

APPLICATION NOTE

HVRT AND LVRT TESTING FOR RENEWABLE ENERGY SYSTEMS

CAPTURE, ANALYZE, AUTOMATE, AND REPORT RIDE-THROUGH TESTS WITH A SINGLE INTEGRATED PLATFORM





ABSTRACT

High-Voltage Ride-Through (HVRT) and Low-Voltage Ride-Through (LVRT) tests are essential for validating the grid-code compliance of renewable energy generation and storage systems. During these tests, equipment such as photovoltaic inverters, wind turbines, and battery energy storage systems must demonstrate stable operation and grid support capability during voltage dips, swells, and other transient grid disturbances.

This application note presents how DEWETRON power analyzers simplify and accelerate ride-through testing by combining high-accuracy power measurements, fast transient detection, real-time calculation of critical ride-through parameters, and comprehensive waveform analysis in a single platform. Engineers can capture and evaluate voltage transients with update rates down to 1 ms while simultaneously monitoring sequence components, power values, phase angles, and other key compliance parameters.

In addition, the application note highlights advanced analysis tools, flexible cursor measurements, SCPI-based automation capabilities, and automated report generation features that help reduce testing effort and improve repeatability. Together, these capabilities provide an efficient and reliable solution for HVRT and LVRT testing, supporting the certification and validation of modern grid-connected energy systems



INTRODUCTION

As renewable energy sources continue to play an increasingly important role in modern power grids, grid operators require generating equipment to remain connected and support grid stability during voltage disturbances. High-Voltage Ride-Through (HVRT) and Low-Voltage Ride-Through (LVRT) tests are therefore essential for verifying the compliance of photovoltaic (PV) inverters, wind turbines, energy storage systems, and other grid-connected energy conversion equipment with national and international grid codes.

Performing ride-through tests presents significant measurement challenges. Voltage levels can change rapidly within milliseconds, making it crucial to capture transient events accurately while simultaneously monitoring electrical parameters, system response, and compliance criteria. Reliable testing requires precise power measurements, high-speed calculations, comprehensive waveform analysis, and efficient reporting tools.

This application note demonstrates how DEWETRON power analyzers simplify HVRT and LVRT testing by combining highly accurate measurements, real-time calculation of ride-through parameters, fast update rates, advanced analysis tools, automated test capabilities, and efficient report generation in a single, integrated solution. Engineers can perform grid compliance testing more efficiently, reduce evaluation effort, and obtain reliable test results for certification and product validation.

The following sections highlight the key capabilities that make DEWETRON an effective platform for ride-through testing of renewable energy and energy storage systems.



HVRT AND LVRT TESTING FOR RENEWABLE ENERGY SYSTEMS

New energy generation equipment such as wind turbines, photovoltaic (PV) inverters, and energy storage systems must undergo High-Voltage Ride-Through (HVRT) and Low-Voltage Ride-Through (LVRT) testing to verify compliance with modern grid codes and ensure stable grid operation.

The high-precision, high-reliability hardware performance of the DEWETRON power analyzer, and the feature-rich software will help you complete this experiment efficiently.

▼ HIGH ACCURACY: $\pm 0.03\%$ OF READING

The DEWETRON power analyzer provides a measurement accuracy of $\pm 0.03\%$ of reading for voltage and current measurements and $\pm 0.04\%$ of reading for power measurements over a fundamental frequency range from 0.5 Hz to 1 kHz. A key advantage is the absence of a range measurement error, ensuring accurate measurements throughout the entire ride-through event. This means that during LVRT and HVRT testing, measurement uncertainty can be calculated using the same accuracy specification. This is particularly important during low-voltage transient events, where the voltage may drop from several hundred volts to only a few volts within milliseconds. Any range-dependent measurement error would significantly affect the measurement results during the transient. DEWETRON power analyzers eliminate range-related errors and guarantee high measurement accuracy throughout the entire voltage transient event.

