Interfacing with Simple Display Devices

Lecture 4

Embedded Systems

Reference: Chapters 7, Arduino Cookbook, Michael Margolis, 1st Edition, 2011, O'Reilly books

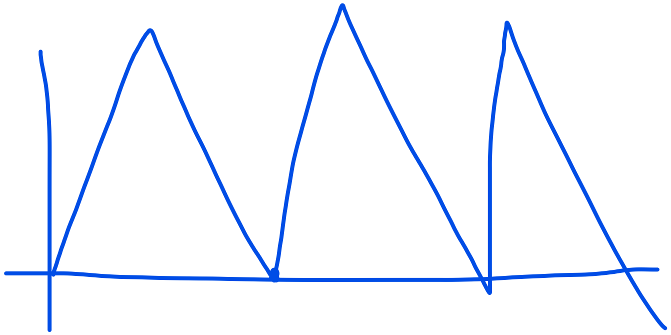
Adjusting the Brightness of an LED

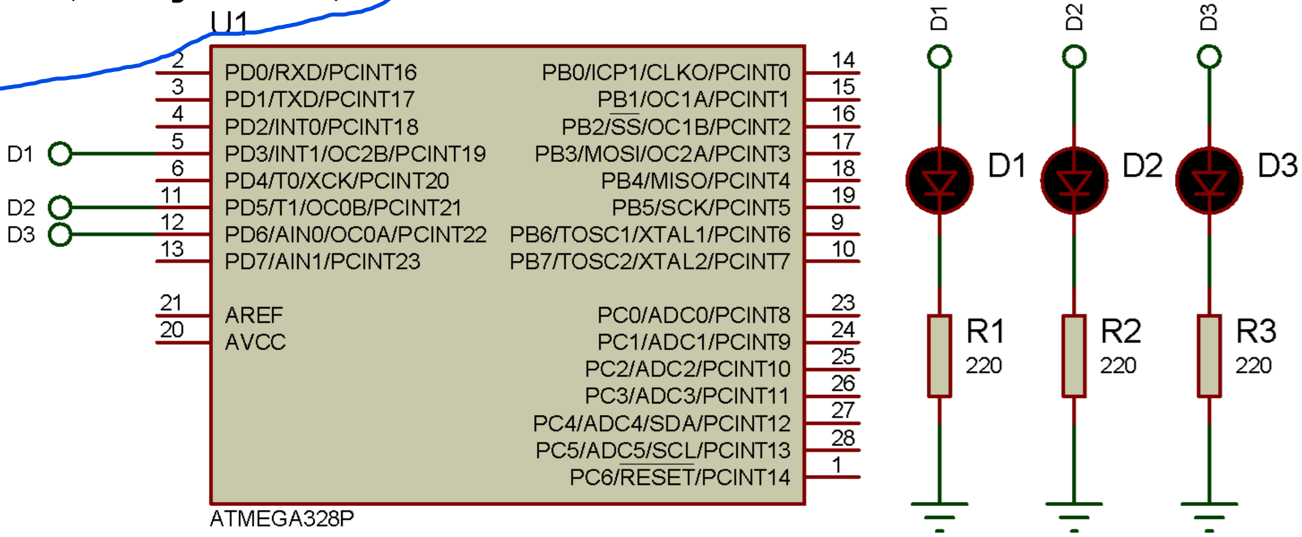
```
#define DT 100
const int firstLed = 3;
const int secondLed = 5;
const int thirdLed = 6;
int brightness = 0;
int increment = 1;
void setup()
{
	// pins driven by analogWrite do not
	// need to be declared as outputs
}
void loop()
{
	if(brightness==255)increment*=-1;
	brightness+=increment;
```

if(brightness==0) increment*=-1; %% y5leny arg3 tany %% , aw kan momkn ast8na 3no 5als w a3rf variable al brightness mn al 2wl (unsigned char)

```
	analogWrite(firstLed, brightness);
	analogWrite(secondLed, brightness);
	analogWrite(thirdLed, brightness );
	delay(DT);
}
```

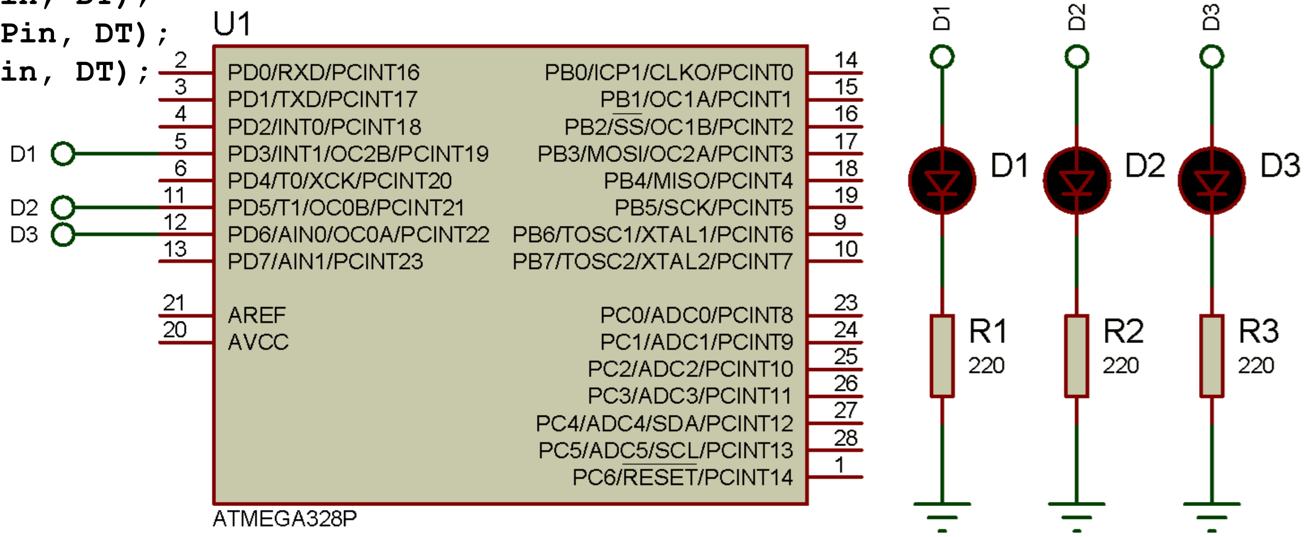
ya3ni mn 8er al line da kont hwsl 255 w b3den anzl l zero w msh htl3 tany 5las





