

Development of a 48 V DC EtherCAT Interface Equipped 4-Axes Integrated Servo Amplifier “SANMOTION R ADVANCED MODEL”

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1. Introduction

Field buses and motion buses between host controllers and servo amplifiers such as EtherCAT, PROFINET and Ethernet IP, which are based on the Ethernet and enable high-speed, real-time control, are becoming remarkably popular due to standardization by the IEC*1 advancing as far as device profiles.

In 2009, Sanyo Denki commercialized an AC servo amplifier which supports EtherCAT and it is used by customers not only in Japan, but also throughout the world. Currently, there is a demand for servo systems with not only servo performance, but which also offer benefits for the customers’ devices on the whole, such as energy-saving, wire-saving, safety and maintainability.

Consequently, we developed the 48 V DC EtherCAT Interface Equipped 4-Axes Integrated Servo Amplifier “SANMOTION R ADVANCED MODEL”, which has low-voltage input and is equipped with a safe torque off function. This paper provides a profile of the product and introduces its features.

2. Product Profile

2.1 Appearance

Figure 1 shows the appearance and Figure 2 shows the external dimensions, of the new model.



Fig. 1: Appearance

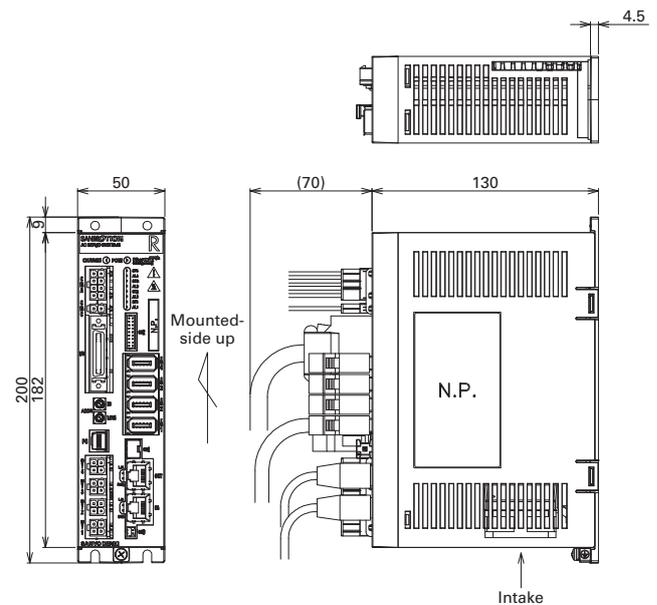


Fig. 2: External dimensions

2.2 Main Specifications

The new model comes with two different output capacities, however apart from the assembled motors and total output of the product, they are identical.

The motor used is the 48 V DC R2GA motor from the SANMOTION R series, and regarding encoders, both the absolute encoder for incremental systems and batteryless

absolute encoder are standardly supported. Furthermore, the small-diameter cylinder linear motor DE0AC001A03MX00 and pulse encoder are supported as options.

The new model complies with the overseas directives of Europe's low-voltage directive, EMC directive, machinery directive, U.S.'s UL/cUL and Korean's KC mark.

Table 1 shows the specifications of the new model.

Table 1: New model specifications

Model No.	RF2J24A0HL5		RF2K24A0HL5
Basic specifications	Size		200H × 50W × 130D mm
	Mass		0.75 kg
	Input voltage	Control	24 V DC ±10%
		Main circuit	48 V DC ±10%
	Operating ambient temperature		0 to 55°C
	Storage temperature		-20 to 65°C
	Operating ambient humidity		90% RH (no condensation)
	Application motor		20 mm sq., 40 mm sq. 20 W, 30 W
	4-axes total output		120 W max.
Application encoder		Absolute encoder for incremental systems Batteryless absolute encoder	
EtherCAT Communication	Device profile		CAN application protocol over EtherCAT (CoE)
	Minimal communication cycle		125 μsec
	Synchronous mode		Free Run, SYNC0, SYNC1
	Control mode		Profile position / velocity / torque mode Cyclic sync position / velocity / torque mode Homing mode
	Motion profile		Linear ramp profile, Jerk-limited ramp profile
	Transfer data length (IN/OUT)		256 bytes or less and 80 objects or less (for all four axes)
Functions	Compensatory function		Model following/ model following damping control Feed-forward damping control, friction compensation
	Assist functions		Position assist, torque assist
Input/output	PC-I/F		SANMOTION motor setup software
	General-purpose IO		8 inputs (common to all 4 axes)/ 8 outputs (2 outputs/axis)
Applicable regulations	UL/cUL		UL508C
	Low voltage directive		EN61800-5-1
	EMC directive		EN61000-6-2, EN61800-3, IEC61326-3-1
	Safe torque off (STO)		IEC61508, SIL3, IEC62061, SILCL3 ISO13849-1, Cat.3, PL=e
	KC mark		KN61000-6-2,KN61000-6-4
	RoHS directive		Compliant

3. Features

3.1 Downsizing and lightening

The circuit surface area of the EtherCAT communication portion of the new model has been reduced by using the FPGA for EtherCAT communication *2 which was developed for the 200 V AC input EtherCAT interface equipped multi-axis AC servo amplifier (RM2 series) of the SANMOTION R ADVANCED MODEL.

Moreover, the power circuit and cooling design were revised, thereby reducing the number of components as much as possible and increasing mounting density of the circuit board at the same time as decreasing volume by around 40% and mass by around 60% compared to when four of our conventional models, the 48 V DC EtherCAT interface equipped single axis servo amplifier “SANMOTION R ADVANCED MODEL” are used. Table 2 shows volume and mass.

