Pls return to : Roy A Shetzline

TM 11-5820-277-35

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

FIELD AND DEPOT MAINTENANCE MANUAL

OSCILLATOR, RADIO FREQUENCY O-330A/FR

HEADQUARTERS, DEPARTMENT OF THE ARMY

1 SEPTEMBER 1960

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TECHNICAL MANUAL
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HEADQUARTERS,
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WASHINGTON 25, D. C., *1 September 1960*

OSCILLATOR, RADIO FREQUENCY O-330A/FR

CHAPTER 1

THEORY

1. Scope

a. This manual covers field and depot maintenance for Oscillator, Radio Frequency O–330A/FR (fig. 1, TM 11–5820–277–12). Throughout this manual, the front panel and chassis assembly is referred to as the variable frequency oscillator. The manual includes instructions appropriate to third, fourth, and fifth echelons for troubleshooting, testing, aligning, and repairing the variable frequency oscillator, replacing maintenance parts, and repairing specified maintenance parts. Maintenance procedures for this equipment are the same at third, fourth, and fifth echelons except that complete rebuilding and meter repair is authorized at fifth echelon only. This manual also lists tools, materials, and test equipment for third, fourth, and fifth echelon maintenance. Detailed functions of the equipment are covered in the theory chapter.

b. The complete technical manual for the variable frequency oscillator includes TM 11–5820–277–12, TM 11–5820–277–10P, TM 11–5820–277–20P, and TM 11–5820–277–35P.

c. Forward comments concerning this manual to the Commanding Officer, U. S. Army Signal Materiel Support Agency, Attn: Pub Engrg Dept, Fort Monmouth, N. J.

Note. For applicable forms and records, see paragraph 2, TM 11–5820–277–12.

2. Block Diagram

The signal paths are shown in the block diagram (fig. 1) and are covered in *a* through *e* below. For complete details, refer to the overall schematic diagrams (fig. 34 and 35).

a. High Frequency Oscillator Section. The high frequency oscillator (hfo) is capable of producing crystal-controlled or a continuously variable radiofrequency (rf) output voltage from 2 to 64 megacycles (mc).

(1) The XTAL switch selects one of three hfo crystals Y202, Y203, or Y204, or the variable master oscillator (vmo) which has a tunable range from 2 to 4 mc.

(2) When one of the three crystals is selected, stage V202 operates as a crystal-controlled oscillator.

(3) When the VMO position is selected, the rf output voltage of variable master oscillator V301 is applied through cathode follower buffer V302A to the same V202 stage which now acts as an rf amplifier.

(4) The output of V202 is amplified by rf amplifier stage V203. Depending on the position of BAND-MCS switch, the output of V203 is fed through one or more successive rf multiplier stages V204, V205, V206, and V207. In these stages, the signal is further amplified or successively doubled in frequency. The output of the hfo section is available at the hfo output terminals for use in associated equipment.

b. Vmo Calibration Circuit. The 2- to 4-mc output of cathode follower V302A (*a*(3) above) is also fed to mixer stage V103. There the signal is mixed with the output of 100-kc crystal oscillator V302B. The output of mixer V103 is an audio beat signal and is fed through audio amplifiers V104A and V104B to ZERO BEAT indicator I303 and the two audio jacks (PHONES and J106 on the rear panel). The visual and aural indicators are used in calibrating the vmo (para 18*c*, TM 11–5820–277–12).

c. Intermediate Frequency Oscillator Section. Stage V201A is a crystal-controlled oscillator producing an rf output voltage in the frequency range of 3.2 to 3.9 megacycles, depending on the crystal used in the circuit. Intermediate frequency oscillator (ifo) amplifier V201B raises the level of the ifo voltage. The output of V201B is available at the IFO output terminals for use in associated equipment.

d. Beat Frequency Oscillator Section. Stage V105 is a crystal-controlled oscillator producing an rf voltage in the frequency range of 300 to 1,000 kilocycles (kc), depending on the crystals used and on the position of crystal selector switch Y101–102. The rf output of the beat frequency oscillator (bfo) is available at the

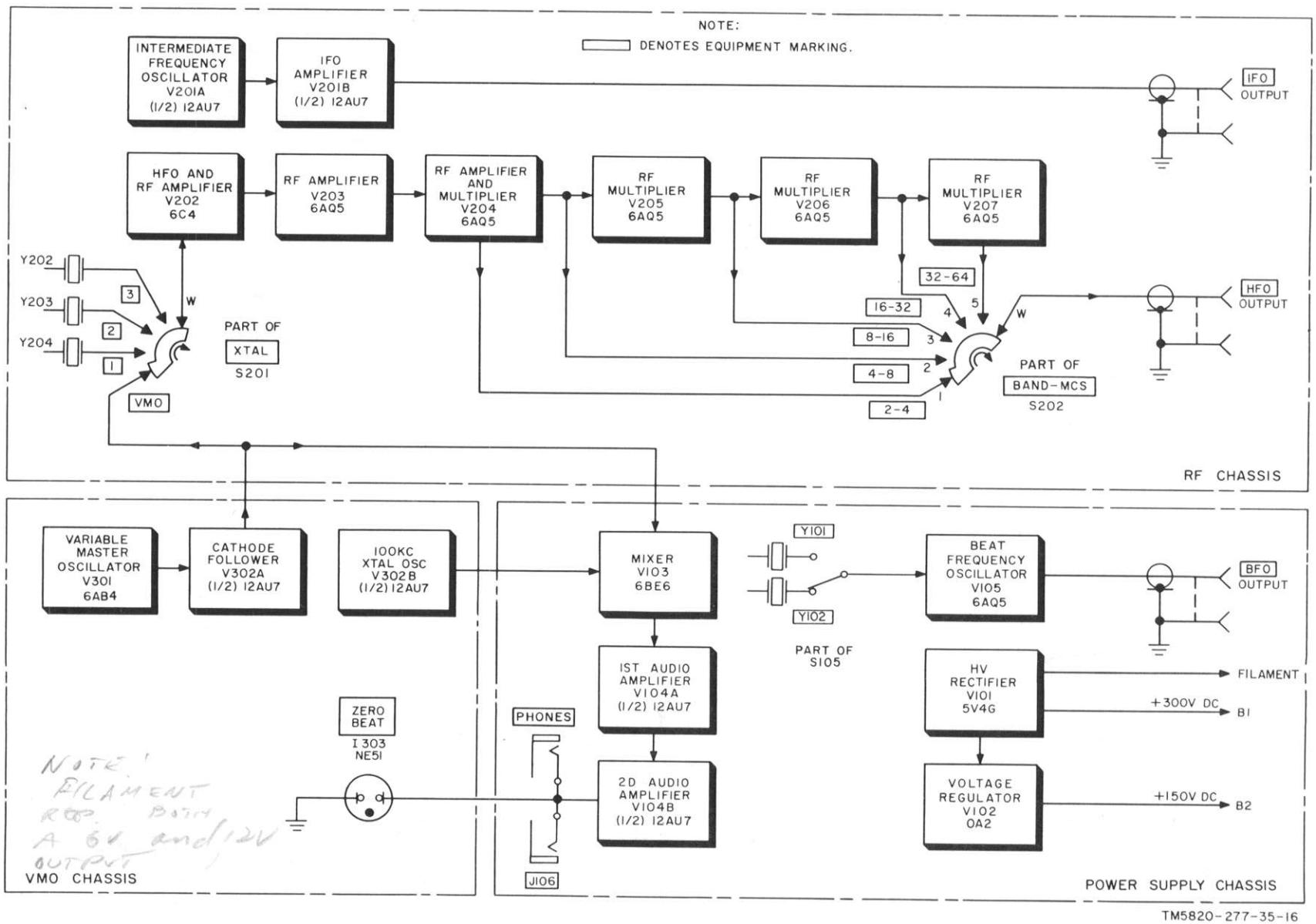


Figure 1. Variable frequency oscillator, block diagram.

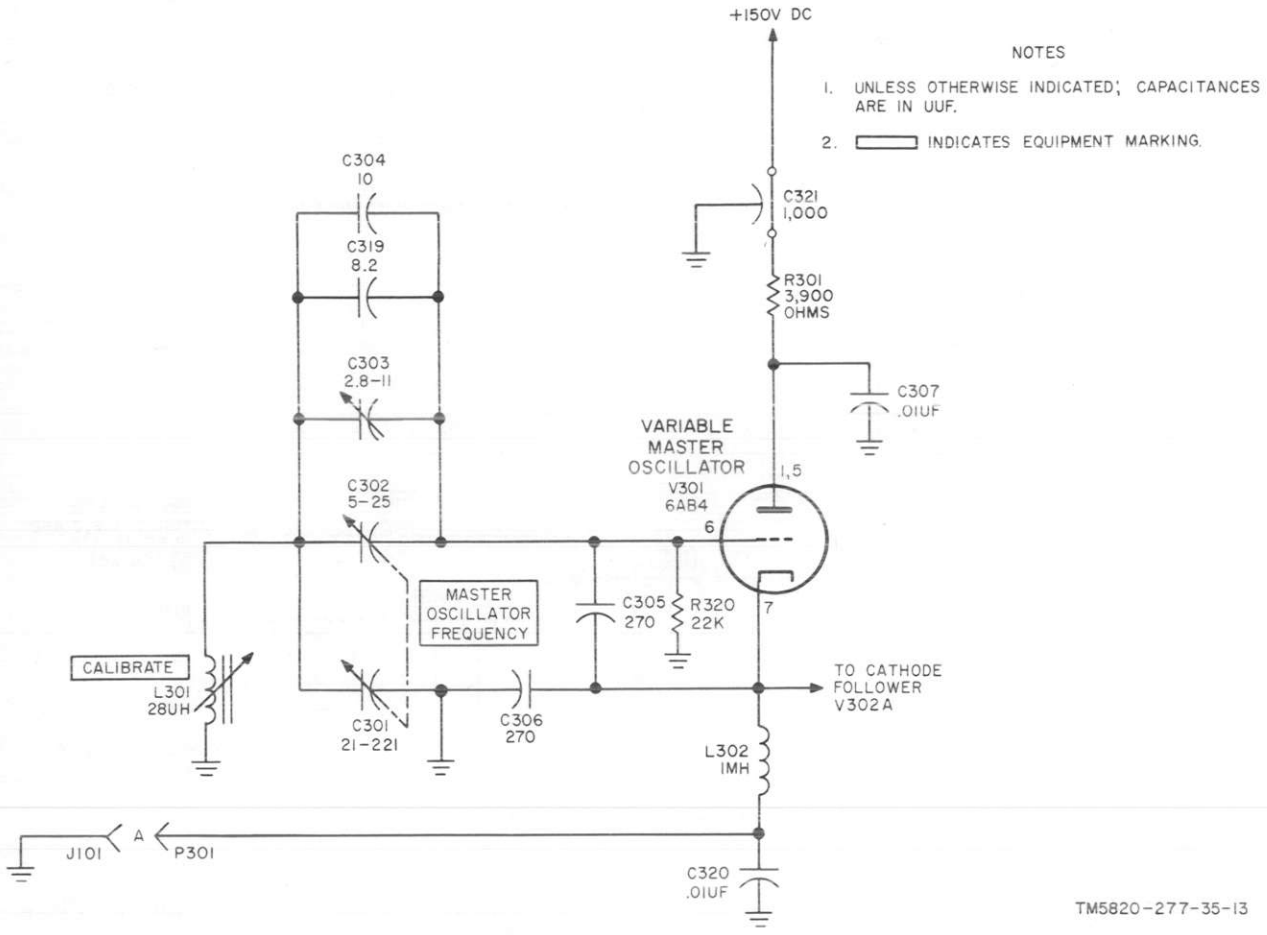


Figure 2. Variable master oscillator V301, schematic diagram.

BFO output terminals for use in associated equipments.

e. Power Supply Section. Two direct current (dc) voltages are distributed to the various stages. Regulated +150 volts is applied to the plate circuits of V301, V302, and V201 and to the screen circuit of V105. The plate circuit of V105 and the plate and screen circuits of all other tubes are supplied by unregulated +300 volts from rectifier V101. Filament voltage (6.3 volts alternating current (ac)) is supplied to all tubes from a secondary winding of input power transformer T101.

3. Variable Master Oscillator V301 (fig. 2)

Tube V301 is used in a modified Colpitts (Clapp) oscillator circuit to provide an rf output voltage in the frequency range of 2- to 4-mc. To prevent frequency changes due to temperature change, the oscillator stage is inclosed in a double-oven assembly. To prevent frequency changes due to loading, the oscillator output is isolated from the following stages by a cathode follower (buffer) stage.

a. Normal tuning is accomplished by the MASTER OSCILLATOR FREQUENCY control which adjusts ganged tuning capacitors C301 and C302. The CALIBRATE control adjusts the inductance of L301. Trimmer capacitor C303 (fig. 10 and 11, TM 11–5820–277–12) is used during initial adjustments (para 15, TM 11–5820–277–12) for balancing the amount of calibration required between the low and high ends of the frequency range.

b. Plate voltage for V301 is obtained from the 150-volt dc regulated power supply through feed-through capacitor C321 and resistor R301. Resistor R301 together with capacitor C307 and C321 decouples rf from the power supply

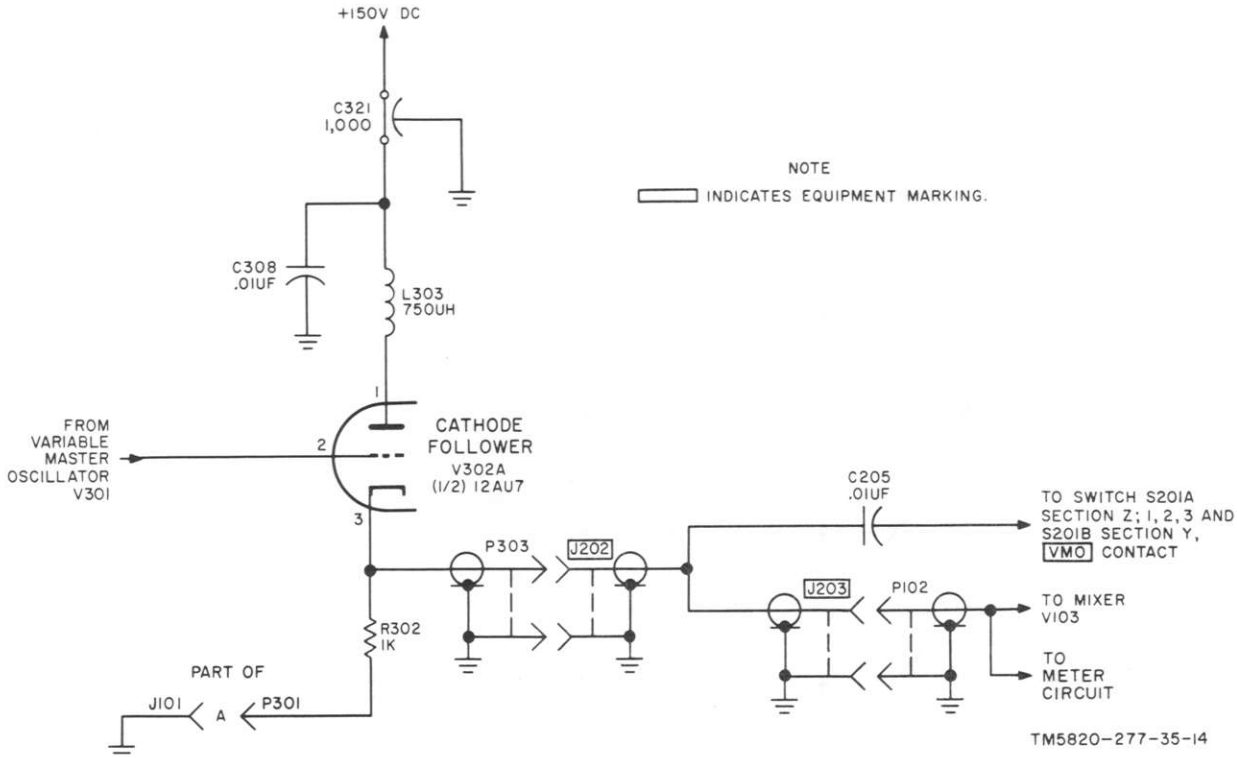


Figure 3. Cathode follower V302A, schematic diagram.

line. Oscillator output is developed across load impedance L302 in the cathode circuit and is directly coupled to the control grid of cathode follower V302A. Capacitor C320 bypasses stray rf in the ground line.

c. Capacitors C304 and C319 are fixed trimmer capacitors in the tank circuit. Capacitor C319, however, is temperature compensating and changes in value with temperature to prevent possible errors in frequency caused by slight temperature variations. Capacitors C305 and C306 are in series from control grid to ground and their junction is connected to the cathode to complete the oscillator circuit. Resistor R320 is the control grid dc return.

4. Cathode Follower V302A
(fig. 3)

The cathode follower, one triode section of a 12AU7 tube, is a buffer between the vmo and the following amplifier and multiplier stages. This buffer stage, located inside the double oven, tends to lessen any loading effect that might affect the vmo stability.

a. The output of V301 is directly coupled to the grid of cathode follower V302A. Plate voltage for V302A is obtained from the 150-volt dc regulated power supply through feedthrough capacitor C321 and inductor L303. Inductor L303 and capacitors C308 and C321 decouple rf from the power supply.

b. The output of V320A is taken across the cathode resistor R302 and coupled through capacitor C205 and XTAL switch S201 to rf amplifier V202. The output is also coupled through capacitor C107 to mixer stage V103 for calibration purposes (para 2*b*) and through capacitor C106 to the meter circuit.

5. Hfo and Rf Amplifier V202
(fig. 4)

Tube V202, a 6C4 triode, is used either as a crystal-controlled oscillator or as an amplifier of the rf output from V302A. The position of XTAL switch S201 determines the particular operation of V202.

a. When S201 is operated to the VMO position, class C rf amplifier operation is selected. In positions 1, 2, or 3, switch section Y of S201B completes the circuit from the control

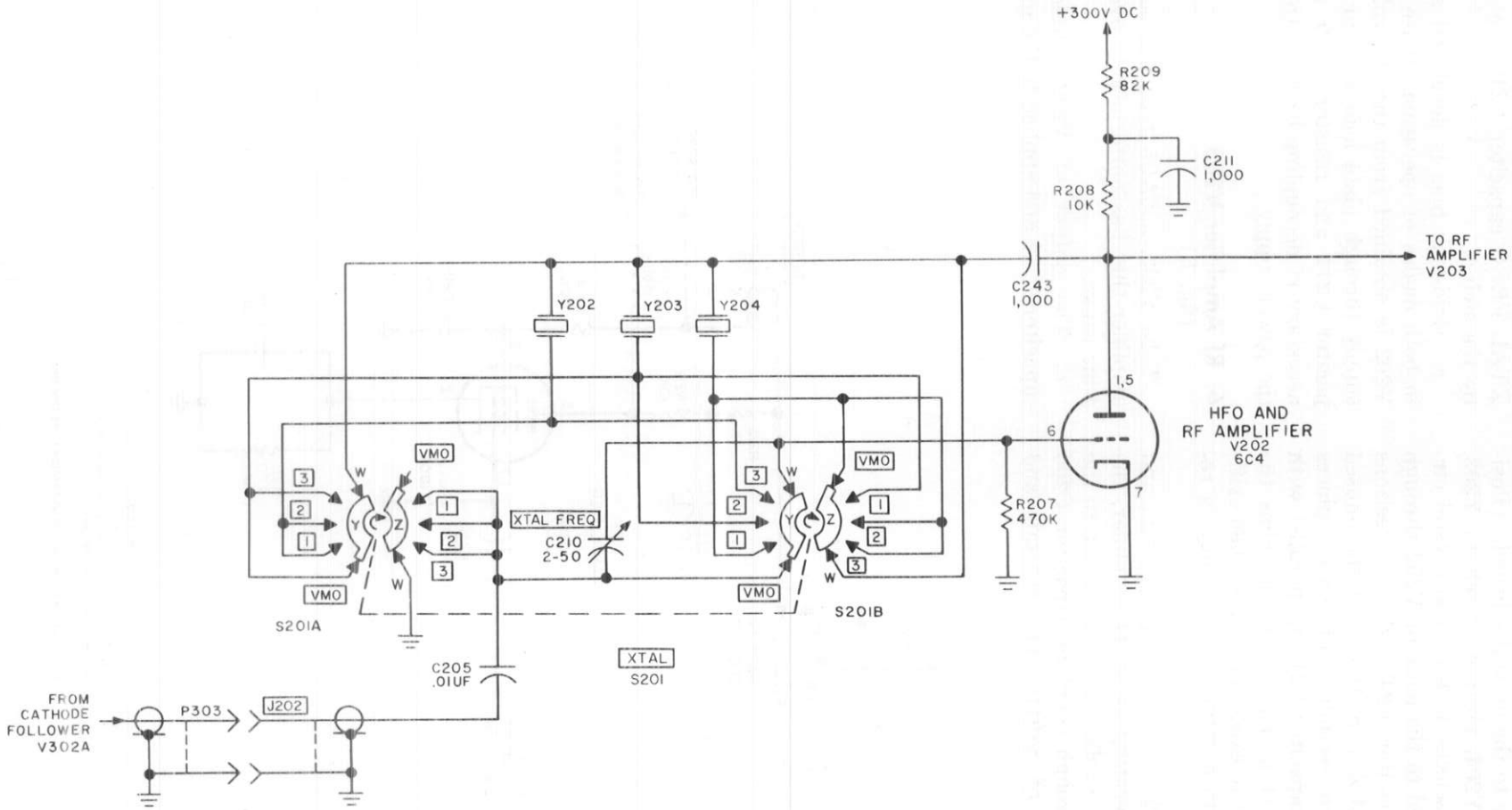


Figure 4. Hfo and rf amplifier V202, schematic diagram.

grid of the tube to the crystal selected. (Position 1 selects Y204, position 2 selects Y203, and position 3 selects Y202). The crystal circuit is completed to the plate of V202 through dc-blocking capacitor C243. Switch sections Y of S201A and Z of S201B short the unused crystals. Switch section Z of S201A places XTAL FREQ capacitor C210 in parallel with the selected crystal. This capacitor trims the oscillator circuit to exact frequency when critical calibration to a standard frequency is required.

b. When S201 is in the VMO position and the stage is operating as an rf amplifier, the output of cathode follower V302A is fed to the control grid through coupling capacitor C205 and section Y of S201B. The crystals and XTAL FREQ capacitor C210 are shorted out by the switch.

c. Grid-leak bias is developed across R207 in both modes of operation. Plate voltage for V202 is obtained from the 300-volt dc power supply through plate load resistor R208. Capacitor C211 and resistor R209 provide the necessary rf decoupling between the stage and the power supply.