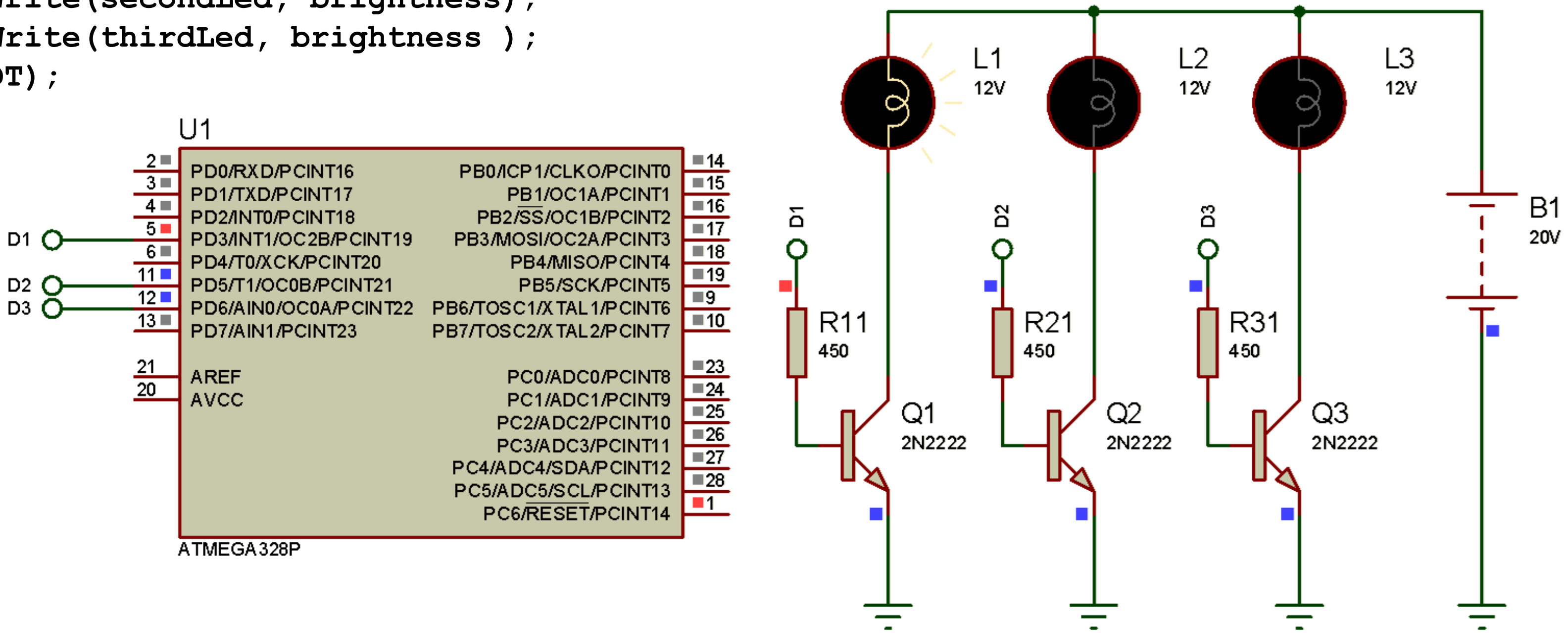
Connecting and Using LEDs

```
#define DT 10
const int firstLedPin = 3;
const int secondLedPin = 5;
const int thirdLedPin = 6;
void blinkLED(int pin, int duration)
{
      digitalWrite(pin, HIGH);
      delay(duration);
      digitalWrite(pin, LOW);
      delay(duration);
}
void setup()
{
      pinMode(firstLedPin, OUTPUT);
      pinMode(secondLedPin, OUTPUT);
      pinMode(thirdLedPin, OUTPUT);
}
void loop()
{
      blinkLED(firstLedPin, DT);
      blinkLED(secondLedPin, DT);
      blinkLED(thirdLedPin, DT);
}
```



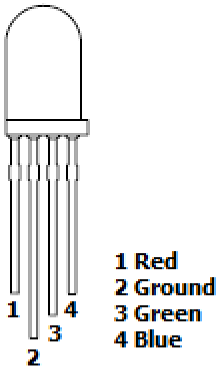
Adjusting the Brightness of an LED

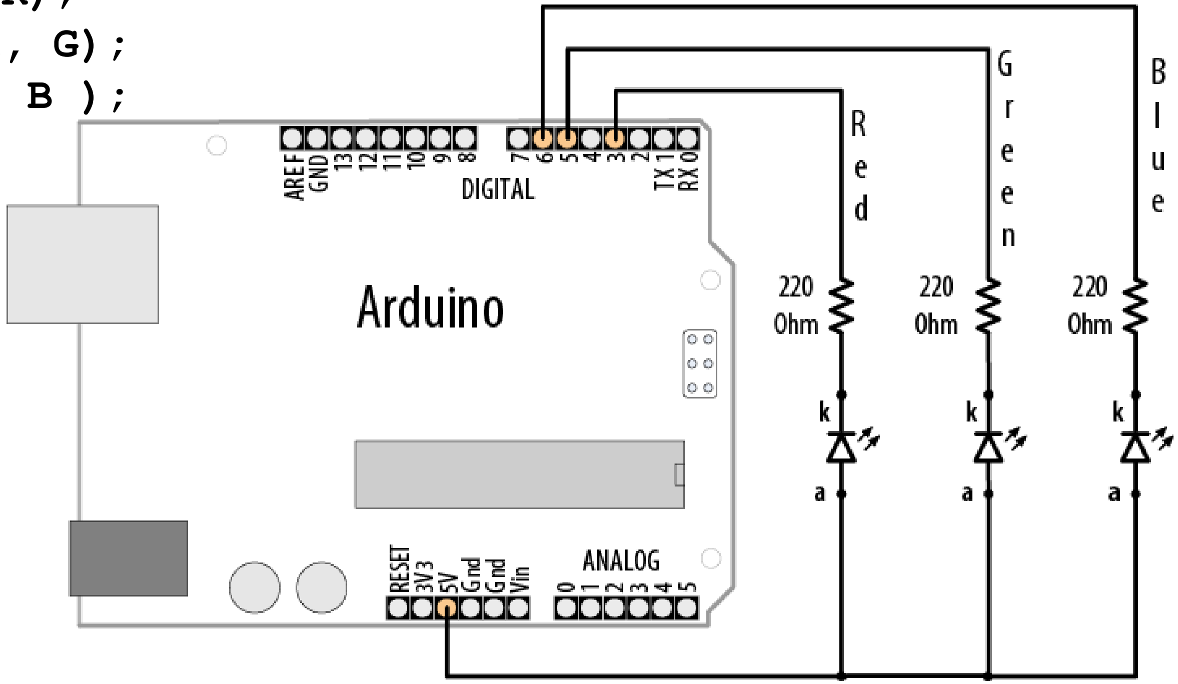
```
#define DT 100
const int firstLed = 3;
const int secondLed = 5;
const int thirdLed = 6;
Unsigned char  brightness = 0;
int increment = 1;
void setup()
{
     // pins driven by analogWrite do not
     // need to be declared as outputs
}
void loop()
{
     if(brightness==255)increment*=-1;
     brightness+=increment;

     analogWrite(firstLed, brightness);
     analogWrite(secondLed, brightness);
     analogWrite(thirdLed, brightness );
     delay(DT);
}
```



