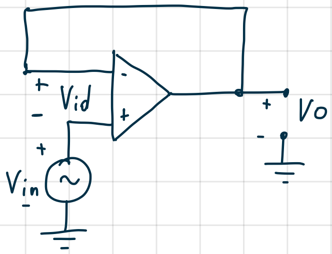
Voltage follower



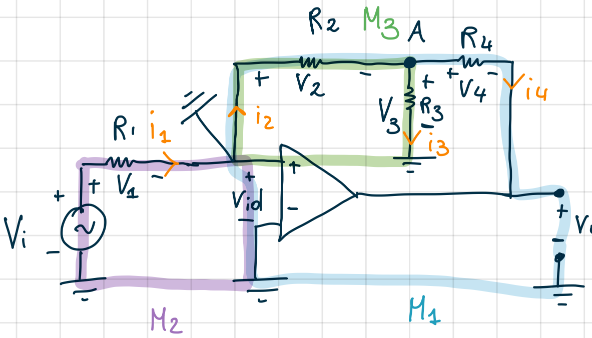
$V_o = A\,V_{id}$ ma $V_o = V_{id} + V_{in}$

$\rightsquigarrow \cancel{V_{id}} + \frac{V_{in}}{V_{id}} = A\,\cancel{V_{id}} \to$ ma $A \triangleq 10^5 \Rightarrow \frac{V_{in}}{V_{id}} \to \infty$

se e solo se $V_{id} \to \emptyset$

$\Rightarrow V_{id} = V^+ - V^- = \emptyset \Rightarrow V^+ = V^-$ ma $V^+ = V_{in} \Rightarrow V^- = V_{in}$ ma V^- c.c. $V_o \Rightarrow \underline{V_o = V_{in}}$ QED

Retroazione a stella



Siccome $V_{id} = V^+ - V^- = \emptyset$ e $V^- = 0 \Rightarrow V^+ = \emptyset$ GND

$\Rightarrow$ c'è una Maglia $R_2 - R_3 \Rightarrow V_3 = -V_2$

$V_0 = -V_4 - V_2 + \cancel{V_{id}}^{\,0} = -V_4 - V_2$ ma $V_2 = R_2 \cdot i_2$

Ma $i^+ = i^- = \emptyset \Rightarrow i_1 = i_2 = \frac{V_1}{R_1} \Rightarrow i_2 = \frac{V_i}{R_1}$

$\Rightarrow V_2 = R_2 \cdot i_2 = \frac{R_2}{R_1} V_i$ V_2

$V_4 = R_4 \cdot i_4$ ma LKC_A: $i_2 = i_3 + i_4 \Rightarrow i_4 = i_2 - i_3$ con $i_3 = \frac{V_3}{R_3}$ ma $V_3 = -V_2 = -\frac{R_2}{R_1} V_1$

$\Rightarrow i_3 = -\frac{R_2}{R_1 R_3} V_1$, $i_2 = \frac{V_i}{R_1} \Rightarrow i_4 = \frac{V_i}{R_1} + \frac{R_2}{R_1 R_3} V_i \Rightarrow V_4 = \frac{R_4}{R_1} V_i + \frac{R_2 R_4}{R_1 R_3} V_i$ V_4

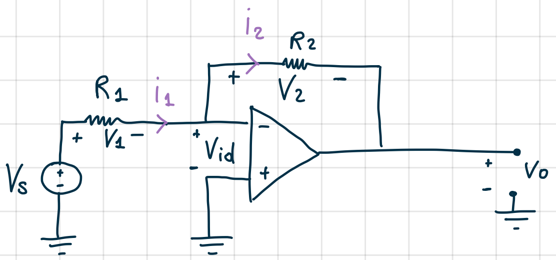
$\Rightarrow V_0 = -V_4 - V_2 = -\frac{R_2}{R_1} V_i \left(1 + \frac{R_4}{R_2} + \frac{R_4}{R_3}\right)$ V_0

Se ho $R_{Max} = 1\,M\Omega \Rightarrow R_2 = R_1 = R_4 = R_2 = 1\,M\Omega$ e $R_3 = 1\,m\Omega$

$\Rightarrow -\frac{R_2}{R_1} V_i \left(1 + \frac{R_4}{R_2} + \frac{R_4}{R_3}\right) \Rightarrow A \approx 10^9$ Bene!

