CHAPTER 3

INTRODUCTION TO RECEIVERS

The most important and demanding task required of a collection operator is the proper operation of receivers. The model of receiver you operate will be determined by the type of signal and frequency range of the signals you are collecting. Your knowledge of how a receiver operates and the functions of the major stages of a receiver will enable you to use it more effectively and efficiently in the accomplishment of your mission.

RECEIVER FUNCTIONS

Most of the receivers used by Naval Security Group personnel have common functions which can be broken down into six broad categories: 1) the sensing of the presence of radio waves on an antenna (reception); 2) the selection of desired waves (selection); 3) the amplification of these waves (RF amplification); 4) the extraction of the intelligence from the waves (detection); 5) strengthening of the extracted intelligence signal (AF amplification); and, 6) reproduction of the intelligence into sound waves (reproduction). See figure 3-1.

Reception

The first thing a receiver must be able to do is to "sense" that a signal voltage is present on the antenna, or, more simply, to "receive" a signal.

Selection

Since many radio signals are present at the receiving antenna at the same time, it is necessary for the receiver to be able to SELECT the one desired signal. This is accomplished through the use of tuned circuits, which act as filters. Tuned circuits allow the receiver to receive a desired signal and reject all, (or most) of the other signals present at the antenna.

Radio Frequency Amplification

The signals present at the antenna must usually be amplified considerably before the intelligence contained in them can be recovered. One or more radio frequency (RF) amplifiers are used to increase the signal to a required level. A circuit in each RF amplifier ensures that only the desired signal is amplified.

Detection

In order to receive the original intelligence, the modulated signal must be separated from the RF carrier. The receiver function which separates the audio frequency signal variations from the RF carrier is known as DETECTION or DEMODULATION. Most detectors do not operate very well at low signal levels; therefore, RF amplification is required ahead of the detection stage.

The detection process employs a Beat Frequency Oscillator (BFO) (to be discussed in detail later) which provides a signal that beats or "heterodynes" against the frequency injected into the detector. (HETERODYNING is the mixing of two different frequencies and using either the sum or difference frequency of the two combined frequencies to produce an Intermediate Frequency (IF)). The resulting intermediate frequency is a low level audio Frequency (AF).

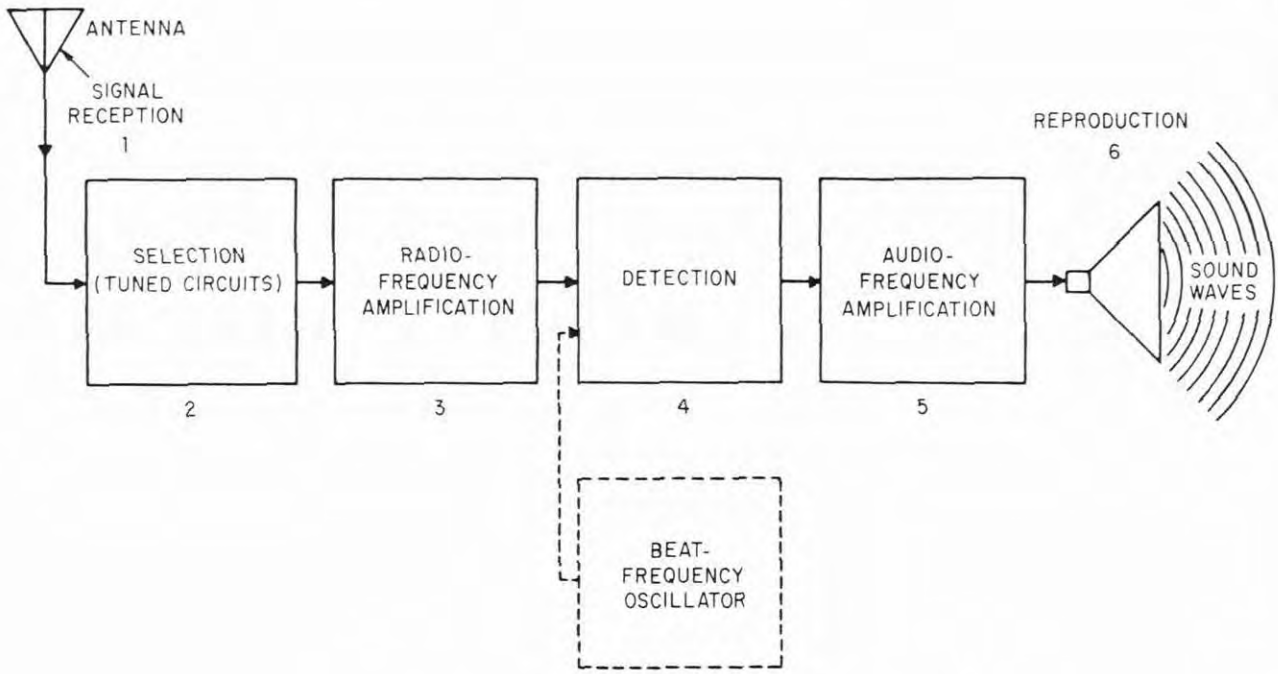

Figure 3-1.—Essentials of radio reception. 76.23

Audio Frequency Amplification

The signal frequency in the audio output of the detector is generally too weak to be heard through a headset or loudspeaker; therefore, one or more stages of AF amplification are required to strengthen the audio output of the detector to a level sufficient to operate the headset or loudspeaker. This is another function of a receiver.

Reproduction

The amplified AF signal is applied to the headset or loudspeaker which, in turn, translates the electrical AF variations into corresponding sound waves. These sound reproductions may be in the form of voice, manual morse, teletype signals, etc., and are now in a usable form for the operator.

RECEIVER CHARACTERISTICS

The measure of the receiver's performance is expressed in terms of its SENSITIVITY, SELECTIVITY, and STABILITY, the three primary characteristics of any receiver.

Sensitivity

The sensitivity of a receiver is a measure of its ability to receive a desired signal. The more sensitive the receiver, the better it is able to receive extremely weak signal voltages present on the antenna.

Selectivity

Selectivity is the measure of a receiver's ability to discriminate between the desired signal and the unwanted signals present on the antenna. The more selective the receiver, the better it is able to receive a desired signal and reject all others.

Stability

Stability, like selectivity, is a measure of signal selection. The difference is a question of

duration–stability is a measure of the receiver's ability to remain tuned to the selected frequency for long periods of time without continuous operator attention.

BASIC SUPERHETERODYNE RECEIVER

A Superheterodyne Receiver, alluded to above, converts all incoming radio frequency signals to a common intermediate frequency before conversion to the original modulation. By changing the frequency of a received signal to a lower, fixed, intermediate frequency before detection, high gain and selectivity may be obtained with improved stability. Older receivers, such as the Tuned Radio Frequency (TRF) receiver, were lacking in stability and consistent selectivity, or were characterized by poor sensitivity. For this reason, the Superheterodyne receiver is used almost universally in radio communications.

Receiver Stages

The basic superheterodyne receiver stages and waveforms are shown in block diagram in figure 3-2. Each stage will be discussed individually, depicting the progressive signal flow through a basic superheterodyne receiver.

RADIO FREQUENCY AMPLIFIER (RF AMP).–The RF AMP receives the signal voltage from the antenna and amplifies it to a sufficient level to drive the receiver. The quality of the RF AMP determines the sensitivity of the receiver.

HIGH FREQUENCY OSCILLATOR (HF OSC).–The HF OSC generates a radio frequency signal, the frequency of which is varied whenever the frequency control of the receiver is tuned to a different frequency by the operator. The ability of the HF OSC to remain on the selected frequency is a measure of the receiver's stability.

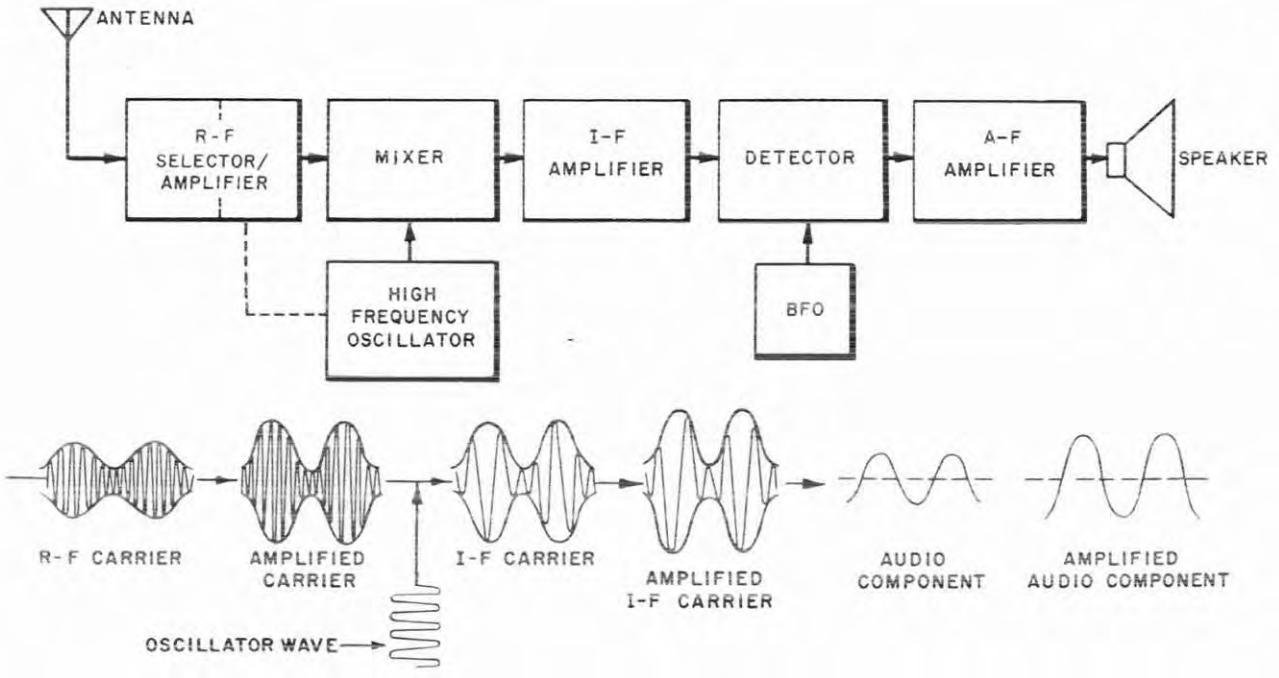

Figure 3-2.–Block diagram of a superheterodyne receiver.

MIXER.—The MIXER receives two input signals, one is the band of frequencies from the RF AMP and the other is a single frequency from the HF OSC. Through heterodyne action, the MIXER produces the intermediate frequency (IF), which is normally 455 kHz.

INTERMEDIATE FREQUENCY AMPLIFIER (IF AMP).—The IF AMP, as the name implies, amplifies the intermediate frequency output from the mixer stage.

DETECTOR.—The DETECTOR takes the intermediate frequency from the IF AMP and detects or demodulates it. This is the process which enables the receiver to obtain the original intelligence (audio frequency) which was placed upon the RF carrier frequency.

BEAT FREQUENCY OSCILLATOR (BFO).—Certain types of signals are not easily interpreted in their demodulated form. An example is ON-OFF keyed Manual Morse. The extremely low modulating frequencies are interpreted by the human ear as only a sequence of "clicks". It is desirable to convert these variations into similar variations in a higher frequency wave. The BFO injects a signal into the DETECTOR which has a slightly different frequency from the IF frequency of the received signal. Heterodyne action again takes place and the output from the DETECTOR will be a signal equal to the difference of the IF signal and BFO signal. By adjusting the frequency of the BFO signal, this difference signal can be changed in pitch so that it is comfortable to the ear of the operator. The BFO signal may also be necessary to produce an output frequency from the detector that is compatible with other electronic equipment, such as frequency shift converters.

AUDIO FREQUENCY AMPLIFIER (AF AMP).—The AF AMP amplifies the audio output of the DETECTOR stage to a sufficient level to drive speakers, headsets, or other electronic equipment.

R-390A/URR SUPERHETERODYNE RECEIVER

The R-390A/URR (figure 3-3) is a high performance, exceptionally stable, general purpose, high frequency receiver. The receiver provides reception of AMPLITUDE KEYED CARRIER (e.g., ON-OFF Keyed Manual Morse), AMPLITUDE MODULATED CARRI methods, (e.g., Single Sideband Voice), FREQUENCY SHIFT KEYED CARRIER methods, (e.g., Two-condition frequency shift keyed teleprinter signal) and PHASE SHIFT KEYED CARRIER methods (e.g., two-condition phase shift key). It is a multiple frequency conversion superheterodyne receiver that can be used in both fixed and mobile applications.

Technical Characteristics

The R-390A/URR has certain technical characteristics that the operator should know:

FREQUENCY RANGE.—The frequency range of the R-390A/URR is from .5 to 32 MHz tuned in 32 continuous bands. Each switched band is 1 MHz wide, except for the first band which is .5MHz.

OUTPUTS.—There are three outputs from the R-390A/URR. Two of these outputs are audio outputs—LOCAL audio and LINE audio. The two audio output channels are essentially the same and provide independently adjustable audio sources for speakers, headsets, ar. electronic equipment. The LOCAL audio channel supplies audio for headsets and speakers. The LINE audio channel supplies audio for other electronic equipment and has a level meter for the precise level adjustments required when the line audio is being fed to other equipment. The third output is an IF output. Certain equipments are designed to accept a 455 kHz input which, as noted above, is the IF output of the R-390A/URR.

BANDWIDTHS.—The R-390A/URR receiver has selectable IF bandwidths to provide for optimum signal reception with a minimum of interference. The bandwidths available are .1, 1, 2, 4, 8, and 16kHz and they are switch-selectable from the front panel of the receiver.

CALIBRATION.—Calibration of the R-390A/URR can be accomplished at every 100kHz dial reading.

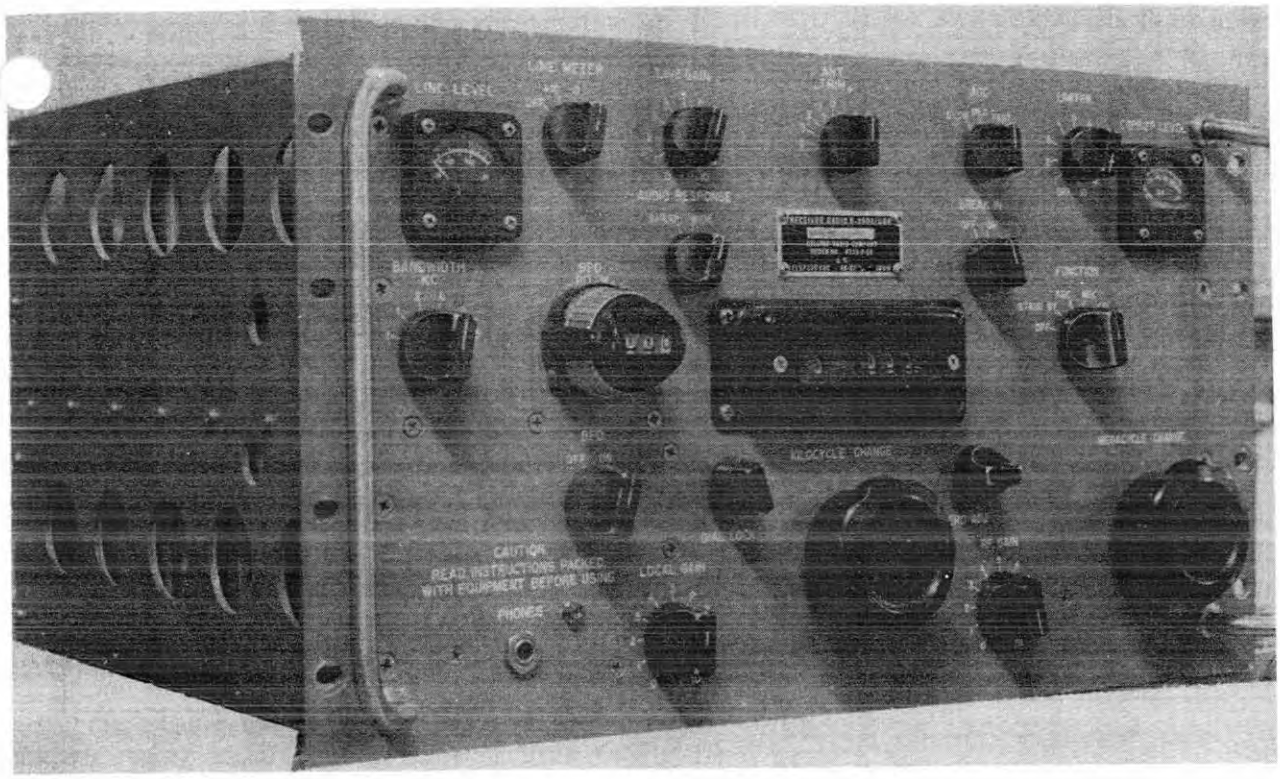

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Figure 3-3.–R-390A/URR receiver.

