# HIGH SEAS AND OVERSEAS RADIO
# MARITIME LINCOMPEX 100/101 TERMINAL
# DESCRIPTION

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## 1. GENERAL

**1.01** Lincompex 100 and 101 channel terminal equipment is used in high-frequency radiotelephone ship-to-shore systems to improve voice transmission so that the quality approaches that obtained on coaxial cable carrier systems. Figure 1 shows the Lincompex 101 coast station. The type 100 ship station is not shown as it is basically the same.

**1.02** Lincompex improves the communication quality and the usable time of a standard 2- or 4-wire HF radio link. This improvement is accomplished by the application of "linked compression and expansion" techniques.

**1.03** At the transmit end of the link, speech syllables over a wide range of amplitudes are compressed. This compression provides the transmitter with a signal of constant amplitude. At the transmit end, an audio control tone is also produced. The frequency of this tone varies with the syllabic level of the speech input. This is transmitted above the speech band, the upper limit of which is restricted to allow space for the tone within the permitted upper limit of the audio band.

**1.04** At the receive end of the link, any variations in amplitude are removed by a fading regulator. An expandor restores the original syllabic amplitude variations to the speech by using the compression information conveyed by the control tone.

**1.05** The Lincompex System provides radiotelephone voice quality by:

(a) Loading the transmitter more efficiently which improves the signal-to-noise ratio at the receiver.

(b) Minimizing radio-circuit fading effects which cause wide variations in received signal levels.

(c) Silencing the voice channel during no speech intervals which reduces the effects of noise and other interference on the listener.

**1.06** Lincompex types 100 and 101 are designed to meet internationally agreed parameters and are primarily designed for marine use, but can be used in any situation where the same economic and system parameter considerations occur. With a ship-borne system, a large number of ships operate through a single coast station. It is therefore economical to make the coast station more complex, if in so doing the complexity of the ship station can be reduced.

**1.07** A typical high-frequency radiotelephone terminal arrangement using Lincompex equipment is shown in Fig. 2. The Lincompex transmit and receive coast station terminals 101 can be separated for installation at different sites if required. Terminals type 101 have separate power supplies. Terminals type 100 (ship station), have a common power supply for the transmit and receive terminals; therefore, they must remain together.

**1.08** The new system requires identical equipment at both ends of a radio circuit. A radiotelephone voice channel cannot be equipped with a Lincompex terminal at one end and a conventional terminal at the other. However, under certain conditions, a radio system providing two or more voice channels may have one or more channel equipped with

