The Lenkurt® Demodulator

NEWS FROM LENKURT ELECTRIC

VOL. 6, NO. 7 JULY, 1957

MICROTEL

A New 6000 Megacycle Microwave System

More than two years of research and development have resulted in a new 6000 megacycle microwave system of advanced design. Trade-named Microtel, the new system uses many of the newest microwave techniques and circuits known. Simple in design, yet flexible in application, it meets the needs of many different communications users.

This article describes the new system and discusses some of the ways it can be used.

Microtel—Lenkurt's Type 74A Radio—is microwave equipment designed specifically for the high-quality transmission of telephone and telegraph information. It can be equipped to operate in any band in the frequency range from 5925 to over 7500 megacycles.

Uses of *Microtel* range from industrial communication needs for as few as four channels to high channel density systems for inter-city commercial telephony or military defense networks. As many as 8 transmitters and receivers can be operated over a common path to form a system capable of handling up to 1920 voice channels plus 60 or more supervisory, remote control or telemetering channels.

A single transmitter-receiver combination is capable of handling 240 channels over a route with two or more

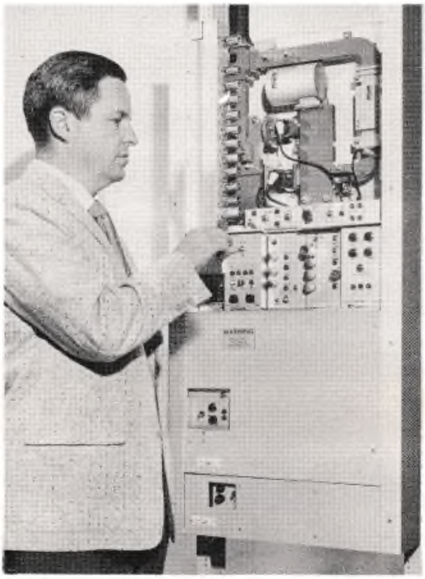


FIG. 1. A basic terminal of Microtel equipment consisting of a transmitter, receiver, and power supplies.

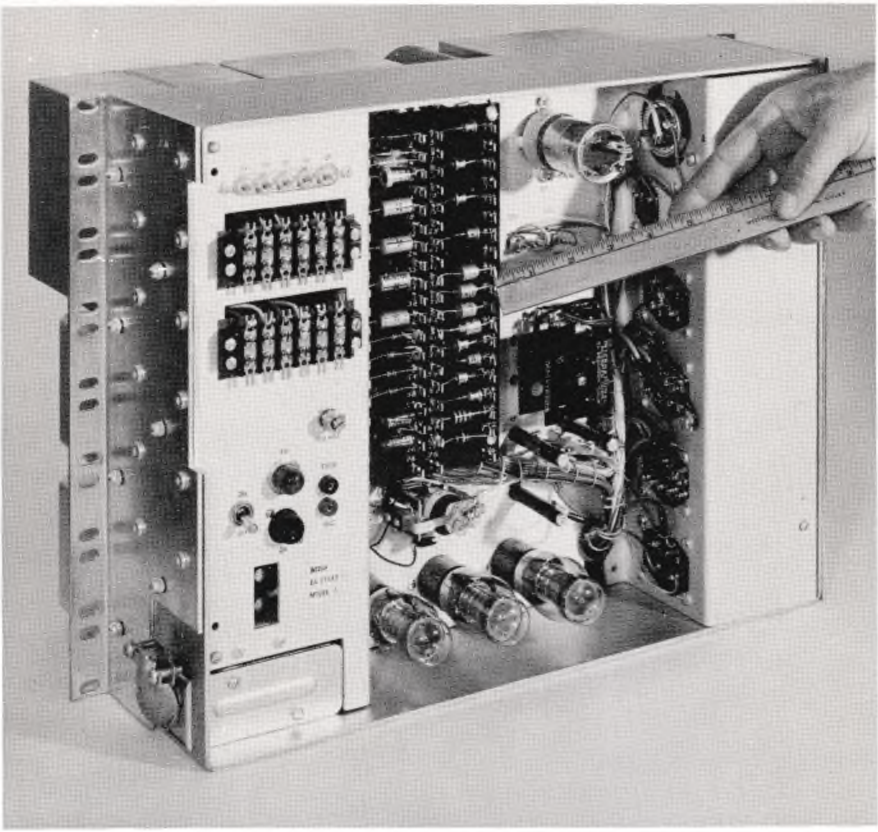


FIG. 2. Power supply for the transmitting and receiving klystrons. The only active components in this supply are the three voltage regulator tubes shown near the bottom of the unit.

repeater sections. The maximum number of repeater sections permissible depends upon system engineering details. If compandors are used or fewer than 240 channels are transmitted, system lengths can be extended considerably.

