Development of AC Servo Amplifier "SANMOTION R" Series Type S Conforming to Overseas Specifications

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1. Introduction

The AC servo amplifier "SANMOTION Q" that went on sale in 2002 has contributed to higher performance equipment and more compact systems. However, change in the marketplace is intense, and the performance requirements for servos are becoming more demanding. Bearing in mind these requirements, this report presents an overview of the AC servo amplifier "SANMOTION R" series that aimed at a global business.

2. Product overview

Machinery that uses servo systems comes in all varieties, and bearing in mind global business, it seems likely that these types of machinery will only increase. Since the functions required of servo systems differ with each type of machine, we sought to provide comprehensive control functions that can be applied to a range of equipment types on the assumption that machinery types will proliferate. In addition, when global business is taken into account, simplifying servo adjustment becomes an unavoidable issue. In response to this, the AC servo amplifier "SANMOTION R" has a range of automatic measuring functions and adjustment functions.

The newly developed amplifier comes in a lineup of six types with a united single axis power supply ranging from 15 A to 300 A. The applicable motors supported are the AC servo motor "SANMOTION P" series and AC servo motor "SANMOTION Q" series rotary motors, while linear motors can also be used. Incremental encoder and absolute encoder sensors can be used, so that both motors and encoders can be applied flexibly. While maintaining basic compatibility with the AC servo amplifier "SANMOTION Q", we used a new generation power module and high-speed CPU. In addition to improving the range of parameters, we improved the ease of use of the servo amplifier itself, and in order to enable enhanced performance of mechanical systems when the

Fig. 1 AC servo amplifier "SANMOTION R" series 15 A and 30 A

Table 1

	Specifications
Supply voltage	AC 200/230V (15 A and 30 A can also be selected in AC 100 V model.)
Amplifier output capacity	15 A, 30 A, 50 A, 100 A, 150 A, 300 A
Applicable motor capacity	30 W - 15 kW (P and Q series)
Encoders	500 - 65535×4 P/R (incremental) 2048 - 2097152 P/R (absolute) (Serial incremental is also supported)
Control functions	Position, speed, torque control
Control system	IGBT PWM control Sine wave drive
Position command	Pulse
Speed/torque command	Analog
Speed control range	1 : 5000
Frequency characteristics	600Hz(JL=JM)
Sequence signal	Contact in/output
Structure	Tray type (mounting is compatible with the Q series)
Safety standards	CE, UL

amplifier is used in machinery, we also used advanced algorithms such as statistical signal processing. Fig. 1 shows the picture of the AC servo amplifier "SANMOTION R" series 15A and 30A, and Table 1 shows the specifications of the AC servo amplifier "SANMOTION R" series.

3. Features

3.1 Auto tuning

The response of the servo drive is significantly affected by load inertia. The servo amplifier includes a self-tuning regulator that estimates the inertia from the torque command and acceleration, and adjusts the control system parameters based on that value. The AC servo amplifier "SANMOTION R" series uses statistical signal processing to estimate the load inertia, thus improving the precision of inertia estimation. In addition, in order to raise the limit on the response of the control system parameters, we increased the breadth of the response settings. Furthermore, in order to match the characteristics with the application, five auto tuning characteristics can be selected. As a result, it is possible to use either PTP or CP control as required. Table 2 shows the differences in auto tuning between the AC servo amplifier ''SANMOTION Q'' series, and the AC servo amplifier "SANMOTION R" series.

Table 2 Auto tuning differences

	AC servo amplifier ''SANMOTION Q''	AC servo amplifier ''SANMOTION R''
Procedure	Traditional manner	Statistical signal processing
Response settings	10 levels	30 levels
Auto tuning characteristics	2 types	5 types

