DEPARTMENT OF THE ARMY TECHNICAL MANUAL ~~TM 11-5096~~

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER TO 33A1-5-57-1

Ser. 227

Radioverkstedet
SAMBANDSAVDELINGEN
LISTA FLYSTASJON

FREQUENCY METER

AN/URM-81

St. no. 6625-649-4280

DEPARTMENTS OF THE ARMY AND THE AIR FORCE

OCTOBER 1955

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Be careful when working on the 240-volt dc plate supply circuits, and on the 115- or 230-volt ac input power circuits.

DON'T TAKE CHANCES!

TECHNICAL MANUAL
No. 11-5096
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DEPARTMENTS OF THE ARMY AND
THE AIR FORCE

WASHINGTON 25, D. C., *17 October 1955*

FREQUENCY METER AN/URM-81

CHAPTER 1. INTRODUCTION

3. OPERATION

CHAPTER 4. ORGANIZATIONAL MAINTENANCE

6. FIELD MAINTENANCE

CHAPTER 7. SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. This manual contains instructions for the installation, operation, maintenance and repair of Frequency Meter AN/URM–81 (fig. 1). Frequency Meter AN/URM–81 consists of Frequency Meter FR–6/U, Meter Case CY–1501/U, and Cord CG–409E/U. Throughout this manual, Frequency Meter FR–6/U will be referred to as *frequency meter.*

b. Forward comments on this publication direct to Commanding Officer, The Signal Corps Publications Agency, Fort Monmouth, New Jersey, ATTN: Standards Division.

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of Army equipment and when performing preventive maintenance:

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745–45–5 (Army); Navy Shipping Guide, Article 1850–4 (Navy); and AFR 71–4 (Air Force).

b. DA Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer as prescribed in SR 700–45–5.

c. DD Form 535, Unsatisfactory Report, will be filled out and forwarded to Commanding General, Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio, as prescribed in SR 700–45–5 and AF TO 00–35D–54.

d. DA Form 11–238, Operator First Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar) will be prepared in accordance with instructions on the back of the form (fig. 8).

e. DA Form 11–239, Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar) will be prepared in accordance with instructions on the back of the form (fig. 9).

f. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use
(fig. 1)

Frequency Meter AN/URM–81 is a precision test instrument used to measure unknown frequencies of radio frequency (rf) carriers within the range of 100 to 500 megacycles (mc). It is capable of measuring these frequencies with an accuracy of one part in 100,000. The instrument may be used in either portable or fixed installations. Frequency Meter AN/URM–81 may also be used as a low-power signal generator for use in alining and calibrating electronic equipment which operates within the frequency range of the frequency meter.

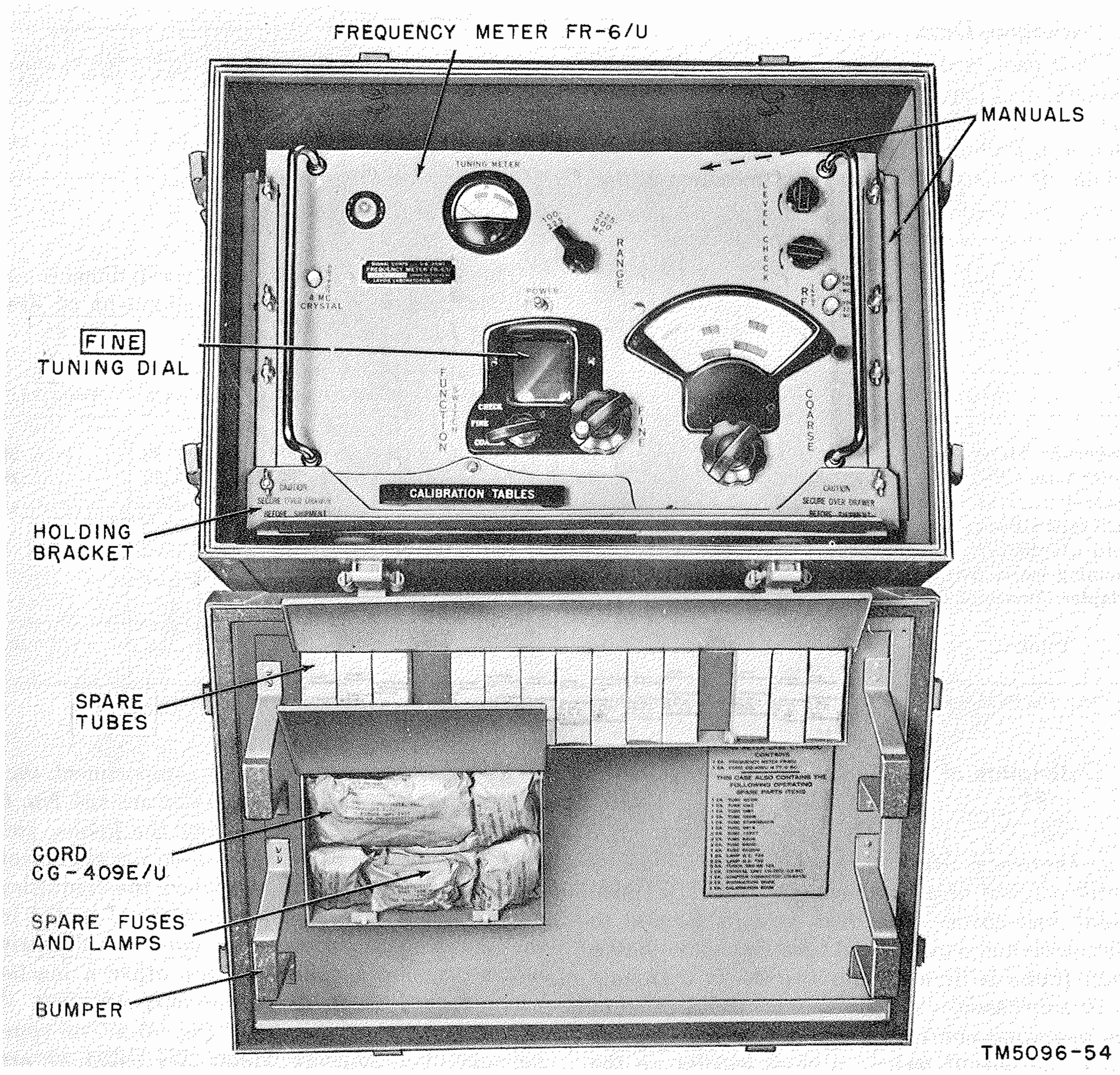


Figure 1. Frequency Meter AN/URM-81.

4. Technical Characteristics

Frequency range:	
Band 1	100 to 225 mc.
Band 2	225 to 500 mc.
Power source	110 v or 220 v ac, 50 to 1,000 cps.
Line voltage stability required	±10 percent
Rf output voltage	Approximately 50 uv into a 50-ohm load.
Spurious response	40 db down from the desired signal.
Sensitivity	Approximately 2 mw with an input of 10,000 uv.
Rf input impedance	50 ohms.
Noise level	Residual noise level is less than 16 uw into a nonreactive load of 600 ohms with an input of 10,000 uv.
Audio power output	1 mw minimum signal plus noise into a nonreactive load of 600 ohms below 500 cps with an input of 10,000 uv.
Accuracy	0.001 percent.
Modulation frequency	800±300 cps.
Power requirements	150 watts.
Number of tubes	25.

5. Packaging Data

When packaged for shipment (fig. 4), the components of Frequency Meter AN/URM-81 are placed in a moisture-vaporproof container and packed in a wooden crate. The size, weight, and volume of the crate is indicated in the chart below.

Note. Items may be packaged in a manner different from that shown, depending upon supply channels.

Crate No.	Width (in.)	Height (in.)	Depth (in.)	Volume (cu ft)	Unit weight (lb)
1 of 1	25	19	24. 5	6. 7	140

6. Table of Components

(fig. 2)

The following chart lists the overall dimensions, volume, and weight of each component of Frequency Meter AN/URM-81.

Component	Required No.	Depth (in.)	Width (in.)	Height (in.)	Volume (cu ft)	Weight (lb)
Frequency Meter FR-6/U	1	17. 2	18.9	12. 3	2. 32	60
Meter Case CY-1501/U	1	20. 75	22.5	15. 97	4. 32	28
Manual	2					
Calibration Book	1	12	9	1. 25		
Cord CG-409E/U	1		48 (lg)			5
Running spares (par. 8)	1 set					8
Adapter Connector UG-641/U	1					1
Total						102

Note. This list is for general information only. See appropriate supply publications for information pertaining to requisition of spare parts.

7. Description of Frequency Meter AN/URM-81

(fig. 3)

a. Frequency Meter FR-6/U. The frequency meter consists of a panel-chassis assembly and a metal dust cover. The dust cover is secured to the chassis and panel by eight screws. The chassis main frame is divided into two decks that hold seven subchassis. The front panel contains all of the operating controls, indicators, dials, and the input and output jacks. A glass window on the panel magnifies the frequency markings on the filmstrip indicator of the FINE tuning dial (fig. 1). The frequency meter can be mounted in a standard 19-inch panel rack. It can also be placed at an angle on a table by pulling out a tilt stand provided on the bottom of the main frame. A pair of carrying handles are mounted on the front panel for placing the frequency meter into or removing it from its case or from the relay rack. The calibration book drawer is located under the front panel and tilts downward when fully extended. The power cord is stored in a shelf at the lower left rear, below the dust cover, during transit or storage conditions. A hinged door, using Dzus fasteners, permits access to the power cord as well as to the fuses located in this compartment (fig. 33). Located on the hinged door are the No. 6 Allen wrench used for removing the knobs, and Adapter Connector UG-641/U used for alignment and for holding an antenna when the frequency meter is used as a signal generator. Located in the rear of the main frame are two extra filmstrip indicators, one a spare and the other a master which is used for making copies only.

b. Meter Case CY-1501/U (fig. 3). The components of Frequency Meter AN/URM-81 are housed in Meter Case CY-1501/U. This case may be used for storage and transportation. The case is a metal-clad wooden case with a removable top. The top is fastened down by latches on the four sides. When placed inside the case, the frequency meter is secured by bumpers to prevent damage from shock and vibration. Carrying handles on the sides of the case (fig. 2) provide easy handling. A separate compartment inside the case cover contains the running spares, manuals, and Cord CG-409E/U.

c. Cord CG-409E/U. Cord CG-409E/U consists of a 4-foot length of Radio Frequency Cable RG-58C/U with a Radio Frequency Plug UG-88C/U at each end.

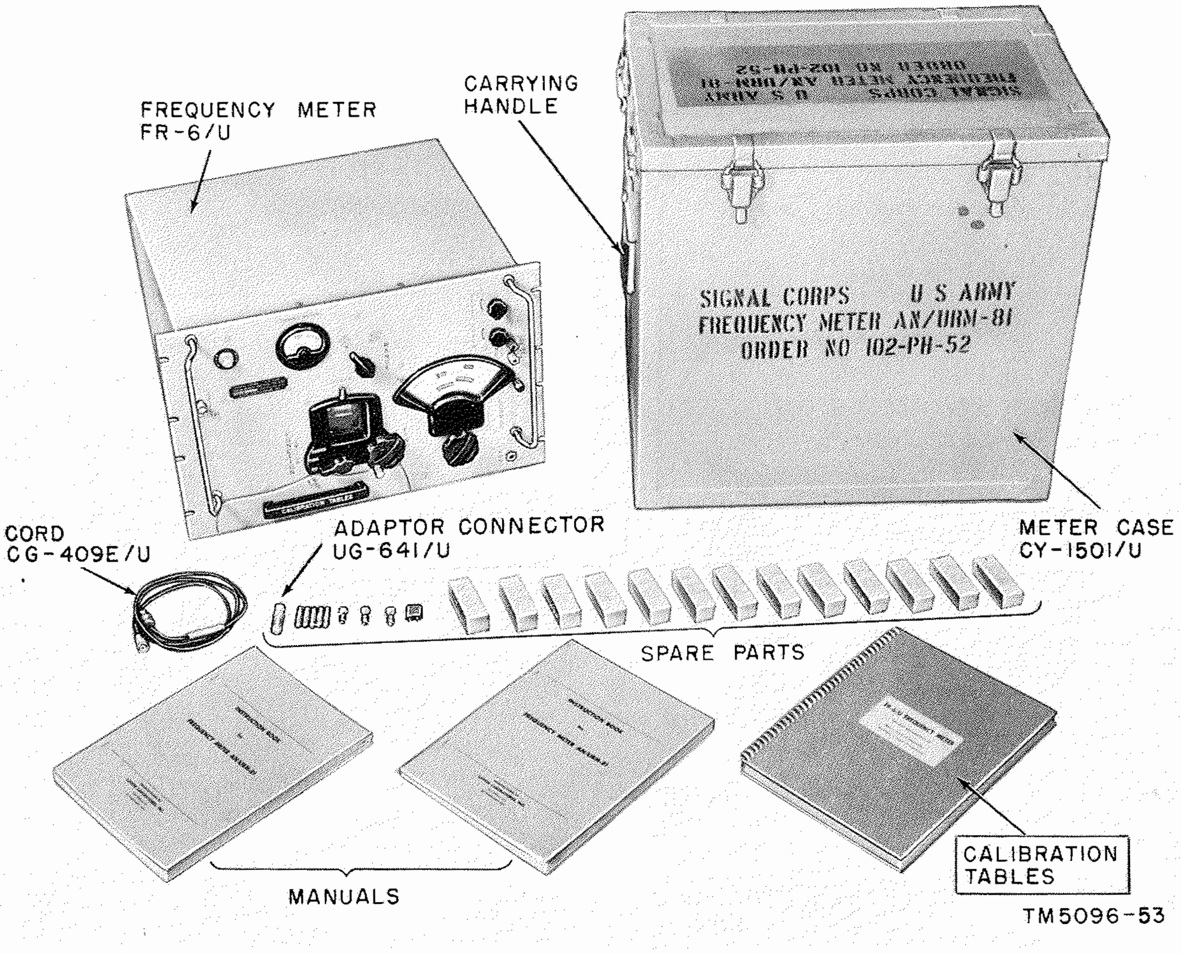


Figure 2. Frequency Meter AN/URM-81, components.

8. Running Spares

Following is a list of running spares for the frequency meter (fig. 2). These items are stored in the cover of the equipment (fig. 3).

- 1 electron tube 6X4W
- 1 electron tube OA2
- 1 electron tube OB2
- 1 electron tube 6BN6
- 1 electron tube 5749/6BA6W
- 1 electron tube 5725/6AS6W
- 1 electron tube 5814
- 2 electron tubes 12AT7
- 2 electron tubes 6AU6
- 2 electron tubes 6AH6
- 1 electron tube 6AQ5W
- 1 calibration book
- 1 Crystal CR-28/U (4 mc)
- 5 fuses, type 3AG-SB, 1.5 ampere
- 1 lamp, type GE #49
- 2 lamps, type GE #55
- 1 Adapter Connector UG-641/U

9. Additional Equipment Required

The following equipment is *not* supplied with the frequency meter but is required for its operation.

- 1 Headset HS-30
- 1 antenna (stiff copper wire approximately 18 in. long)

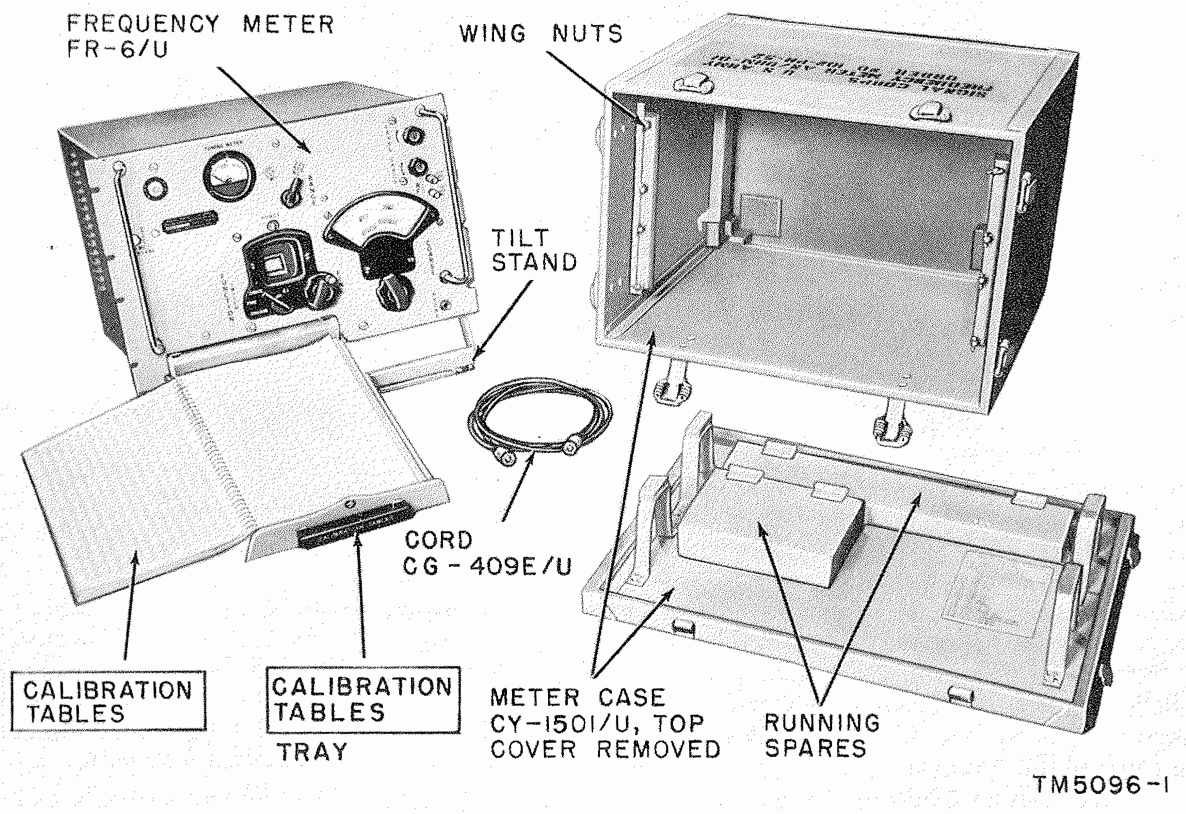


Figure 3. Frequency Meter AN/URM-81, disassembled.

CHAPTER 2

INSTALLATION

10. Uncrating, Unpacking, and Checking New Equipment

(fig. 4)

Note. For used or reconditioned equipment, refer to paragraph 14.

a. General. Equipment may be shipped in packing cases or in its own carrying case. When new equipment is received, select a location where it may be unpacked without exposure to the elements and which is near the permanent or semipermanent installation of the equipment. Aside from checking to be sure that all carrying cases are present and that the equipment is undamaged, no special unpacking and uncrating procedures are necessary for equipment shipped in carrying cases.

Caution: Be careful when uncrating, unpacking, and handling the equipment; it is easily damaged. If it becomes damaged or exposed, a complete overhaul might be required, or the equipment might be rendered useless.

b. Step-by-Step Instruction for Uncrating and Unpacking New Equipment.

(1) Place the packing case as near the operating position as is possible.

(2) Cut and fold back the metal straps.

(3) Remove the nails with a nail puller. Remove the top and one side of the packing crate. Do not attempt to pry off the other sides and the top; this may damage the equipment.

(4) Lift out the moistureproof barrier case from the crate and set the empty crate to one side.

(5) Remove the moistureproof barrier, outer corrugated carton, and the moisture-vaporproof barrier covering the equipment.

(6) Open the inner corrugated carton and remove the corrugated fillers, felt pads, manuals, and desiccant.

(7) Remove Frequency Meter AN/URM-81 from the inner corrugated carton.

(8) Unfasten the eight clamps on Meter Case CY-1501/U and remove and place the top cover on the work bench.

(9) Remove the eight wing nuts (fig. 3) holding the frequency meter and place the unit on the bench in the operating position.

(10) Remove and open the package containing Cord CG-409E/U located in a compartment in the meter case cover (fig. 1).

c. Checking New Equipment.

(1) Inspect the equipment and spares for signs of possible damage incurred during shipment.

(2) Check the contents of the packing case against the master packing slip.

11. Preinstallation

a. Input Power Adjustments. Frequency Meter AN/URM-81 is shipped with the 110 VAC 220 switch in the 110 position (fig. 38). Be sure the switch is placed in the position corresponding to the alternating current (ac) voltage source. To place the switch in the 220 position, proceed as follows:

(1) Remove the dust cover:

  (*a*) Loosen the four screws holding the cover to the front of the frequency meter. It is not necessary to remove the screws.

  (*b*) Turn the four DZUS screws (rear) counterclockwise to release the dust cover from the rear of the meter.

  (*c*) Slide the dust cover off the main frame of the frequency meter.

(2) Take off the nut holding the 110 VAC 220 switch and guard, and set the switch to the 220 position.

(3) Return the guard and nut to the switch and retighten.

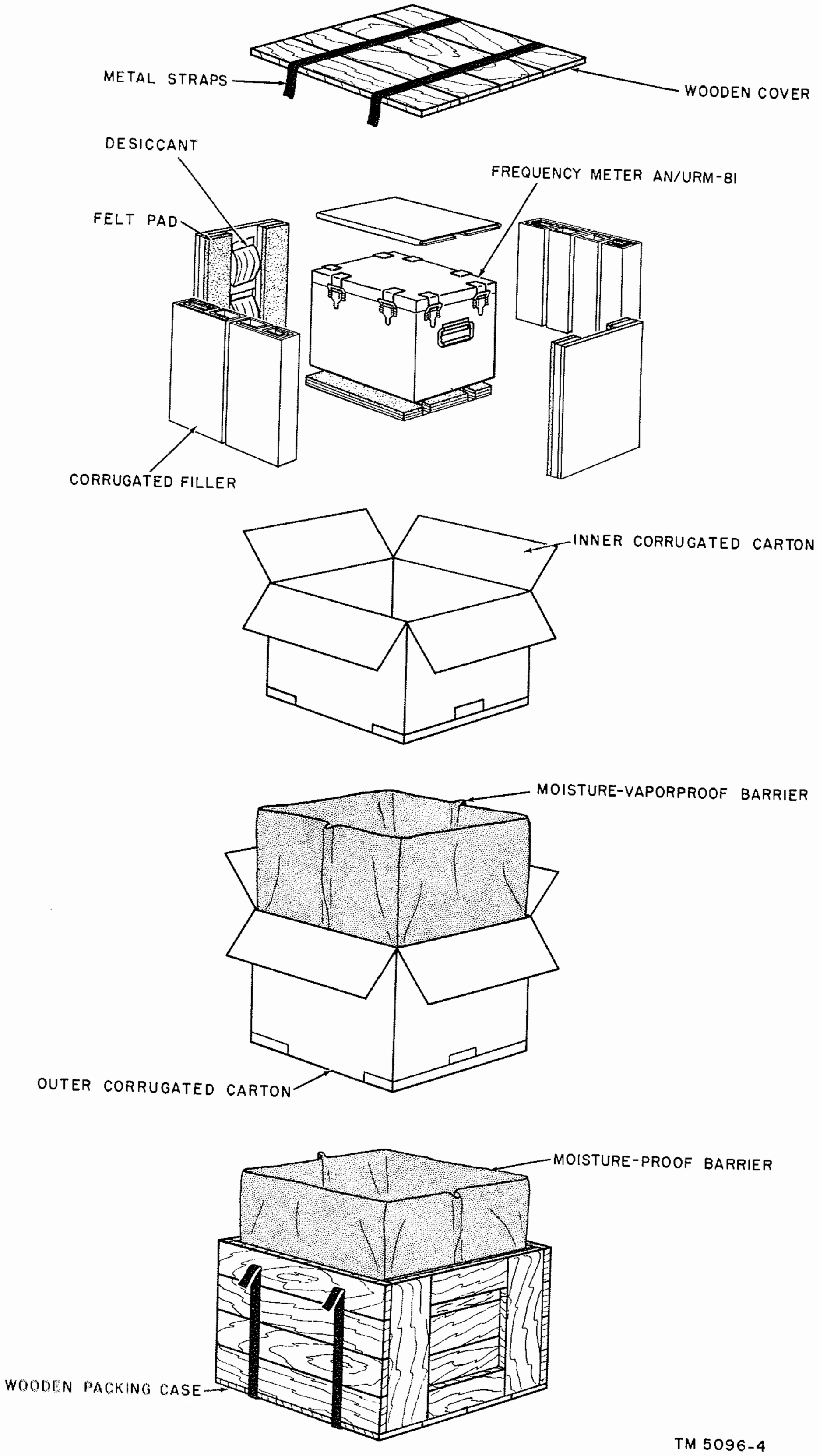


Figure 4. Typical unit packed for shipment.

(4) Slide back the dust cover and retighten by reversing the procedure outlined in (1) above.

(5) Place a tag marked *220V* on the outside of the equipment.

(6) If this procedure is reversed, tag the equipment accordingly.

b. Checking Electron Tube Placement. The electron tubes are shipped in their respective sockets. Check the proper installation of the tubes in the equipment against figures 32, 34, and 38.

12. Installation of Frequency Meter

This equipment is portable and can be installed or mounted wherever a suitable ac power source is available. When installing the frequency meter, be sure it is rigidly supported and protected against rain or other adverse weather conditions.

a. Portable Installation.

(1) Place the frequency meter close to the equipment being tested.

(2) If desired, set the frequency meter up on the tilt stand by pulling out the metal tabs on the levers located on the sides of the equipment; pull the tilt stand forward (fig. 3).

b. Permanent Installation.

(1) Place a standard (19 in. wide) rack as close as possible to the operating bench. This enables the equipment controls and jacks of the meter, when mounted, to be close to the equipment to be tested.

(2) Mount the frequency meter in the rack by means of the screws and washers provided with the rack.

13. Connections

Warning: Do not allow the power cord or Cord CG–409E/U to drape across high-voltage lines or high-potential circuits. Severe burns or shock to the operator and damage to the equipment may result.

a. Be sure the power supply switch is set properly (par. 11*a*).

b. Check the rating of the fuses as follows:

(1) F701 and F702, 1.5 amperes.

(2) F703 and F704 (spares), 1.5 amperes.

c. Set the POWER switch to OFF (fig. 5).

d. Open the door on the rear of the dust cover to remove the frequency meter power cord from its storage place and plug it into the power source receptacle.

e. Plug the headset in the PHONE jack (fig. 5).

f. Connect Cord CG–409E/U to the RF INPUT jack, 110–225 MC or 225–500 MC, depending on the frequency of the signal to be measured.

14. Service upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions given in paragraph 10 for uncrating, unpacking, and checking the equipment.

b. Check the used or reconditioned equipment for tags or other indications pertaining to changes in the wiring of the equipment. If any changes in wiring have been made, note the changes in this manual, on the overall schematic diagram, and on the other wiring diagrams affected by these changes.

c. Check the operating controls for ease of rotation. If lubrication is required, refer to the lubrication instructions given in paragraphs 33 and 34.

d. Perform the installation and connection procedures given in paragraphs 12 and 13.

CHAPTER 3

OPERATION

Section I. CONTROLS AND INSTRUMENTS

15. General

Haphazard operation or improper settings of the controls can cause damage to Frequency Meter FR–6/U. For this reason, it is important to understand the functions of the instruments and controls before attempting operation of the frequency meter. .

16. Functions of Controls and Instruments

(figs. 5 and 6)

The following chart lists the functions of the controls and instruments of Frequency Meter FR–6/U:

Control	Function
POWER switch	Connects frequency meter to ac power source when placed in the clockwise (on) position.
110 VAC 220 switch (on power supply subchassis).	Enables frequency meter to operate from either 110- or 220- volt power source.
RANGE switch	Selects operation of frequency meter in one of the following bands: Band 1 ---- 100–225 MC Band 2 ---- 225–500 MC
FUNCTION switch	Selects sequence of operation in determining the frequency of the unknown signal. The function of these positions is as follows: COARSE position: Permits approximate tuning of the frequency meter to the unknown signal through use of the COARSE tuning control. FINE position: Permits exact tuning of the frequency meter to the unknown signal through use of the FINE tuning control. CHECK position: Permits calibration of the frequency meter through use of the CHECK calibration control.
COARSE tuning control	Adjusts the frequency meter to the approximate frequency of the unknown signal as indicated in the MEGACYCLES window on the COARSE-FINE tuning dial, a tone heard in the headset, and the TUNING METER needle pointing in the LEVEL SET area.
FINE tuning control	Tunes the frequency meter exactly to the frequency of the unknown signal as indicated simultaneously on the FINE tuning dial, by the movable index across the correct HARMONIC number over the black rectangle on the COARSE-FINE tuning dial, and when no sound (zero beat) is heard in the headset.
CHECK calibration control	Calibrates the frequency meter to the FINE tuning dial as shown by TUNING METER needle pointing to the ZERO position, and no sound heard in headset (zero beat).
LEVEL gain control	Adjusts the af gain of the frequency meter (in the COARSE and FINE tuning positions) as indicated by the TUNING METER needle seen in the OVERLOAD or LEVEL SET area and af heard in headset.

Control	Function
TUNING METER	Shows tuning of the frequency meter when the pointer is in the following positions: ZERO position: indicates ZERO when the FINE tuning control is turned exactly to the frequency of the incoming signal and when the CHECK calibration control is properly set. LEVEL SET position: Indicates in the LEVEL SET area (green) when the COARSE tuning control is turned to the frequency of the incoming signal and when the LEVEL gain control is properly adjusted. This position also indicates the strength of the incoming signal. OVERLOAD position: Indicates in the OVERLOAD area (red) when the frequency meter is tuned close to the incoming signal in the FINE position, when the frequency meter is close to zero beat in the CHECK position, and when the signal is too strong when receiving in the COARSE position.
4 MC ADJUST	Adjusts the frequency meter crystal oscillator stage to exactly 4 mc when being compared with a known frequency standard signal applied to the 4 MC CRYSTAL OUTPUT jack.
FINE tuning dial	Indicates the standard basic frequency (BASIC FREQ.) as generated by the frequency meter. Also contains black diamond-shaped marks for use as indicators for calibrating the frequency meter.
COARSE-FINE tuning dial	The tuning dial functions as follows (fig. 6): Indicates frequencies in band 1 when the RANGE switch is in the 100–225 MC position. Indicates frequencies in band 2 when the RANGE switch is in the 225–500 MC position. Indicates the HARMONICS of the frequency meter by the appearance of a black rectangle and a harmonic number in the HARMONICS window as selected by the COARSE tuning control. Indicates the approximate frequency in MEGACYCLES of the unknown signal as selected by the COARSE tuning control. Indicates the exact frequency being measured when the movable index driven by the FINE tuning control coincides with the correct HARMONICS number (also zero beat heard in headset).
PHONE jack	Receptacles for plugging in the headset. Enables the operator to measure the frequency of the unknown signal by listening for tones in coarse tuning and obtaining zero beat in check and fine tuning procedures.
RF INPUT jacks	Receptacles to provide connection of signal to be measured to the frequency meter.
Amber panel light	Indicates frequencies in band 1 to be measured on the COARSE-FINE tuning dial.
Green panel lamp	Indicates frequencies in band 2 to be measured on the COARSE-FINE tuning dial.
OVEN HTR lamp (white)	Intermittent lighting indicates proper operation of crystal oven heater components.
FINE tuning dial lamps (white)	Illuminate film strip markings of the BASIC FREQ. of the frequency meter.
Power fuses (fig. 33)	Protect the equipment in case of overloads or short circuits.
Tray switch	When pressed, it releases the CALIBRATION TABLES tray from the frequency meter.

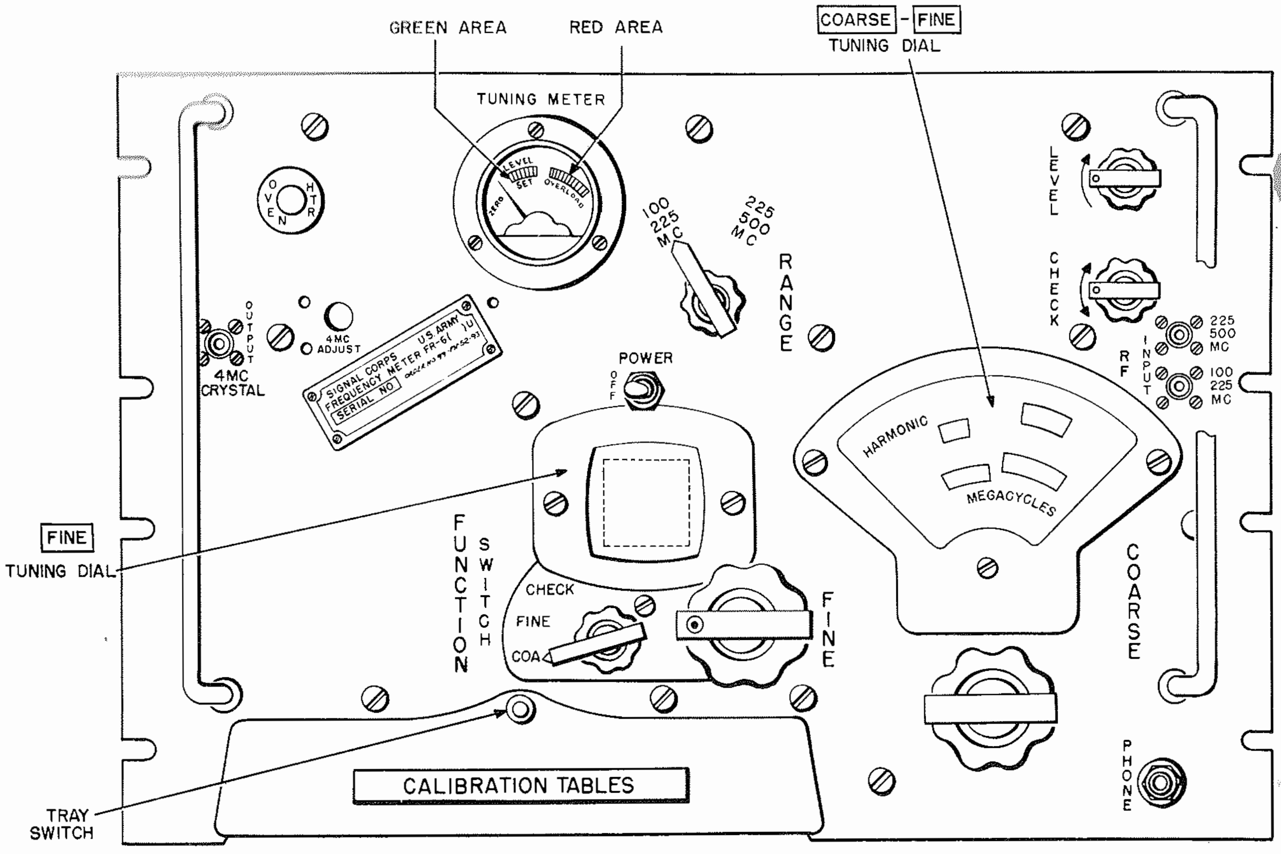


Figure 5. Frequency Meter FR–6/U, front panel.

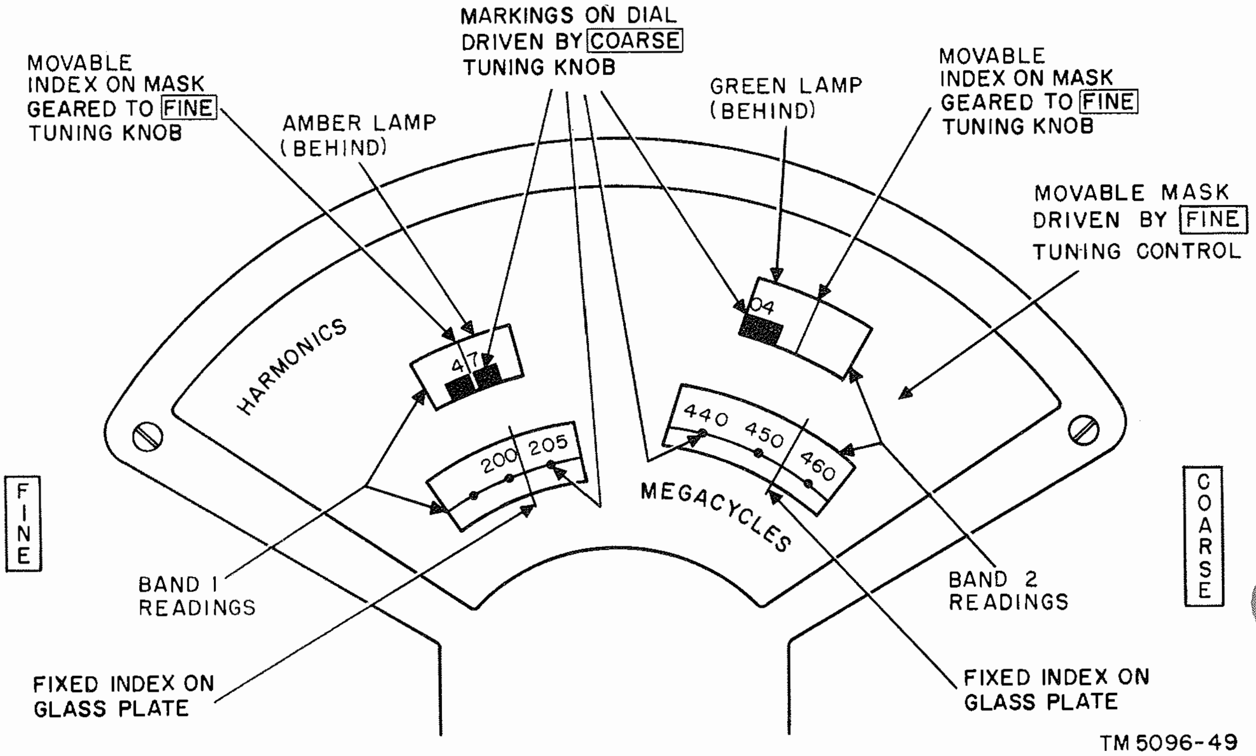


Figure 6. COARSE-FINE tuning dial.

Section II. OPERATION UNDER UNUSUAL CONDITIONS

17. Starting Procedure

Perform the starting procedure given below before using the operating procedure described in paragraph 18.

Caution: Be sure that the 110 VAC 220 switch located on the power supply subchassis is in the correct position before inserting the power plug into the line. See paragraph 11*a* for proper adjustment if needed.

a. Preliminary. Set the power switch to OFF; then plug in the power cord and set the front panel controls (fig. 5) as follows:

Control	Position
POWER switch	OFF.
FUNCTION SWITCH	COARSE.
RANGE switch	110–225 MC.
CHECK calibration control	Any.
COARSE tuning control	Any.
FINE tuning control	Any.
LEVEL gain control	Midposition.

b. Starting.

(1) Set the POWER switch on and allow a minimum 20-minute warmup period. This is necessary for the crystal oven to reach operating temperature.

(2) Couple the signal to be measured by means of Cord CG–409E/U to the appropriate RF INPUT jack. If the approximate frequency of the signal is not known, connect the signal to the 100–225 MC (band 1) jack.

Caution: Do not couple the frequency meter directly to a transmitter output.

18. Measurement of Unknown Frequency

a. COARSE Tuning (fig. 5).

(1) Turn the FUNCTION SWITCH to COARSE.

(2) Set the RANGE switch to the desired band.

(3) If the band is unknown, start with the RANGE switch set at band 1.

(4) The COARSE-FINE tuning dial lights as follows: amber for band 1, and green for band 2.

(5) Turn the COARSE tuning control until an audio tone is heard in the headset. If a tone is not heard, turn the LEVEL gain control fully clockwise.

(6) If tone still is not heard, proceed as follows:

(*a*) Switch the input connector to the RF INPUT 225–500 MC jack.

(*b*) Turn the RANGE switch to the 225–500 MC position.

(*c*) Follow the procedure outlined in (5) above; then perform the procedure outlined in (7) below.

(7) Observe the TUNING METER; if the needle is pointing in the OVERLOAD area, adjust the frequency meter as follows:

(*a*) Turn the LEVEL gain control counterclockwise (ccw) until the TUNING METER needle is set to the top of the LEVEL SET (green) area.

(*b*) Readjust the COARSE tuning control for a peak reading on the meter. If the needle exceeds the position mentioned in (*a*) above, back off the LEVEL gain control for the proper setting. This position of the meter needle indicates maximum allowable input to the audio frequency (af) amplifier.

(8) Read the approximate frequency as seen through the MEGACYCLES window of the COARSE-FINE tuning dial. See figure 6 for a sample reading of approximately 203 mc on band 1.

b. FINE Tuning (fig. 5).

(1) Turn the FUNCTION SWITCH to FINE. The tone no longer will be heard.

(2) Turn the FINE tuning control and listen for a tone in the headset.

(3) Turn the FUNCTION SWITCH to CHECK.

(4) Turn the FINE tuning control and observe the FINE tuning dial until the nearest black diamond-shaped mark is lined up with the hairline on the window under CH'K (arrows on the film strip indicate the direction to the nearest check point). See FINE tuning dial on figure 14 for a sample reading of 4333340.

(5) When the step in (4) above has been performed, an audio tone will be heard in the headset as the check point is approached. To reduce the tone to zero

beat, proceed as directed in (*a*) and (*b*) below:

(*a*) Turn the CHECK calibration control in the direction which lowers the tone.

(*b*) Watch the TUNING METER needle and slowly continue turning the CHECK calibration control; note that the needle will vibrate at a decreasing rate and come to rest at the ZERO area when zero beat is attained.

(6) Calibration is complete when the TUNING METER needle (fig. 14) is seen at ZERO and no tones are heard in the headset.

(7) Return the FUNCTION SWITCH to the FINE position.

(8) Turn the FINE tuning control until the tones decrease, disappear, then reappear. Turn the control back to where the tones disappeared; this is the zero-beat condition.

(9) Observe the TUNING METER needle and carefully readjust the FINE tuning control until the fluctuations of the needle reduce to zero.

Note 1. The hairline of the HARMONIC window of the COARSE-FINE tuning dial must fall on a black rectangle. If not, a spurious beat note has been used or a mistake has been made. Repeat the procedure outlined in (8) and (9) above until a beat note is found for which the hairline does fall on a numbered black rectangle.

Note 2. If the frequency of the signal being measured is not stable enough, an estimate of zero beat must be made.

(10) To determine the frequency by use of the CALIBRATION TABLES (fig. 7), proceed as follows:

(*a*) Turn to the section of the CALIBRATION TABLES that is the same color as the illuminated portion of the COARSE-FINE tuning dial (amber or green).

(*b*) Turn to the page number indicated under *PG* (page) in the FINE tuning dial. See figure 14 for a sample reading of 56.

(*c*) Read the BASIC FREQ. of the FINE tuning dial. See figure 13 for a sample reading of 4331450 and locate this number in the BASIC FREQ. column of the CALIBRATION TABLES.

(*d*) Read the numbered black rectangle exposed in the HARMONIC window of the COARSE-FINE tuning dial. See figure 13 for a sample reading of 47 and locate this number in the HARMONICS column of the tables.

(*e*) At the intersection of the lines containing the BASIC FREQ. and the HARMONICS column, read the frequency in MEGACYCLES PER SECOND. This is the frequency of the signal being measured. See figure 7 for a sample reading of 203.578 mc.

(11) To determine the frequency without the aid of the CALIBRATION TABLES, proceed as follows:

(*a*) Write down the number indicated on the FINE tuning dial. See figure 13 for a reading of 4331450.

(*b*) Write down the number indicated in the HARMONIC window of the COARSE-FINE tuning dial. See figure 13 for a reading of 47.

(*c*) The product of these two numbers (4331450 X 47) is the frequency in mc (203.578150) of the signal under measurement.

Note. The CALIBRATION TABLES are made up by the above procedure. If the tables should become damaged or lost, the above procedure must be used. If the manual should become damaged or lost, operating instructions are contained in the CALIBRATION TABLES.

19. Operating Frequency Meter FR-6/U as Signal Generator

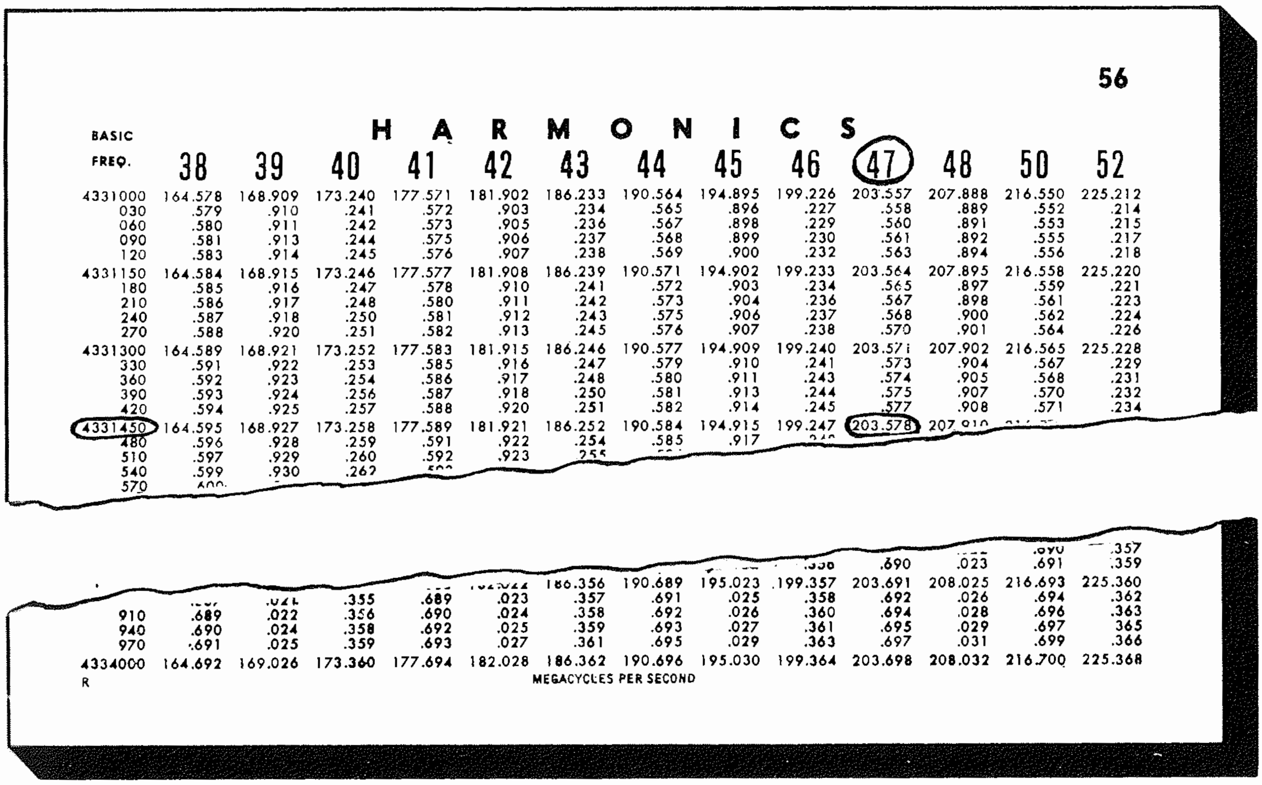
a. Presetting Frequency Meter.

