CHAPTER 9

SATELLITE COMMUNICATION SYSTEMS

Historically, long-range communications between commands afloat and ashore have been accomplished by HF radio communications methods in various modes. The principle disadvantage of HF communications is that they are dependent upon the density of the ionosphere to refract and reflect the HF radio signal beyond the horizon to attain the desired distances. When the ionosphere dissipates, the effectiveness of HF communications diminish. Propagation of satellite communication frequencies is not dependent upon reflection or refraction, and is affected only slightly by atmospheric phenomena. The reliability of satellite communications, therefore, is limited essentially only by the reliability of the equipment used, and the skill of the operating and maintenance personnel.

Satellite communication systems were discussed in chapter 5 of this manual. This chapter builds upon the information presented in that chapter by discussing the latest shipboard satellite communication terminal, the AN/WSC-1(V).

AN/WSC-1(V) GENERAL DESCRIPTION

Shipboard Satellite Communication Terminal AN/WSC-1(V) consists of a radio set group and an antenna group. It may be installed in various configurations of one to five modems (modulator-demodulator units) in the radio set group, and one or two antennas and associated equipment in the antenna group. The terminal provides communication via a synchronous orbiting satellite in FM (analog) voice, teletype, and vocoder (digital voice) modes. A single modem terminal provides full-duplex FM voice or half-duplex data (digital voice and teletype) communication. The multimodem terminal provides full-duplex communication in all modes.

The transmitter power is variable to 1 kilowatt in the frequency range of 300 to 315 MHz. Reception occurs at 240 to 260 MHz. A large ship configuration of the terminal consists of the receiver-transmitter rack, the multimodem rack, and the antenna group, as shown in figure 9-1 at the end of this chapter.

Receiver-Transmitter Rack

The receiver-transmitter rack (rack No. 1, fig. 9-1) contains the transmit-receive equipment and other units, assemblies, and subassemblies necessary for single modem operation. This equipment and its location in rack No. 1 are shown in figure 9-2. All functional units use solid state parts and integrated circuits. Only one electron tube is used in the terminal. This tube is located in RF Amplifier AM-6138/URC.

A system of filtering and bandpass shaping is used because of the signal levels, signal characteristics, and frequencies involved. Electrically synthesized frequencies and binary coded decimal (BCD) switching gates provide for instantaneous frequency switching. No mechanical tuner or channeling period is required.

Two frequency synthesizers (7 and 8, fig. 9-2) are used, one for receive operation and one for transmit. This feature, together with a diplexer, permits full-duplex operational capability in voice mode operation. In the data modes (teletypewriter and vocoder) the multimodem configuration permits full-duplex operation, as stated previously. Beacon acquisition is accomplished in a receive mode only; no transmission is required. During beacon acquisition, a signal from a frequency standard in the main receiver is phase compared with the signal received from the beacon, and the frequency standard is adjusted to zero beat with the beacon signal. This provides optimum operation of the terminal with the satellite. A terminal self-test loop operates in a nonradiating mode using a dummy load to dissipate transmitter power.

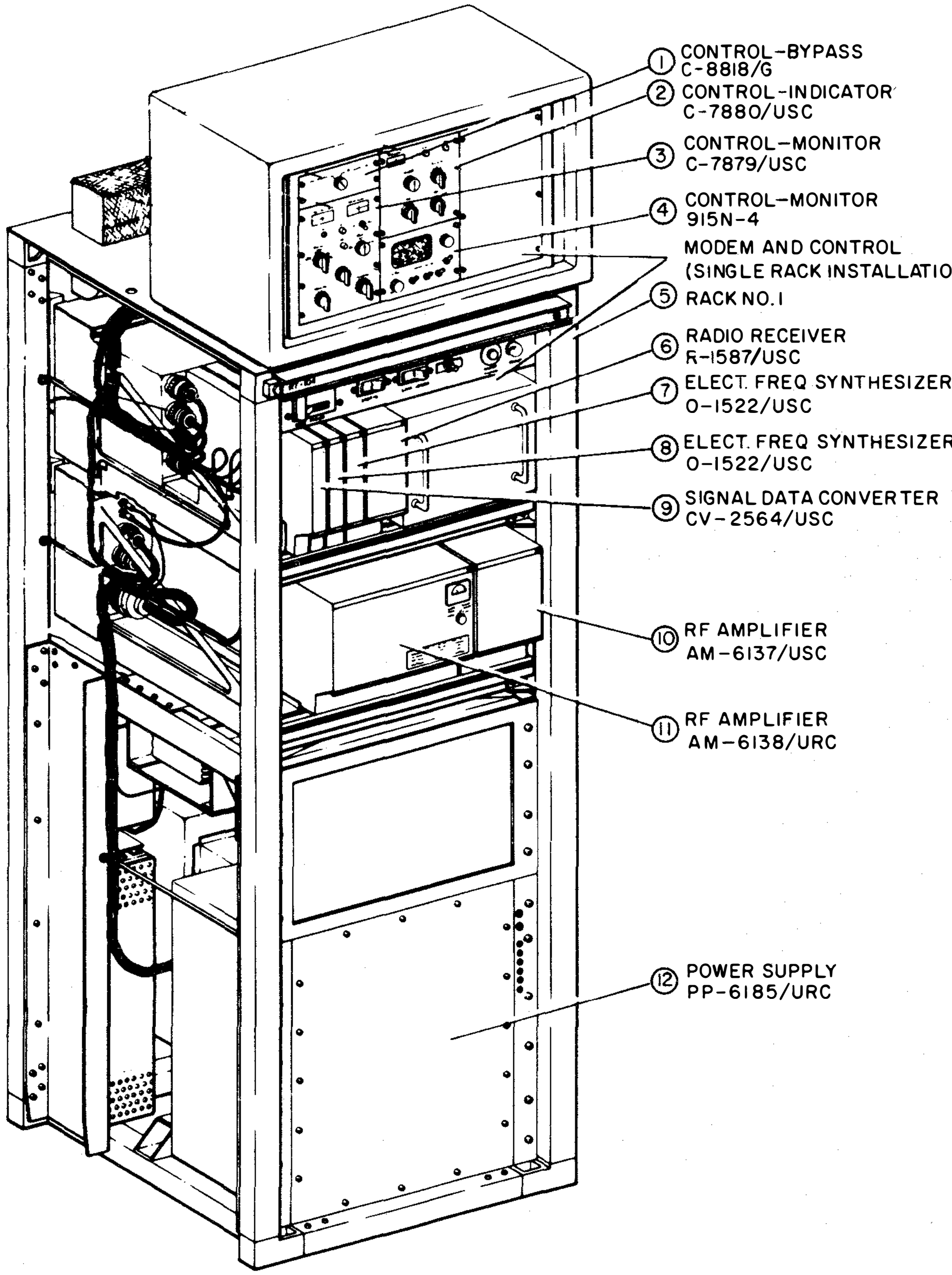

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Figure 9-2.—Receiver-transmitter rack.

Transmitter power output is controllable from 1 watt to 1 kilowatt. A closed-loop automatic level control (ALC) circuit maintains the output power at the selected level. Power output is controlled by setting the bias level in the 100-watt RF amplifier (10, fig. 9-2). For power output levels of 100 watts or less in single modem operation, the 1-kilowatt RF amplifier (11, fig. 9-2) is bypassed, and the output of the 100-watt RF amplifier is fed to the diplexer. In test mode operation, the output power of the 1-kilowatt RF amplifier is reduced by 3 db.

Control Case

The control case (mounted on top of rack No. 1 (fig. 9-2) contains Control-Bypass C-8818/G, Control-Indicator C-7880/USC, and Control-Monitors C-7879/USC and 915N-4. Control-Monitor C-7787/UCA-1 for the No. 1 modem and Control-Amplifier C-8202/WSC-1(V) are located in a remote control console in the multimodem configuration of the terminal. The front panels of these assemblies are shown in figures 9-3 through 9-5.

The CONTROL-BYPASS C-8818/G (fig. 9-3A) selects either single or multimodem transmission.

