Development of "SANMOTION F" Stepping Motor 2-phase 42mm-sq. 0.9°

Masaaki Oohashi　Shigenori Miyairi

1. Introduction

The stepping motor has features that are not found in other motors such as open loop control and high hit rate, and as a result, it is widely used as a control motor in OA equipment, medical instruments, and semiconductor manufacturing equipment. Each year, this type of equipment faces growing demands for higher precision, more compact sizes, and lower costs, and so stepping motors are also being called on to provide higher accuracy, lower vibrations, compact size with high torque, and lower costs.

Previously, applications that required high precision used the 5-phase stepping motor with its small step angle, but the complexity of the drive circuits in the 5-phase stepping motor means that the system cost was high. Therefore, higher accuracy has been called for in 2-phase stepping motors which have simple drive circuits and low system cost.

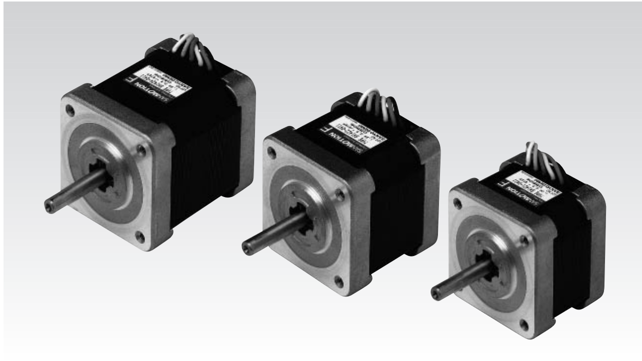


Fig. 1　"SANMOTION F"

This report presents a product overview and features of the 2-phase 42mm sq. 0.9° stepping motor "SANMOTION F", which was newly developed to respond to these needs.

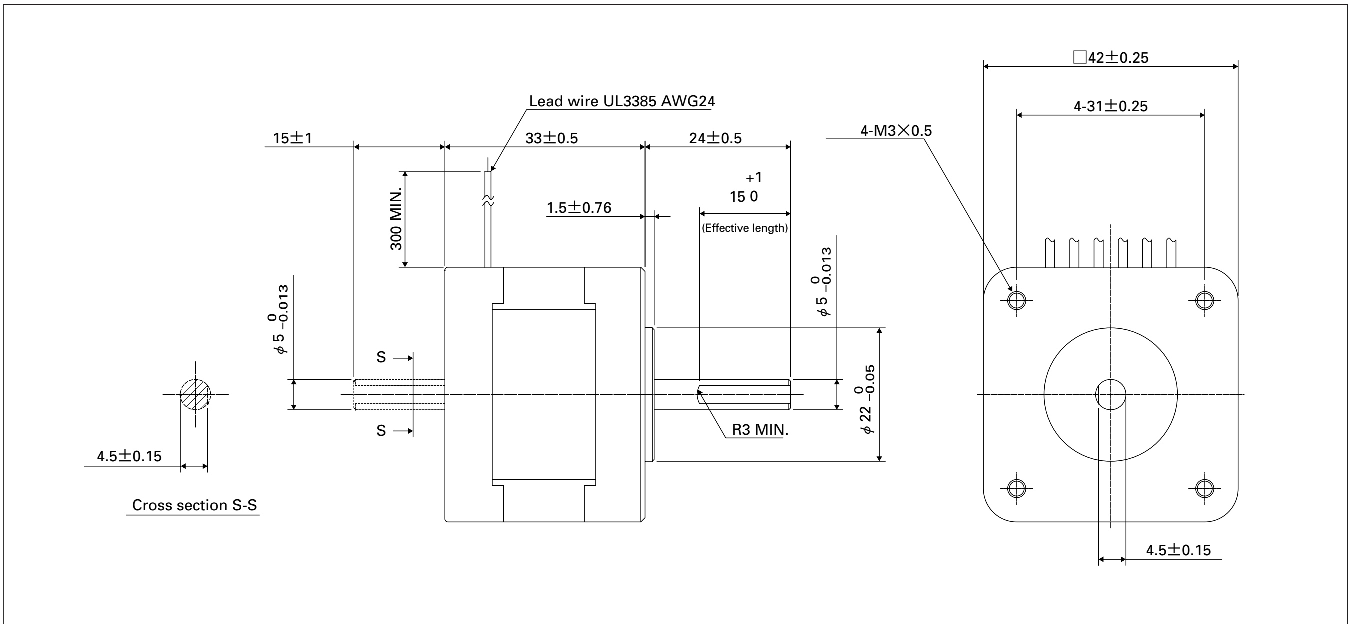


Fig. 2 External dimensions of the 2-phase 42mm Sq. 0.9° stepping motor "SANMOTION F"

