NEP RSD

NORTHERN ELECTRIC

September, 2023
Rapid Shutdown Solutions
NEP CONFIDENTIAL

www.northernep.com

Who is NEP

Northern Electric Power Technology Inc (NEP) was founded in the USA and has a 13 year history of developing advanced solar power conversion solutions. We have shipped of our microinverter and rapid shutdown MLPE products to customers in over 35 countries.

NEP has a relentless focus on safety, reliability, cost efficiency and customer focused innovation.

NEP is legally formulated in America as a Benefit Corporation striving for human and shareholder value.

Silicon Valley, CA headquarters, advanced engineering, exec team, finance
Operations and product development in Asia

Experienced Leadership Team

Ed, Jing, Fan; American and majority owners of NEP

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Strong Cross-Functional USA Team

Est. 20 Staff in the USA

Jake LeVitre

General Manager of North America

Jake has experience in distribution
knowledge in data structures. Jake
strategies to optimize supply chain

John "Gino" Espino

Director of Commerical Sales

John is well-versed with many years
development, strategic planning, an
energy industry.

Mark Hudspeth

Regional Sales Manager

South/Southeast

Mark has been in the Solar industry
operations, project management, ar
their business by providing the best

Felicia Yang

Customer Operations Ma

Felicia has worked in cust
in these areas, makes her

Wendy Yang

Customer Operations Ass

Wendy has worked in logi
years. Her experience and
mission.

Sarah Li

Inside Sales & Marketing

Sarah has built up a wealt
cellular phone stores in h
promotions makes her a

Jacob Benzaquen

Product Manager

Jacob has over 3 years of experie
about helping customers transitio
products that make it easier for p

George Vuduc

Technical Support Lead

George has extensive experience
UPS companies. Also, he has spe
George was instrumental in buildi
engineers.

Zach Kiebler

Technical Support Lead EC

Zach has 10 years of residential s
excited to work with installers an
RSD monitoring. In his downtime,

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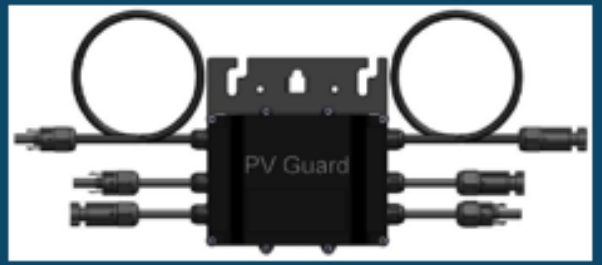
MLPE over 10 years

Microinverters	Rapid Shutdown
	
Residential Single and Dual Data monitoring Global	Residential, Commercial Single, Dual, Triple Data monitoring USA and emerging markets

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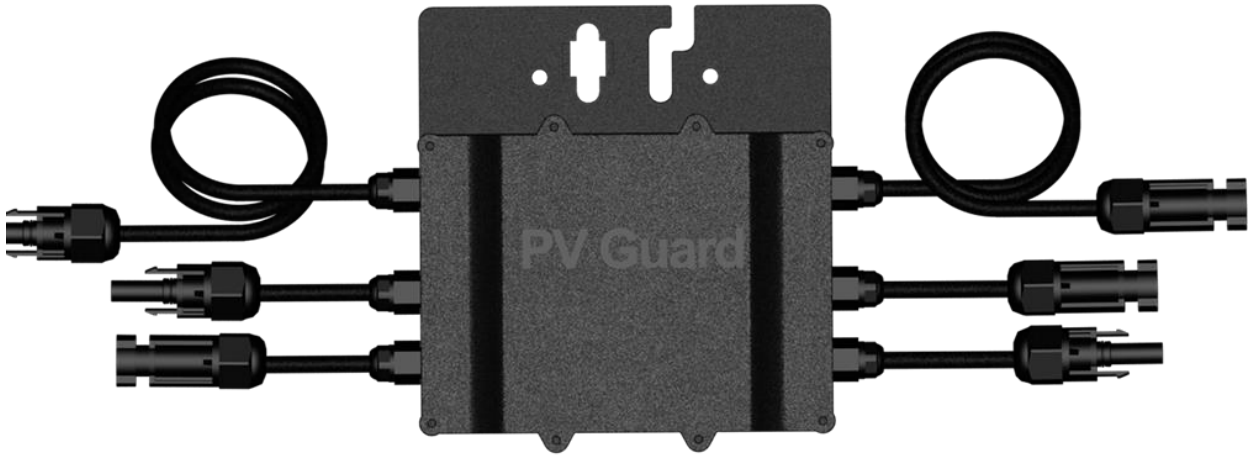
PVG-2-L
PVG-3-L



