ISSN 1345-3041

Jun.2014 / Vol.146

Mitsubishi Electric

ADVANCE

Latest FA Equipment and Industrial Processing Systems

MITSUBISHI ELECTRIC
Changes for the Better

Jun. 2014 / Vol. 146
Mitsubishi Electric
ADVANCE
Latest FA Equipment and Industrial Processing Systems

• **Editorial Inquiries**
Kiyoshi Sakai
Corporate Total Productivity Management
& Environmental Programs
Fax +81-3-3218-2465

• **Product Inquiries**
Masaki Mizuuchi (p.2 - p.5, p.11 - p.18)
Product Marketing Section
Overseas Planning & Administration Department
Fax: +81-3-3218-6820

Gota Yoshiyama (p.6 - p.8)
Strategic Planning Section
Numerical Controller Business Development Dept.
Fax: +81-3-3218-6820

Hiroshi Mitake (p.9 & p.10)
EDM/Laser Marketing Section
Industrial Automation Machinery Dept.
Fax: +81-3-3218-6822

Mitsubishi Electric Advance is published on line quarterly (in March, June, September, and December) by Mitsubishi Electric Corporation.

CONTENTS

Technical Reports

Overview 1
by *Fumihiko Kimura*

Simple Motion Module & Servo Amplifier Compatible with Motion Control Function of CC-Link IE Field Network 2
by *Takuya Sakaishi* and *Masao Amano*

Highly Cost-Effective CNC “E70 Series” 6
by *Susumu Hamamoto* and *Yoji Tsutsumishita*

New Fiber Laser Processing System “NX-F Series” 9
by *Toshiki Koshimae* and *Takashi Inoue*

“iQ Sensor Solution” by FA Integrated Engineering Software “MELSOFT iQ Works” 11
by *Naoki Takeshita* and *Akira Fujisawa*

High-Speed Universal Model QCPU Module 14
by *Takayuki Suzuki* and *Yasuhiko Chiba*

Energy Measuring Unit for MELSEC-Q Series 16
by *Masayoshi Shimoe*

Precis

To be a Global No.1 FA supplier, Mitsubishi Electric has been promoting the factory automation business, developing easy-to-use products that can be marketed globally. This issue presents FA products that have been developed to help solve customers’ problems, based on the concept of “e-F@ctory”, aiming to optimize the entire factory from production and quality control on the production floor to energy management.

Overview

Author: *Fumihiko Kimura**

Manufacturing System Severely Constrained by Energy and Resource Shortage

In the 20th century, manufacturing technologies progressed dramatically, from mass production to numerical control and information networks, thus enabling flexible and highly efficient production. However, manufacturing systems are now facing severe constraints on energy and resources, and so innovative energy-saving and resource-saving technologies need to be developed. It is important to consider innovation not only for each physical element of production but also for the entire system. Effective approaches include: identifying and eliminating non-essential elements to achieve the objective, and designing the system configuration to optimize the operating conditions. When evaluating the economic impact, a strict assessment of the energy and resource constraints may lead to an unprecedented system design.

Manufacturing systems must also deal with dynamic problems which are interrelated with the external environment such as the recent shortage of electricity. They must not only save power within the factory but also adjust the local power network for the smart grid. Next-generation manufacturing systems will be linked with the external world through the regular supply chain; connected with local communities through the flow of energy and resources; configured to be open to the local community via information networks; and form a part of the social infrastructure. A totally new concept of factory may emerge.

**Professor, Department of Mechanical Enginerring, Faculty of Science and Engineering, Hosei University*

Simple Motion Module & Servo Amplifier Compatible with Motion Control Function of CC-Link IE Field Network

Authors: *Takuya Sakaishi** and *Masao Amano**

As an open network, CC-Link IE Field is now equipped with a motion control function. The QD77GF16 simple motion module and MR-J4-B-RJ010 servo amplifier have been developed to be compatible with the motion control of the CC-Link IE Field Network.

1. Requirements for Field Network

In the field of factory automation (FA), there are increasing needs in the following areas:

(1) Integration of multiple networks

As the size and complexity of a manufacturing system increases, the number of network-connected machines also increases. To reduce wiring, save cost and standardize operations, there is a need to integrate general control (I/O control and inter-controller communication), motion control and safety control into a single network.

(2) Connectivity with a wide range of products/Conformity to international standards

For easy replacement of the existing system (compatibility with existing equipment), and a wider choice of products for selecting the most suitable system equipment, an open network that conforms to international standards is desirable.

Accordingly, we have developed a new motion function to extend the functionality of the CC-Link IE Field network, which, as an open network, had already integrated the general and safety control functions. We have also established a new drive profile based on international standards to expand the lineup of network-connectable equipment. In addition, we have developed the QD77GF16 simple motion module and MR-J4-B-RJ010 servo amplifier, both being compatible with the motion function for CC-Link IE Field and the new drive profile.

This paper presents the motion function and drive profile of the CC-Link IE Field network, and describes the outline of the compatible products.

2. Motion Function for CC-Link IE Field

For the motion control function to perform complicated path control and a highly accurate simultaneous start, the operation cycles of the servo amplifiers must be synchronized with each other. However, control operations through the conventional CC-Link IE Field

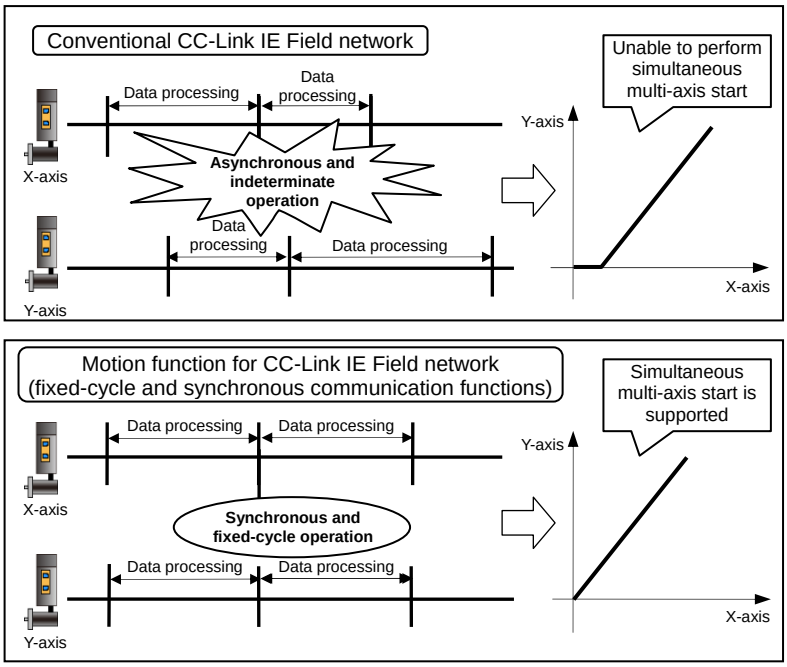


Fig. 1 Motion function for CC-Link IE field

*Nagoya Works

network were performed in an asynchronous manner.

As shown in Fig. 1, the new CC-Link IE Field network supports the motion control function through the addition of a fixed-cycle communication function and a synchronous communication function. The motion control function and these communication functions are collectively referred to as the motion function for CC-Link IE Field.

3. Drive Profile

To promote wider use of the CC-Link IE Field network, we have established a drive profile based on the international standard IEC 61800-7 (CiA 402) (Fig. 2).

The drive profile is a set of parameters that determine the settings, commands and status of devices in the network. It also specifies the interface for sending and receiving those parameters between the devices.

With the newly established drive profile, received/transmitted commands and status data between devices are controlled in the form of objects, and an interface is provided for the read/write access from/to each object. Each device is able to receive/send or transmit data from/to another device using a read or write access command for the object that corresponds to the intended command or status.

At present, the established drive profile is being promoted as an International Electrotechnical Commission (IEC) standard through CAN in Automation (CiA). Adding the drive profile to the IEC 61800-7-301 standard was approved by IEC in April 2012. The drive profile is expected to be discussed to finalize the profile specifications, and then adopted as a standard. It should be noted that the newly developed QD77GF16 simple motion module and MR-J4-B-RJ010 servo amplifier both conform to this drive profile. Device manufacturers, who offer network devices conforming to CiA 402, are able to make their devices connectable to the new QD77GF16 or MR-J4-B-RJ010 by simply replacing the communication driver with the CC-Link IE Field network. In other words, third-party manufacturers can easily and quickly develop power drive devices compatible with the CC-Link IE Field network, thus providing a wide product lineup from which users can select suitable devices.

