The Lenkurt Demodulator

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ALARM CIRCUITS

For 45-Class Carrier

Dependability is a watchword in the operation of most public utilities. The telephone company, like other utilities, has the important responsibility of providing its customers with the most efficient, reliable service possible at reasonable cost. This kind of service can best be furnished with adequate, well engineered telephone plant. An important factor in the attainment of such a plant is the reduction to a minimum of equipment and circuit outage time. Alarm circuits are used to help achieve this purpose.

In this article the general philosophy of alarm and supervisory circuits is discussed and the application of this philosophy to the alarm features available in Lenkurt 45-class is described.

It is generally recognized that toll calls are one of a telephone company's major sources of revenue. The ability of a subscriber to call any place at any time, quickly and easily is an important factor in maintaining and building toll revenues. To be able to provide the service conducive to profit making toll traffic, a high quality toll plant with an adequate number of circuits must be maintained.

One of the most important factors in reduction of circuit outage time in the toll plant is an adequate alarm system. In the larger offices, alarm systems are usually extensive and complex. In the smaller offices, they may be very simple. In either case, their primary purpose is to monitor the operation of the telephone plant and to alert maintenance personnel immediately in case of trouble.

Desirable Features

Of all the various features that can be incorporated into an alarm system, there are two that are of paramount importance. These are reliability and simplicity. A system of alarms is worthless if it fails to operate when an alarm condition occurs. Similarly, it is of doubtful value if it gives false alarms or is so complex that in itself it presents an operating and maintenance problem. Of course, not all alarm systems can be simple. Operation of remote unat-

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tended telephone equipment may require a rather extensive and complex alarm system. However, even in this case, the alarm system should be as simple and reliable as is consistant with adequate supervision and control.

A very desirable feature in any alarm system is operation on a fail-safe principle. That is, failure of any component of the alarm system should in itself cause an alarm to be given. Other desirable features of an alarm system include provisions for silencing any audible indications while the alarm condition is being cleared and simple means of resetting the alarm system to normal after the trouble has been removed.

45-Class Carrier Alarms

Outstanding examples of the applications of the basic philosophy concerning alarms can be found in the alarm systems available in Lenkurt 45-class carrier systems. The alarms provided are simple yet effective. Their primary purposes is to monitor the operation of the carrier equipment such that failure of any component, voltage supply, or transmission facility common to a system or large group of circuits will give an alarm.

The basic alarm circuits of all 45-class carrier systems are essentially the same. Every system has two alarms; a "fuse" alarm and a "system" alarm.

The fuse alarm operates when any fuse in the plate or filament supplies of a common equipment shelf or channel bank is blown. The system alarm operates if for any reason the carrier terminal fails to receive sufficient power from signaling or channel regulating tones transmitted from the distant terminal. Both the fuse and system failure alarms operate when a filament or plate fuse in the common equipment shelf power supply fails. A five second delay is incorporated into the system alarm circuit to prevent an alarm being given for momentary interruptions of the received signal. Such momentary interruptions are usually caused by transfer of power supplies, transfer of radio receivers to standby equipment or line

The system alarm in type 45A systems is also arranged to operate if the levels of the received system regulating tones fall too low. If this arrangement were not provided, failure of either a system regulator or pilot oscillator at a terminal or failure of a regulator at one of the system repeaters could cause system transmission levels to go awry without causing a system failure alarm.

Both the fuse and system alarm circuits have provisions for local and remote indications as well as cut-off switches for silencing or disabling the alarm. If the fuse alarm circuit operates, a lamp on the front of the carrier system alarm unit lights to give local indication of the alarm. A similar lamp is provided on the alarm unit for indication of a system failure. Operation of either the fuse or system alarm circuit causes a relay common to both of these circuits to operate to close two pairs of contacts that set off the audible and visual office alarms. Figure 1 is a close-up of an alarm panel showing the local indicating lamps, cut-off switches and reset button of a typical 45-class system alarm unit.

It is almost always desirable to silence the audible office horn or bell as soon as possible after an alarm has been given. In many larger offices it is also desirable to disconnect the visual indicator (usually an aisle lamp) following an alarm. This is normally desirable because the same indicators may be used to provide indication for more than one alarm circuit.

