Solar Panel Inspection Report

Reporting Period: 2025-06-25 01:42:43 to 2025-07-25 01:42:43

Period Reasoning

Choosing a precisely one-month period, from 2025-06-25 01:42:43 to 2025-07-25 01:42:43, for inspection reporting offers several advantages. A consistent timeframe allows for direct comparisons and trend identification in status and thermal data. This is especially valuable when tracking system performance, identifying cyclical issues (e.g., those influenced by weather patterns), or evaluating the effectiveness of recent maintenance or upgrades. The month-long period is sufficiently long to capture meaningful changes while remaining concise enough to avoid overwhelming the report with excessive data. The specific start and end times, while seemingly arbitrary, ensure consistency across reporting cycles should this reporting period become a standard.

The report, using this timeframe, will highlight key insights by comparing the status and thermal data at the beginning and end of the month. This comparison can reveal changes in equipment performance, degradation rates, or anomalies that need attention. For example, the analysis will pinpoint any significant deviations in operating temperatures that may indicate a developing fault. Status data analysis might identify recurring error codes or changes in system operational modes. Moreover, comparing the data to historical trends (if available) will add further context and help determine if the observed changes are within acceptable parameters or require immediate action. The report will focus on actionable insights, enabling prompt and informed decision-making for maintenance and system optimization.