4. Product Outline of QD77GF – Integration of Motion Control and I/O Control

The new QD77GF16 simple motion module supports both the motion control function of QD77MS16, the SSCNET III/H compatible simple motion module, and the I/O control function of QJ71GF11-T2, the master/local module for the CC-Link IE Field network. That is, as shown in Fig. 3, both a slave station that is responsible for I/O control and a servo amplifier that is responsible for motion control can be connected to the same network. As a result, wiring can be reduced, installation simplified, and costs saved.

In addition, the QD77GF16 can handle up to 120 devices including servo amplifiers, and thus is applicable to large-scale systems such as those in the semiconductor and automobile fields, and food packaging machines that require synchronous control (cam function).

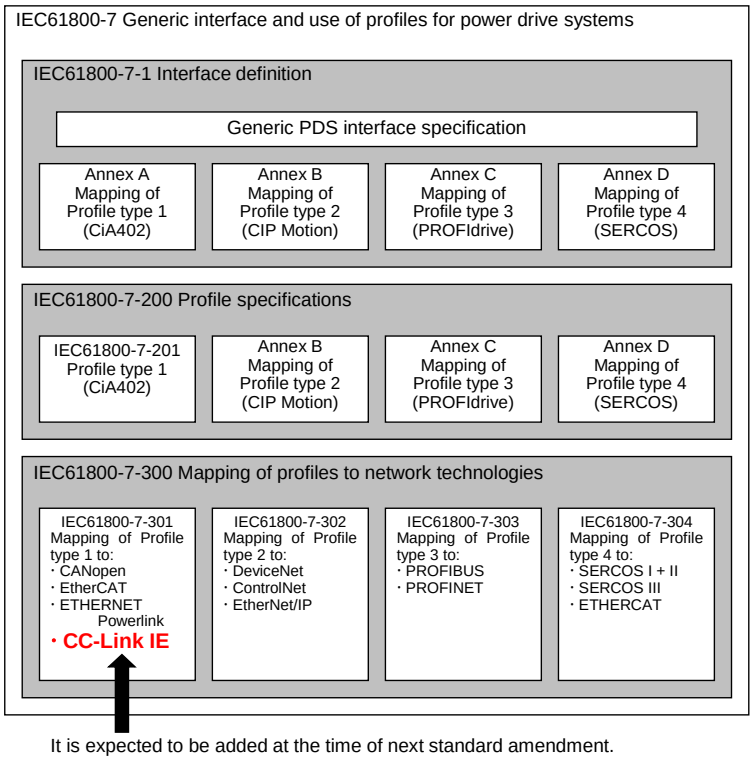


Fig. 2 IEC 61800-7 standard system

5. Product Outline and Key Features of MR-J4-B-RJ010

The new MR-J4-B-RJ010 servo amplifier is used in combination with MR-J3-T10, the interface unit for the CC-Link IE Field network, and serves as a general-purpose AC servo amplifier with external optional units. The MR-J4-B-RJ010 inherits the basic performance of the MR-J4-B (-RJ), the SSCNET III/H compatible servo amplifier, and is equipped with a CC-Link IE Field compatible communication interface.

In the existing CC-Link IE Field compatible products, a MR-J3-T endpoint control type servo amplifier is included. However, because of its incompatibility with the motion function for CC-Link IE Field, the MR-J3-T supports only simple point-to-point (PTP) control, thus resulting in limited application fields where complicated motion control is not required.

On the other hand, the new MR-J4-B-RJ010 servo amplifier is compatible with the motion function for CC-Link IE Field, and is capable of performing complicated path control using its high-precision synchronous successive position control (Fig. 4).

Table 1 compares the MR-J4-B-RJ010 with existing products: the CC-Link IE Field compatible MR-J3-T and SSCNET III/H compatible MR-J4-B (-RJ) servo amplifiers. As previously described, the MR-J4-B-RJ010 is capable of more complicated control compared to the MR-J3-T, and is thus applicable to various fields similarly to the MR-J4-B (-RJ).

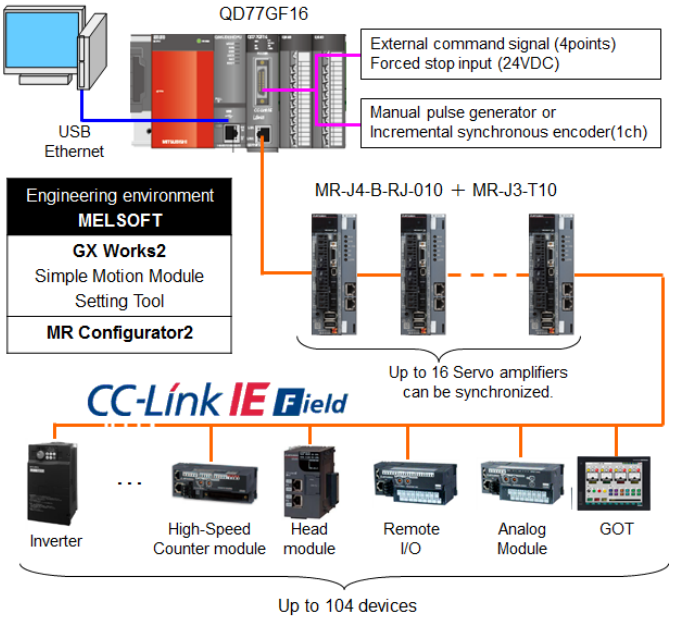
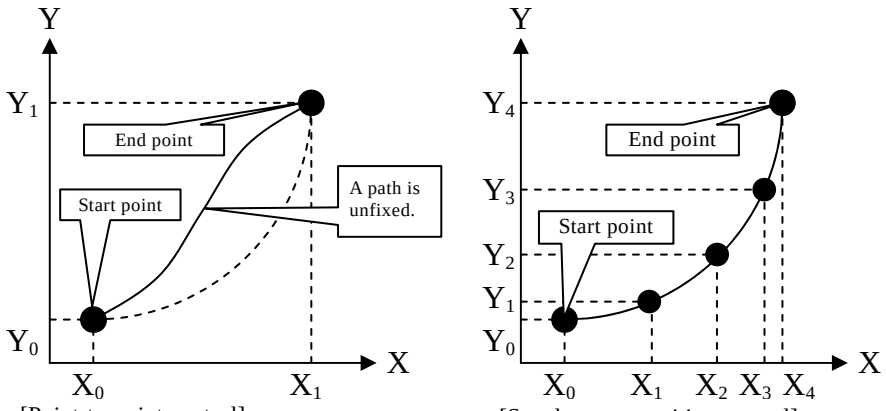


Fig. 3 System configuration



[Point-to-point control]
The position along each axis moves independently to its own end point. The path from the start point to the end point cannot be controlled.

[Synchronous position control]
The position along each axis moves to successive target positions (X_n, Y_n) in a synchronized manner. The path from the start point to the end point can be precisely controlled.

Fig. 4 Difference between point-to-point control and synchronous successive position control

6. Conclusion

This paper described the motion function for CC-Link IE Field and the drive profile being promoted as an international standard.

The newly developed QD77GF16 simple motion unit and MR-J4-B-RJ010 servo amplifier, both compatible with the motion function for CC-Link IE Field, will meet the needs of open network oriented customers.

Table 1 Comparison of servo amplifiers

Model	MR-J4-B-RJ010 + MR-J3-T10	MR-J3-T + MR-J3-T10	MR-J4-B (-RJ)
Network	CC-Link IE Field motion	CC-Link IE Field	SSCNET III/H
Open/close	Open		Close
Synchronization	Synchronous	Asynchronous	Synchronous
Control mode	Successive position/successive velocity/successive torque	Point to point	Successive position/successive velocity/successive torque
Capacity	0.1 to 22 kW		
Motor type	Rotary		Rotary/DD/linear
Communication cycle	0.88 msec (minimum)		0.22 msec (minimum)

Highly Cost-Effective CNC "E70 Series"

Authors: *Susumu Hamamoto** and *Yoji Tsutsumishita**

1. Introduction

Mitsubishi Electric has been working to meet the needs of domestic and Western markets by enhancing the performance of the M700V series for high-end computerized numerical control (CNC). This time, in response to emerging market needs, a panel-in type highly cost-effective CNC E70 series has been developed.

