The Lenkurt Demodulator

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Introducing Type 45CB

A NEW 4-CHANNEL CARRIER SYSTEM

For Open-Wire Lines

Lenkurt's new Type 45CB carrier system, operating in the frequency range from 40 to 76 kilocycles, transmits up to four high-quality voice and signaling channels over an open-wire pair. Field tests made during the past summer have indicated that the new system can be expected to perform satisfactorily. Several new electrical design features have been incorporated, including transistors.

This article and the article on page 10 describe the new system and discuss some of its design features and possible applications.

Type 45CB is a member of the 45-class Lenkurt carrier systems which provide multi-channel communications over open-wire, cable, or radio facilities. The electrical and mechanical design of these 45-class systems is such that many of their subassemblies are completely interchangeable. Their modulation plans have been designed so that channel groups from one system can be transferred, at carrier frequencies, to another system to economize in overall system layout and in future possible rearrangements as requirements may change from time to time.

The latest proven electrical and mechanical design techniques have been used in the Type 45CB system to improve performance and reduce operating costs. Unitized plug-in construction and miniature components have simplified maintenance, increased reliability, and reduced power consumption.

The basic Type 45CB system terminal consists of an equipment shelf and five system terminal units. Four of these are removable plug-in units and one is wired to the shelf assembly. The shelf also has space for four plug-in channel units and four plug-in compandors. The complete shelf mounts on a 19-inch equipment rack and requires only 15-3/4

A 45CB system will be on display at the U. S. Independent Telephone Association convention in Chicago, October 10, 11, and 12. The equipment will be in the Automatic Electric exhibit in Room 507 of the Conrad Hilton Hotel.

inches of vertical space. Fig. 1 shows a complete 4-channel terminal assembly.

Channel units for the 45CB system consist of a basic chassis and a number of different plug-in subassemblies. The chassis is not peculiar to the 45CB system, but is used by all 45-class systems. Many of the plug-in subassemblies are also common to all 45-class systems. By the use of different subassemblies, the channel unit is adapted for different frequency bands, signaling options, and voice frequency terminations. Channel number and frequency band are determined by the use of one of four bandpass filter subassemblies. Another subassembly provides facilities for out-of-band frequency shift signaling. The signaling power supply is also used for automatic channel level regulation. The signal receiving relay is likewise a plug-in unit.

The signaling circuits in the channel units are arranged to provide for the several types of dial or d-c ringdown signaling employed in present day practice. Miniaturized converters are supplied when a-c ringdown signaling is to be used. Signaling leads can also be connected back-to-back without need for pulse-link repeaters.

When signaling facilities are not required, a standard modified arrangement can be used to provide only the regulator circuitry. This arrangement permits a 3100 cps low-pass filter subassembly to be replaced by a similar 3300 cps filter subassembly which provides a wider channel bandwidth. All plug-in subassemblies are indicated by broken lines in the block diagram shown in Fig. 5 (Pages 6 and 7).