The CONTROL-INDICATOR C-7880/USC (fig. 9-3B) provides functions for system testing. When all controls are set for the test condition,

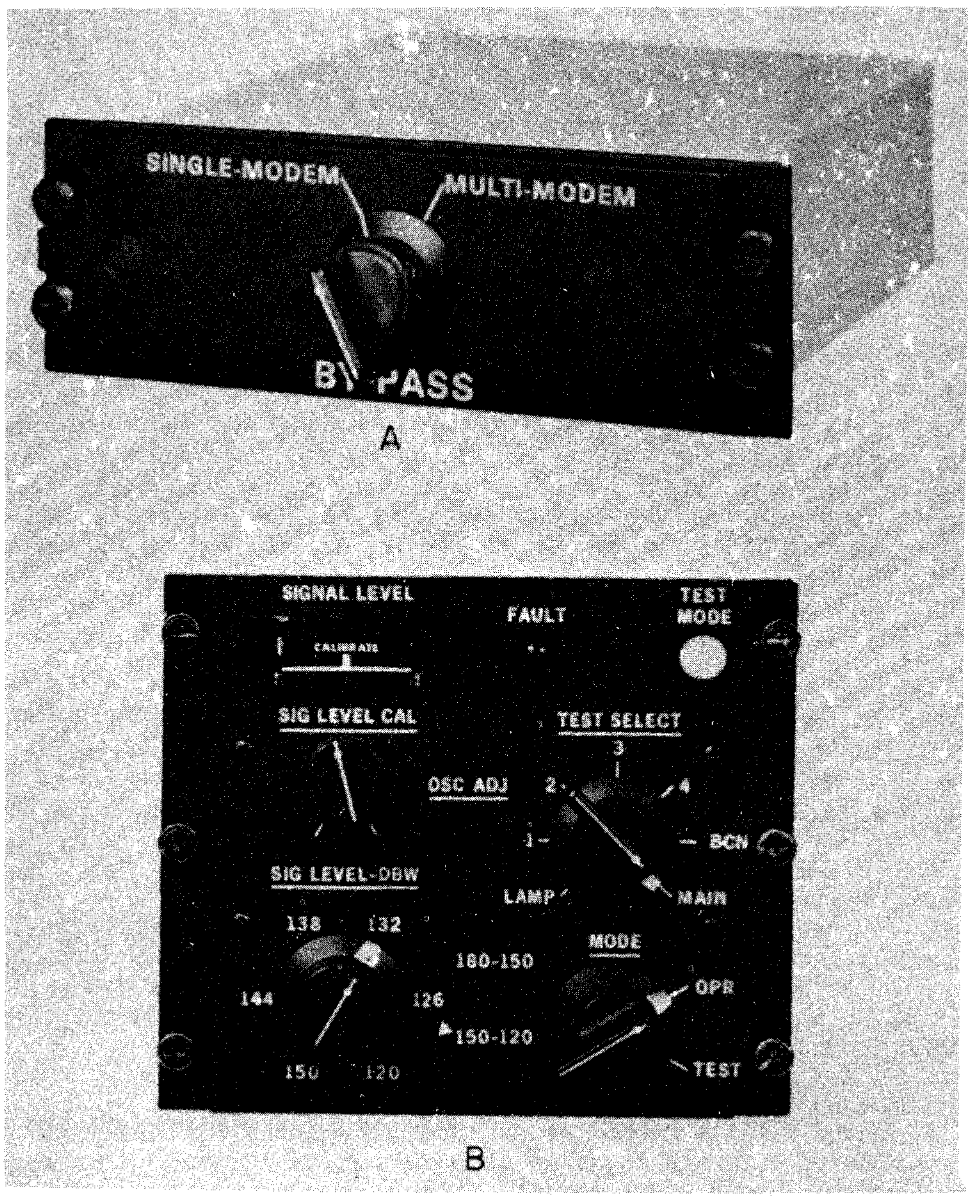

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Figure 9-3.—Control-Bypass C-8818/G and Control-Indicator C-7880/USC.

the operator can check out the communication system and use the information provided to assist in locating faults.

The control-indicator develops an RF signal that is mixed and processed with a sample of the up-link transmitted signal. The resulting down-link receive frequency signal provides a test signal for the system receiver. Fault signal output of the two synthesizers, converter, and power supply can be switched to the fault indicator for indication of module condition.

CONTROL-MONITOR C-7879/USC (fig. 9-4A) provides the system control and monitoring functions. The control-monitor is basically a switching unit. In addition to the front panel controls and indicators (shown in figure 9-4A), the unit contains four relays, a delay network, a voltage divider, and a frequency strapping panel. The frequency strapping panel is a terminal board with a number of standoff solder terminals. The frequency scheme is preset by soldering jumper wires to appropriate terminals. This procedure is called "strapping."

In the Control-Monitor C-7879/USC (fig. 9-4A) the MODE control selects the operating mode for the overall system and selectively enables the equipment required for operation in the selected mode. This control also activates the appropriate key lines and routes the modulating capabilities according to the mode selected. In the OFF position, operating power is removed from all units of the communication system. Selection of voice mode operation supplies an enabling ground to the power enabling circuits of the system which enables all the equipment basic to the communication system. Selection of the TTY mode enables the teletypewriter and modem in addition to all the basic units. Vocoder selection removes the enabling ground from the TTY and enables the vocoder instead; the modem remains enabled.

In all operating modes, the RF circuits are enabled either intermittently or constantly according to the selected mode. In voice mode operation, pressing the microphone push-to-talk button activates the RF circuits and routes the microphone audio to the modulator for processing and transmission. In TTY and vocoder mode operation, the modulation is routed through the modem prior to being impressed on the carrier.

The Control-Monitor C-7879/USC provides control and monitoring functions for transmitter power output and monitoring functions for standing wave ratio. It also provides a key-line interlock and delay network to minimize arcing when switching transmitter power levels. Control functions are provided by the FWD-REFL toggle switch and a concentric PWR CONTROL. The PWR CONTROL consists of a 3-position rotary switch (outer knob) to select the power operating range and a potentiometer (inner knob) to set the power level within the selected limits. Each selected monitoring function is displayed on the XMTR PWR meter.

The XMTR PWR meter normally indicates forward power output. Reflected power may be measured by holding the FWD-REFL toggle switch in the REFL position. The switch returns to the FWD position when released. Sensing devices and gating circuits are included in the high-voltage power supply and in the RF power amplifiers. When a high-voltage or VSWR fault is sensed in the 100-watt power amplifier, a gated signal enables the FAULT indicator on the control panel.

Selection of an operating channel and its corresponding assigned frequency is accomplished by the SATELLITE and CHANNEL controls. The SATELLITE control, a 5-position rotary switch, selects one of five broad frequency bands. The CHANNEL control, a concentric rotary switch, selects the transmit and receive operating frequencies (for FM voice operation) within the broadband. The outer knob positions a 12-position switch to select a beacon or 1 of 11 FM receive channels. The inner knob controls an 11-position switch to select 1 of 11 FM transmit channels. The system is normally operating in the receive condition; transmit operation is initiated by keying the transmitter.

