

# CHAPTER 1

## COMMUNICATIONS

As an Aviation Electronics Technician, you will be tasked to operate and maintain many different types of airborne communications equipment. These systems may differ in some respects, but they are similar in many ways. As an example, there are various models of AM radios, yet they all serve the same function and operate on the same basic principles. It is beyond the scope of this manual to discuss each and every model of communication equipment used on naval aircraft; therefore, only representative systems will be discussed. Every effort has been made to use not only systems that are common to many of the different platforms, but also have not been used in the other training manuals. It is the intent of this manual to have systems from each and every type of aircraft in use today.

### RADIO COMMUNICATIONS

*Learning Objective: Recognize the various types of radio communications. Identify the various frequency bands and their uses and limitations.*

In basic terms, communication is defined as the meaningful transfer of information from one location (the sender, source, originator) to another location (the destination or receiver). Electronic communication uses electrical energy to transmit the information to be communicated. Since this electrical energy travels at the speed of light, the transfer can occur within a fraction of a second. The information must be converted from its original form of sound, light, or mechanical energy into electrical energy. This electrical energy can then be transmitted via wires or radiated through space to a receiver. The receiver must then convert the electrical energy back into its original form to complete the communication cycle.

### TYPES OF RADIO COMMUNICATIONS

Radio communications has become a highly sophisticated field of electronics. All Navy aircraft have the capability to use the commonly used ship-to-ship, ship-to-air, air-to-air, air-to-ground, and ship-to-shore

communication circuits. These operations are accomplished through the use of compatible and flexible communication systems.

Radio is the most important means of communicating in the Navy today. There are many methods of transmitting in use throughout the world. This manual will discuss three types. They are radiotelegraph, radiotelephone, and teletypewriter.

#### Radiotelegraph

Radiotelegraph is commonly called CW (continuous wave) telegraphy. Telegraphy is accomplished by opening and closing a switch to separate a continuously transmitted wave. The resulting "dots" and "dashes" are based on the Morse code. The major disadvantage of this type of communication is the relatively slow speed and the need for experienced operators at both ends.

#### Radiotelephone

Radiotelephone is one of the most useful military communication methods. It is used by aircraft, ships, and shore stations because of its directness, convenience, and ease of use. The equipment used for tactical purposes usually operate on frequencies that are high enough to have line-of-sight characteristics. This cuts down not only on the possibility of the enemy intercepting the messages, but also cuts down on the distance between the transmitter and receiver.

#### Teletypewriter

Teletypewriter (TTY) signals may be transmitted by either landlines (wire), cable, or radio. The Navy uses radio teletypewriter (RTTY) for high-speed automatic communications. The keyboard used with a TTY system is similar to that of a typewriter. When the operator strikes a key, a sequence of signals is transmitted. At the receiving station, the signals are translated back into letters, figures, and symbols that are typed onto paper for use.

**Table 1-1.-Radio-Frequency Spectrum**

FREQUENCY	DESCRIPTION
30 GHz – 300 GHz	Extremely high frequency (EHF)
3 GHz – 30 GHz	Super high frequency (SHF)
300 MHz – 3 GHz	Ultrahigh frequency (UHF)
30 MHz – 300 MHz	Very high frequency (VHF)
3 MHz – 30 MHz	High frequency (HF)
300 kHz – 3 MHz	Medium frequency (MF)
30 kHz – 300 kHz	Low frequency (LF)
3 kHz – 30 kHz	Very low frequency (VLF)
300 Hz – 3 kHz	Voice frequency
up to 300 Hz	Extremely low frequency (ELF)

**NAVY FREQUENCY BAND USE**

Table 1-1 shows the radio-frequency spectrum broken down into bands that are used by the military. Each band of frequencies has its own characteristics. Navy Electricity and Electronics Training Series, Module 17, *Radio-Frequency Communications Principles*, discusses all the bands. This chapter will only discuss the bands that are of interest to the Aviation Electronic Technician.

**VLF and LF Band Communications**

The very low frequency (VLF) and low frequency (LF) bands were originally used for radio telegraphy. Because the wavelengths were in the kilometer range and higher (30 kHz has a wavelength of 10 kilometers, or about 6.2 miles), enormous antennas had to be used. With today’s technology, this is no longer a factor.

**MF and HF Band Communications**

The medium-frequency (MF) and high-frequency (HF) bands are not only used by the Navy, but portions are also used by commercial AM broadcasting stations. These spectrums also include the international distress frequencies (500 kHz, 2182 kHz, 8364 kHz, 3023.5 kHz and 5680 kHz).

Signal radiation in these frequency ranges have the important property of being reflected by the ionosphere.

The ionosphere is a layer of electrically charged particles at the top of the earth’s atmosphere. The layer is caused by the strong solar radiation entering the upper atmosphere. When a radio wave in the MF or HF range hits this layer, it is reflected back to earth. Multiple reflections between this layer and earth are possible, allowing great distances to be obtained in these ranges, particularly the high-frequency band.

The disadvantage of this type of propagation is that it depends on the characteristics of the ionosphere, which varies widely, especially during daylight hours. As a result of this varying, the waves are reflected differently and take different paths over a period of time. This causes the signal at the receiver to vary in strength, which causes the output to fade in and out.

**VHF and UHF Band Communications**

Signal radiation in these frequency ranges get very little ionospheric reflection. As a result, communications in these ranges tend to be line-of-sight and over a short distance. Line-of-sight means exactly what the name says—the transmitter and receiver must be within a straight visual sighting line from each other. Buildings and uneven terrain may affect the transmission. The lower part of the UHF band and the VHF band is also used for mobile communications and television.

## INTERCOMMUNICATION SYSTEM (ICS)

Learning Objective: *Recognize components and operating features of an intercommunication system used in naval aircraft.*

The intercommunication system that will be discussed in this section is the OK-248( ) (V)/AI, Intercommunication-Communication Control Group (ICCG). This system is found on the S-3 aircraft.

The OK-248( ) (V)/AI provides intercommunications for crew members and maintenance personnel. It also controls operation and signal interfacing for all radio sets, and controls operation and signal interfacing for aural monitoring of the navigation aids.

### MAJOR COMPONENTS

The following is a discussion on the various components in the OK-248( ) (V)/AI system.

#### C-8760/AI Intercommunication-Communication Control Panel

The C-8760/AI (fig. 1-1) is commonly called the integrated radio control (IRC). The IRC panel performs the following functions:

- Controls HF radio modes and functions
- Controls UHF radio modes and functions
- Displays In-Flight Performance Monitor (IFPM) status of communication subsystems and components
- Initiates on-line operating configuration of communication systems

There are eight switches for the HF system function selections, along with a squelch knob. These switches are used to select the various modes of operation for the HF system on board. The squelch knob is turned clockwise to increase squelch and counterclockwise to decrease squelch.

The next section of switches (labeled UHF) on the IRC panel are used to control the UHF radios. There are twelve of these switches but only eleven are used. The switch labeled SPARE is not used.

The next section consists of a numerical keyboard, five switches, and three sets of indicators. The keyboard is where the operator inputs the desired channel and frequencies for the HF and UHF radios. The CLR button

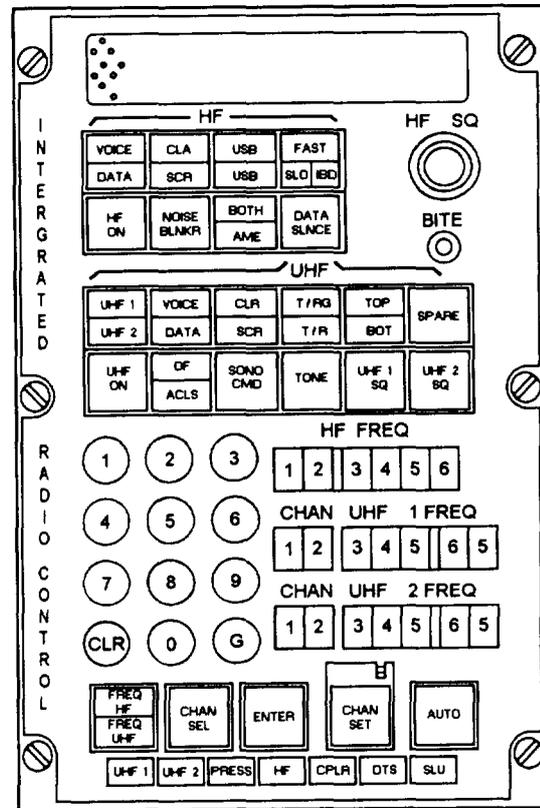


Figure 1-1.-C-8760/AI intercommunication-communication control panel.

is used to clear an error and start over with the selection. The G button is used to select a guard channel. The three indicator groups display the following:

- HF FREQ—displays the selected frequency for the HF radio set
- CHAN UHF 1 FREQ—displays the selected channel and frequency for the UHF 1 radio set
- CHAN UHF 2 FREQ—displays the selected channel and frequency for the UHF 2 radio set

The five switches are used to select what type of information the operator is inputting via the keyboard. After the operator inputs the channel or frequency, the ENTER switch must be pressed.

The last section of the panel contains seven fault indicator lights. These indicators are labeled UHF1, UHF2, PRESS, HF, CPLR, DTS, and SLU. Each one is the fault indicator for the system or component for which it is labeled. It will illuminate when a fault occurs in its corresponding system or component.

Located directly under the HF squelch knob is a BITE indicator. This indicator will illuminate when a fault is detected in the IRC.

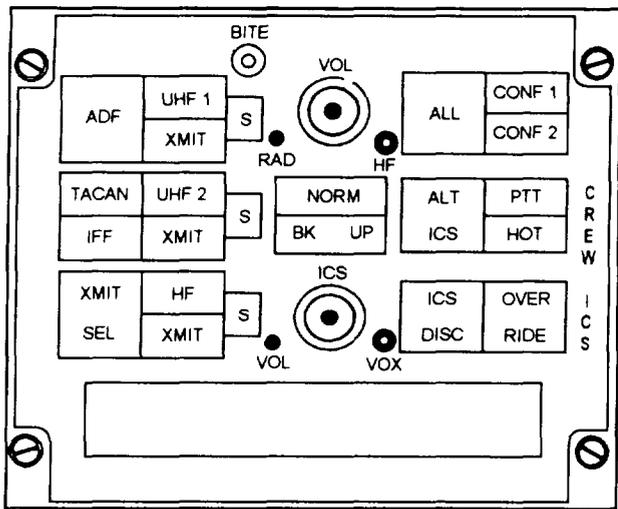


Figure 1-2.-LS-601/AI crew control panel.

### LS-601/AI Crew Intercommunication System (ICS) Panel

Each of the crew members has a LS-601/AI ICS panel (fig. 1-2). These ICS panels enable the crew members to do the following:

- Select six ICS modes
- Select three radios to monitor
- Select navigation aids and IFF to monitor
- Select either hot microphone or push-to-talk keyline operation
- Control the volume for ICS, radios, navigational aids, and the IFF aural functions

Control signals from the crew's ICS control panels consist of multiplexed binary words in the Manchester format and hard wired ground and analog voltages.

The crew's control panel has 14 switchlights that are self-explanatory. The two volume knobs are dual-purpose knobs. Each one controls two volumes, depending whether you turn the inner or outer knob. The BITE indicator will illuminate when a fault is detected in the control panel.