Adjusting the Color of an LED

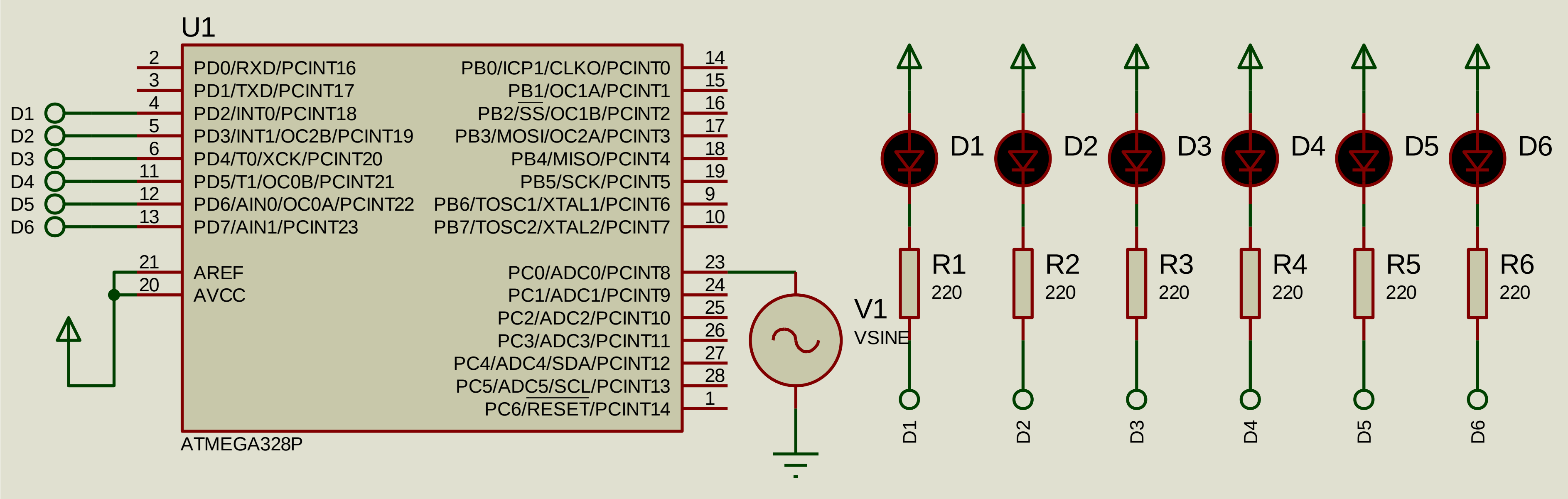
```
#define DT 10
const int redPin = 3;
const int greenPin = 5;
const int bluePin = 6;
int R = 255, G = 165, B = 0; // Orange
void setup()
{
     // pins driven by analogWrite
     // do not need to be declared as outputs
}
void loop()
{
     analogWrite(redPin, R);
     analogWrite(greenPin, G);
     analogWrite(bluePin, B );
     delay(DT);
}
```





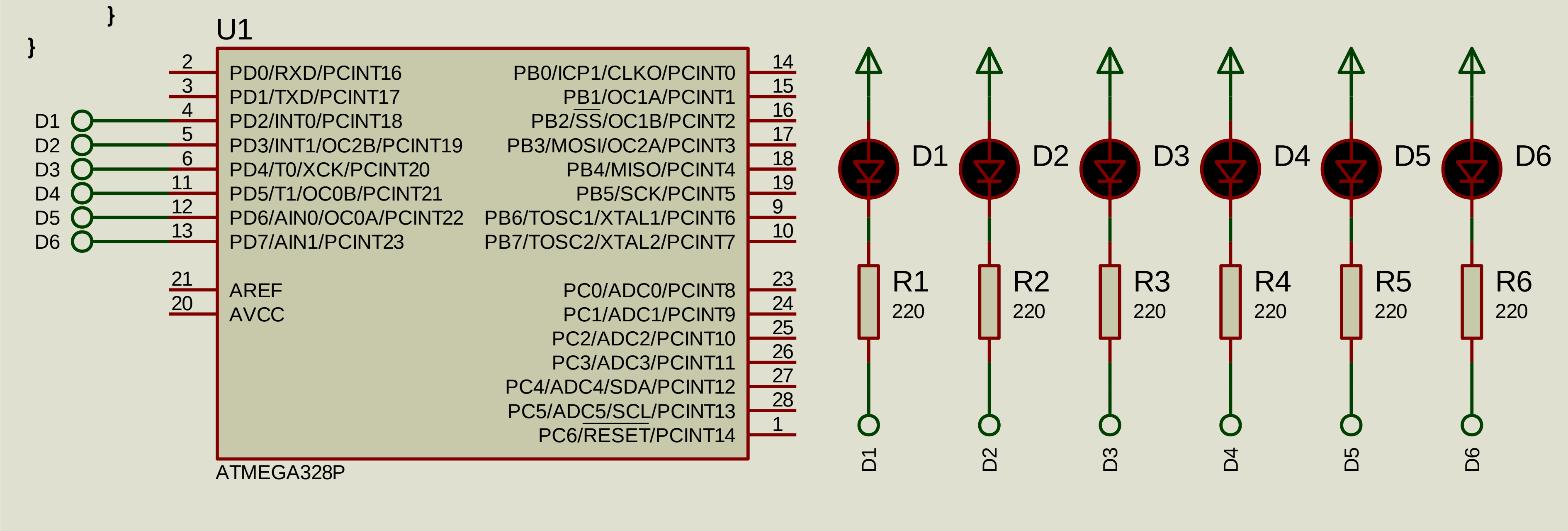
Sequencing Multiple LEDs 1

```
const int leds[] = { 2, 3, 4, 5, 6, 7};
const int nLeds = sizeof(leds)/sizeof(int);
const int analogInPin = 0;
void setup() {
    for (int i = 0; i < nLeds; i++)
        pinMode(leds[i], OUTPUT);
}
void loop() {
    int sensorValue = analogRead(analogInPin);
    sensorValue = map(sensorValue, 0, 1023, 0, nLeds);
    for (int i = 0; i < nLeds; i++)
    {
        if(i < sensorValue)
            digitalWrite(leds[i], HIGH);
        else
            digitalWrite(leds[i], LOW);
    }
}
```