Table 1 Specifications of 2-phase 42mm Square 0.9° Stepping Motor SANMOTION F

Model			Holding torque At 2-phase excitation	Rated current	Winding resistance	Rotor inductance	Rotor inertia	Mass
Winding system	Single-ended spindle	Dual-ended spindle	N・m MIN.	A/phase	Ω/phase	mH/phase	×10-4 kg・m²	kg
Unipolar	**SH1421-0441**	**-0411**	0.2	1.2	2.7	3.2		
Bipolar	**SH1421-5041**	**-5011**	0.23	1	3.3	8	0.044	0.24
	SH1421-5241	**-5211**	0.23	2	0.85	2.1		
Unipolar	**SH1422-0441**	**-0411**	0.29	1.2	3.1	5.3		
Bipolar	**SH1422-5041**	**-5011**	0.34	1	4	14	0.066	0.29
	SH1422-5241	**-5211**	0.34	2	1.05	3.6		
Unipolar	**SH1424-0441**	**-0411**	0.39	1.2	3.5	5.3		
Bipolar	**SH1424-5041**	**-5011**	0.48	1	4.7	15	0.089	0.38
	SH1424-5241	**-5211**	0.48	2	1.25	3.75		

2. Product overview

2.1 Motor Dimensions

The external view of the motor is shown in Fig. 1, and the external dimensions of the product are shown in Fig. 2.

2.2 Specifications

Table 1 shows the product specifications.

The typical winding systems are the unipolar type (6 lead wires), which is commonly used in Japan, and the bipolar type (4 lead wires), which is commonly used in Europe and the United States.

In the unipolar type, the drive circuits can be made with a simple design for a low system cost. The bipolar type features a high usage ratio of motor winding for providing a large torque.

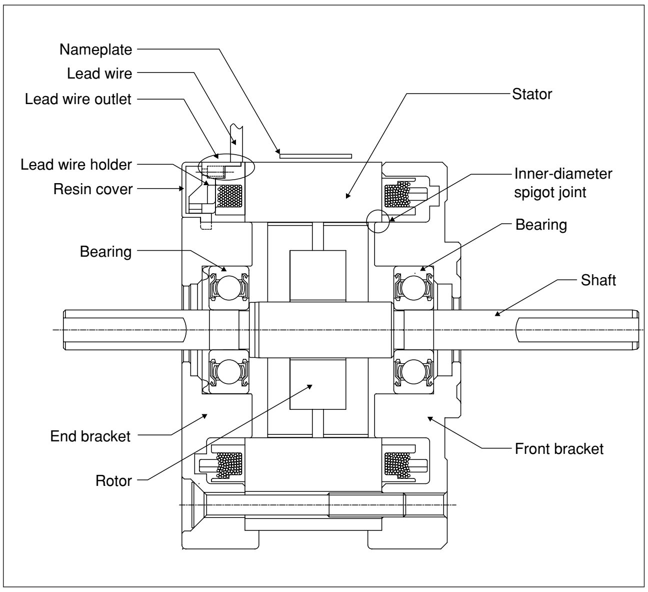


Fig. 3 Motor Structure

3. Features of the product

3.1 High Resolution

More teeth for the rotor and stator were used to enable a high resolution. In this product, the die precision of the rotor and stator were improved, and the number of teeth was doubled from before. This enabled the obtaining of a high resolution at a basic step angle of 0.9° compared to the regular basic step angle of 1.8°.

3.2 Low vibration and low noise

Fig. 3 shows the motor structure. The brackets used an "inner diameter spigot system" where they were assembled based on the stator inner diameter. In this system, the rotor and stator centers have high-level concentricity that enables better rotational balance for lower vibrations and lower noise. The inner diameter spigot system also enabled higher rigidity for the stators for lower vibrations and lower noise.

Fig. 4 shows a vibration comparison of the basic step angle 1.8° stepping motor and the newly-developed basic step angle 0.9° stepping motor. The superiority of the 0.9° stepping motor is evident in nearly all speed ranges.

