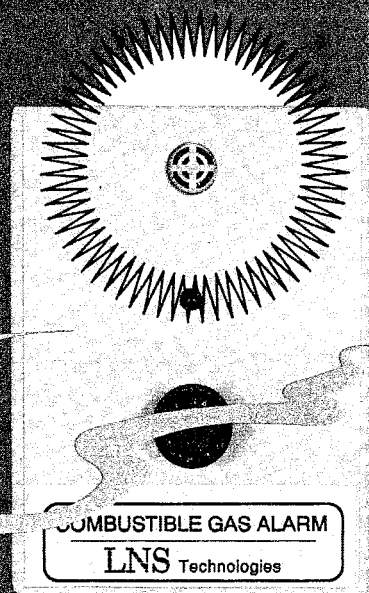
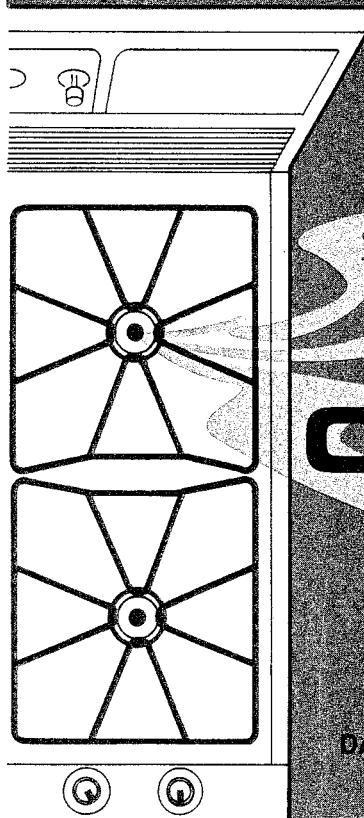


Detect combustible gases in your home before they reach explosive levels with our semiconductor-based gas alarm.



COMBUSTIBLE GAS ALARM

DAVID WILLIAMS

MOST PEOPLE TODAY ARE AWARE OF the dangers of a home fire, and depend on smoke detectors for an early warning. However, fires caused by combustible gases can be avoided by detecting the gases before they ever reach toxic levels or ignite. A combustible-gas detector can provide a much earlier warning than any smoke detector!

Theory of operation

The gas alarm is based on a semiconductor sensor element, shown in Fig. 1, that undergoes a change of resistance when exposed to gases that have an affinity for oxygen. Gases with that property are known as *reducing gases* and they include methane, butane, propane, and carbon monoxide. The sensor is

WARNING

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composed mainly of tin dioxide on a ceramic base; it includes an internal heater coil which maintains the semiconductor at a constant temperature.

In normal air, and at a fixed temperature, the sensor is designed to absorb oxygen at a constant rate. Because the conductivity of the tin dioxide is related to the rate of oxygen absorption, it is also a constant

in normal air. However, in the presence of a reducing gas, the sensor's internal resistance decreases in proportion to the gas-concentration level. By converting the sensor's resistance change to a DC voltage, the circuit can detect specific gas concentrations and trigger an alarm before the concentration reaches a dangerous level.

The circuit

The sensor is labelled SEN1 in the gas-alarm schematic of Fig. 2. The 9-volts DC from wall transformer T1 is regulated to 5 volts by an LM2940 regulator, IC3. Capacitors C1 and C2 provide filtering and stability to the regulator. The 5-volt output from IC3 is connected to the heater coil of SEN1 at pins 2 and

5. The sensor's internal resistance element is connected in series with resistor R1 to form a voltage-divider circuit. Note that R1 is a calibrated resistor that has been specifically matched to each gas sensor by the manufacturer and is included with the purchase of each sensor. Do not substitute any other resistor for R1 or the alarm trip point will be incorrect.

The SEN1/R1 combination results in 2.5 volts across R1 in the presence of approximately 5,000 parts per million (ppm) of methane gas at a temperature of 20 degrees Celsius. That concentration level represents 1/10 the level at which methane becomes explosive in air. The trigger point is low enough to provide advanced warning of a

natural gas leak, yet is high enough to avoid false alarms from common home vapors such as hair sprays or cooking fumes.

