SUNPOWER®

SUNPOWER® PV-SYST MODELING GUIDELINE

Maxeon Product Line Modules

March 27, 2020, V00

1. SunPower Technologies: Special Modeling Guidelines

SunPower technologies have premium performance characteristics which require special attention when modeling energy production in PVSyst. The sections of PVSyst input guidance provided below are specifically defined for Maxeon IBC Modules:

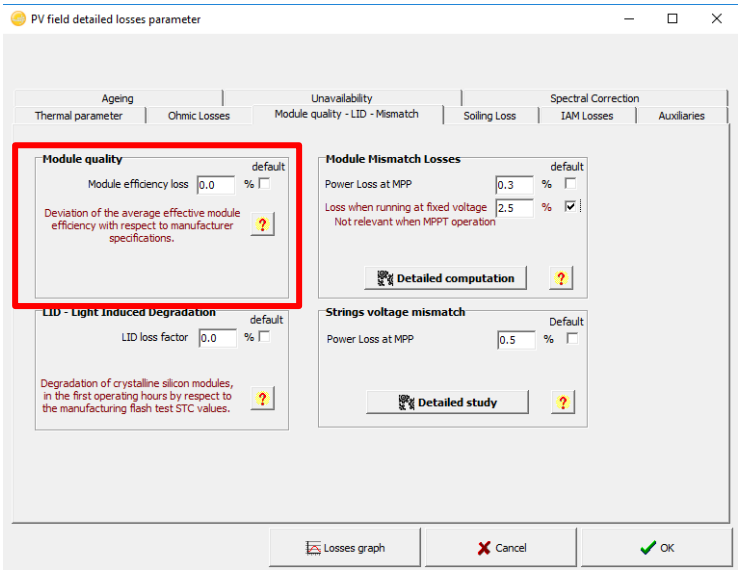
1.1 Module Quality

Module Quality = 0%

The "Module Quality" setting in PVSyst defines the expected collective power rating of the modules delivered to a project, pre-LID.

The industry tolerance standard on module flash have improved, and most manufacturers should be delivering modules which flash—on average—very close to their nameplate rating with a distribution of no greater than -0%/+5%.

The Module Quality should be set to 0% for all Maxeon modules.



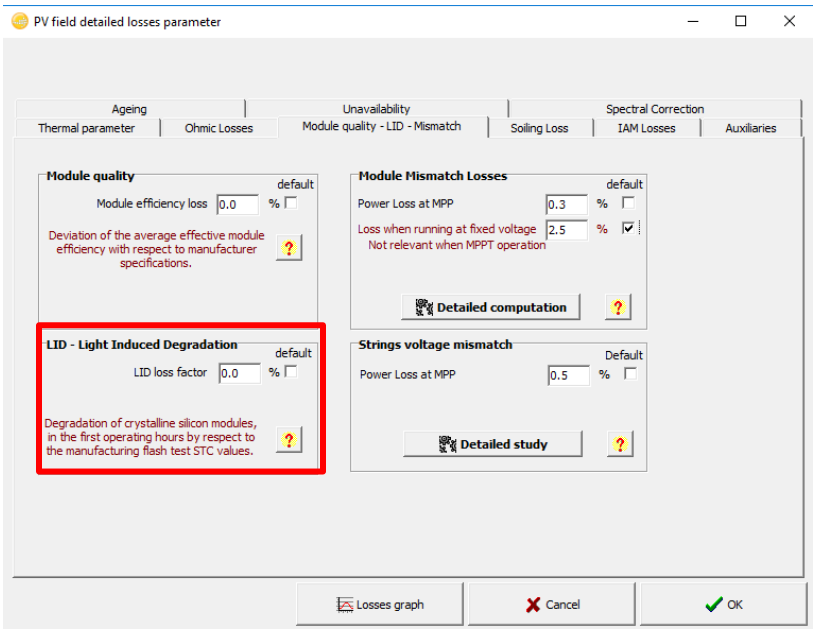
1.2 Light-Induced Degradation

LID = 0%

Light Induced Degradation (LID) effects conventional p-type boron-doped wafer technologies. Premium technologies using n-type doped wafers, like SunPower's interdigitated back contact (IBC) mono-facial cells, are not affected by LID.

Note that most p-type crystalline and thin-film PV technologies experience 1-3% LID after the first several hours of sun exposure following installation.

*PVSyst Help defines LID effect as "*The LID effect only arises with conventional p-type boron-doped wafers. Unconventional technologies using n-type doped wafers (as for example SunPower mono-facial cells) are not affected".



