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What's All the Noise About?

Gary Breed
Editorial Director

If you'll pardon the above pun, I can note that this issue's tutorial topic and Technology Report both cover aspects of noise ("Online Resources for Understanding Noise and its Measurement" and "Recent Developments in EMC Standards and Regulations" on pages 46 and 36 respectively). Noise is an important aspect of all electronic engineering, both as a natural phenomenon and as a man-made source of potential interference. It deserves a few comments.

Noise as a Natural Phenomenon

The laws of physics require a certain amount of random behavior—which, in electronic circuits, is noise. No matter what we do, we can't get rid of it, but a great deal of effort goes into reducing it to the lowest possible amount. Some of the most valuable measurements of our circuits' performance are noise-based. Noise figure is used to evaluate a circuit by comparing its output to the minimum possible noise at the operating temperature—the noise floor. We define the quality of signal sources by "phase noise," which really includes amplitude, frequency and phase components. Increasingly, we use signal-to-noise ratio in various mathematical forms to evaluate communications systems. How many times have you seen the terms bit-error rate (BER) and E_b/N_0 (energy per bit/noise spectral power density)? These are the measures used to evaluate today's digital communications systems.

Low noise is good, high noise is bad. It's that simple. In circuits, noise is the enemy. Occasionally, we trade off noise performance for some other specification, but do so reluctantly and hope to figure out how to fix the problem later.

Like many individual engineering topics, noise is fascinating. It involves everyday design techniques, but deals with a fundamental physical principle. This combination of the practical and theoretical is the type of challenge that interests the most curious engineers.

Man-Made Noise and Electromagnetic Compatibility

EMC is the engineering specialty that deals with "peaceful coexistence" among various electronic systems. Maxwell's equations guarantee that every electronic circuit will radiate some energy. We can consider this man-made energy to be noise, because it has the undesirable effect of degrading

the performance of systems that it gets transferred to, whether by radiation, or by conduction through wires and cables.

The purpose of EMC regulations is to establish standards for this unwanted energy. We can't eliminate it completely, so we must agree on a level that is low enough to minimize its detrimental effects. There are a rapidly-increasing number of wireless products, with many more receivers and transmitters of energy that can cause or be subject to interference. Then you must add the growing number of computers and other electronic and electrical devices, each of which contributes at least a little more energy to the amount of man-made noise in the environment.

EMC and the FCC

You would think that the levels of protection would be stiffened to minimize the effects of these additional sources of interference...

However, the process of determining these levels of protection is both technical and political. While it is technically possible to keep equipment "quiet," it also adds to the cost. In the past two decades, electronic technology of all types—especially wireless telecommunications—has been a growth industry, and has the rapt attention of our political leaders.

Recently, the Federal Communications Commission has moved toward reducing the present interference limits, and is exploring concepts that would result in further reductions of protection from interference. I feel that this is a shortsighted approach to the problem. Sure, it will encourage continued development of new wireless technologies and products—that's definitely a good thing—but it may be too much of a good thing in the future, if the total noise level finally becomes overwhelming and nothing works any more. There are already trouble spots where interference is a problem. These problems may be subtle—excessive dropped cell phone calls, "sparkles" on a TV picture or reduced range on a cordless phone. They can be obvious too. Any public safety officer will have a story about troublesome interference to his or her radio.

Before things get any worse, I hope the FCC and other regulatory bodies around the world realize that the electromagnetic spectrum is worth protecting for future generations. Manage it wisely and it will continue to be a valuable resource. We don't want it to become the next over-fished ocean or clear-cut forest.

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