

# Technology Supporting Globalization of Servo Systems

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## 1. Introduction

Due to globalization of the economy and industries, Sanyo Denki's servo systems are being used by customers not only in Japan, but also many different regions around the world, with a focus on North America, Europe, China and SE Asia, and are contributing to improvement in the performance and quality of machines and equipment.

Conventionally, requirements for servo systems included performance, characteristics and downsizing and these were extremely important elements, however in line with globalization, requirements are becoming more diversified. For example, energy conservation, environmental-resistance, reliability, safety, convenience and operability are requiring, normally.

This report introduces the requirements for stepping motors, servo amplifiers and motion controllers in line with globalization and examples of concrete activities against the requirements.

## 2. Stepping Motor Activities

### 2.1 Stepping motor requirements

Below are the main requirements for stepping motors.

- (1) Improvement of environmental-resistance performance such as splash proof and dust resistance
- (2) Expansion of motor drive voltage
- (3) Conformity with international product safety standards
- (4) Adoption of a easily obtainable connector
- (5) Improvement of maintainability

Sanyo Denki is working to develop more standard products which fulfill these requirements. Furthermore, we are offering customization of standard products in order to meet requirements for particular applications limited to specific regions.

The 2-phase stepping motor "SANMOTION F2" series is one concrete example of our activities.

### 2.2 "SANMOTION F2" series activities

So that our products could be used in a wide-range of applications across many regions, we have added an IP65-supporting, 2-phase stepping motor with environmental-resistance, safety and convenience, to our "SANMOTION F2" series.

The flagship models are the "flange size: 56 mm sq., rated current: 1A" and "flange size: 86 mm sq., rated current: 2A. The main specifications of each are shown in Tables 1 and 2. Below is an explanation of their characteristics.

#### (1) Improved environmental-resistance

The demand for photovoltaic systems, etc. has increased in recent years in the push for better energy conservation, and motors are required to be highly waterproof and dustproof due to the relevant operation environments.

This motor adopts a new adhesive agent in the seal of its joined faces which has a high level of water protection and moreover has a coat of paint around the outer periphery of the stator core lamination, thus satisfying IP65.

Implementing these measures has eliminated the need for motor protection even in applications such as outdoor devices and food processing machines where there is exposure to water or dust, making it possible to reduce the size and cost of equipment.

#### (2) Expansion of the motor drive voltage and response to product safety regulations

This product is designed to sufficiently secure insulation distance within the motor and has expanded the drive voltage to a maximum of 250 V AC.

Moreover, this product conforms to international product safety standards such as UL and CE and can be used in many regions.

(3) Adopt a easily obtainable connector

As Fig. 1 demonstrates, the outlet of the power cable has been standardized as cable type with versatility. At the same time, we have added to the lineup an M12 type splash proof connector which is widely used in Europe, thereby improving convenience for European use.

Table 1: Main specifications of the 56 mm sq. motor

Model	SP2563-5000	SP2566-5000	SP2566-5060
Drive voltage	250 V AC or less		
Number of phases	2		
Rated current	1 A		
Step angle	1.8°		
Holding torque	1.0 N·m or more	1.7 N·m or more	
Rotor inertia	0.21 x 10 <sup>-4</sup> kg·m <sup>2</sup>	0.36 x 10 <sup>-4</sup> kg·m <sup>2</sup>	
Total motor length	80 mm	102 mm	
Motor mass	0.9 kg	1.2 kg	
Protection class	IP65		
Power cable specifications	M12 connector	M12 connector	Cable
Heat-resistance class	F class		

Table 2: Main specifications of the 86 mm sq. motor

Model	SP2862-5000	SP2863-5000	SP2863-5060
Drive voltage	250 V AC or less		
Number of phases	2		
Rated current	2 A		
Step angle	1.8°		
Holding torque	6.4 N·m or more	9.0 N·m or more	
Rotor inertia	3.0 x 10 <sup>-4</sup> kg·m <sup>2</sup>	4.5 x 10 <sup>-4</sup> kg·m <sup>2</sup>	
Total motor length	120 mm	150 mm	
Motor mass	3.1 kg	4.2 kg	
Protection class	IP65		
Power cable specifications	M12 connector	M12 connector	Cable
Heat-resistance class	F class		

