Flatness inspection plan for photovoltaic module frames

solar-frame-flatness

SHANGHAI MICROCRE OPTICS-MECH TECH CO.,LTD

Telephone: 400-812-7833 | 021-58391850

Address: 1478 Nanfeng Road, Fengcheng Town, Fengxian District, Shanghai, China | Postal code: 201411

Contact email: shanghai@yr17.net

Service email: rockwei@yr17.net

Application template; not a claim of a completed customer project.

Scope

For sampling inspection of PV aluminium frame flatness (2278×1134 mm, example/teaching data) before and after lamination. The frame is flexible, so results depend strongly on the support state, which must be fixed in the plan. An autocollimator profiles the mid-surface of the long side; evaluation uses the endpoint-line datum with a flipped re-measurement.

Equipment and configuration guidance

• Photoelectric autocollimator (0.5″ class sufficient, example) with 200 mm reflector base

• Equal-height support blocks at L/5 from the ends (example)

• Station marking and batch recording tools

• Temperature logger

Principle and calculation

$\Delta h = L \cdot \tan\theta$; with L=200 mm, 1″≈0.970 μm (example/teaching data). Endpoint residual $r_i = h_i - (h_0 + i \cdot (h_n - h_0)/n)$; flatness=max(r)−min(r); flipped runs are averaged.

On-site checklist

• Support positions identical across frames

• Flipped runs averaged

• Batch sample size meets the agreement

Suggested records

• Per-frame profile and peak-to-valley record

• Batch statistics table

• Support and measurement state log

Limitations

Results for this flexible part depend strongly on the support state and must not be compared with free-state or other support data. Frame strength, assembly-load deformation and lamination quality are not assessed.

Detailed teaching example

PV Module Frame Flatness Inspection · Tutorial Case

Scenario and task

Teaching demonstration, not a real customer project: span-segment flatness sampling of a PV module aluminium frame mounting face; data are instructional settings.

Workflow overview

Support sample → Aim optical axis → Read per segment → Convert heights → Flatness evaluation

Preparation and measurement steps

01. Support the frame sample steadily on the inspection bench

02. Aim the autocollimator along the frame mounting face

03. Move a 250 mm bridge against the mounting face step by step

04. Record the angular reading of each segment

05. Evaluate flatness cumulatively after three segments

Teaching example readings

• Bridge span L=250 mm; segment 1 autocollimator reading θ□=+0.2″

• Segment 2 autocollimator reading θ□=-0.4″

• Segment 3 autocollimator reading θ□=+0.3″

Calculation procedure

Height conversion: Δh = L·tan(θ·π/648000)×1000 (μm). Segment 1: 250×tan(+0.2″)=+0.24 μm; Segment 2: 250×tan(-0.4″)=-0.48 μm; Segment 3: 250×tan(+0.3″)=+0.36 μm. Cumulative heights: 0→+0.24→-0.24→+0.12 μm; peak-to-valley PV=+0.24−(-0.24)=+0.48 μm.

Example result and interpretation

Tutorial result PV≈0.48 μm, demonstrating flatness evaluation of the PV frame mounting face.

Example verification checklist

• Bridge feet seat well on the aluminium extrusion

• Avoid extrusion joints and mounting holes

• Sampling covers the middle of the long frame side

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