Operator Controls and Indicators

All of the operating controls, indicators, and a PHONES jack are located on the front panel of the R-390A/URR (refer to figure 3-4). Haphazard operation or improper setting of the controls and indicators can result in poor reception; therefore, it is important to know the function of each control.

CAUTIONS:

1. DO NOT turn the MEGACYCLE CHANGE control below 00 or beyond 31 megacycles.

2. DO NOT turn the KILOCYCLE CHANGE control beyond 000 counterclockwise or 999 clockwise. If a + or - appears in the third frequency indicator column from the left, the control has been turned too far.

3. DO NOT turn the FUNCTION switch counterclockwise beyond OFF or clockwise beyond CAL.

4. DO NOT turn the BFO PITCH control above or below 13.0.

5. ALWAYS turn the ZERO ADJUST counterclockwise after calibration.

LINE LEVEL METER.–The LINE LEVEL METER indicates the output level of the audio in the line audio channel. The meter is calibrated in Volume Units (VU's) which is a quantitative expression for volume in an electrical circuit.

LINE METER SWITCH

The LINE METER SWITCH connects the line meter to the line audio output and selects

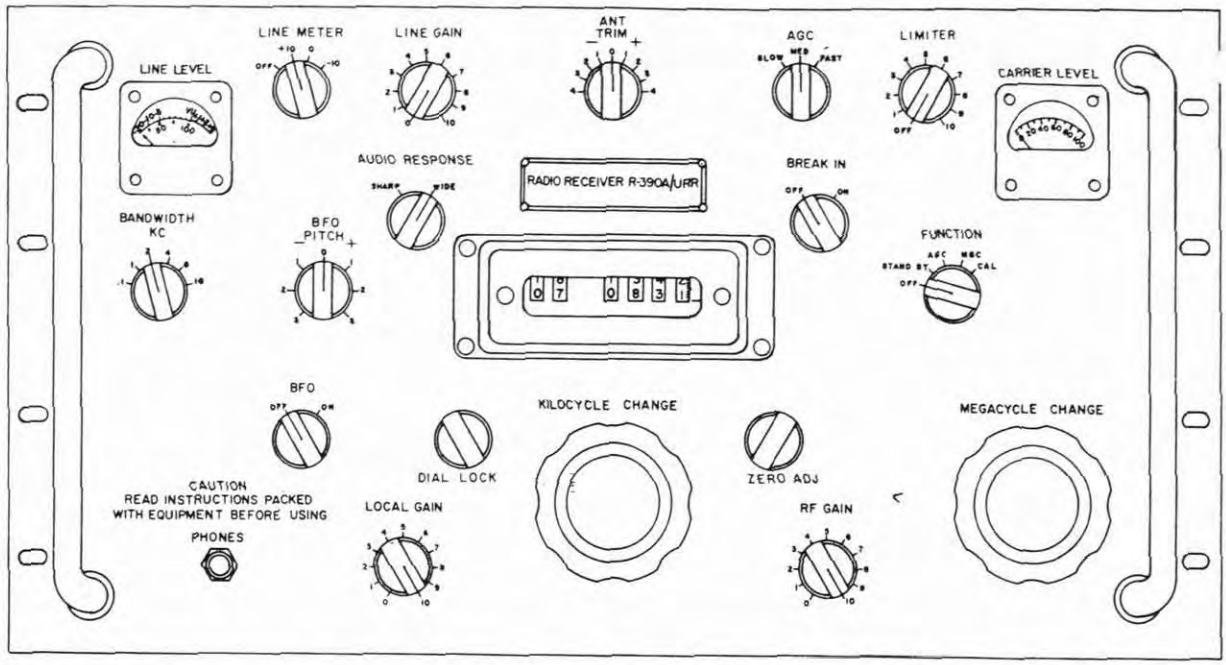

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Figure 3-4.—R-390A/URR front panel operating controls.

the range of the Line meter reading. This four-position switch operates as follows:

a. OFF—The Line Meter is out of the circuit.

b. +10—+10 VU is to be added to the meter reading.

c. 0—The meter reading is direct.

d. -10—-10 VU is to be subtracted from the meter reading.

NOTE: Except for when calibrating the BFO, the LINE METER SWITCH should be placed in the OFF position, as most of the electronic equipments you will be using with the R-390A contain their own input level meters. This prevents possible damage to the meter should a required input level exceed the maximum meter reading.

LINE GAIN CONTROL.—The LINE GAIN control adjusts the level of the audio output from the Line Audio Channel. When adjusting the level of line audio input to other electron' equipment, this control will provide the mea.. for making the adjustment.

ANTENNA TRIM.—The ANTENNA TRIM control allows adjustment for optimum receiver sensitivity with the particular antenna and on the particular frequency desired. Adjustment of this control is accomplished in conjunction with the relative reading of the CARRIER LEVEL Meter to be covered later.

AUTOMATIC GAIN CONTROL (AGC).—The AGC is a three-position switch which allows for the selection of one of three AGC time-constant characteristics. This feature enables the operator to choose the AGC time-constant which most effectively compensates for fading RF signals. The operation of this switch is dependent upon the setting of the FUNCTION switch being in the AGC position.

Slow.—The receiver recovers slowly from the effects of a strong signal; thus, if a strong signal is keyed, there will be a noticeable delay between the time the signal is removed and the time that the automatic gain circuitry again restores the receiver to full sensitivity. The SLOW position is useful for copying medium to strong Morse signals and for copying certain types of Single Sideband, suppressed carrier signals. Strong bursts of static may cause unnecessary loss of the signal because of the time delay and use of the SLOW AGC position during periods of heavy static is discouraged.

Med.—The MED position of the AGC switch allows the AGC to recover more rapidly from the effects of strong signals. This position enables the receiver to maintain a nearly constant sensitivity over most conditions of fading encountered in the high frequency bands, and is the best general purpose setting of the AGC control.

Fast.—The FAST setting of the AGC switch allows nearly instantaneous recovery from the effects of strong signals. This position of the AGC switch is most useful when severe static conditions exist or when rapid and extreme signal fading is present. Caution must be used when employing this control setting, as it will cause certain signals, such as manual morse, to sound "choppy." This choppy effect is not desired unless extreme static conditions warrant the trade-off.

LIMITER.—The LIMITER control provides for the limiting of positive and negative peaks in the audio output signal. When properly adjusted the limiter can be used to cut back the amplitude of pulse-type noise which may be interferring with the desired signal. Caution should be exercised when using the LIMITER control, as excessive limiting can distort the desired signal.

CARRIER LEVEL METER.—The CARRIER LEVEL meter indicates the relative strength of the incoming radio signal. The meter is scaled in Decibels (db), a measure of relative power, and its readings are affected by the setting of the ANT TRIM control and the RF GAIN control.

BANDWIDTH KC SWITCH.—The BANDWIDTH KC switch changes the bandpass centered on the carrier frequency to the width selected. Optimum setting of this control is important for good reproduction of the received signal. It is most important that the BANDWIDTH KC switch not be placed in a position that is LESS than the bandwidth of the incoming signal. Excessively wide bandwidths are also discouraged as this allows greater noise levels to be amplified in the IF amplifiers, degrading the quality of the reproduced signal. Excessive bandwidths also make the signal subject to interference from signals on adjacent frequencies. It is a good policy to set the BANDWIDTH KC switch to the setting which is the next largest when compared to the bandwidth of the signal. Thus, if the signal is 3kHz wide, the 4 KC position of the BANDWIDTH KC switch should be selected. The BANDWIDTH KC switch is labeled as follows:

.1 KC
1 KC
2 KC
4 KC
8 KC
16 KC

BFO.—The two-position BFO switch turns the BFO (Beat Frequency Oscillator) ON and OFF.

BFO PITCH.—The BFO PITCH control varies the output frequency of the BFO above and below 455kHz. The normal R-390A BFO is designed to vary by 3kHz above and below 455kHz. Many of the R-390A receivers with which you will come into contact have a modified BFO pitch control, called a MICRODIAL. This modification enables the BFO to be varied over a 26kHz range (13kHz above and below 455kHz.)

AUDIO RESPONSE.—The two-position AUDIO RESPONSE switch allows the use of a highly selective audio filter for copying manual morse transmissions.

a. Sharp.—In this position the selective filter is in the audio circuit. This filter has an

approximate center frequency of 800 Hz and a bandwidth of 45Hz. Care should be exercised when using this filter. If the BFO PITCH control is not adjusted for an 800Hz tone, the Morse signal will literally be "lost" when the SHARP position of this control is selected.

b. Wide.–In this position the filter is not in the audio circuitry, and the audio response is limited only by the characteristics of the received signal or by the limitations placed on the received signal by the BANDWIDTH KC switch.

BREAK-IN.–The two-position BREAK-IN switch works in conjunction with a relay and a set of terminals on the back of the receiver. When the R-390A is installed with a collocated transmitter, the keying circuits of the transmitter can be used to disable the receiver during periods of transmission. Placing the BREAK-IN switch in the ON position permits this function. You will probably not have an occasion to use this switch, and it should remain in the OFF position.

FUNCTION.–The five-position FUNCTION switch controls the overall operating mode of the receiver as follows:

Off.–Removes all a.c. power from the receiver.

Stand by.–In this position, the tubes of the receiver are hot, but no operating voltages are present. In this mode, the receiver is inoperative, but can be placed into an operational mode without a delay for warm-up. The STAND BY mode should be used when the receiver is not to be used, but is to be maintained in a state of readiness.

AGC.–In this position, the AGC circuits of the receiver are operational. AGC is a technique used for maintaining a relatively constant audio output level over a wide range of input signal levels, such as would be experienced during conditions of signal fading. In the AGC position, the RF GAIN control acts as a master gain, which sets the overall level of AGC action that will be applied to the signal.

MGC.–In this position the AGC circuits are inoperative and the gain of the receiver is solely a function of the RF GAIN control setting.

CAL.–This position is used when calibrating the R-390A receiver. When selected, the CAL position causes the antenna to be switched out of the input circuit, the calibration oscillator to be activated, and the AGC function of the receiver to be activated. The operating calibration oscillator is used to precisely calibrate the FREQUENCY READOUT INDICATOR at each 100kHz interval.

DIAL LOCK.–When the DIAL LOCK is turned clockwise, it locks the KILOCYCLE CHANGE control to prevent changing the frequency. Use of this control is limited to a few special applications and you will seldom be called upon to use it.

ZERO ADJ.–When turned clockwise the ZERO ADJ control disengages the KILOCYCLE CHANGE control from the FREQUENCY INDICATOR. This control will always be turned clockwise when calibrating the FREQUENCY INDICATOR of the R-390A.

PHONES.–This audio output jack provides means of connecting headphones to the LOCAL AUDIO channel of the receiver. This enables the operator to listen to the signal being received.

LOCAL GAIN.–The LOCAL GAIN control adjusts the level of the audio to the LOCAL AUDIO channel. You can adjust the level of the audio output to headphones or speakers by means of this control.

KILOCYCLE CHANGE.–The KILOCYCLE CHANGE control tunes the receiver continuously to any frequency with a one MHz band. When rotated, the last three digits of the FREQUENCY INDICATOR will be affected.

RF GAIN.–The RF GAIN control adjusts the gain of the RF and IF amplifiers. It is the sole source of gain adjust when the function is in the MGC position, and it is an adjustment of overall AGC action when the FUNCTION switch is in the AGC position.

MEGACYCLE CHANGE.–The MEGACYCLE CHANGE control is used to select the MHz band, of the 32 available, over which the KILOCYCLE CHANGE control is to operate. The MEGACYCLE CHANGE control affects the first two digits of the FREQUENCY INDICATOR.

Calibration Procedures

Calibration is a very important step in tuning the R-390A because it is the first step to properly tune any signal. It ensures that the frequency indicator is correct and that the BFO output is 455 kHz at calibrated zero. The R-390A should be calibrated each time the MEGACYCLE CHANGE control is retuned. The frequency indicator calibration is accomplished by setting the receiver controls in the following manner:

PRELIMINARY SETUP

(1)	Local Gain	5
(2)	Dial Lock	Counterclockwise
(3)	BFO	OFF
(4)	Bandwidth KC	.1
(5)	Audio Response	WIDE
(6)	Line Meter	OFF
(7)	Line Gain	0
(8)	Limiter	OFF
(9)	Function Switch	CAL
(10)	RF Gain	10

OPERATOR ADJUSTMENTS

(1) Turn the frequency indicator to the exact 100kHz point nearest the frequency desired for reception (e.g., signal 10240kHz–calibrate on 10200kHz).
(2) Turn the ZERO ADJUST control knob clockwise as far as it will go. DO NOT FORCE THIS KNOB.
(3) Adjust the KILOCYCLE CHANGE control for a maximum indication of the CARRIER LEVEL meter.
(4) Rotate the ANTENNA TRIM control and set it to obtain maximum indication on the CARRIER LEVEL meter.
(5) Turn the ZERO ADJUST control counterclockwise until it stops. The frequency indicator dial is now accurately calibrated.

BFO PITCH CALIBRATION.–Continue as follows to calibrate the BFO pitch:

(6) Place the BANDWIDTH KC switch at 16.
(7) Turn the BFO switch to ON.
(8) Turn the LINE METER switch to the 0 position and the LINE GAIN control in a clockwise direction until a reading of 100db is obtained on the LINE METER.
(9) Tune the BFO PITCH control in the direction of the zero beat of the tone until the line METER deflects to 0. The BFO is now calibrated at 455kHz.

Frequency Excursion Measurements

Frequency excursion (the distance between the UPPER and LOWER frequency extremes of a signal) information is necessary to determine the minimum setting of the BANDWIDTH KC switch. This procedure is not sufficiently accurate for analysis purposes, but it may be used to determine the minimum BANDWIDTH KC setting for frequency shift keying methods, (e.g., FSK and DFSK).

(1) Tune above signal, slowly tune down to signal, stop at zero beat of the upper frequency, note reading.
(2) Tune below signal, slowly tune up to signal, stop at zero beat of the lower frequency, note reading.
(3) Subtract lower from higher frequency for frequency excursion.
(4) The BANDWIDTH KC switch will be set at least ONE number above the frequency excursion.

Frequency Shift Measurements

Frequency shift measurements (the distance between adjacent frequencies) are important to know when using a frequency shift converter in conjunction with the R-390A. Once the

frequency excursion measurement is known, it is a simple procedure for determining the frequency shift measurements.

(1) FSK frequency shift will be the same as the frequency excursion.
(2) DFSK frequency shift is determined by dividing the frequency excursion by three (3).

Tuning Procedures

The R-390A can be used to receive various types of signal modulation, i.e., ON-OFF keying, FREQUENCY SHIFT keying, AMPLITUDE keying, PHASE SHIFT keying, etc. The tuning procedures used will depend upon the type of modulation of the signal being received.

ON-OFF KEYING (MANUAL MORSE).–

a. Set the R-390A controls as follows:

(1) LOCAL GAIN	5
(2) DIAL LOCK	Counterclockwise
(3) BFO	ON
(4) BFO PITCH	0 (calibrated)
(5) BANDWIDTH	8 KC
(6) AUDIO RESPONSE	WIDE
(7) LINE METER	OFF
(8) LINE GAIN	0
(9) AGC	Slow
(10) LIMITER	OFF
(11) FUNCTION	AGC
(12) RF GAIN	10

b. Use the MEGACYCLE CHANGE and KILOCYCLE CHANGE controls to set the frequency indicator to the frequency of the desired signal.

c. Use the KILOCYCLE CHANGE control to tune for zero beat of the desired signal.

d. Adjust the ANT TRIM control for maximum reading on the CARRIER LEVEL meter.

e. Adjust the BFO PITCH control to ±1.5 kHz from calibrated zero.

f. Adjust the RF GAIN control for the best signal-to-noise ratio.

g. Adjust the LOCAL GAIN control for the desired volume level.

h. If noise is excessive, rotate the LIMITER control clockwise as needed.

i. If keying is at a slow speed so that the AGC brings noise up between characters, set the FUNCTION switch to MGC and reduce the RF GAIN control to prevent blocking.

j. If interference is heard, set the BANDWIDTH KC switch to the next lower position. For the greatest degree of selectivity set the BANDWIDTH switch to 2 KC, 1 KC or .1KC position. Set the BFO PITCH control for approximately .8 kHz and set the AUDIO RESPONSE switch to SHARP.

k. When a balanced-line audio output circuit is used as an input for an audio recorder and/or RD-112U, etc., set the LINE METER switch to the required range and adjust the LINE GAIN control for the desired reading on the LINE LEVEL meter, normally at the O VU mark.

