Development of "SANMOTION F2" – An AC Power Input Two-phase Stepping Driver

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1. Introduction

Stepping systems can be used to easily build positioning systems without the need for complicated adjustments, and as such are used in a wide variety of equipment with a focus on transfer axes. Moreover, by leveraging the characteristics of synchronous motors and performing linked operation with other systems during transfer, stepping systems can also easily support applications which require intricate trajectories and are therefore widely used in such applications.

Meanwhile, due to being an open loop system without position feedback, there are risks such as step-out due to torque margin insufficiencies and vibration due to resonance with machinery.

Further still, methods of confirming behavior in comparison to actual operations are lacking and this is a hindrance during the development of equipment and when analyzing phenomenon upon trouble occurrence.

Based on this background, we have developed an AC power input type two-phase stepping driver, the SANMOTION F2 series, which has functions for analysis and enhanced basic performance such as torque characteristics. This document introduces these features.

2. Product Specifications

The new model features two products with differing output capacities which have common functions and external appearance and differ only in regards to the combination motor. Table 1 shows the specification of the new model.

Table 1: Specification of the new model

Product model No.			F2BAW200M100	F2BAW400M100
Output capacity			2 A	4 A
Combination motors (flange size)			□42 mm, □60 mm, □86 mm	□60 mm, □86 mm
Size, mass			160 (H) x 48 (W) x 130 (D) mm, 0.8 kg	
Input power voltage			Single phase 100 to 240 V AC	
Operating ambient temperature			0 to 55˚C	
Operating ambient humidity			90% RH or less (non-condensing)	
Suitable motor option		Encoder	Incremental type 3ch phase difference input method, 4000P/R	
		Brake	Non-excitation actuation type (power supplied from driver)	
Input/output	Command pulse input type		Line receiver input method	
	General input/output		Photocoupler method I/O – 4 points each	
	Encoder input		Line receiver input method	
	Encoder output		Line driver output method	
	PC-I/F		RS485 half-duplex communication	
Functions	Operation mode		Normal mode, analysis mode	
	Command resolution selection		- 1/1 to 1/256 micro step - Electronic gear	
	Monitoring function		Voltage monitoring, overcurrent monitoring, overheating protection	
Conforming regulation, etc.			UL/cUL, low voltage directive, EMC Directive, KC Mark	

3. Features

3.1 Improvement of basic performance

Fig. 1 and Fig. 2 show comparison data between the new model and conventional model in the case of an identical motor.

Through digital current control utilizing the newly developed control ASIC, torque has been improved by as much as 12% compared to the conventional product. In low-speed rotation ranges, approximately 10% less current is consumed at an equivalent or higher torque output, thus reducing loss.

Moreover, by establishing a low-vibration mode, speed fluctuation is reduced by an average of 10% compared with the conventional product primarily during low-speed rotation.

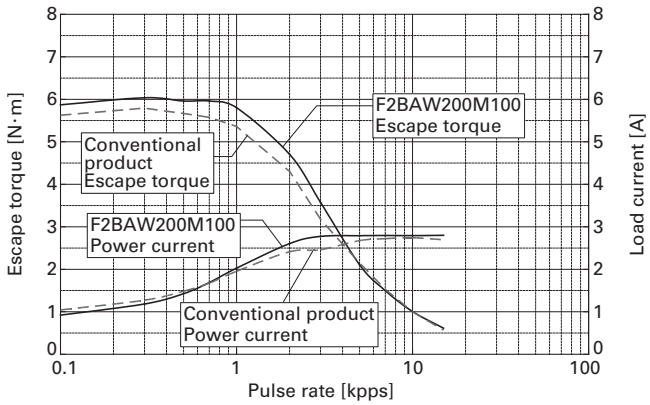

Fig. 1: Comparison of torque and power current with conventional product

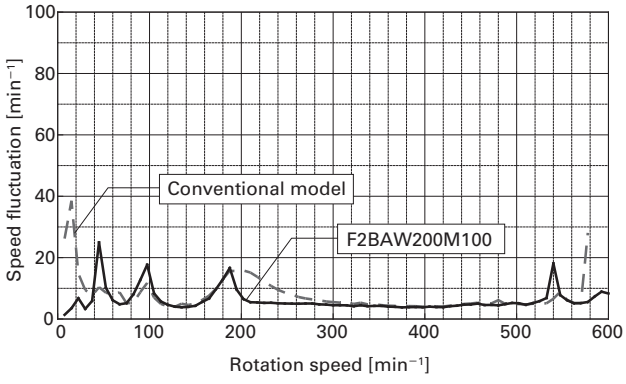

Fig. 2: Comparison of speed fluctuation with conventional product

3.2 Size and weight reduction

Compared with Sanyo Denki's conventional product, the new model has 24% less volume and 38% less mass. To achieve downsizing, functions were integrated on a combined type power module and control ASIC which reduced the number of components to the extent possible. Furthermore, BGA components, etc., were proactively used in order to minimize implementation surface area.

