SOIL MOISTURE METER

Don't let summer heat dry your plants out! Keep them properly watered with this inexpensive digital moisture meter.

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FEW THINGS ARE MORE FRUSTRATING than planting a fancy new hybrid rose and finding, a few days later, that it died because it didn't receive enough water. You can avoid dehydrating your plants with our digital moisture meter. It can help you keep all your plants—indoors and out—in tip-top condition by indicating when a plant needs water. In addition, it will help you from overwatering your plants; overwatering can be just as detrimental as underwatering. The circuit is inexpensive (under $30), and it can be put together in an evening or two.

To obtain a digitally-accurate readout of moisture content, just turn the meter on, insert the probe into the earth beneath your plant, and read the three-digit LCD display. A rose bush, for example, needs a moisture level between 70 and 80 (on the scale developed by our meter). If the measured level is equal to or higher than that, the plant needs no additional water. The instruction manual that comes with the probe (discussed below) contains information about the proper moisture level for many varieties of plants.

How it works

The moisture meter's circuit is shown in Fig. 1; IC1, an Intersil ICL7106, is the heart of the circuit. It contains an A-to-D (*A*nalog-to-*D*igital) converter, a 3½-digit LCD driver, and all necessary support circuitry, including a clock, a voltage reference, and seven segment decoders and display drivers. A similar part, the ICL7107, can be used to drive seven-segment LED's.

The sensor probe is similar to one used in Radio-Shack's *Plant Light and Moisture Meter*, which is no longer sold. If you already own one of those units, you can simply remove the probe and attach it to the circuit. Otherwise, you can build a suitable probe using comon materials.

The construction of the probe is shown in the photograph of Fig. 2. The body is a five-inch length of lightweight aluminum tubing. A suitable body can be salvaged from an old TV or radio telescoping antenna. The probe tip is made from a small, ¾-inch long, ⅛-inch diameter solid aluminum rod. File down ¼-inch of the rod to a diameter of about 1/16-inch. File the remainder of the rod to a rounded point.

The leads from the circuit are connected to the body and tip of the probe. The leads are held in place using the two caps shown. In addition, the forward cap provides electrical insulation between the probe tip and body. The caps are simply end caps salvaged from old BIC ballpoint pens.

To build the probe, start by drilling small holes through the pen caps. Pass both wires through the pen cap. Then pass one of the wires through the probe body and the forward cap. Strip about ¼-inch of insulation from that wire. Next insert the forward cap into the probe body and finish up by inserting the probe tip into the forward cap in such a way that the stripped wire is pinched between the cap and the tip. Finally, trim the second wire to an appropriate length, strip about ¼-inch of insulation from the end, and insert the rear cap so that the stripped end is pinched between the probe body and the cap.

The sensor functions as a variable resistor that varies Q1's base current, hence its collector current. That varying collector current produces a varying voltage across 100-ohm resistor

