YOKOGAWA

Application Note

Evaluation Test of Power Conditioning System for Solar/Wind Power Generation

IS8000 Integrated Software Platform

1. Introduction

A power conditioning system (also referred to as an inverter, PCS, or power conditioner) is used to convert the DC power generated by solar modules or windmills into AC power in systems that produce renewable energy that has been introduced as a response to global environmental issues, such as a wind power generation system or solar power generation system including a mega-solar power system. This conversion efficiency is improving every year. One of the goals of the power conditioner developers is to develop ones with low conversion loss, which are highly competitive in the market.

The efficiency measurement method for power conditioning systems for photovoltaic power generation is specified in JIS C 8961 in Japan and the international standard IEC 61683. Regulations concerning efficiency measurement may differ for each country and some countries specify the methods of measuring not only the maximum efficiency but also Euro efficiency or CEC efficiency.

While maximum efficiency is the efficiency data under specific conditions where efficiency is maximized, Euro/CEC efficiency is the efficiency that is obtained by measuring the efficiencies at multiple points under light load to rated load and weighting them according to the load factor.

There are various problems in interconnection to the grid. If a large amount of output from solar power generation, wind power generation, or others are connected to the power grid and power conditioners get disconnected all at once due to the disturbance of the grid, the power quality is greatly affected. To prevent such a problem caused by simultaneous disconnection or the like, a power conditioner needs to have continuous operation performance that is the ability to continue its operation (stay connected to the grid) even when an instantaneous voltage drop occurs. The requirements for the continuous operation performance of dispersed generators, which is necessary to ensure the power quality even during grid disturbance, are continuously developed.

Evaluation of maximum efficiency, Euro efficiency, and CEC efficiency includes a voltage fluctuation test, frequency fluctuation test, and temperature rise test. Power measurement using a power meter, checking of instantaneous waveform fluctuations using an oscilloscope, or high-speed data acquisition equipment, and temperature measurement tests are conducted around the world.

2. Challenges

As the amount of renewable energy generated often varies depending on natural conditions, the power grid may become unstable due to a sudden increase in power generation. The power grid also becomes unstable when lightning strikes the grid and the power generation system side is disconnected all at once or when an event occurs where the generated power fluctuates due to weather changes and the voltage and frequency of the power grid fluctuate. Developers of the power conditioning system may want to examine such events by continuously measuring the fluctuations in active power, reactive power, voltage, frequency, power factor, and efficiency during the events. The main purpose of a waveform measurement instrument is to continuously monitor a grid for a long time and capture abnormal data, but on the other hand, the developers also want to capture transient events and changes with high-speed sampling at the same time. It is difficult to perform the long-term measurement and capturing of fast abnormal events simultaneously. It is even more difficult to capture the numerical changes in power data efficiently and analyze the data at the same time with the long-term measurement and high-speed capturing.

3. IS8000 Solution

- Data checking and operation by online monitor
- Integration of DL software and WT software
- IEEE1588 WT/DL time-synchronized display
- Integrated file management by project file
- Utilization of reliable power data with guaranteed accuracy
- Automatic report creation using waveform and power meter data

4. IS8010 Solution (Detailed descriptions)

4.1 Data checking and operation by online monitor

The online monitor operation allows measurement instruments to be controlled remotely from a PC via a communication interface.
The touch panel screen (control screen) of the DL950 ScopeCorder or WT5000 Power Analyzer main unit is displayed on the PC screen. A user can freely change the settings or check the measured waveform and power meter data from a PC at a remote location in the same manner as operating the measurement instrument.
There is no need to newly learn the operations of software that are different from those of the instrument main unit. The user can simply check the settings and waveform display to make sure there is no problem, then begin collecting the waveform or power meter data.
The waveform on the DL950 located away from the control room can be checked on the PC, which enables efficient data collection without the trouble of going back and forth between the test room and control room to save the waveform data or change the setting conditions.

