

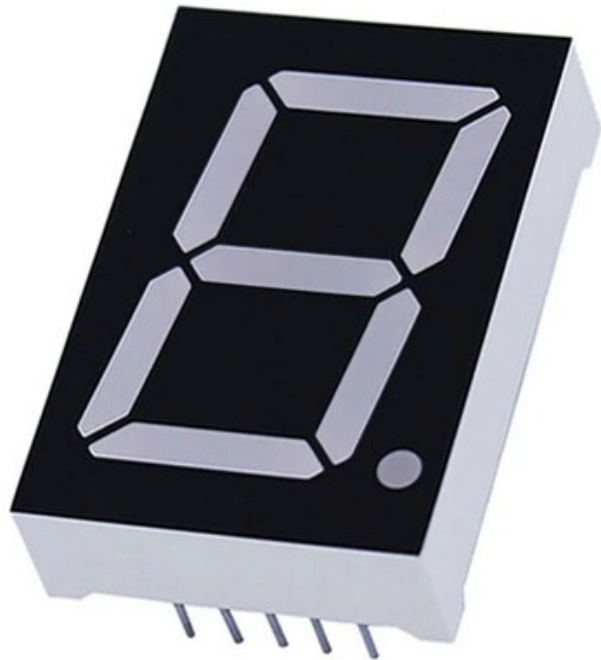


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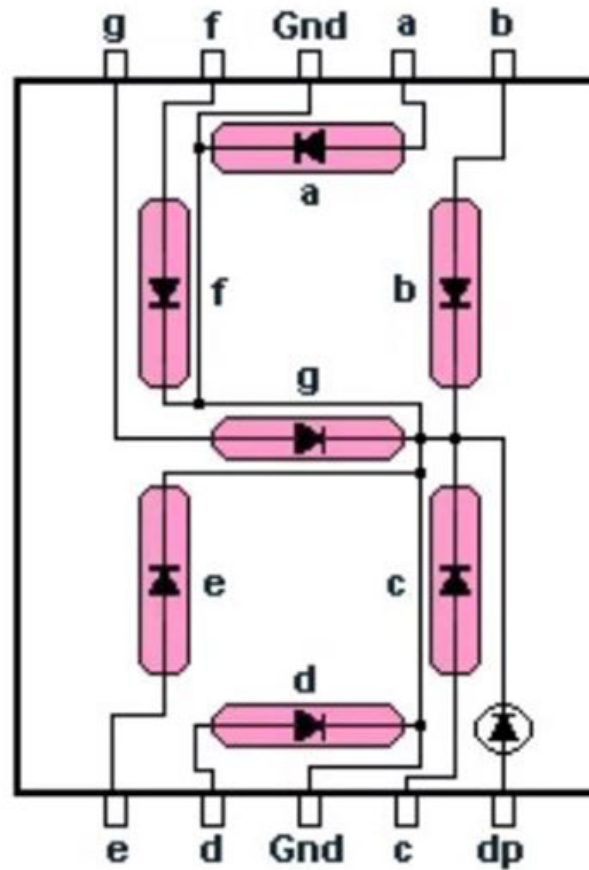
# Microcontrollers & Applications

