Stepper Motors

Stepper Motors

- more accurately controlled than a normal motor allowing fractional turns or n revolutions to be easily done
- low speed, and lower torque than a comparable D.C. motor
- useful for precise positioning for robotics
- Servomotors require a position feedback signal for control

Stepper Motor Diagram

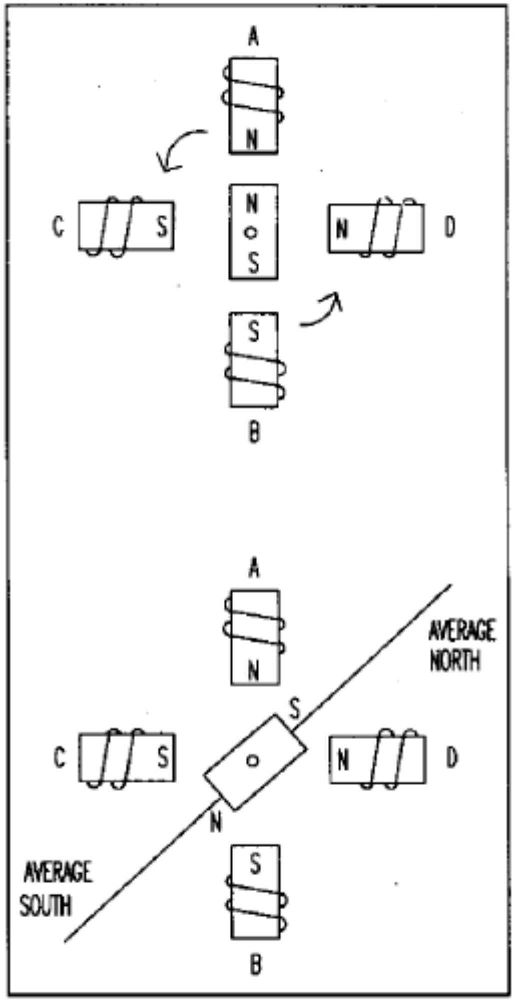


Figure 4-38. Rotor Alignment

(Courtesy of Superior Electric Company)

Stepper Motor Step Angles

Table 4-12: Stepper Motor Step Angles

Step Angle	Steps Per Revolution
0.72	500
1.8	200
2	180
2.5	144
5	72
7.5	48
15	24

Terminology

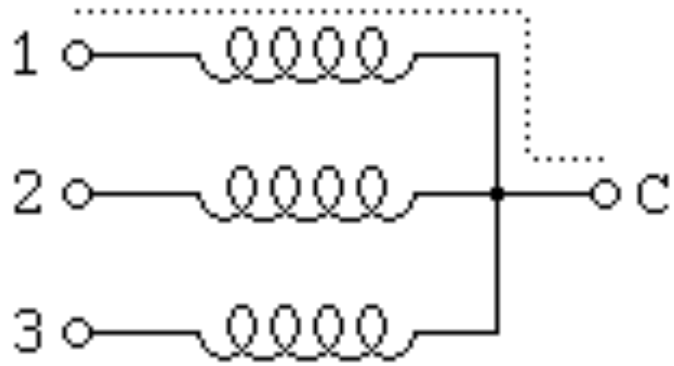
- Steps per second, RPM
  - SPS = (RPM * SPR) /60
- Number of teeth
- 4-step, wave drive 4-step, 8-step
- Motor speed (SPS)
- Holding torque

