Automotive Radiator Monitor

You could be in big trouble if your car loses its coolant through boilover or a leaky radiator or heater hose. Don't take a chance on being stranded. This easy-to-build monitor warns you the instant the coolant level drops.

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IN A WARM ENVIRONMENT, AN AUTOMOBILE is definitely put to the test. During any of the warm months, about ten per year, one can take a drive down any of our highways and observe every few miles a car with its hood up and steam boiling out of the radiator. There is no sure solution to this problem; but, an important precaution is the radiator monitor described in this article.

About the Monitor

About the easiest method to detect a low fluid level, if the fluid is conductive, is to use an ohmmeter. If the fluid level is above the level of the probe tip then a relatively low resistance is detected; but, if the level falls below the probe tip's level then an infinite resistance is measured. If a threshold reference resistance is chosen between these two extremes, a binary detection system can be used. If the measured resistance is below that of the threshold then the fluid level is OK; but if the resistance of the sensor is above this threshold then the radiator needs more coolant.

The circuit described in this article is built around a National Semiconductor LM1830 integrated circuit fluid detector. The LM1830 contains its own internal regulated power supply, a detector, a power amplifier, an oscillator, and a reference resistance. In normal operation, an AC signal is generated by the oscillator. This signal is passed through the conductive liquid by two probes. A detector circuit determines, by comparing the resistance of the fluid between the two probes to that of the reference resistor, if the fluid is present at the probe level. The output of the detector is coupled to the open-collector output amplifier; that drives a LED. When the LED is lit, the fluid level is low.

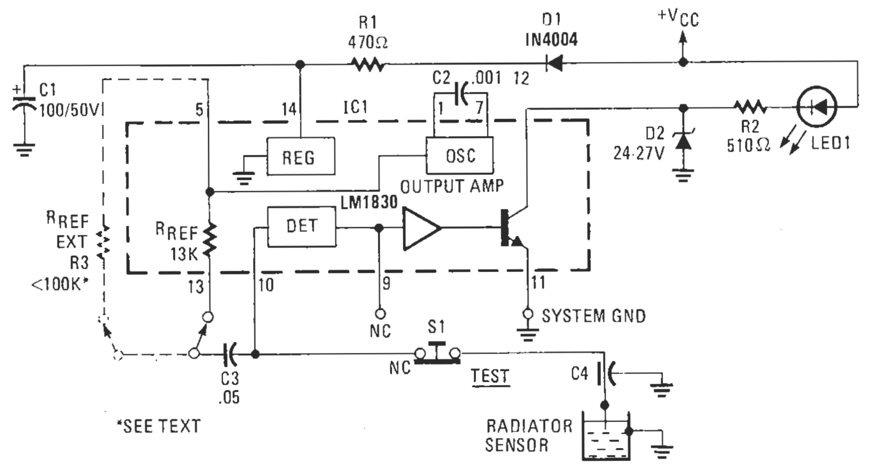

FIG. 1—RADIATOR MONITOR checks the level of coolant in the car's radiator and flashes a signal on the dashboard when coolant is low.

Refer to the schematic diagram shown in Fig. 1. Whenever electronic circuits are used in an automotive environment, transient protection must be considered. There are two types of transients that occur. The first is when a dead battery is being charged at a high-current rate and a cable is removed. This causes a positive transient on the power line, in the order of 60 to 120 volts; the transient is due to alternator inductance. The second transient is negative; about −75 volts on the ignition line. This type is due to field decay. That is, when the ignition is turned "off" the energy stored in the field winding will produce this negative pulse.

During this negative transient, diode D1 will be reverse biased and will prevent the flow of reverse current in IC1. If the transients occur only for a short time, then capacitor C1 will power IC1 and provide continuous operation. In the case of a positive transient, resistor R1 in conjunction with an internal resistor and Zener diode limit the voltage across IC1. Also, external Zener diode D2 and resistor R2 protect the output transistor of the IC power amplifier.

Only external capacitor C2 is required to complete the oscillator; if C2 is 0.001 μF, as shown in Fig. 1, then the output

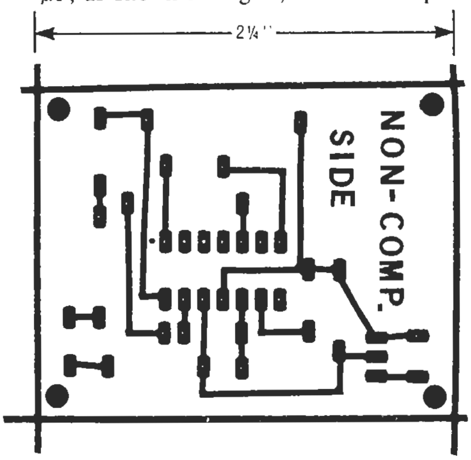

Fig. 2—FOIL PATTERN for the PC board used in constructing the radiator monitor.

