Madhav Institute of Technology & Science Gwalior (M.P.)

(A GOVT. AIDED UGC AUTONOMOUS INSTITUTE, AFFILIATED TO R.G.P.V. BHOPAL)
NAAC ACCREDITED WITH A++ GRADE

DEPARTMENT OF ELECTRONICS ENGINEERING

A Skill Based Mini Project Report

On

Design logarithmic and antilog operator using 741 IC

Submitted By:

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Under the Mentorship of

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Certificate

We are hereby certify that the skill based Mini Project entitled Design logarithmic and antilog operator using 741IC which is being submitted in the **Department of Electronics Engineering** is a record of our work carried out under the mentorship of **Dr. R.Jenkin Suji**,Assistant Professor, Department of Electronics Engineering, Madhav Institute Of Technology & Science, Gwalior.

Date:

Place: Gwalior

Ratnesh Asati
(0901EC221087)

This is to certify that the above statement made by the candidates is correct to the best of our knowledge and belief.

Dr. R.Jenkin Suji
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Content

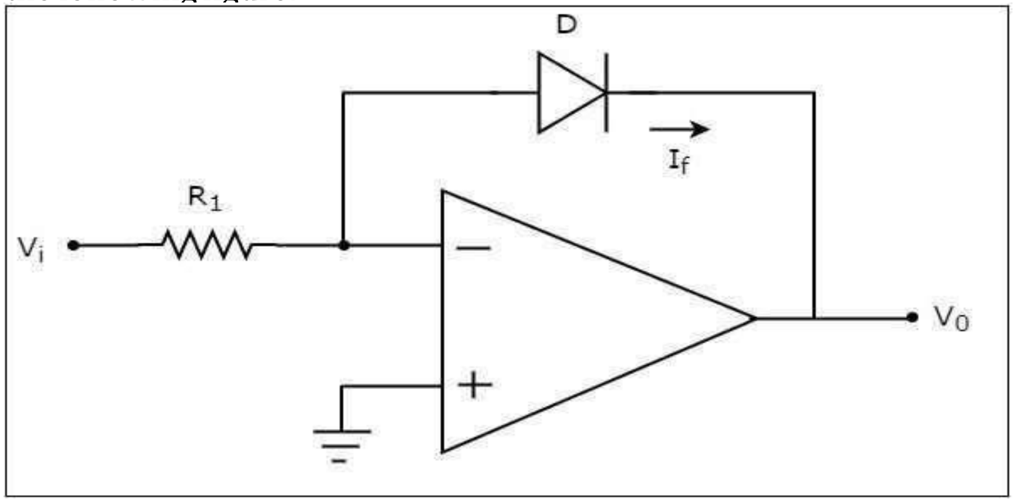
Objective

Design logarithmic and antilog operator using 741 IC.

Introduction

Logarithmic Amplifier

A logarithmic amplifier, or a log amplifier, is an electronic circuit that produces an output that is proportional to the logarithm of the applied input. This section discusses about the op-amp based logarithmic amplifier in detail.
An op-amp based logarithmic amplifier produces a voltage at the output, which is proportional to the logarithm of the voltage applied to the resistor connected to its inverting terminal. The **circuit diagram** of an op-amp based logarithmic amplifier is shown in the following figure:



WORKING:

In the above circuit, the non-inverting input terminal of the op-amp is connected to ground. That means zero volts is applied at the non-inverting input terminal of the op-amp.

According to the virtual short concept, the voltage at the inverting input terminal of an op-amp will be equal to the voltage at its non-inverting input terminal. So, the voltage at the inverting input terminal will be zero volts.

The nodal equation at the inverting input terminal's node is −

0−Vi/R1+If=0

- ⇨ If=Vi/R1 ......Equation1

The following is the equation for current flowing through a diode, when it is in forward bias −

If=Ise^(Vf/nVT) Equation2

where,

Is is the saturation current of the diode,

Vf is the voltage drop across diode, when it is in forward bias,

VT is the diode's thermal equivalent voltage.

The KVL equation around the feedback loop of the op amp will be −

$0-Vf-V0=0$

⇨ $Vf=-V0$

Substituting the value of Vf in Equation 2, we get −

$$If=Ise^{(-V0/nVT)} \qquad \text{......Equation3}$$

Observe that the left hand side terms of both equation 1 and equation 3 are same. Hence, equate the right hand side term of those two equations as shown below −

$$Vi/R1=Ise^{(-V0/nVT)}$$
$$Vi/R1Is=e^{(-V0/nVT)}$$

Applying natural logarithm on both sides, we get −

$$In(Vi/R1Is)=-V0/nVT$$
$$V0=-nVTIn(Vi/R1Is)$$

Note that in the above equation, the parameters n, VT and Is are constants.

