Thermal Cycling Test:
Mitrex Solar Facade

MITREX™

1. Introduction

The Thermal Cycling Test is an indispensable assessment technique designed to evaluate the durability and performance of materials when subjected to drastic temperature fluctuations. This rigorous examination ensures the reliability of these materials in practical, real-world conditions.

Mitrex, in its commitment to maintaining the highest standards, has conducted the Thermal Cycling Test in collaboration with Intertek, a reputable third-party laboratory. This testing procedure has been applied to both solar framed modules and honeycomb solar facade modules.

Sections 2 and 3 of this documentation delve into comprehensive explanations of the Thermal Cycling Test. For further insight, the appendix section presents a confirmation report detailing previous tests, including the crucial Thermal Cycling Test.

2. Thermal Cycling Test (MST 51) IEC 61730

This test is equivalent to MQT 11 in IEC 61215-2. Technology specific variations of the test can be found in the sub-parts IEC 61215-1-x (x is 1 to 4). Figure 2 shows which version (50 cycles or 200 cycles) is to be applied with the samples.

3. Thermal Cycling Test (MQT 11) IEC 61215

2.1 Purpose
To determine the ability of the module to withstand thermal mismatch, fatigue and other stresses caused by repeated changes of temperature.

2.2 Apparatus
a) A climatic chamber with automatic temperature control with means for circulating the air inside and means to minimize condensation on the module during the test, capable of subjecting one or more modules to the thermal cycle in Figure 1.

b) Means for mounting or supporting the module(s) in the chamber, so as to allow free circulation of the surrounding air. The thermal conduction of the mount or support shall be low, so that, for practical purposes, the module(s) are thermally isolated.

c) Measurement instrumentation having an accuracy of 2.0 °C and repeatability of 0,5 °C for measuring and recording the temperature of the module(s).

d) Means for applying a continuous current. The value of the current is defined in the technology specific parts in this standard.

e) Means for monitoring the flow of current through each module during the test.

2.3 Procedure
a) Attach a suitable temperature sensor to the front or back surface of the module(s) near the middle. If more than one module of the same type are tested simultaneously, it will suffice to monitor the temperature of one representative sample.

b) Install the module(s) at room temperature in the chamber.

c) Connect the temperature-monitoring equipment to the temperature sensor(s). Connect each module to the appropriate current supply by connecting the positive terminal of the module to the positive terminal of the power supply and the second terminal accordingly. During the thermal cycling test set the continuous current flow during the heat up cycle to the technology specified current in 2.2 at temperature from -40 °C to 80 °C. During cool down, the -40 °C dwell phase and temperatures above 80 °C the continuous current shall be reduced to no more than 1.0 % of the measured STC peak power current to measure continuity. If the temperature rises too fast (greater than 100 °C/h) at the lowest temperature, the start of the current flow can be delayed until the temperature has reached -20 °C.

d) Close the chamber and subject the modules to cycling between measured module temperatures of (-40 + 2) °C and (+85 + 2) °C. in accordance with the profile in Figure 1. The rate of change of temperature between the low and high extremes shall not exceed 100 C/h and the module temperature shall remain stable at each extreme for a period of at least 10 min. The cycle time shall not exceed 6 h unless the module has such a high heat capacity that a longer cycle is required. The number of cycles shall be as shown in the relevant sequences in Figure 1 of IEC 61215-1:2016. Air circulation around the module(s) has to ensure compliance with each module under test meeting the temperature cycling profile.

e) Throughout the test, record the module temperature and monitor the current yow through the module(s).

NOTE: In a module with parallel circuits, an open circuit in one branch will cause a discontinuity in the voltage but not cause the current to go to zero

2.4 Final measurements
After a minimum recovery time of 1 h at (23 + 5) °C and a relative humidity less than 75 % under open-circuit conditions, repeat the tests of MQT 01 and MQT 15.

2.5 Requirements
a) No interruption of current flow during the test; in the case of a module with parallel circuits, a discontinuity in current flow indicates an interruption of flow in one of the parallel circuit.

b) No evidence of major visual defects, as defined in IEC 61215-1.

c) Wet leakage current shall meet the same requirements as for the initial measurements.