6. Rf Amplifier V203
(fig. 5)

Tube V203, a 6AQ5 type pentode, is an rf amplifier that has uniform gain over the 2- to 4-mc range.

a. The output of V202 coupled through capacitor C212 and applied to the grid of V203

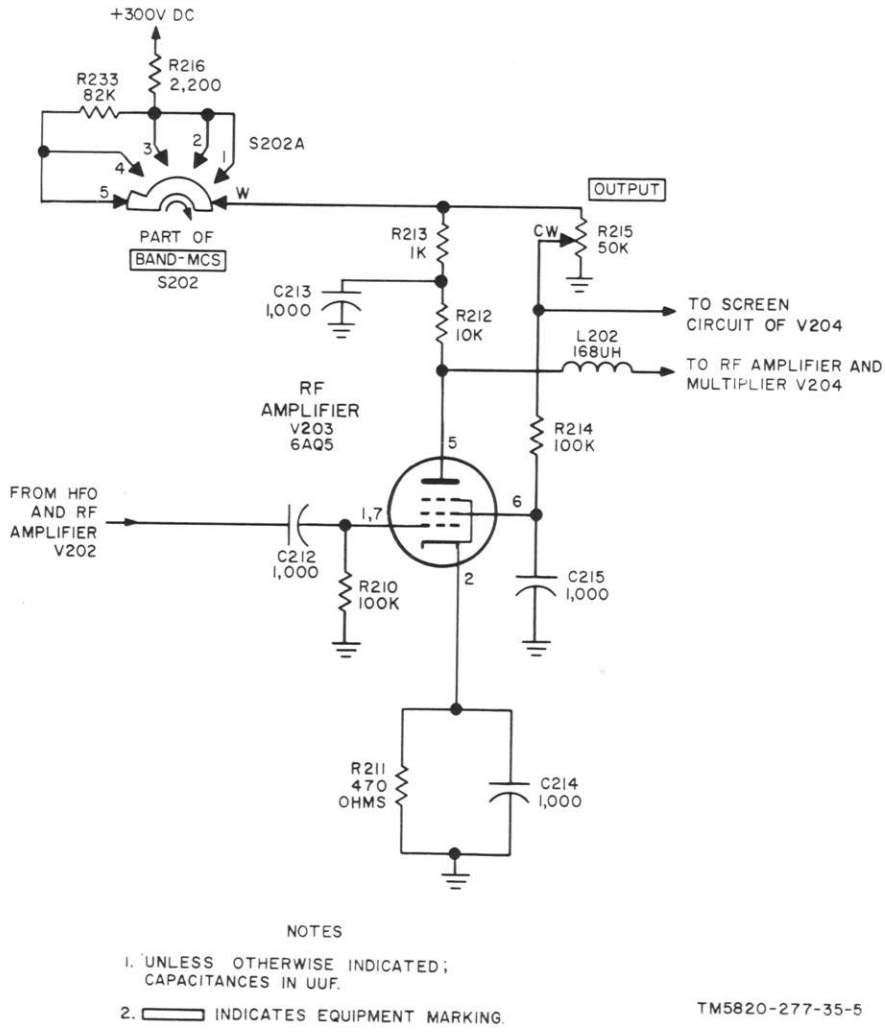


Figure 5. Rf amplifier V203, schematic diagram.

develops grid-leak bias for the stage across resistor R210. Resistor R211 and capacitor C214 provide cathode bias for the stage. This cathode bias protects the tube from excessive current if the input signal should fail.

b. When wafer S202A, part of BAND-MCS switch S202, is in position 1, 2, or 3 (labeled 2–4, 4–8, and 8–16, respectively), plate voltage is obtained from the 300-volt power supply through resistors R216, R213, and R212. Screen voltage is obtained through resistor R216, potentiometer R215, and resistor R214. When switch S202A is in position 4 or 5 (labeled 16–32 and 32–64, respectively) more stages of amplification are used, and it is desirable to reduce the gain of the stage. In those positions, resistor R233 is switched into the circuit, lowering plate and screen voltages and reducing stage gain. OUTPUT potentiometer R215 in the screen circuit is also in the screen circuit of V204 (para 7). It controls the gain of both stages and of the hfo section. Capacitor C213 and resistor R213 decouple the rf output from the power supply line. Capacitor C215 is the screen bypass capacitor.

c. The output of V203 is taken across load resistor R212 and fed through peaking coil L202 and C217 to rf amplifier and multiplier V204. Peaking coil L202 causes stage V203 to produce an output voltage of uniform gain in the frequency range of 2- to 4-mc.

7. Rf Amplifier and Multiplier V204 (fig. 6)

Tube V204, a 6AQ5 pentode, is used either as an rf amplifier or as a frequency doubler of the 2- to 4-mc signal from V203. The position of BAND-MCS switch S202 determines the particular operation of V204.

a. The 2- to 4-mc output of V203, coupled through C217 and applied to the control grid of V204, develops grid-leak bias across resistor R218. Resistor R219 and C218 provide cathode bias for the stage to limit current through the tube if the input signal should be cut off.

b. Screen grid voltage is obtained from the 300-volt dc power supply through R216, switch S202A, OUTPUT potentiometer R215, and R217. Switch S202A determines the gain of V204 (and V203 (para 6)). With S202 in position 4 or 5 (labeled 16–32 and 32–64, respectively) voltage dropping resistor R233 is inserted in the screen circuit to lower the screen grid dc voltage, and consequently the gain of the stage. The output level of V204 and V203 (para 6) is further controlled by OUTPUT potentiometer R215. Capacitor C216 is the screen bypass capacitor.

c. When the BAND-MCS switch is in position 1, plate voltage for V204 is obtained from the 300-volt power supply through rf choke L204 and the primary of transformer L203. Choke L204 and C220 decouple rf from the power supply line. The primary of L203, together with capacitors C224 and TUNING capacitor C225A, forms a tank circuit resonant in the 2- to 4-mc range. The voltage developed across the secondary of L203 is fed to HFO output jacks J208, J209, and J210. Resistor R223 across the secondary of L203 is a damping resistor used to allow uniform response throughout the 2- to 4-mc range. The line to the meter circuit (para 14) is taken from the input to these jacks.

d. When the BAND-MCS switch is in position 2, 3, 4, or 5 (labeled 4–8, 8–16, 16–32, and 32–64, respectively), plate voltage for V204 is obtained from the 300-volt dc power supply through resistor R220 and the primary of transformer L205. Resistor R220 and capacitor C221 decouple rf from the power supply line. The primary of L205, together with capacitors C244 and C224, and TUNING capacitor C225A, forms a tank circuit resonant in the 4- to 8-mc range (second harmonic of input frequencies). If the BAND-MCS switch is in position 2 (4–8), the voltage induced in the secondary is applied to HFO jacks J208, J209, and J210. If the switch is in position 2, 3, or 4, the output is coupled through C219 to the grid circuit of rf multiplier V205.

8. Rf Multipliers V205, V206, and V207 (fig. 7)

Tubes V205, V206, and V207, 6AQ5 type pentode amplifiers, are successive stages of frequency multipliers. Each multiplier stage amplifies the second harmonic of the preceding stage. The position of BAND-MCS switch S202 determines whether one, two, or three of these multipliers are used to produce the output frequency.

a. The input to these multipliers is from the 4- to 8-mc range output of V204. With the

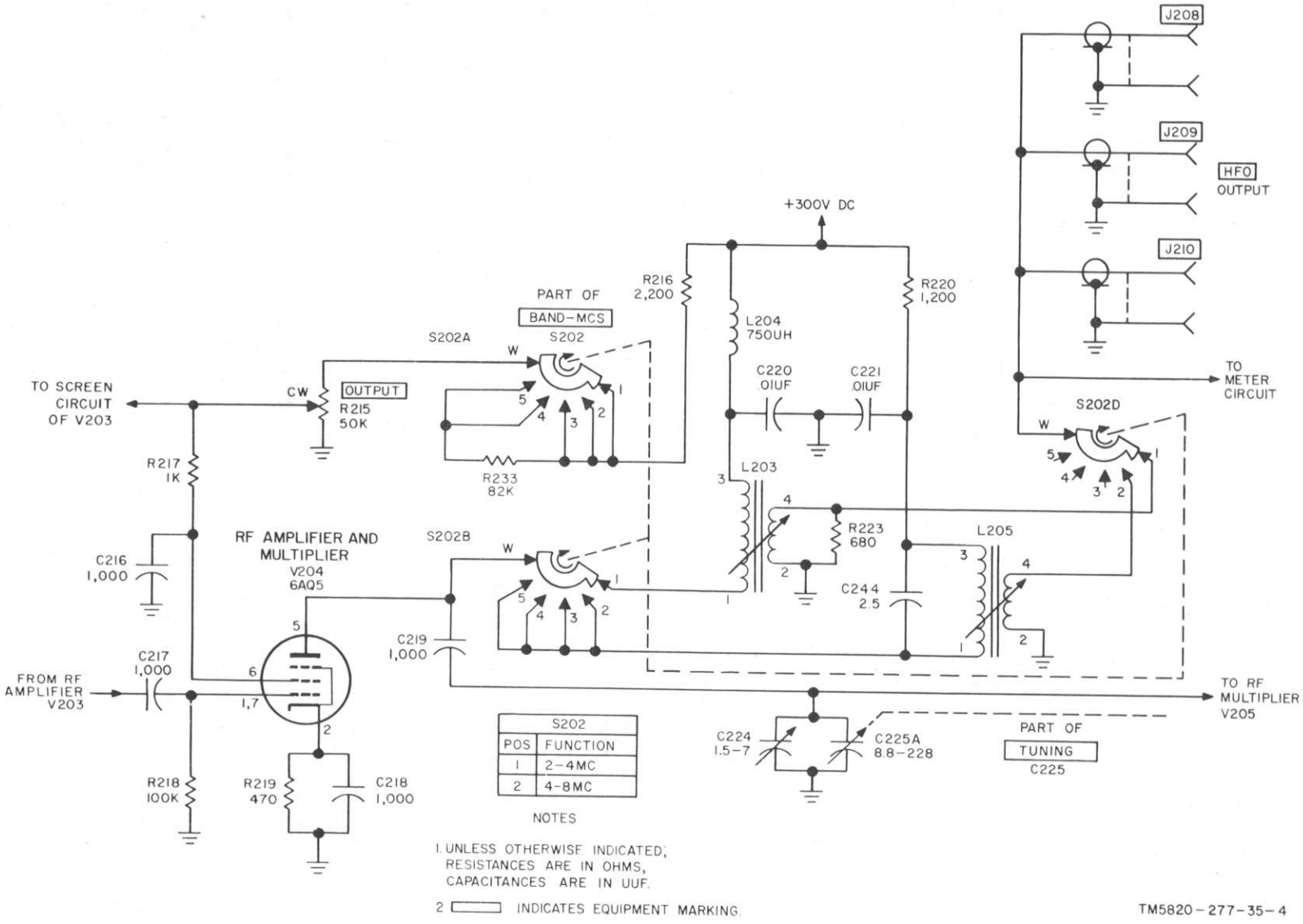


Figure 6. Rf amplifier and multiplier V204, schematic diagram.

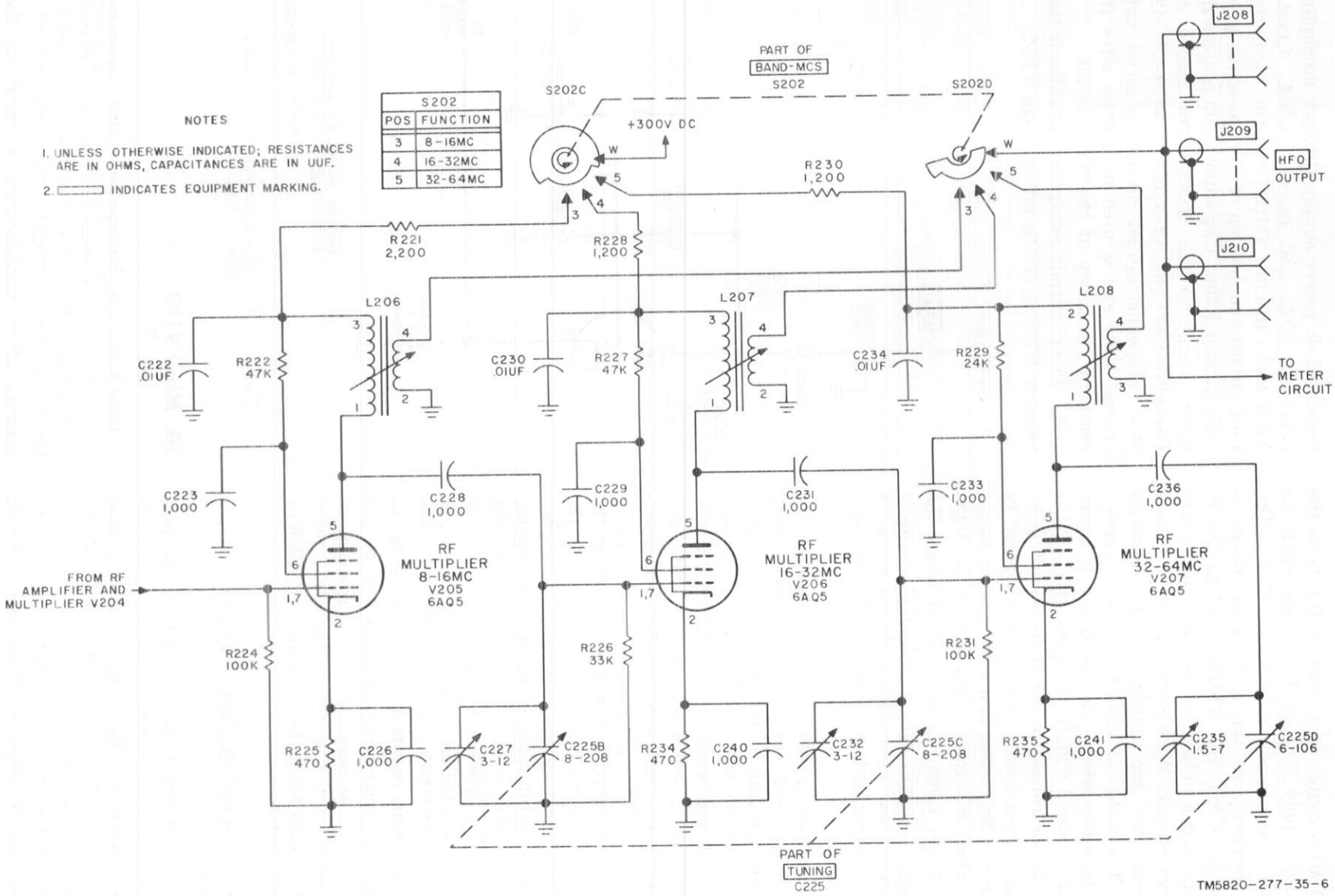


Figure 7. Rf multipliers V205, V206, and V207, schematic diagram.

BAND-MCS switch in position 3, B+ from the dc power supply is applied through S202C to the plate and screen circuits of V205. The input frequency in the 4- to 8-mc range is doubled by V205, and S202D connects the 8- to 16-mc range output to the HFO jacks and the meter circuit. With S202 in position 4, both V205 and V206 are connected to B+ through S202C. The output of V205 (8- to 16-mc range) is fed to V206 where the frequency is again doubled; switch S202D connects this output (16- to 32-mc range) to the HFO output jacks and the output meter circuit. With S202 in position 5, V205, V206, and V207 are connected to B+ through S202C. The output of V206 (16- to 32-mc range) is fed to V207 where the frequency is again doubled; S202D connects this output, now in the 32- to 64-mc range to the HFO output jacks and the output meter circuit.

b. The V205, V206, and V207 stages are very similar, and corresponding components have corresponding functions. For this reason, only stage V205 will be discussed. Grid-leak bias is developed across resistor R224. Cathode resistor bias is developed across R225 and C226. If excitation is removed, the bias developed across R225 protects the tube from possible excessive current. Capacitor C223 is the screen grid bypass capacitor and R222 is the screen voltage-dropping resistor. Capacitor C222 and resistor R221 make up a decoupling network to isolate plate circuit rf from the B+ line. The primary of transformer L206, together with coupling capacitor C228, trimmer C227, and TUNING capacitor C225B, makes up a tank circuit resonant to frequencies in the 8- to 16-mc range (second harmonic of the input signal). Depending on the position of S202, the rf output is fed to the HFO jacks through S202D from the secondary of L206 or coupled to V206.

9. 100-kc Crystal Oscillator V302B
(fig. 8)

Tube V302B, one triode of a 12AU7, is used as a 100-kc crystal oscillator against which the vmo is calibrated. To insure stability, this oscillator is located inside the temperature-controlled double oven.

a. When BEAT switch S104 is set to ON, plate voltage is obtained from the 150-volt regulated dc power supply through decoupling capacitor C322 and resistor R304. Crystal Y301 and capacitor C312 form the oscillating tank circuit and develop rf voltage across grid-leak resistor R306. Capacitor C309 couples the plate circuit to the crystal and blocks dc. Capacitor C311 (fig. 12 of TM 11–5820–277–12) is a rear panel adjust control in series with crystal Y301 and is used to slightly alter the resonant frequency of the tank circuit.

b. The rf output voltage across cathode load resistor R305 is fed to mixer stage V103.

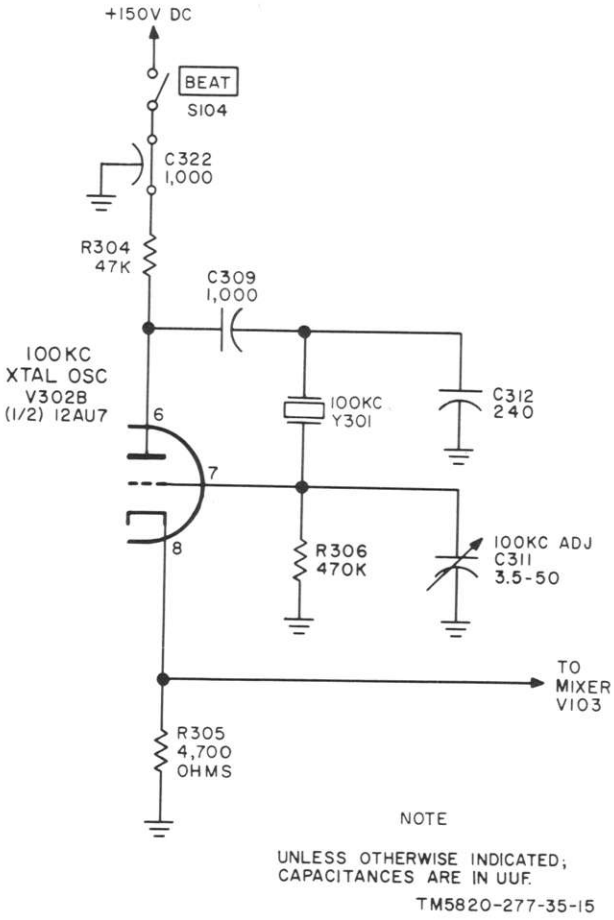


Figure 8. 100-kc crystal oscillator V302B, schematic diagram.

10. Mixer V103
(fig. 9)

Tube V103, a 6BE6 type pentagrid converter, is used to mix the output of cathode follower V302A (para 4) with one of the harmonics of 100-kc oscillator V302B. The difference frequency, after amplification, is used as the

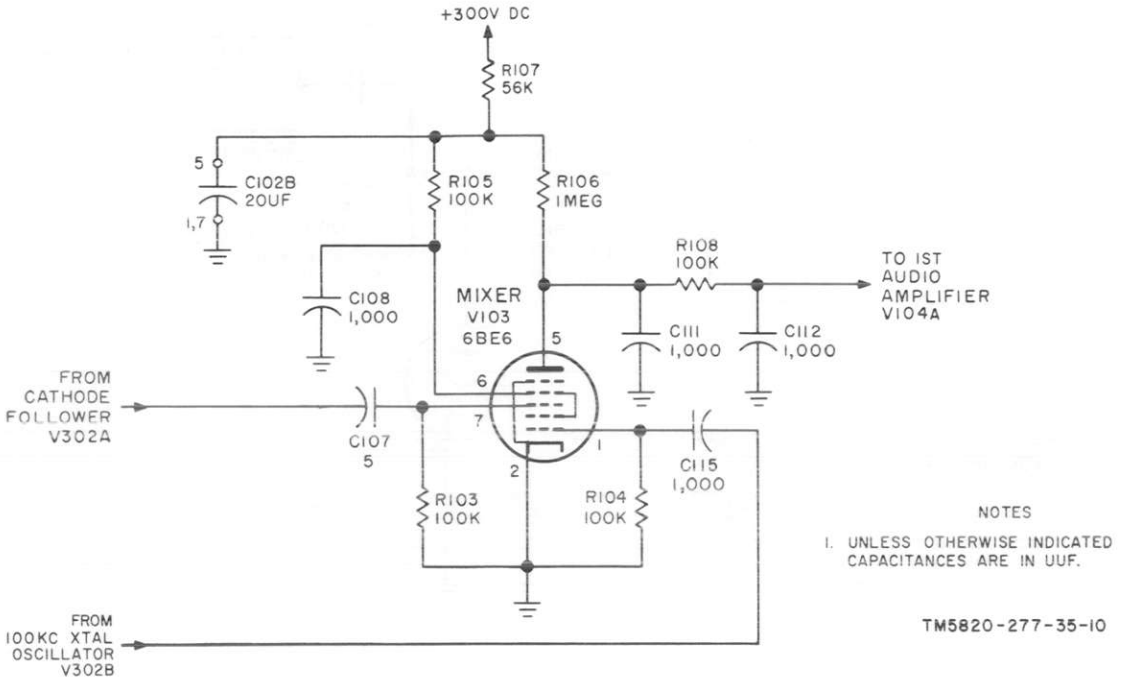


Figure 9. Mixer V103, schematic diagram.

guide in setting the CALIBRATE control in the variable master oscillator V301 stage.

a. The output of V302A is coupled to mixer grid pin 7 through coupling capacitor C107; the output of V302B is coupled to mixer grid pin 1 through coupling capacitor C115. Resistors R103 and R104 provide the necessary grid biasing for their respective control grids.

b. Screen grid voltage is obtained from the 300-volt dc power supply through resistors R105 and R107. Resistor R105 is the screen grid resistor and capacitor C108 is the screen bypass capacitor. Plate voltage is obtained from the 300-volt dc power supply through resistors R106 and R107. Capacitor C102B and resistor R107 form a decoupling network for both plate and screen circuits. The composite output (original, sum, difference, harmonic frequencies) is developed across plate load resistor R106 and is fed through a low-pass filter network, made up of resistor R108 and capacitors C111 and C112, to V104A for amplification. This low-pass filter network bypasses the high frequencies of the composite output to ground and passes through, to the next stage, only the lower frequencies. These lower audio-frequencies are the difference frequencies of the composite output developed by the mixing of different input frequencies.

11. First and Second Audio Amplifiers
(fig. 10)

Tube V104 provides two stages of audio amplification for the audio output of V103. The amplified signal at the output of V104B can be detected by a headset plugged into PHONES jack J105 and J106 or it can be indicated visually at ZERO BEAT indicator I303.

a. The audio output of V103 is coupled to the control grid of V104A through coupling capacitor C113. The input signal is developed across R110. Plate voltage is obtained from the 300-volt dc power supply through resistor R107 and plate load resistor R111. Capacitor C102B and resistor R107 are the same decoupling network used in stage V103. The amplified audio output to stage V104B is taken across plate load resistor R111.

b. The output of V104A is coupled to the control grid of V104B through coupling capacitor C114, and is developed across resistor R112. Plate voltage is obtained from the 300-volt dc power supply through load resistor R113. The

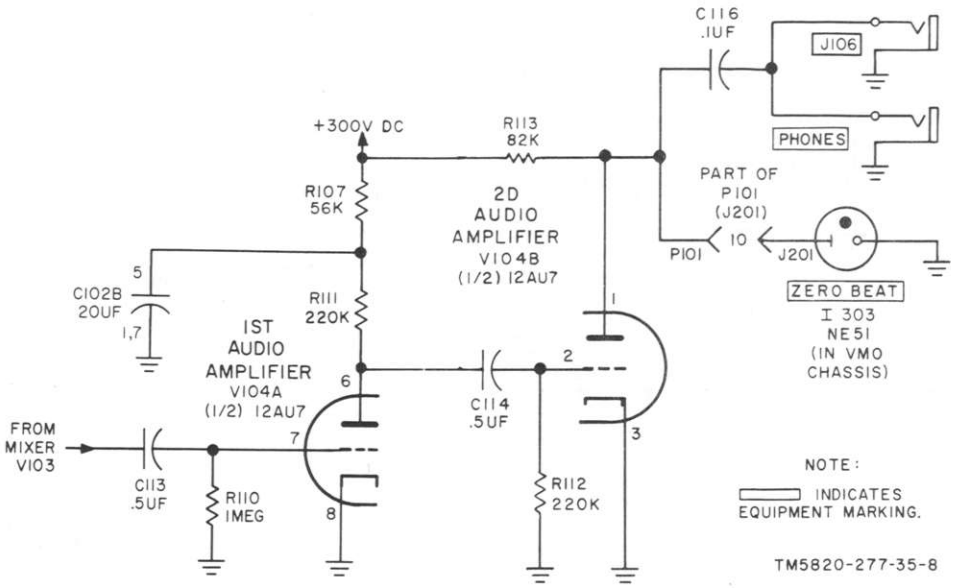


Figure 10. First and second audio amplifiers, schematic diagram.

amplified audio output developed across the load resistor is coupled to the output phone jacks J105 and J106, through coupling capacitor C116. The audio output is applied directly across neon ZERO BEAT indicator I303.

c. Neon indicator I303 lights when the plate voltage of V104B rises above a predetermined value. When zero beat occurs, no signal is applied to the grid of V104B. Tube V104B draws a relatively heavy plate current and the plate voltage drops to extinguish I303. When a signal is present at the grid of V104B the grid bias developed across R112 drops the plate current and plate voltage rises to light I303.

