Development of the "SANMOTION F" Series Small-size 5-phase Micro-step Driver

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1. Introduction

In 2006, the small-size 5-phase stepping motor driver "FS2D140C00" was developed and produced for mounting on a PCB. It was well received as a driver that is small and could be mounted to a PCB.

Based on this driver, we added micro-step control to develop the "SANMOTION F" Series small-size 5-phase micro-step driver for use as a stepping system to achieve low noise and low vibration for use indoors or in environments where quietness is desired.

This document introduces the features of the small-size 5-phase micro-step driver "SANMOTION F" Series.

2. Product Overview

2.1 Exterior and structure

The developed product is covered in a plastic case and has pins at the bottom for insertion to a PCB. On the top of the product, switches for various settings are laid out. Fig. 1 shows an image of the driver.

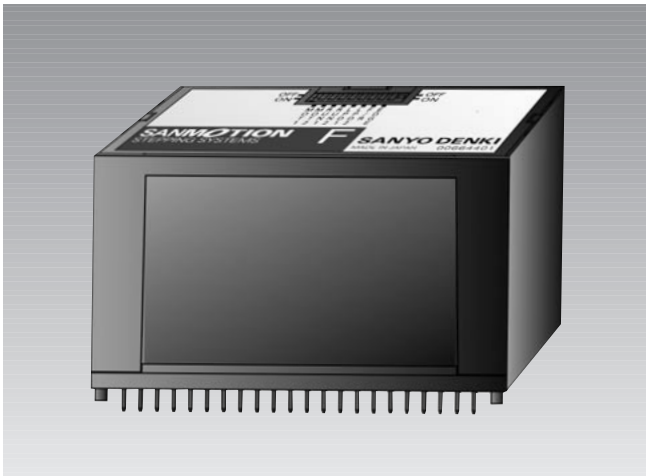

Fig. 1 Image of the driver

2.2 Structure of the driver

The driver consists of three modules: the power block, the current control block, and the driver control block. The power block uses an aluminum substrate to achieve small size and low-loss, and an FET chip is mounted with the bonding. The current control block contains a new current detection circuit for micro-step control. The driver control block includes switches for controlling the motor and for setting functions.

The outer case of the driver is covered in plastic, and it is shaped to prevent any foreign matter from getting inside and to protect internal electronic parts. The switches are placed on the top so that settings and status can be checked easily.

3. Product Specifications and Features

3.1 Specifications

Table 1 shows product specifications and Fig. 2 shows dimensions.

Products can be combined with the 28 mm sq. or 42 mm sq. 5-phase stepping motor "SANMOTION F" Series. After positioning the mounted products on the customer's PCB, it is assumed that a microcomputer will be used as the host controller. The I/O interface is provided with consideration to controllability from the microcomputer so that loading functions and setting functions, current, and resolution can be performed while running the motor.

3.2 Operation current setting function

Setting items for the motor driving current are broken down into categories in order to configure settings according to application or usage conditions. The rated current of the motor can be set between two types of current and the current used during operation can be set to one of four levels (90%, 80%, 70%, or 60% of the rated current).

In a normal trapezoidal drive, the power consumption for the device can be suppressed by operating with rated current while accelerated and operating with current lower than the rated current

during constant speed and while decelerating.

(1) Selection of motor rated current

Either a rated current of 0.35 A/phase or 0.28 A/phase can be selected.

(2) Selection of operation current

Operation current can be selected from four levels: 100%, 80%, 70%, or 60% of rated current.

(3) Selection of low-loss operation current

Low-loss operation current can be selected from four levels in the range of 90% to 60% of the operation current. Operation current and low-loss current can be switched by turning on or off the low-loss operation input signal.

(4) Selection of stopping current

The current used when the motor is stopped can be set to 50% of the operation current 100 ms after the superimposed final command pulse.

