ICT 5307 : Embedded System Design

Lecture 12
Interfacing Motors

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DC Motor

- DC (Direct Current) Motors are two wire (power & ground), continuous rotation motors.
- When you supply power, a DC motor will start spinning until that power is removed.
- Most DC motors run at a high RPM (revolutions per minute), examples being computer cooling fans, or radio controlled car wheels!
- The speed of DC motors is controlled using pulse width modulation (PWM).
- Each pulse is so rapid that the motor appears to be continuously spinning.

The Servo Motor

- Servo motors are generally an assembly of four things: a DC motor, a gearing set, a control circuit and a position-sensor.
- The position of servo motors can be controlled more precisely than those of standard DC motors, and they usually have three wires (power, ground & control).
- Power to servo motors is constantly applied, with the servo control circuit regulating the draw to drive the motor.
- Servo motors do not rotate freely like a standard DC motor.
- Instead the angle of rotation is limited to 180 Degrees (or so) back and forth.
- Servo motors receive a control signal that represents an output position and applies power to the DC motor until the shaft turns to the correct position, determined by the position sensor.

Servo Motor (continued.....)

- PWM is used for the control signal of servo motors.
- However, unlike DC motors it's the duration of the positive pulse that determines the position, rather than speed, of the servo shaft.
- A neutral pulse value dependent on the servo (usually around 1ms) keeps the servo shaft in the center position.
- Increasing that pulse value will make the servo turn clockwise, and a shorter pulse will turn the shaft anticlockwise.
- The servo control pulse is usually repeated every 20 milliseconds.
- When a servo is commanded to move, it will move to the position and hold that position, even if external force pushes against it.
- The servo will resist from moving out of that position, with the maximum amount of resistive force the servo can exert.

