hallicrafters

COMMAND LINE

INSTALLATION AND SERVICE INSTRUCTIONS

TWO-WAY FM LAND-MOBILE RADIO TRANSMITTER/RECEIVER MODEL CSM-20-2

~~312-259-7600~~
816-231-0700

INSTALLATION AND SERVICE INSTRUCTIONS FOR COMMAND LINE TWO-WAY FM LAND-MOBILE RADIO TRANSMITTER/RECEIVER MODEL CSM-20-2

Manufactured by

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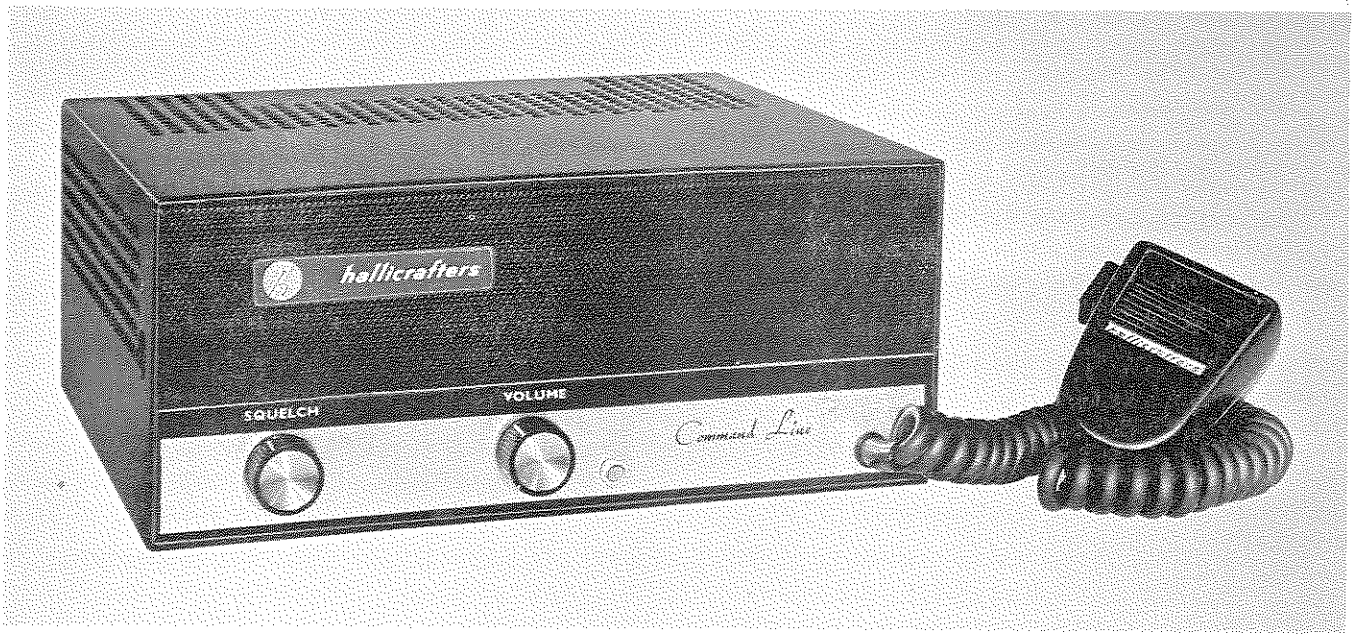


156-003861

Figure 1. Hallicrafters' Model CSM-20-2 Transmitter/Receiver.

SECTION 1

INTRODUCTION

1-1. DESCRIPTION

Hallicrafters' Model CSM-20-2 is a crystal-controlled, mobile two-way radio designed for narrow-band FM service (16F3 emission) in the 148 to 174 MC range. This equipment is completely self-contained in a single cabinet and is supplied complete, tuned to customer specified frequency, ready for connection to antenna and power source. Because of its compact size, the unit is ideally suited for underdash mounting in any normal truck or passenger-car application.

The equipment is designed to operate from a nominal 12 VDC source (13.6 volts EIA standard) and contains a transistorized power supply. The equipment can be installed in both negative and positive ground installations without modification to the transmitter/receiver unit.

The transmitter/receiver unit can be removed from the vehicle in a matter of seconds for maintenance checks or transfer to another vehicle. The removal of two machine screws on the side of the case and two quick release electrical disconnects (antenna and power cord) are the only items required for removal of the unit.

The unit is constructed of steel. The front panel is attractively styled and conveniently arranged, keeping operator convenience in mind.

This Hallicrafters' equipment meets the requirements of Parts 10, 11, 16, and 21 of the FCC Rules and Regulations and has been type accepted in accordance with provisions of Parts 2 and 15.

1-2. FEATURES

Compact Size and Weight. - The transmitter/receiver and power supply are contained in a single case which also includes the speaker and operating controls. The equipment measures 4-1/2 inches high by 10-3/4 inches wide by 10 inches deep and weighs only nine pounds.

Transmitter Power Output Rating. - The final amplifier tube used in the transmitter has a rated IMS dissipation of 35 watts and a rated IMS power output of 46 watts at 175 MC. On the basis of the 20-watt rated power output, the power amplifier is, therefore conservatively designed. All units as shipped, will deliver a minimum power output of 20 watts and in most cases actual output will be substantially higher.

Careful Thermal Design. - Despite its small size, internal temperatures of the unit have been maintained an average of 25°C lower than for trunk-mounted equipment of the same power-output class. This has been accomplished as follows:

A. No tube shields are employed. This results in rapid convection cooling of tubes with little heat transfer to the chassis and components.

B. Careful positioning of vents in the case permits effective cooling of the chassis. A dust-tight cover on the send/receive relay prevents any deterioration of relay performance caused by the entry of dust through cooling vents.

Universal Battery Polarity. - Either negative or positive battery systems can be accommodated without modification of the unit proper. Only a simple change to the battery cable is required, which can easily be accomplished in the field. The standard battery plug as supplied is wired for negative-grounded systems.

Ease of Maintenance. - The unit can be removed for maintenance easily by either of the following methods:

A. Removal of the complete transmitter/receiver in its case from the vehicle by unfastening two screws on each side holding the unit to the trunion bracket and strap.

B. Removal of chassis from the case by removing two machine screws from the side of the case.

Low Susceptibility to Ignition-Noise Interference. - Two design features have succeeded in minimizing ignition noise problems:

A. The lumped IF filter design is characterized by a rounded nose, avoiding sharp discontinuities in attenuation and phase characteristics. This is accomplished while maintaining adequate nose-to-skirt ratio for rejection of adjacent-channel interference.

B. The gated beam limiter/discriminator circuit employed has an inherently short time constant.

Both of the above features reduce pulse stretching which is the main annoyance factor in ignition-noise interference.

SECTION II

SPECIFICATIONS

MECHANICAL SPECIFICATIONS AND FEATURES

CABINET

Steel; dull-black, baked-enamel finish.

CONSTRUCTION (Except Cabinet)

Steel; cadmium chromate finish.

OVERALL SIZE (HWD)

4-1/2 by 10-3/4 by 10 inches.

NET WEIGHT

9 pounds.

POWER SUPPLY

Self-contained; dual transistors with silicon rectifiers.

INSTALLATION

Underdash.

SPEAKER

Internal Three-inch PM, 3.2 ohm.

MICROPHONE

Handheld ceramic.

CONTROLS

Power on/off-volume.
Squelch.
Power on-transmit indicator lamp.

ANTENNA CONNECTOR

Screw type (SO-239).

ELECTRICAL SPECIFICATIONS AND PERFORMANCE

General (Receiver and Transmitter):

FREQUENCY RANGE

148 to 174 MC.

FREQUENCY STABILITY

±0.0005%, oven controlled.

AMBIENT TEMPERATURE RANGE

-30°C to +60°C (exterior of case).

VIBRATION

Meets mobile requirements of CD I-100.

INPUT VOLTAGE

12 volts DC nominal (13.6 volts EIA Standard).

Receiver:

TYPE OF CIRCUIT

Crystal-controlled, dual-conversion superheterodyne.

SENSITIVITY

Less than 0.5 μ V for 20 DB noise quieting.

SQUELCH SENSITIVITY

0.25 μV or less.

CRYSTAL

Third-overtone, series-resonant, similar to MIL type CR-32/U (85°C).

CONVERSION SYSTEM

Dual; 8.0 MC and 455 KC.

SECOND CONVERSION OSCILLATOR

Crystal controlled.

SELECTIVE ELEMENT

Lumped IF filter (hermetically sealed) incorporating ten ferrite-cored tuned circuits.

SELECTIVITY

Better than 75 DB (two signal method).

OSCILLATOR RADIATION

Within limits established by FCC Rules and Regulations, Part 15, Sub-Part C.

AUDIO POWER OUTPUT

1.5 watts at less than 10% distortion.

AUDIO OUTPUT IMPEDANCE

3.2 ohms.

AUDIO FREQUENCY RESPONSE

Within +2 to -8 DB of a standard 6 DB/octave de-emphasis curve from 300 to 3000 CPS referenced at 1000 CPS (EIA Standard).

DUTY CYCLE

Intermittent (EIA).

TUBE COMPLEMENT

First RF Amplifier	6CY5
Second RF Amplifier	6CY5
First Mixer/Oscillator-Multiplier	6CL8A
First IF Amplifier	6AU6
Second Oscillator/Mixer	6CL8A
First Low IF Amplifier	6AU6
Second Low IF Amplifier	6AU6
Third Low IF Amplifier	6AU6
Audio Amplifier	12AT7
Audio Output	6GW8

POWER DRAIN

4.8 amperes +0.5 ampere intermittent oven.

