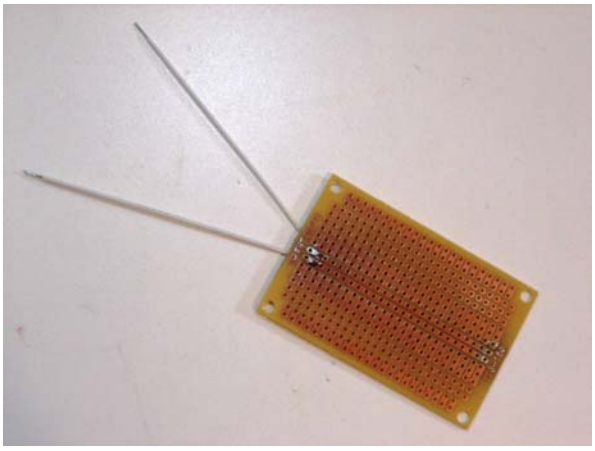
Water Alarm



A water alarm is an electronic device that sounds an alarm when its liquid sensor comes in contact with water. These devices are very useful in homes (especially basements) to protect against water damage and/or mold growth from leaky water pipes, broken plumbing fixtures, a backed-up sewer, or runoff from a heavy thunderstorm. In this activity, you will build a water alarm using a small piece of copper printed circuit (PC) board with a Vernier Analog Breadboard Cable to detect the presence of water, and a Vernier Digital Control Unit (DCU) to activate an alarm.

DESIGN OBJECTIVES

- Build a sensor to detect water
- Use a Vernier Analog Breadboard Cable to connect the water sensor to the lab interface
- Configure Logger *Pro* to detect a voltage change in the water sensor circuit and trigger a Vernier DCU
- Use a Vernier DCU to activate a buzzer

MATERIALS

Vernier computer interface
Vernier Logger *Pro* software
computer
USB cable
Vernier Analog Breadboard Cable
Vernier Digital Control Unit (DCU)
LabQuest or LabPro power supply
printed circuit board
breadboard
6 VDC piezo buzzer
10 kΩ resistor
jumper wires
soldering iron and solder

BACKGROUND

A water alarm must perform both an input and an output function – detect the presence of water using some type of liquid sensor and send out a signal to activate an alarm. A Vernier interface and Logger *Pro* software provide an excellent way to coordinate these two functions with the addition of just a few simple electronics. In Figure 1, the liquid sensor serves as the "switch" in

the alarm system. Normally, when a switch is open, there is a gap in the electrical circuitry and current cannot flow. Any device that may be connected to the circuit, such as a buzzer, will not operate. When the switch is closed, the circuit is complete allowing current to flow.

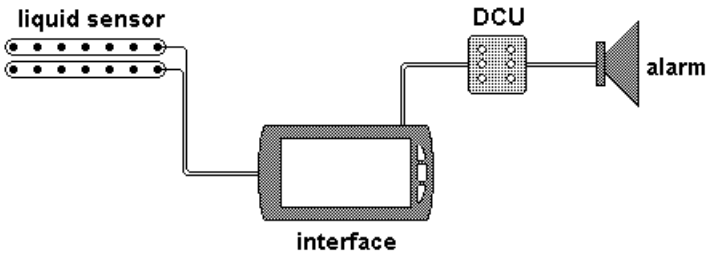


Figure 1 Water alarm

A PC board works well for the liquid sensor, because the strips of copper are in close proximity to one another, but still electrically isolated. When the sensor is dry, the gap between the copper strips will not allow current to flow; but when the PC board is immersed in water, the water will bridge the gap and complete the circuit, allowing the interface to detect a change in the voltage. A Vernier Analog Breadboard Cable can be used to connect the liquid sensor to the interface. The sensor also requires the addition of a resistor. Even though water will complete the circuit, its low conductance creates very small changes in voltage making it difficult for the interface to reliably detect the signal. *Electrical conductance* is a measure of the degree to which an object can conduct electricity, calculated as the ratio of current flow to potential difference. Pure (distilled) water has a very low conductance (less than 0.055 microsiemens per cm) due to a lack of impurities or charged particles which allow current to flow. Tap water and rainwater have a higher conductance due to the presence of dissolved salts and/or acids in the water. A properly-sized resistor can be used to increase the range of the output voltage. In our water alarm, we used a 10 kΩ resistor.

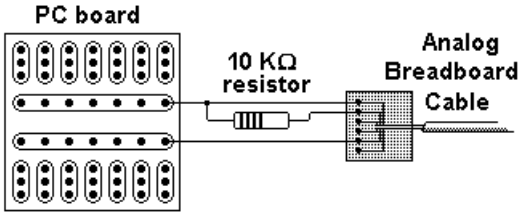


Figure 2 Liquid sensor

The water alarm also requires an audible alarm such as a buzzer. Piezo buzzers are the recommended type of buzzer, because they do not require an oscillating signal in order to emit a tone. The Vernier DCU is used to control the on/off signal to the buzzer. It comes with a 9-pin cable for use in attaching electronic components. Many components, such as buzzers, require a stronger current than that provided by the interface alone. The DCU provides this additional current. When using it, you should keep the power limitations of the DCU in mind: 1000 mA total current.