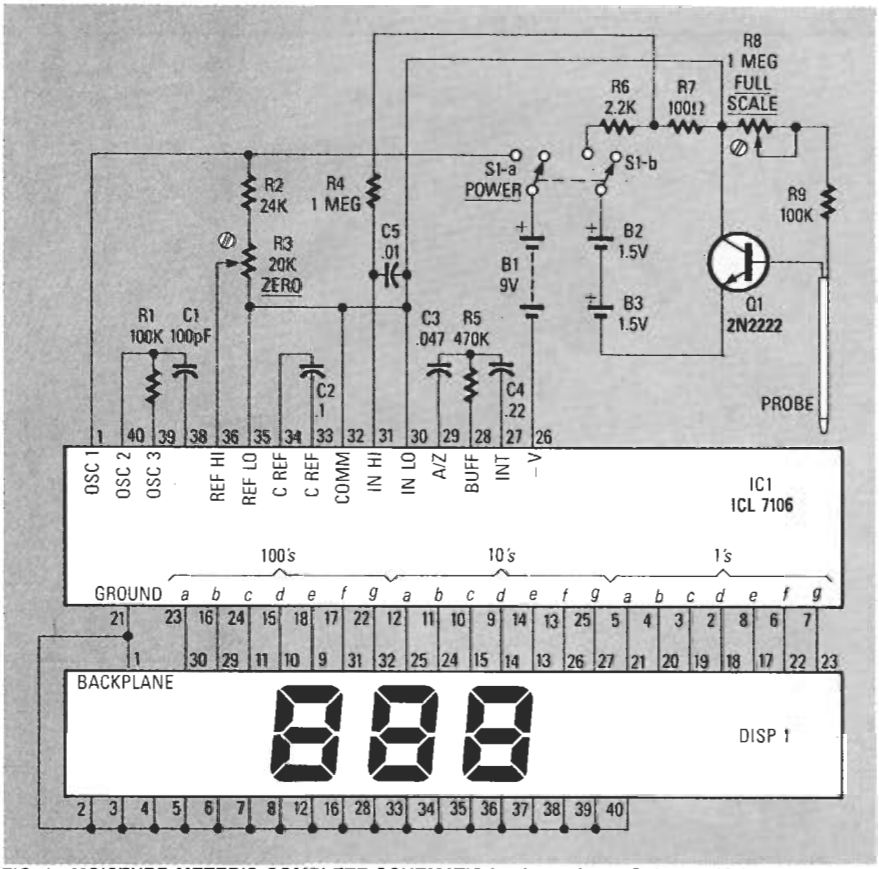

FIG. 1—MOISTURE METER'S COMPLETE SCHEMATIC is shown here. Only one IC is required; the entire circuit can be put together for about $30.

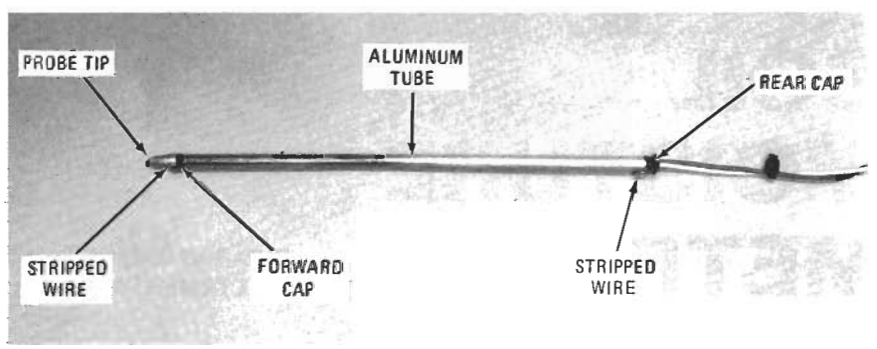

FIG. 2—THE SENSOR PROBE shown here can be built from common household items. The end caps, salvaged from inexpensive ballpoint pens, are used to hold the leads in place without soldering.

R7, and that voltage is what IC1 converts for display.

The LCD specified in the Parts List is actually a 4½-digit device; it also contains periods and colons between digits, and a leading plus sign. All unused characters are simply tied to pin 1 (BACKPLANE) to avoid erroneous displays and excessive power consumption.

The LCD consumes about 25 microamperes, and IC1 consumes under 2 mA, so the circuit will run for a long time when it is powered by a standard 9-volt battery. Current drain of the two 1.5-volt AA cells is also very low: under 300 μA.

Construction

Any convenient construction technique may be used. We used several pieces of pre-etched perfboard to mount all components except the power switch and the batteries. The LCD mounts on one board, and IC1 and the remaining components mount on the other. Short lengths of hookup wire connect appropriate points on the two boards.

Everything except the probe mounts in a plastic case that measures approximately 2 × 3¾ × 6 inches. A small hole, through which the probe wires pass, is drilled in the side of the case. A ⅞ × 2 (inches) rectangular hole is cut in the front of the case; the LCD is visible through that hole. Last, another small hole must be cut for S1.

The probe cord should be pushed through the hole in the case. Tie a knot in the cord for strain relief, and then solder the ends to Q1 and R9.

Check your work carefully. When you're satisfied that you've made no errors (or after you've fixed them), you're ready to calibrate the meter.

Calibration

First rotate R3 to the center of its range. Then place the end of the probe into a glass of water and adjust R8 for a reading of 100. When you remove the probe from the water, the LCD should indicate 000. You may have to adjust R3 slightly for the display to indicate 000. If so, re-adjust R8 with the probe immersed. Check for a reading of 000 again with probe out of water. After the resistors are adjusted, screw the case together.

Now you have one less excuse for not keeping your flowers and plants blooming beautifully! **R-E**

PARTS LIST

All resistors are ¼-watt, 5%.
R1, R9—100,000 ohms
R2—24,000 ohms
R3—20,000 ohms, trimmer potentiometer
R4—1 megohm
R5—470,000 ohms
R6—2200 ohms
R7—100 ohms
R8—1 megohm, trimmer potentiometer

Capacitors
C1—100 pF, ceramic disk
C2—0.1 μF, mylar
C3—0.047 μF, mylar
C4—0.22 μF, mylar
C5—0.01 μF, mylar

Semiconductors
IC1—ICL7106, A/D converter & LCD driver (Intersil)
Q1—2N2222

Other components
DISP1—LCD display, Amperex LC513041-301.15/IS (Digi-Key part no. LCD004)
S1—SPDT slide or toggle switch
Probe—see text

Miscellaneous: Perforated construction board, plastic case, wire, solder, etc.