The CONTROL-MONITOR 915N-4 (fig. 9-4B) provides amplification, control, and monitoring functions for AF signals within the satellite communications system. It performs the following functions:

1. Amplifies the audio output from the communications receiver to drive an internal speaker, an external audio level meter, and a remote receive audio line
2. Amplifies the audio input from an external microphone to supply voice modulation for the transmitter
3. Contains the squelch threshold adjustment for the receiver
4. Provides sidetone audio which is mixed with the receive audio to drive a remote receive audio line, an internal speaker, and an external audio level meter. Sidetone audio level is independent of receive audio level

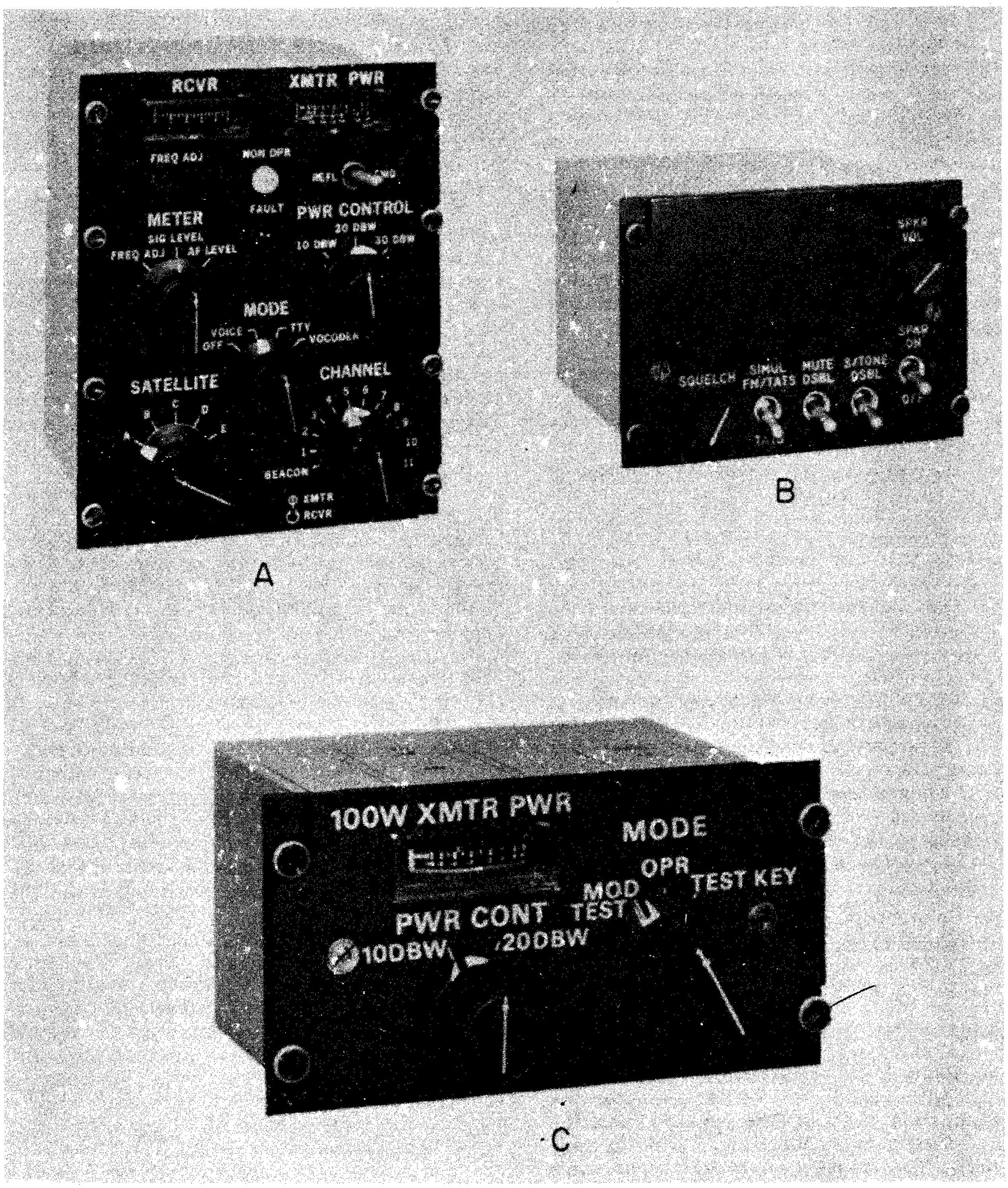

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Figure 9-4.—Control-Monitors C-7879/USC and 915N-4, and Control-Amplifier C-8202/WSC-1(V).

5. Provides a ground for the FM key line when 12 volts d.c. and ground is supplied from an external source
6. Disables sidetone when the S/TONE DSBL switch is in the up position or when an external ground is applied to the sidetone disable input line
7. When keyed externally and the FM-TATS switch is placed in the SIMUL FM/TATS position, provides a ground for the simultaneous FM and RF key line-The modems used in the AN/WSC-1(V) are a modified version of the Tactical Transmission System (TATS) modem. Thus they are sometimes referred to as TATS modems
8. When the FM-TATS switch is placed in the TATS position, provides + 28 volts d.c. switched to Control-Amplifier C-8202/WSC-1(V)

The CONTROL-AMPLIFIER C-8202/WSC-1(V) (fig. 9-4C) performs the following functions:

1. Sets the modem for tests and normal operation
2. Keys the associated RF amplifier AM-6137/USC, Signal Data Converter CV-2564-USC, and Power Supply PP-6185/URC
3. Enables 70 MHz command to the modem (The modem generates a 70 MHz signal that is used to set the power level of the associated RF Amplifier AM-6137/USC.)
4. Measures and adjusts the output power level of RF Amplifier AM-6137/USC when the bypass switch on Control-Bypass C-8818/G is in the MULTI-MODEM position.

The CONTROL-MONITOR C-7787/UCA-1 (fig. 9-5) controls and monitors operation of the modem. (The modems have no front panel controls or indicators.)

Receiver

The Radio Receiver R-1587/USC (fig. 9-2) is used with associated equipment to form a communication system. The receiver unit includes a frequency standard and converter subassembly. The frequency standard generates a reference frequency used in the receiver and throughout the terminal. The converter produces control and reference signals used for injection, translation, and synchronization.

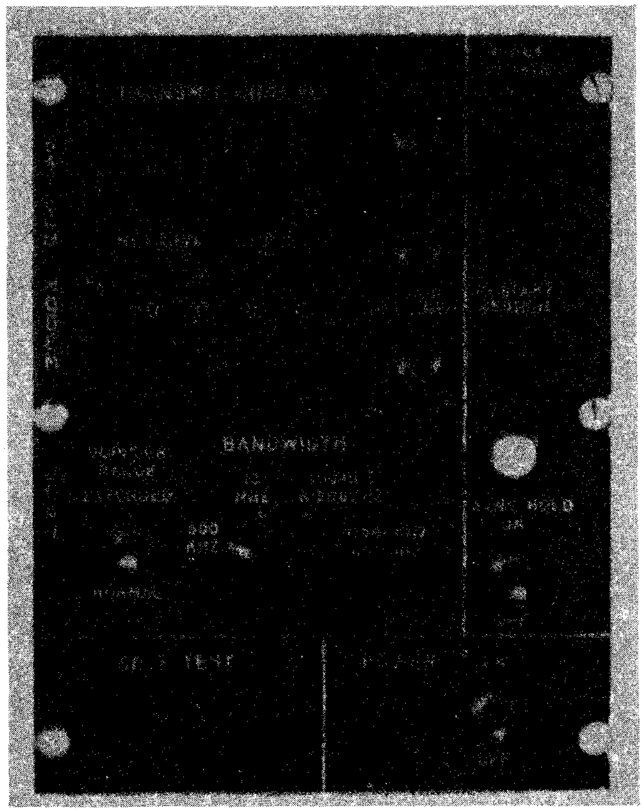

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Figure 9-5.—Control-Monitor C-7787/UCA-1.

The receiver accepts and processes FM voice and digital data signals in the frequency range of 240 to 260 MHz. It functions in voice, modem, and beacon modes. Selection of operating mode is accomplished remotely; operating voltages are applied or removed according to the requirements of the selected mode.

All received RF signals are processed through a common front end. In modem mode operation, the receiver uses a single frequency conversion, and the signal is then routed to an external modem for demodulation. In voice and beacon mode operation, the receiver uses a second frequency conversion, and the signal then is demodulated. Separate demodulation channels are used for the two modes.

Signal Data Converter

The Signal Data Converter CV-2564/USC (fig. 9-2) contains four subassemblies which generate, combine, and process signals and translate an RF injection signal to a modulated RF carrier. The carrier is then supplied at a level suitable for driving a power amplifier. The subassemblies are the audio processor and power supply, the 9 MHz frequency modulator, the 5 MHz crystal oscillator bank, and the IF-RF translator.

