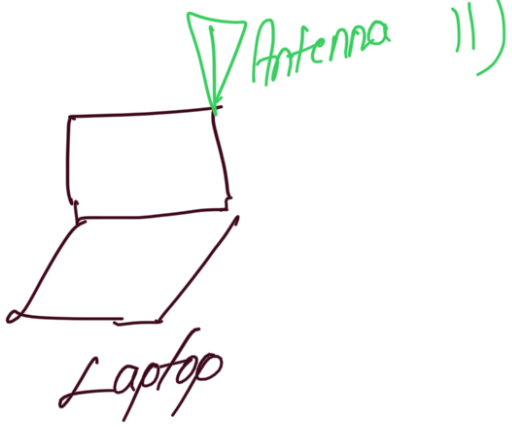
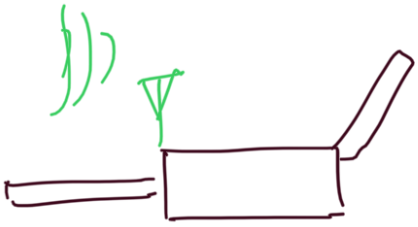
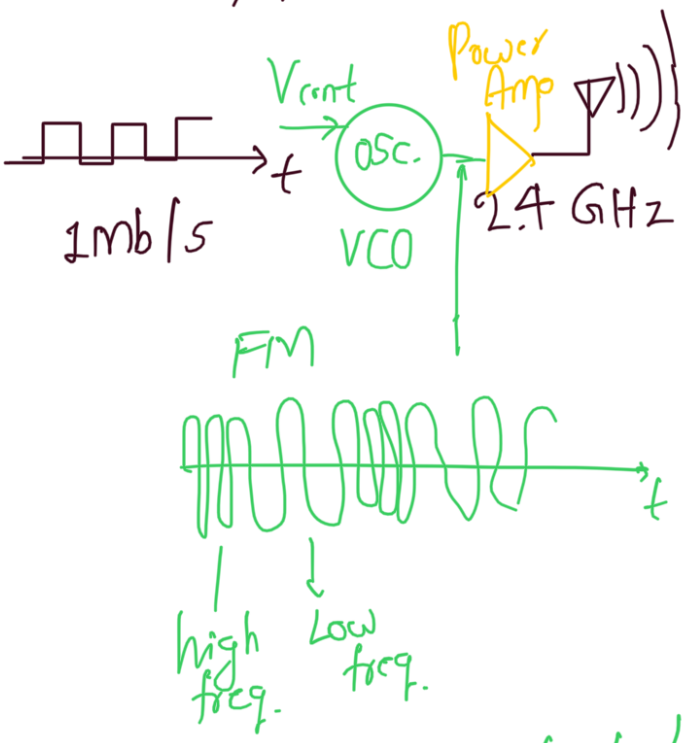
Bluetooth:



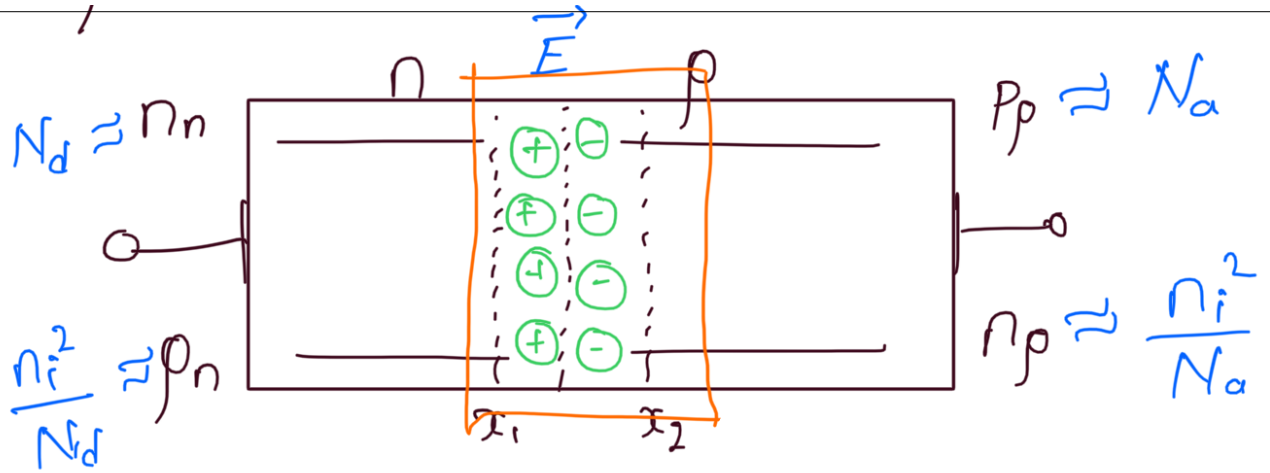




frequency is modulated.

here input data speed is not compatible with small antenna. i.e it's wavelength is too high ∴ freq is less. we need freq. in range of 2.4 GHz. So we are using oscillator to achieve the requirements.

→ p-n Junction in Equilibrium:



methametical approach to find when will our device reach equilibrium.

We have.

$$J_{drift} = (\mu_n n + \mu_p p) E \cdot q$$

$$J_{diff} = \left(D_n \frac{dn}{dx} - D_p \frac{dp}{dx}\right) q$$

Junction will stop carrying the diffusion current when drift current associated with Electric field cancles diffusion current associated with this difference in density.

Equilibrium condition:

Diffusion current of e^- = drift current of electrons

.. holes = . . . holes

$$D_p \frac{dp}{dx} \cdot q = \mu_p p \cdot E \cdot q$$

$$D_p \, dp = \mu_p \mathcal{E} \, dx$$

$$\frac{dp}{p}$$

$$\int_{p_n}^{p_p} D_p \frac{dp}{p} = \mu_p \int_{x_1}^{x_2} \mathcal{E}\, dx$$

$$D_p \ln \frac{p_p}{p_n} = \mu_p \underbrace{[V(x_1) - V(x_2)]}_{V_0}$$

$$\left(\because V_{AB} = -\int_A^B \mathcal{E}\, dx \right)$$

$$V_0 = \frac{D_p}{\mu_p} \ln \frac{N_a N_d}{n_i^2}$$

$$\frac{D}{\mu} = \frac{kT}{q} \quad \text{(Einstein's eq}^{n}\text{)}$$

$$\therefore \boxed{V_0 = \frac{kT}{q} \ln \frac{N_a N_d}{n_i^2}}$$

Built-in Potential

26 mV

@ 300 K N_a & N_d — Doping levels

Quiz: Is there an Electric field outside the depletion region?

Gauss' law: Amount of E field that we measure on a surface is $\propto$ net charge enclosed by that surface

Electric field = 0
Voltage drop = 0
in the "neutral" region

Observations :-

① Same V_0 expression is obtained if the electron currents are considered.