All of the alarm arrangements in 45-class carrier equipment are designed to be fail-safe. Under normal conditions, the relays in the alarm circuitry are held in the operated position. Should the alarm system power supply fail because of a blown fuse or other cause, the alarm relays would be released giving local and office alarms. Should any vital component in the alarm circuitry fail (such as a relay or tube) the most probable result would be the release of one of the relays in the alarm circuitry which would initiate an alarm.

Auxilliary Circuits

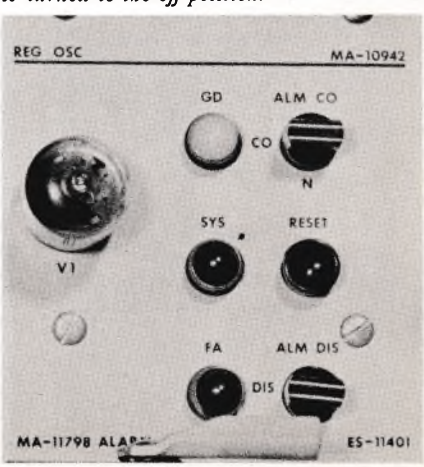
When a carrier system is operated in conjunction with automatic dial controlled equipment, auxiliary alarm equipment is desirable to prevent the machine switching equipment from "seizing" a defective circuit instead of passing over it to a good circuit. To eliminate this possibility, an optional alarm feature called "disconnect-make busy and Loop test" (DMB for short) is available on Lenkurt 45-class carrier equipment. Should the carrier system fail, the DMB equipment disconnects all called parties from the carrier system drops at both ends of the system and then arranges the carrier system signaling equipment to appear to be busy at both ends of the system signaling equipment to appear to be busy at both ends of the system. This frees any automatic switching equipment that is seized by loss of the system and prevents any further connection to the channel drops. Since each channel drop appears to be busy, the automatic switching equipment passes over it and continues to search for an idle circuit. Figure 2 shows a simplified schematic diagram of a typical 45-class alarm circuit with the auxiliary DMB circuit.

The DMB equipment also includes a means of testing the carrier system to determine if it is operating properly following an alarm. Testing the carrier system following an alarm is accomplished by operating test keys momentarily at one carrier terminal to transmit a test signal to the far end of the system. If the system is operating properly, the DMB circuitry at the far end terminal will automatically retransmit the test signal back to the originating terminal where a test lamp will flash in response to each operation of the test key.

A loop test is desirable because it enables maintenance personnel to determine immediately whether a failure which has caused alarm is only of temporary nature. If the trouble is of a sustained nature, the loop test is a valuable tool in locating the fault.

When the trouble causing an alarm has been removed, the alarm and DMB equipment must be reset to restore operation to normal. On systems not equipped with the DMB feature, the alarm circuits of both terminals of the system must be manually reset by operation of a reset key at each terminal. If the system is equipped with the DMB feature, however, the whole sys-

FIGURE 1. Alarm unit for 45A multiplexing equipment. The guard lamp (GD) lights when either of the alarm cutoff keys is turned to the off position.



tem can be reset from either terminal. Holding down the loop test key for 15 seconds or longer causes all the relays at both terminals of a system to be returned to normal and removes the "busy" condition from the channel signaling leads at both terminals. This far-end reset feature is especially advantageous when one terminal of a system is unattended.