Mechanical design of *Microtel* equipment is similar to that of the 45-class carrier equipment. In its simplest form a terminal consists of a microwave-frequency waveguide assembly, intermediate-frequency amplifier, four plug-in units for input and output circuits, and a wired-in power distribution and alarm unit.

All plug-in units are similar to those of 45-class equipment—a design feature which simplifies routine maintenance and repairs. Figure 1 shows the simplest terminal arrangement consisting of a single transmitter, receiver and power supplies.

The waveguide assembly is the transmitter-receiver portion of the terminal and contains two long-life Varian klystron tubes—one for transmitting and one for receiving. Two power supplies provide proper voltages for the klystrons and the necessary voltages and current to operate the plug-in amplifiers and low-voltage units.

The klystron power supply (Fig. 2) is of special design using magnetic amplifiers and semi-conductor diodes in place of the usual vacuum tube rectifiers. Three gas-filled voltage regulator tubes (cold cathode type) are the only active components used, thus assuring a long, trouble-free life. The low voltage power supply is completely transistorized, using transistors and semi-conductor diodes instead of tubes. The complete absence of vacuum tube filaments in the power supplies greatly increases their .efficiency and reduces the total drain from the a-c mains or central office supply to a minimum. The combined input power to both power supplies is only 245 watts. When a terminal is to be operated from a central office battery, an optional inverter can be used to convert the direct current from the battery into 60-cycle alternating current to operate the klystron supply

A number of optional panels and equipment items can be used with the basic transmitter-receiver assembly to provide automatic standby, special alarms, and simultaneous operation of two or more transmitter-receiver assemblies using the same antenna.

For multiple operation, a ferrite circulator (a hybrid-like device) is used to couple the output waveguide circuits of the different transmitter-receiver units into a common waveguide transmission line for connection to the antenna. Figure 3 shows the ferrite circulator designed for *Microtel* equipment.

When a second terminal operating on a different frequency is to be used for automatic standby protection, a combining and transfer unit is added to

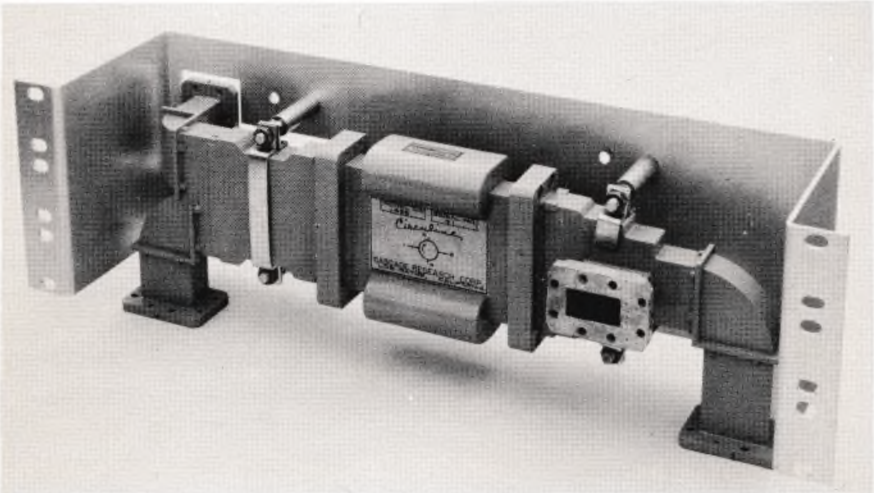


FIG. 3. The waveguide ferrite circulator designed specifically for the Type 74A Radio System. This device permits three microwave terminals to be connected to the same antenna without mutual interference.

