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PV Lifetime Project - 2025 NLR Annual Report

Chris Deline, Dirk Jordan, Bill Sekulic, Josh Parker, Heyaw Getabecha, Byron McDanold, and Allan Anderberg

National Laboratory of the Rockies

The National Laboratory of the Rockies is a national laboratory of the U.S. Department of Energy, Office of Critical Minerals and Energy Innovation, operated under Contract No. DE-AC36-08GO28308.

Technical Report
NLR/TP-5K00-98639
February 2026

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Executive Summary

DOE's PV Lifetime project was initiated in 2016 with the goal of accurately characterizing the early-life evolution of photovoltaic (PV) field performance. Different PV cell and module technologies result in different initial degradation rates due to effects like light-induced degradation (LID) and light & elevated temperature-induced degradation (LeTID). To accurately characterize the initial field degradation of maximum power (P_{mp}) requires the use of high-accuracy indoor IV curve measurements at standard test conditions. Therefore, PV modules involved in this study are removed from the field once or twice per year and brought indoors for measurement under constant temperature and irradiance conditions.

Current samples deployed and monitored in this way include Jinko Solar (2016), Trina Solar (2016), Hanwha Q-Cells (2017), Panasonic (2018), LG (2018), Canadian Solar (2018), Mission Solar (2019), Sunprime (2019), and LONGi (2020). Modules from Prism Solar (2019), REC (2023) and Solaria (2023) are being reported on for the first time in this 2025 report.

Overall annual degradation rates are as follows: our first modules to be deployed (Jinko, Trina, QCells) have annual median degradation rate between $-0.4\%/yr$ and $-0.5\%/yr$ mainly concentrated in the first year.

Mission Solar, LG and Panasonic modules are all displaying modest degradation, better than -0.3% / year. Indeed, Mission Solar fielded modules degraded less than their control modules which remain indoors and un-exposed. This is also true for the LONGi monofacial modules, which had some field degradation, but not as much as the degradation of the indoor control modules. The LONGi bifacial modules on the other hand have degraded more in the field than their monofacial counterparts, although still a modest amount ($-0.4\%/yr$).

Of the four newest module types in the study, only one has had better than average degradation. REC360NP2 (N-type TOPCon) had a slight performance increase over the first year and a half of field deployment. For the other three new module types (plus one older module type), degradation was more rapid.

In our study of 16 module types, four have demonstrated degradation faster than $-1\%/yr$: two N-type Heterojunction, one PERC bifacial and one PERC shingled module. The two heterojunction modules in our study are degrading the most rapidly. Sunprime n-HIT bifacial modules are showing a loss rate around $-1.5\%/yr$, for over -10% total to date. This is largely attributed to loss in front-side I_{sc}. This is distinct from the REC 405AA-Pure modules which have degraded -6.8% in only a year and a half, for an annualized decline of $-3.9\%/yr$. For this module type, the decline is roughly half in Voc, with the remaining split between FF and I_{sc}. Of the remaining two module types, Prism Solar PERC bifacial has declined -5% total since 2019, although this loss appears to have stabilized in the most recent measurement. The Solaria PowerX-400R Shingled module type has also lost around -3.2% in the first 1.5 years of field deployment. It remains to be seen if these losses will continue with time.

Several module types exhibit strong seasonal performance change, consistent with LeTID susceptibility. This is characterized by lower indoor IV measurement after prolonged high-temperature exposure, and a recovery during cooler temperatures. This can result in a sawtooth-

type response when sequential indoor measurements are taken in the spring and again in the fall. These types of profiles are visible in Jinko, Trina and Mission Solar module types. It is possible that Canadian Solar multi-PERC also follows this trend, but the measurement timing has not lined up to confirm this possibility.

An analysis was conducted on the initial module performance relative to their nameplate rating. Most module types had initial performance right at nameplate rating, or within 1%: Jinko, Trina, LONGi, Panasonic, QCells and REC N-peak (TOPCon). Other module types came in 2% – 3% below nameplate: Mission Solar and Solaria. The REC 405 Pure Alpha came 3%-4% below nameplate, which is outside of its stated accuracy bounds. It wasn't all bad news - LG modules were measured at 2% above nameplate. Finally, the Sunpreme heterojunction modules had inconsistent measurements which made it difficult to make any statements on their nameplate accuracy. Due to new measurement procedures implemented by our module characterization group in 2025, a shift in reported module performance up to 1% has been introduced to match old data with a new reference module 'MR6X11B'. From now on, corrections to match this updated reference module will be applied.

Three related publications published in 2022 have made use of the PV Lifetime data included in this report, and can help provide greater context and additional information. M. Theristis et al., "Anonymous early-life performance degradation analysis of recent photovoltaic module technologies" (<http://doi.org/10.1002/pip.3615>) provides additional analysis and measurements from New Mexico and Florida test sites for comparable module samples. An international round-robin test on LeTID stabilization processes was published by Karas et al., "Results from an international interlaboratory study on light- and elevated temperature-induced degradation in solar modules" (DOI: [10.1002/pip.3573](https://doi.org/10.1002/pip.3573)). Finally, a detailed discussion of LeTID kinetics and how this affects field performance and LCOE is provided in the MRS Bulletin, I. Repins et al., "Long-Term Impact of Light and Elevated Temperature Induced Degradation on Photovoltaic Arrays". (DOI: [10.1557/s43577-022-00438-8](https://doi.org/10.1557/s43577-022-00438-8))

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1 Introduction

In 2016, the US Department of Energy initiated the PV Lifetime project – an effort to procure, deploy and accurately characterize the initial performance degradation of commercial PV module samples. In the process of this project, NLR and Sandia national laboratories have collaborated to deploy and publish on the initial performance of over 950 different samples from 12 different manufacturers to date. This report represents a cumulative snapshot of field results for the PV modules deployed at NLR.



Figure 1. Overview of the NLR PV Lifetime field samples ca 2018

As of 2025, the following module types have been deployed at each of the PV Lifetime locations:

Table 1. PV Lifetime Modules under test in Albuquerque, NM, Golden, CO and Cocoa, FL.

Company	Model	Type	Number in NM	Number in CO	Number in FL
Jinko Solar	JKM260P 260W	Multi	28	28	56
Jinko Solar	JKM265P 265W	Multi	28	28	-
Trina Solar	TSM-PD05.05 255W	Multi	-	28	-
Trina Solar	TSM-PD05.08 260W	Multi	56	28	56
Canadian Solar	CS6K-270P 270W	Multi	48	-	-
Canadian Solar	CS6K-275M 275W	Mono	48	-	-
Canadian Solar	CS6K-300MS 300W	PERC	-	28	-
Hanwha Q-Cells	Q.Plus BFR-G4.1 280	PERC	48	28	-
Hanwha Q-Cells	Q.Peak BLK G4.1 290	Mono-PERC	48	28	-
Solar World	SW 245W Mono	Mono	21	-	-
LG	LG320N1K-A5 320W	N-Si	48	30	-
LG	LG400Q1C-A6	N-IBC	30	-	-
Panasonic	VBHN330 330W	N-HIT	48	28	-
Mission Solar	MSE360SQ65 300W	Mono-PERC	48	20	-
Sunpreme	HxB-400	Bifacial HIT	-	20	-
LONGi	LR6-72BP-360M	Bifacial PERC	-	20	-
LONGi	LR6-72PH-365M	Monofacial	-	20	-
Prism Solar	BN72 (360W)	Bifacial PERC	16	20	-
REC	REC405AA Pure Black	N-type HIT	28	10	-
REC	REC360NP2	N-type TOPCon	-	12	-
Solaria	PowerX-400R	Mono, shingled	28	14	-
Program Total			>950 modules		

The objective of the PV Lifetime Project is to determine and communicate module degradation profiles over time, including the uncertainty and any differentiation between module types. This will be done by:

- Annual flash testing of PV modules operated in the field in a variety of locations and climates.
- Analysis of periodic data to detect system degradation rates and causes.
- Sharing of reviewed results and data publicly.

For additional information on the PV Lifetime project background and initial module performance, see the WCPEC conference publication for additional details: J. Stein et al. [PV Lifetime Project: Measuring PV Module Performance Degradation: 2018 Indoor Flash Testing Results](#), WCPEC-7 (2018).

1.1 PV system descriptions and initial LID performance

The PV Lifetime systems currently deployed at NLR are described below. Where initial LID performance is stated, it is based on repeated indoor flashing of modules following small increments of outdoor light soak exposure in the range of 5 – 20 kWh/m².



Figure 2. NLR PV Lifetime installations. Jinko Solar (left) and Trina Solar (right)

Jinko Solar. PV systems composed of 28 modules each of Jinko JKM260P-60 and Jinko JKM265P-60 modules were deployed outdoors in October 2016 following initial baseline PV measurements in September 2016. The systems are grid-tied through an ABB TRIO 20.0 inverter, in two strings of 14 modules apiece. Due to a delay in system electrical configuration, the PV system was not grid-tied until April 2017. An initial light-induced degradation of up to 1.5% was detected following 10+ kWh/m² of light exposure of the control modules.

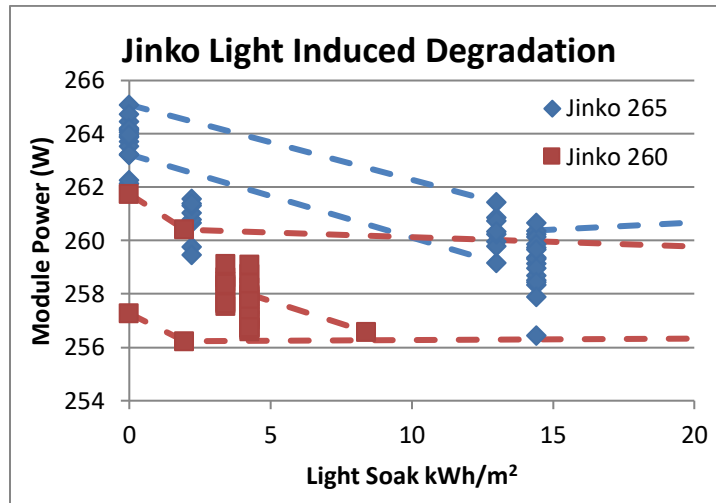


Figure 3. Jinko Solar initial LID data showing 0.5% LID loss for JKM260 and 1.5% LID loss for JKM265 modules. Data from repeated indoor IV measurements. Dashed lines shown for select modules.

This system was offline (open circuit) in 2023 due to failure of the ABB TRIO inverter (7 years of field operation). The system was offline from April – August 2023 and was replaced with a Fronius SYMO 20.0-3 480 inverter. During this time period the system size was reduced from 28 modules to 14 modules per type to make room for additional new partners.

Trina Solar. PV systems composed of 28 modules each of Trina TSM-PD05.08 260W and Trina TSM-PD05.05 255W (Black backsheet) modules were deployed in October, 2016. The systems are grid-tied through an ABB TRIO 20.0 inverter, in two strings of 14 modules apiece. The PV

system was grid-tied in April, 2017. An initial light-induced degradation of ~0.4% was detected following 10 kWh/m² of light exposure of the control modules.

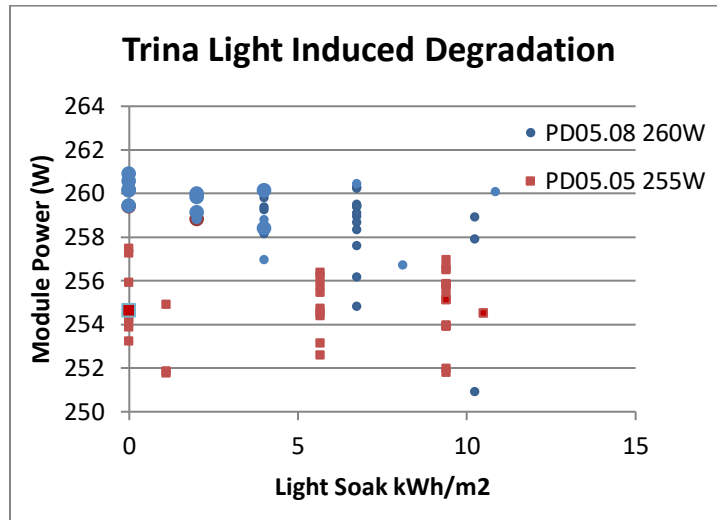


Figure 4. Trina Solar initial LID data showing 0.4% LID loss for both module types. (Data from repeated indoor IV measurements)

This system was offline (open circuit) in 2023 due to failure of the ABB TRIO inverter (7 years of field operation) which was in common with the Jinko system. The system was offline from April – August 2023 and was replaced with a Fronius SYMO 20.0-3 480 inverter. During this time period the system size was reduced from 28 modules to 14 modules per type to make room for additional new partners.



Figure 5. NLR PV Lifetime installations. QCells (left) and Panasonic (right)

QCells. PV systems composed of 28 modules each of QCells Q.Plus BFR-G4.1 280 (multi-PERC) and Q.Peak BLK-G4.1 290 (mono-PERC, black backsheet) modules were deployed in October, 2017 following baseline measurements in July 2017. The systems are grid-tied through an ABB TRIO 20.0 inverter, in two strings of 14 modules apiece. An initial light-induced degradation of around 1% was detected following 10 kWh/m² of light exposure.

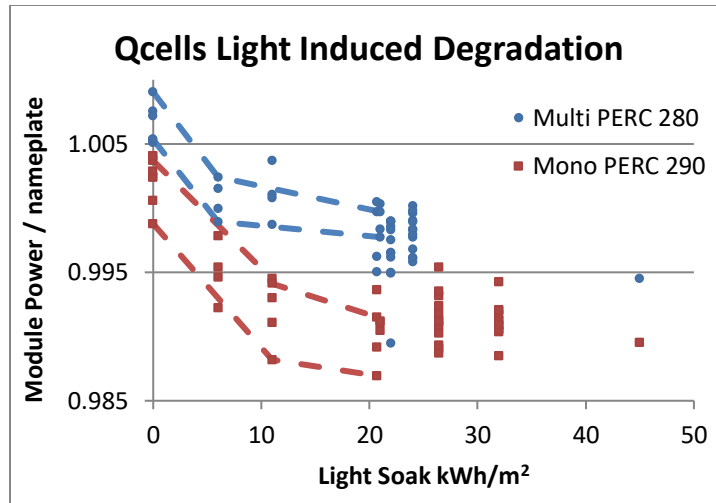


Figure 6. QCells initial LID data showing 0.9% LID loss for Qplus (multi PERC) 280W and 1.2% LID loss for QPeak (monoPERC) 290W. Data from repeated indoor IV measurements. Dashed lines shown for select modules.

Panasonic, Canadian Solar, LG. Three separate PV systems were deployed in 2018 composed of 30 modules of Panasonic VBHN3305A16 (Heterojunction “HIT”), 28 modules of Canadian Solar CS6K-300MS (Mono-PERC) and 28 modules of LG LG320N1K-A5 (N-Type Mono-Si “NeON2”). The systems are grid-tied through HiQ ProHarvest inverters, in either two-string (Canadian, LG) or three-string (Panasonic) configurations. PV module baseline data were taken in June 2018, with modules installed June – October 2018. Initial LID performance changes following 20 kWh/m² of light exposure depended on product technology: Canadian Solar: -0.5%. LG: 0%. Panasonic: +0.6% improvement.

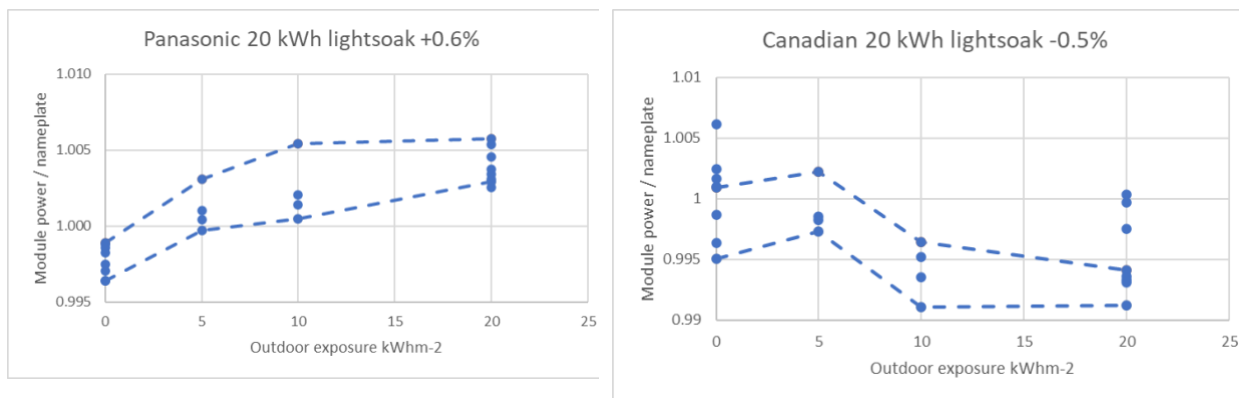


Figure 7. Panasonic initial light-soak data showing +0.6% performance gain and Canadian CS6K-300MS showing -0.5% decline. Data from repeated indoor IV measurements. Dashed lines shown for select modules.

Prism Solar, Mission Solar, Supreme, LONGi Bifacial tracker. A 10-row single-axis tracked system was installed in 2018–2020. The site supports four PV Lifetime systems: 20 modules

each of Prism Solar BN72 (PERC bifacial), Mission Solar MSE360SQ6S (Mono-PERC), Sunpreme Maxima HxB 400 (bifacial HJT) and LONGi (bifacial and monofacial mono-PERC). The systems are grid-tied through SolarEdge SE20k inverters, and utilize module-level power optimization to identify module-level mismatch throughout the system. The other rows in the system are part of a separate research program on bifacial PV energy gain and field durability. A detailed study of LID loss in the first 10–20 kWhm⁻² light exposure was not conducted for these modules.



Figure 8. NLR 75-kW tracking PV system supporting PV Lifetime performance data

REC 360NP2 (TOPCon), REC 405AA Pure Black (HIT), Solaria PowerX-400R. These next module types were deployed in late 2023. These module technologies include n-type silicon heterojunction (HIT) and TOPCon technology from REC, as well as shingled p-type PERC solar cells from Solaria. All three module types utilize half-cut solar cells, and feature all-black module frame and backsheet. A total of 10-14 modules of each type was deployed. All three of these module types have monofacial (not bifacial) module construction.



Figure 9. REC 360NP2 (left), 405AA Pure Black (middle) and Solaria PowerX-400R (right)

1.2 Program measurement methodology

Rather than focusing on in-situ performance monitoring under prevailing meteorological conditions, the PV Lifetime project instead takes periodic indoor IV curve measurement at 25 °C and 1000 W/m². On a regular schedule of 1–2 times per year, a subset of fielded PV modules are brought indoors for high accuracy STC flash test measurement. In between measurements, the modules are returned outdoors and put back under grid-tied conditions.

Un-exposed indoor control modules are also maintained for each module type to distinguish between field-induced changes and other factors. These can include simulator setting changes or sample instability. Since we are measuring the inherent performance of the PV module as it changes in time, we use the term ‘degradation rate’ in reporting on module STC loss over time. The wider term ‘performance loss rate’ refers to system-level AC performance of a fielded system as it changes with time. The DC degradation rate is a subset of all system-level performance losses, which also include items like module soiling, tracker pointing errors or AC availability, which are not considered here.

1.2.1 Initial simulator measurement (Spire 5600)

Indoor IV curve measurements at NLR are conducted on multiple test platforms with various stability and accuracy specifications. The highest accuracy measurement is the Module Self-Reference (MSR) methodology, with a stated accuracy of 1.1% ([Levi et al, 2017](#); [Ndione et al, 2020](#)). This is a time-consuming method that is only conducted once per module type at the beginning of the experiment. The faster approach is to take flash measurements on a Spire simulator. The flash simulator can result in offset errors due to illumination level setting, but is relatively stable over time. It is therefore useful in identifying relative levels of change.

To judge the overall accuracy of the Spire 5600 simulator, in Figure 10 and 11 we plot the high accuracy MSR measurements taken for all module types against comparable Spire 5600 measurement. The Spire 5600 flash platform is generally below the dashed black 1:1 line, indicating that it is measuring a lower P_{mp} value than the MSR platform. For the Panasonic, Jinko, Trina, LONGi and Mission Solar modules, the Spire measurement is within 1% of the true value, but for Canadian, REC, Solaria and QCells the Spire values are 2%–3% low, and for LG modules the Spire values are measuring 4.4% below the true value. A tremendous difference in the two platforms of 6%–8% was found for the Sunpreme HJT modules, which should be investigated further. The difference in measurement platforms should be considered when looking at the figures in the remainder of this report, all of which were measured with the Spire 5600 flasher. These values may be adjusted by the offset shown in Figure 10 and 11 to arrive at a more accurate absolute power value..

Figure 10 and 11 also provide a comparison between a module’s nameplate rating and its actual measured value. In the figure, nameplate values are represented by vertical dashed lines with color corresponding to the given module type. In the case of Canadian, Jinko, Trina, LONGi, Panasonic and REC TOPCon, initial baseline measurements are right at expected nameplate rating. LG was measured at 2% above nameplate. QCells was within 1% but consistently low, and Mission Solar and Solaria were 3% below nameplate. The two REC 405Pure AA modules were at 2% and 4% below nameplate rating, which somewhat falls outside of its stated nameplate accuracy of 3%. The Sunpreme HxB heterojunction modules had a lot of variability in their

initial measurement, with the Spire 5600 showing initial performance 3% – 4% below nameplate, but the higher accuracy MSR measurement showing performance at 2% – 6% above nameplate. The cause of this discrepancy is under investigation.

New in 2025 is the addition of Prism Solar BN72 PERC bifacial modules. These have a nameplate rating of 360W and were initially measured with the MSR method at 351.1 W, roughly 2.5% below nameplate.

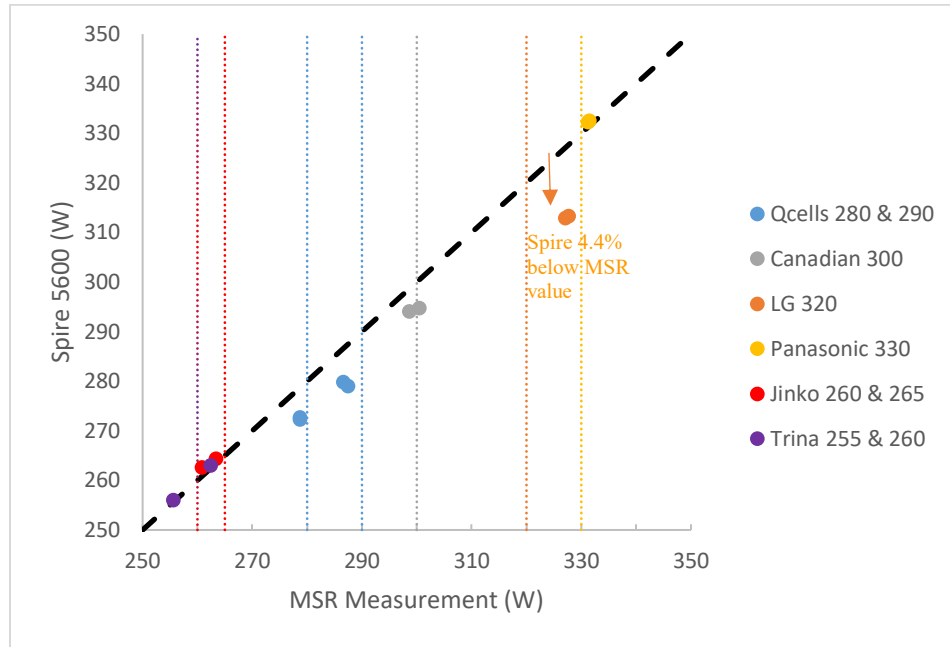


Figure 10. Initial baseline characterization of the first half PV Lifetime modules. MSR measurement (1.1% absolute accuracy) compared with Spire 5600 measurement (lower accuracy). Vertical lines represent nameplate rating of each module type.

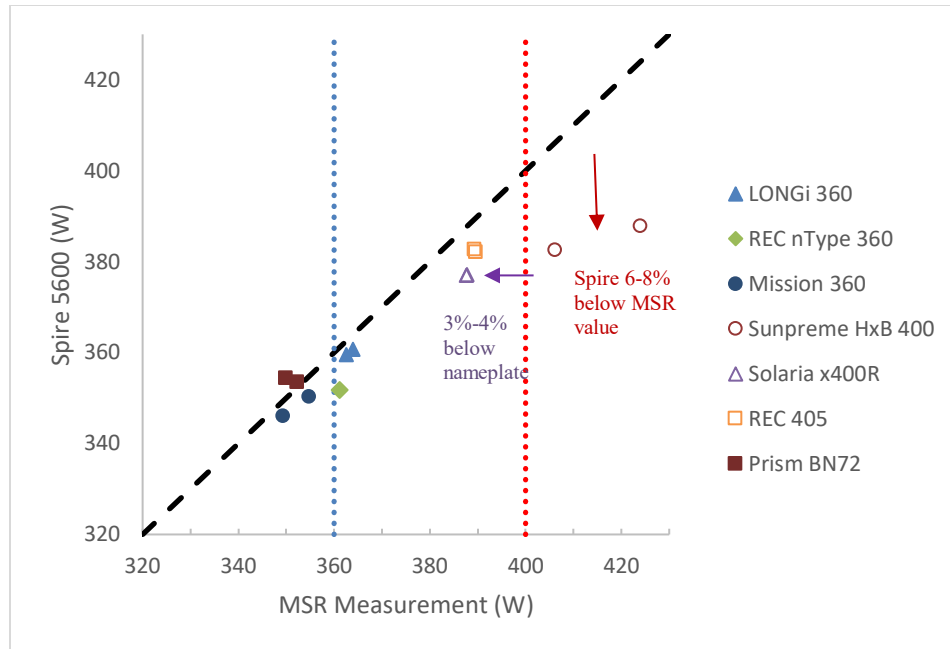


Figure 11. Initial baseline characterization of the second half PV Lifetime modules. MSR measurement (1.1% absolute accuracy) compared with Spire 5600 measurement (lower accuracy). Vertical lines represent nameplate rating of each module type, either 360 W (closed symbols) or 400-405 W (open symbols).

1.2.2 Temporary Spire 4600 measurements (2022)

For a brief period in 2021–2022 the PV Lifetime project switched to taking measurements on even another flash simulator platform. The Spire 4600 flash simulator user facility at the VTIF building has lower absolute accuracy than the Spire 5600 instrument described above, but has much more time availability. For one example of reduced accuracy, building temperature is only controlled within ± 5 C vs 0.1 C, leading to a requirement for temperature correction of these measurements. Furthermore, simulator uniformity, spectral match and aperture area is worse, leading to systematic offsets in measurements. To allow recent Spire 4600 measurements to be compared directly with earlier Spire 5600 measurements, control modules of each module type were measured on both platforms, allowing a correction factor to be developed (Figure 12). For some module types (Jinko, Trina) the Pmp error is small, < 1 W. For the largest discrepancy (QCells) the measurement difference is on the order of 5–6 W.