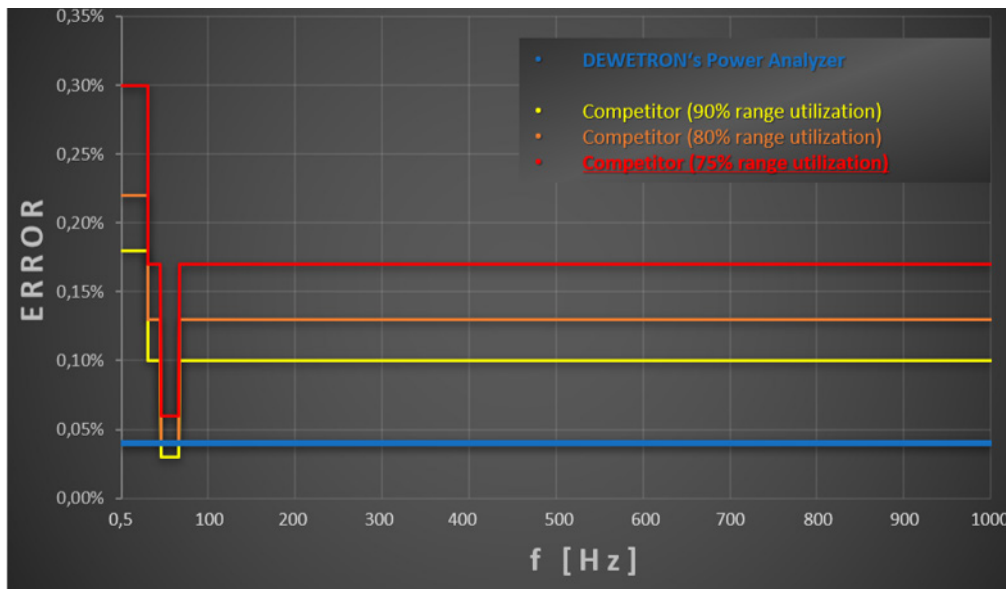


Fig. 1: High Accuracy: $\pm 0.03\%$ of Reading

▼ COMPLETE PARAMETER SET FOR RIDE-THROUGH TESTING

In addition to conventional power parameters, the DEWETRON power analyzer performs real-time calculation of all key parameters required for voltage transient and ride-through testing. These parameters include positive- and negative-sequence voltage, current, and power components, as well as phase-angle measurements.

All calculated values are available online during the test, allowing direct observation and evaluation of system behavior during transient events. This eliminates the need for data export and post-processing in third-party software, streamlining the analysis workflow and improving test efficiency.

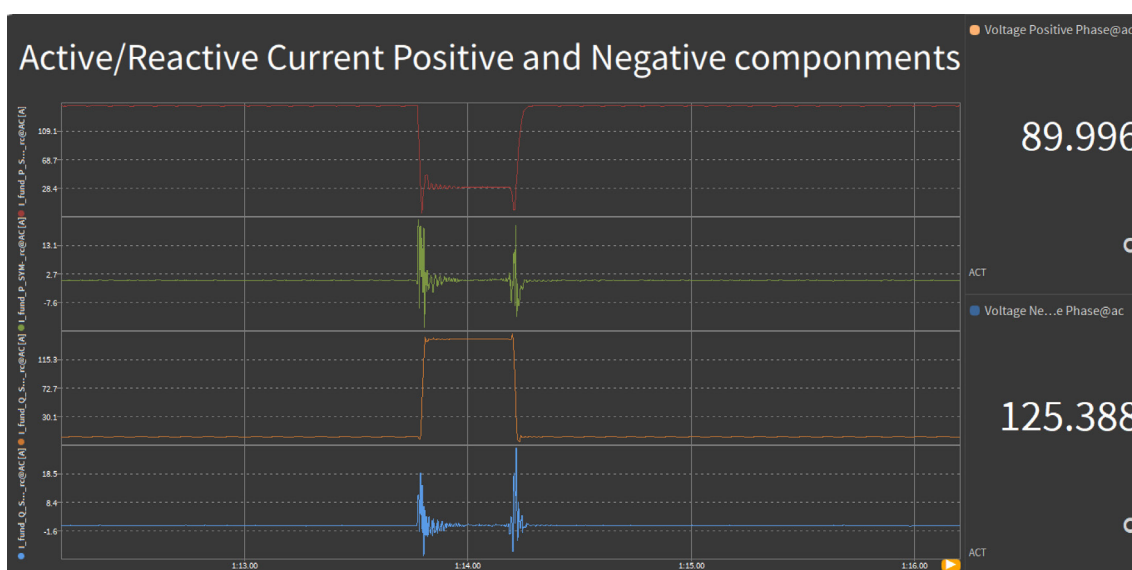


Fig. 2: Important Parameters for Ride-Through Testing

CONVENIENT DATA ANALYSIS OF WAVEFORM DATA AND CALCULATED DATA

The DEWETRON power analyzer provides continuous, gap-free acquisition and visualization of analog signals at the selected sampling rate. Users can simultaneously monitor voltage and current waveforms together with calculated power parameters during transient testing.

