1. **Overview**: Visual acceptance criteria applicable to P type (PERC) & N type (TOPCon) Bifacial and Mono facial modules

1.1 Purpose: The purpose of this document is to describe the acceptance criteria for Visual Appearance of PV module

1.2 Defect Classification for Visual Inspection of Modules:

Defects detected during inspection are classified in three different categories as follows:

- **Critical (Cr):** A latent of overt defect that is likely to result in a hazardous or unsafe condition for the individual using themodule, contravenes mandatory regulations and/or may cause damage to other products or property

- **Major (Ma):** A latent or overt defect that could impair the usability or result in under-performance or premature failure of the module

- **Minor (Mi):** A latent or overt defect that does not impair the usability of the PV module, but is nevertheless considereda workmanship defect beyond normal, acceptable quality standards. This includes obvious visual defects. Any module with purely minor defects should not be cause for rejection.

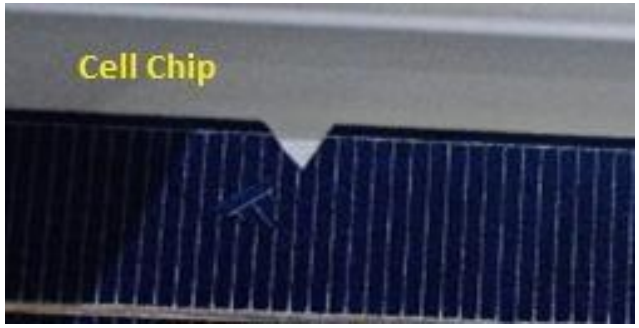
1.3 VISUAL INSPECTION Method:

DURATION: Visual inspection time is approximately 30 seconds per module.

LIGHTING: Visual inspection is performed under 1000 lux daylight fluorescent lamp and perpendicular to the surface of inspection.

DISTANCE: The module should be inspected at a distance of 1m to the eyes.

1) Solar Cells(Front or back)

S/N	VISUAL INSPECTION PARAMETER	DEFECT CODE	DEFECT CLASS	DEFECT REPRESENTATION	DEFECT DESCRIPTION	ACCEPTANCE CRITERION
1	Cell Crack	1	Major		Any crack visible by naked eye without magnification or backlight	Non-Conforming
2	Cell chip	2	Major		U chip / V chip or any other chip in cell extending to grid line	**V chip** is not allowed. **For U Chip:** if L≤3mm, width < 1mm, 1/cell, 4/module, should not reach grid lines

S/N	VISUAL INSPECTION PARAMETER	DEFECT CODE	DEFECT CLASS	DEFECT REPRESENTATION	DEFECT DESCRIPTION	ACCEPTANCE CRITERION
3	Cell Scratch	3	Minor		Any scratch on cell visible by naked eye but not affecting the cell integrity or printing	**Front side:** L<=10mm: Ignore 10mm < L ≤ 50 mm, and ≤ 1 scratch per cell and not visible from 1 m Distance: 2 cells per module allowed L>50mm or visible from 1m distance: Not allowed **Rear Side:** L ≤ 20mm: Ignore 20mm < L ≤ 80 mm and <=1 scratch per cell and not visible from 1m Distance: 10% of cells per Module allowed L > 80mm or visible from 1m distance not allowed
4	Finger Interruption	4	Minor		Grid line missing in solar cells	Length should be ≤ 2mm **Qty. Allowed**: 4 within a cell & 3 such cells in a module **For Rear side**: no count
5	Pin Hole in cell	5	Minor		Visible hole in cell	Non-conforming

