ELECTRONICS TECHNICIAN 3&2 VOL. 3

NAVAL EDUCATION AND TRAINING COMMAND

RATE TRAINING MANUAL AND NONRESIDENT CAREER COURSE

NAVEDTRA 10198

Although the words "he", "him", and "his", are used sparingly in this manual to enhance communication, they are not intended to be gender driven nor to affront or discriminate against anyone reading *Electronics Technician 3 & 2, Volume 3*, NAVEDTRA 10198.

PREFACE

This Rate Training Manual and Nonresident Career Course (RTM/NRCC), *Electronics Technician 3 & 2, Vol. 3,* NAVEDTRA 10198, is intended to serve as an aid for personnel who are seeking to acquire the theoretical knowledge and operational skills required of candidates for advancement to the rate of Electronics Technician Third and Second Class.

This volume contains descriptions of representative communications equipment/systems currently in use in the Navy. The theory of operation is presented along with pertinent data about the use of the systems in the field. The text is not intended to replace or supplement existing technical manuals for the purposes of operation or maintenance of the equipment/systems.

This training manual and nonresident career course was prepared by the Naval Education and Training Program Development Center, Pensacola, Florida, for the Naval Education and Training Command. Special credit is given to the following commands for their reviews during the preparation of the manual: Naval Telecommunication Command Headquarters, Washington, D.C.; Naval Electronics System Command, San Diego, California; Service School Command, Great Lakes, Illionis; Electronics Technican Class "C" School, Fleet Training Center, Norfolk, Virginia; Service Schools Command, San Diego, California; and the Combat Systems Technical Schools Command, Mare Island, California.

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

CONTENTS

CHAPTER 1

INTRODUCTION TO COMMUNICATIONS SYSTEMS

Until recently, the term "radio communications" brought to mind either telegraphy (cw) voice (AM) or possibly teletype (RATT) communications. Today, radio communications has become a highly sophisticated field of electronics. Even small Navy ships have the capabilities for "coming up" on the commonly used ship-to-ship, ship-to-air, and ship-to-shore communications circuits. These circuit operations are accomplished through the use of compatible and flexible communication systems.

A communication system (as will be seen later) consists of two or more sets, each having its own separate identity, arranged and interconnected to perform a circuit operation that cannot be performed by any one of the individual sets alone. Navy communication systems vary from simple to the very complex, depending upon the circuit operations involved. Each system requires the integrated use of various types of equipment. Thus, a large number of sets, groups, and units are involved when several systems must be operated separately and simultaneously. The concept of shipboard efficiency not only dictates where these sets, groups, and units will be located physically, but also that they be installed in a manner permitting operating flexibility for the various system applications. This flexibility is provided through a complex arrangement of interconnections which allows the physically separated sets, groups, and units to be selectively switched (patched) into the different circuit configurations.

Most shipboard communications equipment is, at one time or another, used in one or more different system operations. Therefore, it is important for the Electronics Technician to know how to perform maintenance at a system level as well as on the individual equipment.

This chapter begins by defining a system and explaining how it is broken down into the various subdivisions, then continues by presenting a brief discussion of Navy communication systems. Other systems are discussed further in subsequent chapters of this manual.

INTRODUCTION TO SYSTEMS

As naval electronics has grown in capabilities, complexity, and extent, an orderly plan of designations has been adopted. The largest designator, SYSTEM, describes equipment which work together for a specific function. For example, a ship's radar system includes every item of electronics equipment used for or with a radar on board that ship. The smallest designator, PART, describes one single piece, such as a bolt, or a resistor.

The majority of troubleshooting will be system oriented. A system is subdivided into sets, groups, units, assemblies, subassemblies, and parts as shown in figure 1-1.

SYSTEM

A system is a combination of parts, assemblies, and sets joined together to perform a specific operational function or functions, such as a communications system, a radar system, or a

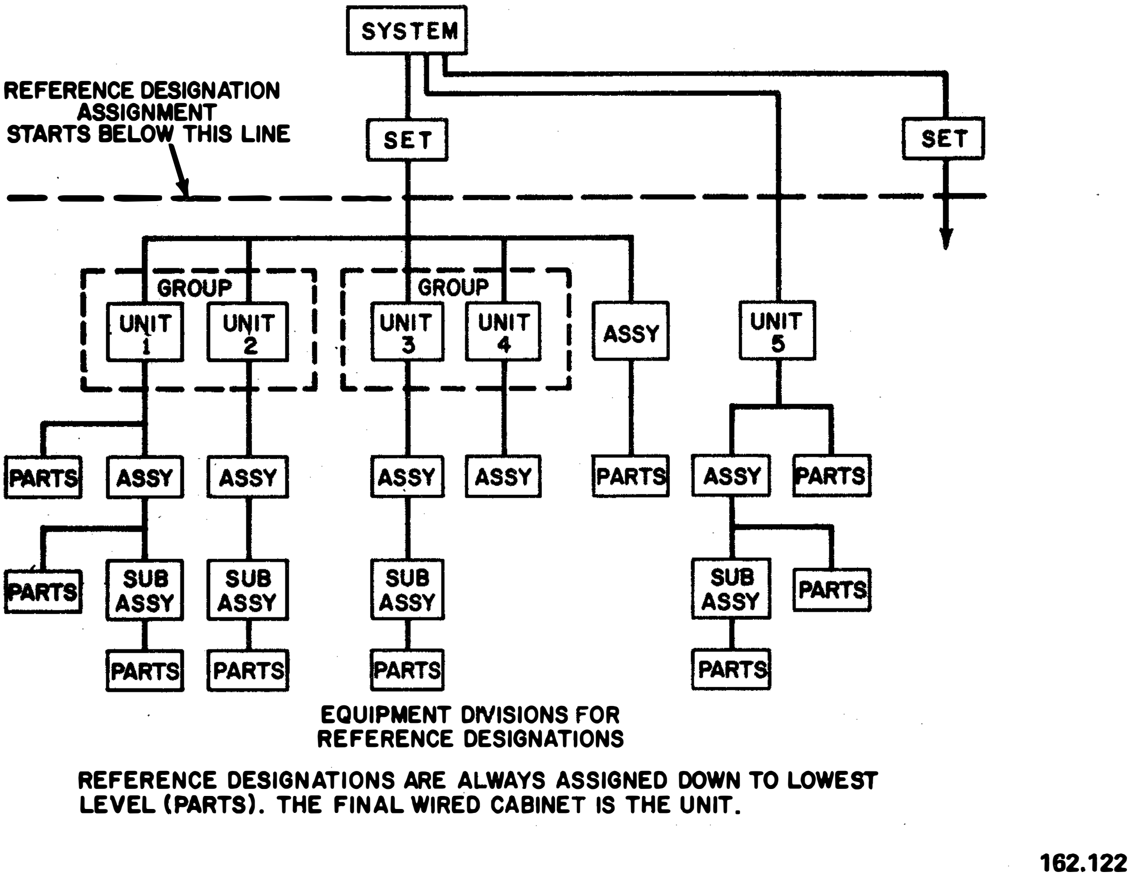

Figure 1-1.—System subdivision.

navigation system. Figure 1-2 is a pictorial view of a typical communication system containing the necessary components for transmission and reception of voice, cw, and teletype signals. Figure 1-3 is a block diagram of the same communication system with the arrows showing the direction of signal flow.

SET

A set consists of a unit or units and the necessary assemblies, subassemblies, and parts connected or associated together to perform an operational function, such as a radio receiving set, or a radio transmitting set.

Figure 1-4 is a block diagram of a radio transmitting set which consists of a radio frequency amplifier unit (1), a radio transmitter unit (2), a power supply unit (3), and an antenna coupler group.

GROUP

A group is a collection of units, assemblies, or subassemblies, which is a subdivision of a set or system, but is not capable of performing a complete operational function. The antenna coupler group in figure 1-4 requires power and signals from the radio frequency amplifier unit for operation.

UNIT

A unit is an assembly or any combination of parts, subassemblies, and assemblies mounted together, normally capable of independent operation in a variety of situations.

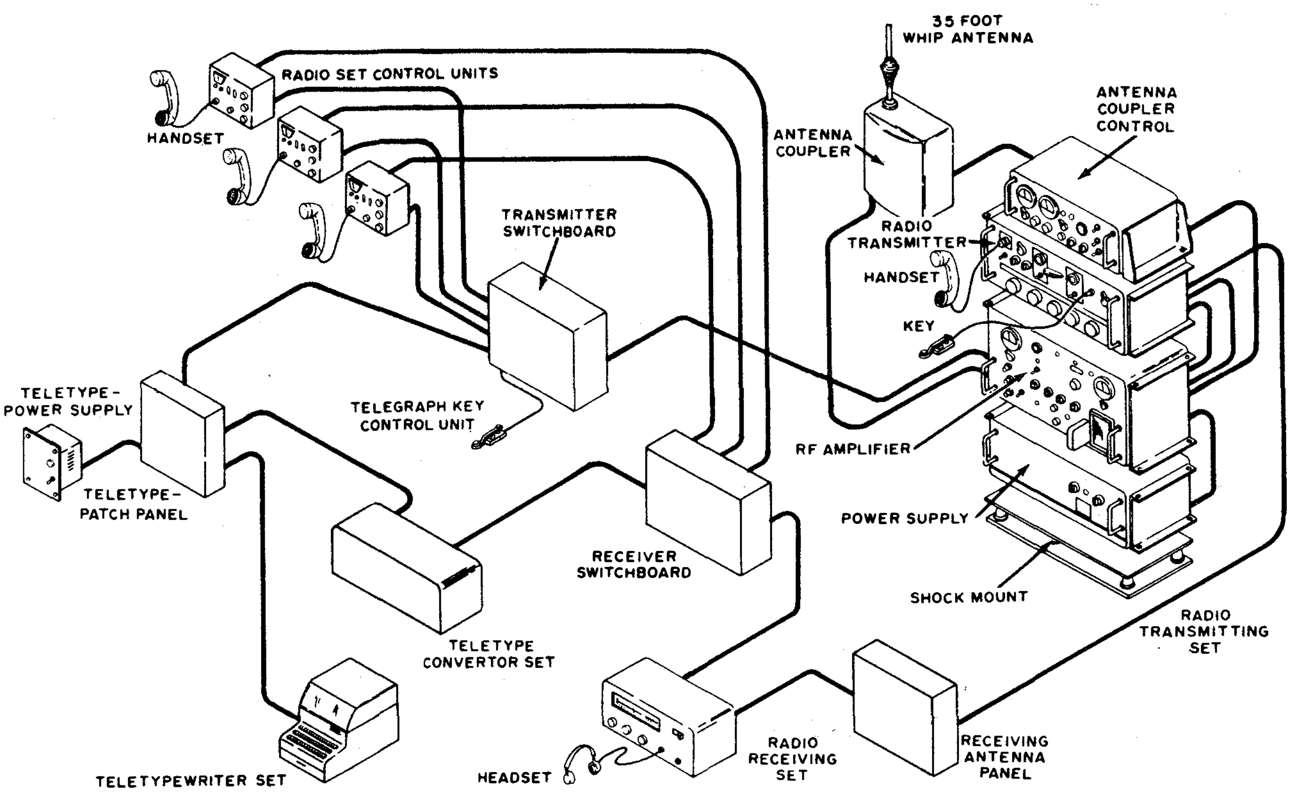

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Figure 1-2.—Communication system pictorial view.

ASSEMBLY

An assembly is a number of parts or subassemblies, or any combination thereof joined together to perform a specific function. Figure 1-5 shows a unit (2) consisting of six assemblies and an assembly (A6) which consists of six subassemblies.

SUBASSEMBLY

A subassembly consists of two or more parts which form a portion of an assembly or a unit, replaceable as a whole, but having a part or parts which are individually replaceable.

The distinction between an assembly and a subassembly is not always exact; an assembly in one instance may be a subassembly in another when it forms a portion of an assembly.

Figure 1-6 shows a printed circuit board subassembly and some of the parts which may be mounted on it.

PART

A part is one piece, or two or more pieces joined together which are not normally subject to disassembly without destruction of the designed use, such as resistors, capacitors, and transistors.

REFERENCE DESIGNATIONS

Each set within a system has an "AN" nomenclature assigned. Each unit, assembly, subassembly, and part of a set has an assigned reference designation. The reference designation consists of letters or numbers, or both, used to identify and locate specific units, assemblies, subassemblies, and parts.

Each unit within a set is assigned an identifying number. This number will begin with one and run consecutively for all units of the set. This number is the reference designation of the unit. Figure 1-4 shows a radio transmitting

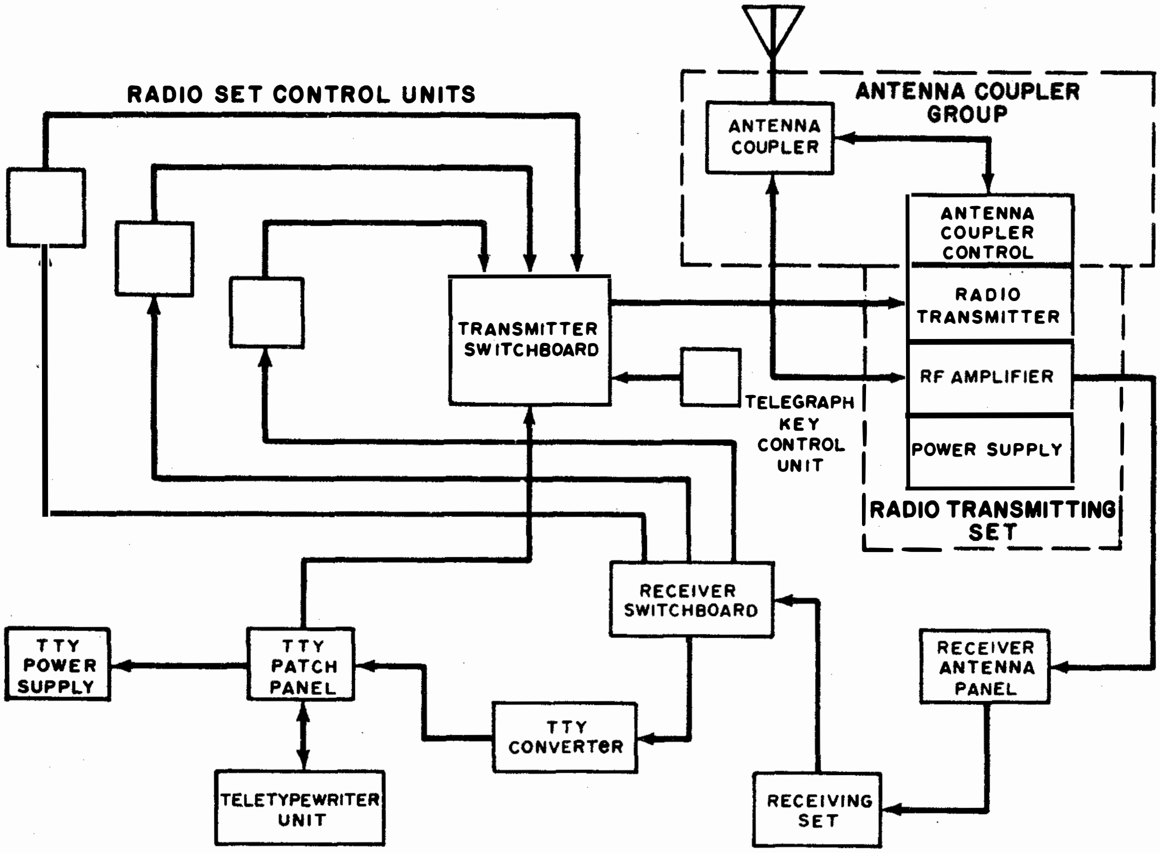

Figure 1-3.—Communication system block diagram. 162.123

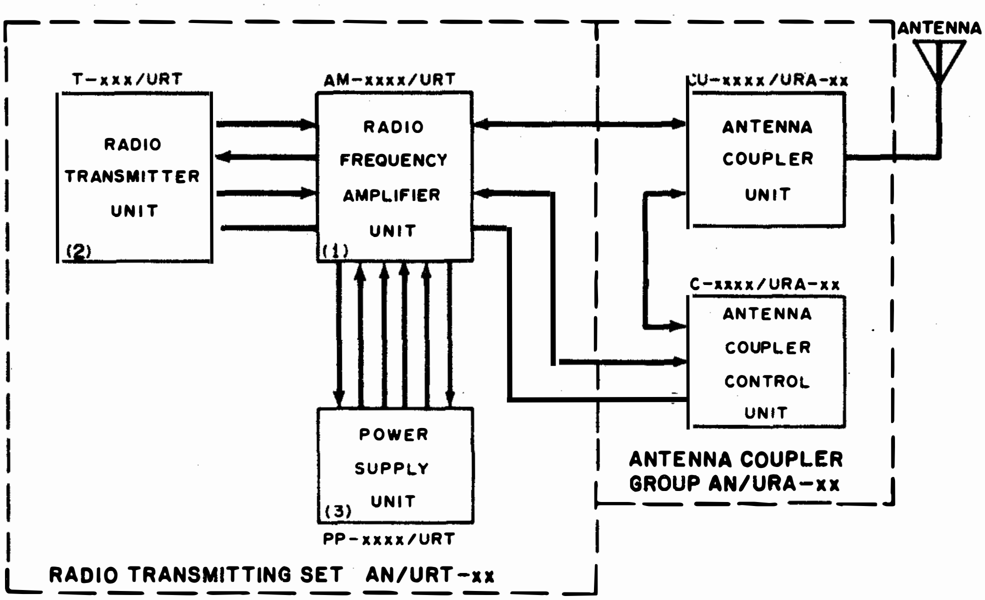

Figure 1-4.—Radio transmitting set.

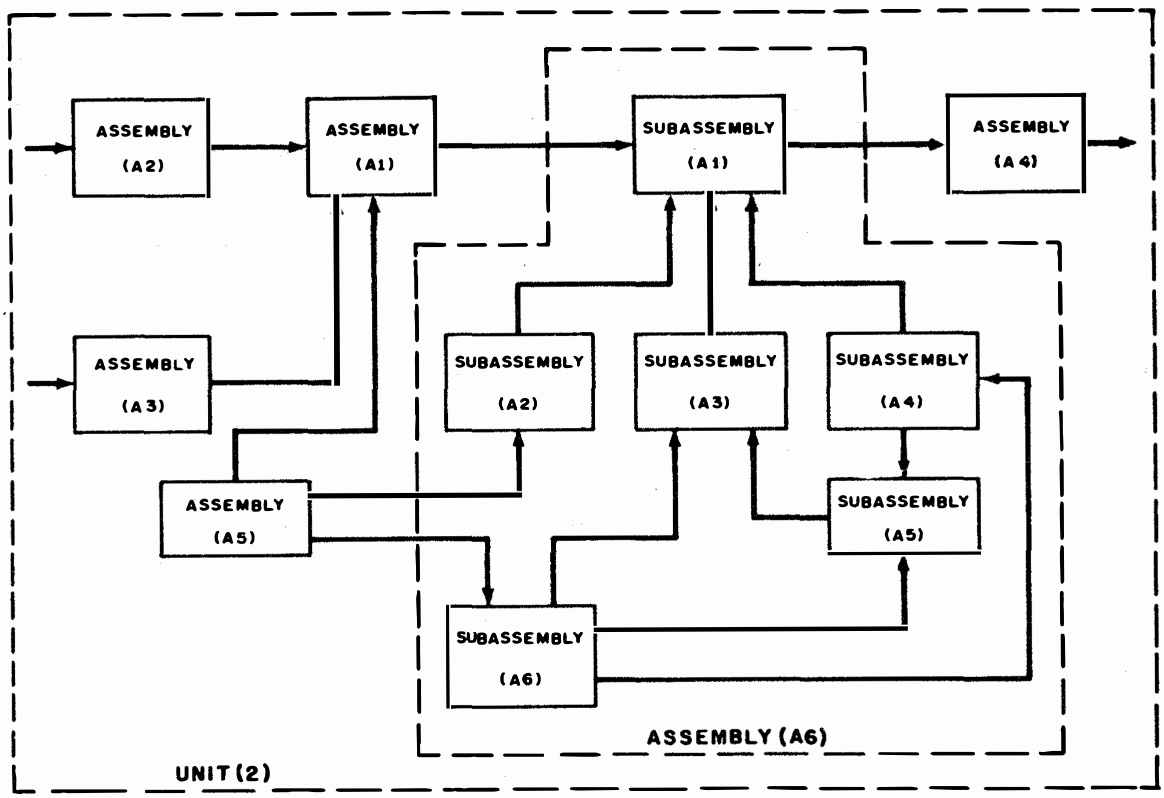

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Figure 1-5.—Unit and assembly.

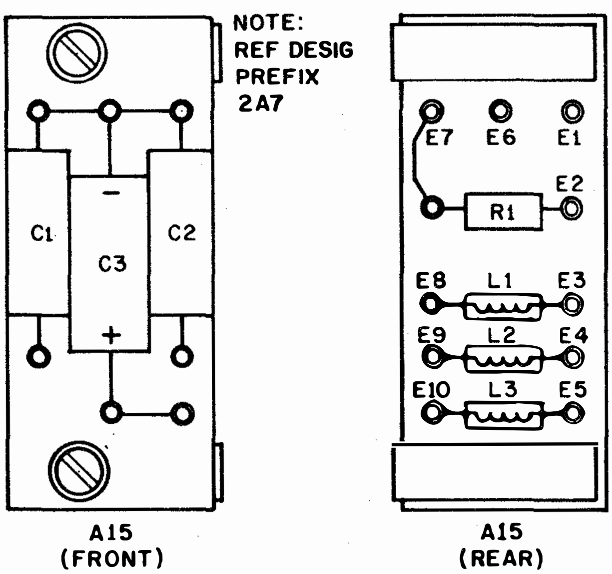

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Figure 1-6.—Typical subassembly.

set AN/URT-xx and the unit numbers (1,2,3). Note that the units may also have an AN nomenclature, such as T-xxx/URT.

The reference designation of an item (assembly, subassembly, or basic part), which is a portion of an assembly, consists of the following, in the order listed:

1. the unit number identifying the unit which contains the particular assembly;

2. the basic reference designation for the particular assembly; and

3. the basic reference designation for the part located in the particular assembly.

For example, the reference designation 2A4C3 identifies capacitor C3, which is on assembly A4 in unit 2. The actual location can be seen in figure 1-7. The reference designations may be expanded or reduced to as many levels as required to identify a particular part. For example, in figure 1-7 the reference designation 2A2A3C1 locates capacitor C1 on subassembly A3, which is on assembly A2, which is in unit 2; another example is 2J1, which identifies jack J1, which is mounted directly on unit 2.

Partial reference designations are used to save space on diagrams. For example, in figure 1-6 partial reference designations are placed near the parts on subassembly A15 and a note indicating the reference designation prefix is added. To identify capacitor C3 on subassembly A15, the complete reference designation would be 2A7A15C3.

TYPES OF RADIO EMISSIONS

By international agreement, the various types of radio emissions (transmissions) are assigned designations as shown in table 1-1. A designation may be preceded by a numerical value to indicate its necessary bandwidth in kHz.

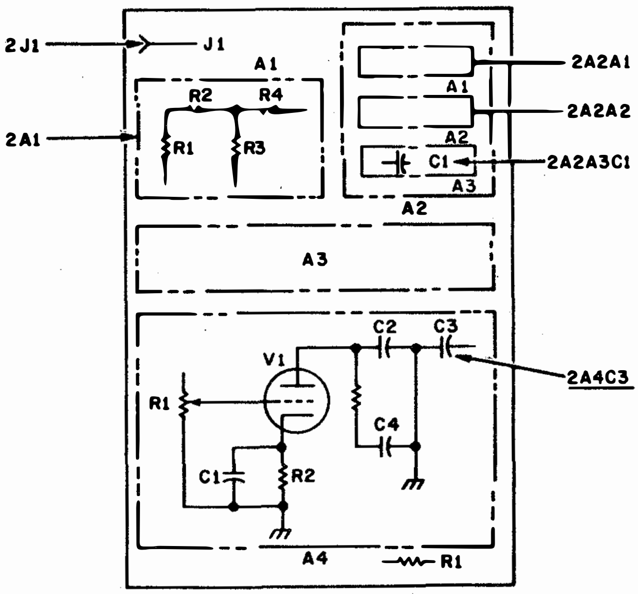

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Figure 1-7.—Reference designations.

Table 1-1.—Types of radio emissions

AM	FM	MODULATION
AØ	FØ	No modulation intended to carry intelligence.
A1	F1	On-off or mark-space keying without the use of a modulating tone.
A2	F2	On-off or mark-space keying of a modulating audio frequency, or of the modulated emission.
A3	F3	Voice-frequency modulating, including simplex AFTS RATT.
A3A		Single-sideband, reduced carrier (SSB).
A3B		Two independent sidebands (ISB).
A3H		Single-sideband, full carrier (compatible SSB).
A3J		Single-sideband, suppressed carrier (SSSC).
A4	F4	Facsimile, with modulation of main carrier directly or by a frequency-modulated subcarrier.
A4A		Facsimile using single-sideband, reduced carrier.
A5	F5	Television.
A5C		Television, vestigial sideband.
	F6	Four-frequency diplex telegraphy (RFCS RATT).
A7		Multi-channel voice-frequency telegraphy (AFTS MUX).
A7A		Multi-channel voice-frequency telegraphy (AFTS MUX) using single-sideband, reduced carrier.
A7B		Multi-channel voice-frequency telegraphy (AFTS MUX) using two independent sidebands.
A7J		Multi-channel voice-frequency telegraphy (AFTS MUX) using single-sideband, suppressed carrier.
A9	F9	Cases not covered by above (e.g., a combination of telephony and telegraphy).
A9B		Combinations using two independent sidebands.

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Table 1-2.—Bands of frequencies

Abbreviation	Frequency band	Frequency range
VLF	Very low frequency	below 30 kHz
LF	Low frequency	30-300 kHz
MF	Medium frequency	300-3000 kHz
HF	High frequency	3000-30,000 kHz
VHF	Very high frequency	30-300 MHz
UHF	Ultrahigh frequency	300-3000 MHz
SHF	Superhigh frequency	3000-30,000 MHz
EHF	Extremely high frequency	30-300 GHz

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FREQUENCY SPECTRUM

Before actually describing the various equipment, it will be advantageous to cover the frequency spectrum, which generally applies to all equipment.

Electronic equipments operate on frequencies ranging from 10,000 Hz through frequencies in the visible light range. These frequencies are generally divided into eight bands as shown in table 1-2.

The Navy normally uses the vlf and lf bands for shore station transmissions. The commercial broadcast band extends from about 550 kHz to 1700 kHz, thereby limiting naval use to the upper and lower ends of the mf band. The hf band lends itself well for long-range communications, therefore most shipboard radio communications are conducted in the hf band.

A large portion of the lower end of the vhf band is assigned to the commercial television industry and is used by the Armed Forces only in special instances. The upper portion of the vhf band (225 MHz to 300 MHz) and the lower portion of the uhf band (300 MHz to 400 MHz) are used extensively by the Navy for its uhf communications. The frequencies above 400 MHz in the uhf band through the shf and ehf bands are normally used for radar, Satellite Communications and special equipment.

COMMUNICATIONS SYSTEMS

A communications system is a collection of equipment used together to accomplish a specific requirement. This requirement could be to send voice communications, receive voice communications, or both, and to send, receive, or send and receive teletype information.

A basic block diagram (fig. 1-8) will be used to explain the equipment used and to show how they interconnect to form a basic communications system. The system used will be a nonsecure voice system.

HANDSET

The handset is a device used to convert acoustical energy to electrical energy for use in modulating the transmitter for the transmission of a signal, and to convert electrical energy to acoustical energy for the reproduction of the received signal. When the push-to-talk button is depressed on the handset, the d.c. keying circuit to the transmitter is closed, placing the transmitter on the air.

The handset is normally connected to a radio set control.

RADIO SET CONTROL

The radio set control unit (fig. 1-8) provides the capability to remotely control certain radiophone transmitter functions and the receiver output. Circuits are provided for turning the transmitter on and off, for voice modulating

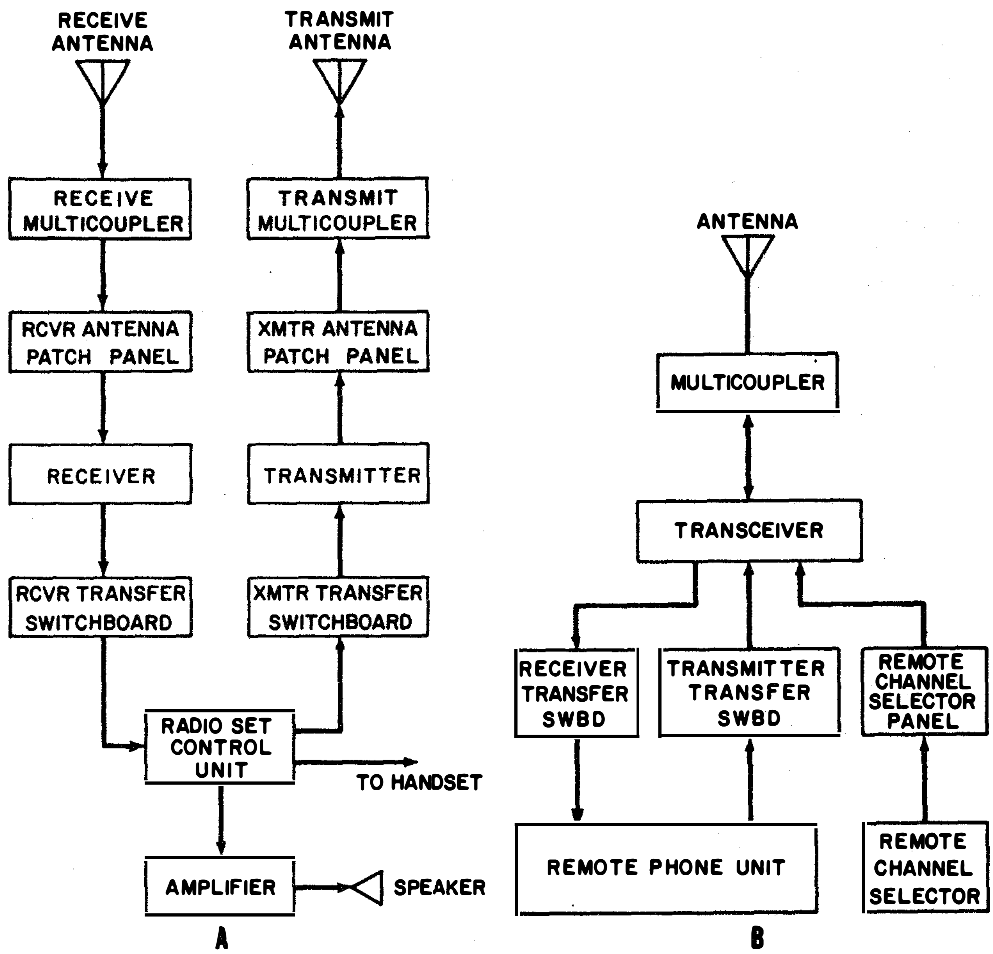

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Figure 1-8.—Nonsecure voice systems.

the transmission (or keying when cw operation is desired), and for controlling the audio output level of the receiver and for muting the receiver when transmitting.

A representative radio set control unit is shown in figure 1-9. Under standard operating conditions, as many as four of these, or similar units, may be paralleled to a single transmitter/receiver group to provide additional operating positions.

TRANSFER SWITCHBOARDS

The transmitter transfer switchboard provides the capability for selectively transferring remote control station functions and signals to the transmitters. A representative transfer switchboard (fig. 1-10) provides the capability for selectively transferring any one, or all, of ten remote control station functions and signals to any one of six transmitters. The cabinet has ten rotary switches, arranged in two vertical rows of five switches each. Each switch having eight positions. Arrangement of the circuitry is such that it is impossible to parallel transmitter control circuits; that is, to connect more than one transmitter to any remote control station.

Each switch operating knob corresponds to a remote control station. Each rotary switch

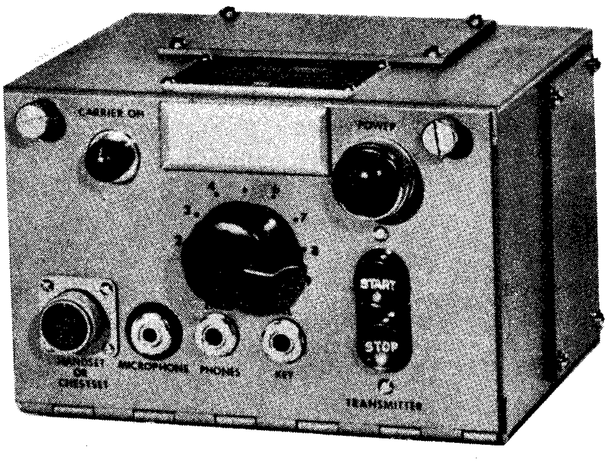

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Figure 1-9.—Radio set control.

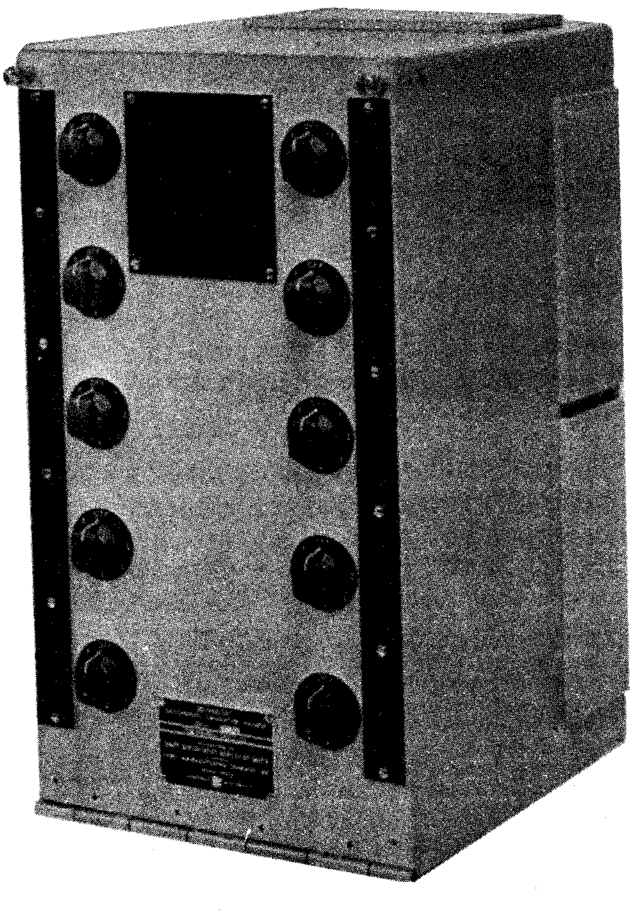

Figure 1-10.—Transmitter transfer switchboard (SB-988/SRT.) 70.64

position (one through six) corresponds to a controlled transmitter. Rotary position X corresponds to an extension providing for the transfer of all circuits to additional Transmitter Transfer Switchboards when more than six transmitters are installed in the system. The rotary position OFF is used to remove the remote from the system.

When it is required, for example, that remote control station number two is to have control of transmitter number three, the switch knob designated number two is rotated until its pointer indicates position three on its respective dial plate. Any of the remote stations may thus be connected to control any of the transmitters installed in the system.

The receiver transfer switchboard provides for transferring the audio output from the receivers to remote control station audio circuits. A representative receiver transfer switchboard is shown in figure 1-11. This switchboard contains ten seven-position switches. Each switch relates to a remote control station, and each switch position (one thru five) relates to a receiver.

Position X on each switch serves to transfer the circuits to additional switchboards, as in the case of the transmitter transfer switchboard.

TRANSMITTERS

An introduction to transmitters has been covered in *Basic Electronics, Volume 1*, NAVPERS 10087-C and the *Navy Electricity and Electronics Training Series (NEETS)*.

The transmitter may be a simple, low power (milliwatts) unit, for sending voice messages a short distance, or it may be a highly sophisticated unit, utilizing thousands of watts of power, for sending many channels of data (e.g., voice, teletype, t.v., telemetry, etc.) simultaneously over long distances.

The transmitter that will be discussed in this chapter is the AN/URT-23( ).

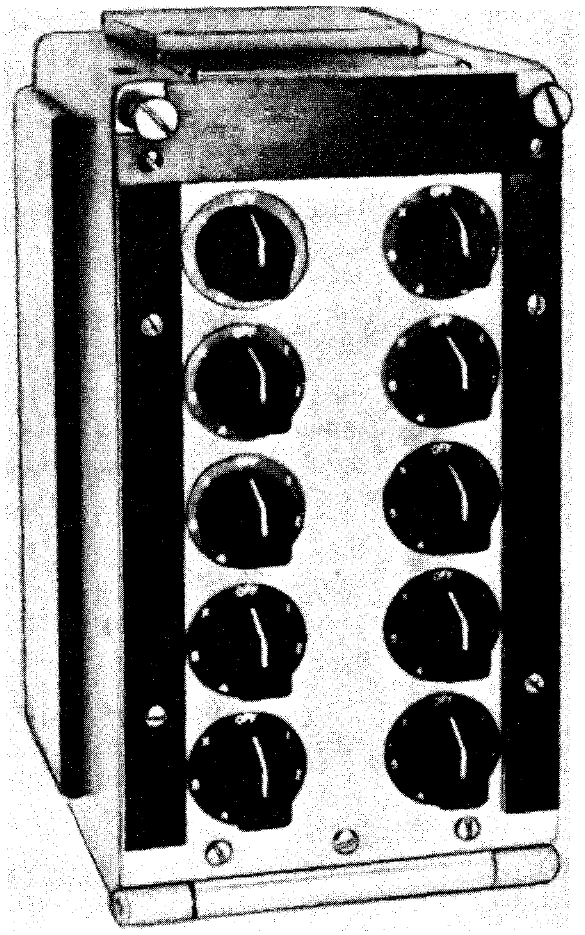

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Figure 1-11.—Receiver transfer switchboard (SB-973/SRT.)

RADIO TRANSMITTING SET AN/URT-23(V)

Radio Transmitting Set AN/URT-23(V) (fig. 1-12) is a 1 kW, single-sideband radio transmitting set that can be supplied in any one of four possible configurations. The normal configuration includes Radio Transmitter T-827/URT, and is capable of general purpose voice, continuous wave, and radio teletypewriter transmissions in the 2- to 30-MHz frequency range. The exact spacing and number of channels available, modes of operation, and frequency range are dependent on the model of the T-827/URT supplied. Stack or rack mounting may be used to install the units of the AN/URT-23(V) in a ship or shore fixed installation with other ancillary equipment to form a complete communications system. Any one of three 3-phase primary power sources can be used to provide operating power to the set: 115 volts 400 Hz; or 208 or 440 volts 60 Hz.

GENERAL DESCRIPTION

The major units used to make up the AN/URT-23(V) are: Radio Transmitter T-827/URT, Radio Frequency Amplifier AM-6909/URT, Power Supply PP-3916/UR or (optionally) Power Supply PP-3917/UR, and Electrical Equipment Shock Mount Base MT-3399/U, as shown in figure 1-12. In both ship and shore installations, Antenna Coupler Group AN/URA-38A (consisting of Antenna Coupler CU-938A/URA-38 and Antenna Coupler Control C-3698A/URA-38) is normally used to automatically match the impedance of the system to the 50-ohm transmission line. Provisions are included, however, which allow operation with any 50-ohm antenna coupling system.

The T-827( )/URT is a low level transmitter (exciter) which provides an Upper Sideband (usb), Lower Sideband (lsb), Independent Sideband (isb), cw, fsk, or compatible AM signal of sufficient power to drive the AM-6909/URT. Digital tuning is used to cover the 2- to 30-MHz frequency range. (Model T-827/URT tunes from 2.0 to 29.9995 MHZ in 500-Hz increments; Model T-827 A/URT and later models tune from 2.0 to 29.9999 MHz in 100-Hz increments.) A five-wire coded output from the T-827( )/URT is also applied to the AM-6909/URT to automatically tune it to the correct frequency band. The T-827( )/URT is discussed in more detail later.

Radio Frequency Amplifier AM-6909/URT

The AM-6909/URT (fig. 1-12) is a two-stage linear power amplifier, which produces an output of 1 kW with a nominal input of 100 mW. Nineteen frequency bands are used to cover

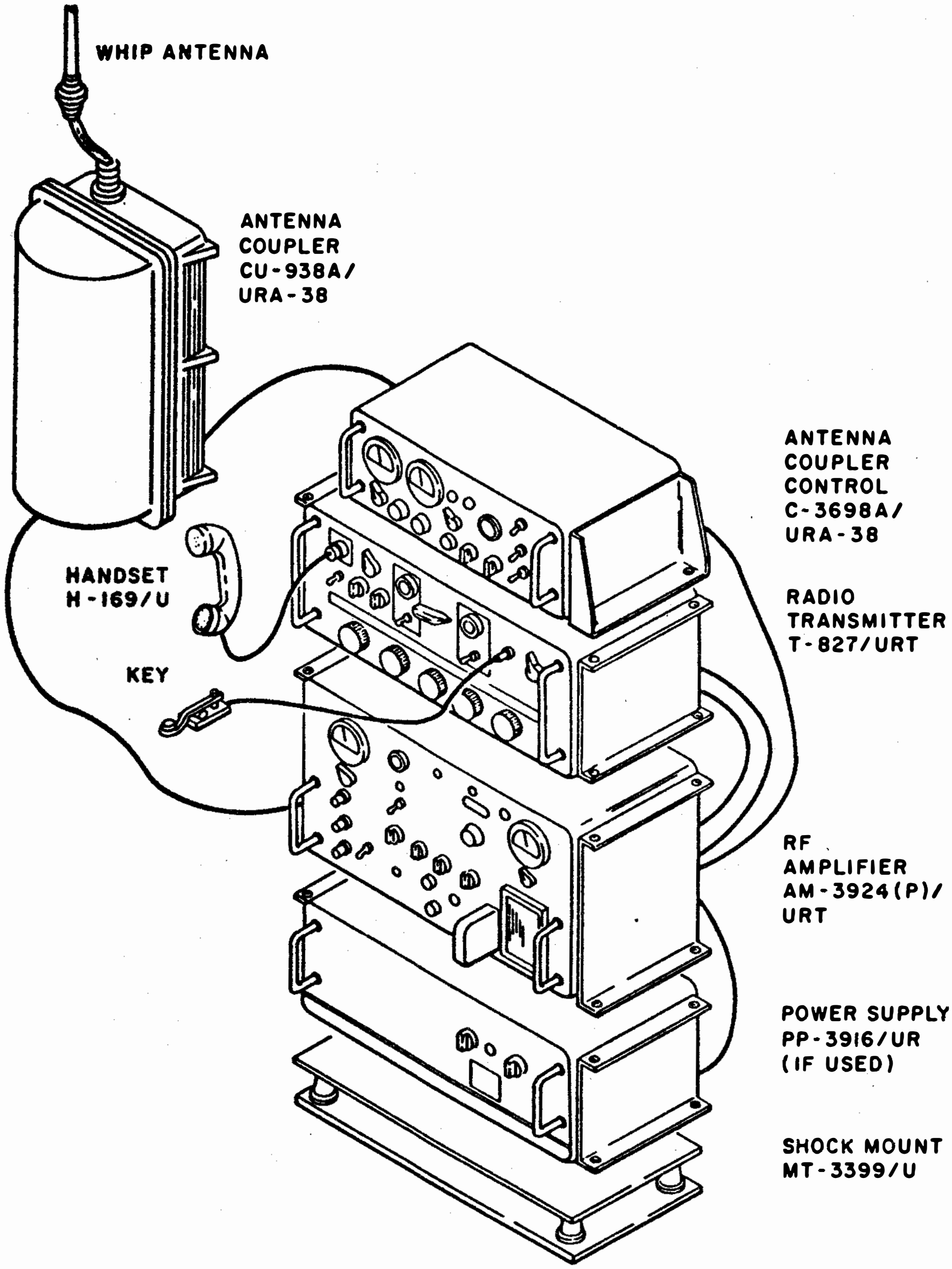

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Figure 1-12.—Radio Transmitting Set AN/URT-23(V).

the 2- to 30-MHz operating frequency range. The operating band is automatically selected by a five-wire code generated by the T-827( )/URT or internally generated if the T-827( )/URT is not used. The code controls two motor-driven bandswitch assemblies on which are mounted broadband transformers used as interstage and output tuned circuits for the two amplifier stages. Automatic control circuits compensate for variations in system gain, mode of operation, or loading to protect the unit against overload. The AM-6909/URT can be modified to allow operation with an exciter other than the T-827( )/URT. Plugged mounting holes are provided in the front panel and rear of the case to allow the installation of the circuitry.

The AM-6909/URT operates from a three-phase primary power source of 115 volts 400 Hz or 208 or 440 volts 60 Hz. All low voltages required for operation (except two of the relay control voltages) are internally produced. The high voltages required for powering the electron tubes used in the amplifier stages are produced by the associated Power Supply PP-3916/UR (when using 60-Hz primary power) or the optional internally mounted Power Supply PP-3917/UR (when using 400-Hz primary power).

All operating controls and indicators are located on the front panel (fig. 1-13). Those controls used only for initial setup are protected by a hinged access cover. All connections are

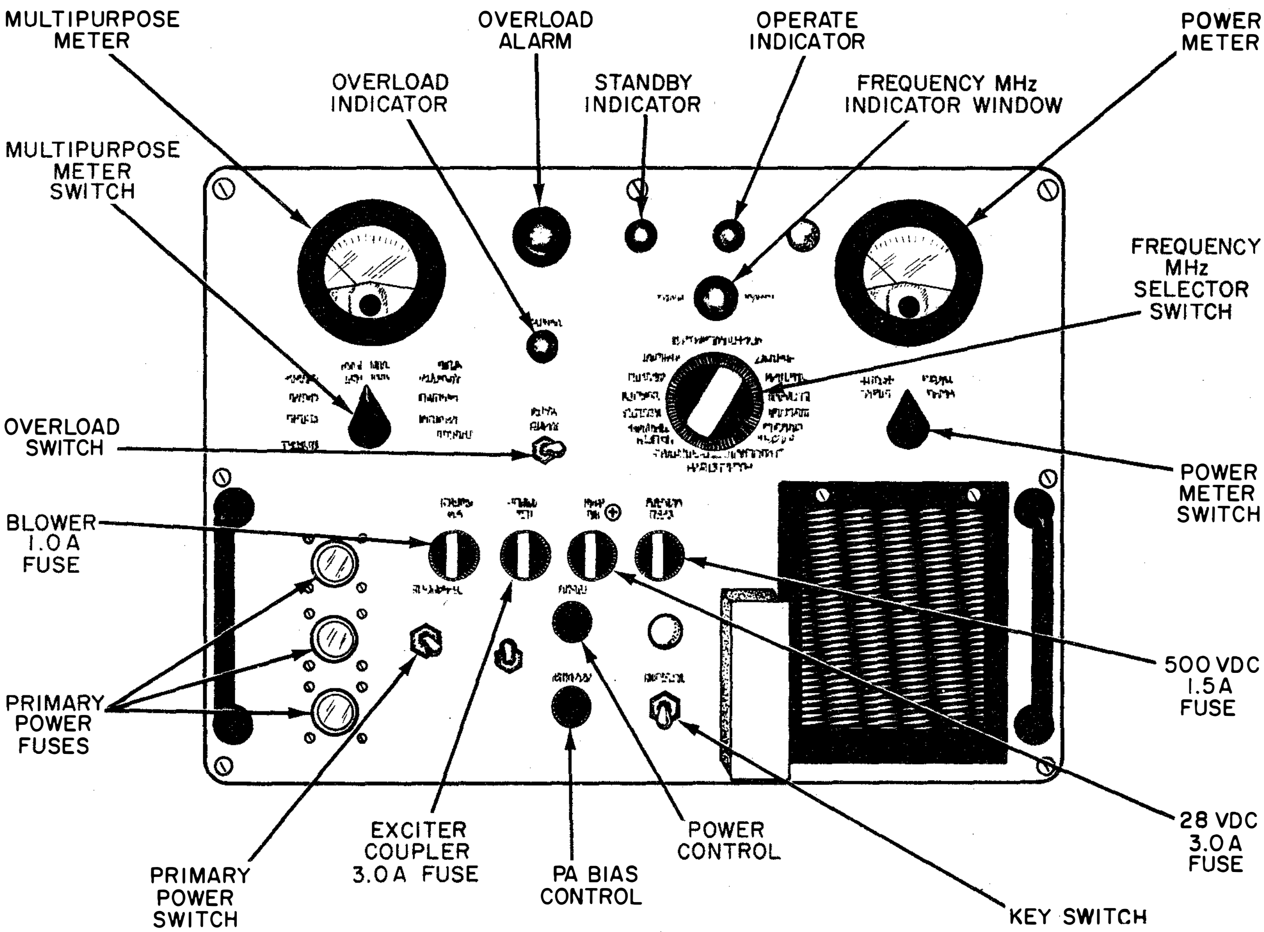

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Figure 1-13.—Radiofrequency Amplifier AM-3924(P)/URT.

made at the rear of the case. The four electron tubes and the associated interstage broadband transformer assemblies are cooled by forced ventilation. Cooling air is drawn through a filter on the front panel and exhausted through a port on the rear of the case.

Power Supplies

Power Supply PP-3916/UR (fig. 1-12) produces operating voltages for the AM-6909/URT when operating from the 60-Hz power sources, as stated previously. All components of the PP-3916/UR, except the power transformers, are mounted on a chassis and panel assembly, which is hinge-mounted to a metal case. Loosening the front panel screws allows the chassis and panel assembly to be dropped 90 degrees to a horizontal position for servicing and troubleshooting. The power transformers are constructed as an integral part of the case. Two self-indicating fuse holders and a POWER ON indicator are located on the front panel of the PP-3916/UR. There are no operating controls.

The PP-3917/UR produces operating voltages for the AM-6909/URT when operating from a 400-Hz, three-phase, 115-volt primary power source. When used, the PP-3917/UR is mounted as an internal subassembly of the AM-6909/URT.

Antenna Coupler Group AN/URA-38A

Antenna Coupler Group AN/URA-38A is an automatic antenna tuning system intended primarily for use with the AN/URT-23(V). However, the equipment design includes provisions for manual and semiautomatic tuning, thus making the system readily adaptable for use with other radio transmitters. In addition, the manual tuning capability is useful when a failure occurs in the automatic tuning circuitry. Also, tuning can be accomplished without the use of rf power (silent tuning). This method is useful in installations where radio silence must be maintained except for brief transmission periods.

Antenna Coupler CU-938A/URA-38 (fig. 1-12) matches the impedance of a 15-, 25-, 28-, or 35-foot whip antenna to a 50-ohm transmission line, at any frequency in the 2- to 30-MHz range. When operating with the AN/URT-23(V), control signals from the associated antenna coupler control unit automatically tune the CU-938A/URA-38 Matching Network in less than five seconds. During manual and silent operation, tuning is accomplished by the operator with the controls mounted on the antenna coupler control unit. A low power (not to exceed 250 watts) cw signal is required for tuning. Once tuned, the CU-938A/URA-38 is capable of handling 1 kW of PEP and average power.

The CU-938A/URA-38 is enclosed in an aluminum, airtight, pressurized case. Access is gained to the chassis by removing the dome-shaped cover from the case. Fins on the bottom of the case carry heat from the unit. Six mounting feet enable the unit to be attached to the mast of a ship at the base of a whip antenna. The CU-938A/URA-38 is pressurized with dry nitrogen to aid internal heat transfer and prevent corona and arcing. All components of the CU-938A/URA-38 are secured to a chassis, which is mounted to the case so that an air duct exists between the chassis plate and the case. An internal fan circulates the nitrogen over and through the heat-producing elements and then through the air duct. While passing through the air duct, the nitrogen loses its heat to the bottom of the case. This heat is then transferred by convection through the fins on the case and by conduction through the mounting feet.

Antenna Coupler Control C-3698/URA-38 (fig. 1-14) provides power and control signals required to tune the CU-938A/URA-38. The control signals are either automatically produced by the C-3698A/URA-38 when a tune cycle is initiated or manually produced with the front panel controls. All d.c. operating voltages are produced from a 115-volt, 48- to 63- or 350- to 450-Hz, single-phase primary power source. Metering and protection circuits are provided to enable complete control of the CU-938A/URA-38 from the remotely positioned C-3698A/URA-38.

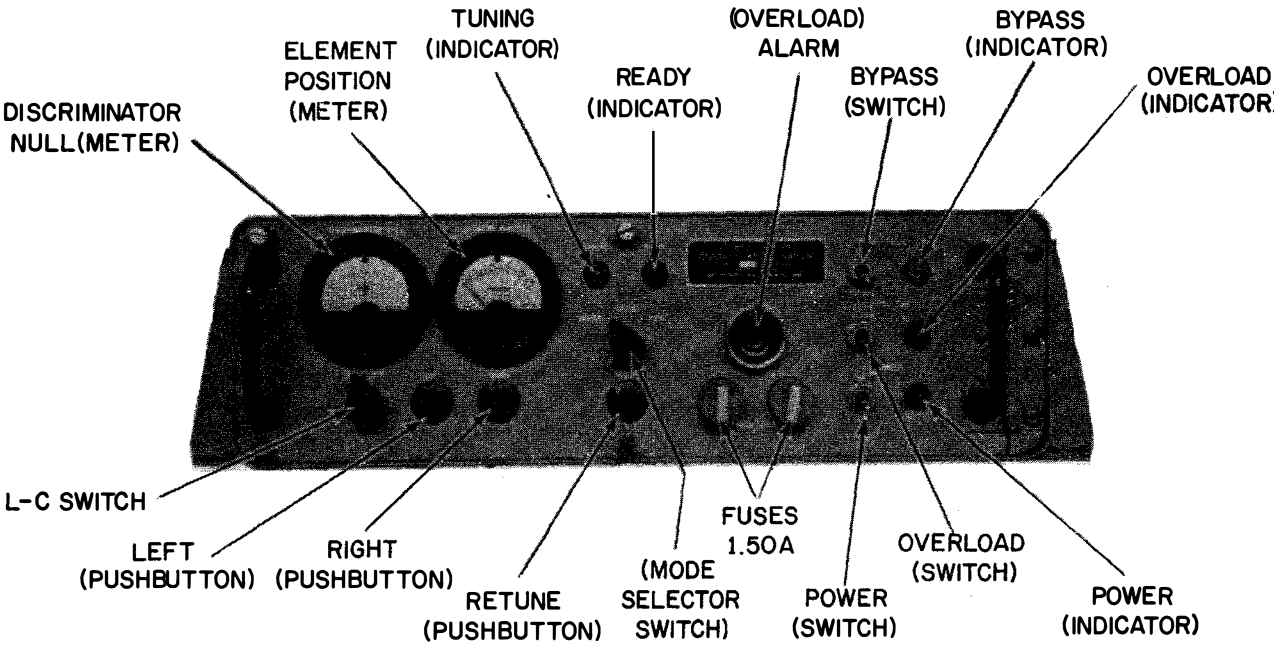

Figure 1-14.—Antenna Coupler Control C-3698/URA-38.

RADIO TRANSMITTER T-827( )/URT

Radio Transmitter T-827( )/URT accepts audio or coded intelligence and converts it to one of 280,000 possible operating radio frequencies in the 2.0- to 29,999-MHz frequency range. It is capable of operating in any of lsb, usb, isb, cw, fsk, and compatible AM modes of operation. Tuning is accomplished digitally by means of five control knobs (MSC and KCS) and a switch (CPS) located on the front panel (fig. 1-15). The T-827( )/URT has a normal rf output level of at least 0.10 watt, and is designed to be used with an associated rf power amplifier such as the AM-3007/URT or the AM-6909( )/URT.

In AM and ssb transmit modes of operation, the output from a handset is applied to the T-827( )/URT. The voice signals are amplified and used to modulate a 500-kHz local carrier, providing a 500-kHz IF. The resulting double sideband signal is filtered according to the mode of operation, amplified, and converted by a triple-conversion process to the desired rf operating frequency. The rf signal is power amplified to a nominal 0.1-watt level. In cw operation, the 500-kHz local carrier is inserted directly into the IF amplifiers at a coded rate. The signal is further processed in the same manner as the voice signals in the AM or ssb modes of operation. In fsk operation, the coded application of loop current is converted to audio frequencies representing marks and spaces. These audio signals are applied to the audio circuits of the T-827( )/URT. Thereafter, these signals are processed in the same manner as the voice signals in AM or ssb modes of operation.

As shown by the functional block diagram (fig. 1-16, foldout at the end of this chapter), the T-827( )/URT consists of nine plug-in electronic assemblies and a power supply. Assembly A2A6 consists of six subassemblies.

Main Signal Flow

The main signal flow in the T-827( )/URT originates in the 5-MHz frequency standard in

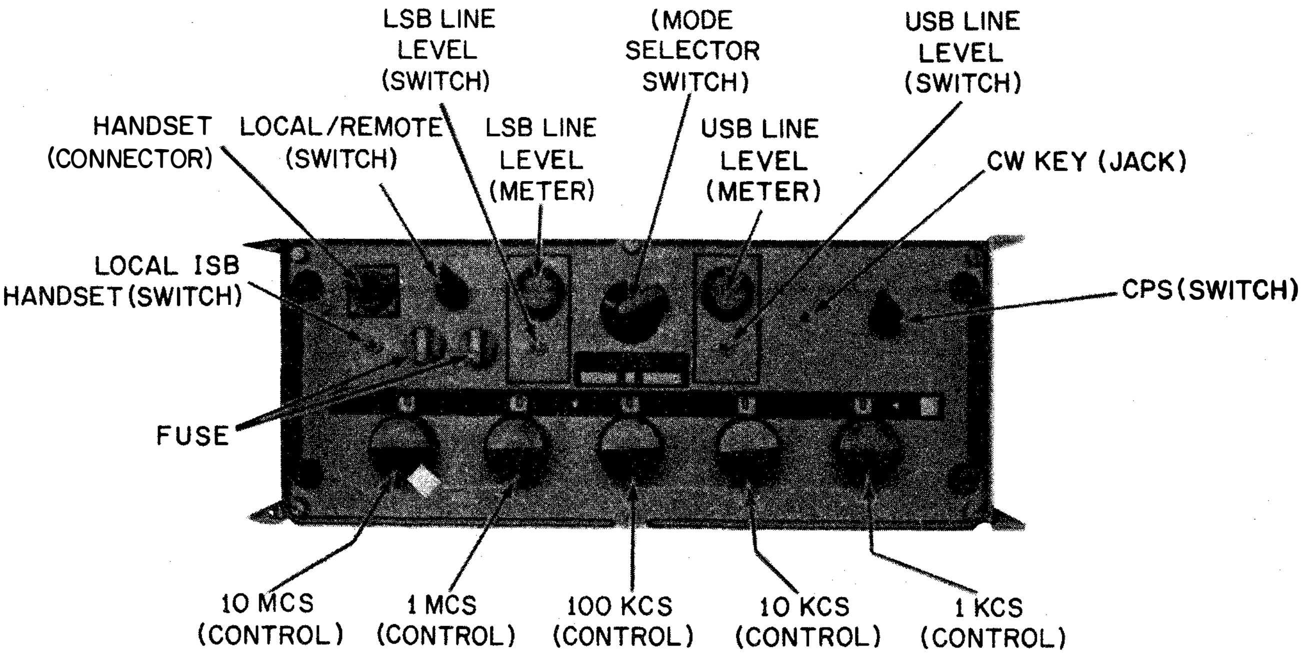

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Figure 1-15.—Radio Transmitting Set T-827( )/URT operating controls and indicators.

Assembly A2A5 (fig. 1-16). This circuit is housed in an oven assembly maintained at a nearly constant temperature of 85°C by the oven control circuit. The 5-MHz frequency standard produces an accurate, stable reference frequency, upon which all frequencies used in the T-827( )/URT are based. The accurate output from the 5-MHz frequency standard is applied to a switching and compare circuit. An external 5-MHz frequency may also be applied to this circuit. The switching and compare circuit routes the internal or external 5-MHz signal to the multiplier-divider circuits or to the compare circuit. The compare circuit compares the internal 5-MHz frequency with the external 5-MHz frequency for an indication of the internal frequency accuracy. The 5-MHz output from the switching and compare circuit is applied to the multiplier-divider circuit, where it is converted to frequencies of 500 kHz, 1 MHz, and 10 MHz. All three frequencies are used in the mixing processes required to produce the injection frequencies used in the rf conversion process. The 500-kHz frequency output from the multiplier-divider circuit also serves as the local carrier for the T-827( )/URT.

The 500-kHz local carrier output from the multiplier-divider circuit is applied to the 500-kHz IF amplifiers in Assembly A2A1 via mode gates. These circuits amplify the 500-kHz local carrier to a level suitable for use in the balanced modulators. There are two balanced modulators, identical except for output filtering. The balanced modulator used is selected according to the mode of operation. One balanced modulator is used in the usb, fsk, AM, and isb modes of operation. The other balanced modulator is used during the lsb and isb modes of operation. Neither balanced modulator is used during the cw mode of operation. Audio intelligence from the audio amplifier is applied to the appropriate balanced modulator to modulate the 500-kHz local carrier, resulting in a double sideband signal without a carrier. The double sideband signal is filtered according to the mode of operation to remove either the lsb or usb portion of the signal.

The other portion of A2A1 Assembly is the control gates sidetone oscillator circuit (described later).

The 500-kHz output from the balanced modulators is applied to the IF amplifiers (Assembly A2A12). The IF amplifiers provide a 500-kHz IF output at a level suitable for use in the low and midfrequency mixers circuit. The level of the 500-kHz IF output from the IF amplifiers is prevented from exceeding a predetermined peak and average power level by application of the average power control (APC) and the peak power control (PPC) signals produced in the associated rf power amplifier. The 500-kHz local carrier is reinserted into the 500-kHz IF signal during the AM mode of operation in the IF amplifier circuit. The unmodulated 500-kHz IF signal for the cw mode of operation is also produced by this circuit. The 500-kHz carrier required in both the AM and cw modes of operation is applied to the IF amplifier circuit by the control gates sidetone oscillator circuit contained in Assembly A2A1 (fig. 1-16).

The output from the IF amplifier circuit is applied to the low and midfrequency mixers. These two mixer circuits, which comprise a part of Subassembly A2A6A6, in conjunction with the high frequency mixer circuit portion of Assembly A2A , convert the 500-kHz IF signal to the desired radio frequency by a triple conversion process. The 500-kHz IF signal is mixed with the 1- and 10-kHz injection frequency by the low frequency mixer to produce a second IF frequency between 2.8 and 2.9 MHz. This frequency is filtered and applied to the midfrequency mixer. The second IF is mixed with the 100-kHz injection frequency by the midfrequency mixer to produce a third IF between 19.5 and 20.5 MHz or between 29.5 and 30.5 MHz. The third IF used is determined by the hi/lo band control signal.

The output from the midfrequency mixer is filtered and applied to the high frequency mixer in Assembly A2A4. The third IF is mixed with the MHz injection frequency by the high frequency mixer to produce the desired rf output frequency. The MHz injection frequency is determined by the position at which the MHz frequency generator is set by the code generator. The output from the high frequency mixer is applied to the rf amplifiers, which amplify the radio frequency to a level suitable to drive the associated rf power amplifier. The input and output circuits of the rf amplifiers are automatically tuned by the tuning code produced by the code generator, according to the frequency of the desired operating channel.

Audio Signal Flow

The intelligence applied to the T-827/URT is either the coded keying for cw, the coded keying for fsk, or the audio for all other modes of operation. The coded cw keying turns a gating circuit on and off in the control gates sidetone oscillator circuit. Each time the key is pressed, the gate is turned on, allowing the 500-kHz local carrier to pass from the 500-kHz amplifiers to the IF amplifiers. Also, each time the cw key is pressed, the output of a sidetone oscillator is gated through to the sidetone line. This sidetone signal is applied to the associated receiver (such as R-1051/URR), enabling the operator to monitor the cw keying. The audio output from the microphone is applied to the audio amplifiers in Audio Amplifier Assemblies A2A2 and A2A3 (fig. 4-16).

When operating in the usb, isb, AM, or fsk modes of operation, the audio input is amplified by Assembly A2A2 and is applied to the appropriate balanced modulator. When operating in the lsb and isb modes of operation, the audio is amplified by Assembly A2A3 and is applied to the appropriate balanced modulator. A gate for each assembly is turned on in the control gates sidetone oscillator (Assembly A2A1) when the corresponding assembly is turned on. This gate allows the audio to pass as a sidetone signal to the associated receiver, enabling the operator to monitor the respective transmission.

When operating in the fsk mode of operation, the coded TTY input is applied to the tty generator in Assembly A2A9. The tty generator produces the required mark and space frequencies and applies them to Audio Amplifier Assembly A2A2. The gate for reinserting the

500-kHz carrier into the IF signal during AM operation is also contained in the control gates sidetone oscillator circuit. This circuit also has a gating network for reinserting a pilot local carrier into the IF signals during lsb, usb, or isb operation.

Frequency Generation

The injection frequencies used in the first frequency conversion in the mixers circuit are generated within the 1- and 10-kHz Synthesizer Subassembly A2A6A3. This circuit consists of two crystal oscillators, each of which has ten possible output frequencies. The output from the 1-kHz oscillator (1.850 MHz to 1.859 MHz, in 1-kHz steps) is determined by the setting of the front panel 1-kHz (KCS) control (fig. 1-15), and the output from the 10-kHz oscillator (5.25 MHz to 5.16 MHz, in 10-kHz steps) is determined by the setting of the front panel 10-kHz (KCS) control. The outputs from the two oscillators are subtractively mixed to produce one of 100 possible frequencies spaced at 1-kHz intervals between 3.301 and 3.400 MHz. The output is applied to the low frequency mixer.

The injection frequencies used in the second frequency conversion in the mixers circuit are generated within Subassembly A2A6A2 (fig.1-16). This circuit consists of a crystal oscillator, the output of which is one of ten frequencies spaced at 100-kHz intervals between 4.553 and 5.453 MHz. The output frequency is determined by the setting of the front panel 100-kHz (KCS) control. If a lo-band injection frequency is required, the 17.847-MHz output from the 17.847-MHz mixer is additively mixed in the lo-band mixer with the output from the 100-kHz oscillator (4.553 MHz to 5.453 MHz, in 100-kHz steps) to provide a frequency in the 22.4- to 23.3-MHz range. If a hi-band injection is required, the 27.847-MHz output from the 27.847-MHz mixer is additively mixed in the hi-band mixer with the output from the 100-kHz oscillator (4.553 MHz to 5.453 MHz, in 100-kHz steps) to provide a frequency in the 32.4- to 33.3-MHz range. In either case, the resultant frequency is applied to the midfrequency mixer.

The injection frequencies used in the third frequency conversion in the mixer circuit are generated within Subassembly A2A6A1. This circuit consists of a phase-locked crystal oscillator that is automatically tuned to produce one of seventeen frequencies between 2.5 MHz and 23.5 MHz. The output frequency is determined by the setting of the front panel MCS controls (fig. 1-15).

Error Cancellation

A combination of error cancelling loops and phase-locked loops is used in the frequency synthesizer circuits of the T-827( )/URT to ensure that the injection frequencies applied to the mixers are correct. Subassembly A2A6A1 (fig. 1-16) employs a phase-locked loop to ensure the accuracy of the MHz injection frequencies. The 1-MHz output from the multiplier-divider in Assembly A2A5 is applied to the spectrum generator to produce a spectrum of frequencies spaced at 1-MHz intervals between 1 MHz and 25 MHz. The output from the spectrum generator and the output from the MHz oscillator are mixed. Any error in output from the MHz oscillator is detected, and an error voltage is produced. This error signal is applied to the MHz oscillator to lock it to the correct frequency. The accuracy of the oscillator output is the same as that of the 5-MHz frequency standard.

Subassembly A2A6A2 employs an error cancelling loop to ensure the accuracy of the 100-kHz injection frequencies. The 500-kHz output from the multiplier-divider is applied to the 100-kHz spectrum generator to produce a spectrum of frequencies spaced at 100-kHz intervals between 15.3 MHz and 16.2 MHz. The output from the 100-kHz oscillator (4.553 MHz to 5.453 MHz, in 100-kHz steps) is applied to the 10.747-MHz mixer, where it is mixed with that spectrum point of the 100-kHz spectrum which will result in an output of 10.747 MHz. The 10.747-MHz signal is additively mixed with the 7.1-MHz output from the 7.1-MHz mixer to produce the 17.847-MHz signal, which is used in one of two mixing processes. It is mixed with the 100-kHz oscillator output to cancel any oscillator frequency error and produce the lo-band injection frequencies, or it is mixed with the 10-MHz output from the multiplier-divider. This mixing produces a 27.847-MHz signal, which is mixed with the 100-kHz oscillator output to cancel any oscillator frequency error and produce the hi-band injection frequencies. The hi- or lo-band of injection frequencies is determined by the voltage level on the hi/lo band control line output from the code generator. If an error were present in the 100-kHz oscillator output, it would be cancelled in this mixing scheme.

Any error existing in the 1- and 10-kHz oscillator (Subassembly A2A6A3) is cancelled in the following manner. The 100-kHz pulses from the 100-kHz spectrum generator are applied to the 10-kHz spectrum generator, producing an output from 3.82 to 3.91 MHz in 10-kHz increments. The 10-kHz spectrum generator also produces 10-kHz pulses, which are applied to the 1-kHz spectrum generator to produce a spectrum of frequencies spaced at 1-kHz intervals between 0.122 MHz and 0.131 MHz. The output from the 10-kHz oscillator (5.25 MHz to 5.16 MHz, in 10-kHz steps) is additively mixed with whichever spectrum point of the 10-kHz spectrum will result in a frequency of 9.07 MHz.

The output from the 1-kHz oscillator (1.850 MHz to 1.859 MHz, in 1-kHz steps) is additively mixed with whichever spectrum point of the 1-kHz spectrum will result in a frequency of 1.981 MHz. The 1.981-MHz and the 9.07-MHz signals are then subtractively mixed, producing the 7.089-MHz signal, which contains the errors of both oscillators. The 1-kHz spectrum generator also produces 1-kHz pulses, which are applied to the 1-kHz pulse inverter to produce an output consisting of a 1-kHz pulse. This pulse is used to lock the output frequency of the 100-Hz phase-locked oscillator to 110 kHz or 119-kHz, when desired. With the front panel CPS switch in the 000 position, the output from the phase-locked oscillator is 110 kHz and is locked to that exact frequency by the 100-kHz spectrum point applied to the phase detector. This 110-kHz signal is divided by ten and applied to the 7.1-MHz mixer, where it is additively mixed with the 7.089-MHz output from the 7.089-MHz mixer. The resulting 7.1-MHz signal is then applied to the error loop of Subassembly A2A6A2. Therefore, if an error exists in the 1- or 10-kHz oscillators, the same error will exist in the 100-kHz injection frequencies. This error is then cancelled in the low and midfrequency mixers of the mixers circuit.

Power Supply

The operating voltages for all circuits in the T-827( )/URT are produced by Power Supply Assembly A2A8 (fig. 1-16). The 105- to 125-V a.c. primary power is converted to d.c. voltages or 110-V d.c. (rf amplifier tubes plate and screen supply), -30-V d.c. (rf amplifier tubes bias), and 28-V d.c. (general use). The 28-V d.c. is also regulated to 20-V d.c. The 20-V d.c. is used for operating voltage in the semiconductor circuits of the T-827( )/URT. The 4-V d.c. is used for fine control of the 100-Hz synthesizer.

FUNCTIONAL BLOCK DIAGRAM

A functional block diagram of the AN/URT-23(V) is shown in figure 1-17 (foldout at the end of this chapter). The rf Power Amplifier AM-6909-URT is driven by a low level (nominal 100mW) rf output from the T-827( )/URT. Two stages of amplification (a driver amplifier and a final amplifier, (fig. 1-17) are used to linearly amplify this input to a level of 1 kW. Each stage consists of two parallel connected electron tubes and operates into one of nineteen pretuned transformer assemblies. The transformer assemblies for each stage are automatically switched into the circuit according to the operating frequency. The 1-kW output from the final amplifier is applied through the vswr bridge and the antenna transfer relay to the antenna coupler system. The vswr bridge samples both reflected and forward power for application to the front panel power meter for measurement and monitoring. In addition, the vswr bridge supplies the necessary signals for the APC and PPC circuits to develop their respective control voltages. The antenna transfer relay connects the antenna to an auxiliary receiver when the system is not keyed.

A five-wire coding scheme is used to automatically switch the correct transformer assemblies into the driver and final amplifier circuits. The code is generated either by the code generator within the T-827( )/URT, or internally by an encoder within the AM-6909/URT when the T-827( )/URT is not used. In either case, the code consists of a pattern of opens and grounds, which establishes a ground path to one side of a relay coil through a decoder switch in the AM-6909/URT bandswitching system. This ground path energizes the relay and, in turn, a motor, which rotates the decoder and bandswitch assemblies until the ground path is broken. While a new channel is being selected, an inhibit signal is applied to the keying circuit to prevent the system from being keyed before the switches have stopped in the correct position.

The vswr bridge supplies a signal to the APC-PPC circuit, which is, in essence, the envelope of the rf output from the system. This signal is used to develop one control voltage which is proportional to the peak power output from the system and another which is proportional to the average power. Both control voltages are applied to the T-827( )/URT, where they are used to maintain the power output from the system at a constant 1-kW PEP. This closed loop circuit ensures that the rf power output is maintained at the rated level as well as preventing it from exceeding a safe limit. In addition, the PPC voltage is applied to the AM-6909/URT Bias Circuits as a protective measure in the event that the control circuits in the T-827( )/URT fail or that the system is being operated with an exciter that does not have power control capabilities. In this condition, as the peak power output increases beyond its rated level, the bias voltage to the driver amplifier is increased to reduce the rf output.

The APC-PPC circuit can also be commanded to reduce the power output from the system to a lower value required for tuning the antenna coupler. This is accomplished either manually with the front panel TUNE KEY switch or automatically by the AN/URA-38. At the same time, a carrier insert signal is supplied to the T-827( )/URT, causing that unit to provide the single-tone carrier output required for tuning. If desired, a resistor in the PPC circuit can be changed in value to enable the tune power level to be set to other values required to tune antenna couplers other than the AN/URA-38. When operating in the cw or fsk mode, the cw/fsk ground from the T-827( )/URT is used to deenergize the APC detector and switch the PPC output to the T-827( )/URT APC input. Also, a class B drive signal is produced and applied to the bias power supply when the cw/fsk ground is present.

An overload detector is used to continually monitor the plate currents of the two final amplifier tubes, the rf output voltage, and the temperature of the PP-3916/UR. If a dangerous condition occurs in any of these areas, the overload circuit trips and provides an inhibit signal to the keying circuit, preventing further keying of the circuit until the overload has been cleared. When the overload circuit trips, an indicator lamp and an alarm are energized to provide both visual and audible indication that an overload condition has occurred. A front panel switch permits the audible overload alarm to be disabled. The overload circuit can be reset through the front panel RESET switch. However, if the overload was not of a momentary nature, the overload circuit will again immediately trip to prevent keying. In addition, the keying circuit remains inhibited whenever the overload switch is held in the reset position, thus preventing an operator from forcing operation in an overload condition.