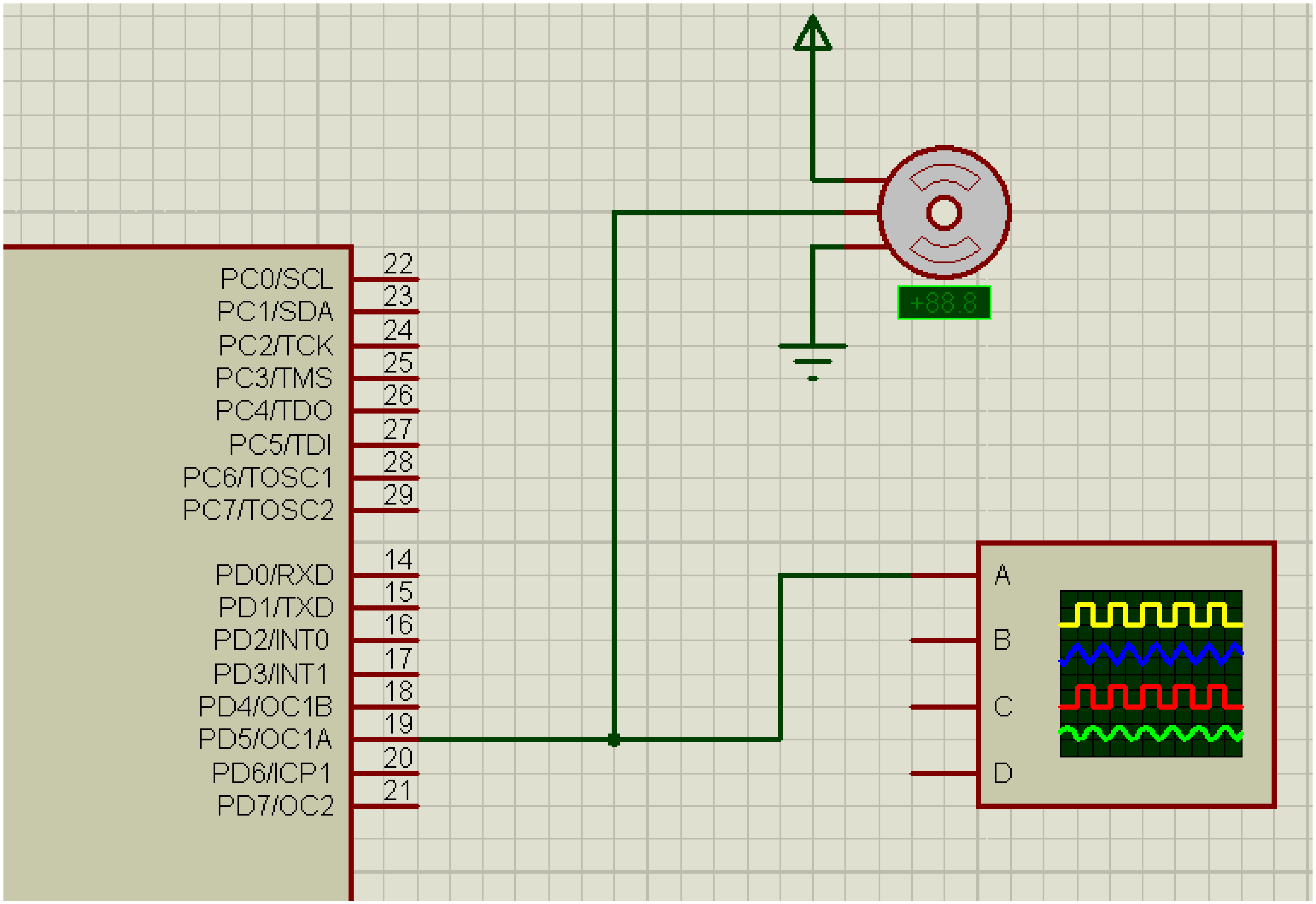
Stepper Motor

- Stepper motors utilize multiple toothed electromagnets arranged around a central gear to define position.
- Stepper motors require an external control circuit or micro controller to individually energize each electromagnet
- When electromagnet 'A' is powered it attracts the gear's teeth and aligns them, slightly offset from the next electromagnet 'B'.