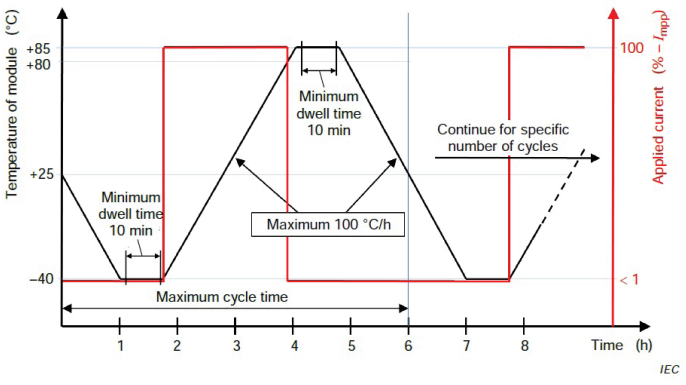

Figure 1: Thermal Cycling Test - Temperature & applied current Profile

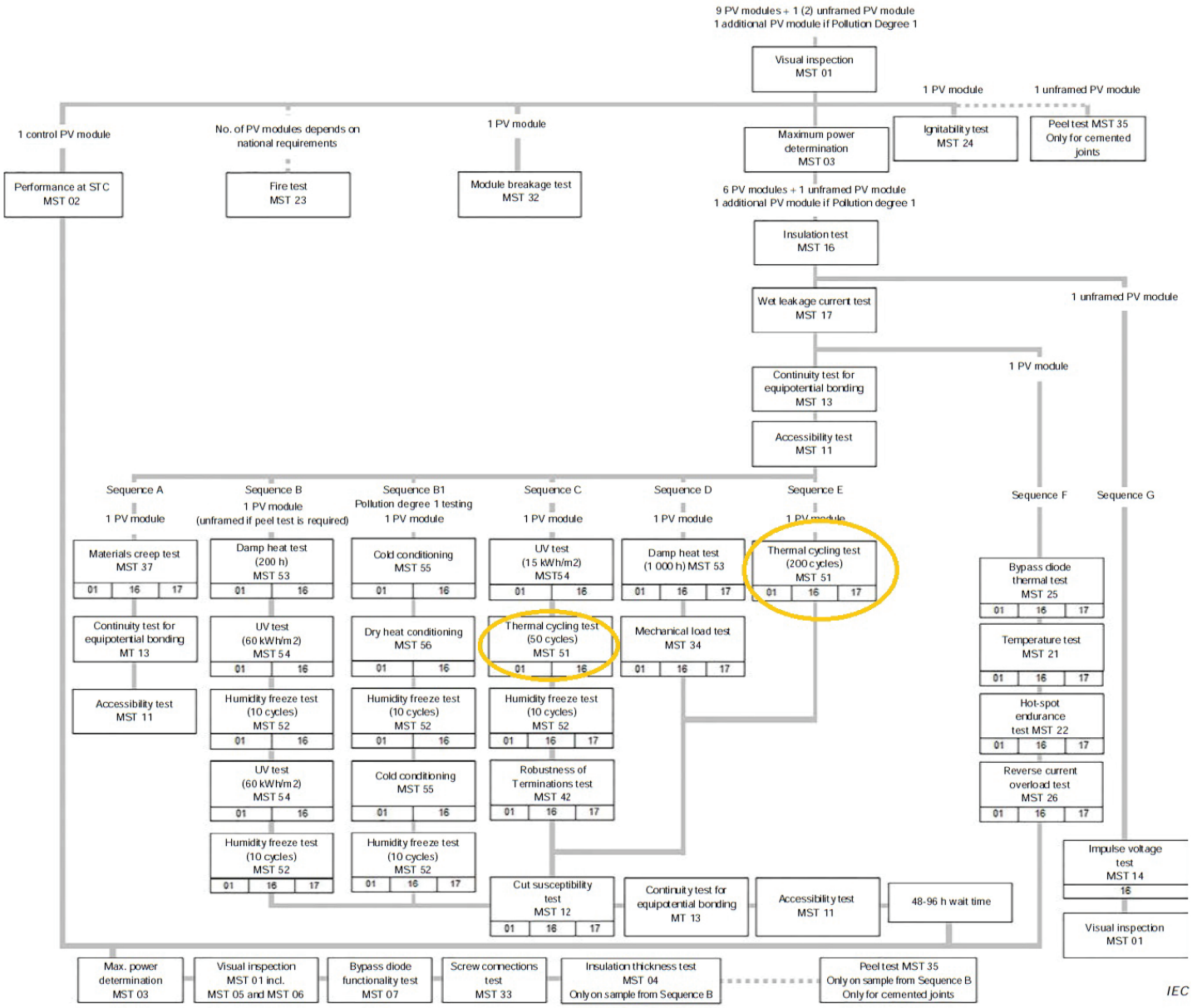

Figure 2 - Test Sequences

4. Appendix

Official Report from Intertek: Including Thermal Cycling Test, for Mitrex Framed and Honeycomb Backing Modules.

1.0 Reference and Address

Report Number	104527642LAX-001	Original Issued: 27-Feb-2022	Revised: 12-Sep-2022
Standard(s)	Photovoltaic (PV) Module Safety Qualification - Part 1: Requirements for Construction [UL 61730-1:2017 Ed.1] Photovoltaic (PV) Module Safety Qualification - Part 2: Requirements for Testing [UL 61730-2:2017 Ed.1] Photovoltaic (PV) Module Safety Qualification - Part 1: Requirements for Construction [CSA C22.2#61730-1:2019 Ed.2] Photovoltaic (PV) Module Safety Qualification - Part 2: Requirements for Testing [CSA C22.2#61730-2:2019 Ed.2] Photovoltaic (PV) Module Safety Qualification - Part 1: Requirements for Construction [IEC 61730-1:2016 Ed.2] Photovoltaic (PV) Module Safety Qualification - Part 2: Requirements for Testing [IEC 61730-2:2016 Ed.2]		

Applicant	Gcat Group Inc.	Manufacturer 1	**Gcat Group Inc.**
Address	41 Racine Road Toronto, ON M9W 2Z4	Address	41 Racine Road Toronto, ON M9W 2Z4
Country	Canada	Country	Canada
Contact	Danial Hadizadeh Hadi Khatibzadehazad	Contact	Danial Hadizadeh Hadi Khatibzadehazad
Phone	1 416 497 7120 1 416 875 8095	Phone	1 416 497 7120 1 416 875 8095
FAX	NA	FAX	NA
Email	danial.h@mitrex.com hadi.k@mitrex.com	Email	danial.h@mitrex.com hadi.k@mitrex.com

8.0 Test Summary					
Evaluation Period	12-28-2020 to 02-27-2022			Project No.	G104527642
Sample Rec. Date	22-Jun-2021	Condition	Production	Sample ID.	LAN2106220729
Test Location	25791 Commercentre Drive, Lake Forest, CA 92630				
Test Procedure	Testing Lab				
Determination of the result includes consideration of measurement uncertainty from the test equipment and methods. The product was tested as indicated below with results in conformance to the relevant test criteria.					
The following tests were performed:					

Test Description	UL/CSA/IEC 61730-2:2017 Ed.1
Visual inspection	MST 01
Maximum power determination	MST 03
Durability of markings	MST 05
Bypass diode functionality test	MST 07
Bypass diode thermal test	MST 25
Accessibility test	MST 11
Cut susceptibility test	MST 12
Continuity test of equipotential bonding	MST 13
Impulse voltage test	MST 14
Insulation test	MST 04
Wet leakage current test	MST 17
Temperature test	MST 21
Hot-spot endurance test	MST 22
Ignitability test	MST 24
Reverse current overload test	MST 26
Module breakage test	MST 32
Static mechanical load test	MST 34
Materials creep test	MST 37
Robustness of terminations test	MST 42
Thermal cycling test (50 & 200 cycles)	MST 51
Humidity freeze test	MST 52
Damp heat test	MST 53
UV test	MST 54
Cold conditioning	MST 55
Dry heat conditioning	MST 56

8.0 Test Summary					
Evaluation Period	06-30-2021 to 02-27-2022			Project No.	G104527642
Sample Rec. Date	30-Jun-2021	Condition	Production	Sample ID.	MID2106161125
Test Location	8431 Murphy Drive Middleton, WI 53562				
Test Procedure	Testing Lab				
Determination of the result includes consideration of measurement uncertainty from the test equipment and methods. The product was tested as indicated below with results in conformance to the relevant test criteria.					
Test Description			UL/CSA 61730-2:2017 Ed.1		
Fire Test			MST 23		
Evaluation Period	08-05-2022 to 09-08-2022			Project No.	G105076869
Sample Rec. Date	30-Jun-2021	Condition	Production	Sample ID.	LAN2208051251
Test Location	25791 Commercentre Drive, Lake Forest, CA 92630				
Test Procedure	Testing Lab				
Determination of the result includes consideration of measurement uncertainty from the test equipment and methods. The product was tested as indicated below with results in conformance to the relevant test criteria.					
Test Description			UL/CSA 61730-2:2017 Ed.1		
Maximum power determination			MST 03		

8.1 Signatures			
Representative samples of the product covered by this report has been evaluated and found to comply with the applicable requirements of the standards indicated in Section 1.0.			
Completed by:	Bo Li	Reviewed by:	Abhinav Prakash
Title:	Project Engineer	Title:	Reviewer
Signature:	Bo Li	Signature:	

