AC Servo Motor “SANMOTION R” Series

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1. Introduction

With recent energy issues and problems with the global environment, we have seen an increase in the demand for highly efficient and resource saving motors. Thanks to increasingly sophisticated equipment and devices, such as industrial robots, semi-conductor manufacturing, and electronic parts manufacturing and assembly, the market demand for high-ability motors that are compact, light weight, high torque, high speed, and low cogging torque is also growing dramatically. These environmental issues and market demands have many common points, as lightweight design leads to resource saving and miniature size requires heat controls, which leads to high efficiency.

This newly developed AC servo motor “SANMOTION R” series was developed specifically with environmental issues and market demand in mind. This document introduces how low loss design using electromagnetic field simulations lead to drastic reductions in both size and weight. It shows how the product contributes to global environment conservation with analysis from Life Cycle Assessment (LCA), one type of environmental impact assessment, that indicates lower CO_2 emissions compared to previous models. Finally, it explains how improvements with improvement of the maximum speed and torque helped to extend the power range.

This product lineup uses a standard power supply voltage of 200 VAC. The lineup has three flange sizes (40 mm, 60 mm, and 80 mm) and six rated outputs (30 W, 50 W, 100 W, 200 W, 400 W, and 750 W) in a total of seven models.

2. Product Features and Upgrades

2.1 miniaturization and weight saving through low-loss design

As seen in Fig. 1, the length of the motor was greatly reduced compared to previous SANYO DENKI models, providing the "SANMOTION R" series with the industry's top class miniaturization and weight saving properties. Fig. 2 shows the rate of reduction for weight and length when compared to previous models. As you can see, the length is reduced 29 to 38%, while the weight is reduced at least 20% for all models. By improving the motor efficiency and controlling the heat due to motor loss, we successfully redesigned the heat transfer within the motor. Fig. 3 shows a type of distribution for magnetic flux density of the stator core in electromagnetic field simulations. By readjusting the balance of magnetic flux density in each location, we were able to reduce the core loss, and by redesigning the slot shape to more easily accept wire winding, we improved the lamination factor for winding, resulting in a more efficient design. Furthermore, we reduced the cogging torque by reducing the local magnetic saturation. Fig. 4 shows the reduced motor loss when comparing the “SANMOTION R” series and previous SANYO DENKI models. Excluding the 30 W model, which shows minimal reduction, all of the models in the lineup show at least a 30% reduction in loss, showing how the “SANMOTION R” series has accomplished miniaturization, weight saving, and also high efficiency.

Fig. 1: Exterior view of motor and shortened total length

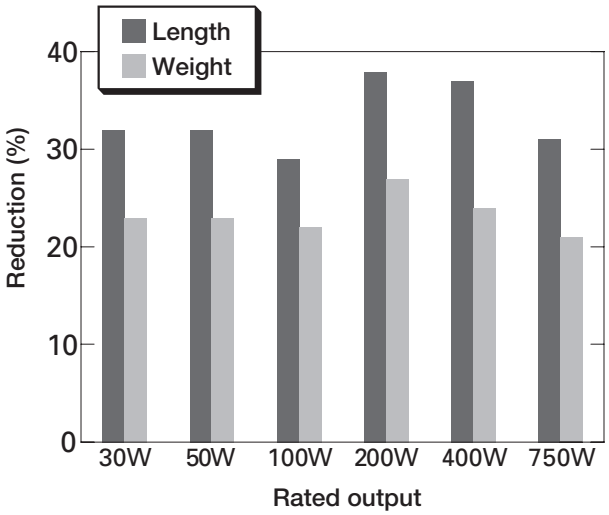


Fig. 2: Reduction in motor length and weight
(Compared to previous Sanyo Denki models)

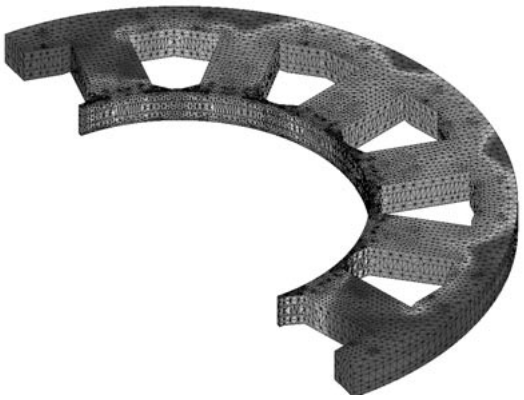


Fig. 3: 3D electromagnetic analysis
(1/2 model of the distribution for magnetic flux density of the stator core)

