Development of the Flange Size 130 mm and 220 mm “SANMOTION R” Series Mid-Capacity AC Servo Motor

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1. Introduction

In the 30 years since the actuators of industrial robots switched from hydraulic actuators to electric actuators, these robots have advanced drastically in both technology and rate of manufacture. It is said that over one million robots up and running all over the world today, primarily in the automotive and electronics industries. The servo motors that drive the arms of industrial robots must be small, lightweight and must efficiently put out high torque, working smoothly at all speeds. We released the “SANMOTION R” series small-capacity AC servo motor [(1)] in 2006. This small, lightweight, high-torque, high-rotational-speed, high-efficiency servo motor being used a lot in robots with a weight capacity that is less than 5 kg and that are used for assembling and mounting electrical and electronic devices.

We have expanded the "SANMOTION R" series AC servo motor lineup and we have developed the 550 W to 5 kW, small, high-torque, high-rotational-speed, low torque ripple, high-efficiency “SANMOTION R” series mid-capacity AC servo motor for robots with a larger weight capacity.

Four models were added to the lineup: a 220 mm square type with rated output 5 kW and a 130 mm square type with rated output 550 W, 1.2 kW, or 2 kW.

2. Features

This section explains the feature of this product. Fig. 1 shows an image of a rated output 1.2kW motor with holding break and absolute encoder.

1) Improvement of maximum torque and maximum rotational speed

This product has achieved both increased maximum torque and increased maximum rotational speed. Fig. 2 shows a torque and rotational speed characteristic comparison between current and previous products with rated output 5 kW motors. The maximum rotational speed has increased 33% from 3000 min^{-1} to 4000 min^{-1}, and the maximum torque has increased 7%. Furthermore, one model of the current product improves the maximum rotational speed 60%, from 3000 min^{-1} to 5000 min^{-1}.

2) Reduced size and lighter weight

The main component of the motor has been newly designed, the magnetic circuit has been optimized, the space factor of winding has been improved, and a thin-type absolute encoder has been used, all of which conduce to downsize the total length of the servo motor.

Table 1 shows a comparison with our previous model.

3) Low torque ripple

The magnetic circuit of this product has been optimized to reduce its cogging torque. Fig. 3 shows the cogging torque waveform for this product. This amplitude value is 0.5% or lower at the continuous stall torque ratio. This is the top value in the industry.

4) High Efficiency

This product has been design for advanced energy-saving, including consideration to the current consumption of the holding brake. Table 2 shows a comparison of power loss with our previous model.

5) Long life

We reconsidered the construction and materials of parts that abrade or deteriorate, such as the bearing, oil seal, and holding break, and designed the product to have a longer life.

Since increasing the maximum rotational speed has increased the load on the bearing, we have used grease suitable for servo motors, which has long life under high temperature and is resistant to frequent forward and reverse rotation.

If the motor is connected directly to the gearbox, the oil seal prevents oil from leaking into the motor. Recently, a wide variety of greases have been used in gearboxes. We have worked with an oil seal manufacturer to develop oil seal materials and the lip shape best suited to this situation.

The holding torque of the holding brake for a 5 kW motor designed for high-load robots have been increased 30%. This

Fig. 1: Image of "SANMOTION R" mid-capacity AC servo motor (1.2 kW motor, with brake)

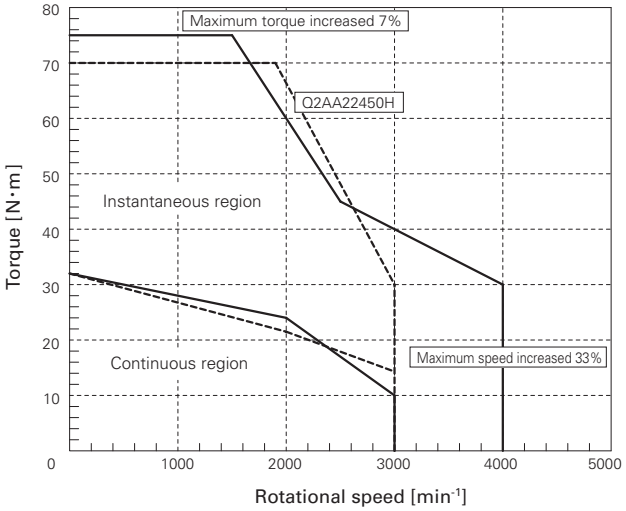


Fig. 2: Torque and rotational speed characteristics for a 5 kW

Table 1: Comparison of the total length

Rated output	New model (with holding brake) (with absolute encoder)	Previous model (with holding brake) (with incremental encoder)
550 W	139.5 mm	171 mm
1.2 kW	160 mm	188 mm
2 kW	216 mm	226 mm
5 kW	220 mm	227 mm