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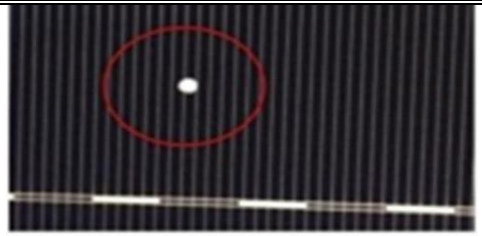
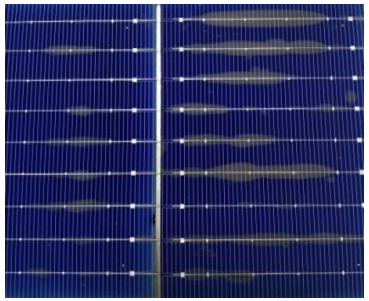
6	Soiling/ Flux mark/ Paste Stain on cell	6	Minor	 	Any stain, smear and smudge on cell	Accept any nonconductive soiling, flux mark and paste stain not visible from 1m distance Soiling area & flux mark ≤ 100mm2, Q ≤ 6/module Paste stain on cell Non-Conforming if: if area of stain is > 1 mm² **Quantity Allowed**: one cell per module
7	Leakage (soldering particle on active area)	7	Minor		Soldering and Back sheet flake on cell	**Solder flake:** ≤3mm should not cross two fingers Q < 1/cell, Q < 3/module **Back sheet flake:** ≤5mm

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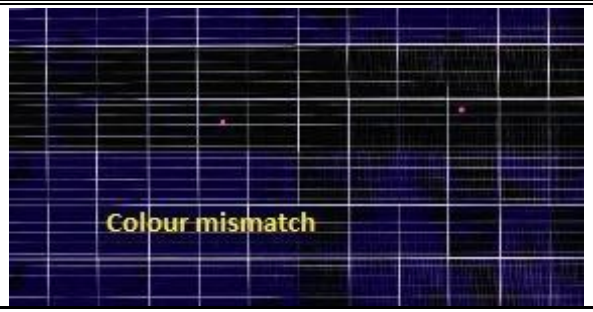
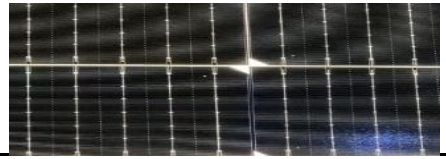
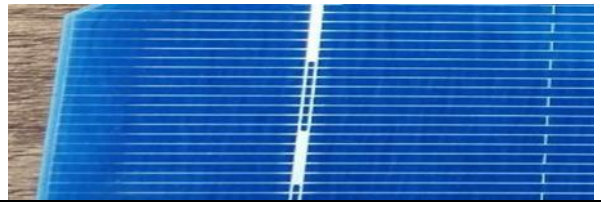
8	Color Variation	8	Minor		Color Difference Between Cells	**Front**: Minor Color Mismatch allowed from Viewing Distance 1.5 m **Rear side for Bifacial module:** Color mismatch allowed but different color more than 20% of cell area not allowed
9	Gap between cell to cell/String to string	9/9A	Minor	 	Gap between Cell to Cell and String to string not maintained	Cell to Cell gap: Minimum 0.2mm String to String gap: Minimum 0.3mm (As per IEC 61730 creepage distance requirements)
10	Cell oxidation	10	Major		Grid color shall be consistent	No yellowing of fingers allowed and Gridlines should be visible

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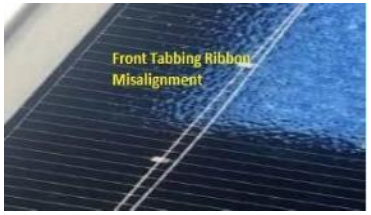
11	Ribbon Misalignment (Front/Back)	11	Minor	  	Misalignment of ribbon or parallel shifting ribbon twist, ribbon bend from front or back side of cells	The distance of deviation allowed is: **Front**: Up to 50% of distance between cell busbars, Up to 50% of distance from cell busbar to cell edge, Up to 3/cell if 3/4th of cell busbar length is covered by ribbon, Up to 1/cell if 1/4th of the cell busbar length is covered by ribbon Up to 5% of total cells/module allowed for above Up to 10% of total cells/module allowed if no point off without soldering **Rear (for Bifacial modules)**: Up to 75% of distance between cell busbars, Up to 75% of distance from cell busbar to cell edge Up to 3/cell if 3/4th of cell busbar length is covered by ribbon Up to 1/cell if 1/4th of the cell busbar length is covered by ribbon Up to 5% of total cells/module allowed for above Up to 50% of total cells/module allowed if no point off without soldering **Note**: Deviation distance to be measured from edge of soldering pad

