



September 27, 2016,

BLUEBIRD SOLAR PVT. LTD.

Plot No. 5, Ecotech - II, Udyog Vihar, Udyog Vihar,
Greated Noida, Uttar Pradesh 201306, India

Reference: File E483105 Project 4787344312.3.1

Subject: Letter Report for CEC/CSI PV module Performance Testing for Cat.no.

BBS300, BBS290, BBS250, BBS240, BB220, BBS210, BBS200 and BBS190.

Dear Mr. Abhay Mittal,

Samples of the subject product were tested at UL in accordance with the requirements of CEC-300-2012-008-CMF –GUIDELINES FOR CALIFORNIA'S SOLAR ELECTRIC INCENTIVE PROGRAMS PURSUANT TO SENATE BILL 1 - Edition 5 - Issue Date January 2013 and IEC standard 61215 - Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval, 2nd Edition.

The testing was conducted on the below model to evaluate the performance of this module. This represents the below models

Model number	Max Power (Watts)
BBS300, BBS290	300
BBS250, BBS240	250
BBS220, BBS210	220
BBS200, BBS190	200

The following Serial numbers were tested:

Model number	Serial number
BBS300	BBS6F72P160230007
BBS250	BBS6F60P160250004
BBS220	BBS6F54P160250003
BBS200	BBS6F48P160250004

MODEL DIFFERENCES:

All models are similar in construction, but differ in output voltage, power and current ratings and number of cells.



Testing of the above models was considered as the representation of the whole series based on the fact that the power output is within the 5% range of already listed photovoltaic modules of this series.

The sample model BBS300 submitted for CEC testing was constructed using the following components:

Construction Item	Information
1. Superstrate	Glass Manufactured by Gujarat Borosil, type "Low Iron tempered and textured Glass", 3.2 mm thick.
2. Encapsulant	R/C(QMFZ2), (E310488) Ethyl-Vinyl-acetate (EVA), manufactured by Specialized Technology Resources Inc. type "15580P(a)" 0.45 mm thick sheet of clear EVA provided in the module, provided on top and bottom of cells
3. Substrate	R/C(QIHE2), (E313506) 3 layer composite backsheets material (PET/PET/EVA), type "Dymat PYE SPV", white, manufactured by Coveme SPA, OuterLayer(Melinex 243 PV is PET. Rated RTI= 105°C, overall thickness is 0.295mm
4. Cell	Manufactured by MING HWEI ENERGY.(Taiwan), Type MHE-3BB Multi crystalline Solar Cell.
5. Number of cells	72
6. Number of strings	3
7. Tabbing	solder plated Copper Ribbon, 0.18 x 1.7 mm used for cell to cell connections, 3 bus strips in parallel End ribbons – to connect the string connection to the junction box. Solder plated copper ribbons of 5.0 mm wide, 0.3 mm thick minimum
8. Junction box	R/C(QIJB2),(E312261) type PV-RH701L6aQVIlf3, Manufactured by ZHEJIANG RENHE PHOTOVOLTAIC TECHNOLOGY CO LTD, Rated 1000 Vdc, 16A max.
9. Module size	Overall dimension: 1954 mm x 989 mm x 40 mm

The sample model BBS250 submitted for CEC testing was constructed using the following components:

Construction Item	Information
1. Superstrate	Glass Manufactured by Gujarat Borosil, type "Low Iron tempered and textured Glass", 3.2 mm thick.
2. Encapsulant	R/C(QMFZ2), (E310488) Ethyl-Vinyl-acetate (EVA), manufactured by Specialized Technology Resources Inc. type "15580P(a)" 0.45 mm thick sheet of clear EVA provided in the module, provided on top and bottom of cells
3. Substrate	R/C(QIHE2), (E313506) 3 layer composite backsheets material (PET/PET/EVA), type "Dymat PYE SPV", white, manufactured by Coveme SPA, OuterLayer(Melinex 243 PV is PET. Rated RTI= 105°C, overall thickness is 0.295mm
4. Cell	Manufactured by MING HWEI ENERGY.(Taiwan), Type MHE-3BB Multi crystalline Solar Cell.
5. Number of cells	60
6. Number of strings	3
7. Tabbing	solder plated Copper Ribbon, 0.18 x 1.7 mm used for cell to cell connections, 3 bus strips in parallel End ribbons – to connect the string connection to the junction box. Solder plated copper ribbons of 5.0 mm wide, 0.3 mm thick minimum
8. Junction box	R/C(QIJB2),(E312261) type PV-RH701L6aQVIlf3, Manufactured by ZHEJIANG RENHE PHOTOVOLTAIC TECHNOLOGY CO LTD, Rated 1000 Vdc, 16A max.
9. Module size	Overall dimension: 1638 mm x 989 mm x 40 mm



