UNCLASSIFIED

TECHNICAL MANUAL

for

CONTROL SYNTHESIZER MODEL HFS-2

THE TECHNICAL MATERIEL CORPORATION

MAMARONECK, N.Y. OTTAWA, ONTARIO

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IN-3001L

Issue Date: 15 Dec. 1966

NOTICE

THE TECHNICAL MATERIEL CORPORATION
COMMUNICATIONS ENGINEERS
700 FENIMORE ROAD MAMARONECK, N. Y.

Warranty

The Technical Materiel Corporation, hereinafter referred to as TMC, warrants the equipment (except electron tubes,* fuses, lamps, batteries and articles made of glass or other fragile or other expendable materials) purchased hereunder to be free from defect in materials and workmanship under normal use and service, when used for the purposes for which the same is designed, for a period of one year from the date of delivery F.O.B. factory. TMC further warrants that the equipment will perform in a manner equal to or better than published technical specifications as amended by any additions or corrections thereto accompanying the formal equipment offer.

TMC will replace or repair any such defective items, F.O.B. factory, which may fail within the stated warranty period, PROVIDED:

1. That any claim of defect under this warranty is made within sixty (60) days after discovery thereof and that inspection by TMC, if required, indicates the validity of such claim to TMC's satisfaction.
2. That the defect is not the result of damage incurred in shipment from or to the factory.
3. That the equipment has not been altered in any way either as to design or use whether by replacement parts not supplied or approved by TMC, or otherwise.
4. That any equipment or accessories furnished but not manufactured by TMC, or not of TMC design shall be subject only to such adjustments as TMC may obtain from the supplier thereof.

Electron tubes* furnished by TMC, but manufactured by others, bear only the warranty given by such other manufacturers. Electron tube warranty claims should be made directly to the manufacturer of such tubes.

TMC's obligation under this warranty is limited to the repair or replacement of defective parts with the exceptions noted above.

At TMC's option any defective part or equipment which fails within the warranty period shall be returned to TMC's factory for inspection, properly packed with shipping charges prepaid. No parts or equipment shall be returned to TMC, unless a return authorization is issued by TMC.

No warranties, express or implied, other than those specifically set forth herein shall be applicable to any equipment manufactured or furnished by TMC and the foregoing warranty shall constitute the Buyers sole right and remedy. In no event does TMC assume any liability for consequential damages, or for loss, damage or expense directly or indirectly arising from the use of TMC Products, or any inability to use them either separately or in combination with other equipment or materials or from any other cause.

*Electron tubes also include semi-conductor devices.

PROCEDURE FOR RETURN OF MATERIAL OR EQUIPMENT

Should it be necessary to return equipment or material for repair or replacement, whether within warranty or otherwise, a return authorization must be obtained from TMC prior to shipment. The request for return authorization should include the following information:

1. Model Number of Equipment.
2. Serial Number of Equipment.
3. TMC Part Number.
4. Nature of defect or cause of failure.
5. The contract or purchase order under which equipment was delivered.

PROCEDURE FOR ORDERING REPLACEMENT PARTS

When ordering replacement parts, the following information must be included in the order as applicable:

1. Quantity Required.
2. TMC Part Number.
3. Equipment in which used by TMC or Military Model Number.
4. Brief Description of the Item.
5. The *Crystal Frequency* if the order includes crystals.

PROCEDURE IN THE EVENT OF DAMAGE INCURRED IN SHIPMENT

TMC's Warranty specifically excludes damage incurred in shipment to or from the factory. In the event equipment is received in damaged condition, the carrier should be notified immediately. Claims for such damage should be filed with the carrier involved and not with TMC.

All correspondence pertaining to Warranty Claims, return, repair, or replacement and all material or equipment returned for repair or replacement, within Warranty or otherwise, should be addressed as follows:

THE TECHNICAL MATERIEL CORPORATION
Engineering Services Department
700 Fenimore Road
Mamaroneck, New York

RECORD OF CORRECTIONS MADE

Change No.	Date of Change	Date Entered	Entered By

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635.17-2

SECTION 1
GENERAL INFORMATION

1-1. FUNCTIONAL DESCRIPTION.

Model HFS-2 Control Synthesizer is a reference signal generator for synthesized receivers and transmitters operating in the 2- to 32-mc band and employing 1.75 mixer injection frequencies. The HFS contains a 1 mc frequency standard and is used as a comparator, with a correction loop, that provides a d-c correction voltage to stabilize the 3.75- to 33.75-mc HFO (high frequency oscillator) in the receiver or transmitter.

In addition to its correction loop function, the HFS provides 1-mc, 2-mc and 250-kc sources, generating from the same 1-mc frequency standard used in the correction loop.

1-2. PHYSICAL DESCRIPTION.

The HFS (see figure 1-1) is a 19-inch rack modular unit. The front panel is 19 inches wide x 10-1/2 inches high x 3/16 inches thick and is finished in grey enamel. The chassis extends 20-1/4 inches behind the panel. The unit is tuned to the receiver or transmitter 2- to 32-mc frequency to four places beyond the megacycle decimal point by means of MC, 100 KC, 10 KC, 1 KC and .1 KC selector switches for these components in the frequency figure. Indications for each switch is brought up on a lighted digital display above the switches.

TABLE 1-1. TECHNICAL SPECIFICATIONS, HFS

Stability	10^8 for a 24-hour period.
HFO input	3.75 to 33.75 mc at a level not greater than 10 millivolts.
Outputs	a. Within -2.5- to +2.5 vdc range. Proportional to the phase difference between the input signal and the reference oscillator. b. Four 2-mc, 1-volt, outputs. Two high impedance and two low impedance. c. Four 250-kc outputs providing at least 1 volt into 25 ohms. Two high impedance and two low impedance. d. 1 mc, 1 volt, across 50 ohms. e. Audio output (frequency difference between input signal and internal reference). f. Sync relay indication.
Meters and Indicators	Digital frequency readout and 1-mc external vs internal phase comparator.
Input Power	+28 vdc at 1 amp; +200 vdc; 6.3 vac, 60 cps.
Dimensions	19" x 10-1/2" x 20-1/4".
Weight	43 lbs.

TABLE 1-2. ELECTRON TUBE AND DIODE COMPLEMENT, HFS

REFERENCE SYMBOL SEMICONDUCTOR DEVICES	TYPE	FUNCTION
CR3101, CR3102, CR3103, CR3201, CR3203, CR3204, CR3403, CR3412, CR3413, CR3415, CR3416	1N463	
CR3202, CR3302	DD-100	
CR3303, CR3304	1N303	
CR3401, CR3402, CR3404, CR3405, CR3406 CR3407, CR3409, CR3410, CR3417, CR3418	1N100	
CR3414	1N2845B	
Q3002	2N697	
TUBES		
V3101, V3201, V3301, V3402	6AS6	Divider
V3102	6AB4	Amplifier
V3103, V3104, V3202, V3204, V3302, V3304, V3512	6AU6	Amplifier
V3105	6AW8A	Amplifier/Comparator
V3701	6AB4	Cathode Follower
V3203, V3303, V3404, V3405, V3406	6AH6	Amplifier
V3401	12AU7	Multivibrator/Amplifier
V3403	12AT7	Amplifier/Cathode Follower
V3407	6DS4	Cathode Follower
V3501	6AW8	Harmonic Generator/Amplifier
V3502	6EW6	Oscillator
V3503	6AB4	Pulse Generator
V3504, V3507, V3508, V3509, V3510	6AK5	Amplifier
V3511	6BE6	Converter
V3506	6AK5	Converter
V3505	6S4	Converter
V3702	6CS6	Converter
V3703	6U8A	Amplifier/Converter

SECTION 2
INSTALLATION

2-1. INITIAL INSPECTION.

Each HFS unit has been calibrated and tested at the factory before shipment. Upon arrival at the operating site, inspect the packing case and contents for possible damage. Unpack the equipment carefully. Inspect all packing material for parts which may have been shipped as "loose item." With respect to damage to the equipment for which the carrier is liable, the Technical Materiel Corporation will assist in describing methods of repair and the furnishing of replacement parts.

The equipment is shipped with all tubes and other plug-in components installed. Check that all such components are properly seated in their sockets.

2-2. MECHANICAL INSTALLATION.

The HFS is designed for rack mounting in a standard 19-inch rack panel. The HFS's outline dimension drawing is shown in figure 2-1.

The HFS can be supplied with slides for mounting in a suitable housing. To install an HFS equipped with slides, set it in position on the tracks until the release buttons catch. Press the release buttons and push the HFS into the equipment rack until the release buttons engage the holes in the equipment. After this, secure the front panel to the equipment rack with screws.

2-3. ELECTRICAL INSTALLATION.

All necessary input and output connections for the HFS are shown in figure 2-2. The power interconnect to jack J3001 at the rear of the unit. All signal inputs and outputs are also connected at the rear of the equipment. Refer to system manual or table 2-1, below, and figure 2-2 before making connections.

2-4. PREOPERATIONAL CHECKOUT.

After properly installing the HFS into the receiver or transmitter system, perform the following to simultaneously check the HFS and HFO tracking for all positions of the HFS frequency selector switches.

a. Connect a frequency counter to the receiver or transmitter 3.75- to 33.75-mc HFO output. Connect a monitor headset to J3014 AUDIO SYNC TONE jack.

b. Set HFS to 2.0000 mc and the receiver or transmitter tuning controls for 2 mc.

c. Move the tuning controls about the 2-mc point until the sync tone is heard on the headset; then adjust the control for a zero beat. The counter should read 3.75 mc.

d. Place 100 KC switch in "1" position and move the tuning control until a zero beat is obtained at 2.1 mc. The counter should read 3.85 mc.

e. Continue this procedure through the remaining positions of the 100 KC selector switch. For each position move the tuning control to obtain a zero beat as indicated in table 2-2.

f. Leaving 100 KC switch in position "9", place the 10 KC selector switch in position "1" and adjust the tuning control to obtain a zero beat at 2.91 mc. The counter should read 4.66 mc.

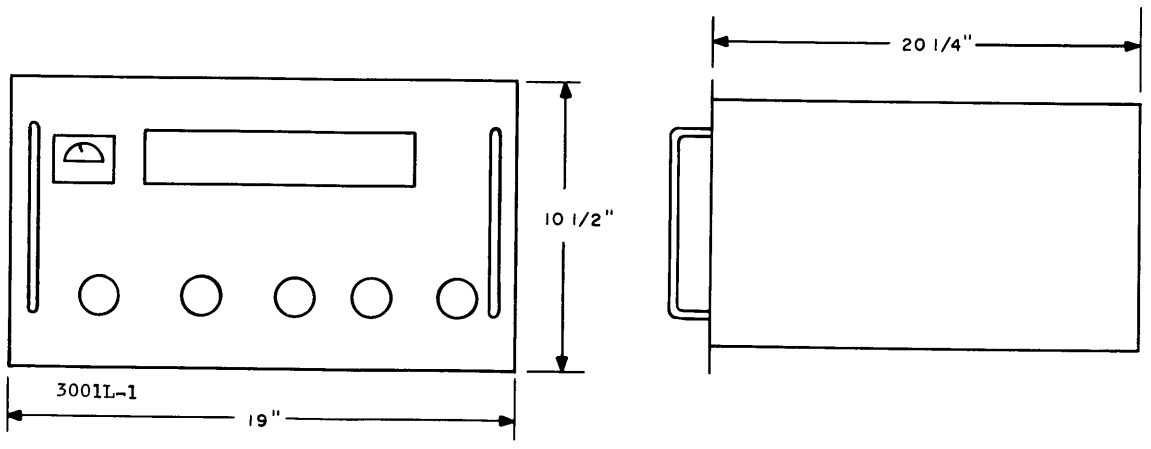

Figure 2-1. HFS Outline Dimensional Drawing

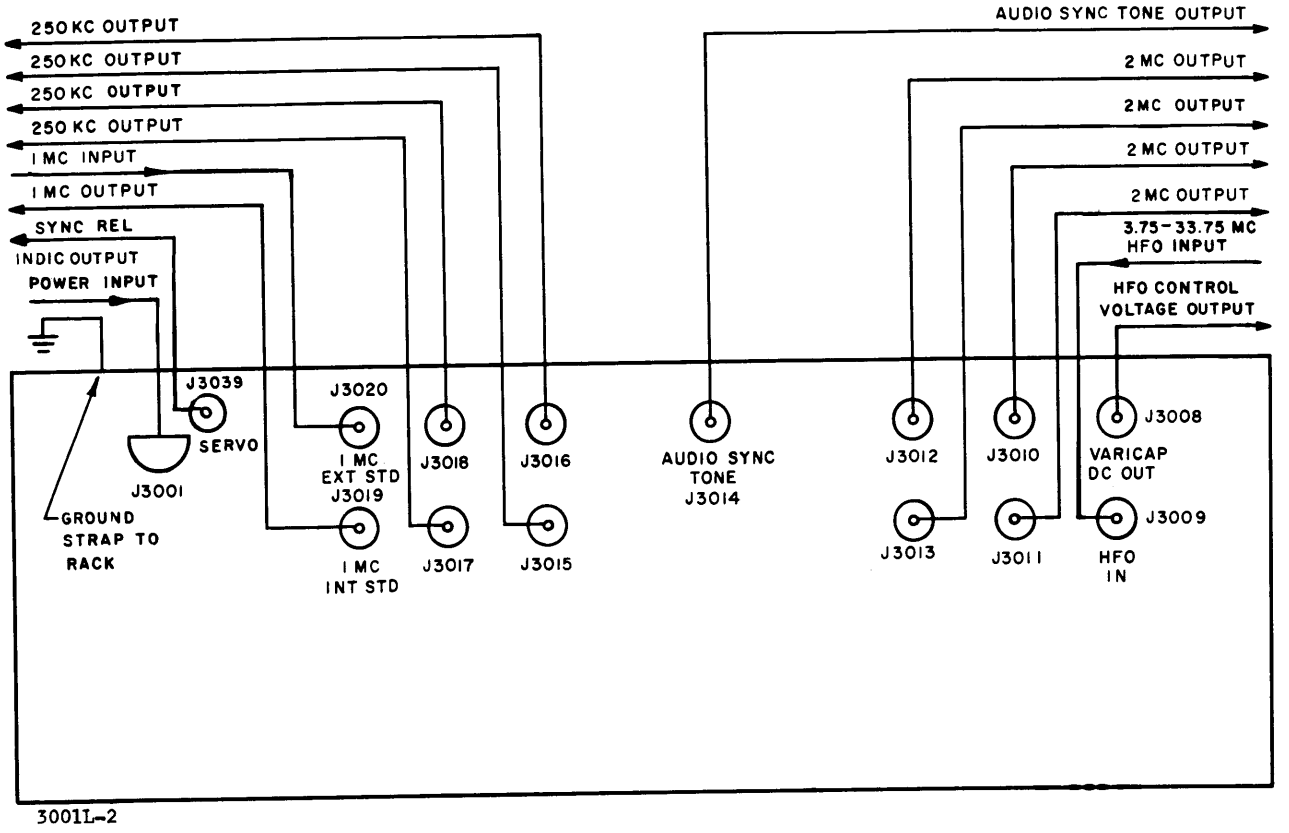

Figure 2-2. HFS Interconnection Diagram

g. Continue this procedure through the remaining positions of the 10 KC selector switch. For each position, move the tuning controls to obtain a zero beat as indicated in table 2-3.

h. Leaving the 10 KC switch in position "9", place the 1 KC selector switch in position "1" and adjust the tuning control to obtain a zero beat at 2.991 mc. The counter should read 4.741 mc.

i. Continue this procedure through the remaining positions of the 1 KC selector switch. For each position move the tuning control to obtain a zero beat as indicated in table 2-4.

j. Leaving the 1 KC selector switch in position "9", place the 0.1 KC selector switch in position "1" and adjust the tuning control to obtain a zero beat at 2.9991 mc. The counter should read 4.7491 mc.

k. Continue this procedure through the remaining positions of the 0.1 KC selector switch. For each position move the tuning control to obtain a zero beat as indicated in table 2-5.

l. Tune the HFS to 3.0000. Move the tuning control to obtain a zero beat at 3 mc. The counter should read 4.75 mc.

m. Continue this procedure for the remaining positions of the 1 MC selector switch, conducting the check at the high and low ends of each band division in the receiver or transmitter. In each case the counter should read 1.75 mc above the selected frequency. See table 2-6 for readings.

TABLE 2-1. INPUT AND OUTPUT CONNECTIONS

INPUT OR OUTPUT DESIRED	CONNECT TO
Use of internal 1-mc standard output	J3019
Use of external 1-mc standard input	J3020
250-kc outputs	J3015, J3016, J3017, J3018
Audio sync tone output	J3014
Sync relay indication outputs	J3039, pins J and N of J3001*
2-mc outputs	J3010, J3011, J3012, J3013
HFO control voltage output (varicap dc out)	J3008
HFO 3.75- to 33.75-mc input	J3009

*See figure 7-1, HFS Schematic wiring, for details.

TABLE 2-2. 100 KC SELECTOR AND FREQUENCIES

100 KC SELECTOR POSITION	TUNING CONTROL SET TO: (MC)	COUNTER READING: (MC)
2	2.2	3.9500
3	2.3	4.0500
4	2.4	4.1500
5	2.5	4.2500
6	2.6	4.3500
7	2.7	4.4500
8	2.8	4.5500
9	2.9	4.6500

TABLE 2-3. 10 KC SELECTOR AND FREQUENCIES

10 KC SELECTOR POSITION	TUNING CONTROL SET TO: (MC)	COUNTER READING: (MC)
2	2.92	4.6700
3	2.93	4.6800
4	2.94	4.6900
5	2.95	4.7000
6	2.96	4.7100
7	2.97	4.7200
8	2.98	4.7300
9	2.99	4.7400

TABLE 2-4. 1 KC SELECTOR AND FREQUENCIES

1 KC SELECTOR POSITION	TUNING CONTROL SET TO: (MC)*	COUNTER READING: (MC)
2	2.992	4.7420
3	2.993	4.7430
4	2.994	4.7440
5	2.995	4.7450
6	2.996	4.7460
7	2.997	4.7470
8	2.998	4.7480
9	2.999	4.7490

*approximately

TABLE 2-5. 0.1 KC SELECTOR AND FREQUENCIES

.1 KC SELECTOR POSITION	TUNING CONTROL SET TO: (MC)*	COUNTER READING (MC)
2	2.9992	4.7492
3	2.9993	4.7493
4	2.9994	4.7494
5	2.9995	4.7495
6	2.9996	4.7496
7	2.9997	4.7497
8	2.9998	4.7498
9	2.9999	4.7499

*approximately

TABLE 2-6. 1 MC SELECTOR AND FREQUENCIES

MC SELECTOR POSITION	TUNING CONTROL SET TO: (MC)	COUNTER READING: (MC)
4	4	5.7500
5	5	6.7500
6	6	7.500
7	7	8.7500
8	8	9.7500
9	9	10.7500
10	10	11.7500
11	11	12.7500
12	12	13.7500
13	13	14.7500
14	14	15.7500
15	15	16.7500
16	16	17.7500
17	17	18.7500

MC SELECTOR POSITION	TUNING CONTROL SET TO: (MC)	COUNTER READING: (MC)
18	18	19.7500
19	19	20.7500
20	20	21.7500
21	21	22.7500
22	22	23.7500
23	23	24.7500
24	24	25.7500
25	25	26.7500
26	26	27.7500
27	27	28.7500
28	28	29.7500
29	29	30.7500
30	30	31.7500
31	31	32.7500

SECTION 3
OPERATOR'S SECTION

3-1. OPERATING CONTROLS.

Table 3-1 indicates the front panel lettering, circuit component designations and functions of HFS controls. See figure 3-1 and refer to this table.

3-2. SEQUENCE OF OPERATION.

If the equipment has been shut down previously, the ovens should be allowed to warm up and stabilize before synthesized operation of the receiver or transmitter is attempted. For full rated frequency stability, a 24-hour period is recommended; however, proper operation often can be expected after an initial warm-up of six hours. The system can be operated with a shorter warm-up period if there is an operator remaining on duty. To set the synthesizer in operation, refer to the procedure spelled out in the TMC receiver or transmitter system manual. If this manual is not available, perform the following steps:

NOTE

It is assumed here that the component in the receiver or transmitter containing the HFO includes a sync indicator lamp (working from the sync relay indicator output at J3039 or J3001) a zero-center-scale d-c correction voltage indicator (working from the d-c output at J3008).

a. Rotate the HFS 1 MC, 100 KC, 10 KC, 1 KC and .1 KC selector switches until receiver (or transmitter) frequency is brought on the digital display.

b. Tune receiver or transmitter as near as possible to frequency in a. as indicated on its calibrated tuning dial.

c. Observe receiver or transmitter sync indicator lamp. Slowly readjust receiver or transmitter tuning controls until lamp remains lit steadily and d-c correction voltage indicator indicates zero-center-scale.

TABLE 3-1. OPERATING CONTROLS

CONTROL NUMBER (FIGURE 3-1)	PANEL AND COMPONENT DESIGNATION	FUNCTION
1	.1 KC switch S3101	Tunes the synthesizer in 100-cycle steps.
2	1 KC switch S3201	Tunes the synthesizer in 1000-cycle steps.
3	10 KC switch S3301	Tunes the synthesizer in 10-kc steps.
4	100 KC switch S3401	Tunes the synthesizer in 100-kc steps.
5	1 MC switch S3501	Tunes the synthesizer in 1-mc steps between 2 and 32-mc.
6	1 MC COMPARATOR meter M3001	Indicates frequency error in internal 1-mc standard.
7	Digital display indicators DS3001, 2 and 4 thru 7.	Indicates the frequency components set by controls.

