

21080 Test Report: 63209+ Sequence 4 Damp Heat Testing on M390-D1FB Modules Produced by Mitrex

Report Number: 21080D-PR-E-001
Report Date: 2022-08-08
Test Period: 2022-02-07 to 2022-07-28
Project ID: 21080 (CFV), 000477 (Customer PO)
Customer: Hadi Khatibzadehazad / Mitrex
41 Racine Rd
Etobicoke, Ontario M9W 2Z4
Canada

Report Prepared by:	Report Reviewed by:	Report Approved by:

Project Summary

CFV Labs conducted extended reliability testing on two **M390-D1FB** modules produced by **Mitrex** per IEC TS 63209-1 Sequence 4.

The modules were subjected to performance measurements and safety tests prior to stress testing. The modules were then subjected to two rounds of DH1000 for a total damp heat dose of 2000 hours. Each test block was followed by post-stress performance and safety measurements.

The average change in STC Pmp [W] from initial to the final post-stress testing was measured to be **-4.70 %**. The modules passed all safety tests and all initial, interim, and final visual inspections.

This report is sub-report 21080D-PR-E-001 of project 21080. All test legs for this IEC TS 63209-1 project are summarized in report 21080-PR-E-001.

Project Test Flow

The figure below shows the overall test flow for this project.

Incoming Inspection	Seq_4 Damp Heat
All samples	21080-010, 21080-013
@Initial	@Seq4_Initial
Incoming Inspection	MQT 06.1 Performance at STC
MQT 01 Visual Inspection	MQT 07 Performance at Low Irradiance
EL Imaging 1.0x Isc	@Seq4_Stabilization
EL Imaging 0.1x Isc	MQT 19 Stabilization - Outdoor Exposure (120 kWh/m ² , MPPT)
	@Seq4_Stabilized
	MQT 06.1 Performance at STC
	MQT 07 Performance at Low Irradiance
	Bifacial Indoor I-V
	EL Imaging 1.0x Isc
	EL Imaging 0.1x Isc
	MQT 03 Insulation
	MQT 15 Wet Leakage Current
	@Seq4_DH1000-1
	MQT 13 Damp Heat (1000 Hours)
	MQT 01 Visual Inspection (Within 2-4 hours following DH)
	MQT 15 Wet Leakage Current (Within 2-4 hours following DH)
	MQT 06.1 Performance at STC
	MQT 07 Performance at Low Irradiance
	EL Imaging 1.0x Isc
	MQT 03 Insulation
	@Seq4_DH1000-2
	MQT 13 Damp Heat (1000 Hours)
	MQT 01 Visual Inspection (Within 2-4 hours following DH)
	MQT 15 Wet Leakage Current (Within 2-4 hours following DH)
	MQT 06.1 Performance at STC
	MQT 07 Performance at Low Irradiance
	Bifacial Indoor I-V
	EL Imaging 1.0x Isc
	EL Imaging 0.1x Isc
	MQT 03 Insulation

Test Flow Assignment

The modules utilized for this testing were supplied by the customer after they were inspected and sampled by PI Berlin for CFV Labs. The report, *CFV21080 Mitrex sample witness report 20220121_R2*, was provided separately to the customer.

These modules were free of obvious defects under visual inspection and electroluminescence imaging. The test flow assignment for each of the modules is provided in the table below. The modules were subjected to the test legs in the order listed.

Module ID	Serial Number	Test Leg(s)	Notes
21080-002	MIT21A04827	Incoming Inspection, Control	-
21080-010	MIT21A04876	Incoming Inspection, Seq_4 Damp Heat	-
21080-013	MIT22A00010	Incoming Inspection, Seq_4 Damp Heat	-

Sample Information

Sample Dimensions

Module Type	Length [m]	Width [m]	Thickness [mm]
M390-D1FB	2.03	0.99	40

Sample Nameplate Values

Module Type	Isc [A]	Voc [V]	Imp [A]	Vmp [V]	Pmp [W]	Max Sys Volt [V]	Fuse Rating [A]
M390-D1FB	9.76	47.3	9.29	42.0	390	1000	20