This paper describes the product features of the new E70 series, as well as the new MDS-DJ series drive unit and NC engineering tools as our total solution for the needs of bulk-volume markets.

2. Mitsubishi CNC E70 Series

2.1 Highly cost-effective hardware

In order to achieve the optimum cost effectiveness as well as enhanced product performance, the hardware was designed and developed with energy saving and high reliability in mind, and a user interface is provided as standard.

The key development points are as follows:

(1) The following functions are included as standard features for easy data input and machining for a large program:
  a) Ethernet[1] for connection with a personal computer
  b) Universal serial bus (USB) interface on the front panel
  c) CompactFlash[2] (CF) interface on the front panel (Fig. 1)

(2) A keyboard option for lathe application with sheet keys is newly added.

(3) The number of I/O points is reduced to 64/48 from the level of the high-end model to offer the best cost effectiveness.

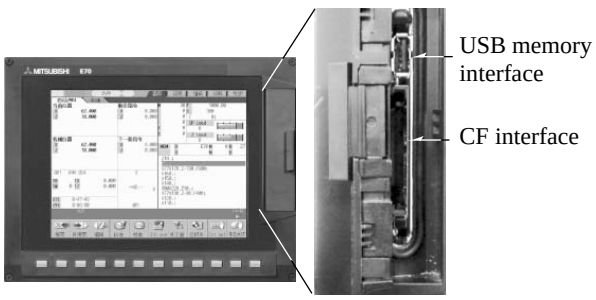


Fig. 1 Front-side USB and CF interfaces

(4) Analog output is provided as standard, in response to the highly requested feature of an inverter spindle drive.

(5) The liquid crystal panel for the 8.4" display unit is equipped with a light emitting diode (LED)-type backlight to prolong service life and save energy.

Despite its position as a low-cost model, the E70 series' external dimensions and appearance are compatible with the upper-grade M70V and M700V series, providing the same feeling of use.

2.2 Functions appropriate for universal lathe and simple machining center

The E70 series is best suited for universal lathes and simple machining centers (M/C) with the following key features:

(1) The number of NC axes and spindles satisfies the requirements for a universal lathe and simple M/C (Table 1).

(2) Commands for cutting smooth surfaces are provided by internal one-nanometer position interpolation, giving the same precision as that of the upper models. High-precision machining is achieved in combination with the MDS-DJ series, which is the ultra-compact drive unit series with built-in converters as described later.

(3) The programmable logic controller (PLC) has sufficient memory capacity for an 8,000-step program, which is required for even an ordinary lathe. In addition, the PLC's high processing speed ensures

Table 1 E70 Series specifications

		M/C system	Lathe system
Number of control axes	Max. number of axes (NC axes + spindles + PLC axes)	6	6
	Max. number of NC axes (in total, across all part systems)	3	3
	Max. number of spindles	1	2
	Max. number of PLC axes	2	2
	Max. number of simultaneous contouring control axes	3	3
Max. number of part systems		1	1
Least command increment		0.1 µm	
Least control increment		1 nm	
Max. program capacity		230 kB (600 m)	
Max. PLC program capacity		8,000 steps	
HMI customization function		NC Designer	
Parameter/Alarm guidance		Stored on CF	

HMI: Human Machine Interface

[1] Ethernet is a registered trademark of Fuji Xerox Co., Ltd.
[2] CompactFlash is a registered trademark of SanDisk Corporation

**Nagoya Works*

high productivity.

(4) The display screen is designed in the same configuration as higher models to give a unified feeling of use. The display screen can also be customized.

(5) Guidance data for parameter setting and troubleshooting is provided on a CompactFlash card, thus allowing the user to select the required guidance.

3. Drive Unit MDS-DJ Series

In parallel with the E70 Series, servo/spindle drive units featuring high performance and compact size have also been developed and added to the product lineup as the MDS-DJ series (Fig. 2, Table 2).

Fig. 2 MDS-DJ series appearance

Table 2 Major new features of MDS-DJ series

	Servo[3]	Spindle
Control functions	• High-speed synchronous tapping control (OMR-DD control) • OMR-FF control	• High-speed synchronous tapping control (OMR-DD control) • OMR-FF control
Compensation control	• Adaptive tracking-type notch filter • Lost motion compensation type 4 • Fully closed quadrant glitch compensation	• Adaptive tracking-type notch filter • Lost motion compensation type 3 • Spindle motor temperature compensation function
Sequence function	• Specified speed output • Safe Torque Off (STO) function	• Specified speed output • Safe Torque Off (STO) function

OMR: Optimum Machine Response; FF: Feed Forward; DD: Direct Detect

3.1 Features of MDS-DJ series

The MDS-DJ series offers ultra-compact size drive units with built-in power supply, best suited for small M/Cs and lathes with 0.1 to 3.5 kW servo motors and 0.4 to 11 kW spindle motors.

The features of the MDS-DJ series are as follows:

(1) Compact size

The ultra-compact size unit with a height of 168 mm (250 mm for 5.5–7.5 kW and 300 mm for 11 kW spindle drive units) contributes to the downsizing of the control panel. In addition, by using a low-loss power module, the 5.5–7.5 kW spindle drive units (MDS-DJ-SP-100/120) are about 20% narrower than the conventional MDS-D-SPJ3 series.

(2) Enhanced Safety and Wire Saving

The MDS-DJ series has the Safe Torque Off (STO) function as a safety function conforming to IEC/EN 61800-5-2. It enables to reduce the number of electromagnetic switches for power shutdown, thus saving wiring and downsizing the control panel. Figure 3 illustrates an example case of shutting down the power to the whole system. It is also possible to provide a stop signal to the STO signal connector installed in the drive unit to stop the spindle independently.

(3) Enhanced Performance

An execution engine has been adopted to integrate the high-speed servo control architecture. The control and compensation functions are equivalent to those of the upper model “MDS-D2 series”. The enhanced performance makes the MDS-DJ series suitable not only for small and inexpensive machines but also for adding optional spindles to high-end machines such as a table axis for an M/C and a milling spindle for a lathe.

4. NC Engineering Tools

For machine tool builders and end users, Mitsubishi Electric offers various NC engineering tools to make

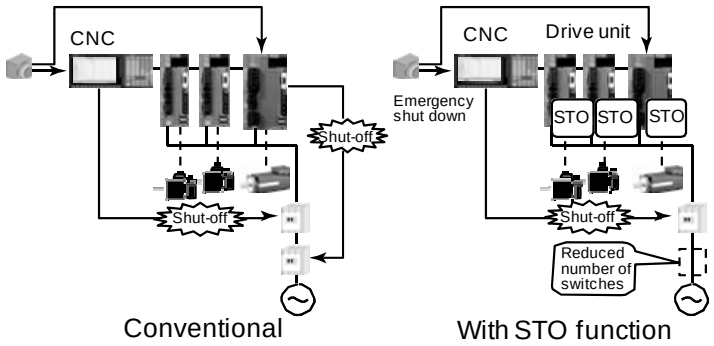


Fig. 3 Application example of STO function and its effect

[3] MDS-D-SVJ3 to SPJ3 ratio

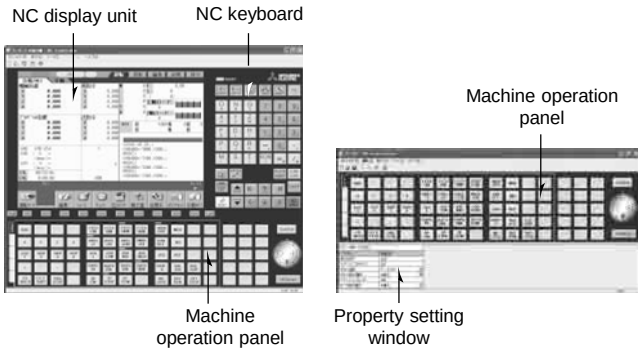
it easier to use Mitsubishi CNCs. These tools are also updated for the new E70 series.

4.1 User support tool "MELSOFT NC Trainer"

The "NC Trainer" is a user support tool for easily learning a CNC operation sequence in an off-line environment.

4.2 Development support tool "MELSOFT NC Trainer plus"

The "MELSOFT NC Trainer plus" is a customized CNC software development support tool for machine tool builders (Fig. 4). By customizing the machine operation panel and entering the CNC parameters generated by the setup tool "MELSOFT NC Configurator2," a development environment tailored to the customer's machine specifications can be built on a personal computer. After the "MELSOFT NC Trainer plus" customizes various data for a specific machine tool, the "MELSOFT NC Trainer" imports the data, and by doing so, a training environment can be created for the operations and maintenance services tailored to the specific machine tool.



