

“SANMOTION R” Series ADVANCED MODEL AC Servo Amplifier with PROFINET Interface

Tsuyoshi Kobayashi

Naohiro Itoh

Hiroyuki Kosuge

Kouichi Machida

Yasuo Nakamura

Keisuke Ishizaki

1. Introduction

In addition to downsizing, cost reduction and providing high performance and functionality, there is also a demand for AC servo motors to support serial interfaces in order to reduce total system costs. In the midst of this situation, Sanyo Denki released an AC servo amplifier equipped with the EtherCAT interface on the market in 2009 as the next generation motion network. However, with the current lineup, customers' choices are limited and there are an increasing number of cases for which we find it difficult to offer solutions. Moreover, there is an expectation that products adopt PROFINET, etc., as the faster, next generation network, in relation to PROFIBUS, which is widespread in the international market. In response to this, we have further enhanced our series by developing an amplifier equipped with the PROFINET interface. PROFINET is one of the open networks created by PROFIBUS & PROFINET International (hereinafter, PI) which has acquired an overwhelming share of the European and Asian markets.

This document provides an overview and feature of the AC servo amplifier equipped with PROFINET interface, developed as part of the Advanced Model lineup of the “SANMOTION R” series (hereinafter, “the new model”).

2. About PROFINET

PROFINET, which is the open standard (IEC61158/61784) is supported by PI. The features of PROFINET are as follows.

- (1) In conformance with IEEE802.3, fully standard Ethernet components can be used.
- (2) With one topology, there are no limitations to the simultaneous, parallel processing of Ethernet connected IO communication and standard IT data (TCP/IP).
- (3) The number of nodes per network is only limited by the IP address and it has no limitations for all practical purposes.
- (4) The network bandwidth can be effectively distributed using multiple port switches and field devices.
- (5) There are 3 performance levels to suit the application – RT (Real-time), IRT (Isochronous Real-time) and NRT (Non Real-time).

3. Product Profile

3.1 Specifications

The new models inherit the assets of the Advanced Model Type S analog interface, part of the “SANMOTION R” series. In order to improve motion profile performance, the control micro computer has been renewed and a 1-chip LSI for PROFINET-supporting input/output control devices has been adopted.

Applicable motors are the rotary motor for “SANMOTION R” as the basis, while the “SANMOTION Q” and “SANMOTION P” series also support linear motors and direct motors. Applicable encoders include start-stop synchronization serial encoders, and they can be operated with either absolute or incremental systems. Apart from this, the full close system also supports the RS-422 communication distance meter.

Fig. 1 shows the new model and Table 1 outlines product specifications.



Fig. 1: The developed amplifier

Table 1: Specifications

Power voltage	200 V AC (15 A and 30 A models can also use 100 V AC)
Amplifier output	15 A, 30 A, 50 A, 100 A, 150 A, 300 A
Applicable motor capacity	30 W to 15 kW (R Series)
Applicable encoders	2048 to 1048576 P/R (Serial) 500 to 65535 x 4 P/R (A, B, Z pulse)
External encoder	Pulse, RS422 serial
Control functions	Position, speed, torque control, full close control
Control method	Sine wave PWM control
Frequency characteristic	Same as R ADVANCED MODEL Type S
Sequence signal	Input 6 ch., output 2 ch.
Built-in functions	Same as R ADVANCED MODEL Type S
I/O signal	PROFINET interface specifications
Communication PC I/F	Same as R ADVANCED MODEL Type S
Operating ambient temperature	0 to 55°C
Structure	Tray type
Standards and compliance	UL,CE,RoHS compliance

3.2 Features and performance

Functions and performance are equivalent to the Advanced Model Type S analog interface, part of the “SANMOTION R” series. In addition, it supports “SANMOTION R” Series ADVANCED MODEL Setup Software for improved maintainability, which enables use under environments equivalent to all the models in the series. In addition, a safety function is included standard in order to improve the safety of the applicable machinery. Table 2 shows the principal control functions.