S/N	VISUAL INSPECTION PARAMETER	DEFECT CODE	DEFECT CLASS	DEFECT REPRESENTATION	DEFECT DESCRIPTION	ACCEPTANCE CRITERION

12	String misalignment from side edge of module (Matrix Shift)	12	Major		Minimumspace between frame and cells not maintained	The distance between cell edge to frame inner edge should not be less than 1.5 mm at any point (or) Cell edge to Glass edge ≥ 10.4mm at any point
13	Gap between cell edge & interconnect	13	Major		Gap between interconnect and cell less	The Distance between Cell edge and interconnect should be ≥ 1 mm
14	Different Cell Pattern	14	Minor		Different pattern of cells in same module	Different cell pattern in same module not allowed. In same batch it should be allowed.

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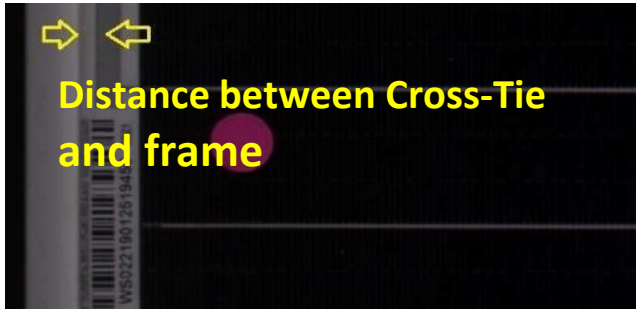
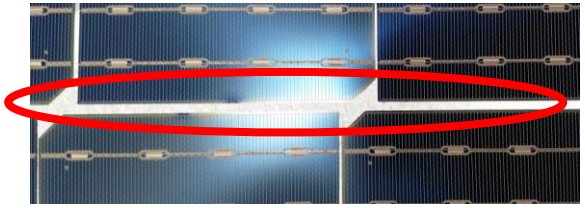
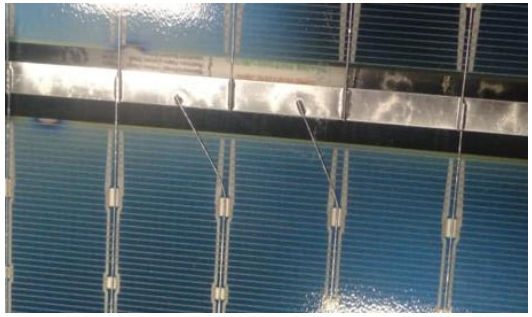
15	Distance between Cross-Ties	15	Major		The distance between cross-ties to be maintained.	Non-conforming if distance between cross-ties < 2mm
16	Distance between String Interconnector (Cross-Tie) and Frame	16	Major		The distance between interconnector and frame should be maintained.	Non-conforming if distance between outer cross-tie and frame < 2mm
17	String Offset	17	Minor		Misalignment betweenStrings	Non-conforming if minimum creepage distances are not met