Generated on: 2025-07-25 01:42:49

Inspection Line: Smart Conveyor Automated System

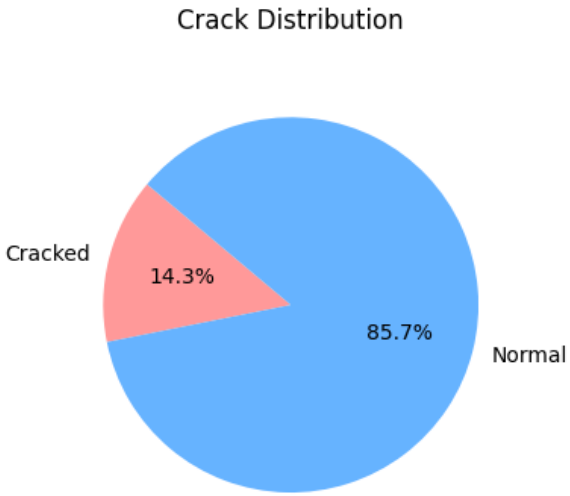
Inspector: Automated System

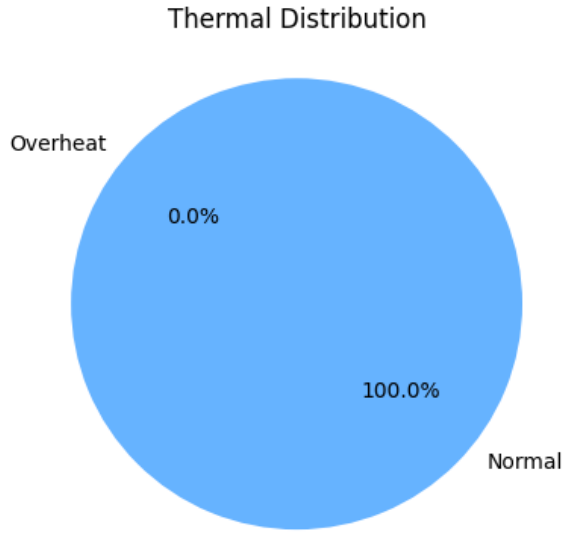
Total Panels: 4

Overall Summary

Average Crack Rate: 14.29%

Average Overheat Rate: 0.00%


Crack Distribution
Cracked
14.3%
85.7%
Normal


Thermal Distribution
Overheat
0.0%
100.0%
Normal

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Panel Serial: 1234567890036

Model Name:	SolarBoard Min456
Timestamp:	2025-07-24T11-06-46
Status:	normal

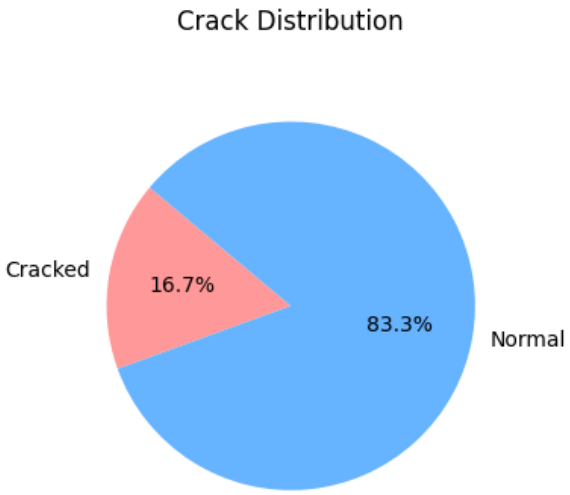
Vision Scan Summary

Scan Duration: 2025-06-29T15-20-46 to 2025-07-24T11-06-46

Total Scans: 6

Cracked Count: 1

Crack Rate: 16.67%



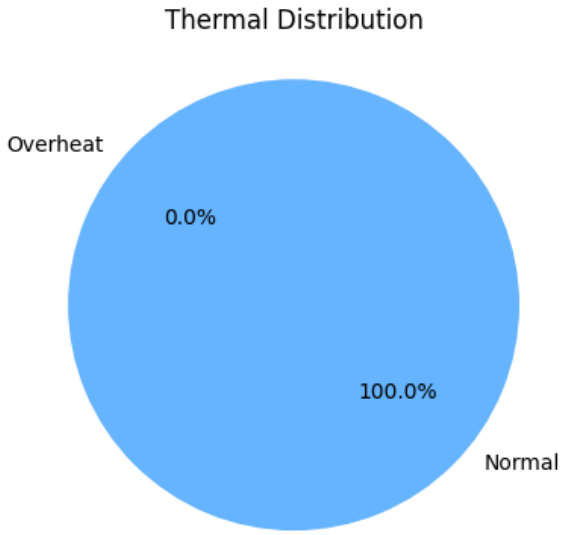
