EE236: Experiment No.3
PIN Diode I-V Characteristics usage as an RF Switch

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September 3, 2022

1 Overview of the experiment

1.1 Aim of the experiment

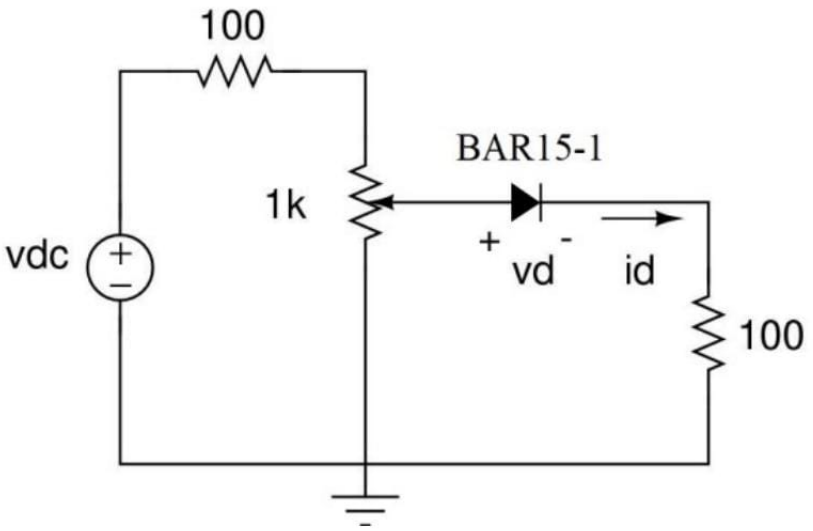
The aims of the experiment are to find reverse recovery time of the given PIN diode at various frequencies and compare it with the reverse recovery time ofthat of the normal PN junction Diode. To observe how the PIN diode works as an RF switch at different DC bias voltages.

1.2 Methods

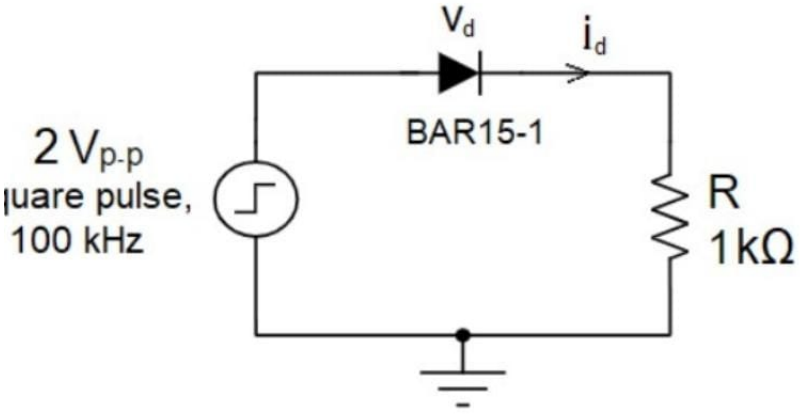
Setup the circuit on bredaboard and used the oscilloscope to measure Vd and Id applied at different frequencies to measure RRT and then compared Vd and Id as Vbias changes