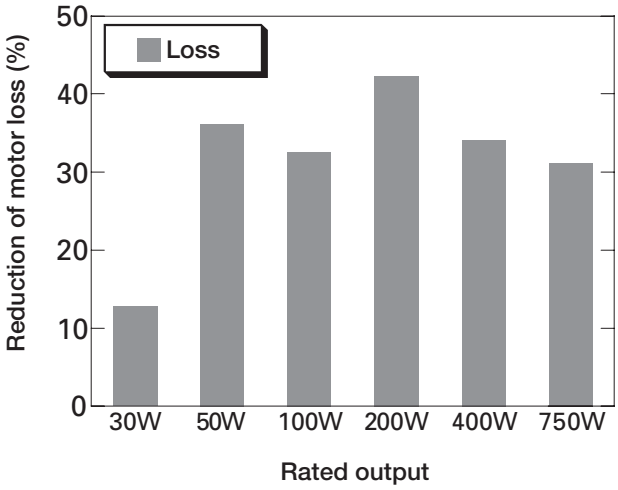


Fig. 4: Reduction of motor loss
(Compared to previous Sanyo Denki models)

2.2 Evaluation of reduction in CO_2 emissions with LCA

Fig. 5 shows the rate and amount of reduced CO_2 emissions when comparing the "SANMOTION R" series and previous SANYO DENKI models with LCA. The “SANMOTION R” series shows up to a 44% reduction in CO_2 emissions, indicating how this new product contributes to global environment conservation. The internet LCA “Eco Assist” from Hitachi, Ltd. was used to calculate the amount of CO_2 emissions with the conditions of operating 20 hours a day for 250 days a year.

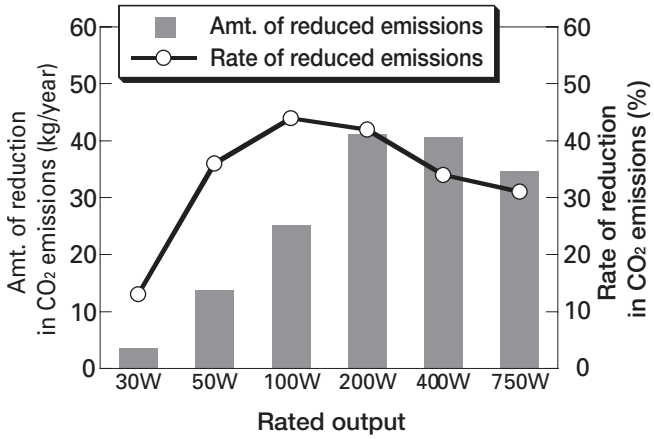


Fig. 5: Rate and amount of reduction in CO_2 emissions
(Compared to previous Sanyo Denki models)

2.3 Wide power range

Fig. 6 shows the improvement in the maximum instantaneous stall torque when comparing the “SANMOTION R” series and previous SANYO DENKI models, while Figs. 7 to 9 show the torque speed (T-N) characteristics. The dotted lines in the diagram for torque speed characteristics indicate the characteristics for the previous models. While the maximum rotating speed for previous models was 4500 min^{-1} or 5000 min^{-1}, the “SANMOTION R” series has been improved to speeds of 6000 min^{-1}. The maximum instantaneous stall torque is 15 to 26% greater than for previous models, while the maximum instantaneous stall torque/rated torque rate is 3.45 to 3.78 times greater. With improvement of the maximum speed and torque, the “SANMOTION R” series achieves one of the broadest power range characteristics in its class for the industry.

