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WIND PRESSURE TESTING OF CANADIAN SOLAR PHOTOVOLTAIC MODULES

ACE REFERENCE: 20-0325.01, REV: 01

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Canadian Solar MSS (Australia) Pty Ltd

Attention: Rebecca Hinchliffe
Mobile: 0432 391 932
Address: 44 Stephenson Street, Cremorne, Vic 3121
Email: rebecca.hinchliffe@canadiansolar.com

RE: Canadian Solar: CS3L-350MS-(IEC1000V); CS3L-355MS-(IEC1000V); CS3L-360MS-(IEC1000V); CS3L-365MS-(IEC1000V); CS3L-370MS-(IEC1000V); CS3L-350MS-(IEC1500V); CS3L-355MS-(IEC1500V); CS3L-360MS-(IEC1500V); CS3L-365MS-(IEC1500V) & CS3L-370MS-(IEC1500V) With 2 Clenergy PV-EZ Rack Solar Mounting System Support Rails at 800 mm & 1200 mm Centres

This Report certifies the Design Wind Pressure for the above mentioned **Canadian Solar** Panel Modules. This Report also verifies that the PV Module is capable of withstanding the Design Wind Loads with the corresponding support points as listed in Table 1.

Albright Consulting Engineers (ACE) Pty Ltd were engaged by Canadian Solar MSS (Australia) Pty Ltd to carry out and witness 4 individual mechanical load tests (simulated static, wind load strength test). The testing was performed on new panels supplied by Canadian Solar.

The solar panel module(s) were mounted front side up using the Clenergy Mounting Rails & Brackets. The rails were bolted to the test bed at 800mm and 1200mm centres, this was to imitate a real-world situation; (this process was repeated for each test sample).

A constant pressure/ load was applied by an airbag located the back of the panel. A calibrated digital manometer was used to measure and track the design test pressures, while a calibrated digital deflection meter was used to measure and record the centre (vertical) deflection of the solar panel at 1kPa intervals. The electrical continuity or the cells themselves were not monitored during each of the tests.

The tests were conducted and observed by Nicholas Kastellorizios of Albright Consulting Engineers in Darwin Northern Territory, on the 20th June 2020. A total of 4 individual panels were tested; 2 panels tested with supports at 800mm centres and the other 2 panels tested with supports at 1200mm centres; the tests were carried out once on each solar panel sample. The behaviour of the modules and supporting fixtures were observed and recorded.

The applied factor for variability for 2 test samples (2 individual units tested per support centre) and adopting a coefficient of variation of structural characteristics of 10% in accordance with AS/NZS 1170.0, Table B1 (when determining the allowable design capacity) is 1.38. Refer to Table 1 for Test Summary & Results.

RESULTS & OBSERVATIONS:

Test No.1, x2 Canadian Solar: CS3L-360MS-(IEC1000V) Solar Panel Modules with Supports at 800mm Centres. Serial Numbers: 12003110792275 & 12003110790843

The solar panels (**1765mm x 1050mm x 40mm**) were mounted to the test rig with support points at **800mm** centres apart on each side with a cantilever/ overhang of approximately **482.5mm** at each end.

During both individual tests, the solar panel modules were observed to be able to support an equivalent design test pressure of **10kPa**, with a centre vertical deflection of **63mm** (approximately) recorded at 8.5kPa.

It was also observed that during all both tests, while in an attempt to increase the design test pressure(s), the solar panel modules buckled due to the excessive deflections and curvature of the aluminium frame. If increased, could cause the panel's pop out from the fixing clamps.

The solar panel modules did not appear to shatter or crack; however, there were visually obvious signs of minor to moderate structural fatigue and buckling at the bottom flanges of shorter cross-sections of the frames. This indicated that the frames may have started yielded (or entered into the plastic phase of the material). However; it was observed that even though the frames began to bend/ buckle under the above mentioned design pressures they still remained fixed to the test rails.

The centre support/ bridging member at the mid span of the frame (which was not fixed to the underside of the backing) sheet was left permanently deflected. This caused the panel to have a slight permanent deflection in the centre.

In each case the solar panel modules did not appear to shatter or crack; however, there were visually obvious signs of structural fatigue and buckling to each end of the frames. The cantilever ends of the panels deflected greater than the same model solar panels tested with supports at 1200mm centres.

Test No.2, x2 Canadian Solar: CS3L-360MS-(IEC1000V) Solar Panel Modules with Supports at 1200mm Centres. Serial Numbers: 12003110791609 & 12003110792152

The solar panels (**1765mm x 1050mm x 40mm**) were mounted to the test rig with support points at **1200mm** centres apart on each side with a cantilever/ overhang of approximately **282.5mm** at each end.

