TYPE N2 CARRIER TELEPHONE SYSTEM
OVER-ALL SYSTEM
DESCRIPTION

CONTENTS PAGE

1. GENERAL

1.01 This section describes the general features of the type N2 carrier telephone system. The N2 carrier terminals can be used with the type N1 electron tube repeaters, the type N1 transistorized repeaters, and when available, the N2 repeaters. This section will only consider the utilization of type N1 repeaters in general terms. However, where there are explicit differences in characteristics, performances, or operations, a more detailed discussion of each type of repeater will be given.

1.02 Descriptive information on the various equipment components of the system is covered in the following plant series sections:

362-400-100 — N1 Electron Tube Repeaters
362-400-120 — N1 Low-High Transistorized Repeaters
362-400-121 — N1 High-Low Transitorized Repeaters
362-801-100 — N2 Terminal Equipment-General
362-802-100 — Power Supply Unit
362-803-100 — Alarm and Control Unit
362-804-100 — Line Terminating Unit
362-805-100 — N2 Transmitting and Receiving Group Units
362-806-100 — Channel Modem Unit
362-807-100 — Compandor Unit

1.03 The type N2 system provides 12 two-way telephone channels on nonloaded cable pairs in aerial or underground exchange or toll cable. It operates on a 4-wire basis using two different frequency ranges on the line for the two directions of transmission, a low group 36 to 140 kc, and a high group 164 to 268 kc. Pairs in the same cable are used for the two directions.

1.04 Fig. 1 shows an N2 carrier terminal with six compandors and modems mounted in positions A through F in the bottom shelf, six compandors and modems in channel positions G through M in the top shelf, and the group, line terminating, alarm, and power supply units in the center shelf. Units for additional services can be used in these terminals when they become available. They include: (a) voice-frequency amplifiers for use where compandors are not desired (b) program channels of various types, and (c) 40.8-kilobit data channel equipment.

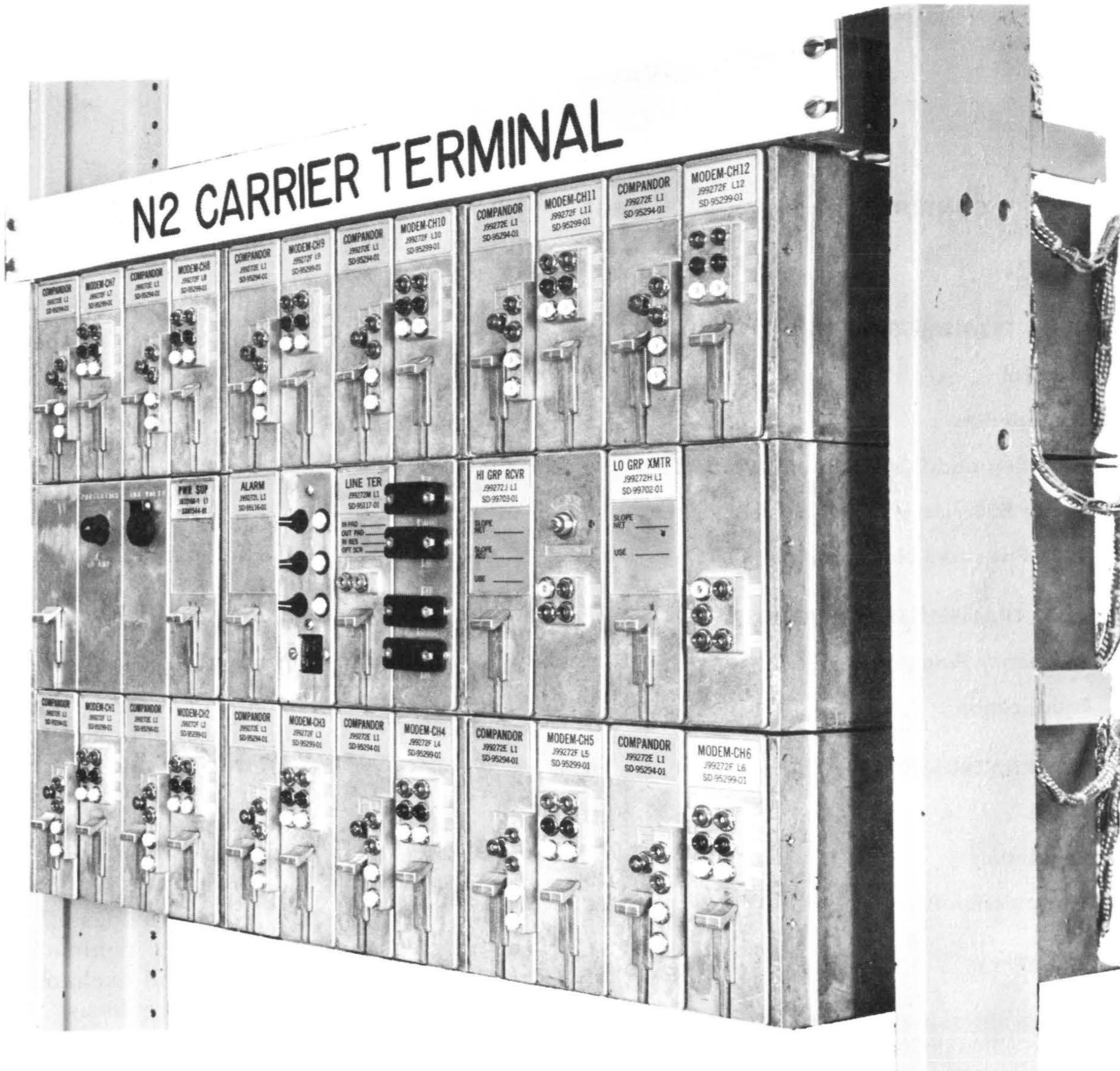


Fig. 1 — N2 Carrier Terminal

1.05 It is permissible to use an additional channel (designated channel 1), as a substitute for any one of channels 2 to 13 (in the 36- to 132- and 172- to 268-kc band) which may be unavailable because its frequency band is used for program or other service, or to avoid undesirable transmission interferences. This channel has a frequency range of 132 kc to 140 kc in the low group and 164 kc to 172 kc in the high group, with carrier frequencies at 136 kc and 168 kc, respectively.

1.06 The principal parts of the system shown in Fig. 2, a simplified over-all schematic of the system are (1) the channel units, consisting of the voice-frequency terminal circuits, and the modulating and demodulating circuits (2) the transmitting and receiving group units and common equipment (i. e., line terminating units, alarm units, power units, etc), and (3) the repeaters.

1.07 The N2 carrier terminal does not have built-in signaling, but utilizes external circuitry, such as type E in-band signaling, for the transmission of supervisory signals and dial pulses over the system.

1.08 Compandors are provided in the channel units. Their use eliminates the need for crosstalk balancing of cable pairs, minimizes special noise treatment of the cable pairs, and leads to more lenient selectivity requirements for the receiving channel band filters. Nearly all of the usual noise and crosstalk interferences encountered in carrier system operation are reduced by the compandor.

1.09 Shop-wired N2 carrier terminal bays J99272B and J99272D are arranged to mount eight and six 12-channel terminals, respectively, as shown in Fig. 3.

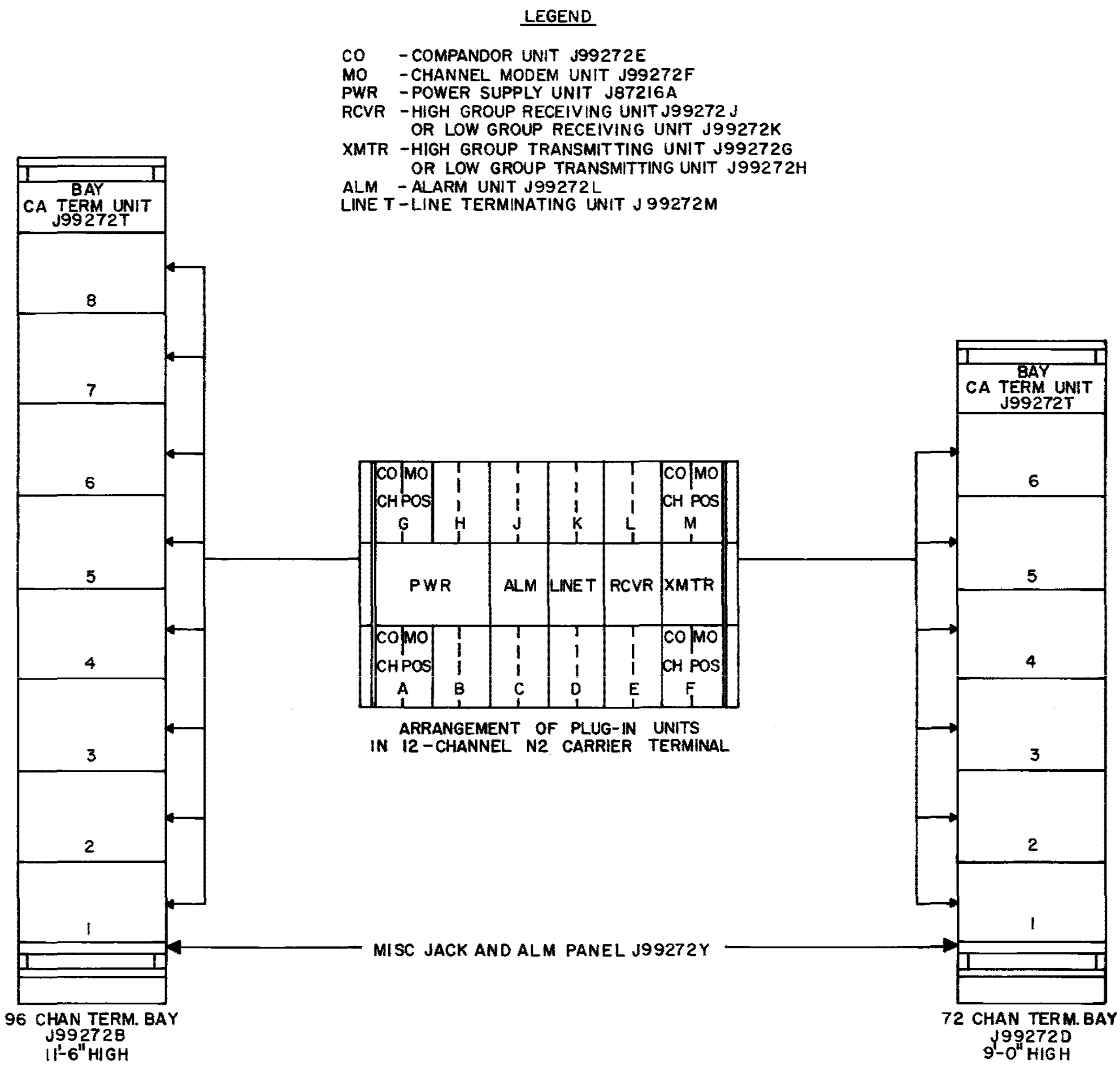


Fig. 3 — Bay Arrangements Shop-Wired N2 Terminal Bays

1.10 Double sideband transmission is used, which, together with the provision of compandors and transmitting low-pass filters, eliminates the need for transmitting band filters for message service. The 12 carriers are transmitted with 8-kc spacing and their combined power controls the flat gain regulation at repeaters and at the receiving group unit, correcting for transmission changes caused by normal temperature variations. Each carrier also controls the corresponding individual channel regulator at the receiving terminal.