Each panel is identical, and they can be swapped between stations. There are differences in operation, depending on the station. The SENSO station cannot transmit so the XMIT SEL switchlight is disabled at that station. The ALT ICS switchlight will place the pilot and copilot's headsets and microphones in parallel. The SENSO and TACCOs will similarly be tied together as a pair. The NORM BK UP switchlight only operates at

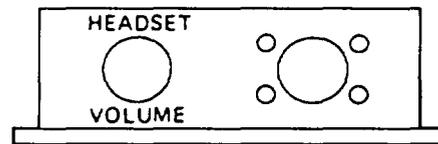


Figure 1-3.-LS-602/AI control panel.

the pilot and copilot's stations. The pilot will connect directly to the UHF-1 radio, and the copilot will connect directly to the HF system.

### LS-602/AI Control Panel

There are three LS-602/AI panels (fig. 1-3) located in the aircraft. These panels are for maintenance/ground handling functions. They provide the communication between the outside of the aircraft and the crew stations. The only control located on this panel is a volume knob, which adjusts the volume in the headset for each individual panel.

### CV-3048( )/AI Converter-Interconnecting Box

The CV-3048( )/AI is the switching logic unit (SLU) for the intercommunication system. The SLU is the signal interface unit for the communication system. Its functions are as follows:

- Voice signal conditioning
- Receive/transmit mode control
- Antenna configuration control
- Signal switching between components
- Binary control signal coding and decoding
- Component mode forcing

### FUNCTIONAL DESCRIPTION

This intercommunication system uses various computer-formatted signals in its operation. As a senior technician, you will be required to understand the various types of languages used by this system.

### Intercommunication-Communication Control Group (ICCG) Signal Interface

The ICCG signal interface consists of a discrete hardwired signal interface and a multiplexed binary word signal interface. Each will be discussed in the following text.

**BINARY-CODED WORD INTERFACE.**— The control signals in the ICCG interface are primarily in a binary-coded word format. The binary words are shifted into and out of the crew ICS panels, the IRC panel, and the SLU on pairs of multiplex lines. The crew ICS panels and the IRC have unique binary word addresses that are identified by a roll call sequence performed in the SLU. Every 25 milliseconds, each crew panel and the IRC are interrogated for a change-of-status by the SLU. This change-of-status data is stored in the SLU until it is transferred to the general-purpose digital computer (GPDC) for permanent storage. The GPDC will be discussed in a later chapter of this TRAMAN. The change-of-status data is then processed by the SLU to produce mode forcing signals that are sent to the appropriate peripheral and ICCG components.

**HARD-WIRE SIGNAL INTERFACE.**— The volume control signals and backup mode control and status signals are interfaced by separate lines between the components. These signals are analog voltages and ground circuits. These signals produce changes in the components as the controls are adjusted or pressed without being processed first.

### **ICCG Indicators**

Most of the indicators in the ICCG are either mode or function status indicators that come on amber and green. When the indicator comes on green, it means that the corresponding function is available for selection. When that function is selected, the indicator will turn to amber. With the indicator off, that function is not available for selection.

On the IRC, the IFPM indicators will illuminate when a fault is detected in the corresponding component. The S indicators on the crew panels will illuminate red when the secure mode of operation is selected for that particular radio system. The indicators in the frequency selection section of the IRC come on red when frequency selection is available.

### **Encoded and Decoded Word Format**

All the components in the ICCG, except for the three LS-602/AI panels, have identical binary encoding and decoding circuits. The encoding circuits transform a signal function into a binary word in the Manchester format for transmission to another component. The decoding circuits transform the Manchester signal functions from another component into basic signal functions for application to processing and control circuits within that component.

Each of the components in the ICCG, except the LS-602/AI, have a unique binary word address. The component responds to an interrogation by the SLU only when its specific address is recognized. The addresses are incorporated into the 36-bit ICCG word format. Each bit is a status or control function, or a part of the 5-bit component address that has a permanently assigned slot in the 36-bit format.

The 36-bit words are serially generated and serially transmitted binary bit words. Each bit is either a 1 or a 0. A logic 1 corresponds to a voltage level between 5.0 and 8.5 volts dc. A logic 0 corresponds to a voltage level between -0.5 and -1.5 volts dc.

**ENCODED WORD FORMAT.**— Encoded word format is setup for 36-bits that are either status/control function information or component addresses. Bit 1 is the control bit and is always a 1.

Bits 2 through 6 are the address bits. Each component has its own unique binary configuration. One example of this is that the SLU recognizes the binary number 01010 as the pilot crew ICS panel. Should this configuration show up in bits 2 through 6, then the SLU will process on the command data from the pilot ICS panel during the 36-bit word cycle. Each component address word is designated by the decimal equivalent to its binary value. With the above example, the pilot ICS panel address 01010 is equal to decimal 10. Therefore, the pilot ICS panel designation is word 10.

Bit 7 is the tag bit needed for binary word house-keeping. It is always 0 for encoded words.

Bit 8 is the enter bit for binary housekeeping. In the encoded words it is always 1.

Bits 9 through 34 are the command functions, status, or spare bits. Bit 35 is a command function, status, spare, or set-zero housekeeping bit.

Bit 36 is the parity bit used for self-check in the binary circuitry. This system uses the odd parity check. If there are an even number of 1's in the first 35 bits, bit 36 will be a 1. If the total number of 1's in the first 35 bits is odd, bit 36 will be a 0. When a component receives the 36-bit encoded word, its decoder checks the parity by counting the 1's. If it comes up with an even number of 1's, the word is not processed and a BITE indicator is illuminated on the component that transmitted the faulty data word.

**DECODED WORD FORMAT.**— The decoded word format is similar to the encoded word format with just a few differences. Bit 1, bits 9 through 34, bit 35 and bit 36 are the same as in the encoded word. Bits 2

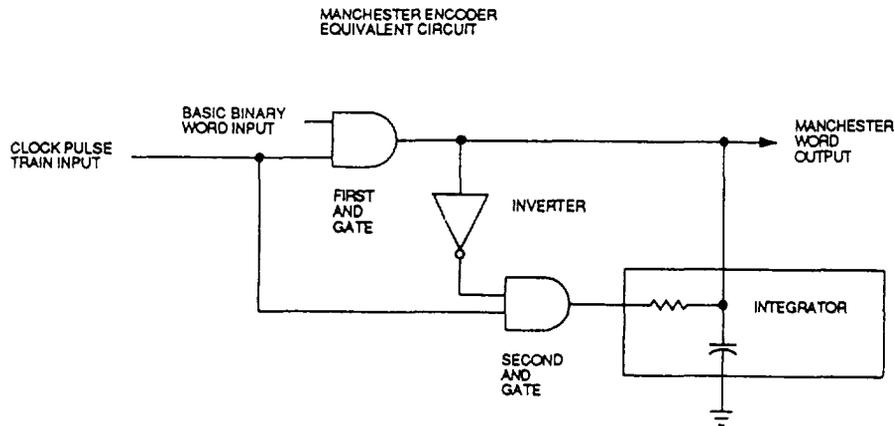
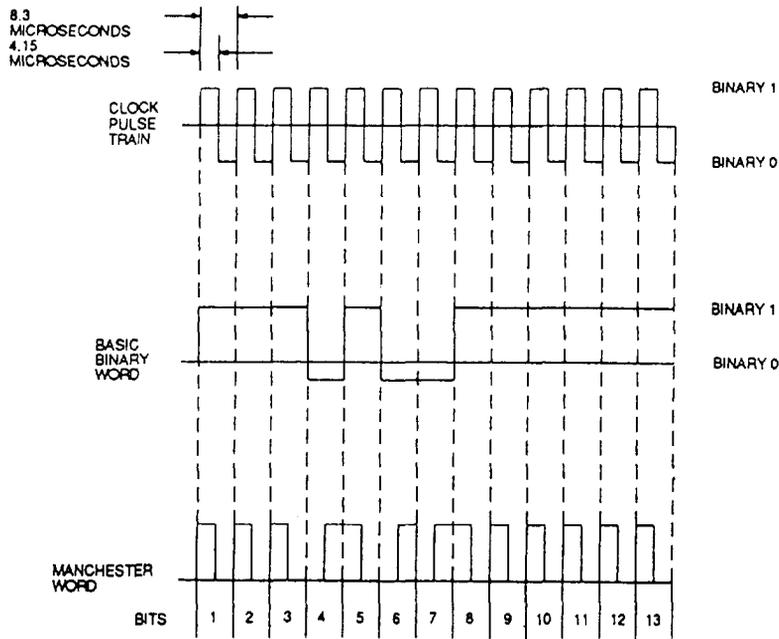


Figure 1-4.-Manchester encoding.

through 6 are the decoded address bit, but it is not the same configuration as the encoded word. Bit 7 is the tag bit and is always 1 in the decoded word. Bit 8 is the enter bit and is always 0 for the decoded words.

The ICCG components process binary command and status words that cause changes in operation and display configuration. Word exchanges between components are done by binary word data encoded in Manchester format.

### Manchester Word Encoding

The Manchester word format is a modification of the 36-bit encoded word generated in the components. This is done for transmission of the information from one component to another. The modification is accomplished by combining the basic 36-bit word with

a master clock pulse train. The clock pulse rate is 120 kHz, and the pulse width is 8.3 microseconds.

Figure 1-4 shows a Manchester encoder equivalent circuit and its input and output signals. When both inputs to the first AND gate are 1, the Manchester word bit is also 1 for the 4.15-microsecond duration of the positive clock pulse. The resulting Manchester pulse occurs during the first half of the bit period. The output pulse of the first AND gate is applied to both the inverter input and the Manchester word output. The inverter produces a 0 output to keep the output of the second AND gate at 0, while a Manchester pulse is being produced. Since the clock pulse is negative during the second half of the bit period, the output of the second AND gate remains at 0.

When the basic binary word bit at the first AND gate is 0 and the clock pulse is 1, the output of the first AND gate is 0. This causes the output of the inverter to be 1.

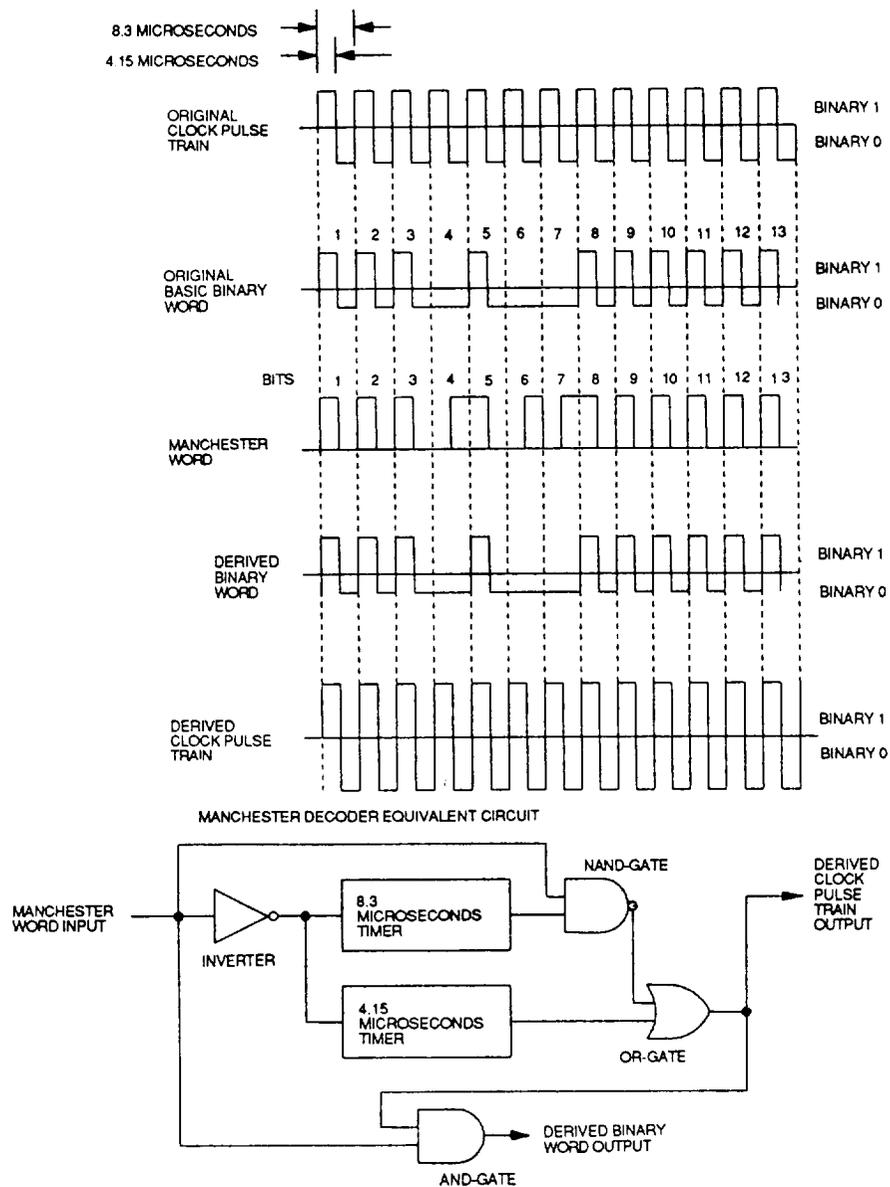


Figure 1-5.-Manchester decoding.