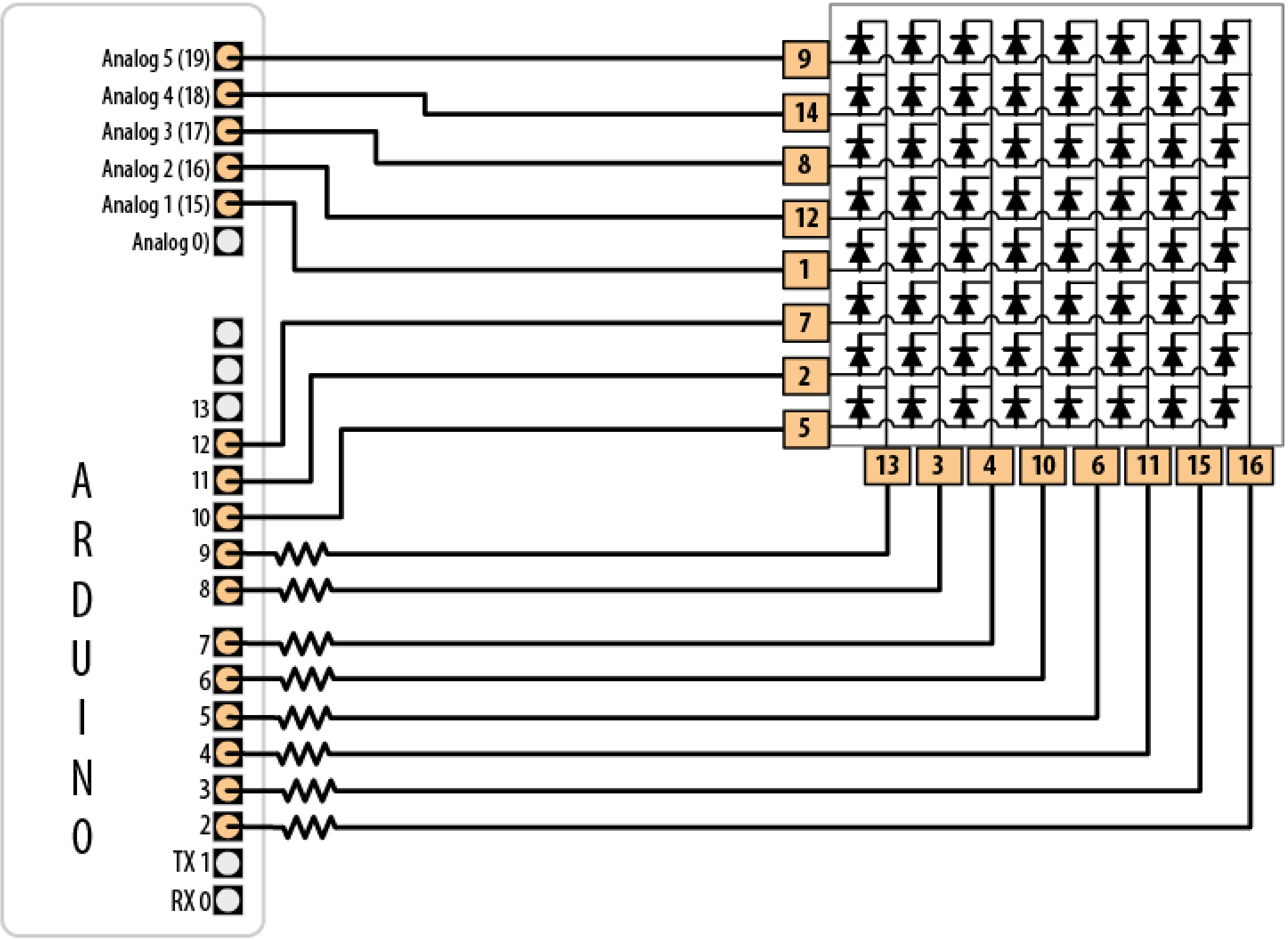


Sequencing Multiple LEDs 2

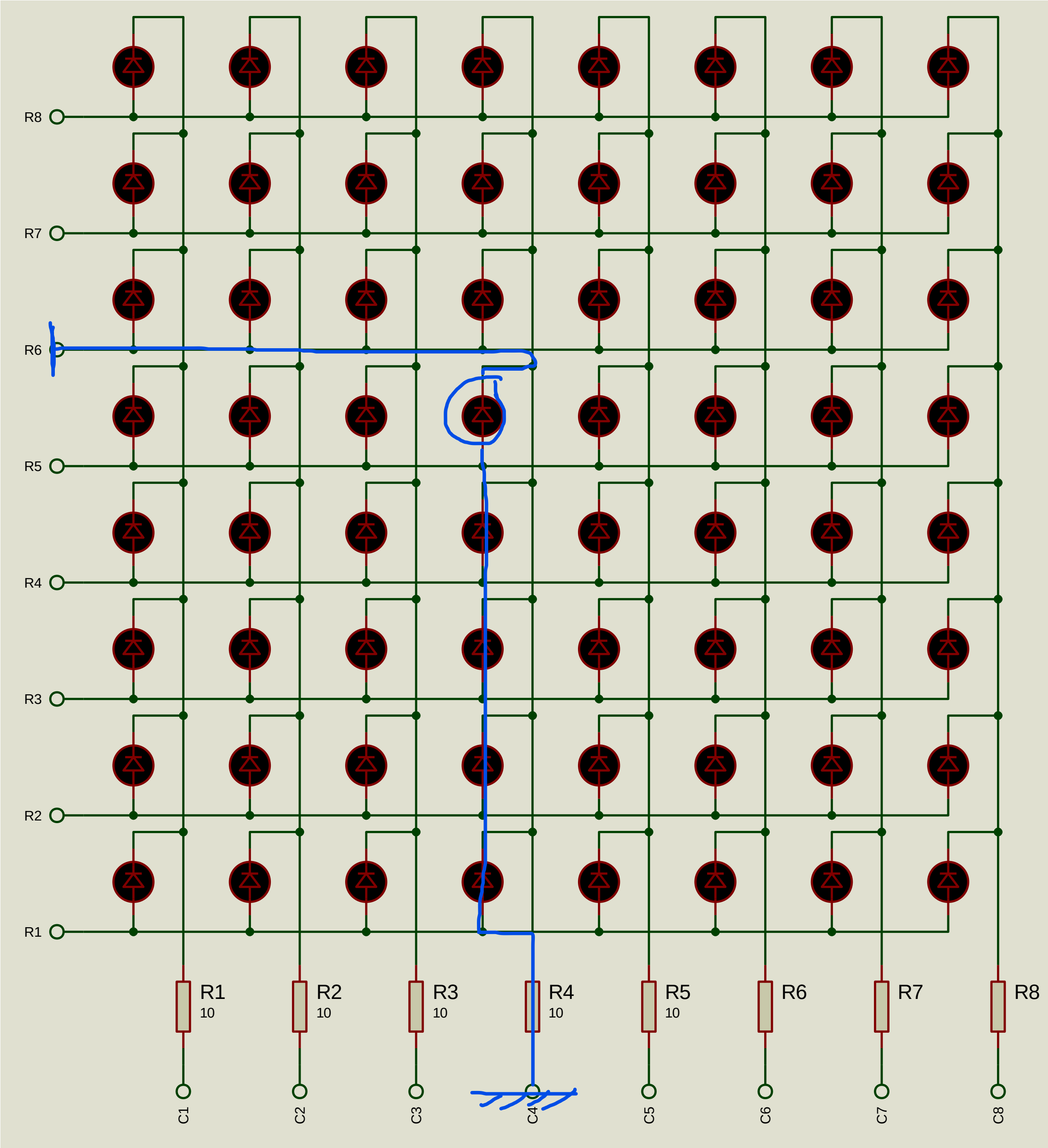
```
#define DT 5
const int leds[] = { 2, 3, 4, 5, 6, 7};
const int nLeds = sizeof(leds)/sizeof(int);
const int analogInPin = 0;
void setup() {
     for (int i = 0; i < nLeds; i++)
          pinMode(leds[i], OUTPUT);
}
void loop() {
     for (int i = 0; i < nLeds-1; i++)
     {
          digitalWrite(leds[i], HIGH); delay(DT);
          digitalWrite(leds[i+1], HIGH); delay(DT);
          digitalWrite(leds[i], LOW); delay(DT*2);
     }
     for (int i = nLeds; i > 0; i--) {
          digitalWrite(leds[i], HIGH); delay(DT);
          digitalWrite(leds[i-1], HIGH); delay(DT);
          digitalWrite(leds[i], LOW); delay(DT*2);
     }
}
```



