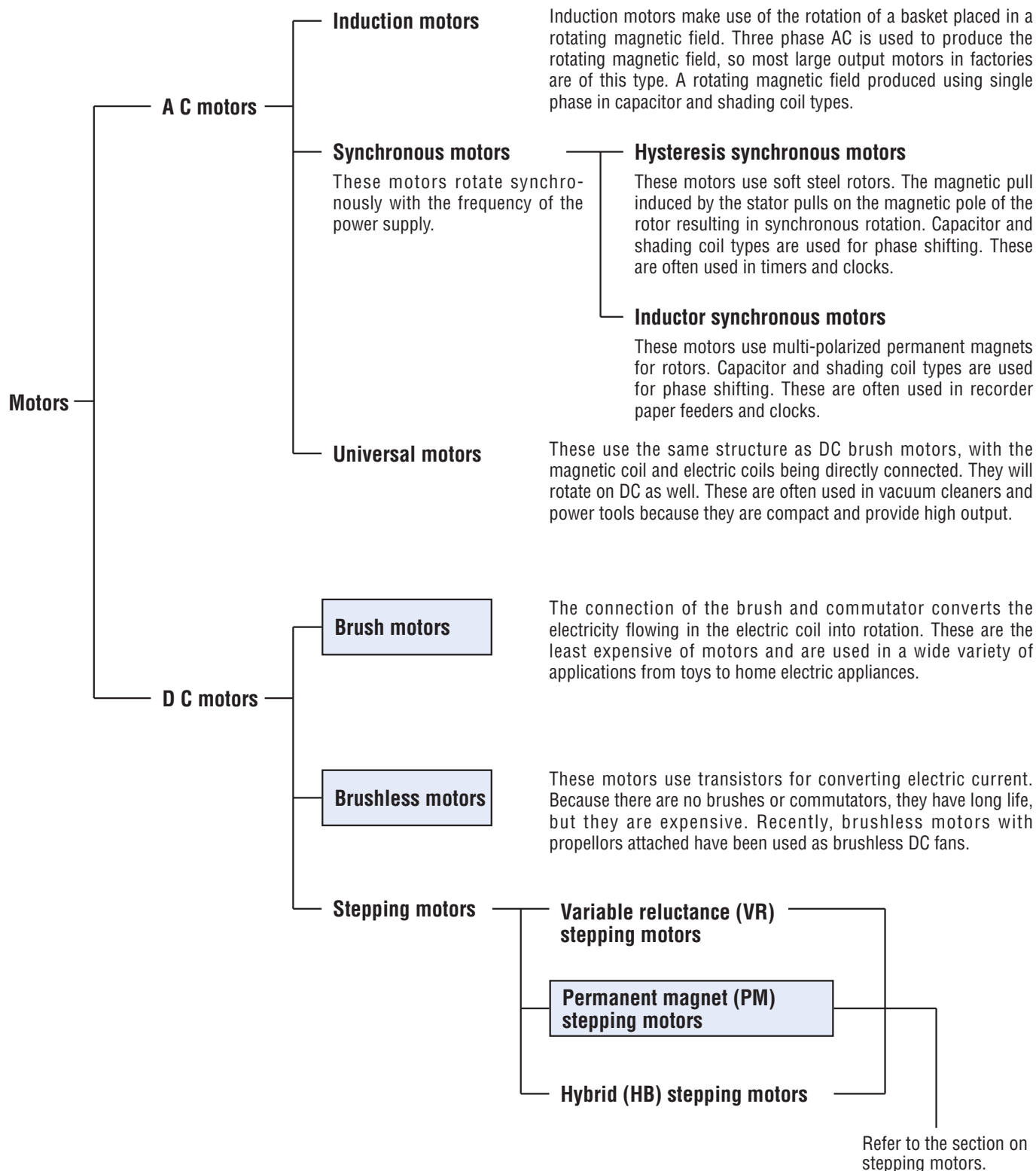


COPAL ELECTRONICS handles motors marked by the 



OUTLINE (MOTORS)

STEPPING MOTORS

FEATURES

Stepping motors differ from general motors that rotate simply by being attached to a power supply in that they rotate just a fixed angle when a pulse signal is applied to the driving circuit. In other words, the number of rotations of the motor is proportional to the number of pulse signals applied to the driving circuit, and the rotational speed is proportional to the frequency of the pulse signals.

