AVR360: Step Motor Controller

8-bit AVR® Microcontroller

Application Note

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.

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Figure 1. Step Motor Step Sequence

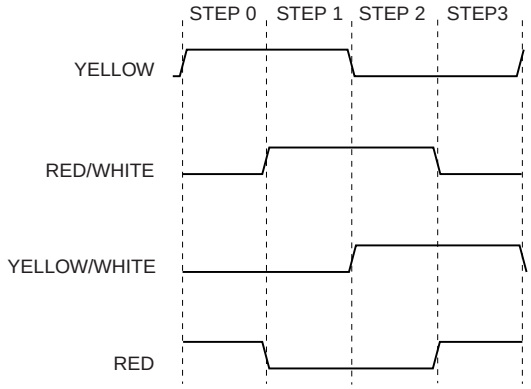


Table 1 shows the hexadecimal values to be output to the step motor to perform each step.

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 µs. When the interrupt is executed, a new step value is output to PORTB.

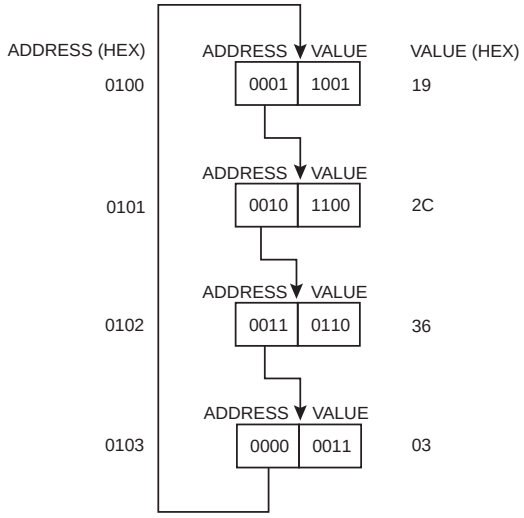
Values for the step motor are stored in Flash memory. At startup, the values are copied to SRAM to achieve faster access and maximum speed performance.

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 µs. If interrupt is required every 100 µs, 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

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