Portable Gas Detector . . . It Can Save Your Life!

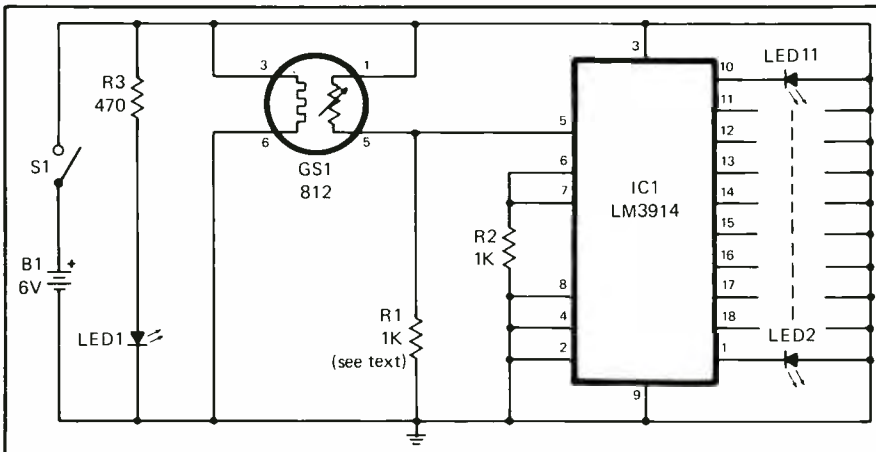
Easy-to-build project gives bargraph indication of concentrations of toxic gases and organic solvents

By Larry D. Gray

Have you ever thought you smelled gas and wished you had a way to check out your suspicion? Do you need to efficiently check the carburetor air-to-fuel mixture in your car but cannot justify spending the big bucks for a professional analyzer? Well, with the Portable Gas Detector described here, you can do both—and the project will cost you only about $35 to build. To top it all off, you can use the Detector as an alcohol breath analyzer.

About the Circuit

At the heart of the gas detector's circuit is a Figaro 812 solid-state gas-sensor device (*GS1* in Fig. 1). The sensor uses n-type SnO_2, the resistance of which decreases with an increase in concentration of gas. The 812 has a high sensitivity to toxic gases and organic solvents. Hence, *GS1* can sense very small concentrations of carbon monoxide and alcohol. Although it is not as sensitive to hydrocarbon products, like natural gas, it still gives good results.



PARTS LIST

B1—Four 1.5-volt AA cells in series (see text)
GS1—Figaro 812 gas sensor
IC1—LM3914 dot/bargraph display driver
LED1—Green 3-mm light emitting diode
LED2 thru LED11—Red 3-mm light-emitting diode
R1,R2—1000-ohm, ¼-watt, 10% tolerance resistor
R3—470-ohm, ¼-watt, 10% tolerance resistor
S1—Spst toggle or slide switch
Misc.—4⅜" × 2½" × 1¼" plastic box; pc board or perforated board and solder posts; four-cell AA battery holder; chassis-mount seven-pin miniature tube socket; machine hardware; hookup wire; solder; etc.

Note: The following are available from QDI Inc., P.O. Box 205, West Union, OH 45693: Figaro 812 gas sensor for $14.95; etched and drilled pc board for $6.95; complete kit of all board-mounted parts, including GS1, tube socket and pc board but not plastic case, for $29.95. Please include $3.00 for postage and handling.

Fig. 1. Circuitry for Gas Detector is very simple. Most of the work is done by gas sensor GS1; IC1 and LED2 through LED11 form the display.

Since *GS1* does all the work in this circuit, the only other items needed are the components that make up the eye-catching bargraph light-emitting diode display. Consequently, the circuit is quite simple. The LM3914 voltage comparator used for *IC1* is all that is needed to sequentially drive the display consisting of *LED2* through *LED11*.

Contained inside the LM3914 are 10 comparators. The first comparator is referenced 0.12 volt above ground. Each successive comparator is then referenced another 0.12 volt above the previous one. With this arrangement, an input of 1.2 volts is required for a full-scale display indication in which all 10 LEDs that make up the bargraph display are lit. Current through the display is controlled by *R2*. The 1000-ohm value specified for this resistor limits the current through the 10 LEDs to 10 mA.

Gas sensor *GS1* and resistor *R1* form a voltage divider that limits the maximum voltage delivered to *IC1* to 1.2 volts. When the sensor is exposed to air, its resistance is relatively high (about 50,000 ohms), and very little voltage (0.08 volt) is applied to the LM3914. As a combustible or toxic gas passes over the sensitive surface of *GS1*, sensor resistance drops, increasing the voltage dropped across *R1*. In turn, this causes *IC1* to light one or more display LEDs, the number being lit increasing as the voltage increases. The more combustible or toxic the gas, the lower the resistance of *GS1* and the greater the number of LEDs that light.

To avoid confusion, a green LED is used for *LED1* to indicate when power is on. Resistor *R3* serves as a current limiter for this LED.

Power for the circuit is supplied by *B1*, which consists of four AA cells in series. While any type of AA cell can be used to power the project, alkaline cells are recommended if you expect to obtain reasonably long operating life, since *GS1*'s heater draws considerable current, though the rest of the circuit draws very little.