Regarding the product shape, it is the same height as the existing servo amplifier and stepping driver at 160 mm, maintaining a sense of unity when arranged side-by-side. Fig. 3 is an external view of the product. The 2 A and 4 A output capacity models are the same shape.

Fig. 3: External view of the developed stepping system

3.3 Wide range input

A wide AC power input range has been made available, supporting input from 100 V AC to 240 V AC. It is now possible to use one type of stepping driver in many different countries and regions, which means users are now able to integrate parts. To support a wide voltage range, input voltage information is finalized within the stepping driver when power is turned on and this is used for optimization of the voltage monitoring range setting and motor control.

3.4 Optional encoder support

The stepping system is an open loop system and it is common practice not to use an encoder for cost reasons. However, it would be possible to shorten the development timeframe for user equipment, if the optimal drive profile could be confirmed at an early stage by using a motor with an encoder. In consideration of this, Sanyo Denki has equipped the new model with an "analysis mode" which supports an optional encoder. This is in addition to the normal open-loop control. In analysis mode, through connection with the optional encoder, it is possible to monitor actual position and actual speed as a wave profile

on a PC and confirm the ability of operations to follow commands. Moreover, the analysis mode features all of the operations of normal mode, in addition to a step-out monitoring function. In systems which demand high reliability, it is possible to use a motor with an encoder to mass production with analysis mode.

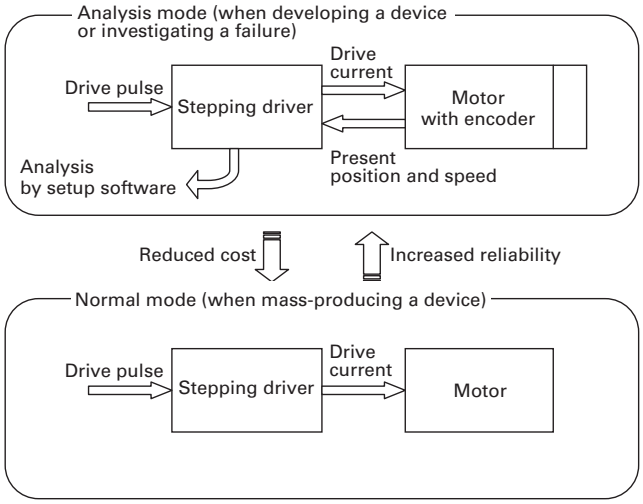

Fig. 4: Differentiation between operation modes

3.5 Brake control

The new model comes standardly equipped with output for a holding brake. Regarding the control timing of brake hold/release, this is performed automatically by the stepping driver to suit the motor excitation status. As such, the user can use the device without needing to be aware of the brake. Moreover, external power is not required as power for the brake is supplied from the stepping driver.

3.6 Conformity with overseas standards

The new model conforms to Europe's low-voltage/EMC directive, North America's UL/cUL and Korea's KC Mark, making it a product which can be rolled out in countries where two-phase stepping motors are widely used.

4. Functions

4.1 Analysis functions

The new model supports the "SANMOTION Motor Setup Software", which is PC software that can be used in common with Sanyo Denki servo amplifiers. By using setup software, it is possible to trace operations, perform trial operation, set parameters for adjustment, confirm alarm information and so on.

The most useful function in reducing the equipment development timeframe is the trial operation function. The trial operation function generates a drive pulse inside the stepping driver and performs operations at the set velocity, acceleration and travel. When this function is being used it is possible to designate the electric current from a PC and confirm torque margin, which is performed when launching a stepping system before development of the host controllers. Moreover, by combining this with the target position confirmation at inching and operation trace functions, it is possible to confirm the amount of overshoot, thus finalizing the optimal drive profile in a short period of time.

The operation trace function is advantageous for confirming behavior of equipment during the development stage or when trouble occurs. On the conventional product, it was only possible to confirm the input status of the command pulse through LED illumination or changes in the electric current through winding. On the new model, by displaying position and speed in a wave profile with the operation trace function, it is possible to view changes on a timeline and drastically improve the efficiency of analysis. Table 2 is a list of the parameters which can be displayed as wave profiles.

Setup software operations are identical to when a servo amplifier is connected, therefore if the person in charge is familiar with the operations of Sanyo Denki's servo amplifier, they will be able to use this software with ease.

