

# PathWave Advanced Power Application Suite

PathWave Advanced Power Application Suite is a Comprehensive Software Solution that Seamlessly Integrates Three Separate Applications into One Unified Platform

## Introduction

The Keysight PathWave Advanced Power Application Suite (PW9254A) consolidates PW9251A PathWave IV Curve Measurement Software, PW9252A PathWave Advanced Power Control and Analysis, and PW9253A PathWave Advanced Battery Test and Emulation into a unified PathWave software solution, enhancing usability and accelerating development cycles for future products.



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PATHWAVE

# PW9254A

PathWave Advanced Power Application Suite Bundle License

PW9254A is a 3-in-1 bundle license. The PW9254A bundle license activates the following software:

1. PW9251A Pathwave IV Curve measurement software
2. PW9252A PathWave Advanced Power Control and Analysis
3. PW9253A PathWave Advanced Battery Test and Emulation

## Key Benefits

- Easily and quickly transfer data in real time between PW9252A and PW9253A software application within a click.
- Experience using PW9251A, PW9252A and PW9253A software simultaneously.

# PW9251A

## Pathwave IV Curve Measurement Software

PathWave IV Curve is a powerful GUI software designed to simplify and accelerate the process of performing synchronous current-voltage (IV) measurements. With a user-friendly interface, the software enables researchers, engineers, and developers to perform IV measurements without any programming knowledge.



## Synchronous Current-Voltage (IV) Measurements with Graphical Results

The PathWave IV curve is ready-made GUI software that enables the performance of a variety of synchronous current-voltage (IV) measurements on up to 40 channels, depending on the number of licenses purchased. Each license connects to one instrument, supporting up to 10 instruments max, all without requiring programming. Various analysis functions on graphs and tables allow users to review test results immediately after the measurement. Export functions of graphs with markers and tables support efficient reporting. Additionally, the test result files contain all the necessary settings, enabling users to review and repeat the test accurately.

The PathWave IV curve accelerates your research, development, and design verification, increasing productivity and enabling more accurate and reliable data acquisition, as well as a more efficient use of the equipment.

## Key Features

- Easily and quickly performing synchronous current-voltage (IV) measurements without programming
- Immediately reviewing test results on graphs with markers and tables
- Efficiently making reports or post-processing by exporting graphs in image files and tables in CSV files
- Easily repeating/reviewing the test result by loading/saving the test results with the entire test setups
- Experience the full range of the application's capabilities without the need for a software license by previewing its features in Demo Mode
- Includes API functions to facilitate integration into your programming environment

## Powerful Setup Menu for Maximum Flexibility

The setup menu enables you to specify and preview settings on multiple SMU channels before performing a measurement, providing flexibility and ease of setting up the SMU channels.



Figure 1. Previewing the settings of multiple SMU channels

# Improve Efficiency with the Built-In Graph Function

The built-in graph function supports both basic and advanced features, allowing for the immediate review of test results through graphs with markers.

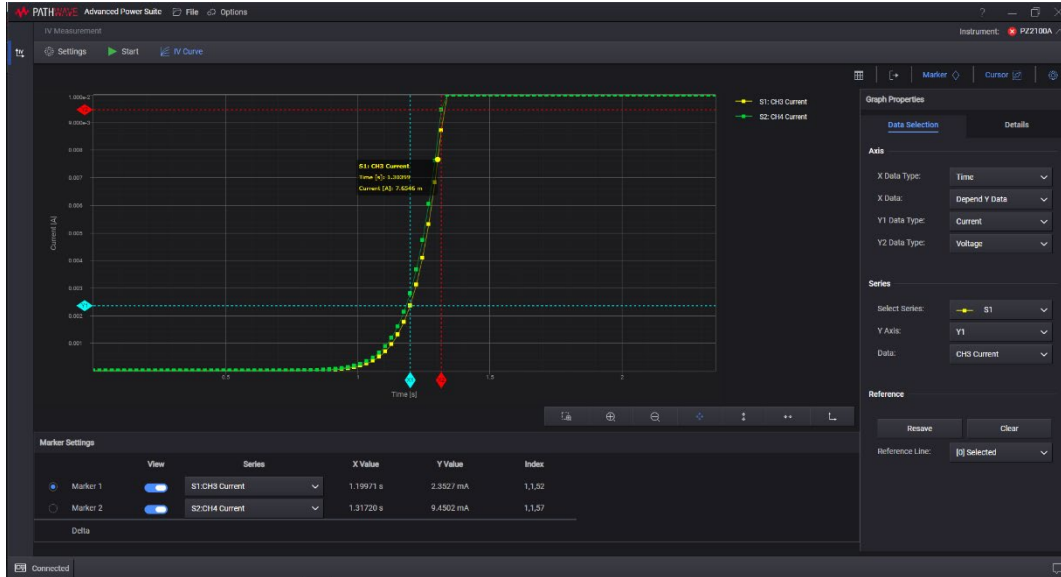


Figure 2. Reviewing test results through graphs with markers

# Post-Processing at Ease

View numerical measurement results in a table format. You can easily export this data into an Excel spreadsheet for post-analysis.