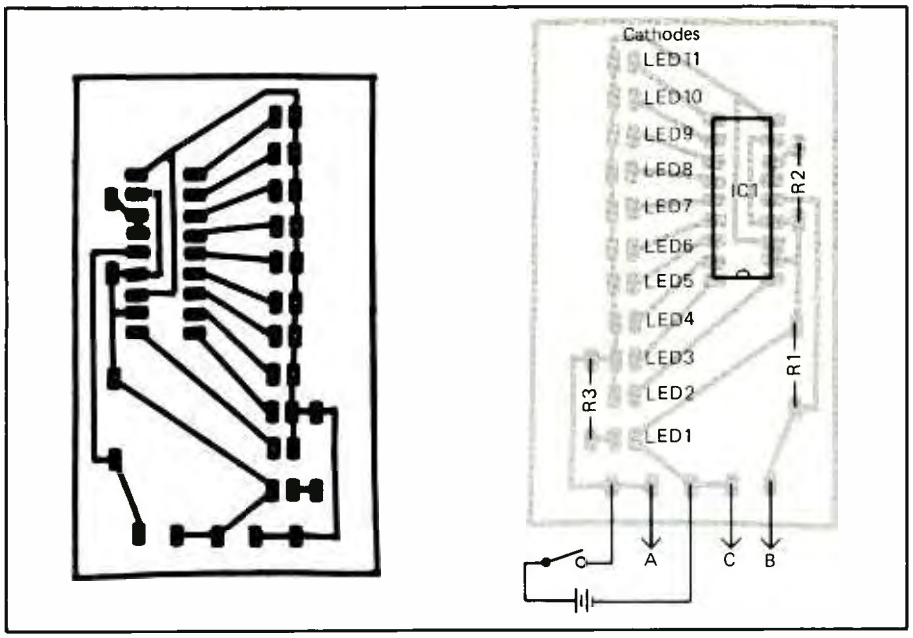


Fig. 2. Actual-size etching-and-drilling guide is at left; components-placement diagram at right gives complete board assembly details.

Construction

Owing to the simplicity of the circuit, you can use either a printed-circuit board or a perforated board and solder posts for assembly. If you decide to fabricate your own pc board, use the actual-size etching-and-drilling guide shown in Fig. 2. Whether you choose pc or perforated board construction, the components-placement guide, also in Fig. 2, should be used. It is not necessary (or advisable) to install *IC1* in a socket.

Gas sensor *GS1* plugs into a seven-pin miniature tube socket and, therefore, presents no problems with regard to indexing during installation. Wiring details for this socket are shown in Fig. 3.

Once the circuit has been assembled, it can be temporarily connected to the battery supply and tested before final assembly. Before proceeding to testing, however, machine the plastic box in which the project is to be housed to accommodate the battery holder on the floor of the box, the gas sensor (in its socket) to the top end, and the circuit board and power switch to the cover. Note that the circuit board mounts to the lid with no hardware. Instead, a single column of 11 holes into which the domes of the LEDs plug is sufficient to hold the assembly in place. Of course, the holes should be just large enough to provide a snug—not force—fit. If you wish, however, you can apply a small drop of clear plastic cement to

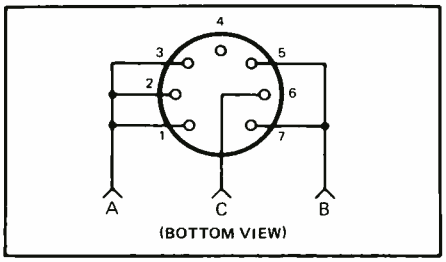


Fig. 3. Wire the gas sensor's socket as shown here; match the lettered points to the same points in Fig. 2.

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LED1 and *LED11* to hold the assembly in place.

Testing and Use

When power is first applied to the circuit by closing *S1, GS1*'s heater element begins to warm up the sensitive surface. This display will initially light, sometimes to full scale, and then fall back to zero as the sensor stablizes. This indicates that the sensor is ready to use. If during warm-up *LED2* or *LED3* remain on, this is an indication that the battery is getting weak and should be replaced.

Testing can be accomplished with a gas-type cigarette lighter. Simply press the gas-release button (do *not* rotate the spark wheel) and allow the escaping gas to come into contact with the gas sensor. If the battery is fresh and you have properly wired the circuit, the LEDs should give a full-scale reading.

Having satisfied yourself that the Gas Detector is operating as it should, turn off the power and proceed to final assembly. Mount the battery holder on the floor of the plastic box with machine hardware. Do the same for the gas sensor's socket on the top of the box. Then carefully align the 11 LEDs with the holes in the box's lid and gently press home. Place a 1″ length of plastic electrical tape over the exposed lugs of the gas sensor's socket to insulate it from the rest of the circuitry. Fit the lid onto the box and secure it in place with the supplied screws. Finally, plug *GS1* into its socket. If you wish, you can label the LEDs and put the legend "Gas Detector" onto the lid with a dry-transfer lettering kit and follow up with two or three light coats of clear lacquer to protect the lettering from scratches.

There are a couple of improvements you might want to incorporate into your Gas Detector. An obvious one is to replace the standard AA cells with rechargeable NiCd cells. If you do this, it is a good idea to also install an appropriate accessory jack to obviate the need to remove the cells for recharging.

Detector sensitivity can be increased by substituting a larger value resistor for that specified for *R1* in the Parts List. This will cause the voltage dropped across *R1* to be greater for a given concentration of gas. If you wish to have both the standard and the increased sensitivities, you can install a switch that will allow you to choose between the 1000-ohm and larger-value resistors as circumstances dictate. **ME**