"FRENIC4000VM6" Low-Voltage Industrial Plant Inverter

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ABSTRACT

As conventional plant control systems are being streamlined and consolidated to improve productivity, compatibility is required for external dimensions and functions. These control systems are also needed to comply with the revised Japanese Industrial Standards (JIS), while simultaneously securing sustainability of existing equipment and saving maintenance work. To meet these demands, Fuji Electric developed the "FRENIC4000VM6" low-voltage industrial plant inverter. It is first equipped with the high-speed E-SX bus, capable of handling high-capacity communications, enabling it to improve control speeds and greatly increase the number of inverters per controller. These enhancements facilitate the building of large-scale plant systems.

1. Introduction

Fuji Electric's variable-speed control systems contribute to the development of the manufacturing industry in terms of control of steel and nonferrous metal manufacturing, paper manufacturing and other plants by meeting various user demands such as faster manufacturing processes, higher product quality and stable operation.

Recently, conventional systems are being streamlined and consolidated to improve productivity of plants. When replacing with a new model, compatibility with the conventional model in external dimensions and functions is required to ensure continuity from the existing equipment. In addition, there is also a need to comply with the Japanese Industrial Standards (JIS), which were revised on July 1, 2019 for consistency with international norms including international standards and safety standards, as well as further requirement for maintenance labor saving.

Fuji Electric has developed the "FRENIC4000VM6" low-voltage industrial plant inverter that complies with these needs and the JIS.

This paper describes the features of the FRENIC4000VM6 and an example of its application to plants.

2. Features of the "FRENIC4000 VM6"

Figure 1 shows the appearance of the FRENIC4000VM6 and Table 1, its major specifications, followed by description of its features.

2.1 Compliance with Japanese Industrial Standards

Fig.1 "FRENIC4000VM6"

The Japanese Industrial Standards were revised on July 1, 2019. The safety requirements for electrical equipment and variable-speed drives in JIS B 9960-1 and JIS C 61800-5-1 have been modified by changing the requirements for grounding systems and equipment safety stop to ensure consistency with international standards. Therefore, the conventional variable-speed drive systems as they are may be unable to comply in some cases. Accordingly, FRENIC4000VM6 has been designed to comply with the new JIS to allow installation in various systems in Japan and overseas.

2.2 Panel installation space saving

An inverter unit is a plug-in structure in which an inverter circuit and auxiliary equipment such as capacitors are integrated into a unit. Figure 2 shows the installation configuration of the units in a panel. As with conventional models, the panel structure for a capacity of 300 kVA or less stacks the units to house them, and that for 450 kVA or more does not use the unit configuration. The units for 25 kVA or less allow

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Table 1 Major specifications of “FRENIC4000VM6”

Item	Standard specifications			Remarks
Compliance	JIS: JIS B 9960-1, 2019; JIS C 6180-5-1, 2016; JIS C 4421, 2008 IEC: IEC 60204-1, 2016; IEC 61800-3, 2017; IEC 61800-5-1, 2007+A1/2016			With PWM converter applied
Altitude	1,000 m or less above sea level			Nonstandard specification possible by derating
Ambient temperature	0°C to +40°C			–
Relative humidity	20% to 90%RH			No condensation
Inverter capacity (kVA)	Unit type	10, 15, 25, 38, 50, 75, 100, 150, 225, 300		Multiple connection for 1,200 kVA and above
	Panel type	450, 600, 900, 1,200, 1,800, 2,700, 3,600, 4,500, 5,400		–
Overload capacity	150% – 1 min			–
Inverter output voltage	3-phase 400 V AC			–
Maximum frequency	200 Hz (maximum)			–
Speed control	ASR fixed cycle 1 ms			–
Control method	Vector control		Sensorless vector control	–
Speed control accuracy	±0.005%		±0.5%	–
Speed control response	40 Hz		4 Hz	Excluding mechanical system
Speed control range	1:1,000		1:100*1	*1: 0.5 Hz or higher
Torque accuracy	±5%, ±3%*2 of rated torque		±5% of rated torque	*2: By a combination test with a motor
Cubicle structure	Front maintenance, IP20, forced air cooling			–
Cable lead-in	Bottom lead-in			–

