

CS 2461: Lab 3
Pull-up (Pull-down) resistors
Building combinational logic circuits

© 2020 Narahari, Shepherd, Preisner

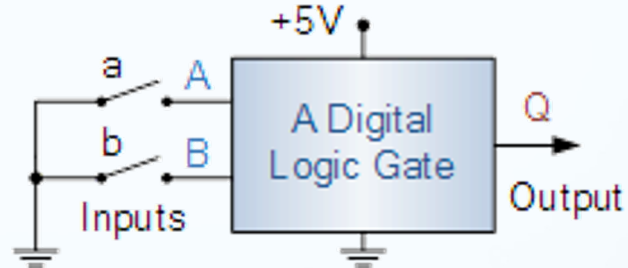
1

**Designing Circuit to switch between
0 and 1**

- Recall- inputs to binary are 0 or 1...
- How to set binary variables to 0 or 1 in your hardware circuits ?
- Use a switch...each switch can be viewed as a binary variable (values are 0 or 1)
- We want to close switch and set input $A=0$
- We want to open switch and set input $A=1$

2

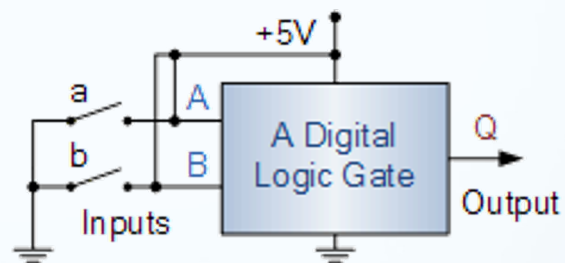
Question



- The switches a and b represent two inputs to the device
- If switch a is 'closed' (on) then:
 - A is connected to ground and $A=0$
- If switch b is closed then:
 - B connected to ground and $B=0$
- Question: What is value of A when switch a is open ?
- Do you see a problem ?

3

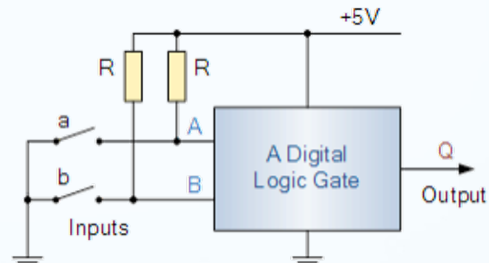
Solution ?



- Open to set $A=1$
- Close to set $A=0$
- Will this work ?

4

Solution



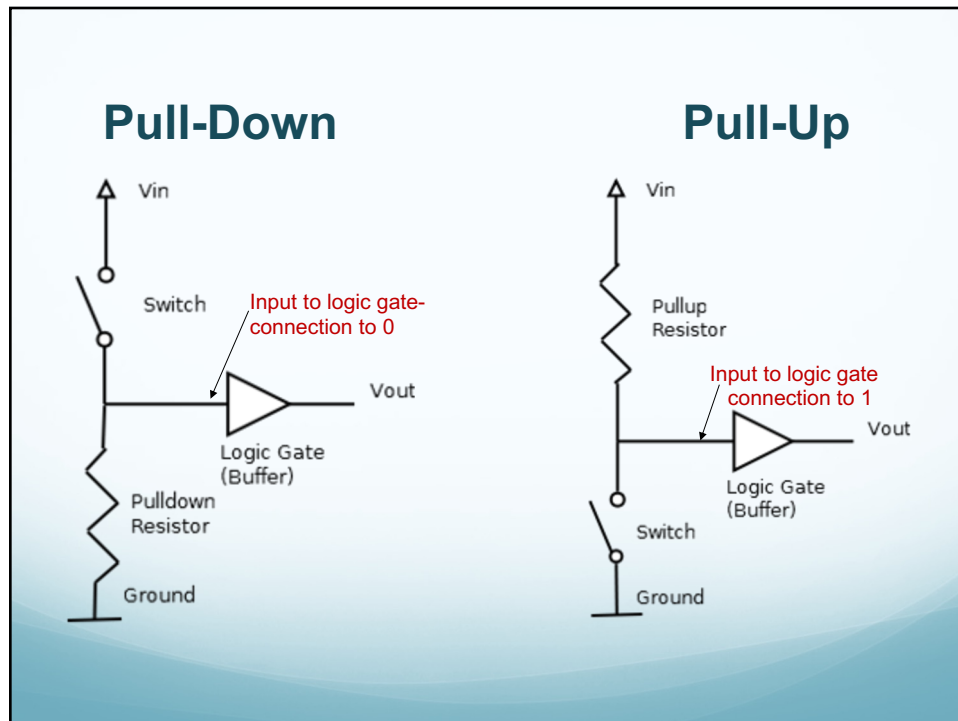
- The switches a and b represent two inputs to the device
- If switch a is 'closed' (on) then:
 - A is connected to ground and $A=0$
- If switch a is open path to +5V:
 - A connected to +5V and $A=1$
- This resistor is called a pull-up resistor
 - When switch is open it pulls up value to 1

5

Pull-up (pull-down) resistor

- Why use pull-up resistor?
 - Suppose we have an IC or a Microcontroller Unit (MCU) with an input pin.
 - Say, we have no connection to the IC or (MCU), but the device still reads some value.
 - Do we know whether the input is high or low?
 - It's a phenomenon called floating
 - To prevent this unknown state, we use a pull-up (or pull-down) resistor.