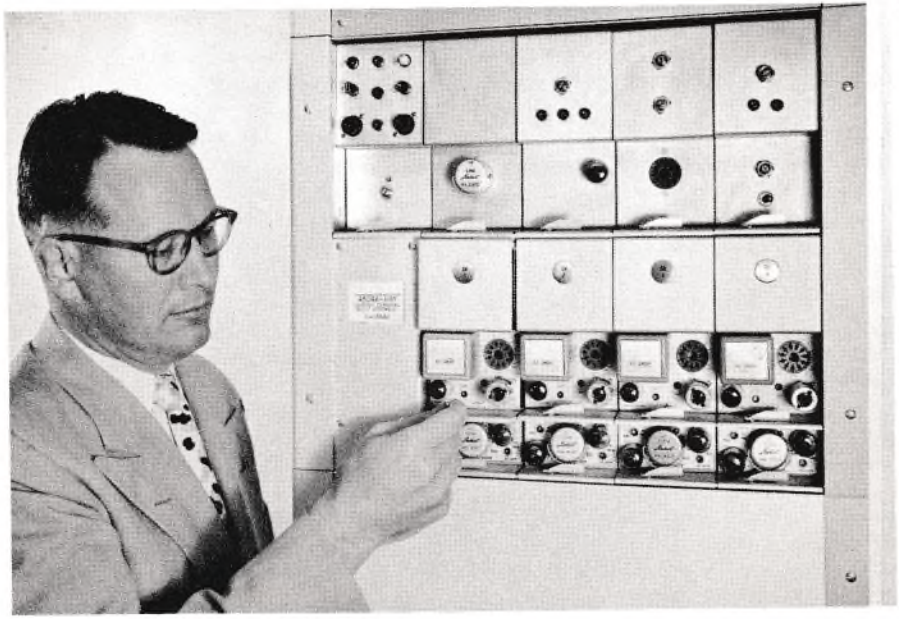


FIG. 1. A complete 4-channel terminal assembly of Type 45CB carrier equipment. This assembly occupies only 15-3/4 inches of vertical rack space.

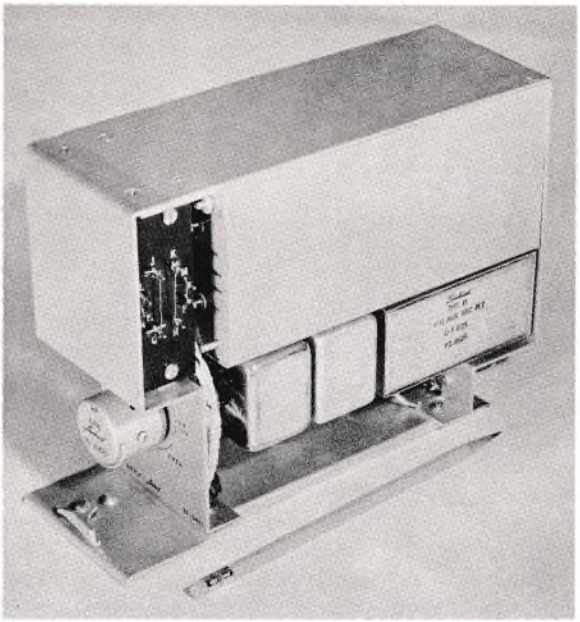


FIG. 2. Directional Filter Unit. This unit is shown strapped to transmit the 60-76 kc band and receive the 40-56 kc band.

In addition to the channel units and compandors, the basic terminal assembly includes group transmitting, group receiving, directional filter, and carrier frequency supply units; also a power distribution and alarm panel. The transmitting, receiving, and carrier frequency supply units make the maximum practical use of transistors and miniaturization techniques. As a result, power drain for these units is reduced to a minimum

The transmitting unit consists of the necessary pads, filter, transistor amplifiers, and a stage of modulation to translate the frequency band received from the channel units to the proper frequency band for transmission over an open-wire pair. Similarly, the receiving unit contains a demodulator, transistor amplifier, and a system gain regulator.

The directional filter units consist of two band-pass filters for isolating the receiving and transmitting units, and for selecting the proper frequency bands for transmission and reception. This unit is shown in Fig. 2.

The carrier frequencies for the transmitting unit, receiving unit, and channel units are generated in the carrier frequency supply unit. This unit is comprised of two crystal controlled transistor oscillators which, through modulation and the generation of harmonics, produce the channel carrier frequencies, group carrier frequencies, and a 12-kc pilot tone for system regulation. One of the six transistors used in the carrier supply unit is pointed out in Fig. 3.

The alarm and power distribution unit provides a convenient central distributing point from which plate and filament power is fed to the various plug-in units. The alarm portion of this panel provides local indication in the event of system failure. An alarm relay provides contacts which can be connected to the office visual and audible alarm systems. A close-up view of the power distribution and alarm unit is pictured in Fig.

4, which also shows the equipment shelf with all plug-in units removed.

Transistor Circuits

The most important design innovation in the 45CB system is the use of transistors. As pointed out in previous Demodulator articles, the evaluation and testing of such new components well in advance of their use in commercial production, is a constant process in Lenkurt's laboratories. Units of the 45CB common equipment with transistor circuits were carefully tested in the laboratory and during the field trial to make sure of their effectiveness and reliability.