1.11 The frequency groups assigned to the two directions of transmission are transposed and inverted at each repeater. This so-called "frequency frogging" provides self-equalization of the line slope. The use of different frequency bands in opposite directions also reduces the crosstalk effects sufficiently to permit both directions of transmission to use pairs in the same cable.

1.12 Two types of repeaters [High-Low (HL), Low-High (LH)] are used alternately along the high-frequency line, spaced at intervals up to eight miles for 19-gauge low capacitance toll cable. For other types of cables the repeater spacing may be from 2.4 to 11 miles. As indicated in Fig. 4, the Low-High repeater receives at its input the low group frequencies which are converted to the high group before amplification. For the High-Low repeater, the high group appears at the input and the low group at the output.

1.13 Power for the terminals is derived from a standard −48 volt office power supply and provision is included to transmit power over the cable transmission pairs to electron tube (N1) or transistor (N1A) repeaters. An adjacent electron tube repeater requires power from both +130 and −130 volt office supplies. One to three adjacent transistor repeaters require −48, +130, −48 and +130, or +130 and −130 volt office supplies depending on the number and type of repeaters and length of repeater spans.

A locally-powered electron tube repeater requires a +130 volt office supply and a locally-powered transistor repeater requires either a −48 or +130 volt office supply. However, either repeater can be arranged (by connection to the appropriate office supplies) to transmit power over the cable to an adjacent electron tube repeater in each direction or to one to three adjacent transitorized repeaters in each direction.

A locally-powered repeater feeding power to an adjacent repeater or repeaters requires the same voltage supplies as stipulated for feeding from the terminal. Accordingly, use of transistor repeaters permits installing as many as six repeaters between power feeding points. With electron repeaters no more than two repeaters may be located between adjacent power feeding points.

1.14 Alarms are provided at terminals for failure of carrier transmission, for fuse operation, and for abnormal terminal power voltage. Alarms are provided for fuse failure only, at locally powered repeaters.

1.15 Bridging tests to determine normal transmission and power supply functioning can be made on an in-service basis at terminals and repeaters. Terminal group transmitting units, group receiving units, power supplies, and repeaters may be replaced on an in-service basis with suitable switching sets. Terminal alarm units may be replaced without service interruption. Terminated measurements and maintenance of channel units are on an individual channel turn-down basis. Line terminating unit adjustment and maintenance are on a system turn-down basis. Maintenance of N2 terminals and repeaters is facilitated by small size plug-in units which make practical the removal and replacement of defective units. Plug-in slope networks and span pads simplify system rearrangement.

1.16 To facilitate system maintenance, the J98704 order wire and alarm circuit can be installed along each N2 system route to provide talking facilities and also relaying of alarms from unattended power feeding points to attended stations. In addition, power is transmitted over this order-wire circuit to supply the repeater switching set, when it is used at a non-power supply point.

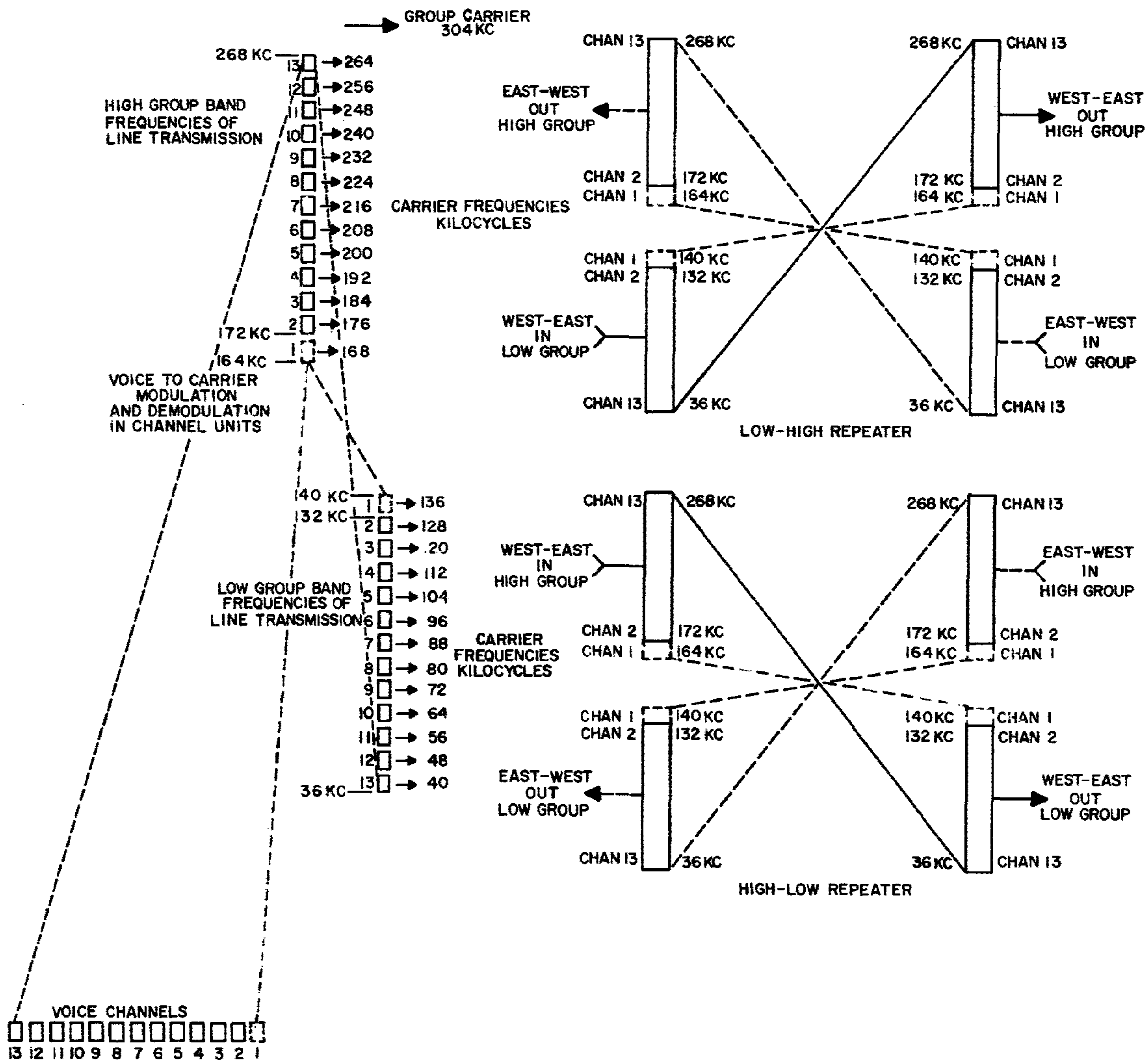


Fig. 4 — N2 Carrier System Frequency Allocation and Group Modulation in Repeaters

1.17 The use of transistors and the consequent reduction in heat dissipation permits compact assemblies and long life of components without requiring the use of forced ventilation to maintain the low temperatures conducive to long component life.

2. TERMINAL TRANSMISSION FEATURES

A. General

2.01 The terminals are assemblies of 12 channel modems and associated compandors (one only being shown in Fig. 2) with a transmitting group unit, a receiving group unit, a power supply unit, a line terminating unit, and alarm unit. The compandors are identical and channel modems are all alike except for the channel carrier frequency used and the receiving channel bandpass filter. The carrier modulates the channel voice-frequency band to its respective place within the spectrum of the high group for transmitting and demodulates it at the receiving end. A regulator, ahead of the demodulator, provides over-all individual channel regulation. The carrier output from the modem units and carrier input to the modem units is always in the high-group band. The modulation steps are indicated in Fig. 4. Both sidebands and the carrier of each channel are transmitted.

2.02 The transmitting group unit may be high-group transmitting (HGT) or low-group transmitting (LGT). The HGT unit amplifies the high-group frequencies received from the channel modems and applies them to the cable. The LGT unit first modulates the channel carriers and sidebands with 304 kc and selects the lower sideband to produce the low-group frequencies, which are then amplified and applied to the carrier line.

2.03 The receiving group unit may be low-group receiving (LGR) which is associated with a HGT unit or high-group receiving (HGR) associated with an LGT unit. The receiving group unit always transmits high-group signals to the channel modems. Thus, when it receives high-group signals it rejects unwanted frequencies, amplifies, regulates, and provides proper slope equalization for them. When it receives low-group signals it must first modulate them to high group.

B. Compandors

2.04 Each compandor consists of a compressor at the transmitting end of the circuit and an expandor at the receiving end.

2.05 The over-all action of compandor circuits is such that the weaker speech is raised in volume, thereby obtaining an improvement in its relation to noise and crosstalk picked up on the N2 channel between the compressor and the expandor. The louder speech, which already has a favorable relation to noise and crosstalk is practically unchanged. Compressing and expanding action is illustrated in Fig. 5 which shows the changes various input powers undergo in transmission through a compandor system.

2.06 The compressor functions by compressing the range of signal amplitudes applied to its input and transmitting from its output a reduced range approximately one-half as great. This means that if the amplitude of a strong signal is decreased by 20 db, the decrease in output amplitude will be only 10 db, i. e., a compression ratio of 2:1 is obtained. The speed with which the compressor adjusts itself from one level to another is determined by the time constants of its control circuit. In the type N systems the time constants have been chosen to provide the best control of speech intensity variations on a syllabic basis.

