FIELD INFORMATION SERVER

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We have developed Field information server "Fis" and software "Fis.View". "Fis" provides acquisition and delivery functions of such field data as meteorological and hydrological data via networks. "Fis.View" runs on PCs and provides an interface function to integrate the information from each Fis via networks, along with displaying information for better viewing on PCs. Since Fis features modularized signal converters for each sensor only by selecting sorts and numbers of converters, the Fis's unit build system can provide users with the ability to build up a suitable Fis system for each application. A converters implements primary processing of input data from filed sensors and stores it. After a CPU module collects these data from each processor, the CPU implements higher-level data processing and transmits them to outside users via networks. With this system, a monitoring system for remote field data can be constructed easily.

INTRODUCTION

Nowadays more and more information is available anywhere through various terminals connected to networks, in this age of a ubiquitous, broadband world. This year the number of broadband users in Japan is expected to surpass that of any other nation.

Information about meteorology—rainfall, wind direction and speed, sunshine and solar radiation, temperature, atmospheric pressure, humidity, and visibility—and hydrology—water level, flow, and temperature—is small in quantity per unit but are scattered over a vast area. Collecting them and understanding their distribution and change is very useful for disaster prevention, recreation, and natural resources management. Yokogawa Denshikiki Co., Ltd. has been providing the corresponding sensors, and information systems as well by configuring networks based on personal computers. Considering the current of the times, we have subsequently developed and released the Field Information Server (Fis)—a system that can easily send field information to networks.

SYSTEM CONFIGURATION AND OPERATION

Figure 1 shows an example of Fis-based environment measurement systems. It is comprised of sensors for weather and water measurement, Fises for receiving sensor signals and passing them on to networks, and a Fis.View which runs on networked personal computers. Fis.View gathers weather and hydrological information from Fises via FTP or socket communication over network and is capable of collectively displaying data of up to 20 Fises, as well as serving the integrated data through the Web. Each Fis is also equipped with Web capability and thus makes its information accessible from personal computers on networks using Internet Explorer or other browsers, but other Fis' information cannot be combined. Further details will be described in the following pages.

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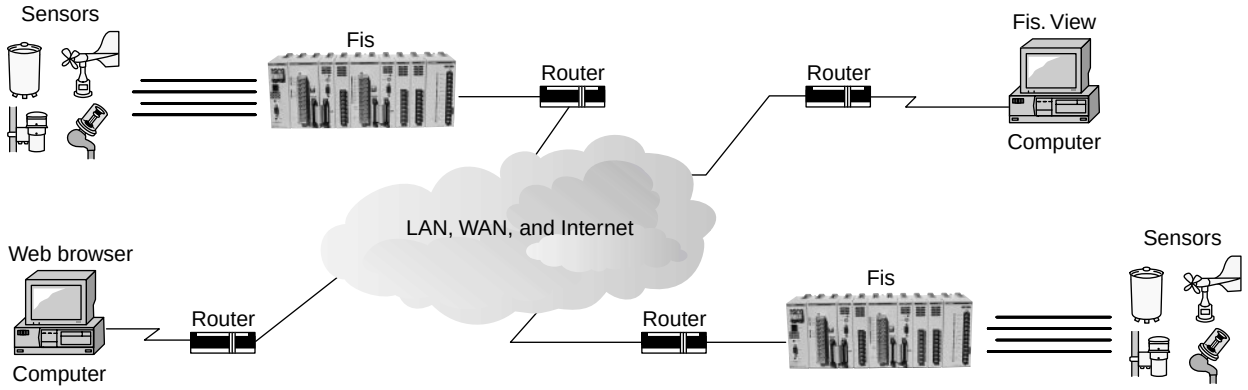

Figure 1 Example of Fis-Based Environment Measurement Systems

HARDWARE CONFIGURATION

Fis Configuration

(1) Design Concept

Environmental measurement not only involves outdoor sensors and transmitters but also is usually performed at intermontane areas or other locations to which there is limited access. Applications can also select different combinations of measurement elements. Therefore the measurement systems need sufficient reliability and lightning resistance to avoid missing data, and must be able to recover immediately in case of failures. To this end, Fis provides remote fault diagnosis and program downloading functions, in addition to a hot swap function. Both converter modules and terminal modules, which are paired with sensors, can be replaced without affecting other modules' operation.

(2) Configuration

Figure 2 shows an external view of Fis. Its function-by-function modules can be freely selected and installed to a base module. A Fis, which can be flexibly deployed for small to large systems, is comprised of a power supply module, a CPU module, converter modules, terminal modules, and a base module.