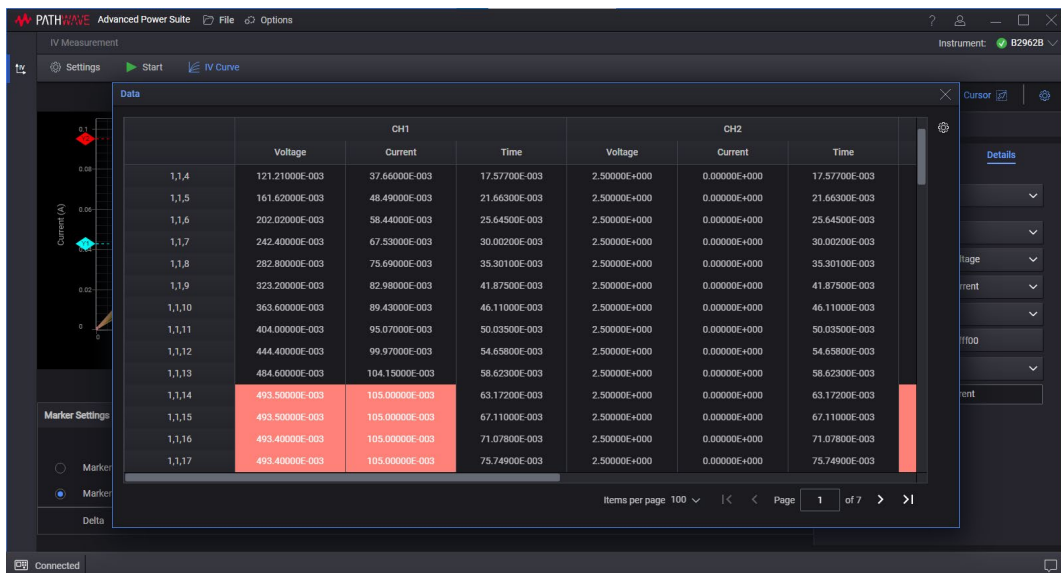


Figure 3. Viewing measurement results in a table format and easily exporting the data into an Excel spreadsheet for post-analysis.

# Supported Models

Series	Models / Modules
B2900 Series Precision Source / Measure Units (SMU)	B2901A, B2902A, B2911A, B2912A, B2961A, B2962A, B2901B, B2901BL, B2902B, B2910B, B2911B, B2912B, B2961B, B2962B, B2901C, B2902C, B2901CL, B2910CL, B2911C, B2912C.
PZ2100A High-Density Precision SMU Mainframe	PZ2120A, PZ2121A, PZ2130A, PZ2131A, PZ2110A, RP7971A, RP7981A

## PW9252A

### PathWave Advanced Power Control and Analysis

#### Introduction

The PW9252A PathWave Advanced Power Control and Analysis from Keysight Technologies are advanced tools designed for easy access to sophisticated sourcing and measurement capabilities in the N6705 DC power analyzer, RP7900 Series Regenerative Power System, Advanced Power System (APS) N7900 Series power supplies, and E36150 Series DC Bench Power Supply.



# Easily Access Your Power Supply's Advanced Sourcing and Measurement Features

The Keysight Technologies PW9252A PathWave Advanced Power Control and Analysis software for advanced power supplies was designed to provide quick and easy access to the advanced sourcing and measurement features of your N6705 DC power analyzer, RP7900 Series Regenerative Power System, RP5900 Series Regenerative Power Supplies, EL4900 Series Regenerative Electronic Loads, and/or Advanced Power System (APS) N7900 Series power supplies without any programming. It can control any of the more than thirty-six DC power modules in the N6700 family when installed in a N6705 mainframe, any of the twenty-three models of the RP7900 Series, any of the twelve models of the RP5900 series and the EL4900 series, ninety-two models of the DP5700 series DC power supplies, and the twelve models of advanced power supplies in the N7900 series. When used to control an N6781A SMU, it supports advanced battery drain analysis applications. PW9252A also allows RP7900 Series operation in primary/secondary mode, making it easy to configure parallel units for higher output current. Depending on the number of licenses purchased, each license lets you connect to one instrument, supporting up to ten instruments simultaneously.

## Compare Features

### N6705 DC Power Analyzer

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- Complements the N6705 DC power analyzer's front panel controls
- Controls and analyzes data up to ten units N6705 DC power analyzer mainframes and any installed modules at once – that's up to forty power supplies simultaneously
- Controls any of the more than thirty-six units of N6700 DC power modules when installed in the N6705 DC power analyzer

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- Integrate software functions into the user's programming environment via API (Automation Programming Interface)
  - Control any combination of four N6705, N7900 or RP7900 models
  - Four modes of operation: scope (short-term waveform capture), data logger (long-term waveform capture), CCDF (statistical analysis), and ARB (waveform creation)
  - Enhanced control and analysis of data – use familiar PC controls and a large display
  - Graphical user software – no programming required
  - Accurately capture current drain measurements from seconds to days at up to 200,000 measurements per second (in scope mode) directly to a PC
  - Advanced marker readout (min, avg, max, RMS, peak-to-peak, charge/energy)
  - Easily create complex waveforms to stimulate or load a DUT by inputting a formula, choosing from built-in waveforms, or importing waveform data
  - Data log measurements directly to a PC and easily export data to a Microsoft Excel spreadsheet or text file
  - Capture a waveform, then "play" it back – use scope or data logger to capture a waveform, then use the power supply's source/sink function to reproduce it
  - Apply mathematical functions to waveforms
  - Name and choose colors for waveform traces for easy identification
  - Perform statistical analysis (CCDF) of power consumption
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### N7900 Series Advanced Power Supplies DP5700 Series DC Power Supplies RP7900 Series Regenerative Power System RP5900 Series Regenerative DC Power Supplies EL4900 Series Regenerative DC Electronic Loads

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- Provides easy access to the advanced features of the N7900, DP5700, RP7900, RP5900 or EL4900 series power supplies without any programming
- Controls and analyzes data up to ten power supplies

# Control

Access all the features of the power supply you are connected to via a virtual front panel of the instrument or the scope, data logger, CCDF, or ARB features of the software.