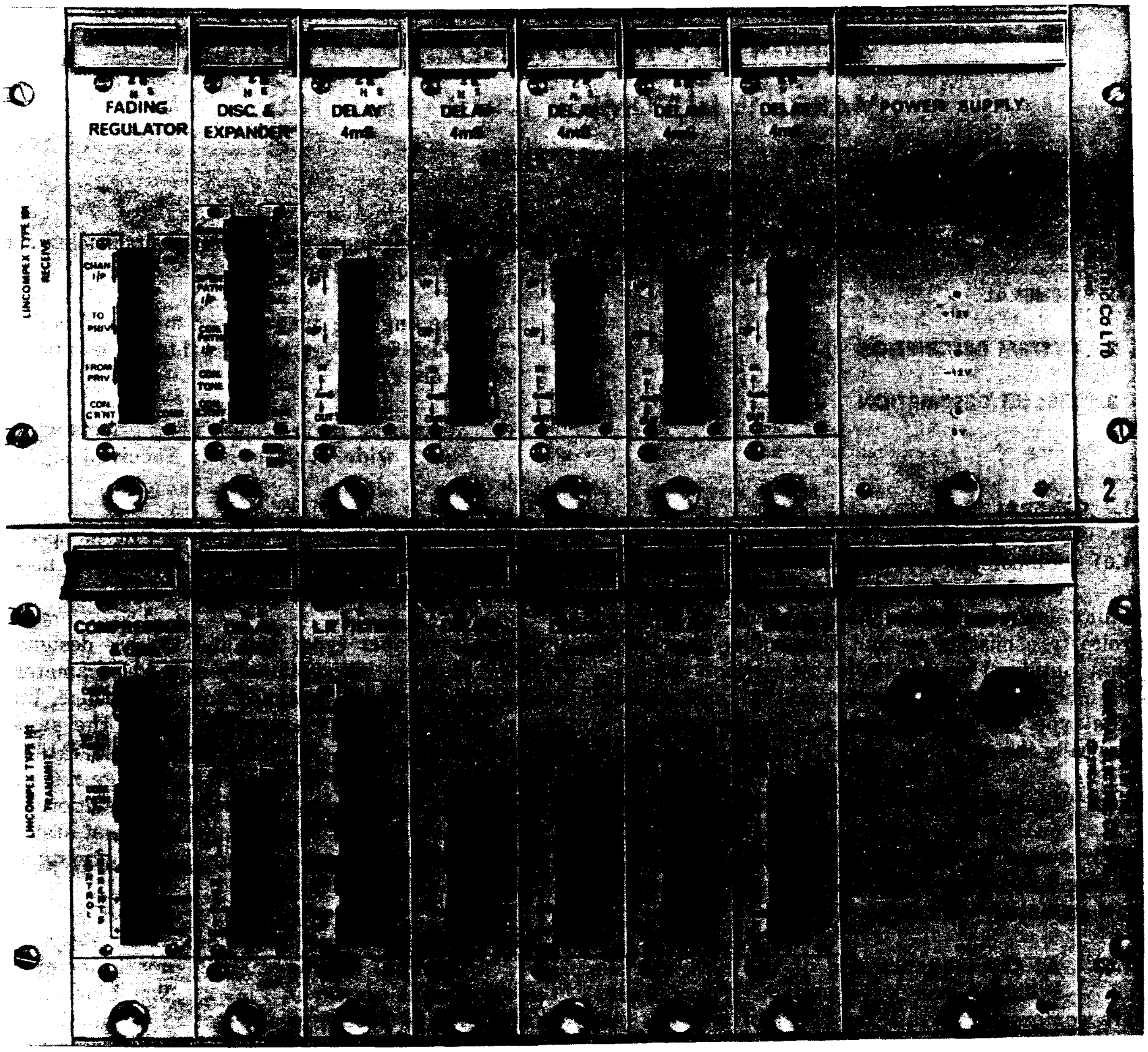


**Fig. 1—Lincompex 101 Coast Station**

Lincompex terminals and the other channels equipped with conventional terminals.

**1.09** In contrast to a conventional system, the Lincompex System does not require adjustments by a radio operator during a call. It is expected that the terminals will require only routine maintenance at intervals similar to those now applied to voice channel modems of coaxial cable carrier systems.

**1.10** Echo suppressors are not required for stable 2-wire terminating, because, irrespective of input signal level, Lincompex maintains a constant loss around the 4-wire loop, provided the loop levels are correctly set up. However, an echo suppressor is required for 2- to 4-wire terminating to suppress echos caused by the leakage of the signal from the receive path to the transmit path across the 2- to 4-wire hybrid.

