CHAPTER 1

COMMUNICATIONS HARDWARE

LEARNING OBJECTIVES

Upon completing this chapter, you should be able to do the following:

- *Determine the equipment required for each communications system.*
- *Identify the hardware setup procedures for radio systems.*
- *Identify the use of COMMSPOTS.*
- *Identify procedures and requirements for communications equipment as it pertains to OTAR/OTAT functions.*
- *Determine utilization, frequencies and watches needed for distress communication equipment.*
- *Interpret how to monitor circuit quality equipment.*

The high-paced operations required of modern fleet units demand communication systems that are capable of providing high-speed, accurate, and secure transmission and reception of intelligence. To keep pace with the ever-increasing complexity of operations, today's communication systems are necessarily highly sophisticated and versatile. For our ships and submarines to operate effectively, whether independently or as part of a battle group, they must have communication systems and operators that are capable of meeting this challenge.

In this chapter, we will discuss various aspects of fleet communication systems. As a Radioman, you will be responsible for knowing the different communication systems used by the Navy and what communication equipments make up a system.

COMMUNICATIONS SYSTEMS

Through equipment design and installation, many equipments are compatible with each other and can be used to accomplish various functions. Using this design concept, nearly all the communication needs of a ship can be met with fewer pieces of communications equipment than were previously required.

Communications can be maintained at the highest possible state of readiness when all levels of command understand the capabilities and limitations of the systems. Many communications failures are attributable to poor administration rather than to equipment failure or technical problems.

In this section, we will discuss predeployment readiness; low-, high-, very-high-, ultra-high-, and super-high-frequency communications systems; and equipment components that comprise these systems.

UNDERWAY PREPARATION

Ships deploying to overseas areas must be in a state of maximum operational and communications readiness. Type commanders determine the level of readiness of deploying ships and ensure they are adequately prepared.

A check-off list is an excellent method to ensure that step-by-step preparations are completed prior to a deployment. This list should cover all aspects of communications readiness and should begin well in advance of the underway period. Some of the points to be checked include scheduling of communications assistance team (CAT) visits, maintenance and operational checks of equipment and antennas, and consumable supply levels.

The *Basic Operational Communications Doctrine (U),* NWP 4 (NWP 6-01), provides suggested minimum check-off sheets, including a **predeployment check-off sheet** and a **preunderway check-off sheet.** The first sheet provides a timetable of required checks and objectives. The second sheet is tailored to individual ships and unique requirements.

LOW-FREQUENCY SYSTEMS

The low-frequency (LF) band (30-300 kHz) is used for long-range direction finding, medium- and long-range communications, aeronautical radio navigation, and submarine communications.

A low-frequency transmitter, such as the AN/FRT-72, is used to transmit a high-powered signal overlong distances. Low-frequency transmitters are normally used only at shore stations or for special applications.

The low-frequency receive system is designed to receive low-frequency broadcast signals and to reproduce the transmitted intelligence. A typical low-frequency receive system is shown in figure 1-1. Refer to the equipments in the figure as you study the next section.

1. **Antennas—** The low-frequency signal is received by the antennas, which are connected to the receiver antenna patch panels and multicouplers (AN/SRA-34, AN/SRA-57, or AN/SRA-58). Multicouplers and patch panels allow the operator to select different antennas and connect them to different receivers. This way, an operator can select the correct combination suited for a particular system.
2. **LF Receiver—** The output of the receiver (audio) is fed to the receiver transfer switchboard.
3. **Switchboard—** The switchboard can connect the receiver output to numerous pieces of equipment. In figure 1-1, the receiver output is connected to the AN/UCC-1 Teleprinter Terminal (discussed later).
4. **AN/UCC-1—** The AN/UCC-1, as a converter comparator, converts the received audio signal

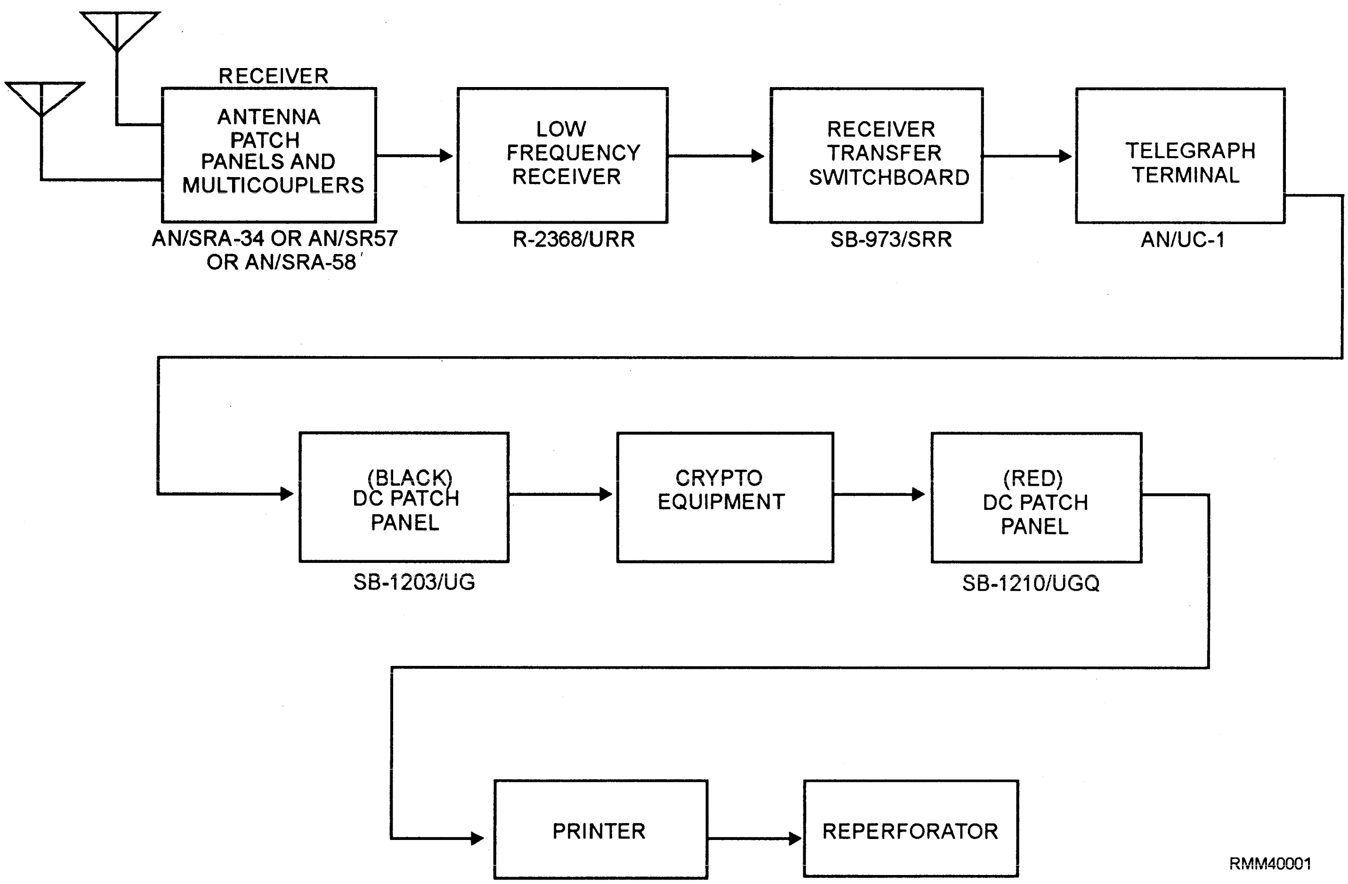


Figure 1-1.—Low-frequency receive system.

(AF) to direct current (dc) for use by the teleprinter equipment.

5. **Black dc Patch Panel—** The dc output of the AN/UCC-1 is fed to the SB-1203/UG DC Patch Panel. The dc patch panel permits the signal to be patched to any cryptoequipment (discussed later) desired.

6. **Cryptoequipment—** The cryptoequipment decrypts the signal and connects its output to the red SB-1210/UGQ DC Patch Panel.

7. **Red dc Patch Panel—** The SB-1210/UGQ can be patched to a selected printer that prints the signal in plain readable text.

HIGH-FREQUENCY SYSTEMS

The high-frequency (HF) band (3-30 MHz) is primarily used by mobile and maritime units. The military uses this band for long-range voice and teleprinter communications. This band is also used as a backup system for the satellite communications system. We will discuss satellite communications later in this chapter.

Figure 1-2 shows a typical high-frequency transmit system. In transmitting teleprinter information, the equipments shown in figure 1-2 perform the same functions as the equipments shown in figure 1-1, except the equipments in the high-frequency system do the functions in reverse order.

In the HF transmit system, the AN/UCC-1 Telegraph Terminal converts dc signals into audio tone signals. The output of the AN/UCC-1 is connected to the transmitter transfer switchboard. The C-1004 Transmit Keying and Receive Control/Teleprinter is used to key the transmitter during teleprinter operations.

Voice communications from some remote locations are also connected to the transmitter transfer switchboard. Voice communications are initiated at a handset (remote phone unit) and connected to the C-1138 Radio Set Control. The output of the radio set control is connected to the transmitter transfer switchboard. The transmitter transfer switchboard permits the operator to select the proper transmitter for the frequency to be transmitted.