Inverter capacity (kVA)	Maximum number stored (per panel)
10, 15, 25	12 units
38, 50, 75	8 units
100, 150	4 units
225, 300	2 units
450, 600, 900	1 set (Panel structure)

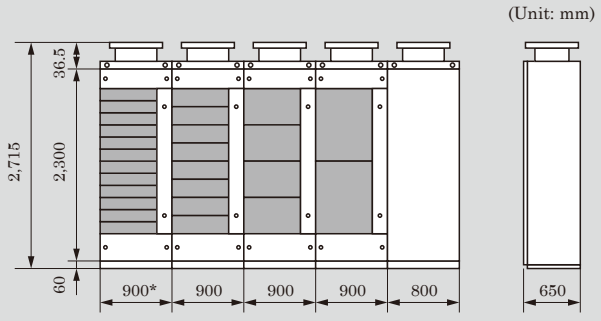

Fig.2 Inverter storage panel

12 stacks, which is the largest number of multiple stacks in the industry, and the units of different capacities from 10 to 300 kVA allow mixed stacks in a free arrangement, thereby achieving significant space saving that allows panel arrangement in a limited space.

2.3 Retrofitting for conventional model

To meet the demand to replace the previous model “FRENIC4000VM5R,” we offer a retrofit type with compatibility ensured in appearance, dimensions and functions. It can flexibly meet customers’ various budgets, needs and constraints by replacement of individual units using the existing panel.

2.4 Improvement of accessibility

With the loader, monitoring and trace functions improved from the conventional models, maintenance labor can be further reduced. The functions that have been enhanced are as follows.(1)

(1) Operation display screen function

The actual parameter values and internal parameter values can be compared and displayed in a block diagram on the monitor to allow the operating conditions to be recognized at a glance.

(2) Failure history screen function

While the loader of the conventional models provided a view of 40 failure records maximum, up to 100 records can now be displayed in the order of occurrence. Checking the factors retrospectively is useful for trend management and preventive maintenance.

(3) Low-speed trace function

The loader of the conventional models was only equipped with high-speed trace function capable of sampling 225 points at 1 ms intervals at the time of failure, which allowed analysis of instantaneous electrical behavior before and after the occurrence of the failure but it was difficult to estimate the mechanical

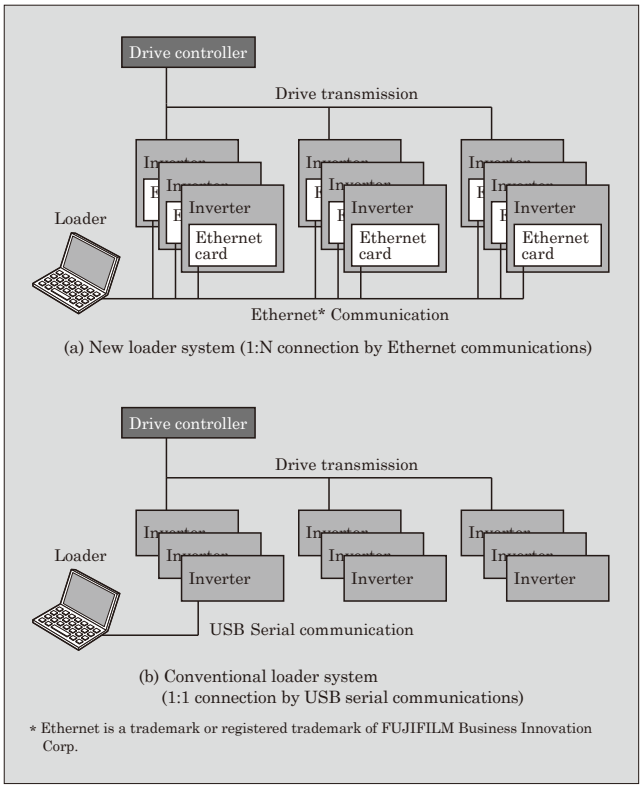

Fig.3 Loader connection

behavior before and after the occurrence of the failure. With the newly added low-speed trace function capable of sampling 225 points at intervals of 200 ms, behavior for a period approximately 200 times longer than with the conventional models can now be recorded. This has allowed mechanical factors to be estimated from the changes in electrical behavior before and after the occurrence of failures, resulting in a shorter analysis time than in the past.