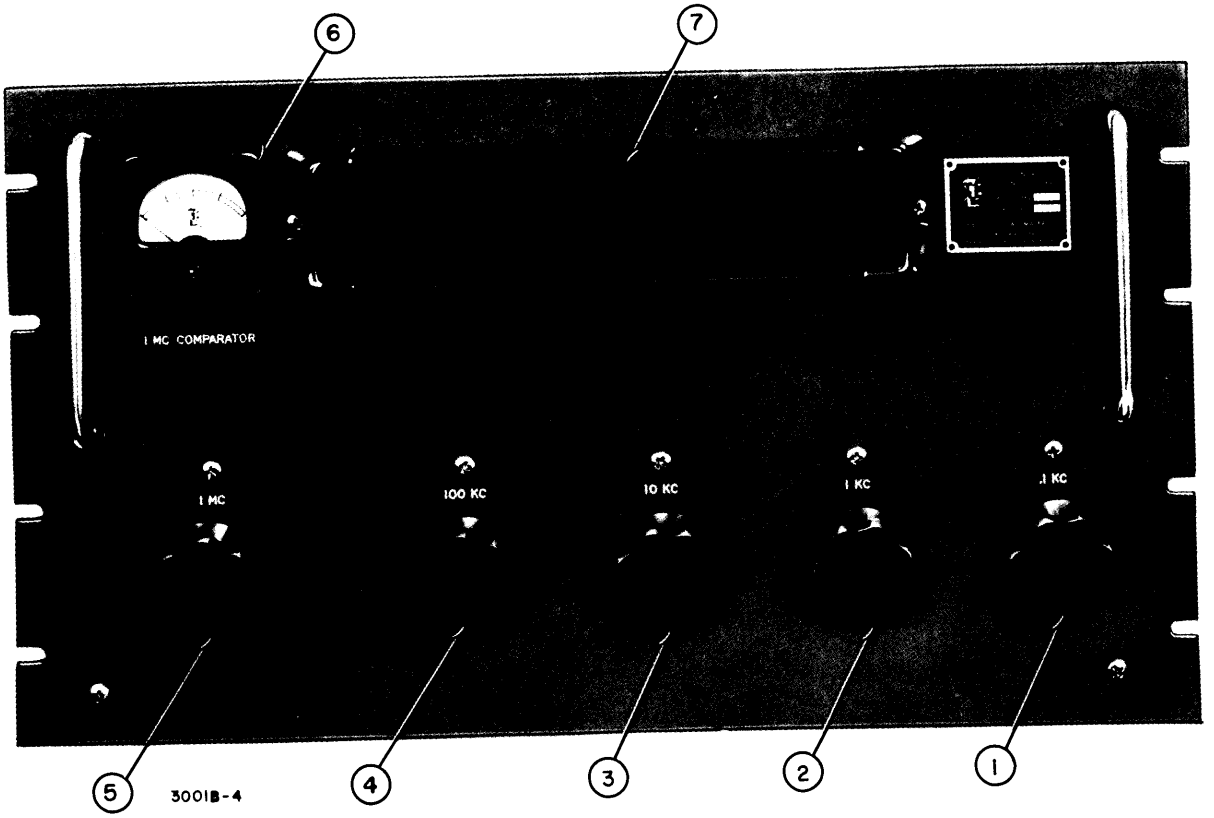

Figure 3-1. HFS Front Panel Controls

635.17-1

3-3. EXTERNAL 1-MC SOURCE.

Normally the internally generated 1-mc source is used as the basic reference frequency for the synthesizer. However, should you want to use an external 1-mc signal instead of the internally generated one, throw INTernal-EXTernal Switch S3102 into the EXTernal position. S3102 is located on the top right side of the chassis. However, when using an external 1-mc source, make sure that the stability of the signal is at least that of the internal source (1 part in 10^8 per 24-hour period). By using a 1-mc source with a stability greater than the internal source, the error of the internal source can be determined. The external 1-mc source is connected to 1 MC EXT STUD jack J3020 at the rear of the equipment. The 1 MC COMPARATOR meter (M3001), located on the front panel, shows the error in cycles per second. If one complete swing occurs in 5 seconds, the error is 1/5 cycle.

3-4. OPERATOR'S MAINTENANCE.

If any malfunction occurs, immediately turn off equipment and visually inspect the equipment for simple defects. If conditions warrant, see the troubleshooting section (Section 5) of this manual. The operator should specifically observe whether the tubes, dial, and meter are functioning properly. Make sure, also, that all parts are clean.

SECTION 4
PRINCIPLES OF OPERATION

4-1. SIMPLIFIED BLOCK DIAGRAM ANALYSIS. (See figure 4-1.)

A 1-mc oscillator, which generates the basic reference signal for the synthesizer, is contained in the 3100 deck. This 1-mc standard is coupled to the 3400 deck where it is reduced to 100 kc; the 100-kc signal, in turn, is used to create synthesized frequencies in the 3400 deck. The same signal is also applied to the 3300 deck where it is reduced to 10 kc and used as a reference for synchesizer circuits in the 3300 deck. This signal is also applied to the 3200 deck where it is reduced to 1 kc and this is subsequently used in the 3100 deck synthesizer circuits to create 100 cps references.

In the 3100 deck, the 100-cps signal is used in the synthesizer circuits to produce a signal between 4 and 3.1 kc, depending on the position of the .1 KC switch. This signal is applied to the 3200 deck where it is added to a synthesized 36 to 27-kc signal to produce a 40 to 30.1-kc output.

The 10-kc signal in the 3300 deck is used in the synthesizer circuits to produce a 410 to 320-kc signal, depending on the position of the 10 KC switch. This signal is added to the 40 to 30.1-kc signal to produce a 450 to 350.1-kc signal. In the 3400 deck, the 100-kc signal is used in the synthesizer circuits to produce a frequency in the range of 3.8 mc to 2.9 mc, depending on the position of the 100 KC switch. This signal is added to the 450 to 350.1-kc signal to produce a 4.25 to 3.2501-mc signal which is subsequently applied to a phase detector.

The same 1-mc signal which is generated in the 3100 deck is also coupled to the 3500-3600 deck where it is used in the synthesizer circuits and applied to a second harmonic generator. These circuits also employ a 48.5 - 77.5-mc oscillator, tuned in 30 one-megacycle steps. Another input to the synthesizer circuits arrives from the HFO in the receiver or transmitter. Since the HFO is always operating 1.75 mc above the incoming signal, the HFO frequency input will range from 3.75 to 33.75 mcs.

The synthesizer circuits of the high frequency loop produce frequencies between 4.25 and 3.25 mc, for

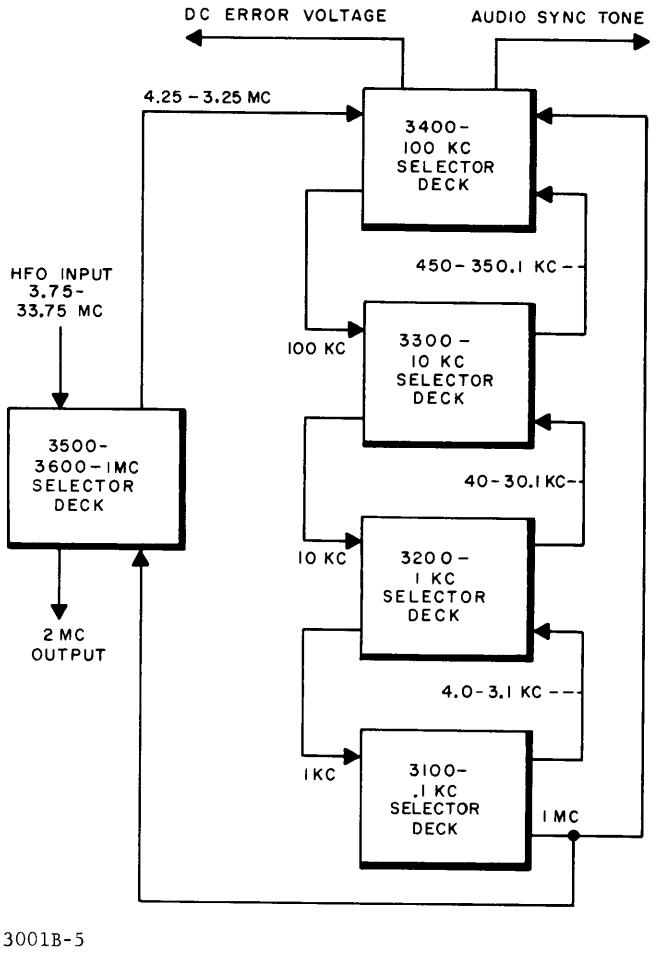

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Figure 4-1. HFS Simplified Block Diagram

each of the 30 one-megacycle steps. This 4.25 to 3.25-mc frequency contains the error, if any, of the HFO circuit. It is delivered to the phase detector circuit of the 3400 deck. The phase detector compares the two normally identical frequencies and develops a correction voltage, the amplitude and polarity of which is determined by the error of the HFO. The correction voltage is used to correct the HFO error. Another phase detector circuit also produces an audio sync tone for tuning and alignment purposes. The tone frequency is proportional to the error; no tone is produced when the error is zero.

The switching is coded so that the frequency to which the receiver or transmitter is tuned is displayed on the synthesizer front panel. The actual frequency output of each synthesizer deck is indicated in table 4-1. The indicator position refers to the lighted digit for each selector deck.

TABLE 4-1. PRODUCT CHART OF BASIC SYNTHESIZER

INDICATOR POSITION	DECK 3400	DECK 3300	DECK 3200	DECK 3100
0	3.8 mc	410 kc	36 kc	4.0 kc
1	3.7 mc	400 kc	35 kc	3.9 kc
2	3.6 mc	390 kc	34 kc	3.8 kc
3	3.5 mc	380 kc	33 kc	3.7 kc
4	3.4 mc	370 kc	32 kc	3.6 kc
5	3.3 mc	360 kc	31 kc	3.5 kc
6	3.2 mc	350 kc	30 kc	3.4 kc
7	3.1 mc	340 kc	29 kc	3.3 kc
8	3.0 mc	330 kc	28 kc	3.2 kc
9	2.9 mc	320 kc	27 kc	3.1 kc

The following examples should clarify the operation of the unit.

EXAMPLE NO. 1

If the indicator readout to the right of the decimal point reads 0 0 0 0, the output of the 3400 deck to the phase detector would be 3.8 + .41 + .036 + .004 = 4.25 mc.

The output of the 3300 deck to the 3400 deck would be .41 + .036 + .004 = .45 mc.

The output of the 3200 deck to the 3300 deck would be .036 + .004 = .04 mc.

The output of the 3100 deck would be .004 mc.

EXAMPLE NO. 2

To obtain .44 mc to the 3400 deck from the 3300 deck:

Set the 3100 deck to position 0	.004
Set the 3200 deck to position 0	.036
Set the 3300 deck to position 1	.400
	.44 mc

EXAMPLE NO. 3

To obtain .36 mc to the 3400 deck from the 3300 deck:

Set the 3100 deck to position 0	.004
Set the 3200 deck to position 0	.036
Set the 3300 deck to position 9	.320
	.360 mc

4-2. DETAILED BLOCK DIAGRAM ANALYSIS. (See figure 4-2.)

a. 3100 DECK. The .1 kc selector deck (3100 deck) receives pulses at a frequency of 1 kc from the 3200 deck. The 3100 deck delivers an output in ten .1-kc steps from 4.0-kc to 3.1 kc to the 3200 deck. The actual output frequency is dependent on the setting of the .1 KC selector switch (S3101).

The 1-kc pulses from the 3200 deck are applied to V3101, a 10:1 divider circuit. The 100-cycle output is applied through cathode follower V3102 to a tuned circuit consisting of capacitors C3128 to C3137 and crystals Y3101 to Y3110. The output frequencies between 4.0 and 3.1 kc, dependent on the position of the .1 kc switch, are generated by this network. This tuned signal is amplified through V3103 and V3104 and applied to the balanced modulator in the 3200 deck.

Included in the 3100 deck is the Z3101 1-mc standard, which acts as a reference for the entire system. The output from Z3101 is applied to phase comparator V3105B and amplifier V3105A, where it is amplified and then coupled to J3103. An external 1-mc signal can be connected to J3020. Both the internal and external 1-mc signals are connected to the phase comparator which couples the signals to a phase comparator meter on the front panel.

b. 3200 DECK. The 1-kc selector deck receives 10-kc pulses from the 3300 deck and signals between 4 and 3.1 kc from the 3100 deck. The 10-kc pulses are applied to divider V3201 which produces a 1-kc output and this is coupled to amplifier-cathode follower V3202 and divider V3101 in the 3100 deck. The harmonic-rich, 1-kc pulses at the cathode of V3202 are applied to tuned circuits consisting of capacitors C3232 to C3241 and crystals Y3201 to Y3210. Frequencies between 36 and 27 kc are generated by these tuned circuits; the selected frequency dependent on the position of the 1 KC control, S3201. The 36 to 27-kc signal is amplified through V3203 and coupled to a balanced modulator network along with a 4.0 to 3.1-kc signal from amplifier V3104 in the 3100

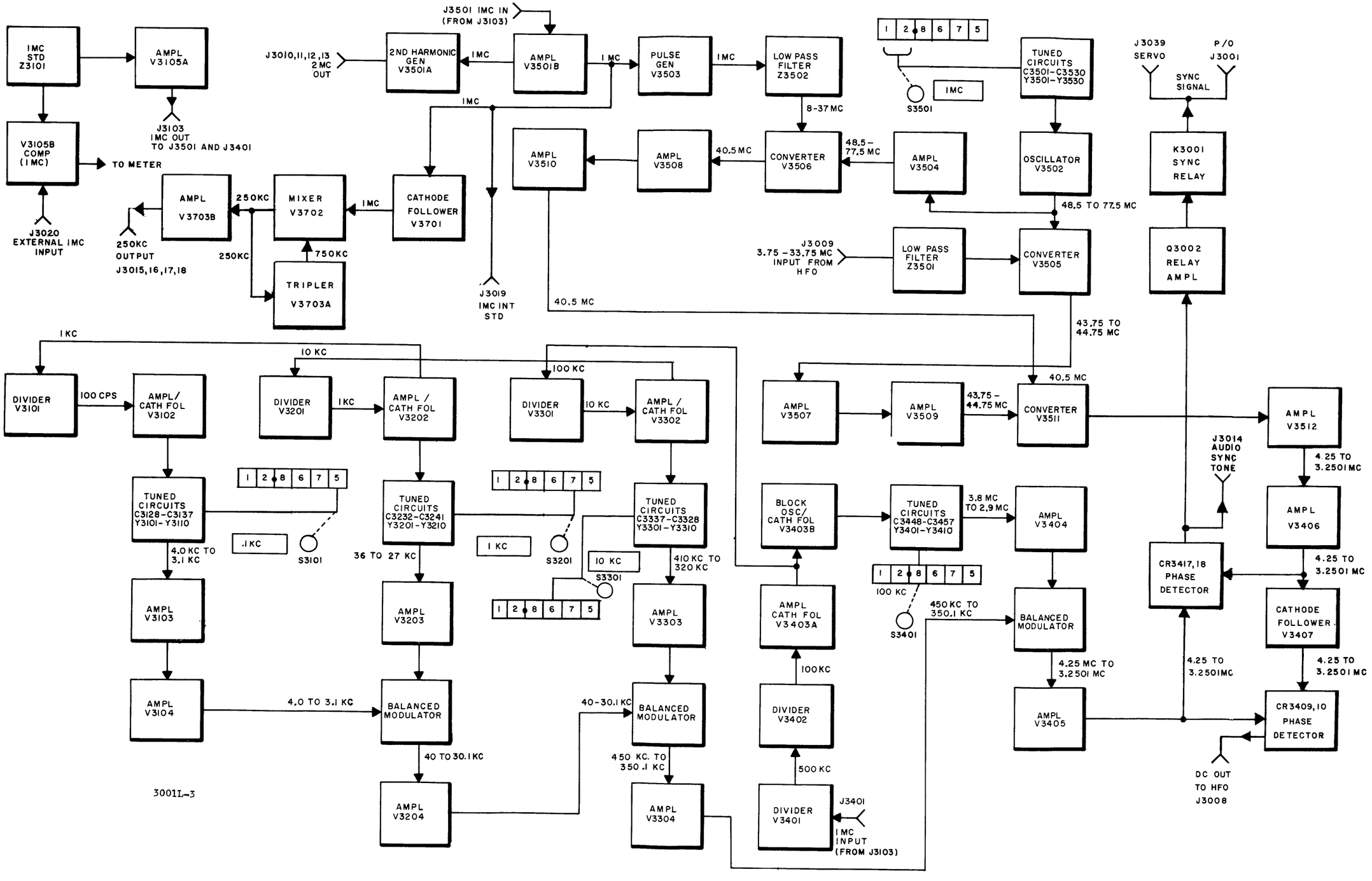


Figure 4-2. HFS Block Diagram

deck. The balanced modulator circuit produces sum and difference frequencies; however, a tuned network passes only the sum frequencies. Thus the output of the balanced modulator consists of signals in a 40 to 30.1-kc frequency range. These signals are coupled to amplifier V3204.

c. 3300 DECK. The 3300 deck (10-kc selector deck) receives 100-kc pulses from the 3400 deck. These 100-kc pulses are applied to 10:1 divider V3301 which produces a 10-kc output. This 10-kc signal is then coupled through amplifier and cathode follower V3302 to a tuned network consisting of capacitors C3337 to C3328 and crystals Y3301 to Y3310. Frequencies between 410 and 320 kc are generated by this network; the output frequency is dependent on the position of the 10 KC selector switch, S3301. This signal is amplified in V3303 and applied to a balanced modulator. Signals between 40 and 30.1 kc are also coupled to this particular modulator which generates a 450 to 350.1-kc output. This signal is amplified in amplifier V3304.

d. 3400 DECK. In the 3400 deck (100-kc selector deck), a 1-mc signal is coupled through J3401 to divider V3401 which, in turn, generates a 500-kc signal. This 500-kc signal is then further divided to 100 kc by divider V3402. This signal is then coupled through amplifier-cathode follower V3403A to divider V3301 in the 3300 deck and to block oscillator V3403B, which generates harmonically-rich pulses. The 100-kc pulse output from V3403B is coupled to tuned filters consisting of capacitors C3448 to C3457 and crystals Y3401 to Y3410. These narrow band filters are tuned to the 29th through 38th harmonics of 100 kc. The output frequency from these circuits, dependent on the position of the S3401 100 KC control, is between 2.9 and 3.8 mc.

These signals are amplified in V3404 and coupled to a balanced modulator along with a 450 to 350.1-kc signal from amplifier V3304 in the 3300 deck. The balanced modulator generates signals between 4.25 and 3.2501 mc. These signals are amplified in V3405 and coupled to two phase detectors, one to produce a d-c correction for the HFO and one to produce an audio sync tone as an aid to tuning. This 4.25 to 3.2501-mc frequency to the detectors represents the reference frequency from the HFS. The 4.25 to 3.2501-mc frequency from the HFO is taken from the 3500 deck and, amplified through V3405, is applied directly to the audio sync tone detector and to the d-c correction phase detector via V3407 cathode follower.

As the receiver or transmitter is tuned towards the synchronization point, CR3417/18 detector produces a difference frequency representing the difference between its two inputs. When this difference frequence falls into the audio range it becomes the audio sync tone and is generally utilized by the operator as a "zero beat" aid in synchronizing the receiver or transmitter HFO into the d-c capture range of the HFS correction loop. This detector also acts through Q3002 transistor to energize K3001 sync relay, providing additional sync indication outputs at J3039 and J3001 receptacles.

When the HFO has been tuned to within the HFS d-c capture range, CR3409/10 detector issues a d-c voltage, the polarity of which is determined by the $\pm$ error in frequency between the two signals being compared. The operator continues to fine-tune the HFO until this voltage becomes zero and this completes the synchronization. Any subsequent tendency of the HFO to wander is corrected by the CR3409/10 phase detector output. This d-c is generally used to change the reactance value in the HFO circuit.

e. 3500 - 3600 DECK, also known as the high frequency loop or 1-mc selector deck, receives: (1) A 1-mc signal from the frequency standard circuits: and, (2) A sample of the HFO circuit in the range of 3.75 to 33.75-mc. The 3500 - 3600 deck delivers: (1) A 2-mc signal for use in a receiver mixer stage; and (2) a frequency between 4.25 and 3.25-mc (the selected frequency is dependent on the position of the 1-mc switch S3501).

The 1-mc input is coupled through J3501 and amplified in V3501B. The output from V3501B is applied to V3501A and V3503. V3501A, a second harmonic generator, provides a 2-mc output at J3010, J3011, J3012 and J3013. V3503, a pulse generator, shapes the 1-mc signal to provide a signal rich in harmonics. These 1-mc pulses are applied to low pass filter Z3502 which passes signals between the 8th and 37th harmonics of the 1-mc signal. These signals are applied to converter V3506.

A 48.5 to 77.5-mc signal is generated by oscillator V3502 and applied to converter V3505 and amplifier V3504. V3506 always generates a 40.5-mc signal, regardless of the operation frequency. This 40.5-mc output is amplified through cascade amplifiers V3508 and V3510 and coupled to converter V3511.

