EE236: Electronics Devices Lab
Lab No. 2

HARDIK KHARIWAL, 22B3954

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1 PIN DIODE v/s PN DIODE

1.1 Aim of the experiment

To find forward voltage, reverse saturation current and ideality factor of the given PIN diode (Infineon BAR 15-1) and compare with normal PN junction Diode (1N4007).
To find the reverse recovery time of the given PIN diode at various frequencies and compare it with the reverse recovery time of normal PN junction Diode. To observe how the PIN diode works as an RF switch at different DC bias voltages.

1.2 Design

In the prelab report we plotted the I-V characteristics of the RN142 PIN diode to measure cut-in voltage and ideality factor. Then we tried measuring reverse recovery time for the same. The next task was to understand how PIN diodes work as RF switches by implementing the given circuit in Figure 1 and compare the same with regular PN junction diodes. Write NGSPICE netlist, simulate the given RF switch circuit, and plot output voltage, output current, and diode current for different DC bias voltages (-5V, 0V, 1V, 3V, 5V).

Following is the code

```
1 LAB_2_1
. model dmodel D (+ IS =127.76 E -12
2
```

```
+ N =1.7346
+  RS =.1581
+  IKF =.14089
+  CJO =385.59 E -15
+ M =.11823
+  VJ =.78827
+  ISR =139.38 E -12
+ NR =3
+  BV =60
+ TT =275.00 E -9) r1 2 0
100
d1  1  2  dmodel
```

```
vin     1  0  dc  0
* DC    Analysis of source vin, to vary                    from    0   to    +5 V
. dc    Vin 0 10 0.01
```

```
. control
```

```
run
plot ( v(2) /100) vs                v(1 ,2)
. end
. end
```

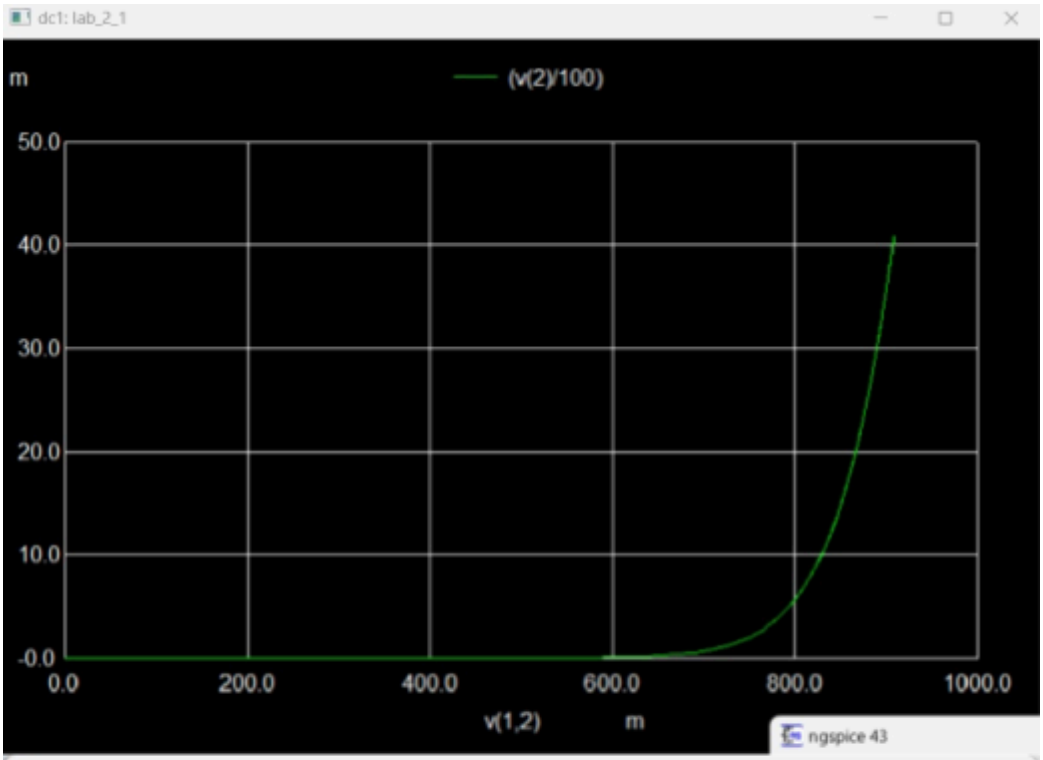
```
LAB_2_2
. model dmodel D (+                 IS =127.76 E -12
+   N =1.7346
+   RS =.1581
+   IKF =.14089
+   CJO =385.59 E -15
+   M =.11823
. control
run
plot V (1)-V (2)
```

```
+   VJ =.78827
+   ISR =139.38 E -12
+   NR =3
+   BV =60
+   TT =275.00 E -9)
```

```
. endc
. end
```

```
LAB_2_3
. model dmodel D (+ IS =127.76 E -12
+ N =1.7346
+  RS =.1581
+  IKF =.14089
+  CJO =385.59 E -15
+ M =.11823
+  VJ =.78827
+  ISR =139.38 E -12
+ NR =3
+  BV =60
+ TT =275.00 E -9)
vin 1 0 AC 6 sin (0 6 10 Meg 0 0)
c1  1  2  100 n
r1  2  0  500
d1  6  2  dmodel
r4  3  6  1
r2  3  4  500
vdc 4 0 dc  -5 s
c2  3  5  100 n
r3  5  0  50
. control
tran  0.1 n  200 n
plot v(3 ,6) v(5) /50 v(5) v(1)
. endc
. end
```