S/N	VISUAL INSPECTION PARAMETER	DEFECT CODE	DEFECT CLASS	DEFECT REPRESENTATION	DEFECT DESCRIPTION	ACCEPTANCE CRITERION

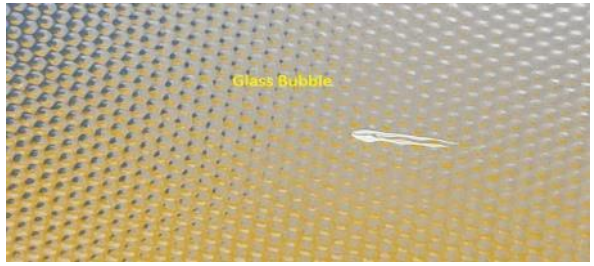
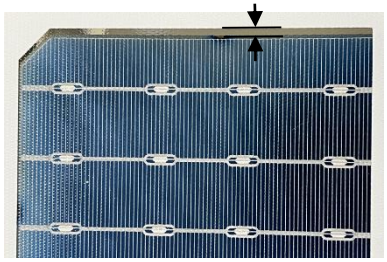
18	Offset of Cell/cell Location	18	Minor	**NA**	Cells are misaligned to each other in both Horizontal and Vertical directions	Non-conforming if minimum creepage distances are not met.
19	Cell Inter-connector mis-alignment with busbar-improper cutting	19	Minor		Cell Interconnector misalignment with busbar	Non-conforming if L ≥ 2mm from Busbar Minimum creepage distance should be met
20	Mis-Alignment between Cell connector (Ribbon) and String Connector(Cross-Tie or Busbar)	20	Minor		Misalignment between cell and string connector	Misalignment length (L)<1mm: ignored L>1mm and at least 50% of ribbon soldered on busbar **Quantity Allowed:** Up to 50% of total soldered joints (Cell connector to String connector) L>1mm and 25% to 50% of ribbon soldered on busbar **Quantity Allowed:** Up to 10% of total soldered joints (Cell connector to String connector)

2) Glass (Front or back)

S/N	VISUAL INSPECTION PARAMETER	DEFECT	DEFECT CLASS	DEFECT REPRESENTATION	DEFECT DESCRIPTION	ACCEPTANCE CRITERION

		CODE				
1	Deformation, Cracks, Chips, Notches, Damaged Corners	21	Major	**NA**	Glass with any Cracks, damage, deformation from any direction	Non-Conforming
2	Dirt on Glass (Stain, smear, smudge)	22	Minor		Glass with any stain, smear and smudge	Allowed if it can be cleaned with wet cloth.
3	Glass Scratch	23	Minor		Glass with scratch seen from 1m	**Front:** Ignore: Length ≤ 20mm & Width ≤ 2mm, 20mm<length ≤ 50mm, Qty. ≤ 4 allowed 50mm<length ≤ 80mm, W ≤ 1mm: Qty≤2 allowed **Rear (for Bifacial glass to glass):** Ignore: Length ≤ 20mm & Width ≤ 2 mm, 20mm<length ≤ 50mm, Qty. ≤ 5 allowed 50mm<length ≤ 100mm, W ≤ 1mm: Qty ≤ 3 allowed

S/N	VISUAL INSPECTION PARAMETER	DEFECT CODE	DEFECT CLASS	DEFECT REPRESENTATION	DEFECT DESCRIPTION	ACCEPTANCE CRITERION

4	Air Bubble on glass	24	Minor		Glass with any air bubbles and other inclusions	**Front:** Minor bubble allowed if there is no reduction in thickness. Non-Conforming if length of bubble is > 5 mm or Width >1.5mm **Rear (for Bifacial glass to glass module):** Minor bubble allowed if there is no reduction in thickness. Non-Conforming if length of bubble is > 8 mm or Width >1.5mm **Qty. Allowed:** 4 (consider separate for front & rear)
5	Encapsulant Residue on Glass	25	Minor		Glass with Encapsulant residue, especially in the active area	**Front & Rear:** Non-conforming if length is L >10mm or A >20 mm^2 **Qty. Allowed:** 2 (consider separately for front & rear)
6	Mesh shifting (For printed rear glass)	26	Major		Misalignment of cell with printed area of rear glass	Mesh shifting allowed ≤ 3mm