(a) MELSOFT NCTrainer plus (b) NCTrainer Builder

Fig. 4 MELSOFT NC trainer plus

4.3 Adjustment support tool "MELSOFT NC Analyzer"

The "MELSOFT NC Analyzer" is a CNC servo adjustment support tool, the functions of which include automatic adjustment of servo parameters, and measurement and analysis of waveforms. Various data analysis functions are also provided to support the data management of individual machine characteristics, and to improve the efficiency of failure analysis. This tool will help support the adjustment of recent high-speed, high-acceleration and high-precision machine tools. The "MELSOFT NC Analyzer" also helps provide sufficient technical support overseas, which has become more difficult due to the market globalization of NC machine tools. In addition, the adjustment time can be drastically reduced; for example, the adjustment work for a machine tool with three servo axes, which normally requires about 6 hours, can be performed in about 10 minutes.

5. Conclusion

The market continues to be bipolarized: the Japanese and Western markets where higher added value, higher precision and higher performance are pursued, and the emerging markets where mass production of low-price products takes place. We will continue to strengthen the development of high-end models as well as make efforts to meet the needs of emerging markets.

New Fiber Laser Processing System "NX-F Series"

Authors: *Toshiki Koshimae** and *Takashi Inoue**

As electricity rates increase and the working population decreases, the manufacturing industry faces the following major challenges: reducing power consumption, reducing working time, and improving productivity. In response to these market needs, Mitsubishi Electric has commercialized the new "ML3015NX-F" fiber laser processing system (referred to as "NX-F") with the product concept of (1) high speed, (2) ecology and (3) high quality. Figure 1 shows the external appearance.

Fig. 1 New "NX-F Series" fiber laser processing system

1. Product Concept of Fiber Laser Processing System

1.1 High speed

A fiber laser has a shorter wavelength than that of CO_2 laser, and thus it exhibits a high absorption coefficient for metals and generates a small, concentrated light beam. We have developed a new processing head with an optical system that takes advantage of these features. As a result, the speed of processing a 1-mm-thick stainless steel sheet has been tripled compared to the NX-45CF-R, Mitsubishi Electric's CO_2 laser processing system (Fig. 2).

With the previous system, in order to set the processing head at the starting position, the head must be stopped after being moved to the starting point. This stopping time increases the takt time.

To solve this problem, the MHL-L function was developed to increase the data communication speed between the controller and the oscillator so that the controller can control the oscillator's laser radiation timing at a high speed.

By implementing this function, the "F-CUT" method for laser processing without stopping the head was realized.

This time, the new "F-CUT Route Generator (FRG)" software has also been developed to automatically generate a processing route suitable for the F-CUT operation. FRG uses a new route optimization algorithm with the machine's operating characteristics taken into consideration and automatically generates a processing route suitable for the NX-F system in optimization processing.

By using the F-CUT function and route optimization of FRG, takt time has been reduced by 56% (Fig. 3).

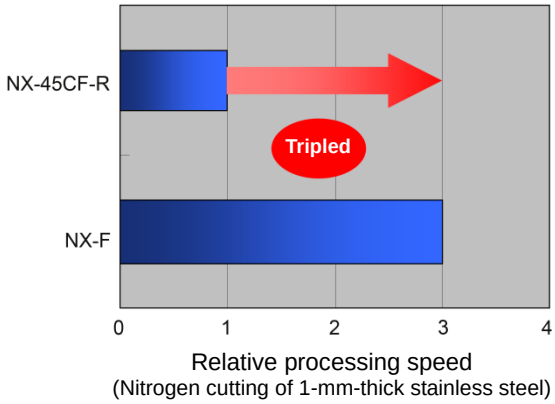


Fig. 2 Improvement of processing speed

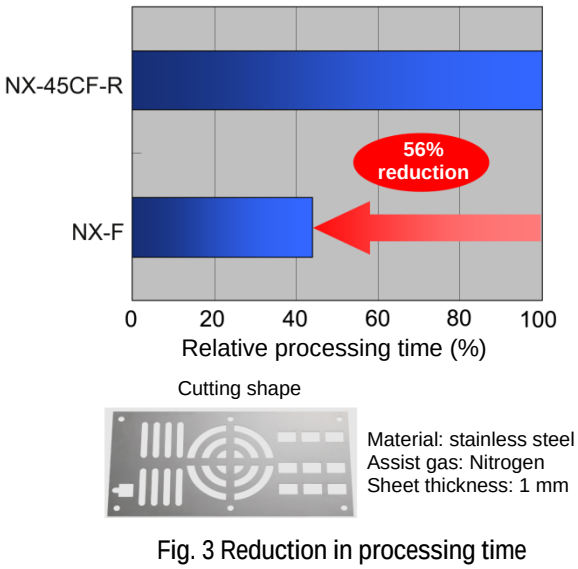


Fig. 3 Reduction in processing time

*Nagoya Works

1.2 Ecology

Electricity consumption accounts for the majority of the running cost of a laser processing system. The NX-F is equipped with low-loss Mitsubishi numerical control (NC), drive units, and high-efficiency fiber laser oscillator, and has successfully reduced the electric power consumption by about 70%, as shown in Fig. 4.

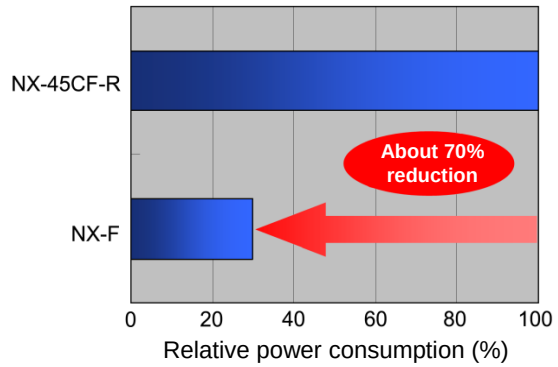


Fig. 4 Reduction in electric power consumption

The NX-F is also equipped with an eco operation mode. In this mode, when processing is suspended, the unnecessary oscillator, purge gas supply, and cooling system are switched off in stages. With this technology, electric power is not wasted during standby, and the power consumption can be reduced by 70% from the level of non-eco mode operation. In addition, processes from the suspended stage until resumed operation are smoothly performed without any adverse effect on operational efficiency. As such, the NX-F offers an environment-friendly laser processing system.

1.3 High quality

To achieve high-quality and stable processing, the NX-F is equipped with a power control system that uses a microcomputer to quickly stabilize the laser power, thus providing laser power stability of ±1%. This system reduces dross, which forms on the rear surface of material being processed at a high speed.

In addition, to take advantage of the high-speed cutting of the fiber laser processing system, the NX-F is equipped with a newly developed lightweight processing head and a new trajectory control system that makes it possible to draw a precise trajectory even during high-speed processing. With these technologies, vibrations in high-speed processing are suppressed, and thus the precision of trajectories in the area processed at high speed has been improved by 10% from that of the flagship system NX series.

2. Processing Examples of NX-F

2.1 Improved productivity of plate processing

In addition to the improved processing speed by means of the fiber laser oscillator and new processing head, the NX-F is equipped with the F-CUT function that enables non-stopping processing and the FRG function that generates an optimum cutting route to maximize the advantages of F-CUT, offering a laser processing system that provides maximum productivity for any cutting shape.

Figure 5 shows a cutting sample of stainless steel sheet with a thickness of 0.8 mm, which was processed at a speed of 40,000 mm/min with the F-CUT function activated, resulting in a productivity improvement of about 60% compared to the conventional method.

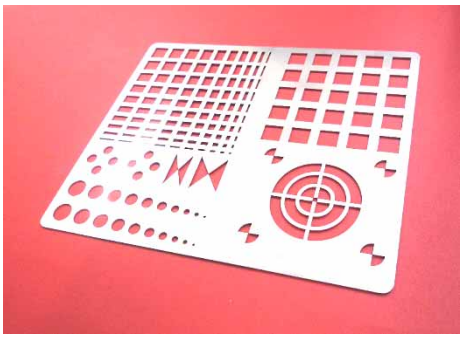


Fig. 5 Cutting sample of stainless steel

2.2 Wider range of processing materials

With the optimized optical system and assist gas flow, the NX-F is capable of cutting various materials from thin to thick plates: mild steel up to 19 mm with oxygen gas, stainless steel up to 12 mm with nitrogen gas, and aluminum alloy up to 10 mm with nitrogen gas.