DOUBLE SIDEBAND (NORMAL SPEECH).–

a. Set the R-390A controls as follows:

(1) LOCAL GAIN	5
(2) DIAL LOCK	Counterclockw
(3) BFO	ON
(4) BFO PITCH	0 (Calibrated)
(5) BANDWIDTH	16 KC
(6) AUDIO RESPONSE	WIDE
(7) LINE METER	OFF
(8) LINE GAIN	0
(9) AGC	MED
(10) LIMITER	OFF
(11) FUNCTION	AGC
(12) RF GAIN	10

b. Use the MEGACYCLE CHANGE and KILOCYCLE CHANGE controls to set the frequency indicator to the frequency of the desired signal.

c. Use the KILOCYCLE CHANGE control to zero beat the constant frequency tone (carrier).

d. Set the BFO switch to the OFF position. The speech should now be clear and intelligible.

e. Adjust the ANT TRIM control for maximum reading on the CARRIER LEVEL meter.

f. Adjust the RF GAIN for the best signal-to-noise ratio.

g. Adjust the LOCAL GAIN control for the desired volume level.

h. If noise is excessive, rotate the LIMITER control clockwise as needed.

i. If the signal fades rapidly, set the AGC switch to FAST.

j. If interference is heard, set the BANDWIDTH switch to the 8KC position.

k. When a balanced-line audio output circuit is used as an input for an audio recorder, set the LINE METER switch to the required range and adjust the LINE GAIN control for the desired reading on the LINE LEVEL meter, normally at the O VU mark.

SINGLE SIDEBAND (INVERTED SPEECH).–

a. Set the R-390A controls as follows:

(1) LOCAL GAIN	5
(2) DIAL LOCK	Counterclockwise
(3) BFO	ON
(4) BFO PITCH	0 (Calibrated)
(5) BANDWIDTH	8 KC
(6) AUDIO RESPONSE	WIDE
(7) LINE METER	OFF
(8) LINE GAIN	0
(9) LIMITER	OFF
(10) FUNCTION	MGC
(11) RF GAIN	5

b. Use the MEGACYCLE CHANGE and KILOCYCLE CHANGE controls to set the frequency indicator to the frequency of the desired signal.

c. Use the KILOCYCLE CHANGE control to zero beat the constant frequency tone (carrier).

d. Set the BFO PITCH control to ±3kHz. Speech should now be clear. Adjust the BFO PITCH control a small amount in either direction to obtain clearest speech.

e. Adjust the ANT TRIM control for maximum reading on the CARRIER LEVEL meter.

f. Adjust the RF GAIN control for the best signal-to-noise ratio.

g. Adjust the LOCAL GAIN control for the desired volume level.

h. If noise is excessive, rotate the LIMITER control clockwise as needed.

i. Set the BANDWIDTH switch to a position that results in the clearest speech.

j. When a balanced-line audio output circuit is used as an input for an audio recorder, set the LINE METER switch to the required range and adjust the LINE GAIN control for the desired reading on the LINE LEVEL meter, normally at the O VU mark.

SINGLE SIDEBAND (NORMAL).–

a. Set the R-390A controls as follows:

(1) LOCAL GAIN	between 5 and 10
(2) DIAL LOCK	Counterclockwise
(3) BFO	On
(4) BFO PITCH	-1 for upper sideband reception +1 for lower sideband reception
(5) BANDWIDTH	8 KC
(6) AUDIO RESPONSE	WIDE
(7) LINE METER	OFF
(8) LINE GAIN	0
(9) LIMITER	OFF
(10) FUNCTION	MGC
(11) RF GAIN	5

b. Use the MEGACYCLE CHANGE and KILOCYCLE CHANGE controls to set the frequency indicator to the frequency of the desired signal.

c. Adjust the ANT TRIM control for maximum reading on the CARRIER LEVEL meter.

d. Use the KILOCYCLE CHANGE control to zero beat the constant frequency tone (carrier) of the desired signal.

e. Adjust the BFO PITCH and/or KILOCYCLE CHANGE controls slightly for the most intelligible signal reception.

f. Adjust the RF GAIN control for the best signal-to-noise ratio.

g. Adjust the LOCAL GAIN control for the desired volume level.

h. When a balanced-line audio output circuit is used as an input for an audio recorder, set the LINE METER switch to the required range and adjust the LINE GAIN control for the

desired reading on the LINE LEVEL meter, normally at the O VU mark.

INDEPENDENT SIDEBAND (SPEECH).–

a. Set the R-390A controls as follows:

(1) LOCAL GAIN	5
(2) DIAL LOCK	Counterclockwise
(3) BFO	ON
(4) BFO PITCH	0 (Calibrated)
(5) BANDWIDTH	8 KC
(6) AUDIO RESPONSE	WIDE
(7) LINE METER	OFF
(8) LINE GAIN	0
(9) LIMITER	OFF
(10) FUNCTION	MGC
(11) RF GAIN	5

b. Use the MEGACYCLE CHANGE and KILOCYCLE CHANGE controls to set the frequency indicator to the frequency of the desired signal.

c. Use the KILOCYCLE CHANGE control to zero beat the constant frequency tone (carrier).

d. Set the BFO PITCH control to ±3kHz. This setting will depend upon which sideband the desired voice canal activity is being carried. Adjust the BFO PITCH control a small amount in either direction to obtain clearest speech.

e. Adjust the ANT TRIM control for maximum reading on the CARRIER LEVEL meter.

f. Adjust the RF GAIN control for the best signal-to-noise ratio.

g. Adjust the LOCAL GAIN control for the desired volume level.

h. If noise is excessive, rotate the LIMITER control clockwise as needed.

i. Set the BANDWIDTH switch to a position that results in the clearest speech.

j. When a balanced-line audio output is used as an input for an audio recorder, set the LINE METER switch to the required range and adjust the LINE GAIN control for the desired reading on the LINE LEVEL meter, normally at the O VU mark.

SINGLE SIDEBAND OR INDEPENDENT SIDEBAND (MULTI-TONES).–

NOTE: The operating procedures explained below are employed when using the CV-157/URR Single Sideband converter in conjunction with the R-390A receiver.

a. Set the R-390A controls as follows:

(1) LOCAL GAIN	5
(2) DIAL LOCK	Counterclockwise
(3) BFO	ON
(4) BFO PITCH	0
(5) BANDWIDTH	16 KC
(6) AUDIO RESPONSE	WIDE
(7) LINE METER	OFF
(8) AGC	SLOW
(9) LIMITER	OFF
(10) FUNCTION	MGC
(11) RF GAIN	5 (or until the signal is audible)

b. Use the MEGACYCLE CHANGE and KILOCYCLE CHANGE controls to set the frequency indicator to the frequency of the desired signal.

c. Adjust the ANT TRIM control for maximum AURAL OUTPUT on the headset.

d. Use the KILOCYCLE CHANGE control to zero beat the carrier of the desired signal.

e. Set the BFO switch to the OFF position.

f. Adjust the RF GAIN control to the overload point of the receiver (the point when increasing the setting of the RF GAIN cont does not produce an increase in signal strength.

g. Adjust the LOCAL GAIN control for a comfortable signal level.

h. Note the frequency indicator reading.

i. Use the KILOCYCLE CHANGE control to adjust the frequency indicator for a higher reading until the intelligence is barely audible.

j. Note the frequency indicator reading.

k. The sideband that contains the Keyed-Tone intelligence is the one that gives the greater difference. If the greater displacement is higher than the carrier frequency, the Keyed-Tone intelligence is in the lower sideband.

l. Return to the carrier frequency position.

m. Set the FUNCTION switch to AGC.

n. Set the RF GAIN control to 10.

o. Adjust the ANT TRIM for maximum indication on the carrier level meter.

PHASE SHIFT KEY.–

a. Set the R-390A controls as follows:

(1) LOCAL GAIN	10
(2) DIAL LOCK	Counterclockwise

(3) BFO	ON
(4) BFO PITCH	0 (Calibrated)
(5) BANDWIDTH	1 KC
(6) AUDIO RESPONSE	WIDE
(7) LINE METER	OFF
(8) LINE GAIN	10
(9) LIMITER	OFF
(10) FUNCTION	MGC
(11) RF GAIN	5

b. Use the MEGACYCLE CHANGE and KILOCYCLE CHANGE control to set the frequency indicator to the desired signal.

c. Adjust the ANT TRIM control for maximum reading on the carrier level meter.

d. Using the KILOCYCLE CHANGE control, tune the receiver below the desired signal.

e. Slowly tune the receiver upwards in frequency, noting the frequency indicator reading when the signal first becomes audible.

f. Tune the receiver upward in frequency through the signal, noting the frequency indicator reading when the signal was last audible.

g. Retune the receiver to the point midway between the reading obtained in steps (e) and (f).

h. Set the BANDWIDTH switch to 8KC.

FREQUENCY SHIFT KEYING.—Frequency Shift keying tuning procedures will be explained in chapter 4.

R-1279/URR VHF RECEIVER

The R-1279/URR (figure 3-5) is a compact (VHF) superheterodyne receiver that has a frequency range of 30-300MHz in two bands: 30-90MHz and 60-300MHz. Because F-M (frequency modulation) activity is prevalent in the VHF range, the R-1279/URR is provided with F-M reception capabilities in addition to A-M and C-W. It is used primarily to receive voice communications and can be used in both fixed and mobile applications. Three IF bandwidths are available: 20 KC, 200 KC, and 2-MC. A tunable beat frequency oscillator (BFO) operates with the 20-KC or 200-KC bandwidths for CW reception. A signal strength meter indicates the relative magnitude of incoming AM and FM signals and a running meter indicates when the receiver is tuned to the center frequency of an incoming FM signal.

Starting Procedures

When properly installed, the receiver is placed in operation by turning the AUDIO

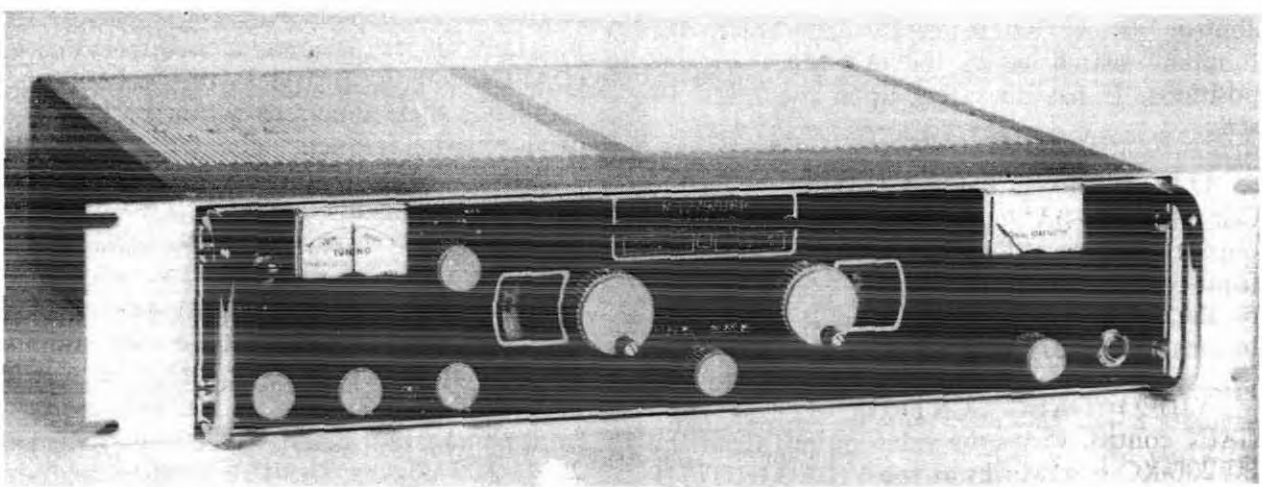

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Figure 3-5.—R-1279/URR receiver.

GAIN control clockwise past the PWR OFF position.

Operating Controls and Indicators

The front-panel controls and indicators used by the operator are shown in Figure 3-5.

BANDSWITCH.–Place switch in the 30-90 MC or 60-300 MC position depending upon the frequency range to be tuned. The tuner dial for the selected band lights up, and the antenna is switched to the proper tuner.

FUNCTION SWITCH.–Place switch in the FM, AM/AGC, AM/MAN, or CW position depending upon the type of signal to be received. With the function switch in the AM/MAN or CW positions the gain of the receiver must be manually controlled by the RF-IF GAIN control.

BANDWIDTH SWITCH.–The 20 KC-200 KC BANDWIDTH switch is set to select the desired bandwidth of the 20/200 KC IF strip. When searching for signals, it is advisable to use the 200 KC bandwidth; for CW signals, (e.g., manual morse), the 20 KC narrow bandwidth is recommended. The receiver's 2 MC IF strip operates continuously.

RF-IF GAIN CONTROL.–The RF-IF GAIN control varies the receiver's gain when the function switch is in the AM/MAN or CW positions. It has no effect upon the 2 MC IF strip.

ON/OFF and AUDIO GAIN CONTROL.–This control varies the audio output from the 20/200 KC IF strip at both the front-panel PHONES jack and at a terminal strip on the rear apron of the receiver. It is also used to turn the R-1279 receiver ON and OFF.

VIDEO GAIN CONTROL.–The VIDEO GAIN control varies the video output from the 20/200-KC bandwidths at the VIDEO OUTPUT jack on the rear apron of the receiver.

BFO TUNING CONTROL.–The BFO TUNING control varies the pitch of the beat note produced during CW reception. It operates only with the 20-KC or 200-KC bandwidths.

SIGNAL STRENGTH METER The SIGNAL STRENGTH meter indicates the relative magnitude of the incoming RF carrier. The meter is not calibrated in any particular units.

TUNING METER.–The TUNING meter indicates "zero" when the receiver is tuned to the exact center of an FM carrier when the function switch is in the FM position. It deviates to the right or left of "zero" when the receiver is tuned above or below the carrier frequency.

Securing Procedures

The receiver is turned off and shut down by turning the AUDIO GAIN control counter clockwise until the dot on the control knob passes the PWR OFF position.

AN/URR-52B RECEIVING SYSTEM

The AN/URR-52B receiving system (figure 3-5A), provides AM, FM, and CW reception, including a visual spectrum display over the 0 to 1000 MHz frequency range in four bands: 30-60 MHz, 60-300 MHz, 235-500 MHz, and 490-1000 MHz. Switching of these four tuners is controlled by the RANGE switch on the front panel. A digital automatic frequency control (DAFC) circuit provides the capability of stabilizing these tuners to within ±1 kHz by use of an external frequency counter. A single FINE TUNING control provides fine frequency adjustments for the operating tuner when the DFAC is not used. Two IF amplifiers are operating at all times. One is a 2 MHz bandwidth amplifier which provides simultaneous AM and FM video outputs; the other IF amplifier provides either 20 kHz, 75 kHz, or 300 kHz bandwidth, depending on the setting of the front-panel IF BANDWIDTH switch. The 20/75/300-kHz bandwidth amplifier contains a beat frequency oscillator (BFO) which operates in the CW position of the function switch in all three bandwidths. A signal monitor provides the visual signal display. Center frequency indication

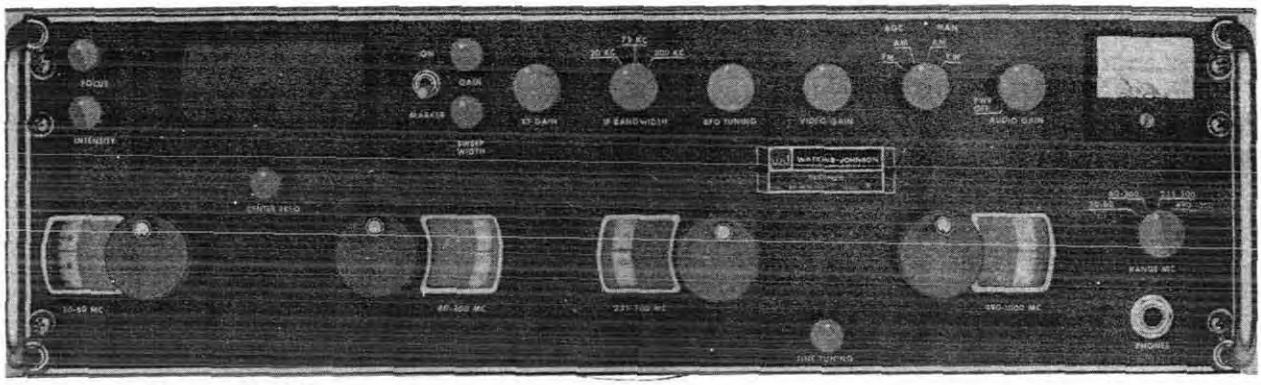

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Figure 3-5A.–AN/URR-52B receiver.

is available for tuning when a 21.4 MHz marker is turned on and results in a pip on the CRT screen. This pip represents the center of the signal monitor response and aids in tuning and in determining the frequency of incoming signals.