The output from oscillator V3502 is also applied to converter V3505. The second input to this converter, a signal between 3.75 and 33.75 mc, comes from the HFO in the receiver or transmitter. This input is coupled through low pass filter Z3501 to V3505. The converter generates a 43.75 to 44.75-mc output. The HFO frequency is always 1.75 mc above the received signal. Note the relationships of the various signals in table 4-2. All frequencies in this table are in megacycles.

The 43.75 to 44.75-mc output from V3505 is amplified through cascade amplifiers V3507 and V3509 and coupled to converter V3511. The second input to V3511 (a 40.5 mc signal) is coupled from amplifier V3510. The output from V3511 is a signal between 4.25 and 3.2501 mc. This signal is coupled through amplifier V3406 to the phase detectors in the 3400 deck.

4-3. DETAILED CIRCUIT ANALYSIS OF 3100 DECK. (See figure 4-3.)

a. DIVIDER V3101. The 1-kc input signal from the 3200 deck is coupled through J3101 to phantastron divider V3101. Frequency division is accomplished

TABLE 4-2. FREQUENCY RELATIONSHIPS

RECEIVER OR TRANSMITTER FREQUENCIES	HFO FREQUENCIES	OSCILLATOR V3502 FREQUENCIES	CONVERTER V3505 OUTPUT
2	3.75	48.5	44.75
3	4.75	49.5	44.75
4	5.75	50.5	44.75
4.2	5.95	50.5	44.55
4.8	6.55	50.5	43.95
4.9	6.65	50.5	43.85
4.95	6.70	50.5	43.70
4.99	6.74	50.5	43.76

in the HFS unit by phantastrons such as that found in the 3100 deck. Figure 4-4 shows a simplified schematic of a typical cathode-coupled phantastron along with some significant waveforms. To gain an understanding of how a typical phantastron works, refer to this illustration along with the following explanation.

When the negative portion of pulse 1 reaches the control grid of V1, the grid's potential is dropped. A trigger impulse of 30 volts is needed to drive the grid downward. The initial drop in grid and plate voltage for this cathode-coupled circuit must be large enough for the cathode to fall a sufficient amount to raise the relative level of the suppressor grid into the region where plate current can flow. (Note that the suppressor is returned to a more negative point than the plate, so that initially the plate current in V1 is cut off.) As in a cathode follower, cathode voltage follows that of the control grid voltage.

The first negative pulse now cuts off the cathode's electrons to the suppressor and switches them to the plate, since the suppressor voltage is higher than that of the cathode. Consequently, the plate voltage drops as shown in the illustration. It should be noted that the first negative pulse charges capacitor C so that the "left hand" plate is negative whereas the "right-hand" plate is positive. It should also be noted that the potential at the junction of R2/R3 increases to the point where V2 responds feebly to incoming pulses 2, 3, through 9. Furthermore, the potential at the junction of R1 and C is lower than that of Ebb. As a result, voltage Ebb charges capacitor C via R_g and the potential on V1's control grid rises, as shown in the illustration. Naturally the potential on V1's cathode follows.

At the tenth negative pulse, the relative potentials at V1's cathode and suppressor grids are such that the electrons from the cathode are switched from the plate to the suppressor. This completes the time delay switching action.

It should be noted that the potential at the junction of R_L and C is variable whereas that at the "top end" of R_g is fixed. If the potential at the junction of R_L and C was constant, the same as the potential at the "top end" of R_g, an exponential voltage would have been applied to the control grid of V1. The contrary being the case, the grid of V1 is linear, as shown in the illustration. This characteristic makes the phantastron circuit ideal for frequency-dividing purposes. In HFS's phantastron circuits, the one-tenth frequency output is taken from the screen grid, instead of at the plate, as shown in the illustration.

b. AMPLIFIERS V3102 - V3104. Referring to figure 4-3, the 100-cps output at pin 6 of V3101 is applied to the grid of amplifier-cathode follower V3102 through a differentiator network consisting of R3110 and C3104. With a time constant of 500 microseconds, the differentiator generates positive and negative spikes occurring at a frequency of 100 cps. This harmonic-rich output is applied to a filter network consisting of crystals Y3101 through Y3110 and trimmers C3128 through C3137. Operating between 3.1 and 4 kc, the output frequency from the filter network is determined by the position of the front panel .1 KC control (S3101E and S3101D).

The selected frequency from the wiper of S3101D is applied to amplifier V3103. The amplified output from V3103 is coupled to the grid (pin 1) of amplifier V3104. The plate circuit of V3104 is tuned by shunting the primary of T3101 with various capacitances selected by S3101B. The 3.1 to 4-kc output from V3104 is coupled to J3102 where it is used in the balanced modulator in the 3200 deck.

V3104 employs an AGC network to insure a reasonably constant output amplitude regardless of the frequency selected. When the signal amplitude at C3119 exceeds 25 volts, the capacitor charges on the positive excursions through CR3102 and discharges through CR3103 on the negative excursions,

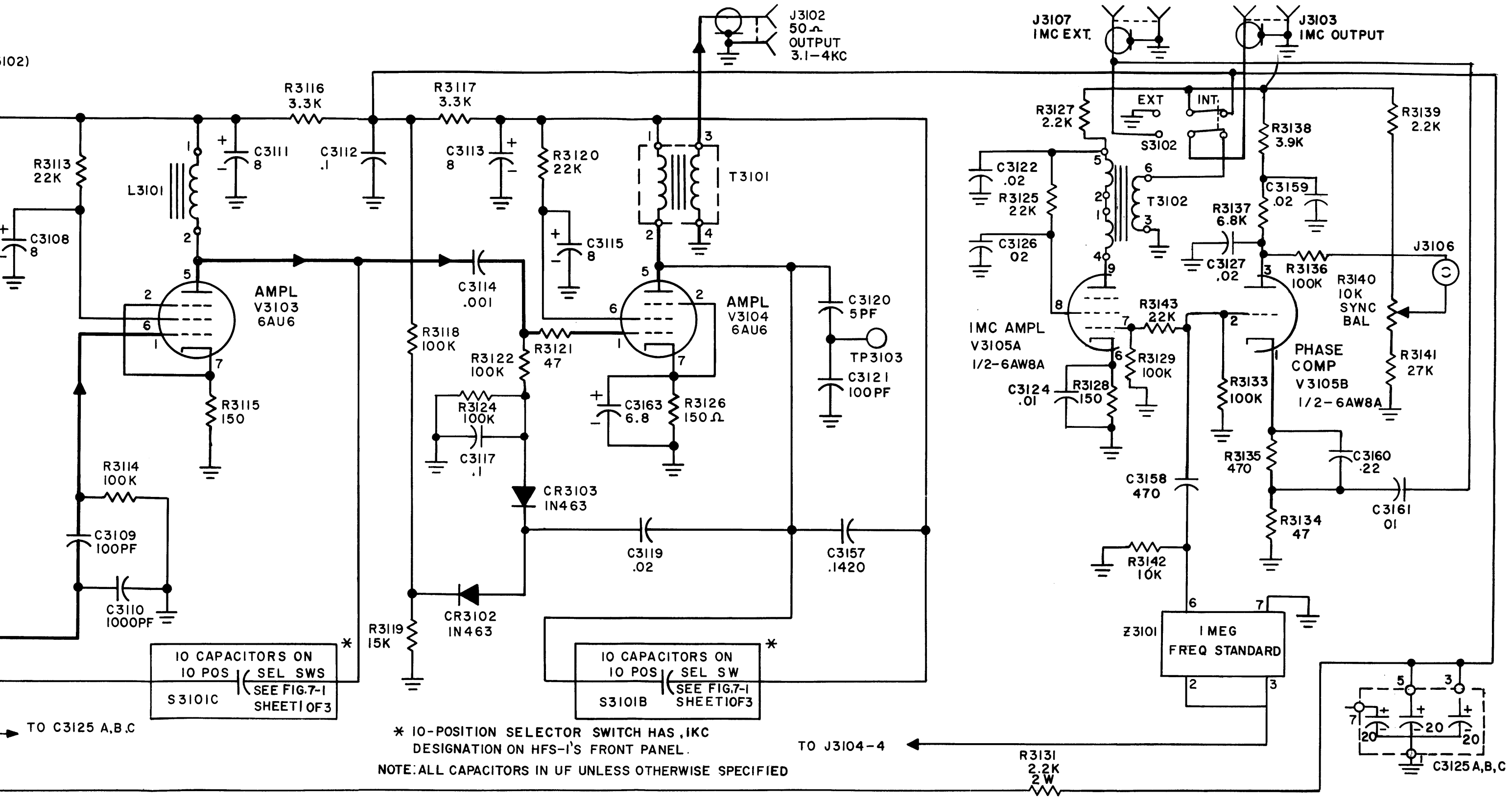
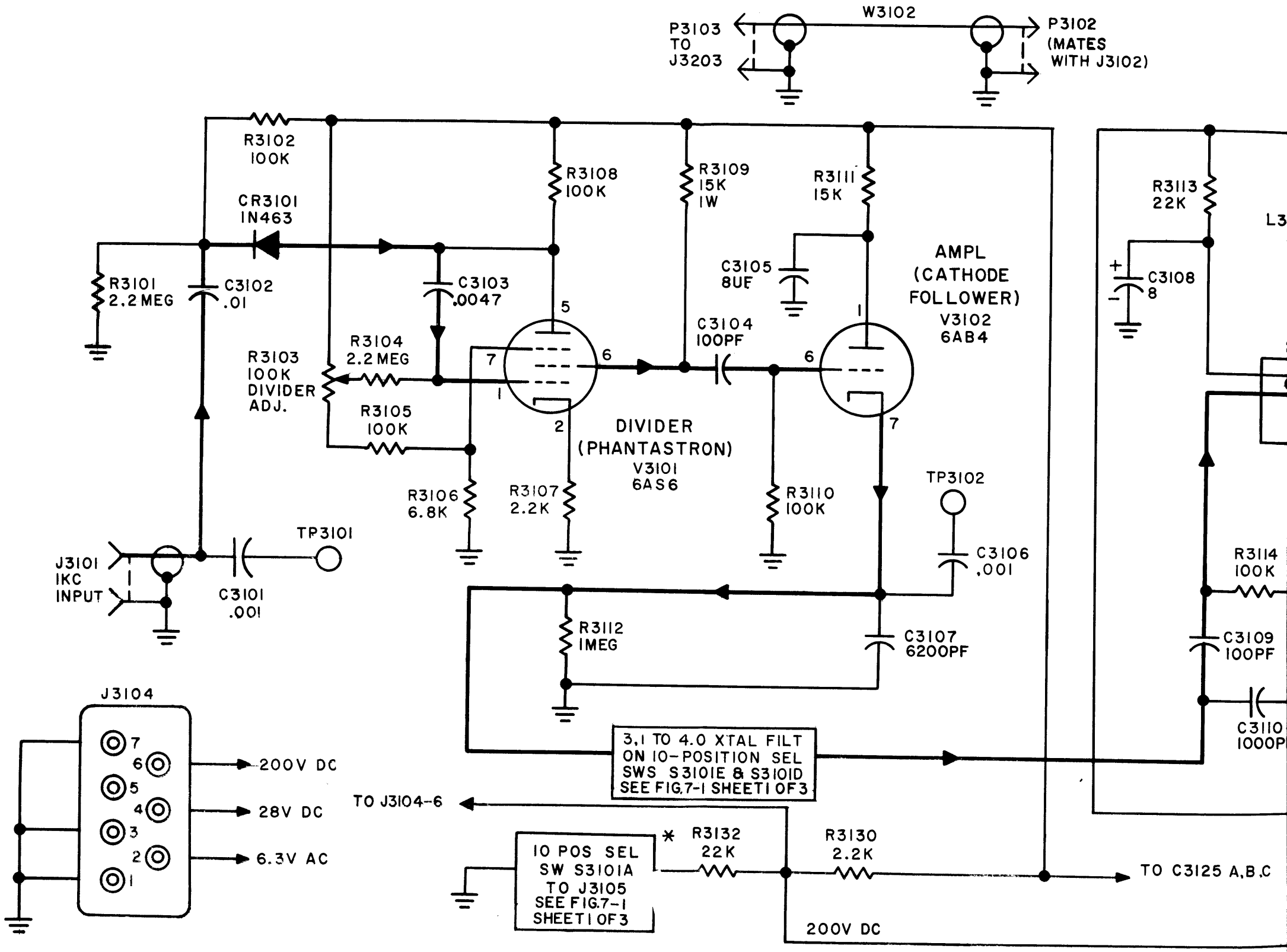


Figure 4-3. 3100 Deck, Schematic Diagram



3001L-4

012663001L

into C3117. The pulsating AGC voltage is coupled to the grid of the tube.

c. 1-MC FREQUENCY STANDARD (See figure 4-5.)

The 3100 deck also houses the 1-mc standard and comparator circuits. A James Knight sealed 1-mc standard (Z3101), an octal plug-in unit containing the crystal standard, a transistor oscillator, oven circuits, and trimmer adjustments, is used as the basic reference source. This standard supplies a 1-mc signal accurate to within one part in 10^8 per day.

Amplifier V3105A amplifies the 1-mc signal from Z3101 and couples it through T3102 to INT(ernal)-EXT(ernal) MC switch S3102. With S3102 in the Internal position, B+ is applied to V3105A and the output is coupled to 1-mc output jack J3103. With S3102 in the External position, B+ is removed from V3105A and a 1-mc external signal, connected to J3107 (and J3020), can be used as a standard.

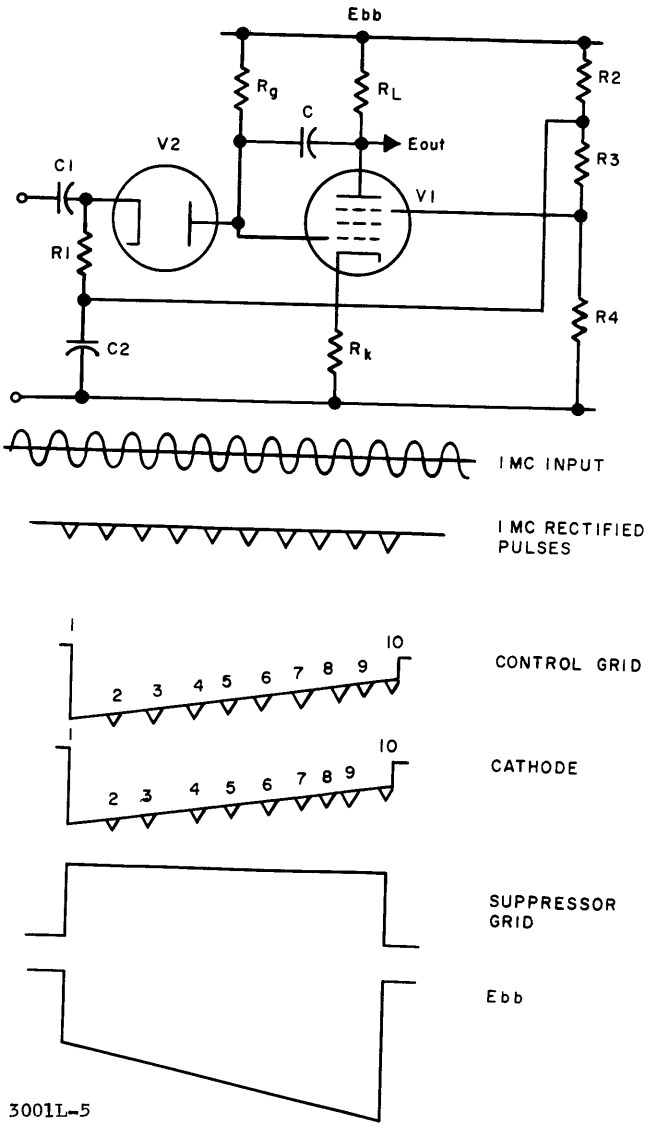


Figure 4-4. Simplified Schematic of Typical Phantastron and Accompanying Waveforms

The phase comparator circuit (V3105B) receives the internal signal at the control grid (pin 2) and the external signal at the cathode. With no signal inputs, the voltage at the plate (pin 3) rests at some value of static plate voltage. Sync balance control R3140 is adjusted to give a zero-center reading on the 1 MC COMPARATOR meter. With two identical 1-mc inputs, the plate voltage at pin 3 will swing higher and lower, as the two inputs swing in and out of phase. The rate of swing is a measure of the error. If, for example, one complete swing occurs in five seconds, the error is 1/5 cycle.

4-4. DETAILED CIRCUIT ANALYSIS OF 3200 DECK. (See figure 4-6.)

a. DIVIDER V3201, CATHODE FOLLOWER V3202 and AMPLIFIER V3202.

Triggers at a frequency of 10 kc arrive at J3201 from the 3300 deck. These triggers, which may be monitored at TP3201, are applied to V3201, a 10:1 phantastron divider circuit. A divider adjust control (R3203) in the grid circuit of V3201 adjusts the output frequency to 1 kc. For a thorough explanation of the operation of a phantastron circuit, see paragraph 4-3a. The 1-kc output at pin 6 is applied through a differentiator circuit to amplifier-cathode follower circuit V3202. This differentiator, consisting of C3204 and R3210, generates positive and negative spikes. The plate output at V3202, consisting of negative triggers, is coupled to 1-kc output jack J3202 for use in the 3100 deck. The cathode output, consisting of positive triggers, is applied to a crystal filter operating between 27 and 36 kc. This filter network is composed of crystal Y3201 through Y3210 and capacitors C3232 through C3241. The operating frequency is determined by switches S3201F and S3201E. The selected frequency at the wiper of S3201E is applied to amplifier V3203. The plate circuit of the stage is tuned by the primary of T3201 and selected values of capacitance, connected in shunt by S3201D.

b. BALANCED MODULATOR CR3202 AND AMPLIFIER V3204.

The plate output of V3203 is coupled through T3201 to a balanced modulator circuit consisting of plug-in diode bank CR3202 and associated components. The second input to the balanced modulator is coupled from J3203 to the wiper of balance adjust control R3219. This signal, the output of the 3100 deck, is at a frequency between 3.1 and 4 kc, as selected by S3101 on the 3100 deck.

The rectifying units (CR3202) used in the balanced modulator operate as carrier-controlled switches. The two signals (27 to 36 kc and 3.1 to 4 kc) are combined in such a manner that the output contains the original 3.1 to 4 kc and the upper and lower sidebands at 30.1 to 40 kc and 23.9 to 32 kc respectively. The original carrier frequency is not in the output. Figure 4-7 shows a balanced-bridge

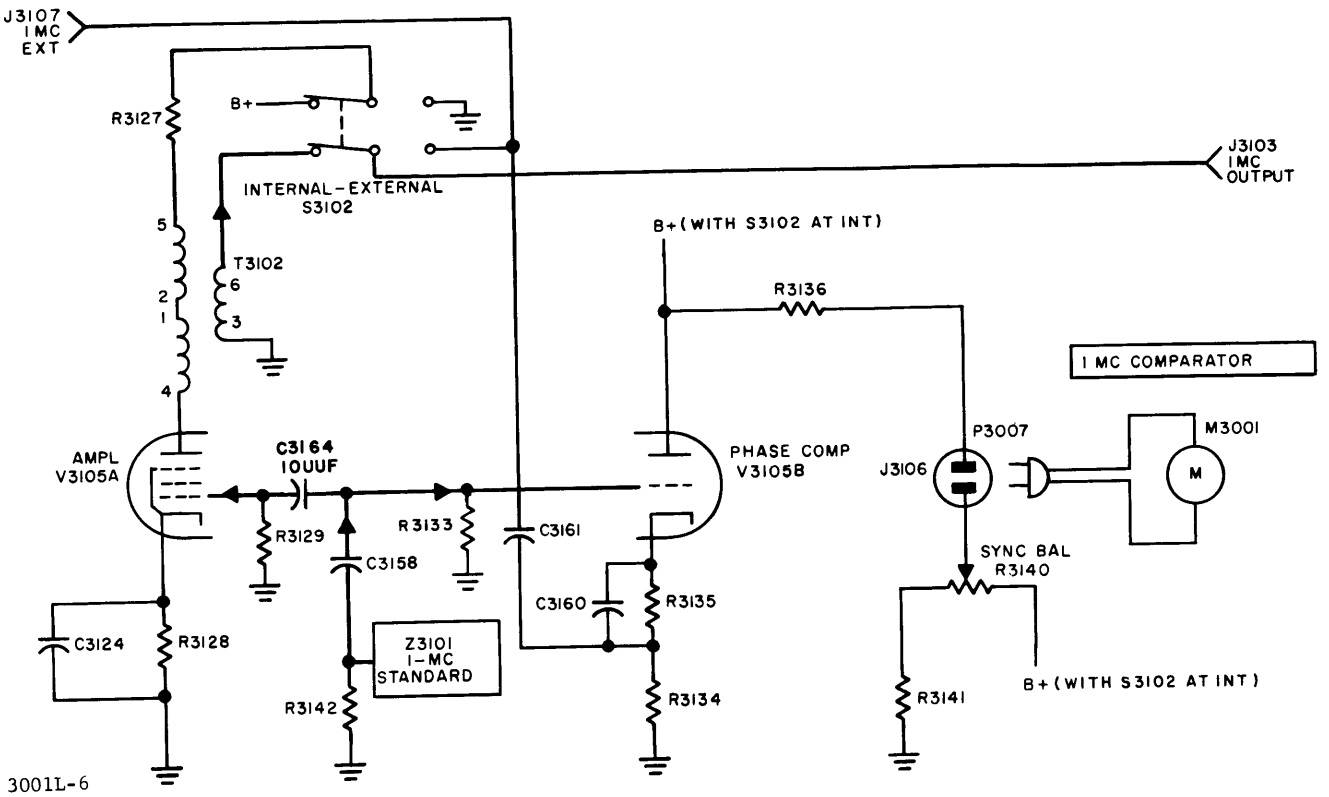


Figure 4-5. 1-Mc Frequency Standard Simplified Schematic Diagram

modulator. The carrier signal (27 to 30 kc) is coupled to T3201 while the "audio" signal (3.1 to 4 kc) is coupled to balance adjust control R3219. The series and shunt-connected diodes comprising CR3202 alternately "open" and "close", depending on the instantaneous polarity of the carrier source. This causes the output polarities to reverse at a 30.1 to 40-kc rate with respect to the 3.1 to 4-kc input polarities.