The sample model BBS220 submitted for CEC testing was constructed using the following components:

Construction Item	Information
1. Superstrate	Glass Manufactured by Gujarat Borosil, type "Low Iron tempered and textured Glass", 3.2 mm thick.
2. Encapsulant	R/C(QMFZ2), (E310488) Ethyl-Vinyl-acetate (EVA), manufactured by Specialized Technology Resources Inc. type "15580P(a)" 0.45 mm thick sheet of clear EVA provided in the module, provided on top and bottom of cells
3. Substrate	R/C(QIHE2), (E313506) 3 layer composite backsheets material (PET/PET/EVA), type "Dymat PYE SPV", white, manufactured by Coveme SPA, OuterLayer(Melinex 243 PV is PET. Rated RTI= 105°C, overall thickness is 0.295mm
4. Cell	Manufactured by MING HWEI ENERGY.(Taiwan), Type MHE-3BB Multi crystalline Solar Cell.
5. Number of cells	54
6. Number of strings	3
7. Tabbing	solder plated Copper Ribbon, 0.18 x 1.7 mm used for cell to cell connections, 3 bus strips in parallel End ribbons – to connect the string connection to the junction box. Solder plated copper ribbons of 5.0 mm wide, 0.3 mm thick minimum
8. Junction box	R/C(QIJB2),(E312261) type PV-RH701L6aQVIlf3, Manufactured by ZHEJIANG RENHE PHOTOVOLTAIC TECHNOLOGY CO LTD, Rated 1000 Vdc, 16A max.
9. Module size	Overall dimension: 1480 mm x 989 mm x 40 mm

The sample model BBS200 submitted for CEC testing was constructed using the following components:

Construction Item	Information
1. Superstrate	Glass Manufactured by Gujarat Borosil, type "Low Iron tempered and textured Glass", 3.2 mm thick.
2. Encapsulant	R/C(QMFZ2), (E310488) Ethyl-Vinyl-acetate (EVA), manufactured by Specialized Technology Resources Inc. type "15580P(a)" 0.45 mm thick sheet of clear EVA provided in the module, provided on top and bottom of cells
3. Substrate	R/C(QIHE2), (E313506) 3 layer composite backsheets material (PET/PET/EVA), type "Dymat PYE SPV", white, manufactured by Coveme SPA, OuterLayer(Melinex 243 PV is PET. Rated RTI= 105°C, overall thickness is 0.295mm
4. Cell	Manufactured by MING HWEI ENERGY.(Taiwan), Type MHE-3BB Multi crystalline Solar Cell.
5. Number of cells	48
6. Number of strings	3
7. Tabbing	solder plated Copper Ribbon, 0.18 x 1.7 mm used for cell to cell connections, 3 bus strips in parallel End ribbons – to connect the string connection to the junction box. Solder plated copper ribbons of 5.0 mm wide, 0.3 mm thick minimum
8. Junction box	R/C(QIJB2),(E312261) type PV-RH701L6aQVIlf3, Manufactured by ZHEJIANG RENHE PHOTOVOLTAIC TECHNOLOGY CO LTD, Rated 1000 Vdc, 16A max.
9. Module size	Overall dimension: 1324 mm x 989 mm x 40 mm



The following is a summary of the test results:

1. Maximum Power Determination (IEC 61215 Clause 10.2)

Model No. (S/N)	Voc (V)	Vmp (V)	Isc (Amps)	Imp (Amps)	Pmp (W)
BBS300 (BBS6F72P160230007)	45.729	36.931	8.843	8.343	308.120
BBS250 (BBS6F60P160250004)	38.156	30.765	8.896	8.421	259.079
BBS220 (BBS6F54P160250003)	34.293	27.593	8.886	8.452	233.221
BBS200 (BBS6F48P160250004)	30.407	24.415	8.864	8.425	205.696

