MELSEC iQ-R Series Energy Measuring Module

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1. Introduction

The revised Japanese energy saving law requires applicable companies to introduce energy management; accordingly, production sites need to work harder to save energy. Under these circumstances, requirements for measuring instruments have been changing, for example, measurement points need to be fractionalized and management of unit consumption needs to be improved by managing energy data and production data collectively.

In addition, it is increasingly necessary to monitor equipment statuses using measured data at production sites to reduce equipment maintenance costs and downtime.

Mitsubishi Electric Corporation has developed a new model of energy measuring module, the MELSEC iQ-R series, to satisfy such needs.

This paper describes the characteristics of the energy measuring module and its technologies.

2. Outline of the Energy Measuring Module

2.1 Product specifications

The RE81WH energy measuring module was developed as the MELSEC iQ-R series. Table 1 lists its main product specifications.

The module is directly inserted into a slot of a sequencer to reduce the work of laying communication lines and creating ladder programs for communications. In addition, the module can collect data at high speed through communications using the system bus of the MELSEC iQ-R series.

Furthermore, compared to the conventional equivalent model, the QE81WH of the MELSEC Q series, the effective value measurement cycle was shortened to one 25th (1/25) from 250 to 10 ms. This improvement has made it possible to monitor equipment statuses more minutely by analyzing current and voltage values.

Moreover, the new model has functions not found in the conventional MELSEC Q series, including those for measuring instantaneous values (on a cycle of 254 μs) and harmonics. These functions can detect high-speed and minute changes that cannot be detected by measuring effective values, enabling more accurate monitoring of equipment statuses.

2.2 Product concept

(1) Realization of equipment status monitoring by shortening the effective value measurement cycle

Usually, when measured values are used for energy management, the measurement cycle does not need to be short, for example, when checking the trend of the electric energy per hour. Therefore, methods in which values measured on a measurement cycle of several hundred ms are collected every minute through communications are used. However, to use measured values for maintenance, the measurement cycle of several hundred ms may not be enough to detect an equipment malfunction. Therefore, for this module, the effective value measurement cycle has been made shorter (to 10 ms) to enable equipment statuses to be monitored more minutely (Fig. 1).

(2) Improved maintenance work using instantaneous values and harmonics

This module has a function for measuring instantaneous values to detect equipment malfunctions by detecting changes at higher speed that cannot be detected using effective values. By measuring instantaneous values, it is possible to monitor the raw waveforms of actual voltages and currents, and thus monitor equipment statuses more minutely (Fig. 2).

In addition, the harmonic measurement function makes it possible to easily obtain analysis results of fast Fourier transform (FFT) with the power supply frequency (50/60 Hz) as the frequency resolution.

(3) Space saving, wire saving, and easy measurement

Many energy management systems are configured as stand-alone measuring instruments and data is sent to higher-level systems (e.g., sequencers) through communications.

Due to this configuration, even for measurement of equipment with a sequencer, (1) space for installing a measuring instrument is needed, (2) a communication line needs to be laid, and (3) a communication program needs to be created. Therefore, much space is required and the cost tends to be high.

To solve such problems, this module is configured by directly inserting it into a slot of a sequencer (Fig. 3), thus offering the following advantages:

(i) Using an empty slot of a sequencer base saves space.

(ii) Direct connection with the sequencer can collect

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Table 1 Specifications of RE81WH energy measuring module

