Application Note

Synchronous Measurement in Motor/Inverter Development

IS8000 Integrated Software Platform

1. Introduction

A motor/inverter evaluation bench system incorporates equipment such as a power meter and a waveform measurement instrument. Generally, when acquiring the evaluation data, it is necessary to collect data from each instrument, and, commonly, a data collection system is constructed according to a customer's request. For example, a power meter obtains measured data including DC voltage, DC current, and DC power that are input from a battery to an inverter, and three-phase AC voltage, AC current, active power, frequency, and power factor that are output from the inverter to a motor—all at a data update rate of one second. A waveform measurement instrument such as an oscilloscope performs high-speed data acquisition at 1 MS/s or 10 MS/s to capture the carrier frequency of the inverter more accurately. It saves both power data and waveform data as a series of evaluation data to create a report that is based on the evaluation results, very quickly and efficiently.

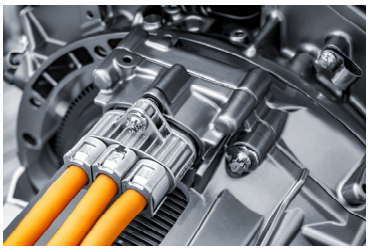
2. Challenges

Power data may be transferred and saved to a PC from a power meter at a data update rate of one second or 100 ms. Since the size of a single item of numerical data is about four bytes, the data volume is small and the data transfer time is unlikely to be a problem even when acquiring 32 items of data, such as inverter input/output voltage, current or power, by a PC. On the other hand, when three-phase inverter waveforms are transferred and saved to a PC from a waveform measurement instrument at a sample rate of 10 MS/s, there are six waveforms of voltage and current signals and it is necessary to transfer a large amount of data, 60 Mega-bytes, per second. Where the amount of waveform data is too large to transfer to a PC within a given time, the data may be saved in the waveform measurement instrument and transferred to the PC after the measurement to continue an evaluation test. However, the data transfer may take several minutes instead of several seconds, during which the evaluation test is interrupted.

Since the data is acquired from the power meter and the waveform measurement instrument separately, it is necessary, at least, to match the start time of the observation on that instrument with the start time on the power meter (the position of the data update cycle) to time-synchronize the waveform sample rate with the power values or calculated values of the power meter. It is practical to synchronize the times in units of one second, but it is quite difficult to manually perform time synchronization within 100 ms. Now, since more tests require the simultaneous acquisition of waveform data and power data, ensuring the simultaneity of data has become a major issue.

3. IS8000 Solution

- DL950 Improved efficiency by DL950 10 Gbit high-speed data transfer
- IEEE1588 WT/DL time-synchronized display
- Integrated file management by project file
- Utilization of reliable power data with guaranteed accuracy
- Report creation using waveform and power meter data



4. IS8000 Solution (Detailed descriptions)

4.1 Improved work efficiency by DL950 10 Gbit data transfer

With the 10G Ethernet interface option (/C60), the ScopeCorder DL950 provides 10 Gbps high-speed data transfer*. While the conventional model DL850E provides PC streaming at 100 kS/s (16ch), the DL950 offers 100 times faster data transfer at 20 MS/s (8ch), allowing measured data to be displayed on the PC software in real time. In inverter measurement, the high switching frequency requires high-speed data capture. The DL950 transfers data continuously to a PC at up to 20 MS/s, so that the data can be output without interrupting the test. There is no need to wait a matter of minutes just for data transfer to complete.
Furthermore, by combining the ScopeCorder DL950 with the WT5000 high-precision power analyzer, it is possible to achieve an industry first by performing high-precision power measurement with power traceability in synchronization with high-speed waveform data.

*HiSLIP communication: High-Speed LAN Instrument Protocol, which enables data transfer that is theoretically 10 times faster than 1000BASE-T (1 Gbps). DL950 10Gbps Ethernet (/C60 option) is required. Without the option, the transfer rate is 200 kS/s (16ch).
*The transfer rate for USB3.0 communication is 64 MB/s.

