

---

## AVR360: Step Motor Controller

### Features

- High-speed Step Motor Controller
- Interrupt Driven
- Compact Code (Only 10 Bytes Interrupt Routine)
- Very High Speed
- Low Computing Requirement
- Supports all AVR Devices

### Introduction

This application note describes how to implement a compact size and high-speed interrupt driven step motor controller. Step motors are typically used in applications like camera zoom/film feeder, fax machines, printers, copying machines, paper feeders/sorters and disk drives.

The high performance of the AVR controller enables the designer to implement high speed step motor applications with low computing requirements of the controller.

### Theory of Operation

A DC step motor translates current pulses into motor rotation. A typical motor contains four winding coils. The coils are often labeled red, yellow/white, red/white and yellow, but may have other colors. Applying voltage to these coils forces the motor to step one step.

In normal operation, two winding coils are activated at the same time. The step motor moves clockwise one step per change in winding activated. If the sequence is applied in reverse order, the motor will run counterclockwise.

The speed of rotation is controlled by the frequency of the pulses. Every time a pulse is applied to the step motor the motor will rotate a fixed distance. A typical step rotation is 1.8 degrees. With 1.8 degree rotation in each step will a complete rotation of the motor (360 degrees) require 200 steps.

By changing the interval of the timer interrupts, the speed of the motor can be regulated, and by counting the number of steps, the rotation angle can be controlled.



---

8-bit **AVR**<sup>®</sup>  
Microcontroller

---

**Application  
Note**

Rev. 1181B-AVR-04/03



**Figure 1. Step Motor Step Sequence**

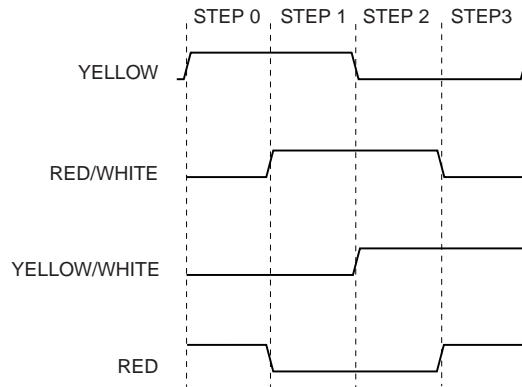


Table 1 shows the hexadecimal values to be output to the step motor to perform each step.

**Table 1. Step Motor Values**

Step	Yellow	Red/White	Yellow/White	Red	Hex Value
0	1	0	0	1	9
1	1	1	0	0	C
2	0	1	1	0	6
3	0	0	1	1	3

## Software Description

The software uses a 16 bits timer with capture function to generate interrupt every 100  $\mu$ s. When the interrupt is executed, a new step value is output to PORTB.

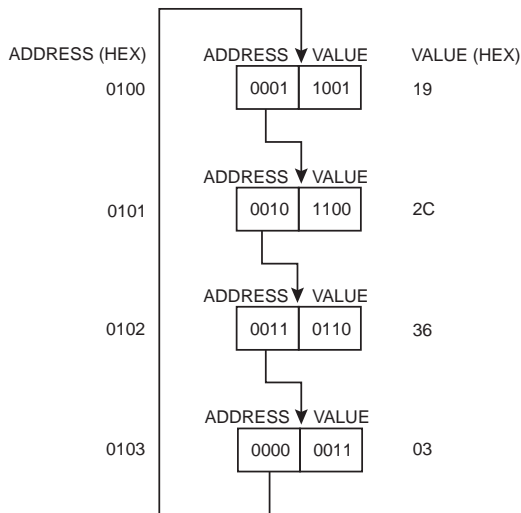
Values for the step motor are stored in Flash memory. At startup, the values are copied to SRAM to achieve faster access and maximum speed performance.

In this implementation, the interrupt routine takes seven cycles + four cycles to enter and four cycles to exit the interrupt. This totals 15 cycles. The step motor control takes less than 2  $\mu$ s. If interrupt is required every 100  $\mu$ s, the step motor handling takes only 2% of the processing power in the CPU.

In this example the values for the step motor are stored at RAM address 0100 (hex). The upper byte of the RAM address is constant and only the low nibble of the low byte is used to access the address information. See Figure 2.

The lower nibble (four bits) of the variables is the actual value to control the step motor, the upper nibble holds the address of the next value.