In carrier circuits, transistors are used in amplifier and oscillator circuits in much the same manner as vacuum tubes. In the 45CB group transmitting unit, four transistors are used in two amplifiers. One of these -- the input amplifier -- uses one transistor; the other -- the output amplifier -- uses three transistors to provide adequate total power output capacity. The receiving unit also uses transistor amplifiers as well as one vacuum tube amplifier.

The most unusual application of transistors in the 45CB system is in the carrier supply unit. This unit uses two transistor oscillators and three transistor amplifiers to generate accurate frequencies of 12, 20, 52, and 64 kc for channel and group modulation. The two oscillators generate fundamental frequencies of 32 and 52 kc. One oscillator also generates (by purposeful distortion) 64 kc, the second harmonic of 32 kc. The distorted output of the 32-kc oscillator is modulated with the 52-kc frequency to obtain several additional frequencies. Two of these, 12 and 20 kc, are selected and amplified for use as channel carrier frequencies. The 12-kc tone is also used for system regulation.

Many benefits accrue from the use of transistors; the most important are the increased reliability, smaller space requirements, and lower power drain. For example, a complete 45CB terminal requires only 1.01 amperes of filament current at 40 volts and 0.244 amperes of plate current at 130 volts. The use of vacuum tubes in those units which have been transistorized would have about doubled the current drains involved.

System Operation

The four channels of the 45CB system can be transmitted over a single open-wire pair with different

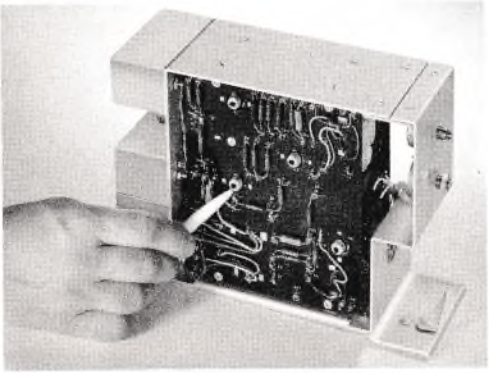


FIG. 3. The carrier frequency supply unit for a Type 45CB carrier terminal. The pointer indicates one of the six transistors in this unit.

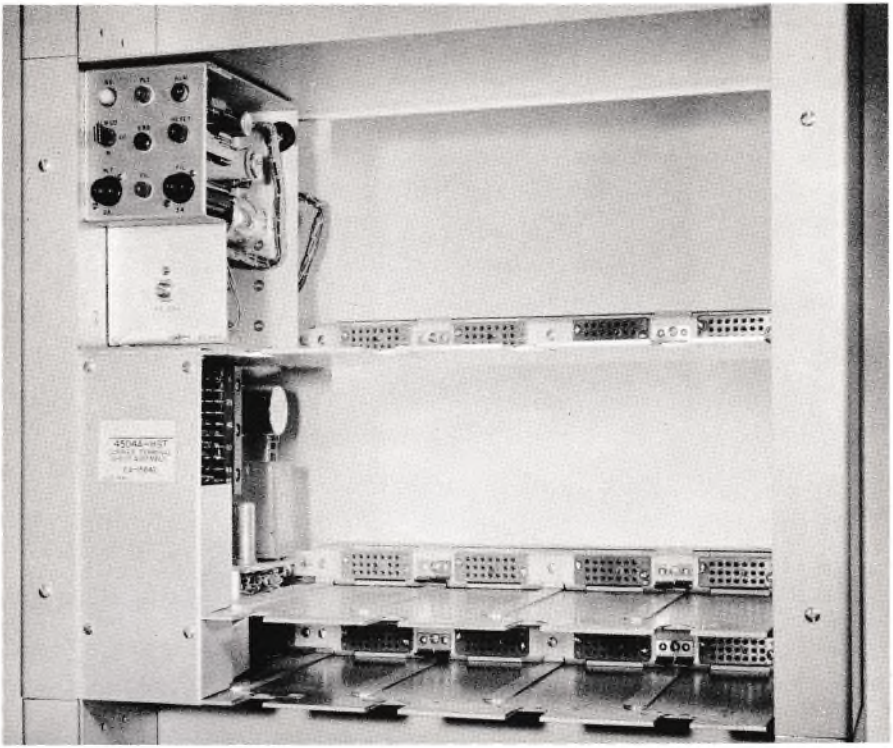


FIG. 4. Type 45CB terminal shelf with plug-in units removed. The Power Distribution and System Alarm Unit is permanently wired to a short section of cabling which permits its partial removal from the shelf for inspection and maintenance.