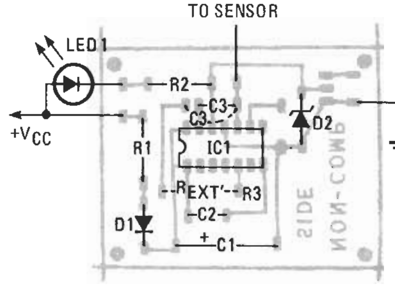

FIG. 3—PARTS PLACEMENT GUIDE for the radiator monitor. The placement of C3 depends on whether reference resistor R3 is internal or is external.

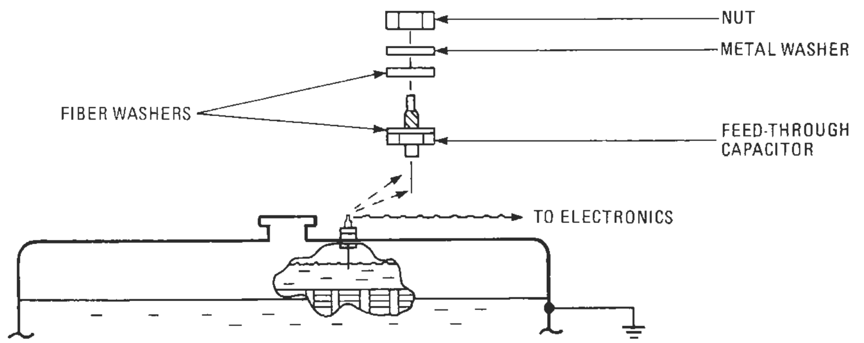

FIG. 4—HOW SENSOR is constructed and installed. Fiber washers insulate against shorts and provide a coolant pressure seal.

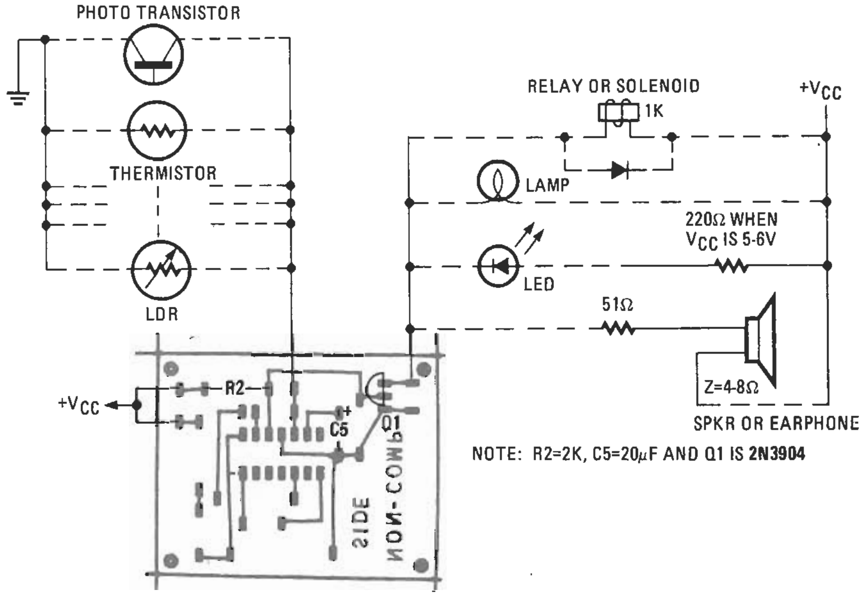

FIG. 5—PARTS PLACEMENT and input and output configuration for a variety of applications.

frequency will be approximately 6 Hz (the frequency of the oscillator is inversely proportional to this external capacitor. The oscillator output is available at pin 5 at pin 13 through the internal reference resistor. In most applications where the resistance of the fluid between the probe tips is less than 10K the output AC signal is applied to the sensor probe and detector input via an internal 13K resistor and external capacitor C3. If the resistance of the fluid is above 10K, then an external reference resistor (the resistance must be larger then the fluid's resistance, but less than 100K) is substituted for internal standard. An AC signal is used in this circuit to prevent the plating problems encountered by using a DC signal. Also, blocking capacitor C3 is used to prevent any net DC current being applied to the probe.

