IPCT SAS IoT Platform Guide

Control Panel

In the following table, you can introduce your desired parameters. Follow the guidelines.

SOLAR ARRAY SIMULATOR - CONTROL PANEL				
INPUT		**VALUE**	**UNIT**	**GUIDELINES**
Update		1		If you want to change multiple inputs at once, set this to 0 until all the changes are made.
Start/Stop		1		Must be either 0 = Stop or 1 = Start.
Solar panel	PV	1		Must be a value **between 1 and 5.** See Table 1 for reference.
Array Rows	Ns	2		Ns and Np must be positive integers. The **product** of Ns and Np must be **equal to or less than 6.**
Array Columns	Np	3		
Irradiance	G	1365	W/m²	Must be a value **between 0 and 1375.**
Temperature	T	30.00	°C	Must be a value **between -80 and 80.**
Incidence Angle	θ	0.00	°	Must be a value **between 0 and 90.**
Control Variable	CV	0	V	Must be either 0 = Voltage or 1 = Current.
Control Variable Value	CVV	5.25	V	Must be a **positive** value **equal to or less than** the **maximum voltage or current** in Table 1.

In the following table, you can check what is the maximum voltage or current value you can introduce with your current inputs.

Table 1: Solar panels and their maximum ratings*.

Solar panel	Value	Max. Voltage (V)	Max. Current (A)
AZUR 3G30A	1	5.37	1.49
AZUR 4G32C	2	6.67	1.36
CESI CTJ30	3	5.12	1.42
Spectrolab UTJ	4	5.30	1.66
<New solar panel>**	5	0.00	0.00

In one or more of the inputs you introduced are invalid, the platform will notify you which are causing problems and the platforms won't be able to receive any parameters until they are corrected.

There are problems with your inputs that need to be fixed before any updates can be applied!

INPUT		VALUE	UNIT	GUIDELINES
Update		-1		If you want to change multiple inputs at once, set this to 0 until all the changes are made.
Start/Stop		2		Must be either 0 = Stop or 1 = Start.
Solar panel	PV	6		Must be a value **between 1 and 5.** See Table 1 for reference.
Array Rows	Ns	-1		Ns and Np must be positive integers. The **product** of Ns and Np must be **equal to or less than 6.**
Array Columns	Np	8.5		
Irradiance	G	1800	W/m²	Must be a value **between 0 and 1375.**
Temperature	T	343.00	°C	Must be a value **between -80 and 80.**
Incidence Angle	θ	91.00	°	Must be a value **between 0 and 90.**
Control Variable	CV	2	V	Must be either 0 = Voltage or 1 = Current.
Control Variable Value	CVV	-6.00	V	Must be a **positive** value **equal to or less than** the **maximum voltage or current** in Table 1.

In the second sheet, you can check and / or modify parameters of four known solar panel. You can also add the parameters of one new panel and use it.

Parameter	Symbol	Unit	AZUR 3G30A	AZUR 4G32C	CESI CTJ30	Spectrolab UTJ	<New solar panel>
Panel efficiency	η	%	30	32	29.5	28.3	
Cell temperature at ref. conditions	Tc,ref	°C	28	25	25	28	
Solar irradiance at ref. conditions	Gref	W/m²	1367	1367	1367	1353	
Open Circuit Voltage	Voc	V	2.699	3.375	2.6	2.66	
Short Circuit Current	Isc	A	0.496	0.455	0.473	0.548	
MPP Voltage	Vmp	V	2.387	2.919	2.306	2.335	
MPP Current	Imp	A	0.487	0.434	0.459	0.52	
MPP Power	Pmp	W	1.162	1.266	1.06	1.214	
Number of cells in series (in a single solar panel)	Ns,cell		1	1	1	1	
Voc temperature coefficient	KVoc	V/°C	-6.20E-03	-8.40E-03	-8.40E-03	-5.90E-03	
Isc temperature coefficient	KIsc	A/°C	3.60E-04	7.00E-05	7.00E-05	3.80E-05	
Band gap	Eg	eV	1.6	1.6	1.6	1.6	
Diode ideality factor	n		1.23	1.99	1.99	1.99	
Photoelectric current	Iph	A	0.496	0.4562	0.4731	0.549	
Diode inverse saturation current	Io	A	9.44E-38	9.45E-30	3.86E-23	2.26E-23	
Series resistance	Rs	Ω	0.3555	0.5705	0.2132	0.2408	
Shunt resistance	Rsh	Ω	996.98	207.91	677.7	138.29	
Root-Mean-Squared-Error	RMSE		0.0021	0.01537	0.00919	0.0084	