(1) Set the RANGE switch (fig. 5) to the desired band.

(2) Turn to the section of the CALIBRATION TABLES (fig. 7) corresponding to the desired band (amber for band 1 or green for band 2).

(3) Locate the page which contains the frequency desired. As a sample, assume 203.578 mc is the desired frequency. This number will be found under 47 of the HARMONICS column on page 56, the right-hand page (R).

(4) On the same line (horizontal) with this frequency, note the number in the BASIC FREQ. column.



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HARMONICS

BASIC FREQ.	38	39	40	41	42	43	44	45	46	47	48	50	52
4331000	164.578	168.909	173.240	177.571	181.902	186.233	190.564	194.895	199.226	203.557	207.888	216.550	225.212
030	.579	.910	.241	.572	.903	.234	.565	.896	.227	.558	.889	.552	.214
060	.580	.911	.242	.573	.905	.236	.567	.898	.229	.560	.891	.553	.215
090	.581	.913	.244	.575	.906	.237	.568	.899	.230	.561	.892	.555	.217
120	.583	.914	.245	.576	.907	.238	.569	.900	.232	.563	.894	.556	.218
4331150	164.584	168.915	173.246	177.577	181.908	186.239	190.571	194.902	199.233	203.564	207.895	216.558	225.220
180	.585	.916	.247	.578	.910	.241	.572	.903	.234	.565	.897	.559	.221
210	.586	.917	.248	.580	.911	.242	.573	.904	.236	.567	.898	.561	.223
240	.587	.918	.250	.581	.912	.243	.575	.906	.237	.568	.900	.562	.224
270	.588	.920	.251	.582	.913	.245	.576	.907	.238	.570	.901	.564	.226
4331300	164.589	168.921	173.252	177.583	181.915	186.246	190.577	194.909	199.240	203.571	207.902	216.565	225.228
330	.591	.922	.253	.585	.916	.247	.579	.910	.241	.573	.904	.567	.229
360	.592	.923	.254	.586	.917	.248	.580	.911	.243	.574	.905	.568	.231
390	.593	.924	.256	.587	.918	.250	.581	.913	.244	.575	.907	.570	.232
420	.594	.925	.257	.588	.920	.251	.582	.914	.245	.577	.908	.571	.234
4331450	164.595	168.927	173.258	177.589	181.921	186.252	190.584	194.915	199.247	203.578			
480	.596	.928	.259	.591	.922	.254	.585	.917					
510	.597	.929	.260	.592	.923								
540	.599	.930	.262										
570													
													.357
										.690	.023	.691	.359
						186.356	190.689	195.023	199.357	203.691	208.025	216.693	225.360
			.355	.689	.023	.357	.691	.025	.358	.692	.026	.694	.362
910	.689	.022	.356	.690	.024	.358	.692	.026	.360	.694	.028	.696	.363
940	.690	.024	.358	.692	.025	.359	.693	.027	.361	.695	.029	.697	365
970	.691	.025	.359	.693	.027	.361	.695	.029	.363	.697	.031	.699	.366
4334000	164.692	169.026	173.360	177.694	182.028	186.362	190.696	195.030	199.364	203.698	208.032	216.700	225.368

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Figure 7. CALIBRATION TABLES, sample page.

(5) Rotate the FINE tuning control until this standard BASIC FREQ. number appears across the hairline of the FINE tuning dial window.

b. Calibration Check. Calibrate the frequency meter as described in paragraph 18*b*(3) through (6).

c. Setting to Frequency.

(1) Return the FUNCTION SWITCH to the FINE position and reset the FINE tuning dial to the standard BASIC FREQ. (*a*(4) above).

(2) Rotate the COARSE tuning control until the HARMONIC number (*a*(3) above) is under the hairline in the illuminated HARMONIC window of the COARSE-FINE tuning dial.

(3) The frequency meter is now tuned to the desired frequency and may be used as a signal generator.

20. Checking Transmitter Frequency

Frequency Meter FR-6/U can be used as a standard signal generator to check the frequency of any transmitter whose carrier is in the 100- to 500-mc range. This procedure will determine to an accuracy of .001 per cent whether the transmitter is operating within allowable frequency tolerances.

Caution: Do not couple the frequency meter directly to the transmitter output.

a. Tune the frequency meter to the desired frequency (par. 19).

b. Tune the transmitter to the desired frequency (refer to appropriate manual). It is not necessary to turn on power stages, because the exciter stages will provide enough signal strength for this procedure.

c. Do not modulate the transmitter.

d. Slowly turn the transmitter tuning control while listening for a beat note in the frequency meter. If no sound is heard, check the tuning of the transmitter and the frequency meter. If sound still is not heard after retuning, connect Adapter Connector UG-641/U to the appropriate RF INPUT jack and insert a stiff copper wire about 18 inches long into the adapter.

e. Tune the transmitter very carefully to obtain zero beat in the frequency meter. To check correct tuning, turn the frequency control of the transmitter slightly above and below the point observed at zero beat; tones should be heard.

21. Receiver Calibration and Alinement

Frequency Meter FR–6/U can be used to calibrate or aline receivers capable of picking up signals in the 100- to 500-mc range. Because of the low output (200 microvolt maximum) however, the frequency meter cannot be used to realine badly misalined receivers.

a. Set the frequency meter to the desired frequency (par. 19).

b. Connect Adapter Connector UG–641/U to the appropriate RF INPUT jack.

c. Insert a stiff copper wire about 18 inches long into Adapter Connector UG–641/U.

d. Tune the receiver to the desired frequency (refer to receiver manual). Abnormal conditions in the receiver are as follows:

(1) The S-meter needle will be at maximum or a zero-beat condition (beat frequency oscillator on) will occur with the tuning dial *off frequency.*

(2) Low output because of intermediate frequency (if.) misalinement.

e. Refer to the alinement instructions for the receiver using Frequency Meter FR–6/U as the signal generator.

22. Stopping Procedure

a. Turn the POWER switch to OFF.

b. If no further frequency measurements are to be made, disconnect the cords.

Section III. OPERATION UNDER UNUSUAL CONDITIONS

23. General

The operation of Frequency Meter AN/URM–81 may be difficult in regions where extreme cold, heat, humidity and moisture, sand conditions, etc., prevail. Adverse conditions may cause errors in measurements unless additional precautions are taken. Paragraphs 24 and 26 contain procedures for minimizing the effects of unusual climatic conditions.

24. Operation in Arctic Climates

Subzero temperatures and climatic conditions associated with cold weather affect the efficient operation of test equipment. Instructions and precautions for operation under adverse conditions follow:

a. Handle the frequency meter carefully.

b. Keep the equipment warm and dry and, if necessary, construct an insulated box for the frequency meter. Keep the tube filaments lighted constantly. To conserve heat, place a blanket over the frequency meter when it is not in use.

c. When equipment that has been exposed to the cold is brought into a warm room, it will sweat until it reaches room temperature. When the equipment has reached room temperature, dry it thoroughly with rags; use a blower for the inaccessible areas. This condition also may arise when a room warms up after a cold night.

25. Operation in Tropical Climates

When operated in tropical climates, test equipment may be installed in tents, huts, or when necessary, in underground dugouts. When equipment is installed below ground or set up in swamp areas, moisture conditions are more acute than normal in the tropics. Ventilation is usually very poor, and the relative humidity causes condensation to form on the equipment whenever the temperature of the equipment becomes lower than the surrounding air. To minimize this condition, provide adequate ventilation.

26. Operation in Desert Climates

a. The main problem arising with equipment operation in desert areas is the large amount of sand, dust, or dirt that enters the moving parts of test equipment. The ideal preventive precaution is to house the equipment in a dustproof shelter. Since such a building is rarely available and would require air conditioning, the next best precaution is to make the buildings in which the equipment is located as dustproof as possible with available materials. Hang wet sacking over the windows and doors. Cover the inside walls with heavy paper, and secure the side walls of tents with sand to prevent their flapping in the wind.

b. Never tie power cords, signal cords, or other wiring connections to either the inside or the outside of tents. Desert areas are subject to sudden wind storms which may jerk the connections loose or break the lines.

c. Keep the equipment as free from dust as possible. Make frequent preventive maintenance checks. Pay particular attention to the condition of the lubrication on the gear trains. Excessive amounts of dust, sand, or dirt that come into contact with oil and grease result in grit, which will damage the equipment.

d. A drastic fall in temperature after sundown often causes condensation. To prevent this, cover the equipment with tarpaulin or similar covering material.

CHAPTER 4

ORGANIZATIONAL MAINTENANCE

Section I. TOOLS AND EQUIPMENT

27. General

a. A number of tools, materials, or tool equipment kits is supplied to organizational maintenance personnel for use with electronic equipment.

b. The actual allowable organizational maintenance that can be performed on Frequency Meter FR–6/U depends to a large extent on the existing military regulations (standing operating procedure), the existing tactical situation, and the tools and other test equipment issued.

28. Tools, Materials, and Test Equipment Required for Frequency Meter FR–6/U

Tools, materials, and test equipment used, but not supplied, with Frequency Meter FR–6/U are listed in *a* through *c* below.

a. Tool.

1 Tool Equipment TE–41.

b. Test Equipment.

Electron Tube Test Set TV–7/U.
Multimeter TS–352/U.

c. Materials.

Orange stick.
Cheesecloth, bleached, lint-free.*
Carbon tetrachloride.
Sandpaper, flint #000.*
Solvent, Dry Cleaning (SD) (Fed spec No. P–S–661a).
Moisture and Fungus Proofing Kit MK–2/GSM.

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*Part of Tool Equipment TE–41.

Section II. PREVENTIVE MAINTENANCE SERVICES

29. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order so that breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from troubleshooting and repair since its object is to prevent certain troubles from occurring.

30. General Preventive Maintenance Techniques

a. Use #000 sandpaper to remove corrosion.

b. Use a clean, dry, lint-free cloth or a dry brush for cleaning.

(1) If necessary, except for electrical contacts, moisten the cloth or brush with the solvent (SD); after cleaning, wipe the parts dry with a cloth. If the part cleaned is normally lubricated, relubricate in accordance with the instructions in paragraphs 33 and 34.

(2) Clean electrical contacts with a cloth moistened with carbon tetrachloride, then wipe them dry with a dry cloth.

Caution: Repeated contact of carbon tetrachloride with the skin or prolonged breathing of the fumes is dangerous. Be sure adequate ventilation is provided.

c. For further information on preventive maintenance techniques, refer to TB SIG 178, Preventive Maintenance Guide for Radio Communication Equipment.

31. Use of Preventive Maintenance Forms.

(figs. 8 and 9)

a. The decision concerning the items on DA Forms 11–238 and 11–239 that are applicable to this equipment is a decision to be made in the case of first echelon maintenance by the communication officer/chief or his designated representative, and in the case of second and third echelon maintenance, by the individual making the inspection. Instructions for the use of each form appear on the reverse side of the form.

ed spec No.

Kit MK-2/

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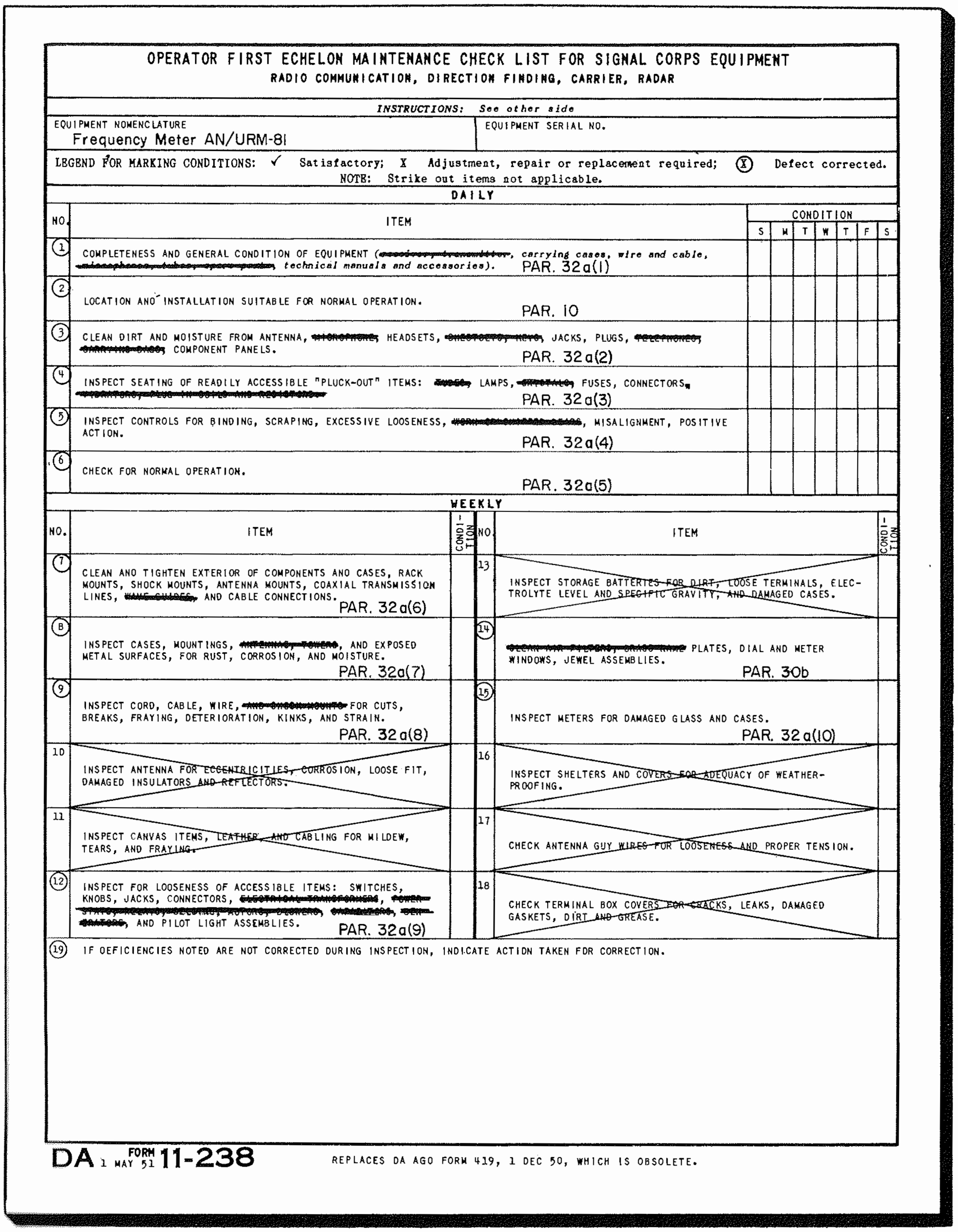


OPERATOR FIRST ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT
RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE Frequency Meter AN/URM-81

EQUIPMENT SERIAL NO.

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; Ⓧ Defect corrected.
NOTE: Strike out items not applicable.

DAILY

NO.	ITEM	CONDITION S	M	T	W	T	F	S
①	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (~~receiver-transmitter~~, *carrying cases, wire and cable,* ~~microphones, tubes, spare parts~~, *technical manuals and accessories*). PAR. 32a(1)							
②	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR. 10							
③	CLEAN DIRT AND MOISTURE FROM ANTENNA, ~~MICROPHONE~~, HEADSETS, ~~CHESTSETS, KEYS~~, JACKS, PLUGS, ~~TELEPHONES, CARRYING CASES~~, COMPONENT PANELS. PAR. 32a(2)							
④	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: ~~TUBES~~, LAMPS, ~~CRYSTALS~~, FUSES, CONNECTORS, ~~VIBRATORS, PLUG-IN COILS AND RESISTORS~~. PAR. 32a(3)							
⑤	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, ~~WORN OR CHIPPED GEARS~~, MISALIGNMENT, POSITIVE ACTION. PAR. 32a(4)							
⑥	CHECK FOR NORMAL OPERATION. PAR. 32a(5)							

WEEKLY

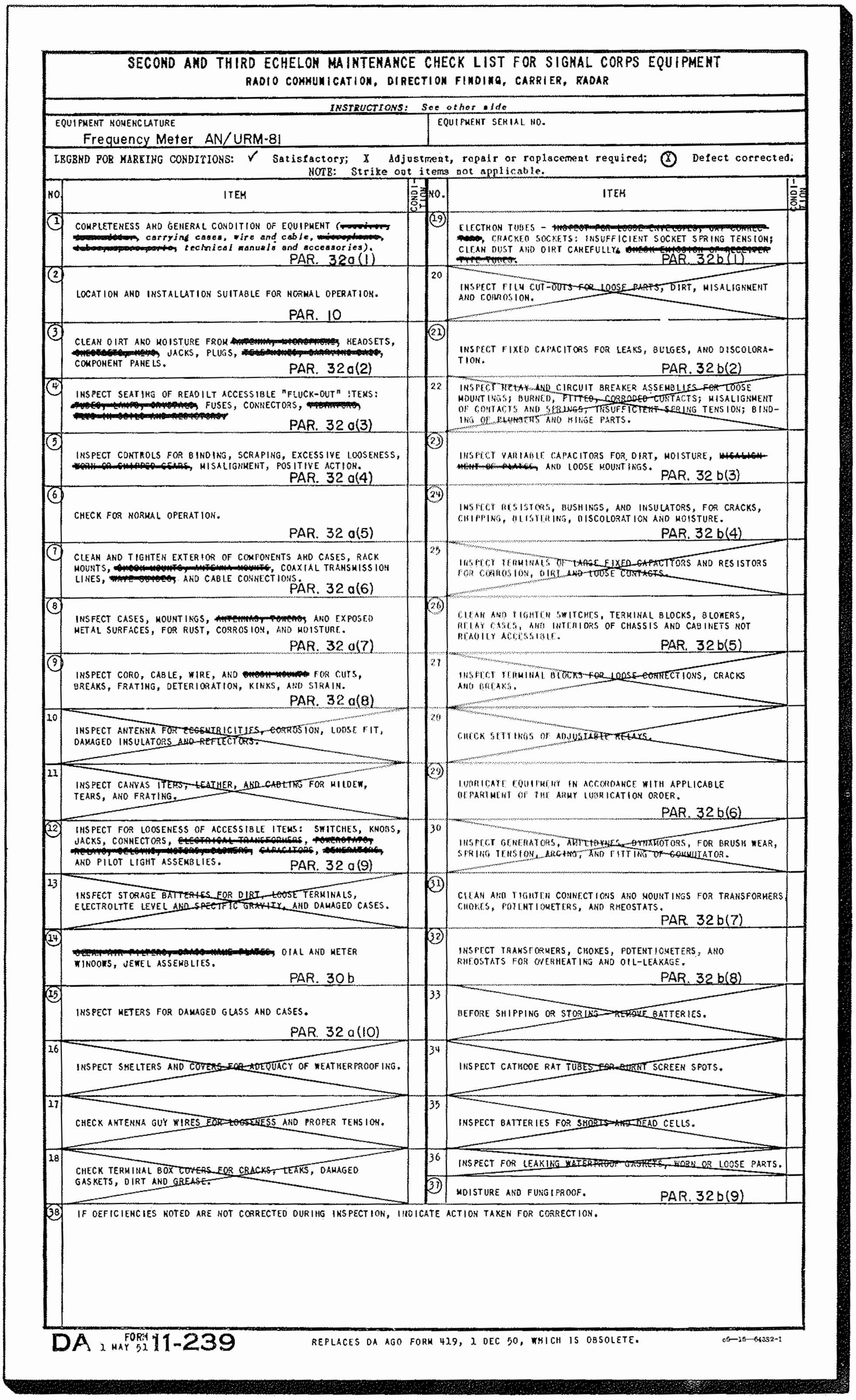
NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
⑦	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, ~~WAVE GUIDES~~, AND CABLE CONNECTIONS. PAR. 32a(6)		13	~~INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.~~	
⑧	INSPECT CASES, MOUNTINGS, ~~ANTENNAS, TOWERS~~, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 32a(7)		⑭	~~CLEAN AIR FILTERS, BRASS NAME~~ PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES. PAR. 30b	
⑨	INSPECT CORD, CABLE, WIRE, ~~AND SHOCK MOUNTS~~ FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 32a(8)		⑮	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 32a(10)	
10	~~INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.~~		16	~~INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.~~	
11	~~INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.~~		17	~~CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.~~	
⑫	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ~~ELECTRICAL TRANSFORMERS~~, ~~POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS~~, ~~CAPACITORS~~, ~~GENERATORS~~, AND PILOT LIGHT ASSEMBLIES. PAR. 32a(9)		18	~~CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.~~	

⑲ IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.

DA FORM 1 MAY 51 11-238 REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

TM 5096-18

Figure 8. DA Form 11-238.



SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT
RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE Frequency Meter AN/URM-81	EQUIPMENT SERIAL NO.

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; ⓧ Defect corrected.
NOTE: Strike out items not applicable.

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
①	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (~~receivers, transmitters~~, *carrying cases, wire and cable*, ~~microphones~~, ~~tubes, spare parts~~, *technical manuals and accessories*). PAR. 32a(1)		⑲	ELECTRON TUBES - ~~INSPECT FOR LOOSE ENVELOPES, CAP CONNECTIONS~~, CRACKED SOCKETS; INSUFFICIENT SOCKET SPRING TENSION; CLEAN DUST AND DIRT CAREFULLY, ~~CHECK EMISSION OF RECEIVER TYPE TUBES~~. PAR. 32b(1)	
②	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR. 10		20	INSPECT FILM CUT-OUTS FOR LOOSE PARTS, DIRT, MISALIGNMENT AND CORROSION.	
③	CLEAN DIRT AND MOISTURE FROM ~~ANTENNA, MICROPHONE~~, HEADSETS, ~~CHESTSETS, KEYS~~, JACKS, PLUGS, ~~TELEPHONES, CARRYING BAGS~~, COMPONENT PANELS. PAR. 32a(2)		㉑	INSPECT FIXED CAPACITORS FOR LEAKS, BULGES, AND DISCOLORATION. PAR. 32b(2)	
④	INSPECT SEATING OF READILT ACCESSIBLE "PLUCK-OUT" ITEMS: ~~TUBES, LAMPS, CRYSTALS~~, FUSES, CONNECTORS, ~~VIBRATORS~~, ~~PLUG-IN COILS AND RESISTORS~~ PAR. 32a(3)		22	INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS; BURNED, PITTED, CORRODED CONTACTS; MISALIGNMENT OF CONTACTS AND SPRINGS, INSUFFICIENT SPRING TENSION; BINDING OF PLUNGERS AND HINGE PARTS.	
⑤	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, ~~WORN OR CHIPPED GEARS~~, MISALIGNMENT, POSITIVE ACTION. PAR. 32a(4)		㉓	INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, ~~MISALIGNMENT OF PLATES~~, AND LOOSE MOUNTINGS. PAR. 32b(3)	
⑥	CHECK FOR NORMAL OPERATION. PAR. 32a(5)		㉔	INSPECT RESISTORS, BUSHINGS, AND INSULATORS, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION AND MOISTURE. PAR. 32b(4)	
⑦	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, ~~SHOCK MOUNTS, ANTENNA MOUNTS~~, COAXIAL TRANSMISSION LINES, ~~WAVE GUIDES~~, AND CABLE CONNECTIONS. PAR. 32a(6)		25	INSPECT TERMINALS OF LARGE FIXED CAPACITORS AND RESISTORS FOR CORROSION, DIRT AND LOOSE CONTACTS.	
⑧	INSPECT CASES, MOUNTINGS, ~~ANTENNAS, TOWERS~~, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 32a(7)		㉖	CLEAN AND TIGHTEN SWITCHES, TERMINAL BLOCKS, BLOWERS, RELAY CASES, AND INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE. PAR. 32b(5)	
⑨	INSPECT CORD, CABLE, WIRE, AND ~~SHOCK MOUNTS~~ FOR CUTS, BREAKS, FRATING, DETERIORATION, KINKS, AND STRAIN. PAR. 32a(8)		27	INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS, CRACKS AND BREAKS.	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.		28	CHECK SETTINGS OF ADJUSTABLE RELAYS.	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRATING.		㉙	LUBRICATE EQUIPMENT IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER. PAR. 32b(6)	
⑫	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ~~ELECTRICAL TRANSFORMERS~~, ~~POWERSTATS~~, ~~RELAYS, SELSYNS, MOTORS, BLOWERS~~, ~~CAPACITORS~~, ~~GENERATORS~~, AND PILOT LIGHT ASSEMBLIES. PAR. 32a(9)		30	INSPECT GENERATORS, AMPLIDYNES, DYNAMOTORS, FOR BRUSH WEAR, SPRING TENSION, ARCING, AND FITTING OF COMMUTATOR.	
13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLTTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.		㉛	CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS FOR TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS. PAR. 32b(7)	
⑭	~~CLEAN AIR FILTERS, BRASS NAME PLATES~~, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES. PAR. 30b		㉜	INSPECT TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS FOR OVERHEATING AND OIL-LEAKAGE. PAR. 32b(8)	
⑮	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 32a(10)		33	BEFORE SHIPPING OR STORING - REMOVE BATTERIES.	
16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.		34	INSPECT CATHODE RAY TUBES FOR BURNT SCREEN SPOTS.	
17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.		35	INSPECT BATTERIES FOR SHORTS AND DEAD CELLS.	
18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.		36 ㊲	INSPECT FOR LEAKING WATERPROOF GASKETS, WORN OR LOOSE PARTS. MOISTURE AND FUNGIPROOF. PAR. 32b(9)	
㊳	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.				

DA FORM 1 MAY 51 11-239   REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.   c6—16—64332-1

TM 5096-46

Figure 9. DA Form 11–239.

b. References in the ITEM columns of figures 8 and 9 refer to paragraphs in text that contain detailed or additional maintenance information.

32. Performing Preventive Maintenance

Caution: Tighten screws, bolts, and nuts carefully. Fittings tightened beyond the pressure for which they are designed will be damaged or broken.

a. External Items (fig. 8).

(1) Check the general condition of the frequency meter. The components of the frequency meter are listed in paragraph 6.

(2) Remove dirt and moisture from the front panel, power receptacle, adapters, and connectors.

(3) Inspect the seating of fuses F701 and F702 (fig. 33), lamps I 601, I 701, and I 702 (COARSE-FINE tuning dial), I 703 and I 704 (FINE tuning dial), and crystal unit E601 (fig. 32).

(4) Inspect the controls for binding, scraping, excessive looseness, and positive action.

(5) Check the frequency meter for normal operation (par. 18).

(6) Clean and tighten the panel mountings of the frequency meter.

(7) Inspect exposed metal surfaces of the transit case and the case of the frequency meter for rust and corrosion.

(8) Inspect power cord and output cord for breaks, deterioration, and loose connectors.

(9) Inspect for looseness of accessible items, such as RANGE switch, COARSE and FINE tuning, and LEVEL gain controls. Inspect all switches and control knobs.

(10) Inspect meter M701 for damaged glass or case.

Caution: Disconnect all power from the frequency meter before performing the following operations. Upon completion, reconnect power and check for satisfactory operation of the frequency meter.

b. Internal Items (fig. 9).

(1) Inspect tubes for insufficient spring tension on tube clamps.

(2) Inspect fixed capacitors C101 and C102 (fig. 38) for leaks or bulging.

(3) Inspect variable capacitor C814, sections A, B, C, and D, for dirt and loose mounting lugs (fig. 32).

Caution: Do *not* touch plates of variable frequency oscillator (vfo) tuning capacitor C410 (fig. 32). Do not touch or bend the plates of C501 or C503 (fig. 34). This will result in loss of frequency calibration of the frequency meter.

(4) Inspect resistors and insulating bushings for cracks, chippings, and discoloration.

(5) Clean and tighten the detent of FUNCTION SWITCH S701.

(6) Lubricate the dial gearing, film mechanism, and vfo gearing in accordance with instructions in paragraph 33 and figure 10.

(7) Clean and tighten the connections and mountings for transformer T101 and chokes L101 and L102 (fig. 38).

(8) Inspect transformer T101, chokes L102 and L402, and resistors R101, R102, R103, R117, R119 (fig. 39), and R707 and R708 on the main frame, for overheating.

(9) Check moistureproof and fungiproof varnish for cracks and chipping.

(10) Inspect chassis base pans for telltale stains and solder particles.

Section III. LUBRICATION

33. Lubrication Instructions

a. The only points to be lubricated are the gear faces, and then only when the film mechanism (part of FINE tuning control) has been disassembled for repairs. Use Grease, Aircraft and Instruments (GL), for all gears that require lubrication. Refer to figure 10 for gears requiring lubrication.

b. Gasoline must not be used as a cleaning fluid for any purpose. When the frequency meter is overhauled or repairs are made, clean the parts with solvent (SD).

c. Carbon tetrachloride will be used as a cleaning fluid only on electrical equipment where inflammable solvents cannot be used because of fire hazard and for cleaning electrical contacts including plugs, jacks, and film mechanism.

Caution: Do not allow carbon tetrachloride to contact film, because the protective coating may be damaged.

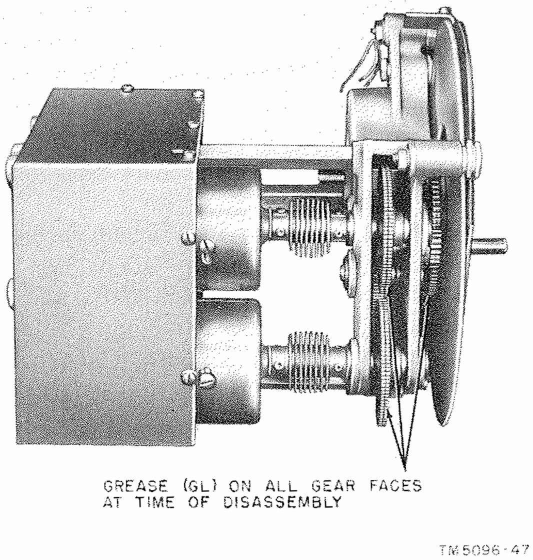


Figure 10. Typical lubrication points.

d. Do not use excessive amounts of oil or grease, and do not allow connections to become greasy.

e. Be sure that lubricants and points to be lubricated are clear and free from sand, grit, or dirt. Use solvent (SD) to clean all parts. Before lubrication, clean all surfaces to be lubricated; use a lint-free cloth dampened with solvent (SD). Keep the solvent (SD) away from surrounding parts.

34. Lubrication Under Unusual Conditions

a. Arctic Regions. The lubricant used in Frequency Meter FR–6/U is satisfactory in arctic regions. Do not overlubricate; excess grease may impair operation of moving parts.

b. Tropical Regions. High temperatures and moisture caused by rain, condensation, etc., may cause normally satisfactory lubricants to flow from moving parts and other surfaces. These bearing surfaces will wear excessively, and hinges, fasteners, and other parts will be damaged or destroyed by rust and corrosion. Inspect the equipment frequently and lubricate it as required to insure efficient operation.

c. Desert Regions. Dust and sand infiltration into the equipment causes grit in the lubricants and will seriously impair and damage the moving parts of the frequency meter. Hot, dry temperatures cause the lubricants to flow from the moving parts, and conditions similar to those described in *b* above will result. Inspect the equipment frequently and lubricate it as required to insure efficient operation.

Section IV. WEATHERPROOFING

35. Weatherproofing Procedures and Precautions

a. General. Signal Corps equipment, when operated under severe climatic conditions such as prevail in tropical, arctic, and desert regions, requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials.

b. Tropical Maintenance. A special moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection. This treatment is explained in TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, and TB SIG 72, Tropical Maintenance of Ground Signal Equipment. The equipment is given the moistureproofing and fungiproofing treatment at the factory, and it is necessary to use this treatment only when parts are replaced or repaired.

c. Arctic Maintenance. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperatures are explained in TB SIG 66, Winter Maintenance of Signal Equipment, and TB SIG 219, Operation of Signal Equipment at Low Temperatures.

d. Desert Maintenance. Special precautions necessary to prevent equipment failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are explained in TB SIG 75, Desert Maintenance of Ground Signal Equipment.

e. Lubrication. The effects of extreme cold and heat on materials and lubricants are explained in TB SIG 69, Lubrication of Ground Signal Equipment. Observe all precautions outlined in TB SIG 69 and pay strict attention to all lubrication orders when operating equipment under conditions of extreme cold or heat. Refer to paragraphs 33 and 34 for detailed instructions.

36. Rustproofing and Painting

a. When the finish on the case has been badly scarred or damaged, rust and corrosion can be prevented by touching up bared surfaces. Use

#00 or #000 sandpaper to clean the surface down to the bare metal; obtain a smooth finish.

Caution: Do not use steel wool or emery cloth. Minute metal particles frequently enter the case and cause harmful internal shorting or grounding of circuits.

b. When a touch-up job is necessary, apply paint with a small brush. Remove rust from the case by cleaning corroded metal with solvent (SD). In severe cases, it may be necessary to use solvent (SD) to soften the rust and to use sandpaper to complete the preparation for painting. The equipment is finished in light gray enamel and paint used will be authorized and consistent with existing regulations.

Section V. TROUBLESHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

37. General Troubleshooting Information

a. The troubleshooting and repairs that can be performed at the organizational maintenance level (operators and repairmen) are necessarily limited by the tools, test equipment, and replaceable parts issued. Accordingly, troubleshooting is based on the performance of the equipment and the use of the senses in determining such troubles as burned-out fuses, broken cords, defective tubes, cracked insulators, etc.

b. Paragraphs 38 through 42 help in determining which of the circuits is at fault and in localizing the fault in the circuit to the defective stage or item, such as a tube or fuse.

38. Visual Inspection

a. Failure of this equipment to operate properly usually will be caused by one or more of the following faults:

(1) Improperly connected power cord to power source.
(2) Worn, broken, or disconnected cords or plugs.
(3) Burned out fuses (usually indicates another fault).
(4) Wires broken because of excessive vibration.
(5) Defective tubes.
(6) Inactive crystal (4 mc).
(7) Burned out crystals (diode types).

b. When failure is encountered and the cause is not immediately apparent, check as many of these items as is practicable before starting a detailed examination of the component parts of the system. If possible, obtain information from the operator of the equipment regarding performance at the time trouble occurred.

Caution: Do not mishandle tubes. Refer to paragraph 39, tube replacement techniques.

39. Electron Tube Replacement Procedure

To prevent the possibility of discarding serviceable electron tubes, follow the procedures described below:

a. Inspect all cording and cabling, connections, and the general condition of the equipment before attempting removal of electron tubes.

b. If possible, isolate the trouble to a particular unit or section of the equipment. If the frequency meter is operating with the function switch in one position and not another, then checking for trouble in the working stages is of no value. For example, if the meter can be calibrated in the CHECK position, this means that the stages in figure 14 are working and testing tubes V301, V302, and V303 is not necessary. Refer to figures 12, 13, and 14 for the tubes used in the COARSE, FINE, and CHECK positions. The table below is given as an aid in locating troubles caused by defective tubes. Assume that a signal is fed to the frequency meter in the COARSE and FINE positions; sound is heard in the headset and a reading is seen on the TUNING METER (refer to the *Indication* column).

Position	Indication	Test
COARSE	1. Sound but no meter reading. 2. Reading on meter but no sound. 3. No meter reading or sound.	1. Tube V108A. 2. Tubes V105, V107, and V108. 3. Tubes V101, V102, V106, V108, and V201.
FINE	1. Sound but no meter reading. 2. Reading on meter but no sound. 3. No meter reading or sound.	1. See item 1 above. 2. See item 2 above. 3. Tubes V101, V102, V106, V108, V201, V601 through V606, V801, and V802.
CHECK	1. Sound but no meter reading. 2. Reading on meter but no sound. 3. No meter reading or sound.	1. See item 1 in COARSE position above. 2. See item 2 in COARSE position above. 3. Tubes V101, V102, V106, V108, V201, V301 through V303, V401, and V601 through V603.

c. Use Electron Tube Test Set TV–7/U to test the tubes that may be causing the trouble, then test the others one at a time. Substitute new tubes only for those which are defective.

d. If a tube tester is not available, troubleshoot by the tube substitution method as follows:

(1) Replace the suspected tubes, one at a time, with new tubes. Save the old tubes. Note the tube and the corresponding socket because different sections of the equipment may use the same tubes. After service for approximately 1 year, many tubes used for af purposes may not work if plugged into an rf stage. For example, af tube V107 and rf tube V302 are both 6BN6 type and if interchanged, a new source of trouble may be created. See (3)(*b*) below for a complete list of similar tubes used in two or more types of circuits.

(2) Reinsert the original tubes, one at a time, in the original sockets. If equipment failure occurs during this step, discard the original tube. Do not leave a new tube in a socket if the equipment operates satisfactorily with the original tube. If practicable, retain any removed tube until its condition is checked by a tube checker.

(3) If there is an insufficient number of spare tubes, perform the following procedures:

(*a*) Substitute a new tube for one original tube. If there is no difference or just a slight difference, remove the new tube and replace it with the original one. Similarly, check each original tube, in turn, until the equipment becomes operative.

(*b*) Often it is possible to remove a tube from one section of the equipment without affecting the operation of another section. If these two sections use identical tubes, use the tube in the working section to serve as a substitute in the defective section if there are no new ones available. Also, the tube

Tube type	Ref No.	Use	Subchassis location
12TA7	V303	Rf detector amplifier	Check system.
	V201	Af preamplifier	Audio amplifier.
	V401	Rf vfo	Vfo.
	V603	Rf buffer	Crystal oscillator.
6BN6	V302	Rf harmonic generator	Check system.
	V107	Af gate amplifier	Audio amplifier.
6AU6	V801	Rf tuned amplifier	Band-pass amplifier.
	V802	Rf untuned amplifier	Band-pass amplifier.
	V602	Rf phase inverter	Crystal oscillator.
	V604	Rf amplifier	Crystal oscillator.
6AH6	V601	Rf crystal oscillator	Crystal oscillator.
	V607	Rf tuned amplifier	Crystal oscillator.
	V301	Rf frequency doubler	Check system.
	V803	Rf band-pass doubler	Band-pass amplifier.

used in the defective section can be placed in the working section which will act as a tube tester in this capacity. If the working section continues to operate satisfactorily, the tube will be good. See the table below for a list of similar tube uses.

(*c*) If a replacement for a bad tube becomes defective, do not substitute another good tube until the trouble has been found.

(4) Do not discard a tube that has been in use a long time; it may still be good. Satisfactory operation of the tube in the equipment is the proof of its condition.

(5) Do not discard a tube that reads at or near to the minimum requirements for that tube. A certain percentage of new tubes barely pass the lower limits of the allowable tolerance.

(6) Be careful when removing tubes from their sockets; this may cause the pins to become broken, bent out of shape, or make intermittent connections. Use a pin straightener to straighten bent pins.

40. Interchangeable Tubes

Refer to the chart below. The older type tube listed in the first column can be used interchangeably with the corresponding preferred type tube listed in the third column. The second column lists the stage or stages in which the tubes can be used interchangeably in Frequency Meter FR–6/U. The older type tube should be used until stocks are exhausted.

Older type tube	Application	Subchassis	Preferred tube
12AT7	Buffer amplifier	Crystal oscillator	12AT7WA.
	Vfo and cathode follower buffer	Vfo	
	Amplifier and detector	Check	
	Preamplifier	Af preamplifier	
5814	Meter and af output		5814A.
6AQ5W	Power amplifier	Band-pass	6005/6AQ5W.

41. Troubleshooting by Using Equipment Performance Checklist

a. General. The equipment performance checklist (par. 42) will help in locating operational troubles within the equipment. The list gives the item to be checked, the conditions under which the item is checked, the normal indications and tolerances of correct operation, and the corrective measures the repairman can take. *To use this list, follow the items in numerical sequence.*

b. Action or Condition. For some items, the information given in the *action or condition* column consists of various switch and control settings under which the item is to be checked. For other items it represents an action that must be taken to check the indication given in the *normal indications* column. Refer to paragraph 39*b* for tube checking.

c. Normal Indications. The normal indications listed include the visible and audible signs that the repairman should perceive when he checks the items. If the indications are not normal, the repairman should apply the recommended corrective measures.

d. Corrective Measures. The corrective measures listed are those the repairman can make without turning in the equipment for repairs. A reference in the list to paragraph 60 indicates that the trouble cannot be corrected during operation and that troubleshooting by an experienced repairman is necessary. If the set is completely inoperative or if the recommended corrective measures do not yield results, troubleshooting is necessary.

42. Equipment Performance Checklist

The equipment performance checklist provides information that enables the repairman to make a rapid performance check of the frequency meter. Properly used, these checks may eliminate careless and haphazard use of the equipment which may lead to a major breakdown or cause the equipment to produce incorrect measurements.

	Item No.	Item	Action or condition	Normal indications	Corrective measures
PREPARATORY	1	POWER switch.	Set to OFF position.		
	2	RANGE switch.	Set to desired band.		
	3	CHECK calibration control.	Set to midposition.		
	4	LEVEL gain control.	Set to midposition.		
	5	FUNCTION SWITCH.	Set to COARSE position.		
	6	COARSE tuning control.	Set to approximate frequency.		
	7	FINE tuning control.	None.		
	8	PHONE jack.	Plug in headset.		
START	9	POWER switch.	Set to on position.	One of the COARSE-FINE tuning dial lamps lights. FINE tuning dial lamps light.	Check fuses F101, F102, ac power source, dial lamps I 701, I 702, I 703, and I 704.
PERFORMANCE EQUIPMENT	10	RF INPUT 100–225 MC and 225–500 MC jacks.	Apply signal to be measured to appropriate jack.		
	11	RANGE switch.	Set to proper band for unknown signal frequency.	Amber or green lamp will light depending on setting.	Check dial lamps I 701 and I 702.
	12	OVEN HTR lamp.	Observe lamp.	Cycles on and off. Lights when OVEN HTR is drawing current.	Check lamp I 601.
	13	COARSE tuning control.	Adjust to approximate frequency.	Indication on tuning meter. Constant frequency tone should be heard.	Set RANGE switch properly. Refer to paragraph 60.
	14	LEVEL gain control.	Set for proper level.	Pointer of TUNING METER should be on green LEVEL SET portion of meter face.	Refer to paragraph 60.
	15	FUNCTION SWITCH.	Set to FINE.	Audio note in headset will disappear.	Refer to paragraph 60.
	16	FINE tuning control.	Rotate control.	Film dial strip will rotate. Audio note will be heard as the unknown frequency is approached. Pitch of tone will decrease as zero beat is approached and increased after it is passed.	Refer to paragraph 60.
	17	FINE tuning dial.	Read frequency under BASIC FREQ. column on right side of film strip in window.		
	18	FUNCTION SWITCH.	Set to CHECK.	Tone heard in headset.	Refer to paragraph 60.
	19	FINE tuning dial.	Turn to nearest diamond check point.	Tone disappears.	Refer to paragraph 60.
	20	CHECK calibration control.	Rotate control.	Tone heard, then reduced to zero beat.	Refer to paragraph 60.
STOP	21	POWER switch.	Set to OFF.	All dial and indicator lamps go out.	Check POWER switch.

CHAPTER 5
THEORY

43. General

The main block diagram for Frequency Meter FR-6/U is shown in figure 11. For more detailed overall circuit information, refer to the main schematic diagram (fig. 53). The individual stages of the frequency meter will be described in detail in paragraphs 45 through 53. To provide a better understanding of the intricate circuits used in the frequency meter, a general description of the main block diagram and three functional block diagrams will be given first.

a. Main Block Diagram (fig. 11). The main function of the frequency meter is to generate a known variable frequency and zero beat it against the frequency of the unknown signal. When the frequency meter is tuned exactly to the frequency of the unknown signal, zero beat will be indicated visually by the TUNING METER and aurally by a headset. To provide an extremely stable frequency, a crystal oscillator stage is used. Stability is insured by placing the low-drift crystal in a temperature-controlled oven. The frequency meter measures signals in the 100- to 500-mc range; therefore, a vfo stage along with frequency multipliers must be used in combination with the crystal oscillator to obtain zero beat against various unknown frequencies. A system of check points is provided to check the calibration of the frequency meter throughout its entire operating range. The other stages complete the frequency measurements by visible and aural indications and provide self-calibration. A description covering the individual blocks is given in (1) through (11) below:

(1) *Crystal oscillator.* The crystal oscillator stage provides the accuracy and the stability of the frequency meter. A 4-mc quartz crystal, Y601, accurate to within .0001 per cent, is housed in a thermostatically controlled oven. The temperature is set at 75° C. (167° F.). Two tubes are used to provide the crystal-controlled output signal. Crystal oscillator tube V601 tunes to the crystal frequency by means of the 4MC ADJUST tuning capacitors located in the plate tank circuit. Tube V602 provides the necessary feedback and helps to isolate the following tubes from shifting the output frequency of the crystal oscillator stage. Because opposite outputs are taken from V602, this tube will be referred to as the phase inverter or phase-inverter stage. A jack, 4MC CRYSTAL OUTPUT, is provided to check the crystal oscillator stage of the frequency meter against a known frequency standard. When checking the crystal oscillator stage, the 4MC ADJUST tuning capacitor is adjusted so that the crystal oscillator stage is tuned exactly to the standard signal. Plate power supplied to V601 and V602 is taken from the regulated section of the power supply to help maintain stability of the crystal oscillator stage. The output of the phase inverter is fed to buffer amplifier V603.