Table 2: Functions

Operation mode	Position, speed, torque, homing, JOG
High response	High output torque control, model following control
High precision	Position command moving average filter, friction compensation function
Damping control	model following damping control (can be used with feed-forward damping control simultaneously)
Trajectory generation profile	Trapezoid, jerk, S-curve profile
Improved usability	Set-up software (multi-window, operation trace, system analysis, etc.) Motor auto-identification function
Safety	Hardware gate-off function
Maintainability	Alarm status display function, alarm history timestamp, multiple alarm monitor

3.3 Exterior and structure

All software processing is performed on 1 CPU achieving downsizing and low cost by integrating control and interface processing. Moreover, because the new model is the same size as the analog interface model, its mounting setup is compatible and the customer can easily switchover to PROFINET without changing the control cabinet.

3.4 PROFINET interface specifications

Table 3 shows PROFINET interface specifications.

Table 3: PROFINET interface specifications

Physical layer	IEC61158-2, IEEE802.3u (100BASE-TX)
Data link layer	IEC61158-3, -4 Type10
Application layer	IEC61158-5, -6 Type10
Communication port	RJ45 connector (2 ports) FastConnect RJ45 plug recommended.
Cable	FastConnect cable recommended. (4 core for high-speed Ethernet)
Communication speed	2 x 100 Mbaud (full duplex)
Topology	Line type
Transmission distance	Max. 100 m (between nodes)
PROFINET communication	PROFINET IO
Real-time communication	RT (real-time), IRT (isochronous real-time)
LED indicator	Port1/2 link and Port1/2 active indicators

4. Features

In addition to inheriting the “homing mode”, “touch probe function” and “safety function”, all popular features of the Advanced Model EtherCAT interface (“SANMOTION R” series), the new model also has the following features.

4.1 Speed jerk, S-curve profile

On the conventional positioning operation generator, only trapezoid position command could be outputted. S-curve was simulated by a smoothing filter using a moving average filter. The new model has jerk and S-curve generator functions.

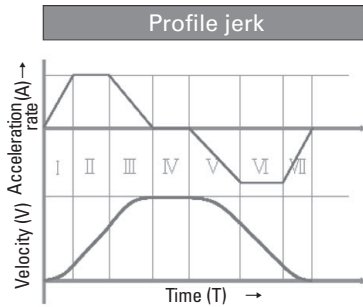


Fig.2 Jerk profile

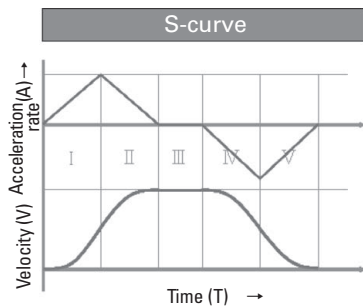


Fig. 3: S-curve profile

4.2 Sequential positioning function

In the positioning operation, up to 5 blocks of continuous operation are possible and multiple positioning patterns can be used until the target position is reached.

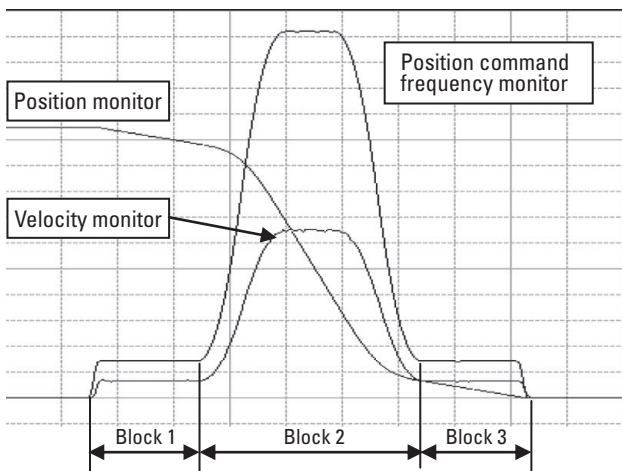


Fig. 4: Continuous 3 block operation

4.3 Standardization of the safety function

Safety functions which were options on the Advanced Model Type S analog interface of the “SANMOTION R” series (IEC61800-5-2: safe torque off and IEC60204-1 stop category 0 defined safety functions) have become standard on the new model. It is possible to immediately meet the requirements of these safety functions.

4.4 Expansion of homing mode

The new model supports the hard stop homing generally used in stepping and closed step systems.

