EE3704 Embedded System

Chapter 4

Presented by
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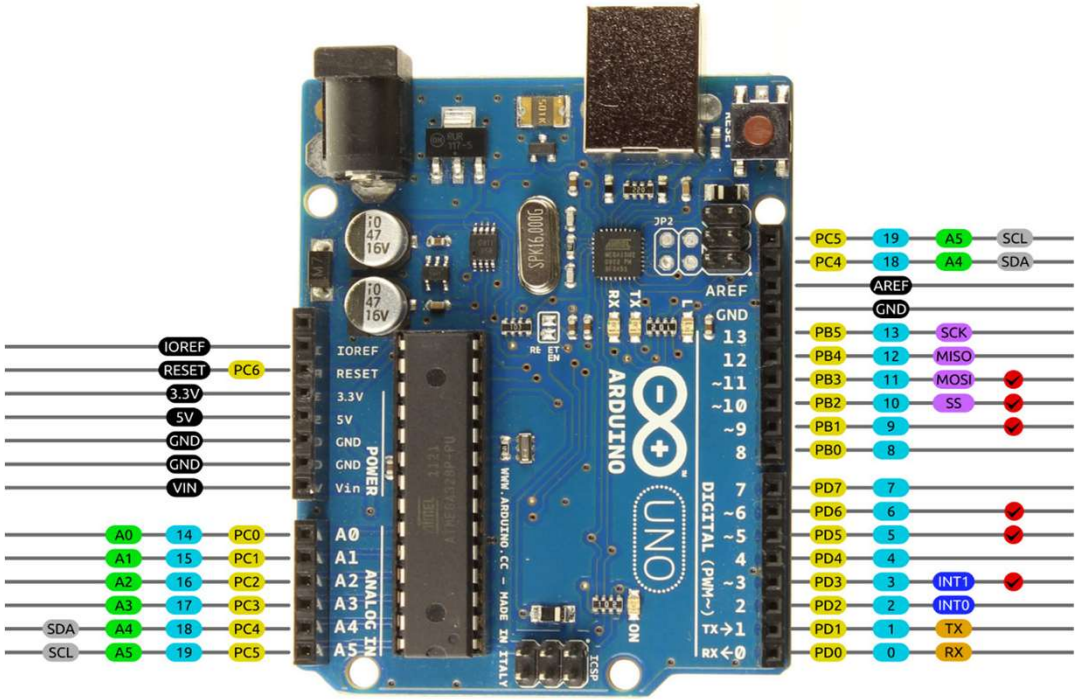
Chapter 4: Serial Communication

Arduino Uno R3 Pinout



AVR DIGITAL ANALOG POWER SERIAL SPI I2C PWM INTERRUPT

Function:

Serial.begin(baudRate);

Serial.print();

Serial.println();

Serial.read();

Chapter 4: Serial Communication

Pin0 and Pin1

Description

Used for communication between the Arduino board and a computer or other devices. All Arduino boards have at least one serial port (also known as a UART or USART): Serial. It communicates on digital pins 0 (RX) and 1 (TX) as well as with the computer via USB. Thus, if you use these functions, you cannot also use pins 0 and 1 for digital input or output.
You can use the Arduino environment's built-in serial monitor to communicate with an Arduino board. Click the serial monitor button in the toolbar and select the same baud rate used in the call to `begin()`.

Serial communication on pins TX/RX uses TTL logic levels (5V or 3.3V depending on the board). Don't connect these pins directly to an RS232 serial port; they operate at +/- 12V and can damage your Arduino board.