1 1 $\frac{1\,M}{1\,m} = \frac{10^6}{10^3} = 10^9$

Configurazione invertente con gain FINITO



LKT: $V_o = -V_2 + V_{id}$ ma $V_{id} = V^+ - V^-$ e $\underset{GND}{V^+ = 0}$

$\Rightarrow V_{id} = -V^-$

Sappiamo che $V_o = A(V^+ - V^-) = -AV^- \Rightarrow V^- = -\dfrac{V_o}{A}$ V_{id}

$V_2 = R_2 \cdot i_2$ ma $i_1 = i_2 = i$ $\Rightarrow$ $V_2 = R_2 i$ ma $i = \dfrac{V_1}{R_1}$ e $V_1 = V_S - V_{id} = V_S + \dfrac{V_o}{A}$

$\Rightarrow i = \dfrac{V_S + \frac{V_o}{A}}{R_1}$ $\Rightarrow V_2 = \dfrac{R_2}{R_1}\left(V_S + \dfrac{V_o}{A}\right)$

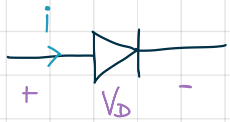
$\Rightarrow \boxed{V_o = -\dfrac{R_2}{R_1}\left(V_S + \dfrac{V_o}{A}\right) - \dfrac{V_o}{A}}$ Trovo V_o in funzione di V_i

$\rightsquigarrow V_o = -\dfrac{R_2}{R_1}V_i - \dfrac{R_2}{R_1 A}V_o - \dfrac{1}{A}V_o \Rightarrow V_o\left(1 + \dfrac{R_2}{R_1 A} + \dfrac{1}{A}\right) = -\dfrac{R_2}{R_1}V_i$

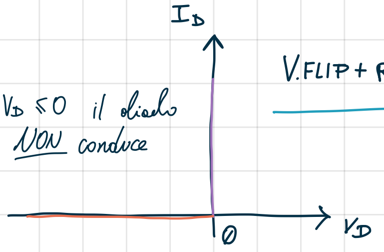
$\Rightarrow V_o = \dfrac{-\frac{R_2}{R_1}}{1 + \frac{R_2}{R_1 A} + \frac{1}{A}} V_i$ che per $A \to \infty$ $V_o = \dfrac{-\frac{R_2}{R_1}}{1 + \underbrace{\frac{R_2}{R_1 A}}_{0} + \underbrace{\frac{1}{A}}_{0}} V_i \rightarrow -\dfrac{R_2}{R_1}V_i$

