

Fluid Level Control Systems Utilizing the LM1830

National Semiconductor
Application Brief 10



Abstract. The LM1830 fluid level detector is a device intended to signal the presence or absence of aqueous solutions. This application brief shows how to implement HIGH/LOW limit control applications utilizing this device.

Many opportunities exist for a device that can reliably control the operation of pumps or solenoid actuated valves in fluid level control applications. Applications include sump pumps, bilge pumps, washing machines, humidifiers, plating baths, continuous replenishment photographic processors, coffee makers, municipal water and waste treatment plants, cooling towers, refrigeration equipment and others.

Classically, these needs have been met by various mechanical arrangements such as float valves or diaphragm actuated switches. These devices are bulky, inaccurate and, because they contain moving parts, unreliable—often with disastrous results when they fail. They are easily disabled by debris or environmental problems such as ice. They can be expensive when used to control the level of corrosive fluids such as plating baths or detergents, or when used to control large differences in depth such as in municipal water towers. Mechanical control devices are prone to false actuation in vehicular applications (such as bilge pump controls) due to their own inertia. In many applications such as coffee makers, they are too bulky to fit within the confines of the package. By utilizing electronic means based on the LM1830, problems inherent in mechanical solutions are overcome and a reliable, cost effective approach to fluid level control is made possible.

The LM1830 is a monolithic bipolar integrated circuit designed to detect the presence or absence of aqueous fluids. An AC signal generated on-chip is passed through two probes within the fluid. A detector determines the presence of the fluid by using the probes in a voltage divider circuit and measuring the signal level across the probes. An AC signal is used to prevent plating or dissolving of the probes as occurs when a DC signal is used. A pin is available for connecting an external resistance in cases where the fluid impedance is not compatible with the internal 13 k Ω divider resistance.

The addition of a CD4016 quad CMOS analog switch (Figure 1) allows the LM1830 to be used for HIGH/LOW limit control applications. The switch sections are opened and closed by a control signal, where a HIGH level turns the switch ON and a LOW level turns the switch OFF. Grounding the input of one switch section and pulling its output up with a resistor creates an inverter. Probes are connected to the inputs of two of the remaining analog switches. Their outputs are connected to pin 10 of the LM1830

which is the detector input. The remaining section of the CD4016 is used to buffer the open collector output of the LM1830. All of the control inputs of the quad analog switch are tied to this output. The last switch section controls the base of a transistor which in turn drives a relay or solenoid actuated valve.

The start and stop probes are set at their appropriate levels in the fluid container, and the ground return is connected to a third probe located at a depth greater than the start and stop probes. If the container is conductive, it may be used as the ground return. Let's assume we have a situation where we wish to empty the container when fluid reaches a predetermined level [sump or bilge pump, Figure 1(a)]. With no fluid covering either of the probes, pin 12 of the LM1830 switches LOW. This disables the relay and enables the analog switch connected to the start probe. Fluid eventually fills the container, covering the start probe. When this occurs, the output of the LM1830 switches HIGH and the pump relay is enabled, thereby draining the container. At the same time, the analog switch used as an inverter enables the analog switch connected to the stop probe and disables the start probe. Draining continues until the stop probe is above the level of fluid in the container. Then the output of the LM1830 switches LOW, disabling the relay (halting the drain operation) and switching the start probe back to its active state.

By reversing the labeling on the probes, as well as reversing the polarity of the relay drive, a container "fill" control is implemented such as would be used in a water tower. Necessary circuit changes are shown in Figure 1(b).

A pump control for a waste water holding tank in a photographic darkroom has been implemented with this circuitry. This replaced a float actuated system which failed consistently due to the corrosive nature of the chemicals used in photographic processing. With one year of continuous service, no failures have occurred in this system. Furthermore, there is no evidence of plating on the sense electrodes, in spite of the fact that the waste water is loaded with silver ions. A plastic holding tank is used, with stainless steel bolts inserted through holes drilled in the tank as sense probes (Figure 2). A solid-state relay controls a 1/4 HP pump motor to empty the tank.

Obviously, careful selection of probe materials must be made to maximize reliability with this system. Excellent sources of information on materials in corrosive environments are available in publications such as Omega's *Temperature Measurement Handbook*, or Eastman Kodak's *Darkroom Design Manual*.

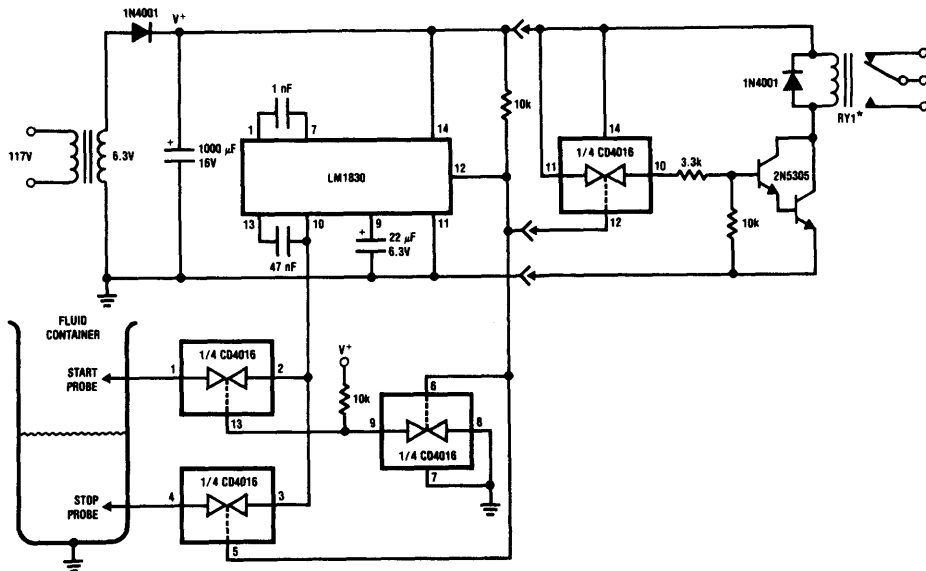
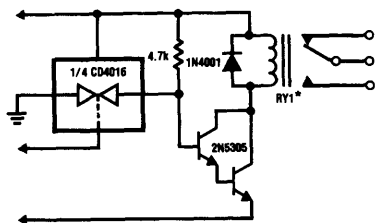
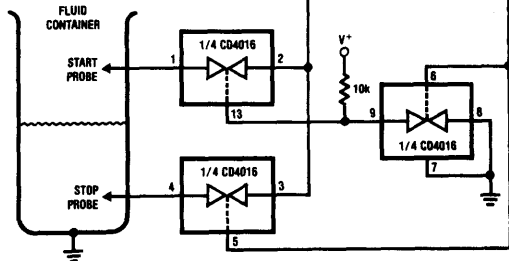


FIGURE 1(a). "Emptying" Processes are Controlled with this Circuit

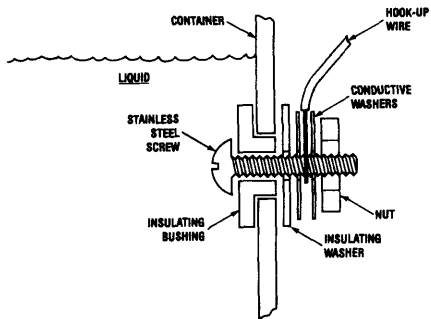
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*RY1 = Magnecraft Part #W388CQX-5

FIGURE 1(b). Filling Processes are Implemented with this Output Circuit and Relabeled Probes

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A sealing compound applied externally protects hook-up wire and prevents leaks.

FIGURE 2. Typical Probe Installation

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