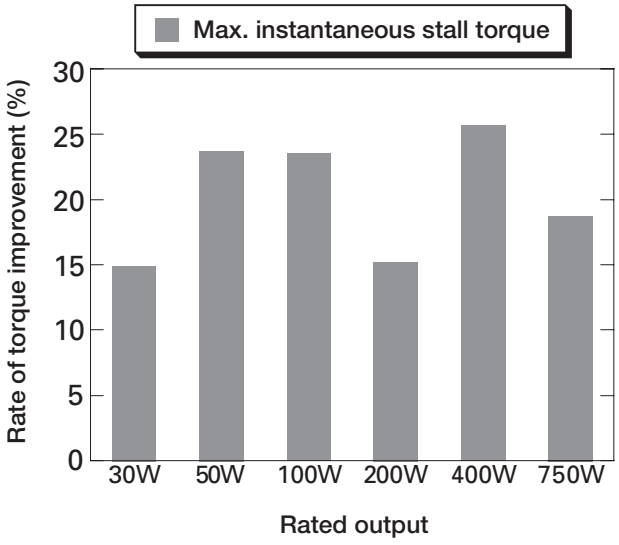
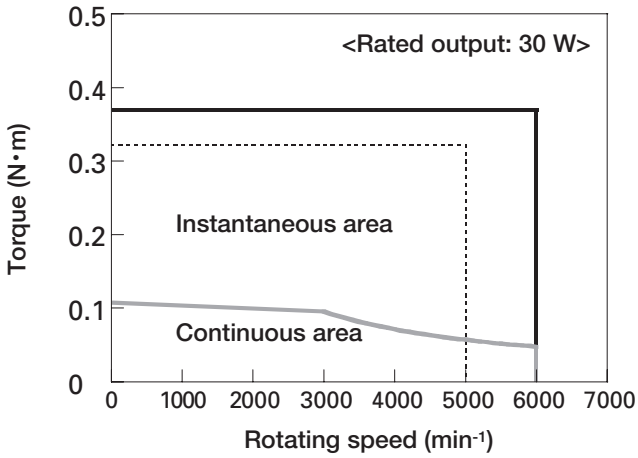
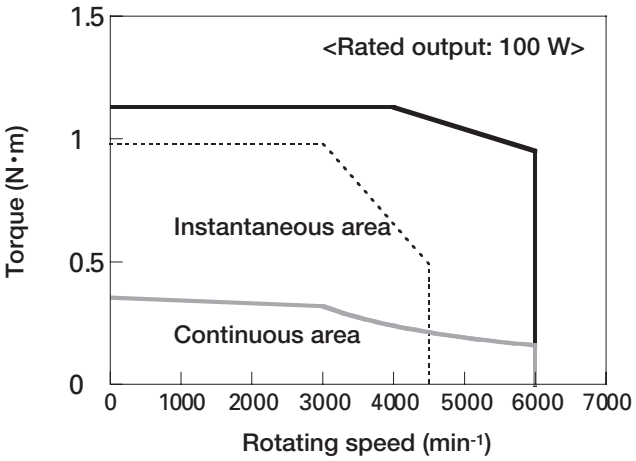
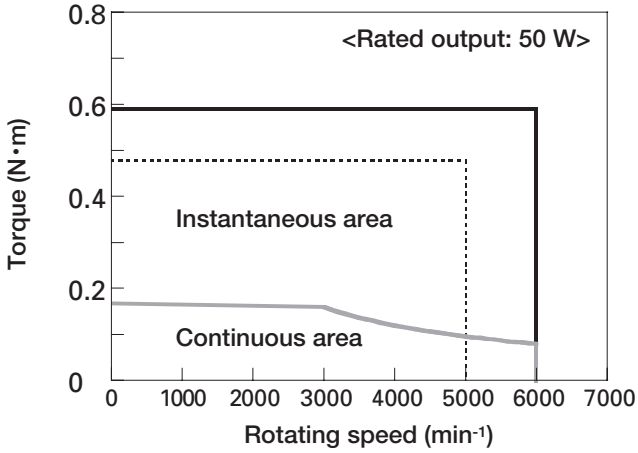
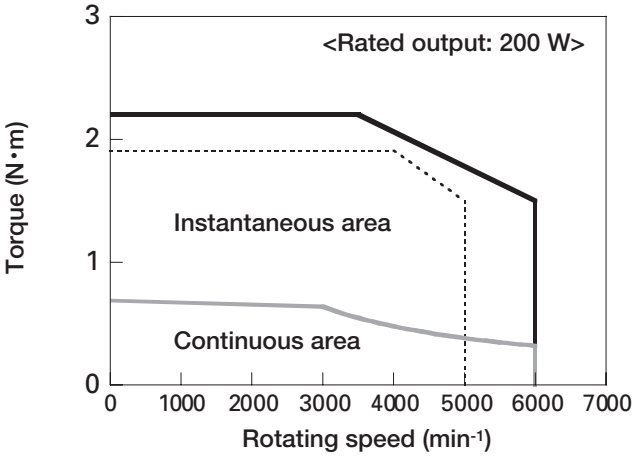


Fig. 6: Rate of improvement for max. instantaneous stall torque
(Compared to previous Sanyo Denki models)









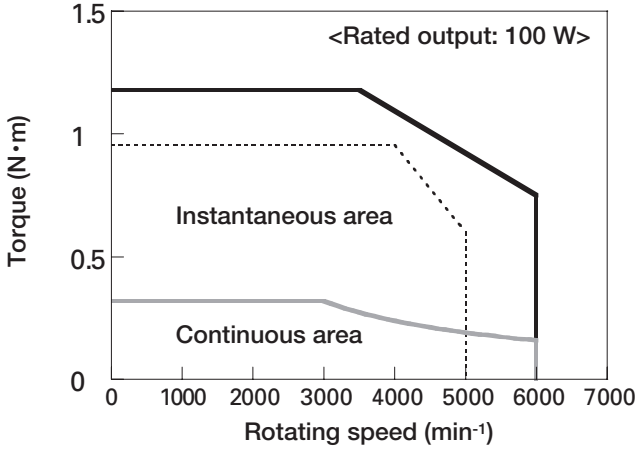


Fig. 7: Torque speed (T-N) characteristics
(Flange dimensions: 40 mm)
(Dotted lines indicate specifications
from previous SANYO DENKI models)