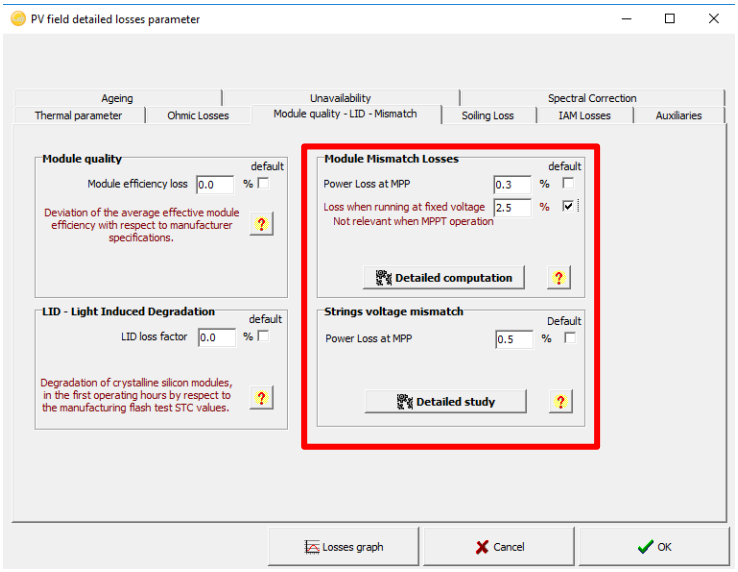
1.3 Mismatch Loss

Total Mismatch = 0.8%

Research has demonstrated that the voltage mismatch associated with current module tolerance standards will result in a loss in system power of significantly less than the PVSyst default of 1%.

SunPower delivers tight Gaussian distributions of module flash ratings to our customers. We therefore recommend using a total, conservative mismatch value of 0.8% for our IBC technologies.

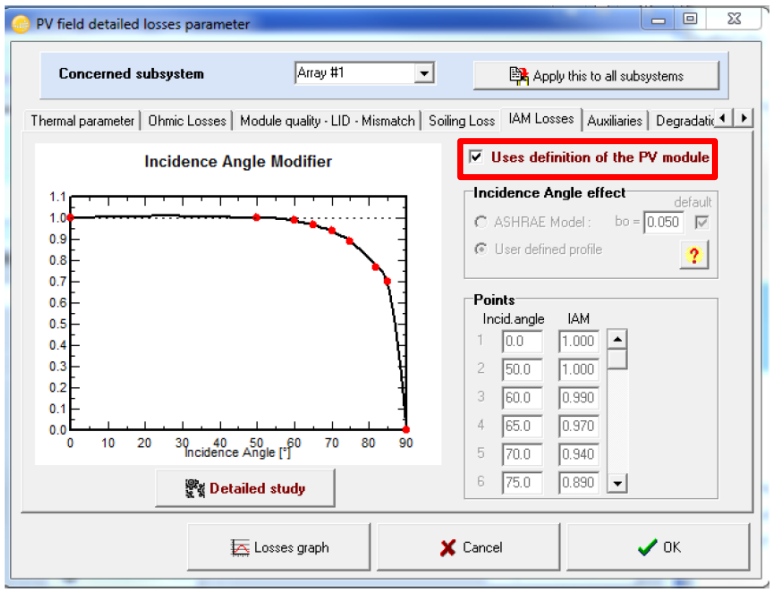
- Module current mismatch = 0.3%
- Strings voltage mismatch = 0.5%



1.4 IAM Profile

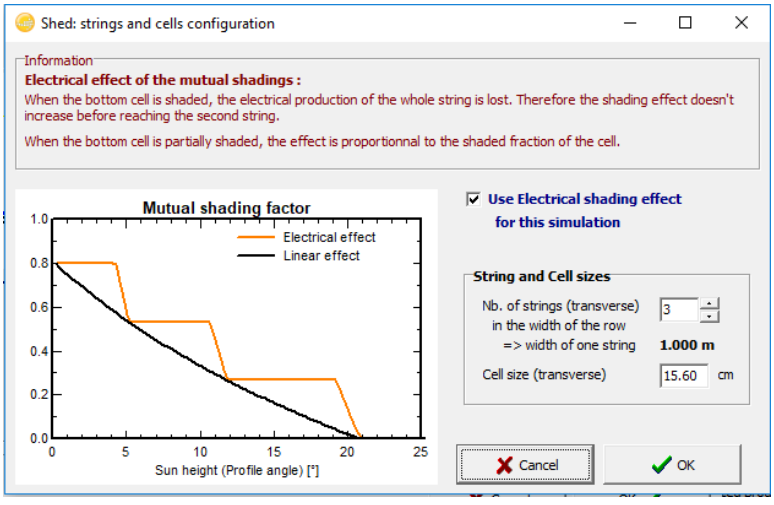
SunPower IAM profiles defined in PAN file