3.3 High Torque

A high torque design in the stepping motor enables it to move large loads. Also, if the loads are identical, the smaller motor can be selected. The more compact design takes up less space, has lower cost, and also contributes significantly to resource conservation. The primary factor that contributes to the torque characteristics of the stepping motor is the magnetic circuit design of the stator and rotor. This development used new, innovative methods and various types of simulations to develop the optimum magnetic circuit design. As a result, the torque was improved by 1.5 times from the conventional product.

Fig. 5 shows a comparison of the torque characteristics of

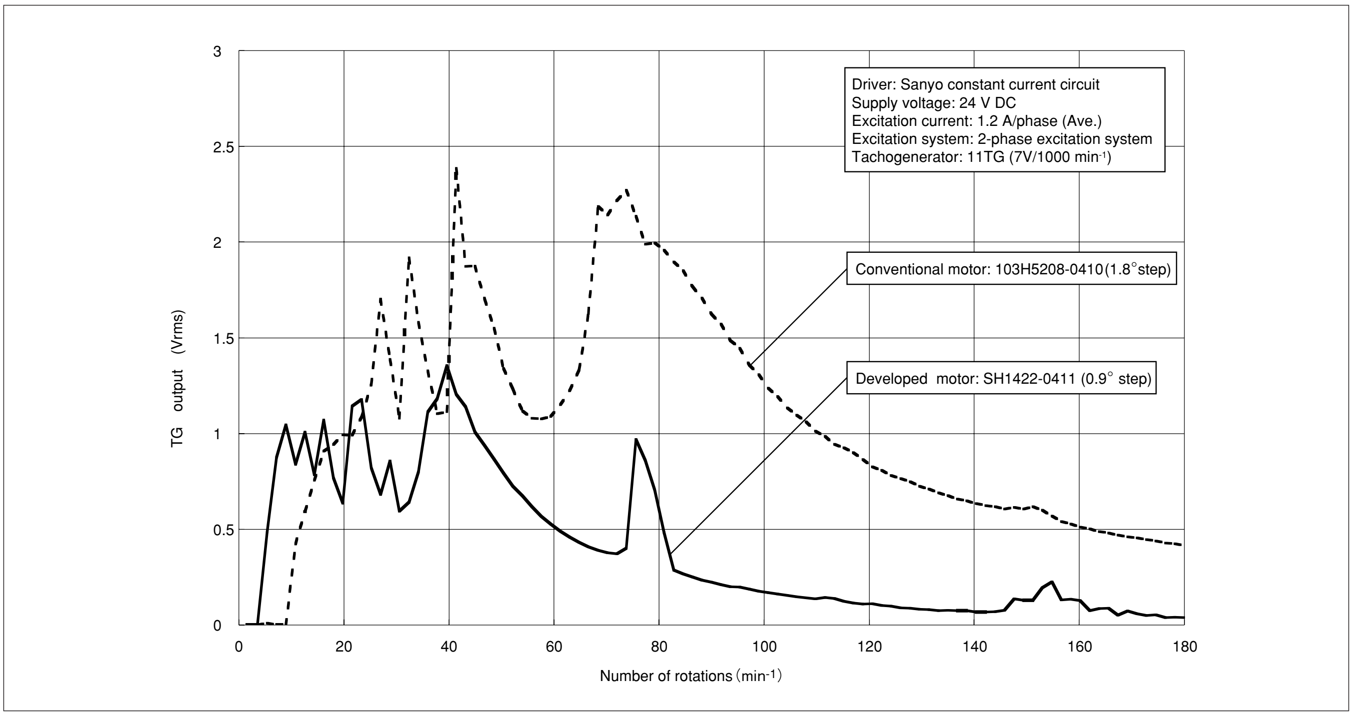


Fig. 4 Comparison of Speed Fluctuations in Basic Step Angle 0.9° and 1.8°

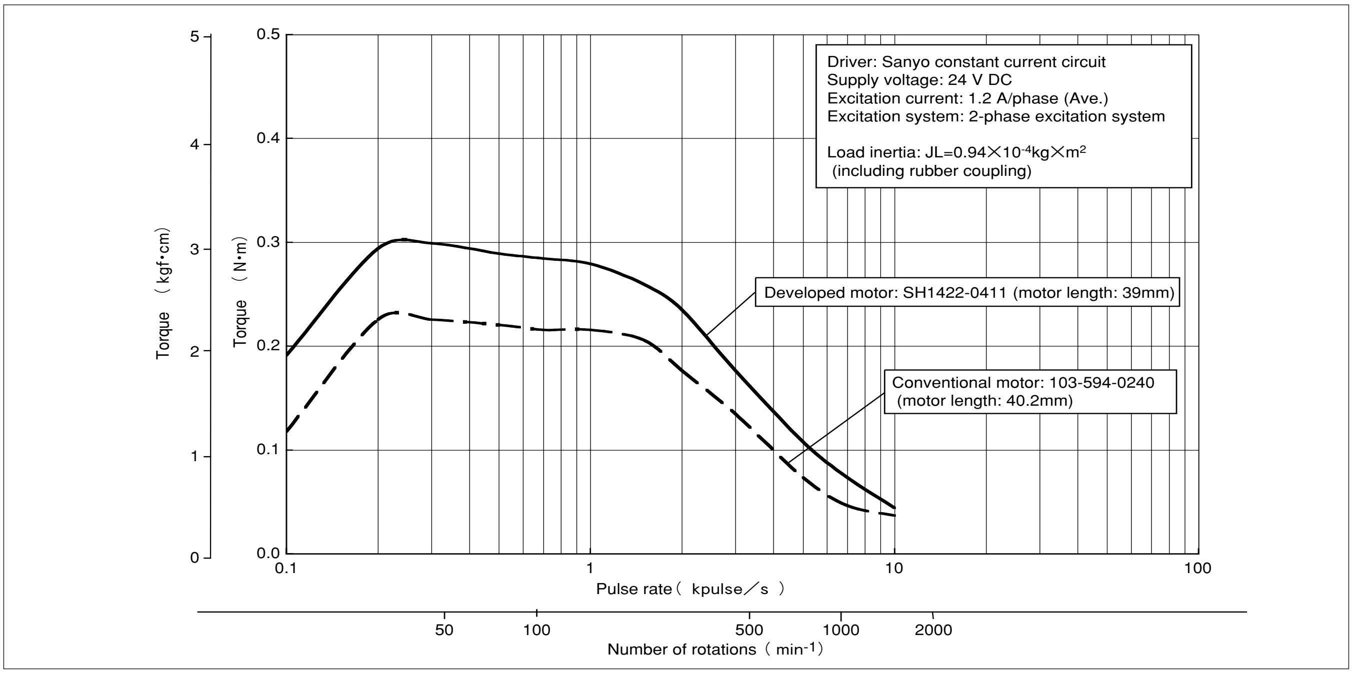


Fig. 5 Comparison of Torque Characteristics

this new 0.9° stepping motor and a conventional 0.9° stepping motor.

3.4 Compact Size for Less Space

Many stepping motors have protrusions where the lead wire outlets extend from the motor square body. The connection is contained within this protrusion because it is difficult to provide space for the connection between the lead wire and motor coil wire inside the motor. However, a smaller device size enables a motor design that takes up less space, and this protrusion of the lead wire outlet can be a hindrance to developing a compact size. This is why a stepping motor without any protrusion for the lead wire outlet is desirable.

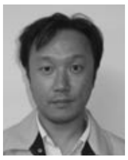