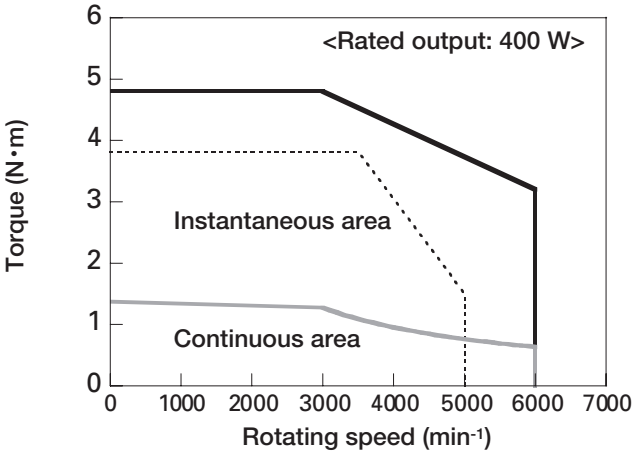


Fig. 8: Torque speed (T-N) characteristics
(Flange dimensions: 60 mm)
(Dotted lines indicate specifications
from previous SANYO DENKI models)

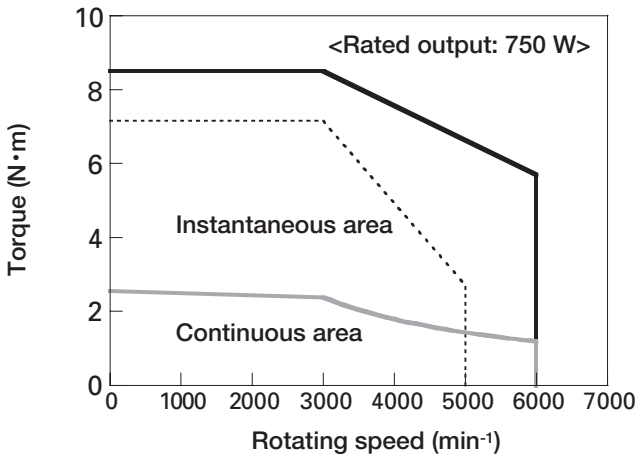


Fig. 9: Torque speed (T-N) characteristics
(Flange dimensions: 80 mm)
(Dotted lines indicate specifications
from previous SANYO DENKI models)

2.4 Low cogging torque characteristics

We performed inspection with electromagnetic field simulations to optimize the shape of the stator core and lowered the amount of cogging torque, while at the same time reducing variations in the dimensions during manufacture to greatly enlarge the suppression of cogging torque. With these steps, we achieved a low cogging torque characteristic with a rated torque rate of less than 1%.

3. Product lineup

Table 1 shows the major specifications for the "SANMOTION R" series. The lineup includes a wide range of 7 models with power voltage of 200 VAC as the standard specification and rated outputs of 30 W to 750 W. The rated rotating speed is 3000 min^{-1}, with a maximum rotating speed of 6000 min^{-1}. The units come with a serial communication absolute encoder that has a standard specification of 17-bit resolution (with a maximum resolution of 20-bit). The "SANMOTION R" series has top class miniaturization for the industry along with a broad and highly efficient power range, giving this lineup with a wide variety of possible applications.

4. Conclusion

This document has described the technologies that make up our company's newly developed AC servo motor "SANMOTION R" series. The "SANMOTION R" series lineup was developed with the product concept of meeting both the recent needs for global environment conservation and the market demand for more sophisticated manufacturing devices. With improvements in high-ability motors that are compact, light weight, high torque, high speed, and low cogging torque, this series can contribute to a wide variety of applications. Furthermore, this motor reduces the burden on the environment with improvements such as reduced CO_2 emissions and plays a large role in global environment conservation.

Table 1: Major specifications

Flange dimensions	**mm**	40			60			80
Motor product No.		R2AA04003F	R2AA04005F	R2AA04010F	R2AA06010F	R2AA06020F	R2AA06040F	R2AA08075F
Combined amplifier (Current capacity)		15A					30A	
Rated output	W	30	50	100	100	200	400	750
Rated rotating speed	min^{-1}	3000						
Max. rotating speed	min^{-1}	6000						
Rated torque	N·m	0.098	0.159	0.318	0.318	0.637	1.27	2.39
Max. instantaneous torque	N·m	0.37	0.59	1.18	1.13	2.2	4.8	8.5
ABS encoder resolution		Normal 17-bit (131072P/R), Max. 20-bit (1048576P/R)						

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