Table 1 lists Fis modules. Terminal modules come between environment sensors and converter modules in order to absorb external noise.

Converter modules receive signals from such environment sensors as anemometers and rainfall gauges, perform various computations with the measurement data, and then output them to external equipment while communicating with a CPU module.

The CPU module collects and saves measurement data—which were run statistic and subject to other operations in converter modules—and static images taken by Web-ready cameras. These data can be viewed on other computers' Web browsers by way of networks.

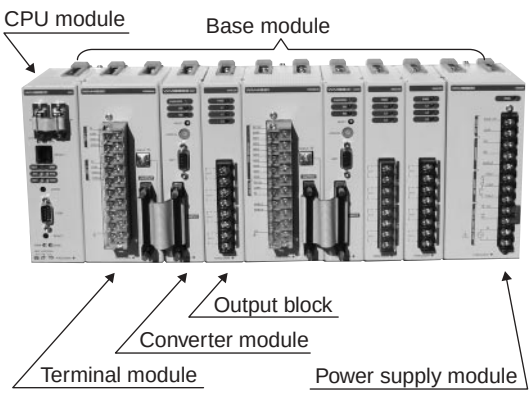

Figure 2 External View of Fis

Table 1 Fis Modules

☆Converter Modules

Model	Module
WM8841	Wind module
WM8842	Temperature and humidity module
WM8844	Temperature module
WM8845	Rain module
WM8847	Sunshine and radiation module
WM8850	Air pressure module
WM8851	Snow module
WM8852	Visibility module
WM8862	Analog input module
WM8871	Flow module

☆Common Modules

Model	Module
WM8801	CPU module
WM8201	Base module
WM8831	Power supply module
WM4521	Terminal module*

* Required for each converter module.

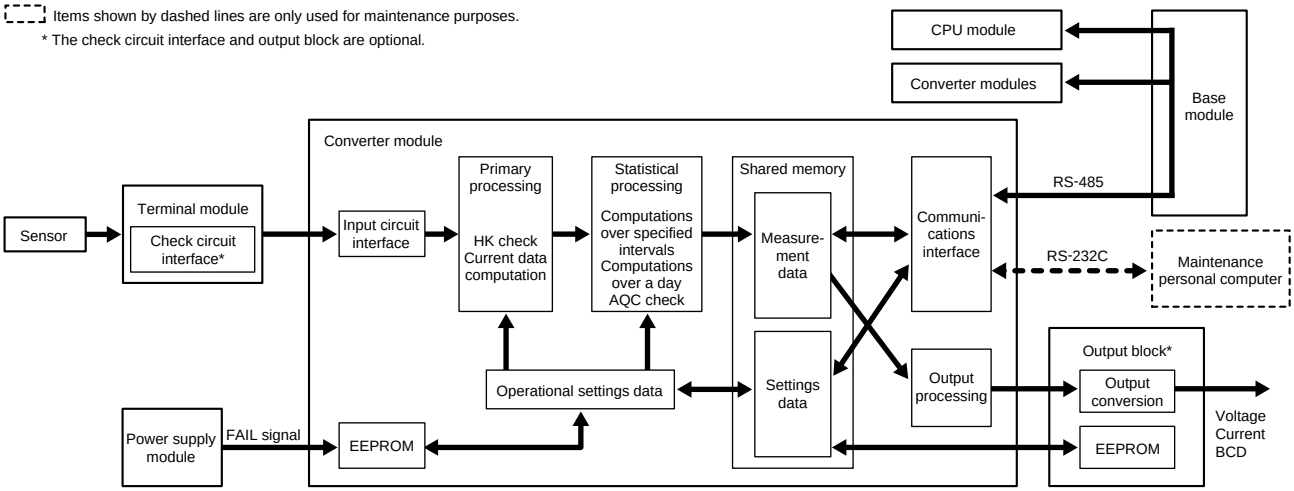

Figure 3 Block Diagram of Data Processing

Data Processing

Figure 3 shows the block diagram of data processing.

(1) Data Processing by Converter Modules

Sensor signals are input to a terminal module and then to a converter module. The input signals are converted by input circuits that are electrically insulated from the internal logic circuit, primary and statistical processing is performed, and the results finally written to shared memory as measurement data.

(2) Module-to-Module Communications

The CPU module and a converter module exchange data with each other through a serial communication means (RS-485). The CPU module accesses the converter module's shared memory at intervals of a minimum of three seconds to read measurement data. The CPU module can also set operations of converter modules.