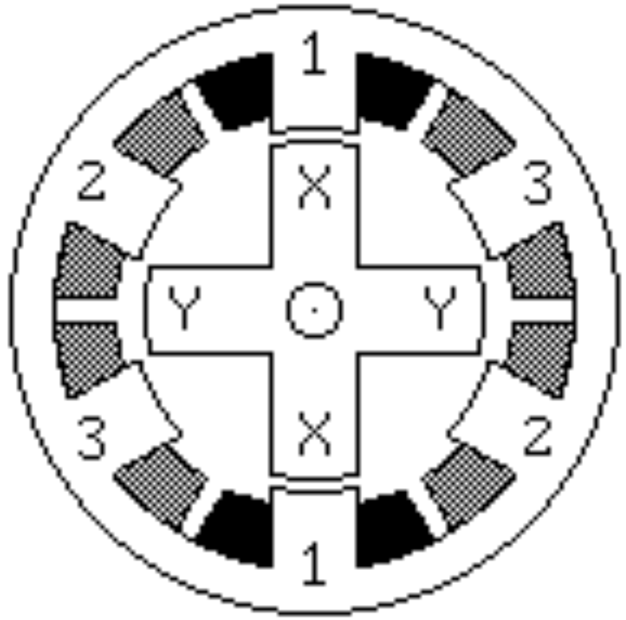
Stepper Motor Types

– Variable Reluctance

– Permanent Magnet

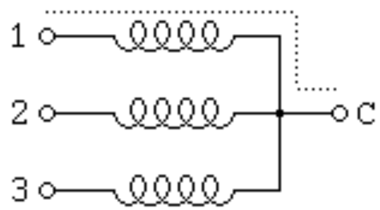
Variable Reluctance Motors

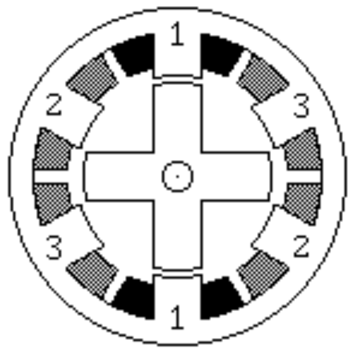




Variable Reluctance Motors

- This is usually a four wire motor – the common wire goes to the +ve supply and the windings are stepped through
- Our example is a 30^o motor
- The rotor has 4 poles and the stator has 6 poles
- Example