SPURIOUS RESPONSE ATTENUATION

-85 DB minimum.

Transmitter:

RF POWER OUTPUT

20 watts.

ANTENNA OUTPUT IMPEDANCE

52 ohms.

CRYSTAL

Fundamental frequency type, similar to MIL type CR-36/U (85°C).

MULTIPLICATION ORDER

2 x 3 x 2 = 12.

SPURIOUS EMISSIONS

Attenuated in excess of EIA Standards.

MODULATION

Crystal-controlled FM (phase) type F3.

MODULATION DEVIATION

Narrow band (30-KC channel spacing); ±5 KC (16F3 emission).

MODULATION CHARACTERISTIC

Within +1 to -3 DB of a standard 6 DB/octave pre-emphasis curve from 300 to 3000 CPS referenced at 1000 CPS (EIA Standard).

DEVIATION LIMITER

Automatic; prevents deviation beyond set amount.

MICROPHONE INPUT

High Impedance.

TUBE COMPLEMENT

First and Second Microphone Amplifier	6CL8A
Oscillator/Phase Modulator	6CL8A
Buffer Amplifier/ Doubler	6360
Second and Third Multiplier	6360
Output Power Amplifier	7984

POWER DRAIN

11.2 amperes, +0.5 ampere intermittent oven.

DUTY CYCLE

Intermittent (EIA).

SECTION III

INSTALLATION

3-1. UNPACKING

After unpacking the equipment, it should be carefully inspected for any possible damage which may have occurred during transit. Should any sign of damage be apparent, immediately file a claim with the carrier stating the extent of damage. Carefully check all shipping labels and tags for any special instructions before removing or destroying them.

3-2. PRELIMINARY TEST

Prior to installing the equipment, it should be bench tested to insure that it is in proper operating condition. The equipment has been completely aligned to frequency and tested at the factory before shipment so no performance deficiency should exist. If operational difficulties are experienced, refer to the maintenance section of this manual to identify and correct the cause of trouble.

IMPORTANT NOTE

According to FCC Rules and Regulations: only persons holding radio-telephone operator licenses (second class or higher) or persons working under their direct supervision are authorized to perform adjustments or tests coincident with the installation, servicing, or maintenance of a radio station, which may affect the proper operation of the equipment as set forth in the Rules and Regulations governing the class of service for which the equipment is licensed.

3-3. MOBILE INSTALLATION

Installation requirements vary greatly depending upon available space, operator preference, service accessibility, etc. To a degree it is up to the discretion and ingenuity of the installer to plan the best possible installation in a particular case. A few moments spent in planning the installation, prior to its commencement, will pay dividends later in terms of performance and ease of maintenance.

Points to remember when planning the installation include:

A. Mount the unit in as protected an environment as possible. Avoid a mounting position where the equipment might be subjected to water damage or in direct exposure to dust and dirt.

B. Mount the equipment for convenient access by the operator. Often holes existing on the under side of the dashboard for vehicle accessories may be used conveniently for mounting the radio equipment.

C. Use extreme care when drilling holes so as not to damage electrical wiring, hydraulic lines, etc.

D. Route power cables and antenna leads in protected places, out of the way of the operator's feet or objects which may cause abrasion and subsequent failure.

3-3-1. INSTALLATION PROCEDURE (Refer to Figure 2)

The unit is mounted by securing the trunion handle to the underside of the dashboard in a position providing operator accessibility to the front panel controls. Additional brackets, formed from the perforated iron strapping supplied, may be necessary in order to fasten the unit in place securely (refer to figure 3).

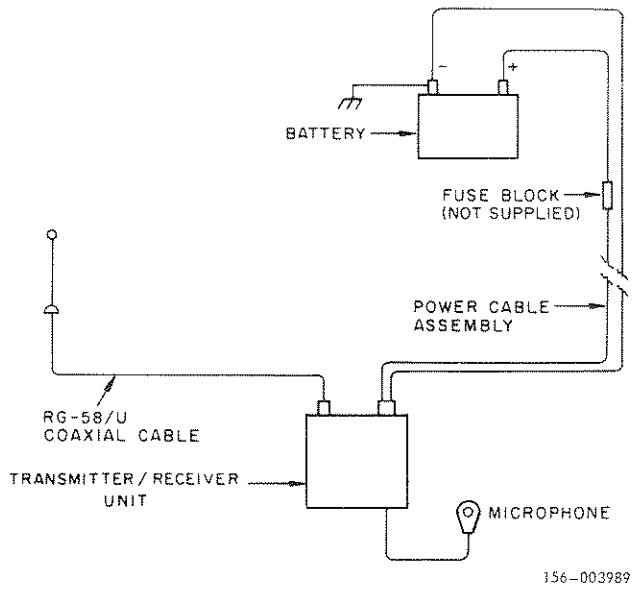


Figure 2. Mobile Installation, Electrical Diagram.

The microphone holder should be mounted near the operator on the dashboard, using the hardware supplied (refer to figure 3).

3-3-2. BATTERY LEADS

The battery leads should be routed from the main chassis to the battery by as direct a means as is possible. Generally, there are holes in the fire-

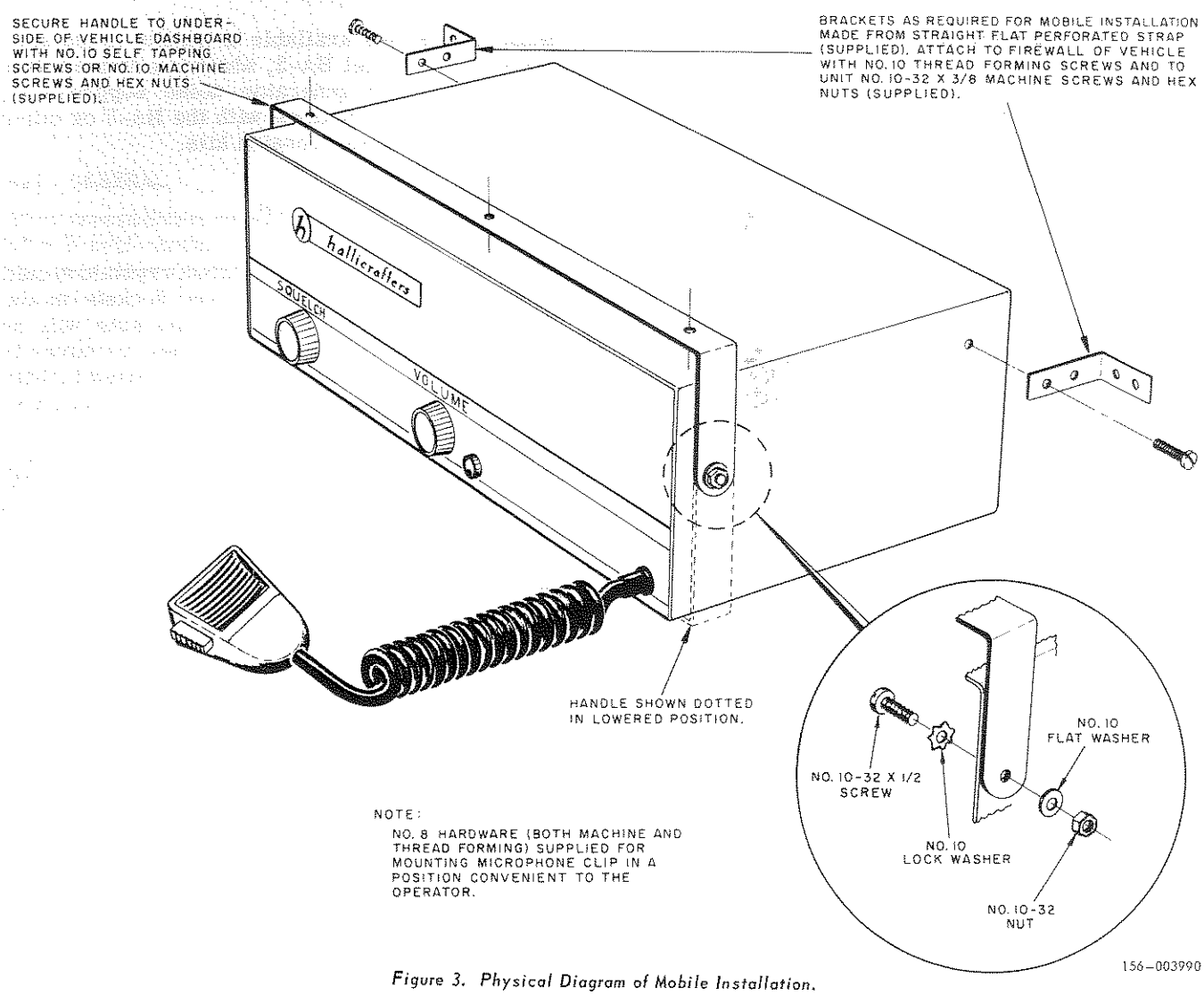


Figure 3. Physical Diagram of Mobile Installation.

wall which will permit access to the battery in the engine compartment. Route these leads neatly, taping or clamping as required to prevent them from coming in contact with the hot engine or becoming frayed on sharp metal extrusions. The ends of the leads should be attached to the battery connectors as shown in figure 2. Tighten with a wrench. If it is desired to insert a fuse block in line with the battery, Hallicrafters has available a Fuse Block Kit, Model C-4101.