The AM-6909/URT is keyed on and off through the bias levels applied to the four electron tubes in the final and driver amplifiers. Keying is accomplished by grounding the system keyline at any of the other units or by setting the AM-6909/URT front panel KEY switch at TUNE KEY or LOCAL KEY. In any case, the keying circuit switches the bias voltage for the driver and final amplifier electron tubes from cutoff to operate levels. The keying circuit is inhibited (bias maintained beyond cutoff) whenever the tuning motor is energized, an overload occurs, the RESET switch is depressed, or the ground key interlock signal is supplied by the AN/URA-38. Also, when the tuning motor is energized or the ground key interlock signal is supplied by the AN/URA-38, the T-827( )/URT is unkeyed by cutting off the 28-V d.c. interlock signal that the AM-6909/URT normally supplies to energize the T/R relays in the T-827( )/URT.

A metering circuit allows any one of eight parameters of the amplifier tubes to be connected to a meter for measurement or monitoring. These parameters consist of the cathode current of each of the four electron tubes, the input rf power to the driver amplifier, the plate supply voltages, and the screen supply voltage.

RADIO RECEIVER R-1051/URR

Radio Receiver R-1051/URR is a triple-conversion superheterodyne receiver, tunable over the high frequency range from 2- to 30-MHz. Tuning of the R-1051/URR is accomplished digitally by five controls—MCS (MHz) and KCS (kHz)—and a switch, CPS (Hz), located on the front panel (fig. 1-18). A display window directly above each control provides a digital readout of the digits to which the controls are set. The displayed frequency can be changed in 1-kHz increments. The front panel switch allows the operating frequency to be changed in 500-Hz increments, or 100-Hz increments depending on the model. This tuning provides 280,000 discrete frequencies in which the receiver is locked to a very accurate frequency standard. Each 1-kHz increment can be continuously tuned through by selecting the VERNIER position of the CPS switch. When using the vernier, the full accuracy of the frequency standard is sacrificed. The R-1051/URR demodulates and provides audio outputs for the following types of received signals: lsb, usb, isb, AM, cw, and fsk. A functional block diagram of the receiver is shown in figure 1-19 (foldout at the end of this chapter).

MAIN SIGNAL FLOW

A received signal from the antenna passes through closed relay contacts in the antenna

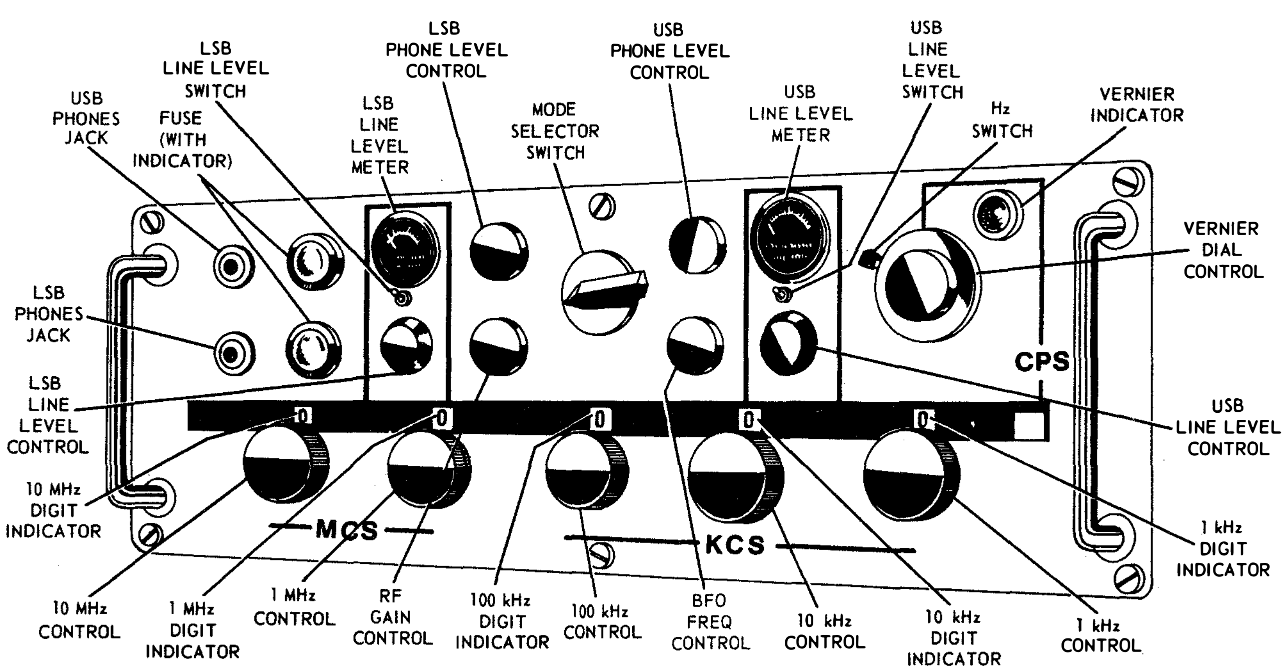

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Figure 1-18.—Radio Receiver R-1051/URR operating controls and indicators.

overload circuit to the rf amplifiers (fig. 1-19). If a signal in excess of 8 volts appears at the receiver input, the antenna overload circuit will open the relay contacts. The excessive voltage is thereby prevented from being applied to the rf amplifiers, which form a part of Assembly A2A4. Within the rf amplifiers, the signal passes through a double-tuned input circuit, two rf amplifier stages, a single-tuned interstage circuit, and output circuits. All of the resonant tuned circuits are tuned by the MCS, 100-kHz (KCS), and 10-kHz (KCS) frequency controls on the front panel (fig. 1-18). The MCS controls operate a code generator, which activates a motor-driven turret containing 28 strips. Each strip contains a tuned transformer and a portion of the capacitance required by each of the four tuned circuits. For each MHz increment, a different tuned transformer and capacitor are switched into the four tuned circuits by the 100-kHz (KCS) and 10-kHz (KCS) controls on the front panel (fig. 1-18).

The output from the rf amplifiers is applied to the mixers, which form a part of Subassembly A2A6A6 (fig. 1-19). The mixers consist of three transistor mixer stages, with interstage coupling provided by selective filters. The first mixer receives the injection frequencies from Subassembly A2A6A1. The injection frequency is determined by the MHz band selected by the MCS controls on the front panel. The desired output frequency from the first mixer always falls within two frequency bands, either 19.5 to 20.5 MHz or 29.5 to 30.5 MHz. The high or low band is also determined by the MHz band to which the R-1051/URR is tuned. The output from the first mixer is gated through the appropriate 20- or 30-MHz filter. This signal is mixed in the second mixer stage with the injection frequencies supplied from 100-kHz Synthesizer Electronic Subassembly A2A6A2. The desired frequency band from the second mixer is 2.8 to 2.9 MHz. This signal is coupled through a 2.85-MHz filter to the third mixer. The injection frequencies for the third mixer are supplied by Subassembly A2A6A3. The output from the third mixer is a 500-kHz IF signal.

The 500-kHz IF output from the third mixer is applied to the mode gates. Three parallel paths are presented to the signal. The path that passes through the lsb mechanical filter (also used in isb) is not gated since it has an independent output from the mode selector electronic assembly. Because the outputs from the usb mechanical filter (also used in fsk and isb) and the AM mechanical filter (also used in cw) are paralleled for a common output, the input paths to these two filters must be gated so that only one path is open at any given time. Application of the correct gating potentials is determined by the mode to operation selected at the front panel.

The output from the lsb filter is applied to the IF amplifiers in Assembly A2A3. The common output of the usb and AM filters is also applied to the IF amplifiers in Assembly A2A2. The operating d.c. voltage is applied to the proper electronic assembly according to the mode of operation selected at the front panel. In the isb mode of operation. a d.c. operating voltage is applied to both IF amplifiers. Automatic gain control voltage from the step agc circuit controls the overall gain of the IF amplifiers by varying the attenuation of the input and the gain of the second IF amplifier stage. The input to the step agc circuit is derived from the output of the second IF amplifier stage.

The output of the IF amplifiers is applied to the detector circuits, consisting of a product detector and an AM detector. Depending on the mode of operation selected at the front panel, either the balanced product detector or the AM detector is powered by d.c. operating voltage. The product detector demodulates the usb, lsb, isb, and fsk signals. In these modes of operation, a 500-kHz injection frequency originating at a multiplier-divider in Assembly A2A5 is applied to the product detector for carrier reinsertion. This 500-kHz injection passes through the 500-kHz gate in Assembly A2A1 with little attenuation in these modes of operation. In AM and cw modes, this gate presents a high attenuation, since no carrier reinsertion is required by the AM detector. In the cw mode of operation, the bfo (beat-frequency oscillator) assembly in Assembly A2A1 is turned on, and a variable 500-kHz output is applied to the input of the AM detector in Assembly A2A2. The output frequency from the bfo circuit is controlled by the BFO FREQ control on the front panel.

The audio derived from the detector circuits in Assembly A2A2 is applied to the usb LINE LEVEL control on the front panel, which controls the audio level prior to its application to the audio amplifiers. The LSB LINE LEVEL control sets the audio level from the product detector in Assembly A2A3. Assemblies A2A2 and A2A3 each have two outputs. One is a 600-ohm remote output, which is applied to a connector at the rear of the case. The second output is to the PHONES jacks on the front panel. The PHONES output passes through a PHONE LEVEL control on the front panel, which adjusts the phone signal amplitude without altering the level of the remote output. Each remote output is monitored at the front panel by a LINE LEVEL meter, which has two scale ranges controlled by the LINE LEVEL switch on the front panel.

Step AGC Signal Flow

The step agc circuit, which forms a part of Assemblies A2A2 and A2A3, controls the gain of the rf amplifiers and IF amplifiers according to the received rf signal strength. The output from the IF amplifiers is applied to the step agc circuits, where it is converted to a d.c. voltage that is applied to both the rf and IF amplifiers. The gain of the rf and IF amplifiers may be manually controlled by applying a d.c. voltage on the agc lines with the RF GAIN control. This manual action overrides the normal agc voltages.

Frequency Standard

The 5-MHz frequency standard (Assembly A2A5, fig. 1-19) produces an accurate, stable reference frequency upon which all frequencies used in the R-1051/URR are based. The circuit is housed in an oven assembly maintained at a nearly constant temperature of 85°C by the oven control circuit. The accurate output from the 5-MHz frequency standard is applied to a switching and compare circuit. An external 5-MHz frequency may also be applied to this circuit. The switching and compare circuit routes the internal or external 5-MHz signal to the multiplier-divider circuits or to the compare circuit. The compare circuit compares the internal 5-MHz frequency with the external 5-MHz frequency for an indication of the accuracy of the internal frequency standard.

The 5-MHz output from the switching and compare circuit is applied to the multiplier-divider circuit, where it is converted to frequencies of 500 khz, 1 MHz, and 10 MHz. These three outputs are used in the mixing processes required to produce the injection frequencies used in the rf conversion process. The 500-kHz output is also applied to the 500-kHz gate circuit for insertion into the product detector for demodulation.

Frequency Generation

The injection frequencies used in the first frequency conversion in the mixers circuit are generated within Subassembly A2A6A1. This circuit consists of a phase-locked crystal oscillator that is automatically tuned to produce one of seventeen frequencies between 2.5 MHz and 23.5 MHz. The output is applied to the high frequency mixer. The output frequency depends on the setting of the front panel MCS controls.

The injection frequencies used in the second frequency conversion in the mixers circuit are generated within Subassembly A2A6A2. This circuit consists of a crystal oscillator, the output of which is one to ten frequencies spaced at 100-kHz intervals between 4.553 and 5.453 MHz. The output frequency is determined by the setting of the front panel 100-kHz(KCS) control. If a lo-band injection frequency is required, the 17.847-MHz output from the 17.847-MHz mixer is additively mixed in the lo-band mixer with the output from the 100-kHz oscillator (4.553 MHz to 5.453 MHz, in 100-kHz steps) to provide a frequency in the 22.4- to 23.3-MHz range. If a hi-band injection frequency is required, the 27.847-MHz output from the 27.847-MHz mixer is additively mixed in the hi-band mixer with the output from the 100-kHz oscillator (4.553 MHz to 5.453 MHz, in 100-kHz steps) to provide a frequency in the 32.4- to 33.3-MHz range. In either case, the resultant frequency is applied to the midfrequency mixer.

The injection frequencies used in the third frequency conversion in the mixers circuit are generated within Subassembly A2A6A3. This circuit consists of two crystal oscillators, each of which has ten possible output frequencies. The output from the 1-kHz oscillator (1.850 MHz to 1.859 MHz, in 1-kHz steps) is determined by the setting of the front panel 1-kHz (KCS) control, and the output from the 10-kHz oscillator (5.25 MHz to 5.16 MHz, in 10-kHz steps) is determined by the setting of the front panel 10-kHz (KCS) control. The outputs from the two oscillators are subtractively mixed to provide one of 100 possible output frequencies spaced at 1-kHz intervals between 3.301 MHz and 3.400 MHz. The output is applied to the low frequency mixer.

A combination of error cancelling loops and phase-locked loops (similar to those described for the T-827/URT) is used in the frequency synthesizer circuits of the R-1051/URR to ensure that the injection frequencies applied to the mixers are correct.

Power Supplies

The operating voltages for all circuits in the R-1051/URR are produced by the Power Supply Assembly A2A8 (fig. 1-19). The 105- to 125-V a.c. primary power is converted to d.c. voltages of 110 volts (rf amplifier tubes plate and screen supply), -30 volts (rf amplifier tubes bias), and 28 volts (general use). The 28-V d.c. is also regulated to 20-V d.c. for use in all semiconductor circuits of the R-1051/URR.

ANTENNA DISTRIBUTION SYSTEMS

Receiving antenna distribution systems operate at low power levels and so are readily adaptable to a standard modular construction form. A basic patch panel is shown in figure 1-20. Even the most basic distribution system would have several antenna transmission lines and several receivers. The patch panel would consist of two of the basic patch panels shown in figure 1-20 mounted in a standard 19-inch rack. One panel would terminate the antenna transmission lines and the other the lines leading to the receivers. Thus any antenna could be patched to any receiver via patch cords.

Many distribution systems will be more complex. A complex distribution system to

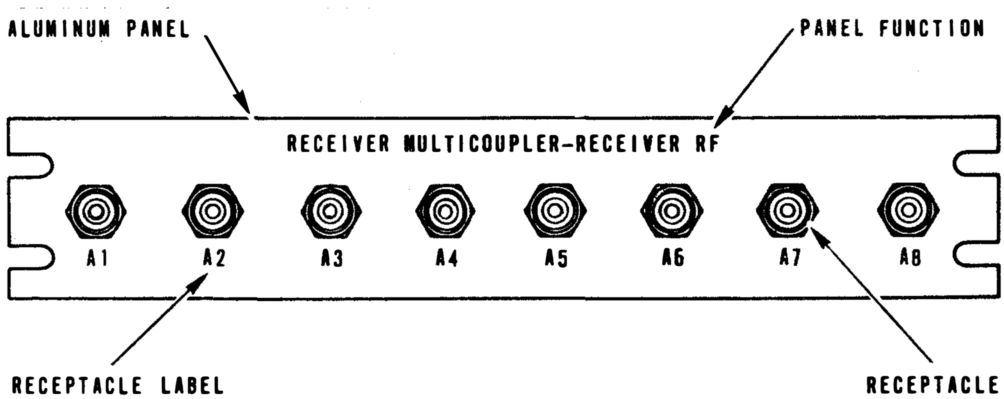

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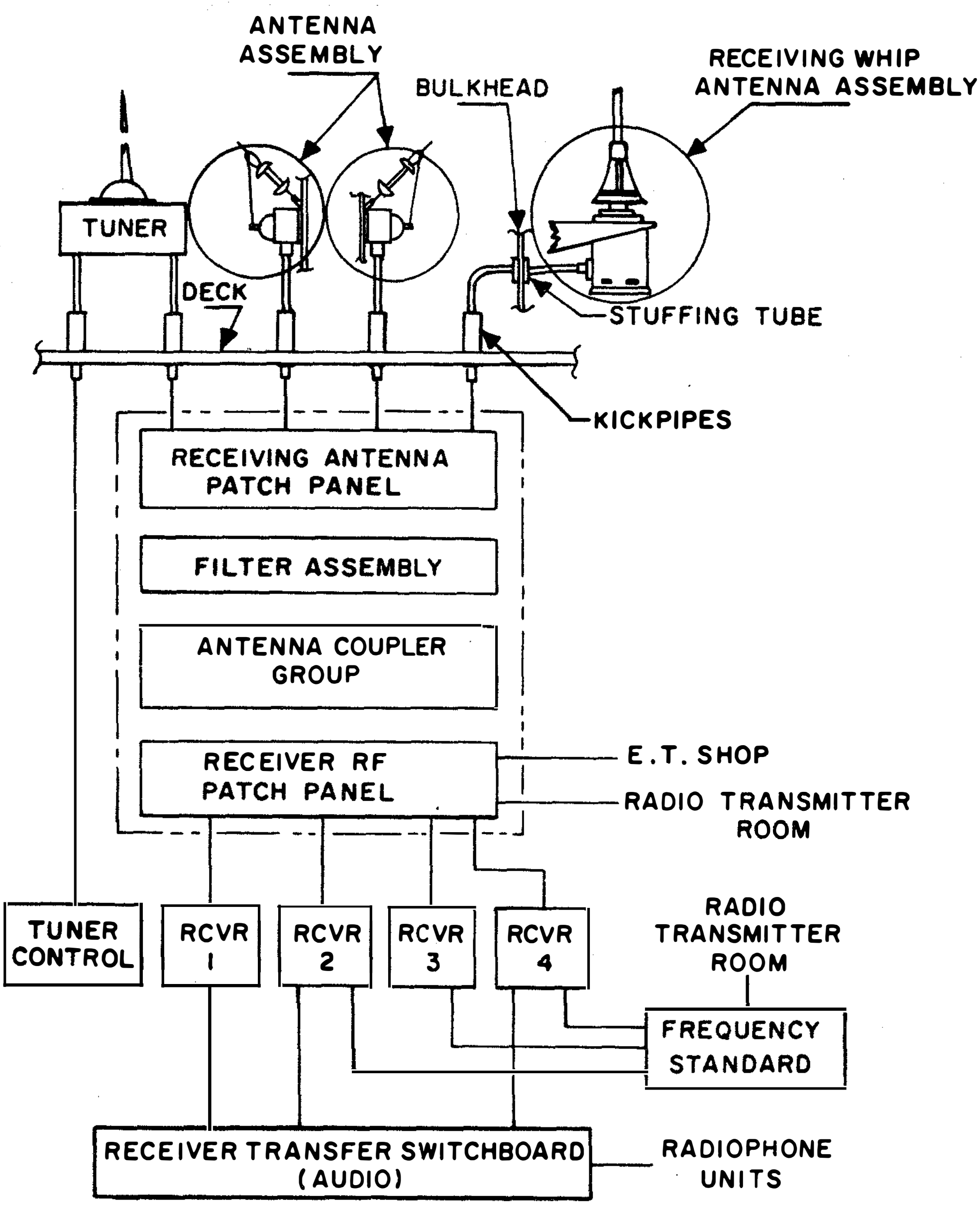
Figure 1-20.—Receiver patch panel.

cover most situations is illustrated in figure 1-21. In this system, four antennas can be patched to four receivers, or one antenna can be patched to more than one receiver via the multicouplers (multicouplers are covered later in the chapter). There are also provisions for patching rf and audio from one compartment to another. A frequency standard is connected (through a distribution amplifier not shown) to the receivers.

Transmitting antenna distribution systems perform the same functions as receiving systems. However, because of the range in power levels, design and fabrication problems are more



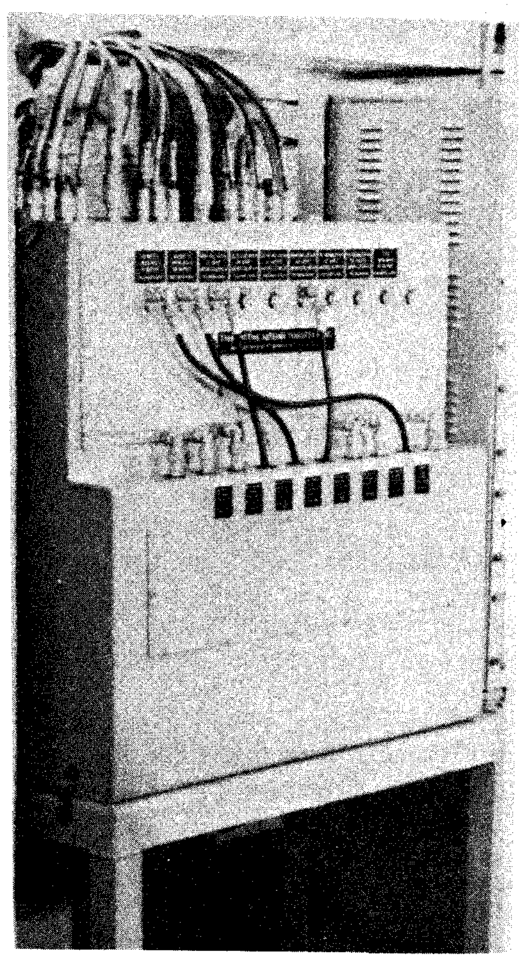
67.227

Figure 1-21.—Complex distribution system.

difficult. The ideal design would be to have all the transmission lines designed for the highest power level. But, because of cost and the fact that high power patch cords are large and difficult to handle, this approach is seldom followed.

In practice, a patch panel similar to the one shown for receiving systems (fig. 1-20) is practical for low power levels. Another type of transmitter patch panel is shown in figure 1-22.

These transmitting patch panels are interlocked with the transmitter so that no open jack connection can be energized and no energized patch cord can be removed. This provides for both personnel and equipment safety.



70.27

Figure 1-22.—Transmitting antenna patch panel.

RECEIVING MULTICOUPLER

The AN/SRA-12 (fig. 1-23) filter assembly multicoupler provides seven radio frequency channels in the frequency range from 14 kHz to 32 MHz. Any or all of these channels may be used independently of any of the other channels, or they may operate simultaneously. Connections to the receiver are made by means of coaxial patch cords, which are short lengths of cable with plugs attached to each end.

A set of nine plug-in type filter assemblies is furnished with the equipment, but only seven of them may be installed at one time. The seven filters installed are selected to cover the most-used frequency bands.

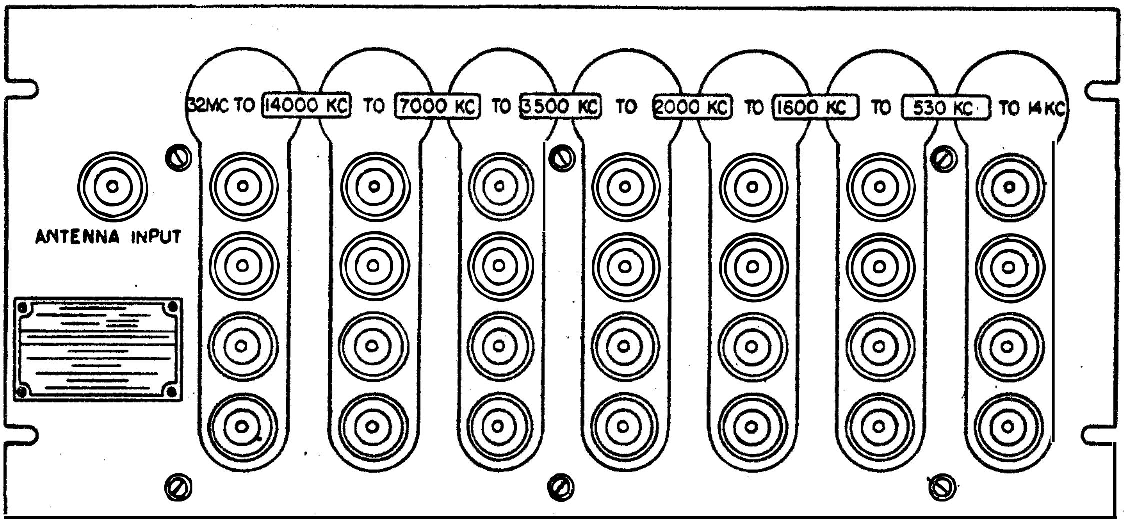
Figure 1-21 illustrates how the AN/SRA-12 is used as a portion of the receiving multicoupler. Along with the receiving antenna patch panel (fig. 1-20) and the receiver rf patch panel (the patch panels used for the receiver antenna and the receiver rf are normally the same panels.) The signal from the antenna can be passed to any number of receivers.

HF MULTICOUPLERS

Most of the multicouplers for the hf range are designed for use with either transmitters or receivers, although there are some which are used with both. Because of the large size of antennas (particularly in the 2- to 12-MHz range), the number of channels in hf multicouplers is usually made as large as practical.

Antenna Coupler Groups AN/SRA-56, 57, & 58

Antenna Coupler Groups AN/SRA-56, -57, and -58 are designed primarily for shipboard use. Each coupler group permits several transmitters to operate simultaneously into a single, associated, broadband antenna, thus reducing the total number of antennas required in the limited space aboard ship.



1.115

Figure 1-23.—Electrical Filter Assembly AN/SRA-12.

These antenna coupler groups provide a coupling path of prescribed efficiency between each transmitter and the associated antenna. They also provide isolation between transmitters, tunable bandpass filters to suppress harmonic and spurious transmitter outputs, and matching networks to reduce antenna impedances.

General Description

The three antenna coupler groups (AN/SRA-56, -57, -58, fig. 1-24) are similar in appearance and function. They differ in frequency ranges and the capability of providing four-channel or eight-channel configurations. Antenna Coupler Group AN/SRA-56 operates in the frequency range from 2 to 6 MHz. The AN/SRA-57, operates from 4 to 12 MHz, and the AN/SRA-58, operates in the 10- to 30-MHz range. Antenna Coupler Groups AN/SRA-56 or -57 can each be operated alone in a four-channel configuration, or two of the same antenna coupler groups can be combined by means of an impedance matching network to form an eight-channel configuration. Antenna Coupler Group AN/SRA-58 can be used in a four-channel configuration only.

A single antenna coupler group consists of four antenna couplers (channels), built as drawer assemblies and installed in an electrical equipment cabinet, and a power supply installed in the bottom position of the cabinet (fig. 1-24). The antenna coupler groups are modular in design. All antenna coupler drawers are interchangeable within the same antenna coupler group. The power supply assemblies and many of the subassemblies and components in the equipment cabinets and in the antenna coupler drawers are interchangeable within all three coupler groups. Each antenna coupler group is a self-contained unit having all required rf circuits, operational controls, monitoring, control, and protective circuits, and power distribution and supply circuits housed within the electrical equipment cabinet.

Each antenna coupler group or eight-channel configuration operates with a separate broadband antenna having a maximum vswr of 3- to -1 over the nominal frequency range of the associated antenna coupler group. The antenna coupler groups can operate with transmitters

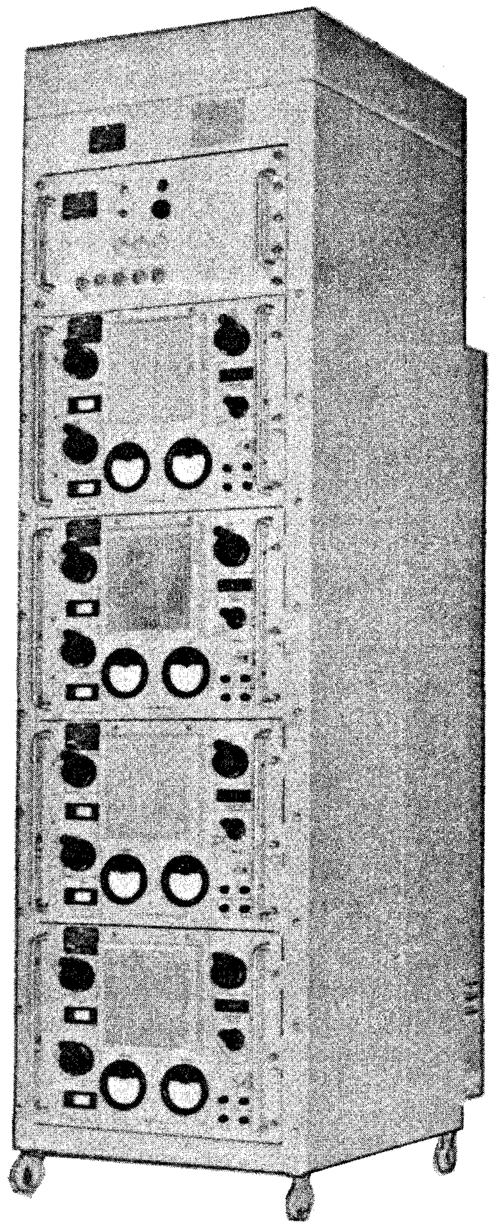


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Figure 1-24.–Antenna coupler group AN/SRA-56, AN/SRA-57, or AN/SRA-58.

having power outputs as high as 1 kilowatt average and 2 kilowatts peak envelope power for each channel, and as low as 500 watts average per channel. Any individual coupler within a coupler group may be operated at any frequency within its tuning range, provided that it does not operate within five percent of the frequency occupied by another coupler within the same group.

Each antenna coupler contains monitoring, control, and protective circuits that provide and enforce sequential tuning and operation. The power supply panel in each coupler group contains a fused circuit that provides a.c. to operate the cooling air fans in each antenna coupler to remove the heat generated during tuning and operation, a power supply that provides d.c. to operate the control and protective circuits, and a sonic generator that provides an audible alarm to warn the operator of a loss of air flow within an antenna coupler.

Functional Description

An overall functional block diagram of Antenna Coupler Groups AN/SRA-56, -57 and -58 is shown in figure 1-25 (foldout at the end of this chapter). Each coupler group cabinet contains four channels that enable four 1-kW (average) transmitters to operate simultaneously into a common broadband antenna. The circuits that form these four channels and the auxiliary circuits required to operate the channels are physically contained in a single equipment cabinet that houses one complete coupler group. Two AN/SRA-56 or AN/SRA-57 coupler groups can be combined into an eight-channel configuration using a separate impedance matching network.

The rf signals from an individual transmitter through a coupler group into an antenna are processed in the following manner. Rf power from transmitter 1 (fig. 1-25, foldout at the end of this chapter) enters the coupler group through operate reflectometer 1A6A2 and is fed to rf relay assembly 1A6A7. During the tuning procedure for the associated antenna coupler (1A1), vacumm relays in the rf relay assembly are activated, and the rf signal path is switched through power attenuator 1A6A1 and tune reflectometer 1A6A6. The attenuated rf is fed to rf circuitry in antenna coupler 1A1 where it is used to tune the antenna coupler before the full power is switched by the rf relays and applied directly to the antenna coupler input during regular operation. The operate and tune reflectometers sample the rf power and provide signal outputs to the monitoring and control circuits during tuning and operation of the antenna coupler.

From the rf relay assembly, either the attenuated rf used in tuning, or the full power rf used in regular operation, is applied to a highly selective bandpass filter in antenna coupler 1A1 through electronic Q control assembly 1A1A4. The processed rf output from the bandpass filter is inductively coupled to the combiner by means of an output coupler link 1A6L1 which is physically moved in and out of the output resonator to load the antenna coupler during the final tuning step and operation.

The rf voltages present on the input and output resonators are sampled to provide additional signal inputs to the monitoring and control circuits of the antenna coupler during tuning and operation. The rf circuits, operational controls, monitoring, and control circuits provide a means of tuning the antenna coupler in the required sequence, operating the antenna coupler in an established manner, and protecting the antenna coupler and its associated transmitter if a malfunction should occur.

In the combiner, the rf output from channel 1 is matched and combined with the rf outputs from the other three channels in the coupler group cabinet. The rf output of the combiner is fed via coaxial transmission line to the antenna, or directly to an impedance matching network when two coupler group cabinets are used in an eight-channel configuration (AN/SRA-56 and AN/SRA-57 only). The impedance matching network operates in a manner similar to the combiner to match and combine the rf outputs from the two coupler groups. The rf output from the impedance matching network is then delivered to the antenna via coaxial transmission line.

The power distribution and supply circuits located on the power supply panel 1A5 provide to each antenna coupler (1) a.c. to operate the cooling fans which remove the heat generated during operation and (2) d.c. to operate the control and protective circuits. The power supply panel also contains an audible alarm to warn the operator of a loss-of-air flow within any of the antenna couplers.

ANTENNAS

Antenna theory and basic antennas are discussed in *Basic Electronics, Volume 1*, NAVPERS 10087-C and the *Navy Electricity and Electronics Training Series (NEETS)*. This section describes some of the common types of antennas used with shipboard communication systems.

WIRE ANTENNAS

A wire antenna consists of a wire rope suspended either vertically or horizontally from a yardarm or the mast itself to outriggers, to another mast, or to the superstructure. A simplified diagram of a shipboard wire antenna is shown in figure 1-26.

Single wire antennas are not used aboard ship as extensively as they have been used in the past. They have, to a large extent, been replaced by whip, dipole, and other antenna assemblies. In some installations, wire antennas are used only in emergencies.

Because of the frequency range in which these antennas are used, the portion of the ship's structure used to support the wire and other nearby structures is an electrically integral part of the wire antenna. Therefore wire antennas are usually designed for a particular ship or installation.

Wire rope used for transmitting will normally be without insulation, while receiving antenna wire rope will have Vinylite insulating jacket (as will transceiving wire antennas) to reduce interference from precipitation static.

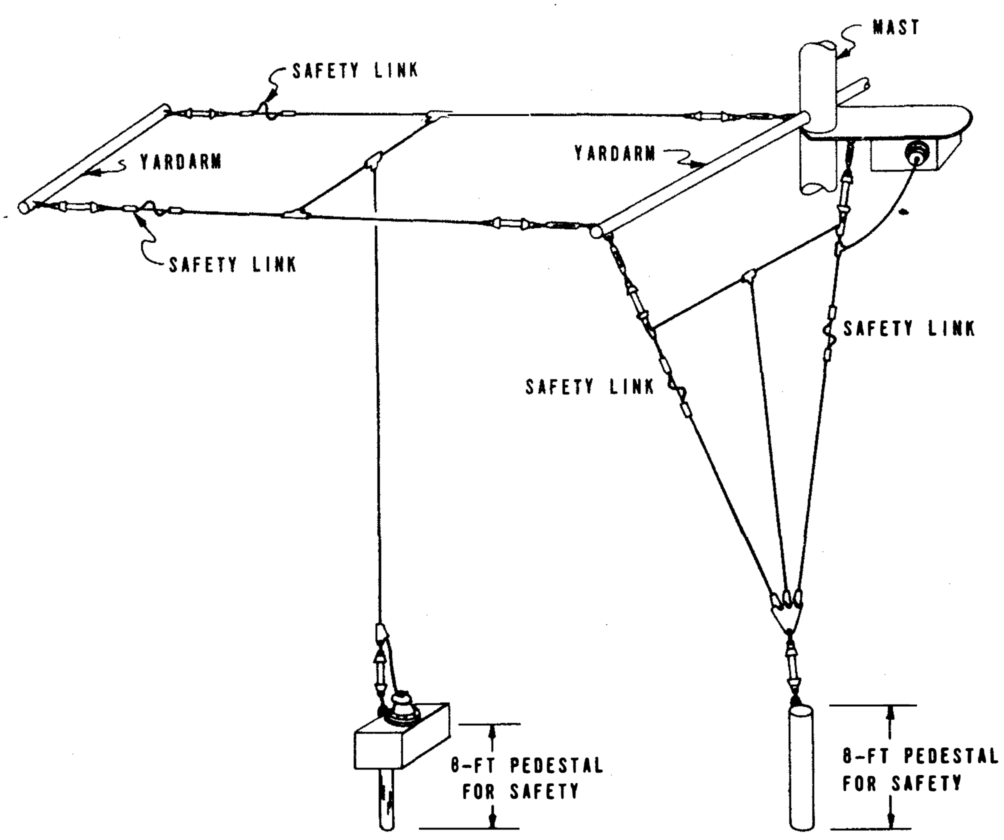

Figure 1-26.—Wire rope antenna.

(Static interference due to the discharge of large charges built up by rain, sleet, snow or electrically charged clouds.)

WHIP ANTENNAS

Because whip antennas are essentially self-supporting, they may be installed in many locations aboard ship where space is at a premium, and locations are unsuitable for other antenna types. They may be deck mounted or mounted on brackets on the stacks or superstructure.

Whip antennas that are to be used for receiving only are mounted as far away from the transmitting antennas as possible so that a minimum of energy from the local transmitters will be picked up.

One type of whip antenna commonly used aboard ship is constructed with seven-foot sections of aluminum rod. The lower rod is three inches in diameter and the whip tapers to a diameter of one inch at the upper section. (Fiberglass whips are replacing the aluminum whips in some installations.) Some whips may be trussed with wire rope (which increases the frequency bandwidth) resulting in better performance (fig. 1-27). The recommended method for mounting a receiving whip antenna up to 35 feet in length is shown in figure 1-28. Whip antennas over 35 feet are mounted on a plate supported by three or four insulators (fig. 1-29) for greater strength. Small whip antennas have been mounted horizontally on yardarms or

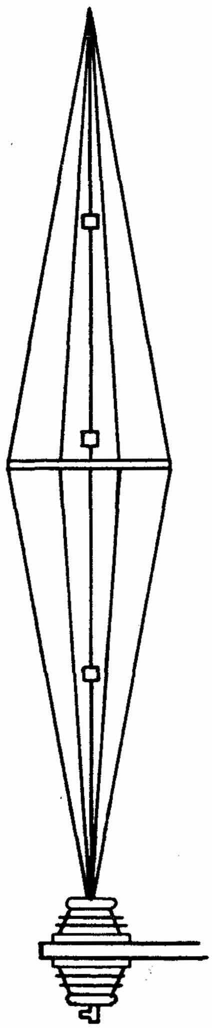

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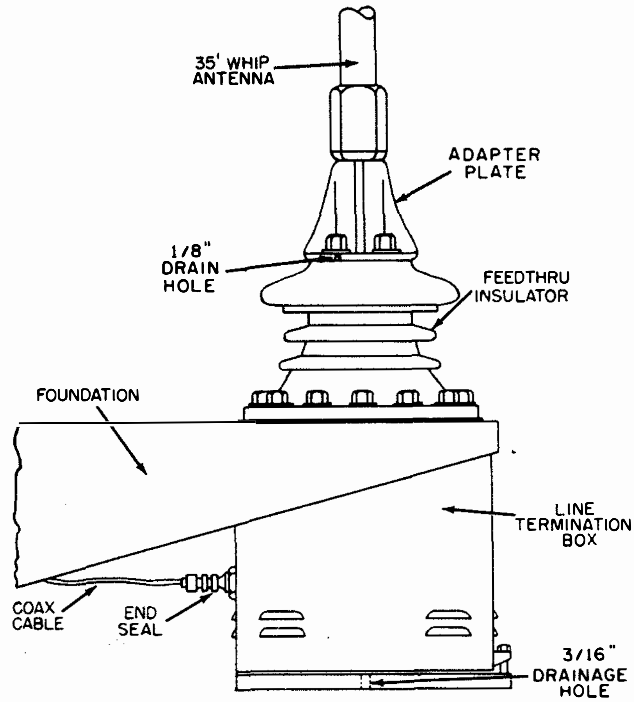
Figure 1-27.—Trussed whip antenna.



1.47
Figure 1-28.—Method of mounting whip antenna of 35 feet or less.

masts in some installations for use as low-frequency probe antennas. Such antennas usually come supplied with line termination box (fig. 1-30) which normally is mounted to the ship's structure. Some applications use two whips connected as a single antenna for better electrical performance.

If the antennas are less than 25 feet apart, they are usually connected with a crossbar (fig.

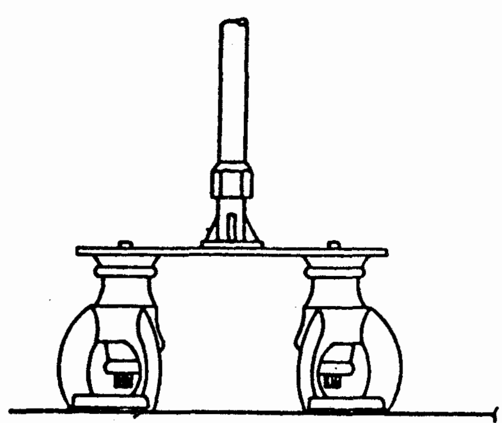


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Figure 1-29.—Method of mounting whip antenna over 35 feet.

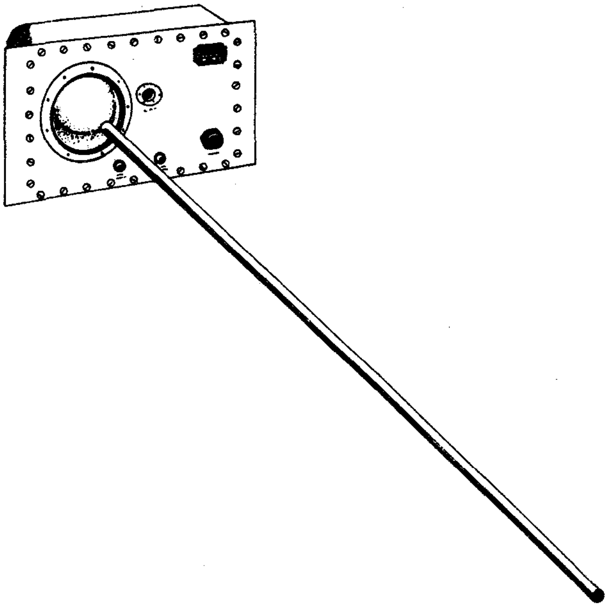

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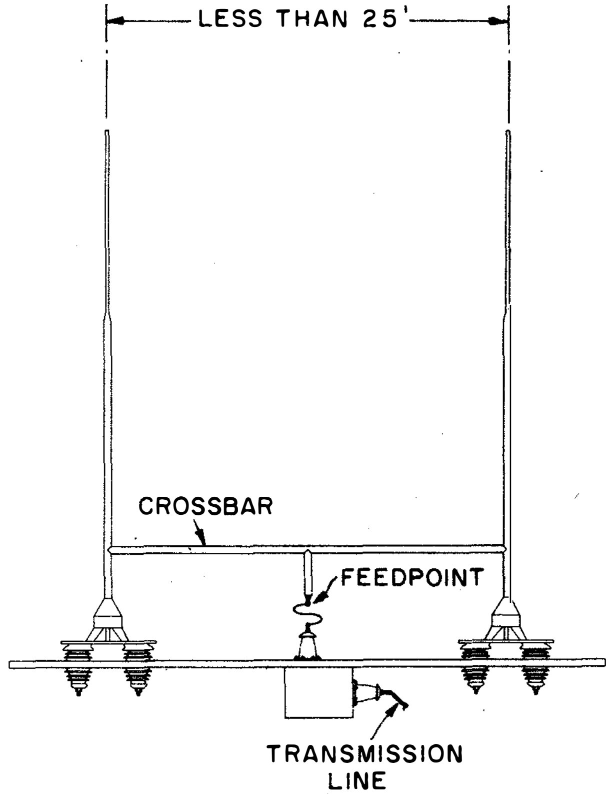
Figure 1-30.–Small whip antenna with line termination box.



67.221
Figure 1-31.–Twin whip antennas with crossbar terminations.

1-31) which is the feedpoint at its center. If the antennas are a considerable distance apart or for some other reason a direct connection is not practical, transmission line termination is used. Referring to figure 1-32, the transmission lines (of equal length) are fed to a tee, which is the assembly feed point. Each whip is usually matched individually to the transmission line by antenna base matching networks. Wire rope is used in place of the whips in some installations.

On aircraft carriers and missile ships, a method of tilting the whip antenna (fig. 1-33) is employed for those installed along the edges of the flight deck, or in the missile firing zone.

The tilting mounts may be mechanically or hydraulically operated. Mechanically operated mounts have a counterweight at the base of the antenna heavy enough to nearly balance the antenna in any position. The antenna may be locked in either a vertical or horizontal position by positive locking devices in both the operating and stowed positions.

BROADBAND ANTENNAS

Broadband antennas for use in the hf and the uhf bands have been developed for use with antenna multicouplers. To be used with a multicoupler, the antenna must be capable of handling simultaneous transmission from several transmitters without excessive loss of power in the multicoupler equipment. The antenna must, therefore, function satisfactorily over a relatively wide band of frequencies.

The effectiveness of a given antenna depends largely on impedance matching. If a good impedance match exists between the transmission line and the antenna throughout the operating band of frequencies, efficiency and power transfer are improved.

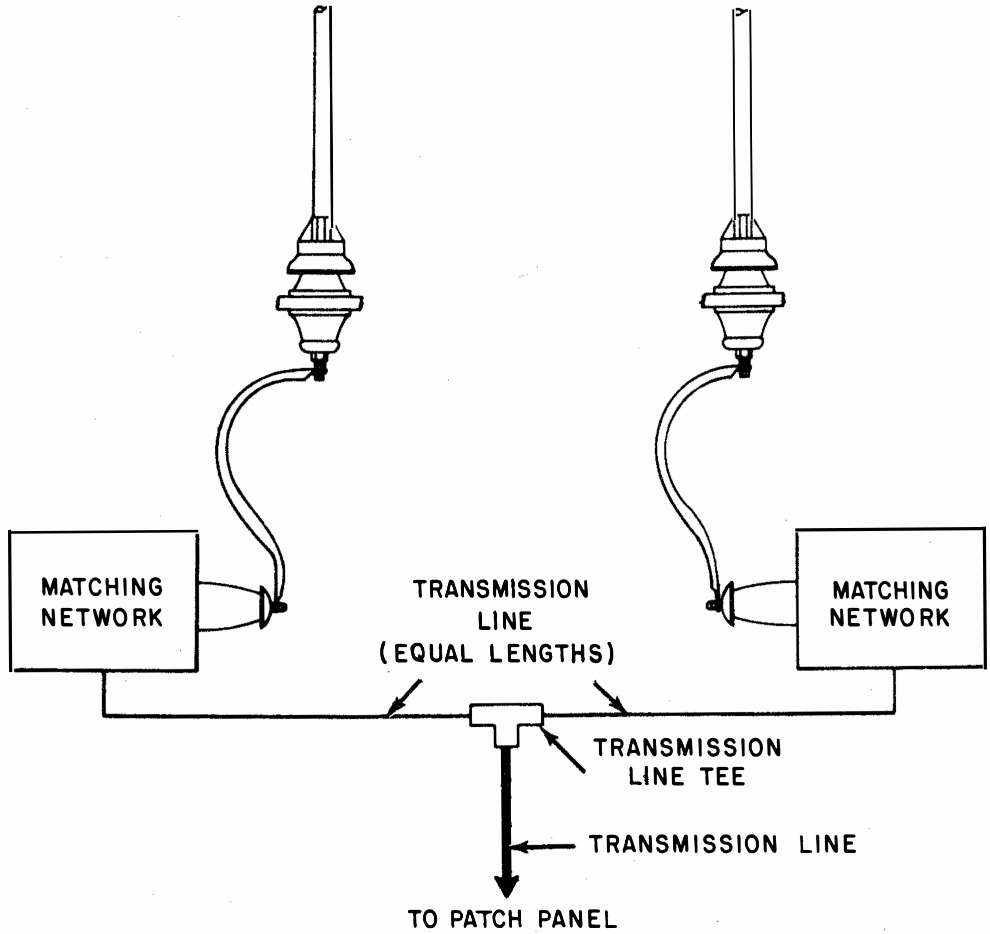


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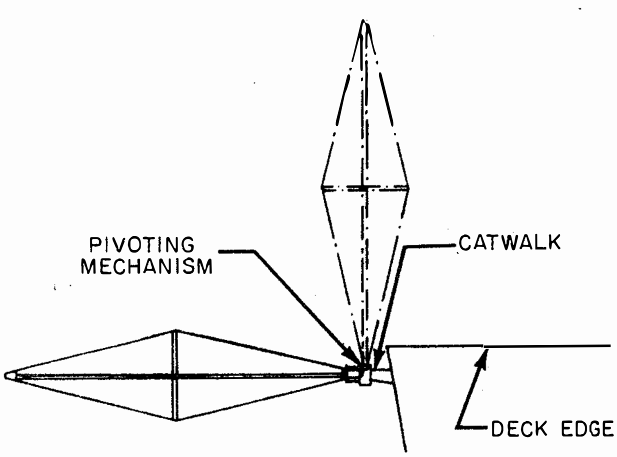
Figure 1-32.—Twin whip antennas with coaxial terminations.



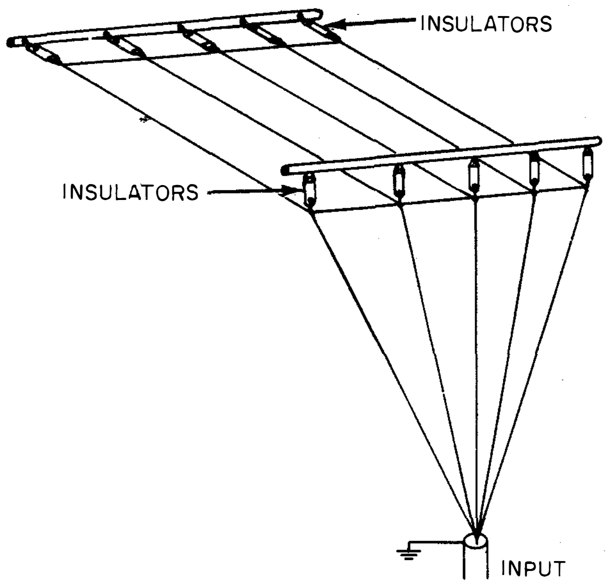
67.223

Figure 1-33.—Tilting whip antenna.

One type of broadband antenna, called a fan, is shown in figure 1-34. Effectively, this is a V-shaped plane radiator. Physically, it is composed of five wires cut for one-quarter wavelength at the lowest frequency to be used. The wires are fanned 30° between adjacent wires. On small ships, the fan antenna may consist of only three or four wires. Ships may have two fan antennas, one a vertical fan and the other a horizontal fan antenna.

UHF ANTENNAS

A large variety of uhf antennas have been developed for shipboard use. Two of these



67.134
Figure 1-34.—Five-wire vertical fan antenna.

antennas are shown in figure 1-35. They are used for transmitting or receiving vertically polarized waves in the 220- to 400-MHz range.

The vswr of the left antenna (fig. 1-35A) is less than 2.1 to 1 over the desired frequency range; however, the antenna may be used over a wider frequency range with only a nominal decrease in efficiency.

The radiation pattern is similar to that of a dipole. However, the pattern may be affected by the external supporting structure and the proximity of metallic masses. (Radiation patterns are discussed in *Basic Electronics, Volume 1*, NAVPERS 10087-C, Chapter 29 and the *Navy Electricity and Electronics Training Series (NEETS)*. The nominal input impedance is 52 ohms; however the actual input impedance is a function of frequency.

The vertical portion of the antenna forms the radiating element and is made up essentially of an inner and outer coaxial line, the two lines being concentric. Two aluminum tubes, (A), welded to the outer antenna sections serve as both the outer conductor of the inner coaxial line and the inner conductor of the outer coaxial line. The tie rod is the inner conductor of the inner coaxial line. An insulated gap is formed in each of the outermost conductors by the spacer insulators.

Another uhf antenna, shown in figure 1-35B, has a vswr of less than 1.9 to 1 over the designed frequency range. This antenna also may be operated over a wider frequency range with only a nominal decrease in efficiency. The radiation pattern of this antenna is similar to that of a dipole, and the nominal input impedance is 52 ohms. However, the actual input impedance is a function of frequency.

The lower antenna section acts as part of the radiating portion and also houses the coaxial feedline. The inner conductor of the feedline is connected to the tie rod, one end of which is attached to the upper antenna section and the other of which is attached to the base of the lower antenna section. The lower portion of the tie rod is encircled by a tuning stub, which is closed and threaded at the top end and open at the bottom end, except for the supporting insulator. By rotating the stub on the threads the input impedance of the antenna may be varied.

Another uhf antenna is shown in figure 1-36. This type is covered with a polyester fiberglass radome which provides a rugged, weatherproof covering for both the transmission line and the antenna without interfering with radiation.

The transmission line is internal and consists of a circular inner conductor and a square outer conductor. It is designed to match the 50-ohm impedance of the external transmission line.

The antenna is a colinear array of two cylindrical, parallel-fed, dipole elements. The non-resonant dipoles provide broadband coverage and an omni-directional horizontal radiation pattern. The lower half power point of the vertically polarized propagation falls on or below the horizon. The required pattern tilt is achieved by feeding the dipoles so that the upper dipole lags the lower dipole in phase by a few degrees.

MATCHING NETWORKS

An antenna matching network consists of one or more parts such as coils, capacitors, and

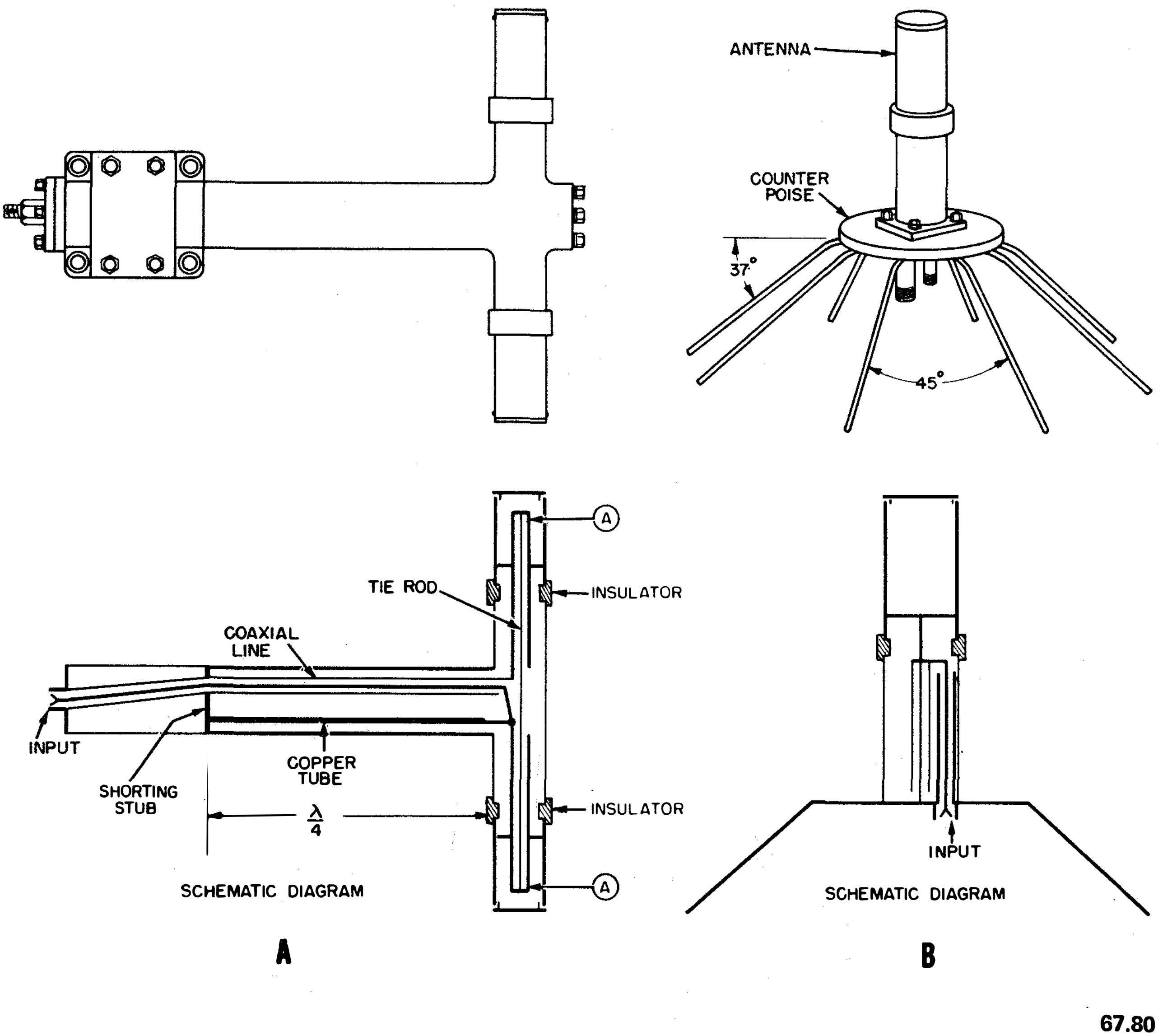


Figure 1-35.—UHF antennas.

lengths of transmission line connected in series or parallel with the transmission line to reduce the standing wave ratio on the line. Matching networks are usually adjusted upon installation and require no further adjustment for proper operation. Figure 1-37 shows a matching network outside of the antenna feedbox with a sample matching network schematic.

Matching networks can also be built with variable components so that they can be used for impedance matching over a band of frequencies. These networks are called antenna tuners.

Antenna tuners are usually adjusted automatically or manually each time the operating frequency is changed. Standard tuners are made with integral enclosures so that installation consists simply of mounting the tuner, assembling the connections with the antenna and transmission line, and pressurizing if required. Access must be provided to the pressure gauge, and pressurizing and purging connections.

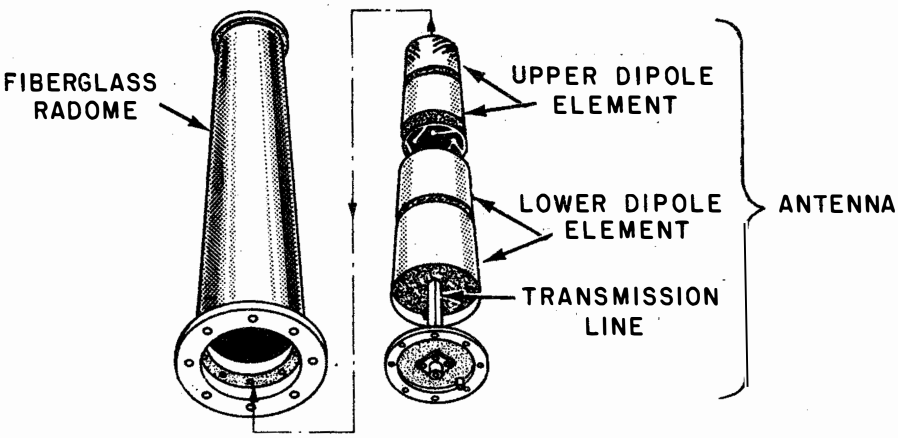


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Figure 1-36.—Mast covered UHF antenna.

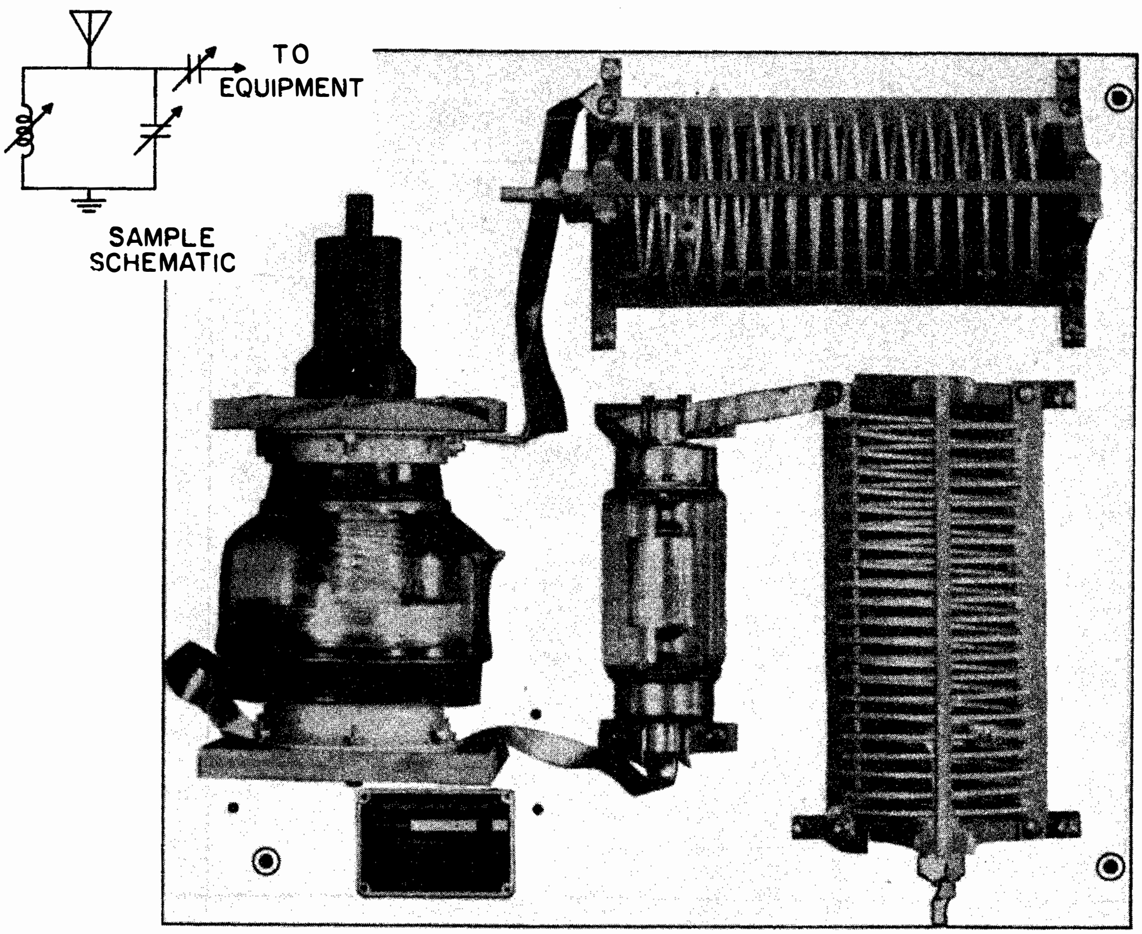

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Figure 1-37.—Matching network.

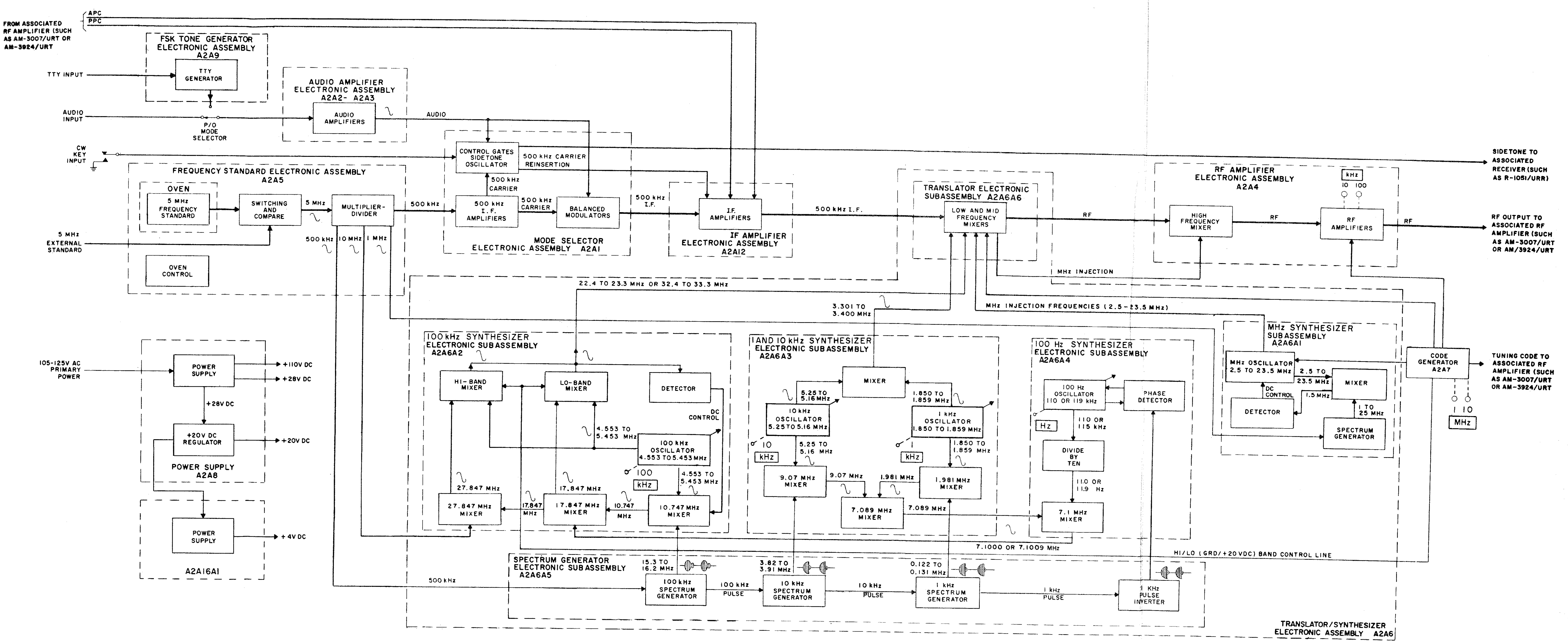

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Figure 1-16.—Radio Transmitting Set T-827( )/URT functional block diagram.

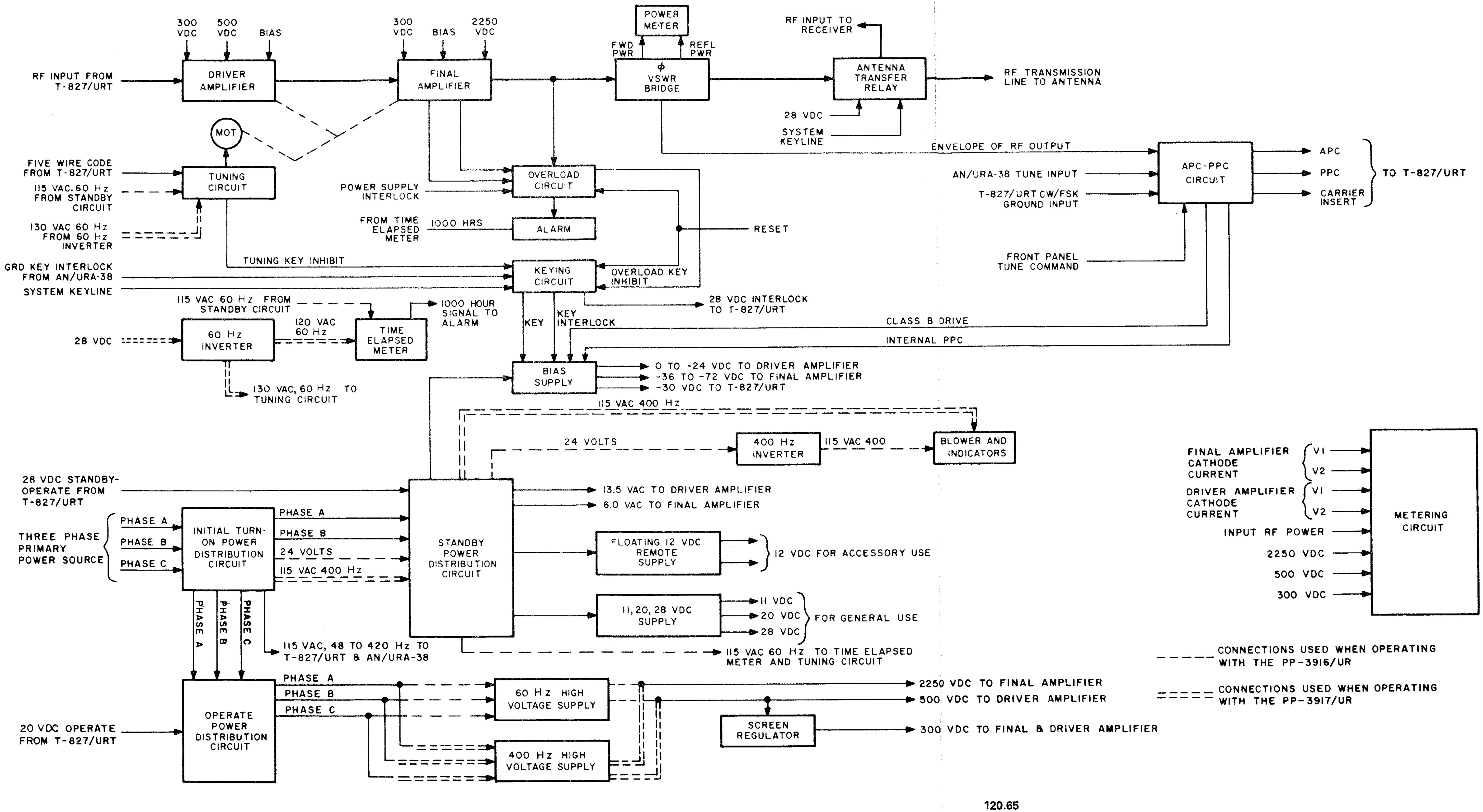

Figure 1-17.—Radio Transmitting Set AN/URT-23(V) functional block diagram.

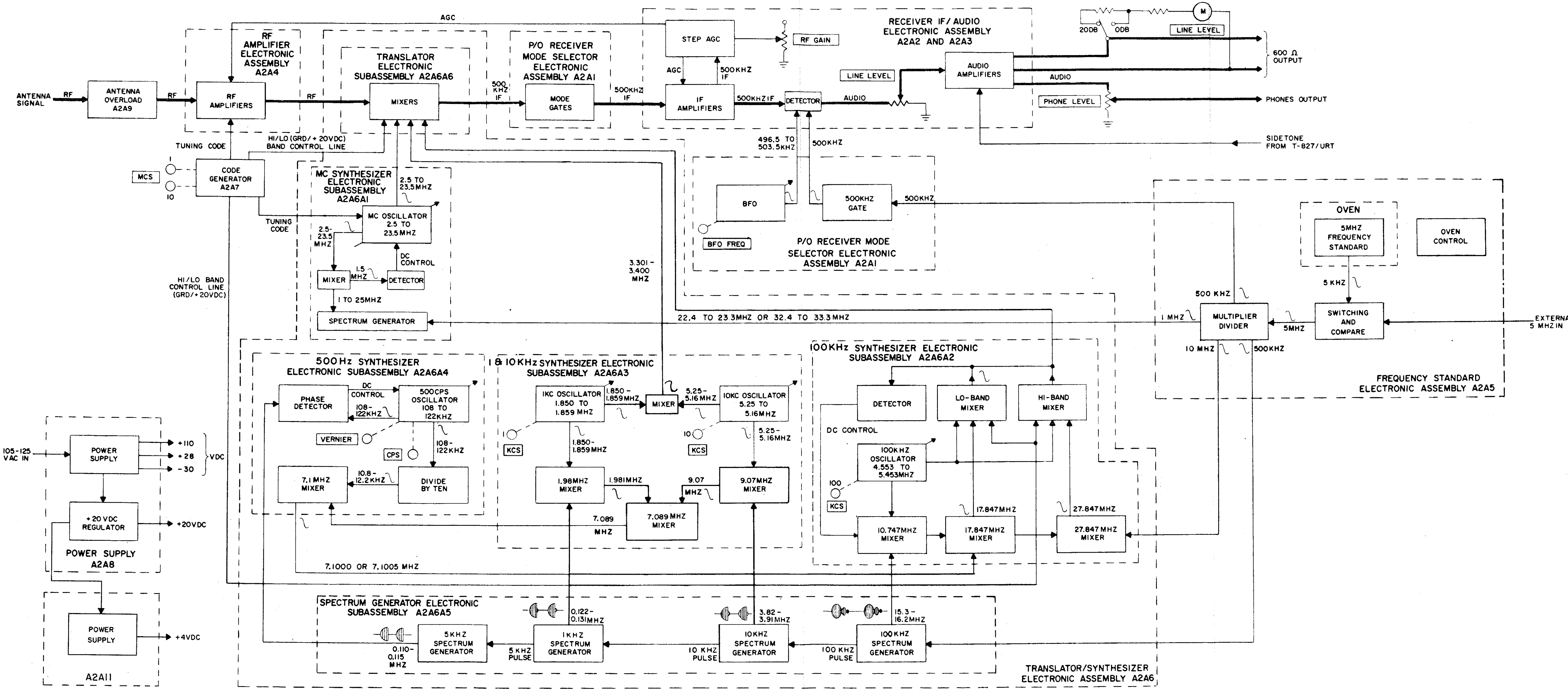

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Figure 1-19.—Radio Receiver R-1051/URR functional block diagram.

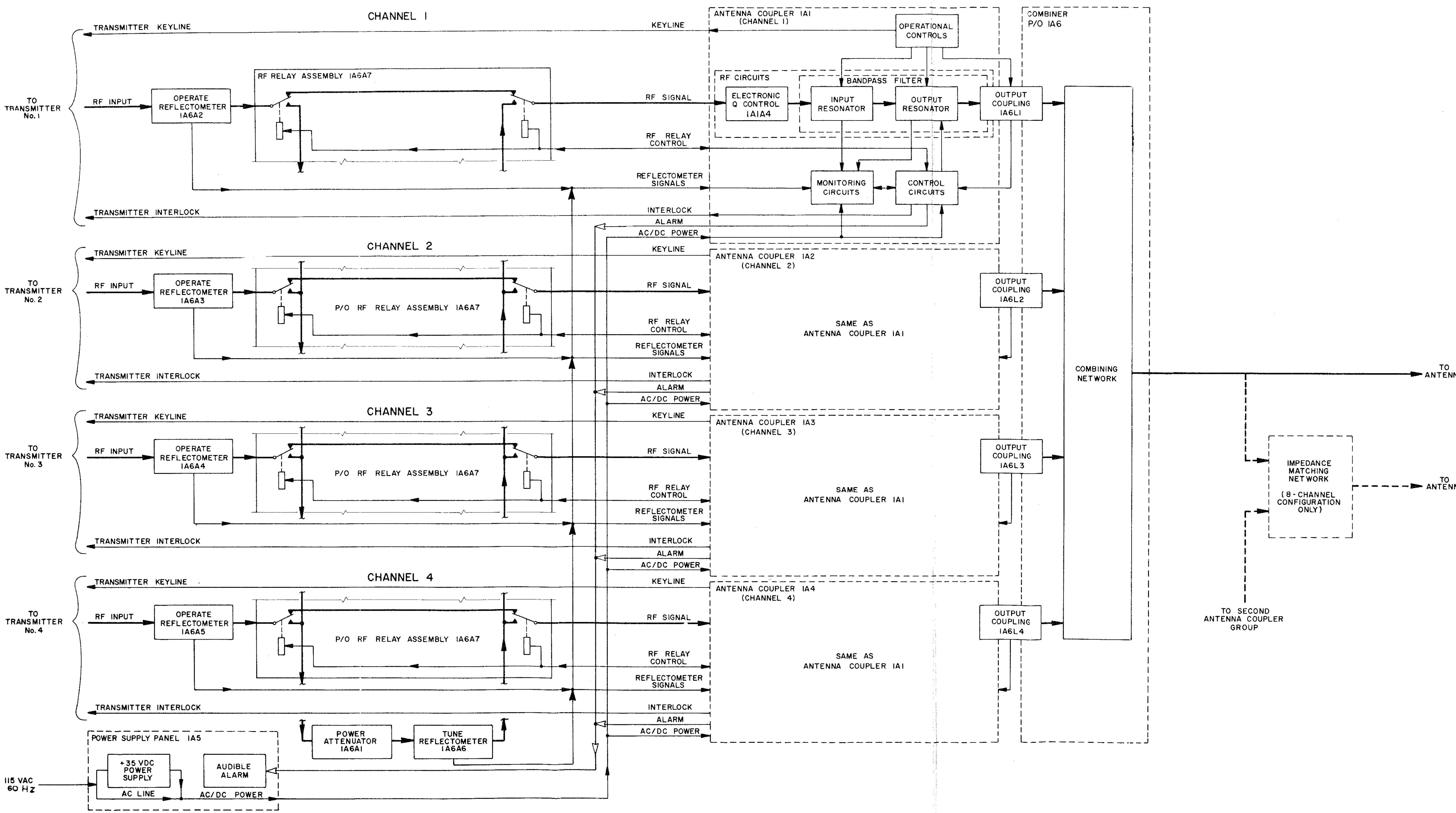

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Figure 1-25.—Functional block diagram (AN/SRA-56,57, or 58.)