So, the output voltage V0 will be proportional to the natural logarithm of the input voltage Vi for a fixed value of resistance R1

Therefore, the op-amp based logarithmic amplifier circuit discussed above will produce an output, which is proportional to the natural logarithm of the input voltage VT , when R1Is=1V

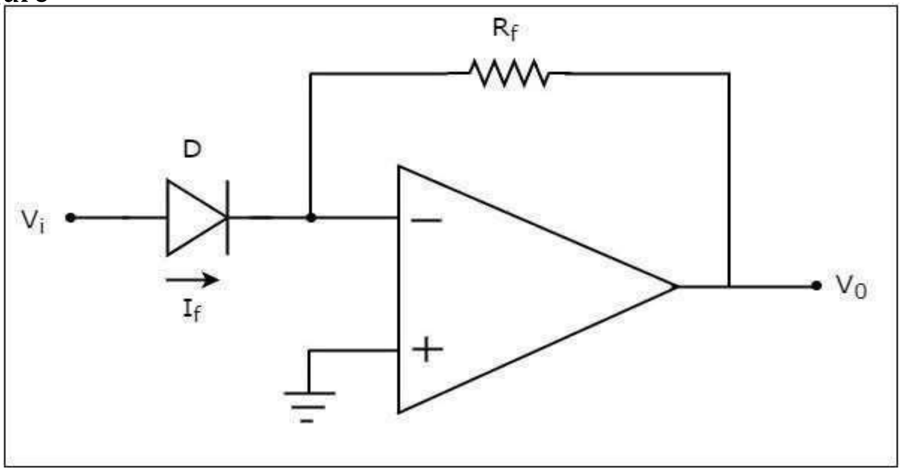
Observe that the output voltage V0 has a negative sign, which indicates that there exists a 1800 phase difference between the input and the output.

Anti-Logarithmic Amplifier

An anti-logarithmic amplifier, or an anti-log amplifier, is an electronic circuit that produces an output that is proportional to the anti-logarithm of the applied input. This section discusses about the op-amp based anti-logarithmic amplifier in detail.

An op-amp based anti-logarithmic amplifier produces a voltage at the output, which is proportional to the anti-logarithm of the voltage that is applied to the diode connected to its inverting terminal.

The **circuit diagram** of an op-amp based anti-logarithmic amplifier is shown in the following figure -



WORKING:

In the circuit shown above, the non-inverting input terminal of the op-amp is connected to ground. It means zero volts is applied to its non-inverting input terminal.

According to the virtual short concept, the voltage at the inverting input terminal of op-amp will be equal to the voltage present at its non-inverting input terminal. So, the voltage at its inverting input terminal will be zero volts.

The nodal equation at the inverting input terminal's node is −

$$-I_f + \frac{0 - V_0}{R_f} = 0$$

=> $$\frac{-V_0}{R_f} = I_f$$

=> $$V_0 = -R_f I_f \quad \text{.......Equation4}$$

We know that the equation for the current flowing through a diode, when it is in forward bias, is as given below −

$$I_f = I_s e^{(V_f/nV_T)}$$

Substituting the value of If in Equation 4, we get

$$V_0 = -R_f\{I_s e^{(V_f/nV_T)}\}$$

$$V_0 = -R_f I_s e^{(V_f/nV_T)} \quad ......\text{Equation5}$$

The KVL equation at the input side of the inverting terminal of the op amp will be

$$V_i - V_f = 0$$

$$V_f = V_i$$

Substituting, the value of Vf in the Equation 5, we get −

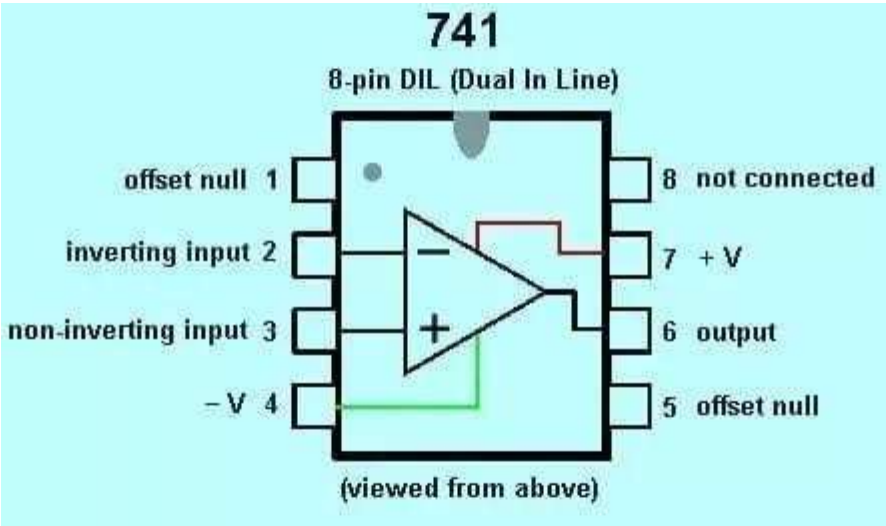
$$V_0 = -R_f I_s e^{(V_i/nV_T)}$$

Note that, in the above equation the parameters n, VT and Is are constants. So, the output voltage V0 will be proportional to the anti-natural logarithm (exponential) of the input voltage Vi , for a fixed value of feedback resistance Rf

