

Reliability of Concentrix™ CPV Modules

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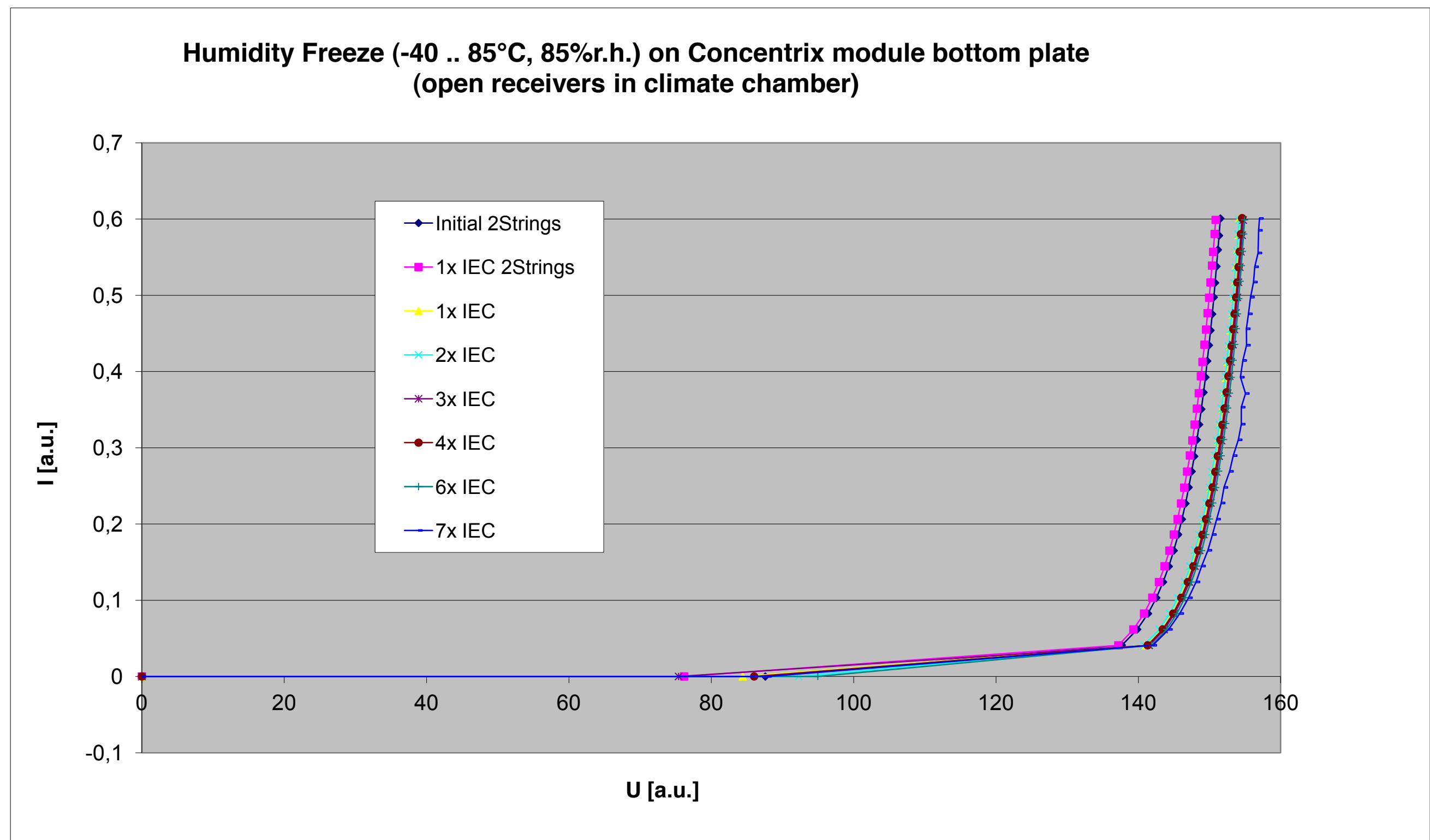