(2) *Buffer amplifier.* Buffer amplifier tube V603 is provided to insure isolation of the crystal oscillator stage from any load changes which could shift the oscillator frequency. Tube V603 also amplifies the incoming signal to the proper level to drive the following balanced-modulator and check system stages.

(3) *Variable frequency oscillator.* The variable frequency oscillator provides the variable frequency which combines with the fixed crystal frequency so that the frequency meter will be capable of measuring a wide range of unknown signals. A twin-triode type tube, vfo V401, is used in this stage. Vfo V401A is tuned by either the FINE tuning or CHECK calibration control to the frequency range of 166 to 340 kilo-

cycles (kc) (fig. 17). The signal from the vfo is fed to the balanced-modulator stage through cathode follower buffer V401B for mixing with the crystal oscillator output when measuring signals. The signal is also fed to amplifier V303B when calibration of the frequency meter is refiuired.

(4) *Balanced modulator.* A mixer of the balanced-modulator type must be used to reject the basic frequencies fed from the crystal and variable frequency oscillator stages and, at the same time, allow their sum to appear in the output. If the basic frequencies also appeared, then other zero beats would be obtained by the frequency meter, and measuring unknown signals accurately would be impossible. The balanced modulator consists of amplifier tube V604, mixer tubes V605 and V606, and tuned amplifier V607. Tube V604 amplifies the crystal oscillator signal to provide the correct level for heterodyning in the mixer tubes. The vfo signal combines with the crystal frequency in the mixers with the sum of their frequencies selected to appear in the output. These frequencies, 4.166 to 4.340 mc, will be known as the standard BASIC FREQ. of the frequency meter (fig. 13). Tuned amplifier V607 amplifies and passes frequencies in this range to the band-pass amplifier stage.

(5) *Band-pass amplifier.* The main purpose of the band-pass amplifier stage is to pass or double the standard basic frequency fed from the balanced modulator. A selective filter in the standard basic frequency range (4.166 to 4.340 mc) prevents unwanted frequencies from entering the amplifier and doubler stages. The output from the doubler is a signal in the 8.332- to 8.680-mc band. The harmonics of these frequencies are used in the rf tuner assembly to zero beat against the incoming unknown signal for accurate measurements. If other signal frequencies, which arise from heterodyning in the balanced-modulator stage, are permitted to ride through, the harmonics of these unwanted frequencies will also zero beat against the incoming signal to produce incorrect measurements. The band-pass amplifier consists of two sections depending upon which band is desired. Tuned amplifier tube V801 contains the filter and is tuned by the FINE tuning control simultaneously with the vfo stage (fig. 13). Untuned amplifier V802 increases the voltage of the standard basic frequency signal. Power amplifier tube V804 provides the necessary power so that strong harmonics of band 1 are fed to the rf tuner stage. Doubler tube V803 increases the frequency range of the standard basic frequency signal by two as mentioned above. Power amplifier tube V805 provides the power required to generate harmonics for measurements in band 2. RANGE switch selects the output of amplifier V802 for either band 1 or band 2 to be fed to either amplifier V804 or voltage doubler V803.

(6) *Audio oscillator.* An af oscillator signal is provided to help tune in unknown rf signals by modulating them in the rf tuner stage. Af oscillator V105 is a relaxation-type oscillator whose output is in the af range of 800 ±300 cycles per second (cps).

(7) *Rf tuner.* The rf tuner assembly tunes the frequency meter to the approximate frequency of the unknown signal and provides heterodyning action for determining the exact frequency of the unknown signal. These functions are accomplished in a dual circuit arrangement of which one-half works in band 1 and the other in band 2. Because the circuitry is the same for either band, the two purposes of the rf tuner are described for operation in band 1 only, as follows:

(*a*) *Approximate tuning measurement.* The incoming signal is applied across a tuned circuit made variable by the COARSE tuning control (fig. 12), and modulated by the internally developed af signal from V105. Modulation takes place by feeding the af signal to crystal CR501 which is connected across a portion of the tank circuit. Also across another portion of the tank circuit is crystal CR503 whose purpose is to remove the af from the modulated signal developed in the tuned tank circuit. After

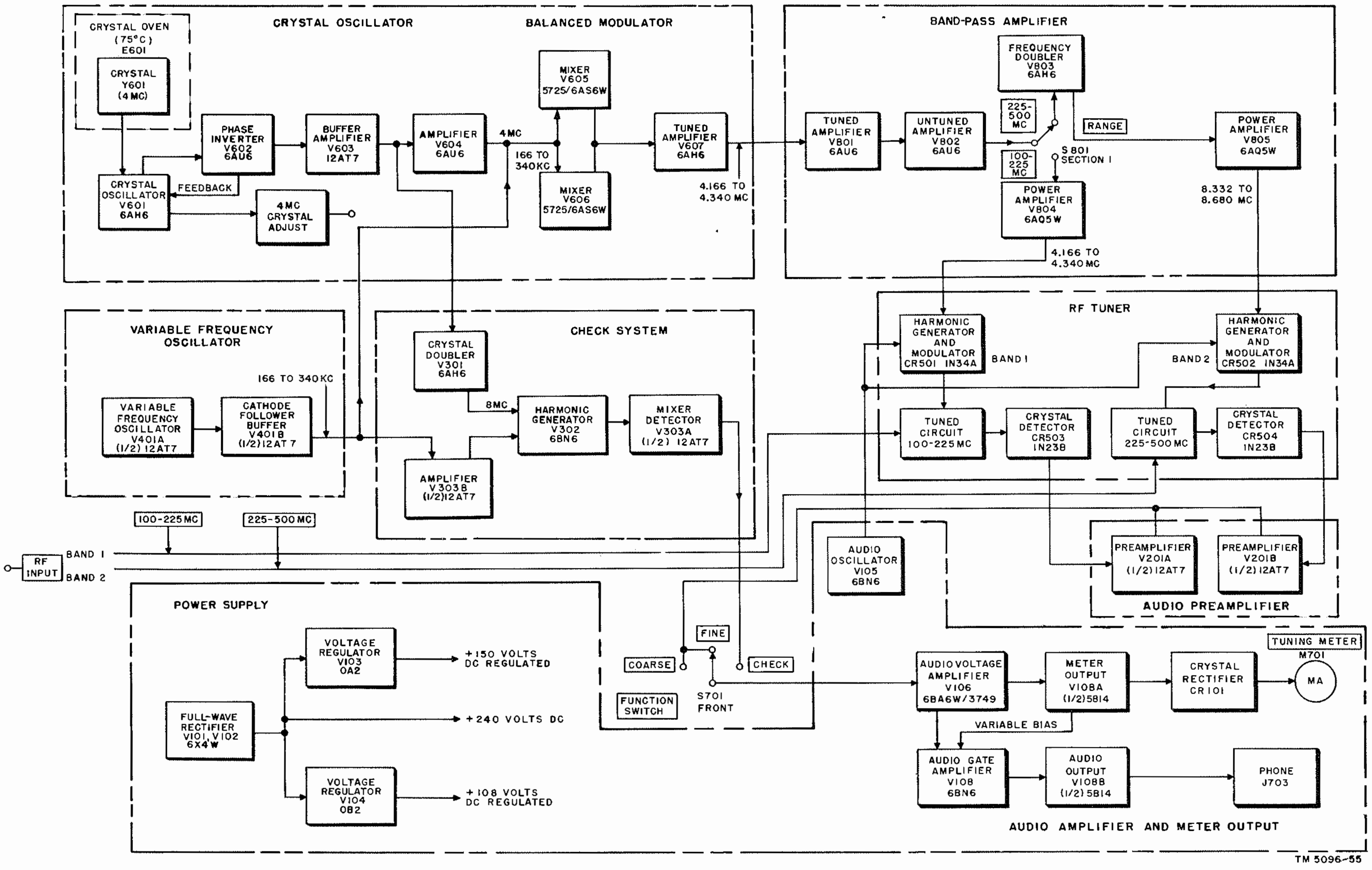


Figure 11. Main block diagram.

detection, the af signal is fed to one-half of preamplifier tube V201B.

(*b*) *Exact tuning measurement.* The incoming signal is heterodyned against the correct harmonic of the standard basic frequency. The output of the band-pass amplifier is fed across crystal CR501, which now becomes a harmonic generator, and is mixed with the incoming unknown signal across crystal CR503. When the FINE tuning control (fig. 13) is set properly, the correct harmonic of the frequency generator heterodynes with the incoming signal to produce zero beat. In the operation of tuning the frequency meter, af tones are heard before and after zero beat; these tones are fed to one-half of audio preamplifier tube V201.

(8) *Preamplifier.* The purpose of preamplifier tube V201 is to increase the voltage level of the af tones coming from the rf tuner assembly. Tube V201 is a twin triode in which one-half (V201A) amplifies the tones resulting from the rf tuner assembly working in band 1 and the other half (V201B) amplifies the tones resulting from the rf tuner working in band 2. The output of the preamplifier is fed to audio amplifier V106.

(9) *Check system.* The check system provides a means of checking the calibration of the frequency meter. The check system consists of crystal doubler tube V301, amplifier tube V303B, harmonic generator tube V302, and detector tube V303A. The crystal oscillator signal is fed to V301, doubled to 8 mc, and applied to V302. The vfo signal is fed to V303B, amplified, and also applied to V302. Tube V302 generates harmonics of the vfo signal and feeds them, as well as the 8-mc signal, to V303A. Heterodyne action is accomplished in V303A with the difference frequencies (and zero beat) falling in the af range. When the harmonic frequency is exactly 8 mc, there is no difference frequency and, accordingly, no af output. The af output is fed to audio amplifier tube V106.

(10) *Audio amplifier and meter output assembly.* The purpose of the af section of the assembly is to amplify the tones developed in the frequency meter for an aural aid in tuning measurements. The main purpose of the meter output section is to give visual means by TUNING METER M701 for accurate tuning of the frequency meter. The meter also gives an indication of the signal strength of incoming signals. The combining action of the af and meter output assembly provides a means of passing the signal under measurement, thereby preventing other frequencies from entering the headset of the meter to give false readings. The assembly consists of voltage amplifier tube V106, gated amplifier tube V107, meter output tube V108A, and af output tube V108B. The af input to V106 is fed either from preamplifier V201 (section A or B) or from detector tube V303A depending upon the position of FUNCTION SWITCH S701. The amplified output from V106 is applied to V108A and V107 simultaneously. Two outputs are taken from V108A. One signal is used to provide a variable bias, whose level depends upon the signal strength for gate tube V107. Tube V107 is a gated amplifier that will cut off unless driven by a signal of sufficient amplitude. This action causes the tube to discriminate against unwanted weak signals but pass the strong tuned beat frequency under measurement. The output signal of V107 is then applied to V108B, where it is amplified and fed to the PHONE jack.

(11) The power supply uses two tubes, V101 and V102, in a full-wave rectifier circuit. Two of the three voltages, 150 and 108 volts, are regulated by voltage regulators V103 and V104. The 240-volt output is not regulated.

b. Functional Block Diagrams. Frequency Meter FR–6/U uses two bands to cover measurements in the 100- to 500-mc range. The principles of operation are basically the same; therefore, the description of each functional position will be given for band 1.

(1) *COARSE position* (fig. 12). When FUNCTION SWITCH S701 is set in the COARSE position, the signal to be measured is applied to the tuned circuit of the rf tuner subassembly through RF

INPUT 100–225 MC jack J702. The tuned circuit is brought to resonance with the incoming signal by variable capacitor C501 which will be indicated by a maximum reading on TUNING METER M701. Capacitor C501 is mechanically linked to the COARSE-FINE tuning dial gear mechanism and is called the COARSE tuning capacitor. The approximate frequency is read through the MEGACYCLES window of the COARSE-FINE tuning dial. The correct window will be indicated when lighted by amber lamp I 701. Before the meter can show the reading indicated above, the signal must be detected, amplified, and rectified to direct current (dc). The detection is accomplished by crystal detector CR503; the detector output is amplified by preamplifier V201 A (fig. 11), and fed through FUNCTION SWITCH S701 and RANGE switch S801 (set in band 1, 100–225 MC). The RANGE switch also selects the proper dial light (green for band 2). The signal is fed to af amplifier V106, V107, and V108B through LEVEL gain control R701. The gain control is used when the signal is strong enough to drive the TUNING METER needle into the OVERLOAD area. The proper setting of the gain control is obtained when the needle is pointing in the LEVEL SET area. After the signal leaves the af amplifiers, it is fed to the meter output circuit and is rectified by crystal rectifier CR101. The dc output is then used to drive the TUNING METER. As an aid in tuning, the rf signal is modulated by feeding an 800-cps signal from af oscillator V105 to crystal modulator CR501. It is then mixed with the rf signal coming from the tuned circuits, modulated by the af signal, and then fed to the crystal detector. The 800-cps af signal path from the detector is identical with that of the meter signal described above except that an af signal can now be heard by listening to a headset plugged into PHONE jack J703. Maximum af output is an indication of tuning in the incoming rf signal to resonance by the tuned circuit.

(2) *FINE position* (fig. 13). When the FUNCTION SWITCH is set to the FINE position, the standard basic variable frequency of the frequency meter is generated. This is accomplished as follows: the 4-mc fixed output of the crystal oscillator stage including V601, V602, V603B, and Y601 is fed to balanced-modulator stage V604, V605, and V606. Also fed to the balanced-modulator stage is the variable 166- to 340-kc output of vfo stage V401. The sum frequencies are variable and range from 4.166 to 4.340 mc. This mixed signal is the standard basic frequency of the equipment and is fed to crystal harmonic generator CR501 through band-pass amplifier stage V801, V802, and V803. The unknown rf signal to be measured is fed to crystal detector CR503 through RF INPUT jack J702. The harmonic output of crystal harmonic amplifier is also fed to the crystal detector to be mixed with the incoming signal and detected by the crystal detector. Only the harmonic of the standard basic frequency close to the unknown signal frequency will mix to produce a beat note in the af range. The signal path starting through preamplifier V201A (fig. 12) and the FUNCTION SWITCH is identical with that of the COARSE setting for the meter and the headset as described in (1) above. The vfo is varied by the FINE tuning control; this control is also coupled by mechanical arrangements to the film system (FINE tuning dial), the band-pass filter of the band-pass amplifier, and the COARSE-FINE tuning dial hairline. As the frequency of the vfo is varied and is added to the crystal oscillator frequency, the band-pass tuner, which has a very narrow band-pass characteristic, automatically follows the sum frequency. At the same time, the hairline in the HARMONIC window is slowly moved toward the proper harmonic block. When the sum frequency is such that a harmonic of it is within audible range of the frequency of the signal under measurement, a beat note will be produced in the headphones. When the beat note is reduced to zero,

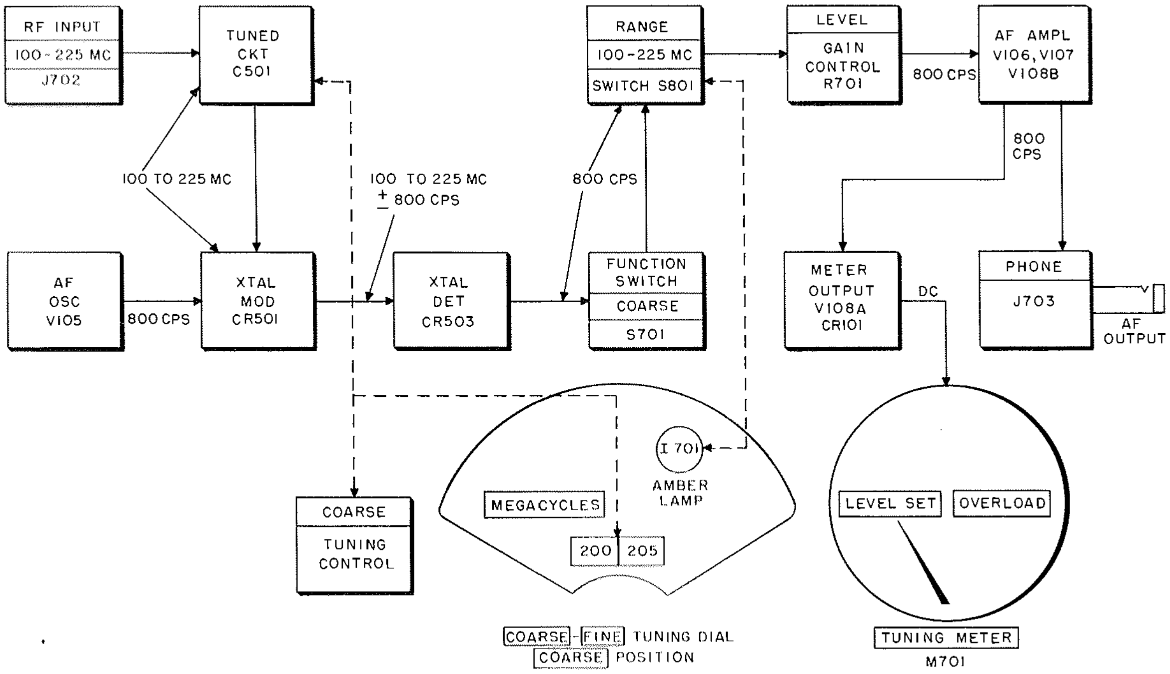


Figure 12. COARSE position, block diagram.

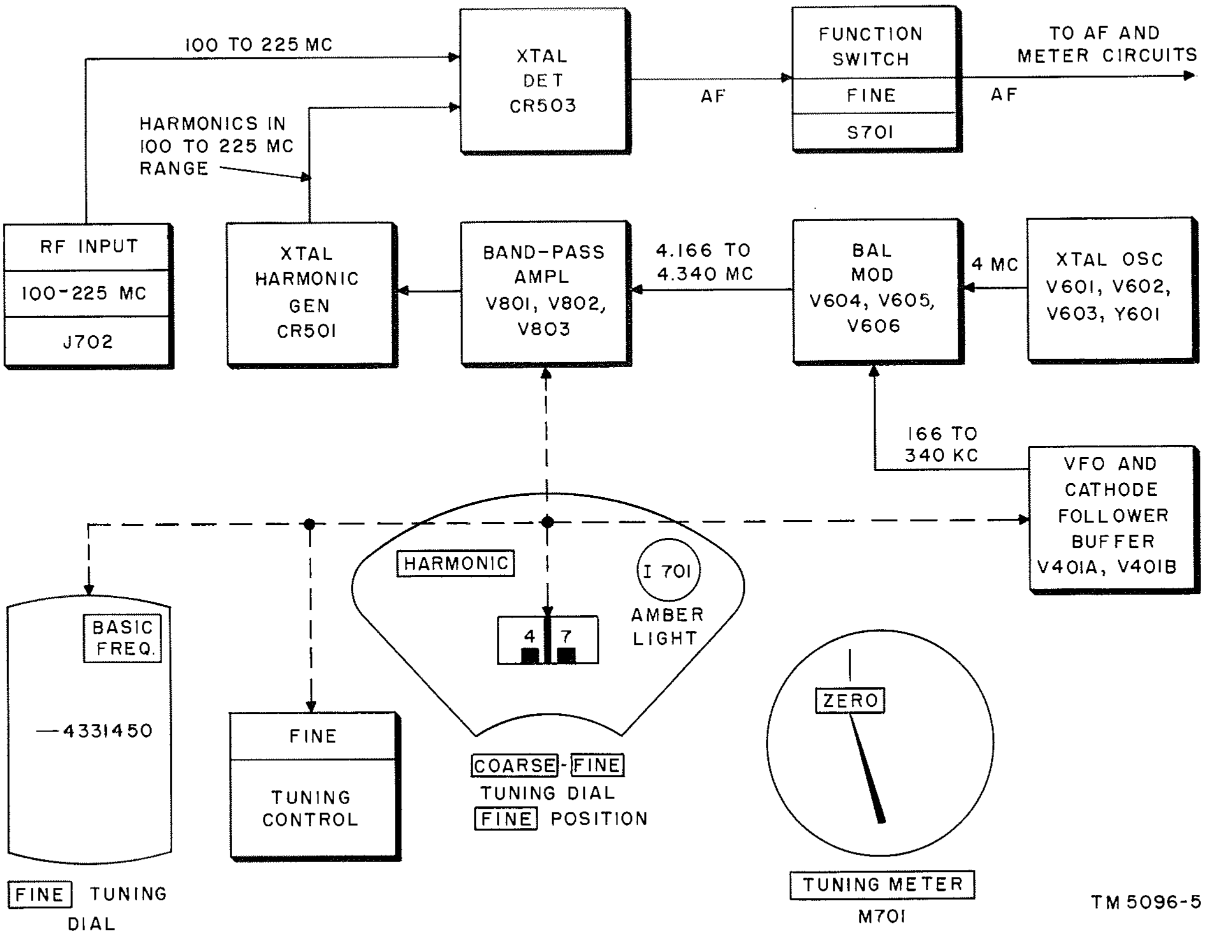


Figure 13. FINE position, block diagram.

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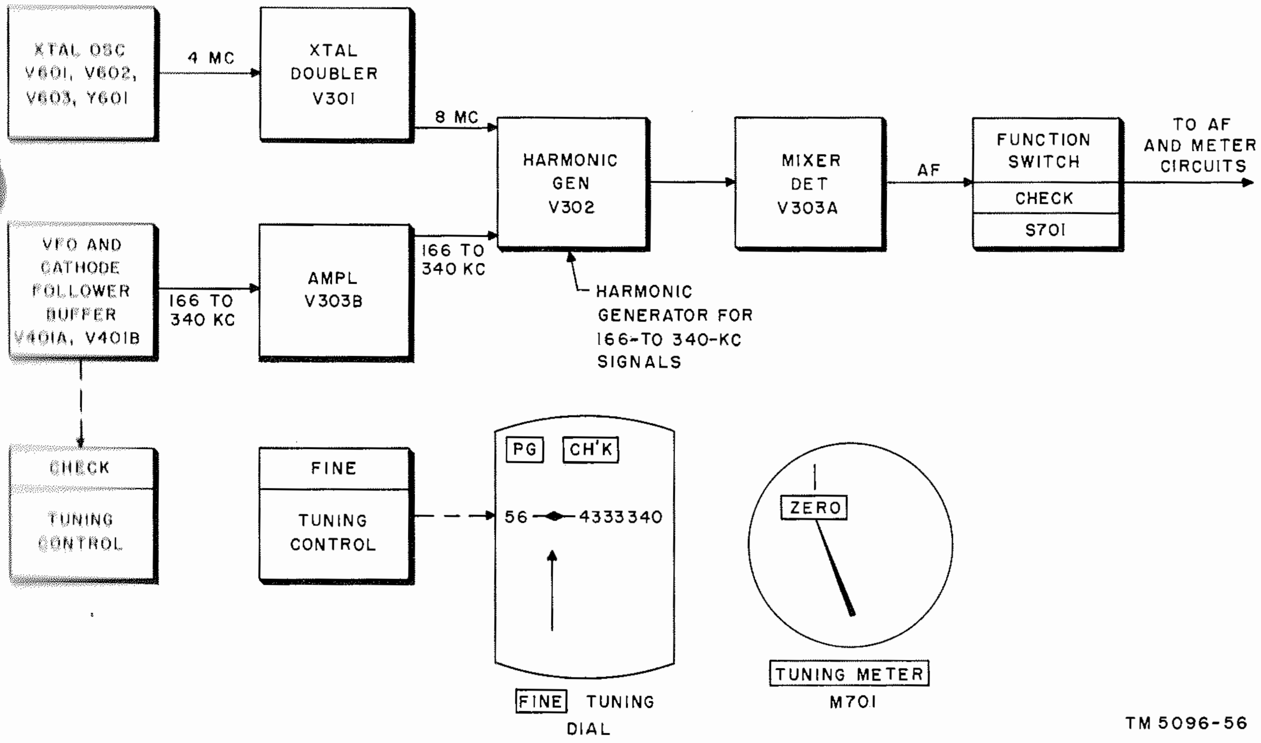

Figure 14. CHECK position, block diagram.

the standard basic frequency is read directly from the FINE tuning dial and the order of the harmonic is obtained from the HARMONICS scale. The product of the standard basic frequency and the order of the harmonic is equal to the frequency of the signal under measurement. At zero beat, the TUNING METER needle will rest at the ZERO position to indicate the exact measurement of the unknown signal. At the same time, the af signal heard in the headset will be reduced to inaudibility (zero beat).

(3) *CHECK position* (fig. 14). When the FUNCTION SWITCH is placed in the CHECK position, the vfo stage is calibrated by heterodyning the harmonics of this oscillator with the second harmonic of the crystal oscillator. This procedure takes place as follows: the 4-mc output of the crystal oscillator stage is fed to doubler stage V301 and its 8-mc output is fed to harmonic generator V302. Also fed to V302 is a signal tuned by the CHECK calibration control in the 166-to 340-kc range from vfo stage V401 through amplifier V303B. The harmonics of the vfo signals are mixed with the fixed 8-mc signal and fed to detector stage V303A. The difference frequency lies in the af range and is fed to preamplifier V201A (Fig. 11) and the FUNCTION SWITCH where the signal path is identical with that of the FINE position described in (2) above. The FINE tuning control is set at the correct diamond indication (par. 18*b*(3) through (6)) and the CHECK calibration control is turned for zero-beat indication. This indication is found when the pointer of the TUNING METER is seen at ZERO and no audible sound is heard in the headset.

44. Crystal Oscillator Subassembly

Two requirements for an oscillator to function are amplification and proper feedback. Frequency Meter FR–6/U uses a tube for each requirement as described below:

a. Crystal Oscillator (A, fig. 15). Crystal oscillator V601 uses a 6AH6 pentode to provide the necessary amplification. The plate-tuned circuit consists of L601 and fixed capacitor C605, shunted by loading resistor R628 to prevent spurious oscillations. This network is fixed-tuned to crystal Y601 at 4 mc but slight adjustments can be made by trimmer capacitors C603 and C604 (4MC ADJUST). The amplified plate output is applied to the control grid of phase inverter V602 through capacitor C608. The phase of the signal (B, fig. 15) fed back to V601 from V602 through capacitor C609 is such that it will sustain oscillation in the circuit. Resistors R601 and R604 form a voltage-divider network which reduces the strain produced on the crystal because of the large feed-back voltage. The voltage developed across R604 is applied to the control grid of V601. The crystal is inclosed in a temperature-controlled oven to insure maximum frequency stability (fig. 53). Stability is also maintained by use of regulated +180 volts that is supplied to the plate and screen circuits. Resistor R606 and capacitor C606 form the crystal oscillator plate decoupling network. Screen voltage is applied through dropping resistor R603, and the screen is bypassed by capacitor C602. Cathode bias is furnished by R602 and capacitor C601.

b. Phase Inverter V602 (fig. 15). Phase inverter V602 uses a 6AU6 pentode as a resistance-capacitance (RC) amplifier for positive feed-back voltage to the crystal oscillator. The signal (B, fig. 15) from tuned amplifier tube V601 is fed through C608 to the grid of phase inverter V602. Assuming that this is the positive half of the cycle, the amplified signal developed across plate load resistor R608 (A, fig. 15) in the plate circuit of V603 will be in a negative-going direction. This negative-going voltage is fed through capacitor C609 to resistor R601 which is shunted by the series combination of crystal Y601 and resistor R604. The resistor and crystal act as a voltage divider with the correct amount of feed-back voltage across R604, the input load resistor for V601. The negative-going signal at the grid of V601 results in a positive-going signal at the plate for the correct feed-back cycle to overcome the circuit losses and sustain oscillations. The output of the phase inverter is taken off the cathode through capacitor C612 using resistor R607 as its load resistor (A, fig. 15). Resistor R607 also acts with capacitor C610 to form the cathode bias circuit. The reactance of C610 is large at the fundamental frequency (4 mc) but presents a low impedence to harmonics; this helps to prevent the harmonics from being passed to the next stage because only a negligible voltage can be developed across R607. Resistors R611 and R609 with capacitor C607 form the plate decoupling circuit. Screen voltage is applied through dropping resistor R609 and the screen is kept at rf ground potential by C611. Regulated +108 volts from the power supply is applied through dropping resistor R611.

c. Buffer Amplifier V603 (fig. 16). Buffer amplifier V603 uses a 12AT7 twin triode in a cathode follower and grounded grid circuit. The buffer amplifier isolates crystal oscillator V601 and phase inverter V602 from the following circuits to avoid oscillator loading and the resultant instability. A common cathode is used for cathode follower V603A and grounded grid amplifier V603B. The signal from cathode follower V603A is injected into grounded grid amplifier V603B. A grounded grid amplifier is used to isolate the crystal oscillator circuit from load variations. Resistor R610 provides the grid return for the buffer amplifier circuit. Resistor R613 is the cathode load resistor for buffer amplifier V603A and the input resistor for V603B. Plate decoupling for V603A is provided by R612 and C613. Resistor R614 is the plate load for V603B. Regulated +108 volts is supplied as plate supply voltage for both sections of V603. Any rf trying to enter the power supply is bypassed by capacitor C636. The output signal is coupled through capacitor C614 to test jack J701, through capacitor C301 to the control grid of doubler V301, and through capacitor C615 to the balanced-modulator circuit.

45. Variable Frequency Oscillator

(fig. 17)

The vfo stage is a highly stable inductance-capacitance (LC) oscillator whose frequency is varied from 166 to 340 kc. It consists of a modified Colpitts oscillator, V401A, known as a Clapp oscillator, and cathode follower buffer V401B.

a. VFO V401A (A, fig. 17).

(1) The circuit of vfo V401A is similar to a Colpitts oscillator, except that a series LC circuit replaces the conventional parallel-tuned circuit (B, fig. 17). The series resonant circuit has a voltage-divider network consisting of C405 and C406 connected across it. The grid is connected to one end of this network and the plate to the other. The ratio of the voltage developed across the divider network determines the amplitude of the feed-back voltage. Thus, a voltage of the proper phase and amplitude necessary to sustain oscillations is fed to the

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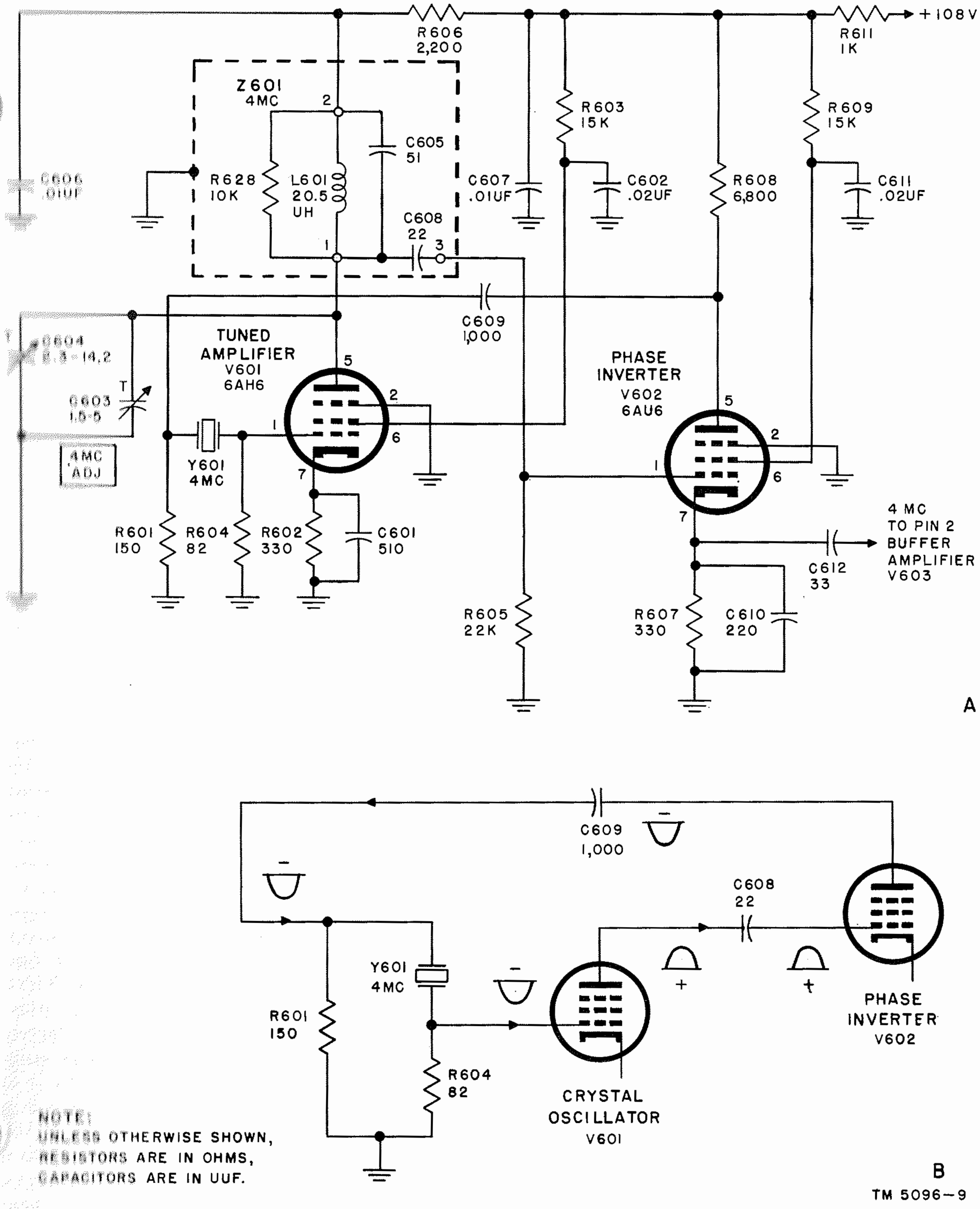


Figure 15. Crystal oscillator circuit, simplified schematic diagram.

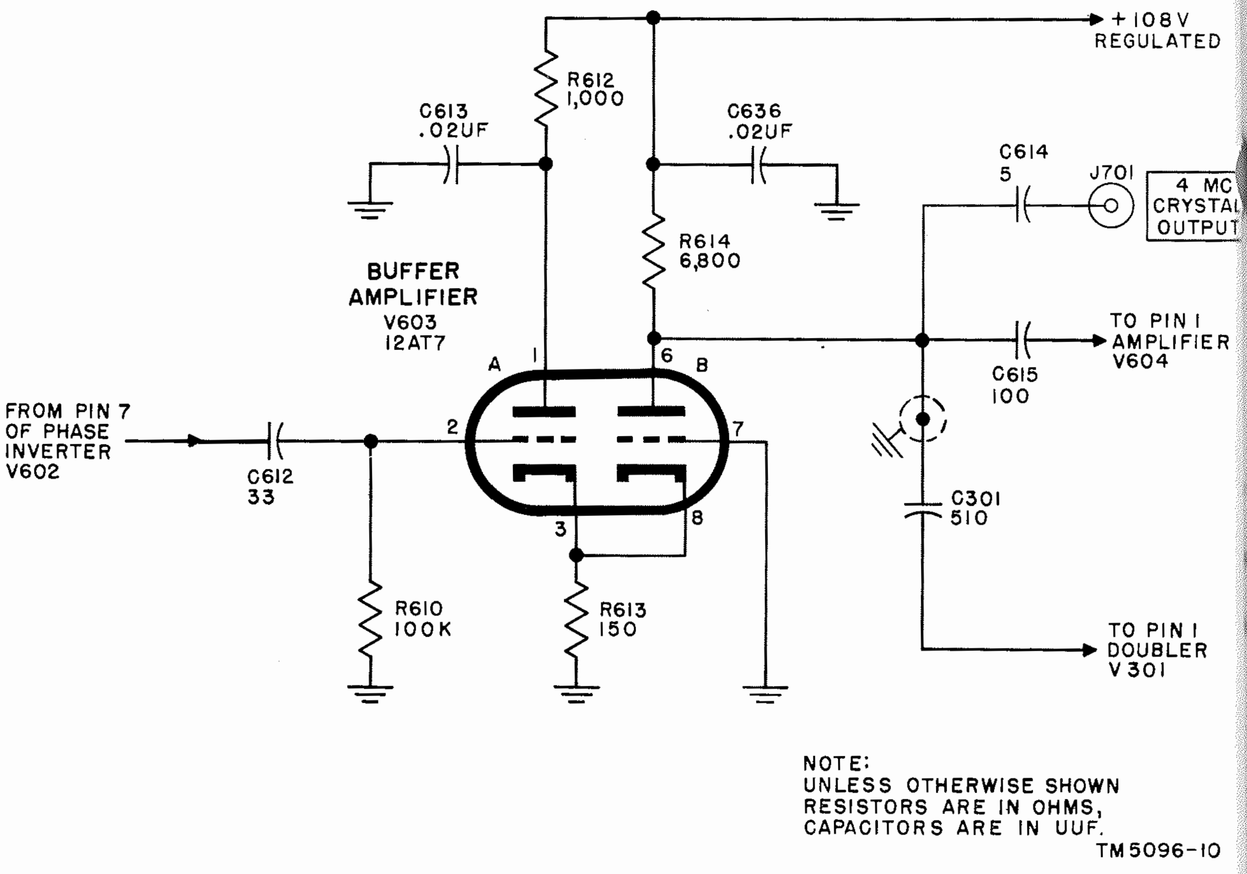
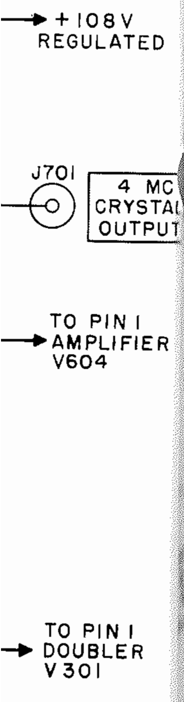


Figure 16. Crystal oscillator buffer amplifier circuit, simplified schematic diagram.

grid of the tube. The capacitance values of C405 and C406 are larger than tuning capacitor C_o; therefore, the tube and internal tube capacitances have little loading effect on the resonant frequency of the series-tuned circuit. The resonant circuit is isolated from tube changes by the capacitance voltage-divider network C405 and C406, resulting in a high degree of frequency stability.

(2) In the actual circuit (A, fig. 17), capacitors C410, C401, C402, and C403 are designated *C* in the equivalent circuit. The tank circuit is composed of these capacitors and inductor L401. Capacitors C405 and C406 form the voltage divider across the series resonant circuit. The voltage developed across C406 is applied to the grid of V401A. This voltage sustains oscillations. Grid leak bias is provided by capacitor C407 and resistor R402. Resistor R402 minimizes grid current, which further reduces the loading effect caused by the tube. The rf signal is applied to the grid through capacitor C407. Rf choke L402 in the cathode leg provides the cathode dc return path as well as keeping the rf above zero (ground) potential. Resistor R405 and capacitor C409A form the plate decoupling network. The vfo is a grounded plate arrangement; no high dc voltages appear at any point in the tank circuit. The oscillator is tuned by the FINE tuning control only when the FUNCTION SWITCH is in the FINE position. The FINE tuning control is linearly geared to C403 and to the film strip. When the FUNCTION SWITCH is in the CHECK position, the oscillator is calibrated at its nearest check point by the CHECK calibration control, which is coupled to C402. A timing belt couples C402 and the film mechanism mechanically. The Clapp oscillator is highly stable against changes in temperature,



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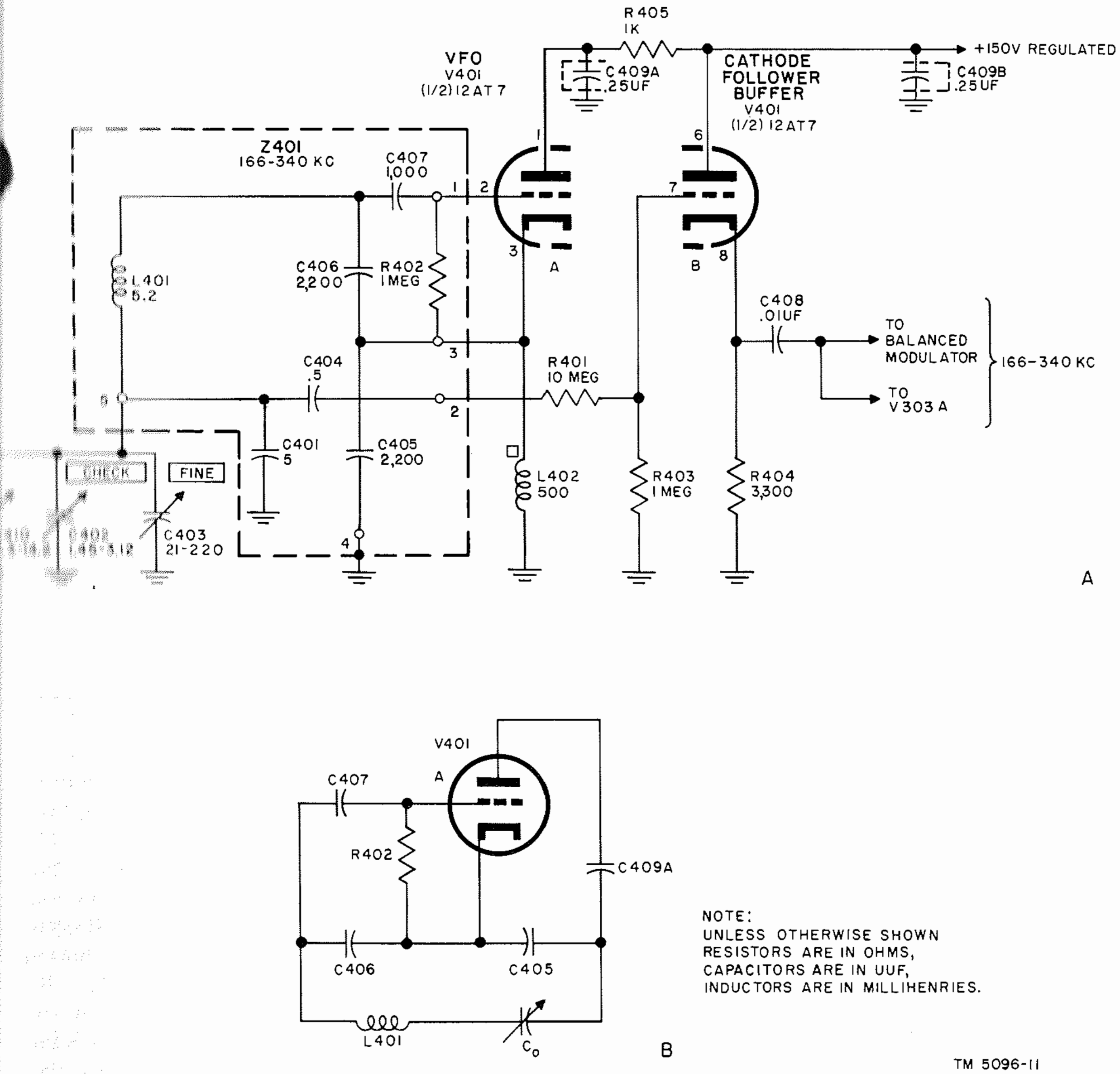


Figure 17. Variable frequency oscillator, simplified schematic diagram.

tube reactances, replacement tubes of the same type, and power supply variations. The output is taken from the junction of L401 and the parallel-tuned capacitors and is applied through C404 and isolating resistor R401 to the grid of cathode follower buffer V401B. To prevent possible oscillator drift, positive 150 volts (regulated) is supplied as plate supply voltage.

b. Cathode Follower Buffer V401B (B, fig. 17). Cathode follower buffer V401B isolates the oscillator against fluctuations and variations caused by circuit loading. The plate of the buffer is bypassed to ground by capacitor C409B. Resistor R403 is the grid return resistor. The output signal (166 to 340 kc) is developed across cathode resistor R404 and applied through capacitor C408 to balanced-modulator V605 and V606 and amplifier V303B. Positive regulated 150 volts is supplied to V401B from the power supply.

46. Balanced Modulator

(figs. 18 and 19)

The balanced-modulator circuit consists of a 6AU6 pentode amplifier, V604; two 5725/6AS6W pentode mixers, V605 and V606; and a 6AH6 pentode-tuned amplifier, V607. This circuit effectively adds the vfo signal, variable between 156 to 340 kc, to the crystal oscillator 4.0-mc signal, which produces an output signal in the 4.166- to 4.340-mc range. It functions as follows:

a. Amplifier V604 (fig. 18). The 4.0-mc signal from the crystal oscillator is fed to the control grid of V604 through capacitor C615. After amplification, the output signal is taken off the plate and is fed through transformer T602 contained in network Z602 to the control grids of mixers V605 and V606. Resistor R615 is the grid return resistor. Cathode resistor R616 and capacitor C617 provide operating bias. Resistor R617 is the screen dropping resistor and capacitor C616 is the screen bypass. Resistor R618 and capacitor C619 form the plate decoupling network. Capacitor C618 is an additional bypass to ground; inductance L603 serves as an rf choke in the plate supply circuit. Fixed capacitor C620, across the primary coil of transformer T602, forms the tuned plate tank of V604. Permeability-tuned filter coupling network Z602 consists of capacitors C620, C621, C622, and C623 and transformer T602. When Z602 is alined, it tunes in the range of 4.166 to 4.340 mc.

b. Mixers V605 and V606 (fig. 18).

