# The "Low Degradation" Performance of N-type Module——Based on the Reliability Tests Conducted by TÜV NORD

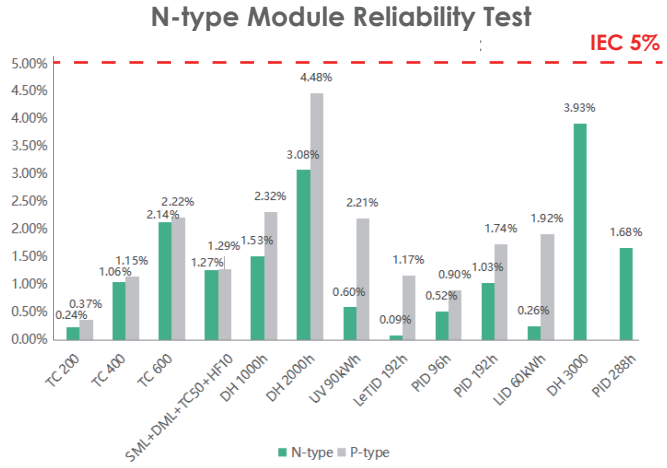
Aging induced, illumination induced LID and LeTID, PID are four forms of PV module degradation, and they both affect modules with monocrystalline cell architectures (i.e PERC, PERT). LID is mainly due to the formation of B-O complex defects by oxygen (O) and boron (B) in the silicon wafer, which reduces the minority carrier lifetime and leads to power degradation. While LeTID is accelerated at high temperatures.

PERC modules' vulnerabilities to the LID and LeTID phenomenon due to its nature of process have been observed in the field, this is one of the reasons that the industry needs to shift towards to N-type technology which is free from or less affected by LID and LeTID in principe. In order to study the degradation mode of N-type TOPCon, TOPCon module reliability test was conducted by TÜV Nord.

The test results revealed that the LID of Jinkosolar' s N-type TOPCon module is only **0.26%** after exposure of 60KWh/m$^2$, while the degradation of conventional PERC module is 1.92% under the same condition. After LeTID test of 192 hours , the power of N-type was degraded less than that of P-type, and the degradation was **0.09%** and 1.17% respectively.

## Reliability Test Method:

1. Accelerated-aged degradation tests were done on N-type TOPCon panels: thermal cycling TC 200 (defined in IEC 61215: 200 cycles, temperature limits of - 40 °C and + 85 °C) 400/600; extended damp heat DH 1000 test (defined in IEC 61215 at a temperature of 85°C and a relative humidity of 85%) 2000/3000; mechanical strength sequence(static mechanical load, dynamic mechanical load, thermal cycling, humidity freeze) SML+DML+TC50+HF10; accelerated ultraviolet UV 90 stress testing.




2. LID 60kWh and LeTID 192h tests were done on N-type TOPCon panels: LID 60kWh, modules undergo outdoor light soaking until stabilization of LID as defined by IEC 63202-1: > 20kWh); LeTID testing for 192 hours, modules are placed in an environmental chamber at 75 °C while connected to a power supply and injected with a low current. The use of a low current is equivalent to the module operating in full sun at maximum power point. Characterization: IV flash testing to measure power loss, visual inspection and wet leakage testing to ensure that power loss can be attributed to LeTID, EL testing to show the visual signature of LeTID.

3. PID tests were done on N-type TOPCon panels: PID 96（IEC 61215) 192/288

## Test Results:

As shown in the figures below, the power degradation of Jinkosolar' s N-type modules are much lower than P-type in various IEC standard aging tests, and the key items such as TC, PID and DH have even passed multiple strict tests.

The LID of Jinkosolar's N-type TOPCon module is only 0.26% after exposure of 60KWh/m$^2$, while the degradation of conventional PERC module is 1.92% under the same condition. After LeTID test of 192 hours , the power of N-type was degraded less than that of P-type, and the degradation was 0.09% and 1.17% respectively.

All these results fully verify the high reliability of Jinkosolar' s N-type, which has lower LID and LeTID than PERC due to its high efficiency cell technology and high-quality n-type silicon wafer, which not only eliminates the LID caused by B-O complex defects, but also has a higher minority carrier lifetime.

In addition, the results also confirm that Jinkosolar' s N-type modules have excellent aging-resistant and PID-resistant properties by adopting premium quality aluminum frame, glass, POE encapsulant , further enhancing the mechanical property and anti-vapor-penetration property.

The UV test is performed on N-type and P-type with UV irradiation of 90KWh/m$^2$. The degradation of module power is 0.60% and 2.21% respectively, and there is no problem of appearance quality.

## Conclusion:

The results certified by the third-party organization TÜV Nord show that Jinkosolar' s N-type TOPCon panel has excellent reliability and stability at various conditions.