



11 August 2026

5:00 pm – 6:00 pm | CEST, Berlin
11:00 am – 12:00 pm | EDT, New York City
8:00 am – 9:00 am | PDT, Los Angeles



Ben Zientara

Editor
pv magazine USA



Michael Scott

Senior Manager, QA and ESG
Intertek CEA



Ankil Sanghvi

Senior Engineering Manager
Intertek CEA

Preventing costly solar junction box failures from factory to field



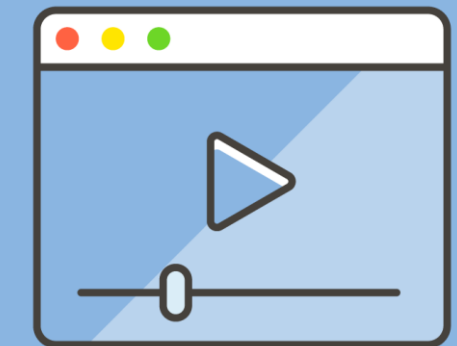
Welcome!

Do you have any questions



Send them via the Q&A tab. We aim to answer as many as we can today! You can also let us know of any tech problems there.

We are recording this webinar today



We'll let you know by email where to find it and the slide deck, so you can re-watch it at your convenience.



Preventing Costly Solar Junction Box Failures from Factory to the Field

Ankil Sanghvi, Sr. Engineering Manager
Mike Scott, Sr. Manager

August 11, 2026



Agenda



01 Junction boxes over time

02 What we are finding in the field

03 Junction box manufacturing and installation

04 Supplier management

05 Advances in manufacturing

06 Manufacturing quality assurance

Concerning reports about fires involving PV Systems

- Reports around "thermal events" on residential as well as ground-mounted PV systems are spreading.
- Often quick conclusions are drawn towards installation quality or connector problems.
- While these are relevant points, one issue remains underestimated.
- The Junction Box Issue.



01

Junction boxes over time



Junction boxes have changed

Bulky, single-piece design → Multiple pieces

- Module power increase → larger surface, higher currents, shading protection
 - Microinverters, communications, etc

O-ring sealed → Potted

- Better encapsulation but poor visibility and difficult repair.