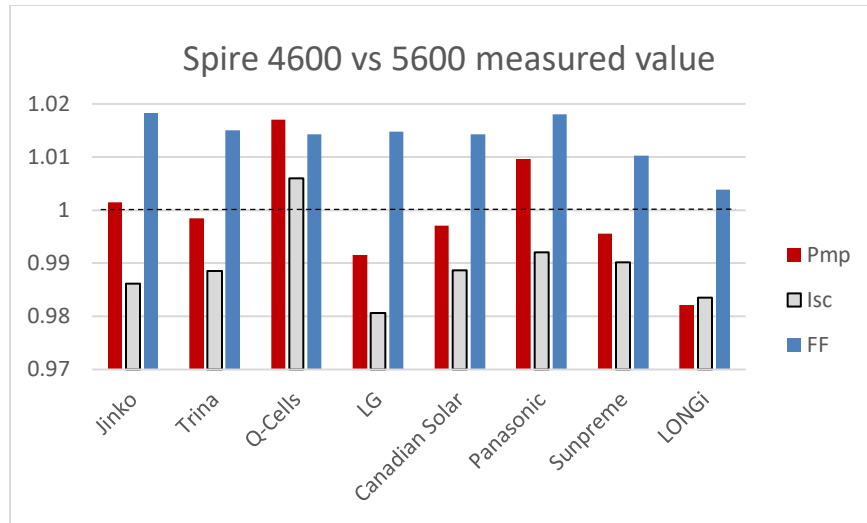


Figure 12. Comparison of Spire 4600 vs Spire 5600 control module measurements. Fill Factor was measured higher on all modules. I_{sc} was either higher or lower based on module type, leading to variability in P_{mp} offset. The largest power offset was for QCells leading to a 5-6W measurement difference. Data taken on this platform is corrected to remove this simulator offset.

For data plotted in this report, measurements taken on the Spire 4600 will be indicated with square markers, post-correction. Stability of this correction factor will be monitored over time by comparisons between Spire 4600 and 5600 each subsequent measurement period. Because of reduced accuracy of these measurements, we returned to measurement on the Spire 5600 in 2023–2024.

1.2.3 Simulator reference module SBM1 replaced (2025)

Starting in 2025, measurements made with the Spire 5600 simulator were measured with a different master control module used to set the light level. Unfortunately, the historical simulator module SBM1 used a type of monocrystalline solar cell that degraded in I_{sc} over time. Because of this, the light level used during measurements began to decline with time for our ‘standard’ module measurements. At the time of this report’s writing, a new module ‘MR6X11B’ has started to be employed. This is a larger-format module and uses Maxeon IBC cells which are expected to be stable for a longer period of time. Based on initial tests, when this reference module is used instead of SBM1, the current (and power) of measurements is increased by 1% on average.

Prior to 2025, we applied a correction factor to module measurements based on the difference between Spire and MSR initial measurements, to help correct for the inaccuracies in the Spire simulator, including with the reference module. With the new and more accurate reference module, we have stopped applying this MSR correction factor to new data, because the Spire measurement platform has a reduced bias error that no longer requires correction. To allow previous data to match the levels of the new simulator setting, the MSR correction factor has been updated per each module, and will be applied to all data collected prior to 2025.

Measurement points taken with the new reference module will be denoted with triangle points in upcoming IV curve measurement plots. Initial IV curve values reported in 2025 may be ~1% higher than in previous annual reports due to this updated data analysis procedure.

2 Field measurement results

Each module type when received by NLR underwent initial light-soak stabilization of 10 – 20 kWh/m² to remove initial LID effects before our first ‘true’ baseline measurement is taken. For some module types, we monitored the fast change in performance over this initial light soak – for others we did not. For all module types, we are using our first post- light-soak indoor P_{mp} measurement as the time zero reference point — subsequent changes are stated as a % of this initial measurement.

2.1 Jinko JKM260

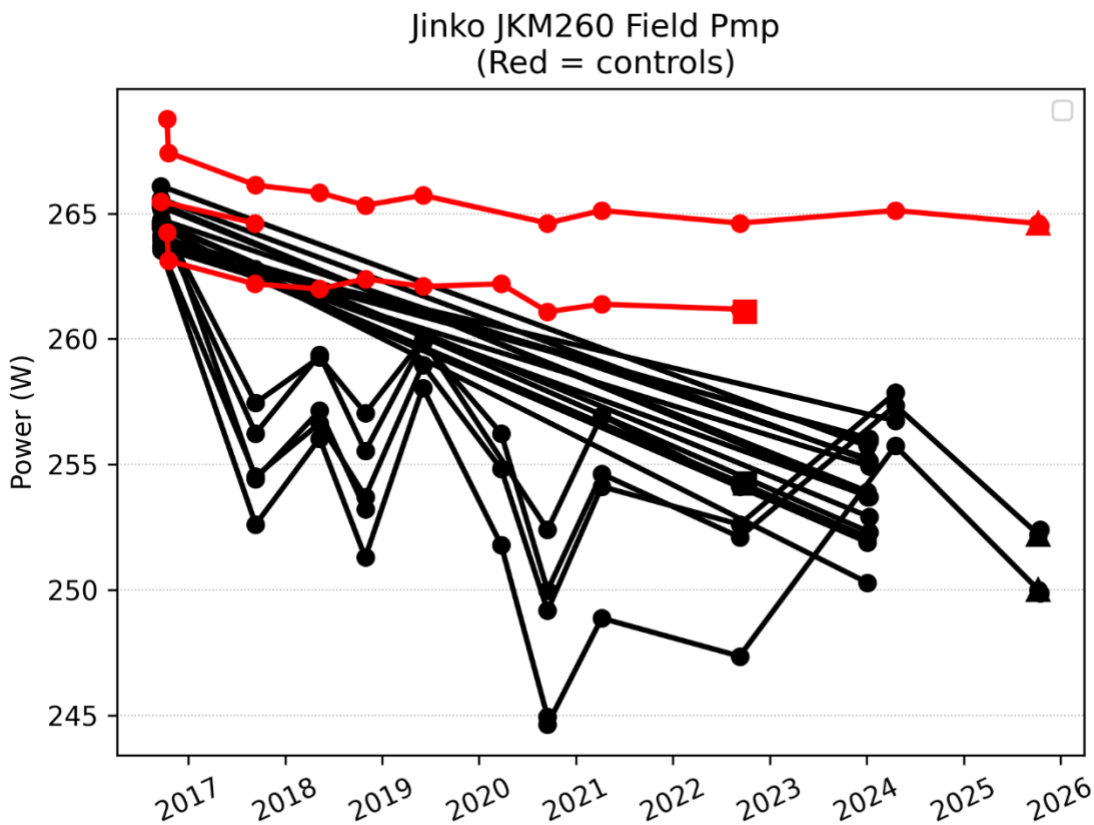


Figure 13. Jinko JKM260 flash measurements. Field modules (black) and indoor controls (red). Square markers indicate Spire4600 measurement (post-correction) and triangle marks indicate uncorrected measurement taken with the new 2025 reference module. Seasonality may still be present, but is not recorded with new annual measurements. A new cohort of 14 modules was measured for the final time when they were de-integrated and removed from further test.

2.1.1 Initial light soak

Jinko JKM260 experienced $\sim 0.5\%$ initial loss due to LID following 22kWhm-2 light exposure

2.1.2 Control module change (post-lightsoak)

Jinko JKM260 control modules showed a modest overall change of -1% over the entire measurement period.

2.1.3 Field module change (post-lightsoak)

The first thing to mention on the plot this cycle is that a large number of additional modules were measured. Because the Jinko JKM260 system was cut down from 2 strings to 1, an additional 14 modules were removed from test and re-measured after 7 years.

Compared with the relatively stable control modules, the fielded modules demonstrate seasonal performance change, related to inherent instability of this module type. For additional information see [Repins, 2020]. In particular, this module type has been tested and found to be LeTID sensitive per the procedure described in Karas, 2022 which is an early draft version of IEC TS 63342.

For the fielded modules (4 of the typically monitored modules plus 14 additional ones), overall median degradation was -4.1% . Based on the few modules measured with more regularity, the majority (-3%) of this loss occurred in Year 1. It's expected that a similar degradation profile applied to the other 14 modules, but no interim data was measured to confirm. The overall annualized Pmp loss works out to $-0.45\%/yr$.

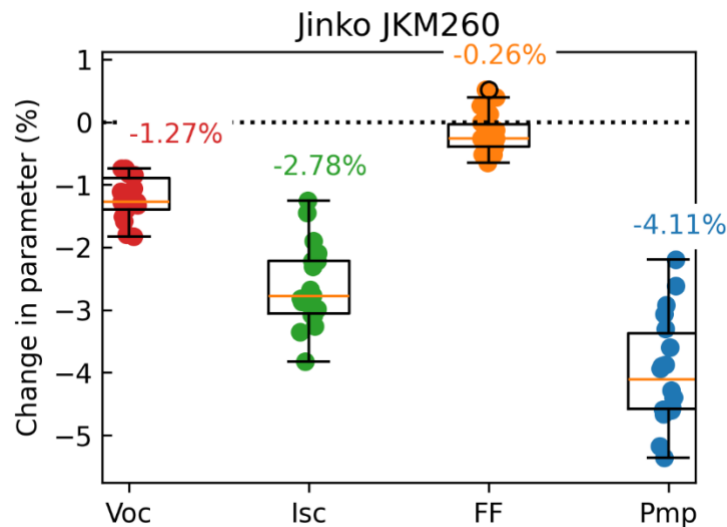


Figure 14. Jinko JKM260 IV curve parameter overall change.

Overall change in performance from 2017 to 2025 for Jinko JKM260 is due to primarily Isc, as well as some Voc loss.

It should be noted that all Jinko and Trina modules in this field withstood a large hailstorm that came through the Golden area on May 2017. Hail on-site was up to 50mm in diameter (egg-sized). Although no SLTE modules experienced broken glass, there were a number of cracked cells that showed up in module EL following their de-integration and final characterization. The below image of module M1609-0008 is typical of the type of damage that occurred – a handful of visible cracks and impact centers.

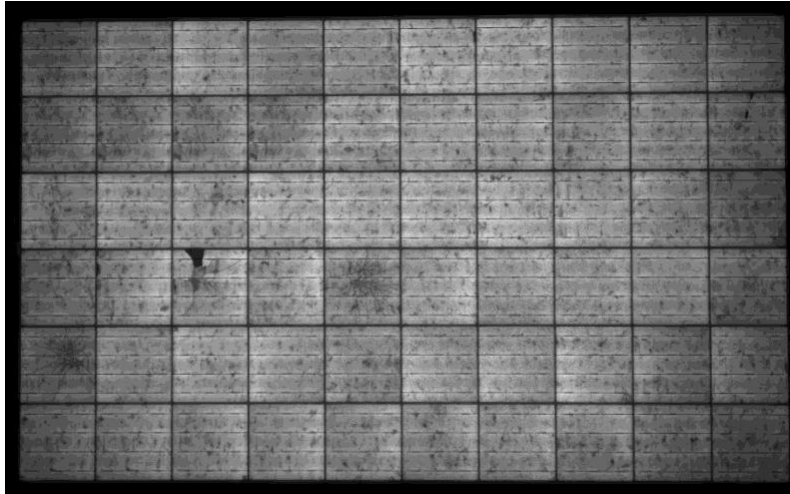


Figure 15. Jinko module EL image at test conclusion in 2024 illustrating 3-4 cracked cells due to hail exposure in 2017. This image is typical of those taken from the field.

2.2 Jinko JKM265

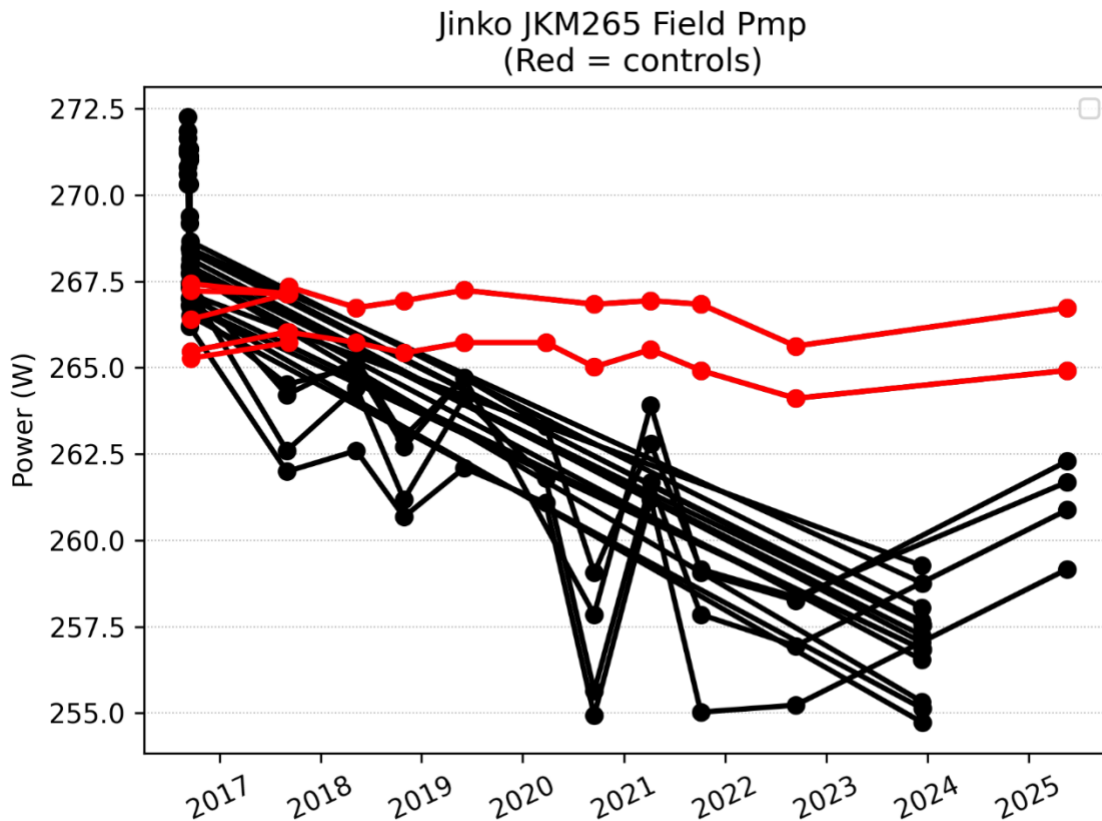


Figure 16. Jinko JKM265 flash measurements. Field modules (black) and indoor controls (red). In 2024 a cohort of 14 modules was measured for a final time when they were de-integrated and removed from further test.

For JKM265, module measurements from 2017 – 2021 were taken with a higher 6-month frequency which makes seasonal performance changes visible. Starting in 2022, seasonality was still present, but is less visible due to reduced measurement frequency. The 2025 measurement was taken in the springtime, rather than the previous two measurements which occurred in the fall. From the figure it is clear that there is a ~4W power increase at this point in time. This shows that seasonal performance is still present, characterized by recovery of module performance over the winter, and decline in performance over the summer.

2.2.1 Initial light soak

Jinko JKM265 experienced 1.5% initial loss due to LID following 22kWhm⁻² light exposure

2.2.2 Control module change (post-lightsoak)

Jinko JKM265 control modules were stable over the measurement period of 2017–2024.

2.2.3 Field module change (post-lightsoak)

Similar to the other Jinko modules, the JKM265 system was reduced from 2 parallel strings of 14 to just one. The 14 modules removed from the system were characterized a final time after 7 years in the field.

Compared with the stable control modules, the JKM265 fielded modules show a relatively high seasonal performance difference depending on the season of measurement. This makes cumulative performance loss difficult to quantify. Based on measurements made in the spring of 2021, post-LID degradation was -1.67% , or $-0.37\%/yr$. However using the more recent (and lower) fall 2022 measurement as an endpoint, degradation was -3.66% or $-0.61\%/yr$. As with the Jinko JKM260 modules, any ongoing seasonality post-2022 was hidden when measurements moved from biannual to annual frequency. Based on the 2025 measurements which were taken on the high side of seasonal performance trend, the overall median degradation was -3.9% or $-0.45\%/yr$. This is compared with the 2022 reported value of $-0.56\%/yr$.

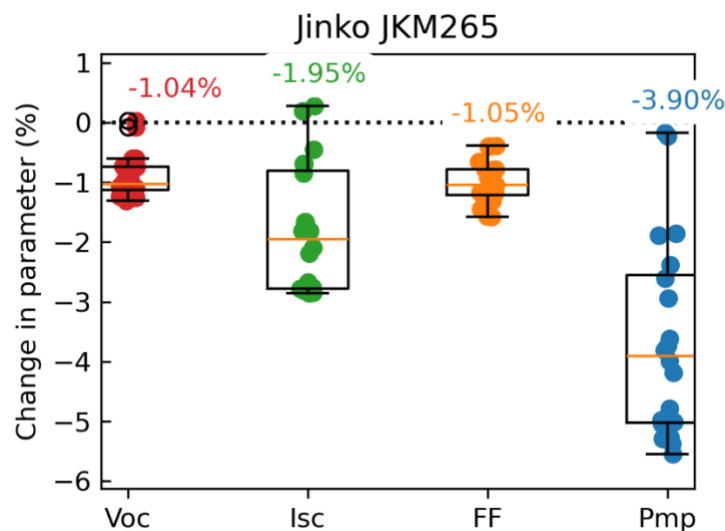


Figure 17. Jinko JKM265 IV curve parameter overall change.

Overall change in performance from 2017 to 2025 for Jinko JKM265 includes contributions from all three parameters – Isc (-2%), Voc (-1%) and Fill Factor (-1%).

2.3 Trina TSM255

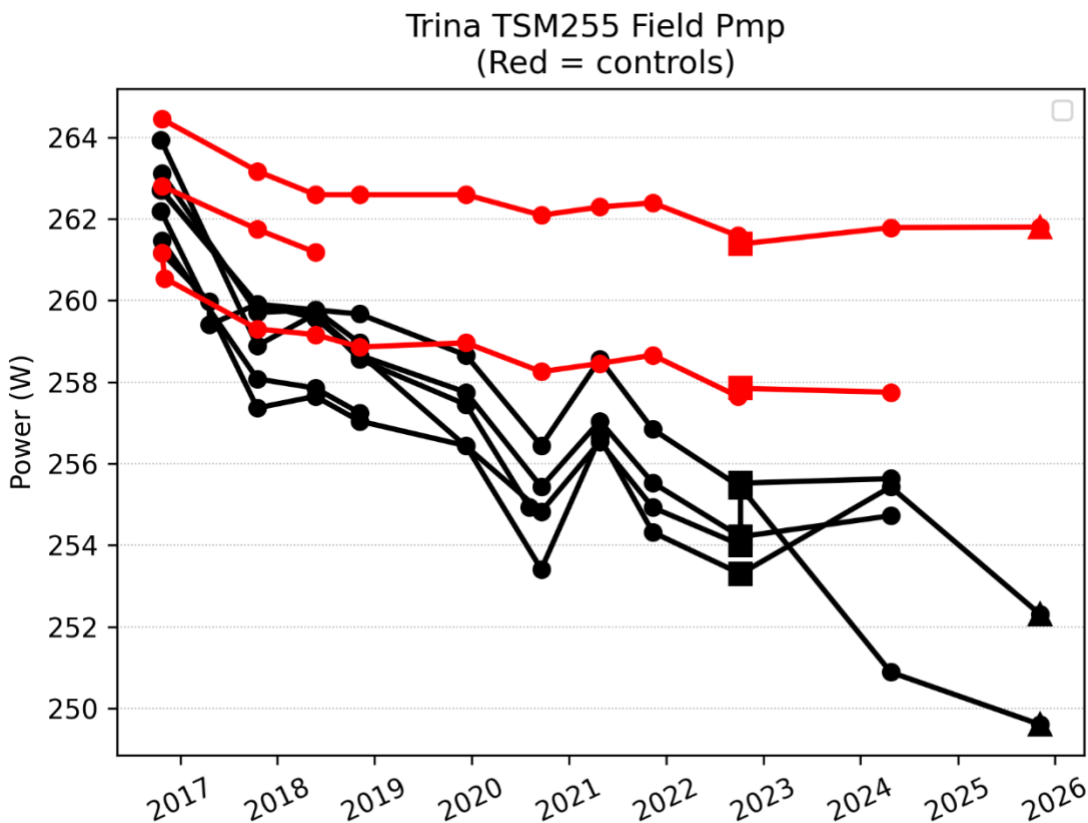


Figure 18. Trina TSM255 flash measurements. Field modules (black) and indoor controls (red). Square markers indicate Spire4600 measurement (post-correction) and triangle marks indicate uncorrected measurement taken with the new 2025 reference module.

Trina modules re-measured in 2025 show consistent performance in the indoor control, and outdoor field modules.

2.3.1 Initial light soak

Trina TSM255 experienced 0.4% initial loss due to LID following 10kWhm⁻² light exposure

2.3.2 Control module change (post-lightsoak)

Trina TSM255 control modules showed a modest overall change of -1.15% from 2017-2025.

2.3.3 Field module change (post-lightsoak)

The TM255 fielded modules showed only modest annual performance change and a slight amount of seasonality. Year 1 degradation was roughly -1% . Overall post-LID degradation from 2017 through 2025 was -3.4% , or $-0.38\%/yr$. Some seasonality in performance may still be happening, but is difficult to determine with the annual measurement frequency.

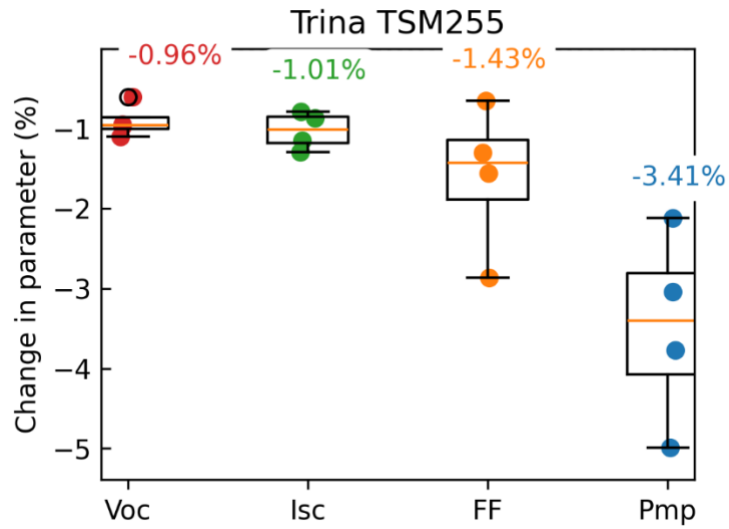


Figure 19. Trina TSM255 IV curve parameter overall change.

Overall change in performance from 2017 to 2025 for Trina TSM255 is split pretty evenly between Isc, Voc and Fill Factor.

2.4 Trina TSM260

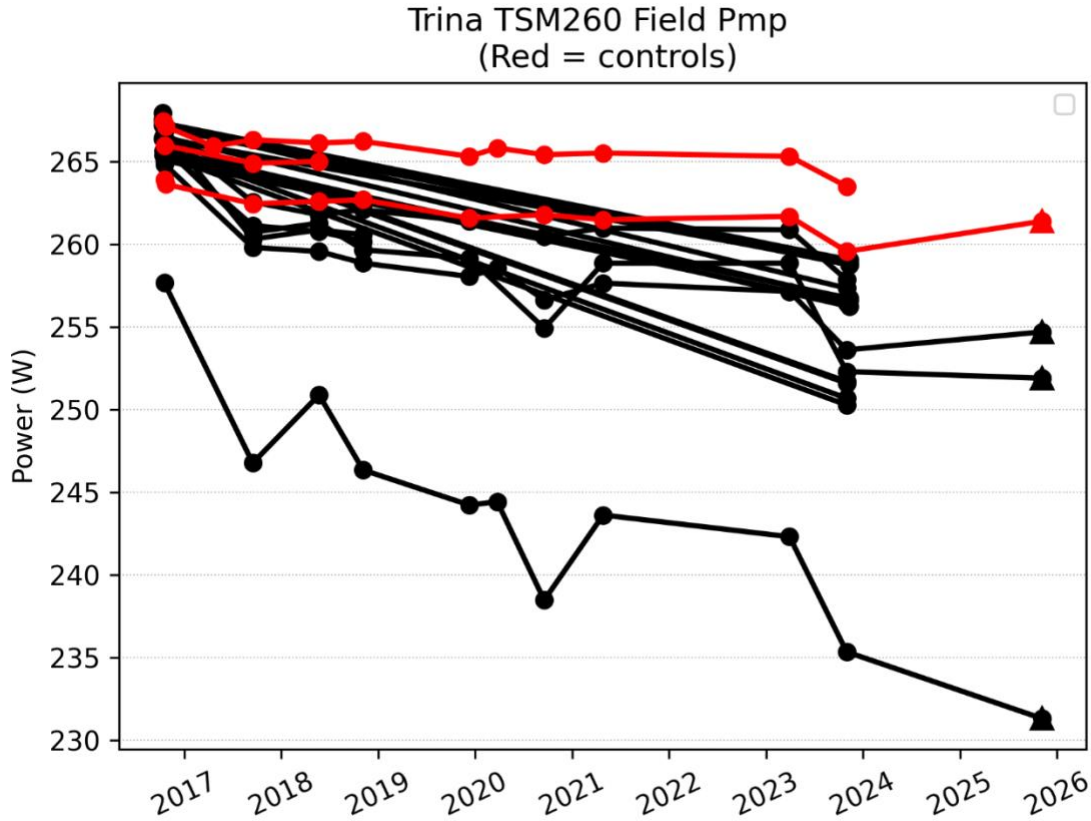


Figure 20. Trina TSM260 flash measurements. Field modules (black) and indoor controls (red). Triangle marks indicate un-corrected measurement taken with the new 2025 reference module

Trina modules re-measured in 2025 show consistent performance in the indoor control, and outdoor field modules.

2.4.1 Initial light soak

Trina TSM260 experienced 0.4% initial loss due to LID following 10kWhm⁻² light exposure

2.4.2 Control module change (post-lightsoak)

Trina TSM260 control modules showed a modest overall change of -0.96% from 2017–2025.

2.4.3 Field module change (post-lightsoak)

Similar to the Jinko modules, a group of 14 modules was removed from the field to re-configure the Trina TSM260 system into a single string. These modules were measured for the final time, and results were similar to the other (well-behaved) modules in this system.