This capability enables detailed analysis of transient behavior and facilitates rapid identification of critical events. Furthermore, the availability of synchronized raw voltage and current data provides a reliable basis for post-processing, validation, and compliance reporting.

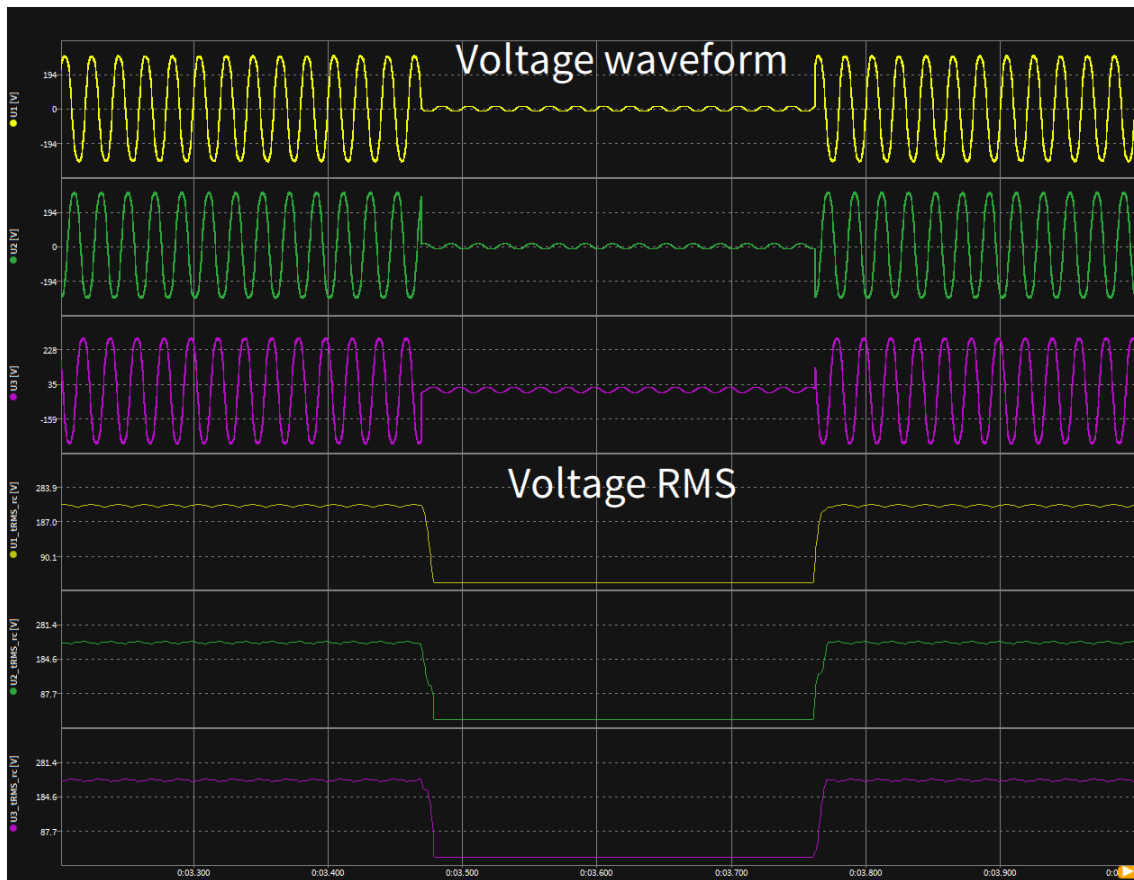


Fig. 3: Convenient Data Analysis

FAST POWER CALCULATIONS – UPDATE RATES DOWN TO 1 MS

Fast and accurate detection of voltage transients is critical for HVRT and LVRT testing. Unlike conventional power analyzers that update measurement results only once per grid cycle or even slower (update-rate of 20ms or slower), DEWETRON power analyzers use high-speed rolling calculations to deliver update rates down to 1 ms, with optional calculations at 0.1 ms.

