

# Development of the “SANMOTION R 3E Model” 75 A Amplifier

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## 1. Introduction

Servo systems must be compact and offer high functionality, high performance and high reliability. Keeping servo systems compact helps to make equipment itself smaller and lighter, which has the advantages of reducing total cost and energy consumption over the equipment’s life cycle. From this perspective, the “SANMOTION R 3E Model” AC servo amplifier developed by Sanyo Denki in 2014 is being used by a variety of customers and proving useful towards improving the performance and quality of equipment, as well as helping to reduce equipment size and weight.

This document introduces the new “SANMOTION R 3E Model” servo amplifier with a current capacity of 75 A. This servo amplifier is ideal for combination with motors with a rated output ranging from 1.8 to 3.5 kW.

First, we will present the product profile of the new model. Next, we will introduce the features of the new model, including its main performances and functions, as well as efforts to reduce size and weight.

## 2. Product Profile

### 2.1 Appearance and exterior

Figure 1 is a photograph of the newly developed “SANMOTION R 3E Model” (hereinafter “3E Model”) 75 A amplifier, and Figure 2 shows its exterior dimensions. The height of the new model has been made the same as a small-capacity amplifier with a current capacity between 10 and 50 A. This is to help reduce the size and weight of equipment control panels.



Fig. 1: Appearance

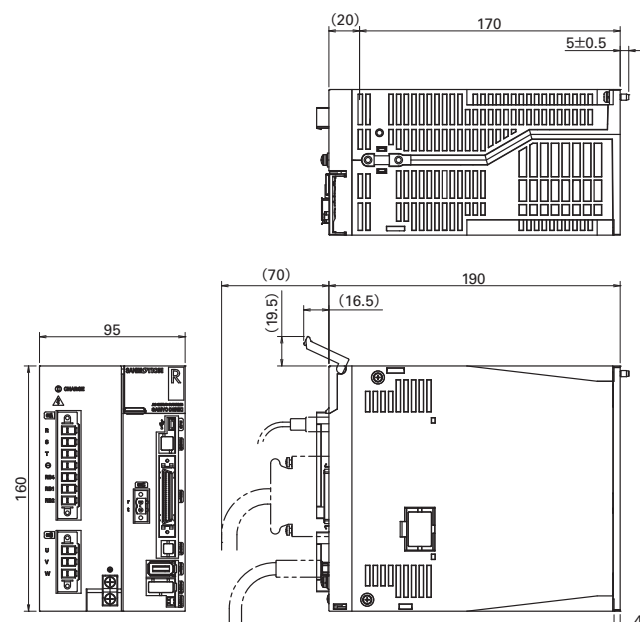


Fig. 2: External dimensions

## 2.2 Main specifications

Table 1 shows the main specifications of the newly developed "3E Model" 75 A amplifier.

This model can be combined with either a 1.8 kW or 2.0 kW motor from the R2 series, which is also used in combination with the conventional 100 A amplifier, or with a newly designed 3.5 kW made to suit the specific properties of a 75 A amplifier.

In terms of the encoder, Sanyo Denki's battery backup-type and battery-less absolute encoders, as well as the wire-saving pulse encoder, are compatible. The new model is

also compatible with HEIDENHAIN's encoder (interface: EnDat2.2) for use in a linear motor system or fully closed-loop control system.

Furthermore, the new model supports Safe Torque Off, a function of the 3E Model series, and SANMOTION motor setup software as a user support function for system start-up.

3E Model also complies with Europe's low voltage directive, the EMC directive, functional safety, America's UL/cUL and Korea's KC Mark.