Year 1 field module degradation was roughly -2% aside from the outlier module M1610-0043 which declined -3.8% in year 1 and continued its low performance. Upon measuring EL, dramatic cell-cracks over 1/3 of the module was visible. It's likely that these cell cracks pre-date module installation.

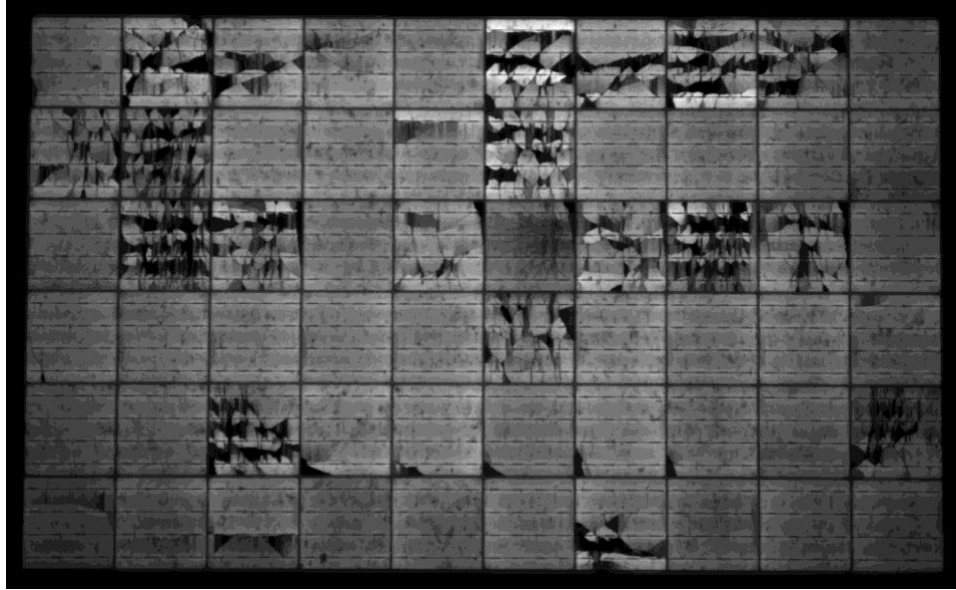


Figure 21. EL image of low performing module M1610-0043 taken in 2023. The nature of the damage (3 parallel tracks across the cell width, centered between busbars) tends to indicate manufacturing damage vs a 'bullseye' crack which would arise from a hail impact. This module's underperformance also predates the May 2017 hail event at NLR.

The TM260 fielded modules (aside from one outlier) showed only modest annual performance change. Median post-LID degradation from 2017-2025 was -3.42% , or $-0.38\%/yr$.

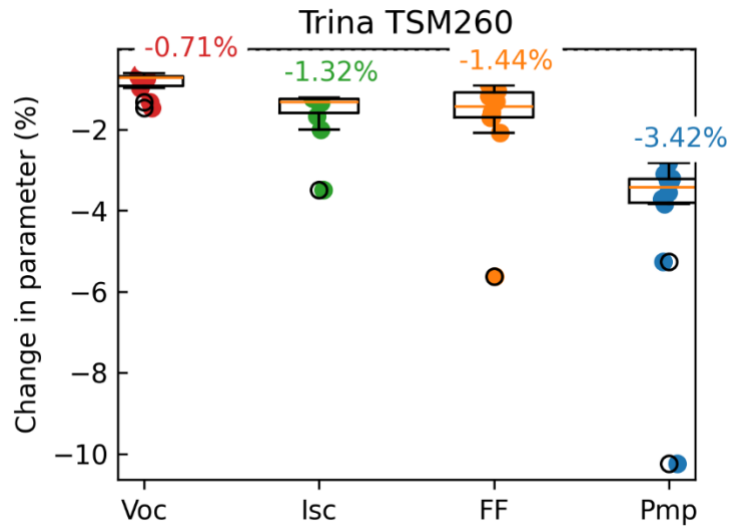


Figure 22. Trina TSM260 IV curve parameter overall change, median values highlighted.

Overall change in performance from 2017 to 2025 for Trina TSM260 is due to both Isc, Voc and Fill Factor. The outlier module Module M1610-0043 declined most significantly in FF, which may be indicative of cell-level mismatch within the module.

When removing these 14 extra modules from the field, EL images were captured to assess the damage due to exposure to the May 2017 hail storm. While no glass cracking occurred, internal module damage and cell cracking was evident. The figure below shows an EL image taken from one of the modules that was removed in 2024. The damage to cell corners/edges and visible cracks on 10%-30% of the cells is typical of the hail-damaged modules.

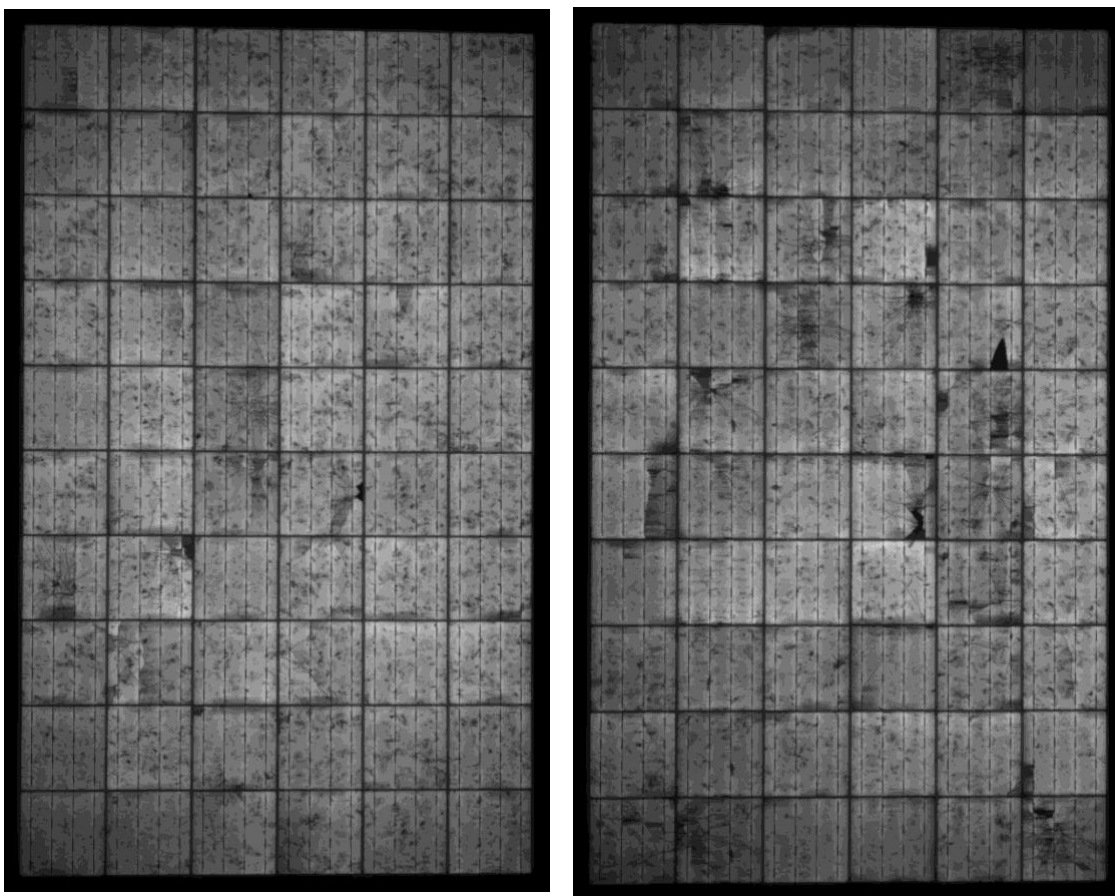


Figure 23. Trina TSM260 cell cracking following 2017 hailstorm. Damage impact and resulting measured power ranged from slight (M1610-0025, left. 255.4W) to moderate (M1610-0042, right. 251.2W).

2.5 QCells Qplus280

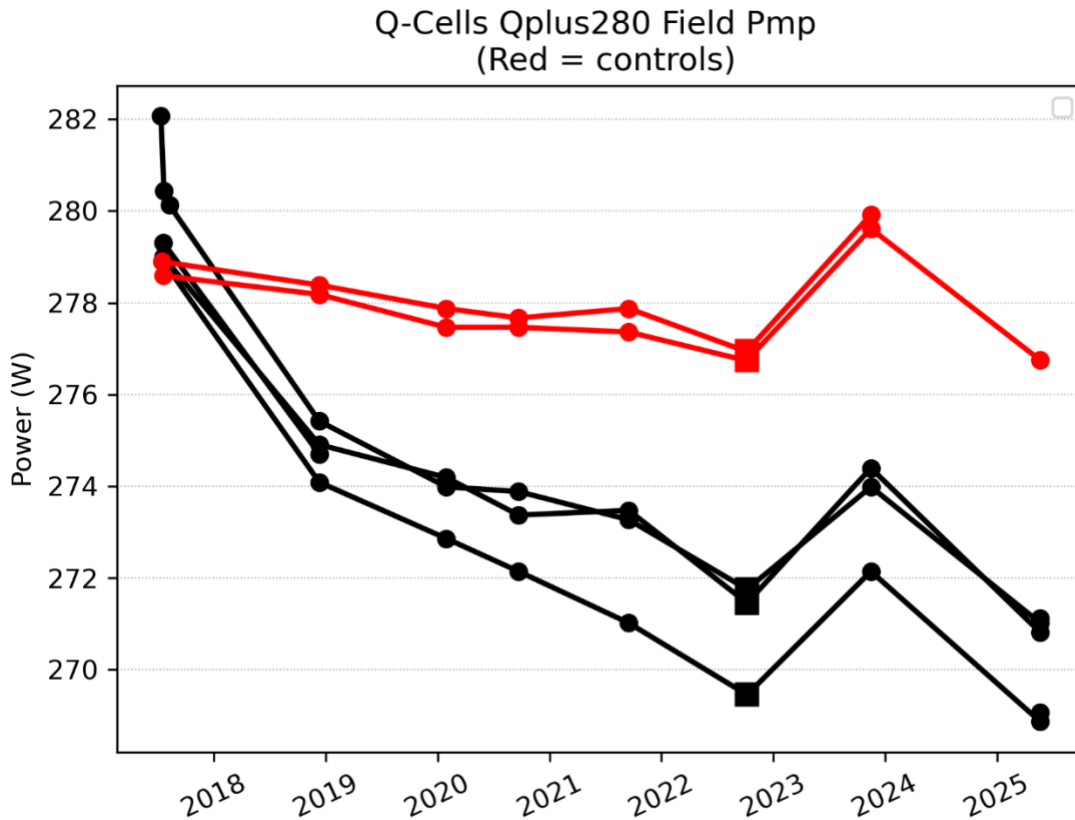


Figure 24. QCells Qplus280 flash measurements. Field modules (black) and indoor controls (red). Square markers indicate Spire4600 measurement (post-correction). In 2024 the flash simulator was temporarily changed to a different reference module, resulting in a +0.6% shift in both control and field measurements. This shift is similar to what is expected from the updated reference module, which will be used starting in 2026 for this module type.

2.5.1 Initial light soak

QCells QPlus280 experienced 0.4% initial loss due to LID following 10kWhm⁻² light exposure

2.5.2 Control module change (post-lightsoak)

In 2024 the QCells QPlus280 control modules showed a sharp increase of 1.8 W (+0.6%) compared to its previous measurements. This is an instrumentation shift that has been isolated to a change in the reference module used to set the Spire 5600 light level. This change showed up in field measurements for this module type as well, and mainly affects I_{sc} . In 2025 the reference module was returned to the original type, temporarily reversing this measurement shift. It is expected that in 2026, another data shift will be experienced with the move to the MR6X11B reference module.

2.5.3 Field module change (post-lightsoak)

Year 1 post-lightsoak field module degradation was roughly -1.5% .

The QPlus280 fielded modules showed overall post-LID degradation from 2017-2025 of -3.4% , or $-0.43\%/yr$, excluding the temporary measurement shift in 2024.

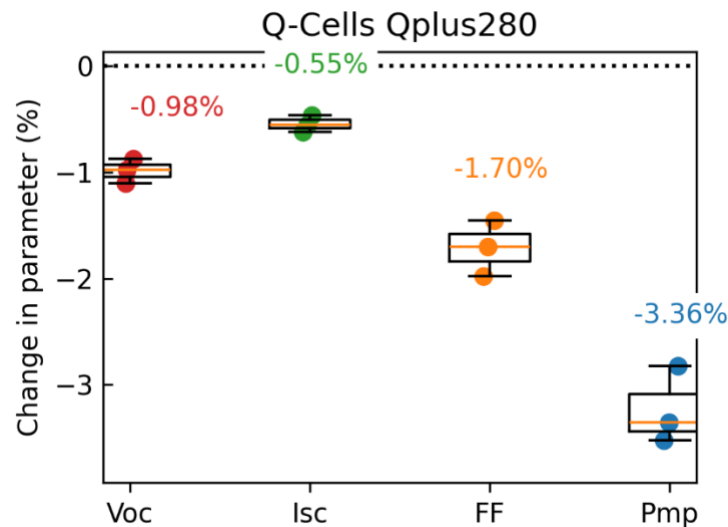


Figure 25. QCells QPlus280 IV curve parameter overall change.

Overall change in Pmp performance from 2017 to 2025 for QCells QPlus280 is -3% due primarily to FF (-1.7%) and Voc (-0.98%).

2.6 QCells QPeak290

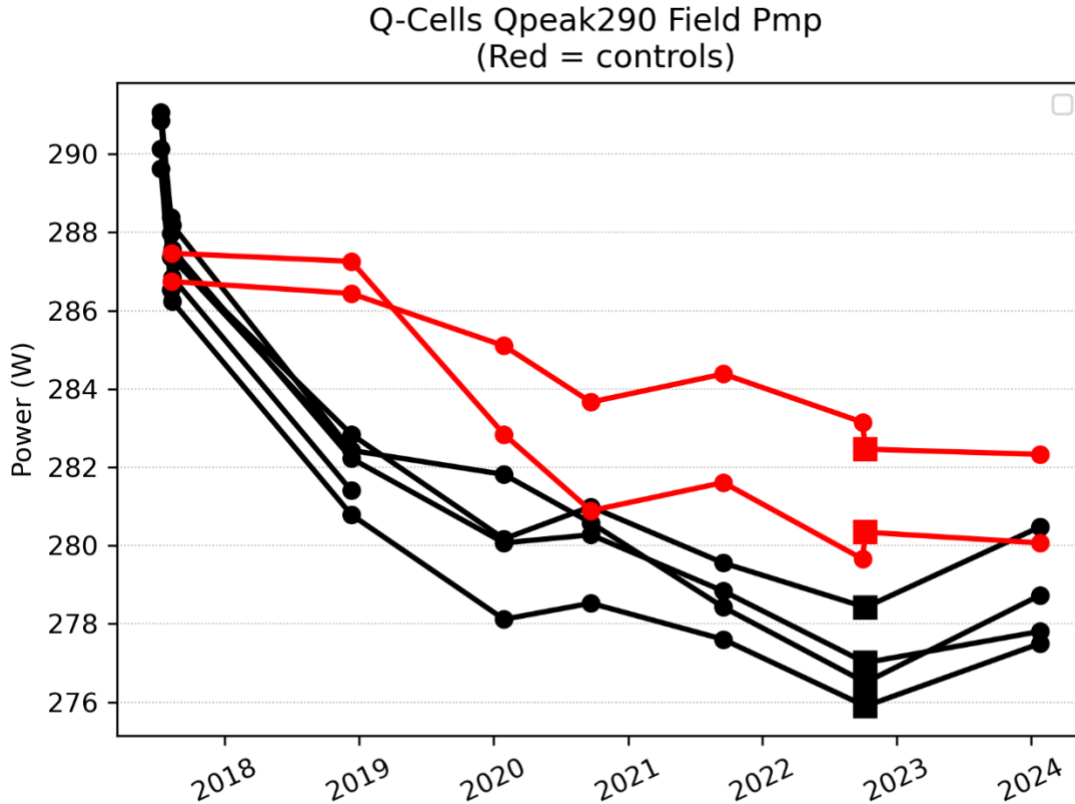


Figure 26. QCells Qpeak290 flash measurements. Field modules (black) and indoor controls (red). Square markers indicate Spire4600 measurement (post-correction).

2.6.1 Initial light soak

QCells QPlus290 experienced 1.2% initial loss due to LID following 10kWhm-2 light exposure

2.6.2 Control module change (post-lightsoak)

QCells QPeak290 control modules showed relatively unstable performance. Overall change in control modules was -2.0% on average from 2017-2024. Unlike with the QPlus280 modules, QPeak290 measurement in 2024 retained the use of the original reference module with the flash simulator. Therefore there is no instrumentation shift in measured control or field modules.

2.6.3 Field module change (post-lightsoak)

The QPeak290 fielded modules showed overall post-LID degradation from 2017-2024 of -2.8% . This is a slight improvement over the 2022 measurement of -3.4% and results in an annual rate of $-0.4\%/yr$.

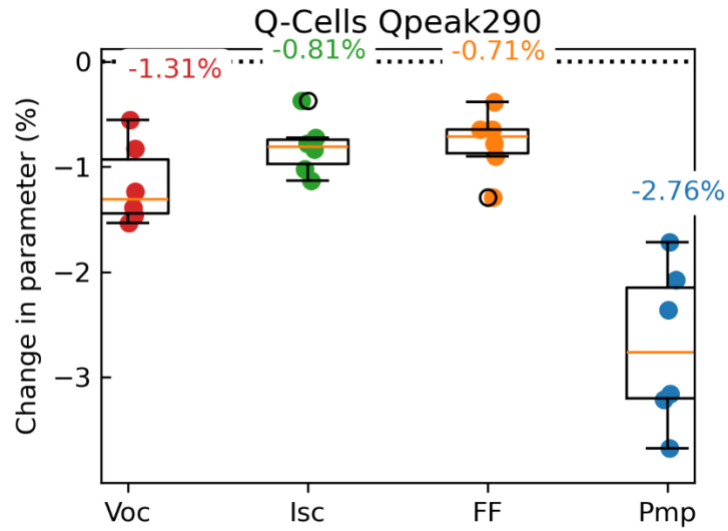


Figure 27. QCells QPeak290 IV curve parameter overall change.

Overall change in performance from 2017 to 2024 for QCells QPeak290 is due to modest changes in Isc, Fill factor and Voc.

2.7 Canadian CS6K-300MS

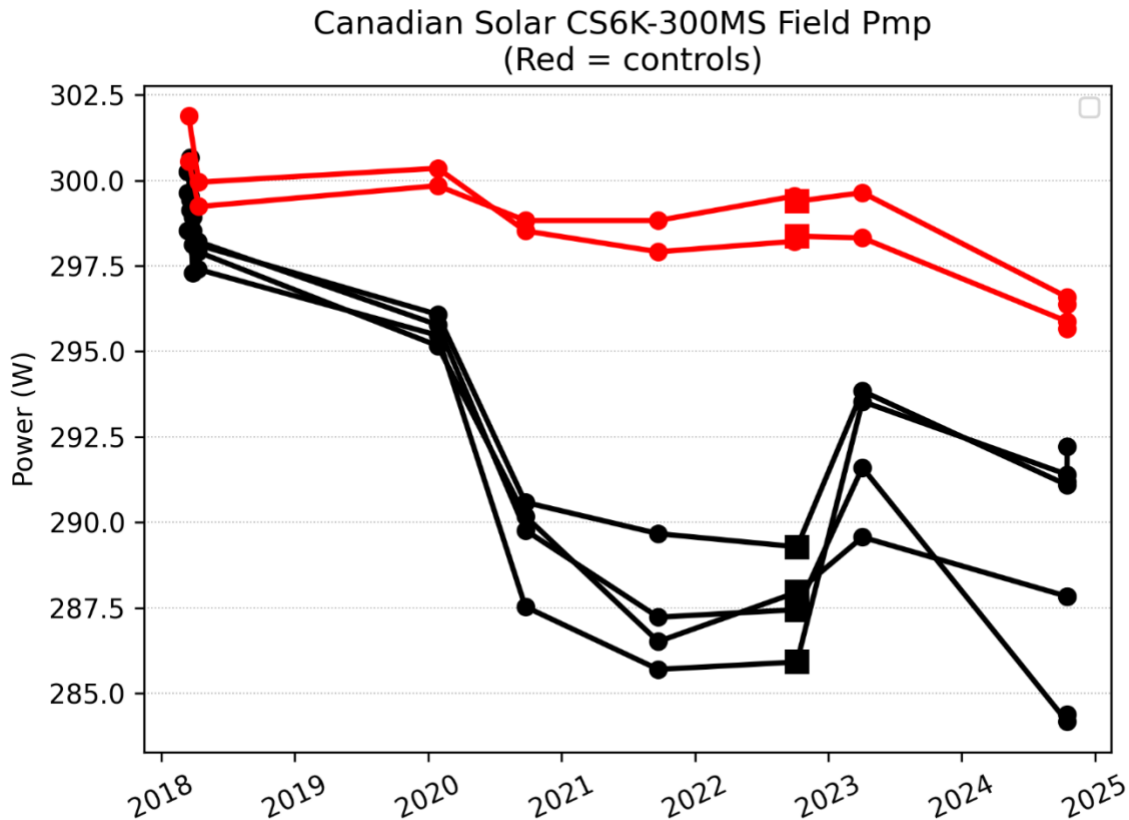


Figure 28. Canadian CS6K flash measurements. Field modules (black) and indoor controls (red). Square markers indicate Spire4600 measurement (post-correction).

2.7.1 Initial light soak

Canadian CS6K-300MS experienced -0.5% initial loss due to LID following 10kWhm^{-2} light exposure

2.7.2 Control module change (post-lightsoak)

Canadian CS6K-300MS control modules showed relatively stable performance with overall change of -1.1% from 2018–2025.

2.7.3 Field module change (post-lightsoak)

The CS6K-300MS fielded modules had initial stability in year-1 with only -0.4% degradation (post-LID). However, degradation accelerated starting in year-2, then stabilized in the third year. Starting in 2023 there was an apparent partial recovery, possibly as LID or LeTID effects have stabilized and recovered. Overall loss from 2018–2023 was -1.8% , or $-0.37\%/yr$. One un-

explored factor in the Canadian Solar performance may be un-detected seasonality in the performance, similar to Jinko or Trina modules. This is because measurements shifted from springtime in year-1 to fall in years 2 and 3, and back to springtime in year-4. This could be leading to the lower measurements in the fall and higher measurements in the spring.

In 2025 a subset of these modules were re-measured in the fall. Unfortunately, the results are mixed with two modules showing performance on the low side, and two more showing performance on the high side of the seasonal trend.

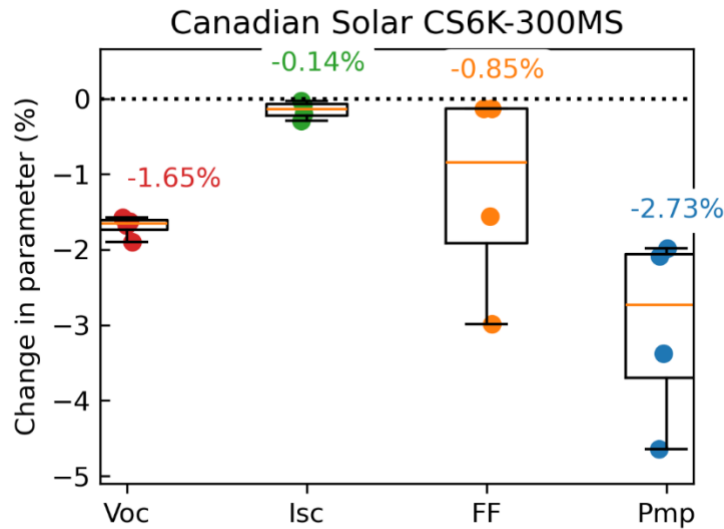


Figure 29. Canadian CS6K-300MS IV curve parameter overall change.

Degradation from 2017 to 2025 for Canadian CS6K-300MS is due primarily to Voc. Interestingly, the spread in the module performance that likely leads to seasonal change is actually in Fill Factor. This factor is varying a great deal from module to module, ranging from a change of ~0% (two module samples) to over -3% (one module sample).

2.8 LG 320N1K

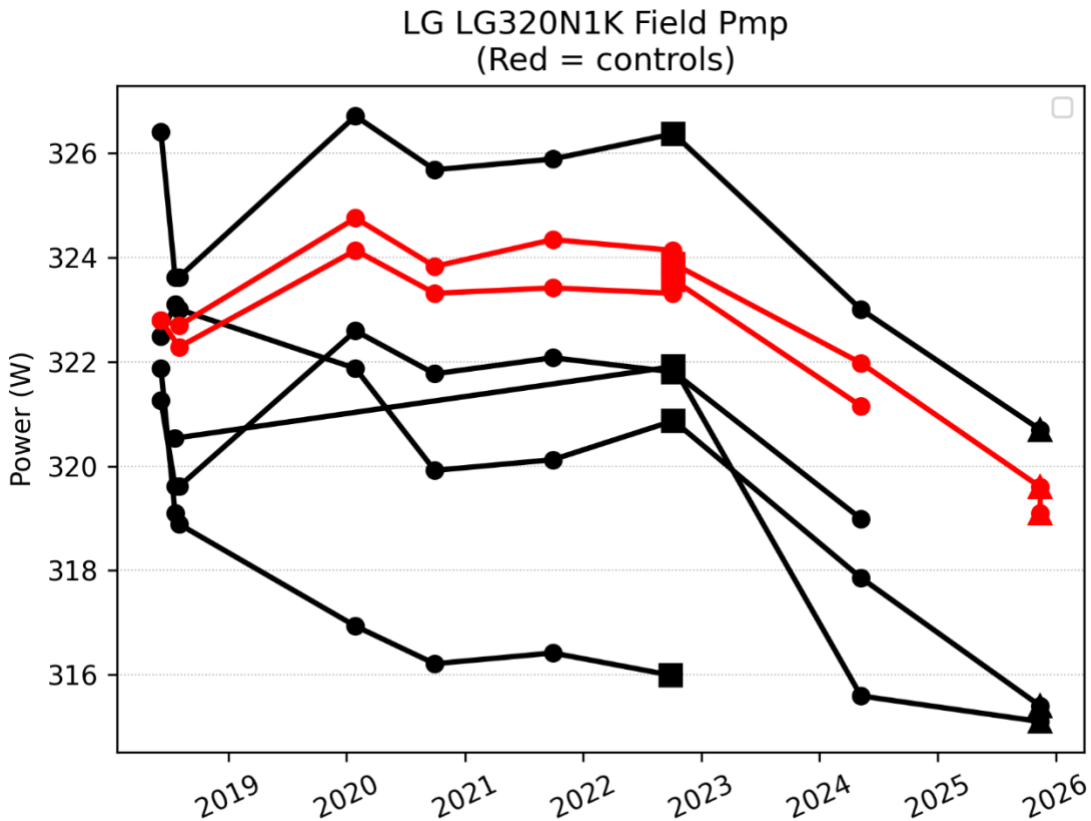


Figure 30. LG 320N1K flash measurements. Field modules (black) and indoor controls (red). Square markers indicate Spire4600 measurement (post-correction), and triangle marks indicate un-corrected measurement taken with the new 2025 reference module.

