Chapter 5 - Troubleshooting

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Figures

Tables

5.1 Introduction

5.1.1
Troubleshooting is a logical procedure used to locate a fault in equipment. The procedure given here is based on knowledge of electronic fundamentals, a thorough understanding of the radio receiver, and the application of information contained in this handbook.

5.1.2
One step in troubleshooting, symptom recognition, depends upon experience with equipment operating characteristics. Daily observation of the normal operation of the receiver helps one to recognize an abnormal condition if it should occur.

5.1.3
A second step, symptom elaboration, calls for the use of front panel controls, meters, and output devices to obtain better identification of the trouble. The maintenance turn-on procedure can be used to advantage in this step.

5.1.4
Following this, a logical decision can be made to select the most likely function responsible for the faulty operation. Here the over-all functional description (para 3.1) and its associated block diagram can be used as an aid.

5.1.5
Tests must then be made to determine whether the chosen function is the faulty one. The signal flow diagram is used in this step to find appropriate test points. Key steps in the trouble isolation tables provide normal indications as an aid in these tests and measurements.

5.1.6
When trouble is found in a certain function, it must be localized to a circuit and then a detail part. This is accomplished by following step-by-step procedures in the trouble isolation tables. Again, the signal flow diagram is useful, especially when supplemented by schematic diagrams and voltage and resistance charts. Functional and circuit descriptions should also be consulted.

5.1.7
Assuming that a faulty circuit and part is found, a review of the situation is in order, to determine whether the part is the cause of the trouble or that some other malfunction has caused the part to become defective.

5.1.8
General references were made above to a number of troubleshooting aids. More specific paragraph references are given in table 5-1 as they pertain to the individual subassemblies.

Table 5-1 - Troubleshooting Index

Sub-Assembly	Voltage & Resistance (Fig. No.)	Parts Location (Fig. No.)	Adjustment		Remove & Replace (Para. No.)
			(Para. No.)	(Fig. No.)	
AF	5-8, 5-10	6-27, 6-28	-	-	6.3.14
Crystal Oscillator	5-5	6-5, 6-12, 6-23, 6-22, 6-24	6.2.9	6-5	6.3.7, 6.3.8
IF	5-6, 5-10	6-5, 6-16, 6-17, 6-18	6.2.7, 6.2.8, 6.2.13, 6.2.15, 6.2.17	6-5	6.3.9, 6.3.10
Mainframe	-	6-9, 6-14, 6-15, 6-32	-	-	6.3.2, 6.3.15
Mechanical	-	6-1, 6-4, 6-3, 6-8, 6-36	6.2.5, 6.2.6, 6.2.18	6-2, 6-13	6.3.16 through 6.3.19
Power supply	5-9	6-29, 6-30	-	-	6.3.13
RF	5-4	6-19, 6-20, 6-21	6.2.10, 6.2.11, 6.2.12, 6.2.14	5-1, 6-6	6.3.3 through 6.3.6
VFO	5-7	6-25, 6-26	6.2.16	6-7	6.3.11, 6.3.12

5.2 Maintenance Turn-On Procedure

5.2.1
The maintenance turn-on procedure (table 5-2) is a step-by-step procedure to be used by maintenance personnel in bringing the equipment to an operating condition from a completely secured condition. Normal conditions are noted along with steps to be followed and reference paragraphs to be used if indications are abnormal,

5.2.2
If dial lamps fail to light, check the AC input fuse F101 and the AC input connections. Measure the AC Input voltage (see table 1-2). Check the 6.3 volt circuits (figures 5-11 and 5-12). If no signal is heard, proceed with next step in table 5-2.

5.2.3
If at least one band is normal, make receiver RF-IF checks on faulty bands beginning with step 8 of table 5-5. If all bands are abnormal, begin at step 1 of table 5-5.

5.2.4
AGC circuits could be faulty. Perform steps 17, 18 and 19 of table 5-5.

5.2.5
Check RF input circuits, figure 5-18, zone C. 5.2.6 Perform steps 4 and 5 of table 5-5.

Table 5-2 Maintenance Turn-On Procedure

Prior Control Settings:	
AUDIO RESPONSE switch:	Wide
BANDWIDTH switch:	8 KC
RF GAIN control:	10
LIMITER control:	OFF
LOCAL GAIN control:	6
ANTENNA:	connected
Loudspeaker or Headphones	connected

Table 5-2 Maintenance Turn-On Procedure - Continued

Step	Action Or Condition	Normal Indication	
1	Turn FUNCTION switch to AGC.	Dial lamps light. Rushing noise or signal heard in speaker or headset.	5.2.2
2	Set MEGACYCLE CHANGE control at each band in turn.	Normal signal output on each band.	5.2.3
3	Tune KILOCYCLE CHANGE control across any band and then to one signal.	CARRIER LEVEL meter indicates strength of received signals.	5.2.4
4	Rotate ANT TRIM control.	Obtain peak indication on CARRIER LEVEL meter for each band.	5.2.5
5	Rotate LOCAL GAIN control in either direction.	Volume at loudspeaker or headset increases or decreases.	5.2.6
6	Rotate LINE GAIN control in either direction,	LINE LEVEL meter indication increases or decreases.	5.2.7
7	Rotate RF GAIN control in either direction.	Audio output and CARRIER LEVEL meter indication increase or decrease.	5.2.8
8	With receiver tuned away from any signal turn FUNCTION switch to MGC.	Noise level should increase slightly and CARRIER LEVEL should not indicate.	5.2.9
9	Turn FUNCTION switch to AGC and tune KILOCYCLE CHANGE control through several different signals.	Output volume nearly constant.	5.2.10
10	Turn FUNCTION switch to CAL and tune KILOCYCLE CHANGE control.	Deflection of at least 40 dB on CARRIER LEVEL meter at each 100 kHz reading.	5.2.11
11	Turn LIMITER fully clockwise.	Noise peaks are reduced in amplitude; audio distortion increases.	5.2.12
12*	Turn BREAK IN relay switch to ON and short BRK IN terminal 9 on rear panel to ground momentarily.	Break-in relay functions to silence receiver.	5.2.13
13	Turn LINE METER switch to 0 and adjust LINE GAIN control for a meter indication at VU mark.	Meter adjusts to VU mark (0 dB).	5.2.14
14	Turn LINE METER switch to +10.	LINE LEVEL meter indicates -10.	5.2.15
15	Turn LINE METER switch to -10.	Meter indicates off scale to right.	5.2.15
16	Turn LINE METER switch to OFF.	No indication on LINE LEVEL meter.	5.2.15

Table 5-2 Maintenance Turn-On Procedure - Continued

Step	Action Or Condition	Normal Indication	
17	Turn BFO control to ON, tune in a CW signal and vary the BFO PITCH control.	Beat note of signal is audible and varies.	5.2.16
18	Turn BANDWIDTH switch from 16 kHz to 0.1 kHz.	Selectivity becomes sharper and noise decreases. Only low frequency tones are heard in the counterclockwise positions.	5.2.17
19	Operate AUDIO RESPONSE switch through both positions.	Permits amplification of full AF range in WIDE position and 800 Hz in SHARP position.	5.2.18

*For Shore Stations only.

5.2.6 Perform step 4 of table 5-5.

5.2.7 Perform step 4 of table 5-5.

5.2.8 Check cathode bias line, figure 5-14, zone D and figure 5-16, Zone A.

5.2.9 Check MGC switching circuit, figure 5-16, zone B.

5.2.10 Perform AGC circuit tests given in steps 17, 18 and 19 of table 5-5.

5.2.11 Perform calibration oscillator tests given in steps 20, 21 and 22 of table 5-5.

5.2.12 Check limiter circuit, figure 5-16, zone D or perform step 6 of table 5-5.

5.2.13 Check break-in relay circuits shown in figure 5-14, zone A and figure 5-15, zone C.

5.2.14 Perform line AF amplifier tests given in step 6 of table 5-5.

5.2.15 Check line meter switching circuits shown in figure 5-23, zone D.

5.2.16 Check BFO circuit shown in figure 5-16, zone D.

5.2.17 Check IF filter circuits shown in figure 5-16, zone B.

5.2.18 Check AF filter circuits shown in figure 5-17, zone A.

5.3 Relays, Lamps and Overload Devices

Table 5-3 - Relays, Lamps, and Overload Devices

Reference Designation	Functional Name Of Item Or Circuit	Energizing Voltage And/Or Rating	Figure Reference
		Relays	
K 101	Antenna relay	24 VDC.	5-11, 5-14 5-11, 5-14, 5-17
K 601	Break-in-relay	6.3VDC.	
		Lamps	
I 101	Pilot lamp	6V. 0.20 amp	5-12
I 102	Pilot lamp	6V. 0.20 amp	5-12
I 103	Antenna overload	65V. 1/4 watt	5-19
		Fuses	
F l0l	AC Input fuse	With 115V input: 3 amp (Ovens switch On) 2 amp (Ovens switch Off) With 230V input: 1-1/2 amp (Ovens switch On) 1 amp (Ovens switch Off)	5-11
F 102	Main B+ line	1/4 amp	5-11
F 103	RF - IF B+ line	1/8 amp	5-11

5.4 Troubleshooting Information

5.4.1
Troubleshooting efficiency can be improved through the knowledge and intelligent use of the many aids available to the technician. For example, the R-390A/URR Receiver is equipped with a number of built-in features which can be used to advantage in troubleshooting. These features will be discussed here along with other suggestions concerning good practices for detecting and locating trouble.

5.4.2
Visual Inspection. The importance of performing a careful visual inspection before launching into functional or detailed troubleshooting is often overlooked. Some suggestions, which can be enlarged upon by an observant technician, are given in table 5-3.

5.4.2.1
Visual inspection can be broken down into external and internal areas of inspection. External inspection includes power and signal input connections, rear terminal board linkages, and output signal connections.

1. Check the input power connector, the fuses and fuse holders. See table 2-3 for proper fuse ratings.
2. Inspect the antenna input connections.
3. Inspect the audio output connections and phone jack.
4. Check the jumpers on the rear panel terminal boards which provide audio and AGC linkages.
5. Check for loose or missing knobs, or damage to meters.

5.4.2.2 Internal inspection concerns tubes and connectors

1. See that tubes are unbroken, are properly seated in their sockets and are equipped with tube shields where applicable.
2. Observe that all subassemblies are securely fastened and completely interconnected.
3. Look for any evidence of overheated components or charred or frayed insulation.

5.4.3 Built-In Troubleshooting Aids.

The built-in features of the equipment which aid the maintenance man include the following: carrier level meter, line level meter, and calibration oscillator. The output transducers, phones or speaker, can also be used as sensing devices for the detection of trouble. The CARRIER LEVEL meter measures the relative signal strength of the incoming RF or test signals. Indications on this meter are proportional to those at the AGC terminals on the rear panel of the receiver. The LINE LEVEL meter readings can be translated into audio output or power ratio readings. The LINE METER switch extends the range of the LINE LEVEL meter over a 40-dB range.

5.4.3.1
The calibration oscillator, while designed primarily for calibration checks can also be used in conjunction with the CARRIER LEVEL meter for rough sensitivity checks across the entire frequency range (refer to table 5-2, step 10). The phones or speaker can also be used for rough sensitivity checks by listening to the relative signal or noise levels. Then too, other faults such as excessive hum, noise, or interference, or intermittent conditions can be detected by this means.

5.4.3.2
~~These built-in features can be used to advantage by performing the maintenance turn-on procedures (table 5.2) and making the appropriate observations.~~ Duh, REALLY?

5.4.4
Trouble Isolation. Physically, the equipment consists of a main frame and six sub-chassis as listed in table 5-1. Functionally, the receiver can be divided into four subsystems, namely, the power supply, the AF, the IF, and the RF circuits. The trouble isolation table (5-5) is based on this functional approach, and tests are arranged in the order named above.

5.4.4.1
Steps 1, 2 and 3 are concerned with power supply tests, since this function is common to and required by the other three functions. Steps 4 through 7 concern the audio circuits. Steps 4 and 5 check out the over-all audio function. Steps 6 and 7 are entered only if there is audio trouble; they are stage-by-stage checks that progress from output to input. Steps 8 and 9 concern, the IF circuits. Step 8 checks out the overall IF function. Step 9 is a stage-by-stage check, that progresses from the detector back to the RF circuits. Steps 10 through 16 are stage-by-stage RF circuit checks which lead back from the third mixer to the antenna.

5.4.4.2
The RF function includes several local oscillators which, since they are internal signal generators, can be checked independently as described in paragraph 5.5.3. In addition, AGC circuits are checked in steps 17, 18 and 19, and calibration oscillator circuits are checked in steps 20, 21 and 22.

5.4.5 Sub-chassis Removal for Troubleshooting.

Caution:	Do not attempt removal or replacement of parts or sub-chassis before reading the instructions in paragraph 6.3.1 through 6.3.1.3.

5.4.5.1
When testing or troubleshooting the receiver, do not remove a sub-chassis unless it is absolutely necessary. Test cables are required for operating a sub-chassis out of the receiver (para 5.5.1). If a receiver in good operating condition is available, a sub-chassis may be connected from it, directly into the receiver being repaired.

Note:	Avoid disturbing the synchronization of the RF gear train assembly with the RF, crystal oscillator, or VFO sub-chassis.

5.4.5.2
To avoid removing a sub-chassis when voltage is to be measured or when a signal is to be injected at a tube-socket pin that does not have a test point, remove the tube and use a tube adapter with test points.

The RF tuning coils and transformers on the RF sub-chassis can be removed readily (para. 6.3.4.3), if necessary, to permit measurement of voltage or resistance at the socket contacts, or measurement of the voltage or resistance at the socket contacts, or measurement of the continuity of the coils.

If trouble is suspected in the RF sub-chassis, perform as much detailed troubleshooting as possible before removing it to be sure that the trouble is in the sub-chassis, since removal and replacement of this sub-chassis is time-consuming.

5.4.5.3
Figure 5-1 shows the numbers of the terminals on the RF and the variable IF coils as seen from the bottom of the RF sub-chassis. These numbers are used to identify the terminals in the schematic diagrams in this manual.

Table 5-4 - Test Cable Data

From Plug No.	Cable Type	To Jack No.
Co-axial Test Cables		
P717	RG-187/U	J217
P215	RG-187/U	J415
P207	RG-187/U	J107
P206	RG-187/U	J106
P205	RG-187/U	J105
P218	RG-187/U	J518
P213	RG-187/U	J513

Multi-Conductor Test Cables		
P108	All shielded and unshielded wires to be no smaller than 18 gauge stranded wire. Refer to figure 5-3.	J208
P109		J709
P110		J410
P111		J811
P112		J512
P119		J619
P120		J620

5.5 Trouble Isolation Procedures

5.5.1 Test Cable Data (See figures 5-2 and 5-3).

Test cables are required when operating sub-chassis out of the receiver. Make all cables 24 inches long. Table 5-4 contains plug and jack reference designations for each test cable required.

5.5.2 Initial Control Settings.

Use the control settings given below before performing any test or troubleshooting procedure. Many of the tests that follow repeat some of these settings, and others refer back to this paragraph to stress the importance of using the proper control settings. Observe these control settings, and change them only when instructions in a particular procedure direct different control settings.

LINE METER	OFF	ANT TRIM	0, or maximum output
LINE GAIN	0	BFO	OFF
AGC	MED	DIAL LOCK	Unlocked, fully counterclockwise
LIMITER	OFF	ZERO ADJ	Disengaged, fully counterclockwise
AUDIO RESPONSE	WIDE	LOCAL GAIN	10, or desired volume
BANDWIDTH	8	OVENS	OFF
BFO PITCH	0	MEGACYCLE CHANGE	01, or as specified
BREAK IN	OFF	KILOCYCLE CHANGE	510, or as specified
FUNCTION	MGC	RF GAIN	10

5.5.3 Oscillator Injection Voltage Tests (See figures 5-18 through 5-24.)

To check the conversion oscillators (V207, V401, and V701) to see if they are oscillating, turn the FUNCTION switch to STANDBY to remove B+ from all tubes except the conversion oscillators. The cathodes and control grids of the mixers act as rectifiers of the oscillator voltage at test points E209, E210, and E211. The voltage at test point E402 (figure 5-21) is the grid leak bias at the control grid of V401

5.5.3.1
Check the DC voltage at test points E209, E210, E211, and E402 with Electronic Multi-meter USM-116. ( )

The voltage should be as follows:

Test Point	Voltage
*E209	-4.0 to -6.8
E210	-3.0 to -8.0
E211	-1.3 to -4.3 (-0.95 to -1.6 with FC-7)
E402	-4 to -11
*To obtain a meter indication at test point E209, the receiver must be tuned below 8 MHz	

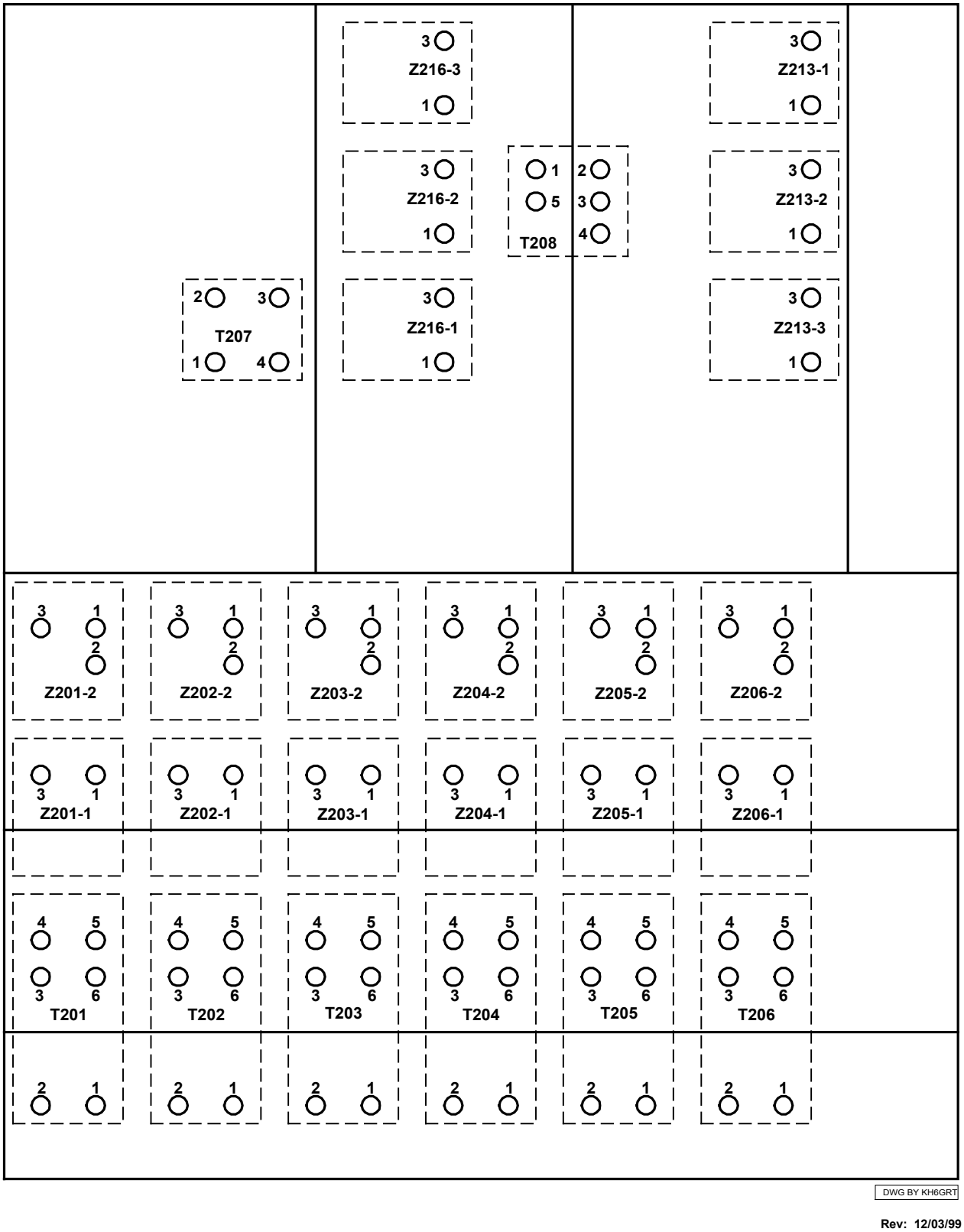


Figure 5-1 Terminal Numbers of RF and Variable IF Coils[1]