Combined with half-cycle RMS calculations, this approach enables precise tracking of rapid voltage changes that occur during voltage dips, swells, and other transient events. Compared to conventional full-cycle calculations, rolling RMS values provide a more realistic representation of the actual grid conditions, ensuring accurate analysis of dynamic system response during ride-through testing.

The figure below compares the measured U12 line-to-line voltage waveform with RMS values calculated using both half-cycle rolling calculations and conventional full-cycle calculations. The rolling calculation method provides significantly higher temporal resolution, enabling the RMS voltage to accurately track rapid voltage variations during transient events.

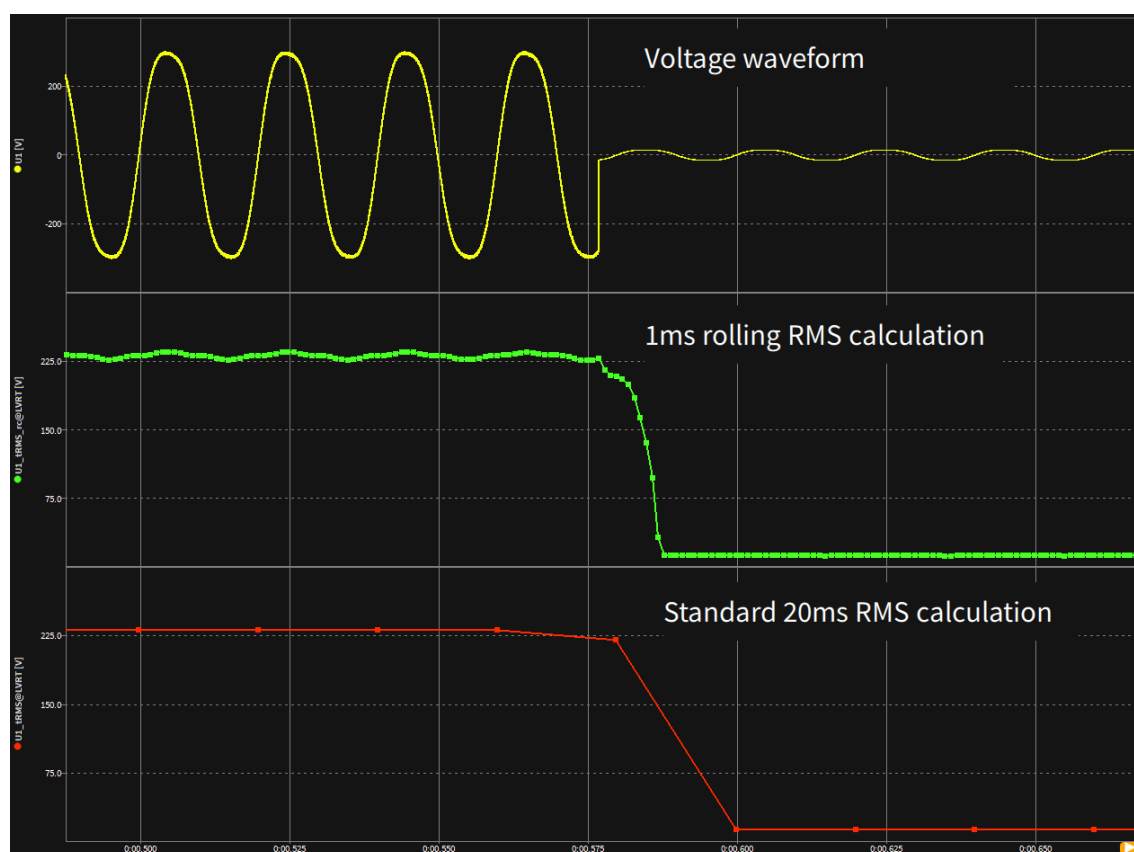


Fig. 4: Fast Power Calculations – Update Rates Down to 1 ms

FLEXIBLE CURSORS – TOOLS FOR PRECISE TIME MEASUREMENTS

Accurate measurement of voltage transition characteristics and transient duration is a critical requirement in voltage transient and ride-through testing. The DEWETRON software provides multiple, independently configurable cursor sets that enable precise and efficient timing analysis of relevant electrical parameters.