Item				Specifications
Model				RE81WH
Measurement specifications	Phase and wire type			Single-phase 2-wire, single-phase 3-wire, and three-phase 3-wire
	Instrument rating	Voltage circuit	Single-phase 2-wire Three-phase 3-wire	Direct input: 110 and 220 VAC Combination with a transformer for measuring instruments (VT): 1 to 6,600 V
			Single-phase 3-wire	110 VAC (between the first and second wires and between the second and third wires) and 220 VAC (between the first and third wires)
		Current circuit		Direct sensor input: 5, 50, 100, 250, 400, and 600 AAC Combination with a converter (CT): 1 to 6,000 AAC
		Frequency		50/60 Hz (automatic discrimination)
	Number of measurement circuits			1
	Tolerance of measure-ment items	Effective values		Current, voltage, electric power, reactive power, and apparent power: ±1.0% (when the rating is 100%) Frequency: ±1.0% (45 to 65 Hz) Harmonic current and harmonic voltage: ±2.5% (when the rating is 100%) Power factor: ±3.0% (when the electrical angle is 90°) Electric energy: ±2.0% (5 to 100% of the rating, power factor = 1) Reactive energy: ±2.5% (5 to 100% of the rating, power factor = 0)
		Instantaneous values		Current and voltage
	Data update cycle			10 to 10,000 ms (can be set at intervals of 10 ms)
	Response time			100 ms or less
Power interruption backup				Backup to a nonvolatile memory (Storage items: Set values, maximum and minimum values, electric energy, and reactive energy)
Number of occupied I/Os				32
External size				27.8 (W) × 106 (H) × 107.1 mm (D), excluding protrusions
Functions	Measurement			Measurement and weighing are performed and the data is successively stored in a buffer memory.
	Periodic electric energy			The electric energy only when the input signals are on is measured and it is successively stored in a buffer memory. (Can be used to determine the electric energy only when equipment is functioning, for example)
	Maximum and minimum values hold			Stores the maximum and minimum values of current, voltage, electric power, and power factor along with the times of occurrence
	Upper and lower limit alarms			Monitors the upper and lower limits of the measured values and outputs the monitoring results as output signals
	Testing			Without current and voltage applied, outputs fixed values to a buffer memory (Can be used to debug ladder programs, for example)
	Integrated value set			Presets the integrated values (electric energy and reactive energy) to any values

data without communications.

(iii) The data can be easily managed with the sequencer only by FROM and TO commands from the sequencer.

3. Characteristics and Technologies for Commercialization

3.1 Shorter effective value measurement cycle

When computing measured values, current and voltage values are input into measuring instruments and then A/D converted into digital values to compute voltage, current, electric power, and other items.

Mitsubishi Electric's measuring instruments (e.g., QE81WH, equivalent model of the MELSEC Q series) use special computation software to calculate measurement values. For the new module, the digital filter used for the computation software was refined to improve the response characteristics, which has shortened the measurement cycle.

3.2 Instantaneous value measurement function

The volume of data is larger with instantaneous values than effective values, making it more difficult to process such data. To solve this problem, this module provides two data acquisition methods; users can select

