ANALOG DEVICES Analog Dialogue
A FORUM FOR THE EXCHANGE OF CIRCUITS, SYSTEMS, AND SOFTWARE FOR REAL-WORLD SIGNAL PROCESSING

A DOZEN WAYS TO MAKE A CIRCUIT FAIL

By James Bryant

Some practical reasons why your analog circuit didn't do what you expected.

1. You forgot to read the data sheet. Application engineers routinely shout "RTFDS" as they hang up the telephone after dealing with a customer's enquiry. Extracting the information which is implicit, rather than just the explicit details, is a skill well worth cultivating.
2. You forgot Ohm's Law. The resistance of a PC track is not zero, and sometimes the difference matters. Conversely, if you are measuring low currents, the leakage resistance of *insulators* is also important.
3. You forgot to provide a path for the bias current. Sometimes your greasy fingerprints will provide a path in the prototype, leading to surprises in the clean(er) final version.
4. You forgot to check the stray resistances, inductances, and capacitances of the final (crowded) PCB, and assumed that if it worked on the breadboard it would work anywhere.
5. You forgot that EMI and RFI occur everywhere and did not filter your supplies and input/output leads.
6. You forgot to consider the effects of temperature variations on circuit elements, including the effects of differing temperature coefficients in nominally identical components.
7. You forgot to verify that the circuit would tolerate having its supplies (and signals) applied in any order (and with any value of dv/dt). Or you forgot to ensure that it would not be exposed to power/signal sequences and rates that it could not tolerate. You may even have forgotten that switching power supplies are not necessarily as noise free as a battery.
8. You forgot that circuits do not necessarily contain power-up reset, but may require additional circuitry to ensure that they stabilize in the correct mode when they are turned on.
9. You forgot that circuits do not turn on instantly: Capacitors must charge, and it is often necessary for the circuit to stabilize thermally, especially in precision circuits.
10. You forgot that not all circuits are stable when driving a reactive load. An output stage that will drive a wide range of resistive loads may oscillate if it sees capacitance. Your circuit may work when its load is close by and fail when it must drive a few meters of cable.
11. You forgot that noise, like death and taxes, is universal. Every ADC has quantization noise and every resistor has Johnson noise. This is intrinsic, not the result of imperfections.
12. You forgot that IC designers are not necessarily user friendly. EOC does not necessarily imply DRDY, and don't dare to assume that CS only selects the chip - it may also reset something on its trailing edge. Again and again I say, "RTFDS!"

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