Database

The logs are saved automatically in the database, monitoring up to 24 different values, plus the date and time. Google Sheets allows for a maximum of 5 millions cells per workbook, so, theoretically, you save upwards to 192000 logs before running out of space.

Date	Time	PV	Ns	Np	G	T	θ	CV	Vcalc	Vmeas	Icalc	Imeas	Pcalc	Pmeas	Rcalc	Rmeas	Err V	Err I	Err P	Err R	n	Iph	Io	Rs	Rsh
10/11/2023	20:37:57	1	2	1	1367	28	0	0	4.78000	4.77198	0.48642	0.48854	2.32510	2.33130	9.82686	9.76783	0.16776	0.43542	0.26693	0.60065	1.23	0.496000	9.44E-38	0.36	996.98
10/11/2023	20:38:01	1	2	1	1367	28	0	0	4.78000	4.77238	0.48642	0.48849	2.32510	2.33128	9.82686	9.77234	0.15937	0.42576	0.26571	0.55482	1.23	0.496000	9.44E-38	0.36	996.98
10/11/2023	20:38:06	1	2	1	1367	28	0	0	4.78000	4.77223	0.48642	0.48868	2.32510	2.33208	9.82686	9.75671	0.16247	0.46338	0.30016	0.71382	1.23	0.496000	9.44E-38	0.36	996.98
10/11/2023	20:38:13	1	2	1	1367	28	0	0	4.78000	4.77346	0.48642	0.48876	2.32510	2.33306	9.82686	9.76656	0.13678	0.47983	0.34239	0.61359	1.23	0.496000	9.44E-38	0.36	996.98
10/11/2023	20:38:31	1	2	1	1367	28	2.5	0	4.78000	4.77562	0.48595	0.48851	2.32285	2.33293	9.83634	9.76879	0.09155	0.52580	0.43377	0.68680	1.23	0.495528	9.44E-38	0.36	997.93
10/11/2023	20:38:35	1	2	1	1367	28	2.5	0	4.78000	4.77182	0.48595	0.48849	2.32285	2.33096	9.83634	9.77368	0.17115	0.52107	0.34902	0.63709	1.23	0.495528	9.44E-38	0.36	997.93
10/11/2023	20:38:40	1	2	1	1367	28	2.5	0	4.78000	4.77828	0.48595	0.48852	2.32285	2.33427	9.83634	9.78120	0.03609	0.52765	0.49137	0.56067	1.23	0.495528	9.44E-38	0.36	997.93
10/11/2023	20:38:45	1	2	1	1367	28	2.5	0	4.78000	4.77748	0.48595	0.48883	2.32285	2.33536	9.83634	9.77334	0.05282	0.59165	0.53851	0.64058	1.23	0.495528	9.44E-38	0.36	997.93
10/11/2023	20:39:02	1	2	1	1367	28	5	0	4.78000	4.76739	0.48455	0.48648	2.31613	2.31922	9.86490	9.79987	0.26379	0.39804	0.13320	0.65922	1.23	0.494113	9.44E-38	0.36	1000.79
10/11/2023	20:39:06	1	2	1	1367	28	5	0	4.78000	4.76912	0.48455	0.48655	2.31613	2.32040	9.86490	9.80322	0.22755	0.41290	0.18441	0.62527	1.23	0.494113	9.44E-38	0.36	1000.79