TYPES

Stepping motors can be categorized into following types depending on their structure.

● Variable reluctance type (VR type)

The electromagnetic force generated by the stator coil turns a rotor made of electromagnetic soft steel.

● Permanent magnet type

The electromagnetic force generated by the stator coil turns a rotor made from a permanent magnet. Therefore, holding torque is generated even during deenergization.

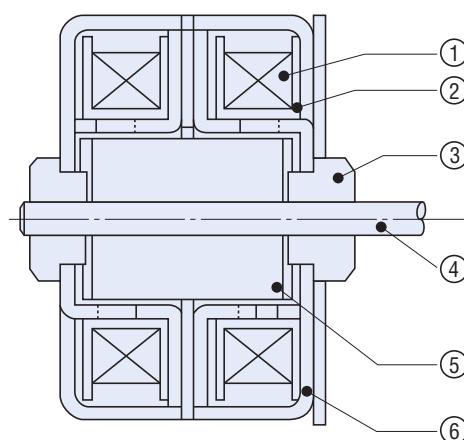
● Hybrid type (HB type)

This is a combination of the above VR and PM types.

※ **COPAL ELECTRONICS manufactures PM types only.**

CONSTRUCTIONS

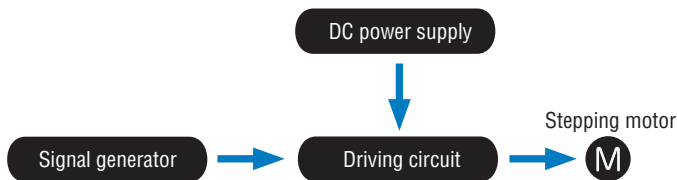
The structure of PM stepping motors (SPG etc.) is shown in the cross section. This stepping motor uses a bifilar wound four phase stator coil, and a ferrite permanent magnet rotor. The bearings used copper sintered metal or special plastic, and the motor can be used for a long period of time without oil.



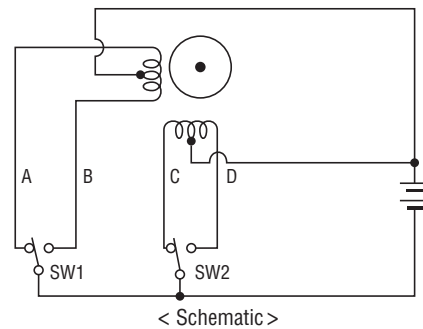
Part name	
①	Stator coil
②	Plastic coil bobbin
③	Bearing
④	Rotating shaft
⑤	Rotor (Ferrite magnet)
⑥	Stator core

STEPPING MOTORS **DRIVING CIRCUIT**

Driving circuit configuration



Excitation and sequence



● 1 phase exciting method

This method performs constant excitation of one phase only. The input is small and little temperature increase occurs, so a small power supply is sufficient. The attenuation vibration for each step, however, is large, so hunting can occur easily. (Refer to Fig. 1, 2)

	SW1		SW2	
	A	B	C	D
1	ON		ON	
2		ON		
3			ON	
4		ON		ON
1	ON			

Fig. 1

Sequence

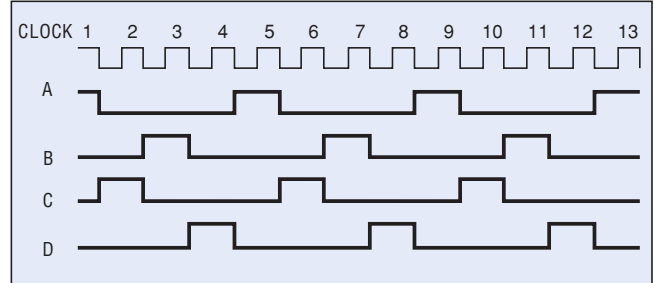


Fig. 2

● 2 phase exciting method

This method performs constant exciting of two phases, and one phase is always exciting during phase switch-over. This results in braking effects during operation, and starting torque is always applied, so hunting decreases and the self starting frequency can be increased. The input is twice that of the 1 phase exciting method. (Refer to Fig. 3, 4)

