Retrofit Technologies for Facility Operation Life Extension

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Abstract

We have shipped a large number of various control panels, on which various devices, such as our Programmable Logic Controller (PLC), are mounted. There are, however, other companies' products and Original Equipment Manufacturer (OEM) products such as indicators, operation switches, and signal converters that are connected to the PLC via a point-to-point communication link. The production of some of these products will be discontinued, and some new models will not have a communication link function with our PLC. To extend the operation life of our control panels used in customer's facilities, we developed a gateway product that can connect the general-purpose equipment of other companies to our PLC when replacing existing old devices in the control panels.

In addition, the operability of our PLC programming tool (loader) varies greatly depending on the developed period. It took a lot of time to modify the program made with an old loader. We, therefore, developed an application program mutual conversion tool to convert old and new loader application to each other.

1 Preface

In order to extend the life of the control panel of a customer's facility, it was necessary to connect general-purpose devices made by another company to our Programmable Logic Controller (PLC) via a point-to-point communication link. Our remote communication link for PLC is a dedicated protocol, and the main products in our control panel have adopted products developed in-house. We have outsourced the Original Equipment Manufacturer (OEM) development even for equipment that has not been developed in-house, and have established standards for adoption as standard parts. These include an illumination switch for the console, a number display for the graphic panel, and a touch panel. Some of these are not available due to discontinuation of production, and some new products are not compatible with our PLC communication link. As such, when the equipment that was once mounted on the control panel is updated to prolong life, there are an increasing number of cases where there is no fully compatible equipment with our PLC. This paper introduces the control panel-related retrofit products and related application program conversion tools that we have supplied until now.

2 Overview of Recent Retrofit Product Development

2.1 Purpose

The purpose of retrofitting is to extend the operation life of a facility while maintaining its existing functions. Retrofitting can be applied even if a complete renewal of equipment is desired. That is, the control panel can be used as it is, and only the delivered parts that have reached the end of their useful life can be partially replaced. As a result, the equipment downtime can be shortened, and the renewal cost can be reduced compared to a complete renewal.

2.2 Background

The background to such retrofitting is the control of capital investment costs by the end users. In addition, in order to perform full-scale renewal, it is necessary to temporarily install existing equipment and renewal equipment at the same time. There are, however, some project sites where enough space for the work cannot be secured. In that case,

the equipment must be stopped for a period of time and renewal work must be carried out. Retrofitting is an effective solution to such cases.

2.3 Recent Trends

Retrofitting is an effective means of equipment renewal, and we have developed many substitute products. In particular, the retrofit products which have the same functions as existing parts and the same mounting dimensions, were very useful and appreciated by the end users. The emphasis has, therefore, been on developing products like these. The development of such retrofit products, however, is costly and time consuming. In addition, there are often no equivalents for the connector and switches to be mounted on the existing product. Furthermore, there is the challenge that engineers who developed existing products are now retired, and it is not possible to pass on technologies, such as design ideas and expertise, to engineers new to the field. Instead of developing a fully compatible product, we instead examined whether retrofitting could be made using commercially available general-purpose equipment. What is most important is that it is easy to install at the time of replacement, and that there would be no need to change the application program such as PLC. Our PLC has ensured continuity of the application language while changing generations of design. The functions are, however, slightly different due to the improvement of performance and the capacity expansion of memory. Therefore, the current situation is that the arithmetic instructions are slightly different. In order to update the existing old PLC to the new PLC, we have developed an application program conversion tool to facilitate the update. When investigating the application program of an existing old PLC, the existing PLC programming tool (loader) is used, but these have poor visibility and operability of the user interface, a factor that lengthened the investigation time. Responding to such challenges is the impetus for retrofit development.

2.4 Retrofit Products

Recently developed retrofit products are introduced below.

2.4.1 Mutual Program Conversion Tool

Table 1 shows our PLC types and applicable loaders. The OS of WP1000 and VP4000 at the time of development was MS-DOS, and it can also run on Windows. The design concept remains MS-DOS.