[1]Courtesy of Pete Wokoun, KH6GRT

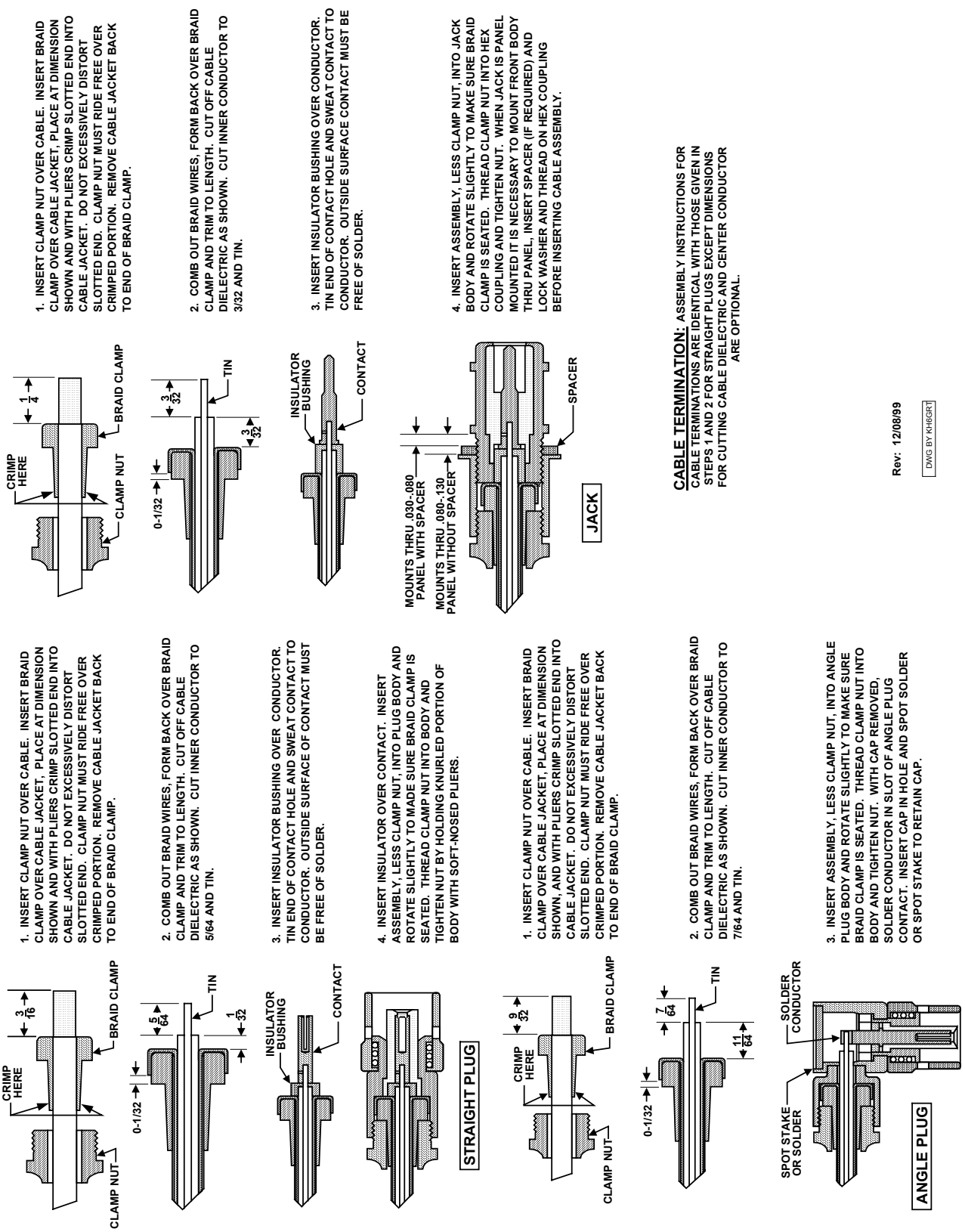


Figure 5-2 Fabrication of Coaxial test Cables[2]

[2]Courtesy of Pete Wokoun, KH6GRT

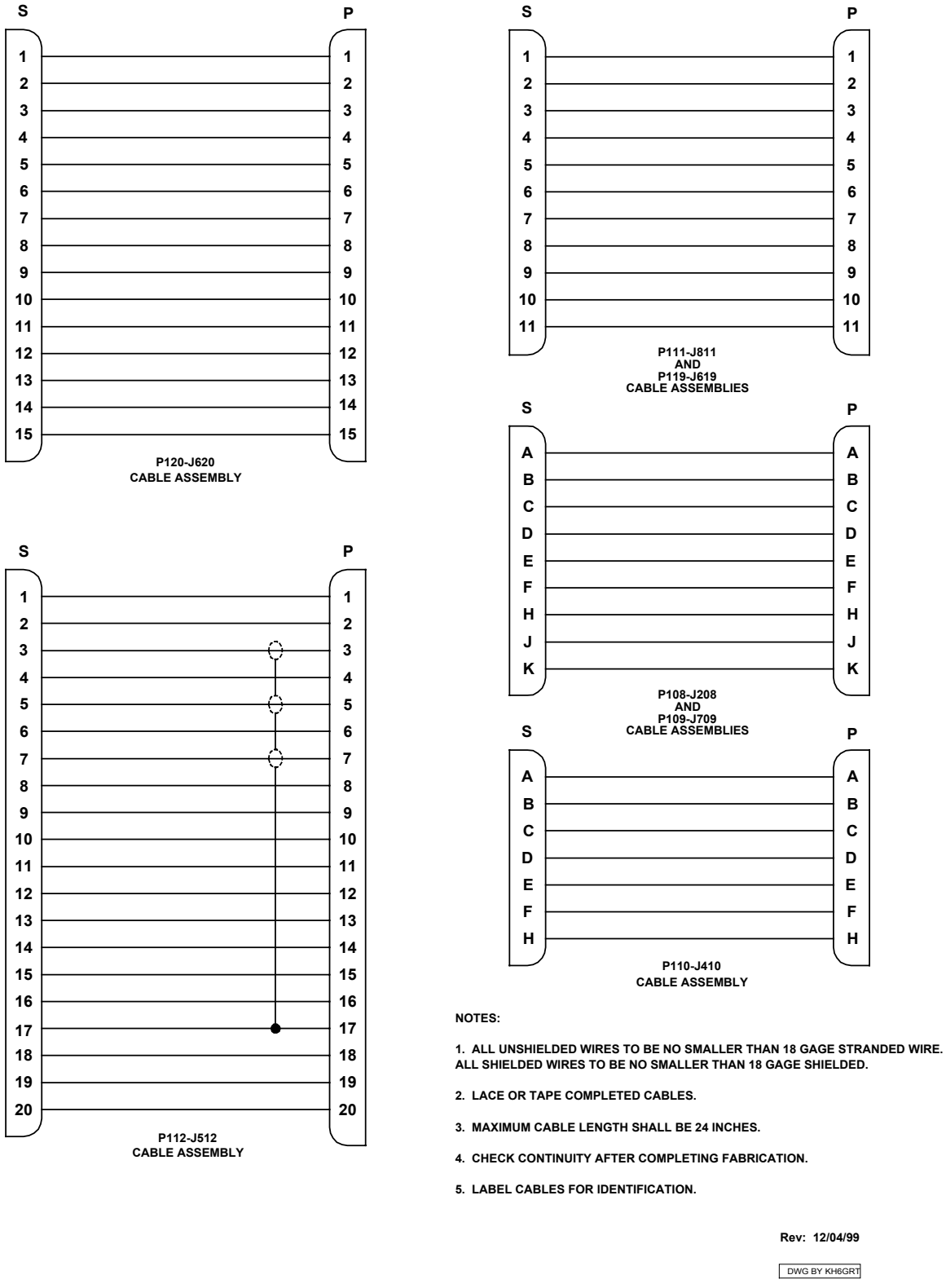


Figure 5-3 Fabrication of Multi-conductor Test Cables[3]

[3]Courtesy of Pete Wokoun, KH6GRT

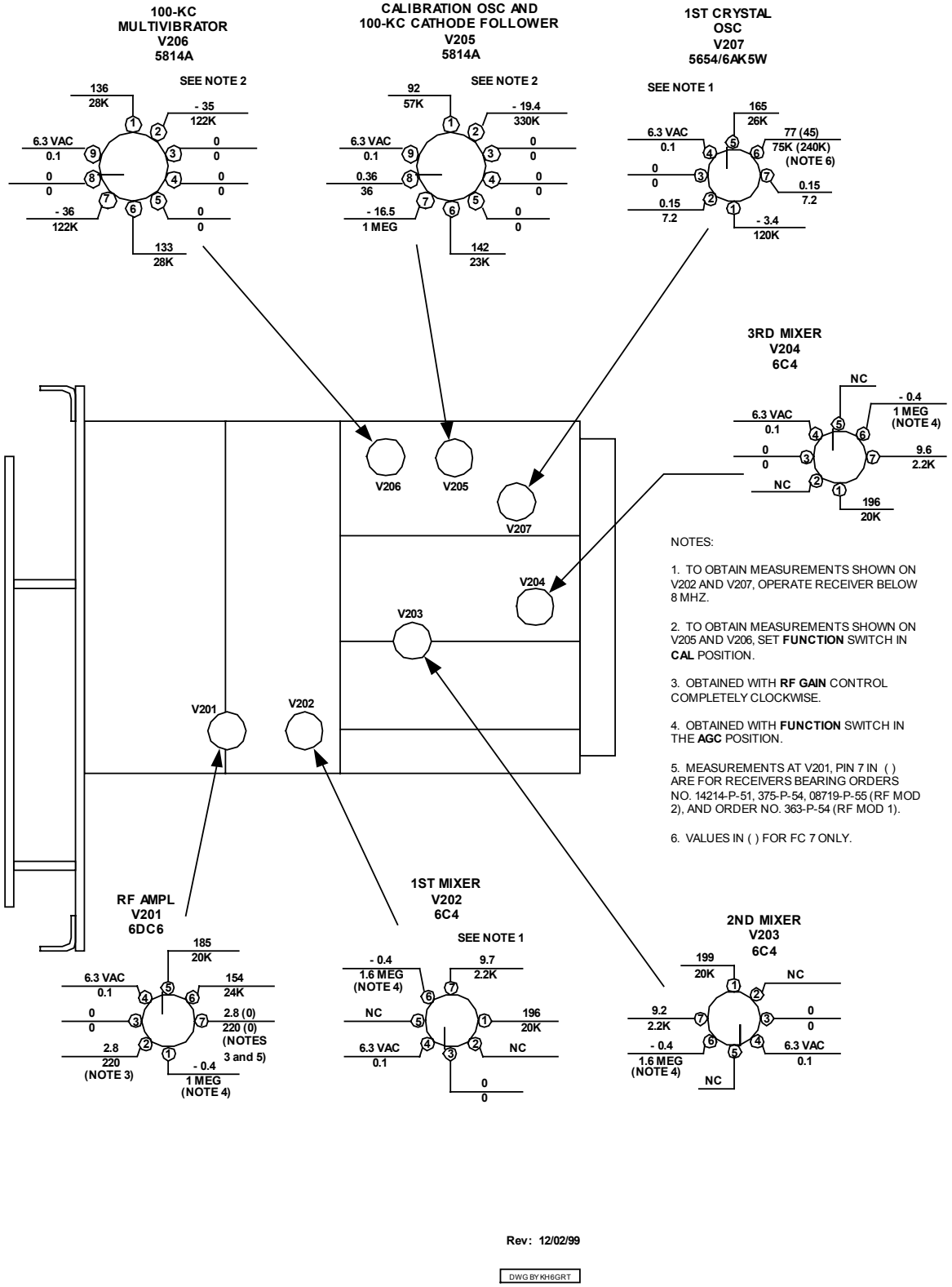


Figure 5-4 RF Sub-chassis, Voltage and Resistance Diagram[4]

[4]Courtesy of Pete Wokoun, KH6GRT

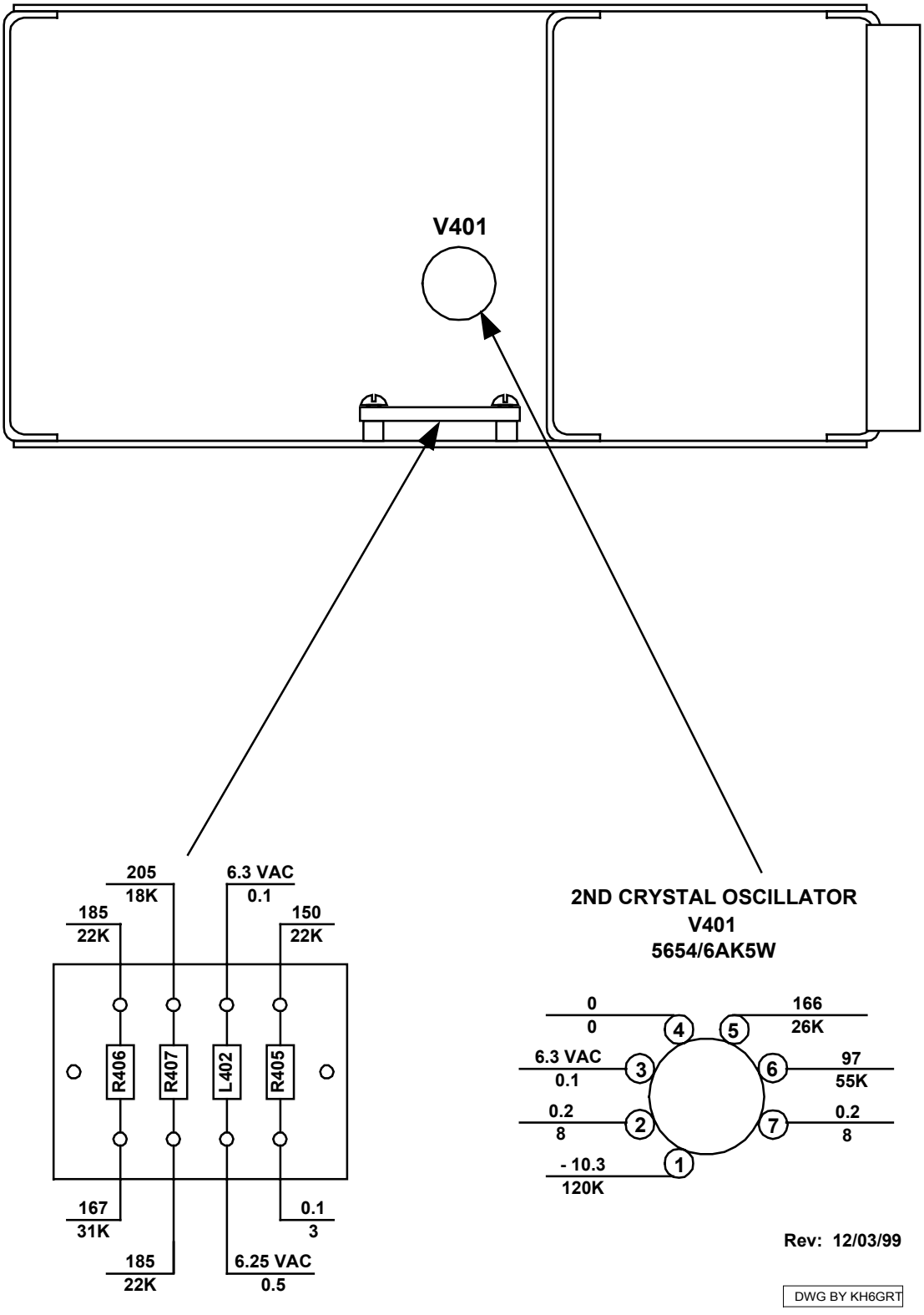
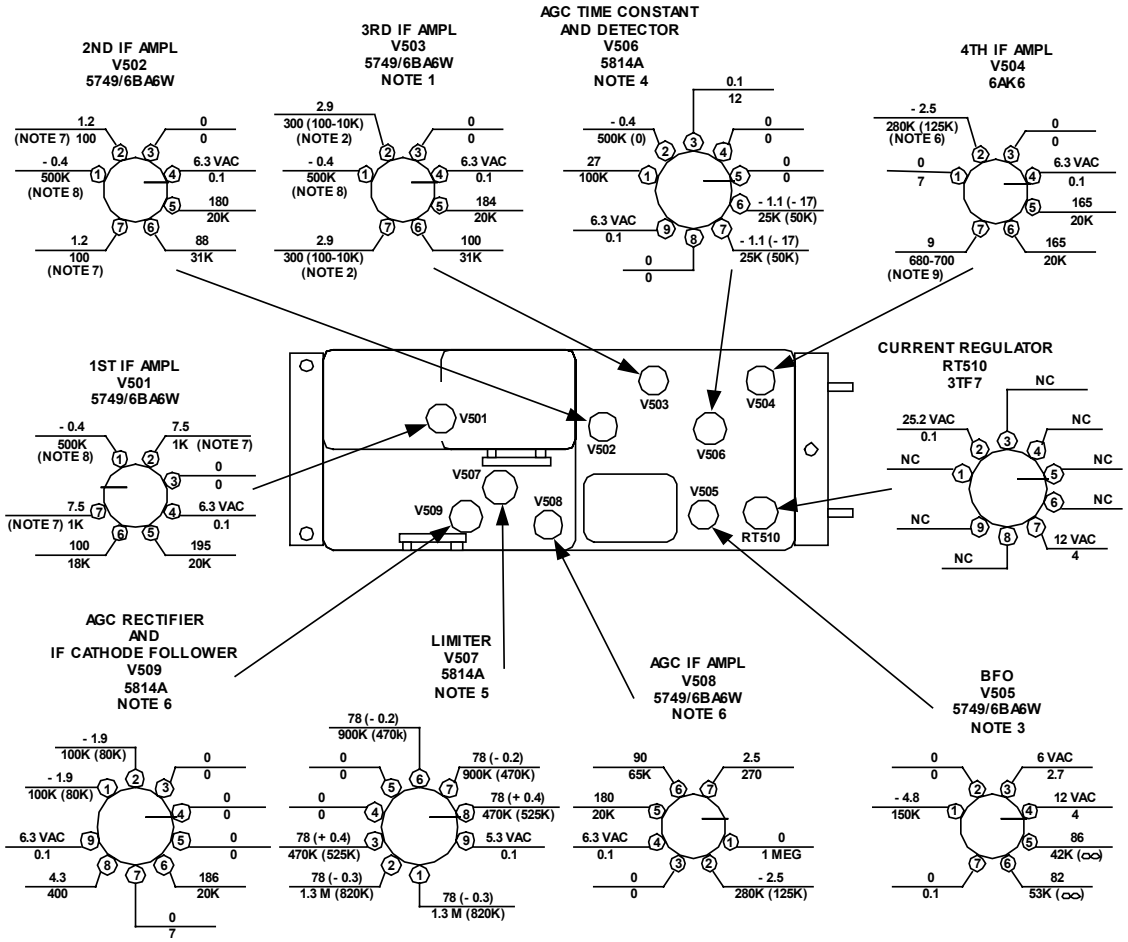