② if N_a & N_d are of the order of $10^{16}/cm^3$,

$$V_0 \simeq 26\,mV \ln \frac{10^{32}}{10^{20}} \simeq 720\,mV$$

=> i.e in typical case, amount of

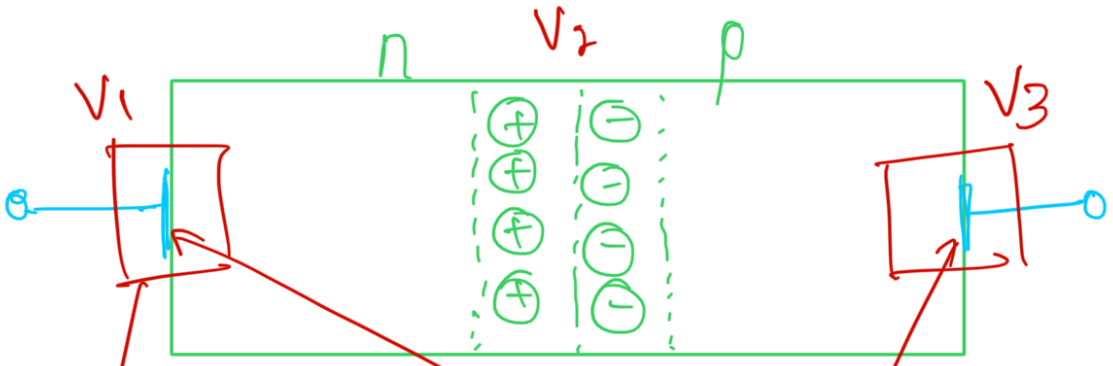
built-in potential of p-n j[illegible] mV.

③ V_0 is localized

④ We can't measure V_0 from outside

i.e if we connect volt-meter to 2 terminals of equilibrium p-n j[2] it's reading = 0 not 700~800 mV.

Why?



another built-in potential.

another junction. metal-semic j[2]

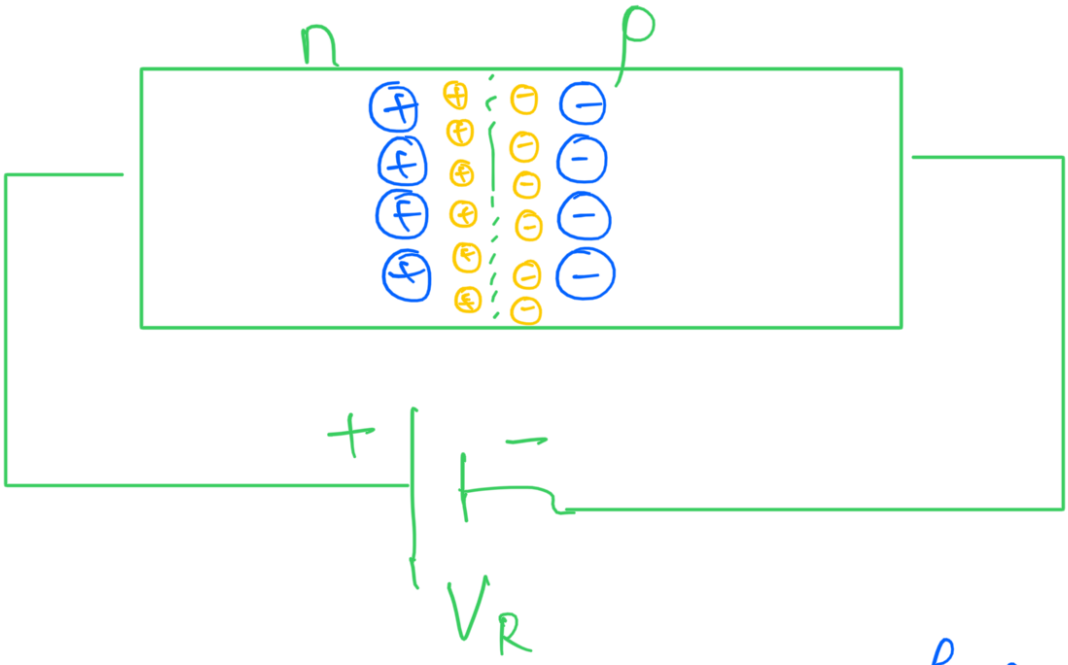
Kirchhoff's voltage law:

$$V_1 + V_2 + V_3 = 0$$

V_1 & V_3 add up to -ve of V_2 &
[illegible]ther

concel each other

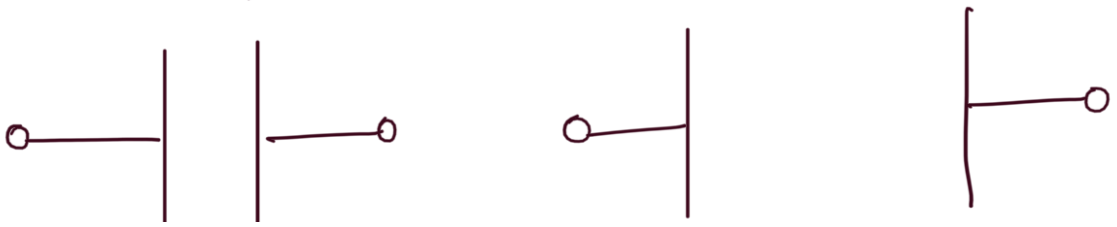
pn Junction in Reverse Bias



some mobile charge out of n-side & p-side because of influence of battery. & depletion region becomes wider.

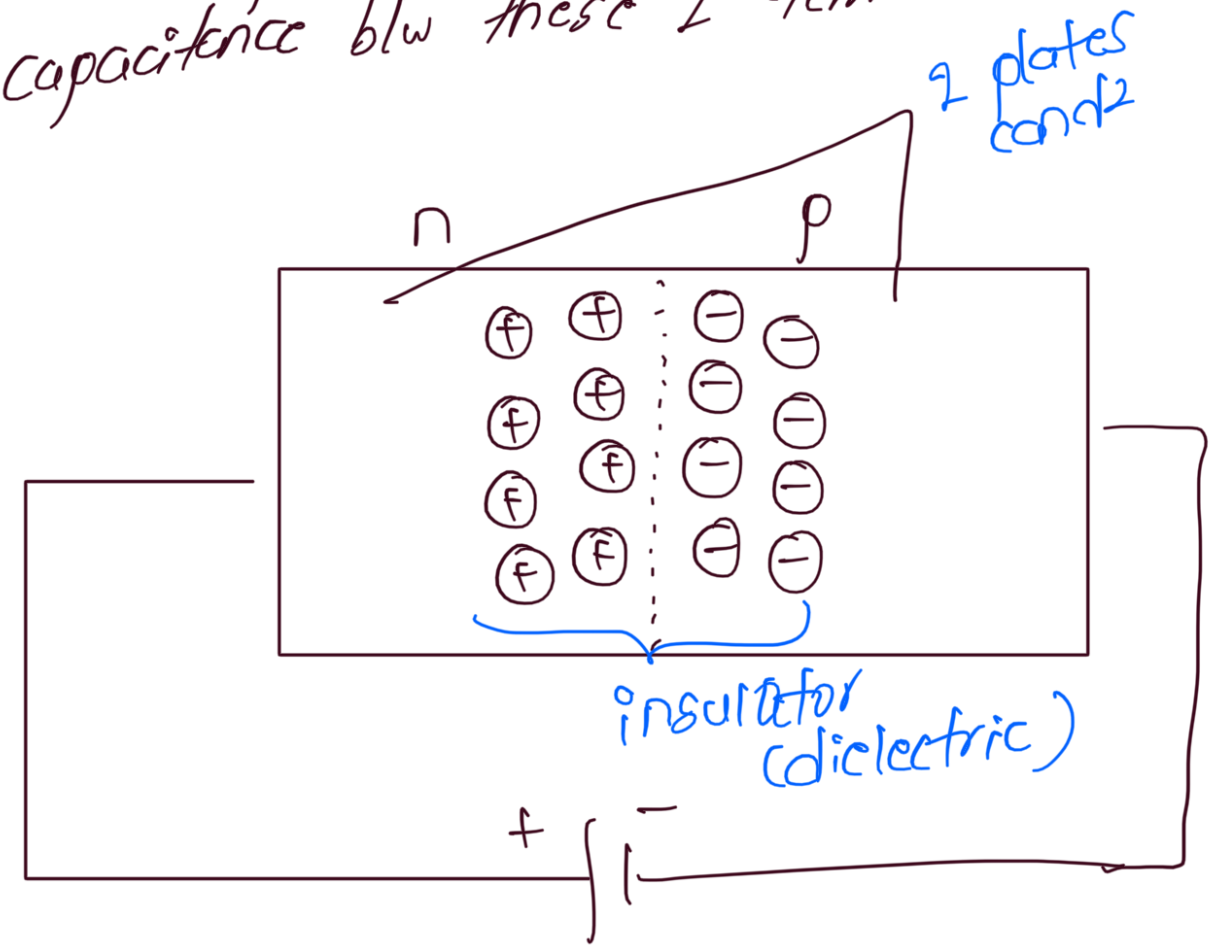
In reverse bias, the depletion region becomes wider.