9.0 Correlation Page For Multiple Listings	
The following products, which are identical to those identified in this report except for model number and Listee name, are authorized to bear the ETL label under provisions of the Intertek Multiple Listing Program.	
BASIC LISTEE	Gcat Group Inc.
Address	41 Racine Road Toronto, ON M9W 2Z4
Country	Canada
Product	Photovoltaic Module

MULTIPLE LISTEE 1	None
Address	
Country	
Brand Name	
ASSOCIATED MANUFACTURER	
Address	
Country	

MULTIPLE LISTEE 1 MODELS	BASIC LISTEE MODELS

MULTIPLE LISTEE 2	None
Address	
Country	
Brand Name	
ASSOCIATED MANUFACTURER	
Address	
Country	

MULTIPLE LISTEE 2 MODELS	BASIC LISTEE MODELS

MULTIPLE LISTEE 3	None
Address	
Country	
Brand Name	
ASSOCIATED MANUFACTURER	
Address	
Country	

MULTIPLE LISTEE 3 MODELS	BASIC LISTEE MODELS

1.0 Reference and Address			
Report Number	104527642LAX-002	Original Issued: 31-Mar-2022	Revised: 15-Nov-2022
Standard(s)	Photovoltaic (PV) Module Safety Qualification - Part 1: Requirements for Construction [UL 61730-1:2017 Ed.1] Photovoltaic (PV) Module Safety Qualification - Part 2: Requirements for Testing [UL 61730-2:2017 Ed.1] Photovoltaic (PV) Module Safety Qualification - Part 1: Requirements for Construction [CSA C22.2#61730-1:2019 Ed.2] Photovoltaic (PV) Module Safety Qualification - Part 2: Requirements for Testing [CSA C22.2#61730-2:2019 Ed.2] Photovoltaic (PV) Module Safety Qualification - Part 1: Requirements for Construction [IEC 61730-1:2016 Ed.2] Photovoltaic (PV) Module Safety Qualification - Part 2: Requirements for Testing [IEC 61730-2:2016 Ed.2]		

Applicant	Gcat Group Inc.	Manufacturer 1	**Gcat Group Inc.**
Address	41 Racine Road Toronto, ON M9W 2Z4	Address	41 Racine Road Toronto, ON M9W 2Z4
Country	Canada	Country	Canada
Contact	Danial Hadizadeh Hadi Khatibzadehazad	Contact	Danial Hadizadeh Hadi Khatibzadehazad
Phone	1 416 497 7120 1 416 875 8095	Phone	1 416 497 7120 1 416 875 8095
FAX	NA	FAX	NA
Email	danial.h@mitrex.com hadi.k@mitrex.com	Email	danial.h@mitrex.com hadi.k@mitrex.com

2.0 Product Description	
Product	Photovoltaic Module
Brand name	Mitrex
Description	The product covered by this report are flat-plate photovoltaic modules which convert elements of the electromagnetic spectrum to DC electrical power. The basic construction of the laminate consists of laminated assembly of individual solar cells and interconnecting ribbons encapsulated within an insulating material. This encapsulated assembly is pressed between a rigid transparent top surface, referred to as the superstrate, and an insulating back surface, referred to as the substrate. The laminated assembly is supported by a aluminum honeycomb structure. Modules are intended to be installed in accordance with the NEC and CEC.
	M followed by 330, 325, 320, 315, 310, 305, 300, 295, 290, 285, 280, 275, 270; followed by -GR01F612, -GR01H612, -BR03F612, -BR03H612, -SL01F612, -SL01H612, -MR02F611, -MR02H611. M followed by 300, 295, 290, 285, 280, 275, 270, 265, 260, 255, 250; followed by -GR01F611, -GR01H611, -BR03F611, -BR03H611, -SL01F611, -SL01H611, -MR02F610, -MR02H610, -MR02F512, -CL01H523. M followed by 275, 270, 265, 260, 255, 250, 245, 240, 235, 230, 225; followed by -GR01F610, -GR01H610, -BR03F610, -BR03H610, -SL01F610, -SL01H610, -GR01F512, -BR03F512, -SL01F512, -MR02F511, -RF04H523, -SD05H523, WD04F612, -WD04H612. M followed by 245, 240, 235, 230, 225, 220, 215, 210, 205; followed by -GR01F609, -GR01H609, -BR03F609, -BR03H609, -SL01F609, -SL01H609, -GR01F511, -BR03F511, -SL01F511, -MR02F510, -RF04F510, -SD05F510, -WD02F511, -RF02F610, -RF02H610, -RF02F512, -WD04F611, -WD04H611, -CL01H519. M followed by 220, 215, 210, 205, 200, 195, 190, 185, 180; followed by -GR01F608, -GR01H608, -BR03F608, -BR03H608, -SL01F608, -SL01H608, -GR01F412, -GR01H412, -BR03F412, -BR03H412, -SL01F412, -SL01H412, -MR02F411, -MR02H411, -RF04F509, -SD05F509, -WD02F510, -RF02F609, -RF02H609, -RF02H522, -SD08F511, -BR01H523, -SL02F610, -SL02H610, -SL02F512, -GR02F610, -GR02H610, -GR02F512, -ML01F610, -ML01H610, -ML01F512, -MR05F610, -MR05H610, -MR05F512, -BR04F611, -BR04H611, -MR03F612, -MR03H612, -GR03F612, -GR03H612. M followed by 190, 185, 180, 175, 170, 165, 160; followed by -GR01F607, -GR01H607, -BR03F607, -BR03H607, -SL01F607, -SL01H607, -MR01F509, -MR01H519, -LS03F509, -LS03H519, -ML02F509, -ML02H519, -SD08F608, -SD08H608,-SD08F412, -SD08H412, -WD04H521, -ML01H522, -MR05H522, -RF05H523, -RF05F511, -LS02H523, -LS02F511, -SD06F610, -SD06H610, -SD06F512, -SD01F612, -SD01H612, -CL01F606, -CL01H515, -CL01F409, -CL01H409, -CL01F312.

