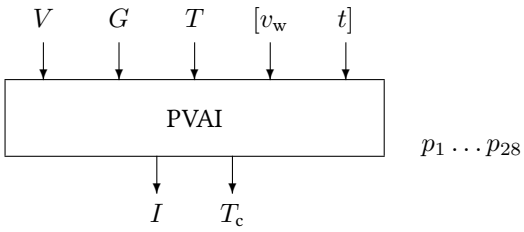
Block PVAI

The PVAI block calculates the output current and the temperature of a (micro-) amorphous photovoltaic generator, depending on PV generator voltage, global radiation on the generator plane, ambient temperature, and wind speed.





Name	PVAI
Function	se0028
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Outputs	2
Parameters	28
Strings	0
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Inputs

1 Voltage V / V
2 Global radiation on the generator plane G / W m^{-2}
3 Temperature T / °C
4 Wind speed close to the generator v_w / m s^{-1}
5 Time t / s

Outputs

1 Current I / A
2 Cell temperature T_c / °C

Parameters

1 Mode
- 0 The cell temperature is given by input 3.
- 1 The cell temperature depends on the thermal parameters of the PV modules and the inputs of the block; initial value of the cell temperature is given by parameter number 26.
- 2 The difference between cell temperature and ambient temperature is a linear function of the global radiation (input 2) on the basis of NOCT.

2 Number of cells in series per module N_s
3 Number of cells in parallel N_p
4 Number of modules in series M_s
5 Number of modules in parallel M_p
6 Area of a single cell A_c / m^2
7 Area of a single module A_m / m^2
8 Coefficient of short-circuit current density c_ph / V^{-1}
9 Temperature coefficient of short-circuit current c_t / $\mathrm{V}^{-1}\,\mathrm{K}^{-1}$
10 Merten parameter M / V^{-1}
11 Built-in voltage parameter v_bi / V
12 Coefficient of saturation current density c_s / $\mathrm{A\,m}^{-2}\,\mathrm{K}^{-s}$
13 Temperature exponent s of saturation current density
14 Band gap parameter e_g / eV
15 Diode ideality factor n
16 Series resistance parameter r_s / $\Omega\,\mathrm{m}^2$
17 Parallel resistance parameter r_p / $\Omega\,\mathrm{m}^2$
18 Module tolerance plus / %
19 Module tolerance minus / % (< 0)
20 Characteristic module length ℓ_m / m
21 Module weight m_m / kg
22 Absorption coefficient a
23 Emission factor ϵ
24 Specific heat of a module c_m / $\mathrm{J\,kg}^{-1}\mathrm{K}^{-1}$
25 Nominal operating cell temperature NOCT / °C
26 Initial value of cell temperature / °C
27 Error tolerance of voltage (or current) of a single cell in the numerical iteration to solve the modified one-diode-model equation
28 Maximum number of iterations to solve the modified one-diode-model equation

Strings

None

Description

The model of the PV module has two parts: an electrical model (a modified “one-diode model”) and a thermal model based on an energy balance.

Electrical model

The relationship between voltage V_c / V of an amorphous silicon solar cell and current density j / A m^{-2} is given by the modified one-diode-model equation

$$\begin{aligned} j =& (c_\mathrm{ph} + c_\mathrm{t} T) G \left(1 - (M(v_\mathrm{bi} - (V_\mathrm{c} + j r_\mathrm{s})))^{-1}\right) \\ & - c_\mathrm{s} T^s \exp\left(-\frac{e_\mathrm{g}}{kT}\right) \left(\exp\left(\frac{q(V_\mathrm{c} + j r_\mathrm{s})}{nkT}\right) - 1\right) - \frac{V_\mathrm{c} + j r_\mathrm{s}}{r_\mathrm{p}} \end{aligned}$$

where the ten free fit parameters are

c_ph	Coefficient of short-circuit current density / V^{-1}
c_t	Temperature coefficient of short-circuit current density / V^{-1} K^{-1}
M	Merten parameter / V^{-1}
v_bi	Built-in voltage parameter /V
c_s	Coefficient of saturation current density / A m^{-2} K^{-s}
s	Temperature exponent of saturation current density
e_g	Band gap parameter / eV
n	Diode ideality factor
r_s	Series resistance parameter / Ω m^2
r_sh	Shunt resistance parameter / Ω m^2

and

T	Cell temperature / K
q	Charge of an electron (1.6021×10^{-19}As)
k	Boltzmann constant (1.3854×10^{-23}JK^{-1})

Hence, the operating point of the PV generator is given by

$$\begin{aligned} V &= V_\mathrm{c} N_\mathrm{s} \\ I &= j A_\mathrm{c} N_\mathrm{p} \end{aligned}$$

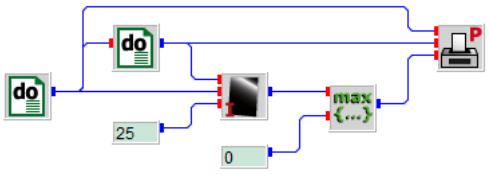
where

A_c	Area of a single cell / m^2
N_s	Number of cells in series (whole generator)
N_p	Number of cells in parallel (whole generator)

Thermal model

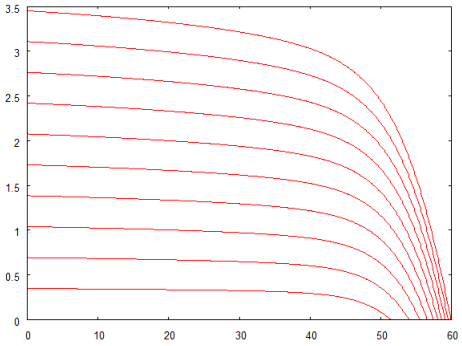
For a description of the thermal model please refer to block PVI.

pvai.vseit



Two DO blocks vary radiation between 100 and 1000 W/m^2 in steps of 100 (outer DO block) and voltage between zero and 60 V in steps of 0.1 V. The module temperature is set constant to 25 °C. These three signals are used by the PVAI block to simulate a micromorphous PV module with 180 cells in total.

In order to avoid the output of negative currents a MAX block with a connected zero forces the PLOT block to display only values $I(V) \geq 0$.



See also Blocks PVAV, PVFITA.