- When 'A' is switch off, and 'B' switched on, the gear rotates slightly to align with 'B', and so on around the circle,
- Each rotation from one electromagnet to the next is called a "step", and thus the motor can be turned by precise pre-defined step angles through 180 or full 360 Degree rotation.

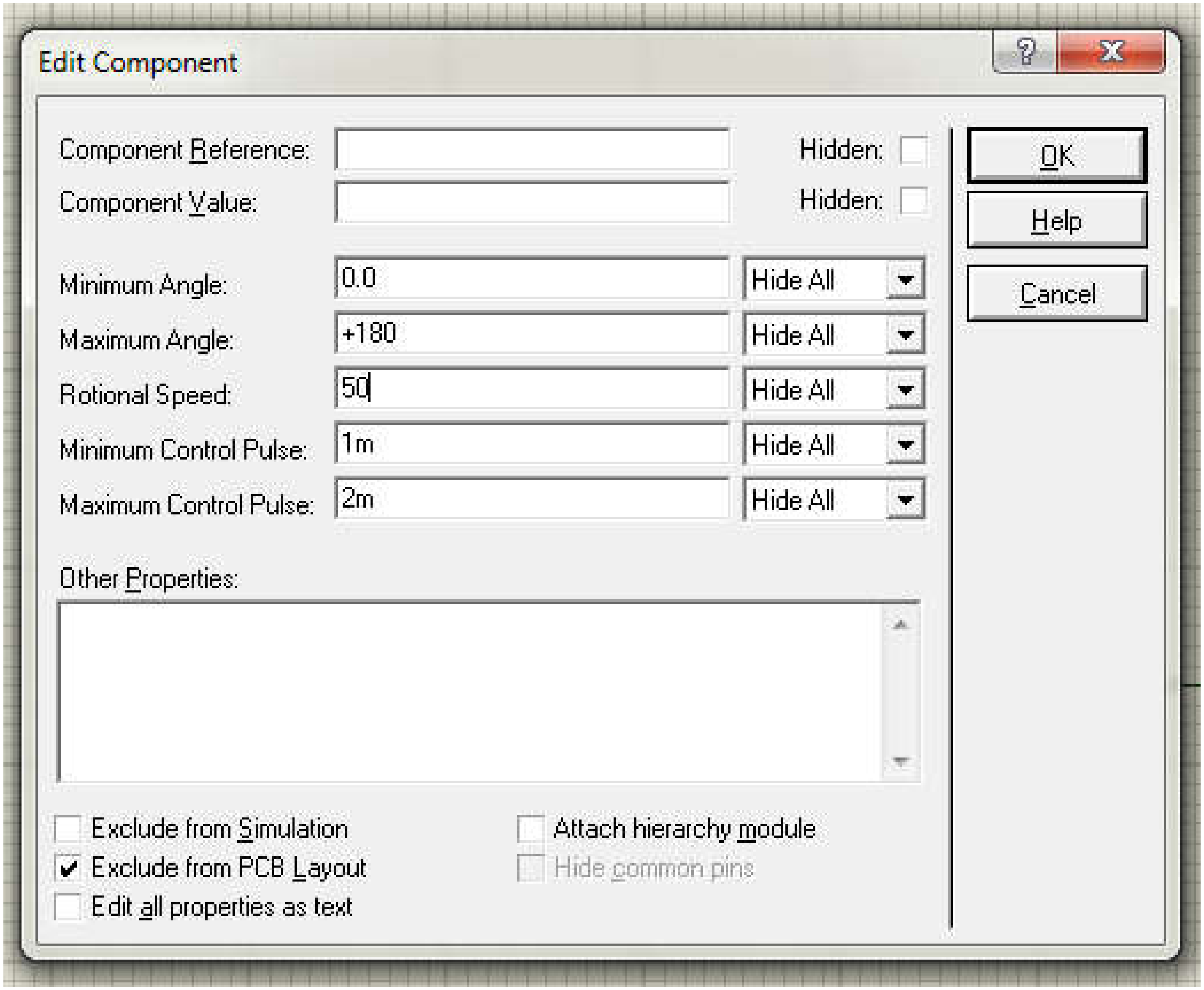
Stepper Motor (continued....)