Sample Type Images

Module Type: M390-D1FB



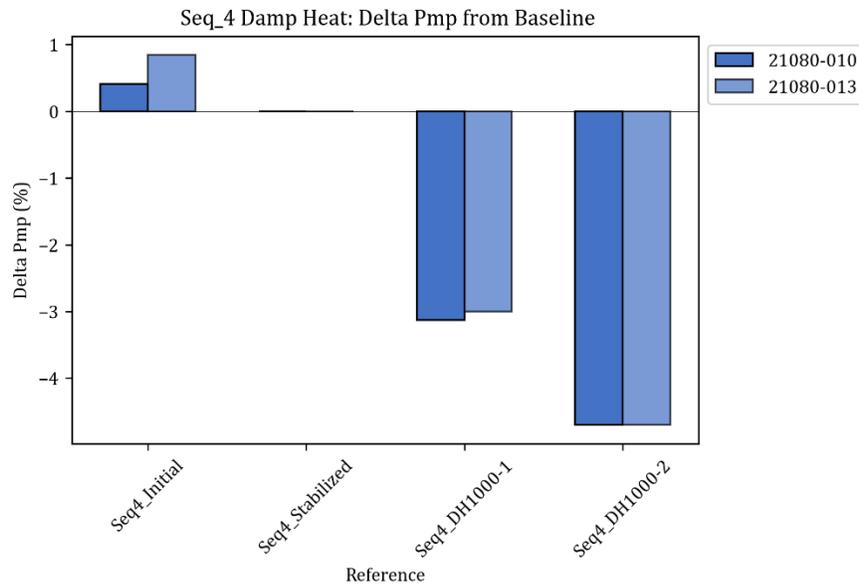


Results: Test Leg – Seq_4 Damp Heat

An incoming inspection report is provided separately to the customer. No issues were observed during the incoming inspection.

Summary of Results – Performance at STC and Safety Testing

The plots below show the Performance at STC measurement results as a change from Baseline (Stabilized).



The tables below show the Performance at STC, Visual Inspection, and safety testing results per module. When required, more detail is provided in the section referenced in the “Notes” field.

Test Conditions

Irradiance [W/m ²]	Temperature [°C]
1000.0	25.0

Estimated Measurement Uncertainty

Technology	Isc	Voc	Imp	Vmp	Pmp
Si, Bifacial (k=2)	± 1.6 %	± 0.75 %	± 2.1 %	± 1.3 %	± 2.2 %

Module: 21080-010

Reference	Isc (A)	Voc (V)	Imp (A)	Vmp (V)	Pmp (W)	ΔPmp (%)	Visual Inspection	Wet Leakage	Insulation
Initial	9.968	49.17	9.458	40.37	381.83	+0.41	pass	pass	pass
Stabilized	9.977	49.08	9.437	40.30	380.28	-	pass	pass	pass
DH1000-1	9.756	48.90	9.227	39.92	368.38	-3.13	pass	pass	pass
DH1000-2	9.699	49.00	9.131	39.69	362.39	-4.70	pass	pass	pass

Notes:

Module: 21080-013

Reference	Isc (A)	Voc (V)	Imp (A)	Vmp (V)	Pmp (W)	ΔPmp (%)	Visual Inspection	Wet Leakage	Insulation
Initial	9.991	49.22	9.472	40.45	383.12	+0.85	pass	pass	pass
Stabilized	9.976	49.12	9.423	40.32	379.91	-	pass	pass	pass
DH1000-1	9.780	48.87	9.241	39.88	368.52	-3.00	pass	pass	pass
DH1000-2	9.723	48.92	9.138	39.62	362.07	-4.70	pass	pass	pass

Notes:

Performance at STC – Change from Stabilized

Module ID	Reference	Δ Isc [%]	Δ Voc [%]	Δ Imp [%]	Δ Vmp [%]	Δ Pmp [%]
21080-010	Initial	-0.10	+0.17	+0.22	+0.18	+0.41
	Stabilized	+0.00	+0.00	+0.00	+0.00	+0.00
	DH1000-1	-2.22	-0.37	-2.22	-0.93	-3.13
	DH1000-2	-2.79	-0.17	-3.23	-1.52	-4.70
21080-013	Initial	+0.15	+0.20	+0.51	+0.33	+0.85
	Stabilized	+0.00	+0.00	+0.00	+0.00	+0.00
	DH1000-1	-1.96	-0.51	-1.94	-1.08	-3.00
	DH1000-2	-2.53	-0.41	-3.03	-1.71	-4.70

Control Module Measurements

Module ID	Reference	Isc (A)	Voc (V)	Imp (A)	Vmp (V)	Pmp (W)
21080-002	Initial	9.981	49.19	9.476	40.33	382.22
	Stabilized	9.975	49.14	9.450	40.19	379.84
	DH1000-1	9.970	49.09	9.446	40.27	380.36
	DH1000-2	9.956	49.10	9.470	40.24	381.09

Bifacial Performance

Test Conditions

Irradiance [W/m ²]	Temperature [°C]
1000.0	25.0

Estimated Measurement Uncertainty

Technology	Isc	Voc	Imp	Vmp	Pmp
Si, Bifacial (k=2)	± 1.6 %	± 0.75 %	± 2.1 %	± 1.3 %	± 2.2 %

Measurements - Backside

Module ID	Reference	Isc [A]	Voc [V]	Imp [A]	Vmp [V]	Pmp [W]
21080-010	Stabilized	6.882	48.53	6.221	42.03	261.46
	DH1000-2	6.593	48.41	5.987	41.51	248.53
21080-013	Stabilized	6.930	48.46	6.224	42.04	261.70
	DH1000-2	6.638	48.40	6.059	41.42	250.97

Bifaciality Calculations

Module ID	Reference	φ _{Isc} [%]	φ _{Voc} [%]	φ _{Imp} [%]	φ _{Vmp} [%]	φ _{Pmp} [%]
21080-010	Stabilized	68.98	98.88	65.93	104.29	68.76
	DH1000-2	67.97	98.80	65.56	104.60	68.58
21080-013	Stabilized	69.46	98.65	66.05	104.29	68.88
	DH1000-2	68.27	98.93	66.31	104.53	69.32

