AC Compatible "SANMOTION" PB System

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1. Introduction

Sanyo Denki's DC power supply input "SANMOTION" PB Series systems were initially introduced into the market as products to bridge the gap between open loop stepping systems and AC servo systems. In recent years, the demand for a wider range of input AC power supplies has grown due to the conditions of power sources for general industrial devices. At the same time, demand has also risen for equipment that is faster, without the increased vibration and noise associated with higher equipment torque.

This report provides an outline of the features of the "SANMOTION" PB Series system designed for compatibility with AC power supply inputs and developed in response to the circumstances described above.

2. Product Outline

Fig. 1 shows the external appearance of the amplifier, Figs. 2 and 3 contain the external circuit block diagrams, Table 1 describes the basic specifications of the amplifier, and Table 2 shows the basic specifications of the motor.

Two amplifier models have been developed, and are categorized based on their interface specifications:

- Pulse Train Input Type….Amplifier Model No. PB3A003P200
- RS-485 / Parallel I/O ….. Amplifier Model No. PB3A003R200

The "SANMOTION" PB Series lineup also includes five different motor models for combination with the amplifier (see Table 2), including the newly developed 86mm sq. motor.

Both amplifiers can be combined with any of the motors.

Fig. 1: External Appearance of the "SANMOTION" PB-R system

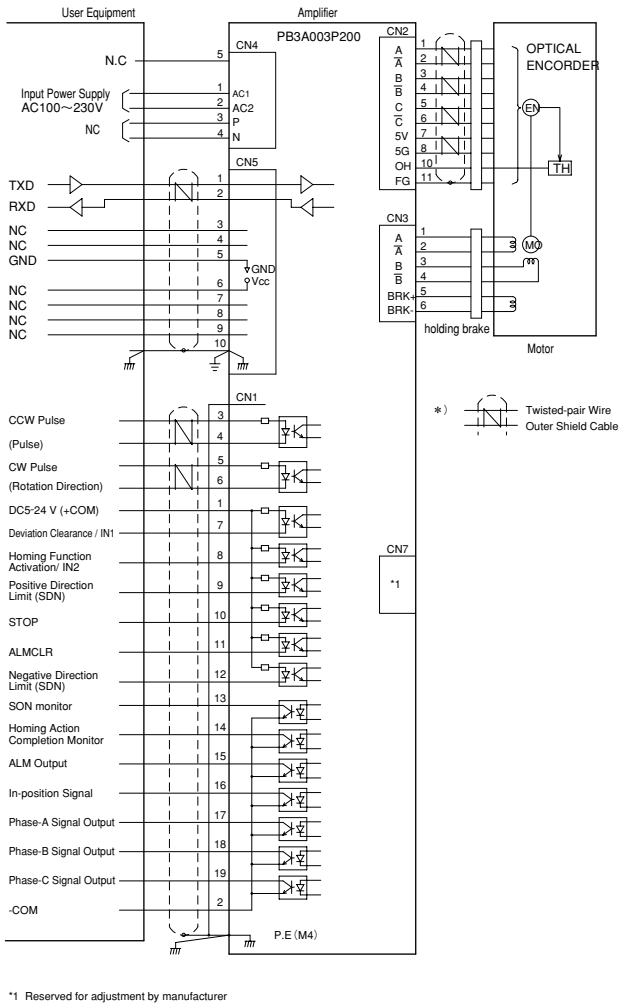
Table 1: Basic Specifications of the Amplifier