2.8.1 Initial light soak

LG 320N1K had no change to module performance following outdoor light soaking. This may be due to the N-type silicon technology which is not affected by the standard B-O light induced degradation effect.

2.8.2 Control module change (post-lightsoak)

Following initial light soaking, LG 320N1K control modules showed slight performance changes. Performance initially increased by roughly 0.3% from 2018–2022, but declined from 2023–2025 for a total change of -0.8% .

2.8.3 Field module change (post-lightsoak)

The LG 320N1K fielded modules showed variable performance with modules increasing in performance for 3–4 years and more recently declining. This leads to overall median post-LID degradation from 2018–2025 of -1.7% , or $-0.23\%/yr$. One module (M1806-0005) was found to have cell cracking which led to low performance and it was removed and will be monitored in a separate cell-crack testbed.

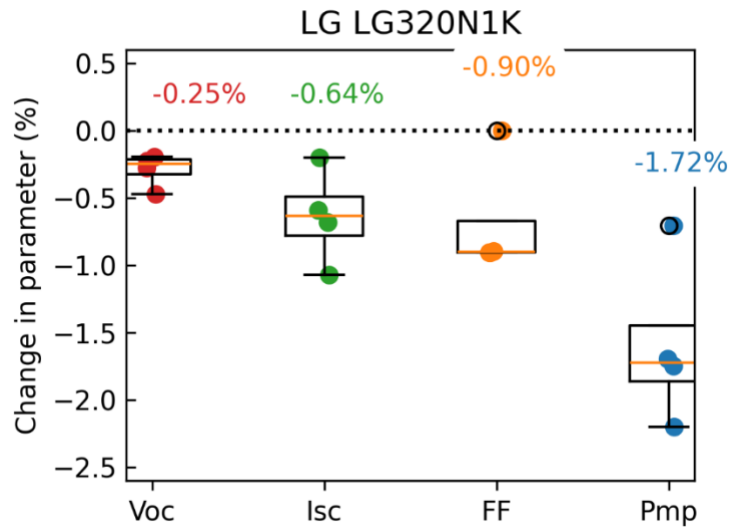


Figure 31. LG 320N1K IV curve parameter overall change.

Overall change in performance from 2018 to 2025 for LG 320N1K is stable, without much change in any particular parameter.

EL imaging of module M1806-0005 shows clear cell cracking in five locations, corroborating the drop in performance.

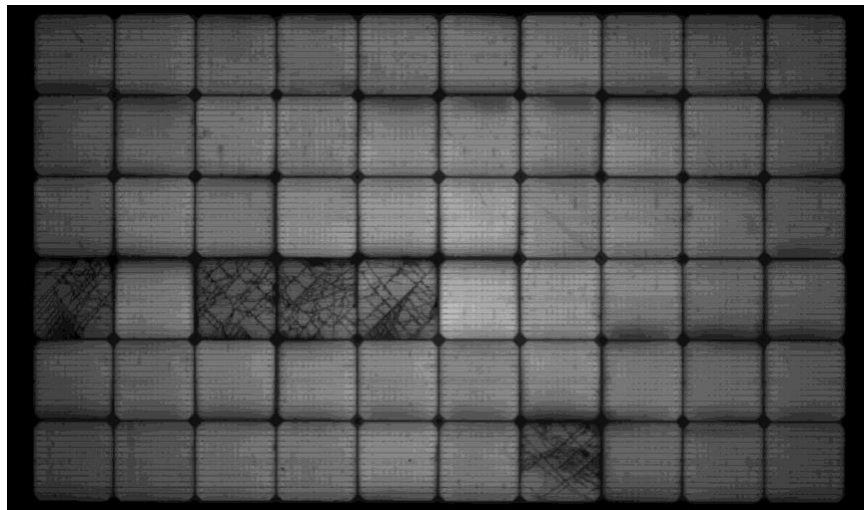


Figure 32. EL image of LG M1806-0005 showing cell cracking. The cause is unknown, but may have happened during installation.

2.9 Panasonic VBHN330

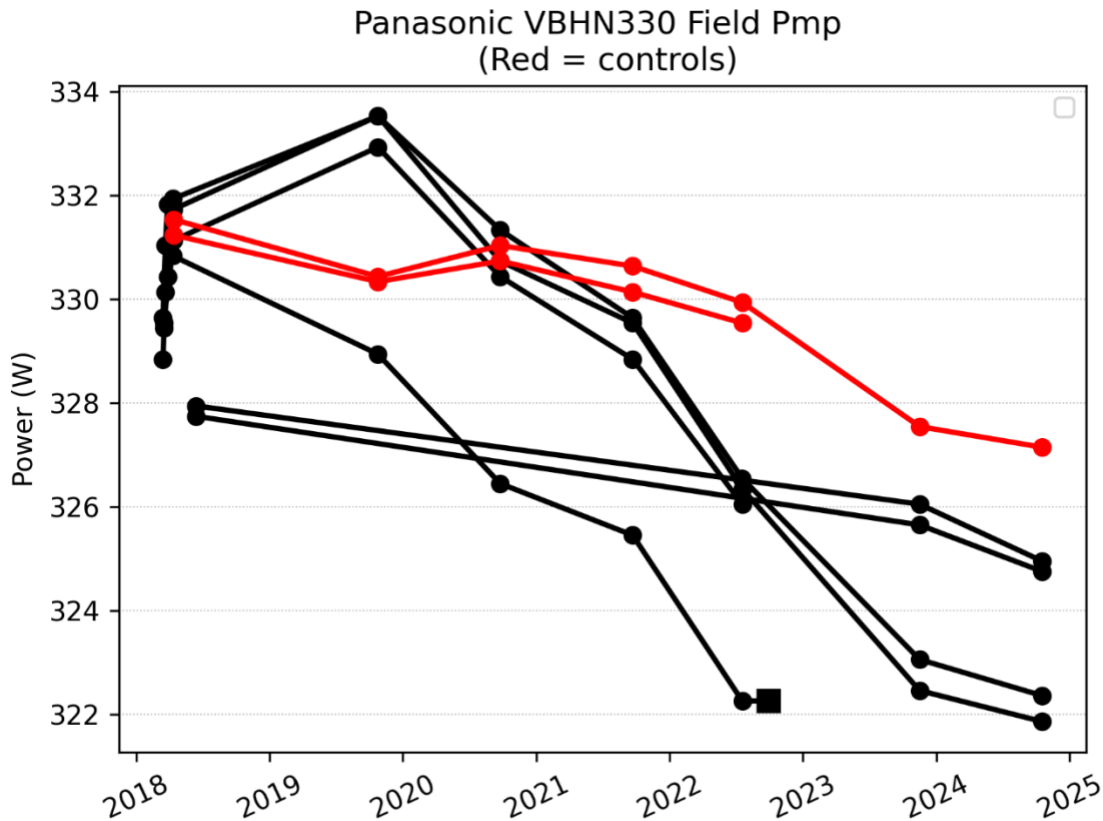


Figure 33. Panasonic flash measurements. Field modules (black) and indoor controls (red)

2.9.1 Initial light soak

Panasonic VBHN330 showed an initial increase in module performance of 0.5% through light soaking. This may be due to the N-type silicon heterojunction technology which is not affected by the standard B-O light induced degradation effect.

2.9.2 Control module change (post-lightsoak)

Following initial light soaking control modules showed a relative decline of -1.3% .

2.9.3 Field module change (post-lightsoak)

Year 1 field module performance showed three modules increasing slightly, and one module declining in performance. Following this year-1 increase, all modules continued to decline at a consistent rate.

Although it was monitored for several years, this low-performing module (M1803-0002) was found to have a backsheet that was scratched during shipping that was identified prior to installation. It was eventually removed from this experiment, and diverted to a separate cell-crack monitoring experiment. In 2024, two different field modules were measured in the place of this cracked module

The VBHN330 fielded modules measured in 2025 showed median post-LID degradation from 2018-2025 of -1.9% or $-0.29\%/yr$. Interestingly, the newly measured modules flashed 3–4W higher than those previously measured, despite the same exposure history and indoor measurement setup.

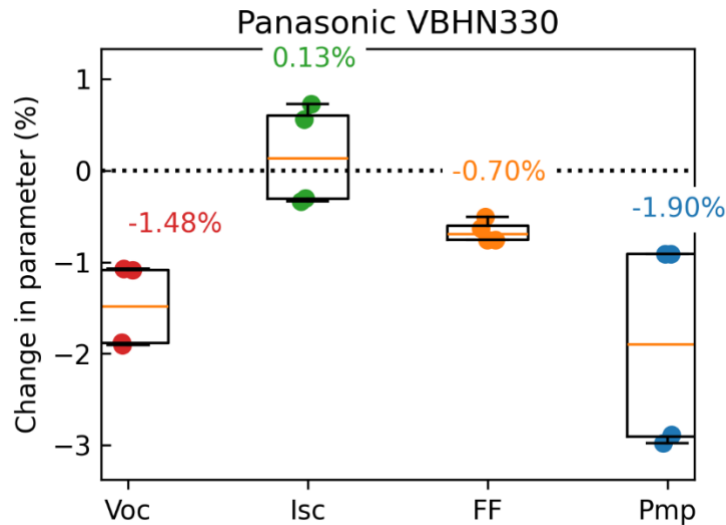


Figure 34. Panasonic VBHN330 IV curve parameter overall change.

Overall change in performance for Panasonic is due mainly to decreases in Voc offset by increases in Isc. One module had some handling damage, and the reduced fill factor indicates multiple cracked cells. Follow-up electroluminescence imaging investigation confirmed that three cells were damaged.

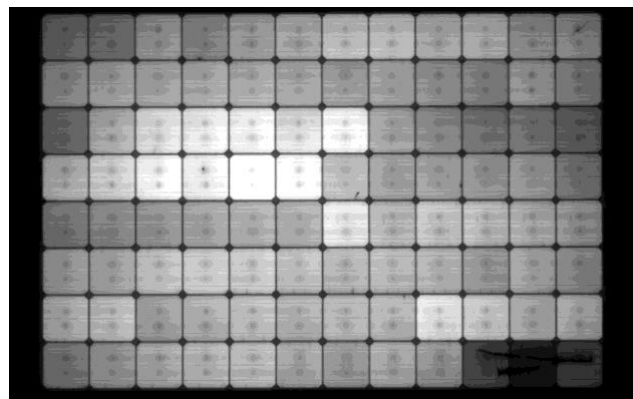


Figure 35. Panasonic module M1803-0002 showing three damaged cells.

2.10 Mission Solar MSE360

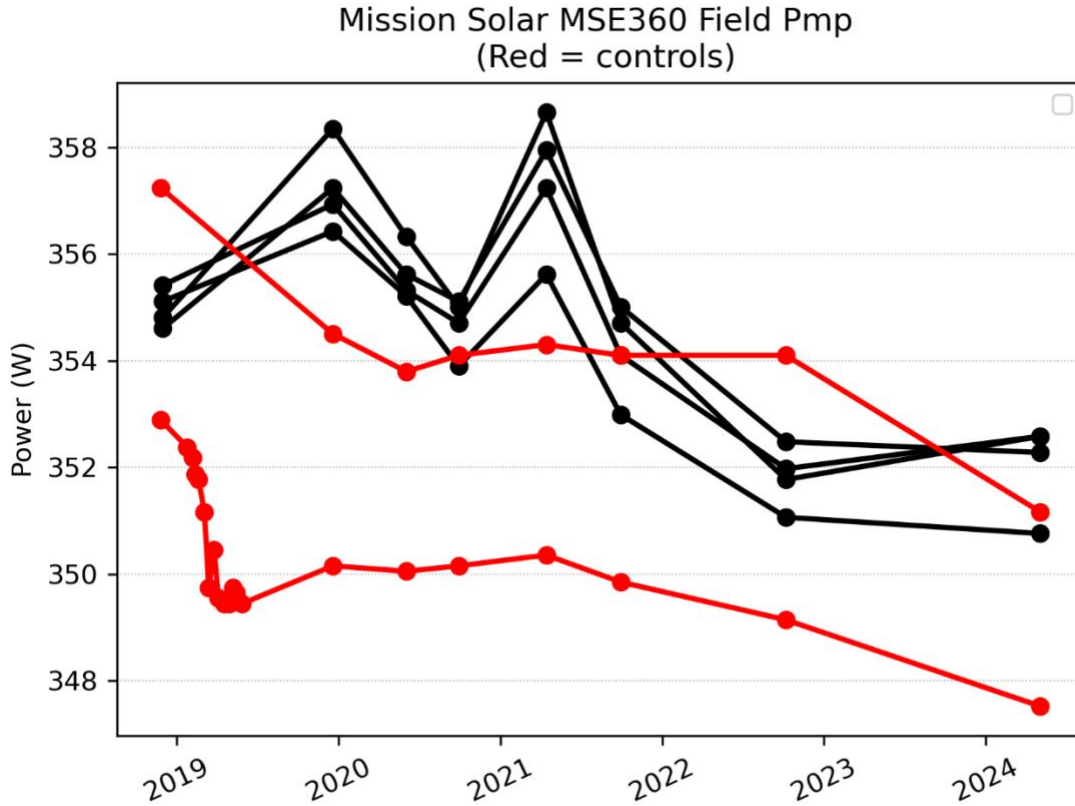


Figure 36. Mission Solar flash measurements. Field modules (black) and indoor controls (red)

Mission Solar modules were not re-measured in 2025.

2.10.1 Initial light soak

Mission Solar MSE360 modules did not have initial measurements taken of the first 10kWhm^{-2} of light exposure. However, a pronounced LeTID sensitivity was identified via indoor test screening. Two samples showed a recoverable 3%-5% LeTID performance change in response to the LeTID screening procedure of Karas et al (2022).

2.10.2 Control module change (post-lightsoak)

Mission Solar MSE360 control modules showed an initial fast degradation over the first year which leveled out, showing a total degradation of -1% in 2022. An additional decline was found again in 2024, for a total change of -1.6%. Initial performance loss is visible by periodic indoor IV curves as the control modules are maintained in dark storage. No specific changes were made in the indoor flash test procedure, so this may either be a physical effect or an as-yet unidentified instrumentation shift.

2.10.3 Field module change (post-lightsoak)

Outdoor exposed fielded modules on the other hand are showing seasonal performance changes, which may be indicative of LeTID sensitivity. These modules in particular were shown to be LeTID sensitive per LeTID screening tests and described in [Repins, 2020].

Overall post-LID performance of the field modules is showing median performance change of -0.7% or -0.1%/yr. As with Jinko and Trina modules, some seasonality may still be present in the Mission Solar measurements, but with annual measurement frequency this is not visible in the figures. Interestingly, at this point in the experiment the indoor control modules have declined more than the outdoor exposure modules for Mission Solar MSE360.

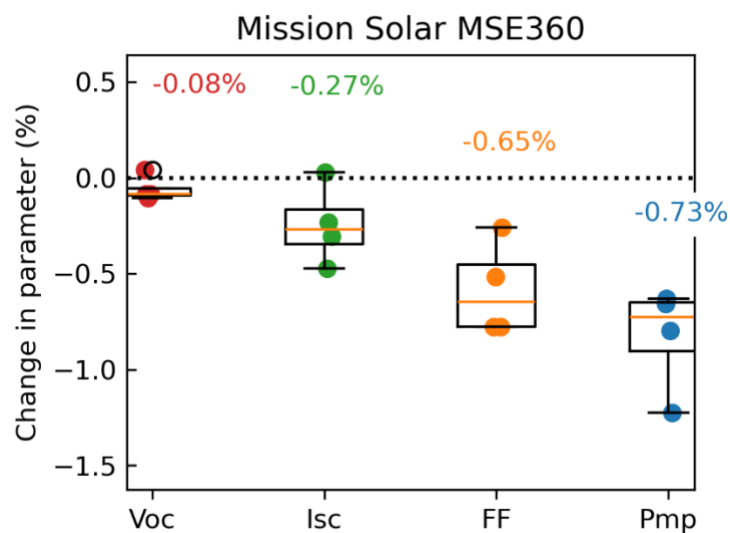


Figure 37. Mission Solar MSE360 IV curve parameter overall change.

Overall change in performance for Mission Solar MSE360 is characterized by only marginal changes in IV parameters.

2.11 Sunpreme HxB-400 (n-type heterojunction) Bifacial

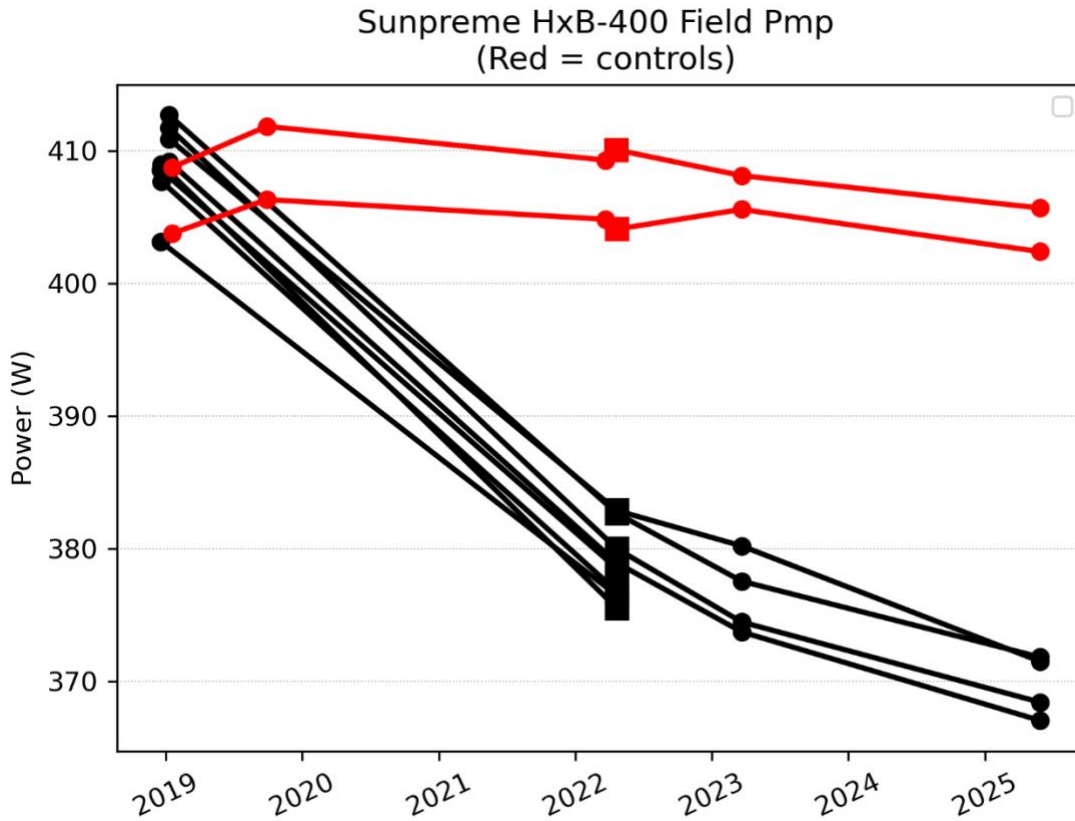


Figure 38. Sunpreme flash measurements. Field modules (black) and indoor controls (red). Square markers indicate Spire4600 measurement (post-correction).

2.11.1 Initial light soak

Sunpreme bifacial modules did not have initial measurements taken of the first 10kWhm^{-2} of light exposure.

2.11.2 Control module change (post-lightsoak)

Sunpreme HxB-400 control modules are stable, showing performance decline of -0.5% from 2019- 2025.

2.11.3 Field module change (post-lightsoak)

Outdoor exposed fielded modules have experienced major losses, visible in the figure above. Overall post-LID performance of the field modules is showing median performance change of -10.1% overall or -1.57% per year. To confirm this large decline, real-time field data was analyzed during the string's operation. A similar $-2\%/yr$ degradation rate was also found using the RdTools analysis package, giving confidence in these numbers.

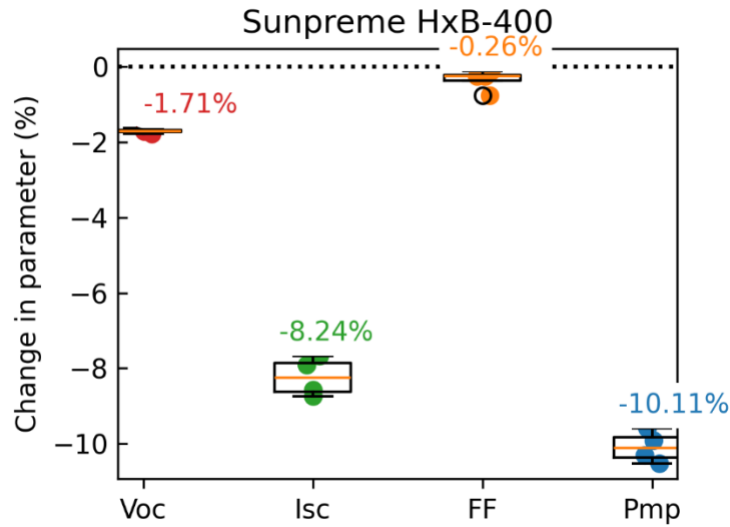


Figure 39. Sunpreme HxB-400 bifacial IV curve parameter overall change.

Overall change in performance for Sunpreme HxB-400 is characterized by a large decrease in Isc. The other two parameters —Voc and Fill Factor are relatively stable. Further study is ongoing to understand the causes of this Isc decline. It is primarily present in front-side Isc decline, rather than the backside of the bifacial module. UV degradation and PID-p (polarization type) degradation are being probed.

2.12 LONGi LR6-72BP-360M (mono-PERC bifacial)

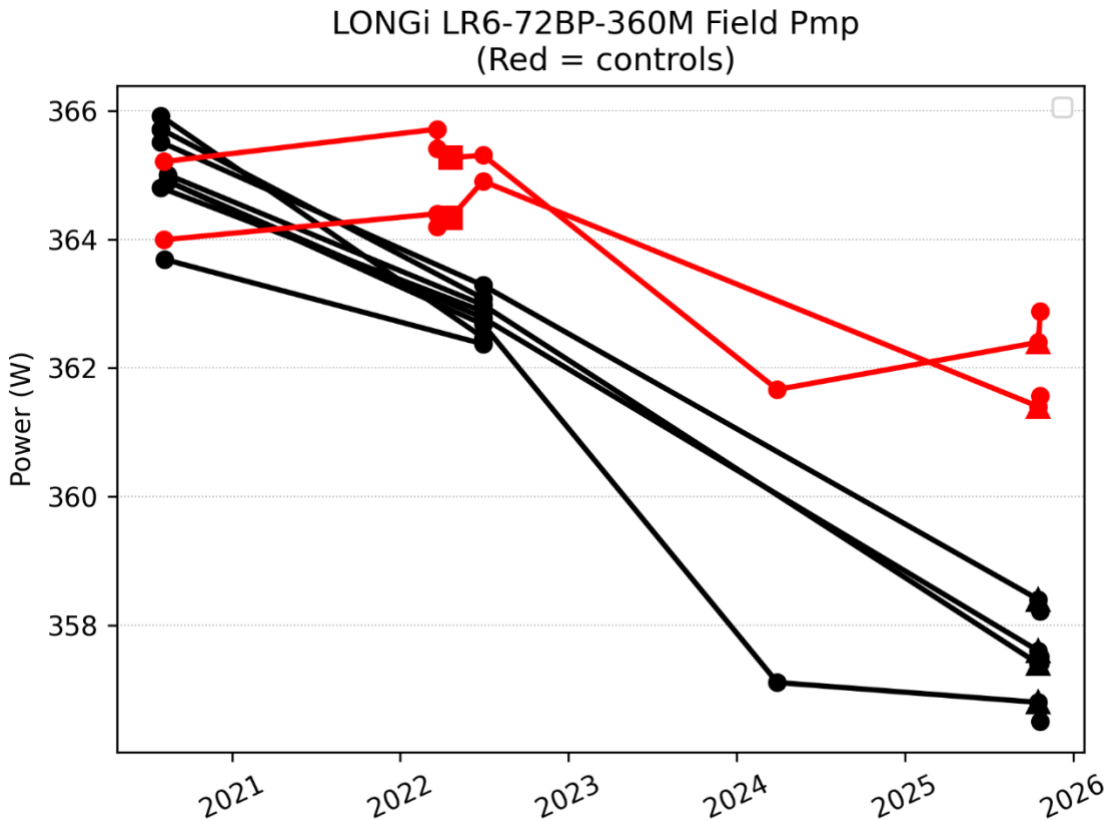


Figure 40. LONGi flash measurements. Field modules (black) and indoor controls (red). Triangle marks indicate un-corrected measurement taken with the new 2025 reference module.

2.12.1 Initial light soak

LONGi LR6-72BP-360 bifacial modules did not have initial measurements taken of the first 10kWhm^{-2} of light exposure.

2.12.2 Control module change (post-lightsoak)

LONGi LR6-72BP control modules showed a slow continuous decline from 2020 - 2025, with a total reduction of -0.65% . As with other module types which showed comparable declines in control module performance, this is likely a physical effect in the modules, as-yet unidentified.

2.12.3 Field module change (post-lightsoak)

Outdoor field-exposed modules showed a continuous slow decline in performance.

Overall post-LID performance of the field modules demonstrates a median performance change of -2% or $-0.4\%/yr$.

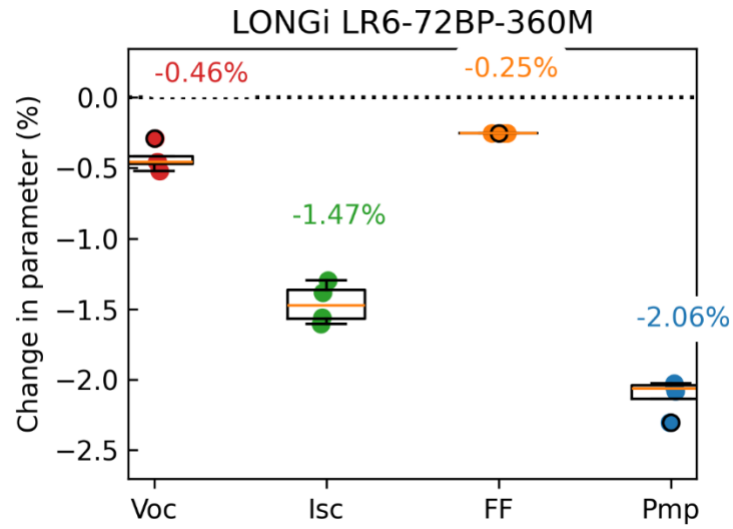


Figure 41. LONGi LR6-72BP-360M bifacial IV curve parameter overall change.