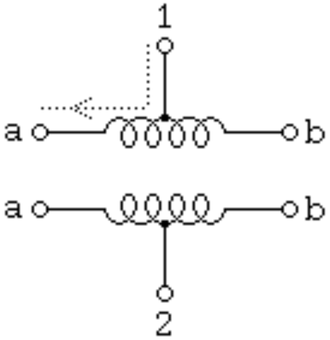


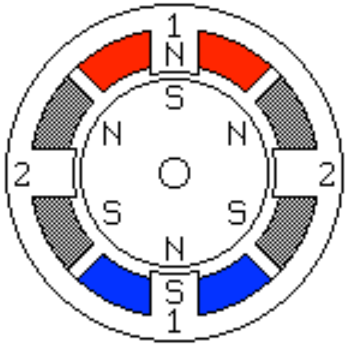


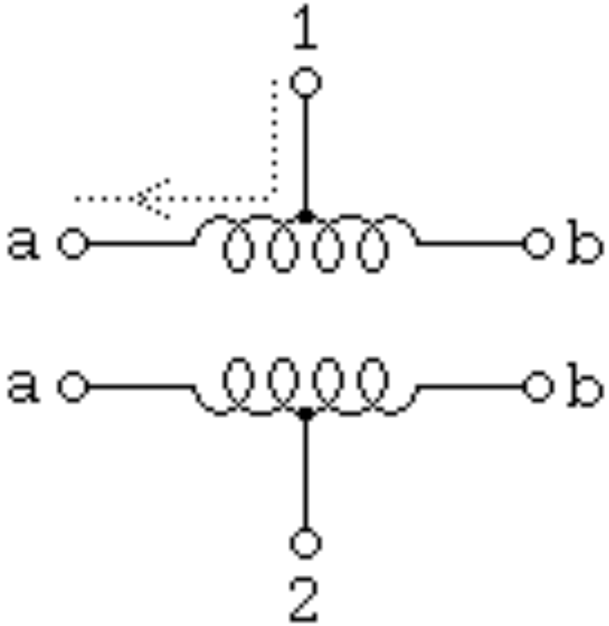
Variable Reluctance Motors

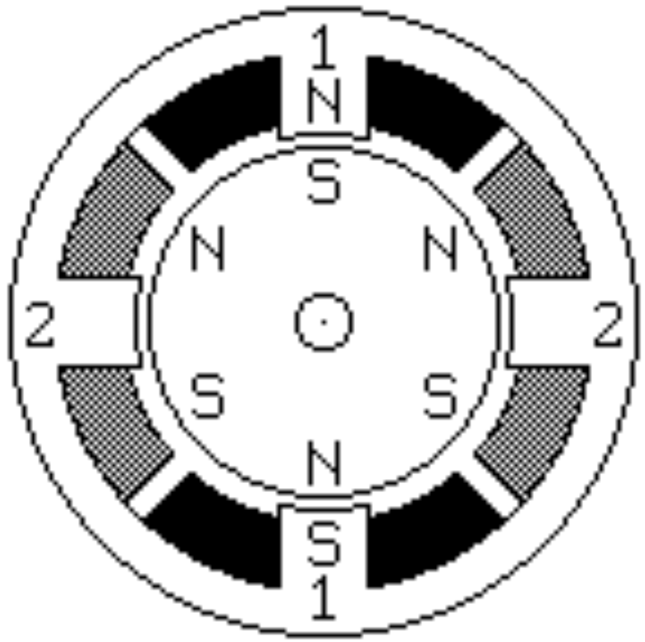
- To rotate we excite the 3 windings in sequence
  - W1 - 100100100100100100100100
  - W2 - 010010010010010010010010
  - W3 - 001001001001001001001001
- This gives two full revolutions

Unipolar Motors









Unipolar Motors

- To rotate we excite the 2 windings in sequence
  - W1a - 1000100010001000100010001
  - W1b - 0010001000100010001000100
  - W2a - 0100010001000100010001000
  - W2b - 0001000100010001000100010
- This gives two full revolutions