(1) Mixers V605 and V606 amplify and mix the fixed crystal and vfo oscillator signals. Fixed capacitor C623 and the secondaries of permeability-tuned transformer T602 form the tuned grid tanks for mixers V605 and V606. The 4.0-mc signal from amplifier V604 is fed to this tank circuit and to the control grids. Fixed capacitors C621, C622, and C623, tuning slugs, and the secondary of transformer T601 provide a tuned circuit for the vfo signal that is inductively coupled across T601. The vfo signal is fed to the suppressor grids of mixers V605 and V606. Each tube mixes the input frequencies, producing at the tube output the sum and difference frequencies. Because of their phase relationship, the original input frequencies cancel each other at the output of V605 and V606. The resultant beat frequencies, however, become additive and are applied to the next stage. Thus, mixers V605 and V606 operate their input in push-pull and their output in parallel.

(2) Cathode bias is provided by R631 for V605 and R632 for V606 for easier balancing of the stages. The plates receive a common B+ supply (150 volts regulated) and voltage-dropping resistors R620 and R622 provide the proper screen grid potential. Variable resistor R621 (BALANCE control) maintains a balance between the outputs of V605 and V606. Capacitors C624 and C626 keep the screen grids at an rf ground potential. The plate tank network Z603, common to both V605 and V606, is composed of of capacitor C628, loading resistor R623, and the permeability-tuned transformer T603. Fine tuning is provided by trimmer capacitor C627. Capacitor C629 is a plate bypass to ground. To insure passing the wanted frequencies, the plate tank tuned network Z603 is tuned to the low end of the 4.166- to 4.340-mc range (the high end is tuned in tuned amplifier V607). This tuned signal then is coupled across transformer T603 to the control grid of tuned amplifier V607.

c. Tuned Amplifier V607 (fig. 19). Because the tuned circuit of Z603 is tuned only to the low end of the 4.166- to 4.340-mc range, an additional tuned amplifier stage, V607, is provided. This stage uses the identical tuned plate network Z604 as the preceding mixers, but is tuned to the high end of the 4.166- to 4.340-mc range. Resistor R624 and capacitor C631 are the cathode-biasing resistor and bypass capacitor, respectively. Resistor R625 is the screen dropping resistor and capacitor C632, the screen bypass to ground. Resistor R627 and capacitor C635 form the plate decoupling network. Inductance L602 and capacitor C638, a bypass to ground, further filter the +150-volt regulated plate supply. The tuned 4.166- to 4.340-mc signal is coupled through capacitor C801 to band-pass amplifier stages V801 and V802.

47. Band-Pass Amplifier

(figs. 20, 21, and 22)

The band-pass amplifier circuit amplifies the selected signal in the 4.166- to 4.340-mc band so that its harmonics may be used to measure unknown frequencies in the 100- to 225-mc range, or it doubles and amplifies the input frequency so that harmonics of a selected signal in the 8.332- to 8.680-mc band may be used to measure un-

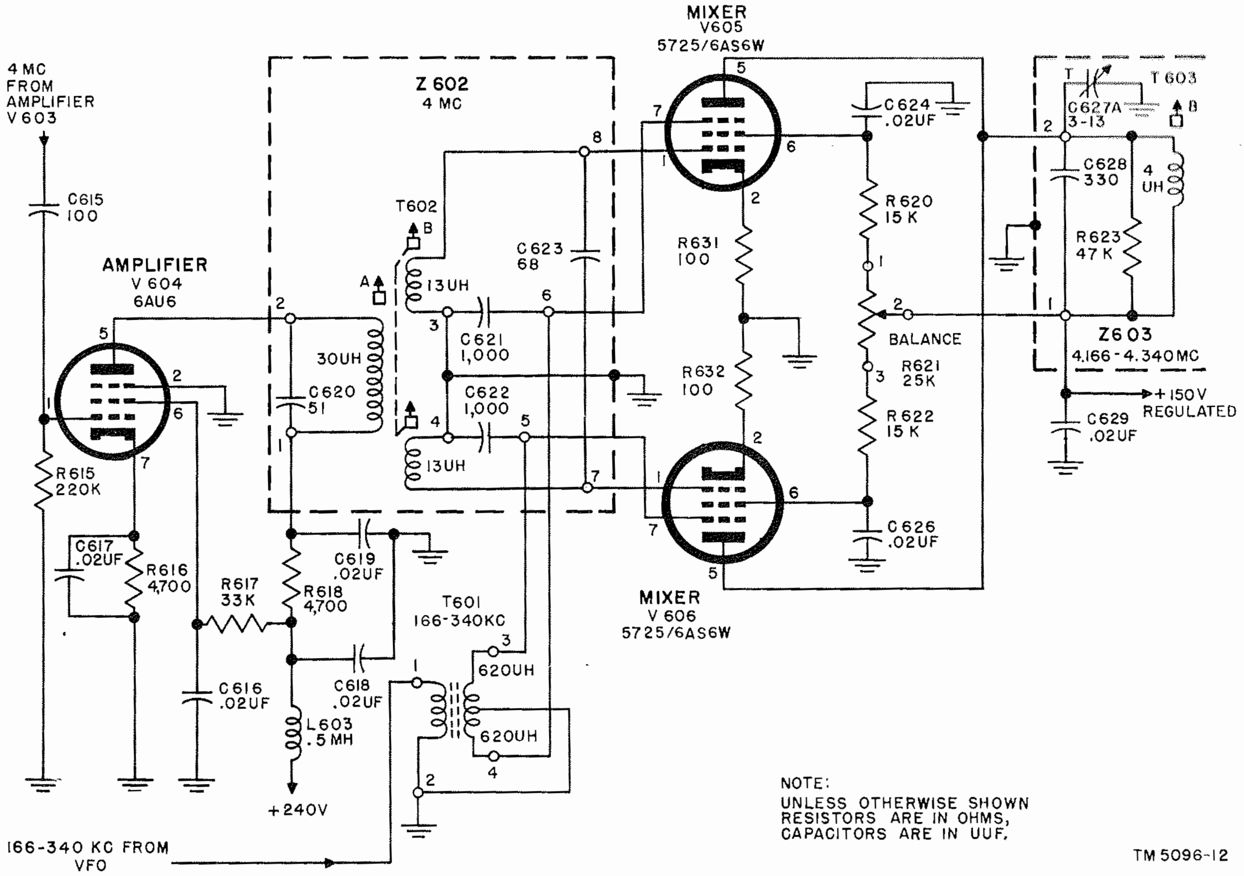


Figure 18. Balanced modulator circuit, amplifier and mixer, simplified schematic diagram.

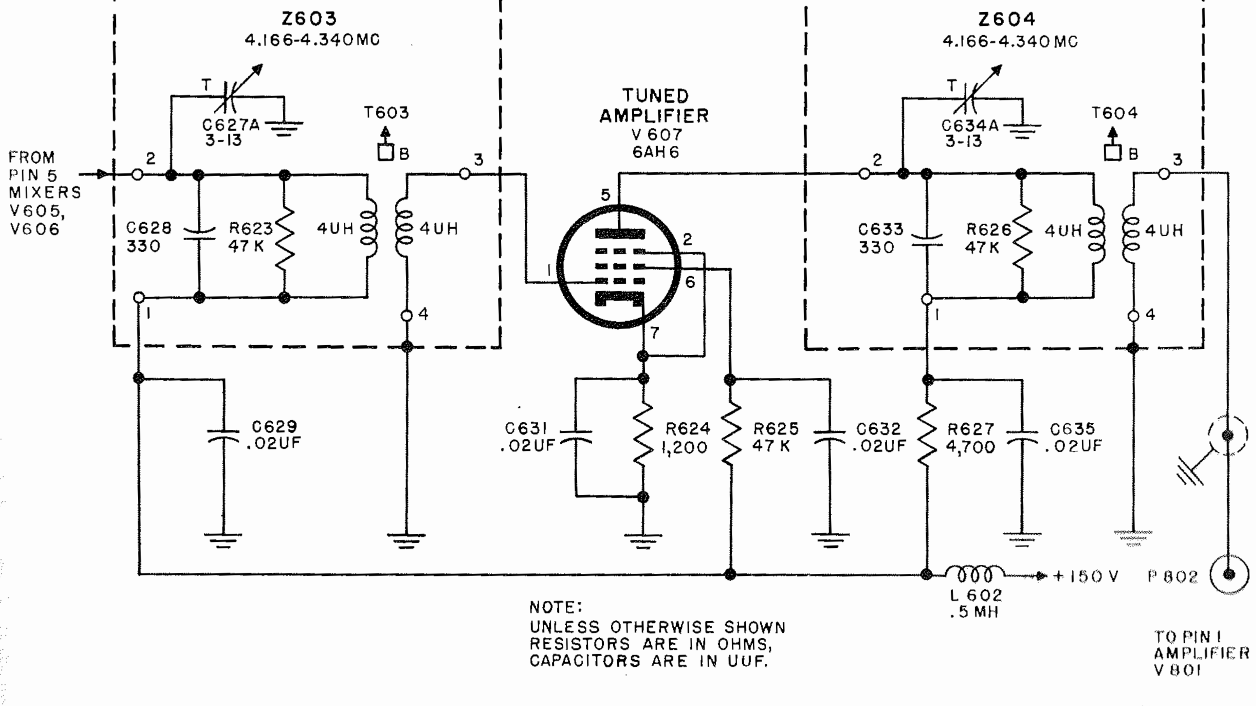


Figure 19. Balanced modulator circuit, tuned amplifier, simplified schematic diagram.

known frequencies in the 225- to 500-mc range. Tuned network Z801 suppresses all spurious signals that form in the mixer circuit that might otherwise mix with the desired signal and prevent erroneous readings from occurring.

a. Amplifiers V801 and V802 (fig. 20).

(1) When FUNCTION SWITCH S701 is placed in the FINE position, the band-pass amplifier circuit is energized by the application of positive 240 volts from the power supply to the plates. The input signal from the balanced modulator output is connected to J802. This signal in the 4.166- to 4.340-mc range is coupled through C801 to the control grid of 6AU6 pentode amplifier V801 across grid return resistor R801. Input amplifier V801 is a cathode-biasing plate-tuned amplifier. The biasing network is C802A and R802. The plate-tuned circuit consists of the primary of T801, section A of gang-tuned capacitor C814, trimmer capacitor C812, and fixed capacitor C813 of Z801. Three more identical circuits of Z801 are used; the output of each is inductively coupled to the following circuit. The inductances are the secondary of T801 and the primary and secondary of T802. Main tuning of the networks is accomplished by sections B, C, and D of gang-tuned capacitor C814; trimmer capacitors C816, C818, and C820 and fixed capacitors C817, C819, and C821 are paired across sections B, C, and D, respectively, of Z801. This tuned network circuit is selective and discriminates against all but the wanted signal.

(2) As the vfo is varied through its frequency spectrum, ganged capacitor C814 simultaneously retunes the network to the crystal-plus-vfo frequency. This tuned signal is coupled through capacitor C822 to the control grid of 6AU6 pentode amplifier V802. Variable capacitor C815 adjusts the band-pass characteristics of the network.

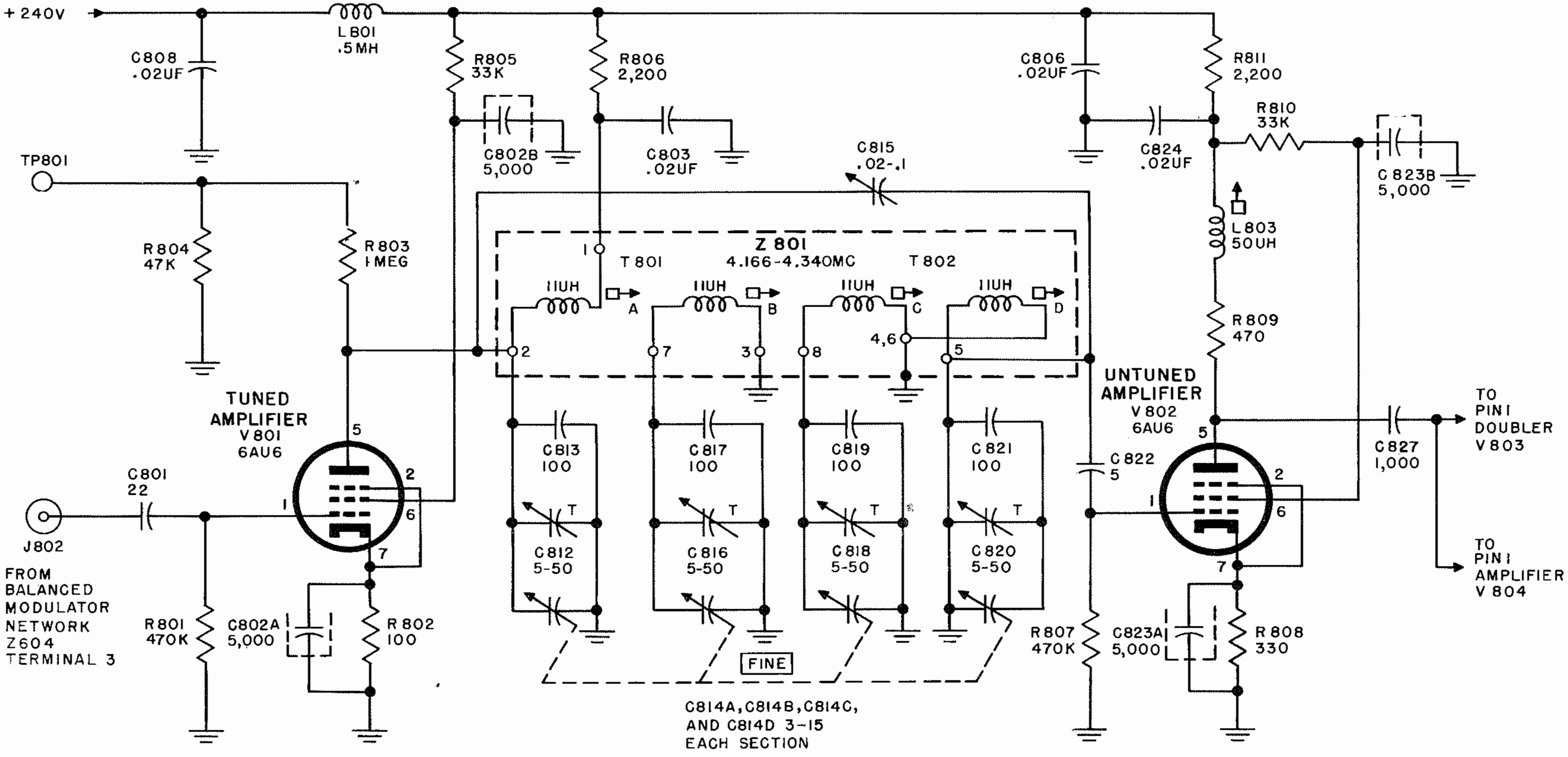
(3) Amplifier V802 is a pentode amplifier that uses cathode bias developed by R808 and C823A. The plate load consists of resistor R809 and peaking coil L803, used to effect a uniform response characteristic across the 4.166- to 4.340-mc spectrum. The output signal is coupled through C827 and applied to amplifier V804, or doubler V803, depending on whether the RANGE switch (fig. 21) is set in the 100–225 MC or the 225–500 MC position, respectively.

(4) Plate supply voltage (240 volts) for V801 and V802 is filtered by C808 and L801. Further filtering is provided by the decoupling networks R806 and C803 for V801 and R811 and C824 for V802. Screen voltage for V801 is supplied through dropping resistor R805 and the screen is bypassed by C802B. Screen voltage for V802 is supplied through dropping resistor R810 and the screen is bypassed by C823B. A test output for measuring dc is available from the plate of V801 at TP801. This test point is at the junction of the resistance voltage divider R803 and R804 in the plate circuit of V801.

b. Doubler V803 (fig. 21).

(1) RANGE switch S801, section 1, energizes either 6AH6 pentode doubler V803 or 6AQ5 pentode amplifier V804, depending on whether the signal under measurement falls in the 100- to 225-mc or the 225- to 500-mc range. If a 225- to 500-mc signal is to be measured, then the 4.166- to 4.340-mc signal coupled through capacitor C827 is coupled through capacitor C828 to the control grid of doubler V803. Output network Z802 is a permeability-tuned filter coupling network that is broadly tuned to a flat response across the 8.332- to 8.680-mc spectrum. The network combines four tuned circuits. The primary consists of inductance T803A and capacitor C833 in one parallel-tuned tank circuit, and T803B and C834 in the second. The secondary consists of inductance T804D and capacitor C836 in one series-tuned tank circuit, and T804C and C835 in the other. The output signal of the network is coupled through C837 to the control grid of amplifier V805.

(2) Doubler V803 is cathode biased by R814 and C830A in parallel. The control grid return is provided by R813. Plate and screen voltage is supplied to V803 through RANGE switch S801, section 1. Resistor R817 and capacitor C832 pro-



NOTE:
UNLESS OTHERWISE SHOWN
RESISTORS ARE IN OHMS,
CAPACITORS ARE IN UUF.

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Figure 20. Band-pass amplifiers, simplified schematic diagram.

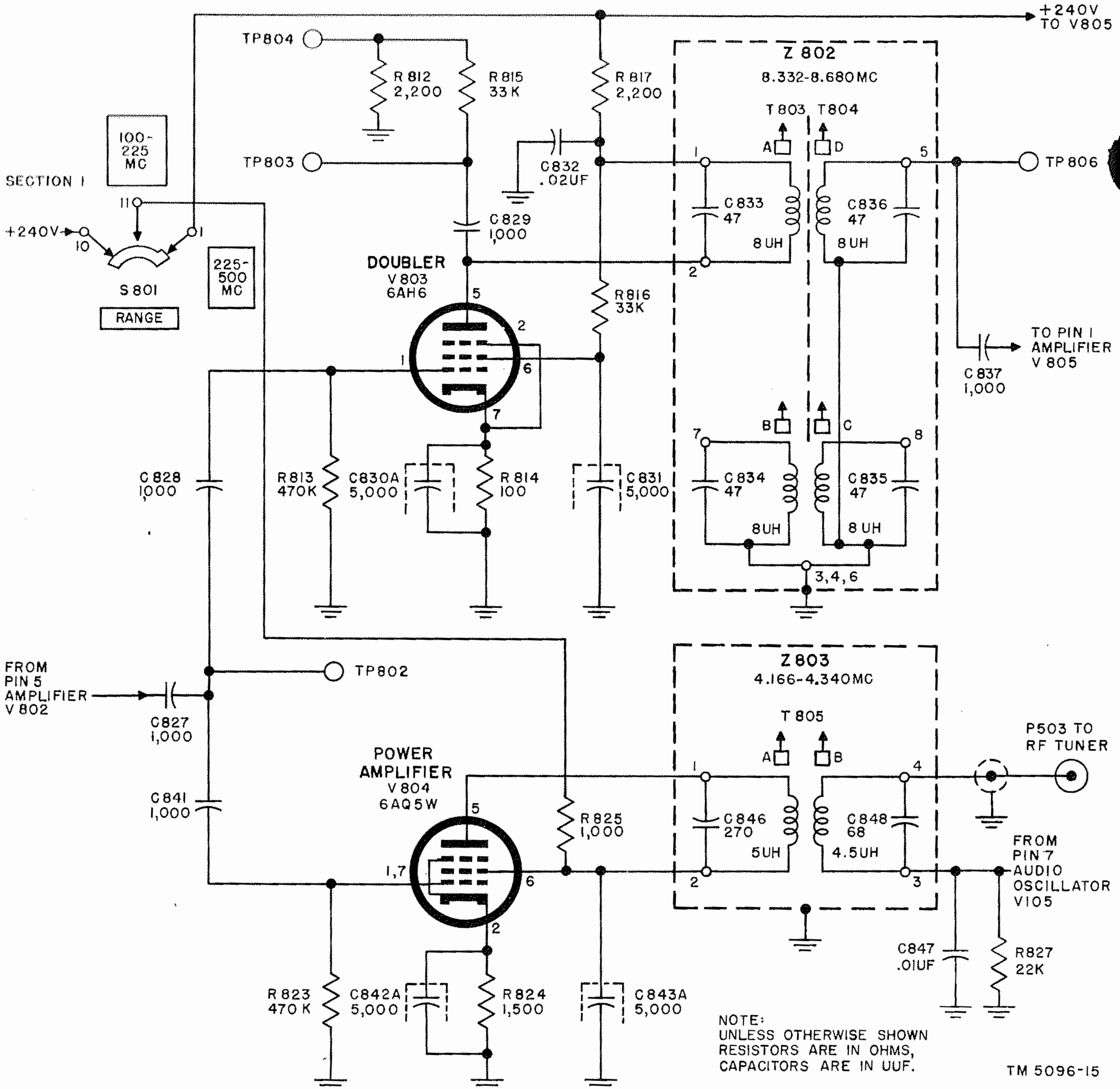


Figure 21. *Doubler V803 and amplifier V804, band-pass circuit, simplified schematic diagram.*

vide decoupling; screen voltage is applied through dropping resistor R816 and the screen is bypassed by C831. Two test points are provided at the plate of V803. The output signal is coupled through C829 to TP803, and a second test output at a lower level is available at TP804, which is connected to the junction of the voltage divider consisting of R812 and R815. Plus 240 volts is supplied from the power supply for screen and plate potentials.

c. Power Amplifier V804 (fig. 21).

(1) If the signal to be measured is in the 100- to 225-mc range, RANGE switch S801, section 1, removes plate power from doubler V803 and applies it to amplifier V804. This tube, a type 6AQ5W, is a cathode-biased, single-ended beam-power amplifier with the plate tank circuit

tuned to a flat response through 4.166 to 4.340 mc. The output of this tube is used to drive a crystal harmonic generator. A high-level. input is necessary, therefore, to make effective use of the upper harmonics.

(2) The input signal is coupled through capacitors C827 and C841 to the control grid. The grid return is provided by resistor R823. The tuned plate load network Z803 for the stage consists of T805A and C846 in the primary and T805B and C848 in the secondary. The output signal developed in the secondary is coupled through P503 to the rf tuner subchassis. When the frequency meter is in the COARSE position, the audio signal from audio oscillator V105 is applied through the secondary circuit to the rf tuner.

(3) Cathode bias for V804 is provided by R824 and C842A. Plate and screen voltage (+240 volts) is supplied through RANGE switch S801, section 1, and through screen dropping and decoupling resistor R825. Capacitor C843A completes the plate decoupling circuit as well as bypassing the screen for rf.

d. Power Amplifier V805 (fig. 22).

(1) The 6AQ5 type beam-power amplifier V805 produces a strong signal for the crystal harmonic generator in the rf tuner so that relatively weak upper harmonics are stong enough to be used effectively. The input signal is coupled through C837 across R818 and applied to the control grid of V805. The output signal is developed in the tuned plate load network Z804 consisting of the primary of T806, C844, and loading resistor R821. The signal is inductively coupled to the secondary of T806 and applied through P504 to the rf tuner subchassis. Network Z804 is permeability tuned to pass unattenuated signals in the 8.322- to 8.680-mc range. The signal from audio oscillator V105 is also applied through the secondary to the rf tuner when the frequency meter is placed in the COARSE position.

(2) Plate and screen voltage is supplied to V805 through RANGE switch S801 when the FUNCTION SWITCH is in the 225–500 MC position. The voltage is applied through decoupling network R822 and capacitors C840A and C849. Test points are provided at three points in the circuit. Test point TP806 is at the input to the stage; TP808 is in the plate circuit, the plate signal being coupled through C838 to the test point; and TP809 is available for checking the audio note from the oscillator. The audio signal is measured across R826 and C845 in parallel.

48. RF Tuner

(fig. 23)

The rf tuner contains a dual circuit arrangement; one-half is used to cover the 100- to 225-mc range, and the other half covers the 225- to 500-mc range. The two sections are identical; therefore, only one section will be described.

a. Tuning network Z501 is a parallel-resonant circuit that consists of a two-conductor transmission line long enough to make its impedance inductive over the frequency range involved, and a precision capacitor that can be rotated to vary the resonant frequency of the combination. The schematic diagram of the rf tuner is shown in A, figure 23; B, figure 23 shows the equivalent circuit as a double-ended parallel LC circuit and C, figure 23 shows the single-ended equivalent. In C, figure 23, crystal diode CR501 is tapped across a portion of the circuit and is connected to a source of audio-frequency signal and an RC biasing combination. The audio voltage across the diode produces an af variation in its impedance, which is reflected into the tuned circuit to cause an af variation in the amplitude of the unknown rf signal that appears across detector CR502. The detector removes the audio signal and passes it to the audio amplifier from which it is available for headphones and TUNING METER. As the capacitor is tuned to a point where it forms a parallel-resonant circuit at the unknown frequency, an audio tone is heard in the headphones or shown on the TUNING METER.

b. When the FUNCTION SWITCH is in the COARSE position as shown in A, figure 23, an 800-cycle audio note from V105 is applied to CR501 in the actual circuit. The unknown signal that is injected into the circuit through the probe is modulated by the audio noise. Crystal diode CR503 detects the audio signal, which is applied to the preamplifier through C505.

c. When the FUNCTION SWITCH is in the

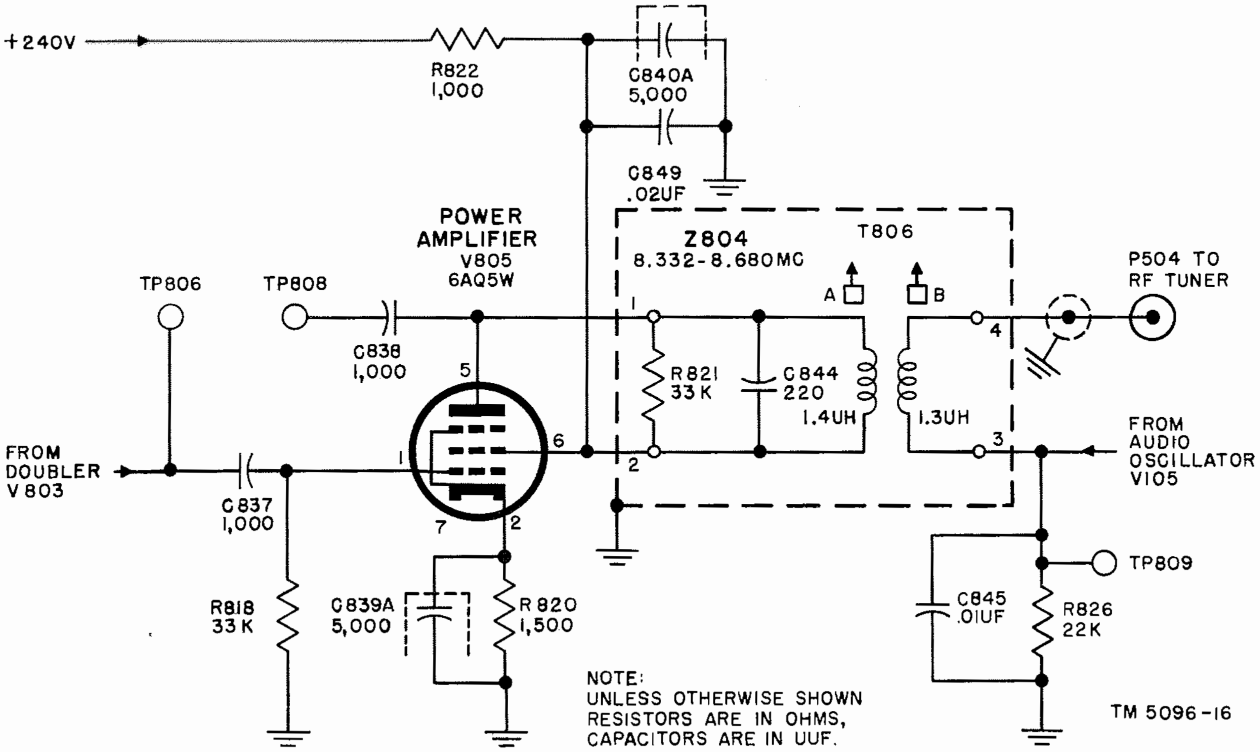


Figure 22. Power amplifier V805, band-pass circuit, simplified schematic diagram.

FINE position, the audio signal is removed from CR501 and replaced by the standard basic frequency output of the band-pass amplifier. Crystal diode CR501 now acts as a harmonic generator. As the vfo frequency is varied, one harmonic will approach the frequency of the unknown signal. Both signals are coupled to detector crystal CR503 and mixed, producing a beat note. All other harmonics are shunted to ground because the resonant circuit is a low impedance at any frequency except that to which it is tuned. Thus, the rf tuner determines the approximate frequency and selects the proper harmonic for producing an audio beat note.

49. Preamplifier

(fig. 24)

a. Preamplifier V201 is a 12AT7 twin triode used to amplify the weak audio signal that results from mixing the unknown frequency with a harmonic of the signal generated within the frequency meter. RANGE switch S801 applies plate power to section B or A of preamplifier V201, depending on whether the signal under measurement is in the 100- to 225-mc band or the 225- to 500-mc band. This switch also applies 6.5 volts to the appropriate range indicator lamp, amber for band 1 and green for band 2. The audio signal to V201A is RC coupled to the control grid by resistor R209, capacitor C203, and resistor R201. Resistor R204 provides the cathode bias. The amplified signal taken off the plate is coupled through capacitor C202 to the audio amplifier V106. Resistor R202 and capacitor C204A are the plate decoupling network and resistor R203 is the plate load for this section of the tube.

b. The audio signal to V201B is RC coupled to the control grid by resistor R210, capacitor C205, and resistor R208. Resistor R205 provides cathode bias. In both sections of V201, the cathodes are unbypassed to produce degeneration for improved frequency response. The amplified signal is coupled through capacitor C201 to audio amplifier V106. Resistor R207 is the plate load. Capacitor C204B and resistor R206 are the plate decoupling network.

50. Check System

(fig. 25)

The check system consists of a 6AH6 type doubler V301, a 12AT7 twin triode used as an amplifier V303B and detector V303A, and harmonic generator V302. This system provides a means of knowing when the vfo is operating at the calibrated frequency, as indicated by the

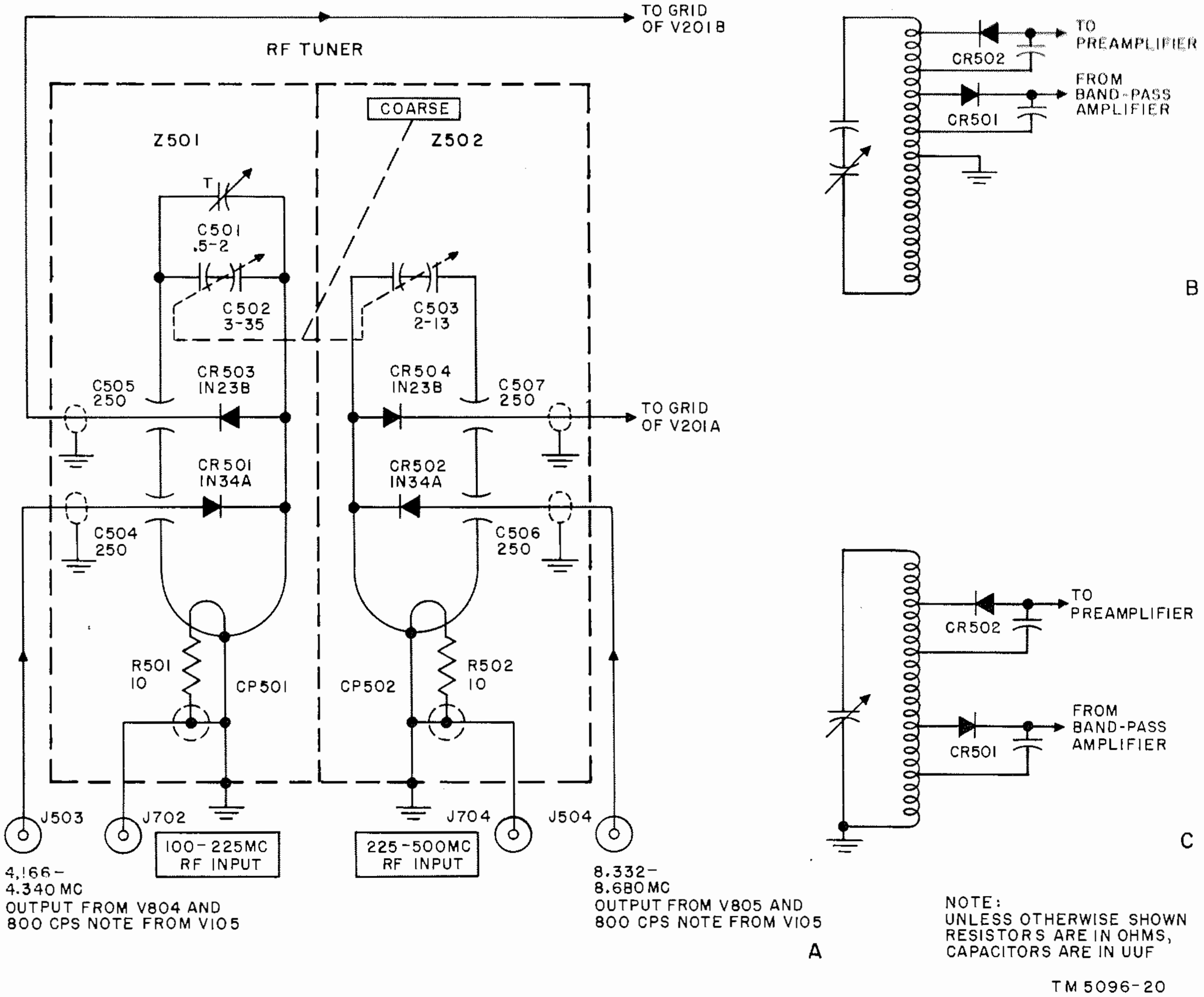


Figure 23. Rf tuner, simplified schematic diagram.

check points along the film strip. To do this, harmonics of the vfo are heterodyned with the second harmonic (8.0 mc) of the crystal oscillator signal.

a. When FUNCTION SWITCH S701 is in the CHECK position, plate voltage is applied to doubler V301 and amplifier V303B, energizing these circuits. Through jack J302, the 4.0-mc signal from the crystal oscillator is fed through capacitor C301 across grid return resistor R301 to the control grid of doubler V301. Cathode bias is provided by resistor R302 and capacitor C302A. The plate tank circuit, one-half of network Z301, consists of the primary of transformer T301 in parallel with capacitor C303 and is permeability-tuned to the second harmonic of the 4.0-mc input signal. This 8.0-mc signal then is coupled across the secondary of transformer T301 to V302. Resistor R304 and capacitor C304 provide plate decoupling; the screen voltage is dropped by resistor R303 and the screen is bypassed by capacitor C302B.

b. Tube V303B amplifies the vfo signal that is coupled through capacitor C309 and across grid return resistor R309 to the control grid. Resistor R308 is the plate load for the output signal, which is coupled through capacitor C308 to harmonic generator V302. Amplifier V303B operates as a grid-leak biased amplifier. Bias is developed in the grid circuit by C309 and R309.

c. The output of doubler V301 is coupled (by the second half of network Z301) across the secondary of transformer T301, approximately tuned to 8.0 mc by fixed capacitor C305. It is exactly tuned by the slug in the transformer secondary. This signal is then applied to the

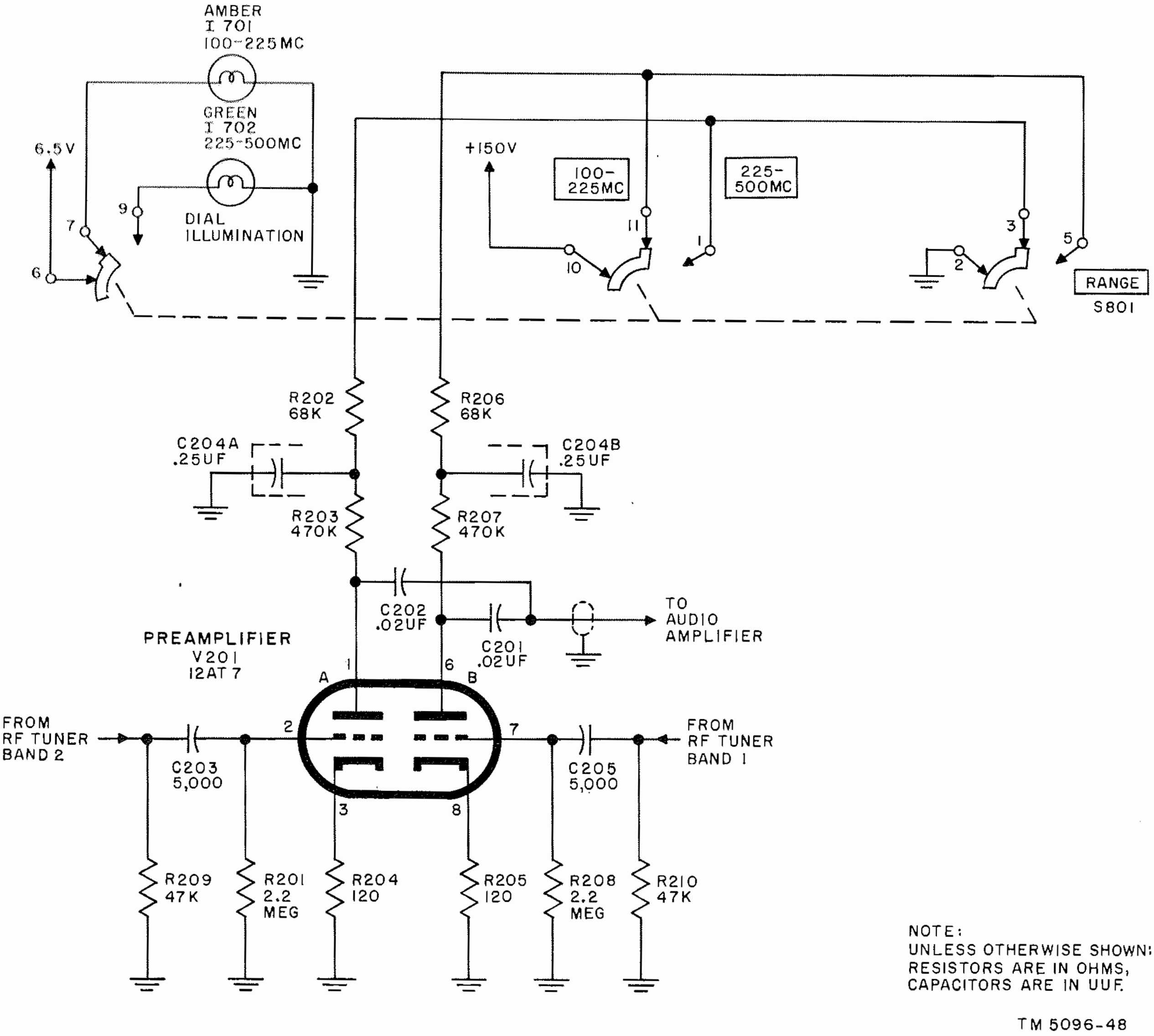
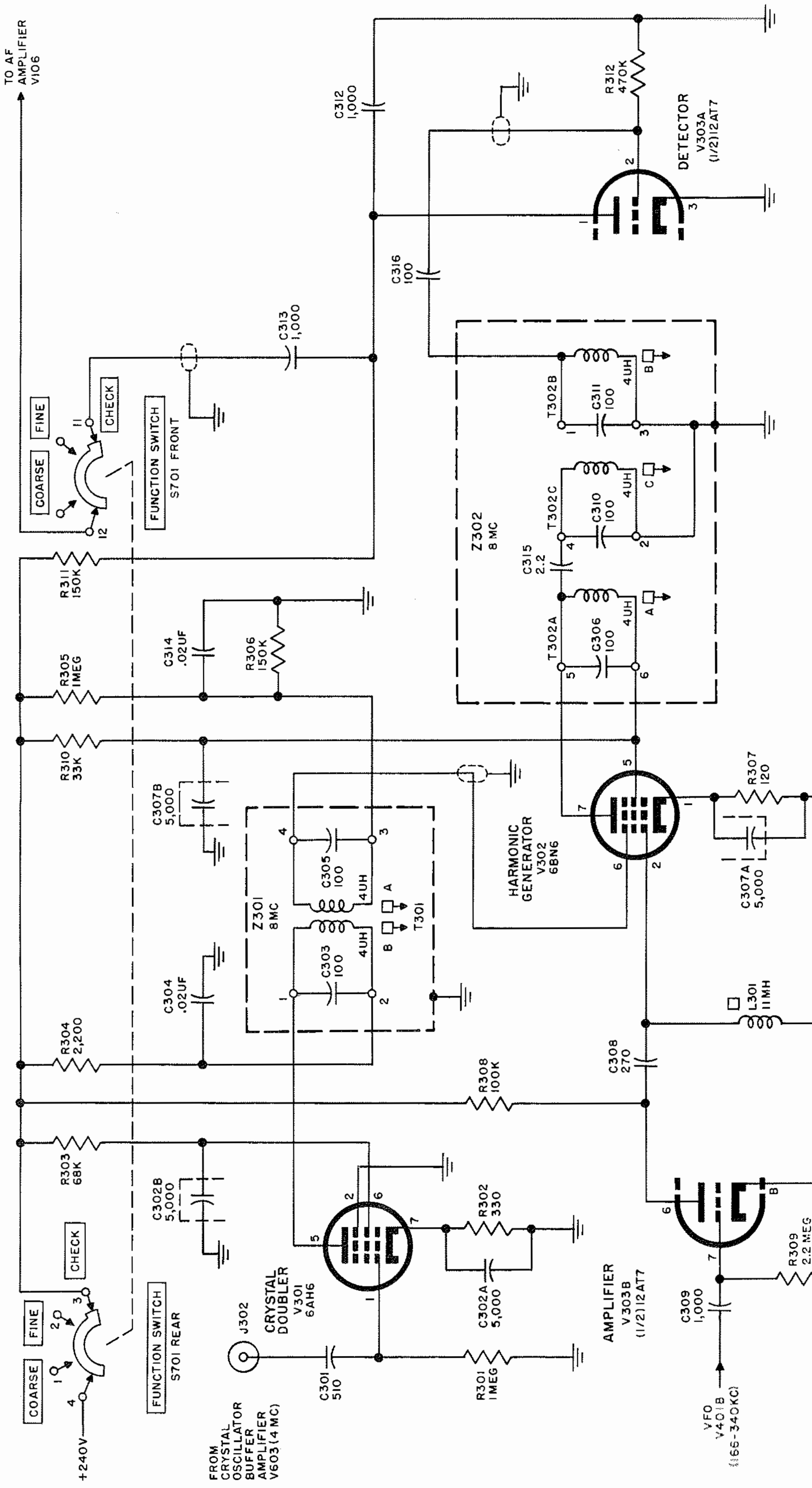


Figure 24. Preamplifier V201, simplified schematic diagram.

quadrature grid (pin 6) of electron-coupled harmonic generator V302. The operating potential of this grid is determined by voltage-divider resistors R305 and R306. Resistor R306 is bypassed by capacitor C314. Harmonic generator V302 will not conduct, however, until a positive signal is developed across rf choke L301 to overcome the cathode bias developed by resistor R307 and capacitor C307A.

d. Gating the tube in this manner causes V302 to discriminate against all but the true vfo signal. Weak spurious harmonic signals cannot develop sufficient positive voltages across L301 to overcome the cathode bias of V302. Beating harmonics of spurious signals with the 8.0-mc signal is thus avoided and also false check points are eliminated. A nonlinear signal, amplified in the triode section of the tube, generates the harmonics necessary to mix with the 8.0-mc signal on the quadrature grid. The plate and accelerator grid (pin 5) operate at the same dc potential as determined by resistor R310. Resistor R310 and capacitor C307B act together as a plate decoupling network.

e. During the CHECK tuning process of the vfo, harmonics will periodically enter the 8.0-mc range. The proper harmonic beats against the 8.0-mc signal, producing an audio difference frequency that modulates the 8.0-mc signal. This modulated signal is permeability tuned in triple



NOTE:
UNLESS OTHERWISE SHOWN
RESISTORS ARE IN OHMS,
CAPACITORS ARE IN UUF.

TM 5096-17

Figure 25. Check system circuit, simplified schematic diagram.

stage network Z302, consisting of capacitor C306 across T302A, capacitor C310 across T302C, and capacitor C311 across T302B. Blocking capacitor C315 couples T302A and T302C.

f. The mixed signal is fed to the grid of detector V303A. The coupling network consists of C316 and R312. A high negative charge builds up in C316, which keeps the tube at cutoff during the negative portion of the signal. Rectification takes place and only half of the modulation envelope appears across plate load resistor R311; C312 bypasses the rf component of the signal to ground while the audio component is applied to the af amplifier through capacitor C313 and the FUNCTION SWITCH.