10/11/2023	20:39:13	1	2	1	1367	28	5	0	4.78000	4.77324	0.48455	0.48658	2.31613	2.32256	9.86490	9.80846	0.14142	0.41950	0.27749	0.57209	1.23	0.494113	9.44E-38	0.36	1000.79
10/11/2023	20:39:17	1	2	1	1367	28	5	0	4.78000	4.77135	0.48455	0.48655	2.31613	2.32148	9.86490	9.80655	0.18107	0.41290	0.23108	0.59149	1.23	0.494113	9.44E-38	0.36	1000.79
10/11/2023	20:39:36	1	2	1	1367	28	7.5	0	4.78000	4.77371	0.48221	0.48460	2.30494	2.31335	9.91280	9.85081	0.13151	0.49687	0.36471	0.62528	1.23	0.491757	9.44E-38	0.36	1005.58
10/11/2023	20:39:42	1	2	1	1367	28	7.5	0	4.78000	4.77650	0.48221	0.48465	2.30494	2.31492	9.91280	9.85558	0.07326	0.50683	0.43319	0.57716	1.23	0.491757	9.44E-38	0.36	1005.58
10/11/2023	20:39:47	1	2	1	1367	28	7.5	0	4.78000	4.77586	0.48221	0.48453	2.30494	2.31404	9.91280	9.85670	0.08657	0.48194	0.39496	0.56587	1.23	0.491757	9.44E-38	0.36	1005.58
10/11/2023	20:40:05	1	2	1	1367	28	10	0	4.78000	4.76739	0.47893	0.48053	2.28930	2.29089	9.98051	9.92102	0.26379	0.33417	0.06950	0.59601	1.23	0.488465	9.44E-38	0.36	1012.36
10/11/2023	20:40:10	1	2	1	1367	28	10	0	4.78000	4.76824	0.47893	0.48064	2.28930	2.29179	9.98051	9.92064	0.24613	0.35588	0.10888	0.59982	1.23	0.488465	9.44E-38	0.36	1012.36
10/11/2023	20:40:15	1	2	1	1367	28	10	0	4.78000	4.76665	0.47893	0.48079	2.28930	2.29175	9.98051	9.91422	0.27929	0.38741	0.10704	0.66421	1.23	0.488465	9.44E-38	0.36	1012.36
10/11/2023	20:40:21	1	2	1	1367	28	10	0	4.78000	4.76784	0.47893	0.48083	2.28930	2.29251	9.98051	9.91586	0.25448	0.39576	0.14028	0.64774	1.23	0.488465	9.44E-38	0.36	1012.36
10/11/2023	20:40:39	1	2	1	1367	28	12.5	0	4.78000	4.76856	0.47474	0.47655	2.26925	2.27244	10.06871	10.00649	0.23933	0.38103	0.14079	0.61800	1.23	0.484243	9.44E-38	0.36	1021.19
10/11/2023	20:40:43	1	2	1	1367	28	12.5	0	4.78000	4.76659	0.47474	0.47644	2.26925	2.27101	10.06871	10.00453	0.28052	0.35912	0.07759	0.63744	1.23	0.484243	9.44E-38	0.36	1021.19
10/11/2023	20:40:48	1	2	1	1367	28	12.5	0	4.78000	4.76837	0.47474	0.47663	2.26925	2.27273	10.06871	10.00338	0.24333	0.39788	0.15359	0.64882	1.23	0.484243	9.44E-38	0.36	1021.19

