International Journal of Engineering Inventions
ISSN: 2278-7461, ISBN: 2319-6491
Volume 2, Issue 1 (January 2013) PP: 07-11

Mathematical Model of Normal Diode Acting As an Amplifier

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Abstract:- In Our Previous Paper "Diode-Unique Behaviour Documentation In In4007"Published In Ijera (Vol-2,Issue-5,September-October 2012)We Showed Diode Acting As Voltage Amplifier And Voltage Follower With Negligible Loss, Continuing Our Study Int His Paper We Are Giving The Mathematical Model Justifying Our Study

Keywords:- Voltage Amplifier,Unity Follower,Mathmetical Model,Eta = 1 For 0 Vdd And Eta = 100 For Any Non Zero Vdd

I. INTRODUCTION

This is our second paper on the topic , in the first paper "diode-unique behaviour documentation on in4007"published in ijera (vol-2,issue-5,september-october 2012) we have showed practicaly the diode acting as amplifier along with voltage follower with almost no loss, in this paper we are forwarding an absolutely new mathematical model justifying our previous study, we in detail the process of modelling and then we will verify the results. But first lets study the conventional theory. No electrons move through the pn junction at equilibrium. Generally the term bias refers to the use of a dc voltage to establish certain operating conditions for an electronic device. In relation to a diode, there are two bias conditions: forward and reverse biasing. Either of these bias conditions is established by connecting a sufficient dc voltage of the proper polarity across the pn junction.

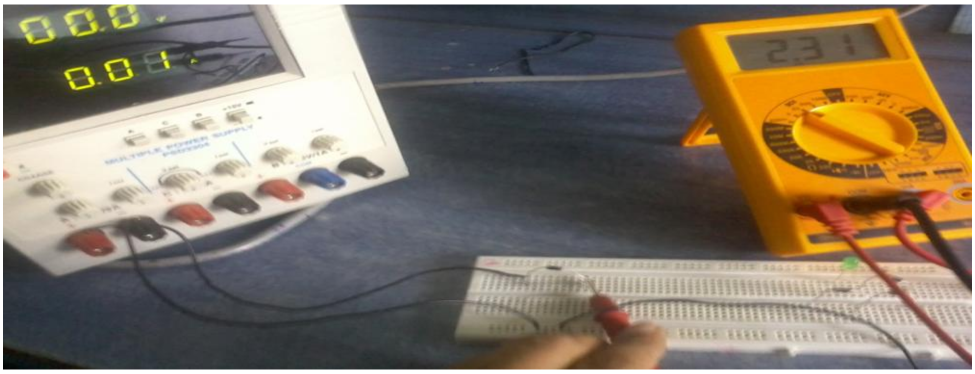
Forward Biasing:

To bias a diode, we apply dc voltage across it. Forward bias is the condition that allows current through the pn junction as shown in below figure, a dc voltage source connected by conductive material (contacts and wire) across a diode in the direction to get forward bias. This external bias voltage is designated as V (Bias). The resistor, R, limits the current to a value that will not damage the diode. The negative side of V Bias is connected to the n region of the diode and the positive side to the p region . This is one requirement for forward bias. A second requirement is that the bias voltage, V *Bias* , must be greater than the barrier potential

Reverse Biasing:

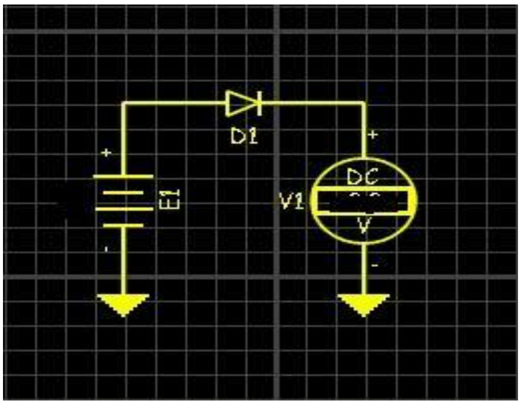
Reverse Biasing is the condition that essentially prevents current through the diode, as we can see below in figure that a dc voltage source connected across a diode in the direction to produce reverse biasing. This external Bias voltage is designated as V BIAS just as it was for forward bias. Notice that the positive side of V BIAS is connected to the n region of the diode and the negative side is connected to the p region. Also note that the depletion region is shown much wider than in forward bias or equilibrium.