(4) The 1:N connection function for the loader and inverters

The connection system between the loader and the inverter has been expanded from the conventional 1:1 connection to 1:N connection, which provides the capability of collective monitoring and management of multiple units (see Fig. 3). As a result, the status and parameter management of several hundred inverters can be performed at one place, greatly reducing the maintenance work of the user.

2.5 Provision of "E-SX bus"

The super high-speed system bus the "E-SX bus" has been provided. The I/O capacity has been expanded from the conventional 512 words maximum to 4,096 words. By combining with a dedicated controller, up to 126 inverters can be connected to one programmable logic controller (PLC), which is an eight times larger number of inverters than in the past. This makes possible simple configurations even in large-scale plant systems. When combined with the "XCS-3000 Type E," loopback control allows operation to be continued if the communication line is disconnected at one point, achieving stable operation of the equipment. The performance of the E-SX bus is as follows.

(1) Bus transmission speed: 100Mbps
(2) Bus distance: 100 m (inter-station), 1 km (total extension)
(3) I/O capacity: 4,096 words
(4) Refresh performance: 512 words/ms

3. Example of Application of "FRENIC4000VM6"

Figure 4 shows an example of replacement in a steel process line.

In the continuous galvanizing line, there are hundreds of motors that require the provision of high-speed and high-precision aligned speed control, tension control and load balance control to apply an appropriate speed and tension to a plated steel plate material. In data transmission of conventional inverter models, there is a trade-off relationship between high-speed control and I/O words per unit time. Therefore, when a sufficient transmission capacity could not be secured for controlling the motors, a large number of drive controllers were provided for inverter connection. Recently, there has been an increasing demand for

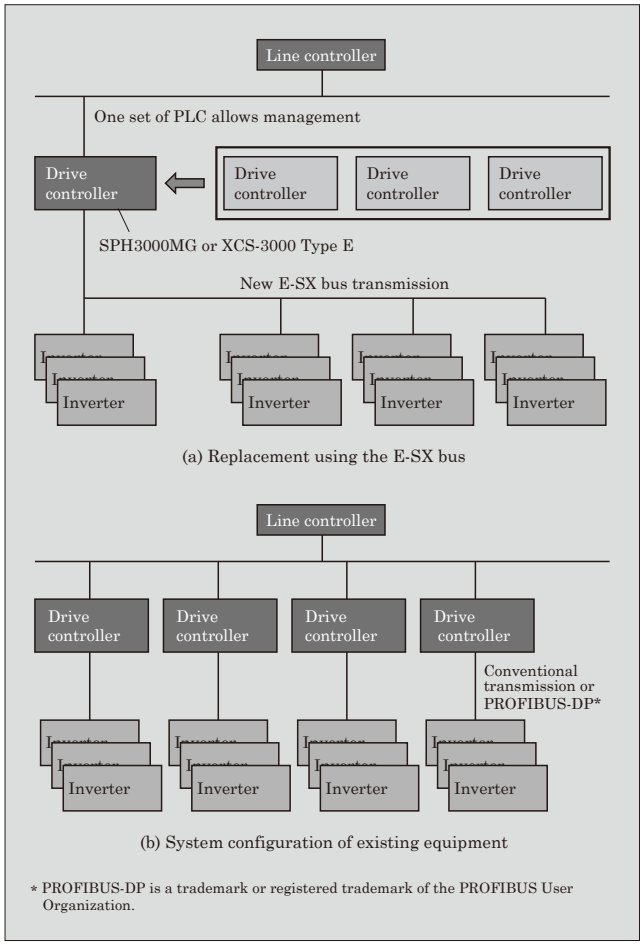

Fig.4 Example of replacement in steel process line

consolidating drive controllers in order to streamline maintenance operations for conventional systems like this. To meet this demand, we have newly provided the E-SX bus transmission, which achieves both high-speed control and large-capacity I/O area, allows the number of conventional drive controllers to be reduced to one-eighth, enabling plant maintenance and preservation to be streamlined.

4. Postscript

This paper has described the low-voltage industrial plant inverter "FRENIC4000VM6." We intend to continue to develop products that enable flexible system construction and propose high value-added solutions.

References

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