

Junction box qualification at REC Solar

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Introduction

The junction box is a very critical component in a PV module. A poor contact in the JB can give rise to temperature increase and potentially lead to hot spots or arcing. Poor adhesion between box and backsheet can cause the JB to detach from the module which again can give rise to numerous problems such as leakage to ground, risk of electrical shock, corrosion of contacts etc. The JB also contains the protective by pass diodes and a failure in one of these diodes can cause hot spot development in shaded cells.



Figure 1: IR image of a junction box with high contact resistance.

Test program

Due to the major impact of the JB on module reliability, REC Solar runs an extensive qualification program before approving a new JB.

- Double IEC 61215 testing (DHT 2000, TC 400, HF 20)
- Adhesion, wet leakage, contact resistance
- Solder joint reliability
- Contact and connector fatigue testing
- Arcing test
- Diode temperature test

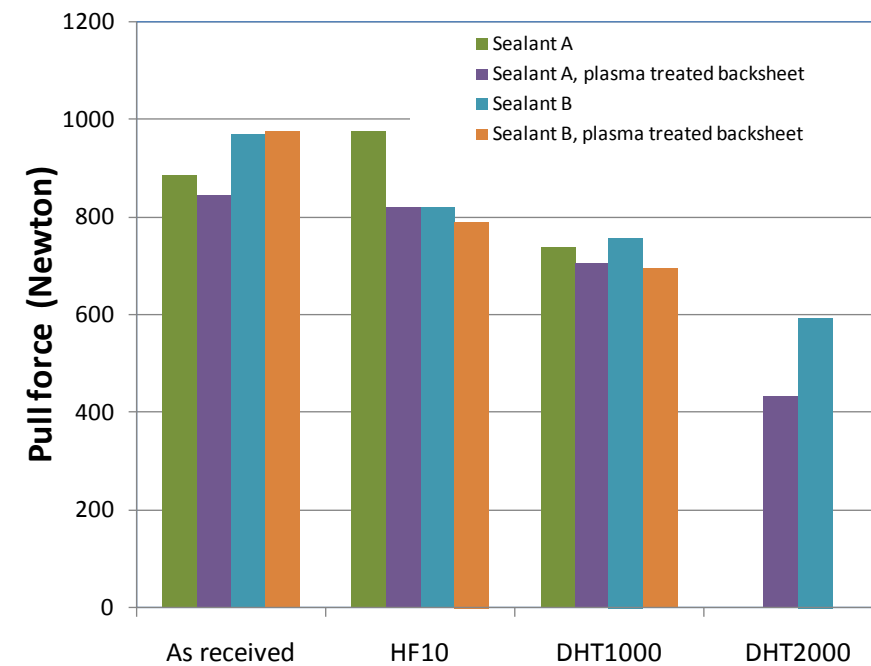


Figure 2: JB pull force after climate chamber ageing at 85°C/85%RH. The adhesion strength decline, but even after 2000 hours it is well above the 160 N limit specified by UL 1703. Plasma treatment of backsheet was found to have little effect on the long term performance.