Visualization Panel

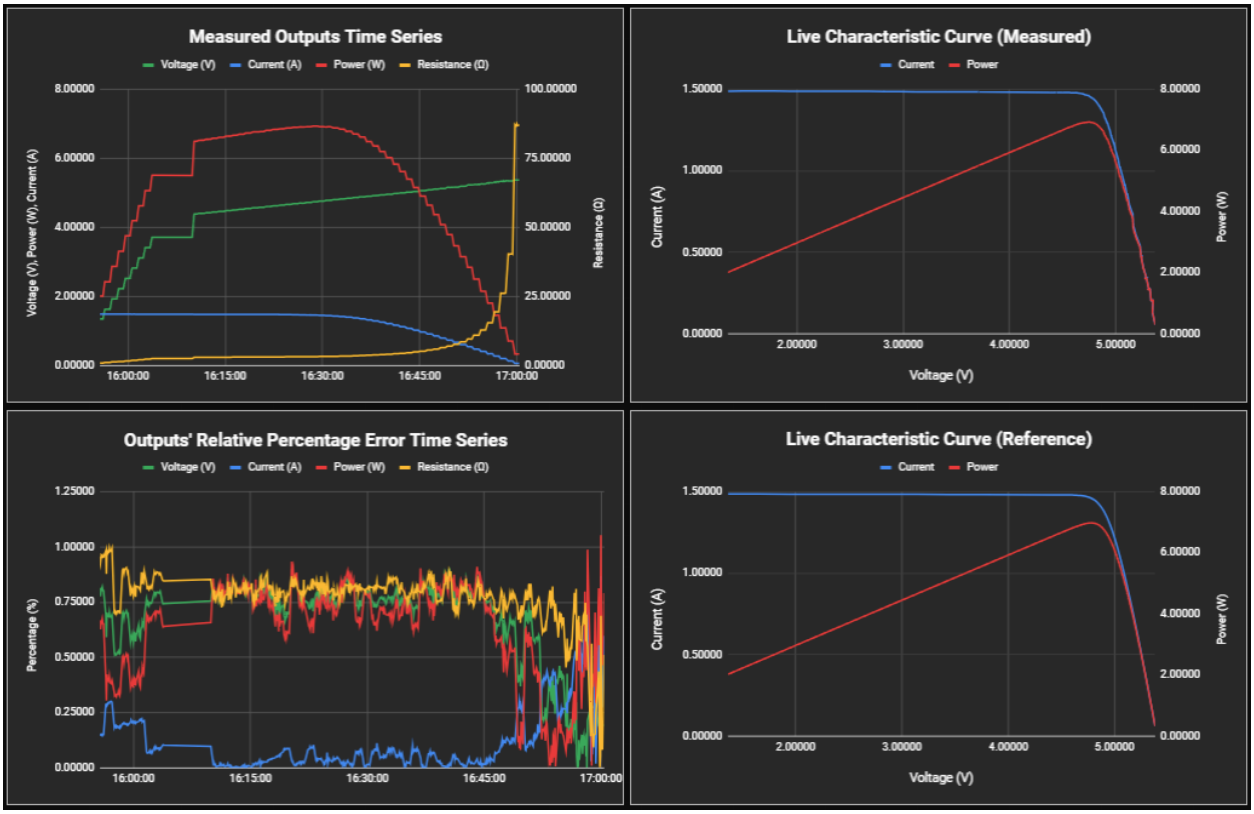
The following table allows you to see the last logged values in multiple parameters, the time between the first and last logs, and an error analysis of all the logs.

Time elapsed		00 h, 19 min, 23 s	
INPUT		**LKV**	**UNIT**
Solar Panel	PV	AZUR 3G30A	
Array dimensions	N_s x N_p	2 x 1	
Irradiance	G	1367.00	W/m²
Temperature	T	28.00	°C
Incidence Angle	θ	87.50	°
Control Variable	CV	Voltage	V
OUTPUT		**LKV**	**UNIT**
Calculated Voltage	V_{calc}	4.58000	V
Measured Voltage	V_{meas}	4.57556	V
Calculated Current	I_{calc}	0.02122	A
Measured Current	I_{meas}	0.02098	A
Calculated Power	P_{calc}	0.09720	W
Measured Power	P_{meas}	0.09600	W
Diode Ideality factor	n	1.23000	
Photoelectric current	I_{ph}	0.02164	A
Saturation current	I_o	9.44E-38	A
Series resistance	R_s	8.150	Ω
Shunt resistance	R_{sh}	22856.350	Ω