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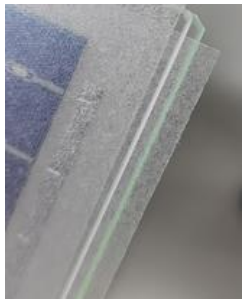
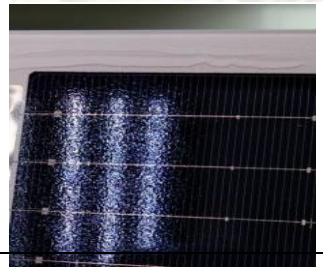
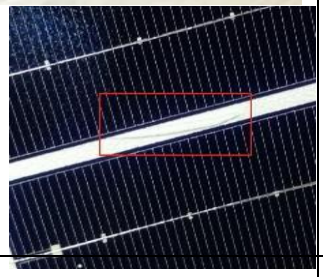
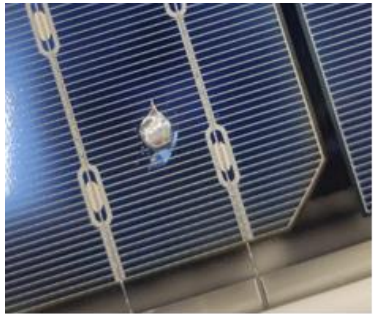
7	Misalignmentbetween glasses (GG modules)	27	Major		No misalignment should be there between both glass.	Non-conforming if **Vertical misalignment:** >2mm

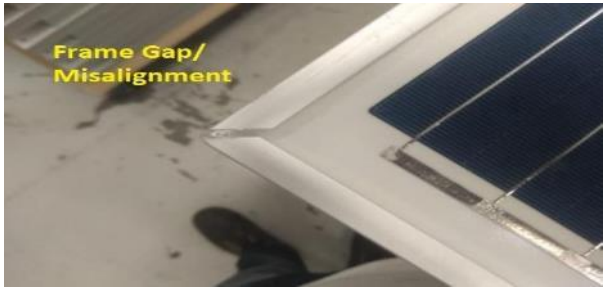
3) EVA

S/N	VISUAL INSPECTION PARAMETER	DEFECT CODE	DEFECT CLASS	DEFECT REPRESENTATION	DEFECT DESCRIPTION	ACCEPTANCE CRITERION
1	Air Bubbles (For Active Area)	28	Major		Any air bubbles visually apparent from the glass side of the EVA	Not allowed on Cell Not allowed if Length of bubble is L>10 mm or Area > 4mm² in area other than cell (ribbon/busbar) **Qty. Allowed**: 3 within a Module other than cell area and not reducing creepage distance.
2	Air bubbles(For Inactive Area)	29	Major		Any air bubbles visually apparent from the glass side of the EVA	Not allowed if: 1) area of any single bubble is > 8 mm2 or if the length of any single bubble is > 15 mm (area is measured by worst case: bubble length x bubble width) 2) if there are more than 5 bubbles within inactive area (except area of holes in the glass where the string connector ribbons go through to connect to the junction box) of a module. 3) any bubble reduces the creep distance against the certification requirement Bubbles at front and rear side will be counted separately.

S/N	VISUAL INSPECTION PARAMETER	DEFECT CODE	DEFECT CLASS	DEFECT REPRESENTATION	DEFECT DESCRIPTION	ACCEPTANCE CRITERION
3	Delamination	30	Major		Delamination or improper lamination	Non-Conforming
4	Encapsulant Wrinkle(For the white Encapsulant)	31	Minor	 		Encapsulant wrinkle outside the cell area, qty≤4; Encapsulant wrinkle inside the cell area, it can be ignored.
5	Inclusions (Non-conductive)	32	Minor		(Backsheet flakes, fiber, insect, dust, gloves piece, tape or any other inclusion which is not conductive)	**For active Area:** **Non-Conforming if:** Diameter of Particle is > 2 mm **Quantity Allowed:** 2 Per module **For Inactive Area:** **Non Confirming if:** Diameter of Particle is > 4 mm **Quantity Allowed:** 4 per module, Insects not allowed **Also Non-Conforming if**: any inclusion creating bubble