opamp inv

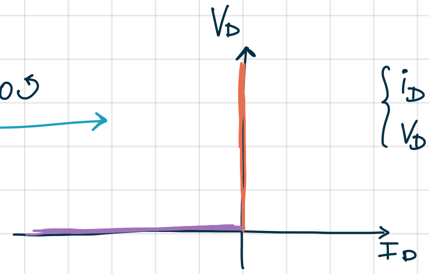
DIODO IDEALE



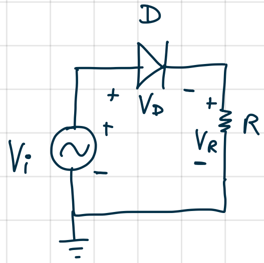
per $V_D \leq 0$ il diodo NON conduce



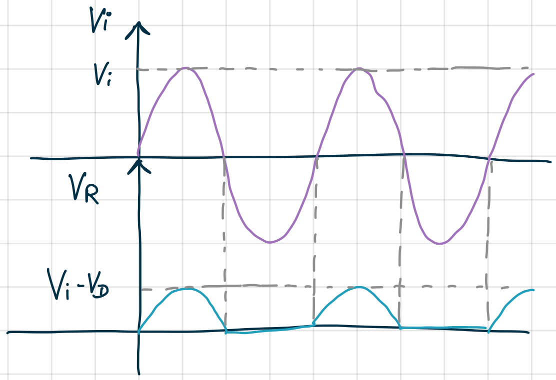
V.FLIP + R90

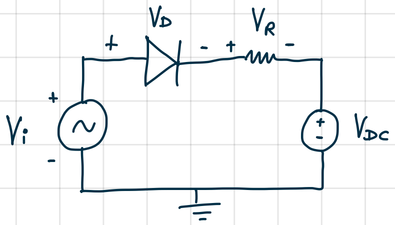


$$\begin{cases} i_D = 0 & , V_D < 0 \\ V_D = 0 & , I_D < 0 \end{cases}$$

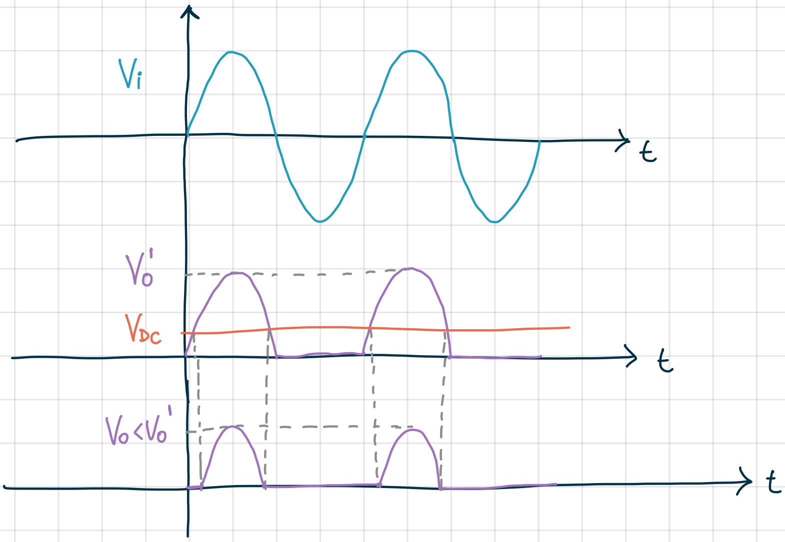


$$V_i = V_D + V_R$$

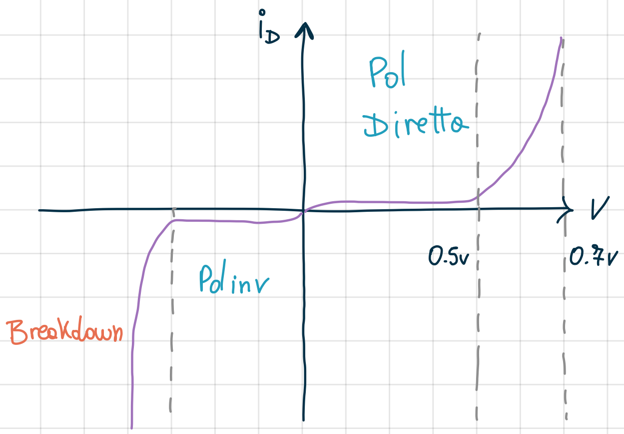




$$V_i - V_{DC} = V_D + V_R$$



Diodo Ideale



Corr di SAT

Tens del diodo

$$i_D = I_S \left(e^{\frac{V_D}{n V_T}} - 1 \right)$$

Tens. Termica

Temperatura

$$V_T \propto T$$

$$\begin{cases} I_S \propto T \\ I_S \propto A_{diodo} \end{cases}$$

- CASO 1: $i_D \gg I_S \Rightarrow$ vuol dire che $e^{\frac{V_D}{n V_T}} \gg 1, I_S \Rightarrow i_D \simeq e^{\frac{V_D}{n V_T}}$ Pol Diretta per $V_D > 0.5\,v$

- CASO 2: $i_D \ll I_S \Rightarrow e^{\frac{V_D}{n V_T}} \ll 1, I_S \Rightarrow i_D \simeq I_S \left(e^{\frac{V_D}{n V_T}} - 1 \right) \Rightarrow i_D \simeq -I_S$ per Tensioni Negative

  ovvero $V_D \ll 0$ $\quad \sim 0$

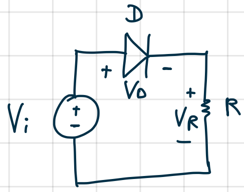
Passo un po' di corrente nel verso opposto!

ma $I_S \triangleq 10^{-14} \Rightarrow$ è un c.c.

