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Feature

Servo Amplifier Supporting SERCOS

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1. Introduction

Up until the early 1980s, servo amplifiers were controlled by analog circuits that have a fast response. Analog inputs have thus become the global standard for inputting commands to the servo amplifier.
Following the introduction of low-price DSP (Digital Signal Processor) that are as fast as analog circuits in the late 1980s, the use of DSP in servo amplifiers has increased. Servo amplifiers have been thus digital/software systemized rapidly.
Despite these advances, the input interface between the NC equipment and servo amplifier has remained analog in many cases. Although advanced digital NC equipment and servo amplifiers were used, NCs D/A converted their output command and servo amplifiers received their input command after A/D converted them. These conversions were unnecessary.
We, Sanyo Denki, have also manufactured analog input models as our standard. On the other hand, we have developed servo amplifiers for digital networks and produced them. But they have not grown into standard models.
To solve this situation, we have developed a servo amplifier that supports the SERCOS interface as a part of the shift toward an open architecture in factory automation. We report here on the features of SERCOS and "PZ-W" series servo amplifier that supports the SERCOS interface.

2. SERCOS

SERCOS is the abbreviation of SErial Realtime COmmunication System that specifies the digital interface between NC control equipment (controller) and servo amplifier; it was standardized by the German VDW (German Machine Tool Builders Association) and ZEVI (German Electrical and Electronic Manufacturer's Association). SERCOS has the following main features:
(1) An optical fiber loop connection is used to connect up to 254 slave units (normally servo amplifiers, I/O units, etc.) and to 1 master unit (normally an FA personal computer for NC control equipment).
(2) A multi-vendor environment is realized at the hardware level by using common hardware (SMA connector type optical module).
(3) The respective commands are numbered, correspondingly to IDN. Because operation of the servo amplifier corresponding to IDN is standardized, a multi-vendor environment at the command level is also realized.
(4) A multiple level command interface such as position commands, speed commands and torque commands, is realized.
(5) The master unit can transfer both the command value and the feedback value while synchronizing all the servo amplifiers that are placed under communication control, using cyclic data. (For example, synchronization of the position control task

of the NC control equipment with the speed control of the SERCOS amplifier.)
(6) Because the SERCOS interface can obtain information on operations inside the servo amplifier, cause of alarm, etc., an intelligent network system can be constructed.
(7) The SERCOS communication speed can be selected from 2 Mbps or 4 Mbps. (10 Mbps communication is being evaluated by the SERCOS Association.)
(8) As the cyclic rate of communication, 62.5μs, 125μs, 250μs, 500μs, 1 ms, or an integer multiple of 1 ms can be selected.
SERCOS was adopted and made public by the International Electro-technical Commission IEC 1491 (61491) in 1995.

3. Background of Product Development

We have stated an open architecture for factory automation in servo control field and has been developing a network servo amplifier. As a part of this project, we have developed "PZ-W" servo amplifier series that supports SERCOS and a SERCOS interface board, "SSF104001", for installation in NC equipment, and we are now developing a product using the advanced control language AML using SERCOS (refer to an application example described later in this issue).
These form new product range of our "PZ" servo amplifiers that add value with the SERCOS interface while inheriting the characteristics of "PZ" series.

4. "PZ-W" Series Servo Amplifier

4.1 Product Outline

"PZ-W" series servo amplifiers are available in five capacities of 15 A to 150 A in 6 models. "PZ-W" series product lineup is shown in Fig. 4.1.
Among the product range, either the wire-saving incremental sensor or the ABS-E (absolute encoder) sensor can be switched by a software parameter. However, the hardware parameter is preset to the ABS-RⅡ (absolute resolver) sensor at shipment from the factory, and cannot be changed after shipping.
"PZ-W" series is configured by adding a sensor connector, remote operator connector, I/O connector and serial communication optical module to the power supply terminal board of "PZ" series servo amplifier.
All models are the same size as "PZ" standard amplifier. The outside view of the PZ0A015W is shown in Fig. 4.2.

4.2 Outline of Functions

4.2.1 SERCOS Communication Function

The communication specifications conform to IEC1491.
However, the serial communication cycle (SERCOS cycle time) and the command refresh cycle (NC cycle time) are set as follows.

