

MANUAL NO. 41398-2

CSB100TR
COMMUNICATIONS
TRANSMITTER RECEIVER
INSTRUCTION & SERVICE MANUAL

Serial No. _____

In order to receive the full unconditional 90-day warranty against defective material and workmanship in this unit, the warranty card must be filled out and mailed within two weeks of purchase.

Please refer to serial number of warranty in correspondence.

THE HAMMARLUND MANUFACTURING CO.
A Giannini Scientific Co.
53 West 23rd Street, New York 10, N. Y.
Export Department: 13 East 40th Street, New York 16, N. Y.

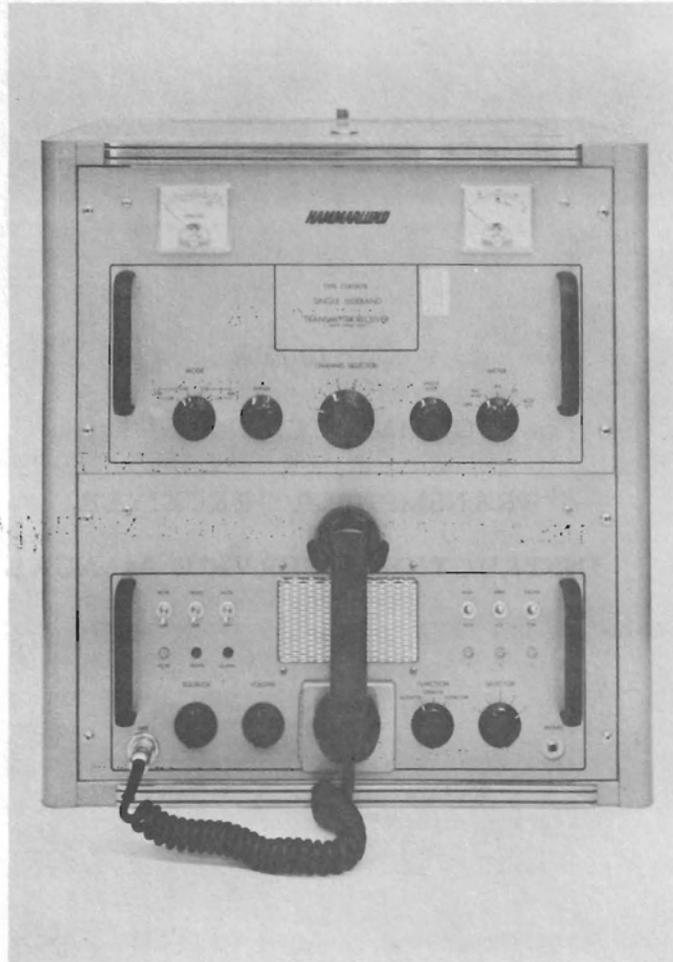


Figure 1. The Hammarlund CSB 100TR
Commercial Single Sideband Transmitter-Receiver

Please refer to serial number of warranty in correspondence.
and must be filed out and mailed within two weeks of purchase.
effective interest, and warranty which will, the warranty
in order to receive full benefit of 90-day warranty against

your department, 13 East 40th Street, New York 16, N. Y.
22 West 51st Street, New York 16, N. Y.
A General Scientific Co.,
THE HAMMARLUND MANUFACTURING CO.

SAFETY NOTICE

This equipment employs voltages which are dangerous and may be fatal if contacted by servicing personnel. Extreme caution should be exercised when working with the equipment.

THE HAMMARLUND MANUFACTURING COMPANY
STANDARD WARRANTY

The Hammarlund Manufacturing Company, warrants this equipment to be free from defects in workmanship and materials under normal and proper use and service for the uses and purposes for which it is designed, and agrees to repair or replace, without charge, all parts thereof showing such defects which are returned for inspection to the Company's factory, transportation prepaid, within a period of 90 days from date of delivery, provided such inspection discloses to the satisfaction of the Company that the defects are as claimed, and provided also, that the equipment has not been altered, repaired, subjected to misuse, negligence or accident, or damaged by lightning, excessive current or otherwise, or had its serial number or any part thereof altered, defaced, or removed. Tubes shall be deemed to be covered by the manufacturer's standard warranty applicable thereto, and such items shall be and are hereby excluded from the provisions of this warranty. Pilot lamps and fuses are not guaranteed for length of service.

Except as herein specifically provided, no warranty, express or implied, other than that of title, shall apply to any equipment sold hereunder. In no event shall the Company be liable for damages by reason of the failure of the equipment to function properly or for any consequential damages.

This Warranty is valid for the original owner of the equipment, and is contingent upon receipt of the Warranty Registration Card by the Company. No equipment shall be returned to the factory for repairs under warranty unless written authorization is obtained by the Company, and the equipment is shipped prepaid by the owner. The Company maintains Authorized Service Stations, names and locations of which will be sent upon request of the owner.

The Hammarlund Manufacturing Company
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53 West 23rd Street, New York 10, N. Y.
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The policy of the Hammarlund Manufacturing Company, is one of continued improvement in design and manufacture whenever and wherever possible, to provide the highest attainable quality and performance. Hence specifications, finishes, etc. are subject to change without notice and without assumption by Hammarlund of any obligation or responsibility to provide such features as may be changed, added or dropped from previous production runs of this equipment.

DO NOT MAKE ANY RETURNS WITHOUT AUTHORIZATION FROM EITHER NEW YORK OFFICE OR FACTORY. ALL AUTHORIZED RETURNS SHOULD BE SHIPPED TO FACTORY, HAMMARLUND MANUFACTURING CO., MARS HILL, NORTH CAROLINA. DO NOT SHIP TO NEW YORK OFFICE.

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TECHNICAL SUMMARY
TRANSMITTER SPECIFICATIONS

Operating Modes

- SSB - (A3A) Single sideband with suppressed carrier
- AM - (A3) Single sideband with reinserted carrier
- CW - (A1) Single sideband keyed tune

Frequency Range

- 6 Preset channels (standard ranges):
 - 1 Channel - 2 to 3 MC/S range
 - 2 Channels - 3 to 7 MC/S range
 - 2 Channels - 7 to 18 MC/S range
 - 1 Channel - 15 to 30 MC/S range

Temperature Range

-10°C to +55°C

Type of Operation

Simplex:

Push-To-Talk (PTT)

Voice Operated Keying (VOX)

Antenna Requirements

Recommend nominal 50 to 100 ohms impedance at feed point.

Internal loading coil permits matching to most random length radiators of not over 1/4 wave in length at the highest operating frequency.

Power Source

115/230V \pm 25% 50/60 CPS, single phase

350 watts maximum

Transmitter Power Output

CW/SSB - 100 watts PEP 2 to 15 MC

75 watts PEP 15 to 30 MC

AM - 25% of SSB PEP Valves

Frequency Stability

0.0002% Temperature controlled crystal ovens

Transmitter Distortion

Distortion products -35 DB (Two tone test)

Spurious radiated products - 60 DB below maximum power

Sideband suppression --50 DB minimum

Carrier suppression -40 DB minimum

Speech Band width

300 CPS to 2600 CPS \pm 3DB

RECEIVER SPECIFICATIONS**Sensitivity**

CW/SSB Better than 0.5 microvolts at S/N ratio of 10 DB

AM Better than 1.0 microvolt at S/N ratio of 10 DB

Selectivity

2.6 KC at 6 DB points

4.0 KC at 50 DB points

Frequency Stability

0.0002% Temperature controlled crystal ovens

IF Rejection

-60 DB Minimum

Image and Spurious Rejection

2 to 10 -60 DB Minimum

10 to 30 MC -40 DB Minimum

AGC

Within 6 DB for inputs of 10 to 100,000 Microvolts

Audio Out put

1.5 watts with less than 10% distortion

+ 10 dbm to 600 ohm line

MECHANICAL SPECIFICATIONS

EQUIPMENT

Size

22.75" H. x 22" W. x 19" H.

Weight

155# Net

DOMESTIC PACK

Size

26.25" H. x 26" W. x 24.5" D.

Weight

175# Gross

158# Legal

OPTIONAL ACCESSORIES AVAILABLE

Item

Remote Antenna Tuner

Selective Calling Encoder

Selective Receiving Decoder

Lower Sideband Crystal Filter

Remote Desk Set

Extended Remote Control

Monitor or Duplex Receiver

Teletype Adapters

SECTION I

GENERAL DESCRIPTION

1.1 SCOPE - This technical manual contains the theory of operation, instructions for installation, operation and maintenance of the CSB100TR transmitter-receiver hereafter referred to as the transceiver. The transceiver was designed and built by the Hammarlund Manufacturing Company, 53 West 23rd Street, New York City.

1.2 PURPOSE - The CSB100TR is a compatible SSB/AM transceiver designed to transmit and receive either single sideband (SSB), amplitude modulated (AM), or interrupted continuous wave (CW), on any one of six preset channels within a frequency range of 2 to 30 megacycles per second (MC/S). The normal distribution of channel selection versus frequency is as follows:

- 1 channel within the 2 to 3 MC/S range
- 2 channels within the 3 to 7 MC/S range
- 2 channels within the 7 to 18 MC/S range
- 1 channel within the 15 to 30 MC/S range

The transceiver was designed to be operated from a fixed site where a power source of either 115V or 230V, 50/60 CPS at a level of 350 watts (inductive load) is available. The transceiver has built-in circuitry which permits audible and visual signalling plus intercom functions between optional remote operating positions and the local position. A telephone line termination enables the CSB100TR to be remotely controlled over a telephone line up to 10 miles long. Push-to-talk or voice operated control of the transmitter is available by a selector switch on the front panel.

1.3 EQUIPMENT SUPPLIED -

- Transceiver
- AC test cable
- Multi conductor test cable
- Handset
- Instruction Manual

1.4 REQUIREMENTS FOR USE -

- Power Source - 115V or 230V, 50/60 CPS, single phase
- Antenna - Not over 1/4 wavelength long at highest operating frequency
- Antenna Connector - PL 259
- Ground Connection

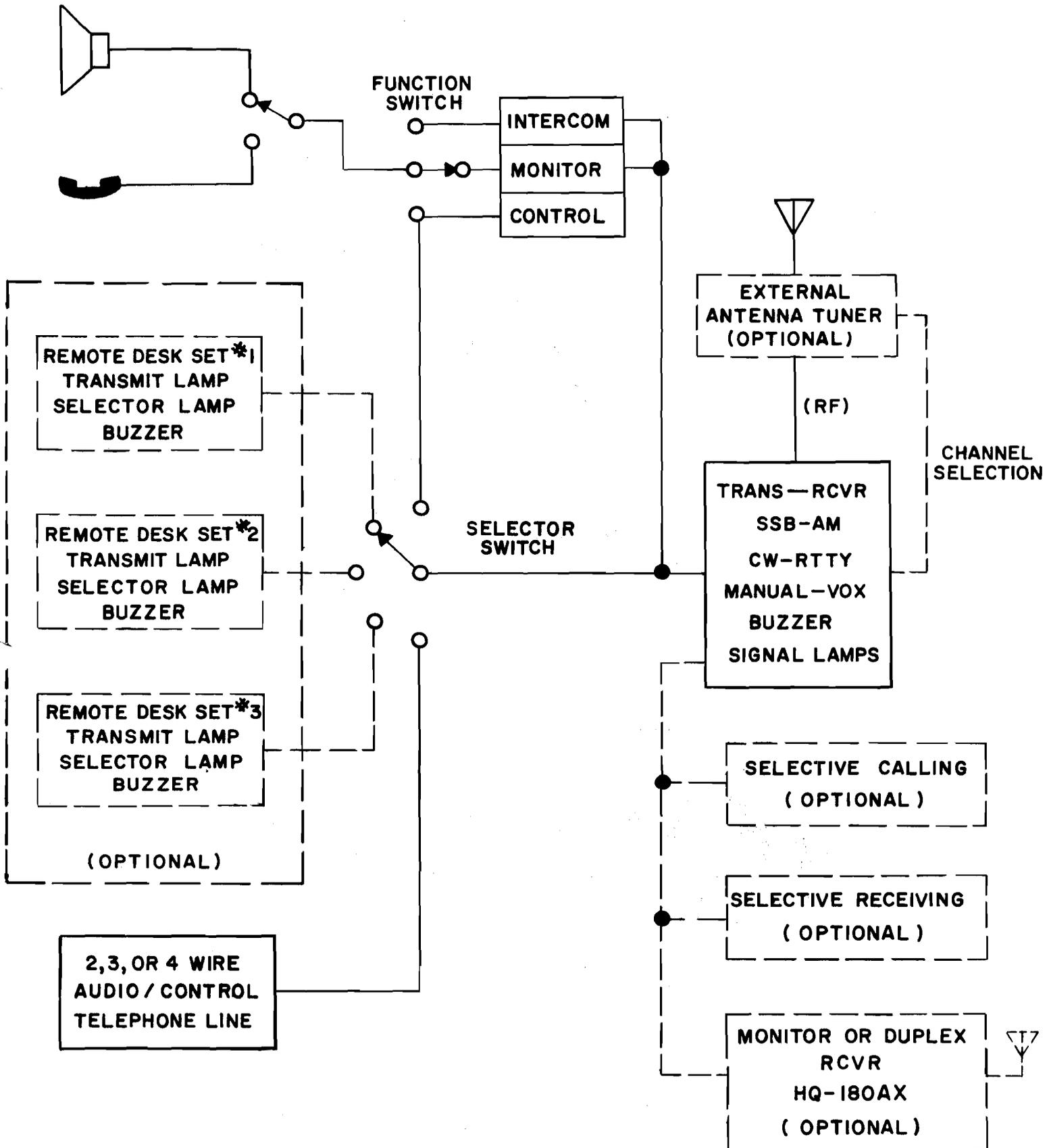
1.5 BRIEF DESCRIPTION OF EQUIPMENT - The CSB100TR transceiver is a self contained transmitter and receiver for operation on any one of six preset frequencies within the 2 to 30 MC/S range. The unit is of rack and panel construction and completely self-contained. It consists of two identical size chassis with interconnection wiring provided in the cabinet. The upper deck contains the R.F. portion of the transmitter and receiver and also that portion of the audio circuitry that is common to both transmit and receive. The lower deck contains the power supplies, audio output stages, VOX circuits and intercom, signalling and selection switches. Test cables supplied with the equipment permit ease of maintenance. The transmitter and receiver functions are shown in the systems Block Diagram, Fig. 2.

A crystal filter is utilized to eliminate the undesired sideband for both single sideband suppressed carrier and single sideband with reinserted carrier transmission and compatible reception. Ease of operation is assured by providing all operating controls and indicators on the front panel of the unit. Built-in circuitry permits signalling and intercom functions between up to three optional remote desk sets and the transmitter position. A telephone line termination enables the transceiver to be remotely controlled over a telephone line up to 10 miles in length by push-to-talk or voice operated control.

Other features include a compression amplifier, a squelch circuit to permit receiver muting during standby operation, an automatic impulse noise suppression IF limiter with 15 DB noise reduction for SSB; an audio noise limiter for AM, and selection of loudspeaker or earpiece audio at the transceiver location. Increased reliability and efficiency are insured by the exclusive use of silicon diodes rectifiers in the power supply.

1.6 ADVANTAGES OF SINGLE SIDEBAND SUPPRESSED CARRIER COMMUNICATIONS -

- (a) The radio frequency spectrum is more efficiently used due to the transmission of only the reduced carrier and one sideband, resulting in 1/2 the band width requirement of AM equipment.
- (b) The power required to transmit a single sideband signal is approximately one-eighth of the power required to transmit a conventional AM signal of equivalent effectiveness, making a 100 watt PEP single sideband signal equal in effectiveness to an 800 watt AM signal. In addition, transmission occurs only when modulation is present, greatly reducing the average power drain.
- (c) The narrow band width of single sideband provides not only an improvement in the signal to noise ratio, but also minimizes the possibility of interference.
- (d) A high degree of privacy is inherent for single sideband transmission since ordinary home-type shortwave receivers used in the reception of AM will not respond to single sideband.



BLOCK DIAGRAM
CSBIOOTR SYSTEM
FIGURE 2

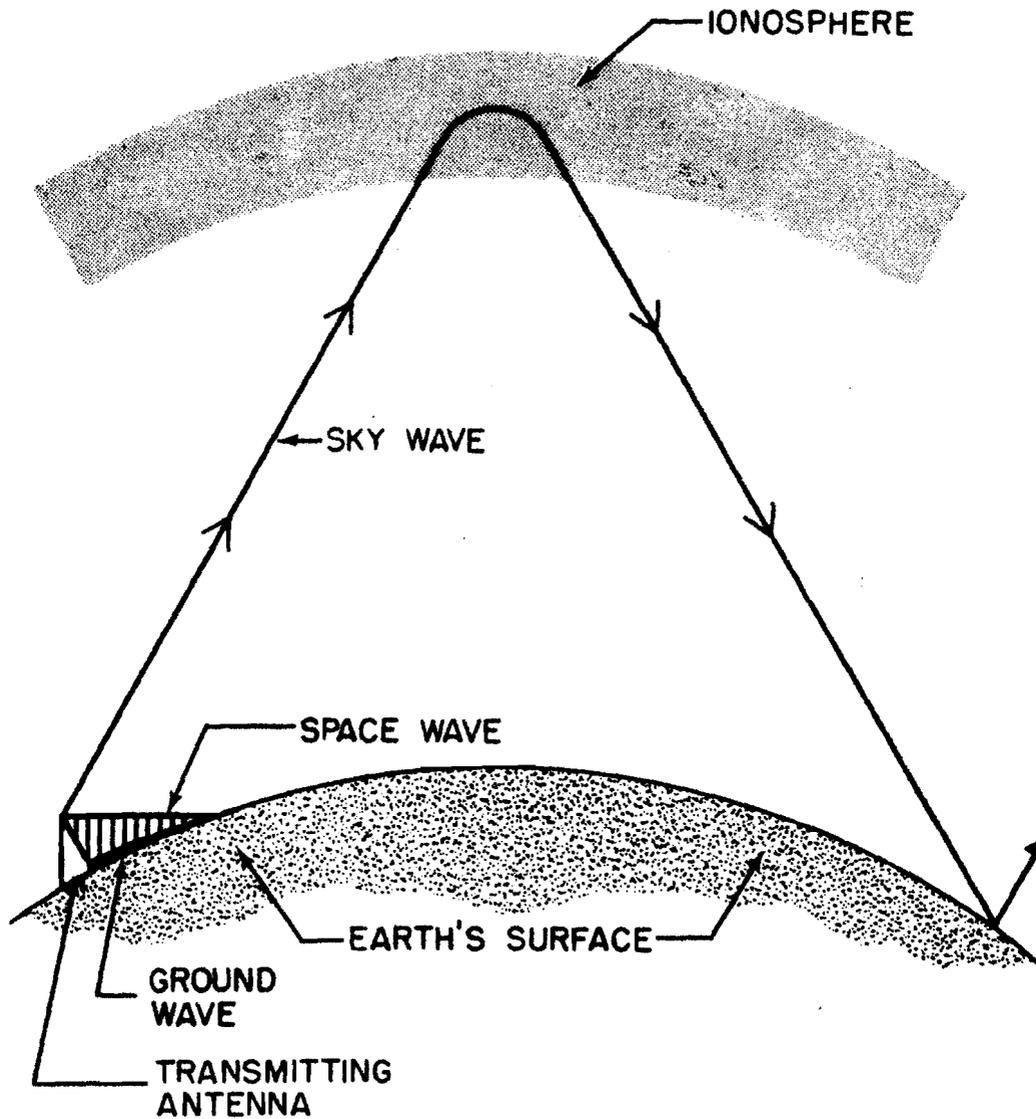


FIGURE 3: The components of a radio signal travel along the earth's surface (ground wave); through the troposphere (space wave), and into the ionosphere (sky wave). Diagram not drawn to scale.

1.7 SYSTEMS OPERATION - The versatility of the CSB100TR transmitter-receiver makes it usable in practically any SSB, AM, CW, or RTTY system. It is possible to switch from one mode of transmission and reception to another immediately by the use of the provided front panel controls. The transmitter can be used as an exciter for a linear power amplifier if higher power is desired. For maximum communications reliability, it is recommended that the following section on propagation be thoroughly studied.

1.8 HIGH-FREQUENCY RADIO PROPAGATION - One of the most fascinating aspects of Radio Communications is the radio wave and its relationship with the sky, earth and the sun of our solar system. For reliable communications it is necessary to take into consideration all factors effecting the radio wave in determining the desired operating frequency. A thorough analysis of the following paragraphs on propagation will insure maximum communications reliability when using the CSB100TR.

(a) **Modes of Propagation** When a radio wave, or signal leaves an antenna it propagates, or travels simultaneously along the ground and through the atmosphere. The component that travels in the lower atmosphere is called the **SPACE** or **TROPOSPHERIC WAVE**, and the component that travels upward into the earth's upper atmosphere is called the **SKY** or **IONOSPHERIC WAVE**. How far each component or the signal travels depends on many factors, such as the power of the transmitter, the transmission frequency, the type of terrain and the electrical characteristics of the earth's atmosphere. The various signal components are shown in Fig. 3.

In the **HIGH-FREQUENCY (HF.)** range of the radio spectrum (3 to 30 mcs), the ground and space wave components of the radio signal travel relatively short distances (generally not exceeding several dozen miles), and **CANNOT** be used for efficient long-distance communications. However, the sky wave component, which is radiated at oblique angles to the earth's surface, travels to very great distances. The CSB100TR transmitter-receiver is designed to provide long-distance HF. communications by means of the sky wave signal.

(b) **The Ionosphere:** In Fig. 3, the sky wave component of the radio signal is seen leaving the antenna at an oblique angle. The signal travels along a straight line in an upward direction until it reaches a region of electrified air beginning at approximately 30 miles. This region is called the **IONOSPHERE**, and extends to beyond 300 miles above the earth's surface.

The Ionosphere is formed primarily by ultraviolet and other radiation emitted by the sun. As this radiation sweeps through space, it causes rarefied gases which exist in the earth's upper atmosphere to become electrified in a physical process called **IONIZATION**. Ionization converts the air in the upper atmosphere into a partial electrical conductor, capable of "reflecting" HF. radio waves over great distances, in somewhat the same manner as a mirror reflects light.

There are several regions of pronounced ionization existing between approximately 30 and 300 miles above the earth. Each region, or layer, overlaps to some extent, forming a continuous but non-uniformly ionized area with at least four levels of peak intensity, designated D, E, F₁ and F₂.

The D layer is nearest the earth and is the least ionized. The E layer is next in height and degree of intensity, while the F₁ and F₂ layers are the highest and most intensely ionized regions of the ionosphere. Most long-distance HF. radio communications take place by means of the F layers, although at times reflection may also take place from the E layer. The structure of the ionosphere is depicted in Fig. 4.

- (c) **Sky Wave Propagation:** On entering the ionosphere, a radio wave imparts electromagnetic energy to the minute particles of electrified gas existing in this region of conducting air, causing them to move. As shown in Fig. 5, the velocity of the particles conveying the radio wave through the ionosphere increases as the ionosphere becomes more dense. Instead of continuing on in a straight line, the wave's line of travel is gradually bent, or **REFRACTED** by the changes in velocity and density, and eventually the signal may be directed downward towards the earth again. Although this process is known technically as **REFRACTION**, it is more often referred to as **REFLECTION**.

Radio signals reflected by the E layer strike the surface of the earth again at distances up to approximately 1300 miles from the transmitters. Signals reflected from the higher, more intense F layers, may strike the earth at distances up to approximately 2400 miles from the transmitter. This is called **SINGLE HOP** propagation. At the point where the signal strikes the ground, it may be reflected upwards again, and the journey through the ionosphere and back to earth may be repeated many times before the signal dies out. High frequency radio signals can be transmitted to any point in the world by means of successive reflections between the ground and the ionosphere. This is called **MULTI-HOP** propagation, and usually takes place by way of the F layers.

In long-distance communication involving one or more hops, radio waves normally follow the great circle path, which is the shortest distance between transmitting and receiving locations. Fig. 6 depicts a typical example of high frequency propagation. Close to the transmitting antenna the ground and space wave components of the signal are received strongly. The signal strength drops off as the distance from the transmitting antenna increases, and at several dozen miles away both components are too weak to be received.

Beyond the limit of ground and space wave reception lies a zone of silence in which the signal cannot be heard. This is called the **SKIP ZONE**. Then,

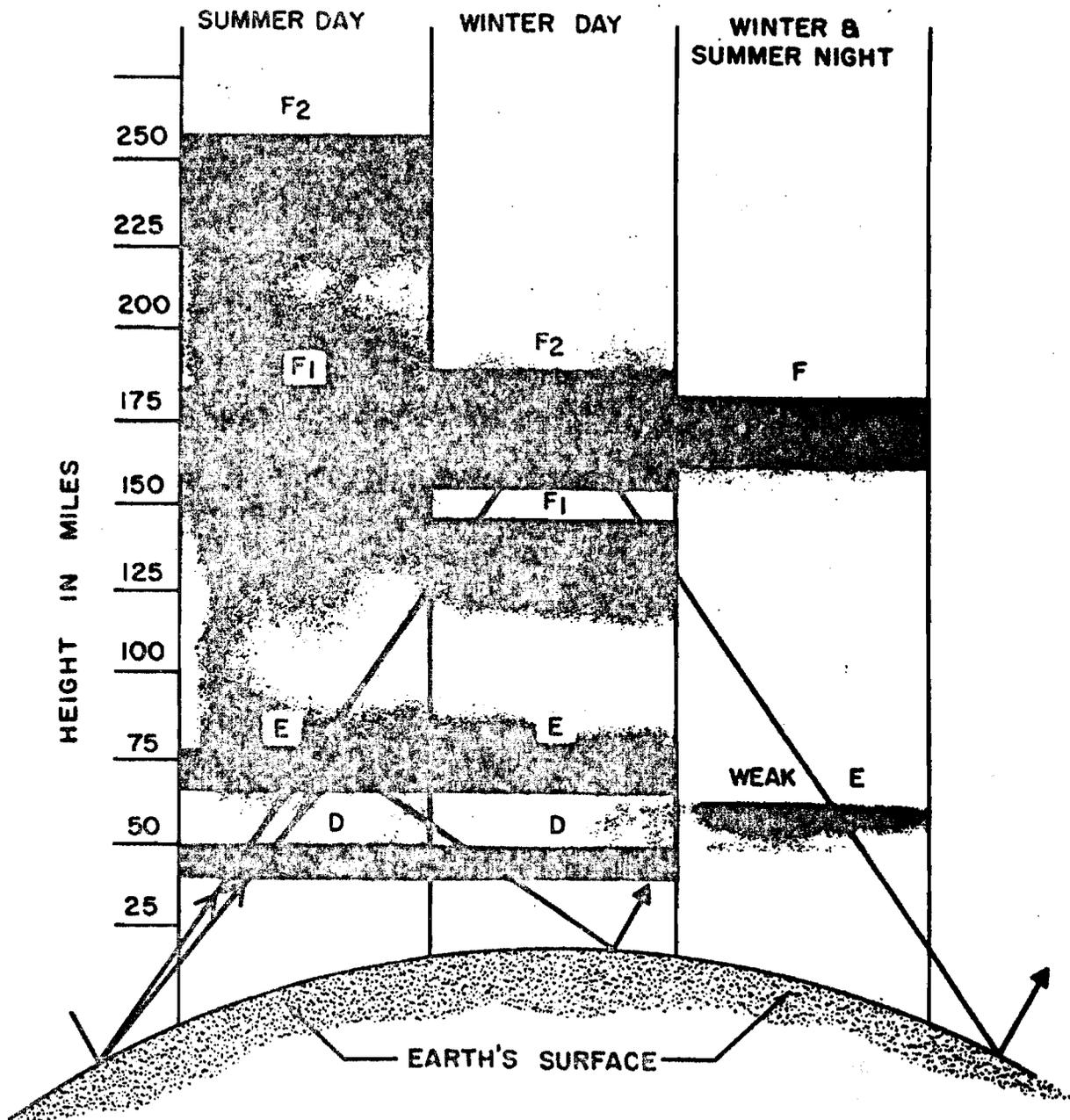


FIGURE 4: Relative positions of ionized regions and their day-night and seasonal variations. High-frequency communication is possible by single-hop E layer reflection for distances up to approximately 1300 miles, and by single-hop F layer reflection for distances up to approximately 2400 miles. Communication beyond 2400 miles is by way of multi-hop propagation. Diagram not drawn to scale.