The multiple-frequency output from the balanced modulator is coupled to the grid circuit of V3204 (figure 4-6). The grid circuit of V3204 is tuned between 30.1 and 40 kc (the upper sideband) by T3202 and capacitances selected by S3201C. Its plate circuit is tuned by the primary of T3203 and selected capacitances inserted by S3201B. The output from V3204 is coupled through T3203 and to 30.1 to 40-kc output jack J3204.

Associated with V3204 is an AGC network similar to that encountered in the 3100 deck. The signal at the plate of V3204 is coupled to an AGC network. CR3204 is the delay diode, backbiased by voltage divider R3220 and R3221. CR3203 is the AGC diode and C3218 the AGC capacitor, which discharges through R3231.

4-5. DETAILED CIRCUIT ANALYSIS OF 3300 DECK. (See figure 4-8.)

a. DIVIDER V3301, CATHODE FOLLOWER V3302, AMPLIFIER V3303.

Triggers at a frequency of 100-kc are coupled from J3301 and applied to V3301, a 10:1 phantastron divider. A divider adjust control (R3303) in the grid circuit of V3301 adjusts the output frequency to 10 kc. For a thorough explanation of the phantastron circuit, see paragraph 4-3a in this manual.

The 10-kc output at pin 6 is applied through a differentiator circuit to cathode follower V3302. The differentiator, consisting of C3304 and R3310, generates positive and negative spikes. The plate output of V3302, consisting of negative triggers, is coupled to 10-kc output jack J3302 for use in the 3200 deck. The cathode output, consisting of positive peaks, is applied to a crystal filter operating between 320 and 410 kc. Tunable in 10-kc steps, the crystal filter is composed of crystals Y3301 to Y3310 and capacitors C3328 to C3337. The operating frequency is determined by switch sections S3301E and S3301F. The selected frequency at the wiper of S3301E is applied to amplifier V3303. The plate

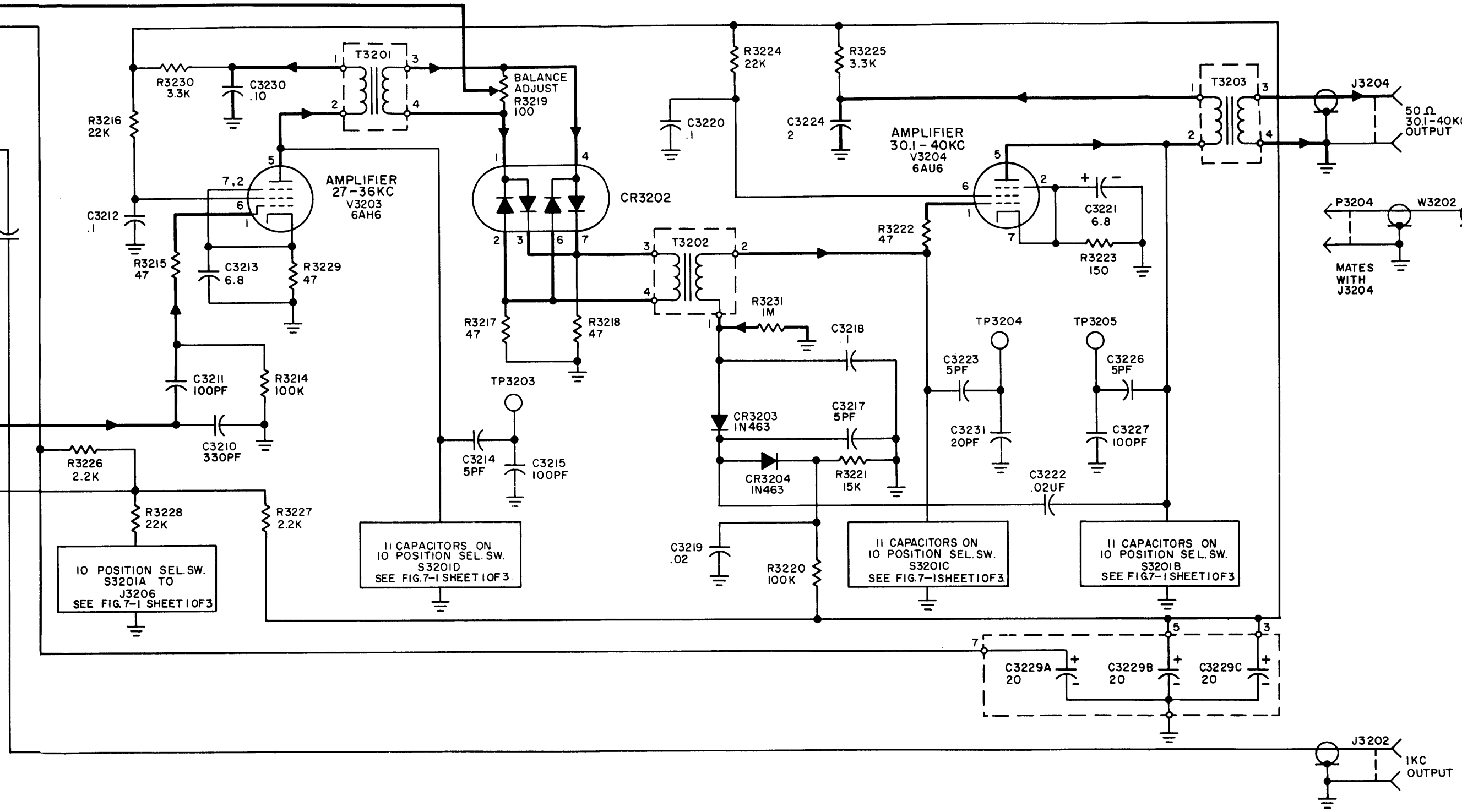
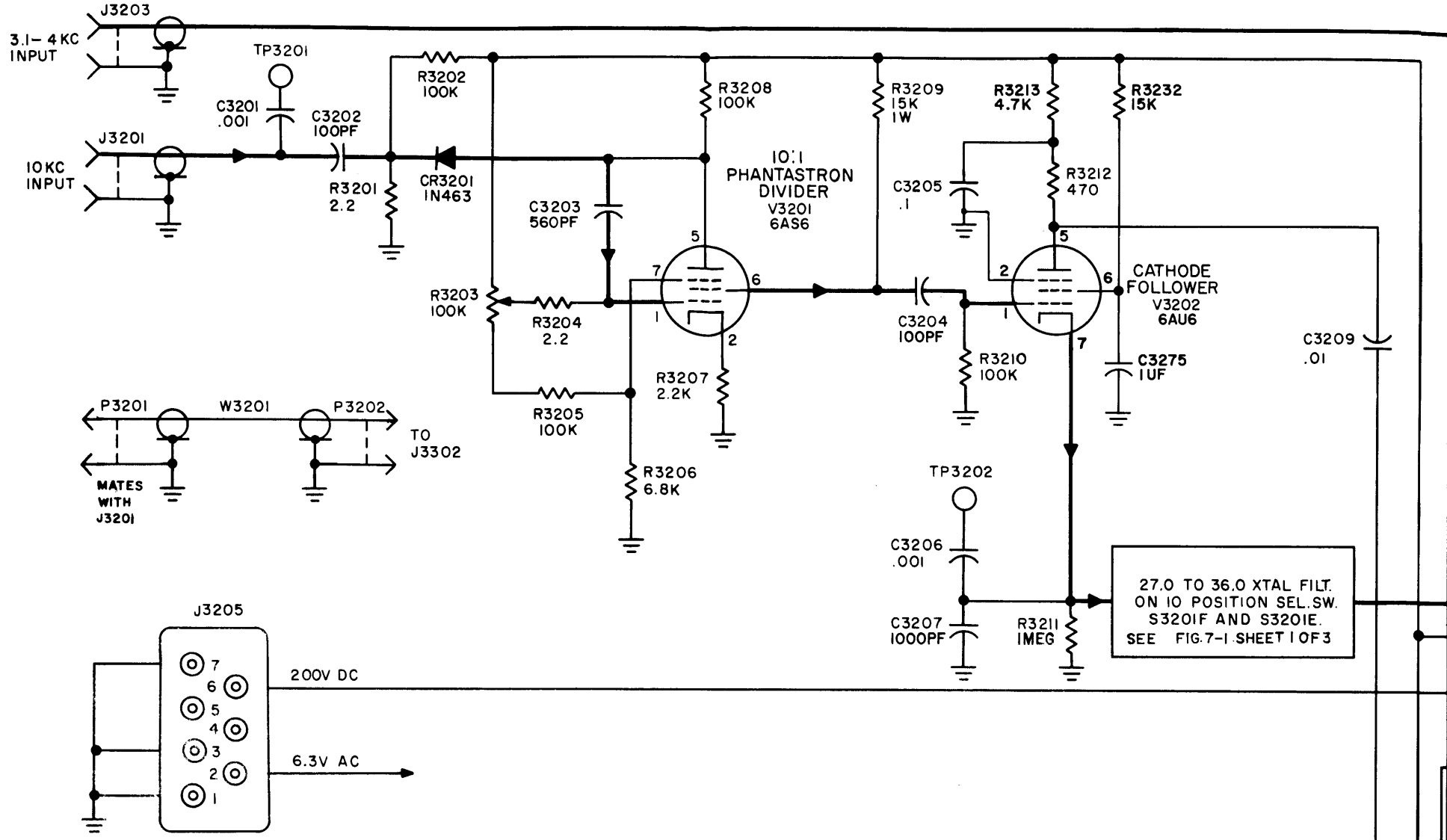


Figure 4-6. 3200 Deck, Schematic Diagram


J3203
3.1-4KC INPUT
J3201
10KC INPUT
TP3201
C3201 .001
C3202 100PF
R3201 2.2
R3202 100K
CR3201 1N463
C3203 560PF
R3203 100K
R3204 2.2
R3205 100K
R3206 6.8K
R3207 2.2K
R3208 100K
10:1 PHANTASTRON DIVIDER V3201 6AS6
R3209 15K 1W
C3205 .1
R3213 4.7K
R3212 470
R3232 15K
C3204 100PF
R3210 100K
CATHODE FOLLOWER V3202 6AU6
C3275 1UF
C3209 .01
P3201
W3201
P3202
MATES WITH J3201
TO J3302
TP3202
C3206 .001
C3207 1000PF
R3211 1MEG
27.0 TO 36.0 XTAL FILT. ON 10 POSITION SEL. SW. S3201F AND S3201E. SEE FIG. 7-1 SHEET 1 OF 3
J3205
200V DC
6.3V AC

circuit of this stage is tuned by the primary of T3301 and selected values of capacitance, connected in shunt by S3301D.

b. BALANCED MODULATOR AND AMPLIFIER V3304.

The plate output of V3303 is coupled through T3301 to a balanced modulator circuit consisting of plug-in diode unit CR3302 and associated components. The second input to the balanced modulator circuit is applied from J3303 to the wiper of balanced adjust potentiometer R3330. This signal, the output of the 3100 deck, is a frequency between 30.1 and 40 kc, as selected by S3101 on the 3100 deck and S3201 on the 3200 deck. The balanced modulator produces sum and difference frequencies, but only the sum frequencies are passed. The significant output, then, is a signal between 350.1 and 450 kc. The output frequency, which depends on the setting of S3101, S3201, and S3301, is coupled through T3302 to V3304, the output amplifier. This range of frequencies represents an overall bandwidth of 100 kc. The grid circuit of V3304 is tuned by the secondary of T3302 and selected capacitances inserted by S3301C. The plate circuit of V3304 is tuned by the primary of T3303 and various capacitances inserted by S3301B.

Associated with V3304 is an AGC network similar to that encountered in the 3200 deck. The signal at the plate of V3304 is coupled back to the AGC network through C3323. CR3304 is the delay diode, back biased by voltage divider network R3332 and R3322. CR3303 is the AGC diode and C3319 the AGC capacitor, which is allowed to discharge through R3320 as necessary.

4-6. DETAILED CIRCUIT ANALYSIS OF 3400 DECK. (See figure 4-9.)

a. MULTIVIBRATOR V3401. The 1-mc reference signal from the standard circuit in the 3100 deck (see paragraph 4-3d, this manual) is coupled through 1-mc input jack J3401 to step-up transformer T3401 and 1-mc output jack J3402. The 1-mc signal at J3402 is applied to the 3500-3600 deck. The 1-mc signal at the secondary of T3401 is coupled through diodes CR3401 and CR3402 to the grids of multivibrator V3401. See figure 4-10.

V3401, basically an Eccles-Jordon trigger circuit, is a driven oscillator whose operation and frequency is controlled by the 1-mc trigger input. This trigger input is rectified through CR3401 and CR3402 and the resulting negative pulses are coupled to the grids (pins 2, 7) of V3401. The circuit possesses two conditions of stable equilibrium. One condition is when V3401A is conducting and V3401B is cut off; the other when V3401A is cut off and V3401B is conducting. The sudden reversal of this flip-flop circuit is triggered by the 1-mc negative trigger inputs.

Initially, due to inherent unbalance in the tube, one portion of the tube will conduct while the other is cut off. Therefore, only the conducting tube will produce an output. When the negative trigger acts on the conducting tube, it causes a sudden decrease in plate current and a corresponding rise in plate voltage. This voltage rise is coupled to the tube in cut-off. Therefore, the tube which was conducting is not cut off and the tube in cut-off begins to conduct. This reversing from one state of equilibrium to another results in a 500-kc square wave output.

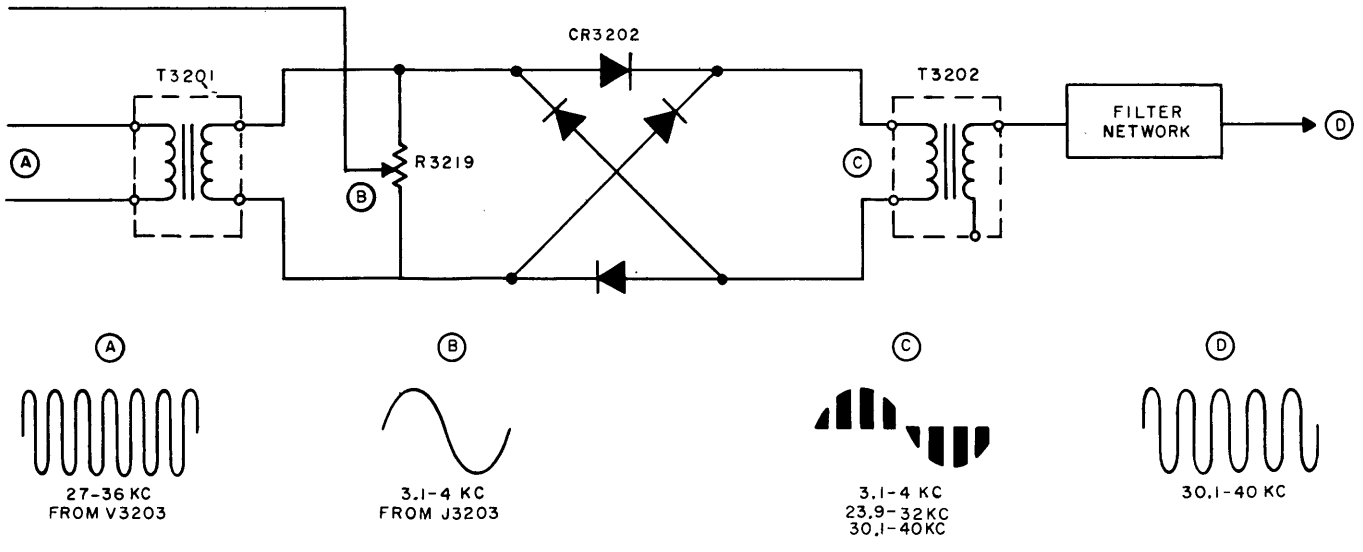


Figure 4-7. Balanced Modulator and Waveforms

b. DIVIDER V3402 AND CATHODE FOLLOWER V3403A. Referring to figure 4-9, the 500-kc square wave output is applied through C3406 through C3408 and CR3403 to 5:1 phantastron divider circuit V3402. The cathode of CR3403 is back-biased by the positive excursions of the squarewave input while the negative excursions trigger the phantastron. Divider adjust control R3411 is set for an output frequency of 100-kc from pin 6 of V3402. This 100-kc signal, differentiated by C3409 and R3418, is applied to cathode follower V3403A. The plate output of V3403A, consisting of positive triggers at 100-kc, is coupled to 100-kc output jack J3403. This 100-kc signal is used in the 3300 deck. The cathode output of V3403A, consisting of positive triggers at 100 kc, is applied to V3403B, a blocking oscillator.

c. BLOCKING OSCILLATOR V3403B AND AMPLIFIER V3404. Blocking oscillator V3403B is a free-running blocking oscillator which can be synchronized by the 100-kc output from amplifier V3403A. The natural frequency of the blocking oscillator is lower than the actual triggered frequency.

As indicated in figure 4-11, V3403B oscillator circuit consists of a triode with transformer T3402 to provide coupling between plate and grid circuits. This transformer develops a positive voltage at the plate of the tube when an increasing current flows in the primary; a negative voltage is developed with a decreasing primary current. The dots at each winding indicate similar polarities. The transformer provides regenerative feedback between the plate and grid circuits, that is, an increase in plate current causes the grid to become more positive. A positive increase in grid voltage further increases the plate current. In this way a cumulative action takes place. Once the current starts increasing, it continues until plate-current saturation is reached.

T3402, with its distributed capacitance across its windings, acts as a resonant circuit. The high voltage developed across the secondary charges up this shunt capacitance. When this voltage decreases, the circuit begins to oscillate. The grid then swings from a positive voltage to a highly negative voltage.

Capacitor C3413 charges up to the positive grid voltage during the positive half-cycle. The charge path is through the low grid-to-cathode resistance of the tube. When the grid voltage swings negative, the full negative voltage is applied to the grid because the charge of the capacitor cannot charge instantaneously. This drives the tube beyond cut-off. Since the negative voltage makes the grid-to-cathode resistance very high, C3413 discharges through R3426.

The tube remains in the cut-off condition for a period of time that depends on the R3426-C3413 time constant. As the capacitor discharges through the resistor, the grid voltage increases until, after a period of time, the cut-off value is reached. At this time the tube starts to conduct. The increase in plate current causes an increase in grid voltage. This starts the cycle over again.

In the paragraphs above, it is assumed that V3403B is completely free-running and not synchronized. However, during normal operation, the blocking oscillator is synchronized to a 100-kc reference signal. As mentioned before, in a free-running blocking oscillator the grid is driven far beyond cut-off by the action of the grid-transformer winding and is maintained at a negative voltage by the charge in C3413. As C3413 discharges, the grid voltage increases until cut-off is reached.

If, however, a positive pulse is applied to the grid circuit before the grid reaches cut-off, and is of sufficient magnitude to drive the grid above cut-off, the tube starts conducting at an earlier time. The output, therefore, can be synchronized to the 100-kc pulse series; the output synchronizes to each sync pulse that changes the tube from a cut-off to a conducting state.

Referring to figure 4-9, the output, consisting of a series of one-microsecond pulses with a time between pulses of ten microseconds, is taken from the cathode of V3403B and applied to one of ten crystals operating between 2.9 and 3.8 mc. The crystals respond to the 29th through 38th harmonics of 100 kc. S3401G and S3401F select the operating frequency which is tunable in 100-kc steps. The output at the wiper of S401F is applied to amplifier V3404. The plate circuit of V3404 is tuned by the primary of T3403 and selected capacitances inserted by S4301E. The output of V3404 is coupled through T3403 to a balanced modulator.

d. BALANCED MODULATOR AND AMPLIFIER V3405. The second input to the balanced modulator circuit arrives at the wiper of balance adjust control R3432 from J3404. The input, a signal between 350.1 and 450 kc, comes from the 3300 deck. The exact frequency depends on the settings of S3101, S3201, and S3301. The balanced modulator produces sum and difference frequencies but only sum frequencies are passed. The signal outputs, then, are signals between 3.2501 and 4.25 mc and are tunable in 100-cycle steps.

The balanced modulator output is applied through the secondary of T3404 to V3405 (see sheet 2), the basic synthesizer output tube. The grid input is tuned by the secondary of T3404 and selected capacitances inserted by S3401D. The plate output is tuned by the primary of T3405 and selected capacitances inserted by S3401C.

Associated with V3405 is an AGC loop similar to those encountered in other decks. The signal at the plate of V3405 is coupled to the loop by C3432. CR3413 is the delay diode, backbiased by voltage divider R3437 and R3438. CR3412 (see sheet 1) is the AGC diode; R3436 and C3428 form a filter storage network. R3435 provides a path for C3428 to discharge. The AGC voltage is applied to the grid of V3405 through T3404. The output from V3405 is applied to the two detector circuits. (d-c correction and audio sync tone).