2.0 Product Description	
	M followed by 165, 160, 155, 150, 145, 140, 135; followed by -GR01F606, -BR03F606, -SL01F606, -GR01F409, -GR01H409, -BR03F409, BR03H409, -SL01F409, -SL01H409, -GR01F312, -BR03F312, -SL01F312, -MR02H323, -MR02F311, -RF04H323, -SD05H323, -RF02F508, -RF02H517, -RF02F410, -RF02H410, -SD08F607, -SD08H607, -BR01F607, -BR01H607, -WD04F411, -WD04H411, -SL02F509, -GR02F509, -ML01F509, -ML01H519, -MR05F509, -MR05H519, -RF05F608, -RF05H608, -RF05F412, -RF05H412, -LS02F608, -LS02H608, -LS02F412, -LS02H412, -BR04F510, -WD01F609, -WD01H609, -WD01H522, -MR03F609, -MR03H609, -MR03H523, -MR03F511, -GR03F609, -GR03H609, -GR03H523, -GR03F511, -WD03F610, -WD03H610, -WD03F512. M followed by 170, 165, 160, 155, 150, 145, 140; followed by -GR01H613, -BR03H613, -SL01H613, -RF04F507, -SD05F507, -MR01F508, -MR01F410, -MR01H410, -LS03F508, -LS03F410, -LS03H410, -ML02F508, -ML02F410, -ML02H410, -RF02F607, -RF02H607, -BR01F411, -BR01H411, -WD04F509, -WD04H519, -SL02H519, -GR02H519, -RF05F510, -LS02F510, -SD06H522, -BR04H521, -WD01H523, -WD01F511, -LS01F610, -LS01H610, -LS01F512, -CL01F408, -CL01H408, -CL01H322. M followed by 255, 250, 245, 240, 235, 230, 225, 220, 215, 210, 205; followed by -GR01H523, -BR03H523, -SL01H523.
	M followed by 240, 235, 230, 225, 220, 215, 210, 205, 200; followed by -GR01H522, -BR03H522, -SL01H522, -MR02F608, -MR02H608, -MR02F412, -MR02H412, -WD02F609, -WD02H609, -WD02H522, -SD08F610, -SD08H610, -SD08F512, -SL02F611, -SL02H611, -GR02F611, -GR02H611, -ML01F611, -ML01H611, MR05F611, MR05H611, -BR04F612, -BR04H612, -CL01F509. M followed by 225, 220, 215, 210, 205, 200, 195, 190, 185; followed by -GR01F510, -BR03F510, -SL01F510, -MR02F509, -RF04H519, -SD05H519, -MR01H522, -LS03H522, -ML02H522, -RF02F511, -SD08H523, -WD04F610, -WD04H610, -WD04F512, -WD01F612, -WD01H612, -CL01F607, -CL01H607. M followed by 230, 225, 220, 215, 210, 205, 200, 195, 190; followed by -GR01H521, -BR03H521, -SL01H521, -MR02H519, -WD02H521, -MR01F609, -MR01H609, -MR01F511, -LS03F609, -LS03H609, -LS03F511, -ML02F609, -ML02H609, -ML02F511, -RF02H523, -RF05F611, -RF05H611, -LS02F611, -LS02H611. M followed by 200, 195, 190, 185, 180, 175, 170; followed by -GR01F509,-BR03F509,-SL01F509, -MR02H517, -RF04F607, -RF04H607, -SD05F607, -SD05H607, -RF04H517, -SD05H517, -WD02H519, -MR01F608, -MR01H608, -MR01F412, -MR01H412, -LS03F608, -LS03H608, -LS03F412, -LS03H412, -ML02F608, -ML02H608, -ML02F412, -ML02H412, -RF02F510, -SD08H521, -WD04F609, -WD04H609, -WD04H522, -SL02F511, -GR02F511, -WD01F611, -WD01H611, -WD03F612, -WD03H612, -CL01H613. M followed by 205, 200, 195, 190, 185, 180, 175; followed by -GR01H519, -BR03H519, -SL01H519, -MR02F607, -MR02H607, -MR01F510, -LS03F510, -ML02F510, -RF02H521, -BR01H522, -WD04F511, -RF05F610, -RF05H610, -RF05F512, -LS02F610, -LS02H610, -LS02F512, -LS01F612, -LS01H612.

2.0 Product Description	
	M followed by 180, 175, 170, 165, 160, 155, 150; followed by -GR01F508, -BR03F508, -SL01F508, -GR01F410, -GR01H410, -BR03F410, -BR03H410, -SL01F410, -SL01H410, -MR02F606, -MR02H515, -MR02F409, -MR02H409, -MR02F312, -WD02H517, -RF02F509, -RF02F411, -RF02H411, -SD08F509, -SD08H519, -BR01H519, -ML01F510, -MR05F510, -SD06H523, -BR04F609, -BR04H609, -BR04F511, -MR03F610, -MR03H610, -MR03F512, -GR03F610, -GR03H610, -GR03F512, -WD03F611, -WD03H611, -CL01H323. M followed by 185, 180, 175, 170, 165, 160, 155; followed by -GR01H517, -BR03H517, -SL01H517, -MR02H613, -RF04H613, -SD05H613, -WD02F607, -WD02H607, -MR01F411, -MR01H411, -LS03F411, -LS03H411, -ML02F411, -ML02H411, -RF02H519, -BR01F608, -BR01H608, -BR01F412, -BR01H412, -WD04F510, -SL02F510, -SL02H521, -GR02F510, -GR02H521, -ML01H521, -MR05H521, -RF05F609, -RF05H609, -RF05H522, -LS02F609, -LS02H609, -LS02H522, -BR04H523, -WD01F610, -WD01H610, -WD01F512, -LS01F611, -LS01H611, -CL01F507. M followed by 155, 150, 145, 140, 135; followed by -GR01F507, -BR03F507, -SL01F507, -MR02F408, -MR02H408, -RF04F311, -SD05F311, -WD02F606, -WD02H515, -WD02F409, -WD02H409, -WD02F312, -MR01H613, -LS03H613, -ML02H613, -SD08F508, -SD08F410, -SD08H410, -BR01H517, -WD04F607, -WD04H607, -SL02F411, -SL02H411, -GR02F411, -GR02H411, -ML01F411, -ML01H411, -MR05F411, -MR05H411, -RF05H519, -LS02H519, -SD06F510, -BR04F608, -BR04H608, -BR04F412, -BR04H412, -LS01F511, -SD01F610, -SD01H610, -SD01F512, -CL01F506, -CL01F310. M followed by 160, 155, 150, 145, 140; followed by -GR01H515, -BR03H515, -SL01H515, -WD02H613, -SD08H517, -SD06H521, -CL01H321.
	M followed by 135, 130, 125, 120, 115; followed by -GR01F506, -BR03F506, -SL01F506, -GR01F310, -GR01H321, -BR03F310, -BR03H321, -SL01F310, -SL01H321, -MR02F407, -MR02H407, -MR02H319, -RF04F407, -RF04H407, -SD05F407, -SD05H407, -WD02H513, -MR01H323, -MR01F311, -LS03H323, -LS03F311, -ML02H323, -ML02F311, -SD08F507, -BR01F507, -WD04F606, -WD04H515, -WD04F409, -WD04H409, -WD04F312, -SL02H613, -GR02H613, -ML01H613, -MR05H613, -RF05F508, -RF05F410, -RF05H410, -LS02F508, -LS02F410, -LS02H410, -SD06F607, -SD06H607, -BR04F607, -BR04H607, -WD01F509, -WD01F411, -WD01H411, -MR03F509, -MR03H519, -GR03F509, -GR03H519, -LS01F608, -LS01H608, -LS01F412, -LS01H412, -WD03F510, -WD03H521, -SD01H522. M followed by 140, 135, 130, 125, 120; followed by -GR01H513, -BR03H513, -SL01H513, -GR01F408, -GR01H408, -BR03F408, -BR03H408, -SL01F408, -SL01H408, -GR01H322, -BR03H322, -SL01H322, -WD02F408, -WD02H408, -WD02H322, -RF02F507, -SD08F606, -SD08H515, -SD08F409, -SD08H409, -SD08F312, -BR01F606, -BR01H515, -BR01F409, -BR01H409, -BR01F312, -WD04H613, -ML01F508, -ML01F410, -ML01H410, -MR05F508, -MR05F410, -MR05H410, -RF05F607, -RF05H607, -RF05H517, -LS02F607, -LS02H607, -LS02H517, -SD06F509, -SD06F411, -SD06H411, -BR04F411, -BR04H411, -WD01H519, -MR03F608, -MR03H608, -MR03F412, -MR03H412, -GR03F608, -GR03H608, -GR03F412, -GR03H412 , -LS01F510, -LS01H521, -SD01F609, -SD01H609, -SD01H523, -SD01F511, -CL01F309. M followed by 195, 190, 185, 180, 175, 170, 165; followed by -GR01F411, -GR01H411, -BR03F411, -BR03H411, -SL01F411, -SL01H411, -MR02F508, -MR02F410, -MR02H410, -RF04F508, -RF04F410, -RF04H410, -SD05F508, -SD05F410, -SD05H410, -WD02F509, -WD02F411, -WD02H411, -RF02F608, -RF02H608, -RF02F412, -RF02H412, -SD08F510, -BR01F510, -BR01H521, -SL02F609, -SL02H609, -SL02H522, -GR02F609, -GR02H609, -GR02H522, -ML01F609, -ML01H609, -ML01F511, -MR05F609, -MR05H609, -MR05F511, -BR04F610, -BR04H610, -BR04F512, -MR03F611, -MR03H611, -GR03F611, -GR03H611.