NOTE

This equipment is designed for use with both negative and positive ground electrical systems. As shipped from the factory, the unit is wired for use with negative ground systems. Refer to the schematic diagram, figure 8, for adapting the unit for use with positive ground electrical systems. For connection to other DC systems, ask your Hallicrafters' representative for assistance, outlining particulars of the required installation.

3-3-3. ANTENNA INSTALLATION

It is desirable to mount the antenna at or near the center of the vehicle's metal roof, as the roof, acting as a ground plane, will insure uniform performance in all directions.

On convertibles or other vehicles where a roof-top installation is impossible, the antenna may be mounted on the rear deck or trunk lid; however, with a probable decrease in overall performance. In these instances, the installation of a gain antenna is highly recommended. This type of antenna will generally outperform the standard roof-top, quarter-wave antenna and is a means by which even roof-top installations may be improved to give increased range or denser coverage.

A Model C-6101 quarter-wave, vertical-whip antenna is available from The Hallicrafters Co. for use with this equipment. This antenna should be installed according to instructions packed with it.

3-3-4. MOBILE NOISE SUPPRESSION

The built-in noise suppression characteristics of this equipment make special precautions against noise sources in the vehicle normally unnecessary. If ignition noise is noticed after the installation, however, check for proper alignment and accurate netting to the base-station transmitter. If ignition noise is still present, perform the following checks on the vehicle.

A. Check distributor points, capacitor, and rotor and all the spark plugs. Replace worn plugs and any other obviously defective parts. Reset spark plug gaps to the correct spacing.

B. Using a DC continuity checker, check for a low-resistance DC path between the spark-plug terminal and the inside contact of the distributor cap. Replace all loose terminals.

C. If ignition noise is not yet eliminated, continue the following procedure step-by-step:

1. Install a standard automobile radio distributor suppressor in the center lead from the ignition coil to the distributor.

2. Install resistor-type spark plugs. Be sure to use the correct type plug set to the recommended gap.

3. Connect a 0.1 to 0.5 μF coaxial feed-through capacitor in series with the primary lead to the distributor. The capacitor used should have a 50-volt, five-ampere minimum rating.

4. Install resistor-type ignition leads.

5. Install bonding straps across the rubber engine-support shock mounts between the engine and the vehicle frame.

Hallicrafters has available a mobile noise suppression kit, Model HA-3, which is suitable to this application. For generator noise suppression, refer to the instructions with the HA-3 or other applicable noise suppression kits.

3-4. CRYSTAL INFORMATION

After the installation is completed, crystals should be installed in the appropriate sockets in the crystal oven. Crystal position marking will be found on the inside of the oven when the cover is removed. The crystals are to be inserted in their appropriate positions (T, transmit; R, receive).

Crystals may be ordered from The Hallicrafters Co. Service Department, 5th and Kostner Avenues, Chicago, Illinois 60624. Transmitting crystals should be ordered under part number 019-003356, and receiving crystals should be ordered under part number 019-003357. Be sure to specify operating frequencies when ordering crystals.

If crystals are obtained from sources other than The Hallicrafters Co., specify:

for the transmitter,

Crystal type: . . . . . MIL CR-36/U
Oven temperature: . . . . . 85°C
Load capacity: . . . . . 32 $\mu\mu$F
Frequency: . . . . . $\frac{\text{Channel frequency}}{12}$

for the receiver,

Crystal type: . . . . . MIL CR-32/U
Oven temperature: . . . . . 85°C
Resonance: . . . . . Series
Frequency: . . . $\frac{\text{Channel frequency - 8 MC}}{3}$

SECTION IV

THEORY OF OPERATION

4-1. GENERAL

This transmitter/receiver is a mobile equipment with a self-contained transistorized supply. This unit operates from a nominal power source of 12 volts DC (13.6 volts EIA standard). Refer to figures 4 and 5 for block diagrams of the receiver and transmitter and to figure 8 for an overall schematic diagram of the equipment.

4-2. RECEIVER

The receiver section of this equipment consists of eleven tubes functioning in a crystal-controlled, dual-conversion superheterodyne circuit. Dual-purpose tubes and semiconductors are used discriminately to provide the equivalent of sixteen-tube operation.

4-2-1. RF AMPLIFIER

The input from the antenna relay, K301, is coupled through the antenna coil, L101, to the grid (pin 1) of V101. Tubes V101 and V102 are type 6CY5 pentodes and comprise the RF amplifier portion of the receiver. Each tube has a tuned plate and tuned grid circuit. Coils L102, L103, L104, and L105 are peaked to the channel frequency to provide maximum selectivity. The RF output from the plate (pin 5) of V102 is coupled through capacitors C175 and C115 to the grid (pin 1) of the receiver first mixer, V103A.

4-2-2. RECEIVER OSCILLATOR

The receiver oscillator, V103B (1/2 6CL8A), is an impedance-inverting type oscillator/multiplier employing a CR-32/U crystal operating at or near its natural series resonant frequency. The crystal, Y101, is housed in a standard plug-in oven which maintains a constant crystal temperature of 85° ±2°C. Small changes in receiver oscillator frequency can be made by adjustment of coil, L106. This adjustment is used to zero (net) the receiver to the exact channel frequency. Coil, L107, in the plate circuit is tuned to the third series harmonic of the oscillator frequency. RF output is coupled from the plate (pin 6) of V103B, through capacitor C122, to the grid (pin 1) of the receiver first mixer, V103A.

4-2-3. RECEIVER FIRST MIXER

RF signals from the RF amplifier, V102, and from the receiver oscillator, V103B, are applied to the grid (pin 1) of the receiver first mixer, V103A (1/2 6CL8A). These signals are mixed and produce a difference frequency of 8.0 MC. The 8.0-MC output from V103A is applied to interstage filter transformers L109 and L110 which reject all frequencies other than 8.0 MC. Transformers L109 and L110 are connected together by top coupling capacitor C128. The output from L110 is applied through capacitor C131 to the grid (pin 1) of the first IF amplifier, V104.

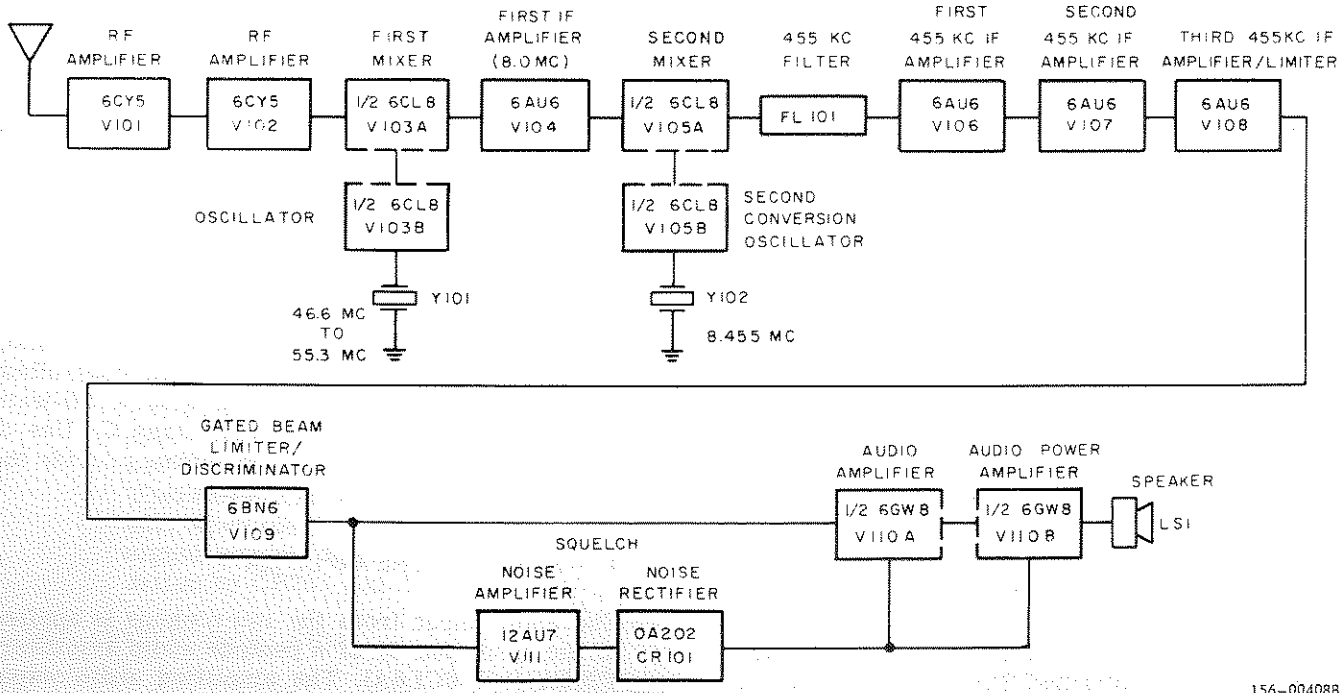


Figure 4. Receiver Block Diagram

4-2-4. RECEIVER FIRST IF AMPLIFIER

Tube V104, a type 6AU6 pentode, is used as a conventional IF amplifier at 8.0 MC. The amplified 8.0-MC signal from the plate (pin 5) of this tube is coupled through IF transformer, L111, and coupling capacitor, C136, to the grid (pin 9) of the receiver second mixer, V105A.

4-2-5. RECEIVER SECOND CONVERSION OSCILLATOR

The receiver second conversion oscillator, V105B (1/2 6CL8A), is a triode operated as a Pierce-type oscillator and requires no adjustment. The circuit uses a standard CR-18/U crystal on 8.455 MC. This frequency is used in the circuit because it is 455 KC (0.455 MC) above the first IF frequency, thus producing a second IF frequency. The crystal output is coupled through capacitor C139 to the grid (pin 9) of the receiver second mixer, V105A.