2.07 At the far end of the transmission path, the expandor receiving compressed speech re-establishes the original volume range by expanding the input range of volume to a range twice as great. A 1-db change in input signal to the expandor is increased to a 2-db change in the output signal. The standard deviation of the compandor tracking error will be approximately 0.4 db. The compandor load capacity is +8 dbm at 0-db system level. This performance is maintained over the range of ambient temperatures encountered by central office equipment.

C. Signaling and Carrier Group Alarms

2.08 The N2 carrier system is designed to work with external type E signaling. Two derived voice-frequency circuits, specifically those assigned to N2 terminal channel positions A and B, require E signaling units in the same office as the N2 terminals not only to provide signaling but also for use with the external carrier group alarm and trunk conditioning circuit. E signaling units for other voice-frequency circuits may be located as dictated by circuit terminal and trunk conditioning requirements. However, if located elsewhere, such circuits will not receive automatic trunk conditioning in the event of system trouble. Each N2 terminal is directly connected to an external carrier group alarm circuit which, in conjunction with the two associated E signaling units, in the event of re-

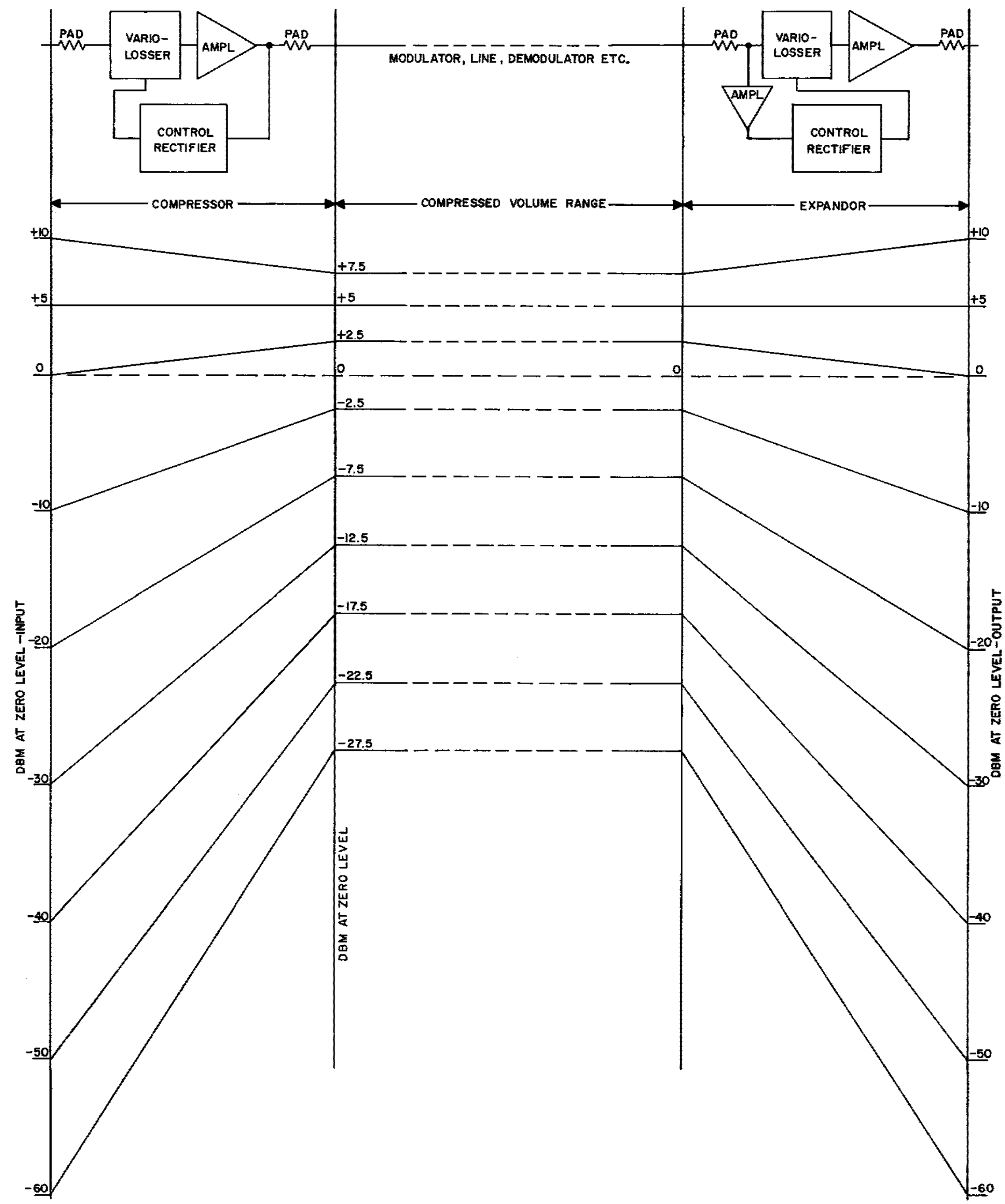


Fig. 5 — Compandor Action on Steady Tones of Different Levels

ceived carrier or terminal failure in either direction of transmission conditions and makes busy at both terminals the trunk circuits associated with the channels of the carrier system. Subsequently, the voice-frequency channels of channel positions A and B and their associated E signaling units are tested by the carrier group alarm circuit. When the trouble condition is cleared and a satisfactory signaling test is completed, the trunk circuits at both terminals are automatically restored to normal. A time delay feature prevents false signals due to momentary carrier interruptions or "hits." Another feature of the conditioning and make busy circuit provides automatic disconnect of called subscribers and prevents false sender seizures. Provision is made for manual overriding of circuit conditioning on a limited number of channels.

D. Group Equalizers

2.09 In the N2 system, plug-in slope equalizers are located in the group transmitting and receiving units. Slope equalization is obtained by the use of 364-type slope equalizers which provide slope changes over the frequency band of 0 db, ±3 db, ±6 db, or ±9 db. In addition, the receiving group units have a finer slope adjustment of −1 db, 0 db, or +1 db built into the unit and controlled by operation of a switch on the face plate. This method of providing variable slopes at terminal inputs and outputs has achieved better control of the channel carriers with respect to line attenuation characteristics and noise performance. In particular, the minimum over-all system noise results when the line characteristics are compensated to provide minimum receiving slope at terminals or repeaters with high-noise induction. Slope is defined as the difference in power output or gain for channel 13 with respect to channel 2, being positive when channel 13 has greater power or gain.

E. Span Pads and Noise Control

2.10 The N2 terminal is arranged for transmitting and receiving plug-in 38-type span pads in the line terminating unit. The pads are available with attenuation values varying in 2-db steps from 0 db to 44 db. These span pads and the slope networks in the group units are separated from the high-frequency line by a transformer which suppresses longitudinal noise, and also provides a simplex connection for power feed to remote repeaters. When line build out external to the N2 terminals is desired for flexibility reasons, N1 slope networks, span pads, etc may be mounted and wired in a cross-connecting cabinet together with noise control equipment, if required. Similar arrangements in cross-connecting cabinets may be used at N1 repeater offices, or the pads may be mounted on the repeater mounting brackets. The N2 38-type plug-in pads and 364-type slope equalizers are not suitable for use in the cross-connecting cabinets or on N1 repeater mounting brackets.

3. REPEATER TRANSMISSION FEATURES

A. Frequency Frogging

3.01 As shown in the frequency allocation diagram in Fig. 4, the repeaters, in addition to their amplification function, modulate the group received from the line in each direction of transmission with a 304-kc carrier to interchange the frequency bands of the line signals in successive cable sections. This is termed "frequency frogging" and is one of the salient features of the type N systems. Owing to the use of different frequency groups at the input and output of each repeater, signals crosstalking from high-level points (repeater outputs) into low-level points (repeater inputs) cannot reach a part of the circuit transmitting signals in the same frequency range, without encountering the suppression provided by the repeater input filter and the balance of the modulator. Other advantages of "frequency frogging" are pointed out in 3.02 and 3.03 below.

B. Equalization

3.02 At the same time as the groups are interchanged by frequency frogging, the position of the channels within the groups is reversed, i. e., channel 13, the highest (264 kc) in the high-group allocation, is the lowest (40 kc) in the low-group allocation. This inversion results in a very nearly constant line loss across the 12-channel group in two line sections of equal length and thus nearly equalizes the line slope. This is indicated by the following table which shows, for the channel 2, 7, and 13 carrier frequencies, the equalization between the losses of typical adjacent cable sections and the gains of the associated N1A LH and HL repeaters. Both the LH and HL repeaters have a nearly flat gain characteristic with three selectable amounts of slope built-in to compensate for the residual line slope obtained when different cable section lengths are encountered.

3.03 It is seen that with the "frequency frogging" and some shaping of the repeater characteristic, the major part of the transmission slope introduced by the line has been elim-

TRANSMISSION THROUGH TWO N1 REPEATER SECTIONS	CHAN 2	CHAN 7	CHAN 13
LG Cable Transmission Loss — db (6.7 miles of 19 ga. Hi-CapPIC Cable)	—42.9	—35.8	—26.5
HG Cable Transmission Loss — db (6.7 miles of 19 ga. Hi-CapPIC Cable)	—50.4	—56.1	—63.2
Total Cable Loss	—93.3	—91.9	—89.7
LH Repeater Gain — db (Slope Setting C)	+47.2	+46.9	+45.4
HL Repeater Gain — db (Slope Setting C)	+47.4	+46.5	+45.3
Total Gain	+94.6	+93.4	+90.7
Over-all Transmission (Gain)	+1.3	+1.5	+1.0

inated. Another advantage of frequency transposition is obvious from the figure in the above table in that the maximum repeater gain, instead of being required to compensate for the loss at the highest frequency, need only compensate for the mean frequency loss. The resulting flat transmission residue in two repeater sections is absorbed primarily by the span pads, and a small amount by the flat-gain regulator in the repeaters.

3.04 *Slope Adjustment:* When shorter spans or cables with different slope characteristics are used, slope equalization is obtained by use of the repeater amplifier slope adjustment. The adjustment is in three steps designated A, B, and C. The approximate slope values which can be derived from the N1 repeater amplifier slope adjustments are shown in the following table.

3.05 *Adjustable Deviation Equalizers:* The remaining cable loss deviations, while small enough not to require correction at each repeater point, are corrected for longer systems by means of adjustable deviation equalizers inserted at selected repeater points. These devices are used to equalize the systematic accumulations of cable and repeater deviations. They operate in the high-group frequency range and are therefore, placed at the outputs of locally-powered low-high repeaters.