Table 2: Operation trace support parameters

Operation mode	Information able to be displayed as wave profiles
Normal mode	Command position, command velocity, current command, I/O signal status
Analysis mode	Command position, current position, command velocity, current velocity, positional error, current command, I/O signal status

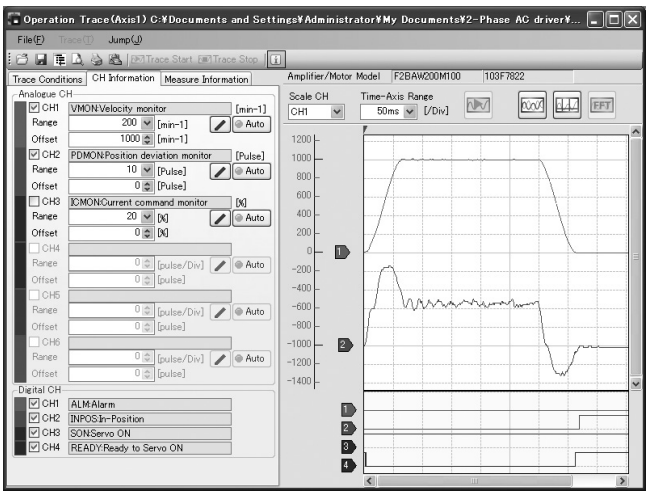

Fig. 5: Example of an operation trace screen

4.2 Command resolution setting with a high degree of freedom

Micro step resolution can be set to a maximum of 1/256. Up to two setting values can be registered in advance and switched over as required using the input signal. This function makes it possible to either perform high-speed rough positioning or fine positioning around the target area, depending on requirements, therefore reducing the burden of high-speed pulse oscillation on host controllers.

Moreover, internal parameters make it possible to switch to a resolution compatible with a 5-phase stepping motor. Setting changes can be performed either in the setup software or using the digital operator at the front of the device unit. The new model can easily replace a 5-phase stepping motor system which is useful when investigating cost reduction methods.

Moreover, a molecular/denominator 16-bit electronic gear is also equipped, making it possible to perform settings in an intuitive, straight-forward state; for example a command position unit of "1 pulse = 1 μm".

4.3 Digital operator

When adjusting the actual machine, the digital operator is a convenient way of performing direct operations without PC connection or I/O signal operation. For example, if a motor with a brake is being used, there are cases of the brake being released momentarily and workpiece position being finely adjusted manually.

In light of this, the new model has been equipped with a simple digital operator just like Sanyo Denki's PB series, a closed loop stepping system. By operating the buttons on the device's front face, it is possible to manually execute the operations of releasing/holding the holding brake and feeding in the target direction. Button operations can also be used to change the settings of those parameters which may change frequently during adjustment of the actual machine.

Table 3: Digital operator control modes

Modes	Functions
0	Displays driver status
4	Sets current at stop
5	Sets step division number mode
6	2nd resolution setting
7	Holding brake operation
8	Sets jog operation speed
9	Jog operations
A	Displays alarm codes

4.4 I/O signal function

Unlike the conventional product, on the new model it is possible to arbitrarily allocate the general I/O signal type and logic by terminal. This means it is possible to select and use only the necessary function out of the total number of functions, which exceed the actual signal terminal number, thereby improving user convenience. Table 4 and Table 5 list the functions of the general input and output signals.

Table 4: General input terminal function

Name	Functions
STOP	Emergency stop
ALMCLR	Resets alarm
EXT	Switches step angle
ACDDIS	Disengages auto current-down
HOME	Current position pre-set

Table 5: General output terminal functions

Name	Functions
ALM	Monitors alarm
INPOS	Positioning complete signal
SONMON	Monitors drive possible status
ZONE	Within zone range

5. Conclusion

This report has introduced the features of our "SANMOTION F2", an AC power input two-phase stepping driver which has enhanced basic characteristics and significantly improved functions.

The basic characteristics of this product are greatly enhanced compared with the conventional product, contributing to shorter equipment tact time and stable operation. SANMOTION F2 also contributes to higher added-value for the user from an environmental perspective due to having reduced power consumption, reduced shipping costs through weight reduction and downsizing, and being energy-saving.

Functions to alleviate the burden on the user of equipment development include wide-range AC power input and the optional motor functions of automatic control and power supply. Moreover, by utilizing the analysis function featured on this product it is possible to reduce the equipment development timeframe. This will help expand user business chances as it will make it possible to launch high-performance equipment on the market at an earlier stage.

Sanyo Denki aims to further improve basic performance and roll out network products, as well as develop more products which provide higher added-value.

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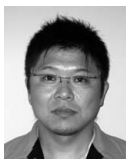

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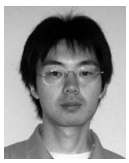

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