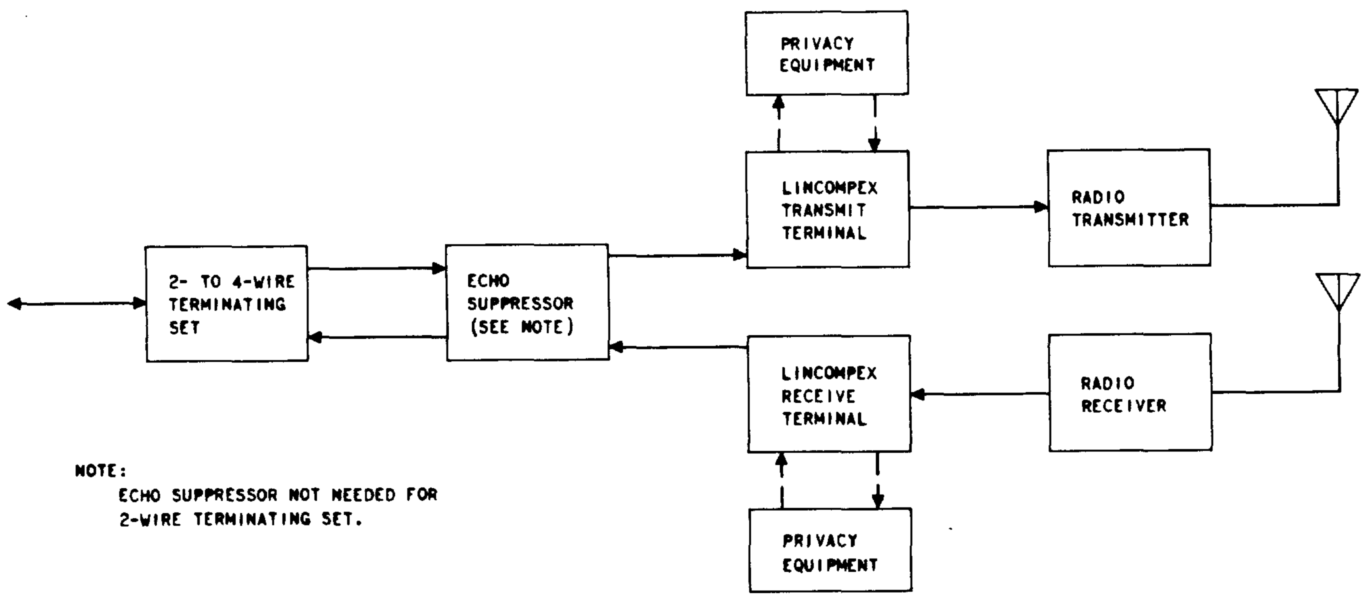


**Fig. 2—Radiotelephone Terminal Arrangement**

**1.11** The loss around the 4-wire loop is maintained at a constant value because the added loss due to expansion and the added gain due to compression are matched over the full range of signal levels. Should extra loss occur in the radio path due to fading, it is counteracted by the fading regulator in conjunction with the radio receiver AGC (automatic gain control).

**1.12** Should the level of the speech input momentarily fall below the compression range at the transmit end, compression may occur in the fading regulator. This compression would also be balanced by expansion.

**1.13** A delay of approximately 20 ms is inserted into the speech path to compensate for time constants and filter delays in the control path, resulting in speech and tone signals arriving together at the expander.

**1.14** Provision is made for the connection of privacy equipment, but frequencies above 2380 Hz must not be transposed, as these are removed by filtering.

## 2. SYSTEM DESCRIPTION

**2.01** The Lincompex 100 and 101 equipment is designed to work within the marine radiotelephone speech bandwidth limit of 2.7 kHz. In order to simplify the ship equipment (type 100), the 20-ms delay required in each go-and-return path is situated in the coast (type 101) equipment.

**2.02** Figures 3 through 6 show the major design parameters of the type 100 and 101 equipment. The compression range of the coast equipment has to account for the variations in speech levels and variations in line loss, as well as the normal syllabic variations.

**2.03** At the ship transmit end of the link, there is no appreciable variation in line loss and a reduced compression range and oscillation range is used (Fig. 3 and 4). At the coast receive end, therefore, it is not necessary to specify the expandor characteristic (Fig. 6) over more than 50 dB.

**2.04** Two versions of Lincompex type 100 are available. These are the 100A and 100B. The Lincompex 100A transmit and receive equipments are housed in a single 19-inch (483 mm) rack-mounting unit and have a common power supply module. External connections are made via terminal strips at the rear of the unit. Input and output attenuators are located in the 2- to 4-wire terminating set together with a 2- to 4-wire hybrid transformer.

