



# Module-Related Parameters for PVsyst<sup>1</sup> Simulations of PV Systems Constructed with FS Series 4 PV Modules<sup>2</sup>

## Purpose

This document provides users of PV system simulation software PVsyst with recommended module-specific settings and parameter values used when performing a simulation of a PV system constructed with First Solar Series 4 PV modules. The simulation results for a PV system's output depend upon simulated project location, meteorological inputs, system design parameters, and global software preferences.

This document describes the configuration of PVsyst module-related parameters recommended by First Solar to most accurately represent the performance of the module based on module characterization testing and observed field performance. First Solar recommends that this configuration of module-related parameters in PVsyst be used when simulating the operation of PV systems in most locations which utilize First Solar PV modules.

## Scope

This configuration is designed to work with the recommended parametric descriptions of First Solar PV modules described in the associated "Recommended Parametric Descriptions of First Solar PV Modules for Use with PVsyst" Application Note documents PD-5-301-04 MS (Series 4), PD-5-301-04-2 MS (Series 4V2), and PD-5-301-04-3 MS (Series 4V3).

## Results

The various settings and values indicated in this document were used to configure PVsyst in preparation for simulating a variety of actual grid-tied PV systems constructed with First Solar PV modules and located in various global climates.

Preferences		
Category	Parameter	Value or Setting
Physical Models	Irradiation Transposition Model	User-Defined (Hay vs. Perez model choice independent of module technology)

**Table 1.** Recommended configuration of PVsyst preferences menu settings for simulation of PV systems constructed with First Solar PV modules.

<sup>1</sup> PVsyst is a commercial software product for the simulation of PV systems. For more information, visit [www.pvsyst.com](http://www.pvsyst.com). This document is intended for use with PVsyst Versions 4.46 and higher.

<sup>2</sup> This includes Series 4 (Example: FS-4100/FS-4100A), Series 4v2 (Example: FS-4110-2/FS-4110A-2), Series 4v3 (Example: FS-4115-3/FS-4115A-3).

Category	Parameter	Unit	Value or Setting
Thermal Parameters <sup>3</sup>	Constant loss factor $K_c$	W/m <sup>2</sup> -K	30.7
	Wind loss factor $K_v$	W/m <sup>2</sup> -K/m/s	0.0
Module Quality-LID-Mismatch	Module Quality <sup>4</sup>	%	0.0
	LID – Light Induced Degradation <sup>5</sup>	%	0.0
	Power Loss at MPP	%	1.0
	Loss when running at fixed voltage	%	0.0
Soiling	Select User defined profile Yearly soiling loss factor	[unit less]%	Site Specific Input
Spectral Loss <sup>6</sup>	Monthly spectral shift factor <sup>6</sup>	%	Use First Solar PD-5-423 EX spectral shift calculator and insert resulting values (Typically -1% to +5% as derived from local meteo data)
IAM Losses <sup>7</sup>	bo	[unit less]	Defined in module file

**Table 2.** Recommended configuration of PVsyst loss settings for simulation of PV systems constructed with First Solar PV modules.

<sup>3</sup> The thermal parameters shown here are representative for a free-field installation. For roof-top installation parameters will depend on mounting height, roof material and orientation.

W. Hayes, A. F. Panchula, and L. Nelson, "Thermal Modeling Accuracy of Hourly Averaged Data for Large Free Field Cadmium Telluride PV Arrays," *38th IEEE Photovoltaic Specialists Conference*, 2012, pp. 1-4.

<sup>4</sup> Module power is measured for 100% of modules on production line simulator and then derated to ensure nameplate power represents stabilized initial field power output. All modules are delivered with a module data report which includes initial out-of-box power plus-sorted at -0/+2.49W, so a conservative estimation of module quality loss is therefore 0%. See PD-5-800 Product Bins and Distribution. The module quality term can also be modified to represent losses that are not explicitly defined in PVsyst, such as DC health or additional spectral correction (see PD-5-423).

<sup>5</sup> First Solar thin-film CdTe modules do not exhibit the Light Induced Degradation mechanism of 1-4% common to many crystalline silicon PV modules. Rather, a different mechanism results in a short initial stabilization period where power output can be more highly variable due to metastability of the thin-film device. See note 4.

<sup>6</sup> First Solar PV modules are rated under Standard Test Conditions (STC) assuming a spectral distribution as defined by ASTM G173 for an Air Mass of 1.5. Site specific spectral irradiance will deviate from STC, resulting in varying performance with regard to module nameplate. This phenomena can result in a loss of energy or a gain of energy and is well approximated using the precipitable water content of the atmosphere. For details on how to calculate monthly spectral loss factors for the purpose of input into energy predictions see PD-5-423, "Module Characterization: Energy Prediction Adjustment for Local Spectrum".

L. Nelson, M. Frichtl, and A. Panchula, "Changes in cadmium telluride photovoltaic performance due to spectrum," *IEEE Journal of Photovoltaics*, vol. 3, No. 1, pp. 488-493, 2013.

<sup>7</sup> In PVsyst release 6 and later, IAM losses can be specified either in a PV module's definition or in the *Detailed Losses* dialog of PVsyst. If IAM losses are specified in the module definition, ensure the box 'Uses definition of the PV Module' is checked the *IAM Losses* tab of the *Detailed Losses* dialog. PVsyst .PAN files supplied by First Solar after May 2014 include the correct user-defined IAM losses. Users of PVsyst versions earlier than 6.0 must enter the IAM response values from document PD-5-422 in the *Detailed Losses* dialog, as this feature of PVsyst 6 is not backwards compatible.

Module Plus Tracker			
Category	Parameter	Unit	Value or Setting
Tracker Orientation	Axis Tilt	degrees	0
	Phi Min/Max (min/max tracking angle)	degrees	Dependent on chosen structure
	Backtracking	Yes/No	No (unchecked)

**Table 3.** Additional recommended configuration of PVsyst settings for simulation of PV tracking systems.

### Multi-Year Energy Prediction

The PV simulation software PVsyst operates on meteorological datasets of one-year length. For each hour in the year, the software determines the energy generated by the PV system. The total energy over the year is then summed to determine the annual energy yield of the system. Common losses in the system, such as ohmic losses in wiring, mismatch losses, and adjustments for module quality are treated as constants.

At this time, PVsyst does not allow the user to define time-dependent loss factors, apart from those defined by the operating environment of the PV system (such as soiling losses and shading losses).

To address long-term performance changes in multi-year energy prediction, modeling the warranty degradation levels (-0.5%/year DC power degradation rate beginning in year 2) would be conservative. (Note: The warranted degradation rate is established based on aggressive hot climate applications and induces buffer to account for statistical distributions.) The expected (guidance) DC power degradation rate is influenced by climate and application type and can be modeled at a lower rate than the warranted rate.