2-phase 86mm sq.1.8° Stepping Motor

Ikuo Takeshita Jun Shimizu Kouji Nakatake Akira Koike

1. Introduction

Stepping motors have been used widely as a driving power source for positioning actuators of various devices and for mechanical systems in general industrial machines. They are used for their ease of open loop usage and low system costs. As the speed of an increasing number of devices becomes higher, enhancement of the motor torque has always been in demand. In addition, considerations for the environment such as reduction of hazardous materials, prevention of energy exhaustion and prevention of global warming have become indispensable for products and their sales, together with the torque enhancement. Customers are seeking products with less impact on the environment, and this also applies to stepping motors.

Our company has offered 2-phase 1.8° stepping motors with an outer diameter of ϕ86mm for the markets of industrial sewing machines, stitching machines and other general industrial machines. If we can make a compact stepping motor of a similar configuration with a high motor torque and a minimal environmental impact, the product would satisfy the demands of customers who want faster devices with reduced burden on the environment. For this reason, the 86mm sq. 2-phase stepping motor was developed.

This product is intended to enhance our competence in the 86mm-class stepping motor market, at the same time strengthening our product lineup.

An outline of the 86mm sq. 2-phase stepping motor is given below.

2. Product Outline

2.1 Outer Shape of the Motor

Fig. 1 shows the external appearance of the new motor and Fig. 2 shows the outer shape and dimensions of the product. The total length of the motor is indicated with symbol L used in Fig. 2.

Three types of motor are available, with L = 66mm, 96.5mm and 127mm.

The size and intervals of screws used when customers attach the motor to their devices are the same as conventional models. Consideration have been given to make replacement of the conventional models with the new model easier and to reduce the changes that need to be made with the equipment.

2.2 Motor Configuration

Fig. 3 shows the structure of motor. The flange and end cap are of the aligned inner radius type that is assembled using the inner radius of the stator as the standard. The core has been changed to square from the conventional circular one, and there is no housing. The rotor collar used with motors of L = 96.5mm and 127mm has a special design to reduce its inertia.

Fig. 4 shows the structure of the stator inside the motor. The lead connection plate method has been used for the lead connection just as with conventional products of the same size. However, the lead wires used with the new motor are passed underneath the connection plate to facilitate finishing works after lead connection. Furthermore, the connection plate and the bush in the outlet section of the lead wire

Fig. 1: External Appearance of the Motor

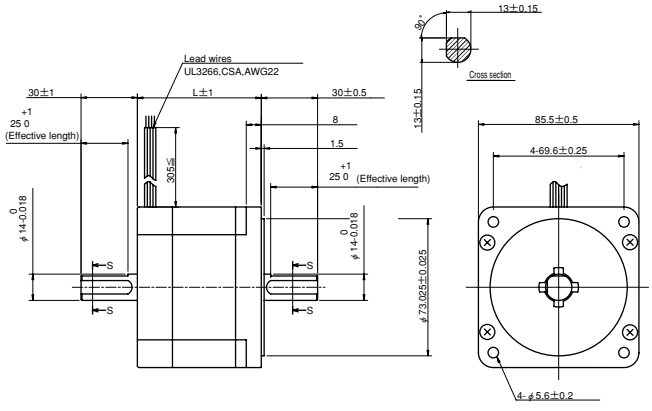

Fig. 2: Outer Shape of the Product

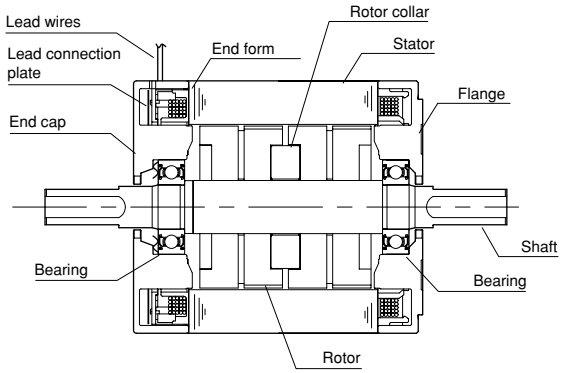

Fig. 3: Structure of the Motor

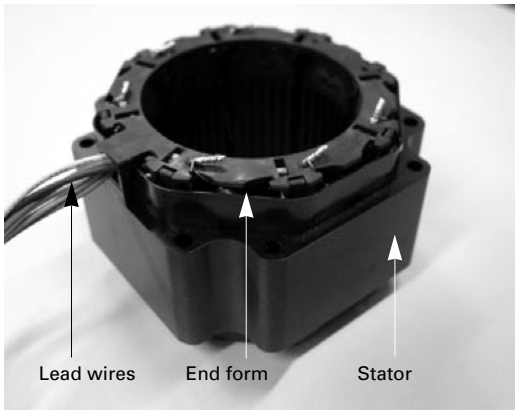

Fig. 4: Inside the Motor

have been integrated in an effort to reduce the number of components.