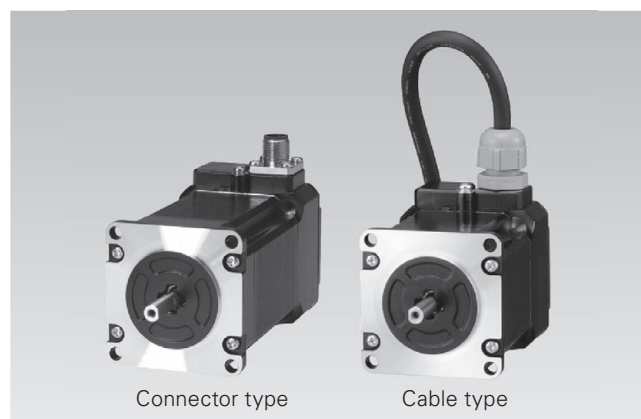


Fig. 1: External view of the 56 mm sq. products

### 3. Servo Amplifier Activities

#### 3.1 Servo amplifier requirements

Below are the main requirements regarding servo amplifiers.

- (1) Expansion of the input power voltage range
- (2) Improvement of product reliability (robustness) and safety
- (3) Better connectivity with various controllers
- (4) Response to various open networks
- (5) Ease of servo adjustment and troubleshooting, support tools in multiple languages

As Fig. 2 shows, the AC servo amplifier “SANMOTION R” series has enhanced specifications, performance and functions compared with the conventional product in order to satisfy these requirements. This series also supports the various open networks.

Here we will introduce the AC servo amplifier “SANMOTION R 3E Model” and an open supporting network product as concrete examples of our activities in line with globalization.

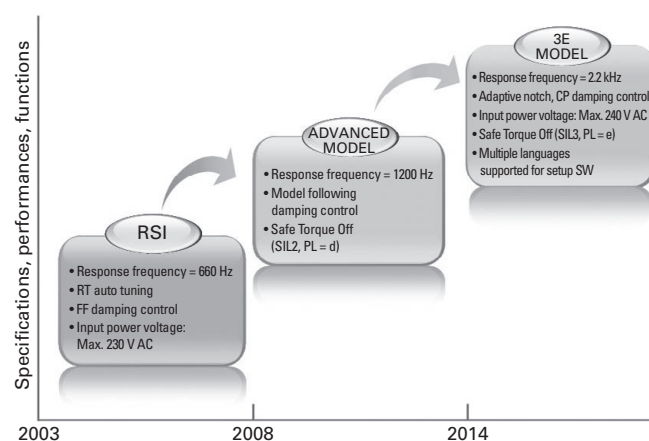


Fig. 2: A roadmap of the AC servo amplifier SANMOTION R series

### 3.2 “SANMOTION R 3E Model” activities

The “SANMOTION R 3E Model” is a new AC servo amplifier which was commercialized in December, 2013. Its main specifications are shown in Table 3.

Table 3: Main specifications of the “SANMOTION R 3E Model”

Power voltage range	200 V AC	200 V to 240 V AC +10%, -15%
	100 V AC	100 V to 120 V AC +10%, -15% (10 to 30 A only)
Amplifier output		10 A, 20 A, 30 A, 50 A, 600 A
Control mode		Position, Velocity, Torque control, Model following control
Command Input	Position	Pulse train command (responding to differential output, sink type, source type open collector output)
	Velocity, Torque	Analog command
General input/output points		Input x 8 points, output x 8 points
Velocity frequency response		2.2 kHz (high speed sampling mode)
Functions	Machine vibration Resonance suppression	<ul style="list-style-type: none"> <li>•Damping control for trajectory control</li> <li>•Adaptive notch filter</li> </ul>
	Servo adjustment	<ul style="list-style-type: none"> <li>•Auto-tuning response – 40 stages</li> <li>•Servo adjustment support function</li> </ul>
	Start-up Monitoring Diagnosis	<ul style="list-style-type: none"> <li>•Virtual motor operation</li> <li>•Power consumption monitor</li> <li>•Drive recorder</li> <li>•Servo adjustment assistance function</li> </ul>
Conformity Regulations	Product safety	UL/cUL, CE mark (LVD, EMC)
	Functional safety	Safe Torque Off: SIL3, PL=e

- (1) Expanded input power source specifications and improved reliability

In consideration of the power specifications and quality of a various regions, we revised the circuit design and components of the conventional product to expand from our conventional product in the following way; From 230 V AC to 240 V AC and from 115 V AC to 120 V AC. Moreover, we improved lightning surge yield strength to be approximately twice that of the conventional product, further increasing product reliability (robustness) and ensuring customers are able to use our product with peace-of-mind across multiple regions.