Chapter 4: Serial Communication

PORTB maps to Arduino digital pins 8 to 13 PortB exist for bits 0 to 5

DDRB - The Port B Data Direction Register - read/write

PORTB - The Port B Data Register - read/write

PINB - The Port B Input Pins Register - read only

The two high bits (6 & 7) map to the crystal pins and are not usable

Chapter 4: Serial Communication

Baud Rate

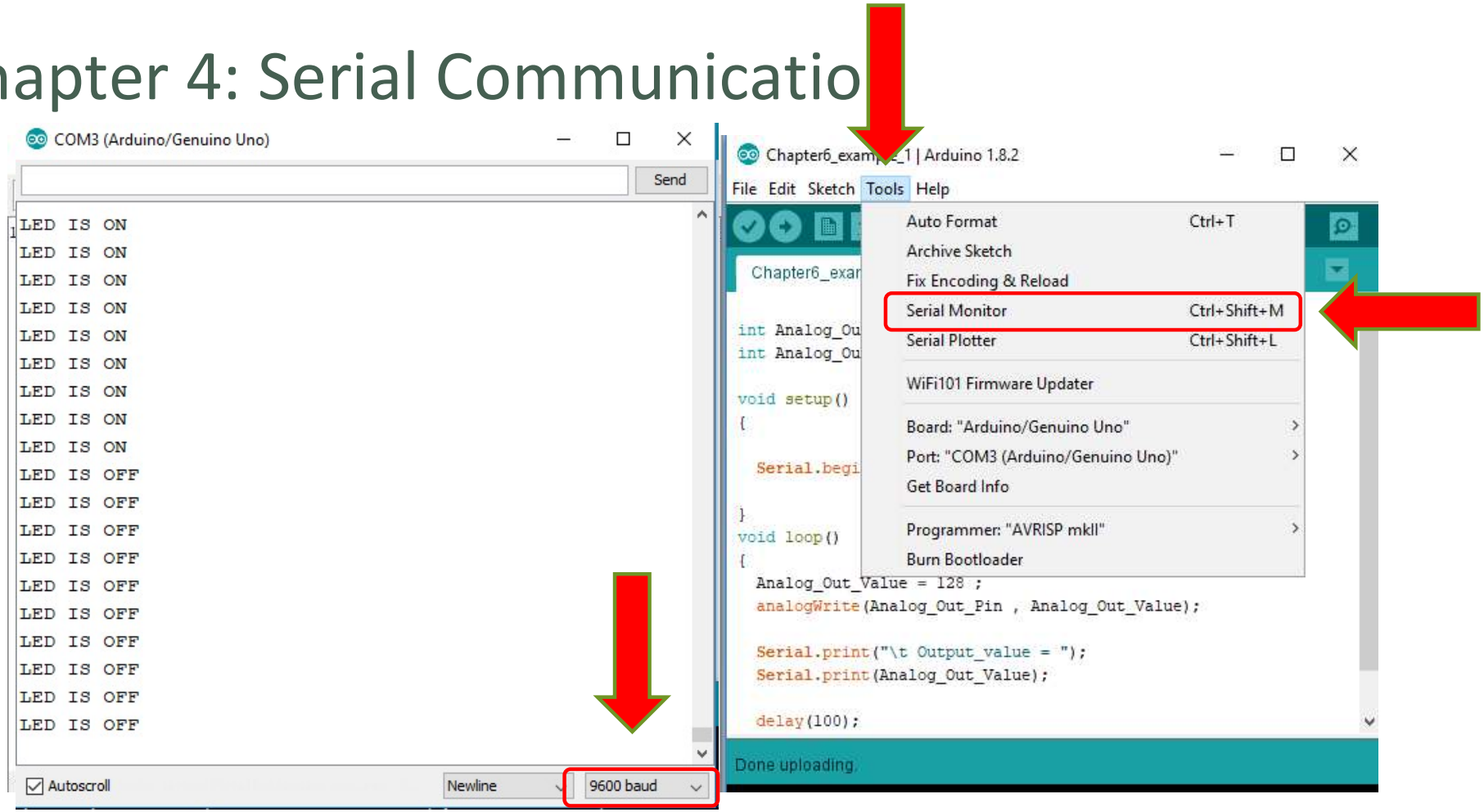
- **If too slow: might take too long to do.**

- **If too fast: error can occur**

Some common speeds

Bit rate (Baud rate)	Time per bit	Windows support[19]
50 bit/s	20000 µs	No
75 bit/s	13333.3 µs	Yes
110 bit/s	9090.9 µs	Yes
134.5 bit/s	7434.9 µs	Yes
150 bit/s	6666.6 µs	Yes
300 bit/s	3333.3 µs	Yes
600 bit/s	1666.7 µs	Yes
1,200 bit/s	833.3 µs	Yes
1,800 bit/s	555.6 µs	Yes
2,400 bit/s	416.7 µs	Yes
4,800 bit/s	208.3 µs	Yes
7,200 bit/s	138.9 µs	Yes
9,600 bit/s	104.2 µs	Yes
14,400 bit/s	69.4 µs	Yes
19,200 bit/s	52.1 µs	Yes
38,400 bit/s	26.0 µs	Yes
56,000 bit/s	17.9 µs	Yes
57,600 bit/s	17.4 µs	Yes
76,800 bit/s	13.0 µs	No
115,200 bit/s	8.68 µs	Yes
128,000 bit/s	7.81 µs	Yes
230,400 bit/s	4.34 µs	No