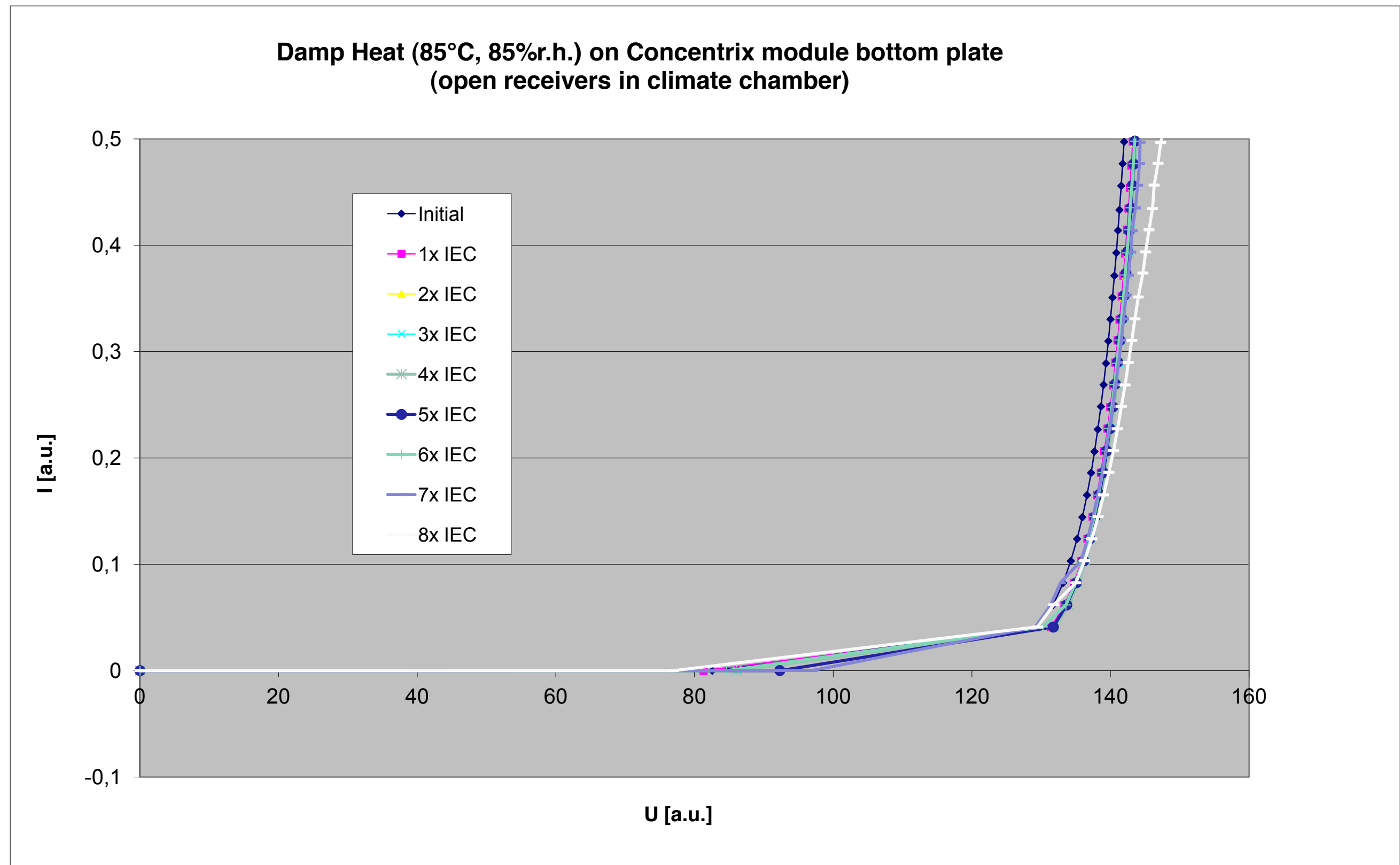
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INTRODUCTION