2. Measurement of Temperature Coefficients (IEC 61215 Clause 10.4)

Model tested (S/N)	BBS300 (BBS6F72P160230007)
Short circuit current (α_s) (%/°C)	0.018
Maximum Power Current (α_m) (%/°C)	-0.026
Open circuit voltage (β_o) (%/°C)	-0.288
Maximum Power Voltage (β_m) (%/°C)	-0.374
Peak (max.) power (δ) (%/°C)	-0.401

Model tested (S/N)	BBS250 (BBS6F60P160250004)
Short circuit current (α_s) (%/°C)	0.026
Maximum Power Current (α_m) (%/°C)	-0.029
Open circuit voltage (β_o) (%/°C)	-0.303
Maximum Power Voltage (β_m) (%/°C)	-0.390
Peak (max.) power (δ) (%/°C)	-0.431

Model tested (S/N)	BBS220 (BBS6F54P160250003)
Short circuit current (α_s) (%/°C)	0.019
Maximum Power Current (α_m) (%/°C)	-0.019
Open circuit voltage (β_o) (%/°C)	-0.284
Maximum Power Voltage (β_m) (%/°C)	-0.369
Peak (max.) power (δ) (%/°C)	-0.404

Model tested (S/N)	BBS200 (BBS6F48P160250004)
Short circuit current (α_s) (%/°C)	0.019
Maximum Power Current (α_m) (%/°C)	-0.016
Open circuit voltage (β_o) (%/°C)	-0.270
Maximum Power Voltage (β_m) (%/°C)	-0.356
Peak (max.) power (δ) (%/°C)	-0.379

3. Measurement of Nominal Operating Cell Temperature (NOCT) (IEC 61215 Clause 10.5)

Model tested (S/N)	BBS300 (BBS6F72P160230007)
Nominal operating cell temperature (NOCT)	47.26



4. Performance at Standard Test Conditions (STC) and NOCT (IEC 61215 Clause 10.6)

TABLE: Performance at STC					
Model No. (S/N)	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmp (W)
BBS300 (BBS6F72P160230007)	45.82	37.41	8.75	8.23	305.65

TABLE: Performance at NOCT					
Model No. (S/N)	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmp (W)
BBS300 (BBS6F72P160230007)	42.32	33.74	7.07	6.61	223.20

TABLE: Performance at STC					
Model No. (S/N)	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmp (W)
BBS250 (BBS6F60P160250004)	38.21	30.87	8.89	8.41	259.62

TABLE: Performance at NOCT					
Model No. (S/N)	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmp (W)
BBS250 (BBS6F60P160250004)	35.40	28.42	7.17	6.72	190.87

TABLE: Performance at STC					
Model No. (S/N)	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmp (W)
BBS220 (BBS6F54P160250003)	34.42	37.74	8.93	8.41	233.26

TABLE: Performance at NOCT					
Model No. (S/N)	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmp (W)
BBS220 (BBS6F54P160250003)	32.03	25.60	7.18	6.78	173.60

TABLE: Performance at STC					
Model No. (S/N)	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmp (W)
BBS200 (BBS6F48P160250004)	30.43	24.29	8.91	8.38	203.51

TABLE: Performance at NOCT					
Model No. (S/N)	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmp (W)
BBS200 (BBS6F48P160250004)	28.23	22.53	7.16	6.71	151.26



5. Performance at Low Irradiance (IEC 61215 Clause 10.7)

Model No.	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmp (W)
BBS300 (BBS6F72P160230007)	42.56	36.25	1.77	1.65	59.71
BBS250 (BBS6F60P160250004)	35.52	29.97	1.80	1.70	51.03
BBS220 (BBS6F54P160250003)	32.00	26.97	1.80	1.70	45.73
BBS200 (BBS6F48P160250004)	28.27	23.71	1.80	1.69	40.12

This completes the work anticipated under Project 4787344312.3.1 and we are closing the project with this letter. You will be invoiced for the charges incurred to date.

Should you have any questions or comments concerning the above, please feel free to contact the undersigned.

Sincerely,

Reviewed by:

Moumita Debnath
Project Engineer
Department: 3015ABNG
E-mail: Moumita.Debnath@ul.com

Ilbong Jeong
Project Engineer
Department:3012BSEO
E-mail: Ilbong.Jeong@ul.com