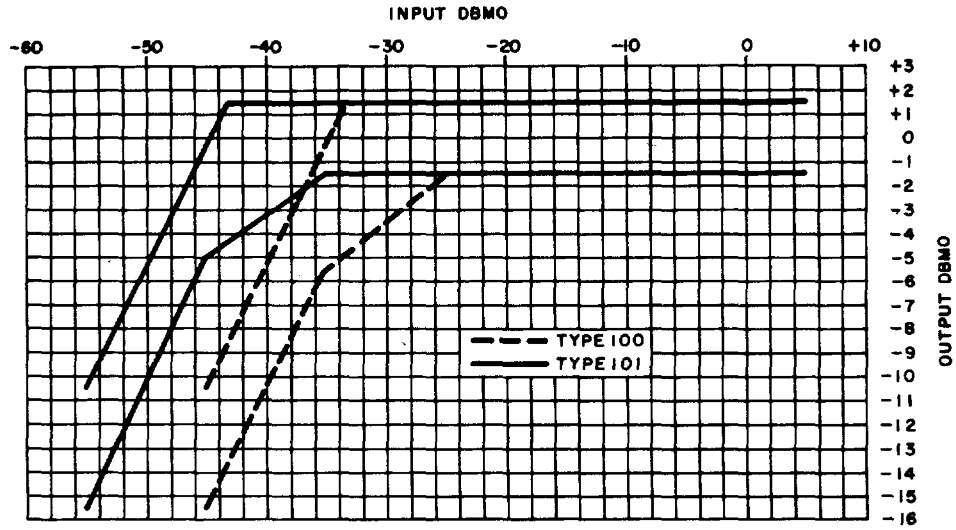


**Fig. 3—Transmit: Compression Characteristic, Input/Output**

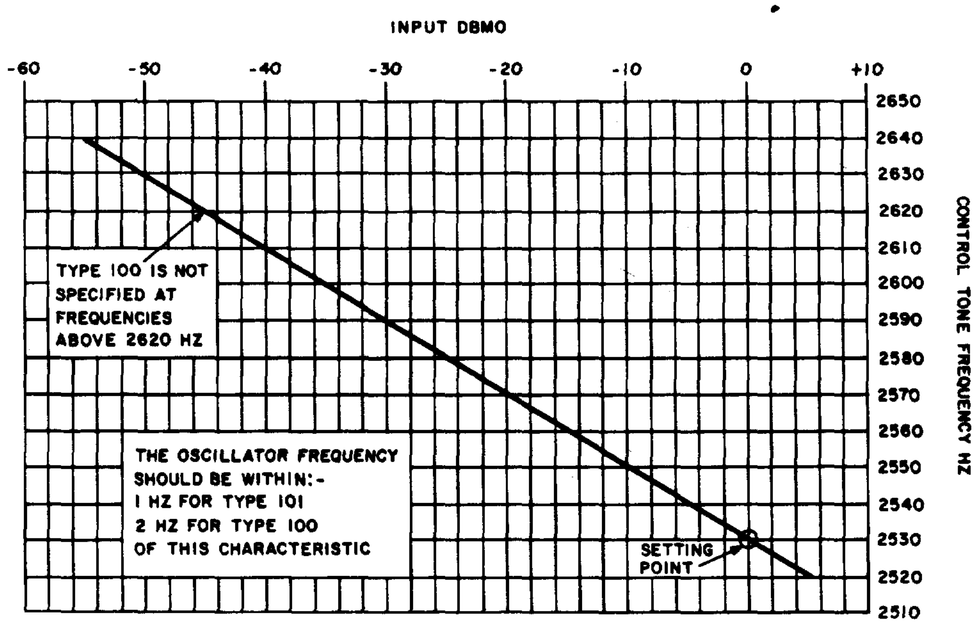


**Fig. 4—Transmit: Input/Control Tone Frequency Characteristic**

**2.05** This equipment is primarily intended for 4-wire systems, but can be used for 2-wire terminating with an echo suppressor external to the unit. Each module, except the 2- to 4-wire terminating set, is retained by two quarter-turn cam retainers operated by knobs on the front panel. No delay modules are fitted in this unit as these are normally provided at the Lincompex 101 coast station.

**2.06** The Lincompex type 100B is identical to type 100A with the addition of two modules which together form an echo suppressor. Type 100B contains all that is required at the ship end

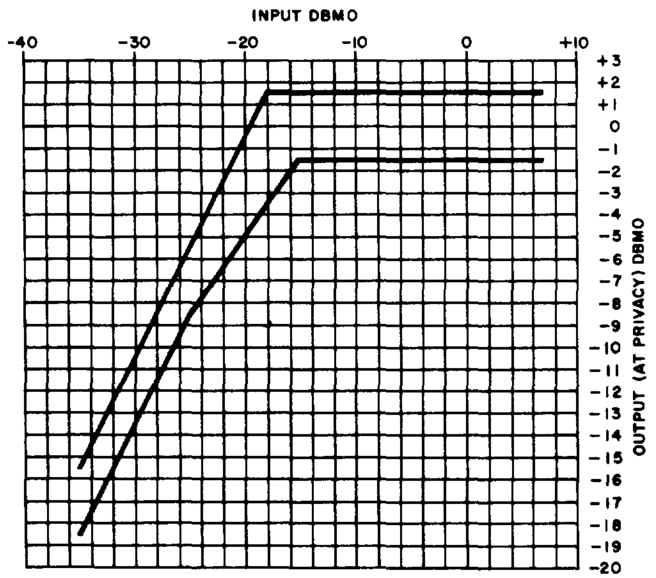


**Fig. 5—Receive: Fading Regulator Characteristic Input/Output**

to enable a ship installation to operate a Lincompex radiotelephone link on a 2-wire speech circuit. A type 100A can be converted to type 100B by the plug-in addition of the two echo suppressor modules.

**2.07** The Lincompex System (Fig. 7) consists of a transmit terminal and a receive terminal which provide a constant net-loss voice channel in the radiotelephone system. ***Constant net-loss*** means that the loss of the voice channel from the transmit terminal input to the receive terminal output remains constant for a wide range of loss variations in the radio signal path.

**2.08** The sending and receiving equipment at a given radio station are completely independent of one another; transmission can occur simultaneously in both directions. One direction of transmission is shown in Fig. 7. The Lincompex System provides two improvements previously unattainable in radiotelephone systems: constant net-loss in the transmission path and simultaneous 2-way conversation.

