we will apply? We will apply a 5 volts, peak to peak sine wave at 1 kilohertz to the V 1.

From where you will apply 5 volts; peak to peak? Now you should all tell or say the same thing which I am saying. Before I give the answer, you should be able to give the answer alright. This 5 volts peak to peak 1 kilohertz frequency can be given to the input of the non invertary amplifier using frequency generator, using the function generator right. And the output voltage observe the output voltage V o and note down, it is peak to peak voltage. This output voltage output voltage from where we will measure output voltage or using what we will measure output voltage? We will measure output voltage using oscilloscope. That is the correct answer, digital oscilloscope right.

Because we have DSO here, you can use a CRO also. You can use C R O cathode ray oscilloscope. No problem. Absolutely, no problem right. If you do not have oscilloscope, you can measure the voltage at the output with the help of digital multimeter. The only disadvantage would be you will not be able to comment on the waveform. You will not be able to comment on the waveform, you will not able to see the waveforms. Otherwise, you can see the voltage. So, that is fine right.

So, here we will if we have if we have function generator, if we have DC power supply, if we have oscilloscope, if you have a breadboard, if you have opamp, if you have a resistors and if you have a diode and if you know this circuit, then you can design this circuit and connect it as shown in figure and then apply 5 volts peak to peak, measure the output voltage V o and then comment on the shape of output signal.

Now, what we will be doing? We will adjust the potentiometer. We will adjust this potentiometer to vary the reference voltage and see how the output waveform changes. This is what this is my positive clipper, this is my positive clipper. So, let us perform this experiment. T. A. Seetharam will use multisim for simulation. So now, we will see the working of the clipper using multisim. Then, we will look into the experiment. So, let me construct the same circuit using multisim.

So, let me open a multisim. So, I will keep side by side. So, I will take an opamp. So, I am taking an opamp. In this case, I am taking 3 terminal opamp. Let me flip it.

So, that it will looks similar to that what we have seen in the circuit 2 and what we require? We require a diode. So, I am taking the diode here, but it should be in reverse. It should be in different way. So, I am just flipping it and we need one 10 k resistor. So, I will take 1 resistor which is nothing but a R L load resistance in this case and the value I am changing it to 10 k right. So, this is where that we have to provide a reference to the circuit. So, let me connect completely. So, this particular terminal has to be connected here and the diode the this has to be connected here and this portion has to be connect here.

So, this is the where we have to provide an input signal and this is where we have to provide an reference signal. So, if you look into the circuit. So, we are providing a input reference voltage. Using a potentiometer in this case rather we can use a potentiometer or we can also use another voltage source. So, for that, so, what I will be doing is that, I will take voltage source D C voltage in this case.

So, connecting from here to here; connecting from positive terminal to this particular value and where as the other the terminal should be connected to the ground. So, let me connect it. So, what I will be doing is that input will be show connected to the positive terminal of an operational amplifier.

So, I will take AC voltage. I will be connecting from here to here and other terminal should be connected to the ground. Now, the circuit is ready. So, in order to understand or realize the circuit, we have to connect a probes. So, I will take a voltage probes. So, the first probe will be connected.

So, which will be represented in terms of green will be connected as a non-inverting terminal of an opamp which shows you how exactly the input signal is of and other one another voltage probe will be connected at V not right. So now, the circuit is ready. So, what I will be doing is that I will be applying a peak to peak value of 5 volt. So, I am changing it to 2.5.

Now, when I run the circuit right, when I run the circuit here, we can see the complete output voltage. So, in since it is very hard, let me enable and disable one by one. So now, if you see since there is the reference voltage is of 12, let me change it to 12 volts. And so, the green the represents are input in this. Whereas, the sky blue represents are output in this case.

Now, what is the peak to peak value that we have applied right. The peak to peak input voltage is of 5 volts and the reference value is 0. So, that means that, whatever the input voltage greater than the reference is completely removed clipped. So, that is why, this is called clipper.

So, let me slowly increase to 1 volt. We can see that, above 1 volt, whatever the input voltage we have is completely clipped. So, if we if you clearly see here, the sky blue represents your output right. Whereas, the green represents your input. So, when I disable the sky blue right, here we can see the input is completely 2.5 volts peak to peak sinusoidal signal. I am enabling it.

So, to make you understand, to compare both the input and output signal, what I am doing is, I am enabling both with the same reference value. So, that is the reason the green is completely embed. You know at the backside of your sky blue. So, that that is why you cannot see the complete sinusoidal input signal? That is nothing but, the green signal.