Bifacial Modules → Minimizing area

25+ year-old modules still operating because of
manufacturing quality

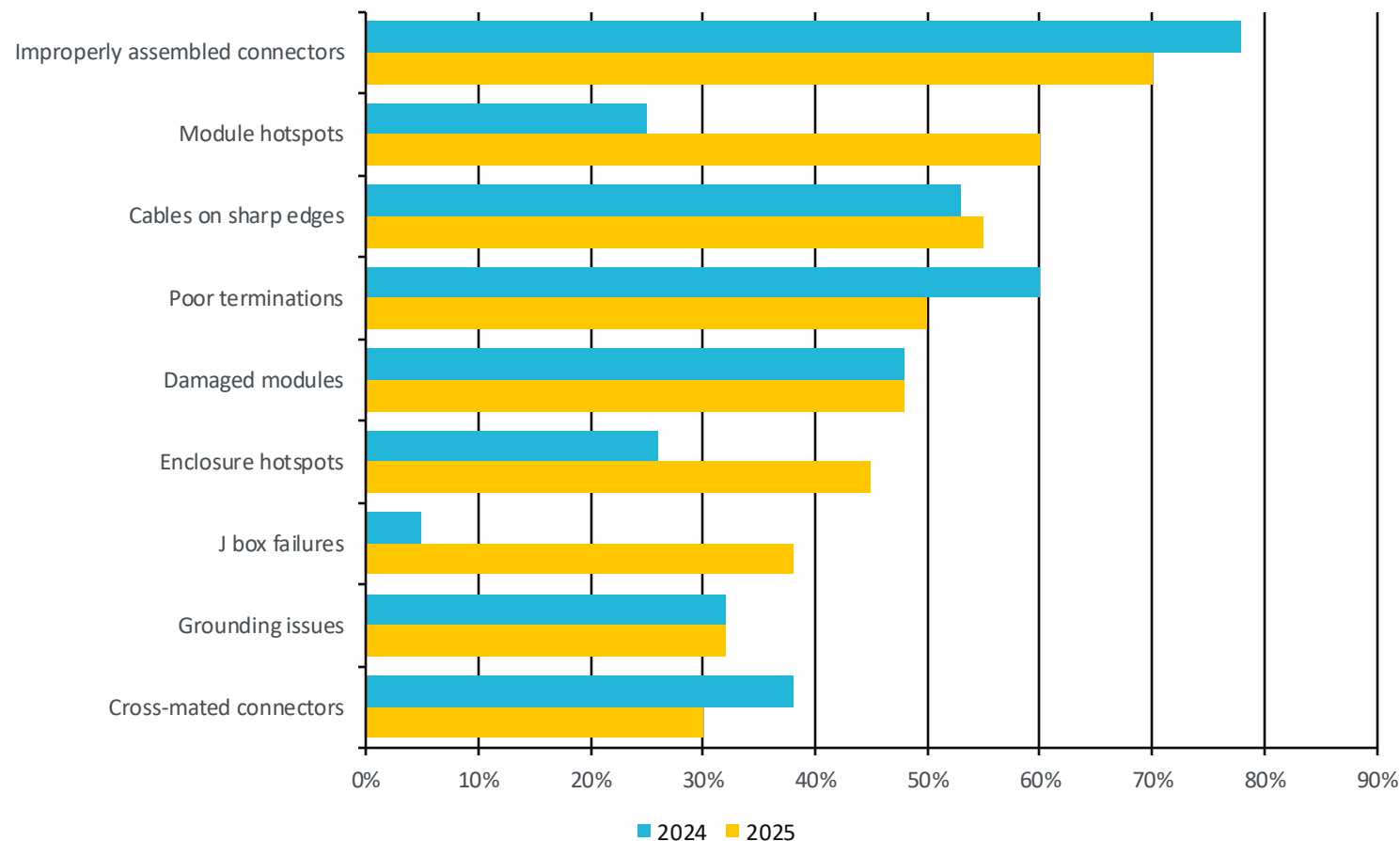


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What are we finding in the field?