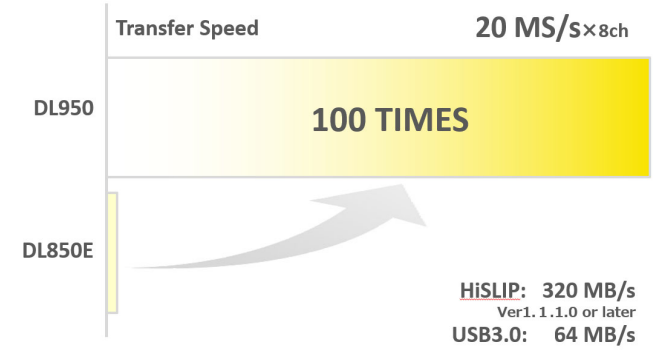


Figure 1. Data transfer comparison between DL850E and DL950

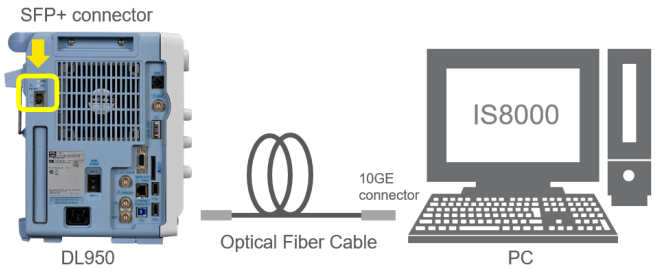


Figure 2. Connection between DL950 and PC

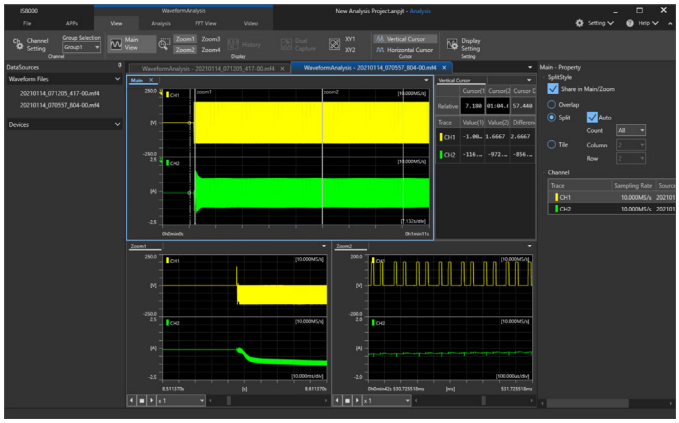


Figure 3. 10 MS/s data transfer measurement screen from DL 950

4.2 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 20 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.
* The synchronization error of two DL950 is within 150 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.

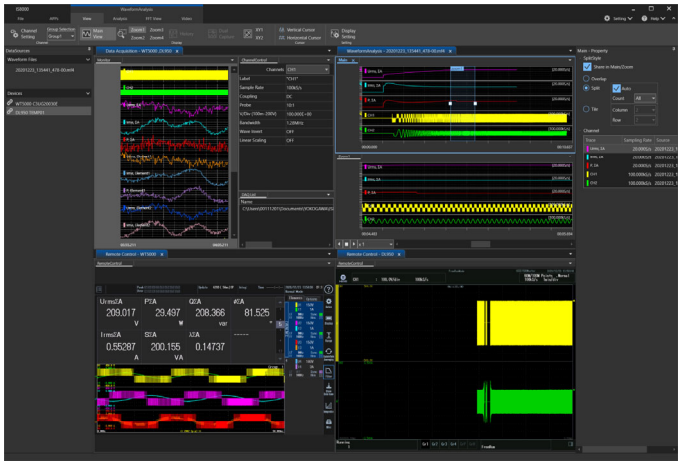


Figure 4. Waveform data monitor screen

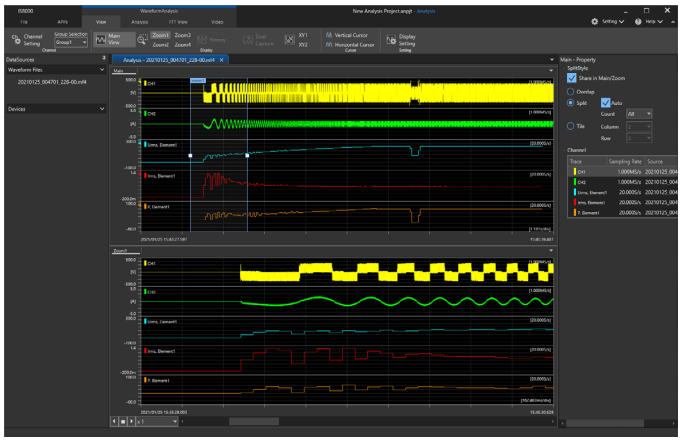


Figure 5. Time-synchronized display of power data and waveform data

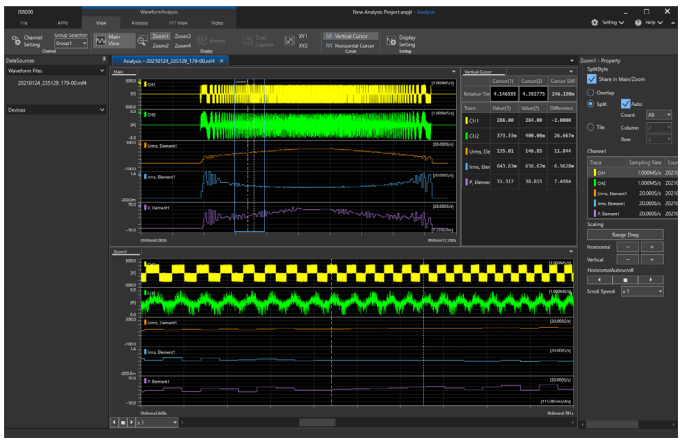


Figure 6. Cursor measurement of power data and waveform data

4.3 Integrated file management by project file

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.