OUR PROPOSED MODEL



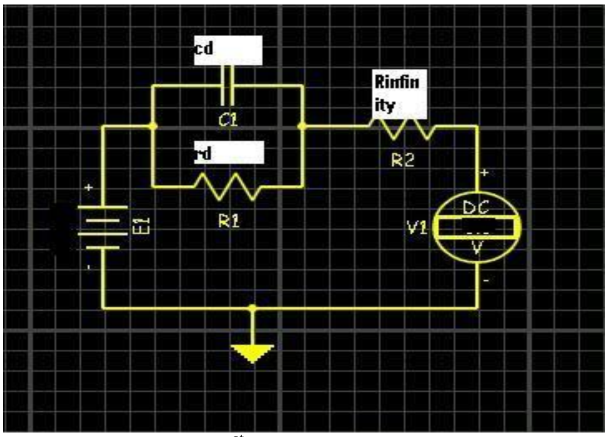
DEDUCTION OF THE MODEL

The circuit connection for diode in above behavior is



Experimental set-up

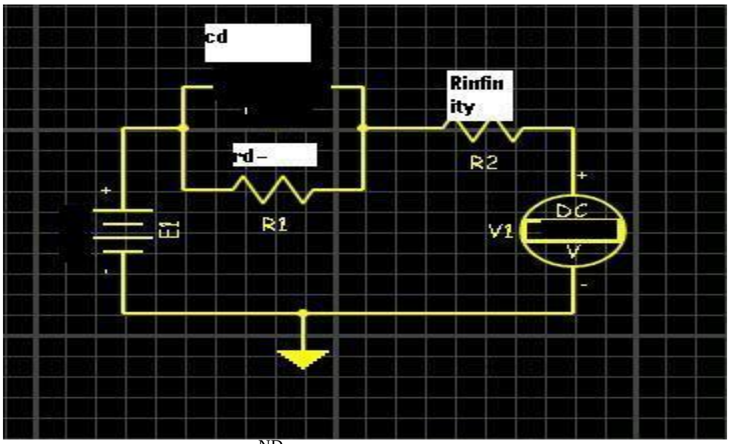
The above diagram illustrates diode in with supply voltage and voltmeter connected between cathode and ground of diode.



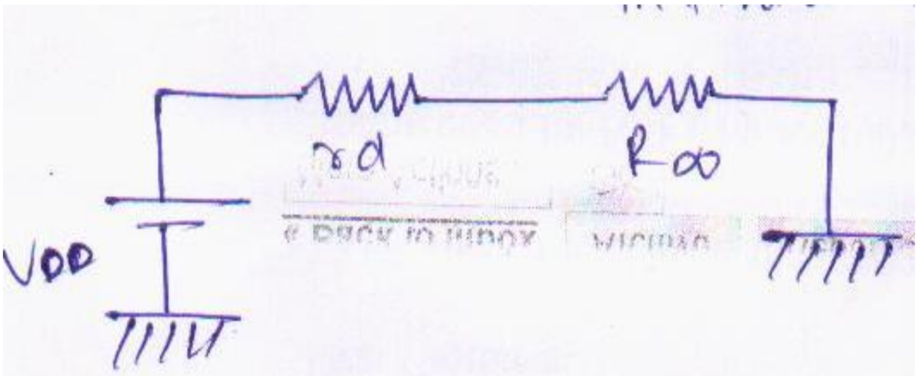
1st deduced step

In the above step we are replacing the diode with internal resistance rd and capacitance cd . the voltmeter is having infinite internal resistance thus replacing it with R∞.

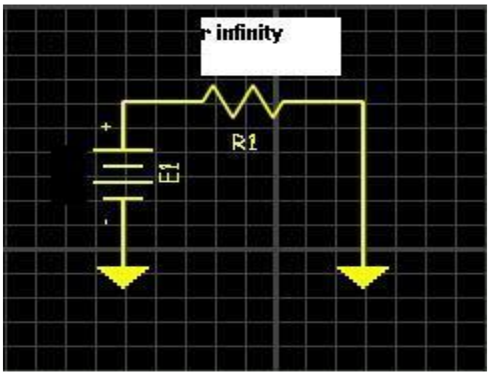
R model deduction



2ND DEDUCED STEP



DEDUCED R MODEL



Final deduced model

In the first step we open circuited the internal capacitor as we are using d.c input the capacitor has no role to play. No it comes internal diode resistance rd in series with r∞. as per the principle there remains only one effective resistance and that is r∞

II. MATHEMATICAL ANALYSIS OF ABOVE DEDUCED MODEL

Normal diode equation is VDD = VD + IR×∞ now I = IS($e^{\frac{vd}{\eta vt}}$ -1)

VD = VDD – (IS($e^{\frac{VD}{\eta VT}} - 1$)R∞)

VD = VDD - IS$e^{\frac{VD}{\eta VT}}$R∞ + IS×R∞ (basic understanding says higher will be the resistance lower will be the current keeping in mind this diode not showing negative resistance propert)

VD = VDD - ∞ + ∞ (mathematical convention any operations with infinity yields the result infinity)

VD = ∞. I solved the above equation conceptually yielding diode outp put voltage infinity. Which definitely don't stand true.