Module problems are among the most common audit findings

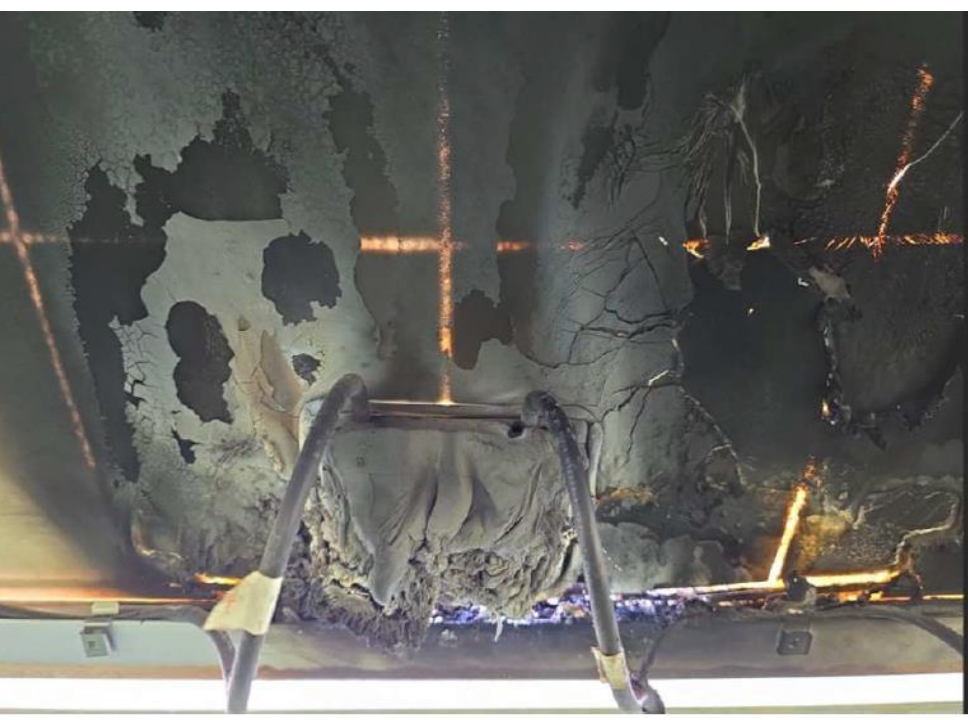
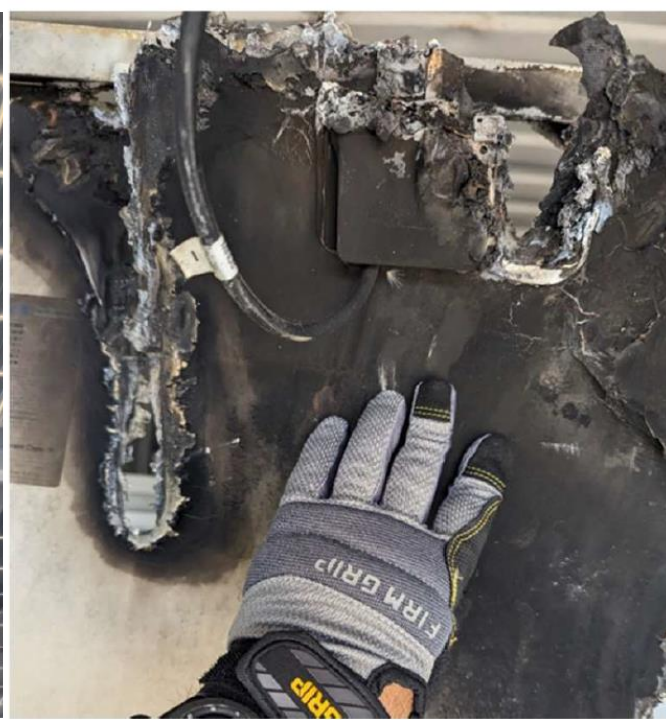
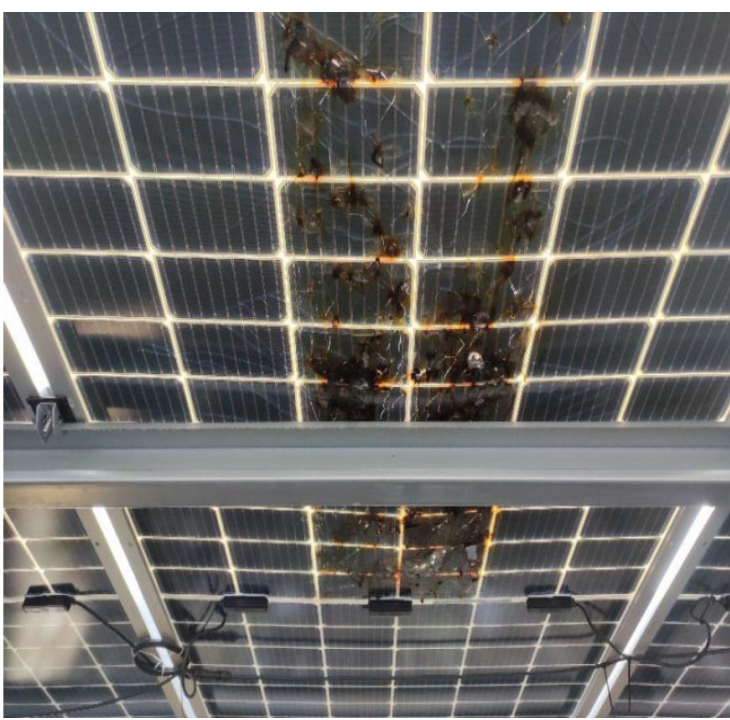


1,375

PV safety audits performed, of which 94% showed major safety concerns

J-Box Findings

J-Box failures have increased to 60% in 2025, up from 38% a year before



Invisible in Factory, Expensive on the Field



>500 °C

Localized cell temperature
once an unprotected
substring is shaded

113 °C

Peak junction box surface
temperature recorded on an
operating US plant

77%

of junction box failures on
one site came from a single
module power class

1,290

Modules on one site that
went from no IR anomaly to
diode anomaly in 3 months

Every one of these numbers traces back to a solder joint or a diode contact that was made — or not made — in the factory.