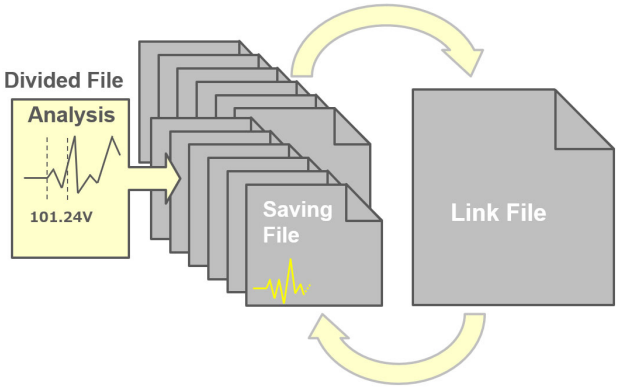


Figure 7. Integrating a project file and divided files

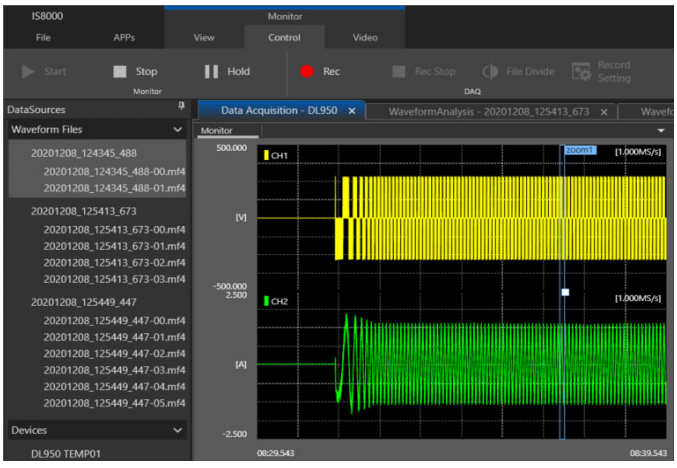


Figure 8. Display of a project file (the left side of the screen)

4.4 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 20 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.

4.5 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.

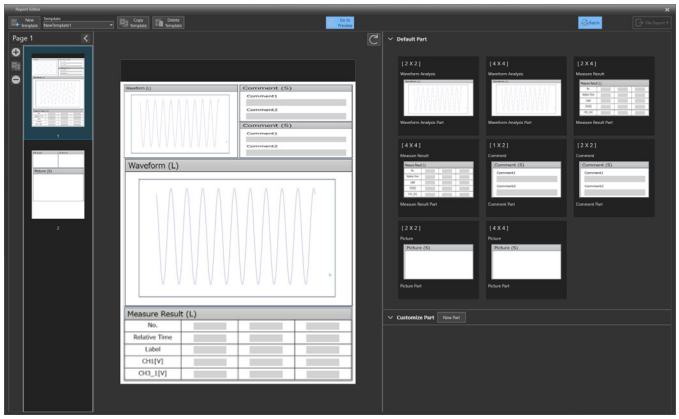


Figure 9. Report template edit screen

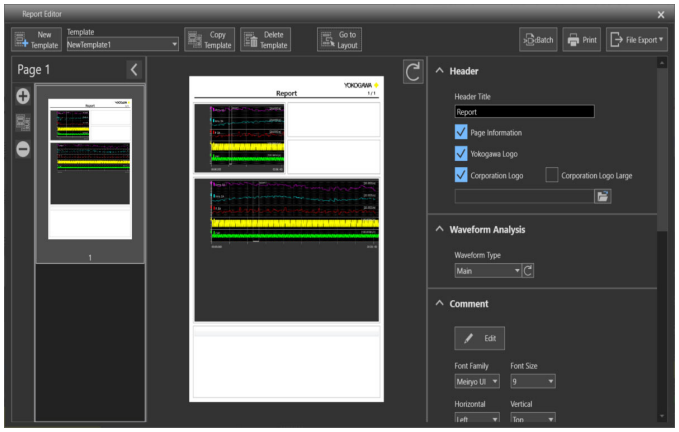


Figure 10. Report creation screen

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