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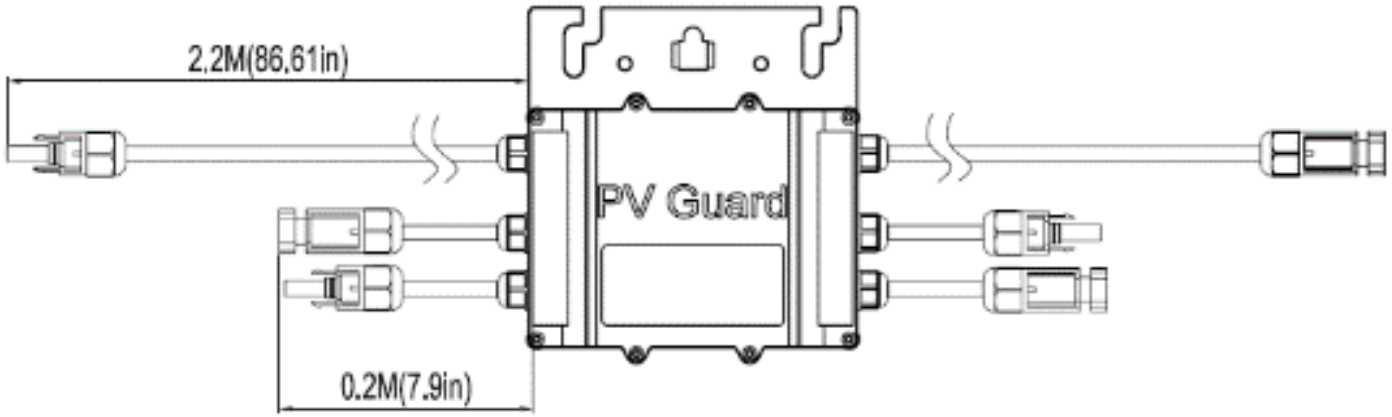
Specification
eg. PVG-2-L



INPUT(DC)	Max DC Open Circuit Voltage per Input (Vdc)	90
	Max DC Current per input (Adc)	15 / 20
OUTPUT(DC)	Maximum Output Voltage (Vdc)	Voc * n (n=1/2/3/4)
SYSTEM	Maximum System Voltage (Vdc)	1500
MECHANICS	PV Cable	12AWG
	PV Connectors	Mc4 (Contact NEP for other connectors options)
	Size (not including PV cable)	5.12' x 4.73' x 1. 14' (PVG-1) 5.90' x 5.71' x 1. 00' (PVG-2)
	Protection Degree	NEMA 6
	Operating Ambient Temperature	-40°C--+85°C
	Mounting Method	Rail, Frame (option)
SIGNAL	Communications	DC Power Line
CERTIFICATION	Product Safety Compliance	UL 1741 CSA C22.2 No. 107.1 NEC 2014/2017 690.12 Canada CEC 2015 64-218

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Comparisons

	NEP RSD	Other RSD
Communication	Two way PLC	One way
Crosstalk Avoidance	YES	NO
I-V Curve Test	YES	VERY DIFFICULT
Remote Trouble Shooting/Monitoring	YES	NO

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PVG vs Optimizer

	NEP PVG	Optimizer
Communication	Two-way	Two-way
Module level monitoring	Yes	Yes
Component count	less	more
Mean Time Between Failure	better	worse
Over heating	almost no heat	Yes
Efficiency	> 99.8%	low
Reliability (topology complexity)	high	low
Module Level MPPT Function	No	Yes
Price	much lower	high
System flexibility	Yes	No