SunPower module technologies are laminated with a high-quality, high-performance, anti-reflective glass, which absorbs significantly more direct and diffuse light than a standard glass surface. The IAM points defining the incidence angle response of the SunPower anti-reflective glass are provided in the PAN file for each module product. IAM tables are also available in Appendix A at the end of this guideline.



1.5 Near Shadings

SunPower E-Series, X-Series and A-Series modules have superior performance under shaded conditions, due to the low reverse-bias breakdown voltage of the interdigitated back contact (IBC) cell. PVSyst offers various methods for characterizing response of shaded SunPower modules :



1. <u>Unlimited Sheds</u> : select « Electrical Effect » in Shades Parameters window

   If Landscape:

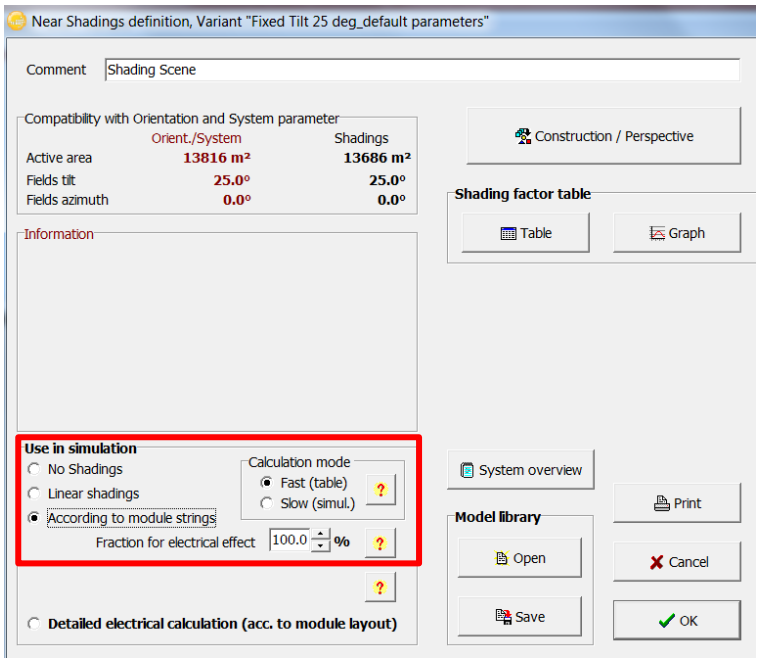
   - Nb. Strings = 3 x #modules/row in north-south direction
   - Cell size = 16.0cm

   If Portrait:

   - Nb. Strings = #modules row in north-south direction
   - Cell size = 16.0cm

2. <u>All other Field Types requiring user-defined Shading Scene --> Construction/Perspective</u>

To reflect the excellent shade response of E and X Series in PV-Syst, create a shading scene in the Near Shadings section and select the 'According to module strings' option.



If Portrait:

- Fraction for Electrical Effect = 75%

If Landscape:

- In the Construction/Perspective tool, subpartition module strings into 3 in height for each module in the racking in the north-south direction. This will allow the model to account for the 3 bypass diode behavior in the module when installed in landscape orientation.
- Fraction for Electrical Effect = 50%

