

Tech-Niques!

by Ron C. Johnson

Here's an interesting integrated circuit that I found in a small control board out of a commercial coffee maker (from my days of fixing almost anything under the sun): the LM1830 Fluid Detector chip. The application it was used for in the coffee maker was a high water level detector. Starting the fill cycle was initiated manually by the person who put in the fresh coffee grounds, etcetera, but the level detector was used to shut off a solenoid valve when the water in the urn reached the correct level. Sensing a water level using a conductivity type probe is not difficult and could be done easily without a specialized chip, but this one is convenient to use and has a couple of features which make it attractive for this, and other, applications.

Figure 1 shows a diagram of the internal function blocks of the chip. As you can see, within the fourteen pin dip package there is an oscillator, a detector input, an output amp and driver, and provisions for connecting three capacitors and a resistor.

In principle, this chip uses a conductive probe as an electrode and the metal container as ground (or two electrodes if the container is not metal), and allows current to flow through the liquid when it reaches a high enough level to complete the circuit between them. It's important to remember that liquids only conduct electricity if they are polar in nature — that is, if they contain mobile ions in solution. An example of this is water with table salt, (NaCl, sodium

chloride) dissolved in it. The salt dissociates into Na⁺ and Cl⁻ ions and becomes a good conductor. Typically drinking water has a high enough level of various elements dissolved in it to conduct electricity quite well. (So don't use your electric shaver in the bathtub!)

As I said, when the water covers the probes it allows current to flow, which we can detect and use as an indication of high level. But why does this chip have an oscillator in it? The answer

In the LM1830 chip the frequency of oscillation can be controlled by selecting the value of the capacitor connected from pin 1 to pin 7. A typical value would be about 0.001 μ F which gives a frequency of oscillation of about 6 kHz. The output of the oscillator is available on two pins of the IC. For most applications using water the output on pin 13 would be used, as the chip is equipped with an internal resistor to adjust the sensitivity for water. If another liquid

(which has a greatly different conductivity) is being sensed, pin 5 is a direct connection, bypassing the internal resistance. A resistance value can be calculated taking the new conductivity into account.

Figure 2 shows a liquid level control circuit similar to the one I found in the coffee machines. You can see that the output of the oscillator, at pin 13, is connected to the detector input, at pin 10, through a 0.05 μ F capacitor. The cap is used to ensure that any DC voltage on the oscillator output is blocked while the AC is coupled to the electrode. The output from the oscillator, then, is connected to the level detection

electrode, the voltage level of which is being sensed by the detector circuitry. As long as the electrode is not being "shorted" to ground (the metal container or other electrode) by the liquid, the oscillator signal is connected through the detector circuitry to the output transistor, turning it on with each pulse of the oscillator. When the level is high enough to "short" the electrode to ground, the signal at the detector input decreases significantly and the transis-