Lecture 5.1: Seven Segment Display

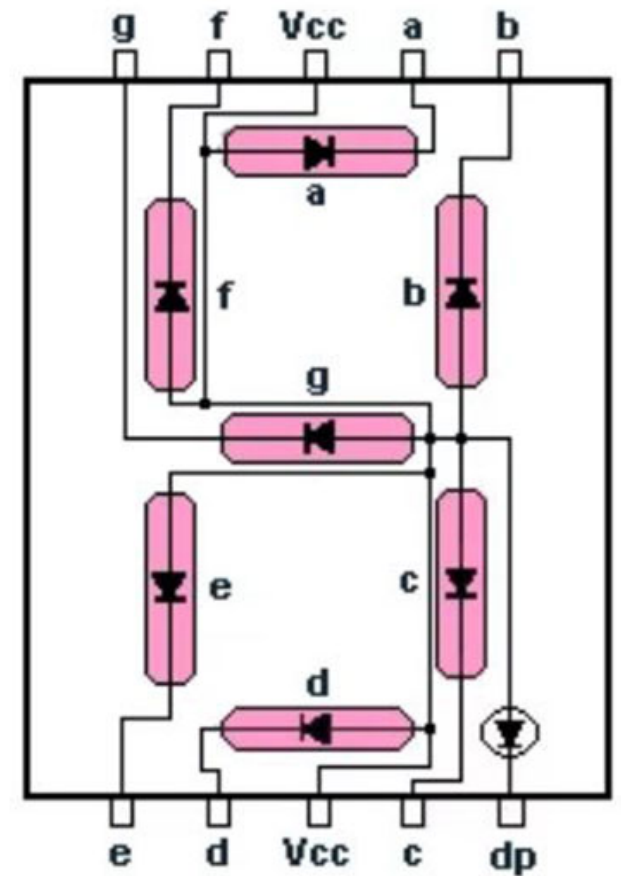
# Seven Segment Display: Structure



Common Cathode

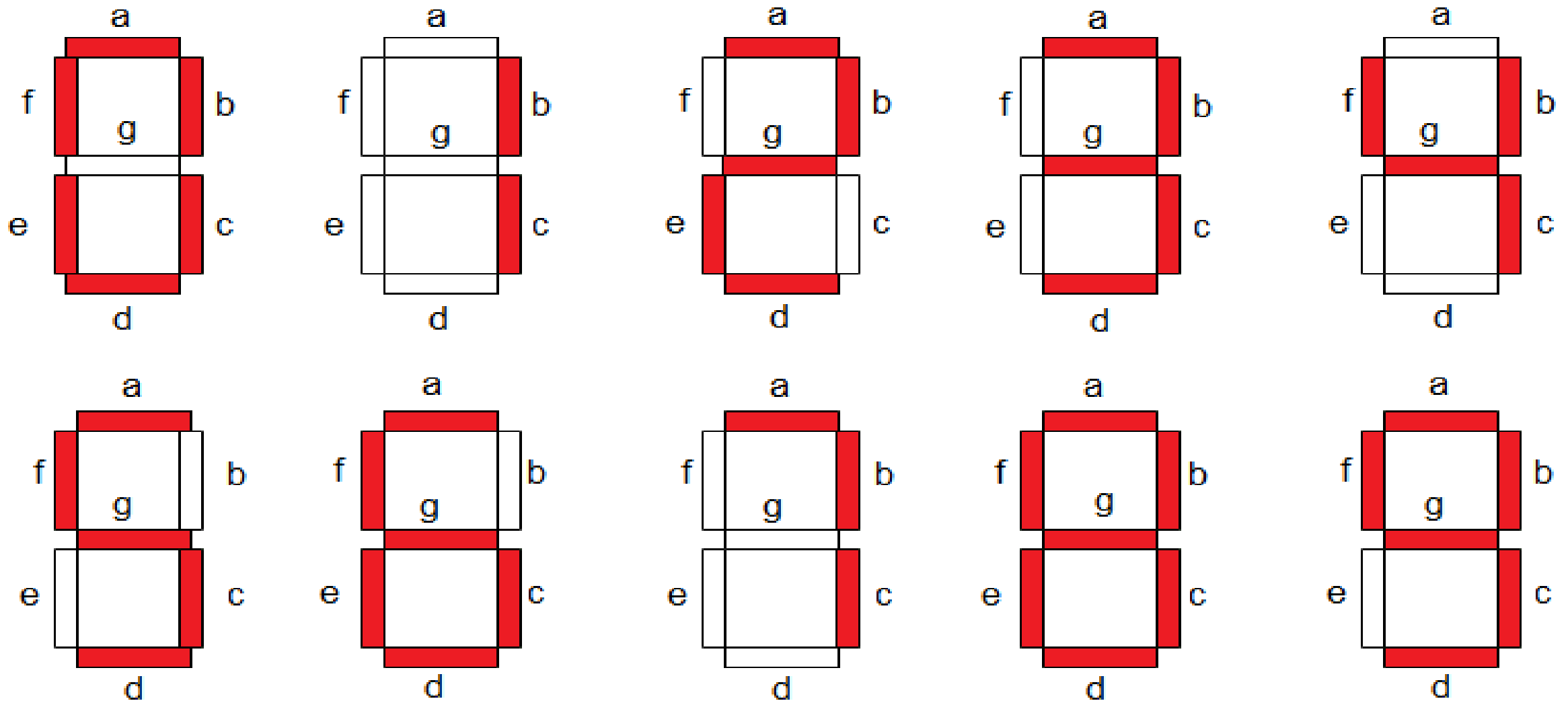


Common Anode



SSD Configuration

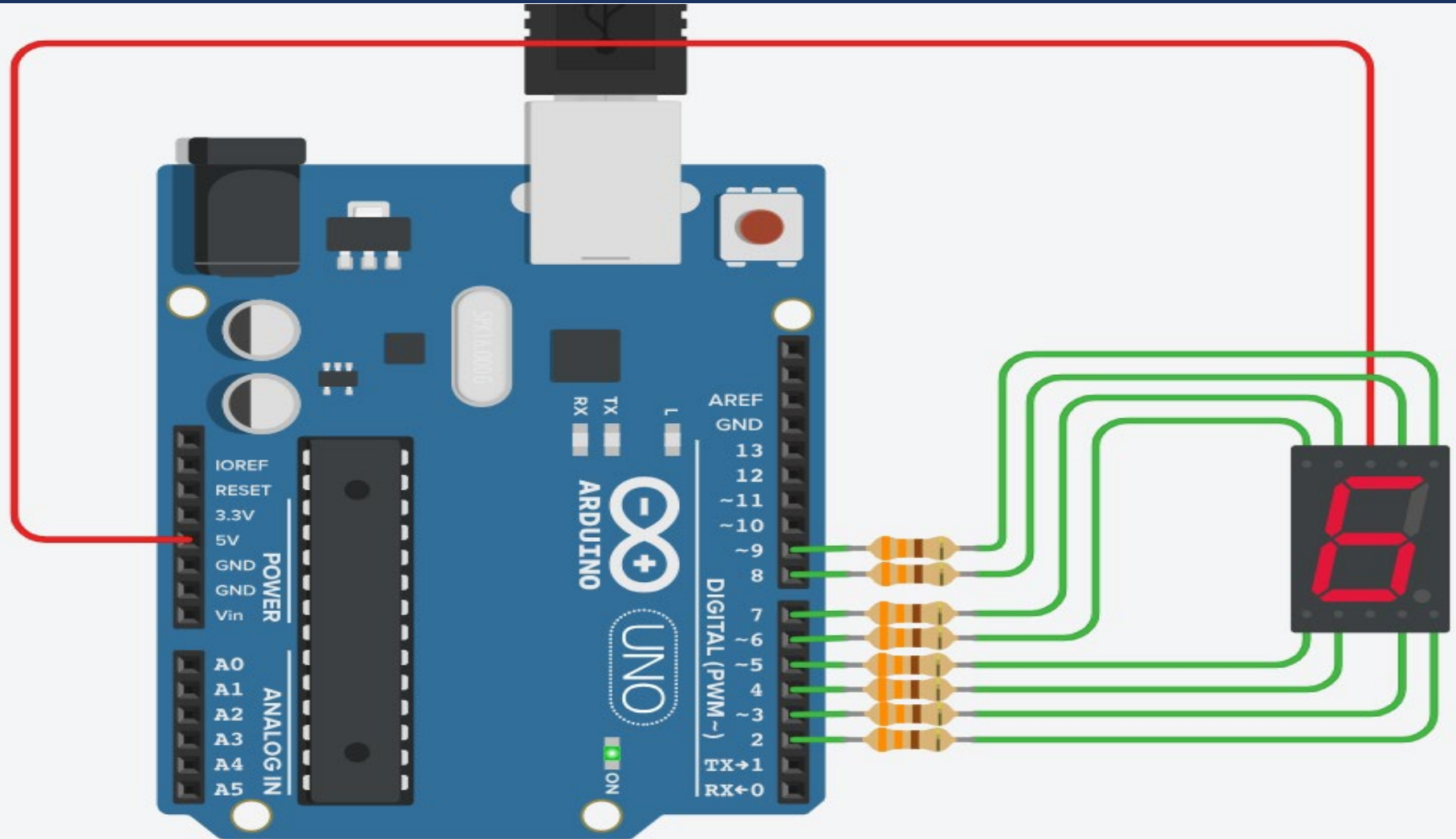
# Seven Segment Display: BCD Numbers



## Seven Segment Display: Truth Table

Segments (✓ = ON)							Display	Segments (✓ = ON)							Display
a	b	c	d	e	f	g		a	b	c	d	e	f	g	
✓	✓	✓	✓	✓	✓		0	✓	✓	✓	✓	✓	✓	✓	8
	✓	✓					1	✓	✓	✓			✓	✓	9
✓	✓		✓	✓		✓	2	✓	✓	✓		✓	✓	✓	A
✓	✓	✓	✓			✓	3			✓	✓	✓	✓	✓	b
	✓	✓			✓	✓	4	✓			✓	✓	✓		c
✓		✓	✓		✓	✓	5		✓	✓	✓	✓		✓	d
✓		✓	✓	✓	✓	✓	6	✓			✓	✓	✓	✓	E
✓	✓	✓					7	✓				✓	✓	✓	F

