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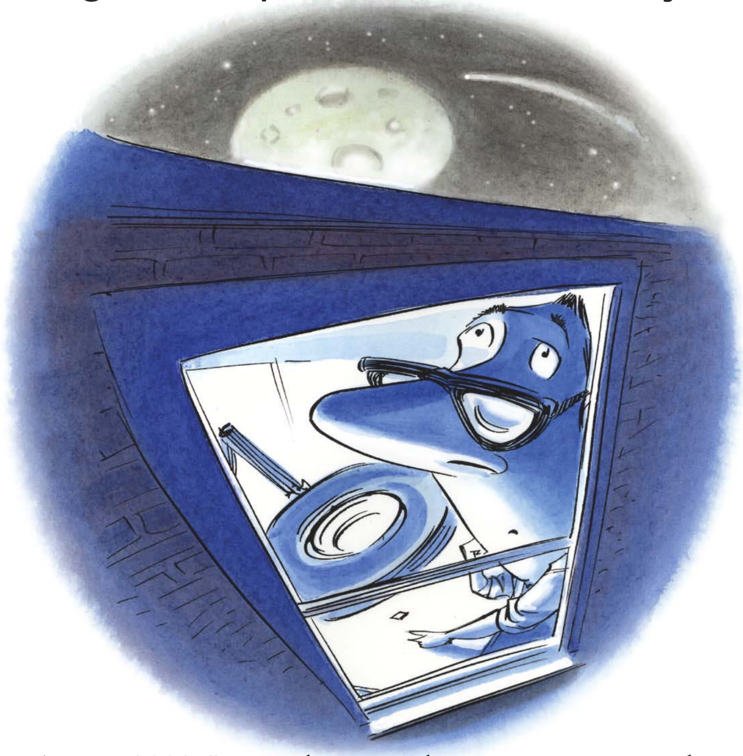
# One giant leap for "enhanced" hybrid



DANIEL VASCONCELLOS

In August 2002, I started a new job in an engineering department with 35-year-old products. I became the lead engineer on the flagship product, most of whose circuitry resided in a hybrid. The hybrid provider was not interested in our small quantities, and quality suffered. We submitted an "updated" design from one of the long-gone engineers to another hybrid house. At that point, there was no rush, and we had plenty of stock.

A wonderful application then emerged. A major contractor wanted our product to go into space. We had a military-qualified hybrid, so it was only "one small step" to an aerospace application, or so we thought. The new hybrid house had all the expertise we required, and the project was now suddenly in overdrive.

But then the hybrid tech called me and said that the internal oscillator was working but wasn't displaying a sine wave. I asked what it was displaying, but he couldn't explain it.

This eddy-current-measurement system had a combined oscillator/AGC (automatic-gain-control) system for a stable signal to the sensor. This technique involves the use of two intertwined loops: one feedback for the crystal oscillator and another to control the amplitude.

The next week, bearing the schematics of both the old and the new hybrids, I drove five hours to the hybrid house. The tech showed me the output of the oscillator. I couldn't describe the signal, either. It periodically spiked, curved, and jumped. As I puzzled over that situation, the tech brought his bench magnifying lamp close to the circuit, and bang! A perfect sine wave appeared. Because the hybrid was using bare dice, the proximity of the light probably changed the gain of the differential amplifier. I shrugged it off as a neat parlor trick and dug into the circuitry.

The first thing I noticed was that the schematic had an emitter resistor on the gain transistor twice the size of the resistor in the old circuit. Fiddling with that problem, we found that we had to reduce the emitter resistance to almost zero to get a good sine wave. That approach didn't sit well with me because it wouldn't give the collector current much limiting. Going back to the output of the differential amp, I noticed that the ugly signal was much higher in amplitude than the oscillator output should be and that it had shifted to positive. A clue! I traced the feedback for the amplitude and noticed that the system was rectifying only the negative swing of the signal and was using it for the error signal. With the signal shifted, there was no correction signal and the differential amp was running wide open. So, somewhere in that loop, something was amiss.

It turns out that someone had added some new circuitry at the output of the differential amp: a diode connected to a biased zener. When you start up any AGC system, you're bound to have a too-large signal due to the filter time constant on the error signal. It looked as if someone had tried to cut off the signal peaks from being too high until the AGC kicked in. But why did that person use a biased zener?

I had the tech remove the two components. Bingo! We saw a perfect sine wave. The attempt to limit the start-up amplitude was amiss in that someone had tried to place the limit on the wrong side of ground. The result was unique.

That hybrid design went into space and is about to do so again. The lesson? Beware of engineers bearing "enhancements"—that is, until you examine them first! **EDN**

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