Because this makes both inputs to the second AND gate to be 1's, the output of the second AND gate will be 1. This 1 will cause the integrator to charge, producing a Manchester word bit of 1 during the second half of the clock pulse. This type of bit is generated for timing purposes only.

### Manchester Word Decoding

When component receives a Manchester word, the digital control circuits must decode the word into the basic binary word and the clock pulse train. This process is required prior to any further processing of the signal by the component. A Manchester decoder equivalent circuit and its input and output signals are shown in figure 1-5.

The first input bit of the Manchester is always a 1. This produces a 0 at the output of the inverter and the inputs of the two timers. The same Manchester input bit is applied to one input of the NAND gate. The 0 output of the 8.3 timer is applied to the other input of the NAND gate, giving an output of 1 from the NAND gate. This 1 is applied to the OR gate, making its output a 1. The 1 from the OR gate represents the first derived clock pulse bit. This 1 is also applied to one of the inputs of the AND gate. The other input is the original 1 from the Manchester word. With both inputs to the AND gate being 1, the output will be a 1. This 1 represents the first bit of the derived basic data bit.

When the Manchester bit goes to 0, the inverter output goes to 1 and starts the two timers. If the next Manchester bit is 1, the two timers are restarted before

they can complete a full cycle. The decoding process is repeated, causing another derived clock pulse bit and another derive basic binary word bit to be generated.

When a Manchester bit is a binary 0, it cannot reset the timers through the inverter. The 4.15-microsecond timer times out and produces a binary 1 at one input of the OR gate. The OR gate output is a binary 1 that represents the next derived clock pulse. Since there is a binary 1 at one input and a binary 0 at the other input of the AND gate, the resulting output is a binary 0 that represents the next derived data bit. The 8.3-microsecond timer is still running because a binary 1 has not been produced in the Manchester word. The 8.3-microsecond timer times out and produces a 1 on one input of the NAND gate. The other input is a 0, which produces a 1 at the output. This 1 produces a 1 at the output of the OR gate, which represents a 1 for the derived clock pulse.

### **Multiplex Transmission**

Multiplex transmission data consists of 32 roll call words with a period of 800 microseconds for each word. The total period of time required for all the words is 25.6 milliseconds. Therefore, any one of the specific roll call periods occurs every 25.6 milliseconds. A roll call word consists of an inhale word and an exhale word, each being 400 microseconds long. Each inhale and exhale word consists of 48 clock intervals of 8.3 microseconds each. These clock intervals correspond to data bits. Of the 48 bits, 6 bits precede the 36-bit Manchester word and 6 bits follow the word. This means that there are 12 bits between the inhale word and the exhale word, which totals 79.6 microseconds. This period of time allows the component to prepare itself to receive or transmit data.

The SLU controls the ICCG. The roll call for the communication systems is generated there. Between the SLU and the other components of the ICCG, the exhale word is a status word. Between the GPDC and the SLU, the exhale word is also a status word. The inhale word between the SLU and the other components of the ICCG is a command word that tells the SLU to change configuration or frequency.

The status is the configuration that the communication systems are in at any specific instant, and is indicated by the color of the switchlight (amber, green, red, or dark). A configuration change occurs whenever a switchlight is depressed. For example, changing HF USB to HF LSB is a configuration change.

Each component in the ICCG has a digital control section that controls all data entering or leaving the component. The IRC and the SLU are the only components that respond to more than one roll call

address. In contrast, the crew ICS panel only has to respond to one roll call address. Because of this, the crew ICS panels use comparators instead of input register decoders. The address logic is hardwired into the aircraft cable connectors for each crew ICS panel. This allows only one address to compare true at each station, which makes the crew ICS panels interchangeable.

### **Roll Call**

The ICCG logic flow and roll call sequence are described in the following text.

**ROLL CALL 0.**— Roll call 0 is a spare on both the inhale and exhale words. When the 800 microseconds have elapsed, the roll call generator produces roll call 1.

**ROLL CALL 1.**— The first part of roll call 1 is exhaled from the SLU. Roll call 1 informs the GPDC that a change in configuration or status has occurred since the last roll call 1. The GPDC buffer and/or multiplex lines (port 2) receives the exhale word from the SLU. There are three components of the ICCG hooked up to port 2. The IRC is the only ICCG component that recognizes roll call 1, and it processes the roll call through the digital control section, line receiver, and inhale word register. In the inhale word register, the Manchester word is decoded into the clock pulses and the data word. The roll call is matched against the address, and the decision is made whether or not to proceed with the processing. The other two components are processing the roll call 1 at the same time, but because the address will not match, only the IRC will continue processing.

In the IRC, the derived data is sent to the input register under the control of the derived clock pulses. Word validation begins at this time. As part of the word validation process, the tag bit is examined. The tag bit of roll call 1 is a binary 1 that identifies the word as a status word from the SLU. A tag bit identification word in the IRC is sent to the inhale/exhale word gate. At the same time, the roll call 1 is sent to the exhale word inhibit gate that starts a 500-microsecond timer. When the timer times out, the exhale AND gate is enabled and the data word is shifted into the exhale word assembly register.

The second part of roll call 1 is generated in the IRC. The data originates in the exhale word generator, and it represents the HF configuration. The configuration of the data bits in the exhale word register is shown in table 1-2. Data bits 15 and 16 are USB and LSB. When the USB/LSB switchlight is depressed to change from USB to LSB, a pulse is generated that sets the bit 16 one-shot circuit. As long as the switchlight is depressed, the

Table 1-2.-Exhale Word Register Configuration

BIT NUMBER	BIT NOMEMCLATURE	BIT CONFIGURATION	
1	Control bit	1	
2	Address bit	1	
3	Address bit	0	
4	Address bit	0	
5	Address bit	0	
6	Address bit	0	
7	Tag bit	0	
8	Enter bit	1	
		<b>FUNCTION SELECTED</b>	<b>FUNCTION NOT SEL.</b>
9	Auto	0	1
10	HF on	1	0
11	Voice	1	0
12	Data	1	0
13	Clear	1	0
14	Secure	1	0
15	USB (Upper Sideband)	1	0
16	LSB (Lower Sideband)	1	0
17	Both	1	0
18	AME	1	0
19	Noise blanker	1	0
20	Fast	1	0
21	Slow	1	0
22	IBD (In-Band Diversity)	1	0
23	Data silence	1	0
24	Spare	1 or 0	
		<b>POSITION</b>	
		<b>0 1 2 3 4 5 6 7</b>	
25	HF squelch	0 1 0 1 0 1 0 1	
26	HF squelch	0 0 1 1 0 0 1 1	
27	HF squelch	0 0 0 0 1 1 1 1	
		<b>BIT CONFIGURATION</b>	
28	Spare	1 or 0	
29	Spare	1 or 0	
30	Spare	1 or 0	
31	Spare	1 or 0	
32	Spare	1 or 0	
33	Spare	1 or 0	
34	Spare	1 or 0	
35	Set zero	0	
36	Parity	1 or 0	

one-shot circuit output is directly applied to the lamp drivers. The lamp drivers cause the LSB lamp to come on amber and the USB lamp to come on green. Once the switchlight is released, an enter pulse is inserted into the word storage of the exhale word generator. If the IRC is in the manual mode, this enter pulse will cause the parallel transfer of the data bits from the one-shot circuits to the word storage register. When the switchlight is released, parallel data from the one-shot data is inhibited from the lamp drivers. The indicators change to the color configuration represented in the status configuration memory. The lamps go off momentarily because of the 25-millisecond cycle time of the roll call sequence required for updating the status registers. The parallel data goes from the word storage register to the parallel-to-serial word converter, and then, under control of the clock and roll call control, to the exhale word inhibit AND gate. From here it is transferred to the exhale word assembly register, where the roll call address and tag bit are added. A parity bit is also added if the first 35 bits are even. The clock pulse and data are combined and then shifted out on the multiplex line.

The second part of the roll call 1 data is now in Manchester format and is applied to the other components on port 2. Only the SLU recognizes roll call 1 in its digital control section. Roll call 1 is an exhale word with respect to the IRC, but it is an inhale word in respect to the SLU.

The inhale word enters the SLU through the line receiver and is transferred to the inhale word register. Here the data and the clock pulses are separated, and the data is shifted to the input register under the control of the derived clock pulses. This is the only function of the derived clock pulses. Once the data is shifted to the input register, the master clock is used to shift the data from one buffer to another.

The roll call word is shifted into the valid word register. This register validates the word by ensuring that there are 36 bits, the address is 5 bits long, the address has a control list and a tag bit, and the word parity is odd. If any of these conditions are not met, the word is sent to the not-valid register. If the input word is invalid three times, the status register sets the BITE indicator on the component that sent the word. If the word is valid, a valid word signal is generated, and the enter bit of the derived data is examined. If the enter bit is not a binary one, no further processing is done. The SLU only processes data if a change is present on the inhale word. If a change is present, the enter bit is a binary one.

If the inhale word is valid and it has an enter bit, it is sent to the HF configuration buffer. Here it is loaded into the multiplex register by the clock pulses and unique strobe G24. The multiplex input register shifts the data to the word decoder, where it is converted from serial binary format to parallel binary format. This parallel data is used to make the configuration change. The data is also converted back to serial binary format and stored for use in the exhale word assembly register for the next roll call 1.

**ROLL CALL 2.**— After the second part of roll call 1 is processed by the SLU, the first part of roll call 2 is processed. Roll call 2 originates during word storage in the HF conjunction buffer of the SLU. The exhale word is sent from the SLU on the common multiplex line. Each component on the common multiplex line compares the address of roll call 2 with its own address. Only the IRC recognizes roll call 2.

The IRC processes the word in its digital control section the same way as the SLU did. The derived data is then sent to the input register where it is validated. The input register senses that the tag bit is a binary one. The binary one starts a 300-microsecond selective strobe counter and a 500-microsecond exhale word counter.

The valid roll call 2 word is sent to all the display registers in the IRC, but because of the address, only the HF configuration status display register will receive clock pulses. The clock pulses will shift the roll call word into the inhale word decoder and storage register. Here it will wait until the selective strobe pulse transfers the parallel word to the lamp drivers. The selective strobe pulse is sent when the 300-microsecond counter times out, signaling the end of the inhale word time. The lamp drivers turn on the lamps by applying aground to the low side of the lamps. The high side of the lamps is supplied by the lamp dimmer control circuit.