With a 2.5-kW fiber laser oscillator, the NX-F can cut thick plates equivalent to those by the 3-kW class Mitsubishi CO_2 laser system.

3. Conclusion

Progress in laser processing system technologies is more remarkable than that of other machine tools, and further improvements are expected in this field. To meet the increasingly diversified needs of users, Mitsubishi Electric, as a synthetic laser processing system manufacturer, will strive to enhance performance and meet the needs of various shop floors.

"iQ Sensor Solution" by FA Integrated Engineering Software "MELSOFT iQ Works"

Authors: *Naoki Takeshita** and *Akira Fujisawa**

A factory automation (FA) system consists of various devices. As the number of installed sensors and their types, particularly digital and multi-functional types, increases, they must be made easier to use. To meet this requirement, Mitsubishi Electric proposes the "iQ Sensor Solution (iQSS)" by "MELSOFT iQ Works," the FA Integrated Engineering Software package (referred to as "iQ Works").

1. Present Issues and Customer Requirements

The uses of sensors installed in an FA system are diversifying, and the number and types of installed sensors are also increasing. As a result, it is becoming more difficult to identify the configuration of installed sensors by reviewing the drawings or by directly checking them, necessitating many man-hours for system startup and modification (Fig. 1).

In addition, the percentage of digital and multi-functional types is increasing, and customers have asked us to make it easier to adjust and monitor sensors. At present, however, each sensor has its own configuration tool, and adjustment and monitoring needs a different tool for each sensor; thus, not only is it time-consuming work, but it also takes a long time for customers to master the operation (Fig. 2).

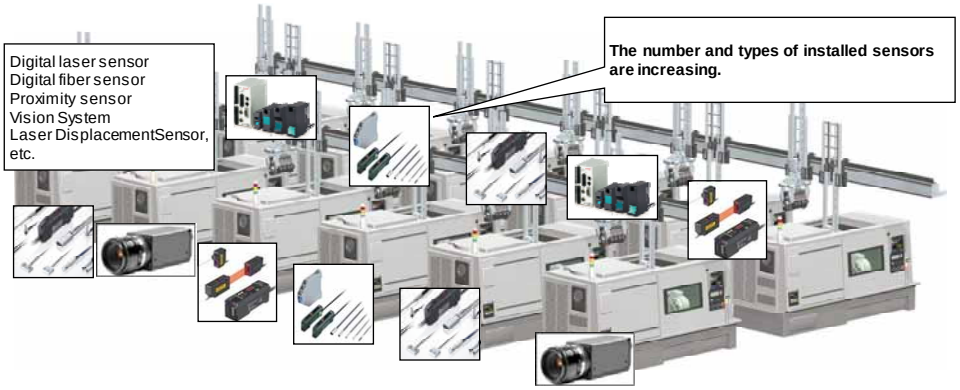


Fig. 1 Sensors installed in FA system

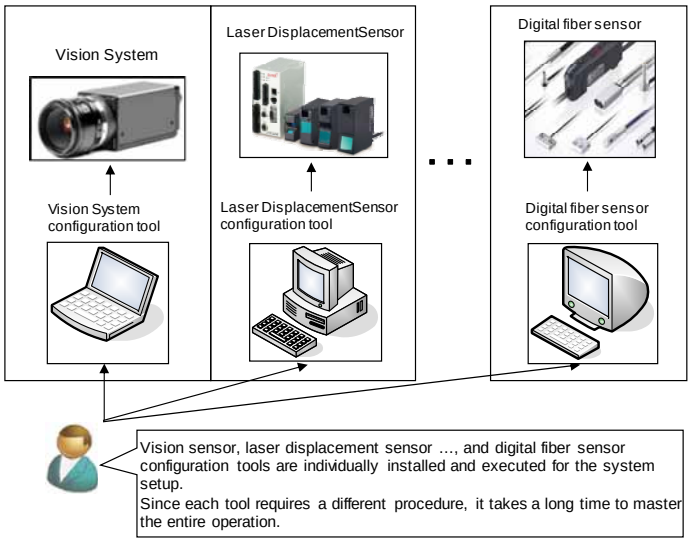


Fig. 2 Current status of sensor configuration

*Nagoya Works

To solve these issues, Mitsubishi Electric proposes iQSS by iQ Works to provide the functions described in Chapter 2.

2. iQSS by iQ Works

With iQSS by iQ Works, the information on sensors is managed through their profiles. The sensor-specific information and behavior is summarized in the profile, and thus the data display and other operations for each sensor can be executed using its profile.

2.1 System configuration

To help identify the configuration of installed sensors, iQSS has a function that automatically detects connected modules, reads their information into iQ Works, and graphically displays the system configuration. Previously, spreadsheet, CAD, or similar software was used to draw the configuration of connected modules. The new iQSS function, which automatically detects connected modules, reads the module identification data from the master module connected to the CC-Link, AnyWireASLINK[1] or Ethernet[2] network, and then displays the configuration of installed modules by mapping the read-out information to the modules' profile data (Fig. 3).

2.2 Sensor monitoring

iQSS also has a sensor/module monitoring function to easily monitor the status of sensors. The information on sensors connected to the CC-Link, AnyWireASLINK, or Ethernet network is graphically displayed on the sensor monitoring screen (Fig. 4). Since the information and icon of each sensor are displayed, the sensor to be monitored can be selected without any mistakes. Simultaneously displayed sensor image and diagnostic information are defined in the profile. It is not necessary to use the configuration tool of each sensor; the status of various sensors can be monitored by iQ Works.

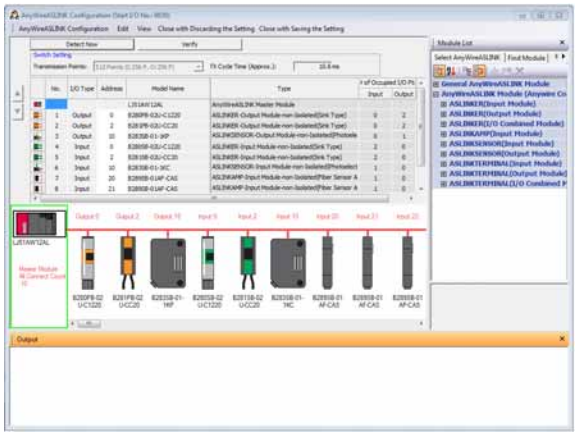


Fig. 3 System configuration

2.3 Sensor parameter read/write

Parameters of the connected sensors can be read or written on the configuration chart as described in Section 2.1 (Fig. 5). Communication with each sensor is performed according to the specified protocol, and each parameter value is checked against the profile data, so sensor setting can easily be verified or changed.