CONSTRUCTION

Build the detector

1. Solder two jumper wires to the ends of the long vertical copper strips on the PC board.

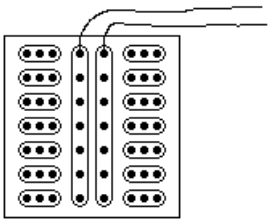


Figure 3 Solder connections to printed circuit board

2. Insert the circuit end of a Vernier Analog Breadboard Cable into a breadboard.

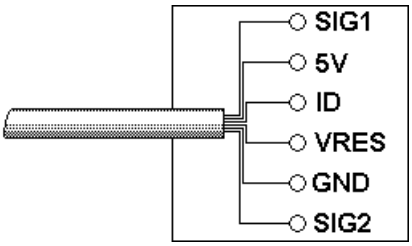


Figure 4 Vernier Analog Breadboard Cable pin-out

3. Connect a 10 kΩ resistor between the +5 V pin and SIG1 pin on the cable.

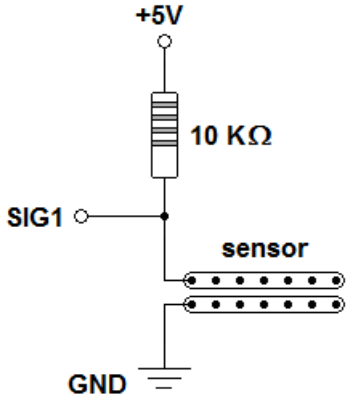


Figure 5 Liquid sensor circuit

4. Connect the two conductor wires on the PC board between the SIG1 pin and the GND pin on the cable.

Connect the sensor to the interface

1. Connect the Analog Breadboard Cable to Channel 1 on the interface.
2. Connect the interface to the computer.

Set up the DCU

1. Connect the DCU cable to the 9-pin socket on the side of the DCU.
2. Connect the buzzer between the D1 line and either GND wire on the DCU cable.

   Tip: *A color-coded label attached to the cable identifies each of the wires.*

3. Connect the DCU to the first DIG port on the interface.
4. Connect an external power supply to the DCU.

SOFTWARE SETUP

1. Start Logger *Pro*.
2. Record the potential reading in the digital meter. This is the value of the electric potential when the fluid detector is dry.
3. Choose Set Up Sensors from the Experiment menu.
4. In the DIG/SONIC1 list, select Choose Sensor, and select Digital Control Unit.
5. Then select Digital Out from the DIG/SONIC1 list.
6. In the Digital Out dialog box, select the Turn ON When check box.

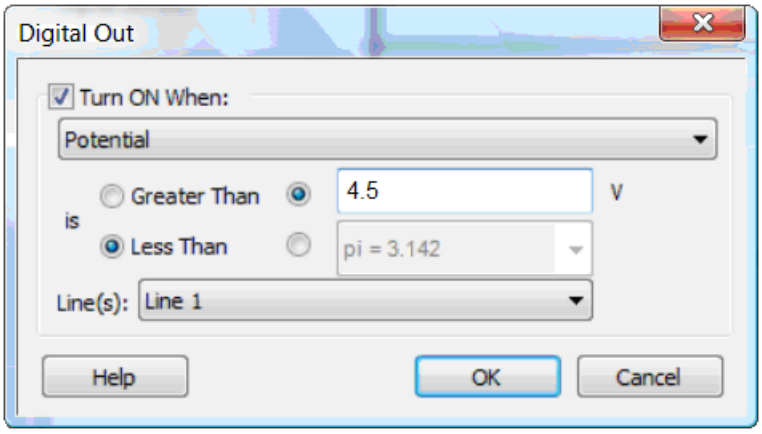


Figure 6 Vernier Analog Breadboard Cable pin-out

7. Click Less Than and enter a threshold value a little less than the potential value you recorded in Step 2. For our sample detector, we used a value of 4.5 V.

   Tip: *Note that the default action is to turn on Line 1. Other lines or combinations of lines can be selected from the drop-down list.*

8. Click OK, and then close the Set Up Sensors dialog box.

Tip: *Values for electric potential will be displayed in the digital meter. When the detector is dry, the potential reading should be near +5 V.*

9. To begin using your fluid detector, click Collect.

TIPS

1. Radio Shack sells a general purpose PC board (catalog #276-150). You can also find PC boards at online electronics stores, such as Mouser and Digikey. The boards with long vertical strips of interconnected holes are preferable, but if they are unavailable, you can always solder a row of holes together to form your own vertical strips.

2. Radio Shack sells a buzzer (catalog #273-054) that emits a reasonable tone of 75 dB. If purchasing a buzzer from an online source, make sure to select a piezo style. Non-piezo buzzers will simply click when a voltage source is applied. They require the application of an oscillating source in order to emit a tone.

3. Ideally the wires connecting the detector to the breadboard circuit should be of sufficient length to prevent water interfering with your electronics.

4. We used a 10 kΩ resistor in our example project, but if you are using a material other than a PC board for your liquid sensor, you may need to use a smaller or larger size resistor.

TROUBLESHOOTING

1. Some PC boards are manufactured with a thin plastic coating over the board to prevent the copper from corroding. Unfortunately, this also prevents the copper from conducting. This coating can be removed by gently rubbing the board with a piece of fine steel wool.

2. If testing your device in the lab, be aware that distilled water does not conduct electricity well. It is better to use city or well water.

APPLICATIONS

1. Use your water sensor as part of a weather station to record the exact start of a rainstorm.

2. Use your water sensor as a shut-off valve to turn off a lawn sprinkler system.