AN/URR-52B Front Panel Operating Controls

The front panel operating controls of the AN/URR-52B receiving system are explained in the following paragraphs, (see figure 3-5A):

RANGE MC.–The RANGE MC switch selects the proper tuner for use as determined by the frequency of the incoming signal. A lamp will light behind the tuning dial of the tuner selected.

AUDIO GAIN/PWR OFF.–When rotated clockwise from the PWR OFF position, the combination AUDIO GAIN control and a.c. power switch turns on the receiving system. Once the unit is operating, this control sets the audio level at the PHONES jack and at the rear apron AUDIO terminal strip.

FUNCTION.–A four-position switch which affects the 20/75/300 kHz bandwidth amplifier. When this switch is in the AM/MAN or CW/MAN positions, the gain of the receiver must be manually controlled by using the RF GAIN control. The BFO is automatically activated when the switch is placed in the CW mode.

BFO TUNING.–The BFO TUNING control allows the operator to change the pitch of the audio signal when the function switch is placed in the CW/MAN position. Place the BFO TUNING control at mid-position when tuning. The audio pitch can then be increased or decreased as desired.

IF BANDWIDTH.–The IF BANDWIDTH switch controls the bandwidth of the 20/75/300 kHz IF amplifier. Set this switch as desired, depending upon the characteristics of the signal to be received. When searching for signals, it is advisable to use the widest bandwidth.

RF GAIN.–The RF GAIN control is used to manually control the gain of the receiver sections (except the 2-MHz bandwidth IF amplifier) when the function switch is in the AM/MAN or the CW/MAN position. In the other two function switch positions, the RF GAIN control is inoperative.

SIGNAL STRENGTH METER.–This meter indicates the relative incoming signal strength. The meter is not calibrated in any particular units.

CATHODE RAY TUBE.–The CRT displays the signal present at the output of the tuner in operation.

VIDEO GAIN.—The VIDEO GAIN control is used to adjust the AM/FM video output levels.

GAIN CONTROL.—This control is used to adjust the amplitude of the display on the CRT. Adjustment of this control does not affect the receiver sections of the unit.

SWEEP WIDTH.—The SWEEP WIDTH control varies the display bandwidth on the CRT. Clockwise rotation of the control increases the bandwidth. When searching for a signal, place the control at the maximum clockwise position and then reduce the bandwidth, as desired, by counterclockwise rotation of the control after the signal has been located.

CENTER FREQUENCY.—Use the CENTER FREQ control to move the displayed pips on the CRT either right or left, as desired, or to place a particular pip on the center marker before reducing the displayed bandwidth.

FOCUS and INTENSITY.—Adjust the FOCUS and INTENSITY controls for maximum sharpness and desired brightness of the CRT trace.

MARKER.—When used, the MARKER switch produces a pip on the CRT at 21.4 MHz. This pip indicates the center of the IF response.

AN/WLR-1 COUNTERMEASURES RECEIVING SYSTEM

The AN/WLR-1 is a narrow-band ESM (ELECTRONIC WARFARE SUPPORT MEASURES) receiver set whose primary purpose is to receive and display electromagnetic radiations in the frequency range from 50 to 10,750 MHz. These electromagnetic radiations include CW, AM, FM, and PM signals. The WLR-1 receiver has a major advantage in that it rapidly analyzes a received signal by simultaneously providing direction finding information, pulse analysis, and a panoramic display; also, rapid scanning techniques and a long persistence raster display (across and back, gradually descending from top to bottom) enhance the probability of intercepting a signal.

Capabilities

When operating the AN/WLR-1 system an ESM intercept search operator can an e received signals and determine such characteristics as:

1. carrier frequency
2. modulation type
3. pulse repetition frequency (PRF)
4. pulse width (PW)
5. antenna scan type
6. antenna scan rate
7. true and relative bearing of the emitter (above 300 MHz)
8. polarization (bands 5-9)
9. estimated beamwidth
10. estimated range capability of the emitter
11. probable function
12. probable platform
13. degree of threat posed by the emitter

The AN/WLR-1 system also provides these additional capabilities:

1. Monitors the frequency spectrum to ensure that there are no violations of the EMCON (EMISSION CONTROL) condition in effect.
2. Monitors the effects of your E operations (ELECTRONIC COUNTERMEASURES) against an enemy.
3. Aids in the identification of unknown contacts.
4. Possesses emergency communication receiver capabilities.
5. Locates lost friendly units through its direction finding capabilities.

Frequency Bands

The frequency range of the AN/WLR-1 is divided into nine overlapping bands, each covering an increment of the frequency range 50-10, 750 MHz (refer to table 3-1).

Operational Modes

Two modes of operation are employed with the WLR-1 system: the Acquisition mode and Analysis mode.

Table 3-1.–AN/WLR-1 Frequency Bands

BAND	FREQUENCY IN MHz
1	50-100
2	90-180
3	160-320
4	300-600
5	550-1100
6	1010-2600
7	2575-4450
8	4406-7375
9	7300-10,750

ACQUISITION MODE.–The acquisition mode of operation is employed when it is necessary to search a relatively large portion of the frequency spectrum, i.e., one or more bands or a large portion of one band. During acquisition, the RF tuner, or band, selected by the ESM operator, is automatically scanned in frequency for rapid acquisition of received signals. Scanning is continuous until the operator selects the Analysis mode. Received signals are displayed on the acquisition IP-480 scope as vertical rows of intensified dots, or "pips" presented at the signal frequency. Successive sweeps of the raster scan will cause the pips of the signal to form a vertical train as the scan is deflected from the top to the bottom of the cathode-ray-tube. This makes it easy to distinguish the signal from noise, which is exhibited in a random pattern (refer to figure 3-6).

The acquisition scope uses a raster type scan and the sweep moves back and forth in the horizontal plane, synchronized with the RF tuner in use. Approximately 1.6 seconds is required to scan the frequency range of the tuner. This scan cycles from top to bottom on the cathode-ray-tube, taking approximately 2 minutes per cycle. The acquisition scope has a high persistency which allows an operator to return to a detected signal for analysis purposes. Later adaptations of the WLR-1 incorporate a multi-purpose cathode-ray-tube which allows the acquisition scope to be used to display polar sweep direction finding information on signals in the analysis mode (refer to figure 3-7).

In addition to the visual presentation on the acquisition scope, an audio indication of a signal is provided the operator by monitoring the incoming signal which has been stretched to provide an audio response in headphones. The audio intercept of a signal is more probable than visual intercept since the audio is fed from a narrow band source containing less noise than the source feeding the scope.

ANALYSIS MODE.–After a signal has been acquired and the operator desires to analyze it, the WLR-1 is switched to the Analysis Mode of operation. In the analysis mode, the operator must manually tune the RF tuner to the frequency of the received signal. To assist the operator in this operation a modification has been made to the WLR-1 that allows the operator to override the analysis mode and visually observe both the analysis and acquisition IP-480 display while manually tuning to the intercepted signal.

When a signal has been acquired and the RF tuner is tuned to the signal frequency, the signal is centered on the panoramic sweep. As the RF tuner is tuned higher in frequency, the signal moves from left to right, and vice versa.

The signal on the panoramic trace may be either a true signal or an image. An image can be detected by the fact that it moves in the opposite direction from which the operator is tuning, while the true signal will move in the same direction as the tuning. When an image is detected, consult a chart at the receiver which lists the IF frequency of each band and a frequency increment which must be added to or subtracted from the image frequency. This will allow tuning of the receiver to the frequency of the true signal.

The signal on the panoramic trace may not be an image of the true signal, but may, instead, be a harmonic. Harmonic checks are performed by tuning the receiver to 1/2 or 1/3 of the indicated frequency. Harmonics of a signal are multiples (not submultiples) of the true frequency.

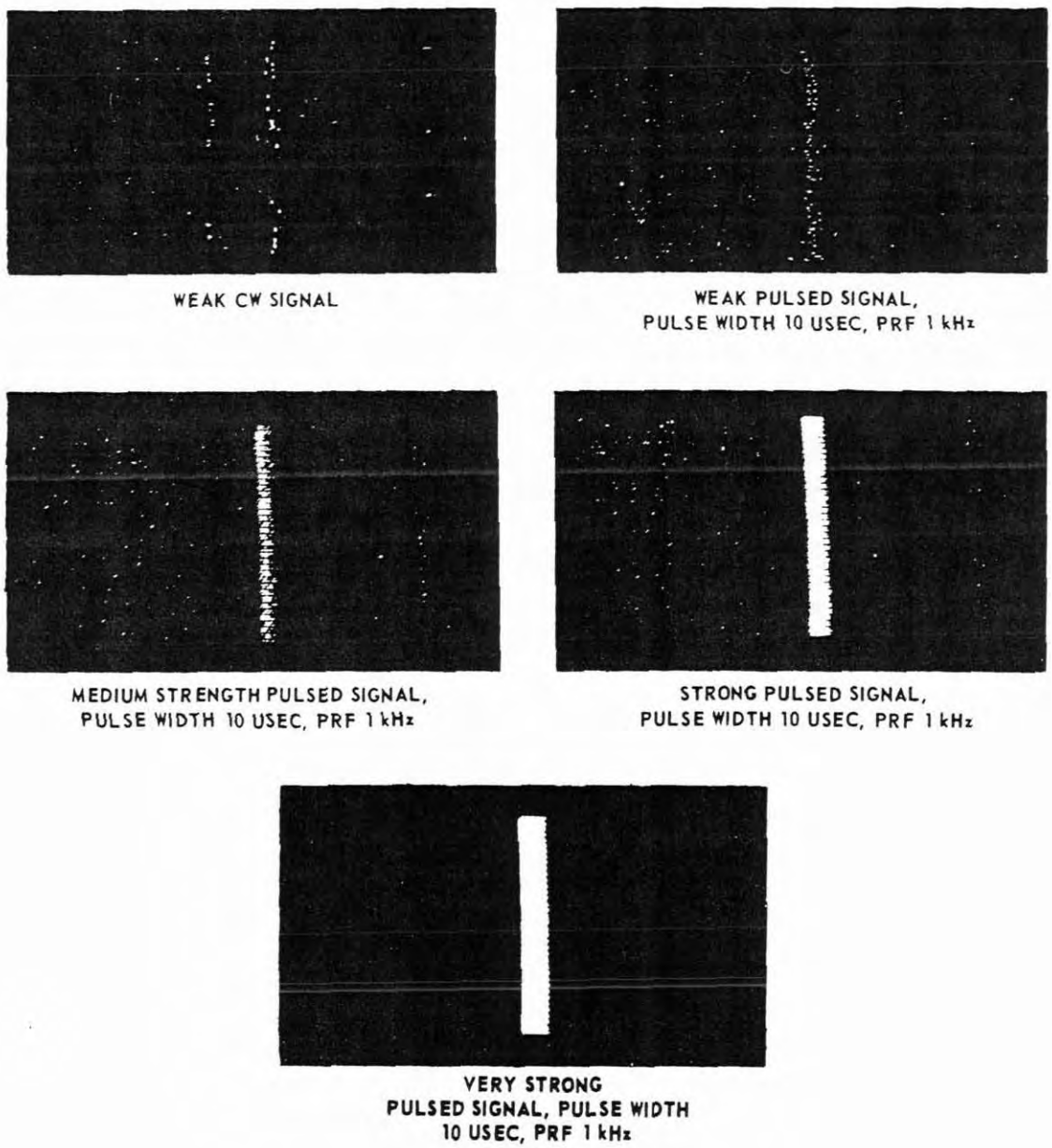

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Figure 3-6.—Acquisition scope presentations.

During analysis, the operator uses headphones to supplement the visual presentation. (The audio monitoring of a signal is essential to ESM operations as it can provide rapid indication of the presence of a possible threat signal, such as fire control, missile guidance, or terminal homing emitters.)

The front of the analysis scope (IP-480) may contain a time display or pulse width/pulse repetition frequency display. The time display comprises five sweeps (refer to figure 3-8).

The top three traces provide a display which permits electronic analysis of the intercepted signal. They may be used to determine pulse

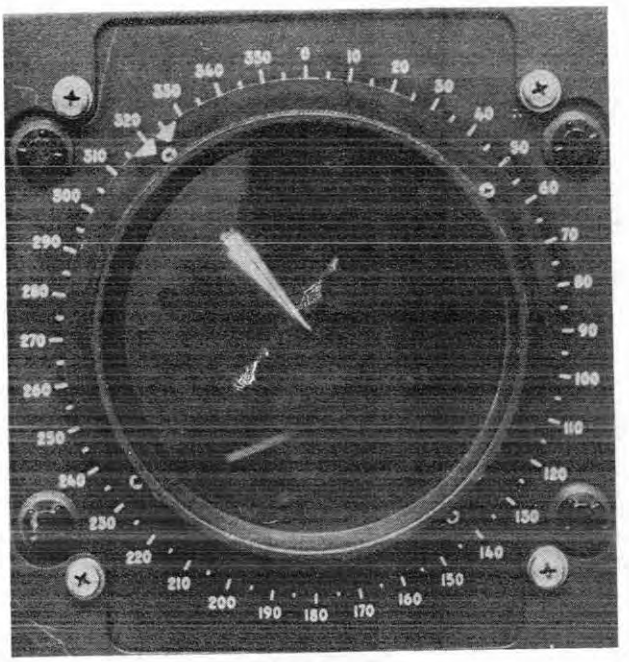

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Figure 3-7.—Direction finding display.

width (PW), pulse repetition frequency (PRF), pulse period, and scan characteristics. The shorter time base traces are used to expand the pulse as much as possible to permit accurate shape and width determination; the longer time base traces are used to present more than one pulse within a trace, permitting accurate determination of PRF by measuring the time between pulses. The upper 1 1/2 sweeps on this display are calibrated and scaled to read pulse widths from 0 to 50 microseconds. When reading the display, pulse width is determined by observing the trailing edge of the initial pulse.

The next 1 1/2 sweeps are calibrated and scaled to read PRF from 20-20,000 pulses per second (pps). PRFs greater than 20,000 may be obtained by calculating the reciprocal of the pulse period ($\frac{1}{PP}$) and, conversely, an unusually high PW could be read from the PRF traces by calculating the reciprocal of the measurement read on the PRF scale ($\frac{1}{PRF}$). When reading the PW/PRF display, the pulse repetition frequency is determined by observing the next pulse following the initial pulse.

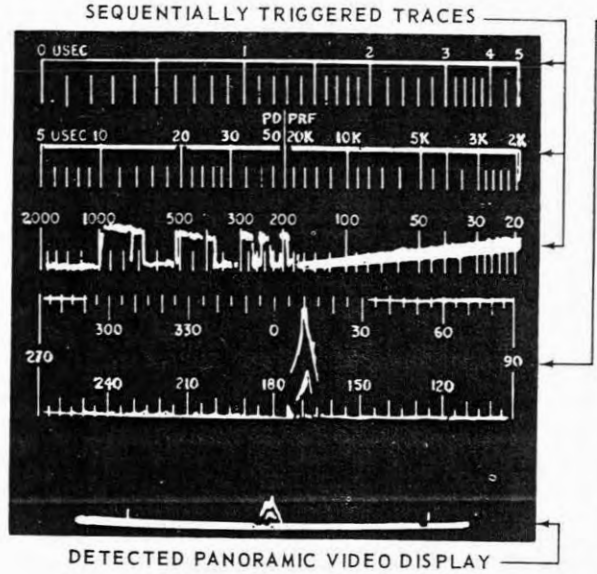
Traces 4 and 5 of the analysis display provide the DF display when the polar display is not integrated into the WLR-1. The electron beam on this sweep is synchronized with the antenna rotation. The beam traces out a rectangular path as the antenna rotates. A received signal will cause a deflection of the beam at a point corresponding to the bearing of the signal. Measurement accuracy of the DF display is $\pm 3^{\circ}$.

The bottom trace is the panoramic display which provides a visual presentation of the signal. In addition to determining whether or not the signal is at a true frequency, we can also observe signal modulation. The bandwidth of the sweep is determined by the tuner selected. This bandwidth is centered about the tuned frequency. Modulation displays are also illustrated in figure 3-8 (bottom trace).