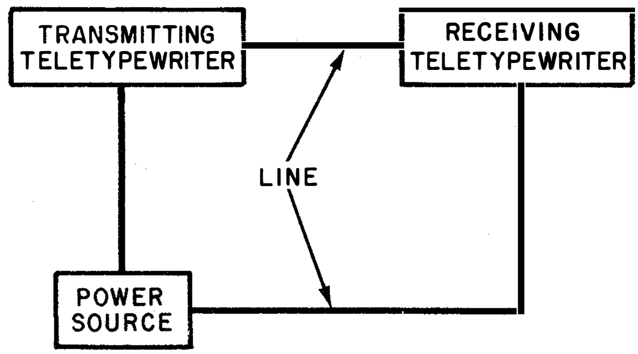
CHAPTER 2

TELETYPE

BASIC PRINCIPLES

To see how intelligence is sent via teletype, one of the simpler devices for electrical communication–the manual telegraph circuit–is first considered. This circuit, shown in figure 2-1, includes a telegraph key, a source of power (battery), a sounder, and a movable sounder armature. If the key is closed, current flows through the circuit and the armature is attracted to the sounder by magnetism. When the key is opened, the armature is retracted by a spring. With these two electrical conditions of the circuit–closed and open–it is possible, by means of a code, to transmit intelligence. These two conditions of the circuit are referred to as MARKING and SPACING. The marking condition occurs when the circuit is closed, and a current flows; the spacing condition occurs when it is open, and no current flows.

If the key at station A is replaced by a transmitting teletypewriter and the sounder arrangement at station B is replaced by a receiving teletypewriter, the basic teletypewriter circuit (loop) shown in figure 2-2 is formed.



1.200

Figure 2-2.–Simple teletype circuit.

If a teletypewriter signal could be drawn on paper, it would resemble figure 2-3. This is the code combination for the letter R. Shaded areas show intervals during which the circuit is closed, and the blank areas show the intervals during which the circuit is open. There are a total of seven units in the signal. Five of these are numbered, and are called INTELLIGENCE units. The first and last units of the signal are

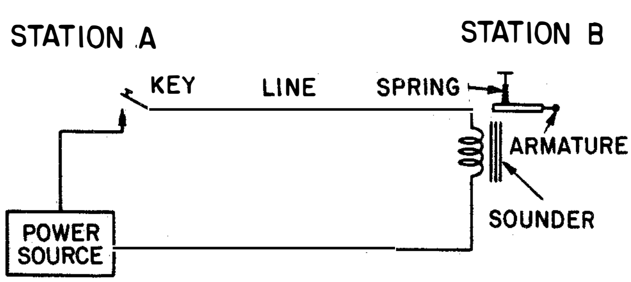


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Figure 2-1.–Manual telegraph circuit.

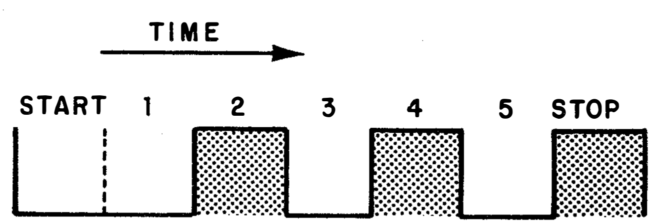

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Figure 2-3.–Mark and space signals.

labeled START and STOP. They are named after their functions: the first starts the signal, and the last stops it. These are a part of every teletypewriter code signal: the START unit is always spacing, and the STOP unit is always marking.

Examine figure 2-3 again. This is theoretically a perfect signal. The time between each unit remains the same during its transmission and the shift from mark to space (and vice versa) is called a TRANSITION. A transition occurs at the beginning and end of each unit when it shifts from mark to space or space to mark, and there will be only two, four or six transitions for each character.

When figuring the time duration of a signal character, no allowance for transition time is made since the transition is instantaneous and is considered to have zero time duration. The time duration for each unit is measured in milliseconds.

CODES

In manual telegraphy, the most widely used code is the Morse code. In this code, two distinctive signal elements are employed–the dot and the dash. The difference between a dot and a dash is usually one of time duration, a dash being three times as long in duration as a dot. Each character is made up of a number of dots and/or dashes. The dot and dash elements constituting any character are separated from each other by a time interval equal to the duration of one dot. The time interval between the characters for each word is equal to the duration of three dots, and the interval between words is equal to seven dots.

In teletypewriter operation, the code group for each character is of uniform length. Since the Morse code is an uneven length code, it cannot be used in teletypewriter operation, without additional code converters.

The Murray five unit (five level) code has been the most commonly used code in modern printing telegraphy, and is universally employed for teletypewriter operation. The mechanical sending device in the teletypewriter divides the sending time for each character into five short code elements (impulses) of equal duration. The five unit code is an example of what is called an even length or constant length code; i.e., one in which the number of signal elements for a character is the same for every character, and the duration of each element is constant. In the five unit code, each character consists of a combination of five signal elements, and each element may consist of either of two basic signaling conditions (marking or spacing). Thus, a total of 2^5 or 32 combinations of the signal elements is possible with this arrangement.

The 32 possible combinations available from the five unit code are insufficient to handle the alphabet and numbers, since 26 combinations are required for the letters of the English alphabet alone. This leaves only six combinations for numerals, symbols, or nonprinting functions. This is obviously inadequate. It therefore becomes necessary to adopt a plan to enable a larger number of characters to be included. This is done by the following means. Two of the 32 combinations are used as shift signals, which permit the remaining code combinations in the first case to be used as letters, and in the second case, the combinations are used for numerals, punctuation signs, etc. The shift signals are often referred to as case-shift signals; i.e., one case is a letter shift, and the other a figure shift. When a letter shift is transmitted, it sets the receiving instrument in a condition to recognize any signal combination subsequently received to be recorded in the letter case, until a figure shift is received. Then the receiving instrument sets itself in a condition to record any subsequent signal combinations received in the figure case. That is, the interpretation of a signal combination is determined by the previous shift signal. The use of this plan enables 30 of the available 32 combinations to have two meanings.

MODES OF OPERATION

There are two basic modes of teletypewriter operation: nonsynchronous (start-stop) and synchronous. The most common mode of teletypewriter operation is the start-stop mode. Synchronous operation is used more in high-speed data systems.

In the start-stop mode of operation the receiving device is allowed to run for only one character and is then stopped to await the reception of a start signal indicating that the next character is about to start. In this manner, any difference in speed between the transmitting and receiving devices can accumulate only during the duration of one character. However, there is a penalty to pay for this advantage. The length of each character must be increased to include an element to start the receiving device and another added to stop it.

The start element precedes the first code (intelligence) element and is always a space signal. Its purpose is to start the receiving machine. The stop element follows the last code element and is always a mark signal. Its purpose is to stop the receiving machine in preparation for receiving the next character. The start element must be equal to at least one element of the code. The standard mode uses a stop element 1.42 times the length of one code element. It is common practice to refer to a code element as a unit and the duration of a unit as the unit interval.

The length of time required to transmit the entire character is called the character interval. Character interval becomes very important in some transmissions due to certain items of equipment being "character length conscious" or "code conscious". Stop unit intervals of various lengths are used or produced by various equipment, such as 1.0, 1.27, 1.5, 1.96, 2.0, etc. Basically the only difference between them is the length of time required to transmit one character.

Synchronous teletypewriter operation, as opposed to start-stop operation, does not in all cases, have to rely upon elements of the transmitted character to maintain proper position in relation to the receiving device. External timing signals may be used, allowing the start and stop elements to be discarded. Then, only the elements necessary to convey a character (and in some cases a reference element) need to be transmitted.

Synchronous systems have certain advantages over start-stop systems. The amount of time taken to transmit stop and start elements is made available for information transmission rather than for synchronizing purposes. Only the intelligence elements are transmitted. In start-stop signaling the ability of the receiving device to select the proper line signal condition is dependent upon interference to the start-stop arrival. This means that if the stop-to-start transition arrives before it should, all subsequent selection positions in that character will appear earlier in time in each code element. A synchronous system, therefore, has a higher capability to accept distorted signals than does a start-stop system.

MODULATION RATE

There are several methods of referring to teletypewriter modulation rates or signaling speeds. These include baud, bits per second (BPS), and words per minute (WPM). Baud is the only one that is technically accurate without using additional qualifying terms. The others are either approximations or require explanation.

The word baud by definition is a unit of modulation rate. It is sometimes used to refer to a signal element, but this reference is technically incorrect. Baud rate is the reciprocal of the time in seconds of the shortest signal element. Hence, to find the modulation rate of a signal in bauds, the number 1 is divided by the time duration of the shortest unit interval present in the signal. For example, 22 milliseconds (.022) is the time interval of the shortest unit in the five unit code at 60 words per minute. To find the number of bauds corresponding to 60 WPM, divide 1 by .022. Rounding off the results of the division, provides the figure 45.5, which is the baud equivalent of 60 WPM. Each increase in WPM will correspondingly decrease the signal unit time interval. (The Defense Communications System standard speed for teletype operation is 100 WPM.)

Words per minute is used only when speaking in general terms for an approximation of speed. The term 100 WPM means the 100 five letter words with a space between them can be transmitted in a 60-second period. However, it is possible to obtain this nominal words-per-minute rate in several systems by varying either modulation rate or the individual character interval (length). For this reason, the modulation rate (baud) method of reference rather than words per minute is used.

Formula for baud and WPM are as follows:

$$\text{Baud} = \frac{1}{\text{Unit interval}}$$

$$\text{WPM} = \frac{\text{Baud}}{\text{Unit code x 0.1}}$$

The term "bit" is a contraction of the words "binary digit". In binary signals, a bit is equivalent to a signal element. As a result of the influence of computer and data processing upon our language, modulation rate is sometimes expressed as "bits per second" (BPS). When it is expressly understood that all signal elements being transmitted are of equal length, then the modulation rate expressed in bits per second is the same as modulation rate expressed in baud.

D.C. CIRCUITS

It has been pointed out that the two conditions mark and space may be represented by any convenient means. The two most common are neutral operation, in which current flow represents the mark and no current flow represents the space, and polar operation, in which current impulses of one polarity represent mark and impulses of the opposite polarity of equal magnitude represent the space.

Neutral circuits make use of the presence or absence of current flow to convey information. These circuits use 60 milliamperes (mA) (or in some cases 20 mA) as the line current value. A neutral teletypewriter circuit is composed of a transmitting device, a battery source to supply current, a variable resistor to control the amount of current, a receiving device, and a line for the transmission medium.

Polar operation differs from neutral operation in two ways. Information is always present in the system, and it is either in a positive or negative condition. A polar teletypewriter circuit is composed of the same items as a neutral circuit plus an additional battery source. The reason for having an extra battery source is that the standard polar circuit uses positive battery for mark and negative battery for space.

The most significant advantage to polar operation is that for all practical purposes it is almost impossible to distort a signal through low line currents, high reactance, or random patching of signal circuits or equipment. Another advantage of polar signaling is that a complete loss of current (a reading of ZERO on the milliammeter) indicates line or, equipment trouble, whereas the same condition with neutral signaling may indicate only that a steady space is being transmitted.

BASIC SYSTEMS

When two teletypewriters are wire-connected (looped), the exchange of intelligence between them is direct. When the teletypewriters are not joined by wire, exchange of intelligence is more complex. Direct-current mark and space intervals cannot be sent through the air. The gap between the machines must be bridged by radio using a radio transmitter and receiver. The transmitter produces a radio frequency carrier wave to carry the mark and space intelligence. Also, a device such as a KEYER is needed to change the d.c. pulses from the teletypewriter into corresponding mark and space modulation for the carrier wave in the transmitter. The radio receiver and a CONVERTER are required to change the radio frequency signal back to d.c. pulses.

The Navy uses two basic radio-actuated teletype (RATT) systems—the tone-modulated system, referred to as audiofrequency tone shift (AFTS), and the carrier frequency shift system, referred to as radio-frequency carrier shift (RFCS). The RFCS system is also called frequency shift keyed (FSK).

Figure 2-4 shows a modulated carrier wave with audio tone impulses impressed on the radio-frequency carrier wave, with corresponding d.c. mark and space signals.

The RFCS signal can be explained by comparing it to the on-off cw signal. As cw signals are of essentially constant frequency,

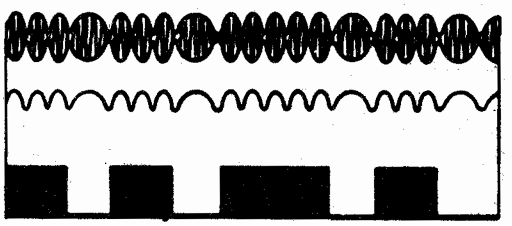

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Figure 2-4.—Modulated carrier wave with audio tone for mark and space.

there is no variation along the frequency axis (fig. 2-5A). The complete intelligence is carried as variations in the signal amplitude. Figure 2-5B shows the same signal as a shift in frequency between the mark and space.

TONE-MODULATED SYSTEM

Tone-Modulated (AFTS) Systems use the process of amplitude modulation to change the d.c. mark and space impulses into audio electrical impulses.

Conversion to the audio tones is accomplished by an audio oscillator in the tone converter. The rapid varying of the tone, according to the characters transmitted from the teletype equipment, amplitude modulates the carrier wave in the transmitter. The receiver receives the modulated signal and separates the audio signal from the carrier. This process of separating the modulated signal is known as detection or demodulation. A basic tone-modulated system is shown in figure 2-6.

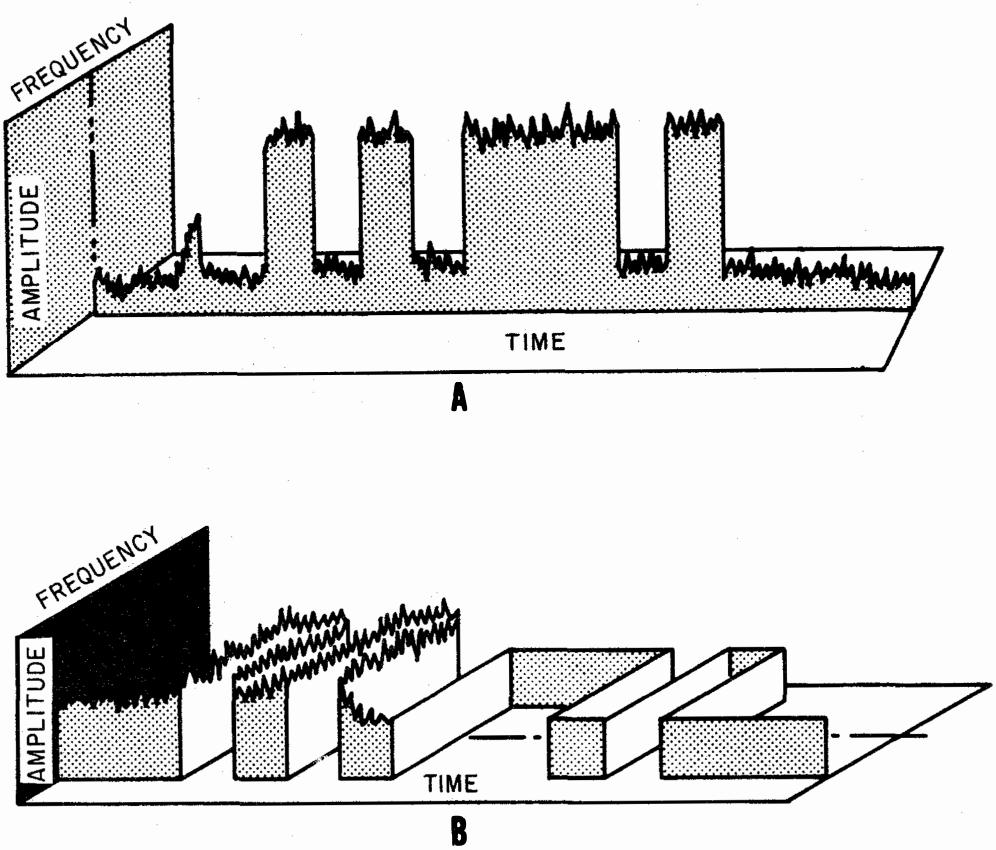

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Figure 2-5.—CW and RFCS telegraph signals.

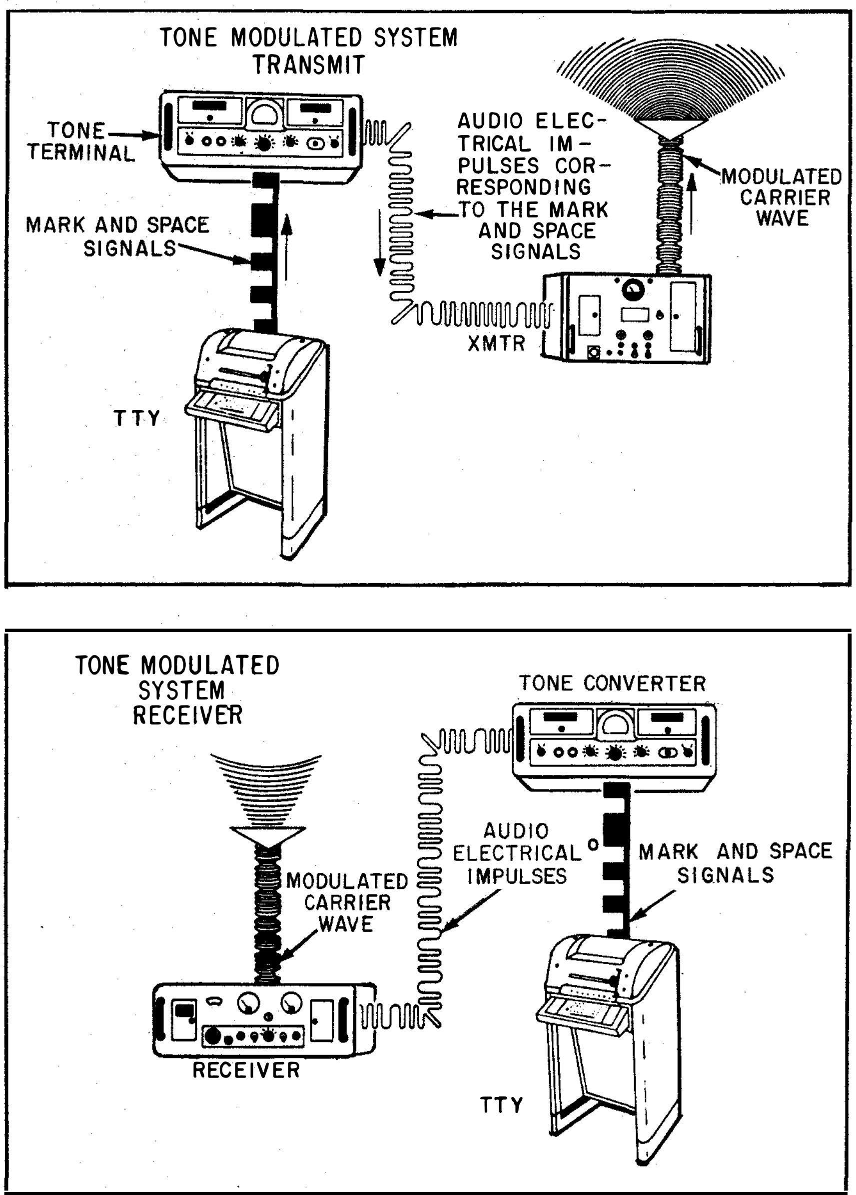

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Figure 2-6.—Basic tone-modulated (AFTS) system.

CARRIER FREQUENCY-SHIFT SYSTEM

For Frequency-Shift (RFCS) Systems, a keyer in the transmitter provides a source of radio-frequency excitation which can be shifted below or above the assigned frequency corresponding to the mark or space required to transmit the teletype characters. Normally the keyer is adjusted for an 850-Hz spread, 425 Hz above the assigned frequency and 425 Hz below. A spacing impulse will be 425 Hz above the operating frequency, and a marking impuse will appear 425 Hz below. Figure 2-7 illustrates a basic frequency-shift system. In modern systems, the keyer is built into the transmitter.

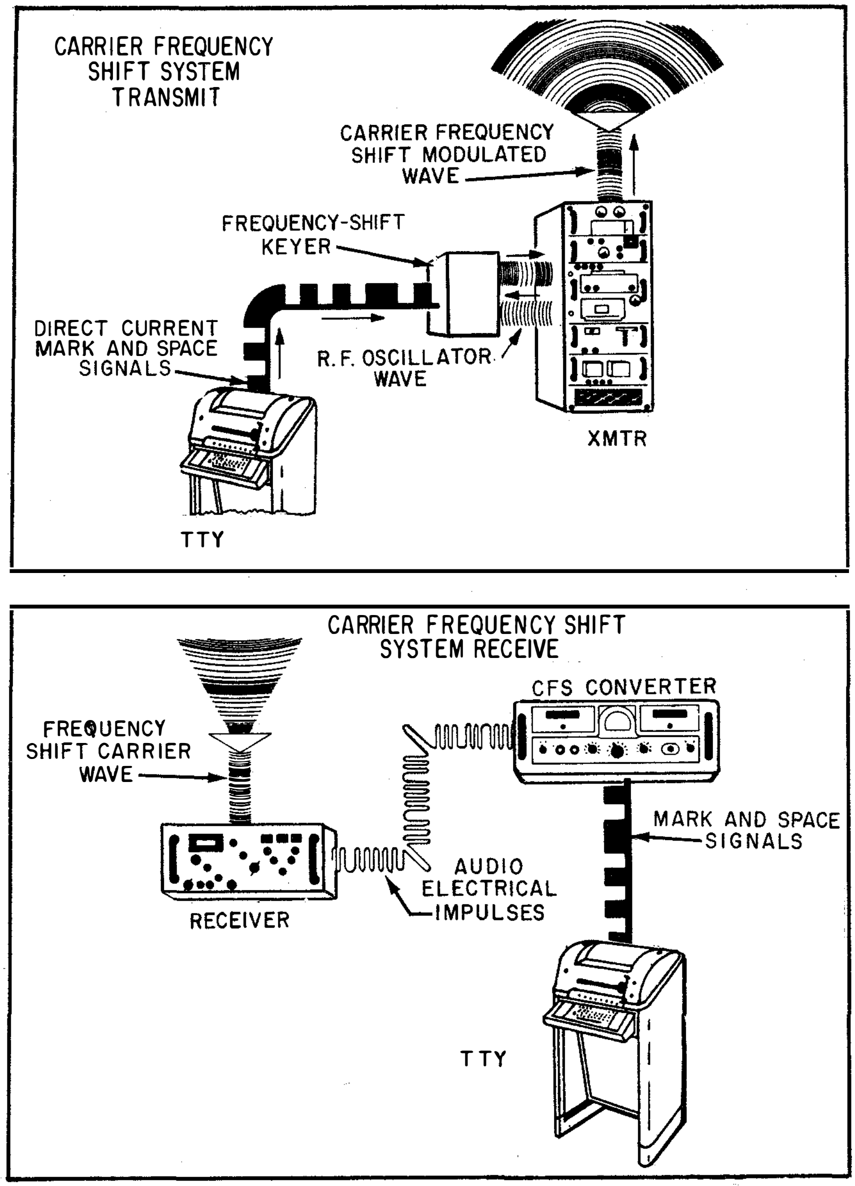

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Figure 2-7.—Basic carrier frequency-shift (RFCS) system.

In both the tone-modulated system and the carrier frequency-shift system, all teletypewriter signals pass through the teletypewriter panel that controls the looping current in all the circuits. The teletypewriter panel integrates the tone-modulated and the carrier frequency-shift systems. It provides every possible interconnection of available teletypewriter equipment; thus, maximum operational flexibility is achieved with the fewest number of circuits and the least amount of equipment.

SIMPLEX RFCS TELETYPE SYSTEM

Radio frequency carrier shift teletype systems are used in the lf to hf bands for long-range communications. To reduce fading and interference problems in these bands, the Navy uses two methods of DIVERSITY RECEPTION. These methods are SPACE DIVERSITY and FREQUENCY DIVERSITY.

In SPACE DIVERSITY reception, one signal is transmitted, and this signal is received by two or more receivers. The receiver antennas are separated by a distance greater than one wavelength. The outputs of the receivers are fed into frequency-shift converters which convert the audiofrequency-shift signals into d.c. mark and space signals. The d.c. signals are then fed into a comparator which selects the best mark and space signals for the teletypewriter. Because of required spacing between the receiver antennas, space diversity is mostly limited to shore stations.

In FREQUENCY DIVERSITY reception, two or more signals carrying the same intelligence are transmitted on different frequencies. The signals are received by receivers and processed in the same manner as for space diversity to operate teletype equipment from the best of the transmitted signals. This form of frequency diversity is known as rf diversity. Another form of frequency diversity called af diversity or tone diversity is used with multichannel broadcasts. This is discussed later in this maunal.

A simplified block diagram of a simplex mf/hf RFCS teletype system is shown in figure 2-8.

A SIMPLEX communication circuit consists of a single channel over which two or more stations may communicate. Each station may transmit and receive, but not simultaneously. On the transmit side (fig. 2-8), the teletypewriter (tty) set keyboard or transmitter distributor applies the d.c. teletype signals to the communication patch panel where they are patched to the transmitter. The d.c. mark and space signals shift the frequency of the rf carrier generated by the transmitter as explained previously.

On the receive side, the rf frequency-shift signal is received and demodulated by the receiver, resulting in an audio signal which shifts 850 Hz between marks and spaces. This audiofrequency-shift signal is fed to a converter

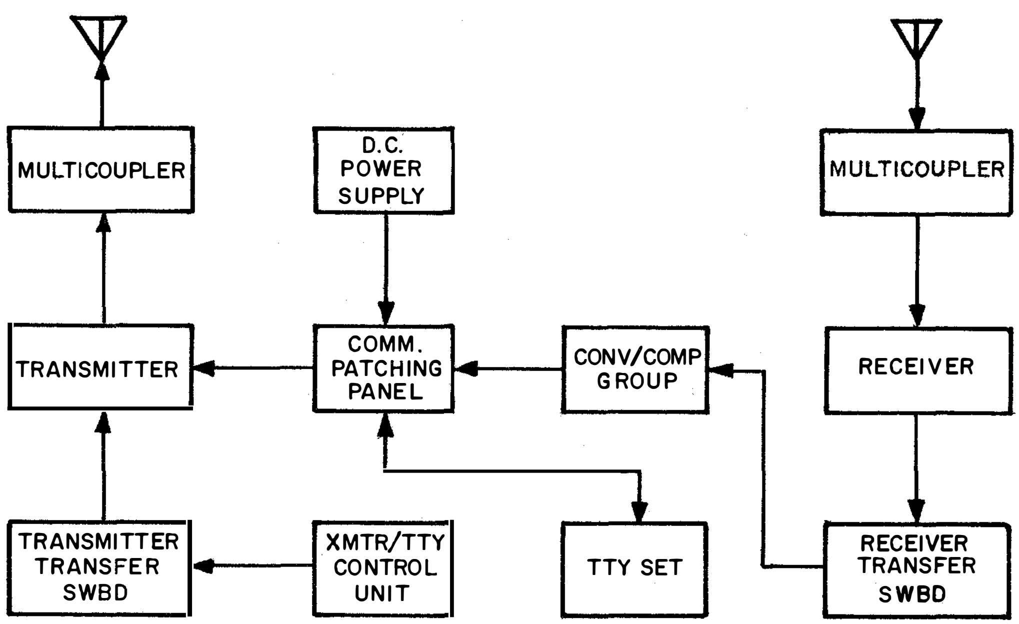

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Figure 2-8.—Simplex RFCS teletype system.

in the converter/comparator group where it is converted into the original d.c. mark and space signals. The d.c. mark and space signals are then patched through the communication patch panel to the tty set.

RFCS SEND SYSTEM

The following is a description of an RFCS teletype transmit communications system. A pictorial diagram (fig. 2-9) will be used and a functional description of the equipment will be given.

Tty Sets

Most of the teletypewriter sets used by the Navy belong to the model 28 family of teletypewriter equipment. The model 28 equipment feature various weights and sizes, quiet operation, and high operating speeds. They present relatively few maintenance problems, and are suited particularly for shipboard use under severe conditions of roll, vibration, and shock.

Another feature of the model 28 teletypewriters is their ability to operate at speeds of 60, 75, or 100 words per minute. Conversion from one speed to another is accomplished by changing the driving gears that are located within the equipment. The majority of the Navy's teletypewriters are presently operated at 100 words per minute.

Teletypewriters may be send/receive units or receive only units. They may be designed as floor models, table models, and rack and wall mounted sets. A representative send/receive floor model set is shown in figure 2-9.

The tty set (fig. 2-9) receives teletype messages from the line and prints them on page-size copy paper. In addition, it can receive messages and record them on tape and in printed form. With page-printed monitoring, the set transmits messages that are originated either by perforated tape or by keyboard operation. It mechanically prepares perforated and printed tape for separate transmission with or without simultaneous transmission and page-printed monitoring.

The teletypewriter set may be composed of the following components: a cabinet, a keyboard, a page printer, a typing perforator, a transmitter distributor, a typing reperforator, power distribution panels, and power supply.

In operation, the components are linked by electrical or mechanical connections to offer a wide range of possibilities for sending, receiving, or storing teletypewriter messages. All equipment components are housed in the cabinet. Transmission signals are initiated through the keyboard or through the transmitter distributor. Signals are received, or local transmission can be monitored, on the page printer. The typing perforator and typing reperforator are devices for preparing tapes on which locally initiated or incoming teletypwriter messages can be stored for future transmission through the transmitter distributor.

The keyboard, typing perforator, page printer, and transmitter distributor are operated by the motor mounted on the keyboard. Selection of these components for either individual or simultaneous operation is by the selector switch located at the front of the cabinet, to the left of the keyboard. All these components are connected in series in the signal line, but the selector switch has provisions for excluding various components from the line. The external signal line is connected to the equipment through a line-test switch. This switch is located below the selector switch on the front of the cabinet. This arrangement provides a means of disconnecting the equipment from the line for local testing of the components. The typing reperforator is operated by a separate motor and power distribution system. It also is connected to a separate external signal line.

To become a part of the Naval Tactical Data System (NTDS), the AN/UGC-6 is modified (and designated AN/UGC-13) to provide input/output communications with a selected data processing computer.

Communication Patching Panels

To provide flexibility in teletype systems, the wiring of all teletypewriters and associated equipment is terminated on jacks in communication patching panels usually referred to as teletype patch panels. The equipment then

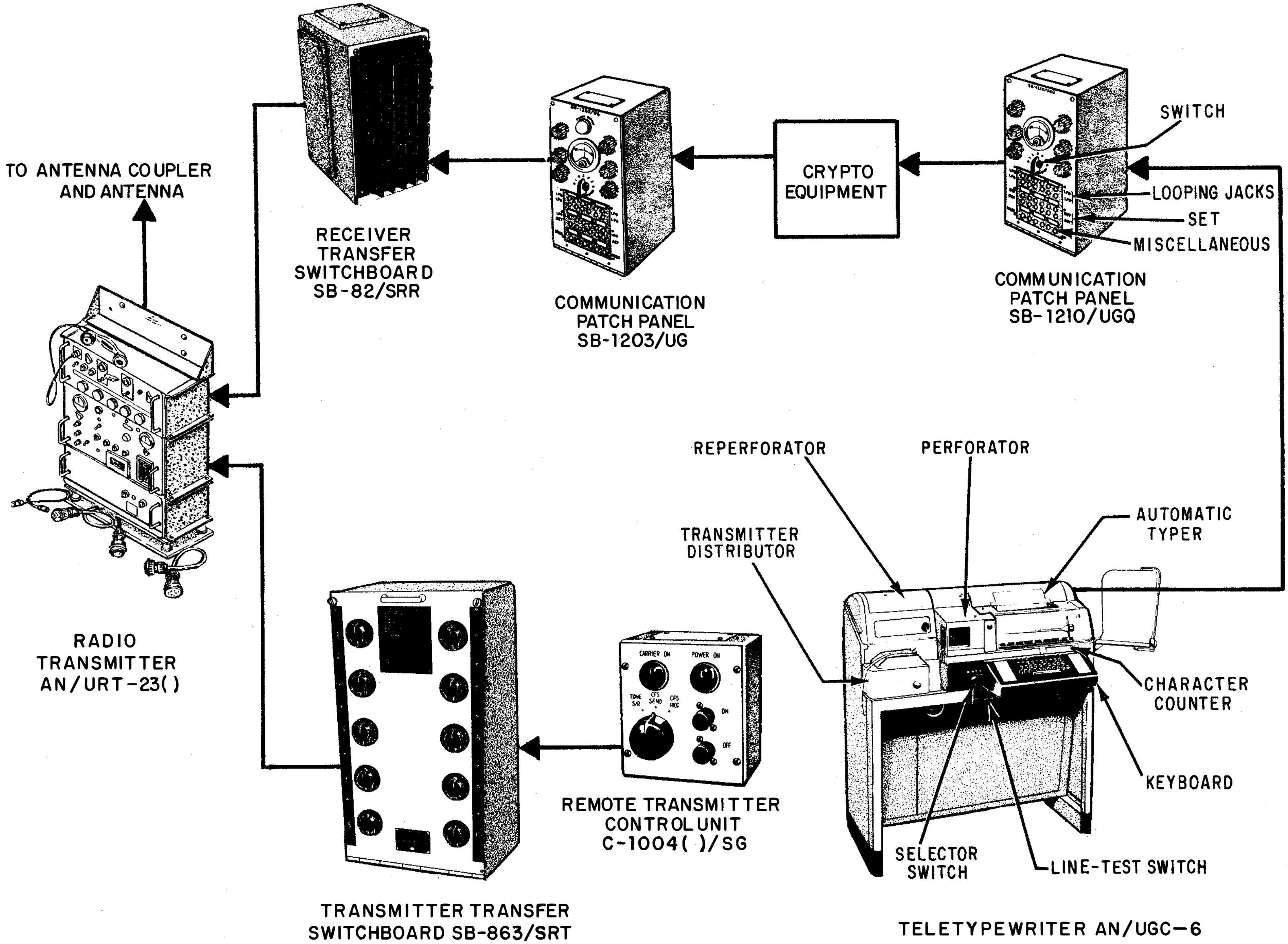

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Figure 2-9.—RFCS transmit (send) system.

is connected electrically in any desired combination by means of patching cords.

The plugs on the cords are inserted into the jacks at the front of the panel. In some instances, commonly used combinations of equipment are permanently wired together within the panel (called "normal-through"). They are wired so that individual pieces of equipment can be "lifted" from the combination, and then used alone or in other combinations.

In addition to providing flexibility, teletype panels also furnish a central point for connecting the d.c. voltage supply into the teletypewriter circuits. Thus, one source of supply can be used for all circuits passing through a particular panel.

Teletype panels SB-1203/UG and SB-1210/UGQ (fig. 2-9) are used for interconnection and transfer of teletypewriter equipment aboard ship. The SB-1203/UG is a general-purpose panel, whereas the SB-1210/UGQ is intended for use with crypotgraphic devices. The colors RED and BLACK are used to identify secure and nonsecure information. Red indicates that secure (classified) information is being passed through the panel, and black indicates that nonsecure (unclassified) information is being passed through the panel.

Each of the panels contains six channels, with each channel comprising a looping 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 according to the panel model. Each panel includes a meter and rotary selector switch for measuring the line current in any channel. There are six miscellaneous jacks. Any teletypewriter equipment not regularly assigned to a channel, may be connected to one of these jacks.

If the desired teletype equipment is wired in the same looping channel as the radio adapter (keyer or converter) to be used (normal through connection), no patch cords are required. But, if the desired teletypewriter (for example, in channel 1) is not wired in the same looping channel as the keyer or converter to be used (for example, channel 3), one end of the patch cord must be inserted in the set jack in channel 1, and the other end in either one of the two looping jacks in channel 3.

In any switching operation between the various plugs and jacks of a teletype panel, the cord plug must be pulled from the looping jack before removing the other plug from the set (machine) jack. Pulling the plug from the set jack first opens the circuits to the channel, causing all teletype messages in the channel to be interrupted. IT ALSO PRODUCES A DANGEROUS D.C. VOLTAGE ON THE EXPOSED PLUG.

Crypto Equipment

Crypto equipment is used to encrypt teletype output for transmission. (Encrypting is the method used to code a transmittal message.) To code or decode any transmitted messages, the sending and receiving crypto machines must be of the same type.

Receiver Transfer Switchboard

Receiver transfer switchboard, type SB-82/SRR, (fig. 2-9) has five vertical rows of ten single-throw (ON-OFF) switches that are continuously rotated in either direction. One side of each switch within a vertical row is wired in parallel with the same sides of the other nine switches within the row. Similarly, the other side of each switch is wired in parallel horizontally with the corresponding sides of each of the other four switches in a horizontal row. This method of connecting the switches permits a high degree of flexibility.

The knob of each switch is marked with a heavy white line to provide visual indication of whether the switch is in the ON or OFF position. Switchboards are always installed with the line positioned vertically when the switch is open (OFF). To further standardize all installations, local equipments usually are connected to the vertical rows of switches, and remote stations are connected to the horizontal rows.

Identification of each equipment and remote station is engraved on the laminated bakelite label strips fastened along the top and left edges of the panel front.

The SB-82/SRR is used to route the teletype signal from the teletype room to the proper transmitter through the use of trunklines. A trunkline is nothing more than a multiconductor cable connected between two spaces to allow passage of information from more than one source to a remote location, rather than using one cable for each assignment. More than one teletype signal could be put on the same trunkline and sent to the same transmitter or to two separate transmitters located in the same space.

Transmitter/Tty Control

The transmitter/tty control unit (fig. 2-9) is mounted close to the teletype keyboard, and permits remote control of the transmitter. It has a transmitter power on-off switch, a power-on indicator lamp, a carrier-on indicator lamp, and a three-position rotary selector switch. For RFCS operation, the operator sets the switch to CFS SEND for transmitting and to CFS REC for receiving. The TONE S/R position is used for both transmitting and receiving AFTS signals.

An audiofrequency tone-shift (AFTS) system will be discussed later in this chapter.

Transmitter Switchboard

The transmitter switchboard (SB-863/SRT) (fig. 2-9) was discussed in chapter one. It is used in this system to connect the tty control to the transmitter that is to be used to transmit the signal on the proper frequency.

Transmitter

The operation of the transmitter was discussed in chapter one. The AN/URT-23 transmitter (fig. 2-9) is used to transmit the proper frequency for the teletype signal. Care must be taken when tuning the transmitter for RFCS operation. The carrier frequency must be set to insure proper frequency is obtained at the output of the transmitter.

RFCS RECEIVE SYSTEM

The RFCS receive system (fig. 2-10) is used to receive the transmitted signal and translate it back to a usable teletype output.

Antenna Filter

The antenna filter AN/SRA-12 (fig. 2-10) is connected to the antenna and receives the rf signal from the antenna. It filters out any unwanted rf signals so that only the band of frequencies desired will be passed on to the receiver.

Radio Receiver

The radio receiver R-1051/URR (fig. 2-10) receives the rf signal passed on by the antenna filter and translates the rf signal to an audio signal.

Receiver Patch Panel

The receiver patch panel SB-973/SRR (fig. 2-10) is a panel used to tie the receiver to any one of the converter units that are connected to it. This allows a wide selection of equipment to be connected to the same receiver.

Converter/Comparator Group

The converter/comparator group (fig. 2-10) is used with receivers in either space or frequency diversity operation. When diversity operation is not required, each converter can be used separately with a single receiver.

Each converter (fig. 2-10) has its own comparator circuitry. This built-in design feature results in a considerable reduction in size from older units where the comparator is located in a separate chassis. A further reduction in size is achieved by the use of semiconductors and printed circuit boards.

The simplified block diagram (fig. 2-11) shows the basic function of converting the frequency-shift rf signal into a signal for controlling the d.c. loop of the tty. The frequency shifts of the af output from the receiver are converted into d.c. pulses by the af discriminator. The d.c. pulses are fed into the loop keyer which opens and closes the d.c. loop of the tty according to the mark and space characters received.

The comparator section of the converter/comparator functions to compare the

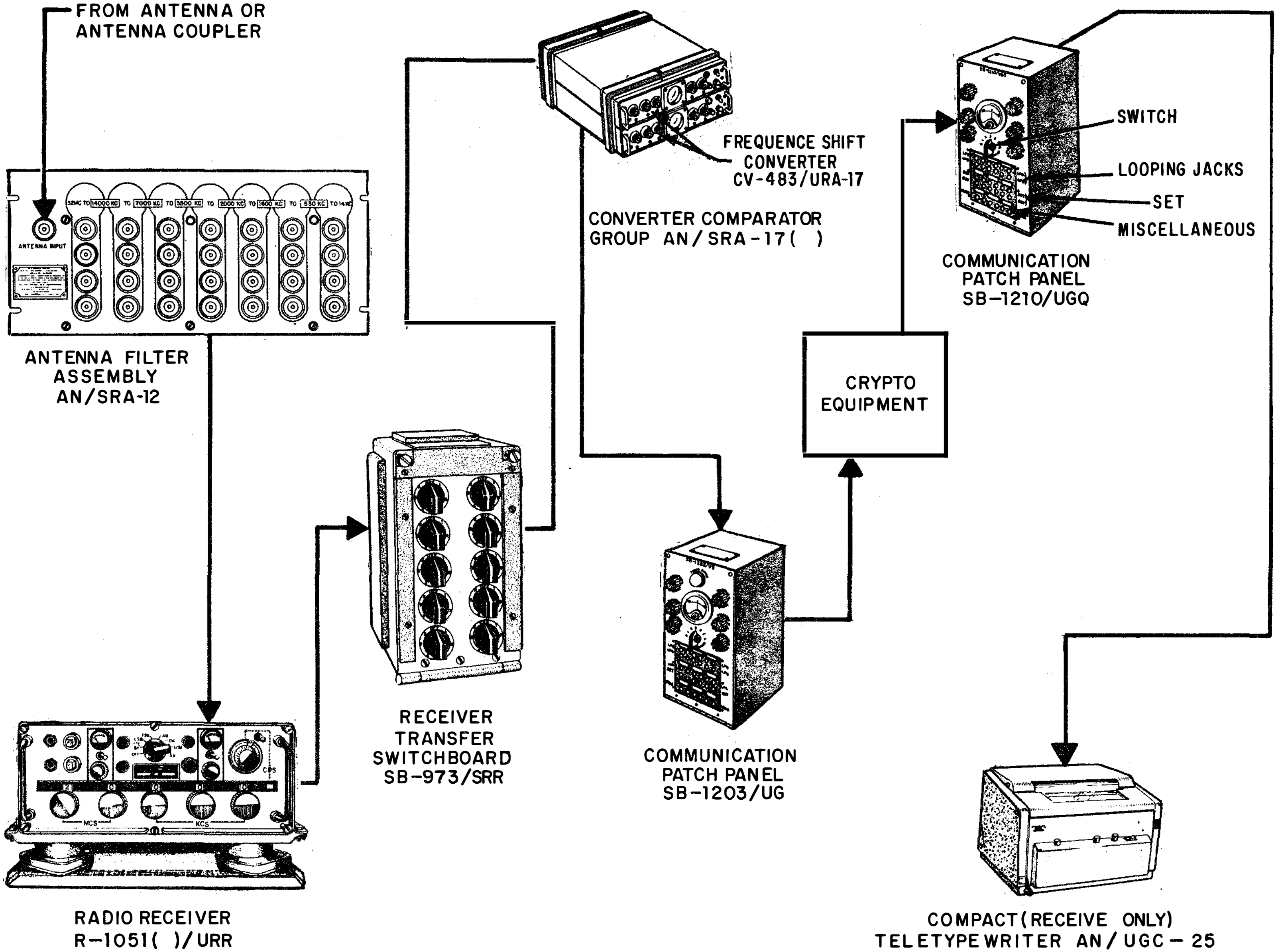

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Figure 2-10.—RFCS receive system.

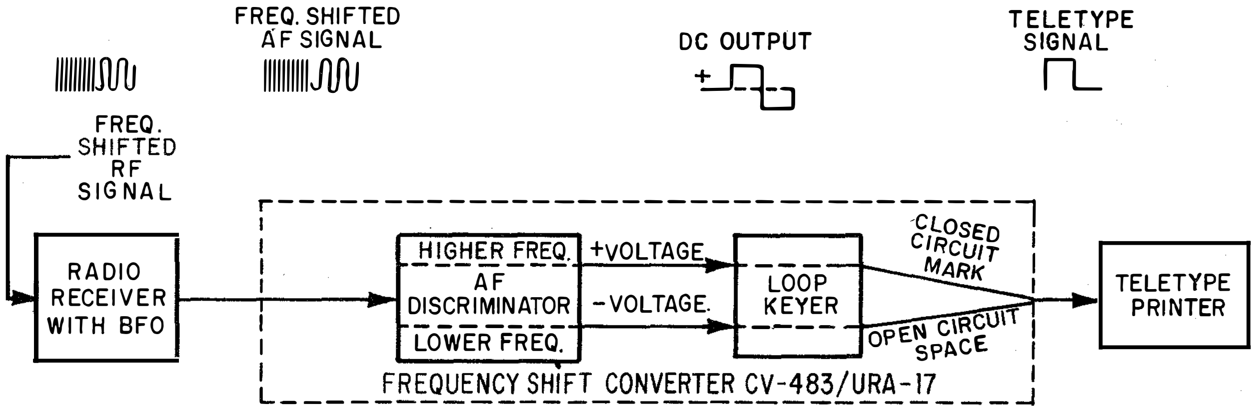

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Figure 2-11.—Frequency shift receiving system simplified block diagram.

strength of the signals from the receivers in diversity operation. Signals from each converter are fed into a comparator circuit which compares the signals and allows only the stronger signal to be fed to the communication patching panel for patching to the tty.

Communication Patch Panel

The communication patch panels (fig. 2-10) serve the same function on the receive side of the RFCS system as they did on the transmit side. That is to route the d.c. signal to the proper crypto equipment, and to route the decoded teletype signal from the crypto equipment to the proper teletype equipment.

Crypto Equipment

The crypto equipment (fig. 2-10) is used to convert the coded signal that was transmitted to a decoded signal that can be printed out in its original state.

Teletype

The teletype equipment is used to convert the d.c. signal received from the communication patch panel to a printed copy of the original transmitted message. The teletype equipment

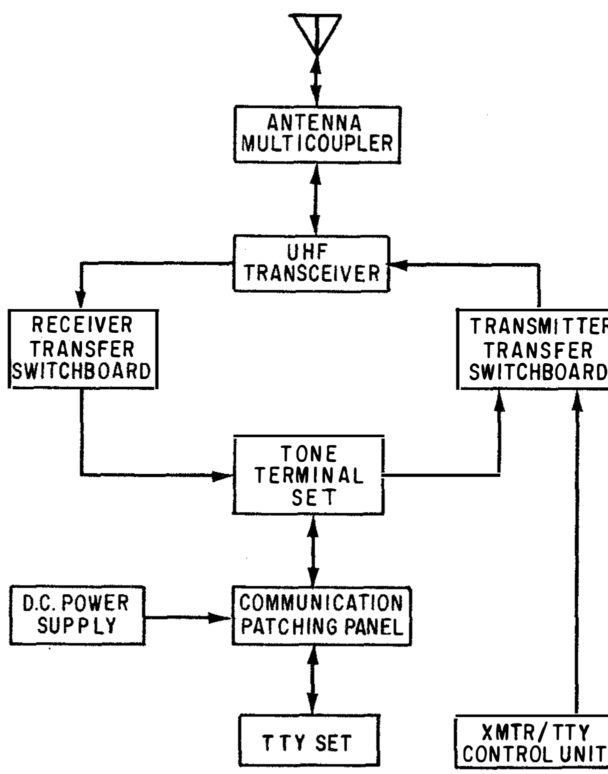

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Figure 2-12.—Half-duplex AFTS teletype system.

shown, AN/UGC-25 (fig. 2-10), is used only for receive and does not have the ability to be used for transmit.

AFTS SYSTEM

A simplified block diagram of a half-duplex (send or receive) uhf AFTS system is shown in figure 2-12. A half-duplex communication circuit permits unidirectional communication between stations. Communication can be in either direction, but not simultaneously. The term half-duplex is qualified by adding "send only", "receive only", or "send or receive".

A FULL-DUPLEX (or DUPLEX) communication circuit permits uninterrupted exchange of information between stations by using two separate circuits. Each station may transmit and receive simultaneously.

Signal Flow

On the transmit side (fig. 2-12), d.c. signals from the tty set are fed to the communication patching panel where they are patched to the tone terminal set. The tone terminal set converts the d.c. signals into audio tone-shift signals, which are patched to the transmitter section of the transceiver through the transmitter transfer switchboard. The audio tone-shift signals modulate the rf carrier generated by the transmitter. The rf tone-modulated signals are then radiated by the antenna.

On the receive side, the rf tone-modulated signals are received at the antenna and patched via the multicoupler to the receiver section of the transceiver, where demodulation takes place. The resulting audio tone-shift signals are then patched through the receiver transfer switchboard in the tone terminal set, where they are converted back to the d.c. signals. The d.c. signals are patched through the communication patching panel to the tty set.

Tone Terminal Set

In tone modulation transmission, the teletypewriter pulses are converted into corresponding audio tones, which amplitude modulate the rf carrier in the transmitter. Conversion to audio tones is accomplished by an audio oscillator in the tone converter.

An internal relay in the tone converter closes the control line to the transmitter which places the transmitter on the air when the operator begins typing a message. The control line remains closed until after the message has been transmitted.

When receiving messages, the tone converter accepts the mark and space tones coming in from an associated receiver and converts the intelligence of the tones into signals suitable to operate a relay in the converter. The make and break contacts of the relay are connected in the local teletypewriter d.c. loop circuit. This action causes the teletypewriter to print in unison with the mark and space signals from the distant teletypewriter.

CHAPTER 3

FLEET MULTICHANNEL BROADCAST SYSTEM

The Fleet Multichannel Broadcast (MULCAST) System is the primary method of delivering shore-to-ship teletype communications. The MULCAST system consists of area-oriented networks of communication stations configured to furnish, to the greatest extent possible, communication coverage to all ocean areas of the world. To provide worldwide coverage, the ocean areas are divided into four Naval Communication Areas (NAVCOMMAREA). Each NAVCOMMAREA has a Naval Communication Area Master Station (NAVCAMS) which is responsible for the coordination of fleet broadcasts, as well as ship-to-shore, air-to-ground, and other communication circuits within the area. The NAVCAMS exercise authority over the NAVCOMMSTAs in their assigned area. One of the functions of the NAVCOMMSTA is to retransmit the area broadcast or transmit a local area broadcast. During emergency conditions, the NAVCAMS adjacent to the troubled area is designated to assume control of the area broadcast. Several transmission frequencies are employed by both the NAVCAMS and NAVCOMMSTAS to provide adequate coverage for all propagation conditions.

At the present time there are two types of communications being used. The primary type is the Satellite Communications and the secondary type is the hf communications. Satellite Communications will be presented later in this text. The following is a presentation of the hf communications system commonly known as the backup system.

Hf backup MULCAST equipment at the shore station consists of transmitting and monitoring equipment. The transmitting equipment includes: (1) tape readers, which convert the alphanumeric symbology of the paper tape into a series of d.c. pulses, (2) security equipment, which converts the plain text d.c. pulses produced by the tape reader into a series of encrypted d.c. keying signals, (3) multiplex units, which accept the d.c. keying signals from several security equipments and combine (multiplex) them into a single composite signal, and (4) transmitters, which, having been modulated by the composite signal, transmit the resulting signal on several frequencies to the fleet.

The monitoring equipment consists of: (1) receivers, which are tuned to the transmitter frequencies so that the MULCAST signal can be monitored, (2) demultiplex equipment, which breaks down the composite signal into it's d.c. components, and (3) security equipment, which translates the d.c. keying signal into its plain text equivalent. Each plain text d.c. signal is then analyzed by the monitor equipment.

The MULCAST receiving equipment aboard ship is similar to the monitoring equipment at the shore station.

TRANSMIT SUBSYSTEM

The shore-based portion of the MULCAST system performs the basic functions of signal processing, signal transmission, and quality control monitoring. A typical communication station (COMMSTA) is made up of a transmitter site, a receiver site, and a communication center. To avoid rf interference, the transmitter and receiver sites may be located 5 to 50 miles from the communication center. In addition, the receiver and transmitter sites are separated from each other by several miles. Landlines (telephone wires) and/or microwave links are used for routing communications between the communication center and the transmitter and receiver sites. The message processing and circuit quality monitoring functions are performed at the communication center.

As shown in figure 3-1, the plain text direct-current (d.c.) signals produced by a tape reader are passed through security equipment when the d.c. signal is encrypted. (Punched tape provides much faster transmission speeds than direct keyboard transmission.) The encrypted d.c. keying signals from several security devices are then applied to telegraph terminal equipment similar to the AN/UCC-1. (The AN/UCC-1 will be discussed later in this chapter.) The telegraph terminal equipment is also referred to as voice-frequency carrier terminal (VFCT) equipment. The telegraph terminal equipment converts each incoming d.c. keying signal to an audiofrequency tone-shift (AFTS) signal. The AFTS signal consists of a carrier which is shifted 42.5 Hz above or below a center frequency in accordance with the incoming d.c. keying signal. The center frequencies, or midpoints, between the channel MARK and SPACE signal frequencies of each AFTS channel, although never actually present, are commonly used as references to identify the AFTS channel.

The telegraph terminal equipment also functions to multiplex each of the individual AFTS signals to form a single composite signal. The resulting composite signal has a bandwidth equivalent to a single-voice channel or approximately 3 kHz. The composite signal is then multiplexed with other COMMSTA circuits and sent to the transmitter site via microwave or landlines.

At the transmitter site the multiplexed signal package is demultiplexed. The MULCAST composite signal is patched to an audio distribution amplifier, the outputs of which are used to key a low frequency (lf) transmitter and several hf transmitters. A Voice-Frequency Bandpass Amplitude Equalizer Coupler (VFBAEC fig. 3-1), breaks out eight channels for low frequency from the 16-channel tone package, and provides for individual channel amplitude adjustment.

The MULCAST system uses the ssb supressed-carrier mode for transmission in the lf, mf, and hf bands. Conventional AM is used for MULCAST transmissions in the uhf band. However, the uhf band is used only at certain locations. MULCAST transmissions in the mf, hf, and uhf bands are capable of supporting up to sixteen 100 wpm information channels transmitted as 16 tone channels. Transmissions in the lf band are capable of supporting only eight 100 wpm tone channels.

HF TRANSMITTERS

Radio transmitters AN/FRT-39 and AN/FRT-40 are representative of the hf transmitters used in the MULCAST system.

The Radio Transmitter Set AN/FRT-39 (fig. 3-2) is capable of providing 10,000 watts of peak envelope power (PEP) output throughout a

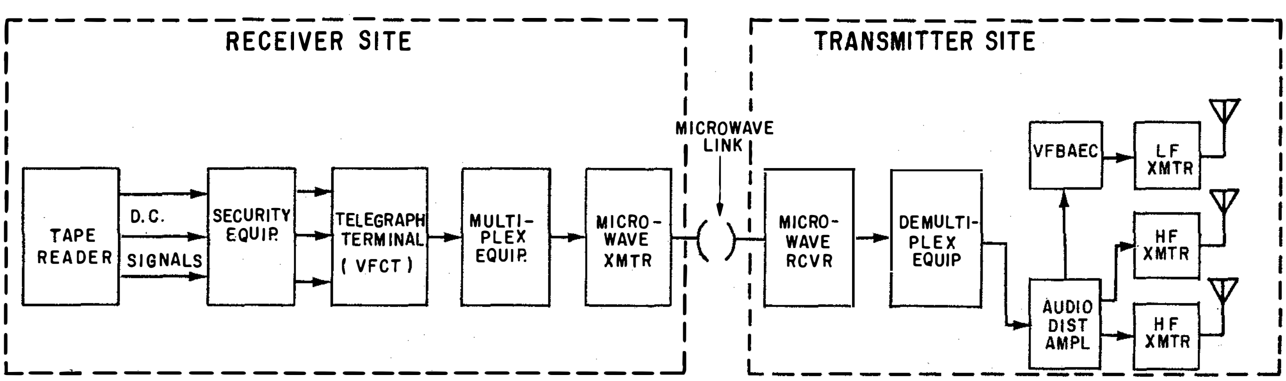

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Figure 3-1.—Fleet Multichannel Broadcast, transmit subsystem.

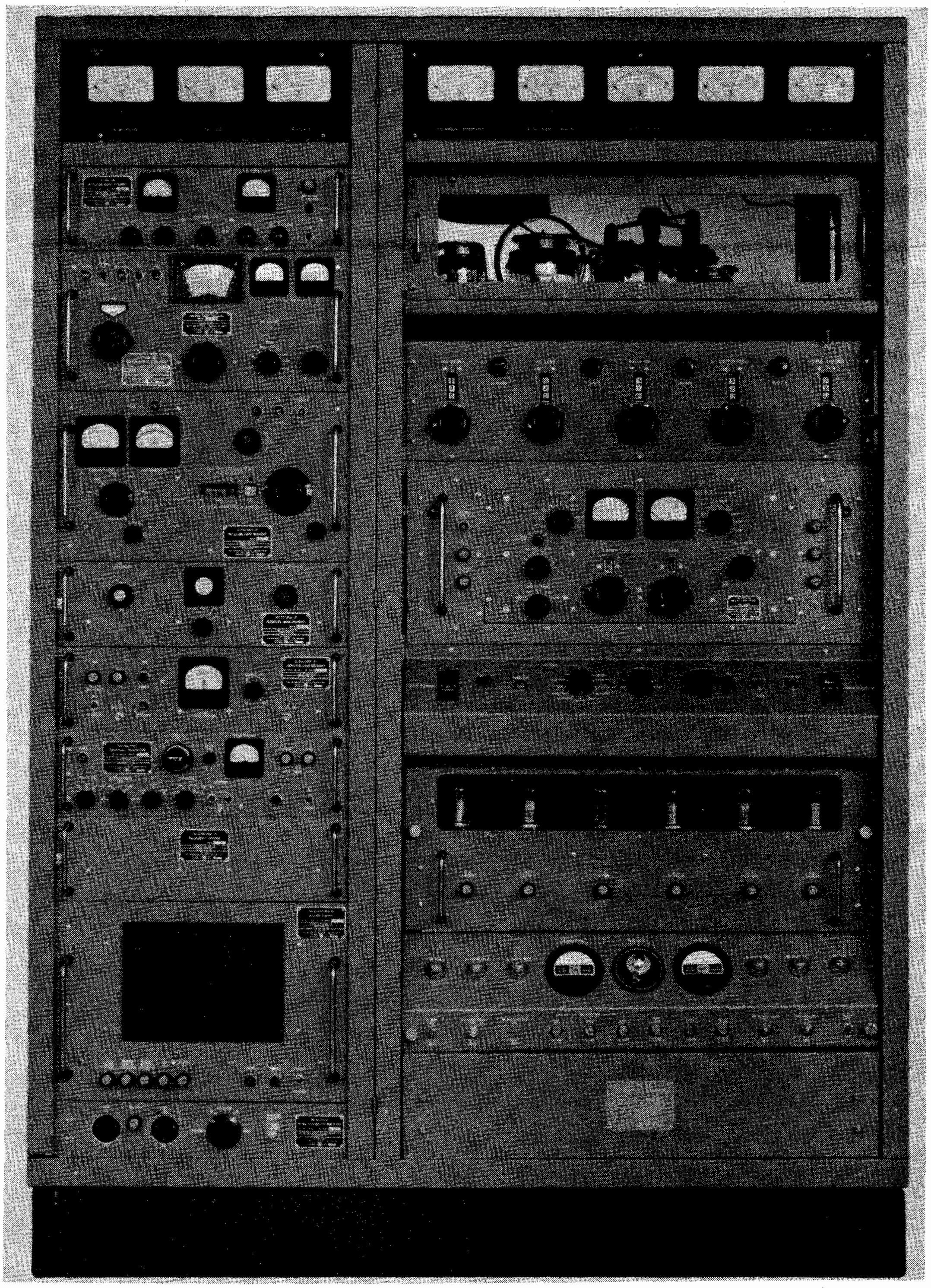

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Figure 3-2.—Radio Transmitting Set AN/FRT-39.

frequency range of 2 MHz to 28 MHz. The principle function of the equipment is to provide long-range communications from shore-to-ship or point-to-point by single-sideband operation. The equipment may also be used for the following types of transmission:

1. Continuous-wave (cw) (keyed carrier)
2. Frequency-shift carrier
3. Single-sideband suppressed-carrier
4. Double-sideband suppressed-carrier
5. Independent-sideband (separate intelligence)
6. Single- or double-sideband (with carrier)

With the addition of two cabinets, a power amplifier, and a power supply, the AN/FRT-39 becomes the AN/FRT-40 (fig. 3-3). The PA stage and antenna tuning controls of the AN/FRT-39 are slightly modified and become the IPA stage of an AN/FRT-40. The final PA section of the AN/FRT-40 consists of a power amplifier, class AB, capable of 40,000 watts (PEP).

LF TRANSMITTER

Radio Transmitting Set AN/FRT-72 is a representative lf transmitter used in the MULCAST system. The AN/FRT-72 consists of

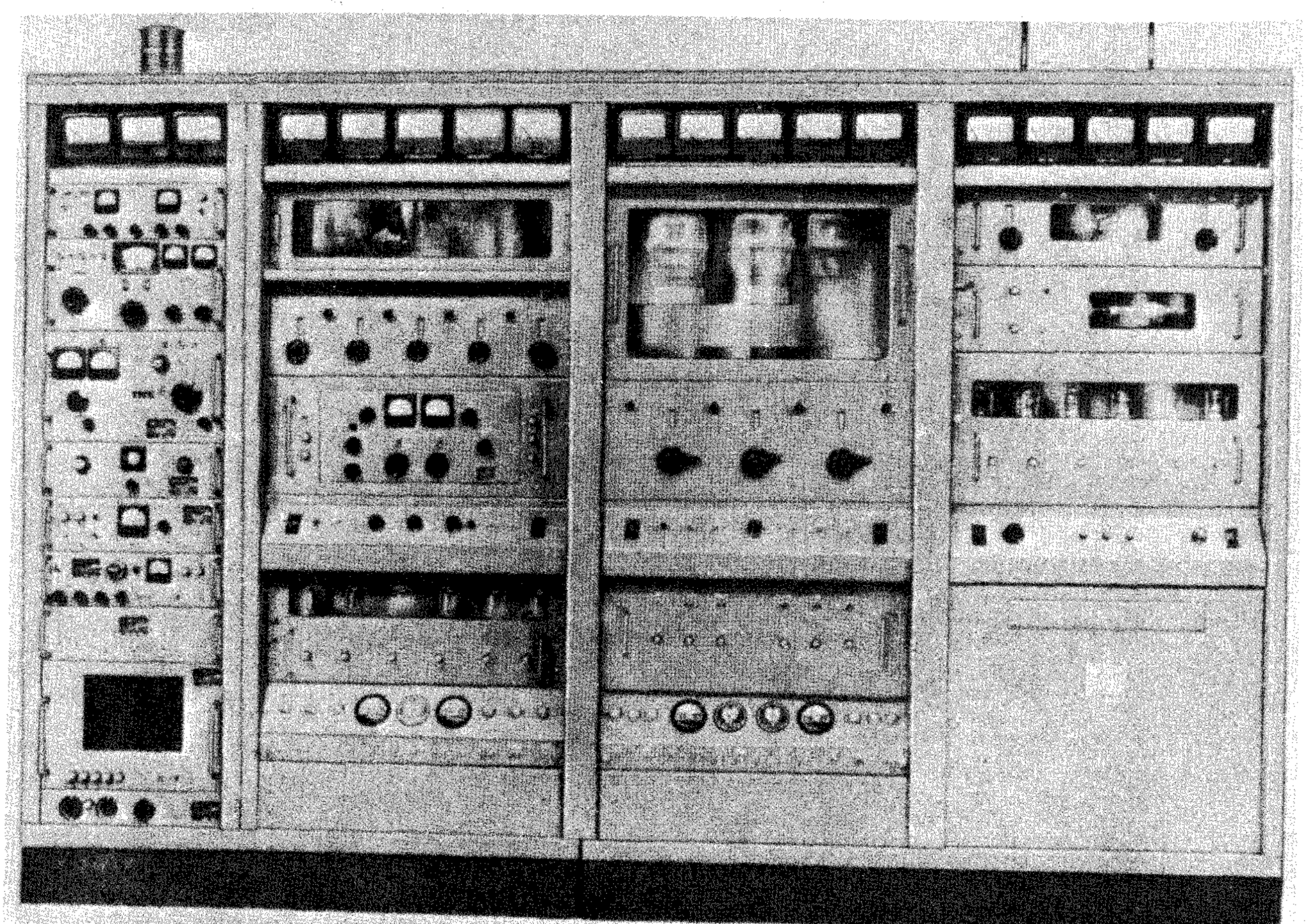

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Figure 3-3.—Radio Transmitting Set AN/FRT-40.

two independently operated power amplifiers, each capable of generating 50 kW of peak envelope power (25 kW of average power) over a frequency range of 30 kHz to 150 kHz. Rf excitation for the two power amplifiers is supplied by one of the two exciters provided with the unit. The PAs may operate singly or in combination.

In combined operation, the transmitter generates 100 kW of peak envelope power (50 kW of average). The complete set consists of six units housed in six cabinets as shown in figure 3-4.

RECEIVE SUBSYSTEM

The shipboard receive portion of the MULCAST system performs the basic functions of signal reception and signal processing. The most widely used frequencies for MULCAST reception are those in the hf band. Normally, two receivers are used for frequency-diversity reception. Standard equipment used in a typical receive subsystem is shown in the functional block diagram of figure 3-5.

SIGNAL FLOW

The encrypted composite multiplex tones are transmitted by the hf transmitters (fig. 3-1) in the usb mode with a fully suppressed carrier. These ssb signals are received and demodulated by the hf receivers (fig. 3-5). One receiver has its output patched via the receiver transfer switchboard to the "A" input of the telegraph terminal. The other receiver output is patched to the "B" input of the telegraph terminal.

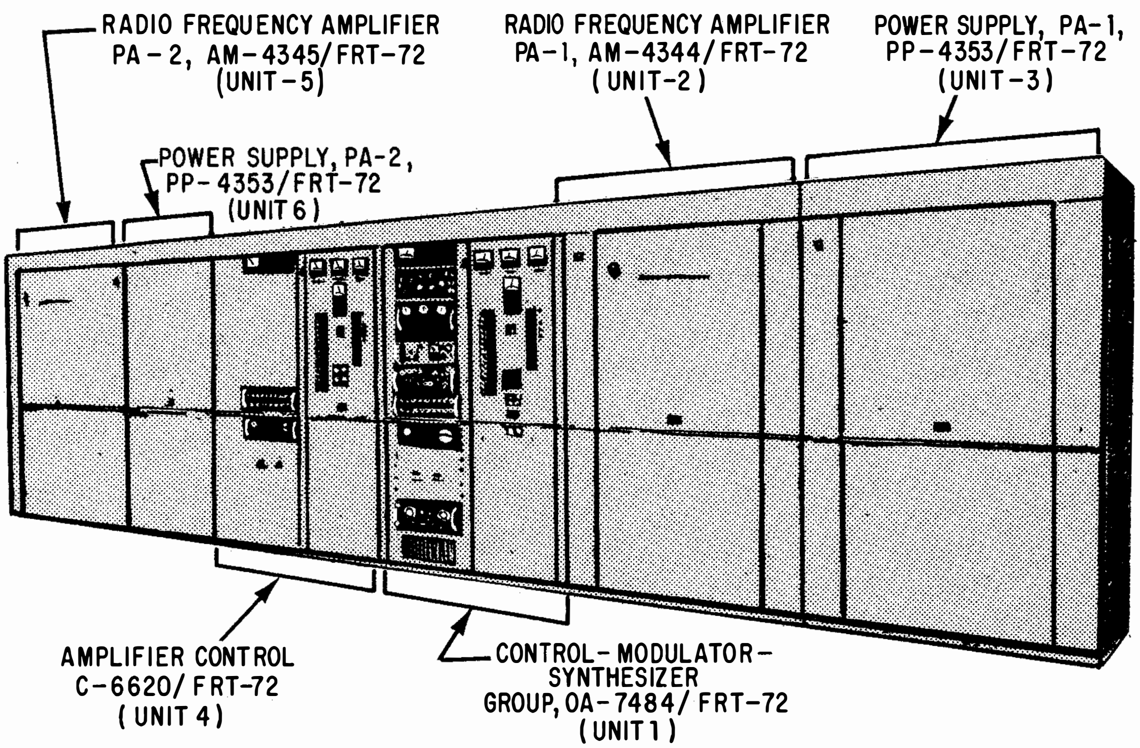

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Figure 3-4.—Radio Transmitting Set AN/FRT-72.

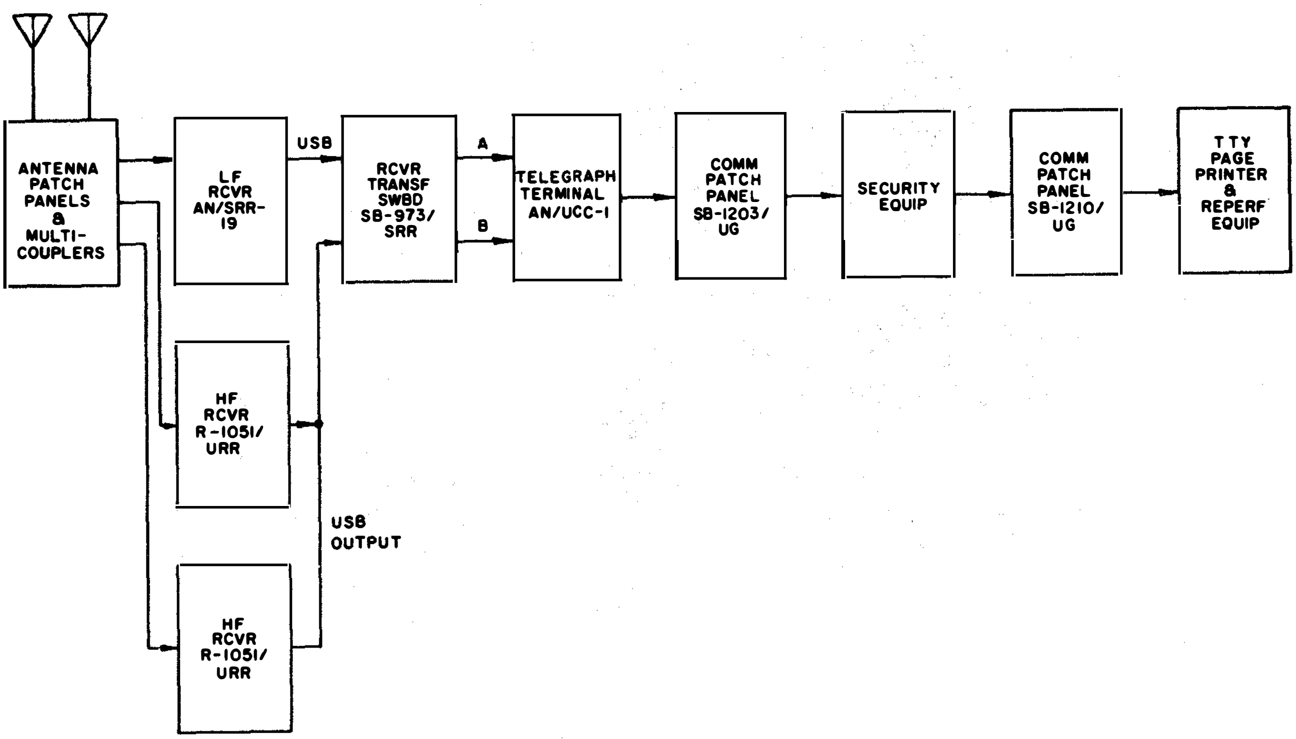

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Figure 3-5.—Fleet multichannel broadcast, receive subsystem.

The telegraph terminal separates each tone, compares diversity combinations, selects the signal with the highest level, and converts the tone-shifted signal to d.c. signals as discussed in chapter 2. The encrypted d.c. signals are patched through the nonsecure communication panel to the crypto equipment where they are decrypted. The decrypted d.c. signals are then patched through the secure communication panel to the tty receive equipment.

LF RECEIVERS AN/SRR-19 AND 19A

The hf MULCAST transmissions are capable of being transmitted over long distances using considerable less power than is used with the lf broadcast. The lf transmissions, however, (although limited in range) are not as susceptible to interference problems as the hf transmissions.

Radio Receiving Sets AN/SRR-19 and 19A are dual-conversion superheterodyne receivers to use in the frequency range of 30 to 300 kHz. The AN/SRR-19A is shown in figure 3-6.

Most of the pieces of equipment shown in figure 3-5 have been covered previously in this text. The only differences are that a different receiver is connected to the antenna coupler and a telegraph terminal set (AN/UCC) is added.

TELEGRAPH TERMINAL AN/UCC-1(V)

Telegraph Terminal AN/UCC-1D(V) is a frequency division multiplex carrier-telegraph terminal equipment for use with ssb or dsb radio circuits, and audiofrequency wire lines, or microwave circuits. Each Electrical Equipment Cabinet CY-4639A houses one Control

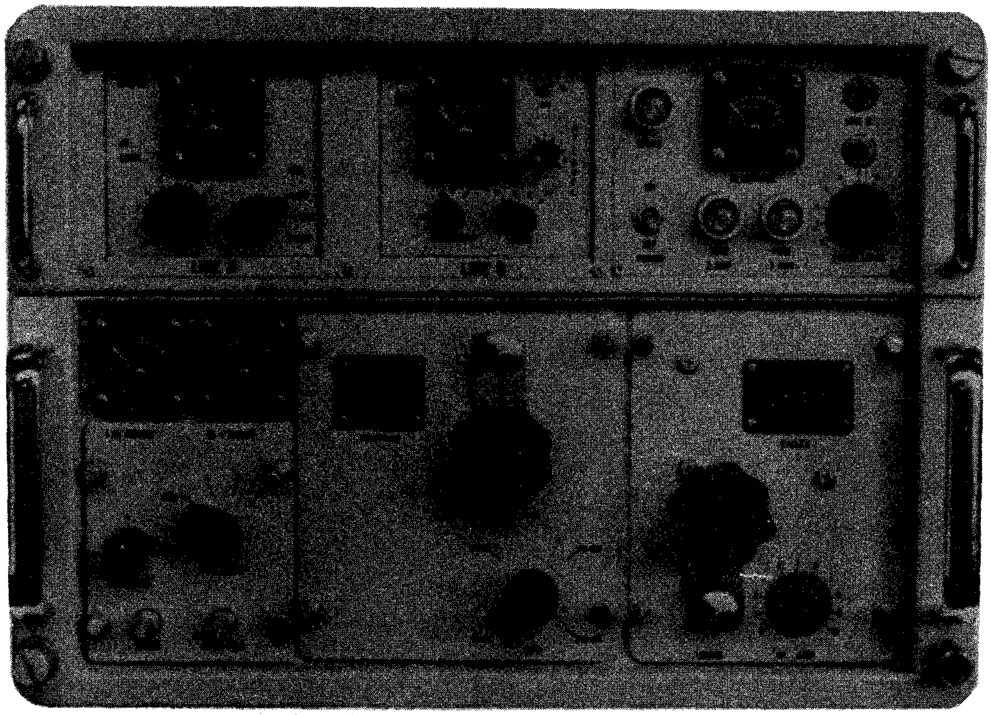

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Figure 3-6.—Radio Receiver AN/SRR-19A.