12. Ifo Section
(fig. 11)

Tube V201 is used in two separate stages. The V201A section is the intermediate frequency crystal oscillator operating in the frequency range of 3.2 to 3.9 mc. The V201B section amplifies the oscillator output.

a. Crystal Y201 is a plug-in crystal and may be of any frequency between 3.2 and 3.9 mc. Crystal Y201 and capacitor C201 form the oscillating tank circuit and develop an rf voltage across grid resistor R201. Capacitor C242 blocks plate voltage dc from the crystal. Plate voltage is obtained from the 150-volt regulated dc power supply through resistors R202 and R203 and IFO switch S102 (fig. 35). Resistor R203 and capacitors C202 and C203 make up an rf decoupling network between the plate circuit and the power supply. The rf output is taken across load resistor R202 and fed to amplifier V201B through coupling capacitor C204.

b. The signal from V201A develops grid-leak bias across resistor R205. Plate voltage is obtained from the 150-volt regulated dc power supply through decoupling network R204 and C206 and the primary of transformer L201. The primary of L201 and capacitor C207 make up a tank circuit that is resonant at approximately 3.5 mc, midway in the frequency range of 3.2 to 3.9 mc. The amplified rf developed across the secondary of L201 is fed to the output meter circuit and to IFO output jacks J205, J206, and J207.

13. Beat Frequency Oscillator V105
(fig. 12)

Tube V105, a 6AQ5 type pentode, is used in a crystal-controlled oscillator and amplifier circuit to supply an rf output in the frequency range of 300 to 1,000 kc. Double-pole, double-throw switch S105 selects one of the two possible bfo frequencies by switching either crystal Y101 or crystal Y102 into operation. The fre-

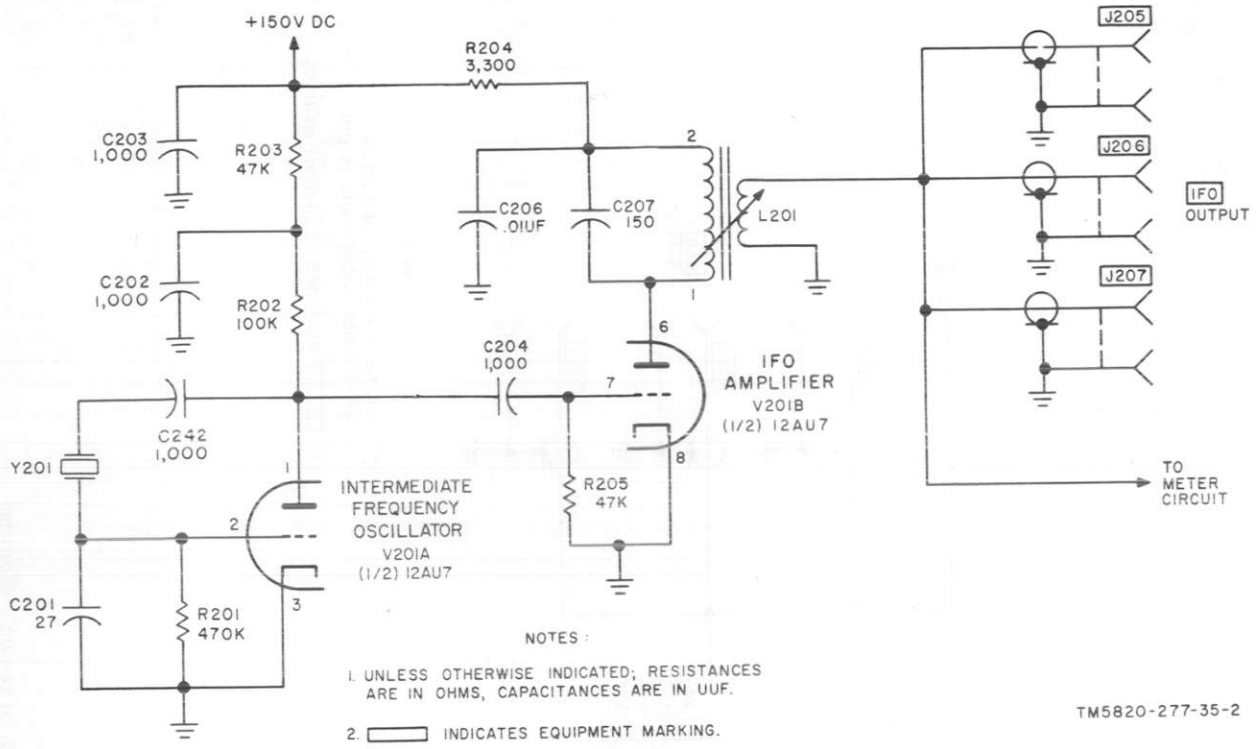


Figure 11. Ifo oscillator V201A and ifo amplifier V201B, schematic diagram.

quencies of crystals Y101 and Y102 are predetermined by operation requirements but must be in the range of 300 to 1,000 kc. The cathode, control grid, and screen grid of the tube make up the oscillator circuit. The screen grid acts as the plate of a conventional triode crystal oscillator. The rf on the screen grid controls the electron flow from the cathode to the plate of V105. The control action of the screen grid creates a corresponding amplified rf in the plate circuit.

a. The selected crystal and capacitor C122 make up the oscillator tank circuit and develop an rf voltage across grid-leak resistor R117. Capacitor C123 blocks dc from the crystal and couples rf to the screen grid. Screen grid voltage is obtained from the 150-volt regulated dc power supply through voltage-dropping resistor R114 and BFO switch S106. Capacitor C121 decouples rf from the power-supply line.

b. Plate voltage is obtained from the 300-volt dc power supply through resistor R118 and load coil L102. Resistor R118 and capacitor C119 decouple rf from the power supply. The rf output is developed across inductor L102 and coupled by capacitor C120 to the arm of potentiometer R116. The output from R116 is fed to the meter circuit and to BFO output jacks J102, J103, and J104. The bfo ADJ potentiometer (R116) varies the bfo output level as required.

14. Output Meter Circuit

(fig. 13)

Output meter M301, calibrated in milliamperes, indicates a dc level proportional to the rf voltage fed to one of four germanium diodes. METER switch S107 selects the desired circuit. The rf voltage is taken across the HFO, IFO, and BFO jacks for the respective readings. When the S201 is operated to the VMO position, the output is taken from the output of cathode follower V302A. Capacitors C106, C118, C208, and C238 couple rf and block dc; the germanium diode in each circuit rectifies the respective rf voltages. Resistors R102, R115, R206, and R232 are individual series dropping resistors in the vmo, bfo, ifo, and hfo circuits respectively. Capacitors C105, C117, C209, and C237 are individual rf bypass capacitors for the specific circuits and C318 is connected directly across the meter for the same purpose.

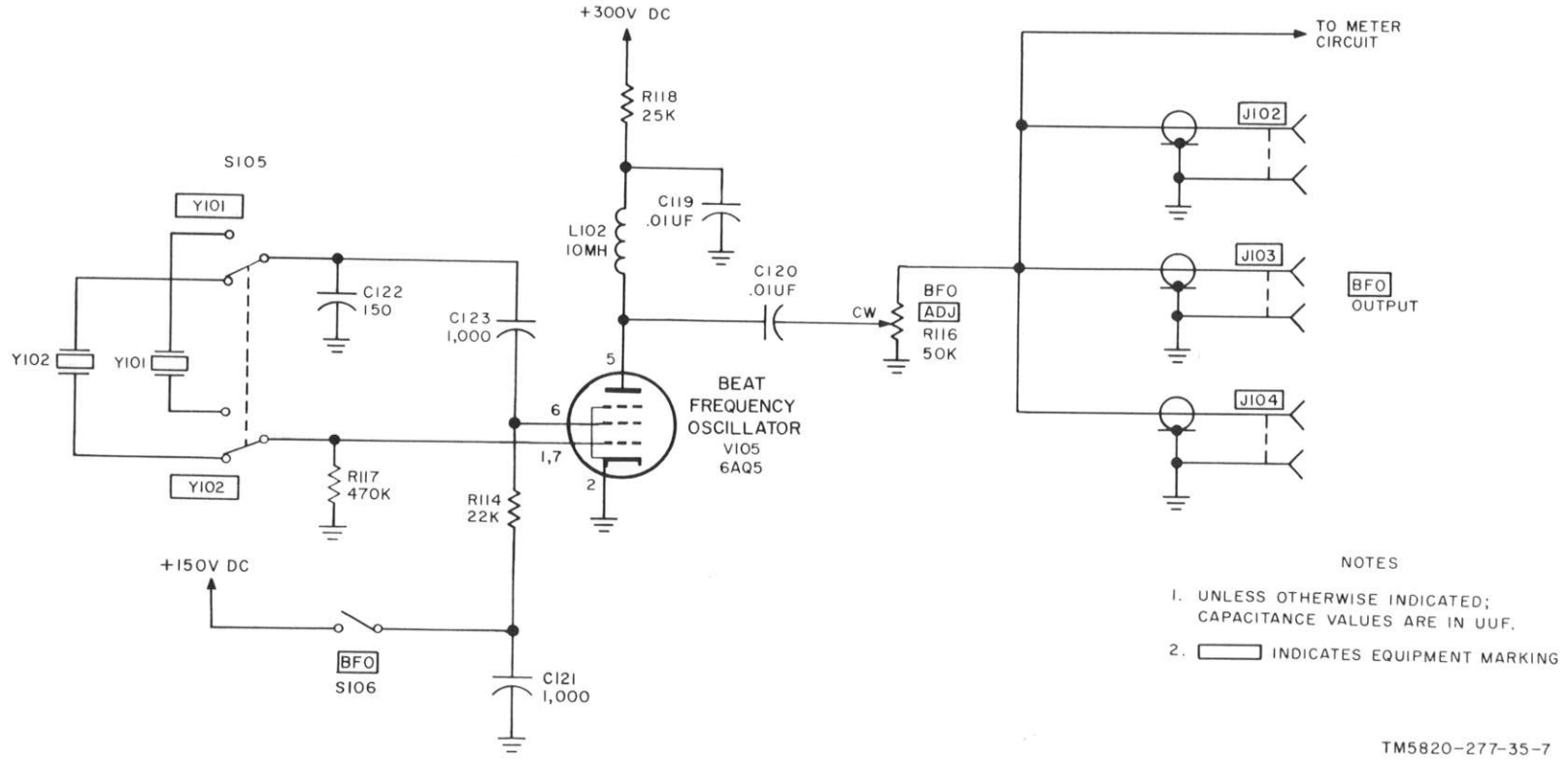


Figure 12. Beat frequency oscillator V105, schematic diagram.

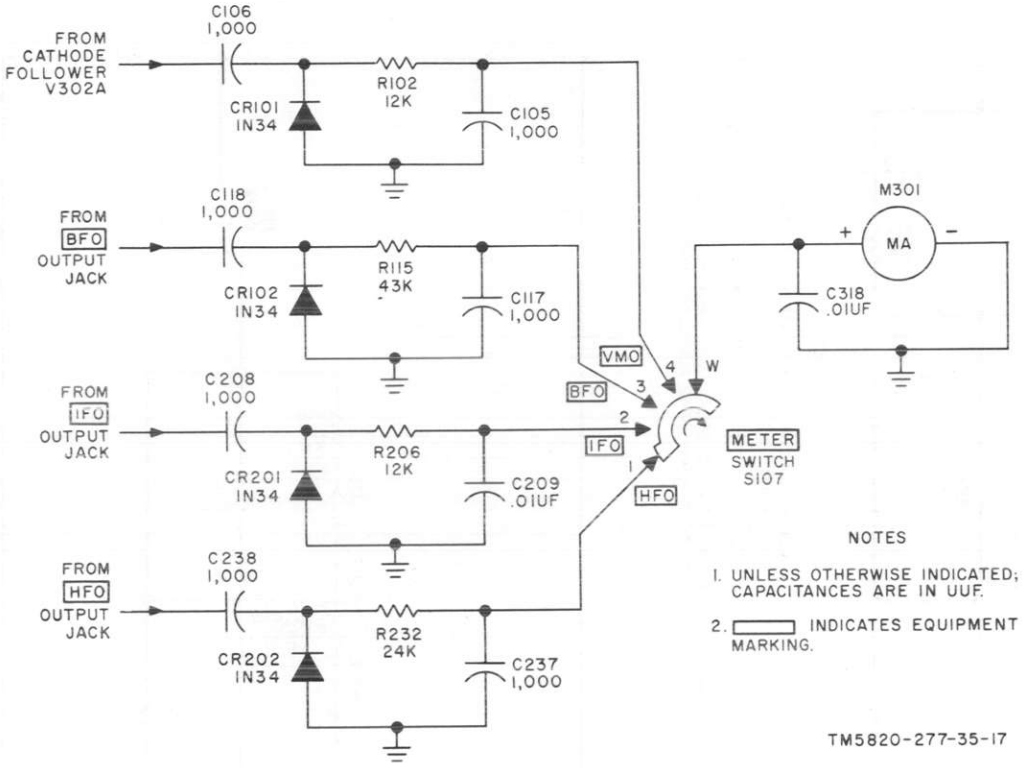


Figure 13. Output meter circuit, schematic diagram.

15. Oven Circuit
(fig. 14)

The oven circuit consists of an inner and outer oven, each of which is temperature controlled. The temperature of the outer oven is controlled by thermostat S303 in series with heating elements R309 and R310. The temperature of the inner oven is controlled by the combination of thermostat S301 and relay contacts of K301 in series with heating elements R307 and R308. The coil of relay K301 is controlled by thermostat S301. The entire assembly contains a large mass of metal and insulating materials distributed through its cross section so that heat inertia is high and consequently temperature is extremely stable.

a. Outer oven thermostat S303 is connected in series with heating elements R309 and R310 across the fused main power input. Shunting the 60° C thermostat are resistor R314 and capacitor C316. This resistance-capacitance (RC) combination suppresses sparking across the contacts during the opening and closing of the thermostat switch. OUTER OVEN indicator light I304, in series with current limiting resistor R315, is shunted across heating elements R309 and R310. When the area around oven thermostat S303 is below 60° C, the thermostat closes and allows current to flow through the heating elements and indicator I304. When the temperature is 60° C or higher, S303 opens and the heating elements and indicator light are disconnected. During normal operation, indicator I304 cycles on for about 5 seconds and off for about 30 seconds.

b. Inner oven thermostat S301 is in series with the parallel combination voltage dividing resistor R317 and the coil of K301 across the fused main power input. When the temperature around oven thermostat S301 is below 70° C, the thermostat is open and relay K301 is deenergized. In the deenergized position, the relay contacts of K301 are closed and current flows through inner oven heating elements R307 and R308 and through INNER OVEN indicator I301 in series with current limiting resistor R312. When the inner oven temperature is 70° C or higher, thermostat S301 closes,

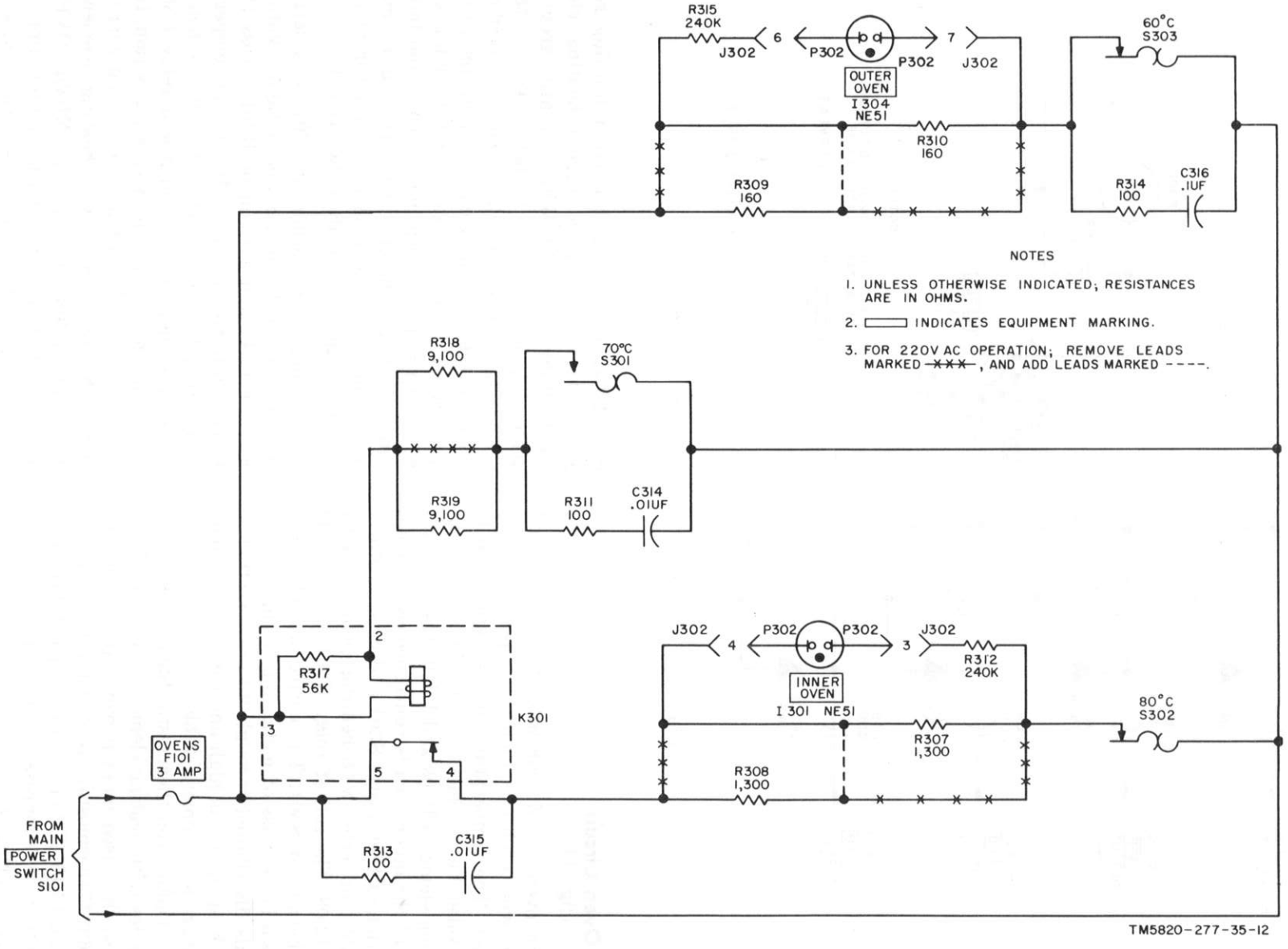


Figure 14. Oven circuit, schematic diagram.

energizing relay K301. This opens the contacts of K301 and prevents current from flowing through the heating elements and the indicator light. If thermostat S301 should fail to operate and the inner oven heating elements continue to heat the oven, safety thermostat S302, located inside the oven, would open at 80° C, and thus interrupt current flow through the heating elements and indicator light. During normal operation, the INNER OVEN indicator cycles on for approximately 90 seconds and off for approximately 90 seconds. Resistor R313 in series with capacitor C315, and resistor R311 in series with capacitor C314 suppress sparking across the contacts during the opening and closing of thermostat S301 and relay K301.

c. The oven circuit is normally wired for 110-volt ac operation. When wired for 220-volt ac operation (note 3, fig. 14), the heating elements of each oven are connected in series rather than in parallel. In addition, the combination of parallel resistors R318 and R319 is added in series with thermostat S301.

16. Power Supply
(fig. 35)

Three voltage outputs are produced by the power supply stages: 300 volts dc, 150 volts regulated dc, and 6.3 volts ac, 50 or 60 cycles, depending on the main power frequency.

a. The main power comes into the primary of transformer T101 through plug P201 and double-pole, single-throw POWER switch S101. The transformer primary circuit is fused by fuse F102. In parallel with the primary of T101 (but before F102), connections are made to the oven circuits (para 15) through fuse F101. Capacitors C245 and C246, connected to ground from each of the power input lines, filter any rf in the line from the power supply.

b. Transformer T101 has three secondary windings: The 6.3-volt ac winding (terminals 8 and 9) supplies filament voltage for all tubes except V101 and V102. The 5-volt ac winding (terminals 10 and 11) supplies filament voltage for full-wave rectifier V101. The center-typed 350-volt winding is applied to the plates of rectifier V101.

c. The pulsating dc output from V101 is filtered by choke L101 and capacitors C101 and C102A. The 300-volt dc output is applied directly to 300-volt B+ points throughout the equipment and through HFO switch S103 to the plates and screen grids of tubes in V202 through V207 in the hfo section.

d. The 300-volt dc output is also applied across R101 in series with voltage regulator tube V102. The internal resistance of type OA2 voltage regulator varies with applied voltage to maintain a constant 150-volt dc drop across the tube. The remainder of the applied voltage is dropped across R101. This 150-volt regulated dc is applied directly to 150-volt B+ points and through IFO switch S102 to the plate circuits of V201; through BEAT switch S104 to the plate circuit of V302B; and through BFO switch S106 to the screen grid circuit of V105. Capacitor C104 decouples any rf in the line to ground.

CHAPTER 2

TROUBLESHOOTING

Section I. GENERAL TROUBLESHOOTING TECHNIQUES

17. General Instructions

a. Troubleshooting at field and depot maintenance level includes all the techniques outlined for organizational maintenance and any special or additional techniques required to isolate a defective part. The field and depot maintenance procedures are not complete in themselves but supplement the procedures described in TM 11–5820–277–12. The systematic troubleshooting procedure, which begins with the operational and sectionalization checks that can be performed at the organizational level, must be completed by means of sectionalizing, localizing, and isolating techniques.

b. During troubleshooting, it may be necessary to remove the power supply chassis from the variable frequency oscillator. To make voltage and performance tests with the power supply removed, connect extension cable assemblies W101, W102, and W103 between the power supply chassis and the other chassis (fig. 15 and para 24, TM 11–5820–277–12). If resistance checks or repair procedures on the power supply or rf multiplier chassis are necessary, and if procedures will involve 5 minutes or more, it may be possible to avoid a long warmup period by leaving the POWER switch on and removing the POWER fuse. The components on the two chassis can be handled safely while the ovens remain heated.

Warning: **Do not touch any terminals on E301 or E302 (fig. 19).**

18. Organization of Troubleshooting Procedures

a. General. The first step in servicing the variable frequency oscillator is to sectionalize the fault. Sectionalization means tracing the fault to a major section. 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, arcing, and shorted transformers can often be located by sight, smell, and hearing. The majority of faults, however, must be isolated by checking voltages and resistances.

b. Sectionalization. Listed below is a group of tests arranged to reduce unnecessary work and to aid in tracing trouble in a defective variable frequency oscillator. The variable frequency oscillator consists of six functional sections: vmo section, hfo section, ifo section, bfo section, calibrating section, and the power supply section. The first step is to locate the section at fault by the following methods:

(1) *Visual inspection.* The purpose of visual inspection is to locate faults without testing or measuring circuits. The output meter readings, conditions of indicating lights, or other visual signs (para 22, TM 11–5820–277–12) should be observed and an attempt made to trace the fault to a particular section.

(2) *Operational tests.* Operational tests frequently indicate the general location of trouble. In many instances, the tests will help in determining the exact nature of the fault. Use the equipment performance checklist (TM 11–5820–277–12) as an operational test.

c. Localization. The tests listed below will aid in locating the trouble. First, localize the trouble to a single stage or circuit, and then isolate the trouble within that circuit or stage by voltage, resistance, and continuity measurements. Use the following methods of trouble localization:

(1) *Troubleshooting chart.* The trouble symptoms listed in the chart (para 21*d*) will aid in localizing trouble to a component part.

