"Q" Series AC Servo Motors

Toshihito Miyashita　Akihiko Takahashi　Daigo Kuraishi　Koujirou Kawagishi
Junpei Oosawa　Hiroshi Hioki　Hirotaka Shimomura　Toshiya Miyashita

1. Introduction

Permanent magnet type synchronous servomotors are widely used for industrial robots, machine tools, and the machines related to semiconductor manufacturing. Sanyo Denki introduced the "82" and "86" series AC servomotors into the market in the 1980's. Later, in the 1990's, the "P" series AC servomotor was introduced which dramatically reduced the package size as compared to the earlier "86" series. Now, we are introducing the "Q" series AC servo motors as the successor to the "P" series.

This paper provides the product overview and technical features of the new "Q" series AC servomotor.

2. Outline of the Product

2.1 Model Lineup

The range of "Q" series AC servo motors is shown in Table 1. The "Q1" series motors are "low inertia and high response" type servomotors while the "Q2" series motors are "medium inertia, low ripple, and high efficiency" type servomotors. The "Q1" series is a successor to the conventional "P2" and "P3" series and the "Q2" series is positioned as a successor to the conventional "P5", "P6", and "P8" series.

The "Q1" series 200V type motors have 17 models with 7 different flange dimensions (40mm sq. ~ 180mm sq.) and rated outputs from 30W ~ 4.5kW. The "Q2" series 200V type motors have 27 models with 8 different flange dimensions (42mm sq. ~ 220mm sq.) and rated outputs from 50W ~ 7kW.

In addition, just like the conventional "P3" and "P5" series, the "Q1" series 100V type has 4 models where the flange dimensions are 40mm sq. and 60mm sq., and the rated output is from 30W ~ 200W. The "Q2" series 100V type has 6 models where the flange dimensions are 42mm sq., 54mm sq., and 76mm sq., and the rated output is from 50W ~ 200W.

2.2 Basic Specifications

Fig.1 shows a picture of various "Q" series AC servo motors. Table 2 shows the basic specifications of the motor. All models have a sealed frame where O-rings are used to improve the waterproof performance.

Fig.1 "Q" Series AC Servomotor

Table 2 Basic Specifications of the Motor

Rate	Continuous
Installation method	Flange type
Insulation class	F class
Protection method	Fully closed, self cooling , IP67
Ambient temperature	0～40℃
Storage temperature	-20～65℃
Ambient humidity	20～90％(without condensation)
Excitation method	Permanent magnet type

One advantage of the "Q" series motors is that they are completely interchangeable with the conventional "P" series concerning the flange and shaft sizes.

Please refer to our product catalog[1] for complete details of the motor specifications and dimensions.

Table 1 Range of "Q" Series Servomotors (200V Type)

Flange sq. [mm]	□40			□42		□54			□60		□76					□86			□100			
Q1 Rated output	30W	50W	100W	—		—			200W	400W	—				750W	—			1kW	1.5kW	2kW	2.5kW
Q2 Rated output	—			60W	100W	50W	100W	200W	—		200W	300W	400W	500W	—	500W	750W	1kW	1kW	1.5kW	—	
Maximum servo amplifier current	15A								30A		15A		30A			50A			100A			

Flange sq. [mm]	□120			□130						□180			□220				
Q1 Rated output	1kW	2kW	3kW	—			3kW	4kW	5kW	—	4.5kW	—	—				
Q2 Rated output	—			500W	1kW	1.5kW	2kW	—		2kW	3.5kW	4.5kW	5.5kW	2.5kW	3.5kW	4.5kW	5.5kW	7kW
Maximum servo amplifier current	50A	100A		30A	50A		100A	150A		100A	150A			100A	150A		

3. Feature

The design of the multi-pole "Q" series motor has been optimized as an AC servo motor resulting in decreased power loss and cogging torque. The motor structure, as already described above, uses a sealed frame with O-rings to ensure the performance of the waterproof rating.

A highly-effective servo system and energy saving machine can be achieved thanks to the increased power efficiency of the motor. In addition, the machine is highly accurate with decreased vibration thanks to the low cogging torque. The motors are also more resistant to the environment due to the IP67 protection class. 5000 min^{-1} top speed is possible with the motors that are 1kW or smaller.

The next section discusses details of the decreased electric power loss and decreased cogging torque.

3.1 Decrease of Power Loss

In general, the power loss generated in the motor can be classified into the copper loss generated in the armature winding, the iron loss generated in the armature iron core, and the mechanical loss caused by the friction of the bearings. The "Q" series AC servo motor has been designed to minimize the sum of copper loss and iron loss by optimizing the "pole count and slot combination" and by optimizing the "magnetic circuit consisting of the armature iron core and permanent magnets".

In the "Q" series AC servo motor, the number of motor poles is 10 for the units with a flange size below 130mm sq. and 12 for 180mm sq. and 220mm sq. flanges. Fig.2 shows a comparison of the losses between the "Q" series and "P" series models.

In the "Q" series, the power loss during rated output has been decreased by about 20% compared with the conventional "P" series. Regarding motor efficiency, the small size motors with flange size up to 86mm sq. have achieved around 90% efficiency while the middle size motors of 130mm sq. or greater flange size have achieved efficiency as high as 95%.