16-kc frequency bands being used for opposite directions of transmission. One direction uses frequencies from 40 to 56 kc and the other direction uses frequencies of 60 to 76 kc. Either band is usable in either direction. The use of directional filters electrically isolates the transmit and receive sections of the system terminals. The particular frequency bands were chosen to coordinate with Western Electric Type O carrier equipment.

The block diagram in Fig. 5 indicates the general functional arrangement and operation of the system terminal. In the transmitting direction, message signals are passed from the voice frequency drops through the compandors, channel units, transmitting unit, and directional filter to the open-wire line. The compandors compress the dynamic range of voice frequencies by a factor of 2 to 1 and pass them on to the channel unit. In the channel units the voice frequencies modulate 12- or 20-kc carrier frequencies to produce four pairs of sidebands. The appropriate resulting sidebands are selected by the channel transmitting bandpass filters so that the combined outputs of the four channel units form a continuous band of frequencies from 8 to 24 kc.

In the transmitting unit, the 8-24 kc output band of the channel unit is combined with a 12-kc regu-

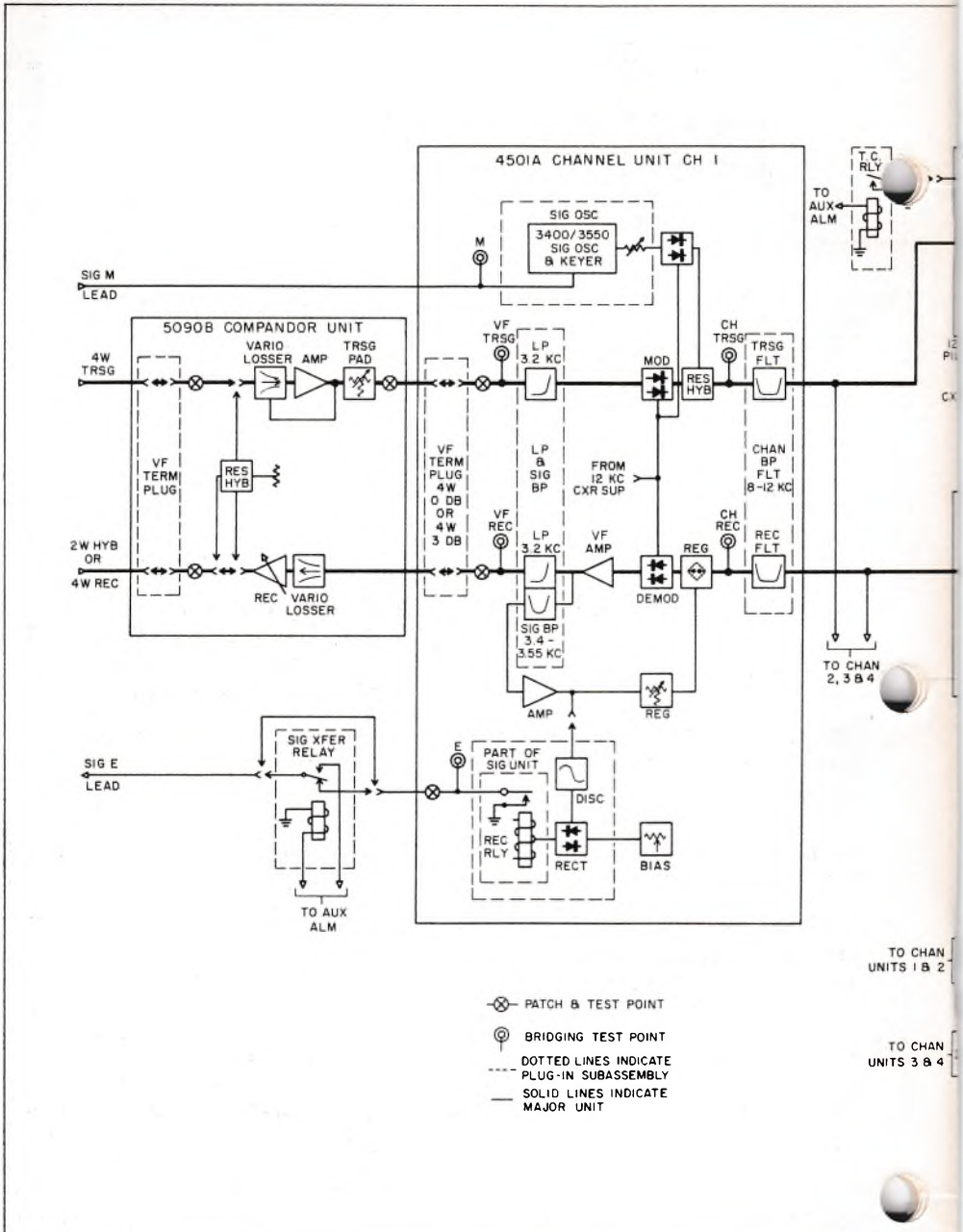
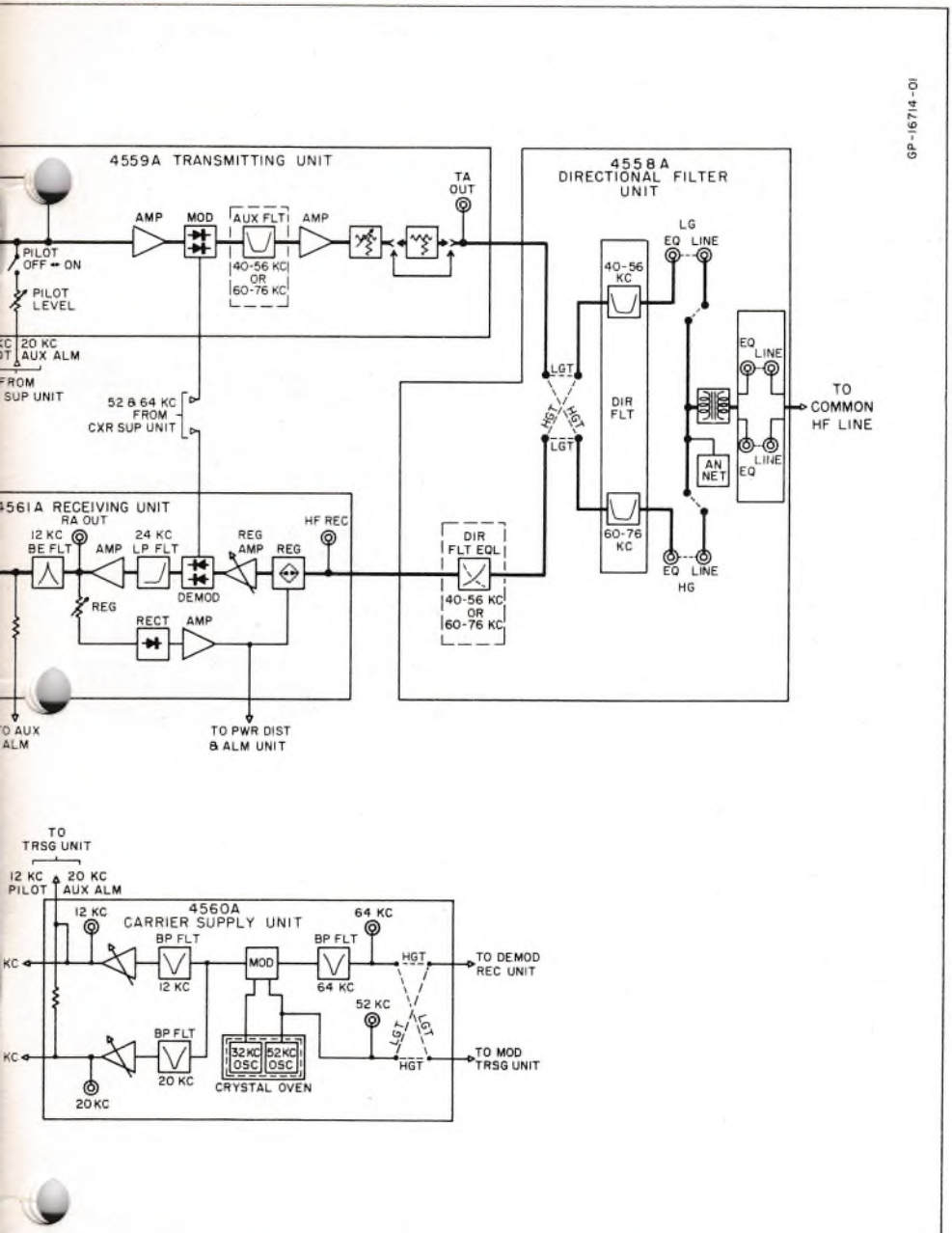