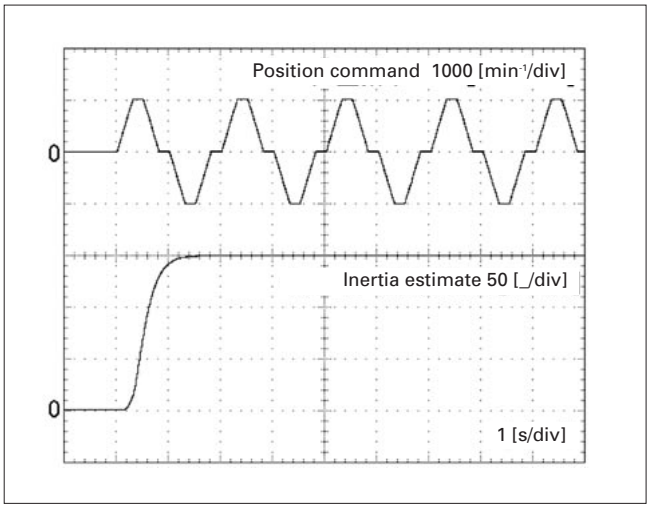

Fig. 2 Inertia estimation characteristics

Fig. 2 shows the inertia estimation characteristics when the load inertia is changed from 1 time inertia to 150 times inertia.

3.2 High settling control

With PTP control, reducing positioning settling time is essential to improving mechanical system throughput. In the AC servo amplifier "SANMOTION R" series, in order to enable reduction of positioning settling time even when there is friction or resonance in a mechanical system, feedforward compensation is performed giving the amplifier high settling control for reducing positioning settling time. By this control, reducing of positioning settling time can be aimed at the actual mechanical system.

3.3. Mechanical resonance suppression

In mechanical systems there are resonance points, typically at couplings and the like, and if the servo system amplifies them, they may become apparent as a loud noise. Notch filters are suitable for suppressing this high frequency resonance. However, if the center frequency of the notch filter is close to the control band, delays may arise in the control band causing deterioration in control performance.

In order to reduce this delay and to enable use of notch filters without excessive loss of control performance, the AC servo amplifier "SANMOTION R" series employs phase lag

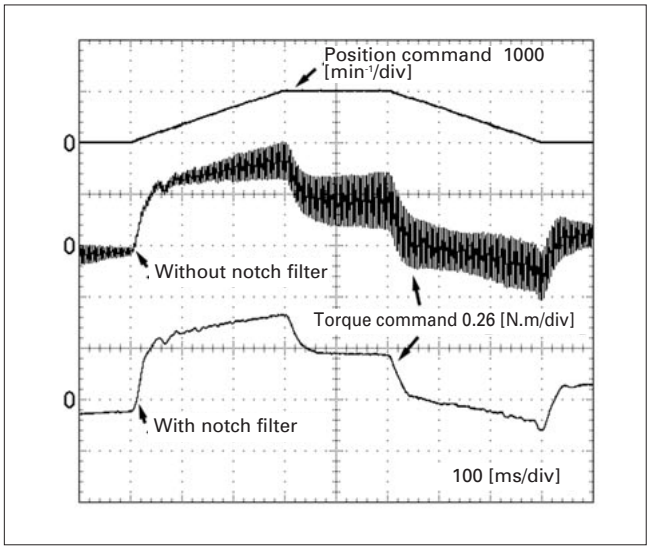

Fig. 3 High-frequency resonance suppression characteristics

reduction notch filters and depth adjustment notch filters. There are four levels of these notch filters, and even if there are several types of mechanical resonance, it is possible to suppress high-frequency resonance without extremely reducing the cutoff frequency of the low pass filters. In this way, it is possible to achieve higher servo stiffness than in the past, and the basic characteristics of the machinery are significantly improved.

In addition, the setting frequency can be easily found by using the system analysis function of the setup software that comes with the AC servo amplifier "SANMOTION R" series and the auto notch filter tuning function of the amplifier itself. Fig. 3 shows the high-frequency resonance suppression characteristics.

