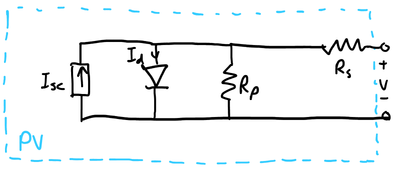
Max Power Point

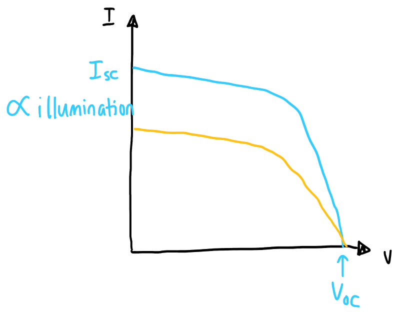
Tuesday, February 27, 2024 4:00 PM

Equivalent Circuit Model for PV cell



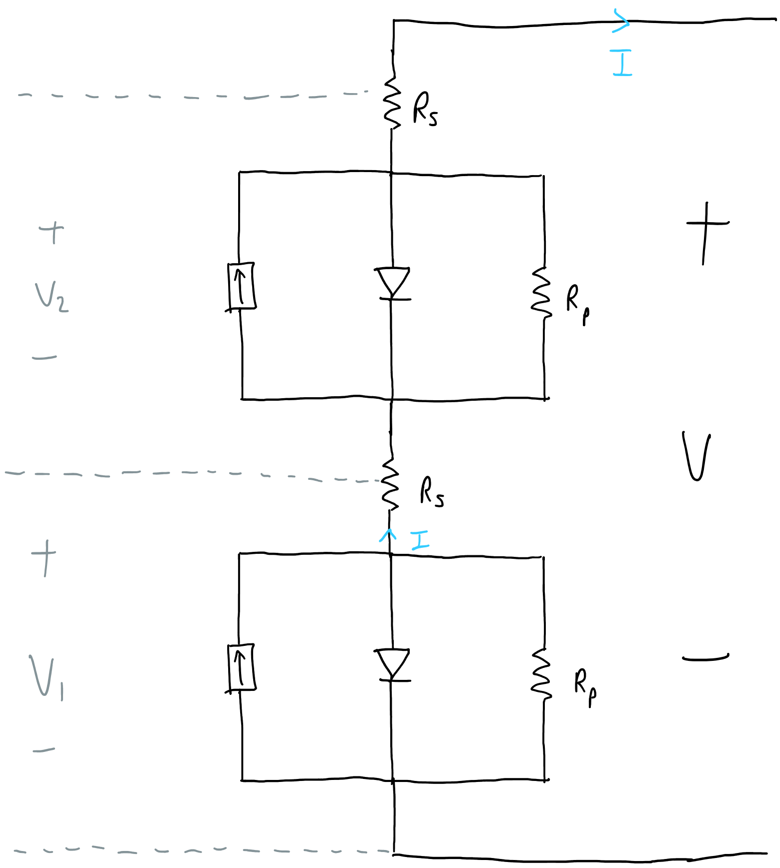
$$I = I_{sc} - I_o\left(e^{qV_d/kT} - 1\right) - \frac{V_d}{R_p}$$

$$V_d = V + IR_s$$

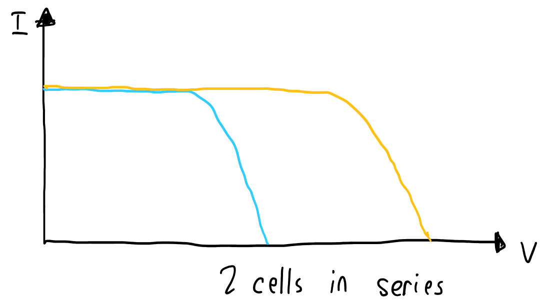


Cells → Modules → Arrays

- individual cells only produce ~0.5V at output
  - > want to connect them in series
  - > may also want to connect in parallel for more current



$$V = V_1 + V_2$$
$$= (V_d - IR_s) + (V_d - IR_s)$$
$$= 2(V_d - IR_s)$$



In general, for n cells in series:

$$V = n(V_d - IR_s)$$

Modules — cells in series. 36, 72, 96, ...

- Ex 72 identical cells connected in series, 1 sun insolation (1 kW/m²)
  For each cell, $I_{sc} = 6A$ @ 25°C, $I_0 = 5 \times 10^{-11}$ A, $R_p = 10\,\Omega$, $R_s = 0.001\,\Omega$, $V_d = 0.57$ V.