4-2-6. RECEIVER SECOND MIXER

The 8.0-MC IF signal from V104 and the 8.455-MC oscillator signal from V105B are applied to the grid (pin 9) of the receiver second mixer, V105A (1/2 6CL8A). These signals are mixed and produce a difference frequency of 455 KC. The 455-KC output from V105A is applied to filter, FL101.

4-2-7. 455-KC FILTER

Filter FL101 is a 455-KC, lumped-IF filter, using ten ferrite-cored tuned circuits. The filter is internally compensated to provide a high order of temperature stability. This filter is the main circuit element determining the bandwidth characteristics of the receiver. The output from FL101 is applied through capacitor C143 to the grid (pin 1) of the first 455-KC IF amplifier, V106.

4-2-8. FIRST AND SECOND 455-KC IF AMPLIFIERS

The 6AU6 pentodes, V106 and V107, are used as conventional IF amplifiers at 455 KC. The output signal from the plate (pin 5) of V107 is coupled through capacitor C149 to the grid (pin 1) of the third 455-KC IF amplifier/limiter, V107.

4-2-9. THIRD 455-KC IF AMPLIFIER/LIMITER

The type 6AU6 pentode used in this stage operates as a conventional IF amplifier in the presence of weak signals and, with signals in excess of a few microvolts, as a limiter. Limiter voltage developed across resistor R126 is filtered and applied to the grid circuit of the RF amplifiers, V101 and V102, to prevent front-end overload on strong signals. The amplified/limited signal output is coupled through capacitors C153 and C155 to the grid (pin 2) of the detector, V109.

4-2-10. GATED BEAM LIMITER/DETECTOR

Tube V109, a gated-beam type 6BN6, functions primarily as a discriminator. It also provides a limiting action which is particularly effective in the removal of fast transient noise pulses (ignition noise) that would otherwise degrade signal quality.

These noise pulses cannot be removed fully by the preceding stages because of the limitations imposed by circuit time constants.

Proper discriminator action is achieved by adjustment of the quadrature coil, L115. Output of the discriminator is developed as a function of phase differences between the signal grid (pin 2) and the quadrature grid (pin 6) across resistor R129. Output is coupled through an RF filter/de-emphasis network to the noise amplifier and audio amplifier.

4-2-11. SQUELCH CIRCUIT

The squelch circuit consists of V111, a type 12AU7 two-stage triode noise amplifier, and CR101, a diode noise rectifier whose output disables both audio amplifier circuits by applying a cutoff bias to their control grids. By applying squelch voltage to the audio power amplifier, a saving of battery drain is achieved under conditions of no received carrier.

4-2-12. AUDIO AMPLIFIER/OUTPUT

Tube V110 is a type 6GW8 triode-pentode. The input from the discriminator/squelch circuitry is applied to the grid (pin 1) of the triode amplifier, V110A. The amplified output from V110A is coupled through capacitor C168 to the grid (pin 8) of the output tube, V110B. Tube V110B amplifies the audio signal which is then transformer coupled, through the audio output transformer, T101, to the speaker, LS101.

4-3. TRANSMITTER

The transmitter section of this equipment consists of five tubes functioning in a crystal-controlled, phase-modulated type circuit with a 20-watt, single-ended output, operating class C. Use of dual-purpose tubes in four envelopes provide the equivalent of nine tube functions.

4-3-1. MICROPHONE AMPLIFIER

The audio input from the microphone is applied to the grid (pin 9) of a pentode audio amplifier, V205A (1/2 6CL8A). The amplified audio output from V205A is coupled through capacitor C241 to the modulation limiter circuit.

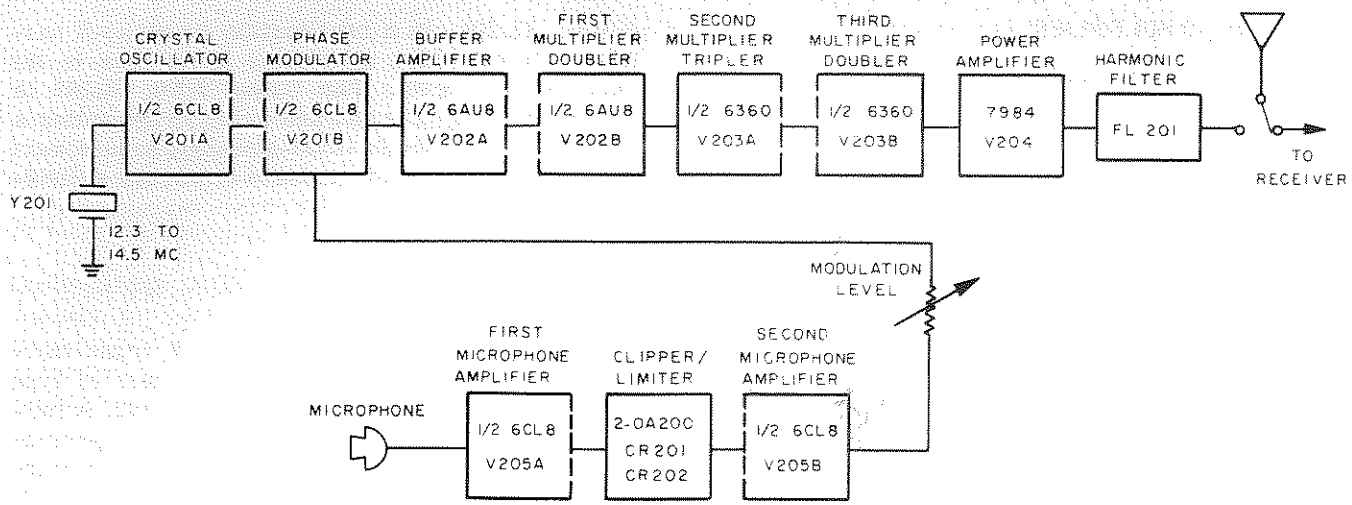


Figure 5. Transmitter Block Diagram.

4-3-2. MODULATION LIMITER

The modulation limiter circuit consists of a pre-emphasis stage (C242 and R223), a symmetrical silicon diode clipper (CR201 and CR202), and a de-emphasis network (PC101). This type of circuit produces a flat frequency response when operating below the clipping level.

By providing high-frequency pre-emphasis before clipping, limiting is applied to the high-frequency signals which are mainly responsible, in a phase-modulation type transmitter, for frequency excursions beyond the rated maximums.

The output from PC101 is applied to the grid (pin 1) of V205B.

4-3-3. AUDIO AMPLIFIER

The clipped output is applied to a triode amplifier, V205B (1/2 6CL8A) for further amplification before application to the phase modulator. The output from the plate (pin 2) of V205B is coupled through C244, L216, R232 (the modulation level control), and R204 to the grid (pin 1) of the phase modulator, V201B.

NOTE

Potentiometer R232 is not an audio gain control. Its function is only to set the maximum deviation limit. Therefore, R232 should be adjusted only when there is sufficient audio signal present to produce clipping action by CR201 and CR202.

4-3-4. CRYSTAL OSCILLATOR

The transmitter oscillator, V201A, is a pentode type using a fundamental-frequency type CR-36/U crystal. Netting capacitor, C201, permits precise adjustment of the oscillator to the required channel frequency. The oscillator output is coupled through capacitor C206 to the grid (pin 1) of the phase modulator, V201B.

4-3-5. PHASE MODULATOR AND BUFFER AMPLIFIER

RF signals from the oscillator circuit and audio signals from the microphone circuit are applied to the grid (pin 1) of the transmitter phase modulator, V201B. This tube varies the phase of the oscillator signal at the rate of the audio input applied. The phase-modulated output of V201B is coupled through capacitor C208 to the grid (pin 2) of the transmitter buffer amplifier, V202A. Tube V202A isolates and amplifies the signal which is then applied to the grid (pin 7) of the transmitter first multiplier, V202B, through capacitor C213. Coil L203 in the plate circuit of V202A is tuned to the oscillator frequency.

4-3-6. FIRST MULTIPLIER

Tube V202B is a conventional pentode doubler circuit with the plate tank coil, L204, tuned to twice the oscillator frequency. The output from V202B is coupled through capacitor C219 to the grid (pin 1) of the transmitter second multiplier, V203A.

4-3-7. SECOND MULTIPLIER

Tube V203A is one tetrode section of a type 6360 dual-purpose tube functioning as a frequency tripler circuit. The plate tank coil, L205, is tuned to three times the frequency of the input signal or six times the oscillator signal. The output is coupled through the common cathode to the third multiplier, V203B.

4-3-8. THIRD MULTIPLIER

Tube, V203B, functions as a tetrode doubler circuit with the output tuned to 12 times the oscillator frequency, the desired channel frequency. The output of V203B is transformer coupled through L207 and L208 to the grid (pin 10) of the power amplifier, V204.

4-3-9. POWER AMPLIFIER

The type 7984 power pentode, V204, amplifies the signal to a level and impedance suitable for application to the antenna. Trimmer C229 in the screen grid circuit is provided to neutralize the stage. Trimmers C233 and C234 in the plate circuit are tuned to the channel frequency. The output from V204 is coupled through L209 and L210 to the output filter, FL201.

Filter, FL201, is a two-section constant-K harmonic filter which attenuates harmonics to the specification level. The output from FL201 is applied through the antenna relay to the antenna. The relay is housed in a dust-proof nylon enclosure and uses gold-plated contacts to assure reliable operation.