The converter provides the following functions:

1. Generates a 9 MHz signal and a 4.795 to 5.205 MHz signal for internal use in frequency translation
2. Accepts injection inputs of 56 MHz and 110.0 to 122.5 MHz for use in frequency translation
3. Accepts analog voice, code burst FSK, modem, or alert message input signals for use in modulation of the RF carrier
4. Combines and translates signals to a modulated 300 to 315 MHz RF carrier at a power level that is suitable for driving a power amplifier
5. Supplies regulated + 18 and + 5.25 volts d.c. power to associated units of the communication system

Power Supply

The Power Supply PP-6185/URC (fig. 9-2) operates from a 3-phase, 60 Hz input power source and supplies operating voltages for a 1-kilowatt RF power amplifier. The operating voltages supplied by the power supply include plate and screen bias, and filament voltages. The power supply also provides interface connections to permit external control and monitoring of power supply performance.

MULTIMODEM RACK

The multimodem rack (rack No. 2, fig. 9-1) contains antenna indicators and controls, a multiplexer unit, and four modems with their associated RF amplifiers and signal data converters. The location of these modules in rack No. 2 is shown in figure 9-6. The Control-Amplifiers C-8202/WSC-1(V) and Control-Monitors C-7787/UCA-1 associated with the modems are remotely located.

The Control-Antenna C-8221/WSC-1(V) includes controls for manual rotation of the antennas in azimuth, and indicators which indicate the position of the antennas in azimuth and elevation, and the ship's heading. Also included on the panel are indicator lights which indicate

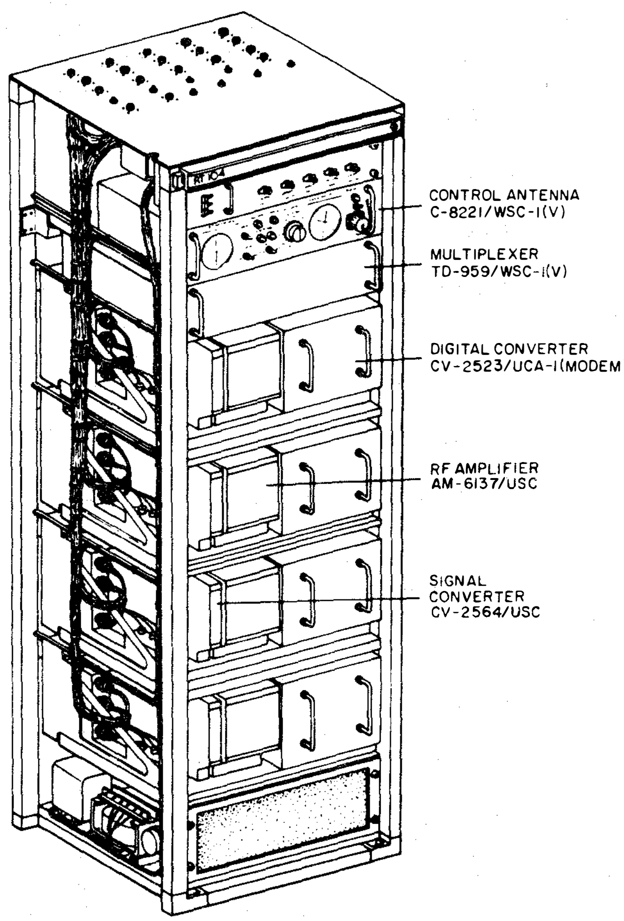

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Figure 9-6.—Multimodem rack.

antenna radiation hazard blockage, low coaxial cable pressure, and antenna(s) in operation. A sound-powered telephone jack box is installed in the lower right-hand corner of the panel.

Multiplexer TD-959/WSC-1(V) provides the terminal with a multichannel capability. The multiplexer assembly includes four subassemblies: a power combiner, and three distribution amplifiers. The power combiner functions to linearly combine up to five 100 watt amplifier outputs. Two distribution amplifiers provide the modems with the receive 70 MHz signal, and the 1 MHz frequency reference signal on individual isolated lines. The third distribution amplifier supplies the signal data converters with the translation frequency from the transmit synthesizer.

The modems are digital data converters which can transmit and receive in a narrow bandwidth of 800 kHz or a wide bandwidth of 10 MHz. The wide bandwidth is used only at SHF frequencies. (The AN/WSC-1(V) is capable of transmitting and receiving wide bandwidth modulation, but this mode is not authorized for use at UHF frequencies.)

ANTENNA GROUP

The antenna group (fig. 9-1) includes two antennas, two amplifier-filter units, two coax switch assemblies, and two relay assemblies. The amplifier-filter units, although actually considered part of the radio set group, are listed with the antenna group for installation purposes.

Antenna AS-2410/WSC-1(V) (fig. 9-1) is a circularly polarized crossed-dipole type antenna. The antenna includes four crossed-dipole elements, a 90-degree hybrid, two combiners, and a dummy load. The antenna is mounted on an antenna pedestal that contains the azimuth and elevation reversible 3-phase, 208-volt, 60-Hz induction motors; two elevation synchro transmitters; three azimuth-controlled differential transmitters; and a switch used to disable the antenna subsystem. The elevation section also contains up-down limit switches, and the azimuth section contains radiation hazard limit switches. Each motor is protected by thermal overload switches. Fail-safe brakes are released when power is applied. External connections are made to the antenna through three connectors and a sound-powered phone jack. Connections to the elevation power and control circuits are made through sliprings.

Amplifier-Filters AM-6205/WSC-1(V) shown in figure 9-1 include a coax switch, a diplexer, and an RF amplifier. The amplifier-filters (sometimes referred to as the deck boxes) and the bulkhead mounted equipment are shown in figure 9-7 (foldin end of chapter). Relay Assemblies RE-1025/WSC-1(V) provide power control for the antenna azimuth and elevation drive motors.

AN/WSC-1(V) FUNCTIONAL DESCRIPTION

Frequency synthesizers develop injection frequency signals used in receive and transmit conditions of the terminal. Two synthesizers are used, one for receive and one for transmit frequencies. The units are identical and interchangeable; both are required to provide full-duplex operational capability. The frequencies produced by the synthesizers are phase locked to the standard through the 25-kHz reference frequency.

Initial frequency selection is made at the SATELLITE switch on Control-Monitor C-7879/USC. Selection of the satellite band applies a BCD control signal to the frequency synthesizer. The synthesizer then produces an RF signal at a frequency depending on a strapping arrangement in the control. The synthesizer output signal is used in the translation of the terminal transmit and receive frequencies.

TRANSMIT FREQUENCY GENERATION

In data transmit operation, the output frequency of the transmit freqeucny synthesizer (110.0 to 122.5 MHz) is routed through the multiplexer to the signal data converter. In the converter the synthesizer frequency is doubled and applied to summing mixer A3 (fig. 9-8). The other input to the mixer, supplied by the modem, is a modulated signal with a 70 MHz nominal center frequency. The 220 to 245 MHz and the 70 MHz signals are mixed to produce the 290 to 315 MHz transmit frequency. (The AN/WSC-1(V) transmits in the range of 300 to 315 MHz only.) The transmit frequency output of the signal data converter is routed through the 100-watt RF amplifier, multiplexer (for multimodem operation), the 1-kilowatt RF amplifier, and then to the antenna subsystem for transmission.

In voice transmit operation, the frequency synthesizer produces the same RF signal as in data transmit operation. This signal is doubled in the signal data converter and applied to the mixer as in data transmission. The 70 MHz signal input to the mixer, however, is derived in a different manner. The FM XMTR CHANNEL switch at Control-Monitor C-7879/USC selects an enabling ground for the crystal oscillator in the signal data converter. The ground enables 1 of 11 crystals of a crystal oscillator bank. The enabled oscillator signal (at a frequency within the range of 4.795 to 5.205 MHz) is applied to summing mixer A1.

