Development of DC Power Input 4-Axes Integrated Driver "SANMOTION Model No. PB"

Ryuichi Yanagisawa Masao Mizuguchi Masao Nagasato Akihiro Matsumoto

1. Introduction

In recent years, a demand has emerged to switch to step-out free systems by leveraging high following ability in relation to position command on devices which adopt open loop control stepping motors in order to improve speed and reliability. Moreover, the market is demanding space-saving and cost reduction. Sanyo Denki already offers the "SANMOTION Model No. PB" series as a step-out free stepping system, however in an attempt to increase following ability, downsize and obtain higher control accuracy, we developed a new pulse train input type 4-axes integrated driver.

This paper provides a profile of the new model and introduces its features.

2. Product Profile

2.1 Appearance and exterior

Figure 1 shows the appearance and Figure 2 shows the external dimensions, of the new model.

Fig. 1: Appearance

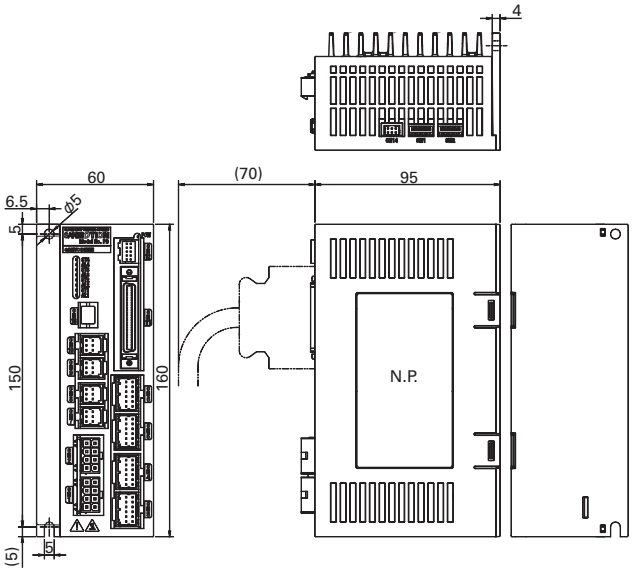


Fig. 2: External dimensions

2.2 Main Specifications

Table 1 shows the main specifications of the new model.

The power input is wide-ranging at 24/48 V DC. A 4000P/R pulse encoder is supported in addition to the conventional 500P/R. The new model also conforms to various overseas standards such as Europe's low voltage, EMC Directive, North America's UL/cUL and Korea's KC mark.

3. Features

3.1 Space-saving, wire-saving

The new model is an integrated driver able to drive up to four motors at a time with a volume around 60% smaller than four single-axis drivers.

Moreover, wire-saving is achieved as it is possible to make those cables that are independent of the number of motors, (e.g. the power cable and I/O signal cable) common. Also, in regards to the power cable, the new model is equipped with two power connectors enabling daisy chain connection of power cables for devices which use multiple drivers in a line.

Table 1: Main specifications

Item	Specifications
Interface	Pulse train
Maximum no. of motors	4
Main circuit power voltage	24/48 V DC
Control circuit power voltage	24 V DC
Operating ambient temperature	0 to 55˚C
Operating ambient humidity	90% RH or less (non-condensing)
Operating altitude	ASL 1000m or less
Dimensions	W60×H150×D95
Mass	0.7 kg
Supported motor size	28 sq., 42 sq., 60 sq.
Applicable encoders	Pulse encoder (A,B,Z) 500×4 P/R, 4000×4 P/R
Holding brake	Non-excitation operation type (power supplied from driver)
Control method	Closed loop control, Deviation-less closed loop control
Operating functions	Automatic home position recovery, Pressing (current control) operation, S-curve operation, Auto micro
Protection function	Overcurrent, overload, driver overheat, voltage monitoring, encoder disconnection, overspeed, position deviation, etc.
LED indicator	Servo On display, Alarm indication
DIP switch	Motor selection
Pulse-train input	Photocoupler input method Max. response frequency: 400 kHz
General-purpose input port	Photocoupler input method No. of inputs: 13
General-purpose output port	Photocoupler output method No. of outputs: 13
PC interface	RS-485 asynchronous half duplex Communication baud rate 57600 bps
Applicable regulations	Low voltage directive, EMC directive, UL/cUL, KC mark