For the end form, which is made of an insulating material, a heat-resistant material with high resin flowability has been chosen.

As a measure to reduce hazardous materials, lead-free solder and screws plated with trivalent chromium have been chosen to make the product compatible with RoHS. Compatibility with RoHS has recently been in demand. In addition, UL3266 that is a bridging polyethylene has been used for lead wires in order to eliminate PVC.

2.3 Measures to Enhance the Torque

The following considerations were given to enhance the torque.

- As a means of enhancing the torque, the outer diameter of the rotor was revised while minimizing the increase in rotor inertia. A rotor structure that offers rotor inertia close to that of the conventional models was chosen.

- The dimension of each magnetic channel was determined to prevent a lowering of the enhanced torque brought about by revising the rotor and to secure the largest possible area for winding.

The characteristics shown in Table 1 have been obtained as a result of these measures.

Torque enhancement is one of the factors necessary for increasing the speed of various devices used by customers, and lowering of the winding resistance is effective for suppressing power consumption and temperature rise. Fewer changes in rotor inertia would also help customers who are considering replacing our conventional models with the newly developed motor. The advantage is that the change in pulse profile for acceleration and deceleration can be minimized for driving the equipment, while keeping the torque needed for acceleration constant.

3. Product Specifications and Features

3.1 Product Specifications

Table 1 shows the specifications for a standard unipolar lead connection-type motor, which is a component of the new product models developed. The motor is compatible with our driver for unipolar winding. A bipolar lead connection-type motor is also available as standard.

Figs. 5 to 7 show the driving frequency – torque characteristics of the above motors. The characteristics of our conventional model motors are also indicated to show the advantages of the newly developed models.

The 86mm sq. 2-phase stepping motor is the improved version of our conventional ϕ86mm motors, with enhanced torque.

Common driving conditions
Driving circuit: Sanyo Denki's standard driver for unipolar lead connection
Power supply voltage: 100VAC
Winding currency: 2A/phase
Method: 2-phase exciting (full step)

3.2 Compatibility with the Environment

In the course of development, life cycle assessment (LCA) was performed and compared for the conventional models and the newly developed models, as indicated below.

The following two points were selected as the evaluation items.

(i) Effect of preventing energy exhaustion

Comparison of the total amount of energy used during manufacture

Table 1: List of Product Model Nos.

Model		Holding Torque at 2 Phase Exciting	Rated Current	Winding Resistance	Winding Inductance	Rotor Inertia	Mass
Single shaft	**Double shaft**	N-m MIN.	A/Phase	Ω/Phase	mH/Phase	×10-4kg-m2	kg
SH2861-0441	**-0411**	2.5	2	2.3	8	1.48	1.75
SH2861-0941	**-0911**	2.5	4	0.6	2	1.48	1.75
SH2862-0441	**-0411**	4.7	2	3.2	13	3	2.9
SH2862-0941	**-0911**	4.7	4	0.85	3.4	3	2.9
SH2863-0441	**-0411**	6.7	2	4	17	4.5	4
SH2863-0941	**-0911**	6.7	4	0.9	4.2	4.5	4

