GTE LENKURT

DEMODULATOR

APRIL 1973

COMMON CHANNEL SIGNALING SYSTEMS

Common channel signaling systems offer improved transmission quality, reduced radio loading, and protection against talkdown and loss of billing due to unauthorized foreign tone sources.

In the telecommunications industry, signaling is the process by which a caller on the transmitting end of a telephone system informs a particular party or listener at the receiving end that a message is to be transmitted. But, signaling is also a two-way process which includes supervision. Supervision informs the caller that the called party is ready to talk, that his line is busy, or that he has hung up. Supervision is also that part of the signaling which holds the path together while the conversation goes on. There are a myriad of signaling techniques and a list of them reads like a table of magical incantations, and they are sometimes just as mysterious. Some of these techniques include E and M signaling, reverse battery signaling, duplex signaling, simplex signaling, closed-circuit signaling, open-circuit signaling, dual-tone multifrequency signaling, loop signaling, separate-channel signaling, in-band signaling, and out-of-band signaling. Also, in most telephone systems, signaling is inextricably tied with switching and ringing. Put very simply, signaling can be viewed as the original command and control; switching, as the process which is controlled and which routes the command to its ultimate destination; and ringing, as the audible or visible signal which informs the party at the distant end that intelligence is to be transmitted.

So many different signaling techniques exist in large part because of past necessity to provide adequate signaling for existing line facilities. Also, signaling facilities have been created to comply with the various switching systems manufactured by telecommunications companies. Two of the most widely used signaling techniques are in-band and out-of-band signaling.

Out-of-Band Signaling

Out-of-band signaling uses one or more ac tones which lie within the pass band of the transmission facility, but just outside of the voice band (see Figure 1). Channel filters for out-of-band signaling are designed with an upper cutoff frequency well below the high-frequency end of the voice channel. This reserves a portion of the spectrum for the transmission of signaling tones. Generally, a tone is keyed to convey signaling information in out-of-band signaling systems. Out-of-band signaling is quite economical in that since voice transmission contains very little speech energy at the upper end of the spectrum, and the telephone handset provides part of the effective filtering, filtering requirements may be somewhat relaxed. This makes it possible to provide good quality transmission for relatively low equipment cost, since the greatest cost of carrier systems is in the channel filters. Also, signaling has little chance to interfere with speech when an out-of-band signaling system is used. Because of this, higher signal levels can be used, thereby improving signaling reliability. Some of the problems with

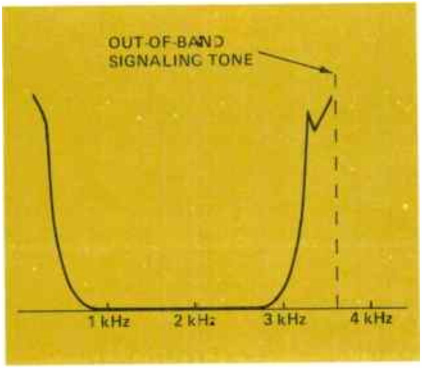


Figure 1. Signaling tones for out-of-band signaling lie outside of the voice band.

out-of-band signaling are that it not only requires a method of coordinating voice and signaling channels, but it also requires a repeater at the end of each link.

In-Band Signaling

With in-band signaling, signaling tones are transmitted within the speech band, usually 1600, 2400, or 2600 Hz, although 2600 Hz is more widely used (see Figure 2). In-band signaling is very flexible in that speech and supervisory signals share the same transmission facility, but at different times. An in-band system is arranged so that supervisory signals are on the line only before and at the termination of a call. And, in-band signaling, in contrast to out of-band signaling, does not require the use of repeaters to reproduce the dc pulse at an interconnect point. One of the objections to in-band signaling is that the signaling tones which lie within the voice band may cause "talkdown" (false signaling due to voice energy). Conversely, the audible supervisory signaling tones cannot be used during conversation as they can with out-of-band signaling.