Figure 5-5 Crystal Oscillator Sub-chassis, Voltage Resistance Diagram[5]

[5]Courtesy of Pete Wokoun, KH6GRT



NOTES:

1. VOLTAGE AND RESISTANCE READINGS ON V503 ARE WITH A NORMAL SETTING OF THE **GAIN ADJ** CONTROL R519. MINIMUM (CLOCKWISE) AND MAXIMUM (COUNTER-CLOCKWISE) SETTINGS CHANGE VOLTAGE READINGS AS FOLLOWS:

	P I N N O.			
R519	2 -	5 -	6 -	7
MIN:	19 -	196 -	144 -	19
MAX:	1.3 -	178 -	85 -	1.3

2. RESISTANCE VALUES IN ( ) INDICATE RANGE OF READINGS DEPENDING UPON SETTING OF R519.

3. SET **BFO** SWITCH TO **ON** POSITION. RESISTANCE VALUES OF PINS 5 AND 6 IN ( ) ARE TAKEN WITH **BFO** SWITCH IN **OFF** POSITION.

4. RESISTANCE READINGS OF PIN 2 IN ( ) TAKEN WITH **FUNCTION** SWITCH SET TO **MGC** . VALUES OF PINS 6 AND 7 IN ( ) TAKEN WITH **LIMITER** CONTROL SET TO **10** .

5. VALUES IN ( ) TAKEN WITH **LIMITER** CONTROL SET TO **10** .

6. RESISTANCE VALUES IN ( ) TAKEN WITH **FUNCTION** SWITCH SET TO **MGC** .

7. **RF GAIN** CONTROL COMPLETELY CLOCKWISE.

8. **FUNCTION** SWITCH IN **AGC** POSITION.

9. RESISTANCE OF PIN 7 VARIES WITH SETTING OF **CARR METER ADJ** CONTROL R523.

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Figure 5-6 IF Sub-chassis, Voltage and Resistance Diagram[6]

[6]Courtesy of Pete Wokoun, KH6GRT

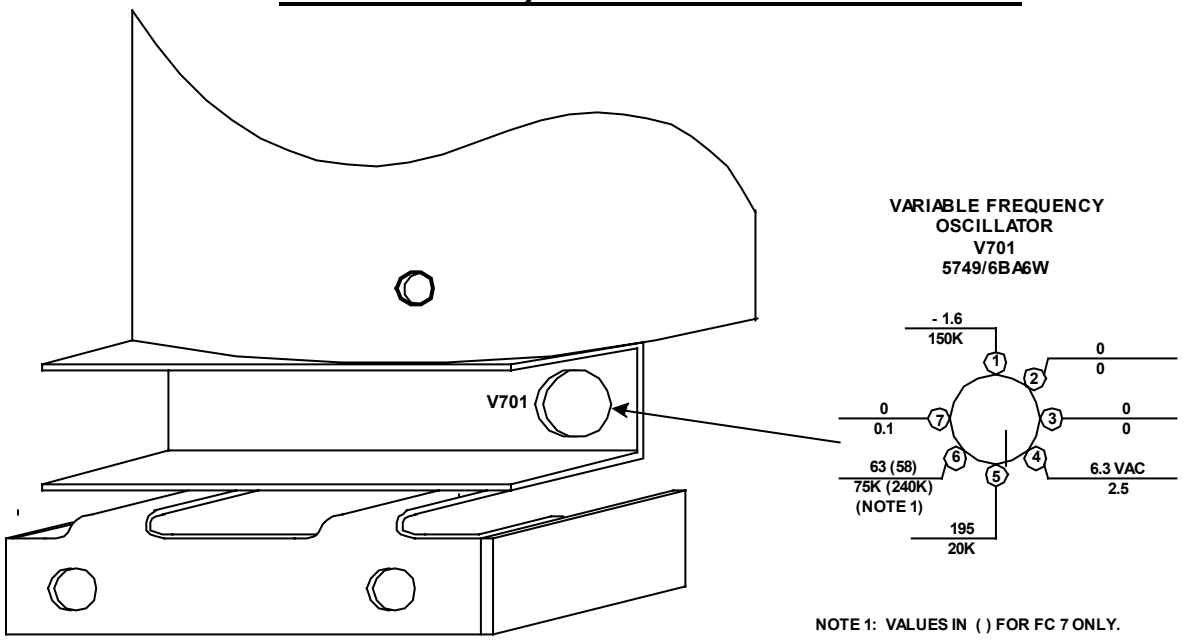

Fig. 5-7 VFO Sub-chassis. Voltage and Resistance Diagram[7]

[7]Courtesy of Pete Wokoun, KH6GRT

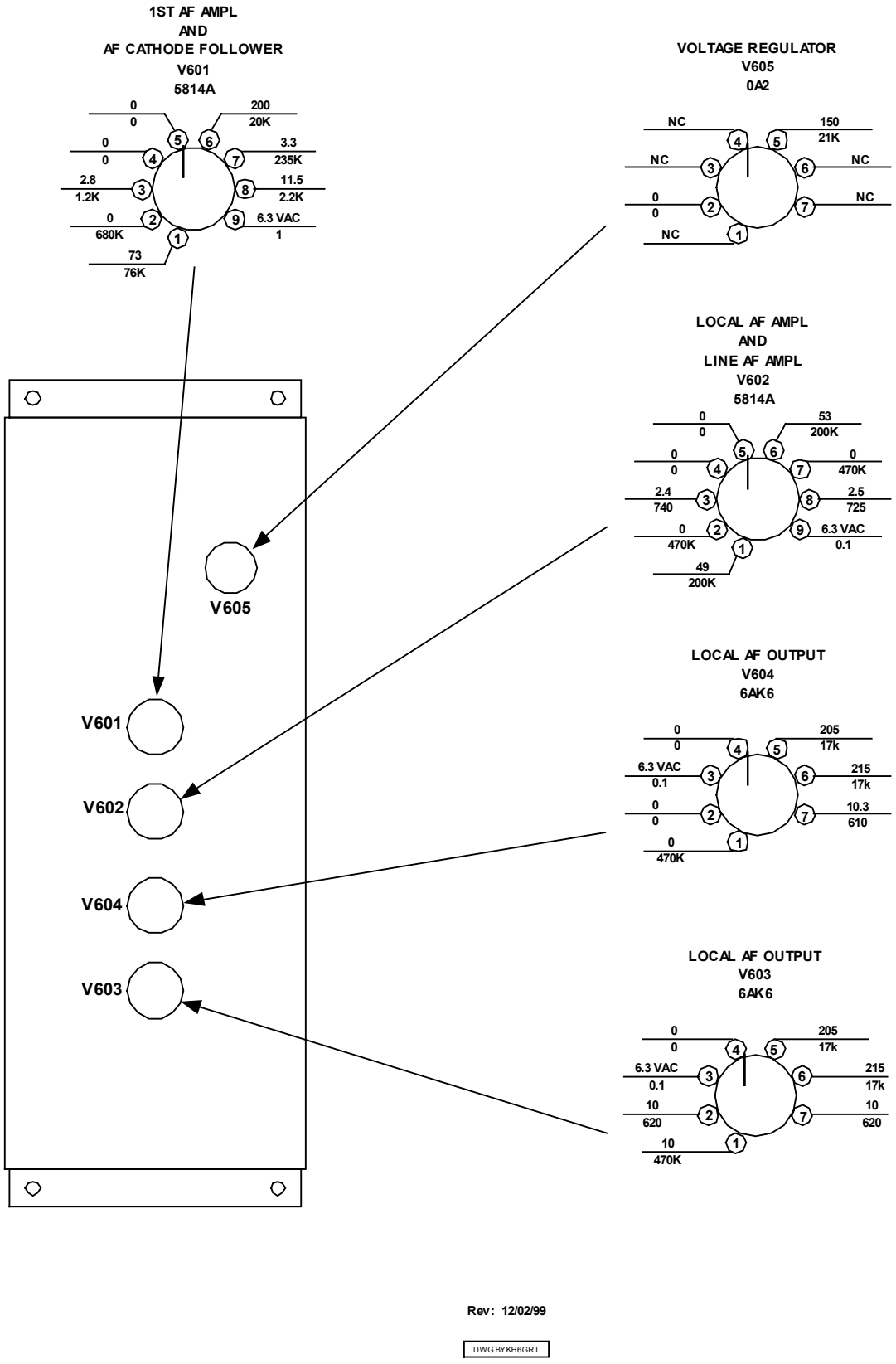

Figure 5-8 AF Sub-chassis, Voltage and Resistance Diagram[8]

[8]Courtesy of Pete Wokoun, KH6GRT

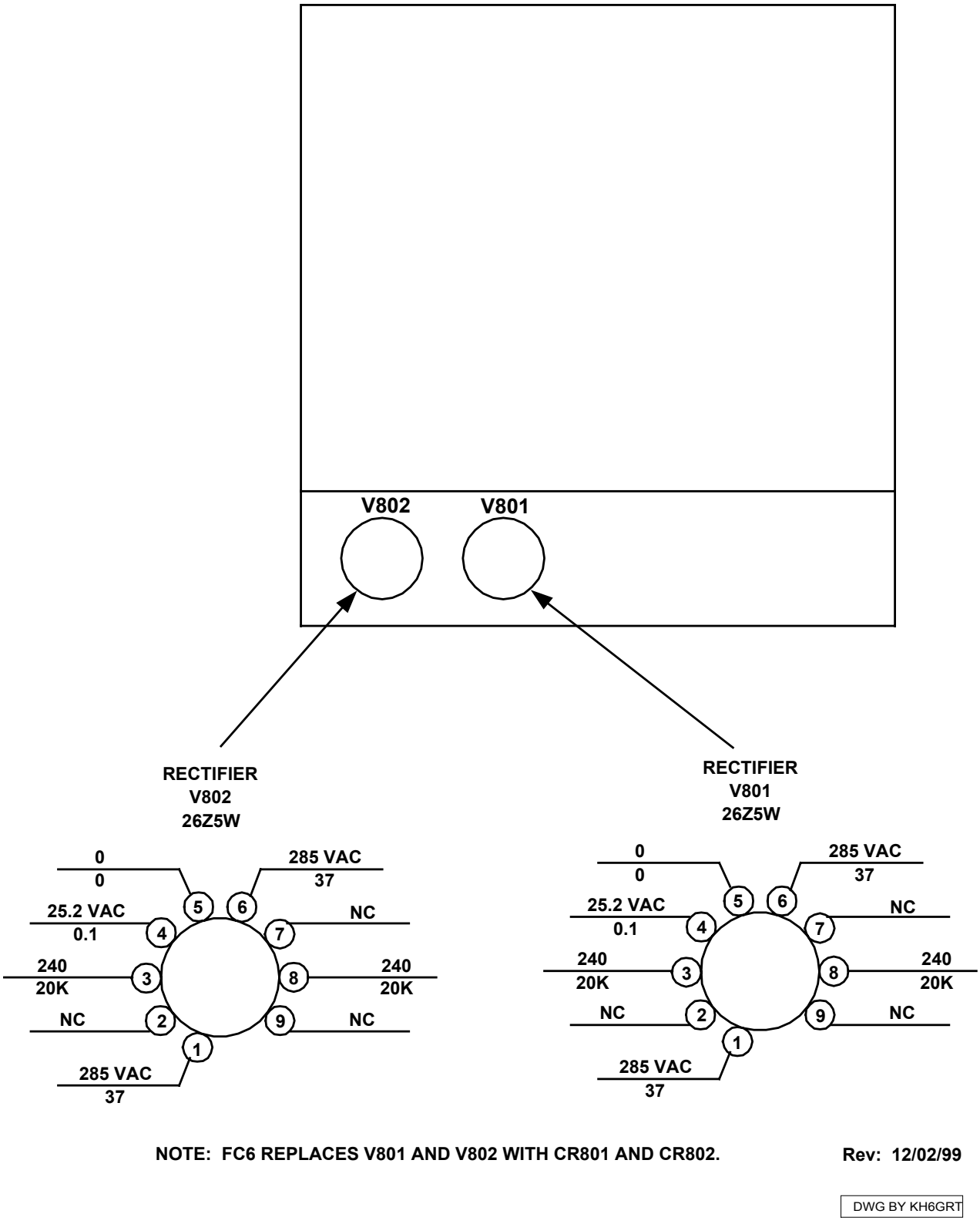

Figure 5-9 Power Supply Sub-chassis, Voltage and Resistance Diagram[9]

[9]Courtesy of Pete Wokoun, KH6GRT

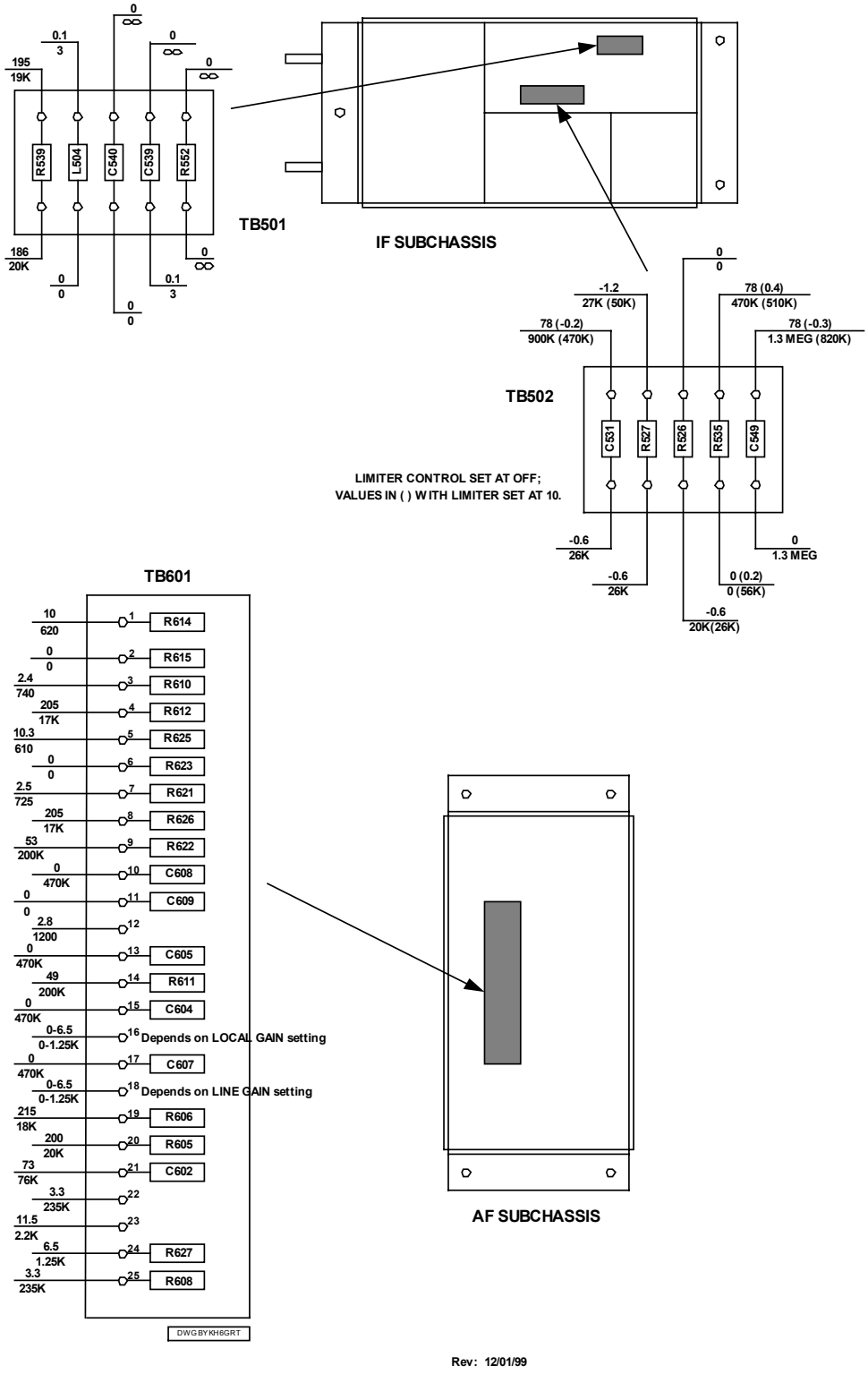

Figure 5-10 IF and AF Sub-chassis Resistor and Capacitor Terminal Boards, Voltage and Resistance Diagram[10]

[10]Courtesy of Pete Wokoun, KH6GRT

5.5.4 Receiver RF - IF Gain Test.

The receiver RF - IF gain test checks receiver operation from the antenna through detector V506B. If the result of this test is normal, the fault is in the audio portion of the receiver.