2.0 Product Description	
Models	M followed by 125, 120, 115, 110, 105; followed by -GR01F407, -GR01H407, -BR03F407, -BR03H407, -SL01F407, -SL01H407, -MR01F506, -MR01F310, -MR01H321, -LS03F506, -LS03F310, -LS03H321, -ML02F506, -ML02F310, -ML02H321, -RF02H513, -RF02H322, -SD08F408, -SD08H408, -SD08H322, -BR01F408, -BR01H408, -BR01H323, BR01F311, -SL02F507, -GR02F507, -ML01F507, -MR05F507, -RF05F606, -RF05H613, -RF05F409, -RF05H409, -RF05F312, -LS02F606, -LS02H613, -LS02F409, -LS02H409, -LS02F312, -SD06F508, -SD06F410, -SD06H410, -WD01F607, -WD01H607, -WD01H517, -MR03F607, -MR03H607, -GR03F607, -GR03H607, -LS01F509, -LS01F411, -LS01H411, -WD03F509, -WD03H519, -SD01F608, -SD01H608, -SD01F412, -SD01H412, -CL01F406, -CL01F308. M followed by 110, 105, 100, 095, 090; followed by -GR01, -BR03, -SL01; followed by F, H; followed by 406. M followed by 150, 145, 140, 135, 130, 125, 120; followed by -GR01H323, -BR03H323, -SL01H323. M followed by 145, 140, 135, 130, 125; followed by -GR01F311, -BR03F311, -SL01F311, -MR02F506, -MR02F310, -MR02H321, -RF04F506, -RF04F310,, -RF04H321, -SD05F506,, -SD05F310, -SD05H321, -WD02H323, -WD02F311, -MR01F507, -LS03F507, -ML02F507, -RF02F606, -RF02H515, -RF02F409, -RF02H409, -RF02F312, -SD08H613, -BR01H613, -WD04F508, -WD04F410, -WD04H410, -SL02F508, -SL02H517, -SL02F410, -SL02H410, -GR02F508, -GR02H517, -GR02F410, -GR02H410, -ML01H517, -MR05H517, -SD06H519, -BR04F509, -WD01F608, -WD01H608, -WD01F412, -WD01H412, -MR03F510, -GR03F510, -WD03F609, -WD03H609, -WD03H522, -CL01F407, -CL01H407, -CL01H319. M followed by 120, 115, 110, 105, 100; followed by -GR01F309, -GR01H319, -BR03F309, -BR03H319, -SL01F309, -SL01H319, -MR02F406, -MR02H413, -MR02F308, -MR02H317, -RF04H413, -RF04H317, -SD05H413, -SD05H317, -WD02F407, -WD02H407, -WD02F309, -WD02H319, -RF02F506, -RF02F310, -RF02H321, -SD08F506, -SD08H513, -SD08F310, -SD08H321, -BR01H513, -BR01H322, -WD04F408, -WD04H408, -WD04H323, -WD04F311, -SL02H323, -SL02F311, -GR02H323, -GR02F311, -ML01H323, -ML01F311, -MR05H323, -MR05F311, -RF05F507, -RF05H515, -LS02F507, -LS02H515, -SD06H613, -BR04F606, -BR04H613, -BR04F409, -BR04H409, -BR04F312, -WD01F508, -WD01F410, -WD01H410, -MR03F508, -MR03H517, -MR03F410, -MR03H410, -GR03F508, -GR03H517, -GR03F410, -GR03H410, -LS01F607, -LS01H607, -WD03F411, -WD03H411, -SD01H519. M followed by 110, 105, 100, 095, 090; followed by -GR01F308, -GR01H317, -BR03F308, -BR03H317, -SL01F308, -SL01H317, -RF02F309, -RF02H319, -SD08F407, -SD08H407, -BR01F407, -BR01H407, -WD04F506, -WD04F310, -WD04H321, -SL02F506, -SL02F310, -SL02H321, -GR02F506, -GR02F310, -GR02H321, -ML01F506, -ML01H513, -ML01F310, -ML01H321, -MR05F506, -MR05H513, -MR05F310, -MR05H321, -RF05F408, -RF05H408, -RF05H322, -LS02F408, -LS02H408, -LS02H322, -SD06F507, -BR04F311, -BR04H323, -WD01F606, -WD01F409, -WD01H409, -WD01F312, -MR03F606, -MR03H613, -MR03F409, -MR03H409, -MR03F312, -GR03F606, -GR03H613, -GR03F409, -GR03H409, -GR03F312, -WD03F508, -WD03H517, -WD03F410, -WD03H410, -SD01F607, -SD01H607, -CL01F307. M followed by 090, 085, 080; followed by -GR01F307, -GR01H315, -BR03F307, -BR03H315, -SL01F307, -SL01H315, -WD02F307, -WD02H315, -SD08F406, -SD08F308, -SD08H317, -BR01F406, -BR01H413, -BR01F308, -BR01H317, -WD04H413, -RF05F407, -RF05H407, -RF05F309, -RF05H319, -LS02F407, -LS02H407, -LS02F309, -LS02H319, -SD06F506, -SD06F310, -SD06H321, -BR04F407, -BR04H407, -WD01F506, -WD01H513, -WD01H322, -WD01F310, -MR03H513, -MR03F408, -MR03H408, -MR03H322, -GR03H513, -GR03F408, -GR03H408, -GR03H322, -LS01H323, -LS01F311, -WD03F507, -SD01F606, -SD01H613, -SD01F507, -SD01H515, -SD01F409, -SD01H409, -SD01F312, -CL01F306.