Metodo grafico

Trovo i punti di funzionamento:

$$\begin{cases} i_D < 0 \Rightarrow V_D = 0 \\ V_D < 0 \Rightarrow i_D = 0 \end{cases}$$

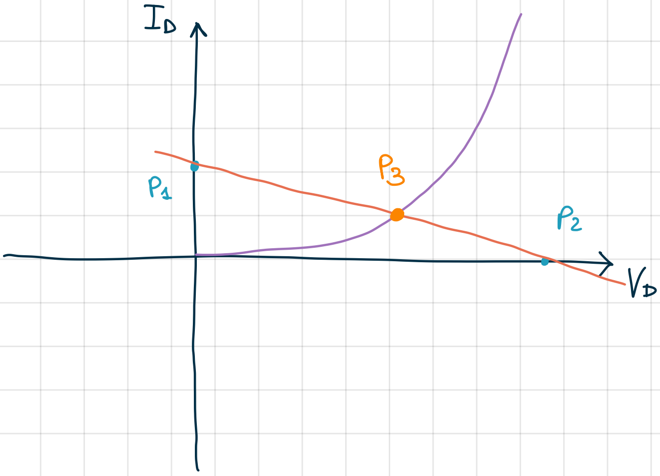


LKT: $V_i = V_D + V_R = V_D + R \cdot i_D$

$\Rightarrow \begin{cases} V_D = 0 \Rightarrow V_i = R \cdot i_D \Rightarrow i_D = \frac{V_i}{R} \\ i_D = 0 \Rightarrow V_i = V_D \end{cases}$

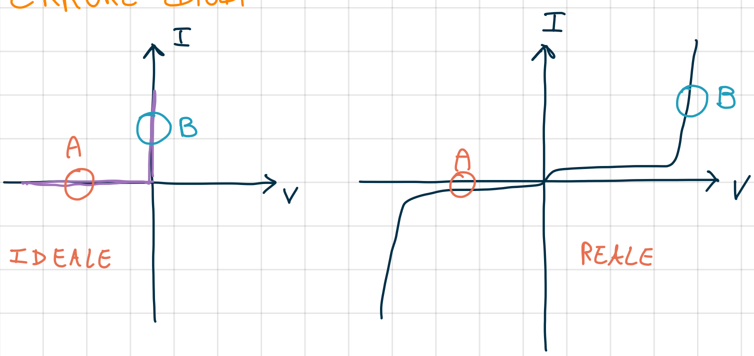
$\begin{matrix} V & I \end{matrix}$ $\left(0, \frac{V_i}{R}\right)$ P_1

$\left(0, V_D\right)$ P_2 $\begin{matrix} I & V \end{matrix}$



P_3: (V_0, I_0) voltaggio e corrente OPERATIVI

ERRORE DIODI



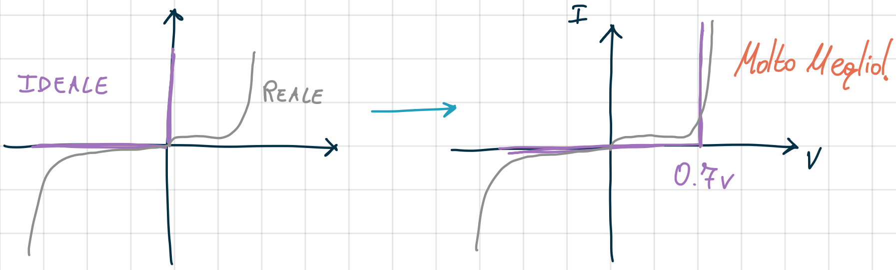
Nella zona B l'errore non è sempre trascurabile.
se $V_T = 0.7V$ e vogliamo una tolleranza del 1%.

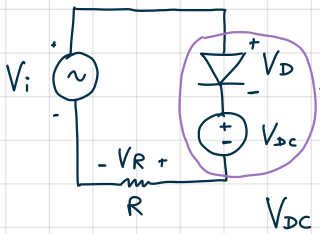
$\Rightarrow \frac{x}{100} = .7 \Rightarrow x = .7 \cdot 100 = 70V$

dovremmo avere centinaia di Volts per approssimare.