1. Connect Multi-meter AN/PSM-4( ) to the DIODE LOAD test jack on the front panel of the receiver and set meter controls for measuring -10 VDC.

2. Connect Signal Generator AN/URM-25( ) to UNBALANCED ANT WHIP jack J103 on the back of receiver and set the controls for a CW output of 10 micro-volts. (J104 must have short inserted if FC-5 is installed.)

3. Tune Signal Generator AN/URM-25( ) and the receiver to the same frequency. Readjust the KILOCYCLE CHANGE control slightly for a maximum indication on the AN/PSM-4( ). Peak ANT TRIM control.

4. Adjust the output of the AN/URM-25( ) for a meter indication of -7 volts, If the AN/URM-25( ) output is between 1 and 4 microvolts, the RF - IF gain of the receiver is normal.

5. If the AN/URM-25( ) output is above or below the limits set in 4 above, readjust the AN/URM-25( ) output for 2 microvolts. Adjust GAIN ADJ control R519 (figure 6-16) for a meter indication of -7 volts. If this adjustment fails to restore normal operation, perform detailed checks of the IF and RF stages beginning with step 8 of table 5-5.

5.5.5 Trouble Isolation Table.

The procedures in table 5-5 can be used to rapidly localize trouble to a particular stage. Preset the receiver front-panel controls as directed in paragraph 5.5.2. Use tube adapters to make connections where test jacks are not provided. Refer to figures 5-11 and 5-14 through 5-17.

Table 5-5 - Trouble Isolation

Step No.	Test Instructions	Sig. Gen Output Control	Normal Indication	Instructions
1	Connect positive lead of Multi-meter AN/PSM-4( ) to F102 terminal and negative lead to ground.	N/A	+240 VDC	1. If indication is correct, proceed to next step. 2. If indication is incorrect, check ac input circuit and power supply sub-chassis (figure 5-11).
2	Connect positive lead of Multi-meter AN/PSM-4( ) to F103 terminal and negative lead to ground.	N/A	+205 VDC	1. If indication is correct, proceed to next step. 2. If indication is incorrect, check filter circuits in AF sub-chassis (figure 5-11).

Step No.	Test Instructions	Sig. Gen Output Control	Normal Indication	Instructions
3	Connect positive lead of Multi-meter AN/PSM-4( ) to test point E607 on AF sub-chassis.	N/A	+150 VDC	1. If indication is correct, power supply circuits are normal. Proceed with next step. 2. If indication is incorrect, check voltage regulator V605 circuit (figure 5-11).
4	Connect Signal Generator AN/URM-25( ) to pin 7 grid of V506. Set CARRIER LEVEL to 10 in CW mode and then set controls for an output of 455 kHz with 30% 400 Hz modulation. Set LINE METER switch to -10 and LINE GAIN control to 10.	0.1V	-10 VU min	1. If indication is correct, proceed to step 5. 2. If indication is incorrect, proceed to step 6.
5	With the signal generator set up as in step 1, connect Electronic Multi-meter ME-6 D/U to PHONES jack J102 on the front panel.	0.1V	-20 dB min	1. If the multi-meter reading is at least -20 dB, proceed to step 8. 2. If reading is incorrect, proceed to step 7.
6	Connect Audio Signal Generator AN/URM-127 to the following points and adjust its output to the given setting. Set the frequency to 800 Hz. Set LINE METER switch to 0. Set LINE GAIN control to 10. Pin 1 Grid V604 Pin 7 Grid V602B Pin 7 Grid V601B Pin 2 Grid V601A Pin 7 Grid V507	 5.0V 0.2V 0.6V 0.04V 0.15V	 0 VU min 0 VU min 0 VU min 0 VU min 0 VU min	1. Continue from stage to stage until an incorrect indication is obtained. The last circuit checked is defective or if all indications are correct, the trouble lies in detector circuit V506B (figure 5-16).

Step No.	Test Instructions	Sig. Gen Output Control	Normal Indication	Instructions
7	Connect Electronic Multi-meter ME-6 D/U to PHONES jack J102 and Audio Signal Generator AN/URM-127 to the following points and adjust its output to the given setting. Set the frequency to 800 Hz. Pin 1 Grid V603 Pin 2 Grid V602A Pin 7 Grid V601B	 1.1V 0.15V 0.4V	 0 dB min 0 dB min 0 dB min	1. Continue from stage to stage until an incorrect indication is obtained. The last circuit checked is defective.
8	Set Signal Generator AN/URM-25( ) for an output of 455 kHz with 30% 400 Hz modulation and connect it to test point E211. Set LINE METER to 0 and LINE GAIN to 9.	10 μV	0 VU min	1. If indication is correct, proceed to step 10. 2. If indication is correct, proceed to next step.
9	With the signal generator set up as in step 8, connect to the following points in turn. Pin 1 Grid V504 Set LINE METER (LM) to -10 and LINE GAIN (LG) to 10 Pin 1 Grid V503 Set LM to -10, LG to 8 Pin 1 Grid V502 Set LM to -10, LG to 9 Pin 1 Grid V501 Set LM to -10, LG to 9	 0.01V 0.001V 100 μV 10 μV	 0 VU min 0 VU min 0 VU min 0 VU min	1. Continue from stage to stage until an incorrect indication is obtained. The last circuit checked is defective. 2. If all indications are correct, proceed to next step.
10	Change the signal generator frequency to 3 MHz, check carrier level and % Mod, and connect to test point E211. Tune the receiver KILOCYCLE CHANGE control above 900 on the counter dial to a peak indication on the LEVEL METER. Set LM to -10, LG to 9.	10 μV	0 VU min	1. If indication is correct, proceed to next step. 2. If indication is not correct, the trouble is probably in the circuit of V701. See paragraph 5.5.3.

Step No.	Test Instructions	Sig. Gen Output Control	Normal Indication	Instructions
11	Connect the signal generator to test point E210 with the frequency still at 3 MHz. Set LM to -10, LG to 9.	10 μV	0 VU min	1. If indication is correct, proceed to next step. 2. If indication is not correct the circuit of V203 is faulty.
12	With the signal generator connected to test point E210 change the signal generator frequency to 13 MHz. Tune the MEGACYCLE CHANGE control to 13 MHz and adjust the KILOCYCLE CHANGE control for a peak indication on the LEVEL METER. Rotate the MEGACYCLE CHANGE control from 14 thru. 31 MHz. Set LM to +10, LG to 10.	.001V	0 VU min	1. If indication is correct, the fault is probably in the 2nd crystal oscillator circuit V401. See paragraph 5.5.3 and figure 3-3.
13	Connect the signal generator to E209 and tune both the receiver and signal generator to 1 MHz peaking the LEVEL METER indication with the KILOCYCLE CHANGE control. Set LM to 0, LG to 9	.01V	0 VU min	1. If indication is correct, proceed to step 15. 2. If indication is incorrect, proceed to next step.
14	Change the signal generator frequency to 18 MHz and adjust for a peak on the LEVEL METER. Set LM to 0, LG to 8.	.001V	0 VU min	1. If indication is correct the faulty circuit is probably the 1st crystal oscillator V207. See paragraph 5.5.3. 2. If indication is incorrect, check the 1st mixer circuit V202.
15	Connect the signal generator to E208 and tune the frequency of the receiver and signal generator to 0.5 MHz adjusting the KILOCYCLE CHANGE control for a peak indication on the LEVEL METER. Check at 15 MHz and 31 MHz also. Set LM to 0, LG to 8.	.5MHz 10 μV 15 MHz 10 μV 31 MHz 10 μV	0 VU min 0 VU min 0 VU min	1. If indication is correct, proceed to next step. 2. If indication is incorrect, check the circuit of V201, figure 5-18.

Step No.	Test Instructions	Sig. Gen Output Control	Normal Indication	Instructions
16	Connect the signal generator to J103 on back of receiver, Tune the receiver and signal generator to 15 MHz. Set LM to -10, LG to 10.	1 μV	0 vu min	1. If indication is correct, proceed to next step. 2. If indication is incorrect, check antenna input circuits.
17	Set FUNCTION switch to AGC position. With the signal generator connected as in previous step, observe indication of CARRIER LEVEL meter.	10 μV 100 μV	40 min 60 ± 2	1. If indication is normal, proceed to step 20. 2. If indication is abnormal, proceed to next step.
18	With the signal generator set up as in previous step, connect Oscilloscope AN/USM117( ) to IF OUTPUT jack on rear panel. Observe 455 kHz waveform.	100 μV	180 mV min	1. If indication is normal, proceed with next step. 2. If indication is abnormal, check the circuit of V509B.
19	Disconnect oscilloscope, and connect Multi-meter AN/PSM4( ) to TB102-3. Observe indication.	100 μV 10 mV	-4.0 VDC min -1.4 VDC min	1. If indication is normal, trouble is in circuit of V506A. 2. If indication is abnormal, trouble is in circuits of V508 or V509A.
20	Disconnect signal generator. Set FUNCTION switch to CALIBRATE position and BFO switch to ON. Turn RF GAIN to 10, and tune receiver to a multiple of 100 kHz. Adjust ANT TRIM for max indication on CARRIER LEVEL meter.	N/A	40 dB min	1. If indication is normal, the receiver is operating properly. 2. If indication is abnormal, proceed to next step.
21	Connect Oscilloscope AN/ USM-117( ) to pin 7 grid of V205B and observe 100 kHz waveform.	N/A	54V p-p min	1. If indication is normal, check circuit of V205B. 2. If indication is abnormal, proceed to next step.
22	Remove V206 from its socket and connect oscilloscope to pin 2 grid of V206 socket. Observe 200 kHz waveform.	N/A	13.5V p-p min	1. If indication is normal, check circuit of V206. 2. If indication is abnormal, check circuit of V205A.

5.5.6 DC Resistances of Transformers and Coils.

The dc resistances of the windings of the transformers and coils in Radio Receiver R-390A/URR as measured with Multi-meter AN/PSM-4( ) are listed in table 5-6.

Table 5-6 - Transformer and Coil Resistances

R-F Sub-chassis

Transformer	Terminals	Ohms
HR202	1-3	5
L201	1-2	7
L202	1-2	0.6
L203	1-2	0.6
L204	1-2	0.6
L205	1-2	0.6
L206	1-2	0.6
L207	1-2	0.6
L208	1-2	7
L209	1-2	7
L210		0.15
L211		7
L236		0.3
T201	1-2	Less than 0.2
	4-6	2.7
T202	1-2	Less than 0.2
	4-6	1.2
T203	1-2	Less than 0.2
	4-6	1.6
T204	1-2	Less than 0.2
	4-6	4
T205	1-2	Less than 0.2
	4-6	Less than 0.2
T208	1-5	2.5
	2-3	2
	3-4	2
	2-4	4
T206	1-2	Less than 0.2
	4-6	Less than 0.2

Coil	Terminals	Ohms
Z201-1	1-3	2.8
Z202-1	1-3	1.8
Z203-1	1-3	1.2
Z204-1	1-3	0.5
Z205-1	1-3	0.2
Z206-l	1-3	Less than 0.2
Z201-2	1-3	2.8
Z202-2	1-3	1.8
Z203-2	1-3	1.2
Z204-2	1-3	0.5
Z205-2	1-3	0.2
Z206-2	1-3	Less than 0.2
Z213-1	1-3	Less than 0.2
Z213-2	1-3	Less than 0.2
Z213-3	1-3	Less than 0.2
Z216-1	1-3	1.1
Z216-2	1-3	1.1
Z216-3	1-3	1.1

Main Frame

Transformer or Coil	Terminals	Ohms
FL101	A-A	Less than 0.1
	B-B	Less than 0.1
K10l	1-2	200

Crystal-Oscillator Sub-chassis

HR401	Gnd. J410-pin E	11
L401		7
L402		0.6
T401	1-2	Less than 0.1
	3-4	Less than 0.1

AF Sub-chassis

Transformer or Coil	Terminals	Ohms
FL601	1-2 2-3 1-3	230 250 480
K601	1-7	2.8
L601	1-2	130
L602	1-2	125
L603	1-2	110
T601	1-2	580
	3-4	28
	5-6	30
T602	1-2	580
	3-4	28
	5-6	30

IF Sub-chassis

Transformer or Coil	Terminals	Ohms
FL502	1-2	40
	3-4	40
FL503	1-2	40
	3-4	40
FL504	1-2	40
	3-4	40
FL505	1-2	40
	3-4	40
L501		7
L502		90
L504		3
L505		90
RT510	2-7	8
T501	1-2	6
	4-5	6
T502	1-2	6 6
	4-5	
T503	1-2	6
	3-4	6.1
	4-5	6.3
	3-5	0.2
Z501	1-2	18.6
Z502	1-2	1.6
	1-3	0.2
	2-3	1.818
Z503	1-5	

VFO Sub-chassis

Transformer or Coil	Terminals	Ohms
L706		0.6
Z702	1-2 3-4	4 0.5

5.5.7 Resistance Measurements at Sub-chassis Connectors.

Connectors are used in this receiver to interconnect the various sub-chassis. Defects may be localized by measurement of the resistance to ground at the receptacle terminals of a sub-chassis. The charts below indicate the normal resistance between the indicated receptacle terminals and chassis ground. To prepare the receiver for these measurements, disconnect the receiver from the power source and remove the connectors from the sub-chassis suspected to be faulty.

Table 5-7 - Connector Resistance Measurements

RF Sub-chassis

Terminal of Receptacle J208	Resistance to Ground (ohms)
A	92k
B	0.8
C	Inf.
D	Inf.
E	1.8M
F	100
H	0
J	Inf.
K	Inf.

Crystal Oscillator Sub-chassis

Terminal of Receptacle J410	Resistance to Ground (ohms)
A	Inf.
B	10
C	Inf.
D	0
E	11
F	11
H	0

IF Sub-chassis

Terminal of Receptacle J512	Resistance to Ground (ohms)
1	Infinity (∞)
2	54k
3	54k
4	474k
5	Infinity (∞)
6	Infinity (∞)
7	Infinity (∞)
8	Infinity (∞)
9	Infinity (∞)
10	444k

Terminal of Receptacle J512	Resistance to Ground (ohms)
11	Infinity (∞)
12	27
13	Infinity (∞)
14	0 to 18
15	134k
16	104k
17	0
18	0
19	Infinity (∞)
20	0.5

Table 5-7 - Connector Resistance Measurements - Continued

AF Sub-chassis

Terminal of Receptacle J619	Resistance to Ground (ohms)
1	3.6
2	90k
3	92k
4	93k
5	90k
6	Infinity (∞)
7	Infinity (∞)
8	Infinity (∞)
9	58
10	Less than 0.1
11	0

Terminal of Receptacle J620	Resistance of Ground (ohms)
1	Infinity (∞)
2	940k
3	Infinity (∞)
4	470k
5	200
6	Infinity (∞)
7	200
8	Infinity (∞)
9	Infinity (∞)
10	Infinity (∞)
11	Infinity (∞)
12	Infinity (∞)
13	0
14	1.35M
15	Infinity (∞)

VFO Sub-chassis

Terminal of Receptacle J709	Resistance to Ground
A	Infinity (∞)
B	Infinity (∞)
C	Infinity (∞)
D	Infinity (∞)
E	Infinity (∞)
F	0
H	3.5
J	Infinity (∞)
K	Infinity (∞)

Power Supply Sub-chassis

Terminal of Receptacle J811	Resistance to Ground
1	Less than 0.1
2	0
3	Infinity (∞)
4	Infinity (∞)
5	Infinity (∞)
6	Infinity (∞)
7	Infinity (∞)
8	Infinity (∞)
9	Infinity (∞)
10	Less than 0.
11	0

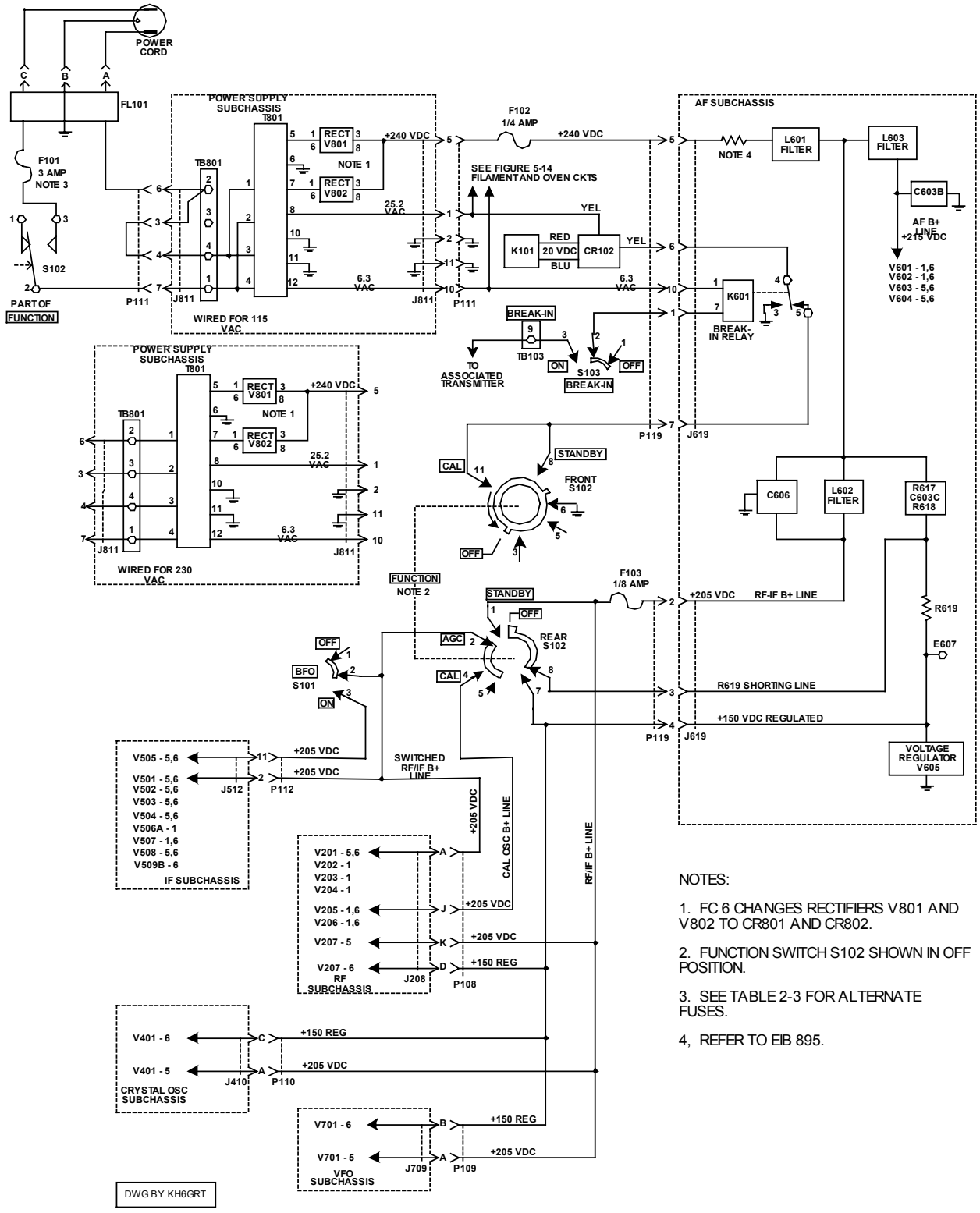

Figure 5-11 Power Distribution Diagram[11]