When the 500-microsecond timer times out, the IRC exhale word is applied to the multiplex lines. This word is the SLU inhale word, and it is processed exactly like the inhale word for roll call 1. The SLU will ensure that the enter bit is a binary one, and if so, will check the frequency to see if it is a legal frequency. If the frequency is legal, the word is processed and sent to the HF radio set in binary-coded-decimal (BCD) format. If the word is an illegal frequency, the frequency that is set upon the thumbwheel switches (on the SLU face) is sent to the HF set in BCD format. The operating frequency status word, which is the next word to be exhaled by the SLU, will equal the frequency that was sent to the HF radio set. If the frequency selected on the IRC is legal,

it will be used; if not, the frequency indicated by the SLU is used

**ROLL CALL 3.**– The first part of roll call 3 is the SLU exhale word 3. This consists of the HF frequency status data. The word is built in the same manner as the first two words. This word is then inhaled by the IRC and processed and displayed. The IRC then exhales a roll call 3 word in the same manner as the first two, and the cycle continues. The only exception is the UHF status words. The status display is shared by both UHF radio sets, but only the UHF set that is on-line will be displayed.

**ROLL CALL 4 THROUGH 12.**– The digital control and input register sections of the SLU process the inhale and exhale words, making the same decisions as they did on the first three words. The buffers react differently, depending on the current word or situation.

Another difference during UHF configuration changes occurs in the channel set/channel select and frequency buffers. If the UHF frequency word has bits 32 and 33 at binary zero, the word is sent directly to the UHF frequency buffer. There is a separate buffer for each of the radio sets. When the word arrives at the buffer, it is checked for validity. If the frequency is illegal, the frequency command sent to the UHF set is a fixed-logic 300-MHz word that comes from the random access memory (RAM) in the SLU. In either case, the frequency is sent out in BCD format from the SLU to the radio set. The status is sent to the IRC in the same manner as for the HF status.

If the channel set bit (bit 32) is a binary one, the frequency and channel number is sent to the RAM for storage. There is storage for 22 channels and frequencies in the RAM. Each UHF radio set has its own RAM. The channel set data remains stored in the RAM until called by bit 33. When bit 33 is a binary one, the channel number attached to the word addresses the frequency associated with that channel in the RAM. If the channel and frequency have been previously stored in the RAM, the frequency code is sent to the UHF frequency buffer for processing. If they have not been set, the 300-MHz frequency code is sent to the UHF frequency buffer for processing.

The IRC/SLU roll call exchange ends with the first part of roll call 8. The SLU/crew ICS panels roll call exchange includes the last part of roll call 8 through the first part of roll call 12. Roll call 8 is recognized by the IRC and the copilot's crew ICS panel. For the IRC, it is a status word as established by the tag bit. The copilot crew ICS panel also recognizes the word and prepares

to send an exhale word to the SLU. Further processing of the inhale word is inhibited by a transmit reset signal.

A crew ICS panel responds to a single word; therefore, the digital control section can be greatly simplified. Instead of an inhale word register, it has inhale word logic. The address coming in is compared with the fixed identification logic. If the word is recognized, the inhale word logic is stored for 800 microseconds, and the transmit detector is set. At the end of 500 microseconds, the exhale word assemble register is enabled

The exhale generator functions the same as the exhale word generators in the IRC. The exhale word generator shifts the data under clock control to the exhale word assembly register, where the housekeeping bits are added. When the word is clocked out of the parity circuit, the reset-transmit detectors set. Resetting the transmit detector enables the inhale word logic. The data word arriving at the SLU from the crew ICS panel is processed and sent to the ICS buffer. The ICS buffer processes the word and places the microphone and headset in a selected configuration. The bit change counter for TACAN, IFF, XMIT SEL, CONF 1, and CONF 2 switchlight selection is located in the ICS buffer. This counter counts the times that the bit associated with the function changes from binary one to binary zero. The times the counter changes determines which function has been selected by a multiple function selector switch.

The status word from the SLU to the crew ICS panel is constructed and transmitted the same way as all other words. When the first part of roll call 9 is on the multiplex line, it is recognized by the TACCO crew ICS panel, but it is also present in the copilot crew ICS panel. It is there because the word logic is still held open by the address detector, which recognized roll call 8. Only the TACCO crew ICS panel will process the data.

Processing of the roll calls continues in this fashion until the roll call rolls back to zero. At this point it starts all over again.

## **VHF COMMUNICATIONS**

*Learning Objective: Recognize components and operating principles of a VHF radio system.*

The AN/ARC-197 VHF communication system provides an aircraft with two-way, plain voice radio communications in the very high-frequency range. Its actual frequency range is from 116.000 to 151.975 MHz.

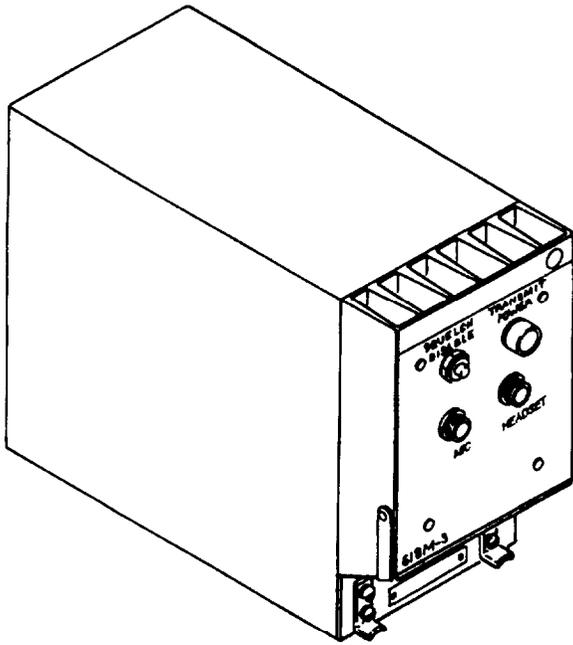


Figure 1-6-RT-1397/ARC-197 transceiver.

In the P-3C aircraft, this system interfaces with four of the intercommunication stations in the transmit/receive functions. The pilot, copilot, TACCO, and NAV/COMM stations can transmit and receive over this radio. The other stations in the aircraft have receive function only.

### MAJOR COMPONENTS

There are three components to the AN/ARC-197 system. These components are the RT-1397/ARC-197 transceiver, the C-11067/ARC-197 VHF-AM control panel, and the 949880 VHF antenna.

#### RT-1397/ARC-197 Transceiver

The RT-1397/ARC-197 transceiver (fig. 1-6) is a solid-state unit, consisting of a power supply, frequency synthesizer, receiver modulator, and transmitter. There is one indicator, one push button, one microphone jack, and one headphone jack on the unit. The indicator is labeled TRANSMIT POWER, which illuminates when output power is greater than 10 watts. The push button is labeled SQUELCH DISABLE, which will disable the squelch for low signal levels. The microphone and headphone jacks are used for maintenance and emergency VHF communication in case of ICS failure in-flight.

#### C-11067/ARC-197 VHF-AM Control Box

The control box (fig. 1-7) controls the operation of the system. There are two dual function knobs and a display window on the control panel. The display window shows the selected frequency of the system.

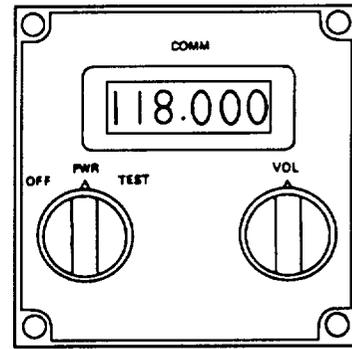


Figure 1-7-VHF-AM control box.

The outer ring of the dual function knob on the left applies system power and selects the test function. The inner knob changes the frequency of operation in 1-MHz steps over the range of control. The outer ring of the dual function switch on the right is labeled VOL, and it is not used in the P-3 aircraft. Volume is controlled by the ICS system. The inner knob of this control is used to change the frequency of operation in 25-kHz steps over the range of control.

#### 949880 VHF Antenna

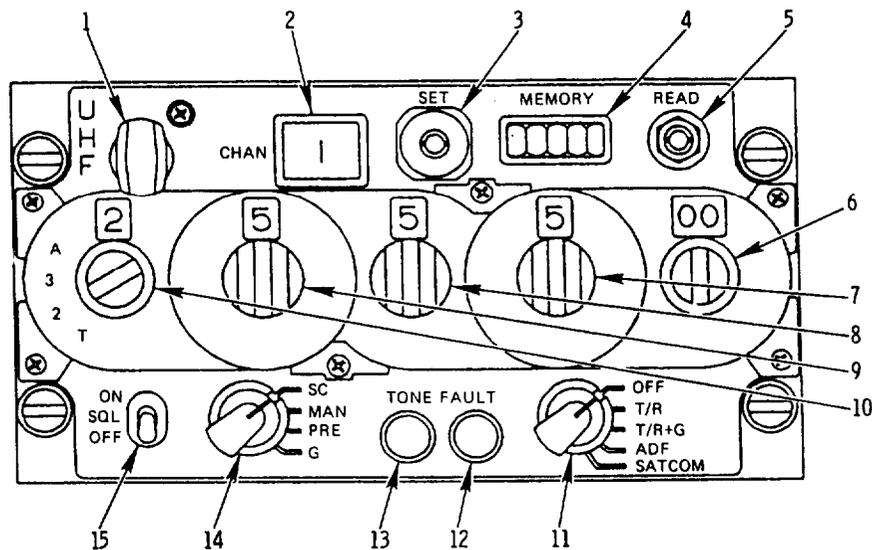
The 949880 antenna is located in the tailcap on top of the vertical stabilizer of the P-3 aircraft. This antenna radiates and receives the VHF radio frequency signals. Signals routed to and from the antenna go through a VHF bandpass filter, which reduces the crosstalk between the VHF and UHF systems.

### VHF FUNCTIONAL DESCRIPTION

There are two modes of operation with the AN/ARC-197 radio. These two modes are receive and transmit.

#### Receive Mode

In the receive mode, the received RF signals from the antenna are routed through the filter, and applied to the receiver circuits in the transceiver. The frequency selected on the control box is applied to the frequency synthesizer. The synthesizer uses a single phase-locked loop to generate RF injection frequencies, in 25-kHz steps, from 116.000 to 155.975 MHz. The RF injection frequencies, along with dc tuning voltages, electronically tune the receiver to the selected frequency. The AM detected audio is applied to the audio amplifier circuit. Squelch circuits disable the output amplifier if the required signal-to-noise ratio or carrier level is not present. The output audio is then applied to the ICS interconnection box for distribution to the various stations.



- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li>1. Preset channel selector switch</li> <li>2. CHAN indicator</li> <li>3. Set switch</li> <li>4. MEMORY read display</li> <li>5. Memory READ switch</li> <li>6. Manual frequency selector switch</li> <li>7. Manual frequency selector switch</li> <li>8. Manual frequency selector switch</li> </ul> | <ul style="list-style-type: none"> <li>9. Manual frequency selector switch</li> <li>10. Manual frequency selector switch</li> <li>11. Function selector switch</li> <li>12. FAULT status indicator</li> <li>13. TONE switch</li> <li>14. SONOBUOY COMMAND/MANUAL/PRESET/GUARD</li> <li>15. SQUELCH ON-OFF switch</li> </ul> |
|---|---|

Figure 1-8.-C-11950/ARC-187 control box.