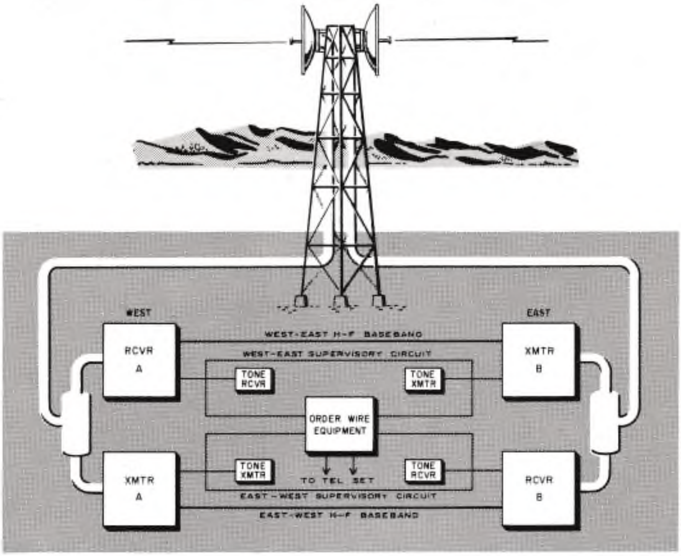


FIG. 4. Block diagram of a typical Microtel repeater station.

transfer the carrier channels from one receiver to the other in the event of a serious fade or equipment failure.

Repeaters for the system are terminals connected back-to-back. This arrangement permits the convenient dropping of channels or a branching of the system at repeater points. Figure 4 is a pictorial block diagram of a typical repeater.

Circuit Description

The basic circuitry of a *Microtel* terminal is relatively simple. The use of klystrons permits the creation of a frequency modulated output wave in just one step. The block diagram of Figure 5 shows the circuit functions provided at a terminal with plug-in units indicated by dashed lines.

There are two input circuits to the transmitter: one for the telephone carrier channels and one for a supervisory channel. The input for the carrier channels accepts frequencies from 12 to 1200 kc and the supervisory channel accepts frequencies from 0.3 to 8 kc. The supervisory channel will accommodate a talking circuit (order-wire circuit) and a number of tone transmitters and receivers for telemetering, control, or supervision (remote indication).

Both input circuits are joined through filtering in the transmitter to form a baseband of frequencies that is continuous from 0.3 to 1200 kc with the exception of a 4-kc slot between 8 and 12 kc. This unoccupied portion of the baseband is used to inject a 10-kc tone generated locally in the baseband transmitting unit. The output of the baseband unit (the carrier channels, supervisory channel, and the 10-kc pilot tone) directly modulates the transmitting reflex klystron to produce a frequency modulated output signal in the 6000-megacycle band.