During both individual tests, the solar panel modules were observed to be able to support an equivalent design test pressure of **8kPa**, with a centre vertical deflection of **47mm** (approximately). During both tests, it was observed that while in an attempt to increase the design test pressures, the solar panels shattered at approximately **9kPa** with vertical deflections exceeding **70mm**. These results were recorded just as the solar panel modules failed/buckled and shattered.

The cause of this failure is likely due to the structural integrity of the panel frames and or the thickness of the glass. In all three cases there were visually obvious signs of major buckling and permanent deflection to the aluminium frames and failure of the glass due to the excessive deflections.

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Likely causes for this failure include: the structural integrity of the aluminium frames (i.e. grade of aluminium and frame connections) and or the thickness of the glass. This indicated that the frames had yielded (plastic phase of the material).

Table 1: Test Summary: Recommended Ultimate Design Strength, Limit Design Capacity

Test	Panel Manufacturer, Model & Size (mm)	Support Points (mm)	Maximum Applied Load (kPa)	Material Variability Factor AS/NZS 1170.0 Table B1 – kt	Recommended Ultimate Design Strength Limit State Design Capacity (kPa)
No.1	Canadian Solar: CS3L-XXXMS-(IEC1000V) & CS3L-XXXMS-(IEC1500V) Solar Panel Modules (1765mm x 1050mm x 40mm)	800	10	1.38	7.25
No.2	Canadian Solar: CS3L-XXXMS-(IEC1000V) & CS3L-XXXMS-(IEC1500V) Solar Panel Modules (1765mm x 1050mm x 40mm)	1200	8.0	1.38	5.79

Note that the above mentioned Recommended Ultimate Design Strength, Limit Design Capacities are only applicable to the models & power series stated within this certificate as well as listed on the attached data sheet.

Canadian Solar CS3L-XXXMS-(IEC1000V), Mechanical Properties:

Solar Cells	Mono-Crystalline 120 (2x (10 x 6))
Dimensions (L x W x H)	1765mm x 1050mm x 40mm
Weight	21.1 kg
Junction Box	IP-68, 3 Bypass Diodes
Backing Material/ Substrate	No Data Provided
Front Material/ Superstrate	3.2mm Tempered Glass
Frame	Anodised Aluminium Alloy

Canadian Solar CS3L-XXXMS-(IEC1500V), Mechanical Properties:

Solar Cells	Mono-Crystalline 120 (2x (10 x 6))
Dimensions (L x W x H)	1765mm x 1050mm x 40mm
Weight	21.1 kg
Junction Box	IP-68, 3 Bypass Diodes
Backing Material/ Substrate	No Data Provided
Front Material/ Superstrate	3.2mm Tempered Glass
Frame	Anodised Aluminium Alloy



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SUMMARY:

We recommended and certify that the **Canadian Solar: CS3L-350MS-(IEC1000V); CS3L-355MS-(IEC1000V); CS3L-360MS-(IEC1000V); CS3L-365MS-(IEC1000V); CS3L-370MS-(IEC1000V); CS3L-350MS-(IEC1500V); CS3L-355MS-(IEC1500V); CS3L-360MS-(IEC1500V); CS3L-365MS-(IEC1500V) & CS3L-370MS-(IEC1500V)** Solar Panel Modules can resist the following vertical design loads, with a Recommended Ultimate Design Strength (Limit State Design Capacity), as listed for the following support conditions:


When supported on purlins and or battens with 2 rail at 800mm centres	7.25 kPa
When supported on purlins and or battens with 2 rail at 1200mm centres	5.79 kPa

This Report has been prepared on behalf of and for the exclusive use of Canadian Solar MSS (Australia) Pty Ltd and is for the testing of the PV module only and **not** the supporting rails and or associated fixings.

The Limit State Design Capacities are only applicable for the panel size, model and support spacing's as used in these tests. Any additional power output models referenced may also be covered under this certificate provided that they are referenced in the same technical datasheets (attached); are mechanically & physically exactly the same as the (tested) Canadian Solar **CS3L-360MS-(IEC1000V)** Solar Panel Modules, **1765mm x 1050mm x 40mm**; and that they are manufactured in the same way with the same materials as the (tested) Canadian Solar CS3L-360MS-(IEC1000V) Solar Panel Modules, **1765mm x 1050mm x 40mm**.

This certificate is no longer valid if the any of the applicable Engineering and Mechanical Properties used in the manufacture of these solar panel modules or if the manufacturing processes or techniques is changed or altered in any way to the above mentioned Tested Solar Panel Modules. It is the responsibility of the manufacturer to confirm if they are altered or changed as re-testing may be required.