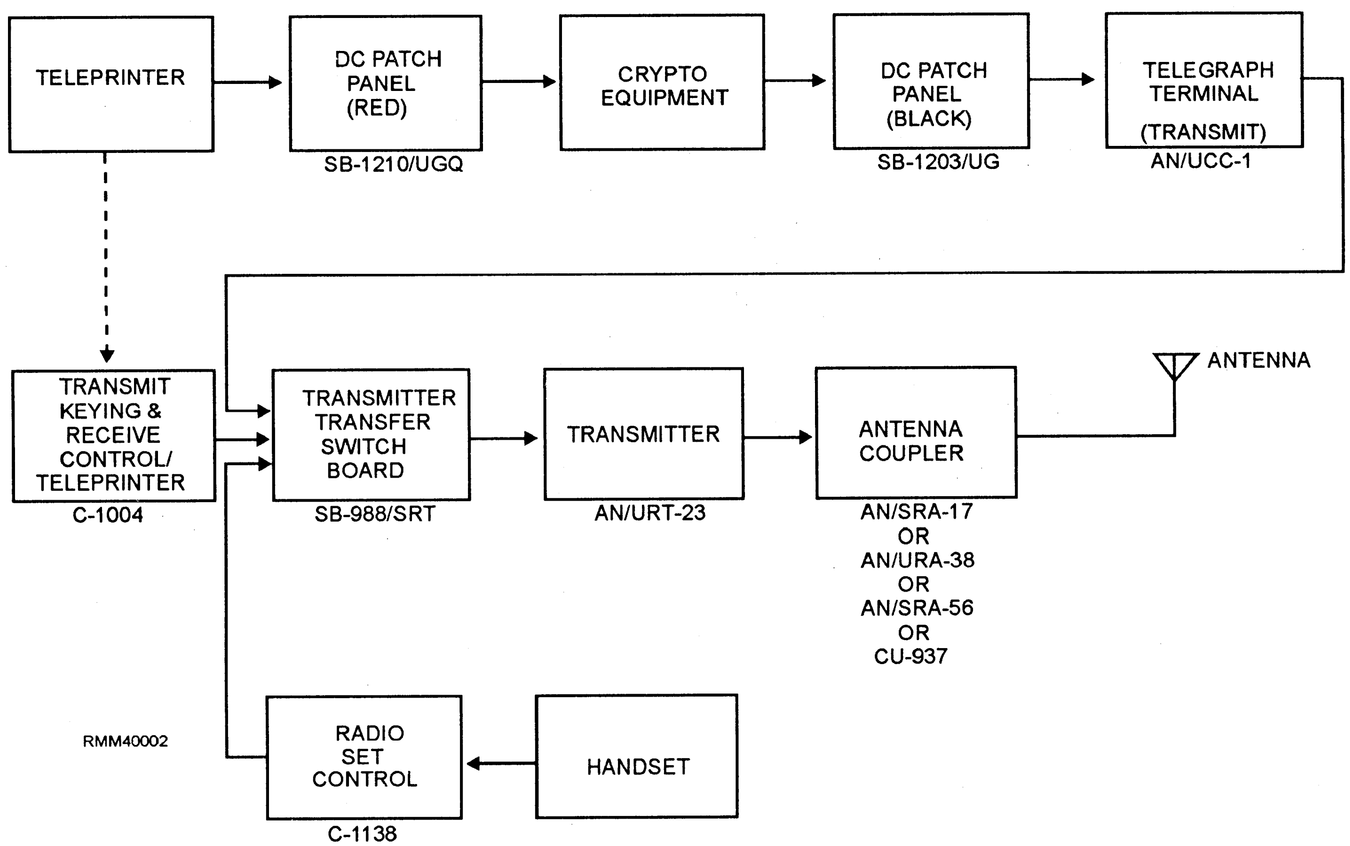


Figure 1-2.—High-frequency transmit system.

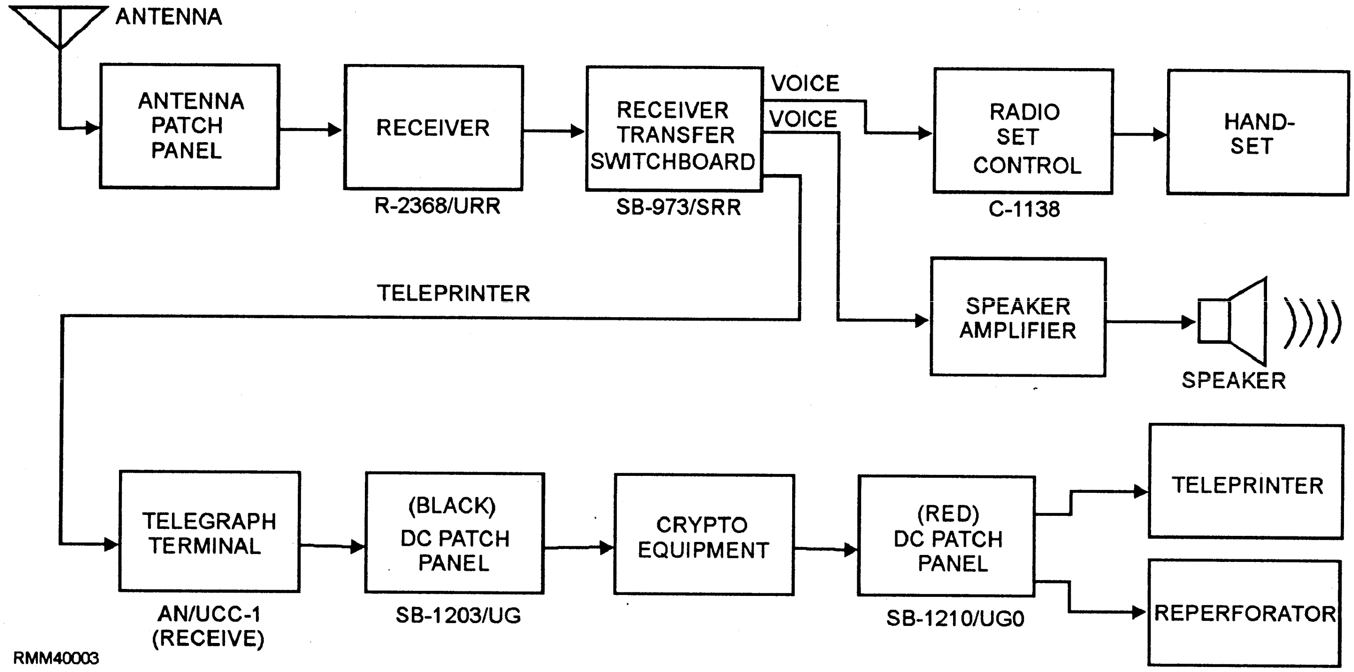


Figure 1-3.—High-frequency receive system.

Figure l-3 shows atypical high-frequency receive system. Refer to the figure as we follow the signal path through the system.

1. A transmitted high-frequency signal is received by the antenna, which converts electromagnetic energy to electrical energy.
2. The signal travels through a transmission line to an antenna patch panel, where it can be distributed to any of a number of receivers.
3. The receiver converts the RF signal into a teleprinter or voice signal, depending upon what is desired.
4. The output of the receiver is then sent to the receiver transfer switchboard.
5. If a teleprinter signal was selected, the teleprinter signal from the switchboard goes to the AN/UCC-1 and then follows the same path as we described in the low-frequency receive section. Identical pieces of equipment are used, and they perform the same functions.
6. If a voice signal was selected, the voice signal from the receiver transfer switchboard is sent to the radio set control. The output is then sent to a handset. The voice signal can also be sent from the switchboard to a remote speaker amplifier. There, it can be placed on a speaker so that the user can listen to the received signal without holding onto the handset.

VERY-HIGH-FREQUENCY SYSTEMS

The very-high-frequency (VHF) band (30-300 MHz) is used for aeronautical radio navigation and communications, radar, amateur radio, and mobile communications (such as for boat crews and landing parties). Figure 1-4 shows a basic block diagram of a

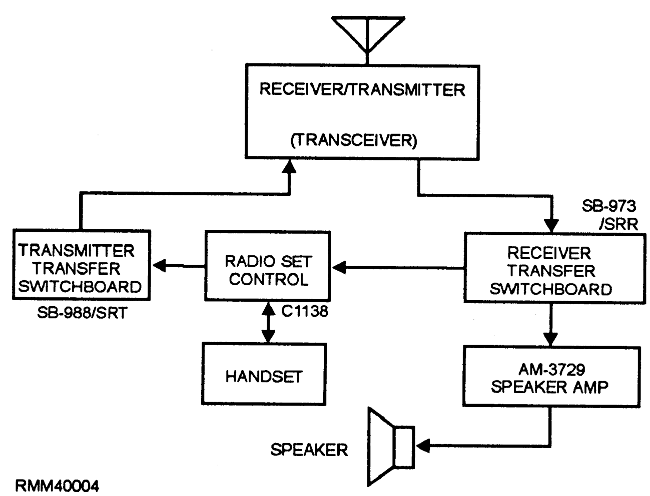


Figure 1-4.—Very-high-frequency transmit and receive system.

VHF transmit and receive system using a transceiver. Although a transceiver is used in this system, the transmit and receive systems are described separately. Refer to figure 1-4 as we follow the signal path on the transmit side of the system.

On the transmit side of the system, the operator, at a remote location:

1. Talks into the handset.
2. The handset is connected to the C-1138 Radio Set Control.
3. The output of the radio set control is sent to the transmitter transfer switchboard.
4. The output of the switchboard is sent to the transmit side of the transceiver.
5. The transceiver converts the input signal to an RF signal for radiation by the antenna.

Continue to refer to figure 1-4 as we follow the path of the incoming signal.

1. The incoming signal in figure 1-4 is received by the antenna.
2. This signal is sent to the receive side of the transceiver.
3. The output of the transceiver is sent to the receiver transfer switchboard.
4. From the receiver transfer switchboard, the output is sent to either the C-1138 Radio Set Control or to a speaker amplifier, or both, depending on the preference of the user.
5. The output of the radio set control is sent to a handset.
6. A speaker receives the output of the speaker amplifier.