51. Audio Amplifier and Meter Output Circuit

(fig. 26)

The audio amplifier amplifies audio signals that result from the heterodyning of the unknown frequency with harmonics of the frequency developed by the frequency meter. It consists of a 6BA6/5749 type af amplifier V106, one-half of 12AT7 meter output amplifier V108, a 6BN6 type gated af amplifier V107, and the second half of 12AT7 type af output amplifier V108.

a. When FUNCTION SWITCH S701 is in CHECK position, the front segment connects the check system signal across grid return resistor R108 to the control grid of af amplifier V106. The rear segment of FUNCTION SWITCH S701 simultaneously connects resistor R704 to resistor R107 to form the cathode bias.

b. When FUNCTION SWITCH S701 is in the FINE or COARSE position, the output signal from preamplifier V201 is taken from potentiometer R701A or R701B, respectively, and is fed across grid return resistor R108 to the control grid of V106. Potentiometer R701 is the LEVEL control to determine the input signal strength to V106. Resistor R705 is used in a voltage-divider network with potentiometer R701A. Resistor R706 is used in a voltage-divider network with potentiometer R701B.

c. In the FINE or COARSE position, FUNCTION SWITCH S701 connects thermal resistor RT701 to resistor R107 to provide the optimum cathode bias for V106. Refer to note 6 on the main schematic diagram (fig. 53) for the values of RT701.

d. The signal applied at the control grid of V106 is amplified and divided at the output. Resistor R110 is the plate decoupler and resistor R112 the plate load. Resistor R111, forming a voltage divider with resistor R107, provides a fixed source of cathode bias to improve operating stability. Capacitors C106B and C107 are af and rf bypasses to ground. One output signal from V106 is coupled through capacitor C109 to the grid of af amplifier V107. The other output signal is fed through capacitor C108 to the control grid of meter output amplifier V108A. Resistor R121 is the grid return for V108A and resistor R123 develops the cathode bias. Resistor R119 is the plate load.

e. The amplified output from V108A is fed through capacitor C116 and meter adjust variable resistor R703 to TUNING METER M701 and through C110 to crystal rectifier CR101. Full-wave rectification of the signal takes place in a crystal bridge arrangement located within the meter. The resulting pulsating dc signal is then used to actuate the dc milliammeter. Variable resistor R703 determines the amount of needle deflection.

f. The signal, coupled through capacitor C110, is rectified by crystal rectifier CR101 and fed through resistor R114 to the control grid of af amplifier V107. Resistor R113 protects the crystal by providing a dc grid return for V107. Capacitor C111 at the control grid is a bypass to ground.

g. Audio-frequency amplifier V107 is a gated tube that remains cut off to all spurious signals and operates as follows: the signal from V106 is coupled through capacitor C109 to the grid of af amplifier V107. The tube does not conduct, however, because of the cutoff bias established by variable resistor R116 in series with resistor R109. The tube remains cut off until a signal from V108A, rectified by crystal CR101, is of sufficient amplitude to drive the control grid positive with respect to the cathode. Because the tuned signal strength exceeds that of spurious signals, GATE ADJ control R116 can gate the operation of V107 to discriminate against all but the desired signal. Resistor R118 is the plate load and capacitor C112 provides a low-reactance path to ground for any high-frequency signals amplified by V107. The screen grid potential is determined by resistor R117 and placed at ac ground level by capacitor C113.

h. The output of V107 is coupled through capacitor C114 and across grid return resistor R120 to the control grid of af output amplifier V108B. The inductance of the primary of T102 and C115 in series with R122 forms a parallel-resonant

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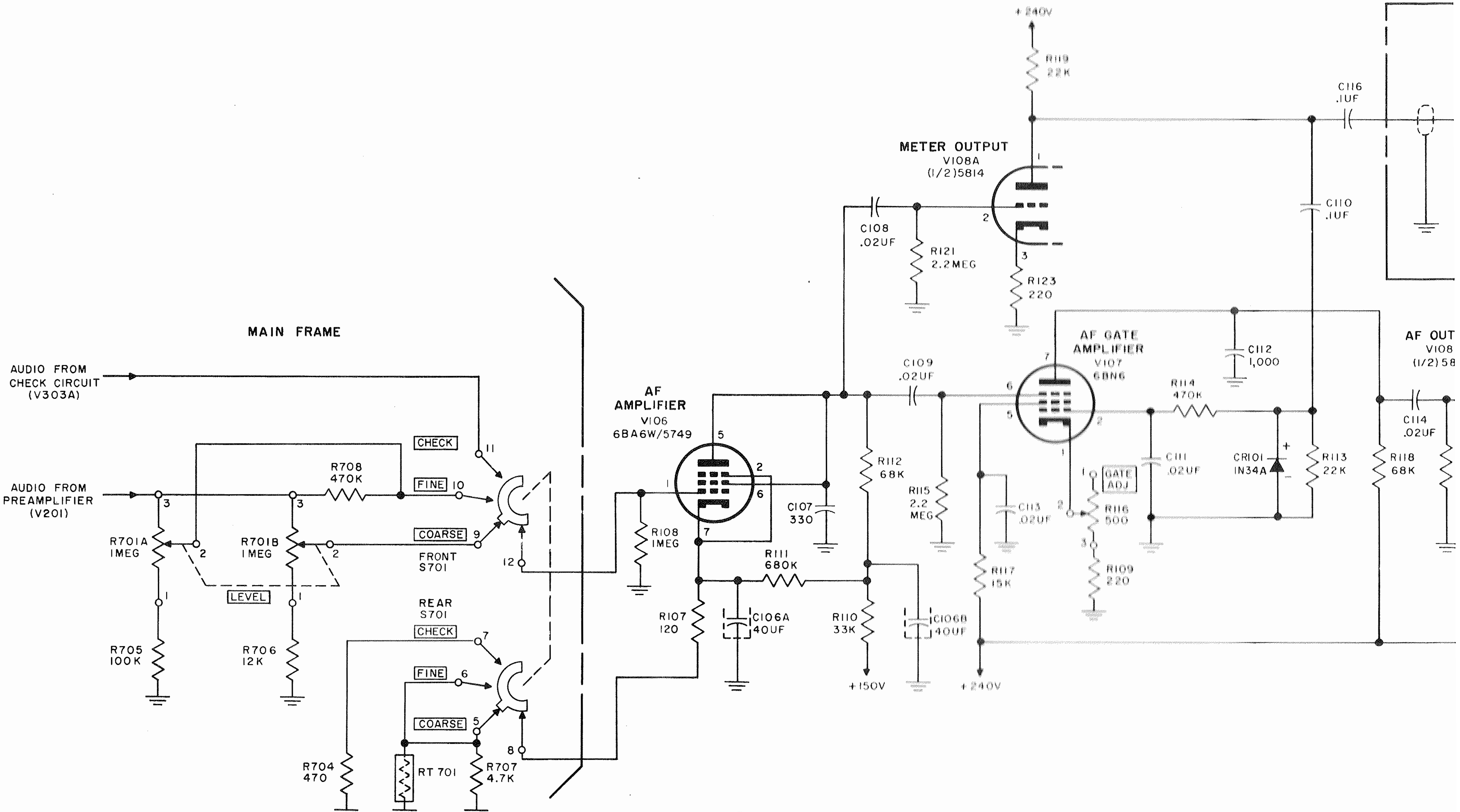
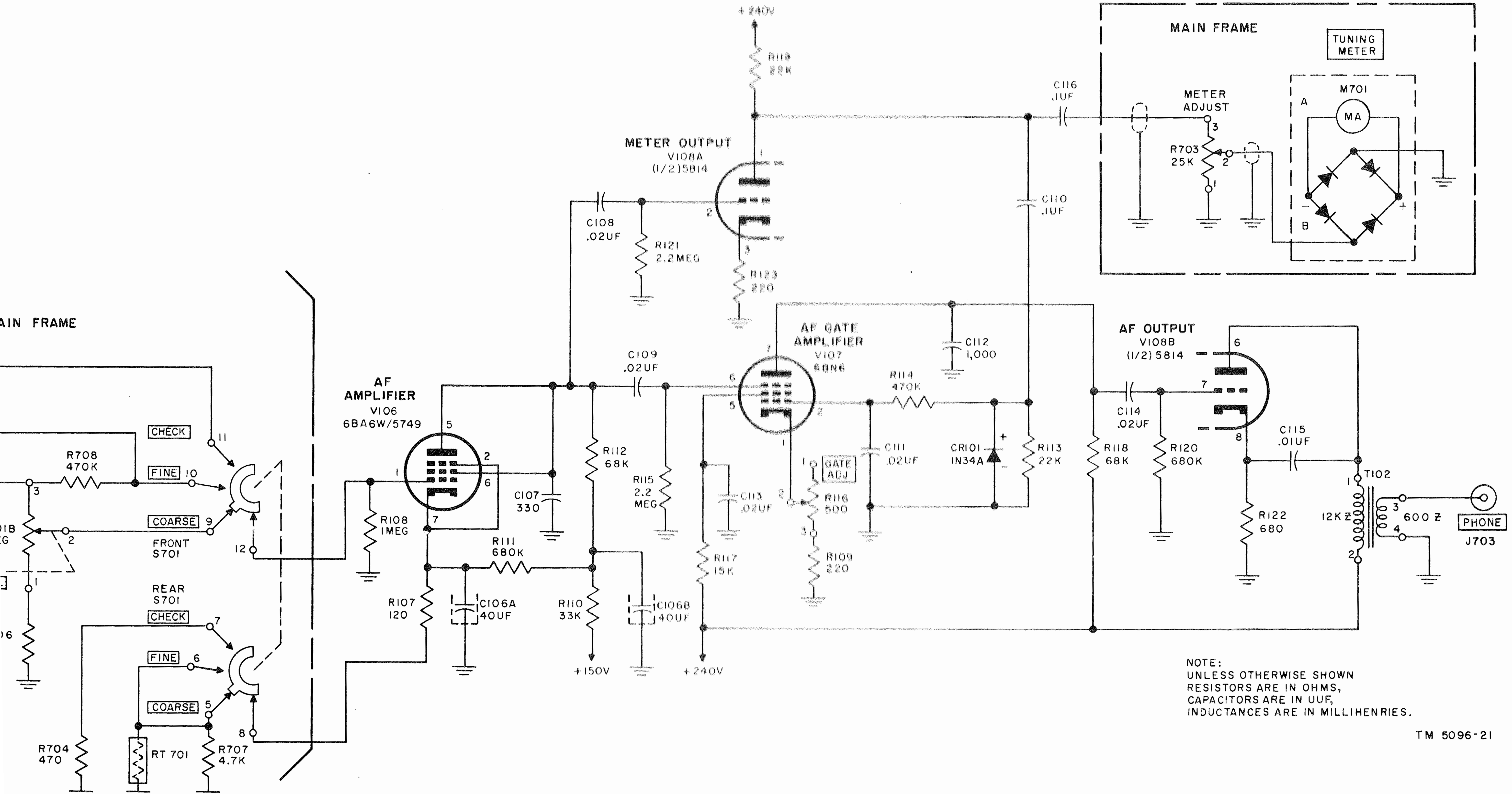


Figure 26. Audio-amplifier circuit, simplified schematic diagram.



NOTE:
UNLESS OTHERWISE SHOWN
RESISTORS ARE IN OHMS,
CAPACITORS ARE IN UUF,
INDUCTANCES ARE IN MILLIHENRIES.

Figure 26. Audio-amplifier circuit, simplified schematic diagram.

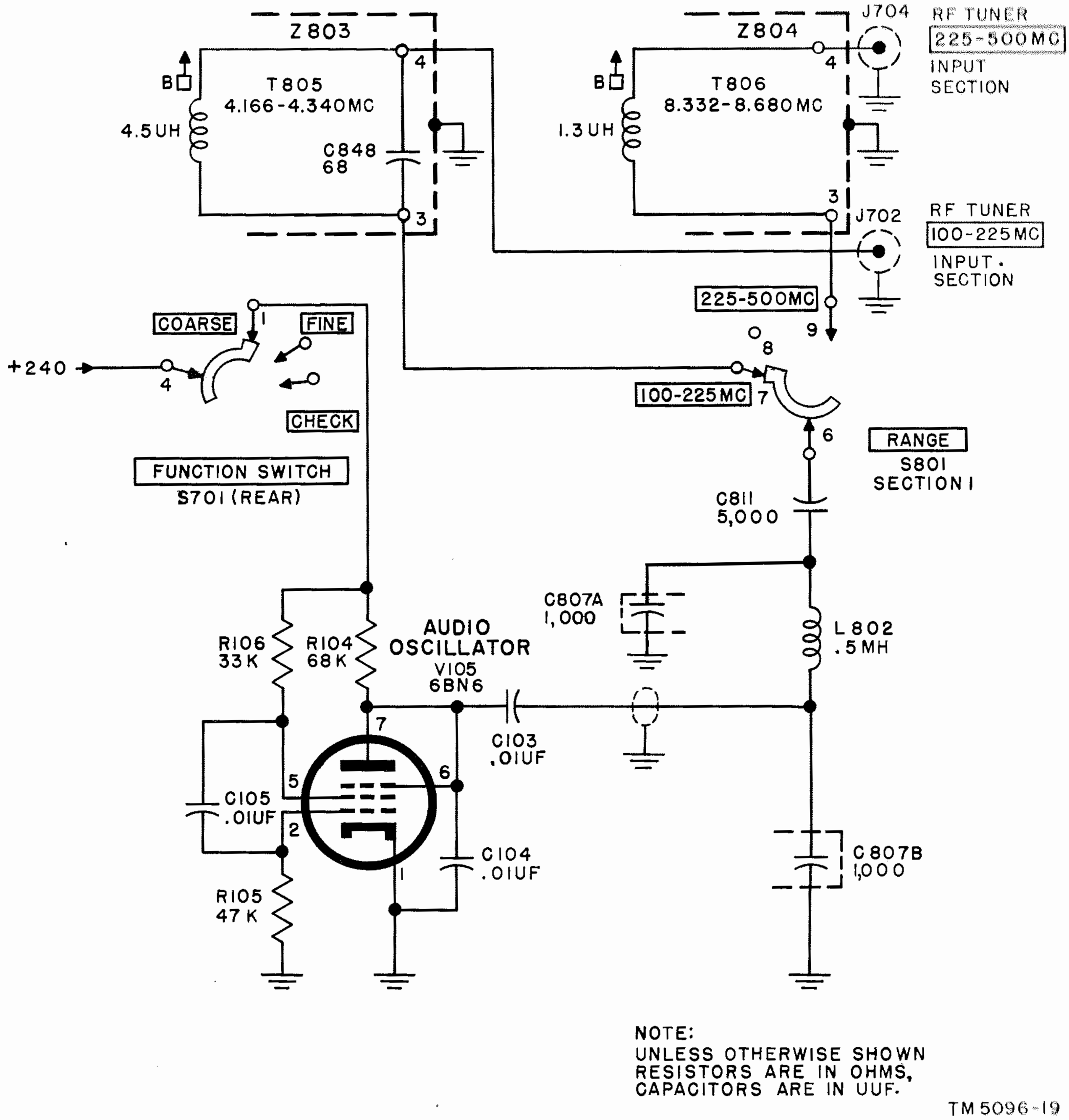


Figure 27. Audio oscillator V105, simplified schematic diagram.

circuit that places the peak of the frequency response at about 800 cycles per second. Matching transformer T102 couples the output from V108B to PHONE jack J703 located on the front panel.

52. Audio Oscillator

(fig. 27)

a. Audio oscillator V105 is an electron-coupled, self-driven relaxation-type oscillator that supplies an 800 ±300-cps audio note to modulate the

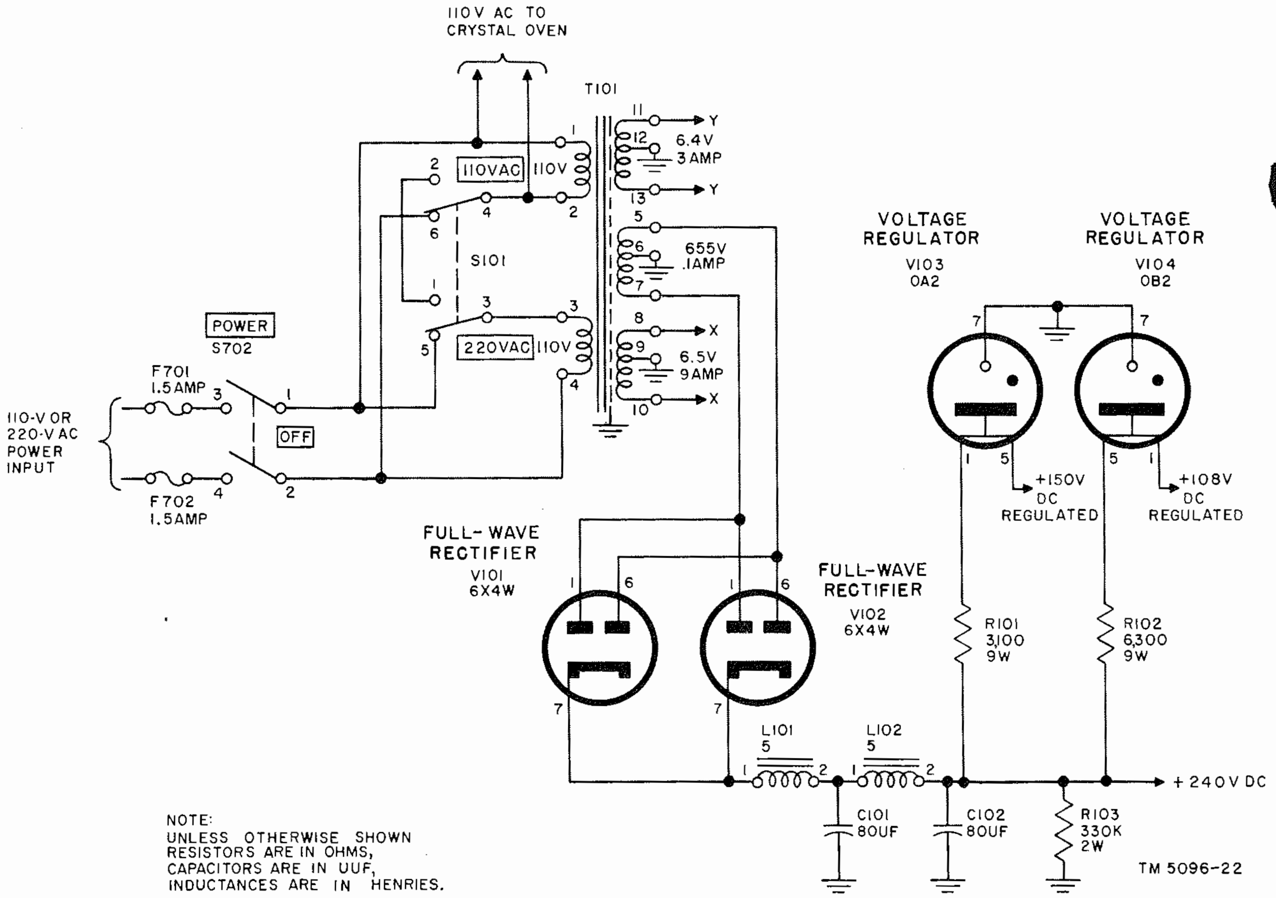


Figure 28. Power supply, simplified schematic diagram.

unknown signal during COARSE tuning. The frequency of oscillation is determined by the time constant of the RC network made up of grid return resistor R105 and capacitor C105. If tube V105 is conducting heavily because of the positive control grid bias and high positive voltage on the accelerator grid, the resulting plate voltage drop is effectively coupled to accelerator grid-dropping resistor R106. Capacitor C105 can no longer hold its high charge and begins to discharge through resistor R105 at a rate determined by the values of each.

b. A negative-going signal occurs at the control grid, reducing the conduction within the tube to cutoff. At cutoff, plate voltage rises and increases on the positive plate of capacitor C105, which begins charging again through resistor R105. A positive-going signal occurs at the control grid and the tube begins conducting heavily again, repeating this cycle at an audio rate. The audio-output signal is taken from plate load resistor R104 and coupled through capacitor C103. Capacitor C104 is a bypass to ground. The signal is applied through C103, the pi-type low-pass filter, consisting of C807B, L802, and C807A, and through C811 to S801. Depending on the position of RANGE switch S801, the audio note is fed to the rf tuner through the secondary of coupling transformer T804 (paralleled by C848) or through T806.

53. Power Supply

(fig. 28)

POWER switch S702 applies line voltage to the primaries of power transformer T101. Switch S101 connects the primaries in parallel when operating the equipment from a 110-volt ac source, and in series for operation from a 220-volt ac source. Heater current for crystal oven E601 is taken across terminals 1 and 4 of the transformer T101 primary. Both sides of the input power line are fused by 1.5-ampere fuses F701 and F702.

a. Filament Supplies. The 6.4-volt ac filament supply for tubes V101, V102, V105, V106, V107, V108 is taken from terminals 11 and 13 of the transformer T101 secondary. All other tube filaments and illumination lamps are supplied by 6.5-volt terminals 8 and 10 of the transformer T101 secondary.

b. Positive 240-volt Dc Supply. Secondary terminals 5 and 7 supply plate power to two 6 x 4 full-wave rectifiers, V101 and V102, connected in parallel for greater current output. The positive pulsating dc taken at the cathodes is smoothed out by a two-section choke input filter composed of choke coils L101 and L102 and filter capacitors C101 and C102. Resistor R103 discharges capacitors C101 and C102 when the equipment is shut down.

c. Regulated Supplies. An OA2 voltage regulator V103 stabilizes the voltage taken from series-dropping resistor R101 at positive 150 volts dc. An OB2 voltage regulator V104 stabilizes the voltage taken from series resitor R102 at positive 108 volts dc.

CHAPTER 6

FIELD MAINTENANCE

Note. This chapter contains information for field maintenance. The amount of repair that can be performed by units having field maintenance responsibility is limited only by the tools and test equipment available and by the skill of the repairman.

Section I. TROUBLESHOOTING AT FIELD MAINTENANCE LEVEL

54. Troubleshooting Procedures

a. General. The first step in servicing a defective frequency meter is to sectionalize the fault. Sectionalization means tracing the fault to the major component or circuit responsible for the abnormal operation of the frequency meter. The second step is to localize the fault. Localization means tracing the fault to the defective part responsible for the abnormal condition. Some faults, such as burned out resistors and shorted transformers, often can be located by sight, smell, and hearing. The majority of faults, however, must be localized by checking voltages and resistances.

b. Component Sectionalization and Localization. Listed below is a group of tests arranged to simplify and reduce work, as well as aid in tracing a trouble to a particular component. The simple tests are used first, followed by those more complex. Follow the procedure in the sequence given. Be careful to avoid further damage to the frequency meter while servicing. In general, the trouble is traced to a section of the frequency meter; the faulty component of that section is located; then the trouble is remedied. The service procedure is summarized as follows:

(1) *Visual inspection.* The purpose of visual inspection is to locate any visible trouble. Through inspection alone the repairman may frequently discover the trouble or determine the circuit in which the trouble exists. This inspection is valuable in avoiding additional damage to the frequency meter which might occur through improper servicing methods and in forestalling future failures.

(2) *Input resistance measurements* (par. 62). These measurements prevent further damage to the frequency meter from possible short circuits. Since this test gives an indication of the condition of the power supply filter circuits, its function is more than preventive.

(3) *Operational test* (par. 18). The operational test is important because it frequently indicates the general location of the trouble. In many instances the information gained will determine the exact nature of the fault. To use this information fully, all symptoms must be interpreted in relation to one another.

(4) *Troubleshooting chart* (par. 60). The trouble symptoms listed in this chart will aid greatly in localizing trouble.

(5) *Signal substitution.* Signal substitution generally is not used for troubleshooting a frequency meter. However, if the proper signal sources are available, it is possible to use signal substitution to advantage.

(6) *Chassis substitution* (par. 58). It is possible to replace any of the easily detached subassemblies with a similar one known to be in operating condition.

(7) *Intermittent troubles.* In all these tests, the possibility of intermittent troubles should not be overlooked. If present, this type of trouble may be located by jarring the equipment or by tapping tubes and other parts. It is possible that an external connection may be causing the trouble. Test wiring and soldered connections with an insulated rod while the frequency meter is tuned on. This may locate a faulty connection or component.

55. Troubleshooting Data

The material supplied in this manual will help to locate faults rapidly. Consult the following troubleshooting data:

Fig. No.	Description
29	Tube socket voltage and resistance diagram, CHECK position.
30	Tube socket voltage and resistance diagram, COARSE position.
31	Tube socket voltage and resistance diagram, FINE position.
32	Location of parts, top view.
33	Rear view with subchassis removed, location of parts.
34	Right side view, location of parts.
35	Film mechanism, exploded view.
36	Crystal-oscillator, balanced-modulator subchassis, location of parts, bottom view.
37	Rf tuner and drive assembly, exploded view.
38	Power supply subassembly, left side view, location of parts.
39	Power supply subchassis, location of parts, bottom view.
40	Band-pass amplifier subchassis, location of parts, bottom view.
41	Variable frequency oscillator subchassis, location of parts, bottom view.
42	Preamplifier subchassis, location of parts, bottom view.
43	Check system subchassis, location of parts, bottom view.
44	MIL STD resistance color codes.
45	MIL STD capacitance color codes.
46	Main frame, wiring and interconnection diagram.
47	Power supply, audio oscillator, and audio amplifier subchassis, wiring diagram.
48	Crystal-oscillator, balanced-modulator subchassis, wiring diagram.
49	Band-pass amplifier subchassis, wiring diagram.
50	Variable frequency oscillator subchassis, wiring diagram.
51	Check system chassis, wiring diagram.
52	Preamplifier subchassis, wiring diagram.
53	Main schematic diagram.

56. Test Equipment Required for Troubleshooting

Test equipment required for troubleshooting Frequency Meter FR-6/U is listed in the following chart:

Item	TM No.	Common name
Electronic Multimeter TS-505/U.	TM 11-5511	Vtvm.
Multimeter TS-352/U	TM 11-5527	Multimeter.
Electron Tube Test Set TV-7/U.	TM 11-5083	Tube tester.

57. General Precautions

Observe the following precautions carefully whenever servicing the frequency meter:

a. Be careful of dangerous voltages when the frequency meter is removed from the dust cover.

b. If the frequency meter has been operating for some time, use a cloth when removing the metal tube shields and a tube puller to remove the tubes to prevent burning the hands or fingers.

c. Be careful not to bend any capacitor plates during servicing. When service is completed, engage all tuning capacitors and examine for contact between the plates.

d. Avoid excessive strain on all screws when tightening.

e. When changing a component that is held by screws, always replace the lockwashers.

f. Disengage electrical plugs and rf cables before removing a subassembly.

g. Careless replacement of parts often leads to new faults. Note the following points:

(1) Before a part is unsoldered, observe the position of the leads. If the part has a number of connections, tag each lead.

(2) Be careful not to damage other leads by pushing or pulling them out of the way.

(3) Do not use a high-wattage soldering iron when soldering small resistors or capacitors. Overheating the small parts may ruin them or change their electrical values.

(4) When resoldering, check leads against wiring diagrams.

(5) Use rosin core solder throughout.

(6) Do not allow drops of solder to drop into the chassis because they may cause shorts.

(7) Avoid using too much solder, especially at tube sockets because flowing rosin may cause a poor connection between tube pin and socket.

(8) Avoid high resistance connection; be sure the soldering iron is hot.

(9) When a part is replaced in a high-frequency circuit, it must be placed in the same position occupied by the original part. A part which has the same electrical value but different physical size may cause trouble in high-frequency circuits. Be careful of proper grounding; use the same grounding post as used in the original wiring.

(10) Twist all filament leads. Lay all wires flat against the chassis to avoid effects of stray coupling.

(11) Avoid sharp bends in coaxial cables that may cause inner conductors to penetrate the dielectric and make contact with the outer conductor.

(12) Observe polarities when replacing electrolytic capacitors.

(13) Do not force tubes into sockets. If difficulty is encountered, check the alinement of pins.

(14) Do not disturb any of the alinement adjustments unless it has been determined that the trouble is caused by a particular adjustment.

58. Subassembly Substitution

If the 'situation is such that extra frequency meters are available, it is possible to substitute a subassembly from a unit known to be operating with one from a defective unit until the defective chassis is found. To remove the subassemblies, follow the instructions in paragraphs 66 through 72.

59. Checking Filament and Plate Supply (B+) Circuits for Shorts

a. The plate supply voltages from the power supply subassembly are distributed to the various subchassis of the equipment. If the B+ voltage readings are low, the trouble may be within the power supply circuit, or the line voltage may be low. Check the line voltage under load. If it is within the proper limits, the trouble is caused by either a faulty rectifier tube, a faulty voltage regulator tube, a shorted filter capacitor, or a shorted filter choke. When checking the filter capacitors, the test meter needle may show a direct short returning to infinity as the electrolyte in the filter capacitor ionizes. This is a normal condition. If the defect causing an abnormal 5B+ voltage is in some other circuit, it can probably be localized by removing the power plug from each subassembly in turn. The B+ voltage should return to its proper value when the plug on the defective subassembly is disconnected. Refer to the main schamatic diagram (fig. 53) and the voltage and resistance measurements (figs. 29, 30, and 31).

b. A trouble in any circuit will be noticed when following the operating procedures in paragraphs 18 through 21. These troubles will be indicated in the equipment performance check list (par. 42). Normally, using this procedure will narrow down the location to a section of the frequency meter or to one particular stage. Sometimes, if a decoupling capacitor in a B+ circuit is shorted, it may drop the voltage so that other stages will be affected.

60. Troubleshooting Chart

The following chart is supplied as an aid in locating troubles in the frequency meter. It lists the symptoms that the repairman observes, either visually or audibly, while making a few simple tests. The chart also indicates how to localize quickly the trouble to a subchassis. After the trouble has been localized to a stage or circuit, a tube check and voltage and resistance measurements of this stage or circuit ordinarily should be sufficient to isolate the defective parts. Normal voltage and resistance readings are shown in figures 29, 30, and 31.

Symptom	Probable trouble	Correction
1. No film dial light when POWER switch is turned on.	1. Defective lamp I 703 or I 704	1. Replace lamp.
2. No RANGE dial light when POWER switch is turned on.	2. Defective lamp I 701 or I 702	2. Replace defective lamp.
3. Frequency meter inoperative.	3. Fuse F701 or F702 blown. Line failure. POWER switch S702 failure. 110 VAC 220 switch S101 failure. Defective rectifier tubes V101 and V102.	3. See item 4 below. Check line voltage. Check voltage across all poles. Check voltage across transformer T101 primary. Replace tubes.

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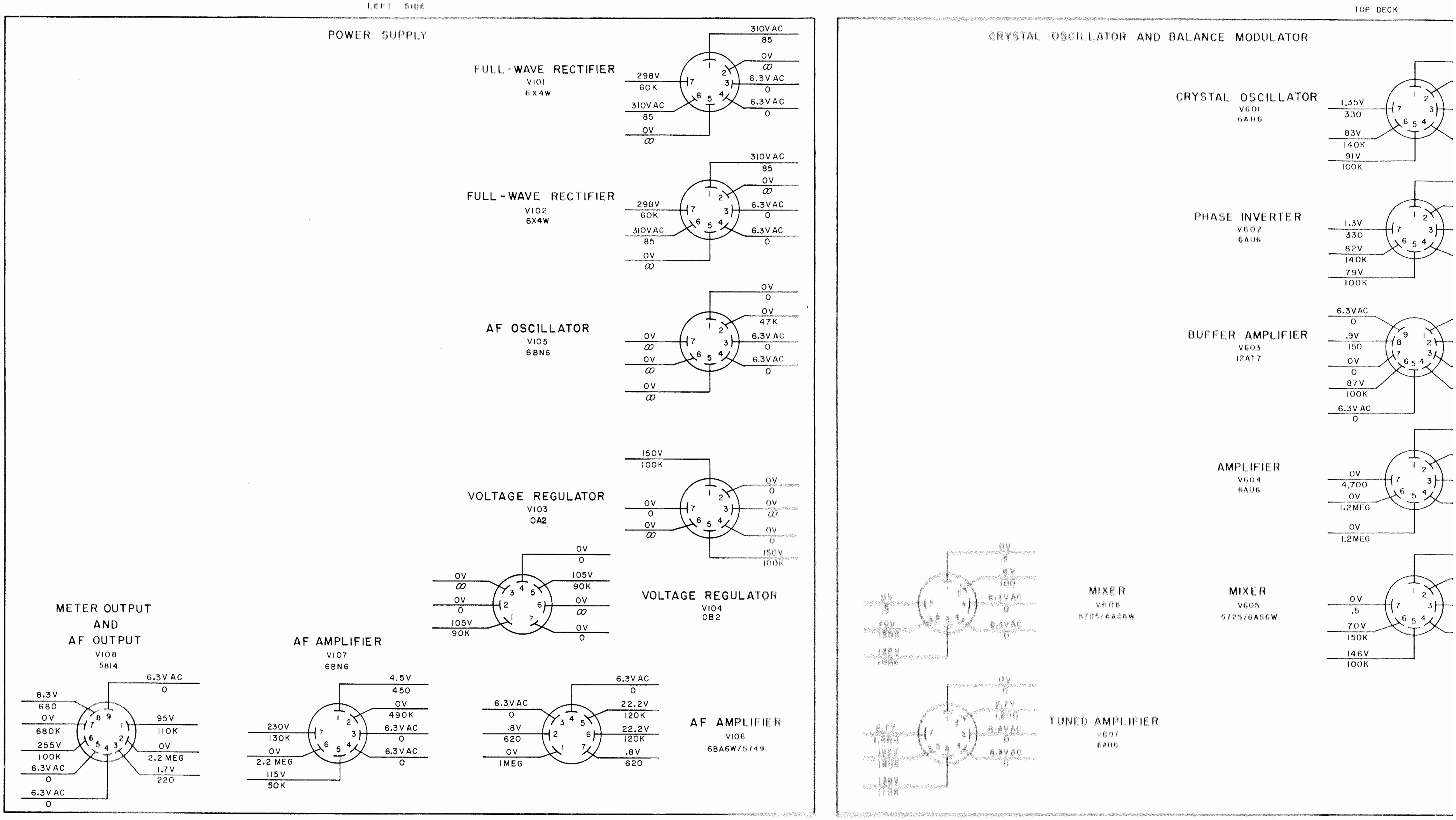
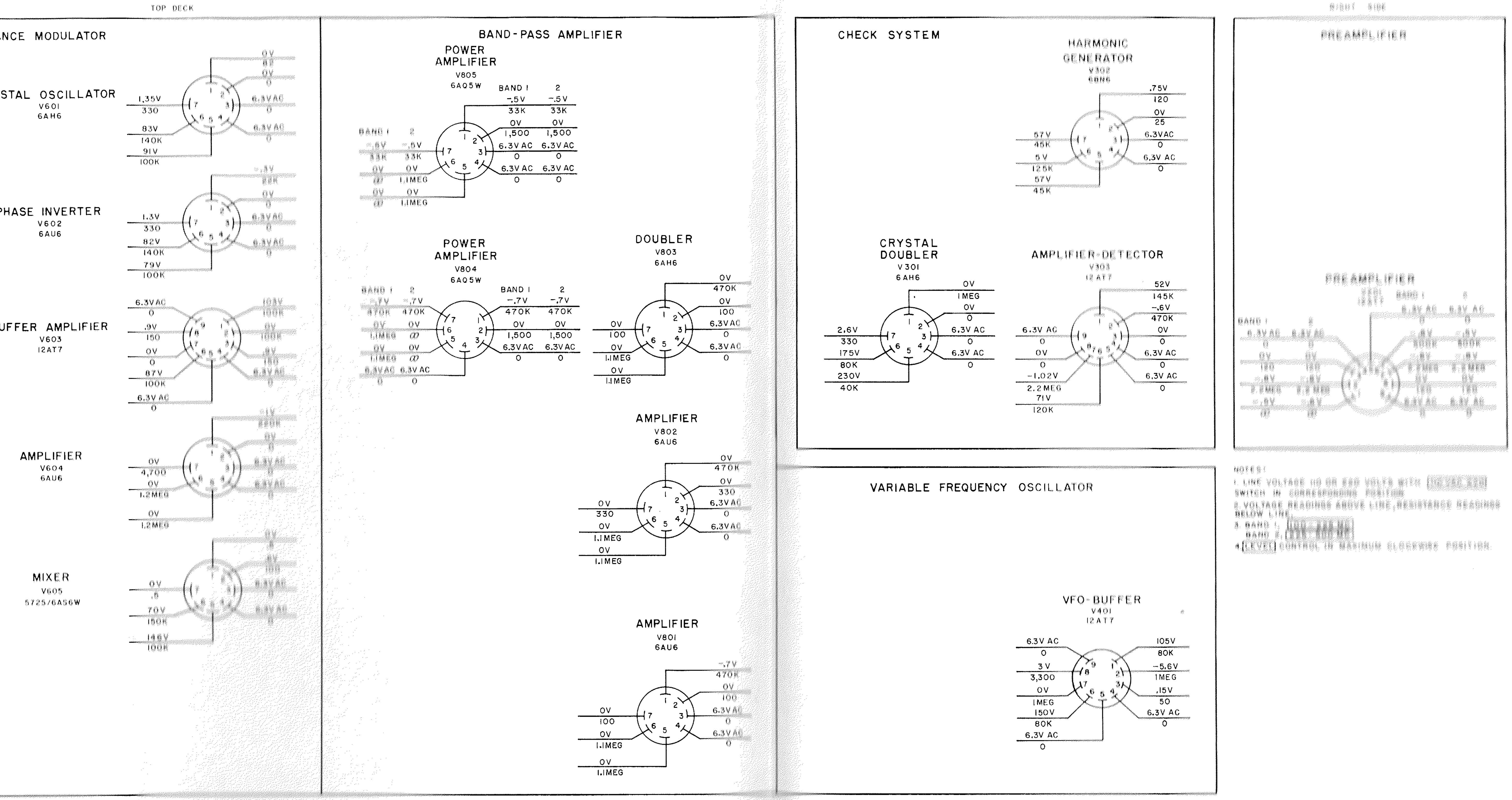


Figure 29. Tube socket voltage and resistance diagr



NOTES:
1. LINE VOLTAGE 110 OR 220 VOLTS WITH [illegible] SWITCH IN CORRESPONDING POSITION.
2. VOLTAGE READINGS ABOVE LINE, RESISTANCE READINGS BELOW LINE.
3. BAND 1, [illegible]
BAND 2, [illegible]
4. LEVEL CONTROL IN MAXIMUM CLOCKWISE POSITION.

Figure 29. Tube socket voltage and resistance diagram, CHECK position.

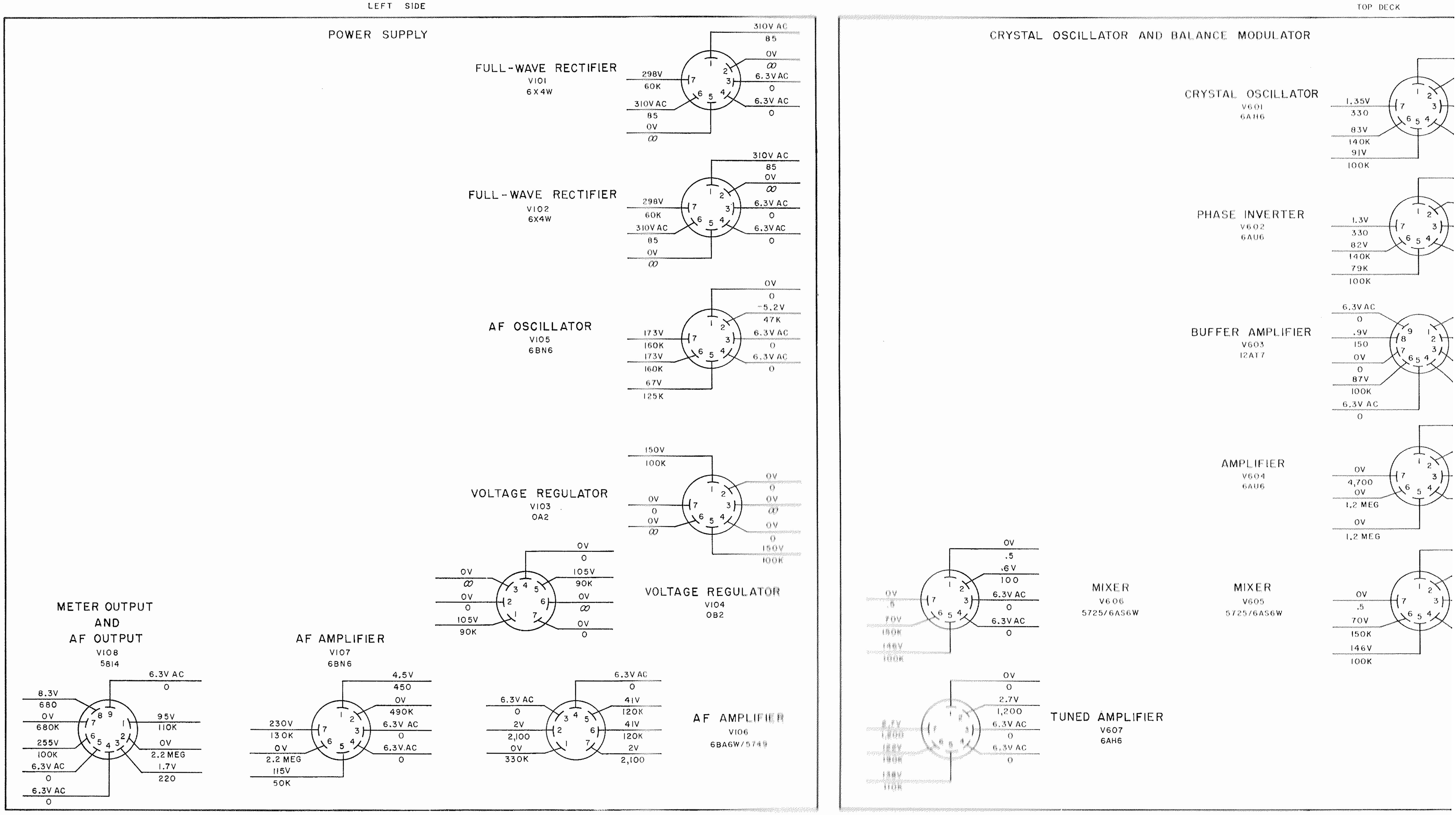
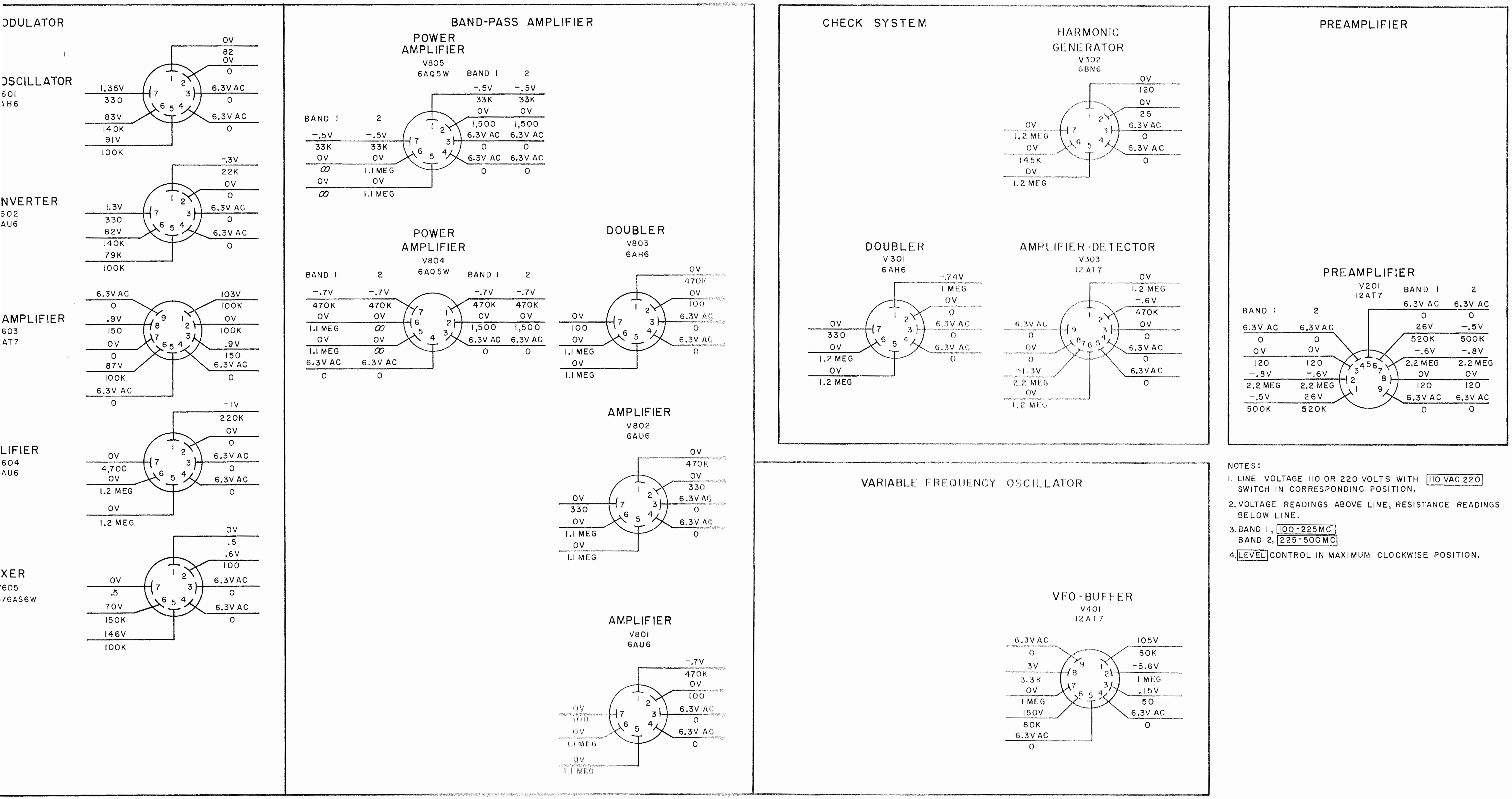


Figure 30. Tube socket voltage and resistance diagr

TOP DECK

RIGHT SIDE



NOTES:

1. LINE VOLTAGE 110 OR 220 VOLTS WITH 110 VAC 220 SWITCH IN CORRESPONDING POSITION.
2. VOLTAGE READINGS ABOVE LINE, RESISTANCE READINGS BELOW LINE.
3. BAND I, 100-225MC. BAND 2, 225-500MC.
4. LEVEL CONTROL IN MAXIMUM CLOCKWISE POSITION.