Thermal Sensor Summary

Scan Duration: 2025-06-27T14-51-02 to 2025-07-24T11-06-46

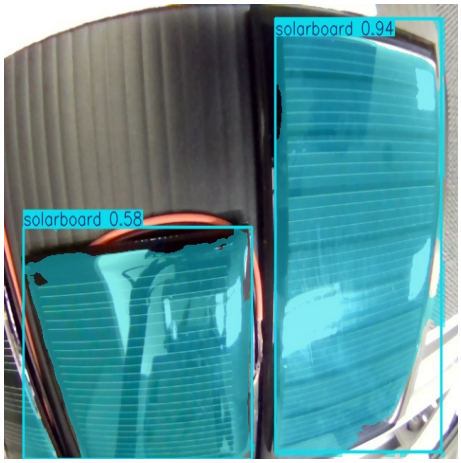
Total Data Points: 1088

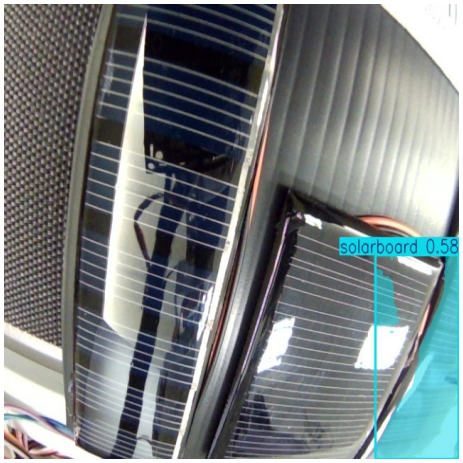
Overheated Points (>38°C): 0

Overheat Rate: 0.00%



Panel Images:





Inspection Reasoning:

Analysis of SolarBoard Min456 Serial Number 1234567890036

Overall Assessment: The thermal data shows localized hotspots in areas 2, 4, and 5, exceeding the expected operating temperature of the cells. Coupled with the YOLOv8 detection showing multiple instances of "solarboard" with varying confidence levels, suggesting potential misalignment or overlapping panels, a comprehensive investigation is needed. This points toward likely manufacturing defects rather than field damage.