FIG. 5. Block diagram, Type 45CB terminal. in all 45-class carrier systems. Any terminal mission by strapping arrangements in the dire



The 4501A channel units are the same as used can be arranged for high or low-group transional filter and carrier supply units.

lating tone, amplified, and used to modulate a carrier frequency of either 64 or 52 kc. The output of this modulation stage is passed to the directional filter which selects the proper sideband for transmission over the open-wire line.

In the receive direction, the directional filter unit selects the appropriate frequency band and provides a fixed amount of filter equalization. The output of the directional filter unit is applied to the receive unit where it is demodulated to again form a band of frequencies from 8 to 24 kc. A portion of the output of the receive unit is rectified and used to control the gain of the receive unit amplifier. Since the power level of the pilot tone is much higher than the message power levels, it largely controls the gain of the receive unit amplifier. This arrangement provides system regulation.

Each of the four channel units selects the proper 4-kc band from the output of the receive unit, demodulates it to voice frequencies and applies it to the expandor portion of the compandor. The receiving branch of each channel unit contains a gain regulator which provides individual channel regulation in addition to the system regulation provided in the receiving unit.

Applications

Type 45CB carrier systems are designed primarily for short to medium haul use on various types of open-wire lines. Maximum distances of about 70 to 120 miles can be spanned without repeaters, depending upon the type of open-wire facility and the weather conditions likely to be encountered.

Because of the noise and crosstalk advantages resulting from the use of compandors, which are a normal part of each 45CB channel, a wide range of line facilities, including pairs which might otherwise be unsatisfactory for carrier

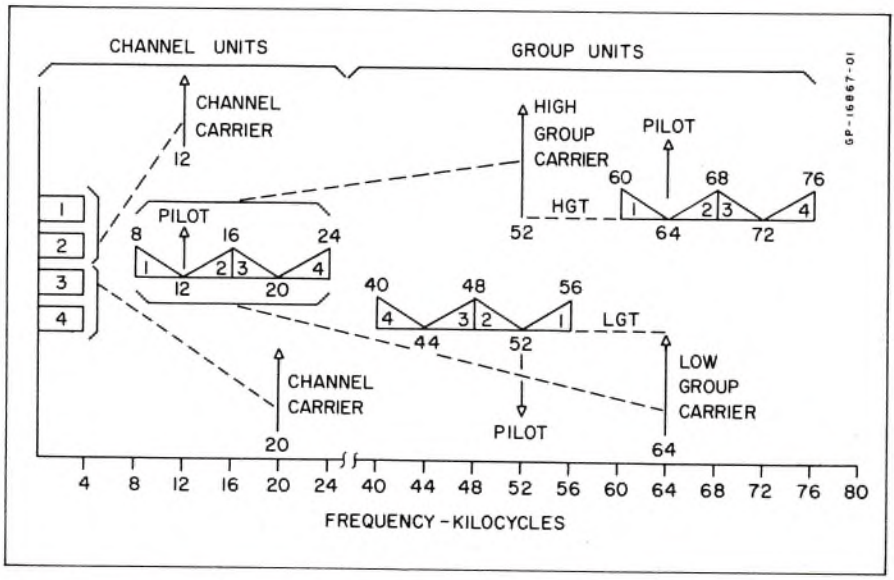


FIG. 6. The frequency allocation and modulation plan of Type 45CB carrier.

frequency operation, can be employed. Almost all 30-kc transposed pairs will be found usable even though line frequencies of the 45CB system are above 40 kc. Where 150-kc transposition systems such as the AE-150, Bell types 01 or J5 are in existance, Type 45CB can be applied in all cases.