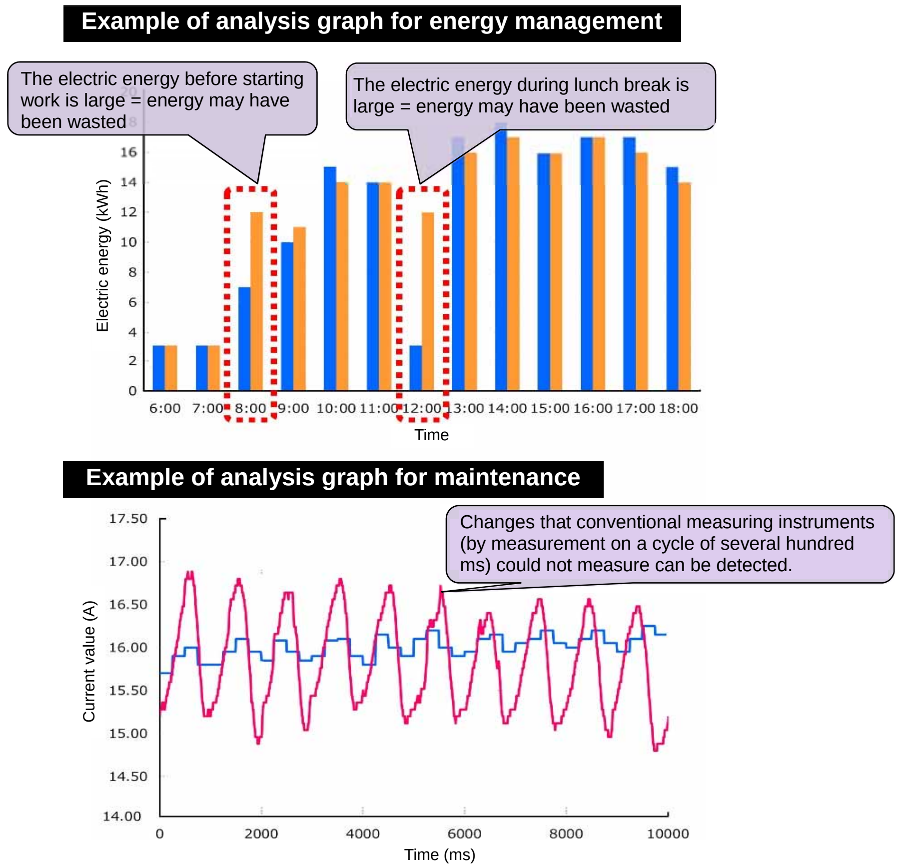

Fig. 1 Examples of graphs for various applications

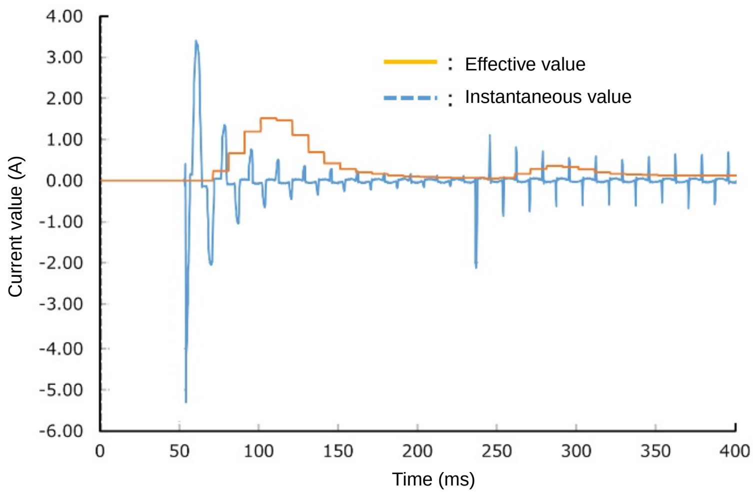

Fig. 2 Example of waveform of instantaneous values

the optimum one based on the length of scanning time and ease of data analysis.

(1) Method of obtaining every data item separately (254 μs)

The energy measuring module stores instantaneous values in one buffer memory on a cycle of 254 μs. Data needs to be obtained faster than the instantaneous value measurement cycle (254 μs) and thereby a shorter scanning time is required for operation, which makes it difficult to coexist with other processing (e.g., control of production equipment). However, when data is converted into CSV, a time stamp can be added to each data item, making it easier to analyze the data on PCs and other devices (Fig. 4a).

(2) Method of obtaining a set of data for a certain period at a time

Data for up to 50 ms is accumulated in the module and once the accumulation is complete, the set of data is stored in multiple buffer memories at a time. Since data is obtained every 50 ms, one time stamp is added per 50 ms (196 data items). Therefore, separate time stamps need to be manually added, which makes analysis complicated. Meanwhile, the scanning time can be longer in operation, which makes it easier to coexist with other processing (e.g., control of production equipment) (Fig. 4b).

3.3 Simple analysis of instantaneous values using harmonics

This module has a harmonic measurement function to monitor equipment statuses based on waveforms (instantaneous values). This function enables the results of FFT analysis to be obtained with the power supply frequency (50/60 Hz) as the frequency resolution as measured values.

Using this function enables monitoring of changes in frequency components in waveforms, making it possible to detect abnormal waveforms.

3.4 Conformance to overseas standards

We have obtained CE marking and UL mark, certifying compliance with overseas standards (requirements), targeting customers overseas and to enable our modules to be installed in systems for overseas markets.