Also, as described in Section 2.2, parameters of

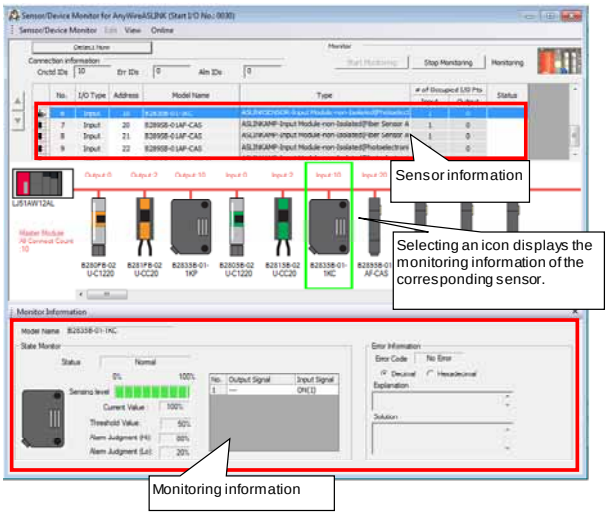


Fig. 4 Sensor monitoring screen

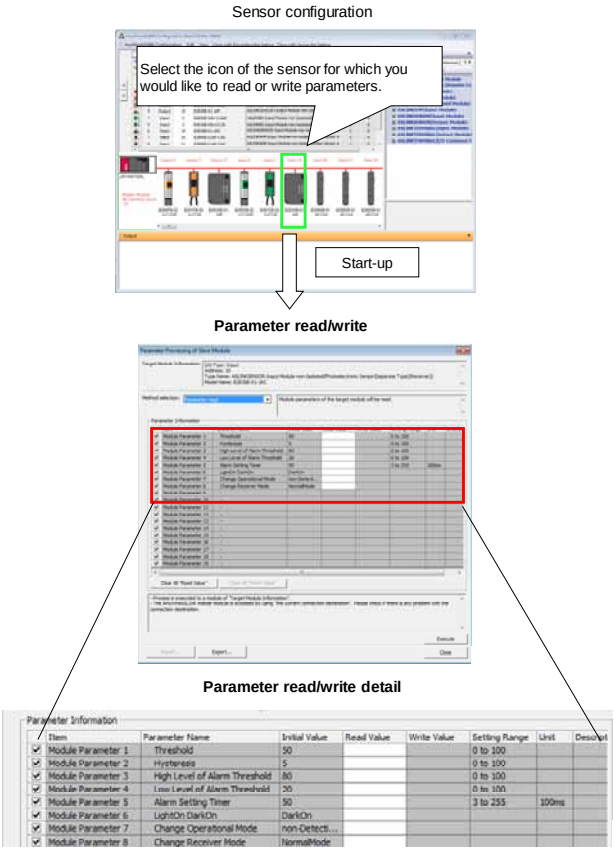


Fig. 5 Sensor Parameter Read/Write

[1] AnyWireASLINK is a registered trademark of Anywire Corporation.
[2] Ethernet is a registered trademark of Fuji Xerox Co., Ltd.

various sensors can be set up by iQ Works without using the configuration tools, and thus it is no longer necessary to execute multiple configuration tools or master their operation, resulting in reduced man hours.

2.4 Sensor parameter backup/restoration[3]

Sensor parameters can be collectively backed up or restored to/from an SD memory card in a programmable logic controller (PLC). This function makes it easy to import certain parameter data into multiple sensors and restore the parameter data when replacing a sensor.

3. Solution with Mitsubishi Display Terminal GOT

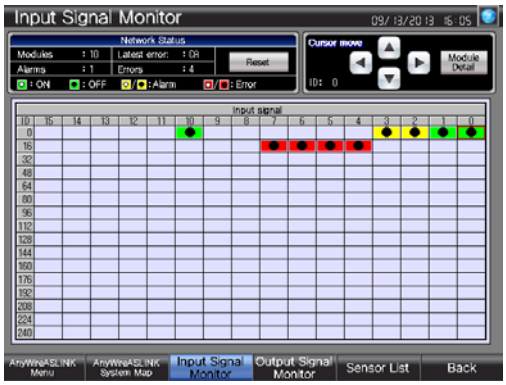
While all iQSS functions described in Chapter 2 are realized by using iQ Works, they are also supported by a graphic operation terminal (GOT). As shown in Fig. 6, the iQSS functions are realized on the GOT sample screen. By using these functions, sensors can also be adjusted and monitored on the shop floor. Download service for the sample screen will be implemented on the Mitsubishi Electric FA web site.

4. Conclusion

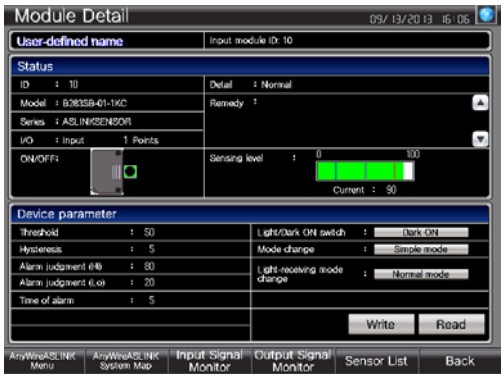
This paper described the iQ Sensor Solution (iQSS) by iQ Works, which makes it easier to use the sensors installed in FA systems. iQSS helps customers to identify the configuration of many connected sensors, and easily adjust and monitor them (Table 1). We will continue to extend the range of applicable sensor manufacturers and sensor types. Simply by registering their profiles to iQ Works, those sensors can be covered by iQSS without updating iQ Works.

Reference

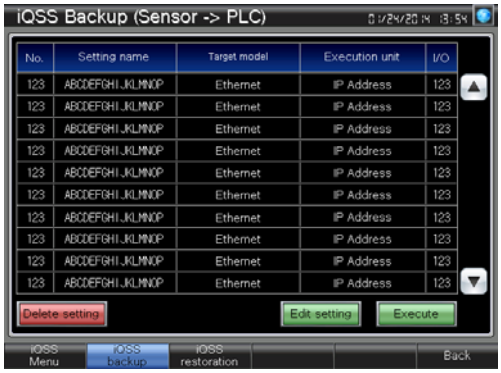
(1) Hiroyuki Furushima, et al.: Profile Technology Applied to Mitsubishi "iQ Platform" FA Integrated Engineering Software "MELSOFT iQ Works," Mitsubishi Denki Giho, Vol. 86, No. 4, 23-26 (2008) (in Japanese).



Sensor monitoring



Sensor parameter read/write



Backup/restoration

Fig. 6 GOT sample screen

Table 1 Benefit for customers

Function	Before	After	Benefit for customers
System Configuration	Configuration of connected sensors needs to be identified by reviewing the drawings or by directly checking the sensors.	Configuration of connected sensors can be identified using a graphic display on the iQ Works screen.	Configuration of connected sensors is easily identified, thus reducing the man-hours for system startup and modification.
Sensor Monitoring Sensor Parameter Read/Write Sensor Parameter Back-up/Restoration	Different tools must be installed and executed to configure each sensor.	Configuration can be set up by iQ Works.	Man-hours can be reduced for the installation and startup of the tools. The customer only needs to master iQSS.

[3] This function is not supported for Ethernet modules.

High-Speed Universal Model QCPU

Authors: *Takayuki Suzuki** and *Yasuhiko Chiba**

To improve ease of use and enhance the performance of the MELSEC-Q series, an iQ Platform compatible "High-Speed Universal Model QCPU" has been developed. The new product features improved computing performance, increased number of device points, enhanced security function, and compatibility with existing models. This paper presents these features and the technologies for achieving them.

1. Features of High-Speed Universal Model QCPU

The key features of the High-Speed Universal Model QCPU (Fig. 1) are as follows:

(1) Improved computing performance

To reduce the equipment cycle time and increase machining accuracy, the performance of this CPU module has been improved as follows:

(a) Reduction of instruction processing time

The execution times of basic instructions are listed in Table 1.

The improved instruction processing performance has achieved a PC MIX value of about 220 (instructions/μs), which is about 3.7 times faster than the conventional universal model QCPU.

Fig. 1 High-speed universal model QCPU

Table 1 Instruction processing performance of high-speed universal model QCPU

Instruction type	Instruction	High-speed type	Universal model
Contact instruction	LD X0	1.9 ns	9.5 ns
Bit output instruction	OUT Y0	3.9 ns	9.5 ns
Data transfer instruction	MOV D0 D1	3.9 ns	19.0 ns
Floating-point operation	E+ D0 D2	13.0 ns	57.0 ns
Repetitive instruction (10 loops)	FOR K10 to NEXT	0.45 μs	8.9 μs
Subroutine call	CALL to RET	1.1 μs	3.9 μs

(b) Reduction of minimum execution interval of fixed-scan-execution type program

The minimum execution interval of a fixed-scan-execution type program has been reduced from 500 μs of the conventional universal model QCPU to 100 μs. The control period can thus be made shorter, which improves the machining accuracy of equipment.

(2) Increased number of device points

The new CPU module can handle more device points and thus a larger volume of recipe data and quality control data.

The number of internal device points has been increased up to 60 K words from 29 K of the conventional universal model QCPU. With an additional extended SRAM cassette (selectable from 1/2/4/8 Mbytes), the built-in standard RAM can be extended to provide up to 4,736 K words of device points.

(3) File access control with security key

The new CPU module is equipped with file access control by security key to protect customers' sequence programs and other design assets against falsification and theft by unauthorized persons.

With this function, files in a CPU module can be locked by setting a security key to the CPU module. Access to the locked files is allowed only with the programming tools in which the security key used for locking the files is registered. (See Fig. 2.)

(4) Compatibility with conventional universal model QCPU

The high-speed universal model QCPU is compatible with the conventional universal model QCPU. It is also possible, by using a programming tool, to generate a project file of the new CPU module from that of the conventional universal model QCPU.

As a result, improved equipment/facility performance can be easily accomplished by changing the CPU module from the conventional universal model QCPU to the high-speed universal model QCPU.

2. Technologies for Achieving the Features

This section describes the technologies developed to achieve the features of the high-speed universal model QCPU.