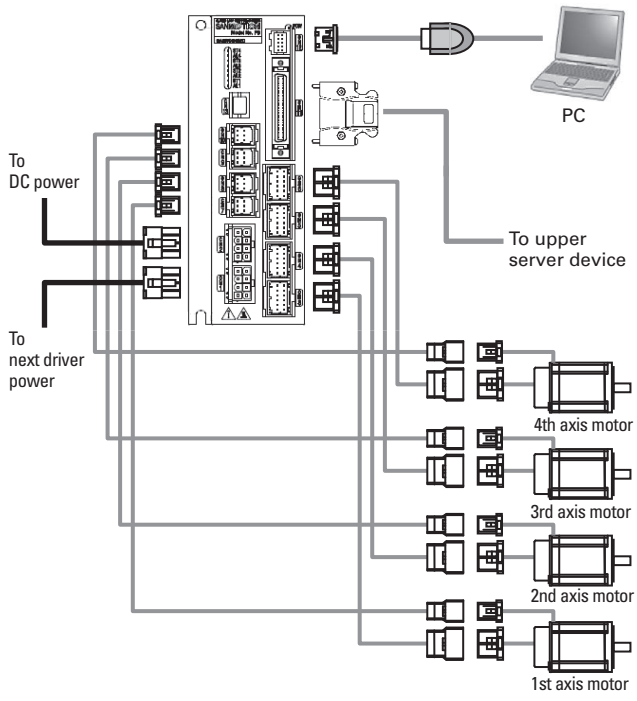


Fig. 3: System configuration diagram

3.2 Improvement of following accuracy in relation to position command

In addition to the conventional motor control method (closed loop control), the new model is equipped with an deviation-less closed loop control which has enhanced following accuracy in relation to position command. This control method, at the same time as being step-out free, achieves an equivalent following accuracy in relation to position command as that of an open loop stepping motor. Figure 4 shows examples of the operational waveforms of closed loop control and deviation-less closed loop control. By using this control method, the position deviation during drive is minimized, and it is possible to easily support applications which demand high following ability in relation to the pulse command, such as the circular interpolation operation on the X-Y table.

Moreover, because deviation-less closed loop control is step-out free, there is no need to secure a torque margin and the maximum torque can be used, therefore making the device faster than an open loop stepping motor.

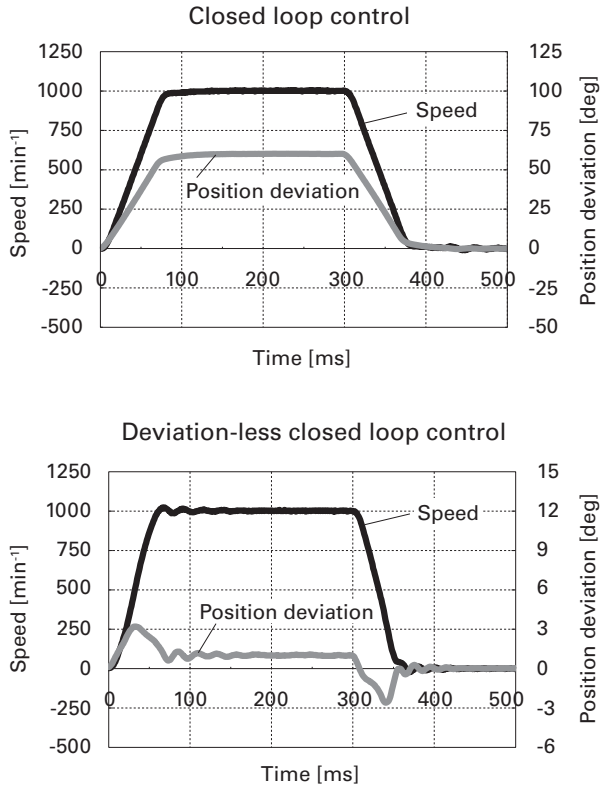


Fig. 4: Examples of operating waveforms created by different control methods

3.3 Improved speed fluctuation during low-speed operation

In the case of the conventional 500P/R pulse encoder, poor resolution meant speed feedback accuracy was low, therefore exacerbating speed fluctuation when the motor was operated at low speed.

The new model supports a 4000P/R pulse encoder and has a higher speed calculation cycle inside the driver, thus improving speed feedback accuracy. This means that even when the motor is operated at low speed, it is possible to supply a stable current and improve speed fluctuation.