**Figure 2. Step Motor Addresses and Values**



By using this method, maximum speed can be achieved, combined with a minimum of processor resources.

## Resources

**Table 2. CPU and Memory Usage**

Function	Code Size	Cycles	Register Usage	Interrupt	Description
Main	38 words	–	R16, XL, XH, ZL, ZH	–	Initialization and example program
OC1A	10 words	13 + return	R16, XL, XH	Timer 1 Output Compare A	Output step motor value and calculate next value
TOTAL	48 words	–	R16, XL, XH, ZL, ZH		

**Table 3. Peripheral Usage**

Peripheral	Description	Interrupts Enabled
4 I/O pins	Step motor output pins	
Timer 1	Generate timer interrupt for step motor frequency generation	Timer 1 Output Compare A



## Atmel Corporation

2325 Orchard Parkway  
San Jose, CA 95131  
Tel: 1(408) 441-0311  
Fax: 1(408) 487-2600

## Regional Headquarters

### Europe

Atmel Sarl  
Route des Arsenaux 41  
Case Postale 80  
CH-1705 Fribourg  
Switzerland  
Tel: (41) 26-426-5555  
Fax: (41) 26-426-5500

### Asia

Room 1219  
Chinachem Golden Plaza  
77 Mody Road Tsimshatsui  
East Kowloon  
Hong Kong  
Tel: (852) 2721-9778  
Fax: (852) 2722-1369

### Japan

9F, Tonetsu Shinkawa Bldg.  
1-24-8 Shinkawa  
Chuo-ku, Tokyo 104-0033  
Japan  
Tel: (81) 3-3523-3551  
Fax: (81) 3-3523-7581

## Atmel Operations

### Memory

2325 Orchard Parkway  
San Jose, CA 95131  
Tel: 1(408) 441-0311  
Fax: 1(408) 436-4314

### Microcontrollers

2325 Orchard Parkway  
San Jose, CA 95131  
Tel: 1(408) 441-0311  
Fax: 1(408) 436-4314

La Chantrerie  
BP 70602  
44306 Nantes Cedex 3, France  
Tel: (33) 2-40-18-18-18  
Fax: (33) 2-40-18-19-60

### ASIC/ASSP/Smart Cards

Zone Industrielle  
13106 Rousset Cedex, France  
Tel: (33) 4-42-53-60-00  
Fax: (33) 4-42-53-60-01

1150 East Cheyenne Mtn. Blvd.  
Colorado Springs, CO 80906  
Tel: 1(719) 576-3300  
Fax: 1(719) 540-1759

Scottish Enterprise Technology Park  
Maxwell Building  
East Kilbride G75 0QR, Scotland  
Tel: (44) 1355-803-000  
Fax: (44) 1355-242-743

### RF/Automotive

Theresienstrasse 2  
Postfach 3535  
74025 Heilbronn, Germany  
Tel: (49) 71-31-67-0  
Fax: (49) 71-31-67-2340

1150 East Cheyenne Mtn. Blvd.  
Colorado Springs, CO 80906  
Tel: 1(719) 576-3300  
Fax: 1(719) 540-1759

### Biometrics/Imaging/Hi-Rel MPU/ High Speed Converters/RF Datacom

Avenue de Rochepleine  
BP 123  
38521 Saint-Egreve Cedex, France  
Tel: (33) 4-76-58-30-00  
Fax: (33) 4-76-58-34-80

---

### e-mail

[literature@atmel.com](mailto:literature@atmel.com)

### Web Site

<http://www.atmel.com>

**Disclaimer:** Atmel Corporation makes no warranty for the use of its products, other than those expressly contained in the Company's standard warranty which is detailed in Atmel's Terms and Conditions located on the Company's web site. The Company assumes no responsibility for any errors which may appear in this document, reserves the right to change devices or specifications detailed herein at any time without notice, and does not make any commitment to update the information contained herein. No licenses to patents or other intellectual property of Atmel are granted by the Company in connection with the sale of Atmel products, expressly or by implication. Atmel's products are not authorized for use as critical components in life support devices or systems.

© Atmel Corporation 2003. All rights reserved. Atmel® and combinations thereof, AVR® are the registered trademarks of Atmel Corporation or its subsidiaries. Other terms and product names may be the trademarks of others.



Printed on recycled paper.