	SW1		SW2	
	A	B	C	D
1	ON		ON	
2	ON	ON	ON	
3		ON	ON	
4	ON	ON	ON	
1	ON		ON	

Fig. 3

Sequence

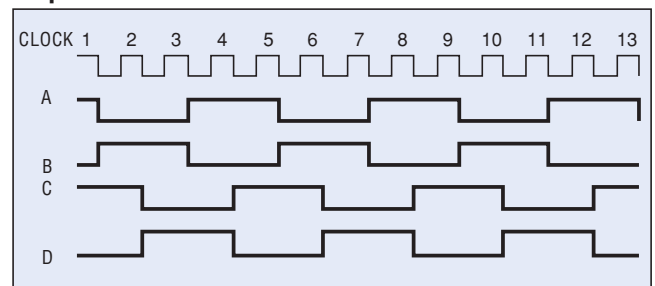


Fig. 4

DRIVING CIRCUIT

STEPPING MOTORS

● 1-2 phase exciting method

This method alternately performs the 1 phase excitation method and the 2 phases excitation method, with the angle deviation being half that of the 1 phase excitation method and the 2 phases excitation method. The response frequency is approximately double. (Refer to Fig. 5, 6)

	SW1		SW2	
	A	B	C	D
1	ON		ON	
2			ON	
3		ON	ON	
4		ON		
5		ON		ON
6				ON
7	ON			ON
8	ON			
1	ON		ON	

Fig. 5

Sequence

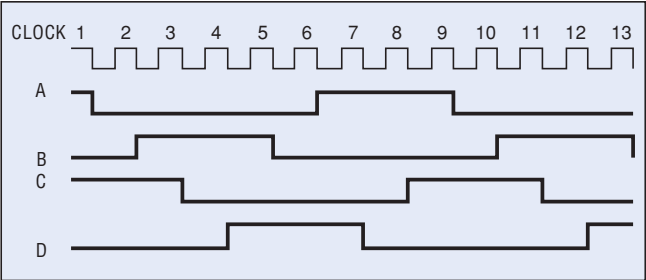


Fig. 6

<Stepping motors in common>

● Slow up/down

This is a method that allows you to gradually increase the frequency of the starting motor within the range of starting characteristics and to increase the range that can be handled during high-speed operation.

This is called slow up during acceleration and slow down during deceleration, but care must be taken to assure that the acceleration and deceleration of the rotator is on time for the change in frequency. If it is too early step out will occur; causing the motor to stop or the number of pulses and rotation angle to become mismatched. The time will differ according to the load inertia.

Depending on the application, frequency can be changed using analog or digital methods.

● Countermeasures for counter-voltage

If coil magnetization is stopped, counter-voltage could damage the main circuit transistor. If the current is returned, however, to the power line via this kind of diode, current will flow in the coil, so it will remain in a magnetized state even if magnetization is cut off, but during this time motor output will be reduced. To counter this, the example circuits in Fig. 1 to 3 can be used.

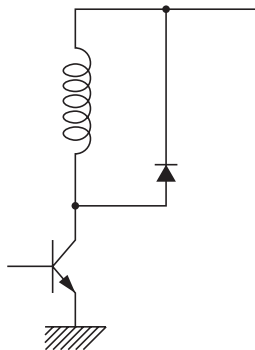


Fig. 1

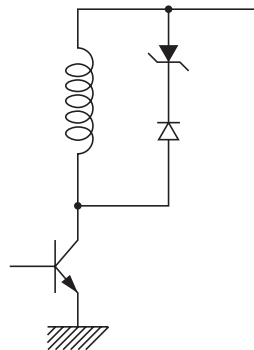


Fig. 2

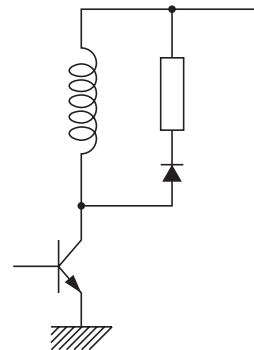


Fig. 3

- According to the increase of the load torque, the stepping angle error will be increased.
- Do not attempt to modify or disassemble the stepping motors. In particular, pinholing or cutting the shaft will result in degraded performance and should be absolutely avoided.
- Do not hold or carry by the lead wires.
- Error or misapplication of power supply voltage may damage the stepping motor. Be careful when wiring.
- **Performance of stepping motors varies with the following factors. Please contact your nearest business office.**
 1. Drive Circuit
 2. Motor temperature rise due to continuous running or motor peripheral temperature
 3. Input voltage variation
 4. Inertia load

● Static maximum torque

This is the maximum torque generated when the rated current is applied in each phase and angular displacement is applied to the motor shaft from its static point. If the external load is lower than this value, when it is removed, the shaft will return to its previous position.