ULTRA-HIGH-FREQUENCY SYSTEMS

The ultra-high-frequency (UHF) band (300-MHz to 3-GHz) is used for line-of-sight (short-range) communications. The term "line of sight," as used in communications, means that both transmitting and receiving antennas must be within sight of each other and unaffected by the curvature of the Earth for proper communications operation.

The UHF band is also used for satellite communications. Although satellite communications are line of sight, the distance the signal travels is much greater than that of UHF surface communications, because the antennas remain in sight of each other.

As in the VHF section, the transmit and receive systems will be described separately. Figure 1-5 shows a basic block diagram of a UHF transmit system, which uses a transceiver.

1. On the transmit side of the nonsecure voice system, the operator at a remote location talks into the handset. The handset is connected to the C-1138 Radio Set Control.
2. The C-1138 is connected to the transmitter transfer switchboard, where it is patched to the transmitter.
3. The operator at a remote location talks into the secure voice remote phone unit (RPU).
4. The RPU is connected to the secure voice matrix. This is the tie point for connecting more than one RPU. The output of the matrix is

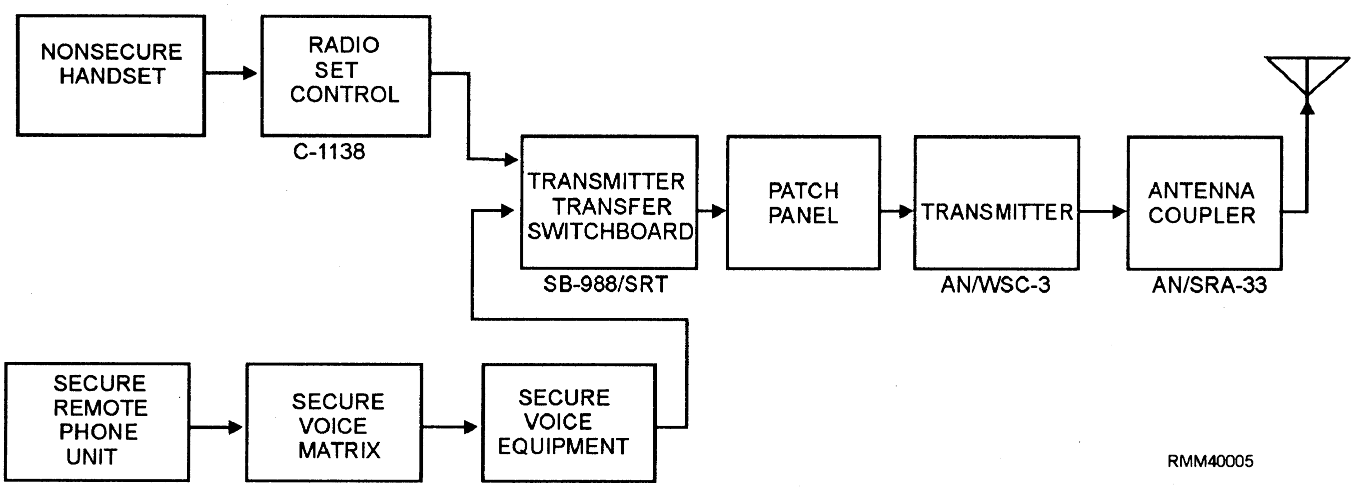


Figure 1-5.—Ultra-high-frequency transmit system.

connected to the secure voice equipment, which encrypts the information received.

5. The output of the secure voice equipment is connected to the transmitter transfer switchboard.
6. The transmitter transfer switchboard is used to connect numerous RPUs to any number of transmitters.
7. The output of the patch panel is connected to the transmitter side of the transceiver, which, in turn, is connected to an antenna coupler.

Figure 1-6 shows a basic diagram of a UHF receive system. We will next follow the UHF signal path through the receive side of the system.

1. The received signal is picked up by the antenna and connected to the receiver side of the transceiver through the antenna coupler.
2. The output of the receiver is connected to the receiver transfer switchboard. From here, it can be connected to either the nonsecure or the secure voice systems, depending upon the mode of transmission.
3. When a nonsecure signal is received, the output of the receiver transfer switchboard can be connected to the radio set control or a speaker amplifier, or both, depending on the preference of the user.
4. The output of the radio set control is connected to a handset, whereas the output of the speaker amplifier is connected to a speaker.
5. If a secure voice transmission is received, the output of the receiver transfer switchboard is connected to the secure voice equipment, where it is decrypted.
6. The secure voice equipment output is connected to the secure voice matrix. The secure voice matrix performs the same function as the matrix on the transmit system.
7. The secure voice matrix output is connected to the secure remote phone unit. Here, the signal is converted back to its original form.

SUPER-HIGH-FREQUENCY SYSTEMS

The super-high-frequency (SHF) band (3-30 GHz) is strictly for line-of-sight communications. It is configured much the same as the UHF system. SHF is mainly used for satellite communications.

SHF satellite communications is a high-volume system that offers reliable tactical and strategic communications services to U.S. Navy elements ashore and afloat. The system is composed of the terminal segment, consisting of U.S. Navy-operated Earth terminals and mobile terminals. It also includes a portion of the Defense Satellite Communications System (DSCS) satellite segment. *Navy Super High Frequency Satellite Communications,* NTP 2, Section 1 (C), provides comprehensive coverage of the Navy SHF satellite system.

PATCH PANELS

Teleprinter patch panels are used for the interconnection and transfer of teleprinter signals aboard ship. In the previous block diagrams two patch panels, one labeled red, the other black, were shown. These are the teleprinter patch panels SB-1210/UG and

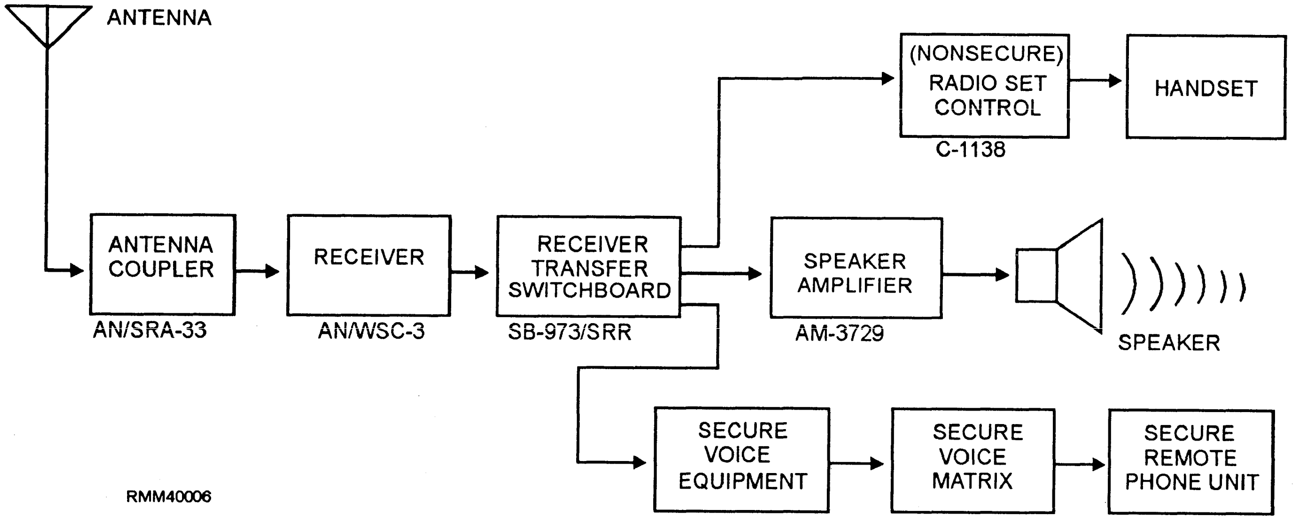


Figure 1-6.—Ultra-high-frequency receive system.