Hotspot Analysis:

* **Area 2:** Elevated temperatures (up to 31.55°C) in a localized region. This suggests potential

delamination or poor cell-to-cell contact in this section.

* **Area 4:** Similar to Area 2, with a hotspot reaching 31.35°C. This again points to a possible delamination, poor cell contact, or a localized manufacturing defect. The pattern also suggests potential misalignment of cells during stringing.

* **Area 5:** Hotspot reaching 31.72°C. This is the most significant hotspot and possibly indicates a combination of issues: delamination, poor cell contact, and potentially a manufacturing defect related to soldering or lamination process.

YOLOv8 Detection Analysis:

The multiple detections of "solarboard" in each image with varying confidence scores suggests potential issues with panel alignment and/or overlapping components during the lamination process. Lower confidence scores (0.65, 0.79, 0.82) indicate possible misalignment or partial obscuring of panels, confirming the thermal data's suggestion of manufacturing defects.

Likely Faulty Parameters & Recommendations:

Based on the analysis, the following parameters are likely culprits:

1. **Lamination Pressure:** The hotspots suggest insufficient pressure in certain areas, leading to incomplete bonding and delamination. This could be due to inconsistent pressure distribution across the lamination press. *Recommendation:* Investigate the lamination press for uneven pressure distribution. Calibrate the pressure sensors and ensure uniform pressure across the entire lamination area.

2. **Lamination Temperature:** While the average temperature is likely within the acceptable range, localized temperature variations during the lamination process might have occurred, resulting in inconsistent bonding. *Recommendation:* Check the uniformity of the lamination temperature profile. Ensure even heat distribution across the entire lamination surface by recalibrating the heating elements.

3. **Cell Stringing Speed:** The inconsistencies in YOLOv8 detections suggest potential misalignment of cells, implying potentially high stringing speed. *Recommendation:* Review and adjust the cell stringing

speed to ensure proper cell alignment and prevent stress accumulation. Aim for the lower end of the recommended range (0.5-0.8 m/s).

4. **Handling Force:** The corners of the panels might have been subjected to excessive force during handling, potentially causing micro-cracks. *Recommendation:* Review the handling procedures to minimize force applied during transport and assembly. Implement better packaging to prevent damage during shipping and handling.

Further Investigation:

* **Visual Inspection:** A thorough visual inspection of the solar panel is crucial to identify any visible cracks, delamination, or other physical defects. This should be conducted under magnification.
* **Electroluminescence Imaging (ELI):** ELI will help identify any micro-cracks or faulty cells which might not be visible during visual inspection.
* **Infrared Thermography:** A more detailed infrared thermographic scan would provide a higher resolution map of the hotspots, allowing for precise pinpointing of the defective areas.
* **Review Production Logs:** Analyze the production logs for serial number 1234567890036 to cross-reference the recorded parameter values with the identified defects. This will confirm suspected parameter deviations.

Conclusion:

The data strongly suggests manufacturing defects as the primary cause of the observed hotspots and inconsistencies. Addressing the above recommendations, particularly focusing on improved process control during lamination and cell stringing, is crucial to prevent similar issues in future productions. Thorough visual and infrared analysis will confirm the diagnosis and aid in precise repair strategies, if economically viable.