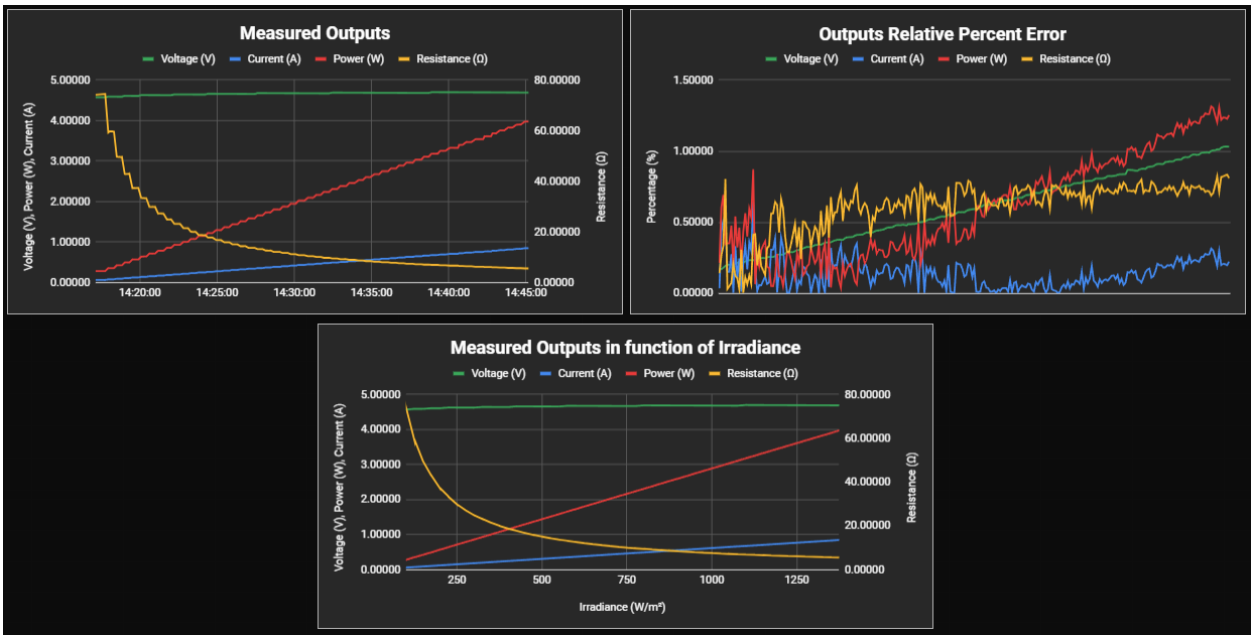
OUTPUT ERRORS	MAXIMUM	MAPE	UNIT
Voltage	0.618	0.244	%
Current	1.888	0.415	%
Power	1.984	0.426	%
Resistance	2.254	0.588	%
MEAN MAPE		0.418	%

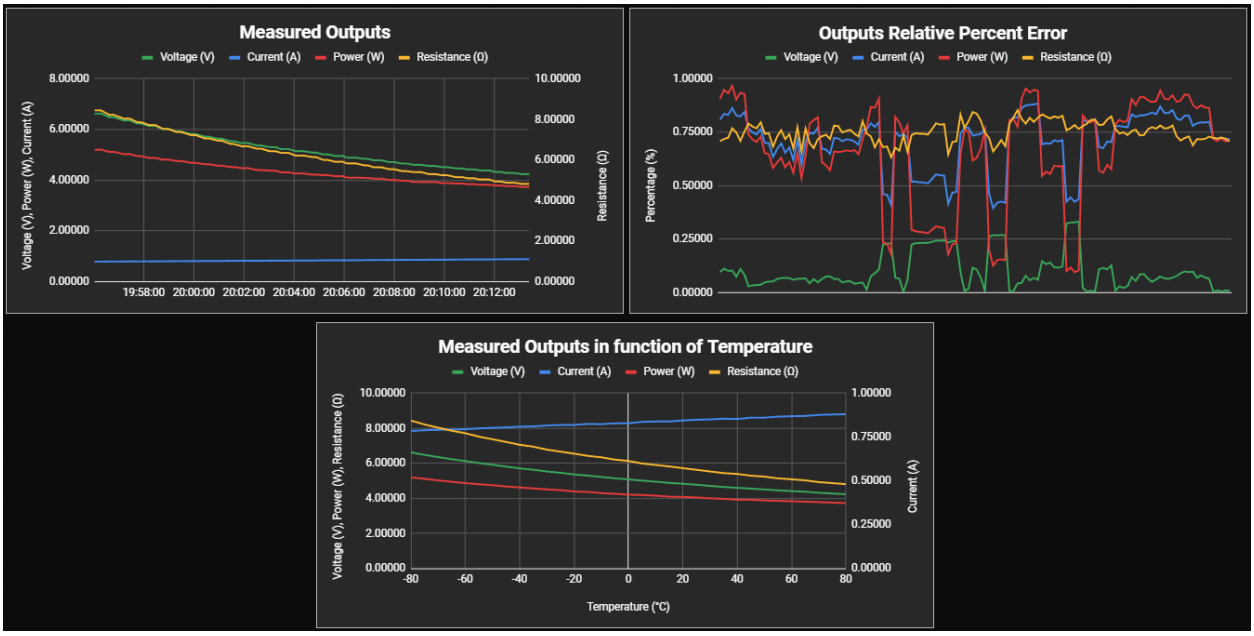
LKV = Last Known Value
MAPE = Mean Absolute Percentage Error

