SANYO DENKI TECHNICAL REPORT No.8 November-1999
New Products Introduction

AC Servo Amplifier "PY"

Izumi Yui　Hidenao Shoda　Tsuyoshi Kobayashi
Hiroyuki Kitazawa　Yoshihiko Oouchi

1. Introduction

Since it developed the first AC servo system "BL82 SERIES" in Japan in 1982, Sanyo Denki has been releasing a number of servo amplifiers. The "867Z," which hit the market in 1993, is particularly remarkable. It is a fully digitally controlled servo amplifier. Since then, on the basis of the "867Z," the company has been providing the market with different series: "PZ," which meets servo motors having different capacities over a wide range from 30W to 30kW; "PU," which is designed for small-capacity servo motors less than 1kW; and "PV," which is based on a PU but with enhanced functions. However, market demands these days cover a wide range, including small size, low cost, high performance, and conformance to international standards. This makes it impossible to meet those requirements with traditional series alone.

The "PY" servo amplifier series is designed to meet this wide variety of market requirements.

Particular attention is paid to amplifiers designed to drive 30W to 1.5kW motors, which amplifiers represent a large market size. For these products, the company provided "PY2" amplifiers, which are compact and low-cost but with the same performance as conventional models. For the increasingly electrical hydraulic machines market, the company provided "PY0" amplifiers, which cover up to 15kW motors in an attempt to meet various market requirements. "PY" is also suitable for use jointed to the company's linear servo motors.

This paper describes the features and characteristics of "PY" servo amplifiers.

2. Features and main characteristics of AC servo amplifiers "PY"

2.1 Features of the control unit

The control unit of the "PY" servo amplifier centers around two processors: DSP and CPU. The portion connected directly to sequence interface alarm processing and other customer controllers is handled by the CPU. Position loop operations, speed loop operations, and various corrections, which are the basic operations conducted by the servo amplifier, are handled by a special-purpose DSP.

The multiple interface, at which Sanyo Denki is strong, is implemented only on the CPU. The operation unit is made independent to achieve high performance, in an attempt to increase development efficiency.

For the "PY" servo amplifiers, the authors proceeded further with inter-processor interface technology that the company had cultivated through its "867Z" and "PZ" servo amplifiers, and enhanced the capability of the processor itself in order to greatly reduce operation time.

This dramatic reduction of operation time allowed the authors to obtain a frequency characteristic about four times as high as that of traditional servo amplifiers as shown in Table 1.

Fig.1 Configuration of the control unit

2.2 Features of the control power supply and power unit

The control power supply of the "PY" servo amplifier incorporates a switching power supply transformer consisting of a thin-film print coil, instead of a normal winding transformer, which results in the use of fewer parts because of highly stable output voltage and a compact control power supply.

Similarly, the use of a switching power device consisting of integrated peripherals for driving the transformer as well has helped reduce the control power supply.

Furthermore, every one of the "PY" servo amplifier series employs an intelligent power module (IPM). This has reduced the number of peripherals and increased reliability.

Fig.2 "PY2" servo amplifier

Table 1 Comparison of the "PY" series and older servo amplifier models in terms of performance and functions

	Specifications and functions		PU	PV	PZ	PY
Basic specifications	Voltage system		AC100/ 200V	AC200V	AC200V	AC200V (100VAC is possible for PY2)
	Number of power phases		1 φ (3 φ for 50A)	1 φ	3 φ	3 φ /1 φ
	Main power/ control power		Separate	Separate	Separate	Separate
	Amplifier output capacity		15/30/50A	15/30A	15/30/50/100A 150/300 /600/900A	15/30/50/100A 150/300A
	Applicable motor capacity		30 ～ 1000W	30 ～ 1000W	30 ～ 30000W	30 ～ 15000W
	Control mode		Position/speed control	Position/speed /torque control	Position/speed /torque control	Position/speed /torque control
	Feedback	Incremental type	2000 × 4P/R (parallel)	2000 × 4P/R (parallel) $^{-1}$	2000 × 4P/R (parallel) $^{-1}$	2000 × 4P/R (parallel) $^{-1}$
		Absolute type	8192P/R (serial)	×	2048P/R (serial) $^{-2}$	2048P/R (serial) $^{-2}$
	Operating conditions	Operating temperature	0 ～ 55 °C	0 ～ 55 °C	0 ～ 55 °C	0 ～ 55 °C
		Operating humidity	90% maximum (non-condensing)	90% maximum (non-condensing)	90% maximum (non-condensing)	90% maximum (non-condensing)
		Vibration resistance	4.9m/S ^{2}	4.9m/S ^{2}	4.9m/S ^{2}	4.9m/S ^{2}
		Impact resistance	19.6m/S ^{2}	19.6m/S ^{2}	19.6m/S ^{2}	19.6m/S ^{2}
	Structure		Built-in book-type power supply	Built-in book-type power supply	Built-in tray type power supply	Built-in tray type power supply
	Method of installation		Front/rear (rear only for 50A)	Rear	Front/rear	Front/rear
Perform-ance	Frequency characteristics ($J_L = J_M$)		50Hz or more	100Hz or more	100Hz or more	400Hz
	Maximum command pulse frequency		600kpulse/s	600kpulse/s	500kpulse/s	2Mpulse/s
Built-in functions	Regeneration		Internal	Internal	Internal	Internal
	Dynamic brakes		×	○	○	○
	Encoder dividing output		○	○	○	○
	Speed acceleration/ deceleration		○	○	○	○
	Jogging		○	○	○	○
	Electronic gear		○	○	○	○
	Internal speed command		×	○	×	○

	Control mode switchover	x	x	x	Position and speed/position; torque/speed and torque
	Auto-tuning	◇	◇	◇	◇
	Programmable filter	◇ (LPF)	◇ (notch filter + LPF)	◇ (notch filter + LPF)	◇ (Two-stage notch filter + LPF)
	Full-closed loop capability	x	x	x	◇ (Optional)
	PC graphic display capability	x	x	x	◇
	Parameter change	Operator	Operator	Operator	Operator
	Communication ability with PC	◇	◇	◇	◇
Options	Connector type	Accessory	Accessory	Accessory	Accessory (Optional for PY2)
	Remote operator	Optional	Optional	Optional	Optional
	Relay cable	◇	◇	x	x
	Regenerative unit (resistor)	◇	◇	◇	◇ (PY2 with an external regenerative resistor)
	Line noise filter	Recommendable model available	Recommendable model available	Recommendable model available	Recommendable model available
	PC interface	DOS	Windows 95	DOS	Windows 95
Other	Safety standards	x	CE・UL	x	CE・UL (Authorization scheduled to be achieved for PY2)
Other			*1:The appropriate one can be chosen from among 2000 to 4096 x 4P/R.	*1:The appropriate one can be chosen from among 512 to 8192 x 4P/R. *2:The appropriate one can be chosen from among 8192 and 32768 P/R.	*1:Conforms to 500 to 65535 x 4P/R. *2:The appropriate one can be chosen from among 2048 to 2097152 P/R.

2.3 Functions

For "PY" servo amplifiers, the authors combined a "PZ" servo amplifier with market-required functions and additional features listed below.

(1)Control mode switchover: While operation, the user can change position, speed, and torque controls.

(2)Full-closed loop capability (optional): The amplifier can contain an external incremental encoder processing circuit to perform positioning in a full-closed manner.

(3)Incremental pulse generation: Even when a sensor with only an absolute output (serial output) is used – such as Sanyo Denki's ABS-E or ABS-RII – the amplifier can generate incremental pulses to perform positioning on the customer controller without a special receiving circuit.

The functions listed below are scheduled to be added one by one.

(4)Observer: This function estimates turbulence applied to the equipment and servo system on the basis of current and speed, thus inhibiting the turbulence.

(5)Real-time auto-tuning: When the load inertia changes while operation, such as in the case of a robot, this function automatically sets the parameters in the servo amplifier according to those changes.

(6)Auto notch filter: This function automatically makes settings in the amplifier for

the frequency of the notch filter, which the user used to set with a remote operator.

3. Features of the AC servo amplifier "PY2"

The following is a summary of the features of the "PY2" servo amplifier, designed with the elements of the "PY" servo amplifier as a servo amplifiers designed to drive motors 30W to 1.5kW.

(1)Simplified input power supply: Taking account of the MCCB which is always installed at input position of servo amplifier unit, the "PY2" omitted fuses in main path, instead of others having fuses. As optimization of printed circuit board layout and arrangement, it was able to remove common mode capacitor which is usually contained in conventional models.

(2)Simplified control power supply: The control power supply was reduced in size by reducing the number of circuit components because of the higher withstand voltage of the components and by removing the need for a ± 15V power supply due to the ingenious circuit design.

(3)Review of the structure unit: A power connector has been introduced to accommodate a compact die-cast radiator fin to reduce costs.

The implementation of these features resulted in a cut in volume by about 50%, which used to be considered difficult (Table 2).

Table 2 Comparison of PY with earlier servo amplifier models in terms of volume

	15A	30A	50A
" PZ " series	205 x 235 x 50 (mm)	205 x 235 x 50 (mm)	205 x 235 x 75 (mm)
	2408.8cm ^{3}	2408.8cm ^{3}	(Note) 4690.5cm ^{3}
" PY " series " PY0 " type	205 x 235 x 50 (mm)	205 x 235 x 50 (mm)	205 x 235 x 75 (mm)
	2408.8cm ^{3}	2408.8cm ^{3}	(Note) 4690.5cm ^{3}
" PY " series " PY2 " type	168 x 130 x 50 (mm)	168 x 130 x 70 (mm)	168 x 130 x 100 (mm)
	1092.0cm ^{3}	1528.8cm ^{3}	2184.0cm ^{3}
Size reduction rate	45.3%	63.5%	46.6%

Note: Includes the volume of the cooling fin for ducting at the rear of the unit. Other models are designed so as to radiate heat from the side.

4. Conclusion

This paper has so far presented the features of the "PY" servo amplifier series, which is the core of Sanyo Denki's AC servo amplifier line-up.

The authors are confident that the "PY" servo amplifier series is good enough to meet the requirements for the fields of semiconductor-making units and electrically driven hydraulic units, along with machines for general industries, which are expected to see growing markets.

To remain competitive in the servo amplifiers market, where competition is expected

to grow more and more cut-throat, the authors are determined to develop further the technologies that they have cultivated through the development of "PY" servo amplifiers, while also aiming to develop applications capable of meeting a wide range of interface requirements.

Izumi Yui
Joined company in 1986
Servo Systems Division, 2nd Design Dept.
Worked on development and design of servo amplifiers

Hidenao Shoda
Joined company in 1990
Servo Systems Division, 2nd Design Dept.
Worked on development and design of servo amplifiers

Tsuyoshi Kobayashi
Joined company in 1991
Servo Systems Division, 2nd Design Dept.
Worked on development and design of servo amplifiers

Hiroyuki Kitazawa
Joined company in 1994
Servo Systems Division, 2nd Design Dept.
Worked on development of
uninterruptible power supplies,
then on development and design of servo amplifiers

Yoshihiko Oouchi
Joined company in 1984
Servo Systems Division, 2nd Design Dept.
Worked on development and design of servo amplifiers

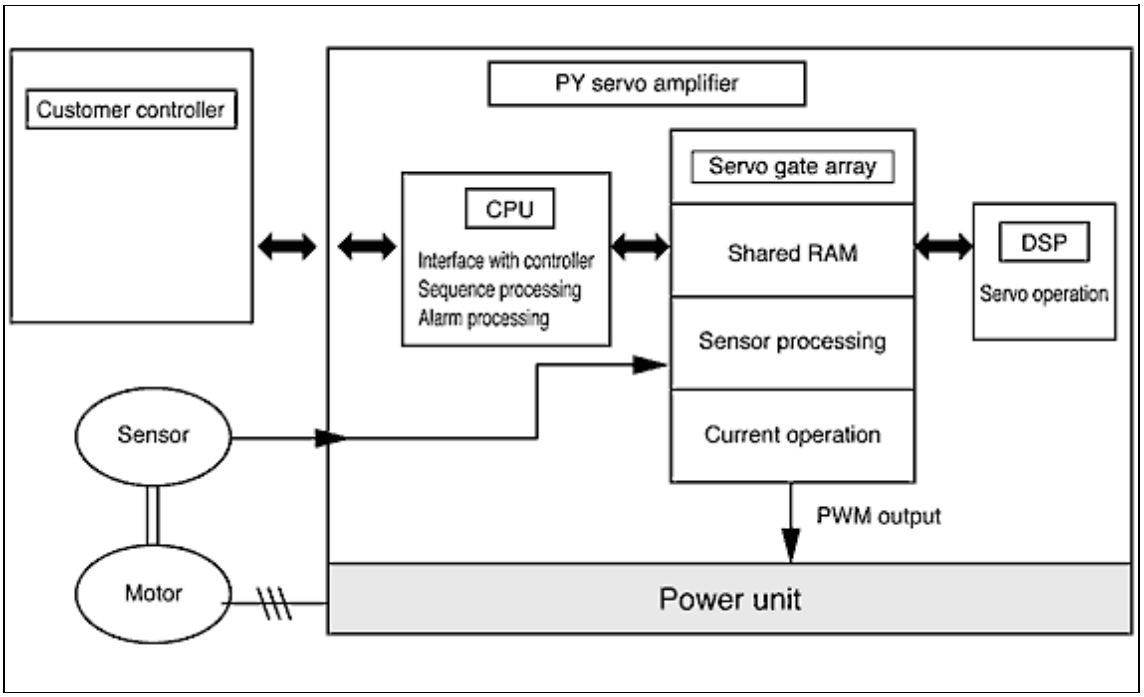

fig.1 Configuration of the control unit

fig.2 ″PY2″servo amplifier