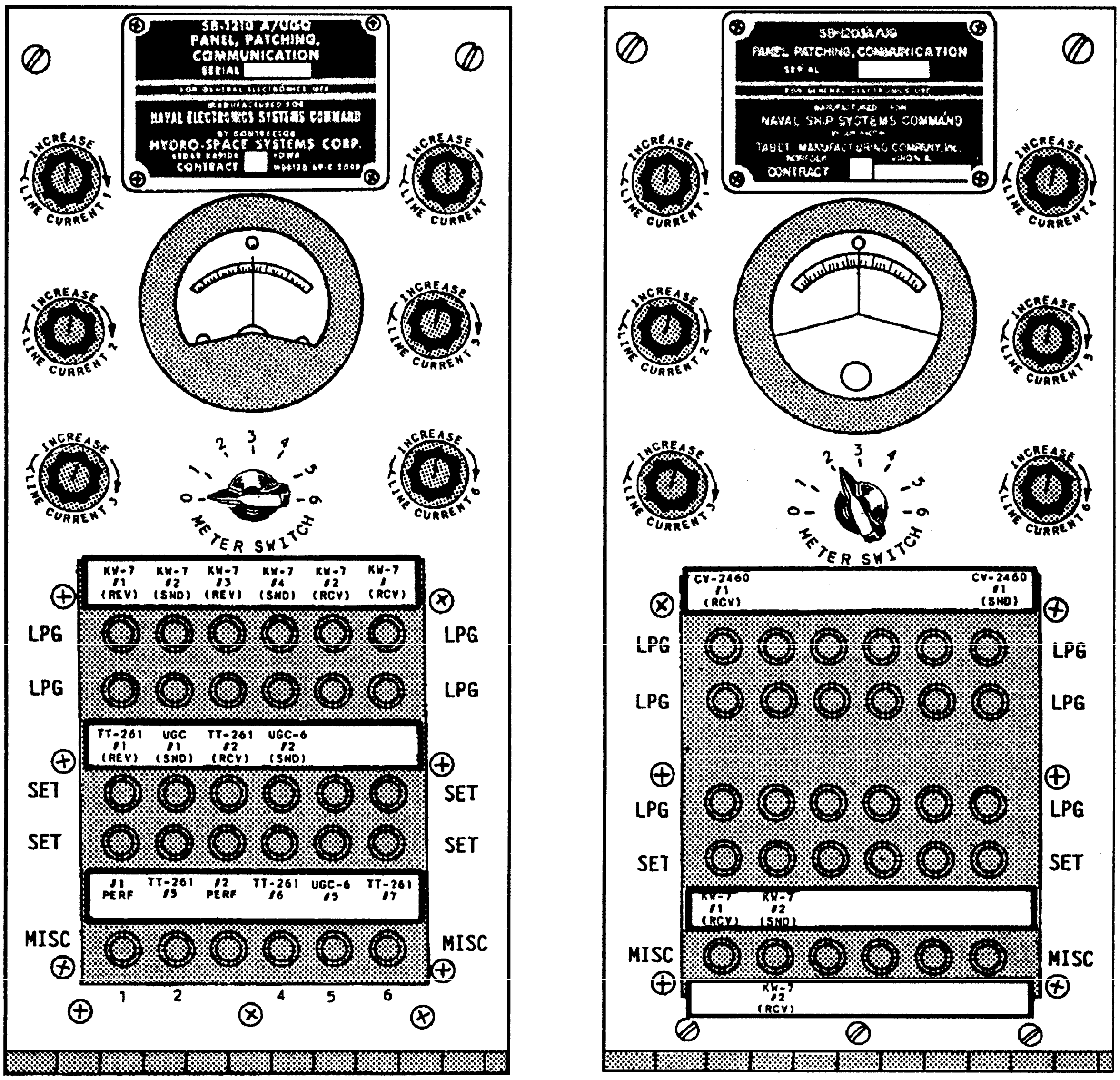
SB-1203/UGQ (figure 1-7). The SB-1210/UG is intended for use with cryptographic devices; the SB-1203/UGQ is a general-purpose panel.

The patch panels are red or black to identify secure and nonsecure information. Red indicates that secure (classified) information is being passed through the panel. Black indicates that nonsecure (unclassified) information is being passed through the panel.

Both panels are also labeled with signs. The red panel sign has 1-inch-high white block letters that read "RED PATCH PANEL." The black panel normally has two black signs containing l-inch-high white block letters. One sign reads "BLACK PATCH PANEL" and the other, "UNCLAS ONLY."

Each panel contains six channels. Each channel has its own series circuit of looping jacks, set jacks, and a rheostat for adjusting line current. The number of looping and set jacks in each channel varies with the panel model. Each panel includes a meter and rotary selector switch for measuring the line current in any channel.

Six miscellaneous jacks are contained in each panel. Any teleprinter equipment not regularly assigned to a channel maybe connected to one of these jacks. In some instances, commonly used combinations of equipment are permanently wired together within the panel (called *normal-through).*



(RED), SB-1210/UG RMM40007 (BLACK), SB1203/UGQ

Figure 1-7.—Teleprinter patch panels.

CRYPTOGRAPHIC EQUIPMENT

Some of the systems in the previous figures contained cryptographic equipment. Cryptographic equipment is only one of a number of the elements that make up a secure communications system. Though several different types of on-line cryptoequipments are in use throughout the naval communications system, they are all designed to perform the same basic function: to encipher and decipher teleprinter or digital data signals.

Simply stated, the transmitter accepts a "plain text" teleprinter or data signal containing classified material from the classified patch panel (red). It then adds a "key," and relays the sum as "cipher text," or an enciphered signal. A key is a sequence of random binary bits used to initially set and periodically change permutations in cryptoequipment for decrypting electronic signals.

Following this encryption, the signal is fed to the unclassified patch panel (black). Here, it is patched directly to the frequency-shift keyer or the multiplex equipment of the transmitter and converted into an audio signal. The audio signal, now in a form suitable for transmission, is routed to the transmitter via the transmitter transfer switchboard.

On the receive side, the signal flow is quite similar to the send side in reverse order. The receiver accepts the enciphered signal from the black patch panel and generates a key to match the one generated by the transmitter. The receiver then subtracts the key from the cipher text input (which restores the plaintext teleprinter or data signal). Finally, it passes the signal on to the red patch panel for dissemination to the terminal equipment for printout.

For further information and operator instructions on a specific type of cryptoequipment, refer to the applicable KAO publication.

AN/UCC-1 TELEGRAPH MULTIPLEX TERMINAL

Because of the traffic volume handled, many ships and shore stations require multiple teleprinter circuits on one sideband circuit. The method for increasing circuits on a sideband is called **multiplexing.** The Navy uses two multiplexing techniques in communications: time division and frequency division. The AN/UCC-1 Telegraph Multiplex Terminal uses the frequency-division technique.

The AN/UCC-1 Telegraph Multiplex Terminal (figure 1-8) is a frequency-division multiplexed terminal equipment for use with single-sideband (SSB) or double-sideband (DSB) radio circuits, audio-frequency wire lines, or microwave circuits. The AN/UCC-1 is normally used afloat on a multichannel ship-shore full-period termination (discussed later).

The following is an overview of how the AN/UCC-1 works:

- At the transmitting station, the signals from the individual circuits, known as *channels*, are multiplexed into one composite signal for transmission. The transmission with the multiplexed channels is known as a *tone package.*
- At the receiving station, the composite signal (tone package) is demultiplexed (separated) into individual signals and distributed to separate teleprinters, as required.

The terminal can operate in a nondiversity, audio-frequency diversity, space diversity, or radio-frequency diversity mode. Because of this versatility, the terminal is installed in various configurations throughout the Navy.

Each electrical equipment cabinet houses one control attenuator (right side) and up to a maximum of eight frequency-shift keyers or eight frequency-shift converters.

Since the control attenuator, keyers, and converters are solid-state, integrated-circuit, plug-in modules, the number of channels can be varied by increasing or decreasing the total number of modules. Depending upon the number of modules and the configuration used, the terminal can provide up to 16 narrowband channels.

For example, if the terminal has keyers in the top cabinet and converters in the bottom cabinet, the system could transmit different information on eight channels. Each keyer would represent a channel on the transmit side and each converter, a channel on the receive side.

Each frequency-shift keyer accepts a dc telegraph signal input from an external loop and generates the appropriate audio-frequency mark and space frequency-shift output. The individual keyers each contain two oscillators operating on opposite sides of a center frequency. For example, in figure 1-9, the center frequency of keyer number one is 425 Hz, the mark frequency is 382.5 Hz, and the space frequency is 467.5

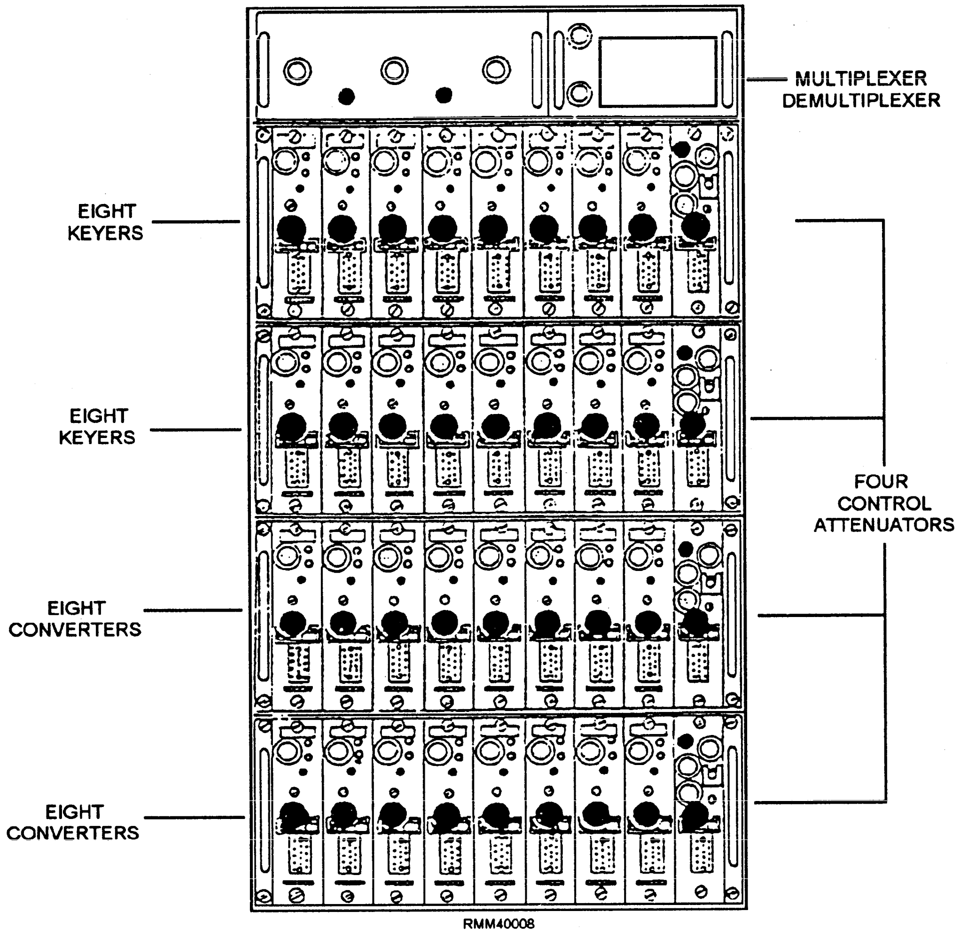


Figure 1-8.—AN/UCC-1 Telegraph Multiplex Terminal.