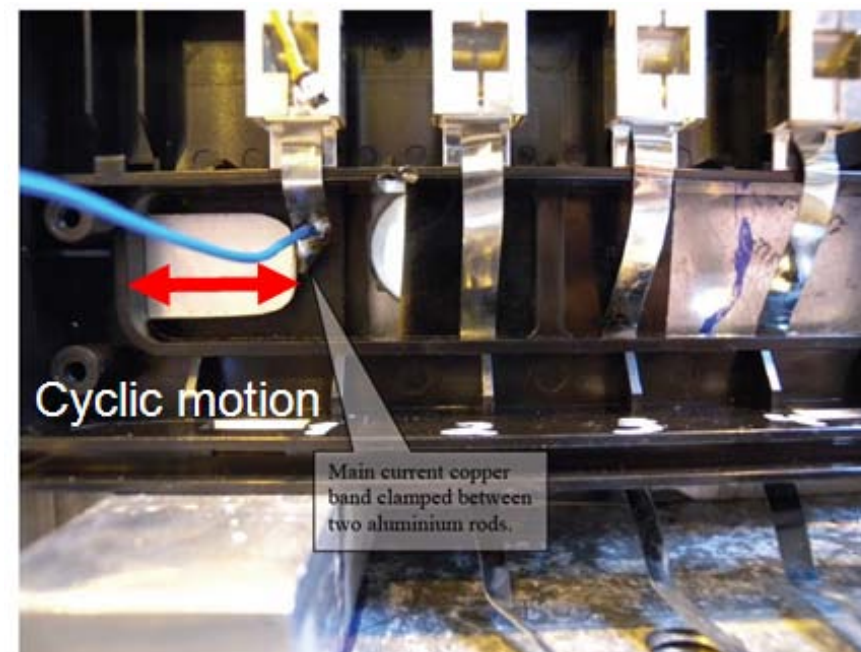


Figure 3: Fatigue testing of junction box terminals. The imposed motion of cross connectors reflect the thermal expansion/contraction that may arise from thermal fluctuation between day and night. Several 10^5 cycles at 1Hz. Failure mechanisms may be fretting corrosion in mechanical clamps or creep/fatigue of soldered terminals in situations with poorly designed stress relief.

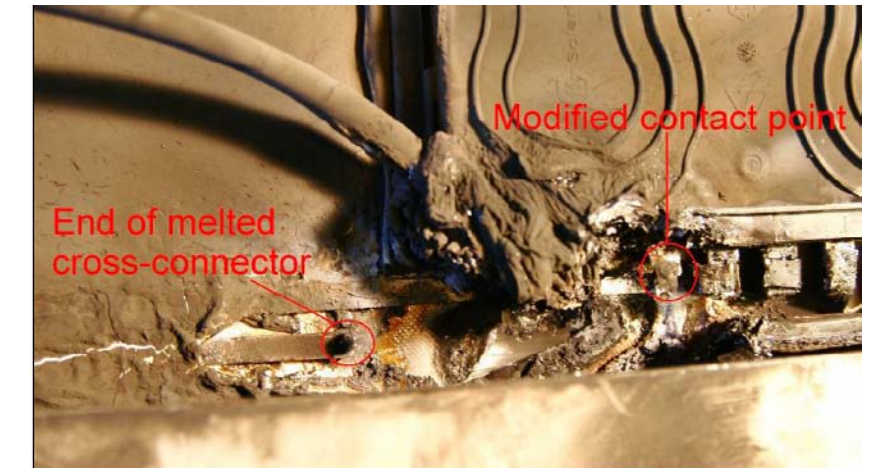


Figure 4: Artificial arc test. Controlled contact resistance of 50 kΩ. The applied voltage was 340 Volt and a short circuit current of 8 A was running through the contact. Arcing and flaming was visible for about 1 minute, after this only a slight smoke indicated heat development. The power was disconnected after 4 minutes.

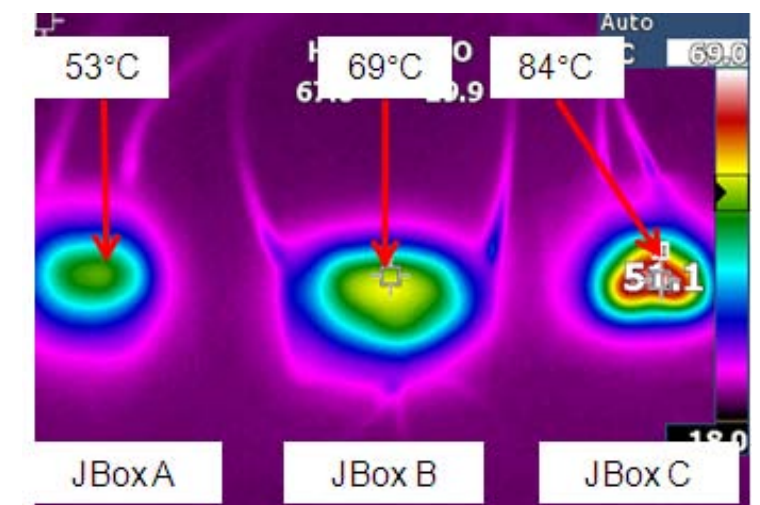


Figure 5: Apply a current equal to the expected current during module field operation. The diodes dissipate a certain power and requirements must be met for diode junction temperature, junction box temperature, and Backsheet temperature.

Conclusion

As part of the reliability testing at REC the junction box is subjected to multiple accelerated tests in order to avoid adverse long term degradation effects. Sound electrical and mechanical integrity is vital for securing PV module longevity. A comprehensive test program has been successful in identifying favorable combinations of materials and components. Future test methods may include shaded module effects on EVA degradation.