2 Design

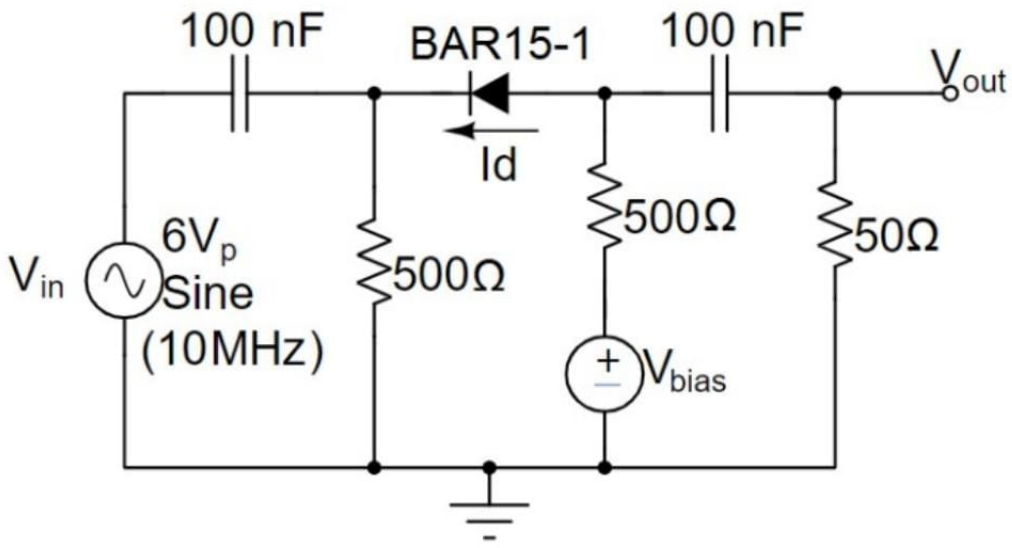
2.1 I-V Characteristics of PIN Diode



2.2 RRT PIN Diode



2.3 RF switch with PIN Diode



3 Simulation results

3.1 Code snippet

3.2 PIN Diode I-V Characteristics(PreLab)

```
.include rn142.txt
v1 1 0 dc
v2 1 2
r1 2 3 100
d1 3 0 DRN142S
.dc v1 0 1 .05
.control
run
plot i(v2) vs v(3)
.endc
```

3.3 RRT of RN142 Diode(PreLab)

```
.include rn142.txt
v1 1 0 pulse(-1, 1, 1us,1us, 1us, .05ms, .1ms)
v2 1 2
r1 2 3 100
d1 3 0 DRN142S
.tran .1us 1ms
.control
run
plot v(1), (2+100*i(v2))
.endc
```

3.4 RN142 diode as RF Switch(PreLab)

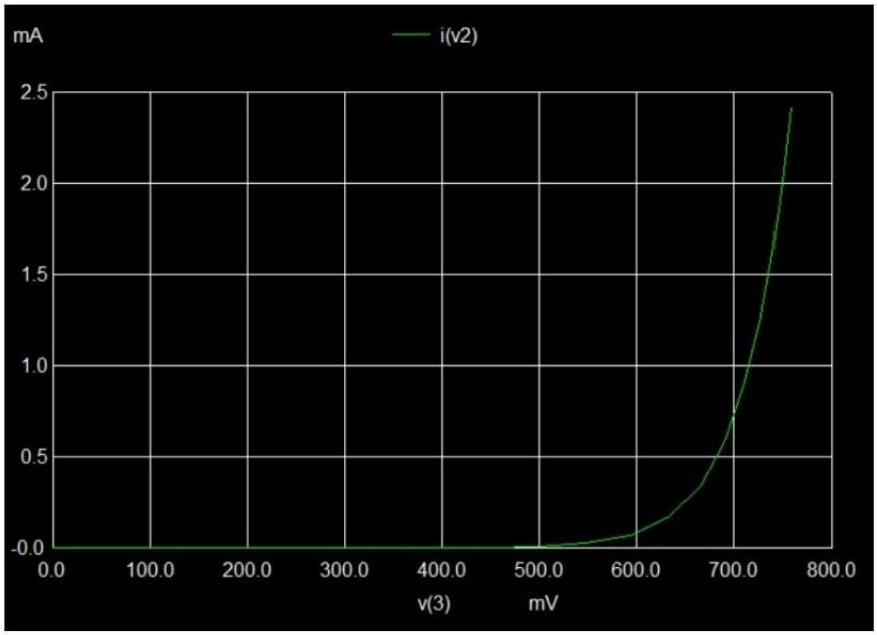
```
.include rn142.txt
v1 1 0 sin(0 3 10Meg 10ns)
c1 1 2 100n
r1 2 0 500
v2 2 6 dc 0
d1 3 6 DRN142S
r2 3 4 500
vb 4 0 dc -5
c2 3 5 100n
r3 5 0 50
.tran .00001u .5u
.control
run
set color2 = green
set color3 = blue
plot v(5) 10*i(v2)
.endc
.end
```

3.5 Dynamic Resistance of RF Switch (PostLab)

```
.include rn142.txt
v1 2 1 dc 1
v2 1 0 sine(0, .25, 1Meg, 1us)
d1 3 0 DRN142S
r1 2 3 1k
.tran 10ns 15us
.control
run
plot v(3) 100*i(v1)
meas tran vptp pp v(3) from=10u to=30u
meas tran iptp pp i(v1) from=10u to=30u
.endc
.end
```

