

21080 Test Report:

IEC TS 63209-1 Sequence 3 Sequential Testing Including UV on Module Back-side on M390-D1FB Modules Produced by Mitrex

Report Number: 21080C-PR-E-001
Report Date: 2022-11-22
Test Period: 2022-02-07 to 2022-11-18
Project ID: 21080 (CFV), 000477 (Customer PO)
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Project Summary

CFV Labs conducted extended reliability testing on two **M390-D1FB** modules produced by **Mitrex** per IEC TS 63209-1 Sequence 3 Sequential Testing Including UV on Module Back-side.

The modules were subjected to performance measurements and safety tests prior to stress testing. The modules were then subjected to DH200 followed by three rounds of UV60+TC50+HF10 for a total UV dose of 180 kWh/m², TC exposure of 150 cycles and HF exposure of 30 cycles. Each test block was followed by safety measurements and visual inspections.

The modules *passed* all initial, interim, and final safety tests and visual inspections. This test protocol focuses on degradation of the module's polymeric backsheets. No cracking or other issues as listed in MQT 01 Visual inspection were observed on the backsheets of the test samples.

This report is sub-report 21080C-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	Seq3_UV_Backsheet
All samples	21080-004
@Initial	@Seq3_Initial
Incoming Inspection	MQT 06.1 Performance at STC
MQT 01 Visual Inspection	MQT 07 Performance at Low Irradiance
EL Imaging 1.0x Isc	@Seq3_Stabilization
EL Imaging 0.1x Isc	MQT 19 Stabilization - Outdoor Exposure (120 kWh/m ² , MPPT)
	@Seq3_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
	@Seq3_DH200
	MQT 13 Damp Heat
	MQT 01 Visual Inspection (Within 2-4 hours following DH)
	@Seq3_UV60-1
	MQT 10 UV Preconditioning (60 kWh)
	MQT 01 Visual Inspection
	@Seq3_TC50-3
	MQT 11 Thermal Cycling (50 cycles)
	@Seq3_HF10-1
	MQT 12 Humidity Freeze (10 cycles)
	MQT 01 Visual Inspection
	@Seq3_UV60-2
	MQT 10 UV Preconditioning (60 kWh)
	MQT 01 Visual Inspection
	@Seq3_TC50-2
	MQT 11 Thermal Cycling (50 cycles)
	@Seq3_HF10-2
	MQT 12 Humidity Freeze (10 cycles)
	MQT 01 Visual Inspection
	@Seq3_UV60-3
	MQT 10 UV Preconditioning (60 kWh)
	MQT 01 Visual Inspection
	@Seq3_TC50-3
	MQT 11 Thermal Cycling (50 cycles)
	@Seq3_HF10-3
	MQT 12 Humidity Freeze (10 cycles)
	MQT 01 Visual Inspection
	MQT 03 Insulation
	MQT 15 Wet Leakage Current

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	-
21080-004	MIT22A00019	Incoming Inspection, Seq_3_UV_Backsheet	-

Sample Information

Sample Dimensions

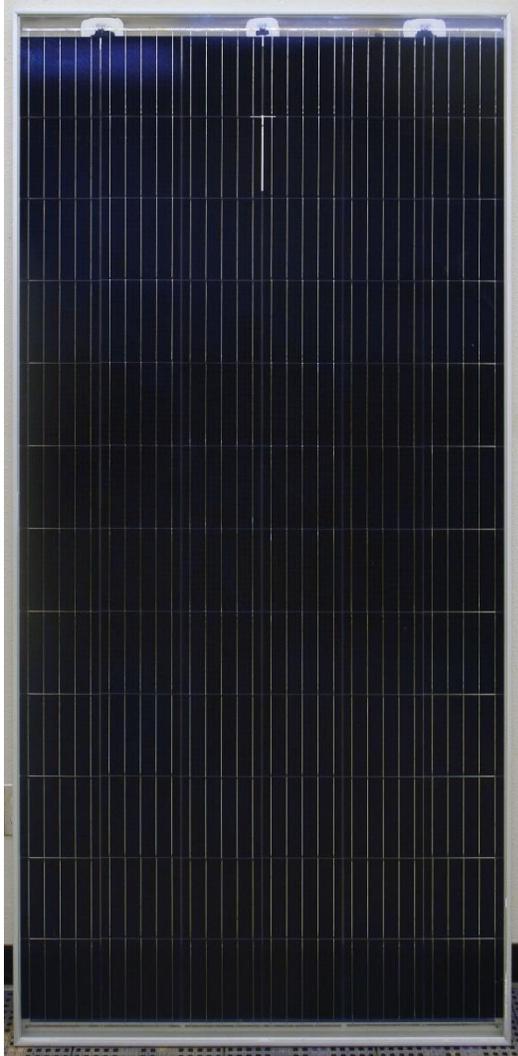
Module Type	Length [m]	Width [m]	Thickness [mm]
M390-D1FB	2.03	0.99	40