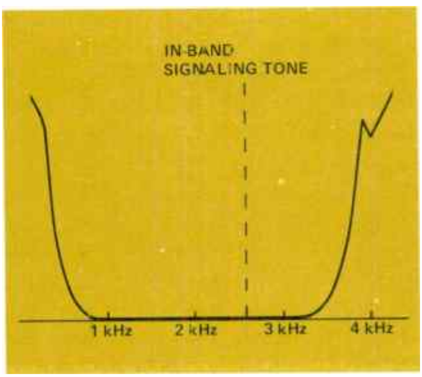
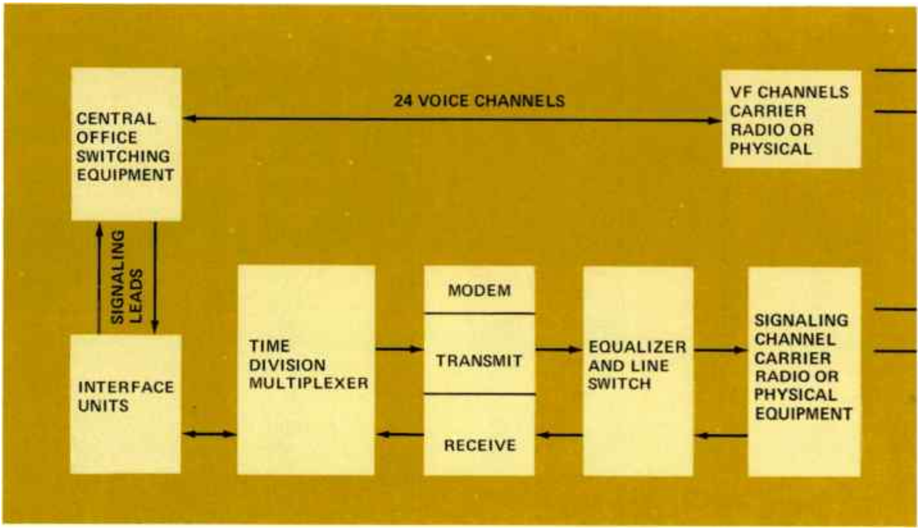


Figure 2. In-band signaling employs tones within the voice band.

Guard circuits which distinguish between speech and signaling tones can usually prevent most talkdown problems. When voice frequencies similar to the signaling tone occur, the guard circuit detects that the signaling tone frequency is caused by speech, not signaling, and therefore prevents signal circuit response. In-band signaling is more complex and expensive than out-of-band signaling, and also requires a more elaborate filtering system.

Common Channel Signaling Systems (CCSS)

Although in-band and out-of-band signaling systems are efficient methods of signaling. both require extensive use of filters and associated circuitry to prevent signaling tones from interfering with the voice band and other equipment such as SATT (Strowger Automatic Toll Ticketing). In the interest of economy, interoffice common channel signaling systems such as GTE Lenkurt's 11A CCSS have been recently introduced. CCSS is an alternative to in-band, single-frequency signaling. It is not a new concept – the Lenkurt 81A exchange trunk carrier, introduced in 1958, used a similar signaling technique. Before that, the Lenkurt 44B signaling system, introduced in the early 1950's, used a common-channel principle in its multitone signaling. The basic concept of common channel signaling is that all signaling



for a number of voice paths is carried over one common channel, instead of within each individual channel.

The greatest advantage offered by CCSS is a savings to both telephone company and customer. CCSS eliminates talk-down and talk-off problems. It eliminates the need for signaling augmentation (greater gain for signaling tones during dialing). It improves the performance of the voice channel because noise generated by in-band signaling components is eliminated. CCSS is also economical in that special filtering is not necessary as in other signaling schemes. And, of more recent interest, CCSS *can* eliminate the "phone phreak" problem which now plagues many telephone companies.

One GTE Lenkurt CCSS terminal can provide signaling for 24 voice channels. It can accommodate physical line, carrier, or microwave equipment. CCSS is a means of interoffice communication, with equipment located in the central office. Figure 3 shows a block diagram of a typical common channel signaling system. The voice paths come out of the central office switch termination and go directly to the carrier channel banks. The signaling for these voice paths enters the CCSS interface units by loop signals or E and M leads. The M lead transMits "on hook" or "off hook" signals to the CCSS equipment, and the E lead recEives on-hook or off-hook signals from the CCSS equipment. Each CCSS terminal contains four gate units, each of which is capable of handling six signaling channels.