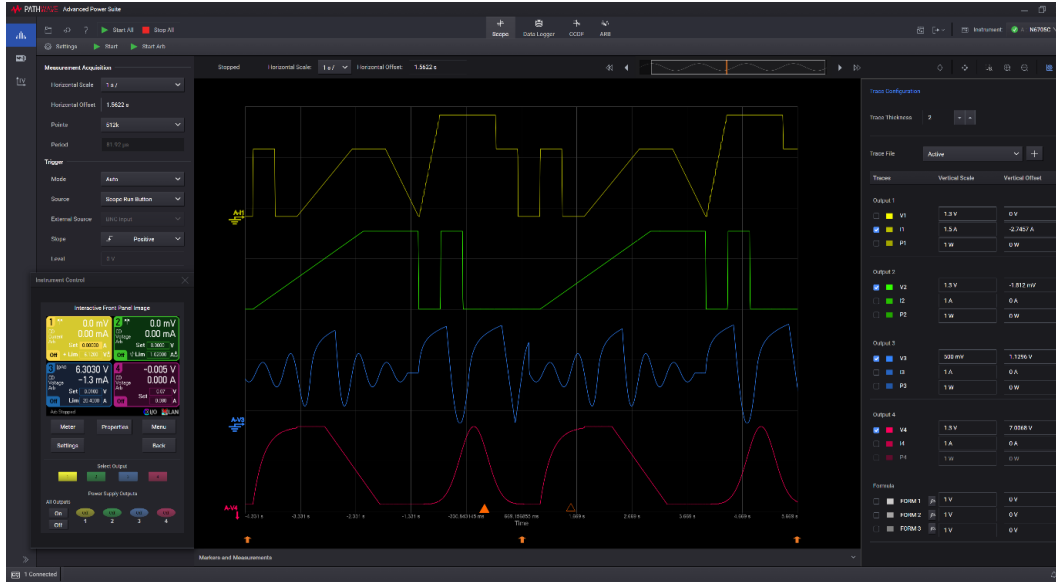


Figure 4. PW9252A connected to N6705C

# Measurements: Scope and Data Logger Modes

Set up short-term measurements using scope mode or long-term measurements using data logger mode to gain insights into your device's power consumption quickly and easily. If you know how to use an oscilloscope, you'll find the software easy and intuitive to use.



Figure 5. PW9252A in data logger mode

## Statistical Analysis CCDF Mode

To help you analyze distribution profiles, the PW9252A software includes a Complementary Cumulative Distribution Function (CCDF) <sup>1</sup>. This function provides a concise way to display long-term dynamic random current drain. It is also an effective way to quantify the impact of design changes (hardware, firmware, or software) on current flows in your device.

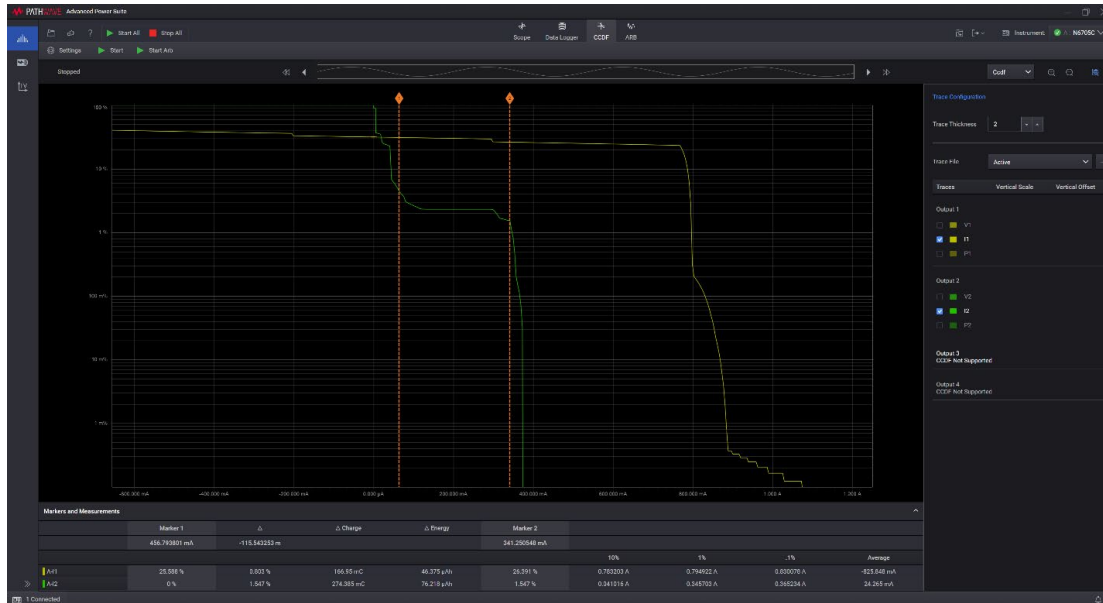


Figure 6. PW9252A in CCDF mode

## Arbitrary Waveforms

Easily create complex waveforms to stimulate or load a DUT by inputting a formula, choosing from built-in or importing waveform data.

## Record and playback – Combining the Power of Measurement and Source/Sink Capabilities

Use the scope or data logger modes to capture a waveform and easily transfer the data to the ARB function of the software. Once transferred, the data can be used to reproduce the waveform via the power supply's source or sink (electronic load) capabilities.

<sup>1</sup> The CCDF value equals (1 – CDF) and the CDF is the area under the Probability Density Function (PDF) curve. Because the CDF ranges from 0 to 100 percent probability, the CCDF ranges from 100 to 0 percent probability.