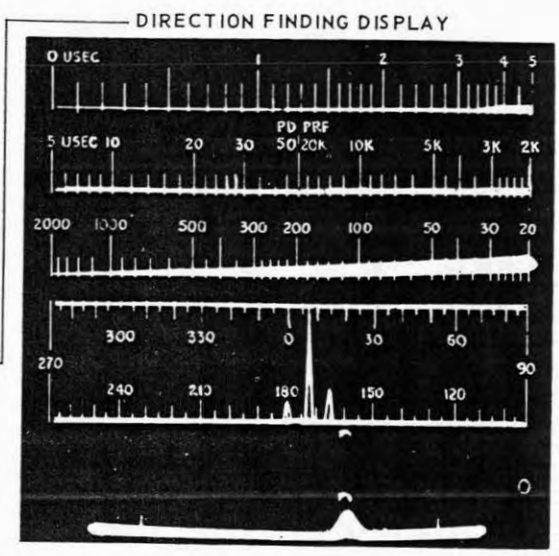
Once a signal has been observed and analyzed, the ESM operator may resume automatic search by switching to the acquisition mode of operation. If for any reason the operator might want to check an intercepted signal, the AN/WLR-1 has the capability to store up to ten tuner frequency settings. To accomplish this, the operator has merely to press one of ten storage buttons while still in the analysis mode. Remember, this action does not store a signal, but a reference position on one of nine band tuners. Then, to return to that frequency position, the operator selects the proper band and depresses the associated storage button. The tuner will automatically return to the stored frequency position. If the emitter is still radiating, the signal will be observed on the analysis traces.

Operator Controls

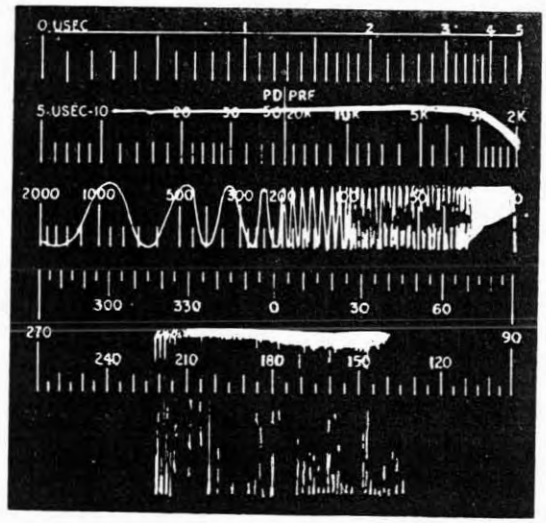
The operator controls for the AN/WLR-1 receiving system are located on three units; Azimuth Indicator-Pulse Analyzer IP-480 (Figure 3-9), Control Storer C-2697 (Figure 3-10), and C-3118/WLR Antenna Control Unit (Figure 3-11). The function of each of these controls is given in Tables 3-2, 3-3, and 3-4.



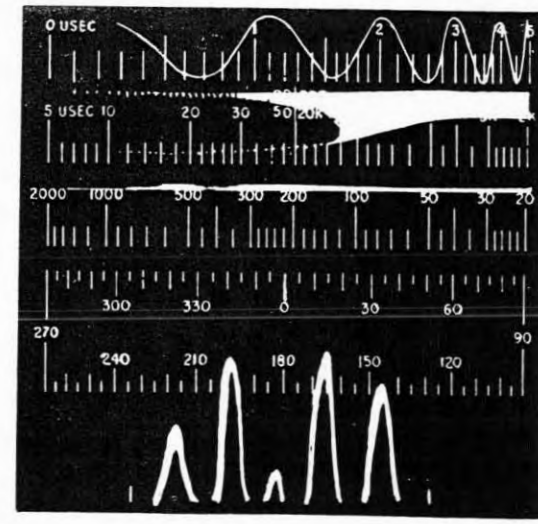
DF DISPLAY, 1 kHz
SQUARE WAVE, ANTENNA SPEED 300 RPM,
BEARING 170 DEGREES



DF DISPLAY,
CW SIGNAL, ANTENNA SPEED 40 RPM,
BEARING 170 DEGREES



FM SIGNAL, SINE WAVE
DEVIATION 6 MHz PEAK TO PEAK,
MODULATION FREQUENCY 1 kHz



FM SIGNAL, SINE WAVE
DEVIATION 6 MHz PEAK TO PEAK,
MODULATION FREQUENCY 1 MHz

32.2.1

Figure 3-8.—Analysis indicator presentations.

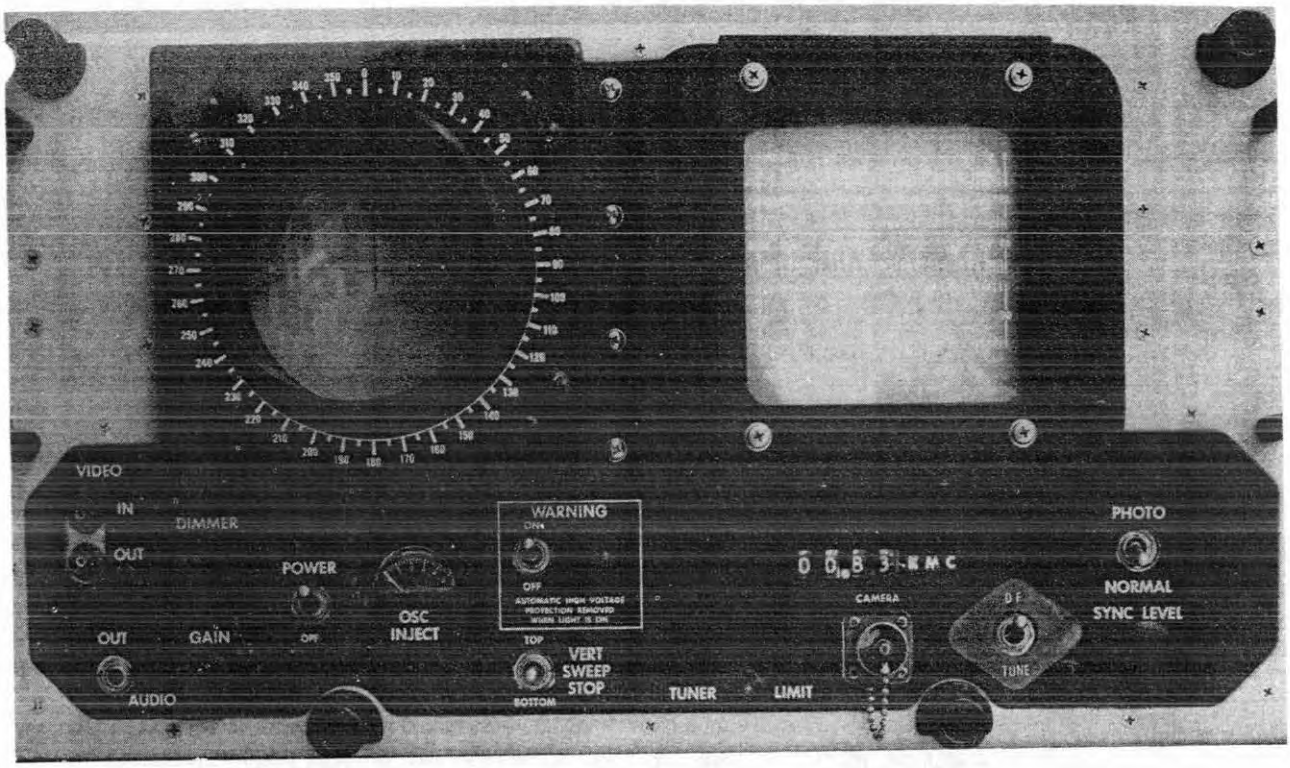


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Figure 3-9.—IP-480 Azimuth Indicator/Pulse Analyzer Unit.

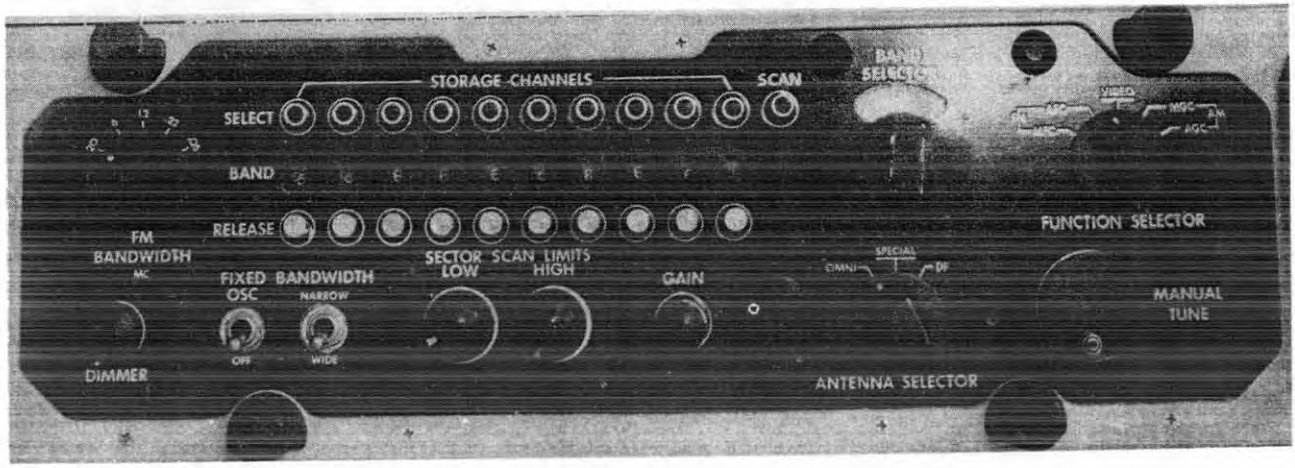

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Figure 3-10.—C-2697 control storer unit.

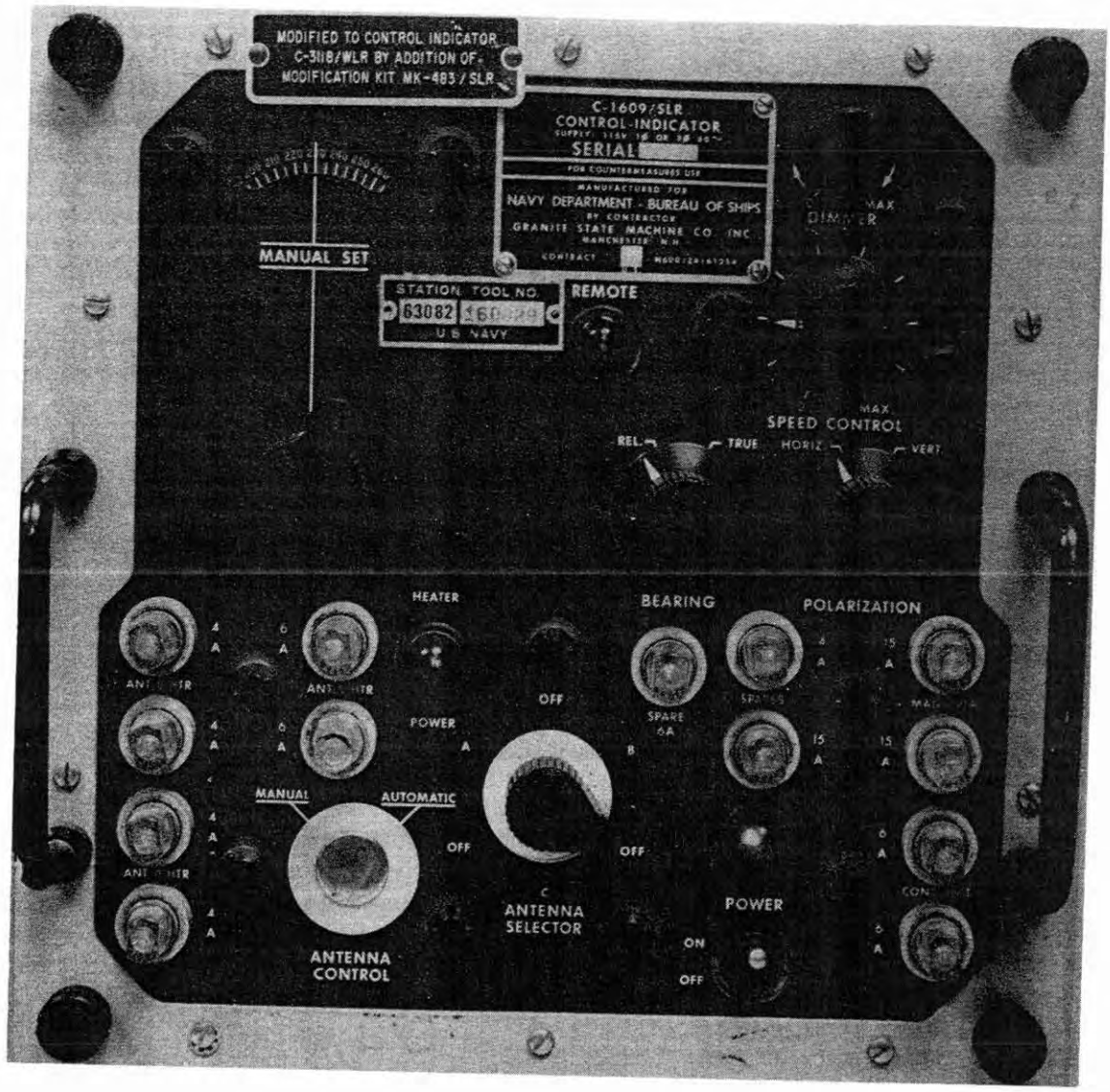

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Figure 3-11.—C-3118/WLR antenna control unit.

Table 3-2.—IP-480 Controls and Functions

CONTROL FUNCTIONS

CONTROL	FUNCTION
AZIMUTH INDICATOR-PULSE ANALYZER IP-480	
POWER Switch	Controls primary power to equipment except for the ANTENNA CONTROL unit.

Table 3-2.–IP-480 Controls and Functions–Continued

CONTROL FUNCTIONS

CONTROL	FUNCTION
AZIMUTH INDICATOR-PULSE ANALYZER IP-480	
WARNING Switch	ON-OFF Switch which disables the interlock safety feature when in the ON position which permits normal high voltage to be applied to the circuits when pulled away from their racks or bays. OPERATORS SHOULD LEAVE THE WARNING SWITCH IN THE OFF POSITION.
AUDIO GAIN Control	Controls the audio level output to the headset independent of the receiver gain.
DIMMER Control	Controls the illumination of the front panel.
VERTICAL SWEEP STOP Switch	A spring-loaded toggle switch that positions the sweep at the top or bottom of the acquisition scope. This switch is used for calibration of the acquisition scope.
DF Switch	NORM position is used for normal DF operation.
	OVRD position allows the operator to monitor tuner position in the frequency spectrum by removing the DF presentation during the analysis mode of operation.
	NB OFF position (narrow Band OFF) position provides momentary removal of interference along with any CW indication from the DF display.
PHOTO-NORMAL Switch	PHOTO position brightens the intensity of the panoramic display.
SYNC LEVEL Control	Controls the level of signal which will trigger analysis sweeps when in analysis operation. It stabilizes the pulse width and pulse Repetition frequency sweep for accurate measurement.

Table 3-3.–C-2697 Controls and Functions

CONTROL FUNCTIONS

CONTROL-STORER C-2697

CONTROL	FUNCTION
SECTOR SCAN LIMITS CONTROL	Controls the low and high frequency scanning limits of a particular band during search operation. These controls permit the operator to scan an entire band or certain portions thereof. The SECTOR SCAN LIMIT LOW determines the low frequency limit of the tuner and the SECTOR SCAN LIMIT HIGH controls the high frequency limit of the tuner.

Table 3-3.—C-2697 Controls and Functions—Continued

CONTROL FUNCTIONS

CONTROL-STORER C-2697

CONTROL	FUNCTION
SCAN Pushbutton Switch	Places the receiver in automatic acquisition mode (automatically scans the selected band.)
BAND SELECTOR Switch	Selects any one of the nine frequency bands.
STORAGE CHANNEL SELECT pushbuttons	Ten pushbuttons which engage the SCAN pushbutton and place the WLR-1 in the analysis mode. It enables manual tuning of the selected band and electronic location storage of the signal, thus giving you the ability to return to that position later if the button has not been depressed and manually tuned to another location, providing the signal is still radiating. BAND indicator lamp is illuminated when a frequency setting is being stored. Ten separate frequencies may be stored.
RELEASE pushbuttons	Ten pushbuttons which must be depressed in order to clear a channel of any stored frequency. When the RELEASE pushbutton is depressed, the SELECT pushbutton light is extinguished and the band indicator returns to the number of the band indicated by the BAND SELECTOR switch.
MANUAL TUNE KNOB	Allows for manually tuning a selected tuner after one of the storage buttons is selected and depressed.
ANTENNA SELECTOR Switch	A three position switch which selects the type of antenna to be used. OMNI position receives equally well in all directions. SPECIAL makes use of a specific type of antenna. DF POSITION connects DF antenna to proper tuners.
DIMMER Control	Controls front panel illumination.
FIXED OSC Switch	Energizes fixed oscillator. Used as aid in accurately tuning signal to center of both wide and narrow band pass.
FM BANDWIDTH MC Switch	A five-position switch used with reception of FM signals. Bandwidths of 20MHz, 6MHz, 1.2MHz, 0.23MHz, and 0.05MHz can be selected.