The other input to the mixer is a 56-MHz reference signal from the main receiver. The mixer output (basically a 61-MHz signal) is applied to another summing mixer, A2. The other input to this mixer comes from the 9 MHz oscillator in the signal data converter. The 9 MHz oscillator signal is voice modulated from the audio circuits of the radio set. The

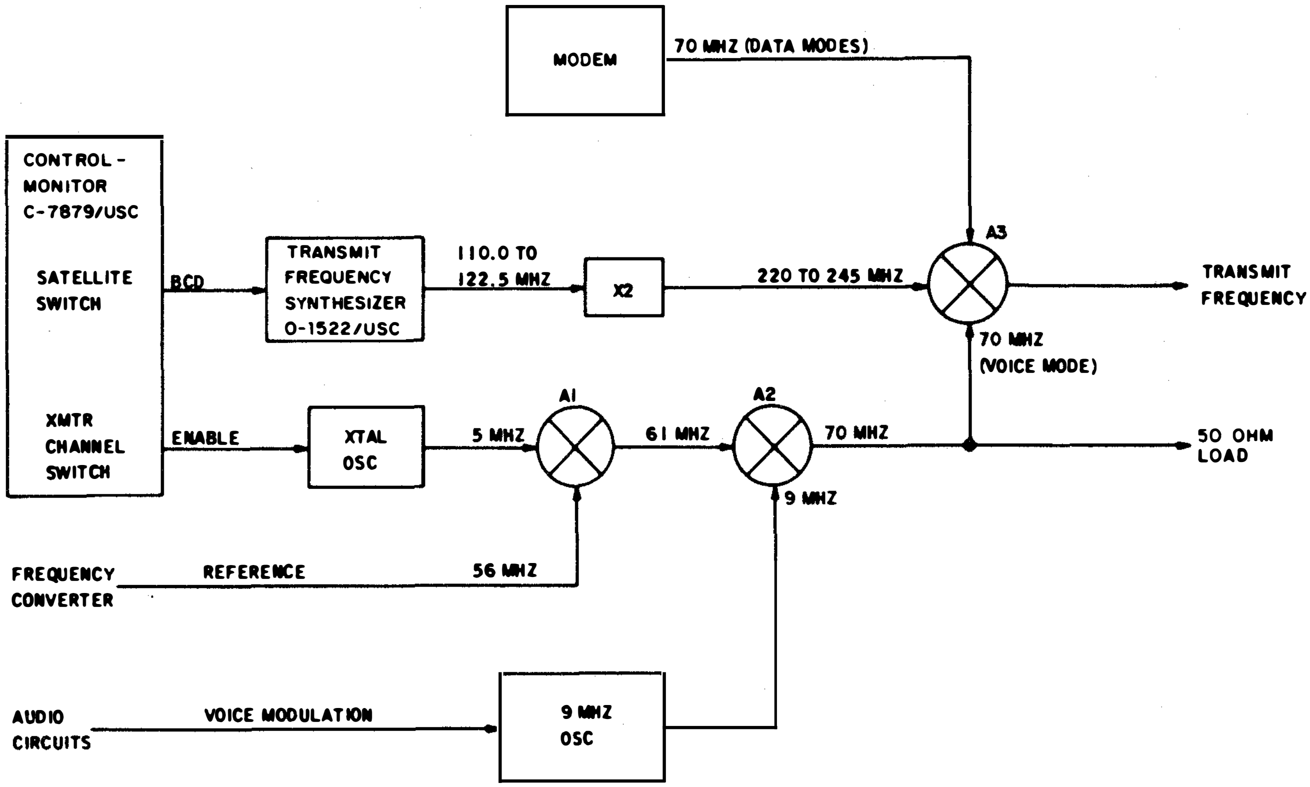

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Figure 9-8.—Transmit frequency generation.

70 MHz output is also mixed with the 220 to 245 MHz to produce the 290 to 315 MHz transmit frequency as in data transmission.

RECEIVE FREQUENCY TRANSLATION

In data receive operation, the SATELLITE switch position and the strapping arrangement at Control-Monitor C-7879/USC determine the control input to the receive frequency synthesizer. The frequency synthesizer produces a frequency within the range of 85 to 95 MHz. The synthesizer output is routed to the main receiver where it is doubled and then applied to difference mixer A3 (fig. 9-9). The received RF signal in the frequency range of 240 to 260 MHz is also applied to the mixer. The resultant 70 MHz signal (with the modulation intact) is routed to the modem for demodulation.

In voice or beacon receive operation, the received and translated injection signals follow the same initial paths as in data receiver operation. The 70 MHz signal is fed to difference mixer A2. The other input to this mixer is a 61 MHz signal. The position of the FM RCVR CHANNEL switch on Control-Monitor C-7879/USC selects an enabling ground for the main receiver. The ground enables 1 of 11 crystals of a crystal oscillator bank in the main receiver. The enabled oscillator signal (at a frequency within the range of 4.795 to 5.205 MHz) is applied to summing mixer A1. A 56 MHz reference signal from the frequency standard (in the receiver) is also applied to the mixer. The sum frequency, 61 MHz, is then combined with the 70 MHz signal in difference mixer A2, to provide the 9 MHz signal. In voice receive operation, the 9 MHz signal is supplied to a voice demodulator circuit to provide an audio output from the receiver. In beacon operation, the 9 MHz signal is supplied to the beacon acquisition and level circuits to provide the receiver outputs.

MAIN SIGNAL FLOW

Main signal paths through the system modules in the various modes of operation are illustrated in figure 9-10 (foldin end of chapter.

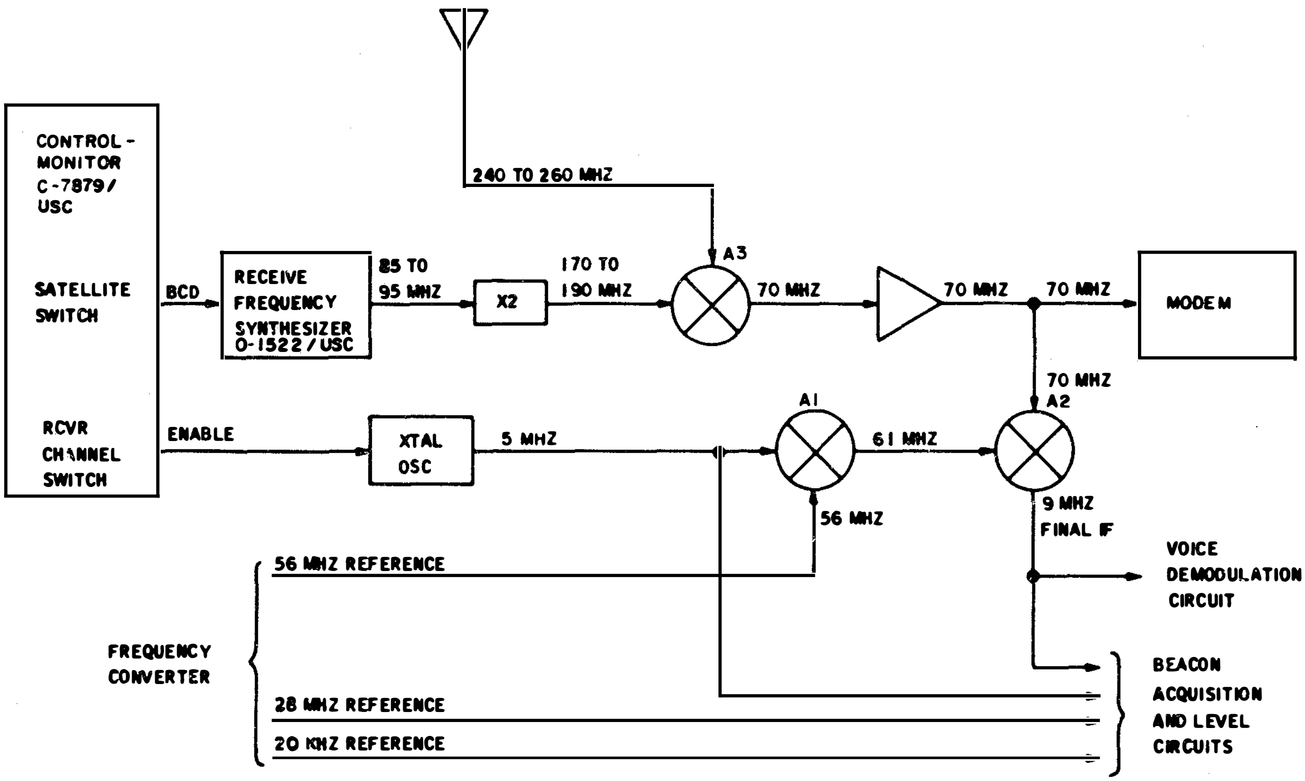

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Figure 9-9.—Receive frequency translation.

