WE500/WE900 MEASURING STATIONS FOR THE WE7000 SERIES OF PC-BASED MEASUREMENT INSTRUMENTS

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We have developed the WE500/WE900 measuring stations for the WE7000 series of PC-based measurement instruments. The WE500/WE900 have inherited the conventional plug-and-play architecture and high-speed data transmission function, and achieved even more advanced functionality and higher performance while maintaining compatibility with the conventional measurement modules. Along with the "embedded module" function that performs internal measurement data processing and autonomous operations, the WE500/WE900 come preinstalled with communication functions based on USB and Ethernet interfaces capable of transmitting data at a maximum rate of 480 Mbps.

INTRODUCTION

The WE7000 series of PC-based measurement instruments has been steadily gaining support since its 1998 release as a series of new-concept measurement instruments[(1)(2)]. By taking into consideration the opinions of various users, we have recently developed the new measuring stations, WE500 and WE900 (Figure 1).

The WE500/WE900 measuring stations have inherited the conventional plug-and-play architecture and high-speed data transmission. They have been developed with the aim of achieving advanced functionality and high performance while maintaining compatibility with conventional measurement modules. The function "embedded module" that achieves internal measurement data processing and autonomous operation has been adopted into the stations. In addition, the stations are equipped with USB 2.0 and Ethernet interfaces as standard communication features. In this paper, we report mainly on the new functions of the WE500/WE900.

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OVERVIEW OF WE500/WE900

Design Concept

With its key features defined as high speed, multiple channels and plug-and-play architecture, the WE7000 series of PC-based measurement instruments announced in 1998 consists of the WE400 measuring station, WE800 measuring station and

Figure 1 WE500/WE900 Measuring Stations

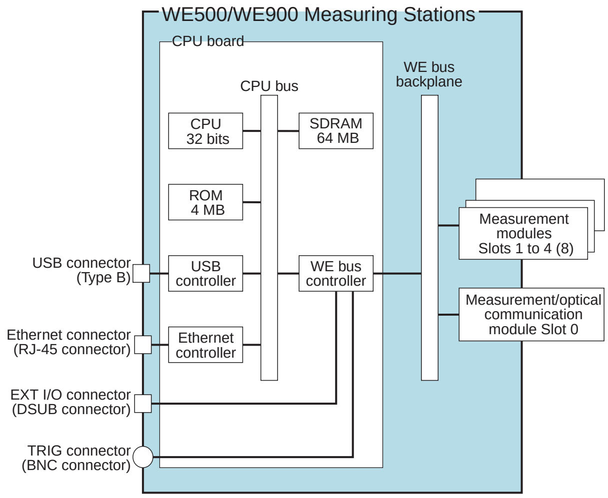

Figure 2 Functional Block Diagram of WE500/ WE900

measurement modules (more than 20 types, including the oscilloscope module and function generator module). The newly developed WE500/WE900 have inherited this design concept. This concept has been further developed while maintaining compatibility with already developed measurement instruments, in order to achieve even more advanced functionality.

Configuration and Features

The WE500 differs from the WE900 only in the number of measurement modules that can be mounted: the former is a 5-slot model while the latter is a 9-slot model.

Although these models are basically the same as the WE400 and WE800 in terms of hardware configuration, improvements have been made mostly to the CPUs within the stations and their peripheral devices in order to achieve increased performance and advanced functionality. Figure 2 shows the functional block diagram of the WE500/WE900.

(1) Increased Speed

An upgraded version of the CPU (improved processing architecture, reinforced cache, inclusion of a floating-point processor, enhanced pipeline processing, and increased internal clock speed) has been adopted and the work memory has also been upgraded to a 64 MB SDRAM. An interface with the WE bus has been newly designed to realize high-speed transmission while maintaining compatibility with existing measurement modules. The USB interface supports up to 480 Mbps, significantly reducing the time required to transfer data to the PC.

(2) Increased Number of Channels

USB and Ethernet interfaces are standard features of the WE500/WE900 main units, making the conventional communication slot available for measurement modules. This means that we were able to add one measurement-channel slot while keeping the enclosure size the same as that of the WE400/WE800.

(3) Simplified DIO Function

A 4-bit simplified DIO function has been incorporated into the EXT I/O connector on the front panel. As a result, it is now possible to control the WE500/WE900 from embedded modules, or from user applications that use the WE control API.

(4) Embedded Modules

Users can configure virtual modules within the WE500/WE900 using software to perform control, calculation, judgment and other processing for individual modules installed in the station(s).