(2) *Voltage and resistance measurements.* Use resistor and capacitor color codes (fig. 32 and 33) to find the value of the components. Use voltage and re-

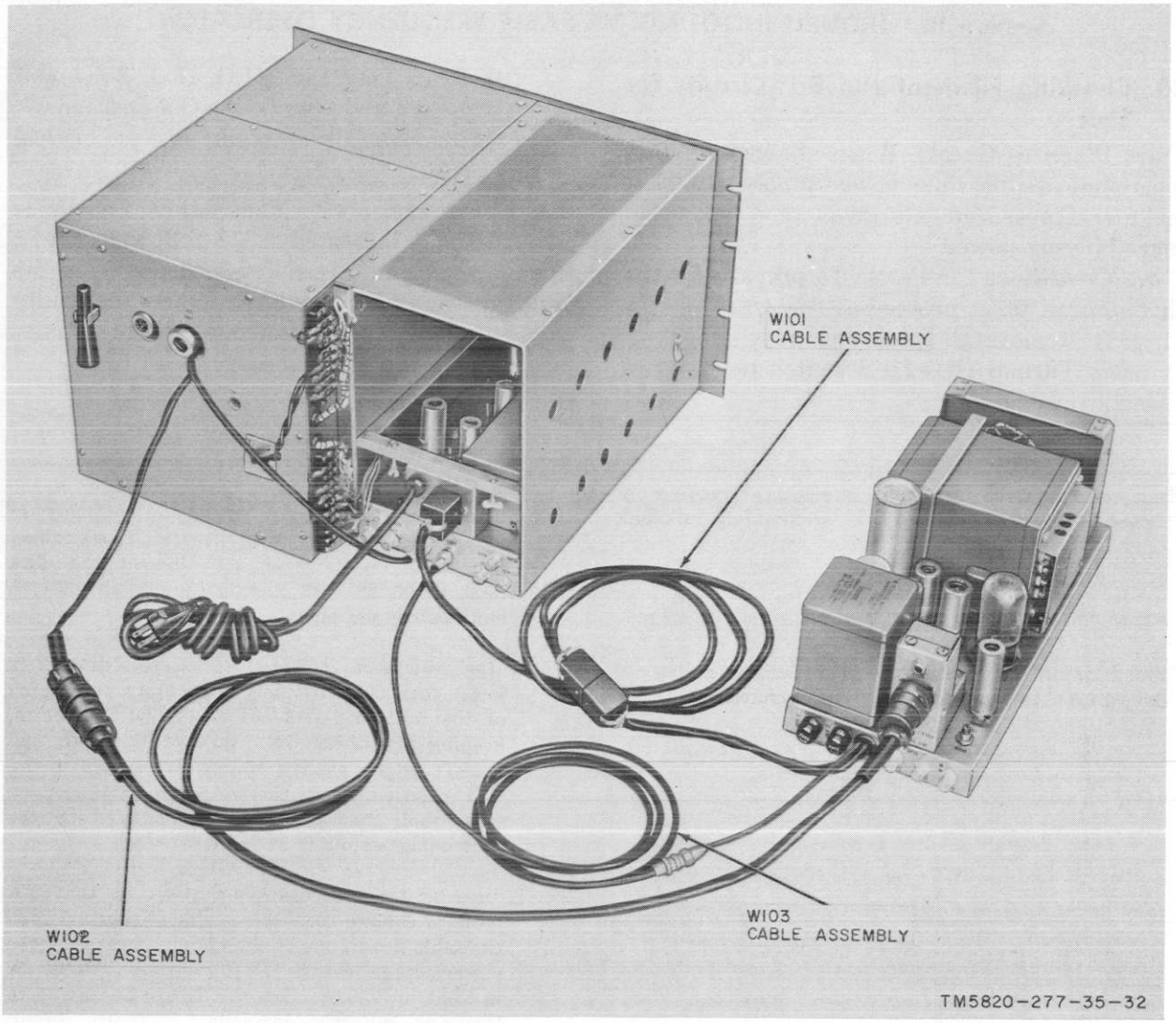


Figure 15. Extension cable connections.

sistance diagrams (fig. 22–25) and the table in paragraph 24 to find normal readings and compare them with readings taken.

(3) *Stage-gain chart.* The stage-gain chart (para 24) will help locate hard-to-find troubles in the individual stage or circuit.

(4) *Intermittent troubles.* In all these tests, the possibility of intermittent troubles should not be overlooked. If present, this type of trouble may often be made to appear by tapping or jarring the equipment. Check the wiring and connections to the chassis of the variable frequency oscillator.

19. Test Equipment Required

The following chart lists test equipment for troubleshooting the variable frequency oscillator and gives the assigned common names:

Test equipment	Common name
Communications receiver	Receiver
Multimeter, Meter ME–26B/U	Multimeter
Test Set, Electron Tube TV–7/U[a]	Tube tester

[a] Test Set, Electron Tube TV-2/U is authorized at fifth echelon.

Section II. TROUBLESHOOTING VARIABLE FREQUENCY OSCILLATOR

20. Checking Filament and B+ Circuits for Shorts

a. When to Check. When abnormal symptoms indicate possible power-supply troubles, make the measurements given in *c* below before applying power.

b. Conditions for Tests. To prepare for the short-circuit tests, proceed as follows:

(1) Remove all tubes and pilot lamps.
(2) Turn BAND-MCS switch to 32–64.
(3) Place POWER, HFO, IFO, BFO, and BEAT switches in the ON position.
(4) Remove all crystals, except crystal Y301.

c. Measurements. Make the resistance measurements indicated in the following chart. If abnormal results are obtained, perform the outlined isolating procedure. When the faulty part is found, repair the trouble before applying power to the equipment.

Point of measurement	Normal indication	Isolating procedure
From terminal 7 on terminal board E302 to ground.	Resistance reading of approximately 1.6 ohms.	A zero resistance indicates a short circuit in the filament or pilot light wiring, or possibly in capacitor C239. Disconnect all interchassis cables and check resistance in the filament and pilot light wiring in each chassis (fig. 34 and 35) to sectionalize the short.
From terminal 9 on terminal board E302 to ground.	Resistance reading of approximately 200,000 ohms.	If the resistance indicated on the multimeter is lower than 200,000 ohms, alternately place each of the following switches in the OFF position, keeping all others ON: HFO, IFO, BFO, and BEAT. If the placing of any one switch in the OFF position brings the resistance reading back to normal, then the circuit designated by the controlling switch is at fault. If none of the switches when placed in the OFF position change the low resistance reading, then the fault lies in one of the circuits located in the power-supply chassis (V101 through V105) or in V301 or V302A. Refer to figure 34 and 35 to locate the defective component in faulty circuit. To gain access to the VMO chassis, refer to paragraph 26.

21. Localizing Troubles

a. General. Procedures are outlined in the following chart for localizing troubles to the vmo, hfo, bfo, ifo, calibrating, and power supply sections and to a stage within the various sections. When use of the procedures results in localization of trouble to a particular stage, use the techniques outlined in paragraphs 22 and 24 to isolate the trouble to a particular part.

b. Use of Chart. The troubleshooting chart supplements the operational checks detailed in the equipment performance checklist of TM 11–5820–277–12. When no operational symptoms are known, begin with item 1 of the equipment performance checklist and proceed until the trouble is located.

Caution: **If operational symptoms are not known, or they indicate the possibility of short circuits within the variable frequency oscillator, make the short-circuit checks described in paragraph 20 before applying power to the unit.**

c. Conditions for Tests. Checks outlined in the chart for correcting frequency calibration require that the variable frequency oscillator be warmed up for at least 48 continuous hours. Checks for determining correct operation of the oven require that the variable frequency oscillator be warmed up for at least 2 hours.

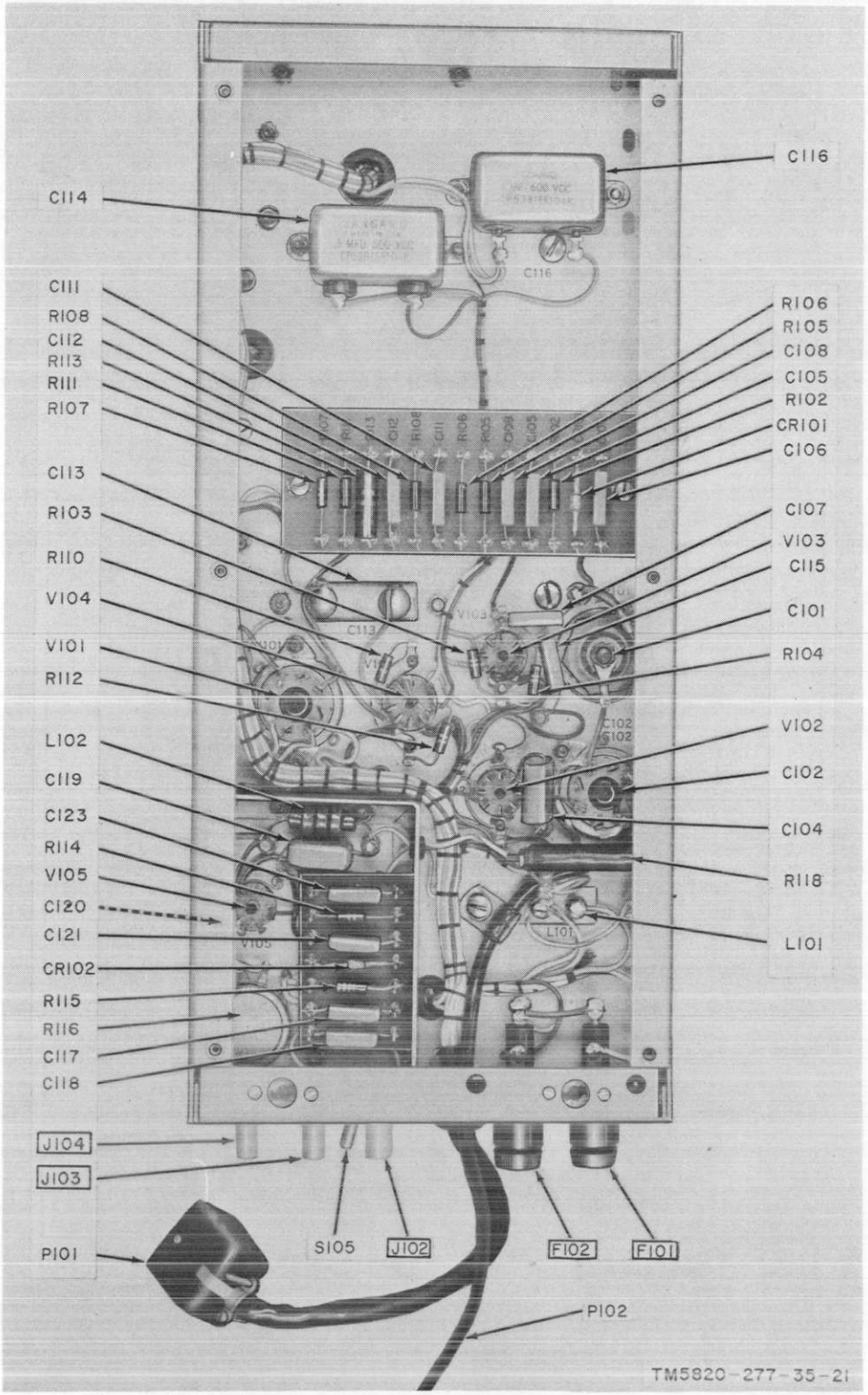


Figure 16. Power supply chassis, bottom view.

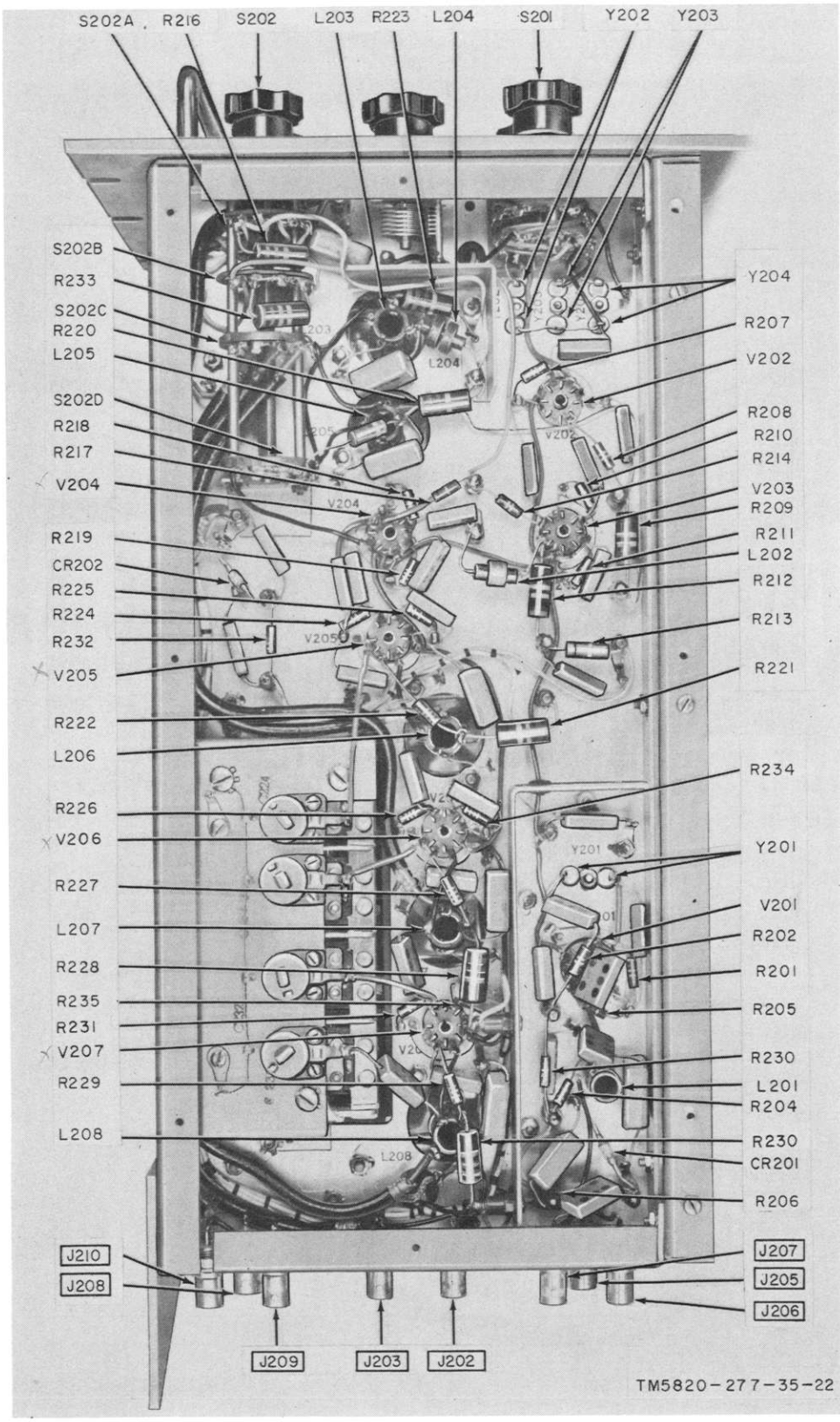


Figure 17. Rf multiplier chassis, bottom view.

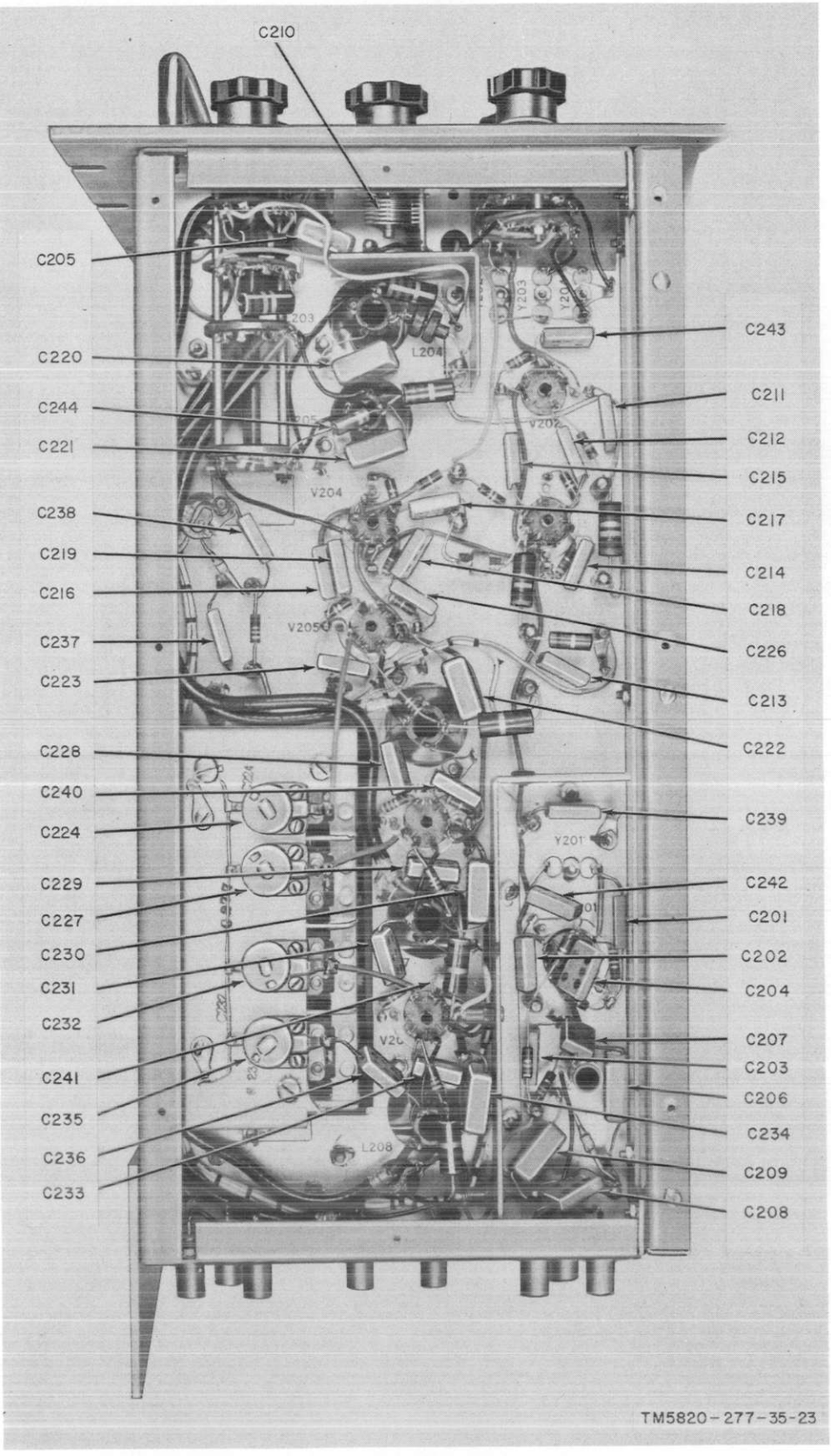


Figure 18. Rf multiplier chassis, bottom view, showing capacitors.

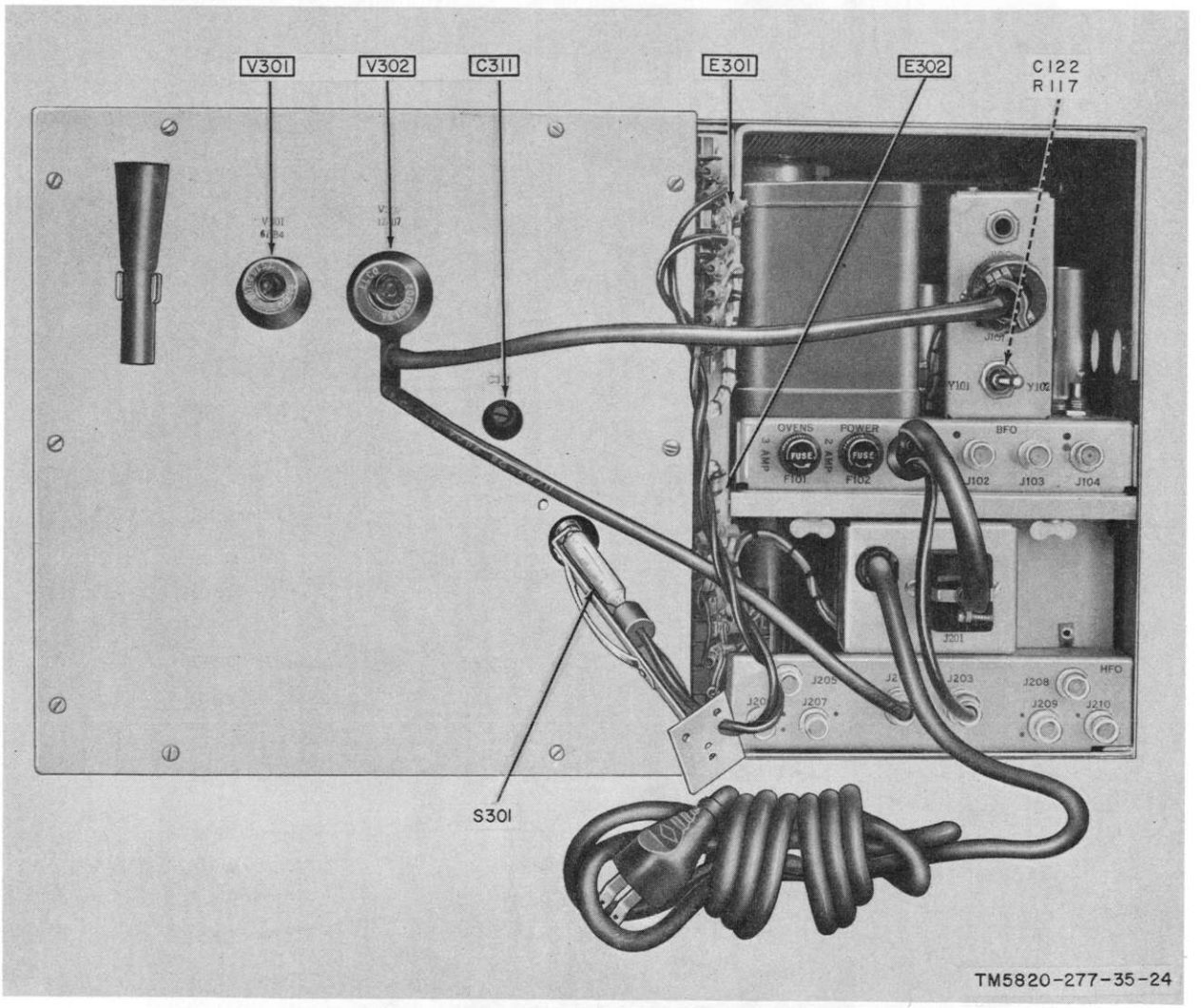


Figure 19. Vmo chassis, rear view.