Overall change in performance for LONGi LR6-72BP is characterized mainly by a reduction in Isc and more stable performance in Voc and FF.

2.13 LONGi LR6-72PH-365M (mono-PERC monofacial)

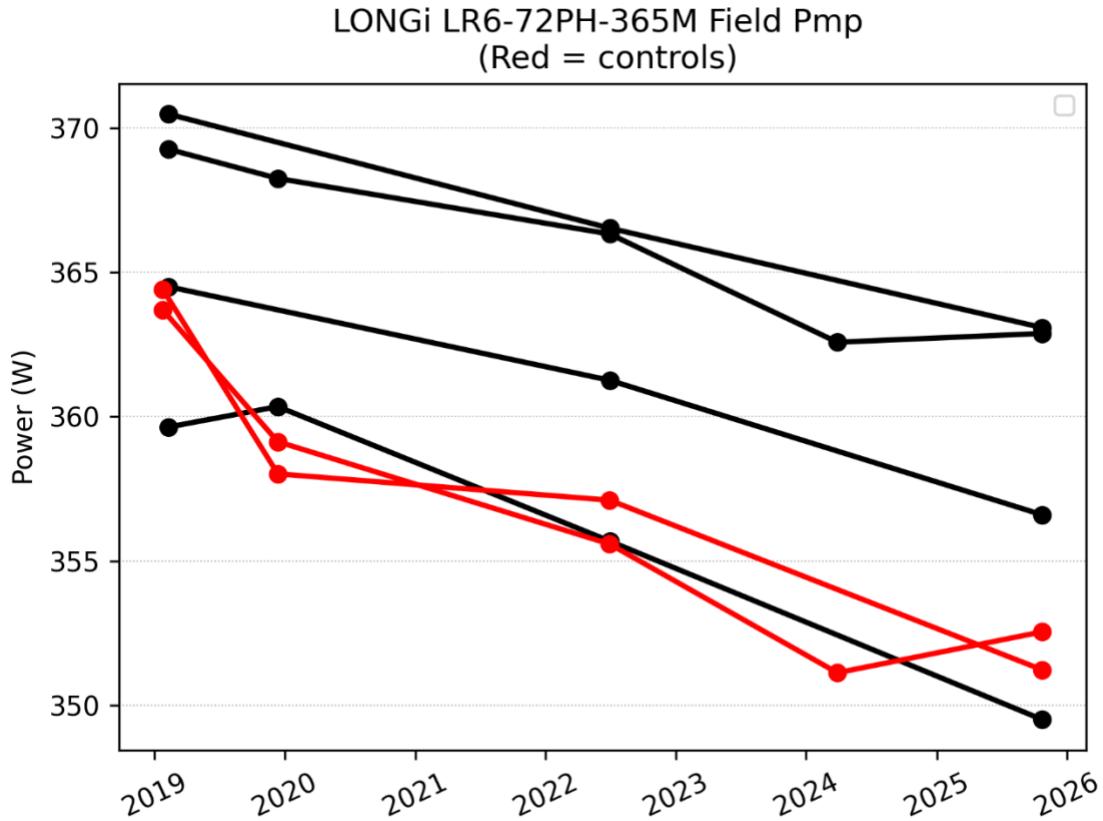


Figure 42. LONGi LR6-72PH flash measurements. Field modules (black) and indoor controls (red)

2.13.1 Initial light soak

LONGi LR6-72PH-365 monofacial modules did not have initial measurements taken of the first 10kWhm^{-2} of light exposure.

2.13.2 Control module change (post-lightsoak)

LONGi LR6-72PH-365 control modules actually declined more than field modules, showing a performance decline of -3.3% from 2019–2025.

2.13.3 Field module change (post-lightsoak)

Outdoor exposed fielded modules have only modest declines relative to the indoor control modules. Overall post-LID performance of the field modules is showing median performance change of -2% or $-0.31\%/yr$.

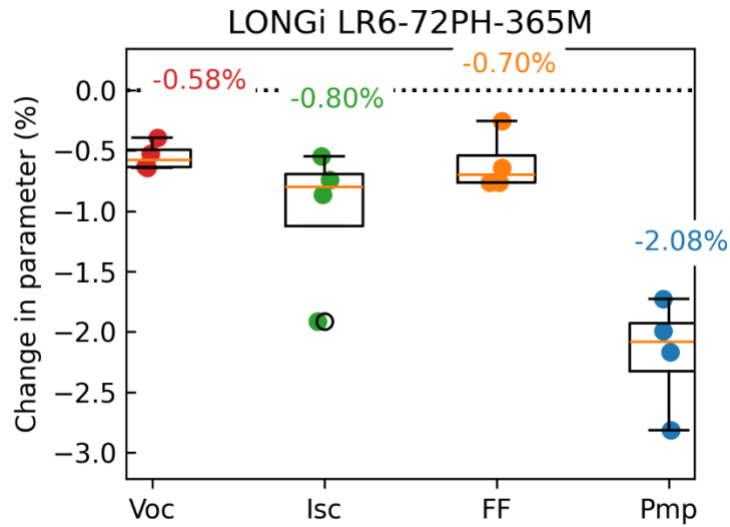


Figure 43. LONGi LR6-72PH-365 monofacial IV curve parameter overall change.

Overall change in performance for LONGi LR6-72PH-365 is characterized by relatively stable performance from 2019-2025 and slight reductions across all three IV parameters. Again, this performance loss of fielded modules was actually less than the measured performance loss of the indoor control modules, possibly indicating an indoor dark relaxation mechanism affecting these modules.

2.14 REC 405AA-Pure (n-Type Heterojunction, monofacial)

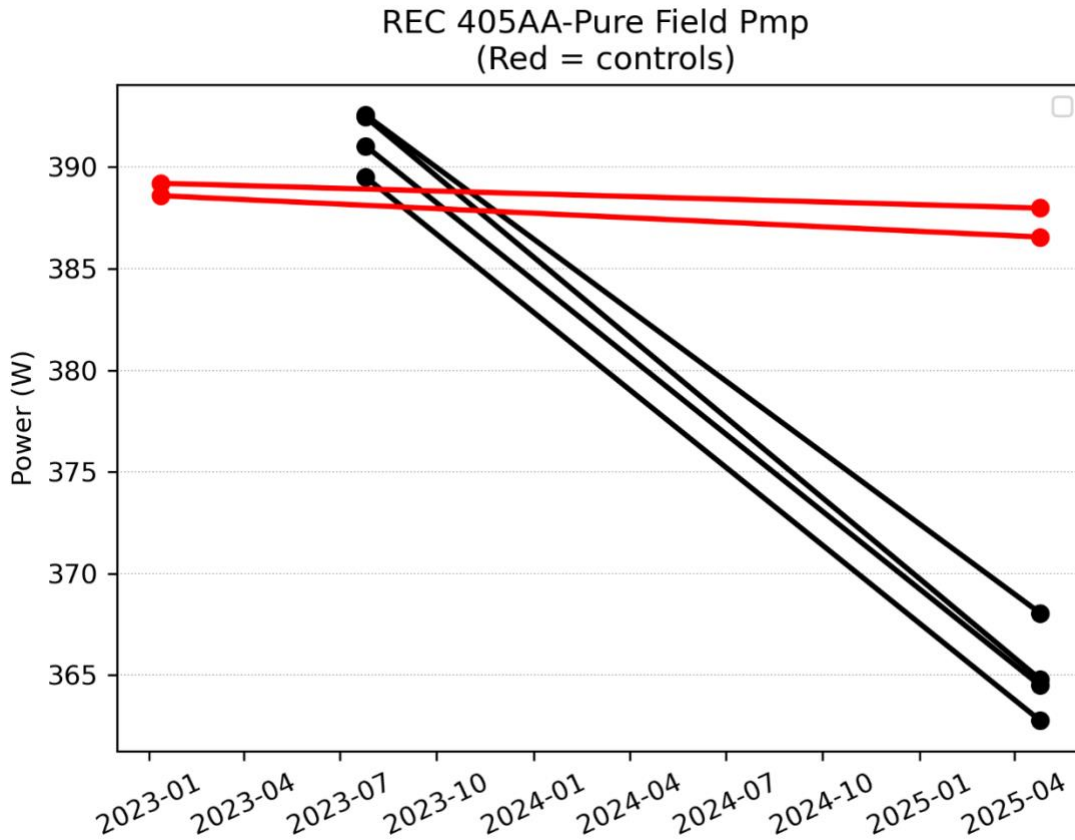


Figure 44. REC 405AA-Pure flash measurements. Field modules (black) and indoor controls (red)

2.14.1 Initial light soak

REC 405AA-Pure n-type HJT modules did not have initial measurements taken of the first 10kWhm^{-2} of light exposure.

2.14.2 Control module change (post-lightsoak)

REC 405AA-Pure control modules were completely stable, showing a 0% performance change from 2023–2025.

2.14.3 Field module change (post-lightsoak)

Outdoor exposed fielded modules have shown significant declines of -6.8% over the period of measurement, representing an annual loss rate of -3.9% /year. This is concerning because warranty coverage for these modules over their entire 25-year lifetime is supposed to be only -8% .

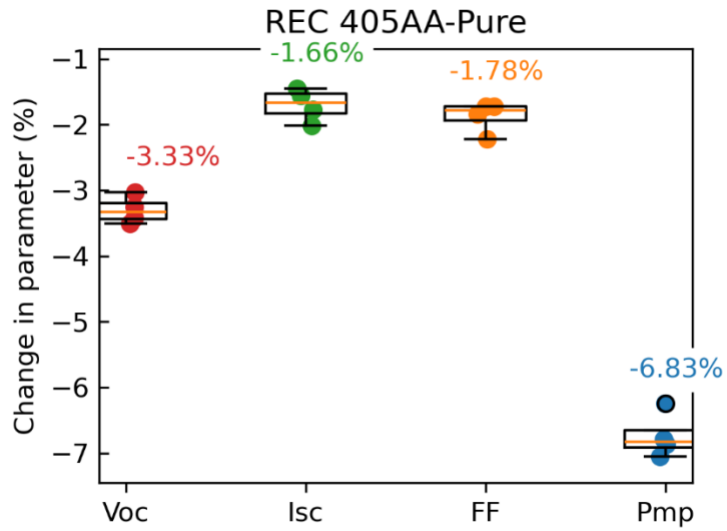


Figure 45. REC 405AA-Pure heterojunction IV curve parameter overall change.

Overall change in performance for REC 405AA-Pure is characterized by declines in all module parameters, but most significantly Voc (−3.3%).

2.15 REC 360NP2 (n-Type TOPCon, Monofacial)

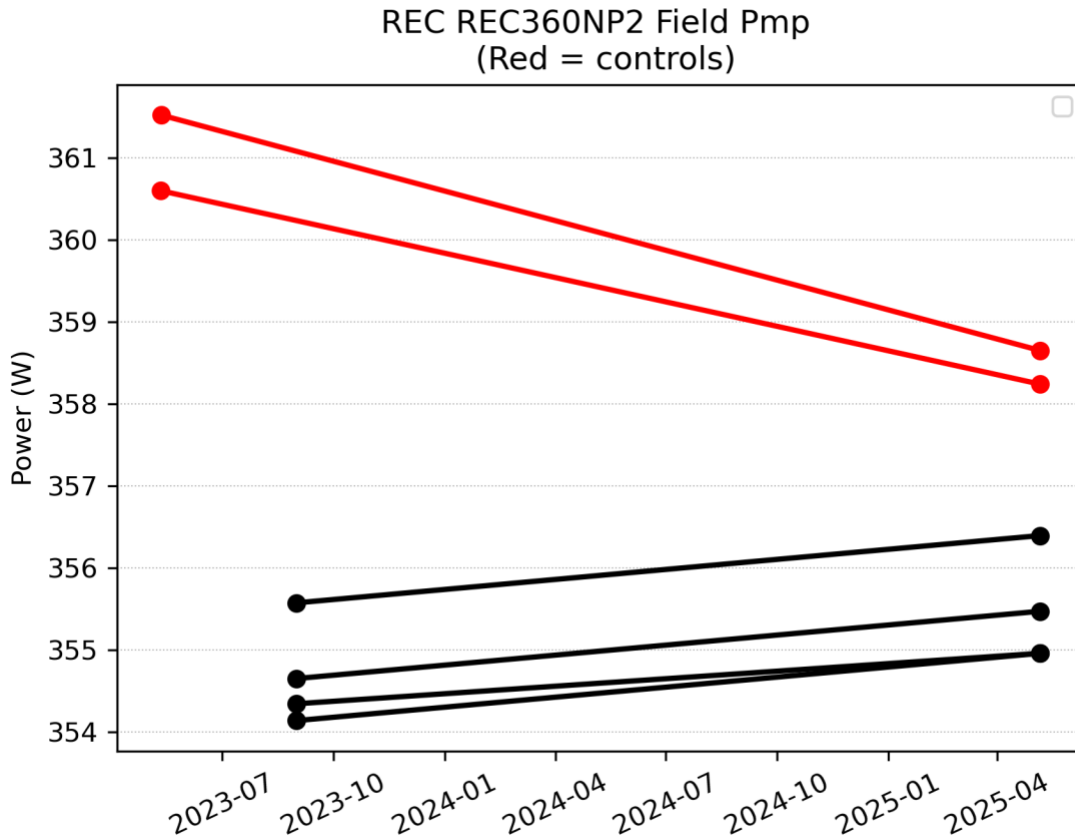


Figure 46. REC 360NP2 flash measurements. Field modules (black) and indoor controls (red)

2.15.1 Initial light soak

REC 360NP2 TOPCon modules did not have initial measurements taken of the first 10kWhm^{-2} of light exposure.

2.15.2 Control module change (post-lightsoak)

REC 360NP2 control modules actually declined more than field modules, showing a performance decline of -0.7% from 2023–2025.

2.15.3 Field module change (post-lightsoak)

As opposed to the rapid decline of REC’s heterojunction product under test, their REC 360NP2 TOPCon modules had a modest performance increase of $+0.23\%$ in the first year and are showing good stability.

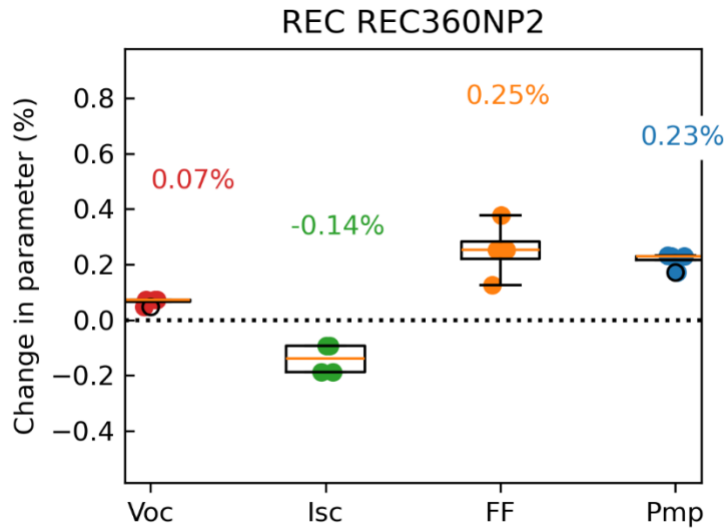


Figure 47 REC 360NP2 monofacial IV curve parameter overall change.

Overall change in performance for REC 360NP2 is characterized by relatively stable performance from 2023-2025.

2.16 Solaria PowerX-400R (p-Type PERC, shingled)

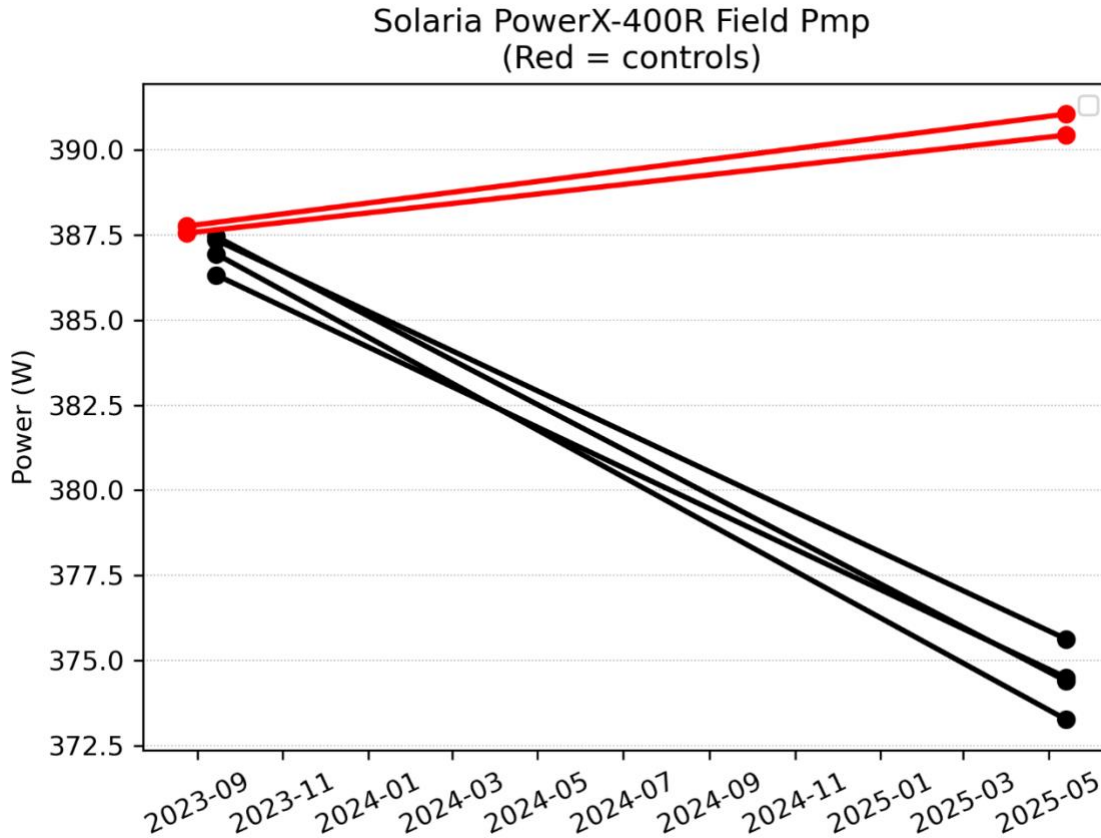


Figure 48. Solaria PowerX-400R flash measurements. Field modules (black) and indoor controls (red)

2.16.1 Initial light soak

Solaria PowerX-400R shingled modules did not have initial measurements taken of the first 10kWhm^{-2} of light exposure.

2.16.2 Control module change (post-lightsoak)

Solaria PowerX-400R control modules had a slight performance increase in the first year, showing an increase of +0.8% from 2023– 2025.

2.16.3 Field module change (post-lightsoak)

Solaria PowerX-400R had a somewhat rapid initial decline from 2023-2025 with a median power loss of -3.2% , or -1.9% / year. It remains to be seen whether this was a temporary initial decline, or a trend that will continue.

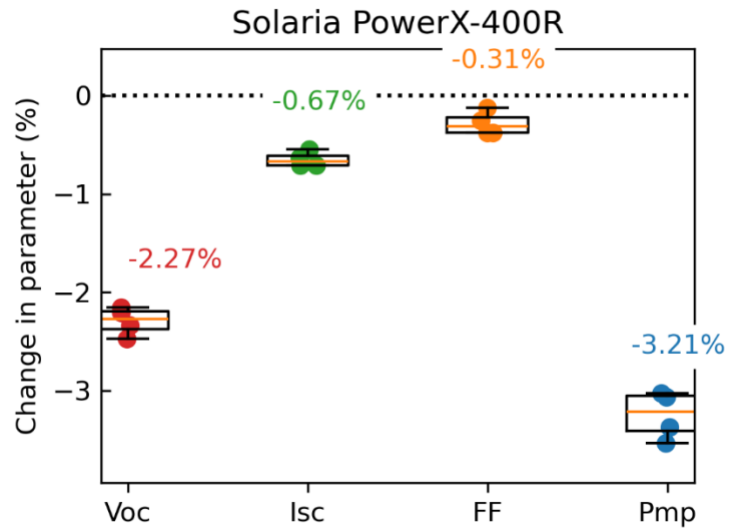


Figure 49 Solaria PowerX-400R monofacial IV curve parameter overall change.

Performance loss for Solaria PowerX-400R is mainly confined to losses in Voc (-2.3%).

2.17 Prism Solar NB72 (p-Type PERC, bifacial)

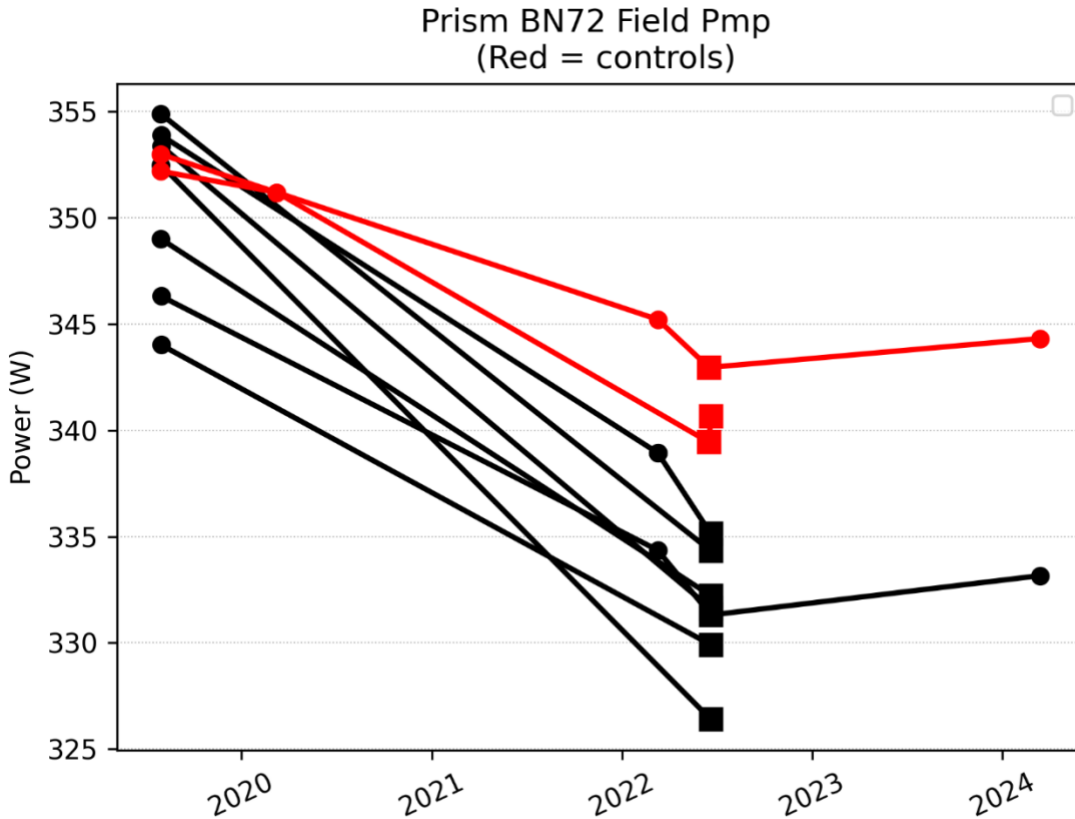


Figure 50. Prism BN72 flash measurements. Field modules (black) and indoor controls (red)

Although installed in 2019, the Prism Solar modules are only now being analyzed and discussed.

2.17.1 Initial light soak

Prism Solar modules did not have initial measurements taken of the first 10kWhm^{-2} of light exposure.

2.17.2 Control module change (post-lightsoak)

Prism Solar control modules have declined a bit, changing by -2.8% from 2019–2025.

2.17.3 Field module change (post-lightsoak)

Prism Solar field modules have followed the indoor control module change, just more rapidly. A median power loss of -5.3% , or -1.15% / year was found. There is the possibility that the decline has stabilized – although a large number of modules were re-measured in 2022, only one field module was measured in 2024.

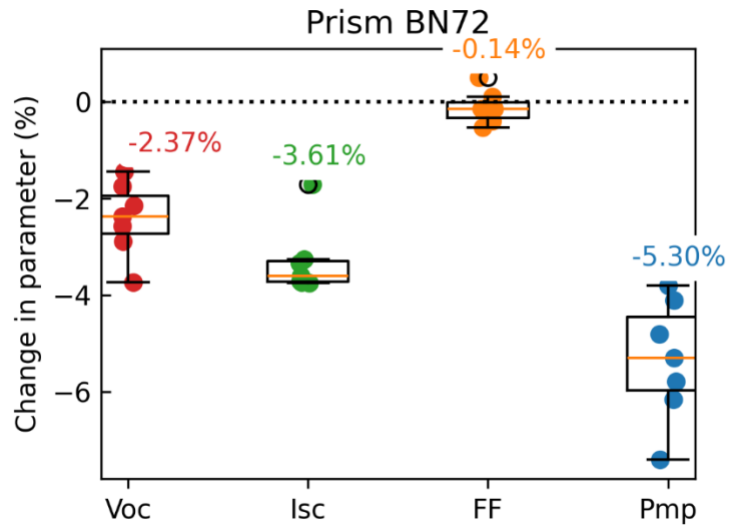


Figure 51 Prism Solar BN72 bifacial PERC IV curve parameter overall change.

Performance loss for Prism BN72 is showing losses in Voc (-2.3%) and Isc (-3.6%).

3 Degradation Summary

Cumulative results are provided below for the various manufacturer and module types, for the median fielded module that has measurement data within the prior 24 months. Values are total cumulative percentage change, except for annualized values where noted. Values do not correct for any performance change in indoor control modules or instrumentation shifts unless noted above.