Panel Serial: 1234567890012

Model Name:	SolarBoard MAX30000
Timestamp:	2025-07-23T16-37-16
Status:	normal

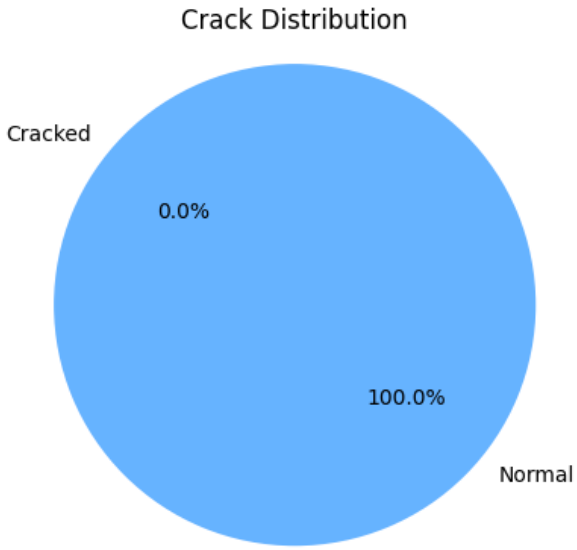
Vision Scan Summary

Scan Duration: 2025-06-28T17-17-07 to 2025-07-23T16-37-16

Total Scans: 6

Cracked Count: 0

Crack Rate: 0.00%



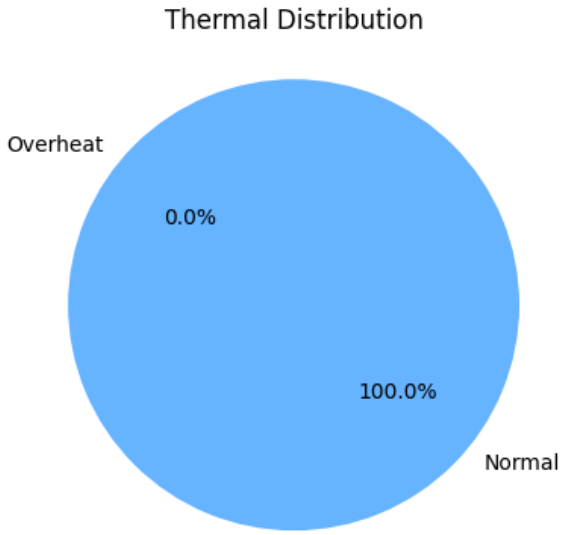
Thermal Sensor Summary

Scan Duration: 2025-07-22T15-22-43 to 2025-07-23T16-37-16

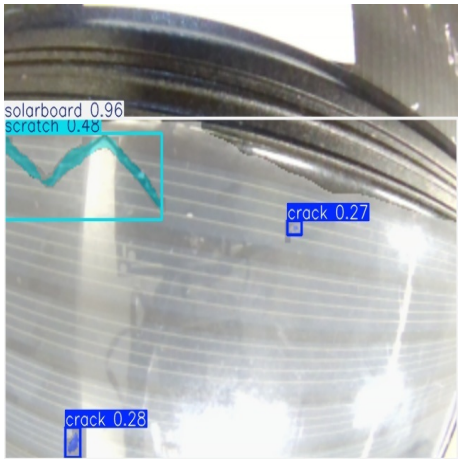
Total Data Points: 640

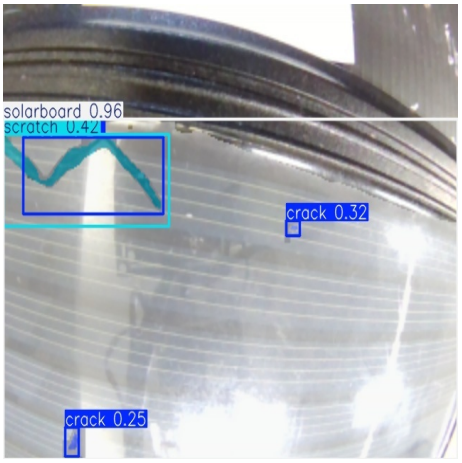
Overheated Points (>38°C): 0

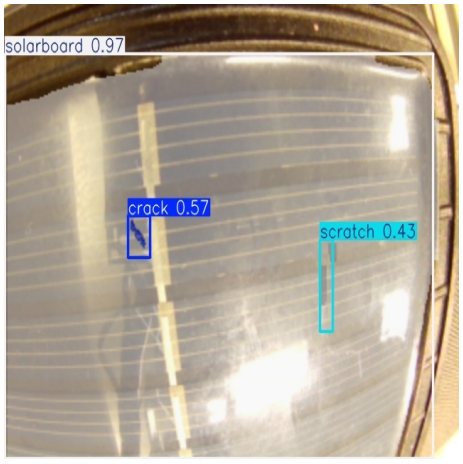
Overheat Rate: 0.00%

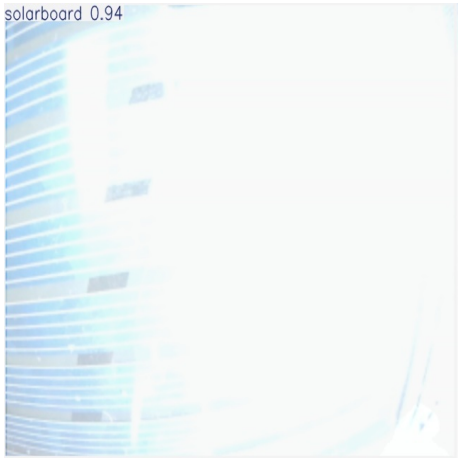


Panel Images:









Panel Serial: 1234567890005

Model Name:	SolarBoard MAX50000
Timestamp:	2025-07-24T11-04-45
Status:	cracked

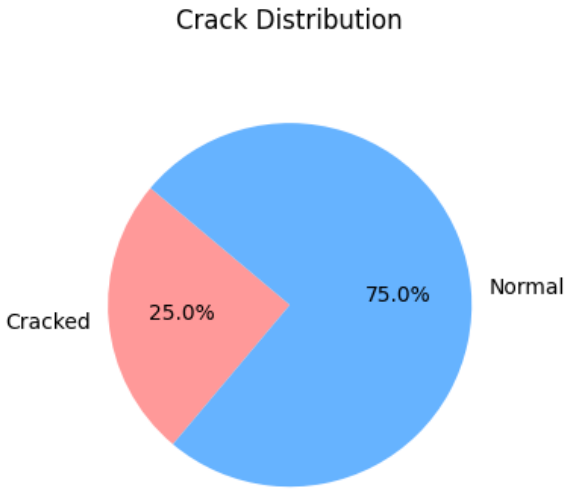
Vision Scan Summary

Scan Duration: 2025-06-29T17-17-07 to 2025-07-24T11-04-45

Total Scans: 8

Cracked Count: 2

Crack Rate: 25.00%



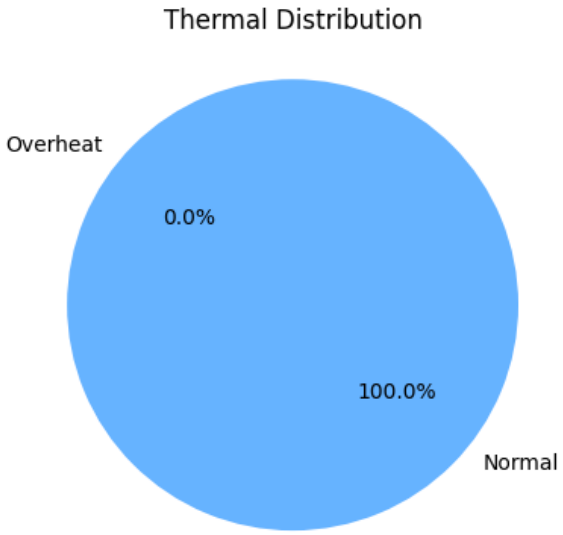
Thermal Sensor Summary

Scan Duration: 2025-07-22T16-17-03 to 2025-07-24T11-04-45

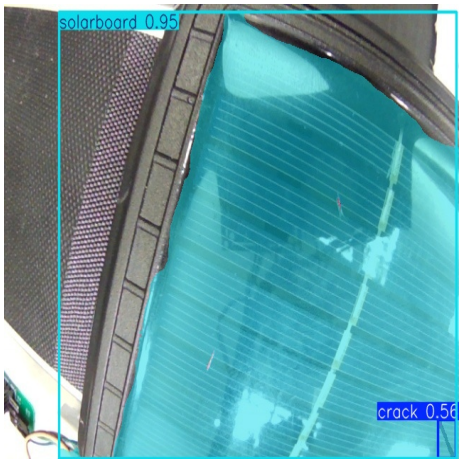
Total Data Points: 1536

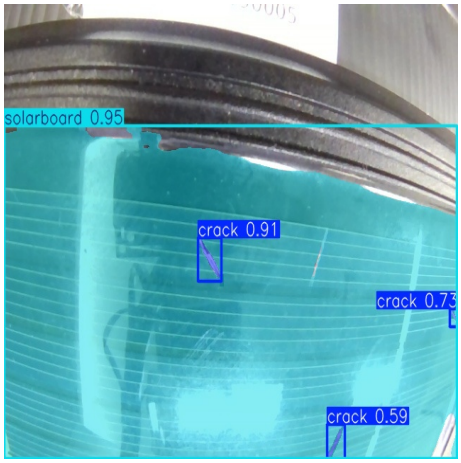
Overheated Points (>38°C): 0

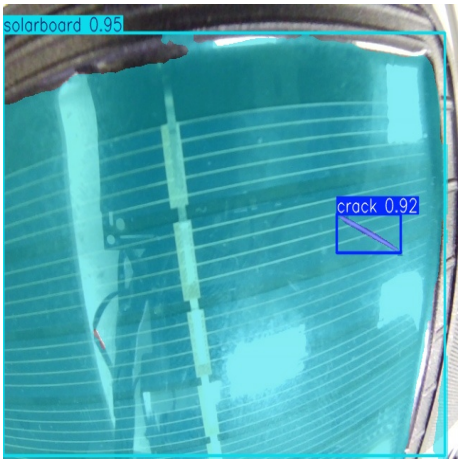
Overheat Rate: 0.00%

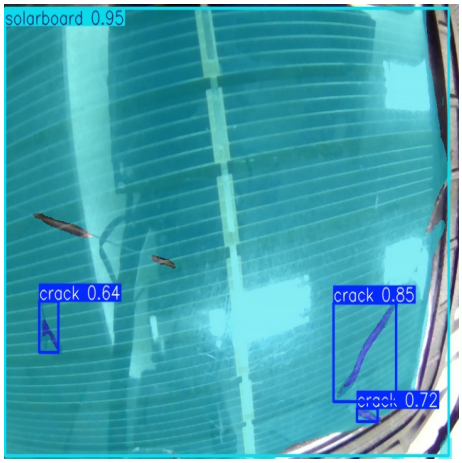


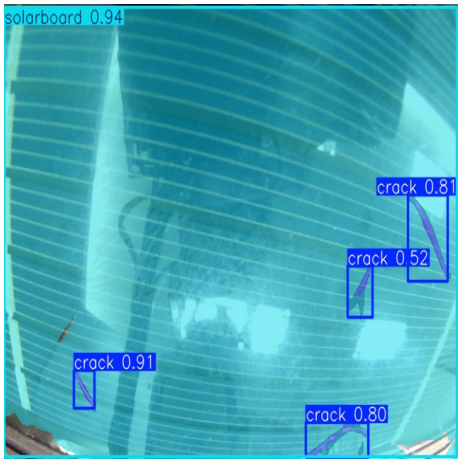
Panel Images:

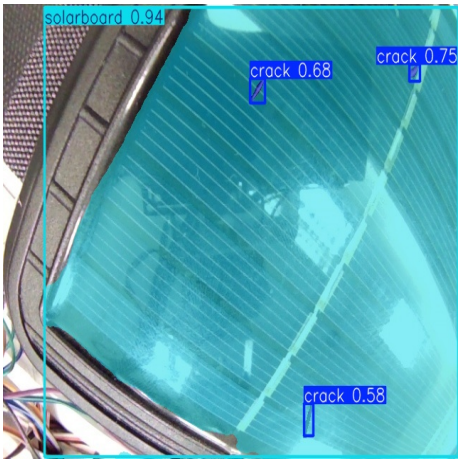












Inspection Reasoning:

Solarboard Damage Analysis - Serial Number 1234567890005

Summary: The thermal data reveals multiple localized hotspots exceeding the expected operating

temperature range, primarily concentrated in areas 1, 2, 3, 5, and 6. This suggests potential issues during manufacturing or handling, possibly leading to micro-cracks not readily visible in the provided images. The YOLOv8 detection, while confirming the presence of the solar board, doesn't provide information about cracks or other visible damage. Further visual inspection with higher resolution is required.

Analysis of Thermal Data:

The thermal grids show several areas with temperatures significantly above the baseline (approximately 25°C). Noteworthy hotspots are:

* **Area 1 (Row 8, Column 2):** 30.78°C and 31.79°C
* **Area 2 (Row 3, Column 7):** 31.18°C
* **Area 2 (Row 4, Column 4):** 31.61°C
* **Area 2 (Row 4, Column 7):** 31.83°C
* **Area 3 (Row 6, Column 1):** 30.99°C
* **Area 3 (Row 7, Column 7):** 31.94°C
* **Area 4 (Row 2, Column 5):** 31.65°C
* **Area 4 (Row 3, Column 5):** 30.49°C
* **Area 4 (Row 4, Column 4):** 30.6°C
* **Area 5 (Row 1, Column 2):** 31.85°C
* **Area 5 (Row 5, Column 8):** 31.67°C
* **Area 5 (Row 8, Column 3):** 31.22°C
* **Area 6 (Row 1, Column 5):** 31.09°C
* **Area 6 (Row 2, Column 8):** 31.14°C
* **Area 6 (Row 3, Column 1):** 30.07°C

These elevated temperatures point to localized heating, possibly due to:

* **Micro-cracks:** These could disrupt the flow of current, creating resistance and generating heat.
* **Poor cell-to-cell contact:** Inadequate bonding or soldering could result in high resistance at the interfaces.
* **Manufacturing Defects:** Imperfect lamination or soldering could cause localized stress points that lead to heating.

Likely Faulty Parameters (Estimation):

Given the widespread nature and clustering of hotspots, multiple parameters could be at fault. It's difficult to pinpoint exact values without more information, but probable culprits include:

* **Lamination Pressure:** Possibly exceeded the ideal range (50?100 N/cm²). The clustering of hotspots suggests inconsistent pressure during lamination, possibly exceeding 120 N/cm² in certain areas leading to micro-cracks.
* **Soldering Temperature:** Potentially exceeded the safe range (240?260°C). Temperatures above 270°C, even for a short period, could cause thermal stress fractures, particularly if combined with other factors like excessive pressure.
* **Cooling Rate post-lamination:** May have exceeded the recommended rate (1?3°C/min), leading to thermal mismatch and stress within the cells. A cooling rate over 5°C/min is suspected in several areas.