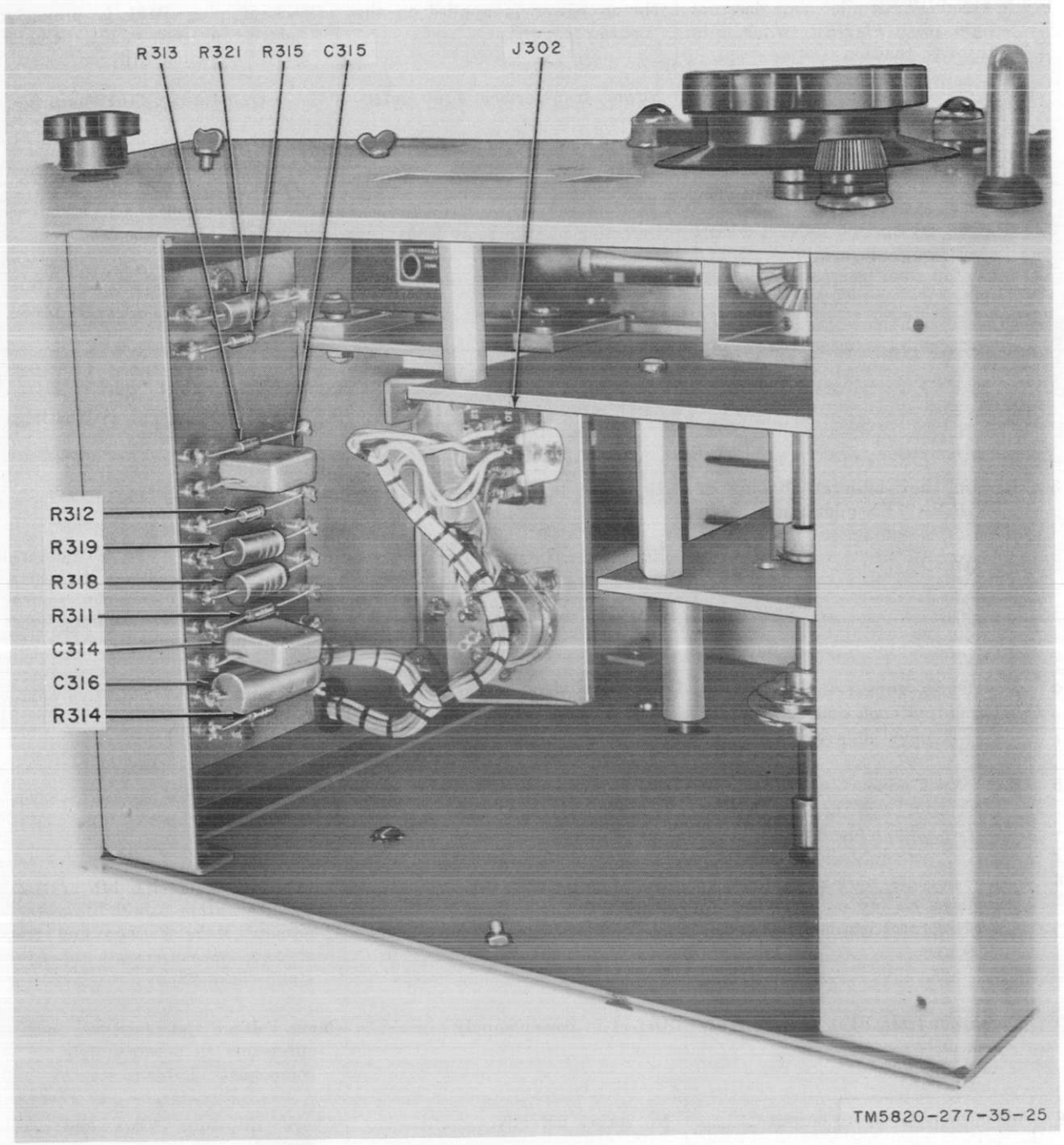


Figure 20. Vmo chassis, bottom view.

d. Troubleshooting Chart.

Item	Symptom	Probable trouble	Procedure
1	MAIN POWER pilot lamp does not light when POWER switch is in the ON position.	No ac power is applied to the power supply.	Check if plug P101 is properly seated in jack J201. Check POWER switch S101.
		Power transformer T101 defective.	Check transformer T101 (para 23).
		Open indicator light circuit	Check plug P302 for proper seating in jack J302.
2	OUTER OVEN and INNER OVEN pilot lamps do not blink on and off for their correct time durations.	Defective plug-in relay K301	Check by substitution.
		Defective thermostat S301, S302, or S303.	Make continuity check to determine defective thermostat (para 22).
		Defective inner or outer oven heating elements.	Confirm by resistance measurements (para 23). Refer to para 27 for replacement instructions for S302 and S303.
3	Erratic short-interval blinking of INNER OVEN pilot lamp.	Defective plug-in relay K301	Check by substitution.
		Defective thermostat S301	Make continuity check across terminals 2 and 4 on terminal board E301. If an open occurs immediately after blinking, replace defective thermostat.
4	Key clicks appear in hfo, ifo, or bfo output each time the OUTER OVEN pilot lamp blinks.	Defective spark suppressor network R314 and C316.	Check and replace defective component.
5	Key clicks appear in hfo, ifo, or bfo output each time the INNER OVEN pilot lamp blinks.	Defective spark suppressor network R311 and C315.	Check and replace defective component.
6	Other outputs normal but insufficient or no bfo output with bfo ADJ control turned completely clockwise.	Bfo stage defective	Check tube V105 and bfo crystal by substitution. Check bfo meter circuit. Make voltage and resistance measurements of bfo stage (para 22).
7	No output from BFO, IFO, or HFO jacks.	Defect in power supply	Make voltage and resistance measurements on power supply components. Refer to step 15.
8	Insufficient or no ifo output	Ifo stages defective	Check ifo tube V201 and ifo crystal.
			Make voltage and resistance measurements of ifo stages V201A and V201B and ifo meter circuit.
			Align L201 (para 30).
			Make stage gain measurement of V201B (para 24).

Item	Symptom	Probable trouble	Procedure
9	Insufficient or no hfo output with XTAL switch S201 in positions 1, 2, or 3, and with OUTPUT control R215 turned completely clockwise.	Defect in rf multiplier stages V205, V206, or V207.	Place the BAND-MCS switch S202 in the 2–4 mc position to determine if there is a normal output from V204. If there is no output, proceed to step 11. If V204 has a normal output, move switch S202 to each of the next positions (8–16, 16–32, 32–64) until the faulty multiplier stage is located. Make voltage and resistance measurements of defective stage. Align the plate tank circuit of the defecitve stage (para 31). Check contacts 3, 4, and 5 on wafer switch S202D. Check hfo meter circuit. Align V204 plate tank circuit L203 and C224 (para 31).
10	Hfo output normal except on one of the crystal positions.	Defective crystal	Replace crystal corresponding to switch position (1, 2, or 3) that produces no output or low output.
11	Insufficient or no hfo output with XTAL switch in VMO position. METER switch in VMO position indicates normal vmo output.	Defect in stage V202, V203, or V204.	Make voltage and resistance measurement of stages V202, V203, and V204. Locate defective component and replace.
12	Insufficient or no hfo output with XTAL switch S201 in VMO position. METER switch S107 in VMO position indicates insufficient or no vmo output.	Output of V302A is not applied to amplifier and multiplier section of hfo.	Check plug P303 for proper seating in jack J202.
		Defective component in stages V301 or V302A.	Check stages V301 and V302. Refer to figure 24 and make voltage and resistance checks at P301. Refer to paragraph 26 for procedure to gain access to oven-located components.
13	No zero beat indication when operating vmo with BEAT switch on and adjusting CALIBRATE control L301. Meter indicates normal vmo output.	Defective stages V103, V104A, V104B, V302B.	Make voltage resistance measurements of stages V103, V104A, and V104B. Make stage gain measurement of stages V104A and V104B (para 24).
		Defective components in stage V302B.	Check crystal Y301. Make voltage and resistance measurements at P301 (fig. 24). Refer to paragraph 26 for removal procedures on this subchassis.

Item	Symptom	Probable trouble	Procedure
14	Required to make more than two complete revolutions of CALIBRATE control L301 to calibrate vmo on any other frequency in the 2–4 mc band after vmo has been calibrated for 2 mcs.	100-kc crystal Y301 slightly off frequency.	Align 100-kc calibration circuit (para 34).
15	No B+ available at any of the circuits. MAIN POWER pilot lamp lighted.	Defective transformer T101	Check transformer T101 (para 23).
		Defect in stages V101 or V102	Make voltage and resistance measurements of stages V101 and V102.

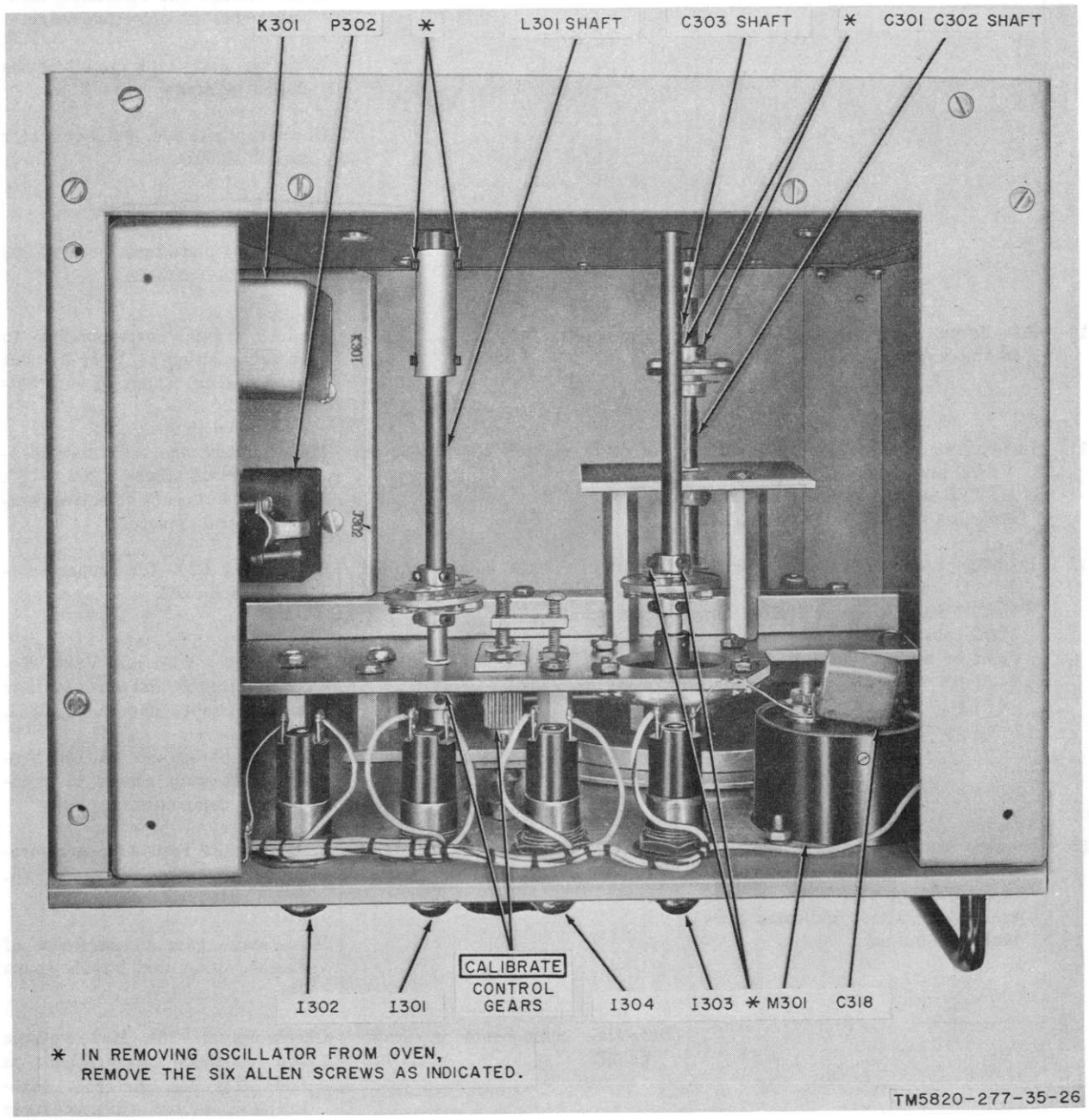


Figure 21. Vmo chassis, top view.

22. Isolating Trouble Within Stage

When trouble has been localized to a stage, use the following techniques to isolate the defective part:

a. Test the tube with a tube tester or by substitution with a known good tube.

b. Take voltage measurements at the tube sockets (*e* below, and fig. 22 and 23), resistor-capacitor boards (fig. 25), and at other points related to the stage in question (fig. 34 and 35).

c. If voltage readings are abnormal, take resistance readings (fig. 22–25) to isolate open and short circuits. Refer also to dc resistances of transformers and coils in paragraph 23. Before making resistance readings, remove all crystals (except crystal Y301) because the dc voltage of the multimeter may damage the crystal. Refer to the notes on the voltage and resistance charts and diagrams for switch positions during measurements.

d. Make continuity checks across appropriate terminals on terminal boards E301 and E302 (fig. 34) to locate defective thermostat or relay.

e. Voltage and resistance data for the oven-located tubes, V301 and V302 are listed in the tables below:

(1) Resistance to ground with P301 removed from J101.

Tube type and symbol	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
6AB4 V301	inf.	inf.	0	2.5	inf.	22K	inf.		
12AU7 V302	inf.	inf.	inf.	2.5	2.5	inf.	470K	4.7K	0

(2) Voltage data.

Tube type and symbol	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
6AB4 V301	+125	0	0	6.3[a]	+125	−2.5	1.5[b]		
12AU7 V302	+150	1.5[b]	1.5[b]	6.3[a]	6.3[a]	+70	−6.5	9[b]	0

[a] Ac filament voltage.

[b] Rf voltage.

23. Dc Resistance of Transformer and Coils

The dc resistances of the transformer windings and the coils in the variable frequency oscillator are listed below:

Transformer or coil	Terminals	Ohms
T101 (Wired for 115-volt input)	1–3	2.2
	2–4	2.2
	5–6	60
	6–7	70
	8–9	0.2
	10–11	0.2
T101 (Wired for 230-volt input)	1–2	2.2
	3–4	2.2
	5–6	60
	6–7	70
	8–9	0.2
	10–11	0.2
L101		100
L102		40
L201	1–2	0.8
L201	3–4	0.2
L202		6.5
L203	1–3	2
L203	2–4	0.4
L204		16
L205	1–3	0.8
L205	2–4	0.2
L206	1–3	0.4
L206	2–4	0.2
L207	1–3	0.8
L207	2–4	0.2
L208	1–2	0.2
L208	3–4	2

24. Stage-Gain Measurements

When troubleshooting, use the stage-gain chart in *b* below as a standard to check the gain of the amplifier stages. A reading within 10 percent of the listed values indicates normal operation. If the gain is abnormally low, use the information in paragraph 22 as a guide in further trouble isolation.

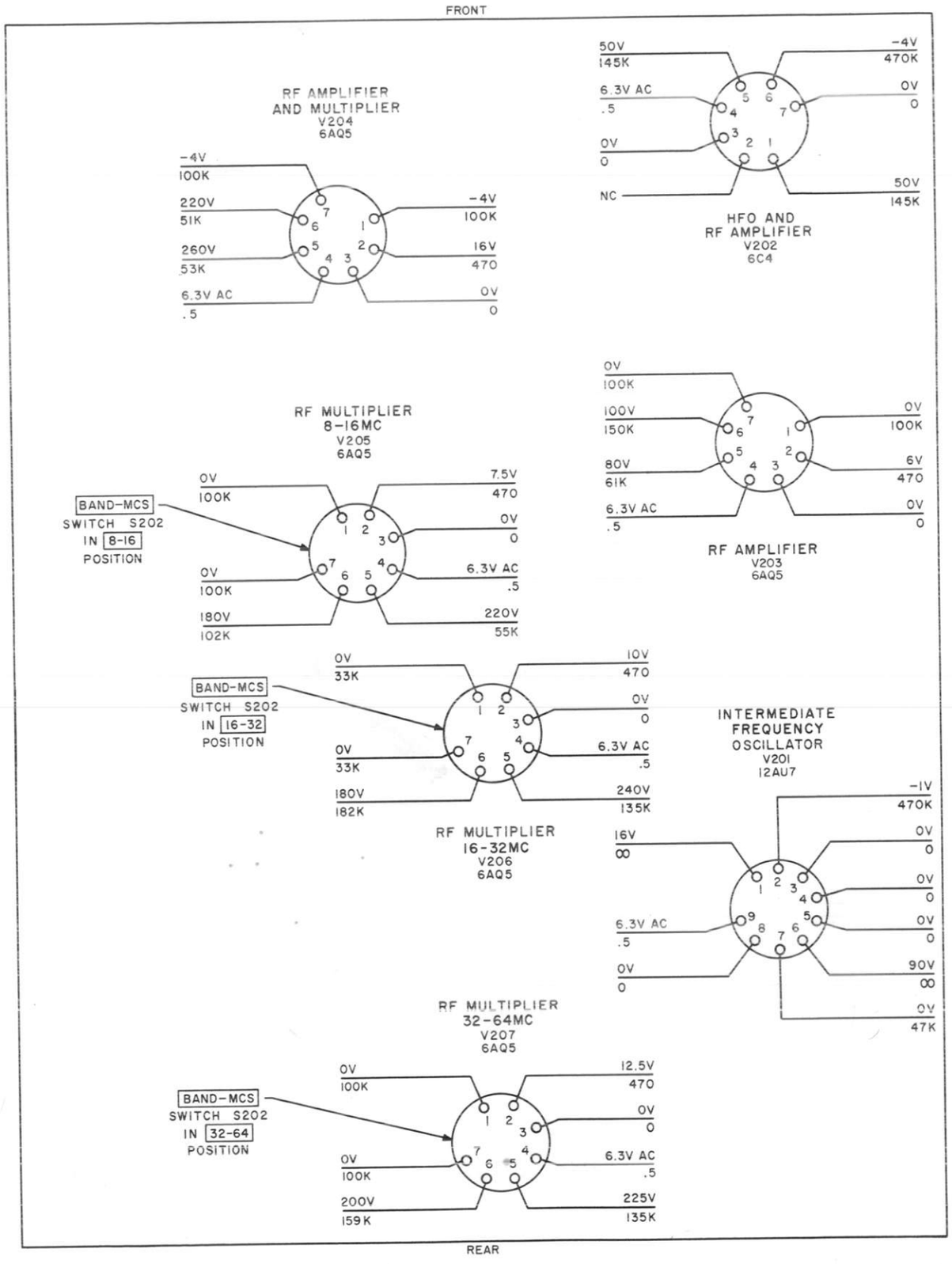
a. Before performing the stage-gain meas-

urements, set the controls of the variable frequency oscillator as follows:

Control	Setting
POWER switch	ON
HFO switch	ON
IFO switch	ON
BFO switch	ON
BEAT switch	ON
MASTER OSCILLATOR FREQUENCY control	2,000 kcs
BAND-MCS switch	32–64 mc
OUTPUT control	Maximum clockwise
XTAL switch	VMO position
TUNING control	Set for maximum output as indicated on METER M301

b. Use the multimeter to make rf voltage measurements at the tube socket pins indicated in the following stage-gain chart:

Stage	Pin	Rf input (volt)	Stage gain	Pin	Rf output (volt)
V104A	7	0.1	10	6	1
V104B	2	1	2	1	2
V105	1, 7	5.5	2	5	11
V201B	7	14	2	6	28
V202	6	1	2	1, 5	2
V203	1, 7	2	3	5	6
V204	1, 7	6	1.5	5	9
V205	1, 7	9	3	5	27
V206	1, 7	27	1.5	5	40
V207	1, 7	40	.25	5	50

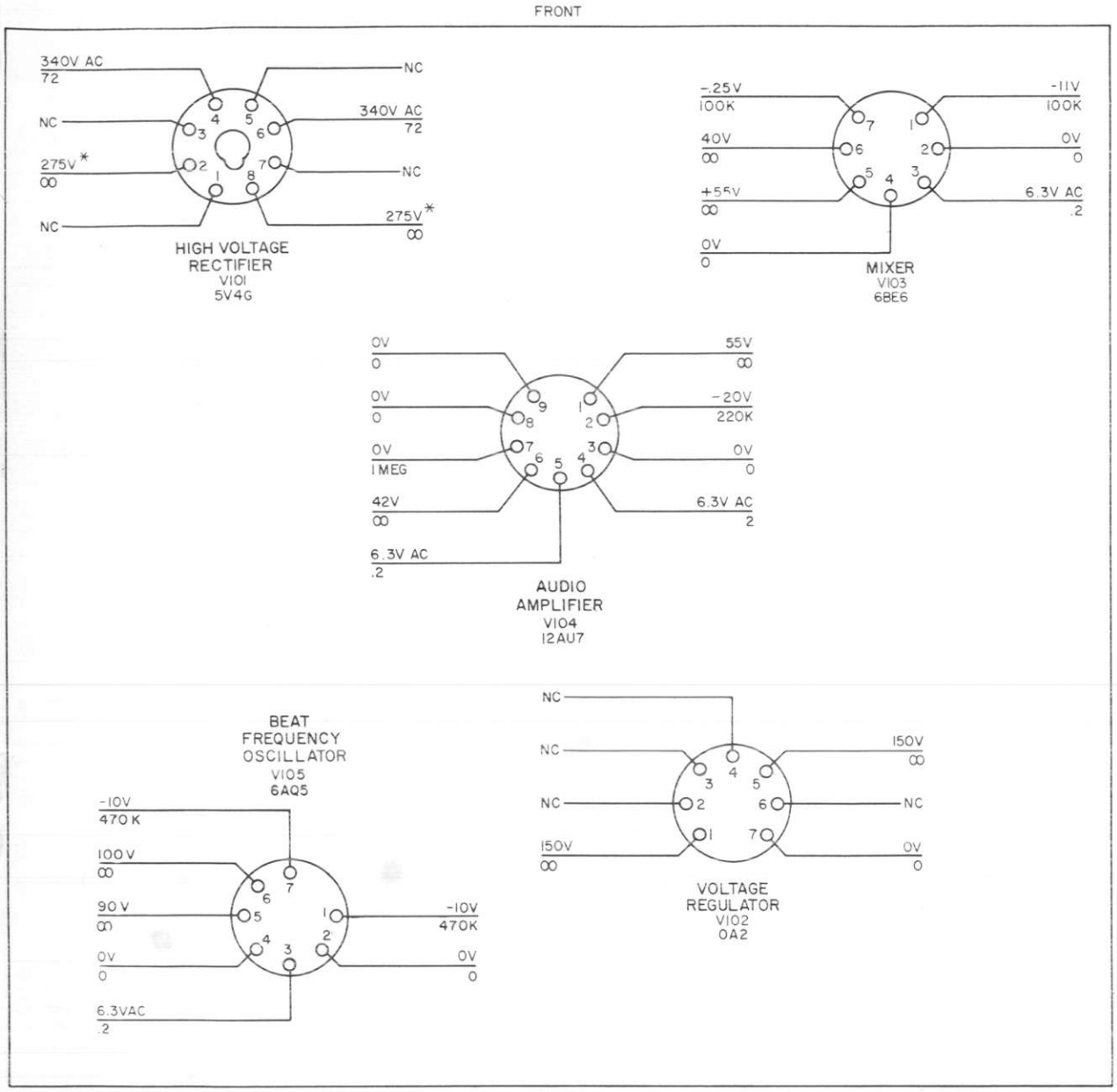


NOTES

1. UNLESS OTHERWISE SHOWN, RESISTANCES ARE IN OHMS. VOLTAGES AND RESISTANCES ARE MEASURED FROM TUBE SOCKET PINS TO GROUND WITH A 20,000 OHMS-PER-VOLT METER. FOR RESISTANCES ONLY, MEASUREMENTS ARE MADE WITH ALL THE INTER-CHASSIS CONNECTORS DISCONNECTED.
2. UNLESS OTHERWISE NOTED, ALL MEASUREMENTS ARE MADE WITH THE BAND-MCS SWITCH IN THE 2-4 POSITION; POWER, HFO, IFO, BFO, AND BEAT SWITCHES IN THE ON POSITION; TUNING CONTROL TO THE APPROXIMATE FREQUENCY OF THE VMO; OUTPUT CONTROL MAXIMUM CLOCKWISE; XTAL SWITCH TO VMO.
3. VOLTAGES ARE DC UNLESS OTHERWISE INDICATED.
4. VOLTAGE READINGS ABOVE LINE, RESISTANCE READINGS BELOW LINE.
5. ∞ INDICATES INFINITY.
6. ▭ INDICATES EQUIPMENT MARKING.

TM5820-277-35-27

Figure 22. Rf chassis, tube socket voltage and resistance diagram.



NOTES

1. UNLESS OTHERWISE SHOWN, RESISTANCES ARE IN OHMS. VOLTAGES AND RESISTANCES ARE MEASURED FROM TUBE SOCKET PINS TO GROUND WITH A 20,000 OHMS-PER-VOLT METER. FOR RESISTANCES ONLY, MEASUREMENTS ARE MADE WITH ALL THE INTER-CHASSIS CONNECTORS DISCONNECTED.
2. UNLESS OTHERWISE NOTED, ALL MEASUREMENTS ARE MADE WITH THE [BAND-MCS] SWITCH IN THE [2-4] POSITION, [POWER], [HFO], [IFO], AND [BEAT] SWITCHES IN THE [ON] POSITION, [TUNING] CONTROL TO THE APPROXIMATE FREQUENCY OF THE VMO, [OUTPUT] CONTROL MAXIMUM CLOCKWISE, [XTAL] SWITCH TO [VMO].
3. VOLTAGES ARE DC UNLESS OTHERWISE INDICATED.
4. VOLTAGE READING ABOVE LINE, RESISTANCE READING BELOW LINE.
5. ∞ INDICATES INFINITY OR OVER TEN MEGOHMS WHEN C102 IS IN CIRCUIT.
6. [ ] INDICATES EQUIPMENT MARKING.