Basic Actuation Wave Forms

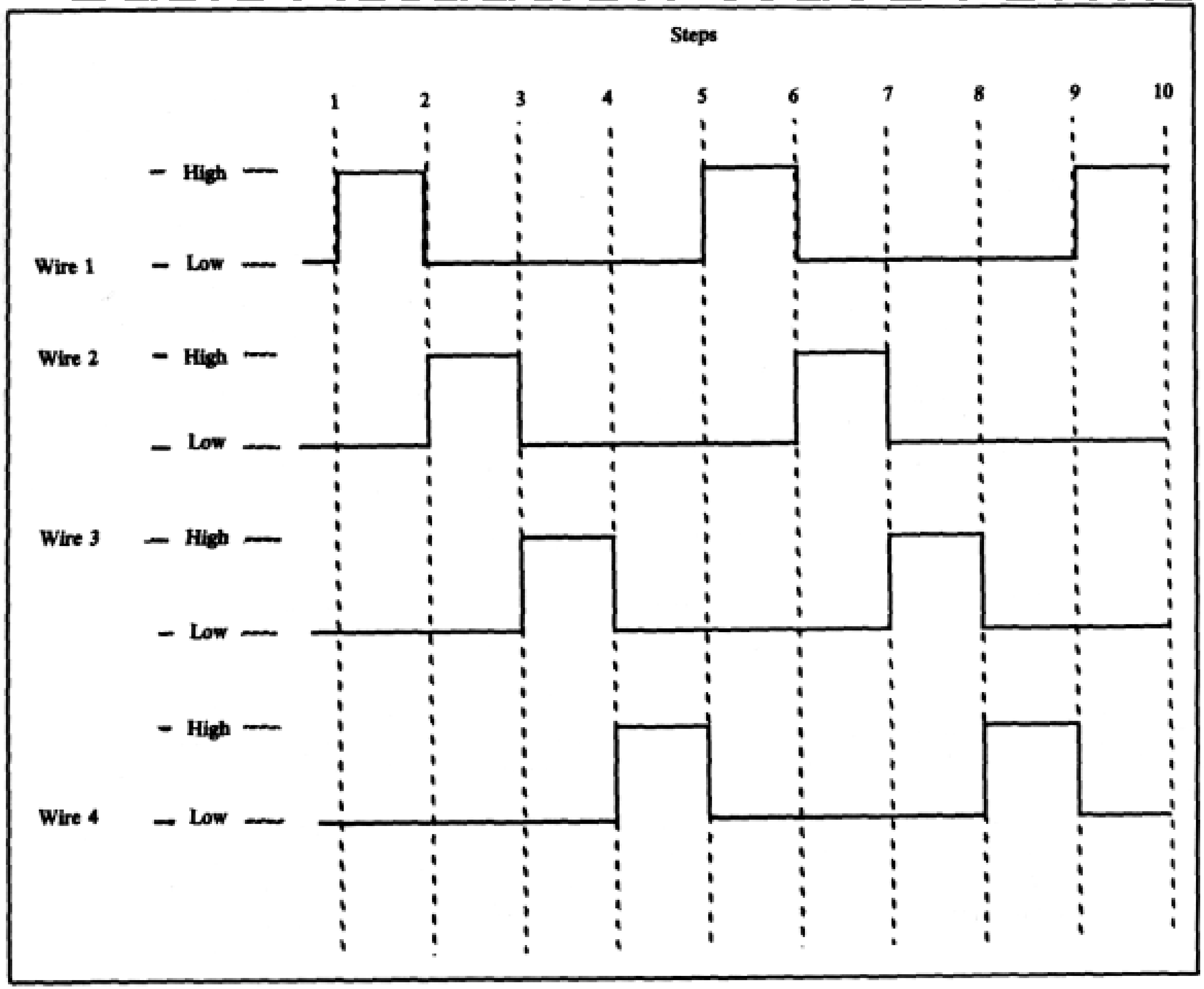


Fig. 14-4. The basic wave-step actuation sequence of a four-phase stepper motor.

Unipolar Motors

- To rotate we excite the 2 windings in sequence
  - W1a - 1100110011001100110011001
  - W1b - 0011001100110011001100110
  - W2a - 0110011001100110011001100
  - W2b - 1001100110011001100110011
- This gives two full revolutions at 1.4 times greater torque but twice the power