Table 1: Main specifications of the "SANMOTION R 3E Model" 75A amplifier

|   |   |   |
|---|---|---|
| <b>Power voltage range</b>                |   | 200 to 240 V AC   |
| <b>Amplifier output</b>                   |   | 75 A  |
| <b>Dimensions</b>                         |   | 160 H × 95 W × 190 D (mm)   |
| <b>Continuous rated current</b>           |   | 18 Arms   |
| <b>Maximum instantaneous current</b>      |   | 45.5 Arms   |
| <b>Application motor (Motor capacity)</b> |   | SANMOTION R series (1.8 kW to 3.5 kW)   |
| <b>Encoder</b>                            |   | <ul style="list-style-type: none"> <li>· Absolute encoders (battery backup, battery-less)</li> <li>· Wire-saving pulse encoder</li> <li>· HEIDENHAIN-made Endat 2.2 encoder</li> </ul>      |
| <b>Control mode</b>                       |   | Position, velocity, torque control<br>Model following control   |
| <b>Command input</b>                      | <b>Position</b>                               | Pulse train command (photocoupler insulation)   |
|   | <b>Velocity, torque</b>                       | Analog command  |
| <b>Universal input/output points</b>      |   | Input x 8 points, output x 8 points   |
| <b>Velocity control range</b>             |   | 1:5000 (internal speed command)   |
| <b>Functions</b>                          | <b>Control functions</b>                      | <ul style="list-style-type: none"> <li>· Dual location feedback control</li> <li>· Tandem operation control</li> </ul>  |
|   | <b>Machine vibration resonance inhibition</b> | <ul style="list-style-type: none"> <li>· FF damping control (2 stages)</li> <li>· Damping control for trajectory control</li> <li>· Adaptive notch filter</li> </ul>                        |
|   | <b>Servo adjustment</b>                       | <ul style="list-style-type: none"> <li>· Auto-tuning response – 40 stages</li> <li>· Servo adjustment support function</li> </ul>   |
|   | <b>Start-up, monitoring, diagnosis</b>        | <ul style="list-style-type: none"> <li>· Virtual motor operation</li> <li>· Encoder/amplifier temperature monitor</li> <li>· Power consumption monitor</li> <li>· Drive recorder</li> </ul> |
| <b>Laws and regulations of compliance</b> | <b>UL/cUL</b>                                 | UL61800-5-1   |
|   | <b>Low voltage directive</b>                  | EN61800-5-1   |
|   | <b>EMC directive</b>                          | EN 61800-3, EN 61326-3-1  |
|   | <b>Functional safety</b>                      | ISO13849-1/PL=e<br>EN 61508/SIL3,<br>EN 62061/SILCL3  |
|   | <b>KC mark</b>                                | KN61000-6-2, KN61000-6-4  |

### 3. Main Performances and Functions

The new model offers the same performances and functions as other products in the 3E Model series. The main features are outlined below.

#### 3.1 Main performances

##### 3.1.1 High response position and velocity control

Based on a control system compatible with the AC servo amplifier “SANMOTION R ADVANCED MODEL”, the new model has enhanced feedback response by being equipped with a function which improves phase delay of the positional control system and speed control system, as well as a function able to increase proportional gain. Moreover, in addition to velocity feed-forward compensation, torque feed-forward compensation has been added to improve command response.

##### 3.1.2 Power consumption monitor function

The new model also features a power consumption monitor function which estimates the power consumption of the servo motor and servo amplifier based on servo motor speed and current. This makes it possible to easily monitor the amount of power used by the equipment.

##### 3.1.3 Virtual motor operation function

As a user support function pursuing user-friendliness, the new model is equipped with a virtual motor operation function which simulates the operations of the servo motor and servo amplifier based on commands from host devices without the need to actually operate the motor.

#### 3.2 Size reduction, low loss

The new model features an optimized heat dissipation structure based on a die cast fin and achieves a significant size reduction through the adoption of a low-loss power device.

On this new model, improved heat dissipation performance was essential, therefore we needed to address the issue of how to suppress local heat. In response, we utilized thermal fluid analysis to optimize part arrangement and fin shape. Figure 3 shows the structural model used in analysis, while Figure 4 shows an analysis example. From Figure 4, it is clear that the temperature rise of parts is becoming uniform. We increased the accuracy of the analysis model and revised boundary conditions to significantly improve analysis accuracy compared with conventional analysis.