Attenuator C-6554A (right side, fig. 3-7) and up to a maximum of eight Frequency-Shift Keyers KY-588A(P) for transmission, or eight Frequency-Shift Converters CV-1920A(P) for receiving, or any combination of both. The terminal also includes a special test set (TS-2232A) as a separate piece of equipment for aligning the keyer and converted circuits.

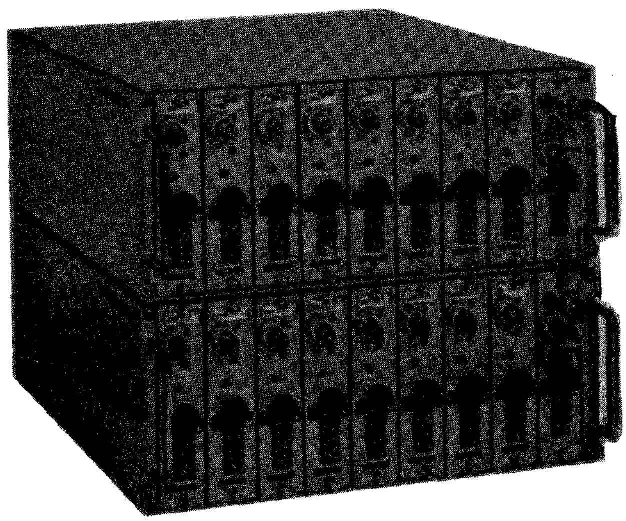

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Figure 3-7.—Telegraph Terminal AN/UCC-1D(V).

GENERAL DESCRIPTION

The control attenuator, keyers, and converters are solid-state, integrated-circuit plug-in modules. Thus, the number of channels may 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 narrow-band channels within a 382 to 3017 Hz bandwidth. The terminal can operate as nondiversity, in-band (af) diversity, space diversity, or rf diversity.

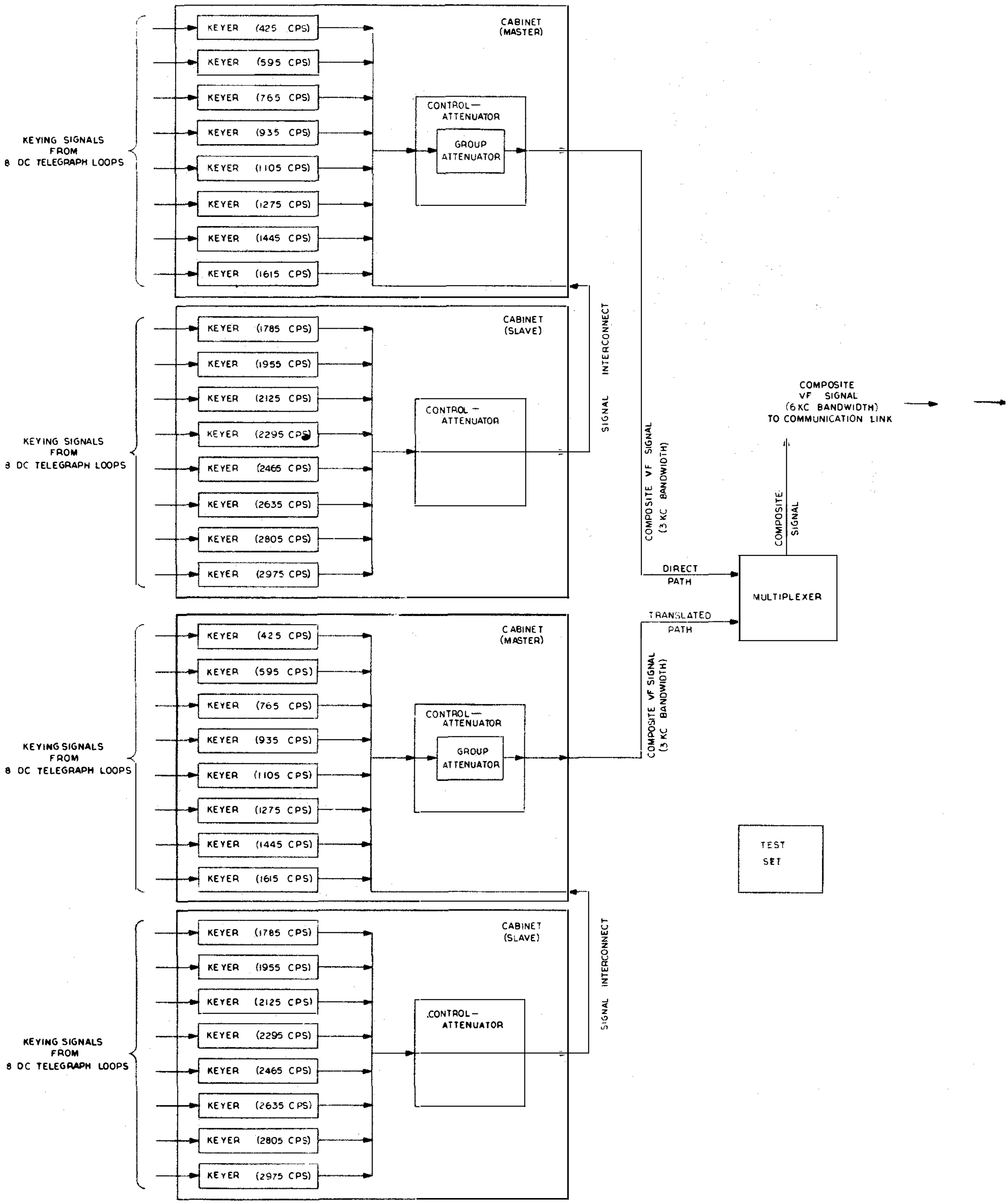

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Figure 3-8.—Telegraph Terminal AN/UCC-1D(V) functional block diagram.

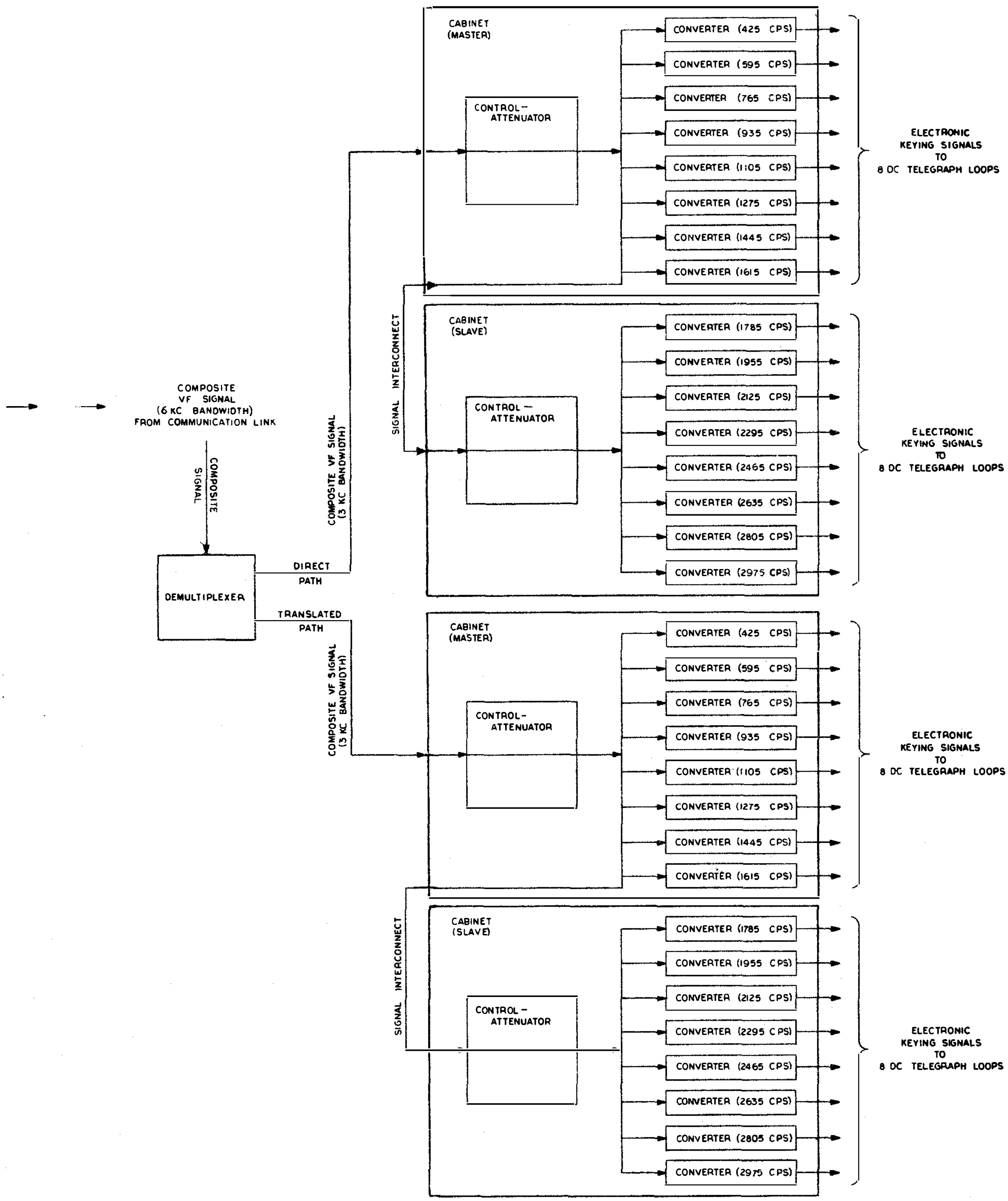

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Figure 3-8.—Telegraph Terminal AN/UCC-1D(V) functional block diagram—Continued.

Each frequency-shift keyer provides one channel that accepts d.c. telegraph signals from an external loop, and supplies the appropriate audiofrequency mark/space frequency-shift output signal. The keyer provides polar or neutral loop operation without any change in switch settings. All active keyer components are contained on a plug-in printed-circuit card that is interchangeable with cards of other keyers. Each keyer has its own power supply.

Each frequency-shift converter provides one channel that accepts a particular frequency-shift audiofrequency signal, and produces an electronic keying signal for operation of a d.c. telegraph loop. The converter is capable of keying either neutral or low-level polar loops. Switch settings allow the voice-frequency input to be obtained from either the composite line or an individual line, and allow connection of either two or four converters to form diversity combinations. All active converter components are contained on a plug-in printed-circuit card that is interchangeable with cards of other converters. Each converter has its own power supply.

Each control attenuator has switches that permit selection of the cabinet's mode of operation (master or slave) and connection of the composite voice-frequency lines to the connectors at the rear of the cabinet. Each unit also incorporates a constant-level amplifier that maintains the composite output power at a constant level when up to 16 tones having peak power within the range of -24 to +18 dBm are combined. A control on the module panel allows adjustment of the composite output power level.

The portable test set used for alignment and test of the other telegraph terminal units provides facilities for the following:

1. Tone-level measurement
2. Loop-current measurement
3. Reversals generation (75 or 150 baud)
4. Converter phase-distortion alignment
5. Audible signal tracing (with speaker)
6. Mark and space tone generation for 16 narrow-band and four wide-band channels

FUNCTIONAL DESCRIPTION

The functions that can be performed by the AN/UCC-1D(V) are shown in figure 3-8. The terminal provides up to 16 different narrow-band audiofrequency tone channels, each passing a different band of frequencies. Associated with each channel are two oscillators and a gate circuit. One oscillator constantly generates the mark frequency; the other constantly generates the space frequency. The gate circuit is keyed by a telegraph loop causing one frequency or the other to pass (frequency-shift keying). The two frequencies are symmetrically disposed with respect to the center of the channel passband. The output from any set of different channels can be combined on a single line for transmission over a single 3 kHz communication link.

Two 3 kHz bandwidth audiofrequency signals can be accommodated by the telegraph terminal for transmission over a single 6 kHz communication link. The two 3 kHz signals may contain 16 telegraph tone channels in each 3 kHz band, or 16 telegraph tone channels in one 3 kHz signal and speech in the other 3 kHz signal. Diversity combination switching is provided in the telegraph terminal at both the transmitting and receiving stations. Thus, one telegraph signal can be used to key two different tone channels (keyers) at the transmitting station. In this case, the corresponding tone channels (converters) at the receiving station both develop keying signals. However, the best signal of the diversity pair operates the receiving telegraph loop, thereby preserving the telegraph signals when fading occurs in one of the two channels in the frequency-diversity pair.

Diversity switching at the receiving station also permits space-diversity or rf-diversity operation, in which tone signals obtained from two different radio receivers are used to operate two identical sets of tone channels. For this type of operation, each pair of identical tone channels (converters) provides a single keying signal. Frequency-diversity operation can be combined with either space-diversity or rf-diversity operation. In this case, one set of four tone channels produces a single keying signal.

In place of 16 narrow-band channels, the telegraph terminal can provide eight narrow-band and four wide-band channels. The wide-band channels use the band portion of the upper eight narrow-band channels, plus the band extending from 3025 to 3815 Hz. However, extension of the wide-band channels above 3625 Hz prevents the use of the multiplexing function.

Frequency-Shift Keyer

The d.c. telegraph loop is connected to the Schmitt trigger circuit Q4-Q5 through the input switch circuit and the adjustable trigger-level bias control circuit (fig. 3-9). The adjustable bias sets the trigger level of the Schmitt trigger circuit.

In neutral operation, input transistor Q3 is turned on (conducting) when loop current flows and is turned off (not conducting) in the absence of loop current. In polar operation, Q3 is turned ON during positive loop current and is turned OFF during negative loop current. With a mark input, the Schmitt trigger circuit will turn gate control transistor Q6 ON and Q7 OFF. The conduction state of Q6 and of Q7 will be reversed with a space input.

The output signal of the gate control circuit and the output frequencies of the mark and space crystal-controlled oscillators (IC 9 and IC 10) are used to drive the diode gates. When the SIGNAL SENSE switch S1 is in the NORMAL position, a loop current (mark input) causes the gate circuits to pass the output of the mark (higher frequency) oscillator. When the switch is in the REVERSE position, a loop current causes the gate circuits to pass the output of the space (lower frequency) oscillator.

The mark and space oscillators operate at frequencies which are 128 times the mark and space frequencies of the channel. They are controlled by crystals to maintain the frequency within a close tolerance. Both oscillators operate at all times, but the output of each is passed through its gate only when the gate is enabled by the gate control circuit. The oscillator frequency passed through the gate is divided by 128 in the divider circuit IC 2 through IC 8. The output of the divider circuit (channel mark or space frequency) is applied through the output amplifier Q1 to the output bandpass filter. The input level to Q1 from IC 8 is adjusted by R14 (TONE).

The cabinet is wired in such a way that the keyers in specific cabinet stations can be

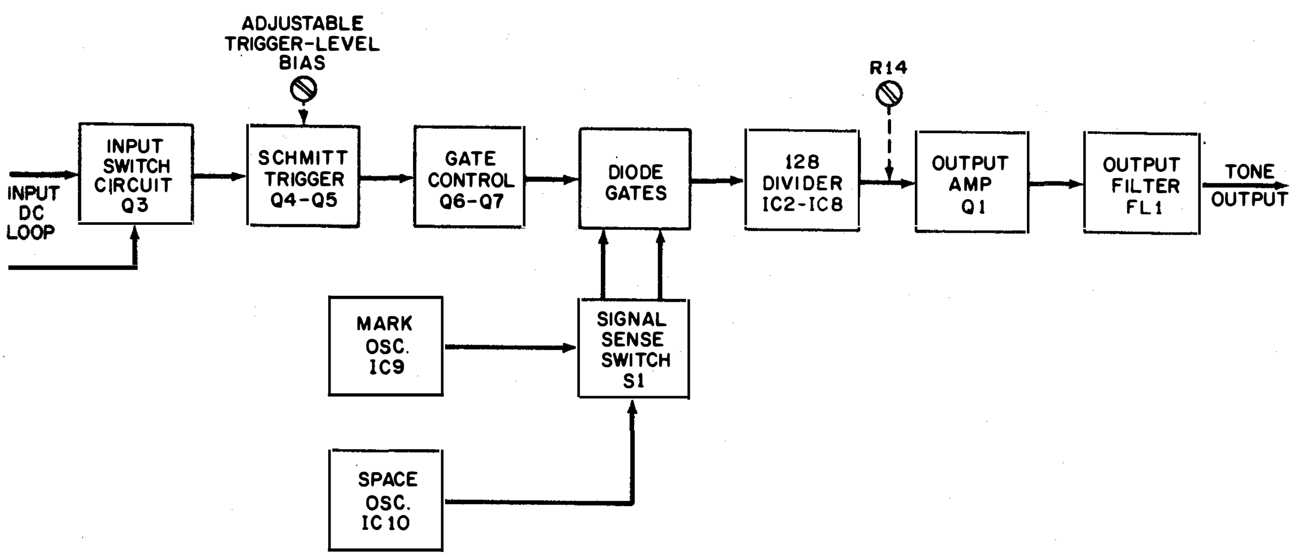

Figure 3-9.—Frequency-shift keyer simplified functional block diagram.

connected in frequency-diversity pairs. These pairs of cabinet stations are A1 and A2, A3 and A4, A5 and A6, and A7 and A8. The cabinet also is wired in such a way that the keyers in specific cabinet stations can be connected to obtain four-channel diversity operation. These groups of four cabinet stations are A1 through A4, and A5 through A8.

With the DIVERSITY switches of the keyers in the ONE position, each keyer is connected to a separate input telegraph loop. Turning the DIVERSITY switches of two keyers in the stations—which are wired to form a diversity pair to the TWO position—connects them to the same input telegraph loop. Both channels process the same input telegraph signals. Turning the DIVERSITY switches of the four keyers in the cabinet stations A1 through A4 or in A5 through A8 to FOUR connects the four keyers to the same input telegraph loop.

The modules plugged into the two or four stations are selected to form a standard frequency-diversity combination. The signals from the output bandpass filter are applied to the TONE OUTPUT switch. When the switch is set to PARALLEL, it applies the channel output through the control attenuator to the composite tone output line. When the switch is set to INDIV, it applies the channel output directly to the individual tone contacts of the cabinet connector for individual tone output.

Frequency-Shift Converter

Either a composite tone signal or an individual tone signal is fed to the input bandpass filter, FL1 (fig. 3-10). This blocks all channel frequencies except those of the converter's channel. The filter also contains the adjustable delay network that provides the means for equalizing delays for diversity operation. The output of FL1 is applied to the attenuator and bias network. This network provides the agc attenuation and also biases the input gain-controlled amplifier IC1. The output of IC1 is applied to the input of the second gain-controlled amplifier IC2.

The output of the second gain-controlled amplifier is applied to the input of fixed gain amplifier IC3. The output of IC3 is applied to the limiter stage IC4, which clips the signal, removing any amplitude-modulated components from the waveform applied to discriminator FL2.

Transformer T1 couples the output of IC3 to the gain and level control circuits. One output of T1 is rectified and applied to the agc detector

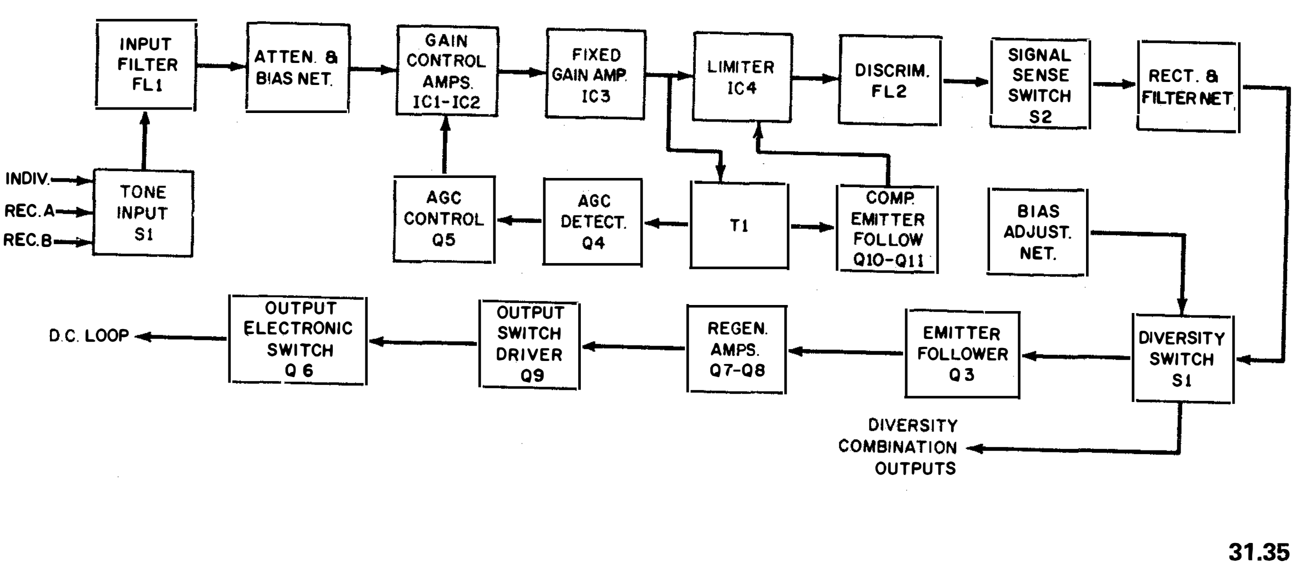

Figure 3-10.—Frequency-shift converter simplified functional block diagram.

transistor Q4. This voltage establishes the conduction level of Q4. The amplified output of Q4 is applied to the agc control amplifier Q5, which provides the power gain necessary to drive the gain-controlled stages IC1 and IC2. Another output taken from T1 is rectified, filtered, and applied to compound emitter-follower circuit Q10-Q11. The output of Q11 is a d.c. voltage proportional to the agc output level. It is applied to the limiter IC4, and used to limit the amplitude of the drive voltage to the discriminator FL2. In diversity operation, when the gain of the receiver is reduced, the discriminator drive waveform is reduced, assuring that a linear combination of detected signals results in the mark-space detection.

The amplitude-limited output of IC4, applied to discriminator FL2, generates a d.c. signal of one polarity when the tone signal is at the mark frequency and of the opposite polarity when the tone signal is at the space frequency. The polarity of the discriminator output connection is determined by the SIGNAL SENSE switch S2. When SIGNAL SENSE switch S2 is set to NORMAL, the polarity of the connection is such that the discriminator supplies a positive level when the tone signal is at the mark frequency. With S2 set to REVERSE, the discriminator supplies a negative level to the emitter follower for a mark frequency tone and supplies a positive level to the emitter follower for a space frequency tone. The output of the discriminator is fed through SIGNAL SENSE switch S2 and the rectifier and filter network to DIVERSITY switch S1, where it is added to the bias level supplied by the bias-level network and fed through emitter follower Q3 to the output level detector Q7-Q8, a regenerative amplifier.

The regenerative amplifier, Q7-Q8, provides a stable reference for the detection threshold. (Threshold, in the electronics field, is defined as the least value of a current, voltage, or other quantity that produces the minimum detectable response.) A negative input cuts off Q8, holding the output switch driver, Q9 in conduction. When a positive input is applied to Q8, Q9 is held cut off. The regenerative action of Q7 and Q8 ensures that output switch driver Q9 is always in either a nonconducting or full conducting state. The output switch driver, Q9, controls electronic output switch Q6, which determines loop current flow.

The two factors which determine converter diversity connections are switch settings on the individual converters and cabinet positions (stations) occupied by the converters. Because cabinet wiring for stations A1 through A4 is identical to that for stations A4 through A8, figure 3-11 shows only one four-station group.

Referring to figure 3-11, it is evident that each channel, regardless of the station into which it is plugged, can be connected, via the INDIV. input line and the TONE INPUT switch, to an associated individual input transformer, located in the input filter. Each channel may also be connected, via RCVR A or RCVR B input lines and the TONE INPUT switch, to either of two composite input transformers located in the input filter. The two composite input lines are used in the frequency-diversity/space-diversity system shown in figure 3-11. In this system, two converter modules are assigned to each channel.

One group of four converters (for the eight channels) processes signals from radio receiver A, which appears on the RCVR A input line; the other group of four converters processes signals from radio receiver B, which appear on the RCVR B input line.

With the TONE INPUT switches set as shown, the converters in stations A1 and A3 are connected to receiver A and the converters in stations A2 and A4 are connected to receiver B. The converters in stations A1 and A3 function as a frequency-diversity pair, as do those in stations A2 and A4. The converters in A1 and A2 also function as a space-diversity pair, as do those in A3 and A4. For example (table 3-1), the converters in the first two stations might be assigned to 425 Hz channels. If that is the case, those in A3 and A4 would be assigned to 1785 Hz channels. These four stations thereby form a narrow-band, frequency-diversity/space-diversity combination.

In this combination, outputs of the four channel discriminators are applied to the A.G.C. regenerative amplifier of the converter in station A1.

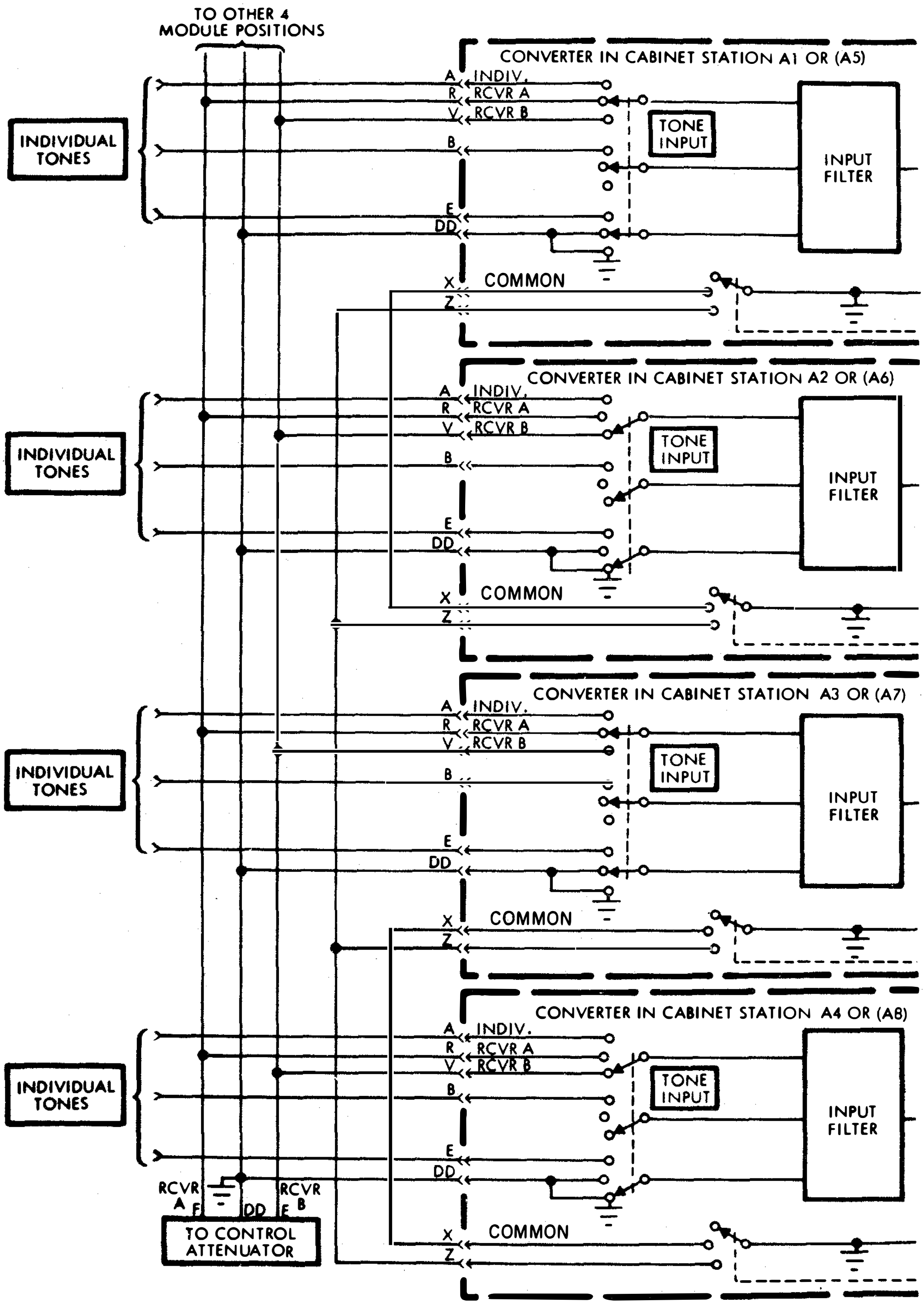

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Figure 3-11.—Frequency-shift converter diversity combination block diagram (Part 1).

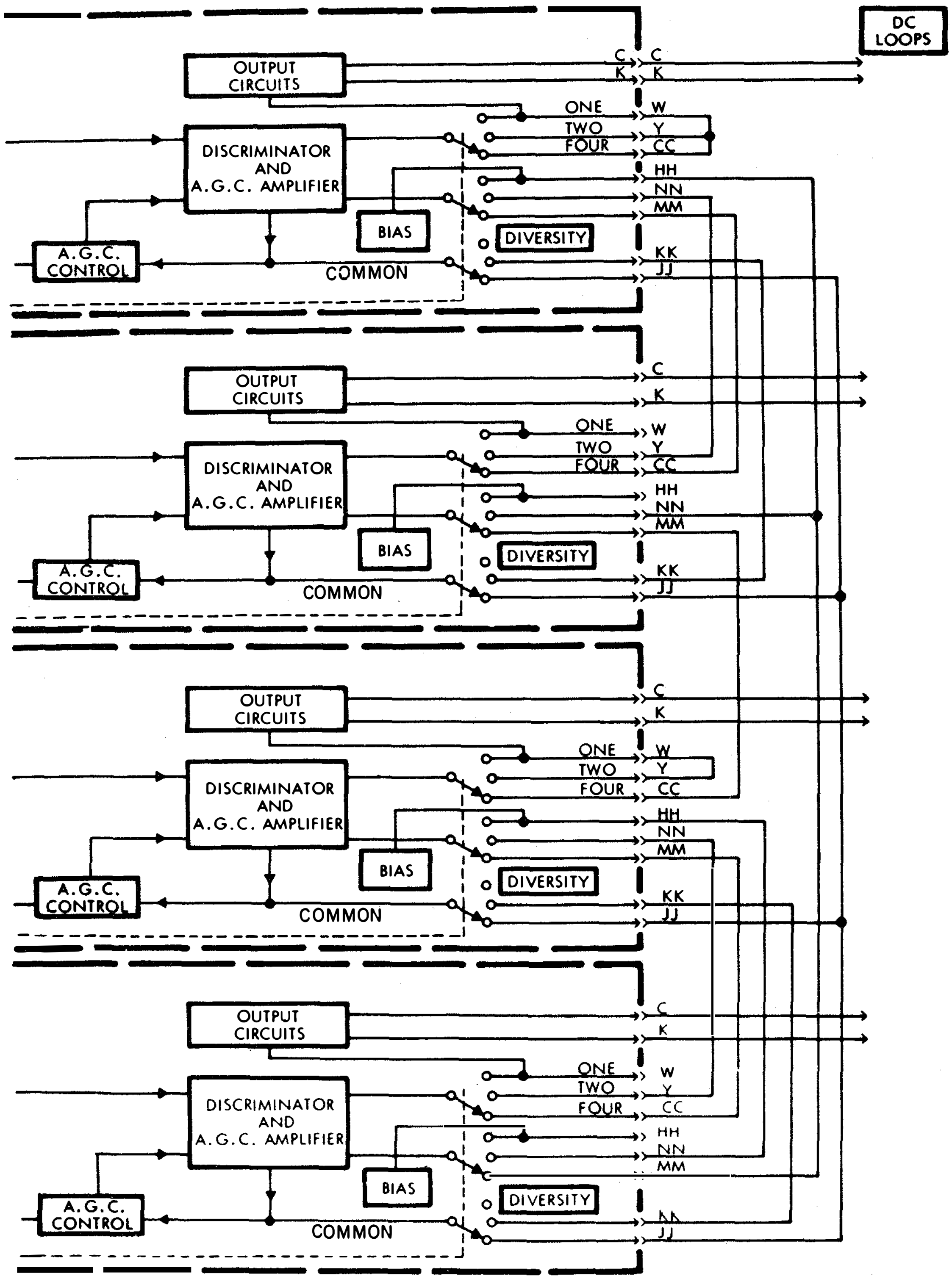

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Figure 3-11.—Frequency-shift converter diversity combination block diagram (Part 2).

Table 3-1.—Frequency-diversity combinations

NARROW-BAND (Hz)		
NORMAL COMBINATIONS	NORMAL AND REVERSE COMBINATIONS	NARROW-WIDE BAND (Hz)
425-1785	425-1785	425-1105
595-1955	595-1955	595-1275
765-2125	765-2125	765-1445
935-2295	935-2295	935-1615
1105-2465	1105-2465	
1275-2635	1275-2635	
1445-2805	1445-2805	
1615-2975	1615-2975	

162.178

The DIVERSITY switch on each converter can also be used to switch the converters in stations A1 through A4 to two separate frequency-diversity pairs. For example, the converters used in stations A1 through A4, respectively, might be assigned 425 Hz, 1785 Hz, 595 Hz, and 1955 Hz channels, the first two and the last two functioning as narrow-band frequency-diversity pairs.

Since no space-diversity pairs are involved, all four of the TONE INPUT switches are set to the same position so that all four converters are connected to the same composite tone line.

The composite input lines are connected to the composite tone lines in each cabinet. The composite tone lines are connected to corresponding lines in other cabinets when more than one cabinet is used. The tone inputs are then received through input transformers in the cabinet. The system shown in figure 3-11 employs four cabinets containing converters. The input lines of the top cabinet and the third cabinet from the top are used.

Each converter can be set to operate individually as a receiving channel through the use of the DIVERSITY switch. Each converter can also be connected to an individual input line through the use of the TONE INPUT switch.

Figure 3-11 illustrates the intermediate A.G.C. circuit connections for diversity operation. When a group of converters are used in a diversity combination, the inputs to the A.G.C. amplifiers of all modules in the group are connected together. The common connection is through the A.G.C. detector of each module. The converter receiving the strongest input signal produces the most negative output from the A.G.C. detector. This signal overrides those of the other converters and drives all A.G.C. amplifiers in the group. This causes the discriminator drive signals of all converters, except the one with the strongest input signal, to be attenuated with respect to the discriminator drive signal of the converter receiving the strongest input signal. Thus, only the strongest input signal produces sufficient discriminator output to drive the regenerative amplifier (output level detector) and the output switch.

Control Attenuator

When the frequency-shift keyer TONE OUTPUT switches are in the PARALLEL position, the signals are combined and applied to the input transformer, T1 (fig. 3-12), of the control attenuator through the MODE switch. The output signal from T1 is applied to the input attenuation and bias network. The attenuation of this network is sufficient to provide the operating range for the amplifiers. The network also biases the input gain-controlled amplifier IC1.

The output of IC1 is RC coupled to the input of fixed-gain amplifier IC2. The output of IC2 is transformer coupled by A1T1 to the output amplifier Q2. It is also coupled, through A1T1, rectified by CR1 and CR2, and applied to the base of the agc detector transistor Q1A. Because the voltage required to cause this transistor to conduct is essentially constant, it serves as a reference to determine (detect) the level of the output signal from the fixed-gain amplifier IC2. The amplified output of Q1A is applied to the base of emitter follower Q1B, which functions as a power amplifier with sufficient gain to control the output of the gain-controlled amplifier IC1.

The output of A1T1 is also applied to the base of the output amplifier Q2. The LEVEL control (not shown) varies the output level by adjusting the level of the signal applied to the base of Q2. The signals from the output amplifiers are coupled out of the control attenuator by output transformer T2, which is located in the rear chassis assembly. Transformers T3 and T4 are the RCVR A and RCVR B isolation transformers. When signals are applied to their inputs, and when the MODE switch is in the MASTER position, the input signals are applied to the RCVR A and RCVR B lines for application to the converter inputs.

The 115-volt a.c./230-volt a.c. switch on the front panel of the control attenuator controls the application of power to the other modules in the cabinet. When the switch is in the 115-volt a.c. position, the input voltage is applied across the 115-volt input terminals of all power transformers; when the switch is in the 230-volt a.c. position, the input voltage is applied across the full primary windings of all power transformers.

Multiplexer-Demultiplexer

At the transmission end of the link (fig. 3-8), the two composite 3kHz signals are applied on separate lines to the multiplexer, which translates one of them to the 3265 to 5915 Hz band signals to form the 6 kHz signal. The 6 kHz

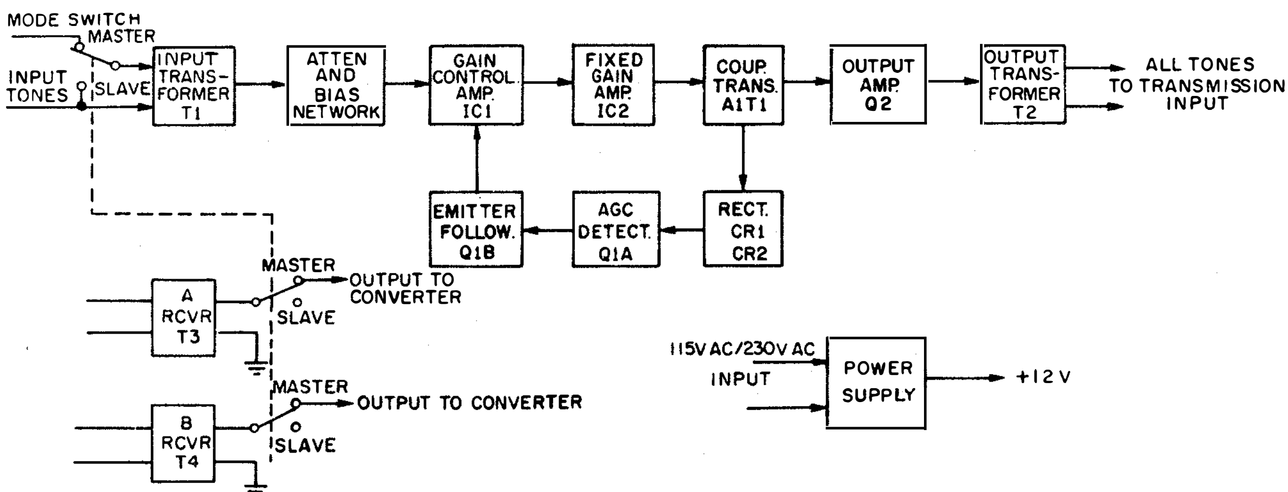

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Figure 3-12.—Control attenuator simplified functional block diagram.

signal is applied to the communication link on the single line.

At the receiving end of the communication link (fig. 3-8), the telegraph terminal reverses the process performed at the transmission end; voice-frequency signals from the 6 kHz bandwidth communication link are applied to the demultiplexer, which reverses the multiplexer frequency-translation action. The resultant two 3 kHz bandwidth tone signals are then applied on separate lines to two sets of receiving tone channels having the same bandpass characteristics as the channels used at the transmission end. Each channel accepts one voice-frequency signal, which it converts into an electronic keying signal for a receiving telegraph loop.

MULTIPLEXER FUNCTION.–When the multiplexer function (fig. 3-13) is performed, one of the two composite tone input signals to be multiplexed is applied to the DIRECT PATH jack, and the other to the TRANSLATED PATCH jack (Mux-Demux inputs).

The DIRECT PATH input passes through input transformer T1, which isolates the floating input circuit from the Mux-Demux ground. The output is applied to the bandpass filter, which passes the 375 to 3025 Hz band of frequencies for summing with the translated path output signal.

The TRANSLATED PATH input is applied to input transformer T3, which isolates the floating input from the Mux-Demux ground and matches the low impedance of the input circuit

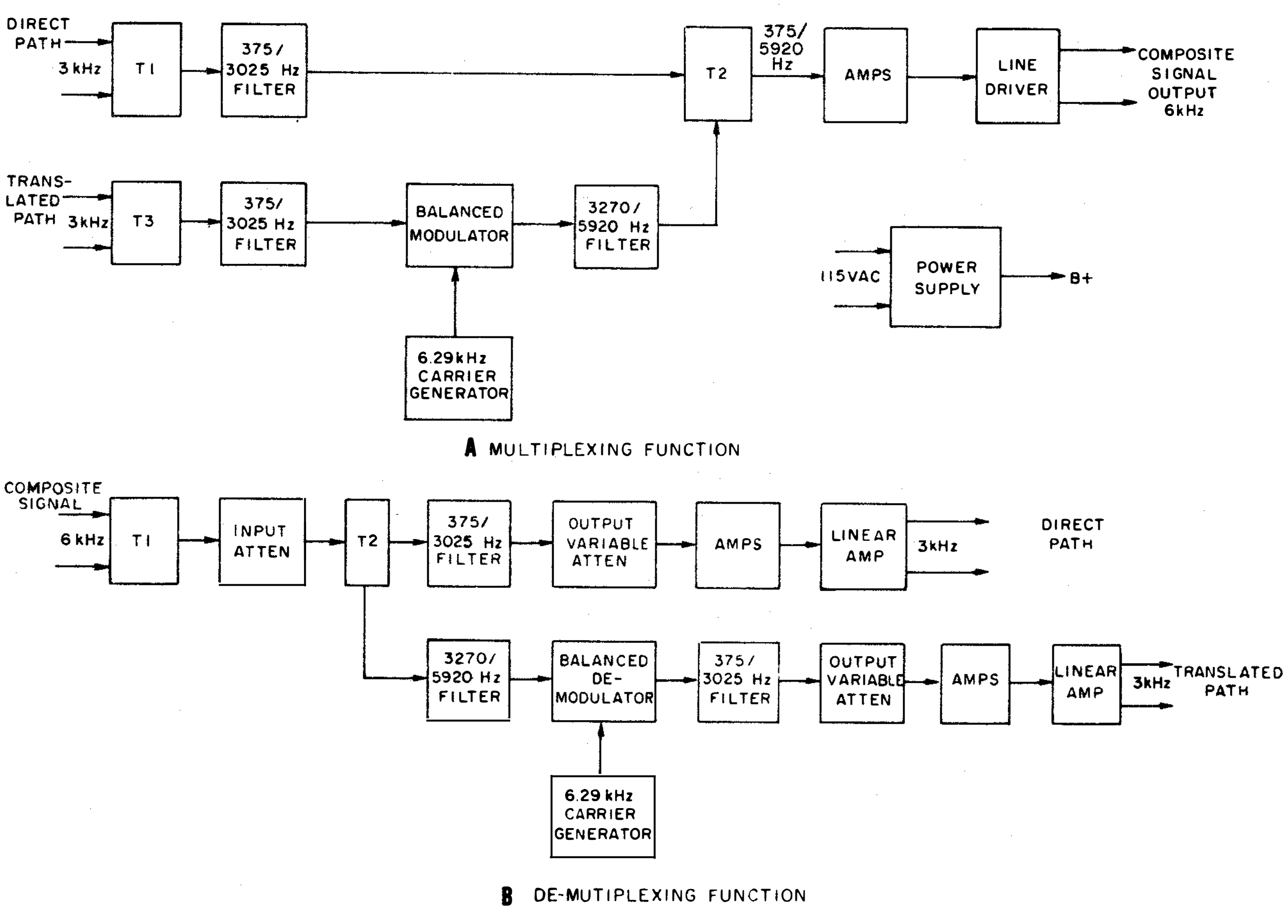

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Figure 3-13.–Multiplexer-demultiplexer block diagram.

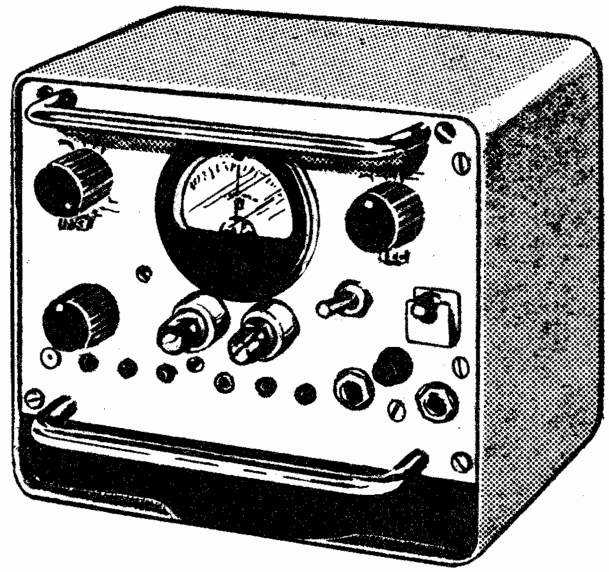
to the higher input impedance of the bandpass filter. A filter removes signals that are outside the 375 to 3025 Hz passband. The output is fed to the modulator-demodulator section, which also receives a 6.29 kHz carrier supplied by the carrier-generator assembly. The modulator-demodulator, a balanced lattice-type modulator, suppresses both the input and the carrier frequencies, and passes the upper and lower sidebands. Of the modulator-demodulator output fed to the bandpass filter, only the lower sideband of the modulated signal is passed (the upper sideband falls outside the 3270 to 5920 Hz passband). The translated path signal is summed with the direct path signal in T2 to form a composite signal with a passband of 375 to 5920 Hz. The composite signal is then amplified to the desired level and applied to a transmission input.

DEMULTIPLEXER FUNCTION.—Demultiplexer operation is essentially the reverse of the multiplexer operation described above. Because two separate outputs are furnished in the demultiplexing function, two variable attenuators and linear amplifiers are used. A third variable attenuator establishes the proper composite input signal level for application to the filters at the inputs of the two paths.

TEST SET

Telegraph Test Set TS-2232A/UCC-1C(V) (fig. 3-14) consists of a reversals generator, an audio amplifier and loudspeaker, a tone generator, a meter, switches to control operation, and a power supply circuit. The FUNCTION SELECTOR switch is the primary control of test set operation. It determines the connection and routing of input and output signals. Because, in various positions, it functions with the various circuits in the test set, these positions will be discussed with the circuits they affect.

The reversals generator (fig. 3-15) consists of a free-running multivibrator driving a transistor switch output circuit. The MODE SELECTOR switch S1 determines the mode of operation of the reversals generator, controlling the timing circuitry and providing loop closure



162.32
Figure 3-14.—Telegraph Test Set TS-2232A/UCC-1C(V).

to pins A (output) and P (ground) of the test connector P1. The positions of S1 and the functions of the reversals generator are as follows:

1. 75 BAUDS—the reversals generator runs at 75 bauds as determined by R2
2. 150 BAUDS—the reversals generator runs at 150 bauds as determined by R1
3. MARK—S1 closes the loop through R16
4. SPACE—S1 opens the loop

The reversals output is available at the test connector only when the FUNCTION SELECTOR switch (S2) is in the REV OUT position.

The tone generator consists of a crystal-controlled oscillator, 12 frequency-controlled crystals, eight integrated-circuit flip-flops (binary divider and diode gates), and a feedback circuit consisting of a pulse amplifier.

Seven of the eight integrated-circuit flip-flops make up a variable seven-stage counter (countdown or frequency-divider) circuit. The function of the eighth stage is slightly different from the others; it functions as a frequency

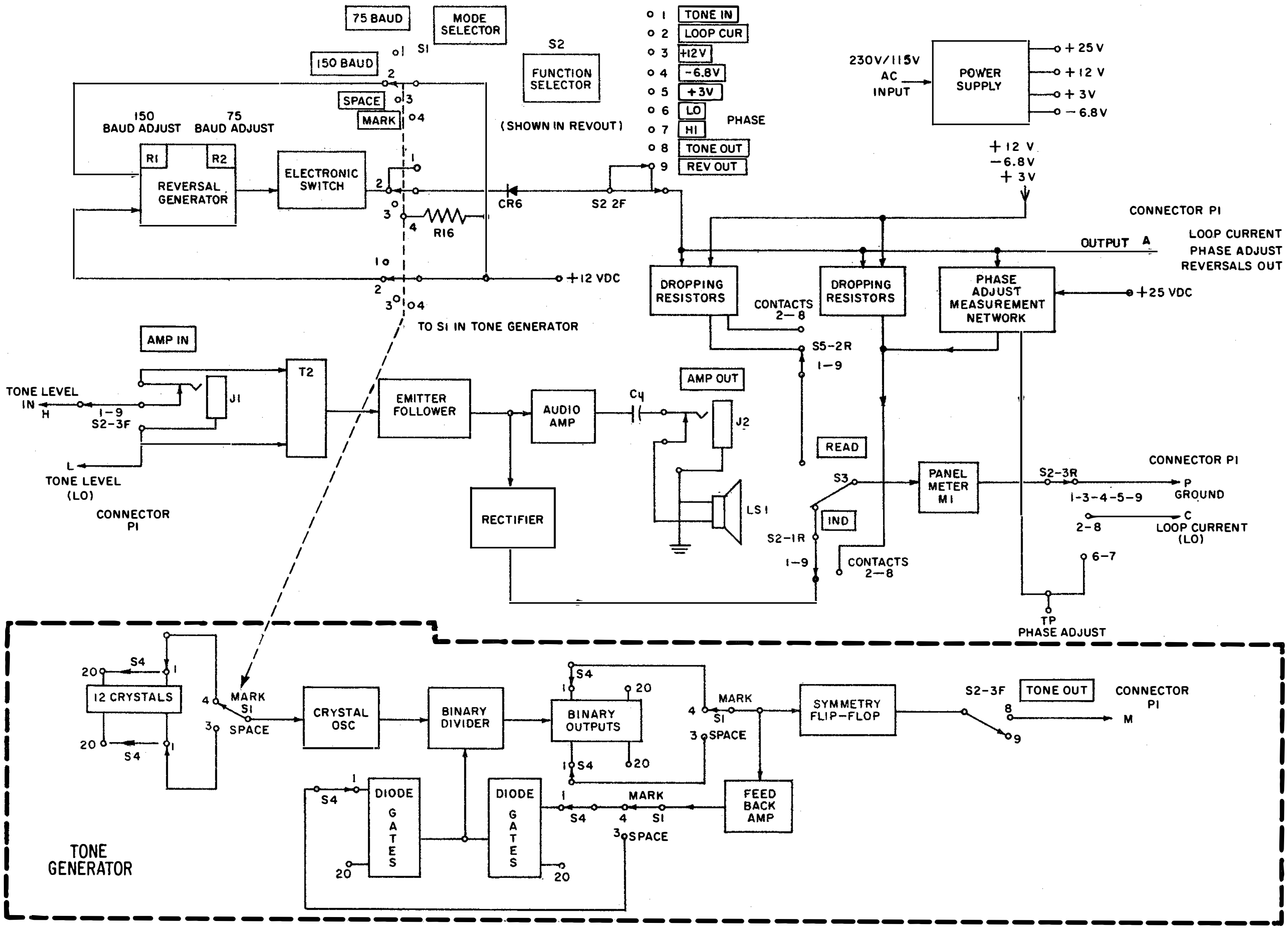


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Figure 3-15.—Telegraph Test Set TS-2232A/UCC-1(V) functional block diagram.

divider with a symmetrical output. The frequency division is changed by the TONE SELECTOR switch (S4), as required, to obtain the correct frequency for the channel selected.

The TONE SELECTOR switch S4 connects two crystals (one for the space frequency, the other for the mark frequency) into the tone generator circuit. Twenty channel frequencies–from 425 Hz to 3230 Hz–are available upon command of the TONE SELECTOR switch. Since each channel has both a mark frequency and a space frequency, a total of 40 frequencies must be derived from the 12 crystals. The TONE SELECTOR switch also alters the configuration of the network of feedback diodes to cause the flip-flop counter to produce the required mark and space frequencies. A number of the frequencies (tones) generated by the test set differ slightly from the actual mark and space frequencies. This difference is the result of using frequency division to generate more than one tone from one crystal-oscillator frequency. For example, the frequency of 2Y2 (91.840 kHz) can be divided by 144 to obtain a frequency of 637.8 Hz, or by 80 to obtain a frequency of 1148 Hz. Although the output tones of the test set are not at the exact frequencies of channel marks and spaces, they are within the tolerances necessary to align the AN/UCC-1(V).

The MODE SELECTOR switch S1 (in MARK or SPACE position) connects one of the two crystals, selected by the TONE SELECTOR switch, into the oscillator circuit at one time. If the MODE SELECTOR switch is in either the 75 BAUDS or the 150 BAUDS position, both mark and space crystals are removed from the oscillator circuit.

The tone outputs are connected to pins M and P of the test connector P1 when the FUNCTION SELECTOR switch is in the TONE OUT position.

Audio Amplifier and Loudspeaker

Tone signals applied across pins N and L of the test connector are connected to input transformer T2 when the FUNCTION SELECTOR switch is in the TONE IN or REV OUT position. The input transformer drives the audio amplifier through the emitter follower. The output of the audio amplifier is capacitively coupled by a capacitor to the loudspeaker and also to AMPLIFIER OUT jack J2. This arrangement provides an audible indication of the presense and keying of signals through the loudspeaker or earphones. Tone signals also may be applied to AMPLIFIER IN jack J1. In this case, the audible signals are available at the speaker or earphones connected to J2 with the FUNCTION SELECTOR switch in any position.

Meter Circuits

The meter and associated circuits perform a variety of functions as selected by the FUNCTION SELECTOR switch. The mode of operation of the meter M1 is determined by the READ/IND switch S3. When S3 is in the READ position, the parameters selected by the FUNCTION SELECTOR switch are measured in terms of volts, milliamperes, and dBm. When S3 is in the IND position, the meter provides a go/no-go indication with a passing range as indicated by a reading in the green band.

Tone Level Measurement

The tone input to the audio amplifier from the emitter follower is also applied to a rectifier. When the FUNCTION SELECTOR switch is set to TONE IN, the rectified signal is applied to the meter. The TONE IN measurement is used for equalizing the output tone levels of the individual channels.

Voltage Measurements

The d.c. supply voltages in the modules may be measured by turning the function selector switch to the +12V, -6.8V, and +3V positions. This connects the meter M1 to the test connector through dropping resistors. When the READ/IND switch is in IND position, a go/no-go indication is obtained; when it is in READ position, the meter indicates the actual value in volts.

Loop Current Measurement

When the FUNCTION SELECTOR switch is turned to the LOOP CUR position, the meter indicates loop current. Each module contains a resistor in series with the d.c. loop. The voltage, which is proportional to loop current, is applied to pins A and C of the TEST connector of the module. This voltage is coupled through the test connector of the test set, the dropping resistor, and the LOOP CUR contacts of the FUNCTION SELECTOR switch, to the meter.

Delay Adjustment

The phase angles of the channel signals applied to pin A of the test connector and to the PHASE ADJ test point are compared by a delay comparison network. The d.c. component value of the output of this network is proportional to the difference in phase of the input signals and dependent in polarity upon which channel has the greater delay. The output of the delay comparison network is applied to meter M1 through the FUNCTIONAL SELECTOR switch when it is set to PHASE LO or PHASE HI. The delays of the two channels may be equalized by adjusting the modules to obtain a zero indication on the meter.

CHAPTER 4

COMMUNICATIONS SYSTEMS EQUIPMENT CONFIGURATIONS

In today's Navy, shipboard communications are highly sophisticated and versatile. Through equipment design and installation, many equipments are compatible with each other and can be used to accomplish many functions. With this design concept, nearly all of the communications needs for a ship can be met with fewer pieces of communications equipment than were previously required.

An example of this is a radio operator operating a communications link with another ship. The radio operator is required to send and receive teletype information to the other ship. In order to do this, the operator must first establish voice communications with the ship that requires the service. From a position in Facilities Control, the operator can use switching arrangements to connect a uhf transceiver to a local position, for voice communications, and can connect a teletypewriter to an hf transmitter and receiver for transmission and reception of the teletype information. This arrangement allows the operator to use the communications equipment for different functions, while remaining at the operating position. This is just one of the many combinations that is available and used in normal shipboard communications.

In this chapter, communication equipment configurations are explained individually. Then, they are shown coupled with one another, forming a simple block diagram of the systems covered. Included in this chapter are the low-frequency, high-frequency, very high frequency, and ultrahigh-frequency systems.

LOW FREQUENCY

The low-frequency band is used for long-range direction finding, medium- and long-range communications, and aeronautical radio navigation.

LOW-FREQUENCY TRANSMIT

The low-frequency transmitter is used to transmit a high-powered signal over very long distances. The AN/FRT-72 transmitter (fig. 4-1) is designed for this purpose. The transmitter produces 50-kW peak-envelope power (25 kW average power) and covers a frequency range of 30 to 150 kHz.

LOW-FREQUENCY RECEIVE

The low-frequency receive system is designed to receive low-frequency broadcast signals and reproduce the intelligence that is transmitted. A typical low-frequency receive system is shown in figure 4-2. The low-frequency signal is received by the antennas and connected to a receiver antenna multicoupler and patch panel. The multicoupler and patch panel AN/SRA-17, allows the operator to select different antennas and connect them to different receivers, thus selecting the correct combination suited for a particular job. In the low-frequency receive system in figure 4-2, the receiver used is the AN/SRR-19A. The AN/SRR-19A operates in the 30 to 300 kHz frequency range. The output of the receiver is fed to Receiver Transfer Switchboard SB-973/SRR. The switchboard can connect the receiver output to numerous pieces of equipment. In figure 4-2, the receiver output is connected to Converter Comparator Set AN/URA-17. The converter comparator set converts the received signal to d.c. for use by the teletype equipment. The d.c. output of the

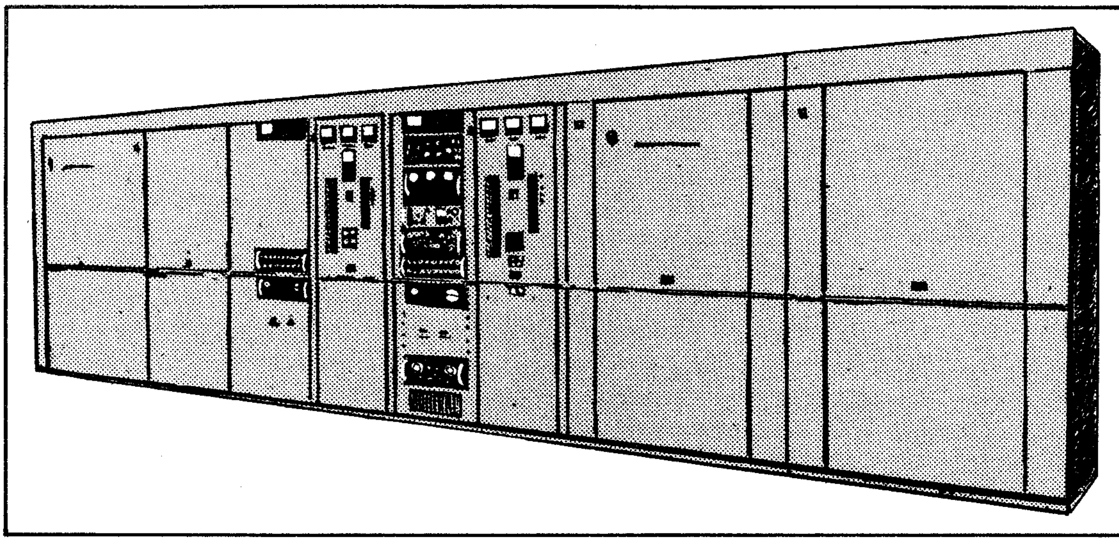

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Figure 4-1.—Radio Transmitting Set AN/FRT-72.

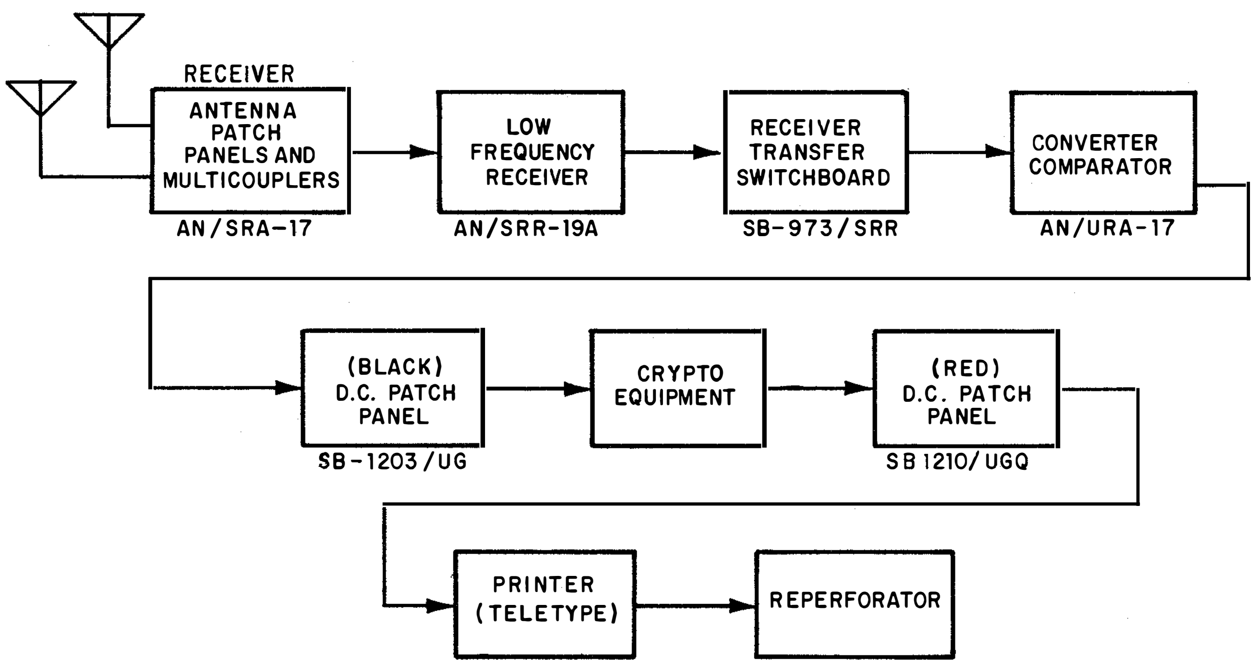

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Figure 4-2.—Low-frequency receive system.

AN/URA-17 is fed to D.C. Patch Panel SB-1203/UG. The d.c. patch panel permits the signal to be patched to any crypto equipment desired. The crypto equipment decrypts the signal and its output is connected to red D.C. Patch Panels SB-1210/UGQ. The SB-1210/UGQ can be patched to a selected teletype printer that prints the signal in plain text or, to a reperforator where a paper tape will be punched for storage to be printed at a later date.

HIGH FREQUENCY

The high-frequency band, 3 to 30 MHz, is used primarily by mobile and maritime units. The military uses this band for long-range voice and teletype communications. This band is also used as a backup system for the satellite communications system (covered in another chapter of this text).

HIGH-FREQUENCY TRANSMIT

The high-frequency transmit signal can be either voice or teletype information. Figure 4-3 shows a typical high-frequency transmit system employed aboard ship.

For the transmission of teletype information, the equipment used—the teletype, D.C. Patch Panel SB-1210/UGQ, the crypto equipment, and D.C. Patch Panel SB-1203/UG—are the same and perform the same functions as they did in the low-frequency receive system, except that they do it in reverse order.

Telegraph Terminal AN/UCC-1(V) (explained earlier in this text) converts d.c. signals into tone signals. The output of the AN/UCC-1(V) is connected to Transmitter Transfer Switchboard SB-988/SRT. Voice communications from some remote locations are also connected to this switchboard. The voice communications are developed at a handset (remote phone unit) and connected to Radio Set Control C-1138. The output of the radio set control is connected to Transmitter Transfer Switchboard SB-988/SRT. The transmitter transfer switchboard permits the operator to select the proper transmitter for the frequency to be transmitted. Transmitter AN/URT-23 receives the input signal from the switchboard and changes the signal to an rf signal that is connected to Antenna Coupler AN/SRA-34, -57, or -58. The antenna coupler is used to match the output impedance of the transmitter to the input impedance of the antenna. Antenna couplers also permit more than one transmitter to be connected to the same antenna as long as certain conditions are met. When the signal reaches the antenna it is radiated into the atmosphere.

HIGH-FREQUENCY RECEIVE

A typical high-frequency receive system is shown in figure 4-4. A transmitted signal, similar

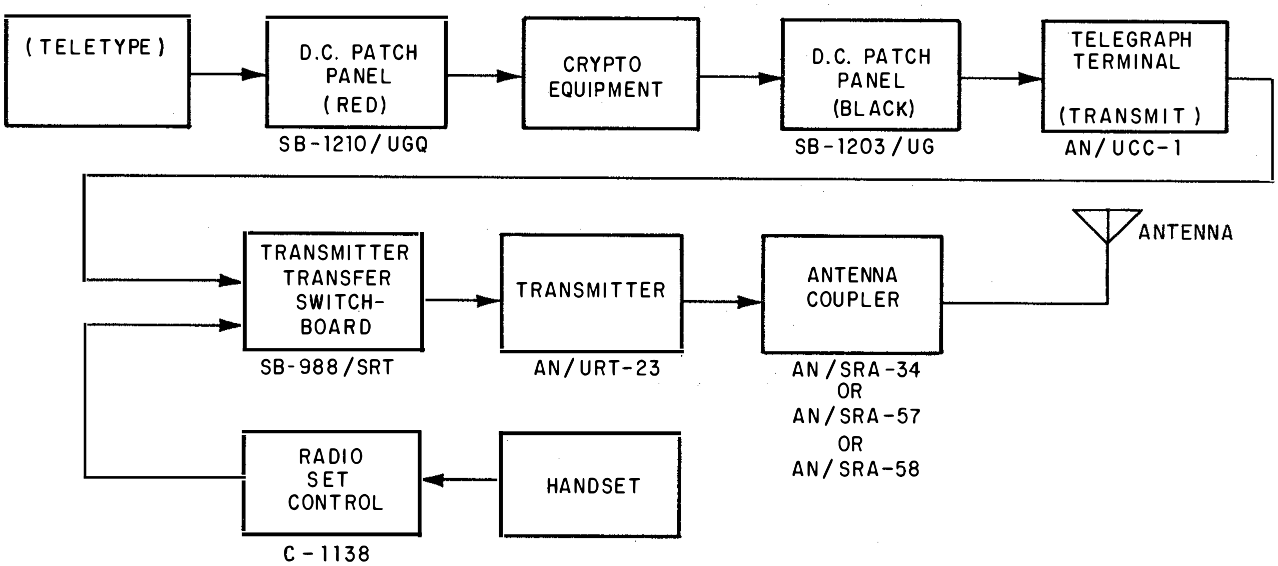

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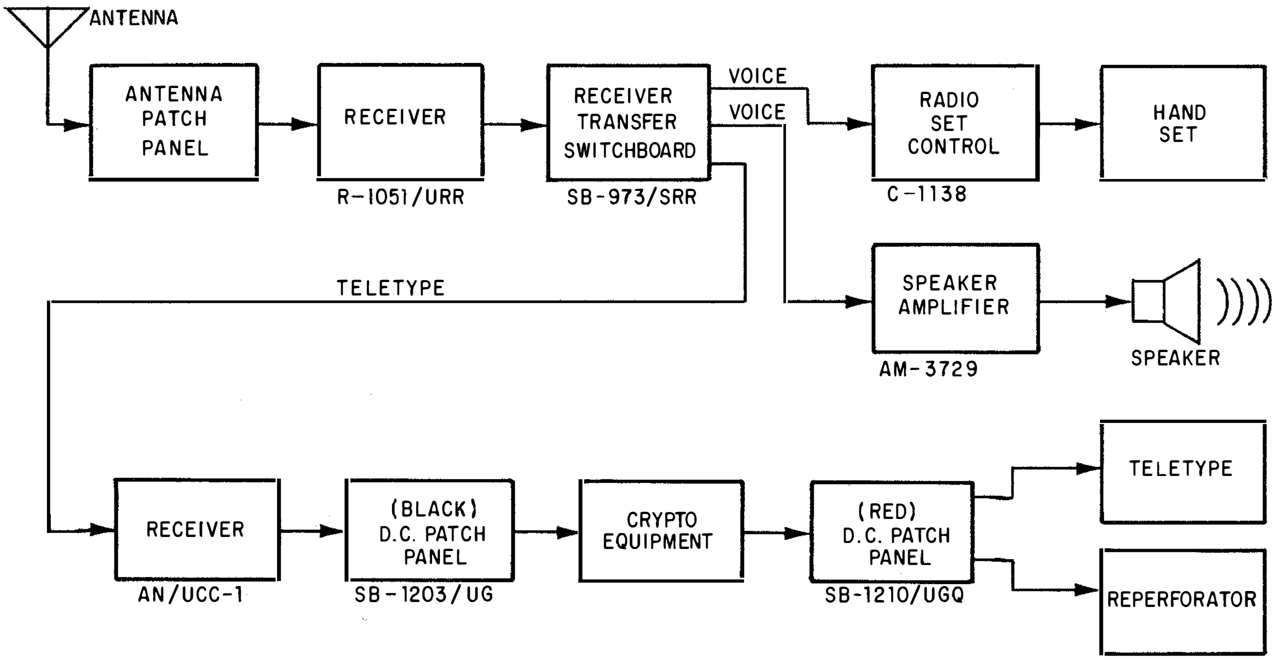
Figure 4-3.—High-frequency transmit system.



162.380

Figure 4-4.—High-frequency receive system.

to the one just developed in the previous section, is received by the antenna, which converts electromagnetic energy to electrical energy. The signal is connected to an antenna patch panel where it can be distributed to any number of receivers. In figure 4-4, Receiver R-1051/URR converts the rf signal into a teletype signal (fsk) or a voice signal, depending upon which is desired. The output of the receiver is then connected to Receiver Transfer Switchboard SB-973/SRR. The teletype signal from the SB-973/SRR will follow the same path used by the low-frequency signal. Identical pieces of equipment are used and they perform the same functions. The voice signal from Receiver Transfer Switchboard SB-973/SRR is sent to Radio Set Control C-1138. The output is then connected to a handset. The voice signal can also be sent from the switchboard to remote Speaker Amplifier AM-3729. 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

The very high frequency band, 30 to 300 MHz, is used for aeronautical radio navigation and communications, radar, amateur radio, and mobile communications. The Navy uses this band for mobile communications, such as for boat crews and landing parties.

VERY HIGH FREQUENCY TRANSMIT

A basic block diagram of a vhf transmit and receive system is shown in figure 4-5. On the transmit side of the system, the operator, at a remote location, talks into the handset. The handset is connected to Radio Set Control C-1138. The output of the radio set control is connected to Transmitter Transfer Switchboard SB-988/SRT. The switchboard performs the same function as it did in the lf and hf systems. The output of the switchboard is connected to the transmit side of the Receiver/Transmitter AN/VRC-46 (transceiver). The transceiver

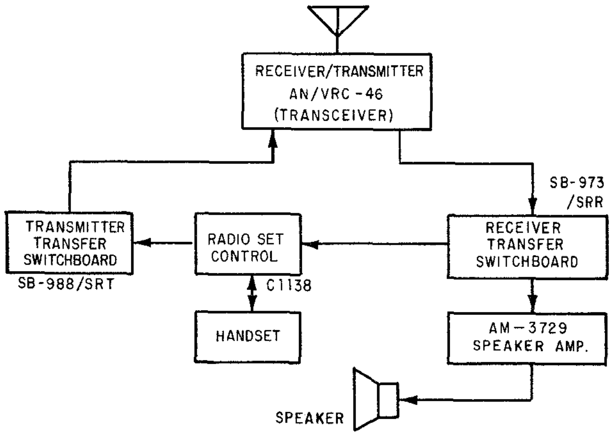


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Figure 4-5.—Very high frequency transmit and receive.

converts the input signal to an rf signal for radiation by the antenna.

VERY HIGH FREQUENCY RECEIVE

The incoming signal (fig. 4-5) is received by the antenna. The signal is connected to the receive side of Transceiver AN/VRC-46. The output of the transceiver is connected to Receiver Transfer Switchboard SB-973/SRR. The output of the receiver transfer switchboard is connected to either Radio Set Control C-1138 or Speaker Amplifier AM-3729, or both, depending on the preference of the user. The output of the radio set control is connected to the handset. The output of the speaker amplifier is connected to the speaker.

ULTRAHIGH FREQUENCY

The ultrahigh-frequency band is used for line-of-sight (short-range) communications. Line-of-sight means that both antennas must be able to see each other for proper operation. This band is also used for satellite communications (explained later in this text). Satellite communications are still line-of-sight, though the distance traveled by the signal is much greater than that of surface communications, because the antennas remain in sight of each other.

The transmitter and receiver used in the uhf system form one piece of equipment (a transceiver); however, the transmit and receive system will be described separately. At the conclusion of this chapter, these two systems will be tied together and shown as a single complete system in the overall block diagram.

ULTRAHIGH-FREQUENCY TRANSMIT

A basic block diagram of a uhf transmit system is shown in figure 4-6. On the transmit side of the nonsecure voice system, the operator at a remote location talks into the handset. The handset is connected to Radio Set Control C-1138. The C-1138 is connected to Transmitter Transfer Switchboard SB-988/SRT, where it is patched to the transmitter.

On the transmit side of the secure voice system, the operator at a remote location talks into the secure voice remote phone unit (RPU). The RPU is connected to the secure voice matrix. The matrix is the tie point for the connection of more than one remote phone unit. The output of the matrix is connected to the secure voice equipment which encrypts the information received. The output of the secure voice equipment is connected to Transmitter Transfer Switchboard SB-988/SRT.

The transmitter transfer switchboard is used to connect numerous remote phone units to any number of transmitters. The output of the patch panel is connected to the transmitter side of the AN/SRC-20/21, which in turn is connected to Antenna Coupler AN/SRA-33. The output of the AN/SRA-33 is connected to the antenna.

ULTRAHIGH-FREQUENCY RECEIVE

A basic block diagram of a uhf receive system is shown in figure 4-7. The received signal is picked up by the antenna and connected to the receiver side of the AN/SRC-20/21, through Antenna Coupler AN/SRA-33. The output of the receiver is connected to Receiver Transfer Switchboard SB-973/SRR, where it can be connected to either the nonsecure or the secure voice systems, depending upon the mode of transmission. When a nonsecure signal is received, the output of the receive transfer switchboard is connected to

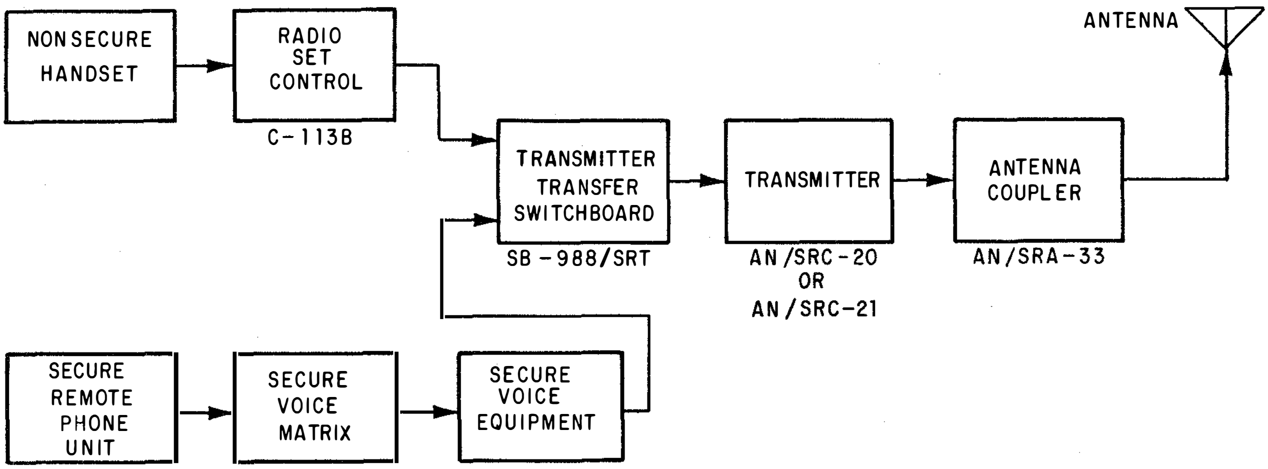

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Figure 4-6.—Ultrahigh frequency transmit.