C_1 < C_2

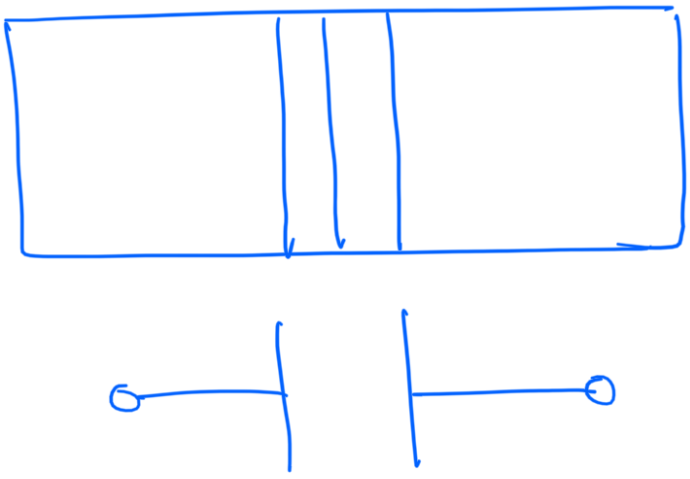


Capacitor

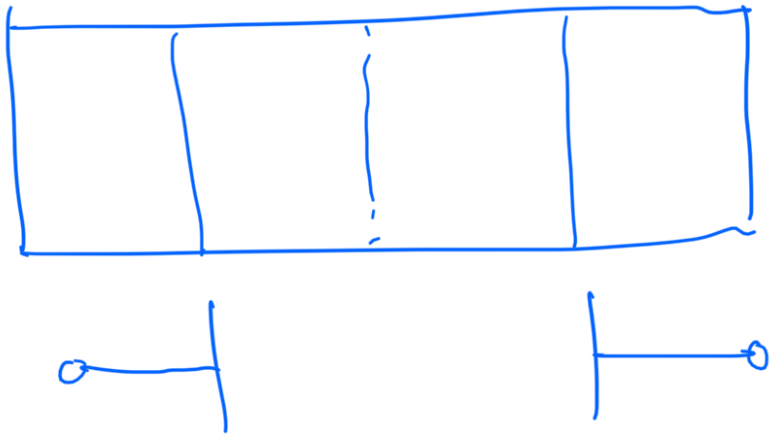
if parallel plates move apart, capacitance blw these 2 terminals decreases.



In equilibrium:



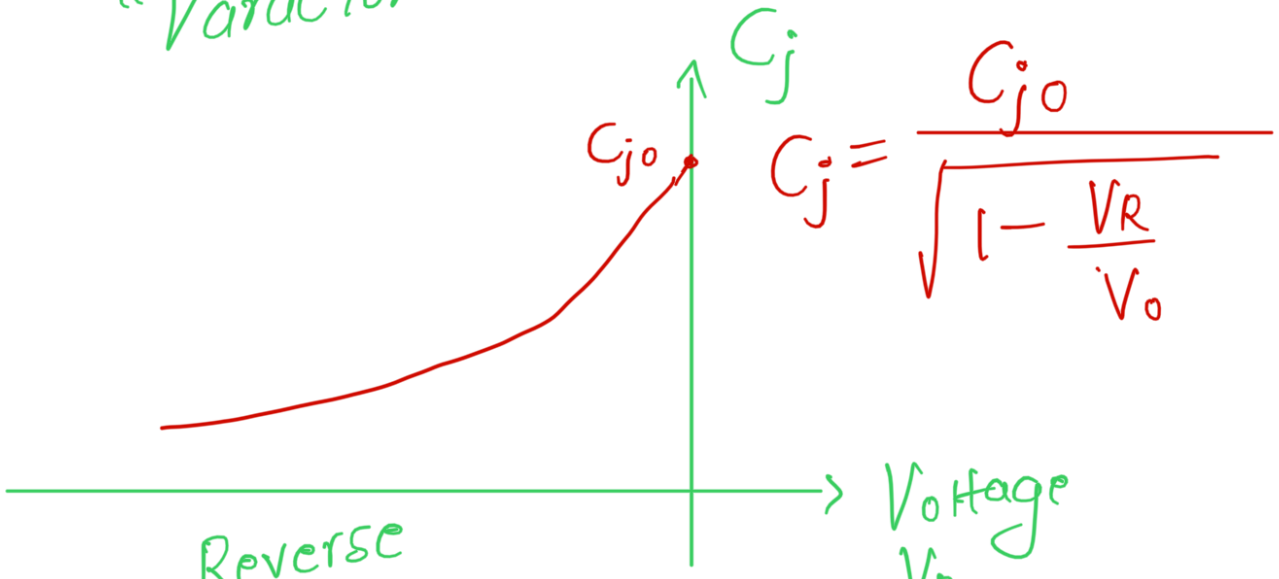
Reverse bias



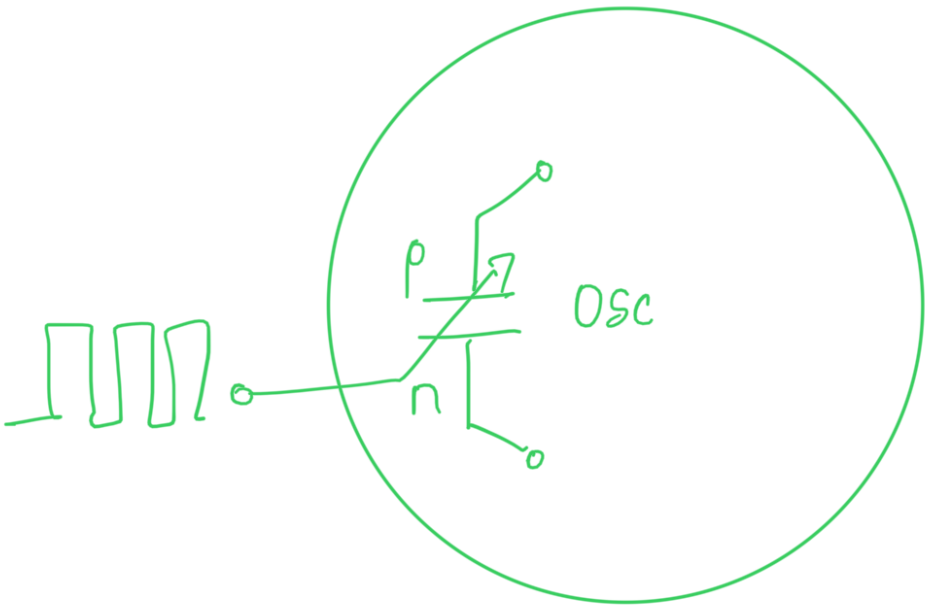
i.e capacitance decreases.

Electronically variable capacitor.

"Varactor"



Oscillator for bluetooth



pn j^2 control from outside,
capacitence of varactor changes.
C is related to frequency.

(how 3 terminal ? ..... ;;)
let's see this next ....