3.06 *Deviation Regulator:* This device is used to automatically compensate the varying residual line loss deviations due to temperature changes on very long N (or ON) systems. Consequently, better control of the attenuation characteristics and the noise performance is achieved. The deviation regulators are also located at the outputs of locally powered low-high repeaters.

STEP DESIGNATION	N1 ELECTRON TUBE REPEATER		N1 TRANSISTORIZED REPEATER	
	L-H REP*	H-L REP*	L-H REP*	H-L REP*
A	—0.6 db	—1.0 db	+2.0 db	+2.0 db
B	—3.0 db	—2.7 db	0 db	0 db
C	—5.1 db	—4.7 db	—2.0 db	—2.0 db

* Db of gain for channel 13 with respect to channel 2.

4. SYSTEM TRANSMISSION FEATURES

A. Levels

4.01 The 4-wire input and output levels, relative to the transmitting switchboard, are −16 and +10 db, respectively.

4.02 The system carrier powers on the high-frequency line are shown by the carrier power diagram, Fig. 6 which is for the typical system shown in Fig. 2. In this carrier frequency part of the system, the powers are expressed in terms of the powers of the transmitted carriers which are 12.5 db above the single sideband message power for a 0 dbm zero system level input signal at voice frequency. At the top of the figure the levels are shown graphically for the A to B direction of transmission and at the bottom for the B to A direction. In this illustration parameters have been chosen so that terminal and repeater output slopes will be +6 db for high-group and −6 db for low-group outputs.

4.03 The channel carrier powers at the inputs to the transmitting group units are all −43 dbm. They are then predistorted to a predetermined slope as engineered for the system route and cable characteristics. The group carrier band is then amplified for transmission at the desired carrier levels. At the receiving group unit the carrier powers are equalized by a slope value determined from the slope of the input signals. This amount of equalization, together with the initial predistortion at the transmitting end, corrects the accumulated line slope.

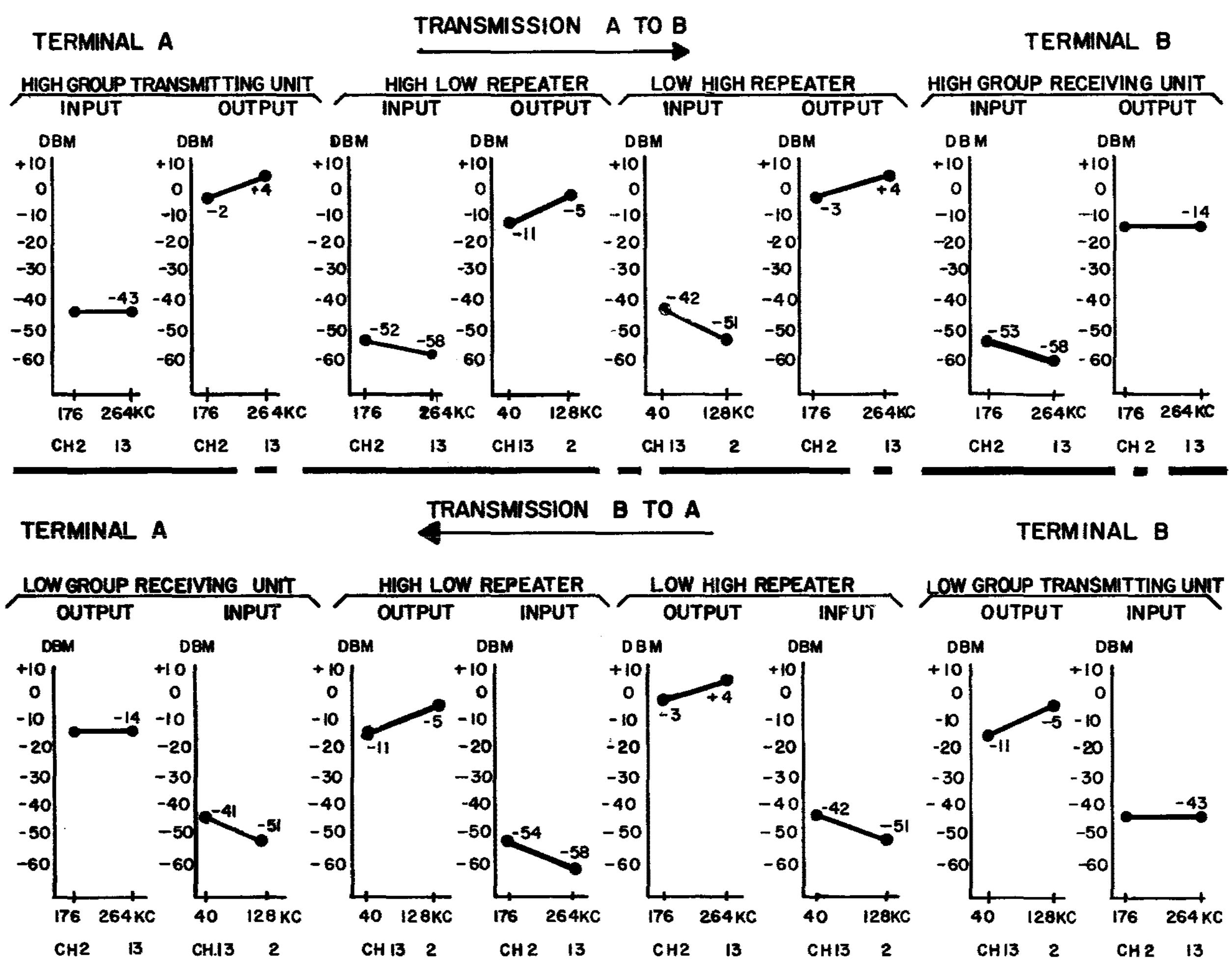


Fig. 6 — Typical N2 Carrier Power Diagram

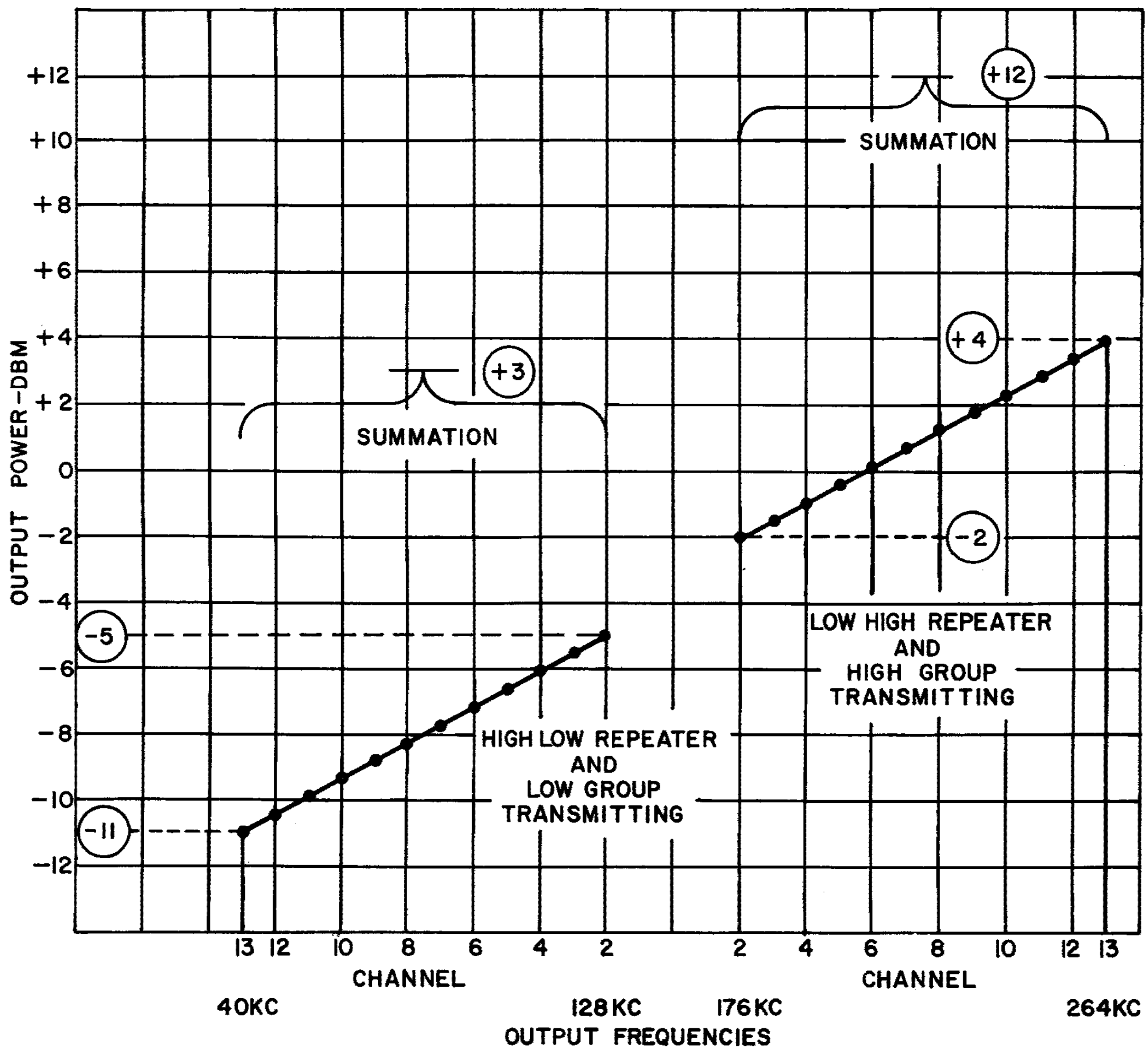


Fig. 7 — Transmitting Group Unit and Repeater Carrier Output Power

4.04 The carrier powers at the outputs of the transmitting group and repeater units are indicated in Fig. 7 for a ±6 db repeater output slope. The total power is indicated for each unit, also the distribution of the powers for the 12 channel carriers within each group.

4.05 The channel carriers at the outputs of the receiving group units are all equal, with a value for each channel of —14 dbm for a perfectly equalized system and a power summation of —3.2 dbm.

4.06 A more detailed level diagram for N2 terminals combined with an N1 or N1A repeatered high-frequency line is shown on the block schematic, Fig. 8.