Table 1 Our PLC Types and Applicable Loaders

The types of PLCs manufactured by our company, the loader models applicable to them, and the PC OS at the time when each loader was developed are shown.

PLC type	Applicable loader	OS used when the loader was developed
RC100/RC200	WP1000	MS-DOS
ADC4000	VP4000	MS-DOS
ADC5000/ADC6000	WP5000	Windows

Fig. 1 Screen of Mutual Program Conversion Tool

This shows when an application of the ADC5000 Series is converted into that of the RC100 Series.

The screen is operated in a single window, so, when changing the setting value while programming, it is necessary to switch the screen. Also, there is no scroll function. The ladder program is a text display. Operability and readability are inferior because the device does not display the name (comment). The ladder program of the WP5000 is a graphic display, and the operability and readability are greatly improved.

When renovating existing older PLCs such as RC100 or ADC4000 to ADC6000, it has been possible to convert the application program of the existing older PLCs for ADC6000. When keeping the existing older PLC as it is, there was no choice but to use the WP1000 or VP4000, so, we developed a mutual conversion tool and made it a graphic screen to greatly improve readability. As a result, the ladder program can be converted between the WP1000/VP4000/WP5000. Fig. 1 shows the screen of the mutual program conversion tool.

2.4.2 IO-Link Ⅱ Metal Gateway

There is an IO-Link Ⅱ Metal as a remote communication link for our PLC. There are many types of devices that can be connected to the IO-Link Ⅱ metal, such as the remote IO and displays. If these devices are our products, these are compatible products, but if these are OEM products, these may not be compatible products. In such a case, to avoid the development of a compatible product, we developed and the IO-Link Ⅱ Metal Gateway (MG1100) with the aim of using general-purpose products to achieve the same functions as existing devices. Fig. 2 shows the external appearance of MG1100, and Fig. 3 shows an application example of MG1100.

As a standard communication link to which general-purpose products can be connected, there are the Modbus/RTU using RS-232C or RS-485 as the communication link medium, and the Modbus/TCP using Ethernet as the communication link medium. In some cases, each product vendor-specific protocol is adopted. The MG1100 enables these general-purpose products to be used via IO-Link Ⅱ metal. The MG1100 has, therefore, not only a protocol conversion function but also a sequence calculation function to convert the data format of general-purpose equipment to the data format of the host PLC. Table 2 shows the functional specifications of the MG1100. By using the MG1100, general-purpose products of other companies can be easily connected to the IO-Link Ⅱ metal communication link.

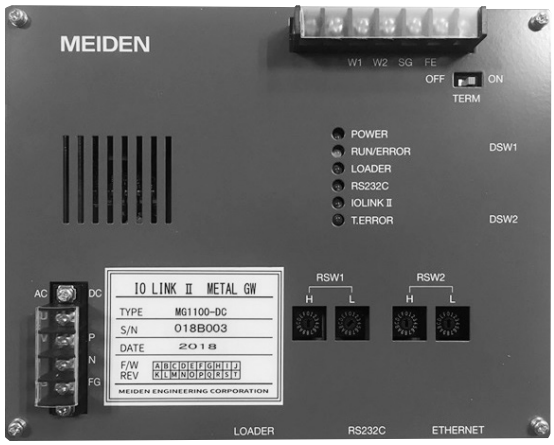

Fig. 2 MG1100

An external appearance of the I/O Link Ⅱ metal gateway (MG1100) is shown.