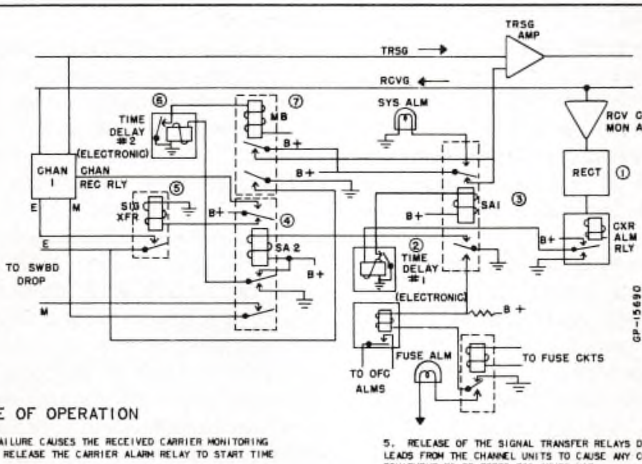
Interconnected Systems

One of the most distinctive features of Lenkurt 45-class carrier equipment is the ability to interconnect the various types of systems at carrier frequencies even though they operate over different transmission media. The interconnection of different carrier systems, however, sometimes poses special problems as far as operation of system failure alarms is concerned. With the system of alarms presently used on 45-class carrier, operation of the system failure alarm (on systems without DMB equipment) automatically disables the transmitting branch of the carrier terminal. This action in turn causes a system alarm at the far end of the system which shuts down the distant terminal also.

If the system is equipped with the DMB feature, the transmitting branch is disabled for only 10 seconds for the purpose of causing a far-end alarm which will operate the DMB equipment at the distant terminal. At the end of the 10-second interval power is restored to the transmitting branch so the system can be loop tested. For both cases, far-end alarms are assured by disabling the transmitting branch upon system failure.

A method of assuring a far-end alarm is usually necessary only on systems using dial signaling and equipped with the DMB feature. If the DMB feature is to be fully effective, channel drops at both ends of a faulted system must be disconnected and made busy. If they

FIGURE 2. Simplified schematic of alarm, disconnect, and make-busy circuit presently used in 45-class carrier equipment. Loop test and reset operations are not shown in this diagram.



SEQUENCE OF OPERATION

1. SYSTEM FAILURE CAUSES THE RECEIVED CARRIER MONITORING AMPLIFIER TO RELEASE THE CARRIER ALARM RELAY TO START TIME DELAY #1.

2. AFTER 5 SECONDS, TIME DELAY #1 OPERATES TO RELEASE RELAY SA1.

3. RELEASE OF RELAY SA1 RELEASES OFFICE ALARM RELAY TO GIVE EXTERNAL OFFICE ALARMS. IT ALSO LIGHTS THE LOCAL SYSTEM ALARM LAMP, REMOVES B+VOLTAGE FROM THE TRANSMITTING AMPLIFIER, AND RELEASES RELAY SA2.

4. RELEASE OF RELAY SA2 RELEASES THE SHELF SIGNAL TRANSFER RELAYS (SIG XFR) AND INITIATES TIME DELAY #2.

5. RELEASE OF THE SIGNAL TRANSFER RELAYS DISCONNECTS ALL "E" LEADS FROM THE CHANNEL UNITS TO CAUSE ANY CONNECTED SWITCHING EQUIPMENT TO BE FREED FOR OTHER USE.

6. ABOUT 10 SECONDS AFTER RELAY SA2 RELEASES, TIME DELAY #2 OPERATES TO RELEASE THE MAKE-BUSY RELAY (MB).

7. RELEASE OF THE MAKE-BUSY RELAY CONNECTS ALL E LEADS SO AS TO TRANSMIT A BUSY SIGNAL TOWARD THE CHANNEL DROPS. (THIS IS USUALLY ACCOMPLISHED BY CONNECTING THE E LEADS TO GROUND.). AT THE SAME TIME THE MAKE-BUSY RELAY RECONNECTS THE B+SUPPLY TO THE TRANSMITTING AMPLIFIER SO THE SYSTEM CAN BE LOOP TESTED.

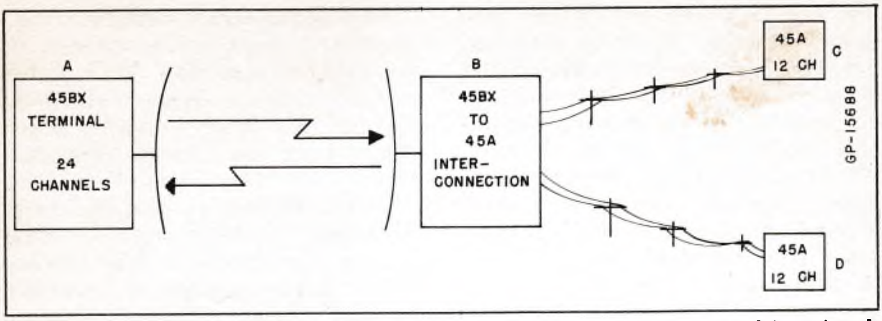


FIGURE 3. Typical interconnection of 45-class carrier equipment. If the network is equipped with the DMB feature, loss of one channel group should not affect any other group.