Now, if I slowly increase, if I see at this particular reference value 1 volt, we can see that the first 2 peaks above to that of this 1 volt is completely clipped off. So, that is what even we have seen in the circuit. So, when you see this is the positive clipper right. So, since we are applying a positive input voltage at this point. So, what is happening?.

So, because we are applying a positive input at this point whichever the voltage is greater than that particular point is completely clipped. Let me change it to 1.5. We can see above 1.5 will be completely clipped. Let me changed to 2 right and let me change to 3. So, what will happen? Since we do not have any signal greater than 3 volts, I cannot see any voltage to be clipped off.

But if your input peak values greater than 2 volts. So, that is why I am changing it to 5 volts. The peak value of 5 volts; that means, peak to peak is of 10 volts. So, you can see here more than 3 voltage. Whatever the input you have, it is completely picked. But, below the reference value of 3 volts. You can completely see the it is simply following your input signal right. Simply, following your input signal. So, so this is how you can understand, analyze the complete circuit using multisim.

Let us see whether we can see the clipping action on the output or not right. Whether we are able to see the clipping action at the output using the oscilloscope, we will see whether the clipping happens or not. So, let us go back to our experimental table and we see here that we have a breadboard. We have a breadboard and the positive clipper is already is already ready and we will ask Anil Vishnu to join us and he will now connect, he will now connect the positive clipper circuit.

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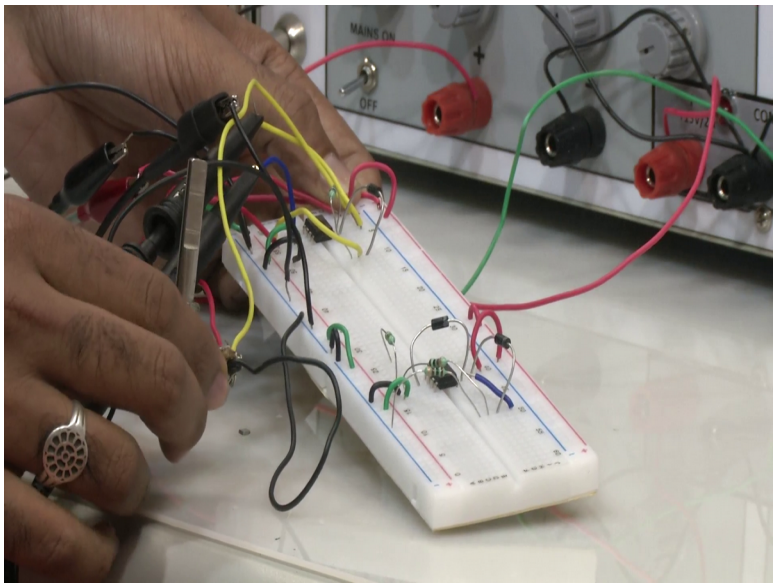

Which you all know, which you all know and if you can if you can show the positive clipper, if you can show the positive clipper, this is the positive clipper. You yeah this is the positive clipper here ok. This like between lot of wires ok. That is fine.

(Refer Time: 34:17) there is a diode, there is a resistor right and there is a opamp, diode resistor opamp. That is what we require and then we have a potentiometer. You see potentiometer is lying somewhere here. Big boy, potentiometer is a big boy you see. It is lying somewhere here and resistor is here. So, through potentiometer we can change the resistance, we are correcting the circuit similar to what we have seen in the we have seen in the screen, we have we are connecting the same circuit.

And now, we will apply the bias voltage through the operational amplifier. So, through the DC power supply to the opamp, so, we are applying the bias voltage through the opamp. Now, you can see he has to turn on the opamp and we applied the bias voltage, the input signal. The input signal is 5 volts peak to peak, 5 volts peak to peak and the

frequency is 1 kilohertz. So, if you see a function generator, what he is doing? He is adjusting or he has to adjust 1 kilohertz 5 volts peak to peak. So, 5 volts peak to peak is there. We have to change it to 1 kilo hertz ok.

So, 1 kilohertz frequency is set. We have 5 volts peak to peak which is also set. Now, we are looking at the output of the opamp, output of the circuit output of the positive clipper circuit. Let us see output voltage. So, if you can focus on the if you can focus and you see he is changing the reference voltage, you see he is changing a beautiful. If he goes on changing the reference voltage, see now we have no clipping action no clipping action.

But, if I see slowly if I change the reference voltage, slowly if you change the reference voltage you will see clipping action. Excellent, he is changing the reference voltage with the help of potentiometer like you see and you see oscilloscope and an potentiometer. These are we turning it. You see he is turning it. The potentiometer in a in a anticlockwise direction, in a anticlockwise direction and you can see the change in the signal at the output volt at the oscilloscope.