(3) Maintenance Functions

Each converter module is equipped with a maintenance port on its front panel. By connecting a personal computer to this port, data can be exchanged through a serial communication means (RS-232C). Specifically, measurement data can be read from the converter module and settings data can be written into the converter module.

(4) Output Processing

Output signals are set directly by the converter module's own CPU so that an output block can respond quickly by outputting signals—voltage, current, and BCD. Settings specific to the output block, including D/A converter parameters, are stored on EEPROM. When the output block has been replaced, the initialization process reads the settings from EEPROM to shared memory, which eliminates the need for a resetting operation of the converter module.

(5) Power Failure Processing

When converter modules detect a FAIL signal from the power supply module, indicating failure of a primary power, they save certain types of measurement data to EEPROM and thus can maintain data continuation after the power is turned on again.

(6) Check Circuit

By installing the optional automatic check board to their terminal modules, the input circuits of converter modules can be automatically and periodically checked (see Figure 4). As normal measurement needs to continue even during this check, converter modules are checked using the following procedure.

The automatic check board periodically generates simulated sensor signals. Converter modules have two input circuits for every single input from sensors. One of the circuits always receives sensor signals, while the other is usually used for actual sensor signals but switches inputs for simulated signals for checking. This can verify that the two input circuits are operating normally.

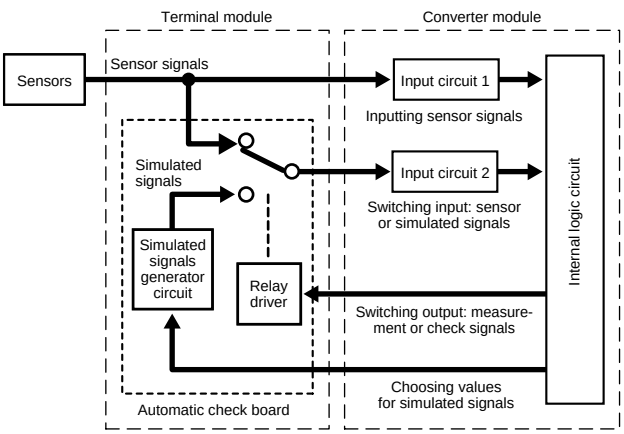

Figure 4 Block Diagram of Check Circuit

CONVERTER MODULES' FUNCTIONS

This chapter describes the features of converter modules' functions.

Meteorological and Hydrological Processing

In the primary processing, an average and integrated value for each measurement element are calculated to obtain the current value. Next the statistical processing computes maximum and minimum, integrated, and other values, over specified intervals and for a day.

Quality Management

(1) HK Information

HK (House Keeping) information is used for comprehending the operating statuses of measurement equipments. It is intended to minimize the duration when measurement data are missing, and to maintain data continuation by monitoring the equipment statuses regularly. The statuses indicated by HK information are divided into two ranks as follows, depending on the seriousness of module abnormality.

Rank A: Failures which disturb normal measurement.

Rank B: Failures which do not disturb normal measurement instantly but will do so if no appropriate measures are taken.

Examples of HK information for wind modules are as follows:

- Wind speed sensor's power error (Rank A)
  This information is used to monitor the status of the power supplied to the wind speed circuits of anemometers, and to detect failures in the power supply circuit, broken wires in sensor cables, poor electrical contacts, etc.
- Wind direction bit error (Rank A)
  This information is used to monitor the wind direction input. The wind direction is detected with a rotating sensor and should be continuously changing. Therefore, if the wind direction changes discontinuously, it can be considered as some kind of failure.

(2) AQC Information

AQC (Automatic Quality Control) information is designed to maintain measurement data quality by monitoring data in order to catch abnormal data and prevent them from being transmitted. As is the case with HK information, the statuses indicated by AQC information are also divided into two ranks.

Examples of AQC information for wind modules are as follows:

- Wind speed input's overrange error (Rank A)
  This information is used to check instantaneous wind speed and an error occurs if the speed exceeds specified ranges.
- Prolonged same wind direction error (Rank B)
  This information is used to monitor the time period in which the same instantaneous wind direction continues. An error occurs if the direction remains unchanged for more than a specified time period, and will not be cleared until the instantaneous wind direction changes.