## Supported Models

Series	Models / Modules
<b>N7900 Series Advanced Power Supplies</b>	N7950A, N7951A, N7952A, N7953A, N7954A, N7970A, N7971A, N7972A, N7973A, N7974A, N7975A, N7976A, N7977A, N69143A, N69145A, N69146A, N69172A, N69173A.
<b>N6705 DC power analyzer</b>	N6705A, N6705B, N6705C, N6731B, N6732B, N6733B, N6734B, N6735B, N6736B, N6741B, N6742B, N6743B, N6744B, N6745B, N6746B, N6751A, N6752A, N6753A, N6754A, N6755A, N6756A, N6761A, N6762A, N6763A, N6764A, N6765A, N6766A, N6773A, N6774A, N6775A, N6776A, N6777A, N6781A, N6782A, N6783A-BAT, N6783A-MFG, N6784A, N6785A, N6786A, N6791A, N6792A.
<b>RP7900 Series regenerative power system</b>	RP7951A, RP7951AT, RP7952A, RP7952AT, RP7953A, RP7961A, RP7962A, RP7963A, RP7931A, RP7932A, RP7933A, RP7935A, RP7936A, RP7941A, RP7942A, RP7943A, RP7945A, RP7946A, RP7971A, RP7972A, RP7973A, RP7981A, RP7982A, RP7983A, RP7984A.
<b>RP5900 Series regenerative DC power supplies</b>	RP5913A, RP5923A, RP5933A, RP5943A, RP5915A, RP5925A, RP5935A, RP5945A, RP5916A, RP5926A, RP5936A, RP5946A.
<b>EL4900 Series regenerative DC electronic loads</b>	EL4913A, EL4923A, EL4933A, EL4943A, EL4915A, EL4925A, EL4935A, EL4945A, EL4916A, EL4926A, EL4936A, EL4946A.
<b>DP5700 Series DC power supplies</b>	DP5721A, DP5722A, DP5723A, DP5724A, DP5726A, DP5728A, DP5730A, DP5731A, DP5733A, DP5736A, DP5741AS, DP5741AL, DP5741AH, DP5742AS, DP5742AL, DP5742AH, DP5743AS, DP5743AL, DP5743AH, DP5744AS, DP5744AL, DP5744AH, DP5746AS, DP5746AL, DP5746AH, DP5748AS, DP5748AL, DP5748AH, DP5750AS, DP5750AL, DP5750AH, DP5751AS, DP5751AL, DP5751AH, DP5753AS, DP5753AL, DP5753AH, DP5756AS, DP5756AL, DP5756AH, DP5761AL, DP5761AH, DP5762AL, DP5762AH, DP5763AL, DP5763AH, DP5764AL, DP5764AH, DP5765AL, DP5765AH, DP5766AL, DP5766AH, DP5768AL, DP5768AH, DP5770AL, DP5770AH, DP5771AL, DP5771AH, DP5772AL, DP5772AH, DP5773AL, DP5773AH, DP5774AL, DP5774AH, DP5775AL, DP5775AH, DP5776AL, DP5776AH, DP5782AL, DP5783AL, DP5784AL, DP5786AL, DP5788AL, DP5790AL, DP5791AL, DP5792AL, DP5793AL, DP5796AL, DP5797AL, DP5799AL, DP5782AH, DP5783AH, DP5784AH, DP5786AH, DP5788AH, DP5790AH, DP5791AH, DP5792AH, DP5793AH, DP5796AH, DP5797AH, DP5799AH
<b>E36150 Series Autoranging Benchtop Power Supply</b>	E36154A, E36155A

# PW9253A

## PathWave Advanced Battery Test and Emulation

### Introduction

The PW9253A PathWave Advanced Battery Test and Emulation application software provides a test environment for you to easily run battery tests, generate battery models and perform battery emulation using one or more Keysight two-quadrant power supplies. The emulation function allows you to quickly output the desired battery operation conditions. It allows you to cover various test scenarios without having to wait for a real battery to go through discharging or charging conditions. Integrating the PW9253A software with Keysight's advanced two-quadrant product families, covers a broad range of low to high power level applications, across various industries from consumer electronics, medical devices, e-mobility, residential energy storage and automotive. The PW9253A also supports RP7900 Series operation in primary/secondary mode which enables parallel units to be configured easily for greater output current/power. Depending on the number of licenses purchased, each license connects to one instrument, supporting up to 10 instruments simultaneously.



## Features

- Tests and emulates batteries up to 200 kW and up to 2000 V
- Supports four modes of operation: emulation, profiler, discharge/charge, and cycler
- Creates custom battery models
- Emulate battery characteristics at various temperature
- Controls up to ten instruments simultaneously, with each license connecting to a single instrument.
- Includes API functions to facilitate integration into your programming environment
- Provides advanced control capabilities - capacity rating, state of charge, constant or dynamic level selection, pulse width control, constant resistance discharge, constant power discharge, temperature
- Simultaneously measures voltage and current with its built-in digitizer
- Accurately captures voltage, current, capacity from seconds up to days
- Creates custom dynamic loading characteristics for discharging
- Import battery models
- Exports combine measurement data
- Provides a graphical view of the battery model
- Supports cut-off condition for battery charging of NiMH or NiCD batteries with time, Negative Delta Voltage (NDV) and temperature
- Provides customizable battery protection parameters
- Includes cycler temperature protection, which halts battery cycle operation when a temperature limit is detected.

## Profiler - Creating Battery Model Tailored Around Device Behavior

A battery profiler is a must tool to have if you are working with different batteries and need to create your own custom battery model library. This ensures you are getting the most accurate models for battery life predictions tailored to your devices and working scenarios. The PW9253A software has the capability of creating custom battery models. It creates a battery model when discharging or charging a physical battery. Discharging a battery can be performed by either static current or dynamic current loading profile or constant resistance or constant power. A battery model created by the PW9253A will consist of a file with of up to 200 points, each point includes the Open Circuit Voltage (Voc), Series Resistance (Ri), and State of Charge (SoC). The software will continue to build up battery model automatically until the stopping condition is reached. While discharging or charging a battery, in real-time the software continuously captures parameters like Voc, Vt, Ri, Current, Time, Capacity, SoC and Temperature. The profiler also can export all graphed data while the test is running for further analysis.

