You auto know

EMI/EMC (electromagnetic-interference/electromagnetic-compatibility) certification is among the toughest design milestones for embedded automotive controllers. My company once developed an 8-bit controller for air-path control of a direct-injection diesel engine. Engine-performance results were encouraging, so the next step was to approach the local certification agency for EMI/EMC-compliance testing. The EMI test was a piece of cake: An onboard 4-MHz crystal generated almost no RF interference.

As the engineer switched on the EMC chamber, we were almost certain that the unit would valiantly withstand the onslaught of strong RF radiation. When the controller reached 50 MHz, however, all of the outputs then turned off.

Suspecting a software error due to intense radiation, I checked the microcontroller's output pins. They were showing dead-on accurate logic levels. This finding pointed the needle of suspicion toward the Infineon TLE 6216 output chip. I couldn't believe that the chip would fail under EMC testing. When we withdrew the EMC-test radiations, the outputs remained off. Apparently, they tripped due to an internal short circuit. As we power-cycled the controller, the outputs regained their correct logic levels. However, when EMC radiation was restored, the outputs immediately tripped again.

Postponing the EMC test until the next day, we took the unit to our laboratory for analysis. The chip outputs included RF-filter capacitors near the field connector.

I understand the purpose of RF input capacitors, but I have never believed that they should be near the power-output pins. I found it hard to believe that EMC radiation would corrupt low-impedance, high-power outputs. Nevertheless, we were religiously placing those capacitors, according to standard automotive-design tenets, at all field connections.

In view of our earlier problems, I checked the ground tracks of the capacitors. They terminated on a separate RF ground. However, RF ground and signal ground were supposed to connect through a small jumper near the power connector, but this prototype unit had a dry-soldered power connector. This finding answered my question regarding the role of the output capacitors: These output pins also included input circuits to sense overcurrents and short circuits to activate internal trip circuits for protection. EMC radiation can corrupt these input circuits, thus tripping the protection circuits.

We rectified the dry-solder problem and continued the test on the next day. This time, the output chip did not trip at all and obediently followed CPU commands for most of the frequencies from 1 to 400 MHz. However, the outputs were erratically tripping at frequencies higher than 400 MHz. Apparently, the low-cost filter capacitors that automotive applications typically use were not up to the task at those frequencies.

I also reviewed designs of other units we had developed that had passed this test. Most of them used output chips with short-circuit limits, which we could program through an SPI (serial-peripheral interface), such as an STMicroelectronics L9823 octal low-side driver. This driver would never cause an IC to trip its outputs during EMI and EMC testing. Using such a chip would have meant lengthy software and hardware modifications. Instead, we inserted inductive-bead filters in the output lines to suppress the high frequencies that were troubling us during the test. This measure was successfully able to guard all of our outputs from spurious tripping during the next EMC tests a few months later. EDN

Vishwas Vaidya heads an embedded-design team at Tata Motors (Pune, India).

DANIEL VASCONCELLOS