# Seven Segment Display: Arduino Example (1)



## Seven Segment Display: Arduino Example (2)

```
const int NUMBERS[10][NUM_LEDS] = {  
    { LED_ON, LED_ON, LED_ON, LED_ON, LED_ON, LED_ON, LED_OFF, LED_OFF},  
    {LED_OFF, LED_ON, LED_ON, LED_OFF, LED_OFF, LED_OFF, LED_OFF, LED_OFF},  
    { LED_ON, LED_ON, LED_OFF, LED_ON, LED_ON, LED_OFF, LED_ON, LED_OFF},  
    { LED_ON, LED_ON, LED_ON, LED_ON, LED_OFF, LED_OFF, LED_ON, LED_OFF},  
    {LED_OFF, LED_ON, LED_ON, LED_OFF, LED_OFF, LED_ON, LED_ON, LED_OFF},  
    { LED_ON, LED_OFF, LED_ON, LED_ON, LED_OFF, LED_ON, LED_ON, LED_OFF},  
    { LED_ON, LED_OFF, LED_ON, LED_ON, LED_ON, LED_ON, LED_ON, LED_OFF},  
    { LED_ON, LED_ON, LED_ON, LED_OFF, LED_OFF, LED_OFF, LED_OFF, LED_OFF},  
    { LED_ON, LED_ON, LED_ON, LED_ON, LED_ON, LED_ON, LED_ON, LED_OFF},  
    { LED_ON, LED_ON, LED_ON, LED_ON, LED_OFF, LED_ON, LED_ON, LED_OFF}  
};
```