Please note: The panel fixing clamps; the support rails; their associated fixings or the fixings of the L Feet to the immediate supporting structure, although not found to be the failure mode in these test runs, may limit the structural design.

Company Name if certification issued on behalf of a corporation Albright Services Group Pty Ltd, Trading as Albright Consulting Engineers		Company NT Registration Number 215037ES	
I certify that reasonable care has been taken to ensure that the structural engineering aspects of the works as described above have been designed in accordance with the requirements of the Building Code of Australia and the Northern Territory Building Regulations			
Name Nicholas Kastellorizios Nominee for Albright Services Group Pty Ltd, Trading as Albright Consulting Engineers	Nominee/Individual NT Registration Number 196514ES	Signature 	Date 24/06/2020

Please contact our office if you require any further information in relation to this report.

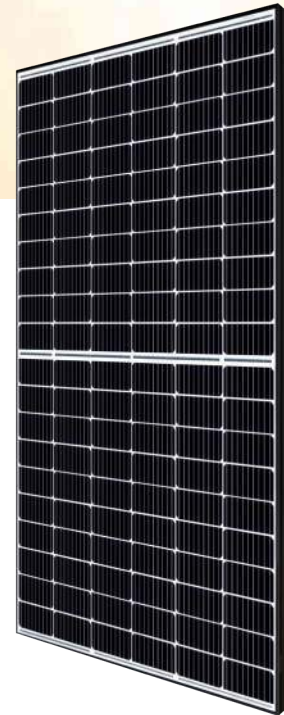
Nicholas Kastellorizios
Director/ Structural Engineer
Albright Consulting Engineers



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Appendix: Data Sheet:



HiKu

SUPER HIGH POWER MONO PERC MODULE 350 W ~ 370 W

CS3L-350 | 355 | 360 | 365 | 370MS (IEC1000 V)

CS3L-350 | 355 | 360 | 365 | 370MS (IEC1500 V)

MORE POWER



26 % more power than
conventional modules



Up to 4.5 % lower LCOE
Up to 2.7 % lower system cost



Low NMOT: 42 ± 3 °C
Low temperature coefficient (Pmax):
-0.36 % / °C



Better shading tolerance

MORE RELIABLE



Lower internal current,
lower hot spot temperature



Cell crack risk limited in small region,
enhance the module reliability



Heavy snow load up to 5400 Pa,
wind load up to 3600 Pa*



linear power output warranty*



enhanced product warranty on materials
and workmanship*

*According to the applicable Canadian Solar Limited Warranty Statement.

MANAGEMENT SYSTEM CERTIFICATES*

ISO 9001:2015 / Quality management system
ISO 14001:2015 / Standards for environmental management system
OHSAS 18001:2007 / International standards for occupational health & safety

PRODUCT CERTIFICATES*

IEC 61215 / IEC 61730: VDE / CE
UL 1703: CSA / Take-e-way



* As there are different certification requirements in different markets, please contact your local Canadian Solar sales representative for the specific certificates applicable to the products in the region in which the products are to be used.

CANADIAN SOLAR INC. is committed to providing high quality solar products, solar system solutions and services to customers around the world. No. 1 module supplier for quality and performance/price ratio in IHS Module Customer Insight Survey. As a leading PV project developer and manufacturer of solar modules with over 36 GW deployed around the world since 2001.

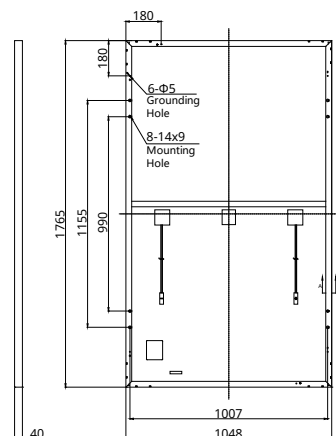
* For detail information, please refer to Installation Manual.

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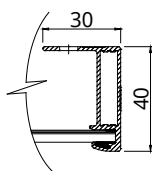
Canadian Solar MSS (Australia) Pty Ltd., 44 Stephenson St, Cremorne VIC 3121, Australia
support@canadiansolar.com, www.canadiansolar.com/au

ENGINEERING DRAWING (mm)