● Detent torque

This is the maximum torque that occurs when angular displacement is applied to the rotor of a PM or hybrid type in the deenergized state.

● Pull-in torque

This shows the dynamic characteristics stepping motor and is the load torque measured that is required to start up the motor where the number of steps of the stepping motor are exactly equal to the frequency of the input pulse.

● Pull-out torque

This is the motor load torque when the motors is started within the range of the pull-in torque characteristics and is rotating synchronously and the input pulse frequency is gradually increased such that the motor rotates synchronously one to one at an input frequency higher than the maximum self starting frequency.

● Maximum starting torque

This is the maximum torque that the stepping motor can move, and is the maximum torque that can be moved when the motor is operated at an input signal frequency of less than 10 pps.

● Maximum pull-in pulse rate

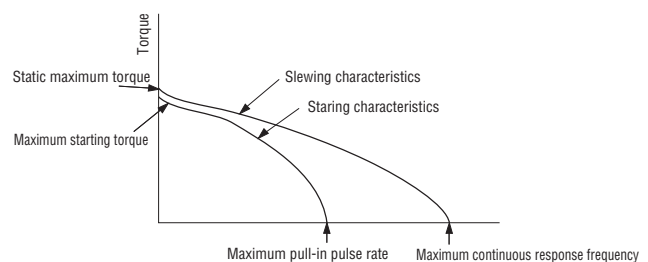
This is the maximum input signal frequency at which the motor can self start with no load and a one to one correspondence with the input signal.

● Maximum continuous response frequency

This is the maximum input signal frequency at which synchronous rotation can occur when the motor is started with no load at a frequency less than the maximum self starting frequency and the frequency is gradually increased.

● Slewing characteristics

This is the relationship between the maximum generated torque and input pulse such that a one-to-one correlation is maintained at frequencies over the starting characteristic when the motor is started within the starting characteristic range with synchronous rotation and the input pulse is gradually increased. (Fig. 1)



Characteristics curves (Fig. 1)

GLOSSARY

STEPPING MOTORS

● Starting characteristics

This is the relationship between the maximum torque generated by the motor and the input pulse such that the number of steps and the input pulse have an exact one to one correlation. (Fig. 1)

● The relationship of frequency to rotational speed

Normally the stepping motor rotates one step for each pulse. The number of pulses per second is the frequency, and the unit of measure is PPS. Further, the number of rotations can be derived from the frequency using the following formula:

$$\text{Rotational speed [r/min]} = \text{Frequency [PPS]} \div \left(\frac{360^\circ}{\text{Step angle}} \right) \times 60$$

● Angle accuracy

1. Step angle accuracy

This shows the difference between the actual angle and the theoretical angle when the motor rotates one step.

(The base point is random, and measurement is performed for one rotation.) (Refer to Fig. 2)

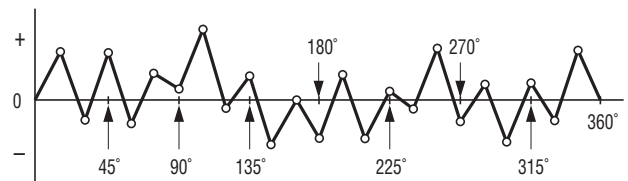


Fig. 2

2. Hysteresis accuracy

This is the angle difference between rotating in the CCW direction.

● θ -T characteristics

This characteristic shows the relationship between the deviation angle of the rotor shaft when external torque is applied to the motor shaft and the torque when the motor is energized at the rated voltage. (Refer to Fig. 3)

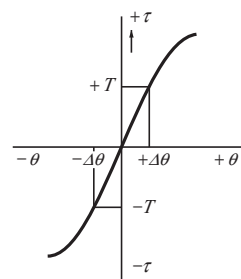


Fig. 3