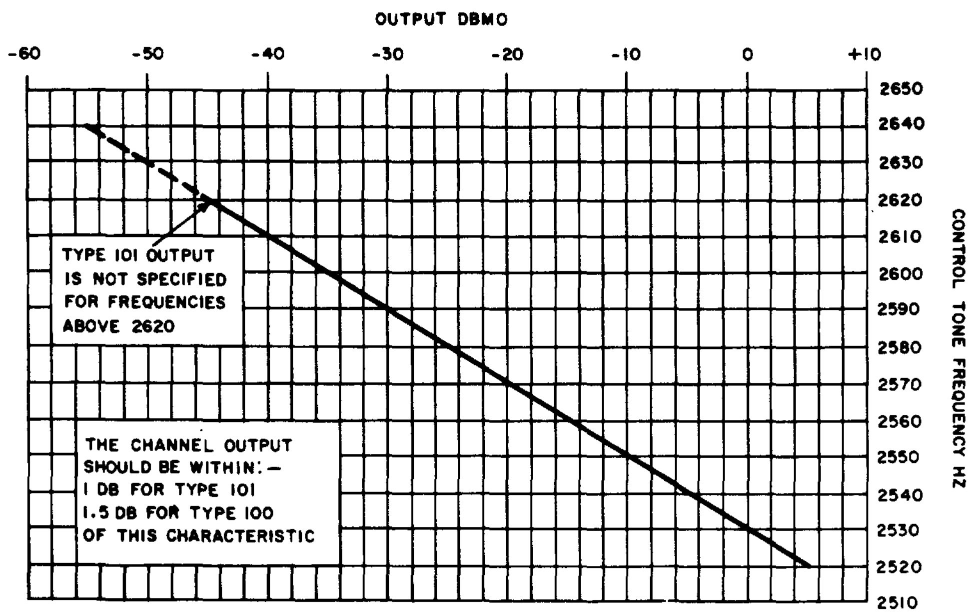


**Fig. 6—Receive: Control Tone Frequency/Output Characteristic**

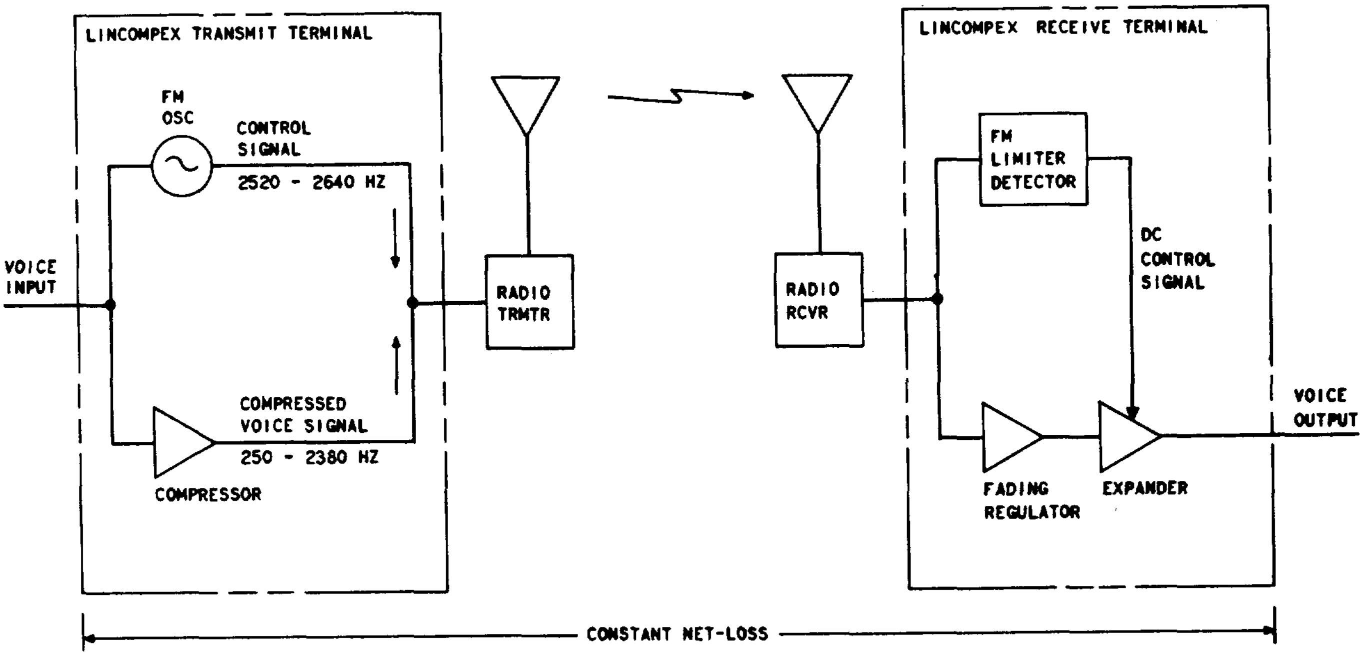


**Fig. 7—Lincompex System**

**2.09** System performance is based on compressor and expandor circuits in the voice path and transmission of a control signal which serves as a continuous level reference.