Using these cursor tools, engineers can easily determine voltage rise and fall times, transient durations, and other time-critical characteristics. In addition, the associated measurement values, timestamps, and delta values can be copied directly with a single click.

Corresponding waveform screenshots can also be captured and exported instantly, significantly simplifying the creation of professional test reports. This streamlined workflow reduces evaluation effort and improves the efficiency of post-test documentation.

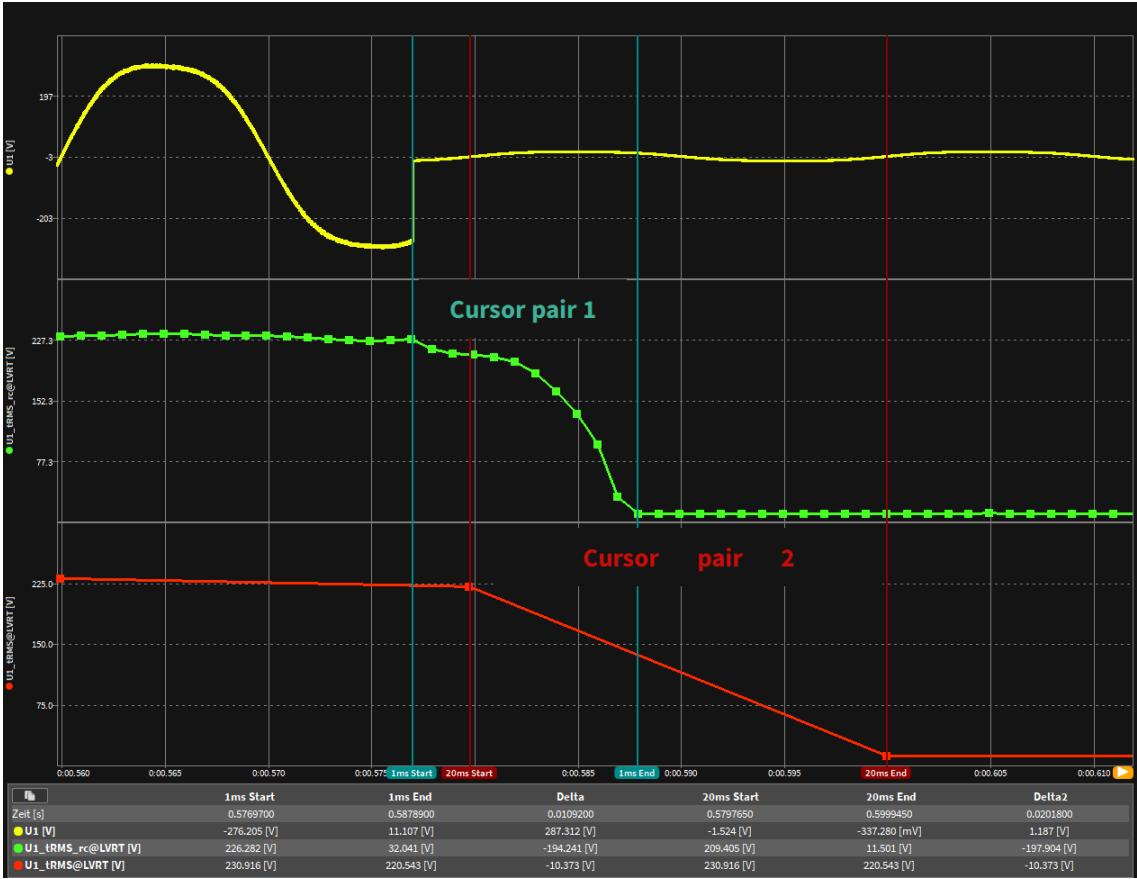


Fig. 5: Flexible Cursor Tools for Precise Time Measurements

AUTOMATED TESTING THROUGH COMPREHENSIVE SCPI SUPPORT

HVRT and LVRT testing typically requires the execution of numerous test scenarios under different grid conditions. Automating these test procedures significantly reduces engineering effort, improves repeatability, and ensures standardized test execution.