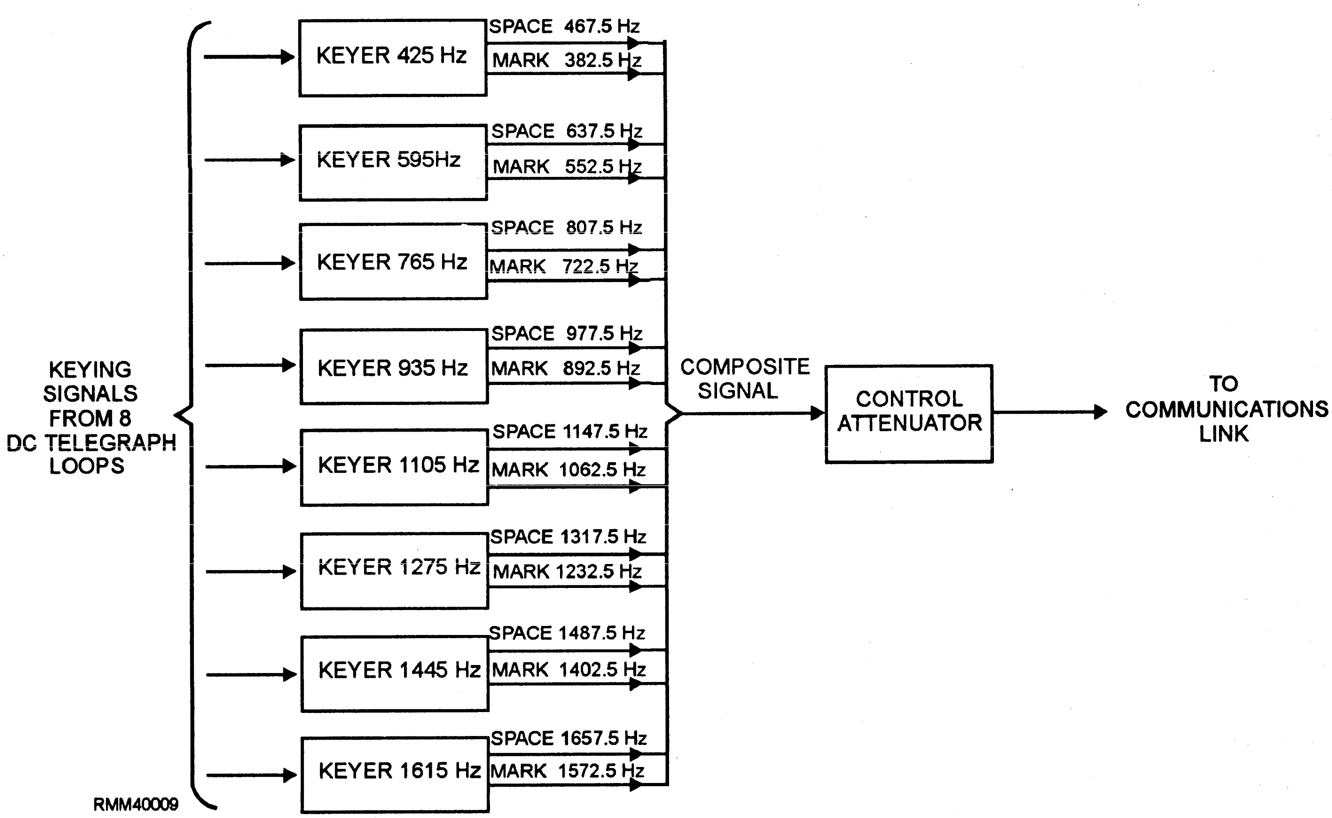


Figure 1-9.—Keying frequencies of the AN/UCC-1.

Hz. These audio-frequency mark and space outputs are referred to as “tones”; thus keyer one has a one-channel, two-tone output.

A dc telegraph signal on channel 1 determines which frequency is gated from the keyer to the group attenuator. Each channel works in the same way. It accepts a dc signal of marks and spaces from selected equipments patched to that channel. It then provides an audio output of either a mark or space frequency-shifted tone, according to the input.

The individual tones are combined at the control attenuator into a composite tone package. The control attenuator ensures that the composite tones remain at a constant amplitude for modulating the transmitter.

At the receiving end of the communications link, the AN/UCC-1 reverses the process performed at the transmitting end. The AN/UCC-1 applies the information on each of the channels to the selected equipments connected to the converter of that charnel.

In a frequency-division circuit configuration, each channel has an input from a different teleprinter. If a channel fades at a particular frequency, the information on the channel could be lost or distorted. In such cases, the information may need to be retransmitted. To help prevent this, diversity switches that will permit the use of more than one channel for the same intelligence are available.

In switch position 1, only the normal channel is used. In position 2, a single teleprinter signal provides input for two adjoining keyers. In position 4, four keyers are connected to the same input loop. The switches on all keyers must be in the same position to provide the same intelligence to the selected combination of channels.

When identical intelligence untransmitted on two or four channels, it is less likely to be lost or distorted. At the receiving end, two or four corresponding converters may be used; the converter having the stronger signal input automatically provides the signal to be used by the receiving teleprinter.

In the fleet broadcast multiplexing system, which consists of 16 channels, 2 channels normally carry the same intelligence. This process is called *twinning.*

Another method of multiplexing mentioned earlier is time-division multiplexing (TDM). In this method, a digital input is fed to a TDM unit. Here, it is multiplexed into a composite intelligence stream for transmission. The output is sent to an end user, where it is broken into its original individual inputs.

However, instead of splitting the frequencies as in frequency-division multiplexing (FDM), TDM shares time. Each input uses the full bandwidth of the assigned frequency but is assigned unique time portions of the system. Figure 1-10 illustrates the front panel of a full-duplex time-diversity modem.

SHIP-SHORE CIRCUITS

As we mentioned earlier, the fleet broadcast is the primary means for delivering messages to afloat commands. This section discusses a few of the other types of circuits by which a ship can transmit its message traffic ashore or to other ships for delivery or relay.

SHIP-SHORE CIRCUIT MODES OF OPERATION

There are three methods of operating communications circuits: duplex, simplex, and semiduplex. The mode of operation at any given time depends upon equipment and frequency availability.

Duplex

Duplex describes a communications circuit designed to transmit and receive simultaneously. In such operations, each station transmits on a different frequency and both stations transmit concurrently. Both

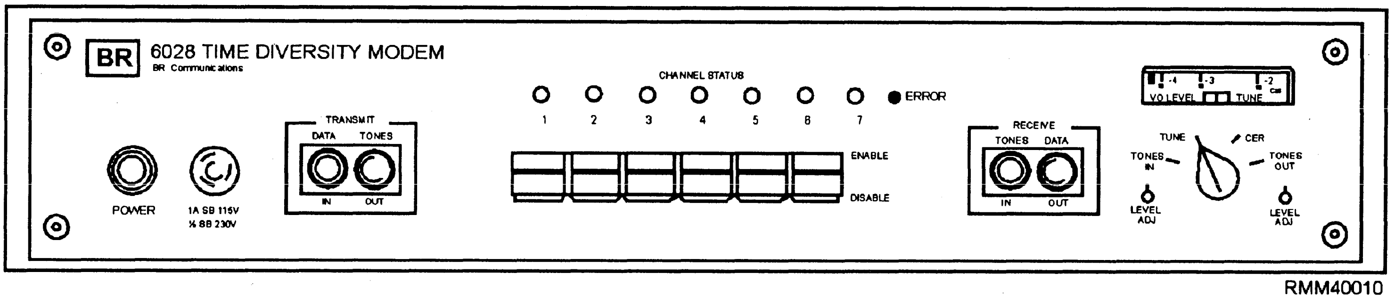


Figure 1-10.—Full-duplex time-diversity modem.

stations are required to keep transmitters on the air at all times and to send a phasing signal at the request of the distant end. Figure 1-11 shows a diagram of a UHF/HF full-duplex FSK (frequency-shift keying) single-channel teleprinter relay circuit.

There are two types of duplex operation: full duplex and half duplex. Full duplex (FDX) refers to a communications system or equipment capable of transmitting simultaneously in two directions. Half duplex (HDX) pertains to a transmission over a circuit capable of transmitting in either direction, but only one direction at a time.

Small ships traveling in company normally use duplex in a task group common net in which they terminate with a larger ship that is serving as net control. The net control ship provides the ship-shore relay services. Ships traveling independently can use this system for anon-call ship-shore termination to transmit their outgoing messages.

Simplex

Simplex is a method of operation that provides a single channel or frequency on which information can be exchanged (figure 1-12). Simplex communications operation is normally reserved for UHF and those ships that do not have sufficient equipment for duplex operation. In some cases, a simplex circuit can be established when equipment casualties occur.

Where no HF simplex frequency is indicated or guarded, ships requiring a simplex ship-shore circuit must call on a duplex ship send frequency. The ship must state "SIMPLEX" in the call-up, indicating that the ship cannot transmit and receive simultaneously.