Therefore, the "Q" series AC servo motor has greatly reduced power loss. The result is a highly effective variable speed drive system when combined with a Sanyo Denki servo amplifier[2]. The combined drive and motor result in measurable energy savings for machine control applications.

The conventional "P" series motors achieved high heat conductivity using molded resin in the armature slots. The resin filled the air spaces between the copper wire and armature steel. However, this molded resin is not required for the "Q" series motor. Even with the elimination of molded resin, the "Q" series motors can achieve a similar output using the same basic motor structure. The reduced power loss has been explained above.

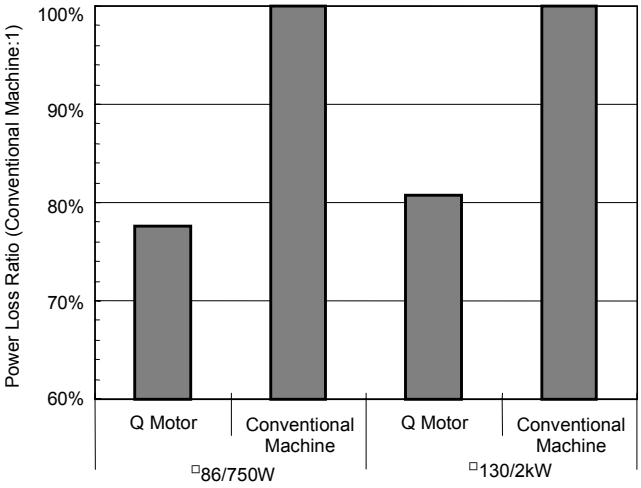

Fig.2 Comparison of Power Loss

3.2 Low Cogging Torque

As mentioned before, the "Q" series motor has minimized the cogging torque by optimizing the "pole count and slot number" while skillfully shaping the armature iron core and permanent magnets.

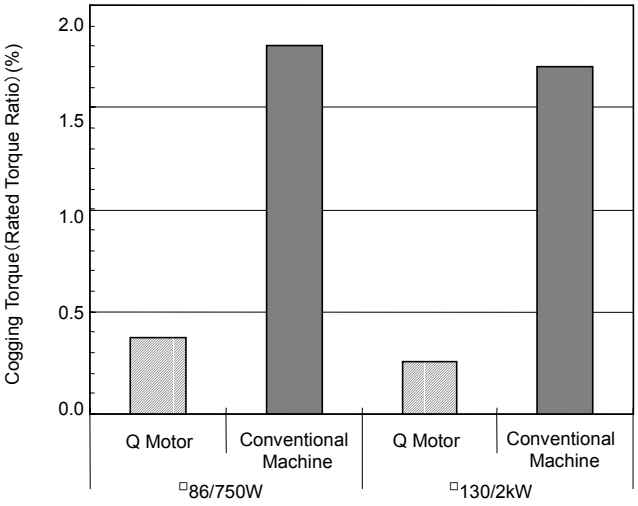

Fig.3 Comparison of Cogging Torque

Fig.3 shows an example of cogging torque for the "Q" series and the "P" series. The "Q" series has achieved cogging torque below 0.5% (as a percentage of rated torque) which is greatly reduced as compared with the conventional motors.

Therefore, due to the low cogging torque of the "Q" series AC servo motor, a smoother drive performance can be achieved and this contributes to highly accurate machine operation with lower vibration.

4. Conclusion

This paper provides an outline of our new "Q" series AC servo motor along with an explanation of the technical features.

The main features of the "Q" series AC servo motor are as follows.

① Power loss of the motor is decreased by about 20% as compared to the conventional "P" series. This supports a highly effective servo system and improved energy efficiency for the machine application.

② Cogging torque as a percentage of rated torque has been reduced to 1% or less. This also results in a smoother drive performance with improved accuracy and reduced machine vibration.

The waterproof level of IP67 has been achieved for the entire motor family. Also, for motors with flange sizes above 130mm sq., optional mounting of the motor sensor using the "Oldham coupling" facilitates replacement of broken sensors in the field.

Reference

(1) Sanyo Denki Product Catalog:「SANMOTION Q」(2002-11)
(2) SANYO DENKI Technical Report No.14:AC Servo Amplifier(Power Supply Embedded･Single Axis Type) "Q" Series S Type (2002-11)

Toshihito Miyashita

Joined company in 1997
Servo Systems Division, 1st Design Dept.
Worked on the development and the design of servo motor

Akihiko Takahashi

Joined company in 1995
Servo Systems Division, 1st Design Dept
Worked on the development and the design of servo motor

Daigo Kuraishi

Joined company in 1999
Servo Systems Division., 1st Design Dept.
Worked on the development and the design of servo motor

Junpei Oosawa

Joined company in 2001
Servo Systems Division, 1st Design Dept..
Worked on the development and the design of servo motor

Koujirou Kawagishi

Joined company in 1996
Servo Systems Division, 1st Design Dept.
Worked on the development and the design of servo motor

Hiroshi Hioki

Joined company in 1990
Servo Systems Division, 1st Design Dept..
Worked on the development and the design of servo motor

Hirotaka Shimomura

Joined company in 1989
Servo Systems Division, 1st Design Dept.
Worked on the development and the design of servo motor

Toshiya Miyashita

Joined company in 1989
Servo Systems Division, 1st Design Dept.
Worked on the development and the design of servo motor