Now, again he is changing. So, by changing the reference voltage can you can you just click positive yeah ok. So, in this case as you see right, we have completely cut or clip the positive of the of the signal. So, signal that is you can see is 1 this is your 5 volts peak to peak which is your yellow signal, that is a input and the output is your blue signal and. You can see the positive part of the blue of the input signal is clipped is clipped completely is clipped completely with the help of the positive clipper right.

So, here you can very easily understand how a positive clipper would be used to clip the signal and how you the reference voltage plays a part right to clip the signal correct. So, you can see again. Since it is very interesting experiment, we have shown you 2 3 times or rather than we can see in live that how the clipping action occurs. So, the circuit is in a perfect condition and this is how it should be demonstrated. So, this is guys for you how the clipping action would work particularly the positive clipper.

Now, another thing that we have learn is the negative clipper, is the negative clipper. So, we all have studied we all have studied what is negative clipper. So, quickly if you want to tell me if in this circuit, if I want from positive clipper to negative clipper, what I will do? I will just change the direction of the diode, I just reverse the diode, I just reverse the diode alright. So, if I want to reverse the diode; that means, if I consider this particular

circuit right you see. So, let this the diode here and the diode here right quickly see diode reversed or otherwise the circuit is same. See circuit is same positive clipper, negative clipper, positive clipper, negative clipper circuit is same; diode is reversed.

Alright, here is my V reference here is my input signal here is my output signal here is my output signal. Now what are the components here again we have the bias voltage that is using the DC regulated power supply right. So, we have V E E, we have V C C right. We have input signal, we have output signal, we have load resistor, we have potentiometer. Easy finally, we have here operation amplifier operation amplifier.

Now, let us see if I connect this circuit as shown in figure 6 and if I want to measure the output voltage when I change, the when I apply input voltage of a 5 volts peak to peak sine wave at V I here right, I will observe my output voltage V o and note down it is peak to peak output voltage right.

What I will do? I will measure the input voltage and I will apply the input voltage 5 volts and I will measure the output voltage V o and note down it is peak to peak voltage peak to peak voltage. Suppose, this is input, what will be my output peak to peak voltage? I will measure at the output peak to peak voltage, I am applying at the input correct.

So, let us see and finally, what I will do? I will comment on the shape of the signal comment on the shape of the output signal. Again, we can use the potentiometer. We can adjust the potentiometer to vary the reference voltage and see how the output voltage waveform changes, that is we are going to change the potentiometer and we will see corresponding change in the waveforms in the output.

Now, T. A. Seetharam will use multisim for simulation. Now, let us see how to analyze and how to design the negative clipper circuit using multisim. So, for that case let me open multisim right. So, let me construct the circuit. So, what I will be doing is I will take an opamp let me clip it. So, it looks similar to what we have seen here and we need a diode.

So, but if we observe carefully, in the previous case the diode connections as well as for the negative clipper the diode, connections are different. As a result, it completely changes which portion of your input signal to be clipped off. In the previous case, which

is of positive clipper right. The this particular the cathode the cathode is connected to the output of your operational amplifier.

Whereas, in case of your negative clipper the anode is be connected to the output of your operational amplifier as a result, as a result it access a negative clipper; that means, that below the reference value which are the voltage that you have will be completely clipped off, but above the reference value will be there. So, in order to understand, what I will do is that, I will take a resistor need not to be connected to a resistor directly.

We can also we can connect to the voltage source directly at this 0.2. Now, I will take a DC voltage. I will be connecting the positive terminal to the 10 k input of your R 1 this R L. This case which is a nothing but R 1. In this case, resistive as a result, I will keep the magnitude as a negative.

So, we can understand what negative amplitude that we are applying as an input to input as a reference right and whereas, the negative inverting terminal should be connected in this way as a feedback now the input should the input voltage which is of sinusoidal as if we connected to the non (Refer Time:29:32) terminal. So, let me connect it other terminal to the ground. So, I will take the peak to peak value as 5 volt. So, the peak value should be 2.5 read one kilohertz. So, in order to understand how exactly the circuit works right. I will take a probes; one at the input side other one at the output.

So; that means, at which of the signal that we see represented using the green will be the input the sky blue represents the output signal. Now, if you if you compare the circuit, whatever we have seen in the presentation as well as we have seen in the multisim, there is a small difference. That difference is that the input voltage. We are connecting in this case using potentiometer. But, where as in this case, we are connecting directly to the circuit. So, as a result whatever the reference value that you said about that reference will be remains and below the reference value will be completely removed off ok.