3.3 Micro-step control

The stepping motor has a simple and convenient actuator to perform positioning with open loop control, but at low speed, the vibrations from the step driver become larger. Micro-step control is added as a method to reduce the vibrations when operating at low speed. This function incrementally controls and drives the current at each phase for the mechanically acquired step angle of the stepping motor in order to reduce the vibrations at low speed. This product includes a circuit that detects and controls the current command and 5-phase current according to the motor angle-torque characteristic and generates the ideal current in order to reduce the motor vibrations. Compared to HALF step drive, using micro-step control drastically reduces the vibrations when operating at low speed.

Fig. 3 shows the vibration comparison data compared to conventional products.

The number of micro-step divisions can be set to 10 types of divisions from 1/1 to 1/80. When the number of micro-step divisions is set to a value like 1/80, the command pulse frequency becomes higher and the load for the host controller pulse output becomes larger. In order to reduce the load on the host controller, this product has a function that can detect both the falling and rising edge of the pulse. By using this function, the number of pulses output by the host controller can be reduced by half in order to reduce the load from pulse output.

3.4 Low-loss

An FET chip with low ON-resistance has been chosen for the power block to control the motor. Both the FET chip and predriver are positioned on the aluminum substrate. These components that make up the source of heat on the driver are concentrated on the aluminum substrate, and this area is exposed from the resin case on the back of the PCB in order to provide heat release measures. This method contributed an approximately 20% decrease in loss compared to our conventional products.

4. Conclusion

The “SANMOTION F” Series small-size, 5-phase micro-step driver is a product that can fuse with the customers’ PCB and realize low-vibration driving.

This product is the industry’s smallest PCB mounted 5-phase micro-step driver, and it allows the customers’ device to be made even smaller. At the same time, we have also managed to develop a product that reduces the design load for the driver block to the lowest possible value. This is recommended for customers who did not use 5-phase stepping motors due to lack of a convenient driver and physical constraints in terms of space in the customers’ devices.

In the future, we plan to reduce the vibrations and loss even further and expand the applications for 5-phase stepping motors as a system that can be used with ease.