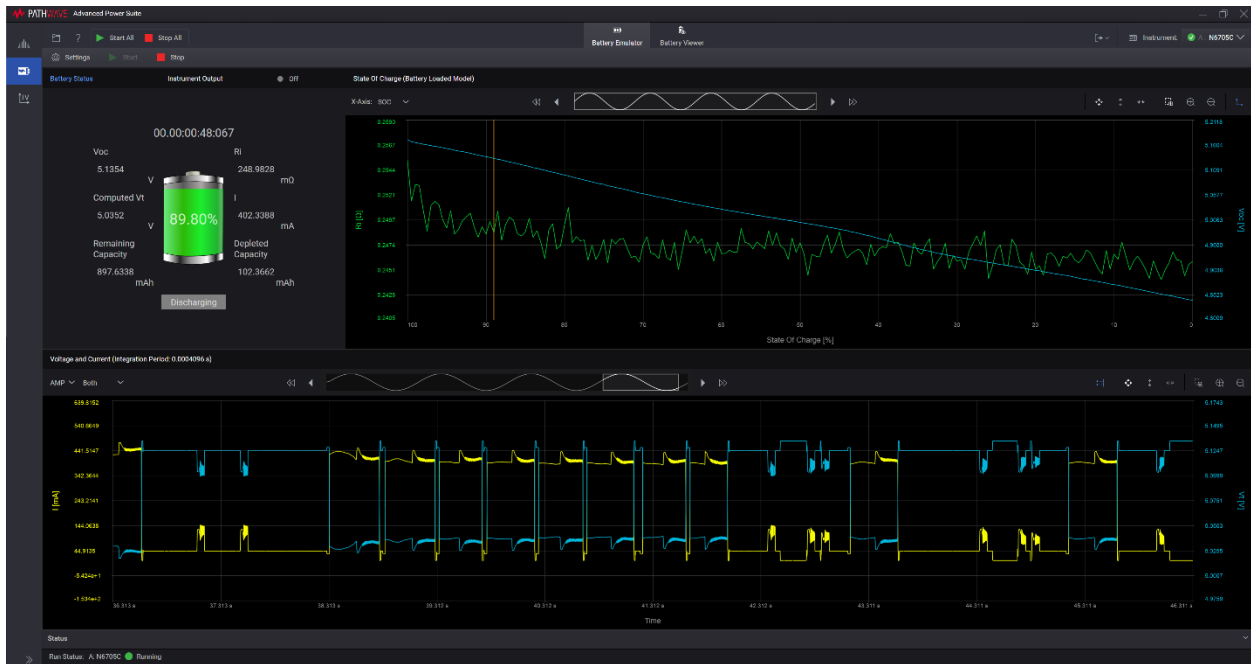


Figure 7. PW9253A creating a battery model with static profile function

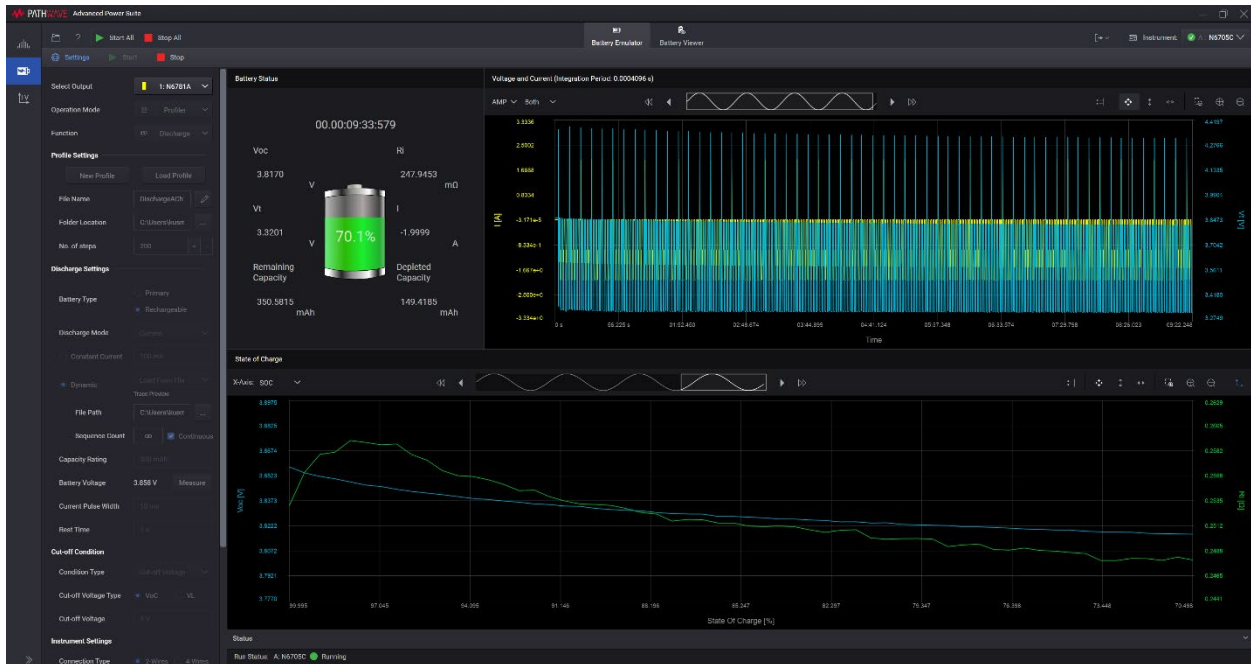


Figure 8. PW9254A creating a battery model with dynamic profile function

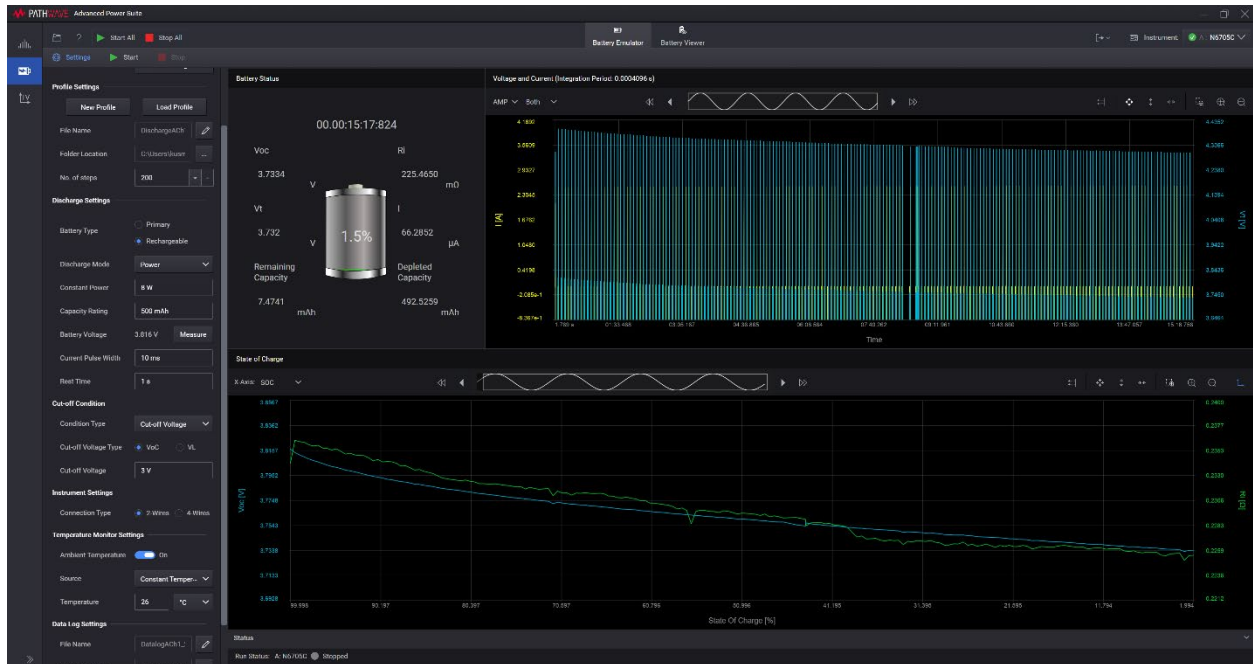


Figure 9. PW9254A creating a battery profiler with ambient temperature, constant power discharge features

## Emulation – Battery Emulation Reduces Test Time

Battery emulation is a critical process as it allows one to understand how the battery or the device would behave in a real-life scenario when connected to each other. Using a battery emulator instead of a real battery has many advantages. A battery emulator helps to create a safer test environment and allowing to validate the various operation modes of the device. To emulate battery characteristics, start by loading a battery model into PW9253A Advanced Battery Test and Emulation software. The software algorithm will follow the battery model in real-time and emulate the battery behavior. The software allows two methods for battery models - open profiles generated by the software or importing external battery models with Voc, SoC, and Ri parameters in a CSV file. For simplicity, you will only need to enter four parameters to emulate a battery – capacity rating, current limit, initial SoC, and a cut-off condition. While emulating a battery, it can simultaneously measure voltage and current continuously and save the measurement results. The software also has capability that allows you to load multiple battery models that have been created at different temperatures.