### Transmit Mode

In the transmit mode, the VHF XMTR control signal from any one of the four ICS master control panels applies a ground to the transceiver as the VHF key signal. This VHF key signal provides the push-to-talk command to the transceiver to switch it from the receive to the transmit mode of operation. The synthesizer generates transmitter drive frequencies from 116.000 to 155.975 MHz in 25 kHz steps. Audio from any of the four ICS master control boxes are applied to the modulator circuit. The modulator circuit provides 90-percent amplitude modulation. The compressor and limiter circuits are included to prevent over-modulation. The transmitter uses five stages of amplifiers to raise the output to 20 watts. The RF output is routed to the antenna, through the filter, for radiation. The transceiver also produces a sidetone output, which is provided to the ICS system in the same manner as the receiver audio.

### UHF COMMUNICATIONS

Learning Objective: *Recognize components and operating principles of the UHF radio system.*

The AN/ARC-187 UHF radio system consists of the UHF-1 radio set, UHF-2 radio set, and the interfacing equipment. The UHF communication system provides amplitude modulation, frequency modulation, and frequency shift key (FSK) operations. The frequency range of this radio system is 225.000 to 399.975 MHz.

### MAJOR COMPONENTS

Each radio set in the system consists of an RT-1571/ARC-187 receiver transmitter, a C-11950(V)3/ARC-187 radio control, an AT-879/ARC antenna, and a 740645 antenna switching relay. The UHF-2 radio set also contains a 974924 antenna select panel. The antenna and the antenna switching relay will not be discussed in detail in this manual.

### RT-1571/ARC-187 Receiver Transmitter

The RT-1571/ARC-187 receiver transmitter contains all the circuitry for the normal operation of the UHF radio set.

### C-11950/ARC-187 Radio Control Box

The C-11950/ARC-187 control box (fig. 1-8) provides all the controls for normal operation of the radio set. We will be discussing each of the controls and

indicators in the following text. Each number corresponds to a pointer in figure 1-8.

1. Preset channel selector switch—Selects anyone of 20 preset channels.

2. CHAN indicator—Indicates channel selected by the preset channel selector.

3. SET switch—Sets anyone of the available 7000 normal mode frequencies.

4. MEMORY read display—Displays the frequency that has been selected by preset channel selector.

5. Memory READ switch—Allows selected frequency to be displayed.

6. Manual frequency selector switch—Selects hundredth and thousandth's digit of the desired manual frequency in steps of 25 (00, 25, 50, or 75).

7. Manual frequency selector switch—Selects the tenth's digit of desired manual frequency (0 through 9).

8. Manual frequency selector switch—Selects unit's digit of the desired manual frequency (0 through 9).

9. Manual frequency selector switch—Selects ten's digit of the desired manual frequency (0 through 9).

10. Manual frequency selector switch—Selects hundred's digit of the desired manual frequency (either 2 or 3). In the A position, the radio set in an anti-jamming mode. In the T position, the radio set is enabled for transmission and reception for one minute.

11. Function selector switch—Selects operating modes.

- a. OFF—Shuts down the radio set.
- b. T/R—Enables main receiver and transmitter.
- c. T/R+G—Enables main receiver, transmitter, and guard receiver.
- d. ADF—Sets the receiver transmitter to the AM mode for automatic direction finding operations.
- e. SATCOM—Allows Satellite Communications by setting the receiver transmitter to the SATCOM mode.

12. FAULT status indicator—Steady illumination indicates an RT fault, a slow flash (1/sec) indicates an interface fault, and a fast flash (4/sec) indicates a control box fault.

13. TONE switch—Enables transmission of an audible tone on the selected frequency.

14. SONOBUOY COMMAND/MANUAL/PRESET/GUARD—This switch selects the mode of frequency selection.

- a. SONOBUOY COMMAND—This position causes the radio set control to deliver a serial data stream corresponding to a preset frequency in the controls memory.
- b. MANUAL—In this position the frequency is manually selected using the five manual frequency selector switches.
- c. PRESET—The frequency is selected using the preset channel selector switch. This position is also used for programming the 20 preset channels.
- d. GUARD—This automatically tunes the main receiver and transmitter to the guard frequency and disables the guard receiver.

15. SQUELCH ON-OFF switch—Enables and disables the squelch circuits of the main receiver.

### **UHF-2 Antenna Select Panel**

The UHF-2 antenna select panel (fig. 1-9) selects which antenna the UHF-2 radio set will use during operation. There is one two-position switchlight on this panel. The switchlight is marked UP ANT and LOW ANT. When the upper tailcap antenna is selected, the UP ANT portion of the switchlight will be illuminated amber. When the lower antenna is selected, the LOW ANT portion will be amber.

### **UHF MODES OF OPERATION**

Figure 1-10 shows a simplified block diagram of the UHF system.

The UHF-1 radio set provides the following modes of operation: plain voice, cipher voice, ADF navigation, plain voice guard, cipher voice guard, and secure SATCOM. The UHF-2 radio set provides plain voice, cipher voice, sonobuoy command, wide-band audio, plain voice guard, cipher voice guard, link 11 plain data, link 11 cipher data, TTY plain data, TTY cipher data, and IACS data.

Operation of these radio sets is supported by various equipment on board the aircraft. Mode selection for UHF-1 is accomplished by the control box and the A344 voice selector. Mode selection for UHF-2 is



Figure 1-9.-UHF-2 antenna select panel.

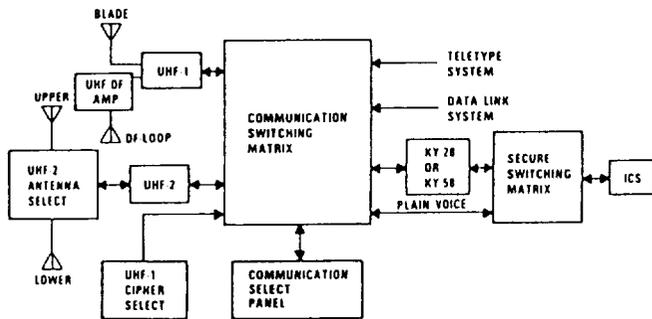


Figure 1-10.-UHF block diagram.

accomplished through the control box and the A516 communications system selector. Some of the peripheral equipment include the AN/AIC-22 intercommunication system, the AN/AGC-6 teletypewriter set (TTY), the AN/ACQ-5 data terminal set (DTS), the AN/ASA-76 generator transmitter group (CASS), and the security equipment TSEC/KY-28 or TSEC/KY-58.

In general, both radio sets are UHF transceivers that provide two-way voice and data communication in the frequency range of 225.000 to 399.975 MHz. They automatically tune 7,000 channels at 0.025-MHz intervals. Built in self-test circuits detect the presence or absence of required operation signals and voltages, then illuminate fault indicators upon detection of faults.

### Voice and Data Signals

Voice and data signals at the UHF-2 radio set are linked to the TTY, ICS, and DTS. The UHF security unit is linked between both radio sets and the ICS. This security unit ciphers and deciphers secure voice information. The UHF-2 radio set is used as a backup transmitter for sonobuoy command signals for the CASS system. The secure switching matrix controls the signal flow between the signal processing equipment and the voice, data source, and monitoring equipment.

### Transmit Functions

During transmit, the keying and transmit signals from the voice or data source are coupled by the COMM

switching matrix to the UHF RT. In the UHF-1 set, the keying signal is interlocked by the UHF-1 RF switch. The voice or data signal modulates the carrier signal generated in the RT, and the output signal is amplified and coupled to the antenna. The UHF-1 output goes through the UHF filter and UHF-1 RF switch to the antenna. UHF-2 output goes through the UHF filter and the UHF-2 RF switch. To provide operating frequency and mode control information, both radio set control boxes generate a digital bit stream that is decoded in the radio's RT. This decoded stream gates the appropriate selected carrier modulation mode and operating frequency. It also gates input voice or data signals by activating the appropriate lines in the RT for the selected operating mode.

The COMM system selector interfaces the UHF-2 radio set with the other systems by controlling the keyline and voice or data signal relay gates in the COMM switching matrix. The UHF-1 set control and the UHF-1 voice selector interface the UHF-1 radio set with the voice or data sources.

The satellite communications (SATCOM) relay panel is activated to the SATCOM mode of operation by the UHF-1 control box. The control sends an FM select signal to the relay panel, and this switches the panel to the SATCOM mode. The UHF-1 RT is connected to the top antenna through the internal preamplifier to receive the UHF RF signals.

### UHF-DF Operation

The UHF-DF operation is accomplished by connecting the UHF-1 radio set to the AN/ARA-50 automatic direction finder set. The ADF received signals are routed through the UHF-1 RT, complete with sidetone to the ICS system for monitoring. During UHF-DF operations, the operator can break in to the mode to transmit. When the mike is keyed to transmit, the UHF-1 RT is automatically connected to the top UHF antenna for transmission. When the mike key is released, the UHF-1 RT is automatically switched back to the ARA-50 antenna for resumption of DF operations.

### UHF-1 Receive

During receive, the RF from the top antenna is coupled through the SATCOM relay panel, the RF SWITCH, and the UHF filter to the RT. In the RT, the signal is applied to both the main receiver and the guard receiver. The main receiver consists of two modules-the receiver and a 70-MHz I/O. The receiver is capable of providing reception of 7,000 channel frequencies. The

Table 1-3.-UHF-1 and UHF-2 Operating Modes

UHF-1		
MODE	TRANSMIT	RECEIVE
Plain voice	AM	AM
Cipher voice	AM	AM
ADF navigation	Not applicable	Wide-band audio
Plain voice guard	Fixed AM	Fixed AM
Cipher voice guard	Fixed AM	Fixed AM
Secure SATCOM	FM	FM
UHF-2		
MODE	TRANSMIT	RECEIVE
Plain voice	AM	AM
Cipher voice	AM	AM
Sonobuoy command	AM	Not applicable
Wide-band audio	Not applicable	Wide-band AM
Plain voice guard	Fixed AM	Fixed AM
Cipher voice guard	Fixed AM	Fixed AM
Link plain data	FM	FM
Link cipher data	FM	FM
TTY plain data	AFSK	AFSK
TTY cipher data	AFSK	AFSK
IACS data	AFSK	

guard receiver is a separate module and is a complete and independent fixed-tuned, crystal-controlled receiver that operates on the guard frequencies. The receiver sections receive command signals from the control box, placing it in the proper condition for the mode selected. All receiver outputs derived from guard, FM, FSK, wide-band, and voice modes are routed through the audio interface, and then switched through the COMM switching matrix to the external equipment.

#### UHF-2 Receive

The RF signal received at the UHF tailcap or UHF lower antenna is coupled into the UHF-2 RT through the antenna switching relay, and the UHF filter. From this point on, the operation is the same as in the UHF-1 radio set.

#### Modes of Operation

Table 1-3 shows the modes of operation for the two radio sets.

#### HF COMMUNICATIONS

Learning Objective: *Recognize components and operating principles of the HF radio system.*

The AN/ARC-161 HF radio system provides two-way communications between the aircraft and any similarly equipped platform. It provides transmission, reception, and processing of intelligence and tactical data. The cipher voice communication is provided by the TSEC/KY-75 high-frequency security unit.