Therefore, the op-amp based anti-logarithmic amplifier circuit discussed above will produce an output, which is proportional to the anti-natural logarithm (exponential) of the input voltage Vi when, Rf Is=1V

Observe that the output voltage V0 is having a negative sign, which indicates that there exists a 180 phase difference between the input and the output

Ic 741:



Apparatus Required:

1. 741 IC- 2
2. Resistors-2
3. Breadboard
4. CRO (Cathode ray oscilloscope)
5. Diode-2

Procedure:

Logarithmic amplifier

1. Set the supply voltage at +12V.
2. Set the input voltage to 1V.
3. See the voltage across the diode. Note the negative sign.
4. Increase the input voltage in the step of 1V up to 20V.
5. Plot the characteristics of input voltage and output voltage.
6. Reverse the polarity of the diode and see the effect for positive input voltage

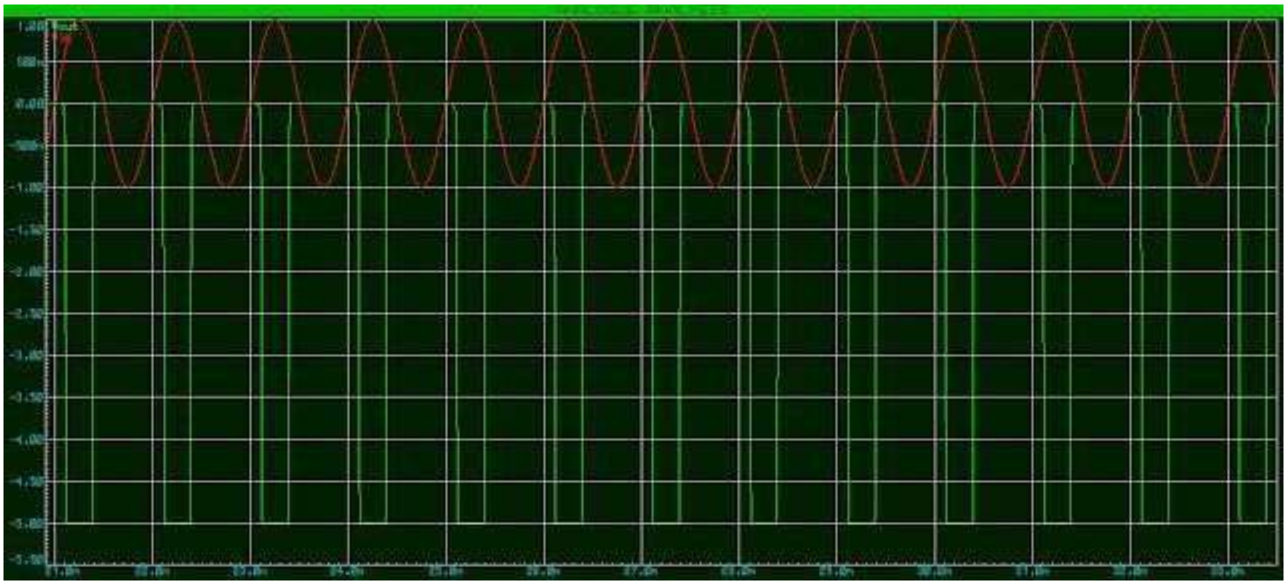
Anti-Logarithmic amplifier

1. Set the input voltage to 100mV.
2. See the voltage across the Resistor. Note the negative sign.
3. Increase the input voltage in the step of 50mV up to 500mV.
4. Plot the characteristics of input voltage and output voltage.
5. Reverse the polarity of the diode and see the effect for positive input voltage

Result:

Logarithmic amplifier

Anti-Logarithmic amplifier



Conclusion

The op-amp based **Logarithmic amplifier** circuit discussed above will produce an output, which is proportional to the natural logarithm of the input voltage VT

The op-amp based **Anti-logarithmic** amplifier circuit discussed above will produce an output, which is proportional to the anti-natural logarithm (exponential) of the input voltage Vi. Hence, This circuit is useful to find the log and antilog results of a input signal easily.

References

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