Prospects for Waveform Measurement Solutions

Nobuo Koyanagi [*1]

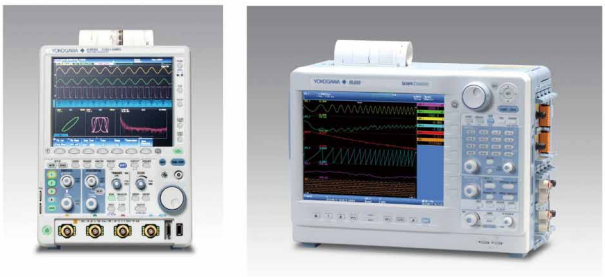
Waveform measuring instruments are one of the most basic measuring devices for observing physical phenomena over time. By changing the technology from analog to digital, these instruments have evolved from a simple unit for observing waveforms to products featuring improved functions of wave data analysis and calculation, and other functions specific to applications. The DL series waveform measuring instruments of Yokogawa Meters & Instruments are ideal for the development of mechatronics and energy-saving products. This paper describes the current situation of waveform measurement solutions and introduces their prospects.

INTRODUCTION

Waveform measuring instruments are measuring devices that satisfy basic needs for intuitively observing physical phenomena. Depending on the target phenomenon, they are called recorders, loggers, or oscilloscopes. As technologies have progressed, the waveform measuring instrument has also changed its system from analog to digital and now can perform long-period measurement by using large-capacity memory, analysis, and advanced computational processing.

Waveform measuring instruments today satisfy diverse requirements. They can measure analog signals such as voltage, current, temperature, strain and acceleration, the digital signals of logic circuits, and serial communication signals. In addition to signal capturing capability, analysis functions have also become sophisticated, and they can perform parameter calculations for frequencies and RMS values, etc., calculations among signals, and frequency analysis by using FFT. They now feature functions specific to applications such as protocol analysis of serial signals, conformity inspection for standards, and high-speed power analysis in the development of energy-saving products.

This paper describes the current situation of waveform measurement solutions and introduces their prospects, taking as examples the DLM2000 mixed signal oscilloscope shown in Figure 1 (a) and the DL850 ScopeCorder shown in Figure 1 (b), both having evolved to satisfy various requirements.



(a) DLM2000 (b) DL850

Figure 1 Waveform measuring instruments

SOLUTIONS FOR MEASUREMENT FIELDS

Debugging and Evaluating Standardized Signals

Serial communication such as USB or Ethernet is widely used for wired communication between instruments. Meanwhile, various other communication standards are used in instruments to reduce wiring costs, including RS-232, I^2C, and SPI in consideration of the communication rate or costs.

When communication is unstable, waveform integrity or operating margins should be verified. In parallel busses, the range to be observed can be located on the basis of the relationship between a clock and each piece of data at this clock. In serial busses, however, the communication protocol must be recognized in order to locate target points or errors. In waveform observation, it is important to specify triggers for selecting the range to be observed and analyzed. The DLM2000 can easily specify triggers by using an auto-trigger function for various serial busses.

The CAN bus with a maximum transfer rate of 1 Mbps is widely used for in-vehicle busses. Although there is another standard with a higher transfer rate (maximum of 10 Mbps)

*1 General Purpose T&M Center,
Yokogawa Meters & Instruments Corporation

called FlexRay, the CAN bus it seems will remain in the mainstream for a while because it can use a wealth of software assets. Meanwhile, the LIN bus, a low-cost bus with a slow transfer rate (maximum of 20 kbps), is also expected to be used for vehicle door control and other applications.

On the CAN and LIN busses, various sensor signals such as vehicle speed and pressure, and actuator signals for valve control, etc., are transmitted. Thus, it is necessary to verify the consistency and timing between analog signals from various sections and signals received and transmitted by ECUs (engine control units and in-vehicle computers) via the CAN and LIN busses. The DL850V ScopeCorder Vehicle Edition can recognize both protocols of the CAN bus and LIN bus and display data as waveform trends.

Serial busses are expected to be used in various applications. Yokogawa's waveform measuring instruments will keep evolving for visualizing the data on those busses to meet user needs.

Evaluating Waveforms in Development of Energy-saving Products

Waveform measuring instruments have been digitalized and now feature computing functions. Displaying a waveform after cancelling waveform characteristics of a specific channel signal can be achieved by simple addition and subtraction between waveforms. However, sophisticated computation is required for developing energy-saving products such as inverters or power conditioners because their efficiency is evaluated on the basis of electric power.

Efficiency improvement, a key issue for inverters, is evaluated on the basis of effective power, which is calculated by multiplying current and voltage values and averaging the result across the waveform cycle time. Therefore, waveform measuring instruments need to have functions to compute channel data and determine one waveform cycle. The DL850 has achieved these features in hardware and can quickly display computed results of every cycle as a waveform. Although its accuracy is lower than that of power meters, the DL850 can observe steep changes in electric power during the start-up of motors or other situations, as well as abnormalities in data including those of digital signals of the control system.

A power conditioner converts unstable DC voltage from solar power generators or fuel cells into AC voltage, and controls the connection with the power grid of electric power companies. To supply power to the power grid (reverse power flow), the quality of the supplying power must be secured to prevent fluctuations in voltage or frequency. So it is necessary to verify the behavior when switching power systems by measuring the waveforms. In the case of a wide-range smart grid, waveforms must be synchronously observed at several points to check the grid connection or cause-effect relationship among those points. However, it is difficult for conventional standalone measuring instruments to achieve this. The DL850 can perform time synchronization based on the standardized signals of the Inter Range Instrumentation Group (IRIG), so it can verify the cause-effect relationship when switching remotely from the measuring location with an accuracy of approximately 1 μs.

In this way, Yokogawa's waveform measuring instruments are incorporating features required for applications and evolving for waveform display.

Probing in Waveform Measurement

In addition to the measuring instrument itself, probing is another important aspect in waveform measuring. An ideal connection (probing) would not affect the device under measurement while capturing signals intact. In reality, however, measuring instruments or probes sometimes act as a load on the signal line, affecting signals and deforming waveforms, or the probe's frequency characteristics or noises prevent precise measurement. Optimal probing of the measurement environment must be ensured.

The signals of the physical layer (standard for electrical signals) of the above mentioned serial busses are often differential signals. In this case, a differential probe should be used. In the case of floating voltage with a relatively low frequency, such as inverter output, an isolation probe is of choice. Yokogawa has a wide lineup of probes to cover broad voltage ranges and frequency bands: from differential probes with a wide frequency band to current measurement probes and isolation probes for developing energy-saving products.

Probing plays a major role in waveform measuring to properly observe waveforms, and the most suitable probe should be selected for the target device. Probes also need to progress along with measuring instruments.

CONCLUSION

Waveform measuring instruments are improving in performance. Equipped with features specific to applications they are being widely used. With concerns over the energy crunch and global warming, most countries including emerging countries continue to invest in the development of energy-saving products. Waveform measuring instruments are expected to offer solutions in this field.

In the development of energy-saving equipment, features such as wide dynamic range and high noise resistance are required. For this, resolution must be improved from 8 bits to 12 bits or 16 bits. Isolated input is effective to eliminate the influence of common-mode noise. Fulfilling both requirements, waveform measuring instruments are then required to operate at high speed.

Yokogawa will continue providing waveform measurement solutions to meet the needs of the times.