Diode Cheat Sheet

Rafael Marinho

General Constants

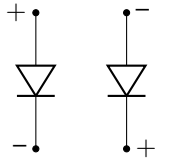
electron charge: $q = 1.6 \times 10^{-19}$	$\mu_n \approx 1350\, cm^2/(V \cdot s)$	$D_n \approx 34\, cm^2/s$
Boltzmann's constant: $k = 1.38 \times 10^{-23}$	$\mu_p \approx 480\, cm^2/(V \cdot s)$	$D_p \approx 12\, cm^2/s$

PN Junction

General semiconductor equations

Polarization

Direct **Inverse**



Semiconductor type	p-type	n-type
electron density	$n \approx N_D$	$n \approx \frac{n_i^2}{N_A}$
hole density	$p \approx \frac{n_i^2}{N_D}$	$p \approx N_A$

General values	
e^- density (Si)	$n_i = 5.2 \times 10^{15} \cdot T^{3/2} \exp\left[\frac{-Eg}{2kT}\right]$
e^- density @ 300K	$n_i \approx 10^{10}$
thermal voltage	$V_T = \frac{kT}{q} = \frac{D}{\mu}$
internal voltage	$\lvert V_0 \rvert = -\frac{kT}{q} \ln\left[\frac{N_A N_D}{n_i^2}\right]$
Saturation Current	$I_S = Aqn_i^2\left[\frac{D_n}{N_A L_n} + \frac{D_p}{N_D L_p}\right]$
Forward Current	$I_D = I_S \exp\left[\left(\frac{V_D}{V_T}\right) - 1\right]$

$$\begin{aligned} I_{diff,tot} &= Aq(\mu_n n + \mu_p p) \cdot E \\ I_{drift,tot} &= Aq\left(D_n \frac{dn}{dx} - D_p \frac{dp}{dx}\right) \end{aligned}$$

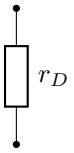
if thermal equilibrium: $\begin{cases} |I_{drift,n}| = |I_{diff,n}| \\ |I_{drift,p}| = |I_{diff,p}| \end{cases}$

Diode Modeling

Exponential model

$$I_D = I_S \exp\left(\frac{V_D}{\eta V_T}\right)$$

Small-signal model



$$r_D = \frac{1}{g_D} = \frac{\eta V_T}{I_D}$$