Table 2. Overall change in performance [%] over the deployment period

Manufacturer	Module type	Year deployed	Pmp Median [Annual %/yr]	Pmp [%] Median	Voc [%] Median	Isc [%] Median	FF [%] Median
Jinko	JKM260	10/2016	-0.44	-4.11	-1.27	-2.78	-0.26
Jinko	JKM265	10/2016	-0.42	-3.90	-1.04	-1.95	-1.05
Trina	TSM255	10/2016	-0.38	-3.41	-0.96	-1.01	-1.43
Trina	TSM260	10/2016	-0.47	-3.42	-0.71	-1.32	-1.44
Q-Cells	Qplus280	10/2017	-0.41	-3.36	-0.98	-0.55	-1.70
Q-Cells	Qpeak290	10/2017	-0.48	-3.18	-1.42	-0.93	-0.84
Mission Solar	MSE360	12/2018	-0.15	-0.73	-0.08	-0.27	-0.65
LG	LG320N1K	8/2018	-0.21	-1.72	-0.25	-0.64	-0.90
Canadian Solar	CS6K-300MS	8/2018	-0.46	-2.73	-1.65	-0.14	-0.85
Panasonic	VBHN330	6/2018	-0.29	-1.90	-1.48	0.13	-0.70
SunPreme	HxB-400	3/2019	-1.56	-10.11	-1.71	-8.24	-0.26
LONGi	LR6-72BP-360M	11/2020	-0.40	-2.06	-0.46	-1.47	-0.25
LONGi	LR6-72PH-365M	11/2020	-0.32	-2.08	-0.58	-0.80	-0.70
REC	405AA-Pure	11/2023	-3.85	-6.83	-3.33	-1.66	-1.78
Solaria	PowerX-400R	11/2023	-1.95	-3.21	-2.27	-0.67	-0.31
REC	REC360NP2	11/2023	0.13	0.23	0.07	-0.14	0.25
Prism	BN72 (360W)	10/2019	-1.16	-5.30	-2.37	-3.61	-0.14

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Repins IL, Jordan D, Woodhouse M, Theristis M, Stein JS, Seigneur H, Colvin D, Karas JF, McPherson AN, Deline C "Long-Term Impact of Light and Elevated Temperature Induced Degradation on Photovoltaic Arrays", *MRS Impact*, submitted

Appendix 1 – Raw Data Results

Extract of all IV curve data for control and field modules. Measurements may be normalized depending on simulator settings which changed from 2016 - 2017 for the Jinko and Trina measurements, and all measurements which were made on the Spire 4600. Modules which have had measurements since 2025 have also required an adjustment in prior data to match the light level of the new ‘MR6X11B’ reference module.

A.1 Jinko JKM260 Controls

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1609-0013	9/7/2017 10:39	264.6	9.100	37.89	76.8
M1609-0013	9/19/2016 11:06	265.5	9.109	37.91	76.9
M1609-0086	10/16/2025 9:48	264.5	9.127	37.88	76.6
M1609-0086	10/9/2025 10:32	264.6	9.130	37.87	76.5
M1609-0086	4/18/2024 10:17	265.1	9.135	37.91	76.6
M1609-0086	9/9/2022 9:07	264.6	9.117	37.89	76.7
M1609-0086	4/7/2021 11:32	265.1	9.132	37.90	76.7
M1609-0086	9/15/2020 10:44	264.6	9.128	37.87	76.6
M1609-0086	6/3/2019 8:40	265.7	9.138	37.93	76.7
M1609-0086	10/29/2018 10:44	265.3	9.139	37.89	76.7
M1609-0086	5/10/2018 8:20	265.8	9.142	37.93	76.7
M1609-0086	9/11/2017 8:42	266.1	9.155	37.96	76.6
M1609-0086	10/17/2016 10:20	267.4	9.183	37.97	76.8
M1609-0086	10/12/2016 9:25	268.8	9.194	38.04	76.9
M1609-0087	9/29/2022 15:40	261.1	9.080	37.61	76.3
M1609-0087	9/9/2022 8:56	261.2	9.075	37.76	76.3
M1609-0087	4/7/2021 11:37	261.4	9.093	37.74	76.2
M1609-0087	9/15/2020 10:35	261.1	9.085	37.72	76.2
M1609-0087	3/24/2020 10:29	262.2	9.097	37.81	76.3
M1609-0087	6/3/2019 8:44	262.1	9.105	37.77	76.2
M1609-0087	10/29/2018 10:31	262.4	9.104	37.84	76.2
M1609-0087	5/10/2018 8:26	262.0	9.114	37.76	76.2
M1609-0087	9/7/2017 10:25	262.2	9.106	37.77	76.3
M1609-0087	10/17/2016 10:31	263.1	9.130	37.78	76.3
M1609-0087	10/12/2016 9:16	264.2	9.142	37.84	76.4

A.2 Jinko JKM260 Modules

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1609-0014	1/11/2024 9:43	252.3	8.861	37.24	76.5
M1609-0014	9/19/2016 11:02	264.7	9.113	37.85	76.8
M1609-0015	1/4/2024 10:29	255.7	8.913	37.46	76.6
M1609-0015	9/19/2016 10:59	266.1	9.124	37.97	76.9
M1609-0016	1/4/2024 9:59	250.3	8.822	37.19	76.3
M1609-0016	9/19/2016 10:55	264.4	9.102	37.88	76.8
M1609-0017	1/11/2024 9:47	255.1	8.919	37.45	76.4
M1609-0017	9/19/2016 10:51	265.6	9.121	37.94	76.8
M1609-0018	1/4/2024 10:09	253.9	8.826	37.35	77.0
M1609-0018	9/19/2016 10:48	265.3	9.124	37.89	76.8
M1609-0019	1/11/2024 9:53	252.9	8.867	37.29	76.5
M1609-0019	9/19/2016 10:44	264.6	9.123	37.83	76.7
M1609-0020	1/4/2024 10:13	253.7	8.904	37.35	76.3
M1609-0020	9/19/2016 10:36	265.4	9.148	37.86	76.7
M1609-0046	1/11/2024 9:58	254.9	8.857	37.45	76.9
M1609-0046	9/20/2016 12:06	263.6	9.119	37.78	76.6
M1609-0047	4/18/2024 10:39	257.9	8.983	37.50	76.6
M1609-0047	9/9/2022 8:43	252.6	8.849	37.27	76.6
M1609-0047	4/7/2021 11:26	254.1	8.891	37.32	76.6
M1609-0047	9/15/2020 10:23	249.2	8.799	37.05	76.4
M1609-0047	3/24/2020 10:38	254.8	8.905	37.37	76.6
M1609-0047	6/3/2019 8:31	259.0	8.995	37.57	76.7
M1609-0047	10/29/2018 10:57	253.7	8.869	37.31	76.7
M1609-0047	5/10/2018 9:47	256.6	8.930	37.46	76.7
M1609-0047	9/11/2017 9:30	254.5	8.867	37.40	76.8
M1609-0047	9/20/2016 11:37	263.6	9.097	37.79	76.8
M1609-0048	1/11/2024 10:03	255.9	8.929	37.50	76.5
M1609-0048	9/20/2016 11:48	264.0	9.131	37.79	76.6
M1609-0049	1/11/2024 10:16	256.0	8.976	37.50	76.1
M1609-0049	9/20/2016 11:45	263.7	9.150	37.80	76.3
M1609-0055	10/16/2025 10:16	249.9	8.803	37.08	76.6
M1609-0055	10/9/2025 11:33	250.0	8.802	37.11	76.5
M1609-0055	4/18/2024 10:32	255.7	8.912	37.44	76.7
M1609-0055	9/9/2022 8:50	247.4	8.767	37.00	76.3
M1609-0055	4/7/2021 11:12	248.9	8.806	37.05	76.3
M1609-0055	9/15/2020 10:11	244.6	8.733	36.82	76.1
M1609-0055	9/15/2020 10:09	244.9	8.732	36.84	76.2
M1609-0055	3/24/2020 10:57	251.8	8.808	37.25	76.8
M1609-0055	6/3/2019 8:22	258.1	8.981	37.54	76.6
M1609-0055	10/29/2018 11:06	251.3	8.794	37.21	76.8

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1609-0055	5/10/2018 9:27	256.0	8.920	37.45	76.7
M1609-0055	9/11/2017 9:03	252.6	8.863	37.28	76.5
M1609-0055	9/20/2016 11:39	263.5	9.108	37.78	76.6
M1609-0057	1/4/2024 10:19	252.1	8.789	37.28	77.0
M1609-0057	9/20/2016 12:02	264.1	9.139	37.77	76.6
M1609-0058	10/29/2018 10:51	253.2	8.903	37.29	76.3
M1609-0058	5/10/2018 9:41	257.1	8.978	37.52	76.4
M1609-0058	9/11/2017 9:16	254.4	8.928	37.40	76.2
M1609-0058	9/20/2016 12:25	265.2	9.110	37.89	76.9
M1609-0059	9/29/2022 15:33	254.2	8.941	37.24	76.2
M1609-0059	9/9/2022 8:28	254.1	8.950	37.38	76.0
M1609-0059	4/7/2021 11:21	256.9	9.001	37.49	76.2
M1609-0059	9/15/2020 10:29	252.4	8.916	37.27	76.0
M1609-0059	6/3/2019 8:36	260.0	9.043	37.65	76.4
M1609-0059	10/29/2018 11:14	257.0	8.985	37.53	76.3
M1609-0059	5/10/2018 9:52	259.3	9.046	37.61	76.3
M1609-0059	9/11/2017 9:26	257.4	8.999	37.57	76.2
M1609-0059	9/20/2016 12:16	264.8	9.138	37.86	76.6
M1609-0061	1/11/2024 10:07	253.7	8.843	37.40	76.7
M1609-0061	9/20/2016 12:11	263.9	9.115	37.83	76.6
M1609-0062	1/4/2024 10:24	255.2	8.924	37.42	76.5
M1609-0062	9/20/2016 12:14	264.8	9.114	37.83	76.8
M1609-0063	1/4/2024 10:35	251.9	8.838	37.32	76.4
M1609-0063	9/20/2016 12:08	264.0	9.121	37.81	76.6
M1609-0065	4/18/2024 10:49	256.7	8.965	37.53	76.4
M1609-0065	9/7/2017 10:35	262.8	9.068	37.84	76.6
M1609-0065	9/20/2016 12:29	263.6	9.097	37.84	76.6
M1609-0066	10/16/2025 9:58	252.4	8.867	37.23	76.5
M1609-0066	10/9/2025 10:58	252.2	8.865	37.22	76.4
M1609-0066	4/18/2024 10:27	257.3	8.951	37.49	76.7
M1609-0066	9/9/2022 8:36	252.1	8.858	37.26	76.4
M1609-0066	4/7/2021 11:16	254.6	8.911	37.35	76.5
M1609-0066	9/15/2020 10:02	250.0	8.808	37.12	76.5
M1609-0066	3/24/2020 10:46	256.2	8.922	37.45	76.7
M1609-0066	6/3/2019 8:27	259.9	9.022	37.61	76.7
M1609-0066	10/29/2018 11:02	255.5	8.896	37.42	76.8
M1609-0066	5/10/2018 9:32	259.4	9.001	37.61	76.7
M1609-0066	9/11/2017 9:12	256.2	8.917	37.47	76.7
M1609-0066	9/20/2016 11:07	264.6	9.125	37.81	76.7

A.3 Jinko JKM265 Controls

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1609-0029	5/20/2025 10:27	266.7	9.207	38.03	76.2
M1609-0029	9/12/2022 13:13	265.6	9.175	38.01	76.2
M1609-0029	10/5/2021 8:41	266.8	9.192	38.08	76.3
M1609-0029	4/7/2021 8:13	266.9	9.196	38.08	76.3
M1609-0029	9/15/2020 9:50	266.8	9.187	38.10	76.3
M1609-0029	6/3/2019 8:48	267.2	9.195	38.10	76.3
M1609-0029	10/29/2018 9:55	266.9	9.194	38.08	76.3
M1609-0029	5/10/2018 8:08	266.7	9.200	38.04	76.3
M1609-0029	9/7/2017 11:40	267.3	9.187	38.09	76.4
M1609-0029	9/1/2017 11:14	267.1	9.196	38.05	76.4
M1609-0029	9/19/2016 14:21	267.4	9.185	38.06	76.5
M1609-0032	5/20/2025 10:32	264.9	9.230	38.08	75.4
M1609-0032	9/12/2022 13:30	264.1	9.178	38.08	75.6
M1609-0032	10/5/2021 8:46	264.9	9.195	38.11	75.6
M1609-0032	4/7/2021 8:19	265.5	9.199	38.16	75.7
M1609-0032	9/15/2020 9:56	265.0	9.189	38.13	75.7
M1609-0032	3/24/2020 11:03	265.7	9.210	38.16	75.6
M1609-0032	6/3/2019 8:52	265.7	9.214	38.14	75.7
M1609-0032	10/29/2018 9:43	265.4	9.220	38.13	75.6
M1609-0032	5/10/2018 8:15	265.7	9.224	38.13	75.6
M1609-0032	9/7/2017 11:32	266.0	9.226	38.15	75.6
M1609-0032	9/1/2017 10:41	266.0	9.223	38.14	75.7
M1609-0032	9/19/2016 14:08	265.5	9.215	38.07	75.7
M1609-0035	9/7/2017 11:30	267.1	9.222	38.07	76.1
M1609-0035	9/19/2016 14:17	267.2	9.211	38.09	76.2
M1609-0036	9/7/2017 10:53	265.7	9.205	38.12	75.8
M1609-0036	9/19/2016 14:14	265.3	9.197	38.07	75.8
M1609-0037	9/7/2017 10:46	267.1	9.190	38.12	76.3
M1609-0037	9/19/2016 14:12	266.4	9.177	38.05	76.3

A.4 Jinko JKM265 Modules

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1609-0005	12/14/2023 14:17	256.8	9.026	37.68	75.6
M1609-0005	9/15/2016 10:28	267.0	9.218	38.03	76.2
M1609-0005	9/9/2016 11:20	270.6	9.280	38.15	76.5
M1609-0006	12/12/2023 14:36	256.5	9.019	37.73	75.4
M1609-0006	9/15/2016 10:33	267.7	9.220	38.15	76.2
M1609-0006	9/9/2016 11:44	270.8	9.286	38.19	76.4

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1609-0007	12/14/2023 13:14	256.8	9.051	37.74	75.3
M1609-0007	9/15/2016 10:46	266.8	9.204	38.02	76.3
M1609-0007	9/9/2016 11:48	271.2	9.291	38.19	76.5
M1609-0008	12/12/2023 14:23	257.2	9.028	37.75	75.5
M1609-0008	9/15/2016 10:49	267.9	9.195	38.16	76.4
M1609-0008	9/9/2016 11:51	271.3	9.263	38.24	76.6
M1609-0009	12/14/2023 13:08	258.8	9.024	37.74	76.0
M1609-0009	9/15/2016 10:58	268.5	9.190	38.12	76.7
M1609-0009	9/9/2016 11:54	272.3	9.264	38.24	76.9
M1609-0010	5/20/2025 10:19	259.2	9.130	37.80	75.2
M1609-0010	9/12/2022 12:56	255.2	9.061	37.64	74.9
M1609-0010	10/5/2021 8:12	255.0	9.053	37.68	74.8
M1609-0010	4/7/2021 8:25	261.2	9.128	37.97	75.4
M1609-0010	9/15/2020 9:40	254.9	9.030	37.65	75.0
M1609-0010	3/24/2020 11:10	261.1	9.124	37.94	75.5
M1609-0010	6/3/2019 8:16	262.1	9.163	37.94	75.4
M1609-0010	10/29/2018 10:20	260.7	9.132	37.94	75.3
M1609-0010	5/10/2018 8:59	262.6	9.154	38.00	75.5
M1609-0010	9/1/2017 10:49	262.0	9.142	38.00	75.5
M1609-0010	9/15/2016 11:01	266.2	9.196	38.13	76.0
M1609-0010	9/9/2016 11:57	270.3	9.265	38.26	76.3
M1609-0011	5/20/2025 10:00	260.9	9.118	37.80	75.7
M1609-0011	9/12/2022 12:39	256.9	9.050	37.64	75.5
M1609-0011	10/5/2021 8:27	257.9	9.062	37.71	75.5
M1609-0011	4/7/2021 11:07	261.7	9.136	37.87	75.7
M1609-0011	9/15/2020 9:27	255.6	9.058	37.60	75.1
M1609-0011	3/24/2020 11:20	261.8	9.125	37.92	75.7
M1609-0011	6/3/2019 8:58	264.1	9.162	37.98	76.0
M1609-0011	10/29/2018 10:10	261.2	9.138	37.88	75.5
M1609-0011	5/10/2018 9:14	264.4	9.171	38.00	75.9
M1609-0011	9/1/2017 10:27	262.6	9.157	37.95	75.6
M1609-0011	9/15/2016 11:04	267.3	9.199	38.11	76.3
M1609-0011	9/9/2016 12:01	271.6	9.271	38.24	76.7
M1609-0012	5/20/2025 10:42	262.3	9.157	37.78	75.9
M1609-0012	9/12/2022 13:04	258.3	9.066	37.65	75.7
M1609-0012	10/5/2021 8:18	259.1	9.068	37.73	75.8
M1609-0012	4/7/2021 8:30	263.9	9.145	37.96	76.1
M1609-0012	9/15/2020 9:16	257.9	9.057	37.67	75.6
M1609-0012	6/3/2019 8:08	264.7	9.186	37.93	76.0
M1609-0012	10/29/2018 10:15	263.0	9.152	37.89	75.9
M1609-0012	5/10/2018 8:53	265.2	9.191	37.97	76.0

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1609-0012	9/1/2017 10:46	264.2	9.172	37.98	75.9
M1609-0012	9/15/2016 11:06	267.4	9.223	38.06	76.2
M1609-0012	9/9/2016 12:06	271.8	9.293	38.22	76.6
M1609-0021	12/14/2023 13:49	257.5	9.007	37.72	75.8
M1609-0021	9/16/2016 14:41	267.8	9.225	38.06	76.3
M1609-0021	9/16/2016 10:34	271.0	9.267	38.20	76.6
M1609-0022	12/12/2023 13:50	257.0	9.017	37.71	75.6
M1609-0022	9/16/2016 14:45	268.1	9.217	38.11	76.4
M1609-0022	9/16/2016 10:31	271.3	9.275	38.21	76.6
M1609-0023	12/14/2023 13:42	255.1	9.024	37.77	74.9
M1609-0023	9/16/2016 14:49	266.5	9.227	38.10	75.8
M1609-0023	9/16/2016 10:23	269.4	9.272	38.19	76.1
M1609-0024	12/12/2023 15:04	257.6	9.022	37.74	75.7
M1609-0024	9/16/2016 14:36	268.4	9.221	38.11	76.4
M1609-0024	9/16/2016 10:17	271.3	9.278	38.20	76.6
M1609-0025	12/14/2023 13:35	254.7	9.006	37.74	75.0
M1609-0025	9/16/2016 14:55	266.8	9.214	38.14	76.0
M1609-0025	9/16/2016 10:08	269.2	9.263	38.20	76.1
M1609-0026	12/12/2023 14:16	255.3	9.012	37.75	75.1
M1609-0026	9/16/2016 14:52	267.7	9.224	38.15	76.1
M1609-0026	9/16/2016 10:05	270.3	9.274	38.22	76.3
M1609-0027	12/14/2023 13:55	257.5	9.016	37.75	75.7
M1609-0027	9/16/2016 14:31	268.5	9.227	38.10	76.4
M1609-0027	9/16/2016 9:59	271.1	9.281	38.17	76.6
M1609-0028	12/12/2023 14:46	258.1	9.001	37.80	75.9
M1609-0028	9/16/2016 14:28	268.7	9.228	38.16	76.3
M1609-0028	9/16/2016 9:53	271.0	9.265	38.22	76.6
M1609-0029	5/20/2025 10:27	266.7	9.207	38.03	76.2
M1609-0029	9/12/2022 13:13	265.6	9.175	38.01	76.2
M1609-0029	10/5/2021 8:41	266.8	9.192	38.08	76.3
M1609-0029	4/7/2021 8:13	266.9	9.196	38.08	76.3
M1609-0029	9/15/2020 9:50	266.8	9.187	38.10	76.3
M1609-0029	6/3/2019 8:48	267.2	9.195	38.10	76.3
M1609-0029	10/29/2018 9:55	266.9	9.194	38.08	76.3
M1609-0029	5/10/2018 8:08	266.7	9.200	38.04	76.3
M1609-0029	9/7/2017 11:40	267.3	9.187	38.09	76.4
M1609-0029	9/1/2017 11:14	267.1	9.196	38.05	76.4
M1609-0029	9/19/2016 14:21	267.4	9.185	38.06	76.5
M1609-0032	5/20/2025 10:32	264.9	9.230	38.08	75.4
M1609-0032	9/12/2022 13:30	264.1	9.178	38.08	75.6
M1609-0032	10/5/2021 8:46	264.9	9.195	38.11	75.6

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1609-0032	4/7/2021 8:19	265.5	9.199	38.16	75.7
M1609-0032	9/15/2020 9:56	265.0	9.189	38.13	75.7
M1609-0032	3/24/2020 11:03	265.7	9.210	38.16	75.6
M1609-0032	6/3/2019 8:52	265.7	9.214	38.14	75.7
M1609-0032	10/29/2018 9:43	265.4	9.220	38.13	75.6
M1609-0032	5/10/2018 8:15	265.7	9.224	38.13	75.6
M1609-0032	9/7/2017 11:32	266.0	9.226	38.15	75.6
M1609-0032	9/1/2017 10:41	266.0	9.223	38.14	75.7
M1609-0032	9/19/2016 14:08	265.5	9.215	38.07	75.7
M1609-0034	12/12/2023 14:53	259.3	9.048	37.80	75.9
M1609-0034	9/19/2016 13:56	267.1	9.201	38.03	76.4
M1609-0045	5/20/2025 10:11	261.7	9.147	37.82	75.7
M1609-0045	9/12/2022 12:49	258.4	9.061	37.69	75.7
M1609-0045	10/5/2021 8:33	259.2	9.061	37.77	75.8
M1609-0045	4/7/2021 11:03	262.8	9.142	37.89	75.9
M1609-0045	9/15/2020 9:46	259.1	9.055	37.77	75.8
M1609-0045	3/24/2020 11:16	263.3	9.128	37.95	76.1
M1609-0045	6/3/2019 8:56	264.7	9.163	37.99	76.1
M1609-0045	10/29/2018 10:01	262.7	9.124	37.91	76.0
M1609-0045	5/10/2018 9:04	265.0	9.161	38.02	76.1
M1609-0045	9/1/2017 10:16	264.5	9.154	38.02	76.1
M1609-0045	9/19/2016 13:40	266.7	9.191	38.05	76.3

A.5 Trina TSM255 Controls

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1610-0065	4/23/2024 10:19	257.8	8.919	37.80	76.5
M1610-0065	10/7/2022 11:03	257.8	8.889	37.66	76.7
M1610-0065	9/27/2022 9:23	257.6	8.898	37.81	76.6
M1610-0065	11/11/2021 10:08	258.7	8.916	37.87	76.7
M1610-0065	4/26/2021 13:07	258.5	8.913	37.85	76.6
M1610-0065	9/18/2020 12:38	258.3	8.919	37.83	76.6
M1610-0065	12/10/2019 11:14	259.0	8.915	37.89	76.7
M1610-0065	11/5/2018 11:46	258.9	8.916	37.88	76.7
M1610-0065	5/23/2018 9:20	259.2	8.927	37.89	76.7
M1610-0065	10/17/2017 13:43	259.3	8.925	37.89	76.7
M1610-0065	11/3/2016 8:33	260.5	8.939	37.95	76.9
M1610-0065	10/24/2016 9:45	261.2	8.973	37.91	76.8
M1610-0068	11/6/2025 11:11	261.8	8.947	38.17	76.7
M1610-0068	4/23/2024 9:35	261.8	8.951	38.17	76.7

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1610-0068	10/7/2022 10:52	261.4	8.925	38.01	76.7
M1610-0068	9/27/2022 9:31	261.6	8.916	38.18	76.9
M1610-0068	11/11/2021 10:16	262.4	8.936	38.21	76.9
M1610-0068	4/26/2021 13:12	262.3	8.936	38.20	76.9
M1610-0068	9/18/2020 12:46	262.1	8.943	38.17	76.8
M1610-0068	12/10/2019 11:20	262.6	8.943	38.22	76.9
M1610-0068	11/5/2018 11:50	262.6	8.949	38.22	76.8
M1610-0068	5/23/2018 8:46	262.6	8.961	38.18	76.8
M1610-0068	10/17/2017 13:53	263.2	8.965	38.22	76.9
M1610-0068	10/24/2016 10:50	264.4	8.997	38.26	76.9
M1610-0082	5/23/2018 9:15	261.2	8.980	37.99	76.6
M1610-0082	10/17/2017 13:34	261.7	8.969	38.02	76.8
M1610-0082	10/24/2016 11:04	262.8	9.005	38.04	76.8

A.6 Trina TSM255 Modules

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1610-0050	11/6/2025 11:19	252.3	8.828	37.69	75.8
M1610-0050	4/23/2024 10:06	255.4	8.869	37.84	76.2
M1610-0050	10/7/2022 11:20	253.3	8.832	37.57	76.0
M1610-0050	11/11/2021 10:48	254.3	8.821	37.82	76.3
M1610-0050	4/26/2021 13:17	256.6	8.870	37.89	76.4
M1610-0050	9/18/2020 13:06	253.4	8.831	37.74	76.1
M1610-0050	12/10/2019 11:40	256.4	8.865	37.91	76.3
M1610-0050	11/5/2018 11:20	257.0	8.869	37.97	76.4
M1610-0050	5/23/2018 10:02	257.6	8.891	37.96	76.4
M1610-0050	10/17/2017 14:20	257.4	8.887	37.97	76.3
M1610-0050	10/20/2016 13:40	262.2	8.931	38.13	77.0
M1610-0051	8/5/2020 10:25	254.9	8.883	37.81	75.9
M1610-0051	12/10/2019 11:31	257.4	8.912	37.92	76.2
M1610-0051	11/5/2018 10:52	258.6	8.936	37.89	76.4
M1610-0051	5/23/2018 10:11	259.7	8.934	38.02	76.5
M1610-0051	10/17/2017 14:32	258.9	8.946	38.01	76.2
M1610-0051	10/20/2016 13:37	263.9	8.977	38.19	77.0
M1610-0060	4/23/2024 9:44	254.7	8.921	37.77	75.6
M1610-0060	10/7/2022 11:10	254.2	8.892	37.53	75.9
M1610-0060	11/11/2021 10:36	255.5	8.890	37.79	76.1
M1610-0060	4/26/2021 13:32	257.0	8.933	37.81	76.1
M1610-0060	9/18/2020 12:52	255.4	8.901	37.75	76.1
M1610-0060	12/10/2019 11:24	257.8	8.935	37.89	76.2