To support automated testing, DEWETRON provides a comprehensive SCPI interface that enables full remote control of the measurement system. Through SCPI commands, users can automate a wide range of tasks, including loading test configurations, modifying channel settings, creating formulas and statistical calculation channels, starting and stopping data acquisition, and retrieving measurement results.

In addition, the SCPI interface provides access to recorded measurement files, enabling automated post-processing and report generation. Analysis workflows such as instrument configuration, cursor placement, extraction of measurement results, and generation of standardized test reports can be performed automatically, further reducing test and evaluation time while increasing efficiency and reproducibility.

6 Application Control	11 External Data Logging (ELOG)
6.1 Setup	11.1 :ELOG:ITEMs <channel>[,<channel>[,...]]
6.1.1 :SETup:LOAD	11.2 :ELOG:ITEMs?
6.1.2 :SETup:APPLY "XML-String"	11.3 :ELOG:PERiod <Duration>
6.1.3 :SETup:SAVE "Path"	12 Data Streaming (DSTREAM)
7 Acquisition Control	12.1 :DSTream:ITEMs[<GRP>] <channel>[,<channel>[,...]]
7.1 :ACQUisition:START	12.2 :DSTream:ITEMs[<GRP>]?
7.2 :ACQUisition:STOP	12.3 :DSTream:PORT[<GRP>] <PORT>
7.3 :ACQUisition:RESTART	13 EXPORT Commands
7.4 :ACQUisition:STATE?	13.1 :EXPort:DIRectory
8 Recording Control	13.2 :EXPort:DIRectory "path"
8.1 :STORe:FILE:NAME "PATH"	13.3 :EXPort:AUTO?
8.2 :STORe:FILE:NAME?	16 Measurement Screen Commands
8.3 :STORe:START	16.1 :SCReen:COUNT?
9 Channel List Access	16.2 :SCReen:ADD
9.1 :CHANNElList:NAMEs?	16.3 :SCReen:SElect?
9.2 :CHANNElList:IDs?	17 Instruments Commands and Queries
9.3 :CHANNElList:ITEM<ChannelID> subsystem	17.1 Identification of an instrument
10 Measurement Values	17.1.1 Common Instrument Commands and Queries
10.1 :RATE {<num>[<unit>]} [NONE]	17.2 :INSTRuments:IDentifier <old_identifier>,<literal>,<new_identifier>
10.2 :RATE?	17.3 :INSTRuments:POSition? <instrument identifier>
10.3 :NUMeric:NORMal:ITEMS <channel>[,<channel>[,...]]	21 Trigger Events
	21.1 :TRIGger[:GET]?
	21.2 :TRIGger:RESet

Fig. 6: Automated Testing Through Comprehensive SCPI Support



REPORTING PLUG-IN: ONE-CLICK TEST REPORT GENERATION*

Preparing test reports and analyzing measurement data is often one of the most time-consuming tasks in HVRT, LVRT, and grid-compliance testing. To address this challenge, DEWETRON has developed an automated data analysis and reporting tool based on recorded measurement data. The software automatically generates standardized test reports for LVRT, HVRT and continuous voltage ride-through test scenarios. This significantly reduces the effort required for post-processing and documentation.

Key advantages of the reporting plug-in include intuitive operation without the need for user programming, direct report generation from DMD measurement files, support for various industry standards such as GB/T 34120, and fully customizable report templates. By automating data evaluation and report creation, the tool minimizes engineering workload, improves consistency, and accelerates the overall testing and certification process.

*¹) For Chinese market only currently.