- Reliability and durability of all (C)PV power plant components is very much impacting the overall life cycle costs of a (C)PV power plant.
- Due to it's intended permanent exposure to intense sun radiation the CPV module is stressed more than other components.
- This is reflected in a significantly more demanding IEC design qualification test program for CPV modules compared to PV modules.
- Soitec's Concentrix™ CPV modules are designed to exhibit an outstanding robustness and reliability even under harsh environmental conditions.
- The last three Concentrix CPV module generations have all been certified according to IEC 62108:2007.
- Based on Soitec's field experience of more than 550,000 months of Concentrix CPV module operation there are no indications as how to improve module reliability have been found. Therefore, we focus on indoor tests here.
- Additionally, field test results available so far provide no indication for any performance degradation (ISFOC and Soitec data analyses).
- To prove and further improve the CPV module robustness, extensive internal and external accelerated ageing tests are executed at Soitec.

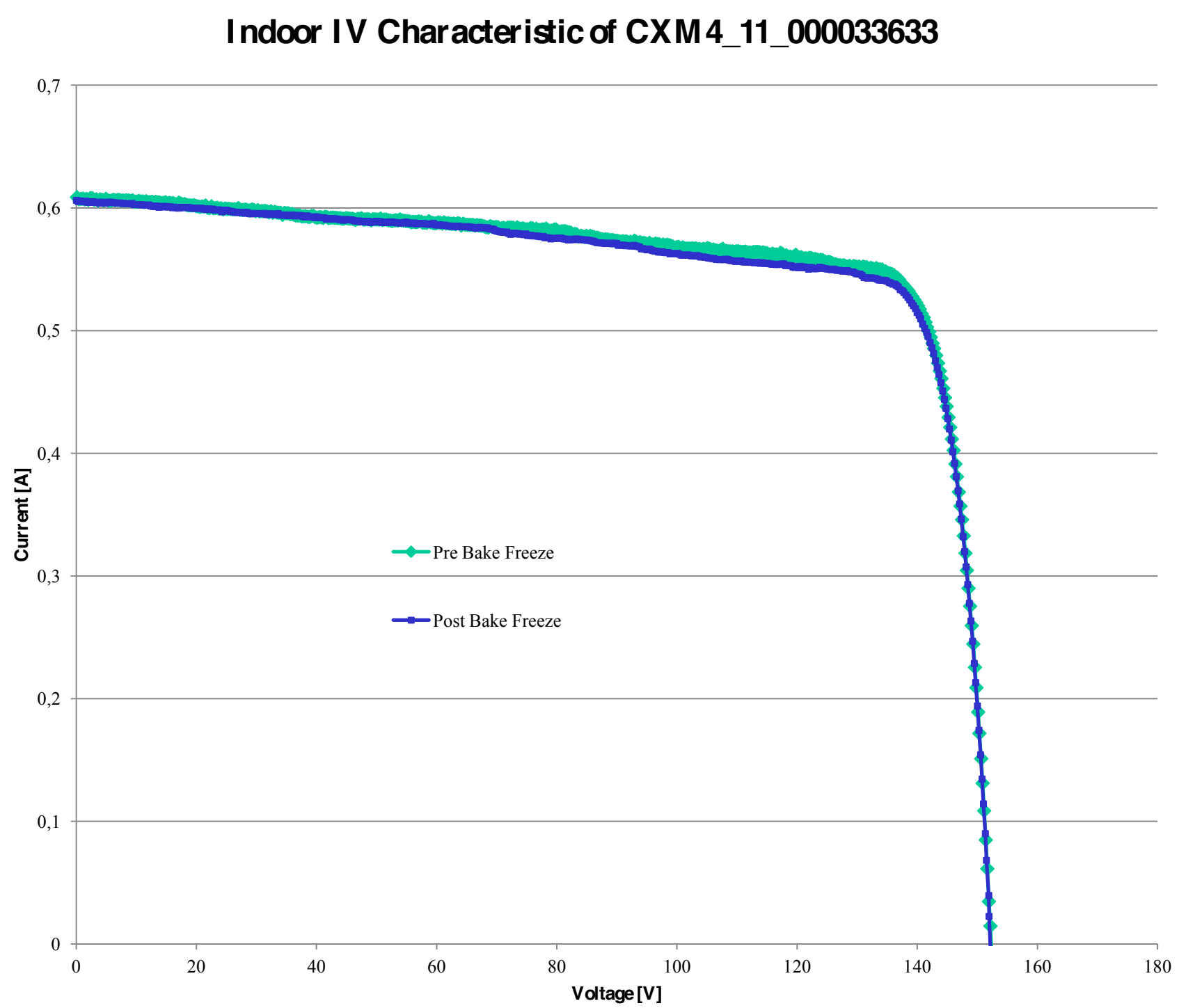
CLIMATE CHAMBER TESTS ON OPEN RECEIVERS

- To increase the hydro-thermal stress applied, electrically connected receivers were stressed without any protective module shell in Damp Heat and Humidity Freeze for a duration exceeding the IEC requirements by far.
- Dark IV and EL measurements were executed after each 1000 hour or 20/40 cycles interval of accelerated ageing.