S/N	VISUAL INSPECTION PARAMETER	DEFECT CODE	DEFECT CLASS	DEFECT REPRESENTATION	DEFECT DESCRIPTION	ACCEPTANCE CRITERION
6	Inclusions (Conductive)	33	Major	 	(hair , solder bids , ribbon pieces & cell pieces)	**For Active Area (Front & Rear):** Non- Conforming **For Inactive Area:** **Non-Conforming if:** Diameter of Particle is > 2 mm (if not making continuous path between two conductive parts and not reducing the acceptable creepage distance) **Quantity Allowed:** 5 per module, Insects not allowed

4) Frames

S/N	VISUAL INSPECTION PARAMETER	DEFECT CODE	DEFECT CLASS	DEFECT REPRESENTATION	DEFECT DESCRIPTION	ACCEPTANCE CRITERION
1	Sharp Edges	39	Major		Edges of the frame sharp which may result in any risk of injury during handling	**Non-conforming if** :it is creating any safety issue
2	Frame Gap/ Misalignment	40	Minor		Gap or misalignment between frames	**Non-conforming if**: space > 1mm in any direction. **Non-conforming if**: misalignment > 0.5mm in any direction

S/N	VISUAL INSPECTION PARAMETER	DEFECT CODE	DEFECT CLASS	DEFECT REPRESENTATION	DEFECT DESCRIPTION	ACCEPTANCE CRITERION
3	Mounting/ grounding Holes Missing/Drain Holes Missing	41	Major		Mounting , Grounding holes and Drain holes not as per specification	Non-conforming
4	Mounting /grounding holes misplaced and out of Spec	42	Major		Mounting and Grounding holes not as per specification	**For Misplaced**: Non-conforming if deviation > ±1mm. **For out of Spec:** Non-conforming if deviation > ±0.5mm.
5	Drain Holes misplaced and out of Spec.	43	Minor	**NA**	Drain holes to be as per specification	**For Misplaced:** Non-conforming if deviation > ±5mm. **For out of Spec:** Non-conforming if deviation > ±0.5mm.
6	Scratch on frame	44	Minor		Any scratch on frame felt by fingernail	Scratch not felt by fingernail should be allowed **A side (Sunny side)**: Total scratch≤50mm*0.5mm; **qty. allowed**:02 **B side (Side 90 degree to laminate)**: Total scratch ≤60mm*0.5mm; **Qty. allowed**: 03 **C side (Rear side)**: Total scratch≤100mm*0.5mm **Qty. allowed**: 04
7	Dents	45	Minor		Dent on frame	Heavy dent not allowed. Minor dent allowed if not visible from distance of 1m.

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5) Junction Box, Cable and Connectors

S/N	VISUAL INSPECTION PARAMETER	DEFECT CODE	DEFECT CLASS	DEFECT REPRESENTATION	DEFECT DESCRIPTION	ACCEPTANCE CRITERION
1	Cover does not ensure sealing of the junction box	46	Major	**NA**	Junction box cover not properly sealing	Non-Conforming
2	Loose Cover/Missing Cover	47	Major		Junction box cover opens easily, no cover	Non-Conforming
3	Bypass diode type not according to specification/Bypass diode missing/Bypass diode damaged/	48	Major	NA	Bypass diode not as per specification, missing, damaged	Non-Conforming

S/N	VISUAL INSPECTION PARAMETER	DEFECT CODE	DEFECT CLASS	DEFECT REPRESENTATION	DEFECT DESCRIPTION	ACCEPTANCE CRITERION
4	Misaligned Junction Box	49	Minor		Junction box improperly aligned	**Non-Conforming if**: JB Tilt is > than ± 3 mm
5	**For Cable connector:** Polarity marks not clearly visible nor correctly positioned/ Cable insulation damaged resulting in exposed wires/Cable insulation damaged but no exposed wires	50	Minor		Cable engraving improper or with any damage	Non-Conforming