Chapter 4: Serial Communicatio



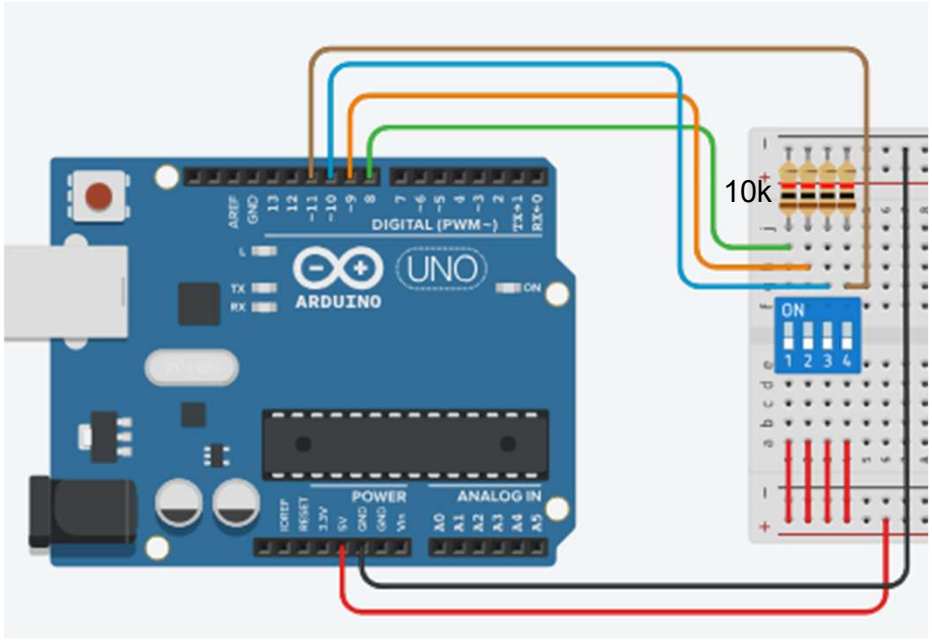
Chapter 4: Serial Communication

Example 4.1: Reading inputs data with serial monitor

- Connect AH-DIP SW as inputs (Port D pin 2 – 5 or Port B pin 8 – 11)
- Reading All Bit data through serial communication
  - Tinkercad
  - Read Arduino Board

Chapter 4: Serial Communication

Example 4.1 : Reading inputs data with serial monitor




```
//Declare input pins
DDRB &= ~(0x01);
DDRB &= ~(0x02);
DDRB &= ~(0x04);
DDRB &= ~(0x08);
```

Chapter4_Example_3

```
byte   dataB ;

void setup()
{
  Serial.begin(9600);
}
void loop()
{
   dataB  = PINB;
  Serial.print("Port B = ");
  Serial.println(dataB);
  delay(100);
}
```

Chapter 4: Serial Communication

- Show in Binary data

```
Chapter4_Example_3 §

byte  dataB ;

void setup()
{
  Serial.begin(9600);
}
void loop()
{
  dataB = PINB;
  Serial.print("Port B = ");
  Serial.println(dataB ,BIN);
  delay(100);
}
```

- Show Hex data

```
Chapter4_Example_3 §

byte dataB ;

void setup()
{
  Serial.begin(9600);
}
void loop()
{
   dataB = PINB;
  Serial.print("Port B = ");
  Serial.println(dataB ,HEX);
  delay(100);
}
```

Chapter 4: Serial Communication

Example 4.2: Read data from KB

- Reading via Serial Communication
- Show Character serial input
  - Tinkercad
  - Real Arduino Board

Chapter4_Example_4 §

```
char input_Character    ;

void setup() {
        Serial.begin(9600);
}

void loop() {

        // send data only when you receive data:
        if (Serial.available() > 0) {
                // read the incoming character:
                input_Character = Serial.read();


                Serial.print("I received: ");
                Serial.println(input_Character);
        }
}
```