Item	Specifications	
Amplifier Model No.	PB3A003R200	PB3A003P200
I/F	RS-485 full-duplex parallel I/O	Pulse train input (RS-232C)
Drive Mode	PAM+PWM Control	SIN Drive Mode
Input Power Source	AC100～230V +10%, -15%	
External Dimensions	H150×W45×D120	
Weight	Approximately 0.9kg	
Structure	Tray-type	
Positioning Resolution	500,1000,2000,4000,5000,10000P/R	
Rotation Speed	0 to 4500min^{-1} (42mm sq., 60mm sq. motor) 0 to 4000min^{-1} (86mm sq. motor)	
Speed Command Unit	1min^{-1}	—
Incorporated Functions	Holding Brake Brake Control Function Regeneration Control Function	
	Point Function Program Function	Auto-micro S-curve Function
Active Functions	Positioning Action Jog Operations Automatic Homing Action Push Action	
	Modulo Function	—
Display	LED display POW/ALM	
Protective Functions	Motor Overheating, Amplifier Overheating Abnormalities in power supply voltage, sensor disconnection Excessive Speed, RST Action Abnormalities in CPU, EEPROM Abnormalities with PAM Voltage Abnormalities with Overloading, Deviation Over-current Detection	
Input Signal Functions	Point Number Point Execution Signal Execution Area Selection Hard Limit External Home Position Signal General Purpose Input Emergency Stop Temporary Stop Alarm Cancellation Homing Function Activation	Pulse Input: (1-or 2-input method) Hard Limit External Home Position Signal Emergency Stop Deviation Clearance ALMCLR Homing Function Activation
Output Signal Functions	Normal Acceptance (Ack) Action Completed Homing Action Completed ZONE Alarm General Purpose Output	SON Monitor Homing Action Completed ALM In-Position Sensor Signals (A,B,C)

*The input and output signal functions, as well as the logic, are set by communication for each function.

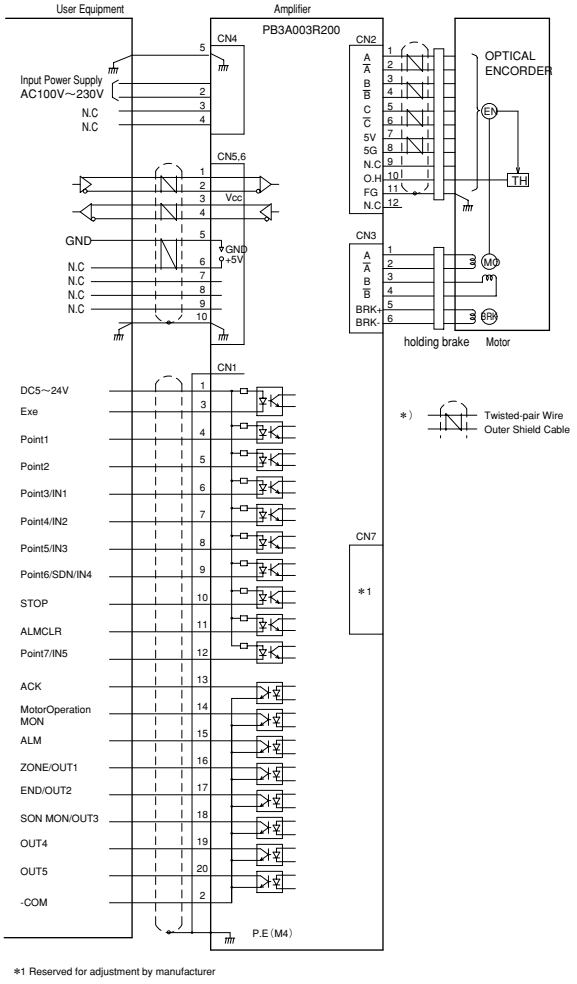
Table 2: Basic Motor Specifications

	Item	PBM423FXE20	PBM603FXE20	PBM604FXE20	PBM861FXE20	PBM862FXE20
Basic Specifications	Maximum Stall Torque (N-m)	0.39	1.3	1.9	3.5	6.6
	Rotor Inertia (kg-cm^2)	0.056	0.4	0.84	1.48	3
	Allowable Thrust Load (N)	9.8	14.7	14.7	60	60
	Allowable Radial Load (N)	49	167	167	200	200
	Motor Weight (kg)	0.35	0.85	1.42	1.9	3.1
	Sensor Specifications	Optical INC 500P/R A/B/C Channel				
Option	Retention Brake	○	○	○	×	×
	Low Backlash Gear	○	○	×	×	×
	Harmonic Gear	○	○	×	×	×



*1 Reserved for adjustment by manufacturer

Fig. 2: External Circuit Block Diagram (Pulse Train Input)



*1 Reserved for adjustment by manufacturer

Fig. 3: External Circuit Block Diagram ("SANMOTION" PB-R)

3. Product Features

3.1 Drive Mode

The new AC power supply input "SANMOTION" PB Series has an enhanced sensor resolution of 500P/R (compared to 200P/R for conventional models), and offers a SIN drive mode by adopting software for the previously hardware-dependent control section. In addition, a PWM switching system has been adopted on top and bottom, to enhance responsiveness to electric currents and reduce the effect from regenerative voltage while driving. All of the modifications listed here were made to the system in order to enhance the following functions and capacities:

(1) Positioning Resolution

To enhance convenience with linear mechanisms, resolution has been set at 500P/R×n(where n = 1, 2, 4, 8, 10 or 20).