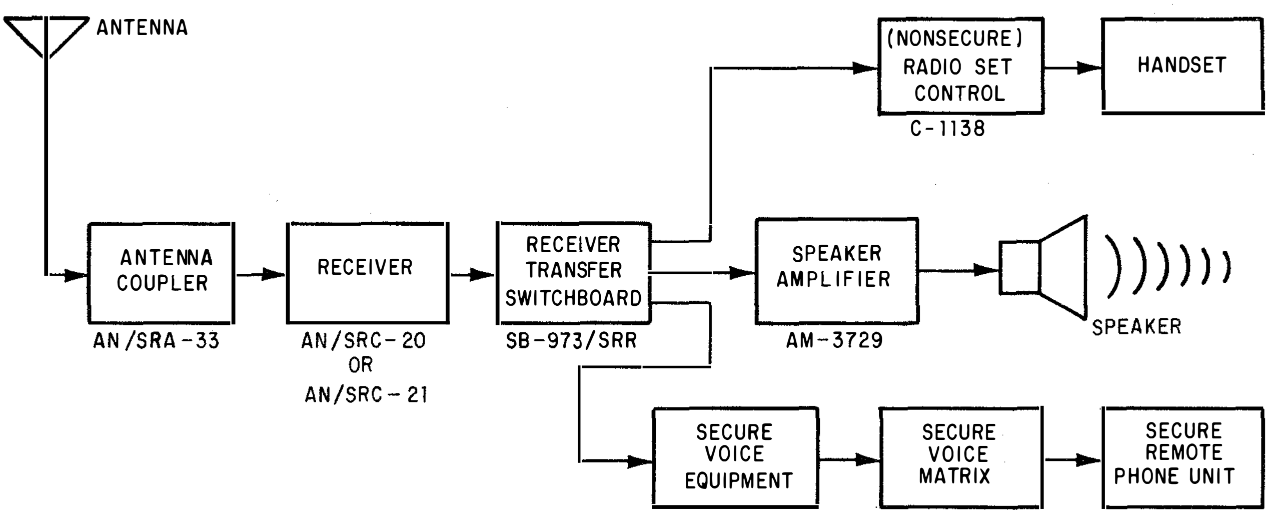

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Figure 4-7.—Ultrahigh frequency receive.

either Radio Set Control C-1138 or Speaker Amplifier AM-3729, or both, depending on the preference of the user. The output of the radio set control is connected to a handset. The output of the speaker amplifier is connected to a speaker.

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. The output of the secure voice equipment is connected to the secure voice matrix which performs the same function as the matrix on the transmit system. The output of the secure voice matrix is connected to the secure remote phone unit, where the signal is converted back to its original form.

COMMUNICATIONS EQUIPMENT CONFIGURATION

All of the communications equipment described in this chapter are combined in figure 4-8 (a foldout at the end of this chapter) to show a representative shipboard communications system. Each system that has been described can be followed on figure 4-8. This figure illustrates that one piece of equipment can be used for more than one system. Examples of this are Transmitter Transfer Switchboard SB-988/SRT and the Receiver Transfer Switchboard SB-973/SRR. With the equipment connected as shown, it is readily apparent that one operator, at any given location, has access to any number of different pieces of equipment, using different patching arrangements. Such arrangements allow the operator to accomplish the mission assigned.

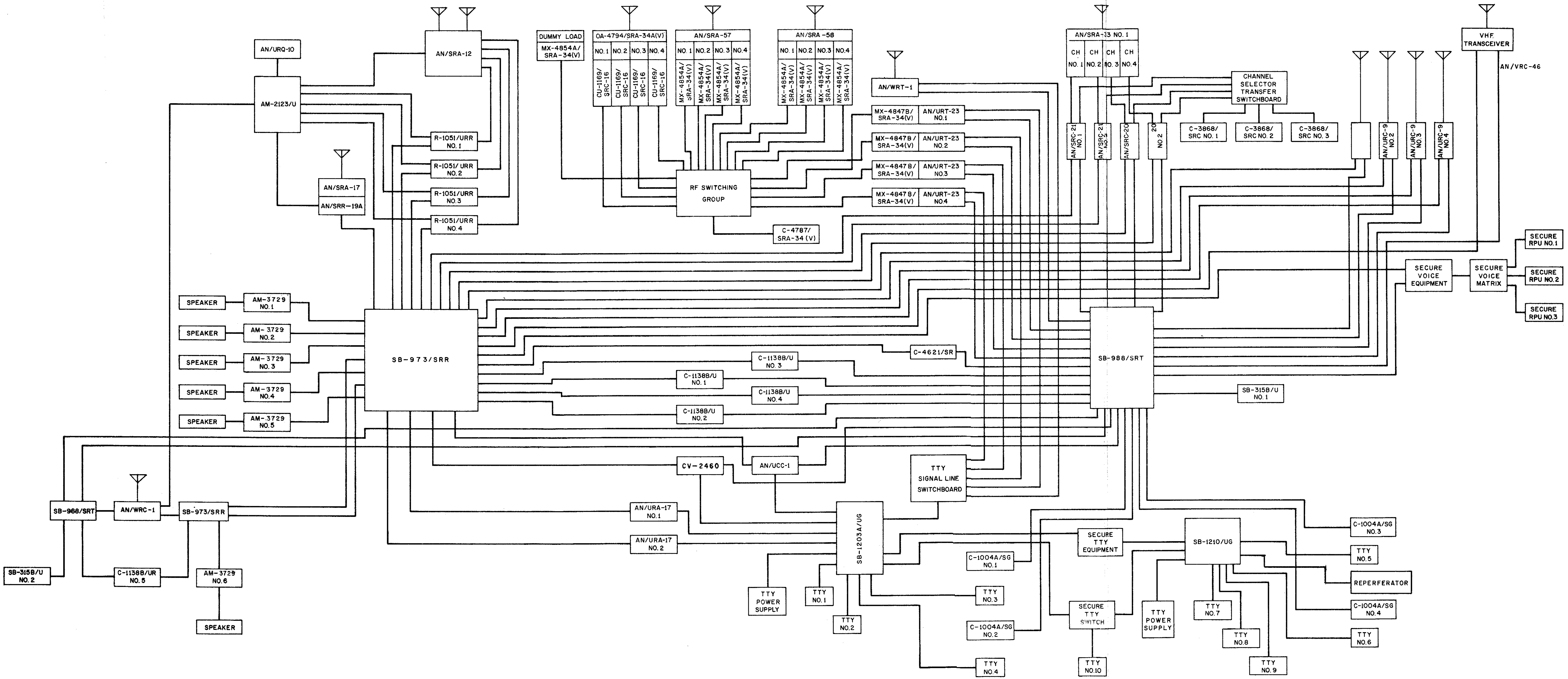

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Figure 4-8.—Communications equipment configuration.

CHAPTER 5

FACSIMILE SYSTEMS

Facsimile systems provide a method of transmitting pictorial and graphic information by wire or radio and reproducing it in its original form at the receiving station. The most common use of facsimile systems by the Navy is transmission of plotted and analyzed weather charts.

Facsimile signals may be transmitted by radio by the audio-frequency tone shift (AFTS) or the radio-frequency carrier shift (RFCS) method. Conventional superheterodyne receivers are used to receive either type of transmission. The receivers output is AFTS signals in which 1500 Hz represents the maximum (black) signal, and 2300 Hz represents the minimum (white) signal, or AFTS signals in which 2300 Hz represents the maximum signal, and 3100 Hz represents the minimum signal. In either case an 800-Hz shift is maintained between the maximum and minimum signal outputs from the facsimile transmitter at the sending station.

SIMPLEX SYSTEM

A simplified block diagram of a simplex facsimile system is shown in figure 5-1. On the transmit side, a 2400-Hz carrier (amplitude modulated corresponding to the various shades of the copy to be transmitted) is produced at the output of the transmitter section of Facsimile Receiver-Transmitter TT-321A/UX and fed to Radio Modulator MD-168A/UX. The MD-168A/UX converts the AM signals to AFTS signals which modulate the rf carrier generated by the transmitter. The transmitter carrier is modulated plus or minus 400 Hz.

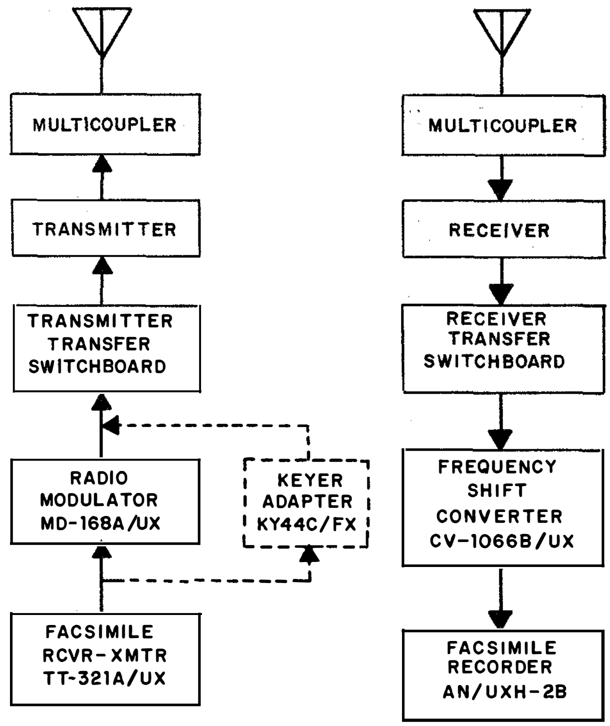

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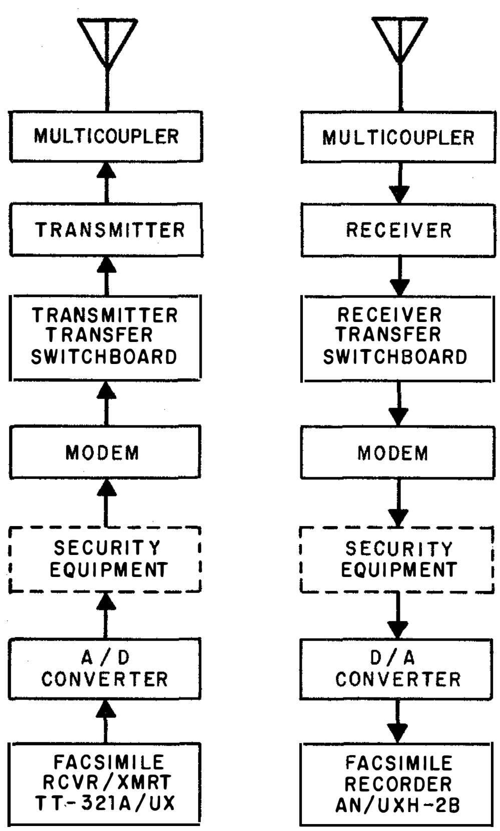
Figure 5-1.—Facsimile system, AFTS and RFCS modes.

If the RFCS method of transmission is to be used, the facsimile receiver-transmitter output is fed to Keyer Adapter KY-44C/FX. Keyer Adapter KY-44C/FX converts the TT-321A/UX AM signal output into d.c. keying signals suitable for use with a frequency-shift exciter unit.

The receiver (fig. 5-1) outputs AFTS signals from 1500 Hz to 2300 Hz, or 2300 Hz to

3100 Hz, depending upon the setting of the receiver beat-frequency oscillator. These AFTS signals are fed to Frequency-Shift Converter CV-1066B/UX where they are converted into equivalent AM signals suitable for operating the facsimile recorder. The Facsimile Recorder AN/UXH-2B, Facsimile Receiver-Transmitter TT-321A/UX, Radio Modulator MD-168A/UX, Keyer Adapter KY-44C/FX, and Frequency Shift Converter CV-1066B/UX are discussed later in this chapter.

The data mode is also used for the transmission of facsimile signals as shown by figure 5-2. The AM signals from the TT-321A/UX (fig. 5-2) are fed to the analog-to-digital converter (adc) where they are converted into equivalent digital data signals and fed to the modem unit. The modem unit converts the digital data signals into AFTS signals, which modulate the transmitter carrier.



162.195
Figure 5-2.—Facsimile system, data mode.

On the receive side, the receiver output signals are fed to the modem unit, where they are converted to digital data signals and fed to the digital-to-analog converter (dac). The dac converts the digital data signals back to AM signals suitable for operating the facsimile recorder. Secure facsimile systems are produced by connecting security equipment between the modem units and the adc and dac.

FACSIMILE RECEIVER-TRANSMITTER TT-321A/UX

Facsimile Receiver-Transmitter TT-321A/UX, used with Power Supply PP-86F/TXC-1, is an electromechanical-optical facsimile set of the revoloving-drum type for the transmission and reception of page copy. The facsimile set is used for transmission of maps, photographs, sketches, and printed or handwritten text (black and white, color, or intermediate shades of gray) over regular voice-communication channels (either wire or radio) between fixed stations. Colored copy may be transmitted, but all reproduction is in black, white, or intermediate shades of gray. Received copy is recorded either directly on chemically treated paper or photographically in either negative or positive form. The facsimile set will transmit or receive a page of copy 12 by 18 inches in 10 minutes at regular speed or in 20 minutes at half-speed operation.

The receiver-transmitter (fig. 5-3) serves either as a facsimile transmitter or recorder, depending upon the setting of a front panel selector switch. Power Supply PP-86F/TXC-1 supplies operating power to the receiver-transmitter and operates from a nominal a.c. power source of 115 volts at 60 Hz.

FACSIMILE TRANSMITTER

The facsimile transmitter must resolve the copy to be transmitted into very small elemental

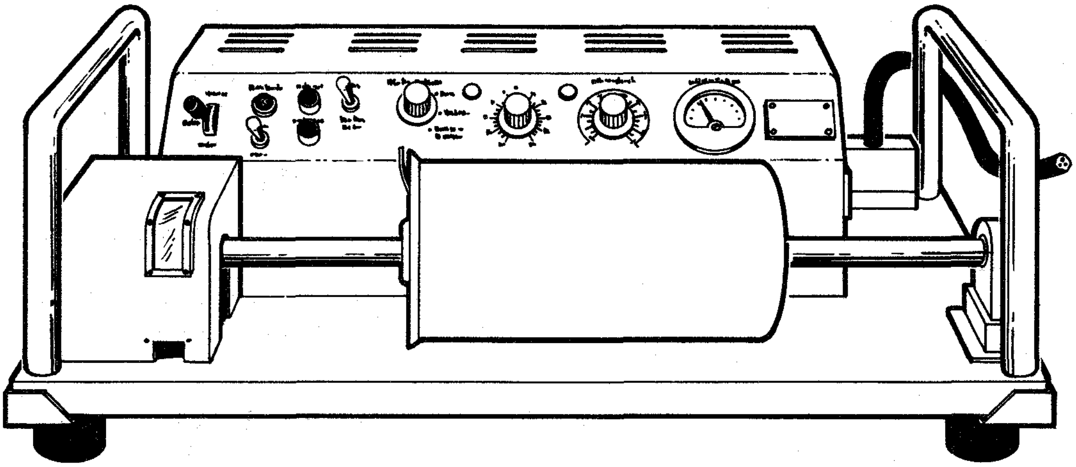


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Figure 5-3.–Facsimile Receiver-Transmitter TT-321A/UX.

areas and transmit the average density of each area separately. The size of these elemental areas must be small enough to resolve the smallest intelligence that is to be transmitted.

An exciter lamp is used as a source of uniform illumination of the copy, and a phototube is used to determine the brightness of each elemental area. The copy to be transmitted is clamped on a drum at the facsimile transmitter. An image of the copy is focused upon an aperture plate, which is located immediately in front of a phototube. The size of the hole in the aperture plate determines the area of the copy image (the elemental area) which passes through to the phototube.

The phototube acts as a valve in a modulator circuit to control the amplitude of a carrier frequency or tone. When a dark area of the copy is seen by the phototube through the aperture, the phototube allows a maximum signal to pass through the modulator circuit. When a white area is seen by the phototube, a minimum signal results. This signal from the phototube modulator is the facsimile signal which is transmitted to the facsimile recorder.

In order to scan each elemental area of the copy, the drum upon which the copy is clamped rotates and, at the same time, moves laterally from right to left so that the relative position of the optical system shifts by one elemental area for each drum revolution. When the optical system has completely scanned the copy, all of the elemental areas on the copy have been seen by the phototube, and a signal of corresponding amplitude has been transmitted for each elemental area.

Figure 5-4 shows functions of the various stages of the facsimile set during transmission. The material being transmitted is affixed to the rotating drum on which the condenser lens system focuses light from the exciter lamp. Amounts of light proportional to the copy density are reflected back through the objective lens and aperture to the phototube. The varying light intensities are converted into varying electrical resistance. Change in the phototube resistance controls the amplitude of a 2400-Hz carrier signal in the bridge modulator. This modulated signal is amplified by a voltage amplifier (V-10 and V-11), the proper signal level is established by a GAIN control, and the signal is boosted further by a power amplifier (V-12) before reaching the output terminals. A separate meter amplifier drives the dB meter which indicates the relative signal level. The fork oscillator supplies an 1800-Hz tone which is amplified in the exciter lamp power supply and keeps the exciter lamp at constant brilliancy. The 1800-Hz tone is also amplified and used to operate the synchronous motor, which drives the drum at a constant speed.

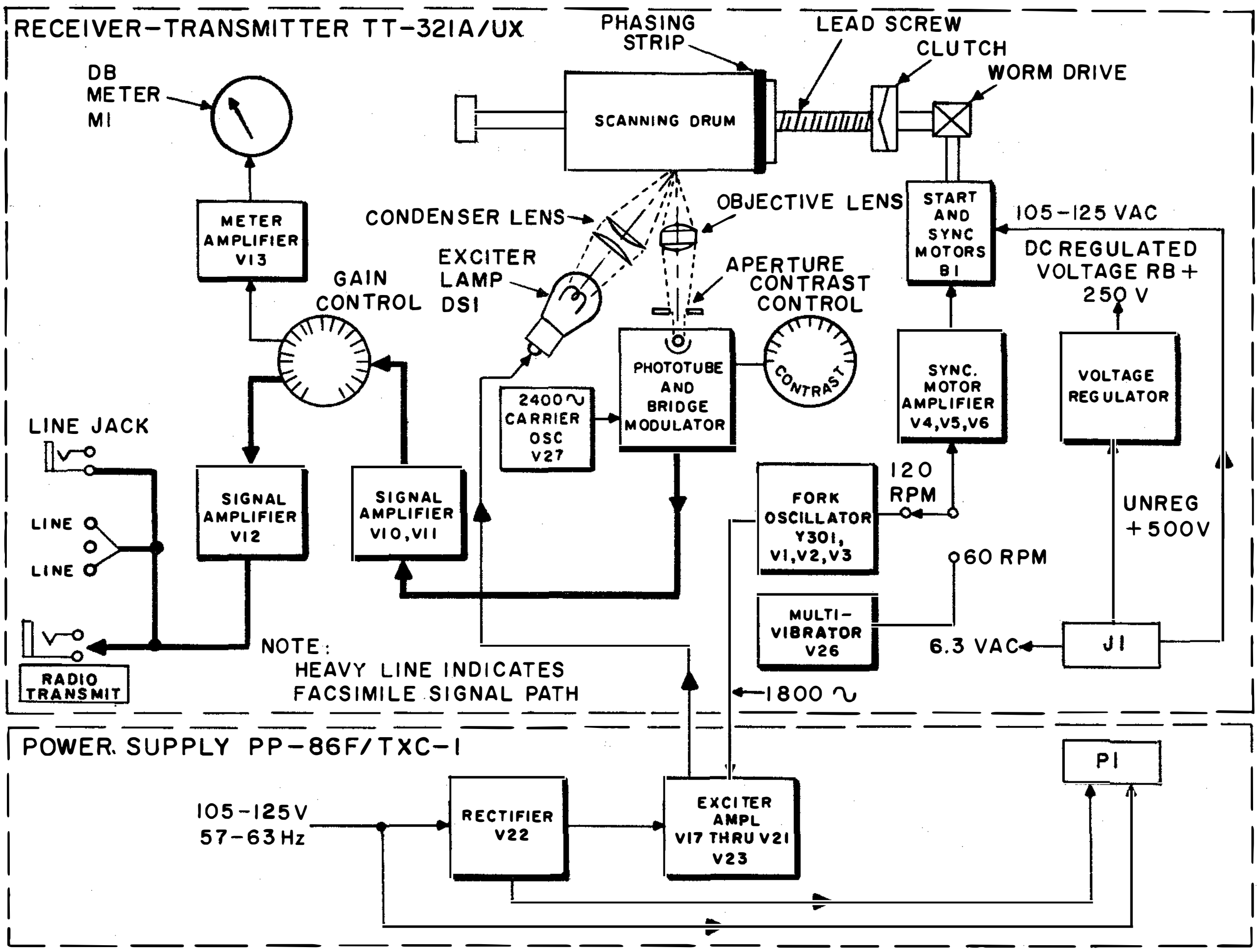

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Figure 5-4.—Transmitting section functional block diagram.

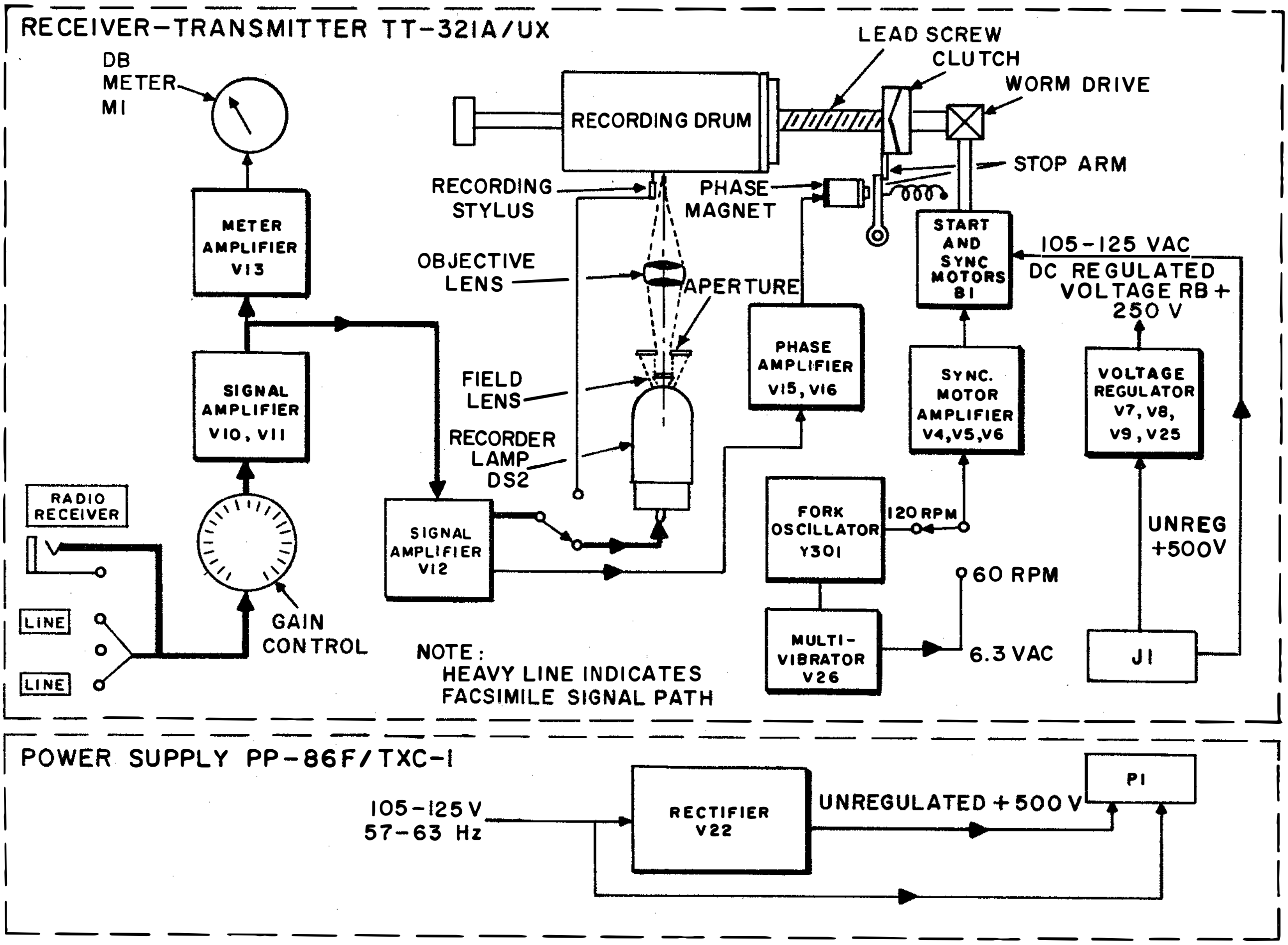
The low voltage power supply, contained in Power Supply PP-86F/TXC-1, provides operating voltages for the transmitting section from a 115-volt, 60-Hz source. The voltage regulator is physically located in the receiver-transmitter.

FACSIMILE RECEIVER

The facsimile receiver amplifies the facsimile signal and converts it back into corresponding density variations on the recording sheet. This is done in direct recording by amplifying the received facsimile signal and applying it to a small stylus needle which is in contact with the recording paper on a drum similar to that of the transmitter. The drum of the facsimile receiver rotates at the same speed as that of the facsimile transmitter so that the two drums are always in the same relative position. When a black area of the copy to be transmitted is seen by the phototube, a maximum amplitude signal is transmitted, which is amplified at the receiver and impressed upon the recording paper by the stylus to print out a corresponding elemental area of maximum density (black). When a white area is seen on the transmitter drum, the signal passed by the phototube is so low that no signal records in the corresponding elemental area of the sheet at the facsimile receiver.

In photographic recording the received facsimile signal is amplified and applied to a light source. Light from this source shines through an aperture focused on the photographic paper or film. If recording on photographic paper, when a black area of the copy to be transmitted is seen by the phototube, a maximum amplitude signal is transmitted, amplified at the receiver, and applied to the recorder lamp so that the photographic paper is exposed to maximum illumination. When a white area is seen on the transmitter drum, the signal passed by the phototube is so low that a small signal is applied to the lamp and little light reaches the photographic paper. If recording on photographic film, a maximum signal is transmitted when a white area is seen on the transmitter drum, and a minimum signal is transmitted when a black area is seen on the transmitter drum.

Functions of the various stages in the receiving section are shown in figure 5-5. The signal from the line is attenuated by a GAIN control, then amplified by a voltage amplifier



70.13

Figure 5-5.—Receiving section functional block diagram.

and a power amplifier. The dB meter, driven by a meter amplifier, indicates the relative level of the signal being used for recording. The power amplifier drives either the recorder lamp for photographic recording or the recording stylus for direct recording. Another connection from the power amplifier sends phasing pulses to the phase amplifier circuit which operates the phase actuator during the phasing process, before each transmission. The fork oscillator serves a single purpose on receiving. It generates an 1800-Hz signal which is amplified to operate the synchronous motor at the same speed as the motor in the transmitting facsimile set.

RADIO MODULATOR MD-168A/UX

Radio Modulator MD-168A/UX (fig. 5-6) is designed to convert amplitude-modulated facsimile signals from a facsimile transmitter (for example, the TT-321A/UX) acting as a transmitter, to audio-frequency-shift facsimile signals of 1500 to 2300 Hz suitable for modulating a radiophone transmitter.

A block diagram of the modulator is illustrated in figure 5-7. Basically, the unit consists of a preamplifier; a keyer (detector); a variable-frequency, phase-shift oscillator; a frequency indicator; and a power supply (not shown). The amplifier increases the received facsimile signal to the proper level for operating the phase-shift oscillator and a pair of earphones. The input signal to the modulator may be monitored by using the phone jack. The frequency limits of the output signal may be monitored by means of a dual-type, tuning-eye indicator.

The input signal to the modulator has a frequency of 1800 to 2400 Hz and an amplitude that varies in accordance with the light and dark segments of the picture being scanned at the facsimile transmitter.

The output signal from the modulator is an audio signal in which 1500 Hz represents the maximum signal input (in amplitude) and 2300 Hz minimum signal input (in amplitude) to the modulator from the facsimile transmitter. Amplitudes between maximum and minimum signals are changed to corresponding frequencies between 1500 and 2300 Hz. The output from the modulator is connected to the audio modulator section of a radio AM transmitter.

The variable-frequency, phase-shift oscillator is caused to change its frequency in accordance with the variations in the magnitude of the d.c. output voltage from the detector by means of a reactance-modulator stage. The phase-shift network is so connected that changes in the plate resistance of the reactance modulator (caused by the varying magnitude of the d.c. voltage applied to its grid) cause a change in the

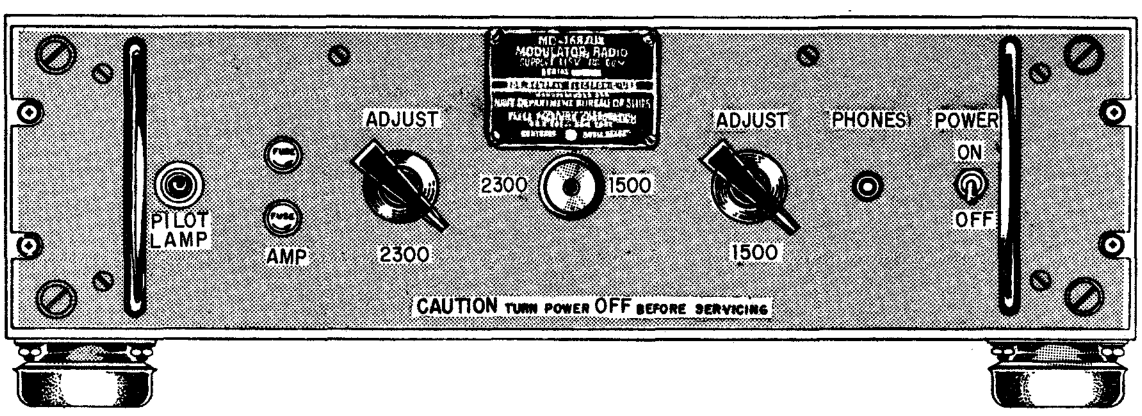


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Figure 5-6.—Radio Modulator MD-168A/UX front panel.

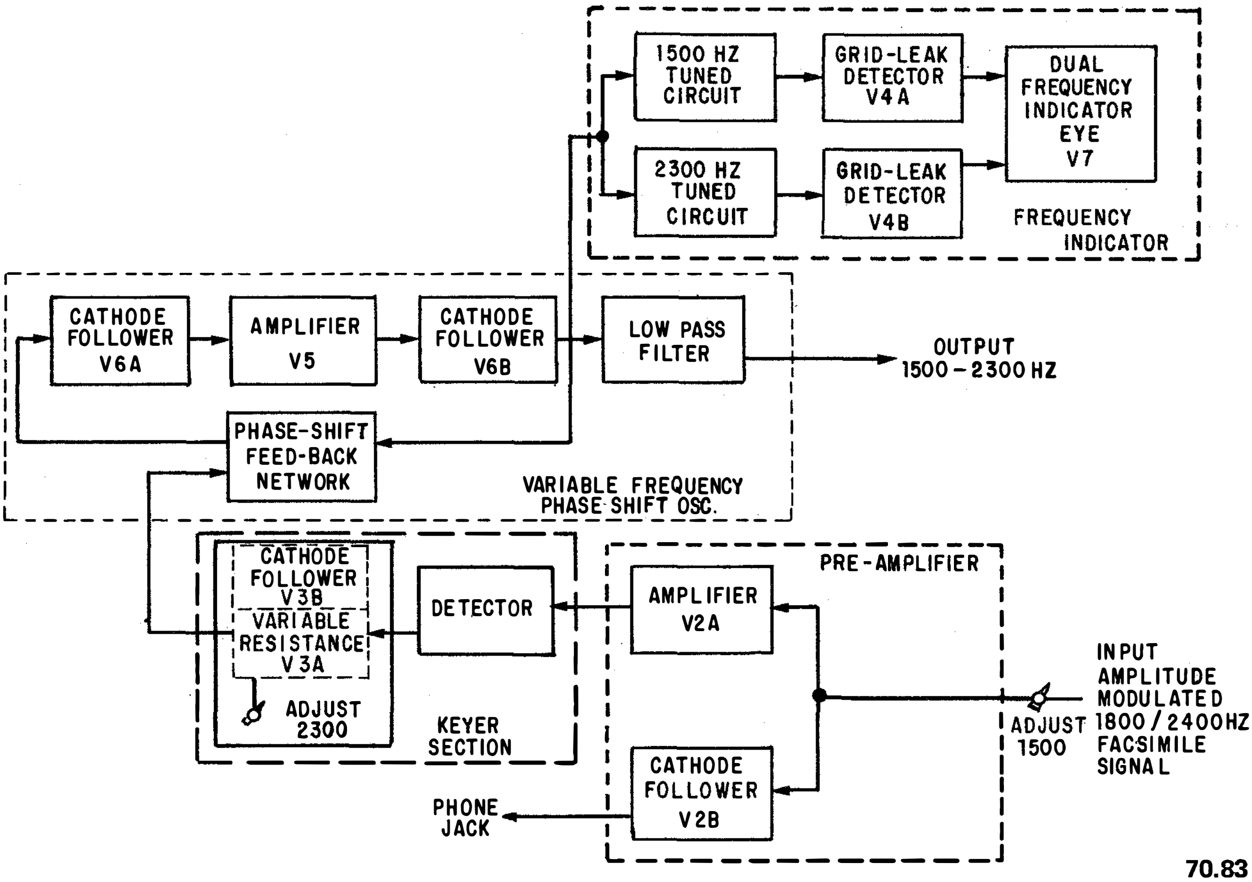

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Figure 5-7.—Radio Modulator MD-168A/UX functional block diagram.

time constant of one branch of the oscillator phase-shift network. This action introduces a change in phase shift through the network, which, in turn, changes the frequency of the oscillator.

The operating controls and indicators are located on the front panel (fig. 5-6). The pilot lamp operates when the set is turned on. Both sides of the power line are fused.

The adjust 2300 control is a potentiometer used to adjust the output frequency of the unit to 2300 Hz when the amplitude of the input facsimile signal is at minimum.

The adjust 1500 control is a potentiometer used to adjust the output frequency of the unit to 1500 Hz when the amplitude of the input facsimile signal is at maximum.

The 2300-1500 frequency indicator is used to indicate the proper frequency limits of the output audio-frequency-shift signal. The left half of the indicator closes when the output signal has a frequency of 2300 Hz, and the right half closes when the output signal has a frequency of 1500 Hz.

The gain of the amplifier is such that when the adjust 1500 control is set at the proper position, the audible level of the earphones will be comfortable.

When the power ON-OFF switch is in the OFF position, power is removed from the entire unit.

When operating the unit, turn the power switch on and allow a five-minute warmup period.

Turn the adjust 1500 control to the extreme clockwise position. When an incoming signal is being received, the 2300-1500 tuning-eye indicator will flicker; monitoring with the headphones will indicate when maximum and minimum levels are being received.

When the input signal to the modulator is maximum, adjust the "adjust 1500" control until the 1500 side of the frequency indicator closes.

When the input signal to the modulator is minimum, adjust the "adjust 2300" control unit until the 2300 side of the frequency indicator closes.

Because the adjust 2300 and adjust 1500 controls are interdependent, repeat the preceding two adjustments.

KEYER ADAPTER KY-44C/FX

Keyer Adapter KY-44/FX is designed to convert amplitude-modulated, audio-frequency facsimile signals into d.c. keying signals for use with frequency-shift exciter units in radio transmitter equipment. It can also be used as an unfiltered detector of amplitude-modulated signals, or as an audio line amplifier. All operational controls, switches, and meters are located on the front panel as shown in figure 5-8.

Keyer Adapter KY-44C/FX is rated to receive amplitude-modulated facsimile signals at levels from -20 to +6 dBm. The carrier frequency may be from 1500 to 7000 Hz and the modulation rate may be from 0 to 800 Hz.

The unit can amplify and detect the amplitude-modulated signal to give output levels up to 25 volts with minimum distortion.

Meters are provided to monitor the input and output signals. Controls are available on the front panel for selecting the type of output signal and for adjusting the output level. Provision is made on the terminal strip at the inside rear of the cabinet to permit grounding either side of the input and output signal lines.

The power source requirement is approximately 40 watts at 115 volts a.c., 60 Hz. With a minor change, the unit may be connected to operate from a 230-volt a.c. source.

The incoming amplitude-modulated facsimile signal, is fed through an rf filter to a multistage amplifier (fig. 5-9). An INPUT meter monitors the dB level of the incoming signal. The FILTER switch is normally in the OUT position. However, it may be thrown to the IN position to insert a bandpass filter after the rf filter, in case the incoming signal has excessive hum or noise. The signal level applied to the first

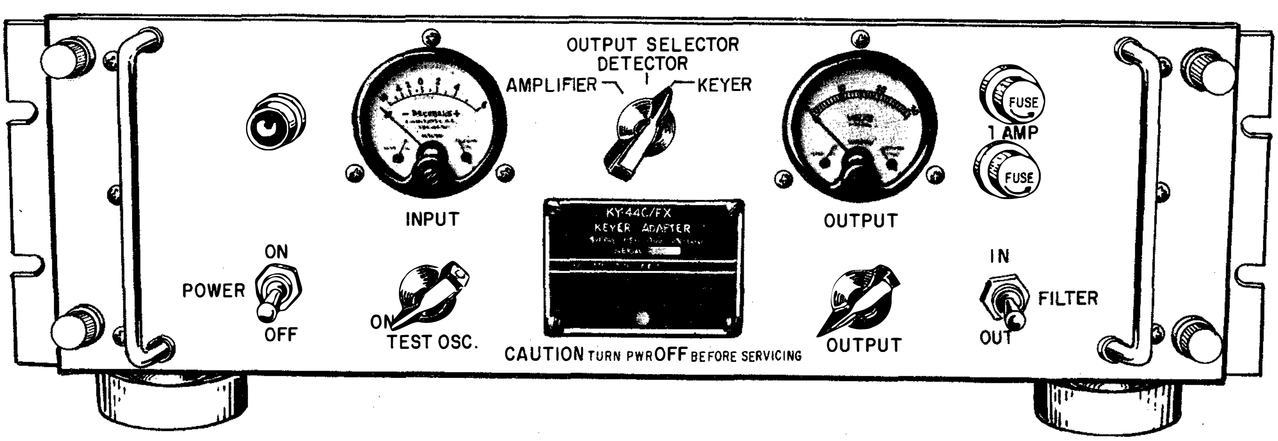

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Figure 5-8.—Keyer Adapter KY-44C/FX front panel.

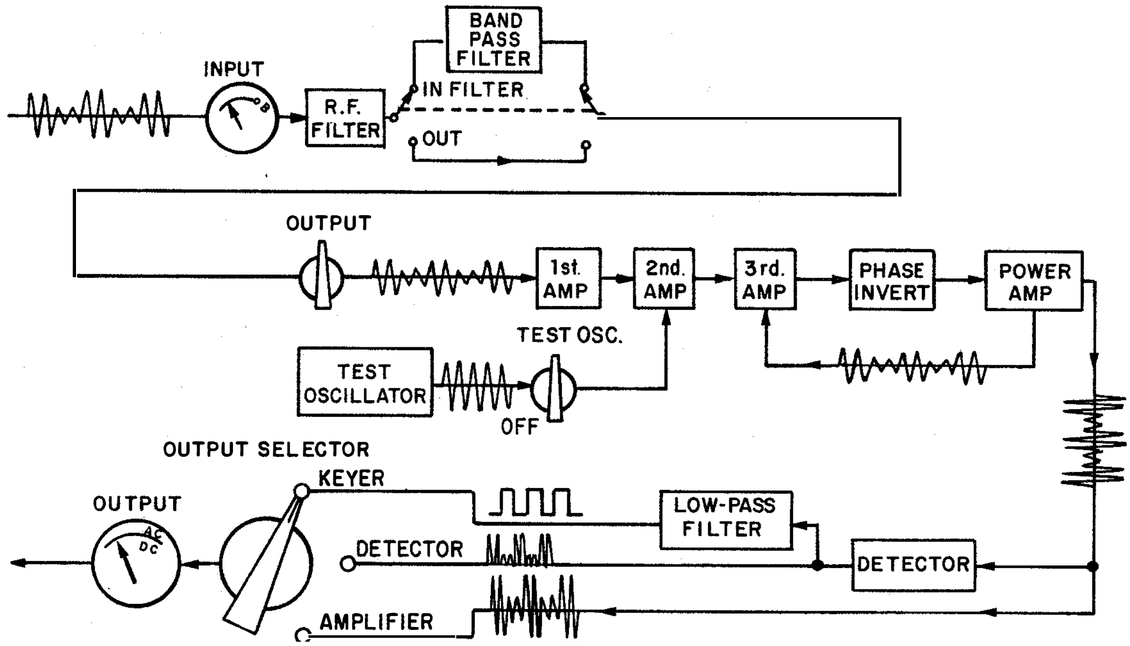

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Figure 5-9.–Keyer Adapter KY-44C/FX functional block diagram.

stage of the multistage amplifier is controlled by the OUTPUT control. After the signal is fed through three stages of voltage amplification, it is fed into a phase inverter to split the signal into two phases 180° apart for operating a push-pull power amplifier. Part of the output of the power amplifier provides degenerative feedback to the third stage for stability and good frequency response.

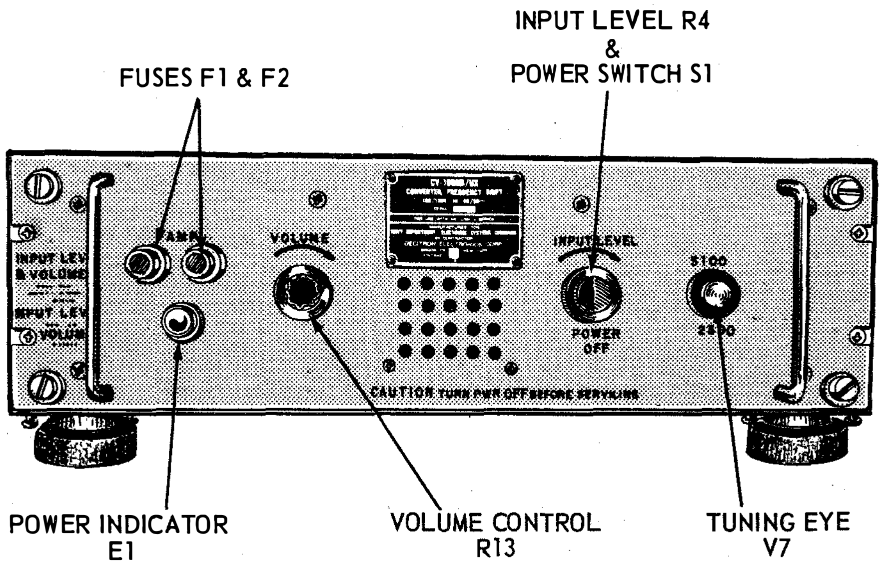
The output from the power amplifier is used according to the position of the OUTPUT SELECTOR switch. When the OUTPUT SELECTOR switch is in the AMPLIFIER position, the amplified facsimile signal is fed directly to the OUTPUT terminals. When the switch is in the DETECTOR position the facsimile signal is detected and fed, unfiltered, to the output terminals. In the KEYER position, the output from the detector is fed through a low-pass filter in order that the envelope of the amplitude-modulated facsimile signal may be fed to the output terminals.

For alignment purposes a test signal from an internal audio oscillator may be fed to the second stage. The TEST OSC control is used to turn on the audio oscillator and adjust for the desired output level. The frequency of the test oscillator is approximately 1800 Hz.

FREQUENCY-SHIFT CONVERTER CV-1066B/UX

Frequency-Shift Converter CV-1066B/UX converts AFTS signals to equivalent AM signals suitable for operating a facsimile recorder. Figure 5-10 shows the location of the converter controls and indicators and lists the function of each. After the controls have been set, operation of the converter is continuous and automatic.

The frequency-shift converter changes a frequency-shift signal between either 1500 to 2300 Hz or 2300 to 3100 Hz to an equivalent amplitude-modulated signal of the same frequencies. The amplitude of the radio receiver output varies as much as 40 dB. At the output of the converter, however, the amplitude of the 1500-Hz signal is fixed at approximately 0.4 volt



F1 & F2—1 AMP. A.C. LINE FUSES; E1—GLOWS WHEN CONVERTER IS ENERGIZED WITH A.C. POWER; R13—CONTROLS LEVEL OF SIGNALS MONITORED BY SPEAKER; S1—A.C. POWER SWITCH, GANGED TO INPUT LEVEL CONTROL; V7—MONITORS RECEIVED FACSIMILE SIGNALS; UPPER HALF OF EYE CLOSES ON 3100 Hz SIGNALS AND LOWER HALF CLOSES ON 2300 Hz SIGNALS

70.85

Figure 5-10.—Frequency Shift Converter CV-1066B/UX controls and indicators.

a.c. The 2300-Hz signal is fixed at approximately 0.1 volt a.c., and the amplitude of the 3100-Hz signal is fixed at approximately 0.025 volt a.c. Signals between the upper and lower frequency limits have corresponding and fixed levels below the 1500-Hz signal.

The difference in levels between the maximum signal (black) and the minimum signal (white), commonly referred to as contrast, is usually stated in dB. Thus, if the amplitudes at the output of the converter are 0.4 volts a.c. at 1500 Hz and 0.1 volt a.c. at 2300 Hz, then the voltage ratio of 0.25 (0.1 to 0.4) is equivalent to 12 dB of contrast.

$$dB = 20 \log \frac{E2}{E1}$$

where E1 equals the voltage at 1500 Hz and E2 equals the voltage at 2300 Hz.

The functional sections of the frequency-shift converter consist of an amplifier, limiter, frequency discriminator, frequency indicator, and power supply, as shown in figure 5-11.

The amplifier (fig. 5-11) amplifies the incoming signal to the level required to drive the limiter and the loudspeaker. The loudspeaker provides an audible indication of the presence of incoming signals and the functioning of the amplifier.

The limiter is placed between the input and output to provide a constant-amplitude reference for the facsimile signals. (Although the intelligence of the incoming signal is insensitive to amplitude variations, it does vary by a considerable degree.) If these variations were reflected in the output, which is sensitive to amplitude variations, noise would constantly appear in the output.

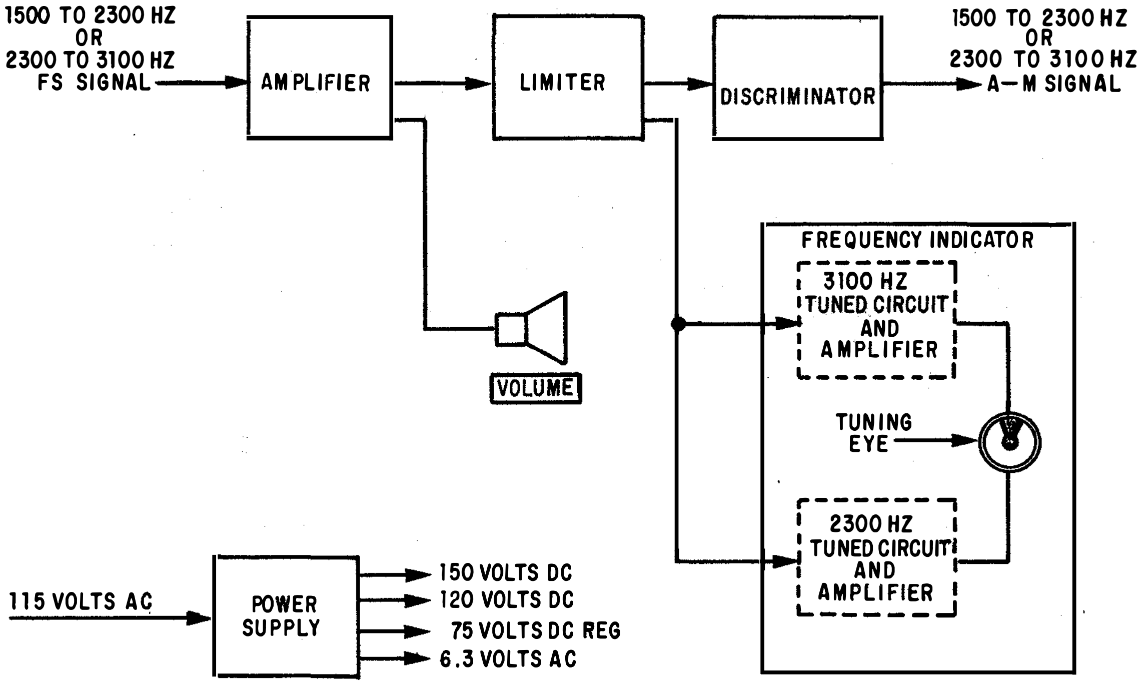


Figure 5-11.—Frequency Shift Converter CV-1066B/UX functional block diagram.

The frequency discriminator provides the contrast between the incoming frequency limits and converts them to AM signals. The frequency discriminator introduces a linear attenuation from approximately +12 dB at 1500 Hz to 0 dB at 2300 Hz to -12 dB at 3100 Hz.

The frequency indicator features a tuning eye which peaks at 2300 Hz and 3100 Hz. For the 2300- to 3100-Hz shift range, the tuning eye provides visual indication of both frequency limits, but the 1500- to 2300-Hz shift range can use only the 2300-Hz portion of the tuning eye as a visual indication.

The power supply provides operating voltages of 150 and 120 volts unregulated, and 75 volts regulated for the limiter section. In addition, the power supply furnishes filament voltages of 6.3 volts a.c.

FACSIMILE RECORDER SET AN/UXH-2B

Facsimile Recorder Set AN/UXH-2B (fig. 5-12) is a continuous-page facsimile recorder designed to make direct recordings of weather maps, tactical graphic information, sketches, and typewritten, printed, or handwritten data, transmitted over land lines or radio.

When receiving from a transmitter which sends the proper control signals, the recorder set will operate automatically. A control signal from the transmitter will start the recording and paper feed mechanisms. On receipt of phasing signals, the recorder unit will position the stylus needles so that the edge of the recorded copy is properly related to the edge of the paper. When copy signals are received, the stylus needles will print as the paper advances, the density of the recording being automatically adjusted to the desired level by the control circuits of the recorder. When the stop signal is received, the stylus needles stop, and the paper ceases to advance. The copy is legible as soon as it is recorded.

The equipment is operated manually when the transmitting station is not able to transmit

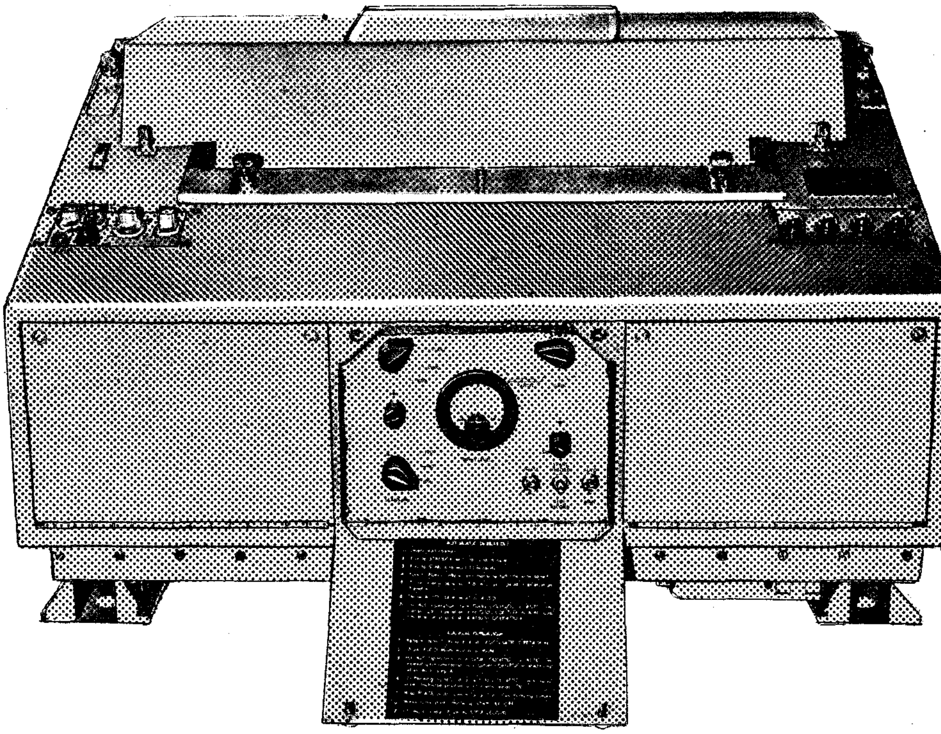


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Figure 5-12.—Facsimile Recorder Set AN/UXH-2B.

the necessary control signals. In manual operation the equipment is phased, the recording started and stopped by means of controls on the front panel.

In either automatic or manual operation, the operator may use a front panel DENSITY control to adjust the density of the printing. The operating controls are accessible by lowering the door in the front center of the set. These controls and their functions are shown in figure 5-13.

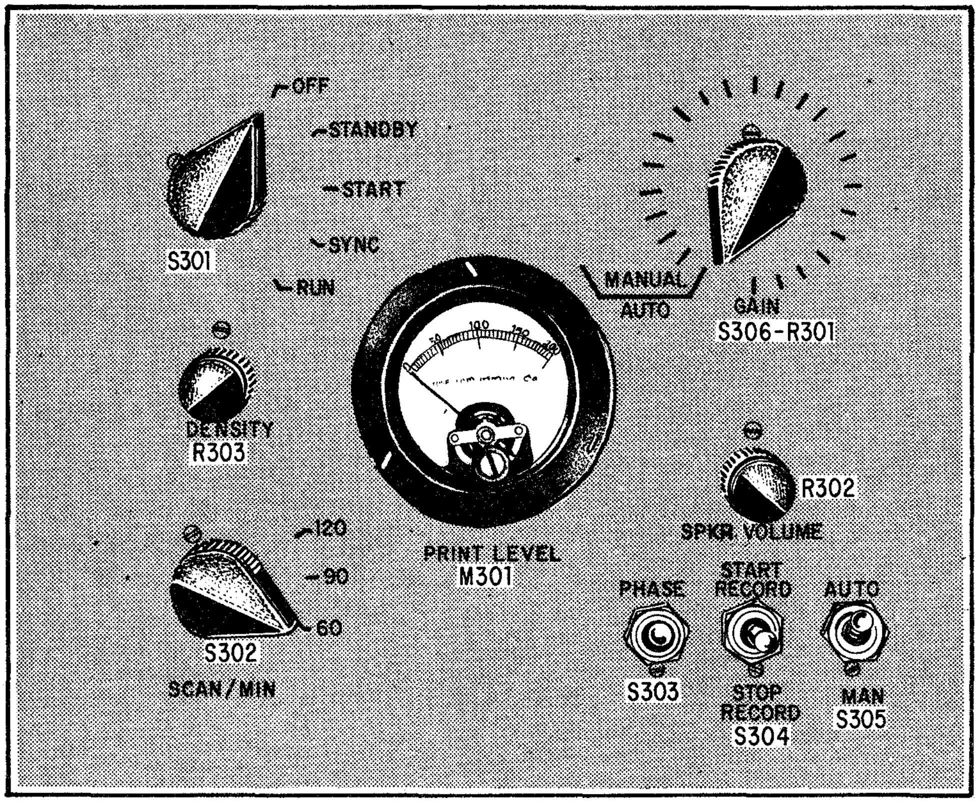
MAJOR UNITS

The AN/UXH-2B consists of three major units. These units are Electrical Control Amplifier AM-4218A/UXH-2A, the Facsimile Recorder R0-293/UXH-2B, and Power Supply PP-1901A/UXH-2, as shown in figure 5-14.

ELECTRICAL CONTROL AMPLIFIER

The incoming signal to the recorder appears across an input transformer in the signal amplifier. From the secondary the signal is fed through a GAIN control. If the GAIN control is in the AUTO position, the automatic level control (ALC) circuit will control the bias on the signal amplifier stages so that the bias will follow the maximum amplitude (black) signal. If the MANUAL position is selected, a fixed bias voltage is applied to the amplifier stages, and the GAIN control is used to control the output signal from the signal amplifier. The speaker amplifier is connected directly to the secondary of the input transformer and is independent of the other circuits. It is used to monitor the incoming signal.

The print amplifier consists of a driver stage and a class B push-pull stage. A contrast potentiometer is used to control the bias on the grids of the push-pull stage so that the tubes are cut off with no driving signal. The signal must be strong enough to overcome this fixed bias before any print power is obtained. This gives a threshold limiting effect, which eliminates the



S301--IN THE OFF POSITION POWER IS REMOVED FROM ALL SECTIONS OF THE RECORDER EXCEPT THE AUXILIARY POWER OUTLET; IN STANDBY POSITION POWER IS APPLIED TO B+, TUBE HEATERS, AND BIAS CIRCUITS; IN START POSITION B+ IS REMOVED FROM THE PRINT AMPLIFIERS AND VOLTAGE IS APPLIED TO THE START MOTOR; IN SYNC POSITION POWER REMAINS APPLIED TO START MOTOR AND POWER IS APPLIED TO THE SYNC MOTOR; IN RUN POSITION POWER IS REMOVED FROM THE START MOTOR AND SYNC MOTOR LOCKS INTO SYNCHRONOUS SPEED. R303--VARIES THE D.C. VOLTAGE ON THE SCREENS OF THE PRINT AMPLIFIERS TO CONTROL THE RECORDING DENSITY. S302--SELECTS THE SPEED AT WHICH THE RECORDER OPERATES, MUST COINCIDE WITH THE SCAN RATE OF THE TRANSMITTER. M301--INDICATES SIGNAL LEVEL AT THE PRINT AMPLIFIERS. S306-R301--ADJUSTS THE INPUT SIGNAL LEVEL TO THE PRINT AMPLIFIERS WHEN USE OF THE ALC CIRCUIT IS IMPRACTICAL. R302--CONTROLS THE VOLUME OF THE MONITORING SIGNAL FROM THE LOUDSPEAKER. S303--RELEASES PHASING MAGNET WHEN PHASING SIGNALS ARE BEING RECEIVED. S304--USED TO START OR STOP THE RECORDING. S305--SELECTS EITHER MANUAL OR AUTOMATIC OPERATION.

70.91

Figure 5-13.–Facsimile Recorder Set AN/UXH-2B operating controls.

signal transmitted by the background of the original copy.

During automatic operation the SELECTOR switch is in the RUN position and the AUTO/MAN switch is in the AUTO position. With no signals applied the machine is in the STANDBY mode. An incoming AM, 300-Hz start signal switches the machine into the PHASING mode. Phasing pulses consisting of the carrier at a black level, interrupted once per second by a change to the white level, are transmitted for 15 seconds. These phasing pulses are amplified and fed to the phase actuator. After phasing is completed, the start-record signal (the carrier signal modulated with 60 Hz)

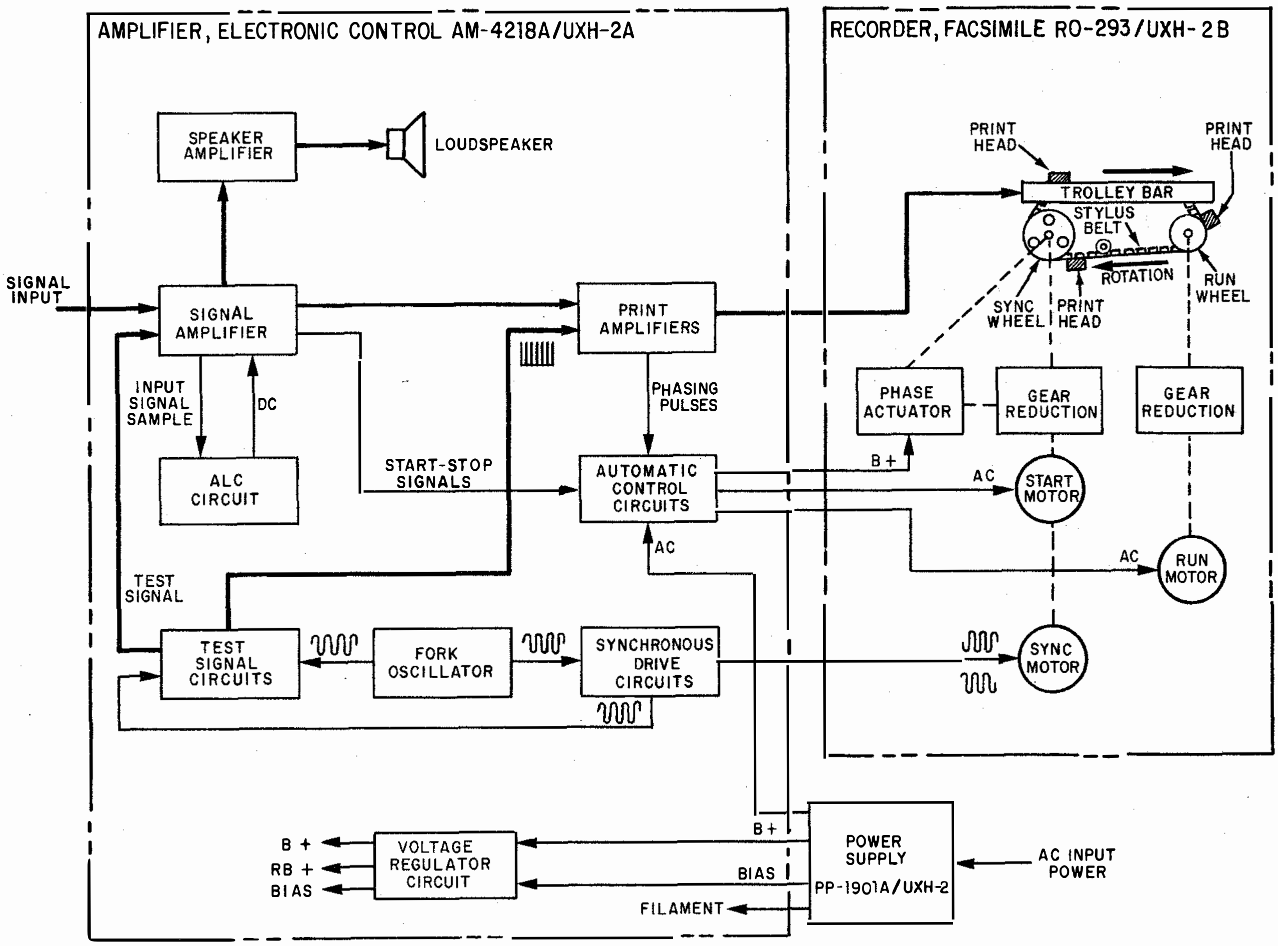


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Figure 5-14.—Facsimile Recorder Set AN/UXH-2B overall block diagram.

causes power to be applied to the run motor, keeps the phase actuator energized, and applies plate voltage to the push-pull stage of the print amplifier. At the end of the transmission, a stop signal (the carrier modulated with 450 Hz) is received and deenergizes the run motor and removes the plate voltage from the print amplifiers.

For manual operation the AUTO/MAN switch is placed in the MAN position, and the SELECTOR switch is in the RUN position. The machine is now in the STANDBY mode. When a phasing signal appears on the line, the operator activates the PHASE switch. The incoming phasing pulses are fed to the phase actuator. After three phasing pulses, the operator releases the PHASE switch. When the copy signals start, the operator momentarily moves switch S-304 to the START RECORD position. Power will be applied to the run motor, the phase actuator is kept energized, and plate voltage is applied to the print amplifier.

When the transmission is ended, the operator momentarily moves switch S-304 to the STOP RECORD position. Power is removed from the run motor, and plate voltage is removed from the print amplifier. An end-of-paper switch stops the recording mechanism and activates the END OF PAPER indicator when the supply of paper becomes exhausted. The 3600-Hz output of the tuning-fork oscillator is applied to a locked oscillator which can be locked at 1200 Hz, 900 Hz, or 600 Hz depending upon the setting of the SCANS/MIN switch. The output of the locked oscillator is amplified and used to drive the sync motor. The speed of the sync motor is directly related to the input signal frequency. For example, for 90 scans/min, the input frequency to the motor is 900 Hz and the motor speed is 900 rpm.

Two test circuits are used in the AN/UXH-2B Recorder. One circuit simulates the control tone signals that would be sent by an automatic transmitter. A second circuit supplies a test signal to the print amplifiers for use during stylus indexing adjustments. The transmitter control signals are simulated by the use of four switches (located on the electrical unit chassis) marked STEADY, START, RECORD, and STOP. The carrier signal for the tests is the 3600-Hz output of the tuning-fork oscillator.

The start-stop test oscillator is tuned to either 300 or 450 Hz depending upon the test switch used. The 60-Hz, start-record signal is obtained directly from the filament supply. The 3600-Hz carrier signal is not modulated when the STEADY button is pressed, and is modulated by 300 Hz, 450 Hz, or 60 Hz when the START, STOP, or RECORD button is pushed. The output of this test circuit is applied to the signal amplifier.

The CHOPPER test switch operates in conjuction with a relaxation oscillator to provide a test signal input to the print circuits. The input for the oscillator is obtained from the sync drive circuits. The input signal synchronizes the relaxation oscillator at the selected motor drive signal (600, 900, or 1200 Hz). The output from the relaxation oscillator consists of a series of spikes that are fed to the print amplifier. These spikes correspond to a black signal from the transmitter and, when recorded, produce a series of black vertical lines on the recording paper.

FACSIMILE RECORDER

Facsimile Recorder RO-293/UXH-2B records by means of three stylus needles mounted on a rubber belt that is driven by two pulleys. As the pulleys rotate, the stylus needles (one at a time, at sync speed) move across the recording paper while the paper feeds from a roll in a direction perpendicular to the stylus movement. The two wheels in figure 5-15 serve as pulleys for the rubber stylus belt that conveys the stylus needles across the recording paper. The run wheel, which is geared to the run motor, drives the stylus belt assembly. Both the run and sync wheels have indentations which engage the teeth of the stylus belt, thus giving positive coupling between the run and sync wheels. In addition, an idler wheel, located between the sync and run wheels, maintains the stylus belt at the proper tension.

The mechanical unit consists of four functional sections: the sync mechanism, run mechanism, stylus belt assembly, and paper feed assembly.

The sync mechanism acts as a governor to control the speed of the stylus needles. It is coupled to the stylus belt through a unidirectional drive assembly, which allows the sync motor to rotate even when the stylus belt is stationary. The sync motor is not self-starting but is brought up to speed by a start motor, the rotor of which is keyed to the sync shaft.

The run mechanism drives the belt above the synchronous speed, until it catches up with the unidirectional drive assembly in the sync mechanism. The stylus needles are then maintained at sync speed by the sync motor.

The stylus belt assembly consists of a rubber belt on which are mounted three electromagnetic print heads. The print head mounted on the moving stylus belt rides on two trolley rails placed in front of the paper. These rails guide the print head to provide the proper line structure, space the print head in relation to the paper feed roller, and act as conductors to supply power to the print head through inside contact wipers. The stylus needle, which is held in place in the print head by a retaining spring, consists of an iron plunger with a free-rolling, carbide-tungsten ball mounted on its forward face. The stylus is free-floating and strikes the

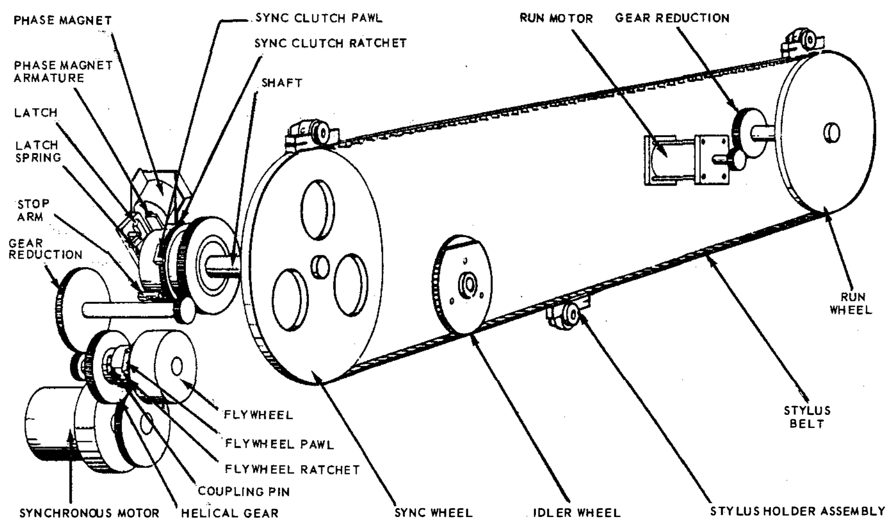

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Figure 5-15.—Synchronous drive and run system.

surface of the pressure-sensitive recording paper, backed up by a steel feed roller, when the magnet is energized.

The paper feed assemblies hold the rolls of recording paper and feed the paper past the stylus needles. A gear train couples the paper feed assembly to the run motor to maintain the proper relationship between the rate of paper feed and the stylus speed.

POWER SUPPLY

The power supply circuit consists of Power Supply PP-1901A/UXH-2 and the regulated (RB+) and bias voltage regulators contained in the electronic control amplifier unit. The power input voltage is 115 or 230 volts, 60 Hz, single phase. B+ voltage consists of unregulated 400 volts d.c. The bias supply circuits furnish -105 volts to the bias voltage regulator. The voltage regulator circuit in the electronic control amplifier unit provides regulated B+ voltage (RB+) of 225 volts d.c. and the four regulated bias voltages needed for the operation of the equipment. If the bias voltage supply should fail, the regulator circuit will reduce RB+ to a low value for the protection of the print and sync amplifier circuits.

CHAPTER 6

SATELLITE COMMUNICATIONS

Experience with satellite communications has demonstrated that such systems can satisfy many military requirements for reliable, high capacity, secure, and cost effective telecommunications.

Satellites are the ideal, if not the only solution to problems of communicating with highly mobile forces deployed worldwide.

Satellites, if properly used, provide an independent alternative to large, fixed ground installations.

For the past 50 years, the Navy has used high frequency (hf) transmission as its principal method of sending messages. In the 1970's, an era when the hf spectrum was overcrowded, when "free" frequencies were at a premium, and when hf jamming techniques were highly sophisticated, the need for new and advanced long-range transmission methods became readily apparent.

Communications via satellite is a natural outgrowth of modern technology and the continuing demand for greater capacity and higher quality communications. Relatively recent technical developments have made satellite communications possible.

Although the communications facilities of the various military departments have generally been able to support their requirements in the past, predictable requirements indicate that large-scale improvements will have to be made to satisfy future needs of the Department of Defense. The usage rate of both commercial and military systems has increased by at least 10 percent per year over the past 15 years, and there appears to be general agreement that this trend will continue at an accelerated rate. Centralized control of military operations, with its accompanying reliability and security requirements, has generated demands for communications with greater capacity and for long-haul communications to previously inaccessible areas. Some of these requirements can be met only by sophisticated modulation techniques and wideband, long-distance transmissions, for which satellite communications is the most promising means.

A BASIC SATELLITE COMMUNICATION SYSTEM

A satellite communication system is one that uses Earth-orbiting vehicles or satellites to relay radio transmissions between Earth terminals. There are two types of communication satellites: active and passive. A passive satellite merely reflects radio signals back to Earth. An active satellite, on the other hand, acts as a repeater; it amplifies signals received and then retransmits them back to Earth. This increases the signal strength at the receiving terminal compared to that available from a passive satellite.

A typical operational link involves an active satellite and two Earth terminals. One station transmits to the satellite on a frequency called the up-link frequency, the satellite amplifies the signal, translates it to the down-link frequency, and then transmits it back to Earth where the signal is picked up by the receiving terminal. This basic concept is illustrated by figure 6-1 which shows several types of Earth terminals.

The basic design of a satellite communication system depends to a great degree upon the parameters of the satellite's orbit. In general terms an orbit is either elliptical or circular and its inclination is classified as

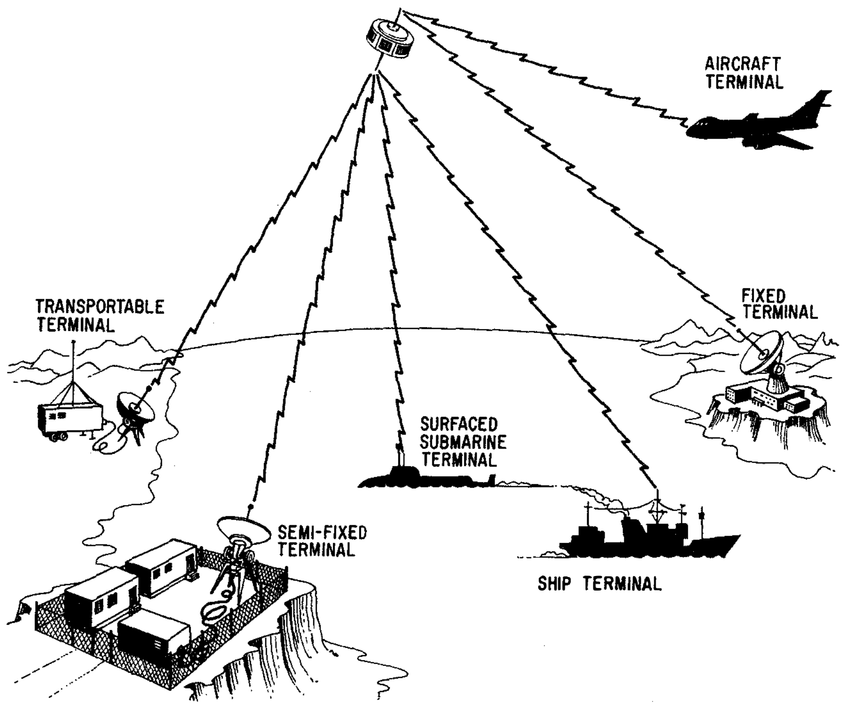

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Figure 6-1.—Satellite communication system.

inclined, polar, or equatorial. A special type of orbit is a synchronous orbit, one in which the period of the orbit is the same as that of the Earth's.

The essential basic system components of an operational communication satellite system are (1) an orbiting vehicle with a communication receiver and transmitter installed and (2) two Earth terminals equipped to transmit signals to and receive signals from the satellite. The design of the overall system determines the complexity of the various components and the manner in which the system operates.