Table 3-3.—C-2697 Controls and Functions—Continued

CONTROL FUNCTIONS	
CONTROL-STORER C-2697	
CONTROL	FUNCTION
BANDWIDTH NARROW/WIDE Switch	Two position toggle switch used to select either NARROW BAND or WIDE BAND video. This switch is used to separate closely spaced frequencies by narrowing bandwidth displayed on the panoramic trace. When the NARROW-BAND position is selected, the system has greater selectivity enabling the operator to differentiate between signals close together in frequency.
FUNCTIONAL SELECTOR Switch	Five position switch used to select desired operation of the system. FM MFC position selects FM video signal with MANUAL FREQUENCY CONTROL (MFC). This position does not allow compensation for signal drift. FM MFC position is used when the noise level is very high. FM-AFC position selects video signals with AUTOMATIC FREQUENCY CONTROL (AFC). This position allows for compensation for signal drift. VIDEO position is used for normal operations and provides a "stretched" aural response for short duration pulses. AM MGC position disables the AUTOMATIC GAIN CONTROL and allows manual control of the receiver gain for AM signals. AM AGC position provides automatic gain control which produces a nearly constant signal level even when the received AM signal strength varies.
GAIN CONTROL	During analysis mode, the GAIN controls the GAIN of IF stages when the FUNCTIONAL switch is in VIDEO or AM MGC position and controls the video output when the FUNCTIONAL SELECTOR switch is in either FM MFC or FM AFC position. When in the SCAN (acquisition) mode, it controls the gain of the mixer amplifier, and RF tuner regardless of the FUNCTION selector setting. The GAIN control is disabled during AM AGC operation.

Table 3-4.--C-3118 Controls and Functions

CONTROL FUNCTIONS	
CONTROL	FUNCTION
C-3118 ANTENNA CONTROL UNIT	
POWER ON-OFF Switch	Lights the POWER indicator and applies power to the DF antennas and C-3118 unit.

Table 3-4.—C-3118 Controls and Functions—Continued

CONTROL FUNCTIONS	
CONTROL	FUNCTION
C-3118 ANTENNA CONTROL UNIT	
DIMMER control	Adjusts the intensity of the front panel lighting on the control indicator.
ANTENNA SELECTOR Switch	Three position switch used to select a desired DF antenna. A position is for operation in band 4. B position is for operation in bands 5 and 6. C position is for operation in bands 6 through 9.
POLARIZATION Switch	Allows the operator to determine the signal polarization in bands 5 through 9.
BEARING Switch	Enables the operator to display either Relative (ship's heading) or True (true north) on the MANUAL SET bearing dial and the bearing trace of the IP-480.
MANUAL SET knob and dial	Provides for manual turning of the antenna and display of the bearing of the antenna.
ANTENNA control	Allows for MANUAL or AUTOMATIC rotation of the antenna.
ANTENNA SPEED control	Allows for varying the speed of the antenna rotation.

Operating Procedures

The AN/WLR-1 operating procedures are as follows:

STARTING PROCEDURES.–

Step 1. Set the operator controls as follows:

PHOTO-NORMAL Switch	NORMAL
BANDWIDTH Switch	WIDE
FIXED OSC Switch	OFF

Step 1. (Cont.)

FUNCTION SELECTOR Switch	VIDEO
DF Switch	NORM
LOW SECTOR SCAN LIMIT	FULLY COUNTERCLOCKWISE
HIGH SECTOR SCAN LIMIT	FULLY CLOCKWISE
ANTENNA SELECTOR Switch	OMNI

Step 2. Connect headphones to AUDIO OUTPUT JACK

Step 3. Set the POWER switch to POWER position (allow 60 seconds for warm up.)

SCAN OPERATION.–Perform the following steps for scan operation (acquisition):

Step 1. Set the IP-480 ANTENNA SELECTOR switch to the OMNI position, if an omni-directional antenna is available for the desired band. The DF position can be used during scan operation with reduced signal intercept probability. If the DF antenna is used, set the switch for a high rotational rate of the DF antenna.

Step 2. Depress the SCAN pushbutton switch.

Step 3. Select the desired frequency band by positioning the BAND SELECTOR switch.

Step 4. Adjust the GAIN control so that random noise is visible on the scan indicator. Adjust the AUDIO GAIN control until the noise can be heard in the headphones.

Step 5. Adjust the SECTOR SCAN LIMIT control until the TUNER LIMIT indicator lamp lights at the same moment the acquisition indicator sweep is at the extreme limits; then, while the system is scanning, adjust the SECTOR SCAN LIMIT control until the indicator lamp is extinguished. Adjust the LOW control for left scan limit and the HIGH control for right scan limit. If only a portion of the band is of interest, the SECTOR SCAN LIMIT controls may be adjusted to reduce the frequency range scanned by the RF tuner, allowing a higher probability of intercept within the reduced sector range.

CAUTION: THE PHOSPHOR OF THE ACQUISITION INDICATOR MAY BE DAMAGED IF THE GAIN CONTROL IS SET TOO HIGH WHILE OPERATING WITH A REDUCED SECTOR SCAN.

Step 6. Observe the acquisition indicator for the presence of a signal intercept. Intercepted signals appear as a vertical row of intensified dots. See figure 3-6 for various acquisition indicator presentations.

ANALYSIS OPERATION.–After intercepting a signal, analysis is performed to determine the signal characteristics.

Intercepted Signal Frequency.–To determine the frequency of the intercepted signal, perform the following steps:

Step 1. Depress one of the 10 SELECT pushbutton switches and hold the DF switch in OVRD position.

Step 2. Rotate the GAIN control clockwise, if necessary, until dot is visible on the scan indicator.

Step 3. Adjust the MANUAL TUNE control until dot returns to the vertical row of intensified dots on the scan indicator.

NOTE: Intermitted received signals will appear as a vertical series of intensified dots only so long as the signal is being transmitted. If a signal is received near the bottom of the scan raster, and the sweep has returned to the top of the raster before the analysis operation is started, the VERT SWEEP STOP switch may be used as an aid in manually tuning to the signal position. Hold the switch in the BOTTOM position while tuning for the signal. The switch may be released after the tuning operation is completed.

Step 4. Release the DF switch, allowing it to return to the NORM position.

Step 5. Center the signal by observing the panoramic display on the analysis indicator while adjusting the MANUAL TUNE control. When the signal is centered on the panoramic display, the frequency is shown on the frequency indicator. The frequency indicator operates only when the equipment is in the analysis mode of operation. When the FIXED OSC switch is in the ON position, the trace will "bloom" on a modulated signal when at the exact frequency.

Step 6. If more than one signal is present on the panoramic display, they may be separated by setting the BANDWIDTH switch to NARROW. In NARROW operation, tuning becomes more critical and the fidelity of the pulse analysis display is decreased; however, the frequency can now be more accurately determined.

Signal Type.—The signal type is determined by observing the panoramic and the pulse analysis displays. Adjust the SYNC LEVEL control to obtain a stable signal presentation, or noise display, on the pulse analysis sweeps. (It may be necessary to adjust the GAIN control for optimum presentation.) If a signal is present on the panoramic sweep, but not on the pulse analysis sweeps, the signal is CW or FM. Pulsed or AM signals appear on the panoramic sweep as a spectrum of pulses. The modulation of a pulsed or other amplitude modulated signal also appears on the analysis sweeps when the FUNCTION SELECTOR switch is in the VIDEO position. If the received signal is voice amplitude modulated, set the FUNCTION SELECTOR switch to AM AGC or AM MGC. In the AM position, the pulse "stretching" applied to the audio output is disabled and the voice modulation may be heard undistorted. In the AM AGC position, automatic gain control is in operation and produces a nearly constant signal level even when the received signal strength varies. In the AM MGC position, manual gain control of the receiver is achieved with the GAIN control. If no signal appears on the pulse analysis display, observe the signal presentation on the panoramic sweep. A frequency modulated signal will appear as a spectrum of pulses across the panoramic sweep. Signals with small deviations produce a narrow spectrum, and large deviations produce a broad spectrum. Very small deviations appear similar to a CW presentation. The deviation can be estimated by observing the portion of the panoramic sweep covered by the spectrum. The sweep covers 5 MHz on bands 1, 2, and 3; 10 MHz on bands 4 and 5; and 20 MHz on bands 6 through 9. Set the FM BANDWIDTH switch to 20 MC and adjust the SYNC LEVEL control until the signal appears on the analysis sweeps. If the signal appears on the analysis sweeps, it is an FM signal. If the signal does not appear, switch the FM BANDWIDTH switch through all position If no signal appears, the signal is CW. If the signal is determined to be an FM signal, locate the optimum setting of FM BANDWIDTH switch by operating the FM BANDWIDTH switch from the 20 MC position through the 0.05 MC position with the GAIN control set to minimum (fully counterclockwise). If the FM signal covers most of the length of the panoramic sweep, then the FM BANDWIDTH switch should be set to one of the narrow positions. The vertical deflection of the analysis sweep signal is used to determine the peak-to-peak frequency deviation. To measure the deviation, rotate the GAIN control fully counterclockwise. This is a calibrated setting which produces a one inch deflection for signals deviating the full bandwidth of each FM BANDWIDTH position. When the FM BANDWIDTH switch is in the 20 MC position, for example, a vertical deflection of one inch indicates a frequency deviation of approximately 20 MC peak-to-peak with the GAIN control in its fully clockwise position. If the signal deflection is one half inch, the signal is deviating approximately 10 MC. Fo optimum observation of the signal displayed on the analysis sweeps, adjust the GAIN control for about one inch of vertical deflection after the frequency deviation is obtained. One fifth the maximum deviation can be observed on any bandwidth by setting the GAIN control to maximum (fully clockwise). This permits overlapping of the FM BANDWIDTH positions. The frequency indicator shows the center frequency of the panoramic trace spectrum. The FUNCTION SELECTOR switch should be in the FM AFC position at all times, except when interference is objectionable. The AFC is not available on 20 MC and 6 MC bandwidths, but leaving the FUNCTION SELECTOR switch in the FM AFC position does not interfere with operation. Manual tuning of the signal is maintained by the MANUAL TUNE control. Pulse "stretching" in the audio output is removed in either FM position on 0.23 MC and 0.05 MC FM bandwidths. This permits voice modulation FM signals to be heard undistorted.

Direction Finding.–The direction finding steps are as follows:

Step 1. Set the ANTENNA SELECTOR switch to the DF position and set the DF antenna for automatic operation.

Step 2. Rotate the cursor on the acquisition indicator until it is lined up with the center of the DF display. Read the bearing from the calibrated scale on the bearing indicator plate. If the signal is amplitude modulated at a very high pulse repetition rate, spikes may appear in the DF display. These spikes may cause difficulty in reading the bearing of the intercepted signal. The spikes can be removed, if desired, by holding the DF switch in the NB OFF position. With the DF switch in the NB OFF position, CW signals are also removed from the acquisition display.

Step 3. Acquisition video may be observed by setting the DF switch to the OVRD position. A dot will appear on the acquisition display. Manual tuning at the C-2697 permits searching for a received signal which will appear as an intensified dot.

Signal Storage

The frequency of the intercepted signal is stored when the SELECTOR pushbutton switch is depressed and the equipment is tuned to the intercepted signal. When the equipment is returned to scan operation, by depressing the SCAN pushbutton switch, the frequency remains stored. At any future time, the equipment may be returned to the stored frequency by resetting the BAND SELECTOR switch to the position indicated by the BAND indicator and depressing the respective SELECTOR pushbutton switch. If the frequency of the intercepted signal has shifted, it may be returned with the MANUAL TUNE control. The band on which the signal is stored is identified by the BAND indicator dial directly below the SELECTOR pushbutton switch. When a storage channel is in use, the BAND indicator dial is illuminated. Any storage channel will store a signal from any frequency band. To clear any storage channel of a stored signal, the RELEASE pushbutton switch must be depressed.

Return To Scan

After analyzing a signal, the system may be returned to the scanning condition by depressing the SCAN pushbutton switch. The GAIN control should not have to be readjusted when returning to scan unless a different band is selected. The FUNCTION SELECTOR switch controls the type of operation only when analyzing. In the scanning condition, the system operates in the VIDEO function, regardless of the setting of the FUNCTION SELECTOR switch.

Camera Operation

The AN/WLR-1 system is designed to accommodate an Oscilloscope Recording Camera KD-2. When taking instantaneous exposures, set the PHOTO-NORMAL switch to NORMAL. When taking a time exposure with the shutter held open while waiting for an intermittent signal to appear, set the PHOTO-NORMAL switch to PHOTO and adjust the GAIN control to only the level needed to allow peaks of noise to show on the panoramic sweep.

Turning Off Equipment

The only operation necessary for turning off the equipment is to set the POWER switch to the OFF position.

R-1051/URR RECEIVER

The R-1051/URR (Figure 3-12) is a versatile superheterodyne receiver capable of receiving Amplitude Keyed Carrier methods, Amplitude Modulated Carrier methods, and Frequency Modulated Carrier methods in the 2 to 30

Megahertz frequency range. Its compactness makes it readily available for installation in afloat, airborne, and ashore units. In U.S. Navy communication applications, it is primarily used as an independent receiver or as a transmitter-receiver combination.

The R-1051/URR uses a digital tuning scheme with an additional fine tuning control which provides continuous tuning between two 1 kHz increments, (e.g., tuning to a frequency of 11200.5 kHz). This receiver uses printed circuit boards and is completely transistorized, except for the RF amplifier tubes. The RF signal output is triple-converted to a 500 kHz IF output.

We will now discuss each of the Front panel controls and indicators located on the R-1051/URR receiver. As you proceed, refer to figure 3-13 to locate each of the controls/indicators discussed.

Controls/Indicators

LSB PHONE JACK.—Used to connect a headset to the lower sideband receiver output.

USB PHONE JACK.—Used to connect a headset to the upper sideband receiver output.

FUSE (with indicator).—There are two. Ea is used to protect the receiver against curren overload. The indicator lamp will glow when the fuse is OPEN, indicating the presence of high current.

LSB LINE LEVEL CONTROL.—Used to adjust the volume of audio input to remote equipment during LSB and ISB (INDEPENDENT SIDEBAND) operation.

LSB LINE LEVEL SWITCH.—Selects the range for LSB LINE LEVEL meter. When in the ØDB position, reading of the LSB LINE LEVEL meter is taken directly. When in the +2ØDB position, 2Ødb is added to the indication of the LSB LINE LEVEL meter.

LSB LINE LEVEL METER.—Indicates the level of the audio supplied to the LSB remote lines.

RF GAIN control.—This variable control is used to adjust the gain of the RF and IF amplifiers.

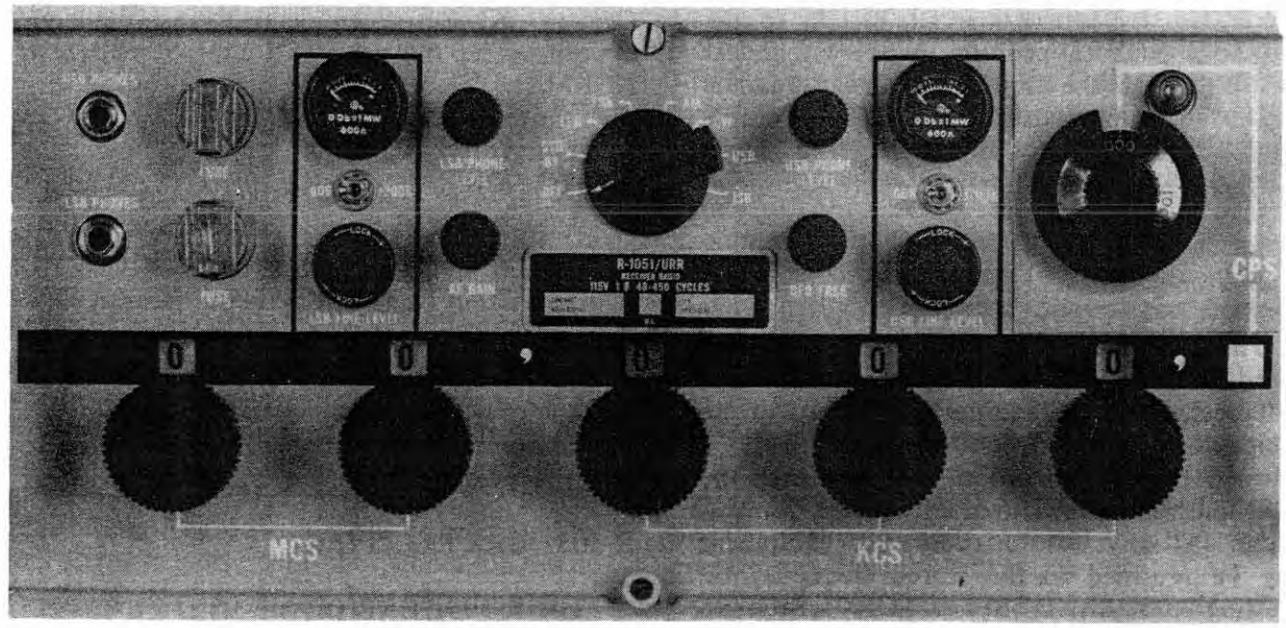

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Figure 3-12.—R-1051/URR receiver.

