

Industrial Circuits Application Note

Stepper Motor Basics

A stepper motor is an electromechanical device which converts electrical pulses into discrete mechanical movements. The shaft or spindle of a stepper motor rotates in discrete step increments when electrical command pulses are applied to it in the proper sequence. The motor's rotation has several direct relationships to these applied input pulses. The sequence of the applied pulses is directly related to the direction of motor shafts rotation. The speed of the motor shafts rotation is directly related to the frequency of the input pulses and the length of rotation is directly related to the number of input pulses applied.

Stepper Motor Advantages and Disadvantages

Advantages

1. The rotation angle of the motor is proportional to the input pulse.
2. The motor has full torque at standstill (if the windings are energized)
3. Precise positioning and repeatability of movement since good stepper motors have an accuracy of 3 – 5% of a step and this error is non-cumulative from one step to the next.
4. Excellent response to starting/ stopping/reversing.
5. Very reliable since there are no contact brushes in the motor. Therefore the life of the motor is simply dependant on the life of the bearing.
6. The motor's response to digital input pulses provides open-loop control, making the motor simpler and less costly to control.
7. It is possible to achieve very low speed synchronous rotation with a load that is directly coupled to the shaft.
8. A wide range of rotational speeds can be realized as the speed is proportional to the frequency of the input pulses.

Disadvantages

1. Resonances can occur if not properly controlled.
2. Not easy to operate at extremely high speeds.

Open Loop Operation

One of the most significant advantages of a stepper motor is its ability to be accurately controlled in an open loop system. Open loop control means no feedback information about position is needed. This type of control eliminates the need for expensive sensing and feedback devices such as optical encoders. Your position is known simply by keeping track of the input step pulses.

Stepper Motor Types

There are three basic stepper motor types. They are :

- Variable-reluctance
- Permanent-magnet
- Hybrid

Variable-reluctance (VR)

This type of stepper motor has been around for a long time. It is probably the easiest to understand from a structural point of view. Figure 1 shows a cross section of a typical V.R. stepper motor. This type of motor consists of a soft iron multi-toothed rotor and a wound stator. When the stator windings are energized with DC current the poles become magnetized. Rotation occurs when the rotor teeth are attracted to the energized stator poles.

Permanent Magnet (PM)

Often referred to as a "tin-can" or "canstock" motor the permanent magnet step motor is a low cost and low resolution type motor with typical step angles of 7.5° to 15°. (48 – 24 steps/revolution) PM motors as the

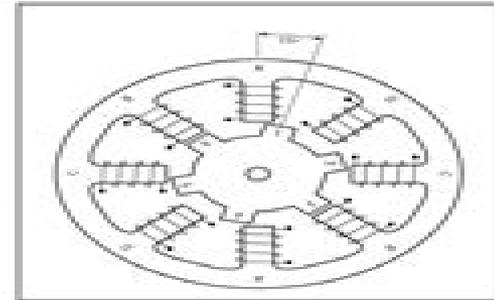


Figure 1. Cross-section of a variable-reluctance (VR) motor.

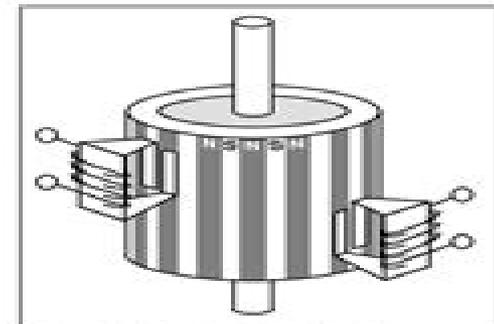


Figure 2. Principle of a PM or tin-can stepper motor.

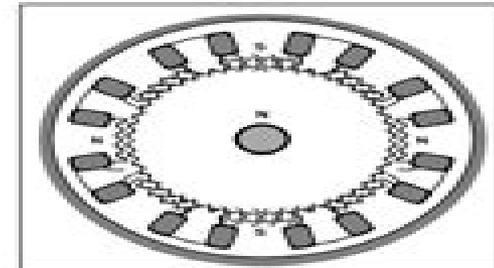


Figure 3. Cross-section of a hybrid stepper motor.