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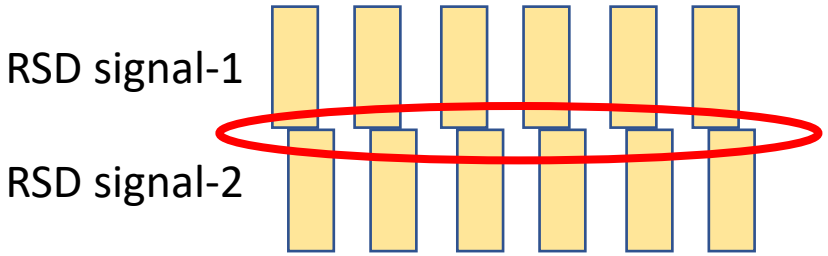
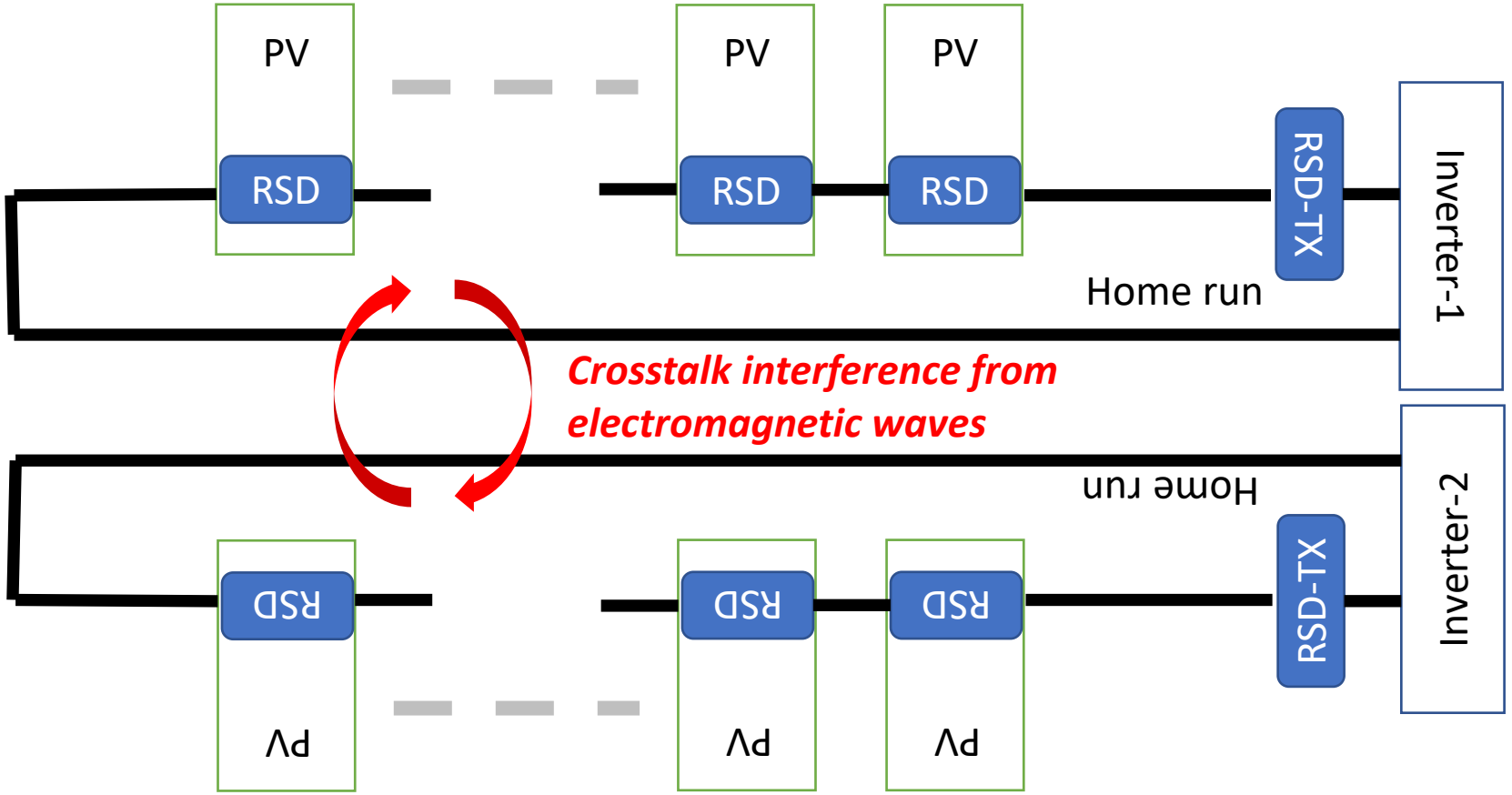
Crosstalk
Root cause



Crosstalk interference jam the signal

<u>UNCONTROLLED</u> on/off



Cross-Talk Challenge

Multi-Strings
In Conduits

Challenging
Application

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Retrofit to NEP

Crosstalk Hazard

Our peers RSD has severe cross talk issue

=> Crosstalk interference can cause UNCONTROLLED on/off of PV panels

=> Damaged RSD, Lower/unbalanced output

=> force installers to conduit one set of cables per inverter

=> many more steel pipes, much more space and much more expensive

Can RSD signal be synchronized?