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1610-0060	11/5/2018 11:35	258.7	8.940	37.92	76.3
M1610-0060	5/23/2018 10:15	259.6	8.952	37.99	76.4
M1610-0060	10/17/2017 14:25	259.9	8.959	37.99	76.4
M1610-0060	10/20/2016 13:43	262.7	8.999	38.14	76.6
M1610-0066	4/23/2024 9:51	255.6	8.858	37.81	76.4
M1610-0066	10/7/2022 11:13	255.5	8.768	37.86	76.6
M1610-0066	10/7/2022 11:13	254.0	8.778	37.59	76.6
M1610-0066	11/11/2021 10:43	254.9	8.827	37.85	76.4
M1610-0066	4/26/2021 13:38	256.5	8.864	37.86	76.5
M1610-0066	9/18/2020 13:01	254.8	8.840	37.78	76.3
M1610-0066	6/5/2018 11:22	259.6	8.914	37.98	76.7
M1610-0066	10/17/2017 13:17	259.9	8.907	38.00	76.9
M1610-0066	4/20/2017 8:37	259.4	8.896	37.99	76.8
M1610-0066	4/20/2017 8:25	260.0	8.894	38.06	76.9
M1610-0066	10/24/2016 10:59	261.2	8.929	38.04	76.9
M1610-0071	11/6/2025 11:25	249.6	8.880	37.67	74.6
M1610-0071	4/23/2024 10:01	250.9	8.908	37.78	74.6
M1610-0071	10/7/2022 11:17	255.4	8.885	37.54	76.3
M1610-0071	11/11/2021 10:25	256.8	8.902	37.80	76.4
M1610-0071	4/26/2021 13:22	258.6	8.920	37.85	76.6
M1610-0071	9/18/2020 13:10	256.4	8.896	37.76	76.4
M1610-0071	12/10/2019 11:36	258.7	8.913	37.89	76.6
M1610-0071	11/5/2018 11:24	259.7	8.923	37.99	76.7
M1610-0071	5/23/2018 9:42	259.8	8.947	37.97	76.5
M1610-0071	10/17/2017 14:11	259.9	8.946	37.96	76.6
M1610-0071	10/24/2016 10:34	262.7	8.996	38.05	76.8
M1610-0072	11/5/2018 11:10	259.0	8.902	37.99	76.6
M1610-0072	5/23/2018 10:06	259.8	8.919	38.04	76.6
M1610-0072	10/17/2017 14:38	259.7	8.917	38.02	76.6
M1610-0072	10/24/2016 10:30	263.1	8.985	38.07	77.0
M1610-0073	11/5/2018 11:40	257.2	8.889	37.78	76.6
M1610-0073	5/23/2018 9:36	257.9	8.899	37.82	76.6
M1610-0073	10/17/2017 14:03	258.1	8.902	37.82	76.7
M1610-0073	10/24/2016 9:30	261.5	8.951	37.92	77.1

A.7 Trina TSM260 Controls

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1610-0027	11/6/2025 9:22	261.4	9.079	37.75	76.3
M1610-0027	10/31/2023 15:05	259.6	9.017	37.74	76.3
M1610-0027	3/30/2023 10:17	261.7	9.063	37.80	76.4
M1610-0027	4/27/2021 8:37	261.5	9.082	37.74	76.3
M1610-0027	9/17/2020 11:13	261.8	9.073	37.78	76.4
M1610-0027	12/10/2019 10:33	261.6	9.089	37.74	76.3
M1610-0027	11/5/2018 10:38	262.7	9.078	37.84	76.5
M1610-0027	5/23/2018 9:25	262.6	9.091	37.82	76.4
M1610-0027	9/15/2017 14:01	262.5	9.076	37.80	76.6
M1610-0027	10/24/2016 11:18	263.6	9.114	37.84	76.5
M1610-0027	10/18/2016 9:34	263.9	9.119	37.84	76.5
M1610-0030	5/23/2018 9:30	265.0	9.110	37.92	76.8
M1610-0030	9/15/2017 13:41	264.9	9.113	37.89	76.8
M1610-0030	10/18/2016 10:20	266.0	9.130	37.92	76.9
M1610-0049	10/31/2023 15:10	263.5	9.097	38.00	76.3
M1610-0049	3/30/2023 10:25	265.3	9.139	38.03	76.4
M1610-0049	4/27/2021 8:42	265.5	9.148	38.02	76.4
M1610-0049	9/17/2020 11:07	265.4	9.146	38.02	76.4
M1610-0049	3/24/2020 10:22	265.8	9.153	38.03	76.4
M1610-0049	12/10/2019 10:13	265.3	9.151	37.99	76.4
M1610-0049	11/5/2018 10:34	266.2	9.148	38.09	76.4
M1610-0049	5/23/2018 9:05	266.1	9.159	38.05	76.4
M1610-0049	9/15/2017 14:07	266.3	9.161	38.05	76.5
M1610-0049	4/20/2017 8:45	265.9	9.150	38.03	76.5
M1610-0049	10/24/2016 11:15	267.1	9.181	38.05	76.5
M1610-0049	10/13/2016 10:14	267.4	9.176	38.08	76.6

A.8 Trina TSM260 Modules

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1610-0020	11/5/2018 10:29	260.2	9.106	37.79	75.7
M1610-0020	5/23/2018 10:40	260.8	9.130	37.76	75.7
M1610-0020	9/15/2017 14:13	261.1	9.136	37.76	75.7
M1610-0020	10/17/2016 11:05	265.8	9.164	37.96	76.5
M1610-0020	10/12/2016 9:29	266.4	9.182	37.97	76.5
M1610-0021	11/5/2018 10:15	260.6	9.110	37.78	75.7
M1610-0021	5/23/2018 10:31	260.9	9.126	37.78	75.7
M1610-0021	9/15/2017 14:32	260.3	9.128	37.73	75.6
M1610-0021	10/17/2016 11:10	266.9	9.170	38.00	76.6

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1610-0021	10/12/2016 9:35	267.2	9.181	37.99	76.7
M1610-0024	10/31/2023 13:50	251.6	8.905	37.42	75.5
M1610-0024	10/18/2016 10:29	266.3	9.122	37.98	76.9
M1610-0025	10/31/2023 14:45	257.9	9.033	37.59	76.0
M1610-0025	3/30/2023 10:35	260.9	9.090	37.68	76.2
M1610-0025	4/27/2021 9:14	261.0	9.105	37.66	76.1
M1610-0025	9/17/2020 11:01	260.5	9.082	37.68	76.2
M1610-0025	12/10/2019 10:43	261.4	9.107	37.68	76.2
M1610-0025	11/5/2018 10:19	262.1	9.100	37.81	76.2
M1610-0025	5/23/2018 11:00	261.8	9.129	37.71	76.1
M1610-0025	9/15/2017 14:19	262.6	9.120	37.78	76.2
M1610-0025	10/18/2016 9:38	266.8	9.180	37.95	76.7
M1610-0026	10/31/2023 13:35	256.4	9.034	37.62	75.5
M1610-0026	10/18/2016 9:54	265.1	9.158	37.86	76.5
M1610-0029	10/31/2023 14:18	251.7	8.879	37.39	75.9
M1610-0029	10/18/2016 10:26	266.4	9.133	37.96	76.9
M1610-0032	10/31/2023 13:57	257.3	9.043	37.70	75.6
M1610-0032	10/18/2016 9:58	267.2	9.171	38.08	76.6
M1610-0032	10/12/2016 10:07	267.9	9.181	38.10	76.7
M1610-0033	10/31/2023 13:42	250.3	8.867	37.35	75.6
M1610-0033	10/18/2016 10:01	265.4	9.108	37.91	76.9
M1610-0033	10/12/2016 10:01	266.4	9.134	37.93	77.0
M1610-0034	10/31/2023 14:05	250.7	8.858	37.39	75.7
M1610-0034	10/18/2016 10:06	265.8	9.088	38.01	77.0
M1610-0034	10/12/2016 9:52	267.5	9.113	38.07	77.2
M1610-0035	11/10/2023 9:30	258.8	9.044	37.82	75.7
M1610-0035	10/18/2016 10:10	267.0	9.177	38.10	76.4
M1610-0035	10/12/2016 9:47	267.5	9.198	38.10	76.4
M1610-0040	11/10/2023 10:05	256.2	9.046	37.60	75.4
M1610-0040	10/13/2016 9:42	265.7	9.159	37.87	76.6
M1610-0041	11/6/2025 10:57	251.9	8.952	37.42	75.2
M1610-0041	10/31/2023 14:39	252.3	8.926	37.48	75.4
M1610-0041	3/30/2023 10:42	258.9	9.038	37.74	75.9
M1610-0041	4/27/2021 9:19	258.9	9.056	37.67	75.9
M1610-0041	9/17/2020 10:43	254.9	8.996	37.49	75.6
M1610-0041	12/10/2019 10:50	259.2	9.052	37.70	76.0
M1610-0041	11/5/2018 10:25	259.7	9.047	37.76	76.1
M1610-0041	5/23/2018 10:45	261.3	9.079	37.78	76.2
M1610-0041	9/15/2017 14:17	260.7	9.063	37.77	76.2
M1610-0041	10/17/2016 10:54	265.9	9.135	37.94	76.8
M1610-0042	11/6/2025 10:48	254.7	9.040	37.48	75.2

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1610-0042	10/31/2023 15:00	253.6	8.991	37.54	75.2
M1610-0042	3/30/2023 10:58	257.1	9.056	37.66	75.4
M1610-0042	4/27/2021 9:02	257.6	9.071	37.61	75.6
M1610-0042	9/17/2020 10:51	256.6	9.040	37.59	75.6
M1610-0042	3/24/2020 11:25	258.6	9.079	37.68	75.6
M1610-0042	12/10/2019 11:02	258.1	9.066	37.63	75.7
M1610-0042	11/5/2018 10:03	258.9	9.068	37.69	75.8
M1610-0042	5/23/2018 10:20	259.6	9.085	37.75	75.7
M1610-0042	9/15/2017 14:40	259.8	9.086	37.70	75.9
M1610-0042	10/17/2016 10:46	264.9	9.150	37.87	76.5
M1610-0043	11/6/2025 9:35	231.3	8.792	37.25	70.6
M1610-0043	10/31/2023 14:54	235.3	8.813	37.33	71.6
M1610-0043	3/30/2023 10:52	242.3	8.925	37.63	72.2
M1610-0043	4/27/2021 9:08	243.6	8.980	37.56	72.3
M1610-0043	9/17/2020 10:57	238.5	8.817	37.32	72.5
M1610-0043	3/24/2020 11:28	244.4	8.960	37.63	72.5
M1610-0043	12/10/2019 11:09	244.2	8.952	37.55	72.7
M1610-0043	11/5/2018 10:12	246.3	8.956	37.59	73.2
M1610-0043	5/23/2018 10:25	250.9	9.028	37.75	73.7
M1610-0043	9/15/2017 14:36	246.8	9.008	37.65	72.8
M1610-0043	10/17/2016 11:01	257.7	9.109	37.82	74.8
M1610-0044	11/10/2023 9:47	259.1	9.026	37.84	75.9
M1610-0044	10/13/2016 9:46	267.3	9.147	38.10	76.7
M1610-0045	11/10/2023 10:01	256.7	9.019	37.65	75.7
M1610-0045	10/13/2016 9:50	265.4	9.138	37.91	76.6
M1610-0046	11/10/2023 9:41	256.6	9.024	37.78	75.3
M1610-0046	10/13/2016 9:54	266.5	9.145	38.05	76.6
M1610-0047	11/10/2023 9:55	258.8	9.049	37.78	75.7
M1610-0047	10/13/2016 9:57	267.3	9.161	38.05	76.7

A.9 Q-Cells Q.Plus280 Controls

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1706-0048	5/22/2025 11:09	276.7	9.496	38.69	75.8
M1706-0048	11/16/2023 12:23	279.6	9.600	38.72	75.7
M1706-0048	10/7/2022 15:21	276.8	9.450	38.68	75.9
M1706-0048	9/29/2022 10:46	276.7	9.470	38.74	75.9
M1706-0048	9/16/2021 8:08	277.4	9.484	38.76	75.9
M1706-0048	9/21/2020 10:36	277.5	9.490	38.76	75.9
M1706-0048	1/29/2020 9:12	277.5	9.497	38.72	75.9

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1706-0048	12/10/2018 14:20	278.2	9.498	38.80	76.0
M1706-0048	7/19/2017 12:34	278.6	9.516	38.76	76.0
M1706-0049	11/16/2023 12:15	279.9	9.586	38.79	75.8
M1706-0049	10/7/2022 15:14	277.0	9.476	38.64	75.9
M1706-0049	9/29/2022 10:36	277.0	9.457	38.81	75.9
M1706-0049	9/16/2021 8:15	277.9	9.470	38.85	76.0
M1706-0049	9/21/2020 10:47	277.7	9.480	38.81	76.0
M1706-0049	1/29/2020 9:21	277.9	9.476	38.80	76.1
M1706-0049	12/10/2018 14:24	278.4	9.480	38.86	76.1
M1706-0049	7/14/2017 9:09	278.9	9.492	38.86	76.1

A.10 Q-Cells Q.Plus280 Modules

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1706-0022	5/22/2025 10:58	271.0	9.447	38.46	75.1
M1706-0022	11/16/2023 10:22	274.0	9.524	38.53	75.1
M1706-0022	10/7/2022 15:31	271.8	9.438	38.41	75.3
M1706-0022	9/16/2021 8:30	273.3	9.435	38.59	75.5
M1706-0022	9/21/2020 10:54	273.9	9.445	38.61	75.6
M1706-0022	1/29/2020 9:27	274.0	9.426	38.62	75.8
M1706-0022	12/10/2018 14:11	275.4	9.441	38.70	75.9
M1706-0022	8/8/2017 10:13	280.1	9.492	38.86	76.4
M1706-0022	7/21/2017 7:49	280.4	9.506	38.84	76.4
M1706-0022	7/11/2017 11:11	282.1	9.532	38.92	76.5
M1706-0029	5/22/2025 10:32	271.1	9.501	38.48	74.6
M1706-0029	5/22/2025 10:23	270.8	9.500	38.49	74.6
M1706-0029	11/16/2023 10:16	274.4	9.595	38.57	74.6
M1706-0029	10/7/2022 15:26	271.5	9.473	38.55	74.6
M1706-0029	9/16/2021 8:23	273.5	9.491	38.65	75.0
M1706-0029	9/21/2020 11:15	273.4	9.491	38.64	75.0
M1706-0029	1/29/2020 9:32	274.2	9.484	38.70	75.2
M1706-0029	12/10/2018 13:56	274.9	9.492	38.72	75.3
M1706-0029	7/19/2017 11:58	279.0	9.553	38.82	75.7
M1706-0040	12/10/2018 14:01	274.7	9.472	38.69	75.5
M1706-0040	7/19/2017 12:54	279.3	9.543	38.80	75.9
M1706-0041	5/22/2025 10:48	269.1	9.489	38.40	74.3
M1706-0041	5/22/2025 10:42	268.9	9.488	38.43	74.2
M1706-0041	11/16/2023 10:29	272.1	9.576	38.51	74.3
M1706-0041	10/7/2022 15:34	269.5	9.460	38.36	74.5
M1706-0041	9/16/2021 8:44	271.0	9.469	38.51	74.8

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1706-0041	9/21/2020 11:03	272.1	9.485	38.55	74.9
M1706-0041	1/29/2020 9:42	272.9	9.442	38.66	75.3
M1706-0041	12/10/2018 14:15	274.1	9.474	38.67	75.3
M1706-0041	7/19/2017 11:26	278.9	9.534	38.83	75.8

A.11 Q-Cells Q.Peak290 Controls

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1706-0081	1/25/2024 11:12	282.3	9.422	39.32	76.8
M1706-0081	10/7/2022 10:07	282.5	9.368	39.25	77.1
M1706-0081	9/29/2022 10:51	283.2	9.389	39.43	77.1
M1706-0081	9/16/2021 9:02	284.4	9.409	39.51	77.1
M1706-0081	9/21/2020 11:56	283.7	9.416	39.43	77.0
M1706-0081	1/29/2020 10:20	285.1	9.411	39.55	77.2
M1706-0081	12/10/2018 13:50	286.4	9.421	39.64	77.3
M1706-0081	8/9/2017 9:44	286.7	9.437	39.59	77.3
M1706-0082	1/25/2024 11:20	280.1	9.355	39.17	77.0
M1706-0082	10/7/2022 10:28	280.3	9.336	39.08	77.2
M1706-0082	9/29/2022 11:01	279.7	9.313	39.20	77.2
M1706-0082	9/16/2021 9:07	281.6	9.340	39.30	77.3
M1706-0082	9/21/2020 11:51	280.9	9.340	39.24	77.2
M1706-0082	1/29/2020 10:15	282.8	9.354	39.36	77.4
M1706-0082	12/10/2018 13:47	287.3	9.396	39.64	77.7
M1706-0082	8/9/2017 9:56	287.5	9.417	39.58	77.7

A.12 Q-Cells Q.Peak290 Modules

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1706-0052	12/10/2018 13:35	282.4	9.357	39.35	77.3
M1706-0052	8/9/2017 9:14	287.4	9.431	39.57	77.6
M1706-0059	1/25/2024 11:40	277.8	9.371	39.06	76.5
M1706-0059	10/7/2022 10:37	277.0	9.326	38.96	76.6
M1706-0059	9/16/2021 9:26	278.8	9.345	39.16	76.8
M1706-0059	9/21/2020 11:39	280.3	9.359	39.24	76.9
M1706-0059	1/29/2020 10:05	280.1	9.331	39.23	77.1
M1706-0059	12/10/2018 13:25	282.2	9.358	39.36	77.2
M1706-0059	8/11/2017 9:38	287.6	9.429	39.66	77.5
M1706-0059	8/7/2017 13:56	288.4	9.450	39.67	77.5
M1706-0059	7/11/2017 8:59	291.1	9.478	39.82	77.7
M1706-0067	1/25/2024 11:32	277.5	9.326	39.04	76.8

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1706-0067	10/7/2022 10:46	275.9	9.321	38.90	76.4
M1706-0067	9/16/2021 9:13	277.6	9.314	39.14	76.7
M1706-0067	9/21/2020 11:23	278.5	9.331	39.16	76.8
M1706-0067	1/29/2020 9:57	278.1	9.279	39.20	77.0
M1706-0067	12/10/2018 13:44	280.8	9.321	39.37	77.1
M1706-0067	8/11/2017 9:18	286.2	9.434	39.59	77.2
M1706-0067	8/7/2017 13:48	286.5	9.433	39.62	77.3
M1706-0067	7/11/2017 9:14	289.6	9.469	39.77	77.5
M1706-0070	1/25/2024 11:26	280.5	9.405	39.19	76.7
M1706-0070	10/7/2022 10:40	278.4	9.334	39.07	76.7
M1706-0070	9/16/2021 9:31	279.6	9.345	39.25	76.8
M1706-0070	9/21/2020 11:30	281.0	9.363	39.32	76.9
M1706-0070	1/29/2020 9:53	280.2	9.321	39.31	77.0
M1706-0070	12/10/2018 13:41	282.8	9.353	39.46	77.2
M1706-0070	8/17/2017 9:31	287.3	9.440	39.68	77.3
M1706-0076	12/10/2018 13:30	281.4	9.358	39.34	77.0
M1706-0076	8/11/2017 10:03	286.9	9.425	39.62	77.4
M1706-0076	8/7/2017 14:24	287.4	9.427	39.67	77.5
M1706-0076	7/11/2017 9:33	290.1	9.465	39.77	77.7
M1706-0080	1/25/2024 11:45	278.7	9.356	39.07	76.8
M1706-0080	10/7/2022 10:43	276.5	9.343	38.91	76.4
M1706-0080	9/16/2021 9:18	278.4	9.341	39.17	76.7
M1706-0080	9/21/2020 11:34	280.6	9.363	39.23	77.0
M1706-0080	1/29/2020 10:07	281.8	9.346	39.32	77.3
M1706-0080	12/10/2018 13:19	282.4	9.383	39.35	77.1
M1706-0080	8/11/2017 9:03	288.2	9.455	39.63	77.5
M1706-0080	8/7/2017 13:41	288.0	9.453	39.62	77.5
M1706-0080	7/11/2017 9:23	290.9	9.475	39.79	77.7

A.13 Mission MSE360 Controls

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1811-0001	5/3/2024 9:26	351.2	9.670	47.32	77.1
M1811-0001	10/7/2022 9:00	354.1	9.708	47.43	77.3
M1811-0001	9/29/2021 8:55	354.1	9.709	47.42	77.3
M1811-0001	4/14/2021 9:27	354.3	9.720	47.40	77.3
M1811-0001	9/28/2020 11:12	354.1	9.708	47.41	77.3
M1811-0001	6/2/2020 11:46	353.8	9.721	47.36	77.2
M1811-0001	12/19/2019 13:10	354.5	9.715	47.45	77.3
M1811-0001	11/26/2018 9:57	357.2	9.724	47.62	77.6

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1811-0008	5/3/2024 9:33	347.5	9.564	47.04	77.6
M1811-0008	10/7/2022 9:11	349.1	9.619	47.07	77.5
M1811-0008	9/29/2021 9:01	349.8	9.622	47.13	77.5
M1811-0008	4/14/2021 9:36	350.4	9.641	47.12	77.5
M1811-0008	9/28/2020 11:17	350.2	9.634	47.13	77.5
M1811-0008	6/2/2020 11:35	350.1	9.638	47.10	77.5
M1811-0008	12/19/2019 13:06	350.2	9.628	47.12	77.6
M1811-0008	5/28/2019 11:02	349.4	9.617	47.07	77.6
M1811-0008	5/15/2019 8:13	349.6	9.621	47.08	77.6
M1811-0008	5/7/2019 8:46	349.7	9.613	47.11	77.6
M1811-0008	4/29/2019 12:07	349.4	9.624	47.07	77.5
M1811-0008	4/17/2019 8:04	349.4	9.617	47.08	77.6
M1811-0008	4/5/2019 8:18	349.5	9.614	47.08	77.6
M1811-0008	3/26/2019 7:50	350.5	9.616	47.16	77.7
M1811-0008	3/14/2019 10:58	349.7	9.612	47.11	77.6
M1811-0008	3/4/2019 13:04	351.2	9.635	47.19	77.6
M1811-0008	2/19/2019 10:51	351.8	9.644	47.22	77.7
M1811-0008	2/12/2019 8:56	351.9	9.643	47.22	77.7
M1811-0008	2/5/2019 13:27	352.2	9.644	47.26	77.7
M1811-0008	1/24/2019 14:46	352.4	9.649	47.25	77.7
M1811-0008	11/26/2018 9:42	352.9	9.660	47.29	77.7

A.14 Mission MSE360 Modules

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1811-0012	5/3/2024 9:45	352.6	9.667	47.53	77.1
M1811-0012	10/7/2022 8:46	352.0	9.699	47.50	76.8
M1811-0012	9/29/2021 9:20	354.1	9.697	47.60	77.1
M1811-0012	4/14/2021 9:49	357.2	9.750	47.71	77.2
M1811-0012	9/28/2020 11:01	354.7	9.733	47.55	77.0
M1811-0012	6/2/2020 11:27	355.3	9.752	47.54	77.0
M1811-0012	12/19/2019 12:54	356.9	9.732	47.65	77.4
M1811-0012	11/30/2018 10:32	355.4	9.690	47.58	77.5
M1811-0017	5/3/2024 9:48	352.6	9.700	47.54	76.8
M1811-0017	10/7/2022 8:54	351.8	9.718	47.47	76.6
M1811-0017	9/29/2021 9:15	354.7	9.724	47.57	77.1
M1811-0017	4/14/2021 9:45	358.7	9.756	47.69	77.5
M1811-0017	9/28/2020 10:50	355.0	9.744	47.49	77.1
M1811-0017	6/2/2020 11:03	356.3	9.758	47.55	77.2
M1811-0017	12/19/2019 12:47	358.3	9.744	47.64	77.6

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1811-0017	11/30/2018 10:39	354.8	9.697	47.52	77.4
M1811-0022	5/3/2024 9:38	350.8	9.683	47.50	76.6
M1811-0022	10/7/2022 8:41	351.1	9.714	47.47	76.5
M1811-0022	9/29/2021 9:10	353.0	9.712	47.55	76.8
M1811-0022	4/14/2021 9:56	355.6	9.761	47.61	76.9
M1811-0022	9/28/2020 11:06	353.9	9.739	47.52	76.9
M1811-0022	6/2/2020 11:09	355.2	9.765	47.52	76.9
M1811-0022	12/19/2019 12:58	356.4	9.755	47.59	77.2
M1811-0022	11/30/2018 10:22	355.1	9.728	47.54	77.2
M1811-0025	5/3/2024 9:54	352.3	9.689	47.50	76.9
M1811-0025	10/7/2022 8:32	352.5	9.715	47.47	76.8
M1811-0025	9/29/2021 9:25	355.0	9.720	47.60	77.1
M1811-0025	4/14/2021 9:41	357.9	9.768	47.65	77.3
M1811-0025	9/28/2020 10:57	355.1	9.744	47.52	77.1
M1811-0025	6/2/2020 10:41	355.6	9.758	47.51	77.1
M1811-0025	12/19/2019 12:39	357.2	9.757	47.58	77.3
M1811-0025	11/30/2018 10:29	354.6	9.718	47.54	77.1

A.15 LG 320N1K Controls

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1806-0001	11/13/2025 8:44	319.1	10.270	40.31	77.0
M1806-0001	11/13/2025 8:41	319.6	10.280	40.32	77.1
M1806-0001	5/8/2024 9:45	322.0	10.331	40.26	77.4
M1806-0001	10/7/2022 12:06	323.9	10.373	40.14	77.5
M1806-0001	10/4/2022 8:06	324.1	10.393	40.29	77.3
M1806-0001	9/29/2021 8:13	324.3	10.362	40.28	77.7
M1806-0001	9/29/2020 8:46	323.8	10.382	40.24	77.4
M1806-0001	1/28/2020 14:49	324.8	10.393	40.29	77.5
M1806-0001	8/1/2018 10:57	322.7	10.321	40.27	77.6
M1806-0001	6/6/2018 11:17	322.8	10.310	40.28	77.7
M1806-0002	5/8/2024 9:53	321.2	10.293	40.27	77.4
M1806-0002	10/7/2022 12:12	323.6	10.341	40.17	77.6
M1806-0002	10/4/2022 8:13	323.3	10.321	40.32	77.7
M1806-0002	9/29/2021 8:21	323.4	10.321	40.32	77.7
M1806-0002	9/29/2020 8:52	323.3	10.321	40.29	77.7
M1806-0002	1/28/2020 14:41	324.1	10.331	40.34	77.7
M1806-0002	8/1/2018 10:40	322.3	10.293	40.31	77.6
M1806-0002	6/6/2018 11:22	322.8	10.275	40.34	77.8