FM (Analog) Voice

For single modem operation, FM voice operation is initiated at Control-Monitor C-7879/USC by selecting the VOICE position on the MODE control. For multimodem operation, FM voice operation is initiated at Control-Monitor 915N-4 by placing the SIMUL FM/TATS-TATS switch to the SIMUL FM/TATS position. Operation is narrow band FM using five frequency bands between 300 and 315 MHz for transmit, and three bands between 240 and 260 MHz for receive. Each band contains 11 discrete frequency channels, eight below and three above the band center frequency. Communication between one terminal and any other terminal is relayed both ways via the satellite. The terminal is normally in the receive condition.

In the transmit mode, the input audio signal is first applied to the Control-Monitor 915N-4 (fig. 9-10) where it is amplified and fed to Signal Data Converter CV-2564/USC. (A portion of the transmit audio signal is also routed to the receive amplifier to provide sidetone.) The audio signal is used to modulate a 9 MHz oscillator in the signal data converter. The modulated RF signal is then translated to the satellite up-link frequency range and fed to the 100 watt RF Power Amplifier AM-6137/USC.

The 100 watt Power Amplifier AM-6137/USC amplifies the signal data converter output to the level required to drive the one kilowatt Amplifier AM-6138/URC. The gain of the 100 watt power amplifier is externally controllable, which allows the output power level to be adjusted from 1 to 112 watts. The 100 watt power amplifier output is connected to bypass relay K1, which switches the signal directly to the input of the one kilowatt power amplifier in the single channel mode or indirectly, via the combiner section of Multiplexer TD-959/WSC-1(V), to the input of the one kilowatt amplifier in the multichannel mode. The combiner is used to combine the outputs of two, three, four, or five 100 watt power amplifiers in order to provide a multichannel transmit capability. Because the combiner is passive in operation, each input signal is subject to a loss, the amount being determined by the number of channels the system is set up for. When the single channel mode is selected, the combiner is bypassed by K1 and the power loss is avoided, making full power available to channel one. Channels two through five transmit capabilities are disabled in the single channel mode.

The one kilowatt Power Amplifier AM-6138/URC is a fixed gain, linear RF amplifier with a rated maximum power output of 1000 watts ±5db. The input power may be varied from approximately 10 to 100 watts which will result in an output power level from 100 to 1000 watts. A typical input may be a composite signal represented by 20 watts from each of five channels for a total power of 100 watts or 100 watts from channel one. In either case the total power amplifier output would be 1000 watts.

The output of the one kilowatt amplifier is connected to the RF sampler, which routes a small portion of the signal to Control-Indicator C-7880/USC for test purposes. The main signal flow is through the HI-PWR coax switch to one or the other of the amplifier-filters (deck boxes). In the deck box the signal passes through the up-link filter to the transmit portion of the diplexer. The diplexer allows simultaneous transmission and reception on a single antenna. The antenna port of the diplexer is connected through a dow key coax switch to the antenna. The transmit signal is beamed into space toward the satellite (provided the operator has properly positioned the antenna). The test coax switch (fig. 9-10) switches the line from the antenna to the dummy load for test purposes.

The receive signal begins at the antenna. Separation of the transmit and receive signals is accomplished by the diplexer. The output of the preamplifier (RF amplifier in fig. 9-7) is connected to the main receiver via the LO-PWR coax switch (RCVR coax switch in fig. 9-7). The main receiver functions in a conventional manner in the FM mode. The voice output from the receiver is fed to the receive input of Control-Monitor 915N-4 (fig. 9-10) where it is amplified and fed to the front panel speaker.

Data Modes

As stated previously, the AN/WSC-1(V) is used in configurations containing one to five data circuits. Each data circuit consists of a signal data converter, 100 watt RF power amplifier, modem, and controls for the amplifier and modem. Teletype or vocoder equipment is connected to the data circuits (note 2 fig. 9-10).

The modems (fig. 9-10) use a unique modulation scheme in which the input data is coded and then modulated on a frequency-hopped carrier. The modulated frequency-hopped signal is centered at 70 MHz, 409.6 kHz wide in the narrow bandwidth mode, 10 MHz wide in the wide bandwidth mode, and the output level is 0 dbm. The modem 70 MHz transmit output is fed to the signal data converter, where it is amplified and translated to the satellite up-link frequency. The remainder of the data mode transmit signal flow is identical to FM voice.

The data mode receive signal flow, from the antenna to the receiver, is identical to FM voice described previously. The receiver amplifies the input signal from the antenna and translates it down to 70 MHz. Receiver gain in the data mode is from 3 to 6 db.

The 70 MHz receiver output is connected to the 70 MHz receive distribution amplifier, which distributes the receive signal to the five modems. The modem demodulates the receive signal, using a special process which analyzes the modulation components of the signal. The data is converted to the proper form in the modem output buffer.

ANTENNA GROUP

The antenna pointing system involves circuitry in the antenna control unit, the relay assembly units and the antenna pedestals. Antenna elevation is controlled with front panel switches on the antenna control unit. Either or both antenna elevation axes may be controlled by making the proper switch selection. Pressing the ELEVATION CONTROL to the UP or DOWN position connects a ground to the corresponding control line which operates the appropriate relays in the relay assembly(s). The relay assemblies apply the correct phase of 208 volt 3-phase a.c. to the elevation drive motors in the antenna pedestals. Synchro transmitters, mechanically driven by the antenna elevation drive, transmit elevation position information for display by the ANT ELEVATION indicator.

Antenna azimuth pointing is referenced to the ship's heading synchro input. The ship's heading information is fed to the input of a synchro repeater (A1, fig. 9-11) which provides four identical outputs for use in the system. One of these outputs (CX4, fig. 9-11) provides an input to the antenna control unit and the antenna position indicator unit SHIP'S HEADING indicators. See figure 9-11 (foldin end of chapter).

Two of the outputs (CX1 and CX2) are connected by the azimuth indicator switch to two control differential transmitters in the selected antenna pedestal. The rotors of these control differential transmitters are mechanically driven by the antenna azimuth drive. The ship's heading input is added to or subtracted from an angle represented by the rotor position, resulting in an electrical output which represents the true antenna bearing. This information is fed back to the antenna control unit, where it is routed through the azimuth indicator control to the ANTENNA position indicators. The duplication in this circuit is provided to drive the duplicate indicators in the antenna control and the antenna position indicator unit.

The fourth output of the ship's heading synchro repeater (CX3) is connected to a control differential transmitter in the antenna control unit. The mechanical input is the front panel AZIMUTH CONTROL. The output of this control differential transmitter represents the angular difference or sum of the ship's heading and the true bearing selected on the AZIMUTH CONTROL. This signal is fed to control transformers in both antenna pedestals which receive a mechanical input from the antenna azimuth drive. When the electrical signal input and the mechanical input represent the same angle, the antennas are pointing at the selected true bearing, and the control transformer output is zero volts. If the ship's heading or the AZIMUTH CONTROL is changed, the control transformer electrical and mechanical inputs no longer represents the same angle and an output error voltage is developed. The amplitude of this error voltage represents the amount of the error, and the phase represents the direction of the error.

These outputs are connected back to the antenna control where they are limited, demodulated and fed to the relay control circuits. When the error signals are of sufficient amplitude, the relay control circuits send a clockwise (CW) or counterclockwise (CCW) control signal to the associated relay assembly. The relay assembly applies the correct phase of 208 volt 3-phase a.c. to the azimuth drive motor in the antenna pedestal. The motor rotates the antenna to the position at which the two inputs to the control transformer agree, and the output error signal is again zero volts.

