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12-Volt Unipolar Stepper Motor (#27964)

Introduction

Stepper motors are electromechanical devices that convert a pattern of inputs and the rate-of-change of those inputs into precise rotational motion. The rotational angle and direction for each change (step) is determined by the construction of the motor as well as the step pattern input. The #27964 is a standard, four-phase unipolar stepper motor that is easily controlled with the BASIC Stamp or Javelin Stamp when buffered with an appropriate high-current driver (ULN2003 or similar suggested).

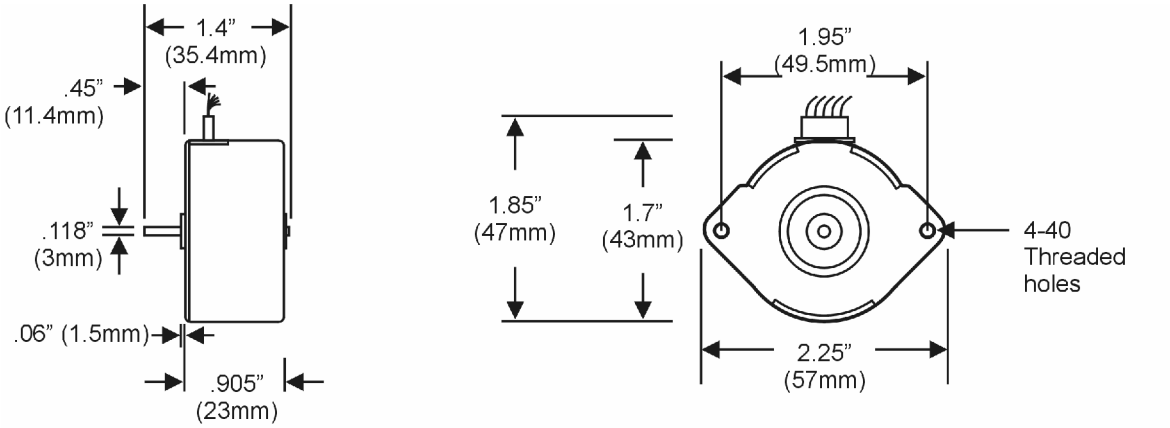
Applications

- Robotics
- Motion Control and Industrial Equipment
- Techno-Art

Technical Specifications

- Rated Voltage 12 vdc
- Rated Current/Phase 259 mA
- No. of Phase 4
- DC Coil Resistance 50 Ω / phase ±7% (100 Ω / coil)
- Step Angle 7.5° / phase
- Excitation Method 2-2 phase (unipolar)

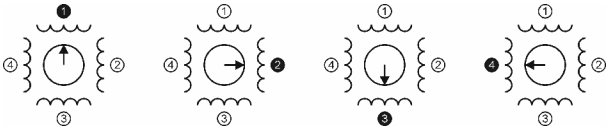
Mechanical Specifications



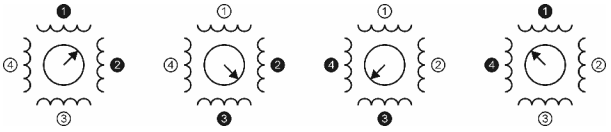
Stepper Basics

Control of a stepper motor comes from applying a specific step sequence; rotational speed is controlled by the timing of the applied steps. The simplified diagrams below illustrate the effect of phase sequencing on rotational motion.

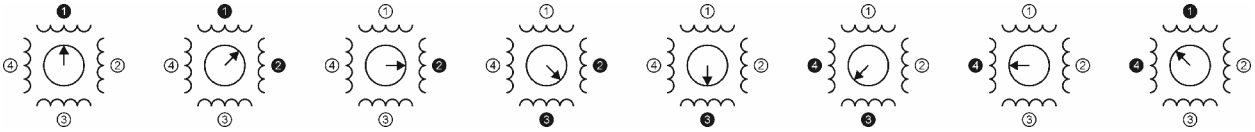
Full Step, Low Torque



Full Step, High Torque (standard application)