2.0 Product Description	
	M followed by 080, 075, 070; followed by -GR01F306, -GR01H313, -BR03F306, -BR03H313, -SL01F306, -SL01H313, -RF02F307, -RF02H315, -SD08F307, -SD08H315, -BR01F307, -BR01H315, -RF05F406, -RF05H413, -RF05F308, -RF05H317, -LS02F406, -LS02H413, -LS02F308, -LS02H317, -WD01F407, -WD01H407, -WD01F309, -WD01H319, -MR03F407, -MR03H407, -MR03F309, -GR03F407, -GR03H407, -GR03F309, -LS01F506, -LS01F310, -LS01H321, -WD03F506, -WD03H513, -WD03H322, -WD03F310, -WD03H321, -SD01F408, -SD01H408, -SD01H323, -SD01H322. M followed by 360, 355, 350, 345, 340, 335, 330, 325, 320, 315, 310, 305, 300; followed by -MR02; followed by F, H; followed by 612. M followed by 265, 260, 255, 250, 245, 240, 235, 230, 225; followed by -MR02F609, -MR02H609, -RF04F511, -SD05F511, -WD02F610, -WD02H610, -WD02F512, -RF02F611, -RF02H611, -SL02F612, -SL02H612, -GR02F612, -GR02H612, -CL01F510. M followed by 280, 275, 270, 265, 260, 255, 250, 245, 240, 235, 230; followed by -MR02H523, -MR01F611, -MR01H611, -LS03F611, -LS03H611, -ML02F611, -ML02H611. M followed by 270, 265, 260, 255, 250, 245, 240, 235, 230, 225, 220; followed by -MR02H522. M followed by 255, 250, 245, 240, 235, 230, 225, 220, 215; followed by -MR02H521, -BR01F611, -BR01H611, -CL01F608, -CL01H608, -CL01F412, -CL01H412.
	M followed by 175, 170, 165, 160, 155, 150, 145; followed by -MR02F507, -RF04F606, -RF04H515, -RF04F409, -RF04H409, -RF04F312, -SD05F606, -SD05H515, -SD05F409, -SD05H409, -SD05F312, -WD02F508, -WD02F410, -WD02H410, -MR01F607, -MR01H607, -MR01H517, -LS03F607, -LS03H607, -LS03H517, -ML02F607, -ML02H607, -ML02H517, -SD08F411, -SD08H411, -BR01F509, -SL02F608, -SL02H608, -SL02F412, -SL02H412, -GR02F608, -GR02H608, -GR02F412, -GR02H412, -ML01F608, -ML01H608, -ML01F412, -ML01H412, -MR05F608, -MR05H608, -MR05F412, -MR05H412, -RF05H521, -LS02H521, -SD06F609, -SD06H609, -SD06F511, -BR04H522, -SD01F611, -SD01H611, -CL01F311. M followed by 150, 145, 140, 135, 130; followed by -MR02H513, -RF04H513, -RF04F408, -RF04H408, -RF04H322, -SD05H513, -SD05F408, -SD05H408, -SD05H322, -WD02F507, -MR01F606, -MR01F312, -LS03F606, -LS03F312, -ML02F606, -ML02F312, -MR01H515, -MR01F409, -MR01H409, -LS03H515, -LS03F409, -LS03H409, -ML02H515, -ML02F409, -ML02H409, -RF02H613, -BR01F508, -BR01F410, -BR01H410, -WD04H517, -SL02F607, -SL02H607, -GR02F607, -GR02H607, -ML01F607, -ML01H607, -MR05F607, -MR05H607, -RF05F509, -RF05F411, -RF05H411, -LS02F509, -LS02F411, -LS02H411, -SD06F608, -SD06H608, -SD06F412, -SD06H412, -BR04H519, -WD01F510, -WD01H521, -MR03H521, -GR03H521, -LS01F609, -LS01H609, -LS01H522, -WD03F511. M followed by 160, 155, 150, 145, 140, 135, 130; followed by -MR02H322, -MR03H522, -GR03H522, -LS01H523.

2.0 Product Description

M followed by 130, 125, 120, 115, 110; followed by -MR02F309, -RF04F309, -RF04H319, -SD05F309, -SD05H319, -WD02F506, -WD02F310, -WD02H321, -MR01H513, -MR01F408, -MR01H408, -MR01H322, -LS03H513, -LS03F408, -LS03H408, -LS03H322, -ML02H513, -ML02F408, -ML02H408, -ML02H322, -RF02F408, -RF02H408, -RF02H323, RF02F311, -SD08H323, -SD08F311, -WD04F507, -SL02F606, -SL02H515, -SL02F409, -SL02H409, -SL02F312, -GR02F606, -GR02H515, -GR02F409, -GR02H409, -GR02F312, -ML01F606, -ML01H515, -ML01F409, -ML01H409, -ML01F312, -MR05F606, -MR05H515, -MR05F409, -MR05H409, -MR05F312, -SD06H517, -BR04F508, -BR04H517, -BR04F410, -BR04H410, -MR03F411, -MR03H411, -GR03F411, -GR03H411, -LS01H519, -WD03F608, -WD03H608, -WD03F412, -WD03H412, -SD01F510, -SD01H521, -CL01H413, -CL01H317.
M followed by 100, 095, 090; followed by -MR02F307, -MR02H315, -RF04H315, -SD05H315, -WD02F406, -WD02F308, -WD02H317, -MR01H413, -LS03H413, -ML02H413, -SD08F309, -SD08H319, -BR01F309, -BR01H319, -WD04F407, -WD04H407, -SL02F407, -SL02H407, -GR02F407, -GR03H407, -RF05F506, -RF05H513, -RF05F310, -RF05H321, -LS02F506, -LS02H513, -LS02F310, -LS02H321, -SD06F408, -SD06H408, -SD06F311, -BR04F408, -BR04H408, -WD01F507, -MR03F507, -MR03H515, -GR03F507, -GR03H515, -LS01F606, -LS01H613, -LS01F409, -LS01H409, -LS01F312, -WD03H613, -SD01F508, -SD01H517, -SD01F410, -SD01H410.
M followed by 085, 080, 075; followed by -MR02F306, -MR02H313, -RF04F306, -RF04H313, -SD05F306, -SD05H313, -MR01F307, -MR01H315, -LS03F307, -LS03H315, -ML02F307, -ML02H315, -WD04F406, -WD04F308, -WD04H317, -SL02F406, -SL02H413, -SL02F308, -SL02H317, -GR02F406, -GR02H413, -GR02F308, -GR02H317, -ML01F406, -ML01H413, -ML01F308, -ML01H317, -MR05F406, -MR05H413, -MR05F308, -MR05H317, -SD06F407, -SD06H407, -SD06F309, -SD06H319, -BR04F309, -BR04H319, -WD01H321, -MR03F506, -MR03F310, -MR03H321, -GR03F506, -GR03F310, -GR03H321, -LS01H513, -LS01F408, -LS01H408, -LS01H322, -WD03F408, -WD03H408, -WD03H323, -WD03F311, -SD01F311.