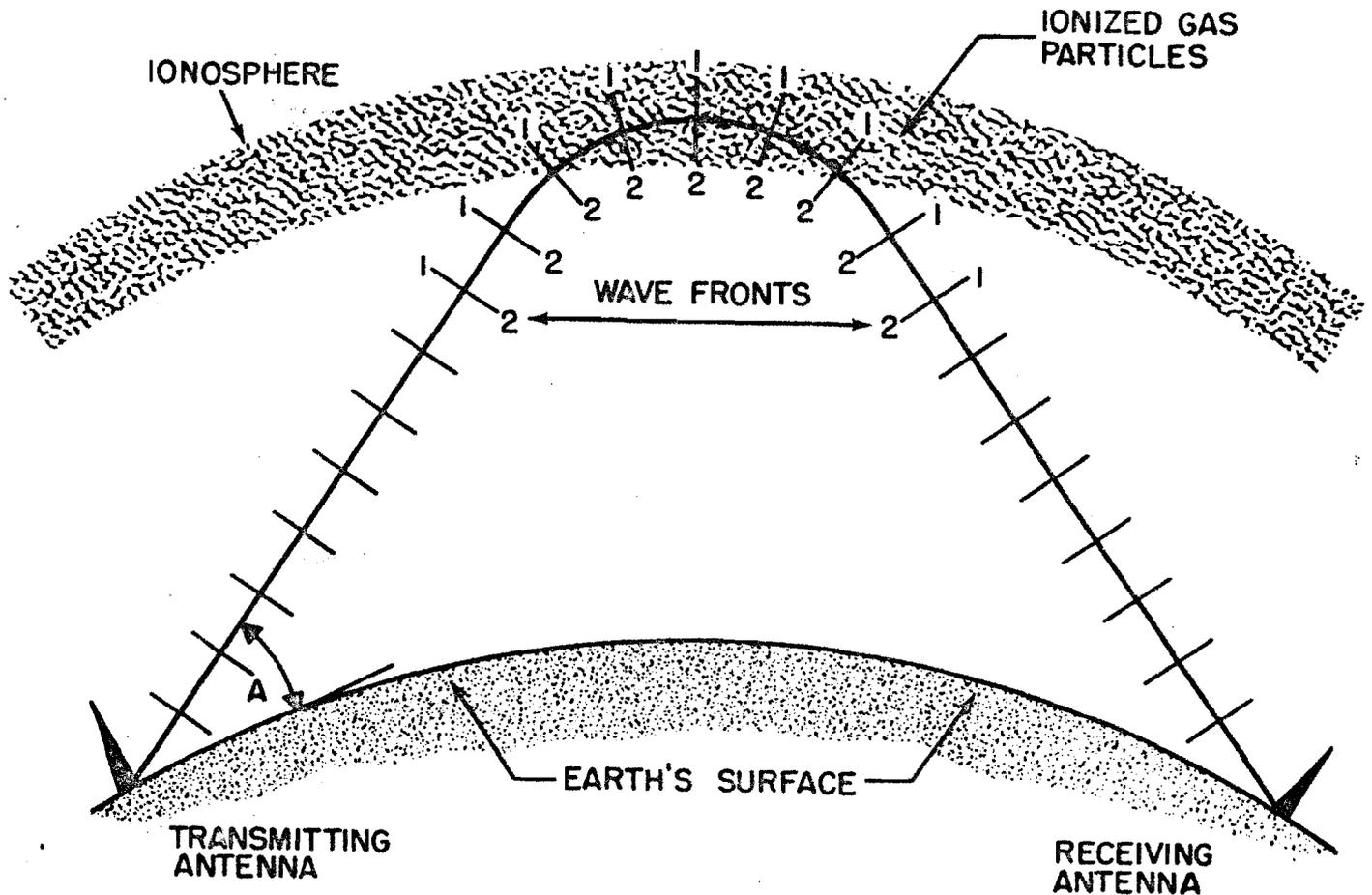
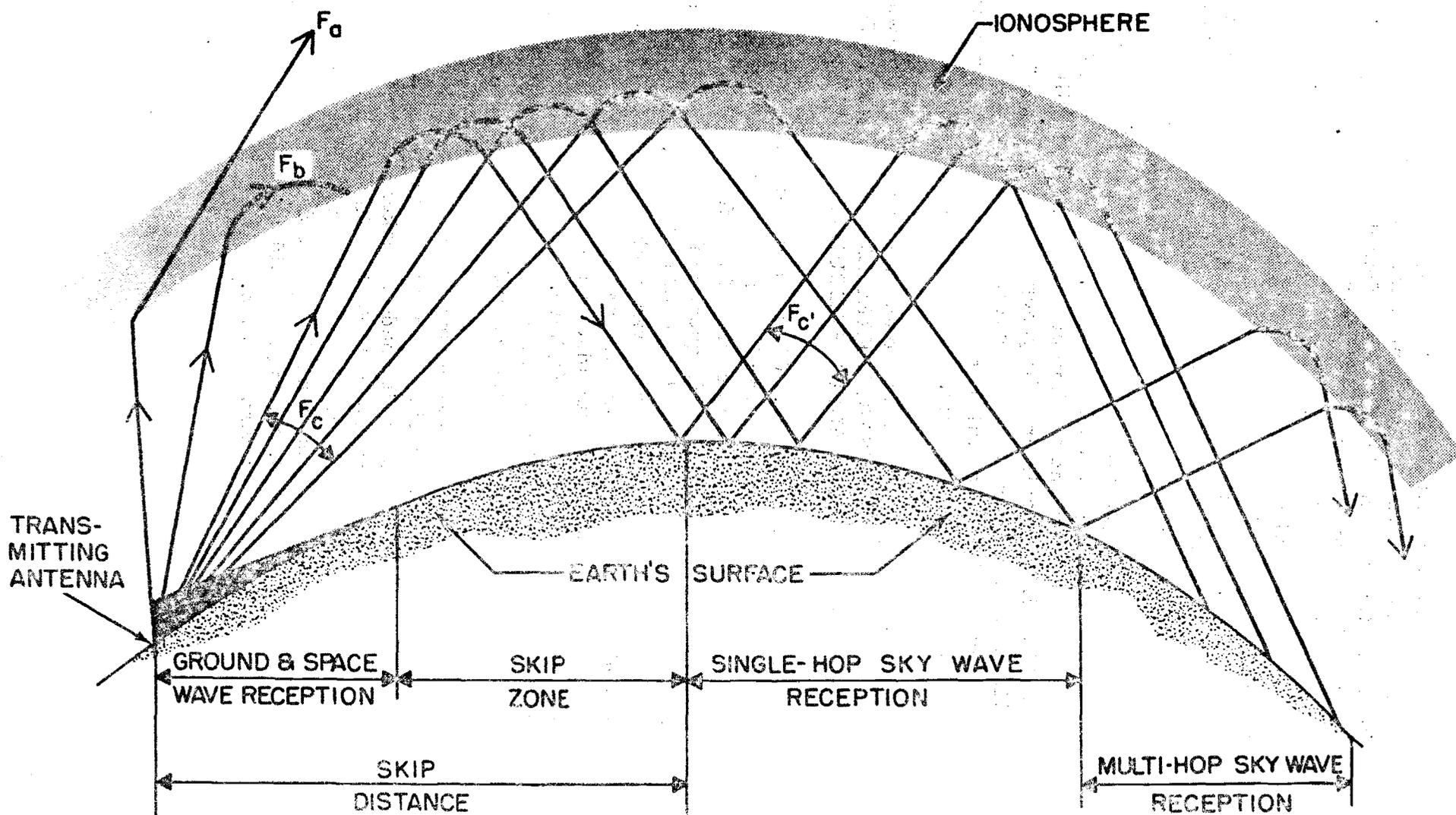


FIGURE 5: Reflection of high-frequency radio waves from the ionosphere. As wave front enters region of ionized gas, velocity of upper portion of wave (1) increases over that of lower portion (2), causing wave front to bend. Eventually, the wave is reflected back to earth over considerable distances. Angle "A" is called the wave angle, or angle of radiation. Diagram not drawn to scale.

FIGURE 6: Typical example of high-frequency propagation. F_a is frequency above the MUF, which penetrates ionosphere. F_b is frequency below the LUF, which is absorbed completely in ionosphere. F_c is frequency between MUF and LUF. F_c' is multi-hop reflection of F_c . Diagram not drawn to scale.



at a still greater distance, a strong signal suddenly is received again. This is where the sky wave component of the signal first returns to earth after being reflected from the ionosphere. This distance between the transmitting antenna and this point is called the SKIP DISTANCE. Continuing along the great-circle path from this point, the signal gradually weakens with distance. Often, as a result of multi-hop propagation, the sky wave signal may be received for thousands of miles beyond the skip distance, depending upon the power of the transmitter. Skip zones, except for the initial one, seldom develop during multi-hop propagation, since the radio energy is so widely dispersed by the many reflections.

The range of frequencies reflected between two given locations is limited primarily by the state of the ionosphere. For a given degree of ionization, there is both a maximum and a minimum frequency that will be reflected. Frequencies ABOVE the maximum will penetrate the ionosphere, while frequencies BELOW the minimum will be absorbed entirely within the ionosphere. In either case, the signal will not return to earth, and communication will not be possible between both points.

The highest frequency that the ionosphere will reflect between two points is called the MAXIMUM USABLE FREQUENCY, or MUF. The lowest frequency is called the LOWEST USEFUL FREQUENCY, or LUF.

- (d) Variation in the Ionosphere: When a radio signal enters the ionosphere it will be either reflected back to earth, penetrate through and be lost in outer space, or be so weakened that it dies out. The effect of the ionosphere on the signal depends primarily upon the frequency of the radio wave, the angle at which it leaves the antenna, and the degree of ionization. Strongly ionized layers will reflect higher frequencies than will weakly ionized layers. Since ionization is dependent primarily upon the effects of the sun, changes in the position of the earth with respect to the sun (due to rotation and revolution), cause corresponding variations in the ionosphere. The intensity of ionization, and hence the degree to which radio waves are reflected, varies considerably from day to night, from summer to winter, and geographically.

The ionosphere is strongest during the hours of daylight when the D, E, F₁, and F₂ layers exist. During the hours of darkness, the ionosphere over the part of the world in the sun's shadow weakens considerably. The D and E layers disappear almost entirely during the night, and the F₁ and F₂ layers merge into a single, weaker F layer. LOWER frequencies must be used during the hours of darkness than during the daylight hours. If the same high-frequencies were used, the signal would penetrate the weakly ionized nighttime layers, and not return to earth.

In the northern hemisphere the ionosphere is generally stronger during the daylight hours of the winter months, when the sun is nearer the earth, than during the summer. Frequencies used during the daylight hours of the winter months are usually considerably HIGHER than those used during any other season. On the other hand, the nighttime ionosphere is stronger during the summer months than during the winter, because of the shorter period of darkness.

The ionosphere is considerably stronger in tropical regions, where the sun is more directly overhead, than in temperate or polar regions. Higher frequencies can generally be used for transmission to tropical areas than to other regions of the world.

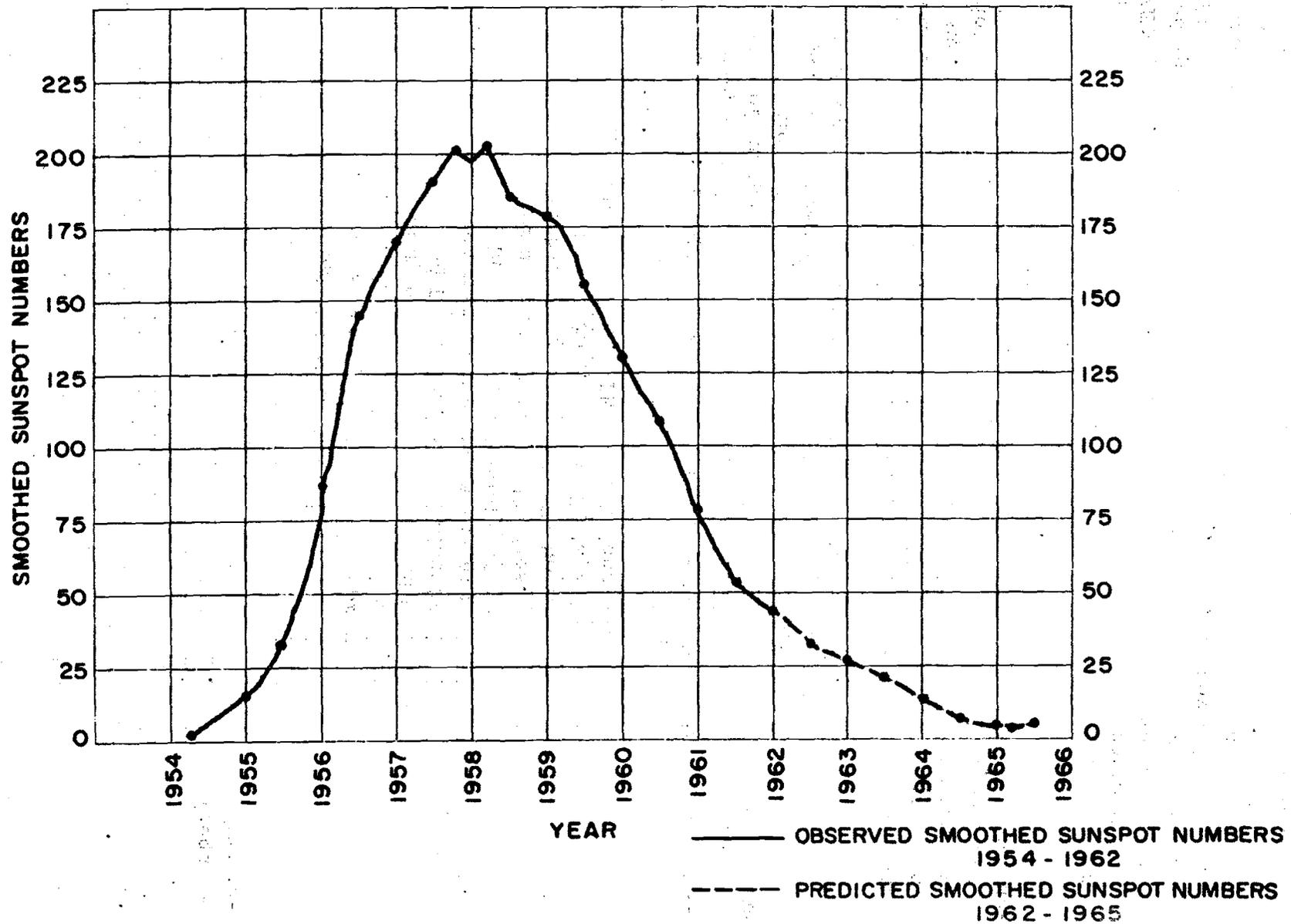
The heights of the D, E, and nighttime F layers remain relatively constant throughout the year. The center of the D layer is approximately 40 miles above the earth's surface, the E layer's average height is approximately 70 miles and the peak intensity of the F layer is located at approximately 175 miles. The daytime F_1 and F_2 layers, on the other hand, vary from season to season. During the summer months the layers are at their highest levels, with the center of the F_1 layer at approximately 175 miles and the peak intensity level of the F_2 layer at approximately 240 miles. During the daylight hours of the winter months, the center of the F_1 layer drops to approximately 140 miles above the earth's surface, and the F_2 layer's level of peak intensity drops to approximately 175 miles. These variations in layer heights are shown in Fig. 4.

- (e) **The Sunspot Cycle:** In addition to the regular variations in the ionosphere discussed above, there is also a long-term change associated with sunspots. The exact nature of sunspots are not known, but they are thought to be solar storms in the gases which make up the visible surface of the sun. When viewed thru a telescope, they appear as groups of black spots on the sun's surface, the diameters of which are often many times that of the earth's.

Scientific studies conducted during the past thirty-five years have shown that sunspots are an indication of the general level of ultraviolet energy radiated by the sun. When sunspots are numerous, the sun radiates large amounts of ultraviolet energy, and consequently the earth's atmosphere is ionized intensely. When there are few spots on the face of the sun, ultraviolet radiation decreases and the ionosphere weakens considerably.

Telescopic records kept almost daily since the eighteenth century, show that the number of sunspots varies throughout a cyclic period of approximately ELEVEN years. At a peak of a sunspot cycle, there are as many as several hundred spots seen on the sun's surface, while towards the end of a cycle, several months often pass without a spot visible. Fig. 7 shows the progress of the latest sunspot cycle which began in 1954 and reached a peak early in 1958. Sunspot activity is now declining towards a minimum, and the ionosphere during the next few years (to approximately 1967), will be considerably weaker than it was during the period 1957-1961.

FIGURE 7: The present sunspot cycle began in 1954, reached a peak of 201 during early 1958, and is now declining towards a minimum which is expected to occur during early 1965.



- (f) **Ionospheric Absorption:** Ionospheric absorption can be looked upon as electrical friction. It causes a radio signal to become weaker as the signal passes through the ionosphere.

As the electrified particles of air convey a radio wave through the ionosphere they collide with much larger gas molecules which are also present. During these collisions the particles lose some of the energy originally transferred to them by the radio wave, causing the signal to emerge from the ionosphere weaker in strength than when it entered. How much signal strength is lost as a result of ionospheric absorption depends on the number of collisions (which is a function of frequency), the length of time during which the wave remains in the ionosphere (which is a function of the distance between transmitter and receiver), and the degree of ionization. Ionospheric absorption varies **INVERSELY** as the square of the frequency; the **HIGHER** the frequency, the less the absorption, and the stronger the signal. Absorption varies **DIRECTLY** with the length of the circuit, - the longer the distance, the **GREATER** the absorption and the weaker the signal.

Ionospheric absorption also varies with the time of day, season of the year, geographically, and with the sunspot cycle. During the daylight hours, absorption is maximum, peaking around noontime and depending generally on the zenith angle of the sun. Absorption is minimum at night, when the earth is in the sun's shadow. Seasonally, absorption is greatest during the summer, when the sun is more nearly overhead. It is also more intense in tropical areas, and in belts around both polar regions, than in temperate zones. There is also evidence to indicate that absorption is greater when there are many sunspots and less intense when few spots appear on the face of the sun.

- (g) **Fading:** The ionosphere is not like a perfectly smooth reflecting surface, but is variable and subject to movement at any given time or place. This causes the strength of a downcoming sky wave signal to change constantly, sometimes rapidly, sometimes slowly, causing distortion and variations in signal amplitude. Fading is nearly always present on a sky wave signal, in a greater or less degree.

The most general kind of fading is called **INTERFERENCE** fading. It results from radio waves reaching the receiving antenna by travelling different paths through the ionosphere. As a result of vertical movements in the ionosphere, or by reflection of the signal from different layers, some of the waves arriving at the receiving antenna may reinforce each other, while others, arriving completely out of phase, will cancel each other entirely. This causes the strength of the received signal to fluctuate considerably from instant to instant. Interference fading is generally **RAPID**, with the duration between fades usually measured in seconds or fractions of a second. This type of fading can often be reduced by **RAISING** the transmission frequency several megacycles.

Much SLOWER fading rates, with the duration between fades on the order of minutes or longer, are caused by ABSORPTION fading and SKIP fading. Absorption fading results from short-time variations on the amount of energy lost because of absorption in the ionosphere. These changes occur rather slowly with the result that the fade occurs at a slow rate. Absorption fading is most prevalent during the sunrise and sunset periods, and can often be reduced by RAISING the transmission frequency several megacycles during the daylight hours, and LOWERING the frequency during the hours of darkness. Skip fading is a condition that exists just at the edge of the skip distance. Here slight changes in the height or density of the ionosphere may cause the sky wave signal to skip back and forth over the receiving location. The duration between fades may be several minutes, and the fluctuations in signal strength may vary as much as 60 decibels. Skip fading can generally be reduced or eliminated by lowering the transmission frequency by several megacycles.

Frequently short-time variations in the ionosphere cause fading conditions which are different for waves of only slightly different frequencies. For example, in the case of a voice-modulated transmission, the sidebands and carrier may not be propagated in the same relative amplitudes and phases they had when transmitted. This effect, known as SELECTIVE fading, can cause severe distortion of the signal. This distortion is most marked on amplitude modulated signals, and is particularly pronounced in the transmission of music. It is possible to reduce the effects of selective fading by the use of single sideband transmission, and by LOWERING the transmission frequency by several megacycles.

The CSB100TR transmitter-receiver has been designed to minimize the effects of fading. The single sideband transmission characteristics of the CSB100TR reduce the distortion caused by selective fading, while the efficient automatic gain control circuit in the receiver reduces the variations due to interference and other types of fading. Fading can also often be reduced further by changing frequency either upward or downward by several megacycles.

- (h) **Abnormal Ionospheric Behavior:** From time to time disturbances occur in the ionosphere which upset the normal behavior of this region. These disturbances fall into two categories - the IONOSPHERIC STORM and the SUDDEN IONOSPHERIC DISTURBANCE, or SID. Ionospheric storms may either develop gradually or commence suddenly, and may continue from one or two days to almost a week. The SID, on the other hand, commences suddenly, and lasts for about twenty minutes to an hour or two, but rarely longer. Although one is long-term and the other short-term, both types of disturbances are similar in that they disrupt high-frequency communication by causing a drastic increase in ionospheric absorption, violent fading, and a severe decrease in the capability of the ionosphere to reflect signals. Under extreme

conditions, the combination of a weaker ionosphere and increased absorption may result in a radio blackout. During such periods it becomes impossible to maintain high-frequency radio communications with many areas of the world, and often even background noise disappears giving the impression that the receiver is "dead".

In temperate and polar regions, auroral display's are often associated with severe ionospheric disturbances. Auroras play havoc with high-frequency radio communications by acting as an electronic screen, shielding transmissions from passing through. The presence of auroral effects on HF. signals can be detected frequently by a characteristic FLUTTER fading. This unique fading component consists of a low frequency flutter of from 100 to 1000 cycles per second which the aurora superimposes on the carrier. During intense auroral displays, this fading component is generally strong enough to render signals unintelligible. A similar type of flutter fading, believed to be associated with the electrojet, is often observed in equatorial regions, especially during a period of several hours after sunset.

- (i) **WWV and WWVH Propagation Transmissions:** The National Bureau of Standards radio stations at Beltsville, Maryland (WWV), and at Maui, Hawaii (WWVH), broadcast descriptions of the latest propagation conditions, as well as short-term forecasts several hours in advance. These broadcasts consist of a letter and a number, transmitted every half hour in Morse Code. The letter is a description of current radio quality, in terms either of N for NORMAL conditions, U for UNSETTLED conditions, and W for DISTURBED conditions. The number is the forecast for the following six-hour period. It is given in terms of a quality index, as follows:

1- Useless	4- Poor to fair	7- Good
2- Very poor	5- Fair	8- Very good
3- Poor	6- Fair to good	9- Excellent

Thus, a broadcast of W 3 would mean that conditions at present are disturbed and are expected to be poor during the next six hours.

The WWV transmissions, which are mainly for trans-Atlantic HF. radio circuits, are broadcast on 2.5, 5, 10, 15, 20 and 25 mcs at 19 1/2 and 49 1/2 minutes past every hour. The WWVH transmissions, which are mainly for trans-Pacific circuits, are broadcast 9 and 39 minutes past each hour, on 5, 10, and 15 mcs. Additional information concerning these transmissions, as well as other propagation services available, can be obtained from the Central Radio Propagation Laboratory, National Bureau of Standards, Boulder, Colorado.

- (j) **The Antenna and Propagation:** In order to achieve optimum high-frequency radio communications, it is very important that the antennas at circuit terminals be designed to take into account certain parameters of sky wave propagation.

The energy radiated in the horizontal plane of the transmitting antennas should be concentrated on the azimuthal bearing corresponding to the great circle path between terminals of the circuit. The receiving antennas also should be aligned accordingly. In the vertical plane, the angle that the wave makes with a tangent to the earth as it leaves the antenna is called the wave angle, or angle of radiation. The optimum angle of radiation is determined by the distance between circuit terminals, and the height at which the wave is reflected by the ionosphere. The transmitting antennas should be designed to concentrate as much energy as possible in the optimum range of wave angles for the circuit. A range of wave angles is specified rather than a single value since the optimum wave angle will vary from day to night and seasonally as the height of the reflecting layer changes. The receiving antennas also should be designed to receive the greatest amount of energy within the optimum range of wave angles.

For most types of antennas, energy can be concentrated within the optimum range of wave angles by adjusting the height of the antenna above ground. Generally, the higher the antenna above ground, the lower the wave angle. Reference should be made to the Antenna Section of this manual for additional information.

The following chart shows the approximate value of optimum wave angle for various transmission distances:

Optimum Wave Angle Chart

<u>Circuit Distances (Miles)</u>		<u>Optimum Wave Angle (Degrees)</u>	
		<u>B layer reflection</u>	<u>F layer reflection</u>
100	100	55	75
	250	32	55
	500	14	33
	750	8	23
	1000	4	17
	1250	-	12
	1500	-	8
	1750	-	5
	2000	-	17*
	2500	-	12*
	3500 and beyond	-	5*

*Multi-hop propagation

Fig. 9

- (k) **Frequency Prediction:** If the variations in the ionosphere are ignored and an attempt is made to transmit on frequencies chosen haphazardly, the chances of maintaining reliable high-frequency communication is very remote. Part of the time the signal would probably penetrate the ionosphere and not return to earth at all, while at other times the signal might be completely absorbed. If, on the other hand, frequencies are chosen carefully to suit propagation conditions prevailing at any given time, the signal will be reflected properly from the ionosphere with a minimum loss of energy. The ability to maintain reliable high-frequency communication depends on a knowledge of ionospheric conditions and the proper choice of frequency.

In 1925, two American physicists developed equipment and techniques for measuring the height and intensity of each of the ionospheric layers. At the present time, the ionosphere is measured continuously at approximately 125 locations throughout the world. From these measurements, the Central Radio Propagation Laboratory of the National Bureau of Standards (located in Boulder, Colorado), is able to predict ionospheric conditions on a world-wide basis. This data is published monthly in map form, three months in advance of the month for which the prediction is made, in a booklet entitled "Basic Radio Propagation Predictions, CRPLD Series". This publication can be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for an annual subscription rate of \$1.50 (to foreign countries, \$2.00 in U. S. currency).

Mathematical procedures have been developed for transforming basic ionospheric data of the type appearing monthly in the CRPLD Series into a determination of the range of frequencies that can be used reliably on a particular circuit. These procedures are explained in Circular 462 of the National Bureau of Standards entitled "Ionospheric Radio Propagation". This Circular contains very useful information concerning the theory of radio wave propagation, measurement techniques, structure of the ionosphere, ionospheric variations, prediction methods, absorption, field intensity, radio noise, lowest required radiated power, and lowest useful high-frequency. Circular 462 is available from the Superintendent of Documents for \$1.25 (to foreign countries, \$1.65 in U. S. currency).

A typical CIRCUIT ANALYSIS CURVE, based on information appearing in the CRPLD Series and Circular 462, is shown in Fig. 8. The upper contour on the curve is the Maximum Usable Frequency, and the lower contour is the Lowest Useful Frequency. The MUF is determined by the height and density of ionization at the point of reflection, while the LUF is determined by ionospheric absorption along the path and noise conditions at the receiving terminal. Between these limiting contours lies a range of frequencies useful for communications on this particular circuit.