Controlling a LED Matrix Using Multiplexing

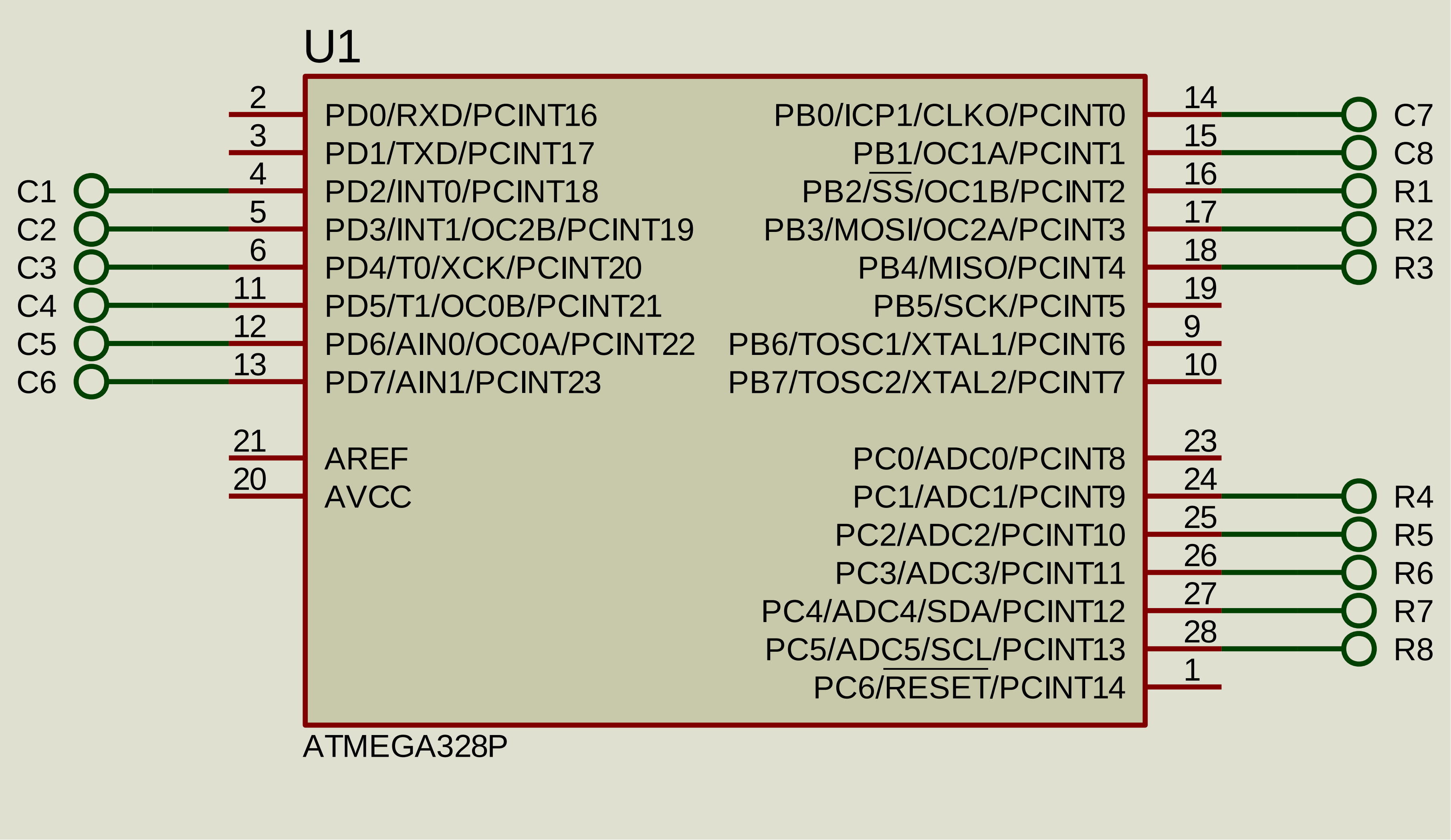


Controlling a LED Matrix Using Multiplexing



ba5od al led ally ana 3ayz anwrha w a7ot al column bta3ha low w al row a5leh high

Controlling an LED Matrix Using Multiplexing



Controlling an LED Matrix Using Multiplexing

```
#define DT 10
const int columnPins[] = { 2, 3, 4, 5, 6, 7, 8, 9};
const int rowPins[] = { 10,11,12,15,16,17,18,19};
int iRow = 0;
int iColumn = 0;

void setup() {
     for (int i = 0; i < 8; i++){
          pinMode(columnPins[i], OUTPUT);
          pinMode(rowPins[i], OUTPUT);
     }
}

void loop() {
    for(int c = 0; c < 8 ; c++)
      digitalWrite(columnPins[c], (c==iColumn)?LOW:HIGH);

     for(int r = 0; r < 8 ; r++)
      digitalWrite(rowPins[r], (r==iRow)?HIGH:LOW);

     delay(DT);
     iColumn++;
     if(iColumn==8){iColumn = 0; iRow++;}
     if(iRow==8){iColumn = 0; iRow = 0;}
}
```

Showing Images

وهكذا

أول صف

تاني صف

```
#define DT 50
byte bigHeart[] = { B01100110, B11111111, B11111111, B11111111,
                    B01111110, B00111100, B00011000, B00000000};
byte smallHeart[]={ B00000000, B00000000, B00010100, B00111110,
                    B00111110, B00011100, B00001000, B00000000};
const int columnPins[] = { 2, 3, 4, 5, 6, 7, 8, 9};
const int rowPins[] = { 10,11,12,15,16,17,18,19};
void show( byte * image, unsigned long duration){
     unsigned long start = millis();
     while (start + duration > millis()){
          for(int row = 0; row < 8; row++){
               digitalWrite(rowPins[row], HIGH);
               for(int column = 0; column < 8; column++){
                    boolean pixel = bitRead(image[row],column);
                    if(pixel)digitalWrite(columnPins[column], LOW);
                    delayMicroseconds(300);
                    digitalWrite(columnPins[column], HIGH);
               }
               digitalWrite(rowPins[row], LOW);
          }
     }
}
void setup() {
     for (int i = 0; i < 8; i++){
          pinMode(rowPins[i], OUTPUT)
          pinMode(columnPins[i], OUTPUT);
          digitalWrite(columnPins[i], HIGH);
     }
}
void loop() {
     show(smallHeart, DT);
     show(bigHeart, 2*DT);
     delay(5*DT);
}
```