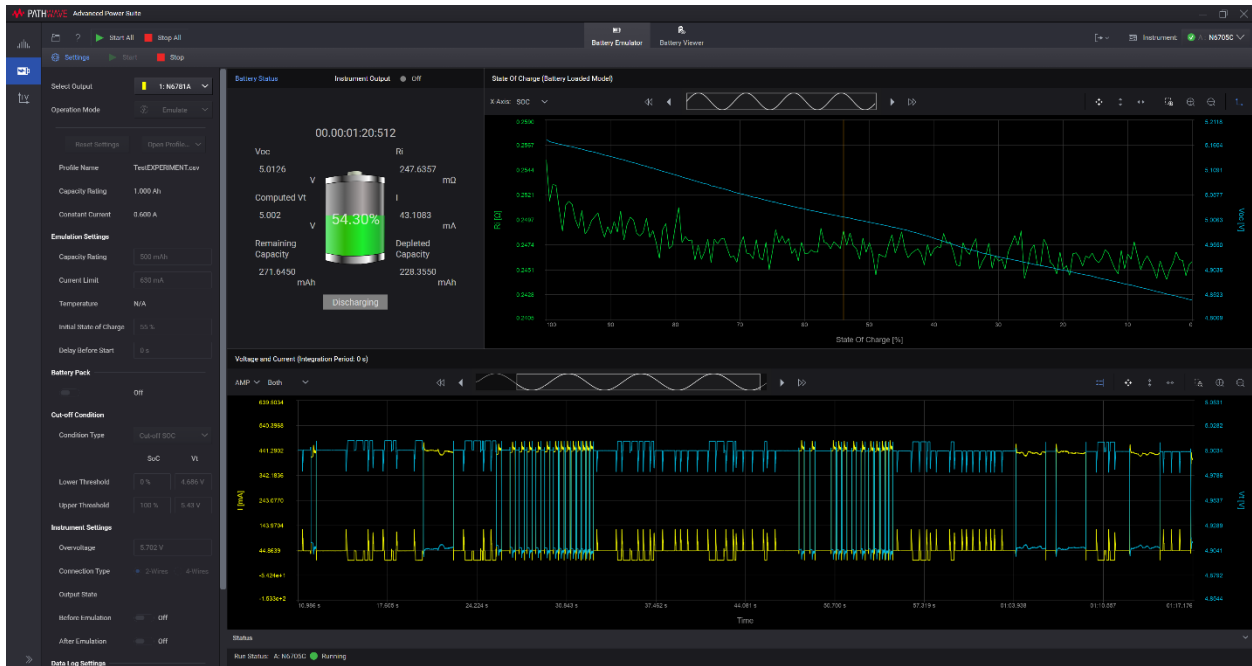


Figure 10. PW9254A Emulating Lithium battery powering a low power device

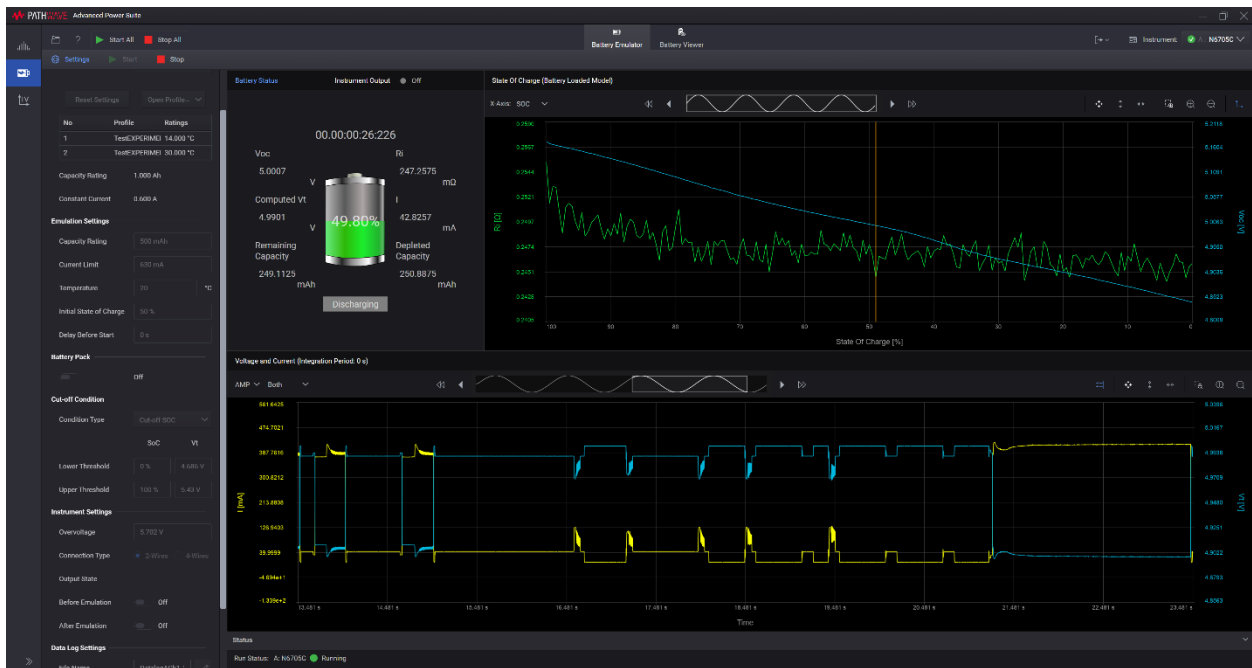


Figure 11. PW9254A Emulating multiple battery models at different temperatures

# Cycler – Life Cycling Battery Characteristics

The cycling function as the flexibility allows you to create a custom sequence of charging, resting, and discharging a battery at various test conditions. The software enables you to make up to 1000 cycle operations on the battery to determine the battery's age effect and reliability under sequence test conditions. While continuously monitoring the battery's health and recording test data parameters of capacity, terminal voltage, current, and time. The cut-off