Switch-case

```
switch(expression) {

   case constant-expression  :
      statement(s);
      break; /* optional */

   case constant-expression  :
      statement(s);
      break; /* optional */

   /* you can have any number of case statements */
   default : /* Optional */
   statement(s);
}
```

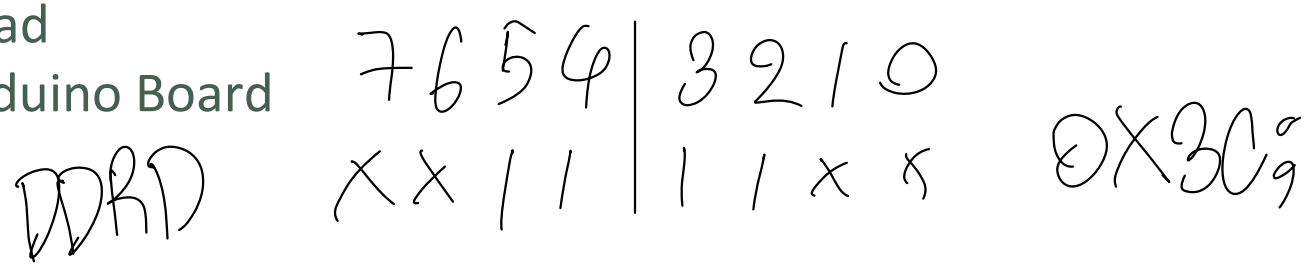
For data with range

```
switch (arr[i])
{
case 1 ... 6:
    printf("%d in range 1 to 6\n", arr[i]);
    break;
case 19 ... 20:
    printf("%d in range 19 to 20\n", arr[i]);
    break;
default:
    printf("%d not in range\n", arr[i]);
    break;
}
```

Chapter 4: Serial Communication

Example 4.3: Reading data from KB and control LEDs (**use switch-case**)
LEDs are connected at Pins 2,3,4,5 or 8,9,10,11

- Press "1" from keyboard AH-LED1 ON (only) show "LED1 is on" in monitor
- Press "2" from keyboard AH-LED2 ON (only) show "LED2 is on" in monitor
- Press "3" from keyboard AH-LED3 ON (only) show "LED3 is on" in monitor
- Press "4" from keyboard AH-LED4 ON (only) show "LED4 is on" in monitor
- Press other characters, Reset all AH-LED to OFF
- Show your circuit diagram, coding and results
  - Tinkercad
  - Real Arduino Board



Chapter 4: Example

- T = 1/f
- Example C 1046.5 Hz
  - T = 956 us
    - Use T delay = T/2
      - ON 477 us
      - OFF 477 us

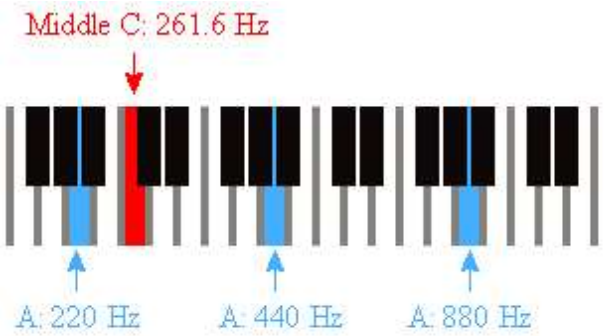


Table of Musical Frequencies

Note	Frequency
C	130.82
C#	138.59
D	146.83
D#	155.56
E	164.81
F	174.61
F#	185
G	196
G#	207.65
A	220
A#	233.08
B	246.94

Note	Frequency
C	261.63
C#	277.18
D	293.66
D#	311.13
E	329.63
F	349.23
F#	369.99
G	392
G#	415.3
A	440
A#	466.16
B	493.88

Note	Frequency
C	523.25
C#	554.37
D	587.33
D#	622.25
E	659.26
F	698.46
F#	739.99
G	783.99
G#	830.61
A	880
A#	932.33
B	987.77

Note	Frequency
C	1046.5
C#	1108.73
D	1174.66
D#	1244.51
E	1318.51
F	1396.91
F#	1479.98
G	1567.98
G#	1661.22
A	1760
A#	1864.66
B	1975.53
C	2093.00

