# Open CMOS inputs

**Luc Lemmens**

As a consequence of poor soldering or an etching fault when making the PCB it can happen that there is no connection between two points. Etching faults in particular can take an enormous amount of time when fault finding the PCB. Poor solder joints with through-hole PCBs are still reasonably easy to find by careful inspection of the solder job. With small SMD components this is already a lot more difficult, often requiring the use of a magnifying glass. Since the arrival of lead-free solder, this visual inspection has become much more difficult anyway. Solder with lead gives a nice shiny finish to the connection to indicate that the solder flowed well, a dull surface indicates too much heat or too much time making the connection which is then likely to be of poor quality. Lead-free solder is always dull in appearance and we therefore have lost a good indicator regarding



the quality of the solder joint. CMOS inputs may never be left open circuit. There is a chance that the input ends up at half the supply voltage and the current consumption of the IC will increase enormously. Besides, it can cause noisy interference that can be detected throughout the entire IC or surrounding cir-

cuit. Whenever the input is open, perhaps because of a design error, poor soldering or a broken PCB track, it is important that this problem is fixed as soon as possible since it is quite possible that the IC will fail. The most thorough method is to test all connections on the PCB with a multimeter, but this is very time consuming and

almost impracticable with all but the simplest of circuit boards. With a little trick, it is very simple to check with an oscilloscope whether a CMOS-input is dangling free:

Take the probe clip from the probe, measure at an input and at the same time touch the input with a finger. If the input is open we will see the 50-Hz (60-Hz) mains hum on the scope that we are picking up ourselves and applying with our finger to the high-impedance input.

Beware: the input has such a high impedance that it is also susceptible to static discharges. So make sure that you first discharge your hands and just to be sure touch the ground of the circuit with your other 'free' hand. In this way the risk of damaging the circuit with this measurement is very low.

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# From 5 to 3.3 V

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Many microcontrollers these days are powered from 3.3 V (or oven lower voltages) instead of the old, familiar 5 V. Lowering the dissipation and increasing the switching speed are the main considerations for reducing the power supply voltage. In addition, the ever continuing miniaturisation results in transistors inside the ICs that are so small that the breakdown-voltage has become much lower and a 5-V power supply would cause problems.
But many of the peripheral ICs have not (yet) followed this lowering of the supply voltage, with the result that many circuits need two or more different power supply voltages. Assuming that a 5-V power supply is already present, there are several simple methods that can be thought of to derive 3.3 V from that.
The most obvious solution is to use a Low Drop Out (LDO) voltage regulator with a 3.3 V output. This regulator must be an
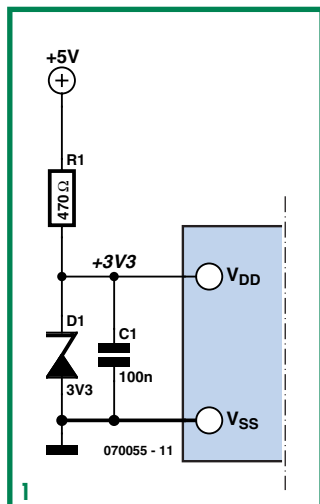


LDO type, because a 'normal' regulator has a drop-out voltage of 2 to 3 V and we don't have that much to play with.
A second method (see **Figure 2**) is very cheap: a resistor and a 3.3-V zener diode. But since the zener voltage depends on the current through the zener, it is very important that the correct value is chosen for R1. R1 has to be low enough so that the
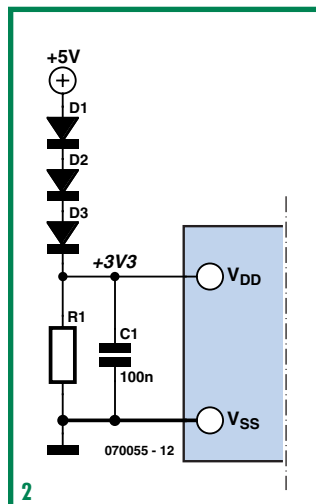
power supply voltage of the microcontroller is still high enough when the controller draws the maximum amount of current. Additionally, the value of R1 has to be such that the power supply voltage does not rise too much when the controller current is almost zero (for example during reset).
We can see another simple solution in **Figure 2**, where we use

the voltage drop across a diode in conduction. This voltage drop is also dependant on the current through the diodes and R1 has to ensure that the voltage across the microcontroller does not become too high when its current consumption is negligible. The diodes have to be selected in such a way that the voltage drop across them is not too high when the microcontroller draws the maximum amount of current.
And finally there is always the switching power supply (step-down converter) to make 3.3 V. There are also special ICs available that can generate multiple output voltages at the same time. Which method you end up using will depend on a number of considerations such as cost, available space on the PCB and the required regulation of the 3.3-V power supply voltage. In particular with regard to the latter consideration, the solutions with diodes are inferior, but they are certainly very small and cheap!

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