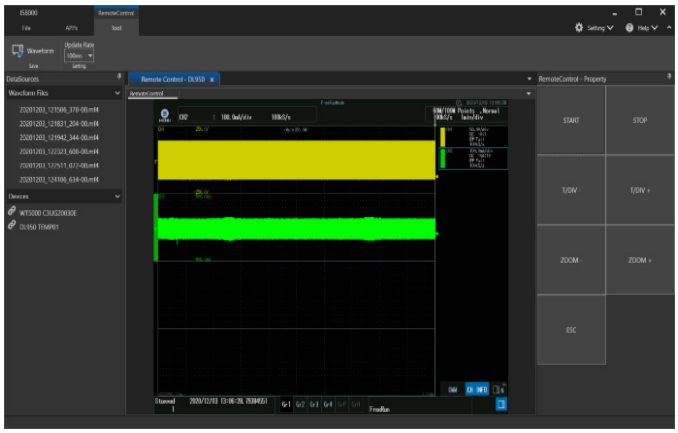

Figure 1. DL950 remote control screen

Figure 2. WT5000 remote control screen

4.2 Integration of DL software and WT software

Conventionally, the oscilloscope software and power meter software have different file formats and it is necessary to collect data using different software tools. The newly developed integrated measurement platform IS8000 can be used as one integrated measurement software to meet the measurement needs for synchronous measurement of waveform data and power meter data. By integrating the data collection software tools, it has become possible to significantly reduce the work of organizing and managing files, compared to the way of collecting data by separately performing measurements with an oscilloscope and a power meter and saving the measured data.

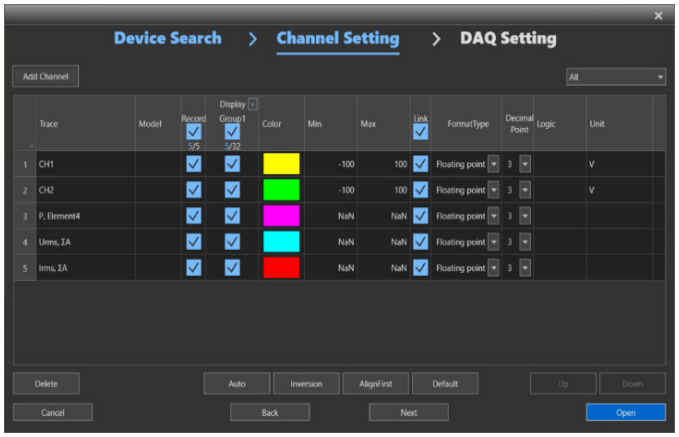

Figure 3. Startup screen of IS8000 integrated measurement platform

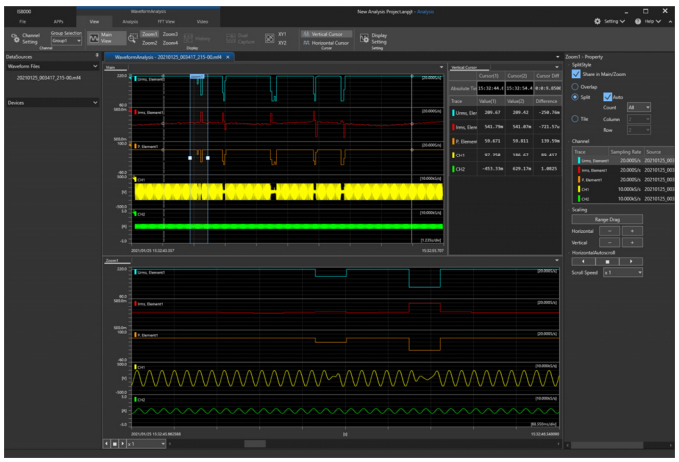

Figure 4. Integrating a project file and divided files

4.3 IEEE1588 WT/DL time-synchronized display

There are cases where power values are verified by displaying them using the waveform calculation function of a waveform measurement instrument, but highly accurate power values with traceability with a measured waveform cannot be obtained. The IS8000 integrated measurement software platform enables easy synchronized measurement by connecting the DL950 and WT5000 at the same time using IEEE 1588-time synchronization. The synchronization error of the DL950 and WT5000 is approximately 10 micro-seconds.

The power parameters of the WT5000 can be displayed on the same time axis on a PC along with the continuous waveform data of eight channels simultaneously acquired at up to 10 MS/s by the DL950. This makes it possible to display the trend of power meter data in time series together with the waveform data, allowing detection of slight fluctuations in power. It, therefore, becomes possible to check the waveform abnormality data occurring at a certain time from the power fluctuations and find the problem.