[11]Courtesy of Pete Wokoun, KH6GRT

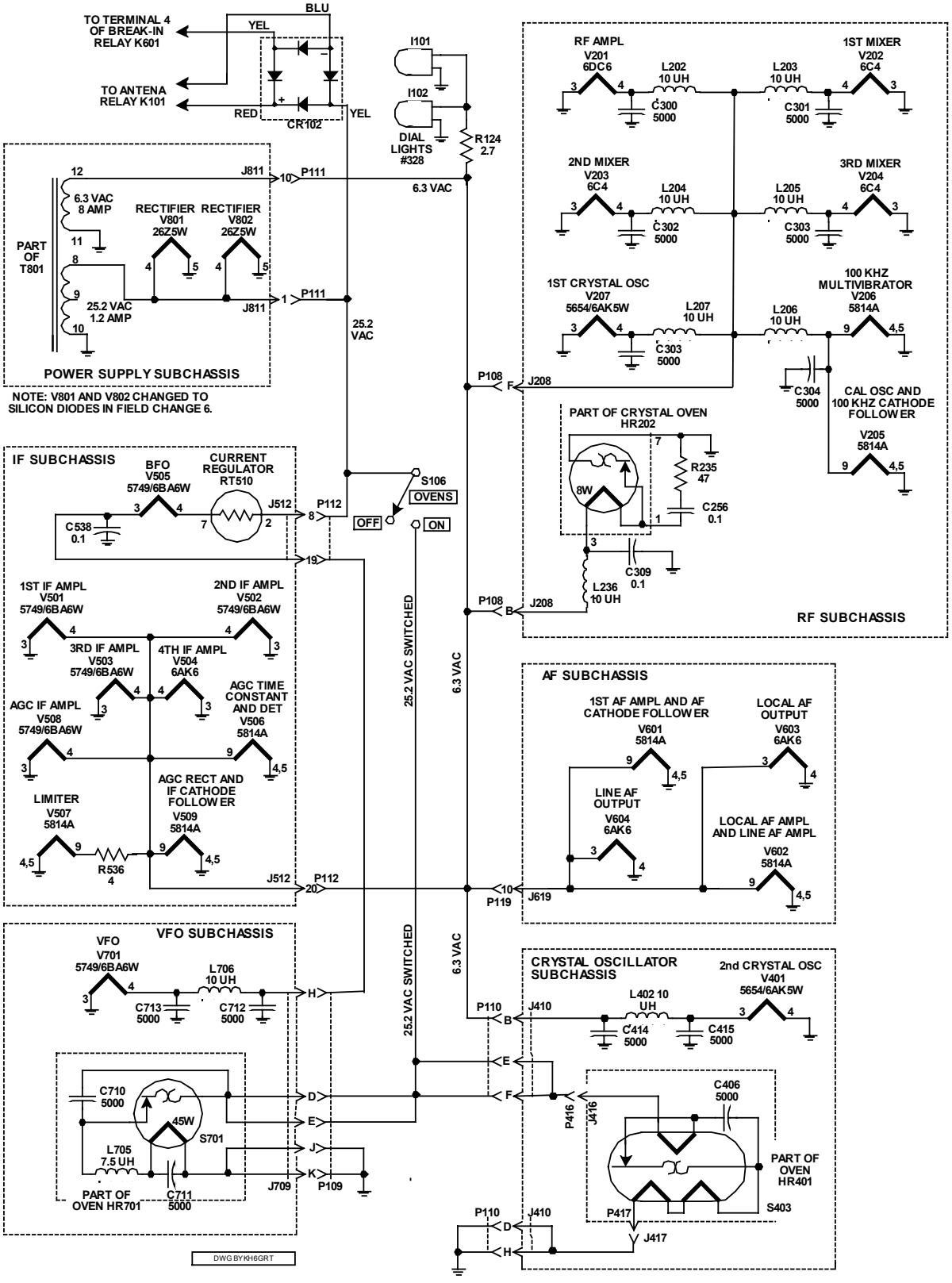

Figure 5-12 Filament and Oven Circuits[12]

[12]Courtesy of Pete Wokoun, KH6GRT

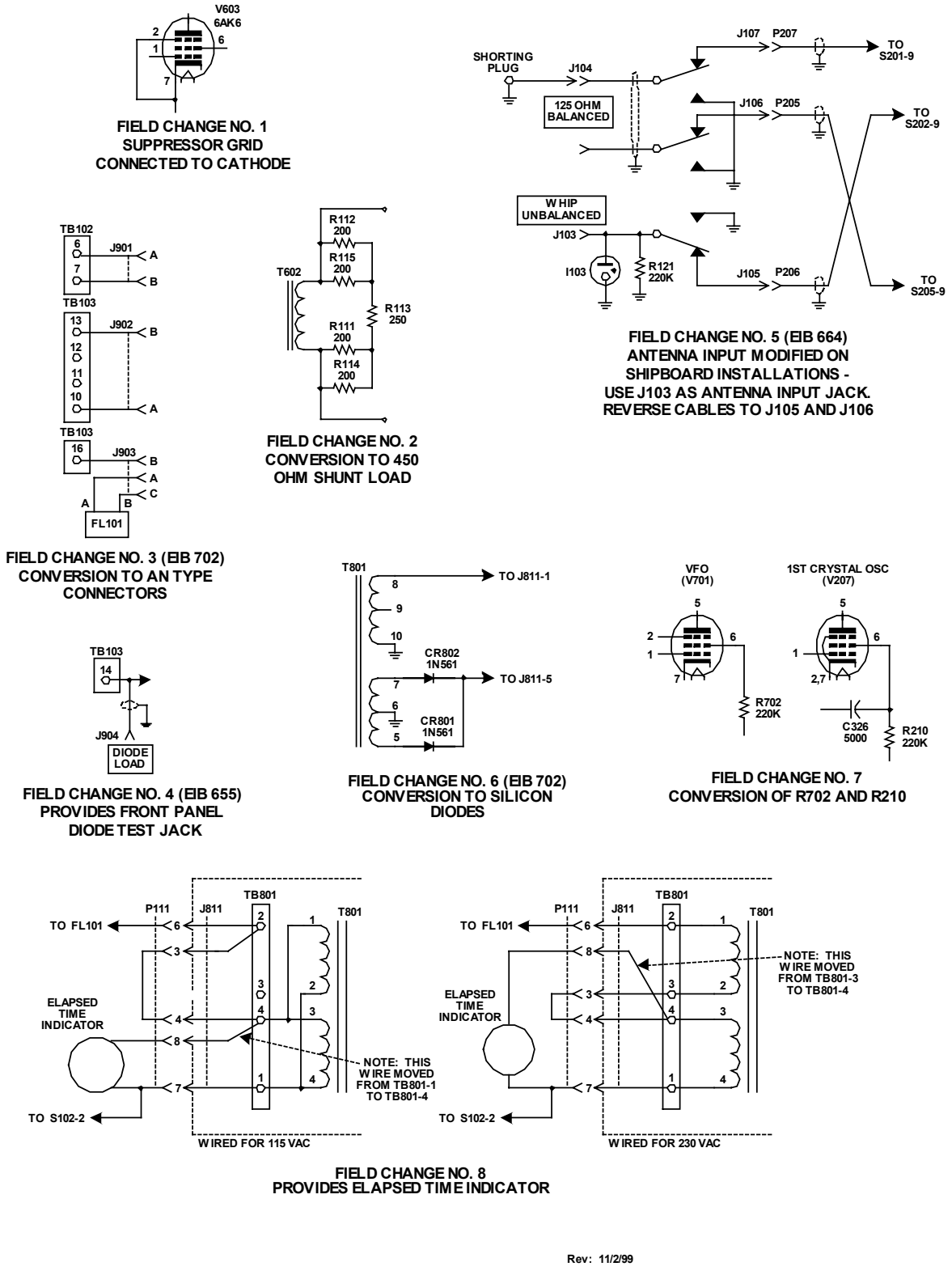

Figure 5-13 Field Changes [13, 14]

[13]Courtesy of Pete Wokoun, KH6GRT
[14]Table 1-9 identifies specific production modifications and associated contract numbers

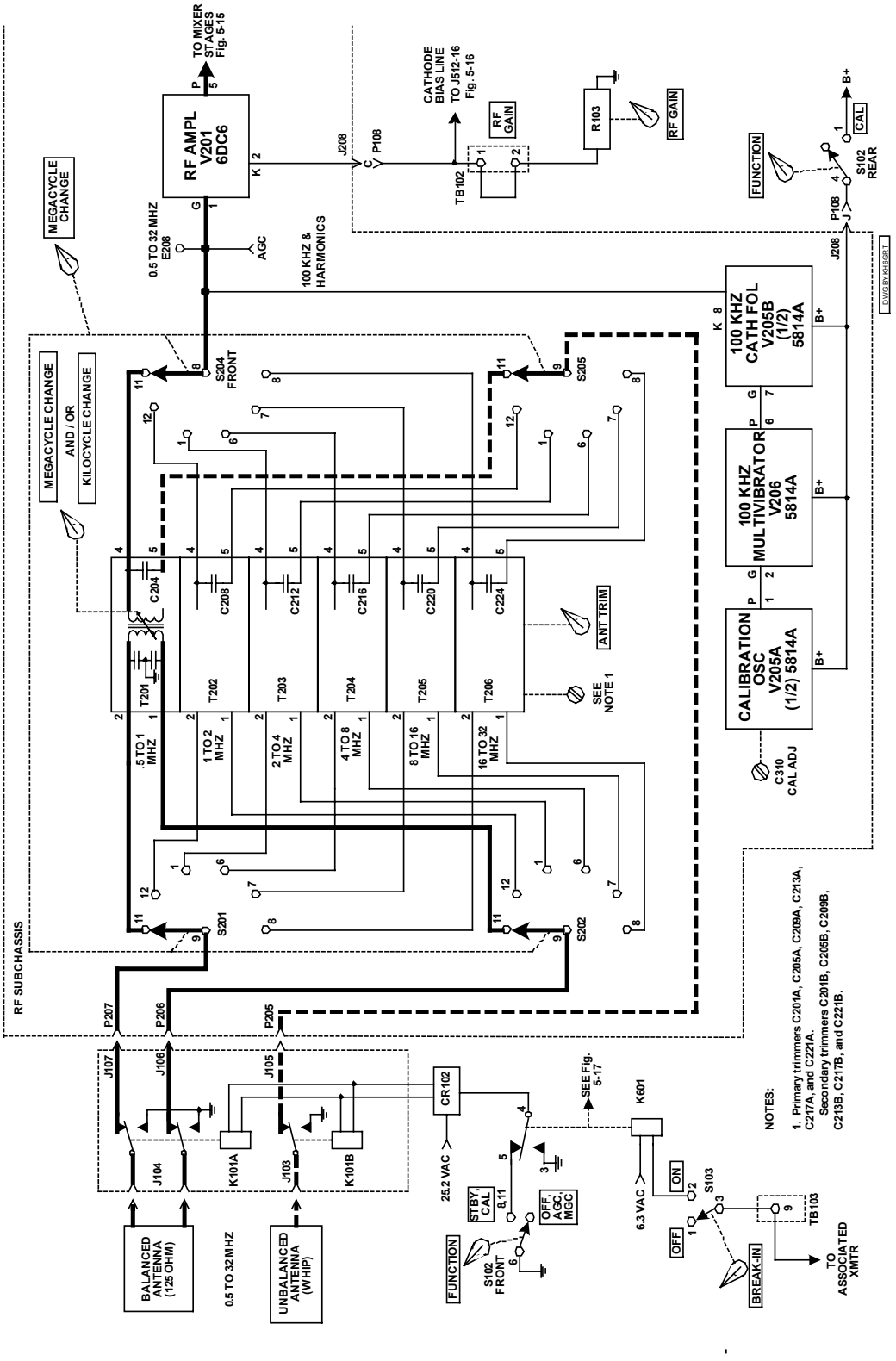

Figure 5-14 Signal Flow Diagram, Part 1 of 4 - RF Stage[15]

[15]Courtesy of Pete Wokoun, KH6GRT

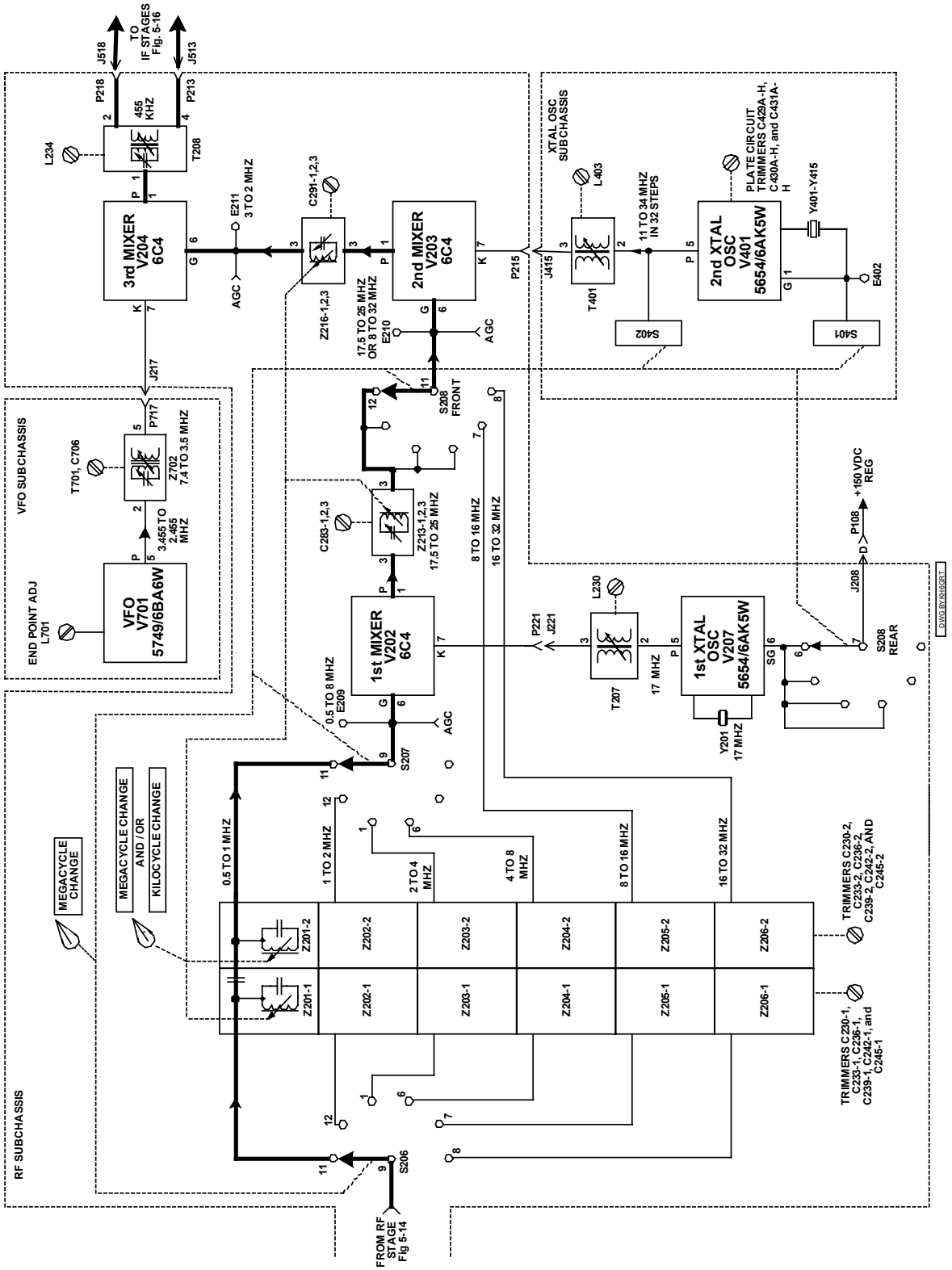

Figure 5-15 Signal Flow Diagram, Part 2 of 4 - Mixer Stages[16]