3.4 Disturbance suppression

The servo systems of many typical machine tools have a multiple axis arrangement, with X, Y, and Z axes. In this kind of multiple axis arrangement, positioning may be affected by the other axes. For example, if axis X is stopped, when axis Z moves, power is applied to axis X through the mechanical system so that the position of axis X may change. In order to suppress this kind of external influence and to improve positioning precision, a disturbance observer is provided. In the AC servo amplifier "SANMOTION R" series, the frequency band of the disturbance observer used in the AC servo amplifier "SANMOTION Q" series is enlarged so that it can detect up to medium frequencies. In this way, it is now possible to suppress disruptive influences in those slightly higher frequencies where it was previously impossible to improve characteristics, and to suppress deterioration in positioning precision due to disturbance.

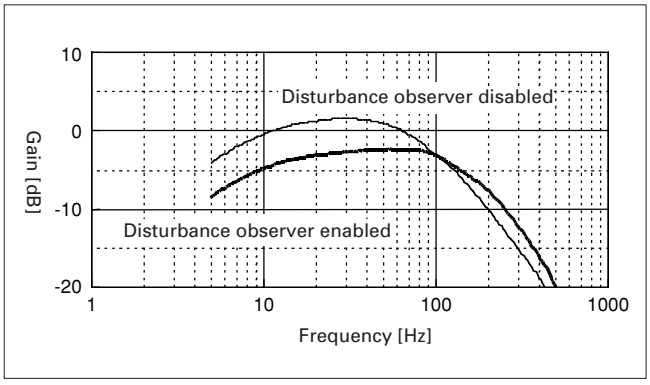

Fig. 4 Disturbance suppression characteristics

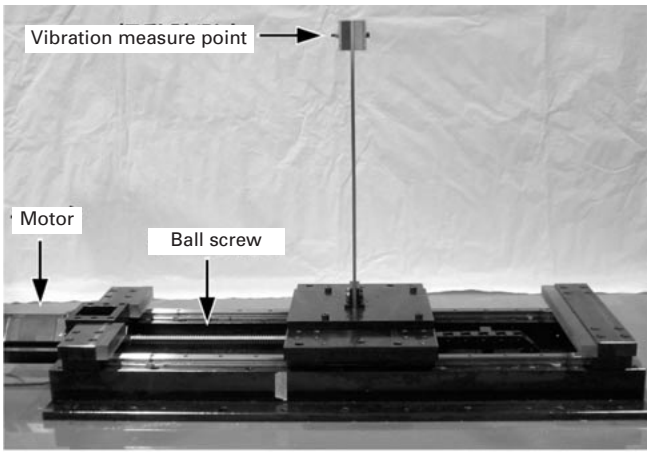

Fig. 5 Damping control evaluation machine

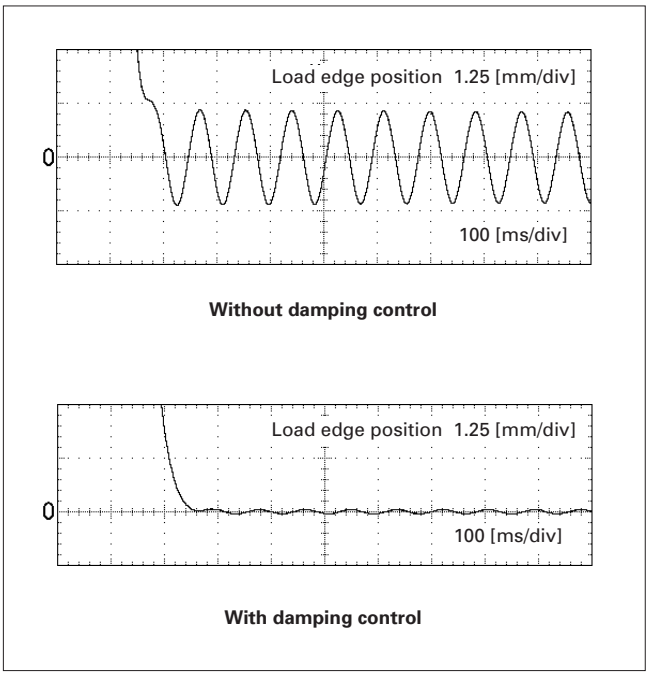

Fig. 6 Damping control characteristics

3.5. Mechanical vibration suppression

Forms of vibration in mechanical systems include vibration due to torsional stiffness in powertrains such as ball screws, as well as edge vibration and machine stand vibration.

