

Development of the High-Speed Processing Controller “SANMOTION C” Series

Shigeki Sato Hideaki Kodama Tomonobu Tazaki Hiroto Endo Masayuki Mizutani

1. Introduction

The “SANMOTION C” Series are motion controllers for industrial machinery which run on servo motor drive. They can control a servo amplifier through a network for motion and control the position, speed, and torque of a servo motor. They are equipped with a robot control function and kinematics to support the various mechanisms of industrial robots.

The “SANMOTION C” Series are module-type system products based the programmable logic controller and are configured from a CPU module and expansion module. There are various types of expansion modules available to choose from to suit the specific application. These include digital/analog input/output module, serial interface module, and encoder module. Moreover, the CPU module, which is the central component of this system, has been produced by SANYO DENKI over the years, with the first-generation model, CP232-Z, and the second-generation models, CP240-A and CP242-A, released in 2006 and 2010, respectively. These are now used by our customers on a wide variety of equipment.

In order to further improve processing quality of equipment, there is a need to speed up the communication cycle to the servo amplifier and control the machine more smoothly. Moreover, to enhance productivity even further, there is a need to increase the number of controllable motor axes and perform complex tasks with multiple robots.

This paper introduces the features of the newly developed CPU module (hereinafter “new model”) which has accomplished even higher speed and performance.

2. Outline of the New Model

2.1 External view and dimensions

The external view and dimensions of the new model are shown in Figure 1 and Figure 2, respectively. Regarding the installation method and addition of an expansion module to

the product, the height and depth have been kept the same as existing products and a common configuration has been used in order to maintain compatibility.



Fig. 1: External view of the new model

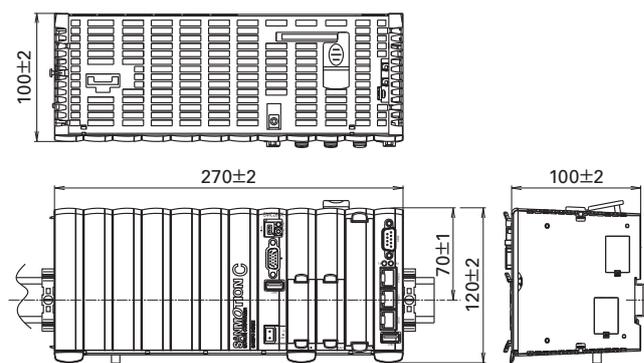


Fig. 2: External dimensions of the new model

2.2 Specifications of the new model

Table 1 shows the specifications of the new model. This time we have developed two models; the SMC263X equipped with a 1.6 GHz CPU and the SMC265X equipped with a 1.8 GHz CPU.

Table 1: Specifications of the new model

Model No.		SMC263X	SMC265X
CPU		1.6 GHz	1.8 GHz
Main memory		1 GB	
Battery backed SRAM		1 MB	
Built-in interface	EtherCAT	100 Mbps	
	CAN	125 kbps to 1 Mbps	
	Ethernet	10/100 Mbps, 2 ch	
	USB	USB2.0 high speed, 2 ch	
Max. connectable number of units		12	
Input power supply		24 VDC (19.2 VDC to 30 VDC)	
Maximum input power		99 W	
Rush current		10 A	
Maximum output power		40 W (K-BUS 24 VDC)	
Maximum output power		10 W (K-BUS 5 VDC)	
Cooling method		Forced air cooling	
Dimensions		120 H x 270 W x 100 D (mm)	
Mass		1335 g	
Conformance	Product standards	IEC 61131-1 (JIS B3501) Programmable logic controller (PLC)	
	UL/cUL	UL 508	
	EMC directive	2004/108/EC	
	RoHS directive	2011/65/EC	

2.2.1 Main memory

The capacity of the main memory has been increased from the 512 MB of the current model to 1 GB.

2.2.2 Fieldbus

The new model comes equipped with fieldbus EtherCAT interface as standard. EtherCAT is based on Ethernet, and is increasingly popular due to its reputation of being open, high-speed, flexible, and safe. Moreover, by adding the expansion module, FM299-A, SANYO DENKI's original fieldbus, GA1060, can be selected.

2.2.3 Addition of expansion modules

Figure 3 shows how to add expansion modules. A maximum of 12 expansion modules can be connected through the connectors for expansion on the right-hand side at the far right module. If more than 12 expansion modules are to be used, or if they are to be used in a decentralized way, this can be done through connection via the bus link module, BL210-B. Table 2 shows the existing expansion modules that can be used with the new model.