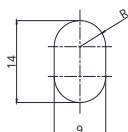
Rear View



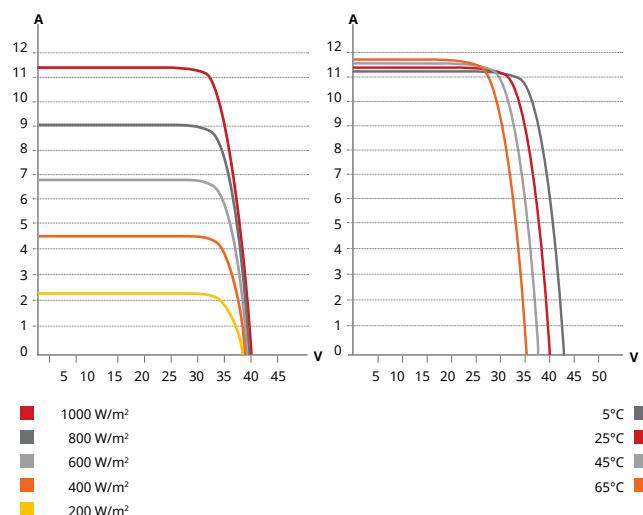
Frame Cross Section A-A



Mounting Hole



CS3L-360MS / I-V CURVES



ELECTRICAL DATA | STC*

CS3L	350MS	355MS	360MS	365MS	370MS
Nominal Max. Power (Pmax)	350 W	355 W	360 W	365 W	370 W
Opt. Operating Voltage (Vmp)	32.7 V	32.9 V	33.1 V	33.3 V	33.5 V
Opt. Operating Current (Imp)	10.71 A	10.80 A	10.88 A	10.97 A	11.05 A
Open Circuit Voltage (Voc)	39.6 V	39.8 V	40.0 V	40.2 V	40.4 V
Short Circuit Current (Isc)	11.33 A	11.38 A	11.45 A	11.52 A	11.59 A
Module Efficiency	18.92%	19.19%	19.46%	19.73%	20.00%
Operating Temperature	-40°C ~ +85°C				
Max. System Voltage	1500V (IEC/UL) or 1000V (IEC/UL)				
Module Fire Performance	TYPE 1 (UL 1703) or CLASS C (IEC 61730)				
Max. Series Fuse Rating	20 A				
Application Classification	Class A				
Power Tolerance	0 ~ + 5 W				

* Under Standard Test Conditions (STC) of irradiance of 1000 W/m², spectrum AM 1.5 and cell temperature of 25°C. Measurement uncertainty: ±3 % (Pmax).

ELECTRICAL DATA | NMOT*

CS3L	350MS	355MS	360MS	365MS	370MS
Nominal Max. Power (Pmax)	261 W	264 W	268 W	272 W	275 W
Opt. Operating Voltage (Vmp)	30.4 V	30.6 V	30.8 V	31.0 V	31.2 V
Opt. Operating Current (Imp)	8.59 A	8.63 A	8.71 A	8.78 A	8.83 A
Open Circuit Voltage (Voc)	37.1 V	37.3 V	37.5 V	37.7 V	37.9 V
Short Circuit Current (Isc)	9.14 A	9.18 A	9.24 A	9.29 A	9.35 A

* Under Nominal Module Operating Temperature (NMOT), irradiance of 800 W/m² spectrum AM 1.5, ambient temperature 20°C, wind speed 1 m/s.

MECHANICAL DATA

Specification	Data
Cell Type	Mono-crystalline
Cell Arrangement	120 [2 X (10 X 6)]
Dimensions	1765 X 1048 X 40 mm (69.5 X 41.3 X 1.57 in)
Weight	21.1 kg (46.5 lbs)
Front Cover	3.2 mm tempered glass
Frame	Anodized aluminium alloy
J-Box	IP68, 3 bypass diodes
Cable	4.0 mm² (IEC), 12 AWG (UL)
Cable Length (Including Connector)	Portrait: 500 mm (19.7 in) (+) / 350 mm (13.8 in) (-); landscape: 1250 mm (49.2 in)*
Connector	T4-PC-1 (IEC 1000 V) or PV-KST4/xy-UR, PV-KBT4/xy-UR (IEC 1000 V) or T4-PPE-1 (IEC 1500 V) or PV-KST4-EVO2/XY, PV-KBT4-EVO2/XY (IEC 1500 V) or UTXC-FA4AM, UTXCMA4AM (IEC 1500 V)
Per Pallet	27 pieces
Per Container (40' HQ)	702 pieces

* For detailed information, please contact your local Canadian Solar sales and technical representatives.

TEMPERATURE CHARACTERISTICS

Specification	Data
Temperature Coefficient (Pmax)	-0.36 % / °C
Temperature Coefficient (Voc)	-0.29 % / °C
Temperature Coefficient (Isc)	0.05 % / °C
Nominal Module Operating Temperature	42 ± 3°C

PARTNER SECTION



* The specifications and key features contained in this datasheet may deviate slightly from our actual products due to the on-going innovation and product enhancement. Canadian Solar Inc. reserves the right to make necessary adjustment to the information described herein at any time without further notice.
Please be kindly advised that PV modules should be handled and installed by qualified people who have professional skills and please carefully read the safety and installation instructions before using our PV modules.

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