COMMUNICATIONS CORNER

Communications noise

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NO MATTER WHERE YOU TURN TODAY, YOU are sure to find that digital technology will play an ever-increasing role. Consider, for instance, noise-free sound reproduction. Audiophiles look to digital systems for wow-free and noise-free discs and tapes, while the communications industry looks to digital advances to remove noise from signals.

Noise has always plagued AM broadcasts. That's because noise itself can amplitude-modulate a transmitted signal. So when the receiver detects the transmitted signal, it also detects noise. That noise can be either atmospheric or man-made, continuous or impulse. (The constant "grind" one hears from a mobile CB is impulse noise.)

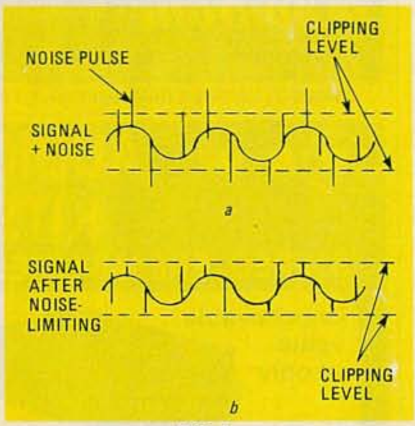

FIG. 1

Figure 1 is a simplified illustration of how noise might be added to a transmitted signal. Note that the noise can be in-phase or out-of-phase with the desired signal. That makes it hard to eliminate—though the phase relationship makes no difference to the ear.

Until the CB era, most noise filters were simple clippers. The clipping level was set at or near the average maximum detector output as shown in Fig. 1-a. Any impulse that exceeded the set clipping level was eliminated. The resultant output appeared similar to that shown in Fig. 1-b. (Notice that the noise pulses are still present but those above the clipping level are sharply attenuated.) Even those attenuated pulses were extremely annoying to the operator. Because of that, the clipping level was often set so that it actually clipped the signal. While that produced even greater noise attenuation, it distorted the desired signal (which can be clipped about 10 dB before becoming "muddy").

You've probably already figured out that a fixed clipping level has many problems associated with it. For instance, if the incoming signal is weak, its noise will be under the clipping level. On the other hand, if the clipping level is set low enough to affect weak signals, strong signals will be clipped excessively.

Eventually, the communications industry came up with the floating or self-adjusting clipper. Its clipping level is controlled by the average DC level of the detector. Say for example, the incoming signal is weak. The floating clipper automatically lowers the clipping level. In contrast, if the received signal is strong, the clipping level is raised. In that way the clipper won't cut too deeply into the desired signal. The fuss over clipping levels eventually reached a point where only better-quality and/or higher-cost receivers provided an adjustable noise-limiter. That allowed the clipping level to be user-selected for a given signal.

It was CB that introduced really effective noise limiting into consumer equipment. That's because most CB gear was installed in some kind of vehicle (since it was originally intended for mobile use) and motor vehicles are among the worst noise generators around. The AM clippers simply couldn't handle the noise created by the ignition system—primarily impulse noise. (Though the vehicle's generator whine was just as annoying—it could be easily corrected using a few simple filter components.)

A much more effective noise-reduction system was needed. Engineers had developed one, called a *noise blanker*, but it was too expensive for consumer equipment that used vacuum-tubes. But with the introduction of transistors it became possible to build a noise blanker into moderate-cost receivers. The cost of noise blankers plunged even farther because of the mass-marketing of CB equipment. In fact, by the end of the CB boom, virtually all CB transceivers were equipped with noise blankers.

How it works

Figure 2-a shows how an early noise blanker worked. The basic receiver used a

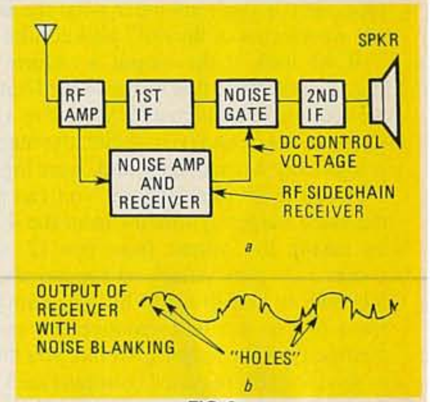

FIG. 2

double-conversion system—with the first conversion at a frequency of about 2.5 to 4 MHz. A noise gate—essentially a normally open electronic switch that is controlled by a DC voltage—is inserted between the first and second IF's. Some of the RF is split off at the amplifier's output and sent to a simple *sidechain* receiver. A sidechain receiver is one that is tuned to an unused frequency that's slightly different than the desired frequency. Say, for instance, that the desired signal frequency was 27 MHz, then the sidechain receiver would be tuned to 25–26 MHz.

The sidechain receiver is used to detect noise pulses. (That makes the reasonable assumption that the noise at 25 MHz is essentially identical to the noise at 27 MHz.) The output of the sidechain receiver is detected, and a DC voltage corresponding to each received noise pulse is generated. That DC voltage is used to control the gate in the main receiver. Whenever a noise pulse is received, the resulting DC is used to turn off the noise gate, thereby punching holes in the signal as it passes from the first IF to the second. The resulting audio signal is shown in Fig. 2-b. The signal is noise-free with "holes" where there would normally be noise pulses. The holes are shown in the conventional manner using little notches in the output signal. The notches are just for clarity—they represent discontinuities in the output.

The sidechain noise blanker performed superbly, but was limited in frequency range and used too many additional components. (To a manufacturer, if 10,001 components are used when 10,000 will

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suffice, that's too many parts.) Blanking for a CB receiver with its limited frequency-coverage was easily provided, but imagine what would happen if the same trick were tried with a 3–30 MHz communications receiver. How could we be certain that the sidechain was receiving on an unused frequency? Can you just imagine finding an "unused" frequency at 7 MHz, 10 MHz, 12 MHz, or any other frequency that you are interested in? To say the least, it's not very likely—especially with the way things are these days.

The modern all-band receiver uses the same gating idea but eliminates sidechains by placing the noise-pulse detector in the signal path between the first IF and the noise gate. As with the sidechain system, the pulse-derived control voltage turns the gate on and off.

Generally, the pulse detector requires a relatively high IF to reduce spreading of the noise pulse. (The signal interruption caused by a spread pulse would be considerably wider than the noise pulse itself. That would make the perceived distortion intolerable.)

Generally speaking, putting a pulse detector in the signal path is not as effective as using a sidechain, but it is far less expensive. It's also the best system available for today's multiband communications receivers. **R-E**