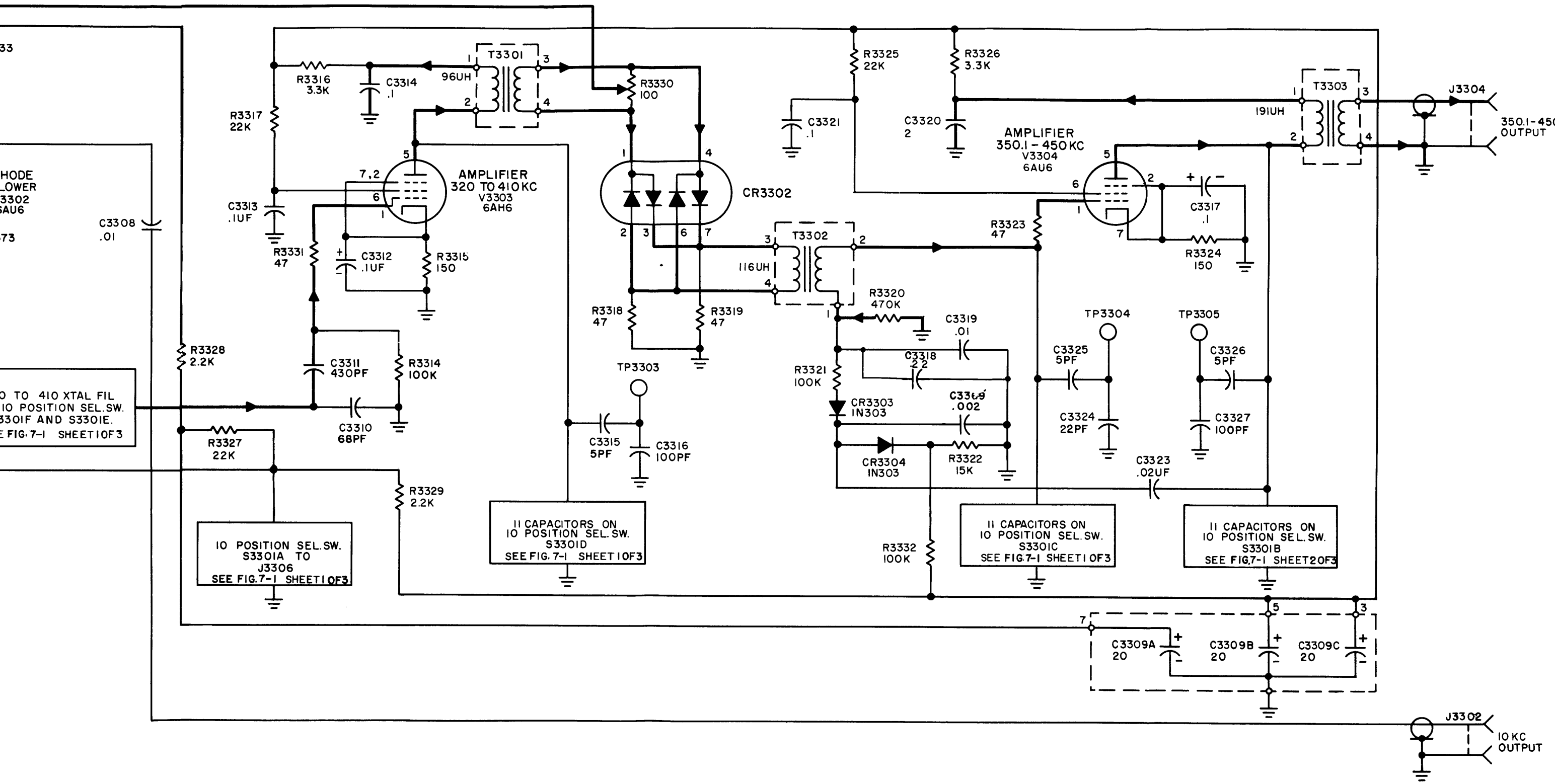
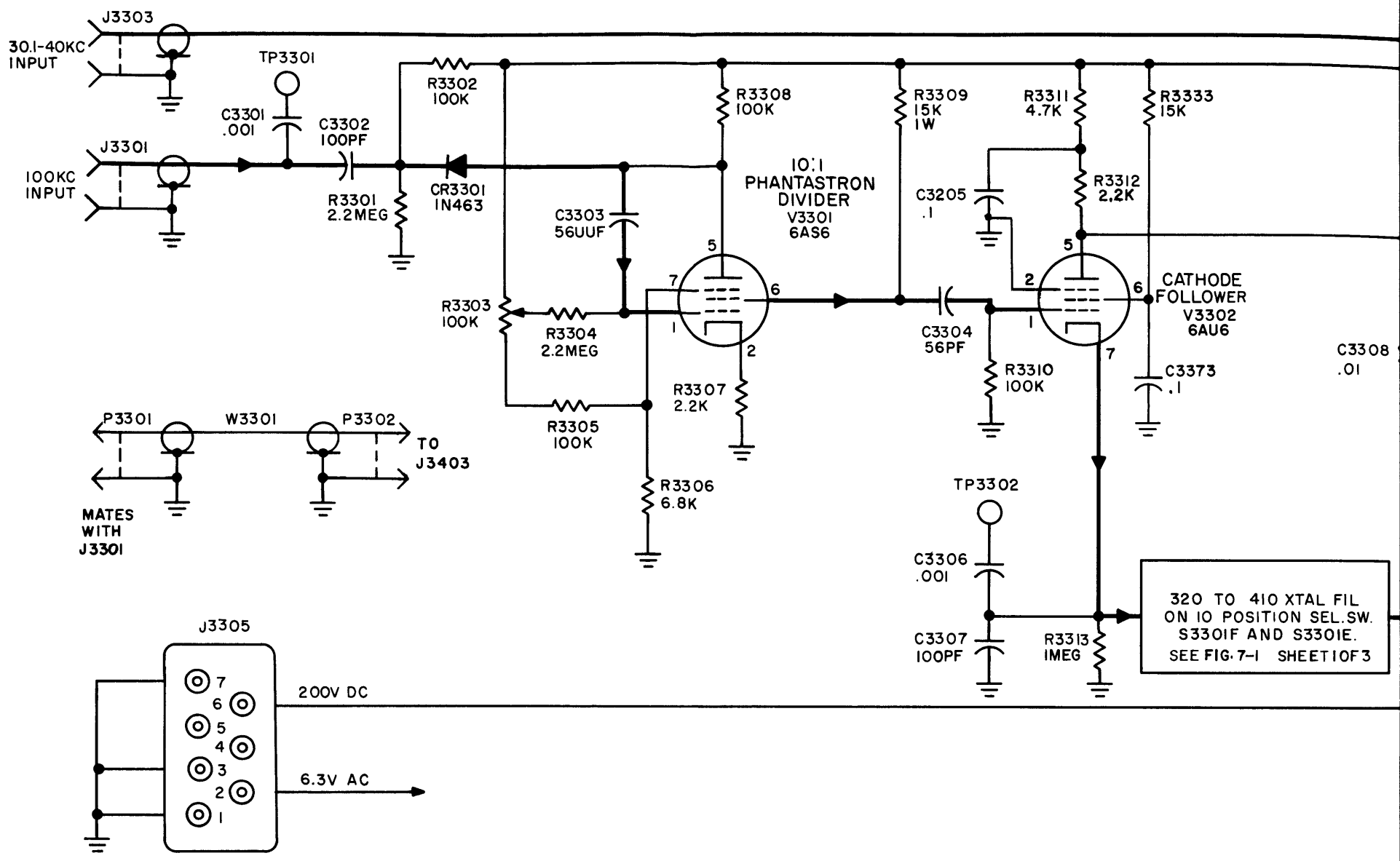


Figure 4-8. 3300 Deck, Schematic Diagram


J3303
30.1-40KC INPUT
J3301
100KC INPUT
TP3301
C3301 .001
C3302 100PF
R3301 2.2MEG
R3302 100K
CR3301 IN463
R3308 100K
R3309 15K 1W
R3311 4.7K
R3333 15K
10:1 PHANTASTRON DIVIDER V3301 6AS6
C3303 56UUF
R3303 100K
R3304 2.2MEG
R3305 100K
R3307 2.2K
R3306 6.8K
C3205 .1
R3312 2.2K
C3304 56PF
R3310 100K
CATHODE FOLLOWER V3302 6AU6
C3373 .1
C3308 .01
P3301
W3301
P3302
TO J3403
MATES WITH J3301
TP3302
C3306 .001
C3307 100PF
R3313 1MEG
320 TO 410 XTAL FIL ON 10 POSITION SEL.SW. S3301F AND S3301E.
SEE FIG. 7-1 SHEET 1 OF 3
J3305
200V DC
6.3V AC

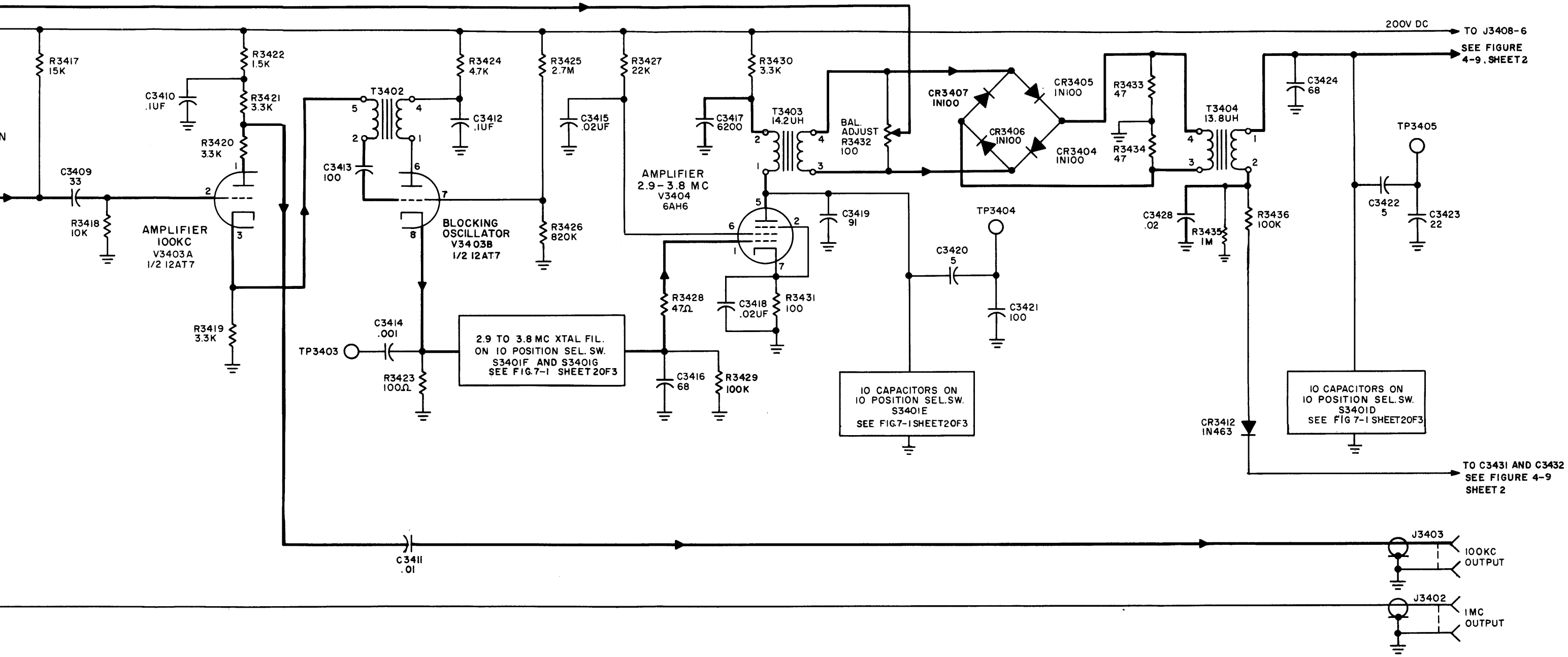
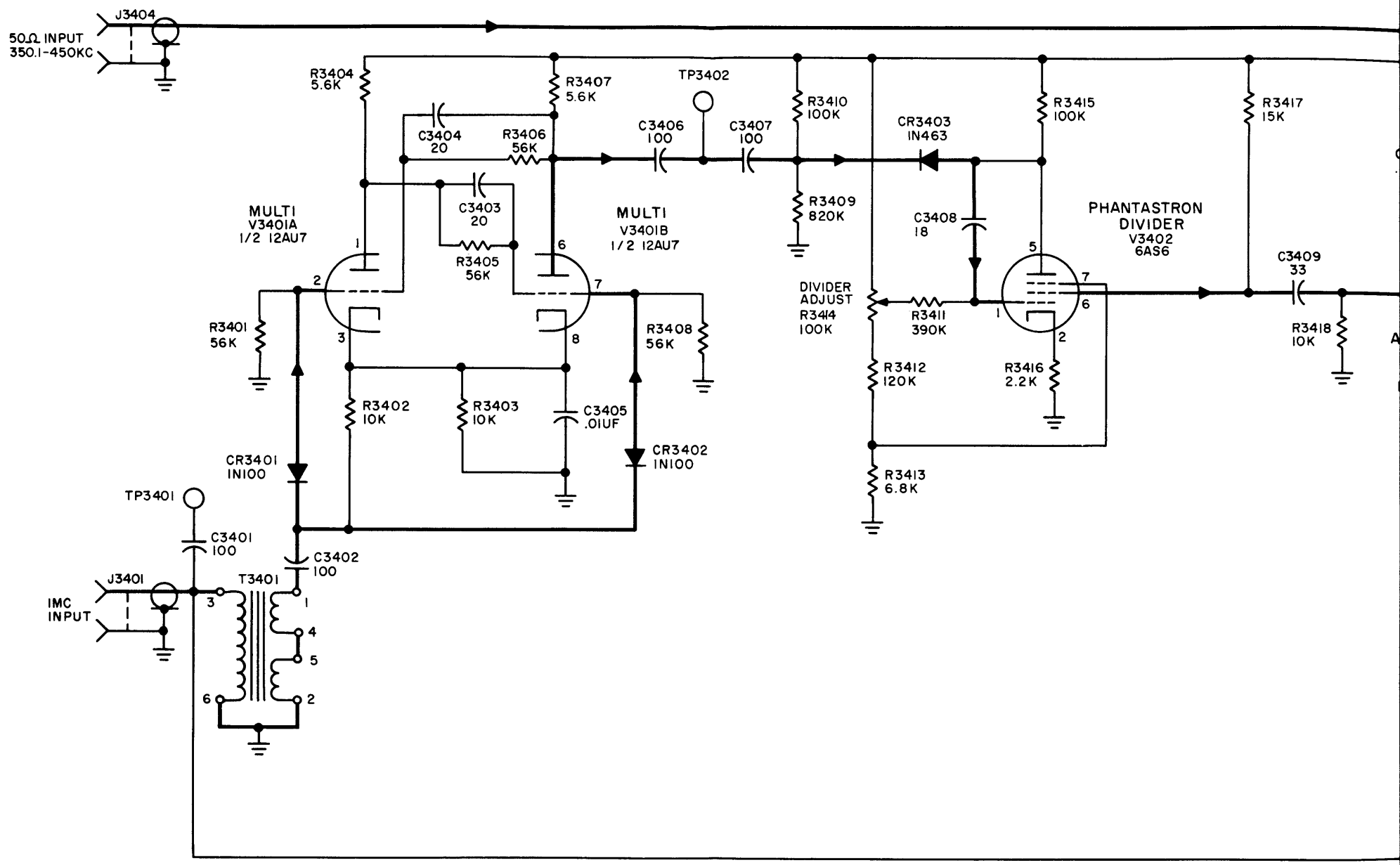


Figure 4-9. 3400 Deck, Schematic Diagram
(Sheet 1 of 2)



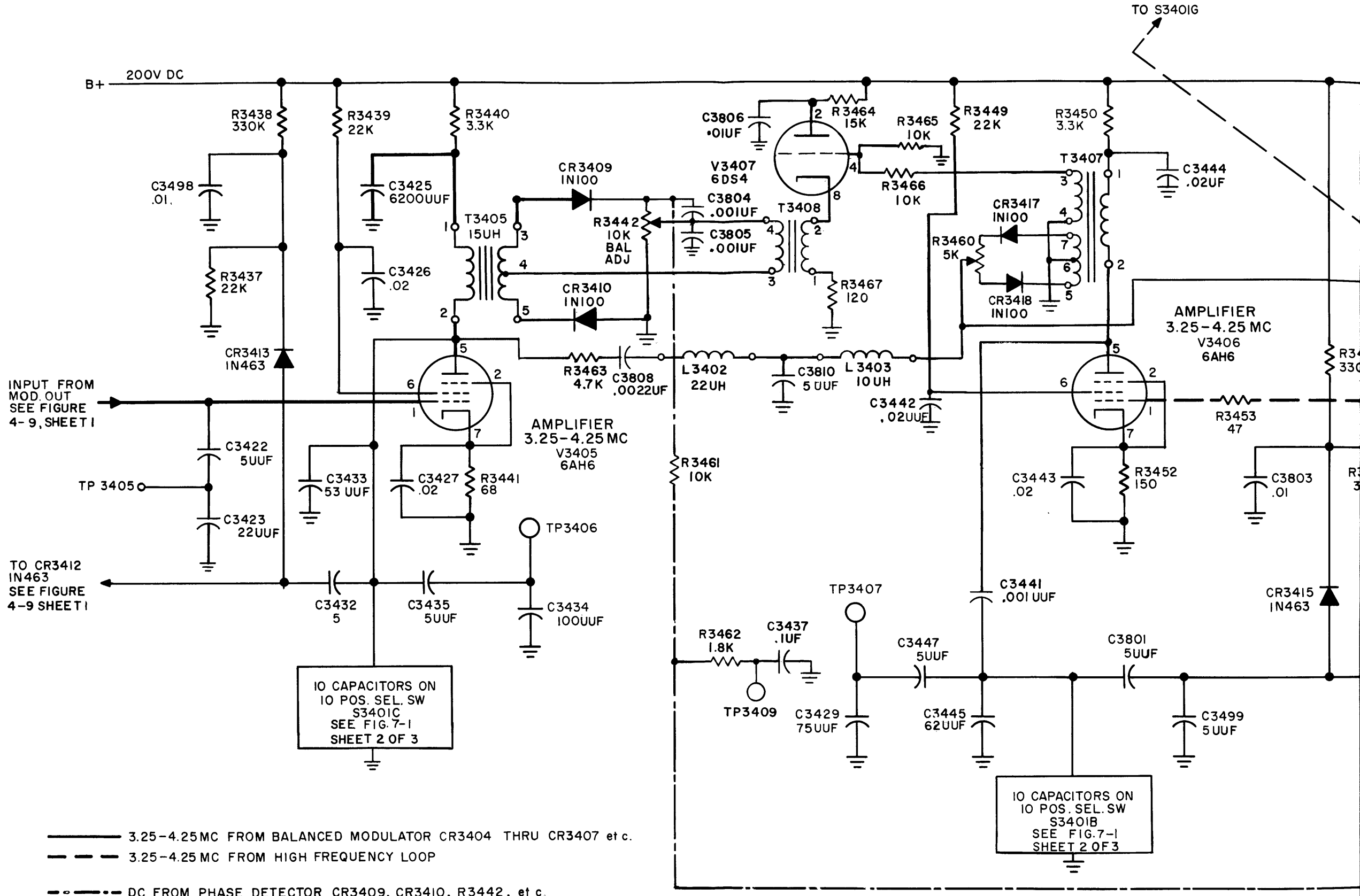
3001L-10

012663001L

M BALANCED MODULATOR CR3404 THRU CR3407 et c.
M HIGH FREQUENCY LOOP

DETECTOR CR3409, CR3410, R3442, et c.

Figure 4-9. 3400 Deck, Schematic Diagram (Sheet 2 of 2)



3001L-11

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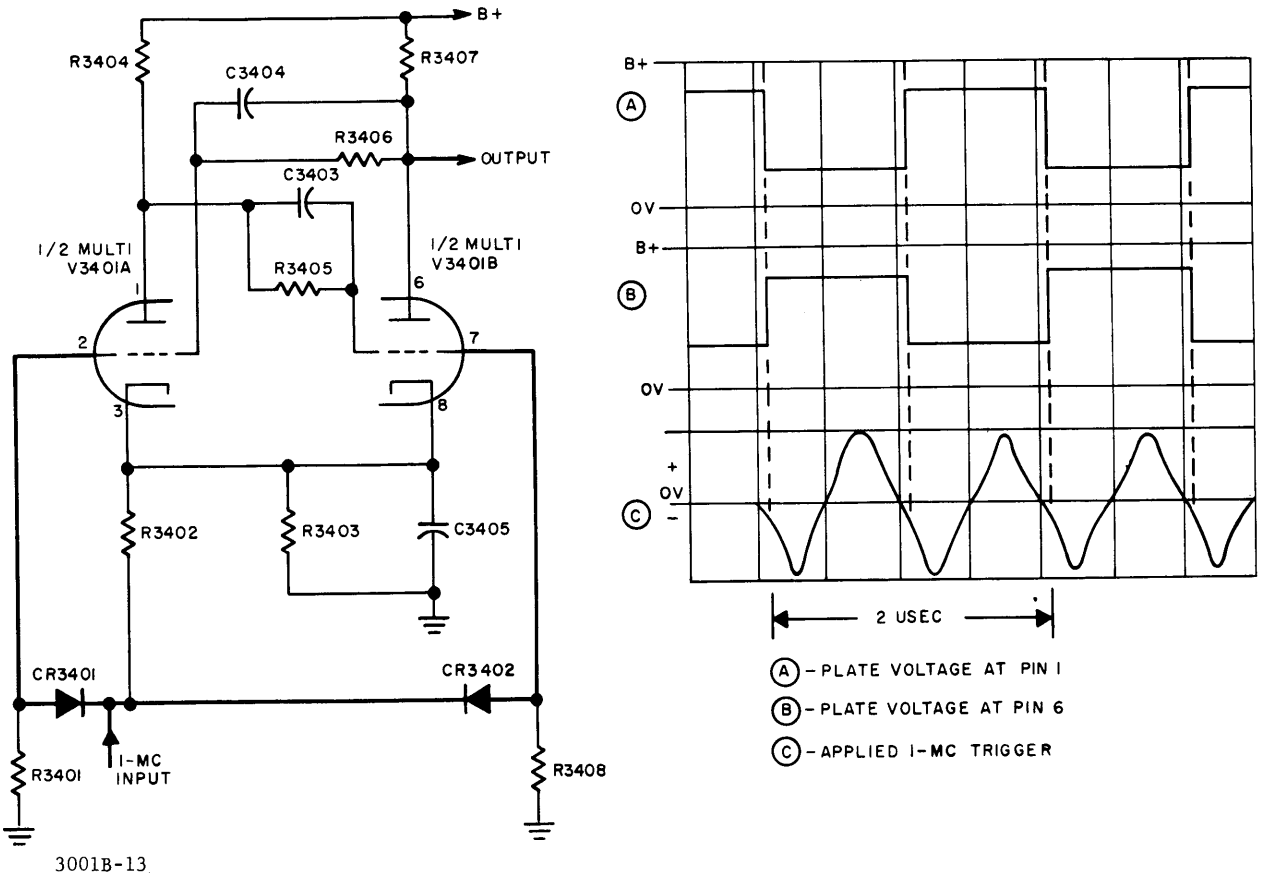


Figure 4-10. Multivibrator Circuit and Waveforms

e. AMPLIFIER V3406, CATHODE FOLLOWER V3407 AND PHASE DETECTORS.