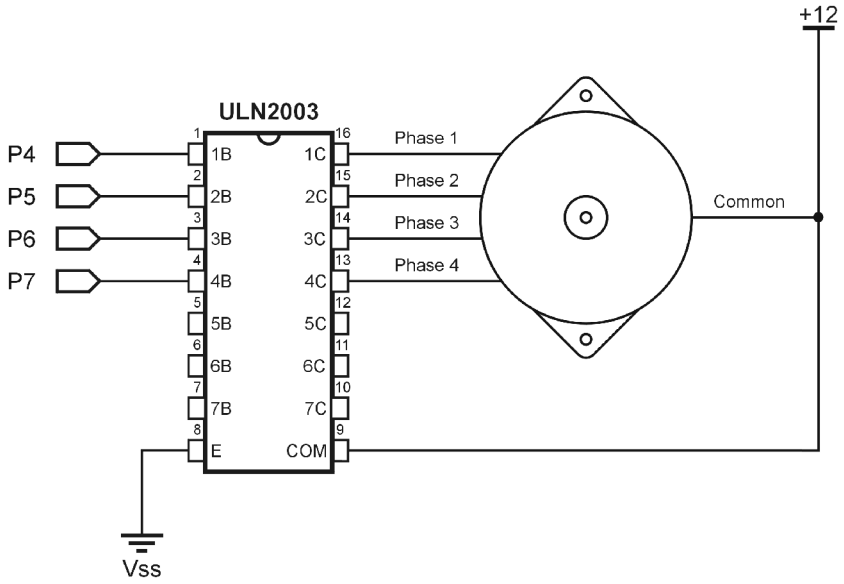


Half Step (best precision):



Circuit Connections

Use the circuit below to connect a 4-phase unipolar stepper motor to a BASIC Stamp or Javelin Stamp. The ULN2803 may also be used and has enough driver circuits to control two stepper motors (*be sure to verify motor current requirement versus ULN2x03 sink capability for multiple outputs*).



Motor Connections

Use the table below when connecting your stepper motor to the driver circuit.

Manufacturer	Mitsumi [1]	Howard Industries [2]
Degrees per Step	7.5	3.6
Steps per Revolution	48	100
Phase 1	Black	Brown
Phase 2	Orange	Green
Phase 3	Brown	Red
Phase 4	Yellow	White
Common	Red	Black

[1] Current motor supplied as PN #27964
[2] Motor originally supplied with StampWorks kit

BASIC Stamp 1 Application

This program demonstrates basic full-step, high-torque control of a unipolar stepper motor. Step sequence data is stored in an EEPROM table to simplify program design and modification. Separate subroutines are used to manipulate the step index pointer that controls rotational direction. Note that the stepper update routine (**Do_Step**) is designed to preserve the state of IO pins that are not being used by the stepper motor.

```
' {$STAMP BS1}
' {$PBASIC 1.0}

SYMBOL  StpsPerRev      = 48                    ' whole steps per rev

SYMBOL  idx             = B2                    ' loop counter
SYMBOL  phase           = B3                    ' new phase data
SYMBOL  stpIdx          = B4                    ' step pointer
SYMBOL  stpDelay        = B5                    ' delay for speed control

Full_Steps:
  EEPROM 0, (%00110000, %01100000, %11000000, %10010000)


Setup:
  DIRS = %11110000                              ' make P4..P7 outputs
  stpDelay = 15                                 ' set step delay

Main:
  FOR idx = 1 TO StpsPerRev                     ' one revolution
    GOSUB Step_Fwd                              ' rotate clockwise
  NEXT
  PAUSE 500                                     ' wait 1/2 second
  FOR idx = 1 TO StpsPerRev                     ' one revolution
    GOSUB Step_Rev                              ' rotate counter-clockwise
  NEXT
```

```
  PAUSE 500                                     ' wait 1/2 second
  GOTO Main
  END

Step_Fwd:
  stpIdx = stpIdx + 1 // 4                      ' point to next step
  GOTO Do_Step

Step_Rev:
  stpIdx = stpIdx + 3 // 4                      ' point to previous step
  GOTO Do_Step

Do_Step:
  READ stpIdx, phase                            ' read new phase data
  PINS = PINS & %00001111 | phase               ' update stepper pins
  PAUSE stpDelay                                ' pause between steps
  RETURN
```

