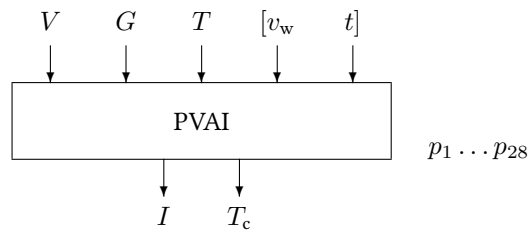


Block PVAI

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
Inputs	3 ... [5]
Outputs	2
Parameters	28
Strings	0
Group	S

Inputs

- 1 Voltage V / V
- 2 Global radiation on the generator plane G / W m^{-2}
- 3 Temperature T / $^{\circ}\text{C}$
- 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 / $^{\circ}\text{C}$

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 $c_t / \text{V}^{-1} \text{K}^{-1}$
10	Merten parameter M / V^{-1}
11	Built-in voltage parameter v_{bi} / V
12	Coefficient of saturation current density $c_s / \text{A m}^{-2} \text{K}^{-s}$
13	Temperature exponent s of saturation current density
14	Band gap parameter e_g / eV
15	Diode ideality factor n
16	Series resistance parameter $r_s / \Omega \text{m}^2$
17	Parallel resistance parameter $r_p / \Omega \text{m}^2$
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 $c_m / \text{J kg}^{-1} \text{K}^{-1}$
25	Nominal operating cell temperature NOCT / $^{\circ}\text{C}$
26	Initial value of cell temperature / $^{\circ}\text{C}$
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

$$j = (c_{ph} + c_t T) G \left(1 - (M(v_{bi} - (V_c + j r_s)))^{-1} \right) - c_s T^s \exp \left(-\frac{e_g}{kT} \right) \left(\exp \left(\frac{q(V_c + j r_s)}{nkT} \right) - 1 \right) - \frac{V_c + j r_s}{r_p}$$

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 / Ωm^2
r_{sh}	Shunt resistance parameter / Ωm^2

and

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

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

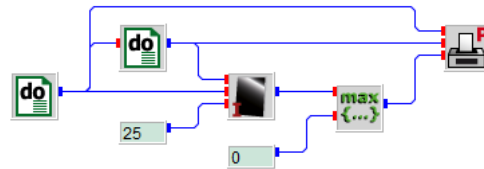
$$\begin{aligned} V &= V_c N_s \\ I &= j A_c N_p \end{aligned}$$

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)

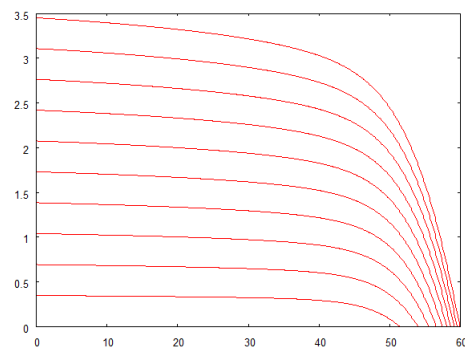
Thermal model For a description of the thermal model please refer to block [PVI](#).

pvai.vseit



Two [DO](#) blocks vary radiation between 100 and 1000 W/m² 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](#).