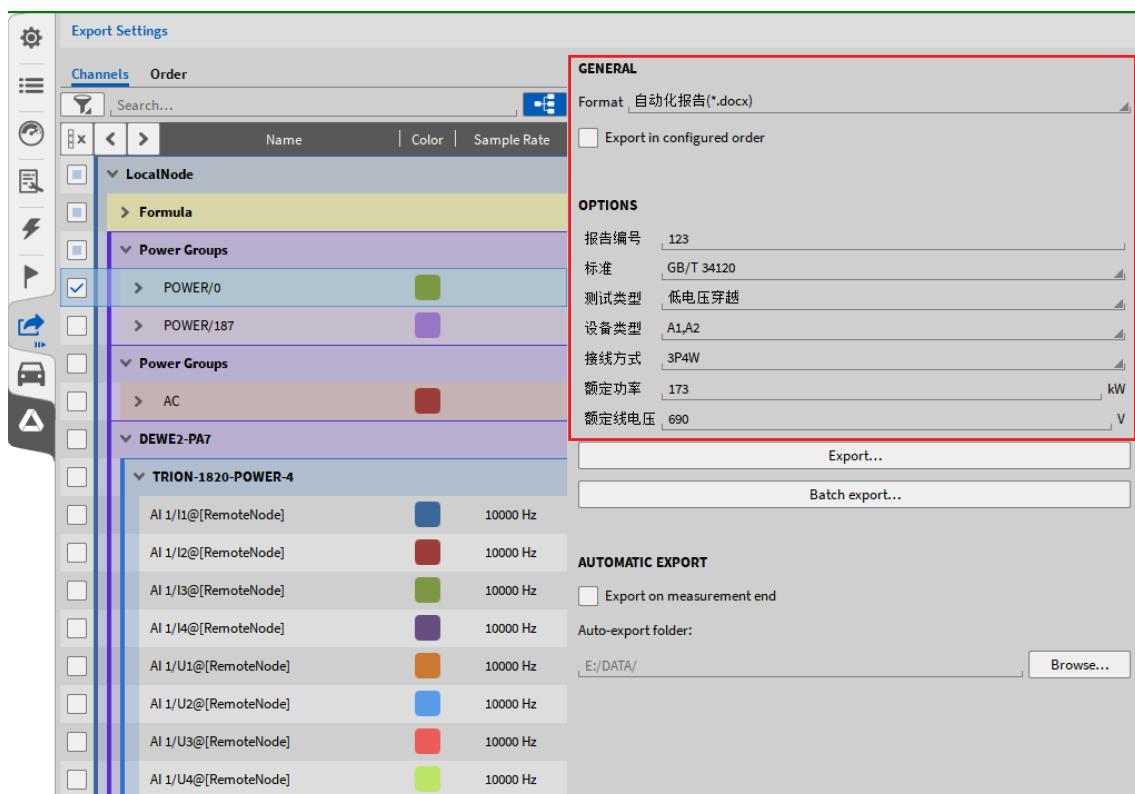


Fig. 7: Reporting Plug-In – One-Click Test Report Generation

SUMMARY

The DEWETRON power analyzer combines high measurement accuracy, comprehensive power quality and ride-through parameter calculations, advanced software functionality, and flexible automation interfaces to support efficient HVRT and LVRT testing.

These capabilities make DEWETRON an ideal solution for the testing and certification of grid-connected power generation and energy conversion systems, including PV inverters, wind turbines, and energy storage systems.

Compliance with modern grid codes requires all grid-connected energy generation and storage equipment to successfully pass HVRT and LVRT tests. By providing accurate measurements, real-time analysis, and powerful automation features, DEWETRON helps engineers perform these tests efficiently, reliably, and in accordance with applicable industry standards.



AUTHOR

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Kevin Zhao is Product Manager at DEWETRON China. Holding degrees from Wuhan University of Technology and Jiangsu University of Technology, he combines four years of wind power industry experience with more than eight years at DEWETRON. His expertise spans automotive, renewable energy, and mechanical structural testing, with a particular focus on advanced test and measurement solutions.



ABOUT DEWETRON

DEWETRON is a manufacturer of precision test and measurement systems and part of the globally operating Anritsu Group. Our reliable measurement data help customers worldwide make processes more predictable, efficient, and safer.

Our strength lies in customized measurement solutions: ready to use right away while remaining flexible to adapt to dynamic testing requirements in the energy, automotive, transportation, and aerospace industries.

More than 35 years of experience and innovation have made DEWETRON a trusted partner in the global test and measurement market.

More than 25,000 DEWETRON measurement systems and over 400,000 measurement channels are in continuous use at leading companies worldwide.

DEWETRON's quality is certified according to ISO 9001 and ISO 14001. The high integrity of the measurement data is guaranteed by our own accredited calibration lab according to ISO 17025.

THE MEASURABLE DIFFERENCE.

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