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Performance Report No. 3187515LAX-003
Project No. 3187515

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Module Performance for Models:

54 cell	60 cell	72 cell
CRM190S156P-54	CRM210S156P-60	CRM250S156P-72
CRM200S156P-54	CRM220S156P-60	CRM270S156P-72
CRM220S156P-54	CRM240S156P-60	CRM290S156P-72
	CRM250S156P-60	

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This report has been generated for use by the California Energy Commission to list eligible photovoltaic modules for solar incentive programs in the state of California. The data included in this report is based on tests conducted to the International Electrotechnical Commission (IEC) standards and Energy Commission specifications. The tests were conducted on site at Intertek in Lake Forest California. The results of these tests apply only to the test samples that were submitted to Intertek by the manufacturer. The results have been summarized for brevity.



Testing

Reference CEC-300-2008-007-CMF

1.1 Test Location

All the tests presented in this report were conducted at Intertek, Lake Forest California, USA. Intertek is located at 33.64 deg N latitude, 117.69 deg W longitude and 148 m elevation above sea level. Intertek is an International Laboratory Accreditation Cooperation (ILAC) accredited laboratory either directly by association of mutual recognition arrangements with A2LA.

1.2 Test Items

The test modules for this program were supplied by the client. Upon receipt of the modules, Intertek conducts an incoming visual inspection of the modules. No significant visual defects or signs of shipping damage were observed on any of the samples.

Total number of modules received.....32
Date of receipt.....August 31, 2009

1.3 Test Equipment

Intertek conducts tests using instruments that have been calibrated at the National Laboratories or the calibration laboratories accredited by the American Association for Laboratory Accreditation (A2LA), or by other laboratories through mutual recognition arrangements of the International Laboratory Accreditation Cooperation (ILAC). All Intertek instruments used for this test program were in calibration at the time of test.

1.4 Electrical Test Results

Intertek conducts all electrical performance evaluations using natural sunlight, a solar simulator, calibrated secondary reference modules, an IV curve tracer and various other weather data collection instruments. Table 2.2 presents the electrical performance data for three modules under three different test conditions – STC (standard test conditions), NOCT (nominal operating cell temperature) and low irradiance. “STC” refers to 1000 W/m² irradiance, 25°C cell temperature and AM 1.5G spectrum. “NOCT” refers to 800 W/m² irradiance, 20°C ambient temperature and 1 m/s wind speed. “Low irradiance” refers to 200 W/m² irradiance and 25°C cell temperature.

Table 1.1: Manufacturer Supplied Electrical Performance Data

Model	I _{sc} (A)	V _{oc} (V)	P _{mp} (W)	I _{mp} (A)	V _{mp} (V)
CRM190S156P-54	7.96	32.50	190	7.41	25.60
CRM200S156P-54	8.14	33.00	200	7.55	26.50
CRM220S156P-54	8.41	33.90	220	7.95	27.60
CRM210S156P-60	7.97	36.10	210	7.42	28.30
CRM220S156P-60	8.12	36.60	220	7.53	29.20
CRM240S156P-60	8.38	37.50	240	7.92	30.30
CRM250S156P-60	8.48	37.90	250	8.05	31.10
CRM250S156P-72	7.96	43.30	250	7.39	33.80
CRM270S156P-72	8.18	44.30	270	7.63	35.40
CRM290S156P-72	8.41	45.10	290	7.91	36.70



Results

2.1 Nominal Operating Cell Temperature (NOCT) procedure – Open Rack/roof BIPV

Reference IEC 61215 section 10.5 / CEC NSHP Appendix 3-A

Two cells are identified near the middle of the module as test cells. A J-type thermocouple is centered behind the selected cells and affixed to the surface of the back side of the module with thermally conductive adhesive in order to determine the module's cell temperature. On a suitable, clear, sunny day with little wind, from the morning to the afternoon, the modules are mounted open-circuited with the radiometer co-planar and positioned so that they are tilted $45^{\circ} \pm 5^{\circ}$ to the horizontal with the front side pointed toward the equator. Temperatures of the two cells for each test module (T_j), the ambient temperature (T_a), the irradiance, and the wind speed and direction are collected at 20-second intervals. Data collected with wind speeds less than 0.25 and greater than 1.75 m/s, a period of ten minutes after wind speeds greater than 4m/s, a period of 10 minutes after irradiance varies by more than 10%, and wind direction within $\pm 20^{\circ}$ of east or west are rejected. This procedure is repeated for two additional days and the average of the three days of temperatures is reported as NOCT.

BIPV Test Bed (rooftop)

The following are specifications for Intertek NOCT test bed for roofing component Building Integrated Photovoltaic (BIPV) modules.

Tilt angle: 23° to horizontal (5:12 roof pitch) instead of the $45^{\circ} \pm 5^{\circ}$.

Configuration: Test modules were placed in the middle of an array that is at least four feet high and four feet wide. The array is surrounded on all sides with a minimum of three feet of the building system for which the BIPV system is designed to be compatible (see Figure 2.1), and the entire assembly was installed and sealed as specified by the manufacturer for a normal installation.

Substrate and Underlayment: The rooftop is made of oriented strand board with a thickness of 15/32 inch that is covered by #30 roofing felt with a minimum R-10 continuous insulation under and in contact with the oriented strand board

Special manufacturer-recommended underlayment: None.