M followed by 355, 350, 345, 340, 335, 330, 325, 320, 315, 310, 305, 300, 295; followed by -RF04F612, -RF04H612, -SD05F612, -SD05H612, -CL01F611, -CL01H611.
M followed by 320, 315, 310, 305, 300, 295, 290, 285, 280, 275, 270; followed by -RF04F611, -RF04H611, -SD05F611, -SD05H611, -WD02F612, -WD02H612, -CL01F610, -CL01H610, -CL01F512.
M followed by 295, 290, 285, 280, 275, 270, 265, 260, 255, 250, 245; followed by -RF04F610, -RF04H610, -RF04F512, -SD05F610, -SD05H610, -SD05F512, -WD02F611, -WD02H611, -RF02F612, -RF02H612, -CL01F511.
M followed by 260, 255, 250, 245, 240, 235, 230, 225, 220; followed by -RF04F609, -RF04H609, -RF04H522, -SD05F609, -SD05H609, -SD05H522, -SD08F611, -SD08H611, -ML01F612, -ML01H612, -MR05F612, -MR05H612.
M followed by 235, 230, 225, 220, 215, 210, 205, 200, 195; followed by -RF04F608, -RF04H608, -RF04F412, RF04H412, -SD05F608, -SD05H608, -SD05F412, SD05H412, -MR01H523, -LS03H523, -ML02H523, -BR01F610, -BR01H610, -BR01F512, -SD06F612, -SD06H612, -CL01F411, -CL01H411.
M followed by 250, 245, 240, 235, 230, 225, 220, 215, 210; followed by -RF04H521, -SD05H521, -WD02H523, -MR01F610, -MR01H610, -MR01F512, -LS03F610, -LS03H610, -LS03F512, -ML02F610, -ML02H610, -ML02F512, -RF05F612, -RF05H612, -LS02F612, -LS02H612.
M followed by 210, 205, 200, 195, 190, 185, 180; followed by -RF04F411, -RF04H411, -SD05F411, -SD05H411, -WD02F608, -WD02H608, -WD02F412, -WD02H412, -MR01H521, -LS03H521, -ML02H521, -SD08F609, -SD08H609, -BR01F609, -BR01H609, -BR01F511, -SD06F611, -SD06H611, -CL01F508, -CL01F410, -CL01H410.

2.0 Product Description	
	M followed by 115, 110, 105, 100, 095; followed by -RF04F406, -RF04F308, -SD05F406, -SD05F308, -MR01F407, -MR01H407, -MR01F309, -MR01H319, -LS03F407, -LS03H407, -LS03F309, -LS03H319, -ML02F407, -ML02H407, -ML02F309, -ML02H319, -RF02F407, -RF02H407, -BR01F506, -BR01F310, -BR01H321, -WD04H513, -WD04H322, -SL02H513, -SL02F408, -SL02H408, -SL02H322, -GR02H513, -GR02F408, -GR02H408, -GR02H322, -ML01F408, -ML01H408, -ML01H322, -MR05F408, -MR05H408, -MR05H322, -RF05H323, -RF05F311, -LS02H323, -LS02F311, -SD06F606, -SD06H515, -SD06F409, -SD06H409, -SD06F312, -BR04F507, -BR04H515, -WD01H613, -LS01F508, -LS01H517, -LS01F410, -LS01H410, -WD03F607, -WD03H607, -SD01F509, -SD01F411, -SD01H411, -CL01H315. M followed by 095, 090, 085; followed by -RF04F307, -SD05F307, -MR01F406, -MR01F308, -MR01H317, -LS03F406, -LS03F308, -LS03H317, -ML02F406, -ML02F308, -ML02H317, -RF02F406, -RF02H413, -RF02F308, -RF02H317, -SD08H413, -WD04F309, -WD04H319, -SL02F309, -SL02H319, -GR02F309, -GR02H319, -ML01F407, -ML01H407, -ML01F309, -ML01H319, -MR05F407, -MR05H407, -MR05F309, -MR05H319, -SD06H513, -SD06H322, -BR04F506, -BR04H513, -BR04F310, -BR04H321, -WD01F408, -WD01H408, -WD01F311, -MR03F311, -GR03F311, -LS01F507, -LS01H515, -WD03F606, -WD03H515, -WD03F409, -WD03H409, -WD03F312, -CL01H313. M followed by 105, 100, 095; followed by -WD02H413, -WD01H515. M followed by 075, 070, 065; followed by -WD02F306, -WD02H313, -MR01F306, -MR01H313, -LS03F306, -LS03H313, -ML02F306, -ML02H313, -WD04F307, -WD04H315, -SL02F307, -SL02H315, -GR02F307, -GR02H315, -ML01F307, -ML01H315, -MR05F307, -MR05H315, -SD06F406, -SD06H413, -SD06F308, -SD06H317, -BR04F406, -BR04H413, -BR04F308, -BR04H317, -MR03H319, -GR03H319, -LS01F407, -LS01H407, -LS01F309, -LS01H319, -WD03F407, -WD03H407, -SD01F506, -SD01H513, -SD01F310, -SD01H321.
	M followed by 305, 300, 295, 290, 285, 280, 275, 270, 265, 260, 255; followed by -MR01, -LS03, ML02; followed by F, H; followed by 612. M followed by 070, 065, 060; followed by -RF02F306, -RF02H313, -SD08F306, -SD08H313, -BR01F306, -BR01H313, -RF05F307, -RF05H315, -LS02F307, -LS02H315, -WD01F406, -WD01H413, -WD01F308, -WD01H317, -MR03F406, -MR03H413, -MR03F308, -MR03H317, -GR03F406, -GR03H413, -GR03F308, -GR03H317, -WD03F309, -WD03H319, -SD01F407, -SD01H407, -SD01F309. M followed by 290, 285, 280, 275, 270, 265, 260, 255, 250, 245, 240; followed by -SD08F612, -SD08H612, -CL01F609, -CL01H609, -CL01H522. M followed by 215, 210, 205, 200, 195, 190, 185, 180, 175; followed by -SD08G522. M followed by 285, 280, 275, 270, 265, 260, 255, 250, 245, 240, 235; followed by -BR01; followed by F, H; followed by 612. M followed by 180, 175, 170, 165, 155, 150; followed by -WD04F608, -WD04H608, -WD04F412, -WD04H412. M followed by 210, 205, 200, 195, 190, 185, 180, 175, 170; followed by -WD04H523, -SL02H523, -GR02H523. M followed by 065, 060, 055; followed by -WD04F306, -WD04H313, -SL02F306, -SL02H313, -GR02F306, -GR02H313, -ML01F306, -ML01H313, -MR05F306, -MR05H313, -SD06F307, -SD06H315, -BR04F307, -BR04H315, -LS01F406, -LS01H413, -LS01F308, -LS01H317, -WD03F406, -WD03H413, -WD03F308, -WD03H317, -SD01H319.