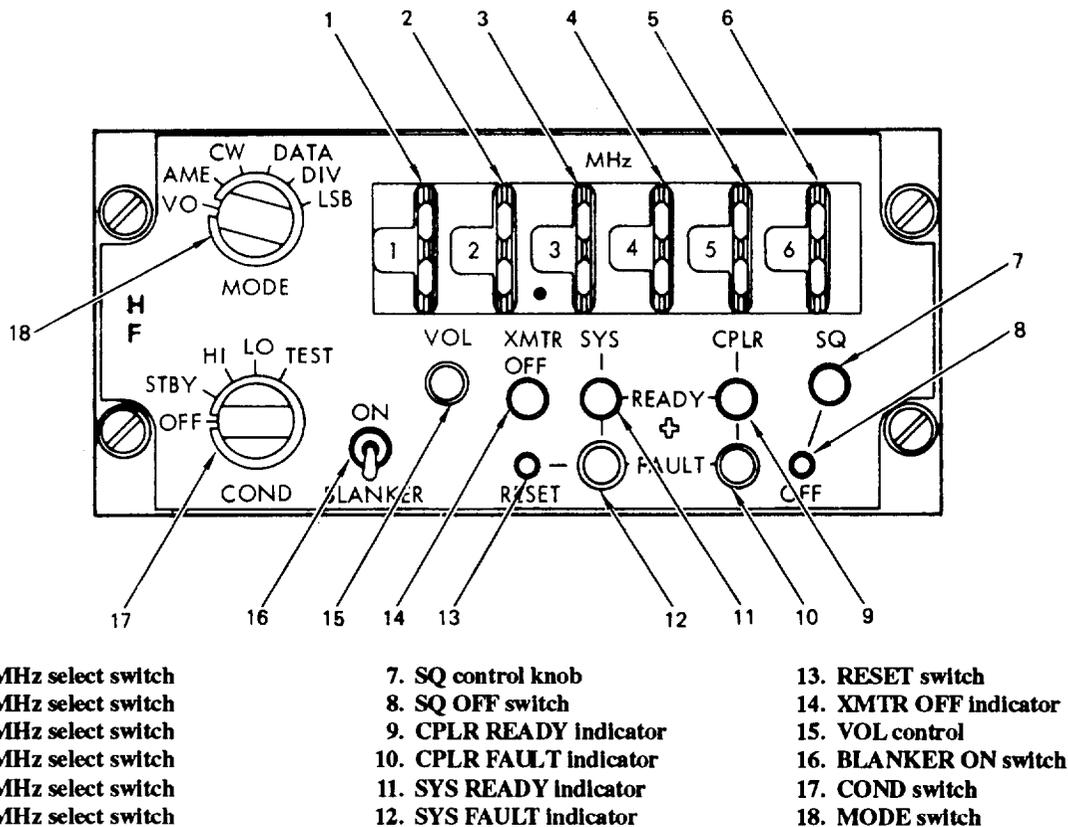


Figure 1-11.-C-9245/ARC-161 control box.

The HF communication system consists of two radio sets and interfacing equipment. These sets are called HF-1 and HF-2. The two radio sets provide two-way, single-sideband (SSB) and plain voice (AME) communication in the frequency range of 2.0000 to 29.9999 MHz, and they automatically tune 280,000 channels at 100-HZ intervals. The HF-1 antenna has four degraded frequency ranges at which coupling might not be possible: 4.8000 to 6.0000 MHz, 12.0000 to 13.2000 MHz, 19.1000 to 20.3000 MHz, and 26.5000 to 27.7000 MHz. The HF-2 antenna has two degraded frequency ranges where coupling might not be possible: 7.9000 to 9.1000 MHz and 18.9000 to 20.1000 MHz.

### HF MAJOR COMPONENTS

Each AN/ARC-161 radio set in the HF communications system consists of the following components: a RT-1000/ARC-161 receiver transmitter, an AM-6561/ARC-161 RF amplifier, a C-9245/ARC-161 control box, a CU-2070/ARC antenna coupler (which includes a lightning arrester), and a long-wire antenna. Both radio sets share the use of a TSEC/KY-75 security unit and TSEC/KY-75 remote control unit.

### RT-1000/ARC-161 Receiver Transmitter

The RT-1000/ARC-161 receiver transmitter controls the radio tuning, coupler tuning, and mode selection. It also contains all circuitry required for the generating of transmitter signals and the processing of received RF signals into audio/data signals.

### AM-6561/ARC-161 Radio-Frequency Amplifier

This component amplifies the output of the RT prior to transmission.

### C-9245/ARC-161 Control Box

The C-9245/ARC-161 control box (fig. 1-11) controls the operation of the HF radio set. There are two of these in the aircraft, one for each radio set. They are identical and interchangeable. Refer to figure 1-11 while reading the following text.

1 through 6. MHz select switches—Selects the desired frequency in the operating range of 2.0000 to 29.9999 MHz.

7. SQ control knob—Controls the amount of squelch threshold voltage in VO and AME operations.
8. SQ OFF switch—When this switch is pressed, the squelch circuits are disabled.
9. CPLR READY indicator—This indicator will illuminate when the associated coupler is properly tuned.
10. CPLR FAULT indicator—This indicator will illuminate to indicate improper tuning of the associated coupler.
11. SYS READY indicator—This indicator will illuminate when the radio set has passed the self-test routine.
12. SYS FAULT indicator—This indicator will illuminate anytime the radio set fails self-test.
13. RESET switch—This switch resets the SYS FAULT indicator to a GO condition after a NO-GO condition was detected
14. XMTR OFF indicator—When this indicator is illuminated the radio set cannot be used to transmit. This indicator will come on during the 3-minute warmup period (the first 3 minutes of initial power up), and anytime the operating frequency is changed by more than 1 MHz. Other than that, anytime there is a fault in the system that affects the transmitter, this indicator will illuminate.
15. VOL control—This control knob is not used in the P-3 aircraft configuration.
16. BLANKER ON switch—This switch is not used in the P-3 aircraft configuration.
17. COND switch—This switch selects the radio set's condition of operation.
  - a. OFF—This position removes primary power from the radio set.
  - b. STBY—Applies power to the radio set's RF Amp final stage filament, frequency standard and other critical circuits.
  - c. HI—Energizes the radio set and sets the transmitter for high-power output.
  - d. LO—Energizes the radio set and sets the transmitter for low-power output.
  - e. TEST—Initializes the radio set's self-test functions.
18. MODE switch—This switch selects the radio set's mode of operation.
  - a. VO—This position permits forced mode selection by the COMM system selector panel.
  - b. AME—This position permits AME transmission and reception.
  - c. CW—With the switch in this position, the radio set will transmit and receive continuous-wave signals.
  - d. DATA, DIV, LSB—In this position, permits forced mode selection by the COMM system selector panel.

### CU-2070/ARC Coupler

The CU-2070/ARC coupler (fig. 1-12) provides impedance matching between the receiver transmitter and the antenna. The lightning arrester provides a spark gap to protect the radio if lightning strikes the long-wire antenna.

### Long-wire Antenna

There are two antennas used in the P-3 aircraft for the HF system. Both are located external of the aircraft, and stretch from the top of the vertical stabilizer to the fuselage. The one on the left is used by HF-1, and the one on the right is for the HF-2 radio set. Both of the top mounts for the antennas are the breakaway type. If either antenna breaks in flight, the wire will depart the aircraft. This is designed for safety reasons. Should the wire get hung up and not depart the aircraft, structural damage could occur from the wire whipping against the fuselage.

### TSEC/KY-75 Security Unit

The TSEC/KY-75 provides the encoding and decoding of the signals when the radio set is in the cipher mode.

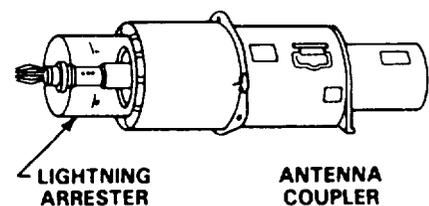
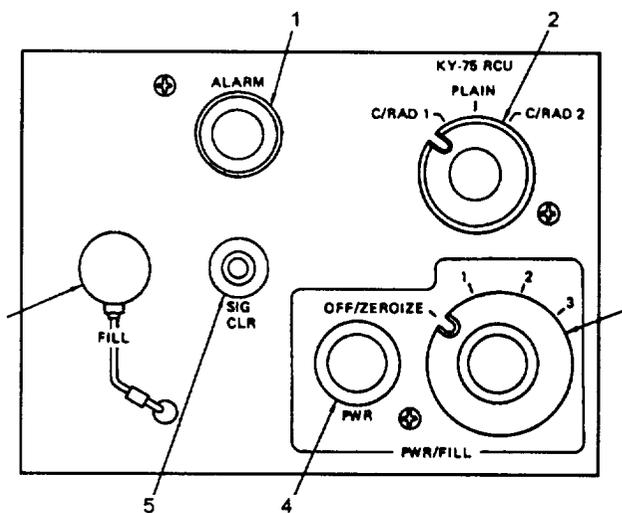


Figure 1-12.-CU-2070/ARC coupler.



- |                          |                   |
|--------------------------|-------------------|
| 1. ALARM indicator       | 4. PWR indicator  |
| 2. TSEC/KY-75 RCU switch | 5. SIG CLR switch |
| 3. PWR/FILL switch       | 6. FILL connector |

Figure 1-13.-TSEC/KY-75 remote control unit.

### TSEC/KY-75 Remote Control Unit

The TSEC/KY-75 remote control unit (RCU) is shown in figure 1-13. This unit enables the operator to operate the security unit without moving from the NAV/COMM station in the aircraft. The following is an explanation of the various controls and indicators on the RCU.

1. ALARM indicator—This indicator will illuminate whenever there is an alarm condition in the security unit.
2. TSEC/KY-75 RCU switch—This switch is not used.
3. PWR/FILL switch—This is a four-position switch used to select the key and storage locations for the various codes used.
  - a OFF/ZEROIZE—This position will zeroize all variables stored in the TSEC/KY-75 security unit. To select this position, the operator must pull the knob out 1/4 inch and turn it counterclockwise. This prevents accidental zeroizing during flight.
  - b. 1, 2, 3—These positions select a particular key for the cipher transmission or reception. They also select the storage area when the key is loaded into the TSEC/KY-75.
4. PWR indicator—This indicator will illuminate white when power is applied to the security unit

and the PWR/FILL switch is not in the OFF/ZEROIZE position.

5. SIG CLR switch—This switch is pressed to enable the till operation if the TSEC/KY-13 or TSEC/KOI-18 is attached. If a fill device is not attached, pressing this switch will cause the security unit to preamble.
6. FILL connector—This connector connects the filling device to the TSEC/KY-75 security unit electrically. This enables the operator to load keys into the security unit.

### HF FUNCTIONAL DESCRIPTION

Both radio sets function in the same manner; the only difference between the two is the peripheral equipment used. Figure 1-14 shows a system block diagram.

#### Receive Function

The RF signal is received by the antenna, coupled through the coupler and the de-energized transmit-receive relay in the RF amplifier, and finally to the receiver transmitter receiver RF input. RF-to-audio conversion is accomplished in the receiver section using inputs from the frequency synthesizer. The recovered audio component is amplified to a power level sufficient to be used as an audio input to the peripheral equipment.

#### Transmit Function

During the transmit function, voice or data signals from the peripheral equipment are switched through the COMM switching matrix to the USB and LSB transmit audio inputs to the receiver transmitter. A keying signal is also applied from the peripheral equipment. For emergency or maintenance operations, voice and keying signals can originate at the mic/headset assembly connected directly to the receiver transmitter.

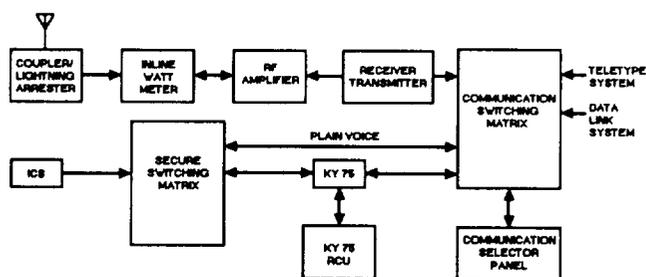


Figure 1-14.-HF system block diagram.