[16]Courtesy of Pete Wokoun, KH6GRT

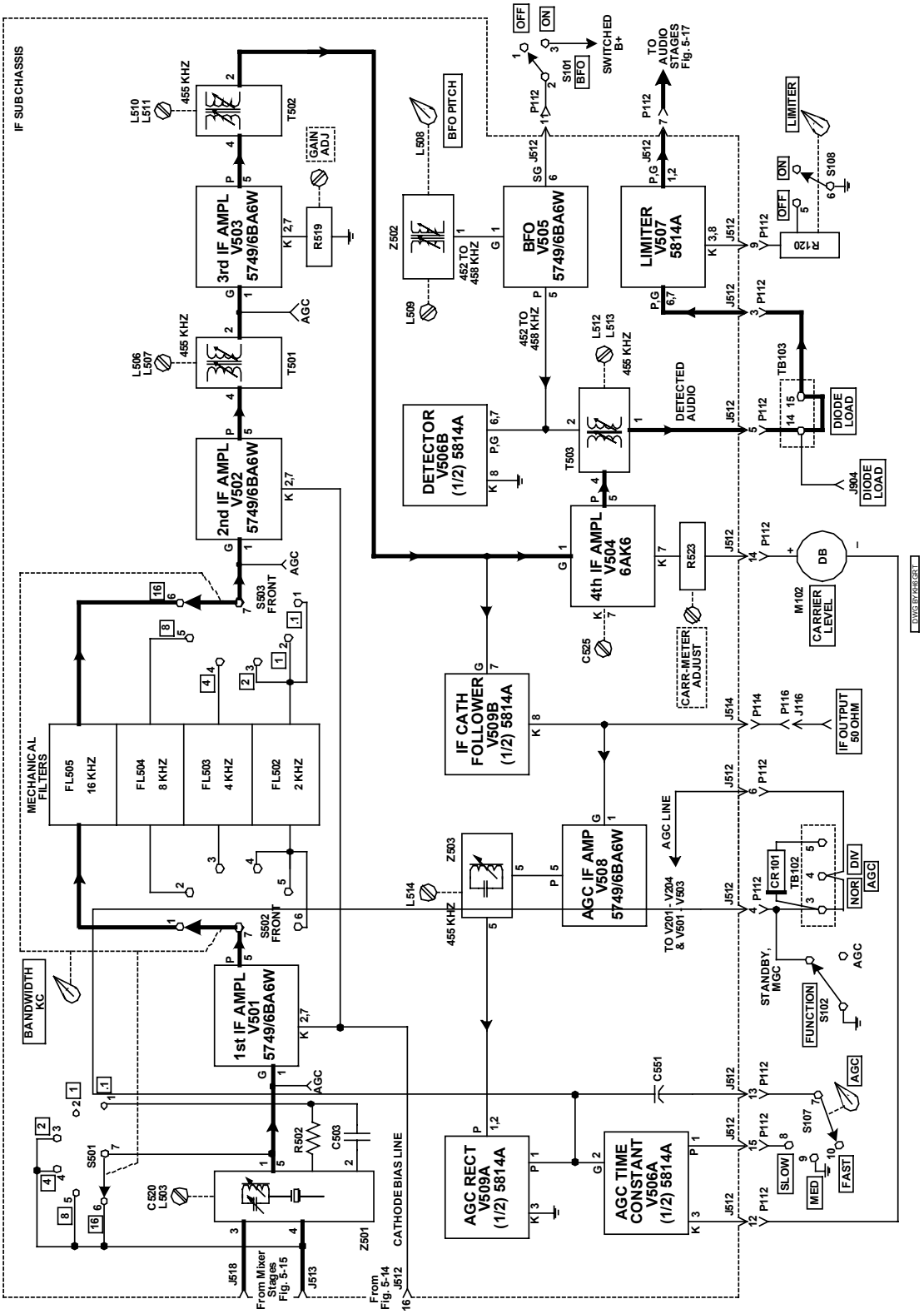

Figure 5-16 Signal Flow Diagram, Part 3 of 4 - IF Stages[17]

[17]Courtesy of Pete Wokoun, KH6GRT

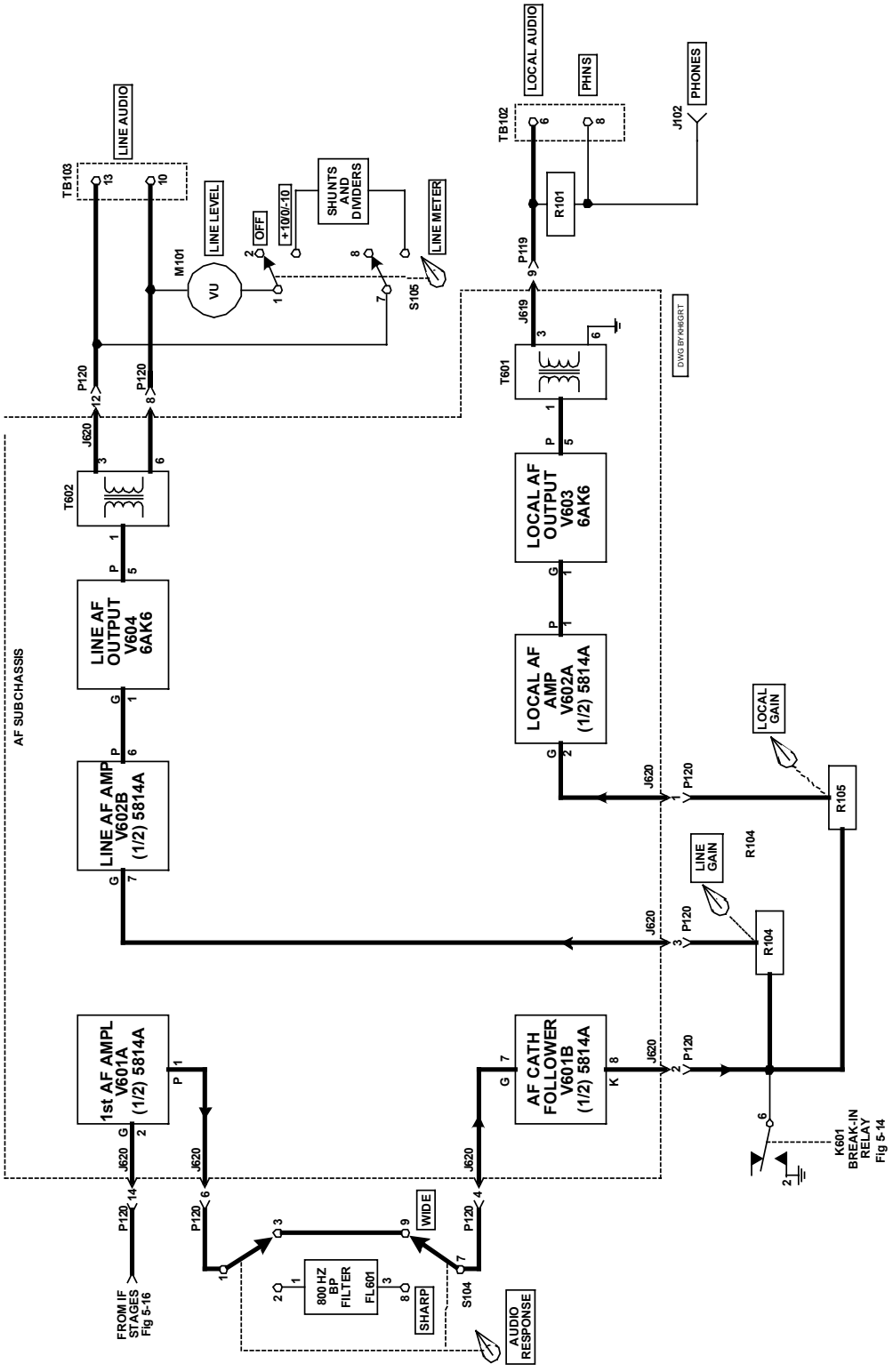

Figure 5-17 Signal Flow Diagram, Part 4 of 4 - Audio Stages[18]

[11]Courtesy of Pete Wokoun, KH6GRT

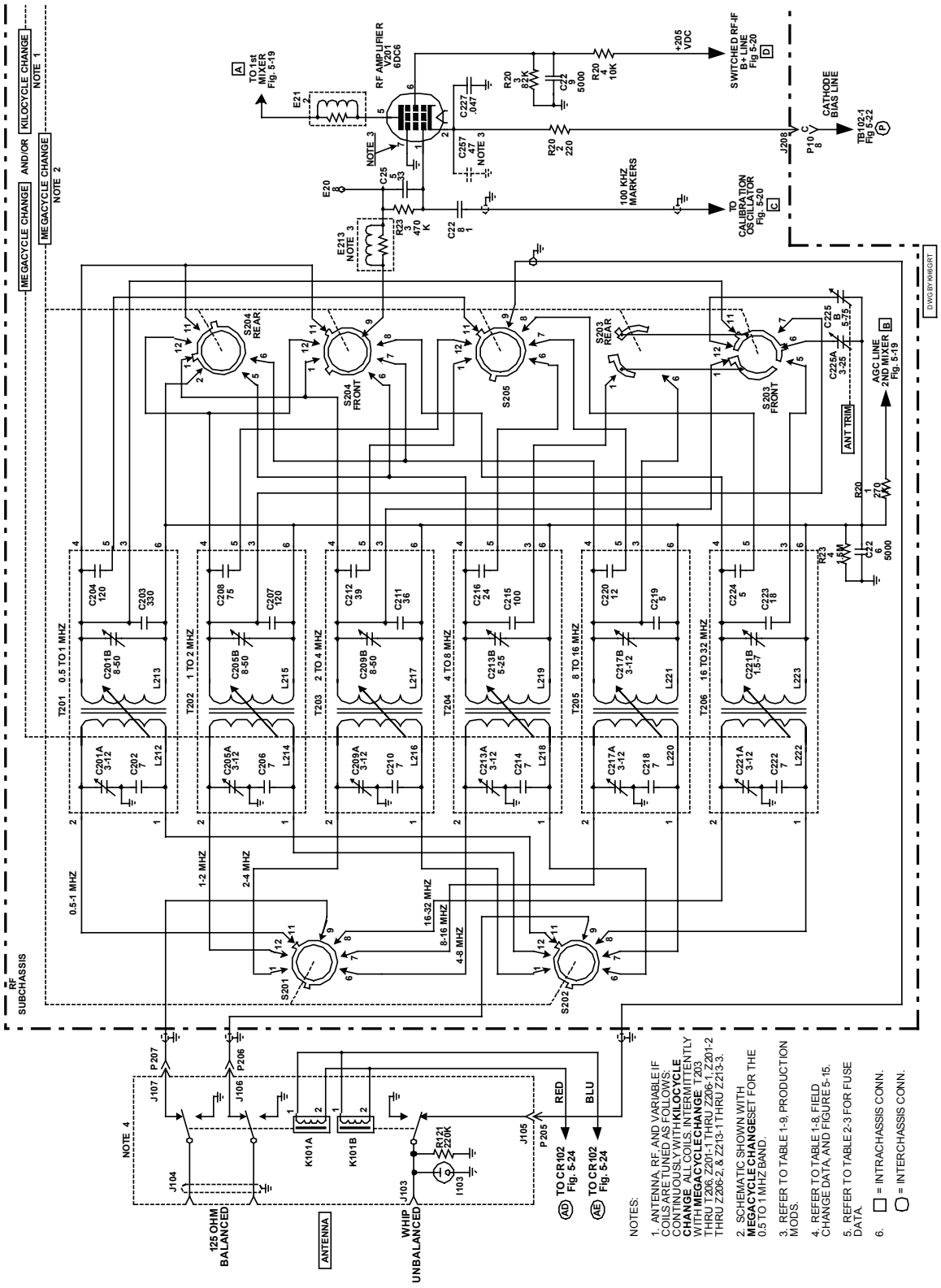

Figure 5-18 Schematic Diagram, Part 1 of 7 - RF Amplifier[19]

[19]Courtesy of Pete Wokoun, KH6GRT

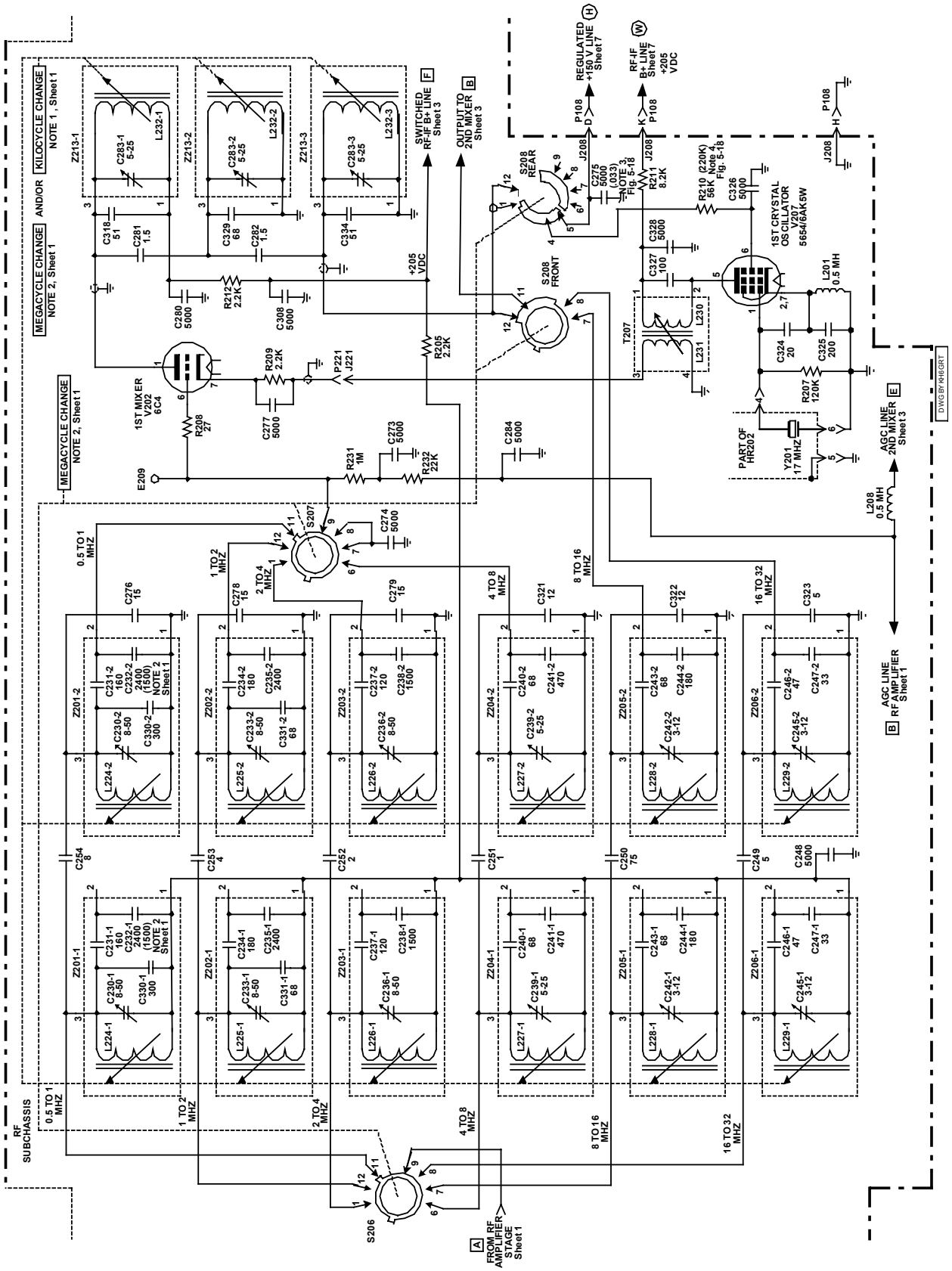

Figure 5-19 Part 2 of 7 - 1st Mixer and 1st Crystal Oscillator

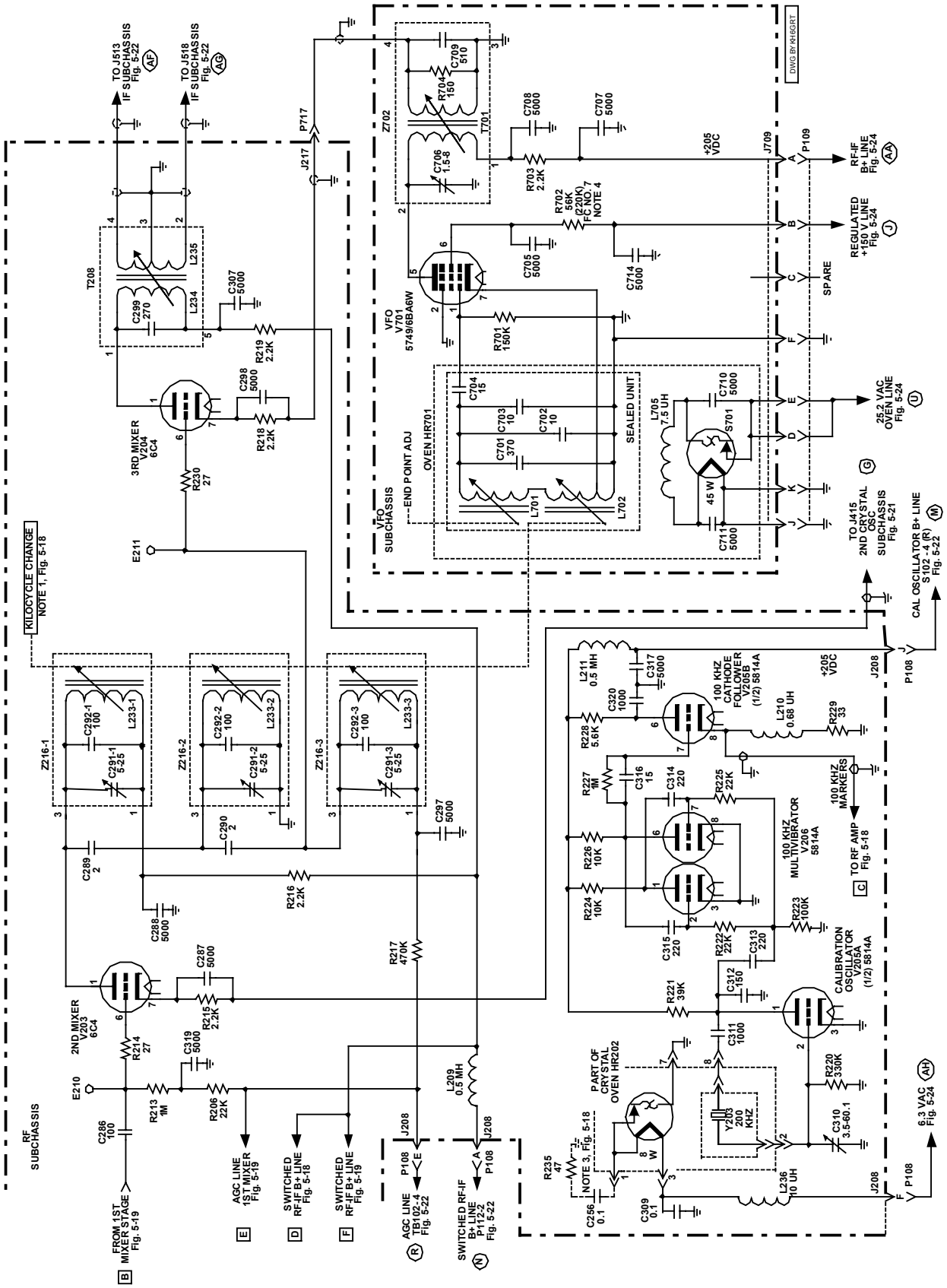

Figure 5-20 Schematic Diagram, Part 3 of 7 - 2nd Mixer and VFO[21]