So, to analyze it, let me split the circuit and run the circuit. Now, what is happening here? We can see the green represents completely our input signal right. So, since the peak to peak is of 2.5. We can see peak to peak and the frequency of 1 kilo, but output shows 12.5 (Refer Time: 31:27). The reason is that the input whatever we have connected is of 12 volts. So, since this shows 12 volts since the input is 12 volts and the reference values is of 12 volts and whereas, your input is 2.5 which is which is very, very smaller than

that. So, since there is no signal to be clipped off that is a reason the output will be whatever you applied.

So now, what I will be doing is to understand this, let me make it as 0 right. If you recall what we have seen in the positive clipper, when the reference is 0 whichever the voltage input voltage below the this particular reference is completely clipped off. So, it looks similar to that of your half way rectifier is not it. But, whereas, in this case if you see that whichever the voltage about to that of your the input signal will is being sent. Whereas, the voltages below to that of the negative is completely removed. So, it is nothing but your negative clipper. So, negative voltages will be clicked.

Now, let me change the reference value to 1 volt. So, we can see the value below to that of 1 1 volt is completely clipped off. So, blue represents your output right. Suppose, what if I give negative value? Now, the reference value is a negative. As a result, we can see that the negative portion below to that of minus 1 volt is completely clipped.

But, whereas, in case of a positive clipper, if you understand, if I give a negative signal which means that from this portion only that particular part would have been allowed and the remaining part about to that particular part will be completely removed. So, that is a difference between your positive and negative clipper.

So, let me change to minus 2 right and let me change to plus 2. So, it is clear that, it is clear that depends upon what is a reference that we are providing the that particular above to that particular signal, we completely passed and below to the particular reference value will be completely clipped off right. So, to make you understand, what I will do that, I will go to settings. I will enable the second channel. So, that here we can clearly see you do not have signal below to that particular reference value right.

Now, what if I let me enable both the things what if I change the reference value to somewhere around 5 here we can see since you do not have any input signal greater than 2.5. So, there is nothing to allow right and since this particular voltage is connected to the 5 volts this value will be shown as only 5 volts. So, suppose if I change the input voltage to input peak to 5; that means, peak to peak of 10-volt sorry peak of 10. So, peak to peak of 20 volts we can see that above to 5 value about to this particular reference which is 5 in this case is completely allowing below to this is completely clipped off.

So, this is this the way that we can understand the working of the positive as well as negative clippers. What we have seen now? Guys, we have seen positive we have seen negative, we have seen the clipper circuits, one is a positive clipper, one is a negative clipper and then we have seen how we can quickly change the reverse the diode and by reversing the diode. We can we can clip the circuits the main the main player in this circuit is your reference voltage.

So, if you change your reference voltage, then you can change the clipping; that means, in one of the clipper positive and in one of the clipper which is negative, you can change the reference voltage and you are able to clip the negative or the positive part of the signal.

The making the long story short the clippers are used to save the waveforms the save the signals alright. So, whenever you are asked that can you do you know what kind of circuits we can design using operational amplifier for shaping the signals. The answer is yes, answer is yes. I can make a opamp and I can make a clipper positive and negative by using operational amplifier by using a diode by using a potentiometer and by applying the bias voltages across the opamp and I can clip positive and I can clip negative signals by reversing the position of the or direction of the diode.

So simple, super simple right. So, be confident when you answer understand your problem and the answers are really simple answers are really simple right. So, your positive clipper and your negative clipper circuits can be formed using your operational amplifier alright. So, this is about the clippers. In the next module, we will see other applications of the opamp and that is the oscillators. What exactly are the oscillators? We have seen in the theory class, we will see in the experimental class how can we design oscillator, how the oscillators would work, what kind of oscillators are there. We will see we will put of (Refer Time: 44:01) into experiment and we will see how the oscillation occurs. We will also see the in some simulation of the oscillators that we will design. And so, that you get a complete idea of how the operation amplifiers can be used as an oscillator alright.

Now, before we go to the next module, let us understand that it is very important that you keep on revising right. Look at the video not 1 time not 2 times. Until you completely understand the circuit that is shown in the video. Also, try to learn other things apart

from what I am giving it to you. What are the applications when you when you ask about shaping of the signals, when it is used as a shaper, alright? So, some things you learn by yourself, some things you learn from the videos that were there in this NPTEL, through this NPTEL media alright.

So, I will see you in the next class. Till then, you take care and keep reading, keep watching the videos. Bye.