Figure 2.1: Measurement of NOCT On Sun



Table 2.1 NOCT Test Data

Date	Average Temp (°C)	Average Wind Speed (m/s)	Average Irradiance (W/m ²)	Ambient Temp Correction Factor (°C)	Wind Speed Correction Factor (°C)
11/20/2009	19.7	1.1	834	20	0
11/22/2009	18.9	1.0	798	20	0
11/23/2009	22.0	1.0	793	20	0
11/24/2009	24.3	1.0	841	20	0
11/25/2009	27.0	0.9	834	20	0
11/26/2009	26.1	1.1	811	20	1
12/08/2009	11.2	1.0	840	20	-1
12/09/2009	13.4	1.0	873	20	0
12/23/2009	16.6	1.2	818	20	0



Table 2.2 NOCT Value

Model	3 Day NOCT Average
CRM190S156P-54	48.3
CRM200S156P-54	47.0
CRM220S156P-54	47.0
CRM210S156P-60	45.5
CRM220S156P-60	46.3
CRM240S156P-60	46.3
CRM250S156P-60	45.9
CRM250S156P-72	47.6
CRM270S156P-72	46.6
CRM290S156P-72	46.6

Table 2.3: Performance at STC

reference IEC 60904-10, IEC 61215 section 10.2 and 10.6

Model	I _{sc} (A)	V _{oc} (V)	P _{mp} (W)	I _{mp} (A)	V _{mp} (V)
CRM190S156P-54	8.01	33.01	194.5	7.60	25.60
CRM200S156P-54	7.67	33.44	186.5	7.01	26.59
CRM220S156P-54	8.30	33.64	203.0	7.57	26.81
CRM210S156P-60	7.78	36.92	206.7	6.87	30.04
CRM220S156P-60	7.97	35.99	209.4	7.53	27.81
CRM240S156P-60	8.26	37.44	227.2	7.79	29.19
CRM250S156P-60	8.42	36.98	228.6	8.06	28.38
CRM250S156P-72	7.53	43.70	243.3	6.98	34.81
CRM270S156P-72	7.74	44.67	252.3	7.17	35.20
CRM290S156P-72	8.10	45.63	278.2	7.72	36.02

Table 2.4: Temperature Coefficients

reference IEC 60904-10, IEC 61215 section 10.4

Model	$\alpha_{I_{sc}}$ %/°C	$\beta_{V_{oc}}$ %/°C	$\gamma_{P_{mp}}$ %/°C	$\alpha_{I_{mp}}$ %/°C	$\beta_{V_{mp}}$ %/°C
CRM190S156P-54	0.125	-0.349	-0.457	0.044	-0.497
CRM200S156P-54	0.117	-0.395	-0.507	0.145	-0.623
CRM220S156P-54	0.059	-0.372	-0.503	0.117	-0.600
CRM210S156P-60	0.136	-0.372	-0.443	0.182	-0.596
CRM220S156P-60	0.076	-0.357	-0.481	0.071	-0.541
CRM240S156P-60	0.091	-0.397	-0.548	-0.031	-0.525
CRM250S156P-60	0.104	-0.343	-0.462	-0.018	-0.448
CRM250S156P-72	0.121	-0.371	-0.483	0.148	-0.604
CRM270S156P-72	0.115	-0.364	-0.487	0.062	-0.538
CRM290S156P-72	0.122	-0.370	-0.495	0.023	-0.515



Table 2.5: Performance at NOCT
reference IEC 60904-10, IEC 61215 section 10.6

Model	I _{sc} (A)	V _{oc} (V)	P _{mp} (W)	I _{mp} (A)	V _{mp} (V)
CRM190S156P-54	6.73	29.70	142.0	6.32	22.47
CRM200S156P-54	6.40	30.01	135.6	5.83	23.28
CRM220S156P-54	6.86	30.40	150.0	6.50	23.14
CRM210S156P-60	6.48	33.55	155.0	6.04	25.69
CRM220S156P-60	6.53	32.83	154.3	6.13	25.18
CRM240S156P-60	6.76	33.79	165.3	6.41	25.79
CRM250S156P-60	6.94	33.91	170.7	6.51	25.86
CRM250S156P-72	6.29	38.77	174.2	5.88	29.61
CRM270S156P-72	6.44	39.87	181.7	6.01	30.22
CRM290S156P-72	6.78	40.88	201.4	6.39	31.51

Table 2.6: Performance at Low Irradiance
reference IEC 60904-10, IEC 61215 section 10.7

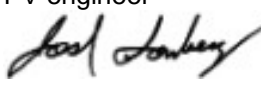
Model	I _{sc} (A)	V _{oc} (V)	P _{mp} (W)	I _{mp} (A)	V _{mp} (V)
CRM190S156P-54	1.70	30.34	40.1	1.56	25.61
CRM200S156P-54	1.61	30.46	37.7	1.47	25.63
CRM220S156P-54	1.84	30.99	44.6	1.69	26.38
CRM210S156P-54	1.73	33.79	45.1	1.61	28.03
CRM220S156P-60	1.76	33.25	45.3	1.61	28.24
CRM240S156P-60	1.78	34.40	46.0	1.58	29.13
CRM250S156P-60	1.83	34.43	50.9	1.72	29.63
CRM250S156P-72	1.61	39.57	48.7	1.45	33.56
CRM270S156P-72	1.61	40.67	51.2	1.51	33.95
CRM290S156P-72	1.79	41.49	58.4	1.66	35.31


Uncertainty for Measurement of P_{mp}:
SDC: X Wm⁻² +/- 4.1% (of Reading)

Report Approval

If there are any questions regarding the results contained in this report, or any of the other services offered by Intertek, please do not hesitate to contact the undersigned.

Please note; this Performance Report does not represent authorization for the use of any Intertek certification marks.

Completed by: Josh Somberg
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Signature: 
Date: December 30, 2009

Reviewed by: Bruce Smith
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Date: December 30, 2009

-----End of Report-----