* IEEE1588 standard: a precision time protocol (PTP) used to synchronize time between devices connected on a network. PTP=Precision Time Protocol
* DL950 IEEE1588 master function(/C40 option) is required.
* 2 units synchronization error of DL950 is within 500 ns.
* DL950 10 Gbps Ethernet (/C60 option) is required.
* IS8000 multi-unit synchronization option (/SY1) is required for synchronized measurement of two or more units.

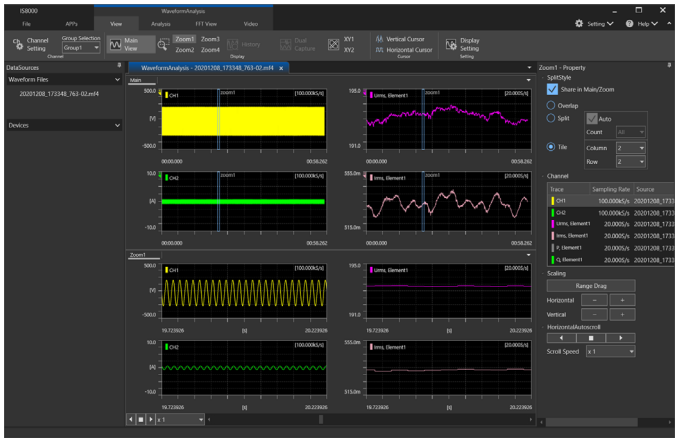

Figure 5. post analysis of waveform data

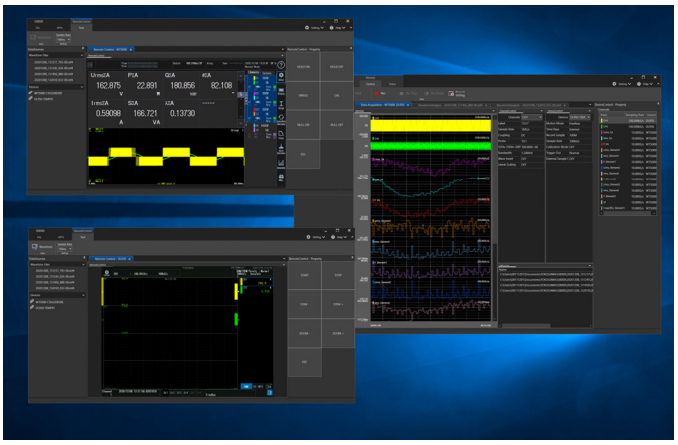

Figure 6. WT5000 and DL950 monitor display on the PC screen

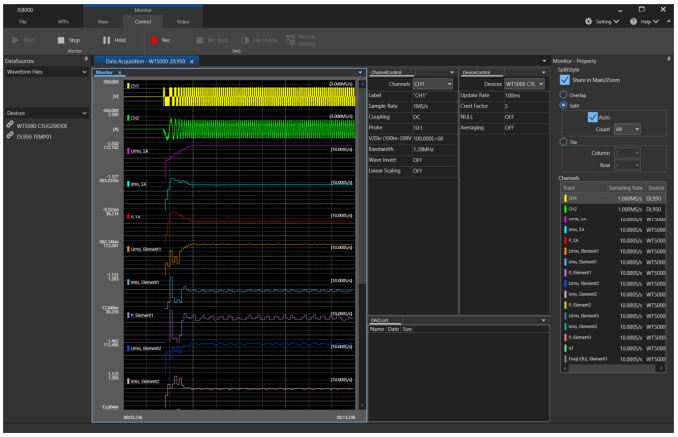

Figure 7. Power data and waveform data sync screen

4.4 Integrated file management by project file saving

The IS8000 integrated measurement platform can manage individual files as one project file. This eliminates the need to save a waveform data file and a power data file with the same name to associate them with each other or the need to manage files by creating a folder for each measurement data and storing a waveform file and a power data file in that folder.
A data file can be divided into segments by specifying the length of time. The data for an entire measurement period and the data for the period desired for analysis during the measurement can be saved as separate files. For example, when measuring for 24 hours, the user can divide the file into one-hour segments and analyze the data of the segments where the measuring process is finished while continuing the measurement.

After the measurement is completed, the file of the entire measurement period and the divided files can be managed as a project file. Measurement using two DL950s or measurement using the DL950 and WT5000 can also be managed as one project file. The fact that the user does not have to associate file names even in the measurement with the DL950 and WT5000 strongly supports the improvement of development efficiency.

