# Solar-driven Moisture Detector

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When we think of solar cells or panels, what springs to mind immediately is producing power — only natural, given the primary purposes of such devices; but we don't necessarily think of using them in applications where the fact they don't produce power in the absence of light may actually be useful. Yet this is just the case in the project discussed here.
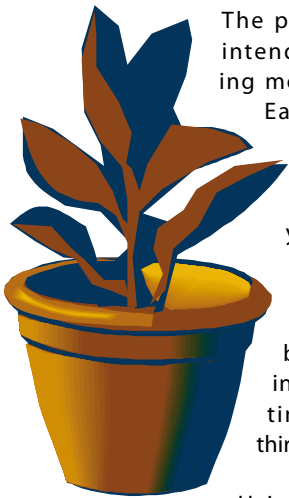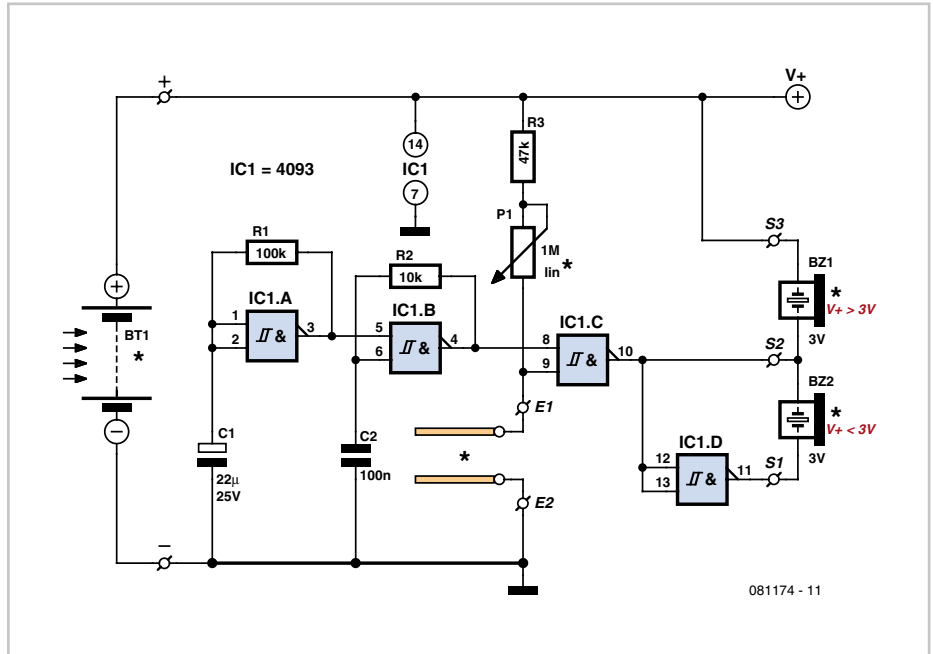
The project, then, is intended for detecting moisture here on Earth using solar power. It's primarily aimed it at those of you who like to brighten up their house or flat with pot plants, but are afraid of inadvertently letting them die of thirst.

Using its two electrodes, formed from two stiff pieces of bare copper wire, it can be stuck into the pot of any plant you want to monitor. As long as the plant isn't thirsty, i.e. the soil in the pot is moist enough, it will just sit there and do nothing at all. But when the soil dries out below a certain threshold (which you can adjust to suit the soil used and the plant being monitored), it starts 'squealing' to tell you it is time to give the poor plant a drink.

But so that your husband/wife/girlfriend/boyfriend (as applicable!) won't throw your plant out of the window because the detector has started squealing in the middle of the night, we obviously want it to work only during the day. This is where the solar cell comes in handy: on the one hand, it is used to power the circuit, making it totally stand-alone; and on the other, the lack of power produced when in darkness means the circuit is automatically silenced at night.

Once we've adopted this principle, the circuit is remarkably simple, using just a single 4093 CMOS logic chip, which contains four 2-input Schmitt trigger NAND gates.