- Stepper motors are available in two varieties; unipolar or bipolar.
- Bipolar motors are the strongest type of stepper motor and usually have four or eight leads.
- They have two sets of electromagnetic coils internally, and stepping is achieved by changing the direction of current within those coils.
- Unipolar motors, identifiable by having 5,6 or even 8 wires, also have two coils, but each one has a center tap.
- Unipolar motors can step without having to reverse the direction of current in the coils, making the electronics simpler.

Interfacing a Servo Motor in Proteus



Properties of the Servo Motor



The Calculations

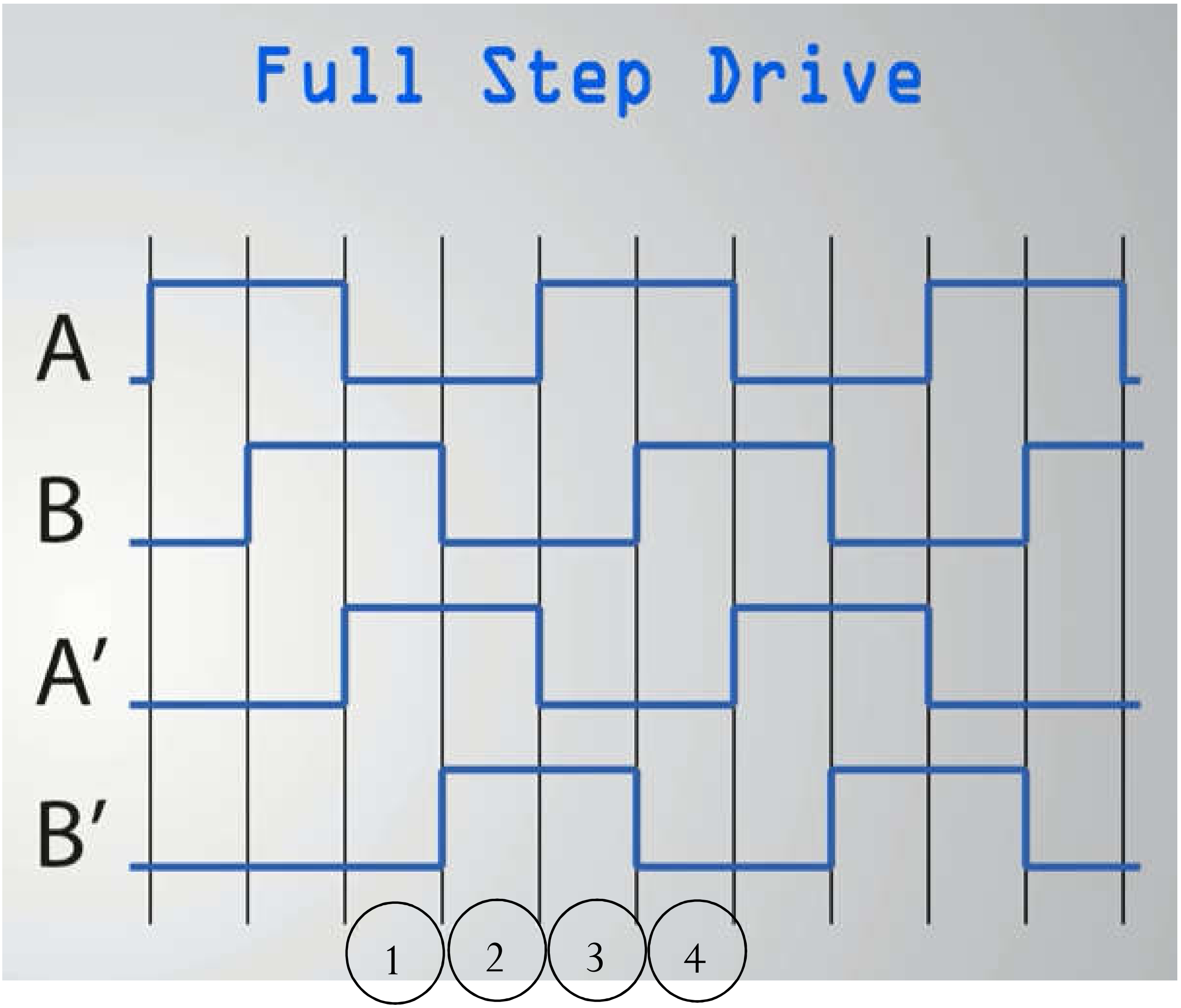
- The minimum time of the pulse = 1 ms
- The maximum time of the pulse = 2 ms
- Time period of the PWM signal = 20 ms (f=50Hz)
- Prescalar=8,
- So fosc=16MHz/8=2MHz
- Ttick=0.5uS
- No. of pulse to make 20 mS=20e-3/0.5e-6=40000=0x9C40
- No. of pulse to make 1 mS=1e-3/0.5e-6=2000
- No. of pulse to make 2 mS=2e-3/0.5e-6=4000
- To start with

  ICR1H=0x9C and ICR1L=0x40, and OCR1A=2000;

The Code for Interfacing A Servo Motor

```
#include <mega32.h>
#include <delay.h>
int i=0;
void main(void)
{
DDRD.5=1;
TCCR1A=(1<<COM1A1) |
(0<<COM1A0) | (0<<COM1B1) |
(0<<COM1B0) | (1<<WGM11) |
(0<<WGM10);
TCCR1B=(0<<ICNC1) |
(0<<ICES1) | (1<<WGM13) |
(1<<WGM12) | (0<<CS12) |
(1<<CS11) | (0<<CS10);
ICR1H=0x9C;
ICR1L=0x40;
while (1)
    {
    OCR1A=1999;
    for (i=0;i<200;i++)
    {       OCR1A=OCR1A+10;
            delay_ms(10);
    }
    delay_ms(2000);
    for (i=200;i>0;i--)
    {       OCR1A=OCR1A-10;
            delay_ms(10);
    }
    delay_ms(2000);
    }
}
```

Interfacing a Stepper Motor (Full Step)