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S/N	VISUAL INSPECTION PARAMETER	DEFECT CODE	DEFECT CLASS	DEFECT REPRESENTATION	DEFECT DESCRIPTION	ACCEPTANCE CRITERION
6	Dirt on Junction Box cable and connector	51	Minor		The junction should be free from any dirt, smear or smudge	Minor overflowing sealant not resulting in major cosmetic issue & Overflowing with W≤5mm is ignored Minor smear or dirt that can easily be removed with a cloth, and not resulting in function failure & dirt area <100mm2
7	Connectors close incorrectly/ Damaged	52	Minor	**NA**	Connectors damaged or incorrect function	Non-Conforming
8	Junction box sealant improper	53	Minor		Junction box sealant non-uniform, gap, bubble	Uniform overflow, no gap, no bubble

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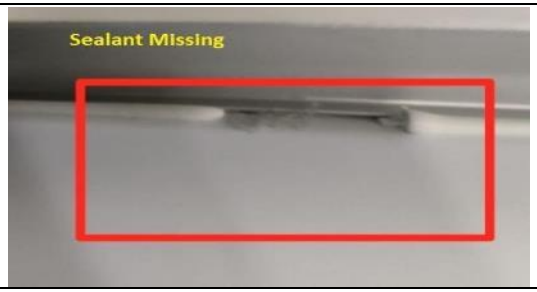
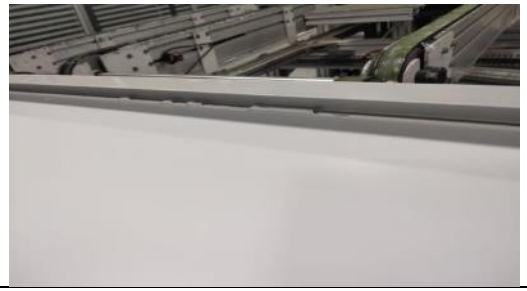
9	Junction box filled with improper potting sealant	54	Minor		Junction box improperly filled with potting sealant	Potting should be filled properly enough so that electrical connection should not be visible, no bubble, no gap

6) Sealant (Frame)

S/N	VISUAL INSPECTION PARAMETER	DEFECT CODE	DEFECT CLASS	DEFECT REPRESENTATION	DEFECT DESCRIPTION	ACCEPTANCE CRITERION
1	Missing Sealant	55	Minor		Sealant missing in some areas	**Non-Conforming if:** Sealant gap is > 8 mm Non-Conforming if: Sealant gap >1/each side frame
2	Over-Flow of Sealant front Side	56	Minor		Sealant overflow on front side	**Non-conforming if:** Length >10 mm or Width >3mm **Quantity Allowed:** 2 per Module (all sides) for L ≤ 10mm or Width ≤ 3mm
3	Non-uniform Sealant back Side	57	Minor		Sealant not uniform throughout the module	**Non-conforming if:** Width variation is more than 50% of original for > 20cm

7) Labels

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S/N	VISUAL INSPECTION PARAMETER	DEFECT CODE	DEFECT CLASS	DEFECT REPRESENTATION	DEFECT DESCRIPTION	ACCEPTANCE CRITERION
1	Bubble on labels	59	Minor		Labels having air Trap	**Non-conforming if**: Diameter> 5 mm **Quantity Allowed:** 3 Per Label

8) Packaging

S/N	VISUAL INSPECTION PARAMETER	DEFECT CODE	DEFECT CLASS	DEFECT REPRESENTATION	DEFECT DESCRIPTION	ACCEPTANCE CRITERION

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1	Non-compliance to customer specification	60	Minor	**NA**	Any Issue in packing or Packing Material or during Packing	Non-Conforming
2	Damaged packaging					Non-Conforming
3	Wrong position / slant					Non-Conforming
4	Deformed / damaged pallet					Non-Conforming
5	Packaging opened / missing seal					Non-Conforming
6	Wet / torn packing					Non-Conforming
7	Missing, incorrect packaging or protective material					Non-Conforming
8	Position on pallet not secured					Non-Conforming
9	Mixed products					Non-Conforming
10	Wrong artwork / colour / logo					Non-Conforming
11	Missing, wrong label / packing list					Non-Conforming
12	Smudge on printing					Non-Conforming
13	Peeled label / packing list					Non-Conforming