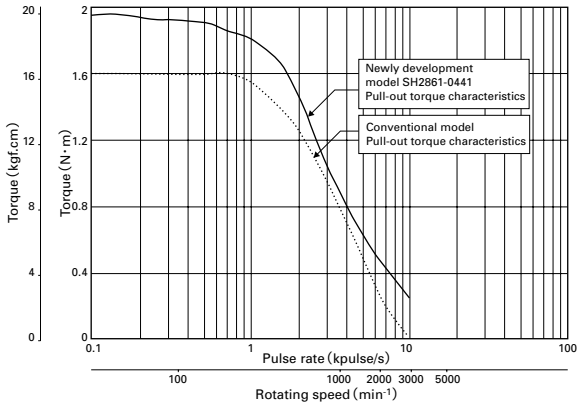

Fig. 5: Comparison of Pulse rate – Torque Characteristics for SH2861-0441/ 0411

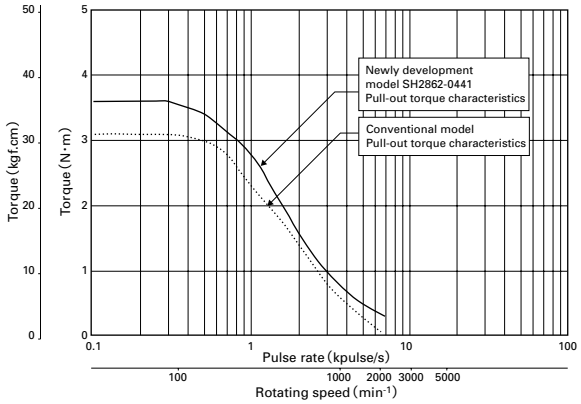

Fig. 6: Comparison of Pulse rate – Torque Characteristics for SH2862-0441/ 0411

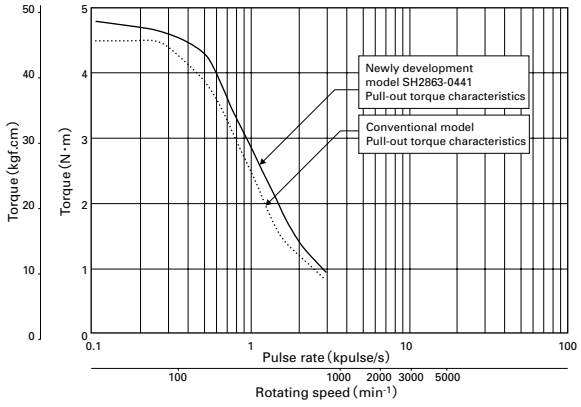

Fig. 7: Comparison of Pulse rate – Torque Characteristics for SH2863-0441/ 0411

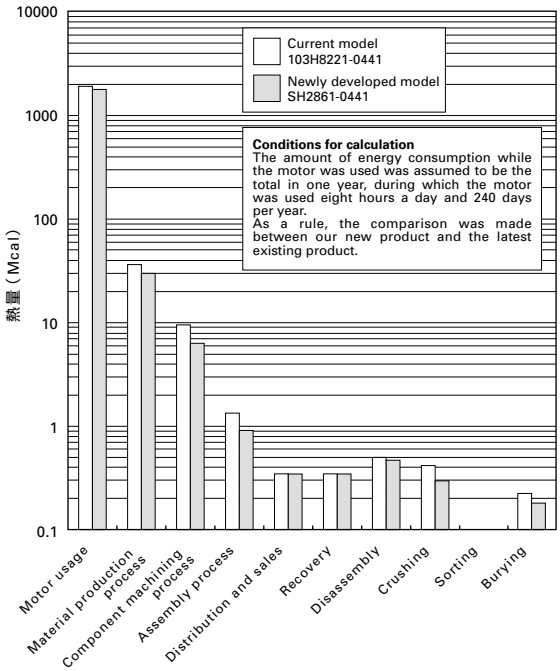

Fig. 8: Comparison of Energy Consumption Amount

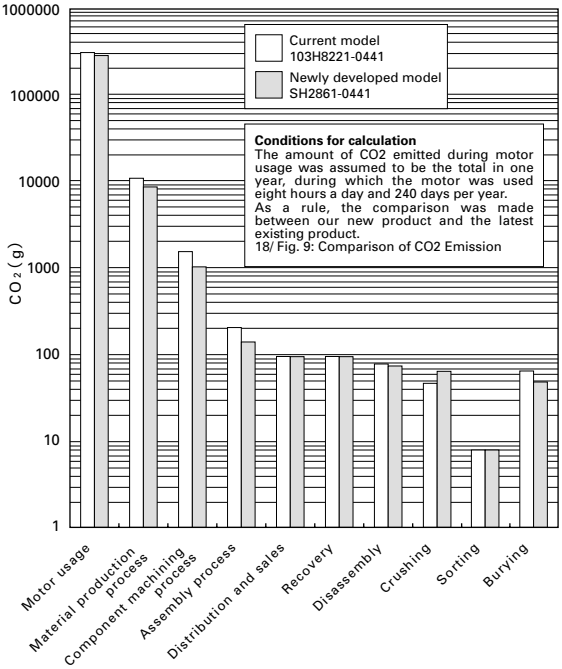

Fig. 9: Comparison of CO_2 Emission

and usage

(ii) Effect of preventing global warming

Comparison of the total CO_2 emission during manufacture and usage

It is estimated that the newly developed model can reduce the burden on the environment by about 6%, with respect to the total CO_2 emission and the total energy consumption during manufacture and usage.

4. Conclusion

The 86mm sq. 2-phase stepping motor has been finished into a product of high cost performance, in addition to being capable of increasing the speed of general industrial machines and reducing environmental impact. The authors are determined to continue working to enhance the product lineup of the stepping motor series, with more consideration given to environmental impact.

Ikuo Takeshita
Joined company in 1985.
Servo System Division, 3rd Design Dept.
Worked on the development and design of the stepping motor.

Jun Shimizu
Joined company in 1984.
Servo System Division, 3rd Design Dept.
Worked on the development and design of the stepping motor.

Kouji Nakatake
Joined company in 2001.
Servo System Division, 3rd Design Dept.
Worked on the development and design of the stepping motor.

Akira Koike
Joined company in 1983.
Servo System Division, 3rd Design Dept.
Worked on the development and design of the stepping motor.