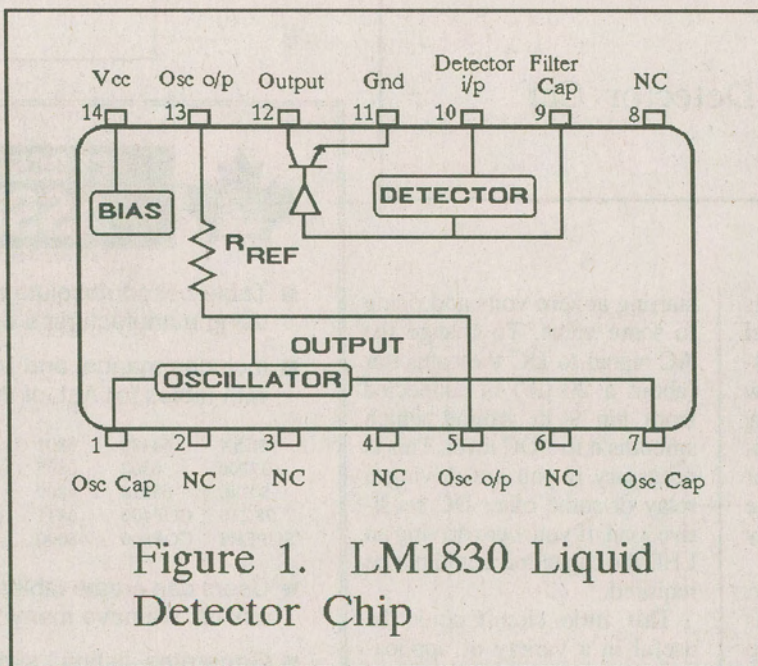


Figure 1. LM1830 Liquid Detector Chip

comes from the fact that when current flows from one electrode to the other (in one direction only, as with DC current), the ions, which enable current flow in a solution, are deposited on the anode, or positive electrode, causing a build up. This is called electroplating, and has lots of uses, but not in this application. To keep this from happening we use AC voltage across the electrodes. The alternating action stops electroplating from happening.

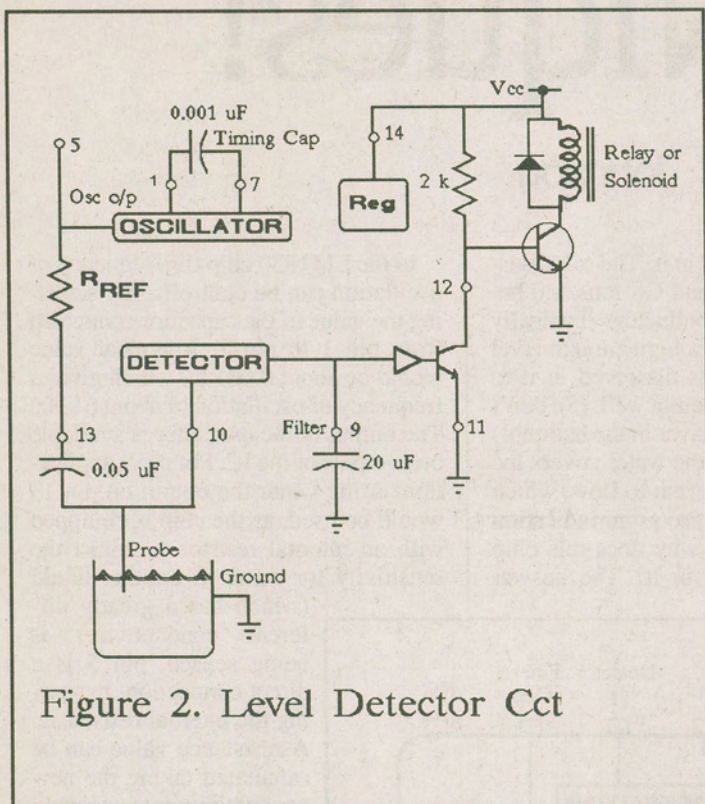


Figure 2. Level Detector Cct

tor is no longer turned on. This constitutes an "active" low level indication, because the transistor is on when the level is below the electrode, but this can easily be inverted using another transistor (as shown in Figure 2) or by choosing the appropriate contact in the relay driven by the output.

There is one more capacitor, connected to pin 9, which is used when the output of the chip is driving a load which requires DC. This is required because the output of the oscillator, which we said was AC, is coupled to the input of the detector (pin 10) and from there drives the output transistor. The output from the transistor, then, will be the same AC signal (roughly a square wave at 6 kHz). At the output of the detector the AC signal is really a pulse waveform, each pulse

starting at zero volts and rising to some value. To change the AC signal to DC the capacitor (about a 20 μ F) is connected from pin 9 to ground which smooths it to a DC level. This is necessary if you are driving a relay or some other DC sensitive load. If you were driving an LED the capacitor would not be required.

This little circuit could be useful in a variety of applications: a sump pump controller, a humidifier water level controller, or an automotive windshield washer alarm. The chip operates from a single supply up to 28 volts and it can sink up to 20 mA of current. It operates with very few external components and the chip itself costs less than five dollars.

Keep those ideas and suggestions coming... □