B. Regulation

4.07 The repeaters and receiving group units have flat-gain regulation to compensate for changes in the cable loss with varying temperature. The line regulation is obtained by means of thermistors which, responding to changes in output power, vary the feedback of the amplifiers and thus their gain. Nominal total output powers are +3 or +2.5 dbm for the HL repeater, +12 or +11.5 dbm for the LH repeater of N1 or N1A, respectively, and —3.2 dbm for the receiving N2 group units. The group unit regulator holds the total power output within about 1 db of its nominal value for group unit or repeater temperature changes from —15° to +110 F. For greater temperature changes the regulator functions less efficiently. Because of the frequency characteristic of the repeatered line, the individual channels may depart by as much as ±3 db from the nominal channel output of a receiving group unit. This is corrected by the individual channel regulator which maintains the received channel carrier to within 0.2 db of its nominal value at the demodulator input.

4.08 The receiving group regulation characteristic is shown in Fig. 9. The receiving group unit input changes are the resultant of the preceding cable span transmission variations and the unregulated residues of repeater regulators. Arrows "A" and "B" indicate the span transmission variations of 8 miles of 19-gauge toll aerial cable for high-group frequencies and temperature ranges of —15° to +110 F and —30° to +130 F, respectively. Within the range indicated by arrows "A" the unregulated residue of preceding repeaters is negligible, but for greater temperature variations the accumulating residues cause an increasing degradation of regulation. The receiving group regulation is somewhat poorer when receiving low group owing to the greater departure from perfect regulation of the preceding high-low repeater as shown in the individual repeater regulating characteristics (solid curves) in Fig. 10. However, this is somewhat offset by the lower db change with temperature of the low group. The curve for H-L repeaters (Fig. 10A) indicates some improvement in the N1A transistor repeater regulation characteristics, as compared to the N1 electron tube repeater characteristics when inputs are well below the nominal value. The dotted curves of this figure show the effect of accumulated residues approached asymptotically for a large number of N1 repeaters. The circled numbers on these dotted curves indicate the number of repeaters which, for the span loss variations given as abscissas, will give the indicated residues. When underground cable or shorter aerial spans are used, the temperature effects are, of course, reduced and the line regulation correspondingly improved.

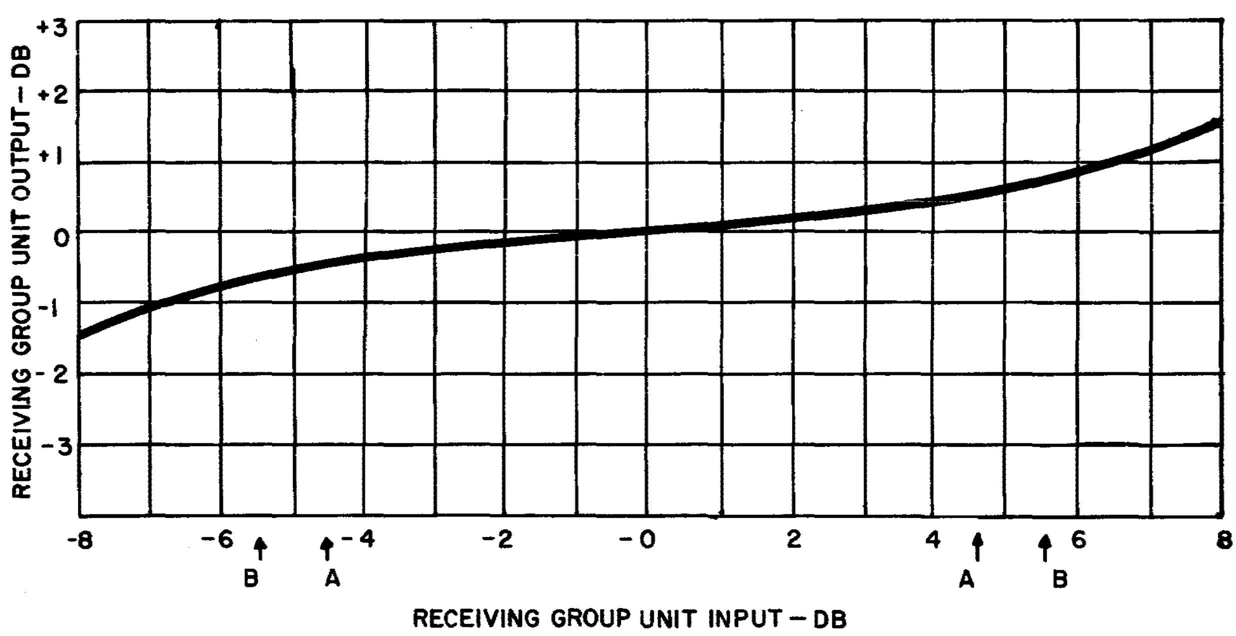


Fig. 9 — N2 Receiving Group Unit Regulation Characteristic

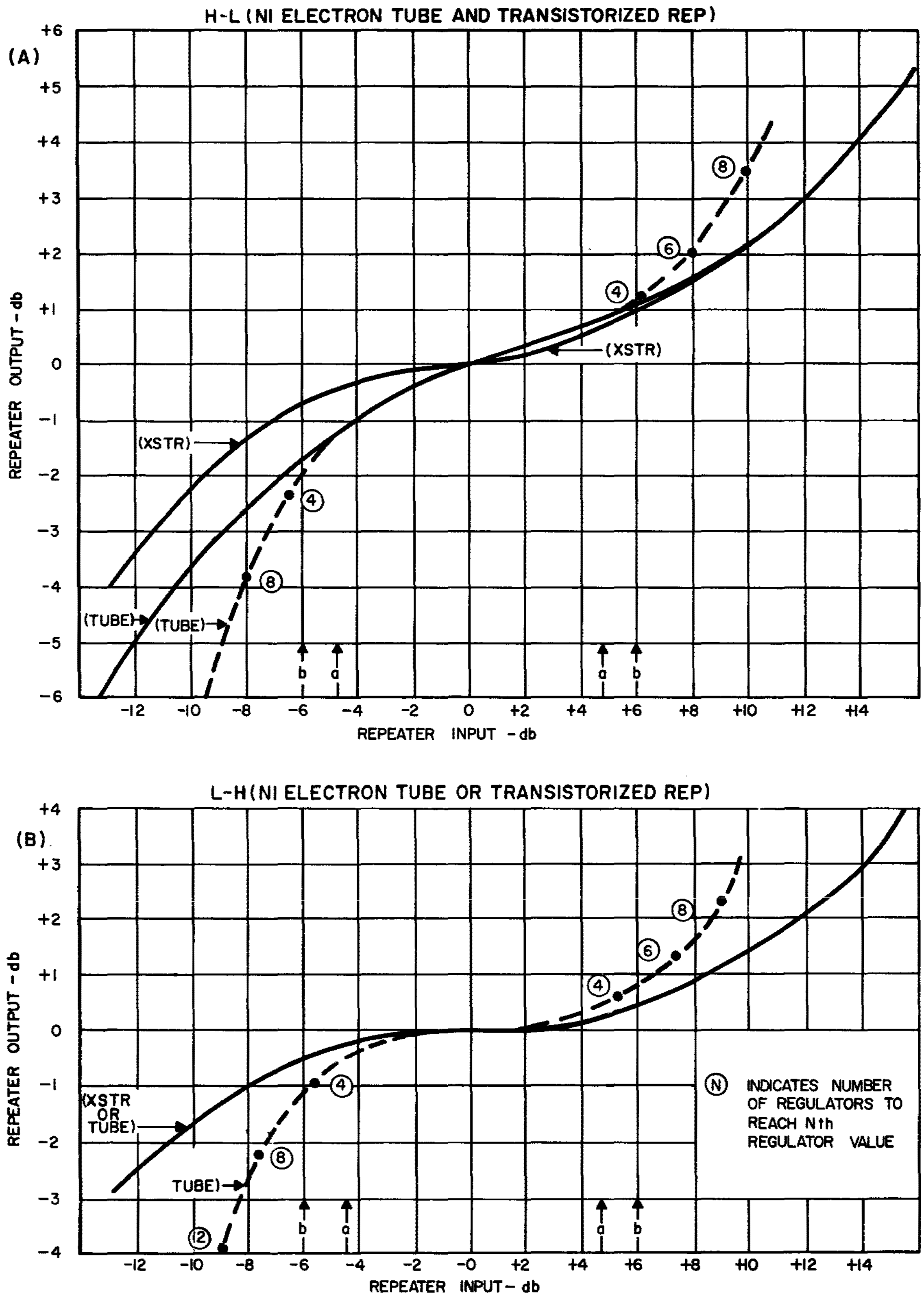


Fig. 10 — Repeater Regulation Characteristics

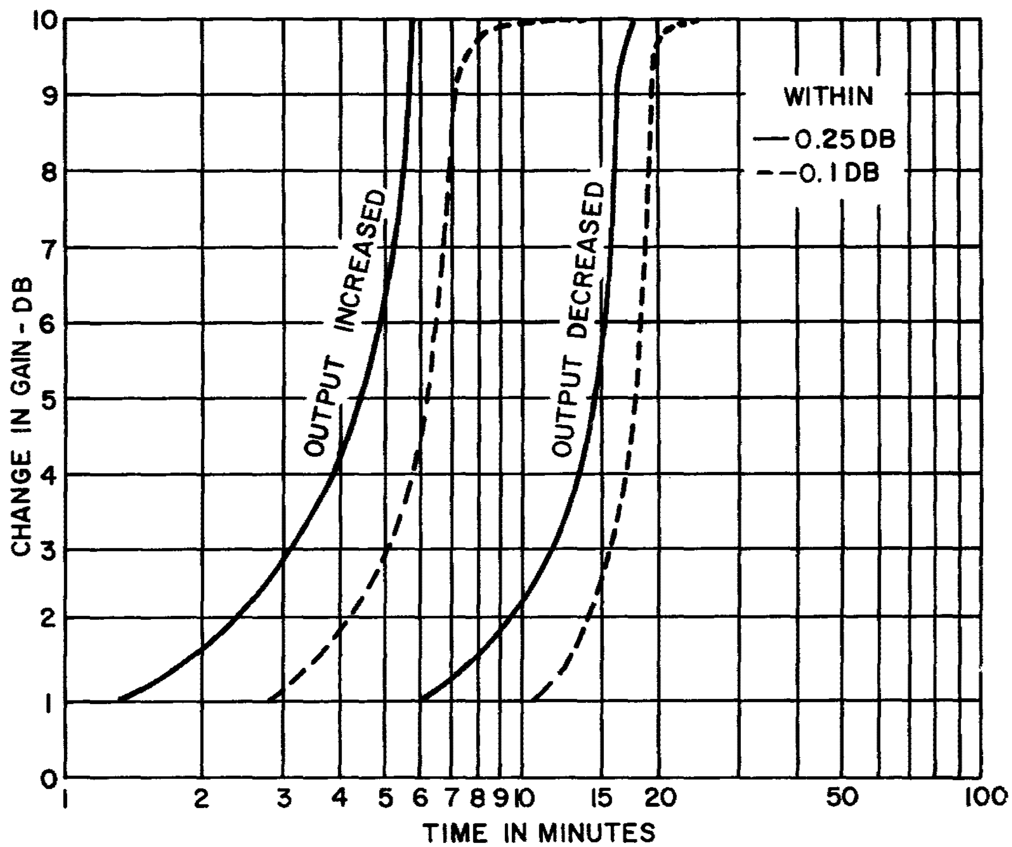


Fig. 11 — Regulator Stabilization Time (N1 Electron Tube or Transistorized Repeaters)