4-4. POWER SUPPLY

This equipment employs a balanced, transistorized DC-to-DC converter using a pair of type 2N442 power transistors, Q301 and Q302. A full-wave bridge rectifier, CR301, is used to provide the various voltages required for operation of the transmitter and receiver circuits.

SECTION V

MAINTENANCE AND ALIGNMENT

5-1. GENERAL

Instructions outlined in this section are directed mainly to servicemen familiar with industrial communications radios. This section contains information on preventive and corrective maintenance.

Preventive maintenance differs from corrective maintenance in that its objective is to prevent troubles from occurring. Preventive maintenance consists of work performed to keep equipment in good working order and reduce breakdowns and interruptions in service. Corrective maintenance is required when a malfunction of the equipment becomes apparent and an electrical or mechanical adjustment and/or replacement of components is necessary.

5-2. PREVENTIVE MAINTENANCE

Periodic checks should be performed by qualified servicemen to minimize equipment failure and maintain continuity of service. The following procedures should be of aid in checking the subject equipment for items which could result in either equipment breakdown or shortening the time of its useful service:

A. Remove all dirt, corrosion, and moisture from sockets, plugs, and case.

B. Examine all plugs and sockets for firm seating and positive contact.

C. Remove dust covers and examine all components, such as capacitors, resistors, tubes, diodes, and transistors, for outward signs of damage.

D. Inspect internal flexible wiring for signs of breaks, improper dress, and burned or frayed insulation.

5-3. CORRECTIVE MAINTENANCE

When the equipment fails to operate properly, the trouble may be corrected by mechanical or electrical adjustment or, if necessary, by replacement of one or more defective components. When a malfunction occurs in this transmitter/receiver, the normal procedure is to identify the trouble and localize the source to a particular stage or component by means of the Signal Strength Chart, Trouble Shooting Chart, and Schematic Diagram (figure 8).

5-3-1. SIGNAL STRENGTH CHART

Table 1 lists the signal strength required for 20 DB receiver quieting with a normal signal. Signal is to be injected from a 50-ohm (terminated) output from a Marconi Model 1066B or equivalent signal generator through an appropriate coupling capacitor.

TABLE 1. RECEIVER SIGNAL STRENGTH CHART

Injected Signal Frequency	Signal Injected at	Maximum Required Signal
455 KC through a 0.01 μF capacitor in series with a 1K ohm resistor	V107-pin 1 V106-pin 1	12 Millivolts 500 Microvolts
8.0 MC through a 0.002 μF capacitor	V104-pin 1 V103-pin 2	8 Microvolts 20 Microvolts
Channel frequency through a 4.7 PF capacitor	V103-pin 1 V102-pin 5	20 Microvolts 30 Microvolts
Channel frequency through 4.7 PF capacitor in series with 1K ohm resistor	V101-pin 1	5 Microvolts
Channel frequency Directly from Generator (not terminated)	Antenna Receptacle	0.5 Microvolts

5-3-2. TROUBLE SHOOTING CHART

Table 2 lists the most common troubles which occur in this type of equipment, their causes and remedies. The table is broken down into receiver, transmitter, and power supply problems to help isolate the malfunction.

TABLE 2. TROUBLE SHOOTING CHART

SYMPTOM	PROBABLE CAUSE	REMEDY
RECEIVER		
Inoperative	(A) Audio Section: Tubes V109, V110 and/or associated circuitry defective. (B) IF Section: Tubes V108, V107, V106, V105, V104, V103A and/or associated circuitry defective. (C) RF Section: Tubes V103B, V102, V101 and/or associated circuitry defective.	Identify defective stage by voltage, resistance, and gain measurements (table 1). Locate and replace defective component.
Squelch Inoperative	Tube V111 and/or associated circuitry defective.	Locate and replace defective component.
Low Sensitivity	(A) Defective tube in RF, IF, or audio section.	Identify defective stage by voltage, resistance, and gain measurements (table 1). Locate and replace defective component.
	(B) Receiver misaligned.	Realign receiver per paragraph 5-4.
	(C) Defective antenna, antenna cable, or relay K301.	Locate and replace defective component.
Audio Distorted	(A) Tube V110 and/or associated circuitry defective.	Locate and replace defective component.
	(B) Receiver misaligned.	Realign receiver per paragraph 5-4.
	(C) Defective or misadjusted channel crystal Y101.	Re-net to frequency or replace crystal if necessary.
TRANSMITTER		
No RF Output	(A) Tubes V201 through V204 and/or associated circuitry defective. (B) Defective relay, K301. (C) Defective channel crystal, Y201.	Following the alignment procedure (paragraph 5-5), identify defective stage; locate and replace defective component.
Low RF Output	(A) Defective or weak tube V201 through V204.	Following the alignment procedure (paragraph 5-5), identify defective stage; locate and replace defective component.
	(B) Transmitter misaligned.	Realign transmitter per paragraph 5-5.
	(C) Low B+ voltage.	Check power supply.

TABLE 2. TROUBLE SHOOTING CHART (CONT.)

SYMPTOM	PROBABLE CAUSE	REMEDY
Modulation Deviation Low	(A) Tube V205 defective. (B) Microphone defective. (C) Deviation control, R232, misadjusted.	Locate and replace defective component. Readjust control per paragraph 5-5-3.
Modulation Distorted	(A) Transmitter misaligned. (B) Defective or misadjusted channel crystal, Y201.	Realign transmitter per paragraph 5-5. Re-net to frequency or replace crystal if necessary.
POWER SUPPLY Inoperative	(A) Defective fuse F301. (B) Defective ON/OFF switch S301. (C) Defective power transformer, T301.	Locate and replace defective component.
Blows Fuses	(A) Transistor Q301, Q302 defective. (B) Silicon diodes in rectifier CR301 shorted. (C) Power transformer T301 defective. (D) B+ shorted.	Locate and replace defective component.
Low B+ Voltage	(A) Shorted tube or B+ bypass capacitor. (B) Defective diodes in power supply. (C) Defective power supply filter capacitor.	Locate and replace defective component.

5-4. RECEIVER ALIGNMENT

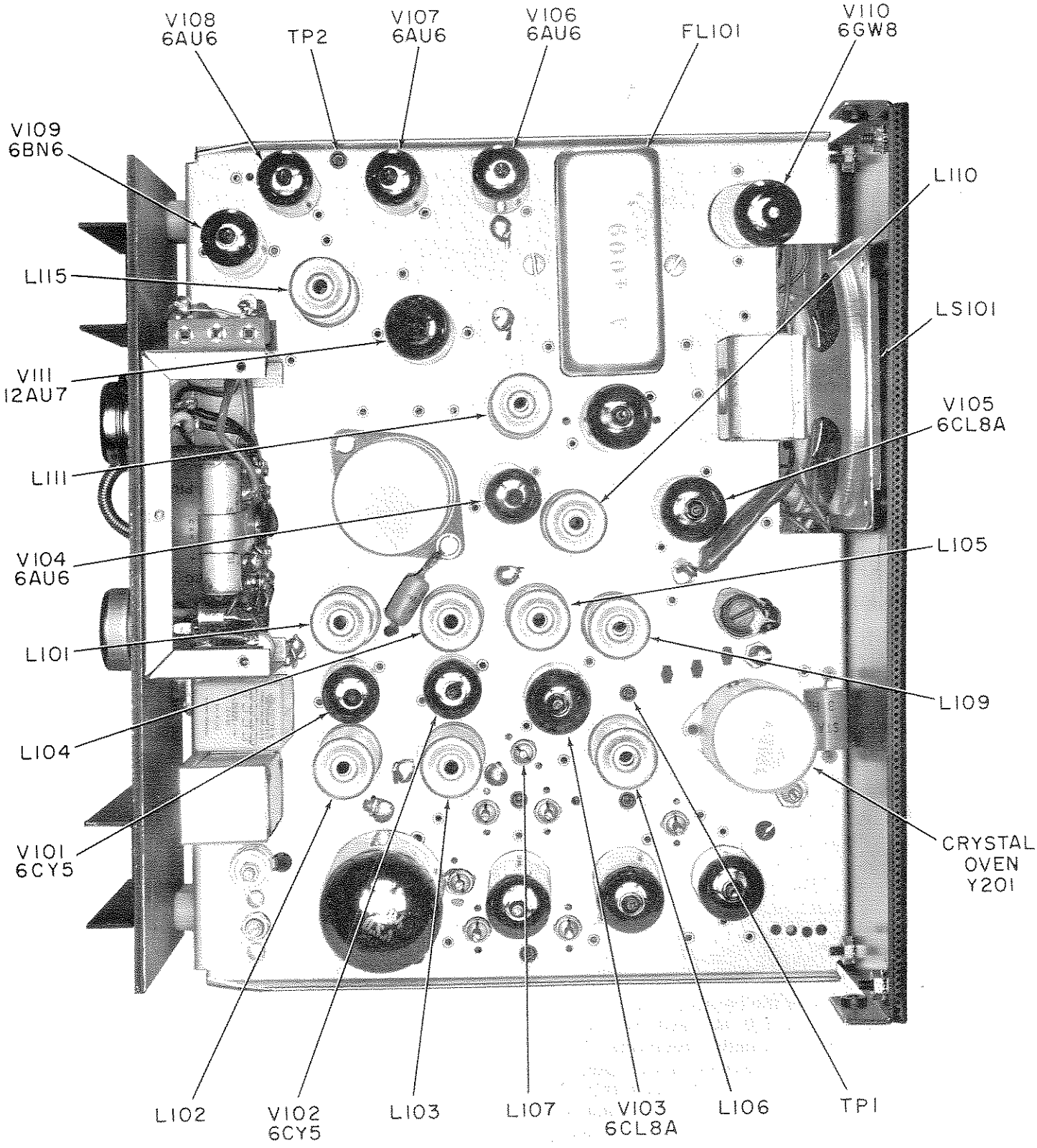
Complete alignment of the receiver requires the use of RF signals at 8.0 MC and the desired operating frequency. Normally, complete alignment will not be required unless a major component has been replaced. In most cases only RF alignment and netting to the system frequency will be required, in which instances proceed directly with paragraph 5-4-7.