FLEET SATELLITE COMMUNICATIONS

The Fleet Satellite Communication (FLTSATCOM) System provides communications links, via satellite, between designated mobile units and shore sites. The area of coverage for these communications links is worldwide, between the latitudes of 70° N and 70° S. Four satellites in synchronous orbit are located at 23° W, 75° E, 172° E, and 100° W longitude. The system includes rf terminals, subscriber subsystems, training, documentation, and logistic support. Within each satellite, the rf channels available for use have been distributed between the Army, Navy, and the Air Force.

The impact of the FLTSATCOM System upon naval communications may be understood when it is realized that equipment installations in support of this system is being placed on 44 types of ships, two types of submarines, P-3C aircraft, and 36 shore stations. These equipment installations vary in size and complexity, depending on the communication requirements at each installation. Furthermore, with the exception of voice communications, the system applies the technology of processor (computer) controlled rf links and employs the assistance of processors in message traffic preparation and handling.

Although any part of the FLTSATCOM System may be operated as a separate module, the system integration provides connections for message traffic and voice communications to DOD communication networks. Backup capability that can be used in the event of an outage is provided between shore stations. This is built in as part of the system design. This backup capability is limited to selected FLTSATCOM subsystems and the ability of shore stations to access various satellites.

The FLTSATCOM System represents a composite of information exchange subsystems that use the satellites as a relay for communications. Each subsystem has been designed to address a selected area of naval communications. The following subsystems comprise the Navy's portion of the FLTSATCOM system.

- Fleet Satellite Broadcast (FSB) Subsystem. This subsystem is an expansion of Fleet Broadcast transmissions which historically have been the central communications medium for operating Naval units.

- Common User Digital Information Exchange Subsystem (CUDIXS)/Naval Modular Automated Communication System (NAVMACS). These two installations (CUDIXS/NAVMACS) combine to form a communications network that is used for transmission of general service message traffic between designated ships and shore installations.

- Submarine Satellite Information Exchange Subsystem (SSIXS). The SSIXS complements existing communications links between SSBN and SSN submarines and shore terminals.

- Anti-submarine Warfare Information Exchange Subsystem (ASWIXS). This subsystem is designed as a communications link for ASW operations.

- Tactical Data Information Exchange Subsystem (TADIXS). This is a direct communications network between command centers ashore and afloat.

- Secure Voice Subsystem. This is a narrowband uhf link that enables voice communications between ships and connection with wide-area voice networks ashore.

- Tactical Intelligence Subsystem (TACINTEL). This subsystem is specifically designed for special intelligence communications.

- Control Subsystem. This subsystem is a communication network that facilitates status reporting and management of FLTSATCOM System assets.

The installation of subsystem baseband equipment and rf terminals aboard ships and aircraft is determined by communications traffic levels, types of communications, and operational missions. Fleet Satellite Broadcast message traffic, being a common denominator for naval communications, will be received by 44 different types of ships. In some installations, such as large ships, the Fleet Broadcast receiver represents one part of the FLTSATCOM equipment suite. A typical suite on a large ship would include Fleet Broadcast, NAVMACS, Secure Voice, and TACINTEL equipment.

SHORE BASED TERMINALS

The installation of FLTSATCOM equipment at shore terminals has been structured by use of existing naval communications centers and the geographical locations of command and operations centers. Four Naval Communications Area Master Stations (NAVCAMS) bear prime responsibility, in selected geographical areas, for naval communications on FLTSATCOM satellites. These stations are:

- NAVCAMS LANT, Norfolk, Virginia
- NAVCAMS MED, Bagnoli, Italy
- NAVCAMS WESTPAC, Finegayan, Guam
- NAVCAMS EASTPAC, Wahiawa, Hawaii

Ten NAVCOMMSTAs are used to retransmit Fleet Satellite Broadcast message traffic via hf links. These COMMSTAs are located in:

Greece	Australia
Spain	Japan
United Kingdom	Philippines
Puerto Rico	Alaska
Diego Garcia	Iceland

The FLTSATCOM equipment installations address the unique requirements of the user. Each subsystem installation consists of two parts: the baseband equipment that is used for collecting and controlling the transmitted or received communications, and the rf terminal that is used by the subsystem.

Current Operations

Fleet Broadcast message traffic is currently being transmitted on uhf via the Gapfiller satellites (explained later) that are positioned in synchronous orbit over the Atlantic, Pacific, and Indian Oceans. Simultaneously, the Fleet Broadcast message traffic is also being rebroadcast on existing hf links. The Naval Communication Processing and Routing System (NAVCOMPARS), which is operational at all locations, is being used to compile and establish a precedence for this message traffic prior to transmission.

With insertion of FLTSATCOM satellites into orbit, the Fleet Broadcast message traffic will be switched over from transmission via Gapfiller satellites to transmission via the FLTSATCOM satellites. When this switchover occurs, no changes to the rf equipment, other than frequency selection and switching (patching), will be effected.

SUBSYSTEMS

The subsystems that comprise the FLTSATCOM System are the:

- Fleet Satellite Broadcast Subsystem (FSB)
- Common User Digital Information Exchange Subsystem (CUDIXS)/Naval Modular Automated Communication System (NAVMACS)
- Submarine Satellite Information Exchange Subsystem (SSIXS)
- Anti-submarine Warfare Information Exchange Subsystem (ASWIXS)
- Tactical Data Information Exchange Subsystem (TADIXS)
- Secure Voice Subsystem
- Tactical Intelligence Subsystem (TACINTEL)
- Control Subsystem

These subsystems, with the exception of the Secure Voice and Control subsystems, apply some form of automated control to the communications being transmitted. This control includes message or data link processing, before and after transmittal, and control of the rf network (link control) in which they are being transmitted. The automation of these functions is handled by a processor. Much of the message processing prior to transmission and after receipt is fully automatic and does not require operator intervention. The actual message or data link transmissions are fully automated and under the control of a processor.

All subsystems have some form of backup mode, either from backup equipment/systems, facilities, or rf channels. Within the limitations of equipment capability, each subsystem has addressed the unique requirements of the user and the environment in which the user operates. The following data is intended to provide a basic understanding of the Fleet Satellite Broadcast Subsystem (FSB) and the CUDIXS/NAVMACS.

FLEET SATELLITE BROADCAST SUBSYSTEM

The Fleet Satellite Broadcast Subsystem (fig. 6-2) will provide the capability to transmit Fleet Broadcast message traffic in a high level jamming

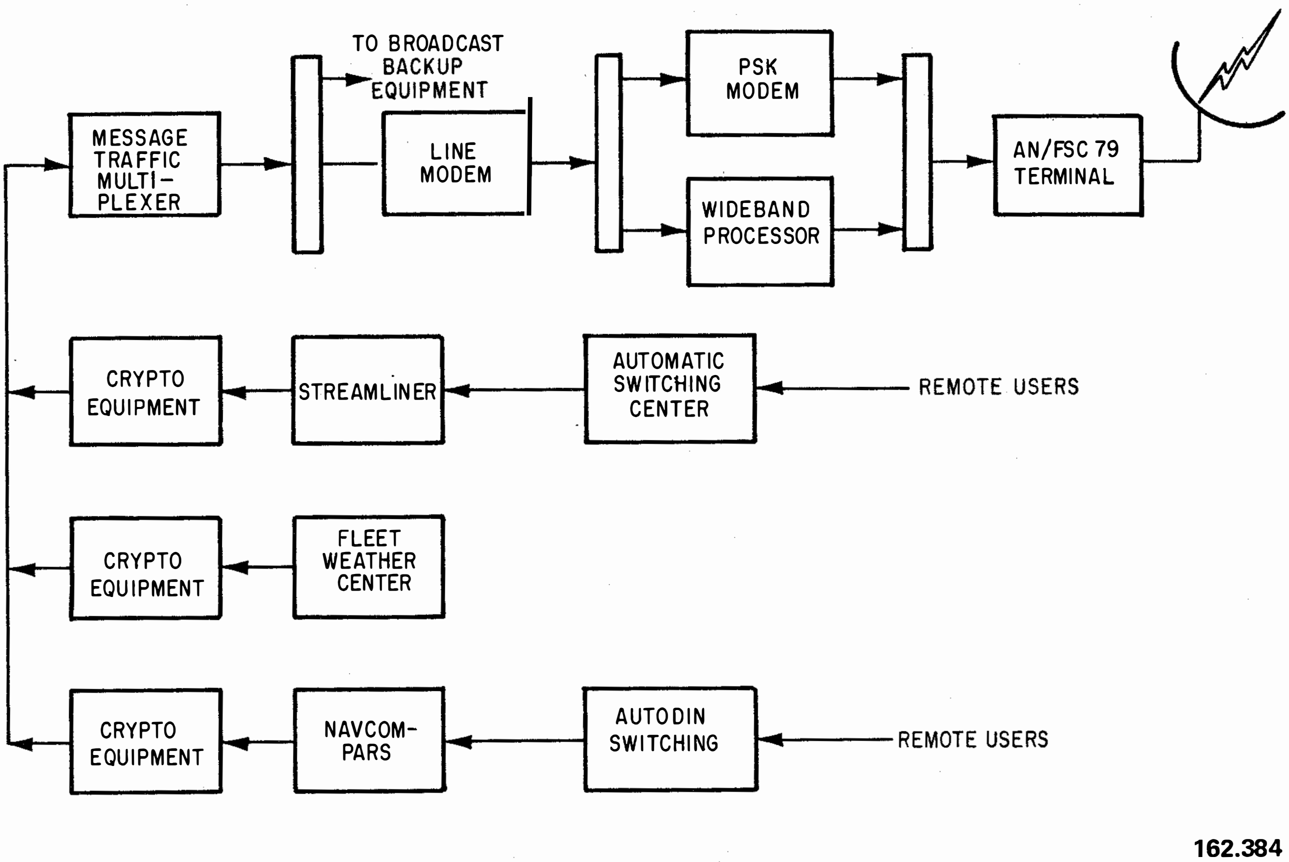

Figure 6-2.—Fleet Satellite Broadcast Subsystem.

environment. The subsystem provides 15 subchannels of covered message traffic. These 15 subchannels are time division multiplexed and transmitted in a one-way shf transmission to the satellite. At the satellite, the transmission is translated from shf to uhf for transmission on the down link to the subscriber.

Message Traffic

The Fleet Broadcast message traffic is arranged and/or channelized prior to transmission by two processor controlled message switching systems. These systems are the Naval Communication Processing and Routing System (NAVCOMPARS), for general service message traffic, and Streamliner, for special intelligence message traffic. Fleet weather data, which are also transmitted on Fleet Broadcast, are input to the transmission by teletype from Fleet Weather Center.

General Service Message Traffic

General service message traffic (fig. 6-3) can be read into the NAVCOMPARS processor by over-the-counter facilities at the NAVCAMS/NAVCOMMSTA, or automatically input to the processor when the message traffic has been sent from an automatic digital information network (AUTODIN) switching center. The output of the NAVCOMPARS, which is general service message traffic, is fed to crypto equipment for encryption. The crypto equipment provides an output of 75 bps (bits per second), which is sent to a message traffic multiplexer for conversion to a 1200 bps signal.

Streamliner

The Streamliner (fig. 6-4) uses basically the same format as the general service message

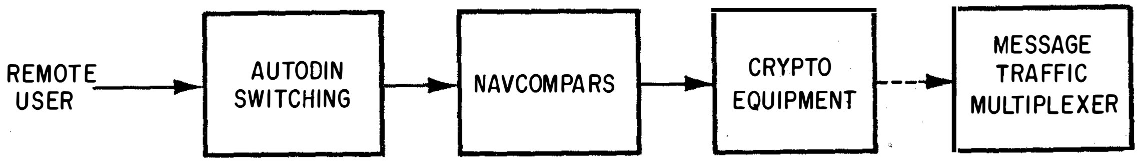

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Figure 6-3.—General service message traffic.

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Figure 6-4.—Special intelligence message traffic.

traffic except it is designated for special intelligence messages. The output of this system is also 75 bps. It is fed to a message traffic multiplexer and converted to a 1200 bps rate.

Fleet Weather

The Fleet Weather Center (fig. 6-5) produces fleet weather data which is put on a teletypewriter or a punched tape reader. This information is then passed on to crypto equipment where it is encrypted. The output of the crypto equipment, with a 75 bps rate, is passed on to the message traffic multiplexer.

RF Transmission

Two frequency bands, shf and uhf, are available for Fleet Broadcast transmission. The shf band uses the AN/FSC-79 Satellite Communications Terminal and the uhf band uses the AN/WSC-5(V) Transceiver for backup operation. All other FLTSATCOM subsystems are transmitted only in the uhf band.

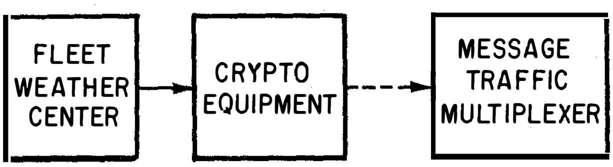

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Figure 6-5.—Fleet weather traffic.

During normal operation, using the AN/FSC-79 Satellite Communications Terminal (fig. 6-6), the output of the message traffic multiplexer is fed to a patch panel where it can be routed to either the backup transceiver or to a line modem (modulator/demodulator). The output of the line modem is fed to another patch panel where selection can be made for the signal to go to either the PSK (phase-shift keying) modem or the wideband processor. Another patch panel selects the output of the PSK modem or the wideband processor for transmission by the AN/FSC-79. The output of the AN/FSC-79 is an shf signal, transmitted to the satellite. At the satellite, this shf signal is converted to a uhf signal for retransmission as the down-link signal.

CUDIXS/NAVMACS

This FLTSATCOM subsystem is divided into two major elements:

- Common User Digital Information Exchange Subsystem (CUDIXS)

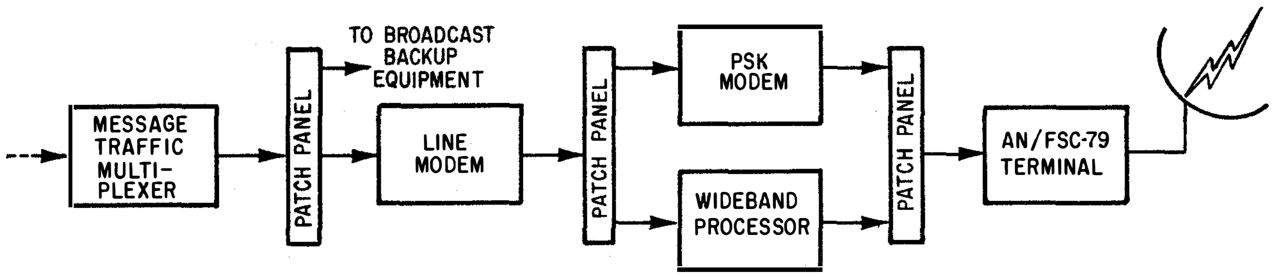

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Figure 6-6.—AN/FSC-79 Satellite Communications Terminal.

- Naval Modular Automated Communications Subsystem (NAVMACS)

Collectively, these two subsystems will provide improved ship-to-shore and shore-to-ship operational communications over what was previously available with hf communications.

General Information

The NAVMACS (V) (fig. 6-7) is a shipboard message processing system that automatically guards as many as four broadcast channels, serves as an automated shipboard terminal for the CUDIXS, and provides accountability for all incoming and outgoing messages. It is intended to serve the message processing needs of small to medium size ships of the fleet.

The NAVMACS (V) consists of software, operator personnel, and the following equipment.

NAVMACS (V) PROCESSOR.—This processor is a general purpose digital computer with 65,536 words of memory.

75-2400 BAUD PRINTERS (2).—These printers are used to print headings and the text of incoming messages and operator requested reports.

CONTROL TELETYPE.—This teletype is used by the operator to control system operation.

MAGNETIC TAPE CARTRIDGES.—These cartridges are used for loading the computer program.

HIGH SPEED PAPER TAPE READER/PUNCH.—The reader is used for inputting outgoing messages. The punch is used as an output device for operator requested retrievals of messages and off-line encrypted messages.

75 BAUD PAPER TAPE PUNCH.—This punch is used as a backup for the high-speed tape punch.

75 BAUD PAPER TAPE READER.—This reader is used as a backup for the high-speed tape reader.

The computer interfaces with the CUDIXS link through an interconnection group and with the broadcast channels through a converter or switchboard.

The operator communicates with the system via the control teletype. Using the control

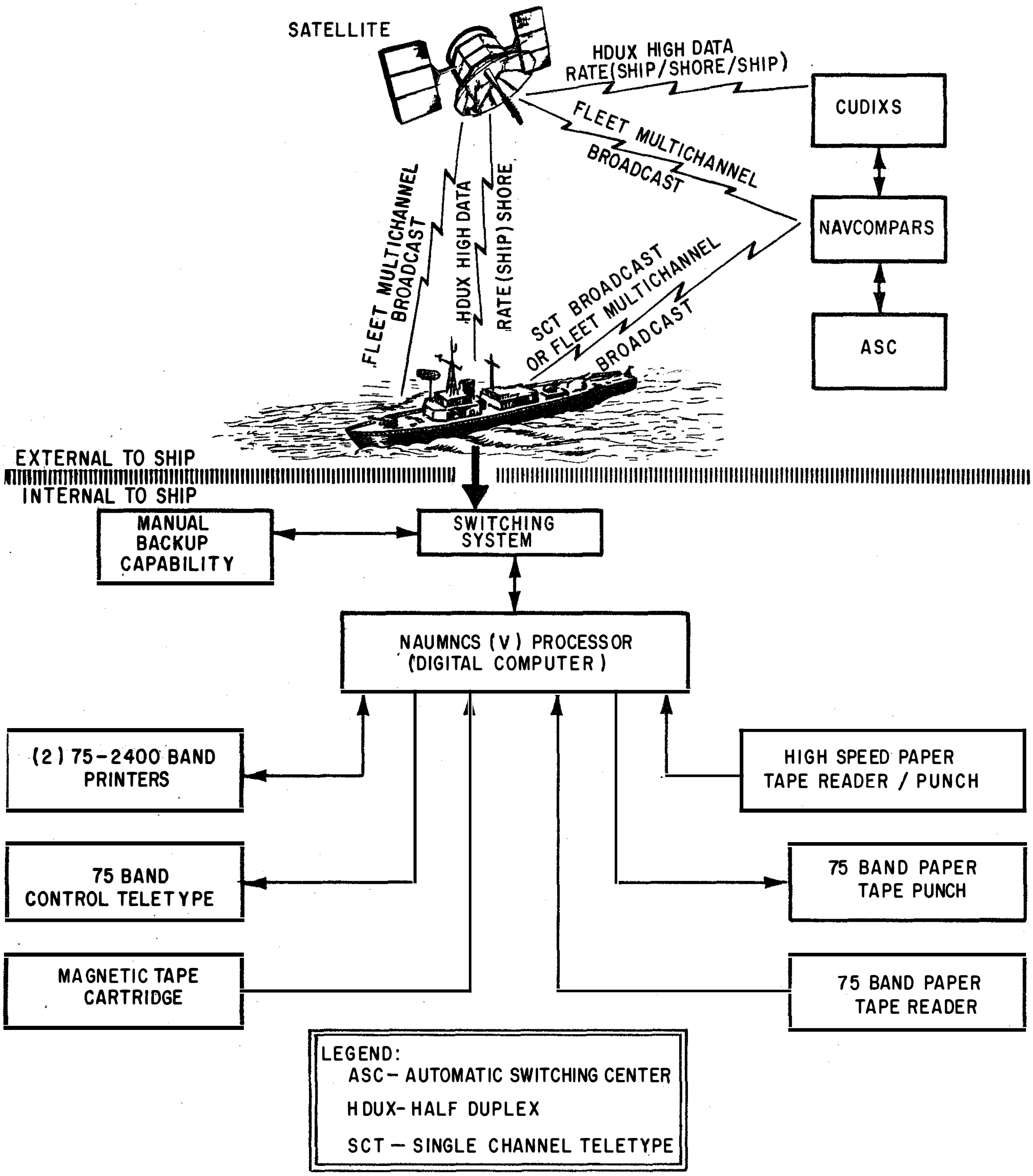

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Figure 6-7.—NAVMACS (V) communications interface.

teletype, the operator instructs the system concerning major operational functions. These functions include identifying: wanted messages, broadcast channels to be guarded, the status of the CUDIXS link, and the status of the equipment.

Operation

The NAVMACS (V) reads the headings of incoming broadcast message traffic and separates those messages addressed to the ship or commands for which it is guarding. The system compares every addressee on each incoming first-run message against entries in its command guard list (CGL). The CGL contains those addresses for which the ship is guarding. When the system finds one or more matches between addresses on the first-run message and the entries of the CGL, the message is printed (copied) completely on a line printer. If an Emergency or Flash precedence message (which could affect everyone in the system) or a first-run message is received, it is printed completely regardless of whether or not a match is found. When a match is not found with the CGL for a message having a precedence lower than Flash, only the heading of the message is printed.

CUDIXS LINK TRAFFIC

The CUDIXS is a high-speed, half-duplex, automated digital communications network using a satellite channel. Communication is between a shore-based network control station (NCS) and subscribers (ships). The NCS accepts and relays messages. There are two types of CUDIXS subscribers, a Primary Subscriber which can send narrative message traffic to the NCS, and a Special Subscriber which can send or receive narrative message traffic to or from the NCS. Narrative message traffic refers to usual naval teletype messages as opposed to computer-to-computer control messages and operator-to-operator (order wire) messages. Information exchange is computer controlled at both the NCS and the shipboard subscriber terminals. NAVMACS (V) provides computer control for either type of shipboard subscriber.

SATELLITES

Leased satellites will be used during the early phase of operation. This use of commercial satellites for Navy communications will continue after the first FLTSATCOM satellites have been launched. The uhf section of the leased satellites has been leased to the Navy for communications. The FLTSATCOM satellites have both shf and uhf capabilities. For the purpose of management and control of communications on these uhf channels, the leased satellites have been given the name Gapfiller by the Navy.

GAPFILLER SATELLITE

As mentioned earlier, this satellite is a leased commercial satellite to be used in conjunction with the FLTSATCOM satellites.

The spacecraft (fig. 6-8) is 381 centimeters high and 215.90 centimeters in diameter; at launch the weight is 655.44 kilograms. It is spin stabilized with a despun, Earth-oriented antenna. (When in orbit, the body of the

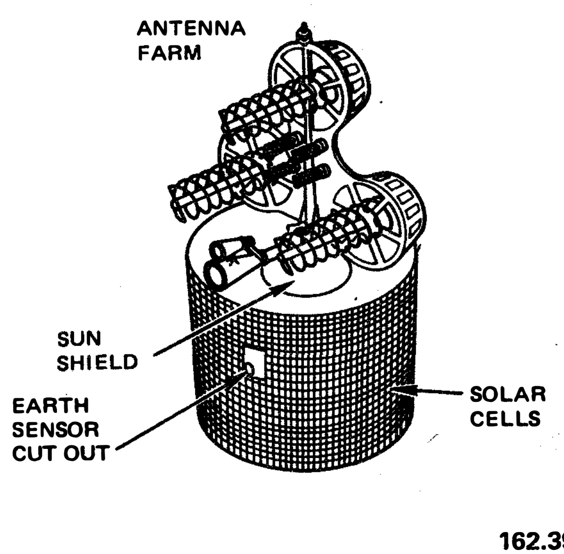

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Figure 6-8.—Gapfiller satellite.

satellite spins at approximately 100 rpm for the purpose of stability, while the antenna remains directed back toward Earth.)

FLTSATCOM SATELLITE

The FLTSATCOM satellite (fig. 6-9) is considerably larger and heavier than the Gapfiller satellite. The estimated spacecraft weight at launch is 1859.73 kilograms. It consists of two major parts: a payload module that includes the antennas, and a spacecraft module with a solar array. The payload module consists of the uhf, shf, and S-band communications equipment, and antennas. Other subsystem equipment contained in the spacecraft includes the Earth sensors, attitude and velocity control, telemetry, tracking and command, and electrical power and distribution. The spacecraft is stabilized on three axes, with the body-fixed antennas kept pointed at the center of the Earth. The solar array is kept pointed at the Sun.

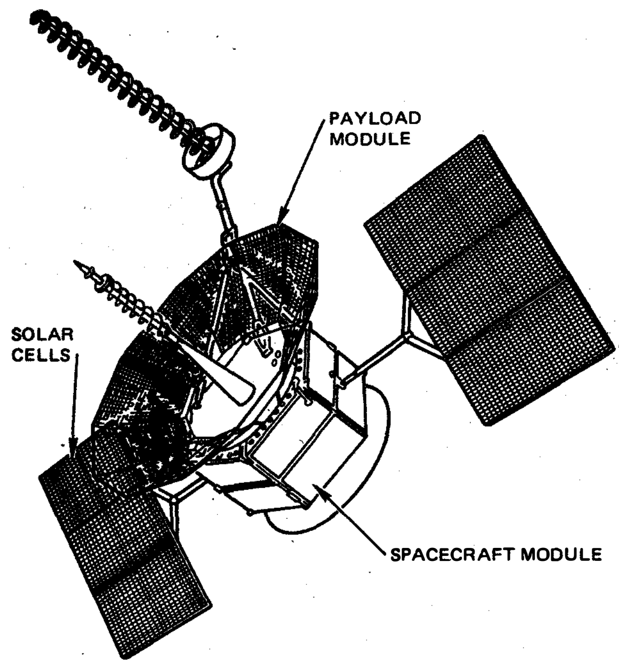

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Figure 6-9.—FLTSATCOM satellite.

CHAPTER 7

MAINTENANCE OF COMMUNICATIONS SYSTEMS (PART 1)

Maintenance of communication systems consists of performing the periodic tests, inspections, and other preventive maintenance procedures (as prescribed by the Planned Maintenance Subsystem) and the troubleshooting and repair of equipment. This chapter presents information relating to inspecting, cleaning, and lubricating communication equipment, and the maintenance of communication antennas. Also discussed are communication receiver sensitivity and bandwidth measurements.

The next chapter, MAINTENANCE OF COMMUNICATION SYSTEMS, PART 2, discusses troubleshooting communication systems.

INSPECTING, CLEANING, AND LUBRICATING

A regular schedule of inspection, cleaning, and lubricating must be carried out on a continuing basis to ensure trouble-free operation of communication and other types of electronic equipment. When making inspections, check for cleanliness of equipment interior and all areas around, behind, and under cabinets and consoles. Dust, dirt, and other foreign matter should not be tolerated.

Dirt and other foreign matter, if allowed to collect on heat dissipating parts, act as thermal insulation, which prevents internally created heat from dissipating into the air. When this happens, the electronic parts affected operate at abnormally high temperatures. This condition shortens the life of the parts and causes a breakdown of the equipment itself. Periodic cleaning of the interior of radio transmitters and other equipment using high voltage is particularly important due to the attraction of dust particles by the high voltage circuits. Potentials in excess of 3000 volts are often present in this equipment, and dust on insulators or other high voltage parts forms a convenient path for arc-overs. In addition, a mixture of dust and lubricant forms an abrasive which can do considerable damage to moving parts.

Periodic lubrication is required for most moving mechanical parts of electronic equipment. Failure to lubricate or improper lubrication (such as using the wrong type of lubricant or overlubricating) shortens the life of the moving parts or parts concerned and may cause damage to other parts or circuits. Lubrication must be performed as specified by the Maintenance Requirement Card (MRC) for the specific equipment concerned or by the equipment technical manual. An MRC for a communications antenna coupler group is shown in figures 7-1A and 7-1B.

PRECAUTIONS

Care must be exercised when cleaning electronics equipment to avoid damage to the equipment parts and injury to personnel. Steel wool or emery cloth must NOT be used for cleaning. When using a vacuum cleaner, use one with a nonmetallic nozzle. Use solvents for cleaning only when absolutely necessary. When using solvents (such as trichloroethane), the following precautions must be observed:

1. Use only in well ventilated spaces. A portable blower, wind chute, or wind scoop may be used to blow fresh air into the space.
2. Do not work alone when using solvents.

SYSTEM	COMPONENT	M. R. NUMBER	
Communication and Control	OA-4794,4794A/ SRA-34(V) Antenna Coupler Group	C-344 A-1	
SUB-SYSTEM	**RELATED M. R.**	**RATES**	**M/H**
Radio Communication	M-1	ET3	1.0

M. R. DESCRIPTION

1. Clean, inspect, and lubricate antenna coupler group.

TOTAL M/H 1.0

ELAPSED TIME: 1.0

SAFETY PRECAUTIONS

1. Observe standard safety precautions.
2. Short across all capacitors to electrical ground, using a shorting probe.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Vacuum cleaner with non-metallic nozzle
2. 1" Soft-bristle brush
3. Warning tag
4. Shorting probe
5. Clean, lint-free rag
6. Grease, MIL-G-7421
7. No. 2 Phillips screwdriver
8. 6" Normal duty screwdriver
9. Grease brush

PROCEDURE

1. Clean, Inspect, and Lubricate Antenna Coupler Group.
   a. Set electrical equipment cabinet POWER switch at OFF.
   b. Turn OFF and tag main power distribution switch.
   c. Loosen captive screws on lower front panel and open panel.
   d. Short across all capacitors to electrical ground, using a shorting probe.
   e. Wipe accessible surfaces with a clean rag.
   f. Use brush to remove dust and dirt from areas not easily accessible.
   g. Remove remaining dust and dirt with a vacuum cleaner.
   h. Inspect interior of equipment. Look for bulged or leaking capacitors, discolored, or scorched resistors, cracked or frayed insulation, and loose connections.
   i. Close lower front panel and tighten captive screws.

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Figure 7-1A.—MRC for antenna coupler group (front).

Procedure (Cont'd)

j. Remove coupler A2 from cabinet.
   (1) Loosen captive screws; push latch levers upward and slide chassis out to lock position.
   (2) Turn captive fasteners fully counterclockwise.
   (3) Pull chassis out and lift from cabinet slides.
   (4) Remove top dust cover.
   (5) Remove subassembly dust covers.
k. Repeat steps 1.d. through h.
l. Reinstall dust covers.
m. Apply a thin film of grease on cabinet slide rails with brush.
n. Reinstall coupler in cabinet; tighten captive screws.
o. Repeat steps 1.j. through n. for couplers A3, A4, and A5.
p. Return equipment to normal condition.
q. Perform MR M-1.

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Figure 7-1B.—MRC for antenna coupler group (back).

3. Do not use solvents around any open flame. Although the solvent may be nonflammable, a poisonous phosgene gas may be formed.

4. Do not apply solvents to hot equipment or parts as this increases the toxic effects of the solvent.

5. Do not breathe the vapor of any cleaning solvent for a prolonged period of time. A five-minute break in an area free of the solvent fumes is recommended every fifteen minutes. One hour per day is considered maximum exposure for one man.

6. Wear rubber gloves to avoid coming into direct contact with the solvent.

7. Do not spray solvents on electrical windings or insulation. (Ultrasonic cleaning with solvents and detergent solutions is described in the *EIMB General Maintenance Handbook*, NAVSHIPS 0967-LP-000-0160.)

CLEANING AIR FILTERS

Cleaning air filters is exceedingly important for the proper operation of electronic equipment. Air filters are sometimes neglected or disregarded until excessive heating causes a breakdown of the equipment.

Forced air cooling is used in most modern transmitters and receivers. This type of cooling system moves a large volume of air over the hot portions of the equipment. The air is filtered to keep dust and other foreign particles out of the equipment. If the filters are efficient, they remove most of this foreign material from the air that passes through them. Dust and dirt tend to clog the filter and prevent the air from moving through. The result is that the equipment becomes overheated and may be ruined.

Some air filters are designed to be installed with a film of oil on the filter element. Filters of this type provide effective filtration with a minimum reduction of air flow. When this type of filter is used without an oil coating, the filter effectiveness is greatly reduced. The major disadvantage of the oiled filters is in cleaning. They may be cleaned by washing the filter element in a standard shipboard dishwashing machine. Many ships have a special room designated as the filter cleaning room. This room is used by all divisions for cleaning filters according to a weekly schedule.

RECIEVER SENSITIVITY MEASUREMENTS

Receiver sensitivity in communications receivers is primarily dependent upon the rf, IF, and af amplifiers. The lowered efficiency of any one tube or transistor, or a change in any one circuit parameter, usually results in lowered overall efficiency of the receiver. The one measurement that provides maximum information about receiver condition in field operation is the sensitivity measurement.

The sensitivity of a radio receiver is an indication of its ability to give a satisfactory output with a weak signal input. Although there may be some variation in the exact wording of the definition, sensitivity is the value of input carrier voltage (in microvolts) that must be applied from the signal generator to the receiver input to develop a specified output power at a specified signal-to-noise (signal-plus-noise to noise) ratio. The settings of the various controls are specified as well as the modulation frequency and percentage of modulation.

In many Navy receivers, sensitivity is the magnitude of signal voltage (in microvolts) that must be fed to the receiver antenna terminals in order to produce a signal-to-noise ratio of 10 dB at 6 mW across a 600-ohm noninductive resistance (fig. 7-2) substituted for the headphones or other device at the receiver output terminals. A sensitivity check of two separate communcation receivers, reveals the following:

INPUT	OUTPUT
3 μV	Receiver #1 6mW
1 μV	Receiver #2 6mW

Receiver #2 has the greater sensitivity because it requires a smaller input signal to provide the same output as receiver #1.

This measurement ordinarily requires that the signal generator be connected to the antenna terminals of the receiver through an impedance, which approximates that of the

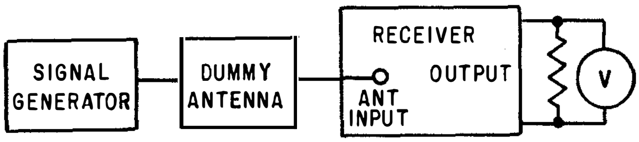

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Figure 7-2.—Equipment arrangement for measuring radio receiver sensitivity.

antenna with which the receiver is to be used. This impedance is known as a DUMMY antenna. The dummy antenna (fig. 7-2) ensures that the signal current in the input circuit of the receiver is the same as would appear with the calibrated signal voltage induced in an ideal receiving antenna. It also ensures that the input circuit of the receiver is "loaded" the same as it would be by an ideal antenna.

A dummy antenna that may be used with high-impedance input receivers is shown in figure 7-3. In the case of low-impedance, a signal generator with a 50-ohm output may be directly connected without the use of an external dummy antenna. Other generator impedances may require special dummy-antenna networks to load the generator and the receiver properly.

A typical sensitivity measuring procedure for A-3 reception is as follows: A carrier modulated 30% by a 1 kHz tone is applied to the dummy antenna. The rf gain control is set at maximum with AGC on the BFO off. Both the input signal level and the af gain control are progressively adjusted until the receiver output noise level is 0.6 milliwatt (0.6 volt across 600 ohms) with the signal generator modulation OFF, and the signal plus noise output is 6 milliwatts (1.9 volts across 600 ohms) with the signal generator modulation ON. This produces a signal-plus-noise to noise ratio of +10dB. The receiver sensitivity, in terms of input voltage, is then read from the signal generator voltage calibration.

High-impedance headphones may be used in shunt with the load for monitoring the output. Low-impedance headphones would load the output appreciably. The output voltage is measured with a high-impedance audio voltmeter capable of accurate indication from 0 to 10 volts. Although some receivers are equipped with audio output meters, their meters may not indicate the required standard noise levels with sufficient accuracy.

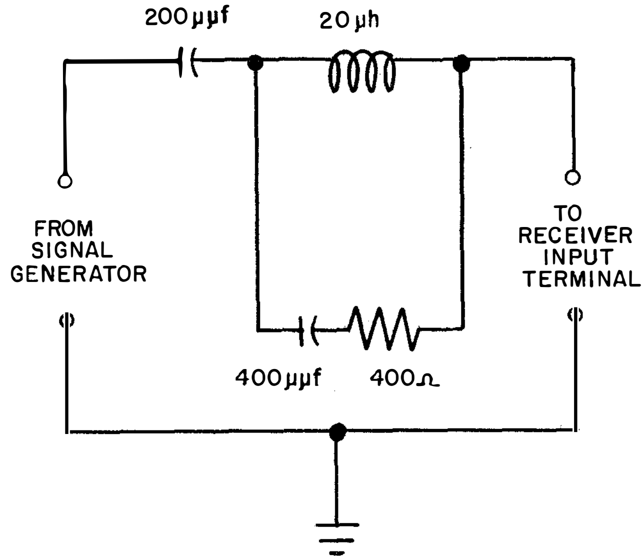

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Figure 7-3.—Dummy antenna circuit.

Detailed instructions for making sensitivity measurements are included on the MRC and in the equipment technical manual. An MRC for measuring the receiver sensitivity of Radio Set AN/URC-9 is shown in figures 7-4A and 7-4B.

SELECTIVITY AND BANDWIDTH MEASUREMENTS

Selectivity is the property which enables a receiver to discriminate against transmission other than the one to which it is tuned. It is usually expressed in the form of a curve obtained from a plot of the strength of a standard modulated-carrier signal that is required to produce a constant (standard)

SYSTEM	COMPONENT	M R NUMBER	
Communications and Data	AN/URC-9 Radio Set	C-362 M-1	
SUB SYSTEM	**RELATED M R**	**RATES**	**M H**
Communications Transceivers	None	RM2	0.8
M R DESCRIPTION		**TOTAL M/H**	
1. Measure receiver sensitivity.		0.8	
		ELAPSED TIME	
		0.8	

SAFETY PRECAUTIONS

1. Observe standard safety precautions.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Signal Generator, AN/URM-26B or equivalent
2. Electronic Voltmeter, AN/USM-143 or equivalent
3. Headset plug adapter, FSN 9N-5935-283-1235
4. 620-ohm 1-watt Resistor, FSN 9N-5905-279-2629

PROCEDURE

Preliminary

a. Turn ON test equipment; allow a 15-minute warmup.
b. Set radio set switches and controls:
   (1) POWER to POWER
   (2) CHAN SEL to MANUAL
   (3) MODE to NOR
   (4) SQUELCH to OFF
   (5) VOLUME fully counterclockwise
   (6) METER to S METER
c. Disconnect antenna cable from ANT jack.
d. Insert headset plug adapter in HEADSET jack.
e. Set signal generator OUTPUT level control to zero.
f. Use test cables to connect signal generator output, through 6db attenuator, to ANT jack.
g. Connect resistor across voltmeter leads and insert leads in headset plug adapter.
h. Set electronic voltmeter RANGE switch to 1.

1. Measure Receiver Sensitivity.
   a. Set radio set MANUAL FREQUENCY switches to 225.0 Mhz.

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Figure 7-4A.—MRC for receiver sensitivity check (front).

Procedure (Cont'd)

b. Set signal generator controls for:
   (1) Frequency of 225.0 MHz.
   (2) Modulation of 1000 Hz at 30 percent
   (3) Output level of 6 microvolts
c. Adjust receiver VOLUME control for -8 db indication on voltmeter.
d. Adjust signal generator frequency control for a peak indication on voltmeter.
e. Adjust receiver VOLUME control for +2 db indication on voltmeter.
f. Turn signal generator modulation to OFF. Meter indication should decrease 10 db or more.
g. Repeat steps 1.a. through 1.f. for frequencies 312.0 and 399.9 MHz.
h. Disconnect test equipment.
i. Reconnect antenna cable to ANT jack.
j. Return equipment to desired condition.

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Figure 7-4B.—MRC for receiver sensitivity check (back).

output, versus off-resonance frequency. Figure 7-5 shows a typical AM receiver selectivity curve with the carrier signal strength at resonance used as a reference.

The bandwidth of a receiver is usually used to define that portion of the selectivity curve that represents the frequency range over which the amplification is relatively constant. For most receivers, the bandwidth represents the usable portion of the curve, and has a direct relation to the fidelity of the modulated intelligence. Practically, the bandwidth is measured at the half-power (3-dB-down) points, or, for certain applications, at the 6-dB-down points. The bandwidth is represented by the frequency range between the two points on a response curve expressed as relative response in dB versus frequency, as shown in figure 7-6. However, the bandwidth at the 3-dB (or often the 6-dB) points, when compared with the bandwidth at 60-dB-down points, gives a good indication of the selectivity of the receiver. In most receivers, the overall bandwidth is determined by the IF amplifiers, therefore, bandwidth is sometimes considered as, fundamentally, an IF characteristic measurement.

When making bandwidth measurements, the receiver avc should be disabled (grounded), connected to a source of fixed bias, or turned off, and the volume control set to maximum. This sets the receiver to a given reference point. The signal generator is set at the receiver frequency, and, if applicable, modulated 30% at 1 kHz. The output of the generator is set to a value which will place the receiver well below the point of overload (no limiting action), and the receiver rf gain is adjusted for a convenient reference receiver-output voltage. The signal generator output is then increased by 3 dB (1.4 times the voltage of the original setting) for measurement at 3-dB-down points, or 6 dB (two times the voltage of the original setting) at the 6-dB-down points. The generator frequency is then varied to one side of resonance until the receiver output gain indicates the reference level; the procedure is then repeated on the other side of resonance. The bandwidth is the total frequency displacement between the 3-dB points (or 6-dB-down points), whichever is applicable.

The MRC for measuring the receiver bandwidth for Radio Set AN/SRC-20 is shown in figures 7-7A and 7-7B.

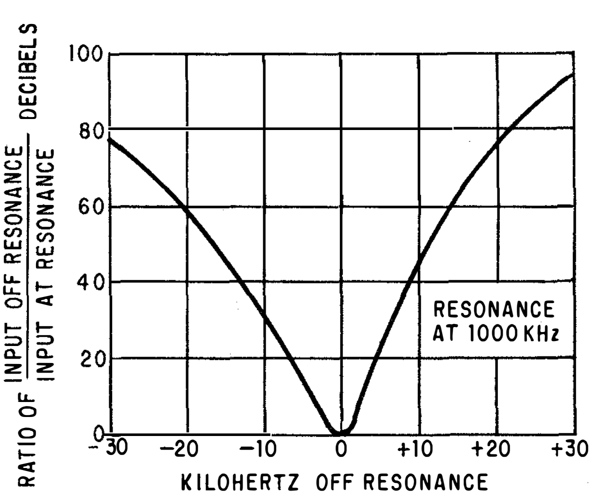

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Figure 7-5.—Selectivity curve.

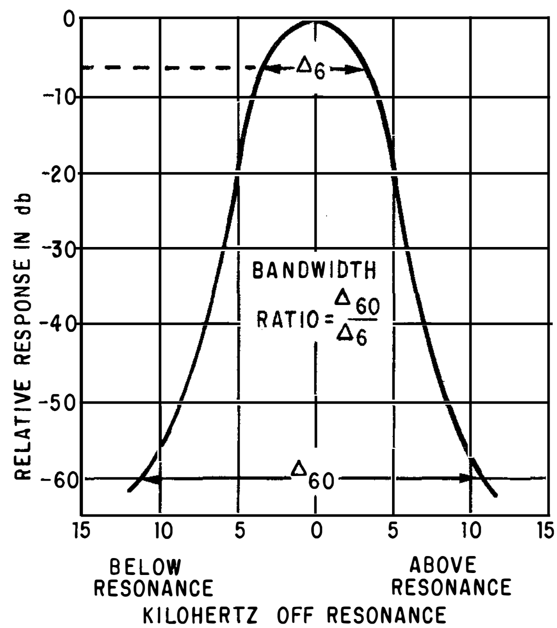

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Figure 7-6.—Receiver response curve.

SYSTEM	COMPONENT	M R NUMBER	
Communication and Control	AN/SRC-20 Radio Set	C-193 S-1	
SUB SYSTEM	RELATED M R	RATES	M/H
Radio Communication	None	RM2	0.6
M R DESCRIPTION		TOTAL M/H	0.6
1. Measure IF bandwidth.		ELAPSED TIME	0.6

SAFETY PRECAUTIONS

1. Observe standard safety precautions.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Warning tag
2. 6" Normal duty screwdriver
3. Signal Generator AN/URM-25D, or equivalent
4. Electronic Counter AN/USM-207, or equivalent
5. Electronic Multimeter AN/USM-116C, or equivalent

PROCEDURE

1. Measure IF Bandwidth.
   a. Turn OFF and tag main power switch.
   b. Disconnect antenna cable from ANT jack; loosen four retaining screws on receiver-transmitter unit.
   c. Turn extractor knob counterclockwise to limit of travel.
   d. Turn extractor knob clockwise three revolutions, stopping with slot horizontal.
   e. Disengage extractor by pushing extractor knob down.

CAUTION: Support chassis while withdrawing it to prevent it from striking deck.

   f. Withdraw receiver-transmitter chassis from cabinet and place it on its left side.
   g. Connect receiver-transmitter maintenance cable, CX-7250/U, between receptacle inside of cabinet and receptacle on back of receiver-transmitter.
   h. Turn ON signal generator and electronic multimeter; allow a 15-minute warmup.

(Cont'd on Page 2)

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LOCATION | DATE 1 Sept 197-

MAINTENANCE REQUIREMENTS CARD
OPNAV 4700-1 (C) (REV. 7/61)

98.176

Figure 7-7A.—MRC for measuring IF bandwidth (front).

Procedure (Cont'd)

i. Adjust signal generator frequency to 3.5 MHz, CW mode, with zero output.
j. Connect signal generator RF output to the orange test point (J-303) on right side of receiver-transmitter.
k. Adjust electronic multimeter to measura -DC volts and connect it between yellow test point (J-504) on bottom side of receiver-transmitter and ground.
l. Remove tag and turn ON main power switch.
m. Turn ON radio set and set it to any frequency with TENTHS control at .5.
n. Set SQUELCH control at OFF.
o. Connect a test cable between signal generator open circuit jack and electronic counter signal input jack.
p. Set signal generator carrier range switch to X 200K.
q. Adjust signal generator frequency and output level until electronic counter indicates 3.5 MHz. Set signal generator carrier range switch to X MULT.
r. Adjust signal generator output for a -0.5 volt indication on electronic multimeter.
s. Note signal generator RF output.
t. Adjust signal generator RF output level to twice the amount indicated in step 1.s.
u. Increase signal generator frequency until electronic multimeter again indicates -0.5 volts.
v. Set signal generator carrier range switch to X 200K.
w. Note electronic counter frequency.
x. Set signal generator carrier range switch to X MULT.
y. Decrease signal generator frequency below 3.5 MHz until electronic multimeter again indicates -0.5 volts.
z. Set signal generator carrier range switch to X 200K.
aa. Note electronic counter frequency.
ab. Verify that difference between frequencies noted in step 1.w. and aa. is at least 80 kHz.
ac. Return equipment to normal condition.

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MAINTENANCE REQUIREMENTS CARD
OPNAV 4700-1 (E) (REV. 7/65)

98.176

Figure 7-7B.—MRC for measuring IF bandwidth (back).

ANTENNA MAINTENANCE

The worst enemies of shipboard antenna installations are salt spray and stack exhausts, which cause corrosion that eats into the antennas, mounting brackets, and associated hardware. They also cover the installations with salt and soot deposits, which, if allowed to accumulate, may short the antennas to ground by providing a path for current flow across the insulators.

Careless painting is another cause of trouble in antenna systems. Paint with a metallic base is a good conductor of electricity. If used, and it gets on the insulator, it will short the antenna in the same manner as salt and soot deposits.

Antenna maintenance consists mainly of visual inspections for physical damage, cleaning insulators, making resistance tests for leakage resistance or insulation breakdown, and checking rf connections.

INSPECTIONS

Wire antennas should be lowered at frequent intervals and inspected for signs of deterioration, particularly at clamps, and where they connect to transmission lines. Avoid nicking or kinking the wire while inspecting as the wire will be weakened at these points.

It is good policy to wire-brush antennas while they are down, as this removes soot and salt deposits as well as revealing any signs of weak or broken strands. (Vinyl covered receiving antennas should be cleaned with soap and water rather than wire-brushed.)

Whip-type antennas are usually hollow and have a tendency to collect moisture inside. A small hole is drilled near the base of metal antennas to permit moisture to drain out. Whip antennas usually can be inspected without being lowered. Look for corrosion spots and blisters, loose mounting bolts, and loose or frayed connections. As with wire antennas, check all insulators for chips, cracks, and cleanliness.

Any insulators on dipole antennas should be carefully cleaned of any paint, salt, or soot deposits. Care should be taken not to damage the glazed surfaces of the insulators. The mechanical condition of dipole antennas should be checked for loose mountings and rust spots.

Maintenance of vhf and uhf antennas is complicated by their inaccessibility. It is often necessary to climb masts or stacks to inspect them properly for damage. For this reason, they sometimes are neglected until a major casualty occurs. These antennas are as susceptible to rust, loose mountings, and broken connections as are other antennas, and must be inspected regularly. Many of the problems experienced in uhf communications can be traced to faulty antennas.

CLEANING INSULATORS

Antenna insulators have a glazed surface to which foreign material does not adhere readily, and which tends to wash clean during rain storms. Although helpful, you cannot depend upon an occasional rain to keep insulators free of salt spray, soot, and dirt. For this reason, insulators must be cleaned periodically. The time between cleaning insulators depends upon the type of ship, the type of operations, and the area of operation.

To clean insulators, use a sharp knife and a small amount of paint thinner to remove any paint that may be on the insulators. Use the sharp knife carefully to avoid nicking the insulator. NEVER USE STEEL WOOL, SAND PAPER, OR OTHER ABRASIVES. Wash them with soap and water, and follow this with several rinsings with clean fresh water. The insulators then should be polished with a dry, soft cloth to restore their glaze.

RESISTANCE TESTS

The most common fault in an antenna system is low resistance to ground. Moisture in coaxial lines, dirty insulators, and breakdown of insulation all cause varying degrees of shunting resistance. These faults must be guarded against if maximum efficiency is to be maintained.

The Megger is the test equipment commonly used for testing an antenna system. As discussed in *Basic Electricity,* NAVPERS 10086-B (or *Navy Electricity and Electronics Training Series (NEETS)),* the Megger is a hand-driven d.c. generator and a megohmmeter combined. The megohmmeter measures the value of resistance through which the generated current flows. The output of the Megger is approximately 500 volts. This voltage is sufficient to break down and reveal weak spots in the insulation if any exist.

Before testing, the antennas should be inspected for intentional d.c. shorts such as those in receiver protective devices. These protective devices, found in most general-purpose, high frequency receiving antennas, usually consist of a fixed resistor of about one-half megohm connected from line to ground. This resistor protects the receiver by draining off any accumulated static charges on the antenna. To prevent a constant and misleading resistance reading from being obtained, the resistor must be disconnected before testing the antenna and transmission line.

After protective devices are disconnected from the antenna, proceed as follows:

1. Connect the ground lead of the Megger to the hull of the ship.

2. Disconnect the transmission line at the equipment, and connect the high side (line connection) of the Megger to the inner conductor of the transmission line.

3. Crank the handle of the Megger until a steady reading is indicated on the megohmmeter.

For insulation resistance, the following values are suggested for hf whips and wire fans:

1. A resistance of 200 megohms or more to ground indicates an antenna in good condition.

2. A resistance of 5 to 100 megohms to ground indicates the need for cleaning the insulators.

3. A resistance of less than 5 megohms to ground indicates an excessive leak in the system. Immediate steps must be taken to locate the leak and restore the antenna system to its original condition.

The preceding values do not apply to vhf and uhf antenna systems that normally are short circuits to d.c. voltages.

Junction boxes usually hold the resistor mentioned previously that is used to drain off static electricity from antennas. The junction boxes should be opened and inspected at least every six months. The resistor should be measured and inspected to ascertain if it is in good condition. The connections within the box should be critically inspected to make sure they are all in good shape and well protected. The gasket on the box should be inspected and replaced if necessary, then the box well sealed and all bolts or screws installed and tightened down to prevent water or salt spray from entering the junction box.

While the junction box is open and the static drain resistor is out of the circuit, the coaxial line from the antenna patch should be checked for grounds and continuity from the equipment end of the cable. A reading in the high megohm range will show if the antenna and the center conductor of the coaxial cable are free from ground, but does not prove that junction boxes, connectors, and cables have continuity through them. Next, ground the antenna near its base and check with an ohmmeter for continuity to ground from the center conductor of that particular antenna outlet on the receiver antenna patch panel in radio central, or wherever the antenna appears inside the ship. The reading should not be more than one or two ohms. Then remove the short, and again megger for short to ground. If a high reading is not obtained, it is possible that the coaxial cable will have to be replaced.

When antennas are being meggered, remember that dry salt is an insulator, and the salt deposit will not become conductive until it becomes damp. For this reason, the antenna should be meggered early in the morning while the morning dew is still present.

Theoretically, any antenna transmission line system should read infinity on the Megger, but this is not always possible to obtain. Abrupt changes in the weather, high humidity, or other natural causes often result in low readings. It is safe to say that any antenna reading under 100 megohms to ground for several successive daily readings should be investigated. In many cases, insulation resistance may be raised by cleaning the insulators or couplings. The coaxial cable and other cables and fittings used to connect the equipment together should also be tested.

RF CONNECTIONS

Checking the antenna with a Megger will show up dirty insulators and moisture problems but will give no indication of bad rf connections. As soon as a gap forms between any mechanical connection, oxidation forms a high resistance rf connection. In many cases, this connection is bad enough to be measured with an ohmmeter as a d.c. resistance. This oxidation is further worsened by stack gases and water.

If the bottom (lower) section of a whip antenna fitting in the socket above the insulator is at all loose in the socket, it is especially susceptible to the collection of water and stack residue. The large nut that tightens this connection (as well as those that tighten other rf connections) must be kept tight. Generally, it is not possible to check the rf connections of any but the first section of a whip antenna without removing the whip. Shaking the whip vigorously will usually reveal any loose sections. If any loose sections are noted, the whip must be removed, disassembled, and cleaned. It is recommended that this be done at least every six months. All grounding straps should be checked at this time and repaired or replaced as necessary. In addition, the antenna should be treated for corrosion prevention as described in EIMB.

CABLES AND TRANSMISSION LINES

Cables, connectors, and transmission lines used in connecting component parts of electronic equipment are often the cause of many maintenance problems encountered in the Navy today. Some of the most common faults, along with the preventive and corrective maintenance procedures to correct these faults, are given in this section.

POWER CABLES

Many cable failures are caused by normal wear during the rough usage to which all military equipment is inevitably exposed. Cable failures may occur at a time when dependable communications or equipment operation is vitally necessary for the success of a tactical operation. It is of the utmost importance to insure against such failure by frequent periodic inspections. Operators and technicians should be continuously on watch for defects in cables that may develop into equipment failures unless corrected at the earliest opportunity. Some of these defects and the trouble that may result are:

1. Frayed conductors that may cause intermittent or unreliable operation.
2. Broken conductors that may cause shutdown of the equipment.
3. Chafed insulation that may cause shorts between conductors or shorts between conductors and ground.
4. Insulation damage that may be caused by contact with oil, gasoline, acid, and other harmful materials.

When any of the above conditions is discovered, the cable should be replaced immediately or temporary repair made until replacement can be made at the earliest opportunity. Always replace the damaged cable with the same type or equivalent cable to avoid possible injury to personnel or damage to the equipment.

RF CABLE

Rf cables (coaxial cable) are divided into three types: solid dielectric, foam dielectric, and gas-filled. The solid and the foam dielectric cables are in prominent use today aboard ships, whereas the gas-filled is becoming obsolete.

Solid coaxial cables require little maintenance outside of regular cleaning and maintenance inspections. Cables containing polyethylene are not designed to withstand heat. Even heat resistant cables will deteriorate when subjected to high temperature over an extended period of time and, therefore, should not be routed through high temperature spaces (galleys, laundry spaces, fire rooms, and the like). If the cable must go through these spaces, it should be mounted as far away as possible from heat sources, such as steam lines, dryers, and ovens.

CONNECTORS

Most plug connections on Navy equipment fit tightly, and caution must be exercised when uncoupling such connections. Such tight-fitting plugs must be disconnected by working them back and forth while applying a steady pull. A quick jerk may break the cable. After removal of a plug from its socket, it should be inspected for bent or loose contact prongs, burned spots on the contacts which are evidence of short circuits or poor connections, stripped threads on screw-type connectors, and worn gaskets or washers in sockets of power cables which might permit the entrance of water.

Many plugs or connectors are equipped with rubber washers through which the cable must be threaded before attachment to the plug insert. Check to insure that these washers have not been reamed out or that the cable insulation has not been whittled down to insure a good fit. When replacing this type of plug, lubricate the cable with soap. Do not use a petroleum product as a lubricant, as it will cause the rubber to deteriorate.

TRANSMISSION LINES

Removal and replacement of rf transmission lines is a very important area of responsibility to the maintenance technician. Considerations must be given to the following areas: length of cable runs, amount of power applied, type of signal, and the routing of the cable.

When the equipment is installed, the manufacturer specifies the maximum length of the cables required to allow the equipment to operate at optimum performance. Therefore, it is very important that defective cables of an equipment be replaced with the same type and length that were originally installed. There are times when this is not possible due to the nonavailability of materials and the requirement for a specific equipment to be made operational immediately to accomplish a specific mission. There are other cables that carry different cable designations that have identical characteristics and can be interchanged without degrading the performance of the equipment. A table of general data concerning types and characteristics of radio-frequency cables can be found in the Reference Data section of the EIMB. This table should be consulted when a specific cable type can not be located to facilitate repairs to the equipment.

The use of a cable other than the type of the original installation could cause other equipment malfunctions or decrease performance. This could appear as a problem in a different area of the equipment, thus increasing the downtime of the equipment.

MANUFACTURE OF CABLE ASSEMBLIES

There are times when working on equipment that it becomes necessary to replace cable assemblies or cable harnesses due to the deteriorated condition of the old assembly or numerous broken wires in the assembly.

To construct a cable assembly or wiring harness requires considerable knowledge and patience on the part of the technician. Practice is sometimes required before the task is to be attempted. This enables the technician to get the feel of the task and to build confidence before starting the job.

The manufacturer's technical manual points out where the conductors connect and their routing and numbering. Information concerning other details, such as: lacing, tying, protection of the conductors, and the numbers and the placement of spare conductors, can be located in the Installation Standards section of the EIMB. The finished product should look, if done properly, as good as the original installation and increase the life of the equipment.

CHAPTER 8

MAINTENANCE OF COMMUNICATIONS SYSTEMS (PART 2)

Most shipboard communication equipment operates at one time or another in some type of system or systems. Thus, it is just as important for the ET to know how to perform maintenance at the system level as on the individual equipment. Shipboard communication systems vary from simple to very complex, depending upon the type ship and circuit operation involved. Each requires the integrated use of various types of equipment, as shown in figure 8-1 (foldin at end of chapter).

To locate and correct troubles in a given system, the technician must know how the different types of communication systems are set up for compatible operation. This knowledge can be gained by studying the equipment manuals, system blueprints and diagrams, and working with the operating personnel. This chapter discusses the six-step troubleshooting procedure as applied to systems. Also discussed are some of the typical troubles encountered in shipboard communication systems.

SIX-STEP TROUBLESHOOTING PROCEDURE

The most effective preventive maintenance program will not totally eliminate troubles during system operation. When a system trouble occurs, an experienced operator may have the trouble localized to a piece of prime equipment such as a set or unit before the technician arrives. However, this may not always be the case. Therefore, the technician must be able to systematically isolate the trouble.

The six-step troubleshooting procedure (discussed in NAVEDTRA 10196, *Electronics Technician 3 & 2, Vol. 1* or *Basic Electronics, Vol. 1,* NAVPERS 10087C) is as effective for isolating the cause of a system malfunction as it is for localizing trouble in a prime equipment.

STEP 1

The first troubleshooting step for locating the problem in a malfunctioning system is the recognition of a trouble symptom. This may or may not be an easy task depending on the nature of the problem. Disrupted or seriously degraded system performance is obvious and will usually be reported by the operator.

Occasionally, the first trouble symptom will be of a nonrepetitive nature and, while noted by the operator, cannot be duplicated and observed later by the technician. Therefore, when responding to a reported problem, the technician should find out if the operator originally noted any symptoms that are no longer present.

Other, less disruptive problems may not exhibit readily apparent trouble symptoms during normal operation of a system. The disclosure of such a problem is usually the result of close observations made during the application of readiness tests or at the time the system is initially set up.

Unless the problem has already been localized when the technician arrives, the first step is to establish the nature of the malfunction as it concerns the overall operation of the given system. This is normally accomplished at the operator position by correlating the complaint reported with the trouble symptom that may be observed firsthand, such as disrupted or degraded transmission or reception.

STEP 2

In step 2, the technician should attempt to further localize the problem area by looking for other indications, both abnormal and normal, that tend to elaborate on the trouble symptom noted in step 1. The determination of which indications would be the most beneficial, and how and where they can be observed, depends upon the nature of the problem, the type of system involved, and the installed arrangement of the equipment actually being used.

STEP 3

Equipped with the information obtained in steps 1 and 2, the technician is able to proceed into step 3 and, through a process of elimination, make an educated guess as to those equipment units that are possibly at fault. To accomplish this, the technician must know how the system operates and the functional relationship of the equipment involved. Based on this knowledge, the technician will find that the nature of the problem will normally allow certain equipment to be logically eliminated as possible sources of trouble. Additional equipment may also be eliminated by observing their front panel indications.

STEP 4

The fourth step requires that the problem area be further localized to only one equipment determined to be possibly at fault in step 3. If, in completing step 3, the problem is already localized to only one equipment, this step may be omitted. On the other hand, if more than one equipment is logically suspected, it will be necessary to determine which one is actually faulty in this step.

There are no hard and fast rules for determining which of several possible faulty equipment units should be tested (or verified) first. For the most part, such a determination is usually based on which equipment is the most probable suspect and/or the least difficult to perform the necessary test on.

After selecting the order in which the tests are to be performed, the technician proceeds to verify the actual status of the suspected equipment. Normally, only a suspected output and/or given input is checked using test points obtained from appropriate technical references.

STEP 5

In step 5, the technician should perform whatever tests are appropriate to systematically isolate the defective circuit stage within the equipment that has been determined to be malfunctioning. The number of checks required to isolate the defective stage depends primarily on the complexity of the equipment involved.

Several systematic checks would undoubtedly be required in order to isolate the defective circuit in relatively complex equipment, such as a receiver or teletype converter. When a piece of multi-unit prime equipment, such as a transmitter, is involved, it may be necessary to initiate a separate six-step procedure in order to isolate the problem to an internal circuit stage. When a simple unit (such as the Control Unit C-1004A/SG, fig. 8-1) is involved, fewer checks may be required to isolate (or verify) the defective circuit.

STEP 6

In the sixth and final step, the technician proceeds to systematically isolate and replace the defective part that is causing the identified circuit to malfunction. This is normally accomplished through a logical sequence of voltage and/or resistance measurements. The exact determination of what checks would be the most effective, in a given situation, depends on the type of circuit involved.

A failure analysis should be conducted, as a part of step 6, as soon as the defective part has been isolated. This is very important as the isolated part may not be the cause of the original problem, in any way, or it may have a companion defect in a cause and effect situation. If neither of these conditions exist, a short study of the failure will logically prove the defect to be both singular in nature and accountable for every observed symptom of the system malfunction. Such an analysis, when conducted properly, allows the technician to determine whether correcting the isolated defect will, in fact, enable the system to be restored to full operation.

SYSTEM TROUBLES

Some typical troubles encountered in shipboard communication systems, along with the troubleshooting procedures required to isolate and correct these troubles, follow.

TROUBLE #1

This trouble occurs after a brief loss of all a.c. power to radio central. After the restoration of power, the following equipment (fig. 8-1) is found to be inoperative: (1) all R-1051/URR receivers, (2) the AN/WRC-1 transmitter-receiver, and (3) the AN/SRR-19A receiver.

Assuming that the Radioman (RM) had not performed any steps to localize the trouble, you would immediately attempt to obtain more information concerning the trouble symptoms (step 2 of the six-step procedure). Proceeding with this step, you find that all receiver dial lights are normal, but the receivers have no outputs other than receiver noise. This information leads you to suspect two units that may be faulty (step 3). These units are Frequency Standard AN/URQ-10 and Distribution Amplifier AM-2123/U. The receivers are switched to the internal frequency standards and operation is normal. This confirms that either the AN/URQ-10 or the AM-2123/U is faulty.

Both the AN/URQ-10 and the AM-2123/U have front panel controls and indicators. Therefore, the faulty unit may be localized (step 4) in this case without the use of test equipment. All front panel indications on the AN/URQ-10 are found to be normal. Observing the AM-2123/U front panel (fig. 8-2), you note that the AC ONLY light is lit. You then rotate the METER FUNCTION switch through all positions. Normal meter readings are obtained in the AC and DC POWER INPUTS positions. The meter reads zero in all other positions. Thus, the trouble is localized to the AM-2123/U.

To localize the trouble to a specific circuit in the AM-2123/U (step 5) requires the use of a vtvm and the equipment technical manual. (At this point, it is recommended that you review that part of chapter 2 that discusses the use of the SIMM equipment manual Maintenance Dependency Chart.)

Referring to the Maintenance Dependency Chart (MDC) shown in figure 8-3 (foldin at end of chapter), you can assume (due to the meter readings obtained, and the fact that the AC ONLY light is lit) the following:

1. 115 volts a.c. is available across terminals A-C on P1 (extreme left, fig. 8-4, foldin at end of chapter).

2. From 22 to 30 volts d.c. is available across terminals A-B on P2.

3. Filter subassembly N-FL-1 and a.c. fuses F1 and F2 are good.

4. 115 volts a.c. is availabe across terminals 1 and 2 of transformer T1.

5. Assembly C-PS-1 is good, and approximately 12 volts a.c. is available from the positive side of Cl to terminal 4 of T1.

6. Resistor R6, filter subassembly N-FL-2, and d.c. fuse F3 are good.

7. From 22 to 30 volts d.c. is available from the positive side of C1 to the B terminal on P2, and resistor R7 is good.

Proceeding to step 1C on the MDC (fig. 8-3), you remove a.c. fuse F1, and with a vtvm set up to read d.c. volts, you read 24 volts d.c. across capacitor C1. This tells you that filter subassembly N-FL-4 is good. You then take a d.c. voltage reading from the positive side of C1 to terminal K on J16 (top left corner of fig. 8-4, foldin at end of chapter). At this point you get no reading on the vtvm. This is an abnormal reading. The reading at this point should have been 20 volts d.c. as shown by signal specificiation #7 on the MDC. You can now conclude that the trouble is in either the C-REG-2 (No. 2 regulator) circuit or the N-FL-5 filter circuit.

The trouble may be localized to one circuit by taking resistance readings with the vtvm.

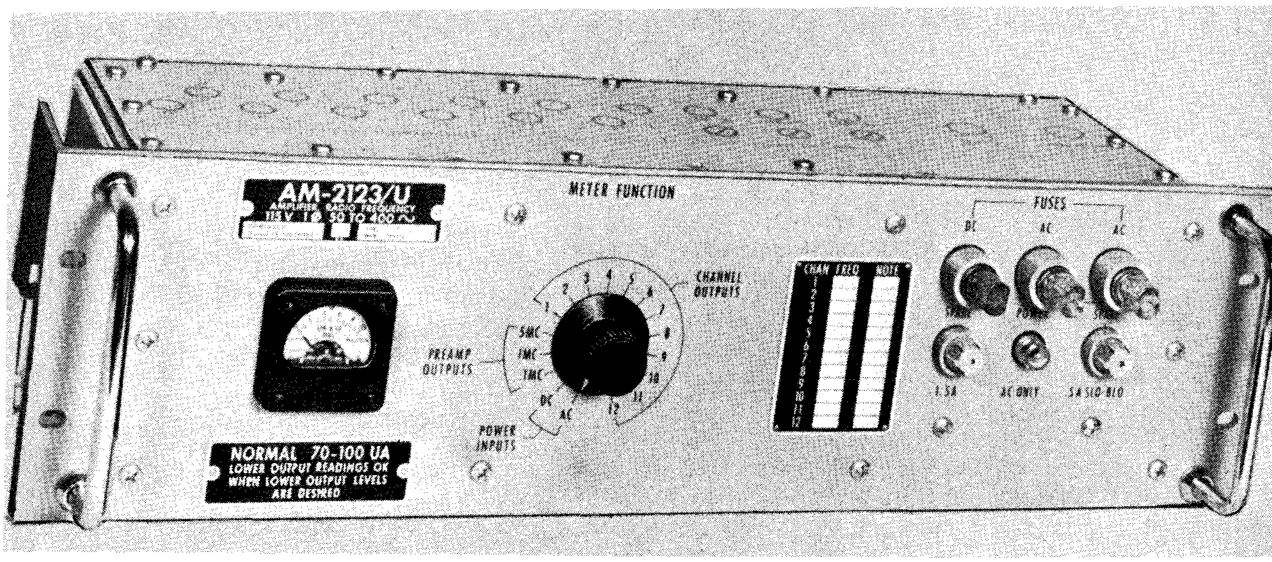

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Figure 8-2.—RF Distribution Amplifier AM-2123/U.

Before doing this, however, you must secure all power to the unit and discharge the capacitors to ground. With the vtvm set up to read resistance, you determine that neither capacitor C4 nor C12 is shorted. This localizes the trouble to the No. 2 regulator circuit.

In isolating the faulty part in the No. 2 regulator circuit (step 6), you must observe the precautions for testing transistors. In the test of series regulator transistor Q1, you get an infinity ohmmeter reading in both directions from the emitter to base and collector to base. This indicates that Q1 is bad (open). After determining that this is the only trouble in the circuit, you replace Q1 and test the unit.

Recall that in localizing the trouble to the faulty circuit, filter subassembly N-FL-5 was tested first. This was because N-FL-5 included only two parts (C4 and C12). An experienced technician, however, may have tested the series regulator Q1 first without eliminating N-FL-5.

TROUBLE #2

The special sea and anchor detail has been set for leaving port. The OOD reports the ship is unable to raise the tugs on the uhf frequencies. The RM watch supervisor patches a different AN/URC-9 to the remote control unit (C-1138B/UR) on the bridge, but the OOD is still unable to raise the tugs. The RM then switches his remote to the AN/URC-9 and calls the tugs. The tugs reply, "Hear you loud and clear." You are called by the watch supervisor to correct the trouble.

Upon arrival, you are informed of the action taken by the RM watch supervisor to establish communications. In addition, you are told that the "carrier on" light on the bridge remote control unit lit when the handset push-to-talk button was depressed; however, there was no transmitter sidetone present when speaking into the microphone. In this case, the RM gained enough information concerning the trouble symptom (step 2) before your arrival to enable you to immediately list the probable faulty functions (step 3).

You assume that the radio set is not faulty because patching a different set did not establish communications. The fact that communications were established by switching another remote to the AN/URC-9 causes you to suspect either the bridge remote unit or the handset as being faulty.

At this point, you jack a test handset into the bridge remote unit and have the RM switch the AN/URC-9 back to the bridge remote. The circuit now tests safisfactory, and the trouble is therefore localized to the handset. You test the faulty handset and find an open microphone wire. You make the repair, reinstall the handset in the bridge remote and test the circuit.

TROUBLE #3

The RM watch supervisor reports that he has trouble with AN/URA-17 #2. You are called to correct the trouble. Upon arrival, you are told that the RM attempted to use AN/URA-17 #2 (fig. 8-1) to establish the receive side of an FSK send-receive circuit but was unable to get any loop current from it.

To elaborate on the trouble symptom, you place the AN/URA-17 function switch in the TUNE position and check for loop current at the Communication Patching Panel SB-1203A/UG. The meter reads zero. Turning the loop control potentiometer to the maximum ccw (minimum current) position, produces approximately 1 mA of loop current. In the maximum cw (maximum current) position, the meter pegs. You immediately turn the control ccw to unpeg the meter. The meter reads zero at any position between the maximum and minimum current positions. This tells you that the loop control potentiometer for this loop is probably open.

To isolate the faulty part, you open up the front panel of the SB-1203A/UG and make a visual inspection. The loop control potentiometer appears normal; however, an open in this type of potentiometer is rarely visible. Troubleshooting communication patching panels must be done, in many instances, with the d.c. power supply on. The loop to be tested may be deenergized by removing the local-remote removable straps for that loop. WARNING: TO REMOVE THESE STRAPS WITH THE D.C. POWER ON YOU MUST OBSERVE THE PRECAUTIONS FOR WORKING ON ENERGIZED CIRCUITS AS STATED IN NAVMAT P-5100, SAFETY PRECAUTIONS FOR SHORE ACTIVITIES, CHAPTER 15, AND OPNAV INSTRUCTIONS 5100.19, NAVY SAFETY PRECAUTIONS FOR FORCES AFLOAT, CHAPTER 5.

Figure 8-5 is a schematic diagram of a single channel of the SB-1203A/UG. The other five channels are identical. In this case, the AN/URA-17 #2 is connected to terminals 1 and 2 of TB-101, and the potentiometer believed to be open is R-108.

To test R-108 and the other parts associated with the loop, the removable straps (fig. 8-5) must be unsoldered and removed. To do this with the d.c. power supply on, you must use a nongrounded type soldering iron. As the negative side of the power supply is grounded (and some of the equipment connected to the panel is grounded), touching the removable straps with a grounded soldering iron will either blow the power supply fuses or draw a heavy arc.

You remove the removable straps (observing all safety precautions for working on energized circuits as stated previously) and test R-108 with an ohmmeter. Potentiometer R-108 reads open. After testing the other parts in the loop to ensure that R-108 is the only trouble, you replace R-108 with a spare. You then replace the removable straps (again observing the proper safety precautions) and test the circuit.

TROUBLE #4

The AN/SGC-1A, TTY #2, and AN/URC-9 #4 (fig. 8-1) are being set up for use in the uhf tone-shift and send-receive configuration. Calling the net control station does not result in a reply. You are called to correct the trouble.

You depress the "letters" key on the teletype machine and observe the transmit and receive lights on the front panel of the AN/SGC-1A. The receive light stays on. You shift the AN/SGC-1A to transmit manually. The receive light now goes out, and the transmit light lights. This tells you that the AN/SGC-1A is not shifting from receive to transmit automatically.