**2.10** The Lincompex type 100 and type 101 are basically the same units. The type 100, for simplicity, does not contain the five 4-ms delay modules, and contains a single power supply for both the transmit and receive units. Therefore, only the type 101 will be discussed.

### *Transmit Unit*

**2.11** During conversation, the voice input level varies continually because of the nature of speech. This varying input is applied to two paths which prepare the composite signal to be transmitted. The ***speech path*** includes a compressor which accepts the varying input and provides a constant volume (compressed voice) output. The ***control path*** uses the varying input to change the frequency of an oscillator. The compressed-voice signal and the frequency-modulated control signal are applied to the radio transmitter.

### *Radio Path*

**2.12** A high-frequency radio path is subject to fading which includes both flat and selective fading. Flat fading affects all voice channels in the radio system at a given time. Selective fading does not affect all voice channels in the radio signal to the same degree at a given time.

**2.13** Automatic gain control (AGC) circuits in the radio receiver minimize the effects of flat fading. Selective fading is compensated for by a fading regulator circuit in the Lincompex receive terminal.

### *Receive Terminal*

**2.14** The compressed-voice signal at the output of the fading regulator is applied to an expander circuit. Simultaneously, the control signal detector provides a dc signal which sets the instantaneous gain of the expander circuit to the proper value. This results in an expander output which is an accurate reproduction of the compressor input. During intervals of no voice input, the expander has a high loss which blocks noise.

*Facility Requirements*

**2.15** The composite signal between Lincompex terminals is composed of the amplitude-modulated compressed-voice signal and the frequency-modulated control signal. This composite signal is subject to the effects of both amplitude variations and frequency variations that may be introduced by the interconnecting transmission facility.

**2.16** The interconnecting facility, exclusive of the high-frequency radio path, is composed of the voice-frequency landline circuit, which may be physical pairs or a carrier (on land) channel, the radio transmitter, and radio receiver for both land and ship stations.

**2.17** For optimum performance, the entire transmission facility should have an essentially flat frequency response over the voice-frequency band from 250 to 3000 Hz and should have an overall frequency-translation error of 2 Hz for type 100 and 1 Hz for type 101 at the control setting point frequency of 2530 Hz.

**2.18** The loading effect of the compressed-voice signal plus the control signal on the radio transmitter depends on the number of voice circuits per system. The high-frequency radio carrier used must be free from spurious frequency and amplitude modulation, or any form of instability, regardless of cause.

**2.19** Four-wire type privacy equipment must be used on circuits where privacy is required. Inversion-type or splitband-type of privacy equipment may be used. If splitband privacy is used, the upper band must be in the normal condition. The delay of the Lincompex should be adjusted to compensate for the delay of the privacy equipment.

## 3. CIRCUIT DESCRIPTION

*Transmit Terminal (Fig. 8)*

**3.01** The design input reference test signal level to the splitter is −16 dBm. An attenuator is used to adjust the splitter input to the required level. The splitter produces two identical outputs which pass along separate paths: the speech path and the control path. The speech path signal is delayed by 4 ms and then passes through compressors 1 and 2, which are controlled by currents from the amplitude assessor (in the control path). Each compressor has a clamping circuit to adjust the overall characteristic to that shown in Fig. 3.

**3.02** The precompressor delay ensures that the compressor starts to operate before the speech signal arrives at the compressor input. This reduces the signal overshoot, at the output of the compressor, to an acceptable level. The peak limiter removes those signal peaks caused by overloads, or input signal peaks of short duration, which could cause overmodulation of the transmitter.

**3.03** From the peak limiter the signal goes to the main delay, consisting of four separate 4-ms delay modules. These provide the delay necessary in the speech path to bring the speech signal and control signal to their correct time relationship in the expandor at the ship end of the link.

**3.04** A 0-25 dB amplifier (in the L.P. FILTER module) is used to correct small variations in the output level from the peak limiter. This ensures that the level at the privacy point is the specified 0 dBm. At the time this section was written, there were no plans for using privacy equipment on the ship-to-shore stations. If those plans change, a revision of this section will be furnished.

**3.05** The low-pass filters ensure that the frequency components of the compressed speech signal above 2380 Hz are not passed to the output, hence preventing speech harmonics from appearing within the control frequency band.