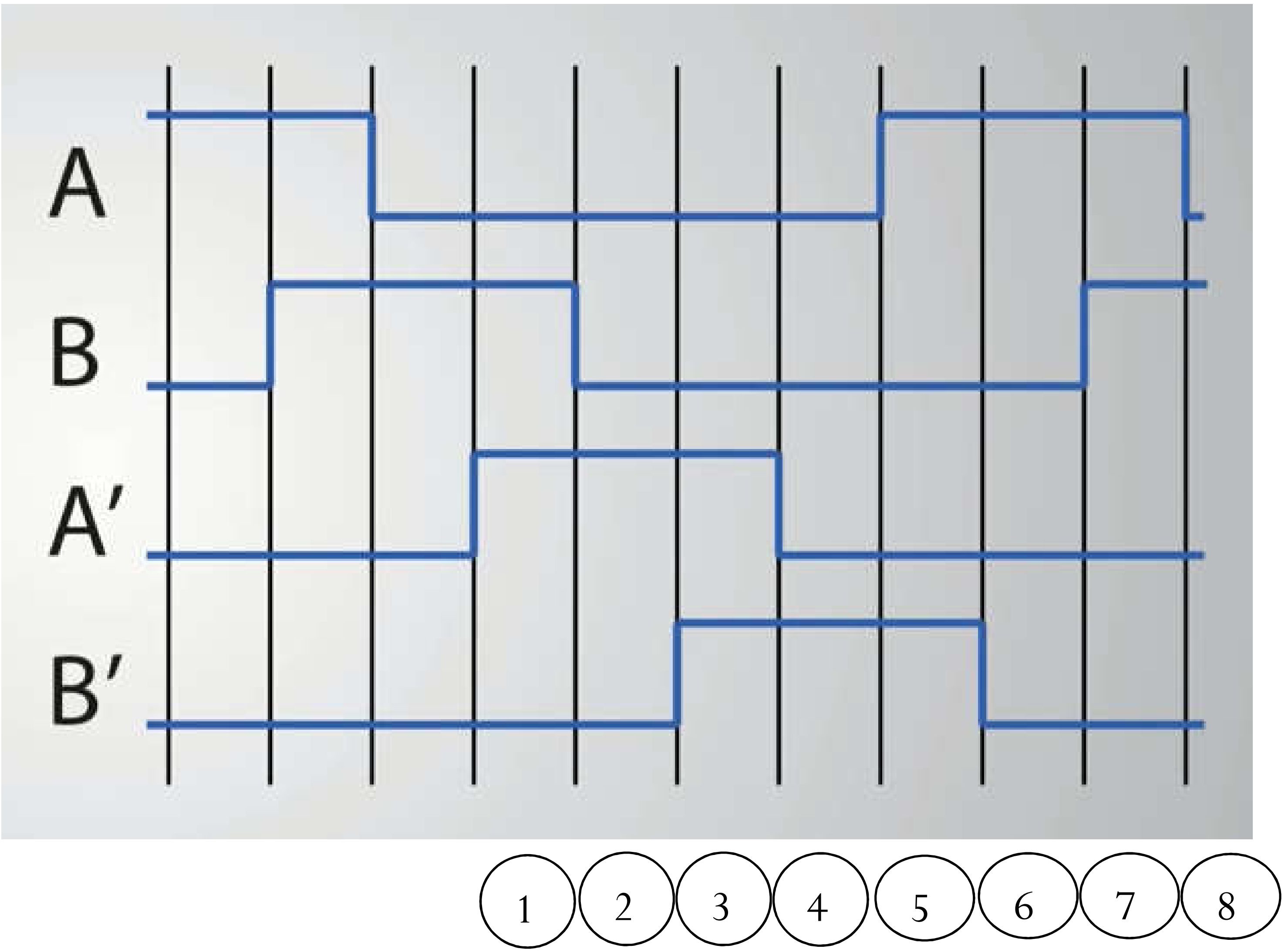
1-0110

2-0011

3-1001