4.09 The thermistor regulator has a sufficiently long reaction time so that channel voice current peaks do not alter the system regulation. This reaction time is three to five times as great to correct for an ouput decreasing with time as for an ouput increasing with time. This effect materially affects the waiting period required after any abrupt transmission change before the circuit will stabilize within the desired measuring accuracy. This waiting period for a single regulator, such as that shown in Fig. 11, resulting from an increase in input of 2 db would require a wait of about 4 minutes for 1/10-db measuring accuracy, whereas a decrease in input of 2 db would require a wait of about 14 minutes. When there are a number of repeaters between the point of circuit change and the point of observation, the tandem action of the regulators results in a shortening of the over-all restoration time. This, however, is no indication that, in the intervening portion of the circuit, the levels have already restored to their normal values, so that there is no possibility of overload. The tandem action may cause the output to overshoot by 10 per cent of the original change before settling to its stabilized value.

4.10 The sideband speech power on a long time average and the signaling tones are 12.5 db or more below their respective channel carriers so they do not appreciably affect the system regulation. The regulators have an ambient temperature control that provides for operating temperatures between —20° and +130 F. Beyond these extremes the regulating action deteriorates rapidly.

C. Transmission Performance

4.11 The approximate frequencies at which the loss of an average channel is a given number of decibels greater than the 1000-cycle valve are shown in the table below. Fig. 12 shows

DB DOWN FROM 1000 CYCLES	FREQUENCY	CYCLES
1	320	3280
3	220	3450
10	90	3640

a typical over-all channel frequency characteristic measured from compressor input to expandor output. A circuit composed of four type N2 channels, patched 4-wire in tandem, is expected to have the 3-db points occurring at approximately 360 and 3000 cycles, and the 10-db points at approximately 200 and 3300 cycles.

4.12 The nominal 1000-cycle transmission variation of any length of N2 carrier link is expected to be less than ±0.5 db.

5. POWER SUPPLY

5.01 Standard office —48 volt power supply alone is required for N2 terminals exclusive of power feed to adjacent repeaters. Each terminal requires approximately 1.1 amperes. A plug-in 48- to 21-volt transistor converter drops the supply voltage and provides a closely regulated —21 volt supply for the channel and group units. An additional 0.1 ampere per terminal is required for alarm circuits. When an auxiliary 48 to —21 volt converter is given a full load test prior to in-service switching of converters a further drain of 1.1 amperes occurs. Separate fuses are provided for the so-called transmission and alarm circuits. Each 48 to —21 volt converter may be manually adjusted for —21 volts with an output load of 1.2 to 2.0 amperes which covers the range of out-

CHANNEL GAIN FREQUENCY CHARACTERISTIC

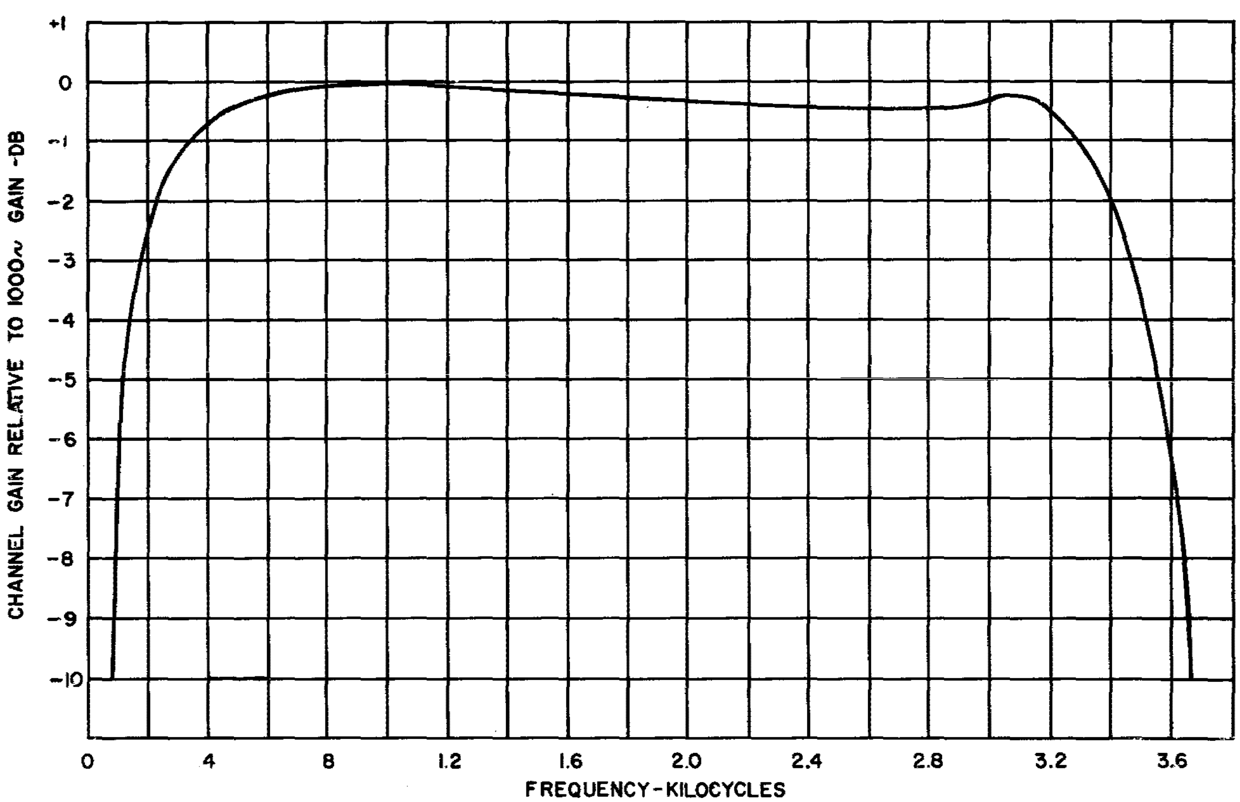


Fig. 12 — Typical Channel Frequency Characteristic

put current for ten to twelve message compandors and modems plus the transmitting and receiving group units. If the terminal is to be operated with less than ten compandors and modems, one or more plug-in loads each equivalent to the nominal load of three compandors and modems (0.375 ampere) is used to build out the converter load.

Standard +130 volt or +130 and —130 volt office supplies also may be required at a terminal to feed power to adjacent repeaters. The plug-in line terminating unit in each terminal is arranged to connect —48 volts and ground, +130 volts and ground, +130 volts and —48 volts, or + and —130 volts to the simplexes of the high-frequency lines as required by the number and type of repeaters to be fed and the resistance of lines and pads in the high-frequency simplex circuits. The required voltages and currents are obtained by adjusting a slide-wire rheostat and screw connectors on the plug-in line terminating unit. Means are provided for in-service current readings but adjustment is on an out-of-service basis. Odd- and even-numbered terminals are arranged for separate power feeders and fuses.

5.02 Locally-powered electron tube repeaters require +130 volt power supply. Locally-powered transistorized repeaters may be operated from either —48 or +130 volt power supplies. When power is to be sent over the simplexed transmission pairs to adjacent repeaters, the power is obtained from +130 volts, +130 and —48 volts, or + and —130 volt office supplies depending on the number and type of repeaters to be fed and the resistance of the lines and pads in the high-frequency circuit simplexes. The repeater battery feed panel may be ordered for the required arrangement i. e., +130 volts and ground, +130 volts and —48 volts, or ±130 volts. In each case, the desired current is obtained by adjusting a slide-wire rheostat.

6. SYSTEM EQUIPMENT FEATURES

6.01 N2 carrier terminals are mounted in shop-wired 23-inch bulb-angle bays arranged for single side access and may be installed back to back or adjacent to a wall. Both 11-foot 6-inch and 9-foot bays are available with capacity for eight and six terminals, respectively. Each bay includes: (1) mountings and connectors for the plug-in transmission, alarm, and power units necessary for the terminals; (2) cabling between connectors and terminal strips at the top of the bay; (3) fuses and battery protective resistors for each terminal; (4) power feeder fuses, and office alarm relays and lamps, and (5) order-wire and test tone appearances. All connections to and from a bay are made to terminals at the top of the bay. Universal bay cabling is used. This facilitates office engineering of the terminal bay and subsequent provision of plug-in units to meet specific initial or subsequent assignments of channels or carrier systems.

6.02 A terminal arranged for a full complement of message channels requires the following plug-in units: 12 compandors, 12 modems, a group transmitter, a group receiver, a line terminating unit, an alarm unit, and a power unit. Modems, group transmitters, and group receivers must be chosen for specific channel or carrier line frequencies. The other units are suitable for any system. Group transmitters and receivers are arranged for plug-in equalizers affording optional transmission slopes. The line terminating units are arranged for plug-in pads affording optional transmission losses, and are also arranged for simple adjustment for any power feed to adjacent repeaters. The alarm and line terminating units include switching and power jacks for use with a portable switching set for in-service switching of group transmitters, group receivers, or power units.

6.03 N1 repeater units are plugged into jacks on a repeater mounting bracket which in turn is assembled on a 19-inch wide repeater mounting shelf. The repeater mounting bracket consists of a die-cast frame which mounts span pads when required, and switching jacks to permit repeater replacement without service interruption. Each repeater mounting shelf mounts four repeaters and brackets. A group of four repeaters requires 14 inches of vertical space or eight mounting plate positions. As in the case of the terminal mounting, the repeater mounting framework is made of natural finish aluminum.