SERCOS cycle time
1 to 32 ms (can be set in 1-ms steps)
NC cycle time
Can be set in integer multiples of the SERCOS cycle time.

4.2.2 Supported Telegram Types

The format of the SERCOS cyclic data transfer is specified according as telegram type. "PZ-W" series can support the telegram type shown in Fig. 4.3.
Telegram type 7 uses a cyclic data format that is unique to "PZ-W" series.

4.2.3 Supported Commands

The SERCOS commands are identified by IDN. IDN includes two types of function: one is the functions that are specified by the IDN specifications, and the other is the functions that can be uniquely specified by each manufacturer. Products that support SERCOS should indicate the supported IDN and also the functions that are uniquely specified by the manufacturer.
"PZ-W" series servo amplifier not only supports the fundamental IDN specifications that are required for servo control but also specifies some maker unique IDNs for various parameter setting functions.
Fig. 4.4 shows some of the IDNs that are supported by "PZ-W" series.
For a multi-vendor environment, it is desirable to implement all of the servo controls only using the specified ISNs. However, because "PZ" series servo amplifier has functions that are not standardized yet, these unique functions are specified as maker-unique IDNs in "PZ-W" series servo amplifier. These maker-unique IDN functions allow maker unique functions to be added without sacrificing the multi-vendor environment by enabling these functions to be used from a remote operator that can be attached to the servo amplifier as an option.

4.2.4 I/O Function

"PZ-W" series amplifier is equipped with an I/O that has the 6 input points and 2 output points. The contents of these inputs and outputs can be changed by means of parameters, hence these input and output points can be used not only as input/output ports of specific functions but also as general-purpose input/output ports.
The input/output functions can be selected by the serial communication and also from the remote operator.
Fig. 4.5 lists the input functions, and Fig. 4.6 lists the output functions.

5. Interface Board "SSF104001"

5.1 Product Outline

In order to drive "PZ-W" series servo amplifier from NC equipment, the NC equipment must issue command output conforming to the SERCOS interface. We have released "SSF104001" interface board that is installed in the NC board to establish the required interface.
Fig. 5.1 shows the outside appearance of "SSF104001".

5.2 Outline of Functions

Fig. 5.2 outlines the function specifications.

6. SERCOS Certification

Verification of whether the functions satisfy the SERCOS interface requirements is done by the Interests Group SERCOS interface e. V. (IGS). We obtained SERCOS certification for the prototype of "PZ-W" series during their development.

Fig.6.1 Certificate

7. Conclusion

We outlined "PZ-W" series servo amplifier supporting SERCOS interface and "SSF104001" interface board.
The SERCOS interface is becoming more popular as the interface standard between NC equipment and servo amplifiers. Sanyo Denki has developed the PC-based controller "S-MAC" using SERCOS as a part of a total factory automation solution. (Refer to Technical Report No. 4 for details of the development concept.)
We sincerely hope that this product will contribute to our key goal of an open architecture in factory automation.
Finally, we would like to thank all those who helped develop this product for their cooperation and advice.

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Fig.4.1 "PZ-W" series product range

Servo amplifier	Servo motor	Sensor
PZ0A015W	P1 series (300W) P3 series (30W to 200W) P5 series (30W to 300W)	Wire-saving incremental ABS-E ABS-RⅡ
PZ0A030WA	P1 series (500W to 1000W) P2 series (1000W) P3 series (400W to 750W) P5 series (400W to 1000W) P6 series (500W) P8 series (750W to 300W)	Wire-saving incremental ABS-E ABS-RⅡ
PZ0A050W PZ1A050W	P1 series (1000W to 2000W) P2 series (1000W to 2000W) P5 series (750W to 1000W) P6 series (1000W to 1500W) P8 series (2500W)	Wire-saving incremental ABS-E ABS-RⅡ
PZ0A100W	P1 series (2000W) P2 series (2000W to 4000W) P6 series (2000W) P8 series (2500W)	Wire-saving incremental ABS-E ABS-RⅡ
PZ0A150W	P1 series (3500W to 5500W) P2 series (4000W to 5000W) P6 series (3000W to 7000W) P8 series (3500W to 4500W)	Wire-saving incremental ABS-E ABS-RⅡ