The 3.2501- to 4.25-mc output of the 3500-3600 deck (representing the HFO translated output) is coupled through J3407 and T3406 to the grid of amplifier V3406 to the grid of amplifier V3406. The plate circuit of this amplifier uses the primary of T3405 and trimmer capacitances selected by S3401B. The plate output from V3406 is applied jointly to the d-c correction and audio sync tone detectors.

The d-c correction phase detector is comprised of T3405 secondary coil, CR3409 and CR3410 diodes, C3804 and C3805 capacitors and R3442 potentiometer. The audio sync tone phase detector consists of T3407 secondary coil (terminals 5 to 7) CR3417 and CR3418 diodes and R3460 potentiometer.

The V3405 3.2501-to 4.25-mc input to the d-c correction phase detector, representing the HFS reference frequency input, is across the T3405 secondary coil. The translated (3.2501- to 4.25-mc) HFO input is across the wiper of R3422 and the center tap of T3405 secondary. This signal arrives from the V3406 plate output via a secondary coil (terminals 3 to 4) of T3407, cathode follower V3407, and T3408. The error in the HFO output develops a d-c voltage at the junction of R3442 and C3804; the polarity of the voltage indicating direction (+) of error and the amplitude indicating amount of error. This voltage (for the external HFO circuit) is routed out of the 3100 deck at J3405 jack. The output may be read at TP3409.

The V3405 3.2501- to 4.25-mc input to the audio sync tone detector, representing the reference input, is between the R3460 wiper and ground. It arrives by way of a delay line, comprised of C3809 thru C3810 capacitors and L3402 and L3403 coils. This delay line changes the phase of the reference frequency by 90°. The translated HFO input to this detector appears across a secondary coil (terminals 5 to 7) of T3407. The error in the HFO frequency causes the difference frequency (audio sync tone) to appear at the wiper of R3460. This tone, used for monitoring, is routed out of the 3400 deck at J3406.

4-7. DETAILED CIRCUIT ANALYSIS OF 3500-3600 DECK. (See figure 4-13.)

a. AMPLIFIER V3501B AND HARMONIC GENERATOR V3501A. The 1-mc standard signal from the 3100 deck is coupled from J3501 to amplifier V3501B through C3569, R3506, and parasitic suppressor PS3501. The plate circuit of V3501B is tuned by the primary of T3505. One output from V3501B is coupled to 1-mc output jack J3502; another output is coupled to V3503; and still another output is coupled through C3562 to the grid of second

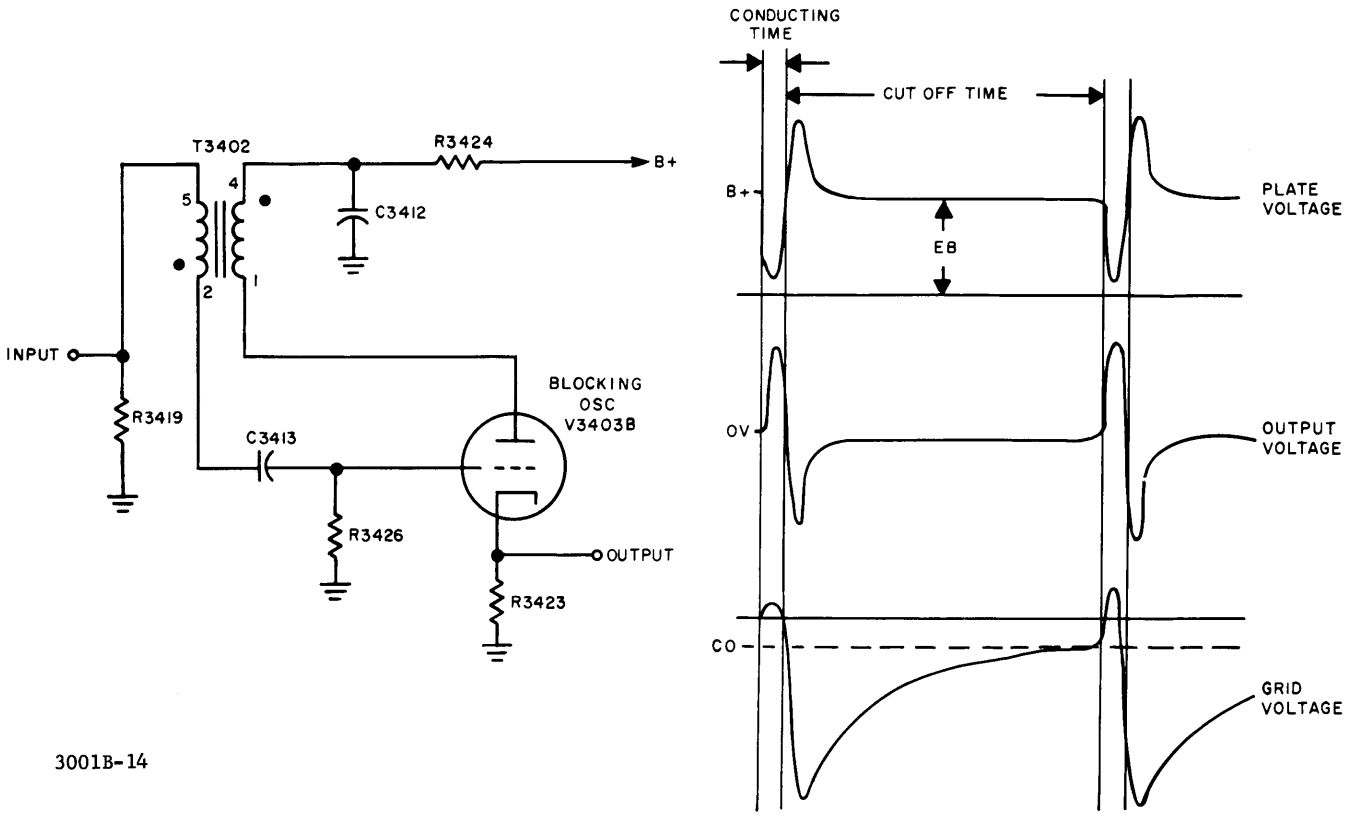


Figure 4-11. Blocking Oscillator and Waveforms

harmonic generator V3501A. T3503, in the plate circuit of V3501A, is tuned to 2 mc. The 2-mc output at the secondary of T3503 is coupled to 2-mc output jack J3505.

b. PULSE GENERATOR V3503. The 1-mc signal coupled to pulse generator V3503 is purposely distorted to produce harmonics of the 1-mc signal since the 8th through 37th harmonics of the 1-mc input is needed. The output from V3503 is applied to low pass filter Z3502 through a differentiator network comprised of C3610 and R3530. The differentiator network has an exceptionally short time constant in comparison with the 1-usec period of the 1-mc signal. The output of the low pass filter is coupled to the cathode circuit of 40.5-mc converter V3506.

c. OSCILLATOR V3502, AMPLIFIER V3504, CONVERTER V3506.

Crystal oscillator V3502 generates frequencies between 48.5 and 77.5 mc. Selector switches S3501D and S3501C select one of 30 crystals operating between 48.5 and 77.5 mc. The output from V3502 is applied to V3505 and V3504. The signal is amplified through V3504 and coupled to the control grid of converter V3506. The 8 to 37-mc signal from V3503 is hetrodyned with the 48.5 to 77.5-mc signal to produce a 40.5-mc output.

Since V3502 is an independent oscillator and not locked to the 1-mc standard, it is subject to drift and, as a result, it is important that any error introduced by this drift be cancelled out. Figure 4-13 illustrates how this error is cancelled out. The f1, in the illustration, is the HFO frequency; f2 is the output of V3502; and f3 is the appropriate harmonic of 1-mc.

d. AMPLIFIERS V3508 AND V3510. Referring to figure 4-12 (sheet 2) the 40.5-mc converter signal is amplified through pentode amplifiers V3508 and V3510. V3508 is tuned by L3528 and C3628 while V3510 is tuned by L3522 and C3635. Parasitic suppressors are incorporated in the grid and plate circuits of these two stages. The output from V3510 is coupled to the control grid of V3511, the final converter stage in the frequency synthesizer.

e. CONVERTER V3505, AMPLIFIER V3507, V3509. A sample of the HFO frequency arrives at J3503. This signal is between 3.75 and 33.75 mc, and is maintained 1.75 mc above the assigned receiver or transmitter frequency. From J3503, this signal is coupled to low pass filter Z3501 which has a cut-off frequency of 34 mc. The output from Z3501 is applied to the cathode circuit of 43.75 to 44.75-mc converter V3505. The HFO input, a signal between 48.5 and 77.5 mc as selected by S3501, is coupled

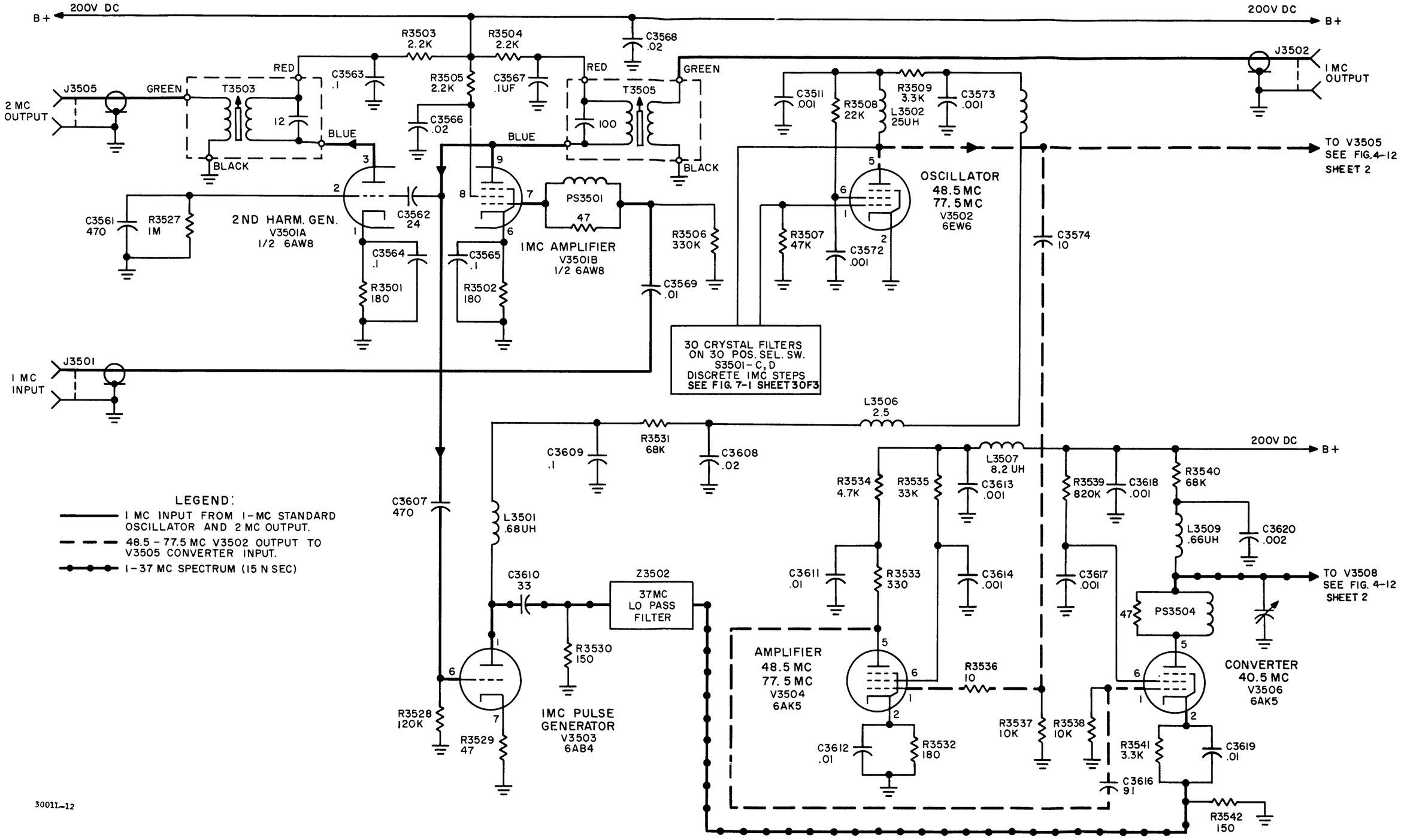


Figure 4-12. 3500-3600 Deck, Schematic Diagram (Sheet 1 of 2)

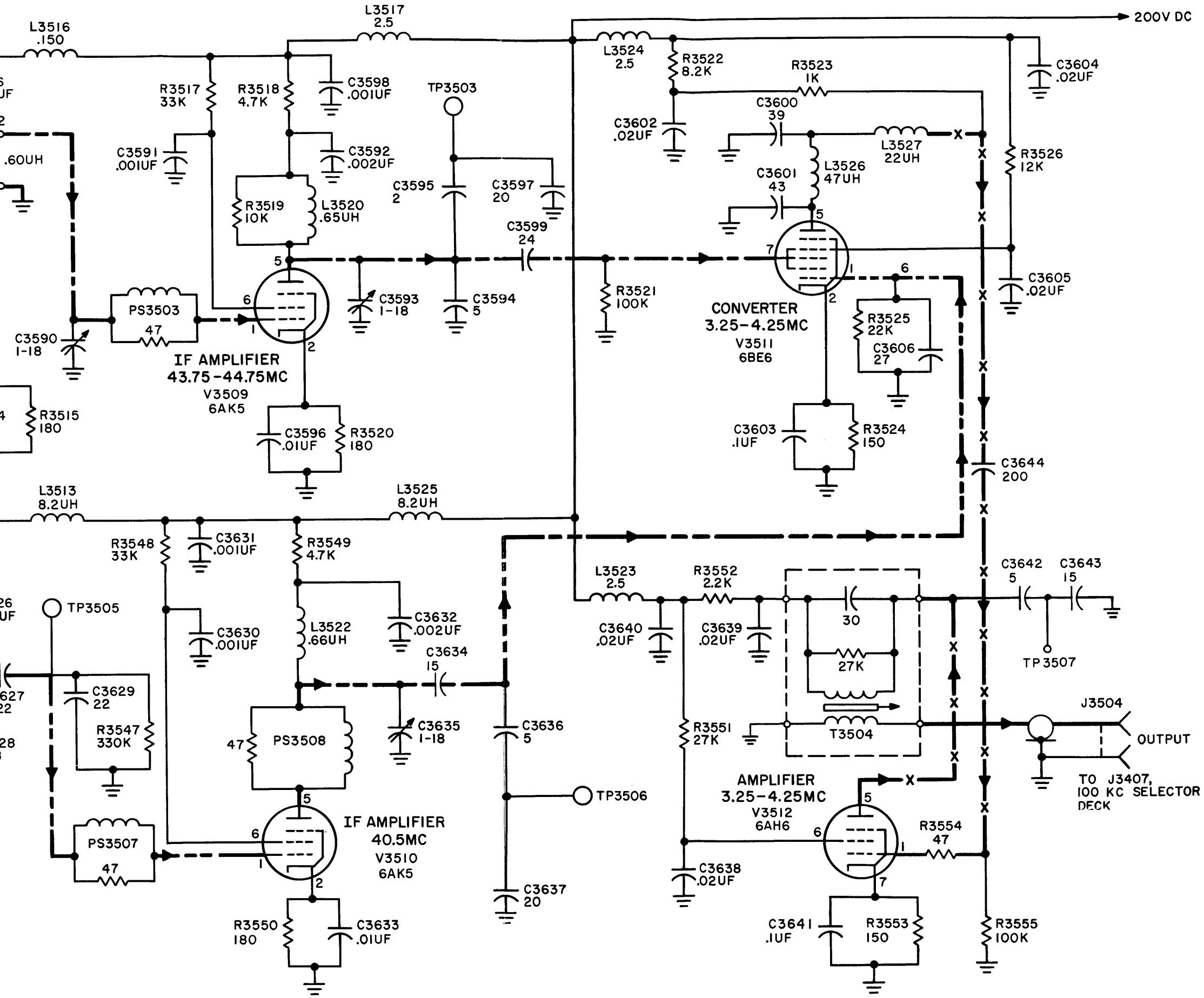
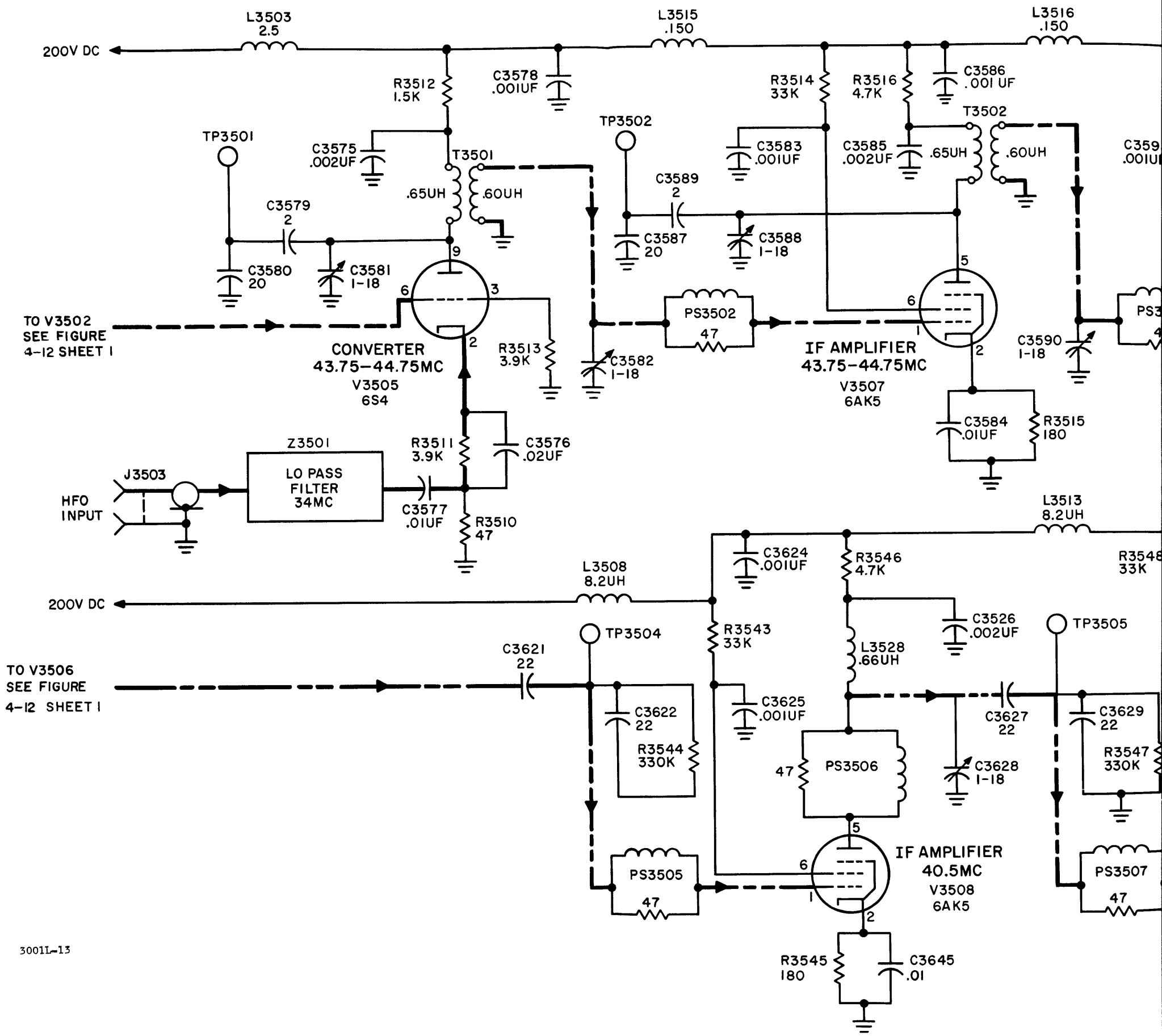


Figure 4-12. 3500-3600 Deck, Schematic Diagram (Sheet 2 of 2)



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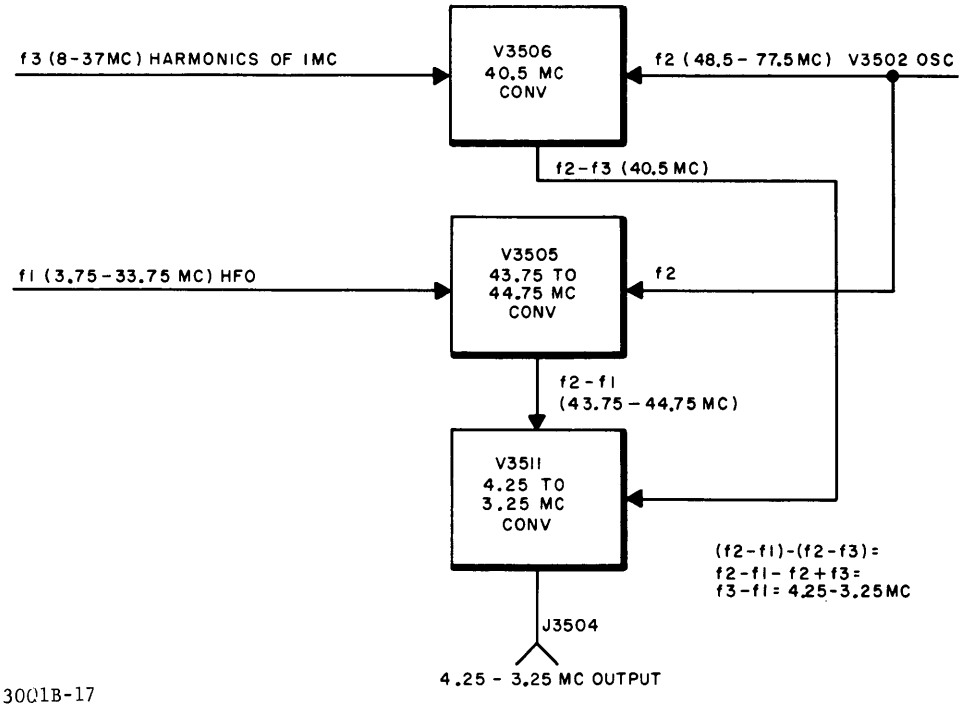


Figure 4-13. Drift Canceling Network

to the cathode of V3505. The plate circuit of V3505, contains a triple-tuned circuit, configured by T3501, C3581, and C3582.