As an aid to the more efficient use of the CSB100TR transmitter-receiver, the following chart has been prepared from a comprehensive analysis of propagation conditions on a worldwide basis. The chart, based on the technical

PROPAGATION ANALYSIS DATA	
CIRCUIT: TERMINAL A TO TERMINAL B	AZIMUTH: 270°
DATE: WINTER, 1963 - 64	DISTANCE: 2250 MILES 3700 KM
EQUIPMENT: TYPE CSB 100 TR	SUNSPOT NUMBER: 15
	OPTIMUM WAVE ANGLE: 13°

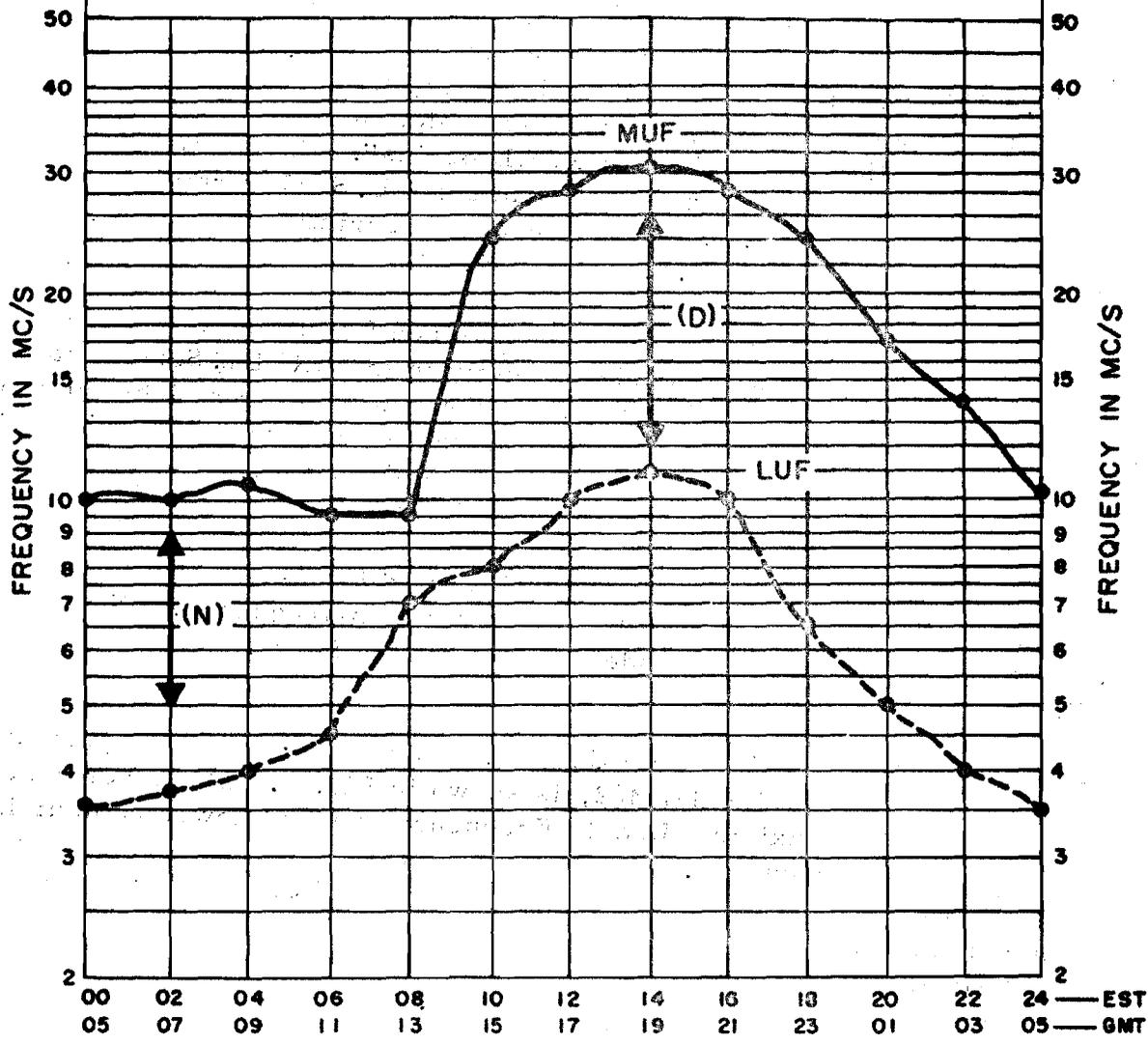


FIGURE 8: Typical Circuit Analysis Curve showing MUF and LUF. (D) designates range of useful daytime frequencies; (N) designates range of useful nighttime frequencies.

characteristics of the CSB100TR, shows the range of frequencies most suitable for communications over distances varying from 100 to beyond 2250 mis. Data is included for the day and night hours, and for the four seasons of the year. From the information appearing in the chart it should be possible to select the most useful range of frequencies for almost every condition under which the CSB100TR is designed to operate. The chart is based upon a transmitting antenna concentrating energy at the appropriate wave angle and along the great circle path between circuit terminals.

Frequency Prediction Chart

CSB100TR Transmitter-Receiver

<u>Circuit Distance</u>		<u>Useful Frequency Range (mcs)</u>					
<u>Miles</u>	<u>Kilometers</u>	<u>Summer</u>		<u>Winter</u>		<u>Spring & Fall</u>	
		<u>Day</u>	<u>Night</u>	<u>Day</u>	<u>Night</u>	<u>Day</u>	<u>Night</u>
100	170	3-4	2-3	3-6	2-3	3-5	2-3
250	420	5-7	3-6	5-9	2-4	5-8	2-5
500	830	6-10	4-7	6-12	2-4	8-11	3-5
750	1250	8-12	5-9	8-16	2-5	8-14	3-7
1000	1660	9-15	5-10	9-18	3-6	9-16	4-8
1250	2100	10-17	5-11	10-21	4-8	10-18	4-9
1500	2500	11-15	6-11	10-22	5-8	10-19	5-9
1750	2900	12-15	7-11	11-23	5-8	11-20	6-10
2000	3300	12-16	7-12	11-24	5-9	12-21	6-10
2250	3700	13-17	7-12	12-26	5-9	12-22	6-10
2500*	4100*	13-17*	7-12*	13-24*	5-8*	13-20*	6-10*

Fig. 10

*Values shown are for multi-hop propagation beyond 2250 miles, and are subject to considerable variation depending upon length of circuit and areas of the world in which terminals are located.

The following typical example demonstrates the use of the frequency prediction chart.

It is planned to use the CSB100TR for establishing communications between two terminals located 650 miles apart. What range of frequencies would be useful during the daylight hours of the winter months?

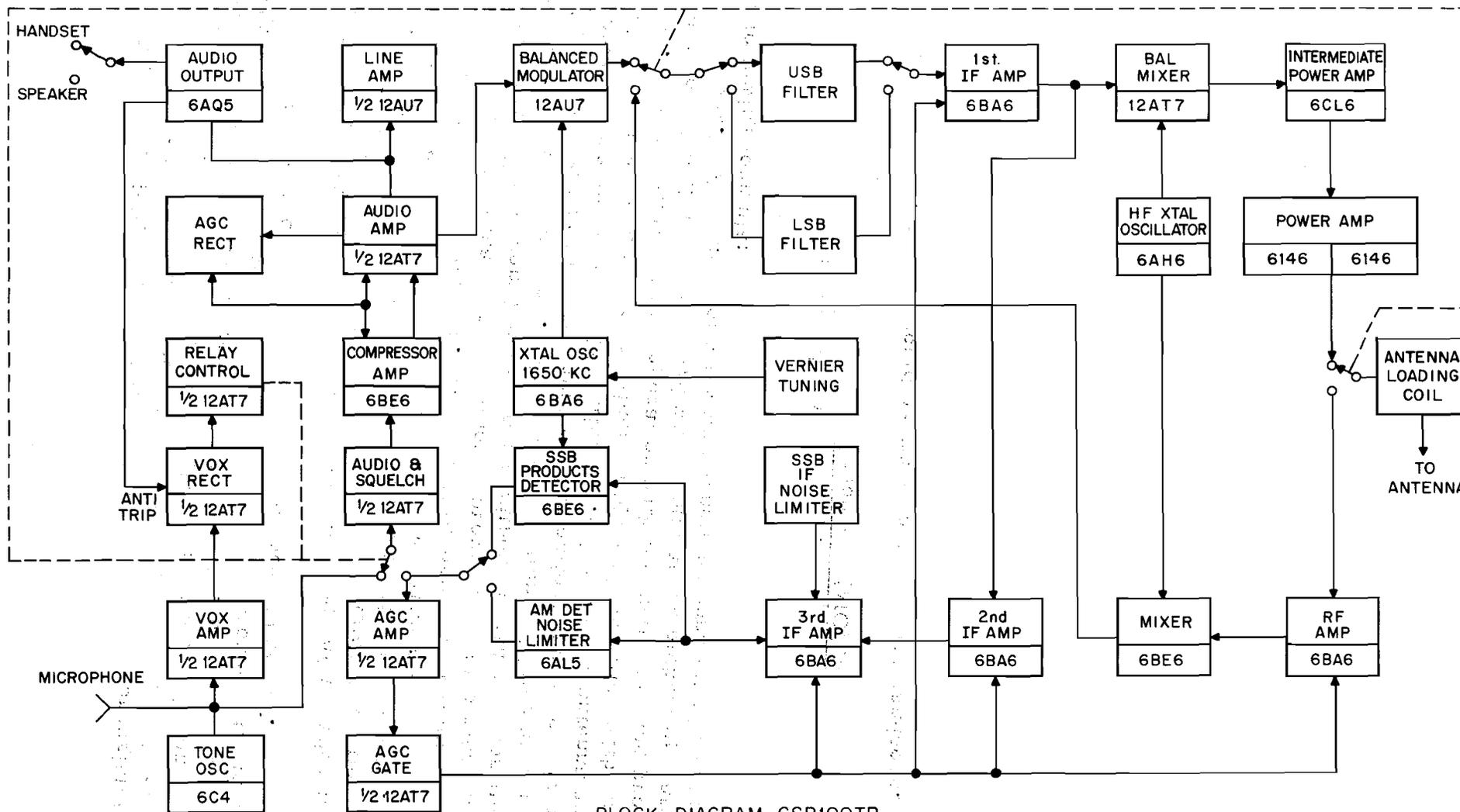
To solve this problem, first enter the Frequency Prediction Chart under a "Circuit Distance" of 500 miles. Under the "Winter, Day" column read a usable frequencies for the required distance of 650 miles. The solution is

found to be 7-14 mcs. Initially, try to use a frequency in an appropriately allocated band as near to the high end of the range as possible, since it will be less attenuated than lower frequencies within the useful range. If communication is not established because of propagation conditions, progressively try lower frequencies within the useful range. If fading is encountered, adjust the frequency as recommended earlier in this section under "Fading".

1.9 ANTENNA SYSTEM - One of the most important parts of a station is the antenna system. Efficiency is normally best when the radiating portion of the antenna system is properly oriented and located as high as possible. This is achieved in the most efficient manner by utilizing a transmission line to carry the RF current to the antenna. A nominal 50 ohm termination is provided for this type of antenna system, although provision is also made in the unit for connection to a random length antenna without a transmission line by the use of an internal loading coil. The use of a system utilizing an external 6 channel automatic antenna tuner provided as an optional accessory is highly recommended for maximum radiation efficiency. A 1/2 wave antenna and 50 or 72 ohm line may be utilized for single frequency operation with excellent results. For multiple channel operation with internal matching provided, an antenna whose length is not over 1/4 wavelength at the highest operating frequency is used. The length of a 1/2 wavelength antenna may be calculated from the following formula:

$$\text{Length (feet)} = \frac{468}{\text{Frequency (MC/S)}}$$

For other antennas, reference should be made to an antenna handbook.



BLOCK DIAGRAM CSB100TR
 TRANSMITTER-RECEIVER
 FIGURE 11

SECTION 2

THEORY OF OPERATION

2.1 GENERAL CIRCUIT THEORY - Audio from the microphone is applied successively to voltage amplifier stages. This audio is applied at the proper level in push-pull to the grids of the balanced modulator. 1650 KC RF. voltage of the proper level is also applied to these grids, but in parallel. With proper adjustment, only the sidebands appear in the output. This signal is impressed on the crystal filter which greatly attenuates the undesired sideband. The output signal from the filter is amplified and applied in push-pull in the grids of the balanced mixer. Due to the fact that the HF. Osc. is applied to these grids in parallel, the predominant signal in the output circuit of the balanced mixer is at the desired output frequency. This signal is amplified in turn by the intermediate power amplifier and by the power amplifier stage. The Pi network provides proper impedance matching between the output tubes and the antenna termination. The incoming signal to the receiver is amplified by the RF. stage and combined with the HF. oscillator in the mixer. A signal at 1650 KC/S results in the output which is impressed first upon the crystal filter to provide selectivity, then amplified by three successive IF stages. For detection, a product's detector is used for SSB, and a diode detector and noise limiter is utilized for AM. The output of the desired detector is amplified before being applied to the grids of the line amplifier and the audio output stage. Receiver audio is also amplified and rectified to provide AGC action for the RF. and IF amplifiers.

2.2 DETAILED THEORY - TRANSMITTER

2.2.1 Audio Amplifier: The output of the microphone appears at pin 7 of P103 on the power deck and at pin 7 of P201 on the RF deck. The audio level is adjusted by the "SPEECH LEVEL" control R310, on the front panel. Normal setting of this control is in the 12 o'clock position. The audio is connected thru contacts 8 and 12 Relay K201 and coupling capacitor C295 to the grid of V204B (1/2 12AT7). In a transmit condition, this stage acts as a normal voltage amplifier. (See Section 3.11 First Audio and Squelch Circuit for further description.)

2.2.2 Audio Compressor and Output: The output audio voltage of the first audio amplifier, V204B, that appears at the junction of R280 and R281 is applied to the grid (pin 1) of the V203(6BE6) thru the coupling capacitor C292, and is of such a magnitude that peaks which would normally cause overdrive of the Balanced Modulator are compressed. The signal applied to the grid is amplified by the compressor stage and applied to the grid of V202B (1/2 12AT7) thru coupling capacitor C289. The signal is again amplified in V202B and appears at the plate of the tube. A portion of this signal passes thru R265 and capacitor C287 and is then rectified by CR202. Back bias for CR202 is developed by resistors R289, R287, R277 and R275 so that CR202 will not conduct below a predetermined voltage level. The negative rectified audio voltage developed by CR202 is filtered by capacitor C290, and

applied to the grid of V203 thru Resistor R272, and to the grid of V204B thru resistor R273 controlling the voltage gain of both tubes at higher speech levels. Compressed transmit audio is obtained from the cathode of V204B. Correct level for both SSB and AM is automatically provided by attenuating the signal to its proper value by resistors R262 and R263, which are selected by the mode switch (wafer S202C).

2.2.3 Carrier Oscillator: The Carrier Oscillator V206 (6BA6) is employed to generate a fixed frequency of 1650 KC/S. The crystal (Y207) is mounted in an 85°C oven (H201) for temperature stabilization. In conjunction with the electron coupled circuitry the frequency is held within .0002% over an ambient temperature excursion of -10°C to +55°C. The frequency of the 1650 KC oscillator may be varied ± 30 cycles by the VERNIER panel capacitor C213. Oscillation occurs in the grid/screen/cathode portion of the tube with the RF voltage appearing across choke L203 in the cathode circuit. Resistor R216 and zener diode CR201 provide for a stable screen supply voltage to insure maximum frequency stability. Capacitor C214 and the grid to cathode tube capacity in conjunction with C215 form a capacity bridge to provide proper feedback to insure adequate crystal activity. Amplified RF voltage appears at the plate of the tube, and, due to the electron coupled circuit, loading of the plate has practically no effect on frequency. RF voltage in the order of 6 volts RMS is fed to the balanced modulator thru capacitor C205.

2.2.4 Balanced Modulator: The input to the Balanced Modulator V201 (12AU7) consists of the 1650 KC/S carrier fed in parallel to the grids and the modulating audio signal which is fed to the grids in push-pull. Since the plate circuit is in push-pull, the 1650 KC/S carrier is effectively balanced out and suppressed by at least 40 DB. A potentiometer R203 in the cathode circuit of the balanced modulator provides an adjustment for carrier balance. A capacitor C204 is employed as an RF phase balance for more complete carrier rejection. This is a factory adjustment and need not be adjusted in the field.

2.2.5 Sideband Filter: Under modulation the output of the balanced modulator contains both upper and lower sidebands of the 1650 KC/S carrier. The filter ZF202 suppresses the upper sideband components by 50 DB. In addition, 20 DB of carrier suppression is obtained because the carrier frequency is set 20 DB down on the response curve of the filter. If the optional lower side band filter has been installed, the same conditions exist with the exception that the upper side band is suppressed. The secondary core of T202 (bottom core) and the core of L233, determine the pass band ripple. This is a factory adjustment and should not be touched in the field.

2.2.6 First IF Amplifier: The output of the crystal filter is impressed across L233 and coupled through C233 to the grid of the amplifier V218 (6BA6). The signal is amplified and appears across the primary of T203.

2.2.7 Transmit Mode Selection: The selection of transmission mode, SSB or AM, is accomplished by the front panel mode switch S202. The receiver is switched simultaneously. One section of wafers S202A and S202B selects the filter for upper sideband or the optional filter for lower sideband output in either the SSB or AM mode. The second section of S202A is wired in such a fashion that the carrier oscillator plate and screen voltage is removed by relay K203 when in a receiving condition in the AM mode, thus eliminating any possibility of a "beat note" with the incoming carrier. The second section of S202B is utilized for reinsertion of the carrier when in the AM mode. S202C provides for the proper audio level to the balanced modulator in both SSB and AM. One section of S202D selects the output of the receiver product detector in the SSB mode, and the diode detector in the AM mode. The second section of S202D disconnects the IF noise limiter in the AM mode.

2.2.8 Balanced Mixer: The grids of the balanced mixer V207 (12AT7) are fed in push-pull by the output of the sideband amplifier. The high frequency injection voltage from the heterodyning oscillator V214 is fed to the mixer grids which are effectively in parallel for this frequency. The output of the balanced mixer is composed of the upper sideband (for lower sideband) component of the 1650 KC/S carrier, the suppressed high frequency mixing frequency, and the single sideband signal, which is a result of the mixing action. A series of highly selective tuned circuits associated with the channel switch are employed to tune the output of the balanced mixer to the desired output frequency. At the same time, undesirable components appearing in the output of the mixer are rejected.

2.2.9 High-Frequency Oscillator: The operation of the high-frequency oscillator is similar to that of the carrier oscillator, except that a type 6AH6 tube (V214) is employed. The six channel crystals are mounted in a separate 85° Coven H202. A resonant choke or coil is used in the plate circuit. For crystal frequencies up to 11 MC/S, a 8.2 microhenry choke L220 is selected. For frequencies between 11 and 15 MC/S, a 4.7 microhenry L219 is utilized, and for frequencies between 15 and 19.6 MC/S, a 2.7 microhenry choke L212 is used. On channel six when in the 15 to 30 MC/S output frequency range, the second harmonic of the crystal is utilized, being tuned by L228 and C337. Resistors R332, R333, R334, and R335 load the plate circuits to provide more uniform output voltage from the high-frequency oscillator across the entire frequency range.

2.2.10 Intermediate Power Amplifier: The output of the balanced mixer is fed to an intermediate power amplifier, V211 (6CL6). This stage amplifies the output of the mixer to a level sufficient to drive the power amplifier stage. A second series of highly selective coupled circuits selected by the channel switch feed the grids of the output amplifiers.

2.2.11 Power Amplifier: The power amplifier consists of a pair of 6146 tubes V212 and V213, wired in parallel. The pi network output circuit is resonated to the desired operating frequency. By the proper adjustment of the input and output capacitors, and appropriate tap selection on inductor L208, the output impedance of the amplifier may be matched to the antenna impedance.

2.2.12 Internal Antenna Loading Coil: The internal antenna loading coil is employed to electrically resonate a single wire antenna which would normally be too short for proper use at a lower frequency than for which it was designed. The proper amount of inductance can automatically be switched into the circuit by switch wafer S201L if the color coded taps are properly placed on the inductance L210.

2.2.13 Metering: Monitoring of the operating condition of the transmitter is provided by the METER switch on the front panel. In the MOD. LEV. position, a portion of the RF voltage appearing at the output connector is rectified by CR210, filtered by C273, and is useful in checking the amplifier output to the antenna. This is a relative reading only. In the PA position, a portion of the RF voltage at the grid of the power amplifier is rectified by CR209 and filtered by C272. The meter indicates the relative amplitude of the RF output from V211. In the BAL.MOD. position, a portion of the RF voltage at the grid of the IPA tube is rectified by CR211 and filtered by C282. The meter indicates the drive to V211 from the balanced modulator.

2.2.14 Tone Oscillator: The tone oscillator V205 is a type 6C4 tube. The frequency at which the circuit oscillates is determined by the value of inductor L204 and capacitors C307 and C308. Normally, the tube cannot oscillate since it is cut off by the application of -90 volts through R301 and R300 to its grid. When in the CW mode of operation, closure of the key grounds the junction of R300 and R301, thereby removing the cutoff bias and permitting the circuit to oscillate at an audio frequency of approximately 1000 CPS. The audio frequency signal is then fed to the speech amplifier and vox system by way of C303.

2.2.15 Vox and Anti-Trip: The vox and anti-trip circuits are located on the power supply deck. The incoming audio from the microphone or the tone oscillator is fed to a grid of V101 by way of the vox gain control R101. The output of V101 which is a two-stage audio amplifier is applied to the vox rectifier V102A, and appears as a pulsating DC voltage at the cathode of V102A. After being filtered by C129, the DC is applied as a positive voltage to the grid of the relay control tube V102B. When the average value of DC at the grid becomes sufficiently high, the tube is caused to draw current, and operates the vox relay K101. When vox operation of the transmitter is used, it is evident that during the period of reception, it is possible to activate the transmitter with the sound from the speaker. To prevent the transmitter, keying circuit from being triggered in anti-trip, circuit is employed. The audio voltage which appears across the speaker winding is fed to V103A by way of variable resistor R105. The audio is rectified and filtered. The DC is then fed to the cathode of the vox rectifier and opposes the normal voltage derived from the vox amplifier V101.

2.3 RECEIVER

2.3.1 RF Amplifier: The incoming signal is routed through the send-receiver relay, then by way of separate highly selective transformers to a conventional pentode amplifier V217 (6BA6) tube.

2.3.2 High-Frequency Mixer: The amplified signal from V217 is coupled to the signal grid of the 6BE6 mixer (V216) and the output from the high-frequency oscillator is fed to the oscillator grid. The received signal is heterodyned to produce an intermediate frequency of 1650 KC/S. A double tuned transformer T219 in the plate circuit is tuned to 1650 KC/S and couples the intermediate frequency to the filter ZF202 by way of the transmit-receive relay K203.

2.3.3 Sideband Filter: The crystal lattice sideband filter is common to the transmitter and the receiver. Its function is to eliminate one sideband of the intelligence being fed into it from either the balanced modulator during the transmit cycle or from the high frequency mixer during the receive cycle.

2.3.4 First IF Amplifier: Following the filter, and common to both transmit and receive functions is V218 (6BA6). It is a conventional RF amplifier and is required to amplify the output of the filter.

2.3.5 Second IF Amplifier: The second IF amplifier V215 (6BA6) receives its input from the preceding stage by way of coupling transformer T218 and again amplifies the 1650 KC/S sideband signal.

2.3.6 Third IF Amplifier: The third IF amplifier V210 is also a 6BA6. The input to this stage from the second IF is by way of transformer T217. This stage amplifies the 1650 KC/S signal to a level that provides proper input to the two detectors.

2.3.7 IF SSB Noise Limiter: An IF noise limiter is inserted at the plate of the 3rd IF amplifier tube V210 when in the SSB mode. This circuit consists of CR207, CR208, R320, C328, and C329. The two diodes are connected in a full wave configuration and placed in shunt with the plate. The diodes are self-biased by the rectification of an IF signal. The time constant of the circuit is adjusted so that the bias varies at approximately an audio rate. This reduces diode conditions and prevents excessive limiting of the signal. When a high sharp noise pulse appears, the time constant of the configuration cannot change rapidly enough to prevent conduction, so the pulse is severely limited by the action of the diodes. b

2.3.8 Products Detector: When the mode selector switch is in either the LSB-SSB or USB-SSB position, the audio is switched to product detector V208. This is a 6BE6 pentode which has the signal applied to the inner grid and the carrier applied to the suppressor grid. The signal modulates the electrons flowing toward the plate. The suppressor grid, which has considerable effect on the current arriving at the plate, will allow more electrons to pass when its voltage is in phase with the signal, and less when it is out of phase. The plate current is the product

of the signal and carrier voltages, or essentially the desired audio component. Since there will be some of the IF component at the plate, an RF filter is inserted between the plate and the first audio amplifier.

2.3.9 AM Detector, Noise Limiter: When the mode selector switch is in either the LSB-AM or USB-AM position, a conventional diode detector-series diode noise limiter circuit is utilized. To allow grounding of the last IF transformer winding, the polarity of the diodes have been reversed, however, the operation is unchanged. The noise diode, V209, pins 1 and 7, is biased to be conducting with normal signal voltages. When a burst of noise occurs, there is an instantaneous positive voltage applied to the diode, and if the amplitude is sufficient to exceed the normal bias, the diode stops conducting and opens the audio circuit for roughly the length of the pulse.

2.3.10 Automatic Gain Control: The AGC system consists of V204A (1/2 12AT7) as an amplifier. The load resistors R288 and R289 provide audio voltages at two levels. The two voltages are rectified and filtered, then are applied to the grid and cathode of V202A (1/2 12AT7). Due to the fact that the grid voltage is initially greater than the cathode voltage, no current will flow from the cathode circuit until the grid potential is reduced by leakage through R293 to a point where the tube is no longer cut off. This provides a "Hang AGC" action. The AGC voltage is derived at the cathode of V202A and then fed to the grids of the controlled stages.

2.3.11 First Audio and Squelch Circuit: The squelch circuit operates by using the characteristic of the voltage at the screen of the RF amplifier tube V217 to control the grid of the first audio amplifier tube V204B. The cathode of this tube bypassed for audio by C291 is fed from a B+ voltage divider R270 and R283, maintaining the cathode at about 100 volts. Resistor R282 determines the tube bias under normal signal conditions. With the squelch fully off, and no signal, the cathode is approximately 98 volts and the grid about 95, so the tube is operating as a normal amplifier. As the squelch is turned on, the grid voltage is lowered so that with full squelch, the grid is about 38 volts, and the cathode about 110, fully cutting off the tube. In operation, the squelch control is set to just cut off the audio stage in the absence of a signal. When a signal of sufficient strength is received, the AGC will bias the RF stage back, the screen voltage will rise, and the audio stage will be turned on. Diode CR203 is employed to ensure that the grid voltage can never be more positive than the normal operating bias.

2.3.12 Audio Voltage Amplifier: The amplified receiver audio signal from the first audio and squelch circuit is applied to the grid of V203 and is further amplified by V202B as described in 2.2.2. The monitor audio is obtained from the plate circuit of V202B by way of a coupling capacitor. Individual volume controls permit the setting of proper levels to the line amplifier V103B and speaker amplifier V105.

2.3.13 Audio Output Amplifier: The audio output amplifier V104 is located on the power supply chassis. The input to the amplifier is fed from V202B thru shielded cables and the chassis connector. The output from V104 is then applied to the Panel Speaker or to the earpiece of the handset, as selected by switch S102.

2.3.14 Line Amplifier: The line amplifier V103B is also located on the power supply deck and is fed from the same point as the output amplifier. An independent level adjustment R116 is used to set the amplitude of the signal to the telephone line and remote desk sets.

2.4 POWER SUPPLY

2.4.1 Input: To provide a simple method of adjusting for primary power variations an autoformer has been included. A single phase 50/60 cycle source of 115 or 230 volts may be used to power the CSB 100TR. Switch S107 located in the power deck chassis selects the proper tap on the autoformer input for the corresponding power line voltage. The switch is set at the 230 volt position at the factory to avoid possible damage to the equipment should the equipment be plugged in before adjustment for proper line voltage has been made. A second switch S110 which is located behind the access door on the front panel, affords a +25%, +12.5%, 0, -12.5% and -25% adjustment for line voltage variations. When the meter switch is in the "LINE" position, S110 can be adjusted so that the meter falls within or very close to the line voltage calibration mark on the meter scale.

2.4.2 Output: The power transformer furnishes the following voltages:

- 1 - 6.3 volts for the filaments of all tubes
- 2 - Low voltage B+ for all tubes except the transmitter output stage
- 3 - High voltage B+ for the transmitter output stage
- 4 - Negative bias voltage

The low voltage B+, high voltage B+ and bias voltage are adequately filtered by the associated filter networks.

SECTION 3

ACCESSORIES

3.1 Antenna Tuner: A remote controlled antenna tuner is available for use with the CSB100TR. The tuner is used to electrically resonate the antenna at each selected channel frequency for attaining maximum radiated efficiency and provides for proper impedance match between the transmitter output and the radiator.

3.2 Selective Calling: Selective calling may be accomplished by the addition of a "secode" encoder. Terminals are provided at the rear of the transceiver for the inclusion of the unit.

3.3 Selective Receiving: When the selective calling unit is installed, the receiver is muted until the proper calling code has been completed by the transmitter which desires to communicate with the selected receiver. Automatic override of the selective calling system may be accomplished by removing the handset from its cradle.

3.4 Lower Sideband Filter: Provisions have been made for mounting a separate crystal filter for lower sideband output. This filter can then be selected by the front panel mode switch.

3.5 Remote Desk Set: This unit is designed for remote control of communications equipment and has provisions for intercom, annunciator, and signal lamp functions. When used with the CSB100TR SSB/AM transceiver, the remote unit when selected can be used to control the transceiver with either push-to-talk or voice operated control. Indication of selection by the control point is provided by illumination of the white lamp on the control unit. Indication of transmitter operation is provided by illumination of the red lamp on all remote units irrespective of selection. To provide privacy the handset is completely disconnected from the transceiver and intercom circuits except when selected. Annunciator operation is available to the control point, even if another remote unit is controlling the transmitter. When the handset is removed from the cradle, signal lamp indication is provided on the CSB100TR transceiver. A foolproof provision has been incorporated in the transceiver. If the control operator has failed to change the function switch from intercom to provide for transmitter control from the remote desk set, operation of the push-to-talk button will actuate the control operator's annunciator.