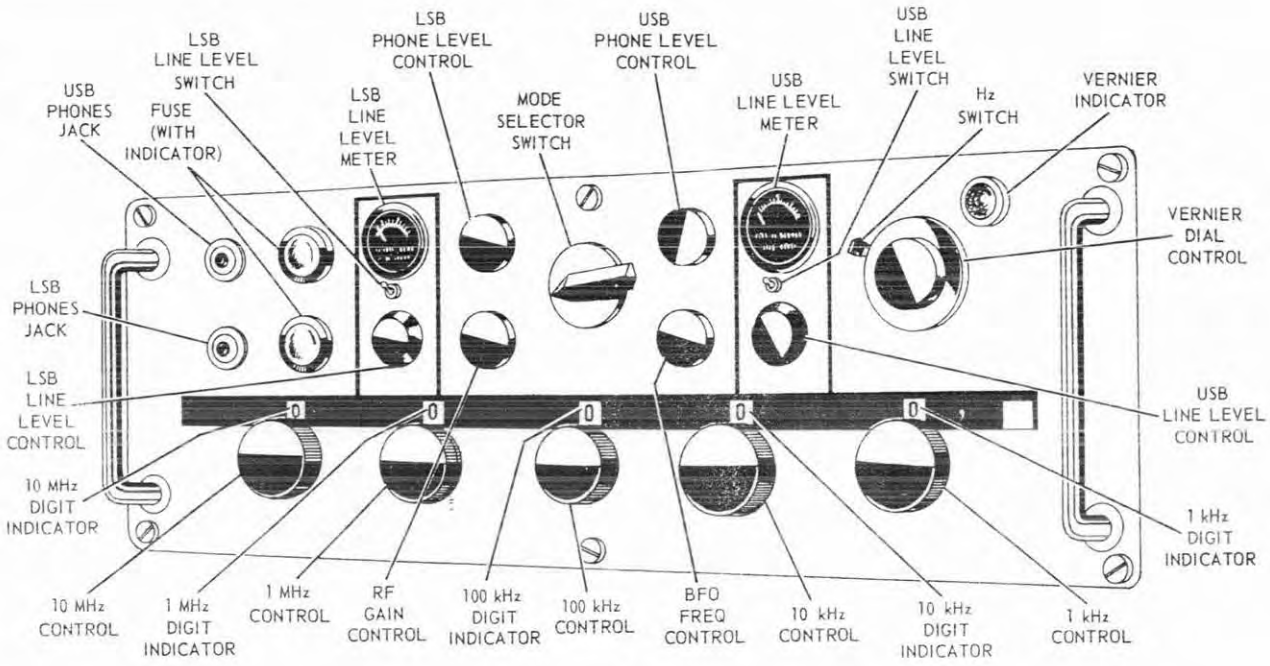

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Figure 3-13.–R-1051/URR operating controls and indicators.

LSB PHONE LEVEL control.–Used to .djust the volume of audio applied to a headphone in LSB and ISB operation.

MODE SELECTOR SWITCH.–This 8-position switch allows selection of the receiver mode of operation as follows:

OFF.–No power is applied to the unit.

STD BY.–Energizes the frequency standard and tube filaments.

LSB.–Receiver operation in lower sideband mode only.

FSK.–Receiver operation in the FSK mode only.

AM.–Receiver operation in the AM mode only.

CW.–Receiver operation in the CW mode only.

USB.–Receiver operation in the upper sideband mode only.

ISB.–Receiver operation in the independent sideband mode only.

BFO FREQ CONTROL.–This variable control is used to adjust the pitch of the audio output tone above and below 500 kHz for CW and FSK signals.

USB PHONE LEVEL CONTROL.–This variable control is used to adjust the volume of the audio applied to the headset in USB operation.

USB LINE LEVEL CONTROL.–This variable control is used to adjust the volume of audio input to remote equipment during USB operation.

USB LINE LEVEL SWITCH.–This switch selects the range of USB LINE LEVEL meter identical to the LSB LINE LEVEL switch.

USB LINE LEVEL METER.–This meter indicates the level of the audio applied to the USB remote lines.

CPS SWITCH.–This switch increases the receiver tuning capabilities. It provides the following capabilities:

000.–In this position, the receiver is tuned to a frequency indicated by the MCS and KCS digit indicators. In effect, the CPS switch is out of the circuitry.

500.–In this position, the receiver is tuned 500 Hz above the frequency indicated by the MCS and KCS digit indicators.

Vernier.–In this position, the receiver may be tuned continuously (with the VERNIER control) between any two 1 kHz steps.

VERNIER CONTROL.–This variable control is used in conjunction with the CPS switch to provide continuous tuning between any two 1 kHz increments.

VERNIER INDICATOR.–This indicator flashes to indicate that the CPS switch is in the VERNIER position.

10MHz CONTROL.–This control selects the 10MHz digit of the desired operating frequency. The digit selected will be displayed in the window immediately above the control.

1MHz CONTROL.–This control selects the 1MHz digit of the desired operating frequency. The digit selected will be displayed in the window immediately above the control.

100kHz CONTROL.–This control selects the 100kHz digit of the desired operating frequency. The digit selected will be displayed in the window immediately above the control.

10kHz CONTROL.–This control selects the 10kHz digit of the desired operating frequency. The digit selected will be displayed in the window immediately above the control.

1kHz CONTROL.–This control selects the 1kHz digit of the desired operating frequency. The digit selected will be displayed in the window immediately above the control.

Frequency Tuning

A frequency of 18.375 MHz would be dialed/tuned on the R-1051/URR receiver turning the front panel controls of the frequency selection knob as follows:

10MHz CONTROL.–Turn either clockwise or counterclockwise until a "1" appears in the window immediately above the control.

1MHz CONTROL.–Turn either clockwise or counterclockwise until a "8" appears in the window immediately above the control.

100kHz CONTROL.–Turn either clockwise or counterclockwise until a "3" appears in the window immediately above the control.

10kHz CONTROL.–Turn either clockwise or counterclockwise until a "7" appears in the window immediately above the control.

1kHz CONTROL.–Turn either clockwise or counterclockwise until a "5" appears in the window immediately above the control.

Operating Procedures

The following is a suggested step-by-step procedure for preparing the R-1051/URR for the reception of radio signals.

1. Set the MODE selector switch to the STD BY position. This should be completed prior to operation, in sufficient time to allow the frequency standard to come up to the proper operating temperature for stability. Allow a 20-minute warm-up for general operation. A 60-minute warm-up is required for optimum frequency stability.
2. Set the MODE selector switch to the desired mode of operation.
3. Using the MCS, KCS, CPS, and VERNIER controls/switches, select the desired operating frequency. Remember, the frequency selected will be displayed in the small windows above the controls/switches.
4. Depending upon the mode of operation, connect the headset to the USB PHONE JACK or the LSB PHONE JACK.

5. Rotate the RF GAIN control fully clockwise. When the strength of the received signal is extremely high, better reception may be achieved by varying the RF GAIN control to reduce the gain. This will desensitize the receiver. Whenever operating channels or frequencies are changed, rotate the RF GAIN control fully clockwise again.

6. Adjust the LSB/USB LINE LEVEL controls or the LSB/USB PHONE LEVEL control, depending upon the mode in use.

7. When CW is being received, adjust the BFO FREQ control to vary the pitch of the received signal.

8. When receiving from a transmitter that is not tuned to the exact same frequency as the R-1051, use the VERNIER control to tune-in the received signal.

9. When an FSK ancillary equipment has only a 2550 Hz center frequency, a special tuning procedure is required in order to receive FSK transmissions using a 2000 Hz center frequency. This procedure is as follows:

a. If FSK transmissions are on the LSB channel, tune the receiver 550 cycles above the frequency selected with the MCS and KCS controls using the VERNIER control.

b. If the FSK transmissions are in the USB channel, set the 1kHz control down one digit from the assigned frequency and use the VERNIER control to tune the receiver 450 Hz above the new frequency.

R-1513 HF RECEIVER

The R-1513 HF receiver (figure 3-14) is a British designed and built general purpose receiver made to provide a high order of selectivity and stability. The receiver covers a

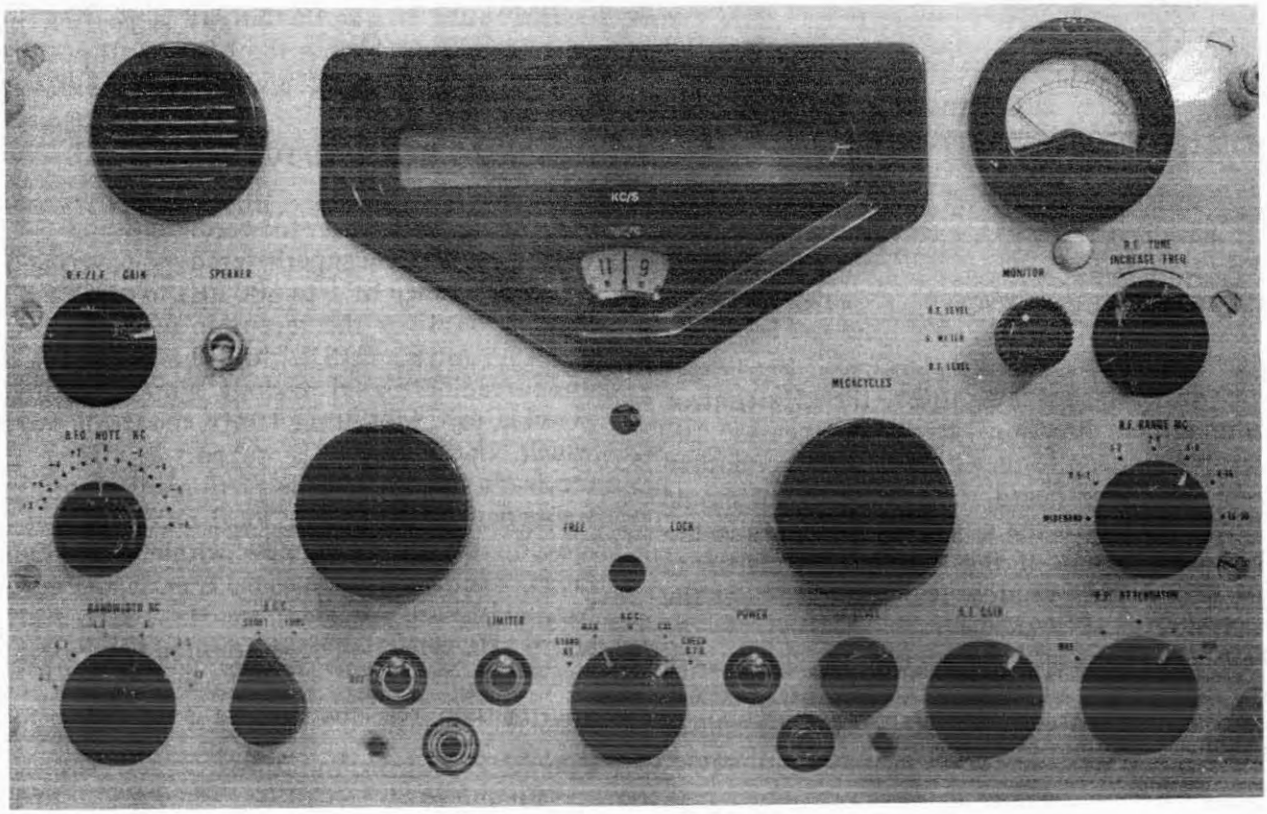

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Figure 3-14.—R-1513 receiver.

frequency range of 1 to 30.0 MHz and is used primarily for receiving CW, AM, and FM signals. It is used in Control Screener Positions for HFDF tip-offs at most Naval Security Group field sites.

Operating Controls, Indicators, and Functions

The front panel controls (table 3-5) are described in the order in which they are used for setting-up prior to operational use. (Refer to figure 3-14.)

Calibration Procedure

When calibrating the R-1513 receiver, the receiver controls should be set as follows:

RF RANGE MC/S switch	desired frequency band
RF ATTENUATER	minimum
AF GAIN	mid-position
SYSTEM switch	calibrate
LIMITER	off
BFO switch	on
BANDWIDTH	3 KC
RF/IF GAIN	three-quarters of fully clockwise
MEGACYCLES/KILOCYCLES	nearest 100 kHz of desired frequency

The next step is to rotate the kHz control, from either direction, across the nearest 100 kHz position. A tone, a null, and then another tone should be heard. The kHz control should then be tuned to the null position, which is the calibration point. If the vertical kHz marker in the kHz display window is not aligned over the nearest 100 kHz position on the dial, simply slide the marker horizontally until it is so positioned. Set the SYSTEM switch to CHECK BFO and adjust the BFO NOTE KC control to zero-beat. The R-1513 receiver is now calibrated.

Tuning Procedure

The first step in tuning the R-1513 is selecting the RF RANGE MC/S switch position according to the frequency of interest. For example, the frequency 12,125 kHz would require the selection of the 8-16 MHz range. Next, rotate the MHz control to select the M band. In the example just given, the MHz dial would be set to 12. In order to properly position the MHz dial, the MHz control must be rotated back and forth to determine the point of highest noise level. The MHz dial should then be positioned at the point of highest noise level. This position might be slightly above or below the numeral 12 on the dial. (Each individual receiver has its own characteristics in this respect and the characteristics of any receiver are best learned through practical experience.) After the MHz band has been selected, rotate the kHz control to select the desired kHz dial setting. Caution must be exercised when rotating the kHz dial. If it is turned past the STOP at either end of the dial, the tape could break resulting in lengthy and expensive repairs. Set the BANDWIDTH to 3 KC/S and rotate the RF TUNE until the audio output is peaked. For voice reception, switch the BFO to off position, and, if necessary, select a wider bandwidth.

R-1401A/G VLF RECEIVER

The R-1401A/G VLF receiver (figure 3 is an all-solid state superheterodyne covering the frequency range of 1 to 600 kHz in one band. It may be used for the reception of AM (CW and MCW), SSB, DSB, or FM signals. A direct-reading digital readout is used, making it possible to read, within 10 Hz, the frequency to which the receiver is tuned. By using the receiver's DAFC circuit (digital automatic frequency control), the local oscillator can be locked to any frequency within the tuning range, whether or not a signal is present. Four IF bandwidths are provided: 150 Hz, 1 kHz, 3 kHz, and 6 kHz. Selection of the desired bandwidth is done by means of a front-panel switch. The intermediate frequency output is 2 MHz.

Operating Controls, Indicators, and Functions

The use of the front-panel operating controls is explained below in Table 3-6. These controls are shown in Figure 3-15.

Table 3-5.–*R-1513 Controls and Functions*

CONTROL/INDICATOR FUNCTION

CONTROL/INDICATOR	FUNCTION
	R-1513 FRONT PANEL CONTROLS
POWER	Makes and breaks the power supply to the main transformer.
RF RANGE MC/S	This control enables the input selection of any one of five antenna ranges plus a WIDEBAND position which can be used for any frequency setting. The five antenna ranges are as follows: 0.5-1 1-2 2-4 4-8 8-16 16-30
RF ATTENUATOR	This control enables the operator to reduce the level of all incoming signals when strong unwanted signals are present.
MEGACYCLES	This control selects the desired MHz frequency. This dial should be checked periodically to ensure that it is center tuned with respect to the band in use.
,YSTEM	This function switch provides for STANDBY, MANUAL (manual gain control), AGC (AVC), CALIBRATION, and CHECK BFO.
BANDWIDTH	This control allows for the selection of one of six IF bandwidth settings: 100 C/S 300 C/S 1-2 KC/S 3 KC/S 5-6 KC/S 13 KC/S
AF GAIN	This control adjusts the audio level of the speaker and headset outputs.
KILOCYCLES	Selects the desired kHz frequency. This frequency scale can be calibrated at each 100kHz interval.
BFO ON/OFF switch	Turns the BFO on or off.
BFO NOTE KC	Varies the frequency of the BFO $\pm$ 8 kHz when the BFO is in the ON position.