7 * 5V AC BETWEEN PINS 2 AND 8 OF V101.

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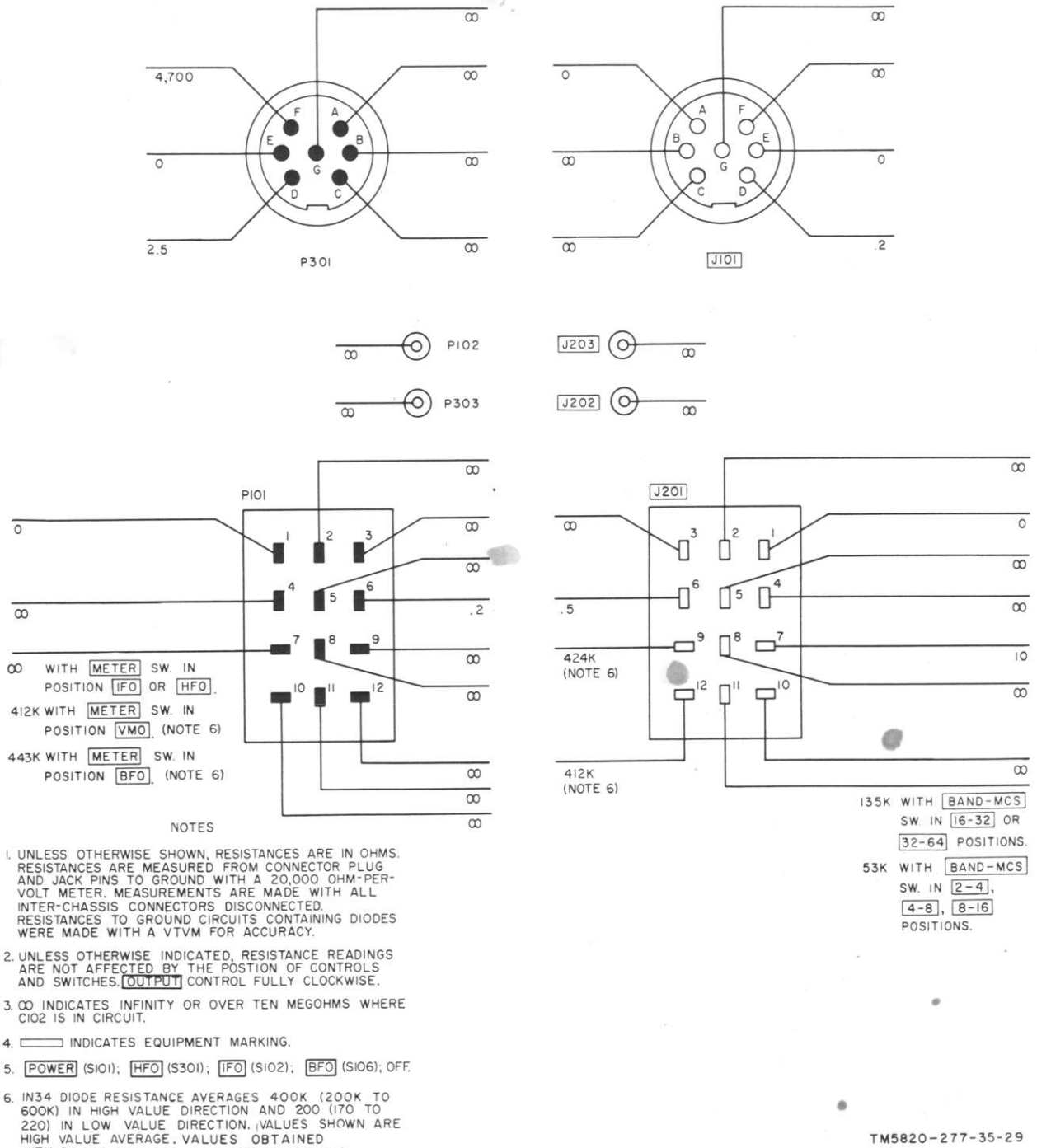
Figure 23. Power supply chassis, tube socket voltage and resistance diagram.

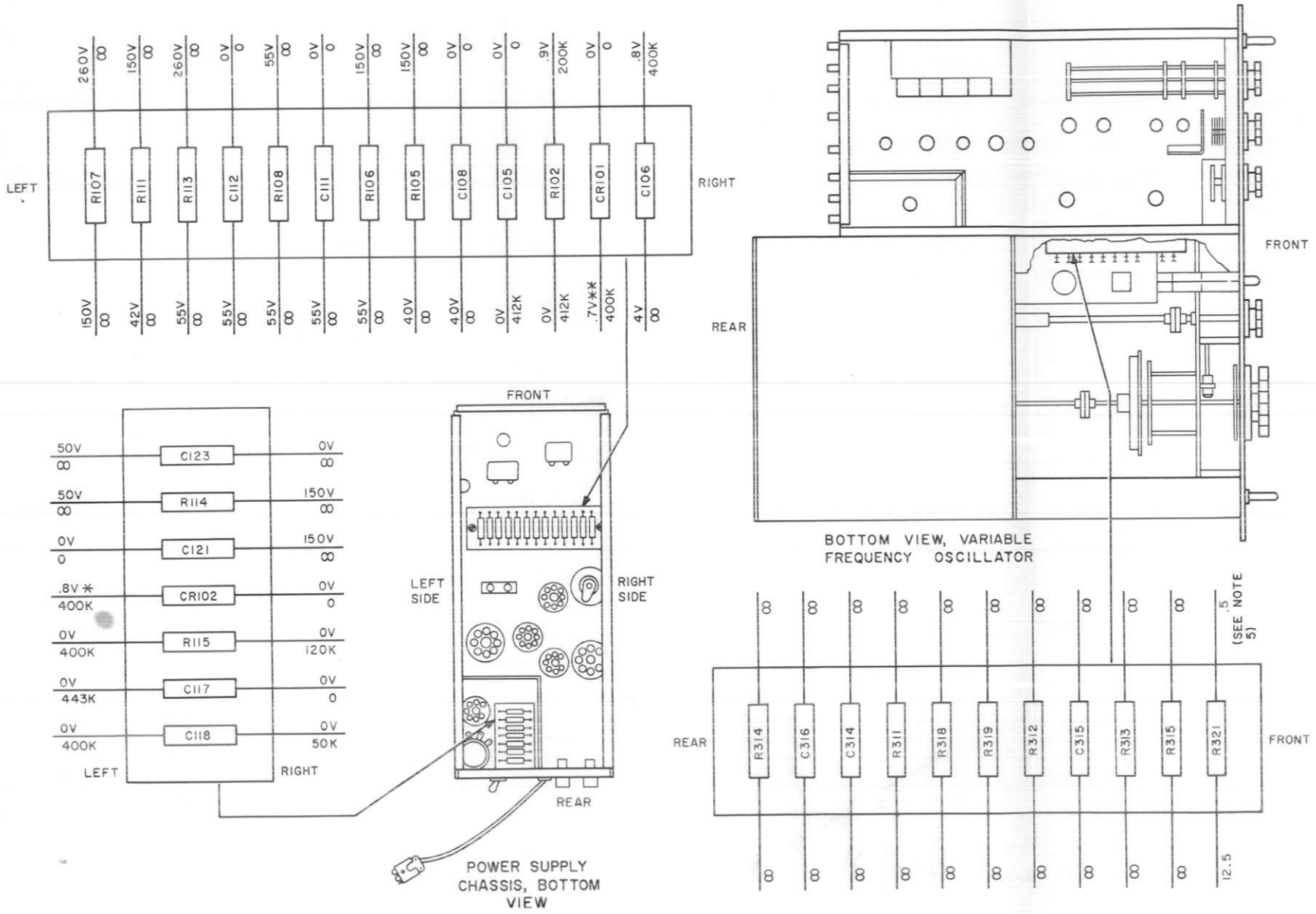


NOTES

1. UNLESS OTHERWISE SHOWN, RESISTANCES ARE IN OHMS. RESISTANCES ARE MEASURED FROM CONNECTOR PLUG AND JACK PINS TO GROUND WITH A 20,000 OHM-PER-VOLT METER. MEASUREMENTS ARE MADE WITH ALL INTER-CHASSIS CONNECTORS DISCONNECTED. RESISTANCES TO GROUND CIRCUITS CONTAINING DIODES WERE MADE WITH A VTVM FOR ACCURACY.
2. UNLESS OTHERWISE INDICATED, RESISTANCE READINGS ARE NOT AFFECTED BY THE POSTION OF CONTROLS AND SWITCHES. OUTPUT CONTROL FULLY CLOCKWISE.
3. ∞ INDICATES INFINITY OR OVER TEN MEGOHMS WHERE C102 IS IN CIRCUIT.
4. ▭ INDICATES EQUIPMENT MARKING.
5. POWER (S101); HFO (S301); IFO (S102); BFO (S106); OFF.
6. IN34 DIODE RESISTANCE AVERAGES 400K (200K TO 600K) IN HIGH VALUE DIRECTION AND 200 (170 TO 220) IN LOW VALUE DIRECTION. VALUES SHOWN ARE HIGH VALUE AVERAGE. VALUES OBTAINED WITH 20,000 OHM-PER-VOLT METER ARE MUCH HIGHER.

TM5820-277-35-29

Figure 24. Plugs and jacks, resistance diagram.



NOTES

1. UNLESS OTHERWISE SHOWN, RESISTANCES ARE IN OHMS. VOLTAGES AND RESISTANCES ARE MEASURED FROM TERMINAL BOARD TO GROUND WITH A 20,000 OHMS-PER-VOLT METER. FOR RESISTANCES ONLY, MEASUREMENTS ARE MADE WITH ALL INTER-CHASSIS CONNECTORS DISCONNECTED.
2. POSITION OF SWITCHES DO NOT AFFECT RESISTANCE READINGS.
3. FOR VOLTAGE MEASUREMENTS SET [POWER], [BEAT], AND [BFO] SWITCHES IN THE [ON] POSITION, AND R116 CONTROL MAXIMUM CLOCKWISE.
4. UNLESS OTHERWISE INDICATED, VOLTAGES ARE DC.
5. NO VOLTAGE READINGS ARE TAKEN.
6. VOLTAGE READINGS ABOVE LINE, RESISTANCE READINGS BELOW LINE.
7. ∞ INDICATES INFINITY OR OVER TEN MEGOHMS WHERE C120 IS IN CIRCUIT.
   * TAKEN WITH [METER] SWITCH IN [BFO] POSITION.
   ** TAKEN WITH [METER] SWITCH IN [VMO] POSITION.
8. INDICATES EQUIPMENT MARKING.
9. IN34 DIODE RESISTANCE AVERAGES 400K (200K TO 600K) IN HIGH VALUE DIRECTION AND 200 (170 TO 220) IN LOW VALUE DIRECTION. VALUES SHOWN ARE HIGH VALUE AVERAGE. VALUES OBTAINED WITH 20,000 OHM-PER-VOLT METER ARE MUCH HIGHER.

TM5820-277-35-30

Figure 25. Variable frequency oscillator, resistor-capacitor boards, voltage and resistance diagram.

CHAPTER 3
REPAIRS AND ALIGNMENT

Section I. REPAIRS

25. General

Most of the components in the variable frequency amplifier are readily accessible and easily replaceable. It may be necessary to remove the power supply chassis from the vmo to reach some of the components. When power supply removal is necessary, refer to paragraph 24 of TM 11–5820–277–12 for correct use of extension cables. The oscillator components contained within the double-insulated oven require special procedures for removal and replacement. These procedures are detailed in paragraph 26. Careless replacement of parts will make new faults inevitable. When replacing parts, observe the following precautions and techniques:

a. When a part is replaced in the double-insulated oven compartment, the new part must be placed in the exact position occupied by the old part. A part that has the same electrical specifications but a different physical size may cause trouble in the oscillator circuits. Give particular attention to grounding. Use the same ground as the original wiring. Failure to observe these precautions may result in improper tracking, spurious oscillations, and undesired coupling.

b. Before the part is unsoldered, note the position of the leads. If the part has a number of connections, tag each of the leads to it.

c. Be careful not to damage other leads or components by pushing them out of the way.

d. Do not allow drops of solder to fall into the chassis.

e. Do not disturb the settings of any of the variable components near a part while replacing that part unless absolutely necessary. If a setting is disturbed, refer to the appropriate instructions for alignment after the repair is completed.

26. Removal and Replacement of Oven-Located Components

a. General. Some of the components located within the double-simulated oven can be replaced *only* at the factory. These components are listed below:

(1) The oscillator case. The periphery of this case must be precisely aligned to cause the oscillator output to track the MASTER OSCILLATOR FREQUENCY dial setting.

(2) Main tuning capacitor C301.

(3) Master oscillator trimmer capacitor C302.

b. Removal of Variable Master Oscillator Assembly.

(1) Remove power plug P301 from J101 (fig. 12, TM 11–5820–277–12).

(2) Remove coaxial plug P303 from jack J202. (fig. 12, TM 11–5820–277–12).

(3) Remove the two thermocouple leads from pins 2 and 4 of terminal board E301 (fig. 9, TM 11–5820–277–12).

(4) Remove four screws from the corners of the front top cover of the variable master oscillator compartment (located at top-left corner of figure 15). Removing the cover exposes the three shafts (fig. 21) that operate C301 and C302 (MASTER OSCILLATOR FREQUENCY), trimmer capacitor C303 (screwdriver adjustment on front panel), and slug inductance L301 (CALIBRATE control).

(5) Remove the two Allen screws on the oven side of the L301 sleeve-type shaft coupler.

(6) Remove the two Allen screws on the oven side of the C303 universal-type shaft coupler.

(7) Before uncoupling the C301 and C302 shaft coupler, set the MASTER OSCILLATOR FREQUENCY shaft to 1,900,000 cps. Note that the shaft has a flat spot near the end closest to the oven and that an Allen screw sets on the flat spot.

(8) Remove the Allen screw on the C301 and C302 shaft universal-type coupler

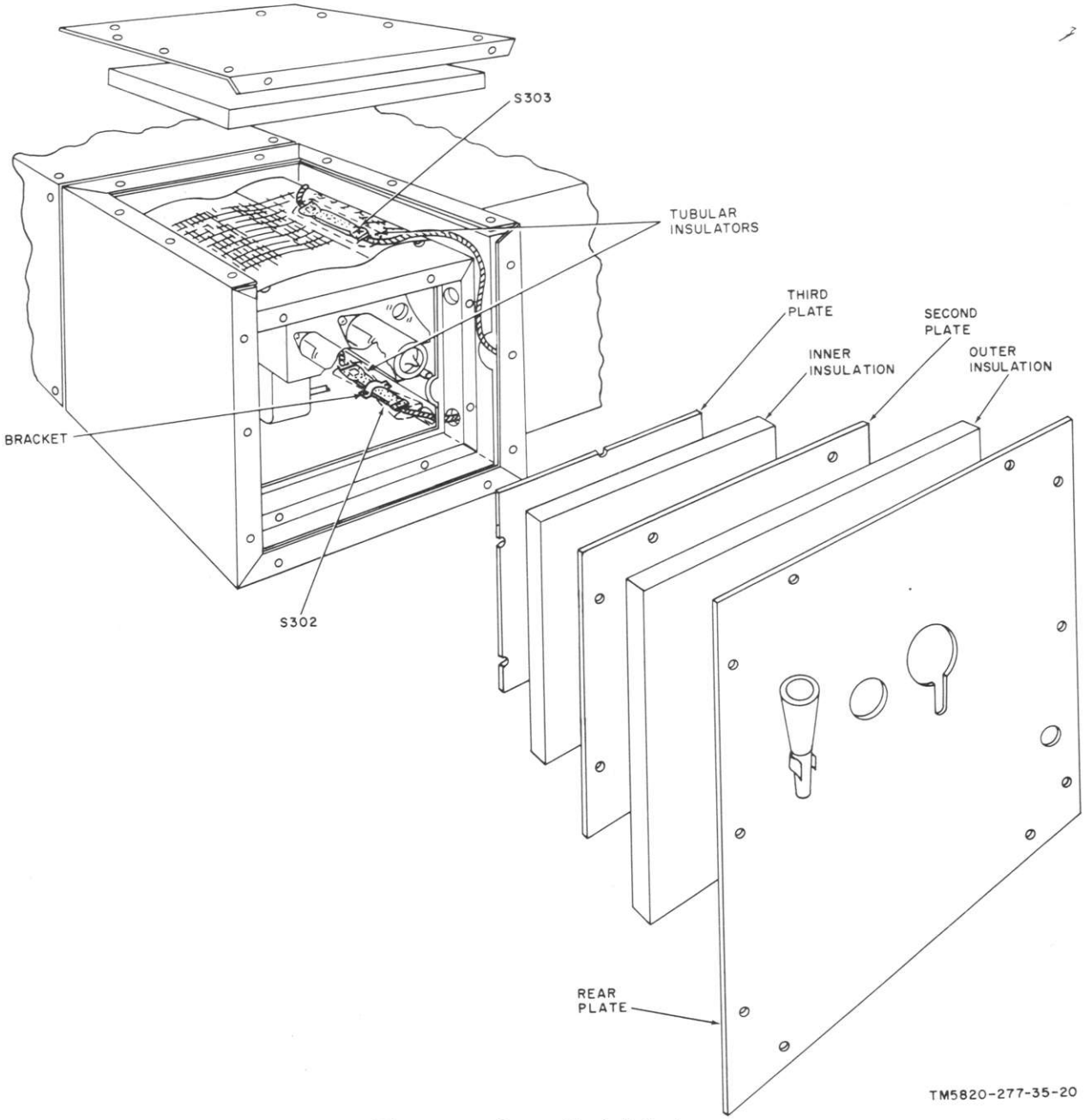


Figure 26. Oven, Exploded view.

that does not fit into a flat spot. Before removing the Allen screw that fits on the flat spot, rotate the MASTER OSCILLATOR FREQUENCY dial slightly so that this screw is facing straight up. Lock the dial and remove the screw. All three shafts are now uncoupled from the front-panel knobs.

Caution: **Do not remove or loosen the Allen screws on the sleeve coupler of the C301 and C302 shaft.**

(9) Remove 10 screws from the rear plate and remove the rear plate. Thread power plug P301 and its cable and coaxial plug P303 and its cable through the openings in the rear plate. This clears the rear plate from the cabling.

(10) Refer to figure 26 and proceed as follows:

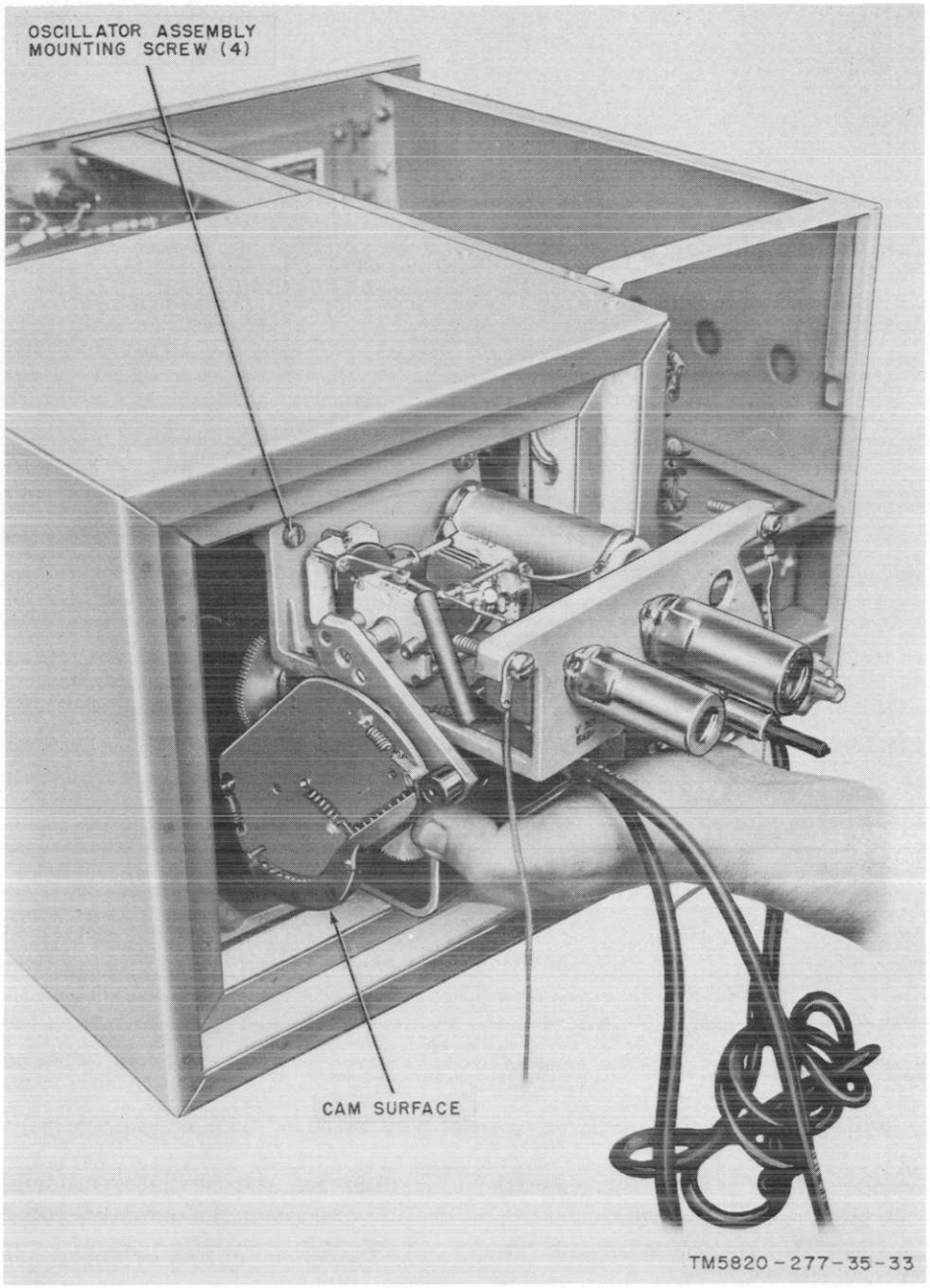


Figure 27. Variable master oscillator, removal.

(*a*) Remove the outer piece of insulation.

(*b*) Remove eight screws from the second plate and remove the plate.

(*c*) Remove the inner piece of insulation.

(*d*) Remove six screws from the third plate. Remove the plate. As in step (9) above, this operation requires threading plugs P301 and P303 through the openings in the plates and insulators.

(11) Refer to figure 27. Loosen the four screws that fasten the oscillator assembly to the oven. Two screws are mounted on the top plate at the front of the oven, and two screws are mounted on the top plate at the rear of the oven.