Miglior approx

Siccome l'area (B) ha un errore maggiore dell'area (A) possiamo migliorare l'area (B) shiftandola verso la posizione corretta:



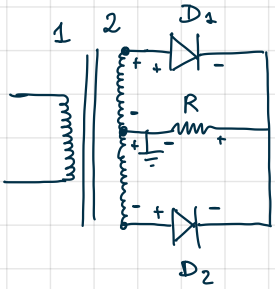


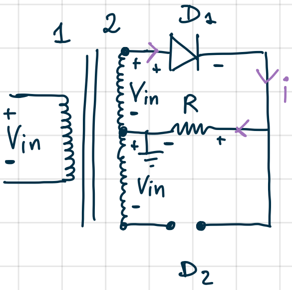
Modello a Batteria

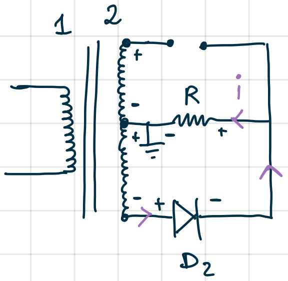
$V_{DC} = 0.7_{DC}V$

$V_i - V_{DC} = V_D + V_R \Rightarrow V_i > V_{DC}$ affinché il diodo conduca $\Rightarrow V_i > 0.7V$

Full wave rectifier A presa centrale







i_R è sempre nella stessa direzione

Valori Max

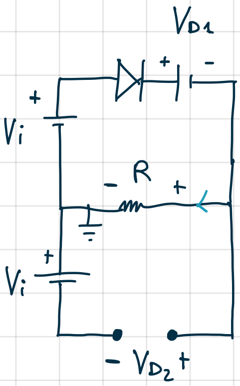
CORRENTE: $i_R = \frac{V_R}{R}$ ma $V_R = V_{in} - V_{D1}$ oppure $V_R = V_{in} - V_{D2}$ ma $V_{D1} = V_{D2} = V_D$

$\Rightarrow i_R = \frac{V_{in} - V_D}{R}$ e $V_D = 0.7V$ $\Rightarrow$ $\boxed{i_R = \frac{V_{in} - 0.7}{R}}$ Max

Vin MAX

Tensione

Ci interessa il voltaggio Max che deve sopportare il diodo in polarizz. inversa:



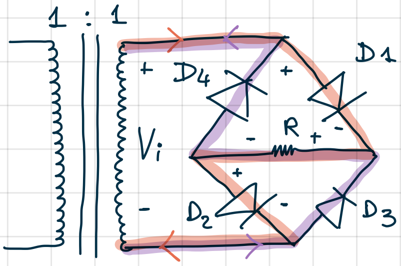
$V_{D2} = V_R + V_i$ ma $V_R = V_i - V_{D1}$ $\Rightarrow$ $V_{D2} = V_i + V_i - V_{D1}$

$= 2V_i - V_{D1}$

PEAK INVERSE VOLTAGE

"protegge" l'altro diodo

Full Bridge Rect



VALORI MAX

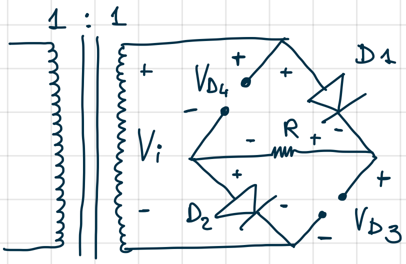
$V_{D_1} = V_{D_2} = V_D = .7V$

Corrente $\quad i_{D_1} = i_{D_2} = \dfrac{V_R}{R} \quad$ ma $\quad V_R = V_i - V_{D_1} - V_{D_2}$

$= V_i - 2V_D = V_i - 1.4V$

sia per + che -

Tensione Max

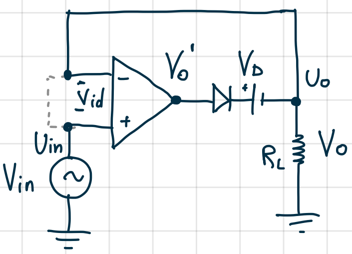


$V_{D_3} = V_R + V_{D_2} \quad$ ma $\quad V_R = V_i - 1.4V \Rightarrow V_{D_3} = V_i - 1.4V + .7V$

$= V_i - 0.7V$

Max Volt

Superdiodo



Semiciclo pos

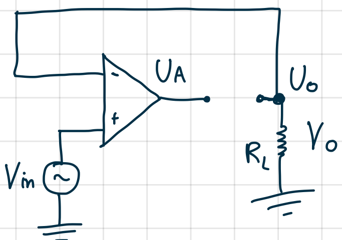
①

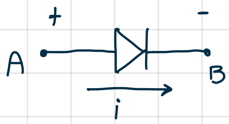
$V_o' = A\,V_{id} \qquad V_o = V_o' - V_D \Rightarrow V_o' = V_o + V_D$