The function of the interface units is to accept various signaling schemes and make them compatible with the CCSS equipment. Signaling between telephone systems is done on an on-hook or off-hook basis, which is a one or zero binary situation, and as such, is well suited to the sampling used in time division multiplex techniques.

A signal gate unit in the time division multiplexer connects to the signaling portions of the interface units, and samples the transmit inputs for on-hook or off-hook conditions at approximately 2400 times a second. Each sample is sequentially fed to a 2.4 kilobit modem. In this way, 24 parallel signals are serialized into one TDM (time division multiplex) stream. At the modem, the TDM stream is transformed into an FSK (frequency

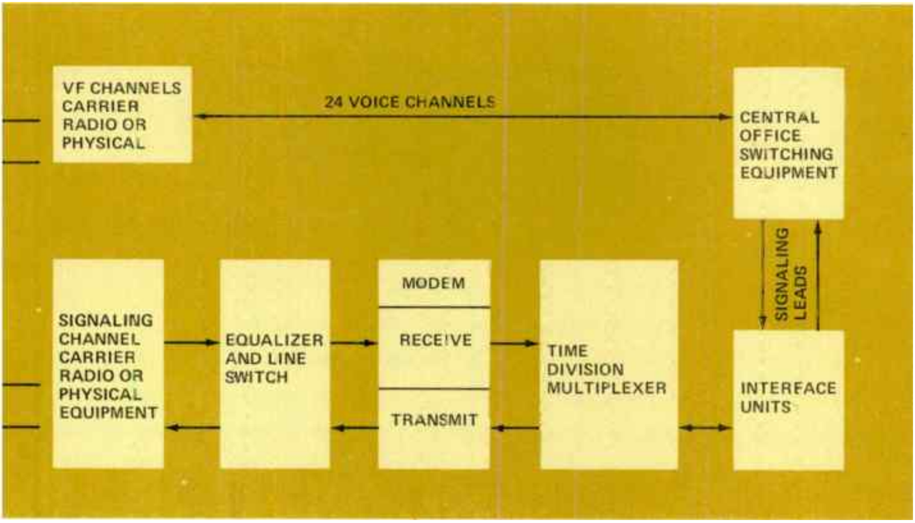


Figure 3. CCSS can accommodate signaling for carrier, radio, or physical equipment.

shift keying) signal within the voice band, which in turn can be put over any standard voice channel, for the purpose of signaling. The reverse of this procedure takes place at the other end of the line.

The Alternate Channel

One means of protecting the CCSS signaling data stream is provided in the form of an alternate channel. Occasionally, a channel will become unsuitable for transmission because of impulse noise. While impulse noise does not affect voice conversation to any large extent, it may introduce a high enough error rate in the signaling channel to interfere with the signaling function. To guard against this, two "quiet" channels (preferably in different groups) are selected when the CCSS is initially installed. Under normal conditions, one of these will be used to carry the signaling and the other will operate as a normal, traffic-carrying voice channel. An error detector monitors the error rate in the signaling channel. This circuit takes into consideration the noise characteristics of channels. That is, that errors due to noise occur in bursts – they are not always present. The bursts are randomly spaced and random in length. Approximately 95% or more of these bursts are less than 50 milliseconds long, and the time between them is approximately five seconds or less. The error detector ignores the first 50 milliseconds of any kind of error occurrence, then begins to count errors for a period of ten seconds. If less than three errors occur during this period, the system goes back to normal operation. If more than three errors occur, the line-switch unit automatically switches the signaling-channel information to the alternate voice channel, and the alternate-channel information to the signal channel. This switch takes approximately 10 milliseconds, which is fast enough that a customer on the alternate channel will not know that a switch has occurred. And, since impulse noise does