(1) Improved speed of execution engine for sequence operation

A new application-specific integrated circuit (ASIC) has been developed for the high-speed universal model QCPU. Figure 3 shows the outline block diagram of this

*Nagoya Works

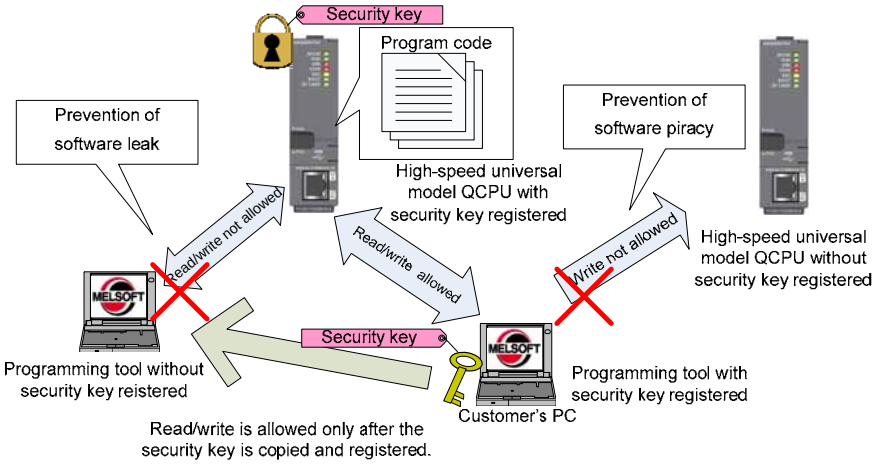


Fig. 2 File access control with security key

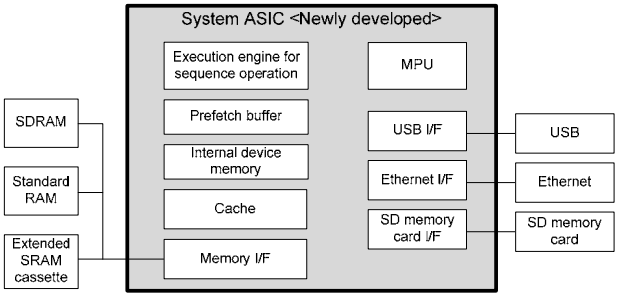


Fig. 3 Outline block diagram of system ASIC

system ASIC.

The new execution engine for sequence operation is a proprietary processor integrated in the system ASIC, and runs at a higher frequency by reviewing the pipeline configuration. In addition, instruction processing for the subroutine call and other individual instructions as well as for the interrupt programs has been optimized to improve the processing performance.

(2) Improved memory access efficiency

To improve the computing performance, a prefetch technique is used when executing a program stored in the SDRAM located outside the ASIC, where a fixed size of program is read beforehand from the SDRAM into the prefetch buffer in the ASIC. This technique improves the efficiency of reading out programs. In addition, a cache has been introduced to improve the efficiency of accessing the standard RAM and extended SRAM cassette.

(3) Security management

When implementing file access control using a security key, it was designed to allow copying of the security key to ensure convenience. By distributing a copied security key to another personal computer, that PC can access the locked CPU module. Meanwhile, to prevent unrestricted copying of security keys, recopying from a copied security key is blocked.

In addition, as a preventive measure against the theft or loss of copied security keys, it was made mandatory to set an expiration date by which time the copied security key must be distributed to the other PC. It was also made mandatory to set a password to each copied security key in case of theft or loss.

The implemented security function thus ensures safety while providing convenience of use as well.

(4) Compatibility with conventional universal model QCPU

While the newly developed system ASIC has a new execution engine architecture for sequence operation, it has inherited the instructions and parameters from the conventional universal model QCPU to maintain compatibility. In addition, a project file of the conventional universal model QCPU can be easily converted to that of the new CPU module by using a programming tool.

3. Conclusion

This paper described the features of the new high-speed universal model QCPU and the technologies for achieving them. The high-speed universal model QCPU will enable the development of higher-speed and higher-accuracy equipment. We will continue to improve the speed, performance, and convenience of the PLC.

Energy Measuring Unit for MELSEC-Q Series

Author: *Masayoshi Shimoe**

The Great East Japan Earthquake in March 2011 has raised awareness of saving electricity and energy, thus increasing attention on energy management for monitoring energy use. As a result, manufacturing industries are also required to strengthen energy-saving efforts on the production floor. Mitsubishi Electric proposed the concept of "e&eco-F@ctory" for simultaneously improving productivity and reducing cost by utilizing energy-related information on the production floor, and in 2010, released "QE81WH" as an energy measuring unit for the MELSEC-Q series, which was the industry's first electric power measurement module mountable in the programmable logic controller (PLC).

This paper presents three newly added models: QE84WH, QE81WH4W and QE83WH4W, which were developed to expand the lineup of PLC slot-in type "Energy measuring units for the MELSEC-Q series," for measuring energy consumption at production facilities.

1. Product Concept of Energy Measuring Unit

Figure 1 shows the external appearance of the energy measuring units for the MELSEC-Q series and an example of the system configuration. In combination with the dedicated split-type current sensors, these units are capable of measuring currents of 50 A, 100 A, 250 A, 400 A, or 600 A. By using the dedicated 5-A current sensor (EMU2-CT5) in combination with a current transformer in the two-stage configuration, these units can also measure a primary-side current of up to 6,000 A. Measurement is continuously performed at a sampling frequency of 4,340 Hz (on both 50/60 Hz), thus providing accurate energy measurement even for a short-cycle load such as a welder, and ensuring suitability for energy measurement at production facilities.

Our product concept for the energy measuring unit for the MELSEC-Q series is: (1) realizing measurement of multiple circuits with one slot and space-saving; (2) compatible with the PLC engineering software GX Works2 for easy setting; (3) easily managing specific consumption of energy (an energy productivity measure expressed as the "amount of energy consumption divided by production quantity") based on the "production information" from the PLC CPU module and the "energy information" from the energy measuring unit; and (4) easily building a data logging and visualization system of electric energy by combining graphic operation terminals (GOTs) and high-speed data logger units (QD81DL96).

2. Multiple Circuits for Improving Processing Speed

2.1 Optimization of data refresh period

This measuring unit is intended to be used to measure energy at production facilities, and so the measurement and mathematical processing speed needs to be improved to provide detailed energy management. The QE81WH measuring unit released in 2010 is a single-circuit model that performs energy and current measurement with a data refresh period of 250

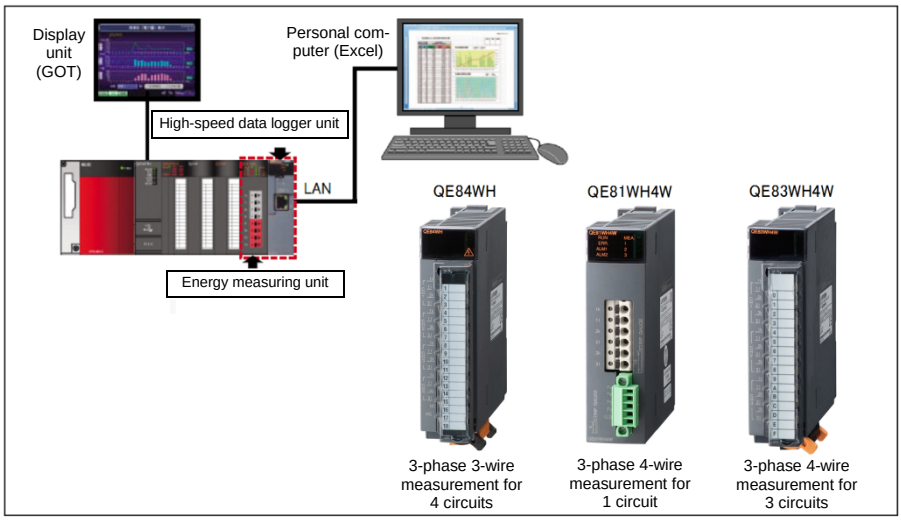


Fig. 1 Energy measuring unit and example of system configuration

**Fukuyama Works*

ms. Since the new unit measures and processes the data for up to four circuits, if the processing is performed in the same manner as the QE81WH, the refresh period would be one second. Consequently, it was necessary to speed up the data refresh cycle by optimizing the measurement and mathematical processing.

