CPU Module "MELSECWinCPU" of Programmable Controller "MELSEC iQ-R Series"

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1. Introduction

Manufacturing businesses must promote and pursue work-style reforms as the working population dwindles and the needs of working people diversify due to an aging society with a declining birthrate. Greater productivity per hour has been raised as one potential solution to work-style reforms. To successfully implement this strategy though, a digital transformation of the information handled on site is essential. However, various challenges manifest as the needs for this digital transformation of information using computers grow, such as cutting costs for data process engineering and computer maintenance and management.

To overcome these challenges, Mitsubishi Electric released its MELSEC iQ-R Series programmable controllers as products to collect and analyze production site data (Table 1). This lineup of products eliminates the need to create programs dedicated to each application to reduce the engineering costs required for adoption. The MELSEC iQ-R Series also features environmental durability and a long-term reliable supply of modules, which can reduce maintenance and management costs.

However, the needs for a digital transformation of information have become more diverse and sophisticated. Customers have begun to pursue optimal ways to manage, analyze and use this data on their production sites. To satisfy those needs, the MELSEC iQ-R Series MELSECWinCPU developed with a Windows*1 operating system enables independent application development, the use of a wealth of applications, and more.

Users can connect the MELSECWinCPU to other programmable controller modules to promote the use of Internet of Things (IoT), Artificial Intelligence (AI), and data analysis. These links allow manufacturing businesses solutions to not only cut costs for data process engineering as well as computer maintenance and management but also overcome many other challenges.

This paper outlines the MELSEC iQ-R Series MELSECWinCPU before describing solutions to the challenges faced by manufacturing businesses using the MELSECWinCPU.

*1 Microsoft and Windows are registered trademarks of the Microsoft Corporation.

Table 1 Information devices in the MELSEC iQ-R Series

Name	Features
MES interface module	The module enables direct connectivity between IT system databases and programmable controller systems.
OPC UA server module	The module enables users to mount an OPC UA server directly to the base unit of programmable controllers.
Recorder module/ camera recorder module	These modules are dedicated recording (logging) modules for corrective maintenance system. Users can aggregate time-stamped data about all devices and labels right after any problem arises with every scan of the programmable controllers.
High-speed data logger Module/ High-speed data communication module	These modules enable high-speed data sampling synchronizing the production status and other data with each programmable controller scan in an easy format to process and aggregate.
C Intelligent Function Module	This module includes VxWorks*2 in the operating system to execute C/C++ programs. The module is also compatible with Linux*3 to facilitate links to cloud services and Python*4 programs.

MES: Manufacturing Execution System, OPC: Open Platform Communications, UA: Unified Architecture

*2 VxWorks is a registered trademark of Wind River Systems.

*3 Linux is a registered trademark of Linus Torvalds.

*4 Python is a registered trademark of the Python Software Foundation.

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2. MELSEC iQ-R Series MELSECWinCPU

2.1 MELSEC iQ-R Series

The MELSEC iQ-R Series is a lineup of Mitsubishi Electric programmable controllers developed to overcome challenges in manufacturing businesses from a standpoint of TCO reductions. Programmable controllers are control devices used in factory automation. These products combine specialized modules by function to configure into systems tailored to each customer's application. These customers can take advantage of the broad MELSEC iQ-R Series lineup of proven programmable controllers to configure these systems. Additionally, highly precise control linking the programmable controller CPU and motion CPU or the open integrated network CC-Link IE TSN can realize seamless high-speed communication between information systems and production sites.

2.2 MELSECWinCPU

MELSECWinCPU adopts Windows as its operating system to achieve data processing similar to a computer in a programmable controller environment. The MELSECWinCPU specifications are shown in Table 2. The MELSECWinCPU can run a wide variety of applications on its Windows operating system. It also lets users develop applications in C/C++, Visual Basic*9 and C#. Furthermore, the MELSECWinCPU offers the same standard interface as a personal computer. Users can combine various peripheral devices for computers with the MELSECWinCPU to configure a system right for each application.

*9 Visual Basic is a registered trademark of the Microsoft Corporation.

3. MELSECWinCPU Features

3.1 Standalone Windows startup function

The updates to applications running in Windows and the backups requiring system restart, which stops operation of the entire programmable controller system. This has been one challenge of a programmable controller system running the Windows operating system. To solve this problem, Mitsubishi Electric has equipped the MELSECWinCPU with a system control function independent of the Windows operating system, which enables Windows to restart while other system modules continue running. This function improves the system operation rate because Windows can restart without stopping control using the multiple CPU system configuration consisting of a programmable control CPU and motion CPU (Fig. 1).

3.2 Adoption of Windows 10 IoT Enterprise LTSC 2019

The MELSECWinCPU uses Windows 10 IoT Enterprise LTSC 2019. Windows 10 generally issues functional update programs to add new functionality and quality update programs to rectify any security vulnerabilities or repair flaws. Windows 10 IoT Enterprise LTSC 2019 issues quality update programs but does not provide functional update programs. Therefore, a programmable controller using Windows 10 IoT Enterprise LTSC 2019 can always stay up to date while enabling stable system operations.