are not, automatic switching equipment will be "hung up" on the out-of-service system and the loop test and far-end reset features of the DMB circuitry will be inoperative. When a system provides ringdown signaling (systems without DMB), far-end alarms are often unnecessary. The inability of an operator to raise the distant end of a circuit is usually sufficient indication of trouble.

The same far-end alarm philosophy also applies to networks of inter-connected carrier systems. A problem is created by interconnection, however, because an end to end connection of a group of channels may no longer involve only a single carrier system. Instead, a group may start at a terminal of one carrier system and end at a terminal of a completely different system. There may be any number of carrier frequency transfers in between the two ends of a group.

If a group of channels uses ringdown signaling (or is not equipped with signaling), a method of insuring far-end alarms is not necessary. If, however, a channel group uses dial signaling, then it is desirable that the channel drops at both terminations be disconnected and made busy when transmission of the group in either or both directions is interrupted. Provision of disconnect-make-busy action at any one terminal upon the loss of received signals is an easy task. The difficulty arises in providing insurance that the opposite end of the channel group will also be disconnected and made busy. The method of assuring far-end alarms now in use on 45-class carrier provides proper alarm and DMB operation for all individual systems and for many interconnected networks depending on the particular arrangement of systems involved. It is anticipated, however, that when additional types of 45-class carrier become available and as interconnected 45-class networks become more complex, a more flexible arrangement will be necessary.

A new method of providing DMB protection for channel groups as small as 4 channels or as large as 60 channels is now being designed so that no matter how complex a network may be or how many types of 45-class carrier are used, any normal grouping of channels can be given alarm and DMB protection. Both ends of a channel group will be disconnected and made busy when transmission is interrupted in either or both directions.

An example of alarm operation in an interconnected carrier network can be given by referring to Figure 3. In this figure a network formed by a 45BX system and two 45A systems provides circuits between points A and C, and A and D. 12 channels operate over the route

ABC and 12 channels operate over the route ABD. The two 12-channel groups are combined and transmitted via a 45BX radio carrier system between points A and B. At point B the 45BX system interconnects with two 45A systems which transmit the two 12-channel groups to their respective desitnations.

With a single system alarm arrangement, failure of the 12-circuit group between B and C would normally cause an alarm to be given at points B and C, but not at point A. (All 24 of the channels between A and B would have to be disabled to cause an alarm at A.) The channel drops at point C would be disconnected and made busy but the drops for this group at point A would be unaffected. This might interfere with the effective operation of the automatic switching equipment at point A. The loop test and far-end reset features would also be unusable.

With the new alarm and DMB circuitry for interconnected systems, failure of the 45-A open-wire system operating between points B and C would cause an alarm at points A and C and possibly at point B, depending on the nature of the trouble. The channel drops at both points A and C would be disconnected and made busy and it would be possible to loop test the troubled 12 channel group from either points A or C. Reset of the alarm system would also be possible from either of these two points. The 12 channel group operating between A and D would be unaffected.

Conclusions

An adequate, dependable alarm system is an asset to any telephone plant. To meet the requirements of adequacy and reliability, an alarm system must give proper warning when any major equipment or circuit outage occurs. In recognition of these requirements, the alarm system designed for 45-class carrier is effective, yet simple and fail-safe. With the new alarm circuitry for interconnected systems, adequate alarm and disconnect-make-busy protection can be provided for any 45-class carrier network no matter how extensive or complex.

DIFFRACTION OF MICROWAVES

In the June 1954 issue of the Lenkurt Demodulator, an explanation was given for the change observed in received signal strength when an obstacle was in or near the line of sight of a microwave system. The June article attributed the change to a phenomenon called diffraction in which it is considered that the whole surface of a wave front contributes energy to a receiving antenna. According to diffraction theory, when part of the wave front is obstructed, the amount of energy contributed to the receiving antenna is different than when the wave front is unobstructed. Not explained in the earlier article, however, was how energy could be received from a portion of a wave front that was not traveling directly towards the receiving antenna.