BASIC Stamp 2 Application

This program demonstrates basic full-step, high-torque control of a unipolar stepper motor using the BS2 family of microcontrollers. With the BS2 family, the programmer can take advantage of an IO structure (IO pins grouped as nibbles) which simplifies programming.

```
' {$STAMP BS2}
' {$PBASIC 2.5}

Phase           VAR     OUTB                  ' phase control outputs

StpsPerRev      CON     48                    ' whole steps per rev

idx             VAR     Byte                  ' loop counter
stpIdx          VAR     Nib                   ' step pointer
stpDelay        VAR     Byte                  ' delay for speed control

Steps           DATA    %0011, %0110, %1100, %1001


Setup:
  DIRB = %1111                                ' make P4..P7 outputs
  stpDelay = 15                               ' set step delay

Main:
  FOR idx = 1 TO StpsPerRev                   ' one revolution
    GOSUB Step_Fwd                            ' rotate clockwise
  NEXT
  PAUSE 500                                   ' wait 1/2 second
  FOR idx = 1 TO StpsPerRev                   ' one revolution
```

```
    GOSUB Step_Rev                                ' rotate counter-clockwise
  NEXT
  PAUSE 500                                       ' wait 1/2 second
  GOTO Main
  END

Step_Fwd:
  stpIdx = stpIdx + 1 // 4                        ' point to next step
  GOTO Do_Step

Step_Rev:
  stpIdx = stpIdx + 3 // 4                        ' point to previous step
  GOTO Do_Step

Do_Step:
  READ (Steps + stpIdx), Phase                    ' output new phase data
  PAUSE stpDelay                                  ' pause between steps
  RETURN
```

Javelin Stamp Application

This program demonstrates basic, full-step control of a unipolar stepper motor using the Javelin Stamp microcontroller. The Stepper class handles the connection details and contains methods that allow the programmer to specify the number of steps, as well as the delay (in milliseconds between steps).

Stepper Motor Class

```
package stamp.misc;

import stamp.core.*;

public class Stepper {

  private int stpIdx = 0;                         // current step index

  private int ph1Pin;                             // phase 1 control pin
  private int ph2Pin;                             // phase 2 control pin
  private int ph3Pin;                             // phase 3 control pin
  private int ph4Pin;                             // phase 4 control pin


  public Stepper(int ph1Pin, int ph2Pin, int ph3Pin, int ph4Pin) {

    this.ph1Pin = ph1Pin;
    this.ph2Pin = ph2Pin;
    this.ph3Pin = ph3Pin;
    this.ph4Pin = ph4Pin;

  }

  private void setFullStep(int theStep) {
```

```
    switch (theStep) {

      case 0:
        CPU.writePin(ph1Pin, true);
        CPU.writePin(ph2Pin, true);
        CPU.writePin(ph3Pin, false);
        CPU.writePin(ph4Pin, false);
        break;

      case 1:
        CPU.writePin(ph1Pin, false);
        CPU.writePin(ph2Pin, true);
        CPU.writePin(ph3Pin, true);
        CPU.writePin(ph4Pin, false);
        break;

      case 2:
        CPU.writePin(ph1Pin, false);
        CPU.writePin(ph2Pin, false);
        CPU.writePin(ph3Pin, true);
        CPU.writePin(ph4Pin, true);
        break;

      case 3:
        CPU.writePin(ph1Pin, true);
        CPU.writePin(ph2Pin, false);
        CPU.writePin(ph3Pin, false);
        CPU.writePin(ph4Pin, true);
        break;
    }
  }

  public void stepFFwd(int steps, int msDelay) {

    while (steps-- > 0) {
      stpIdx = (stpIdx + 1) % 4;
      setFullStep(stpIdx);
      CPU.delay(msDelay * 10);
    }
  }

  public void stepFRev(int steps, int msDelay) {

    while (steps-- > 0) {
      stpIdx = (stpIdx + 3) % 4;
      setFullStep(stpIdx);
      CPU.delay(msDelay * 10);
    }
  }
}
```

Test Program for Stepper Class

```
public class stepperTest {

  public static final int STEPS_PER_REV = 48;


  public static void main() {

    Stepper motor = new Stepper(CPU.pin4, CPU.pin5, CPU.pin6, CPU.pin7);

    while(true) {
      motor.stepFFwd(STEPS_PER_REV, 15);        // one rev clockwise
      CPU.delay(5000);                          // wait 1/2 second
      motor.stepFRev(STEPS_PER_REV, 15);        // one rev counter clockwise
      CPU.delay(5000);                          // wait 1/2 second
    }
  }
}
```