Junction box failures: what shows up on an operating site



113.2 °C

peak junction box surface temperature recorded in a site thermal survey

61 of 80

thermal measurement points on that survey showed a heated junction box

66.4 °C

peak cable temperature — and 44 °C at the cell busbars, on the same survey

The junction box is the hottest thing on the module — by a wide margin.

Results from an RCA



Teardown: ribbon not bonded to the contact pad

100%

of disassembled modules showing a sub-module anomaly had a ribbon that was not connected

100%

of modules with a suspected shorted diode signature had heating at the diode and a loose diode connection

8 of 10

modules sent for independent lab teardown showed burn marks or discoloration near the diode, with a loose cable at the positive junction box entry

Pottant

found between ribbon and solder on several units — encapsulant cannot migrate into a joint that was properly soldered



So what is a Lost Bypass Diode (LBPD)?

The defect

A bypass diode that is physically present inside the module but not electrically connected usually because the solder joint linking it to the cell string was broken, or never properly formed, during production.

Why nobody sees it

In normal, unshaded operation, a bypass diode is dormant — reverse-biased and inactive. A disconnected one behaves identically to a healthy one. Rated power. Normal IV curve. Clean EL image. No thermal signature on a drone survey.

1

A shadow falls

Row-to-row shading, soiling, vegetation or debris covers part of one substring.

2

No bypass path

String current has nowhere to go but back through the shaded cells, in reverse.

3

Heat Dissipation

Cells reach reverse breakdown. All the power the healthy cells are making dissipates in a few square centimeters of silicon.

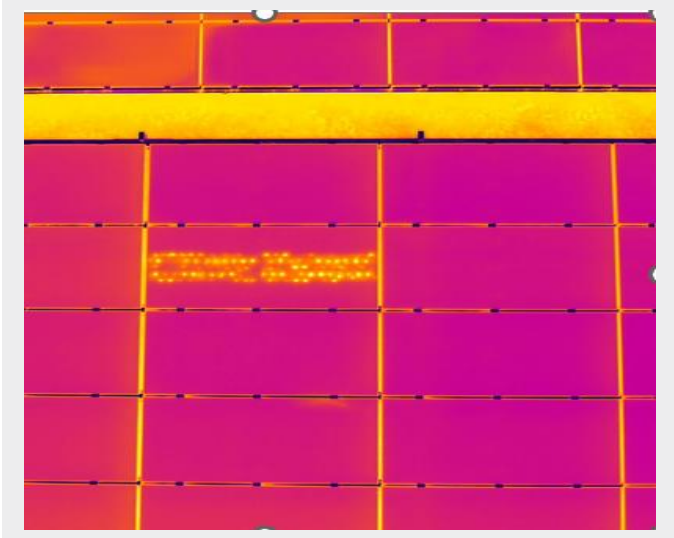
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Above 500 °C

Burned back sheets, melted encapsulant, cracked glass, arcing — and in documented cases, fire.

It is a manufacturing defect that behaves like a healthy module — right up until the first ordinary shading event.

How LBPD screening helps — and where it fits



Testing runs at night with the string disconnected from the inverter — daytime production is unaffected.

1 String screening

A current-limited DC supply drives a small controlled current through the string in reverse polarity. Controlled electrical stimulus induces a thermal signature. Pass or fail — no interpretation needed on site.

2 Module localization

Leave the supply connected at the indicated voltage. Within seconds, the affected substring develops an avalanche thermal signature that a handheld or drone-mounted IR camera detects. The module and the substring are photographed and documented.