Table 2 MELSECWinCPU Specifications

Item	Description
OS	Windows 10 IoT Enterprise LTSC 2019
Programming language	C/C++, Visual Basic, C#
MPU	Intel Atom*5 E3930 Dual Core
Main memory	4GB
Internal storage	60GB
External I/F	USB3.0:1ch, USB2.0:3ch
	Ethernet*6(1000BASE-T):2ch
	RS232:1ch
Display I/F	HDMI*7
Memory I/F	SDHC/CFast*8

LTSC: Long-Term Servicing Channel, MPU: Micro Processing Unit, SDHC: SD High Capacity

*5 Intel Atom is a registered trademark of the Intel Corporation.

*6 Ethernet is a registered trademark of the Fuji Film Business Innovation Corporation.

*7 HDMI is a registered trademark of HDMI Licensing Administrator, Inc.

*8 CFast is a registered trademark of CompactFlash Association.

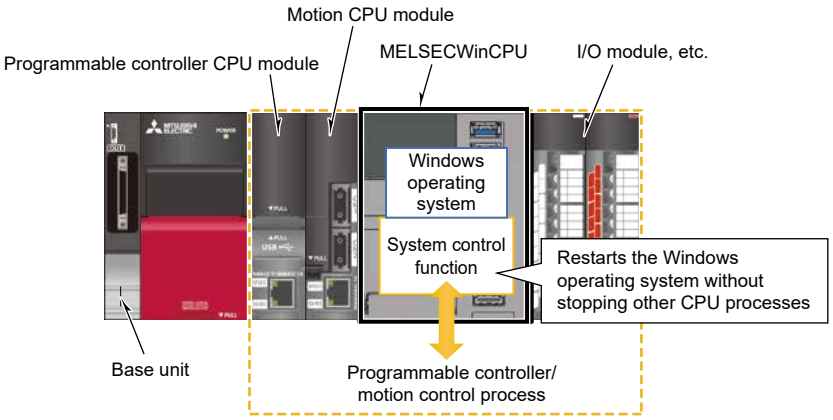

Fig. 1 Standalone Windows startup function

3.3 Easy access to each programmable controller module

MELSECWinCPU provides MELSEC Data Link Functions as methods of communication between Windows programs and each programmable controller module. These MELSEC Data Link Functions come as libraries that can be executed using C/C++, Visual Basic and C# programs in the Windows operating system, which enables the MELSECWinCPU to access each programmable controller module. In addition to accessing each programmable controller module connected to the same base unit, the MELSEC Data Link Functions can access the CPU modules via a network. The MELSECWinCPU also provides these MELSEC Data Link Functions as communication libraries that do not rely on any specific communication channel. Therefore, users can easily access modules by simply specifying a specific parameter for the module to access, such as a slot or network number. This type of access makes it easy to connect to various programmable control modules and a wide variety of Windows applications, peripheral devices, and other assets. Users can develop programs in an environment that they are familiar with because MELSECWinCPU supports Visual Studio*10 as an environment for program development.

*10 Visual Studio is a registered trademark of the Microsoft Corporation.

3.4 Robust hardware

The MELSECWinCPU does not use cooling fans, disk drives, or any other drive components to offer the same environment stability as other MELSEC iQ-R Series modules. It also features the same MELSEC iQ-R Series environment stability and long-term reliable supply of modules, which can reduce maintenance and management costs. Thanks to the Reliability, Availability, and Serviceability (RAS) equivalent to the programmable controller CPU, users can configure a system more reliable and robust than one using personal computers.

4. MELSECWinCPU Solutions for Manufacturing Businesses

4.1 Technology to reduce the data process engineering costs

Manufacturing businesses struggle to reduce engineering costs related to linking data and control processing. Ladder logic primarily used in manufacturing businesses is known for its strengths in control processes, such as used in programmable controllers. On the other hand, C and other high-level programming languages are proficient in the data processing necessary for complex operations, such as those used in numerical analyses, even though these languages are not as good for programming the control processes of programmable controllers. That is why systems that require both data and control processing sometimes combine a computer environment proficient at data processing and a programmable controller system proficient at control processing.

However, an integrated computer and programmable controller system requires communication programs for both the computer and controller, which increases the engineering costs necessary to develop the communication programs. Moreover, users often need to undertake development beyond the desired added value for equipment and systems, such as that to take into account the impact the communication program has on the programmable control system, which results in excess engineering costs.

The MELSECWinCPU overcomes this problem by linking to the programmable control system using MELSEC Data Link Functions. These MELSEC Data Link Functions eliminate the need for communication programs on existing programmable controllers to

make connections with a wide range of programmable controller modules easy. Through this innovation, users can introduce MELSECWinCPU to an existing programmable control system when adding data processing on existing equipment to realize control processing on equipment via conventional programmable controller modules and data processing via the MELSECWinCPU. Users can then shift their focus to the development of functions that provide added value to equipment and systems while reducing the engineering costs related to linking data and control processing (Fig. 2).