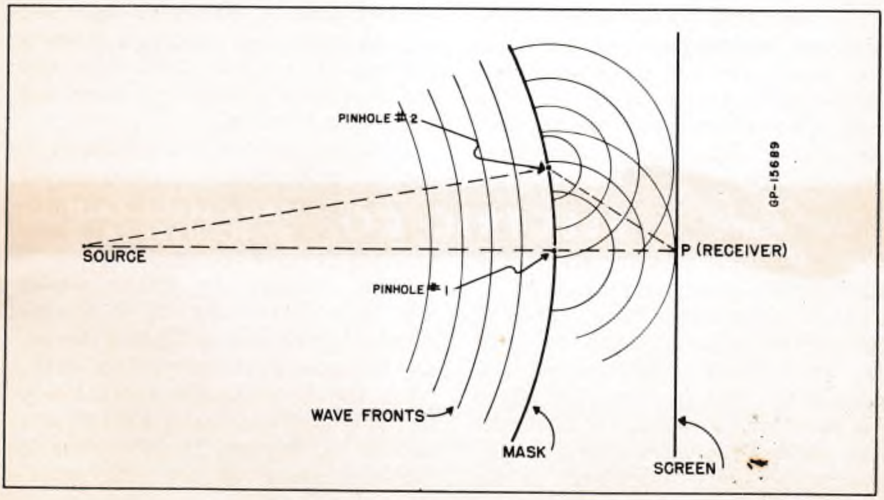
The purpose of this article is to explain this apparent discrepancy in microwave propagation by giving a brief description of the mechanics of wave travel.

The manner in which waves travel is described by a fundamental principle of optics known as "Huygens Principle". This principle, though originally applied only to light, applies equally well to microwaves. Huygen, in attempting to explain some of the characteristics of light, proposed that light traveled as waves in an "ether" and that the orderly progression of the waves through the ether could be explained if every point of an advancing wave front were considered to be a secondary source of radiation, and that each point of a wave front be considered the source of secondary wavelets emanating in the general direction of wave travel.

Huygen's principle is illustrated by the sketch shown in figure 1. In this sketch, a mask is placed in the path of a train of microwaves completely blocking wave travel except for a small hole. If a screen is placed behind the mask, it will be found that the whole screen will be illuminated by the pinhole source with the strongest illumination occuring at the point (P) that is in line of sight with the pinhole and original source of radiation. If a second pinhole is placed in the mask, it will be found that this second pinhole will also contribute some radiant energy to point P. Thus, if a very large number of pinholes are made in the mask (or the mask is removed), energy will be received at point P from all parts of the wave front.

In the example given in figure 1, energy arrives at point P over two different paths; one path being longer than the other. If the difference in path length is some odd multiple (1, 3, 5, etc.) of a half-wave length, the two sources of illumination will tend to cancel each other; if the difference is an even multiple of a half-wave length they will tend to reinforce each other. When the mask is removed, the combined result of all cancellations and reinforcements is such that the energy received at P appears to come from the source in a straight line. If, instead of a mask, an obstacle such as a hill or tall building, is placed in or near the path of the radio wave front, the balance between the cancelling wavelets and the reinforcing wavelets is upset and the amount of energy received at point P will be greater or less than the energy received without the obstacles' presence. Even if the receiver lies in the geometrical shadow of the obstacle (for example, a microwave receiver masked by a hilltop), some energy will be received.

FIGURE 1. Illustration of Huygen's Principle. The pinholes in the mask act as secondary point sources of radio energy.



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Recently Issued Publications

Issue No. 1 of Lenkurt Bulletin **45A-P4** includes an expanded technical summary in addition to a more complete system description than appeared in the preliminary issue. Type **45A** carrier is a 12-channel system for open-wire lines.

Product Information Letter No. 11 summarizes the **carrier frequency interconnections** planned for Lenkurt's **45-class carrier.** With these arrangements, extensive carrier networks can be developed using a single equipment type.

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