How lost bypass diodes are
hidden risk

WHERE IT PAYS FOR ITSELF

Pre-COD acceptance · operating plants never screened at commissioning · after a thermal event, on the rest of the batch · M&A and insurance due diligence · any TOPCon or glass-glass portfolio

03

Junction box manufacturing and installation



Junction box defects and failure timeline

Defect

Failure timeline

• Placement

- Not enough adhesive → • **Long-term** – water intrusion / short circuit
- Shift before curing → • **Immediate** – short circuit

• Electrical connections

- Ribbon to J-Box connection → • **Immediate** – no flash
- J-Box diode (J-Box manufacturing) → • **Long-term** – thermal event
- Cable connections (J-Box manufacturing)

• Potting defect

- Wrong A:B ratio → • **Long-term** – water intrusion
- Incomplete coverage, bubbles and blisters → • **Possible** – conductive debris we can't see

In-Line Production Monitoring and Pre-shipment Inspection

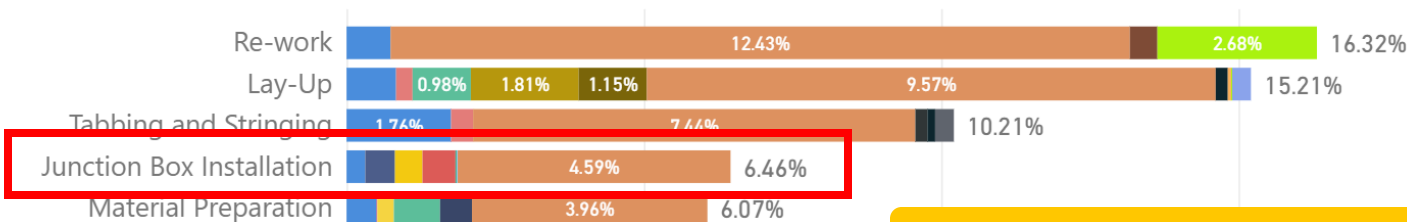


In-Line Production Monitoring

- ~6.5% of IPM findings
 - 71% Process – not checking the solder joint
 - 9% Busbar connection

Pre-Shipment Inspection

- Less than 1% of PSI findings
 - Potting or adhesive



- In-line Production Monitoring is where J-Box Defects must be caught

Worst case



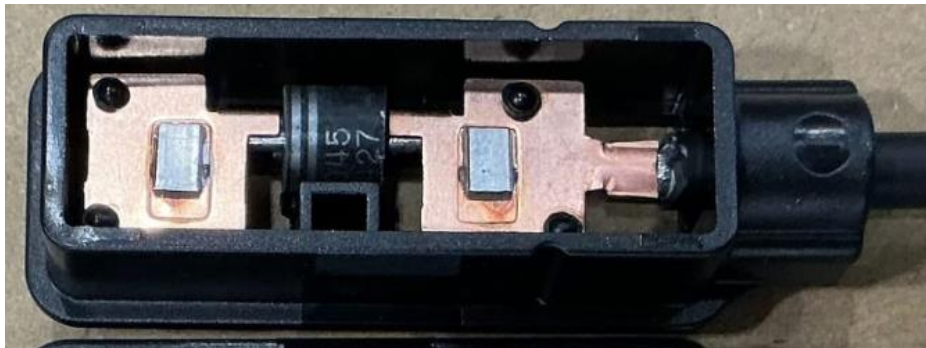
- Enough contact for flash test
- Becomes a heating element in the field



Junction box manufacturing



- **Plastic housing**
 - ABS injection molding
- **Assembly**
 - Terminal placement
 - Diode installation
- **Connector installation**
 - Wire crimping
 - Connector attachment



- Module buyers should ask suppliers about J-Box Supplier Management
- Consider auditing or visiting J-Box supplier

Junction box installation

- Ribbons bent vertical for second encapsulation sheet and back glass or back sheet
- Ribbons bent flat for lamination
- Teflon cover or tape to contain encapsulant

LAMINATION

- Removal of Teflon cover or tape
- Ribbons bent vertical again
- Junction box adhesive
- Junction box placement
- Ribbon to J-Box connection
 - Automated Optical Inspection, Maintenance
- Potting and lid