[21]Courtesy of Pete Wokoun, KH6GRT

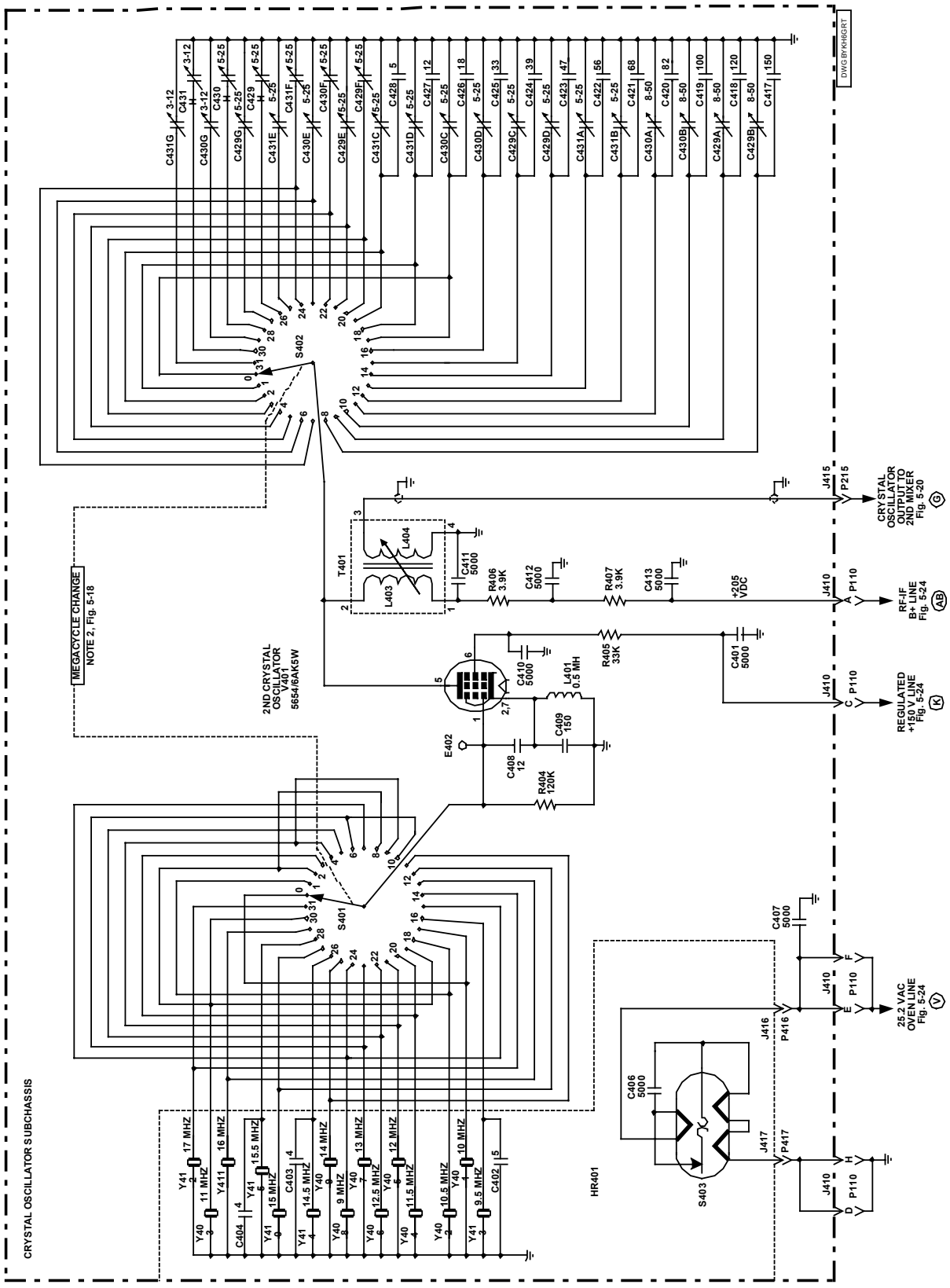

Figure 5-21 Schematic Diagram, Part 4 of 7 - 2nd Crystal Oscillator[22]

[22]Courtesy of Pete Wokoun, KH6GRT

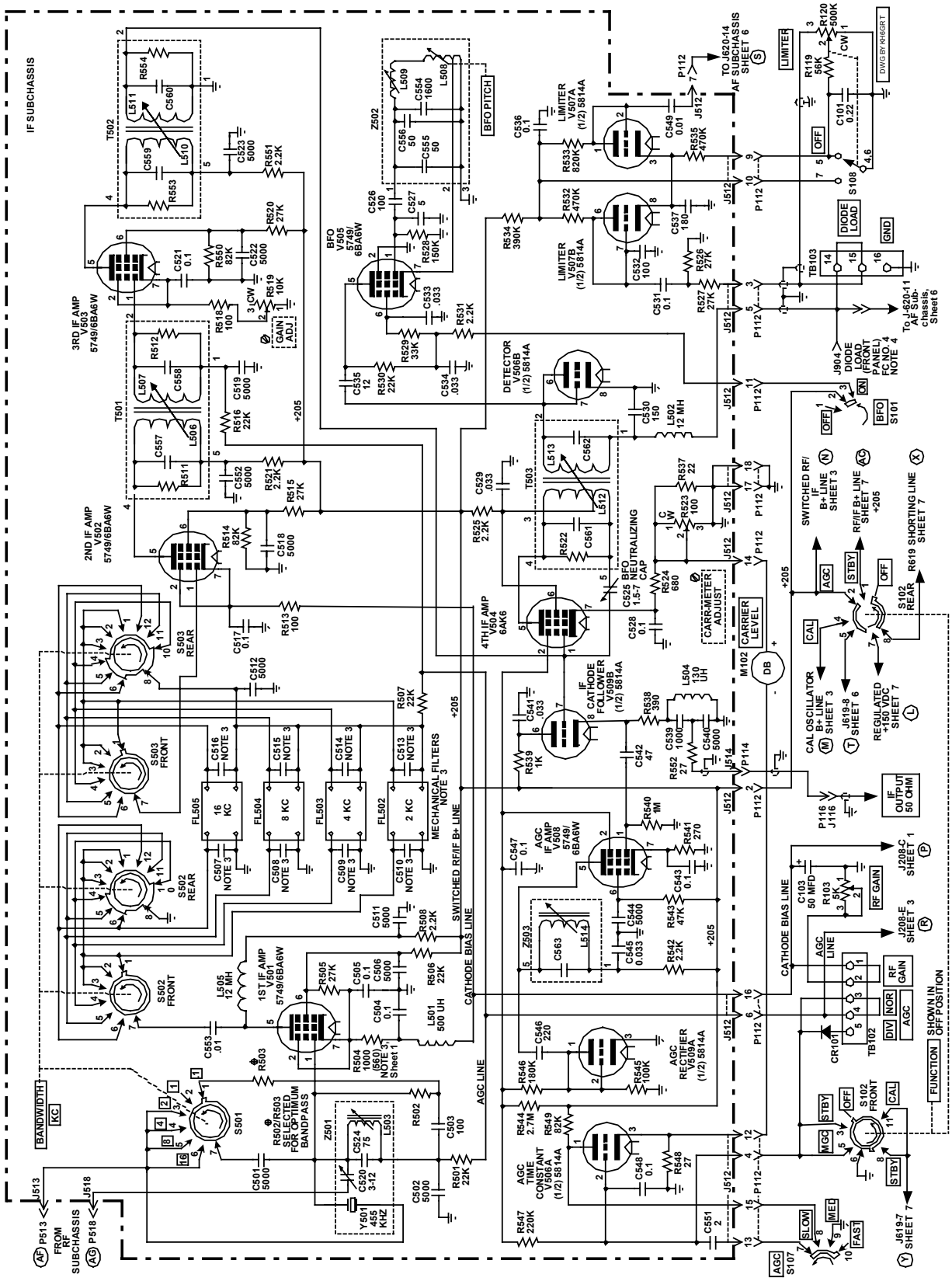

Figure 5-22 Schematic Diagram, Part 5 of 7 - IF Amplifiers, AGC, Limiter and Detector[23]

[23] Courtesy of Pete Wokoun, KH6GRT

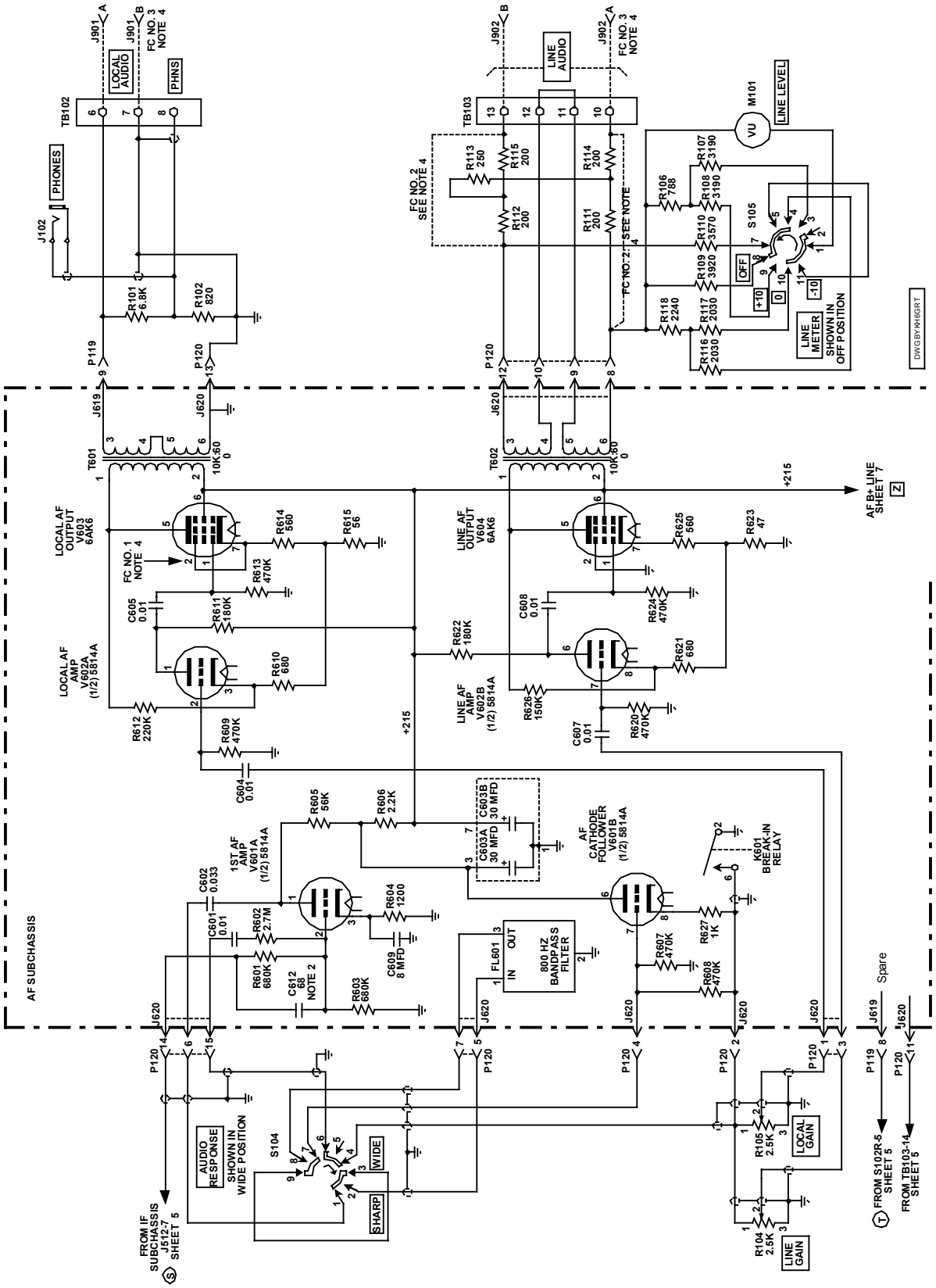

Figure 5-24 Schematic Diagram, Part 6 of 7 - Line and Local Audio Amplifiers

[25]Courtesy of Pete Wokoun, KH6GRT

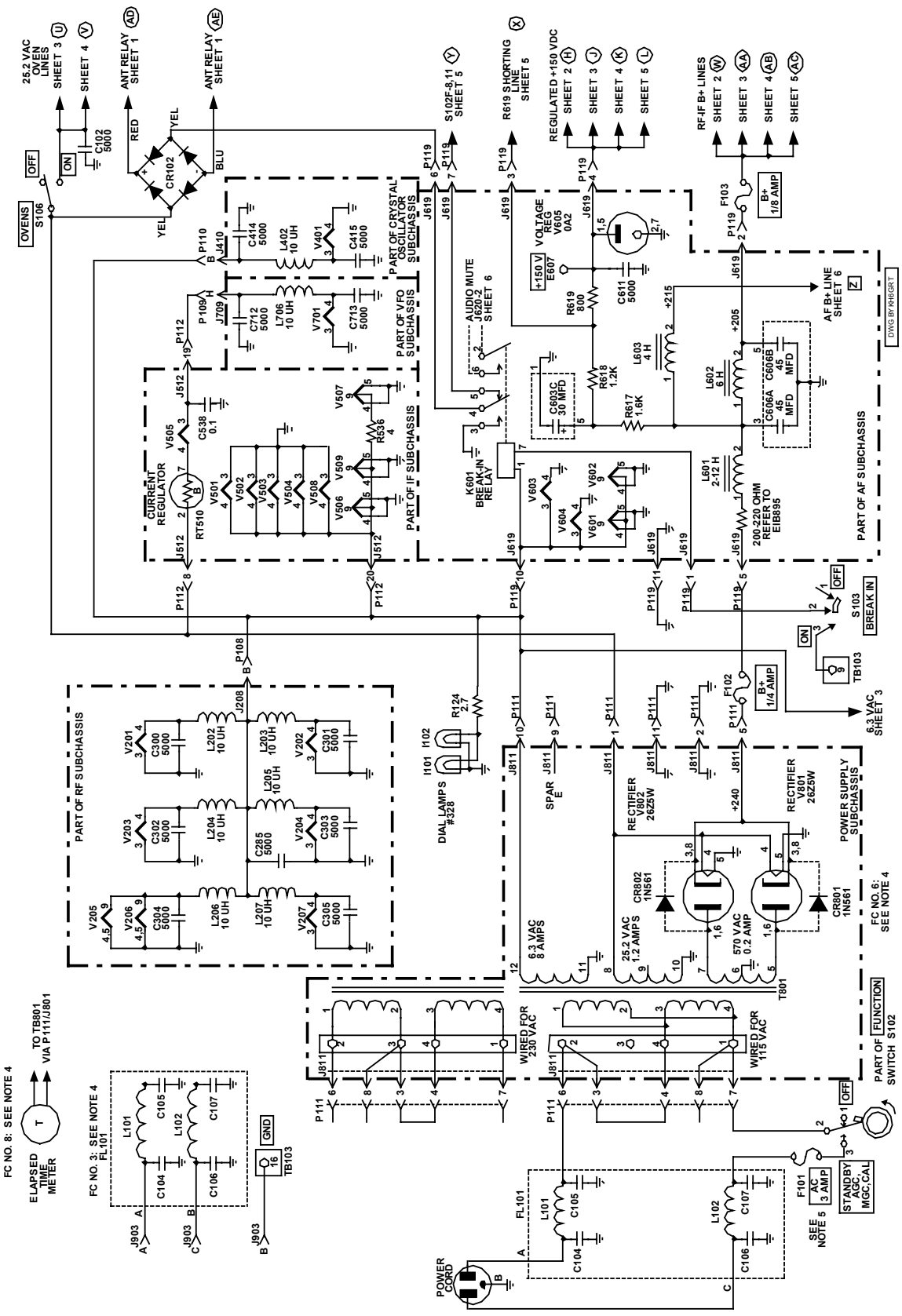

Figure 5-24 Schematic Diagram, Part 7 of 7 - Power Supply[25]

[25]Courtesy of Pete Wokoun, KH6GRT

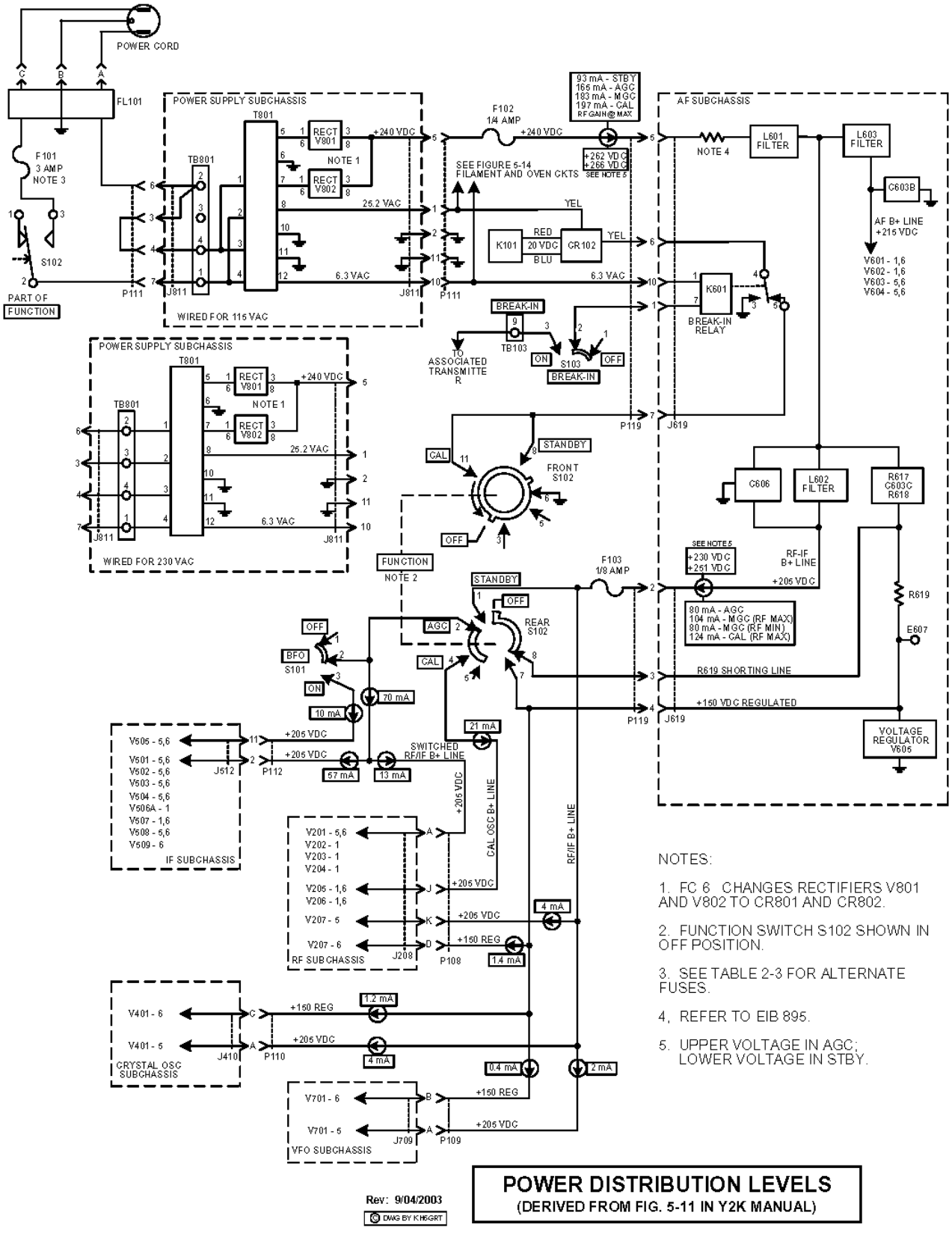

Figure 5-25 Power Distribution Levels [25]

[25]Courtesy of Pete Wokoun, KH6GRT

5.6 Zoning for schematic diagrams figures 5-18 through 5-24.

Sheet refers to the sheet number within the schematic diagram.