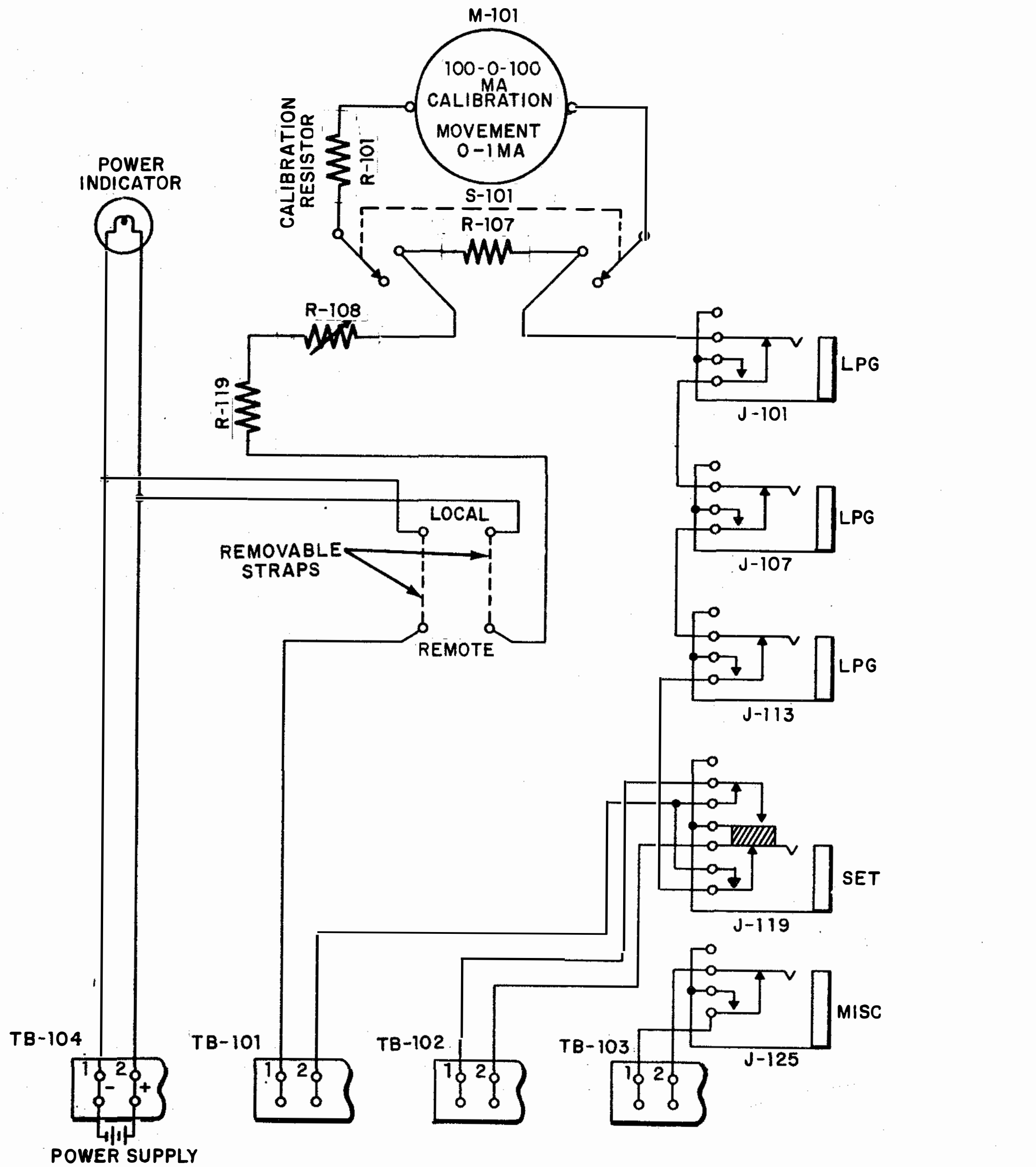

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Figure 8-5.—SB-1203/UG single channel simplified schematic.

At the receiver Transfer Switchboard SB-973/SRR, you patch the AN/URC-9 #4 output to a speaker, and the receiver noise is extremely loud. This high noise level locks the AN/SGC-1A in receive. The receiver noise indicates that the receiver squelch control is improperly set, and the high volume indicates that the receiver output volume level is set too high. You reset these controls to correct the trouble.

TROUBLE #5

You are serving aboard a carrier using an AN/SRC-21 UHF system. There are 20 transceivers and five AN/SRA-33 multicouplers. Sixteen of the transceivers are controlled by Facilities Control (Radio Central), and four are controlled by Carrier Air Traffic Control Center (CATCC). During normal operations, Facilities Control reports that transceiver #1 will not receive on channel #5. You are called to correct the trouble.

Upon reporting to Facilities Control, you get permission to make a radio check. Calling the other station on channel #5 results in no reply. You then get permission from Facilities Control to use transceiver #10 for a radio check. Using transceiver #10, you dial channel #5 and request a radio check from the other station. They reply "roger, over" (indicating that they have been receiving you loud and clear). You request them to change to channel #7 and stand by for a check. Dialing channel #7 on transceiver #1, you obtain a "roger, over" (i.e., loud and clear) radio check from the other station. You now return control of transceiver #10 to Facilities Control and proceed to the uhf radio space.

Upon arrival at the uhf radio space, you turn the LOCAL-REMOTE switch on the C-3866/SRC associated with transceiver #1 to LOCAL and dial channel #5. You disable the squelch by depressing the CALL LIGHT/SQUELCH DISABLE switch on the RT-581/URC-9. (This switch is located above the middle handle on the RT-581/URC-9.) You then turn the LOCAL-REMOTE switch on the RT-581/URC-9 to LOCAL and obtain a "roger, over" (i.e., loud and clear) radio check.

After switching the LOCAL-REMOTE switch on the RT-581/URC-9 back to REMOTE, you open the squelch control access drawer and set the squelch control potentiometer for channel #5 to the maximum ccw position. Turning the volume control to maximum produces a barely audible noise, which is normal. Noting that the CALL LIGHT on the RT-581/URC-9 is on, you rotate the channel #5 squelch potentiometer cw until the CALL-LIGHT barely goes out and stays out. You now call the other station on channel #5 from a remote position, and they report receiving you "roger, over" (i.e., loud and clear.)

While transmitting on channel #5 with transceiver #1, you note that the coupler (AN/SRA-33) for transceiver #3 is reading a high swr. Checking the channel on transceiver #3, you find that it is on channel #9. At this point, you suspect that channel #5 and channel #9 must be very close in frequency. Checking transceivers #1 and #3, you find that transceiver #1 is on 320.5 MHz and transceiver #3 is on 316.7 MHz. Realizing that these two channels are closer in frequency than the 10 MHz allowed on the AN/SRA-33 multicoupler, you detune transceiver #1 and call Facilities Control. Facilities Control informs you that transceiver #3 is controlled by CATCC.

Although the AN/SRC-21 System has channel lockout, it does not have frequency lockout. Thus, equipment damage can result from tuning frequencies within 10 MHz into the same AN/SRA-33. Because of this, you hold a training session with the controllers from Facilities Control and CATCC. As a result of this session, CATCC submits a frequency plan to Facilities Control, and Facilities Control provides a copy of an accurate overall uhf plan to CATCC.

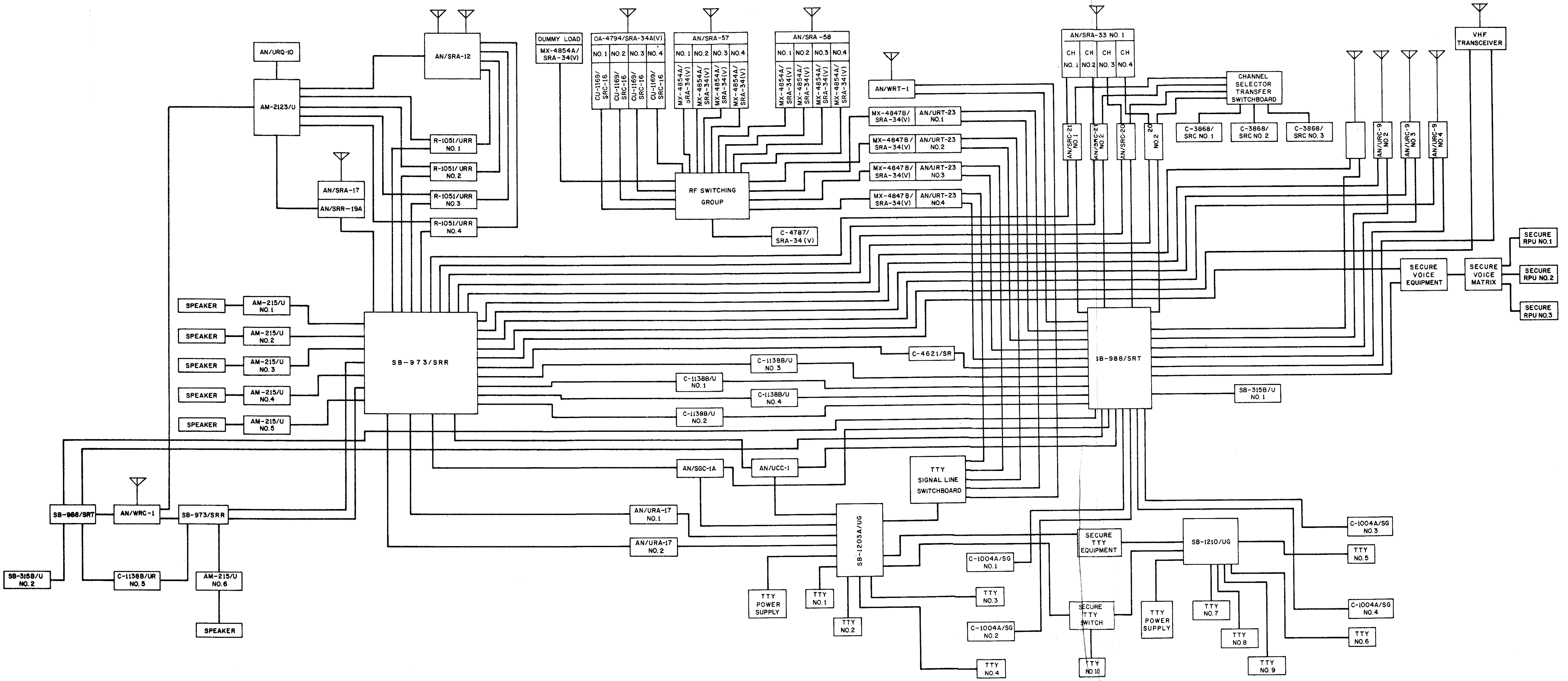
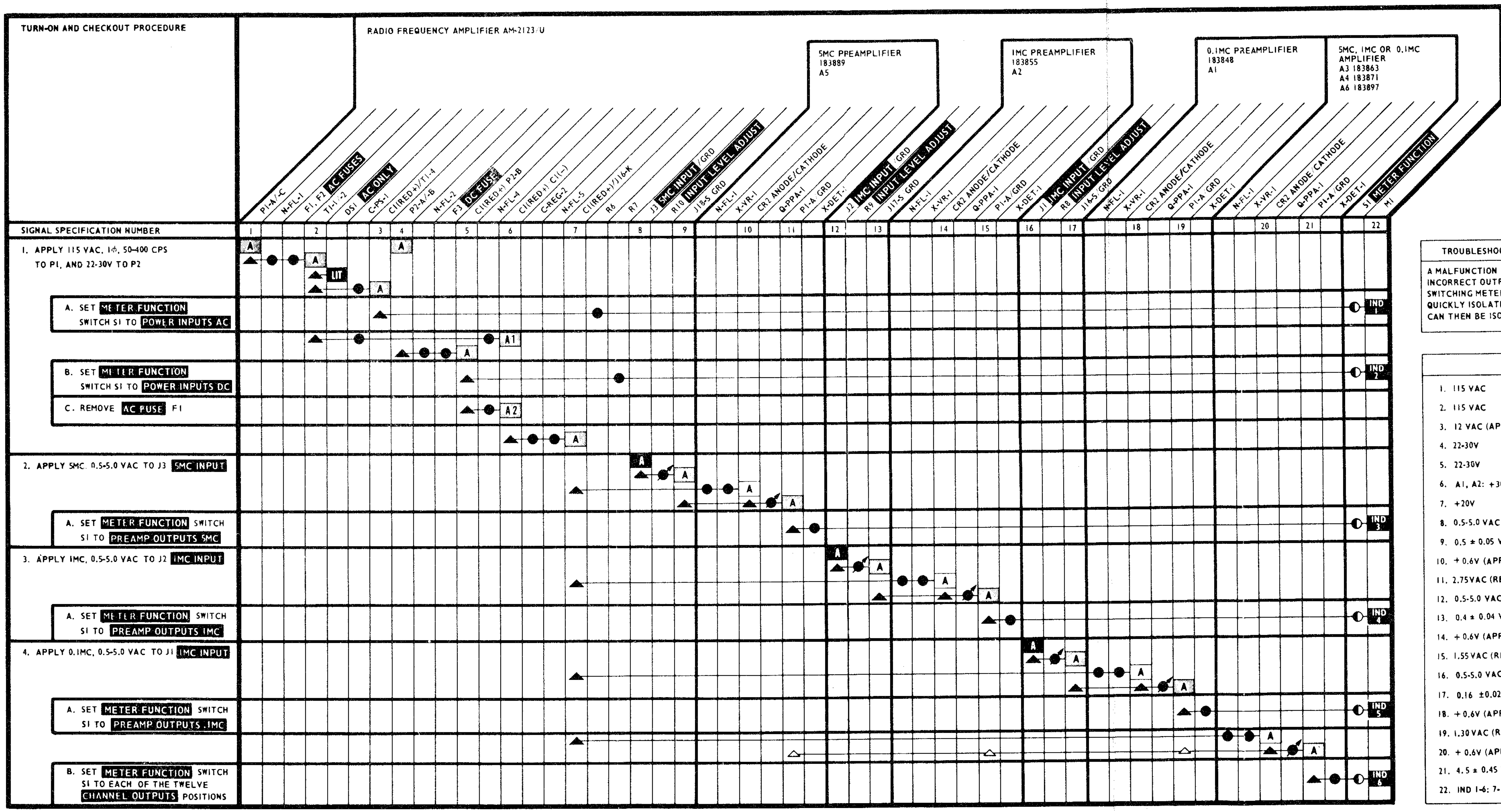


Figure 8-1.—Communication system.



LIST OF TEST EQUIPMENT

VTVM AN/USM-116 OR EQUIVALENT

TROUBLESHOOTING PROCEDURE FOR RADIO FREQUENCY AMPLIFIER AM-2123/U

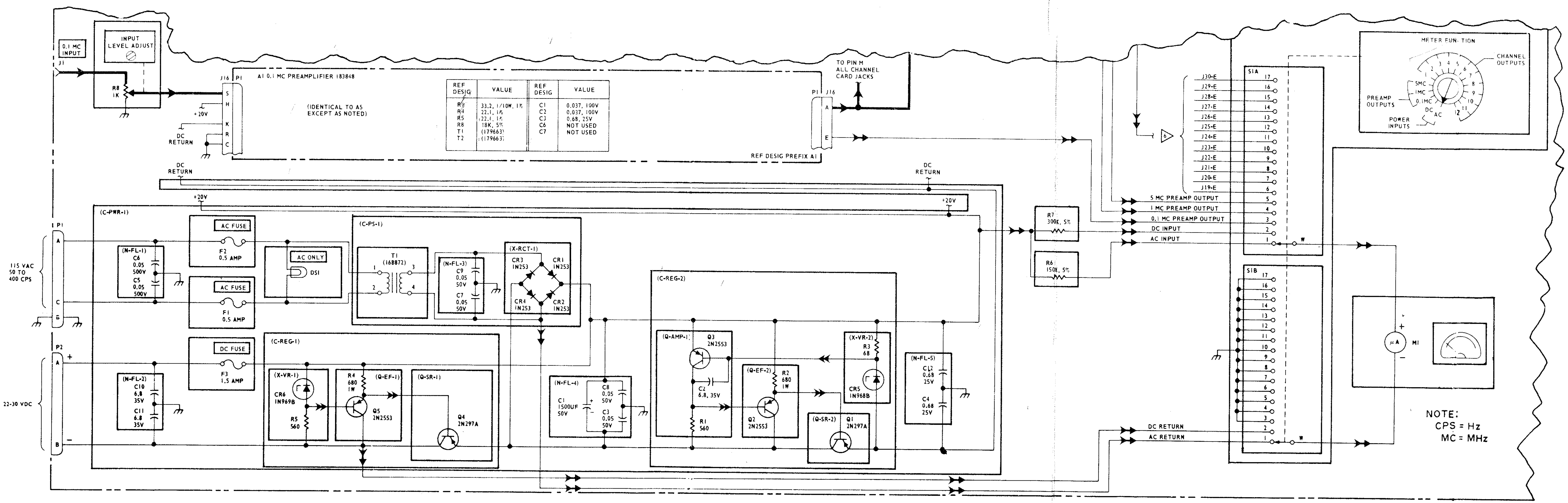
A MALFUNCTION IN THE AM-2123/U WILL BE READILY APPARENT BY NOTING AN INCORRECT OUTPUT FROM ONE OR MORE OF THE TWELVE OUTPUT CHANNELS. SWITCHING METER FUNCTION SWITCH S1 THROUGH ALL OF ITS POSITIONS WILL QUICKLY ISOLATE A MALFUNCTION TO A PARTICULAR ASSEMBLY. A MALFUNCTION CAN THEN BE ISOLATED BY SIGNAL TRACING THROUGH THE ASSEMBLY WITH A VTVM.

SIGNAL SPECIFICATIONS

1. 115 VAC
2. 115 VAC
3. 12 VAC (APPROX)
4. 22-30V
5. 22-30V
6. A1, A2: +30V
7. +20V
8. 0.5-5.0 VAC
9. 0.5 ± 0.05 VAC (REFER TO PREAMPLIFIER ALIGNMENT.)
10. + 0.6V (APPROX)
11. 2.75VAC (REFER TO PREAMPLIFIER ALIGNMENT.)
12. 0.5-5.0 VAC
13. 0.4 ± 0.04 VAC (REFER TO PREAMPLIFIER ALIGNMENT.)
14. + 0.6V (APPROX)
15. 1.55VAC (REFER TO PREAMPLIFIER ALIGNMENT.)
16. 0.5-5.0 VAC
17. 0.16 ±0.02 VAC (REFER TO PREAMPLIFIER ALIGNMENT.)
18. + 0.6V (APPROX)
19. 1.30 VAC (REFER TO PREAMPLIFIER ALIGNMENT.)
20. + 0.6V (APPROX)
21. 4.5 ± 0.45 VAC INTO 50 OHM LOAD. (REFER TO AMPLIFIER ALIGNMENT).
22. IND 1-6: 7-10 DIVISIONS

162.206

Figure 8-3.—AM-2123/U Maintenance Dependency Chart.



162.207

Figure 8-4.—AM-2123/U section of block schematic.

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ELECTRONICS TECHNICIAN 3&2, VOLUME 3

NAVEDTRA 10198

Prepared by the Naval Education and Training Program Development Center, Pensacola, Florida

Your NRCC contains a set of assignments and self-scoring answer sheets (packaged separately). The Rate Training Manual, Electronics Technician 3&2, Vol.3 NAVEDTRA 10198 , is your textbook for the NRCC. If an errata sheet comes with the NRCC, make all indicated changes or corrections. Do not change or correct the textbook or assignments in any other way.

HOW TO COMPLETE THIS COURSE SUCCESSFULLY

Study the textbook pages given at the beginning of each assignment before trying to answer the items. Pay attention to tables and illustrations as they contain a lot of information. Making your own drawings can help you understand the subject matter. Also, read the learning objectives that precede the sets of items. The learning objectives and items are based on the subject matter or study material in the textbook. The objectives tell you what you should be able to do by studying assigned textual material and answering the items.

At this point you should be ready to answer the items in the assignment. Read each item carefully. Select the BEST ANSWER for each item, consulting your textbook when necessary. Be sure to select the BEST ANSWER from the subject matter in the textbook. You may discuss difficult points in the course with others. However, the answer you select must be your own. Use only the self-scoring answer sheet designated for your assignment. Follow the scoring directions given on the answer sheet itself and elsewhere in this course.

Your NRCC will be administered by your command or, in the case of small commands, by the Naval Education and Training Program Development Center. No matter who administers your course you can complete it successfully by earning grades that average 3.2 or higher. If you are on active duty, the average of your grades in all assignments must be at least 3.2. If you are NOT on active duty, the average of your grades in all assignments of each creditable unit must be at least 3.2. The unit breakdown of the course, if any, is shown later under Naval Reserve Retirement Credit.

WHEN YOUR COURSE IS ADMINISTERED BY LOCAL COMMAND

As soon as you have finished an assignment, submit the completed self-scoring answer sheet to the officer designated to administer it. He will check the accuracy of your score and discuss with you the items that you do not understand. You may wish to record your score on the assignment itself since the self-scoring answer sheet is not returned.

If you are completing this NRCC to become eligible to take the fleetwide advancement examination, follow a schedule that will enable you to complete all assignments in time. Your schedule should call for the completion of at least one assignment per month.

Although you complete the course successfully, the Naval Education and Training Program Development Center will not issue you a letter of satisfactory completion. Your command will make a note in your service record, giving you credit for your work.

WHEN YOUR COURSE IS ADMINISTERED BY THE NAVAL EDUCATION AND TRAINING PROGRAM DEVELOPMENT CENTER

After finishing an assignment, go on to the next. Retain each completed self-scoring answer sheet until you finish all the assignments in a unit (or in the course if it is not divided into units). Using the envelopes provided, mail your self-scored answer sheets to the Naval Education and Training Program Development Center where the scores will be verified and recorded. Make sure all blanks at the top of each answer sheet are filled in. Unless you furnish all the information required, it will be impossible to give you credit for your work. You may wish to record your scores on the assignments since the self-scoring answer sheets are not returned.

The Naval Education and Training Program Development Center will issue a letter of satisfactory completion to certify successful completion of the course (or a creditable unit of the course). To receive a course-completion letter, follow the directions given on the course-completion form in the back of this NRCC.

You may keep the textbook and assignments for this course. Return them only in the event you disenroll from the course or otherwise fail to complete the course. Directions for returning the textbook and assignments are given on the book-return form in the back of this NRCC.

PREPARING FOR YOUR ADVANCEMENT EXAMINATION

Your examination for advancement is based on the Manual of Navy Enlisted Manpower and Personnel Classification and Occupational Standards, Section 1 (NAVPERS 18068). The sources of questions in the examination are given in the Bibliography for Advancement Study (NAVEDTRA 10052). Since your NRCC and textbook are among the sources listed in this bibliography, be sure to study both in preparing to take your advancement examination. The qualifications for your rating may have changed since your course and textbook were printed, so refer to the latest editions of NAVPERS 18068 and NAVEDTRA 10052.

NAVAL RESERVE RETIREMENT CREDIT

The course is evaluated at 15 Naval Reserve retirement points. Points for satisfactory completion of each creditable unit will be assigned as of the date the last assignment of the unit is mailed Points for creditable units will be assigned as follows:

Unit	Points	Assignment
1	12	1 through 6
2	3	7 through 8

These points are creditable to personnel eligible to receive them under current directives governing the retirement of Naval Reserve Personnel. Credit cannot be given again for this course if the student has previously received credit for completing another Electronics Technician 3&2, Vol. I (Communications).

COURSE OBJECTIVE

In completing this NRCC, you will demonstrate a knowledge of the subject matter by correctly answering items on the following:

Communication systems including sets, groups, units, assemblies, subassemblies, and reference designations;
types of emissions, radio set controls, transfer switchboards, transmitters;
AN/URT-23(V) Radio Transmitters;
R-1051/URR Radio Receiver; and antennas

Teletype systems, Fleet Multichannel Broadcast System including the AN/SRR-19 and 19A LF Receiver, and the AN/UCC-1(V) Telegraph Terminal Set

Communication System Equipment configurations, including low, high, very high, and ultra-high frequencies

Facsimile systems including simplex, the TT-321 A/UX Facsimile Receiver-Transmitter, the MD-168 A/UX Radio Modulator, the KY-44C/FX Keyer Adapter, the CV-1066B/UX Frequency-Shift Converter, and the AN/UXH-2B Facsimile Recorder Set

Satellite Communications; and Maintenance of Communication Systems

While working on this nonresident career course, you may refer freely to the text. You may seek advice and instruction from others on problems arising in the course, but the solutions submitted must be the result of your own work and decisions. You are prohibited from referring to or copying the solutions of others, or giving completed solutions to anyone else taking the same course.

Naval nonresident career courses may include a variety of items -- multiple-choice, true-false, matching, etc. The items are not grouped by type; regardless of type, they are presented in the same general sequence as the textbook material upon which they are based. This presentation is designed to preserve continuity of thought, permitting step-by-step development of ideas. Some courses use many types of items, others only a few. The student can readily identify the type of each item (and the action required of him) through inspection of the samples given below.

MULTIPLE-CHOICE ITEMS

Each item contains several alternatives, one of which provides the best answer to the item. Select the best alternative and erase the appropriate box on the answer sheet.

SAMPLE

s-1. The first person to be appointed Secretary of Defense under the National Security Act of 1947 was

1. George Marshall
2. James Forrestal
3. Chester Nimitz
4. William Halsey

The erasure of a correct answer is indicated in this way on the answer sheet:

	1 T	2 F	3	4	
s-1		C			

TRUE-FALSE ITEMS

Determine if the statement is true or false. If any part of the statement is false the statement is to be considered false. Erase the appropriate box on the answer sheet as indicated below.

SAMPLE

s-2. Any naval officer is authorized to correspond officially with a bureau of the Navy Department without his commanding officer's endorsement.

The erasure of a correct answer is also indicated in this way on the answer sheet:

	1 T	2 F	3	4	
s-2		CC			

MATCHING ITEMS

Each set of items consists of two columns, each listing words, phrases or sentences. The task is to select the item in column B which is the best match for the item in column A that is being considered. Items in column B may be used once, more than once, or not at all. Specific instructions are given with each set of items. Select the numbers identifying the answers and erase the appropriate boxes on the answer sheet.

SAMPLE

In items s-3 through s-6, match the name of the shipboard officer in column A by selecting from column B the name of the department in which the officer functions.

A. Officers	B. Departments
s-3. Damage Control Assistant	1. Operations Department
s-4. CIC Officer	2. Engineering Department
s-5. Assistant for Disbursing	3. Supply Department
s-6. Communications Officer	

The erasure of a correct answer is indicated in this way on the answer sheet:

	1 T	2 F	3	4	
s-3		C			
s-4	C				
s-5			C		
s-6	C				

How To Score Your Immediate Knowledge of Results (IKOR) Answer Sheets

	1 T	2 F	3	4	
1		C	6		1
2	C	9		9	2
3			C		
4	CC	12			1

Total the number of incorrect erasures (those that show page numbers) for each item and place in the blank space at the end of each item.

Sample only

Number of boxes erased incorrectly	0-2	3-7	8-
Your score	4.0	3.9	3.8

Now TOTAL the column(s) of incorrect erasures and find your score in the Table at the bottom of EACH answer sheet.

NOTICE: If, on erasing, a page number appears, review text (starting on that page) and erase again until "C", "CC", or "CCC" appears. For courses administered by the Center, the maximum number of points (or incorrect erasures) will be deducted from each item which does NOT have a "C", "CC", or "CCC" uncovered (i.e., 3 pts. for four choice items, 2 pts. for three choice items, and 1 pt. for T/F items).

Assignment 1

Introduction to Communication Systems

Textbook Assignment: ET 3 & 2, Vol. 3, NAVEDTRA 10198; pages 1-1 through 1-16

Learning Objective: Define an electronic system and its sub-divisions.

1-1. A communications system has ______(a)______ with one set/two or more sets ______(b)______ separate/similar identities.

1. (a) one set (b) separate
2. (a) one set (b) similar
3. (a) two or more sets (b) separate
4. (a) two or more sets (b) similar

1-2. Which of the following designators is the largest designator that describes an equipment that performs a specific operational function?

1. A group
2. A set
3. A system
4. A unit

1-3. A set is contained within which of the following designators?

1. An assembly
2. A group
3. A system
4. A unit

1-4. Which of the following items, when combined, form a complete set?

1. Parts and subassemblies
2. Units, assemblies, subassemblies, and parts
3. Systems, groups, subassemblies, and parts
4. Systems, groups, and units

1-5. Which of the following statements describes a characteristic of a group?

1. Not capable of performing a complete operational function
2. Not normally subject to disassembly
3. Normally capable of independent operation
4. Performs a specific operational function

1-6. A group is contained within which of the following designators?

1. An assembly
2. A part
3. A set
4. A unit

1-7. Which of the following statements is characteristic of a unit?

1. Not normally subject to disassembly
2. Normally capable of independent operation
3. Normally requires power and signal from another source
4. Performs a specific operational function

1-8. Which of the following items are contained within a unit?

1. Assemblies, subassemblies, and parts
2. Groups, assemblies, and parts
3. Sets, groups, subassemblies, and parts
4. Systems, sets, and parts

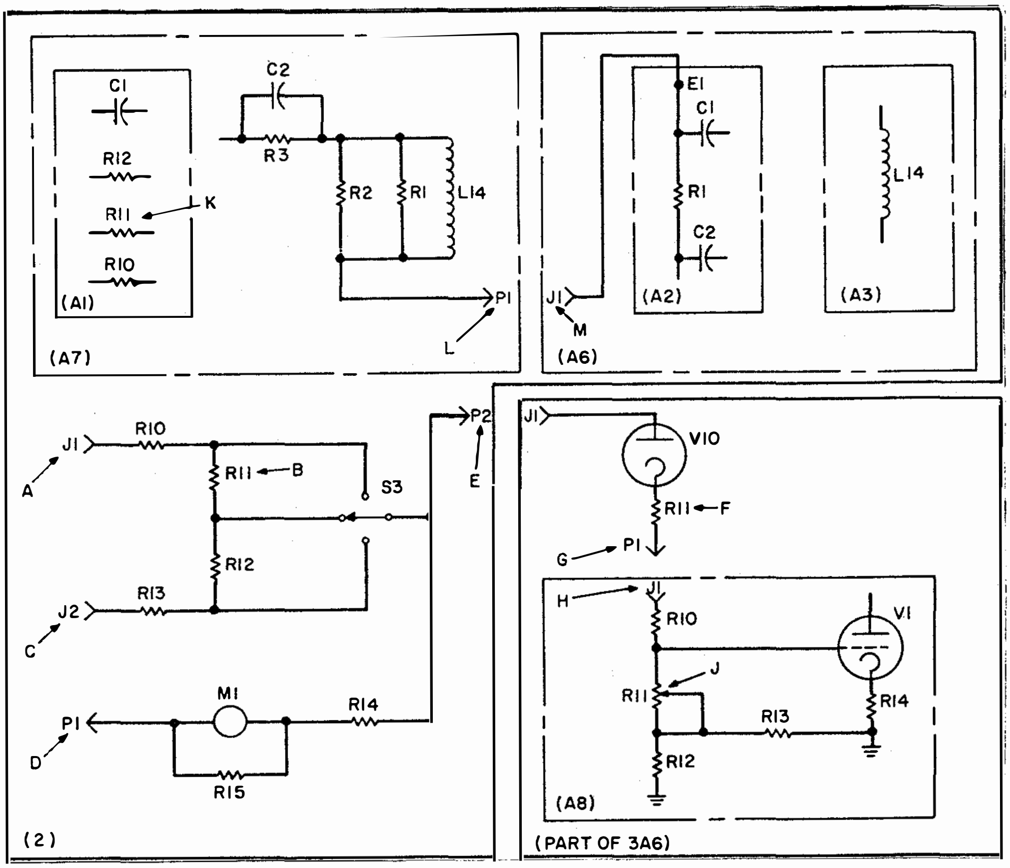


Figure 1-A.—Reference designations

1-9. Which of the following items are contained within an assembly?

1. Groups and units
2. Units and parts
3. Subassemblies and parts
4. Parts only

1-10. Which of the following items is NOT normally subject to disassembly?

1. An assembly
2. A part
3. A subassembly
4. A unit

REFER TO FIGURE 1-4 OF THE TEXT WHEN ANSWERING ITEMS 1-11 AND 1-12.

1-11. What is the "AN" nomenclature of the Antenna Coupler Control Unit?

1. AM-xxxx/URT
2. AN/URA-xx
3. C-xxxx/URA-xx
4. CU-xxxx/URA-xx

1-12. What is the "AN" nomenclature of the Power Supply Unit?

1. PP-xxxx-URT
2. T-xxx/URT
3. C-xxxx/URA-xxx
4. AM-xxxx/URT

REFER TO FIGURE 1-A WHEN ANSWERING ITEMS 1-13 THROUGH 1-15.

1-13. What part has the reference designation 2P1?

1. D
2. E
3. G
4. L

1-14. What part has the reference designation 2A7P1?

1. D
2. E
3. G
4. L

1-15. What is the reference designation for part "J"?

1. 2A6A8R11
2. 2A7A1R11
3. 3A6A8R11
4. 3A6R11

Learning Objective: Describe the frequency spectrum and its use by the Navy.

1-16. What is the frequency range of the vhf band?

1. 300 to 3,000 kHz
2. 3,000 to 30,000 kHz
3. 30 to 300 MHz
4. 300 to 3,000 MHz

1-17. Which of the following bands is most often used for shipboard communications?

1. Lf
2. Mf
3. Hf
4. Uhf

1-18. The shf and ehf bands are normally used for which of the following purposes?

1. Citizens band transmissions
2. Emergency weather broadcasts
3. Radar
4. Celestial navigation

Learning Objective: Describe the configuration of a communications system including the various types of equipment associated with the system and their uses.

1-19. The handset is used to convert acoustical energy to electrical energy and vice versa. For which of the following other purposes is it used?

1. To place the transmitter on the air
2. To tune the transmitter
3. To adjust the power output of the transmitter
4. To apply primary power to the transmitter

1-20. Which of the following is a purpose of the radio set control unit?

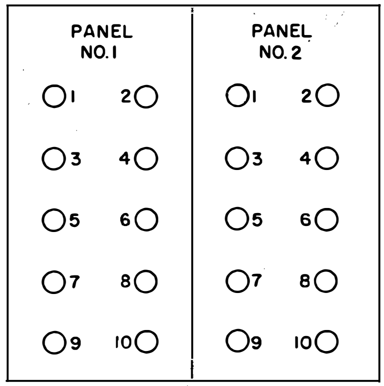
1. It amplifies the input signal
2. It controls the audio output of the receiver
3. It couples the received signal from the antenna
4. It transmits the signal

1-21. Using the transmitter transfer switchboard, what is the maximum number of remote control stations which may be connected to one transmitter?

1. One
2. Two
3. Five
4. Ten

1-22. Using the transmitter transfer switchboard, what is the maximum number of transmitters which may be connected to any remote control station?

1. One
2. Two
3. Five
4. Ten



PANEL NO. 1 SWITCH POSITIONS	PANEL NO. 2 SWITCH POSITIONS	SWITCH	REMOTES
1 XMTR NO. 1	1 XMTR NO. 6	NO. 1	RPU NO. 1 CIC
2 XMTR NO. 2	2 XMTR NO. 7	NO. 2	RPU NO. 2 CIC
3 XMTR NO. 3 USB	3 TRNK NO. 3	NO. 3	RPU NO. 3 CIC
4 XMTR NO. 3 LSB	4 TRNK NO. 4	NO. 4	RPU NO. 4 BRIDGE
5 XMTR NO. 4	5	NO. 5	RPU NO. 5 BRIDGE
6 XMTR NO. 5	6	NO. 6	RPU NO. 6 RDO CENT
		NO. 7	TRUNK NO. 1
		NO. 8	TRUNK NO. 2
		NO. 9	RPU NO. 7 EMERG RDO
		NO. 10	

Figure 1-B.—Transmitter Transfer Switchboard.

TO ANSWER ITEMS 1-23 AND 1-24, REFER TO FIGURE 1-B. FIGURE 1-B SHOWS TWO TRANSMITTER TRANSFER SWITCHBOARDS WITH A LIST OF THE REMOTE CONTROL UNITS AND THEIR CORRESPONDING SWITCH NUMBERS, AND A LIST OF THE TRANSMITTERS WITH THEIR PANEL NUMBER AND SWITCH POSITIONS.

1-23. Which of the following switch positions will establish a connection between XMTR #7 and RPU #7?

1. Panel #1, switch #9, position #2; panel #2, switch #9, position OFF
2. Panel #1, switch #9, position X; panel #2, switch #9, position #2
3. Panel #1, switch #2, position #9
4. Panel #2, switch #2, position #1

1-24. Which of the following switch positions will establish a connection between XMTR #3 USB and RPU #1, and RPU #4?

1. Panel #1, switch #1, position #3; panel #1, switch #4 position #3
2. Panel #1, switch #3, position #1; panel #1, switch #3, position #4
3. Panel #1, switch #1, position #1; panel #2, switch #1, position #4
4. Panel #2, switch #1, position #3; panel #2, switch #4, position #3

1-25. What circuits are connected or transferred by the receiver transfer switchboard?

1. Receiver audio outputs to the remote control units
2. Receiver rf inputs from the antennas
3. Remote control unit audio outputs to the receivers
4. Remote receiver controls to the receivers

1-26. On the receiver transfer switchboard what is the maximum number of remote control audio circuits which may be connected to any one receiver?

1. One
2. Two
3. Five
4. Ten

Learning Objective: Describe the capabilities, purpose, and relationship of each of the major units of the AN/URT-23.

1-27. What is the power output capability of the AN/URT-23?

1. 100 mW
2. 250 mW
3. 150 W
4. 1 kW

1-28. What primary power inputs are utilized by the AN/URT-23?

1. 115 V 60 Hz, 208 V 60 Hz, or 440 V 60 Hz; 3 phase
2. 115 V 60 Hz, 208 V 400 Hz, or 400 V 400 Hz; single phase
3. 115 V 400 Hz, 208 V 60 Hz, or 440 V 60 Hz; 3 phase
4. 115 V 400 Hz, 3 phase; 208 V 60 Hz, single phase; or 440 V 60 Hz, single phase

1-29. What unit or group is used to match the impedance of the rf amplifier to the impedance of the antenna transmission line?

1. AM-3924(P)/URT
2. AN/URA-38
3. PP-3916/UR or PP-3917/UR
4. T-827()/URT

1-30. What unit provides excitation to the rf amplifier unit?

1. The AM-6909/URT
2. The C-3698A/URA-38
3. The PP-3916/UR or PP-3917/UR
4. The T-827()/URT

1-31. What units generate frequencies from 2.0 to 29.9995 MHz in 500 Hz steps?

1. The T-827/URT
2. The T-827A/URT
3. The T-827B/URT
4. The T-827C/URT

1-32. What unit provides the frequency band information to the rf amplifier?

1. The AM-3007/URT
2. The AM-6909/URT
3. The PP-3916/UR
4. The T-827()/URT

1-33. What unit provides the final rf power amplification in the AN/URT-23?

1. The AM-6909/URT
2. The CU-938A/URA-38
3. The PP-3916/UR
4. The T-827()/URT

1-34. What maximum number of frequency steps does the AM-6909/URT use to cover the 2 to 30 MHz frequency range?

1. 5
2. 19
3. 56,000
4. 280,000

1-35. When operating as part of the T-827()/URT, the AM-6909/URT frequency band is selected by

1. a direct drive band selection switch in the T-827()/URT
2. a five-wire code from the T-827()/URT
3. a manual frequency selector switch on the front panel of the AM-6909/URT
4. an automatic frequency detector circuit in the AM-6909/URT

1-36. What circuits in the AM-6909/URT are selected by the bandswitch assemblies?

1. Input and interstage tuned transformers
2. Input, interstage, and output tuned transformers
3. Input and output tuned transformers
4. Interstage and output tuned transformers

1-37. Where are most of the low voltages produced that are required for the operation of the AM-6909/URT?

1. In the AM-3007/URT
2. In the AM-6909/URT
3. In the PP-3916/UR
4. In the T-827()/URT

1-38. What unit provides the high voltages for the operation of the AM-6909/URT?

1. The AM-3007/URT or the AM-6909/URT
2. The C-3698A/URA-38 or the CU-938A/URA-38
3. The PP-3916/UR or the PP-3917/UR
4. The T-827()/URT

1-39. What controls are located behind the hinged access cover on the AM-6909/URT?

1. The excitation level control, the overload reset switch, and the primary power switch
2. The initial setup controls
3. The key switch, the manual frequency selector switch, and the metering switch
4. The operating controls and indicators

1-40. How are the AM-6909/URT components cooled?

1. By an internal blower and a distilled water heat exchanger
2. By an internal blower using external air
3. By natural air convection
4. By radiation from the outer case

1-41. What are the primary power input voltages of (a) the PP-3916/UR and (b) the PP-3917/UR?

1. (a) 115 V 60 Hz, 3 phase
   (b) 208 V or 440 V 400 Hz, 3 phase
2. (a) 208 V or 440 V 60 Hz, 3 phase
   (b) 115 V 400 Hz, 3 phase
3. (a) 208 V or 440 V 400 Hz, 3 phase
   (b) 115 V 60 Hz, 3 phase
4. (a) 440 V 60 Hz, 3 phase
   (b) 28 V d.c. or 115 V 400 Hz, 3 phase

1-42. What unit may be mounted as a subassembly of the AM-6909/URT?

1. The C-3698A/URA-38
2. The PP-3916/UR
3. The PP-3917/UR
4. The T-827()/URT

1-43. How much rf power is required to tune the AN/URA-38 during a silent tuning operation?

1. 0 W
2. 150 W
3. 250 W
4. 1000 W

1-44. During normal operation, tuning of the CU-938A/URA-38 with the AN/URT-23 is accomplished

1. automatically by control signals from the C-3698A/URA-38
2. manually by the operator with the controls on the C-3698A/URA-38
3. manually by the operator with the frequency selector controls on the T-827()/URT
4. semiautomatically by control signals from the frequency selector circuits of the T-827()/URT

1-45. How is the tuning of the CU-938A/URA-38 accomplished during the silent tuning mode?

1. Automatically by control signals from the C-3698A/URA-38
2. Manually by the operator with the controls on the C-3698A/URA-38
3. Manually by the operator with the frequency selector controls on the T-827()/URT
4. Semiautomatically by control signals from the frequency selector circuits in the T-827()/URT

1-46. What type of rf emission is required from the T-827()/URT during the tuning operation of the AN/URA-38?

1. An AM emmission
2. A cw emmission
3. An fsk emission
4. An ssb emission

1-47. What is the maximum amount of power required during the tuning operation of the AN/URA-38?

1. 0 W
2. 150 W
3. 250 W
4. 1000 W

1-48. What is the maximum power handling capability of the AN/URA-38 after the tuning operation has been completed?

1. 0 W
2. 150 W
3. 250 W
4. 1000 W

1-49. What type of heat transfer medium is used inside the CU-938A/URA-38?

1. Deionized distilled water
2. Pressurized dry air
3. Pressurized dry freon gas
4. Pressurized dry nitrogen gas

1-50. Which of the following is a purpose of the heat transfer medium in the CU-938A/URA-38?

1. To improve heat transfer
2. To prevent arcing
3. To prevent corona
4. Each of the above

1-51. What method is used to remove the heat from the case of the CU-938A/URA-38?

1. A distilled water to fresh water heat exchanger
2. A gas to distilled water heat exchanger and conduction through the case legs to the ship's hull
3. Continuous release of the internal pressurized gas
4. Convection to the atmosphere from the bottom of the case and conduction to the ship's hull through the mounting feet

1-52. Which unit provides the power and control signals for the CU-938A/URA-38?

1. The AM-6909/URT
2. The C-3698A/URA-38
3. The PP-3916/UR or PP-3917/UR
4. The T-827()/URT

Learning Objective: Describe the T-827()/URT by determining operational functions and explaining the purpose, and relationship of the assemblies and subassemblies. (Continued in Assignment 2.)

1-53. What is the output frequency range of the T-827()/URT?

1. 2.0 to 29.9500 MHz
2. 2.0 to 29.9995 MHz
3. 2.0 to 29.9999 MHz
4. 2.0 to 30.0000 MHz

1-54. What are the emission modes of the T-827()/URT?

1. AM, fsk, isb, mcw, and ssb
2. AM, fsk, lsb, mcw, and usb
3. Compatible AM, cw, fsk, and ssb
4. Compatible AM, cw, fsk, isb, lsb, and usb

1-55. What is the rf power output level of the T-827()/URT?

1. 100 mW
2. 250 mW
3. 150 W
4. 1000 W

WHEN ANSWERING ITEMS 1-56 AND 1-57, REFER TO FIGURE 1-15 OF THE TEXT.

1-56. To what positions will the controls be set when the assigned frequency is 14.273 MHz?

	10 MHz	1 MHz	100 kHz	10 kHz	1 kHz	Hz
1.	0	1	4	2	7	300
2.	0	14	2	7	3	000
3.	1	4	2	7	3	000
4.	14	2	7	3	0	000

1-57. To what positions will the controls be set when the assigned frequency is 7.2715 MHz?

	10 MHz	1 MHz	100 kHz	10 kHz	1 kHz	Hz
1.	0	0	7	2	7	150
2.	0	7	2	7	1	000
3.	0	7	2	7	1	500
4.	7	2	7	1	5	000

1-58. What assembly contains the internal frequency standards?

1. A2A5
2. A2A6
3. A2A6A1
4. A2A6A5

1-59. What is the standard frequency of the T-827()/URT?

1. 10 MHz
2. 5 MHz
3. 1 MHz
4. 500 kHz

1-60. What external input frequency can be applied to the T-827()/URT to replace the internal standard?

1. 10 MHz
2. 5 MHz
3. 1 MHz
4. 500 kHz

1-61. How can an external standard frequency be used in the T-827()/URT?

1. As the carrier reinsertion frequency
2. As a replacement for the internal standard frequency or as the frequency against which the internal standard is compared
3. As the standard frequency to which the internal standard is phase locked
4. To provide a spectrum of frequencies against which all internally generated frequencies are compared

1-62. What is/are the output frequency(ies) of the frequency standard electronic assembly?

1. 500 kHz, 1MHz, 5 MHz, and 10 MHz
2. 500 kHz, 1 MHz, and 10 MHz
3. 1 MHz, 5 MHz, and 10 MHz
4. 5 MHz only

1-63. What is the frequency of the carrier signal applied to the balanced modulators?

1. 300 to 3000 Hz
2. 500 kHz
3. 1 MHz
4. 5 MHz

1-64. Which of the following modes of operation require(s) the use of both balanced modulators?

1. The AM or fsk mode
2. The cw or mcw mode
3. The isb mode
4. The usb mode

1-65. What mode of operation does NOT utilize the balanced modulators?

1. The AM mode
2. The AM or fsk mode
3. The cw mode
4. The isb mode

1-66. What signal is obtained from the balanced modulators?

1. The carrier plus the upper sideband
2. The carrier plus the upper and lower sidebands
3. The upper or lower sideband only
4. The upper and lower sidebands only

1-67. What part of the signal from the balanced modulators is removed by the filters?

1. The audio and the carrier
2. The carrier
3. The upper sideband and the carrier
4. Either the upper or lower sideband

1-68. What unit controls the signal level in Assembly A2A12 of the T-827()/URT?

1. The AM-6909/URT
2. The C-3698/URA-38
3. The PP-3916/UR
4. The T-827()/URT

1-69. What is the frequency of the first IF signal?

1. 500.0 kHz
2. 2.9 MHz
3. 20.5 MHz
4. 30.5 MHz

1-70. What signal is mixed with the first IF to produce the second IF?

1. 500 kHz injection
2. 1 and 10 kHz injection
3. 100 kHz injection
4. MHz injection

1-71. What is the frequency of the second IF signal?

1. 28.0 to 0.29 MHz
2. 2.8 to 2.90 MHz
3. 28.0 to 29.00 MHz
4. 280.0 to 290.00 MHz

1-72. What signal is combined with the second IF in the midfrequency mixer?

1. 500 kHz carrier reinsertion
2. 1 and 10 kHz injection
3. 100 kHz injection
4. MHz injection

1-73. Which of the following frequencies are used as the third IF signal?

1. 1 and 10 kHz
2. 500 kHz, 1.0 MHz
3. 2.8 to 2.9 MHz or 3.3 to 3.4 MHz
4. 19.5 to 20.5 MHz or 29.5 to 30.5 MHz

1-74. Which of the following signals is combined with the third IF to produce the rf output signal?

1. 500 kHz injection
2. 1 and 10 kHz injection
3. 100 kHz injection
4. MHz injection

1-75. Which assembly or subassembly contains the high frequency mixer?

1. A2A1
2. A2A4
3. A2A6A1
4. A2A6A6

Assignment 2

Introduction to Communications Systems

Textbook Assignment: ET 3 & 2, Vol. 3, NAVEDTRA 10198; pages 1-16 through 1-28

Learning Objective (continued): Describe the T-827()/URT by determining operational functions and explaining the purpose and relationship of the assemblies and subassemblies.

2-1. What circuits of rf Amplifier A2A4 are tuned by the signals from the code generator assembly?

1. The input, interstage, and output circuits
2. The input and interstage circuits
3. The input and output circuits
4. The interstage and output circuits

2-2. An audio input is applied to the T-827()/URT during which of the following modes of operation?

1. AM, fsk, isb, usb, lsb
2. AM, isb, lsb, usb
3. Cw, fsk
4. Isb, lsb, usb

2-3. Which of the following subassemblies control(s) the 500 kHz carrier signal during cw operation?

1. The 500 kHz IF amplifiers
2. The balanced modulators
3. The control gates sidetone oscillator
4. The tty generator

2-4. What is the output frequency range of the 10 kHz oscillator?

1. 1.850 to 1.859 MHz
2. 3.301 to 3.400 MHz
3. 4.553 to 5.453 MHz
4. 5.250 to 5.160 MHz

2-5. What is the output frequency range of the 100 kHz oscillator?

1. 2.500 to 23.500 MHz
2. 3.301 to 3.400 MHz
3. 4.553 to 5.453 MHz
4. 22.400 to 23.300 MHz

2-6. The injection signal from A2A6A2 during hi-band operation is

1. 12.394 to 13.294 MHz
2. 22.394 to 23.294 MHz
3. 22.400 to 23.300 MHz
4. 32.400 to 33.300 MHz

2-7. What is the frequency range of the MHz injection signal?

1. 1.0 to 25.0000 MHz
2. 2.0 to 29.9995 MHz
3. 2.0 to 30.0000 MHz
4. 2.5 to 23.5000 MHz

2-8. The accuracy of the MHz oscillator depends upon the

1. accuracy of the 5 MHz frequency standard
2. error cancelling loop in the high frequency mixer
3. stability of code generator A2A7
4. stability of the primary power input voltage

2-9. The output of the 100 kHz oscillator is 4.753 MHz. What is the frequency of the spectrum point that will produce the desired output from the 10.747 MHz mixer?

1. 5.994 MHz
2. 10.747 MHz
3. 15.500 MHz
4. 17.847 MHz

2-10. What frequencies are combined to produce an input to the hi-band mixer?

1. 4.553 to 5.453 MHz and 27.847 MHz
2. 4.553 to 5.453 MHz and 15.3 to 16.2 MHz
3. 7.1 MHz and 10.747 MHz
4. 100 kHz and 27.847 MHz

2-11. Which of the following frequencies are the (a) input and the (b) output frequencies of the spectrum generator that is utilized by 10 kHz synthesizer?

1. (a) 5 kHz (b) 0.110 to 0.115 MHz
2. (a) 10 kHz (b) 0.122 to 0.131 MHz
3. (a) 100 kHz (b) 3.820 to 3.910 MHz
4. (a) 500 kHz (b) 15.300 to 16.200 MHz

2-12. The output of the 1 kHz oscillator is 1.850 MHz. What is the frequency of the spectrum point that will produce the desired output frequency from the 1.981 MHz mixer?

1. 0.122 MHz
2. 0.131 MHz
3. 3.831 MHz
4. 3.880 MHz

2-13. What is the output frequency of the 500 Hz oscillator when the CPS switch is in the 000 position?

1. 0.0 Hz
2. 11.0 kHz
3. 110.0 kHz
4. 7.1 MHz

Learning Objective: Describe the AM-6909/URT by explaining the purpose, operational functions, and relationships of the assemblies and subassemblies.

2-14. What voltages are utilized by the rf amplifier tubes?

1. +20 volts, +28 volts
2. +20 volts, +110 volts
3. +28 volts, -30 volts
4. +110 volts, -30 volts

2-15. How many stages of amplification are used in the AM-6909/URT?

1. One
2. Two
3. Five
4. Four

2-16. What circuit provides the required signals to the APC and PPC circuits?

1. The driver amplifier
2. The metering circuit
3. The power meter circuit
4. The vswr bridge

2-17. What condition causes the decoder and bandswitch assemblies in the AM-6909/URT to stop rotating?

1. A ground is applied to the tuning circuit
2. An open placed in the ground path to the tuning circuit
3. The key inhibit signal is removed from the AM-6909/URT
4. The vswr of the amplifier falls below 2.1

2-18. What prevents the T-827()/URT from being keyed while the AM-6909/URT is tuning?

1. A high vswr signal from the AM-6909/URT
2. A key inhibit signal from the AM-6909/URT tuning circuit
3. An inhibit signal from the APC-PPC circuit
4. The high voltage power supply interlock

2-19. What signal, if any, controls the bias voltage of the driver amplifier?

1. The APC
2. The PPC
3. The agc
4. None of the above

2-20. What class of drive signal is supplied to the bias power supply during cw or fsk operation?

1. Class A
2. Class AB
3. Class B
4. Class C

2-21. Which, if any, of the following actions will allow the AM-6909/URT to be operated during a constant overload condition?

1. Disable the audible alarm and reset the overload circuit
2. Hold the reset switch in the operate position
3. Turn the reset switch to the emergency operate position
4. None of the above

2-22. Which of the following events will occur when the system keyline is grounded?

1. The AM-6909/URT will be keyed on
2. The keying circuit will be inhibited
3. The T-827()/URT will be unkeyed
4. The tuning motor will be energized

2-23. Which of the following conditions will cause the AM-6909/URT keying circuit to be inhibited?

1. A ground key interlock signal is supplied by the AN/URA-38
2. The RESET switch is depressed
3. The tuning motor is energized
4. Each of the above

2-24. Which of the following parameters is/are measured by the metering circuit?

1. The cathode current of each power amplifier tube
2. The plate and screen supply voltages
3. The rf input power to the drive amplifier
4. Each of the above

Learning Objective: Describe the capabilities, purposes, and relationships of each of the assemblies and subassemblies of the R-1051/URR by listing the input frequency range, rf input modes; tracing the signal flow from the rf input to the audio outputs; and explaining the frequency generation methods.

2-25. What is the input frequency range of the R-1051/URR?

1. 2.0 to 29.9990 MHz
2. 2.0 to 29.9995 MHz
3. 2.0 to 29.9999 MHz
4. 2.0 to 30.0000 MHz

2-26. Which of the following signals may be received and demodulated by the R-1051/URR?

1. The AM, cw, fm, fsk, lsb, and usb
2. The AM, cw, fsk, isb, lsb, and usb
3. The AM, fm, fsk, lsb, and usb
4. The fm, fsk, isb, mcw, lsb, and usb

2-27. Against which of the following rf input voltage levels will antenna overload circuit A2A9 protect the rf amplifier?

1. A signal in excess of 8 volts
2. A signal between 7 volts and 8 volts
3. A signal between 5 volts and 7 volts
4. A signal below 5 volts

2-28. Which of the following frequency selection controls is/are used to tune the circuits in the rf amplifier stages?

1. MCS
2. MCS, 100 kHz, and 10 kHz
3. MCS, 100 kHz, 10 kHz, and 1 kHz
4. 100 kHz, 10 kHz, and 1 kHz

2-29. What is the frequency range of the first IF signal?

1. 2.7 to 2.8 MHz
2. 2.8 to 2.9 MHz
3. 3.301 to 3.400 MHz or 5.25 to 5.16 MHz
4. 19.5 to 20.5 MHz or 29.5 to 30.5 MHz

2-30. What is the frequency range of the second IF signal?

1. 2.700 to 2.8 MHz
2. 2.800 to 2.9 MHz
3. 3.301 to 3.4 MHz
4. 19.500 to 20.5 MHz

2-31. The usb mechanical filter is used for what input modes?

1. The AM and cw
2. The AM, cw, and usb
3. The fsk, isb, and usb
4. The isb and usb

2-32. Which of the following IF amplifiers is/are gated on during isb operation?

1. A2A1 only
2. A2A1, and A2A2
3. A2A2, and A2A3
4. A2A3 only

2-33. Which signals are demodulated by the product detector in Assembly A2A3?

1. The AM and cw
2. The fsk, isb, and usb
3. The fsk, isb, lsb, and usb
4. The isb and lsb

2-34. What mode of reception requires a bfo signal from A2A1?

1. The AM mode
2. The cw mode
3. The fsk mode
4. The usb mode

2-35. What control determines the overall audio level in Assembly A2A2?

1. The USB LINE LEVEL
2. The USB PHONE LEVEL
3. The LSB LINE LEVEL
4. The LSB PHONE LEVEL

2-36. Which audio output signals are measured by the LINE LEVEL meters?

1. Local audio levels
2. Remote audio levels
3. Both local and remote audio levels
4. Local sidetone and local phone levels

2-37. What circuits are controlled by the signal from the step agc circuit?

1. Detector subassembly and IF amplifiers
2. IF amplifiers only
3. IF and rf amplifiers
4. Mode gate subassembly and rf amplifiers

2-38. What is the standard frequency of the R-1051/URR?

1. 500 kHz
2. 1 MHz
3. 5 MHz
4. 10 MHz

2-39. How is the external standard frequency utilized in the R-1051/URR?

1. As the carrier reinsertion frequency
2. As a replacement for the internal standard frequency or as the frequency against which the internal standard is compared
3. As the standard frequency to which the internal standard is phase locked
4. To provide a spectrum of frequencies against which all internally generated frequencies are compared

2-40. What assembly or subassembly produces the first injection signal?

1. A2A6A1, MHz synthesizer
2. A2A6A2, 100 kHz synthesizer
3. A2A6A3, 1 and 10 kHz synthesizer
4. A2A6A4, 500 kHz synthesizer

2-41. What is the frequency range of the first injection signal?

1. 2.5 to 23.5 MHz
2. 3.301 to 3.400 MHz
3. 17.847 to 27.847 MHz
4. 22.4 to 23.3 MHz or 32.4 to 33.3 MHz

2-42. What frequencies are combined in Subassembly A2A6A2 to produce the 10-band injection signal?

1. 1.850 to 1.859 MHz minus 5.25 to 5.16 MHz
2. 4.553 to 5.453 MHz plus 17.847 MHz
3. 4.553 to 5.453 MHz plus 27.847 MHz
4. 5.25 to 5.16 MHz minus 1.981 MHz

2-43. To what mixer is the output of the 100 kHz synthesizer applied?

1. The low frequency mixer
2. The midfrequency mixer
3. The high frequency mixer
4. The high frequency mixer during hi-band operation

2-44. What front panel control determines the output frequency of the 5.25 to 5.16 MHz oscillator?

1. 1 kHz (KCS)
2. 10 kHz (KCS)
3. 100 kHz (KCS)
4. MHz (MCS)

2-45. What assembly provides the operating voltages for the R-1051/URR?

1. The A2A4
2. The A2A5
3. The A2A8
4. The A2A9

2-46. What voltage provides the bias for the rf amplifier tubes?

1. -30 volts
2. +20 volts
3. +28 volts
4. +110 volts

2-47. What is the input voltage to the d.c. regulator circuit?

1. -30 volts
2. +20 volts
3. +28 volts
4. +110 volts

Learning Objective: Describe the various capabilities and limitations of common Navy antenna distribution systems.

2-48. All ____(a)____ receiving, transmitting antenna distribution systems ____(b)____ equipped with are, are not interlock circuits for protection

1. (a) receiving (b) are
2. (a) receiving (b) are not
3. (a) transmitting (b) are
4. (a) transmitting (b) are not

2-49. What total number of radio frequency channels is provided by the AN/SRA-12?

1. Five
2. Six
3. Seven
4. Eight

Learning Objective: Describe Antenna Coupler Groups AN/SRA-56, -57, and -58 with respect to the purpose of the multicouplers, functions of various assemblies, and operation.

2-50. What is the primary purpose of Antenna Coupler Groups AN/SRA-56, -57, and -58?

1. They allow several transmitters to use a single antenna
2. They allow several antennas to be used with a single transmitter
3. They allow several receivers to use a single antenna
4. They allow several antennas to be used with a single receiver

2-51. Antenna Coupler Groups provide which of the following services?

1. Transmitter isolation
2. Suppression of spurious transmitter outputs
3. Antenna impedance matching
4. Each of the above

2-52. What antenna type is used with Antenna Coupler Group AN/SRA-56?

1. Broadband antenna, 2 to 6 MHz
2. Directional antenna, 2 to 4 MHz
3. Longwire antenna, 6 to 8 MHz
4. Omnidirectional antenna, 4 to 5 MHz

2-53. Antenna Coupler Group AN/SRA-58 can be operated in what configuration?

1. Four channels, 4 to 12 MHz
2. Four channels, 10 to 30 MHz
3. Eight channels 2 to 6 MHz
4. Four or eight channels, 10 to 30 MHz

2-54. Which of the following assemblies is interchangeable between channel #1 and channel #4 of AN/SRA-56?

1. Bandpass filter
2. Operate reflectometer
3. Rf relay
4. Each of the above

2-55. What, if any, additional equipment is needed to operate the AN/SRA-58?

1. A power supply
2. A remote control unit
3. An rf monitor
4. None

2-56. What are the input power range limits for the AN/SRA-58?

1. 500 watts average to 1 kw average
2. 500 watts average to 1 kw PEP
3. 500 watts PEP to 1 kw average
4. 500 watts PEP to 2 kw PEP

2-57. Channel #1 of the AN/SRA-56 is operating at a frequency of 5.570 MHz. Which of the following frequencies may be used in the AN/SRA-57 at the same time?

1. 5.292 MHz
2. 5.848 MHz
3. 5.970 MHz
4. Each of the above

2-58. Which combinations of antenna coupler groups can be operated simultaneously with a single antenna?

1. One AN/SRA-56 and one AN/SRA-57
2. One AN/SRA-57 and one AN/SRA-58
3. Two AN/SRA-56s
4. Two AN/SRA-58s

2-59. In the AN/SRA-56, rf power is supplied through assemblies 1A6A1 and 1A6A6 during what operating condition?

1. Alarm
2. Operate
3. Standby
4. Tune

TO ANSWER QUESTION 2-60, REFER TO FIGURE 4-25 OF THE TEXT.

2-60. Which of the assemblies provide signal voltages to the monitoring circuits during tuning and operation?

1. The 1A6A1, the 1A6A6, the 1A1A4, and the output resonator
2. The 1A1A4, the 1A6A2, the 1A6L1, and the input resonator
3. The 1A5, the 1A6A1, the bandpass filter, and the combining network
4. The 1A6A2, the 1A6A6, the input resonator, and the output resonator

2-61. The output of each channel of the antenna coupler group is applied to the ___(a)___ combining, impedance matching network by means of ___(b)___ capacitive, inductive coupling.

1. (a) combining (b) capacitive
2. (a) combining (b) inductive
3. (a) impedance matching (b) capacitive
4. (a) impedance matching (b) inductive

2-62. What additional assembly is required to operate two antenna coupler groups into one antenna?

1. A combining network
2. An impedance matching network
3. A monitoring circuit
4. Operate reflectometer

2-63. Which circuits are used by all channels in the AN/SRA-57?

1. The a.c. supply to the cooling fans, the audible alarm, and the d.c. power supply
2. The audible alarm, the input resonator, and the output resonator
3. The electronic Q control, the rf relay assembly, and the tune reflectometer
4. The operate reflectometer, the output coupling, and the power attenuator

Assignment 3

Introduction to Communication Systems and Teletype

Textbook Assignment: ET 3 & 2, Vol. 3, NAVEDTRA 10198; pages 1-28 through 2-12

Learning Objective: Identify some of the characteristics and the various types of communications antennas, matching networks, and distribution systems with respect to purpose, frequency range and bandwidth, impedance, and mounting methods.

TO ANSWER ITEMS 3-1, 3-2, AND 3-4 THROUGH 3-6, REFER TO FIGURE 3A.

3-1. What antennas are classed as wire antennas?

1. A, B, and C
2. B, F, and I
3. D, E, and F
4. G, H, and I

3-2. What antennas are designed and built for a particular ship or class of ship?

1. A, B, and C
2. B, E, and G
3. D, E, and F
4. G, H, and I

3-3. What is the purpose of the insulating jacket on wire rope antennas?

1. To electrically isolate the antenna from the ship's structure when transmitting or receiving
2. To eliminate personnel shock hazards when transmitting
3. To reduce interference from precipitation static when receiving
4. To reduce interference to fire control radars

3-4. What antennas require the least mounting space?

1. A, B, and C
2. A and D
3. B and E
4. D, E, and F

3-5. What antenna, if any, is at its widest frequency bandwidth?

1. A
2. B
3. C
4. None

3-6. Which antenna is normally mounted and operated in the horizontal plane?

1. A
2. C
3. G
4. I

3-7. What antenna is connected with a like antenna to provide increased performance?

1. A whip
2. A wire
3. A trussed whip
4. A five-wire vertical fan

3-8. The efficiency and power transfer capabilities of an antenna depend upon the

1. amount of rf power applied to the antenna
2. bandwidth of the antenna
3. impedance match between the transmission line and the antenna
4. type of antenna

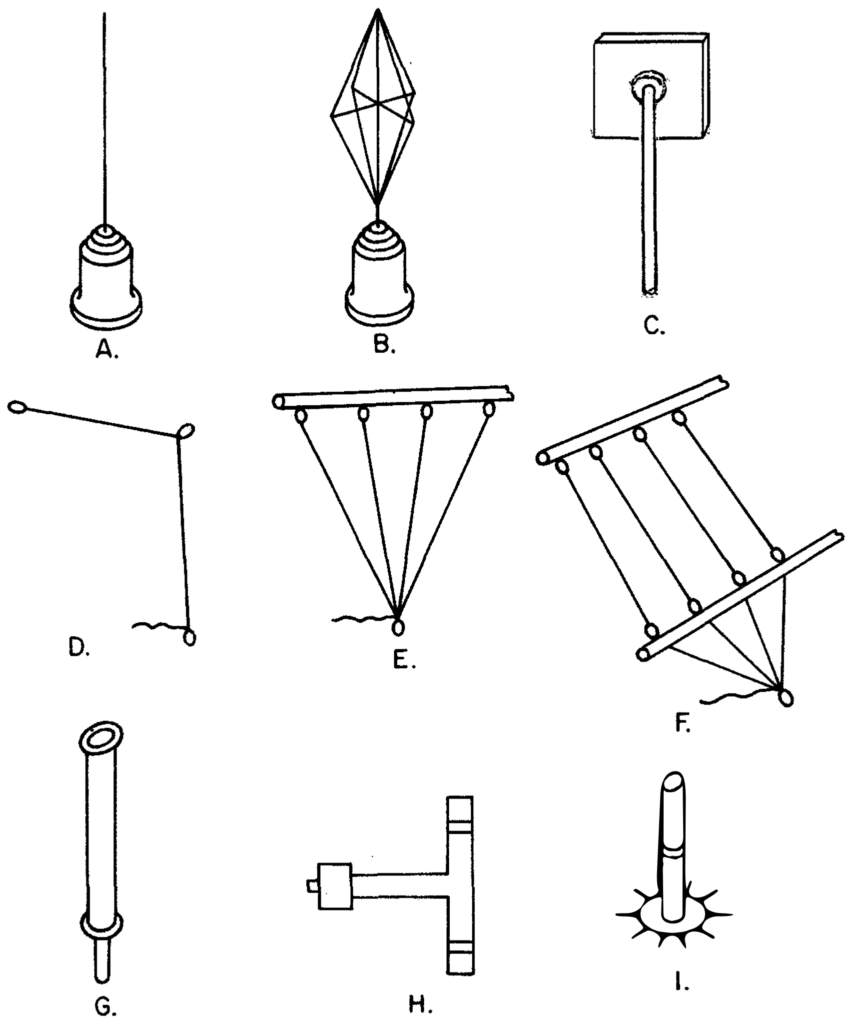


Figure 3-A.—Antennas.

3-9. The broadband antenna, referred to as a fan in the text, is constructed with its wires cut to which of the following one-quarter wavelengths?

1. The lowest frequency to be used
2. The midfrequency used
3. The highest frequency to be used
4. Double the frequency to be used

TO ANSWER ITEMS 3-10 THROUGH 3-12, REFER TO FIGURE 3A.

3-10. What antennas are used in the uhf bands?

1. B and C
2. D and G
3. E and F
4. H and I

3-11. What is the nominal input impedance of uhf antennas?

1. 25 ohms
2. 52 ohms
3. 75 ohms
4. 300 ohms

3-12. What antenna has an adjustment for the input impedance?

1. D
2. F
3. G
4. I

TO ANSWER QUESTIONS 3-13 AND 3-14, REFER TO FIGURE 4-36 OF THE TEXT.

3-13. What is the purpose of the radome?

1. It provides broader frequency coverage
2. It provides a broader radiation pattern
3. It provides a narrower radiation pattern
4. It provides protection from the elements

3-14. The antenna provides (a) broadband, narrow-band coverage with a/an (b) directional, omnidirectional radiational pattern.

1. (a) broadband
   (b) directional
2. (a) narrow-band
   (b) directional
3. (a) broadband
   (b) omnidirectional
4. (a) narrow-band
   (b) omnidirectional

3-15. What is the purpose of an antenna matching network?

1. To increase the directivity of the antenna
2. To increase the power handling capability of the antenna
3. To reduce the effective gain of the antenna
4. To reduce the voltage standing wave ratio

3-16. Antenna tuners are designed to (a) match impedances to, vary the bandwidth of antennas (b) at a fixed frequency, over a band of frequencies either manually or automatically.

1. (a) match impedances to
   (b) at a fixed frequency
2. (a) match impedances to
   (b) over a band of frequencies
3. (a) vary the bandwidth of
   (b) at a fixed frequency
4. (a) vary the bandwidth of
   (b) over a band of frequencies

Learning Objective: Describe the basic principles of operation for teletype communications equipment.

3-17. Refer to figure 5-1 in the text. When the key is closed, what is the circuit condition?

1. Spacing
2. Marking
3. Retracted
4. Attracted

3-18. The teletypewriter code signal is comprised of how many intelligence units?

1. Two
2. Five
3. Seven
4. Eight

3-19. The stop unit of a teletype (tty) character must always be a

1. double mark
2. mark
3. space
4. space followed by a mark

3-20. The transition time from space to mark is

1. instantaneous
2. measured in milliseconds
3. variable
4. followed by a space

3-21. Refer to figure 2-3 in the text. How many transitions are in the tty character shown?

1. Zero
2. Two
3. Six
4. Four

3-22. The code group for a teletype operation is of ____(a)____ [even, uneven] length and that for Morse code is of ____(b)____ [even, uneven] length.

1. (a) even (b) even
   (a) even (b) uneven
   (a) uneven (b) uneven
   (a) uneven (b) even

3-23. The characters in the five-unit code consist of

1. two synchronizing elements
2. five equal code elements
3. six equal code elements
4. seven code elements

3-24. What is the purpose of the two case-shift signals produced from the five-unit code?

1. They set the transmitting unit so it will recognize letters or numbers
2. They receive letters or numbers
3. They set the receiving unit so it will recognize letters or numbers
4. They send letters or numbers

3-25. In the ____(a)____ [nonsynchronous, synchronous] mode of operation the ____(b)____ [start, stop] element is always a space.

1. (a) nonsynchronous
   (b) start
2. (a) synchronous
   (b) stop
3. (a) nonsynchronous
   (b) stop
4. (a) synchronous
   (b) start

3-26. The duration of a code element is referred to as the

1. character length
2. intelligence length
3. unit interval
4. character interval

3-27. External timing signals are used in ____(a)____ [synchronous, nonsynchronous] teletype operation, allowing ____(b)____ [start and stop elements, shift signals] to be discarded.

1. (a) synchronous
   (b) start and stop elements
2. (a) nonsynchronous
   (b) start and stop elements
3. (a) synchronous
   (b) shift signals
4. (a) nonsynchronous
   (b) shift signals

3-28. Which of the following is an advantage of synchronous teletype systems over nonsynchronous teletype systems?

1. Synchronous teletype systems are more efficient in their use of transmission time
2. Synchronous teletype systems can transmit more often
3. Synchronous teletype systems are able to use Morse code
4. Synchronous teletype systems allow more time between character units

3-29. Which of the following modulation rate terms is the most accurate when used alone?

1. Bits per second (BPS)
2. Bits per minute (BPM)
3. Words per minute (WPM)
4. Baud

3-30. A teletype machine operates at 70 bauds using a 7 unit code. What is the maximum operating speed, in WPM, of this machine?

1. 65.0
2. 94.3
3. 100.0
4. 140.0

3-31. A teletype machine has a baud rate of 70. What is the approximate unit interval of the tty code?

1. 7.42 milliseconds
2. 14.30 milliseconds
3. 22.00 milliseconds
4. 70.00 milliseconds

3-32. A teletype machine is operating at 75 bauds using a code in which all elements are of the same time duration. What is the modulation rate in bits per second?

1. 60
2. 70
3. 75
4. 100

TO ANSWER ITEMS 3-33 THROUGH 3-36, MATCH THE CIRCUIT CURRENT IN COLUMN B TO THE CORRESPONDING CIRCUIT CONDITION IN COLUMN A. RESPONSES IN COLUMN B ARE USED ONLY ONCE.

	A. Condition	B. Current
3-33.	Neutral mark	1. Current flow
3-34.	Neutral space	2. Negative current
3-35.	Polar mark	3. No current flow
3-36.	Polar space	4. Positive current

3-37. In which of the following ways does polar teletype operation differ from neutral teletype operation?

1. Neutral is always in a positive or negative condition
2. Polar is always in a current or no current flow condition
3. Neutral always has information present
4. Polar always has information present

3-38. A major difference between polar operation and neutral operation is that signal distortion may be

1. caused by random patching
2. caused by high reactance
3. caused by low line currents
4. nonexistant because of random patching, high reactance, or low line current

Learning Objective: Indicate the operational characteristic and describe some of the basic differences between the audio frequency tone shift (AFTS) and the radio frequency carrier shift (RFCS) radio teletype systems. (Continued in assignment 4).

3-39. A keyer device is used to change

1. a.c. pulses to mark and space modulation
2. d.c. pulses to mark and space modulation
3. radio frequency signals to d.c. pulses
4. radio frequency signals to a.c. pulses

3-40. The converter is used to change

1. a radio frequency to a.c. pulses
2. a.c. pulses to a radio frequency
3. d.c. pulses to a radio frequency
4. a radio frequency to d.c. pulses

3-41. What are the names of the two commonly used radio-actuated teletype (RATT) systems?

1. Tone modulated (AFTS) and carrier frequency shift (RFCS)
2. Pulse modulated (PM) and carrier frequency shift (RFCS)
3. Tone modulated (AFTS) and pulse modulated (PM)
4. Pulse modulated (PM) and amplitude modulated (AM)

3-42. In the ___(a)___ system the
AFTS, RFCS
___(b)___ frequency is
audio, carrier
shifted above and below an assigned frequency to ___(c)___
amplitude,
______ modulate the output of
frequency
the transmitter.

1. (a) AFTS
   (b) carrier
   (c) frequency
2. (a) AFTS
   (b) audio
   (c) frequency
3. (a) RFCS
   (b) carrier
   (c) frequency
4. (a) RFCS
   (b) audio
   (c) amplitude

3-43. If the keyer of an RFCS teletype system is adjusted for an 850 Hz spread, the space impulse will be 425 Hz ___(a)___ while the
above, below
mark impulse will be 425 Hz
___(b)___ the reference fre-
above, below
quency.

1. (a) above (b) above
2. (a) above (b) below
3. (a) below (b) below
4. (a) below (b) above

3-44. In a teletype installation, optimum flexibility, using the fewest circuits and equipment, is accomplished at the

1. keyer
2. transmitter transfer switchboard
3. teletypewriter panel
4. receiver transfer switchboard

3-45. ______(a)______
Diversity reception, Simplex
______ is used with __(b)__
operation AFTS,
____ systems to reduce fading
RFCS
and interference in ___(c)___
long, short
-range tty communications.

1. (a) Diversity reception
   (b) AFTS
   (c) long
2. (a) Diversity reception
   (b) RFCS
   (c) long
3. (a) Simplex operation
   (b) AFTS
   (c) short
4. (a) Simplex operation
   (b) RFCS
   (c) short

3-46. ____(a)____ diversity opera-
Frequency, Space
tion utilizes ____(b)____
different frequen-
__________ and
cies, wide spaced antennas
requires the least amount of physical space.

1. (a) Frequency
   (b) different frequencies
2. (a) Frequency
   (b) wide spaced antennas
3. (a) Space
   (b) different frequencies
4. (a) Space
   (b) wide spaced antennas

3-47. What are the two types of frequency diversity mentioned in the text?