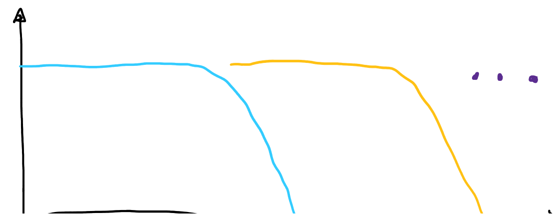
$$I = I_{sc} - I_0\left(e^{38.9 V_d} - 1\right) - \frac{V_d}{10}$$
$$= 6 - (5\times10^{-11})\left(e^{(38.9)(0.57)} - 1\right) - \frac{0.57}{10}$$
$$= 5.73 \text{ A}$$

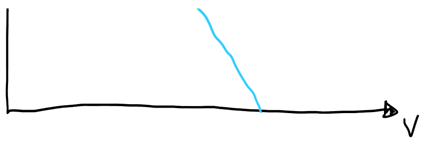
$$V_{module} = n(V_d - IR_s)$$
$$= 72(0.57 - 5.73 \times 0.001)$$
$$= 40.6 \text{ V}$$

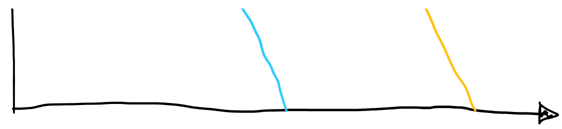
$$P = V_{module}\, I$$
$$= (40.6)(5.73)$$
$$= 233 \text{W}$$

- Arrays
  - connect modules in series or parallel

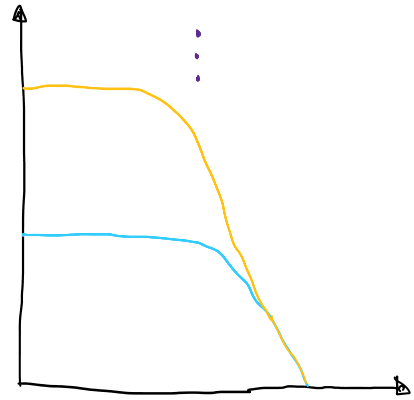
Series



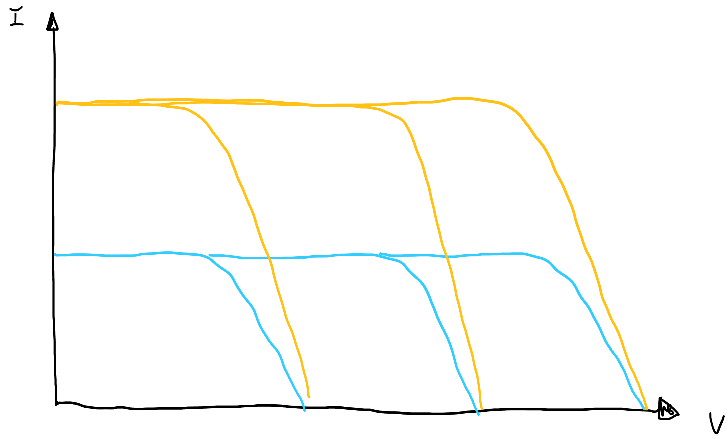




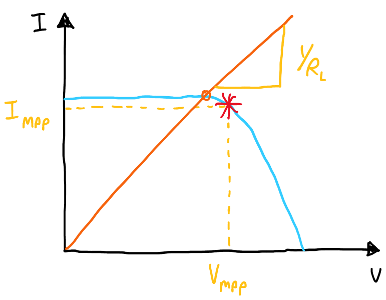
Parallel

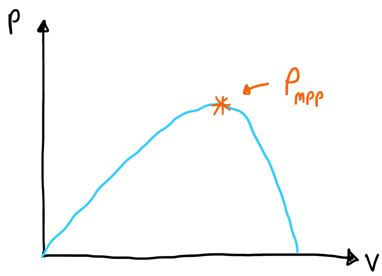


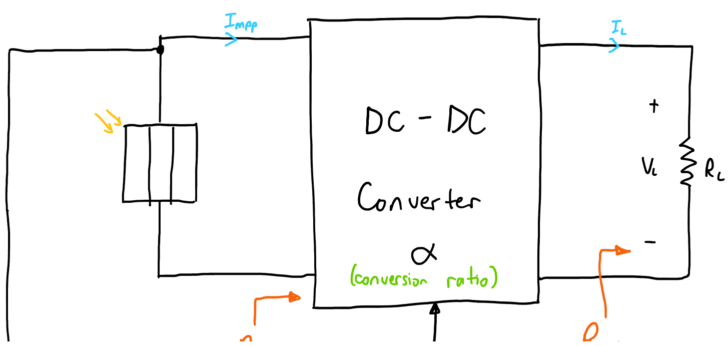
• What about parallel combination of 3 series-connected modules?



• Maximum Power Tracking



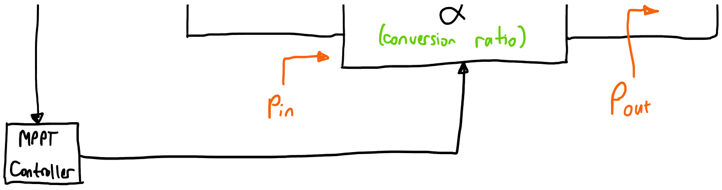




Ideally:

$V_L = \alpha V_{mpp}$

$I_L = \frac{1}{\alpha} I_{mpp}$



$I_L = \alpha I_{MPP}$