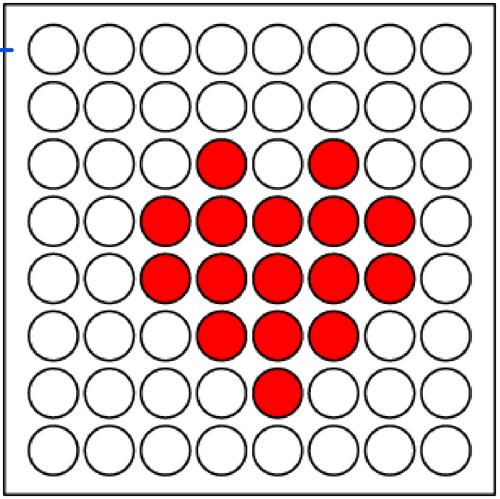
b5ly al row high
3shan yb2a gahz
3shan ay column
yb2a low y48l al led

blf hna 3la al columns kolha .. tb a5ly
men high w men low ?
3la 7sb al bitRead lw 2altly an al row
high b5ly al column b low

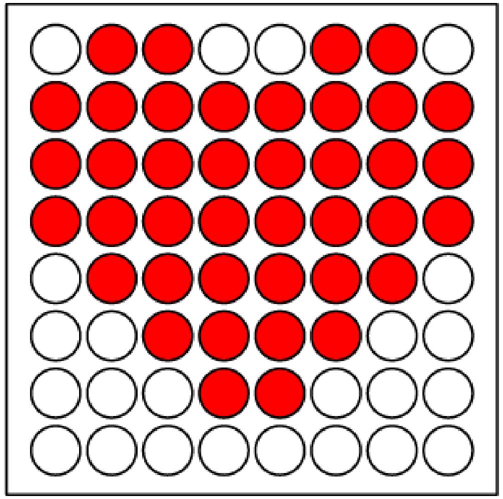
hna brg3 a5ly al column b high 3shan atfeha

row[0]

row[7]



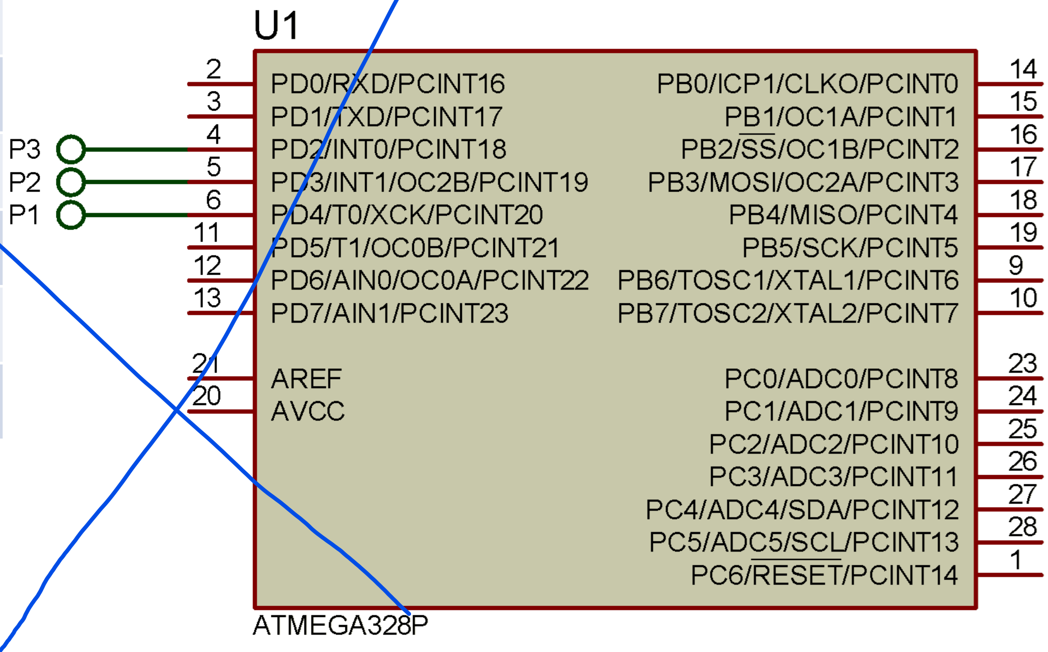
Small Heart

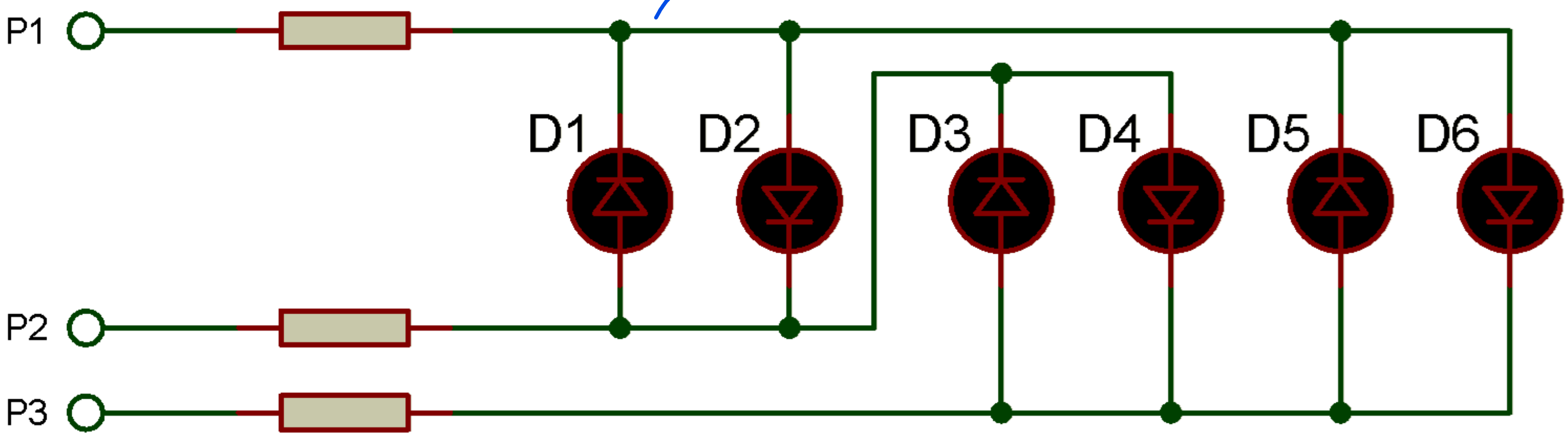


Big Heart

Using Charlieplexing

	P1	P2	P3
-	LOW	LOW	LOW
D1	LOW	HIGH	INPUT
D2	HIGH	LOW	INPUT
D3	INPUT	LOW	HIGH
D4	INPUT	HIGH	LOW
D5	LOW	INPUT	HIGH
D6	HIGH	INPUT	LOW