3.6 Extended Remote Control: Provision for extended remote control has been incorporated in the CSB100TR for control of the transmitter from a remote point over a 2, 3, or 4 wire line up to 10 miles in length. When selected by the local operator, the remote location has a keying voltage available for push-to-talk operation. This voltage activates relay K102 which turns the transmitter on. Audio for modulating the transmitter is obtained from T105 line transformer. The transmitter may also be turned on by the incoming audio by setting the VOX-MAN

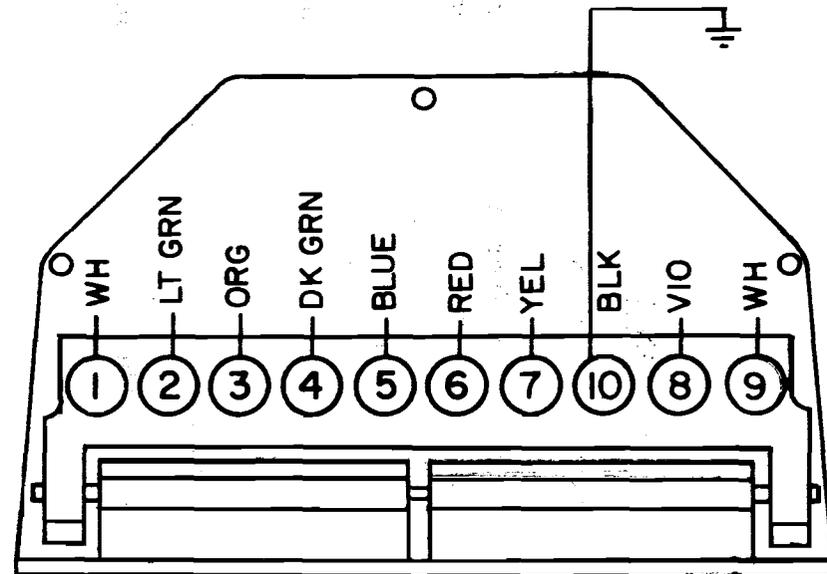
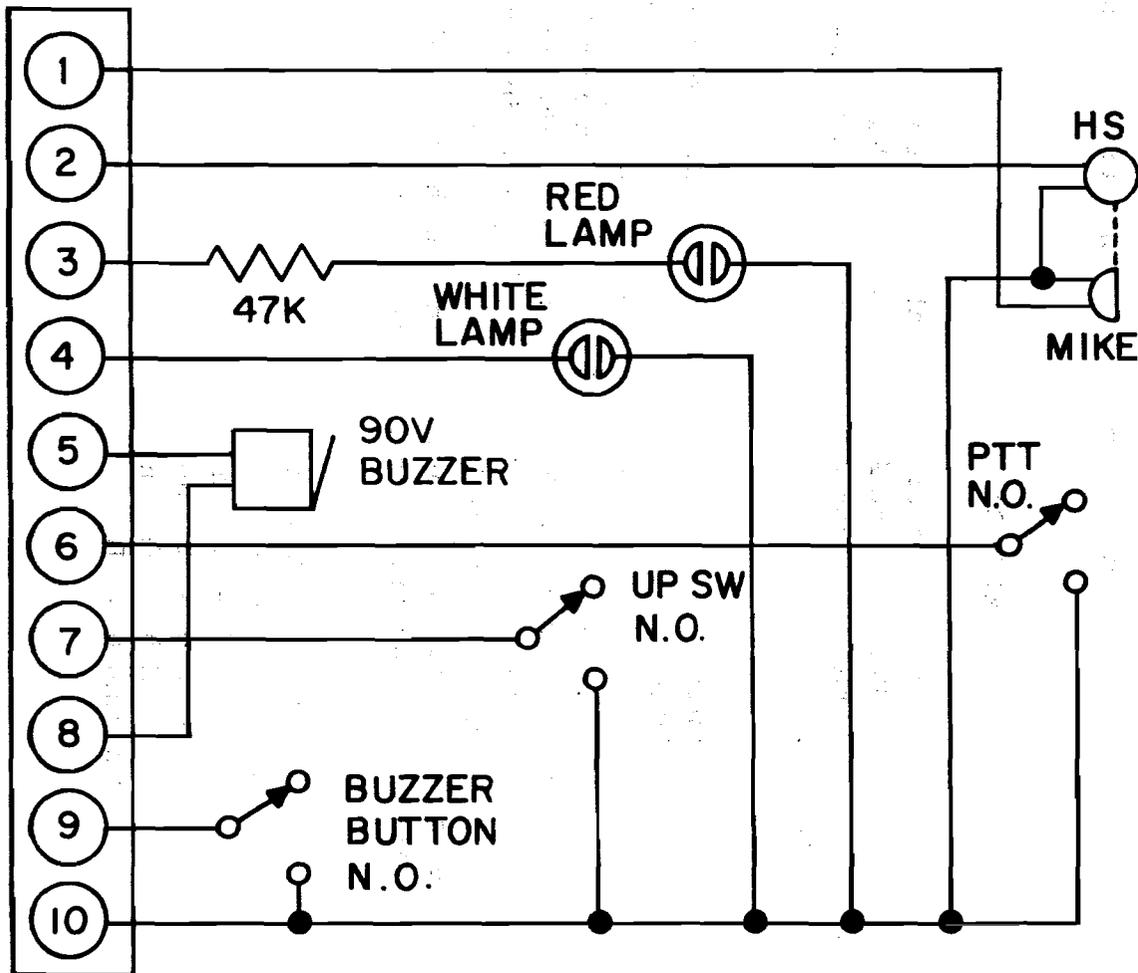
switch into the VOX position. Audio level to-and-from the remote location is adjusted by R124 and R149 respectively. When the extended remote control is not used to control the transmitter, pressing the push-to-talk button will activate the annunciator at the equipment.

3.7 Monitor or Duplex Receiver: USE - The Hammarlund HQ-180AX "Universal" communications receiver is an ideal companion receiver to the CSB100TR single sideband transmitter-receiver. A variety of applications in which the HQ-180AX can be used include: Frequency monitoring, full duplex voice operation, simplex voice operation with single sideband transmitter, alarm system operation, and simplex or full duplex operation for telegraph or teleprinter service. Constructed on a compact chassis, the HQ-180AX can be rack-mounted.

CIRCUIT DESCRIPTION - The new Hammarlund "Universal" receiver HQ-180AX retains all of the outstanding features of the famous HQ-180, but additionally provides the versatility of crystal-fixed frequency, accuracy and stability and the ability to operate on 115/230 volts, 50/60 cycles. The "Universal" version of the HQ-180 communications receiver features 11 fixed-frequency crystals in addition to the VFO, six of which are plugged in on the face of the instrument (in the area formally provided for the 24-hour clock-timer) the balance accessible through the trap door design of the cabinet. The five in-cabinet crystals may be used for those frequencies which are not likely to be changed, e.g. WWV frequencies. The six front cabinet crystals may be employed for quick-change frequencies. Crystal stability, coupled with an all-purpose receiver designed for use with common domestic and foreign power sources, has opened a new range of applications for the HQ-180AX. In addition to meeting the requirements of the radio amateur interested in RTTY, MARS, C. A. P., AND CD, the "Universal" HQ-180AX will provide excellent service in commercial and industrial laboratories.

3.8 Teletype: For teletype operation of the CSB100TR, two accessories are required:

- 1 - An audio frequency shift oscillator for the transmitter is fed into the 600 ohm line termination.
- 2 - An audio frequency converter for the receiver. The transmission and reception of RTTY are accomplished using the single sideband mode.



REMOTE DESK SET BASE
WITH COVER REMOVED

SCHEMATIC
REMOTE DESK SET
FIGURE 12

SECTION 4

INSTALLATION

4.1 Unpacking: Carefully remove the carton from the transceiver. Remove the front panel screws and all the internal packing. The handset and test cables are enclosed within the unit. Remove the power and RF decks from the cabinet by pulling out to the slide stops and then lifting the front end of each to clear the stops. Visually inspect the unit. Place the 110/220 power selector switch on the power deck in its proper position and reinstall the two decks in the cabinet. Secure them in place with the front panel screws.

4.2 Operating Position: Select an operating position which is reasonably free from excessively warm or drafty locations such as those near radiators and air-conditioning or heating vents. The unit should be placed in a location where there is adequate space around it to permit free circulation of clear air thru the cabinet openings:

4.3 Power Source: The CSB100TR is designed to operate from either 115V or 230V 50/60 CPS power source. The power consumption during transmission is 350 watts.

CAUTION

If in doubt about your power source, contact the local power company prior to connecting the CSB100TR into the AC power outlet. Plugging the transceiver power cord into the wrong power source can cause extensive damage to the unit.

4.4 Antenna Connector: The antenna is connected to a coaxial fitting located at the top of the cabinet. A PL 259 plug is required. If the equipment was ordered to include the operating crystals, the unit is shipped with all circuits properly tuned to the specified frequencies. The output matching network is normally adjusted to operate into a 50 ohm antenna load. Antenna impedances other than 50 ohms will require readjustment of the pi network to attain the proper impedance match to the amplifier. If a long wire antenna is employed, it is necessary to use the internal loading coil for proper match of the antenna to the transmitter. Top leads to the load coil are provided and are color-coded to correspond with the channel.

Channel 1 - Brown
Channel 2 - Red
Channel 3 - Orange
Channel 4 - Yellow
Channel 5 - Green
Channel 6 - Blue

4.5 The channel crystals are mounted in the six position crystal oven H202. The sockets are color-coded by channels: 1 - brown, 2 - red, 3 - orange, 4 - yellow, 5 - green and 6 - blue. Channel crystals are 1650 KC/S above the channel frequency except on a normal channel 6 range of 15 to 30 MC/S. Full crystal ordering data is as follows:

	<u>Description</u>	<u>Part No.</u>
Y201 thru Y206	Crystal, CR-36/U	K58114-1

Specifications

Specify desired operating frequency and channel. Channels must progressively increase in frequency with channel numbers.

Crystal Frequency Formula:

Range 1	-	2 - 3 MC
Range 2	-	3 - 7 MC
Range 3	-	7 - 18 MC
Channel 6	-	Range 1, 2, or 3

Oscillating Frequency = XMTR/RCVR Channel Frequency plus 1.650 MC

Channel 6, Range 4 - 15.0 to 30.00 MC

Oscillating Frequency = $\frac{\text{XMTR/RCVR Channel Frequency plus 1.650 MC}}{\text{Divided by 2}}$

4.6 Initial Adjustments: When the channel crystals had been ordered with the equipment, it is suggested that a slight repeaking of the tuned circuits should be made. Set the mode switch to SSB and connect a key across the keying terminals. Set the channel selector to channel 1 and key the transmitter. With the audio gain control at its maximum counterclockwise position, check the PA plate current. The meter should indicate 45 MA. If it does not, adjust the Bias Adj pot until the meter indicates 45 MA. With an audio signal of 0.25 V RMS, 1000 cycles, adjust the audio gain control to approximately the 10 o'clock position. Set the meter to the IPA position. Key the transmitter and peak T214, T215, and L218 for maximum indication of the meter. With the meter switch in the RF output position, resonate and load the output amplifier by C253 and C259 for maximum indication of the meter. Always start with C259 at maximum capacity. C253 should always

be the last adjustment. When properly tuned the PA cathode current should read between 200 and 250 MA with the audio gain at approximately the 12 or 1 o'clock position. Repeat the above procedure for the other channels. Be careful to tune the circuits associated with the selected channel. Do not disturb those already peaked. After all channels have been peaked using the SSB mode, switch to the AM mode and with the audio gain control at its maximum counterclockwise position, adjust the "carrier inset" pot for an RF output of 25 watts. Under this condition the PA current will be approximately 100 MA. The audio level control setting for maximum modulation capability in the SSB mode will also correspond to 100% modulation in the AM mode. If the antenna system presents other than a 50 ohm impedance, the antenna transformer in the receiver chain should be re-peaked. When checking the output frequency for any channel, make certain that the vernier control is in the "12 o'clock" position before adjusting any of the crystal oscillator trimmer capacitors, C315 thru C520.

SECTION 5

OPERATION

5.1 Operating Controls: All normal operating controls are available on the front panel of the unit. The RCVR/OFF switch controls application of filament voltage to all tubes that are utilized in receiving and turns on the low and high B+ and bias voltages. The TRANS/OFF switch controls application of filament voltage to the transmitter tubes on the RF deck. The MUTE/OFF switch disables the buzzer and speaker in the OFF position. The MAN/VOX switch sets control of the transmitter for either push-to-talk or VOX. The SPKR/HS switch selects either speaker or handset earpiece receiver audio. The PHONE/CW switch connects the microphone circuit to the transmitter in the phone position and the key terminals on the rear terminal strip in the CW position. Behind the access door, the LINE IN control adjusts the level for the telephone line termination. This should be set for "0" DBM at the rear line termination. This level also provides proper level for the remote desk set earpieces. For VOX operation, the VOX gain control is adjusted to turn on the transmitter under normal speech conditions. The VOX delay control adjusts the time constant for turn off from a transmit condition and may be adjusted to anywhere from a fraction of a second to approximately two seconds. The ANTI-TRIP control is adjusted to prevent received audio from turning on the transmitter. Do not hang up the handset in the cradle when the VOX/MAN switch is in the VOX position. The line voltage is adjusted with a screwdriver to the proper position so that the test meter in the line position indicates proper voltage. The function switch must be in the operate position for transmission of phone signals from the local handset. For remote operation, either the operate position or the monitor position may be used. On the monitor position both transmit and receive audio from and to the remote may be monitored. To signal or talk to any remote position, the function switch must be turned to the intercom position. The selector switch determines what location has transmitter control when the function switch is in monitor or operate. When the selector switch is in the intercom position, depressing the handset push button will activate the buzzer at the selected position indicated by the selector switch. The white select light at the remote location will also be illuminated, indicating selection. Inter communication may be accomplished with the selected remote without depressing the push buttons. When any remote handset is removed from its cradle, its corresponding light on the front panel will light.

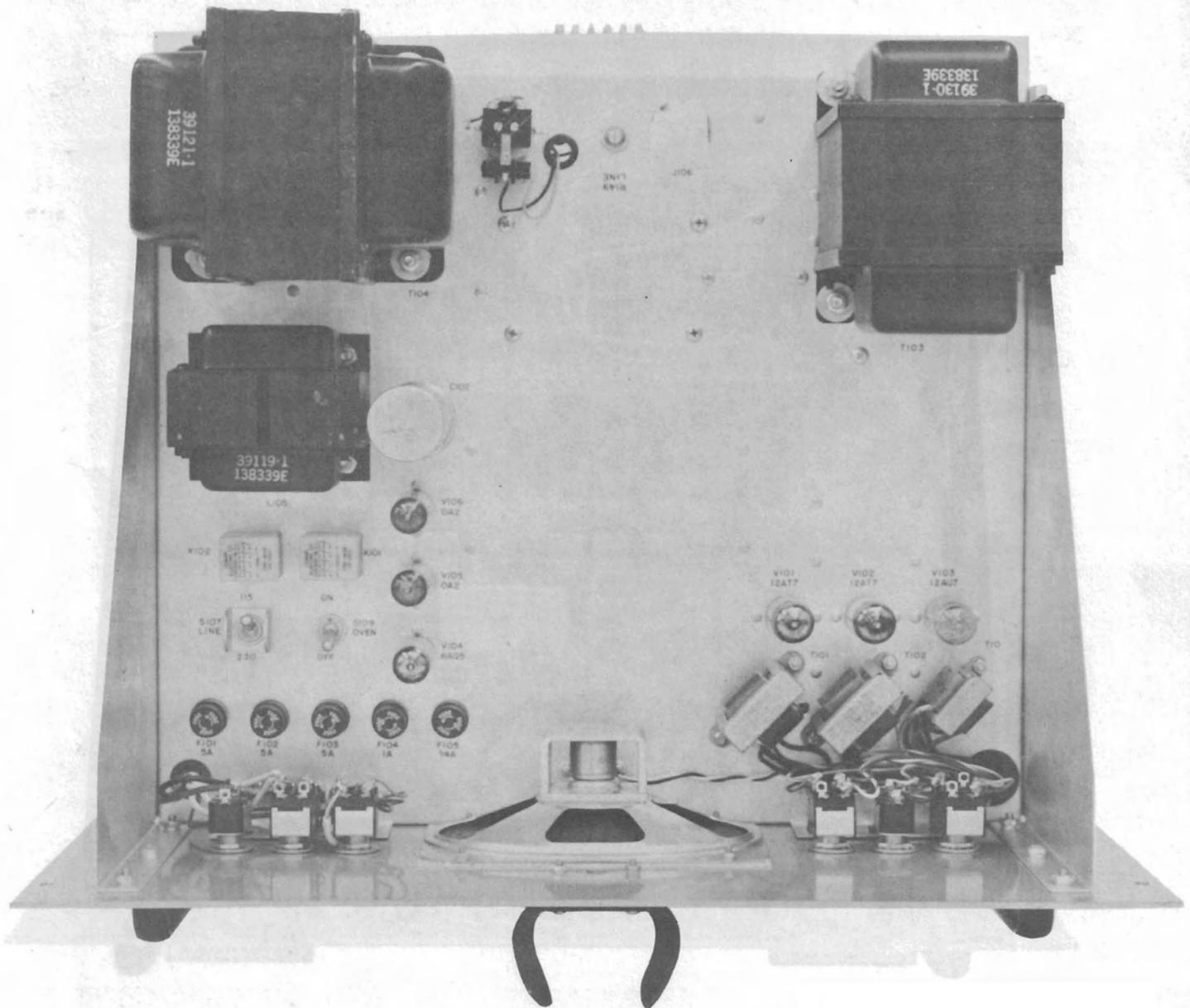
5.2 Operating Procedure: For normal push-to-talk SSB operation, set controls as follows: CHANNEL SELECTOR to desired channel. MODE SWITCH to SSB-USB. VERNIER to '12 o'clock' position. SPEECH LEVEL to '12 o'clock' position. METER SWITCH to PA position. SQUELCH CONTROL backed off counterclockwise until just squelched with no signal. VOLUME CONTROL for comfortable audio level. RCVR and TRANS switches ON, and MUTE SW in off position. RIGHT-HAND switches SET for MAN, SPKR and PHONE. FUNCTION switch should be on OPERATE and the SELECTOR switch on LOCAL (L). Push the handset push button to talk and release to receive.

SECTION 6

ROUTINE MAINTENANCE

6.1 Lubrication: The transceiver has no mechanical devices that require periodic lubrication. **Cleaning:** The unit should be kept clean of dust and dirt.

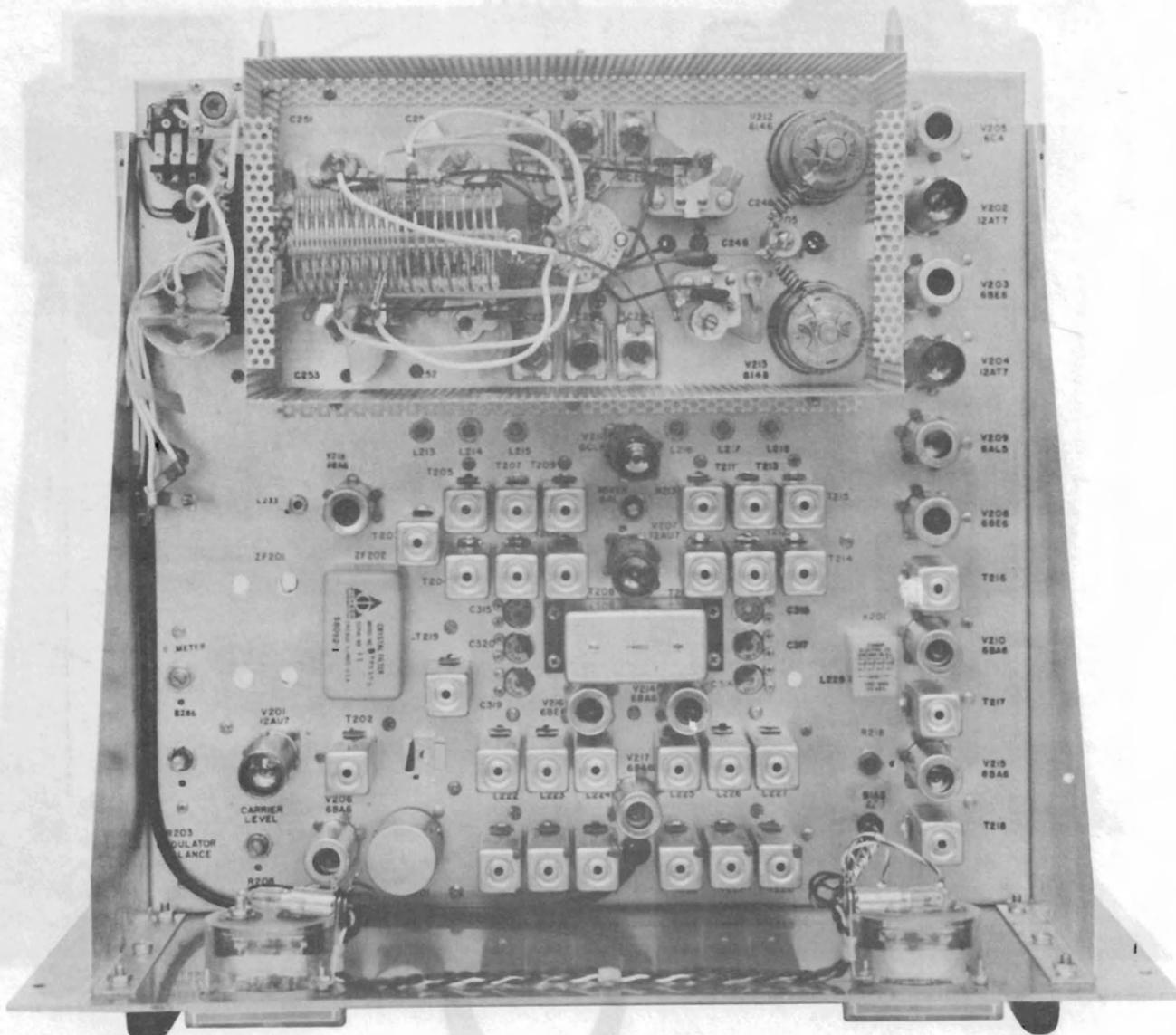
6.2 Performance Checks: Transmitter frequency, power output, and receiver sensitivity should be checked on all channels at periodic intervals. Proper operation of all panel controls should also be checked at the same time. The extent of further tests depends upon the number of hours the equipment is in use. It is not necessary, nor felt advisable, to test tubes unless the transceiver does not meet performance specifications.



RF DECK-TOP VIEW

POWER DECK-TOP VIEW

FIGURE 13



RF DECK-TOP VIEW

FIGURE 14

FIGURE 13

SECTION 7**CORRECTIVE MAINTENANCE****7.1 GENERAL INSTRUCTIONS -****Conditions for Test**

- (a) Remove the RF deck from the cabinet and inter-connect with the test cable.
- (b) Remove V214 (6AH6) and V206 (6BA6).
- (c) Apply both power and allow the set to warm up for ten minutes.
- (d) Adjust the "S" meter for zero reading with R286.
- (e) Test Points are indicated on the schematic diagram as a letter within a box **A**. Locations of test points are indicated in Fig. 22.

Test Equipment Required

- (a) Signal Generator, frequency range 1.6 MC/S - 30 MC/S; Output voltage 0.3 microvolts - 1.0 volt.
- (b) Volt ohmmeter, 20K ohms/volt, Simpson Model 260 or equal.

Optional Equipment

- (a) Audio Generator
- (b) Vacuum Tube Voltmeter
- (c) RF Voltmeter

7.2.1 Table of Resistances - RF Deck:

NOTE: All measurements are made with a 20K ohm/Volt Simpson Model 260 meter, and with the RF Deck completely disconnected from the rest of the unit. Measurements are made with the Negative Test lead grounded to the chassis.

RF DECK

Circuit Symbol	Tube Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V201	12AU7	26K	240K	4K	INF.	INF.	INF.	220K	4K	INF.
V202	12AT7	270K	1.3M	8K	INF.	INF.	0	400K	700	INF.
V203	6BE6	700K	11K	INF.	INF.	270K	270K	10K	-	-
V204	12AT7	270K	8.3K	50K	INF.	INF.	210K	400K	2.2K	-
V205	6C4	145K	NC	INF.	INF.	145K	220K	7K	-	-
V206	6BA6	47K	200	INF.	INF.	INF.	INF.	200	-	-
V207	12AT7	50K	100K	2.8K	INF.	INF.	50K	100K	2.8K	INF.
V208	6BE6	47K	280	INF.	INF.	85K	40K	48K	-	-
V209	6AL5	2M	800K	INF.	INF.	1.6	NC	300K	-	-
V210	6BA6	550K	180	INF.	INF.	22K	30K	180	-	-
V211	6CL6	0	24K	21K	INF.	INF.	26K	0	21K	24K

7.2.1 Table of Resistances - RF Deck: Contd.

NOTE: All measurements are made with a 20K ohm/Volt Simpson Model 260 meter, and with the RF Deck completely disconnected from the rest of the unit. Measurements are made with the Negative Test lead grounded to the chassis.

RF DECK

Circuit Symbol	Tube Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V212	6146	0.5	INF.	INF.	0.5	95K	0.5	INF.	0	-
V213	6146	0.5	INF.	INF.	0.5	95K	0.5	INF.	-	-
V214	6AH6	50K	200	INF.	INF.	29K	44K	200	-	-
V215	6BA6	550K	500	INF.	INF.	22K	29K	500	-	-
V216	6BE6	22K	500	INF.	INF.	28K	75K	0.2	-	-
V217	6BA6	550K	200	INF.	INF.	28K	280K	200	-	-
V218	6BA6	500K	0	INF.	INF.	28K	120K	200	-	-

7.3.1 Table of Voltages - Transmit Condition: Set controls as follows:

MODE SW - SSB/USB
 SPEECH LEVEL - CCW
 CHANNEL SW - CH1
 METER SW - PA

VOLUME - CCW
 MUTE - OFF
 MAN/VOX - MAN
 SPKR/HANDSET - SPKR

PHONE/CW - PHONE
 FUNCTION SW - OPERATE
 SELECTOR SW - LOCAL
 BIAS CONTROL ADJUST - PA-45MA

RF DECK

Circuit Symbol	Tube Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V201	12AU7	255V	0	16.8V	6.3AC	6.3AC	255V	0	16.2V	0.34AC
V202	12AT7	132V	0	2.7V	6.3AC	6.3AC	0	-0.14V	0.12V	0.34AC
V203	6BE6	0	17.5V	0.34AC	6.3AC	225V	225V	16V	-	-
V204	12AT7	192V	125V	128V	6.3AC	6.3AC	122V	0	2.06V	0.34AC
V205	6C4	144V	NC	0.34AC	6.3AC	144V	-100V	0	-	-
V206	6BA6	0	1.55V	0.34V	6.3AC	245V	85V	1.55V	-	-
V207	12AT7	205V	0	7.0V	6.3AC	6.3AC	205V	0	7.0V	0.34AC
V208	6BE6	0	2.5V	0.34AC	6.3AC	135V	92V	0	-	-
V209	6AL5	0	-0.25V	0.34AC	6.3AC	0	NC	-0.06V	-	-
V210	6BA6	0	112V	0.34AC	6.3AC	265V	112V	112V	-	-
V211	6CL6	0	-2.8V	130V	0.34AC	6.3AC	255V	0	130V	-2.8V

NOTE: All measurements made with a 20K ohm/Volt Simpson Model 260 meter.

7.3.1 Table of Voltages - Transmit Condition: Contd.

RF DECK

Circuit Symbol	Tube Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V212	6146	0.025V	0.34AC	230V	0.025V	-58V	0.025V	6.3AC	0	Plate 810V
V213	6146	0.025V	0.34AC	230V	0.025V	-58V	0.025V	6.3AC	0	Plate 810V
V214	6AH6	0	2.4V	0.34AC	6.3AC	250V	150V	2.4V	-	-
V215	6BA6	0	3.7V	0.34AC	6.3AC	250V	112V	3.7V	-	-
V216	6BE6	-0.7V	2.35V	0.34AC	6.3AC	255V	65V	0	-	-
V217	6BA6	0	112V	0.34AC	6.3AC	260V	250V	112V	-	-
V218	6BA6	0	0	0.34AC	6.3AC	250V	68V	1.4V	-	-

POWER DECK

Circuit Symbol	Tube Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V101	12AT7	60V	0	1.25V	6.3AC	6.3AC	55V	0	1.25V	0
V102	12AT7	0	0	0.05V	6.3AC	6.3AC	180V	0	1.75V	0
V103	12AU7	-0.18V	-0.18V	0.06V	6.3AC	6.3AC	255V	0	5.4V	0
V104	6AQ5	-38.5V	0	6.3AC	0	270V	270V	-38.5V	-	-
V105	OA2	NC	NC	NC	0	150V	NC	0	-	-
V106	OA2	150V	NC	NC	NC	150V	NC	0	-	-

NOTE: All measurements made with a 20K ohm/Volt Simpson Model 260 meter.