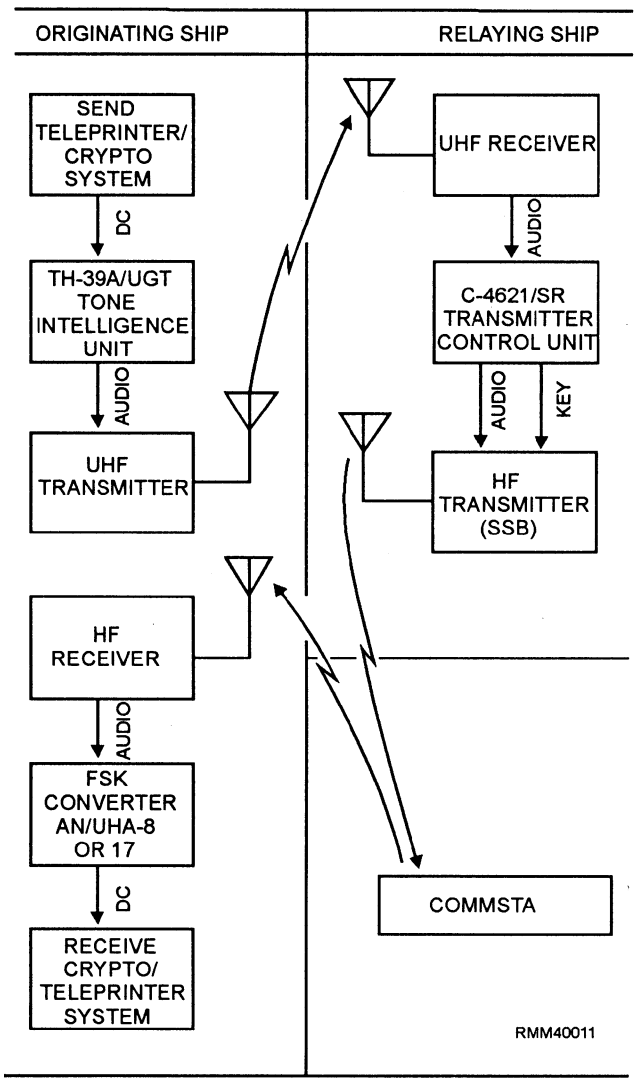


Figure 1-11.—UHF/HF full-duplex FSK single-channel teleprinter relay circuit.

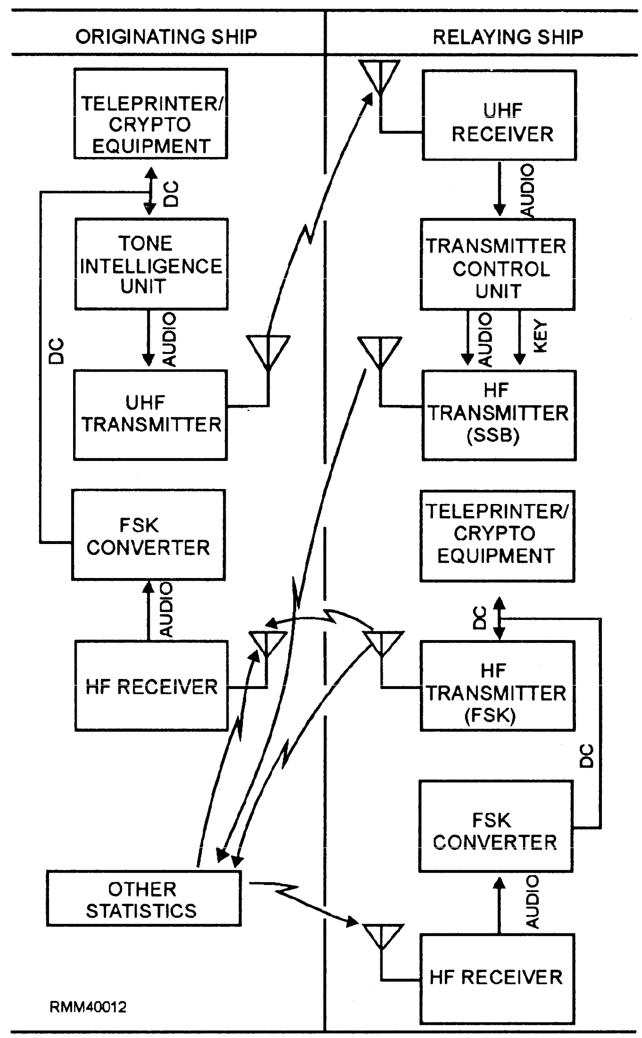


Figure 1-12.—UHF/HF netted simplex FSK teleprinter relay circuit.

When a ship requests simplex operation on duplex circuits, the shore station may be required to shift transmitters prior to acknowledging call-up. If no reply is received within 45 seconds, the ship should repeat the call-up procedures. If a third attempt is required, the ship should check equipment to ensure proper operation.

Semiduplex

Semiduplex communications circuits, used primarily on task force/task group/ORESTES, are a combination of the simplex and duplex modes. All stations except the net control station (NECOS) transmit and receive on the same frequency. The NECOS transmits and is received on a second frequency. The NECOS may transmit continuously, whereas all other stations must transmit in accordance with simplex procedures.

UHF/HF RELAY

The UHF/HF relay method permits long-range, uninterrupted communications during periods of hazardous electromagnetic radiation (HERO). Figure 1-13 shows a block diagram of a UHF/HF voice relay circuit.

Modern radio and radar transmitting equipments produce high-intensity RF fields. It is possible for RF energy to enter an ordnance item through a hole or crack in its skin or to be conducted into it by firing leads, wires, and the like. Here is an example of HERO. An aircraft carrier is arming aircraft on board. During arming operations, all HF transmitters must be secured to prevent possible detonation of the ordnance. To maintain its ship-shore communications, the carrier transmits to a relay ship via a UHF circuit. The relaying ship then retransmits the signal on a HF circuit to a terminated NAVCOMTELSTA. On-line

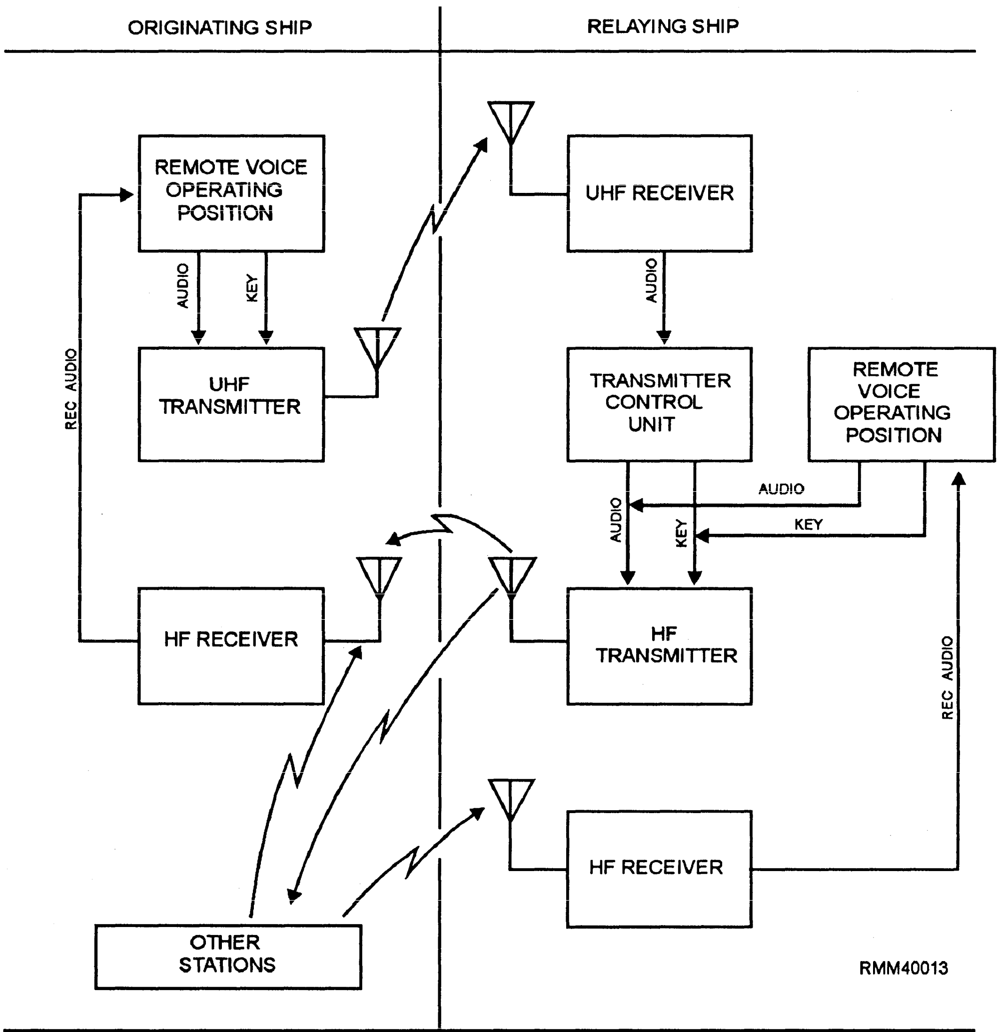


Figure 1-13.—UHF/HF voice relay circuit.

radioteleprinters can be relayed, as well as voice, using this circuit.

SECURE VOICE WORLDWIDE VOICE NETWORK

The secure voice network is designed to provide red-time voice communications between forces afloat and operational commanders ashore, using either HF or satellite connectivity. This system is commonly referred to as GPS Worldwide HICOMM.

System Control

This system consists of three separate networks. Each network has an area control station controlled by a FLTCINC; either CINCLANTFLT, CINCPACFLT, or CINCUSNAVEUR. Each area has subarea control stations determined by each FLTCINC to ensure worldwide coverage.

Satellite System Control

The secure voice system, using satellite transmissions, has limited shore access points at the four COMMAREA master stations and NAVCOMTELSTA Stockton, California. These sites serve as the interface channel to both the wideband and narrowband voice systems in order to extend calls to operational commanders ashore.

