5.0 - Digital Inputs

About Digital Inputs

Many microprocessor circuits sense the state of input devices in order to control output devices. Unlike common home electrical circuits in which a switch (the input device) actually controls current passing through it to a light (the output device), digital inputs are designed to create a change in potential that is sensed by the microprocessor. In other words, the input device controls the voltage sensed by the microprocessor, but does not conduct any load current to the output device.

Digital input activity

1. The reset circuit is composed of D2, R2, R3 and S1. Find the reset circuit on your schematic diagram. Re-draw the circuit below, but instead of copying how it was drawn on the schematic, re-draw the circuit showing R2, D2 and S1 in a straight line connected between +5 V and GND.

   The purpose of resistor R3 is to limit current caused by static discharge when a finger contacts the reset switch. In normal operation the microprocessor pin RE3 has a high impedance, so the effect of R3 on the circuit is negligible. As a result, you can simplify your diagram by omitting R3.

2. From your diagram it should be apparent that the input circuit is a series circuit, which functions as a voltage divider, although it's made up of a resistor and a switch instead of two resistors. Think of the switch as a resistor with two possible states, namely infinitely high resistance (open) and zero resistance (closed). Predict the potential across the switch for each state.

   E_{S1} (open) = E_{S1} (closed) =

3. Install D2, R2, R3, and S1 into your CHRP circuit board. Connect your CHRP circuit to a power supply and measure the potential at pin 1 of U2 corresponding to each switch state.

   E_{S1} (open) = E_{S1} (closed) =

4. Does your prediction agree with your measurement?

   Teacher Check ☐

5. In the reset circuit, R2 is known as a pull-up resistor. The switch circuits connected to Port B of the microcontroller (indicated by the pin names RB0-RB7) also need pull-up resistors to function, but instead of being connected externally, the pull-ups are found inside the microcontroller.

   All eight Port B switch circuits are identical. Re-draw a schematic diagram showing just one of the Port B switch circuits, including the switch and both the internal and external resistors. Use 20 kΩ as the value of the internal pull-up resistor (as found in the microcontroller's data sheet).

Teacher Check ☐

Digital input analysis

6. Calculate the potential drop across the external switch and resistor, both when the switch is open and when it is closed.

   E_S (open) = E_S (closed) =

7. The microcontroller's Port B pins connect to multiple devices. List all of the Port B devices here, and state whether they would be considered input or output devices.

8. Assuming a Port B is set as an output and a switch gets pressed, calculate the current flow through the switch and the external resistor.

9. What purpose does the external switch serve?

10. Install the remaining switches, starting from S2, and their associated resistors into your CHRP.