Chapter 4: Example

Example 4.4: Use Buzzer/Speaker as output to create music note

- Press “d” from keyboard produce “Do”
- Press “r” from keyboard produce “Re”
- Press “m” from keyboard produce “Mi”
- Press “f” from keyboard produce “Fa”
- Press “z” from keyboard produce “Zol”
- Press “l” from keyboard produce “La”
- Press “t” from keyboard produce “Ti”

- Show Circuit diagram / and Coding
  - Real Arduino board

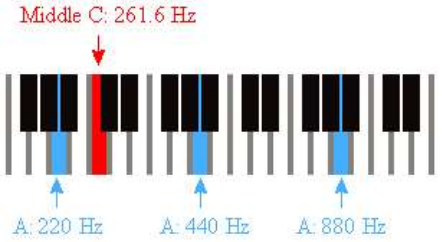


Table of Musical Frequencies

Note	Frequency	Note	Frequency	Note	Frequency	Note	Frequency
C	130.82	C	261.63	C	523.25	C	1046.5
C#	138.59	C#	277.18	C#	554.37	C#	1108.73
D	146.83	D	293.66	D	587.33	D	1174.66
D#	155.56	D#	311.13	D#	622.25	D#	1244.51
E	164.81	E	329.63	E	659.26	E	1318.51
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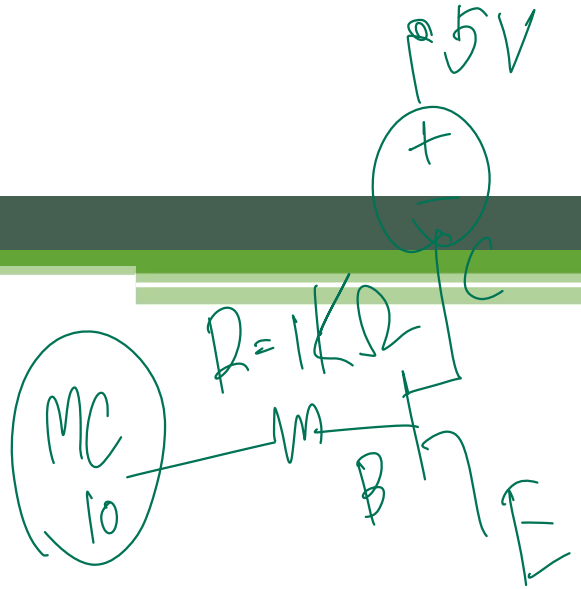
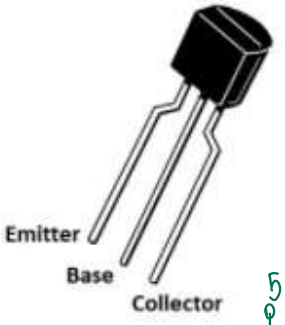
F#	185	F#	369.99	F#	739.99	F#	1479.98
G	196	G	392	G	783.99	G	1567.98
G#	207.65	G#	415.3	G#	830.61	G#	1661.22
A	220	A	440	A	880	A	1760
A#	233.08	A#	466.16	A#	932.33	A#	1864.66
B	246.94	B	493.88	B	987.77	B	1975.53
						C	2093.00

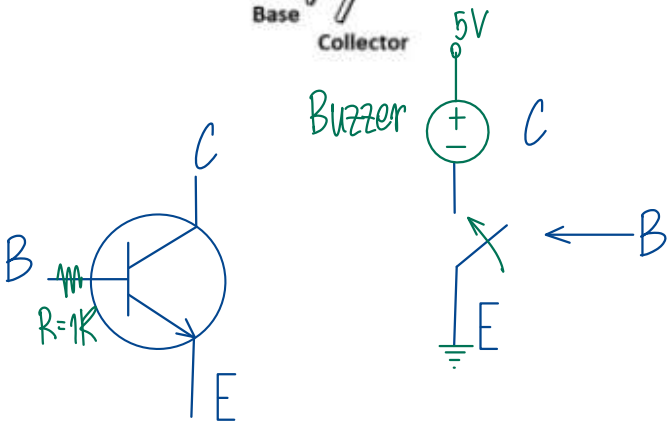
478
426
379
358
319
284
253



Chapter 4: Example

- Use transistor (PN2222A) to drive buzzer
- Use delayMicroseconds()





Philips Semiconductors — Product specification

NPN switching transistor — **PN2222A**

FEATURES

- High current (max. 600 mA)
- Low voltage (max. 40 V).