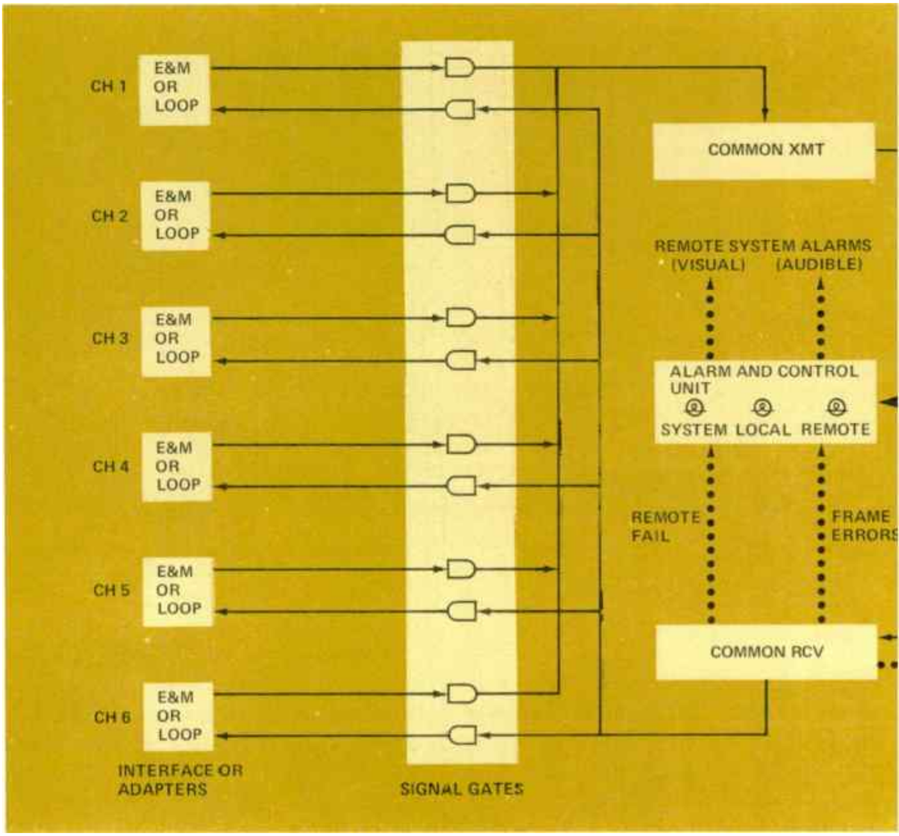
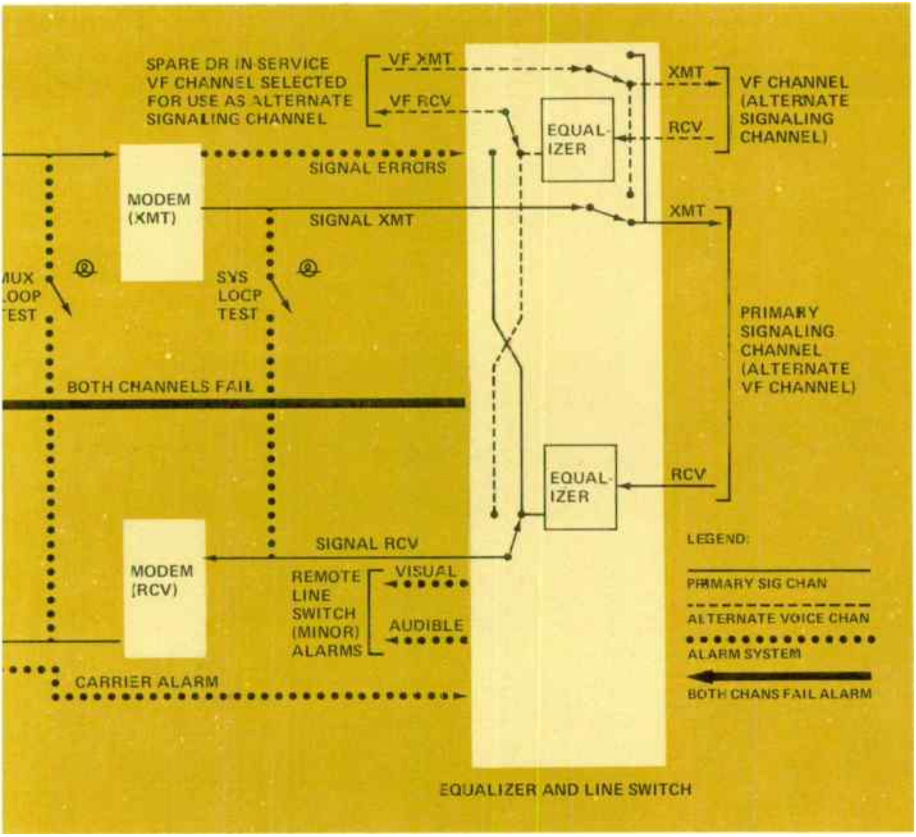