(2) Command Resolution (for the "SANMOTION" PB-R Model)

Improving on the resolution of conventional speed command at 18.75min^{-1}, this new system is equipped with a speed command resolution of 1min^{-1}, enabling even more detailed speed control.

(3) Reduced vibration

This improved "SANMOTION" PB Series system is not only free of the resonance frequently observed in open loop stepping systems, but it has also achieved even more stable velocity variation properties by changing both the sensor resolution and control method.

Fig. 4 compares the new and conventional PB systems (the latter with sensor resolution of 200P/R).

(4) Reduced Noise

Motor noise has been significantly reduced, particularly in the frequently-used speed range below 1000min^{-1}.

Fig. 5 compares the noise levels of the new PB system and a typical open loop stepping system.

3.2 Voltage Control Functions

In general, when rectifier voltage is applied directly to a motor connected to an AC power supply input amplifier, the PWM causes an expanding current ripple, because the motor damping time constant for stepping motors is small. This could result in heat dissipation from the motor iron, a potential problem. Depending on the driving conditions, practical application could become difficult, especially with compact motors of small inductance.

To solve this problem, heat dissipation from the motor has been reduced by equipping the PB amplifier with a step-down circuit, and by controlling the voltage through provision of an optimal motor type and driving conditions. By doing so, we have achieved our goal of low inductance for a 42mm sq. motor.

Furthermore, the input power supply voltage is compatible with a wide range of input between AC100V and AC230V. At the same time the system exhibits constant torque properties, since its dependence on the input voltage has been eliminated, as heat dissipation and torque generated in the motor are controlled in the step-down circuit.

In contrast to a STEP system that continuously supplies constant current, through PI control, only the necessary amount of electric current is supplied to the motor in a "SANMOTION" PB amplifier; this control method is also effective for reducing heat dissipation.

Fig. 6 compares the operating temperatures of the new "SANMOTION" PB system with those of a typical open loop stepping system, with AC100V directly applied.

3.3 Torque Properties

We have achieved torque enhancement in the high-speed region thanks to an optimum phase control that complements the rotation speed and the increase in applied voltage attained by AC power supply. Fig. 7 compares the velocity-torurue characteristic of the new "SANMOTION" PB system with the conventional "SANMOTION" PB DC power supply input model.

Incidentally, torque generated in the "SANMOTION" PB system is effectively utilized due to the fact that the torque margin does not require consideration.

3.4 "SANMOTION" PB- R Functions

The amplifier is equipped with pulse generation function, as well as non-volatile memory for mounting the point function (128 points) and

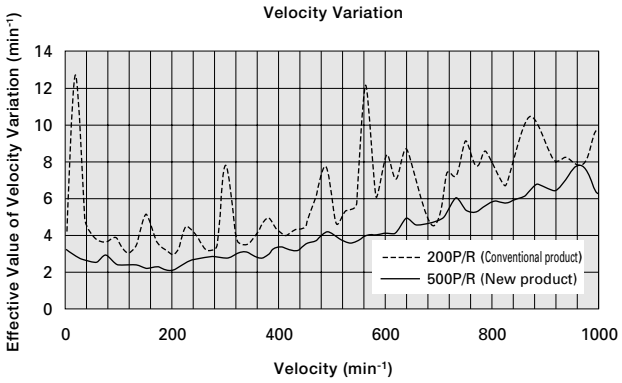


Fig. 4: Comparison of Velocity Variation (Equivalent to PBM603)

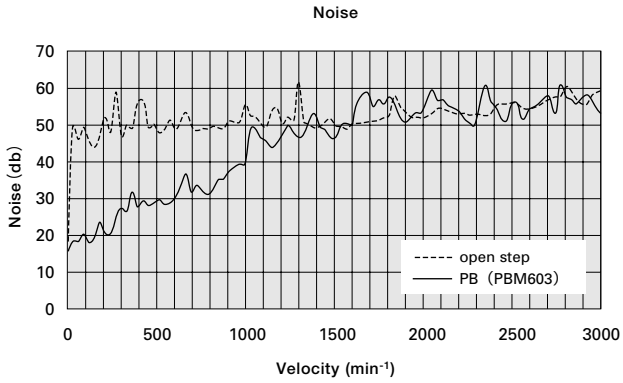


Fig. 5: Comparison of Motor Noise (Equivalent to PBM603)

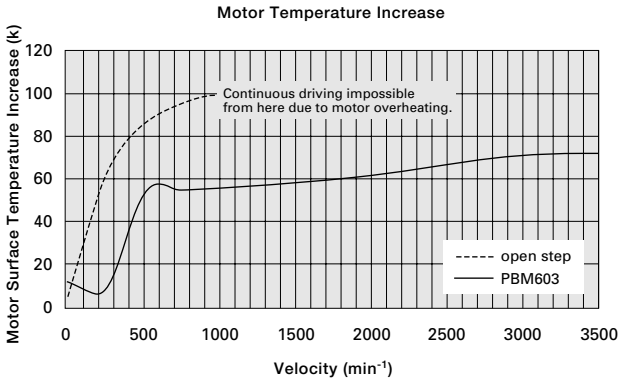


Fig. 6: Motor Temperature Increase (during No-Load Continuous Operation)

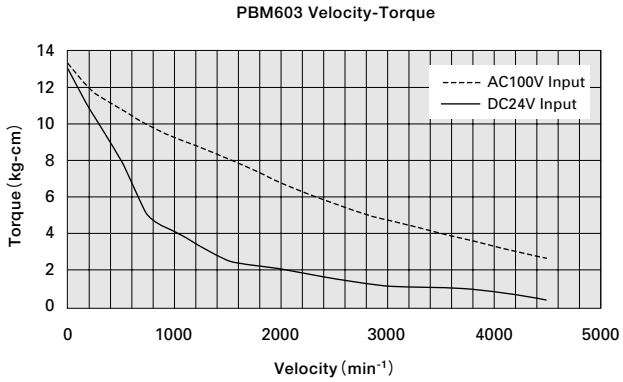


Fig. 7: Comparison of velocity-torurue characteristic

program function (1 program x 1024 lines or 128 programs x 8 lines). Therefore, data previously stored in the non-volatile memory can be controlled only by contact signals.

These measures should contribute toward reduction of the load of arithmetic operations on the system, as well as the overall cost of the system.

For providing direct control by communication, the new "SANMOTION" PB utilizes the general - purpose RS-485 protocol. This simple communication protocol interfaces well with personal computers and other master devices, such as PLCs.

3.5 Features of Pulse Train Input

SIN driving, even with low position command resolution, is achieved through internal amplifier control; the processing time for current loops has been reduced thanks to a faster CPU, giving smooth operation even under extremely low-speed driving.

The S-curve control function is also added for smooth, application-oriented operation.

3.6 Additional Key Points

- Since the amplifier is equipped with a retention brake control function, a power supply and relay contact for the retention brake are not necessary.

- The amplifier is also equipped with a regeneration control function unique to PB systems, eliminating the need for an external regeneration unit.

- Data settings for pressing torque and pressing displacement can be made on the same command with normal displacement for the PB-R model, enabling simple management of pressing control.

- The PB-R model includes a modulo function, providing short-cut control for index tables and other applications.

- A diverse range of automatic home return functions have been incorporated into the system, such as origin (edge) detection, homing by connecting to the amplifier's external origin sensor, and more.

4. Conclusion

The development of the AC power supply input "SANMOTION" PB Series system will enhanced the speed and performance of general industrial machines, as highly sophisticated products with the versatility to handle various power source types and high cost performance, together with conventional DC power supply input "SANMOTION" PB Series systems.

The authors of this report pledge their intention to continue to improve and enhance the performance of "SANMOTION" PB Series systems.

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