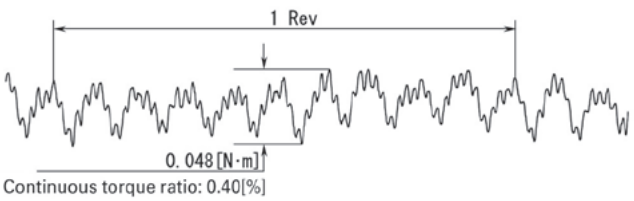


Fig. 3: Cogging torque for a 5 kW motor

Table 2: Comparison of power loss

Rated output	New model (300 min^{-1} continuous torque)	Previous model (300 min^{-1} continuous torque)
550 W	52 W 10 W	62 W 23 W
1.2 kW	79 W 12 W	79 W 19 W
2 kW	81 W 16 W	143 W 24 W
5 kW	245 W 29 W	267 W 38 W

Upper stage: loss of motor,
Lower stage: loss of holding brake (DC 24 V)
will make holding operations more stable.

3. Specifications

Table 3 shows the specifications for this product. Figs. 4 through 7 show graphs of torque and rotational speed.

The maximum rotational speeds have been increased from 3500 min^{-1} to 5000 min^{-1} and from 2500 min^{-1} to 4000 min^{-1} over the previous product.

Rotor inertia is compatible with the "Q2" series medium-inertia servo motor

4. Conclusion

This document has introduced the features and specifications of the “SANMOTION R” series mid-capacity AC servo motor.

The demand for industrial robots is forecasted to increase due to improvement in productivity of the factory, labor shortage resulting from a low birthrate and an aging population, substitute demand for dangerous work, and assurance of stability in the quality of manufactured goods.

This product includes the following features.

- High rotational speed, large torque
- Reduced size and lighter weight
- Low torque ripple
- High efficiency
- Long life

These features will help improve the productivity of industrial robots while helping to conserve energy.

Additionally, we hope that this product will satisfy customers with equipment in other fields, including metal working machinery, woodworking machinery, medical equipment, semiconductor equipment, FPD equipment, and textile machinery.

Our next step is to develop a large-capacity “SANMOTION R” series AC servo motor.

Bibliography

(1) Hiroshi Hioki: AC Servo Motor “SANMOTION R” Series SANYO DENKI Technical Report, No.22 (2006-11)

Table 3: Specifications

Motor model ( ) Flange dimension			R2AA13050H (130)	R2AA13050D (130)	R2AA13120D (130)	R2AA13200D (130)	R2AA22500L (220)
Item	Symbol	Unit					
Rated output	P_R	kW	0.55		1.2	2	5
Rated rotational speed	N_R	min^{-1}	2000				2000
Maximum rotational speed	N_{max}	min^{-1}	3500	5000			4000
Rated torque	T_R	N·m	2.6	2.6	5.7	9.5	24
Continuous torque	T_S	N·m	3.0	2.6	6.0	12	32
Maximum instantaneous torque	T_P	N·m	9.0	7.0	16	30	75
Rotor inertia (including encoder)	$J_m \times 10^{-4}$	$kg{\cdot}m^2(GD^2/4)$	3.1		6.0	12	55
Motor weight (including encoder)	W_E	kg	5		7	10	24
Holding brake torque	T_B	N·m	3.5 or better		9.0 or better	12 or better	42 or better
Applicable servo amplifier model			RS1A03		RS1A05	RS1A10	RS1A15
Power input of servo amplifier			AC 200 V to 230 V +10, -15%, 50/60 Hz ±3 Hz				