7.3.2 Table of Voltages - Receive Condition: Set controls the same as in Section 7.3.1.

RF DECK

Circuit Symbol	Tube Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V201	12AU7	0	-4.9V	0.15V	6.3AC	6.3AC	0	-4.9V	0.15V	0.34AC
V202	12AT7	135V	0	2.7V	6.3AC	6.3AC	0	-0.14V	0.12V	0.34AC
V203	6BE6	0	17.5V	0.34AC	6.3AC	225V	225V	16V	-	-
V204	12AT7	225V	98V	105V	6.3AC	6.3AC	122V	0	2.06V	0.34AC
V205	6C4	144V	NC	0.34AC	6.3AC	144V	-135V	0	-	-
V206	6BA6	0	1.55V	0.34AC	6.3AC	245V	85V	1.55V	-	-
V207	12AT7	270V	-68V	0	6.3AC	6.3AC	270V	-68V	0	0.34AC
V208	6BE6	0	2.4V	0.34AC	6.3AC	192V	82V	0	-	-
V209	6AL5	-0.15V	-4.6V	0.34AC	6.3AC	0	NC	0.56	-	-
V210	6BA6	0	1.22V	0.34AC	6.3AC	255V	62V	1.22V	-	-
V211	6CL6	0	-7.3V	172V	0.34AC	6.3AC	270V	0	172V	-7.3V
V212	6146	0	0.34AC	230V	0	-135V	0	6.3AC	0	-

NOTE: All measurements made with a 20K ohm/Volt Simpson Model 260 meter.

7.3.2 Table of Voltages - Receive Condition: Contd.

RF DECK

Circuit Symbol	Tube Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V213	6146	0	0.34AC	230V	0	135V	0	6.3AC	0	-
V214	6AH6	0	2.4V	0.34AC	6.3AC	250V	150V	2.4V	-	-
V215	6BA6	0	2.25V	0.34AC	6.3AC	255V	64V	2.25V	-	-
V216	6BE6	-0.05V	2.35V	0.34AC	6.3AC	255V	65V	0	-	-
V217	6BA6	0	2.65V	0.34AC	6.3AC	250V	125V	2.65V	-	-
V218	6BA6	0	0	0.34AC	6.3AC	250V	68V	1.4V	-	-

POWER DECK

Circuit Symbol	Tube Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V101	12AT7	60V	0	1.25V	6.3AC	6.3AC	55V	0	1.25V	0
V102	12AT7	-0.2V	-0.2V	-0.05V	6.3AC	6.3AC	255V	0	5.8V	0
V103	12AU7	-0.15V	-0.15V	0.12V	6.3AC	6.3AC	255V	0	5.4V	0
V104	6AQ5	0	16V	6.3AC	0	260V	270V	0	-	-
V105	OA2	NC	NC	NC	0	150V	NC	0	-	-
V106	OA2	150	NC	NC	NC	150V	NC	0	-	-

NOTE: All measurements made with a 20K ohm/Volt Simpson Model 260 meter.

7.4 HIGH-FREQUENCY OSCILLATOR CONNECTIONS - For proper high frequency oscillator RF output voltage, the switched leads from S201D should be connected to the plate circuit inductances as follows:

<u>Crystal Frequency</u>	<u>Inductance</u>	
2.0 - 11.0 MC/S	L220	8.2 microhenry
11.0 - 15.0 MC/S	L219	4.7 microhenry
15.0 - 19.65 MC/S	L212	2.7 microhenry

The exception is on Channel 6 which is connected to L228 and C337, if on the normal 15.0 - 30.0 MC/S range.

7.5 RECEIVER IF AND TRAP ALIGNMENT -

- (a) Connect the signal generator to test point B. Connect the output meter (Simpson 260) to test point A.
- (b) Set the mode switch to USB-AM.
- (c) Set the signal generator to 1650 MC/S with 1000 cycle 30% modulation.
- (d) Adjust the top and bottom cores of T216 and T217, of T218 and T203, and the top core of T219 for maximum output.

NOTE: The core of L233 and the bottom core of T219 are factory adjustments that affect the pass band ripple of the crystal filter and adjustments should be avoided unless found necessary. (See Section 7.6 for recommended procedure.)

With a signal generator output of 3000 microvolts, the output meter reading should approximate 0.7 volts RMS.

- (e) For trap alignment connect the signal generator to the antenna terminal with the generator tuned to 1650 KC/S and modulated 30% with a 1000 cycle tone. Adjust the core of the 1650 KC/S trap (L232 for minimum output.

7.6 FILTER ALIGNMENT -

- (a) Connect the signal generator to test point B.
- (b) Set the mode switch to USB-SSB.

- (c) Carefully vary the frequency of the signal generator ± 1650 KC/S with no modulation and note the variation in the "S" meter reading within the pass band of the crystal filter.
- (d) Set the generator to the center of the greatest dip in the pass band and peak the bottom core of T219 and the core of L233. With a generator output of S7 and S8 across the pass band. A slight readjustment following the above procedure may be necessary to achieve this ripple value.
- (e) The adjustment of T202, the input filter tuning-transmit-condition should not be made prior to completion of Sections 7.7 and 7.9.
 - (1) Remove V206 (6BA6).
 - (2) Connect the signal generator to test point E.
 - (3) Set panel test meter switch to the IPA position for output indication.
 - (4) Set the mode switch to USB-SSB.
 - (5) Key the transmitter with the handset push button and carefully vary the frequency of the signal generator ± 1650 KC/S with no modulation and note the variation in the test meter reading within the pass band of the crystal filter.
 - (6) Set the generator to the center of the greatest dip in the pass band and peak the bottom core of T202 only.
 - (7) Approximately 0.8 volt generator output should give a meter reading of 200. The variation in meter reading across the pass band should not exceed three meter scale divisions. A slight readjustment following part (f) above may be necessary to achieve this ripple value.

7.7 PRELIMINARY TRANSMITTER ADJUSTMENT - It is advisable to pretune the following circuits for ease of transmitter alignment. This is due to the wide range available on some coils and the possibility of alignment to the high-frequency oscillator or undesired beat frequency:

- (a) Connect the signal generator to test point C through a 100 pf capacitor.
- (b) Adjust the generator to the desired channel frequency with an output voltage

- (c) Turn on the transmitter with the push-to-talk button on the microphone and tune as follows:

<u>Peak</u>	<u>Test Meter Position</u>	<u>Typical Reading</u>
Channel 1	T214, T215	BAL. MOD. 30
Channel 1	L218	IPA 90
Channel 2	T212, T213	BAL. MOD. 30
Channel 2	L217	IPA 90
Channel 3	T210, T211	BAL. MOD. 30
Channel 3	L216	IPA 90
Channel 4	T208, T209	BAL. MOD. 30
Channel 4	L215	IPA 90
Channel 5	T206, T207	BAL. MOD. 30
Channel 5	L214	IPA 90
Channel 6	T204, T205	BAL. MOD. 30
Channel 6	L213	IPA 90

7.8 RECEIVER FRONT END ALIGNMENT

- Connect the signal generator to the antenna terminal and adjust the generator to the channel frequency with 1000 cycle 30% modulation.
- Connect the output meter to test point A. Set the mode switch to SSB-AM.
- Tune as follows for maximum output. If more than one peak is found, the setting with the core furthest in the coil is the correct setting:

Channel 1	T220, L227
Channel 2	T221, L226
Channel 3	T222, L225
Channel 4	T223, L224
Channel 5	T224, L223
Channel 6	T225, L222

With an input of 50 microvolts, the output will be approximately 0.8 volts rms., and the "S" meter will indicate approximately S6 or more.

7.9 TRANSMITTER ALIGNMENT 1650 KC -

- (a) Replace V214 (6AH6). The injection voltage at test point D should be 6 volts rms. or more as measured with an RF voltmeter.

NOTE: The Preliminary Transmitter Adjustment should be made prior to the following alignment. (See Section 7.7)

- (b) Set the mode switch to USB-AM.
- (c) Set the modulator balance control R203 and the carrier level control R208 in their fully clockwise positions.
- (d) Set the test meter to the IPA position.
- (e) Key the transmitter with the handset, push button, and adjust the top core of T203 for maximum reading.
- (f) Set the mode switch to USB-SSB. Key the transmitter and adjust the top core of T202 for maximum reading.

NOTE: If necessary, the bottom core of T202 may be adjusted to secure minimum ripple. (See Section 7.6 Filter Alignment)

- (g) Adjust the modulator balance control for minimum reading.

NOTE: C210 is a factory adjustment which has been made in conjunction with T202 and R203 for maximum carrier suppression. It should not require readjustment in the field.

7.10 CHANNEL FREQUENCY ALIGNMENT, BALANCED MIXER & IPA -

- (a) Set mode switch to USB-AM.
- (b) Set carrier level control R208 fully clockwise.
- (c) Key the transmitter and recheck all adjustments listed under Preliminary Transmitter Alignment.
- (d) Adjust the carrier level control for adequate meter readings on the first channel. This adjustment should hold for this portion of the transmitter alignment.

7.11 EQUALIZATION OF DRIVE - With the test meter in the IPA position, the reading should be noted on all channels. Readjust the carrier level control R208 for a meter reading between 180 and 200. Adjustment should be made as necessary to equalize the RF voltage to the grids of the 6146 tubes as indicated by the panel test meter. This may be accomplished by a slight detuning of the IPA grid coils. Channels should be adjusted to the reading of the lowest channel as follows:

Channel 1 (T215) Adjust to the high-frequency side,
(core furthest out of coil)

Channel 2 (T213, T211, T209, T207 and T205) Adjust
thru 6 to the low-frequency side,
(core furthest in to coil)

7.12 FREQUENCY CHECK - A frequency meter may be coupled to the grid circuit of the final stage thru a 10 pf capacitor.

(a) Set vernier knob to "12" o'clock.

(b) Set mode switch to USB-AM.

(d) Adjust to frequency as follows:

Channel 1	-	C319
Channel 2	-	C320
Channel 3	-	C315
Channel 4	-	C318
Channel 5	-	C317
Channel 6	-	C316

7.13 TRANSMITTER PA ALIGNMENT -

(a) Remove all power from the equipment.

(b) Placement of taps on coils should be made, using the following chart as a guide: Coil clips for the various channels are color coded as follows:

Channel 1	-	Brown
Channel 2	-	Red
Channel 3	-	Orange
Channel 4	-	Yellow
Channel 5	-	Green
Channel 6	-	Blue

Coil turns are numbered from the switch end of the coil:

2 MC/S	31 turns
3 MC/S	24 turns
4 MC/S	18 turns
6 MC/S	12 turns
10 MC/S	9 turns
14 MC/S	6 turns
20 MC/S	5 turns
30 MC/S	2 turns

- (c) Reconnect R245 and R246.
- (d) Connect a 50 ohm dummy load to the antenna connector.
- (e) Set the mode switch to USB-SSB and the speech level control counterclockwise.
- (f) Key the transmitter with the handset push button and adjust the bias control (R218) for a PA reading of 45 MA (400 MA scale).
- (g) Connect a telegraph key across terminals TB5-3 and TB2-10 (GND) on the rear of the cabinet.
- (h) Place the phone/CW switch in the CW position; the VOX/manual switch in the VOX position, and the test meter in the PA position.
- (i) Close the key and adjust the VOX control for CW/VOX operation.
- (j) Set the speech level control to the "12 o'clock" position and key the transmitter with the hand key. Do not exceed a PA reading of more than 250 MA. When the meter reads greater than 250 MA, decrease the current with the speech level control.
- (k) Capacitor adjustments are as follows:

<u>Channel No.</u>	<u>Tuning</u>	<u>Loading</u>
1	C253	C259
2	C252	C258
3	C251	C257
4	C250	C256
5	C249	C255
6	C248	C254

Starting with the loading capacitor fully compressed, resonate the tuning capacitor for a minimum PA meter reading. Adjust the loading capacitor counterclockwise to increase the loading, and re-dip with the tuning capacitor until the indicated plate current is 200 to 250 MA. Always make the tuning capacitor adjustment last.

7.14 Trouble Chart Transmitter:**(a) No output or Low Output:**

- (1) Check high-frequency oscillator at test point D for an RF output voltage of 6V. RMS or more.
- (2) Screen voltage of V212 and V213 should be approximately 220V.
- (3) Check RF voltage at the grids of V212 and V213... should be at least 30V RMS.
- (4) Check High voltage to Power Amplifier.
- (5) Check 1650 KC/S oscillator (V206) for RF output.
- (6) Check for proper relay operation.

(b) No CW Output:

- (1) Check tone oscillator for oscillation.
- (2) Check VOX circuitry for proper operation from tone oscillator signal.

7.15 Trouble Chart-Receiver:**(a) Low volume or no volume: Check the following:**

- (1) High-frequency Oscillator (V214)
- (2) CR 2074 CR208 for low back resistance.
- (3) SSB - V206 1650 KC/S OSC) and product detector (V208)
- (4) AM - Check AM detector (V209)
- (5) Relay action K201, K202, and K203.
- (6) Audio stages V203, V202B and V204

(b) No squelch action: Check V204B and V217**(c) No AGC action. Check V204A, V202A, CR205, CR206, and CR204.**

SECTION 8**CHANGING CHANNEL FREQUENCIES****8.1 Changes Within a Range:**

- (a) Check high-frequency oscillator connection for the new frequency (para. 7.4) and change crystal.
- (b) Retune transmitter and receiver circuits as outlined in (paras. 7.7, 7.9, 7.10, 7.11, 7.12 and 7.13.)
- (c) All channels must progressively increase in frequency.

8.2 Changes Requiring a Change in Range:

- (a) Check the frequency conscious components list for the necessary parts and replace as required.
- (b) Follow steps as listed in (para. 8.1).

SECTION 9

REPLACEMENT PARTS LIST

9.1 Cabinet Parts:

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
J-101	Plug, 30 contacts	M41156-2
J-102	Socket, 21 contacts	M41157-1
J-103	Plug, 33 contacts	M41156-3
J-201	Socket, 33 contacts	M41157-3
TB-1/TB-2	Terminal Strip, 20 term.	M58026-1
TB-3/TB-4	Terminal Strip, 20 term.	M58026-1
TB-5	Terminal Strip, 10 term.	K15891-10

9.2 Power Deck Parts:

C-101	Capacitor, disc ceramic .01 MFD, $\pm 20\%$, 500V	M23034-28
C-102	Capacitor, electrolytic 80/10 MFD,	K15504-58
C-102A	10MFD, 450V	Included in C-102
C-102B	80 MFD, 450V	Included in C-102
C-103	Capacitor, mylar .22 MFD, $\pm 10\%$, 400V	K23933-1
C-104	Capacitor, disc ceramic .01 MFD, $\pm 20\%$, 500V	M23034-28
C-105	Capacitor, disc ceramic .01 MFD, $\pm 20\%$, 500V	M23034-28
C-106	Capacitor, disc ceramic .01 MFD, $\pm 20\%$, 500V	M23034-28
C-107	Capacitor, disc ceramic .01 MFD, $\pm 20\%$, 500V	M23034-28
C-108	Capacitor, disc ceramic .01 MFD, $\pm 20\%$, 500V	M23034-28
C-109	Capacitor, electrolytic 20 MFD, 25V	M23091-1
C-110	Capacitor, mylar .22 MFD, $\pm 10\%$, 400V	K23933-1
C-111	Capacitor, disc ceramic .01 MFD, $\pm 20\%$, 500V	M23034-28
C-112	Capacitor, mylar .22 MFD, $\pm 10\%$, 400V	K23933-1
C-113	Capacitor, electrolytic 20 MFD, 25V	M23091-1

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
C-114	Capacitor, electrolytic 10 MFD, 25V	K23073-1
C-115	Capacitor, electrolytic 10 MFD, 25V	K23073-1
C-116	Capacitor, disc ceramic .01 MFD, GMV 1400V	M23034-26
C-117	Capacitor, disc ceramic .01 MFD, GMV 1400V	M23034-26
C-118	Capacitor, disc ceramic .01 MFD, GMV 1400V	M23034-26
C-119	Capacitor, disc ceramic .01 MFD, GMV 1400V	M23034-26
C-120	Capacitor, electrolytic 100 MFD, 150V	K23073-85
C-121	Capacitor, electrolytic 20 MFD, 150V	K23073-77
C-122	Capacitor, electrolytic 100 MFD, 450V	K23088-2
C-123	Capacitor, electrolytic 100 MFD, 450V	K23088-2
C-124	Capacitor, electrolytic 100 MFD, 450V	K23088-2
C-125	Capacitor, mylar .22 MFD, $\pm 10\%$, 400V	K23933-1
C-126	Capacitor, electrolytic 20/20 MFD, 150V	K23100-1
C-127	Capacitor, disc ceramic .01 MFD, $\pm 20\%$, 500V	M23034-28
C-128	Capacitor, disc ceramic .01 MFD, GMV, 1000V	M23034-8
C-129	Capacitor, disc ceramic .01 MFD, $\pm 20\%$, 500V	M23034-28
C-130	Capacitor, mylar .1 MFD, $\pm 10\%$, 200V	K23933-2
CR-101	Rectifier, silicon 250MA 1000 PIV	M41215-4
CR-102	Rectifier, silicon 250MA 1000V PIV	M41215-4
CR-103	Rectifier, silicon 250MA 1000V PIV	M41215-4
CR-104	Rectifier, silicon 250 MA 1000V PIV	M41215-4
CR-105	Rectifier, silicon 250 MA 1000V PIV	M41215-4

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
CR-106	Rectifier, silicon 250 MA 1000V PIV	M41215-4
CR-107	Rectifier, silicon 250 MA 1000V PIV	M41215-4
CR-108	Rectifier, silicon 250 MA 1000V PIV	M41215-4
CR-109	Rectifier, silicon 250 MA 1000V PIV	M41215-4
CR-110	Rectifier, silicon 250 MA 1000V PIV	M41215-4
CR-111	Rectifier, silicon 250 MA 1000V PIV	M41215-4
CR-112	Rectifier, silicon 250 MA 1000V PIV	M41215-4
CR-113	Rectifier, silicon 250 MA 1000V PIV	M41215-4
CR-114	Rectifier, silicon 250MA 1000V PIV	M41215-4
CR-115	Rectifier, silicon 150 MA 400V PIV	M41215-2
DS-101	Buzzer, 90V DC	K58058-1
F-101	Fuse, cartridge 5A, 125V Slo-Blow	K15888-6
F-102	Fuse, cartridge 5A. 125V Slo-Blow	K15888-6
F-102	Fuse, cartridge 5A. 125V Slo-Blow	K15888-6
F-104	Fuse, cartridge 1A. 250V	K15928-5
F-105	Fuse, cartridge 1/4A, 250V	K15928-2
I-101	Lamp, neon, white	K51033-7
I-102	Lamp, neon, white	K51033-7
I-103	Lamp, neon, white	K51033-7
I-104	Lamp, neon, red	K51033-8
I-105	Lamp, neon, white	K51033-7
I-106	Lamp, neon, yellow	K51033-9
J-104	Connector, female Mike.	K15972-1
J-105	Jack, phone	K41113-3
K-101	Relay, 4PDT 110V DC	K40417-1
K-102	Relay, 4PDT 110V DC	K40417-1

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
L-101	Choke, RF	K58066-1
L-102	Choke, RF	K58066-1
L-103	Choke, filter 8 H. @ 20 MA	M39122-1
L-104	Choke, filter, swinging 13 H. @ 50 MA DC 3.5 H. @ 200 MA DC	K42357-2
L-105	Choke, filter 7 H. @ 225 MA	M39110-1
LS-101	Speaker, 4 x 6, 3.2 ohms	M26646-1
P-101	Socket, 30 contacts	M41157-2
P-102	Plug, 21 contacts	M41156-1
P-103	Socket, 33 contacts	M41157-3
R-101	Resistor, variable, 1 meg VOX gain	K15382-13
R-102	Resistor, fixed 100K, $\pm 10\%$, 1/2 watt	K19309-97
R-103	Resistor, fixed 470K, $\pm 10\%$, 1/2 watt	K19309-113
R-104	Resistor, fixed 2.7K, $\pm 10\%$, 1/2 watt	K19309-59
R-105	Resistor, variable, 1 meg Anti-trip	K15382-13
R-106	Resistor, fixed 100K, $\pm 10\%$, 1/2 watt	K19309-97
R-107	Resistor, fixed 100K, $\pm 10\%$, 1/2 watt	K19309-97
R-108	Resistor, fixed 12K, $\pm 10\%$, 1/2 watt	K19309-75
R-109	Resistor, fixed 1 meg, $\pm 10\%$, 1/2 watt	K19309-121
R-110	Resistor, fixed 470K, $\pm 10\%$, 1/2 watt	K19309-113
R-111	Resistor, fixed 2.7K, $\pm 10\%$, 1/2 watt	K19309-59
R-112	Resistor, fixed 1 meg, $\pm 10\%$, 1/2 watt	K19309-121
R-113	Resistor, fixed 220 ohms, $\pm 10\%$, 1/2 watt	K19309-33
R-114	Resistor, fixed 100K, $\pm 10\%$, 1/2 watt	K19309-97
R-115	Resistor, fixed 1 meg, $\pm 10\%$, 1/2 watt	K19309-121
R-116	Resistor, variable, 1 meg Line in gain	K15382-13

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
R-117	Resistor, fixed 1 meg, $\pm 10\%$, 1/2 watt	K19309-121
R-118	Resistor, fixed 1 meg, $\pm 10\%$, 1/2 watt	K19309-121
R-119	Resistor, variable, 5 meg VOX delay	K15382-14
R-120	Resistor, variable, 1 meg Receiver volume	K15382-15
R-121	Resistor, fixed 4.7 meg, $\pm 10\%$, 1/2 watt	K19309-137
R-122	Resistor, fixed 33K, $\pm 10\%$, 2 watt	K19304-54
R-122	Resistor, fixed 1K, $\pm 10\%$, 1/2 watt	K19309-49
R-124	Resistor, fixed 1 meg, $\pm 10\%$, 1/2 watt	K19309-121
R-125	Resistor, fixed 470 ohm, $\pm 10\%$, 2 watt	K19304-10
R-126	Resistor, fixed 3.3 ohm, $\pm 10\%$, 5 watt	K19336-1
R-128	Resistor, fixed 3.3 ohm, $\pm 10\%$, 5 watt	K19336-1
R-129	Resistor, fixed 220 ohm, $\pm 10\%$, 1/2 watt	K19309-33
R-130	Resistor, fixed 150 ohms, $\pm 10\%$, 1/2 watt	K19309-29
R-131	Resistor, fixed 47K, $\pm 10\%$, 2 watt	K19304-58
R-132	Resistor, fixed 1K, $\pm 10\%$, 1/2 watt	K19309-49
R-133	Resistor, fixed 47K, $\pm 10\%$, 2 watt	K19304-58
R-134	Resistor, fixed 1K, $\pm 10\%$, 1/2 watt	K19309-49
R-135	Resistor, fixed 47K, $\pm 10\%$, 1/2 watt	K19309-89
R-136	Resistor, fixed 47K, $\pm 10\%$, 1/2 watt	K19309-89
R-137	Resistor, fixed 47K, $\pm 10\%$, 1/2 watt	K19309-89
R-138	Resistor, fixed 47K, $\pm 10\%$, 1/2 watt	K19309-89
R-139	Resistor, variable, 10K Squelch	K15382-16

<u>Csrcuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
R-140	Resistor, fixed 47K, $\pm 10\%$, 1/2 watt	K19309-89
R-141	Resistor, fixed 47K, $\pm 10\%$, 1/2 watt	K19309-89
R-142	Resistor, fixed 220 ohms, $\pm 10\%$, 1/2 watt	K19309-33
R-143	Resistor, fixed 5K, $\pm 10\%$, 10 watt W. W.	K19337-4
R-144	Resistor, fixed 2K, $\pm 10\%$, 10 watt W. W.	K19337-6
R-145	Resistor, fixed 20K, $\pm 10\%$, 10 watt W. W.	K19337-12
R-146	Resistor, fixed 20K, $\pm 10\%$, 10 watt W. W.	K19337-12
R-147	Resistor, fixed 20K, $\pm 10\%$, 10 watt W. W.	K19337-12
R-148	Resistor, fixed 47K, $\pm 10\%$, 1/2 watt	K19309-89
R-149	Resistor, variable, 10K Line out gain	K15382-17
R-150	Resistor, fixed 3.3 ohm, $\pm 10\%$, 5 watt	K19336-1
R-151	Resistor, fixed 1K, $\pm 10\%$, 1/2 watt	K19309-49
R-152	Resistor, fixed 1 meg, $\pm 10\%$, 1/2 watt	K10309-121
R-153	Resistor, fixed 3K, $\pm 10\%$, 10 watt, W. W.	K19337-2
R-154	Resistor, fixed 47K, $\pm 10\%$, 1 watt	K19310-89
R-155	Resistor, fixed 6.8K, $\pm 10\%$, 1/2 watt	K19309-69
S-101	Switch, toggle, DPDT 3A. 250V AC 6A. 125V AC	K52032-1
S-102	Switch, toggle, SPDT 10A. 250V AC 15A. 125V AC	K52031-1
S-103	Switch, toggle, DPDT 3A. 250V AC 6A. 125V AC	K52032-1
S-104	Switch, function, 3 deck 9 pole, 3 position	M52034-1
S-105	Switch, selector, 4 deck 8 pole, 5 position	M52035-1

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
S-106	Switch, toggle, DPDT 3A. 250V AC 6A. 125V AC	K52032-1
S-107	Switch, toggle, SPDT 10A. 250V AC 15A. 125V AC	K52031-1
S-108	Switch, toggle, SPDT 10A. 250V AC 15A. 125V AC	K52031-1
S-109	Switch, toggle, SPDT 3A. 125V AC 6A. 125V AC	K52031-2
S-110	Switch, tap 10A. 150V AC 1 pole, 5 position	K52028-1
S-111	Switch, toggle, DPDT 3A. 250V AC 6A. 125V AC	K52032-1
T-101	Transformer, output Plate to 500 ohms	K40063-1
T-102	Transformer, output Plate to 3.2 ohms	K40063-2
T-103	Tapped autoformer 115/230 to 115	P39130-1
T-104	Transformer, power Primary, 115V AC Secondary <u>SEC. #1</u> 900-0-900V AC - 250 MA tapped @ 350-0-350V AC - 225 MA bias tap @ 120V AC <u>SEC. #2</u> 6.3 AC @ 11A	P39121-1
T-105	Transformer, line matching 500 ohms balanced to 500 ohms unbalanced	K40060-1

9.3 RF Deck Parts:

C-201	Capacitor, Disc ceramic .01 MFD \pm 20% 500V	M23034-28
C-202	Capacitor, Disc ceramic .01 MFD \pm 20% 500V	M23034-28
C-203	Capacitor, Dur-Mica DM-15 220 pf \pm 5% 500V	K23006-10
C-204	Capacitor, Dur-Mica DM-15 220 pf \pm 5% 500V	

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
C-205	Capacitor, Dur-Mica DM-15 270pf \pm 5% 500V	K23006-93
C-206	Capacitor, Dur-Mica DM-15 47pf \pm 10% 500V	K23006-6
C-207	Capacitor, Disc ceramic .01 MFD \pm 20% 500V	M23034-28
C-208	Capacitor, Disc ceramic .01 MFD \pm 20% 500V	M23034-28
C-209	Capacitor, Disc ceramic .01 MFD \pm 20% 500V	M23034-28
C-210	Capacitor, Trimmer 3-35 pf	K23043-5
C-211	Capacitor, Dur-Mica DM-15 17 pf \pm .5 pf% 500V	K23006-82
C-212	Capacitor, Feed-Thru .001 MFD GMV 500V	K23940-4
C-213	Capacitor, Variable 15 pf	K34452-49
C-214	Capacitor, Temp. Compensating 15 pf	K23061-173
C-215	Capacitor, Dur-Mica DM-15 200 pf \pm 5% 300V	K23006-52
C-216	Capacitor, Disc ceramic .002 MFD \pm 20% 1KV	M23034-54
C-217	Capacitor, Dur-Mica DM-15 47 pf \pm 10% 500V	K23006-6
C-218	Capacitor, Disc ceramic .002 MFD \pm 20% 1KV	M23034-54
C-219	Capacitor, Disc ceramic .002 MFD \pm 20% 1KV	M23034-54
C-220	Capacitor, Disc ceramic .01 MFD \pm 20% 500V	M23034-28
C-221	Capacitor, Feed Thru .001 MFD GMV 500V	K23940-4
C-222	Capacitor, Dur-Mica DM-15 30 pf \pm 2% 500V	K23006-109
C-223	Capacitor, Dur-Mica DM-15 100 pf \pm 10% 500V	K23006-1
C-224	Capacitor, Disc ceramic .005 MFD \pm 20% 500V	M23034-31
C-225	Capacitor, Dur-Mica DM-15 25 PF \pm 5% 500V	K23006-142

