“SANMOTION R 3E Model” 400 VAC Input Servo Amplifier

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1. Introduction

Servo systems are required to satisfy a variety of demands, including high performance, high reliability, and energy-saving. The “SANMOTION R 3E Model” 200 VAC input servo amplifier, developed in 2014 in response to such demands, is used by a diversity of customers and helps to improve machinery performance and quality as well as save energy.

The “SANMOTION R” 400 VAC input servo amplifier, released in 2007, has been used in a broad range of fields such as conveying machines and general manufacturing equipment. However, in recent years, demands are changing more diverse; typically, compliance with functional safety standards, the need to support high-speed networks, and IoT compatibility.

This paper introduces the newly developed 400 VAC input servo amplifier added to the “SANMOTION R 3E Model” series responding to such demands.

We will first provide an outline of the new model, and then describe the following topics: performance and functions, product features, and the points of development.

2. Outline of the New Model

2.1 External view and dimensions

The 400 VAC input servo amplifier developed on this occasion (hereinafter “new model”), is available in three different amplifier capacities; 25 A, 50 A, and 100 A.

Figure 1 is an external view of the 25 A model, while Figures 2 through 4 are external dimensions of 25 A, 50 A, and 100 A, respectively.

To maintain compatibility with our current product (RS1 series), the height and depth have been kept the same.

Fig. 1: External view of the new model (25 A)

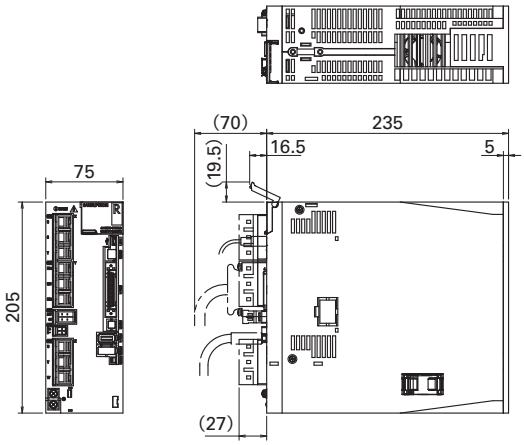


Fig. 2: Dimensions (25 A)

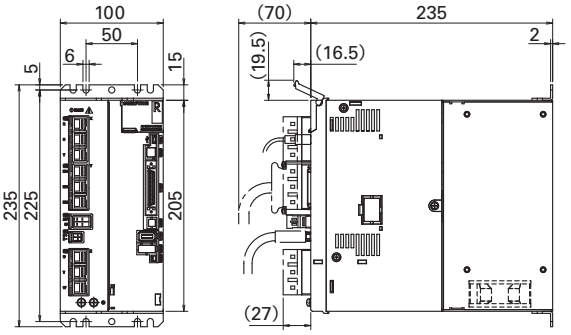


Fig. 3: Dimensions (50 A)

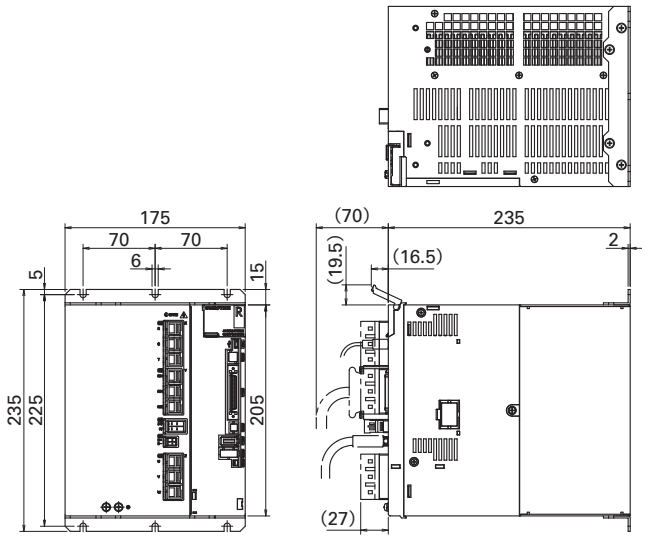


Fig. 4: Dimensions (100 A)