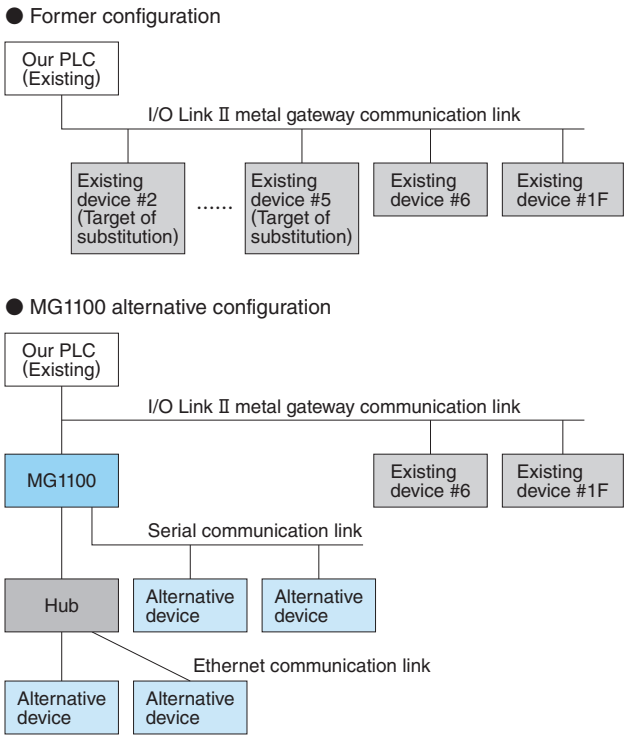

Fig. 3 Application Example of MG1100

The configuration of the existing system and the application example of the MG1100 when replacing it with general-purpose equipment are shown.

Table 2 Functional Specifications of MG1100

An overview of the functional specifications of the MG1100 is shown.

Function name	Minor item	Description	Remarks
PLC function	Program language	Ladder program	Equivalent to RC200
	Data memory	8 kW	Equivalent to RC200
	Program memory	Steps at 8K Max.	Equivalent to RC200
I/O Link Ⅱ metal	Functions	Adapter function only	
	Data transfer speed	125 k・250 k・500 k・1 Mbps	
	Data transfer distance		
Serial data communication	Communication standard	RS-232C (RS-485 for some converters)	
	Data transfer speed	1200/2400/4800/9600/19200/38400 bps	
	Transmission system	Start-stop synchronization system	
	Protocol	Modbus/RTU (Master/slave function)	
		Non-procedure	Equivalent to VM110
	Destinations for connection	8 destinations Max.	
Ethernet	Data transfer speed	10/100 Mbps	
	Protocol	Modbus/TCP (Master/slave function)	
		Open protocol	Equivalent to VM108
	Destinations for connection	2 destinations Max.	

2.4.3 Smart Distributed System (SDS)/ Actuator-Sensor-interface (AS-i) Gateway

In many cases, the existing monitoring consoles were configured to display the operation and status with an illuminated switch with a bus communication function, and the actual control was performed with a PLC manufactured by our company. As the illumination switch, such console adopted the type that communicates on the SDS manual bus or AS-i communication link. On the other hand, our PLC communicates on the IO-Link Ⅱ metal communication link, so it cannot be directly connected to the SDS or AS-i communication link. The SDS manual bus controller and AS-i gateway (IOC210) have been used as repeaters, but these repeaters can no longer be used due to the discontinuation of production of the illumination switch with bus communication function.

In order to configure an alternative system, it is necessary to connect the IO type illumination switch and PLC instead of the SDS or AS-i communication link. An IO module can be added to the PLC, or remote IO can be used if there is no empty slot, but the allocation of the data memory address on the PLC side changes, so the application needs to be redesigned. To avoid this, we have developed the SDS/AS-i Gateway (MG3000A). **Fig. 4** shows the external appearance of the MG3000A. By using MG3000A, the existing application can be used without modification, so the man-hours and labor costs required for redesign have been significantly reduced.

Fig. 4 **MG3000A**

An external appearance of the MG3000A is shown.

3 Postscript

Substitute development of discontinued products requires an approach from the “redevelopment of products equivalent to existing products” to “realizing equivalent functions with general-purpose equipment without changing higher-level applications”. By using such an approach, we developed substitutive products introduced in this paper.

Going forward, we will continue to develop substituting technologies and products to extend the life of our customers’ facility.