Enhanced Waveforms

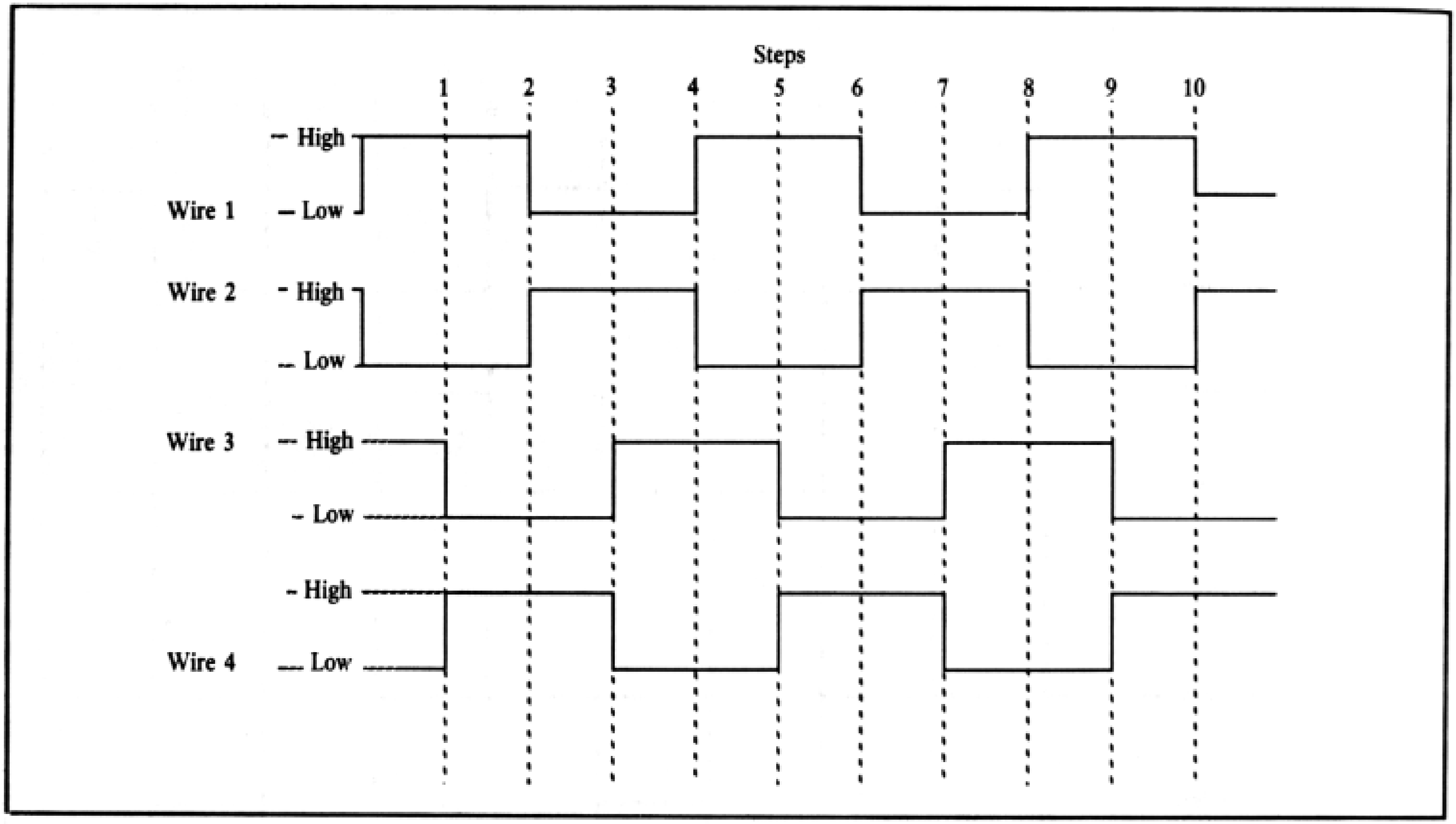


Fig. 14-5. The enhanced on-on/off-off actuation sequence of a four-phase stepper motor.

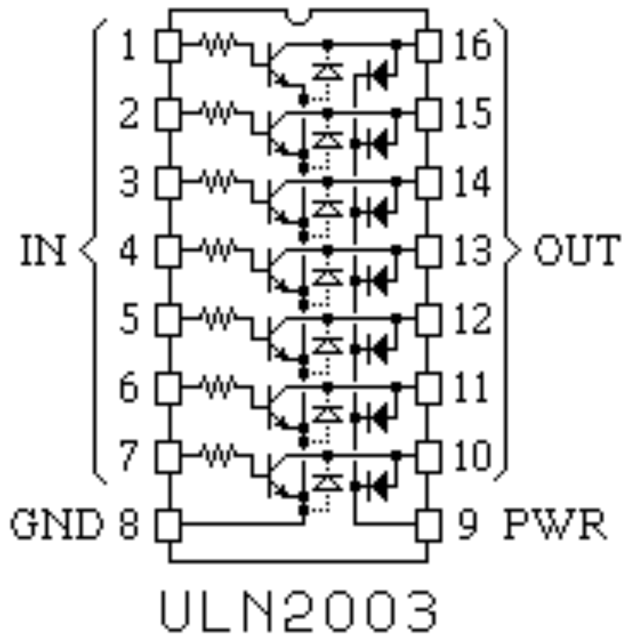
- better torque
- more precise control

Unipolar Motors

- The two sequences are not the same, so by combining the two you can produce half stepping
  - W1a - 11000001110000011100000111
  - W1b - 00011100000111000001110000
  - W2a - 01110000011100000111000001
  - W2b - 00000111000001110000011100

Motor Control Circuits

- For low current options the ULN200x family of Darlington Arrays will drive the windings direct.