Table 1: Main specifications

Amplifier capacity		25 A	50 A	100 A
Control power supply voltage range		24 VDC		
Main circuit power supply voltage range		380 to 480 VAC		
Dimensions		205 H × 75 W × 235 D mm	205 H × 100 W × 235 D mm	205 H × 175 W × 235 D mm
Continuous output current		4.8 Arms	12.0 Arms	20.0 Arms
Instantaneous maximum current		14.1 Arms	29.2 Arms	52.9 Arms
Compatible motor		0.55 to 2.0 kW	1.0 to 3.5 kW	3.5 to 5.5 kW
Compatible encoder		· Absolute encoder (battery back-up, battery-less) · Wire saving pulse encoder · HEIDENHAIN EnDat2.2 encoder		
Control mode		Position, velocity, torque control · Model-following control		
Command input	Position	Pulse train command (photocoupler isolation)		
	Velocity, torque	Analog command		
No. of general-purpose inputs/outputs		Input × 8, output × 8		
Speed command frequency		2.2 kHz (high-speed sampling mode)		
Speed control range		1:5000 (internal speed command)		
Functions	Control function	· Tandem operation control · Dual positioning feedback control		
	Mechanical vibration/ resonance suppression	· FF vibration suppression control (2-step) · CP vibration suppression control · Adaptive notch filter		
	Servo tuning	· Auto tuning response 40 levels · Servo tuning support function		
	Start-up, monitoring, diagnosis	· Virtual motor operation · Power consumption monitoring · Drive recorder · Encoder temperature monitoring · Amplifier temperature monitoring		
Standard compliancy	UL	UL61800-5-1		
	CSA	C22.2 No.274-13		
	Low-voltage directive	EN61800-5-1		
	EMC directive	EN61800-3, EN61326-3-1		
	Functional safety	ISO13849-1 PL=e, EN61508 SIL3, EN62061 SIL CL3		
	KC mark	KN61000-6-2, KN61000-6-4		

2.2 Main specifications

Table 1 shows the specifications of the new model. In addition to analog/pulse train input, the 400 VAC input servo amplifier is a platform product supporting various interfaces and safety feature-enhanced products.

The new model supports the newly developed R2 series 400 V input 0.55 to 5.5 kW motor.

Regarding encoders, this model supports our battery-less and battery-backup absolute encoders, and wire-saving pulse encoder. Moreover, this model also supports encoders manufactured by HEIDENHAIN (EnDat2.2 interface) for use with linear motors or fully-closed loop control systems.

3. Properties / functions

The new model achieves the same performance and functions as the "SANMOTION R 3E Model" series 200 VAC input servo amplifier.

The main features are as follows.

3.1 High response control

As the "SANMOTION R 3E Model", derivative compensation has been added to the velocity feed forward, thus making the model-following control even faster and more responsive. The full closed mounting base vibration suppression control that can follow an ideal model is capable of high-speed positioning even with full closed control.

Moreover, to achieve higher speed in applications involving the switching between positioning and trajectory control modes, the new model is equipped with a real-time switching function for switching between model-following (damping) control and feedback control at short time.

3.2 Suppression of mechanical resonance and vibration

The new model features an adaptive notch filter that estimates mechanical resonance and applies the estimated frequency to the actual notch filter of the control system, thus ready to respond to fluctuations of mechanical resonance frequency. Furthermore, the new model is also equipped with a function to suppress micro-vibration which prevents the impact of micro-vibration from amplifying, therefore enabling to suppress resonance when the motor is stopped and achieve high gain.

3.3 Average power monitoring function

The new model features an average power monitoring function which estimates the average power consumption of the servo motor and amplifier based on the speed and current of the motor. This makes it possible to easily monitor the power consumption of the servo amplifier and servo motor, which not only helps to make customers' equipment more energy-saving, but also enables to monitor any drops in efficiency, such as those caused by component or equipment failure.

3.4 Low noise, low power consumption

By adopting a variable speed fan for cooling the servo amplifier, we have reduced noise emitted during standby mode and reduced power consumption by up to 29% compared to our current model*. Moreover, by adopting a low-loss power device, we have reduced power consumption by up to 15% compared to our current model*.

3.5 User assist function

The new model supports "SANMOTION Motor Setup Software", which is comprised of a Safe Torque Off function and user assist functions at system start-up.

Moreover, as a function aimed at enhancing usability, the new model is equipped with a "virtual motor operation function" which simulates operations of the servo motor and servo amplifier based on commands from a controller, without actually operating the motor. This allows users to confirm the operation pattern of their equipment in advance without having to actually operate the motor, making it possible to shorten start-up time.

4. Features

4.1 Holding brake output

As an additional to the conventional "holding brake timing signal" the new model is standardly equipped with a "holding brake output with power supply" that can directly drive the motor's holding brake. This means customers no longer need to prepare a circuit to control the motor holding brake, improving convenience and decreasing costs due to less wiring.

This function can be operated using "SANMOTION Motor Setup Software" and allows the user to check holding brake operation in advance, therefore enabling to diagnose operations and degradation of the overall equipment.

4.2 Simple wiring

As this amplifier is compatible with SANYO DENKI servo motors of 3.5 kW or higher output, connectors are adopted for every connection. In particular, the main circuit connector adopts a spring-type connector, therefore wiring can be performed by the customer without using special-purpose tools.

4.3 UL 61800-5-1 compliant

The new model complies with the US standard UL 61800-5-1 (Power Drive System). This standard targets servo amplifier/inverter products and is based on the requirements of the UL 508C (Power Conversion Equipment) applied up until now, with the requirements of European standard, EN 61800-5-1, also incorporated. Conformance to this standard, the safety level of the product is further enhanced, and contribute customer equipment can easily obtain the UL standard and undergo upgrades.