Between the transmitting klystron

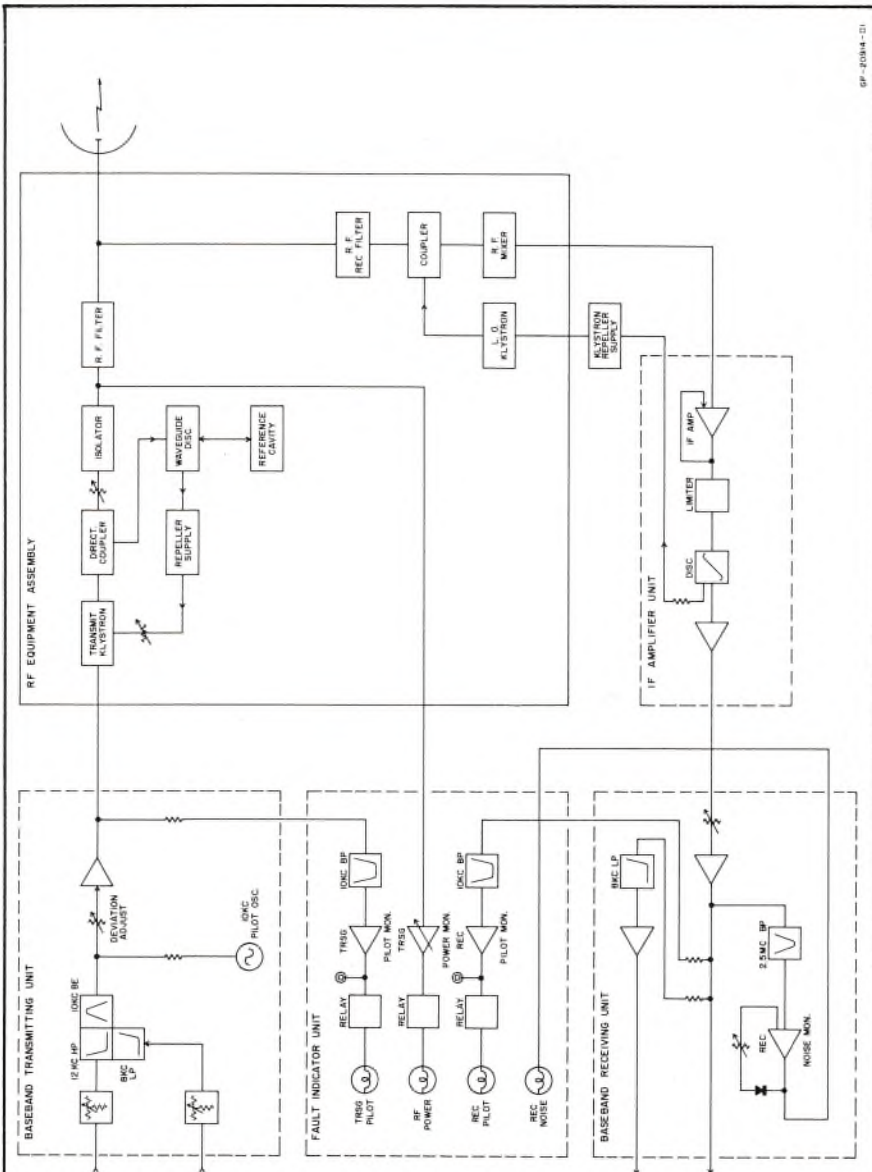


FIG. 5. Simplified block diagram of a Microtel terminal. When standby equipment is furnished, a terminal also includes a combining and transfer unit and a ferrite circulator.

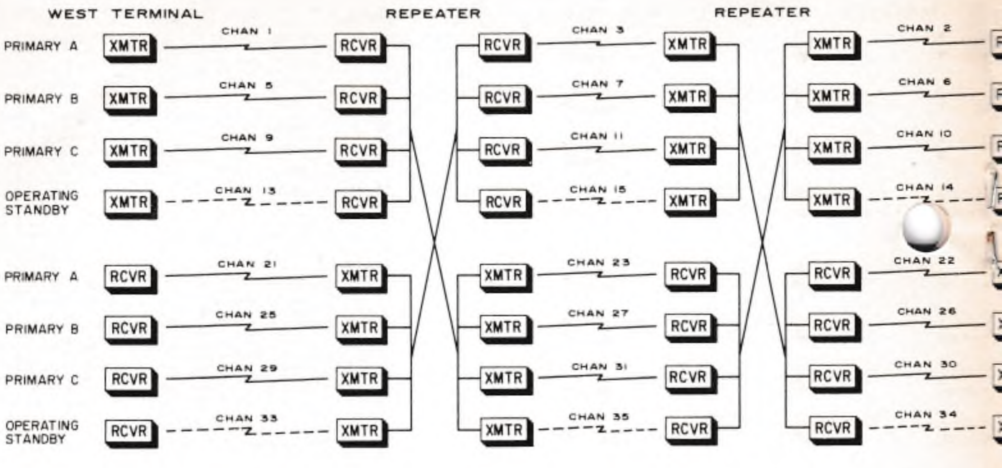


FIG. 6. Frequency assignment plan for a f
plan, each radio-frequency chann

and the antenna are a ferrite isolator and a waveguide filter. The isolator tends to prevent reflections from the antenna and filter from affecting the klystron frequency; the filter eliminates from transmission all but the desired spectrum. Output power of the klystron is a minimum of 0.7 watts depending on the frequency and operating conditions of the klystron.