=> Additional cable to connect all RSD transmitters requires more labors

=> Sync control signal delay due to transmission and processing

=> Most importantly, phase delay due to inductance of long PV cable can counter impact the synchronization of the transmitters

CONCLUSION: Simple 1-bit RSD signal cannot eliminate crosstalk

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Crosstalk Avoidance

Unique protocol for crosstalk avoidance

Allows installers to put multiple sets of inverter cables into one conduit

Save space, save time and save money

Proprietary advanced signal processing and error control coding technique

No additional hardware. NEP 2-way communications between transmitter and RSD devices ensures a firm data/control ‘handshake’

Retrofit to NEP
Duke Energy Site
Colorado

US patent pending

IV Curve Trace Mode

Unique function for IV Curve tracing

PVG switch can be set as open or closed

This function allows third party curve tracer measurements

This function can save commissioning time

Demonstration at AGT Site

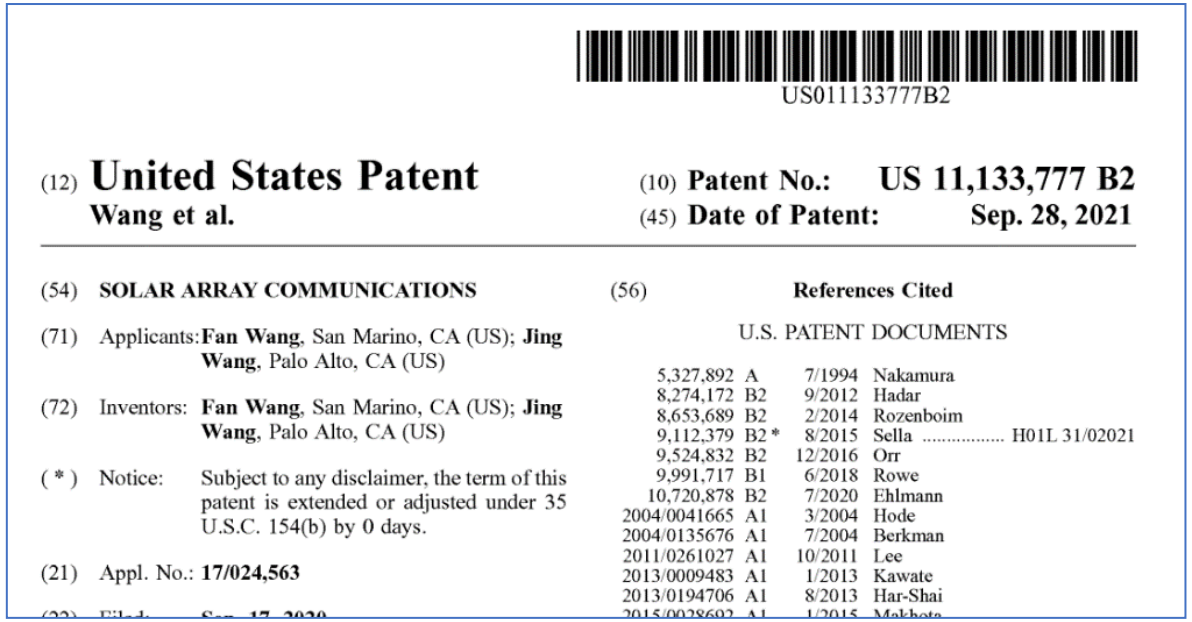
Jointly with SEAWARD Florida

US Patent Coverage

IV curve trace test

RSD System Device Level Monitoring

Cross talk avoidance



US011133777B2

(12) **United States Patent**
Wang et al.