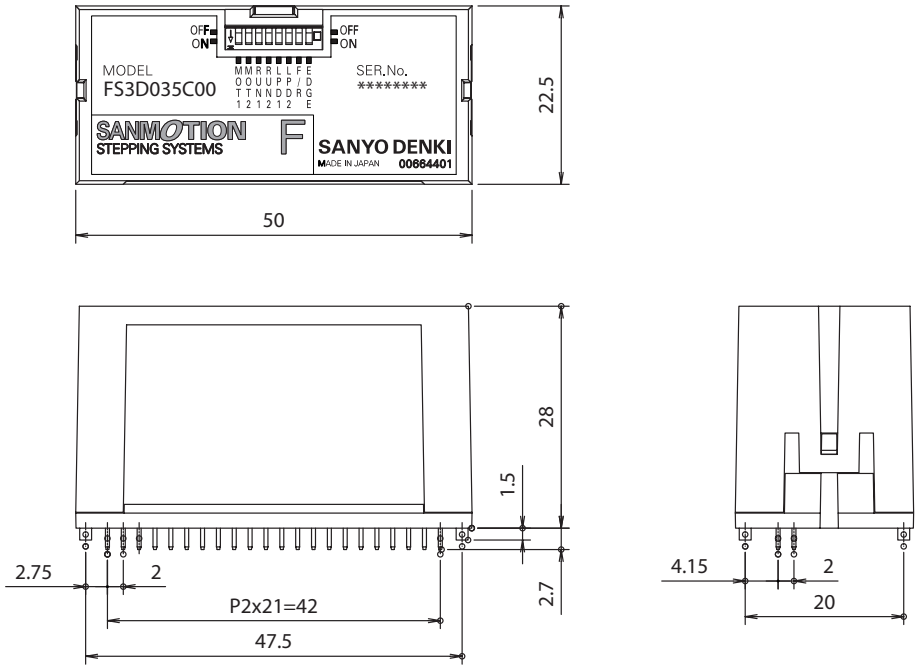

Fig. 2 FS3D035C00 outside view

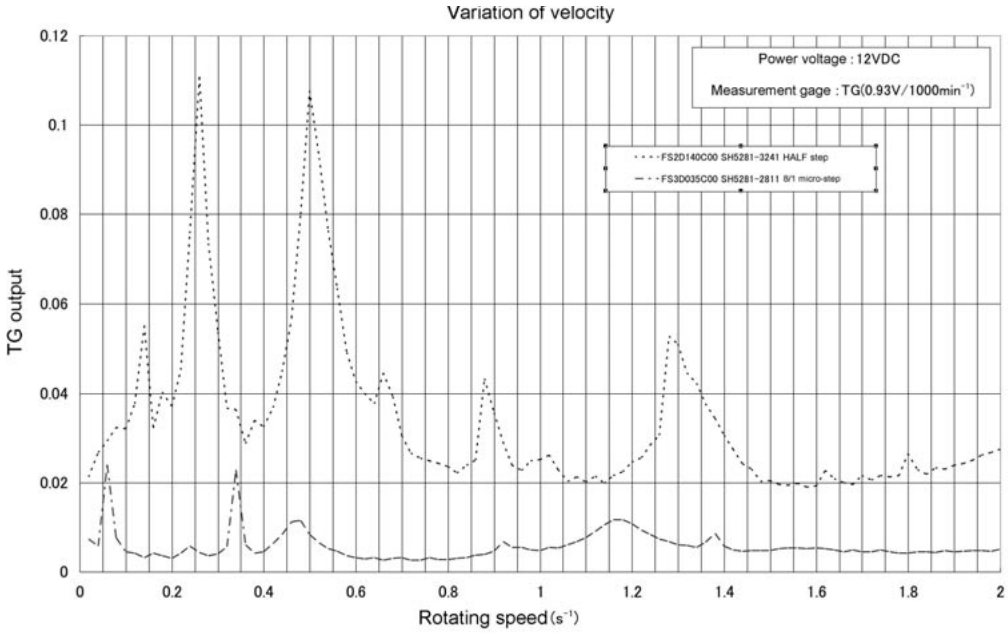

Fig. 3 Vibration comparison

Table 1 Specifications

Basic specifications	Model No.		FS3D035C□□
	Main circuit power		12 VDC ±10%
	Control power		5 VDC ±5%
	Main circuit power current (A)		1
	Control power current (A)		0.1
	Environment	Protection class	Class Ⅲ
		Operating ambient temperature	0 to +50°C
		Storage temperature	-20 to +70°C
		Operating ambient humidity	35 to 85% RH (no condensation)
		Storage humidity	10 to 90% RH (no condensation)
		Vibration	4.9 m/s² Frequency range 10 to 55 Hz, 2 hours in the X, Y, Z direction
	Mass (g)		28
	Soldering specifications		Up to twice at 260°C for max. 10 s (soldering bath) Up to twice at 350°C for max. 3 s (soldering iron)
Functions	Selection functions		Selection of motor, operating current, low-loss operation current, pulse input method, and edge
	Step angle divisions		1, 2, 2.5, 4, 5, 8, 10, 20, 40, 80
	Built-in functions		Automatic current reduction function
Input/output signal	Command pulse input signal		C-MOS input method Input signal voltage "H" level: 4.0 to 5.5 V "L" level: 0 to 0.5 V Max. input frequency 400 kpulse/s
	Power off input signal Low-loss operation input signal Step angle setting input signal		C-MOS input method Input signal voltage "H" level: 4.0 to 5.5 V "L" level: 0 to 0.5 V
	Phase origin monitor output signal Ready output signal Motor selection status output signal Operation current selection status output signal Low-loss operation current selection status output signal Pulse input method selection status output signal Edge selection status output signal		C-MOS output method Output signal voltage "H" level: 4.0 to 5.25 V "L" level: 0 to 0.5 V Output current: ±4 mA

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