Most conventional stepping motors without protrusions for the lead wire outlet make the connection between the lead wire and motor coil wire inside the stator slot. However, because the stator slot is a space for storing the motor coil, the connecting of the lead wire and motor coil wire in this space naturally limits the length of the motor coil and reduces the motor characteristics (torque and temperature rise).

To resolve this problem, the new "lead wire holder system" was devised and implemented. In the lead wire holder system, the resin-made lead wire holder and end bracket structure are designed so that the connection between the lead wire and motor coil wire can be made in less space. Also, because this system does not use a stator slot, the protrusion of the lead wire outlet can be eliminated without sacrificing motor characteristics for enabling a more compact size that takes up less space.

4. Conclusion

The 2-phase 42mm square 0.9° stepping motor SANMOTION F has a high resolution, compact size, and high torque and can contribute to higher precision, lower costs, and more compact sizes for OA equipment, medical instruments, and semiconductor manufacturing equipment.

We will continue to work to develop motors using other technology for providing even more improved performance in the future.



Masaaki Oohashi
Joined Sanyo Denki in 1982.
Servo System Division, 3rd Design Dept.
Worked on stepping motor development and design

Shigenori Miyairi
Joined Sanyo Denki in 1990.
Servo System Division, 3rd Design Dept.
Worked on stepping motor development and design