Programmed switch cams in the antenna pedestals send radiation hazard signals to the antenna control unit when such a condition exists. Normally, the antenna selection switch cams will cause the antennas to be switched before the condition exists. However, if the system is in the single antenna mode, or both antennas constitute a radiation hazard condition at a common azimuth, a relay in the antenna control will be deenergized. When the radiation hazard relay is deenergized, the RF interlock circuit is opened, which disconnects the +28 volt d.c. from the 100 watt control units when the system is in the MULTIMODEM mode or disconnects RF key line number one in the SINGLE-MODEM mode, in either case preventing the system from being keyed.

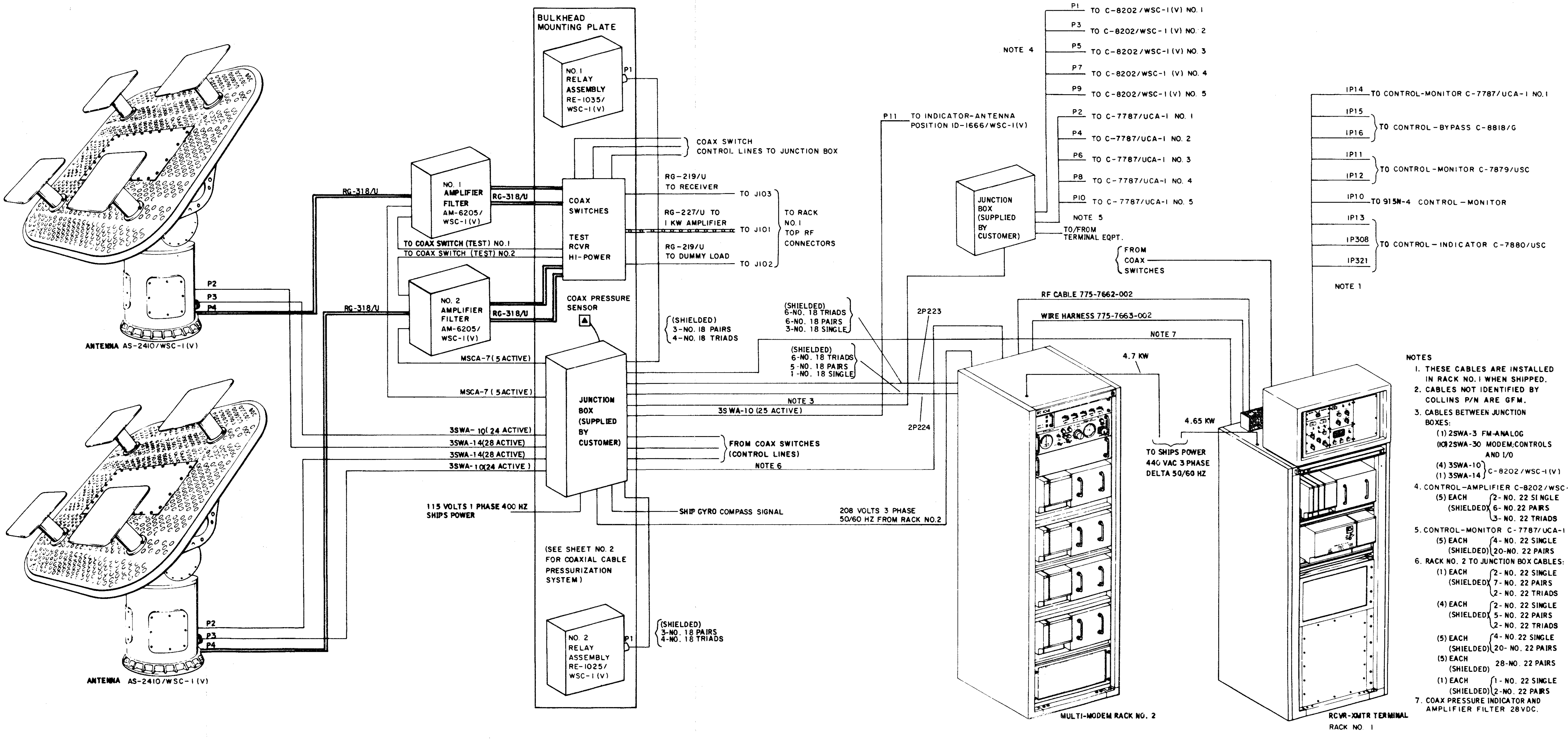
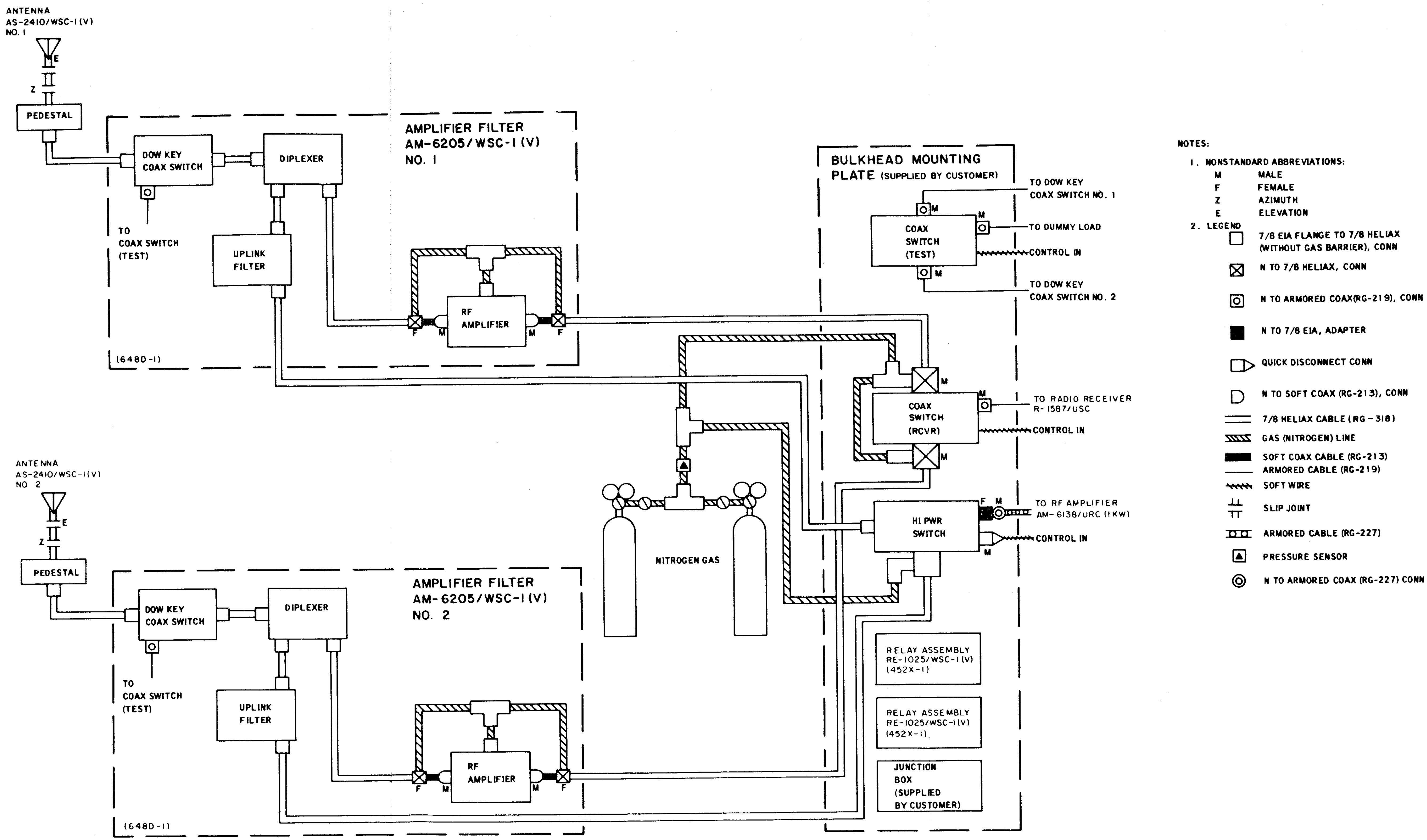


Figure 9-1.—AN/WSC-1(V) large ship configuration.