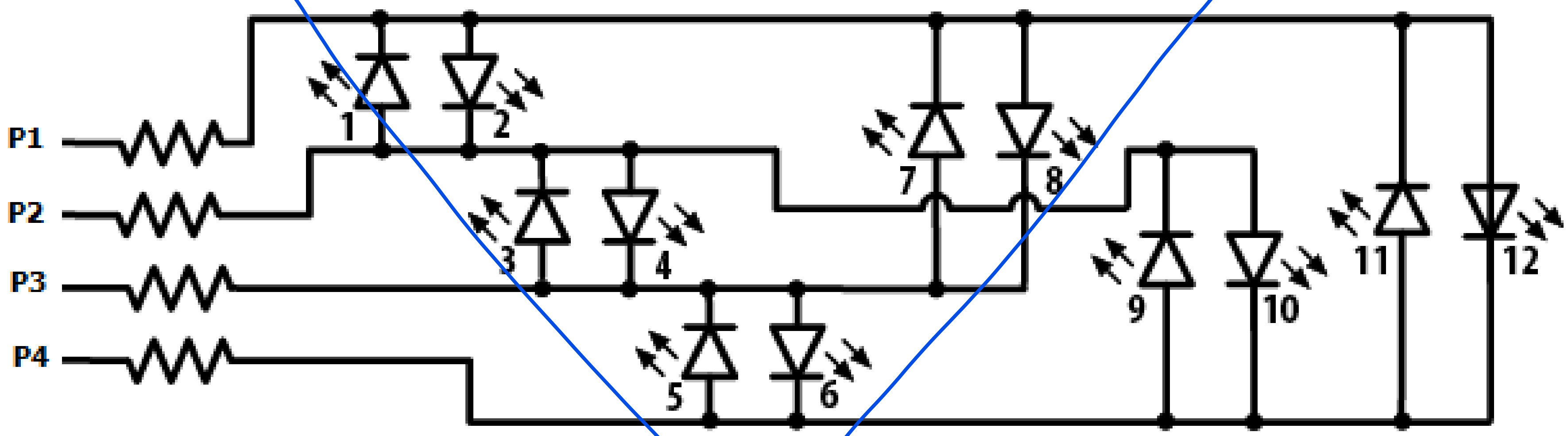




```
#define DT 100
byte pins[] = {2,3,4};
const int NUMBER_OF_PINS = sizeof(pins)/ sizeof(pins[0]);
const int NUMBER_OF_LEDS = NUMBER_OF_PINS * (NUMBER_OF_PINS-1);
byte pairs[NUMBER_OF_LEDS/2][2] = { {0,1}, {1,2}, {0,2} };
void setup(){}
void loop(){
     for(int i=0; i < NUMBER_OF_LEDS; i++){
          lightLed(i);
          delay(DT);
     }
}
void lightLed(int led){
     int indexA = pairs[led/2][0];
     int indexB = pairs[led/2][1];
     int pinA = pins[indexA];
     int pinB = pins[indexB];
     for(int i=0; i < NUMBER_OF_PINS; i++){
          if(i!=indexA && i!=indexB){
               pinMode(pins[i], INPUT);
               digitalWrite(pins[i],LOW);
          }
     }

     pinMode(pinA, OUTPUT);
     pinMode(pinB, OUTPUT);
     if( led % 2 == 0){
          digitalWrite(pinA,LOW);
          digitalWrite(pinB,HIGH);
     }
     else{
          digitalWrite(pinB,LOW);
          digitalWrite(pinA,HIGH);
     }
}
```

~~Using Charlieplexing~~

Using Charlieplexing

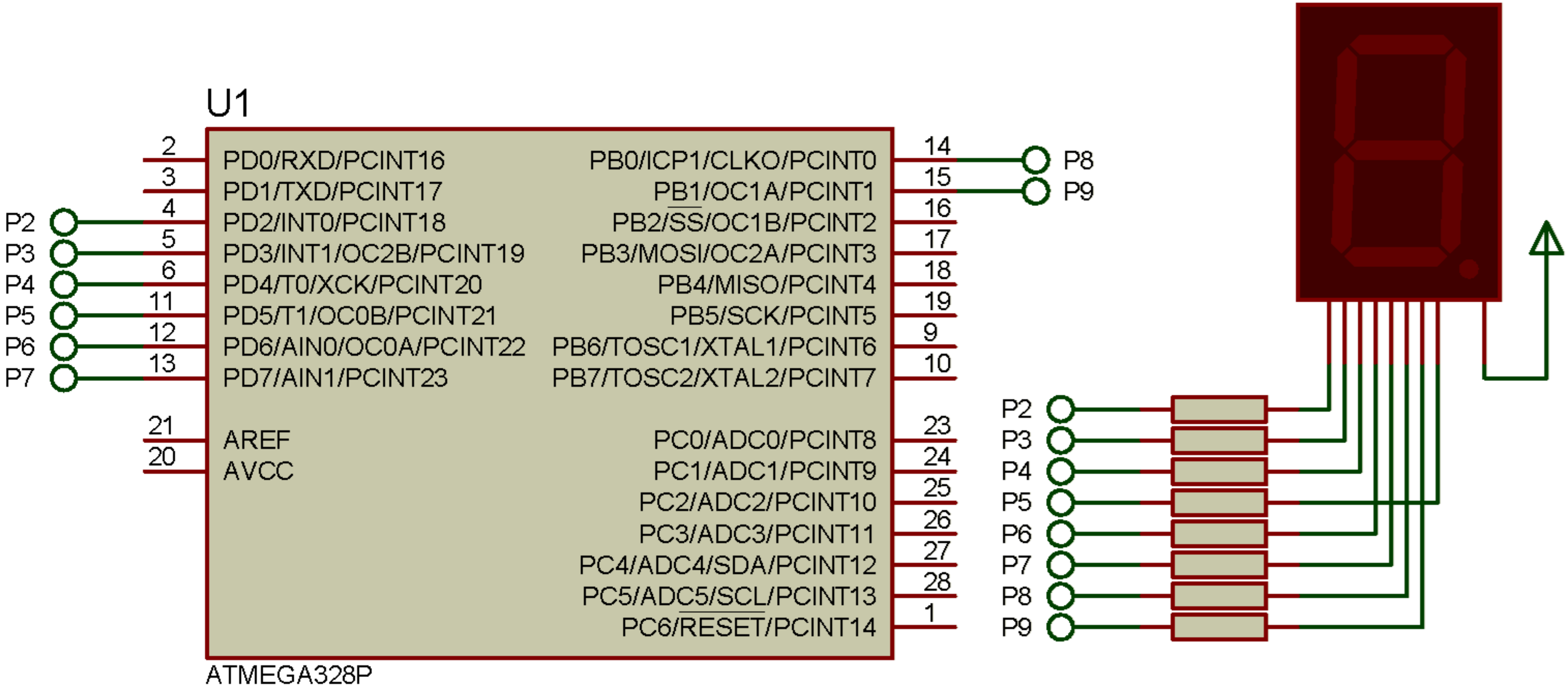


	P1	P2	P3	P4
-	LOW	LOW	LOW	LOW
D1	LOW	HIGH	INPUT	INPUT
D2	HIGH	LOW	INPUT	INPUT
D3	INPUT	LOW	HIGH	INPUT
D4	?	?	?	?

