Lessons Learned Along the Way

RFI Control

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EMI and RFI are not new phenomena. Their problems have been around for years. When I was a small boy (longer ago than I will admit) I grew up across the street from a ham radio enthusiast named Bob Beebe, W7IGM (who has long since passed away.) Bob bought me my first soldering iron, introduced me to Heathkits, and played a significant role in my becoming an electrical engineer.

This was long before we had things like FCC compliance requirements, and even before my family had (or could even afford) a TV. Bob was a successful businessman and could be called an innovator; he had the first TV on the block, had a powerful one-kilowatt linear amplifier for his ham rig, and had a rotating beam antenna on his roof that covered more area than his roof did! And we could hear him on every electrical appliance we owned! His calls are indelibly etched in my memory --- "Hello, CQ, CQ, CQ. Hello CQ, CQ, CQ. This is W7IGM, I Got Manila." (Manila was the name of his wife!) Every time we'd get a new radio, we'd have to call Bob to come over and wrap it in copper or place ground wires all around it in order to shield out his emissions. We got to know him well.

Today, we are more attuned to EMI and RFI issues, and this magazine devotes lots of resources to help board designers learn about them and how to control them. But sometimes, the problems are beyond our ability to control them with our designs. This is a true story of one of those cases.

In another life I ran a company that made weighing systems for weighing trucks – to make sure they were within legal highway weight limits. Our systems were unique. They were portable, could be towed behind a police car on a small trailer, and used portable electronics that plugged into the car's cigarette lighter. They ran off the same electrical system the police radio did, and the indicators were often placed right next to the radio or on the car roof, right next to the antenna. Immunity to RFI was a significant design requirement. (Note to designers: Circuits that radiate RFI are also good RFI receivers, and visa versa. The same design principles apply in both cases.)

We had just finished a complete redesign of our indicator family. We had access to a screen room facility and technician through another company with which we had a relationship, and my engineering team went there to do the EMI/RFI testing. The indicator read up to 99,990 lbs in ten pound increments. The design requirement was no more than one increment (10 lb) change under any RFI condition. We expected some system "tweaks" were going to be necessary to achieve this goal, which was one of the purposes for the trip to the screen room.

During the very first test, however, the indicator went totally off-scale! After two hours of tweaking we got some improvement, but then hit a plateau. No matter what we did we could not quiet down the indicator.

The screen room technician, who worked for the other company, had been quietly running the test and measuring equipment. He did not have an engineering degree but did have about 30 years' practical experience. Finally he spoke up and asked us what the input circuit looked like. We told him it was a high-gain differential amplifier which then fed an A/D converter. He asked us what part number the amplifier was. We told him. It was a commonly available amplifier made by at least four or five manufacturers. He then asked who manufactured the part. We told him. He then told us that that particular manufacturer often had RFI problems with its parts and why didn't we go down to the local distributor and buy the same part manufactured by another vendor. We did, and the RFI problems almost totally went away. It took only a few more hours to achieve the RFI objective and the product then successfully went into production.

There was no clue in any published specification from any of the manufacturers of this part number that there would be differences in RFI sensitivity between product offerings. We had no reason whatsoever to suspect that part. We might have struggled with that design for months if that technician had not put us on the right path.

There are two morals to this story:

A. A good technician with experience can be more valuable than someone else with all the degrees in the world!
B. There can be subtle differences inside IC packages in otherwise identical parts that may only be determined by laboratory testing or trial.

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More than one engineer has been burned by a part that behaved unexpectedly. Sometimes, as in this case, there are simply differences in design in otherwise "identical" parts.

Sometimes a supplier *changes* a manufacturing process without telling anyone. Often this involves the implementation of an improved process, which may coincidentally offer faster rise times. Perhaps the manufacturer thinks that the change or improvement will have no particular consequence to anyone, and it treats it as simply an in-line adjustment. But it sometimes happens that the faster rise time results in timing or EMI problems that didn't exist in the user's design before. These can be particularly difficult to troubleshoot, because people rarely equate the problem with a device, particularly a device that *used* to work just fine!

When systems exhibit performance characteristics that are particularly unexpected, or are particularly difficult to troubleshoot, you need to open up your horizons and consider *all* possibilities, no matter how unlikely they may seem at first.