6.04 N1 repeaters may be mounted in pole-mounted cabinets at nonpower supply points or in standard relay racks at power supply offices. When pole-mounted cabinets are used, a terminal block with cable stub is provided. The cabinet, which is approximately 6 feet high, provides sufficient space for the terminal block and a maximum of 12 repeaters. It is made of sheet steel, white enameled on the outside and has insulated walls. It has ventilating openings at the top and bottom with a thermostatically controlled shutter at the top. The terminal block includes a 19-gauge cable stub with protectors for a capacity of 52 pairs. It may be mounted either at the top or bottom of the cabinet depending on whether the entrance cable is aerial or underground.

6.05 When N1 repeaters are mounted on standard relay racks at power supply points, a power distribution panel is required for each four 12-channel carrier systems. This panel includes the fuse, fuse alarms and resistors for power supply to four local repeaters and for the four to twelve adjacent repeaters in each direction. The number of adjacent repeaters which may be supplied depends upon their type, resistance of the cable pairs, and the span pads.

Repeaters may be mounted on standard relay racks in offices or buildings and receive power over the cable from power feed offices.

7. MAINTENANCE FEATURES

A. Testing Arrangements

7.01 In-service power or voltage measurements may be made at the inputs and outputs of the voice-frequency channels, the modems, the group transmitters, the group receivers, and the power converter through pin jacks or switching jacks located on the faces of the plug-in units. Similar pin jacks permit measurement of the emitter voltages of the main transistors in the group transmitters and receivers and measurement of the simplex current being fed to adjacent repeaters. Use of the portable J99272U N2 switching set affords in-service switching of group transmitters, group receivers, and power units as well as accurate adjustment of power unit output voltage.

Voice-frequency channels may be tested by a portable J99272W terminal test stand on a terminated basis. Use of this stand also permits bridging access to all input and output connections of the compandor and modem units.

An out-of-service voice-frequency channel may be used as a temporary maintenance talking circuit by connecting 52K head telephone sets to pin jacks on the compandors of the idle channel at the terminals of the system.

B. Order-Wire and Alarm Circuit

7.02 In order to aid in the testing and maintenance of the type N2 system, the J98704 order wire and alarm circuit will be utilized. This circuit, which uses two pairs along each system route, provides complete talking service, transmission of alarms from unattended to attended stations, and power for the repeater switching set. A simplified schematic of these facilities is shown in Fig. 13.

7.03 The order-wire arrangements are designed to use a 16- or 19-gauge pair with H88 or H172 loading. Signaling is provided by sending an uninterrupted 1900-cycle signal. Standard 1000 20-cycle signaling may also be used but the 1900-cycle system provides simpler arrangements. At pole-mounted repeater points calling-in signals are generated by an appropriate whistle

7.04 The alarm circuit uses the second pair mentioned above. It provides for alarms to be brought into the attended points from unattended stations by means of voice-frequency tones spaced 400 cycles apart i. e., 700, 1100, 1500, or 1900 cycles. These tones are generated at the unattended stations and, under control of relays at these stations, the tone is removed from the line to give an audible and visual alarm indication at the attended station. A control is provided for silencing the audible alarm. In this condition, when the trouble has been

NOTE:
1 MAXIMUM NUMBER OF AUX REP STA BETWEEN POWER FEED POINTS IS:
N1 ELECTRON TUBE REP - 2
N1 TRANSISTORIZED REP - 6

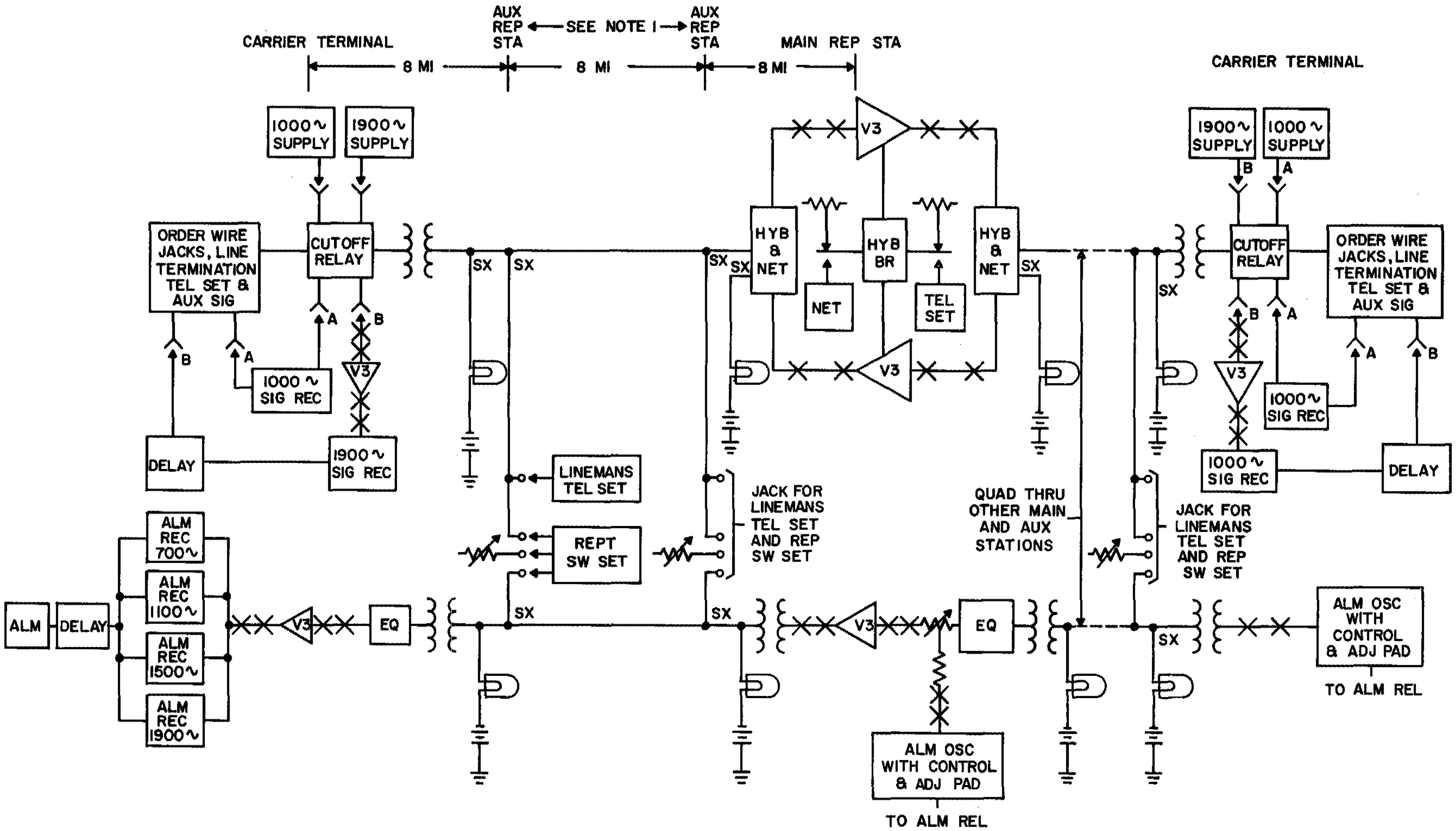


Fig. 13 — Order Wire and Alarm Circuit

cleared at the unattended station, the audible alarm will again sound at the attended point until the control is set back to normal. The alarm has a 5-second delay interval to guard against false operation from static or maintenance hits. Each tone is capable of one alarm indication and the four tones can therefore provide a single alarm from four unattended stations. This single alarm can be a general alarm for any station in which there is more than one alarm condition.

7.05 The order wire and alarm pairs have dc power simplexed onto them from all the powered terminal or repeater stations. This provides at each nonpowered repeater station the power supply required for repeater switching.