Net Membership

If a ship, aircraft, or shore station needs to enter the secure voice network, it must be prepared to do so with minimum time delay. Units desiring to enter the net on a temporary basis must specify the length of time and purpose for entering the net. They must also obtain permission from the appropriate control station. The area net control station (NECOS) is responsible for completing all calls originating from senior commands to all commands, ships, or aircraft within the specific FLTCINC's net. Certain rules must be observed when on the secure voice net, as follows:

- HF transmitter tuning is prohibited on secure voice. Transmitters must be calibrated and pretuned on a dummy load. Final tuning may be accomplished during live transmissions.

- All stations must maintain a continuous log on secure voice. The actual time of significant transmissions must be entered into the log. When available, recording devices must be used in lieu of a paper log.

- The net operates as a free net unless otherwise directed by the area FLTCINC. NECOS retains the prerogative of exercising control over all transmissions to ensure proper circuit discipline.

FULL-PERIOD TERMINATIONS

Full-period terminations are dedicated circuits that provide communications between shore stations and afloat commands. These terminations require allocation of limited NCTAMS/NCTS assets. Therefore, the criteria for requesting, approving, and establishing such circuits is necessarily strict.

Termination Requests

Afloat commands and individual units can request full-period termination during special operations, deployments, intensive training periods, or exercises when primary ship-shore circuits will not suffice. Commands should request full-period terminations only when traffic volume exceeds speed and capability of ship-shore circuits and when operational sensitivity requires circuit discreetness or effective command and control necessitates dedicated circuits.

The heavy demands placed upon NCTAMS/NCTSs for full-period terminations require maximum cooperation between shore stations and afloat commanders prior to and during an operation. Ships having a need for a full-period termination, either for training or operational requirements, must submit a termination request to the COMMAREA master station at least 48 hours prior to activation time.

Emergency commitments or a command directive may necessitate a lead time of less than 48 hours. Whenever possible, however, the 2-day limit must be honored to achieve maximum preparation and coordination. NTP 4 gives details of required information that must be included in a termination request message.

The COMMAREA master station will assign a shore station for a ship's termination circuit. Once the shore station has been assigned, both the ship and the station may begin coordination to identify specific equipment keylists and frequencies needed to effect termination. The shore station will also act as NECOS. Two hours prior to the scheduled termination, the shore station can coordinate with the ship by telephone, local circuitry, or by primary ship-shore.

When the ship shifts terminations, the securing of the current termination and the establishment of a new termination should coincide with a broadcast shift whenever possible. The ship must submit a COMMSHIFT message.

Termination Types

There are six types of full-period terminations, as follows:

- Single-channel radioteleprinter using either radio path or landline transmission media;
- Single-channel low-data-rate satellite access using satellite transmission media;
- CUDIXS special satellite access for NAVMACS-equipped ships using satellite transmission media;
- Multichannel radioteleprinter using either radio path or landline transmission media;
- Multichannel radioteleprinter using SHF satellite transmission media; and
- Tactical intelligence (TACINTEL) access for TACINTEL-equipped ships using satellite transmission media.

Equipment Tests

To ensure that circuit equipment is in peak operational condition, complete system back-to-back off-the-air tests must be completed 24 hours prior to termination activations. Check cryptoequipment back-to-back after daily crypto changes and prior to putting circuits into service.

An aggressive PMS and quality monitoring program is essential. When checking equipment, look for power levels, scorch or burn marks, proper operation of interlocks, and cleanliness. When cleaning and inspecting antennas, look for cracks, chips, or blistering of insulators. Also check for deterioration, loose connectors, and correct insulator resistance.

COMMSPOT Reports

COMMSPOT reports will be submitted by all ships, including nonterminated units, any time unusual communication difficulties are encountered. Ships will submit the COMMSPOT to the terminating communications station. Timely submission of COMMSPOT reports is necessary to minimize further deterioration of the situation.

Rules and general instructions for preparing JINTACCS formatted COMMSPOT reports are found in the *Joint Reporting System (General Purpose Reports)*, NWP 1-03, Supp-1 (formerly NWP 10-1-13).

PRIMARY SHIP-SHORE CIRCUITS

Primary ship-shore (PRI S/S) circuits are encrypted FSK/PSK teleprinter nets that permit ships to transmit messages for delivery ashore. This service is available to units that do not maintain a full-period ship-shore termination. Navy tactical UHF satellites or the HF/UHF spectrum may be used to conduct ship-shore circuit operations. Ships may use this circuit for coordinating and establishing a full-period termination with the shore station.

The frequencies for NCTAMS and NAVCOMTELSTAS that guard primary fleet ship-shore circuits are listed in applicable CIBs distributed by the COMMAREA master stations. These frequencies are subject to change by the cognizant FLTCINC or by the NCTAMS.

OVER-THE-AIR TRANSFER (OTAT) AND OVER-THE-AIR REKEY (OTAR)

There are significant vulnerabilities associated with the handling of paper cryptographic material. Sound application of over-the-air transfer/rekey (OTAT/OTAR) procedures and techniques can reduce the amount of paper keying material required and reduce the potential for compromise. These procedures and techniques are contained in the *NAG-16B Procedures Manual for Over-the-Air Transfer (OTAT) and Over-the-Air Rekey (OTAR).*

OTAT/OTAR also makes the transfer of keying material more responsive to rapidly changing operational requirements. The use of NAG-16B was developed and verified by extensive use during operation Desert Shield/Storm. The specified procedures served as an effective vehicle for transferring keying to satisfy rapidly changing joint and Navy requirements. Expanded definitions, general procedures, and equipments are found in NAG-16B.

DISTRESS COMMUNICATIONS

Special methods of communication have been developed to use in times of distress and to promote safety at sea and in the air. Distress message traffic is best described as all communications relating to the immediate assistance required by a mobile station in distress. Distress traffic has priority over all other traffic. All U.S. Navy communicators must be familiar with distress signals to properly evaluate their meanings and to take appropriate action when necessary.

If a ship becomes involved in a distress situation, communications personnel should send distress messages on normal operating encrypted circuits. If the need for assistance outweighs security considerations, the ship's commanding officer may authorize the transmission of an unclassified distress message on one of the national or international distress frequencies.

When a ship in distress is traveling in company with other ships, the ship in distress will transmit the distress message to the officer in tactical command (OTC), who will take appropriate action.

DISTRESS FREQUENCIES

Several frequencies in different bands are designated for the transmission of distress, urgency, safety, or search and rescue (SAR) messages. The following frequencies have been designated for use during a distress or emergency situation:

- **500 kHz—** International CW/MCW distress and calling;
- **2182 kHz—** International voice distress, safety, and calling;
- **8364 kHz—** International CW/MCW lifeboat, life raft, and survival craft;
- **121.5 MHz—** International voice aeronautical emergency;
- **156.8 MHz—** FM United States voice distress and international voice safety and calling; and
- **243.0 MHz—** Joint/combined military voice aeronautical emergency and international survival craft.

During SAR missions, the following frequencies are authorized for use:

- **3023.5 and 5680 kHz—** International SAR frequencies for the use of all mobile units at the scene of a search. Also for use of shore stations communicating with aircraft proceeding to or from the scene of the search. CW and voice are authorized.
- **123.1 MHz—** International worldwide voice SAR use.
- **138.78 MHz—** U.S. military voice SAR on-the-scene use. This frequency is also used for direction finding (DF).
- **172.5 MHz—** U.S. Navy emergency sonobouy communications and homing use. This frequency is monitored by all U.S. Navy ASW aircraft assigned to a SAR mission.
- **282.8 MHz—** Joint/combined on-the-scene voice and DF frequency used throughout NATO.

The control of distress message traffic on any designated frequency is the responsibility of the station in distress. However, this station may delegate its responsibility to another station on the frequency.

Distress Watches

Navy units at sea have always maintained listening watches on distress frequencies. Communication watch requirements vary according to the operational mission of the ship and available equipment assets. Ships in company normally divide distress watch requirements among the group.

STATUS BOARD

The technical control of the shore station that is NECOS for fill-period terminations and PRI S/S circuits must maintain a status board. The status board should indicate, as a minimum, all systems/circuits that are active, tuned in, or in a standby status. It should also indicate all inoperative equipment. The watch supervisors must verify the accuracy of the information contained on the status board at watch turnover and update while on watch. The status board must show the following minimum information for active and standby circuits:

- Functional title of circuit;
- Frequency(ies), both send/receive, if fill-duplex operation is used;
- Circuit designator, from communication plan;
- Transmitter and receiver designations;
- For shore stations, keying line designations;
- Terminal equipment designation (for example, R-2368/URR #l);
- Cryptoequipment, keying material, and restart time;