## Seven Segment Display: Arduino Example (3)

```
// For common anode displays:
#define LED_ON LOW
#define LED_OFF HIGH

#define NUM_LEDS 8

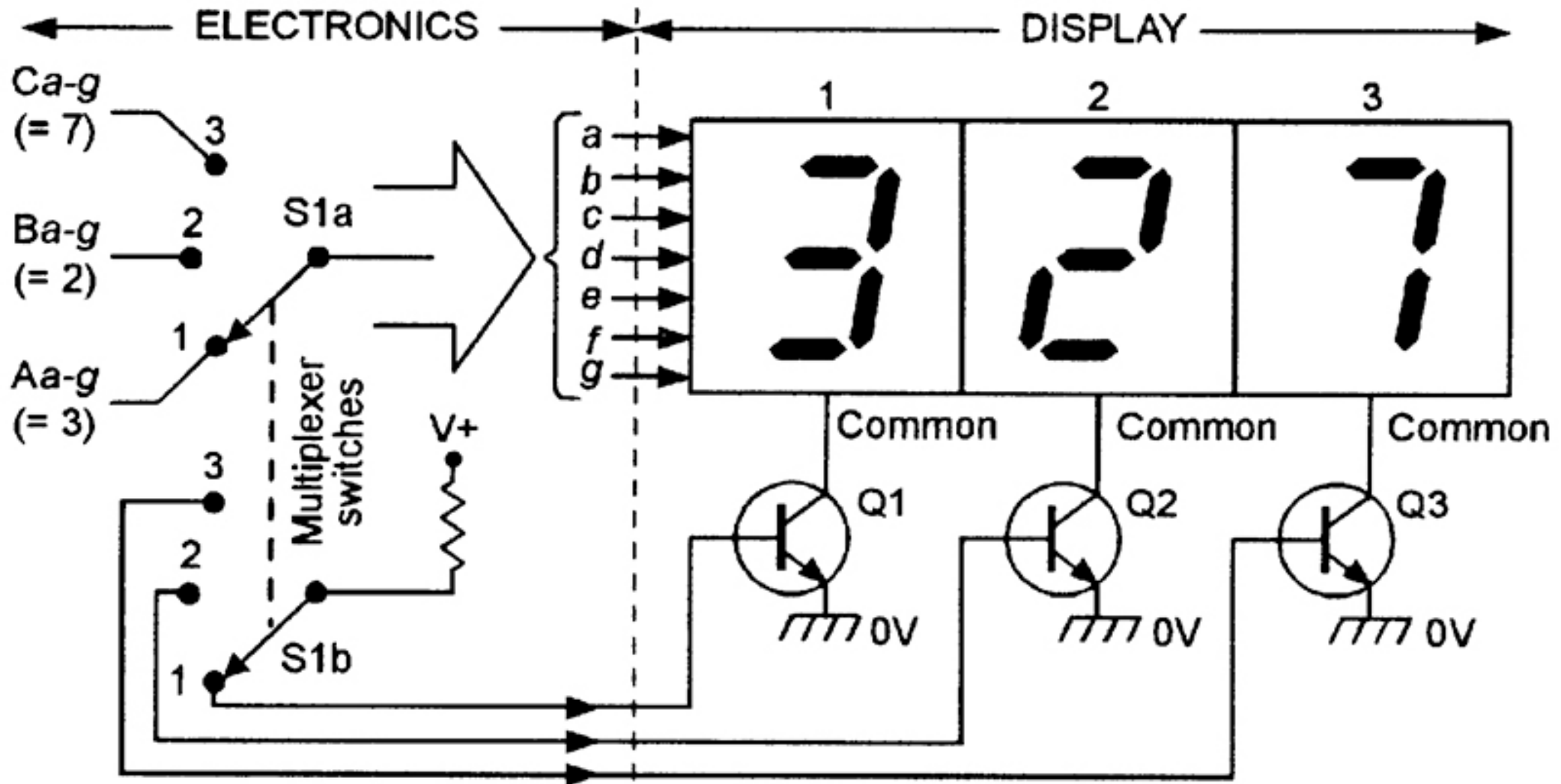
const int LED[NUM_LEDS] = {8, 9, 3, 4, 5, 7, 6, 2};

// const int NUMBERS here from previous slide

void setup() {
  for (int i=0; i<NUM_LEDS; i++) {
    pinMode(LED[i], OUTPUT);
    digitalWrite(LED[i], LED_OFF);
  }
}

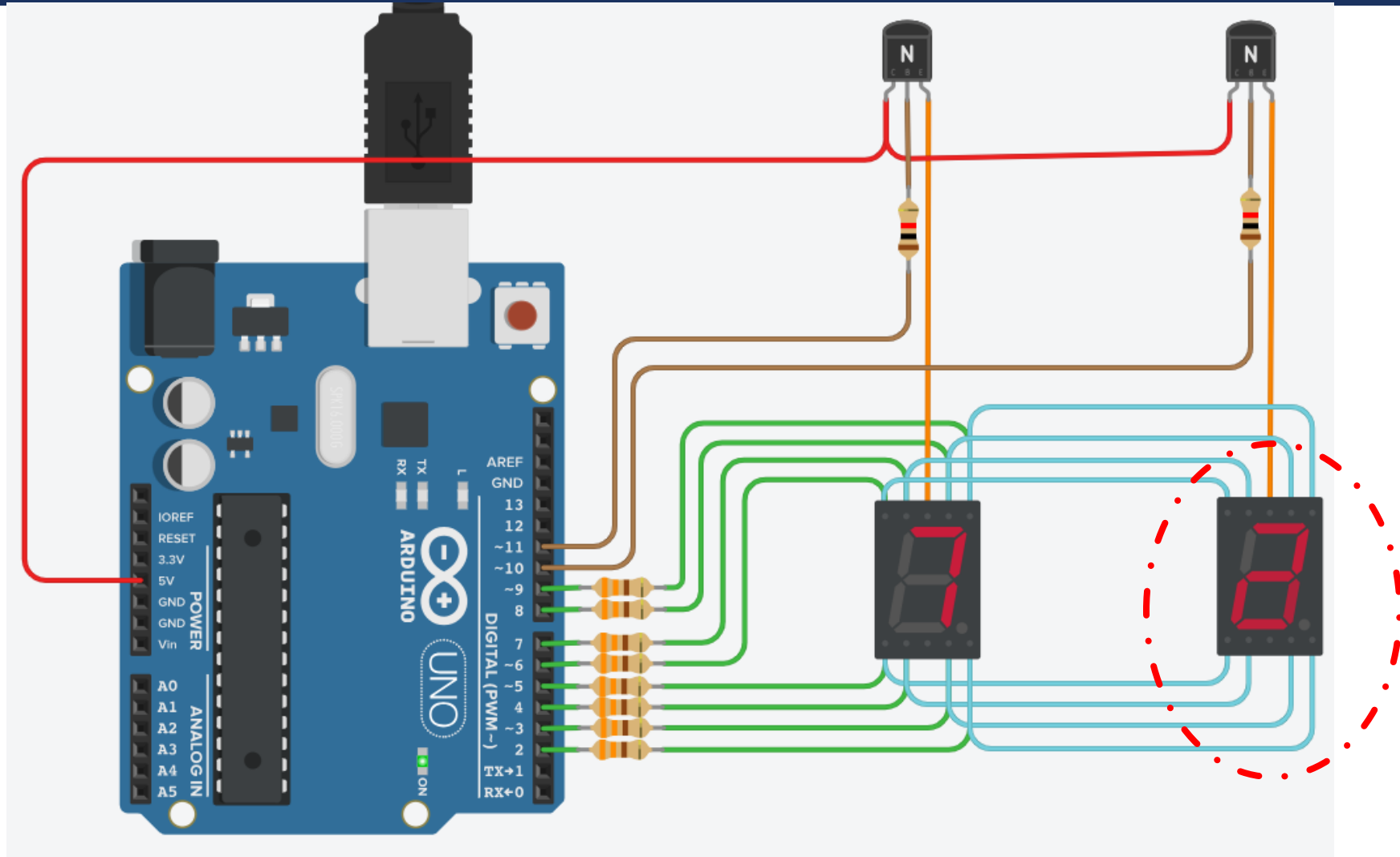
void loop() {
  for (int num=0; num<10; num++) {
    for (int i=0; i< NUM_LEDS; i++)
      digitalWrite(LED[i], NUMBERS[num][i]);
    delay(1000);
  }
}
```