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
C-226	Capacitor, Disc ceramic .01 MFD \pm 20% 500V	M23034-28
C-227	Capacitor, Dur-Mica DM-15 7 pf \pm .5 pf 500V	K23006-24
C-228	Capacitor, Dur-Mica DM-15 10 pf \pm 10% 500V	K23006-8
C-229	Capacitor, Dur-Mica DM-15 100 pf \pm 10% 500V	K23006-1
C-230	Capacitor, Dur-Mica DM-15 47 pf \pm 10% 500V	K23006-6
C-231	Capacitor, Dur-Mica DM-15 47 pf \pm 10% 500V	K23006-6
C-232	Capacitor, Dur-Mica DM-15 47 pf \pm 10% 500V	K23006-6
C-233	Capacitor, Dur-Mica DM-15 47 pf \pm 10% 500V	K23006-6
C-234	Capacitor, Disc ceramic .001 MFD GMV 500V	M23034-30
C-235	Capacitor, Dur-Mica DM-15 220 pf \pm 5% 500V	K23006-10
C-236	Capacitor, Disc ceramic .001 MFD GMV 500V	M23034-30
C-237	Capacitor, Disc ceramic .001 MFD GMV 500V	M23034-30
C-238	Capacitor, Disc ceramic .002 MFD \pm 20% IKV	M23034-54
C-239	Capacitor, Dur-Mica DM-15 220 pf \pm 5% 500V	K23006-10
C-240	Capacitor, Disc ceramic .001 MFD GMV 500V	M23034-30
C-241	Capacitor, Disc ceramic .002 MFD \pm 20% IKV	M23034-54
C-242	Capacitor, Disc ceramic .001 MFD GMV 500V	M23034-30
C-243	Capacitor, Dur-Mica DM-15 47 pf \pm 10% 500V	K23006-6
C-244	Capacitor, Disc ceramic .001 MFD GMV 500V	M23034-30
C-245	Capacitor, Disc ceramic .01 MFD \pm 20% 500V	M23034-28
C-246	Capacitor, Variable 15 pfn 750V RMS	K34453-G9
C-247	Capacitor, Disc ceramic .002 MFD \pm 20% IKV	M23034-54

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
* C-248	Capacitor, Variable	M4112-X
* C-249	Capacitor, Variable	M4112-X
* C-250	Capacitor, Variable	M4112-X
* C-251	Capacitor, Variable	M4112-X
* C-252	Capacitor, Variable	M4112-X
* C-253	Capacitor, Variable	M4112-X
* C-254	Capacitor, Trimmer	K23935-X
* C-255	Capacitor, Trimmer	K23935-X
* C-256	Capacitor, Trimmer	K23935-X
* C-257	Capacitor, Trimmer	K23935-X
* C-258	Capacitor, Trimmer	K23935-X
* C-259	Capacitor, Trimmer	K23935-X
* C-260	Capacitor, Dur-Mica DM-15 $\pm 5\%$ 500V	K23006-X
* C-261	Capacitor, Dur-Mica DM-15 $\pm 5\%$ 500V	K23006-X
* C-262	Capacitor, Dur-Mica DM-15 $\pm 5\%$ 500V	K23006-X
* C-263	Capacitor, Dur-Mica DM-15 $\pm 5\%$ 500V	K23006-X
* C-264	Capacitor, Dur-Mica DM-15 $\pm 5\%$ 500V	K23006-X
* C-265	Capacitor, Dur-Mica DM-15 $\pm 5\%$ 500V	K23006-X
C-266	Capacitor, Disc ceramic .005 MFD $\pm 20\%$ 500V	M23034-31
C-267	Capacitor, Disc ceramic .002 MFD $\pm 20\%$ 1KV	M23034-54
C-268	Capacitor, Disc ceramic .002 MFD $\pm 20\%$ 1KV	M23034-54
C-269	Capacitor, Disc ceramic .005 MFD $\pm 20\%$ 500V	M23034-31
C-270	Capacitor, Dur-Mica DM-15 10 pf $\pm 10\%$ 500V	K23006-8
C-271	Capacitor, Disc ceramic .001 MFD GMV 3KV	M23034-32
C-272	Capacitor, Disc ceramic .01 MFD $\pm 20\%$ 500V	M23034-28
C-273	Capacitor, Disc ceramic .001 MFD GMV 500V	M23034-30
C-274	Capacitor, Disc ceramic .001 MFD GMV 3KV	M23034-32

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
* C-275	Capacitor, Dur-Mica DM-15 + 5% 500V	K23095-X
* C-276	Capacitor, Dur-Mica DM-15 + 5% 500V	K23095-X
* C-277	Capacitor, Dur-Mica DM-15 + 5% 500V	K23095-X
* C-278	Capacitor, Dur-Mica DM-15 + 5% 500V	K23095-X
* C-279	Capacitor, Dur-Mica DM-15 + 5% 500V	K23095-X
* C-280	Capacitor, Dur-Mica DM-15 + 5% 500V	K23095-X
C-281	Capacitor, Disc ceramic 470 pf + 20% 500V	M23034-15
C-282	Capacitor, Disc ceramic .01 MFD + 20% 500V	M23034-28
C-283	Capacitor, Disc ceramix .01 MFD + 20% 500V	M23034-28
C-284	Capacitor, Disc ceramix .01 MFD + 20% 500V	M23034-27
C-285	Capacitor, Electrolytic 20 MFD 350V	K23088-1
C-286	Capacitor, Disc ceramic .005 MFD + 20% 500V	M23034-31
C-287	Capacitor, Disc ceramic .005 MFD + 20% 500V	M23034-31
* C-288	Capacitor, Dur-Mica VDM-20 360 pf + 5% 1000V	K23095-5
C-289	Capacitor, Disc ceramic .01 MFD + 20% 500V	M23034-28
C-290	Capacitor, Mylar .22 MFD + 10% 400V	K23933-1
C-291	Capacitor, Mylar .1 MFD + 10% 200V	K23933-2
C-292	Capacitor, Disc ceramic .005 MFD + 20% 500V	M23034-31
C-293	Capacitor, Disc ceramix .02 MFD + 80-20% 500V	M23034-27
C-294	Capacitor, Disc ceramic .02 MFD + 80% 500V	M23034-27
C-295	Capacitor, Disc ceramic .005 MFD + 20% 500V	M23034-31
C-296	Capacitor, Electrolytic 8 MFD 350V	K23073-24

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
C-297	Capacitor, Disc ceramic .02 MFD ± 80 -20% 500V	M23034-27
C-298	Capacitor, Mylar .22 MFD 125V	K23927-3
C-299	Capacitor, Mylar .22 MFD 125V	K23927-3
C-300	Capacitor, Electrolytic 20 MFD 25V	M23091-1
C-301	Capacitor, Dur-Paper .047 MFD $\pm 20\%$ 400V	K23045-2
C-302	Capacitor, Mylar .1 MFD $\pm 10\%$ 200V	K23933-2
C-303	Capacitor, ceramix .001 MFD GMV 500V	M23034-30
C-304	Capacitor, Disc ceramix .01 MFD $\pm 20\%$ 500V	M23034-28
C-305	Capacitor, Electrolytic 20 MFD 150V	K23073-77
C-306	Capacitor, Disc ceramix .01 MFD $\pm 20\%$ 500%	M23034-28
C-307	Capacitor, Disc ceramic .02 MFD $\pm 30\%$ 500V	M23034-7
C-308	Capacitor, Disc ceramix .02 MFD $\pm 30\%$ 500V	M23034-7
C-309	Capacitor, Disc ceramic .01 MFD $\pm 20\%$ 500V	M23034-28
C-310	Capacitor, Mylar .22 MFD 400V	K23933-1
C-311	Capacitor, Disc ceramic .01 MFD $\pm 20\%$ 500V	M23034-30
C-312	Capacitor, Dur-Mica DM-15 500 pf $\pm 10\%$ 1000V	M23034-13
C-313	Capacitor, Disc. ceramic 470 pf $\pm 20\%$ 500V	M23034-15
C-314	Capacitor, Disc ceramic .001 MFD GMV 500V	M23034-30
C-315	Capacitor, Trimmer 5-25 pf NPO	K23038-3
C-316	Capacitor, Trimmer 5-25 pf NPO	K23038-3
C-317	Capacitor, Trimmer 5-25 pf NPO	K23038-3
C-318	Capacitor, Trimmer 5-25 pf NPO	K23038-3

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
C-319	Capacitor, Trimmer 5-25 pf NPO	K23033-3
C-320	Capacitor, Trimmer 5-25 pf NPO	K23038-3
C-321	Capacitor, Dura-Paper .047 MFD $\pm 20\%$ 400V	K23045-2
C-322	Capacitor, Disc ceramic .01 MFD $\pm 20\%$ 500V	M23034-28
C-323	Capacitor, Dura-Paper .047 MFD $\pm 20\%$ 400V	K23045-2
C-324	Capacitor, Mylar .1 MFD $\pm 10\%$ 200V	k23933-2
C-325	Capacitor, Dur-Mica DM-15 10 pf $\pm 10\%$ 500V	K23006-B
C-326	Capacitor, DM-15 220 pf $\pm 5\%$ 500V	K23006-10
C-327	Capacitor, Disc ceramic .01 MFD $\pm 20\%$ 500V	M23034-28
C-328	Capacitor, Mylar .1 MFD $\pm 10\%$ 200V	K23933-2
C-329	Capacitor, Mylar .1 MFD $\pm 10\%$ 200V	K23933-2
C-330	Capacitor, Disc ceramic .01 MFD $\pm 20\%$ 500V	M23034-28
C-331	Capacitor, Disc ceramic .01 MFD $\pm 20\%$ 500V	M23034-28
C-332	Capacitor, Disc ceramic .01 MFD $\pm 20\%$ 500V	M23034-28
C-333	Capacitor, Disc ceramic .01 MFD $\pm 20\%$ 500V	M23034-28
C-334	Capacitor, Disc ceramic .01 MFD $\pm 20\%$ 500V	M23034-28
C-335	Capacitor, Disc ceramic .01 MFD $\pm 20\%$ 500V	M23034-28
C-336	Capacitor, Dur-Mica DM-15 10 pf $\pm 10\%$ 500V	K23006-8
* C-337	Capacitor, Dur-Mica DM-15 47 pf $\pm 10\%$ 500V	K23006-6
C-338	Capacitor, Disc ceramic .002 MFD $\pm 20\%$ 1KV	M23034-54
C-339	Capacitor, Dur-Mica DM-15 100 pf $\pm 10\%$ 500V	K23006-1
C-340	Capacitor, Disc ceramic .002 MFD $\pm 20\%$ 1KV	M23034-54

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
C-341	Capacitor, Disc ceramic .01 MFD $\pm 20\%$ 500V	M23034-28
C-342	Capacitor, Disc ceramic .01 MFD $\pm 20\%$ 500V	M23034-28
C-343	Capacitor, Disc ceramic .002 MFD $\pm 20\%$ 1KV	M23034-54
C-344	Capacitor, Disc ceramic .001 MFD GMV 500V	M23034-30
C-345	Capacitor, Dur-Mica DM-15 10 pf $\pm 10\%$ 500V	K23006-8
C-346	Capacitor, Dur-Mica DM-15 47 pf $\pm 10\%$ 500V	K23006-6
C-347	Capacitor, Disc ceramic .001 MFD GMV 500V	M23034-30
C-348	Capacitor, Metalized Paper 1 MFD 200V	K23035-7
C-349	Capacitor, Disc ceramic .001 MFD GMV 500V	M23034-30
C-350	Capacitor, Disc ceramic .002 MFD $\pm 20\%$ 1KV	M23034-54
C-351	Capacitor, Dur-Mica DM-15 100 pf $\pm 5\%$ 300V	Included in L-232
C-352	Capacitor, Disc ceramic .001 MFD GMV 500V	M23034-30
C-353	Capacitor, Disc ceramic .01 MFD $\pm 20\%$ 500V	M23034-28
C-354	Capacitor, Disc ceramic .01 MFD $\pm 20\%$ 500V	M23034-28
C-355	Capacitor, Disc ceramic .002 MFD $\pm 20\%$ 1KV	M23034-54
C-356	Capacitor, Disc ceramic .002 MFD $\pm 20\%$ 1KV	M23034-54
C-357	Capacitor, Disc ceramic .002 MFD $\pm 20\%$ 1KV	M23034-54
C-358	Capacitor, Disc ceramic .002 MFD $\pm 20\%$ 1KV	M23034-54
C-359	Capacitor, Disc ceramic .002 MFD $\pm 20\%$ 1KV	M23034-54
C-360	Capacitor, Disc ceramic .002 MFD $\pm 20\%$ 1KV	M23034-54
C-361	Capacitor, Disc ceramic .02 MFD $\pm 80-20\%$ 500V	M23034-27
C-362	Capacitor, Feed-thru .001 MFD GMV 500V	K23940-4

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
C-363	Capacitor, Feed-thru .001 MFD GMV 500V	K23940-4
C-364	Capacitor, Disc ceramic .01 MFD $\pm 80-20\%$ 500V	M23034-28
C-365	Capacitor, Disc ceramic .01 MFD $\pm 80-20\%$	M23034-28
C-366	Capacitor, Disc ceramic .01 MFD $\pm 80-20\%$ 500V	M23034-28
C-367	Capacitor, Disc ceramic .01 MFD $\pm 80-20\%$	M23034-28
C-368	Capacitor, Disc ceramic .01 MFD $\pm 80-20\%$ 500V	M23034-28
C-369	Capacitor, Feed thru .001 MFD GMV 500V	K23940-4
C-370	Capacitor, Feed thru .001 MFD GMV 500V	K23940-4
C-371	Capacitor, Disc ceramic .002 MFD $\pm 20\%$ 1KV	M23034-54
C-372	Capacitor, Disc ceramic .002 MFD $\pm 20\%$ 1KV	M23034-54
C-373	Capacitor, Disc ceramic .002 MFD $\pm 20\%$ 1KV	M23034-54
C-374	Capacitor, Disc ceramic .002 MFD $\pm 20\%$ 1KV	M23034-54
C-375	Capacitor, Disc ceramic .002 MFD $\pm 20\%$ 1KV	M23034-54
C-376	Capacitor, Disc ceramic .002 MFD $\pm 20\%$ 1KV	M23034-54
C-377	Capacitor, Disc ceramic .002 MFD $\pm 20\%$ 1KV	M23034-54
C-378	Capacitor, Disc ceramic .002 MFD $\pm 20\%$ 1KV	M23034-54
* C-379	Capacitor, Dur-Mica VDM-20 $\pm 5\%$ 1000V	K23095-X
* C-380	Capacitor, Dur-Mica VDM-20 $\pm 5\%$ 1000V	K23095-X
* C-381	Capacitor, Dur-Mica VDM-20 $\pm 5\%$ 1000V	K23095-X
* C-382	Capacitor, Dur-Mica VDM-20 $\pm 5\%$ 1000V	K23095-X
* C-383	Capacitor, Dur-Mica VDM-20 $\pm 5\%$ 1000V	K23095-X

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
CR-201	Diode, Zener VR105	M41214-3
CR-202	Rectifier, Silicon 750 MA 400 V PIV	M41223-3
CR-203	Rectifier, Silicon 750 MA 400V PIV	M41223-3
CR-204	Rectifier, Silicon 750 MA 400V PIV	M41223-3
CR-205	Rectifier, Silicon 750 MA 400V PIV	M41223-3
CR-206	Rectifier, Silicon 750 MA 400V PIV	M41223-3
CR-207	Diode, Germanium IN634	K41206-1
CR-208	Diode, Germanium IN634	K41206-1
CR-209	Diode, Germanium IN34A	K41205-1
CR-210	Diode, Germanium IN34A	K41205-1
CR-211	Diode, Germanium IN34A	K41205-1
CR-212	Rectifier, Silicon CER70A 150 MA 400V PIV	M41215-2
H-201	Oven, Crystal	K26633-2
H-202	Crystal Oven (6 Freq)	M51044-1
I-201	Lamp, Incandescent #47	K16004-1
I-202	Lamp, Incandescent #47	K16004-1
J-202	Connector Receptacle	K16111-1
K-201	Relay 4 PDT DC	K40417-1
K-202	Relay Open Type 3 PDT	K40380-4
K-203	Relay Open Type 3 PDT	K40380-4
L-202	Choke, RF 2.5 MH	K26779-1
L-203	Choke, RF 430 uh	K26633-1
L-204	Choke, Audio 3.0 HY	K26667-1
L-205	Choke, RF Plate	K42353-1
L-206	Parasitic Suppressor Assy	K26775-G1 ^{Includes} R-243
L-207	Parasitic Suppressor Assy	K26775-G1 ^{Includes} R-241
L-208	Coil RF Plate Loading	M26740-1
L-209	Choke, RF 2.5 MH	K26779-1
L-210	Coil, Antenna Loading	K26776-G1
L-211	Choke, RF 2.5 MH	K26779-1
L-212	Choke, 2.7 uh	K40064-3
* L-213	Output Coil Driver	K58086-X
* L-214	Output Coil Driver	K58086-X
* L-215	Output Coil Driver	K58086-X
* L-216	Output Coil Driver	K58086-X
* L-217	Output Coil Driver	K58086-X
* L-218	Output Coil Driver	K58086-X

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
L-219	Choke 4.7 uh	K40064-4
L-220	Choke 8.2 uh	K40064-5
L-221	Choke, Filament 22 uh	K58116-1
* L-222	Coil, RF	M58094-X
* L-223	Coil, RF	M58094-X
* L-224	Coil, RF	M58094-X
* L-225	Coil, RF	M58094-X
* L-226	Coil, RF	M58094-X
* L-227	Coil, RF	M58094-X
* L-228	Output OSC. (14.9 - 30. IMC)	K58086-4
L-229	Choke, Filament 22 uh	K58116-1
L-230	Choke, RF 4.30 uh	K26633-1
L-231	Choke, RF 2.5 MH	K26779-1
L-232	Coil Trap	K58125-1-Includes
L-233	Coil, Inductance Filter Output	M26741-1 C-351
M-201	Meter, "s"	K26149-5
M-202	Meter, Test	K58091-1
P-201	Plug	M41156-3
R-201	Resistor, Fixed 47K \pm 10% 1/2 W	K19309-89
R-202	100K \pm 10% 1/2W	K19309-97
R-203	Resistor, Variable 1.5 K	K15368-2
R-204	Resistor, Fixed 10K \pm 10% 1/2 W	K19309-73
K-205	Resistor, Fixed 47K \pm 10% 1/2 W	K19309-89
R-206	Resistor, Fixed 220K \pm 10% 1/2 W	K19309-105
R-207	Resistor, Fixed 2.7K \pm 10% 1/2 W	K19309-59
R-208	Resistor, Variable 100K	K15382-20
R-209	Resistor, Fixed 220K \pm 10% 1/2 W	K19309-105
R-210	Resistor, Fixed 2.7K \pm 10% 1/2W	K19309-59
R-211	Resistor, Fixed 4.7K \pm 10% 1/2W	K19309-65
R-212	Resistor, Fixed 20K \pm 5% 1/2W	K19309-218
R-213	Resistor, Variable 1.5 K	K15368-2
R-214	Resistor, Fixed 47K \pm 10% 1/2 W	K19309-89

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part.No.</u>
R-215	Resistor, Fixed 180 ohm \pm 10% 1/2 W	K19309-31
R-216	Resistor, Fixed 22K \pm 10% 1/2W	K19309-81
R-217 (D.M.)	Resistor, Fixed 3.3K \pm 10% 1/2W	K19309-61
R-218	Resistor, Variable 10K 30%	K15382-1
R-219	Resistor, Fixed 1 K \pm 10% 1/2W	K19309-49'
R-220	Resistor, Fixed 470 K \pm 10% 1/2 W	K19309-113
R-221	Resistor, Fixed 47K \pm 10% 1/2 W	K19309-89
R-222	Resistor, Fixed 82K \pm 10% 1W	K19310-95
R-223	Resistor, Fixed 180 ohm \pm 10% 1/2W	K19309-31
R-224	Resistor, Fixed 3.3K \pm 10% 1/2 W	K19309-61
R-225	Resistor, Fixed 33K \pm 10% 1/2 W	K19309-85
R-226	Resistor, Fixed 12K \pm 10% 1/2 W	K19309-75
R-227	Resistor, Fixed 22K \pm 10% 1 W	K19310-81
R-228	Resistor, Fixed 1.8K \pm 10% 1/2W	K19309-55
R-229	Resistor, Fixed 1.8K \pm 10% 1/2W	K19309-55
R-230	Resistor, Fixed 100K \pm 10% 1/2W	K19309-97
R-231	Resistor, Fixed 100K \pm 10% 1/2 W	K19309-97
R-232	Resistor, Fixed 47K \pm 10% 1/2W	K19309-89
R-233	Resistor, Fixed 47K \pm 10% 1/2W	K19309-89
R-234	Resistor, Fixed 22K \pm 10% 1 W	K19310-81
R-235	Resistor, Fixed 1K \pm 10% 1/2W	K19309-49
R-236	Resistor, Fixed 390K \pm 10% 1/2W	K19309-111

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
R-237	Resistor, Fixed 22K \pm 10% 1/2W	K19309-81
R-238	Resistor, Fixed 27K \pm 10% 2 W	K19304-32
R-239	Resistor, Fixed 15K \pm 10% 2 W	K19304-46
R-240	Resistor, Fixed 1 K \pm 10% 1 W	K-19310-49
R-241	Resistor, Fixed 47 ohm \pm 10% 1 W	Part of L-207
R-242	(Not Used)	
R-243	Resistor, Fixed	Part of L-206
R-244	(Not Used)	
R-245	Resistor, Fixed 100 ohm \pm 10% 1/2W	K19309-25
R-246	Resistor, Fixed 100 ohm \pm 10% 1/2W	K19309-25
R-247	Resistor, Wire Wound .5 \pm 1% 1/2W	K19443-2
R-248	Resistor, Fixed 1 K \pm 10% 2W	K19304-18
R-249	Resistor, Fixed 100K \pm 10% 1/2W	K19309-97
R-250	Resistor, Fixed 4.7K \pm 10% 1/2W	K19309-65
R-251	Resistor, Fixed 10K \pm 10% 1/2W	K19309-73
R-252	Resistor, Fixed 22 K \pm 10% 1W	K19310-81
R-253	Resistor, Fixed 470 ohm \pm 10% 1 W	K19310-41
R-254	Resistor, Fixed 4.7K \pm 10% 1/2W	K19309-65
R-255	Resistor, Fixed 12K \pm 10% 1/2W	K19309-75
R-257	Resistor, Fixed 2.2K \pm 10% 1/2W	K19309-57
R-258	Resistor, Fixed 100K \pm 10% 1/2W	K19309-97
R-259	Resistor, Fixed 10K \pm 10% 1/2W	K19309-73
R-260	Resistor, Fixed 33K \pm 10% 1/2W	K19309-85
R-261	Resistor, Fixed 100K \pm 10% 1/2 W	K19309-97

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
R-262	Resistor, Fixed 18K + 10% 1/2W	K19309-79
R-263	Resistor, Fixed 82K + 10% 1/2W	K19309-95
R-264	Resistor, Fixed 220K + 10% 1/2W	K19309-105
R-265	Resistor, Fixed 100K + 10% 1/2W	K19309-97
R-266	Resistor, Fixed 220K + 10% 1/2W	K19309-105
R-267	Resistor, Fixed 150K + 10% 1/2W	K19309-101
R-268	Resistor, Fixed 1 K + 10% 1/2W	K19309-49
R-269	Resistor, Fixed 10 K + 10% 1/2W	K19309-73
R-270	Resistor, Fixed 100K + 10% 1/2W	K19309-97
R-271	Resistor, Fixed 470K + 10% 1/2W	K19309-113
R-272	Resistor, Fixed 470K + 10% 1/2W	K19309-113
R-273	Resistor, Fixed 2.2 Meg + 10% 1/2W	K19309-129
R-274	Resistor, Fixed 2.2 Meg + 10% 1/2W	K19309-129
R-275	Resistor, Fixed 470K + 10% 1/2W	K19309-113
R-276	Resistor, Fixed 8.2 K + 10% 1/2W	K19309-71
R-277	Resistor, Fixed 10 Meg + 10% 1/2W	K19309-145
R-278	Resistor, Fixed 12K + 10% 1/2W	K19309-75
R-279	Resistor, Fixed 22K + 10% 1/2W	K19309-81
R-280	Resistor, Fixed 82K + 1/2W	K19309-95
R-281	Resistor, Fixed 150K + 10% 1/2W	K19309-101
R-282	Resistor, Fixed 6.8K + 10% 1/2W	K19309-69
R-283	Resistor, Fixed 56K + 10% 1/2W	K19309-91

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
R-284	Resistor, Fixed 1 Meg \pm 10% 1/2W	K19309-131
R-285	Resistor, Fixed 27K \pm 10% 1/2W	K19309-83
R-286	Resistor, Variable 10K \pm 30%	K15382-1
R-287	Resistor, Fixed 47K \pm 10% 1/2W	K19309-89
R-288	Resistor, Fixed 47K \pm 10% 1/2W	K19309-89
R-289	Resistor, Fixed 1 Meg \pm 10% 1/2W	K19309-121
R-290	Resistor, Fixed 2.7K \pm 10% 1/2W	K19309-59
R-291	Resistor, Fixed 3.9 K \pm 10% 1/2W	K19309-63
R-292	Resistor, Fixed 2.2K \pm 10% 1/2W	K19309-57
R-293	Resistor, Fixed 1.5 Meg \pm 10% 1/2W	K19309-125
R-294	Resistor, Fixed 47K \pm 10% 1/2W	K19309-89
R-295	Resistor, Fixed 470K \pm 10% 1/2W	K19309-113
R-296	Resistor, Fixed 470K \pm 10% 1/2W	K19309-113
R-297	Resistor, Fixed 100K \pm 10% 1/2 W	K19309-113
R-298	Resistor, Fixed 100K \pm 10% 1/2 W	K19309-97
R-299	Resistor, Fixed 68K \pm 10% 1/2W	K19309-89
R-300	Resistor, Fixed 47K \pm 10% 1/2W	K19309-89
R-301	Resistor, Fixed 100K \pm 10% 1/2W	K19309-97
R-302	Resistor, Fixed 2.2K \pm 10% 1/2W	K19309-57
R-303	Resistor, Fixed 270K \pm 10% 1/2W	K19309-107
R-304	Resistor, Fixed 120K \pm 10% 1/2W	K190309-(
R-305	Resistor, Fixed 4.7K \pm 10% 1/2W	K19309-65

100 100 1

100 100 1

100 100 1

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
R-306	Resistor, Fixed 4.7K \pm 10% 1/2W	K19309-65
R-307	Resistor, Fixed 4.7K \pm 10% 1/2W	K19309-65
R-308	(Not Used)	
R-309	Resistor, Fixed 2.2K \pm 10% 1/2W	K19309-57
R-310	Resistor, Variable 1 Meg	K15382-15
R-311	Resistor, Fixed 47K \pm 10% 1/2W	K19309-89
R-312	Resistor, Fixed 56K \pm 10% 1/2W	K19309-91
R-313	Resistor, Fixed 22K \pm 10% 1W	K19310-81
R-314	Resistor, Fixed 270 ohm \pm 10% 1/2W	K19309-35
R-315	Resistor, Fixed 47K \pm 10% 1/2W	K19309-89
R-316	Resistor, Fixed 820K \pm 10% 1/2W	K19309-119
R-317	Resistor, Fixed 1 Meg \pm 10% 1/2W	K19309-121
R-318	Resistor, Fixed 470K \pm 10% 1/2W	K19309-113
R-319	Resistor, Fixed 270K \pm 10% 1/2W	K19309-107
R-320	Resistor, Fixed 470K \pm 10% 1/2W	K19309-113
R-321	Resistor, Fixed 27K \pm 10% 1/2W	K19309-83
R-322	Resistor, Fixed 2.2K \pm 10% 1/2W	K19309-57
R-323	Resistor, Fixed 3.3K \pm 10% 1/2W	K19309-61
R-324	Resistor, Fixed 15K \pm 10% 1/2W	K19309-77
R-325	Resistor, Fixed 180 ohm \pm 10% 1/2W	K19309-31
R-326	Resistor, Fixed 470K \pm 10% 1/2W	K19309-113
R-327	Resistor, Fixed 3.3K \pm 10% 1/2W	K19309-61