Table 2: Reduction rate of volume and mass

Model No.	RS2K04A2HL5 4 single-axis units	RF2K24A0HL5 4-axes integrated	Reduction rate
Volume	2,176 cm ³	1,300 cm ³	40.3%
Mass	2.2 kg	0.8 kg	63.6%

3.2 Wire-saving, clustering of the safe torque off feature

In contrast with the six general-purpose inputs per axis for the single axis servo amplifier, the new model has eight inputs for four axes, and by changing the parameter settings, it is possible to allocate the eight inputs for all axes.

In regards to the I/O for the safe torque off function, there are eight inputs (two inputs x four units) and four outputs (one output x four units) if four single axis servo amplifiers are used. In contrast to this, the new model offers a system whereby the safety-related area is clustered for all four axes, thus obtaining certification for two inputs and one output, which is the same as one single axis servo amplifier. This achieves significant wire saving compared to using four single axis servo amplifiers.

Moreover, like “SANMOTION R 3E Model”, the new model complies with “SIL3/IEC61508 PL=e/ISO13849-1” therefore can be used in applications such as medical devices which require high safety performance.

3.3 Ease of use

Downsizing and lightening were the focus for conventional multi-axis servo amplifiers therefore an open-frame design was adopted. There were many products for which the customer was required to prepare radiator fin and cooling fans depending on the operating conditions therefore there was a great burden on the customer to select the right radiator fin and cooling fan, perform heat evaluations, etc.

The new model has a built-in cooling fan (RF2K24A0HL5 only) therefore the customer does not need to select a radiator fin or cooling fans. Also, by adopting an enclosed design, the safety of the product is increased, meaning it can be used for a variety of applications.

Moreover, the motor setup software serial communication of the new model is connected to individual control CPUs in a daisy chain. This makes communication with all axes possible using only one communication cable. Hence, usability has been improved as parameter changes and operation monitoring of all axes can now be achieved on one computer. Figure 3 shows the operation screen of the motor setup software.

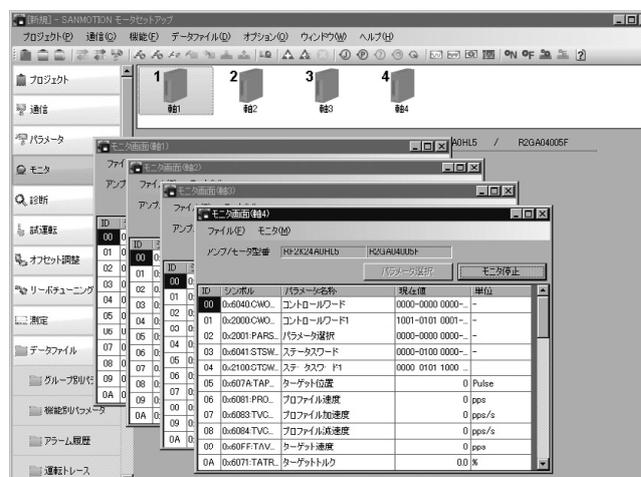


Fig. 3: Operation screen of the motor setup software

3.4 Compatibility

The new model uses the same encoder connector as the “SANMOTION R ADVANCED MODEL” 48 V DC EtherCAT interface equipped single axis servo amplifier and maintains compatibility with the EtherCAT communication device profile therefore can be used together with the existing products or as an alternative. Caution is required however, as the transfer data length is restricted to 256 bytes or less (for all four axes) and 80 objects or less (for all four axes).

3.5 Tandem synchronization/ multi-axis assist

The EtherCAT system has extremely high command synchronization due to adopting the Distributed Clocks^{*3} method. However, a delay occurs on the feedback control servo amplifier, therefore compensation of the encoder position is necessary to further improve synchronization accuracy.

On the conventional product, two servo amplifiers were connected with separate non-EtherCAT communication cable in order to achieve tandem operation of position feedback.

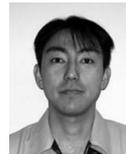
The new model eliminates the need for a separate cable by achieving serial communication connection between individual control CPUs within the servo amplifier. Moreover, by enabling torque assist operation for a maximum of four axes, the new model can also be flexibly applied to devices requiring outputs of 200 W or more.

4. Conclusion

This paper has provided a profile of the 48 V DC EtherCAT Interface Equipped 4-Axes Integrated Servo Amplifier and introduced its features. This new model proposes replacement of the conventional 48 V DC Single-axis EtherCAT AC Servo Amplifier, and offers the merits of wire-saving and space-saving. Moreover, even compared with Sanyo Denki's conventional product and the products of our competitors both overseas and domestic, we believe the new model has a strong competitive edge.

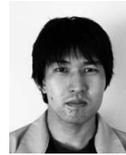
It is feasible that the demand for multi-axis system products which match our customers' requirements regarding system configuration motor capacity and number of motors will increase. To respond to further globalization, Sanyo Denki would like to be able to propose systems even easier to use and with even more benefits to customers.

- *1: IEC-International Electrotechnical Commission
An international standardization body which handles electrical engineering, electronic engineering and related technologies.
- *2: FPGA-Field Programmable Gate Array
Programmable integrated circuit
- *3: DC-Distributed Clocks
An EtherCAT device function which enables high-accuracy time synchronization.



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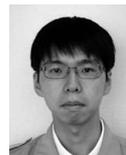
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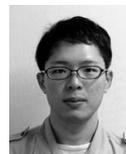
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