Driving a 7-Segment LED Display

for common Andoe (put LOW)
for common Cathode (put HIGH)

Common Anode



Driving a 7-Segment LED Display

```
#define DT 50
const byte digits[10] = {
   //ABCDEFGP
     B11111100, // 0
     B01100000, // 1
     B11011010, // 2
     B11110010, // 3
     B01100110, // 4
     B10110110, // 5
     B00111110, // 6
     B11100000, // 7
     B11111110, // 8
     B11100110, // 9
};
const int segmentPins[8] = { 5,9,8,7,6,4,3,2};
int number= 0;
void setup(){
     for(int i=0; i < 8; i++)
          pinMode(segmentPins[i], OUTPUT);
}
void loop(){
     showDigit(number++);
     delay(DT);
     if(number==10)number= 0;
}
void showDigit(int number){
     for(int segment = 0; segment < 8; segment++)
     {
          boolean isBitSet = bitRead(digits[number], segment);
          digitalWrite( segmentPins[segment], !isBitSet);
     }
}
```

importance of bitRead , badeha byte w batlob mnha bit kza ,, for EX:

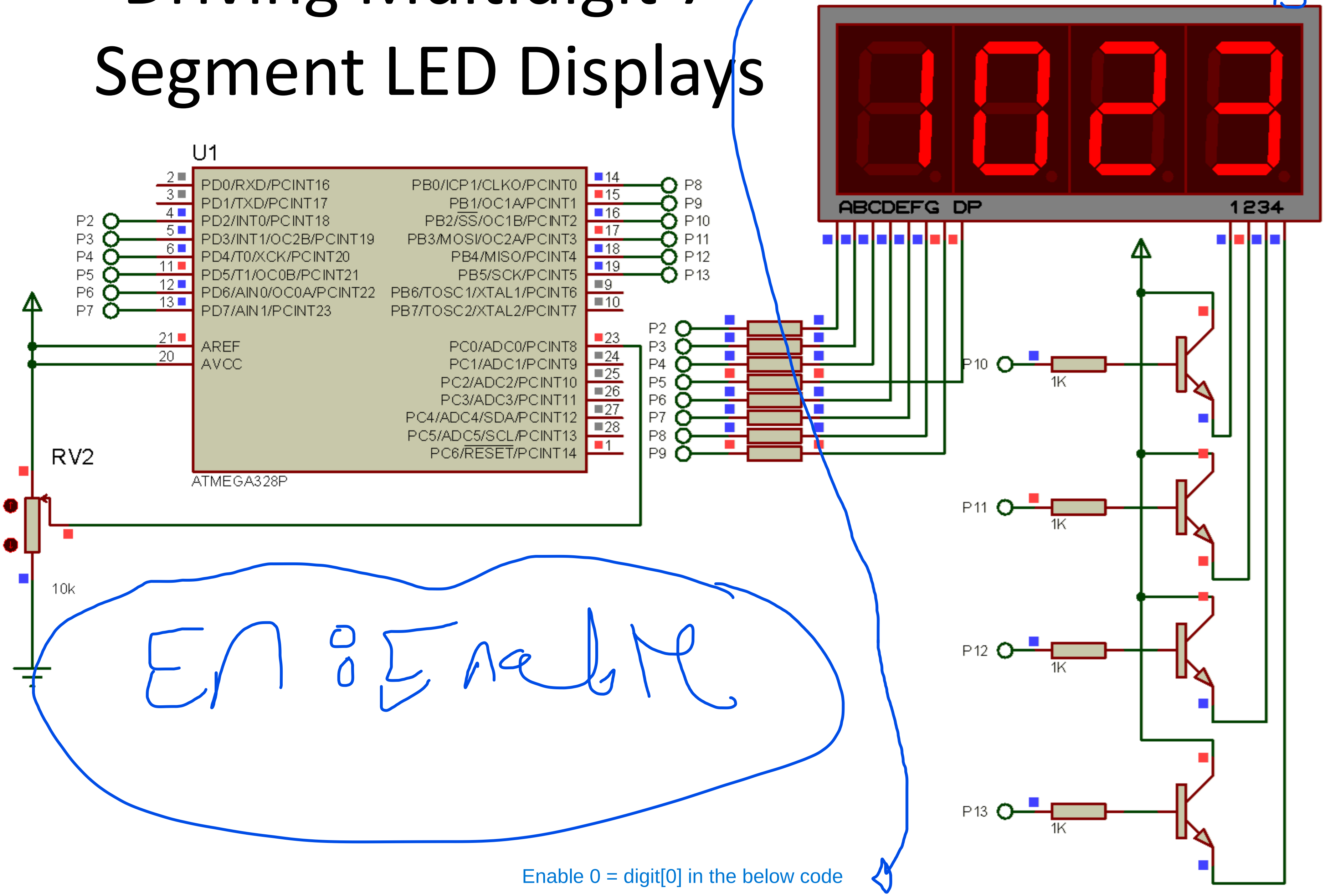
bitRead(B11100110,0) >>>> 0
bitRead(B11100110,1) >>>> 1
bitRead(B11100110,2) >>>> 1
bitRead(B11100110,3) >>>> 0
bitRead(B11100110,4) >>>> 0

From Right.

3shan anwr al led bady zero msh wa7d 3shan da common andoe

Driving Multidigit 7-Segment LED Displays

En_0 En_3



En : Enable

Enable 0 = digit[0] in the below code

Driving Multidigit 7-Segment LED Displays

```
#define DT 1
const byte digits[10]={  B11111100, B01100000, B11011010,
                              B11110010, B01100110, B10110110,
                              B00111110, B11100000, B11111110,
                              B11100110};
const int segmentPins[8] = { 5,9,8,7,6,4,3,2};
const int digitPins[4] = {10,11,12,13};
int nDigits = sizeof(digitPins)/sizeof(int);
void setup(){
     for(int i=0; i < 8; i++)
          pinMode(segmentPins[i], OUTPUT);
     for(int i=0; i < nDigits; i++)
          pinMode(digitPins[i], OUTPUT);
}
void loop(){
     int value = analogRead(0);
     showNumber(value);
}
void showNumber(int number){
     for(int digit = nDigits-1; digit >= 0; digit--){
          showDigit(number % 10, digit) ;
          number = number / 10;
     }
}
void showDigit(int number, int digit){
     digitalWrite(digitPins[digit], HIGH);
     for(int segment = 0; segment < 8; segment++)
     {
          boolean isBitSet = bitRead(digits[number], segment);
          digitalWrite( segmentPins[segment], !isBitSet);
     }
     delay(DT);
     digitalWrite(digitPins[digit], LOW);
}
```

Enables

btt7km men fe al 4 ally hya ht4t8l 3aleh (anhy enable ya3ni)

1023%10 >> 3
1023/10 >> 102

Last Digit (En)

102%10 >> 2
102/10 >> 10

10%10 >> 0
10/10 >> 1

1%10 >> 1
1/10 >> 0

first digit (En)