Performance at Low Irradiance

Test Conditions

Irradiance [W/m ²]	Temperature [°C]
200.0	25.0

Estimated Measurement Uncertainty

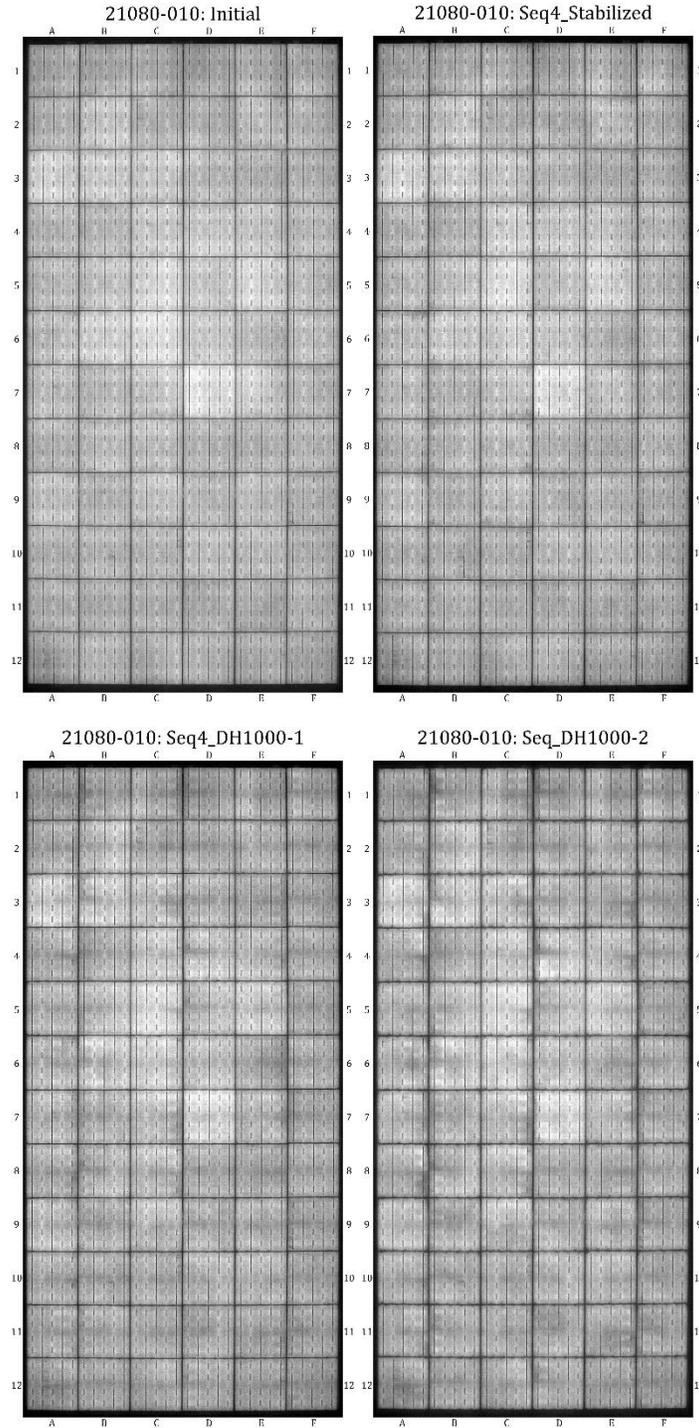
Technology	Isc	Voc	Imp	Vmp	Pmp
Si, Bifacial (k=2)	± 1.6 %	± 0.75 %	± 2.1 %	± 1.3 %	± 2.2 %

Measurements

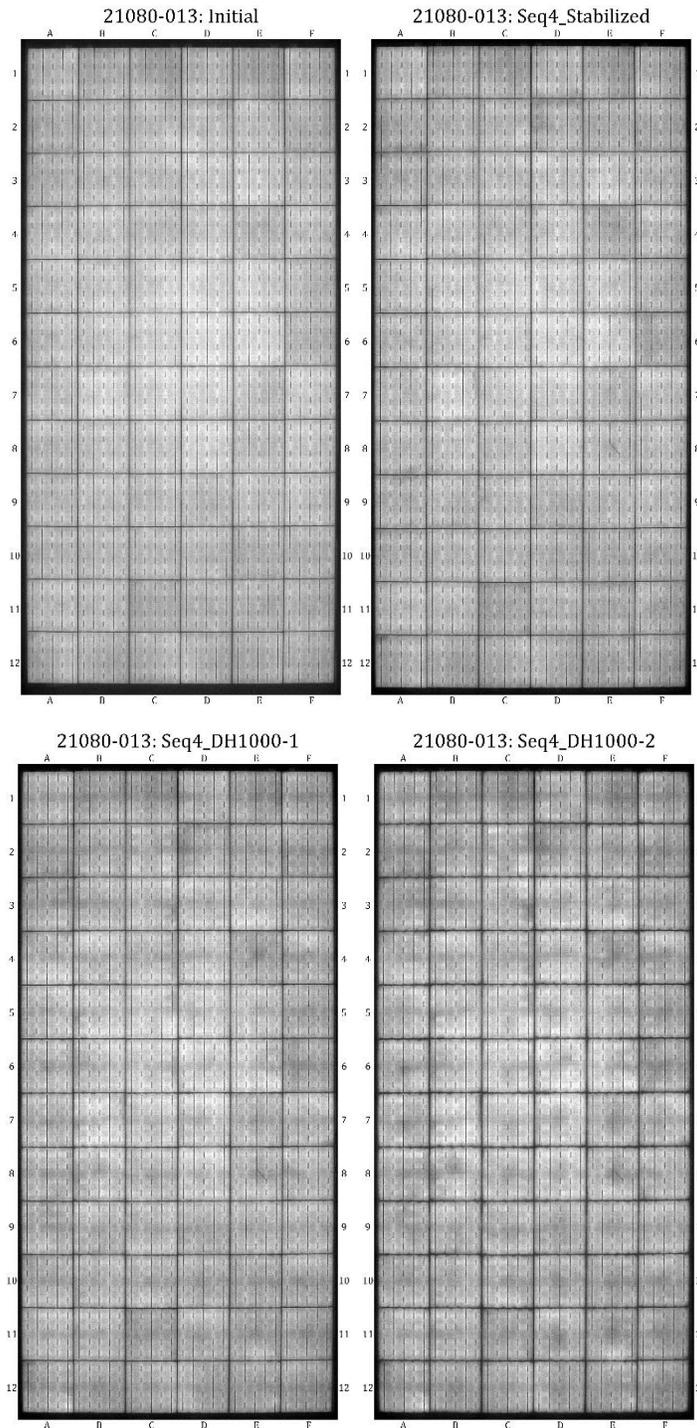
Module ID	Reference	Isc [A]	Voc [V]	Imp [A]	Vmp [V]	Pmp [W]
21080-010	Initial	1.996	46.12	1.888	39.54	74.64
	Stabilized	2.007	46.01	1.879	39.41	74.06
	DH1000-1	1.959	45.85	1.837	39.14	71.92
	DH1000-2	1.960	45.86	1.844	39.06	72.03
21080-013	Initial	1.995	46.10	1.890	39.49	74.63
	Stabilized	2.007	45.97	1.870	39.13	73.16
	DH1000-1	1.964	45.81	1.842	39.14	72.12
	DH1000-2	1.959	45.83	1.847	39.01	72.04