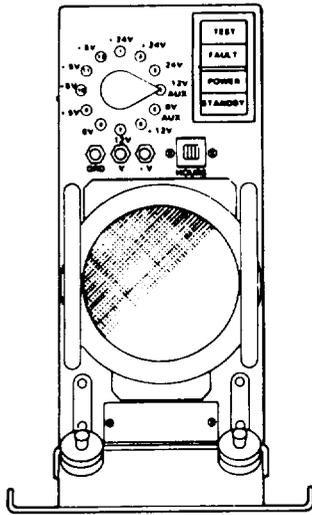


Figure 1-15.-PP-6140/ACQ-5 power supply.

Audio-to-RF conversion is accomplished when the carrier frequency is modulated by the audio input. The modulated RF is amplified by the RF amp to the selected power level of 400 or 1000 watts, depending on the mode selected on the control box, and then coupled to the antenna for transmission.

### DATA LINK SYSTEM

*Learning Objective: Recognize components and operating principles of a data link system.*

The data link system serves as a communications link that allows computer-to-computer exchange of data between participating units. Airborne platforms capable of data link include Air Force AWACS, P-3 patrol aircraft, and most carrier aircraft. Surface or subsurface platforms equipped with Navy tactical data systems (NTDS) may also receive and transmit information over data link. The data transmitted is sent by the central computer to a communications interface, which reformats the data into serial digital data (standard NTDS) transmission language. The serial data is then encrypted and passed through a modulator/demodulator to make it compatible with the P-3 radios. Either HF-1, HF-2, or UHF-2 may be used to transmit and receive data link.

In general, the data link system is designed exclusively to transmit tactical symbology. This symbology is available in the aircraft for display on the TACCO display. An additional function is plain text. This allows transmission for text information through link net. This information is available only to certain

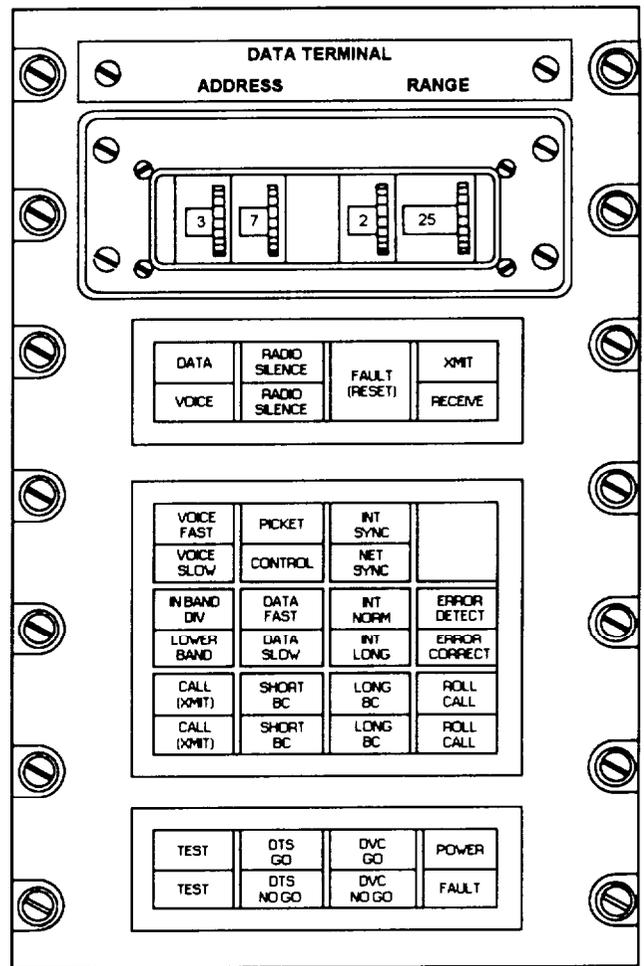


Figure 1-16.-C-7790/ACQ-5 control monitor panel.

airborne platforms (P-3, E-2) and shore-based anti-submarine warfare operating centers (ASWOCs).

Control of the data link setup and monitoring of the active link net is the responsibility of the NAV/COMM. Once it is set up and operating, the only software function available to the NAV/COMM is plain text transmission and reception. The TACCO controls the transmission of all tactical data from the aircraft.

### DATA LINK SYSTEM COMPONENTS

The major components of the data link system are discussed in the following text.

#### Data Terminal Set Converter-Control, CV-2528/ACQ-5

This component is a modulator/demodulator (modem) that takes 26-bit serial digital data from the data communications interface and converts it into audio

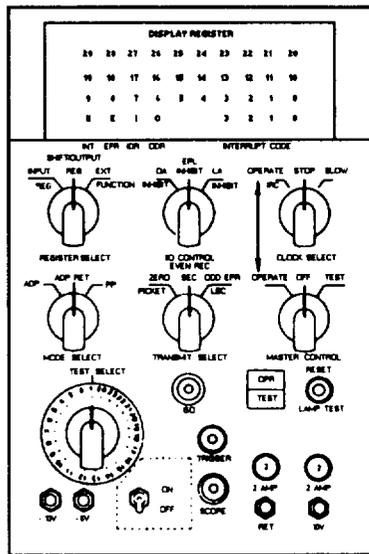


Figure 1-17.-Communications interface No. 2.

tones that can be transmitted over a voice radio. The digital numeric readouts and a test button on the front of the modem display fault indications when the system is operating in the TEST mode. The left display indicates digital control unit (DCU) faults, and the right display indicates modem faults.

**Data Terminal Set Power Supply, PP-6140/ACQ-5**

This component (fig. 1-15) provides primary power to the modem and to the data terminal set control panel. The power supply is mounted next to the modem. Two switchlights and a wafer switch are on the front panel. The POWER/STANDBY switch applies power to the power supply if the data terminal set (DTS) control

panel is in OFF. If the DTS control panel is ON, the power supply supplies primary power to the system. The TEST/FAULT switch initiates a test of the power supply voltage selected on the wafer switch.

**Data Terminal Set Control-Monitor Panel, C-7790/ACQ-5**

Located at the NAV/COMM station, this unit (fig. 1-16) allows control over the modem. It enables control of operating mode, self-test functions, and operational system monitoring. The DTS control panel was designed to be a single control box for multiple systems; therefore, it has many functions that are not currently used.

**Communications Interface No. 2**

This unit (fig. 1-17) provides the connection between the central computer and the data link system. It converts 30-bit parallel binary computer data words into 26-bit serial data transmission language. Several wafer switches and indicators are provided on the box for troubleshooting. The two switches on the right side of the box, labeled CLOCK SELECT and MASTER CONTROL, must be in the OPERATE position for normal data link operation. When these switches are in OPERATE, all other switches are inoperative.

**DATA LINK SYSTEM DESCRIPTION**

A block diagram of the data link system is shown in figure 1-18.

The NAV/COMM has primary responsibility for the hardware setup of the data link system, In general, during preflight the NAV/COMM selects an HF or UHF

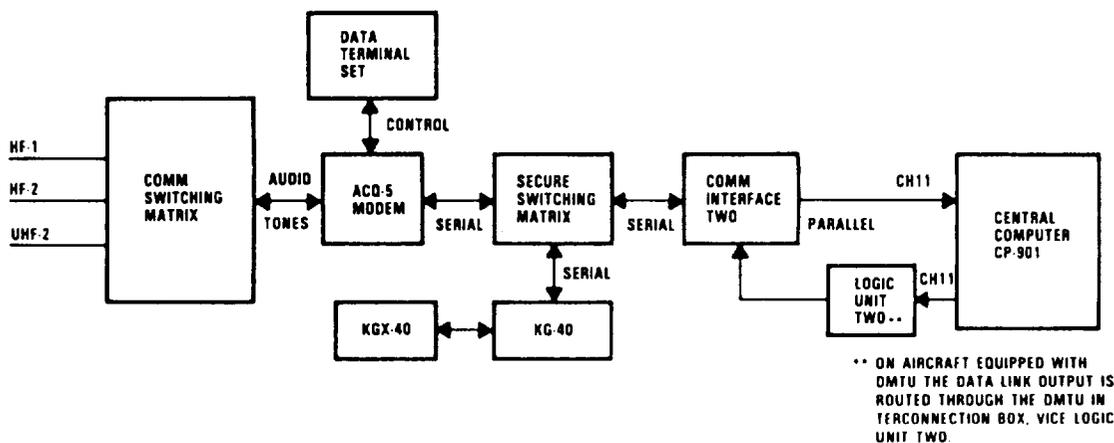


Figure 1-18.-Data link system block diagram.

link frequency. A picket unit (PU) address is obtained from the net controller and inserted into the data terminal set. An appropriate data mode is then selected on the communication selector panel and the cipher data selected amber for encrypted operation. Once these steps are completed, the hardware is setup and ready for the software initialization.

The data link system formats tactical information into blocks of fixed length, called "frames." Each frame contains a 4-bit header block which serves as a control code to tell the modem what type of data follows, and 26 bits of serial information. The 26 bits of data include an address that identifies the originating PU or the DNCU, type of information, the tactical data, and a check sum (parity check).

### **Data Link Terms**

There are four commonly used data link terms that you must be familiar with to work with data link systems. These four terms are discussed in the following paragraphs.

Participating unit is any ship, aircraft, or shore station that is active in the data-link net.

Data Net Control Unit (DNCU) is the participating unit that has overall control over the link net. Only one DNCU may be active in the net.

Picket Unit (PU) is any station in the net that is not the DNCU. As many as 20 units are allowed as PUs.

Data Link Reference Position (DLRP) is the latitude and longitude position that is used as a reference for all data transmitted on the net. When a participating unit is operating below 60 degrees north or south latitude, this position must be within 1024 minutes of latitude of the unit. Above 60 degrees north or south latitude, 2048 minutes of latitude is allowed.

### **Modes of Operation**

Roll call is the normal system operation mode. The DNCU sends out a message requesting each PU, in a certain order, to respond with tactical data. The transmitted data is available for use by all units in the net, but is displayed only if the participating unit is entered into the individual system. In the P-3C, participating units must be entered in the data link control tableau to have their data accepted for display by the computer. All received data is sent to the central computer, which then looks at the label portion of the data message to determine if the information should be ignored or displayed.

When acting as a DNCU, the participating unit selects CONTROL and ROLL CALL on the DTS. The hardware/software system automatically transmits the request-for-transmit message to each unit entered in the data link control tableau.

When a surface ship or an antisubmarine warfare operating center (ASWOC) is DNCU, PICKET is selected on the DTS. The hardware/software transmits only when a request for data is received from the DNCU. If no request is received, the modem does not transmit.

Two modes of operation used for data link net transmission are LONG BROADCAST and SHORT BROADCAST. LONG BROADCAST, when selected, transmits continuously as long as the function remains active. SHORT BROADCAST transmits a single set of data when the switchlight is pressed. A broadcast net is normally used to preserve emission control (EMCON) conditions (roll call not being conducted by the DNCU) until one of the PU's obtains significant information for transmission to the net. The picket unit or DNCU then transmits the data to the net continuously until deactivated in the long broadcast mode or to the net one-time in the short broadcast mode. The DNCU may elect to use the broadcast functions while conducting roll call to increase the probability of data reception by pickets. Pickets do not use the broadcast functions during roll call by the DNCU since the transmissions will not be synchronized with the roll call and may interfere with transmission from the DNCU.