1.6 Ageing (Degradation)

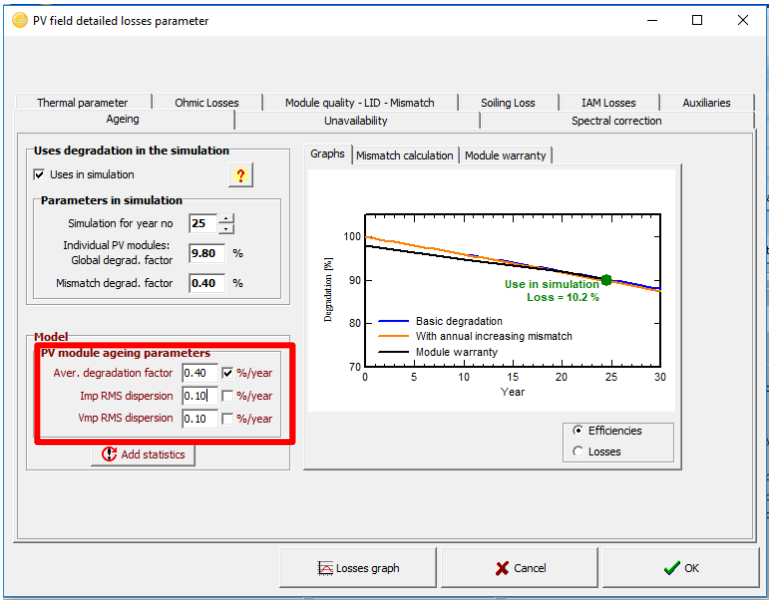
Average Degradation Factor = 0.25%/yr

Imp RMS dispersion = 0.10%/yr

Vmp RMS dispersion = 0.10%/yr

SunPower modules set the industry standard for low degradation at 0.25% per year. This also means that the variance in current and voltage also does not change significantly over time, resulting in very low RMS dispersion rates (estimated 0.1%/yr).

The resulting long-term degradation for SunPower modules is consistent with the low degradation rate in the Sunpower module warranty.



2. General Parameters for Best Modeling Practices:

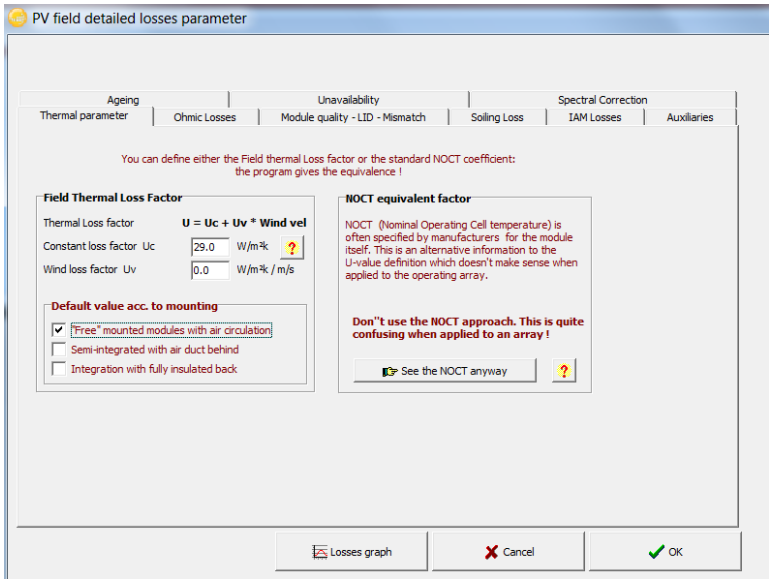
Several modeling parameters in PVSyst are important to understand for proper modeling of systems, but are not typically unique to individual technologies. The following guidelines may be applied to systems using any module technology:

2.1 Transposition Model Selection

SunPower has determined that the Perez tilted-plane (transposition) model can significantly improve the accuracy of calculated plane-of-irradiance (POA) irradiance accuracy in solar array applications. Therefore, select the Perez-Ineichen physical model under *Preferences*.

2.2 Thermal Parameter Selection

System Type	Uc	Uv
Open Rack (SAT, GFT)	29.0 (PVsyst Default)	0.0 (PVsyst Default)
Single Tilt	26.0	1.2
Dual Tilt	20.0	1.0
Flush or Invisi Mount	20.0	0.0



For Open Rack systems SunPower recommends to use Pvsyst default values. SunPower has conducted a study to determine the best thermal response coefficients for use in PVSyst, based on thermal performance of a subset of the SunPower fleet in which the thermal loss coefficients are aligned with PVsyst.

2.3 Soiling Loss

Soiling and dust impact on PV plant performance may be assessed in a dynamic way using rainfall data, manual washing dates, and information about the local climate and environmental air quality.

Set the annual soiling loss to *1%* for rainy regions and *2%* for dry regions (with a number of washes to be defined).

Appendix A

Incidence Angle Modifier points for E-Series and X-Series modules:

X Series IAM profile

AOI [°]	Recommended setting for PVsyst
0	1.00
10	N/A
20	1.00
30	1.00
40	1.00
50	1.00
60	0.99
70	0.94
80	0.78
90	0.00

E Series IAM Profile

AOI [°]	Recommended setting for PVsyst
0	1.00
10	N/A
20	1.00
30	1.00
40	1.00
50	1.00
60	1.00
70	0.96
80	0.80
90	0.00