The new model also complies with Europe's Low Voltage Directive, the EMC Directive, functional safety (STO), Canada's CSA standard, and Korea's KC mark.

5. Key Points of Development

5.1 Improved productivity/ manufacturing quality

Conventionally, many lead components were used in the printed circuit boards featured in power system parts, however the new model has adopted surface mount components such as commutation diode electrolytic capacitors. By reducing the number of hand-inserted components, the design has been made suitable for automated production.

Moreover, as a countermeasure against solder bridges in connectors and in order to improve visibility, the printed circuit board has been designed to prevent human error through measures such as standardizing the silk color as yellow, etc. Through these innovative ideas, the new model contributes to improved productivity and manufacturing quality.

5.2 Early improvement of issues

By performing thermal fluid analysis on components which generate heat using heat sinks and cooling fans from the initial stages of development, we succeeded in building a structure capable of obtaining optimal cooling results. Figure 5 provides an example of a 25 A amplifier analysis. You can see that, the cooling fan suppresses local temperature increase by providing a smooth air supply, and the heat sink cools with its entire surface.

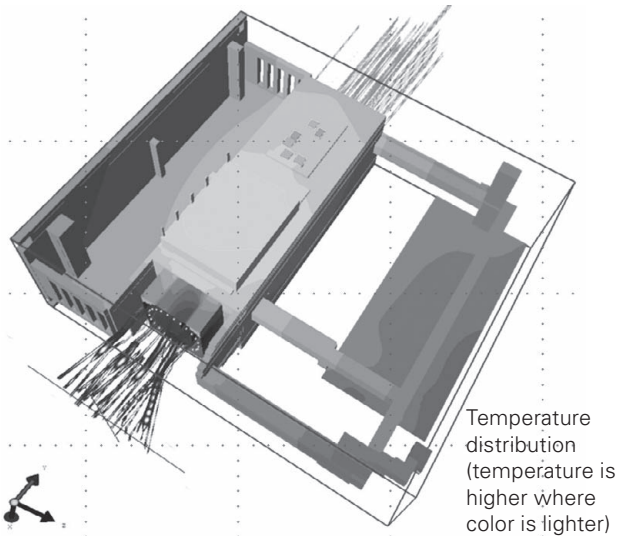


Fig. 5: Thermal fluid analysis of the 25 A amplifier

Moreover, by utilizing near magnetic field analysis from the prototype stage, we have succeeded in improving the quality of the printed circuit board and realizing a more efficient design process. We identified the areas of the prototype circuit board with high noise levels and revised component arrangement and wiring pattern, then applied these optimal countermeasures to the mass produced circuit boards. Figure 6 provides an example of analysis application. For the prototype circuit board, the section in the right middle on the right-hand side has a darker color, indicating a high noise level, however the figure shows that this section appears lighter on the mass produced circuit boards, thus demonstrating a drop in noise level.

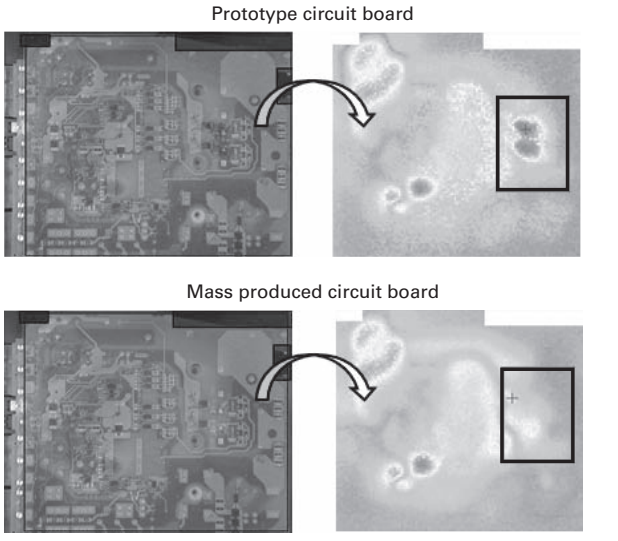


Fig. 6: Example of near magnetic field analysis

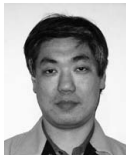
6. Conclusion

This paper has presented an overview of the 400 VAC input servo amplifier that has been newly added to the AC servo amplifier "SANMOTION R 3E Model" lineup, and covered its performance, functions, and features.

Compared to the current model, the new model has higher performance, more sophisticated functions, better safety, and enhanced userability. In particular, functions such as average power monitoring and holding brake output with power supply help to improve the level of convenience for our customers. Moreover, by improving manufacturing quality and productivity, we believe we now are capable of providing our customers with high-quality products on a stable basis.

SANYO DENKI wishes to continue expanding the lineup of servo amplifiers compatible with high-capacity servo motors and constantly be aware of the demands placed on servo systems so that we may incorporate many IoT functions that create value for our customers' equipment.

* SANMOTION R Series 400 VAC Input Servo Amplifier



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