The output of V3505 is applied to cascaded amplifiers V3507 and V3509. The plate circuit of V3507 contains a triple-tuned circuit, configured by T3502, C3588 and C3590. The plate circuit of V3509 contains a resonant tank, configured by L3520 and trimmer C3593. The resonant tank is damped by R3519 to obtain the required bandpass characteristic.

f. CONVERTER V3511 AND AMPLIFIER V3512. The 43.75 to 44.75-mc signal from V3509 is applied to the grid (pin 7) of converter V3511. V3511 also receives the 40.5-mc signal from amplifier V3510. This converter produces a difference frequency between 3.25 and 4.25-mc which is coupled to the grid (pin 1) of amplifier V3512. The 3.25 to 4.25-mc output from V3512 is taken from T3504 and coupled to J3504. The output signal which contains any errors of the HFO circuit, is coupled to the phase detector circuits in the 3400 deck.

4-8. DETAILED CIRCUIT ANALYSIS OF 3700 DECK. (See figure 4-14.)

The 3700 deck is a regenerative divider circuit which generates a 250-kc output from the 1-mc reference input. The 250-kc output is generally used as: (1) a synthesized carrier in the receiver mixer and (2) as a synthesized injection frequency in the alignment generator section of the receiver r-f tuner.

The 1-mc input is coupled through J3701 and voltage step-up transformer T3701 to cathode follower V3701; V3701 acts as a buffer for V3702. The output from V3701 is coupled through C3702 to the control grid (pin 1) of converter V3702.

V3702 operates in conjunction with tripler V3703A. Initially V3703A acts as a noise generator (this is before the tube stabilizes). When power is first applied, plate current flows and the resultant noise at 750 kc is amplified and coupled to the grid (pin 7) of V3702. With a 1-mc signal applied at the control grid of V3702 and a 750-kc noise signal at the screen grid, a mixing action occurs producing a small 250-kc signal at the plate. This small 250-kc signal is applied to the control grids of V3703A and V3703B.

The small component of 250 kc delivered to the grid of V3703A is tripled to produce an increased value of 750-kc signal in the plate circuit. This signal is fed back to a grid of V3702. This cycle continues until the circuit stabilizes and a healthy 750-kc signal is produced at the plate of V3703A. The 250-kc signal is finally amplified in V3703B. The output from V3703B is coupled to 250-kc output jack J3702 which, in turn, connects to output jacks J3015 through J3018.

4-9. MAIN CHASSIS (3000 DECK) DESCRIPTION.

The 3000 deck contains the input and output terminal connections, digital indicators, the 1 MC COMPARATOR front panel meter, the filter panel, and the transistor-operated sync relay (K3001).

Figure 4-15 shows a typical digital selector indicator with its associated circuitry. Six of these type of indicators are found in the HFS. They

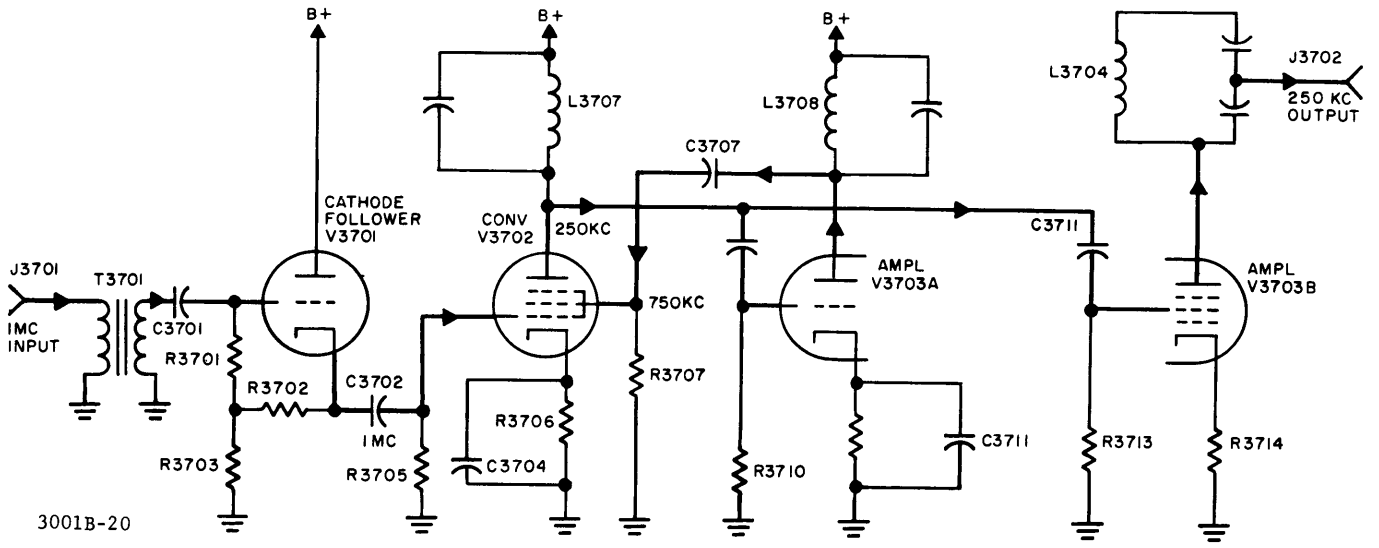
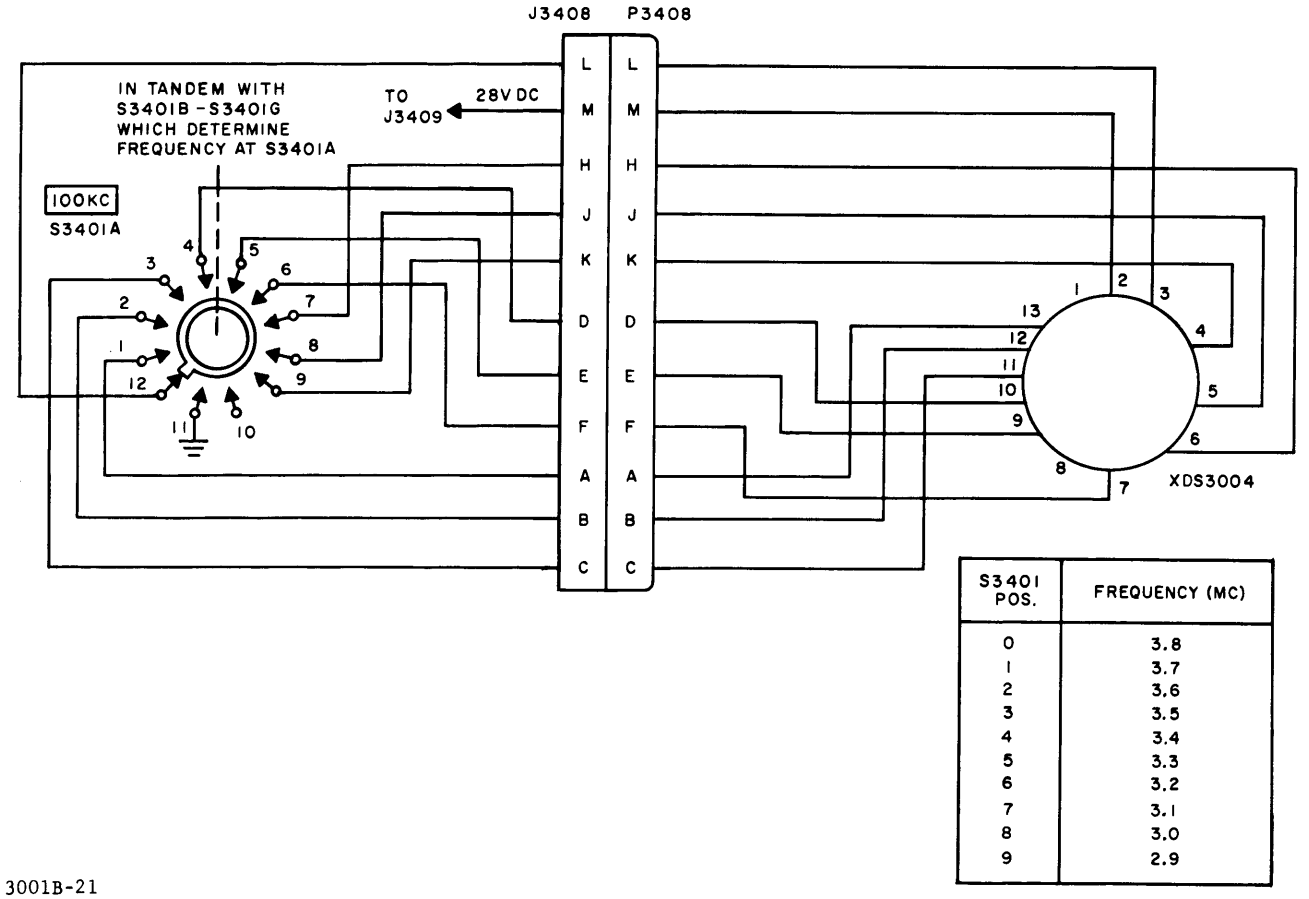


Figure 4-14. 3700 Deck, Regenerative Divider



S3401 POS.	FREQUENCY (MC)
0	3.8
1	3.7
2	3.6
3	3.5
4	3.4
5	3.3
6	3.2
7	3.1
8	3.0
9	2.9

Figure 4-15. Typical Digital Indicator Connection

indicate the frequency to which the receiver or transmitter is tuned, not the synthesizer frequency, and are controlled by the .1 KC, 1 KC, 10 KC, 100 KC, and 1 MC front panel controls. In the 3400 deck, wafers S3401A through S3401G are interconnected into various tuned networks and, by placing S3401 in various positions, various signals corresponding to the desired digit are coupled to the indicator. This signal, in the illustration shown, is coupled through J/P3408 to the appropriate pin on base, XDS3004. Twenty-eight volts dc, coupled through J3409, is used as the operating voltage. In the 3100 deck, switch wafers S3101A through S3101D are interconnected into various tuned networks in V3102 through V3104. In the 3200 deck, switch wafers S3201A through S3201E are connected to tuned circuits in the balanced modulator and in V3202 and V3204. In the 3300 deck, switch wafers S3301A through S3301F are connected to tuned circuits in V3302 through V3304 and the balanced modulator. In the 3500 deck, switch wafers S3501A through S3501D are connected into various tuned circuits.

The 1 MC COMPARATOR meter (M3001) is coupled to the phase comparator circuit in the 3100 deck through J3106. The phase difference between the two 1-mc signals is indicated by the rate of swing at the meter. Sync balance control R3140 is used as a meter zero adjust.

Transistor Q3002 and relay K3001 form an extra sync indication output signal for associated equipment in the receiver or transmitter. When the operator has adjusted the HFO into the sync "capture range", a positive ripple voltage, generated by the CR3417/CR3418 phase detector, appears at C3440. This voltage, at the base of Q3002 transistor, causes Q3002 to conduct and a current passes through K3001 coil energizing the relay. With K3001 de-energized (in non-sync position), the center conductor of coaxial jack J3039 and pin N of J3001 are grounded; with K3001 energized, both J3039 and pin N are disconnected from ground and pin J of J3001 is grounded.

SECTION 5
MAINTENANCE

5-1. PREVENTIVE MAINTENANCE.

a. In order to prevent equipment failure due to dust, dirt and other destructive elements, it is suggested that a schedule of preventive maintenance be set up and adhered to.

b. At periodic intervals, the equipment should be removed from its mounting for cleaning and inspection. All accessible covers should be removed and the wiring and all components inspected for dirt, corrosion, charring, discoloring or grease. Remove dust with a soft brush or vacuum cleaner. Remove dirt or grease from other parts with any suitable cleaning solvent. Use of carbon tetrachloride should be avoided due to its highly toxic effects. Trichlorethylene or methylchloroform may be used, providing the necessary precautions are observed.

WARNING

When using toxic solvents, make certain that adequate ventilation exists. Avoid prolonged or repeated breathing of the vapor. Avoid prolonged or repeated contact with skin. Flammable solvents shall not be used on energized equipment or near any equipment from which a spark may be received. Smoking, "hot work," etc. is prohibited in the immediate area.

CAUTION

When using trichlorethylene, avoid contact with painted surfaces, due to its paint removing effects.

5-2. TROUBLESHOOTING

a. INTRODUCTION. Generally it is advisable, when troubleshooting the HFS, to first determine the functional section (or deck) at fault before attempting to identify the particular faulty component within the functional section. Contained in this section is (1) table 5-2, Unit Troubleshooting Chart, for a preliminary check of the HFS to determine which functional section is at fault, (2) table 5-3, Functional Section Troubleshooting Chart, (3) table 5-5, Voltage and Resistance Chart and (4) table 5-6, Visual Inspection Procedure.

b. OVERALL TROUBLESHOOTING. Have available test equipment as listed in table 5-1. Connect the HFS into the receiver or transmitter system normally. Proceed to perform steps as indicated in table 5-2 and steps in table 5-3 as indicated in table 5-2, at intervals. If not using the 1-mc, 2-mc and/or 250-kc outputs in the particular system, install the dummy loads, described in table 5-4, to the unused output jacks as follows:

Output	Jack	Dummy Load
1mc	J3019	47-ohm
2mc	J3012	27-ohm
250kc	J3016	56-ohm

Remove any connection at J3014, AUDIO SYNC TONE jack.

TABLE 5-1. TROUBLESHOOTING TEST EQUIPMENT

NAME	MODEL
Oscilloscope	Tektronics Type 545A or equivalent
RF VTVM	Ballantine 314 or equivalent

c. FUNCTIONAL SECTION TROUBLESHOOTING. Table 5-3 outlines a systematic approach to troubleshooting the various functional sections of the HFS. Before proceeding, make sure that all power and signal connections are made, as described in paragraph 5-2b. Note that all oscilloscope readings in table are given in peak-to-peak voltages unless otherwise specified. Refer to figures 5-1 and 5-2 which show test points and component locations.

d. VOLTAGE AND RESISTANCE MEASUREMENTS. Table 5-4 lists test equipment required for verifying voltage and resistance measurements listed in table 5-5.

Table 5-5 lists each vacuum tube in the HFS and the voltage and resistance from each pin of the tube to ground. Refer to table 5-4 and the following procedure to verify required values.

(1) Remove top dust cover from HFS, and set 1 MC EXT/INT switch (located inside, on right side of chassis deck) at EXT.

(2) Connect 47-ohm dummy load to J3019 on rear of HFS chassis.

(3) Connect 27-ohm dummy load to J3012 on rear of HFS chassis.

(4) Connect 56-ohm dummy load to J3016 on rear of HFS chassis.

(5) Connect power cable from power supply to J3001 on rear of HFS chassis.

(6) Remove tube from socket at which voltage or resistance is to be measured.

TABLE 5-2. UNIT TROUBLESHOOTING CHART

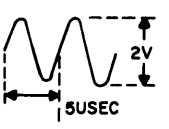
STEP	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	Apply system power to HFS.	Tubes should light and B+ should be applied to the various stages within the HFS. Check B+ line to ground with ohmmeter - reading should be infinite.	If indication is abnormal, check power input connection and fuses. If indications are normal, proceed to step 2.
2	Tune system to any desired frequency between 2 and 32 mc. Tune system in 100 cps increments between 000 and 900 cycles, turning .1 KC switch to selected frequency. Determine sync at each frequency. (.1 KC switch should be rotated between "0" and "9.")	Intelligence is readily discernable at each frequency. System should remain in sync.	If indication is abnormal, see step 1 in table 5-3. If indication is abnormal, proceed to step 3.
3	Repeat procedure in step 2, tuning system in 1-kc increments between 0 and 9000 cycles, and turning 1 KC switch to selected frequency. Determine sync at each frequency. (1 KC switch should be rotated between "0" and "9.")	Same as "normal indication" in step 2.	If indication is abnormal, see step 6 in table 5-3. If indication is normal, proceed to step 4.
4	Repeat procedure in step 2, tuning system in 100-kc increments between 0 and 900-kc. and turning 100 KC switch to selected frequency. Determine sync at each frequency. (100 KC switch should be rotated between "0" and "9.")	Same as "normal indication" in step 2.	If indication is abnormal, see step 16 in table 5-3. If indication is normal, proceed to step 5.
5	Connect oscilloscope alternately to 2-mc output jacks J3010 through J3013 and note signals.		If indication is abnormal, perform step 27 (only) in table 5-3. If indication is normal, proceed to step 6.
6	Repeat procedure in step 2, tuning system in 1-mc steps between 2 and 32-mc and turning 1 MC switch to selected	Same as "normal indication" in step 2.	If indication is abnormal, see step 28 in table 5-3. If indication is normal, proceed to step 7.

TABLE 5-2. UNIT TROUBLESHOOTING CHART (CONT'D)

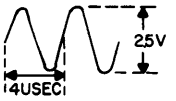
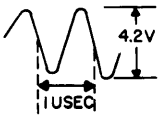
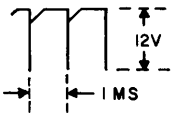
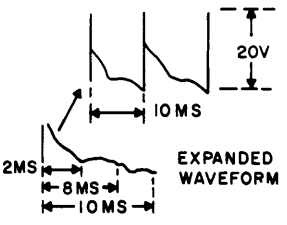
STEP	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
6 (cont.)	frequency. Determine sync at each frequency.		
7	Connect an oscilloscope alternately to 250-kc output jacks J3015 through J3018 and note signals.		If indication is abnormal, see step 36 in table 5-3.

TABLE 5-3. FUNCTIONAL SECTION TROUBLESHOOTING CHART

STEP	POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	①	Connect oscilloscope at J3103*.		If indication is normal, proceed to step 3. If indication is abnormal, proceed to step 2.
2	A1	Connect oscilloscope to terminal 6 on Z3101 and adjust scope for .5 usec/cm.		If indication is normal, check V3105, T3102, and associated circuitry. If indication is abnormal, check Z3101.
3	②	Connect oscilloscope to TP3103 and adjust scope for 50 usec/cm. Place .1 KC switch at "0."		If indication is normal, proceed to step 6. If indication is abnormal, see step 4.
4	B1	Connect oscilloscope to TP3101 and adjust scope for .5 ms/cm.		If indication is normal, proceed to step 5. If indication is abnormal, any of the other decks may be at fault.
5	B2	Connect oscilloscope to TP3102 and adjust scope for 2 ms/cm.		If indication is normal, check V3103, V3104 and associated circuitry. If indication is abnormal, readjust R3103. If indication is still abnormal, check V3101 and V3102 and associated circuitry.

*With 47-ohm dummy load as described in table 5-4.

