Solar Design Algorithm

The document below defines the calculations used to design and evaluate a PV system in preparation for creating electrical drawings.

The secondary documents are automatically created from this source:

- A printable PDF document describing the algorithm, with no computer code (SDA_standard.pdf).
- Key computer code used in FSEC's online express drawing creation application (SDA.js).
- A printable PDF document describing the algorithm and it's related computer code (SDA.pdf).

Note: For each section, the symbols are pre-pended by a section name to assist with their use in the computer code, in the form of "section.symbol".

System specification

These are the what uniquely define the system design. Every other value is deterministically calculated from these variables. These are the user input in FSEC's online express design application.

Description	Symbol	Unit
Inverter manufacturer name	inverter.manufacturer_name	-
Inverter model	inverter.device_model_number	-
Module manufacturer name	array.manufacturer_name	-
Module model	array.device_model_number	-
Grid voltage	inverter.grid_voltage	V
Number of PV Source Circuits	array.num_of_strings	ea.
Total Number of Modules	array.num_of_modules	ea.
Maximum Number of Series-Connected Modules per Source Circuit	array.largest_string	ea.
Minimum Number of Series-Connected Modules per Source Circuit	array.smallest_string	ea.
Minimum Distance Above Roof (in)	module.array_offset_from_roof	in.
Main panel supply OCPD rating (A)	interconnection.supply_ocpd_rating	A
Main panel busbar rating (A)	interconnection.bussbar_rating	A
Total of load breakers (A)	interconnection.load_breaker_total	A

Constants

These are fixed values that are not calculated or provided by the user.

Description	Symbol	Limits	Value used	Unit
2% Maximum Temperature	array.max_temp	In Florida: 30 to 36	36	°C
Extreme Annual Mean Minimum Design Dry Bulb Temperature	array.min_temp	In Florida: -9 to 11	-9	°C
Maximum Voltage Rating?	array.code_limit_max_voltage	600	600	V
Voltage Correction Factor	array.voltage_correction_factor		1.14	

The most extreme temperatures (http://www.solarabcs.org/about/publications/reports/expedited-permit/map/index.html) are used so that the designed system is usable anywhere in Florida.
Voltage correction factor is taken from Table 690.7.

```
array.max_temp = 36;
array.min_temp = -9;
array.code_limit_max_voltage = 600;
array.voltage_correction_factor = 1.14;
```

Manufacturer data

The following information is taken from the manufacturer specification sheets. In FSEC's online express design application, this information is stored in FSEC's database.

Inverter:

Description	Symbol	Unit
UL1741 listed/FSEC approved?	inverter.ul_1741	-
Is inverter tranformerless	inverter.tranformerless	-
Inverter type (string, micro, DC-DC)	inverter.type ???	-
Maximum inverters per branch	inverter.max_per_branch ???	-
Maximum dc voltage, Vmax,inv (V)	inverter.vmax	V
MPPT minimum dc operating voltage (V)	inverter.mppt_min	V
MPPT maximum operating voltage (V)	inverter.mppt_max	V
Min. dc operating voltage (V)	inverter.voltage_range_min	V
Min. dc start voltage (V)	inverter.vstart	V
Number of inverter inputs or MPP trackers	inverter.mppt_channels	A
Maximum OCPD Rating (A)	inverter.max_ac_ocpd	A
Maximum DC short circuit current per inverter input or MPP tracker	inverter.isc_channel	A
Maximum DC operating current per inverter input or MPP tracker	inverter.imax_channel	A
Maximum DC input power 120	inverter.max_dc_inputpower_120	W
Maximum DC input power 208	inverter.max_dc_inputpower_208	W
Maximum DC input power 240	inverter.max_dc_inputpower_240	W
Maximum DC input power 277	inverter.max_dc_inputpower_277	W
Maximum DC input power 480	inverter.max_dc_inputpower_480	W
Nominal AC output power 120	inverter.nominal_ac_output_power_120	W
Nominal AC output power 208	inverter.nominal_ac_output_power_208	W
Nominal AC output power 240	inverter.nominal_ac_output_power_240	W
Nominal AC output power 277	inverter.nominal_ac_output_power_277	W
Nominal AC output power 480	inverter.nominal_ac_output_power_480	W
Maximum AC output current 120	inverter.max_ac_output_current_120	V
Maximum AC output current 208	inverter.max_ac_output_current_208	V
Maximum AC output current 240	inverter.max_ac_output_current_240	V
Maximum AC output current 277	inverter.max_ac_output_current_277	V
Maximum AC output current 480	inverter.max_ac_output_current_480	V

Microinverters also have the following values.

Description	Symbol	Unit
Maximum units per branch	inverter.max_unitsperbranch	-
Minimum units per branch	inverter.min_unitsperbranch	-
Minimum panel wattage	inverter.min_panel_wattage	W
Maximum panel wattage	inverter.max_panel_wattage	W
Maximum number of cells per panel	inverter.max_module_cells	-
Maximum watts per string	inverter.max_watts_per_branch	-

DC-DC optimizer systems also have the following values for the main inverters.

Description	Symbol	Unit
Nominal DC input voltage	inverter.dc_voltage_nominal	V

DC-DC optimizers have the following values.

Description	Symbol	Unit
Rated max power	optimizer.rated_max_power	W
Max input voltage	optimizer.max_input_voltage	V
MPPT operating range min	optimizer.mppt_op_range_min	V
MPPT operating range max	optimizer.mppt_op_range_max	V
Max Short Circuit Current (Isc)	optimizer.max_isc	A
Max output current	optimizer.max_output_current	A

Max output voltage	optimizer.max_output_voltage	V
Min optimizers / string	optimizer.min_optis_per_string	-
Max optimizers / string	optimizer.max_optis_per_string	-
Max power / string	optimizer.max_power_per_string	-

Module:

Description	Symbol	Unit
Description	Symbol	Unit
FSEC certified	module.FSEC_approved	-
Maximum power @ STC (W)	module.pmp	W
Open-circuit voltage @ STC (V)	module.voc	V
Short-circuit current @ STC (A)	module.isc	A
Maximum power voltage @ STC (V)	module.vmp	V
Maximum power current @ STC (A)	module.imp	A
Number of cells	module.total_number_cells	-
Maximum overcurrent device rating (A)	module.max_series_fuse	A
Maximum system voltage rating (V)	module.max_system_v	V
Temp Coeff Voc (%/°C)	module.tc_voc_percent	%/°C
Temp Coeff Vmp (%/°C)	module.tc_vpmax_percent	%/°C
Nameplate rating	module.nameplaterating	W