- (2) Better connectivity with various controllers

The digital I/O circuit with the host controllers is primarily sink type in Japan, however source type is mainstream in Europe. The conventional product cannot directly receive a pulse train position command from a source type open collector therefore it is necessary to establish a circuit for signal conversion at some point in between. In contrast to this, the new model adopts a high-speed photocoupler in its pulse train position command input circuit, making it capable of directly receiving commands from both sink and source type circuits and improving connectivity with various controllers.

- (3) Improved convenience

In line with an expansion in demand for servo systems, ease of servo adjustment is an important element. The new model has improved basic servo performance and is equipped with an abundance of control functions, diagnosis functions, etc. The “SANMOTION Motor Setup Tool”, which was prepared in order to use these functions with ease, is available in several languages as Japanese, English and Chinese, making it highly convenient.

### 3.3 Open network product activities

As Fig. 3 shows, the movement toward open-architecture of networks, such as field buses and motion buses, began in the 1990s and currently industrial Ethernet such as “EtherCAT” and “PROFINET” which enable high-speed, real-time control is becoming mainstream. Table 4 shows the main open networks supported by the AC servo amplifier “SANMOTION R” series.

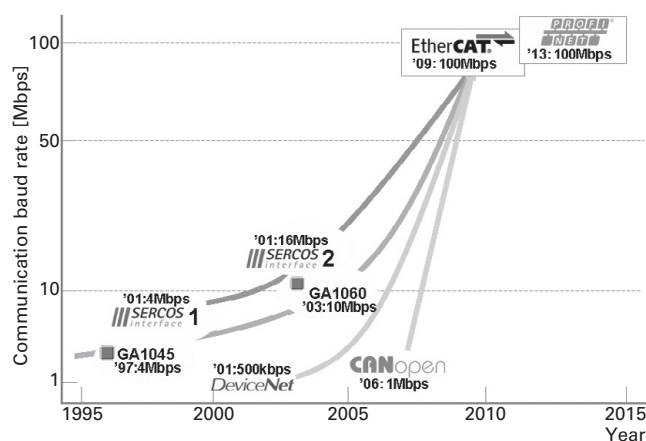


Fig. 3: Transition of networks supported by Sanyo Denki

Table 4: Main products responding to open network

Name	MODBUS	CANopen	EtherCAT	PROFINET
Physical layer	RS-485	CAN	Ethernet	Ethernet
Transfer speed	115 kbps	1 Mbps	100 Mbps	100 Mbps
Device profile	-	CiA402	CiA402	PROFIdrive

Originally, open supporting network drive devices had differing functions and communication specifications as they were made by several different manufacturers and there was no compatibility of servo control and motion control amongst these manufacturers. However, a movement of standardize regarding drive functions and communication specifications has emerged recently. This is referred to as “device profile”.

Sanyo Denki has placed emphasis on standardizing open network products to meet this device profile to offer mutual operating compatibility (inter-operability) so they can be commonly used on the global market.

## 4. Motion Controller Activities

### 4.1 Motion controller requirements

The “SANMOTION C” Motion Controller is a controller product which primarily aims to control the servo system and combines a programmable logic controller (sequence controller), motion controller, and robot controller functions.

With the globalization of industry, there has been acceleration in automation and streamlining, and controllers are now expected to not merely be a technology which controls motors, but also that controls the entire system. Moreover, from the perspective of machine development, the below requirements have emerged.

- (1) Real-time control of each device through high-speed communication
- (2) Functions to utilize image processing devices and touch panel displays
- (3) Support tools for in-house robot development

To meet such requirements, the “SANMOTION C” Motion Controller adopts EtherCAT, an open network, for communication between control devices such as the motor, making it possible to select the optimal devices for each system and achieve high-speed, real-time control.

Moreover, regarding program tool and programming language, the “SANMOTION C” Motion Controller adheres to the international directive for programmable

logic controller language, IEC61131-3, enabling programmable logic controllers worldwide to develop “SANMOTION C” programs with ease.

By using the multitude of functions available for robot control, customers are able to independently develop robots. The next section details a concrete example of robot development.

### 4.2 An example of palletizing robot development

SE Asia’s food industry is becoming more and more automated and unique, leading to many demands from companies to be able to develop palletizing robots which transfer loads from containers and sort them. To respond to these requirements, we have newly prepared a configuration tool for palletizing robots, robot calculation routine and special-purpose software library. The characteristics of these individual functions are explained below.