4.2 Reduction of computer maintenance and management costs

Manufacturing businesses struggle to reduce the computer maintenance and management costs to use both data and control processing. These maintenance and management costs primarily consist of the costs to develop hardware and software resulting from production stoppages due to computers and expansion boards for computers and the costs to handle the impact of irrelevant functional updates of the operating system on existing programs.

The lifecycle of computers and the expansion boards for these computers is not only relatively short, but the reliable acquisition of these components is also difficult. On top of that, the expansion boards for the computers often used for I/O control, analog control, and motion control differ manufacturer to manufacturer, which results in compatibility issues and meticulous tuning. The need for hardware and software development to adapt to any discontinued products or specification change often drives maintenance and management costs up as well. Furthermore, automatic functional updates to the operating systems can also impact programs

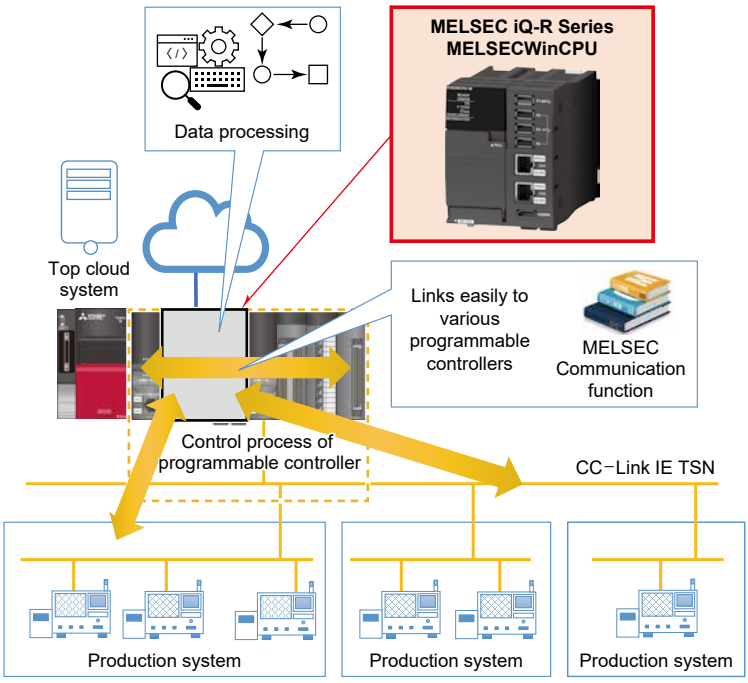

Fig. 2 Links between information and programmable controller processes

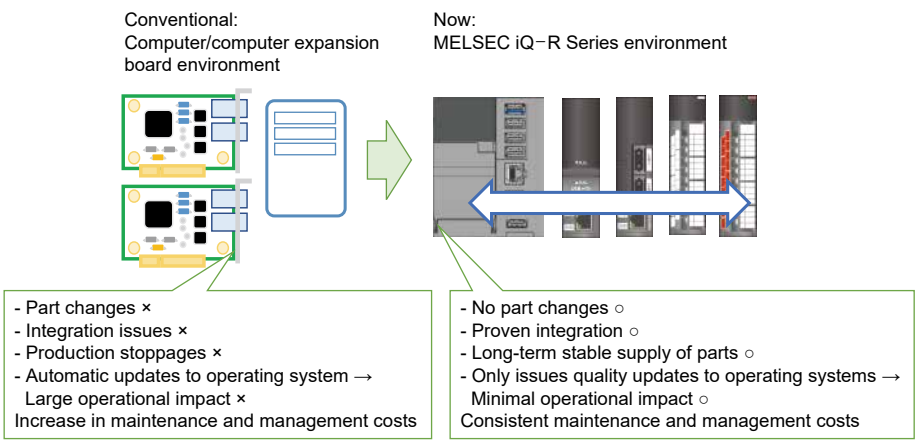

Fig. 3 Computer-MELSECWinCPU management and maintenance costs

already running in the production system, which makes maintenance and management costs an issue when using a Windows operating system for factory automation applications.

MELSECWinCPU addresses these issues that have just been described through the use of a broad range of MELSEC iQ-R Series modules and Windows 10 IoT Enterprise LTSC.

The use of MELSEC iQ-R Series modules even ensures a long-term stable supply of components. MELSECWinCPU can link to a variety of programmable controller modules, making a combination of a variety modules with guaranteed compatibility. These features enable users to reduce engineering costs related to maintenance and management resulting from typical system changes. The adoption of Windows 10 IoT Enterprise LTSC 2019 minimizes the impact on existing equipment because Microsoft only issues quality update programs and not functional update programs (Fig. 3).

5. Conclusion

This paper has provided an overview of the MELSEC iQ-R Series MELSECWinCPU. MELSECWinCPU enables the use of a Windows operating system as the programmable controller environment to reduce costs for data process engineering and computer maintenance and management, which have been obstacles standing in the way of a digital transformation of information using computers.