(10) **Patent No.: US 11,133,777 B2**
(45) **Date of Patent: Sep. 28, 2021**

(54) **SOLAR ARRAY COMMUNICATIONS**

(71) Applicants: **Fan Wang**, San Marino, CA (US); **Jing Wang**, Palo Alto, CA (US)

(72) Inventors: **Fan Wang**, San Marino, CA (US); **Jing Wang**, Palo Alto, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **17/024,563**

(56) **References Cited**

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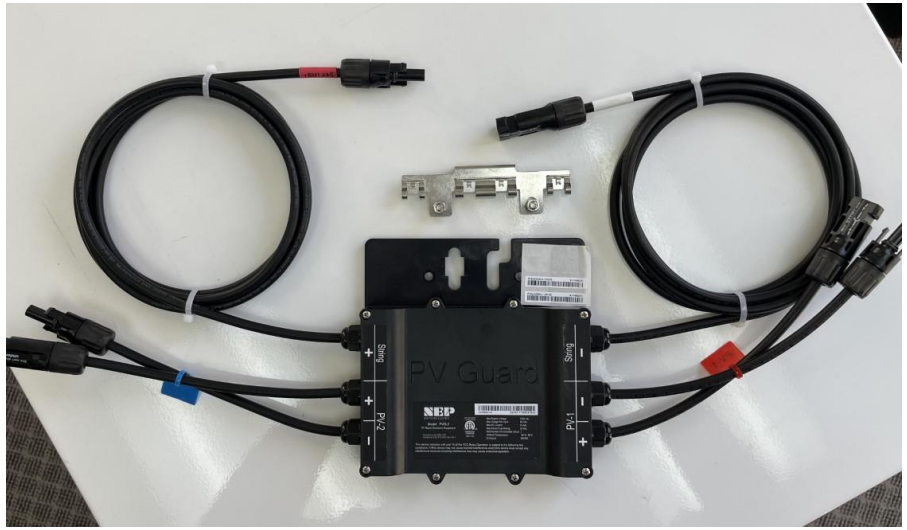
Mounting

Rail or PV Frame(Clip) Mount



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Fail Safe

PVEL test report is available

Extra protection for heat dissipation and protection over the plastic case

An RSD was subjected to a localized flame in order to observe the RSD's response to a flame. Throughout the test, the RSD continued to operate even while the plastic enclosure of the RSD was burning.

Upon removal the of the flame source, the plastic enclosure quickly stopped burning.

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Third Party Evaluation

2 Test Plan Overview

This report outlines the TC200 reliability test and thermal shutdown validation test performed on the NEP PVG-2-L MLRSD. The testing sequence aims to validate the MLRSD's performance over the reliability and validation tests to better understand operational advantages, while providing design feedback and supporting data sets on design and performance deficiencies.

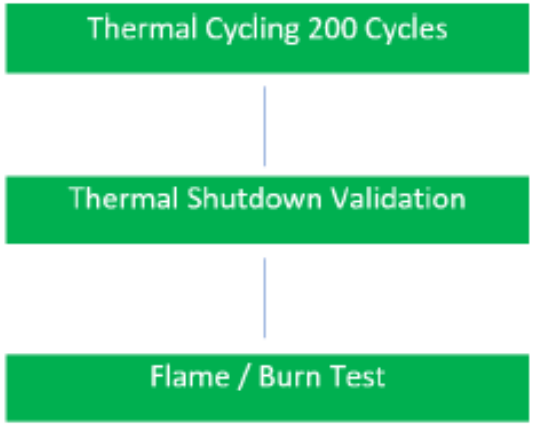

Figure 2-1: Test plan process diagram

This evaluation focuses on a series of indoor (laboratory) tests to monitor the RSDs' capability to remain operational throughout the thermal cycling accelerated age testing profile as well as to validate the RSDs' ability to shut down upon an over temperature event. An explanation of each test is provided along with a description of the setup, equipment used to evaluate the results, and a short analysis of the inverter's performance.

PVEL

Final Engineering Report

Northern Electric Power Co.