Interfacing to Stepper Motors

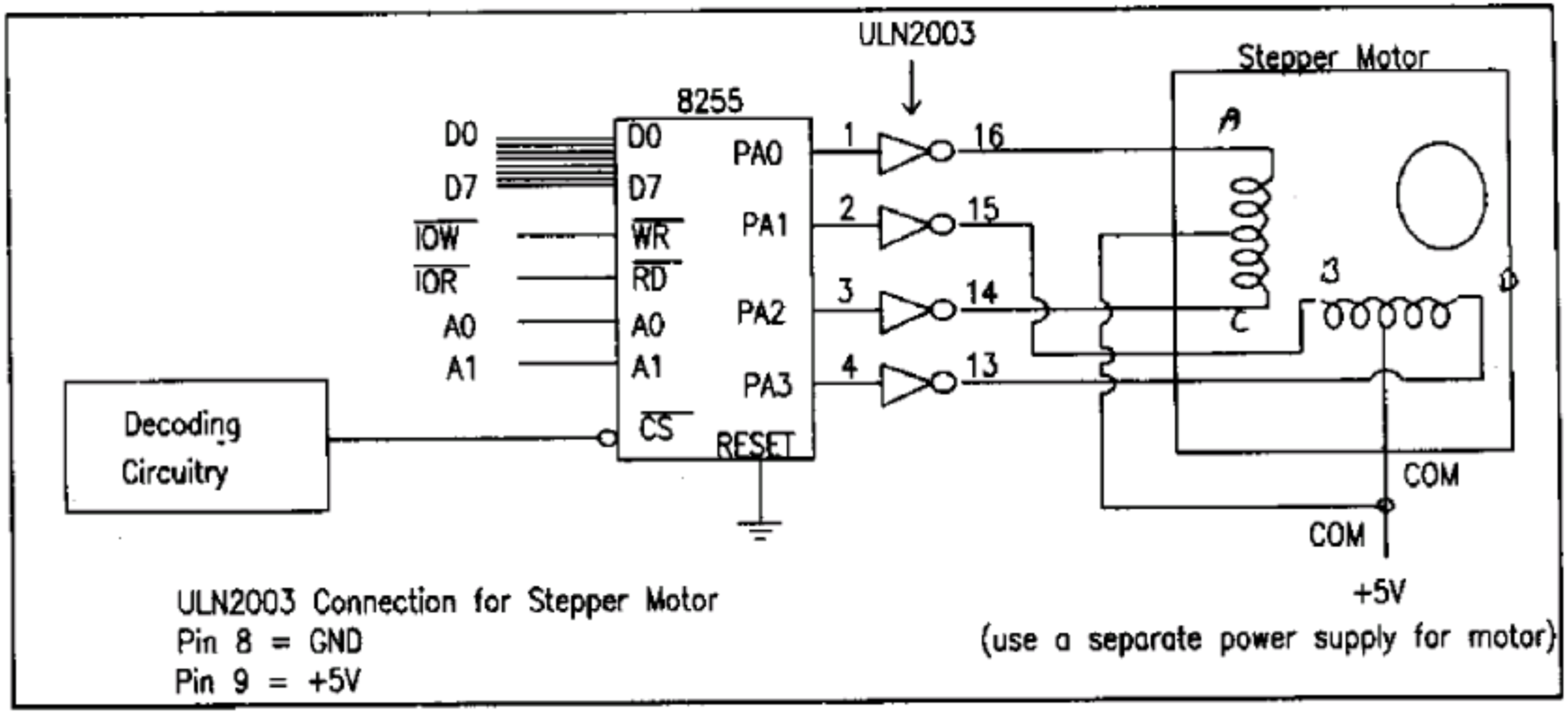


Figure 4-40. 8255 Connection to Stepper Motor

Example

```
          MOV   AL,80H      ;control word for all 8255 ports as out
          MOV   DX,303H     ;control reg address of 8255 on PC Trainer
          OUT   DX,AL       ;to control reg
          MOV   BL,66H      ;or BL=33H, BL=99H or BL=0CCH
AGAIN:    MOV   AH,01       ;check the key press
          INT   16H         ;using INT 16
          JNZ   EXIT        ;stop if any key pressed
          MOV   AL,BL       ;otherwise send pulse to stepper motor
          MOV   DX,300H     ;port A address of 8255 on PC Trainer
          OUT   DX,AL
          MOV   CX,0FFFFH   ;(change this value to see rotation speed)
HERE:     LOOP  HERE        ;wait for delay
          ROR   BL,1        ;rotate for next step
          JMP   AGAIN       ;and continue until a key is pressed
EXIT:
```