. *Tube socket voltage and resistance diagram, COARSE position.*

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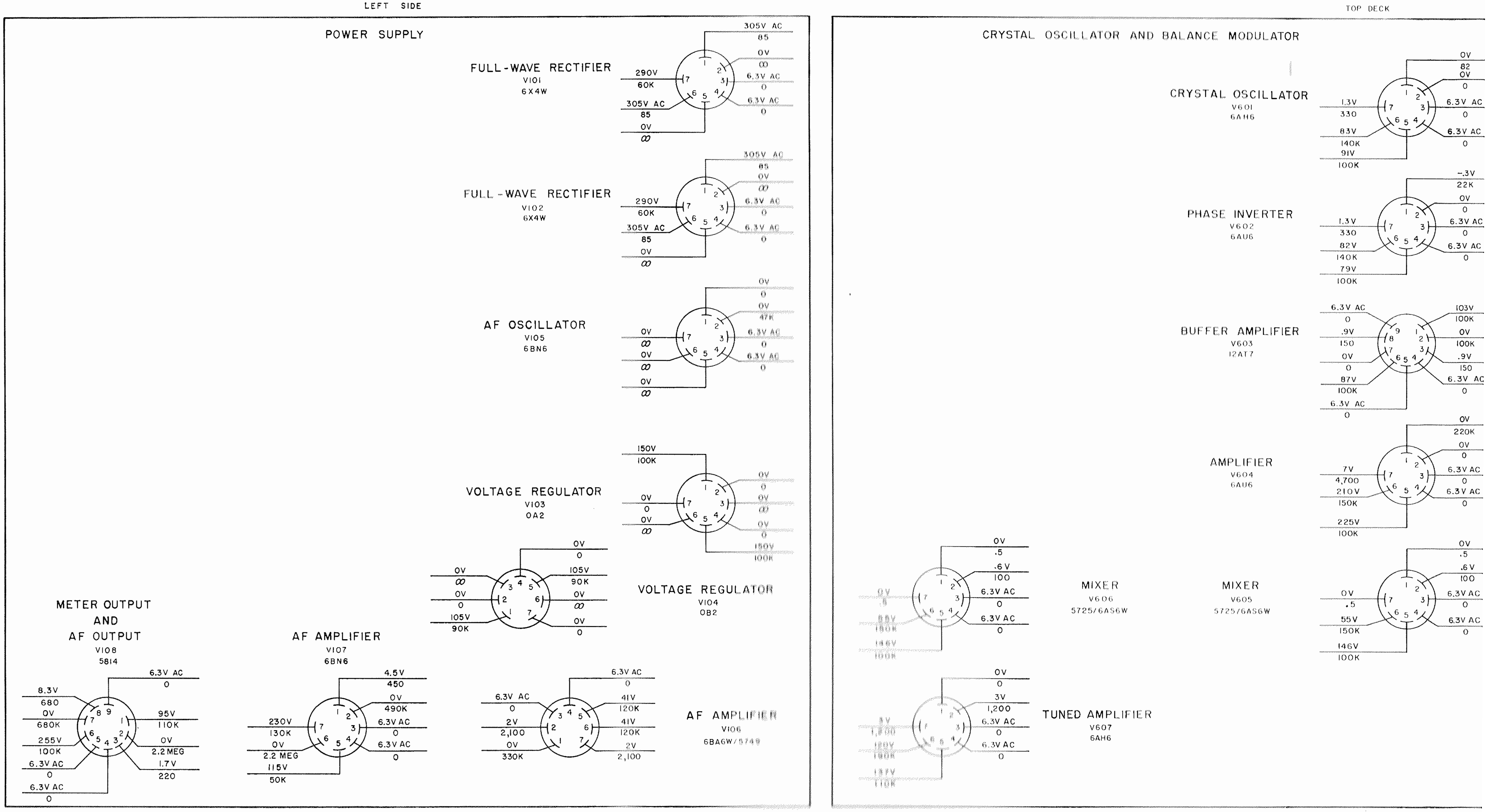
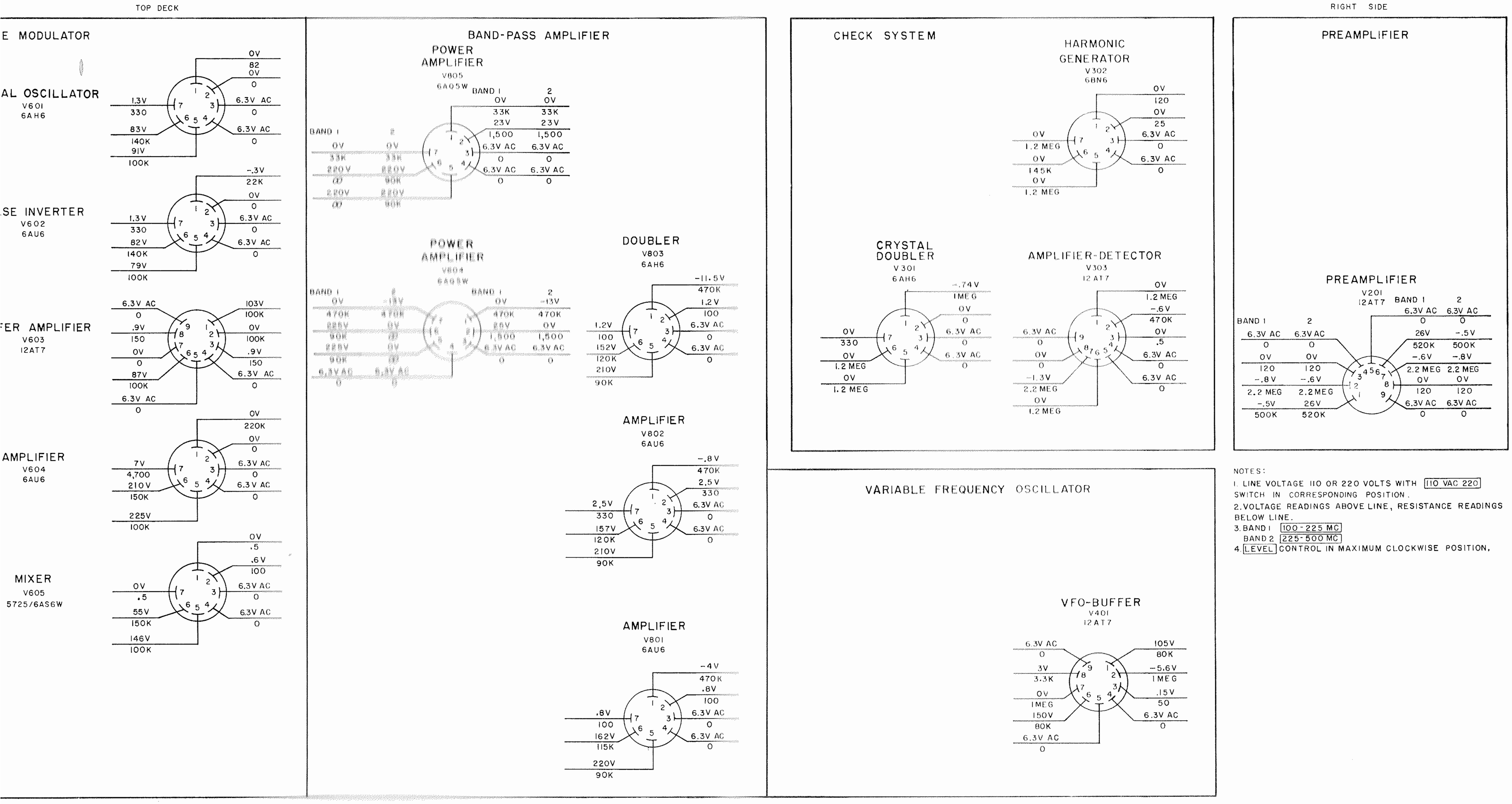


Figure 31. Tube socket voltage and resistance diagram, F1.



NOTES:

1. LINE VOLTAGE 110 OR 220 VOLTS WITH [110 VAC 220] SWITCH IN CORRESPONDING POSITION.
2. VOLTAGE READINGS ABOVE LINE, RESISTANCE READINGS BELOW LINE.
3. BAND 1 [100-225 MC]
   BAND 2 [225-500 MC]
4. [LEVEL] CONTROL IN MAXIMUM CLOCKWISE POSITION.

ure 31. *Tube socket voltage and resistance diagram, FINE position*

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Symptom	Probable trouble	Correction
4. Blown fuses F701, F702.	4. Shorted filter capacitors.	4. Replace capacitors C100 and C102.
	Short in filament circuits.	Check T101 secondary voltage across terminals 8 and 10 and 11 and 13. If reading is abnormal, check winding, then individual filament circuits for fault.
	Short in B+ circuits.	Check T101 secondary voltage at terminals 5 and 7. If abnormal, check B+ circuits and filter capacitors C101 and C102.
5. Low 240-volt dc circuit voltages.	5. Defective tube V101 or V102.	5. Replace defective tube.
	Defective filter capacitor C101 or C102.	Replace defective capacitor.
6. Low 150-volt circuit voltages.	6. Tube V103 defective.	6. Replace tube.
	Low supply voltage.	Refer to item 5.
7. Low 108-volt circuit voltages.	7. Tube V104 defective.	7. Replace tube.
8. No audio tone at output during COARSE tuning, although tone is present when FUNCTION SWITCH S701 is in FINE or CHECK position.	8. Audio oscillator tube V105 defective.	8. Replace tube.
9. No audio tone at output when switch S701 is in FINE position although tone is present during COARSE tuning.	9. Defective vfo V401.	9. Replace tube.
	Defective crystal oscillator circuit V601, V602, or V603.	Replace defective tube.
10. No audio tone at output during FINE tuning, although present when S701 is in CHECK position.	10. Defective balanced-modulator V604, V605, or V606 or band-pass amplifier circuit V801 through V805.	10. Replace tubes in these circuits with tubes known to be in good condition.
		Refer to items 15, 16, and 17 below.
11. No audio tone at output when switch S701 is in CHECK position, although present when in COARSE or FINE position.	11. CHECK system circuit V301 through V303 defective.	11. Replace tubes in check system circuit with tubes known to be in good condition.
		Refer to item 18 below.
12. During COARSE tuning, audio note is heard at output on one range band only.	12. Defective rf tuner.	12. Replace either crystals CR501 and CR504 or crystals CR502 and CR503, depending on which are defective.
13. No audio tone at output in any operation position of FUNCTION SWITCH and RANGE switches.	13. Preamplifier V201 or audioamplifier circuits defective.	13. Replace tubes in these circuits with tubes known to be in good condition.
		Refer to item 17 below.
14. Crystal oscillator frequency erratic or output low.	14. Aging of crystal Y601 or oven heater E601 burned out.	14. Replace crystal or oven unit.
15. Balanced-modulator output is low.	15. Input or output signals out of alinement.	15. Check and aline as outlined in paragraph 75.
16. Band-pass amplifier output is low.	16. Defective tube in circuit.	16. Replace tube.
	Band-pass amplifier out of alinement.	Check and aline as outlined in paragraph 77.
17. Audio-amplifier circuit output is low.	17. Defective tubes (V106, V107, and V108) in circuit.	17. Replace tubes.
	Defective crystal CR101.	Replace crystal.
	Tube V107 overbiased.	Readjust GATE ADJ potentiometer R116 (par. 78*c*).
18. Noise or hum present at output.	18. Tube V107 underbiased.	18. Readjust potentiometer R116 (par. 78*c*).

61. Reference Symbol Numbers

The following chart lists the reference symbol number series for the various subassemblies:

Ref. symbol No. series	Subassembly
100	Power supply.
200	Preamplifier.
300	Check system.
400	Variable frequency oscillator.
500	Rf tuner.
600	Crystal oscillator-balanced modulator.
700	Main frame.
800	Band-pass amplifier.

62. DC Resistances of Transformers and Coils

The dc resistances of the transformers and coils in Frequency Meter FR–6/U are listed in the following chart:

Ref. symbol	Dc resistance (ohms)
L101 and L102	100.
L602, L603, L801, and L802	20.
L402	50.
L601	.8.
L401	28.4.
T101	
Primary (two windings)	2.1 (parallel), 4.2 (series).
Secondary	
High voltage	85 (each side of center tap).
Filament (6.4)	0.
Filament (6.5)	0.
T301	.31, .31.
T302C	.31.
T302A and T302B	.31, .31.
T601	1.1, .8, .8.
T602	1.0.
T602	.5, .5.
T603 and T604	.25, .15.
T801 and T802	.5, .5.
T803 and T804	.35, .35.
T805	.3, .3.
T806	1., .1.
L803	3.2.
L301	23.

Section II. REPAIRS

63. Replacement of Parts

a. Most of the components of Frequency Meter FR–6/U can be reached and replaced easily if found to be faulty.

b. If any of the switch wafers require replacement, carefully mark the wires connected to the wafer with tags to avoid misconnections when the new wafer is installed. Follow this practice wherever replacement requires the disconnection of numerous wires.

c. To remove any subchassis cover, first remove the subchassis; then remove the screws with the black ring. Be careful when replacing all cables and connectors to avoid excessive binding.

64. Removal and Replacement of Film Mechanism

Caution: Be careful when removing and replacing the film mechanism to prevent damage to the film strip by a projection from the main frame.

a. To remove the film mechanism proceed as follows:

(1) Remove the FINE tuning knob (E902) with the #6 Allen wrench supplied (par. 7*a*).

(2) Remove the drive belt (O901) (fig. 35) from the vfo large gear wheel (fig. 32).

(3) Withdraw the CALIBRATION TABLES tray by pressing the tray switch (fig. 1).

(4) Remove the four retaining screws located on the bottom of the main frame that hold the film mechanism (fig. 33).

(5) Pull out the film mechanism through the rear of the main frame.

b. To replace the film mechanism within the main frame, proceed as follows:

(1) Turn the film strip by hand to its low end so that 01–4166000 appears in the slot.

(2) Turn the COARSE control fully counterclockwise (lowest numbers on band dial).

(3) Replace the film mechanism in the main frame and tighten the four retaining screws.

(4) Replace and tighten the FINE tuning knob.

Caution: Do not touch variable tuning capacitor C410 (figs. 32 and 34). It is factory adjusted and is extremely critical. Any movement of this capacitor will void the entire calibration of the equipment.

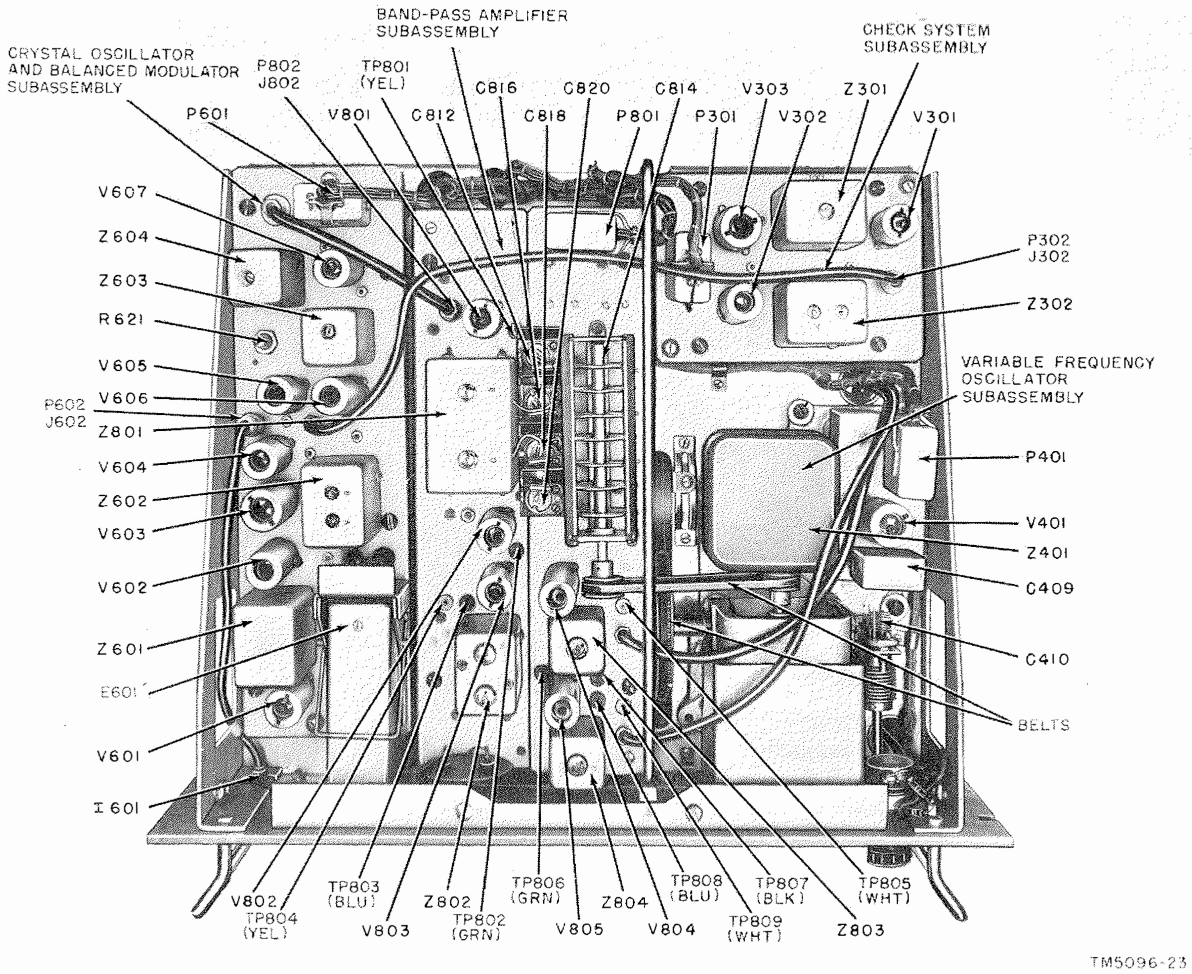


Figure 32. Location of parts, top view.

(5) Put variable tuning capacitor C402 at half mesh by using the CHECK control.

(6) Put tuning capacitor C403 (fig. 32) to full mesh by using the large gear wheel on the side of the vfo subchassis.

(7) Put variable tuning C814 to full mesh by turning the gear wheel on the shaft of capacitor C814 on the band-pass amplifier.

(8) Hook up the rubber drive belt; be careful to maintain the capacitor settings of the previous steps.

(9) Turn the FUNCTION SWITCH to the CHECK position and apply power.

(10) Turn the FINE control to the low end until a zero beat is obtained on the TUNING METER (needle at ZERO). This should occur at the first check point on the filmstrip dial. If it occurs only slightly off this point, proceed as instructed in (11) below. If it occurs more than two readings away from the check point, proceed as instructed in (12) below.

(11) Center the check point in the window and adjust the CHECK control so that the zero beat is heard again. Proceed as instructed in (13) below.

(12) Remove the rubber drive belt from the film mechanism and turn the film shaft so that the check point is centered in the window; then replace the drive belt. If the zero beat does not now occur exactly at the check point, proceed as instructed in (10) above.

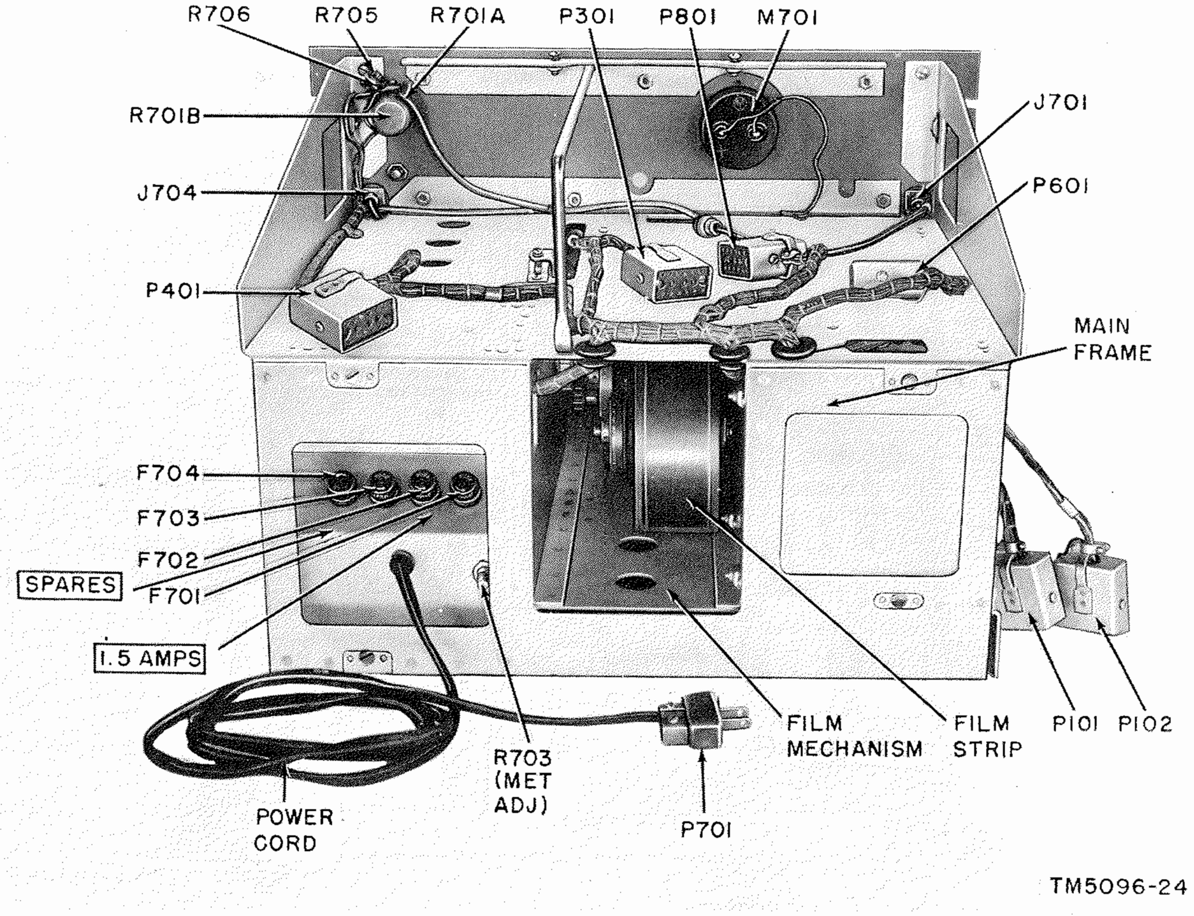


Figure 33. Rear view with subchassis removed, location of parts.

(13) Turn the FINE tuning control clockwise and calibrate the filmstrip at each of the four succeeding check points as in (11) above. The film mechanism is now replaced and realined.

c. Two spare filmstrip indicators are provided with the frequency meter in case the regular indicator becomes damaged. One is a spare which is used for replacement but the other, a master reel, is not to be used in the meter. When damage has occurred to the normal one and the spare is being used, the master reel should be copied in order to have another spare reel. To remove the reels, proceed as follows:

(1) Remove the dust cover (par. 11*a*(1) through (4)).

(2) Remove the 10/32 screw that holds a metal bar against the two containers located above the fuses.

(3) The markings MASTER FILM and SPARE FILM on the containers indicate the proper reel to be used.

65. Disassembly and Reassembly of Film Mechanism

a. Remove the film mechanism (par. 64). Disassembly is performed as follows (fig. 35):

(1) Loosen the associated setscrews and remove the knob (1); then remove the frequency meter subassembly (2).

(2) Loosen the setscrews and remove the pulley (3).

(3) Remove the attaching screws and remove the film drive (4) from the frequency meter subassembly (2).

(4) Remove the attaching shoulder screw (5) and remove the lever assembly (6), pin (7), and spring (8).

(5) Loosen the setscrews and remove the cam (9) from the spur gear (11).

(6) Remove the shoulder screw (10) and spur gear (11). Remove the attaching shoulder screws (12) and lever stop (13) from the drive assembly.

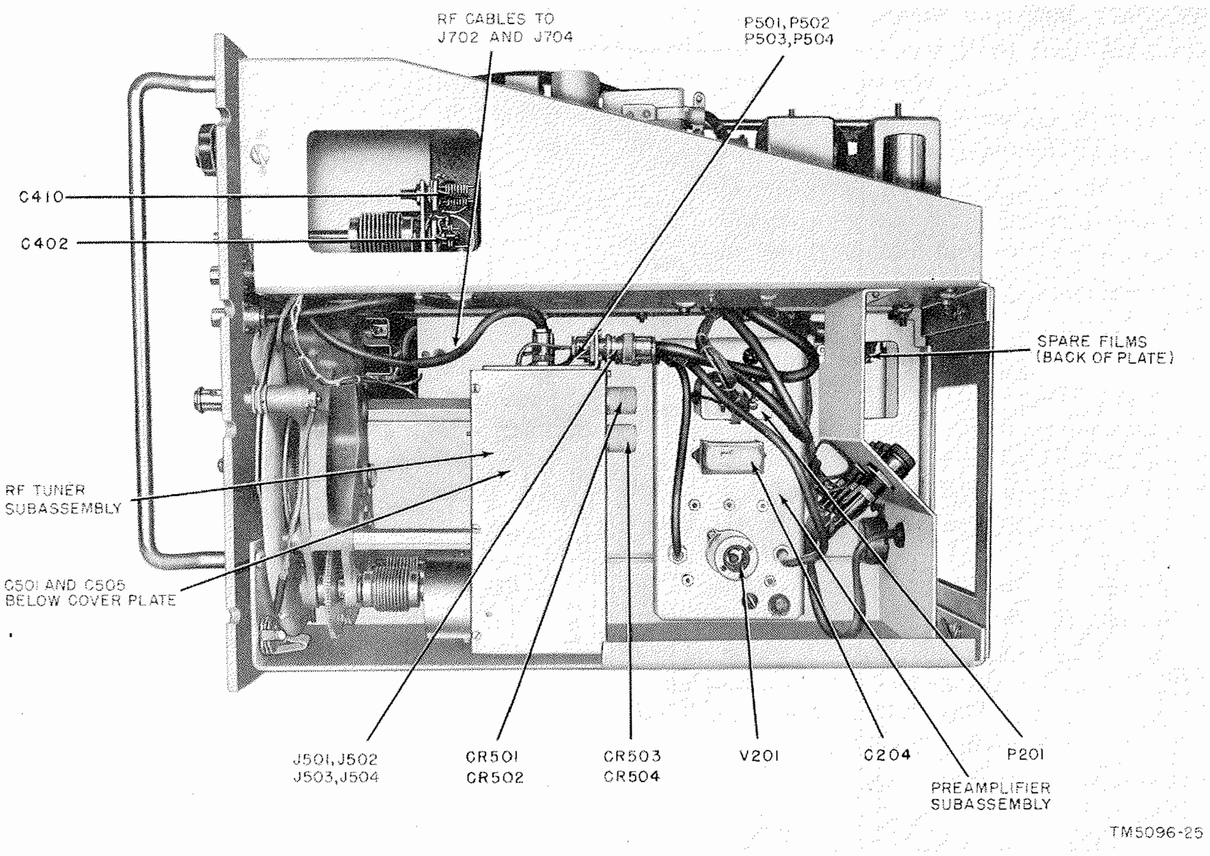


Figure 34. Right side view, location of parts.

(7) Remove the spring (14) and grooved pin (15).

(8) Remove the retainer ring (16) and shaft assembly (17).

(9) Disassemble the worm gear (18), ball bearing (19), and gear (20). Extract the ball bearing (21).

(10) Remove the retaining screw (22) from the film frame (23).

(11) Loosen the setscrews on the wheel sprocket (25) and remove the gear and shaft assembly (24).

(12) Remove the spacers (26 and 28) and bearings (27).

(13) Remove the shaft (29) and spring (30) from the lever assembly roller (31).

(14) Remove the attaching screws, front window assembly (33), and frame assembly (35). Remove the window (34).

(15) Remove the spring washers and remove the shaft (36) and film roller (37).

(16) Remove the belt (38).

(17) Loosen the two setscrews and remove the pulley and flange assembly (39).

(18) Remove the spring washer, slotted shaft (40), and film reel (41).

(19) Loosen the setscrews and remove the cover (42), and spiral torsion spring (43) from the pulley and flange assembly.

(20) Remove the spring washer and slotted shaft (45).

(21) Remove the film reel (46).

(22) Remove the frames (47) by knocking them out with a suitable punch.

(23) Remove the attaching screws and remove the film viewer bezel (48) from the front panel.

(24) Remove the hood assembly (49) and sight lens (50).

(25) Remove the terminal (51), lamp holder (52), and incandescent lamp (53).

b. To reassemble the film system assembly, reverse the disassembly procedure.

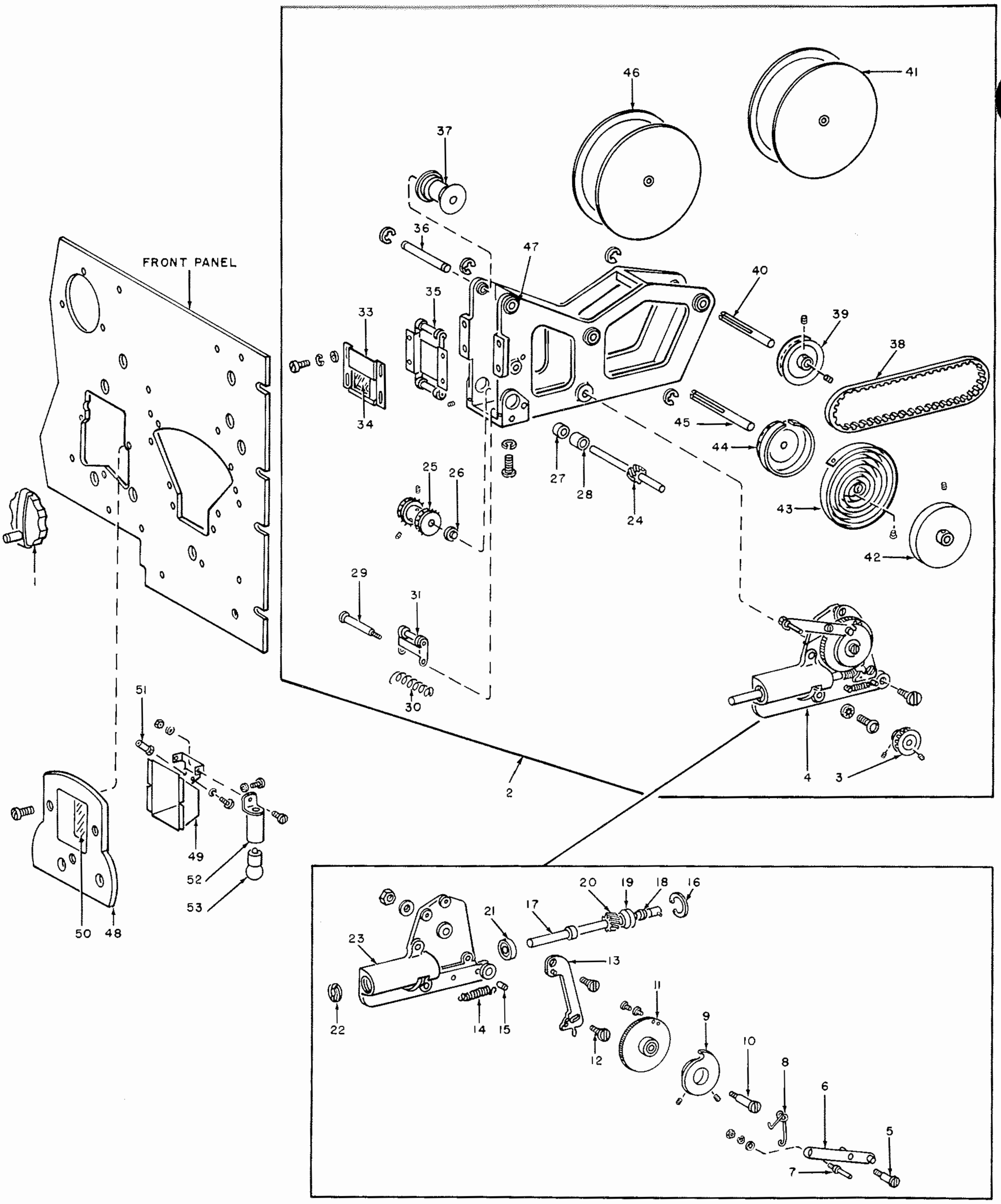


Figure 35. Film mechanism, exploded view.

66. Removal and Replacement of Crystal-Oscillator and Balanced-Modulator Subassembly

This chassis is located at the left side on the top deck (fig. 32). To remove the chassis, proceed as follows:

a. To remove the crystal-oscillator chassis, proceed as follows:

(1) Remove P602 from J602.
(2) Remove P302 from J302.
(3) Remove P601 from J601.
(4) Remove P802 from J802.
(5) Loosen the four black-headed retaining screws, two on each long side of the crystal-oscillator and balanced-modulator subassembly, until the subassembly can be lifted out of the main frame.
(6) The crystal-oscillator and balanced-modulator subassembly can now be removed.

b. To replace the crystal-oscillator and balanced-modulator subassembly, reverse the procedure in *a* above.

67. Removal and Replacement of RF Tuner and Drive Subassembly

The rf tuner and drive subassembly (fig. 34) is mounted on the right side of the main chassis between the top and lower decks.

a. To remove the rf tuner and drive assembly, proceed as follows:

(1) Remove the preamplifier (par. 71*a*).
(2) Remove P503 and P504 from J503 and J504, respectively.
(3) Remove the eight screws (fig. 5) that hold the two RF INPUT jacks J702 and J704 to the front panel.
(4) The rf tuner and drive assembly can now be removed from behind the front panel.

b. To replace the rf tuner and drive assembly, proceed as follows:

(1) Position the rf tuner carefully behind the front panel in its proper location.
(2) Install the ground posts and secure the tuner with the two nickel-plated screws.
(3) Reconnect P503 to J503 and P504 to J504.
(4) Reinstall the preamplifier as described in paragraph 71*b*.

c. When the rf tuner is removed as described in *a* above, the drive assembly can be disassembled. Refer to figure 37 and proceed as follows:

(1) Remove the escutcheon dial (1) by removing its attaching screws.
(2) Remove the bezel glass (2).
(3) Loosen the set screws and remove the knob (3).
(4) Remove the dial control (4) from the front panel by removing its attached screws.
(5) Remove the lamp indicator assembly (5) from the dial control (4).

Figure 35—Continued

1	Knob (E902)
2	Frequency meter subassembly (O924)
3	Pulley (O917)
4	Film drive (O925)
5	Shoulder screw
6	Assembly lever (O905)
7	Pin
8	Spring
9	Cam (O926)
10	Shoulder screw
11	Spur gear (O903)
12	Shoulder screw
13	Lever stop
14	Spring
15	Grooved pin
16	Retainer ring
17	Shaft (O911)
18	Worm gear
19	Ball bearing
20	Gear
21	Ball bearing
22	Screw
23	Film frame
24	Gear and shaft assembly
25	Sprocket wheel (O915)
26	Spacer
27	Bearing
28	Spacer
29	Shaft (O909)
30	Spring (O919)
31	Lever assembly, roller (O906)
32	Not used
33	Front window assembly (H903)
34	Window
35	Frame assembly
36	Shaft (O910)
37	Roller, film (O908)
38	Belt (O901)
39	Pulley and flange assembly (O904)
40	Shaft (O912)
41	Reel, film (O907)
42	Cover
43	Spring, spiral torsion (O927)
44	Pulley and flange assembly (O928)
45	Shaft
46	Reel, film (O918)
47	Frame (H902)
48	Bezel (O929)
49	Hood assembly
50	Lens
51	Terminal
52	Lamp holder (XI703)
53	Lamp, incandescent (I704)

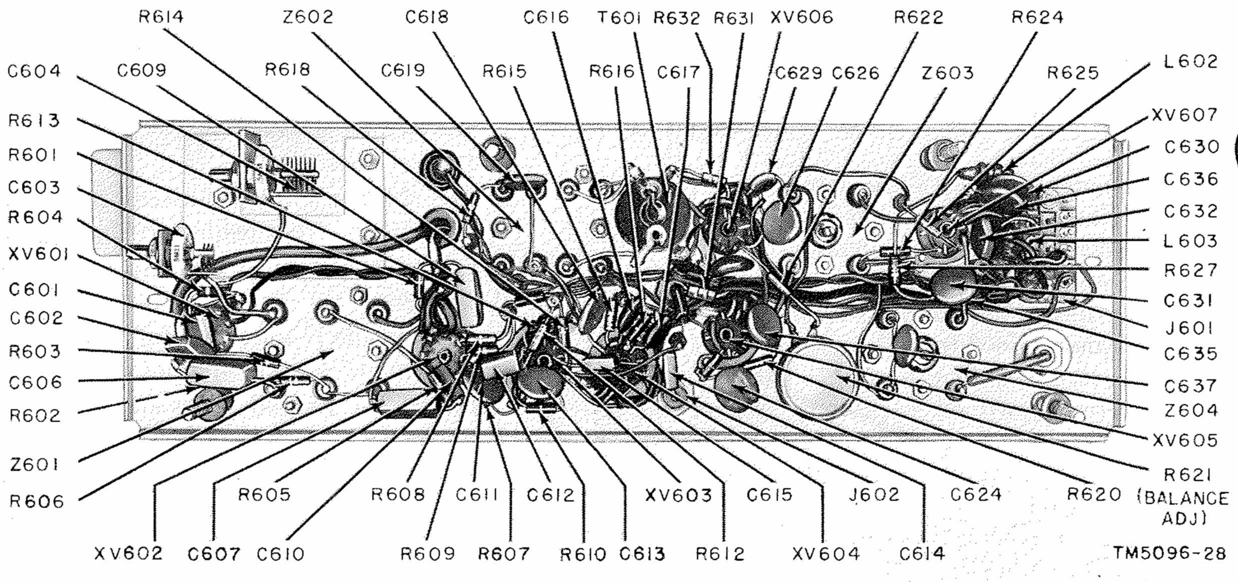


Figure 36. Crystal oscillator balanced-modulator subchassis, location of parts, bottom view.

68. Removal and Replacement of Power Supply Subassembly

The power supply subassembly (fig. 38) mounts an audio-frequency oscillator, an audio-frequency amplifier, and meter output circuits in addition to the power supply. This subassembly is mounted on the left side of the equipment, between the upper and lower decks.

a. To remove the power supply from the chassis, proceed as follows:

(1) Remove plug P101 from J101.
(2) Remove plug P102 from J102.
(3) Loosen the eight black-headed retaining screws, four located on each long side.
(4) Lift out the power supply.
(5) To remove the power supply chassis cover, remove the black-ringed screws.

b. To replace the power supply on the chassis, proceed as follows:

(1) Replace the power supply chassis cover.
(2) Set the power supply in position and secure it with the eight retaining screws.
(3) Reconnect plug P101 to J101 and P102 to J102.

69. Removal and Replacement of Band-Pass Amplifier Subassembly

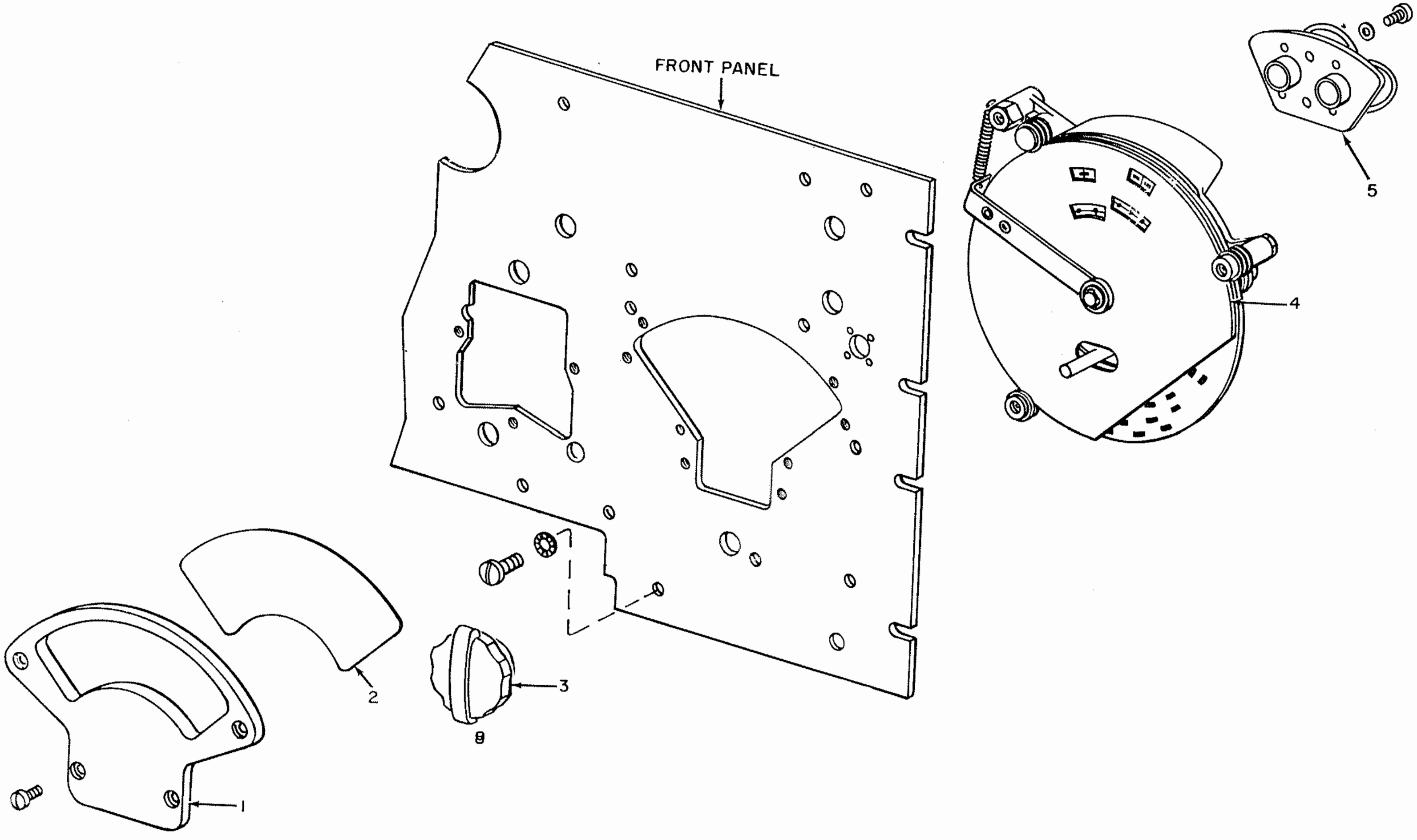
This subassembly is located in the center of the top deck (fig. 32).

a. To remove the band-pass amplifier subassembly, proceed as follows:

(1) Remove the belt from the pulley on capacitor C814.
(2) Remove plug P801 from J801.
(3) Diconnect the three coaxial cables P503, P504 (fig. 34), and P802.
(4) Loosen the four black-headed retaining screws, one located in each corner.
(5) Lift out the band-pass amplifier subassembly; be careful not to damage TUNING METER M701.

b. To replace the band-pass amplifier subassembly, proceed as follows:

(1) Position the band-pass amplifier subassembly in the main frame.
(2) Tighten the four black-headed retaining screws.
(3) Turn the FINE control so that 01-4166000 appears in the film window.
(4) Manually turn the plates of tuning capacitor C814 to exactly full mesh.
(5) Replace the drive belt on the capacitor shaft.
(6) Reconnect plug P801 to J801.
(7) Reconnect the three coaxial cables to their proper sockets, as marked on the cables. The band-pass amplifier subassembly is now secured to the chassis.



1 Escutcheon dial
2 Bezel glass (H706)
3 Knob (E903)

4 Dial control
5 Indicator assembly (A711)

Figure 37. Rf tuner and drive assembly, exploded view.

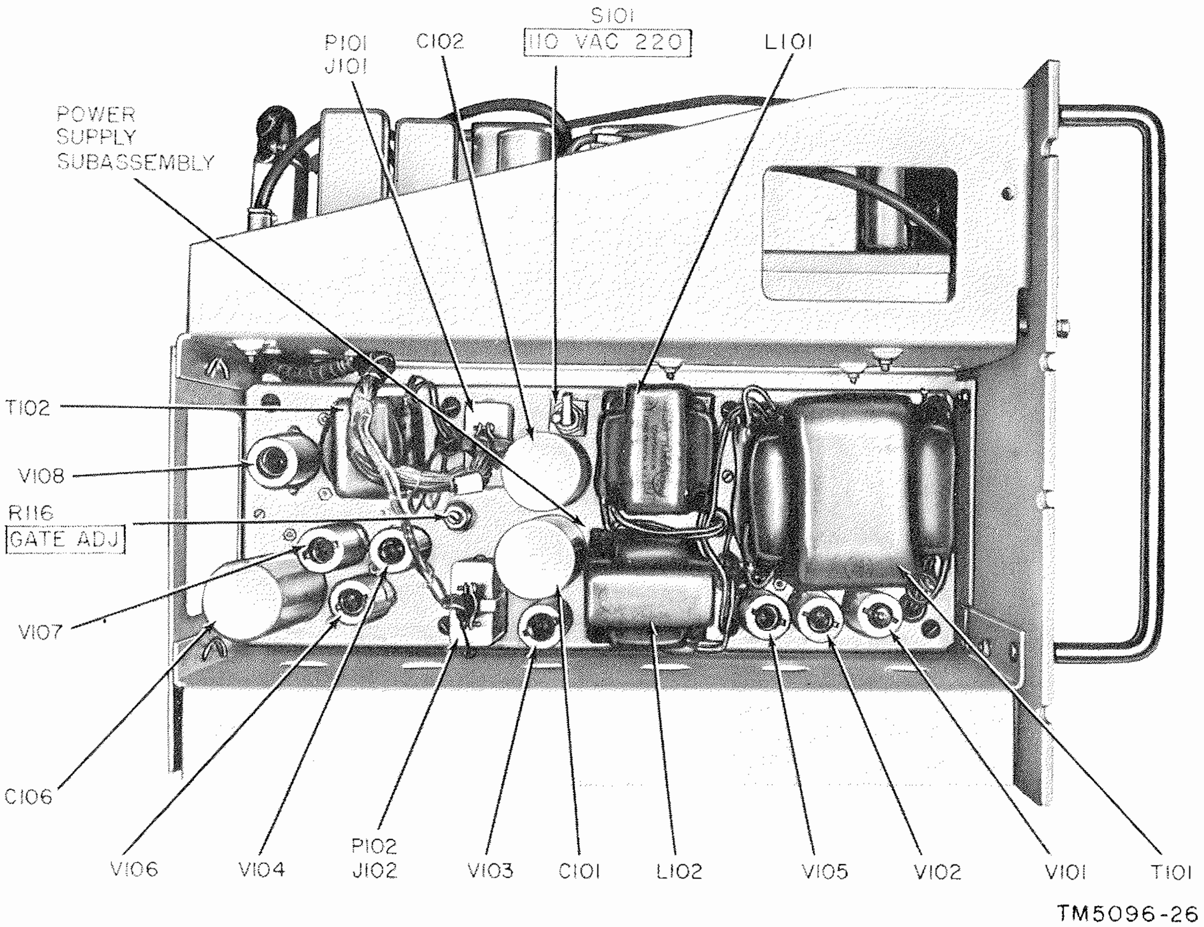


Figure 38. Power supply subassembly, left side view, location of parts.