The output voltage from the SEN1/R1 divider goes to the positive input (pin 2) of an LM311 comparator (IC1). The negative input (pin 3) is set to a reference voltage determined by R2, R3, R4, and thermistor R8. Those components provide a 2.5-volt reference voltage at room temperature. Because SEN1's gas detection is based on the principle of chemical adsorption, its output voltage is affected by humidity and temperature changes, and that can cause variations in the alarm trip point. Therefore, a negative temperature coefficient (NTC) thermistor (R8) is used to effectively adjust the threshold voltage to compensate for those variations.

In the presence of a reducing gas, the resistance of SEN1 will drop and the voltage at pin 2 of IC1 will rise. When it reaches 2.5 volts or greater, the output of IC1 will turn on transistor Q2 which will in turn activate the buzzer, BZ1. Resistor R5 provides some hysteresis to IC1 and capacitors C5 and C6 provide noise filtering on the comparator inputs.

A flashing light-emitting diode (LED1) indicates that the sensor is operating with the cor-

rect supply voltage. An LM3909 low-power LED flasher (IC2) uses C3 to set the flash rate at approximately 1 hertz. A DS1233 voltage detector (IC4) monitors the 5-volt output from IC3. If the output falls below 4.75 volts, the DS1233 will turn off transistor Q1, which in turn will turn off IC2 and the LED.

A 9-volt battery (B1) and blocking-diode (D2) provide battery-backup operation for short power outages. The LM2940 is a low-dropout regulator that will give a regulated output with input voltages as low as 5.8 volts. (A normal regulator works properly only when the input voltage is above 7.5 volts.) Therefore, the LM2940 regulator allows for longer backup times as the battery voltage drops. The gas alarm draws approximately 170 milliamps during operation; that relatively high current draw is due to the heater element in SEN1. A fresh 9-volt alkaline battery will provide slightly over an hour of backup operation. If you want longer backup operation, you must replace B1 with a higher-capacity external nickel-cadmium or lead-acid battery.

Construction

The easiest way to build the gas alarm is with a PC board. Artwork is provided here; etched and drilled boards can be purchased from the source

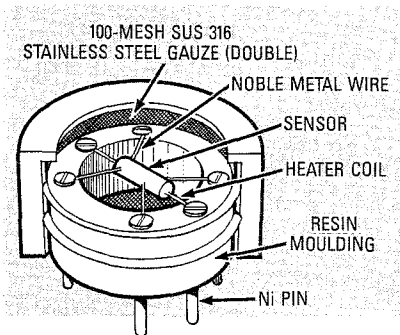


FIG. 1—THE GAS SENSOR is mainly composed of tin dioxide on a ceramic base; the resistance of the sensor varies depending on the concentration of reducing gases in the air.