APPLICATIONS

- General purpose switching and linear amplification.

DESCRIPTION

NPN switching transistor in a TO-92; SOT54 plastic package. PNP complement: PN2907A.

PINNING

PIN	DESCRIPTION
3	collector
2	base
1	emitter

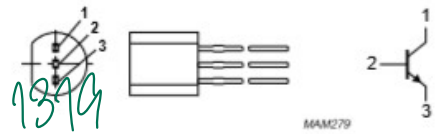


Fig. 1 Simplified outline (TO-92; SOT54) and symbol.

d = 1046.5Hz r = 1175.Hz m = 1319

Td = 956 μs Tr = 852 Tm = 768

$\frac{Td}{2}$ = 478 μs $\frac{Tr}{2}$ = 426 μs $\frac{Tm}{2}$ = 379

Random function

random()

[Random Numbers]

Description

The random function generates pseudo-random numbers.

Syntax

```
random(max)
random(min, max)
```

include↑ ↑exclude

Parameters

`min` - lower bound of the random value, inclusive (optional)

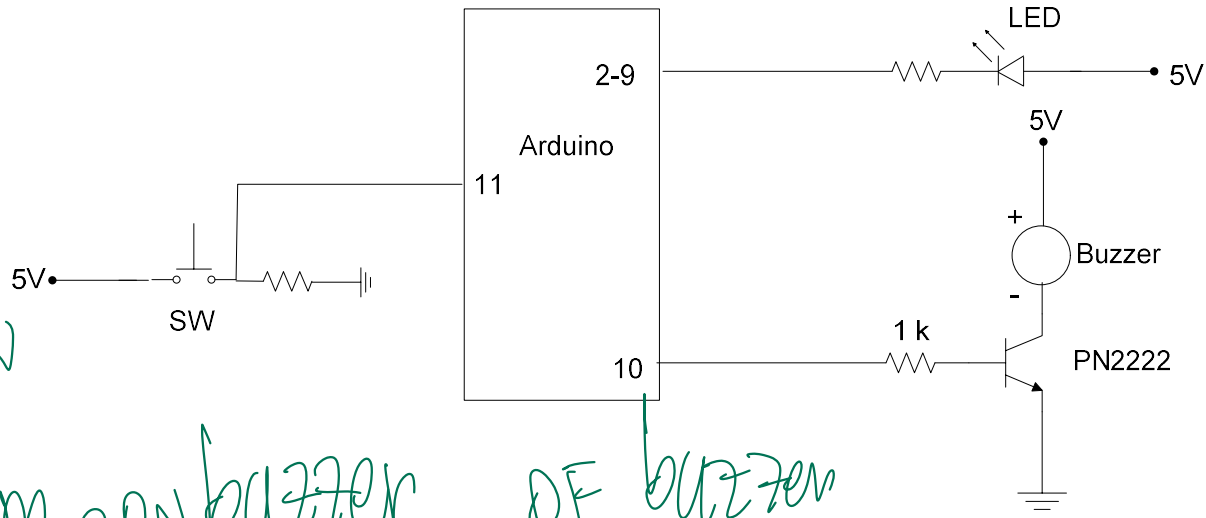
`max` - upper bound of the random value, exclusive

Chapter 4: Mini Project

Example 4.5: Random LED game when SW is pressed

**LED pins 2-9, Buzzer pin 10, SW pin 11;

- Make 8 LEDs (AL) go incrementally with fastest speed (example 10ms)
- When a SW is Pressed, a random number is calculated and show on a LED randomly, a buzzer sound is audible for 1s
- LED is on for 3s and go off
- Loop is keep repeating



Chapter 4: Mini Project

Example 4.6: Random LED game when SW is pressed (with higher random range)

- From Example 4.5, make random number between 0-100.
- Separate 0-100 range into 8 slots for LED with 1st LED of highest odds, and 8th LED of lowest odds. Other LEDs can be your own choice.

1st led : 1-70 High
2nd led : 71-85
3rd led : 86-98
8th led : 99-100 low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