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
R-328	Resistor, Fixed 470K \pm 10% 1/2W	K19309-113
R-329	Resistor, Fixed 2.2K \pm 10% 1/2W	K19309-57
R-330	Resistor, Fixed 470K \pm 10% 1/2W	K19309-113
R-331	Resistor, Fixed 4.7K \pm 10% 1/2W	K19309-65
* R-332	Resistor, Fixed 1.8K \pm 10% 1/2W	K19309-55
R-333	Resistor, Fixed 1.8K \pm 10%	K19309-55
R-334	Resistor, Fixed 1.8K \pm 10% 1/2W	K19309-55
R-335	Resistor, Fixed 1.8K \pm 10% 1/2W	K19309-55
R-336	Resistor, Fixed 47K \pm 10% 1/2W	K19309-89
R-337	Resistor, Fixed 180 ohm \pm 10%	K19309-31
R-338	Resistor, Fixed 47K \pm 10% 1/2W	K19309-89
R-339	Resistor, Fixed 3.3K \pm 10% 1/2W	K19309-61
R-340	Resistor, Fixed 3.3K \pm 10% 1/2W	K19309-61
R-341	Resistor, Fixed 470 ohm \pm 10% 1/2W	K19309-41
R-342	Resistor, Fixed 22K \pm 10% 1/2W	K19309-81
R-343	Resistor, Fixed 100K \pm 10% 1/2W	K19309-97
R-344	Resistor, Fixed 100K \pm 10% 1/2W	K19309-97
R-344	Resistor, Fixed 33K \pm 10% 1/2W	K19310-85
R-345	Resistor, Fixed 100K \pm 10% 1/2W	K19309-97
R-346	Resistor, Fixed 470K \pm 10% 1/2W	K19309-113
R-347	Resistor, Fixed 3.3K \pm 10% 1/2W	K19309-61
R-348	Resistor, Fixed 180 ohm \pm 10% 1/2W	K19309-31

<u>Circuit Symbol</u>	<u>Description</u>	<u>Part No.</u>
T-201	Transformer, Audio	M39101-1
T-202	Transformer, BAL. MOD. 1650KC	M58088-1
T-203	XFMR, BAL. Mixer Input 1650KC	M58088-15
* T-204	XFMR, BAL. Mixer Output	M58088-X
* T-205	XFMR, Drive Input	M58088-X
* T-206	XFMR, BAL. Mixer Output	M58088-X
* T-207	XFMR, Driver Input	M58088-X
* T-208	XFMR, BAL. Mixer Output	M58088-X
* T-209	XFMR, Driver Input	M58088-X
* T-210	XFMR, BAL. Mixer Output	M58088-X
* T-211	XFMR, Driver Input	M58088-X
* T-212	XFMR, BAL. Mixer Output	M58088-X
* T-213	XFMR, Driver Input	M58088-X
* T-214	XFMR, BAL. Mixer Output	M58088-X
* T-215	XFMR, Driver Input	M58088-X
T-216	Transformer, IF 1650KC	M39305-1
T-217	Transformer, IF 1650KC	M39305-1
T-218	Transformer, IF 1650KC	M39305-1
T-219	Transformer, Receiver Mixer Output	M58088-2
* T-220	Transformer, Antenna	M58088-X
* T-221	Transformer, Antenna	M58088-X
* T-222	Transformer, Antenna	M58088-X
* T-223	Transformer, Antenna	M58088-X
* T-224	Transformer, Antenna	M58088-X
* T-225	Transformer, Antenna	M58088-X
Y-207	Crystal CR-36-u	K58115-1
ZF-202	Crystal Filter LSB 1650KC	M58092-1
	Knob 1 1/2 Dia.	M50087-4
	Knob 2 Dia.	M50087-6

FREQUENCY SENSITIVE COMPONENTS

RF DECK

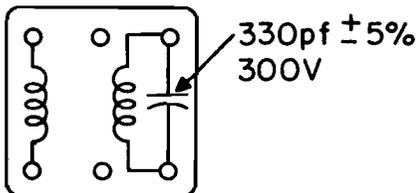
	<u>Description</u>	<u>Range 1</u> <u>2 - 3 MC</u>	<u>Range 2</u> <u>3 - 7 MC</u>	<u>Range 3</u> <u>7 - 18 MC</u>	<u>Range 4</u> <u>15 - 30 MC</u>
C-260 thru C-265	Capacitor, fixed, Dur-Mica <u>+ 5%</u> , 500V DC	360 pf K23006-143	270 pf K23006-93	130 pf K23006-144	68 pf K23006-117
C-275 thru C-280	Capacitor, fixed, Dur-Mica <u>+ 5%</u> , 1000V DC	360 pf K23095-5	100 pf K23095-1	Not Used	Not Used
C-248	Capacitor, variable	12-250 pf M4112-G49	12-250 pf M4112-G49	12-250 pf M4112-G49	8-100 pf M4112-G48
C-254 thru C-259	Capacitor, variable, mica, compression type	1400-3055 pf K23935-3 (4) 315	880-2330 pf K23935-2 (4) 312	340-1070 pf K23935-5 (4) 307 M	100-500 pf K23935-4 (4) 304 M
C-288, C-379 thru C-383	Capacitor, fixed, Dur-Mica <u>+ 5%</u> , 1000V	360 pf K23095-5	Not Used	Not Used	Not Used
C-337	Capacitor, fixed, Dur-Mica <u>+ 5%</u> , 500V DC	Not Used	Not Used	Not Used	47 pf K23006-71

FREQUENCY SENSITIVE COMPONENTS Contd.

RF DECK

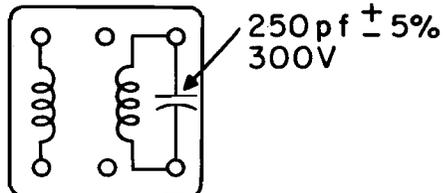
	<u>Description</u>	<u>Range</u> <u>2 - 3 MC</u>	<u>Range 2</u> <u>3 - 7 MC</u>	<u>Range 1</u> <u>7 - 18 MC</u>	<u>Range 4</u> <u>15 - 19</u>
L-213 thru L-218	Coil, driver output, unshielded, slug tuned	K58086-1	K58086-2	K58086-3	K58086-3
L-222 thru L-227	Coil, receiver RF shielded, slug tuned	M58094-1	M58094-2	M58094-3	M58094-4
L-228	Coil, oscillator, unshielded, slug tuned	Not Used	Not Used	Not Used	K58086-3
R-332	Resistor, fixed + 10%, 1/2 W	Not Used	Not Used	Not Used	1.8 K K19309-55
T-204, T-206, T-208, T-210 T-212, T-214	Transformer, RF balanced mixer output	M58088-13	M58088-11	M58088-9	M58088-7
T-205, T-207 T-209, T-211 T-213, T-215	Transformer, RF driver input	M58088-14	M58088-12	M58088-10	M56088-8
T-220 thru T-225	Transformer, RF receiver antenna	M58088-3	M58088-4	M58088-5	M58088-6

RANGE - 1
2-3 MC



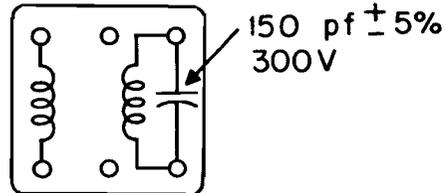
PT. NO. 58088-3

RANGE 2
3-7 MC



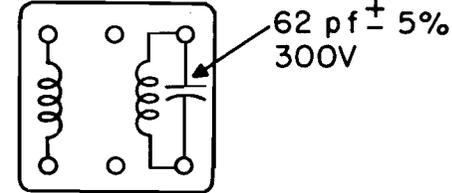
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RANGE 3
7-18 MC

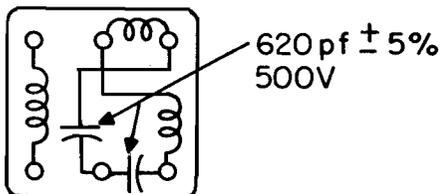


PT. NO. 58088-5

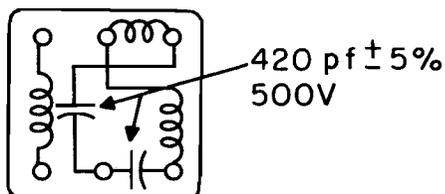
RANGE 4
15-30 MC



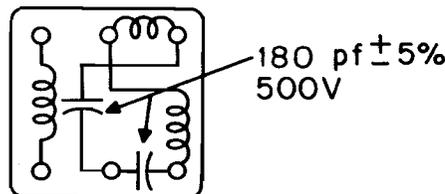
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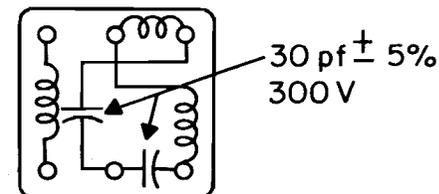
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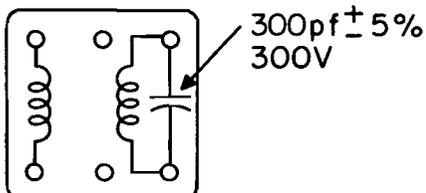
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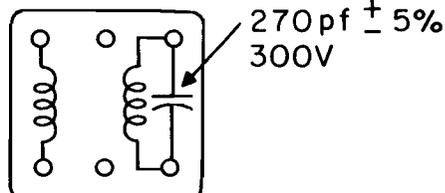
PT. NO. 58088-9



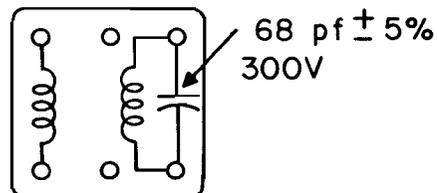
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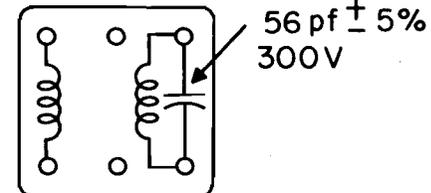
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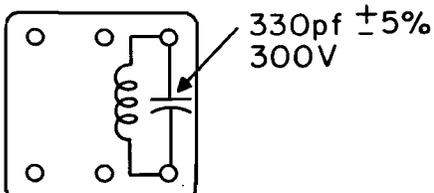
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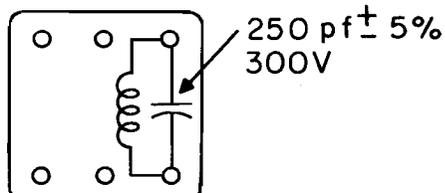
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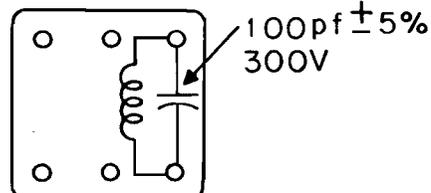
PT. NO. 58088-8



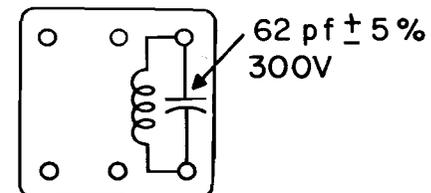
PT. NO. 58094-1



PT. NO. 58094-2



PT. NO. 58094-3

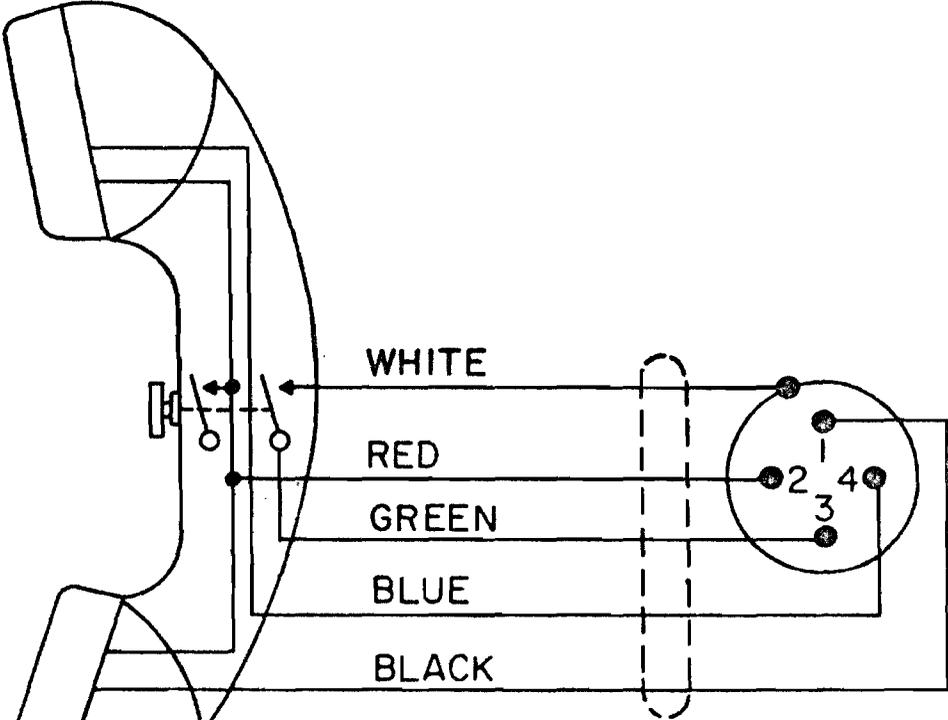


PT. NO. 58094-4

FREQUENCY SENSITIVE

COMPONENTS

FIGURE 15



HANDSET SCHEMATIC
FIGURE 16

TB-1, TB-2, TB-3

REMOTES

10	GROUND
9	BUZZER BUTTON
8	BUZZER POWER
7	UP SWITCH
6	P. T. T.
5	BUZZER
4	STANDBY LAMP
3	XMTR LAMP
2	EARPIECE
1	MIKE

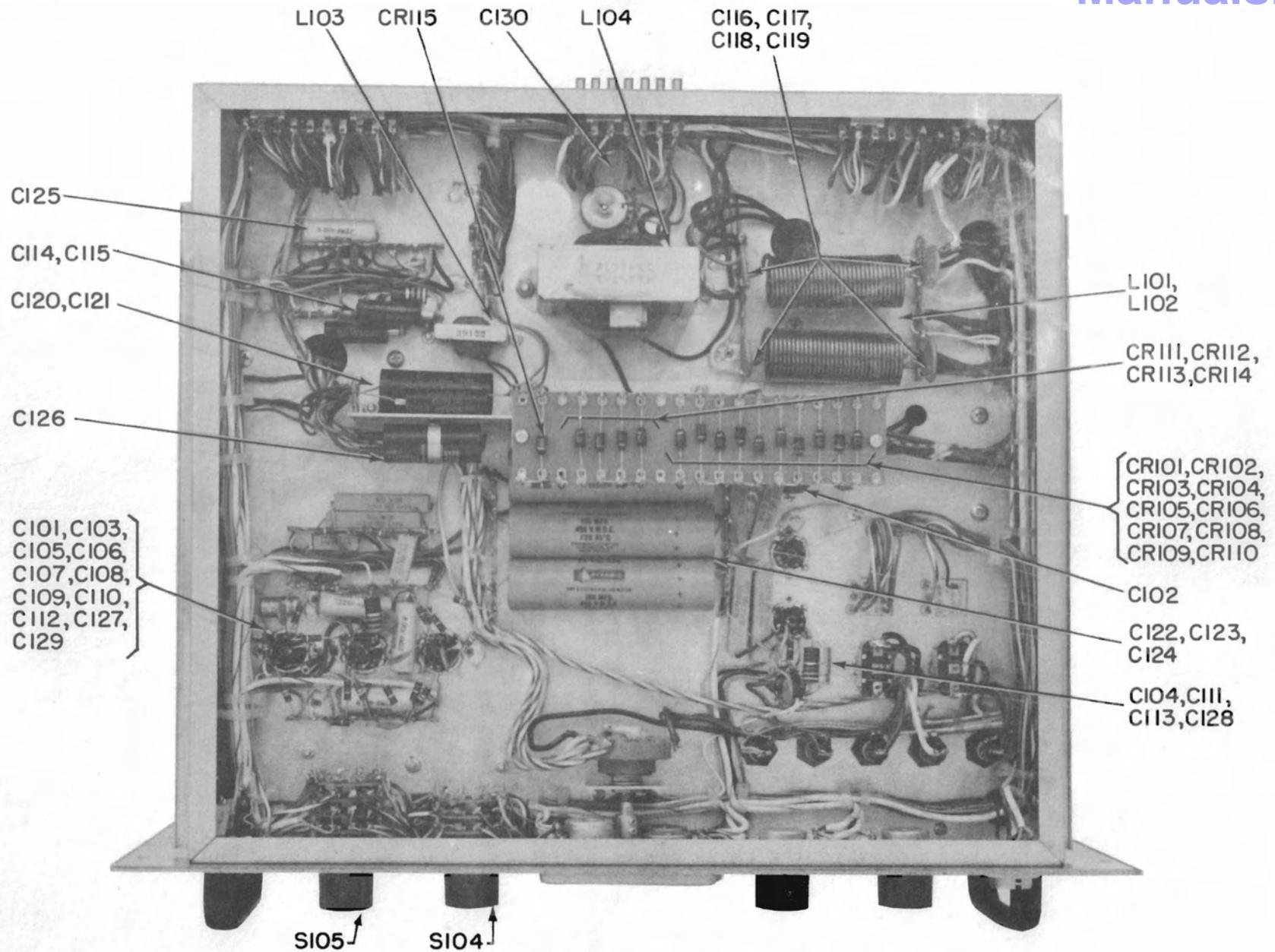
TB-4

10	NORMALLY OPEN	EXTERNAL RELAY CONTROLLED CIRCUITRY
9	ARM	
8	NORMALLY CLOSED	
7	LINE	600 Ω LINE CONNECTIONS
6	LINE RELAY	
5	LINE TRANS	
4	GROUND	
3	LINE TRANS	
2	LINE RELAY	
1	LINE	

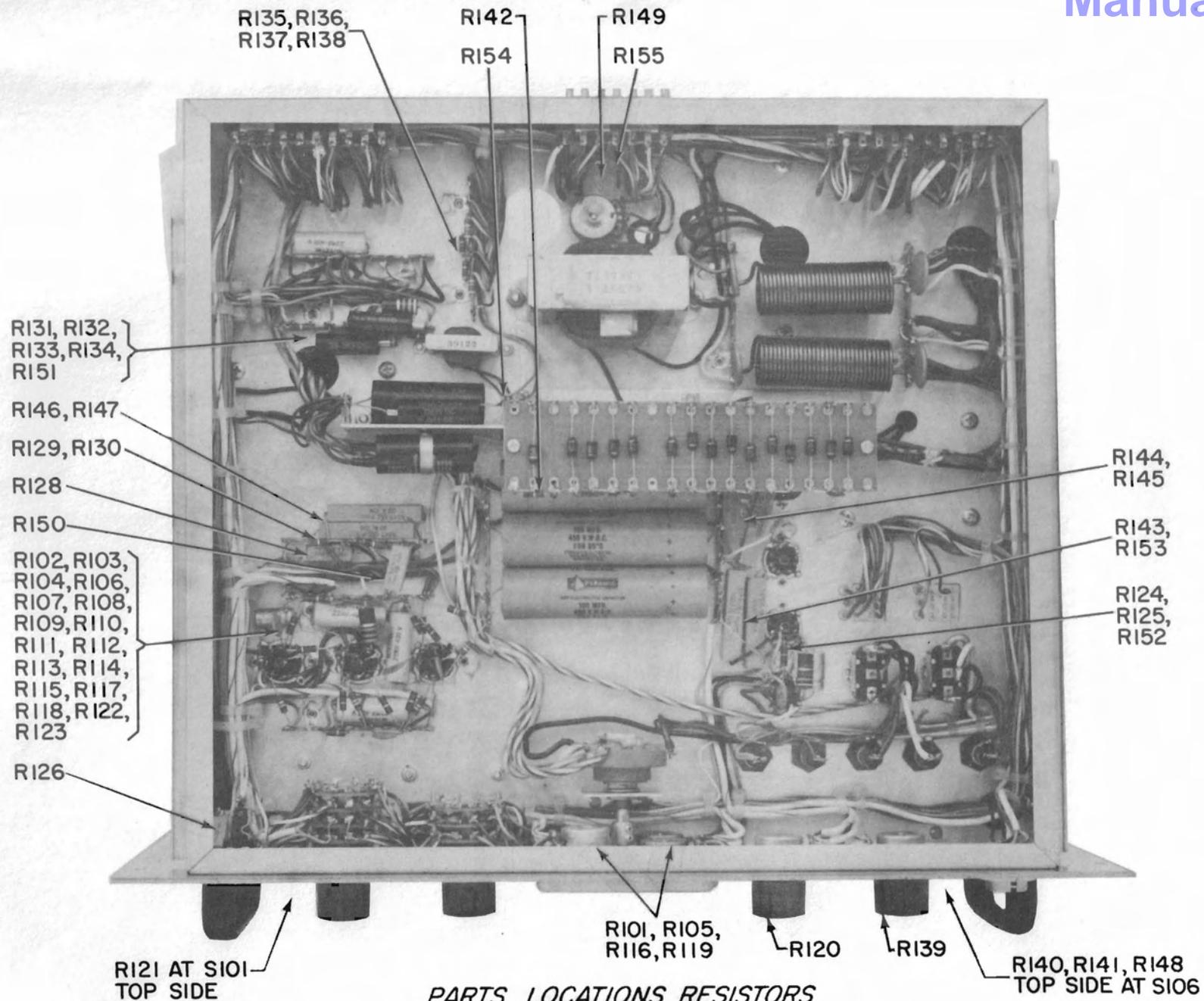
TB-5

10	CH 6 ANTENNA TUNER
9	CH 5 ANTENNA TUNER
8	CH 4 ANTENNA TUNER
7	CH 3 ANTENNA TUNER
6	CH 2 ANTENNA TUNER
5	CH 1 ANTENNA TUNER
4	ANTENNA TUNER COMMON
3	KEY / REMOTE TUNER TEST SWITCH
2	SECODE
1	SECODE

WIRING INFORMATION
EXTERNAL TERMINAL STRIPS
FIGURE 17



PARTS LOCATIONS CAPACITORS, CHOKES AND DIODES
 POWER DECK
FIGURE 18



PARTS LOCATIONS RESISTORS
POWER DECK
FIGURE 19

C247,C266,C267,
C274,C275,C376

C286,C287,C289,
C290,C292,C296,
C299,C303,C305,
C306,C307,C308

C245,C268,C269,
C270,C272,C377,
C378

C242,C243,C281,
C282

C285,C291,C293,
C294,C295,C297,
C300,C301,C302,
C304,C323,C326

C233,C337,C338,
C339,C340,C343,
C344,C345,C358

C309,C310,C311,
C312,C313,C314,
C321,C324,C325,
C327,C328,C329,
C330,C331,C332

C284

C298,C333,C334,
C335,C336,

C341,C342,C346,
C347,C348,C349,
C350,C355,C357,
C359,C360

C351,C356

C273

C244

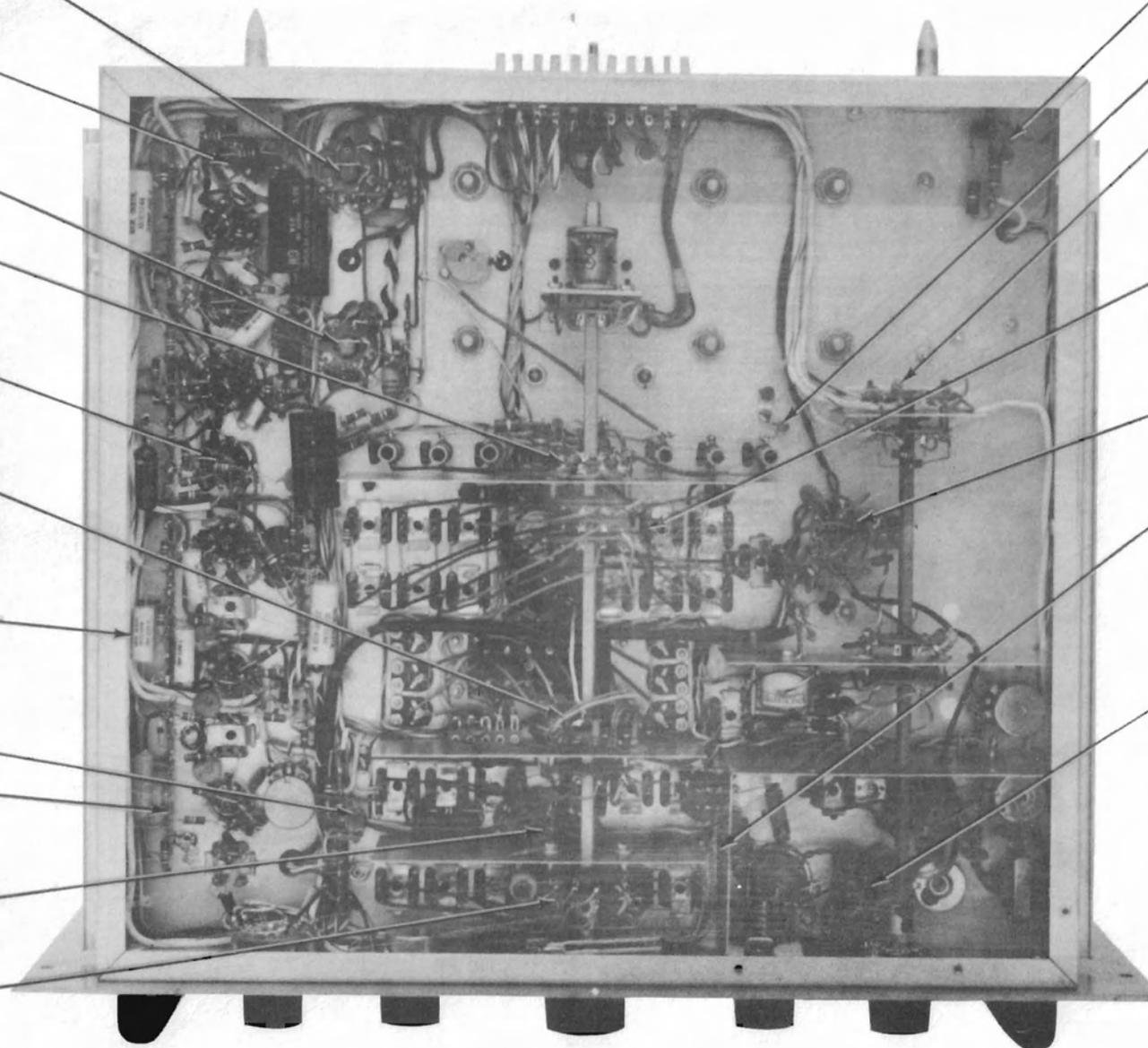
C322

C231,C232,C234,
C235,C236,C237,
C238,C239,C241,
C371,C372,C373,
C374

C222,C223,C224,
C225,C226,C227,
C228,C229,C230,
C240,C353,C354

C352,C361

C201,C202,C203,
C204,C205,C206,
C207,C208,C209,
C210,C211,C212,
C213,C214,C215,
C216,C217,C218,
C219,C220,C221,
C362,C363,C364,
C365,C366,C367,
C368,C369,C370