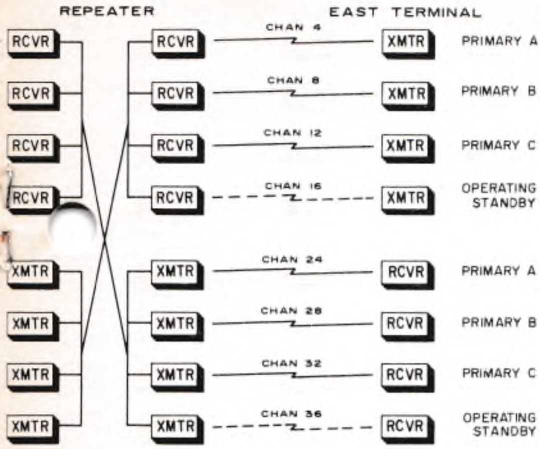
Frequency control of the transmitter is accomplished automatically by a feedback system which compares the output frequency of the transmitter klystron to the resonant frequency of a reference cavity. Any difference between the output frequency and the reference cavity frequency alters the klystron repeller supply voltage to vary the tuning in the direction of zero frequency error.

Stability is further improved by attaching the transmitter klystron to a large mass of aluminum. The aluminum mass forms a heat reservoir or "heat sink" which tends to keep the operating temperature of the klystron constant and well below the maximum allowable. Use of the heat-sink principle eliminates the need for cooling fans or blowers.

In the receiving direction, incoming signals are selected by a waveguide filter and mixed (heterodyned) with the output of a local klystron oscillator to produce upper and lower sidebands. Frequency control of the local oscillator klystron is similar to that of the transmitting klystron.

The lower sideband (66-74 mc) of the r-f mixer is selected and amplified by a tuned intermediate frequency amplifier (i-f amplifier) unit. The output stage of the i-f amplifier is a frequency modulation discriminator which extracts from the i-f band the original baseband delivered to the transmitting klystron at the far end of the system. The i-f amplifier, like the transmitter klystron has a heat-sink to control and dissipate the heat generated by its several amplifier tubes.

The output of the i-f amplifier unit



CHANNEL NO.	FREQUENCY MEGACYCLES	CHANNEL NO.	FREQUENCY MEGACYCLES
1	5937.7875	21	6189.8375
2	5952.6125	22	6204.6625
3	5967.4375	23	6219.4875
4	5982.2625	24	6234.3125
5	5997.0875	25	6249.1375
6	6011.9125	26	6263.9625
7	6026.7375	27	6278.7875
8	6041.5625	28	6293.6125
9	6056.3875	29	6308.4375
10	6071.2125	30	6323.2625
11	6086.0375	31	6338.0875
12	6100.8625	32	6352.9125
13	6115.6875	33	6367.7375
14	6130.5125	34	6382.5625
15	6145.3375	35	6397.3875
16	6160.1625	36	6412.2125

NOTE: A branching section may repeat assignment that is useda minimum of two sections away.

ı fully-developed Microtel route. With this ınel can carry 120 voice channels.

is further amplified in a baseband receiving unit. This unit also separates the baseband into its three components: carrier channels, supervisory channel, and 10-kc pilot tone. It also monitors the noise received in a 2-megacycle band just above the baseband.

The 10-kc tone and the output of the noise monitor are passed to a third unit —the fault indicator unit. This unit contains monitoring and alarm circuits and lamps to indicate a failure of any essential function of the system. For example, failure to receive the 10-kc tone from the distant terminal or an increase in received noise will be indicated on this unit. Also monitored and indicated by this unit are the transmitted 10-kc pilot tone and the power output of the transmitter.

Applications

Anticipated uses of *Microtel* cover a very wide range of communications needs. The frequency spectrum for which it can be equipped to operate includes the common carrier band from 5925 to 6425 megacycles, the industrial band (Operational Fixed) from 6575 to 6875 megacycles, and part of the government band from 7125 to 8500 megacycles. In these bands, *Microtel* can be used for almost any type of point-to-point communications. Voice channel requirements from 4 to more than 1900 can be satisfied.

For telephone company use, where expandability is important, a system can be installed initially with only a few carrier channels. Then, as traffic increases, it can be expanded economically at will by the addition of more channelizing equipment or paralleling transmitter-receiver assemblies. As many as four systems can use the original antenna and antenna transmission line.

Fig. 6 shows a frequency assignment plan that will permit up to 4 radio channels to be operated over a path with a number of repeaters. This plan is compatible with the tentative frequency assignment plan for Western Electric Type TH microwave.