Construction

Begin construction by making up a PC board from the pattern in Fig. 2 and then install the components following the parts layout in Fig. 3 and the parts list. If the sensor resistance is less than 10K (this will depend on fluid composition and the probe geometry), assemble the circuit as shown. Only nine components are required at this time, one IC, three diodes, two resistors, and three capacitors. If the fluid resistance is greater than 10K one additional resistor is required (the external reference resistor). Install the resistors, capacitors, and diodes onto the PC card; the IC should be soldered to the PC board last.

Figure 4 shows how I designed the sensor. A feed-through type capacitor, (value is unimportant—100 pF was used), was installed near the radiator cap. The area chosen was both smooth and level. A set of vernier calipers was employed to determine the diameter of the capacitor's stud; a hole slightly larger was then drilled in the radiator, in the area previously discussed. Two fiber washers were then fabricated from heavy asbestos gasket stock, using the drill and a pair of scissors. One fiber washer is placed upon the capacitor; then, via the radiator fill spout, the capacitor assembly is fed through the mounting hole, stud end up. The other fiber washer and a metal washer (the inside of the metal washer should be drilled out or reamed to provide a snug fit) are then placed upon the stud. Next, place the nut supplied with the capacitor on the stud and tighten. Now, solder a length of light-gauge Teflon-coated wire to the top terminal of the capacitor. The other inside terminal is cut, via the radiator filler neck, to the level desired; consult your automobile owner's manual. After placing a piece of heat-shrinkable tubing over the solder joint, route the wire to the auto's dashboard area. A 2 x 1½ x 2¾-inch aluminum utility box was used to fabricate a case. A small general-purpose red LED and an SPST normally-closed pushbutton switch was mounted on one end; the LED, of course, is used to inform the driver as to the level of coolant. The SPST pushbutton switch is used to test the monitor; it is in series with the sensor—thus, when pressed, the contacts are opened, and the line impedance should be infinite. This will of course light the LED.

Seven holes were also drilled in the case; four were used to mount the PC board, on insulating spacers; two were used to mount the assembly on the underside of the auto's dashboard; and one was used to bring out the power and sensor wires via a rubber grommet, the case

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PARTS LIST

Resistors ¼ watt, 10%
R1—470 ohms
R2—510 ohms
R3—See text; as required but less than 100,000 ohms
C1—100 µF, 50 volts, electrolytic
C2—.001 µF, disc
C3—.05 µF, disc
C4—See text, low-value feed-through
D1—1N4004 or equivalent diode
D2—Zener diode, 24 to 27 volts
LED1—Red general-purpose LED
IC1—LM1830 fluid detector (National Semiconductor)
S1—normally closed pushbutton switch

The following may be obtained from Questar Engineering Co., 50 South McDonald Drive, Mesa, AZ 85202: a kit of all parts (including case but excluding R3, C5, Q1 and the 2K value of R2) $19.95; PC board $5.50; LM1830 IC $2.50. Add $1.75 for shipping in U.S., $3.00 on foreign orders. All COD orders will incur COD charges.

RADIATOR MONITOR

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provides the ground. Note that this circuit depends upon the auto's electrical system employing a negative ground; the radiator tank is used as the negative sensor probe, and the case of the electronics package was used as ground terminal.

In normal operation, the LED will only be lit if the coolant level is low or the TEST pushbutton is being pressed. Also, during normal operation of your vehicle, the LED may occasionally blink on and off; this is normal and will vary with water level, the number of bumps encountered, and the speed at which the coolant is flowing (this will depend upon the engine RPM and temperature).

Other possible applications.

The circuit board shown in Fig. 2 can be put to uses other than those previously described. It could be used in an aquarium to detect a low-water condition; a relay then could switch on a water pump, or open a water valve to fill the aquarium. It could be used as part of a sump-pump system in your basement to remove the water from a broken pipe or the spring rains. Or it could be used in a washing machine or dish washer to sense the full water condition (or empty state). Other fluid-sensing areas are steam boilers, water reservoirs, irrigation systems, etc.

Observe the parts placement guide in Fig. 5—another two components are shown: transistor Q1 to provide enough current drive capability for a relay (or low-current solenoid) and capacitor C5 to provide steady on and off states. Without C5 the output will oscillate with a 50% duty cycle; the output device should be a LED, earphone, or speaker. If capacitor C5 is used, the output device could be a relay, solenoid, or LED.

On the other hand, the input sensor could be a set of probes in a tank of conductive liquid (as previously seen), a photo-transistor, a light-dependent resistor, a thermistor, a strain gauge, a humidity sensor, a carbon microphone, etc . . . The only requirement is that the device have a resistance level above and below the chosen reference resistance over the range of the phenomena being observed. As you can see, this circuit could be the heart of any system from a fire or burglar alarm to a light switch. Its usefulness is limited only by your imagination. **R-E**