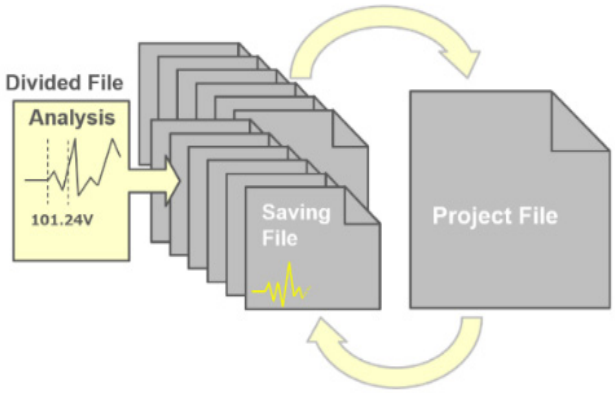

Figure 8. Integrating a project file and divided files

4.5 Utilization of reliable power data with guaranteed accuracy

The number of products that incorporate a function to calculate power values into waveform measurement instruments is increasing. It is very useful to calculate power values using a waveform measurement instrument because the simultaneity of data can be ensured even in a transient phenomenon. However, the user should pay attention to the assurance of the accuracy of power data traceable to national standards. The main purpose of waveform measurement instruments is to capture the shape of a measured signal more accurately with the high bandwidth and high sample rate by using a voltage probe and current probe. In other words, unlike a power meter, the result of a power calculation by a waveform measurement instrument has no guarantee of accuracy, and it is necessary to carefully verify the reliability. Yokogawa's power analyzers ensure highly precise measurement standards and traceability that are linked to national standards and provide highly reliable measurements of voltage, current, phase, and frequency.

On the IS8000 integrated measurement software platform, power measurement by the WT5000, which ensures power traceability, and eight-channel data transfer at 10 MS/s by the DL950 are available. Reliable power values and waveform data can be displayed on the same time axis at the same time.

4.6 Automatic report creation using waveform and power meter data

The automatic report creation option (/RP1) allows report creation and output on a PC.A user can easily create a report by setting the report layout (with image display) using the report creation wizard function. From the files measured or saved by the DL950 ScopeCorder or the WT5000 Precision Power Analyzer, the user can choose measurement conditions, waveform output, measurement results, or other data. The report can be output to PDF or EXCEL.

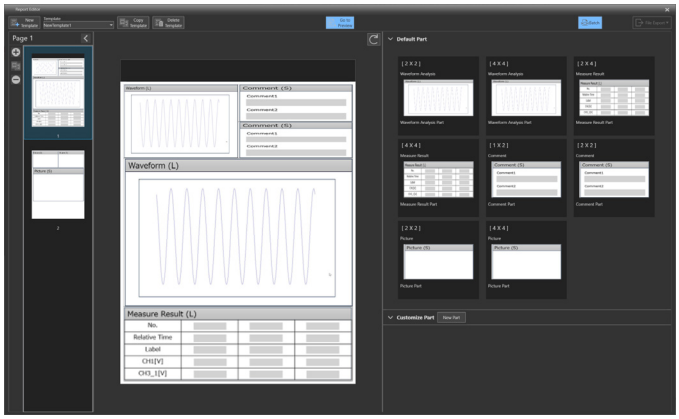

Figure 9. Report template edit screen

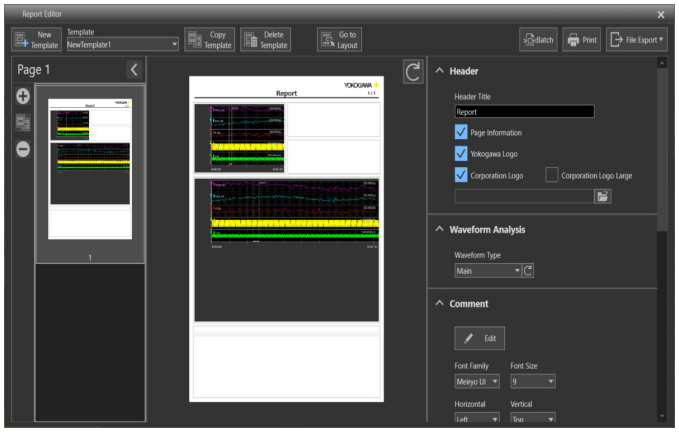

Figure 10. Report creation screen

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