Figure 3 USB and Ethernet Interface Section

COMMUNICATION FUNCTIONS

Communication Interfaces

In the past, the communication interface essential to the WE400/WE800 required the installation of a dedicated communication interface module. This time, however, we have equipped the WE500/WE900 main units with USB and Ethernet interfaces as standard features (Figure 3). The newly employed USB interface conforms to USB 2.0 and supports both high-speed mode (480 Mbps) and full-speed mode (12 Mbps). In addition to the advantage of being able to transfer data faster than the 100BASE Ethernet, this interface is free from troublesome procedures such as setting the IP address, net mask, gateway and DNS. Thus, we have achieved the plug-and-play feature which means: “simply connect it and it is ready for use.” As before, users can still use the optical communication modules that support long-distance data transfer between the WE500 and WE900 and ensure compatibility with intense electromagnetic fields.

Improved Communication Performance

Figure 4 is a graph characterizing the relationship between the volume of data and the transfer rate. The USB interface achieves a transfer rate of 2400 kilobytes/s, and the Ethernet interface achieves 950 kilobytes/s.

Figure 5 is a graph created by plotting the transfer rate of the WE500 on the basis of the transfer rate of the combination of the WE400 measuring station and WE7052 Ethernet interface module. For the respective communication interfaces, we were able to increase the transfer rate by a factor of 1.3 to 3.2.

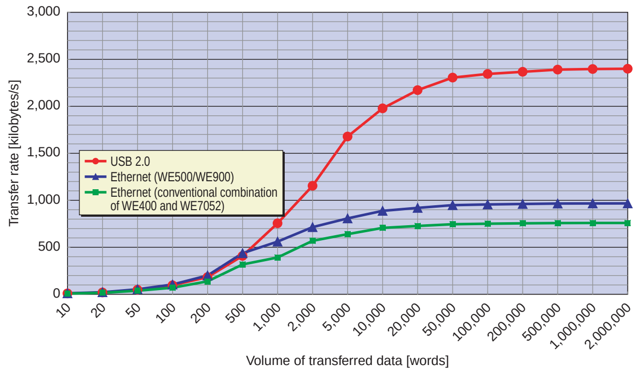

Figure 4 Data Volume vs. Transfer Rate Characteristics

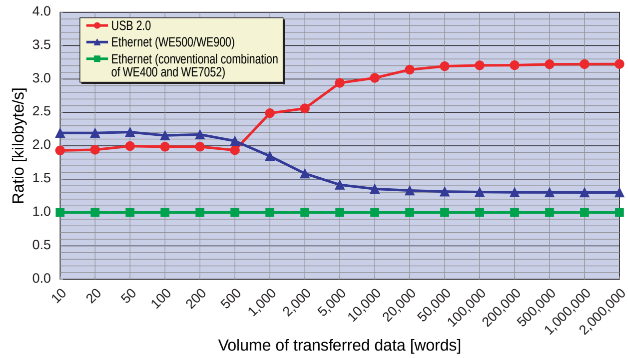

Figure 5 Performance Comparison with Conventional Measuring Stations

TECHNOLOGY FOR FIRMWARE IMPLEMENTATION OF THE EMBEDDED MODULE FUNCTION

The embedded module function allows users to configure virtual modules within the measuring station using software to perform control, calculation, judgment and other processing for individual modules installed in the station. A maximum of four embedded modules can be brought into operation within a single measuring station by downloading the relevant program from the PC to the flash memory of the measuring station.

Features

The features of the embedded module function are as follows:

(1) Autonomous Operation

As the name of the traditional/conventional WE7000 series 'PC-based measurement instrument' implies, it was necessary for the PC to conduct all types of control. However, by pre-loading embedded modules, it is now possible for the WE7000 series to operate in routine mode with no PC connected.

(2) Virtual Measurement Module Function

As in the case of real measurement modules, dedicated setup/operation panels can be started from the WE7000's standard software. It is also possible to use a variety of functions, such as monitoring waveforms, saving measured data and storing setup information, available with the software.

(3) Real-time Processing

Since the embedded module function does not involve any control in conjunction with external equipment, measurement instruments can be controlled at speeds at least one order of magnitude higher than before.

(4) Advanced Computing

By taking advantage of the enhanced CPU performance, it is now possible to perform advanced arithmetic processing that could traditionally only be performed on a PC, such as fast Fourier transform, within the measuring station.

Basic Architecture

Embedded modules refer to real-time operating system (μITRON 2.0)-based task programs that run on the CPU within the measuring station. The basic software architecture of these modules is the same as that of the driver program contained in measurement modules. In a physical sense however, the programs for the embedded modules are stored in the flash memory of the measuring station, while the driver programs for the measurement modules are stored in the flash memory of the modules (Figure 6).

Available Resources

Table 1 illustrates resources that can be used in a program for a single embedded module.