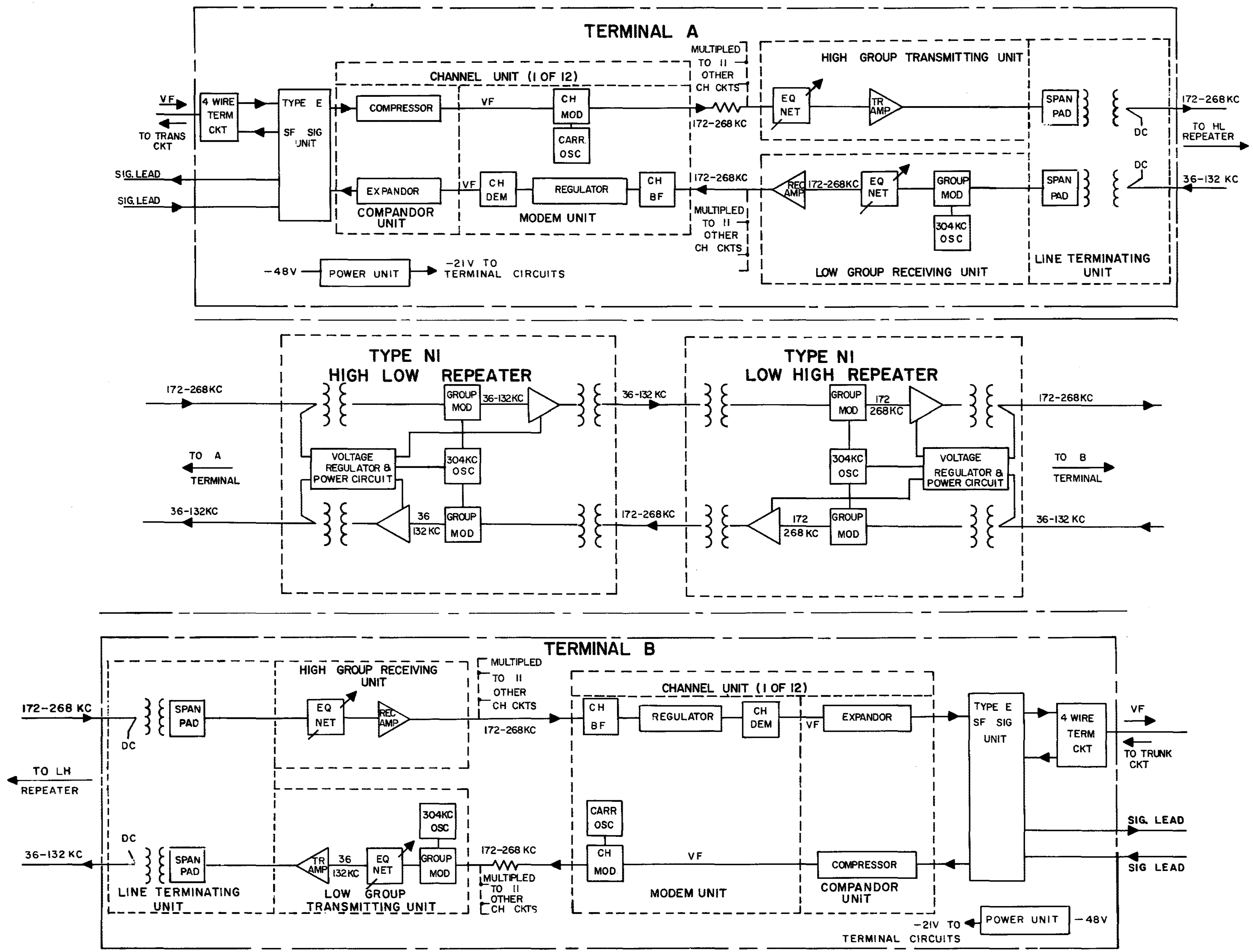


Fig. 2 — N2 Carrier Telephone System

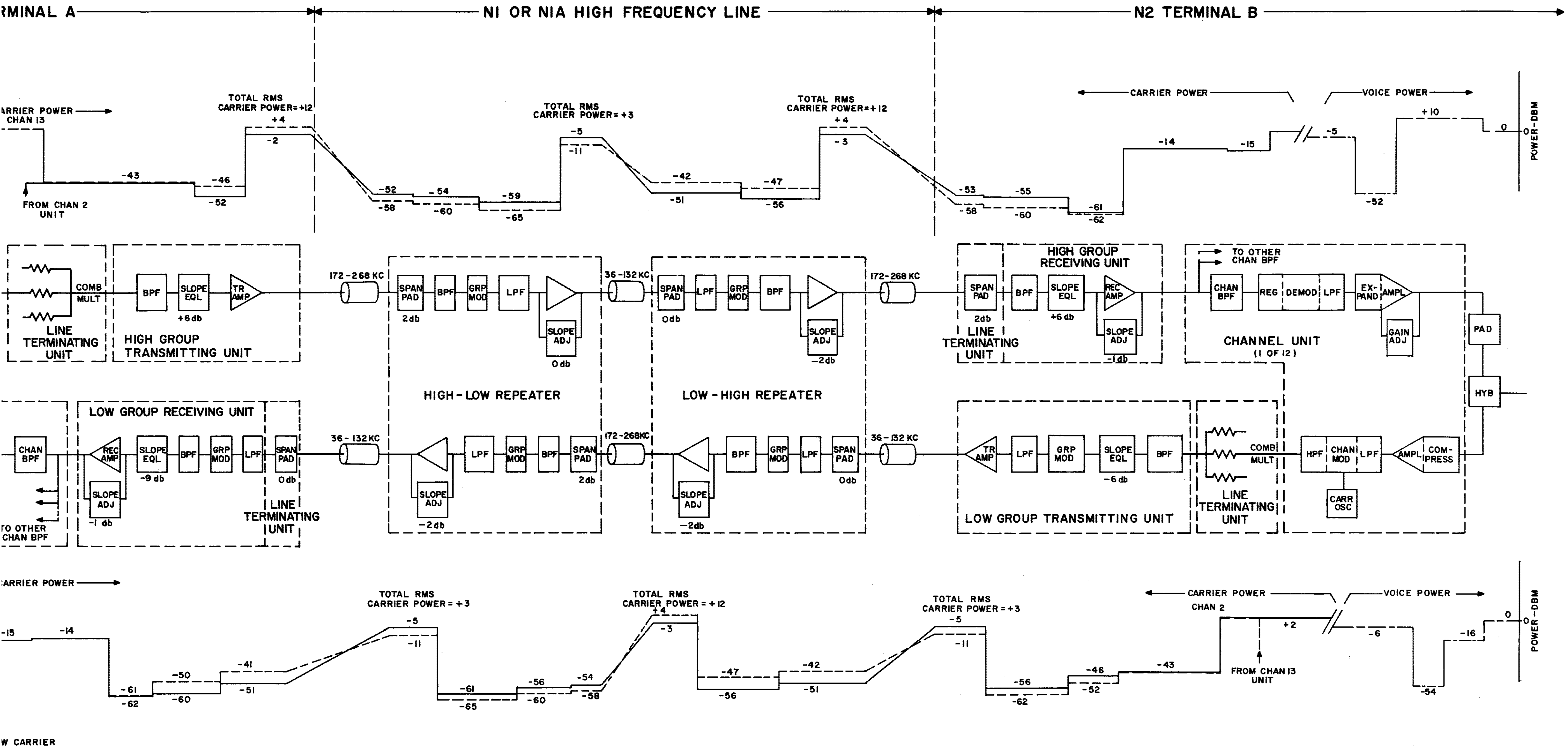
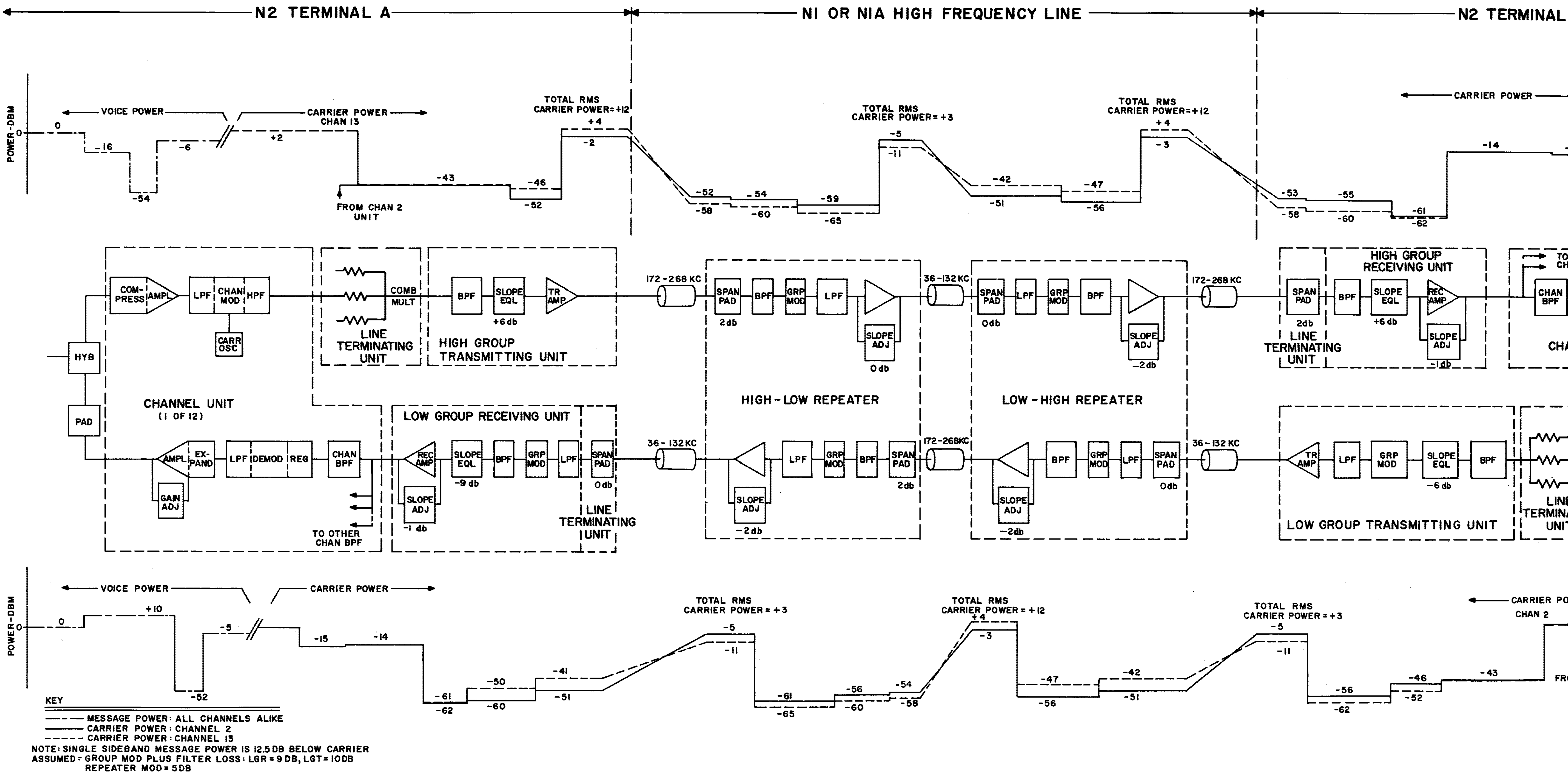


Fig. 8 — N2 Carrier Power Levels


N2 TERMINAL A
N1 OR N1A HIGH FREQUENCY LINE
N2 TERMINAL
POWER-DBM
VOICE POWER
CARRIER POWER
CHAN 13
TOTAL RMS CARRIER POWER = +12
TOTAL RMS CARRIER POWER = +3
TOTAL RMS CARRIER POWER = +12
FROM CHAN 2 UNIT
COM-PRESS
AMPL
LPF
CHAN MOD
HPF
CARR OSC
COMB MULT
LINE TERMINATING UNIT
BPF
SLOPE EQL
TR AMP
HIGH GROUP TRANSMITTING UNIT
172-268 KC
36-132 KC
SPAN PAD
GRP MOD
SLOPE ADJ
HIGH-LOW REPEATER
LOW-HIGH REPEATER
HIGH GROUP RECEIVING UNIT
REC AMP
CHAN BPF
HYB
PAD
CHANNEL UNIT
(1 OF 12)
EX-PAND
DEMOD
REG
GAIN ADJ
TO OTHER CHAN BPF
LOW GROUP RECEIVING UNIT
LOW GROUP TRANSMITTING UNIT
TOTAL RMS CARRIER POWER = +3
TOTAL RMS CARRIER POWER = +12
TOTAL RMS CARRIER POWER = +3
CHAN 2
KEY
MESSAGE POWER: ALL CHANNELS ALIKE
CARRIER POWER: CHANNEL 2
CARRIER POWER: CHANNEL 13
NOTE: SINGLE SIDEBAND MESSAGE POWER IS 12.5 DB BELOW CARRIER
ASSUMED: GROUP MOD PLUS FILTER LOSS: LGR = 9 DB, LGT = 10 DB
REPEATER MOD = 5 DB