- Figure 5-18 = Sheet 1
- Figure 5-19 = Sheet 2
- Figure 5-20 = Sheet 3
- Figure 5-21 = Sheet 4
- Figure 5-22 = Sheet 5
- Figure 5-23 = Sheet 6
- Figure 5-24 = Sheet 7

Zone refers to location quadrant on a sheet, i.e.

- A = Upper Left
- B = Upper Right
- C = Lower Left
- D = Lower Right

Table 5-8 - Schematic Component Location Zones

REF DESIG	SHEET	ZONE
Capacitors		
C101	5	D
C102	7	B
C103	5	C
C104	7	C
C105	7	C
C106	7	C
C107	7	C
C201A	1	A
C201B	1	A
C202	1	A
C203	1	B
C204	1	B
C205A	1	A
C205B	1	A
C206	1	A
C207	1	B
C208	1	B
C209A	1	A
C209B	1	A
C210	1	A
C211	1	B
C212	1	B
C213A	1	C
C213B	1	C
C214	1	C
C215	1	D
C216	1	B
C217A	1	C
C217B	1	C
C218	1	C
C219	1	D
C220	1	D
C221A	1	C
C221B	1	C
C222	1	C
C223	1	D
C224	1	D
C225A	1	D
C225B	1	D
C226	1	D
C227	1	B
C228	1	B
C229	1	D
C230-1	2	A
C230-2	2	A
C231-1	2	A
C228	1	B
C229	1	D
C230-1	2	A
C230-2	2	A
C231-1	2	A
C231-2	2	A
C232-1	2	A
C232-2	2	A
C233-1	2	A
C233-2	2	A
C234-1	2	A
C234-2	2	A

REF DESIG	SHEET	ZONE
Capacitors Cont.		
C235-1	2	A
C235-2	2	A
C236-1	2	A
C236-2	2	A
C237-1	2	A
C237-2	2	A
C238-1	2	A
C238-2	2	A
C239-1	2	C
C239-2	2	C
C240-1	2	C
C240-2	2	C
C241-1	2	C
C241-2	2	C
C242-1	2	C
C242-2	2	C
C243-1	2	C
C243-2	2	C
C244-1	2	C
C244-2	2	C
C245-1	2	C
C245-2	2	C
C246-1	2	C
C246-2	2	C
C247-1	2	C
C247-2	2	C
C248	2	C
C249	2	C
C250	2	C
C251	2	C
C252	2	A
C253	2	A
C254	2	A
C255	1	B
C256	3	C
C257	1	B
C273	2	B
C274	2	B

REF DESIG	SHEET	ZONE
C275	2	D
C276	2	B
C277	2	B
C278	2	B
C279	2	B
C280	2	B
C281	2	B
C282	2	B
C283-1	2	B
C283-2	2	B
C283-3	2	B
C284	2	D
C285	7	A
C286	3	A
C287	3	A
C288	3	A
C289	3	A
C290	3	A
C291-1	3	A
C291-2	3	A
C291-3	3	A
C292-1	3	A
C292-2	3	A
C292-3	3	A
C297	3	A
C298	3	B
C299	3	B
C300	7	A
C301	7	A
C302	7	A
C303	7	A
C304	7	A
C305	7	A
C307	3	B
C308	2	B
C309	3	C
C311	3	C
C312	3	C
C313	3	C

REF DESIG	SHEET	ZONE
Capacitors Cont.		
C314	3	C
C315	3	C
C316	3	C
C317	3	C
C318	2	B
C319	3	A
C320	3	C
C321	2	D
C322	2	D
C323	2	D
C324	2	D
C325	2	D
C326	2	D
C327	2	D
C328	2	D
C329	2	B
C330-1	2	A
C330-2	2	A
C331-1	2	A
C331-2	2	A
C334	2	B
C401	4	C
C402	4	C
C403	4	A
C404	4	A
C406	4	C
C407	4	C
C408	4	C
C409	4	C
C410	4	C
C411	4	B
C412	4	D
C413	4	D
C414	7	B
C415	7	B
C417	4	D
C418	4	D
C419	4	D

REF DESIG	SHEET	ZONE
C420	4	D
C421	4	D
C422	4	D
C423	4	D
C424	4	D
C425	4	D
C426	4	B
C427	4	B
C428	4	B
C429A	4	D
C429B	4	D
C429C	4	D
C429D	4	D
C429E	4	B
C429F	4	B
C429G	4	B
C429H	4	B
C430A	4	D
C430B	4	D
C430C	4	B
C430D	4	B
C430E	4	B
C430F	4	B
C430G	4	B
C430H	4	B
C431A	4	D
C431B	4	D
C431C	4	B
C431D	4	B
C431E	4	B
C431F	4	B
C431G	4	B
C431H	4	B
C501	5	A
C502	5	A
C503	5	A
C504	5	A
C505	5	A
C506	5	A
C507	5	A

REF DESIG	SHEET	ZONE
Capacitors Cont.		
C508	5	A
C509	5	A
C510	5	A
C511	5	A
C512	5	A
C513	5	A
C514	5	A
C515	5	A
C516	5	A
C517	5	A
C518	5	B
C519	5	B
C520	5	A
C521	5	B
C522	5	B
C523	5	B
C524	5	A
C525	5	D
C526	5	B
C527	5	B
C528	5	D
C529	5	B
C530	5	D
C531	5	D
C532	5	D
C533	5	B
C534	5	B
C535	5	B
C536	5	D
C537	5	D
C538	7	B
C539	5	C
C540	5	C
C541	5	C
C542	5	C
C543	5	C
C544	5	C
C545	5	C

REF DESIG	SHEET	ZONE
C546	5	C
C547	5	C
C548	5	C
C549	5	D
C551	5	C
C552	5	B
C553	5	A
C554	5	B
C555	5	B
C556	5	B
C557	5	B
C558	5	B
C559	5	B
C560	5	B
C561	5	D
C562	5	D
C563	5	C
C601	6	A
C602	6	A
C603A	6	C
C603B	6	C
C603C	7	D
C604	6	A
C605	6	B
C606A	7	D
C606B	7	D
C607	6	C
C608	6	D
C609	6	A
C611	7	D
C612	6	A
C701	3	D
C702	3	D
C703	3	D
C704	3	B
C705	3	D
C706	3	B
C707	3	D
C708	3	D
C709	3	B

REF DESIG	SHEET	ZONE
Capacitors Cont.		
C710	3	D
C711	3	D
C712	7	B
C713	7	B
C714	3	D
Rectifiers		
CR101	5	C
CR102	7	B
CR801	7	C
CR802	7	C
Test Points		
E208	1	B
E209	2	B
E210	3	A
E211	3	B
E212	1	B
E213	1	B
E402	4	A
E607	6	D
Fuses		
F101	7	C
F102	7	C
F103	7	D
Filters		
FL101	7	C
FL502	5	A
FL503	5	A
FL504	5	A
FL505	5	A
FL601	6	C

REF DESIG	SHEET	ZONE
Ovens		
HR202	2	D
HR202	3	C
HR401	4	C
HR701	3	B
Lamps		
I101	7	A
I102	7	A
I103	1	A
Jacks		
J102	6	B
J103	1	A
J104	1	A
J105	1	C
J106	1	A
J107	1	A
J110-B	7	B
J116	5	C
J208-8	7	A
J208-A	3	A
J208-D	2	D
J208-E	3	A
J208-F	3	C
J208-J	3	C
J208-K	2	D
J208C	1	D
J217	3	B
J410-D	4	C
J410-E	4	C
J410-F	4	C
J410-H	4	C
J415	4	D
J416	4	C
J417	4	C
J512-10	5	D
J512-11	5	D
J512-12	5	C

REF DESIG	SHEET	ZONE
Jacks Cont.		
J512-13	5	C
J512-14	5	D
J512-15	5	C
J512-16	5	C
J512-17	5	D
J512-18	5	D
J512-19	7	B
J512-2	5	C
J512-20	7	B
J512-3	5	D
J512-4	5	C
J512-5	5	D
J512-6	5	C
J512-7	5	D
J512-8	7	B
J512-9	5	D
J513	5	A
J514	5	C
J518	5	A
J619-1	7	D
J619-10	7	D
J619-11	7	D
J619-2	7	D
J619-3	7	D
J619-4	7	D
J619-5	7	D
J619-6	7	B
J619-7	7	B
J619-8	6	C
J619-9	6	B
J620-1	6	C
J620-10	6	D
J620-12	6	D
J620-13	6	B
J620-14	6	A
J620-15	6	A
J620-2	6	C
J620-3	6	C
J620-4	6	C

REF DESIG	SHEET	ZONE
J620-5	6	A
J620-6	6	A
J620-7	6	A
J620-8	6	D
J620-9	6	D
J709-A	3	D
J709-B	3	D
J709-C	3	D
J709-D	3	D
J709-E	3	D
J709-F	3	D
J709-H	7	B
J709-J	3	D
J709-K	3	D
J811-1	7	C
J811-10	7	C
J811-11	7	C
J811-2	7	C
J811-3	7	C
J811-4	7	C
J811-5	7	C
J811-6	7	C
J811-7	7	C
J811-8	7	C
J811-9	7	C
J901-A	6	B
J901-B	6	B
J902-A	6	D
J902-B	6	D
J903-A	7	A
J903-B	7	A
J903-C	7	A
J904	5	D

Relays		
K101A	1	A
K101B	1	A
K601	6	C
K601	7	B

REF DESIG	SHEET	ZONE
Plugs		
P108-A	3	A
P108-B	7	A
P108-C	1	D
P108-D	2	D
P108-E	3	A
P108-F	3	C
P108-H	2	D
P108-J	3	C
P108-K	2	D
P109-A	3	D
P109-B	3	D
P109-C	3	D
P109-D	3	D
P109-E	3	D
P109-F	3	D
P109-H	7	B
P109-J	3	D
P109-K	3	D
P110-A	4	D
P110-B	7	B
P110-C	4	C
P110-D	4	C
P110-E	4	C
P110-F	4	C
P110-H	4	C
P111-1	7	C
P111-10	7	C
P111-11	7	C
P111-2	7	C
P111-3	7	C
P111-3	7	C
P111-4	7	C
P111-5	7	C
P111-6	7	C
P111-7	7	C
P111-8	7	C
P111-9	7	C
P112-10	5	D

REF DESIG	SHEET	ZONE
P112-11	5	D
P112-12	5	C
P112-13	5	C
P112-14	5	D
P112-15	5	C
P112-16	5	C
P112-17	5	D
P112-18	5	D
P112-19	7	B
P112-2	5	C
P112-20	7	B
P112-3	5	D
P112-4	5	C
P112-5	5	D
P112-6	5	C
P112-7	5	D
P112-8	7	B
P112-9	5	D
P114	5	C
P116	5	C
P119-1	7	D
P119-10	7	D
P119-11	7	D
P119-2	7	D
P119-3	7	D
P119-4	7	D
P119-5	7	D
P119-6	7	B
P119-7	7	B
P119-8	6	C
P119-9	6	B
P120-1	6	C
P120-10	6	D
P120-12	6	D
P120-13	6	B
P120-14	6	A
P120-15	6	A
P120-2	6	C
P120-3	6	C

REF DESIG	SHEET	ZONE
Plugs Cont.		
P120-4	6	C
P120-5	6	A
P120-6	6	A
P120-7	6	A
P120-8	6	D
P120-9	6	D
P205	1	C
P206	1	A
P207	1	A
P215	4	D
P221	2	B
P416	4	C
P417	4	C
P513	5	A
P518	5	A
P717	3	B
Resistors		
R101	6	B
R102	6	B
R103	5	C
R104	6	C
R105	6	C
R106	6	D
R107	6	D
R108	6	D
R109	6	D
R110	6	D
R111	6	D
R112	6	D
R113	6	D
R114	6	D
R115	6	D
R116	6	D
R117	6	D
R118	6	D
R119	5	D
R120	5	D

REF DESIG	SHEET	ZONE
R121	1	A
R124	7	A
R201	1	D
R202	1	D
R203	1	D
R204	1	D
R205	2	B
R206	3	A
R207	2	D
R208	2	B
R209	2	B
R210	2	D
R211	2	D
R212	2	B
R213	3	A
R214	3	A
R215	3	A
R216	3	A
R217	3	A
R218	3	B
R219	3	B
R220	3	C
R221	3	C
R222	3	C
R223	3	C
R224	3	C
R225	3	C
R226	3	C
R227	3	C
R228	3	C
R229	3	C
R230	3	B
R231	2	B
R232	2	B
R233	1	B
R234	1	D
R235	3	C
R404	4	C
R405	4	C

REF DESIG	SHEET	ZONE
Resistors Cont.		
R406	4	D
R407	4	D
R501	5	A
R502	5	A
R503	5	A
R504	5	A
R505	5	A
R506	5	A
R507	5	A
R508	5	A
R511	5	B
R512	5	B
R513	5	B
R514	5	B
R515	5	B
R516	5	B
R518	5	B
R519	5	B
R520	5	B
R521	5	B
R522	5	D
R523	5	D
R524	5	D
R525	5	B
R526	5	D
R527	5	D
R528	5	B
R529	5	B
R530	5	B
R531	5	B
R532	5	D
R533	5	D
R534	5	D
R535	5	D
R536	7	B
R537	5	D
R538	5	C
R539	5	C
R540	5	C
R541	5	C
R542	5	C

REF DESIG	SHEET	ZONE
R543	5	C
R544	5	C
R545	5	C
R546	5	C
R547	5	C
R548	5	C
R549	5	C
R550	5	B
R551	5	B
R552	5	C
R553	5	B
R554	5	B
R601	6	A
R602	6	A
R603	6	A
R604	6	A
R605	6	A
R606	6	A
R607	6	C
R608	6	C
R609	6	A
R610	6	A
R611	6	B
R612	6	A
R613	6	B
R614	6	B
R615	6	B
R617	7	D
R618	7	D
R619	7	D
R620	6	C
R621	6	C
R622	6	A
R623	6	D
R624	6	D
R625	6	D
R626	6	C
R627	6	C
R701	3	D
R702	3	D
R703	3	D
R704	3	B

REF DESIG	SHEET	ZONE
Ballast Tube		
RT510	7	B
Switches		
S101	5	D
S102	7	C
S102F	5	C
S102R	5	D
S103	7	D
S104	6	A
S105	6	D
S106	7	B
S107	5	C
S108	5	D
S201	1	A
S202	1	C
S203F	1	D
S203R	1	D
S204F	1	B
S204R	1	B
S205	1	D
S206	2	A
S207	2	B
S208F	2	D
S208R	2	D
S401	4	A
S402	4	B
S403	4	C
S501	5	A
S502F	5	A
S502R	5	A
S503F	5	A
S503R	5	A
S701	3	D

REF DESIG	SHEET	ZONE
Transformers		
T201	1	A
T202	1	A
T203	1	A
T204	1	A
T205	1	C
T206	1	C
T207	2	D
T208	3	B
T401	4	B
T501	5	B
T502	5	B
T503	5	D
T601	6	B
T602	6	D
T701	3	B
T801	7	C
Terminal Blocks		
TB102-1	5	C
TB102-2	5	C
TB102-3	5	C
TB102-4	5	C
TB102-5	5	C
TB102-6	6	B
TB102-7	6	B
TB102-8	6	B
TB103-9	7	C
TB103-10	6	D
TB103-11	6	D
TB103-12	6	D
TB103-13	6	D
TB103-14	5	D
TB103-15	5	D
TB103-16	5	D
TB103-16	7	A

REF DESIG	SHEET	ZONE
Tubes		
V201 (6DC6)	1	B
V202 (6C4)	2	B
V203 (6C4)	3	A
V204 (6C4)	3	B
V205A (5814)	3	C
V205B	3	C
V206 (5814)	2	D
V207 (5654)	4	A
V401 (5654)	5	A
V501 (5749)	5	A
V502 (5749)	5	B
V503 (5749)	5	B
V504 (6AK6)	5	D
V505 (5749)	5	B
V506A (5814)	5	C
V506B	5	D
V507 (5654)	5	D
V508 (5749)	5	C
V509A (5814)	5	C
V509B	5	C
V601A (5814)	6	A
V601B	6	C
V602A (5814)	6	A
V602B	6	C
V603 (6AK6)	6	B
V604 (6AK6)	6	D
V605 (OA2)	7	D
V701 (3TF7)	3	B
V801 (26Z5)	7	C
V802 (26Z5)	7	C

REF DESIG	SHEET	ZONE
Crystals		
Y201 17 MHz	2	D
Y203 200 kHz	3	C
Y401 10 MHz	4	A
Y402 10.5 MHz	4	A
Y403 11 MHz	4	A
Y404 11.5 MHz	4	A
Y405 12 MHz	4	A
Y406 12.5 MHz	4	A
Y407 13 MHz	4	A
Y408 8 MHz	4	A
Y409 14 MHz	4	A
Y410 15 MHz	4	A
Y411 16 MHz	4	A
Y412 17 MHz	4	A
Y413 9.5 MHz	4	A
Y414 14.5 MHz	4	A
Y415 15.5 MHz	4	A
Y501 455 kHz	5	A
Assemblies		
Z201-1	2	A
Z201-2	2	A
Z202-1	2	A
Z202-2	2	A
Z203-1	2	A
Z203-2	2	A
Z204-1	2	C
Z204-2	2	C
Z205-1	2	C
Z205-2	2	C
Z206-1	2	C
Z206-2	2	C
Z213-1	2	B
Z213-2	2	B
Z213-3	2	B
Z216-1	3	A
Z216-2	3	A
Z216-3	3	A
Z501	5	A
Z502	5	B
Z503	5	C
Z702	3	B

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