Since it is difficult to detect edge vibration and machine stand vibration using a motor encoder, it is often hard to suppress it with feedback control. In order to control edge vibration and machine stand vibration, the AC servo amplifier "SANMOTION R" series has a feedforward damping control function. Feedforward damping control provides feedforward compensation in order to prevent the occurrence of mechanical vibration, and it can also be used in applications where vibrational components cannot readily be fed back to the motor.

Table 3 shows the new functions of the AC servo amplifier "SANMOTION R" series.

1	Auto tuning	● Load inertia estimation using statistical signal processing ● Selection of 5 types of auto tuning characteristics ● 30 levels of response settings (high response) ● Load inertia ratio manual setting function ● Parameter automatic saving function ● Parameter manual saving function
2	Improved tracking	● High settling control function ● High tracking control function ● 4 level gain switching function (with switching filter)
3	Resonance suppression	● Speed command notch filter function ● Torque command phase lag reduction notch filter function (1 level) ● Torque command depth adjustment notch filter function (3 levels) (Total 4 level torque command notch filter)
4	Disturbance suppression	● Disturbance observer for medium frequencies ● Function for processing selection of valid conditions of the disturbance observer ● High-speed processing - Speed/torque adding function ● 2 types of internal torque adding command setting function ● Normal and reverse rotation detection function
5	Damping control	● Feedforward damping control ● Damping frequency 4-level switching function ● Auto damping frequency tuning function
6	Monitor	● Main circuit direct current voltage monitor function

Furthermore, the setting frequency can be easily found by using the system analysis function of the setup software that comes with the AC servo amplifier "SANMOTION R" series, and the damping frequency identification function of the amplifier itself. Fig. 5 shows an evaluation machine, and Fig. 6 shows the damping control characteristics.

3.6 Ultrahigh-resolution

In recent years, the precision required in mechanical systems is shifting from micron-order to nano-order depending on the application, and higher resolution position accuracy is also required. In the AC servo amplifier "SANMOTION R" series, these requirements can be met with the 1,000,000-point resolution encoder provided as standard, as well as making improvements that enable control appropriate for the encoder resolution. Table.3 shows the new functions of AC servo amplifier "SANMOTION R" series.

4. Global business development

In Europe there is a strong emphasis on protecting the environment. In pursuit of improved environmentally friendly technology, the AC servo amplifier "SANMOTION R" series was designed not to cause any harm due to toxic substances, and it can meet the Restriction of Hazardous Substances (RoHS) (compliance is scheduled to start from January of next year). In addition, in order to reduce energy consumption, it shortens the positioning settling time of the servo system, and reduces the power consumed by the motor. Furthermore, IPM power consumption is minimized through use of a new generation IPM.

For overseas production, it is necessary to take into account use of local components. For the AC servo amplifier "SANMOTION R" series, we changed the material of the radiator fins to a more common material to take availability of components into consideration. Also, to facilitate automation of inspection, we provided the servo amplifier with internal software for a range of inspections, integrating the inspection parts with the amplifier itself.

Furthermore, the design can easily accommodate a range of power supply voltages and network functions, and can easily be readied for overseas use.

5. Conclusion

This report presented an overview of the AC servo amplifier "SANMOTION R" series. Compared with the AC servo amplifier "SANMOTION Q" series, the AC servo amplifier "SANMOTION R" series incorporates a range of functions that, when combined with mechanical systems, improve their characteristics. This increases the range of equipment type it can be used with. In addition, it is designed to take the environment into account, to be modified easily in a variety of ways, and to be used overseas without difficulty. With these improved functions, the parameter settings are significantly different from those of the AC servo amplifier "SANMOTION Q" series, but in fact, since they are now arranged into function groups, they are actually easier to use. We will continue to expand the range of application of our servo system, and will make every effort to improve their characteristics.

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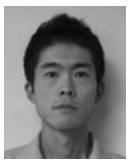

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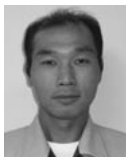

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