1.3 Simulation results of PreLab



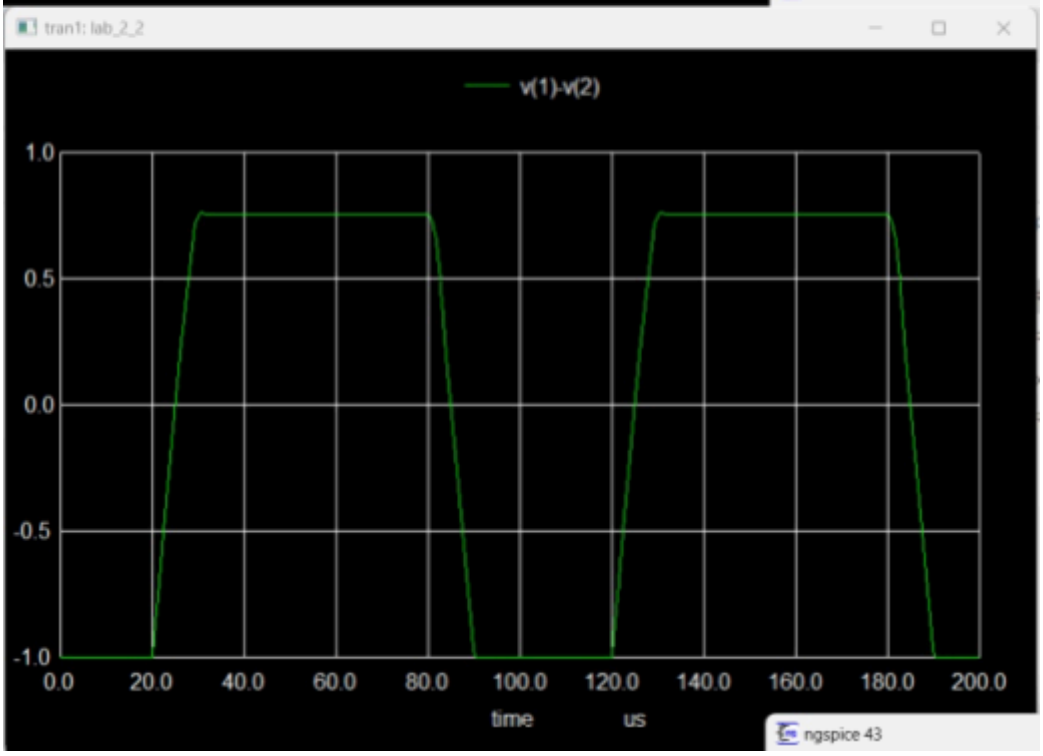
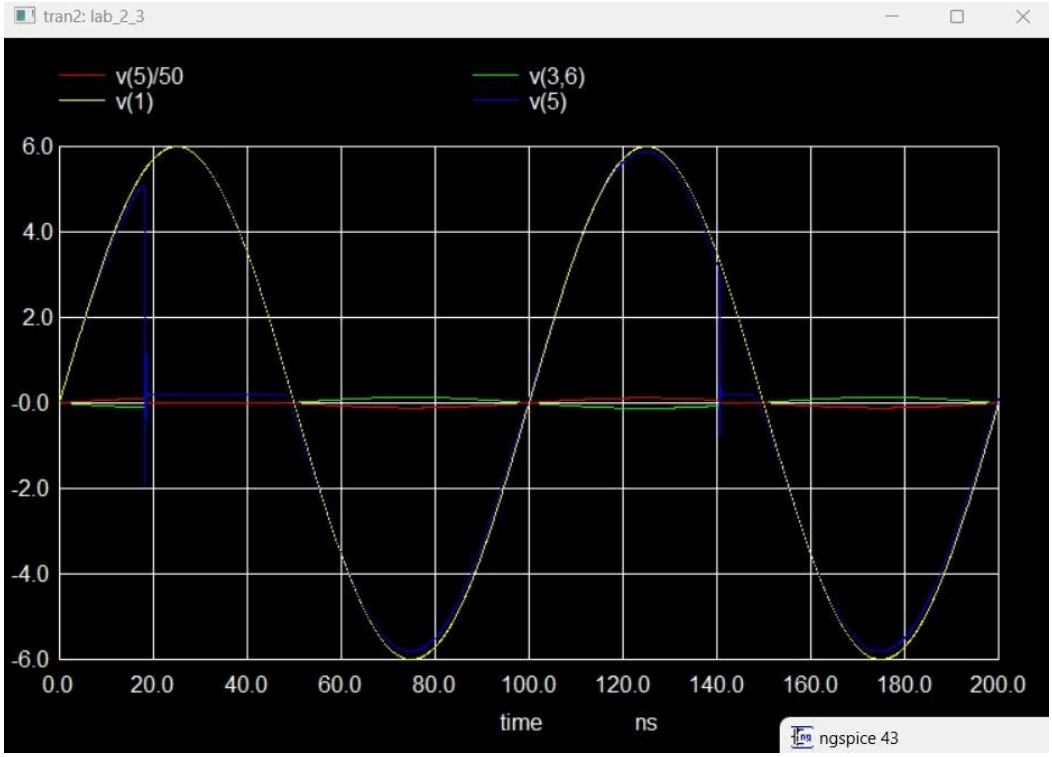


Figure 3 at bias 5volts



Values got:

Cut-in voltage = 800 mV Ideality Factor (N) = 2.74 Recovery time = 5 microseconds

1.4 In-Lab

In the lab, we built the following circuit using pot and transistors then tried to check IV characteristics Data was collected manually.

Slope: Slope was found using the Linest function of Excel.

Ideality Factor: As we know with the help of the equation, slope=q/nkT where kT/q is 0.026 so we got the ideality factor.

Then we compared the reverse recovery time of both diodes using 4 different frequencies. There may be an error here as it was manually calculated.

Then we built an RF switch and saw it working at different bias voltages.