162.189

Figure 9-7.—AN/WSC-1(V) deck boxes and bulkhead mounted equipment.

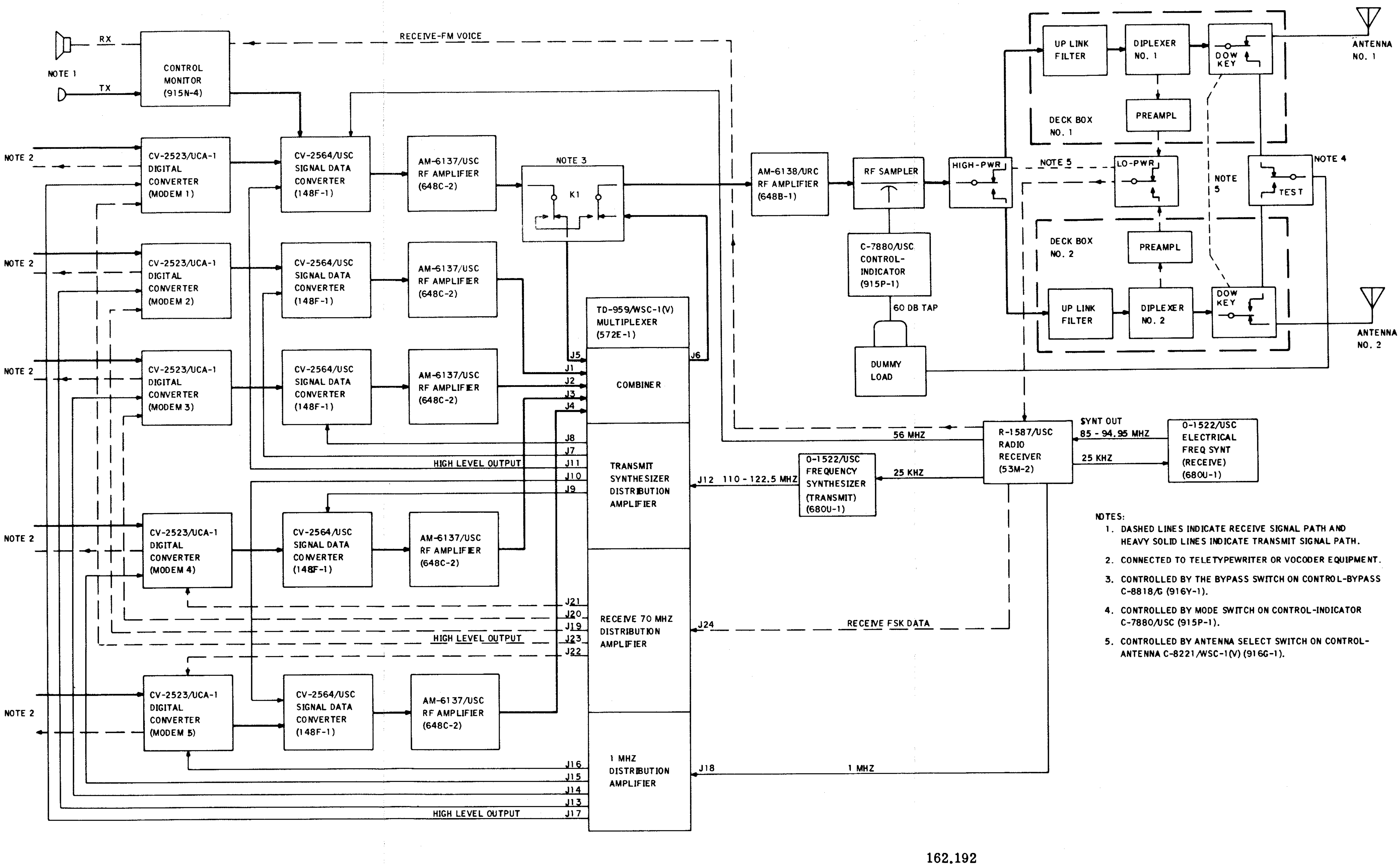
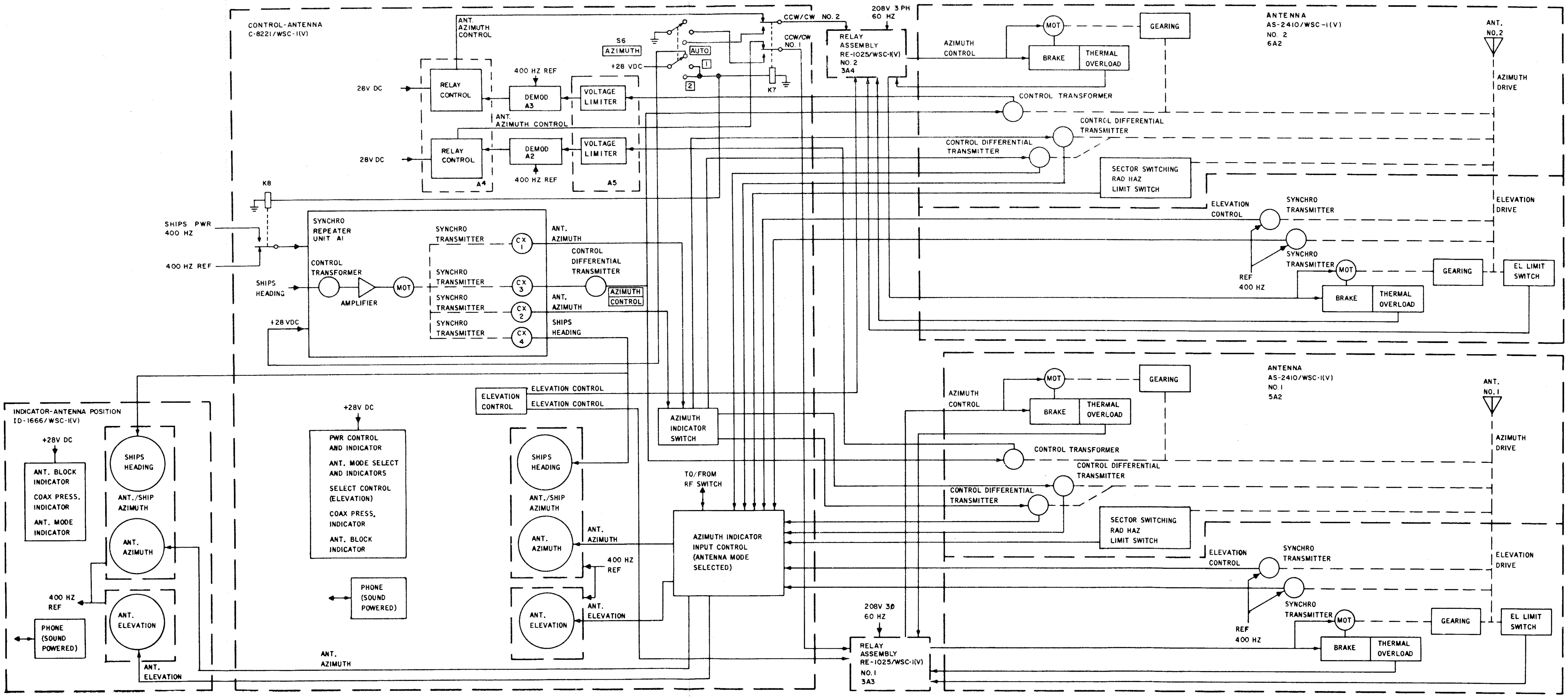


Figure 9-10.—AN/WSC-1(V) main signal flow block diagram.



162.193

Figure 9-11.—Antenna group functional block diagram.