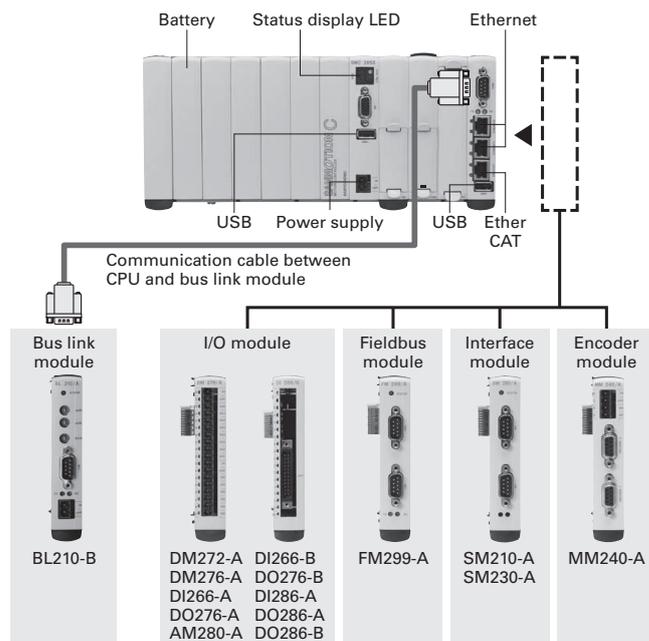


Fig. 3: Expansion module additions

Table 2: Available expansion modules

Type	Model No.	Specifications
Plug-in module	SX210-A	RS232C, 1 ch
	SX230-A	RS485/422, 1 ch
	FX200-A	CAN, 1 ch
I/O module	DM272-A	8DI (negative-common input) 8DO (source output)
	DM276-A	6DI (positive-common input) 8DO (sink output)
	DI266-A DI266-B	16DI (positive-common input) -A: Terminal block-type connector -B: Square connector
	DO276-A DO276-B	16DO (sink output) -A: Terminal block-type connector -B: Square connector
	DI286-A	32DI (Positive/negative-common input)
	DO286-A	32DO (source output)
	DO286-B	32DO (sink output)
AM280-A	4AI, 4AO	
Fieldbus module	FM299-A	GA1060 interface
Interface module	SM210-A	RS232C, 2 ch
	SM230-A	RS485/422, 2 ch
Encoder module	MM240-A	Encoder input: 2 ch Latch input: 2 points
Bus link module	BL210-B	For decentralized expansion of expansion modules

2.2.4 Built-in interface

The new model is standardly equipped with ports for EtherCAT, CAN, Ethernet (2ch) and USB (2ch). The Ethernet ports can be connected to a computer installed with the integration development tool software, SANMOTION C Studio, to enable programming, configuration and debugging. They can also be used as data communication ports with peripheral equipment such as programmable touch panels, image processing devices or teaching pendants.

2.2.5 Runtime firmware

Runtime firmware can be installed into a compact flash card (hereinafter “CF card”) and inserted into the slot for CF cards on the top of the new model. Three types of runtime firmware with different functions as shown in Table 3 are available for the new model, and the user can select the one best suited to user’s application.

Table 3: Runtime firmware categories

Type	Functions
SMC-MFB-CP26X	Sequence/motion control (Electronic gear/electronic cam)
SMC-PTP-CP26X	Sequence/motion/robot control (PTP control)
SMC-PATH-CP26X	Sequence/motion/robot control (3D linear, circular interpolation control)

2.3 Control function

“SANMOTION C” is equipped with PLC control, motion control, and robot control functions. The control and programming methods differ between motion control and robot control so “SANMOTION C” supports both by having various runtime firmware and integrated development tool software to choose from depending on user’s application.

2.3.1 Motion control

By using the various standardized MFB (motion function block), anyone can write a motion control program with ease. Table 4 provides details of the motion control function.

2.3.2 Robot control

By supporting kinematics for various mechanisms and by using original robot language, robot orientation and TCP (tool center point) position can be controlled. Table 5 provides details of the robot control function

Table 4: Motion control function

No. of controlled axes	Max. 64
EtherCAT cycle time	1 to 8 ms
Control method	Position control (PTP), speed control, torque control
Acceleration/ deceleration method	Automatic trapezoidal acceleration/ deceleration, S-shaped acceleration/ deceleration
Positioning unit	Arbitrary (pulse, mm, inch, degree)
Max. positioning value	-2147483648 to 2147483647 (with a 32 bit sign)
Programming language	Complies with IEC61131-3 (IL, ST, LD, FBD, SFC, CFC)
Motion Function Block	Homing, incremental mode, absolute mode, constant speed mode, electronic cam, electronic gear

Table 5: Robot control function

No. of controlled axes (for each robot)	Max. of 9 (6-axes articulated robot + additional 3 axes)
EtherCAT cycle times	2 to 8 ms
Control method	PTP, 3D linear, 3D circular
Teaching method	Remote teaching, numeric input
Positioning unit	Arbitrary (pulse, mm, inch, degree)
Programming language	Original robot language
Supported robots	Cartesian robots, horizontal articulated robots, vertical articulated robots, parallel link robots

3. Product Features

3.1 Enhanced processing performance

The most notable feature of the new model is the enhanced processing performance achieved by equipping a CPU capable of high-speed processing, increasing memory capacity and revamping hardware. Enhancement of the processing performance has led to the following types of benefits.