Table 2 Status Information

Status		Description
0	Normal	Normal measurement without missing source data
1		No measurable episode* without missing source data
4		With 20% or less of missing source data
5		No measurable episode* with 20% or less of missing source data
6		Includes Rank B AQC information
8	Data quasi-missing	With more than 20% of missing source data
9		No measurable episode* with more than 20% of missing source data
A		Includes Rank A AQC information
B		Under maintenance
C	Data missing	All the source data are missing
D		Under maintenance with all the source data missing
E		Data missing intentionally
F		Invalid or not measured

* "No measurable episode" means that the magnitude of data is not enough for valid measurement: calm, no precipitation, no sunshine, etc.

(3) Status Information

After statistical processing, measurement data have extra bits of information expressing the data statuses. This status information is categorized in detail as shown in Table 2, thereby helping improve data quality and analyze failures.

External Output

The external output is available in an analog output block with up to four voltage channels or one or two current channels, and a BCD output block with one channel.

A single converter module can be fitted with up to two external output blocks, where the two types of blocks can freely be paired for facilitating the configuration of minimum-scaled systems tailored for applications.

Moreover, the internal Plug-and-Play function enables output blocks connected with converter modules to be automatically recognized at power-up, and outputting of predefined measurement data starts immediately. The desired output elements or scaling can also be changed.

Firmware Upload

Relying on an MPU with built-in flash memory, converter modules facilitate uploading firmware from external equipment, and remote maintenance which is described in the next chapter.

Firmware can be uploaded using a personal computer through a dedicated tool, or a Web browser via the CPU module, according to systems or applications.

Common Platform

Adopting the same CPU board for all the converter modules ensures flexibility for the basic architecture of the software, thereby increasing software quality and competitive prices even if the software is developed in a limited period.

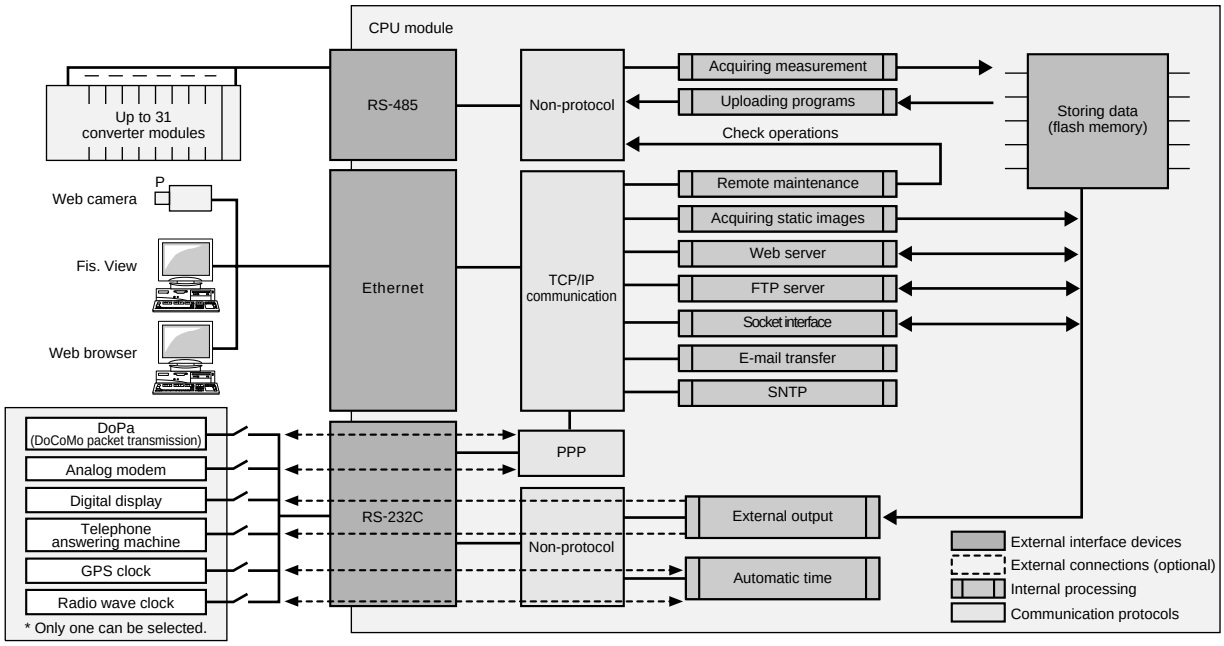

Figure 5 Functional Structure of CPU Module

CPU MODULE'S FUNCTIONS

Figure 5 shows the functional structure of the CPU module. The CPU module gathers and stores measurement data from converter modules connected to it, and static images from a Web camera. These data can be downloaded to a networked computer and viewed on a Web browser.