**3.06** The control path signal is processed by the amplitude assessor, which produces three current outputs. Two of the outputs control the speech path compressors; the others control the log amplifier.

**3.07** The logarithmic amplifier converts the linearly changing control current into a logarithmic input to the FM oscillator. This produces a linear relationship between input signal level changes in dB and frequency changes in Hz. The FM oscillator frequency changes 2 Hz for each dB change in input signal level. A 0-31 dB attenuator, in the COMPRESSOR & OSCILLATOR module, is set to give a control tone frequency level 5 dB below that of the compressed speech signal at the channel output.

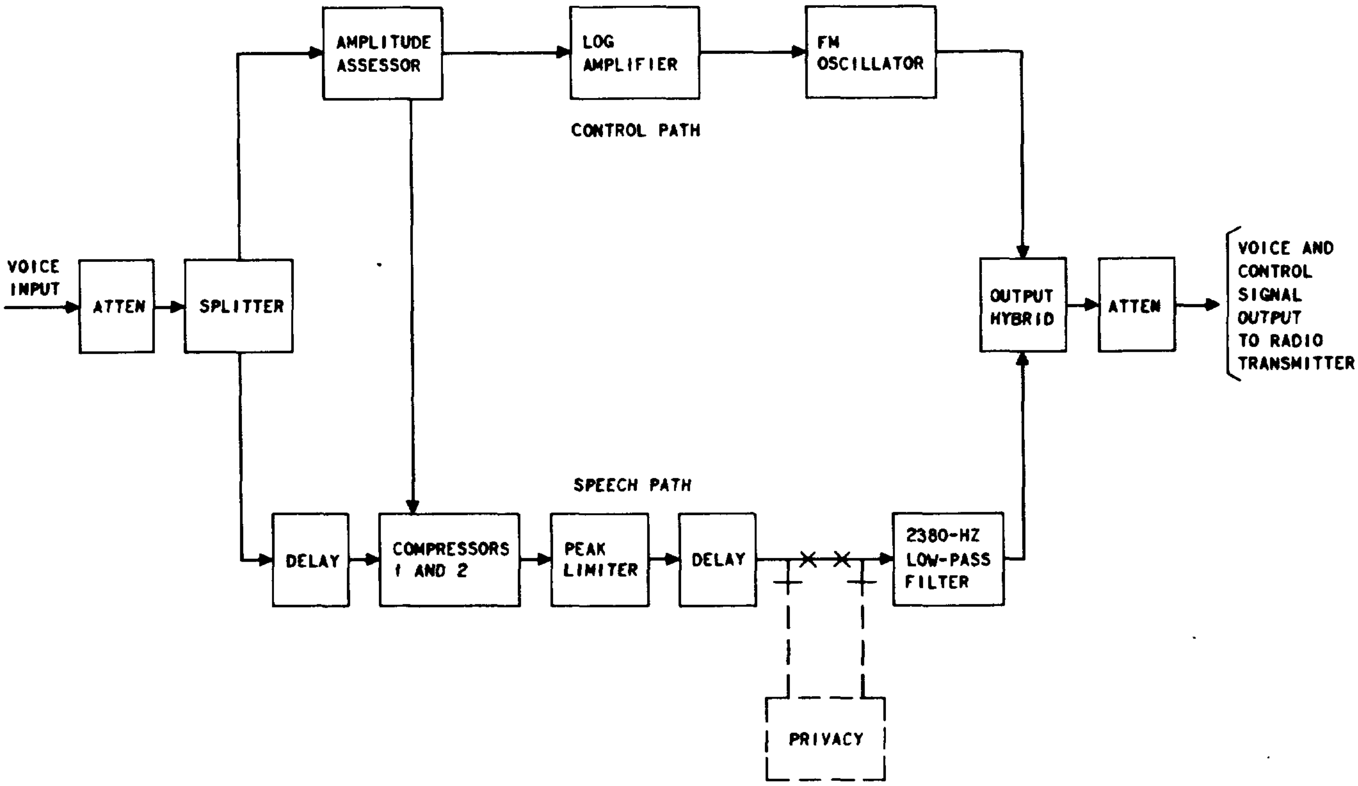


**Fig. 8—Transmit Terminal—Block Diagram**

**3.08** The control path and speech path signals are combined in the hybrid transformer and the mixed signal is amplified to a fixed level. A 0-31 dB attenuator, mounted on the rear panel, is used to adjust the composite signal level to the level required to optimally modulate the radio transmitter.

