COMMUNICATIONS CORNER

Recreating sound

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SEVERAL YEARS AGO WE PROPOSED IN AN article on the future of high fidelity that, through the computer and frequency synthesis, it would be possible to reconstruct the sounds of yesteryear. That is, one would be able to play an old cylinder recording, process the sound through a computerized device that had stored in its memory the waveform characteristics of every musical instrument including the human voice, and eventually end up with a perfect recreation of the original signal source. Imagine hearing the full-fidelity voice of Enrico Caruso, or the legendary sound of the Original Dixieland Jazz Band.

Though we haven't quite reached that stage yet—if memory serves, we predicted it would take place sometime around 1985—we have recreated the actual voices of modern day sports announcers, and in a few emergency situations we have recreated the sound of "live" music.

Recreate voices and music? Let's explain what we mean. In the early days of broadcasting a "remote broadcast"—be it sports, drama, or whatever—meant a special radio line installed by the telephone company. Depending on the type of program material, the line might be equalized out to 15 kHz, 8 kHz; 5 kHz, or it might be unequalized (for voice transmission), and all that was missing were the upper-midrange and high frequencies. Putting the cost of that special line aside for a moment, if the head of the station called the phone company at 9 AM for a line at 1 PM it was in, equalized, and working by 1 PM—particularly if the input and output were in the same city. Today, it can take a week just to process the paperwork, possibly another week to a month to install the line, and then one hopes the line doesn't crash in the middle of the remote.

To get around the problems of cost and slow installation, many sports broadcasters went to the dial-up phone system. Using a special portable amplifier that clipped directly to a telephone line (usually across the handset's transmitter terminals), the field crew dialed the radio station's telephone, and when the phone was answered they clipped onto the handset. At the station, technicians connected the phone line's signal to the studio console, and eventually broadcast the signal they received through the dial-up telephone system.

As time progressed, the remote equipment got a little fancier and the connection was neater, but one problem remained. Because the dial-up system has a restricted frequency response range of approximately 250–3000 Hz (actually more like 300–3000 Hz), not only was the announcer unhappy with his basso voice coming out sounding like a thin squeak but, what was even worse was that the shrill sound of 300–3000 Hz eventually wears down the listener.

It took a number of years, but both problems—that of the thin voice and shrill reception—were resolved by reconstructing the "missing" low frequencies with a device users call a Comrex, which is actually the name of the company that manufacturers the device. Now the full-fidelity low frequencies of the announcers's voice could be broadcast over the dial-up system, and it was even possible in case an equalized radio line failed, to broadcast a "musical" program with some semblance of "balanced sound" by using the phone system.

The Comrex borrows its technology from the "freqwee," a device that makes humans sound like chipmunks in the TV and movie cartoons; the same technology is used to reduce the amount of spectrum used by a radiotelephone signal.

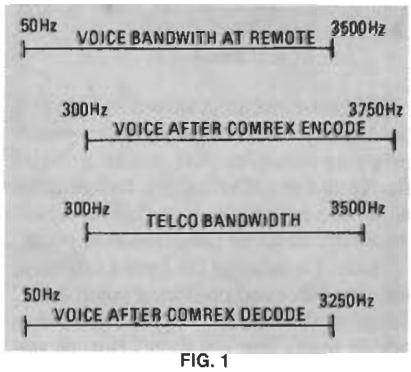

FIG. 1

Figure 1 shows how its done. At the sending or input side of the circuit, the microphone signal is passed into a Comrex encoder that slides the entire frequency range up 300 Hz by beating the audio against a fixed crystal-controlled carrier. The lower voice frequency of 50 Hz becomes 300 Hz, while the voice frequency of 3000 Hz becomes 3250 Hz. That signal is fed into the dial-up telephone system. Because of the bandwidth restrictions of the dial-up system and the Comrex equipment, the frequency range of 300 Hz to 3000 Hz is passed to the receiving end, while the frequencies below 300 Hz and above 3000 Hz are attenuated.

At the receiving end of the circuit a Comrex decoder "beats" the 300–3000 Hz signal back down to the range of 50 to 2750 Hz. Now, the announcer's original "bass" tones are reproduced at the radio studio. True, the upper frequencies are attenuated above 2750 Hz, but with the low frequencies back in the voice the "timbre" is restored, and the sound quality at the receiver is "more natural"—not hi-fi, but more closely approximating the "real" voice, and certainly more comfortable to listen to.

Another advantage of the Comrex is that the 300-Hz filter of the Comrex attenuates the telephone line's hum components of 60, 120, and 180 Hz caused by the telephone company using a common pole with the electric utility. The decoded Comrex signal is essentially hum-free.

What happened to the frequencies between 2750 and 3000 Hz? They are lost because the Comrex does not recreate what does not exist. Remember, when the signal from the microphone was processed by the sending Comrex the frequencies between 2750 and 3000 Hz became 3000 to 3250, and were sharply attenuated by the phone system; for all practical purpose they weren't received. The highest received frequency was 3000, which was Comrex'd down to 2750.

Keep in mind that the upper frequency limit is determined by the upper cut-off frequency of the telephone system. If by chance one were using the Comrex on a Schedule A phone line, which has a frequency range of 100-5000 Hz, the Comrex'd upper frequency limit would be a definitely acceptable 4750 Hz.

The success of the Comrex—and it is an unqualified success—raises the question of how superior the recreation might be if the receiving end had a computer that "remembered" the announcer's "actual voice." Certainly, having the low frequencies in addition to the midband should make a "high fidelity" recreation possible. And if we can do it with voice, why not with music.

Just imagine 1985—if we take a long length of string, two paper cups, and a Comrex, we might just be able to eliminate the phone company! **R-E**