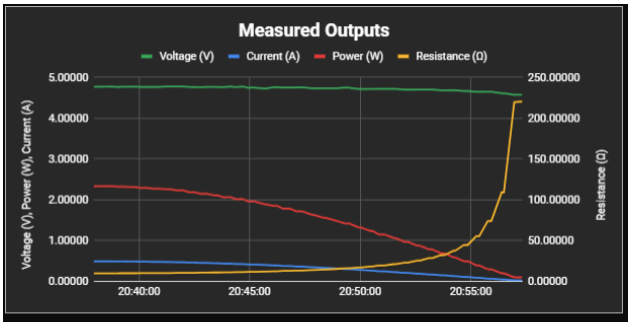
There are plots that allow you to see the change in the outputs in function of time, as well as the associated errors. There are also plots that monitor the change in current and power in function of the voltage, allowing to see real-time characteristic curves.

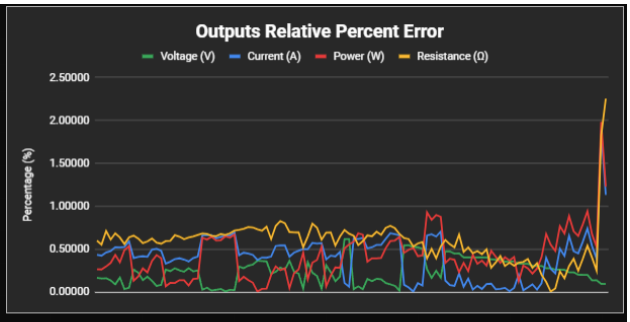


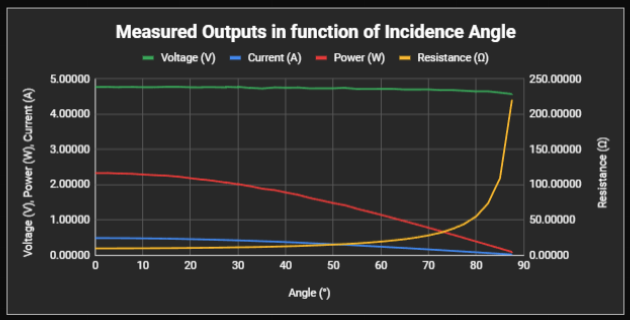
There are other plots that allow you to see how the outputs change in function of the external conditions (irradiance, cell temperature and incidence angle).






Measured Outputs
Voltage (V)
Current (A)
Power (W)
Resistance (Ω)
Voltage (V), Power (W), Current (A)
Resistance (Ω)
5.00000
4.00000
3.00000
2.00000
1.00000
0.00000
250.00000
200.00000
150.00000
100.00000
50.00000
0.00000
20:40:00
20:45:00
20:50:00
20:55:00


Outputs Relative Percent Error
Voltage (V)
Current (A)
Power (W)
Resistance (Ω)
Percentage (%)
2.50000
2.00000
1.50000
1.00000
0.50000
0.00000


Measured Outputs in function of Incidence Angle
Voltage (V)
Current (A)
Power (W)
Resistance (Ω)
Voltage (V), Power (W), Current (A)
Resistance (Ω)
5.00000
4.00000
3.00000
2.00000
1.00000
0.00000
250.00000
200.00000
150.00000
100.00000
50.00000
0.00000
0
10
20
30
40
50
60
70
80
90
Angle (°)