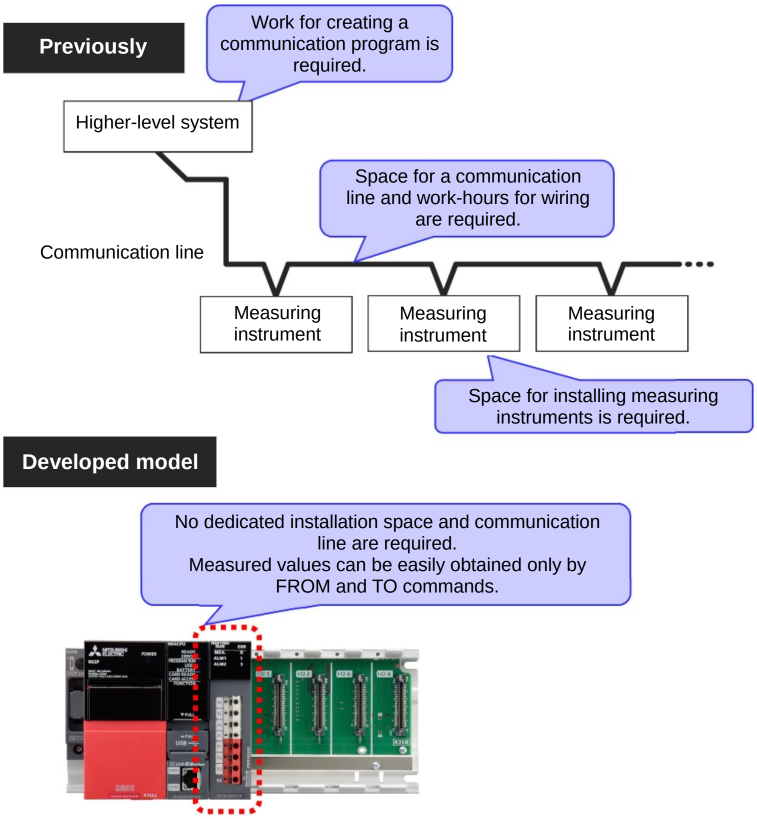

Fig. 3 Advantages of insertion into a sequencer slot

→ : Data order

Time stamp	Instantaneous value
0 μs	1
254 μs	2
508 μs	3
762 μs	4
1016 μs	5
1270 μs	6
1524 μs	7
1778 μs	8
2032 μs	9
2286 μs	10
⋮	⋮

(a) Method of obtaining every data item separately (254 μs)

Time stamp	Instantaneous values						
	0 μs	254 μs	508 μs	762 μs	1016 μs	…	49530 μs
0 ms	1	2	3	4	5	…	196
50 ms	197	198	199	200	201	…	392
100 ms	393	394	395	396	397	…	588
150 ms	589	590	591	592	593	…	784
200 ms	785	786	787	788	789	…	980
250 ms	981	982	983	984	985	…	1176
300 ms	1177	1178	1179	1180	1181	…	1372
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

(b) Method of obtaining a set of data for a certain period at a time

Fig. 4 Example of CSV file output

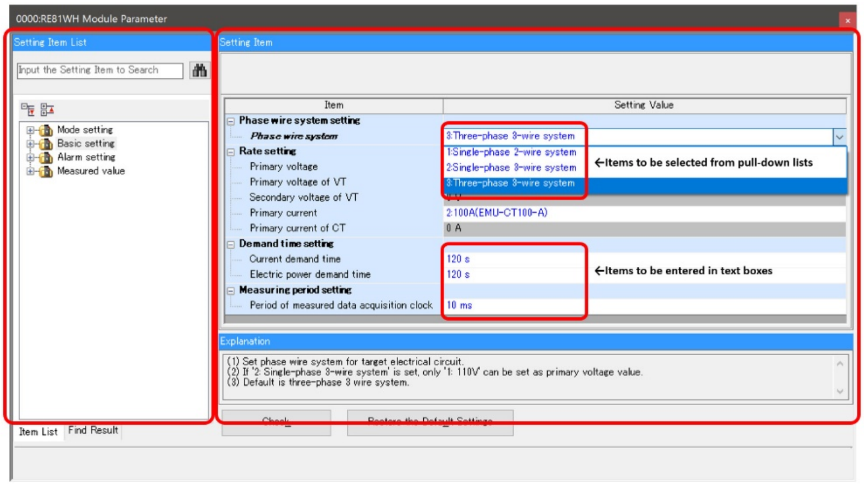

Fig. 5 Parameter setting screen

3.5 Development of an engineering environment

To perform the initial configuration necessary for measurement (e.g., setting of phase and wire type, primary voltage, and primary current) easily, this module has been made compatible with the parameter setting function of intelligent units (Fig. 5). This allows the initial configuration to be performed by easy operations (e.g., selecting options from pull-down lists), thus reducing the hours required for engineering.

4. Conclusion

This paper described the MELSEC iQ-R series energy measuring module that contributes to energy management and maintenance work by customers.

We will continue to develop products that contribute to customers' energy management and maintenance work by improving the functions of this module and proposing comprehensive solutions including stand-alone measuring instruments, such as the EcoMonitor series.