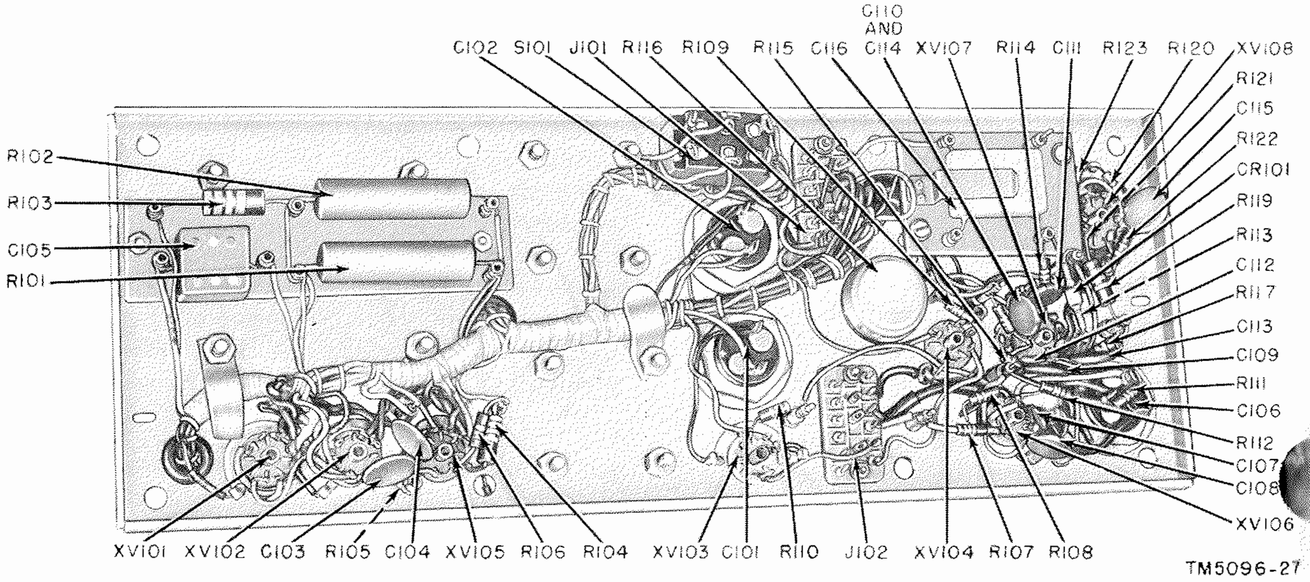


Figure 39. Power supply subchassis, location of parts, bottom view.

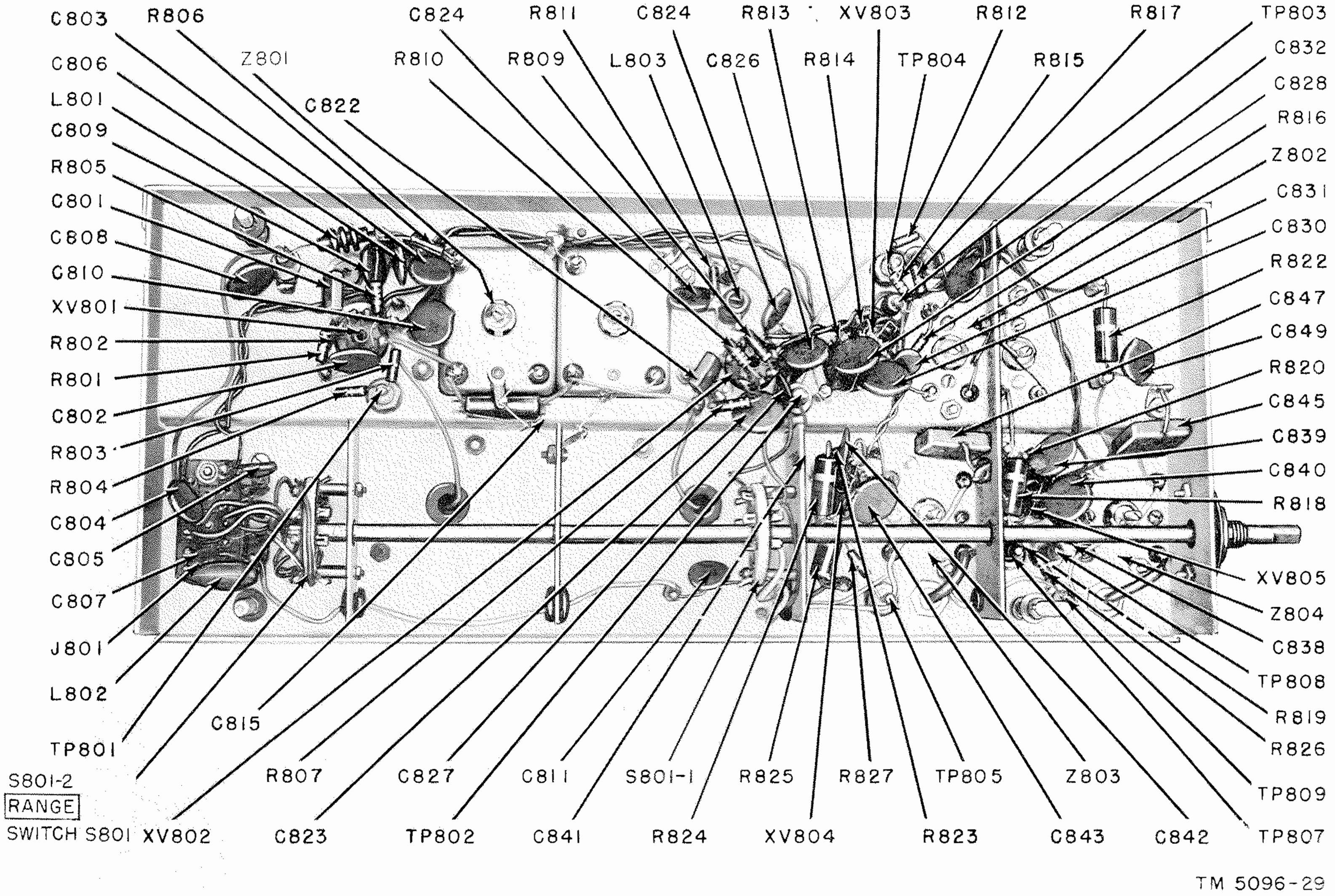


Figure 40. Band-pass amplifier subchassis, location of parts, bottom view.

70. Removal and Replacement of Vfo Subassembly

This subassembly is mounted at the right side front of the top deck (fig. 32).

a. To remove the vfo subassembly, proceed as follows:

(1) Remove the CHECK control knob by loosening its two recessed set screws.

(2) Remove the rubber belt between the vfo subchassis and variable capacitor C814 on the band-pass amplifier subassembly.

(3) Remove the rubber belt between the film drive and the large gear on the vfo.

(4) Remove plug P401 from J401.

(5) Loosen the three black-headed retaining screws.

(6) Remove P503 and P504, and push the coaxial cable aside.

(7) Lift the vfo subassembly off the main frame.

b. To replace the vfo subassembly, proceed as follows:

(1) Replace the vfo on the main frame.

(2) Tighten the three black-headed retaining screws.

(3) Turn the FINE control so that 01-4166000 is centered in the film window.

(4) Turn the COARSE control fully counterclockwise (lowest numbers on the band dial).

(5) Replace the rubber drive belt on the large gear wheel that drives C403.

(6) Turn the rotor of capacitor C814 to exactly full mesh.

(7) Replace the rubber drive belt on the shaft of C814.

(8) Reconnect P401, P503, and P504 to their respective jacks.

(9) Recalibrate the vfo to the film strip as outlined in paragraph 64*b*(4) through (13).

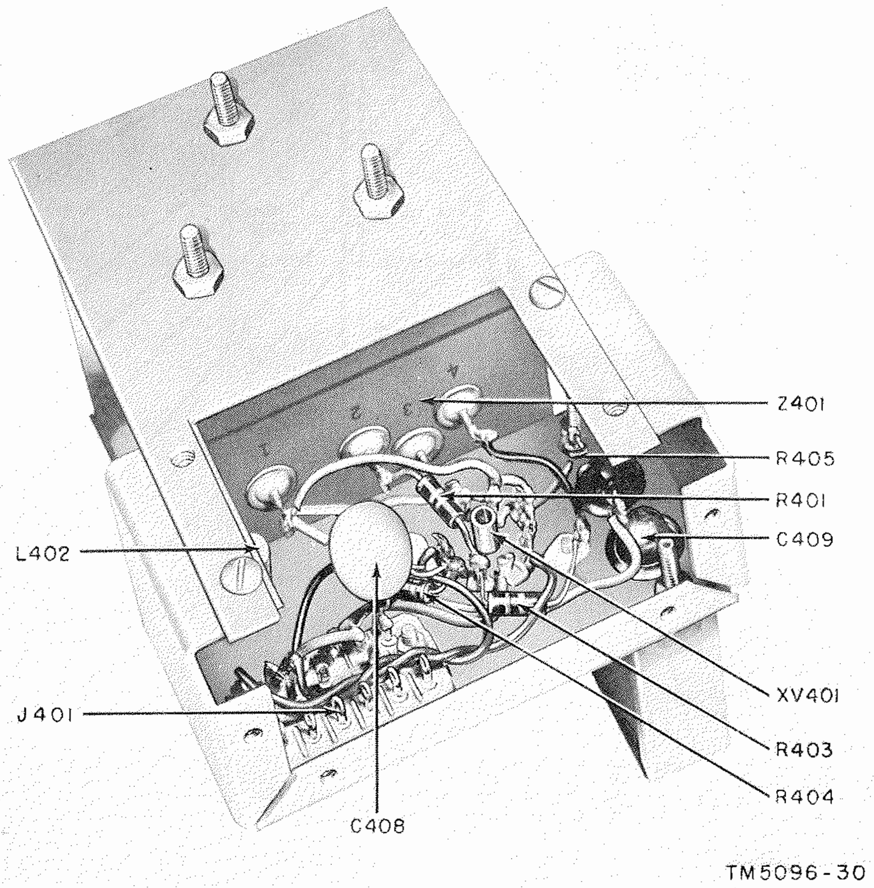


Figure 41. Variable frequency oscillator subchassis, location of parts, bottom view.

(10) Turn the FINE control to the lowest check point on the film strip. Zero-beat this check point. If the zero beat occurs only slightly off this point, proceed as instructed in (11) below. If it occurs more than two readings away from the check point, proceed as instructed in (12) below. After checking the low end of the band, repeat the procedure at the high end of the band; that is, at the last check point on the film. It may be necessary to check the high and low ends alternately and to shift the pulley on the vfo and C402 each time until the final adjustment is made.

(11) Center the check point in the window and adjust the CHECK control so that the zero beat is heard again.

(12) Remove the rubber drive belt from the film mechanism and turn the film shaft so that the check point is centered in the window; then replace the drive belt. If the zero beat does not now occur exactly at the check point, repeat the instructions in (10) above.

71. Removal and Replacement of Preamplifier Subassembly

This subassembly is located between the top and lower decks on the right side (fig. 34).

a. To remove the preamplifier subassembly, proceed as follows:

(1) Remove plug P201 from jack J201.

(2) Remove P501 from J501, and P502 from J502.

(3) Loosen the two black-headed retaining screws.

(4) Remove the subassembly from the right side of the main frame.

b. To replace the preamplifier subassembly, proceed as follows:

(1) Secure the subassembly to the main frame by tightening the two black-headed mounting screws.

(2) Connect the two coaxial cables, P503 and P504.

(3) Connect plug P201 and jack J201.

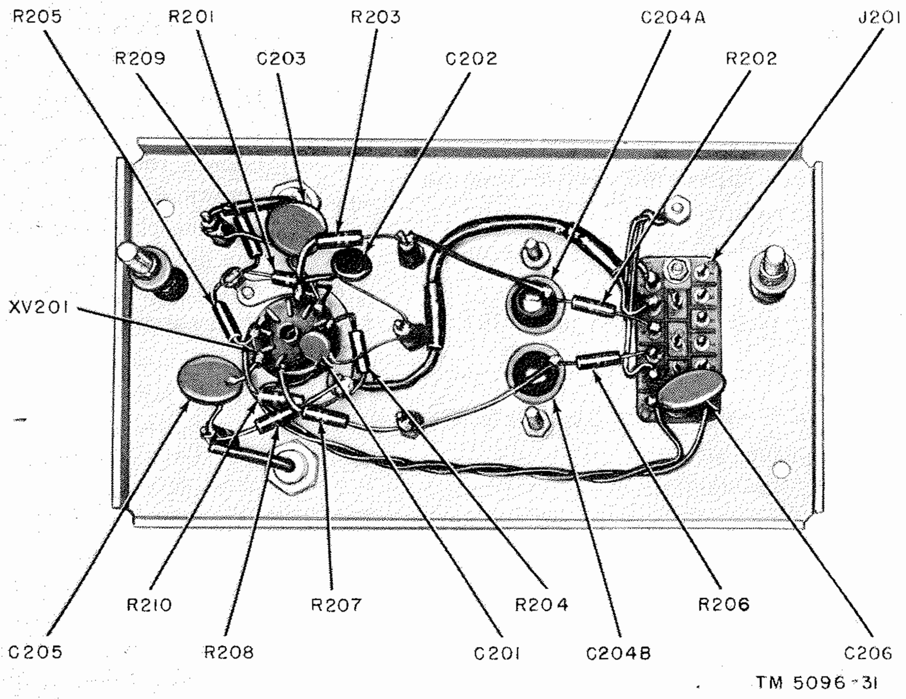


Figure 42. Preamplifier subchassis, location of parts, bottom view.

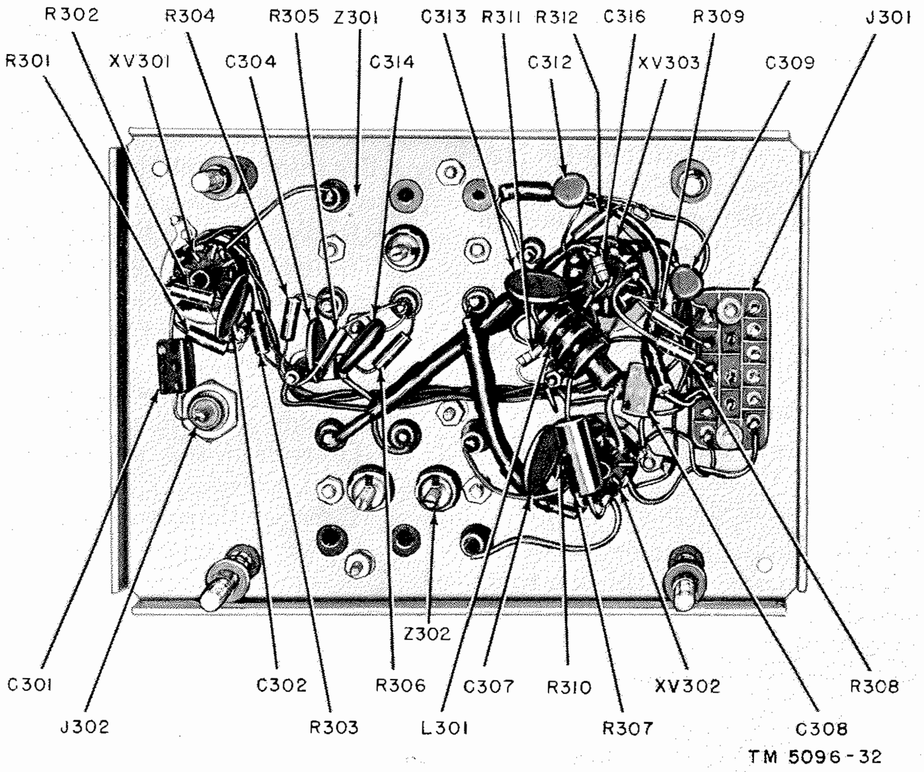


Figure 43. Check system subchassis, location of parts, bottom view.

72. Removal and Replacement of Check System Subassembly

The check system subassembly is located on the top deck at the right rear (fig. 32).

a. To remove the check system subassembly, proceed as follows:

(1) Disconnect plug P301 from jack J301.

(2) Disconnect coaxial fitting P302 from J302.

(3) Loosen the four black-headed mounting screws.

(4) Lift the check system subassembly from the main frame.

b. To replace the check system subassembly, reverse the disassembly procedure in *a* above.

Section III. CALIBRATION AND ALINEMENT

73. Test Equipment Required for Calibration and Alinement

The following test equipment is required for calibration and alinement of Frequency Meter FR-6/U:

Item	Common name
Frequency Calibrator Meter Set AN/URM-18.	Calibrator set.
Multimeter TS-352/U	Multimeter.
Oscilloscope OS-8A/U	Oscilloscope.
Q Meter TS-617/U	Q-meter.
Radio Receiver R-390/URR	Receiver.
Signal Generator TS-497B/URR	Signal generator.
Signal Generator AN/URM-25	Signal generator.
Voltmeter ME-30A/U	Vtvm.
Connector Adapter UG-274A/U	T-connector.

74. Crystal Oscillator Alinement

This paragraph contains the alinement procedures for the crystal oscillator. The following test equipment is required: a receiver with a 4-mc range and equipped with an S-meter, such as Radio Receiver R-390/URR; a signal source of 4 mc or some submultiple which has been derived from, or is compared to, a frequency standard having an accuracy of one part in 10 million, such as Frequency Calibrator Meter Set AN/URM-18; and an oscilloscope with good response to above 400 kc, such as Oscilloscope OS-8A/U.

a. Compensation for Crystal Aging. Because of the aging of a crystal, frequency correction is necessary once a month for the first 6 months and every 6 months thereafter. To maintain maximum accuracy, the crystal oscillator must be regularly compared to a standard frequency source and, if necessary, adjusted. Proceed as follows:

(1) Connect 4MC CRYSTAL OUTPUT J701 to the vertical amplifier input of the oscilloscope.

(2) Connect the output (4 mc) of the frequency standard to the horizontal amplifier input of the oscilloscope. A Lissajous pattern will result on the oscilloscope tube.

(3) Remove all screws, except the lower right one that secures the name plate and slide the name plate aside to reach 4-MC ADJUST control C603 (fig. 5).

(4) Adjust C603, with a screwdriver, until the pattern is absolutely stationary. The crystal oscillator is now accurately tuned to 4 mc.

b. Alternate Method of Crystal Oscillator Alinement.

(1) Connect a cable from the 4MC CRYSTAL OUTPUT jack to the antenna terminals of the receiver.

(2) Connect the standard signal source to the antenna terminals.

(3) Tune the receiver to 4 mc. With the beat-frequency oscillator switch of the receiver in the off position, a low-frequency audio tone will be heard in the headphones.

(4) Turn the 4MC ADJUST control to decrease the frequency of the audio tone by using a screwdriver. As the frequency nears zero, observe oscillation of the S-meter pointer. Continue to adjust the control until the pointer ceases to move. The crystal oscillator now is accurately tuned to 4 mc.

c. Compensation for Changed Components. If the crystal oven unit E601 or tube V601 is changed, more correction may be required than can be achieved by the procedures described in *a* and *b* above. Modify the procedures as follows:

(1) Set 4MC ADJUST control C603 to the midposition, as seen by a horizontal slot orientation.

(2) Turn variable capacitor C604 (fig. 37) to obtain the zero beat described in *a* and *b* above.

75. Balanced-Modulator Alinement

a. The tubes must be checked and replaced if necessary before alinement. Radio Receiver R-390/URR and Voltmeter ME-30A/U are required. The balanced modulator requires alinement when:

(1) In FINE tuning, substantial signals, less than 40 db down from normal signal output, can be found without application of an input signal.

(2) The output from P802 is less than 1.5 volts at any frequency setting of the FINE tuning dial.

b. Some of the adjustments mentioned in the following procedure are on the underside of the balanced-modulator chassis. Loosen the subassembly holding screws and turn the unit so that the underside is accessible. If necessary, remove P602; do not remove any of the other connections. The frequency meter must be turned on and sufficient warmup time allowed. Refer to figures 32 and 36 for location of alinement slugs. It is not necessary to remove the base plate.

(1) Remove V606 and replace it with a 5725 tube, which has one filament pin, 3 or 4, cut off. Set balance and control R621 (fig. 36) to approximately the center of its rotation.

(2) Couple the control grid, pin 1, of V607 through a 1-micromicrofarad ($\mu\mu$f) capacitor and a shielded cable to the receiver. Tune the receiver to 4 mc.

(3) Tune slugs A and B of Z602 for maximum deflection on the receiver tuning meter. It may be necessary to alternate the adjustment of these slugs to attain maximum deflection.

(4) Remove the disabled 5725 tube and replace it with V606. Allow 10 minutes for the tube to warm up. Tune the frequency meter to a film indication of 4166000.

(5) Adjust balance control R621 for minimum meter deflection on the receiver.

(6) Remove the receiver coupling from V607. Connect the probe of Voltmeter ME–30A to terminal 3 of Z604, or directly to P802, through a 1-$\mu\mu$f capacitor.

(7) Tune slug B of Z603 for maximum meter indication.

(8) Turn the FINE tuning control for a film indication of 4340000. Tune slug B of Z604 for the same level indication as in (7) above.

(9) Tune the frequency meter over the entire range and observe the meter. The indication should be constant within 2 db. If this is not the case, readjust slug B of Z604 for minimum variation in output.

76. Check System Alinement

a. To aline the check system, Signal Generator AN/URM–25 or equivalent and Frequency Calibrator Meter Set AN/URM–18 or equivalent, capable of measuring 8 mc, are required.

b. Energize the rf signal generator and allow sufficient warmup time. Set the rf signal generator exactly to 8 mc by using the frequency meter.

c. Remove P302 from J302 and connect the output of the signal generator to J302. Energize Frequency Meter FR–6/U, and allow it to warm up.

d. Turn the FUNCTION SWITCH to CHECK. Remove V401.

e. Switch the audio modulation on in the rf signal generator.

f. Tune slugs A and B of Z301 and slugs A, B, and C of Z302 (fig. 32 and 43) for maximum audio output at the PHONE jack.

g. Replace V401. The check system is now accurately alined.

77. Band-pass Amplifier Alinement

To aline the band-pass amplifier, the use of Q Meter TS–617/U, Voltmeter ME–30A/U, Connector Adapter UG–274A/U, and a receiver tunable to 4 mc (Radio Receiver R–390/URR) is required. It will be necessary to have access to the underside of the band-pass amplifier chassis. All adjustments are stamped on the underside of the chassis.

a. Trimmer Alinement. Trimmer capacitors C812, C816, C818, and C820 usually do not require adjustment, but should be adjusted if one of these is accidentally changed in setting or if any of the trimmers or associated shunting fixed mica capacitors are replaced.

(1) Disconnect the following leads at one end only: jumper lead from terminal 2 of Z801 to pin 5 of V801, the white lead from C816 to terminal 7 of Z801, white lead from C818 to terminal 8 of Z801, and the green lead from terminal 5 of Z801 to the tie point. *Do not disturb C815.* Carefully place loose wires out of the way to avoid short circuits.

(2) Set up the Q meter with a suitable coil and resonate it at 4 to 5 mc by a 200-$\mu\mu$f capacitor. Attach 3-inch rigid clip leads to the C terminals of the Q meter before resonating.

(3) Connect the ground clip lead to the frame of C814.

(4) Connect the high clip lead to the C814A stator, and set C814 to half mesh.

(5) Set the Q meter capacitor at 65 $\mu\mu$f (a change of 135 $\mu\mu$f).

(6) Adjust C812 for maximum reading on the Q meter.

(7) Move the high clip lead to the stator of C814B.

(8) Adjust C816 for maximum reading on the Q meter.

(9) Move the high clip lead to the stator of 814C.

(10) Adjust C818 for maximum reading on the Q meter.

(11) Move the high clip lead to the stator of C814D.

(12) Adjust C820 from maximum reading on the Q meter.

(13) Replace all the wires that were removed in (1) above.

b. Network Alinement. Realinement of the various networks in the band-pass amplifier may be required if the output is too low, as evidenced by an indication of less than negative 30 volts dc at TP805, with the RANGE switch in the 100–225 MC position, or TP809, with the RANGE switch in the 225–500 MC position, as measured on a 20,000 ohms per voltmeter, such as Multimeter TS–352/U. Before proceeding with realinement check and replace, if necessary, the tubes in the band-pass amplifier; check the tracking of the band-pass amplifier tuning capacitor with the variable frequency oscillator tuning capacitor; check the output of the balanced modulator; and change crystals CR501 and CR502 in the rf tuner. The band-pass amplifier must be removed from its position in the main frame (par. 69) for network realinement, but all interconnections must be intact.

(1) *Alinement of Z801.* Set the FUNCTION SWITCH to FINE and the RANGE switch to 100–225 MC. Place Connector Adapter UG–274A/U on jack J802. Connect P802 to one side of the tee and a 1,000-ohm carbon variable resistor to the other side of the tee and between center and outer conductors. Set the FINE tuning dial to 4253000. Connect a vacuum-tube voltmeter (vtvm), (such as Voltmeter ME–30A/U) to TP801, and short stator of C814B to the frame.

(*a*) Tune C814 for maximum meter reading. Adjust the carbon potentiometer to reduce meter reading for sharpest tuning, approximately .3 volt on the meter. Set C814 at approximately 90° out of full mesh; turn it clockwise as viewed from the front.

(*b*) Adjust slug A of Z801 for maximum meter reading. Move the short from the C814B stator to the C814C stator.

(*c*) Adjust slug B of Z801 for minimum meter reading. Move the short from the C814C stator to the C814D stator.

(*d*) Adjust slug C on Z801 for maximum meter reading. Remove the short from the C814D stator.

(*e*) Adjust slug D of Z801 for minimum reading. This completes the alinement of Z801.

(2) *Alinement of L803.* Connections and equipment should be set up as instructed in (1) above. Disconnect the vtvm from TP801. Set the multimeter to the 50-volt range. Connect the negative lead to TP805 and the positive lead to the band-pass amplifier chassis. Adjust slug L803, located on the chassis main frame, for maximum meter reading.

(3) *Alinement of Z803.* Connections and equipment should be set up as indicated at conclusion of the preceding procedure in this paragraph.

(*a*) Shunt terminals 3 and 4 of Z803 with a 1,000-ohm, ½-watt composition resistor.

(*b*) Tune slug A of Z803 for maximum meter reading. Transfer the 1,000-ohm shunt resistor from terminals 3 and 4 to terminals 1 and 2 of Z803.

(*c*) Tune slug B of Z803 for maximum meter reading. Remove the shunt.

(*d*) Check the meter reading at both ends of the FINE tuning dial range and make it uniform by adjusting slug B of Z803.

(4) *Alinement of Z802.* The connections and equipment should be set up as indicated at the conclusion of the preceding subparagraph.

(*a*) Disconnect the multimeter lead from TP805. Connect the vtvm to TP804 and the chassis. Set the RANGE switch to 225–500 MC.

(*b*) Ground pin 7 of Z802 and adjust slug A of Z802 for a maximum vtvm reading. Remove the ground from pin 7 and ground pin 8 of Z802.

(c) Tune slug B of Z802 for minimum reading on the vtvm. Remove the ground from pin 8 and ground pin 5 of Z802.

(d) Tune slug C of Z802 for maximum meter reading. Remove the ground from pin 5 of Z802.

(e) Tune slug D of Z802 for minimum meter reading.

(5) *Alinement of Z804.* Connections and equipment should be set up as indicated at the conclusion of the preceding subparagraph.

(a) Disconnect the vtvm.

(b) Set the multimeter to the 50-volt range. Connect the negative lead to TP809 and the positive lead to the chassis.

(c) Shunt terminals 3 and 4 of Z804 with a 1,000-ohm, ½-watt composition resistor.

(d) Tune slug A of Z804 for maximum meter reading.

(e) Transfer the shunt resistor from terminals 3 and 4 to 1 and 2 of Z804.

(f) Tune slug B of Z804 for maximum meter reading.

(g) Remove the shunt. Check the meter reading at both ends of the FINE tuning dial range, and equalize the reading by adjusting slug B of Z804.

(6) *Adjustment of C815.*

(a) Connect the receiver input to TP802.

(b) Set the film strip to read 4166000.

(c) Set C814 to maximum capacitance.

(d) Tune the receiver to 4 mc, and adjust the receiver gain for convenient meter reading on the receiver.

(e) Adjust the wires of C814 to provide minimum meter reading. Use a nonmetallic tuning tool.

78. Meter and Gate Adjustments

a. Equipment Required. Adjustment of meter potentiometer R703 and GATE ADJ potentiometer R116 require the use of an rf signal generator (such as Signal Generator TS-497B/URR) with a calibrated output and an ac meter (such as Voltmeter ME-30A/U).

b. TUNING METER Adjustment (R703).

(1) Set the FUNCTION SWITCH to COARSE and the COARSE tuning dial to 230 mc on band 2. Turn the LEVEL control fully clockwise.

(2) Adjust the rf signal generator to provide a 230-mc, 10-millivolt output. Connect the rf signal generator output to 225-500 MC RF INPUT jack J704.

(3) Set the COARSE tuning dial for a maximum reading on the TUNING METER and/or maximum audio output.

(4) Adjust R703 until the indicator reaches the high end of the green block on the TUNING METER.

c. GATE ADJ (R116).

(1) Set the FUNCTION SWITCH to COARSE and the COARSE tuning dial to 230 megacycles on band 2. Turn the LEVEL control fully clockwise.

(2) Adjust the rf signal generator to provide a 230-mc, 1-millivolt output. Connect the signal generator output to 225–500 MC RF INPUT jack J704.

(3) Set the COARSE tuning dial for a maximum reading on the TUNING METER.

(4) Set the LEVEL control so that the needle reaches the high end of the green block.

(5) Connect a 600-ohm noninductive resistor and Voltmeter ME–30A/U across PHONE jack J703.

(6) Adjust GATE ADJ potentiometer R116 to provide a reading of 0 dbm (1 milliwatt (mw)) on the AC multimeter.

Section IV. FINAL TESTING

79. General

This section is a guide to be used in determining the quality of a repaired Frequency Meter AN/URM–81. The minimum test requirements outlined in paragraphs 81 and 82 may be performed by maintenance personnel with adequate test equipment and the necessary skills. Repaired equipment meeting these requirements will furnish uniformly satisfactory operation.

80. Test Equipment Required for Final Testing

The test equipment required for final testing is as follows:

Item	Common name
Frequency Calibrator Meter Set AN/URM–18.	Calibrator set.
Signal Generator TS–497B/URR	Signal generator.
Frequency Calibrator AN/USM–45	Calibrator.
Voltmeter ME–30A/U	Vtvm.

81. Tests

Perform the following tests at three equally spaced frequencies in the low, center, and high regions of each band (six times). If, during the performance of these tests, spurious responses are noted, check each response according to the instructions in paragraph 82. Perform the tests in the order given for each frequency selected, rather than performing a particular test at all frequencies, the next test at all frequencies, and so on.

a. Accuracy.

(1) Connect the rf cord from the appropriate RF INPUT jack to Frequency Calibrator AN/USM–45, so that the harmonic output of the calibrator set feeds Frequency Meter FR–6/U.

(2) Connect the crystal output of AN/USM–45 to Frequency Calibrator Meter Set AN/URM–18. The AN/URM–18 is used to monitor and check the crystal output of the AN/USM–45 to insure an accurate and stable output.

Note. The second, third, and fourth harmonics of the calibrator set are used for checking band 1. The fifth through ninth harmonics of the calibrator set are used for checking band 2.

(3) The frequency meter should measure each frequency to an accuracy of .001 percent.

b. Sensitivity, Audio Output, and Signal-to-Noise Ratio. To perform these checks, proceed as follows:

(1) Set the FUNCTION SWITCH to COARSE, and the COARSE tuning dial to 150 MEGACYCLES on band 1. Turn the LEVEL control fully clockwise.

(2) Connect the rf output of Signal Generator TS–497B/URR to the RF INPUT jack and adjust the output attenuator to 10-microvolt (uv) unmodulated output. Tune the signal generator near 150 mc until a tone is heard in the headphones or until the tuning meter indicates upscale.

(3) Connect a 600-ohm noninductive resistor and voltmeter 30A/U across the PHONES jack and adjust the COARSE tuning for maximum audio output.

(4) Adjust the signal generator attenuator to provide 1–mw output (0 dbm). Record this input voltage as COARSE sensitivity. It must be 10 microvolts or less. Reduce the signal generator output to zero. If the audio output drops at least 1 db below 1 mw, the signal-to-noise ratio is normal.

(5) Set the FUNCTION SWITCH to FINE, turn the signal generator attenuator to 10 millivolts (mv), and tune for zero beat. Detune slightly for maximum indication on the multimeter.

(6) Adjust the signal generator output to provide 0-dbm audio output. Record this input voltage as the FINE sensitivity. It must be 10 mv or less. Reduce the signal generator output to zero. If the audio output drops at least 1 db below 1 mw, the signal-to-noise ratio is normal.

(7) Satisfactory results from the tests described above will indicate that the audio output and the signal-to-noise ratio are within allowable limits.

82. Spurious Responses

To check for spurious responses in the rf tuner, proceed as follows:

a. With the equipment set up as described in paragraph 81, place the FUNCTION SWITCH in the COARSE position and tune the frequency meter through the band. When a spurious response is obtained, tune the COARSE control for a maximum indication on the TUNING METER or, if the signal can be heard, tune for a maximum audio output.

Note. The amplitude of the injected signal should be such that the TUNING METER reads near the top of the green area, with the LEVEL control set fully clockwise when the COARSE tuning control is set to the input frequency.

b. Disconnect the headphones and connect a 600-ohm, noninductive resistor in parallel with voltmeter ME-30A/U to the PHONE jack. Measure the voltage across the resistor.

c. Disconnect the 600-ohm resistor and the multimeter and reconnect the headphones. Complete the measurement of the unknown frequency in the COARSE position only.

d. When the TUNING METER has been maximized, disconnect the headphones, reconnect the 600-ohm load, and again measure the voltage across the load.

e. The previous measurement of spurious response should be 40 db down from the measurement of the desired response. If this 40-db difference cannot be obtained, refer to paragraph 78*c*.

CHAPTER 7

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

83. Disassembly

The following instructions are recommended as a guide for preparing Frequency Meter AN/URM–81 for shipment.

a. Remove Cord CG–409E/U from the equipment and wrap it in a waterproof barrier material. Place it inside the cover of Meter Case CY–1501/U.

b. Slide Frequency Meter FR–6/U into its carrying case and tighten the eight wing nuts that secure the frequency meter in the transit chest.

c. Secure the drawer and drawer catch with the metal bracket.

84. Field Repackaging Data

a. Materials Required. The following chart lists the estimated amount of materials required to prepare Frequency Meter AN/URM–81 for shipment:

Materials	Amount
Waterproof barrier	35 sq ft.
Fiberboard, corrugated, single-faced, flexible.	102 sq ft.
Tape, paper, gummed	25 ft.
Tape, water-resistant, pressure-sensitive	15 ft.
Flat steel strapping	16 ft.
Wooden shipping box	1 ea.

b. Box Size. The dimensions of the shipping box required for Frequency Meter AN/URM–81 are given in the following chart.

Box No.	Inner dimensions			Board ft	Volume (cu ft)	Packed weight (lb)
	Height (in.)	Width (in.)	Depth (in.)			
1 of 1	25¾	19⅜	22⅞	25	7	150

85. Repackaging Frequency Meter

Package the frequency meter as follows:

a. Technical Manuals. Wrap the manuals and the calibration book in waterproof-barrier material. Seal all the seams and folds with water-resistant, pressure-sensitive tape. Stow in Meter Case CY–1501/U (fig. 1).

b. Spare Parts. Wrap the fuses, lamps, and Adapter Connector UG–641/U in waterproof-barrier material and seal as described in *a* above. Place wrapped parts in their own compartment and close the lid. Place the spare tubes in their compartment and close the lid. Refer to figures 1 and 3 for these compartments.

c. Meter Case CY–1501/U. Put on the cover and secure all fastenings. Adequately cushion the case on all surfaces with pads of single-faced, flexible, corrugated paper, designed to absorb the shock of impact normally encountered in handling and transit. Secure the cushioning with gummed paper tape. Wrap each cushioned case within two thicknesses of single-faced flexible corrugated paper and secure each wrap individually with gummed paper tape. Seal the entire box closure, corners and joints with water-resistant pressure-sensitive tape.

86. Construction of Wooden Shipping Box

The wooden shipping box must be big enough to allow a 1-inch clearance on all sides between the packaged frequency meter and the box. To determine the dimensions of the bottom, sides, and top of the box, add two thicknesses of the material used, to the dimensions given in paragraph 84*b*. Construct the box in the following order (fig. 4):

a. Construct the bottom of the box, the two ends, the two sides, and the top.

b. Assemble the bottom, the two ends, and the two sides and nail them together.

87. Repacking, Strapping, and Marking

a. *Packing*.

(1) Cut a piece of corrugated paper twice the length of the box.

(2) Fold it in half and place it in the bottom of the box so that it forms a cushion.

(3) Place the packaged Frequency Meter AN/URM–81 in the box.

(4) Pack corrugated paper around all sides to prevent movement. Place more corrugated paper on top of the packaged meter.

(5) Nail the top of the box securely to the sides and ends of the box.

b. *Strapping*. Strap the box for intertheater shipment only. Secure the box with two flat, steel, straps and run them at right angles to the grain of the wood.

c. *Marking*. Mark the box in accordance with the requirements of SR 55–720–1, Section 11, Transportation and Travel, Preparation for Oversea Movement of Units (POM).

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

88. General

The demolition procedure outlined in paragraph 89 will be used to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished only upon order of the commander.

89. Methods of Destruction

a. *Smash*. Smash controls, switches, transformers, tubes, coils, and capacitors; use sledges, axes, handaxes, pickaxes, hammers, crowbars or heavy tools.

b. *Cut*. Cut cords and wiring; use axes, handaxes, and machetes.

c. *Burn*. Burn cords, resistors, capacitors, coils, wiring, calibration books, and technical manuals; use gasoline, kerosene, oil, flame throwers, or incendiary grenades.

d. *Bend*. Bend panels and chassis.

e. *Explode*. If explosives are necessary, use firearms, grenades, or TNT.

f. *Dispose*. Bury or scatter the destroyed parts in slit trenches, fox holes, or other holes, or throw them into the streams.

g. *Destroy*. Completely destroy everything.

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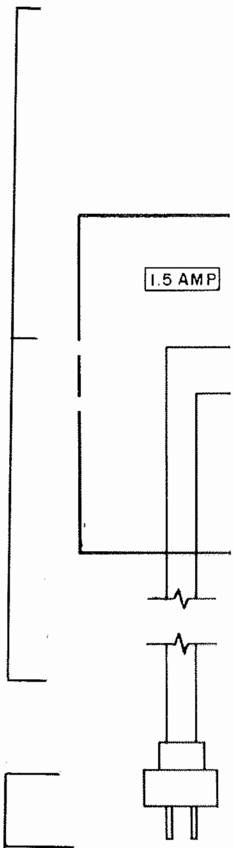

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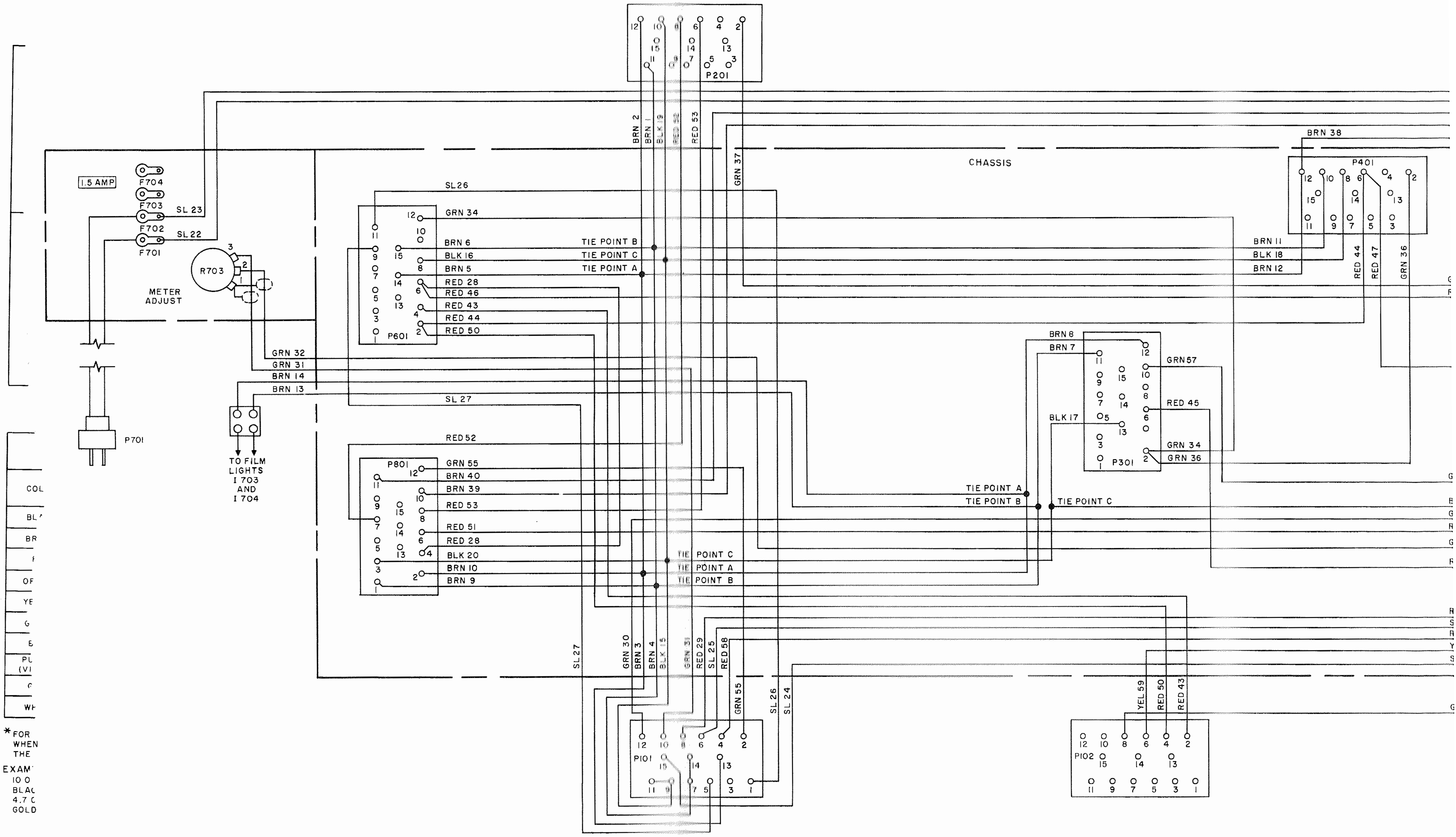

Figure 40. Main frame, wiring and interconnection diagram.