condition features allow you to define a stop condition where cycling will automatically stop once capacity loss percentage is reached.



Figure 12. PW9254A Cycle testing a 18650 battery



Figure 13. PW9254A Performing a battery charge on iron phosphate battery

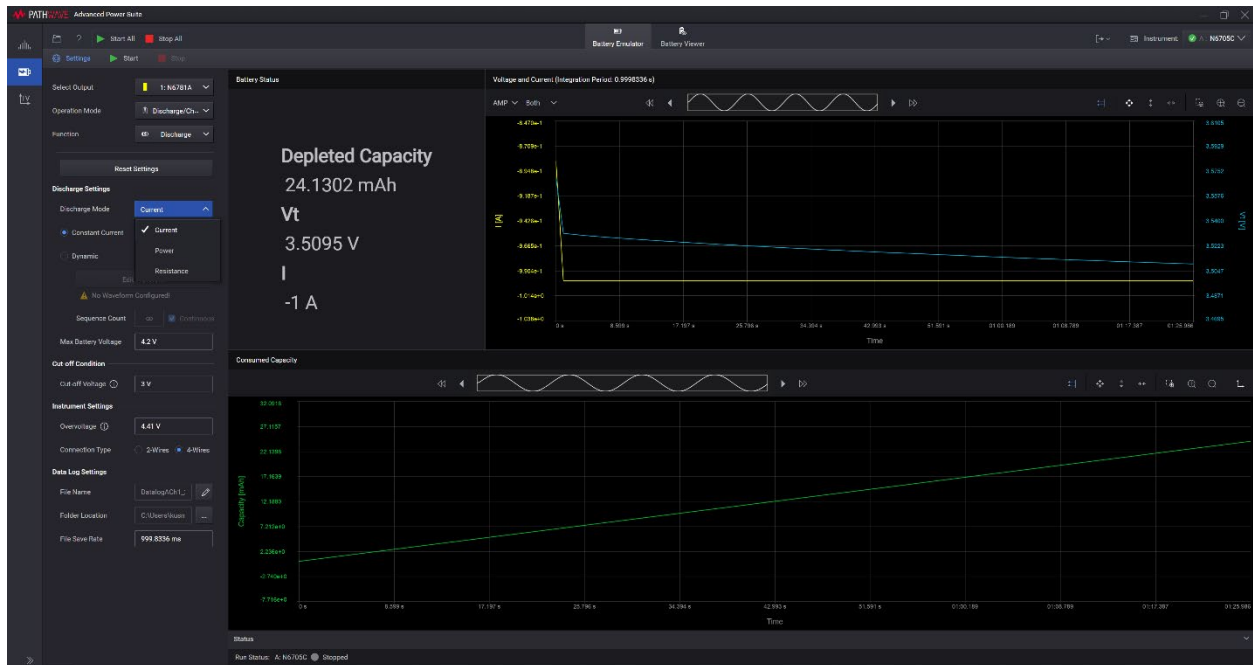


Figure 14. PW9254A enables you to choose various discharge mode option (constant current, power, resistance, and dynamic current discharge)

# Importing Battery Model Characteristics

The PW9253A software provides an easy way for you to import battery models created outside of the PW9253A test environment. You can import a CSV file consisting of the following battery parameters: state of charge, open circuit voltage, and series resistance parameters.