Development Environment

(1) Compilation Environment

The C/C++ cross compiler developed by Green Hills Software, USA, must be used to configure embedded modules.

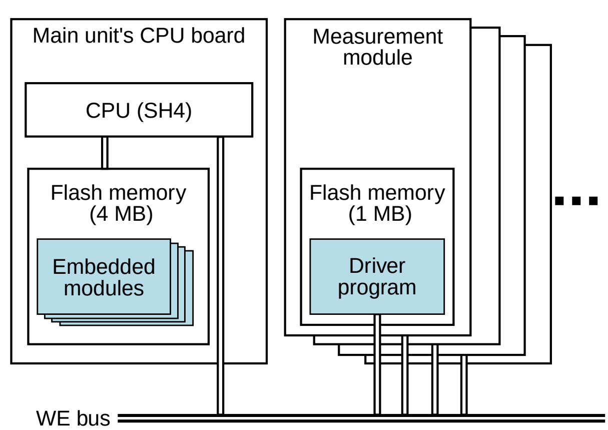

Figure 6 Basic Architecture

Table 1 Resources Available for Embedded Modules

Resource	Quantity of Resource Items Available per Embedded Module
Task	5
Event flag	5
Semaphore	5
Interval timer	1
RAM (SDRAM)	16 MB
ROM (flash memory)	512 KB

(2) Libraries
The library called STLib, which is packaged with OS system calls, measurement module control routines and arithmetic routines, is available. With this library, it is possible to configure embedded modules without the need for any in-depth knowledge of WE7000 series module architecture.

(3) Documents
Development procedure manuals, library interface specifications, and sample programs are available so that system development can be promoted only if the user has a basic knowledge of the C language and real-time operating systems.

(4) Methods for Obtaining Libraries/Documents
Yokogawa is ready to provide the abovementioned library and documents on CD-ROM only if users sign a nondisclosure contract with the company.

Specific Examples of Embedded Modules

Some specific examples of embedded modules are discussed below:

(1) High-speed Go/No-Go Analyzer
This analyzer calculates the min-max values of channel-by-channel waveforms measured with the WE7111 100-MHz digital oscilloscope module. If any of these min-max values is out of the setting range, a given logic output is provided from the simplified DIO terminal of the measuring station (Figure 7). The analyzer can cope with each Go/No-Go judgment approximately 20 ms faster than when the same function is realized using PC applications.

(2) FV Converter
This converter performs first-order conversion on the frequencies measured with the WE7521 timing measurement module and outputs the results through the WE7281 D/A module. The period of conversion is 10 ms. The conversion delay of this embedded module-based converter is less than 2 ms, while the conversion delay is more than 15 ms when the same function is realized using PC applications.

(3) Autonomous Monitoring/Recording Unit
This unit saves data in the main memory for one hour each

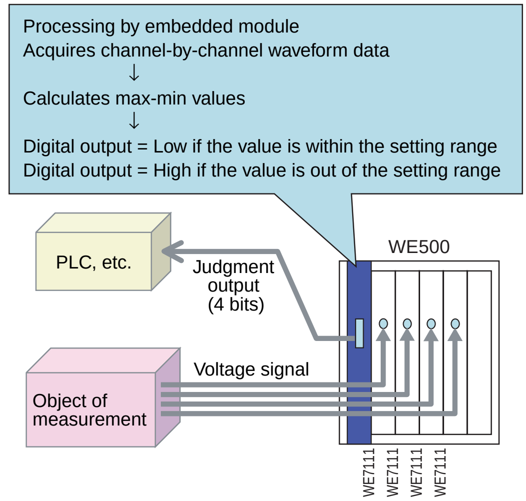

Figure 7 High-speed Go/No-Go Analyzer

before and after the moment the measured value of the digitizer module exceeds the reference range. It returns the data when requested by the PC. This embedded module-based unit (number of channels: 16 max., sampling interval: 10 ms min.) is characteristic in that it requires no PC during measurement.

CONCLUSION

The WE500/WE900 measuring stations developed this time specifically feature even higher-speed multichannel measurement and an even higher degree of compatibility with PCs. While inheriting the design concept of the WE7000 series, we have implemented the USB interface and embedded modules to increase the performance and functionality of the measuring stations. We will continue to incorporate opinions from users and expand the family of applications.

REFERENCES

(1) Yamaguchi Yuuji, et al., “WE7000 Series of PC-based Measurement Instruments”, Yokogawa Giho, Vol. 42, No. 3, 1998, pp. 107-110 (in Japanese)

(2) Yamaguchi Yuuji, et al., “WE7000 Network for KEK Proton Synchrotron”, Yokogawa Giho, Vol. 44, No. 1, 2000, pp. 45-48 (in Japanese)