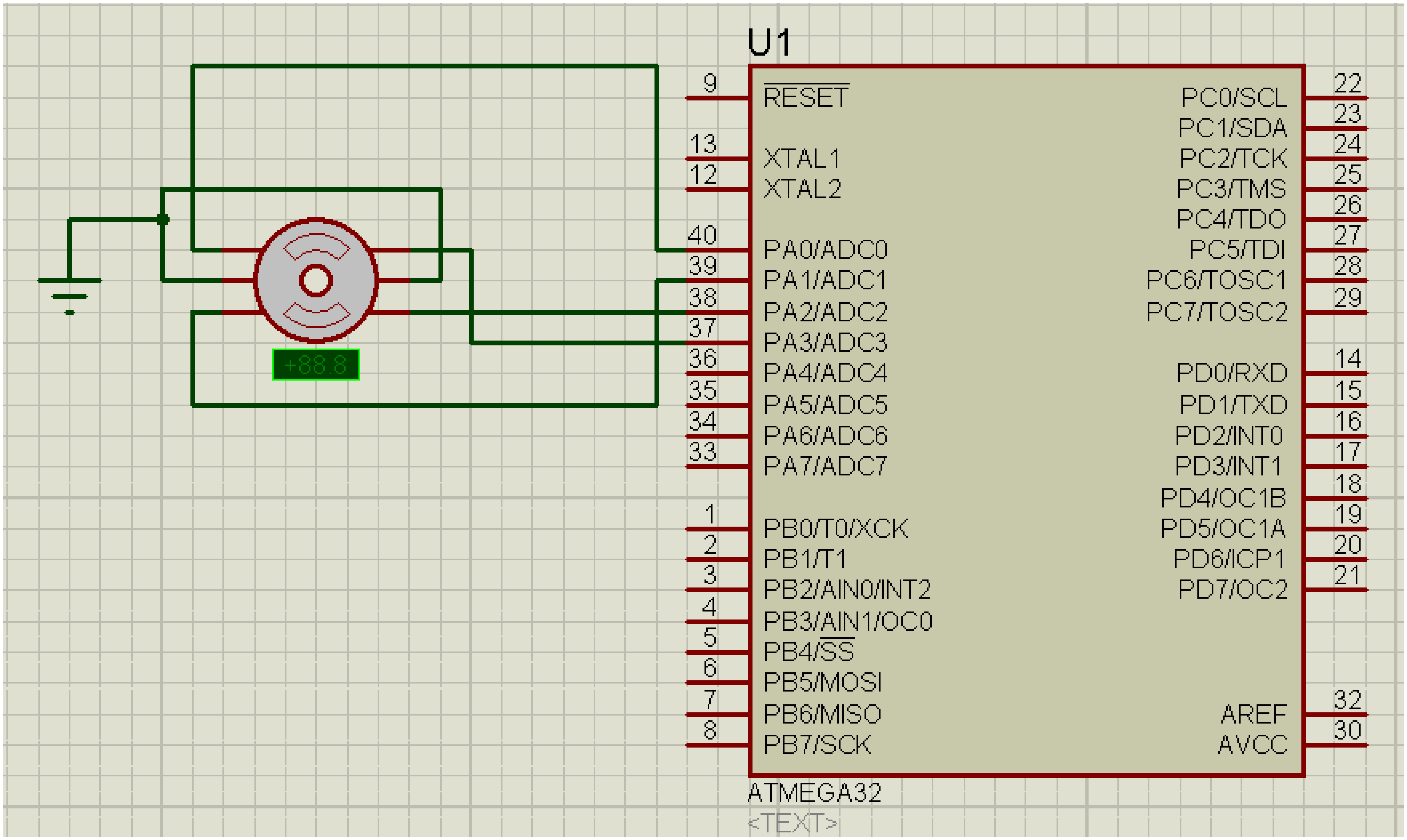
4-1100

Interfacing a Stepper Motor (Half Step)

