BY RON TIPTON • TDL TECHNOLOGY INC

Mysterious data errors

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In the early 1990s, I was working as an engineer at White Sands Missile Range, NM. A contractor delivered a digital data-collection system that mostly worked correctly but put out garbled data at seemingly random times. The rack-mounted system comprised a number of approximately 5×5-in. PCBs (printed-circuit boards) that plugged into a card cage with a hand-wired backplane. Its developers designed and built it with the TTL (transistor-to-transistor logic) that was common at the time. The system received its power from a central, 5V, regulated supply.

We put up with the corrupted data for a month or so, and then the boss said to me, "Go fix it!" To the best of my knowledge, test equipment to troubleshoot this problem was not readily available at that time; at least, we didn't have any. So, I had to start by designing and building a way to monitor the incoming and outgoing data. I also built a data source that let me set any of the incoming 16 bits to either one or zero. It took more time to build the equipment than it did to find the problem! Whenever 12 or more of the incoming bits were ones, the ground bus on one PCB bounced up to about 0.7V. But the output error depended on which 12 bits were high.

The double-sided PCBs had a connector along one edge. A ground bus ran around the other three edges, but it was on only the bottom side and about 1/8-in. wide. The 5V bus on the top side ran down the middle of the board parallel to the connector side. It, too, was only 1/8-in. wide. As it turned out, the engineers who designed the system did an excellent job, but they apparently had little or no communication with the person who did the PCB design.

I fixed the problem using some solid, bare 12-gauge AWG wire, forming a three-sided loop, and continuously soldering it to the 1/8-in.-wide ground bus, making sure that it connected to all four ground pins in the connector. I did the same thing to the 5V bus. Apparently, only the one board was responsible for our errors. However, to be safe, I applied the same fix to the other boards.

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This lesson was a useful one. Since then, I almost always design PCBs with a continuous ground bus around the outside edges. This bus is at least 0.2 in. wide on both sides of the board, and the two sides connect to each other with numerous vias. This approach goes a long way toward eliminating glitches in digital circuits and also helps lower noise in analog circuits. EDN

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