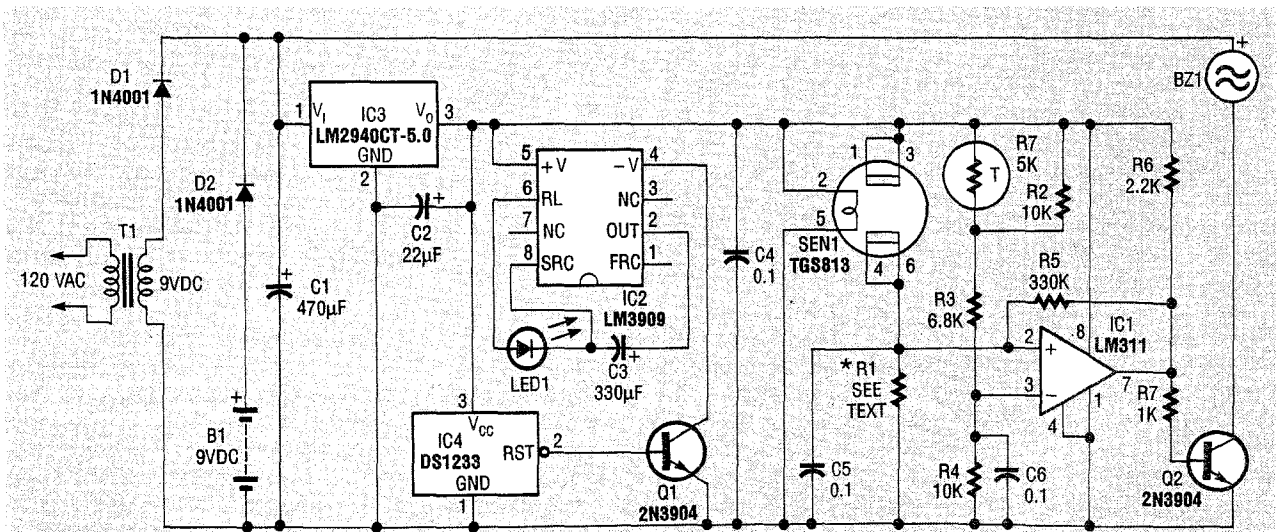


FIG. 2—THE SENSOR'S RESISTANCE ELEMENT is connected in series with resistor R1 to form a voltage-divider circuit; R1 is specifically matched to each gas sensor by the manufacturer.

PARTS LIST

All resistors are 1/4-watt, 5%

R1—Calibration resistor, included with sensor (see text)

R2, R4—10,000 ohms

R3—6800 ohms

R5, R6—330,000 ohms

R7—1000 ohms

R8—5000-ohm thermistor

Capacitors

C1—470 μ F, 16 volts, electrolytic

C2—22 μ F, 10 volts, electrolytic

C3—330 μ F, 6 volts, electrolytic

C4—C6—0.1 μ F, ceramic

Semiconductors

IC1—LM311 voltage comparator

IC2—LM3909 LED flasher

IC3—LM2940CT-5.0 (or 7805T) voltage regulator

IC4—DS1233 power monitor

Q1—2N3904 NPN transistor

D1, D2—1N4001 diode

SEN1—TGS813C gas sensor (Figaro)

Other components

B1—9-volt battery

T1—9-volt DC, 300 mA wall transformer

BZ1—12-volt DC buzzer

Miscellaneous: PC board, 9-volt battery connector, enclosure (SERPAC #231-I, or similar), hardware, two 8-pin IC sockets, wire, solder

Note: The following items are available from LNS Technologies, 20993 Foothill Blvd, Suite 307R, Hayward, CA 94541-1511 (510) 886-9296:

- SEN1 gas sensor, 6-pin socket, and calibration resistor (R1)—\$24.00

- Complete kit of parts for the gas alarm, including PC board, all parts, and plastic enclosure—\$49.00

Please add \$5.00 S&H to all orders. California residents must add local sales tax. MC/VISA orders accepted.

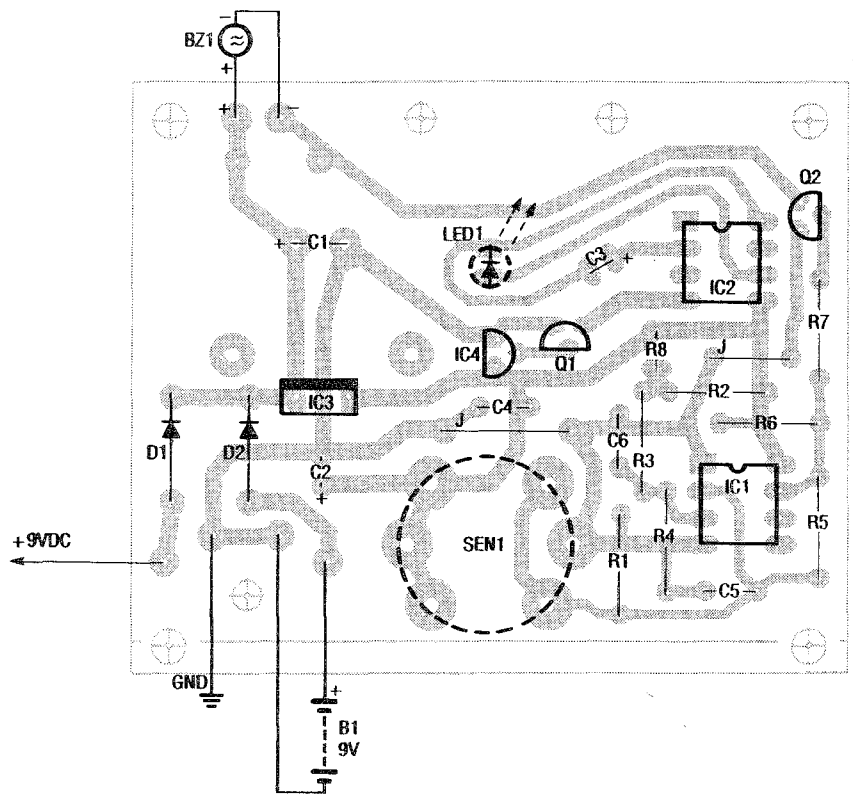
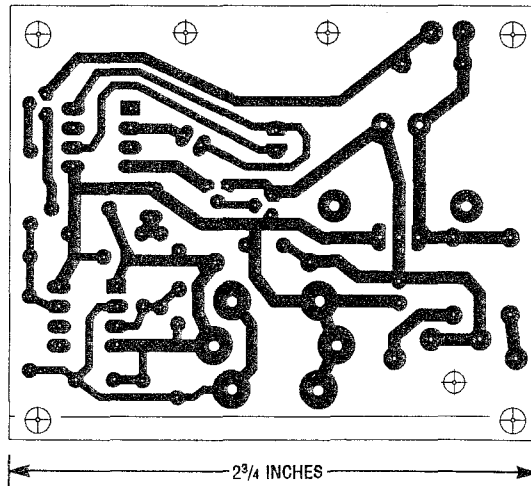