Microtel is particularly applicable to commercial telephone communications when:

1. New toll routes are needed.

2. The traffic handling capacity of a route must be increased in such a short time that cable or wire line systems can not be expanded or constructed quickly enough to meet the situation.

3. Existing cable and wire lines are loaded to capacity with carrier channels. Usually in such cases, *Microtel* will be more economical, storm-proof, and trouble-free than conventional facilities.

4. Temporary toll facilities must be provided to a special installation such as a construction project or military base.

Industrial uses for *Microtel* include railroad, pipeline, electric power system and turnpike communications. Such users often require a small number of voice and telemetering or control channels operated over considerable distances. *Microtel,* though normally designated as a short to medium-haul wideband system, can meet this requirement by exchanging its extra bandwidth for lower noise and distortion.

In FM microwave, noise and distortion performance are related to the number of channels transmitted and the amount of frequency swing per channel. For a system with a given bandwidth, the frequency deviation per channel must be decreased as the number is increased. At the same time, the noise resulting from intermodulation between channels increases since there is more loading and there are more possible intermodulation products. These are the most important factors which limit the useful length of any FM microwave system.

The noise and distortion per channel of a wide-band system such as *Microtel* is less when only a small number of channels is transmitted and the frequency swing per channel is increased. The smaller amount of noise and distortion generated permits the system to be operated over greater distances with more repeater stations.

Other uses for *Microtel* which do not normally require a large number of channels include public safety communications systems such as police, fire district and flood control networks.

In the government band above 7125 megacycles, many different uses of *Microtel* can be enumerated. One large area of use is military networks for national defense. Such networks often require a large number of channels and a very high degree of reliability—both requirements that are met by *Microtel.* Other government uses include airfield-to-airfield links, airfield-to-control center communications, and networks operated by state and local governments.

Standby Protection

For many applications of microwave equipment, outages caused by fading or improper equipment operation must be kept to a minimum. Protection against outages is usually provided by some arrangement of standby equipment. Several schemes are possible. Each has its own advantages and disadvantages.

A conventional scheme is a second system operating on the same frequency as the primary system with provisions for manual or automatic transfer of the carrier channels when the primary system fails. This gives protection against lengthy outages resulting from equipment failure but does not permit rapid