When radio silence is selected, the DTS will receive data only. Even if a request for data is received the system cannot transmit. All information received is sent to the central computer.

## **TELETYPE SYSTEM**

*Learning Objective: Recognize components and operating principles of a teletype system.*

The teletypewriter system is an integrated communications system that provides the ability to transmit and receive encrypted information with compatible ships, aircraft, and ground stations. The keyboard portion of the teletype inputs data into a central computer.

There are basically two modes of teletype operations: on-line and off-line. In the on-line mode, data is sent from the central computer through the teletype system. Received data is routed to the computer. In the off-line mode, the characters that are typed into

the keyboard are sent directly. Received data is printed on the high-speed printer adjacent to the keyboard

Three radios are available in the aircraft for TTY transmission and reception: UHF-2, HF-1, and HF-2. The TSEC/KW-7 security unit provides encryption and decryption for all teletype data. The teletype information is always routed through the TSEC/KW-7 for encryption and decryption.

### SYSTEM COMPONENTS

The following is a brief description of the major components of the teletype system.

#### Keyboard Transmitter TT-568/AGC-6

The keyboard transmitter is shown in figure 1-19. This unit controls the TTY system. In addition to a standard keyboard, there are special function keys provided.

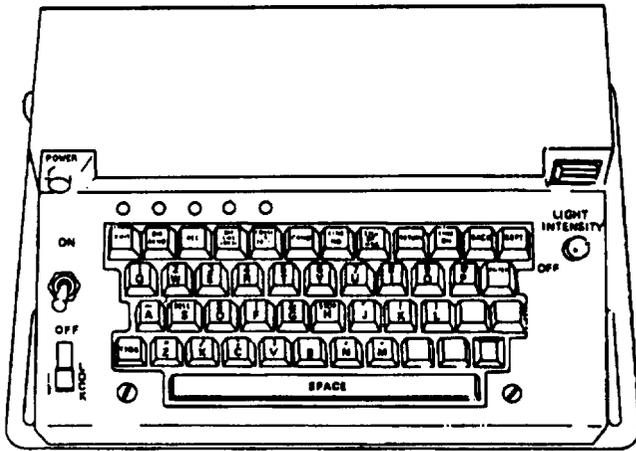


Figure 1-19-Keyboard transmitter TT-568/AGC-6.

#### Teleprinter TT-567

This unit (fig. 1-20) is a high-speed printer. It contains the necessary hardware and logic circuitry to process baudot inputs and produce hard-copy outputs.

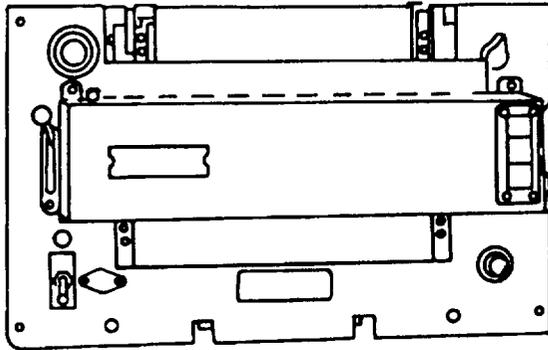


Figure 1-20.-Teleprinter TT-567.

#### TTY Signal Data Converter

This unit (fig. 1-21) provides an interface between the TTY and the radios. It converts teletype language (baudot code) into audio tones, which can be transmitted

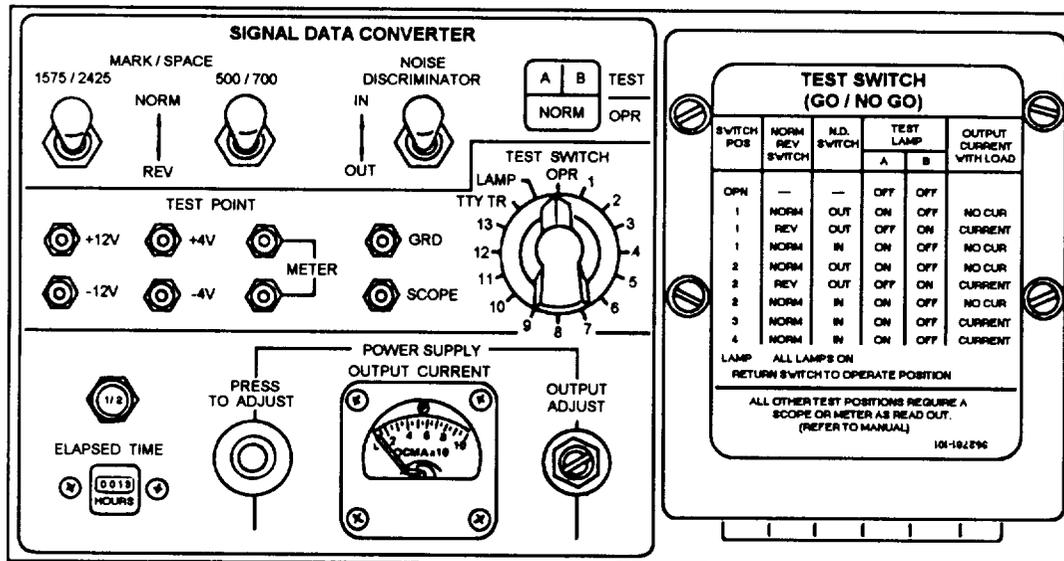


Figure 1-21.-TTY signal data converter.

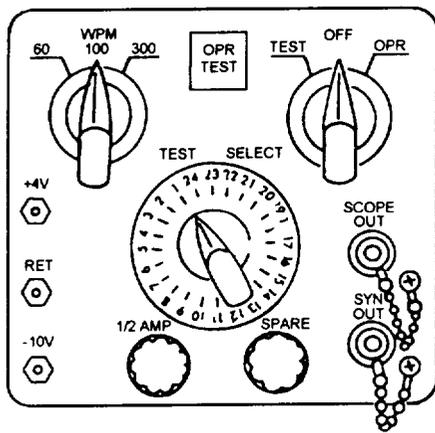


Figure 1-22.-COMM interface No. 1.

over voice radio. Switches on the front of the box provide control over data conversion,

### TSEC/KW-7 Security Unit

This unit provides encryption and decryption of the baudot code. It is used whenever the teletype is in operation.

### TSEC/KWX-7 security Unit Remote Control Unit (RCU)

This unit is located next to the TTY keyboard and enables the operator to control the TSEC/KW-7 without having to leave his/her seat.

### Teleprinter Secure Interface

Mounted under the TTY keyboard, this unit provides remote selection of secure or clear TTY operation. By placing the red guarded TTY/TPR switch to the BYPASS position, the operator closes a relay to bypass the TSEC/KW-7.

### Communications Interface No. 1

This unit (fig. 1-22) connects the TTY system with the central computer. It converts the baudot code into 30-bit, parallel, binary computer language. The switches and controls on the front of the interface are inoperative in the OPERATE mode.

### TELETYPE SYSTEM OPERATION

Figure 1-23 shows the teletype system block diagram.

Off-line operation of the TTY system requires the operator to select an appropriate frequency on the HF-1, HF-2, or UHF-2 control panel and to select TTY mode on the communications selector panel. The selected radio is automatically mode forced into a data transmission mode. The operator selects words per minute (WPM) speed (normally 100) and TTY on the HSP, and DIR SEND on the TTY keyboard. Phasing the TSEC/KW-7 sends a synchronization signal that is received by all other units on the frequency. Once all units are synchronized, they are ready to accept data. When a key is depressed on the TTY keyboard, the corresponding baudot code is generated. This is sent to

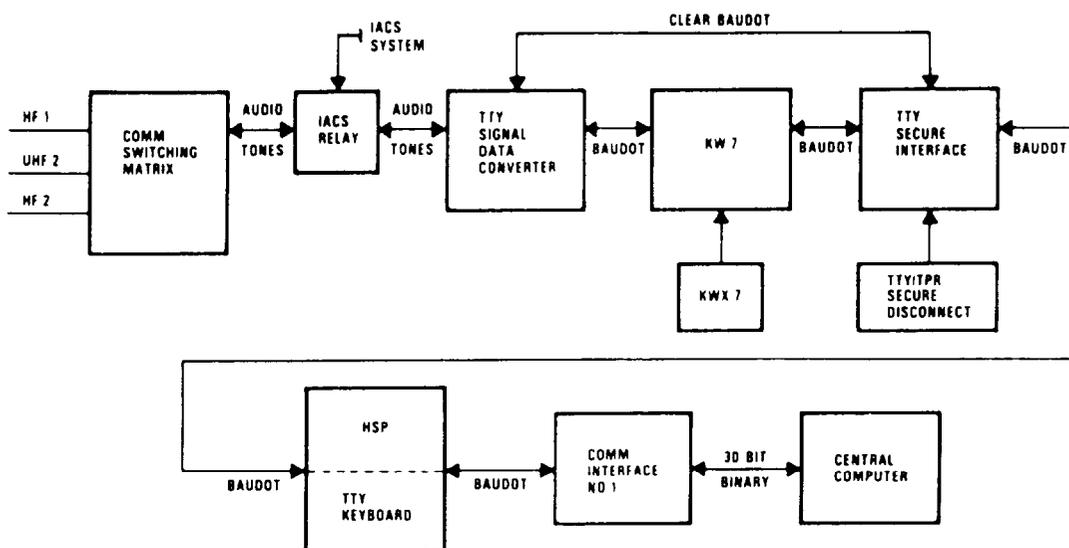


Figure 1-23.-Teletype system block diagram.

the signal data converter, where it is converted to audio tones and then transmitted out over the selected radio. When the message is complete, REC (receive) is selected on the keyboard. This selection allows the system to receive phase tones and incoming messages from other stations on the frequency.

The on-line mode is designed to simplify the work of the operator. Actual system operation is covered in various software publications. In general, the operator types an outgoing message in the central computer. The operator performs all the operations described above, except XMIT is selected on the TTY keyboard. Depression of the XMIT switch on the keyboard directs the central computer to send the stored message through Communications Interface No. 1 into the TTY system. In the same manner, when REC is selected on the keyboard and CMPTR selected on the HSP, any incoming messages are sent to the central computer. Currently, the computer has the ability to store one message of approximately 800 characters for review by the operator.

In addition to teletype data, the TTY system can send and receive data to and from the central computer. In input data, the operator simply selects CONST & EDIT on the keyboard. Any keyboard depressions are then sent to the central computer via the communications interface.

To produce hardcopy of computer data, CMPTR is selected on the HSP. Software functions then allow the central computer to print data on the HSP via Communications Interface No. 1. This data is sent at 3,000 words per minute regardless of the WPM SPEED switch on the HSP.

## REVIEW QUESTIONS

- Q1. *What is the most important means of communicating in the Navy today?*
- Q2. *What frequencies are included in the super high-frequency band?*
- Q3. *How many LS-602/AI panels are there in a typical aircraft?*
- Q4. *What type of encoding/decoding is used in the ICCG system?*
- Q5. *What is the actual frequency range of the AN/ARC-197 radio set?*
- Q6. *How many preset channels are available with the AN/ARC-187 radio set?*
- Q7. *What fault is indicated when the fault indicator on the C-11950/ARC-187 control box flashes at a slow rate?*
- Q8. *The HF-2 long-wire antenna has degraded operation at which frequencies?*
- Q9. *What is the purpose of the lightning arrester used in the HF system?*
- Q10. *What radio sets can be used with the data link system?*
- Q11. *Who has primary responsibility for the hardware setup of the data link system?*
- Q12. *Which unit in the TTY system provides the interface with the radios?*
- Q13. *Which unit connects the TTY system with the central computer?*