2.0 Product Description	
	M followed by 205, 200, 195, 190, 185, 180, 175, 170, 165; followed by -ML01H523, -MR05H523. M followed by 060, 055, 050; followed by -RF05F306, -RF05H313, -LS02F306, -LS02H313, -BR04F306, -WD01F307, -WD01H315, -MR03F307, -MR03H315, -GR03F307, -GR03H315, -LS01F307, -LS01H315, -SD01F406, -SD01H413, -SD01F308, -SD01F317. M followed by 105, 100, 095, 090, 085; followed by -SD06H323, -BR04H322. M followed by 055, 050, 045; followed by -SD06F306, -SD06H313, -WD01F306, -WD01H313, -MR03F306, -GR03F306, -WD03F307, -WD03H315, -SD01F307, -BR04H313. M followed by 100, 095, 090, 085, 080; followed by -WD01H323, -MR03H323, -GR03H323. M followed by 045; followed by -LS01F306, -LS01H313, -WD03F306, -WD03H313. M followed by 155, 150, 145, 140, 135, 130, 125; followed by -WD03H523. M followed by 050, 045, 040; followed by -SD01H315, -MR03H313, -GR03H313. M followed by 040; followed by -SD01F306, -SD01H313. M followed by 390, 385, 380, 375, 370, 365, 360, 355, 350, 345, 340, 335, 330, 325, 320; followed by -CL01; followed by F, H; followed by 612. M followed by 270, 265, 260, 255, 250, 245, 240, 235, 230; followed by -CL01H521. M followed by 215, 210, 205, 200, 195, 190, 185; followed by -CL01H517. M followed by 165, 160, 155, 150, 145; followed by -CL01H513.
Model Similarity	All models of modules are similar in construction but differ in output voltage, power, current ratings, cell number and module dimension. The generic model nomenclature is Mxxx-yyzzAbcc: M: Denotes Mitrex xxx: Denotes the power in Watts yy: Denotes the superstrate pattern [GR = Granite; MR = Marble; RF = Roof; SD = Solid; BR = Brick; SL = Slate; WD = Wood; LS = Limestone; ML = Metal; CL = Clear.] zz: Denotes pattern number on related category A: Denotes type of cell, F for full cell and H for half cell b: Denotes number of strings (cell columns) cc: Denotes number of cells per string
Ratings	See illustrations 2a to 2by

8.0 Test Summary					
Evaluation Period	12-28-2020 to 03-31-2022			Project No.	G104527642
Sample Rec. Date	22-Jun-2021	Condition	Production	Sample ID.	LAN2106220729
Test Location	25791 Commercentre Drive, Lake Forest, CA 92630				
Test Procedure	Testing Lab				

Determination of the result includes consideration of measurement uncertainty from the test equipment and methods. The product was tested as indicated below with results in conformance to the relevant test criteria.

Due to prior testing performed under the Report 104527642LAX-001 only the following tests were performed:

Test Description	UL/CSA/IEC 61730-2:2017 Ed.1
Visual inspection	MST 01
Maximum power determination	MST 03
Durability of markings	MST 05
Bypass diode functionality test	MST 07
Impulse voltage test	MST 14
Insulation test	MST 04
Wet leakage current test	MST 17
Hot-spot endurance test	MST 22
Reverse current overload test	MST 26
Module breakage test	MST 32
Static mechanical load test	MST 34
Materials creep test	MST 37
Thermal cycling test	MST 51
Humidity freeze test	MST 52
Damp heat test	MST 53
UV test	MST 54

8.0 Test Summary					
Evaluation Period	06-30-2021 to 03-31-2022			Project No.	G104527642
Sample Rec. Date	30-Jun-2021	Condition	Production	Sample ID.	MID2106161125
Test Location	8431 Murphy Drive Middleton, WI 53562				
Test Procedure	Testing Lab				
Determination of the result includes consideration of measurement uncertainty from the test equipment and methods. The product was tested as indicated below with results in conformance to the relevant test criteria.					

Test Description			UL/CSA 61730-2:2017 Ed.1		
Fire Test			MST 23		
Evaluation Period	11-10-2022 to 11-15-2022			Project No.	G105076869
Sample Rec. Date	N/A	Condition	Production	Sample ID.	N/A
Test Location	8431 Murphy Drive Middleton, WI 53562				
Test Procedure	Testing Lab				
Tests were done in previous projects. No test is needed to add additional the model numbers.					

8.1 Signatures			
A representative sample of the product covered by this report has been evaluated and found to comply with the applicable requirements of the standards indicated in Section 1.0.			
Completed by:	Bo Li	Reviewed by:	Abhinav Prakash
Title:	Project Engineer	Title:	Reviewer
Signature:	Bo Li	Signature:	

9.0 Correlation Page For Multiple Listings	
The following products, which are identical to those identified in this report except for model number and Listee name, are authorized to bear the ETL label under provisions of the Intertek Multiple Listing Program.	
BASIC LISTEE	Gcat Group Inc.
Address	41 Racine Road Toronto, ON M9W 2Z4
Country	Canada
Product	Photovoltaic Module

MULTIPLE LISTEE 1	None
Address	
Country	
Brand Name	
ASSOCIATED MANUFACTURER	
Address	
Country	

MULTIPLE LISTEE 1 MODELS	BASIC LISTEE MODELS

MULTIPLE LISTEE 2	None
Address	
Country	
Brand Name	
ASSOCIATED MANUFACTURER	
Address	
Country	

MULTIPLE LISTEE 2 MODELS	BASIC LISTEE MODELS

MULTIPLE LISTEE 3	None
Address	
Country	
Brand Name	
ASSOCIATED MANUFACTURER	
Address	
Country	

MULTIPLE LISTEE 3 MODELS	BASIC LISTEE MODELS

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