***Receive Terminal (Fig. 9)***

**3.09** The design input reference test signal level to the splitter is a mixed signal comprising a speech level of −15 dBm plus a control tone level at −20 dBm. A 0-31 dB attenuator, mounted on the rear panel, is used to adjust the maximum signal from the radio receiver, to this level. In this condition, with a fading signal, the full range of the fading regulation is utilized.

**3.10** The outputs from the splitter are passed through filters which accept, in one path, the speech signal, and in the other, the control tone signal. The speech path signal is processed by the fading regulator which gives a constant output for input signal level variations of up to 25 dB.

**3.11** The last stage of the FADING REGULATOR, a 0-25 dB amplifier, is used to adjust the level of the privacy access point to the specified 0 dBm. Following the 0-25 dB amplifier is the main delay, consisting of five separate 4-ms delay modules. These provide the delay necessary in the speech path to bring the speech signal and control signal to their correct time relationship in the expander.

**3.12** In the control path, the tone limiter prevents amplitude variations in the control tone from affecting the discriminator. The discriminator produces a dc voltage which changes linearly with changes in the control tone frequency. This signal is sent to the antilog amplifier, where it is amplified and converted into the control current. This control current has an antilogarithmic relationship with the control tone frequency. Hence, the control current is directly proportional to the compressor

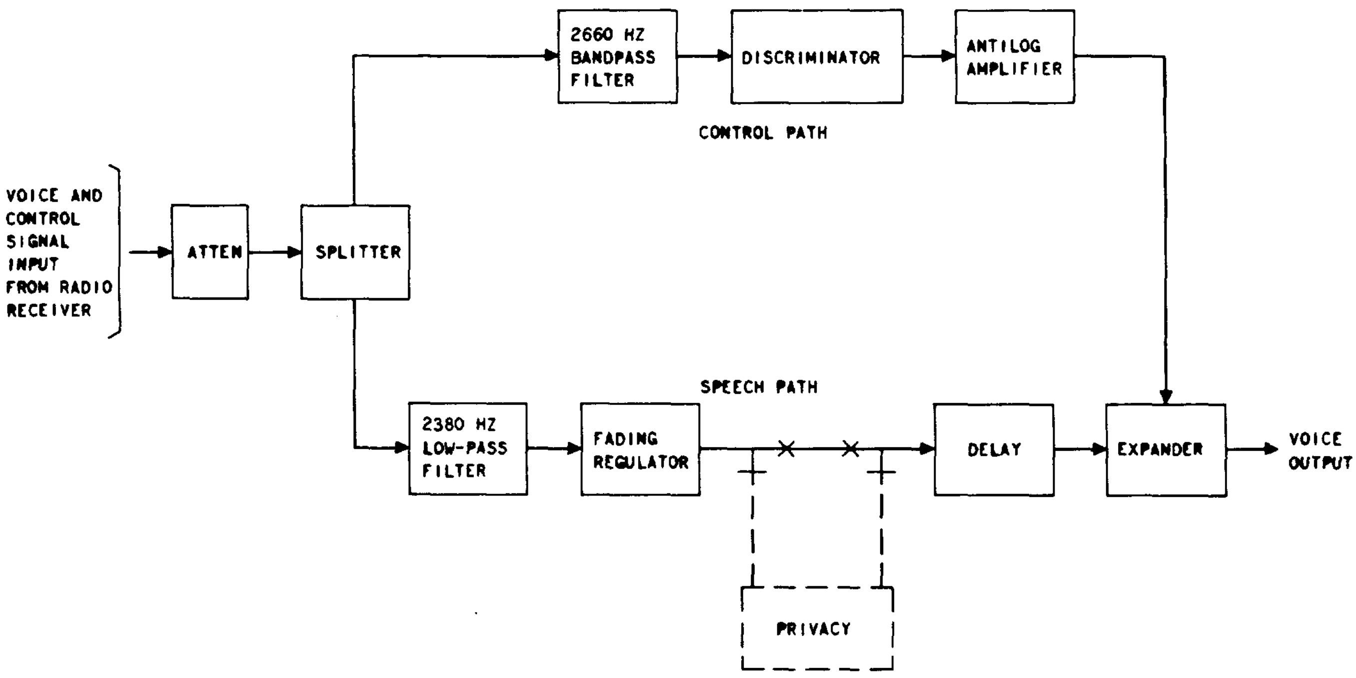


**Fig. 9—Receive Terminal—Block Diagram**

control current in the Lincompex transmit channel at the ship end of the link.

**3.13** The expander, under control of the dc control signal from the antilog amplifier, applies an instantaneous gain correction opposite that applied to the compressor. Thus, the expander output is a good reproduction of the voice signal at the transmit terminal input.