✓ Stringer peel-test monitoring

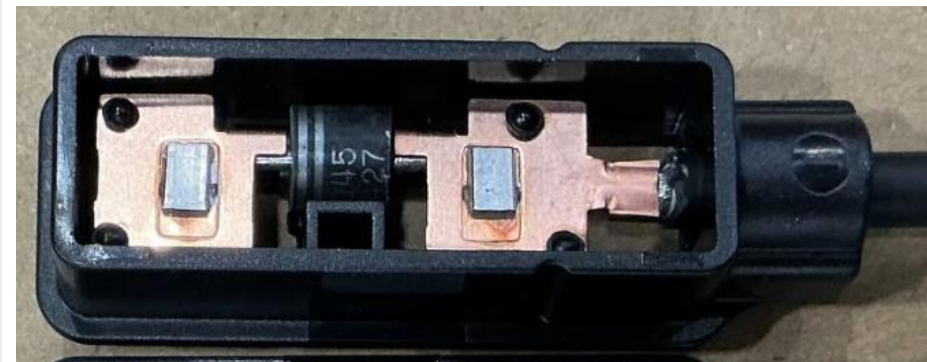
✓ Lay-up positioning

✓ Pre-lamination rework

✓ Trimming quality and framing checks

✓ Junction box installation

✓ Final EL, IV and Safety Tests



04

Supplier management



Junction box considerations in module procurement and supplier management



- Ask module supplier about J-Box suppliers, review supplier management work products
- Visiting / auditing J-Box sub-supplier(s)
- Specific criteria for J-Box suppliers
 - Diode tests, production data





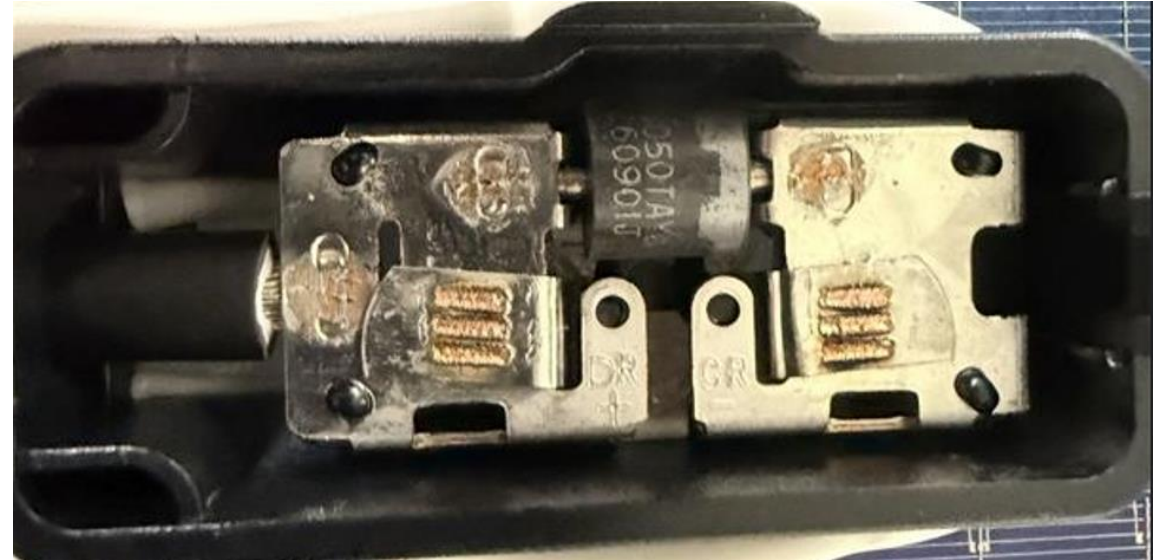
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Advances in manufacturing



Advanced manufacturing process – Laser welding

- Conventional process melts solder to join ribbon to J-Box terminal
 - Silver blob for AOI
- Laser Welding leaves discrete weld spots that make AOI “easier”
- Significant but worthwhile investment





06

Manufacturing quality assurance



Quality assurance

- Factory Audit
- Suppliers' QMS requirements → Accountability
- In-line Production Monitoring
 - Stringers
 - Laminators
 - EL Tools
 - Flash Test Calibration and Environmental Conditions
 - Packing
- Pre-shipment Inspection
- Container Loading Monitoring
- Findings tracking and closure



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ced
Solar Energy. Assured.

Thank you!



info@cea3.com



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Ben Zientara
Editor
pV magazine USA

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today!**