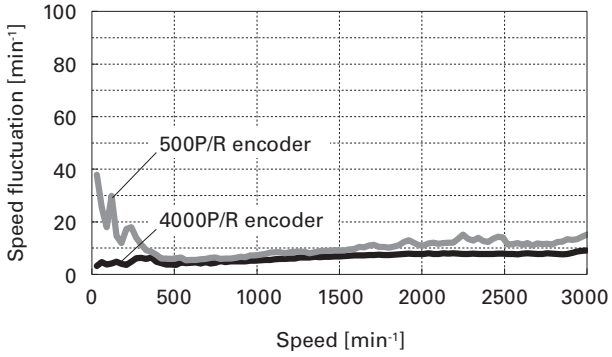


Fig. 5: Comparison of speed fluctuation depending on encoder resolution

3.4 Encoder-based positioning

PB systems use closed loop control during motor operation and stop the motor with open loop control utilizing holding torque of a stepping motor. This prevents minute vibration caused by hunting when the motor is stopped. However, when switching to open loop control in the case of the conventional product, the vertical axis would be pulled downwards due to gravity, causing the motor to stop lower than the target position.

The new model is able to detect displacement when the motor stops using encoder feedback and correct the position, thus achieving high accuracy positioning (accuracy of ±0.045 deg or less).

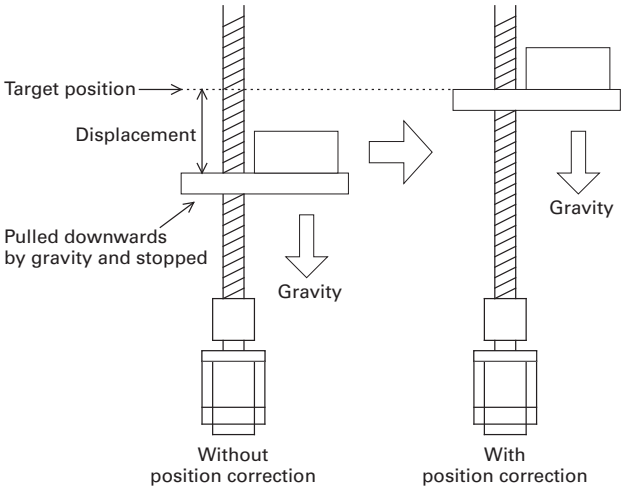


Fig. 6: Comparison of stop position with/without position correction

3.5 Rich command resolution

Users can choose from 16 stages of command resolution, ranging from 200P/R to 51200P/R (refer to Table 2). Moreover, by using an electronic gear function, command resolution can be set with greater flexibility in order to achieve a command resolution easy to intuitively understand with direct drive, etc. (1 pulse 1 μm).

Two types of command resolution can be registered in advance and switched between using an input signal. This means it is possible to select the appropriate command resolution for either high-speed or low-speed operation.

Table 2: Command resolution list

Command resolution	
200 P/R	6400 P/R
400 P/R	10000 P/R
800 P/R	12800 P/R
1000 P/R	20000 P/R
1600 P/R	25000 P/R
2000 P/R	25600 P/R
3200 P/R	50000 P/R
5000 P/R	51200 P/R

3.6 Improved analysis function

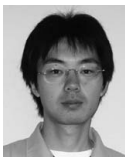
The new model supports the same setup software as our servo amplifier, “SANMOTION Motor Setup Software”, and uses operation trace, trial operation, alarm history, drive record functions, etc. to perform analysis when faults occur. The drive record function in particular is capable of storing up to 10 types of operational data, including motor speed, current position and main circuit power voltage, in non-volatile memory when a fault occurs, therefore making it easy to analyze past phenomena.

4. Conclusion

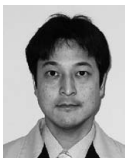
This paper has provided a profile of the pulse train input type 4-axes integrated driver.

By adopting deviation-less closed loop control, reliability has been improved and tact time has been reduced on devices which require high following ability in relation to position command. Moreover, we believe this product can contribute to reducing our customers’ costs, and achieving space-saving and wire-saving due to its 4-axes integrated structure.

Moving forward, Sanyo Denki will exert efforts to enhance our lineup with serial communication types, etc. using the new model as a platform.



Ryuichi Yanagisawa
Joined Sanyo Denki in 1996.
Servo Systems Division, 2nd Design Dept.
Worked on the development and design of stepping drivers.



Masao Mizuguchi
Joined Sanyo Denki in 1998.
Servo Systems Division, 2nd Design Dept.
Worked on the development and design of stepping drivers.

Masao Nagasato
Joined Sanyo Denki in 1988.
Servo Systems Division, 2nd Design Dept.
Worked on the development and design of stepping drivers.

Akihiro Matsumoto
Joined Sanyo Denki in 1990.
Servo Systems Division, 2nd Design Dept.
Worked on the development and design of servo amplifiers.

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