(12) The oscillator assembly is now free of

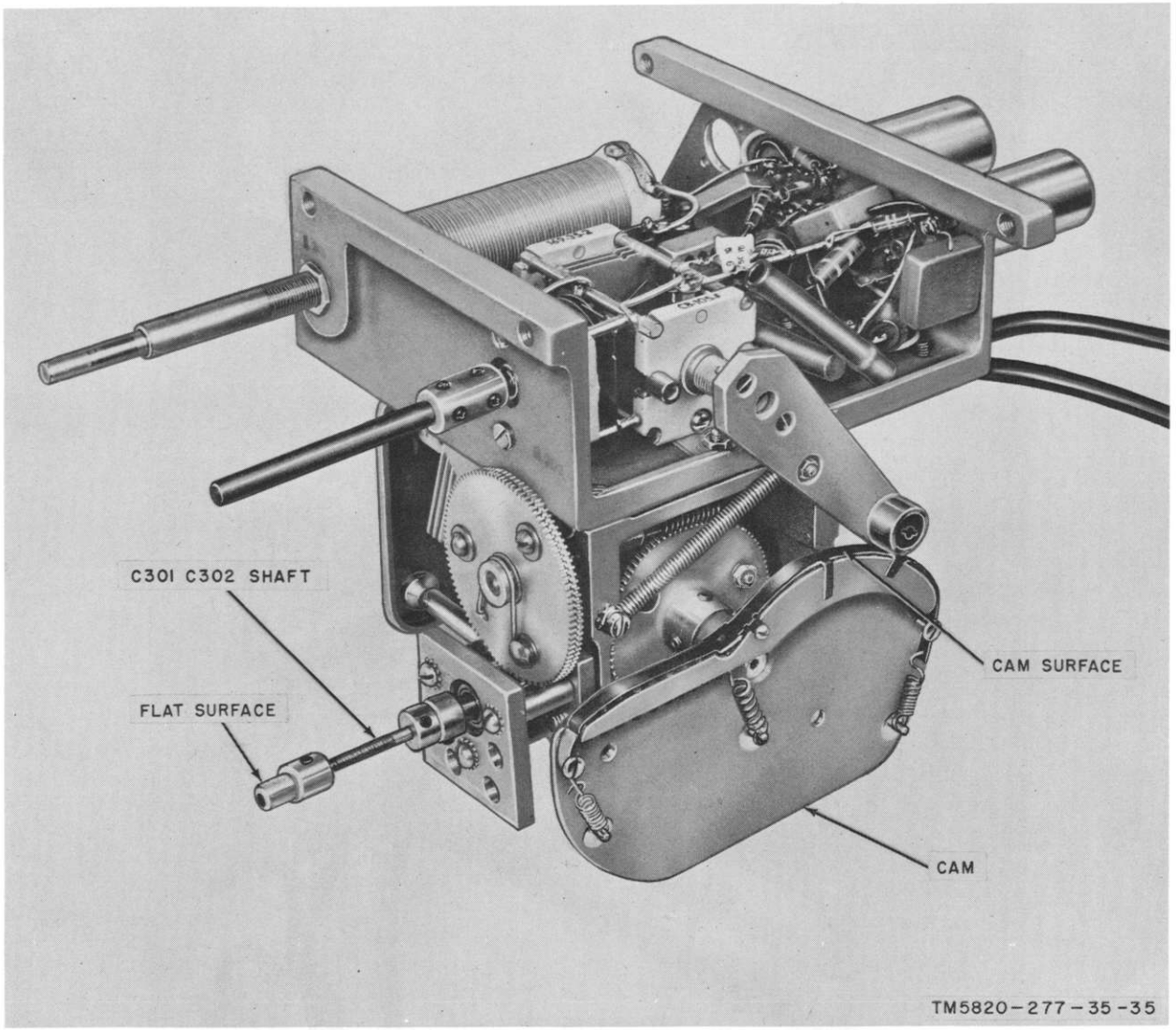


Figure 28. Variable master oscillator, correct cam position during repair procedures.

the oven chamber and the three shafts on the front panel controls.

Caution: **Handle the oscillator assembly gently. Note that the working surface of the cam (fig. 27) faces downward. This surface must *not* be disturbed. Do *not* set the oscillator assembly down with the cam in this position. If the cam surface is dented or its periphery changed during this procedure, the oscillator will no longer track the dial setting. As a result, factory realignment will be required.**

(13) Turn the C301 C302 shaft until the cam is positioned as shown in figure 28.

(14) Set the oscillator assembly down and replace the defective component.

c. Replacement of Variable Master Oscillator Assembly.

(1) Set the oscillator assembly down as shown in figure 30.

(2) Turn the C301 C302 shaft until C301 is in full mesh. Hold a 3- by 5-inch card above the capacitor (fig. 30). When no light is seen beneath the card, the capacitor is in exact full mesh. This position corresponds to the locked dial setting of 1,900,000 cps.

(3) Holding the oscillator assembly as

shown in figure 27, replace the oscillator assembly within the oven chamber. When replacing the assembly, gently work in the three shafts within the shaft couplers. Be careful not to disturb any of the oscillator assembly components.

(4) Note that the flat spot (fig. 28) on the C301 C302 shaft faces upward.

(5) Tighten the four oscillator assembly mounting screws that fasten the oscillator assembly to the oven.

(6) Thread plugs P301 and P303 through the holes in the three rear plates and two pieces of insulation.

(7) Replace the third plate and fasten it with six screws.

(8) Replace the inner insulation.

(9) Replace the second plate and fasten with eight screws.

(10) Replace the outer piece of insulation.

(11) Replace the rear plate and fasten with 10 screws.

(12) Replace the two Allen screws on the C301 C302 universal-type shaft coupler.

(13) Replace the two Allen screws on the C303 universal-type shaft coupler.

(14) Replace the two Allen screws on the L301 sleeve-type shaft coupler.

(15) Replace the top cover of the variable master oscillator compartment and attach with four screws.

(16) Replace the two thermocouple leads to pins 2 and 4 of terminal board E301.

(17) Replace P303 into J202 and P301 into J101.

(18) Perform initial tuning adjustments as outlined in paragraph 15 of TM 11–5820–277–12.

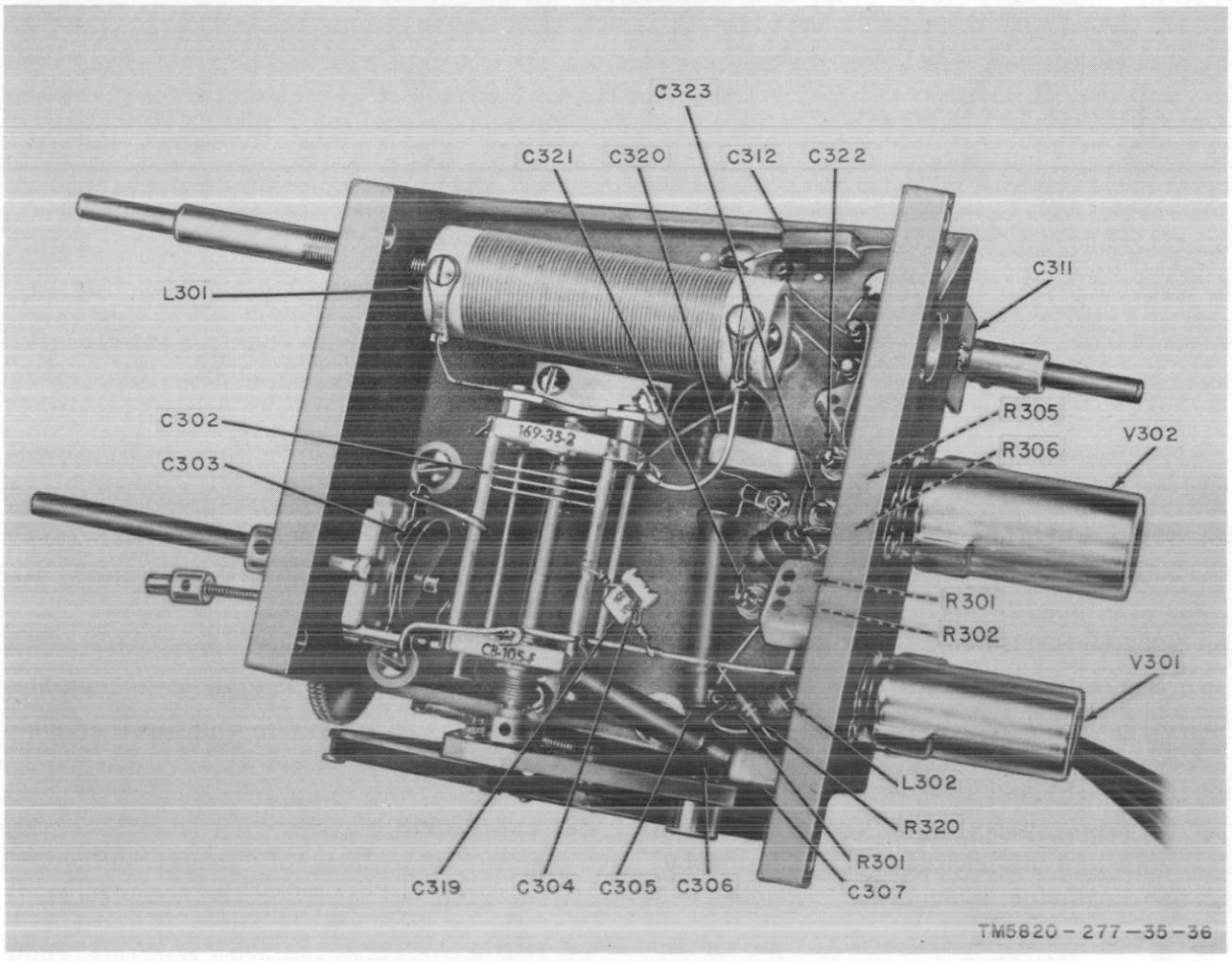


Figure 29. Variable master oscillator, location of components.

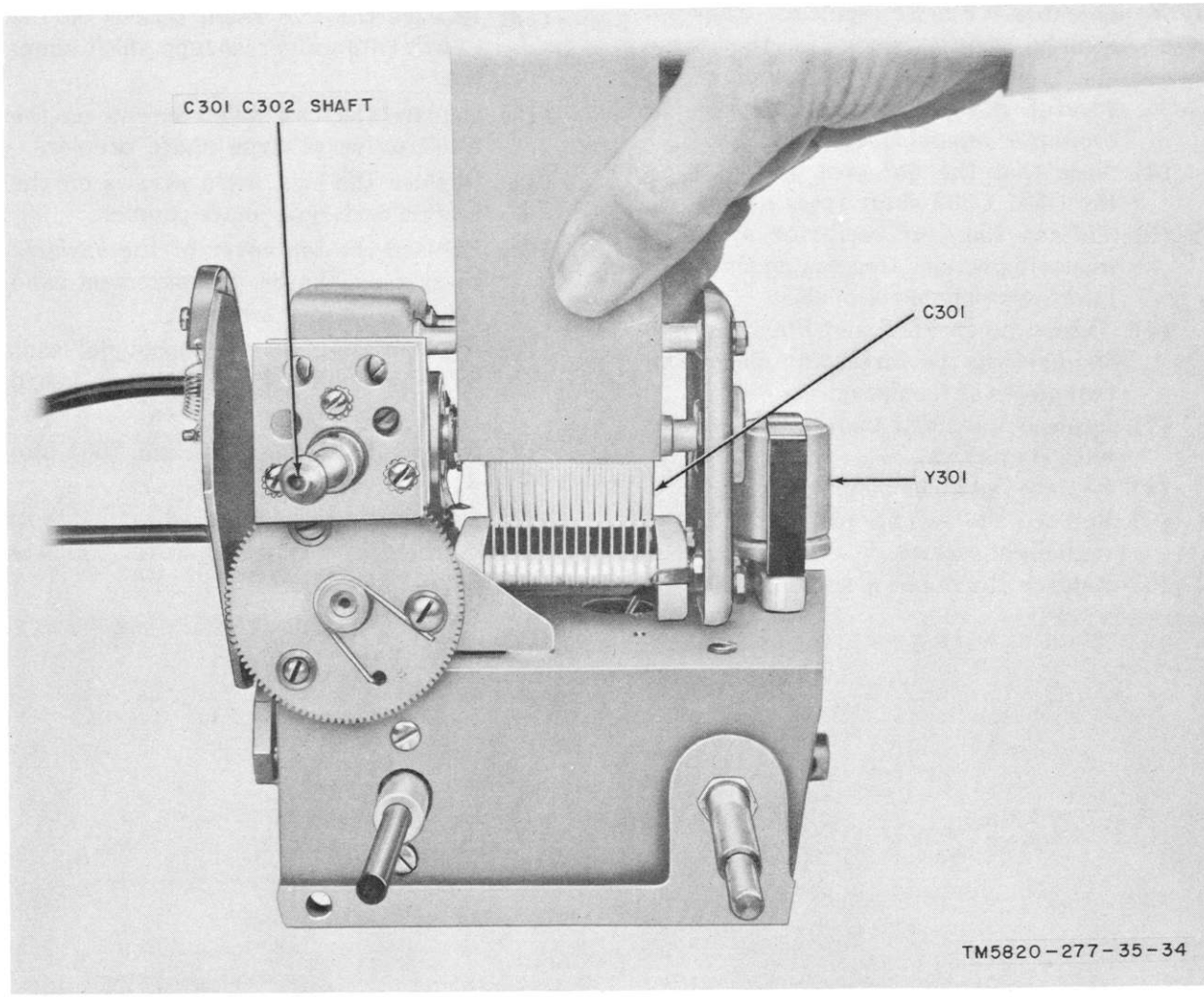


Figure 30. Variable master oscillator assembly, adjustment procedure.

27. Replacement of Thermostats S302 and S303

The oven must be opened to replace thermostat S302 or S303. Refer to figure 26.

a. Remove eight screws from the top rear cover and remove the cover and insulation.

b. Remove the rear plates and insulators as directed in (9) and (10) of paragraph 26*b*.

c. To remove S303, slide the tubular insulation aside and unsolder the two leads. Replace tubular insulator when new thermostat is installed.

d. To remove S302, remove the two screws from the bracket holding S302 down. Remove the bracket, slide tubular insulation aside, and unsolder the two leads. Replace tubular insulator and bracket after new thermostat is replaced.

e. Replace rear plates and insulation as directed in (6) through (11) of paragraph 26*c*.

f. Replace top insulation and top rear plate and fasten with eight screws.

28. Lubrication

Apply a few drops of Grease, automotive MIL–G–2108, to the CALIBRATE control gears (fig. 21) at least once a year. If the CALIBRATE control does not work smoothly, apply this lubricant at more frequent intervals.

Section II. ALIGNMENT

29. Alignment Procedures

Warm up the variable frequency oscillator for at least 6 hours before performing the alignment procedures. Refer to figure 31 for location of alignment controls. The only tool required is a conventional alignment tool.

30. Ifo Adjustment

With the POWER and IFO switches in the ON position, turn the METER selector switch to the IFO position. Adjust coil L201 for a maximum reading on meter M301.

31. Hfo Alignment

a. Place a 2-mc crystal in crystal socket Y204 and a 4-mc crystal in crystal socket Y203 (fig. 7, TM 11–5820–277–12).

b. Place the POWER and HFO switches at ON. Turn the METER selector switch to HFO.

c. Place the BAND-MCS switch on 32–64.

d. Place the XTAL switch in position 1.

e. Adjust the OUTPUT control to obtain an approximate one-third-scale deflection.

f. Adjust the TUNING control for maximum hfo output as indicated on meter M301.

g. Adjust the OUTPUT control to obtain a two-thirds-scale deflection on meter M301.

h. Place the BAND-MCS switch on 2–4; place the XTAL switch in position 2.

i. Adjust coil L203 for a maximum output reading.

j. Place the BAND-MCS switch on 4–8.

k. Place the XTAL switch in position 1 and adjust L205 for a maximum output reading. Place the XTAL switch in position 2 and adjust C224 for a maximum output reading. Repeat the L205 and C224 adjustments until no further increase in meter output is possible.

l. Place the BAND-MCS switch on 8–16.

m. Repeat step *k*, adjusting L206 with the XTAL switch in position 1 and C227 with the XTAL switch in position 2.

n. Place the BAND-MCS switch on 16–32.

o. Repeat step *k*, adjusting L207 with the XTAL switch in position 1 and C232 with the XTAL switch in position 2.

p. Place the BAND-MCS switch on 32–64.

q. Repeat step *k*, adjusting L208 with the XTAL switch in position 1 and C235 with the XTAL switch in position 2.

r. Repeat steps *h* through *q* above.

32. Bfo Adjustment

a. Check that a 455-kc crystal is in each bfo crystal socket (Y101 and Y102).

b. Place the BFO switch to the Y101 position.

c. Connect a 1,000-ohm, 1-watt resistor between BFO output jack J102 and ground.

d. Set the METER switch to BFO and adjust bfo potentiometer R116 (fig. 12, TM 11–5820–277–12) for maximum indication on the meter.

e. Place the BFO switch to the Y102 position and repeat procedures in *c* and *d* above.

33. Vmo Adjustment

Once the hfo section is aligned (para 31), no alignment for the vmo is necessary. For adjustment procedures covering the vmo section, refer to paragraph 18*c* of TM 11–5820–277–12.

34. 100-kc Oscillator Alignment

a. Turn on the receiver (para 19) and the variable frequency oscillator and allow a 6-hour warmup period.

b. Loosely couple the hfo output of the variable frequency oscillator to the antenna input of the receiver. Location of the variable frequency oscillator close to the receiver is generally sufficient coupling.

c. Tune the receiver to a WWV frequency at 2.5 mc.

d. Tune the variable frequency oscillator to produce an output at 2.5 mc.

e. Note the S-meter on the receiver. At the point of exact zero beat, deep and clearly discernible dips will be observed.

f. Set the BEAT switch to ON.

g. While observing the ZERO BEAT indicating lamp, adjust C311 (fig. 19) until the indicator lamp flickers off and on slowly. This indicates that a point very close to zero beat has been reached. At the exact point of zero beat, the ZERO BEAT indicator should go out. (Exact zero beat is difficult to maintain because

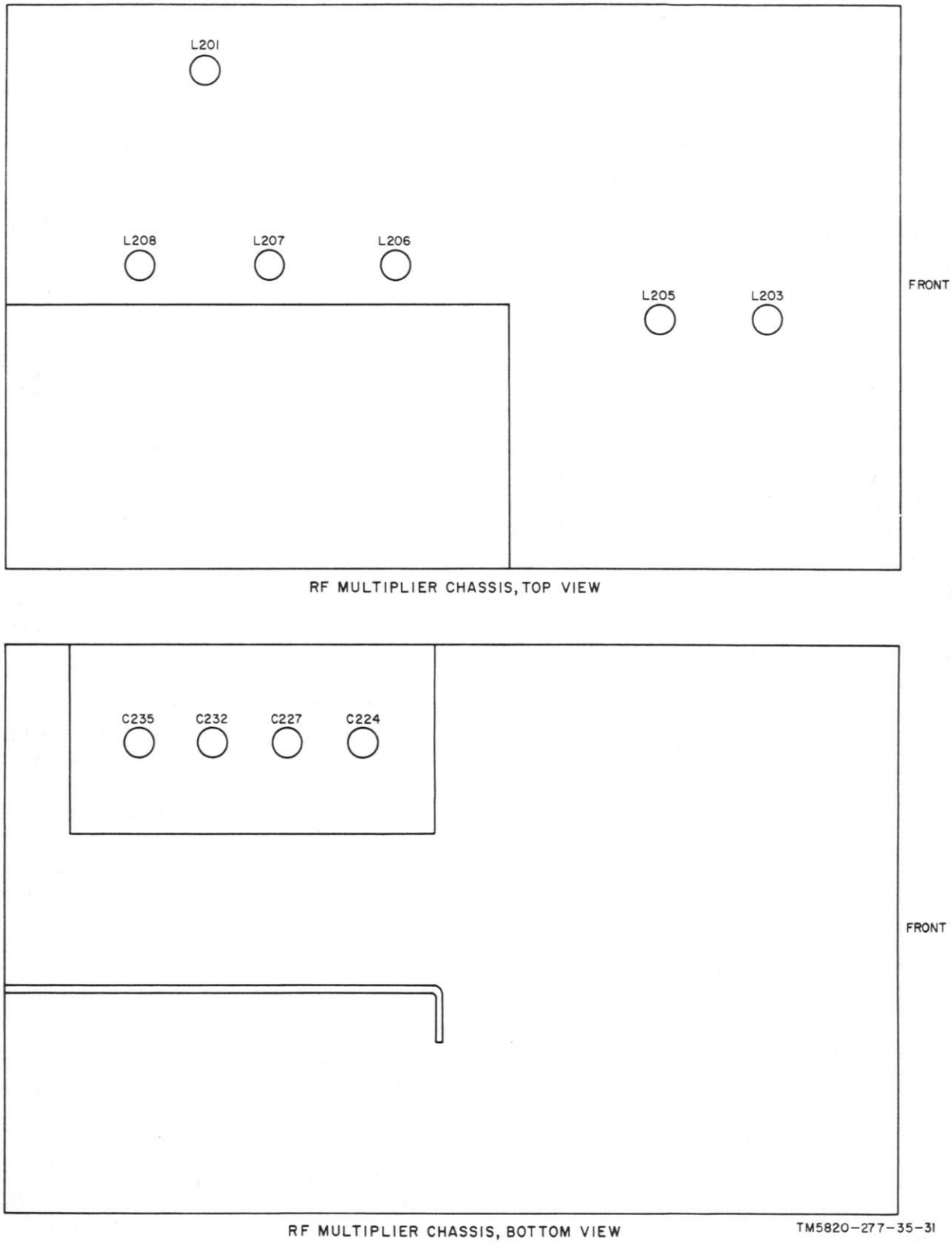


Figure 31. Alignment controls location.

not only the frequency but the phase of the two signals must be the same. Normally, when the lamp flickers slowly, a satisfactory calibration is accomplished.)

CHAPTER 4
FINAL TESTING

35. Purpose of Final Testing

The procedures outlined in this section are to be used as a guide in determining the quality of a repaired variable master oscillator. Repaired equipment that meets these requirements will provide satisfactory operation, equivalent to that of new equipment. If the equipment fails to meet the performance standards determined by the tests, refer to applicable troubleshooting procedures in chapter 2.

36. Test Equipment Required for Final Testing

In addition to the test equipment listed for troubleshooting (para 19), Panoramic Indicator IP–259/U and Frequency Meter AN/USM–26 are required.

37. Final Test Procedures

In all the test procedures outlined in this paragraph, the equipment should be allowed at least a 6-hour warmup period.

a. Hfo Crystal Check.

(1) Set the HFO switch to ON.
(2) Set the METER switch to HFO.
(3) Turn the XTAL switch to position 1.
(4) Set the BAND-MCS switch to correspond to the frequency of the crystal inserted in socket Y202.
(5) Adjust the OUTPUT control for a slight reading on the meter.
(6) Adjust the TUNING control for a maximum reading on the meter.
(7) The crystal is satisfactory if an indication over half the full-scale reading is obtained.
(8) Repeat the procedures in (3) through (7) above for crystal checks for positions 2 and 3 of the XTAL switch.

b. Ifo Check.

(1) Turn the POWER and IFO switches to ON.
(2) Set the METER selector switch to IFO.
(3) An indication above one-half the full-scale reading should be obtained.

c. Hfo Frequency Check.

(1) Connect the SIGNAL INPUT jack of Frequency Meter AN/USM–26 to one of the HFO output jacks (J208, J209, or J210).
(2) Turn the MASTER OSCILLATOR FREQUENCY control from 2 to 4 mc in steps of 100 kc. THE MASTER OSCILLATOR FREQUENCY dial setting and the frequency indicated by Frequency Meter AN/USM–26 should agree within 100 cycles.

d. 100-kc Crystal Oscillator Check.

(1) Connect the SIGNAL INPUT jack of Frequency Meter AN/USM–26 to pin 1 of V103.
(2) Frequency Meter AN/USM–26 should indicate 100 kc.
(3) Adjust crystal oscillator trimmer capacitor C311 (fig. 19) if necessary.

e. Output Voltage Check.

(1) *Hfo output.* Connect a 75-ohm one-watt resistor between HFO output J208 and ground. Connect the multimeter (para 19) across the resistor. The multimeter should indicate a minimum of 12.5 volts ac when the BAND-MCS switch is placed in the 2–4 range. The multimeter should indicate a minimum of 6 volts ac when the BAND-MCS switch is placed in any of the other four positions.
(2) *Bfo output.* Connect a 1000-ohm one-watt resistor between BFO output jack J102 and ground. Connect the multimeter across the resistor. The multimeter should indicate a minimum of 6 volts ac.
(3) *Ifo output.* Connect a 75-ohm one-watt resistor between IFO output jack J205 and ground. Connect the multimeter across the resistor. The multimeter should indicate a minimum of 2 volts ac.

f. Hfo Spurious Frequency Check.