FIG. 3—FOLLOW THIS PARTS-PLACEMENT DIAGRAM when building the gas alarm. Install two wire jumpers at the locations marked "J."



FOIL PATTERN for the gas alarm.

mentioned in the Parts List. Figure 3 is the parts-placement diagram.

Two wire jumpers must be installed on the PC board at the locations marked "J." Next, install resistors R1 through R6. Note that the calibration resistor (R1) has a solid gray body with no color bands. Install diodes D1 and D2, paying close attention to their polarity.

Sockets are recommended for IC1 and IC2, and they can be installed now. (Don't insert the

IC's yet.) Next install ceramic capacitors C4, C5, and C6, and thermistor R8. The voltage monitor (IC4) and the transistors (Q1 and Q2) look very similar, so pay careful attention to their identity, and to their orientation. Install electrolytic capacitors C1, C2, and C3, and the voltage-regulator IC3.

Note that LED1 and SEN1 (both shown with dashed outlines) are mounted on the foil side of the circuit board. That arrangement allows the parts to

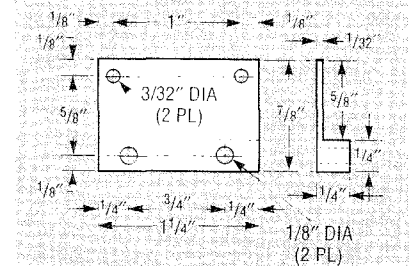


FIG. 4—IF YOU USE THE SAME CASE as the prototype, the buzzer must be mounted to the PC board with this metal bracket.

fit through openings in the top cover of the plastic enclosure.

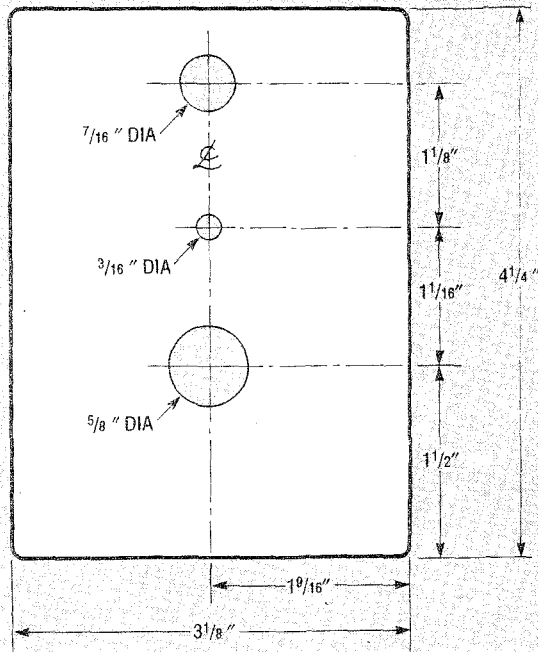


FIG. 5—THE TOP COVER of the case must be drilled as shown here to accommodate the LED, the gas-sensor socket, and the buzzer.