$\rightsquigarrow V_o + V_D = A\,V_{id} \rightsquigarrow V_{id} = \dfrac{V_o + V_D}{A}$ ma $A \triangleq 10^5 \quad V_{id} \approx 0V$

$V^+ = V^- \Rightarrow V^+ = V_{in} \Rightarrow V^- = V_{in} \Rightarrow \underline{V_o = V_{in}}$ QED

Negativo



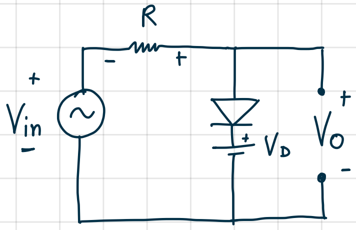


$U_A > U_B$

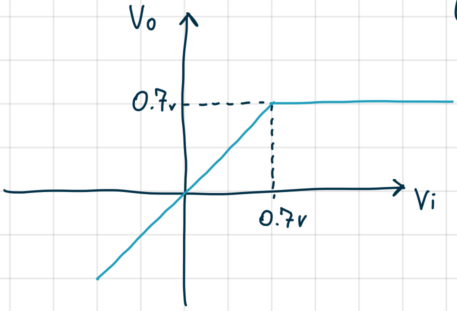
$U_B = \emptyset$ (GND)

$\Rightarrow U_A < 0 \Rightarrow V_{in} < \emptyset$

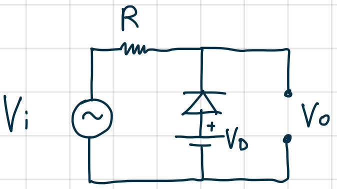
CLIPPER

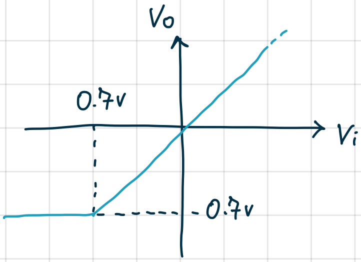


$V_o = V_D$ ma $V_D = .7V \Rightarrow$ $\begin{cases} POS: \text{ Pol dir} \rightarrow C.C \Rightarrow \underline{V_o = V_D = .7V} \\ NEG: \text{ Pol inv} \rightarrow V_o = V_D = V_R + V_{in} \\ \quad \text{ma } i = 0 \Rightarrow V_R = 0 \Rightarrow \underline{V_o = V_{in}} \end{cases}$

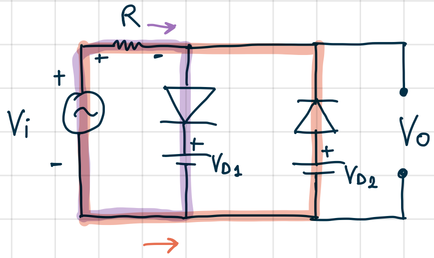


inverto il diodo





Unisco



POS

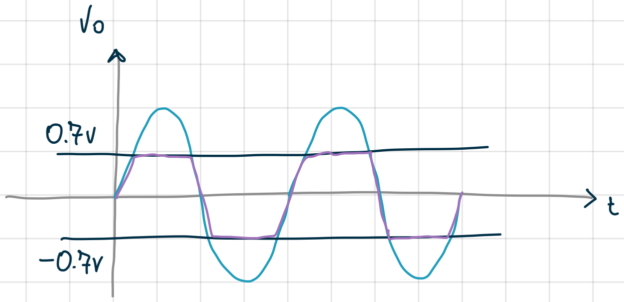
$V_i > 0$
- $V_i > V_{D1} \rightarrow C.C. \Rightarrow V_o = V_{D1}$
- $V_i < V_{D1} \rightarrow C.A. \Rightarrow V_o = V_i$

* D_2 sicuramente spento

Neg

$V_i < 0$
- $|V_i| > |V_{D2}| \rightarrow C.C.$ $V_o = V_{D2}$
- $|V_i| < |V_{D2}| \rightarrow C.A$ $V_o = V_i$

* D_1 S. Spento



DIODI