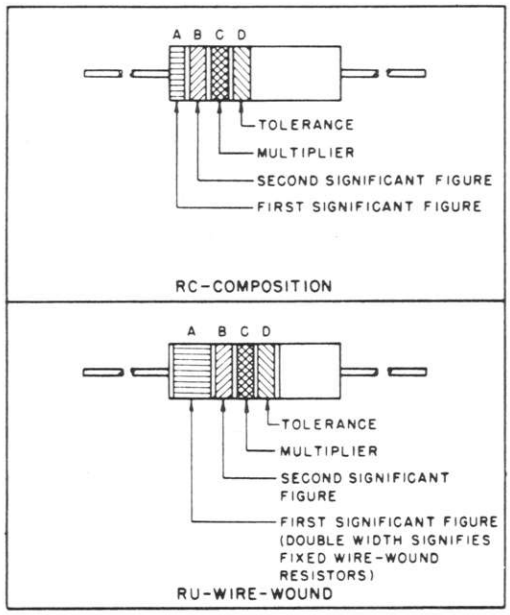
(1) Connect the HFO output to the input of Panoramic Indicator IP–259/U.
(2) Set the controls on Panoramic Indi-

cator IP–259/U as directed in paragraph 22 of TM 11–5114 for relative amplitude measurements.

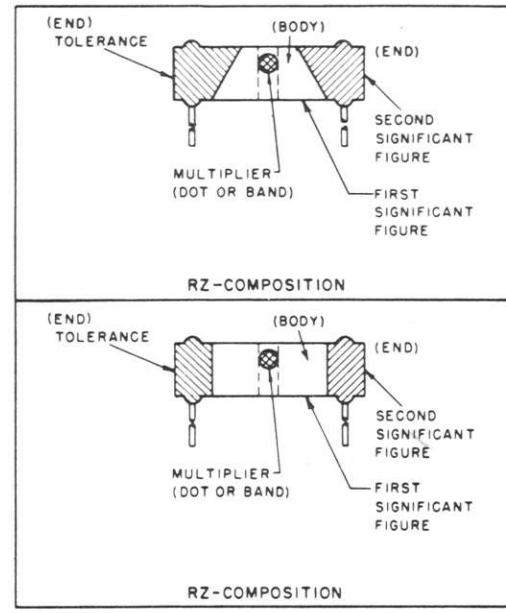
(3) Hum and noise should be at least 40 db below the hfo fundamental frequency.

RESISTOR COLOR CODE MARKING
(MIL-STD RESISTORS)

AXIAL-LEAD RESISTORS
(INSULATED)



RADIAL-LEAD RESISTORS
(UNINSULATED)



RESISTOR COLOR CODE

BAND A OR BODY*		BAND B OR END*		BAND C OR DOT OR BAND*		BAND D OR END*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1	BODY	± 20
BROWN	1	BROWN	1	BROWN	10	SILVER	± 10
RED	2	RED	2	RED	100	GOLD	± 5
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000		
GREEN	5	GREEN	5	GREEN	100,000		
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	GOLD	0.1		
WHITE	9	WHITE	9	SILVER	0.01		

*FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH. WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND) OR END COLOR, THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

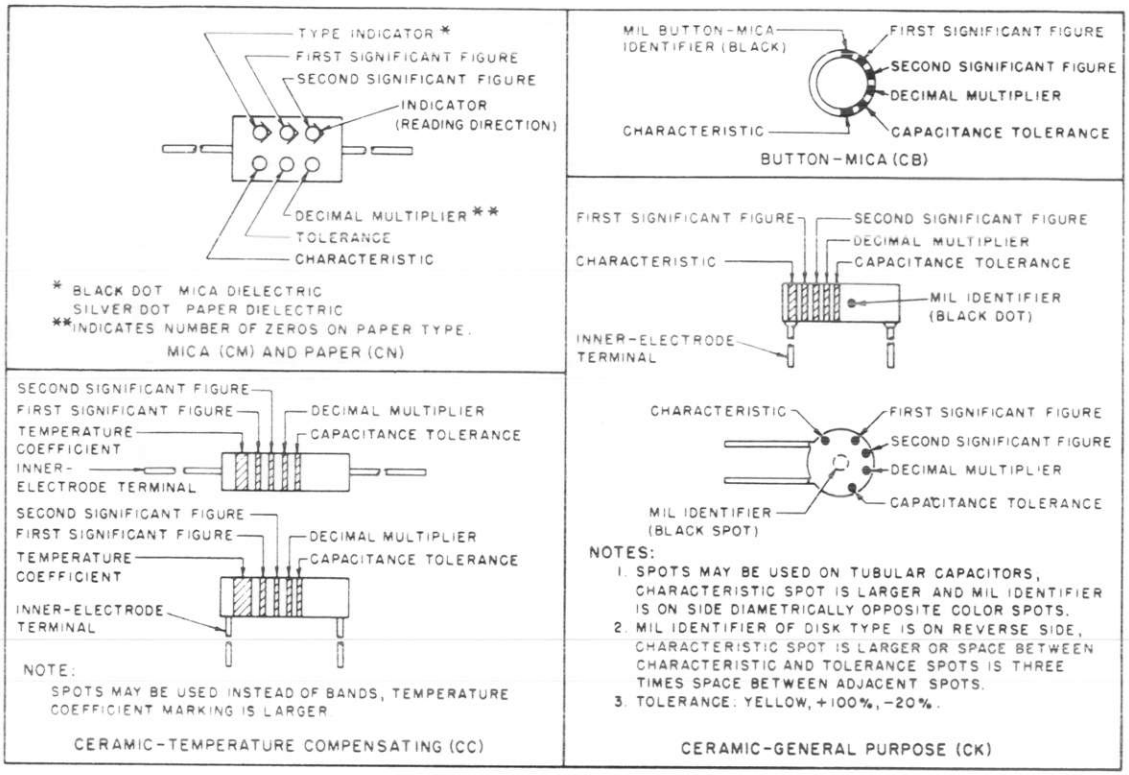
EXAMPLES (BAND MARKING):
10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B, BLACK BAND C; NO BAND D.
4.7 OHMS ±5 PERCENT: YELLOW BAND A; PURPLE BAND B; GOLD BAND C; GOLD BAND D.

EXAMPLES (BODY MARKING):
10 OHMS ±20 PERCENT: BROWN BODY, BLACK END, BLACK DOT OR BAND, BODY COLOR ON TOLERANCE END.
3,000 OHMS ±10 PERCENT: ORANGE BODY, BLACK END, RED DOT OR BAND; SILVER END.

STD-R1

Figure 32. Resistor color-code markings.

CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)



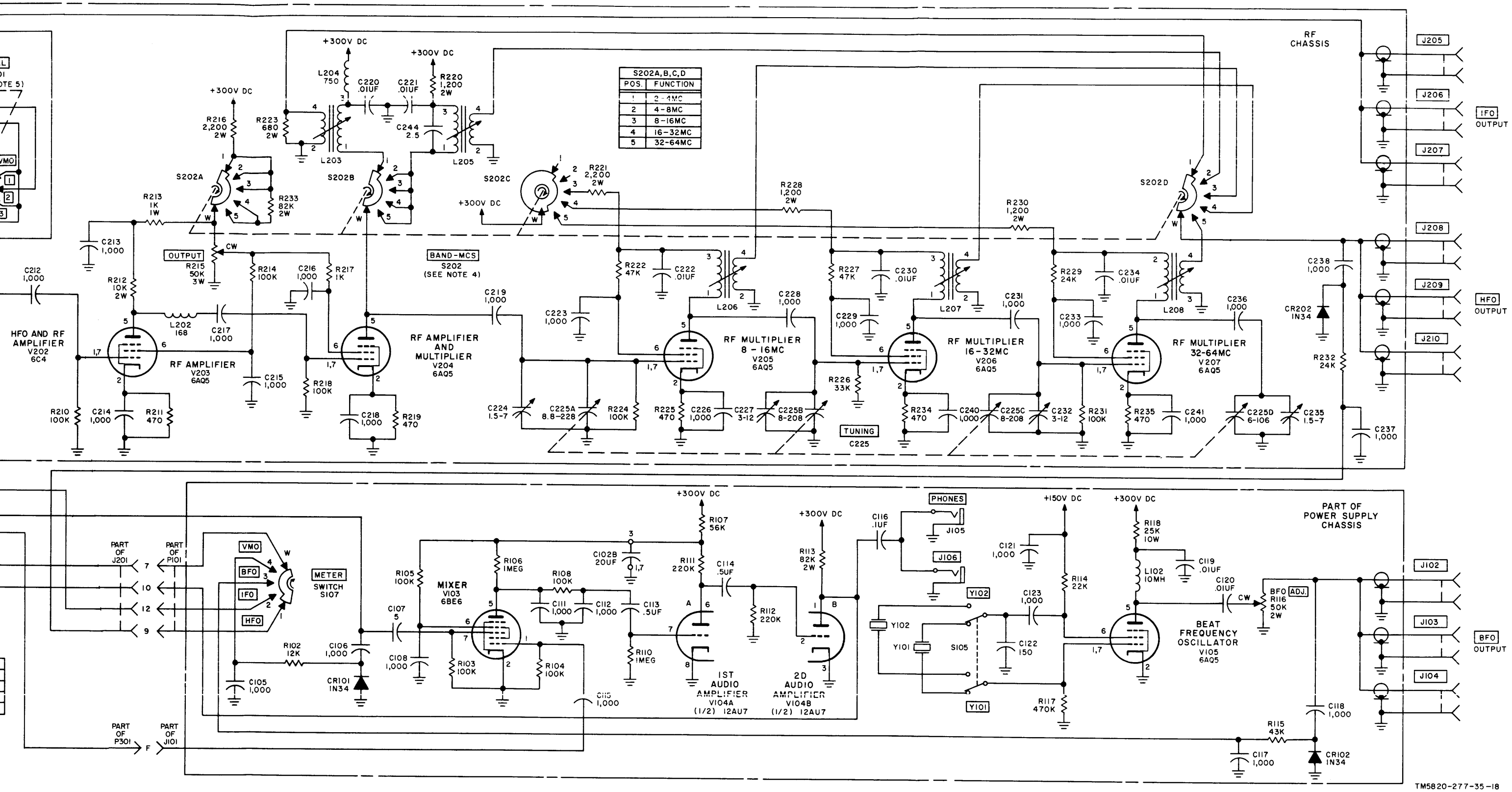
CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER		CHARACTERISTIC[1]				TOLERANCE[2]					TEMPERATURE COEFFICIENT (UUF/UF/°C)
		DECIMAL	NUMBER OF ZEROS	CM	CN	CB	CK	CM	CN	CB	CC		
											OVER 10UUF	10UUF OR LESS	CC
BLACK	0	1	NONE		A			20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W				1		-30
RED	2	100	2	C	H		X	2		2	2		-80
ORANGE	3	1,000	3	D	J	D			30				-150
YELLOW	4	10,000	4	E	P								-220
GREEN	5		5	F	R						5	0.5	-330
BLUE	6		6		S								-470
PURPLE (VIOLET)	7		7		T	W							-750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	-330(±500)[3]
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

1. LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2. IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION.

STD-C1

Figure 33. Capacitor color-code markings.



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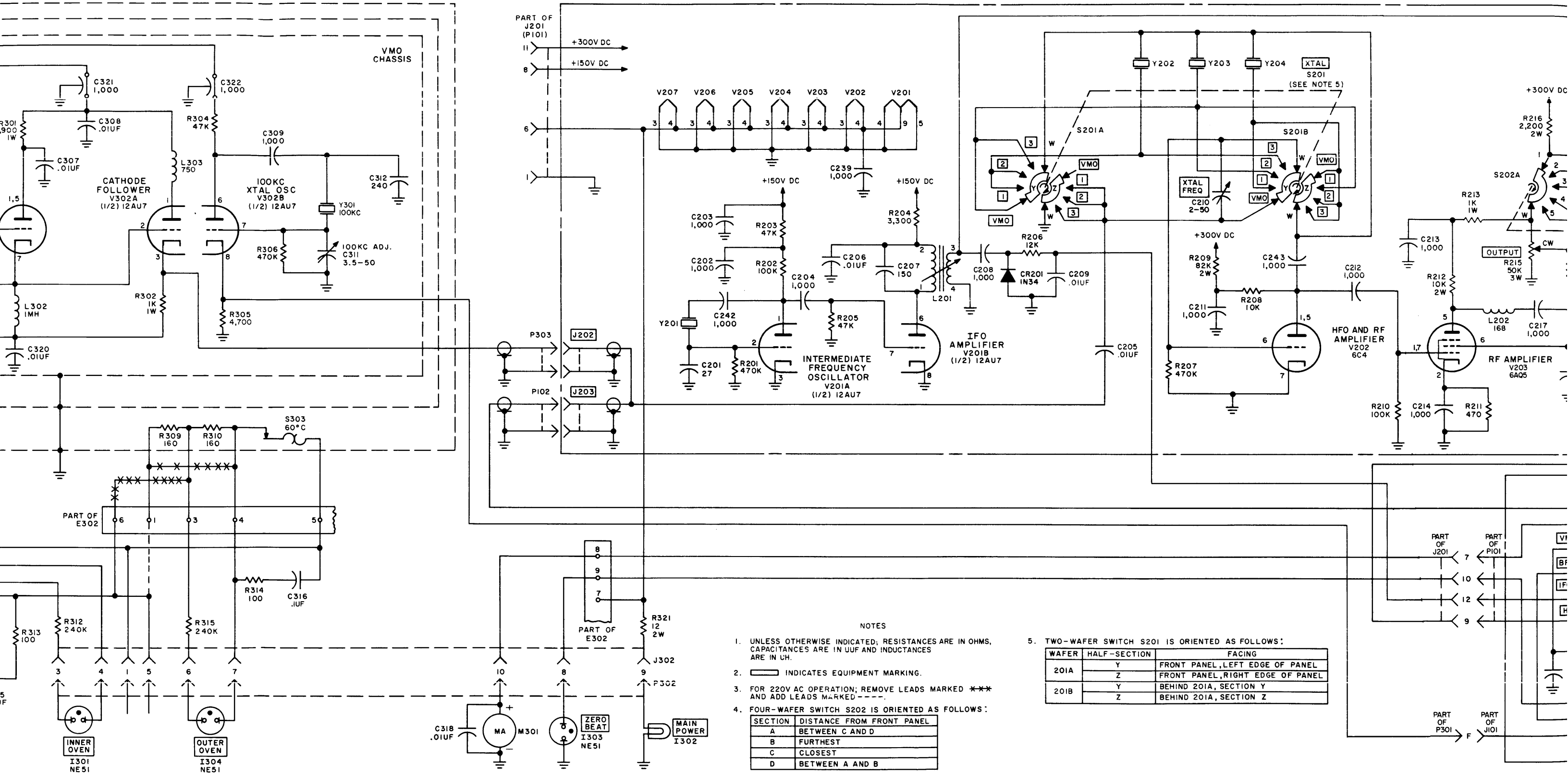

NOTES

1. UNLESS OTHERWISE INDICATED; RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN UUF AND INDUCTANCES ARE IN UH.
2. ▭ INDICATES EQUIPMENT MARKING.
3. FOR 220V AC OPERATION; REMOVE LEADS MARKED ✕✕✕ AND ADD LEADS MARKED - - - -.
4. FOUR-WAFER SWITCH S202 IS ORIENTED AS FOLLOWS:

SECTION	DISTANCE FROM FRONT PANEL
A	BETWEEN C AND D
B	FURTHEST
C	CLOSEST
D	BETWEEN A AND B

5. TWO-WAFER SWITCH S201 IS ORIENTED AS FOLLOWS:

WAFER	HALF-SECTION	FACING
201A	Y	FRONT PANEL, LEFT EDGE OF PANEL
	Z	FRONT PANEL, RIGHT EDGE OF PANEL
201B	Y	BEHIND 201A, SECTION Y
	Z	BEHIND 201A, SECTION Z

atic diagram.

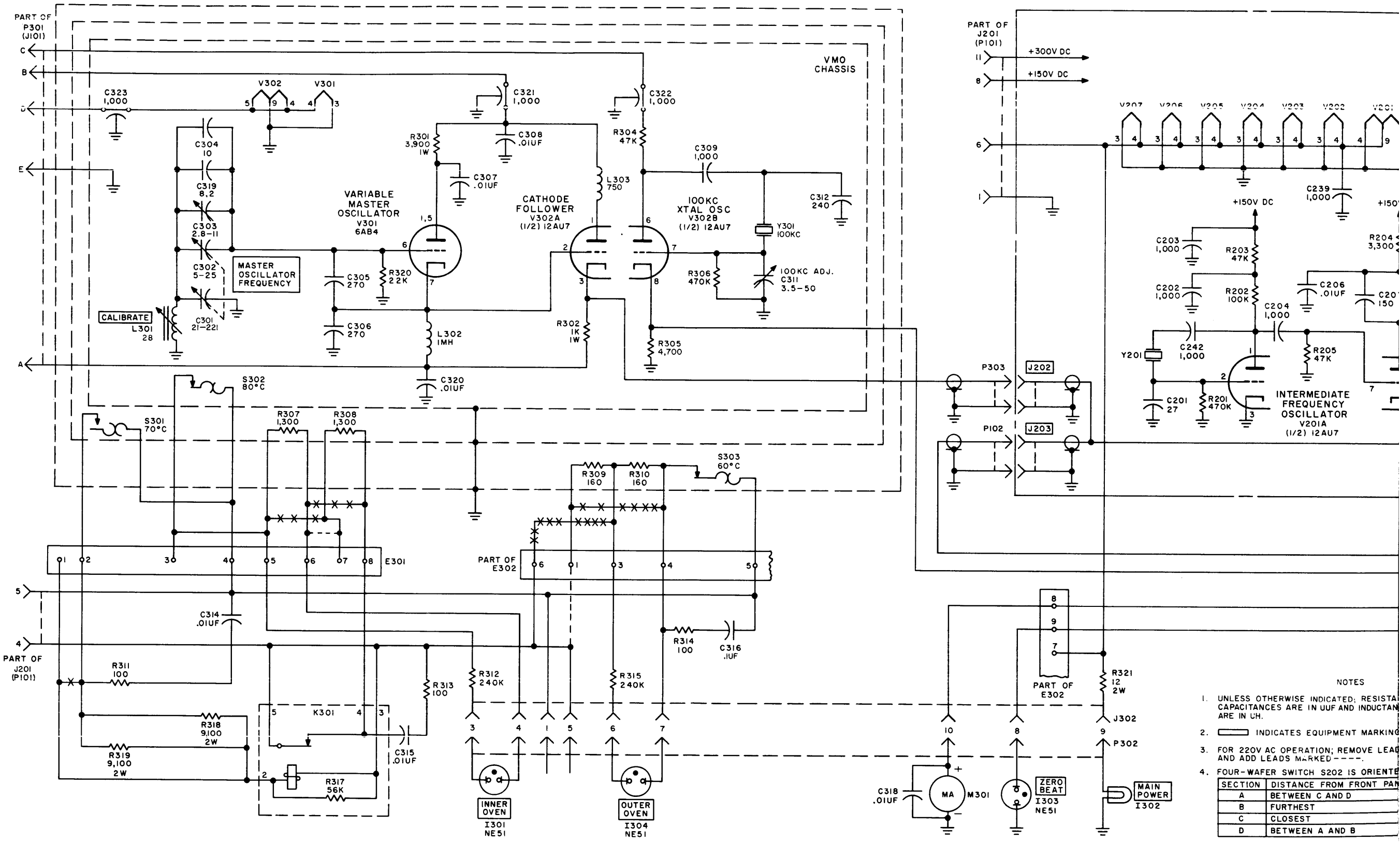

Figure 34. Variable frequency oscillator, schematic diagram.

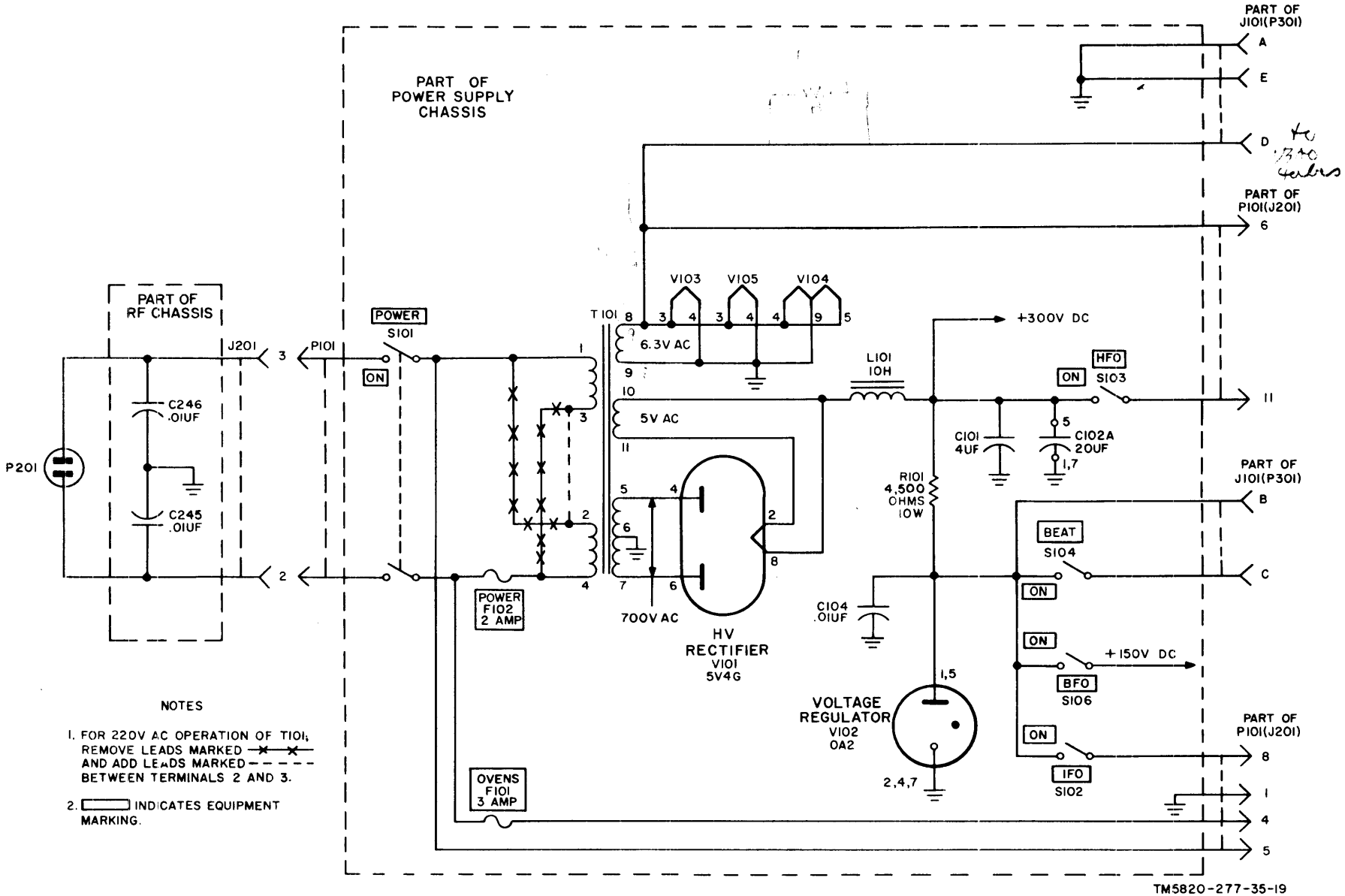

Figure 35. Variable frequency oscillator, power supply, schematic diagram.

APPENDIX

REFERENCES

Following is a list of applicable references available to the field and depot maintenance repairman of this equipment:

TM 11–2661	Electron Tube Test Sets TV–2/U, TV–2A/U, and TV–2B/U.
TM 11–5057	Frequency Meter AN/USM–26.
TM 11–5083	Electron Tube Test Sets TV–7/U, TV–7A/U, TV–7B/U, and TV–7D/U.
TM 11–5114	Panoramic Indicator IP–259/U.
TM 11–5820–277–10P	Operator's Maintenance Repair Parts and Special Tools List for Oscillator, Radio Frequency O–330/FR.
TM 11–5820–277–20P	Organizational Maintenance Repair Parts and Special Tools List and Maintenance Allocation Chart for Oscillator, Radio Frequency O–330/FR.
TM 11–5820–277–35P	Field and Depot Maintenance Repair Parts and Special Tools List for Oscillator, Radio Frequency O–330/FR.
TM 11–6625–200–12	Operation and Organizational Maintenance: Multimeter ME–26B/U.

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For explanation of abbreviations used, see AR 320–50.

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