The frequency allocation of Type 45CB (shown in Fig.6) has been designed to coordinate with Western Electric Type OB carrier. It can also be used advantageously on the same pair with lower-frequency carrier systems such as the Lenkurt Types 33A or 32E and Western Electric Types C or H. The second article in this issue describes how 45CB and 33A combine to make efficient use of open-wire facilities transposed for 30-kc operation.

Because of level and frequency differences, Type 45CB can be used for only very limited distances and under favorable circumstances on lines that have pairs equipped with Lenkurt Type 45A, Western Electric J, or similar systems. However, Type 45CB interconnects with 45A on a carrier frequency basis.

Interconnection

The transfer of channels from a 45CB system to another Lenkurt 45-class system at carrier frequencies is made possible by the use of identical channel groupings in all 45-class systems. In every 45-class system, the first stage of modulation translates and arranges four channels into the frequency band of 8 to 24 kc. At this stage the channel grouping is called the pregroup. A simple plug-in pregroup transfer unit is available to transfer pregroups of 4 channels between 45CB and other 45-class systems at carrier frequencies. Channel units are not required at the transfer point.

The advantages obtained from interconnection include the major savings obtained through maximum usage of existing facilities and the omission of channel units at connecting points. Future possible rearrangements should be less expensive because of the flexibility in interconnection. In addition, higher transmission quality is maintained than would be possible if carrier systems were connected together at voice frequencies.

Repeaters

The majority of applications of 45CB carrier are not expected to require the use of repeaters. However, when required, repeatered 45CB systems will provide high-grade toll service for any circuit lengths likely to be encountered in short or medium haul commercial applications. They also are suitable for longer haul applications under favorable operating conditions and moderately relaxed transmission requirements.

Conclusions

During August and September, a 45CB system underwent a trial to determine its performance under actual field conditions and especially under conditions of high lightning incidence. The trial system was operated on a line that also carried Western Electric Type OB carrier. This permitted the coordination aspects of the 45CB design to be tested and verified. The results of these tests showed that the 45CB carrier system meets all requirements for a short to medium haul open-wire carrier system and that reliable, satisfactory operation in normal service can be expected.

33A and 45CB CARRIER SYSTEMS

Are Complementary

Among the various things which tend to lower the cost of providing additional toll circuits is the use of carrier arrangements which are complementary; that is, arrangements in which each subsequent carrier addition fits into the overall picture with a minimum of change.

As shown graphically in Fig. 1, Lenkurt's 33A and 45CB carrier systems, although differing in type, are complementary because their respective frequency allocations permit them to be superposed on the same open-wire pair. Moreover, several combinations of 33A, 45CB and other types of carrier are compatible and afford a substantial degree of flexibility.

With combinations of 33A and 45CB carrier systems, as many as seven additional circuits can be derived from an open-wire pair. For example, one, two or three channels of 33A and one to four channels of 45CB carrier can be installed initially, or from time to time, as needed. In other situations where carrier systems such as Lenkurt's Type 32C or 32E, or Western Electric Type C systems have already been installed on an open-wire pair, one to four channels of 45CB carrier can be added as required.

In addition to the facilities provided by a combination of 33A and 45CB carrier, it is anticipated that the frequency space above 76 kc -- the highest frequency employed by the 45CB system -- will be available for deriving additional carrier channels through the use of Lenkurt carrier systems projected for the future.

In the arrangements shown in Fig. 1, it is necessary that carrier systems superposed on one open-wire pair coordinate with systems which are, or may be, operated on other pairs on the same line. This requires consideration of the frequency allocations of all of the systems involved, the transposition arrangements, or any other measures which might be needed to prevent intolerable crosstalk, absorption or noise effects.

