

# Diode Cheat Sheet

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## General Constants

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

## PN Junction

### General semiconductor equations

Polarization		Semiconductor type		General values	
Direct	Inverse	p-type	n-type		
				$e^-$ density (Si)	$n_i = 5.2 \times 10^{15} \cdot T^{3/2} \exp\left[\frac{-E_g}{2kT}\right]$
		electron density	$n \approx N_D$	$e^-$ density @ 300K	$n_i \approx 10^{10}$
		hole density	$p \approx \frac{n_i^2}{N_D}$	thermal voltage	$V_T = \frac{kT}{q} = \frac{D}{\mu}$
			$p \approx N_A$	internal voltage	$ V_0  = -\frac{kT}{q} \ln\left[\frac{N_A N_D}{n_i^2}\right]$
				Saturation Current	$I_S = Aq n_i^2 \left[ \frac{D_n}{N_A L_n} + \frac{D_p}{N_D L_p} \right]$
				Forward Current	$I_D = I_S \exp\left[\left(\frac{V_D}{V_T}\right) - 1\right]$

$$I_{diff,tot} = Aq(\mu_n n + \mu_p p) \cdot E$$

$$I_{drift,tot} = Aq \left( D_n \frac{dn}{dx} - D_p \frac{dp}{dx} \right)$$

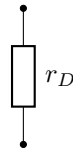
if thermal equilibrium:  $\begin{cases} |I_{drift,n}| = |I_{diff,n}| \\ |I_{drift,p}| = |I_{diff,p}| \end{cases}$

## Diode Modeling

### Exponential model

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

### Small-signal model



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