# Seven Segment Display: Multiplexing (1)





## Seven Segment Display: Multiplexing (2)



# Seven Segment Display: Multiplexing (3)

```
// For common anode displays:
#define LED_ON LOW
#define LED_OFF HIGH

// For NPN transistors:
#define BJT_ON HIGH
#define BJT_OFF LOW

#define NUM_LEDS 8

const int LED[NUM_LEDS] = {8, 9, 3, 4, 5, 7, 6, 2};
#define TENS 11
#define ONES 10

// const int NUMBERS here

void setup() {
    for (int i=0; i<NUM_LEDS; i++) {
        pinMode(LED[i], OUTPUT);
        digitalWrite(LED[i], LED_OFF);
    }
    pinMode(TENS, OUTPUT);
    digitalWrite(TENS, BJT_OFF);
    pinMode(ONES, OUTPUT);
    digitalWrite(ONES, BJT_OFF);
}

void loop()
{
    int num=0;
    while (num<100) {
        int tens = num / 10;
        int ones = num % 10;

        for (int repeat=0; repeat <50; repeat++) {
            for (int i=0; i< NUM_LEDS; i++)
                digitalWrite(LED[i], NUMBERS[tens][i]);
            digitalWrite(TENS, BJT_ON); delay(5);
            digitalWrite(TENS, BJT_OFF); delay(1);

            for (int i=0; i< NUM_LEDS; i++)
                digitalWrite(LED[i], NUMBERS[ones][i]);
            digitalWrite(ONES, BJT_ON); delay(5);
            digitalWrite(ONES, BJT_OFF); delay(1);
        }
        num++;
    }
}
```

## Seven Segment Display: Multiplexing (4)

// loop() is changed:

```
void loop()
{
  for (int num=0; num<100; num++)
    printNumber(num, 1000);
}
```

// printNumber() is added:

```
void printNumber(int number, int show_time) {
  number %= 100; // The number [0, 99]
  int repeat = show_time / 12.5; // Approximately

  int tens = number / 10;
  int ones = number % 10;
```

```
  for (int r=0; r <repeat; r++) {
    for (int i=0; i< NUM_LEDS; i++)
      digitalWrite(LED[i], NUMBERS[tens][i]);
    digitalWrite(TENS, BJT_ON); delay(5);
    digitalWrite(TENS, BJT_OFF); delay(1);

    for (int i=0; i< NUM_LEDS; i++)
      digitalWrite(LED[i], NUMBERS[ones][i]);
    digitalWrite(ONES, BJT_ON); delay(5);
    digitalWrite(ONES, BJT_OFF); delay(1);
  }
}
```

## Seven Segment Display: Left to Students

When a number is received from the serial port, print it on the 2-digit 7-segment display until a new number is received ! Please use the template given in this lecture 😊



Thanks for  
listening 😊

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