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_3_UV_Backsheet

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 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 or in a separate section below.

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: 21080-004

Reference	Isc (A)	Voc (V)	Imp (A)	Vmp (V)	Pmp (W)	ΔPmp (%)	Visual Inspection	Wet Leakage	Insulation
Initial	9.987	49.15	9.489	40.29	382.29	+0.84	pass	pass	pass
Stabilized	9.972	49.11	9.448	40.12	379.09	-	pass	pass	pass
DH200	-	-	-	-	-	-	pass	-	-
HF10-1	-	-	-	-	-	-	pass	-	-
HF10-2	-	-	-	-	-	-	pass	-	-
HF10-3	-	-	-	-	-	-	pass	pass	pass

Notes: This test leg is a backsheet test, so performance was not conducted for the majority of the project.

Performance at STC – Change from Stabilized

Module ID	Reference	Δ Isc [%]	Δ Voc [%]	Δ Imp [%]	Δ Vmp [%]	Δ Pmp [%]
21080-004	Initial	+0.15	+0.08	+0.43	+0.41	+0.84
	Stabilized	+0.00	+0.00	+0.00	+0.00	+0.00

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

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]
21080-004	Stabilized	6.881	48.47	6.210	42.06	261.19

Bifaciality Calculations

Module ID	Reference	φ_Isc [%]	φ_Voc [%]	φ_Imp [%]	φ_Vmp [%]	φ_Pmp [%]
21080-004	Stabilized	69.00	98.69	65.73	104.82	68.90

Performance at Low Irradiance

Test Conditions

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

Estimated Measurement Uncertainty

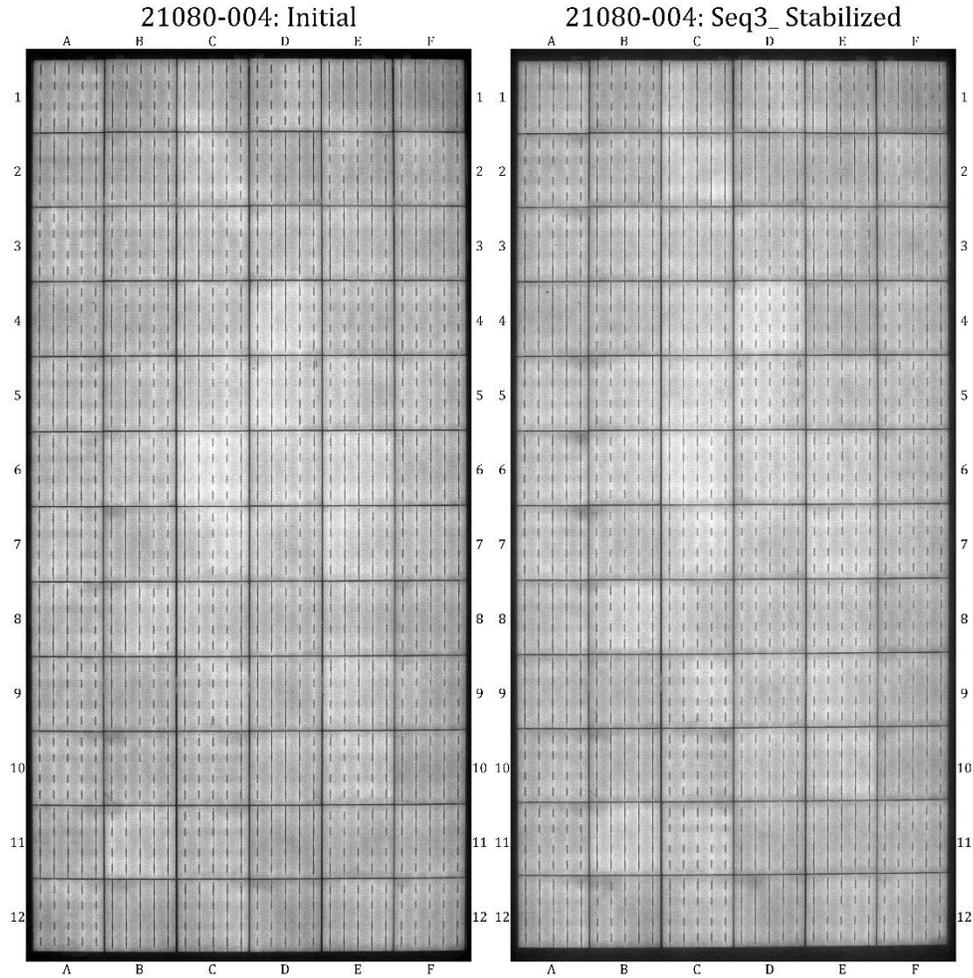
Technology	Isc	Voc	Imp	Vmp	Pmp
Si, Bifacial (k=2)	± 1.6 %	± 0.75 %	± 2.1 %	± 1.3 %	± 2.2 %