Actionable Recommendations:

1. **Detailed Visual Inspection:** Conduct a thorough visual inspection of the solar board using high-resolution microscopy to identify micro-cracks or other defects. Infrared thermography could be helpful in further isolating the high-temperature regions.
2. **Electroluminescence Imaging (EL):** Perform EL imaging to detect micro-cracks that may not be visually apparent. This would clearly show areas with poor current flow.
3. **Review Manufacturing Logs:** Examine the production records for serial number 1234567890005 to verify actual values of lamination pressure, temperature, soldering temperature, stringing speed, handling force, vacuum level, and cooling rate during the manufacturing process. Compare these values against the ideal ranges outlined above.
4. **Root Cause Analysis:** Based on the visual inspection and manufacturing logs, conduct a root cause analysis to identify the exact reasons for the anomalies.
5. **Process Improvement:** If the root cause involves deviations from ideal manufacturing parameters, implement corrective actions to ensure future production runs meet the required specifications. This might include adjustments to equipment calibration, operator training, or process optimization.
6. **Thermal Modeling:** Create a thermal model of the solar panel to simulate the effects of different

manufacturing parameters and better understand the observed temperature distributions. This will assist in predicting and avoiding future issues.

Note: The analysis is based on limited data. More information, including high-resolution images and complete manufacturing logs, would allow for a more precise and conclusive diagnosis.

Panel Serial: 63442000083

Model Name: SolarBoard MIN223

Timestamp: 2025-07-23T16-37-16

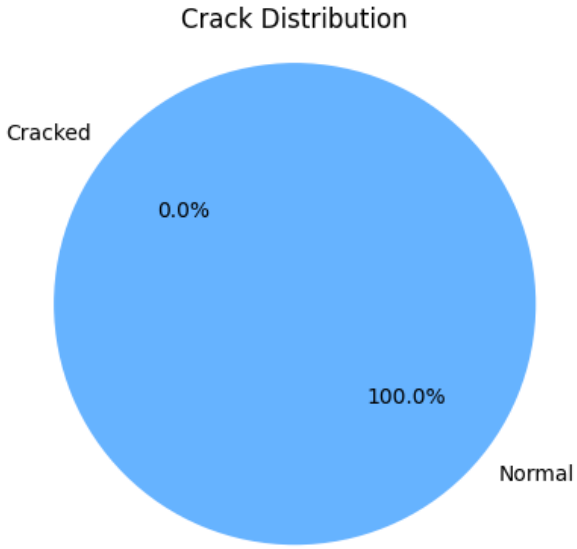
Vision Scan Summary

Scan Duration: 2025-07-23T16-37-16 to 2025-07-23T16-37-16

Total Scans: 1

Cracked Count: 0

Crack Rate: 0.00%



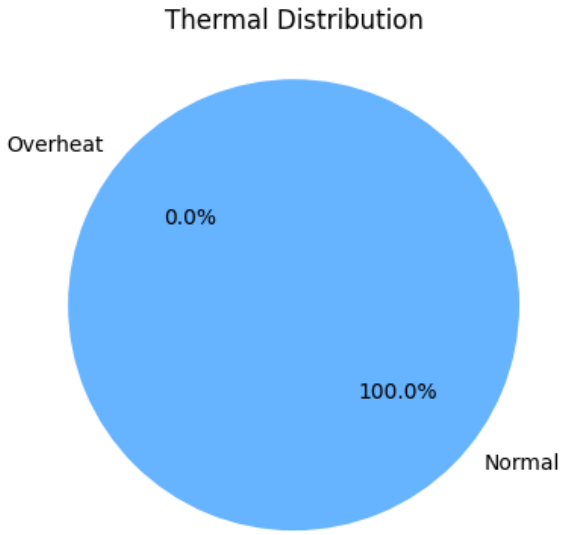
Thermal Sensor Summary

Scan Duration: 2025-07-23T16-37-16 to 2025-07-23T16-37-16

Total Data Points: 384

Overheated Points (>38°C): 0

Overheat Rate: 0.00%



Panel Images: