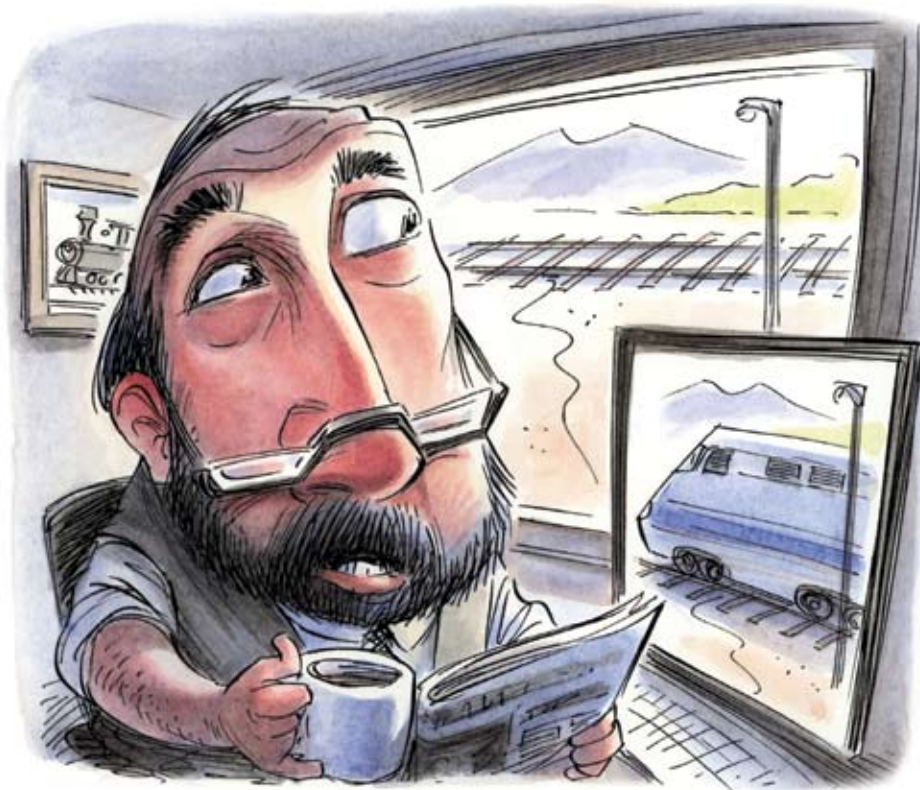


Unreal-wheel deal



A while ago, I got involved with troubleshooting a field issue on one of our wheel-sensing products. The product used inductive methods to sense the presence or absence of a train wheel. The inductive sensor would then drive an analog signal over twisted-pair copper wires from the sensing point to a central-processing location. The issue in this application was that the sensors were detecting phantom wheels.

The source of the problem was not obvious from initial clues and surface investigations. To troubleshoot, we started out by generating a diagram to map out all possible root causes. The one that seemed the most obvious, given the clues we had, was noise on the power supply to the sensor electronics. After isolating the power supply from the rest of the neighboring electronics and floating the supply from ground, we learned that the power supply was definitely not the cause of the phantom-wheel detections. We then became fixated on the local ground

reference for the central-processing system. We tested the ground and found it to be less than 1Ω —also not the problem.

We began to focus on capturing the actual waveforms coming into the central-processing system from the wheel sensors. We placed some analog data-acquisition modules on key signals coming from the wheel sensors. Once we captured the anomaly, we saw that there was a large noise disturbance on the analog signal after the signal was heavily filtered. Further dissection of the clues showed that the disturbances

coincided with a train's presence. We also noticed that the disturbances appeared to have a repetitive frequency of 100 Hz associated with them, as well. We began to suspect that we were seeing rectified noise from electric trains that used the overhead, 50-Hz electrification system for motive power. This idea sounded reasonable, but the question still remained about how this noise was getting into our system.

The system includes some heavy hardware and software filtering, such that any noise that could affect the system would have to be in-band with the wheel-detection signal, which was approximately 50 kHz. It is well-known that electric-train propulsion systems emit a broad band of harmonic frequencies. Was it possible that a 50-kHz component of these harmonics was magnetically coupling into our cables between the wheel sensors and the central-processing system? Our first reaction was that this scenario was not possible because we always used shielded cables and grounded the cable shield at the receiving end of the signal.

After weeks of frustration, I came across an old textbook stating that, when the cable length exceeds one-twentieth of a wavelength, you should ground both ends of the cable shield instead of just the receiver end. Just out of curiosity, I ran the calculation for one-twentieth of a wavelength for my signal at 50 kHz and determined it was 300m. Hmmm. Our cables in some cases could be as long as 2000m. Could it be that these recommendations and formulas that I had reserved in my mind for high-speed digital design applied to a much lower-frequency analog signal with a nearly one-mile-long cable?

We modified the installations in which our cable lengths exceeded 300m to ground both ends of the cable shield, and we thus solved the problem. **EDN**

Jeff Fries is a principal engineer and technologist for global signal technology at GE Transportation (Grain Valley, MO).

✚ www.edn.com/tales