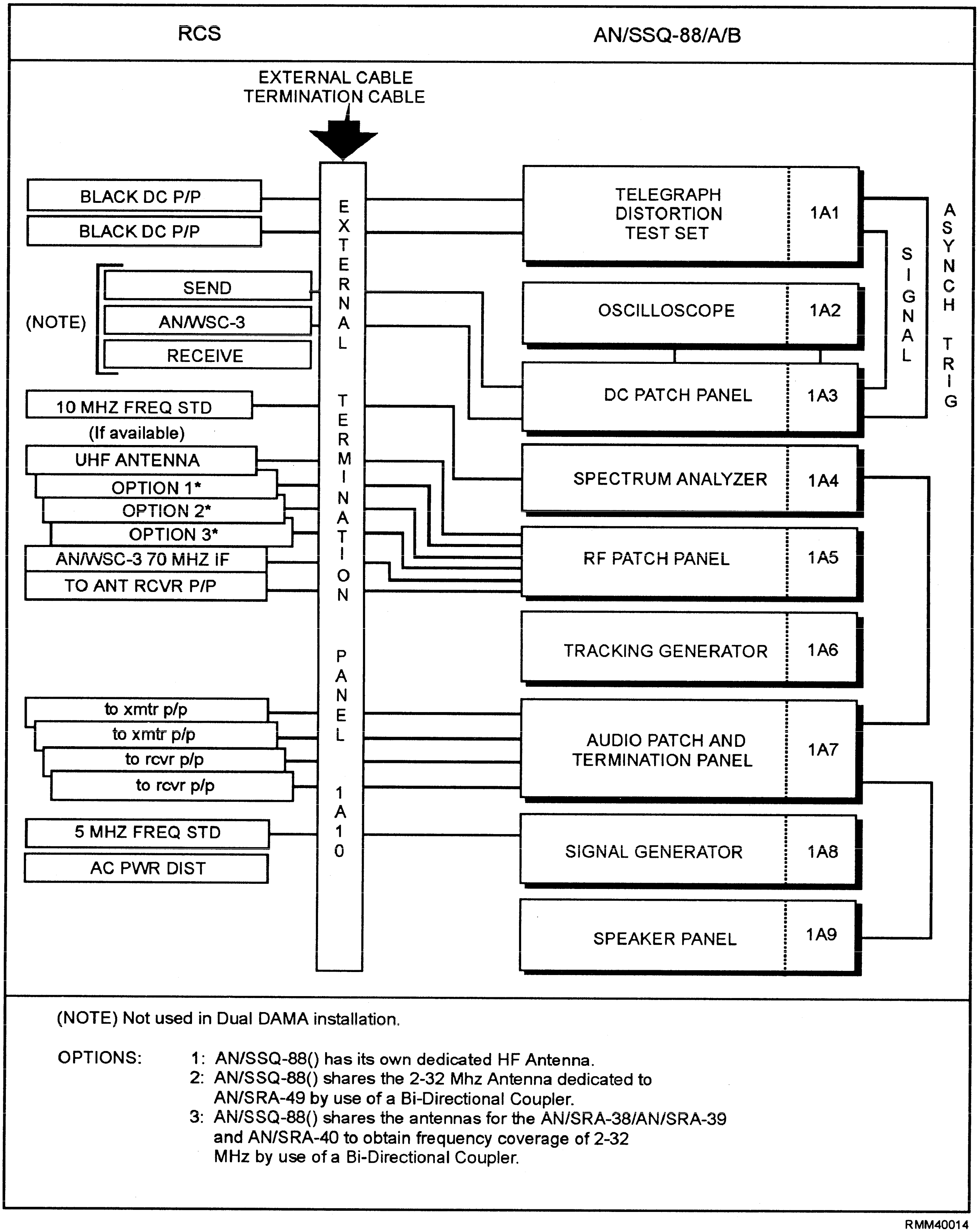


Figure 1-14.—AN/SSQ-88 Quality Monitoring Set and RCS interface.

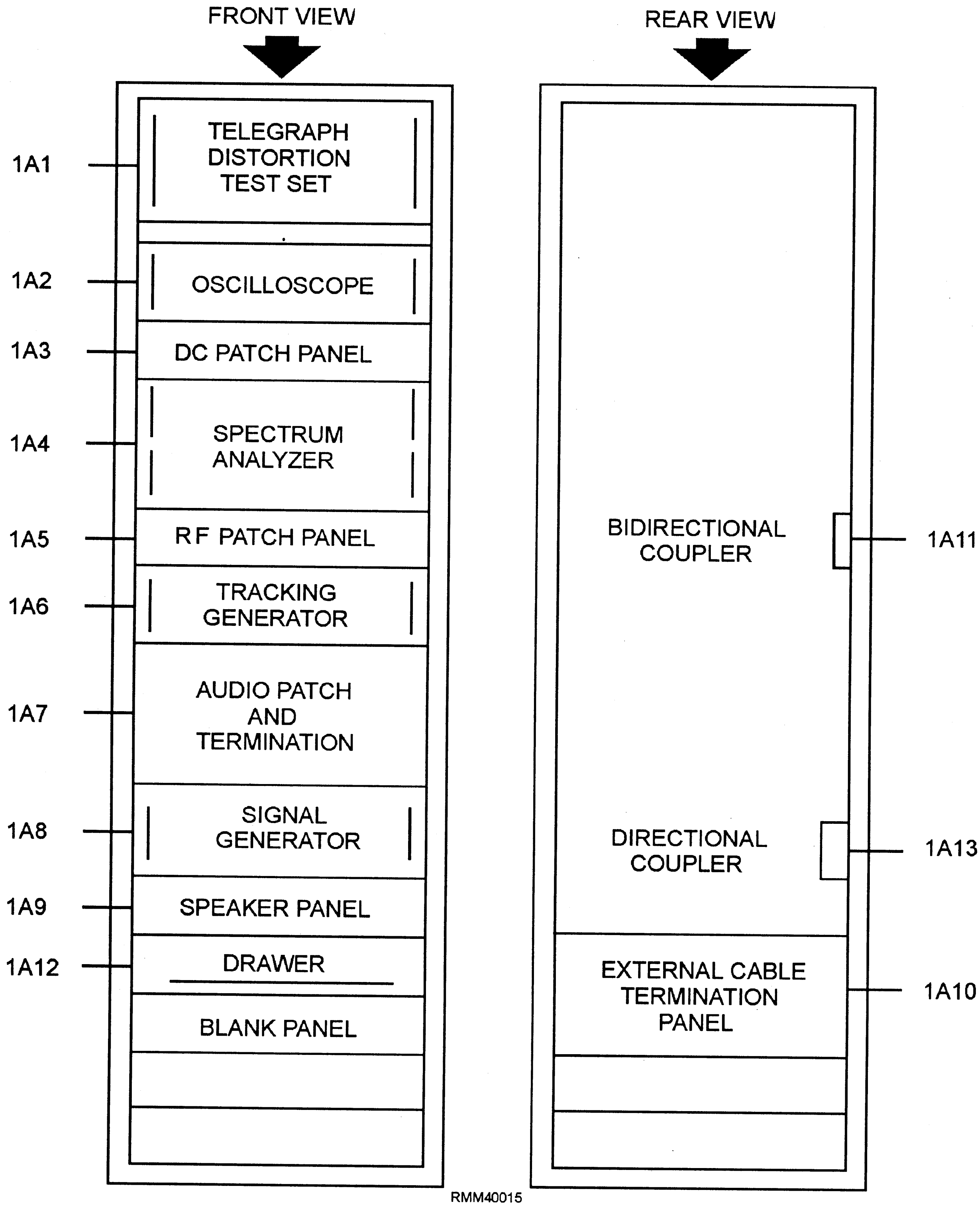


Figure 1-15.—AN/SSQ-88 equipment configuration.

- Operating position or remote control unit designation; and
- Remarks, as appropriate.

QUALITY MONITORING

In recent years, the volume of communications has increased dramatically. This rapid expansion has led to the installation of increasingly sophisticated equipment. Such factors as frequency accuracy, dc distortion, inter-modulation distortion (IMD), and distribution levels are critical to the operation of communications systems.

Satisfactory operation of these systems demands precise initial line-up and subsequent monitoring. System degradation is often caused by many small contributing factors that, when combined, render the system unusable. Simply looking at the page printer or listening to the signal is inadequate.

Simply stated, quality monitoring is the performance of scheduled, logical checks that will ensure continuous, optimum performance and, in many cases, prevent outages before they occur. Some communications personnel quite often fail to realize the benefits of quality monitoring. An attitude develops that questions the need for quality monitoring. The result of this incorrect attitude is that circuits are either **UP** or **DOWN.** Personnel with this attitude perform no quality monitoring when the circuits are **UP** and are, therefore, forced to treat each outage as if it were a unique occurrence.

With no precise information concerning the trend of the system's performance, personnel must jump from one assumed probable cause to another assumed probable cause, while valuable circuit time is lost. A ship with an aggressive quality monitoring program usually has personnel who are thoroughly familiar with all installed communications systems.

QUALITY MONITORING PROGRAM

The primary function of the quality monitoring program is the direct measurement of signal quality characteristics, including:

- Dc distortion;
- Audio distribution level;
- Frequency accuracy of RF signals;
- Spectrum analysis; and
- Loop current.

These measurements are broad categories and can be broken down to specific tests for specific systems.

Quality Monitoring System

Figure 1-14 is a diagram of a quality monitoring system and RCS interface. The system was designed to provide a means of monitoring and evaluating performance of any communications system used by forces afloat.

The monitoring system is a grouping of specific test equipments into a console designated as the AN/SSQ-88 Quality Monitoring Set. The set contains equipment for measuring and analyzing signals sampled by sensors installed in each communications circuit interface. The system should be operated only by personnel with sufficient knowledge to analyze the signals being transmitted and received via the ship's circuits, including individual channels of the multichannel circuits.

The console configuration shown in figure 1-15 may not be compatible with all ships; however, most ships can use equivalent test equipment to establish a quality monitoring test system.

SUMMARY

Your commanding officer must be able to communicate with ships and shore stations to maintain effective command and control of the situation at hand. Communications are, and always will be, the "voice of command." In the age of nuclear weapons, guided missiles, supersonic aircraft, and high-speed ships and submarines, top performance is required of our fleet communicators. You, as a Radioman, and your equipment must always be in constant readiness to meet this formidable challenge.

Distress communications are methods that have been developed for use in times of distress. They indicate the need for immediate assistance and have priority over all other traffic. Various publications and local instructions will assist you in carrying out your required responses to these situations.

Communication systems are periodically tested to ensure that they operate efficiently and accurately. The combined tests, checks, and measurements help determine the condition of systems, subsystems, and individual equipments. Tests and measurements of communication systems and equipments range from the very simple to the very complex.