State of Charge(%)	Open Circuit Voltage(V)	Internal Resistance(ohm)	Status
100.00	9.609423	7.544065	
99.50	8.828673	3.889564	
99.00	8.645126	3.791465	
98.50	8.516480	3.767940	
98.00	8.411436	3.780916	
97.50	8.320710	3.804418	
97.00	8.240466	3.840828	
96.50	8.167970	3.886445	
96.00	8.102751	3.927822	
95.50	8.043658	3.971063	
95.00	7.990255	4.014665	
94.50	7.942882	4.057762	
94.00	7.899871	4.098643	

Figure 15. PW9253A Importing a CSV file battery model

## Supported Models

Series	Models / Modules
N7900 Series Advanced Power Supplies	N7950A, N7951A, N7952A, N7953A, N7954A, N7970A, N7971A, N7972A, N7973A, N7974A, N7976A, N7977A, N7953ALG.
N6705 DC power analyzer	N6705A, N6705B, N6705C, N6700C, N6701C, N6702C, N6781A, N6782A, N6784A, N6785A, N6786A.
RP7900 Series regenerative power system	RP7951A, RP7952A, RP7953A, RP7961A, RP7962A, RP7963A, RP7951AT, RP7952AT, P7953AT, RP7961AT, RP7962AT, RP7963AT, RP7931A, RP7932A, RP7933A, RP7935A, RP7936A, RP7941A, RP7942A, RP7943A, RP7945A, RP7946A, RP7971A, RP7972A, RP7973A, RP7981A, RP7982A, RP7983A, RP7984A.
RP5900 Series regenerative DC power supplies	RP5913A, RP5923A, RP5933A, RP5943A, RP5915A, RP5925A, RP5935A, RP5945A, RP5916A, RP5926A, RP5936A, RP5946A.
B2900 Series precision source / measure units (SMU)	B2901A, B2902A, B2911A, B2912A, B2961A, B2962A, B2901B, B2901BL, B2902B, B2910BL, B2911B, B2912B, B2961B, B2962B, B2901C, B2901CL, B2902C, B2910CL, B2911C, B2912C, B2961C, B2962C
E36731A battery emulator and profiler	E36731A
34970A Data Acquisition / Data Logger Switch Unit	34970A
34972A LXI Data Acquisition / Data Logger Switch Unit	34972A
DAQ970A / DAQ973A Data Acquisition System	DAQ970A, DAQ973A

# System and Installation Requirements

## Computer Operating System

Windows 10,11	64-bit (version 1809 or later)
Computer hardware	<b>Recommended processor:</b> Intel Core i5 (or equivalent) <b>RAM:</b> 16 GB  <b>Storage:</b> 900 MB free space for Windows
Interfaces	USB, GPIB, LAN, RS-232
Display resolution	1280x1024 minimum recommended for single instrument view (higher resolution recommended for multiple instrument view) 1920 x 1080 minimum
Data exports to Excel or csv	Pathwave supports Microsoft Office 2003 and later

# Free Trial and Licensing

The PW9254A PathWave Advance Power Application Suite software is available to download with a 30-days free trial period. Download a free 30-day trial today at: [www.keysight.com/find/PW9254ATrial](http://www.keysight.com/find/PW9254ATrial)

Each license connects to one instrument, supporting up to 10 instruments simultaneously.

## How to Order a License :

Product	License Type	License Term		
		Perpetual		Subscription
		License	Support	License & support
E.g:BV0001B	Node-locked	SW1000-LIC-01	SW1000-SUP-01	SW1000-SUB-01
	Transportable			
	USB portable <sup>1</sup>			
	Floating (single site, single region, worldwide)			

1. USB portable license requires a certified USB dongle (available for additional purchase, Keysight part number SW1000-D10).

Step 1 Determine the Software Model	Step 2 Choose License Term	Step 3 Select License Type
Choose the right software model: <ul style="list-style-type: none"> <li>• PW9251A Pathwave IV Curve Measurement Software</li> <li>• PW9252A PathWave Advanced Power Control and Analysis</li> <li>• PW9253A PathWave Advanced Battery Test and Emulation</li> <li>• PW9254A PathWave Advanced Power Application Suite Bundle License</li> </ul>	<ul style="list-style-type: none"> <li>• Perpetual</li> <li>• Subscription</li> </ul>	<ul style="list-style-type: none"> <li>• Node-locked</li> <li>• Transportable</li> <li>• USB portable</li> <li>• Floating               <ul style="list-style-type: none"> <li>- Single site</li> <li>- Single region</li> <li>- Worldwide</li> </ul> </li> </ul>
Step 4 Select Duration	Step 5 Select USB HW Key	Step 6 Select Delivery Method
<ul style="list-style-type: none"> <li>• 12,24,36,60 months (Perpetual)</li> <li>• 3,6,12,24,36 months (Subscription)</li> </ul>	<ul style="list-style-type: none"> <li>• Only applicable for USB portable licenses and if the customer currently does not possess an existing USB dongle</li> </ul>	<ul style="list-style-type: none"> <li>• Paper Certificate</li> <li>• eMail and Paper Certificate</li> <li>• eMail Certificate</li> </ul>

An Entitlement Certificate is delivered with each purchased software order. Follow the directions on the certificate to redeem your order for your license. License redemption requires an internet connection.



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Mess- und Prüftechnik. Die Experten.

Keysight enables innovators to push the boundaries of engineering by quickly solving design, emulation, and test challenges to create the best product experiences. Start your innovation journey at [www.keysight.com](http://www.keysight.com).

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