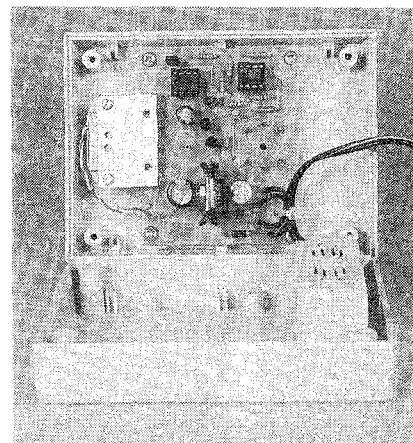


FIG. 7—A FINISHED UNIT looks like this inside. The board is held in place with four self-tapping screws.

case you have to make one. Otherwise you can mount the buzzer anywhere off-board, or hot-melt glue the buzzer in place.

Final assembly

If you use the same enclosure as the prototype, drill the three holes in the top cover as shown in Figure 5. (Note that the case included with the kit comes pre-drilled.) Figure 6 shows how the buzzer mounts to the metal bracket and how the final assembly fits into the plastic enclosure. Be sure to solder the two wires from the buzzer to the locations shown in Fig. 3. Position the PC board so that the LED, the gas-sensor socket, and the buzzer can be seen through the holes in the top of enclosure. (The sensor should not be in its socket yet.) The PC board should lie flat against the four plastic standoffs in the case, and held in place with four #4 × 1/4-inch self-tapping screws. Figure 7 shows the inside of the prototype.

Cut or file a slot in the bottom edge of the case for the transformer wires to fit through when the case is closed. Screw the two halves of the enclosure together with the four remaining screws.

Operation

Plug the gas sensor into its socket (polarity is unimportant), and plug the wall transformer into an AC outlet. The red LED should flash to show that the unit is powered up.

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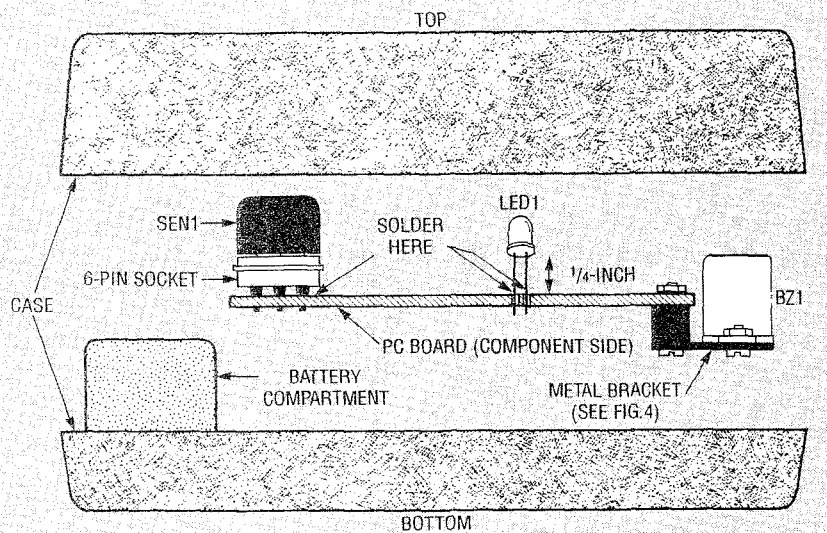


FIG. 6—THE FINAL ASSEMBLY fits into the plastic enclosure as shown here. The PC board should lie flat against the four plastic standoffs.

When soldering the LED to the foil side of the PC board, make sure that its bottom edge is 1/4-inch from the board. The sensor has a 6-pin socket that should be installed on the foil side of the board.

Next attach the wires for the battery connector, making sure that the red wire goes to the positive pad. It is also necessary to observe the correct polarity when attaching the wires from the 9-volt DC wall transformer

T1. You can check the output of T1 with a DC voltmeter to determine which wire is positive if you're not sure. Then unplug the transformer and solder the wires in the proper locations.

The last step is to attach the buzzer to the PC board with a metal bracket and screws (included in the kit). The bracket is necessary only if you are using the same case that is supplied in the kit. Figure 4 shows the dimensions of the bracket in

tantial issues. In recent years, vendors coalesced around two groups of standards, those promulgated by the Open Software Foundation (which includes IBM, DEC, HP, and others), and those by a combination of AT&T and Sun. At long last, the walls have come tumbling down. HP, IBM, SCO, Sun, Univel, and Unix Systems Laboratories (formerly of AT&T, but recently purchased by Novell) announced the Common Open Software Environment (COSE, pronounced *cozy*), a global application programming interface that hopes to eliminate inter-platform portability problems. With Microsoft's Windows NT due to be released this spring, this is clearly an act of desperation.