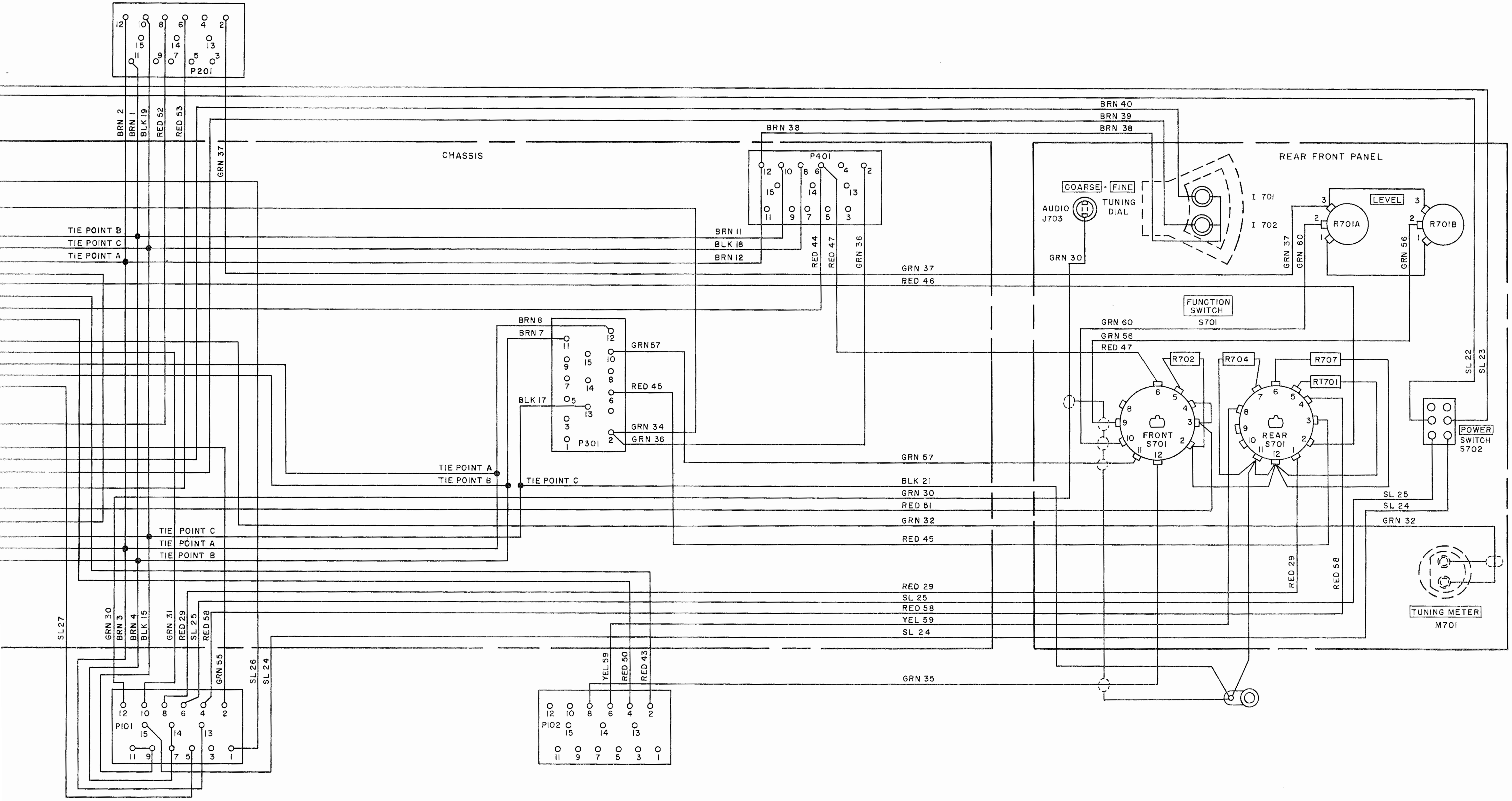

Figure 46. Main frame, wiring and interconnection diagram.

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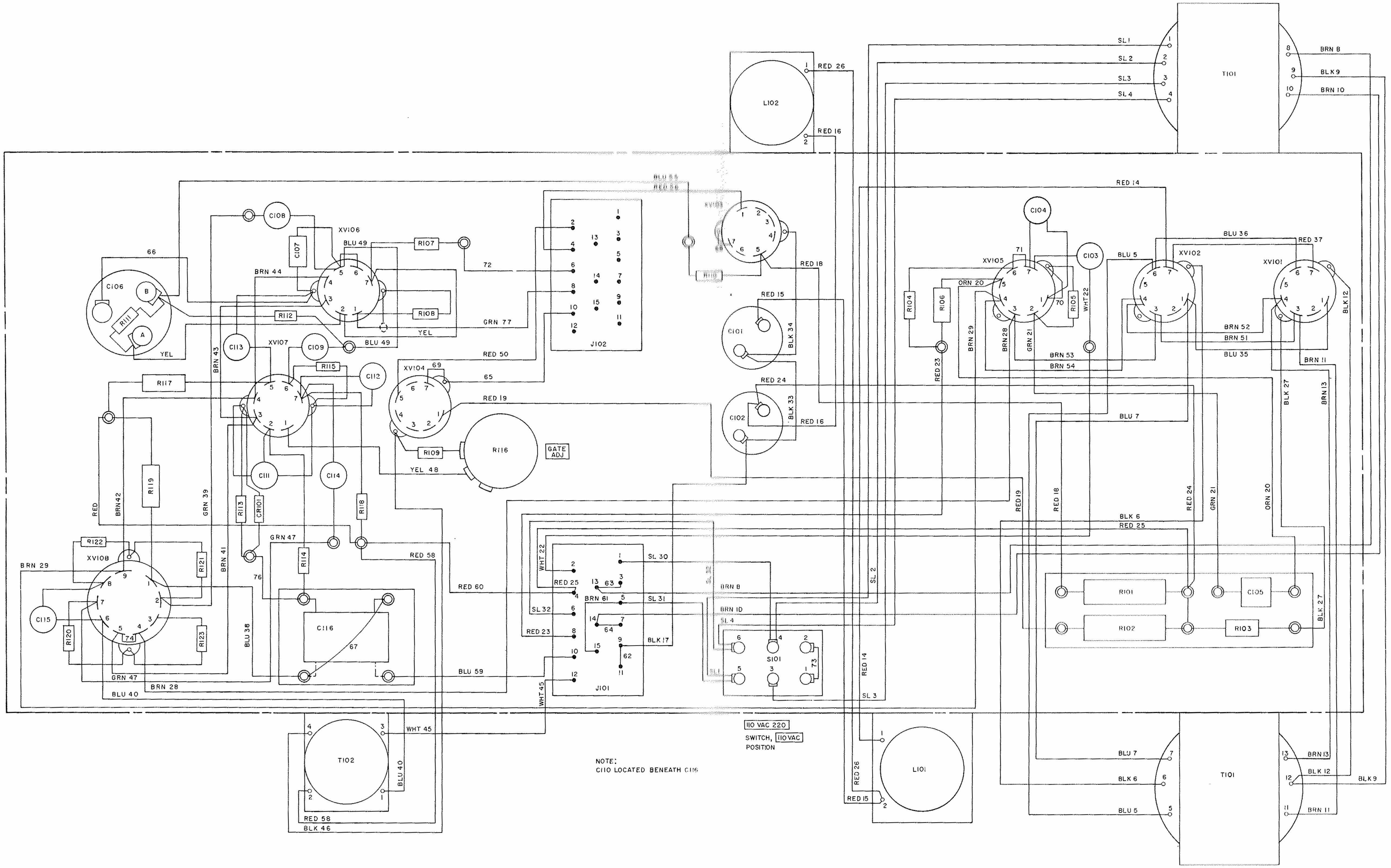

Figure 47. Power supply audio oscillator, and audio amplifier subchassis, wiring diagram.

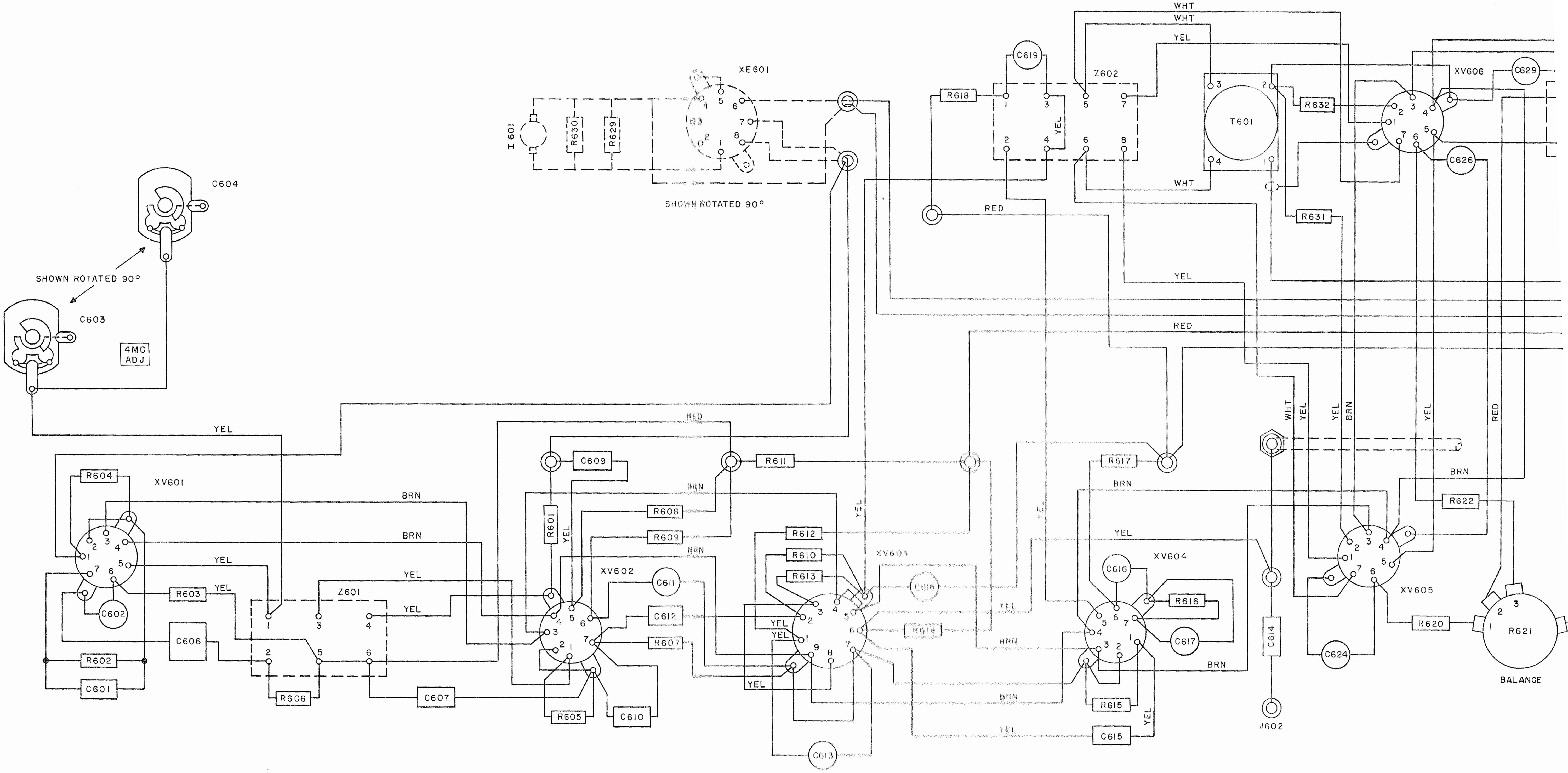

Figure 48. Crystal oscillator balanced-modulator subchassis, wiring diagram.

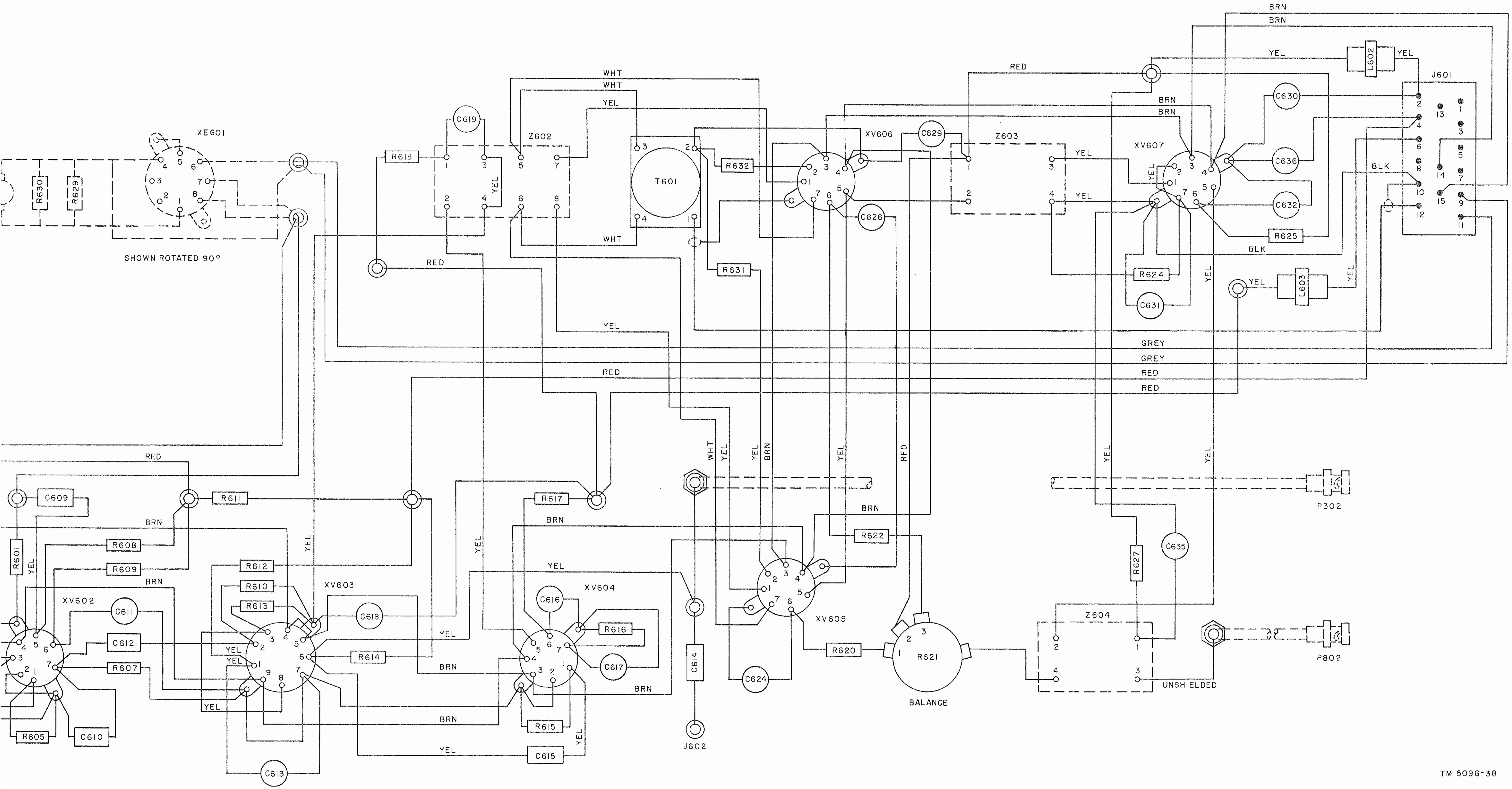

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Figure 48. Crystal oscillator balanced-modulator subchassis, wiring diagram.

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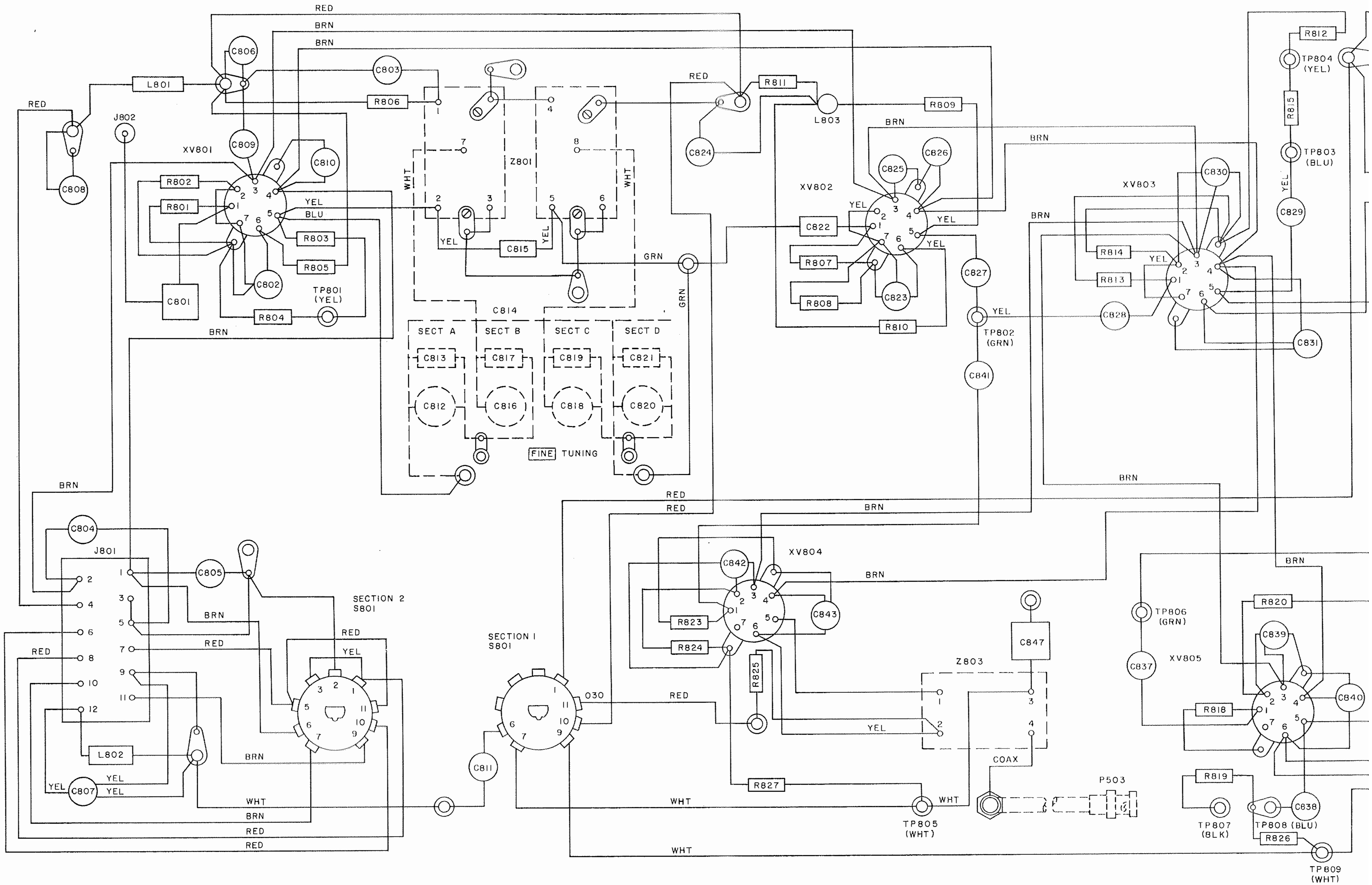

Figure 49. Band-pass amplifier subchassis, wiring diagram.

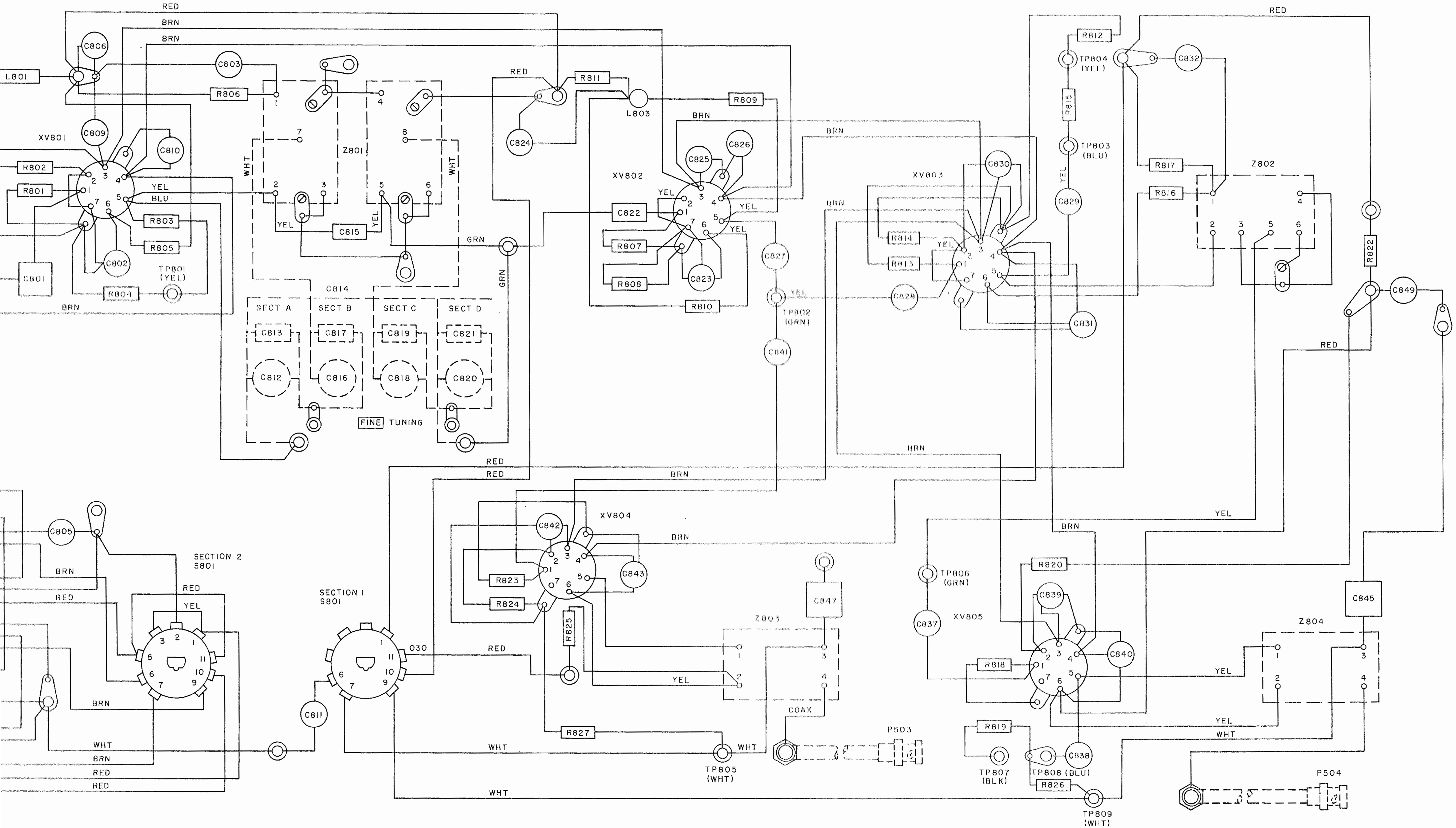

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Figure 49. Band-pass amplifier subchassis, wiring diagram.

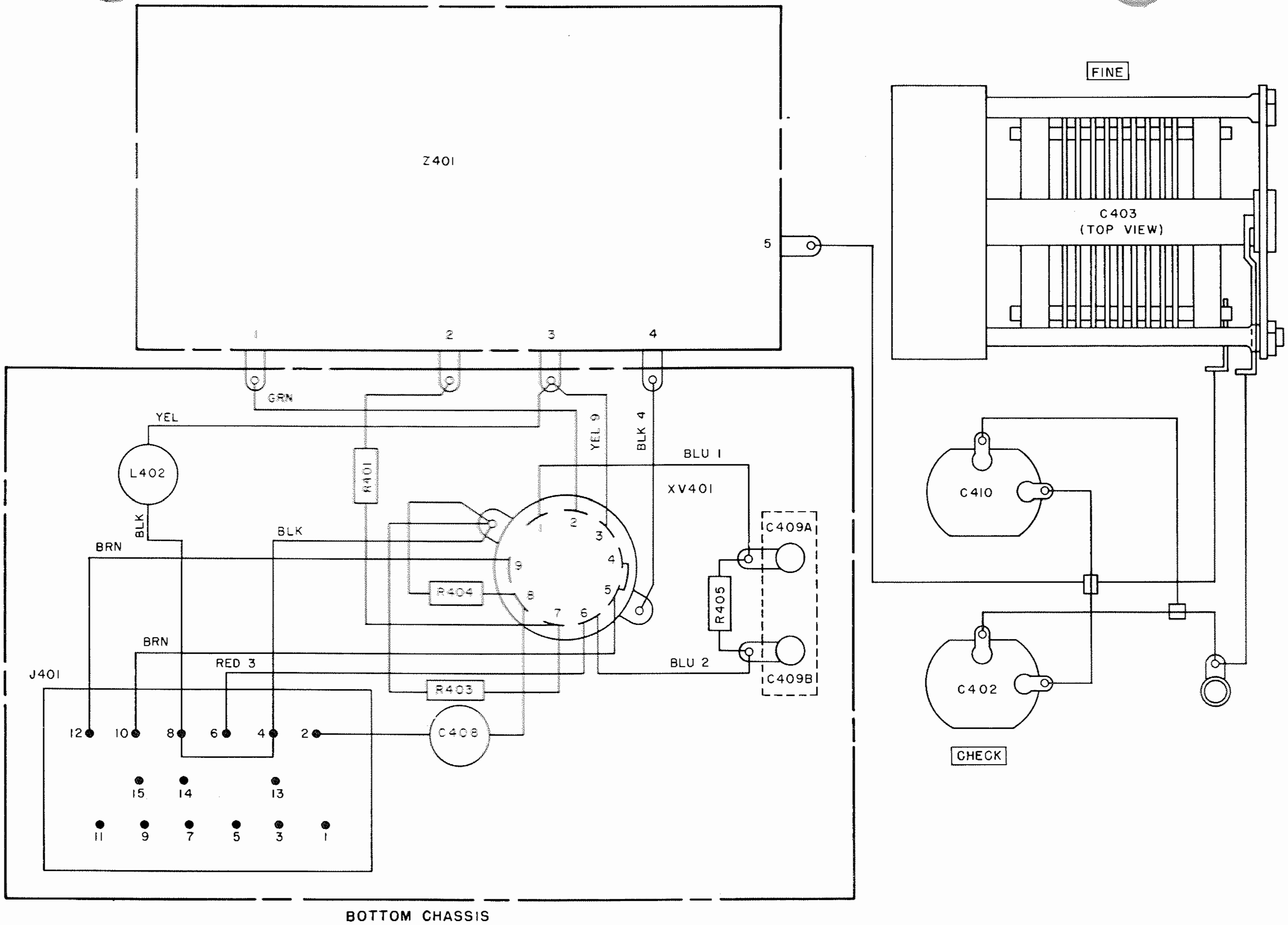

Figure 50. Variable frequency oscillator subchassis, wiring diagram.

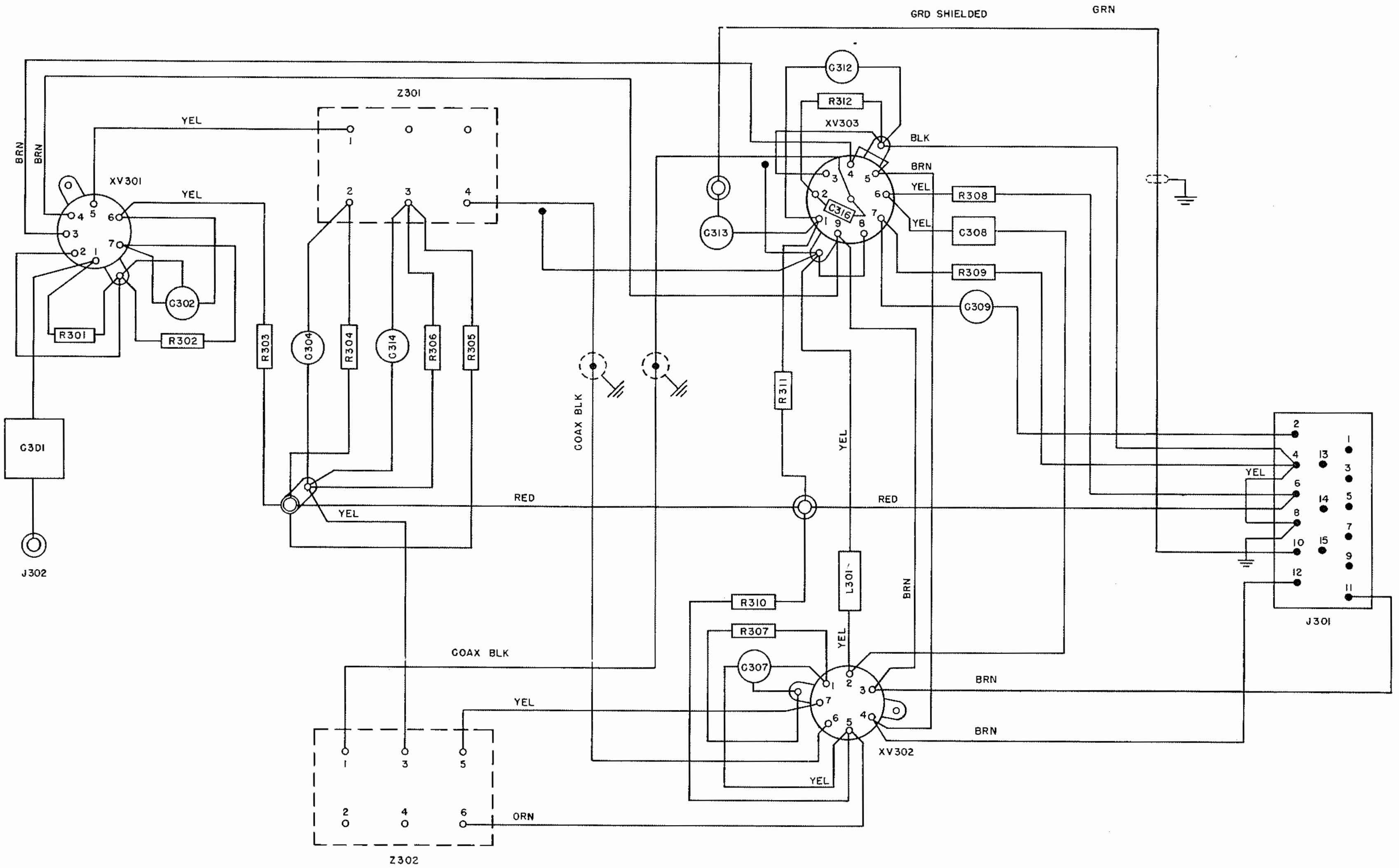

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Figure 51. Check system subchassis, wiring diagram.

Figure 51. Check system subchassis, wiring

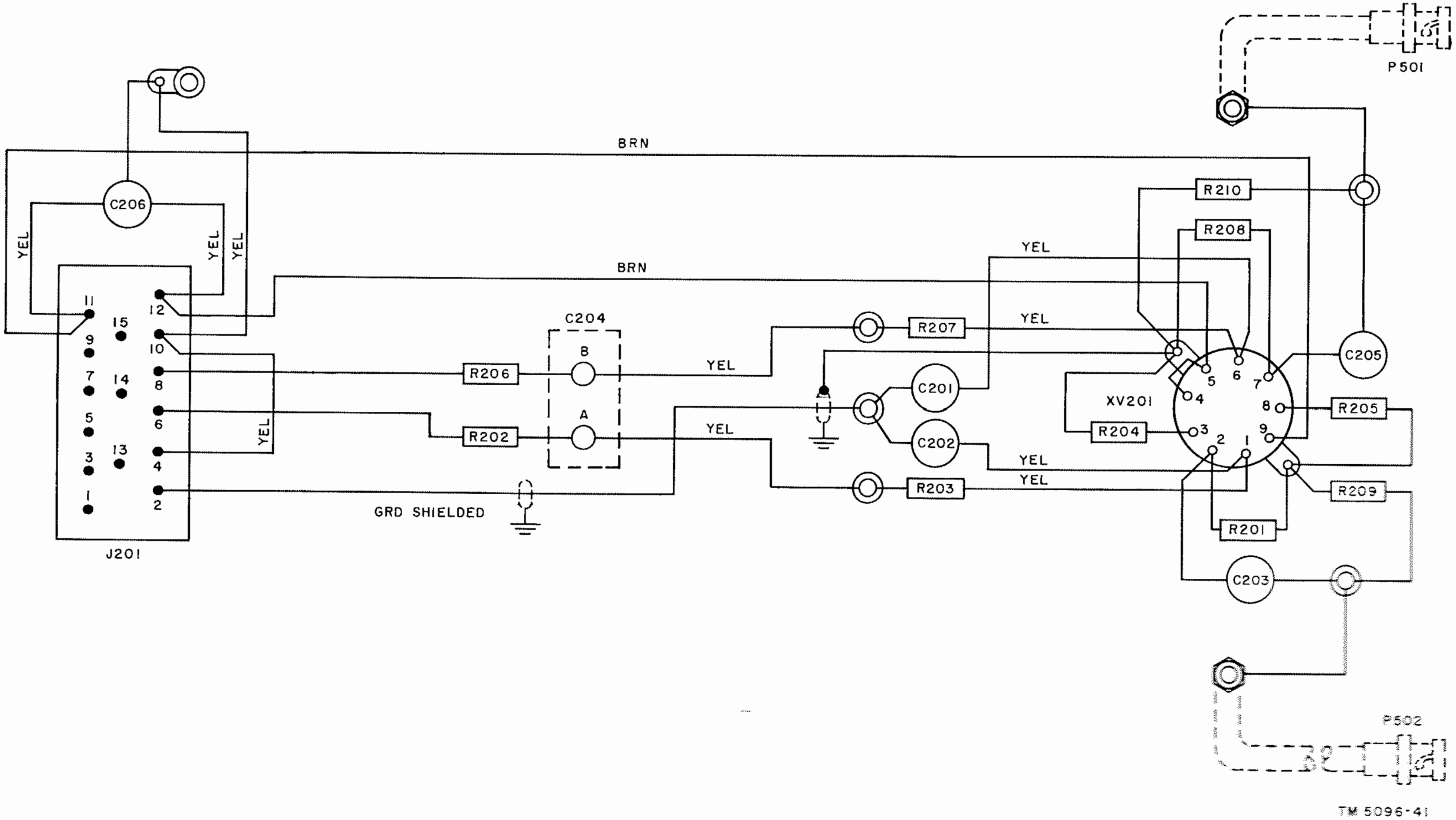


Figure 52. Preamplifier subchassis, wiring diagram.

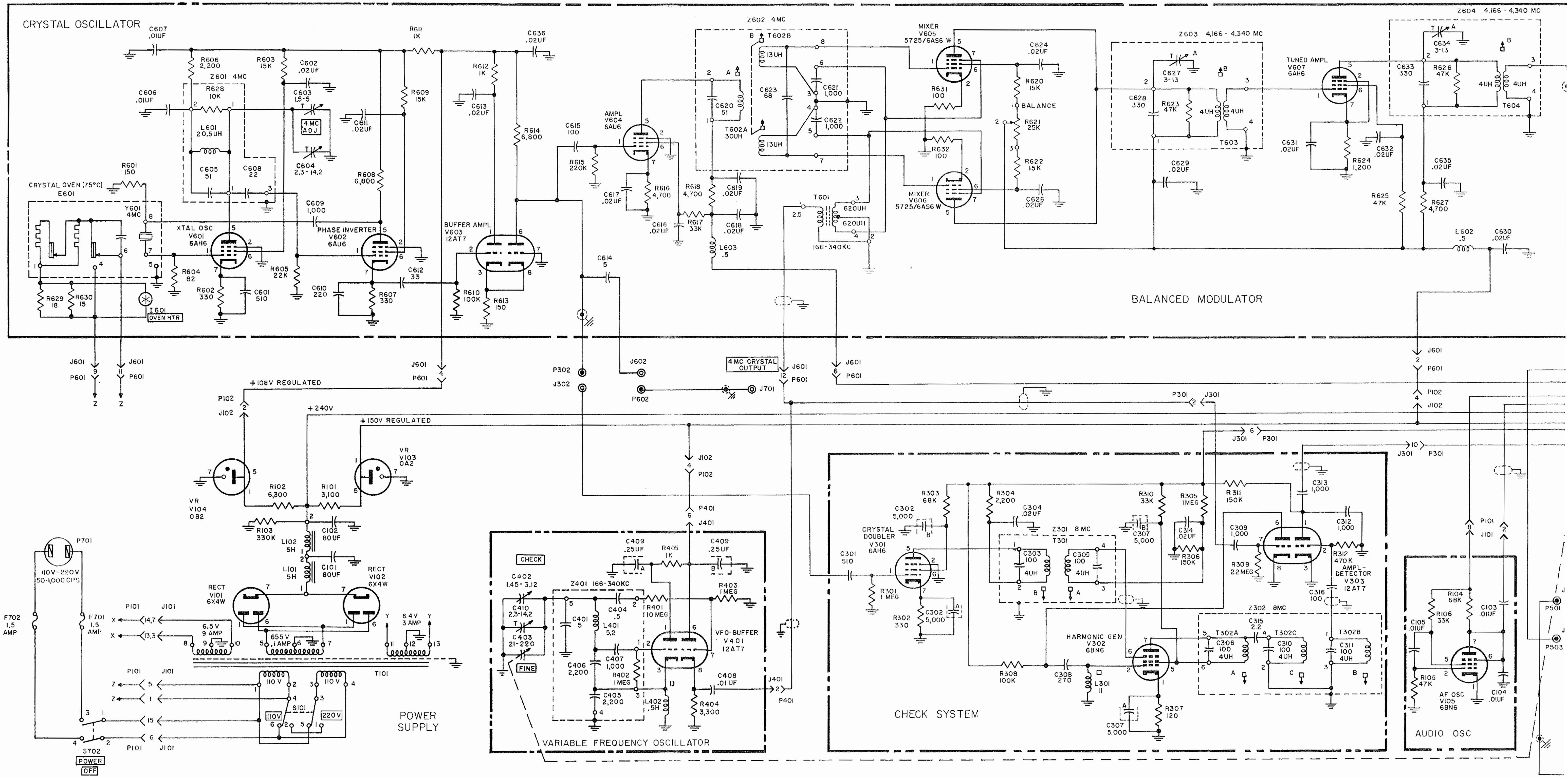


Figure 53. *Mai*

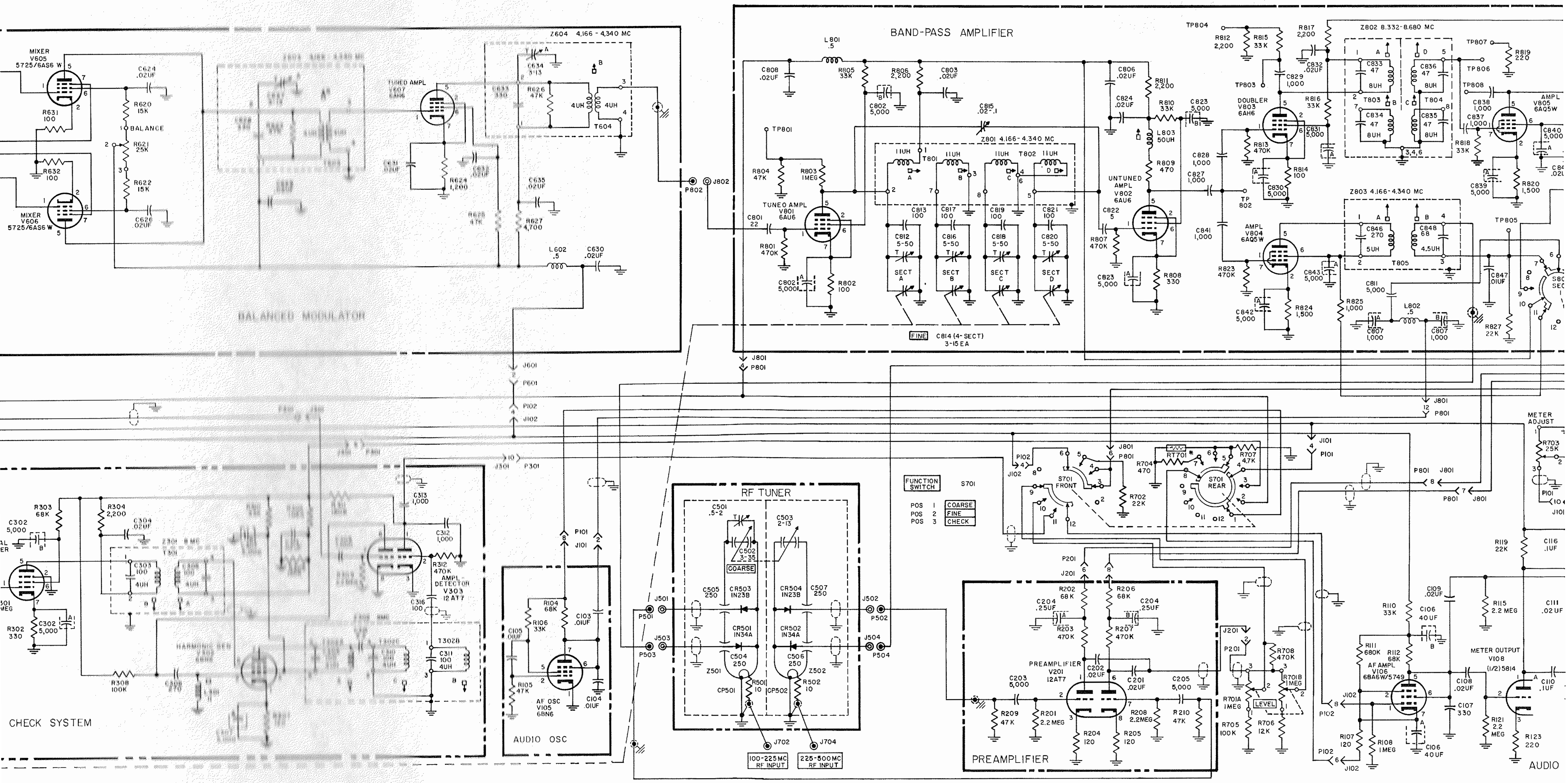
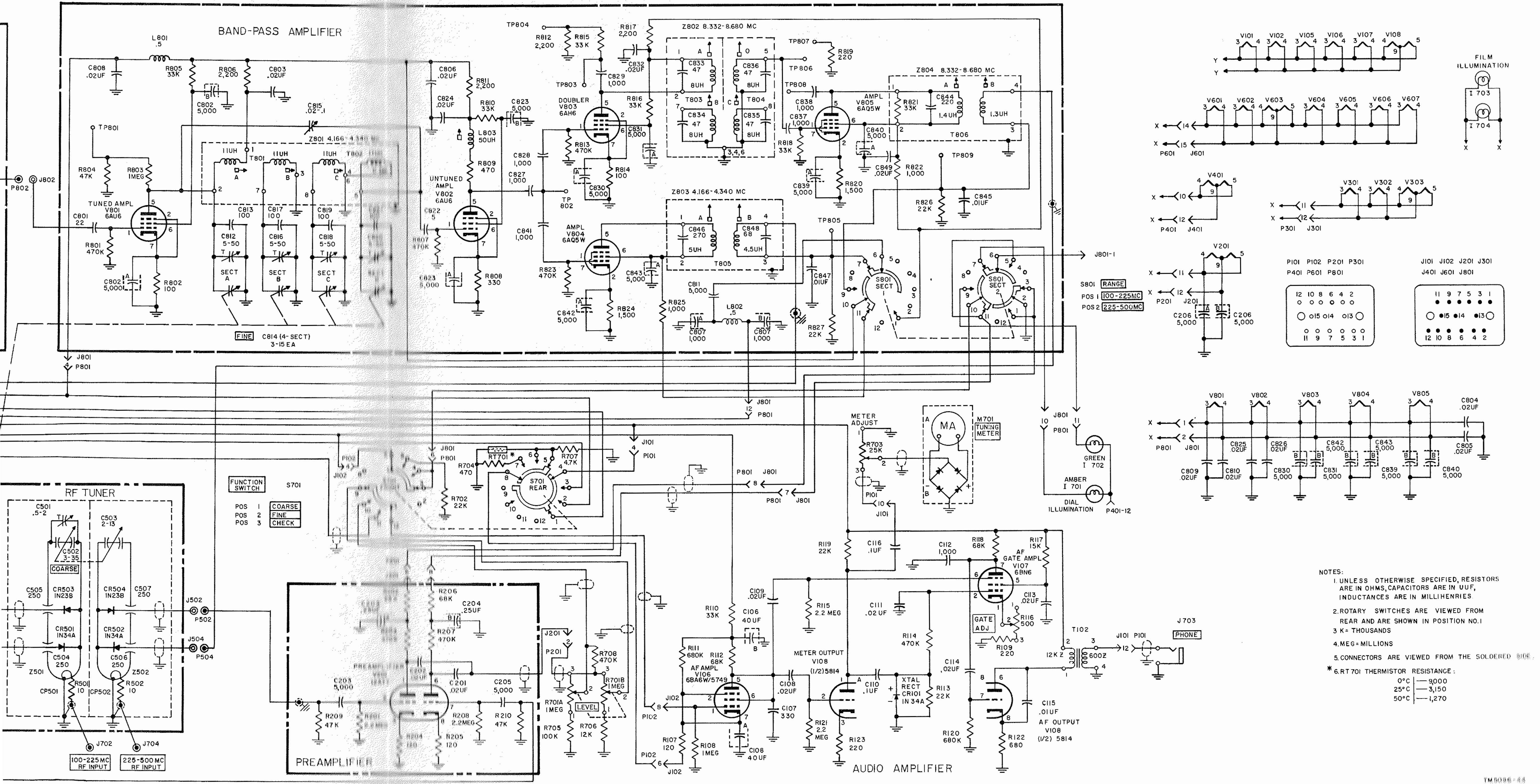


Figure 53. Main schematic diagram.



NOTES:

1. UNLESS OTHERWISE SPECIFIED, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF, INDUCTANCES ARE IN MILLIHENRIES.
2. ROTARY SWITCHES ARE VIEWED FROM REAR AND ARE SHOWN IN POSITION NO. 1
3. K = THOUSANDS
4. MEG = MILLIONS
5. CONNECTORS ARE VIEWED FROM THE SOLDERED SIDE.

*6. RT 701 THERMISTOR RESISTANCE:

0°C	9,000
25°C	3,150
50°C	1,270

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ematic diagram.

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[AG 413.44 (12 Sep 55)]

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NG: State AG (6); units—same as Active Army except allowance is one copy to each unit.

USAR: None.

For explanation of abbreviations used, see SR 320-50-1.

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