As shown in Fig. 2, the processing time of the new unit has been improved through parallel processing of multiple circuits, where the processing of each circuit consists of receiving data from the measuring ASIC and mathematical processing by the CPU. As a result, a data refresh period of 500 ms has been achieved for the 4-circuit measurement.

2.2 Current measurement mode

As described above, in the case of mathematical processing of voltage, current, power, and other measuring data for four circuits, the data refresh period is longer than that of the single-circuit model. However, in the case of preventive maintenance or quality control, the data refresh rate must be faster than that of the current single-circuit model (250 ms). Accordingly, the QE84WH, QE81WH4W and QE83WH4W are equipped with a current measurement mode, where only the current is measured and processed at a high-speed rate (Fig. 3).

In the current measurement mode, without measuring power consumption, only the current is measured on eight circuits with a data refresh period of 100 ms. In addition, upper and lower limit alarm values can be set to each circuit (alarm monitoring at a demand current value), which makes them suitable for use in the field of quality control, as well as for preventive maintenance on those failure modes in which the current increases due to anomalies, e.g., motors in the facility.

3. Compatibility with Engineering Tools

The new models have been designed to be compatible with GX Works2, the PLC engineering software, to support easy setting, monitor the measurement data,

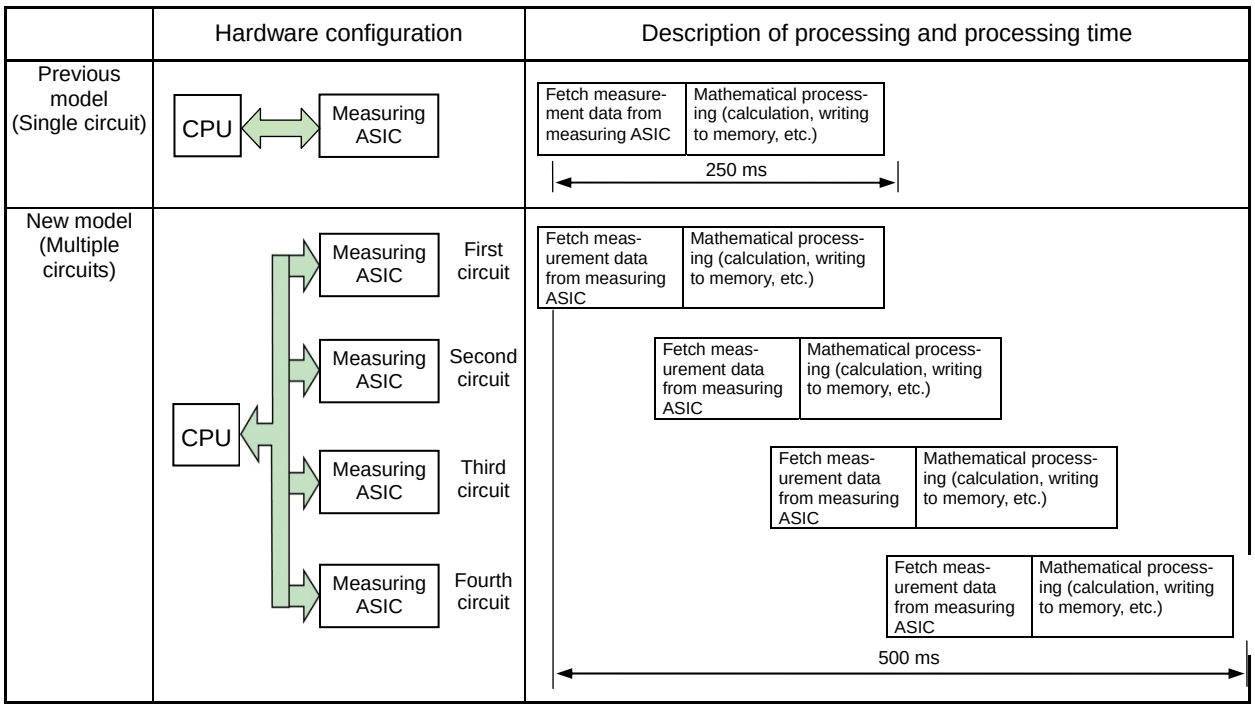


Fig. 2 Measurement and mathematical processing method, and processing time

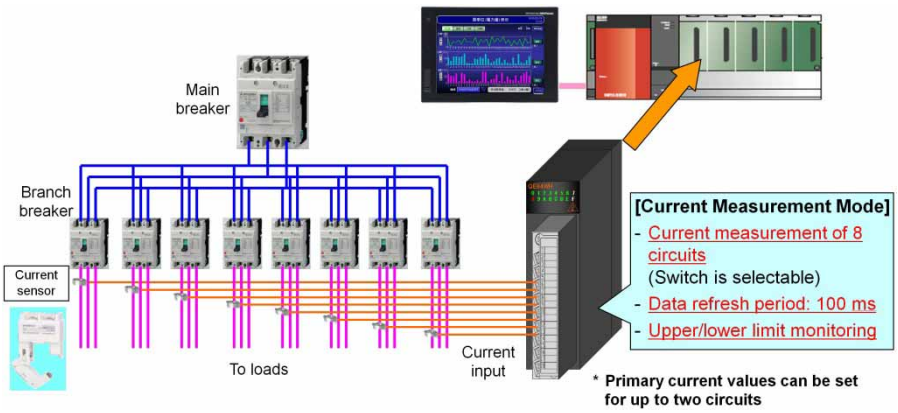


Fig. 3 Current measurement mode

and check the operating status.

3.1 Setting of operation parameters

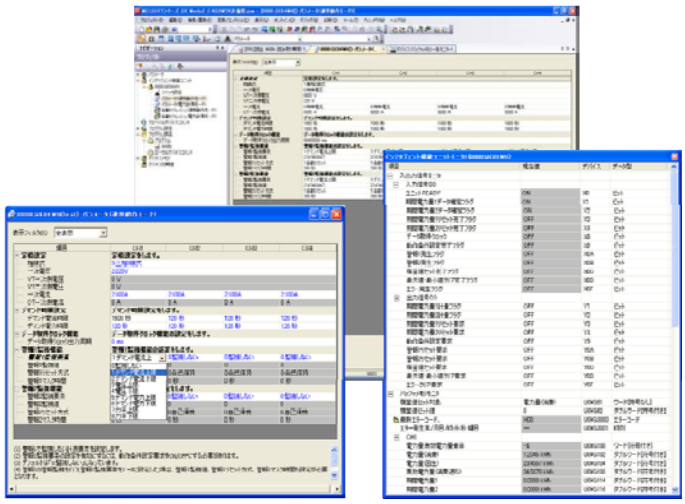
The energy measuring unit has two types of parameters:

i Parameters to set the operation mode such as: phase wire system, primary voltage, primary current, etc.

ii Parameters to be changed only when desired during operation such as integrated power

Once the operation parameters of the energy measuring unit are set up on the GX Works2 parameter setting screen, those setting values are loaded at every power-on of the energy measuring unit. Therefore, it was necessary to set up Type i and ii parameters in different ways, because Type i parameters can be reloaded at every power-on without any problem, whereas integrated power and other Type ii parameters are reset to the initial setting values when reloaded at every power-on.

Therefore, while Type i parameters are set to the values defined on the parameter setting screen, the setting values for Type ii parameters are first read from the “Intelligent function module monitor” screen and stored in the buffer memory, and then each parameter is actually set to the pre-stored value only as desired during operation by flag manipulation (Fig. 4).



[Parameter setting screen] [Intelligent function module monitor screen]

Fig. 4 Parameter setup by GX Works2

3.2 Measurement data monitoring

With the previous model, measurement data in the buffer memory can be monitored by the GX Works2 “Buffer memory collective monitor” function. However, only buffer memory addresses and stored data are displayed, and in order to identify which measuring item is indicated by the display data, it is necessary to refer to the operation manual.

The newly developed models are compatible with the “Intelligent function module monitor” of GX Works2, and so the names of the measurement items are also displayed on the screen, which makes it easy to verify the measurement data during on-site installation (Fig. 5).

4. Conclusion

This paper presented the expanded lineup and enhanced functionality of the energy measuring unit for the MELSEC-Q series, which realizes detailed management of the specific energy consumption for each production facility.

We will continue to enhance the functionality of this unit and expand the lineup of peripheral tools, to boost usage of “e&eco-F@ctory” that simultaneously improves productivity and reduces cost.

Fig. 5 Measurement data monitoring by GX Works2

MITSUBISHI ELECTRIC CORPORATION