Software Design Features

The quality of the CPU module's internal software has been improved by incorporating the following design features:

- Development process utilizing XP (eXtreme Programming)
- Object-oriented analysis and design technique based on UML (Unified Modeling Language)
- Program structures which combine fewer, simple logic operators based on cyclomatic complexity. This ensures software reliability due to ease of testing, and maintainability since it is easy to understand and modify.

Communication Features

The CPU module offers upper and lower communications capabilities.

(1) Upper Communications

Ethernet and RS-232C communications are available, which provide various functions—including transferring measurement data files, displaying them on a Web browser, socket communication, e-mail transfer, and measurement conditions setting—by way of TCP/IP (Ethernet) or PPP (RS-232C).

(2) Lower Communication

RS-485 communication is used for collecting measurement data from converter modules that are connected with the CPU module in a multidrop manner via the base module, and setting measurement conditions to converter modules.

Measurement Data

(1) Data Items

In addition to the conventional numerical information, visually friendly static images from a Web camera can also be processed as measurement data. This is because images can be more informative and useful in assessing situations than numerals, such as a water level of 10 m and a flow speed of 8 m/s in a typhoon. Our proposal of harnessing numerals in combination with images can bring a new type of benefit to the environmental measurement market.

(2) Storage Formats

Numerical measurement data are saved in a CSV file and static images in a JPEG file. These files can be downloaded to a user computer via FTP.

(3) Storage Media

Taking the recording intervals into account, we employed flash memory as the storage media for measurement data, which reliably offers a servicing period of at least 10 years.

Network Services Functions

The CPU module provides computers and their users hooked up to upper communication lines with the following services:

(1) Web Server

Displays measurement data and equipment statuses on a Web browser and gives a means of changing settings.

(2) FTP Server

Allows measurement data to be downloaded.

(3) E-mail Transfer
Notifies system administrators of measurement equipment failures, including sensors, and any data abnormality.
(4) Socket Interface
Allows the acquisition of measurement data and settings changes, and notifies system administrators of measurement equipment failures, including sensors, and any data abnormality.

Automatic Time Adjustment

The CPU module is standard-equipped with an automatic time adjustment function using radio waves, GPS, or an SNTP clock, to facilitate performing measurement in standard time.

With the existing systems, a marginal time lag between measurement equipment in the field and upper equipment, caused trouble, for example, in which old data was collected before being updated.

Adopting standard time ensures not only more reliable measurement data but also the configuration of measurement systems, including that of upper equipment, without being conscious of time synchronization.

Remote Maintenance

Fis and sensors are often installed outdoors or in remote rural areas, which requires them to operate continuously under harsh conditions. As missing data can cause serious problems to environmental measurement, achieving good maintainability is essential such as periodical inspections or isolating failures promptly. Furthermore, when used for research institutions, Fis systems must accommodate frequent changes in measurement or statistical methodologies. To respond to these requirements immediately, Fis offers the following network capabilities.

- Self-diagnosis and reference to various logs
- Referring to and changing threshold levels and settings
  On-line overwriting of internal software (Firmware upload)

Alarm Notification

Basically Fis systems, powered by an uninterruptible power supply, continuously operate and measure environment data without human intervention. If there is a possibility of interruption of measurement, some measures must be taken so that administrators are notified of failures or abnormalities without delay in order to minimize the effects of missing data.

To this end, Fis is equipped with e-mail transfer capability and event notification through socket communication, both of which are triggered by HK and AQC information which converter modules detect.

HK and AQC information, however, can frequently change under circumstances, which might cause an excessive amount of e-mail or events to be issued, or the importance of the information to vary depending on the users. Therefore various conditions can be specified, such as the type of information and ranks to be issued, issuance timing, or dead times.

Fis.View EXTENSIONS

Meteorological and hydrological data and static images measured by Fis can be transmitted to its upper Fis.View, a GUI application software running on Windows, to provide a variety of contents as well as distribute interactive information on the Internet via Web servers.

Fis.View can connect to a maximum 20 Fises through LAN or other communication lines, and automatically handles such processes as collecting data, building databases, and statistical transactions including monthly and yearly compilations. All sorts of data stored in databases can be displayed and printed as reports or graphs, serially output to external equipment, and edited to re-build databases as well.

In addition, diverse package software can be created based on Fis.View to offer the most appropriate contents to many fields—including road-related weather, fire fighting, dams, and rivers—thereby offering high-value-added functions.

CONCLUSION

Network capability seems boundless and there will continue to be additional services in the future. Yokogawa Denshikiki Co., Ltd. will provide network systems to precisely convey the relevant information, together with new sensors. ◆

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