Measurements

Module ID	Reference	Isc [A]	Voc [V]	Imp [A]	Vmp [V]	Pmp [W]
21080-004	Initial	1.996	46.05	1.892	39.38	74.50
	Stabilized	2.004	45.98	1.888	39.27	74.14

Electroluminescence Imaging

Module 21080-004 (Images taken at $0.1 \times I_{sc}$ are provided separately in digital format)



Damp Heat

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

Module	Test Reference	Hour Count	Total Hour Count	Temp [°C]	Humidity [% RH]	Pass/Fail
21080-004	Seq1_DH200-1	200	200	85	85	Pass

UV Conditioning

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

Module	Test Reference	Dose [kW/m ²]	Total Dose [kW/m ²]	Temp [°C]	Pass/Fail
21080-004	Seq3_UV60-1	60	60	60	Pass
21080-004	Seq3_UV60-2	60	120	60	Pass
21080-004	Seq3_UV60-3	60	180	60	Pass

Thermal Cycling

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

Module	Reference	Cycle Count	Total Cycle Count	Temp - High [°C]	Temp - Low [°C]	Pass/Fail
21080-004	Seq3_TC50-1	50	50	85	-40	Pass
21080-004	Seq3_TC50-2	50	100	85	-40	Pass
21080-004	Seq3_TC50-3	50	150	85	-40	Pass

Humidity Freeze

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

Module	Test Reference	Cycle Count	Total Cycle Count	Temp - High [°C]	Temp - Low [°C]	Humidity [% RH]	Pass/Fail
21080-004	Seq3_HF10-1	10	10	85	-40	85	Pass
21080-004	Seq3_HF10-2	10	20	85	-40	85	Pass
21080-004	Seq3_HF10-3	10	30	85	-40	85	Pass

Visual Inspection

Module	Test Reference	Pass/Fail	Comments
21080-004	Initial	Pass	No backsheet cracking or other listed defects
21080-004	Stabilized	Pass	No backsheet cracking or other listed defects
21080-004	Seq3_DH200-1	Pass	No backsheet cracking or other listed defects
21080-004	Seq3_HF10-1	Pass	No backsheet cracking or other listed defects
21080-004	Seq3_HF10-2	Pass	No backsheet cracking or other listed defects
21080-004	Seq3_HF10-3	Pass	No backsheet cracking or other listed defects

Note: A full set of images taken during visual inspection were provided separately to the customer in digital format

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
Stabilization	IEC 61215-2:2016 MQT 19	ISO 17025
Performance at STC	IEC 61215-2:2016 MQT 06.1	ISO 17025
Bifacial IV	IEC TS 60904-1-2:2019	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
Thermal Cycling	IEC 61215-2:2016 MQT 11	ISO 17025
Humidity Freeze	IEC 61215-2:2016 MQT 12	ISO 17025
Damp Heat	IEC 61215-2:2016 MQT 13	ISO 17025
UV Conditioning	IEC 61215-2:2016 MQT 10	ISO 17025

Equipment Calibration Information

Equipment and Calibration information is available upon request.

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