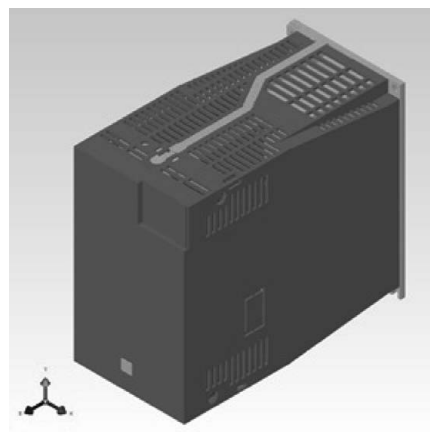


Fig. 3: Structural model

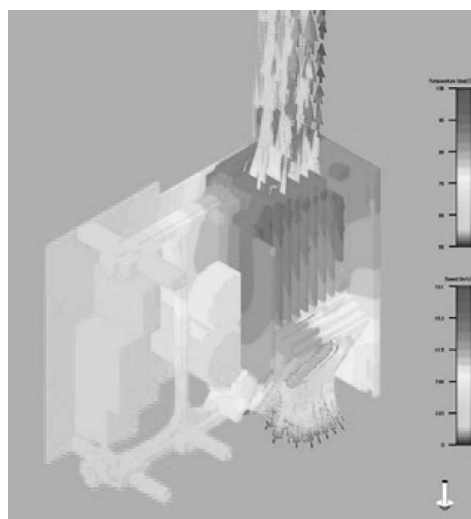


Fig. 4: Example of heat simulation analysis (amplifier interior)

Figure 5 shows the cooling structure inside the amplifier. The new model has been designed to make it easy for heat to escape by positioning the cooling fan diagonally and proactively directing air onto the heat dissipating surfaces of the converter's rectifier stack and inverter's power device.

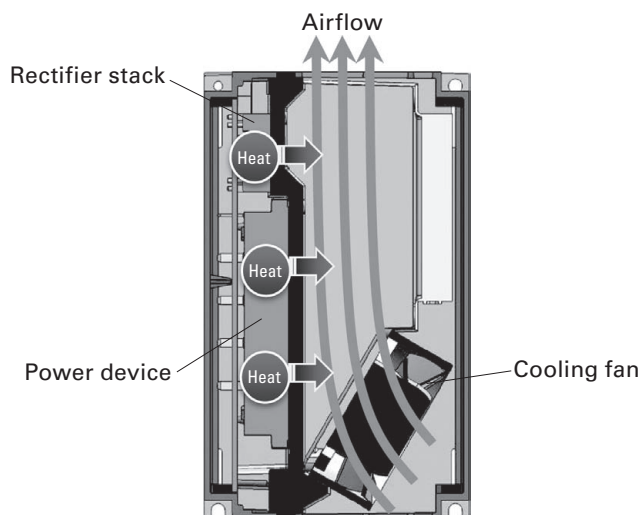


Fig. 5: Cooling structure inside the amplifier

Moreover, the new model adopts a low-loss, new-generation power device to achieve around 11% less loss during rated operation (when used in combination with a 3.5 kW motor) compared with the "SANMOTION R ADVANCED MODEL" 100 A amplifier.

The new model is around 36% smaller and 40% lighter than the "SANMOTION R ADVANCED MODEL" 100 A amplifier. This makes it the smallest servo amplifier able to be combined with a motor of a rated capacity ranging from 1.8 to 3.5 kW (as of March 28th, 2016, according to an investigation by Sanyo Denki)

### 3.3 Compliance with UL61800-5-1

The new model complies with U.S. standard, UL61800-5-1 (for Power Drive Systems). This standard specifically covers servos and inverters and, in addition to the requirements of UL508C (for Power Conversion Equipment), the standard which had been applied to such products to date, now incorporates the requirements of the E.U. standard, EN61800-5-1. The safety of this product has been increased even further through compliance with this standard.

## 4. Conclusion

This document has introduced the features of the "SANMOTION R 3E Model" amplifier with a current capacity of 75 A, including its main performances and functions, as well as efforts to reduce size and weight.

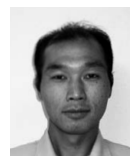
The new model amplifier is compact, lightweight, and can be combined with motors of a rated capacity ranging from 1.8 to 3.5 kW. Moreover, by having the same height as a small-capacity amplifier (current capacity between 10 and 50 A) the new model helps to reduce the size and weight of equipment. Moreover, this model can be alternated with a 100 A amplifier to suit the maximum instantaneous torque and maximum rotating speed of the required motor, offering our customers the choice of the optimal servo amplifier to suit their particular application.

As the market continues to change, we will continue to develop servo systems which will solve our customers' issues and create new value.



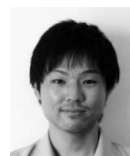
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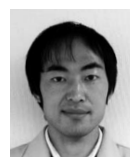
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