5-4-1. EQUIPMENT REQUIRED

1. FM Signal Generator; Boonton Type 202E, Marconi Model 1066B, or equivalent.
2. Multimeter; Simpson Model 260 or equivalent.

or

3. Vacuum Tube Voltmeter (VTVM); Hewlett-Packard Model 410B or equivalent.
4. Frequency Standard capable of better than 0.0002% accuracy on the desired channel; Gertsch Model FM-7, Bailey Model 700 "Zero-Beat" or equivalent.
5. LF Signal Generator; Hewlett-Packard 606A, Measurements Model 65B, or equivalent.



156-003863B

Figure 6. Top View of Chassis Showing Receiver Components.

6. An audio wattmeter; this can be constructed by connecting a three-ohm resistor in parallel with a rectifier-type AC voltmeter having a full-scale deflection of about 3 volts (in this case one watt corresponds to approximately 1.7 volts).

7. Alignment tool; General Cement NO. 9091 or equivalent.

5-4-2. 455-KC IF ALIGNMENT

The 455-KC IF stages, V106, V107, and V108 are fixed-tuned stages and no adjustments are required.

5-4-3. 8.0-MC IF ALIGNMENT

Set the signal generator to 8.0 MC (unmodulated) and connect the output to pin 1 of V103. Connect the negative lead on the test meter to test point TP2 and the positive lead to chassis ground. Set the signal generator to read approximately one volt on the test meter. Throughout the 8.0-MC alignment, reduce the generator output to maintain this one-volt reading.

Adjust the top and bottom cores of coils L109, L110, and L111 for maximum meter indication. Repeat the adjustments until no further increase in meter reading can be obtained.

Peak readings on the test meter can be obtained in two positions of each tuning core. Always tune the coils to the position closest to the ends of the core.

This completes the alignment; disconnect all test equipment.

5-4-4. RECEIVER OSCILLATOR ADJUSTMENT

Connect the test meter to test point TP1, ascertain that the crystal is oscillating, and then adjust oscillator coil, L106, for maximum indication on the meter. After adjustment is completed, disconnect the meter.

Netting. - In order that the receiver frequency exactly coincide with the system channel frequency, the receiver oscillator must be adjusted so as to "net" the receiver on frequency. Inasmuch as the receiver selectivity is symmetrical, centered on 8.0 MC, it is absolutely essential that the high-frequency oscillator be set to produce this 8.0-MC IF signal exactly when heterodyned with the incoming channel signal. This can be accomplished by the following procedure.

A. Inject an unmodulated 8.0-MC signal (exactly on frequency) from the signal generator to the receiver first mixer (V103). This can be accomplished by wrapping a two or three turn link of hookup wire, connected to the generator output lead, around the tube.

B. A signal source, known to be on the desired channel frequency, either an accurately adjusted signal generator or a signal from the system control transmitter, should be connected to the receiver antenna input.

C. The oscillator coil (L106) should be adjusted for zero beat with the 8.0-MC injected signal. Zero beat will be heard in the receiver speaker (volume control set at about mid range).

The adjustment is completed; disconnect all test equipment.

5-4-5. RF ALIGNMENT

Set the signal generator to the channel frequency (unmodulated) and connect it to the antenna connector, J302. Connect the negative lead of the test meter to test point TP2 and the positive lead to chassis ground. Set signal generator to indicate approximately one-volt on the meter. Throughout this alignment, reduce the generator output as necessary to maintain the one-volt reading.

Adjust coils L107, L105, L104, L103, L102, and L101 for maximum indication on the meter. Repeat adjustment of L107 and L105 as necessary until no further interaction is observed.

This completes the RF alignment; disconnect all test equipment.

5-4-6. QUADRATURE COIL ADJUSTMENT

Disconnect the ungrounded end of the speaker LS101 from the audio output transformer T101. Connect a three-ohm audio wattmeter across the secondary of T101. Connect an FM signal generator to the ANTENNA connector, J302. Set the signal generator to the receiver channel frequency, FM modulated to give 3.3-KC deviation at a modulation frequency of 1000 CPS. Adjust quadrature coil L115 for a maximum indication on the wattmeter. When the adjustment is completed, disconnect the test equipment and reconnect the speaker to the output transformer.

5-4-7. PERIODIC RECEIVER FREQUENCY CHECK

In the performance of normal periodic maintenance checks, complete alignment will not be necessary. The following procedure is to be performed in order to peak the receiver on the correct frequency.

Connect the FM signal generator to the antenna input and set it to the exact operating frequency. Connect the negative lead of the test meter to test point TP2 and the positive lead to chassis ground. Adjust the signal generator output for a meter reading between 0.5 and 1.5 volts with no limiting.

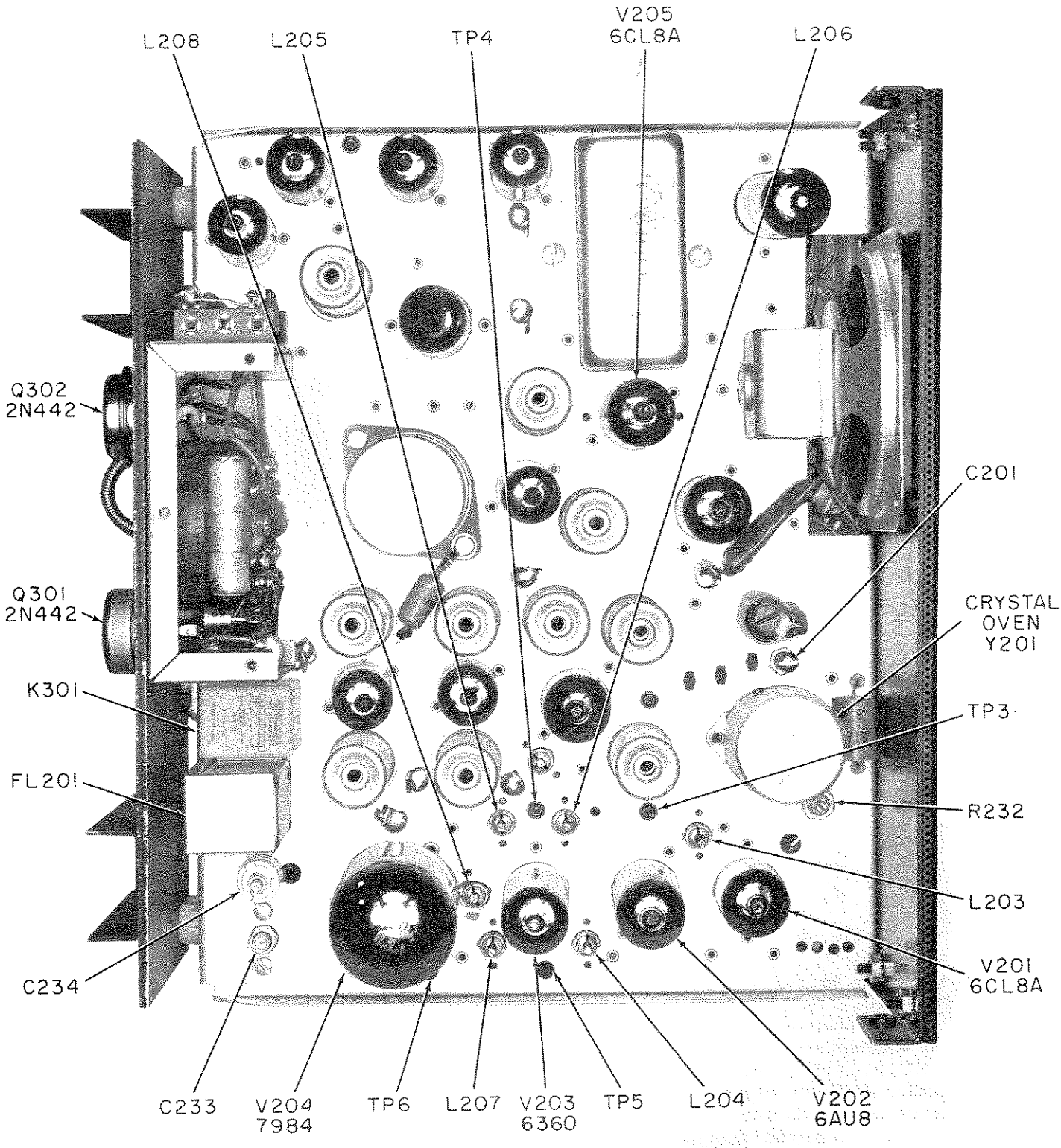


Figure 7. Top View of Chassis, Showing Transmitter and Power Supply Components.

Repeak the following coils and transformers in the order shown: L106, L107, L105, L101, L102, L103, L104, and the top and bottom cores of L109, L110, and L111. (This may also be accomplished using a weak signal from a transmitter in the system.) Disconnect the test meter.