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Ensheng Dong



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Contemporary Computing Sanjay Ranka, Arunava Banerjee, Kanad Kishore Biswas, Sumeet Dua, Prabhat Mishra, Rajat Moona, Sheung-Hung Poon, Cho-Li Wang, 2010-08-12 This book constitutes the second part of the refereed proceedings of the Third International Conference IC3 2010 held in Noida India in August 2010 The 23 revised full papers presented were carefully reviewed and selected from numerous submissions

Power Electronics Handbook Muhammad H. Rashid, 2010-07-19 Power electronics which is a rapidly growing area in terms of research and applications uses modern electronics technology to convert electric power from one form to another such as ac dc dc dc dc ac and ac ac with a variable output magnitude and frequency Power electronics has many applications in our every day life such as air conditioners electric cars sub way trains motor drives renewable energy sources and power supplies for computers This book covers all aspects of switching devices converter circuit topologies control techniques analytical methods and some examples of their applications 25% new content Reorganized and revised into 8 sections comprising 43 chapters Coverage of numerous applications including uninterruptable power supplies and automotive electrical systems New content in power generation and distribution including solar power fuel cells wind turbines and flexible transmission

Thyristors, Rectifiers, and Diacs RCA Corporation. Solid State Division, 1972

Fundamentals of Power Electronics Bhattacharya S.K., 2009-11-01 The Application Of Power Electronics Is Increasingly Being Seen In Residential Commercial Industrial Transportation Aerospace And Telecommunication Systems An Electrical Electronics Or Control Systems Engineer Needs To Understand The Basic Devices

Fundamentals of Power Semiconductor Devices B. Jayant Baliga, 2018-09-28 Fundamentals of Power Semiconductor Devices provides an in depth treatment of the physics of operation of power semiconductor devices that are commonly used by the power electronics industry Analytical models for explaining the operation of all power semiconductor devices are shown The treatment here focuses on silicon devices but includes the unique attributes and design requirements for emerging silicon carbide devices The book will appeal to practicing engineers in the power semiconductor device community

A Study of the Technical Feasibility of Developing a Standardized Energy Control System Specifically for Army Facilities Dominic Eng, K. H. Wu, 1977 This report evaluates the feasibility of developing a standardized energy control system ECS for monitoring and controlling energy use in Army buildings and facilities Criteria used in the evaluation were that the system must Maximize use of off the shelf hardware Use standard software programs and language Use hardware and software modules which can be easily changed or expanded to insure the user maximum independence of the original equipment manufacturer Provide reliable real time facility monitoring and control functions for all types of equipment systems Minimize number of personnel and skills required for operation Maintain cost effectiveness and Be easy to operate Results of the evaluation show that a standardized Army system for energy conservation is feasible and would be cost effective Available hardware can be used but further development is needed to prepare necessary standardized software The

proposed standardized ECS consists of 1 microprocessor based remote terminals for optimum fail safe operations strategically located throughout the installation and capable of monitoring and controlling real time processes and 2 a centrally located minicomputer based console for supervisory energy control activities and data logging The proposed system would be capable of efficient system modification and expansion and provide good system reliability *Motorola Linear Interface Integrated Circuits* Motorola Semiconductor Products Inc. Technical Information Center,1979 EDN. ,1975

Electronics Applications Sourcebook Harry L. Helms,1986 *RCA Power Devices* RCA Corporation. Solid State Division,1981 Electronic Design ,1984 Industrial Management ,1919 **High-reliability Devices** RCA Corporation. Solid State Division,1976 Industrial Management John Robertson Dunlap,Arthur Van Vlissingen,John Michael Carmody,1918 *Western Society of Engineers Bulletin* Western Society of Engineers (Chicago, Ill.),1945 **College Credit Recommendations** ,2002 *Wireless World* ,1971 *Industrial Management* John R. Dunlap,1919 **The Wireless World** ,1973 *EE Systems Engineering Today* ,1972

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