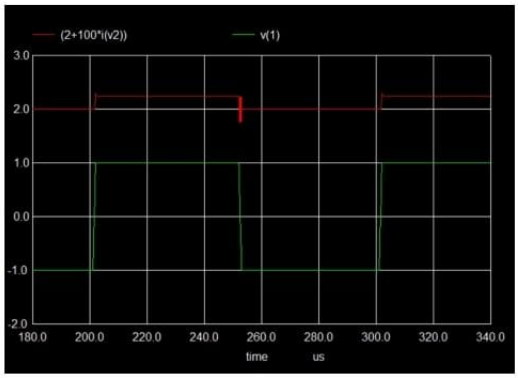
3.6 Simulation results

3.7 PIN Diode I-V Characteristics(PreLab)

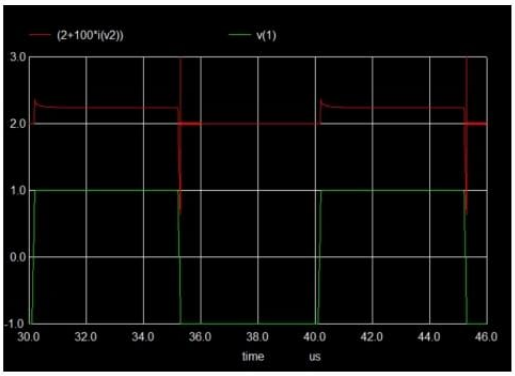


At 1mA current voltage acroos diode is 0.711V. So, Cut-in Voltage = .711V Using the given equation to find ideality factor and Using the ln(Id) plot
Slope = 22.04
Ideality factor = 1.767
ln(ID/I0) + Eg/kT = qV/kT

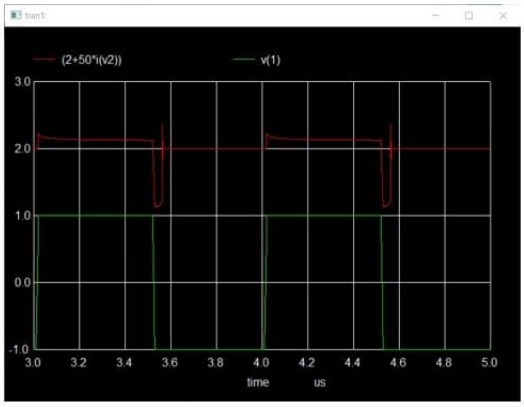
3.8 RRT of RN142 Diode(PreLab)



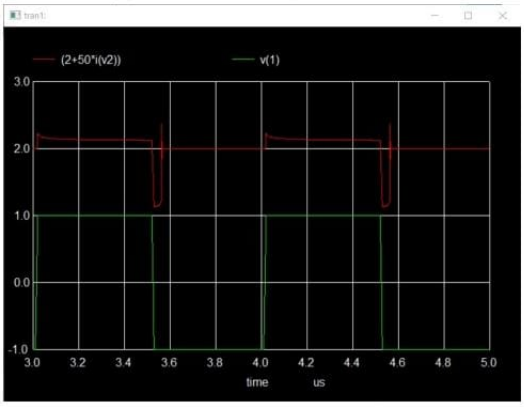
(a) Frequency: 10Khz



(b) Frequency: 100Khz



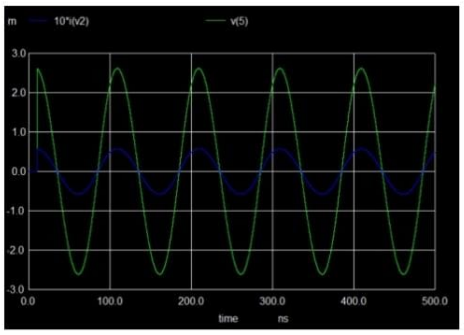
(c) Frequency: 1Mhz



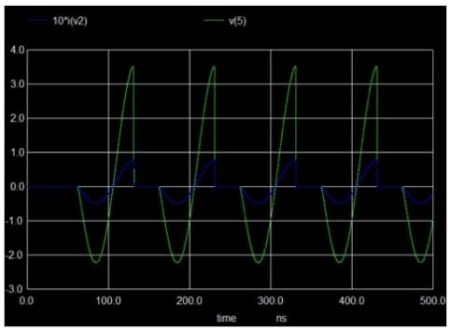
(d) Frequency: 10Mhz

RRT at freq :10KHz = .25 µs
RRT at freq :100KHz = .081 µs
RRT at freq :1MHz = 41 ns
RRT at freq :10mHz = 11ns

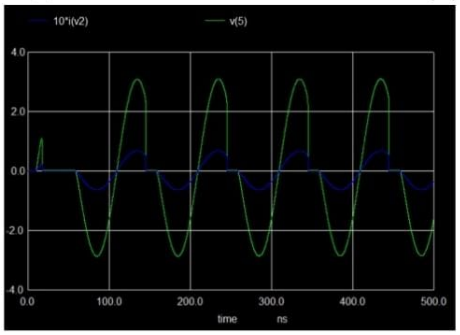
3.9 RN142 diode as RF Switch(PreLab)