- The high-speed, high-accuracy control of multiple peripheral control devices such as control machinery and conveyors is possible with just one controller unit, and tact-time can be shortened.
- The trajectory accuracy during positioning control and control accuracy during synchronized control such as cam are enhanced.

As a numerical example of how processing performance has been enhanced, the following sections describe the control performances of the new and current models when SANYO DENKI’s servo amplifier equipped with an EtherCAT interface is connected.

3.1.1 Command processing time

Table 6 is a comparison of the processing times for the basic command (floating-point addition instruction). Compared with the current model’s (CP242-A) processing time of 20 ns, the new model has achieved 11 ns.

Table 6: Basic command processing time

Model No.	Basic command processing time
CP242-A	20 ns
SMC263X	18 ns
SMC265X	11 ns

3.1.2 Higher number of maximum control axes

Table 7 shows a comparison of the number of maximum control axes. Compared to the 32 axes controlled by the current model (CP242-A), processing performance of the new model has been improved, enabling it to control up to 64 axes.

Table 7: Max. no. of controllable axes

Model No.	EtherCAT cycle times		
	4 ms	2 ms	1 ms
CP242-A	32 axes	-	-
SMC263X	64 axes	32 axes	16 axes
SMC265X	64 axes	64 axes	32 axes

3.1.3 Control of multiple robots

Table 8 is a comparison of the number of 6-axes articulated robots that can be controlled with one controller. While the current model (CP242-A) can only control one robot, the new model can control two.

Table 8: No. of controllable robots

Robot type	Model No.	EtherCAT cycle times		
		8 ms	4 ms	2 ms
6-axes articulated Robot input	CP242-A	1 unit	1 unit	-
	SMC263X	2 units	1 unit	-
	SMC265X	2 units	2 units	1 unit

3.2 Improved convenience

As shown in Figure 4, convenience has been improved by increasing the number of Ethernet ports and providing slots for plug-in modules.

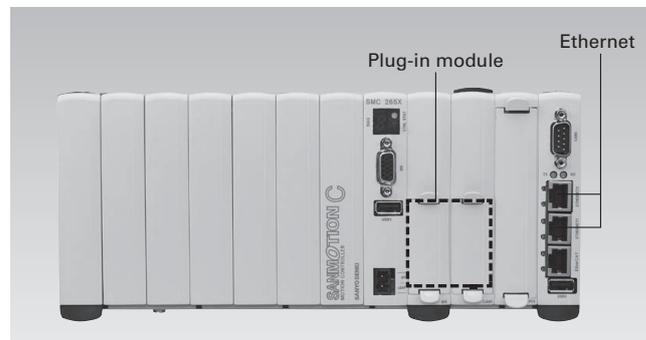


Fig. 4: Ethernet port and plug-in module

3.2.1 More Ethernet ports

The new model has two Ethernet ports, compared to just one on the current model. This means that two peripheral devices can be connected at the same time without using a HUB (network equipment).

3.2.2 Plug-in module support

By using a plug-in module for function expansion, it is possible to expand the interface without widening the width, compared to if the module was expanded by using the extension connectors on the right side of the far right module.

4. Conclusion

This paper has introduced the features of the CPU module that has been newly added to the “SANMOTION C” Series lineup as a high-speed processing controller. The new model has improved processing performance and convenience compared with the current model. Particularly in regards to processing performance, the following enhancements have been achieved.

- (1) EtherCAT cycle times: 1ms
- (2) Max. no. of controllable axes: 64
- (3) Simultaneous control of two 6-axes articulated robots

We believe that these enhancements in performance will help customers achieve device performance that meets their expectations. We wish to continue engaging in product development with consideration to what customers will require in the future.



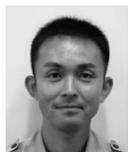
Shigeki Sato

Joined SANYO DENKI in 1984.
Servo Systems Div., Design Dept. 2
Works on the design and development of system products.



Hideaki Kodama

Joined SANYO DENKI in 1991.
Servo Systems Div., Design Dept. 2
Works on the design and development of system products.



Tomonobu Tazaki

Joined SANYO DENKI in 1997.
Servo Systems Div., Design Dept. 2
Works on the design and development of system products.



Hiroto Endo

Joined SANYO DENKI in 2007.
Servo Systems Div., Design Dept. 2
Works on the design and development of system products.



Masayuki Mizutani

Joined SANYO DENKI in 2013.
Servo Systems Div., Design Dept. 2
Works on the design and development of system products.