Electroluminescence Imaging

Module 21080-010 (Images taken at $0.1 \times I_{sc}$ are provided separately in digital format)



Module 21080-013 (Images taken at $0.1 \times I_{sc}$ are provided separately in digital format)



Stabilization

Pass/Fail also determined by follow-up MQT 01 Visual Inspection and MQT 15 Wet Leakage Current.

Module	Reference	Total Dose [kWh/m ²]	Pmp - Delta from Initial [%]
21080-010	Stabilized	145.78	-0.41
21080-013	Stabilized	145.78	-0.85
21080-002	Z_Stabilized	141.27	-0.62

Damp Heat

Pass/Fail also determined by follow-up MQT 01 Visual Inspection and MQT 15 Wet Leakage Current.

Module	Reference	Hour Count	Total Hour Count	Temp [°C]	Humidity [% RH]	Pass/Fail
21080-010	DH1000-1	1000	1000	85	85	Pass
21080-010	DH1000-2	1000	2000	85	85	Pass
21080-013	DH1000-1	1000	1000	85	85	Pass
21080-013	DH1000-2	1000	2000	85	85	Pass

Procedures

The procedures for the testing contained in this report are summarized in the following table.

Test Name	Standard / Procedure	CFV Accreditation
Incoming Inspection	CFV	NA
Visual Inspection	IEC 61215-2:2016 MQT 01	ISO 17025
Electroluminescence Imaging	IEC TS 60904-13:2018	ISO 17025
Preconditioning	IEC 61215-2:2016 MQT 19	ISO 17025
Performance at STC	IEC 61215-2:2016 MQT 06.1	ISO 17025
Performance at Low Irradiance	IEC 61215-2:2016 MQT 07	ISO 17025
Wet Leakage Current	IEC 61215-2:2016 MQT 15	ISO 17025
Insulation	IEC 61215-2:2016 MQT 03	ISO 17025
Damp Heat	IEC 61215-2:2016 MQT 13	ISO 17025

Equipment Calibration Information

Equipment and Calibration information is available upon request.

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