Lecture 3

LED
Diode

A diode is a semiconductor component that, in general, will pass current in only one direction.
Water Analogy of Diodes
Diode: How it Works

Forward-biased (“open door”)

Holes

Electrons

Electron flow

Forward-biased (“open door”)

P
N
Diode: How it Works

Reverse-biased (“closed door”)

SMART 2010
Diode Applications 1

Half-Wave Rectifier
Diode Applications 2

Full-Wave Bridge Rectifier
Diode Applications 3

Basic AC-DC Power Supply
Diode Applications 4

DC application

AC application

Voltage Dropper
Zener Diode

Acts as a pn-junction diode but it also has the ability to conduct in the reverse-biased direction when a specific breakdown voltage is reached.
LED

Light-emitting diode

Semiconductor

Has polarity
LEDs
LED: How It Works

[Diagram showing the internal components of an LED, including P and N regions, electron flow, holes, electrons, photons, epoxy lens, LED chip, reflector, cathode, and anode.]
Kinds of LEDs 1

Visible-Light LEDs

Infrared LEDs
Kinds of LEDs 2

Blinking LEDs

Tricolor LEDs
How to Connect LED

- Requires 1.5~2.5V and 10 mA
- To prevent overloading, use resistor (470 Ω)
Connect LED to BS2

LED is on when P0 is high

LED is on when P1 is low
Connect Multiple LEDs to BS2

8 LEDs are connected to BS2
Each I/O/pin (P0-P7) is allowed to sink 6.25mA

\[
R = \frac{V}{I} = \frac{3.6}{6.25 \times 10^{-3}} = 576\Omega
\]
7 Segment LEDs

- 7 Light-emitting diodes in one
- Display any single-digit number (0–9)
7 Segment LED Circuit

<table>
<thead>
<tr>
<th>Number</th>
<th>Segments</th>
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<tbody>
<tr>
<td>0</td>
<td>1, 2, 7, 8, 10, 13</td>
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<tr>
<td>1</td>
<td>10, 13</td>
</tr>
<tr>
<td>2</td>
<td>1, 7, 8, 11, 13</td>
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<tr>
<td>3</td>
<td>1, 8, 10, 11, 13</td>
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<tr>
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<td>2, 10, 11, 13</td>
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<td>6</td>
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<tr>
<td>7</td>
<td>1, 13, 10</td>
</tr>
<tr>
<td>8</td>
<td>1, 2, 7, 8, 10, 11, 13</td>
</tr>
<tr>
<td>9</td>
<td>1, 2, 10, 11, 13</td>
</tr>
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Decimal Point: 6 and 9
# LED Experiments

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<td>1, 2, 6.1-6.3</td>
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<td>Smart Sensors</td>
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<td>Stamp Works</td>
<td>Exp. 1-10</td>
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Lecture 4

Button/Switch
Button/Switch

Symbol
Switches 1

**SPST switches** (Single Pole, Single Throw)

- Throw switch
- Normally open push-button
- Normally closed push-button

**SPDT switches**

- Throw switch
- Normally open/closed push-button
Switches 2

DPST switches

![Diagram of DPST switch]

Throw switch

Normally open push-button

DPDT switches

![Diagram of DPDT switch]

Throw switch

Normally open/closed push-button
Switches 3

SP(n)T switches

Multiple contact slider switch

Multiple contact rotary switch (SP8T)

(n)P(m)T switches

3P4T

2-deck rotary (DP8T)
Button Connection 1
(Wrong)

BS2 will get damaged when P0 is pulled high since the current limit through pin is violated

\[ I = \frac{V}{R} = \frac{5}{0} = \infty \]
Button Connection 2 (Wrong)

P0 is pulled low when the button is pressed.
But P0 is not connected to anywhere when the button is not pressed then P0 could be either high or low so called a floating input condition.
Button Connection 3 (Wrong)

- Button is not pressed
  P0 is pulled high
- Button is pressed
  P0 is pulled low
- By mistake, P0 is used as an output when the button is pressed then …
Button Connection 1
(Pull up resistor)

- Button is not pressed
  P0 is pulled high
- Button is pressed
  P0 is pulled low
- 270Ω is for protecting I/O pin
  - Preferred
Button Connection 2
(Pull down resistor)

- Button is not pressed
  P0 is pulled low
- Button is pressed
  P0 is pulled high
- 270Ω is for protecting I/O pin
Limit Switch

SPDT limit switch
Limit Switch
# Button Experiments

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<td>Others</td>
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Simple Project

Problem 2: Recently, at a local primary school a young student was left behind on the school premises at the end of the school day. The student was rescued after his parents’ frantic efforts to locate him. Following this incident, the school hired a safety consultant to recommend solutions to prevent recurrence of such incidents. The safety consultant has suggested that the school implement the following solution to keep real-time count of individuals on school’s premises.
Simple Project -Cont.

Individuals will enter and exit the school from two separate gates. A pressure sensitive pad at the entrance gate will register entrance by an individual whenever it is depressed. Another pressure sensitive pad at the exit gate will register exit by an individual whenever it is depressed. A microcontroller will continuously monitor the two pressure pads. You are to develop a prototype real-time people counting system. Use two buttons to mimic the pressure pads and write a program that will provide real-time people count. What are some of the drawbacks of the above solution? How can this solution be further improved?