Table 3-5.—R-1513 Controls and Functions—Continued

CONTROL/INDICATOR FUNCTION	
CONTROL/INDICATOR	FUNCTION
R-1513 FRONT PANEL CONTROLS	
RF TUNE	Allows for fine tuning to increase the receiver's sensitivity.
RF/IF GAIN	This control is operative when the SYSTEM functional switch is in the MANUAL or AGC position. The GAIN setting should be at a minimum position consistent with satisfactory AF level when the MANUAL function is being used, the RF/IF gain control should be set at maximum with a possible exception of CW signals.
AGC (AVC) SHORT LONG	This control is operative when the SYSTEM functional switch is in the AGC (AVC) position. LONG - when receiving voice signals. SHORT - when receiving FSK signals.
AF LEVEL	Controls the line gain used for associated equipment. This control is NOT affected by the AF GAIN control.
LIMITER	Used to reduce signal interference.
"S" METER	Indicates the RF and AF level when the meter switch is in the RF and AF position. The "S" METER position is used for meter calibration.
SPEAKER	The loudspeaker may be switched ON or OFF as required The headset audio output is NOT affected by this control.

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Figure 3-15.—R-1401A/G VLF receiver.

Table 3-6.–R-1401A/G Controls and Functions

CONTROL/INDICATOR FUNCTION

CONTROL/INDICATOR	FUNCTION
R-1401A/G OPERATING CONTROL AND FUNCTION	
MAIN TUNING control	Permits coarse tuning of the receiver
FINE TUNING control	Permits small adjustments to the receiver's tuning
INPUT ATTENUATOR switch	Used to prevent overdriving the receiver on strong signals
IF BANDWIDTH switch	Selects one of the receiver's four IF bandwidths: 150 Hz, 1 kHz, 3 kHz, and 6 kHz. The position to be used depends on the type of signal to be received.
AUDIO BANDWIDTH switch	Two position switch which affects the audio output both from the front-panel PHONES jack and the balanced 600-ohm output. NORMAL - Used during search operaton NARROW - Used for narrow frequency shift signals
AUDIO GAIN control	Varies the audio output only at the PHONES jack
BFO SELECTOR switch	Six position switch used to select any one of the five internal beat frequency oscillators: OFF - BFO is NOT activated ZERO - Used to zero beat the incoming signal and measuring the frequency of an incoming signal VAR - BFO note varies from 0 to 7 kHz 5.5 - BFO note of 5.5 kHz only USB - Used to demodulate single sideband signals. 3kHz IF bandwidth must be used in this position LSB - Used to demodulate single sideband signals. 3kHz IF bandwidth must be used in this position
BFO FREQUENCY control	Used to vary the BFO note between 0 to 7 kHz when the BFO SELECTOR switch is in the VARIABLE position
IF GAIN control	Varies the receiver's IF gain when any of the BFO's are operating

Table 3-6.—R-1401A/G Controls and Functions—Continued

CONTROL/INDICATOR FUNCTION	
CONTROL/INDICATOR	FUNCTION
R-1401A/G OPERATING CONTROL AND FUNCTION	
AGC control	Activates the automatic gain control. This position can be used only when the BFO SELECTOR switch is in the OFF position.
NOISE CANCELLER THRESHOLD control	Variable control used for noise suppression
MODE switch	This switch determines the scaling factor of the frequency display and sets the receiver for digital automatic frequency control (DAFC) operation, when desired. NORMAL DISPLAY - The last digit of the display indicates the tuned frequency within 100 Hz. TUNE is used when tuning to a desired frequency. DAFC locks the receiver to a desired frequency within 100 Hz. DECIMAL SHIFT - Shifts the decimal point one place to the left so that the last digit indicates the tuned frequency within 10 Hz. If the receiver is tuned to 100 kHz or higher, in the DECIMAL SHIFT mode, the initial digit of the frequency disappears and must be mentally added. TUNE is used when tuning to a desired frequency. DAFC DECIMAL SHIFT switch locks the receiver to a desired frequency within 10 Hz.
DAFC LAST DIGIT switch	This switch functions when the MODE switch is in either of the DAFC positions. It sets the last digit of the frequency display and locks the receiver's local oscillator to this digit (0 to 9).

Operating Procedure

The MAIN TUNING control is used with the BFO SELECTOR switch in the ZERO position to tune to the desired frequency. (Finer tuning may be made by the FINE TUNING control.) When setting the receiver to a frequency in the DAFC mode, first tune as closely as possible to the frequency with the MODE switch in a TUNE position. Then place the MODE switch in a DAFC position and set the DAFC LAST DIGIT switch to the last digit of the desired frequency. If, when in the DAFC mode, the receiver is to be retuned to a new frequency of more than 0.5

kHz from the first frequency, place the MODE switch in a TUNE position and tune to the new equency. The position of the BFO SELECTOR switch is determined by the type of signal being received. A breakdown of signal types and the BFO SELECTOR switch setting follows:

DOUBLE SIDEBAND	OFF
ON-OFF KEYING (CW)	VAR
FREQUENCY SHIFT KEYING	5.5
SINGLE SIDEBAND	USB or LSB

When receiving double sideband signals, the IF BANDWIDTH switch should be set at 3 kHz, with the BFO selector switch in the OFF position. The 3 kHz IF setting should also be used when receiving single sideband. If noise is present, the NOISE CANCELLER THRESHOLD control may be used to suppress it. When the signal is too strong and the receiver is being overdriven, set the INPUT ATTENUATOR switch to -20, -40, or -60 dB, as appropriate.

R-1307A/GR RECEIVER

The R-1307A/GR receiver (figure 3-16) covers the frequency range of 3 kHz to 810 kHz in five bands and receives AM, CW, MCW, SSB, DSB, and FM signals. It is similar to the R-1274 SELECTIVE VOLT METER in that it can also be used to measure discreet signal levels.

Operating Controls, Indicators, and Functions

The front-panel operating controls and their functions are discussed in Table 3-7 below.

Calibration Procedure

Calibration of the R-1307A/GR is performed for the purpose of setting the voltage

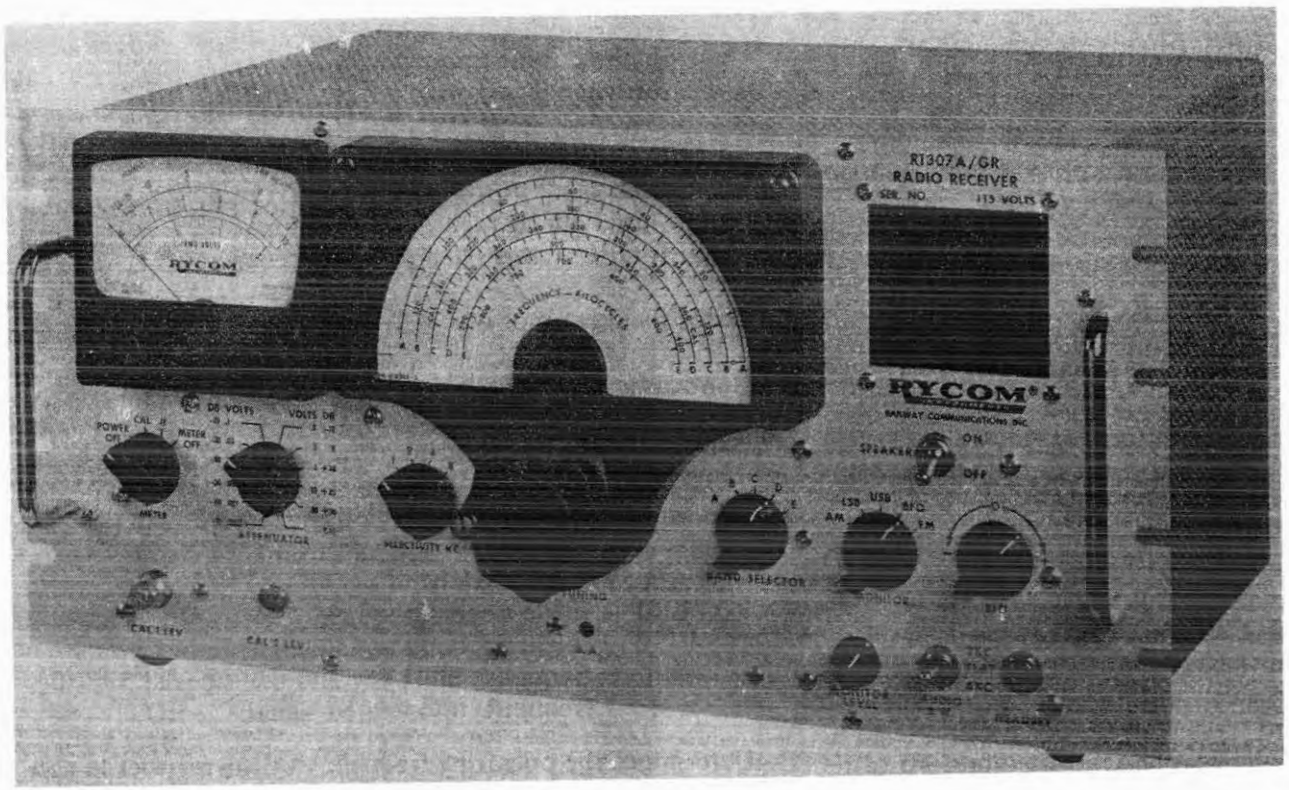

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Figure 3-16.—R-1307A/GR receiver.

Table 3-7.—R-1307A/GR Controls and Functions

CONTROL/INDICATOR FUNCTION

CONTROL/INDICATOR	FUNCTION
R-1307A/GR FRONT PANEL CONTROLS AND FUNCTION	
AUDIO B.W.	Three position switch, 2 KC, 6 KC, or FLAT which controls the audio frequency output.
ATTENUATOR	Controls signal input level to receiver in 10 db steps. CAL position is used for receiver calibration.
BAND SELECTOR	Selects one of the five bands used in conjunction with the TUNING to determine the operating frequency of the receiver. A - 3 to 120 kHz B - 110 to 250 kHz C - 240 to 410 kHz D - 390 to 590 kHz E - 570 to 810 kHz
BFO	Controls the output frequency of the beat frequency oscillator when it is in use
METER	METER OFF - meter is turned off IF - meter reads average output of IF amplifier CAL - used during receiver calibration POWER OFF - turns a.c. power to receiver off
SPEAKER	Turns speaker on or off
MONITOR LEVEL	Controls audio gain for speaker and headsets
SELECTIVITY KC	Determines the IF passband of receiver; 1, 2, 4, or 8 KC
MONITOR	Determines the type of detection the receiver will perform AM - double sideband signal LSB - single sideband signal USB - single sideband signal BFO - frequency shift key and CW signals FM - frequency modulated signal
TUNING	Determines the operating frequency of the receiver in conjunction with the BAND SELECTOR, e.g., the frequency 320 kHz would be selected by selecting BAND C and tuning the frequency indicator to 320.
HEADSET	Provides audio output for headsets

meter and checking the frequency calibration. The voltage meter is calibrated at 250 KC. Frequency calibration can be performed at every 250 KC and "0" frequency on band A. The receiver should be calibrated at least once a day.

PRELIMINARY SETTINGS.–Set the receiver controls listed below to their designated position.

METER switch	CAL
ATTENUATOR	CAL
SELECTIVITY KC	1
BAND SELECTOR	B or C
MONITOR	BFO
BFO	0
MONITOR LEVEL	desired level
SPEAKER	ON
AUDIO B.W.	FLAT

PROCEDURE.–Adjust the TUNING at CAL (250 KC) until the voltage meter reads maximum. Further TUNING adjustment may be necessary to ensure that the calibration signal is approximately center tuned. Adjust the BFO until the audio output indicates a "zero beat" (the BFO knob should be set at the "0" reading on the panel. If not, notify maintenance to align the knob to "0"). The frequency may also be calibrated on other bands at "0" (band A), 500 KC (band D), and 750 KC (band E).

Level and Frequency Measurements

The receiver may be used to measure frequencies and level of discreet signals spaced more than 1.5 kHz apart.

PRELIMINARY SETTINGS.–Set the controls listed below to their designated position.

METER switch	IF
SELECTIVITY KC	1
MONITOR	AM
SPEAKER	ON
MONITOR LEVEL	desired level
AUDIO B.W.	FLAT

PROCEDURE.–Set the ATTENUATOR to the lowest level signal to be measured. Adjust the TUNING and BAND SELECTOR until the meter is deflected. Adjust the TUNING for maximum meter indication while increasing attenuation (by using the ATTENUATOR). Final adjustment should give a presentation of between +2 dB and -8 dB on the dB meter scale. The level of the tuned signal is determined by the algebraic sum of the meter indication and the ATTENUATOR setting. The frequency is determined by the TUNING pointer and BAND SELECTOR. If the audio output is noise, the signal is a single frequency and does not have amplitude modulation under 500 CPS. Higher modulation frequencies can be checked by using a wider selectivity. FM can be checked by using the FM monitor position.

Operating Procedure

The operating procedure for the R-1307A/GR will depend upon the type of signal being received. Each procedure will now be discussed.

AM (Double Sideband or Modulated Carrier Wave).–The controls should be set as follows:

METER switch	IF
MONITOR	BFO
SPEAKER	ON
MONITOR LEVEL	desired level
AUDIO B.W.	6 KC
BFO	0

(1) Set the SELECTIVITY KC to the desired bandwidth or 8 KC. Set the ATTENUATOR to the approximate level of the signal to be demodulated or to the noise base of the spectrum. Set the BAND SELECTOR to the appropriate frequency range.

(2) Adjust the TUNING to the frequency to be demodulated. Simultaneously increase attenuation by turning the ATTENUATOR clockwise until a maximum scale reading is reached. This maximum should read between -8 db and +2 dB on the dB meter.

(3) Listen to the audio output and zero beat the carrier with the BFO. Switch the MONITOR to AM. If the signal frequency is narrow, the selectivity and audio bandwidth may be decreased.

SSB (Single Sideband).—The procedures for receiving either upper or lower sideband are identical, except that the MONITOR switch will be placed in either the USB or LSB position. The controls should be set as follows for the SSB:

METER switch	IF
MONITOR	LSB or USB
SPEAKER	ON
MONITOR LEVEL	desired level
SELECTIVITY KC	4
AUDIO B.W.	6 KC

(1) Set the ATTENUATOR at the approximate level of the signal to be demodulated or at the noise base of the spectrum. Set the BAND SELECTOR to the appropriate frequency range. Adjust the TUNING to the frequency to be demodulated. Simultaneously increase attenuation by turning the ATTENUATOR clockwise and adjust the TUNING until a maximum scale meter reading is reached.

(2) Listen to the audio output, adjusting the TUNING for the best signal result. Upper sideband will give the best results when the TUNING is set to the lower frequency edge of the channel being demodulated. Lower sideband will have best results when the TUNING is set to the upper frequency edge of the channel being demodulated.

CW (Carrier Wave).—For CW signals, set the receiver controls as follows:

METER switch	IF
MONITOR	BFO
SPEAKER	ON
MONITOR LEVEL	desired level
SELECTIVITY KC	1
AUDIO B.W.	2 KC
BFO	0

(1) Set the ATTENUATOR at the approximate level of the signal to be demodulated or at the noise base of the spectrum. Set the BAND SELECTOR at the appropriate frequency range and adjust the TUNING to the frequency to be demodulated. Simultaneously increase attenuation by turning the ATTENUATOR clockwise until a maximum scale meter reading is reached. Zero beat the signal with the BFO control. The maximum reading should be between -8 db and +2 db on the db meter. (NOTE: The meter will be pulsating.)

(2) Adjust the BFO for the best audio result.

FM (Frequency Modulation).—For FM signals, set the receiver controls as follows:

METER switch	IF
MONITOR	FM
SPEAKER	ON
MONITOR LEVEL	desired level
SELECTIVITY KC	8

(1) Set the ATTENUATOR at the approximate level of signal to be demodulated or at the noise base of the spectrum. Set the BAND SELECTOR at the appropriate frequency range and adjust the TUNING to the frequency to be demodulated. Simultaneously increase the attenuation by turning the ATTENUATOR clockwise until a maximum scale meter reading is reached. The maximum should read between -8 db and +2 db on the db meter. Turn the ATTENUATOR CCW one position.

(2) Re-adjust the TUNING for the best output.

FSK (Frequency Shift Keying).—Set the receiver controls as follows for FSK signals:

METER switch	IF
MONITOR	BFO
SPEAKER	ON
SELECTIVITY KC	2
MONITOR LEVEL	desired level
AUDIO B.W.	6 KC
BFO	0

(1) Set the ATTENUATOR at the approximate level of signal to be demodulated or at the noise base of the spectrum. Set the BAND SELECTOR at the appropriate frequency range and adjust the TUNING to the frequency to be demodulated. Simultaneously increase attenuation by turning the ATTENUATOR clockwise until a maximum reading on the scale

meter is reached. The maximum should read between -8 db and +2 db on the db meter. Turn the ATTENUATOR CCW one position.

(2) Adjust the TUNING until a nearly continuous tone is heard. The selectivity may be reduced, providing it does not affect the continuous tone.

(3) Adjust the BFO to obtain two audio output frequencies in the desired part of the audio spectrum.