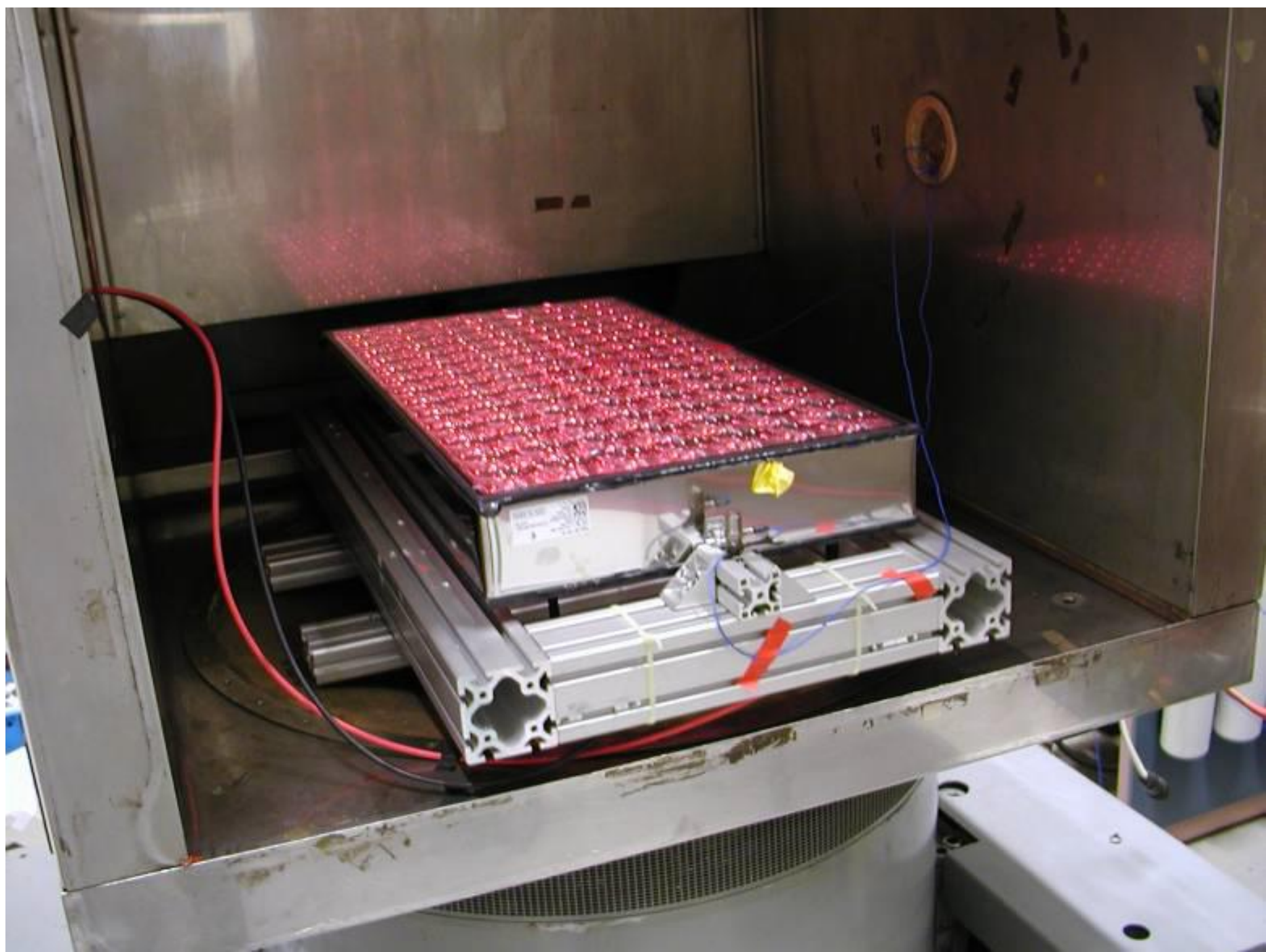
BAKE FREEZE TEST

- To verify the temperature stress resistance of the Concentrix CPV module design, an extreme temperature test was conducted in which a CPV module was baked 160°C for one hour and then frozen at -70°C for an additional hour.
- Indoor flasher IV curve measurement results taken before and after this severe stress test show no significant differences in the IV curve.



VIBRATION TESTING

- In normal operation, a CPV module is not expected to be exposed to vibration load. But during transportation to the site it might be exposed to significant vibration stresses. Considering the Concentrix CPV module design specifics, the bond wires and the 6 module shell surfaces are potentially sensitive to resonances.
- The bond wires showed resonances at around 1 kHz. The CPV module shell (glass plates) resonances were determined to be at around 60 Hz.
- While in EL operation mode the CPV module was subjected and passed a random vibration test with an acceleration up to 31 g (10 PSD).



CONCLUSION

- Besides the test results shown, Concentrix CPV modules and/or components have also been subjected to other tests as well such as salt spray test (IEC 61701 Ed.2), IPX6 tests, sand storm test, and temperature and UV tests.
- After greatly prolonged accelerated hydro-thermal ageing, the wired receivers show some significant resistance increase which will need to be further investigated.