Figure 4. The CCSS alternate-channel protection function is initiated when an increase in error rate or a channel failure takes place.

not seriously impair voice, the customer can continue his conversation. This technique takes advantage of another peculiarity of impulse noise, and that is that noise does not necessarily occur in all channels at the same time. So, in effect, it is quite likely that when there is noise on one channel, the alternate channel will not be undergoing a similar effect. A "minor" alarm is sounded to indicate that a switch has occurred.

In the event that both channels are bad, and this would be a rare situation, a "major" alarm system takes over — bells are rung, lights are turned on, the system is made busy, and a technician is sent to remedy the situation. Figure 4 depicts the CCSS alternate-channel protection system. The thin black lines trace the primary signaling channel. the dotted lines show the alarm paths, and the dashed lines show the alternate channel. When a switch is effected, the signaling data which was initially traveling over the primary signaling channel, now is put on the alternate channel. At the same time, the customer. who was on the alternate channel. is placed on the signaling channel. The alarm path is activated if both channels fail (a major alarm), or when a line switch takes place (a minor alarm). Another type of protection for the CCSS is in the form of continual monitoring of one terminal



by the other with an alarm being given in case of malfunction.

Phone-Phreak Phree

Telephone abuse by the so called "phone phreak" is one of the recent problems that has been frustrating telephone companies. and is costing an untold amount in lost revenue. The phone phreak is an individual who has enough knowledge about telephone system operation to access the system by generation of generally used signaling tones. By generating tones of the correct frequency and at the correct time, the phone phreak can make long distance calls without being charged. This kind of telephone abuse is most commonly found in systems that employ in-band or multifrequency signaling. Since the CCSS technique completely separates the signaling from the voice channel, false tones cannot be used to access the telephone system. The only stipulation here is that CCSS be used *end to end*; a tandem link with a tone-signaling system would make the system vulnerable to the phone phreak.

Common channel signaling is an improvement over most conventional signaling — both in economy and quality of transmission. It is a concept which will become increasingly prevalent in future systems. And, with systems such as the 24-channel CCSS, small offices as well as large can install them and add more as the need arises.

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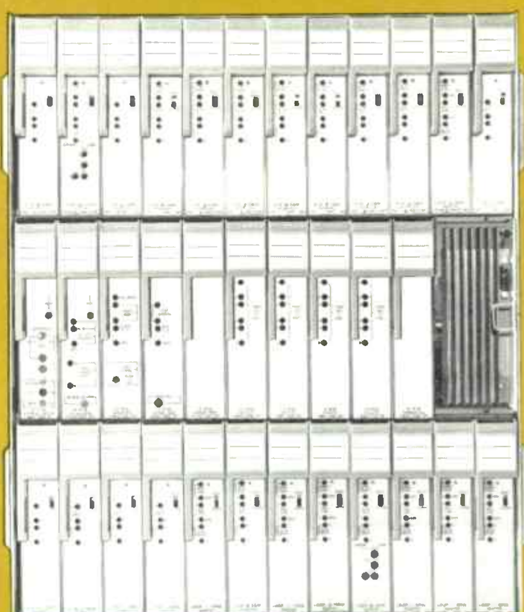

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