Connect a wattmeter as described in paragraph 5-4-6. Modulate the signal generator with a 1,000-CPS tone at 3.3 KC deviation and adjust the quadrature coil (L115) for maximum indication on the wattmeter (if a transmitter is used, modulate with voice). The receiver sensitivity should be about 0.5 microvolt for 20-DB quieting with a squelch threshold opening of approximately 0.25 microvolt if the receiver is properly aligned.

5-5. TRANSMITTER ALIGNMENT

IMPORTANT NOTE

According to FCC Rules and Regulations: Only persons holding radio-telephone operator licenses (second class or higher) or persons working under their direct supervision are authorized to perform adjustments or tests coincident with the installation, servicing, or maintenance of a radio station, which may affect the proper operation of the equipment as set forth in the Rules and Regulations governing the class of service for which the equipment is licensed.

5-5-1. EQUIPMENT REQUIRED

1. Frequency standard capable of better than 0.0002% accuracy on the desired channel; Gertsch Model FM-7, Bailey Model 700 "Zero-Beat" or equivalent.

2. Deviation meter; Marconi Model TF-791D or equivalent.

3. Wattmeter/Load; Bird Model 612 or equivalent.

4. Multimeter; Simpson Model 260 or equivalent (use 0-50 μA range).

5-5-2. RF ALIGNMENT

A. Connect the indicating type wattmeter/load to the antenna output, using a minimum length of RG-8/U coaxial cable. Turn the equipment ON and leave it warm up for a minimum of 15 minutes to permit the oven and crystal to stabilize. If the circuits are considerably out of alignment remove tubes V203 and V204 to prevent damage and overdissipation.

B. Connect the negative lead of the test meter to test point TP3 and the positive lead to chassis ground. Key the transmitter and adjust the buffer plate coil, L203, for maximum meter indication. It may be necessary to adjust the crystal trimmer capacitor, C201, slightly to obtain an indication on the meter.

C. Connect the test meter between test point TP4 and ground. Return tube V203 to its socket and allow a few minutes for that tube to warm up. Key the transmitter and adjust the first doubler plate coil, L204, for maximum meter indication.

D. Connect the test meter between test point TP5 and ground. Key the transmitter and adjust coils L205 and L206, respectively, for maximum meter indication. Repeat adjustments of L205 and L206 until there is no further interaction.

E. Connect the test meter between test point TP6 and ground. Return tube V204 to its socket and allow a few minutes for that tube to warm up. Key the transmitter and adjust coils L207 and L208, respectively, for maximum meter indication. Repeat adjustments of L207 and L208 until there is no further interaction.

F. Preset the antenna capacitor, C234, for minimum capacity. Key the transmitter and adjust trimmer C233 for maximum power output into the load. Readjust L207, L208, C233, and C234 for maximum power output.

G. Adjust the neutralizing trimmer, C229, for maximum indication on the test meter at test point TP6. When retuning C233, maximum power output should coincide with maximum grid-drive indication at test point TP6.

NOTE

If coils L207 and L208 are considerably out of adjustment, it will be difficult to obtain grid-drive indication at test point TP6. By tuning C233 for some indication on the wattmeter/load, it can be used as an indicator for tuning L207 and L208 until grid drive is large enough to give an indication at test point TP6.

H. Repeat steps D, E, and F. The multimeter reading at test point TP5 should indicate not less than 40 microamperes. The multimeter reading at test point TP6 should indicate not less than 15 microamperes. The power output delivered to the load should be not less than 20 watts. Disconnect the test equipment.

5-5-3. FREQUENCY DEVIATION

To check carrier deviation, sample the output at the load with a pickup loop connected to the deviation meter. Speak in the microphone in a loud voice and note the deviation. This should indicate not more than ±5 KC. If necessary, unlock and adjust the modulation level control, R232, to maintain the deviation within the ±5-KC limits. After adjustment, lock R232 and seal the shaft with a drop of glyptol cement.

5-5-4. NETTING THE TRANSMITTER

Frequency netting of the transmitter is accomplished by precise adjustment of the crystal oscillator frequency to correspond with that marked on the crystal case. Netting compensates for the various circuit and component tolerances of the transmitter by placing the transmitter on its assigned channel frequency. A pickup loop should be constructed from a length of RG-58/U cable by removing six inches of outer shield and forming ing a two-turn loop large enough to slip over the oscillator tube, V201. The end of the loop should be soldered to the shield. The other end of the cable should be connected to the frequency counter.

Set the counter frequency converter for the correct mixing frequency and place the pickup loop (constructed as described in the preceding paragraph) over the oscillator tube, V201.

Adjust C201 for the correct crystal frequency. Where an oven is employed, C201 should be adjusted for the approximate center of the oven-heating cycle. This completes the transmitter alignment.

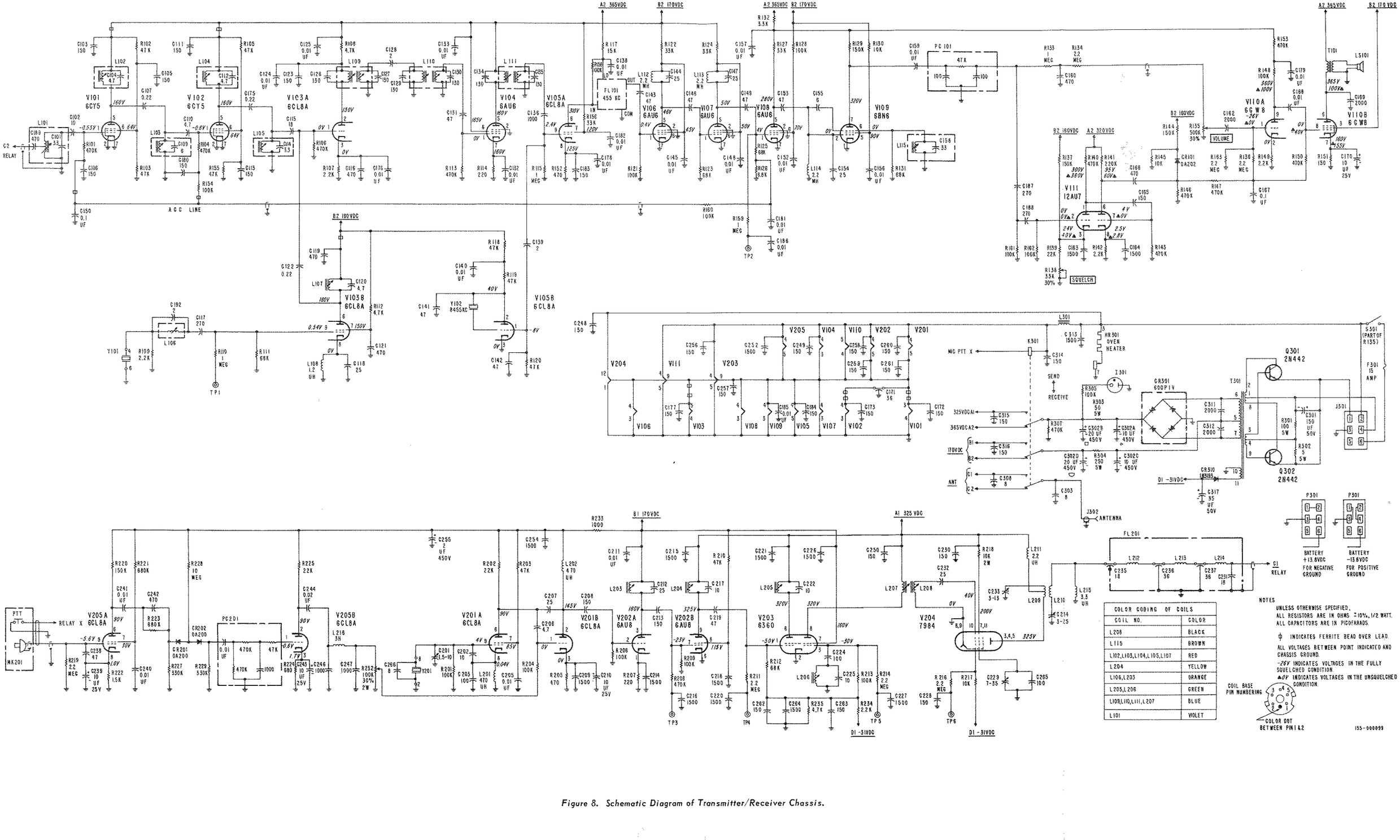


Figure 8. Schematic Diagram of Transmitter/Receiver Chassis.