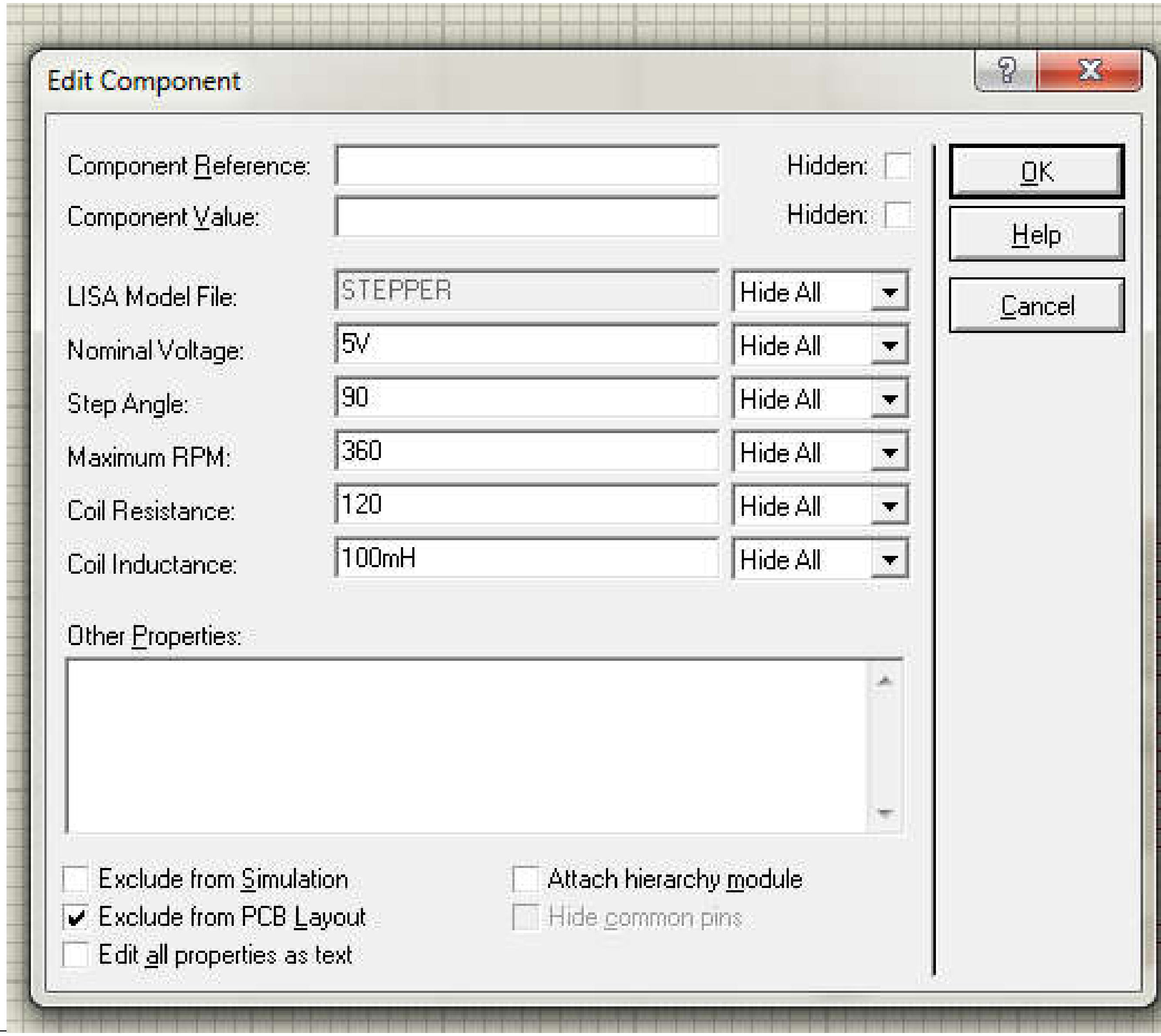


1-0110
2-0010
3-0011
4-0001
5-1001
6-1000
7-1100
8-0100

Interfacing a Stepper Motor in Proteus



Properties of the Stepper Motor



The Code for Interfacing for Full Stepping

```
#include <mega32.h>
#include <delay.h>
void main(void)
{
DDRA=0xFF;
while (1)
    {
        full_step();
    }
}
```

```
void full_step(void)
{
    PORTA=0b00000110;
    delay_ms(1000);
    PORTA=0b00000011;
    delay_ms(1000);
    PORTA=0b00001001;
    delay_ms(1000);
    PORTA=0b00001100;
    delay_ms(1000);
}
```

The Code for Interfacing for Half Stepping

```
#include <mega32.h>
#include <delay.h>
void main(void)
{
DDRA=0xFF;
while (1)
   {
         half_step();
   };
}
```

```
void half_step(void)
  {       PORTA=0b00000110;
          delay_ms(1000);
          PORTA=0b00000010;
          delay_ms(1000);
          PORTA=0b00000011;
          delay_ms(1000);
          PORTA=0b00000001;
          delay_ms(1000);
          PORTA=0b00001001;
          delay_ms(1000);
          PORTA=0b00001000;
          delay_ms(1000);
          PORTA=0b00001100;
          delay_ms(1000);
          PORTA=0b00000100;
          delay_ms(1000);
}
```

Thanks