So now trying to deduce the above equation in mathematical pure way

VD = VDD - IS×R∞($e^{\frac{VD}{\eta VT}}$-1)

VD = VDD - $e^{\frac{VD}{\eta VT}}$ + 1 (IS×R∞ is ineffective since infinite resistance will give effective zero current)

III. FINAL MATHEMATICAL EQUATION

VD = VDD - $e^{\frac{VD}{\eta VT}}$ + 1 ($\eta = 1$ *for vdd* $= 0$ *and* $\eta = 100$ *for vdd* $\gg 0$) (we are replacing VT with vak voltage observed across anode and cathode. We are doing this as to inculcate diode behavior in terms of all apparent quantities. In all previous study they did not considered all apparent parameter instead they included variable factor thermal voltage, and this started a new trend of incomplete documentation)

PRACTICAL READINGS AND VERIFICATION

VA/VDD (SUPPLY VOLTAGE AT ANODE)	VAK(VOLTAGE BETWEEN ANODE AND CATHODE)	VK/VD (VOLTAGE OBTAINED AT CATHODE,I.E BETWEEN CATHODE AND GROUND)	MATHEMATICAL VOLTAGE AFTER CALCULATION	ERROR BETWEEN PRACTICAL RESULT AND CALCULATED RESULT
0v	1.51V	1.51v	1.71v	0.2v
5v	1.71V	5.06v	4.99v	0.07v
10v	1.82V	9.86v	9.95	0.09v
15v	1.70V	14.87v	14.92	0.05v
20v	1.52V	19.83v	19.87	0.04v
25v	1.9V	24.8v	24.81	0.01v
30v	1.6V	29.8v	29.81	0.01v

When vdd = 0v and vk = 1.51V and vak = 1.51v
Vd = 0 – $e^{\frac{1.51}{1\times1.51}}$ + 1
Vd = 1 – 2.71
Vd = 1.71v
When vdd = 5v and vk = 5.06V and vak = 1.71v
Vd = 5 – $e^{\frac{5.06}{100\times5.06}}$ + 1
Vd = 6 – 1.01v
Vd = 4.99v
When vdd = 10v and vk = 9.86V and vak = 1.82v
Vd = 10 – $e^{\frac{9.86}{100\times1.82}}$ + 1
Vd = 11 – 1.05v
Vd = 9.95v
When vdd = 15v and vk = 14.87V and vak = 1.70v
Vd = 15 – $e^{\frac{14.87}{100\times1.70}}$ + 1
Vd = 16 – 1.08v
Vd = 14.92v
When vdd = 20v and vk = 19.83V and vak = 1.52v
Vd = 20 – $e^{\frac{19.83}{100\times1.52}}$ + 1
Vd = 21 – 1.13v
Vd = 19.87v
When vdd = 30v and vk = 29.8V and vak = 1.6v
Vd = 30 – $e^{\frac{29.8}{100\times1.6}}$ + 1
Vd = 31 – 1.19v
Vd = 29.81v

VA/VDD (SUPPLY VOLTAGE AT ANODE)	VAK(VOLTAGE BETWEEN ANODE AND CATHODE)	VK/VD (VOLTAGE OBTAINED AT CATHODE,I.E BETWEEN CATHODE AND GROUND)	MATHEMATICAL VOLTAGE AFTER CALCULATION	ERROR BETWEEN PRACTICAL RESULT AND CALCULATED RESULT
0v	1.64V	2v	2.35v	0.35v

5v	**1.93V**	**5.06v**	**4.91v**	**0.15v**
10v	**1.39V**	**9.85v**	**9.93v**	**0.08v**
15v	**1.40V**	**14.91v**	**14.9v**	**0.01v**
20v	**1.14V**	**19.90v**	**19.87v**	**0.03v**
25v	**1.2V**	**24.9v**	**24.78v**	**0.03v**
30v	**0.9V**	**29.9v**	**30.67v**	**0.7v**

When vdd = 0v and vk = 2V and vak = 1.64v
Vd = 0 – $e^{2}_{1\times 1.64}$ + 1
Vd = 1 – 3.35
Vd = 2.35v
When vdd = 5v and vk = 5.06V and vak = 1.93v
Vd = 5 – $e^{5.06}_{100\times 1.93}$ + 1
Vd = 6 – 1.09v
Vd = 4.91v
When vdd = 10v and vk = 9.85V and vak = 1.39v
Vd = 10 – $e^{9.85}_{100\times 1.39}$ + 1
Vd = 11 – 1.07v
Vd = 9.93v
When vdd = 15v and vk = 14.91V and vak = 1.40v
Vd = 15 – $e^{14.91}_{100\times 1.40}$ + 1
Vd = 16 – 1.10v
Vd = 14.9v
When vdd = 25v and vk = 24.9V and vak = 1.2v
Vd = 25 – $e^{24.9}_{100\times 1.2}$ + 1
Vd = 26 – 1.22v
Vd = 24.78v
When vdd = 30v and vk = 29.9V and vak = 0.9v
Vd = 30 – $e^{29.9}_{100\times 0.9}$ + 1
Vd = 31 – 1.07v
Vd = 30.67v

IV. CONCLUSIONS

thus we conclude the documentation of amplification/unity follower behaviour of IN4007 diode.this is the unique documentation of its type in the world so we take pleasure in naming this model as "mobassir niyaz diode amplification model".

REFERENCES

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