SERVICE REPAIR PARTS LIST

CAPACITORS

Schematic Symbol	Description	Hallicrafters Part Number
101,114	3.3 PF, 5%, 1000V, Ceramic Disc	512-001021-339
102,202, 7,222,225	10 PF, 5%, 1000V, Ceramic Disc	512-001091-100
103,105, 06,111,113, 23,165,172, 73,177,180,183,184,208,213,228,230,248, 49,250,256,257,258,259,260,261,262,263, 4,315,316	150 PF, 10%, 500V, Ceramic Disc	047-001875-001
104,110, 2,120,206	4.7 PF, 5%, 1000V, Ceramic Disc	512-001021-479
107,122, 75	0.22 PF, 5%, 500V, Composition	047-300430-002
109,155	6 PF, 5%, 1000V, Ceramic Disc	512-001021-060
115,231	18 PF, 5%, 1000V, Ceramic Disc	512-001081-180
116,119, 21,160, 56,242	470 PF, 10%, 1000V, Ceramic Disc	047-001882-003
117,187, 88	270 PF, 5%, 500V, Plastic Mica	482-162271
118,144, 47,154, 07,212,232	25 PF, 5%, 1000V, Ceramic Disc	512-001091-250
124,125, 32,133,140, 45,148,152, 56,168,176,178,181,182,185,186,205, 1,240,241	0.01 μF +80-20%, 500V, Ceramic Disc	047-001888-005
126,127, 29,130, 34,135	130 PF, 5%, 500V, Plastic Mica	482-162131
128,139, 92	2 PF, 5%, 1000V, Ceramic Disc	512-001091-020
131,141, 42,143,146, 49,153,219, 38	47 PF, 5%, 1000V, Ceramic Disc	512-002091-470
136,246, 47	1000 PF, 10%, 1000V, Ceramic Disc	047-001882-010
138,157, 59,179	0.01 μF, GMV, 1000V, Ceramic Disc	047-001884-026
150,167	0.1 μF, 10%, 125V, Paper Tubular	046-001563
158	33 PF, 5%, 1000V, Ceramic Disc	512-002081-330
162,169, 11,312	2000 PF, 20%, 1400V, Ceramic Disc	047-001883-011
163,164, 09,214,215, 16,218,220, 21,226,227, 52,254,264,313	1500 PF, GMV, 500V, Ceramic Disc	047-001888-002
170,210, 39,243	10 μF, +50-10%, 25V, Electrolytic	045-001177
171,236, 37	36 PF, 2%, 500V, Ceramic Feed-Through	047-001885-001
189	470 PF, 10%, 1000V, Ceramic Disc	047-001930
201	Variable, Trimmer, 1.5-10 PF, Ceramic (Inc. Hardware)	047-001891
203,224, 65	100 PF, 5%, 1000V, Ceramic Disc	512-003091-101
229	Variable, Trimmer, 7-35 PF, 500V	044-000608
233	Variable, Trimmer, 3-13 PF, Air Type	048-000563
234	Variable, Trimmer, 3-25 PF, 20%, 500V, (Inc. Hardware)	044-000609
235	18 PF, 1%, 500V, Ceramic Feed-Through	047-001885-002
244	0.02 μF, 20%, 500V, Ceramic Disc	047-001888-008
255	2 μF, 450V, Electrolytic	045-001178
266,303, 08	8 PF, 5%, 1000V, Ceramic Disc	512-001021-080
301	150 μF, 50V, Electrolytic	045-001176
302A,B, ,D	20-20-10-10 μF, +30-10%, 450V, Electrolytic	045-001175
317	35 μF, 50V, Electrolytic	045-001174

*RESISTORS

Schematic Symbol	Description	Hallicrafters Part Number
R101,104, 106,113,140, 143,146,147, 150,153,208, 307	470K Ohm	451-252474
R102,103, 105,118,119, 120,155,203, 210	47K Ohm	451-252473
R107,109, 142,149,234	2200 Ohm	451-252222
R108,112, 235	4700 Ohm	451-252472
R110,115, 133,159	1 Megohm	451-252105
R111,123, 125,131,212	68K Ohm	451-252683
R114,207	220 Ohm	451-252221
R117	15K Ohm	451-252153
R121,128, 148,154,158, 160,161,162, 201,204,206, 209,213,305	100K Ohm	451-252104
R122,124, 127,156	33K Ohm	451-252333
R126	6800 Ohm	451-252682
R129,137, 144,220	150K Ohm	451-252154
R130,145, 217	10K Ohm	451-252103
R132	3300 Ohm	451-252332
R134,136, 163,211,214, 216,219	2.2 Megohm	451-252225
R135	Variable, 500K Ohm, ±30%, SQUELCH	025-002374
R138	Variable, 33K Ohm, ±30%, VOLUME	025-002375
R139,202, 225	22K Ohm	451-252223
R141	220K Ohm	451-252224
R151	150 Ohm	451-252151
R152,205	470 Ohm	451-252471
R218	10K Ohm, 2 watt	451-652103
R221,223	680K Ohm	451-252684
R222	1500 Ohm	451-252152
R224	680 Ohm	451-252681
R227,229	330K Ohm	451-252334
R228	10 Megohm	451-252106
R232	Variable, 100K, 2 watt	025-002371
R233	1000 Ohm	451-252102
R301	100 Ohm, 10%, 5 watt, Wire Wound	445-012101
R302	5 Ohm, 10%, 5 watt, Wire Wound	445-012050
R303	50 Ohm, 10%, 5 watt, Wire Wound	445-012500
R304	250 Ohm, 10%, 5 watt, Wire Wound	445-012251

* All RESISTORS are carbon type, 10%, 1/2 watt unless otherwise stated.

COILS AND TRANSFORMERS

Schematic Symbol	Description	Hallicrafters Part Number
L101	Coil, Antenna	050-001637
L102,103, 104,105	Coil, Radio Frequency	050-001638
L106	Coil, Oscillator Grid	050-001639
L107	Coil, Oscillator Plate	050-001640
L108	Coil, 1.2 μH, RF Choke	050-001580-004
L109,110, 111	Coil, Intermediate Frequency	050-001641
L112,113,114	Coil, 2.2 MH, RF Choke	050-001581
L115	Coil, Quadrature	050-001642
L201,202	Coil, 470 μH, RF Choke	050-001580-001
L203	Coil, Buffer Plate	050-001643
L204	Coil, Multiplier Plate	050-001644
L205,206	Coil, Multiplier Plate and Grid	050-001645
L207	Coil, Multiplier Plate	050-001646
L208	Coil, Power Amplifier Grid	050-001647
L209	Coil, Power Amplifier Plate	050-001553
L210	Coil, Link Antenna	050-001552
L211	Coil, 2.2 μH, RF Choke	050-001582
L212,213, 214	Coil, Filter	050-001561
L215	Coil, 3.3 μH, RF Choke	050-001580-002
L216	Coil, 3H, RF Choke	056-000708
L301	Coil, Filament Choke	050-001589
T101	Transformer, Audio Output	055-000544
T301	Transformer, Power	050-001757

ELECTRON TUBES, TRANSISTORS & DIODES

Schematic Symbol	Description	Hallicrafters Part Number
V101,102	Tube, Type 6CY5	090-001556
V103,105, 201,205	Tube, Type 6CL8A	090-001557
V104,106, 107,108	Tube, Type 6AU6	090-900808
V109	Tube, Type 6BN6	090-900826
V110	Tube, Type 6GW8	090-001502
V111	Tube, Type 12AU7	090-901291
V202	Tube, Type 6AU8	090-901168
V203	Tube, Type 6360	090-901253
V204	Tube, Type 7984	090-001555
Q301,302	Transistor, Type 2N442	112-300041
CR101	Diode, Silicon, Type OA202	019-003371
CR201,202	Diode, Silicon, Type OA200	019-003370
CR301	Diode, Silicon, Rectifier Bridge, Type FW600	019-003369
CR310	Diode, Silicon, Rectifier, Type 1N3193	019-002768

MISCELLANEOUS

Schematic Symbol	Description	Hallicrafters Part Number
J302	Connector, Antenna	010-100056
J301	Connector, Receptacle, 6 prong	006-001137
P301	Connector, Plug, 6 prong	010-003001
	Cover Assembly	066-004254
Y101	Crystal, Receiving	019-003357
Y201	Crystal, Transmitting	019-003356
Y102	Crystal (8455 KC)	019-003350
	Ferrite Beads	077-003040
	Flex Relief (Mic Cable)	016-002381
FL201	Filter Assembly, Low-Pass	150-007652
PC101	Filter, Couplate	049-000244
PC201	Filter, Couplate	049-000300
FL101	Filter, Lumped-IF, 455 KC	049-000299
F301	Fuse, Cartridge, 15 AMP, 3 AG	039-100367
XF301	Fuseholder (Inc. Hardware)	006-100451
	Heat Sink	067-012271
	Iron Core (L101,102,103, 104,105)	003-007726
	Iron Core (L106)	003-004566
	Iron Core (L107,203,204, 205,206,207,208)	003-007856
	Iron Core (L115)	077-001283
	Knob (W/Set Screw)	015-001561
MK201	Microphone (Inc. Mounting Clip)	085-000247
HR301	Oven, Crystal	021-000760
	Power Cable Assembly	087-008108
K301	Relay, Armature (12V)	021-000759
LS101	Speaker	085-000243
	Spring, Retaining	075-000974
TP1,2,3, 4,5,6	Test Point	035-000089
	Washer, Mica (Used with Q301 & Q302)	004-101912
	Panel, Front	068-001528
I301	Lamp, Indicator (Inc. Hardware)	039-000742
	Nameplate (HLC Logo)	013-002993
	Trim Strip (Front Panel)	007-000891

WARRANTY

"This product is warranted to be free from defective material or parts, and it is agreed to furnish a new part in exchange for any part of this unit which under normal installation, use and service discloses such defect, provided the unit is delivered by the owner to the authorized radio dealer or wholesaler from whom purchased, intact, for examination with all transportation charges prepaid, within one year from the date of sale to original purchaser and provided that such examination discloses that it is thus defective. Warranty on tubes, pilot lights, transistors, and silicon diodes is effective for a period of 90 days.

This warranty does not extend to any radio products which have been subjected to misuse, neglect, accident, improper installation, or to use in violation of instructions furnished by us, nor does it extend to units which have been repaired or altered outside of our authorized facilities, nor to cases where the serial number thereof has been removed, defaced or changed, nor to accessories used therewith not of our own manufacture.

This warranty is in lieu of other warranties expressed or implied and no representative or person is authorized to assume for us any other liability in connection with the sale of our radio products."

the hallicrafters co.

156-00421I