MLRSD Testing

Report No. R8271A-1
Date: 27 April 2022

Rigorous Testing
for Reliability

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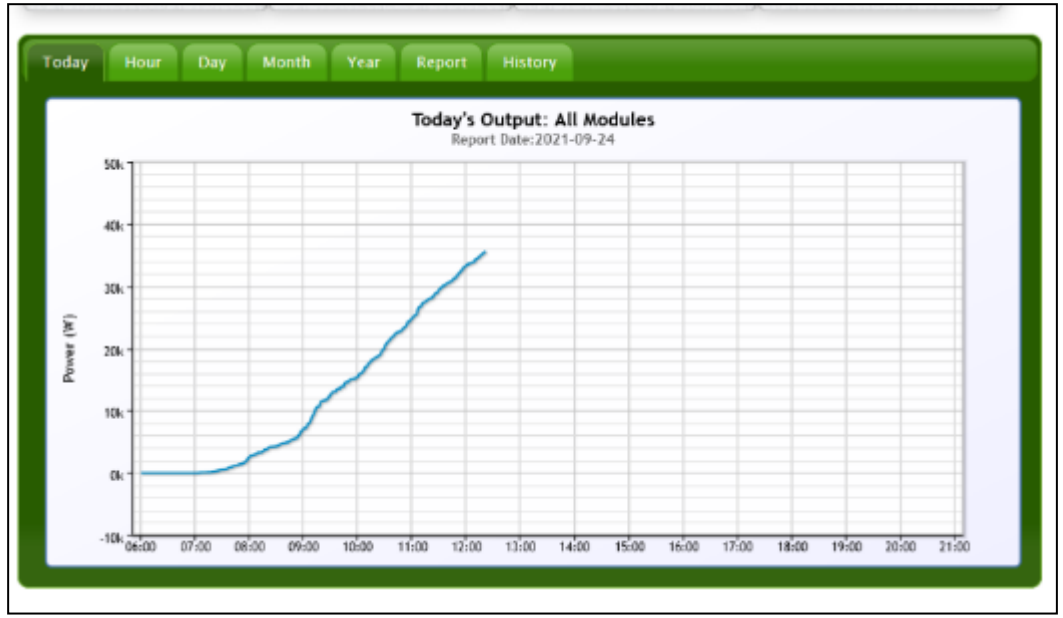
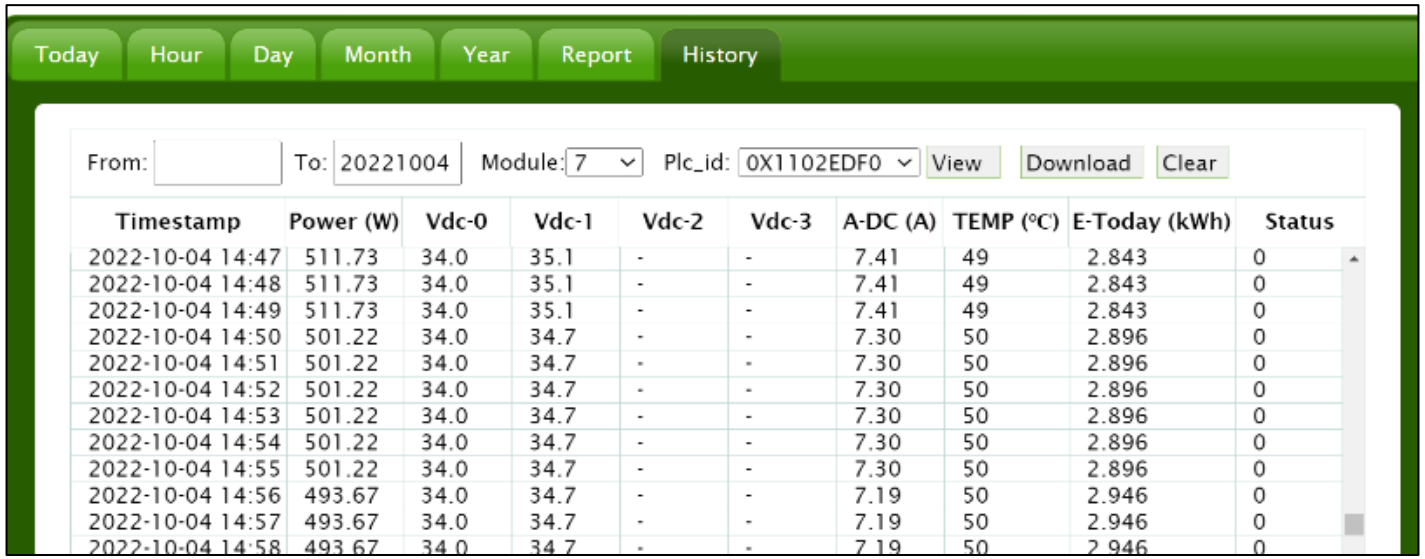
PVG
Field Data