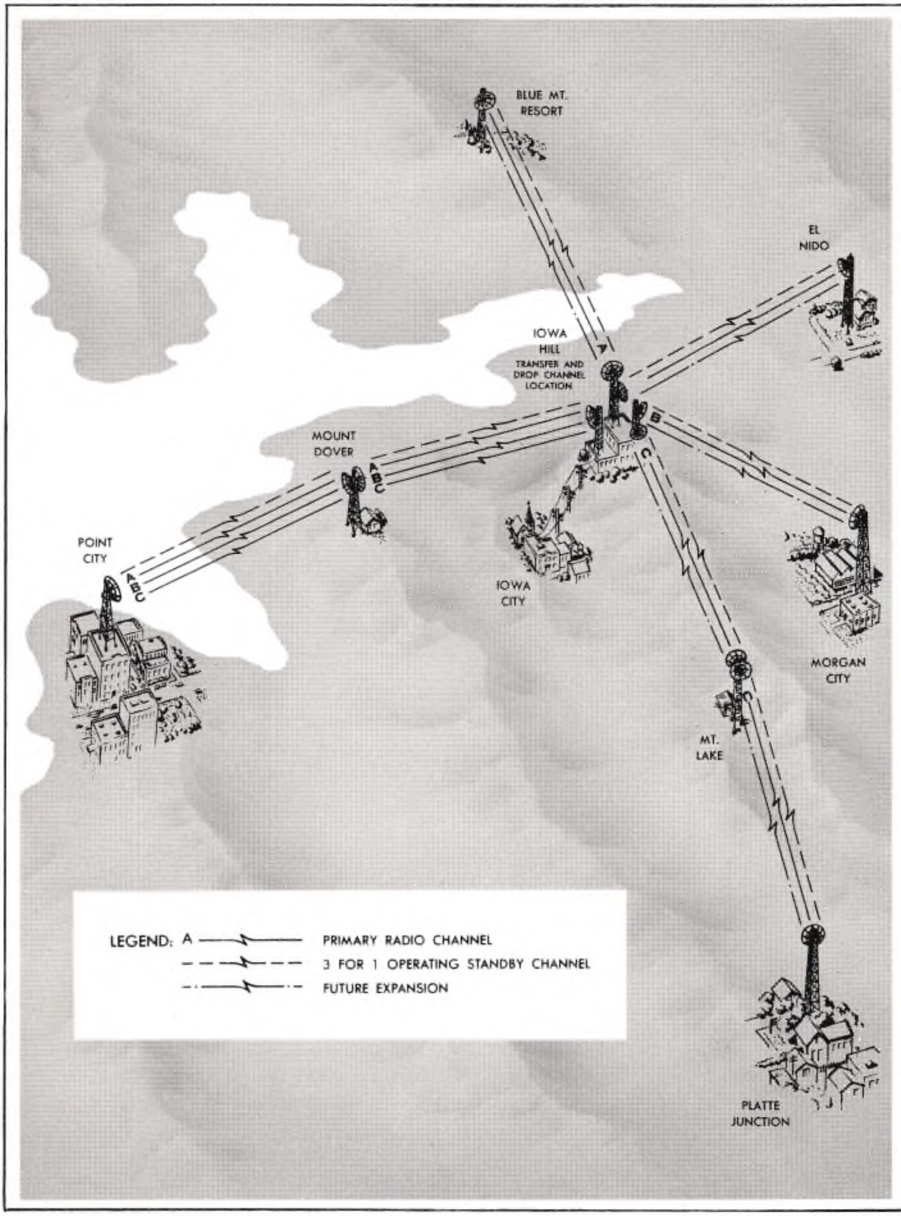


FIG. 7. A possible network of Type 74A microwave equipment using one standby channel for three operating channels.

enough restoration to avoid telephone dialing errors. Any fade affects both the regular and standby systems since both use the same frequency and antenna.

Protection against circuit outages resulting from fades can be obtained by operating the second system over a slightly different path (space diversity) or at a different frequency (frequency diversity) or both. Fades are not likely to occur simultaneously on separate paths or at significantly different frequencies.

Space diversity uses a minimum of frequency spectrum, but it has the disadvantage of requiring separate antennas for the standby system. Conversely, frequency diversity has the advantage of not requiring separate antennas, but it does require additional frequency spectrum.

Where two or three systems are to operate over the same path, an additional system operating at a frequency different from any of the primary system frequencies can be justified as standby for the group of primary systems. For during a normal fading condition, only a narrow band of frequencies will fade at any one time. Usually a fade starts at one end of a band and progresses across the band, causing fades of different radio frequency channels at slightly different times. Thus, one standby channel can protect up to three primary channels.

Such a scheme is usually referred to as a one for two or one for three operating standby system. It provides excellent protection in the event of either fading or equipment failure and is the most economical approach to standby protection in terms of equipment and spectrum utilization where more than one microwave channel is operated over a given path. Figure 7 shows a possible *Microtel* network using one-for-three frequency diversity standby.

A TRANSISTORIZED REPEATER

For Type 45C Open-Wire Carrier

Newest addition to the Lenkurt 45C Carrier System is an all-transistorized repeater. It provides amplification and regulation for line sections having a maximum loss of 53 decibels at 76 kc. It also employs frequency frogging to compensate for the normal variation of line loss with frequency.

The 45C system has four stackable channel groups, each with four channels. The groups are designated 45CA, 45CB, 45CC, and 45CD. Their frequency ranges are 2—36 kc, 40—76 kc, 80—116 kc, and 120—156 kc respectively.

Mechanical design of the repeater is similar to other 45-class equipment. Its five plug-in units mount in a shelf occupying 8¾ inches of vertical space on a standard 19-inch telephone equipment rack or in a suitable pole-mounting weatherproof cabinet. The same shelf is used for all four frequency allocations.

The repeater's five plug-in units include two amplifier-regulators, two directional filters, and a power distribution and carrier supply unit. The amplifier-regulator units can be adapted for West-East or East-West operation by the use of suitable plug-in subassemblies. Similarly, the directional filters can be used for either low-high or high-low frequency frogging by a simple strapping arrangement. Fig. 1 is a functional block diagram showing the interconnections of the various units.