A.16 LG 320N1K Modules

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1806-0005	9/29/2022 15:26	316.0	10.340	39.73	76.6
M1806-0005	9/29/2021 8:32	316.4	10.321	39.94	76.7
M1806-0005	9/29/2020 8:57	316.2	10.321	39.91	76.7
M1806-0005	1/28/2020 14:30	316.9	10.352	39.98	76.6
M1806-0005	8/1/2018 10:15	318.9	10.352	40.06	76.9
M1806-0005	7/20/2018 8:16	319.1	10.341	40.10	76.9
M1806-0005	6/6/2018 11:42	321.9	10.362	40.07	77.5
M1806-0006	11/13/2025 8:55	315.4	10.220	40.25	76.7
M1806-0006	5/8/2024 10:05	317.9	10.269	40.11	77.1
M1806-0006	10/7/2022 12:23	320.9	10.314	39.98	77.5
M1806-0006	9/29/2021 8:40	320.1	10.299	40.17	77.4
M1806-0006	9/29/2020 9:25	319.9	10.321	40.14	77.2
M1806-0006	1/28/2020 14:33	321.9	10.321	40.30	77.3
M1806-0006	8/1/2018 9:54	323.0	10.331	40.36	77.4
M1806-0006	7/20/2018 8:04	323.1	10.331	40.36	77.4
M1806-0006	6/6/2018 11:36	322.5	10.331	40.32	77.4
M1806-0007	5/8/2024 10:09	319.0	10.310	40.17	77.0
M1806-0007	10/7/2022 12:17	321.8	10.351	40.06	77.3
M1806-0007	9/29/2021 8:27	322.1	10.341	40.25	77.3
M1806-0007	9/29/2020 9:07	321.8	10.341	40.21	77.3
M1806-0007	1/28/2020 14:19	322.6	10.352	40.26	77.4
M1806-0007	8/1/2018 10:03	319.6	10.331	40.40	76.6
M1806-0007	7/20/2018 8:08	319.6	10.331	40.41	76.5
M1806-0007	6/6/2018 11:32	321.3	10.331	40.36	77.0
M1806-0008	11/13/2025 10:05	320.7	10.240	40.43	77.4
M1806-0008	5/8/2024 10:14	323.0	10.279	40.32	77.9
M1806-0008	10/7/2022 12:26	326.4	10.329	40.22	78.2
M1806-0008	9/29/2021 8:36	325.9	10.331	40.41	78.0
M1806-0008	9/29/2020 9:11	325.7	10.341	40.38	77.9
M1806-0008	1/28/2020 14:24	326.7	10.362	40.46	77.9
M1806-0008	8/1/2018 10:09	323.6	10.331	40.51	77.3
M1806-0008	7/20/2018 8:13	323.6	10.331	40.54	77.3
M1806-0008	6/6/2018 11:27	326.4	10.310	40.49	78.1
M1806-0011	11/13/2025 10:13	315.1	10.270	40.03	76.6
M1806-0011	5/8/2024 10:22	315.6	10.321	39.88	76.6
M1806-0011	10/7/2022 12:19	321.9	10.436	39.88	77.1
M1806-0011	7/19/2018 7:45	320.5	10.331	40.12	77.3

A.17 Canadian CS6K-300MS Controls

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1803-0042	10/15/2024 14:17	295.7	9.863	39.60	76.2
M1803-0042	10/15/2024 14:15	295.9	9.868	39.62	76.2
M1803-0042	4/4/2023 10:29	298.3	9.882	39.67	76.6
M1803-0042	10/7/2022 11:43	298.4	9.875	39.48	76.6
M1803-0042	9/29/2022 10:06	298.2	9.877	39.70	76.5
M1803-0042	9/22/2021 10:09	297.9	9.875	39.64	76.6
M1803-0042	9/23/2020 11:45	298.5	9.881	39.67	76.6
M1803-0042	1/27/2020 8:55	300.4	9.890	39.80	76.8
M1803-0042	4/13/2018 9:14	299.9	9.826	39.87	77.0
M1803-0042	3/16/2018 11:25	301.9	9.880	39.90	77.0
M1803-0043	10/15/2024 14:09	296.4	9.809	39.67	76.6
M1803-0043	10/15/2024 14:08	296.6	9.812	39.68	76.7
M1803-0043	4/4/2023 10:40	299.6	9.848	39.78	77.0
M1803-0043	10/7/2022 11:31	299.4	9.842	39.56	76.9
M1803-0043	9/29/2022 10:15	299.5	9.840	39.77	77.0
M1803-0043	9/22/2021 10:15	298.8	9.836	39.73	76.9
M1803-0043	9/23/2020 11:40	298.8	9.841	39.73	76.9
M1803-0043	1/27/2020 8:51	299.8	9.840	39.82	77.0
M1803-0043	4/13/2018 9:09	299.2	9.777	39.90	77.2
M1803-0043	3/16/2018 11:28	300.6	9.810	39.92	77.2

A.18 Canadian CS6K-300MS Modules

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1803-0036	10/15/2024 13:50	287.8	9.790	39.12	75.6
M1803-0036	10/15/2024 13:47	287.8	9.792	39.14	75.6
M1803-0036	4/4/2023 11:17	289.6	9.807	39.20	75.8
M1803-0036	10/7/2022 11:55	288.0	9.753	38.95	75.8
M1803-0036	9/22/2021 10:34	286.5	9.781	39.14	75.3
M1803-0036	9/23/2020 11:49	290.2	9.795	39.27	75.9
M1803-0036	1/27/2020 8:31	295.2	9.821	39.46	76.6
M1803-0036	4/10/2018 9:39	297.9	9.793	39.88	76.8
M1803-0036	3/27/2018 10:38	298.1	9.804	39.90	76.7
M1803-0036	3/21/2018 9:38	299.4	9.799	39.96	77.0
M1803-0036	3/14/2018 13:23	299.6	9.827	39.91	76.9
M1803-0037	10/16/2024 11:01	292.2	9.800	39.18	76.6
M1803-0037	10/15/2024 14:26	291.1	9.801	39.15	76.3
M1803-0037	4/4/2023 10:51	293.8	9.839	39.21	76.7
M1803-0037	10/7/2022 12:00	289.3	9.796	38.92	75.9

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1803-0037	9/22/2021 10:19	289.7	9.798	39.15	76.0
M1803-0037	9/23/2020 12:05	290.6	9.800	39.23	76.0
M1803-0037	1/27/2020 8:41	296.1	9.826	39.50	76.8
M1803-0037	4/10/2018 9:36	298.1	9.820	39.83	76.7
M1803-0037	3/27/2018 10:34	298.5	9.821	39.86	76.8
M1803-0037	3/21/2018 9:35	299.5	9.823	39.89	76.9
M1803-0037	3/14/2018 13:27	300.3	9.846	39.87	77.0
M1803-0038	10/15/2024 14:04	284.4	9.780	39.16	74.7
M1803-0038	10/15/2024 14:02	284.2	9.783	39.17	74.6
M1803-0038	4/4/2023 11:01	291.6	9.821	39.20	76.2
M1803-0038	10/7/2022 11:50	287.4	9.750	38.91	75.8
M1803-0038	9/22/2021 10:23	287.2	9.751	39.12	75.8
M1803-0038	9/23/2020 12:00	289.8	9.778	39.23	76.0
M1803-0038	1/27/2020 8:47	295.8	9.774	39.50	77.1
M1803-0038	4/10/2018 9:27	298.2	9.789	39.79	77.0
M1803-0038	3/27/2018 10:41	298.9	9.783	39.87	77.1
M1803-0038	3/21/2018 9:40	300.7	9.795	39.96	77.3
M1803-0038	3/14/2018 13:30	300.3	9.827	39.86	77.1
M1803-0039	10/15/2024 13:57	291.2	9.778	39.03	76.8
M1803-0039	10/15/2024 13:56	291.4	9.780	39.05	76.8
M1803-0039	4/4/2023 11:07	293.5	9.823	39.10	76.9
M1803-0039	10/7/2022 11:58	285.9	9.698	38.72	76.2
M1803-0039	9/22/2021 10:30	285.7	9.726	38.90	76.0
M1803-0039	9/23/2020 11:56	287.5	9.759	39.03	75.9
M1803-0039	1/27/2020 8:37	295.5	9.823	39.35	76.9
M1803-0039	4/10/2018 9:31	297.4	9.807	39.70	76.9
M1803-0039	3/27/2018 10:43	297.3	9.802	39.72	76.8
M1803-0039	3/21/2018 9:42	299.1	9.813	39.80	77.1
M1803-0039	3/14/2018 13:32	298.5	9.836	39.72	76.9

A.19 Panasonic VBHN330 Controls

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1803-0007	10/17/2024 9:41	327.1	6.019	70.30	78.4
M1803-0007	11/16/2023 9:59	327.5	6.024	70.36	78.3
M1803-0007	7/18/2022 11:50	329.9	6.073	70.24	78.4
M1803-0007	9/21/2021 13:30	330.6	6.069	70.33	78.5
M1803-0007	9/23/2020 9:04	331.0	6.077	70.37	78.5
M1803-0007	10/24/2019 9:24	330.4	6.067	70.28	78.5
M1803-0007	4/13/2018 8:54	331.5	6.045	70.58	78.8

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1803-0008	7/18/2022 11:26	329.5	6.075	70.24	78.3
M1803-0008	9/21/2021 13:25	330.1	6.070	70.30	78.4
M1803-0008	9/23/2020 9:11	330.7	6.077	70.36	78.4
M1803-0008	10/24/2019 9:44	330.3	6.069	70.30	78.5
M1803-0008	4/13/2018 9:01	331.2	6.047	70.53	78.7

A.20 Panasonic VBHN330 Modules

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1803-0001	10/17/2024 9:47	322.4	6.032	69.26	78.2
M1803-0001	11/16/2023 9:51	323.1	6.025	69.41	78.3
M1803-0001	7/18/2022 10:26	326.6	6.092	69.45	78.2
M1803-0001	9/21/2021 12:57	329.6	6.085	69.85	78.6
M1803-0001	9/23/2020 9:17	331.3	6.090	70.08	78.7
M1803-0001	10/24/2019 10:03	333.5	6.090	70.32	78.9
M1803-0001	4/10/2018 9:44	331.9	6.051	70.58	78.8
M1803-0001	3/27/2018 10:29	331.8	6.048	70.60	78.8
M1803-0001	3/21/2018 9:31	331.0	6.044	70.53	78.7
M1803-0001	3/14/2018 13:05	329.6	6.050	70.36	78.5
M1803-0002	9/29/2022 15:15	322.3	6.067	69.45	77.5
M1803-0002	7/18/2022 10:45	322.3	6.068	69.45	77.5
M1803-0002	9/21/2021 12:47	325.5	6.070	69.83	77.8
M1803-0002	9/23/2020 9:33	326.5	6.068	70.03	77.9
M1803-0002	10/24/2019 10:28	328.9	6.071	70.28	78.1
M1803-0002	4/10/2018 9:48	330.8	6.029	70.54	78.8
M1803-0002	3/27/2018 10:26	330.4	6.021	70.52	78.9
M1803-0002	3/21/2018 9:25	330.1	6.025	70.47	78.8
M1803-0002	3/14/2018 13:10	328.8	6.029	70.31	78.6
M1803-0005	7/18/2022 10:56	326.1	6.066	69.52	78.4
M1803-0005	9/21/2021 13:13	328.8	6.071	69.82	78.6
M1803-0005	9/23/2020 9:22	330.4	6.067	70.08	78.8
M1803-0005	10/24/2019 10:16	332.9	6.069	70.35	79.0
M1803-0005	4/13/2018 8:48	331.1	6.031	70.53	78.9
M1803-0005	3/16/2018 11:30	329.5	6.027	70.45	78.7
M1803-0006	10/17/2024 10:00	321.9	6.020	69.30	78.2
M1803-0006	11/16/2023 9:29	322.5	6.013	69.40	78.3
M1803-0006	7/18/2022 10:51	326.4	6.073	69.57	78.3
M1803-0006	9/21/2021 13:03	329.5	6.070	69.96	78.7
M1803-0006	9/23/2020 9:28	330.7	6.080	70.11	78.6
M1803-0006	10/24/2019 10:33	333.5	6.080	70.45	78.9

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1803-0006	4/13/2018 9:04	331.7	6.041	70.64	78.8
M1803-0006	3/16/2018 11:34	329.4	6.036	70.44	78.5
M1803-0028	10/17/2024 10:08	325.0	6.028	69.66	78.4
M1803-0028	11/16/2023 9:41	326.1	6.027	69.87	78.5
M1803-0028	6/13/2018 8:59	327.9	5.995	70.41	78.8
M1803-0034	10/17/2024 9:52	324.8	6.034	69.64	78.3
M1803-0034	11/16/2023 9:10	325.7	6.030	69.83	78.4
M1803-0034	6/13/2018 8:49	327.7	5.991	70.40	78.8

A.21 Sunpreme HX-150 Controls

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1812-0010	5/28/2025 13:24	405.7	9.209	54.91	77.2
M1812-0010	3/21/2023 14:59	408.1	9.244	54.92	77.4
M1812-0010	4/20/2022 15:37	410.1	9.272	54.79	77.3
M1812-0010	3/22/2022 10:16	409.3	9.237	55.01	77.5
M1812-0010	9/27/2019 11:06	411.8	9.243	55.00	78.0
M1812-0010	1/18/2019 9:15	408.8	9.210	54.95	77.7
M1812-0011	5/28/2025 13:12	402.4	9.119	54.64	77.7
M1812-0011	3/21/2023 14:35	405.6	9.143	54.70	78.0
M1812-0011	4/21/2022 10:55	404.1	9.122	54.42	78.0
M1812-0011	3/22/2022 10:01	404.8	9.157	54.71	77.8
M1812-0011	9/27/2019 10:49	406.3	9.156	54.69	78.1
M1812-0011	1/18/2019 9:27	403.8	9.129	54.71	77.8

A.22 Sunpreme HX-150 Modules

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1812-0016	4/21/2022 12:51	375.5	8.639	53.97	77.1
M1812-0016	12/19/2018 13:23	409.0	9.252	54.93	77.4
M1812-0018	4/21/2022 11:13	376.8	8.594	54.26	77.4
M1812-0018	12/19/2018 13:00	407.7	9.188	55.03	77.6
M1812-0025	4/21/2022 11:30	378.5	8.667	53.92	77.6
M1812-0025	12/18/2018 13:05	408.6	9.192	54.92	77.9
M1812-0026	4/21/2022 13:03	376.5	8.650	53.82	77.4
M1812-0026	12/18/2018 13:13	403.1	9.166	54.77	77.3
M1812-0030	5/28/2025 13:45	371.5	8.468	54.19	77.9
M1812-0030	3/21/2023 14:14	380.2	8.634	54.41	77.9
M1812-0030	4/21/2022 13:49	382.9	8.628	54.26	78.3
M1812-0030	1/9/2019 9:16	410.9	9.196	55.09	78.1
M1812-0031	5/28/2025 14:10	368.4	8.450	54.12	77.5

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1812-0031	3/21/2023 13:55	374.5	8.570	54.16	77.6
M1812-0031	4/21/2022 13:40	380.0	8.641	54.24	77.6
M1812-0031	1/9/2019 9:35	411.7	9.259	55.06	77.7
M1812-0032	5/28/2025 14:04	371.8	8.429	54.28	78.2
M1812-0032	3/21/2023 10:32	377.5	8.530	54.33	78.4
M1812-0032	4/21/2022 13:31	382.7	8.576	54.41	78.5
M1812-0032	1/9/2019 9:27	412.7	9.130	55.23	78.8
M1812-0033	5/28/2025 13:56	367.0	8.414	54.08	77.6
M1812-0033	3/21/2023 9:42	373.7	8.551	54.17	77.6
M1812-0033	4/21/2022 13:22	378.9	8.632	54.15	77.7
M1812-0033	1/9/2019 9:22	409.2	9.203	55.06	77.7

A.23 LONGi Bifacial Controls

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M2003-0001	10/21/2025 9:49	362.9	9.611	48.16	78.4
M2003-0001	10/17/2025 11:42	362.4	9.614	48.13	78.3
M2003-0001	3/29/2024 13:12	361.7	9.583	48.14	78.4
M2003-0001	6/29/2022 14:10	365.3	9.680	48.16	78.4
M2003-0001	4/20/2022 16:15	365.3	9.677	47.89	77.3
M2003-0001	3/22/2022 11:23	365.4	9.673	48.15	78.4
M2003-0001	3/22/2022 11:19	365.7	9.678	48.17	78.4
M2003-0001	8/5/2020 12:10	365.2	9.674	48.14	78.4
M2003-0002	10/21/2025 9:35	361.6	9.608	48.03	78.3
M2003-0002	10/17/2025 11:22	361.4	9.610	48.03	78.3
M2003-0002	6/29/2022 14:19	364.9	9.672	48.11	78.4
M2003-0002	4/20/2022 15:59	364.3	9.672	47.79	77.3
M2003-0002	3/22/2022 11:13	364.2	9.675	48.03	78.4
M2003-0002	3/22/2022 11:12	364.4	9.677	48.04	78.4
M2003-0002	8/5/2020 11:46	364.0	9.668	48.03	78.4

A.24 LONGi Bifacial Modules

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M2003-0006	6/29/2022 15:28	362.4	9.627	47.97	78.5
M2003-0006	8/6/2020 12:49	363.7	9.662	47.97	78.5
M2003-0011	10/21/2025 10:13	357.4	9.513	47.87	78.5
M2003-0011	10/17/2025 11:59	357.4	9.513	47.89	78.5
M2003-0011	6/29/2022 14:29	363.0	9.607	48.07	78.6
M2003-0011	8/13/2020 11:00	365.0	9.647	48.09	78.7

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M2003-0012	10/21/2025 10:33	357.5	9.527	47.91	78.3
M2003-0012	10/17/2025 12:15	357.6	9.527	47.95	78.3
M2003-0012	6/29/2022 14:48	362.8	9.615	48.07	78.5
M2003-0012	8/13/2020 13:55	364.9	9.677	48.05	78.5
M2003-0014	10/21/2025 11:08	356.5	9.501	47.86	78.4
M2003-0014	10/17/2025 12:37	356.8	9.503	47.92	78.4
M2003-0014	3/29/2024 13:22	357.1	9.485	47.99	78.5
M2003-0014	6/29/2022 15:15	362.7	9.604	48.09	78.5
M2003-0014	8/13/2020 14:26	364.9	9.656	48.08	78.6
M2003-0016	6/29/2022 15:37	363.1	9.627	48.08	78.4
M2003-0016	7/30/2020 10:38	365.7	9.682	48.14	78.5
M2003-0019	10/21/2025 10:49	358.2	9.539	47.87	78.4
M2003-0019	10/17/2025 12:28	358.4	9.538	47.92	78.4
M2003-0019	6/29/2022 15:05	363.3	9.623	48.04	78.6
M2003-0019	7/30/2020 9:31	365.5	9.659	48.10	78.7
M2003-0019	7/30/2020 9:30	365.7	9.664	48.12	78.6
M2003-0024	6/29/2022 15:52	362.5	9.647	47.94	78.4
M2003-0024	7/30/2020 10:07	365.9	9.690	48.10	78.5
M2003-0025	6/29/2022 15:44	362.9	9.634	47.96	78.5
M2003-0025	7/30/2020 10:28	364.8	9.659	48.01	78.7

A.25 LONGi Monofacial Controls

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1901-0001	10/23/2025 9:55	352.6	9.626	46.97	78.0
M1901-0001	3/28/2024 8:51	351.1	9.588	46.95	78.0
M1901-0001	6/29/2022 10:52	355.6	9.710	46.98	77.9
M1901-0001	12/12/2019 10:43	359.1	9.740	47.25	78.0
M1901-0001	1/24/2019 13:59	363.7	9.773	47.62	78.1
M1901-0002	10/23/2025 9:42	351.2	9.581	46.94	78.1
M1901-0002	6/29/2022 11:04	357.1	9.720	47.15	77.9
M1901-0002	12/12/2019 10:54	358.0	9.716	47.24	78.0
M1901-0002	1/24/2019 14:10	364.4	9.746	47.75	78.3

A.26 LONGi Monofacial Modules

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1901-0003	10/23/2025 10:35	363.1	9.737	47.81	78.0
M1901-0003	6/29/2022 12:59	366.5	9.807	47.84	78.1
M1901-0003	2/8/2019 11:11	370.5	9.791	48.12	78.6
M1901-0004	10/23/2025 10:12	362.9	9.764	47.84	77.7
M1901-0004	3/28/2024 8:44	362.6	9.741	47.84	77.8
M1901-0004	6/29/2022 12:55	366.3	9.848	47.84	77.8
M1901-0004	12/12/2019 10:24	368.2	9.848	47.97	77.9
M1901-0004	2/8/2019 11:06	369.3	9.836	48.03	78.2
M1901-0005	10/23/2025 10:04	349.5	9.552	47.10	77.7
M1901-0005	6/29/2022 13:21	355.7	9.720	47.22	77.5
M1901-0005	12/12/2019 10:33	360.3	9.751	47.48	77.8
M1901-0005	2/8/2019 10:52	359.6	9.738	47.40	77.9
M1901-0006	10/23/2025 10:27	356.6	9.661	47.45	77.8
M1901-0006	6/29/2022 13:06	361.3	9.749	47.53	78.0
M1901-0006	2/8/2019 10:35	364.5	9.745	47.70	78.4

A.27 REC 400W SHJ Controls

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M2301-0011	4/25/2025 11:19	388.0	9.953	48.64	80.9
M2301-0011	1/12/2023 8:24	389.2	9.931	48.79	81.1
M2301-0012	4/25/2025 11:35	386.6	9.972	48.61	80.5
M2301-0012	1/12/2023 8:09	388.6	9.944	48.75	80.9

A.28 REC 400W SHJ Modules

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M2301-0015	4/25/2025 10:56	364.5	9.829	47.14	79.4
M2301-0015	7/25/2023 13:54	391.0	9.973	48.73	81.2
M2301-0016	4/25/2025 10:05	364.8	9.764	47.05	80.1
M2301-0016	7/25/2023 14:02	392.5	9.965	48.72	81.6
M2301-0017	4/25/2025 11:12	362.8	9.774	46.93	79.8
M2301-0017	7/25/2023 14:11	389.5	9.950	48.64	81.2
M2301-0018	4/25/2025 10:44	368.1	9.828	47.26	80.0
M2301-0018	7/25/2023 14:19	392.6	9.984	48.74	81.4

A.29 Solaria 400W PERC Controls

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M2302-0031	5/13/2025 12:02	391.1	13.210	37.21	79.5
M2302-0031	8/24/2023 13:05	387.8	13.107	37.23	79.5
M2302-0032	5/13/2025 11:21	390.4	13.189	37.21	79.6
M2302-0032	8/24/2023 13:20	387.6	13.097	37.23	79.5

A.30 Solaria 400W PERC Modules

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M2302-0045	5/13/2025 11:06	374.5	13.004	36.36	79.2
M2302-0045	9/14/2023 12:48	386.3	13.097	37.18	79.3
M2302-0046	5/13/2025 11:02	374.4	12.984	36.35	79.3
M2302-0046	9/14/2023 12:56	387.5	13.076	37.22	79.6
M2302-0047	5/13/2025 11:11	375.6	13.014	36.40	79.3
M2302-0047	9/14/2023 13:00	387.4	13.086	37.20	79.5
M2302-0048	5/13/2025 10:55	373.3	12.984	36.27	79.3
M2302-0048	9/14/2023 13:06	386.9	13.066	37.19	79.6

A.31 REC 360W TOPCon Controls

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M2304-0012	5/6/2025 10:01	358.2	11.144	40.84	79.1
M2304-0012	5/11/2023 10:06	360.6	11.175	40.86	79.3
M2304-0013	5/6/2025 10:16	358.6	11.144	40.89	79.1
M2304-0013	5/11/2023 14:22	361.5	11.175	40.90	79.4

A.32 REC 360W TOPCon Modules

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M2304-0024	5/6/2025 9:09	355.0	11.000	40.95	79.2
M2304-0024	8/31/2023 10:45	354.3	11.010	40.92	79.1
M2304-0025	5/6/2025 9:40	355.5	11.000	40.93	79.3
M2304-0025	8/31/2023 10:41	354.7	11.021	40.90	79.1
M2304-0026	5/6/2025 9:24	355.0	11.000	40.93	79.2
M2304-0026	8/31/2023 10:02	354.1	11.021	40.90	79.0
M2304-0027	5/6/2025 9:49	356.4	10.979	40.99	79.6
M2304-0027	8/31/2023 10:23	355.6	10.990	40.97	79.3

A.33 Prism BN72 360W Bifacial Controls

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1905-0005	3/13/2024 10:57	344.3	9.330	47.90	77.2
M1905-0005	6/16/2022 15:34	343.0	9.237	47.82	77.4
M1905-0005	3/10/2022 12:55	345.2	9.312	47.99	77.4
M1905-0005	3/9/2020 13:46	351.2	9.453	48.09	77.4
M1905-0005	7/31/2019 9:30	353.0	9.460	48.15	77.6
M1905-0006	6/20/2022 14:39	340.6	9.164	47.73	77.6
M1905-0006	6/16/2022 15:17	339.4	9.237	47.66	76.9
M1905-0006	3/9/2020 13:37	351.2	9.459	48.01	77.5
M1905-0006	7/31/2019 9:38	352.2	9.456	48.07	77.6

A.34 Prism BN72 360W Bifacial Modules

NLR ID	Timestamp	Adjusted Pmp (W)	Adjusted Isc (A)	Voc (V)	FF
M1905-0011	6/20/2022 16:52	332.2	9.117	46.89	77.5
M1905-0011	7/31/2019 10:30	349.0	9.471	47.92	77.1
M1905-0012	6/20/2022 16:46	329.9	9.098	46.60	77.6
M1905-0012	7/31/2019 13:16	344.0	9.404	47.28	77.5
M1905-0013	6/20/2022 16:01	331.6	9.142	46.81	77.3
M1905-0013	7/31/2019 12:43	353.4	9.494	48.20	77.4
M1905-0016	6/20/2022 16:13	334.3	9.156	46.97	77.5
M1905-0016	7/31/2019 10:49	354.9	9.499	48.21	77.7
M1905-0020	6/20/2022 15:24	335.1	9.185	46.95	77.5
M1905-0020	3/10/2022 13:38	338.9	9.343	47.19	77.0
M1905-0020	3/10/2022 13:36	338.9	9.340	47.19	77.0
M1905-0020	7/31/2019 11:27	353.9	9.502	48.09	77.6
M1905-0022	3/13/2024 11:11	333.2	9.320	46.64	76.8
M1905-0022	6/20/2022 15:04	331.3	9.164	46.63	77.3
M1905-0022	3/10/2022 14:05	334.4	9.295	46.83	77.0
M1905-0022	7/31/2019 11:21	346.3	9.482	47.47	77.1
M1905-0025	6/20/2022 16:24	326.4	9.164	46.35	76.6
M1905-0025	7/31/2019 10:15	352.5	9.522	48.15	77.0