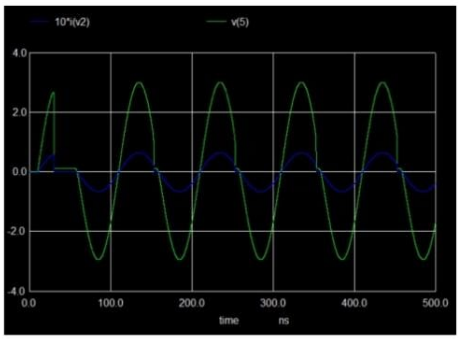
(a) $V_{bias=-5V}$



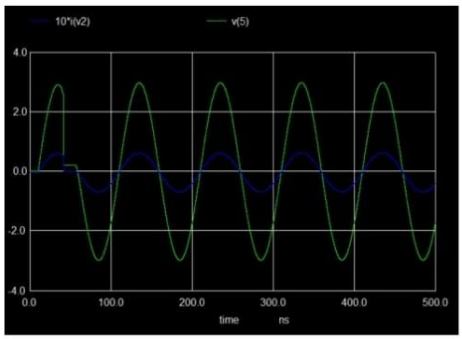
(b) $V_{bias=0V}$



(c) $V_{bias=1V}$

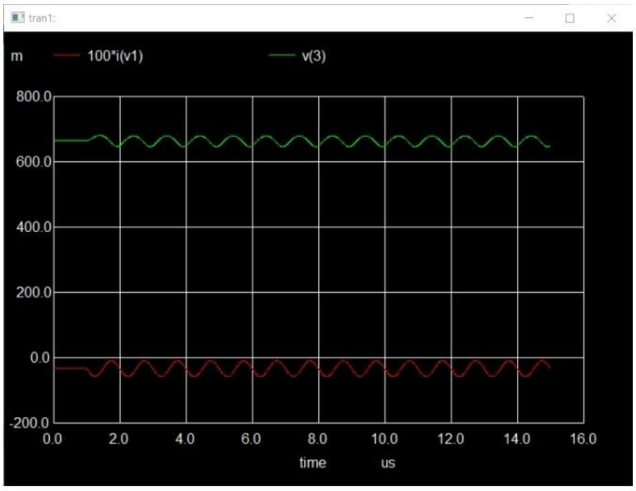


(d) $V_{bias=3V}$



(e) $V_{bias=5V}$

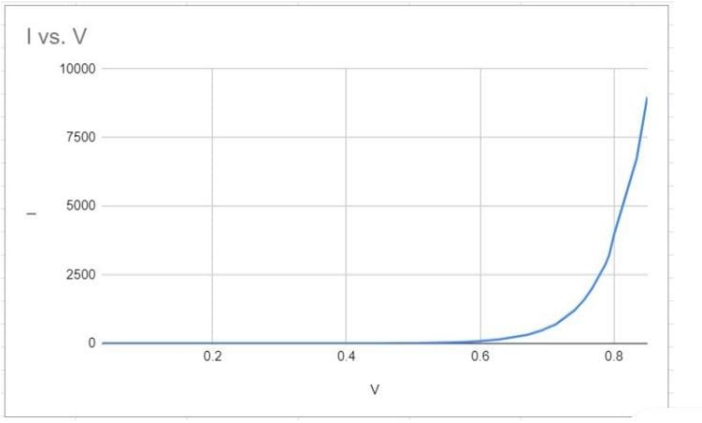
3.10 Dynamic Resistance of RF Switch (PostLab)



RF resistance at 1MHz = 67.62Ω
RF resistance at 10MHz = 102.18Ω

4 Experimental results

4.1 I-V Characteristics of PIN Diode



V	I(uA)
0	0
0.11	0
0.23	0
0.31	0
0.42	0.002
0.52	0.017
0.67	0.34
0.7	0.59
0.74	1.26
0.754	1.57
0.77	1.97
0.788	2.98
0.792	3.18
0.802	3.86
0.815	4.92
0.821	5.38
0.828	6.12
0.835	6.9
0.841	7.84
0.848	8.91
0.858	10.3
0.88	16.6
0.902	22.3
0.912	25.5
0.921	28.8

4.2 RRT values of PIN and PN Diodes

Freq	PIN(BAR15)	PN
10k	1.2us	1.220us
100k	1.28us	0.920us
1M	0.512us	0.470us

4.3 PIN Diode as RF Switch

PIN

Vbias	Id(mA)	Vd(mV)
-5	0.002	60
0	0.62	82
1	0.93	230
3	2.32	240
5	4.25	270

PN

Vbias	Id(mA)	Vd(mV)
-5	0.02	880
0	0.08	480
1	0.46	740
3	2.3	780
5	4.28	780

5 Experiment completion status

All the asked parameters and the required comparisions to be made are done in the lab itself and the results and calculations are produced in the report.