PVG-2
Field Data - Temperature



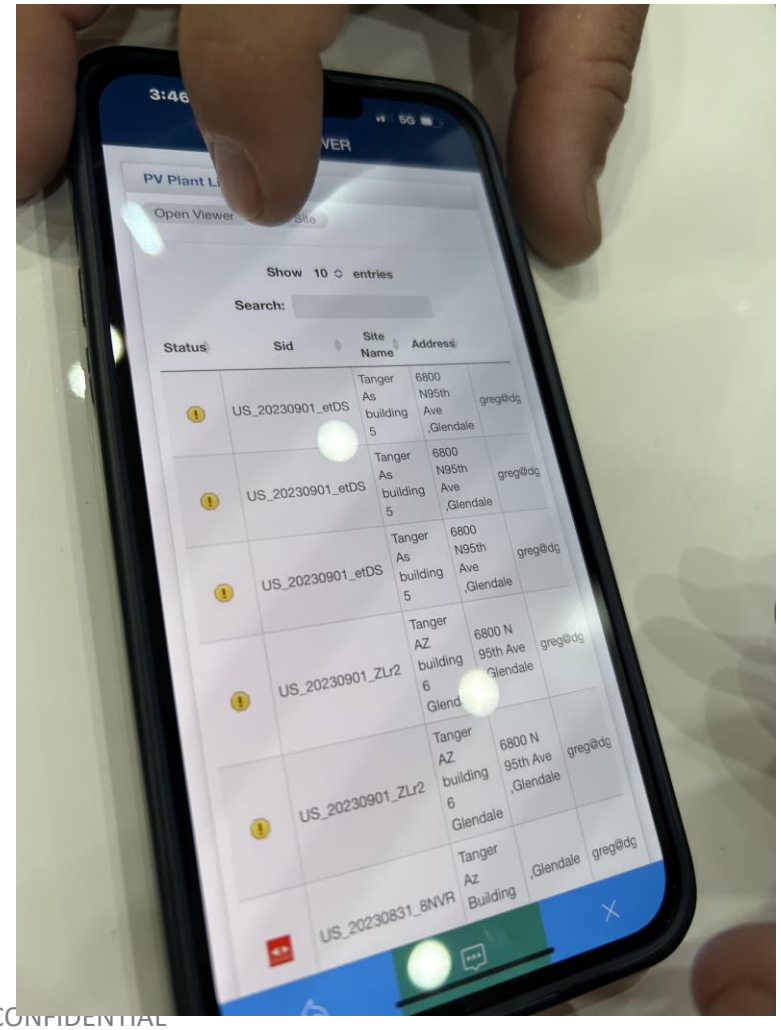
Timestamp	Power (W)	Vdc-0	Vdc-1	Vdc-2	Vdc-3	A-DC (A)	TEMP (°C)	E-Today (kWh)	Status
2022-10-04 14:47	511.73	34.0	35.1	-	-	7.41	49	2.843	0
2022-10-04 14:48	511.73	34.0	35.1	-	-	7.41	49	2.843	0
2022-10-04 14:49	511.73	34.0	35.1	-	-	7.41	49	2.843	0
2022-10-04 14:50	501.22	34.0	34.7	-	-	7.30	50	2.896	0
2022-10-04 14:51	501.22	34.0	34.7	-	-	7.30	50	2.896	0
2022-10-04 14:52	501.22	34.0	34.7	-	-	7.30	50	2.896	0
2022-10-04 14:53	501.22	34.0	34.7	-	-	7.30	50	2.896	0
2022-10-04 14:54	501.22	34.0	34.7	-	-	7.30	50	2.896	0
2022-10-04 14:55	501.22	34.0	34.7	-	-	7.30	50	2.896	0
2022-10-04 14:56	493.67	34.0	34.7	-	-	7.19	50	2.946	0
2022-10-04 14:57	493.67	34.0	34.7	-	-	7.19	50	2.946	0
2022-10-04 14:58	493.67	34.0	34.7	-	-	7.19	50	2.946	0