Think HDTV is something? Then check out Ultra Definition TV (UDTV), a new project sponsored by the Japanese Government and 100 of Japan's largest electronics firms. This may be a tacit admission of defeat in the HDTV wars, so the Japanese are leapfrogging to the next generation.

Remember the switch from 256K to 1Mb DRAM's? Maybe you noticed increasing usage of 4-Mb devices? The industry is about to make the next jump: 16-megabit DRAM's. Toshiba, Fujitsu, and NEC are already producing on the order of 500,000 units per month, and promise to double or triple that quantity over the next year. Not to be outdone, NEC has introduced 16-megabit synchronous DRAM's, which provide 10-ns access times; initial production rates will be 30,000 units per month. The ultimate is Hitachi's recent breakthrough announcement: the so-called single-electron memory, which would allow construction of power-effective gigabyte semiconductor memories. But give it about ten years to reach commercial status.

Bell Atlantic has built a demo Intelligent Home, which is prewired with fiber optic cables and features extensive multimedia communications. Using a TV, users can access telephone, cable TV, shopping, and other information services. This is the kind of forward-thinking use of technology that we should see more of. Ω

EQUIPMENT REPORT

continued from page 22

wrong because the picture we were viewing, SportsChannel, was not on Galaxy 2 (our highest satellite), but on one satellite to the east!

The receiver also offers an handy audio "Squawk" that provides an audio indication of signal strength. It's a easy way to peak the dish position because it allows an installer to keep his eyes on his work instead of on a signal meter or spectrum analyzer.

The PTR-25A portable test receiver has a list price of \$1395. The PSA-37D portable spectrum analyzer has a list price of \$2475. Thanks to the time they can save an installer, they should pay for themselves in short order. And the improved performance they can potentially bring to a dealer's installed systems should keep his customers happy—and coming back for more! Ω

COMB. GAS ALARM

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When power is first applied, the alarm will sound for several seconds as the heater element brings the sensor to the correct operating temperature. After the alarm stops, it takes approximately 2 minutes for the sensor to stabilize before accurate gas concentrations can be measured. After the warm-up period, you can test the alarm by using alcohol instead of methane. Dip your fingers into some rubbing alcohol and rub them together directly in front of the sensor element. The alcohol vapors should trip the alarm and the buzzing should stop once the alcohol has dissipated.

To use the backup feature, install a fresh 9-volt alkaline battery and repeat the alcohol test with the wall transformer unplugged. Remember to remove the battery whenever the unit is not in use to prevent discharge. Your gas sensor alarm is now ready to use. Remember that methane gas rises in normal air, so the alarm should be mounted near the ceiling. Ω

PRINTER MINDER

continued from page 64

this connector. Perform the following tests before installing the board in a case:

1. With no power applied, use an ohmmeter to verify that there is more than 20 ohms resistance between +5 volts and ground.
2. Apply AC power and ensure that the +5-volt source is accurate. It's convenient to measure across pins 20 and 10 of IC1.
3. Without connecting the printer, verify that LED1 (Printer On) is off. Attach one end of a test lead to pin 1 of J1 (STROBE IN). Momentarily ground the other end of the lead (e.g., to pin 19 of J1). The LED should illuminate, and should remain on for about one hour. While it's on, there should be 120 VAC across power connector J4.
4. With the LED still on, verify the power-fail feature by momentarily removing input power. The LED should go out, and J4 should lose power.

If any of those tests fail, correct the source of the trouble before proceeding.

The last step is to mount the board. If you use a case like our prototype, slide it in the tracks extruded into the wall of the case, and then seal the case with two end caps.

Hooking up

Now you're ready to connect Printer Minder between your computer and your printer. To understand the wiring scheme, refer back to Fig. 1, and perform the following steps:

1. Unplug the AC cable from your printer; it will be used later.
2. Unplug the data cable from your printer and connect it to J1 of Printer Minder.
3. Now connect another data cable from J2 of Printer Minder to the input port of your printer.
4. Connect an AC extension cable from J4 of Printer Minder to the printer's AC input.
5. Now apply power to Printer Minder by connecting the AC cable removed from the printer in Step 1 to J3.
6. Verify proper operation by printing a file. Ω