#### (1) Configuration tool

The robot information necessary for control can be easily configured by simply specifying robot shape and gear ratio, then inputting machine conditions following screen prompts. Fig. 4 shows the configuration screen of the developed configuration tool for palletizing robots.

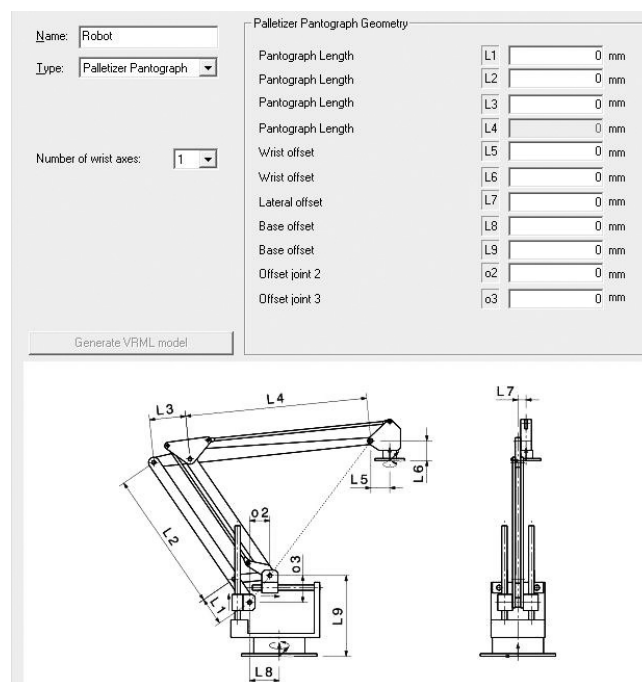


Fig. 4: Configuration screen for the configuration tool of the palletizing robot Setting screen

## (2) Kinematics calculation function

Kinematics calculation processing for palletizing robots is embedded on the controller firmware side and the position of each axis is calculated based on the data set using the configuration tool, thus controlling robot orientation.

## (3) Software library for palletizing

Palletizer systems serve the purpose of loading and unloading items being transported along multiple conveyor belts on to and off of pallets. We have prepared a software library which can automatically calculate where the items are to be placed by simply specifying the number of items and stacking style. This means improved convenience and user-friendliness for operators. Fig. 5 shows the screen on

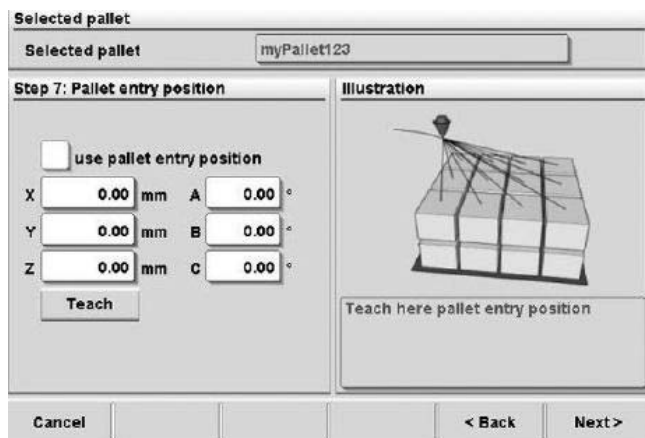


Fig. 5: Palletizer configuration screen

which the palletizing method is set.

These expansion functions alleviate the burden placed on customers during robot development, contribute to in-house robot development, and clearly demonstrate how Sanyo Denki is engaging in activities to enhance functions to fulfill the requirements of various regions.

## 5. Conclusion

This report has introduced the below activities which aim to satisfy the requirements of servo systems in line with globalization of the market and industry.

- (1) Enhancement of the 2-phase stepping motor “SANMOTION F2” series which has improved environmental-resistance (responds to IP65), expanded motor drive voltage, conformity with product safety standards and adopts a easily obtainable connector.
- (2) AC servo amplifier “SANMOTION R 3E Model” with expanded input power voltage, power quality reliability, good connectivity with controllers and improved convenience.
- (3) An open network supporting servo amplifier designed with emphasis on mutual operating compatibility (inter-operability) to enable common usage in the global market.
- (4) The “SANMOTION C” Motion Controller which adopts an open network, supports programmable logic controller program language of the international standard and has enhanced functions to suit the requirements of various markets.

Globalization will lead to further advancements in the automation and streamlining of industry across multiple regions and it is predicted that requirements towards servo products will become even more diversified. Sanyo Denki aims the development of products which can be used in the global market, without satisfaction at present spec and quality, depending on change of market.



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