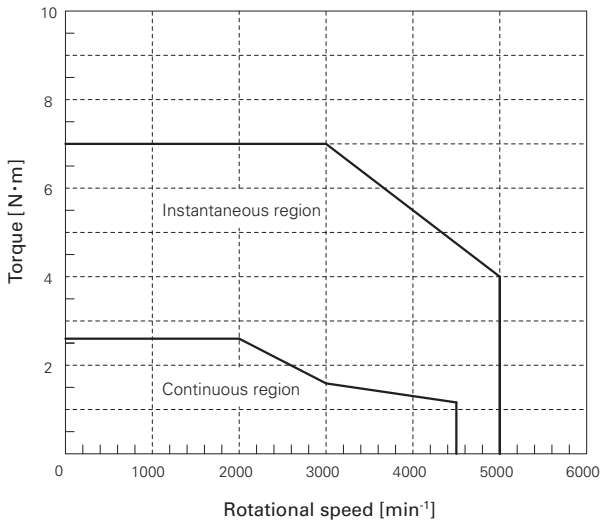


Fig. 4: T-N characteristics for a 550 W motor

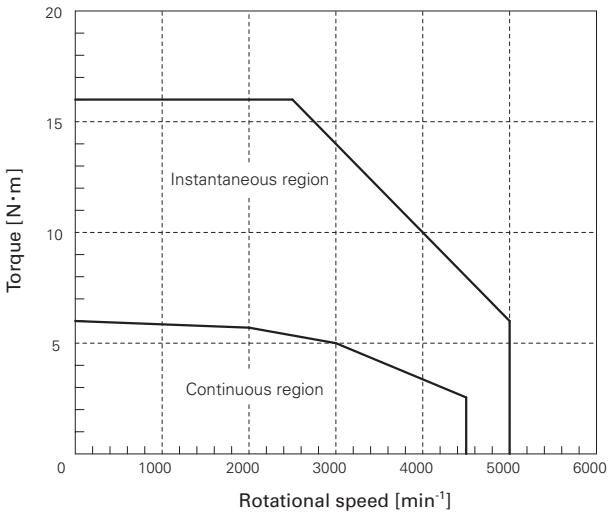


Fig. 5: T-N characteristics for a 1.2 kW motor

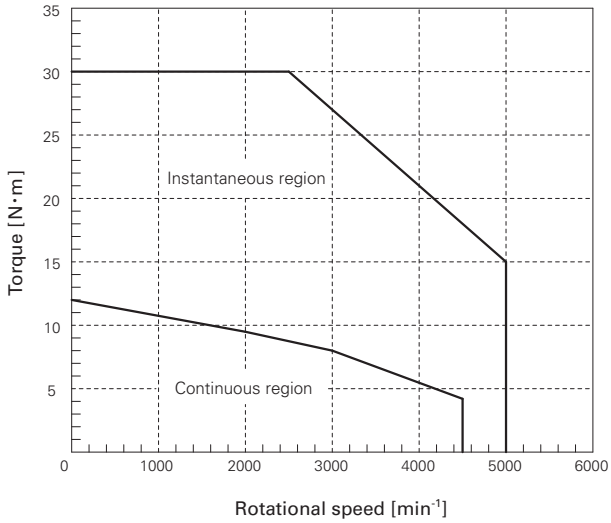


Fig. 6: T-N characteristics for a 2 kW motor

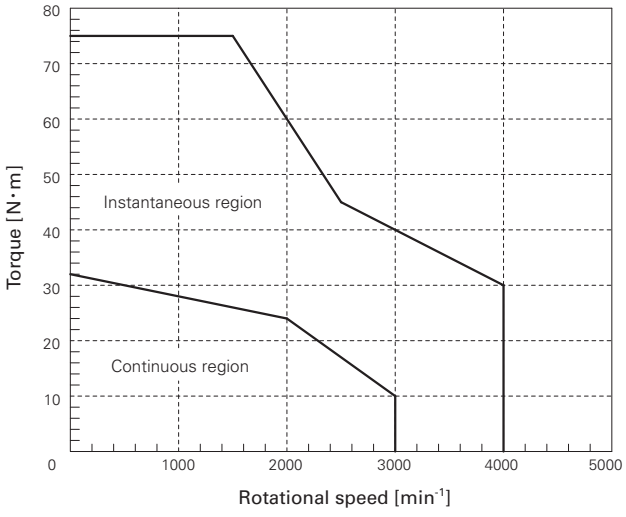
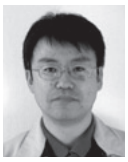


Fig. 7: T-N characteristics for a 5 kW motor



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