Fig4.2 Outside view of PZ0A15W

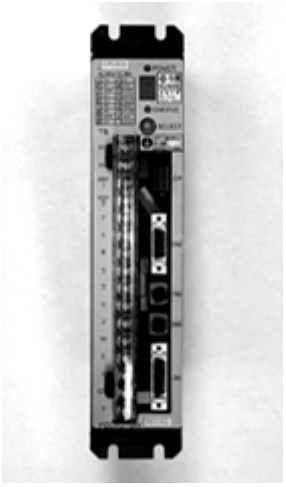

Fig.4.3 List of telegram type

No.	Command	Feedback
1	Torque command	None
2	Speed command	Speed
3	Speed command	Position
4	Position command	Position
5	Speed command or position command (Switched by ID)	Speed, position
6	Speed command	None
7	Customization (Speed command, position command or torque command)	Speed, position (I/O can be added)

Fig.4.4 Example of IDNs

IDN	Contents
1	NC cycle time
2	SERCOS cycle time
3	Shortest time before starting AT transmission
4	Transition time of select transmission or reception
5	Minimum feedback acquisition time
11	Class 1 diagnosis (Alarm)
12	Class 2 diagnosis (Warning)
13	Class 3 diagnosis (Status)
14	Interface status
36	Speed command value
40	Speed feedback value
47	Position command value
51	Position feedback value 1
55	Polarity parameter of position
57	Imposition width
80	Torque command value
82	Torque limit value in positive direction
83	Torque limit value in negative direction
84	Torque feedback value
99	Reset of class 1 diagnosis (Alarm clear)
100	Speed loop proportional gain
101	Speed loop integration time constant
104	Position loop KV coefficient
116	Rotary resolution of motor feedback
146	Home return procedure command by NC
159	Error limit value of excessive position error
189	Position error
32768	Position loop feed forward gain
32769	Current command BEF
32770	Feed forward LPF
32771	Speed command LPF
32772	Current command LPF
32784	User I/F function select (UIF)
32785	Select switch (Function 1)
32786	Select switch (Function 2)

Fig.4.5 List of input function

Input port name	Function
IN (1)	Over-travel input, general-purpose input
IN (2)	Over-travel input, general-purpose input
IN (3)	Reserved, general-purpose input
IN (4)	Reserved, general-purpose input
IN (5)	Encoder clear (absolute sensor), general-purpose input
IN (6)	Reserves
IN (7)	HOME input, general-purpose input

Fig.4.6 List of output function

Output port name	Function
OUT (1)	Hold brake control timing output, general-purpose output
OUT (2)	General-purpose output

Fig.5.1 Outside view of interface board "SSF104001"

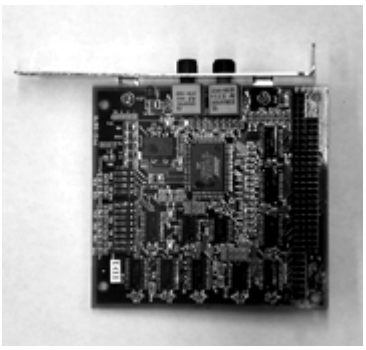

Fig.5.2 Outline of functions

Communication interface	Conforms to IEC1491
Card size	Conforms to PC/104 specifications (3.6inch×3.8inch)
Power supply specifications	5v±5%
Current consumption	5 V / 400 mA or less
Operating temperature	0 to 55℃
Storage temperature	-20 to 65℃

Fig.6 Certificate

SERCOS interface
Certification Office

Certificate

The Interests Group SERCOS interface e. V. (IGS)
submits to
Sanyo Denki Co. Ltd. in Tokyo
the Certificate No.: Z00014 for the following product:

Product Name	:	AC Servo Amplifier (PZ-SERCOS) PZ0A
Hardware	:	XK-18943
Firmware	:	AZCX1A

This certificate confirms, that the product has successfully passed the test in regard of its conformity to the digital interface SERCOS interface.

The tests have been executed at the test laboratory IAM FuE, Braunschweig, authorized by IGS. Test extent and -results are reported in Test Report No. 11-3/97 of September 17, 1997.

The certificate is submitted on basic of IGS guidelines for testing and certification.

Bonn, October 31, 1997

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