PARTS LOCATIONS CAPACITORS

RF DECK

FIGURE 20

R264, R265, R266,
R267, R268, R269,
R271, R272, R273,
R274, R276, R288,
R290, R291, R293,
R294, R300, R301

R275, R277, R279,
R280, R281, R282,
R283, R284, R285,
R292, R295, R296,
R297, R298, R299
R302, R303

R236, R270, R278,
R287, R289, R304,
R311, R312, R313,
R314, R315, R316,
R317, R318, R319
R350

R307, R320, R322,
R323, R324, R325,
R326, R349

R259, R260, R261,
R305, R332

R306, R321, R327,
R328, R329, R330,
R331, R346

R336, R338, R340,
R343, R344, R345,
R347, R348

R309, R310

R242, R245,
R248

R244, R246,
R247, R249,
R250, R251

R238, R240,
R256, R257,
R258

R252, R253,
R255

R262, R263

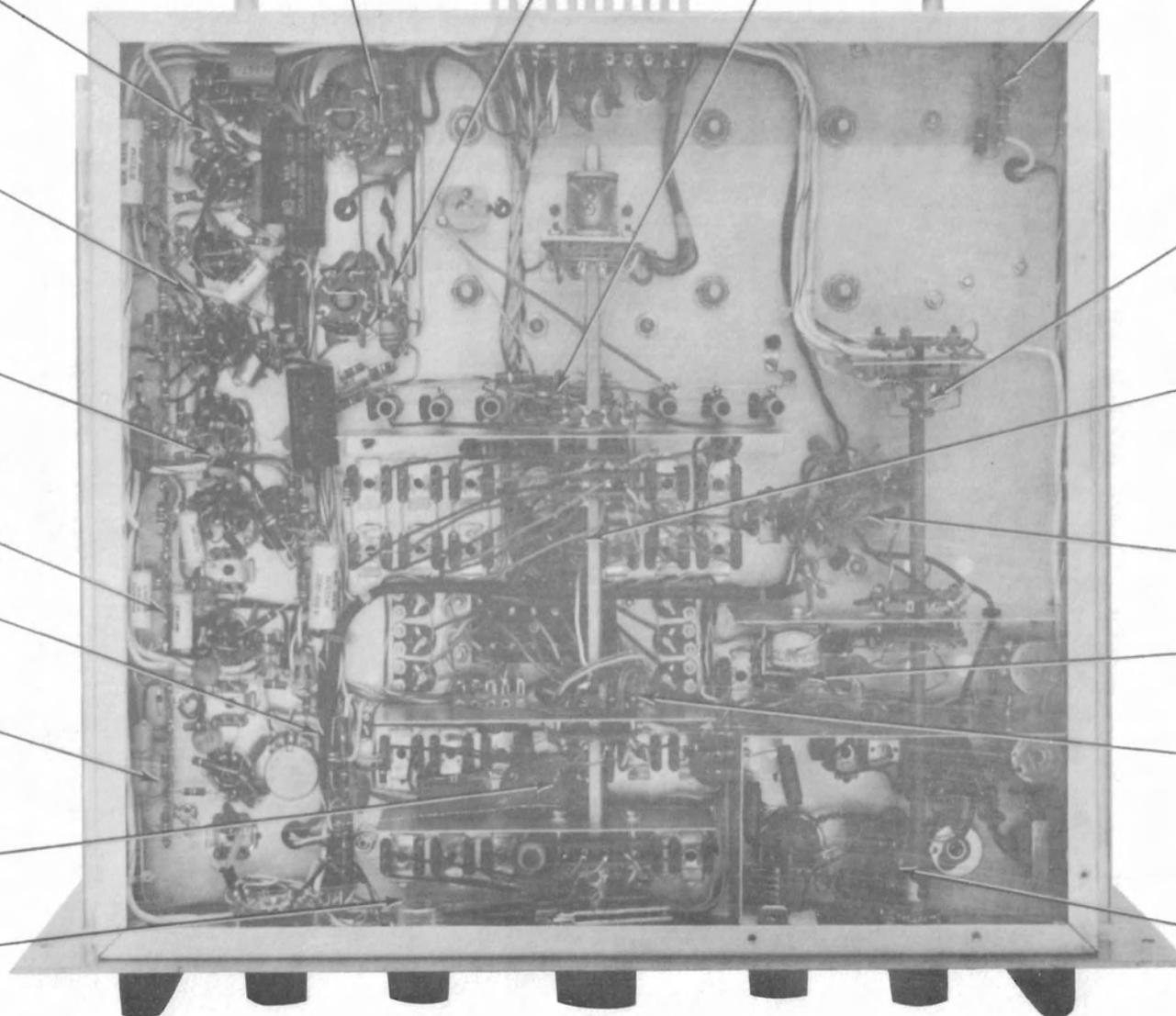
R227, R228,
R229, R230,
R231, R232,
R233, R234,
R235, R239

R220, R222,
R223, R224,
R225, R226,
R237

R211, R212

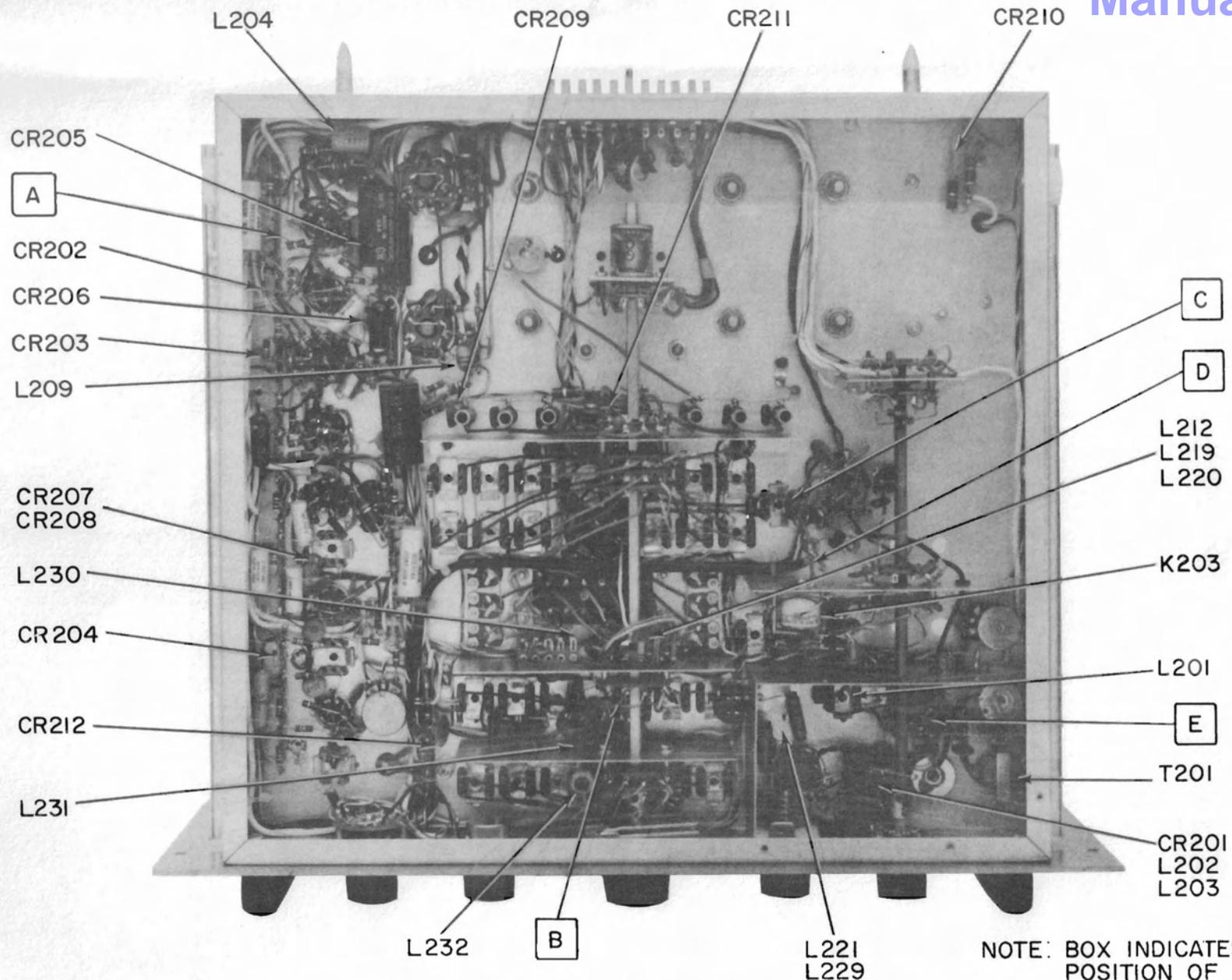
R333, R334,
R335, R337,
R339, R341,
R342

R201, R202,
R204, R205,
R206, R207,
R209, R210,
R214, R215,
R216, R217,
R219, R221



PARTS LOCATIONS RESISTORS

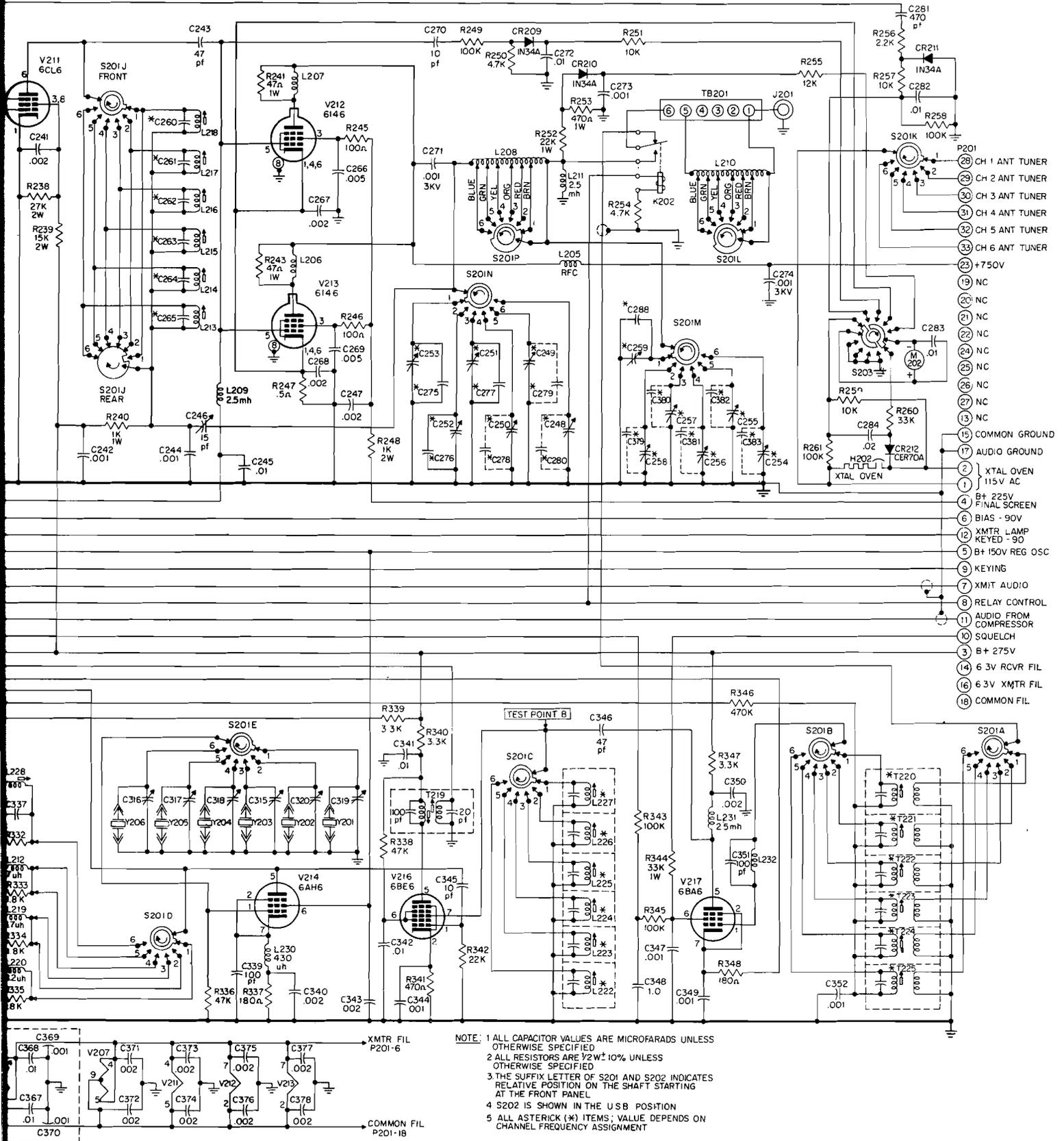
RF DECK
FIGURE 21



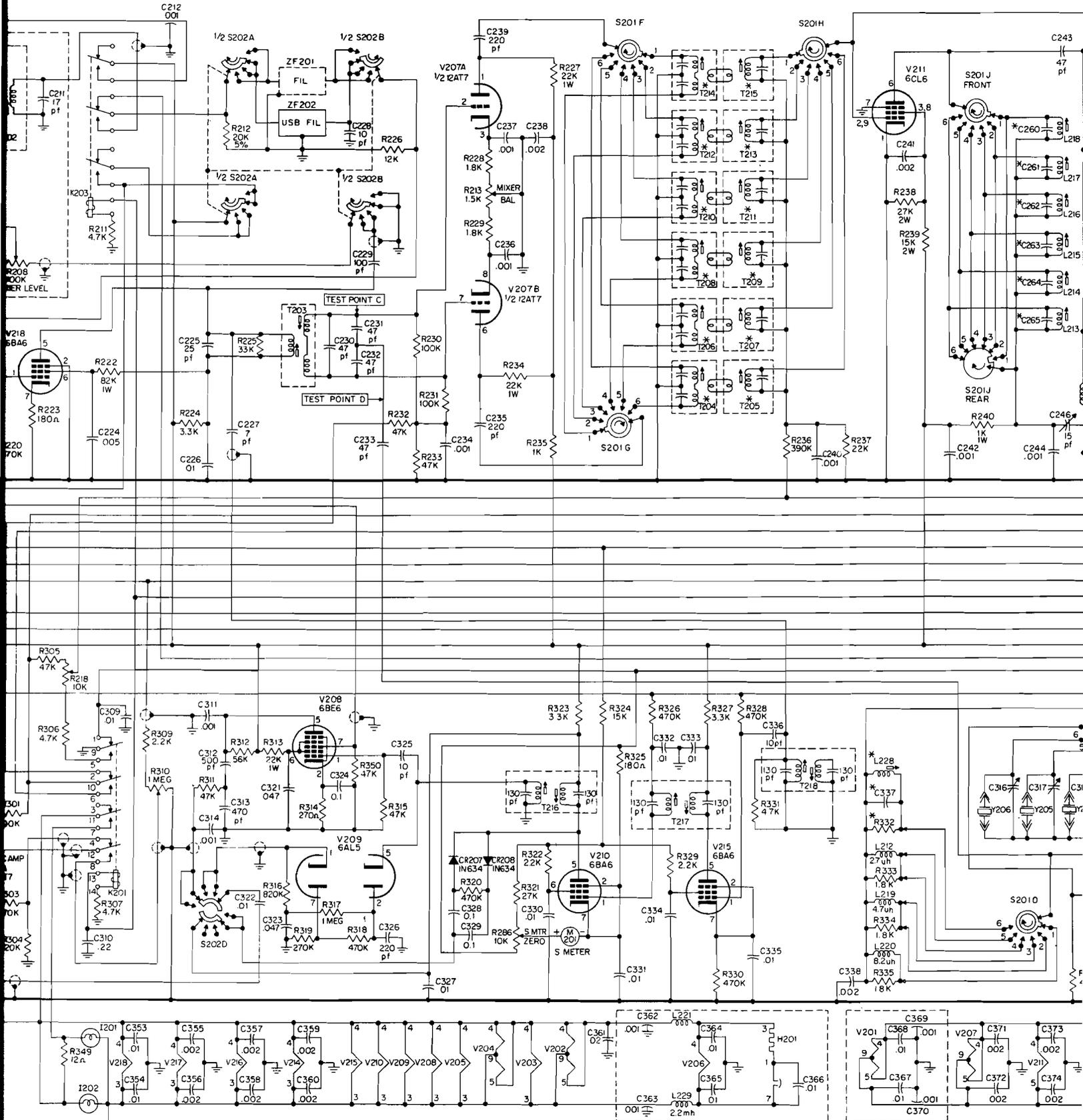
PARTS LOCATIONS - COILS AND DIODES

RF DECK

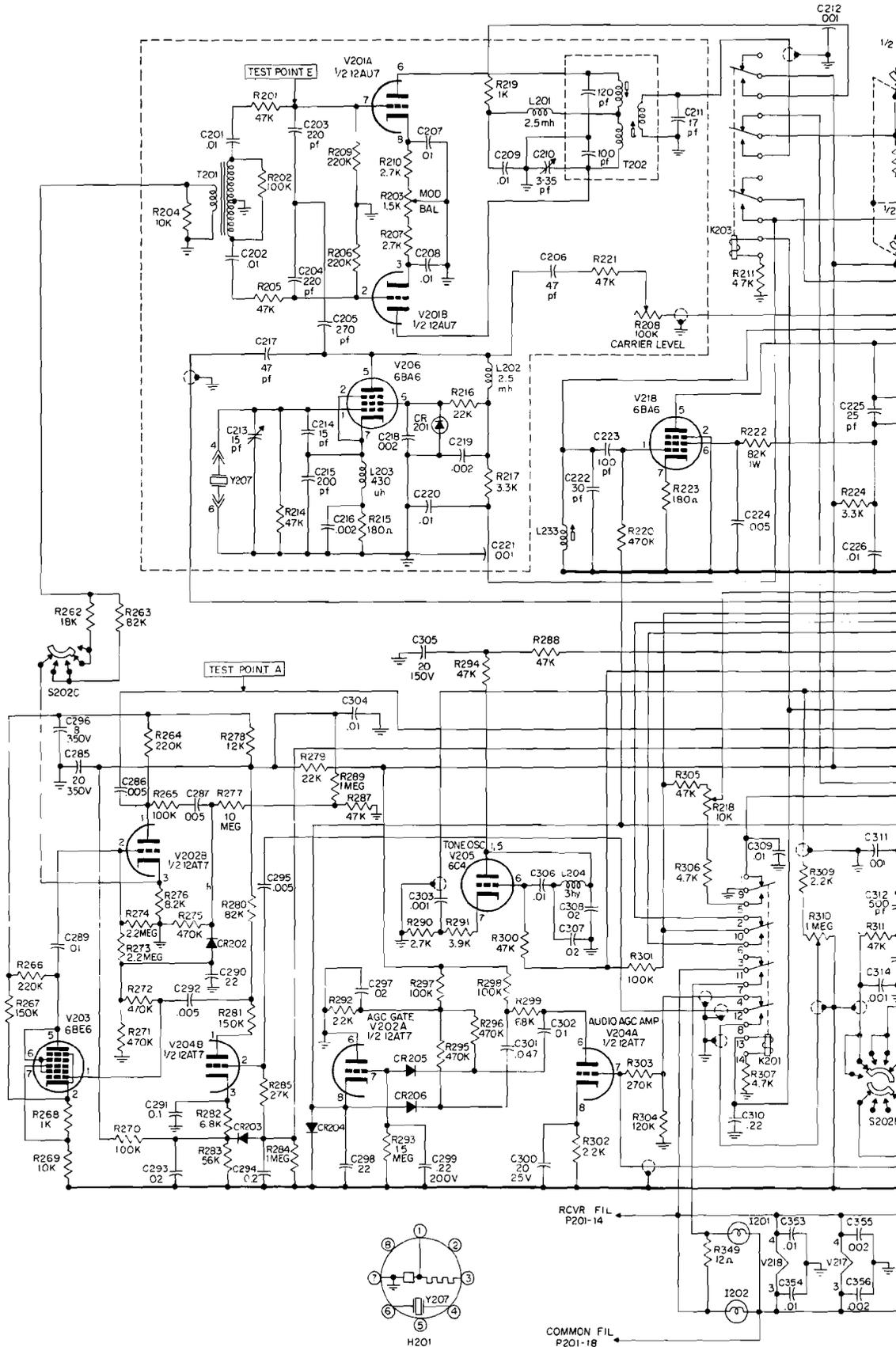
FIGURE 22

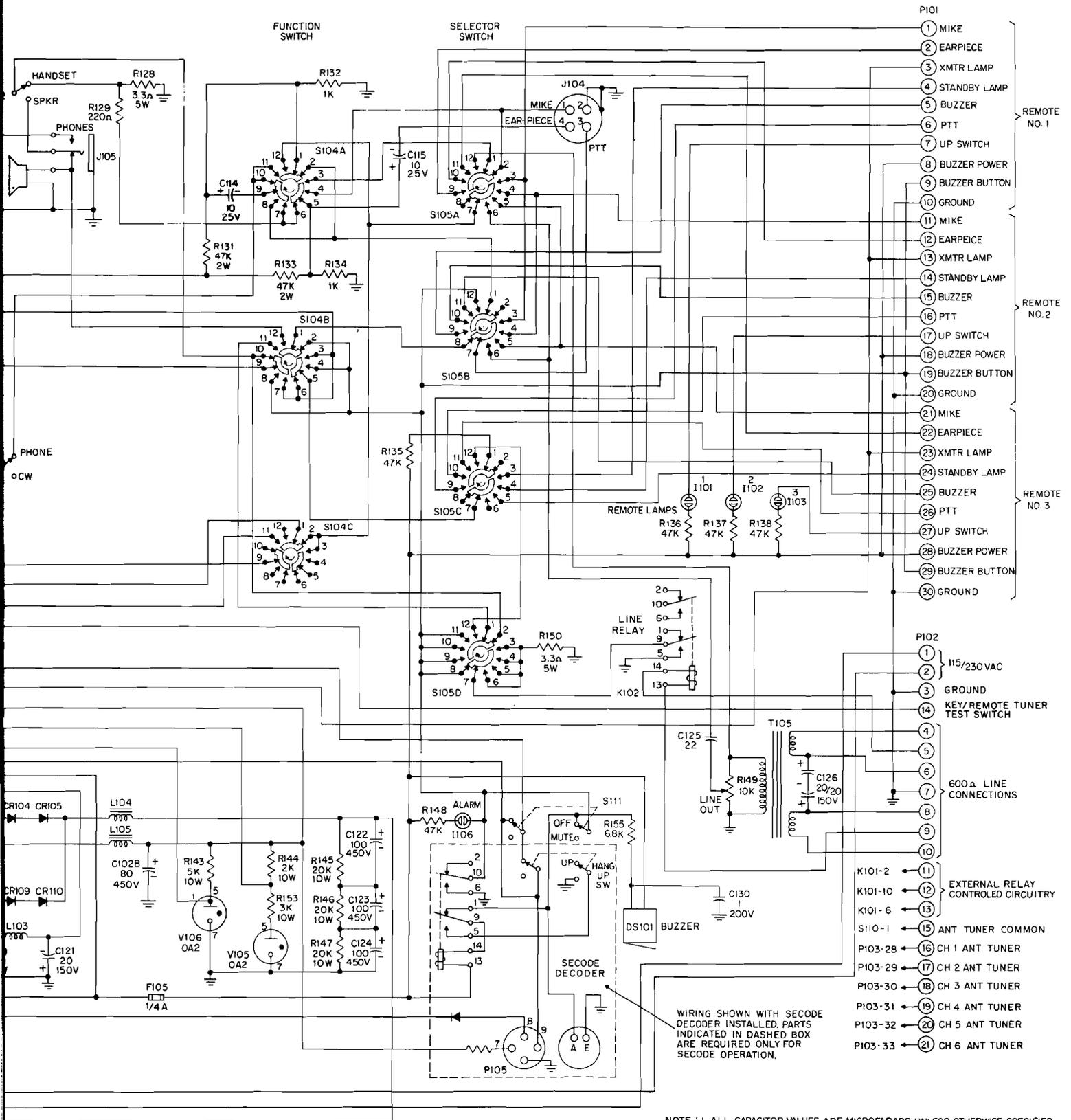


- 28 CH 1 ANT TUNER
- 29 CH 2 ANT TUNER
- 30 CH 3 ANT TUNER
- 31 CH 4 ANT TUNER
- 32 CH 5 ANT TUNER
- 33 CH 6 ANT TUNER
- 23 +750V
- 19 NC
- 20 NC
- 21 NC
- 22 NC
- 24 NC
- 25 NC
- 26 NC
- 27 NC
- 13 NC
- 17 COMMON GROUND
- 7 AUDIO GROUND
- 2 XTAL OVEN
- 1 115V AC
- 4 B+ 225V FINAL SCREEN
- 6 BIAS - 90V
- 12 XMTR LAMP KEYED - 90
- 5 B+ 150V REG OSC
- 9 KEYING
- 7 XMTR AUDIO
- 8 RELAY CONTROL
- 11 AUDIO FROM COMPRESSOR
- 10 SQUELCH
- 3 B+ 275V
- 14 6.3V RCVR FIL
- 16 6.3V XMTR FIL
- 18 COMMON FIL



SCHMATIC DIAGRAM - R-F DECK
FIGURE 23





SWITCH - FUNCTION
SHOWN IN CCW POSITION (1)

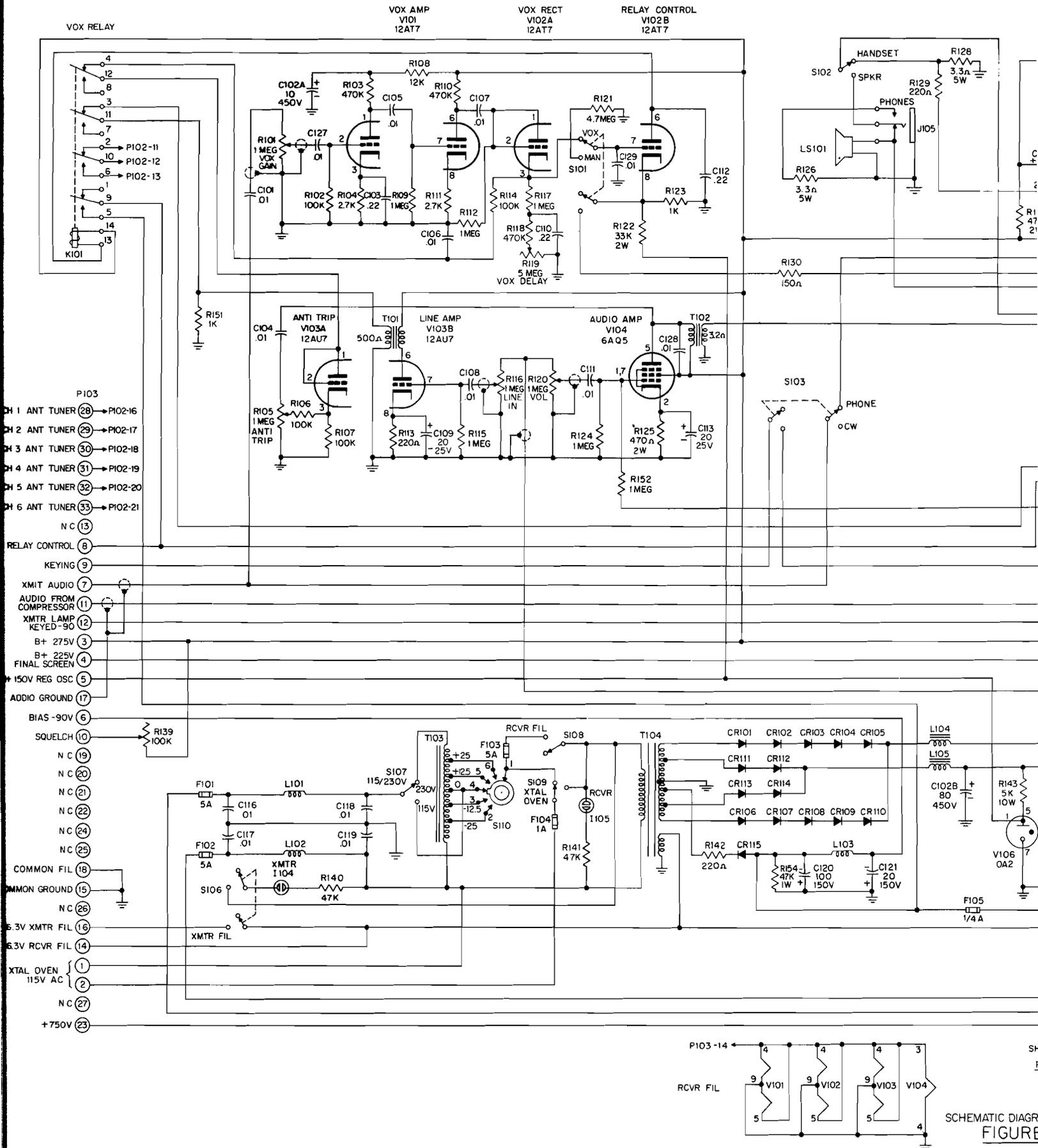
POSITION	FUNCTION
1	MONITOR
2	OPERATE
3	INTERCOM

SWITCH - SELECTOR
SHOWN IN CCW POSITION (1)

POSITION	SELECTOR
1	L (LOCAL 1)
2	1 REMOTE 1
3	2 REMOTE 2
4	3 REMOTE 3
5	T (600Ω LINE)

SCHEMATIC DIAGRAM - POWER DECK
FIGURE 24

NOTE 1: ALL CAPACITOR VALUES ARE MICROFARADS UNLESS OTHERWISE SPECIFIED.
2: ALL RESISTORS ARE 1/2 W ± 10% UNLESS OTHERWISE SPECIFIED.



SCHMATIC DIAGRAM
FIGURE