The first gate, IC1a, is wired as a very low frequency astable oscillator. When its output is at logic high, which occurs at regular intervals, it enables IC1b, which is also wired as an astable oscillator, but this time at an audible frequency. The signal from IC1b then has to pass through IC1c, which can only happen if E1 and E2 are not connected, allowing the corresponding input to be pulled up to logic High. You will have realised that E1 and E2 are the electrodes stuck into the soil and so will not be connected if the latter is not sufficiently conductive, i.e. when it starts to dry out. The threshold at which gate IC1c turns on is obviously adjustable using P1.
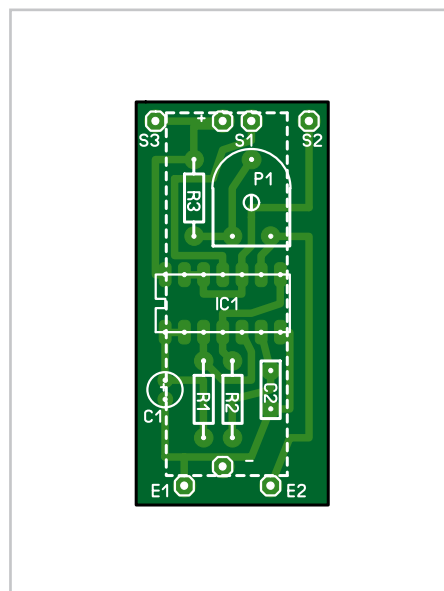
COMPONENT LIST

Resistors
R1 = 100kΩ
R2 = 10kΩ
R3 = 47kΩ
P1 = 1MΩ linear potentiometer

Capacitors
C1 = 22µF 25V
C2 = 100nF

Semiconductors
IC1 = 4093

Miscellaneous
Solar cell (see text)
Piezo buzzer
2 copper wire electrodes
PCB no. 081174-I

Depending on whether or not the circuit is supplied from a voltage greater or less than 3 V — which depends on the solar cell used, as we'll be seeing in a moment — the piezo sounder can be connected either directly between IC1c output and the positive supply, or between the outputs of IC1c and IC1d, which is wired as a simple inverter and so enables you to double the output voltage.

The circuit is very simple to build, and you can just as easily use the suggested board design [1] or build it on a piece of prototyping board. The sounder used must of course be one without built-in electronics, as here it is just being used as a simple transducer. If it's a large-diameter flat type, you could, for example, glue it onto the casing of IC1, while if it's a small-diameter type with rigid pins, it can be soldered directly onto the end of the PCB where its connection pads are located. As for the solar cell, for the prototype Solems devices were used, available for example from Selectronic France [2]; these are marked with a very simple 3-figure code in the form NN/LL/WW, where NN is the number of elements in the cell (each element producing around 0.5 V), LL is the length of the cell,

and WW the width, in mm. Equivalent cells from other suppliers may work equally well though.

Although in theory standard CMOS logic ICs only work above 3 V, the majority of those we tried in our circuit did actually work with a lot less, which means that if you're on a tight budget (or have a lot of plants to monitor!), you can use the cheapest cells, part no. 05/048/016.

If your budget is a little higher, and you don't want to bother selecting the 4093 CMOS ICs, go for a 07/048/016, or better still a 07/048/032, which will allow the circuit to work under excellent conditions as soon as the illumination reaches around 1,000 lux. You can also cannibalize such cells from solar-powered garden lights, which can often be found at giveaway prices in the big DIY stores.

Given the size of the suggested PCB, the Solems cells can be soldered directly onto the copper side of it. But when connecting the cell up, do take care to be very quick soldering the leads to the two silvered pads at each end of it. They are actually metallised

directly onto the glass of the cell and so are pretty fragile.

As soon as the cell is connected, if the two electrodes E1 and E2 are 'in mid-air', the circuit should start 'squealing', as long as it is getting enough light. You can then solder two stiff copper wires onto E1 and E2 (e.g. stripped offcuts of 1.5 mm² / AWG16 domestic wiring cable) and spike the circuit into the plant you want to monitor. Then all you have to do is adjust P1 so that the circuit cries for help when the soil has reached the level of dryness you have chosen.

If the frequency of the sound produced doesn't suit you, you can change it by increasing or reducing C2 and/or R2. Likewise, if you don't like its repeat frequency, you can change that by adjusting C1 and/or R1.

(081174-I)

Internet Links

[1] www.elektor.com/081174

[2] www.selectronic.fr

Download

081174-1 PCB layout (.pdf), from [1]