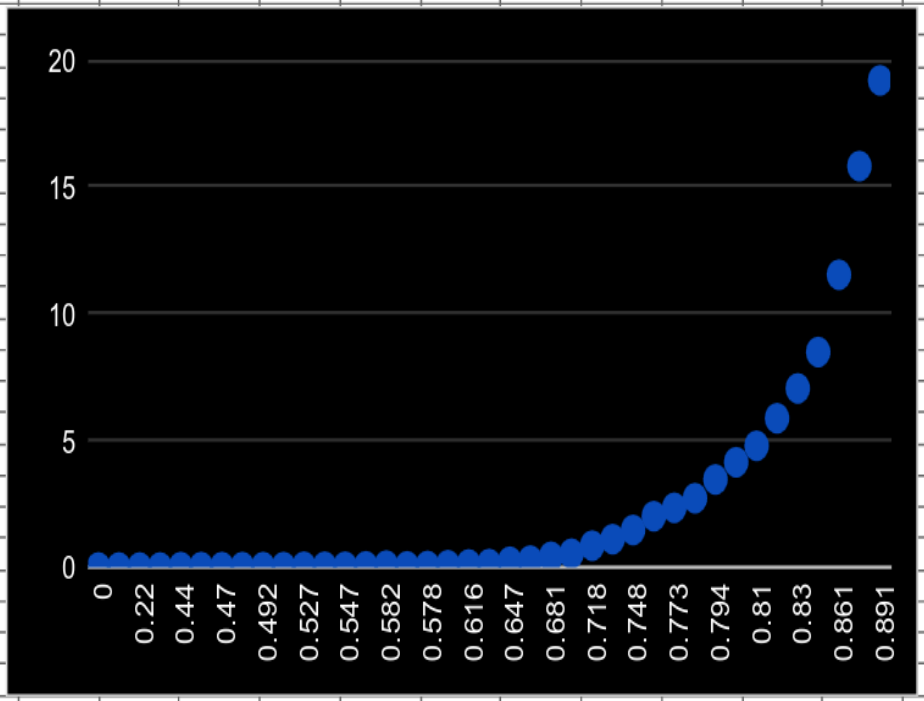
1.5 Simulation Results of Lab

LAB-2 (EE236)

exp1	
vd	id
0	0
0.1	0
0.22	0
0.31	0
0.44	0.004
0.45	0.005
0.47	0.007
0.483	0.009
0.492	0.011
0.5	0.013
0.527	0.022
0.534	0.025
0.547	0.031
0.553	0.036
0.582	0.064
0.56	0.042
0.578	0.057
0.594	0.078
0.616	0.12
0.623	0.138
0.647	0.215
0.657	0.259
0.681	0.41
0.7	0.543
0.718	0.849
0.734	1.113
0.748	1.471
0.764	2.02
0.773	2.35
0.782	2.73
0.794	3.46

exp2	bar15-1		pn-diode	
f	t	Vmax	t	vmax
10k	2.4us	1.45	4.24 us	2.26
100k	2.14us	1.33	2.42us	2.26
1m	0.486us	0.72	0.490us	2.06
3m	0.151us	0.435	0.161	1.33

exp3	bar15 -1		pn-diode	
vb	id	vout	id	vout
0	0.998 ma	928mv	0.102 ma	1.86
1	1.551ma	1.136v	0.361ma	2.16
3	2.5ma	1.34v	2.4 ma	2.44
5	4.2ma	1.416v	4.3ma	2.48
-5	11.2 ua	53.2 mv	0.026ma	120mv



1.6 Conclusion and Inference

In this experiment, the forward voltage, reverse saturation current, and ideality factor of the Infineon BAR 15-1 PIN diode were determined and compared with those of the standard 1N4007 PN junction diode. The results indicated that the PIN diode exhibits a lower forward voltage drop and higher reverse saturation current than the PN junction diode, making it more suitable for high-frequency applications.

The reverse recovery time was also measured for both diodes at various frequencies. It was observed that the PIN diode demonstrated a significantly lower reverse recovery time than the PN junction diode, particularly at higher frequencies. This chaInacteristic enhances the PIN diode's performance in switching applications, especially in RF circuits.

Furthermore, the behavior of the PIN diode as an RF switch was studied at different DC bias voltages. The experimental results confirmed that the PIN diode can efficiently operate as an RF switch, with its performance highly dependent on the applied bias voltage.

Finally, the experiment revealed that at a frequency of 3 MHz, the PIN diode has a greater potential to pass a major portion of the input signal to the output compared to the PN junction diode. This makes the PIN diode a better choice for high-frequency switching and signal-processing applications.

Overall, the Infineon BAR 15-1 PIN diode outperforms the 1N4007 PN junction diode in high-frequency and RF switching applications, making it a preferable choice in these scenarios.

1.7 Experiment completion status

Completed