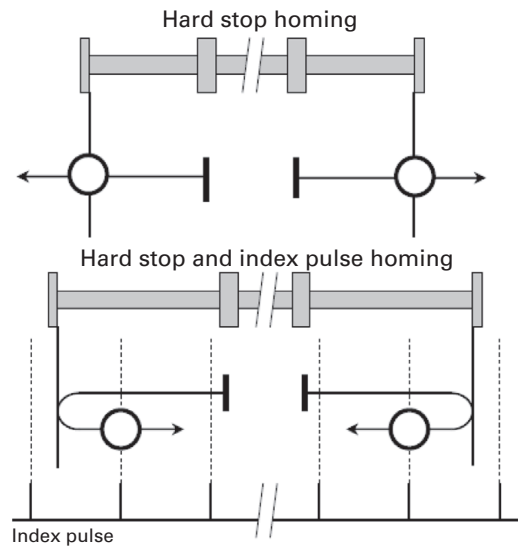


Fig. 5: Hard stop homing

4.5 Dual position feedback compensation function

Previously in full close control, response is quite lower than semi-close control. In order to improve this, hybrid control combining a full-close control and semi-close control was implemented. This hybrid control increases the semi-close control percentage at acceleration/deceleration and positions as full-close at constant velocity and when stopped.

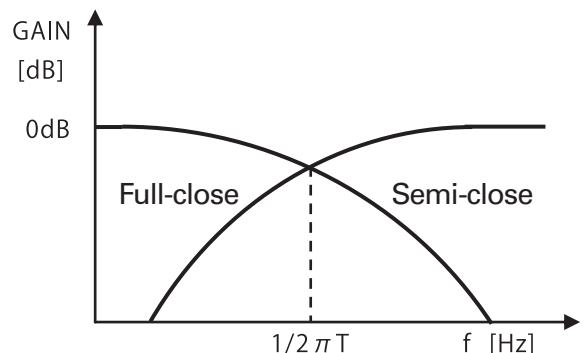


Fig. 6: Dual position feedback compensation

4.6 Feed-forward damping control frequency improvement

In the control range of the feed-forward damping control featured on the “SANMOTION R” series (5-500 Hz), there were limitations on damping lower than this. The new model has been improved so that damping is possible in a frequency range as low as 1 Hz. This has made it applicable even with low-rigidity equipment.

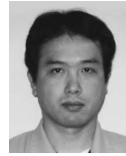
5. Conclusion

This document introduced an overview of the AC servo amplifier with a built-in PROFINET interface.

The new model inherits the functions and performance of the Advanced Model Type S analog interface from the “SANMOTION R” series as well as a renewed CPU with network interface processing and additional functions.

Because it was built the same size as the analog interface model, molds and other equipment parts are common. As such, we believe we have developed a highly competitive product, just like the EtherCAT model, even in comparison to our network models and products of other Japanese and overseas manufacturers.

We will work towards developing 24/48 V DC power input in the future and aim to answer the diverse needs of our customers.



Tsuyoshi Kobayashi

Joined Sanyo Denki in 1991.
Servo Systems Division, 2nd Design Dept.
Worked on the development and design of servo amplifiers.



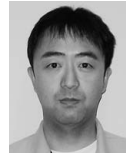
Naohiro Itoh

Joined Sanyo Denki in 1992.
Servo Systems Division, 2nd Design Dept.
Worked on the development and design of servo amplifiers.



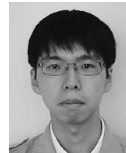
Hiroyuki Kosuge

Joined Sanyo Denki in 1987.
Servo Systems Division, 2nd Design Dept.
Worked on the development and design of servo amplifiers.



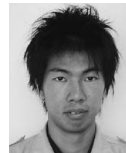
Koichi Machida

Joined Sanyo Denki in 1994.
Servo Systems Division, 2nd Design Dept.
Worked on the design of servo amplifiers.



Yasuo Nakamura

Joined Sanyo Denki in 2009.
Servo Systems Division, 2nd Design Dept.
Worked on the design of servo amplifiers.



Keisuke Ishizaki

Joined Sanyo Denki in 2008.
Servo Systems Division, 2nd Design Dept.
Worked on the structural design of servo amplifiers.