

R A Q ' s

# Rarely Asked Questions

Strange but true stories from the call logs of Analog Devices

## Isolating the Key Detail (or Lunching With a Mermaid and Pickled Herring)

**Q.** *There is a fault in my CMOS multiplexer . . . ?*

**A.** Recently, we considered an applications problem where the engineer was reticent, making it difficult to obtain the facts needed to solve it. Long ago, just after I joined Analog Devices, I met a problem where all details but one were almost irrelevant.

It was in Copenhagen. I had been discussing an analog electronics course with a professor from the University of Copenhagen and we decided to walk through Kastellet to see the Little Mermaid on her rock before having lunch on the quayside at Nyhaven in the oldest part of the harbor. As we walked Lars told me that Karen, one of his graduate students, was having accuracy troubles making measurements on three channels with one analog-to-digital converter (ADC).

If there are three channels there is usually a fourth not being used—so I told him I could probably cure the problem on that information alone. We telephoned the student and told her to ground all unused multiplexer (MUX) inputs and outputs, and retest her system.

Unconnected channels on CMOS switches and MUXes, whether on a separate chip or part of a multi-input ADC, can pick up signals from stray electrostatic fields and inject them into the substrate of the chip, turning on spurious substrate devices—even if the unconnected channel is disabled. These devices' leakage can degrade the performance of the active channel or channels, or even of an ADC which shares the chip.

In the past the effect might be so large as



to trigger a parasitic thyristor across the supplies and destroy the device, but modern CMOS processes are mostly protected against such catastrophes, but not against more subtle degradations of accuracy. "Fault-protected" switches

and MUXes are far less vulnerable to such effects, too, but not totally immune—and by no means are all MUXes fault-protected as the protection circuitry increases chip size and, as a result, cost.

It is therefore essential that all inputs and outputs of a CMOS switch or MUX, even one integrated into an ADC, be connected to a potential somewhere between its supplies. Generally this means grounding all unused inputs and outputs, but sometimes leakage and/or capacitive crosstalk can better be minimized by connecting unused pins to a signal or a power supply.

By the time Lars and I had consumed a Tuborg and a plate of marinated herring, and had waved goodbye to the mermaid, Karen had called us back to report that her system was working perfectly.

**To learn more about  
behavioral problems in  
ADCs & how to avoid them**

**Go to:**

**<http://rbi.ims.ca/5696-102>**



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**Have a question**

**involving a**

**perplexing or**

**unusual analog**

**problem? Submit**

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