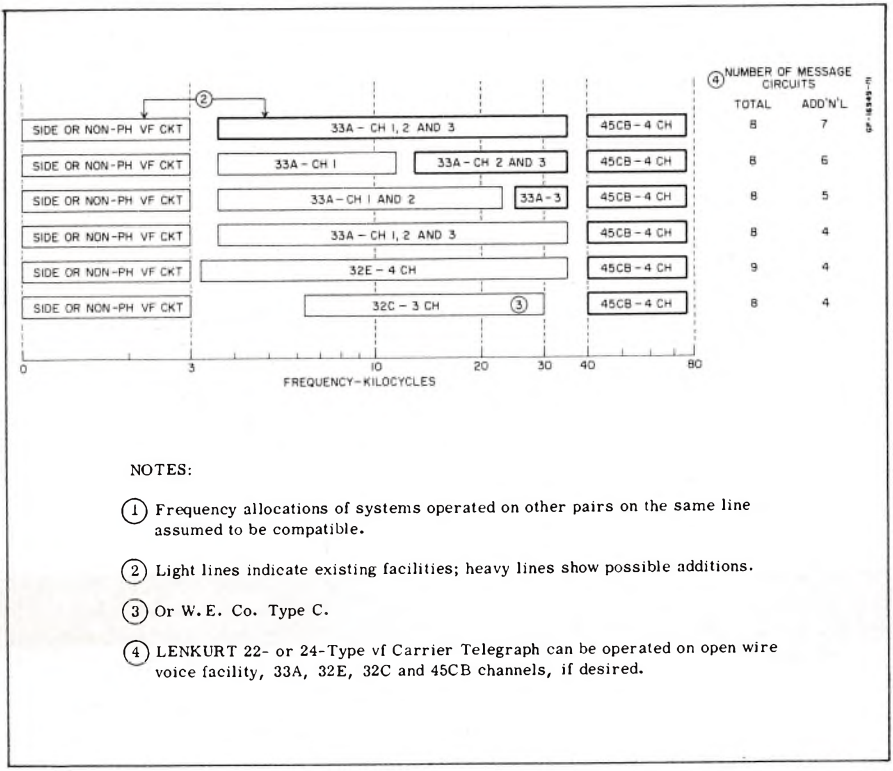
Generally, any one of the combinations of facilities shown in Fig. 1 can be operated on open-wire pairs -- phantomed or non-phantomed -- which are correctly transposed for 30-kc operation. The 45CB system, which employs frequencies in the 40 to 76 kilocycle frequency range, usually operates satisfactorily on such pairs because it is equipped with compandors that reduce noise and crosstalk effects substantially.

The use of compandors with the 45CB system also makes it possible to employ, to a limited extent, open-wire pairs transposed for

voice frequency operation only. Before doing this, however, it is desirable to determine, in each specific instance, whether or not possible absorption and crosstalk effects of undesirable magnitudes are likely to be encountered.

In considering the subject of transpositions, one further item of general importance may be mentioned briefly. As previously stated, phantomed or non-phantomed open-wire pairs transposed for 30 kc operation are ordinarily satisfactory for frequencies up to about 80 kc because of the beneficial use of compandors. At higher frequencies -- 80 to about 150 kilocycles -- non-phantomed pairs and more effective transposition arrangements are usually required, particularly when more than one pair is to be used for carrier operation.

If operation at frequencies above 80 kc can be anticipated sufficiently in advance of requirements, it is usually desirable and economical to non-phantom, transpose, and otherwise arrange the open-wire facilities for the higher frequency operation at the start of the development. Otherwise, undesirable service interruptions and very substantially increased costs are likely to be encountered when the necessary changes are made at a later date.



NOTES:

(1) Frequency allocations of systems operated on other pairs on the same line assumed to be compatible.

(2) Light lines indicate existing facilities; heavy lines show possible additions.

(3) Or W. E. Co. Type C.

(4) LENKURT 22- or 24-Type vf Carrier Telegraph can be operated on open wire voice facility, 33A, 32E, 32C and 45CB channels, if desired.

FIG. 1. Additional circuits which can be derived from an open-wire pair with Lenkurt's 33A and 45CB Carrier Systems.

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Editor . . . . . P. C. DeMuth

Recently Issued Publications

A general description of Lenkurt's **Type 45CB** carrier telephone system is given in a new bulletin, **Form 45CB-P4.** In addition to the descriptive and application information contained in this issue of the DEMODULATOR, **Form 45CB-P4** provides a technical summary which lists important design and operating characteristics. Copies of this publication are available from Lenkurt's distributors.

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