6



7

- Points to Note:
 - The value of pull up resistor is really high (order of 1k)
 - Pull-down attach to ground.
 - Pull up attach to voltage.
- When should you use a Pull-up vs. Pull-down?
 - Pull-up: when you want the 'default value' to be 1
 - Pull-down: when you want the 'default value' to be 0

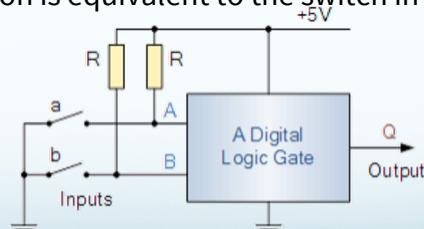
8

- The value of the pull-up resistor needs to be chosen to satisfy two conditions:
 - *When the button is pressed*, the input pin is pulled low. The value of resistor R1 controls how much current you want to flow from VCC, through the button, and then to ground.
 - *When the button is not pressed*, the input pin is pulled high. The value of the pull-up resistor controls the voltage on the input pin.
- The material for Pull-up resistors was taken from:
 - <https://learn.sparkfun.com/tutorials/pull-up-resistors>

9

Using ON/OFF buttons for inputs

- Now that you know how to use pull-up/pull-down resistors....you can input a value of 0 or 1 using a “switch” in the form of an ON/OFF button
- The ON/OFF button is equivalent to the switch in the diagrams.



10

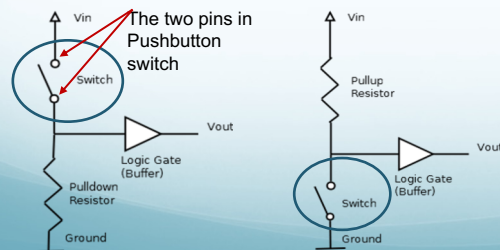
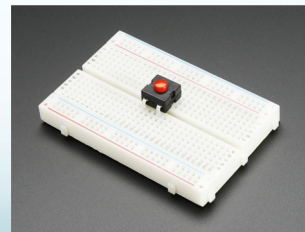
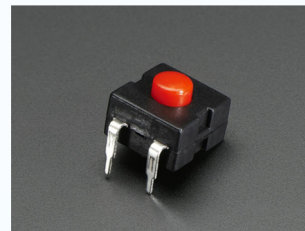
Using ON/OFF buttons: Example

- Question: Can you build a circuit with one button to input a 0 or a 1
 - Connect to the “lighting an LED” circuit you build in Lab1
 - LED should light up when we press the button (i.e., input=1)

11

What's in your lab kit: Pushbutton Switch – toggle switch

- Push once to turn on (close)
- Push again to turn off (open)
- Need to place a pull-up or pull-down resistor IF you are using the switch to input a 0 or 1



12

Lab Exercise 1: Using pushbutton switches for Lab HW1

Work in two person groups...

Check your Lab HW1: circuit to implement

$F = (A \text{ OR NOT } B) \text{ AND } (B \text{ OR NOT } C)$

Three inputs: A,B, C

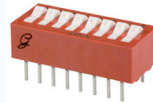
Next, use three push-buttons to input the values A,B,C

i.e., instead of connecting the input to power (1) or ground (0), you connect it to the out of the switch

and switch outputs 1 or 1 depending on ON or OFF

13

DIP Switch



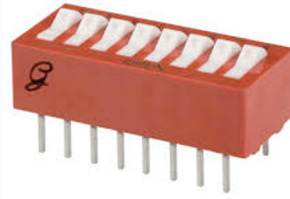
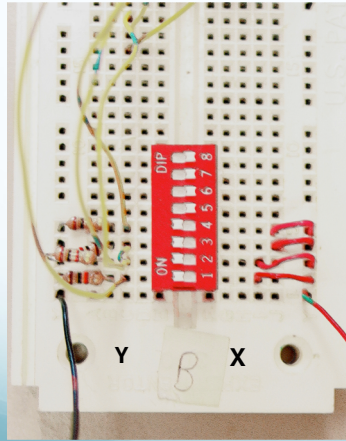
set of tiny switches in one package (housing)-
housing looks like a chip

Can set switch to ON or OFF

- They are toggle switches, i.e., they have two possible positions – on (1) or off (0).
- Connect one side (inputs) to power bus (Vcc)
- Connect other side (output) to your circuit
- If ON then output = 1 (Vcc)
- OFF then output = 0 (ground)
- You can also swap things so that ON=0 and OFF=1
- **IMPORTANT: You have to use pull-up (or pull-down) resistors!!**

14

DIP Switch



If switch is set to ON then closed circuit –
X connects to Y
If switch is set to OFF then no connection

Ex: If X goes to Vcc (1),
then ON means Y=1

OFF means Y=0

15

DIP Switch Example: Lighting the LED circuit

- Using a DIP switch to light LED
- Two inputs, and two LEDs
- Note use of Pull-up resistors (or pull-down resistors)
 - Very important...circuit won't work without these!

16

Lab Exercise 2: Using DIP switch for your Lab Homework 1

Lab HW1: build a circuit to compute:

$$S = (A \text{ OR NOT } B) \text{ AND } (B \text{ OR NOT } C)$$

- Modify (i.e., by adding DIP switch component) your circuit so that the inputs A,B,C are set by a DIP switch.
- This is a relatively small modification to the circuit you just built using Pushbutton switches.

17

Lab Homework 2

- Design and implement a circuit that tests if two 4-bit numbers $A=(A_3 A_2 A_1 A_0)$ and $B=(B_3 B_2 B_1 B_0)$ are equal.
 - Use DIP switches to input your 4-bit number
 - You can use any of the 7400 series integrated circuits
1. First design your logic functions and circuit using basic gates. *Think about the solution on paper first.*
 2. Next identify the 7400 ICs that contain the logic gates you need.
 3. Finally, build your circuit

See BlackBoard assignment for full specs.

18