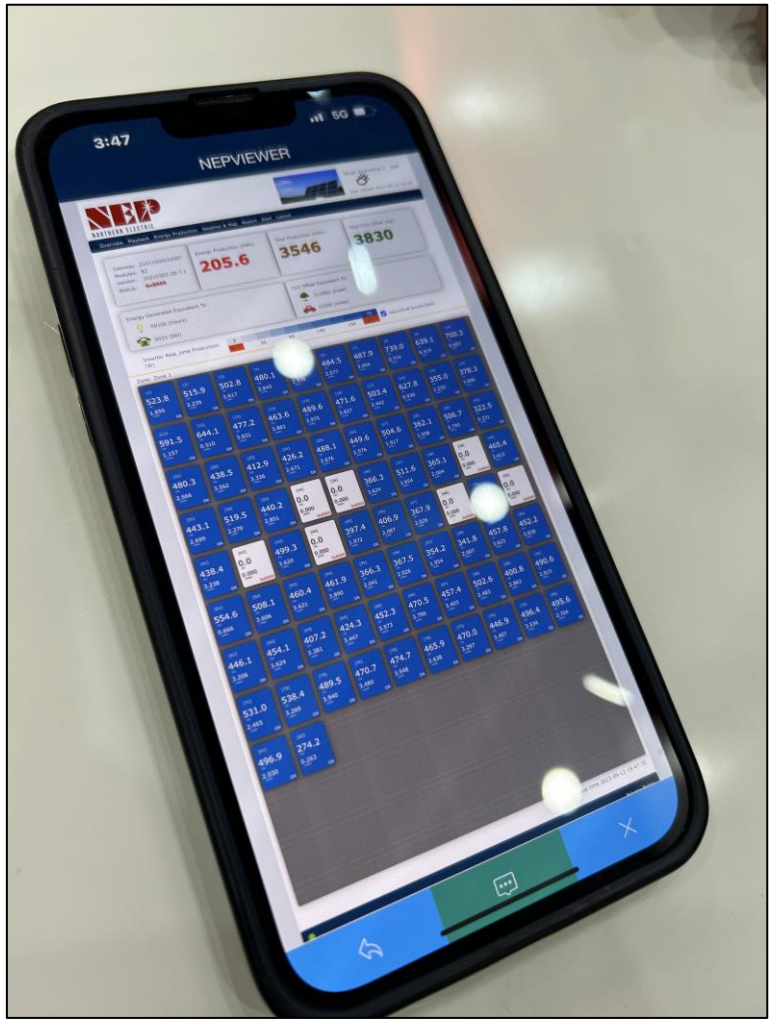
Panel Level monitoring

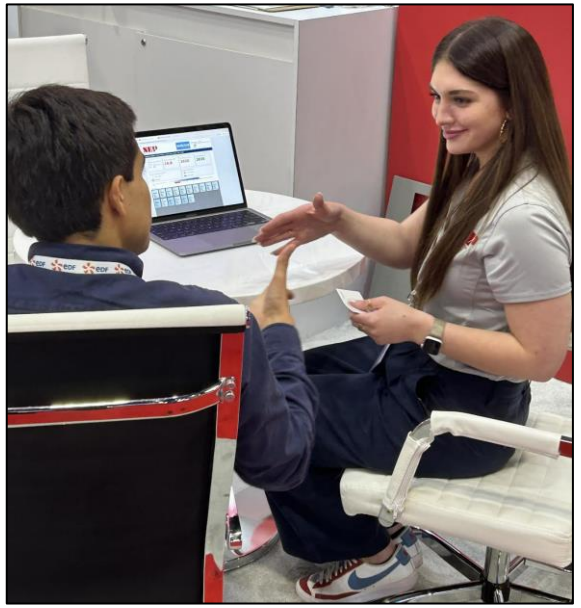
- Each panel real-time voltage
- String current
- Real-time Temperature
- Alert

Site and PV Data

Tools and People for site performance







People you can Count On

Challenge Us !

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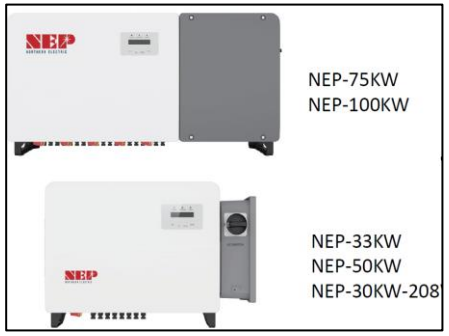
Supplements

See Also

NEPTUNE – 3-phase inverters

https://northernep.com/products/3-phase-inverters/



Galaxy – Data-comm for inverters and RSD

https://northernep.com/wp-content/uploads/2023/09/NEP-NEPTUNE-Galaxy-Data-Comms-Solution-Sept-2023.pdf