Because it is completely transistorized, the repeater requires only a small amount of power. It can be operated from either a —48 volt d-c or +130 volt d-c source. When operated from a —48 volt source, the current used is approximately 135 milliamperes (6.5 watts). When operated from a +130 volt source, the power drain is about 15 watts.

The repeater can be operated from an office battery or from a suitable a-c power supply such as Lenkurt's Type 5064A. This power supply, designed specifically for transistorized carrier equipment, will handle up to ten Type 45C repeaters with a drain from the a-c mains of about 80 watts. At 5c per kilowatt-hour, the power cost for each repeater would be only $3.50 a year.

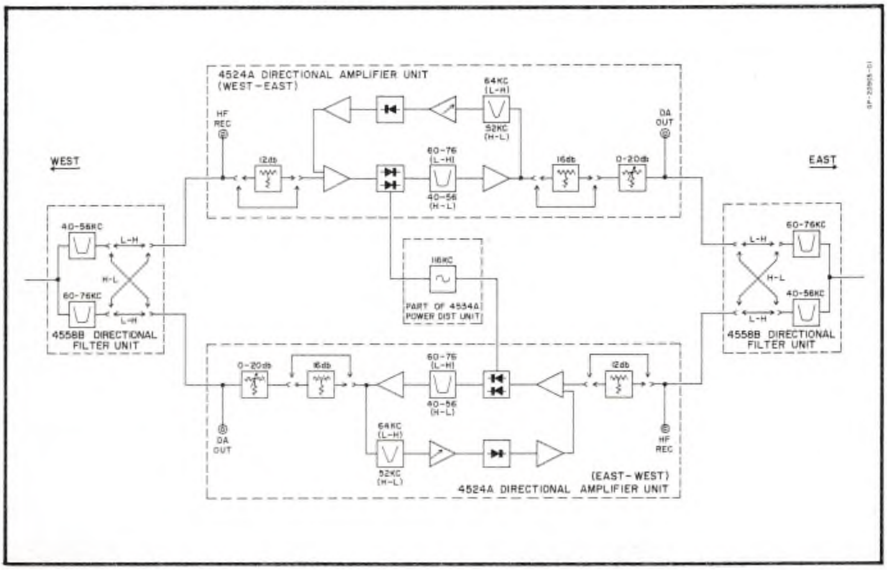


FIG. 1. Block schematic diagram of the 45C Repeater. The frequencies shown are for the CB allocation.

Lenkurt Electric Co.
San Carlos, Calif.

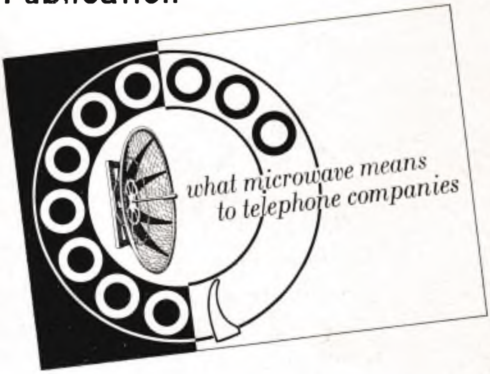
Sec 34.66, P. L. and R.
U. S. POSTAGE
Paid
San Carlos, Calif.
Permit No. 37

W. F. CRUESS, DESIGN ENGR.
WESTINGHOUSE ELECTRIC CORP.
SWITCHBOARD ENGINEERING DEPT.
EAST PITTSBURGH, PA.
754 20

Form 3547
REQUESTED

New Publication

A new booklet, **What Microwave Means to Telephone Companies,** discusses some of the reasons why microwave is becoming a major part of the toll plant of many telephone companies. Non-technical in nature, this publication will be of interest to telephone people concerned with the economic and practical operating aspects of microwave. Copies are available from Lenkurt plants and distributors.



LENKURT ELECTRIC

SAN CARLOS, CALIF. • VANCOUVER, B.C. • MEXICO, D.F.
LYtell 1-8461 GLenburn 4000 24—60—86

Automatic Electric Company and Automatic Electric International Inc., Chicago, and their affiliates are distributors of Lenkurt products.
The Lenkurt DEMODULATOR is a monthly publication circulated to individuals interested in multi-channel carrier, microwave radio communication systems and allied electronic products. Permission to reproduce material will be granted upon request.

LITHO IN USA