1. Rf and af
2. PM and FM
3. Tone and rf
4. Tone and PM

3-48. Refer to figure 2-8 in the text. The simplex RFCS teletype system allows

1. receiving only
2. transmitting only
3. transmitting and receiving simultaneously
4. transmitting and receiving at different times

TO ANSWER ITEMS 3-49 THROUGH 3-53, REFER TO FIGURE 2-8 OF THE TEXTBOOK AND MATCH THE TIME THAT THE EQUIPMENT IS USED IN COLUMN B TO THE EQUIPMENT IN COLUMN A. NOT ALL RESPONSES IN COLUMN B ARE USED.

	A. Equipment		B. Time used
3-49.	Communications patching panel	1.	Receive only
3-50.	Converter/ comparator group	2.	Transmit only
3-51.	Receiver	3.	Transmit and receive at the same time
3-52.	Transmitter	4.	Transmit or receive
3-53.	A tty set		

3-54. Which of the following is NOT a characteristic of the Model 28 teletype family?

1. Low operating speeds
2. Quiet operation
3. Low maintenance
4. Tolerates typical ship's motions

3-55. Model 28 teletypewriters may be operated at which of the following speeds?

1. 60 words per minute
2. 75 words per minute
3. 100 words per minute
4. Each of the above

3-56. Refer to figure 2-9 in the text. The teletypewriter set does NOT include which of the following components?

1. A transmitter transfer switchboard
2. A typing perforator
3. A transmitter distributor
4. A character counter

3-57. Which of the following components may be used to transmit signals from the tty set?

1. A page printer
2. A page printer or typing perforator
3. A keyboard or transmitter distributor
4. A typing reperforator

3-58. Local or incoming signals are printed on page-sized paper by the

1. page printer
2. typing reperforator
3. typing perforator
4. transmitter distributor

3-59. Which piece(s) of equipment is/are used to receive local transmissions?

1. The page printer, typing perforator, or typing reperforator
2. The keyboard and transmitter distributor
3. The transmitter distributor and page printer
4. The typing reperforator only

3-60. Which of the following pieces of equipment may be used to produce locally prepared tapes?

1. The page printer and keyboard
2. The transmitter distributor
3. The typing perforator and and typing reperforator
4. The typing reperforator and keyboard only

3-61. Taped messages can be transmitted by using a

1. keyboard
2. transmitter distributor
3. typing perforator
4. typing reperforator

3-62. A separate external signal line is connected to the

1. page printer
2. keyboard
3. typing perforator
4. typing reperforator

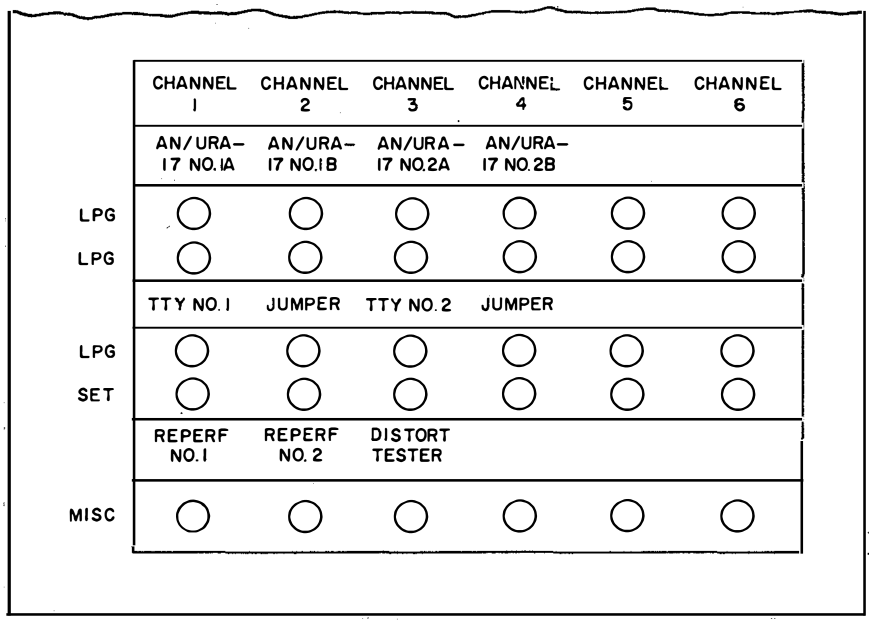


Figure 3-B.—Patching section of Teletype Patch Panel #1.

3-63. To provide the flexibility of connecting tty equipment in any desired combination, which of the following pieces of equipment is used?

1. A teletypewriter
2. A remote transmitter control
3. A communication patch panel
4. A transmitter transfer switchboard

3-64. The communication patch panel is used to provide a central point of distribution for

1. transmitter selection
2. d.c. voltages
3. receiver selection
4. a.c. voltages

3-65. A patch panel used to pass cryptographic information is ___(a)___ and is designated
red, black
___(b)___
SB-1203/UG, SB-1210/UGQ

1. (a) red (b) SB-1203/UG
2. (a) black (b) SB-1210/UGQ
3. (a) red (b) SB-1210/UGQ
4. (a) black (b) SB-1203/UG

WHEN ANSWERING ITEMS 3-66 THROUGH 3-68, REFER TO FIGURE 3-B.

3-66. Which, if any, of the following patches must be made to operate tty #1 with the AN/URA-17 #1A?

1. Patch from tty #1 looping jack to AN/URA-17 #1A looping jack
2. Patch from tty #1 set jack to AN/URA-17 #1A looping jack
3. Patch from tty #1 set jack to tty #1 looping jack
4. None

3-67. Which, if any, of the following patches must be made to operate tty #1 with the AN/URA-17 #1B?

1. Patch from tty #1 looping jack to AN/URA-17 #1B looping jack
2. Patch from tty #1 looping jack to AN/URA-17 #1B set jack
3. Patch from tty #1 set jack to AN/URA-17 #1B looping jack
4. None

3-68. Which, if any, of the following patches must be made to operate both tty #2 and REPERFORATOR #1 from the AN/URA-17 #2A?

1. Patch from REPERFORATOR #1 misc jack to AN/URA-17 #2A looping jack only
2. Patch from REPERFORATOR #1 misc jack to tty #2 set jack
3. Patch from REPERFORATOR #1 misc jack to AN/URA-17 #2A looping jack, and patch from tty #2 set jack to AN/URA-17 #2A looping jack
4. None

3-69. The tty #2 set jack is patched to the AN/URA-17 #1A looping jack. Which of the following methods must be used to disconnect the patch without interrupting the messages being received on tty #1?

1. Connect a patch cord between the looping and set jacks of tty #1, then remove the patch between the AN/URA-17 #1A looping jack and the tty #2 set jack
2. Connect a patch cord between the tty #1 set jack and the AN/URA-17 #1A looping jack, then remove the patch between the AN/URA-17 #1A looping jack and the tty #2 set jack
3. Remove the patch cord from the AN/URA-17 #1A looping jack, then remove it from the tty #2 set jack
4. Remove the patch cord from the tty #2 set jack, then remove it from the AN/URA-17 #1A looping jack

3-70. In the receiver transfer switchboard, each switch in the vertical row of switches and each switch in the horizontal row of switches is wired in ___(a)___ (series, parallel) to provide maximum ___(b)___ (flexibility, maintenance ease)

1. (a) parallel (b) flexibility
2. (a) series (b) flexibility
3. (a) parallel (b) maintenance ease
4. (a) series (b) maintenance ease

3-71. In the communications patch panel, removing the patch cord from the looping jack before removing it from the set jack is important for which of the following reasons?

1. The a.c. voltage on the cord is dangerous
2. The a.c. power could be lost
3. The d.c. voltage on the cord is dangerous
4. The d.c. power could be lost

3-72. If the white line on a knob of the receiver transfer switchboard is positioned vertically, it indicates a/an

1. off condition
2. start condition
3. stop condition
4. on condition

3-73. For standardization, receiver transfer switchboards are normally connected with ___(a)___ (local, remote) stations in vertical rows, and ___(b)___ (local, remote) stations are connected in horizontal rows.

1. (a) local (b) local
2. (a) remote (b) local
3. (a) local (b) remote
4. (a) remote (b) remote

3-74. In which of the following ways is teletype information transferred from one space to another?

1. A waveguide
2. A microwave
3. A trunkline
4. A landline

3-75. Which of the following statements describes the operation of the tty system when the Power-on and Carrier-on indicator lamps are lighted on the transmitter tty control unit?

1. The transmitter is deenergized; the transmitter is not radiating; and the control switch is in the CFS SEND position
2. The transmitter is energized; the transmitter is not radiating; and the control switch is in the CFS REC position
3. The transmitter is energized; the transmitter is radiating; and the control switch is in the CFS SEND position
4. The transmitter is energized; the transmitter is radiating; and the control switch is in the CFS REC position

Assignment 4

Teletype and Fleet Multichannel Broadcast System

Textbook Assignment: ET 3 & 2, Vol. 3, NAVEDTRA 10198; pages 2-12 through 3-19

Learning Objective (continued)—Indicate the operational characteristic and describe some of the basic differences between the audio frequency tone shift (AFTS) and the radio frequency carrier shift (RFCS) radio teletype systems.

4-1. What unit permits remote control of the teletype transmitter?

1. The keyboard
2. The communication patch panel
3. The line test switch
4. The transmitter/tty control

4-2. The transmitter switchboard, SB-863/SRT, is used to connect the

1. communication patch panel to the keyboard
2. tty control to the transmitter
3. communication patch panel to the teletypewriter
4. tty control to the teletypewriter

4-3. Refer to figure 2-10 in the text. The purpose of the system shown is to

1. receive an AFTS signal and translate it into a usable teletype signal
2. translate an RFCS signal into a usable teletype and transmit signal
3. receive an RFCS signal and translate it into a usable teletype signal
4. translate an AFTS signal into a usable teletype and transmit signal

4-4. Refer to figure 2-10 of the text. The antenna filter, AN/SRA-12, is used to filter unwanted

1. rf signals and to retain only the exact desired transmitted frequency
2. af signals and to retain only the band of desired transmitted frequencies
3. rf signals and to retain only the exact desired transmitted frequency
4. af signals and to retain only the exact desired transmitted frequency

---

TO ANSWER ITEMS 4-5 THROUGH 4-8, REFER TO FIGURE 2-11 IN THE TEXTBOOK AND MATCH THE UNIT OF COLUMN B TO THE OPERATION IN COLUMN A. RESPONSES IN COLUMN B ARE USED ONLY ONCE.

	A. Operation		B. Unit
4-5.	Converts marks and spaces into printed characters	1.	An af discriminator
4-6.	Converts RFCS signals into frequency shifted af signals	2.	A loop keyer
4-7.	Converts the frequency shifted af signals into positive and negative d.c. pulses	3.	A radio receiver
4-8.	Opens and closes the tty loop	4.	A teletype printer

4-9. In diversity operation, the comparator selects which of the following signals for application to the tty equipment?

1. The signal which has the longer marks
2. The signal which has the longer spaces
3. The signal which is stronger
4. The signal which is weaker

4-10. The half-duplex teletype system
may ________(a)________
send or receive, send and
________ while the full duplex
receive
teletype system may __(b)__
send or
________________ at any
receive, send and receive
given moment in time.

1. (a) send and receive
   (b) send or receive
2. (a) send or receive
   (b) send and receive
3. (a) send and receive
   (b) send and receive
4. (a) send or receive
   (b) send or receive

ITEM 4-11 IS TO BE JUDGED TRUE OR FALSE.

4-11. The function of the tone terminal set, during the receive operation, is to convert audio tone signals to d.c. signals.

Learning Objective: Describe the basic Fleet Multichannel Broadcast System by explaining the purpose of each of the units that make up the transmit and receive subsystems.

4-12. What method of communication is utilized by the MULCAST system?

1. Continuous wave
2. Facsimile
3. Teletype
4. Voice

4-13. The overall responsibility for all naval communications circuits in a given geographical area is a function of which control station?

1. NAVCOMMSTAS
2. NAVCAMS
3. NAVCOMMAREA
4. NAVMULCAST

4-14. The primary type of communications presently used by MULCAST is

1. satellite
2. hf
3. lf
4. vlf

4-15. What equipment converts symbols into d.c. pulses?

1. Monitor equipment
2. Multiplex equipment
3. Security equipment
4. Tape reader equipment

4-16. What equipment separates the composite signal into d.c. components?

1. Demultiplex equipment
2. Monitor equipment
3. Receiving equipment
4. Security equipment

4-17. Which of the following signals are analyzed by the monitor equipment?

1. The composite teletype signals
2. The encrypted d.c. signals
3. The plain text d.c. signals
4. The rf signals

4-18. What methods are used to transfer signals between the transmitter and receiver sites and the communications center?

1. Landlines and/or microwave links
2. Microwave links and/or troposcatter
3. Communications satellites and/or hf links
4. Vhf and/or uhf links

4-19. What equipment receives encrypted input signals from the security equipment?

1. An audio distribution amplifier
2. A multiplexer
3. A tape reader
4. A telegraph terminal

4-20. What equipment converts the d.c. keying signal into an AFTS signal?

1. An audio distribution amplifier
2. A multiplexer
3. A security equipment
4. A telegraph terminal

4-21. What is the reference of an AFTS signal that does not appear as an output?

1. Center frequency -42.5 Hz
2. Center frequency
3. Center frequency +42.5 Hz
4. 95.0 Hz

4-22. What is the approximate bandwidth of the composite AFTS signal?

1. 1.5 kHz
2. 3.0 kHz
3. 4.5 kHz
4. 6.0 kHz

4-23. What mode of transmission is used by the MULCAST broadcasts in the lf, mf, and hf bands?

1. Audio modulation
2. Compatible audio modulation
3. Double sideband pilot carrier
4. Single sideband suppressed carrier

4-24. What total number of information channels is used in the lf band?

1. 32
2. 16
3. 8
4. 4

Learning Objective: State how the AN/FRT-39 and AN/FRT-40 hf transmitters function by explaining the purpose and function of each of the units of the set.

4-25. What is the output power capability of the AN/FRT-39?

1. 1 kW (PEP)
2. 10 kW (PEP)
3. 20 kW (PEP)
4. 40 kW (PEP)

4-26. What is the output frequency range of the AN/FRT-39?

1. 1.5 to 30.0 MHz
2. 2.0 to 28.0 MHz
3. 2.0 to 32.0 MHz
4. 2.5 to 30.0 MHz

4-27. What is the power output of the AN/FRT-40?

1. 10 kW (PEP)
2. 20 kW (PEP)
3. 30 kW (PEP)
4. 40 kW (PEP)

Learning Objective: State how each of the major units and subassemblies of the AN/FRT-72 functions and its power output, frequency range, and emission modes.

4-28. What is the frequency range of the rf output signal from the AN/FRT-72?

1. 10 to 250 kHz
2. 30 to 150 kHz
3. 30 to 300 kHz
4. 510 to 519 kHz

4-29. What is the peak power output capability of each power amplifier of the AN/FRT-72?

1. 10 kW
2. 25 kW
3. 50 kW
4. 100 kW

4-30. The frequency band most widely used for MULCAST reception is

1. lf
2. mf
3. hf
4. uhf

4-31. Which of the following functions is performed by telegraph terminal AN/UCC-1?

1. It separates each tone
2. It compares diversity combinations
3. It converts tone shifted signals to d.c. signals
4. Each of the above

Learning Objective: Describe the AN/SRR-19 and AN/SRR-19A receivers by stating the characteristics and interrelationship of each of the major assemblies.

4-32. Which of the following is an advantage of using the lf band instead of the hf band for MULCAST?

1. The lf band has a greater channel capacity
2. There is less interference in the lf band
3. Less power is required with the lf band
4. The lf band has a shorter range

4-33. What is the frequency range of the AN/SRR-19 and the AN/SRR-19A?

1. 30.0 to 150.0 kHz
2. 30.0 to 300.0 kHz
3. 1746.0 to 2016.0 kHz
4. 1.5 to 25.5 MHz

Learning Objective: Explain the AN/UCC-1D(V) by describing the purpose, function, and interrelationship of the frequency-shift keyer, frequency-shift converter, control-attenuator, and multiplexer-demultiplexer.

4-34. The teletype signals in the AN/UCC-1D(V) system are separated by differences in

1. frequency
2. pulse
3. space
4. time

4-35. What assembly converts individual d.c. signals into audio frequency shift signals?

1. The control-attenuator
2. The frequency-shift converter
3. The frequency-shift keyer
4. The multiplexer-demultiplexer

4-36. Which of the following types of d.c. input signals are utilized by the AN/UCC-1D(V)?

1. Polar loop signals only
2. Neutral loop signals only
3. Either polar or neutral loop signals

4-37. What assembly converts audio frequency shift signals into individual d.c. signals?

1. The control-attenuator
2. The frequency-shift converter
3. The frequency-shift keyer
4. The multiplexer-demultiplexer

4-38. Which of the following assemblies amplifies the composite audio output signal and determines the level of the composite signal?

1. The control-attenuator
2. The frequency-shift converter
3. The frequency-shift keyer
4. The multiplexer-demultiplexer

4-39. What is the maximum number of narrow-band channels that can be provided by an AN/UCC-1D(V) terminal?

1. 32
2. 16
3. 8
4. 4

4-40. What is the maximum number of narrow-band channels that can be accomodated by a 3 kHz communications link?

1. 32
2. 16
3. 8
4. 4

4-41. Diversity combination switching is accomplished at which, if any, of the following stations?

1. The receiving station only
2. The transmitting station only
3. At both the receiving and transmitting stations

4-42. What total number of frequency-shift converters is required for each d.c. telegraph channel during combined frequency-diversity/rf diversity operation?

1. 1
2. 2
3. 4
4. 8

4-43. What is the maximum number of wide-band channels that can be accomodated by the AN/UCC-1D(V)?

1. 32
2. 16
3. 8
4. 4

4-44. In the frequency-shift keyer, the input switch Q3 is turned __(a)__ when loop current flows
off, on
and __(b)__ when loop current
off, on
does not flow.

1. (a) off (b) off
2. (a) off (b) on
3. (a) on (b) off
4. (a) on (b) on

4-45. In the frequency-shift keyer, what are the conduction states of gate control transistors Q6 and Q7 during a mark input?

1. Q6 off, Q7 off
2. Q6 off, Q7 on
3. Q6 on, Q7 on
4. Q6 on, Q7 off

4-46. In the frequency-shift keyer, what is the output of the diode gates circuit during a mark input when the signal sense is (a) normal and (b) reverse?

1. (a) (Higher frequency) mark oscillator
   (b) (higher frequency) mark oscillator
2. (a) (Higher frequency) mark oscillator
   (b) (lower frequency) space oscillator
3. (a) (Lower frequency) space oscillator
   (b) (lower frequency) space oscillator
4. (a) (Lower frequency) space oscillator
   (b) (higher frequency) mark oscillator

4-47. In the frequency-shift keyer, what method is used to provide the close frequency tolerance from oscillators IC9 and IC10?

1. Crystal control
2. Error cancelling loops
3. External frequency standard input
4. Phase-locked loops

4-48. In the frequency-shift keyer, when does oscillator IC9 operate?

1. IC9 operates during a mark input signal only
2. IC9 operates during a space input signal only
3. IC9 operates at alternate times with IC10
4. IC9 operates continuously

4-49. In the AN/UCC-1D(V), which cabinet stations may be connected to form a frequency-diversity pair?

1. A1 and A2
2. A1 and A3
3. A2 and A4
4. A4 and A5

4-50. The AN/UCC-1D(V) is using eight frequency-shift keyers. What is the maximum number of d.c. telegraph loop inputs that may be used during diversity ONE operation?

1. 1
2. 8
3. 16
4. 4

4-51. The AN/UCC-1D(V) has eight frequency-shift keyers. What total number of d.c. telegraph loop inputs can be accommodated during diversity FOUR operation?

1. 1
2. 2
3. 8
4. 4

4-52. To connect the output tones from the frequency-shift keyers to a composite tone output line, the tone output switch must be in the

1. INDIV position
2. LINE A position
3. LINE B position
4. PARALLEL position

4-53. What part of the frequency-shift converter selects the incoming channel frequency?

1. Discriminator FL2
2. Bandpass filter FL1
3. Limiter IC4
4. Transformer A1T1

4-54. The agc circuit of T1, Q4, and Q5 provides the power gain and agc control for what circuits?

1. FL1 and IC1
2. FL2 and IC3
3. IC1 and IC2
4. IC2 and IC3

4-55. What is the purpose of Q5 in the frequency-shift converter?

1. It amplifies the agc signal from Q4 to drive IC1 and IC2
2. It controls the delay equalization in FL1
3. It provides the control voltage for FL2
4. It sets the limiting level of IC4

4-56. What circuits in the frequency-shift converter controls the amplitude of the signal from limiter IC4?

1. FL1 and FL2
2. IC1 and IC2
3. Q4 and Q5
4. Q10 and Q11

4-57. What circuit in the frequency-shift converter converts the mark-space frequencies into polarized d.c. signals?

1. FL1
2. FL2
3. Q3
4. Q10

4-58. In the frequency-shift converter, the incoming tone is at a mark frequency with the signal sense switch in the normal position. What type of signal is applied to Q3?

1. A positive d.c. level
2. A negative d.c. level
3. A mark frequency
4. A space frequency

4-59. In the frequency-shift converter, what is the conduction state of Q9 during (a) a positive input to Q8 and (b) a negative input to Q8?

1. (a) Conduction
   (b) conduction
2. (a) Conduction
   (b) cut off
3. (a) Cut off
   (b) cut off
4. (a) Cut off
   (b) conduction

4-60. In the frequency-shift converter, what stage has direct control of the current in the d.c. loop?

1. FL2
2. S2
3. Q3
4. Q6

4-61. What is the designation of the composite audio input line to the frequency-shift converter?

1. INDIV
2. PARALLEL
3. RCVR A or RCVR B
4. TONE IN

4-62. A group of frequency-shift converters is set up in the following manner:

STATION	CHANNEL FREQ.	INPUT	DIVERSITY
A1	425 Hz	RCVR A	FOUR
A2	1785 Hz	RCVR A	FOUR
A3	425 Hz	RCVR B	FOUR
A4	1785 Hz	RCVR B	FOUR

What converters, if any, are operating as frequency diversity pairs?

1. A1-A2 and A3-A4
2. A1-A3 and A2-A4
3. A1-A4 and A2-A3
4. None

TO ANSWER QUESTION 4-63, REFER TO FIGURE 3-11 OF THE TEXTBOOK.

4-63. Which channel frequency combinations may be used as frequency diversity pairs?

1. 425 Hz and 595 Hz
2. 595 Hz and 1785 Hz
3. 765 Hz and 2125 Hz
4. 935 Hz and 1785 Hz

4-64. Frequency-shift converter stations A1, A2, A3, and A4 are operating in the diversity four mode. What station is directly connected to the d.c. output loop?

1. A1
2. A2
3. A3
4. A4

4-65. Frequency-shift converter stations A1, A2, A3, and A4 are operating in the diversity two mode. What stations, if any, are combined in frequency diversity pairs?

1. A1-A2 and A3-A4
2. A1-A3 and A2-A4
3. A1-A4 and A2-A3
4. None

TO ANSWER QUESTION 4-66, REFER TO FIGURE 6-11 OF THE TEXTBOOK.

4-66. Which of the following controls allows a converter to be used individually?

1. The control attenuator
2. The agc control
3. The diversity switch
4. The bias control

4-67. A group of frequency-shift converters is operating in a diversity combination. Which agc signal would take control of the other converters?

1. The most positive signal
2. The most negative signal
3. The signal with the fastest rate of change
4. The signal that is closest to the tone volt reference level

4-68. When the Tone Output switches are in the PARALLEL position, the composite output tones from the frequency-shift keyers are applied to which of the following transformers?

1. T1 only
2. T3 only
3. T4 only
4. T3 and T4

4-69. In the control-attenuator, which of the following stages is/are used as the reference detector(s) for the output of IC2?

1. A1T1
2. CR1 and CR2
3. Q2
4. Q1A

4-70. In the control-attenuator, the level control adjusts the signal level applied to which of the following stages?

1. A1T1
2. IC1
3. Q1A and Q1B
4. Q2

4-71. In the control-attenuator, the frequency-shift converter composite input tones are applied to which of the following transformers?

1. A1T1 and T1
2. T1 and T2
3. T2 and T3
4. T3 and T4

4-72. What are the bandwidths of the (a) direct path and the (b) translated path input signals to the multiplexer-demultiplexer?

1. (a) 3 kHz (b) 3 kHz
2. (a) 3 kHz (b) 6 kHz
3. (a) 6 kHz (b) 6 kHz
4. (a) 6 kHz (b) 3 kHz

4-73. What is the bandwidth of the input signal to the demultiplexer?

1. 1.5 kHz
2. 3.0 kHz
3. 6.0 kHz
4. 6.9 kHz

4-74. What is the frequency range of the (a) direct path and (b) translated path input transformers in the multiplexer-demultiplexer?

1. (a) 375 to 3025 Hz
   (b) 375 to 3025 Hz
2. (a) 375 to 3025 Hz
   (b) 3720 to 5920 Hz
3. (a) 3720 to 5920 Hz
   (b) 6.29 kHz ±3 kHz
4. (a) 6.29 kHz ±3 kHz
   (b) 375 to 3025 Hz

4-75. What signals are suppressed by the balanced modulator in the multiplexer?

1. 375 to 3025 Hz and 3270 to 5920 Hz
2. 375 to 3025 Hz and 6.29 kHz
3. 375 to 3025 Hz, 6.29 kHz, and 6665 to 9315 Hz
4. 3270 to 5920 Hz and 6665 to 9315 Hz

Assignment 5

Fleet Multichannel Broadcast System

Textbook Assignment: ET 3 & 2, Vol. 3, NAVEDTRA 10198; pages 3-19 through 5-8

Learning Objective (continued)—Explain the AN/UCC-1D(V) by describing the purpose, function, and interrelationship of the frequency-shift keyer, frequency-shift converter, control attenuator, and multiplexer-demultiplexer.

5-1. In the multiplexer, what portion of the signal from the balanced modulator is passed through the bandpass filter to T2?

1. The input and carrier signals
2. The input and lower sideband signals
3. The lower sideband signals only
4. The upper sideband signals

5-2. What is the passband of the composite signal from the multiplexer?

1. 375 to 3025 Hz
2. 375 to 5920 Hz
3. 3270 to 5920 Hz
4. 6665 to 9315 Hz

5-3. How many variable attenuators are used in the demultiplexer?

1. One
2. Two
3. Three
4. Four

Learning Objective: Describe the TS-2232A/UCC-1C(V) by explaining the purpose and function of each of the various circuits.

5-4. What selector switches in the test set determine the connection and routing of the input and output signals?

1. Function
2. Meter
3. Mode
4. Tone

5-5. What selector switches control the reversals rates of the reversals generator?

1. Function
2. Meter
3. Mode
4. Tone

5-6. What adjustments set the baud rate of the reversals generator during (a) 75-baud and (b) 150-baud operation?

1. (a) R2 (b) R1
2. (a) R16 (b) T2
3. (a) S2 (b) S4
4. (a) S1 (b) S4

5-7. What total number of frequencies is available from the tone generator circuit?

1. 2
2. 12
3. 20
4. 40

5-8. Which of the following switches determine(s) the output frequency of the tone generator?

1. The function selector and mode selector
2. The function selector and tone selector
3. The mode selector and tone selector
4. The tone selector only

5-9. At which of the following pins in connector Pl are the tone output signals available?

1. A and P
2. C and P
3. H and L
4. M and P

5-10. What (a) switches and (b) switch positions connect the tone generator output to test connector Pl?

1. (a) Function selector (b) tone out
2. (a) Mode selector (b) 75-baud or 150-baud
3. (a) Mode selector (b) MARK or SPACE
4. (a) Tone selector (b) all positions

5-11. Which of the following positions of the function selector switch allows the application of audio signals from test connector Pl to the audio amplifier?

1. PHASE HI or PHASE LO
2. TONE IN or REV OUT
3. TONE IN or TONE OUT
4. Any position

5-12. At which of the following points is the output of the audio amplifier available?

1. At Pl, pins A and P
2. At Pl, pins M and P
3. At J1 and J2
4. At J2 and LS1

5-13. Which of the following switches determines the parameters to be applied to the meter circuit?

1. The function selector
2. The meter selector
3. The mode selector
4. The tone selector

5-14. The function selector switch is in the +12 volt position; the Read-Ind selector is in the IND position. What type of reading or indication will be presented on the meter?

1. +12 volts ±0.5
2. The actual voltage level
3. The average voltage level during a mark condition
4. A go/no-go indication

5-15. During the phase angle measurements, the ____(a)____ of the meter reading is determined by the amount of phase difference between the two signals, and the ____(b)____ of the meter reading is determined by the channel that has the greater delay.

(a) polarity, value; (b) polarity, value

1. (a) polarity (b) polarity
2. (a) polarity (b) value
3. (a) value (b) polarity
4. (a) value (b) value

Learning Objective: Explain the purposes and differences between lf, hf, vhf, and uhf communications systems.

5-16. Modern naval communications use ____(a)____ numbers of communications equipment while becoming ____(b)____ versatile.

(a) fewer, greater; (b) more, less

1. (a) fewer (b) more
2. (a) fewer (b) less
3. (a) greater (b) more
4. (a) greater (b) less

5-17. Before establishing a teletype link with another ship, the operator must complete which, if any, of the following actions?

1. Connect the uhf transceiver to the local position for voice communication
2. Connect the teletypewriter to the lf transmitter
3. Connect the vlf transceiver to the local position for teletype information exchange
4. None of the above

5-18. Which of the following means of transmissions would NOT normally be used in the low-frequency band?

1. Long-range communications
2. Teletype
3. Long-range direction finding
4. Aeronautical radio navigation

5-19. The AN/FRT-72 transmitter operates in which of the following frequency ranges?

1. 3 to 30 kHz
2. 30 to 150 kHz
3. 150 to 300 kHz
4. 300 to 1500 kHz

TO ANSWER QUESTIONS 5-20 AND 5-21, REFER TO FIGURE 4-2 OF THE TEXT.

5-20. Which unit converts the received signal to d.c.?

1. The AN/SRR-19A
2. The SB-973/SRR
3. The AN/URA-17
4. The SB-1210/UGQ

5-21. What unit delivers the converted d.c. signal to the crypto equipment?

1. The AN/SRR-19A
2. The SB-973/SRR
3. The AN/URA-17
4. The SB-1203/UG

5-22. Satellite communications backup systems are operated in what frequency band?

1. The lf band
2. The hf band
3. The vhf band
4. The uhf band

TO ANSWER QUESTIONS 5-23 AND 5-24, REFER TO FIGURE 4-3 OF THE TEXT.

5-23. The voice communication developed at the handset is patched to the antenna coupler using which of the following equipment sequences?

1. The C-1138, SB-1210/UGQ, SB-988/SRT, and AN/URT-23
2. The SB-1210/UGQ, SB-1203/UG, and AN/UCC-1
3. The SB-988/SRT, C-1138, and AN/URT-23
4. The C-1138, SB-988/SRT, and AN/URT-23

5-24. In what unit is the intelligence converted to rf energy?

1. At the SB-988/SRT
2. At the AN/URT-23
3. At the AN/SRA-34
4. At the AN/UCC-1

5-25. In the high-frequency receive system, at what point is electromagnetic energy converted to electrical energy?

1. At the receiver
2. At the antenna
3. At the antenna patch panel
4. At the d.c. patch panel

5-26. What is the purpose of the AM-3729?

1. It converts rf to d.c.
2. It is a remote handset
3. It converts d.c. to rf
4. It is a remote speaker

5-27. Which of the following types of communication is NOT normally used in the vhf band?

1. Radar
2. Aeronautical radio navigation
3. Amateur radio
4. Long-range communications

TO ANSWER QUESTION 5-28, REFER TO FIGURE 4-5 OF THE TEXT.

5-28. What unit is common to both the receive and transmit function?

1. The AN/VRC-46
2. The AM-3729
3. The SB-973/SRR
4. The SB-988/SRT

5-29. The uhf frequency band is used for which of the following types of communications?

1. Long-range
2. Short-range
3. LORAN navigation
4. Aeronautical radio navigation

TO ANSWER QUESTIONS 5-30 AND 5-31, REFER TO FIGURE 4-6 OF THE TEXT.

5-30. The AN/SRT-21 receives its input from what piece of equipment?

1. The C-1138
2. The secure voice equipment
3. The AN/SRA-33
4. The SB-988/SRT

5-31. What is the tie point for connection of more than one secure remote phone unit?

1. The secure voice matrix
2. The radio set control
3. The AN/SRA-33
4. The AN/SRC-20

5-32. Where is a received secure voice transmission decrypted?

1. In the C-1138
2. In the AM-3729
3. In the SB-973/SRR
4. In the secure voice equipment

Learning Objective: Identify each unit of the basic simplex facsimile systems shown in figures 5-1 and 5-2 of the textbook by purpose, operating frequencies, and type of modulation or signal.

5-33. What is the total frequency shift between a black and a white signal in an AFTS facsimile system?

1. 400 Hz
2. 800 Hz
3. 1500 Hz
4. 3100 Hz

WHEN ANSWERING ITEMS 5-34 THROUGH 5-38, REFER TO FIGURE 5-1 IN THE TEXTBOOK.

5-34. What unit of the simplex facsimile system provides a 2400 Hz amplitude-modulated signal during transmit?

1. CV-1066B/UX
2. KY-44C/FX
3. MD-168A/UX
4. TT-321A/UX

5-35. What unit converts the amplitude-modulated signal into an AFTS signal during transmit?

1. CV-1066B/UX
2. KY-44C/FX
3. MD-168A/UX
4. TT-312A/UX

5-36. What unit would be used only during the transmission of an RFCS facsimile signal?

1. AN/UXH-2B
2. CV-1066B/UX
3. KY-44C/FX
4. MD-168A/UX

5-37. What unit produces the d.c. keying signals during RFCS transmit?

1. CV-1066B/UX
2. KY-44C/FX
3. MD-168A/UX
4. TT-321A/UX

5-38. What unit converts AFTS signals into amplitude modulation during receive operation?

1. CV-1066B/UX
2. KY-44C/FX
3. MD-168A/UX
4. TT-321A/UX

WHEN ANSWERING ITEMS 5-39 THROUGH 5-42, REFER TO FIGURE 5-2 IN THE TEXTBOOK.

5-39. When transmitting facsimile signals in a data mode, what unit converts the amplitude modulated signals into digital data signals?

1. The analog-to-digital converter
2. The modem
3. The AN/UXH-2B
4. The TT-321A/UX

5-40. What unit converts the digital data signals into AFTS signals for transmission?

1. The analog-to-digital converter
2. The modem
3. The AN/UXH-2B
4. The TT-321A/UX

5-41. What unit converts the AFTS signal into a digital data signal during receive operation?

1. The analog-to-digital converter
2. The digital-to-analog converter
3. The modem
4. The AN/UXH-2B

5-42. Between which two units in a secure receive facsimile system is the security equipment connected?

1. The AN/UXH-2B and the digital-to-analog converter
2. The AN/UXH-2B and the TT-321A/UX
3. The digital-to-analog converter and the modem
4. The modem and the receiver

Learning Objective: Explain the principles of operation and the function of Facsimile Transmitter-Receiver TT-321A/UX.

5-43. Which of the following type(s) of copy may be transmitted by the TT-321A/UX?

1. Black and white copy
2. Colored copy
3. Copy with intermediate shades of gray
4. Each of the above

5-44. The copy received on the TT-321A/UX will be

1. black, white, or intermediate shades of gray
2. colored
3. colored with intermediate shades of gray
4. each of the above

5-45. What part of the facsimile transmitter illuminates the copy to be transmitted?

1. A crater lamp
2. An exciter lamp
3. A phototube
4. A stylus

5-46. What factor determines the elemental area that is transmitted to the phototube?

1. The average density of the copy
2. The intensity of the exciter lamp
3. The size of the hold in the aperture plate
4. The size of the phototube

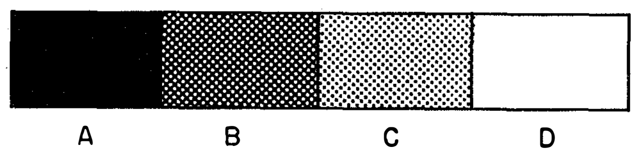


Figure 5-A.—Elemental areas of copy.

5-47. What area of figure 5-A will cause the phototube to pass the maximum signal?

1. A
2. B
3. C
4. D

5-48. Which of the following actions accomplishes the required scanning of the copy?

1. The copy drum rotates and moves laterally in front of the phototube
2. The copy drum rotates while the phototube moves laterally
3. The exciter lamp is moved across the rotating copy drum
4. The phototube rotates and moves laterally across the copy drum

5-49. What controls the amount of light applied to the phototube?

1. The capacitance of the elemental area
2. The density of the elemental area
3. The electrical resistance of the elemental area
4. The thickness of the paper

5-50. What is the frequency of the carrier signal from the TT-321A/UX?

1. 1500 Hz
2. 1800 Hz
3. 2400 Hz
4. 3100 Hz

5-51. What type of signal is produced by the bridge modulator circuit?

1. An amplitude-modulated signal
2. A frequency-modulated signal
3. A phase-modulated signal
4. A single-sideband signal

5-52. What is the frequency of the signal applied to the exciter lamp?

1. 60 Hz
2. 1500 Hz
3. 1800 Hz
4. 2400 Hz

5-53. What is the frequency of the signal used to drive the synchronous motor in the transmitter?

1. 60 Hz
2. 120 Hz
3. 1800 Hz
4. 2400 Hz

5-54. Direct recording requires the use of a

1. recording lamp and photographic film
2. recording lamp and photographic paper
3. stylus in contact with recording paper
4. stylus in contact with photographic paper

5-55. What is the rotational speed difference between the receiving drum and the transmitting drum?

1. There is no difference
2. 2:1
3. 3:1
4. 4:1

5-56. A maximum amplitude signal will be applied to the stylus in the recorder when the area transmitted is

1. white
2. light gray
3. dark gray
4. black

5-57. What is the illumination level for a black area when recording on (a) photographic paper, and on (b) photographic film?

1. (a) Maximum (b) maximum
2. (a) Minimum (b) maximum
3. (a) Maximum (b) minimum
4. (a) Minimum (b) minimum

5-58. What is the frequency of the signal used to drive the synchronous motor in the receiver?

1. 60 Hz
2. 120 Hz
3. 1800 Hz
4. 2400 Hz

Learning Objective: Describe the purpose and functions of each of the major assemblies and the operation of Radio Modulator MD-168A/UX.

5-59. What is the purpose of the MD-168A/UX?

1. It converts AFTS signals to AM signals
2. It converts AFTS signals to RFCS signals
3. It converts AM signals to AFTS signals
4. It converts AM signals to d.c. keying signals

5-60. Which of the following signal(s) may be monitored at the earphone jack?

1. A 1500 to 2300 Hz frequency-modulated output signal
2. An 1800 to 2400 Hz amplitude-modulated input signal
3. A 2300 to 3100 Hz frequency-modulated output signal
4. Either the input signal or the output signal

5-61. What are the (a) input and (b) output signal frequencies of the MD-168A/UX?

1. (a) 1800 Hz
   (b) 1500 to 2300 Hz
2. (a) 1800 to 2400 Hz
   (b) 1500 to 2300 Hz
3. (a) 1800 to 2400 Hz
   (b) 1500 to 3100 Hz
4. (a) 2400 Hz
   (b) 2300 to 3100 Hz

5-62. What is the output frequency of the MD-168A/UX when a maximum amplitude signal is applied?

1. 1500 Hz
2. 1800 Hz
3. 2300 Hz
4. 3100 Hz

5-63. What causes the variable-frequency, phase-shift oscillator to change frequency?

1. The varying pulse width of the d.c. voltage
2. The varying magnitude of the d.c. voltage
3. The varying amplitude of the a.c. voltage
4. The varying frequency of the a.c. voltage

5-64. The plate resistance of the reactance modulator is controlled by the

1. amount of phase shift in the phase-shift network
2. amplitude of the d.c. voltage applied to its grid
3. output frequency of the oscillator
4. time constant of the phase-shift network

5-65. The plate resistance of the reactance modulator determines the

1. amplitude of the d.c. voltage applied to the reactance modulator
2. amplitude of the input signal from the facsimile transmitter
3. amplitude of the signal from the oscillator
4. time constant of the phase-shift network

5-66. The amount of phase shift in the phase-shift network determines the

1. magnitude of the d.c. voltage applied to the reactance modulator
2. output frequency of the oscillator
3. plate resistance of the reactance modulator
4. time constant of the network

5-67. The dual-frequency indicator provides an indication of the

1. exact output frequency at all times
2. input frequency
3. input and output frequency limits
4. limits of the audio output frequency

5-68. The audio output level at the earphone jack is determined by the

1. frequency of the input signal
2. position of the adjust 1500 control
3. position of the adjust 2300 control
4. position of both the adjust 1500 and adjust 2300 controls

5-69. During a minimum amplitude input signal the "adjust ____(a)____"
1500, 2300
control is adjusted to close the ____(b)____ side of the frequency
left, right
indicator.

1. (a) 1500 (b) left
2. (a) 1500 (b) right
3. (a) 2300 (b) left
4. (a) 2300 (b) right

Assignment 6

Facsimile Systems

Textbook Assignment: ET 3 & 2, Vol. 3, NAVEDTRA 10198; pages 5-8 through 6-10

Learning Objective: Explain the purpose, functions, and uses of some of the stages of Keyer Adapter KY-44C/FX.

6-1. What is the purpose of the KY-44C/FX?

1. It converts AFTS signals to RFCS signals
2. It converts AM signals to AFTS signals
3. It converts AM signals to d.c. keying signals
4. It converts AM signals to RFCS signals

6-2. What is the input frequency range of the KY-44C/FX?

1. 0 to 800 Hz
2. 1500 to 2300 Hz
3. 1500 to 7000 Hz
4. 2300 to 3100 Hz

6-3. The input meter is used to monitor the

1. dB level of the incoming signal
2. distortion level of the incoming signal
3. incoming signal frequency
4. modulation rate of the incoming signal

6-4. Excessive noise or hum is removed from the input signal by the

1. bandpass filter
2. degenerative feedback circuit
3. low pass filter
4. rf filter

6-5. The output control determines the

1. gain of the detector circuit
2. gain of the first and second amplifiers
3. phase angle of the degenerative feedback
4. signal level applied to the first amplifier

6-6. Why is degenerative feedback applied to the third amplifier stage?

1. To improve amplifier gain
2. To improve stability and frequency response
3. To increase the output signal level
4. To remove the hum and noise from the signal

6-7. What position of the output selector switch would provide a detected and filtered output signal?

1. AMPLIFIER
2. DETECTOR
3. KEYER
4. FILTER IN

6-8. What portion of the incoming amplitude-modulated facsimile signal is applied to a transmitter when the output selector switch is in the KEYER position?

1. The carrier frequency
2. The frequency modulation
3. The modulation envelope
4. The upper sideband

Learning Objective: Describe the purpose and function of the stages of Frequency Shift Converter CV-1066B/UX.

6-9. What is the purpose of the CV-1066B/UX?

1. It converts AFTS signals to AM signals
2. It converts AFTS signals to d.c. signals
3. It converts AFTS signals to FM signals
4. It converts AFTS signals to RFCS signals

6-10. What are the (a) input and (b) output frequency ranges of the CV-1066B/UX?

1. (a) 1500 to 2300 Hz or 2300 to 3100 Hz
   (b) 1500 to 2300 Hz or 2300 to 3100 Hz
2. (a) 1500 to 2300 Hz
   (b) 2300 to 3100 Hz
3. (a) 2300 to 3100 Hz
   (b) 1500 to 2300 Hz
4. (a) 2400 Hz
   (b) 1800 Hz

6-11. Which of the following input frequencies will produce the greater output amplitude?

1. 1500 Hz
2. 2300 Hz
3. 2600 Hz
4. 3100 Hz

6-12. The loudspeaker in the CV-1066B/UX provides an indication of the proper functioning of which stage?

1. The amplifier
2. The frequency discriminator
3. The frequency indicator
4. The limiter

6-13. What stage has the effect of reducing the noise level at the output?

1. The amplifier
2. The frequency discriminator
3. The frequency indicator
4. The limiter

6-14. The conversion from an AFTS signal to amplitude modulation is provided by the

1. amplifier stage
2. frequency discriminator stage
3. frequency indicator stage
4. limiter stage

6-15. The contrast between the black and white output signals is provided by the

1. amplifier stage
2. frequency discriminator stage
3. frequency indicator stage
4. limiter stage

6-16. What frequency limits are visually indicated by the frequency indicator?

1. 1500 Hz and 2300 Hz
2. 1500 Hz, 2300 Hz, and 3100 Hz
3. 1800 Hz and 2400 Hz
4. 2300 Hz and 3100 Hz

Learning Objective: Explain the purpose of the major assemblies and parts of Facsimile Recorder AN/UXH-2B.

6-17. What front panel control may be used to adjust the blackness of the incoming picture during automatic operation?

1. AUTO/MAN
2. DENSITY
3. GAIN
4. SCANS/MIN

6-18. The ALC circuit will cause the ___(a)___ signal to follow the
bias, plate
incoming ___(b)___ signal.
black, white

1. (a) bias (b) black
2. (a) bias (b) white
3. (a) plate (b) black
4. (a) plate (b) white

6-19. The ALC circuit loses control of the signal amplifier gain when

1. switch S305 is in the MAN position
2. The GAIN control is in the MANUAL position
3. the recorder is phasing
4. the selector switch is in the RUN position

6-20. What signal would be eliminated by the print amplifier fixed bias?

1. The transmitted background signal
2. The transmitted black signal
3. The bias signal
4. The ALC signal

6-21. What control signal will switch the facsimile machine from the standby mode to the phasing mode?

1. Start
2. Phase
3. Start-record
4. Stop

6-22. What automatic control signal will cause plate power to be applied to the print amplifier stages?

1. Start
2. Phase
3. Start-record
4. Stop

6-23. To deenergize the print and run mechanisms of the recorder, the carrier must be modulated with a

1. 1 Hz signal
2. 60 Hz signal
3. 300 Hz signal
4. 450 Hz signal

6-24. Refer to figure 5-13 in the textbook. Which of the following controls or switches must be used by the operator during manual operation of the facsimile recorder?

1. R301 and R302
2. R301 and S303
3. R303 and S302
4. S303 and S304

6-25. What circuit controls the frequency stability of the locked oscillator?

1. The tuning-fork oscillator
2. The print amplifier
3. The sync motor
4. The test signal

6-26. What circuit is used to drive the sync motor?

1. The automatic control
2. The tuning-fork oscillator
3. The locked oscillator
4. The test signal

6-27. What circuit provides the carrier signal for the test control tones?

1. The automatic control
2. The tuning-fork oscillator
3. The print amplifier
4. The test signal

6-28. What type of recording is produced by the chopper test circuit?

1. Black vertical lines
2. Black horizontal lines
3. White diagonal lines
4. White squares

6-29. What part maintains the stylus belt at the proper tension?

1. The idler wheel
2. The run motor
3. The sync clutch
4. The start motor

6-30. What mechanism determines the speed of the stylus belt?

1. The idler wheel
2. The run mechanism
3. The start motor
4. The sync mechanism

6-31. The stylus belt is brought from the zero speed to above the sync speed by the

1. phase actuator
2. run mechanism
3. start motor
4. sync mechanism

6-32. What is the purpose of the trolley rail set?

1. To provide proper spacing between the print heads and the feed roller
2. To provide power to the print head
3. To provide proper line structure
4. Each of the above

6-33. What type of recording paper is required?

1. Electrically conductive paper
2. Photographic paper
3. Pressure-sensitive paper
4. Each of the above

6-34. What circuit protects the amplifier circuits in the event the bias voltage fails?

1. The automatic control
2. The automatic load control
3. The regulator
4. The test signal

Learning Objective: Describe the events which have brought about the advent of satellite communications systems. The description will include the advantages they offer over previous communications systems.

6-35. Which of the following communications methods offers an ideal manner of communicating with highly mobile forces?

1. Flashing light communication
2. Elf communication
3. Laser communication
4. Satellite communication

6-36. A satellite offers ___(a)___ capacity and ___(b)___ quality communications.
(a) maximum, minimum
(b) high, low

1. (a) maximum (b) high
2. (a) minimum (b) low
3. (a) maximum (b) low
4. (a) minimum (b) high

6-37. Satellite communications offers large scale improvement in communications capacity due, partially, to ___(a)___ ___(b)___-distance transmission capability.
(a) wideband, narrow-band
(b) long, short

1. (a) wideband (b) long
2. (a) narrow-band (b) long
3. (a) wideband (b) short
4. (a) narrow-band (b) short

Learning Objective: List and describe the various satellite communications systems in use by the U.S. Navy today.

6-38. A passive satellite acts as a ___(a)___; while an active satellite performs ___(b)___ communications functions.
(a) reflector, repeater
(b) reflector, repeater

1. (a) reflector
   (b) reflector
2. (a) repeater
   (b) reflector
3. (a) reflector
   (b) repeater
4. (a) repeater
   (b) repeater

6-39. Which of the following statements best describes the satellite down-link frequency?

1. The signal from the transmitter is sent to the satellite
2. The signal from the receiving station is sent to the satellite
3. The signal from the satellite is sent to the receiving station
4. It is the same as the up-link frequency

6-40. Which of the following is NOT a parameter of an orbiting communication satellite?

1. The orbit shape
2. The amplification
3. The inclination
4. The orbit period

6-41. At which of the following coordinates are FLTSATCOM satellites located?

1. 23°N, 75°S, 172°N, 100°W
2. 75°W, 23°E, 100°E, 172°W
3. 23°W, 75°E, 172°E, 100°W
4. 75°N, 23°S, 100°E, 172°N

6-42. The FLTSATCOM System is being utilized on

1. aircraft only
2. submarines and surface ships only
3. shore stations only
4. aircraft, ships, and shore stations

6-43. What special technology is applied to rf links and message preparation in the FLTSATCOM System?

1. Computer
2. Laser
3. Troposcatter
4. Fibre optics

FOR ITEMS 6-44 THROUGH 6-47, SELECT FROM COLUMN B THE FUNCTION THAT MATCHES THE TITLE IN COLUMN A. RESPONSES IN COLUMN B ARE USED ONLY ONCE.

	A. TITLE		B. DESCRIPTION
6-44.	CUDIX/NAVMACS	1.	Special intelligence communications
6-45.	SSIXS	2.	Communications link for ASW operations
6-46.	TACINTEL	3.	General service message traffic
6-47.	ASWIXS	4.	Submarine communications

6-48. What is the primary purpose of a NAVCAMS station?

1. To retransmit FSB message traffic
2. To design communications devices for the fleet
3. To provide FLTSATCOM satellite communications to designated areas

6-49. Which of the following countries has a FLTSATCOM communication facility that has the primary responsibility for Naval communications in a specific geographical area?

1. Iceland
2. Italy
3. Australia
4. Greece

6-50. The Gapfiller satellite currently uses the (a) [uhf, hf] band for Fleet Broadcast message traffic, and (b) [uhf, hf] links are used for simultaneous transmission of Fleet Broadcast messages.

1. (a) uhf (b) hf
2. (a) hf (b) uhf
3. (a) uhf (b) uhf
4. (a) hf (b) hf

6-51. Which of the following FLTSATCOM subsystems is not automated for control of communication transmissions?

1. SSIXS
2. TACINTEL
3. TADIXS
4. Secure voice

6-52. In the Fleet Satellite Broadcast Subsystem, what total number of subchannels are provided for covered message traffic?

1. 5
2. 10
3. 15
4. 20

6-53. In the Fleet Satellite Broadcast Subsystem, the up-link frequency band is (a) [uhf, shf], and the down-link frequency band is (b) [uhf, shf].

1. (a) uhf (b) shf
2. (a) shf (b) shf
3. (a) uhf (b) uhf
4. (a) shf (b) uhf

6-54. In the Fleet Satellite Broadcast Subsystem, the special intelligence message traffic is channelized by the (a) [Streamliner, NAVCOMPARS] system and the general message traffic is channelized by the (b) [Streamliner, NAVCOMPARS] system.

1. (a) Streamliner (b) NAVCOMPARS
2. (a) NAVCOMPARS (b) Streamliner
3. (a) Streamliner (b) Streamliner
4. (a) NAVCOMPARS (b) NAVCOMPARS

6-55. The crypto equipment in the FSB subsystem provides which of the following signals as an output to the message traffic multiplexer?

1. 50 bps
2. 75 bps
3. 100 bps
4. 1200 bps

6-56. The AN/FSC-79 Satellite Communications Terminal utilizes the __(a)__ (uhf, shf) and the backup transceiver, AN/WSC-5(V), operates in the __(b)__ (uhf, shf) band.

1. (a) uhf (b) shf
2. (a) uhf (b) uhf
3. (a) shf (b) shf
4. (a) shf (b) uhf

6-57. The output of the AN/FSC-79 may be described as

1. a uhf signal transmitted to the satellite
2. an shf signal transmitted from the satellite
3. a uhf signal transmitted from the satellite
4. an shf signal transmitted to the satellite

6-58. The NAVMACS shipboard processing system is capable of guarding a maximum of how many broadcast channels?

1. One
2. Two
3. Three
4. Four

6-59. What is the word capacity capability of the NAVMACS processor?

1. 75,566 words
2. 75,536 words
3. 65,536 words
4. 24,566 words

ITEMS 6-60 THROUGH 6-64 ARE TO BE JUDGED TRUE OR FALSE.

6-60. The operator utilizes the control teletype to control major operational functions.

6-61. The NAVMACS compares selected addresses on incoming first-run messages against the command guard list.

6-62. An Emergency or Flash precedence message or a first-run message is printed completely whether or not a match exists.

6-63. The CUDIX is a half-speed, full-duplex autonated digital communication system.

6-64. The Gapfiller satellite allows the antenna to search Earth in 15 degree sectors.

Assignment 7

Maintenance of Communication Systems (Part-1)

Textbook Assignment: ET 3&2, Vol. 3, NAVEDTRA 10198; pages 7-1 through 7-11

Learning Objective: Point out some of the safety precautions involved in cleaning electronics equipment.

7-1. To ensure troublefree operation of electronic equipment, inspections should be carried out

1. annually
2. quarterly
3. monthly
4. continuously

7-2. The accumulation of dirt and other foreign matter in electronics equipment creates which of the following?

1. A heat reflector
2. A heat dissipater
3. A thermal insulator
4. A thermal unit

7-3. Failure to clean equipment when required will cause which, if any, of the following?

1. Arc-over in high voltage circuits
2. Shortened component life
3. Abrasive compounds
4. Each of the above

7-4. When lubricating electronic equipment, which, if any, of the following should be referred to for the proper selection of lubricants?

1. The MRC only
2. The technical manual only
3. The MRC and technical manual
4. None of the above

7-5. Which item(s) must NOT be used for cleaning electronic equipment?

1. Steel wool and emery cloth
2. Trichloroethane
3. A vacuum cleaner with a nonmetallic nozzle
4. Each of the above

7-6. Which of the following describes a proper precaution to be followed while cleaning electronic equipment?

1. You are alone and are cleaning a radio transmitter in an unventilated space using inhibited methyl chloroform solvent
2. You are using a vacuum cleaner with a nonmetallic nozzle to remove dust from an antenna multicoupler
3. You are removing a spot of corrosion from the interior of a radio receiver with emery cloth
4. You are using trichloroethane solvent to remove oily dirt from your hands

7-7. You are using a cleaning solvent in electronic equipment. What is the maximum daily time that you may be exposed?

1. 15 minutes
2. 60 minutes
3. 90 minutes
4. 120 minutes

7-8. Solvents must NOT be used on which of the following?

1. Electrical insulation
2. Hands
3. Hot equipment
4. Each of the above

7-9. What is the purpose of the equipment air filter?

1. To muffle the sound of the air blowers
2. To prevent dust and dirt from entering the equipment
3. To prevent personnel from coming into contact with the blades of the air blowers
4. To remove foreign particles from the air being exhausted from the equipment

ITEM 7-10 IS TO BE JUDGED TRUE OR FALSE.

7-10. An oil filter is almost as effective, when installed dry, as it is when installed with a light coat of oil.

Learning Objective: Explain the purpose and use of sensitivity measurements including the equipment and methods used to make the measurement.

7-11. What circuit(s) in a radio receiver determine(s) the overall sensitivity of the receiver?

1. Rf
2. IF
3. Af
4. Each of the above

7-12. Which measurement provides an indication of the efficiency of a communications receiver?

1. Bandwidth
2. Frequency response
3. Selectivity
4. Sensitivity

7-13. A value which indicates the level of a carrier input signal that is required in order to produce a specified output power level is the

1. bandwidth of the receiver
2. frequency response of the receiver
3. selectivity of the receiver
4. sensitivity of the receiver

7-14. Receiver sensitivity measurements are usually expressed in which of the following terms?

1. Volts
2. Millivolts
3. Microvolts
4. Nanovolts

7-15. Impedance matching between the signal generator and the receiver antenna input, if needed, is provided by

1. a variable attenuator
2. a dummy antenna
3. an electronic voltmeter
4. a 600-ohm noninductive load

7-16. Which of the following statements is/are true?

1. A dummy antenna is part of the receiver
2. A dummy antenna is used to simulate an ideal antenna
3. A dummy antenna insures that the receiver is loaded properly
4. Both 2 and 3 above

Figure 7-A. Receiver sensitivity measurement block diagram.

WHEN ANSWERING ITEMS 7-17 THROUGH 7-19, REFER TO FIGURE 7-A.

7-17. Which item is represented by block C?

1. Audio voltmeter
2. Dummy antenna
3. Rf signal generator
4. 600-ohm noninductive load

7-18. Which of the following signals appear(s) between the receiver and block C?

1. Audio
2. Audio and rf
3. Unmodulated rf
4. Modulated rf

7-19. At which point would the signal generator be connected?

1. A
2. B
3. C
4. D

WHEN ANSWERING ITEMS 7-20 AND 7-21, REFER TO THE FOLLOWING INFORMATION.

The output of a signal generator, used to make sensitivity checks on four communications receivers, is shown below:

SIGNAL GENERATOR OUTPUT	RECEIVER
1.5 microvolts	#1
4.0 microvolts	#2
6.4 microvolts	#3
8.1 microvolts	#4

7-20. Which receiver has the best sensitivity?

1. #1
2. #2
3. #3
4. #4

7-21. The Maintenance Requirement Card for this type receiver specifies a minimum sensitivity of 5 microvolts. Which receivers DO NOT meet the specifications?

1. #1 and #2
2. #2 and #3
3. #3 and #4
4. #4 and #1

7-22. Where would information be found on how to perform receiver sensitivity measurements?

1. On the equipment front panel
2. In section one of the equipment technical manual
3. In the EIMB Communications Handbook
4. On the current MRC

Learning Objective: Explain the purpose of bandwidth and selectivity measurements and the methods used to make the measurements.

7-23. The ability of a receiver to discriminate against signals other than the one to which it is tuned is its

1. bandwidth
2. frequency response
3. selectivity
4. sensitivity

7-24. The frequency range of a receiver over which amplification is relatively constant is its

1. bandwidth
2. selectivity
3. sensitivity
4. signal-to-noise ratio

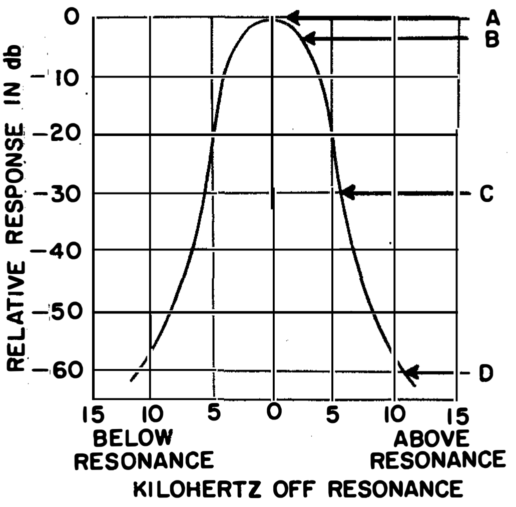


Figure 7-B. Receiver response curve.

7-25. The fidelity of a receiver is directly related to its

1. bandwidth
2. IF gain
3. sensitivity
4. signal-to-noise ratio

WHEN ANSWERING ITEMS 7-26 THROUGH 7-28, REFER TO FIGURE 7-B.

7-26. At which point is the bandwidth measured?

1. A
2. B
3. C
4. D

7-27. What is the approximate bandwidth of the receiver?

1. 1.5 kHz
2. 5.0 kHz
3. 12.0 kHz
4. 22.0 kHz

7-28. To obtain an indication of receiver selectivity the bandwidths are compared at points

1. A and B
2. A and C
3. B and D
4. C and D

7-29. A bandwidth measurement has been taken on a receiver. The center frequency is 3.5 MHz, the upper frequency is 3.540 MHz, and the lower frequency is 3.453 MHz. What is the bandwidth of this receiver?

1. 40 kHz
2. 47 kHz
3. 87 kHz
4. 3.5 MHz

Learning Objective: Describe the purpose and some of the methods of antenna maintenance aboard ship.

7-30. Which of the following would have a corrosive effect on antennas and their hardware?

1. Paint thinner
2. Metallic-based paint
3. Nonmetallic-based paint
4. Salt spray and soot

7-31. Which of the following substances tend(s) to provide a ground path across antenna insulators?

1. Metallic-based paint
2. Salt spray
3. Soot
4. Each of the above

7-32. Which maintenance method is to be used on wire antennas?

1. Inspect for deterioration, wire brush the antenna, inspect the insulators, drain out any accumulated moisture
2. Lower the antenna, inspect for deterioration, clean the antenna with a sharp knife and paint thinner
3. Lower the antenna, inspect for deterioration, wipe the antenna wire, inspect the insulators
4. Lower the antenna, inspect for deterioration, wire brush the antenna, inspect and clean the insulators

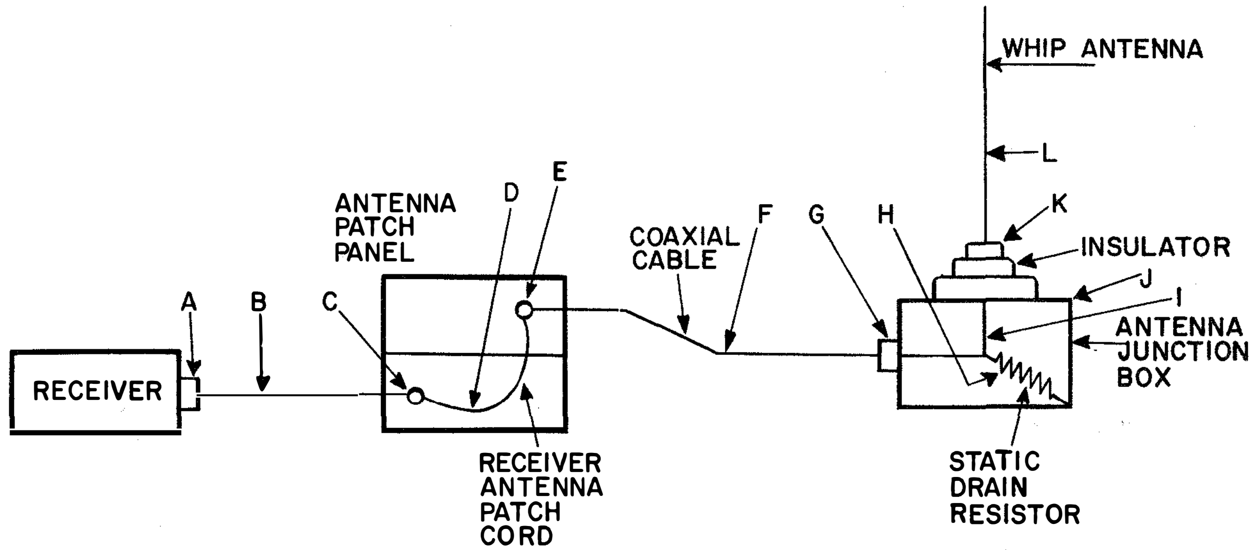


Figure 7-C. Receiver antenna system.

7-33. While inspecting an antenna, you find an insulator with paint splashes on it. What would you use to remove the paint?

1. Dry, soft cloth and trichloroethane solvent
2. Sharp knife and paint thinner
3. Steel wool and emery paper
4. Wire brush

7-34. What would you use to remove salt, dirt, and soot from an antenna insulator?

1. Sandpaper
2. Sharp knife and paint thinner
3. Soap, water, and clean cloths
4. Wire brush

WHEN ANSWERING ITEMS 7-35 THROUGH 7-55, REFER TO FIGURE 7-C AND THE FOLLOWING INFORMATION:

You have been assigned to inspect and repair a receiving antenna system.

IN ANSWERING QUESTIONS 7-40 THROUGH 7-44, 7-47, AND 7-51 THROUGH 7-54 YOU WILL BE REQUIRED TO USE THE SIX-STEP TROUBLESHOOTING PROCEDURES OUTLINED IN YOUR TEXTBOOK. FOR FURTHER INFORMATION ON THE TROUBLESHOOTING PROCEDURES REFER TO CHAPTER 27, BASIC ELECTRONICS, VOLUME 1, NAVEDTRA 10087-C OR THE NAVY ELECTRICITY-ELECTRONICS TRAINING SERIES (NEETS) MODULE, INTRODUCTION TO TEST EQUIPMENT.

7-35. Which part could cause a misleading reading while making an insulation resistance test?

1. D
2. F
3. H
4. L

7-36. What must be done to prevent a misleading resistance check?

1. Disconnect the static drain resistor
2. Ground the whip antenna
3. Remove the patch cord
4. Short the inner and outer conductors of the coaxial cable

7-37. Which test equipment is to be used to make an insulation resistance test?

1. Megger
2. Ohmmeter
3. Voltmeter
4. Vswr meter

7-38. At which point would you break the transmission line so as to check the entire line?

1. A
2. E
3. G
4. K

7-39. At which point would you connect the test equipment to check the insulation resistance of the entire line?

1. A
2. E
3. G
4. K

An insulation resistance reading of 100 kohms is obtained.

7-40. Where would you break the line to isolate the probable fault?

1. A
2. E
3. G
4. K

An insulation resistance reading of 100 kohms is again obtained.

7-41. Where would you break the line to further isolate the probable fault?

1. A
2. C
3. G
4. K

An insulation resistance reading of 500 megohms is obtained.

7-42. Where is the fault located?

1. B
2. D
3. F
4. L

7-43. Between which points does the insulation resistance of the transmission line check out as good?

1. A to C
2. C to E
3. E to G
4. G to K

7-44. At which point would you connect the test equipment to check the insulation resistance of the rest of the transmission line?

1. A
2. E
3. G
4. L

An insulation resistance reading of 55 megohms is obtained.

7-45. What is the probable location of the fault?

1. F
2. I
3. K
4. L

7-46. What step would you take to correct the fault?

1. Clean the insulator
2. Disconnect the static drain resistor
3. Disconnect the transmission line at point G
4. Wire brush the whip antenna

An insulation resistance reading of 500 megohms is obtained.

7-47. Which part must be repaired and replaced before a continuity check of the entire transmission line can be made?

1. B
2. D
3. H
4. K

7-48. At which point would you ground the system to make a continuity check?

1. C
2. E
3. G
4. I

7-49. Which test equipment would you use to check the continuity of the system?

1. Megger
2. Ohmmeter
3. Rf signal generator
4. Vswr meter

7-50. At which point would you connect the test equipment so as to check the continuity of the entire system?

1. A
2. C
3. G
4. I

The resistance reading is 150 ohms.

7-51. At which point would you break the line and insert a short to ground to aid in isolating the probable fault?

1. A
2. C
3. G
4. I

The resistance reading is 0 ohms.

7-52. Which section of the line has been checked out as good?

1. A to C
2. C to E
3. E to G
4. G to I

You break the line at point E, place a short to ground at point I, and make a continuity reading from point E. The resistance reading is 0 ohms.

7-53. What section of the line has been checked out as good?

1. A to C
2. C to E
3. E to I
4. A to I

7-54. Where is the fault probably located?

1. B
2. D
3. F
4. H

You have repaired and replaced the faulty part.

7-55. What tests would you perform for a final checkout of the entire line?

1. Continuity and insulation resistance
2. Frequency response and vswr
3. Impedance and radiation pattern
4. Selectivity and sensitivity

Learning Objective: Describe the process for checking rf cable connectors and how electronic and electrical cables are removed or replaced.

7-56. Cable failures may happen under which of the following conditions?

1. In port
2. When getting underway
3. At sea
4. Each of the above

7-57. Damaged cable should be replaced with

1. cable of the same physical size
2. any cable available
3. same type or equivalent cable
4. none of the above

7-58. Rf cables are divided into how many different types?

1. One
2. Two
3. Three
4. Four

7-59. Which type of rf cable is used least often?

1. Gas-filled
2. Solid dielectric
3. Foam dielectric
4. Twin lead

ITEM 7-60 IS TO BE JUDGED TRUE OR FALSE.

7-60. Heat resistant cables are not effected by heat.

7-61. The proper method for uncoupling cable connectors is to

1. use a cable puller
2. apply a quick jerk
3. apply steady pulling pressure
4. use a hammer

7-62. When replacing cable connectors that have rubber washers, what type of lubricant should be used?

1. Vaseline
2. Light weight oil
3. Soap
4. Grease

7-63. While working on a transmitter, it is noted that the rf cable from the equipment is defective. A check with supply shows that this number cable is not in stock. What would be the next step to follow?

1. Deenergize the equipment until the proper cable is received by supply
2. Look around the shop for any piece of cable that looks the same as the defective piece.
3. Refer to the technical manual for instructions
4. Refer to the Reference Data section of the EIMB and try to locate a substitute cable

7-64. Before a technician attempts to construct a cable assembly or cable harness what would be the most practical process to follow?

1. Order the cable or wire from supply
2. Consult the manufacturer's technical manual
3. Consult the Installation Standards section of the EIMB
4. Both 2 and 3 above

Assignment 8

Maintenance of Communications Systems (Part-2)

Textbook Assignment: ET 3&2, Vol. 3, NAVEDTRA 10198; pages 8-1 through 8-7

Learning Objective: Recognize the various steps in the troubleshooting of a communications system.

8-1. The relationship of the various units of an equipment can be obtained from which of the following?

1. Equipment technical manuals
2. Diagrams of the equipment
3. Operating personnel
4. Each of the above

8-2. What is the first step that should be performed when troubleshooting a system?

1. Analyze the fault
2. Elaborate on the trouble system
3. List the probable faulty equipment
4. Recognize the trouble symptom

ITEM 8-3 SHOULD BE JUDGED TRUE OR FALSE.

8-3. A trouble symptom, noted by an operator, is sometimes difficult to detect by the technician

8-4. An obvious trouble symptom recognized when the equipment is operating, is its

1. degraded performance
2. improper output
3. low volume
4. system failure

8-5. Establishing the nature of the system malfunction is part of which troubleshooting step?

1. 1
2. 6
3. 3
4. 4

8-6. Symptom elaboration is the process that you must accomplish to obtain

1. additional information about a trouble symptom
2. information about the functional units of the system
3. information about the test equipment required to check the system
4. voltage and resistance readings

8-7. How does the third troubleshooting step help the technicians?

1. It enables them to eliminate guessing as one of the elements in the troubleshooting procedure
2. It enables them to immediately employ test equipment in troubleshooting the system
3. It enables them to locate immediately the faulty equipment in the system
4. It pinpoints the probable trouble areas so that they can proceed efficiently

8-8. What is the primary purpose of step four?

1. To isolate the trouble to one particular unit of equipment in the system
2. To isolate the defective unit in the equipment without employing test equipment
3. To isolate the trouble to the defective part in the equipment
4. To determine the amplitude of the signals at each test point

8-9. In locating the faulty equipment, the use of test equipment should be limited to

1. checking the a.c. power input to the equipment
2. checking the input and output signals of the suspected equipment
3. testing each stage of the suspected equipment
4. testing parts in the suspected equipment

8-10. Which step in the system troubleshooting procedure may require the starting of a separate six-step procedure?

1. Symptom elaboration, step 2
2. Localizing the faulty equipment, step 4
3. Localizing the faulty circuit, step 5
4. Failure analysis, step 6

8-11. At which point in the six-step troubleshooting procedure does the technician make the actual repair on the equipment?

1. Step 5
2. Step 6
3. Step 3
4. Step 4

8-12. Which of the following statements best describes the failure analysis step of the troubleshooting procedure?

1. This step enables the technician to employ test equipment for the first time in the troubleshooting procedure
2. This step helps the technician to locate and verify all faulty parts in the equipment under test
3. This step enables the technician to replace the defective part and then determine the cause of the part failure
4. This step enables the technician to systematically replace each part in the circuit with parts that are known to be in good condition

Learning Objective: Localize an equipment malfunction by using systematic logical steps of elimination.

IN ANSWERING QUESTIONS 8-13 TO 8-15, REFER TO TROUBLE #1 IN THE TEXT.

8-13. What two visible indications allow the technician to localize the trouble to the frequency standard and the distribution amplifier?

1. The absence of the line a.c. and the report of the radioman
2. The indicator lights of both pieces of equipment were very dim
3. The receiver lights were normal but there was no output
4. The receiver lights were on and the receiver operation was normal in the internal frequency mode

8-14. How does the technician know, without measuring with the meter, that the 115 volts a.c. is available at P-1 in the AM-2123/U?

1. The light is not lit
2. The voltage reading was obtained on the equipment meter
3. The fuses F-1 and F-2 are good
4. The report of the radioman said so

8-15. What indication was present on the multimeter to determine that Q1 was bad?

1. A short on the emitter to base and an open from the collector to base
2. A short on both the emitter to base and collector to base
3. An open on both the emitter to base and collector to base
4. An open on the emitter to base and a short on the collector to base

IN ANSWERING QUESTION 8-16, REFER TO TROUBLE #2 OF THE TEXT.

8-16. The technician's troubleshooting job was greatly simplified because of

1. the prompt answering of the tug master
2. the problem was insignificant
3. the availability of a spare remote unit
4. the action taken by the RM watch supervisor

IN ANSWERING QUESTIONS 8-17 AND 8-18, REFER TO TROUBLE #3 IN THE TEXT.

8-17. Which of the following enabled the technician to determine that a potentiometer was probably the defective component?

1. The readings obtained on the meter between maximum and minimum read zero
2. The potentiometers were the only active elements in the circuit
3. The indicator light on the SB-1203A/UG was off
4. A visual inspection showed a cracked potentiometer

ITEM 8-18 IS TO BE JUDGED TRUE OR FALSE.

8-18. A technician should use an ungrounded soldering iron when working on an energized circuit.

IN ANSWERING QUESTIONS 8-19 AND 8-20, REFER TO TROUBLE #5 IN THE TEXT.

8-19. Which of the following steps determined that transceiver #1 was bad only on channel 5?

1. The check out procedure of transceiver #10
2. The carrier light on channel 5 of transceiver #1
3. The radio check on channel 5 of transceiver #1
4. The local remote switch on transceiver #1 was on the local position

8-20. Why did transceiver #1 cause a high SWR reading on the AN/SRA-33 for transmitter #3?

1. The output power was too great for the coupler
2. The frequency allocation of the transceivers was less than 10 MHz
3. The frequency allocation of the transceivers was greater than 10 MHz
4. The AN/SRA-33 of transceiver #3 was defective

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