TABLE 5-3. FUNCTIONAL SECTION TROUBLESHOOTING CHART (CONT'D)

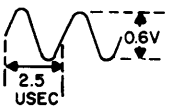
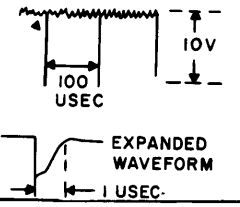
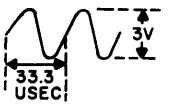
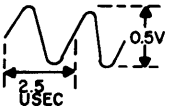
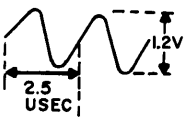
STEP	POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
6	③	Connect oscilloscope to TP3205 and adjust scope for 5 usec/cm. .1 KC switch in 0 position and 1 KC switch in 0 position. (This is equivalent to 40 kc.)		If indication is normal, proceed to step 11 below. If indication is abnormal, check V3204, T3203 and J3204. If indication is still abnormal, proceed to step 7.
7	C1	Connect oscilloscope to TP3201 and adjust scope for 20 us/cm.		If indication is normal, proceed to step 8. If indication is abnormal, one of the other decks, J3201, or cabling is at fault.
8	C2	Connect oscilloscope to TP3202 and adjust scope for .2 ms/cm.		If indication is normal, proceed to step 9. If abnormal indication exists, adjust T3203. If indication is still abnormal, check V3201, V3202, CR3201, and associated tuned circuits.
9	C3	Connect oscilloscope to TP3203 and adjust scope for 5 usec/cm. Place 1 KC switch in "7" position. This corresponds to a frequency of 30 kc.		If indication is normal, proceed to step 10. If indication is abnormal, check V3203, T3201, and associated tuned circuits.
10	C4	Connect oscilloscope to TP3204 and adjust scope for 5 usec/cm. Set .1 KC selector to "0" and 1 KC selector to "0." This corresponds to a frequency of 40 kc.		If indication is normal, check V3204. If indication is abnormal, first check to ensure that a 3.1 to 4-kc signal exists at R3219. Then check CR3202, T3202 and associated tuned circuits.
11	④	Connect oscilloscope at TP3305 and adjust scope for 1 usec/cm. Place .1 KC in "0" position, 1 KC in "0" and 10 KC in "5." This corresponds to a frequency of 400 kc.		If indication is normal, proceed to step 16. If indication is abnormal, check V3304, T3303, J3304 and associated circuitry. If indication is still abnormal, proceed to step 12.

TABLE 5-3. FUNCTIONAL SECTION TROUBLESHOOTING CHART (CONT'D)

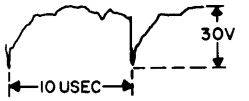
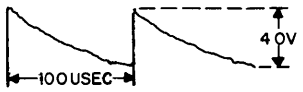
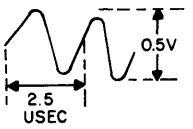
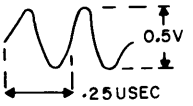
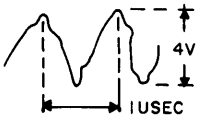
STEP	POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
12	D1	Connect oscilloscope at TP3301 and adjust scope for 2 usec/cm.		If indication is normal, proceed to step 13. If indication is abnormal, check J3301, cabling, and other decks.
13	D2	Connect oscilloscope at TP3302 and adjust scope for 20 usec/cm.		If indication is normal, proceed to step 14. If abnormal indication exists, readjust divider adjust control R3303. If indication is abnormal, check V3301, V3302, CR3301, and associated circuitry.
14	D3	Connect oscilloscope to TP3303 and adjust scope for 1 usec/cm. Place 10 KC selector in "1" position. This corresponds to 400-kc.		If indication is normal, proceed to step 15. If indication is abnormal, check V3303 and associated tuned circuits.
15	D4	Connect oscilloscope to TP3304. Place .1 KC selector in "0", 1 KC selector in "0", and 10 KC selector in "5." This corresponds to 400 kc.		If indication is normal, check V3304. If indication is abnormal, first check to see that a 30.1 to 40-kc signal is coupled across R3330. Then check T3301, CR3302, and associated balanced modulator circuitry.
16	5	Connect oscilloscope to TP3408 and adjust scope for .1 usec/cm. Set switches to 02.2600 mc.		If indication is normal, proceed to step 17. If indication is abnormal, proceed to step 27.
17	E1	Connect oscilloscope to TP3401 and adjust scope for .5 usec/cm.		If indication is normal, proceed to step 18. If indication is abnormal, check cabling, J3401, and 1-mc source in 3100 deck.
18	E2	Connect oscilloscope to TP3402.		If indication is normal, proceed to step 19. If indication is abnormal, check V3401, T3401, CR3401, CR3402, and associated circuitry.

TABLE 5-3. FUNCTIONAL SECTION TROUBLESHOOTING CHART (CONT'D)

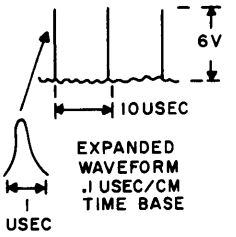
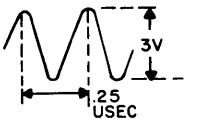
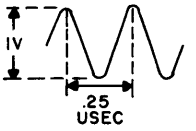
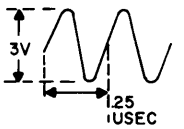
STEP	POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
19	E3	Connect oscilloscope to TP3403 and adjust scope to 2 usec/cm.		If indication is normal, proceed to step 20. If indication is abnormal, adjust divider adjust control R3411. If indication is still abnormal, check CR3403, V3402, V3403 and associated tuned circuits.
20	E4	Connect oscilloscope to TP3404 and adjust scope to 0.1 usec/cm. Set 100 kc selector at position "8." This corresponds to 3 mc.		If indication is normal, proceed to step 21. If indication is abnormal, check V3404 and associated circuitry.
21	E5	Connect oscilloscope to TP3405. Place .1 KC in "0," 1 KC in "0," 10 KC in "5," and 100 KC in "2." This corresponds to a frequency of 4 mc.		If indication is normal, proceed to step 22. If indication is abnormal, first check to ensure that a 350.1 to 450-kc signal exists on R3432. If indication is still abnormal, check R3432, CR3404 through CR3407, T3404, R3433, R3434 and associated tuned circuits.
22	E6	Connect oscilloscope to TP3406.		If indication is normal, proceed to step 23. If indication is abnormal, check CR3412, C3431, CR3413, C3432, C3435, and C3434.
23	E7	Connect oscilloscope to TP3408. Set selectors for 02.2500 mc. Tune system to 2.25 mc, system in sync.		If indication is normal, proceed to step 24. If indication is abnormal, check T3406.
24	E8	Connect oscilloscope to TP3407.		If indication is normal, proceed to step 25. If indication is abnormal, check V3406, V3407 and associated tuned circuits.

TABLE 5-3. FUNCTIONAL SECTION TROUBLESHOOTING CHART (CONT'D)

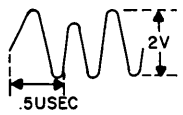
STEP	POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
25	(E9)	Connect oscilloscope to d-c output jack J3008. Set HFS switches to 02.2500 mc. Observing K3001 relay, move tuning control slowly and slightly in both directions and back to sync.	Points at which K3001 de-energizes: + ——— 2.5V – – – – – 0V – ——— 2.5V The reference should shift before system drops out of sync.	If indication is normal, proceed to step 26. If indication is abnormal, check associated cabling.
26	(E10)	Connect monitor headset to J3014 AUDIO SYNC TONE jack. Move tuning control slowly out of sync.	Audio tone should appear and increase up the scale as control is moved out of sync.	If indication is normal, proceed to step 27. If indication is abnormal, check T3405, CR3409, CR3410, R3442, C3804 and C3805.
27	⑥	Connect oscilloscope to 2-mc output jacks J3010 through J3013. Adjust scope for .1 usec/cm.	 Signal should have unequal peaks on upper trace and nearly equal lower peaks. Adjust T3503 for proper indication if necessary.	If indication is normal, proceed to step 28. If indication is abnormal, first check J3019 to see if a 5 volt peak-to-peak, 1-mc source exists there. If indication is still abnormal, check T3505, V3501, T3503, J3505, P3008.
28	⑦	Connect VTVM at TP3507 and measure r-f voltage. Set synthesizer to 2.25 mc.	VTVM indicates 0.707 volts rms.	If indication is normal, proceed to step 36. If indication is abnormal, proceed to step 29.
29	(F1)	Connect VTVM at TP3501 and measure signal.	VTVM indicates 0.14 volts rms.	If indication is normal, proceed to step 32. If indication is abnormal, check V3505. If still abnormal, proceed to step 30.
30	(F2)	Connect VTVM to HFO jack J3009 and measure voltage.	VTVM indicates 20 to 50 mv (rms)	If indication is normal, proceed to step 31.

TABLE 5-3. FUNCTIONAL SECTION TROUBLESHOOTING CHART (CONT'D)

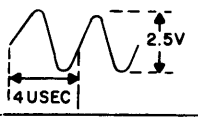
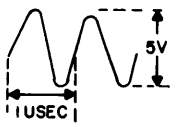
STEP	POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
31	(F3)	Connect VTVM to TP3504 and measure voltage.	VTVM indicates 0.1 volt rms.	If indication is normal, proceed to step 32. If indication is abnormal, check V3503, Z3502, V3506, V3504, V3502, and associated tuned circuits.
32	(F4)	Connect VTVM to TP3502 and measure voltage.	VTVM indicates 0.1 volts rms.	If indication is normal, proceed to step 33. If indication is abnormal, check V3507, T3502, and associated circuitry.
33	(F5)	Connect VTVM to TP3503 and measure voltage.	VTVM indicates 0.1 volts rms.	If indication is normal, proceed to step 34. If indication is abnormal, check V3509 and associated circuitry.
34	(F6)	Connect VTVM to TP3505.	VTVM indicates 0.17 volts rms.	If indication is normal, proceed to step 35. If indication is abnormal, check V3508 and associated circuitry.
35	(F7)	Connect VTVM to TP3506.	VTVM indicates 0.27 volts rms.	If indication is normal, check V3511 and V3512 and their associated circuitries. If indication is abnormal, check V3510 and its associated circuitry.
36	(8)	Connect oscilloscope to 250-kc output jacks J3015 through J3018 and determine signal at each jack.		If indication is abnormal, proceed to step 37.
37	(G1)	Connect oscilloscope to P3020 and adjust scope for .5 usec/cm.		If indication is normal, proceed to step 38. If indication is abnormal, check 1-mc source in 3100 deck and cabling.
38	(G2)	Connect VTVM to TP3701 and measure voltage.	VTVM indicates 20 volts rms.	If indication is normal, proceed to step 39. If indication is abnormal, check J3701, T3701, C3701, R3701, R3703.
39	(G3)	Connect VTVM to TP3702 and measure voltage.	VTVM indicates 0.74 volts rms.	If indication is normal, yet no output at any of jacks (J3015-J3018), check J3702, P3021, and cabling. If indication is abnormal, check V3701, V3702, V3703, and associated circuitry.

TABLE 5-4. VOLTAGE AND RESISTANCE TEST EQUIPMENT

QUANTITY REQUIRED	EQUIPMENT	TYPE
2	Signal generator	Must provide 1 mc. at 1.5 vrms and 3.75 mc. at 20 mv. rms.
1	Power Supply	Must provide regulated +200 vdc at 0.5a., 6.3 vac at 15a., 60 cps and +28 vdc at 1a.
1	Simpson Model 260	Volt-ohm-milliameter, 20,000 ohms-per-volt.
1	Dummy load	47 ohm, 1/2 watt resistor, mounted on RG-174/U cable. Cable equipped with TMC-PL-204 plug or equivalent.
1	Dummy load	56 ohm, 1/2 watt resistor, mounted on RG-174/U cable. Cable equipped with TMC-PL-204 plug or equivalent.
1	Dummy load	27 ohm, 1/2 watt resistor, mounted on RG-174/U cable. Cable equipped with TMC-PL-204 plug or equivalent.
1	Test socket adapter	7-pin miniature.
1	Test socket adapter	9-pin miniature.
1	Power cable	Must provide: (1). +200 vdc from power supply to pin K of J3001 on HFS. (2). 6.3 vac from power supply to pin A, pin B, pin E and pin R of J3001 on HFS. (3). +28 vdc from power supply to pin C of J3001 on HFS. (4). Common ground connection between power supply and HFS at pin D, pin F, pin H and pin P of J3001 on HFS.

TABLE 5-5. VOLTAGE AND RESISTANCE CHART

SYM. NO.		PIN NUMBER								
		1	2	3	4	5	6	7	8	9
V3101	V	+1.2	+6	7.0AC	0	+110	+200	+5.6		
	R	3 MEG	2.2K	0	0	65K	26K	7.5K		
V3102	V	+200	NC	7.0AC	0	NC	0	+6.7		
	R	26K	NC	0	0	NC	100K	1 MEG		
V3103	V	0	+0.7	7.0AC	0	+125	+85	+0.7		
	R	110K	150	0	0	10K	25K	+150		
V3104	V	-1	+0.5	7.6AC	0	+125	+100	+0.5		
	R	130K	150	0	0	10K	30K	150		
V3105	V	+1.0	-1.5	+125	0	7.0AC	+1.1	-0.3	+90	+125
	R	500	50K	17K	0	0	150	50K	32K	8K
V3201	V	+3.5	+6.5	7.2AC	0	+115	+165	+6.0		
	R	1.8 MEG	2.2K	0	0	64K	22K	7.5K		

TABLE 5-5. VOLTAGE AND RESISTANCE CHART (CONT'D)

SYM. NO.		PIN NUMBER								
		1	2	3	4	5	6	7	8	9
V3202	V	0	NC	6.3AC	0	0	+200	+30		
	R	100K	NC	0	0	11K	20K	1 MEG		
V3203	V	-0.1	+0.6	7.0AC	0	+145	+120	+0.6		
	R	110K	50	0	0	15K	26K	50		
V3204	V	-5	+0.1	7.0AC	0	+175	+175	+0.1		
	R	23K	150	0	0	10K	30K	150		
V3301	V	+3.6	+7	7.0AC	0	+110	+165	+5.5		
	R	1.8 MEG	2.2K	0	0	62K	20K	7K		
V3302	V	0	0	7.0AC	0	+200	+190	+50		
	R	100K	0	0	0	15K	20K	1 MEG		
V3303	V	0	+1.4	7.1AC	0	+150	+130	+1.4		
	R	110K	150	0	0	10K	30K	150		
V3304	V	-4.5	+1.1	7.2AC	0	+175	+175	+0.1		
	R	110K	150	0	0	12K	30K	150		
V3401	V	+160	+60	+75	0	7.0AC	+150	+65	+75	0
	R	10K	14K	10K	0	0	10K	14K	10K	0
V3402	V	+14	+11	7.0AC	0	+160	+110	+4.6		
	R	440K	2.4K	0	0	50K	20K	7K		
V3403	V	+165	-0.15	+5.0	0	7.0AC	+180	-12	0	0
	R	18K	10K	3.3K	0	0	12K	650K	100	0
V3404	V	0	+1.1	7.0AC	0	+150	+130	+1.1		
	R	80K	100	0	0	10K	28K	100		
V3405	V	0	+0.8	7.2AC	0	+155	+135	+0.8		
	R	150K	65	0	0	10K	30K	65		
V3406	V	0	+1.4	7.0AC	0	+155	+130	+1.4		
	R	150K	150	0	0	10K	30K	150		
V3407	V	NC	+75	NC	0	NC	NC	NC	+0.8	
	R	NC	20K	NC	5K	NC	NC	NC	120	
V3501	V	+0.4	-5	+175	0	7.0AC	+3.4	0	+175	+150
	R	200	1.1 MEG	7.5K	0	0	200	330K	7.5K	7.5K

TABLE 5-5. VOLTAGE AND RESISTANCE CHART (CONT'D)

SYM. NO.		PIN NUMBER								
		1	2	3	4	5	6	7	8	9
V3502	V	-1.0	0	7.0AC	0	+150	+135	0		
	R	50K	0	0	0	10K	28K	0		
V3503	V	+70	NC	7.0AC	0	NC	-35	+0.1		
	R	75K	NC	0	0	NC	125K	50		
V3504	V	0	+2.0	7.0AC	0	+150	+105	+2.0		
	R	11K	190	0	0	15K	45K	190		
V3505	V	NC	+10	0	0	7.0AC	0	NC	NC	+180
	R	NC	3.9K	90K	0	0	90K	NC	NC	7.5K
V3506	V	0	+3.0	6.3AC	0	+150	+30	+3.0		
	R	10K	3.5K	0	0	70K	900K	3.8K		
V3507	V	0	+1.5	6.3AC	0	+155	+120	+1.5		
	R	0	190	0	0	16K	40K	190		
V3508	V	0	+1.7	6.3AC	0	+155	+120	+1.7		
	R	350K	190	0	0	10K	40K	190		
V3509	V	0	+1.6	6.3AC	0	+155	+120	+1.6		
	R	0	190	0	0	12K	40K	190		
V3510	V	0	+1.6	6.3AC	0	+155	+115	+1.6		
	R	325K	190	0	0	12K	40K	190		
V3511	V	0	+1.4	6.3AC	0	+155	+95	0		
	R	20K	145	0	0	20K	20K	90K		
V3512	V	0	+1.3	6.3AC	0	+175	+125	+1.3		
	R	90K	150	0	0	8K	28K	150		
V3701	V	+180	NC	6.3AC	0	+140	+22	+37		
	R	10K	NC	0	0	8K	110K	8K		
V3702	V	-10	+1.2	6.3AC	0	+135	+70	-11		
	R	22K	150	0	0	13K	25K	100K		
V3703	V	+160	-0.1	+130	0	6.3AC	+170	+2.0	+4	0
	R	6K	100K	38K	0	0	6K	200	700	300K

Note: Voltage readings are in volts, ±10%, to ground.

Resistance readings are in ohms, ±10%, to ground. Resistance measurements in stages containing diodes will vary depending upon polarity of meter.

NC = no connection.

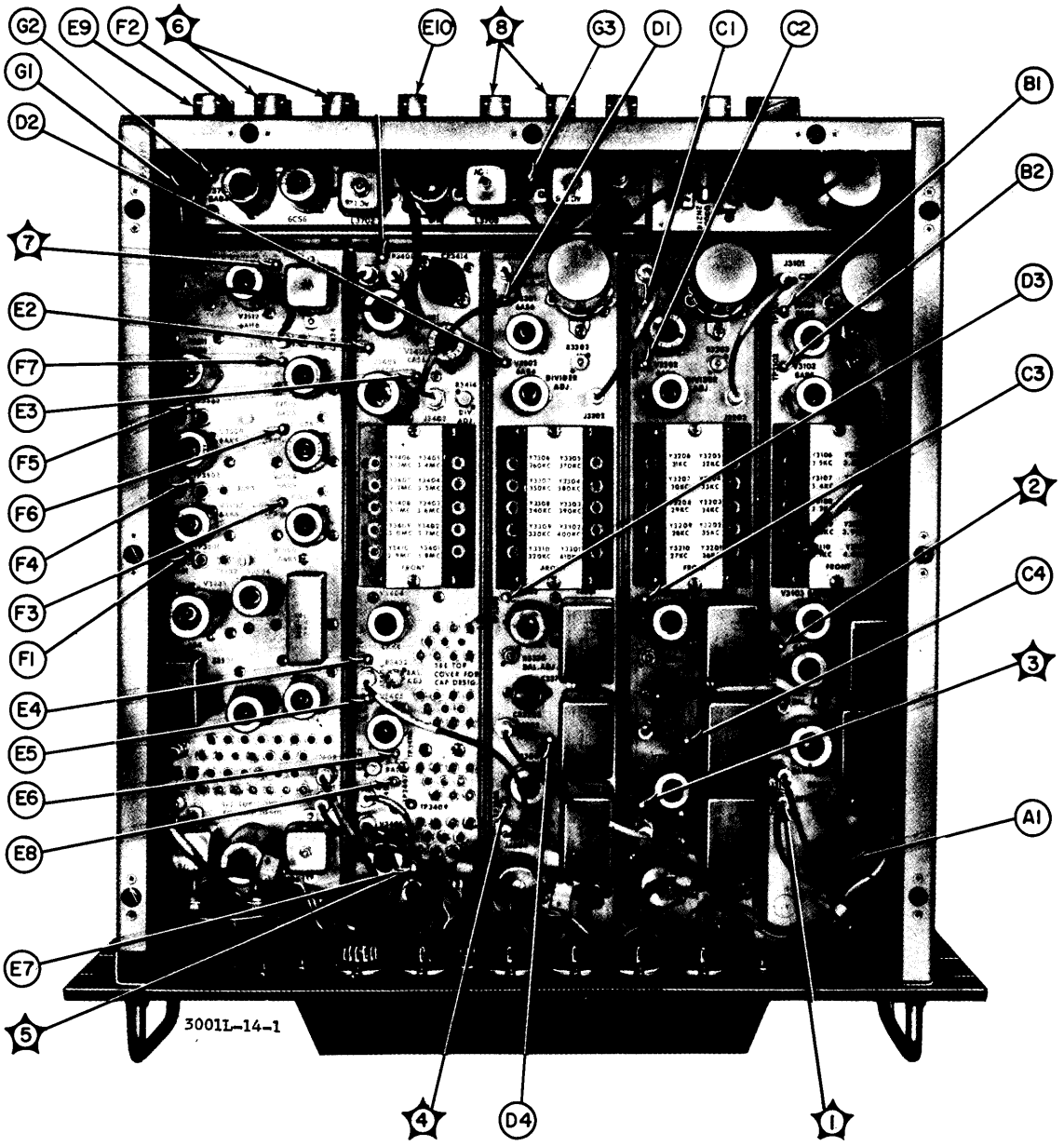


Figure 5-1. HFS, Top View Showing Test Points

62 9.14-17

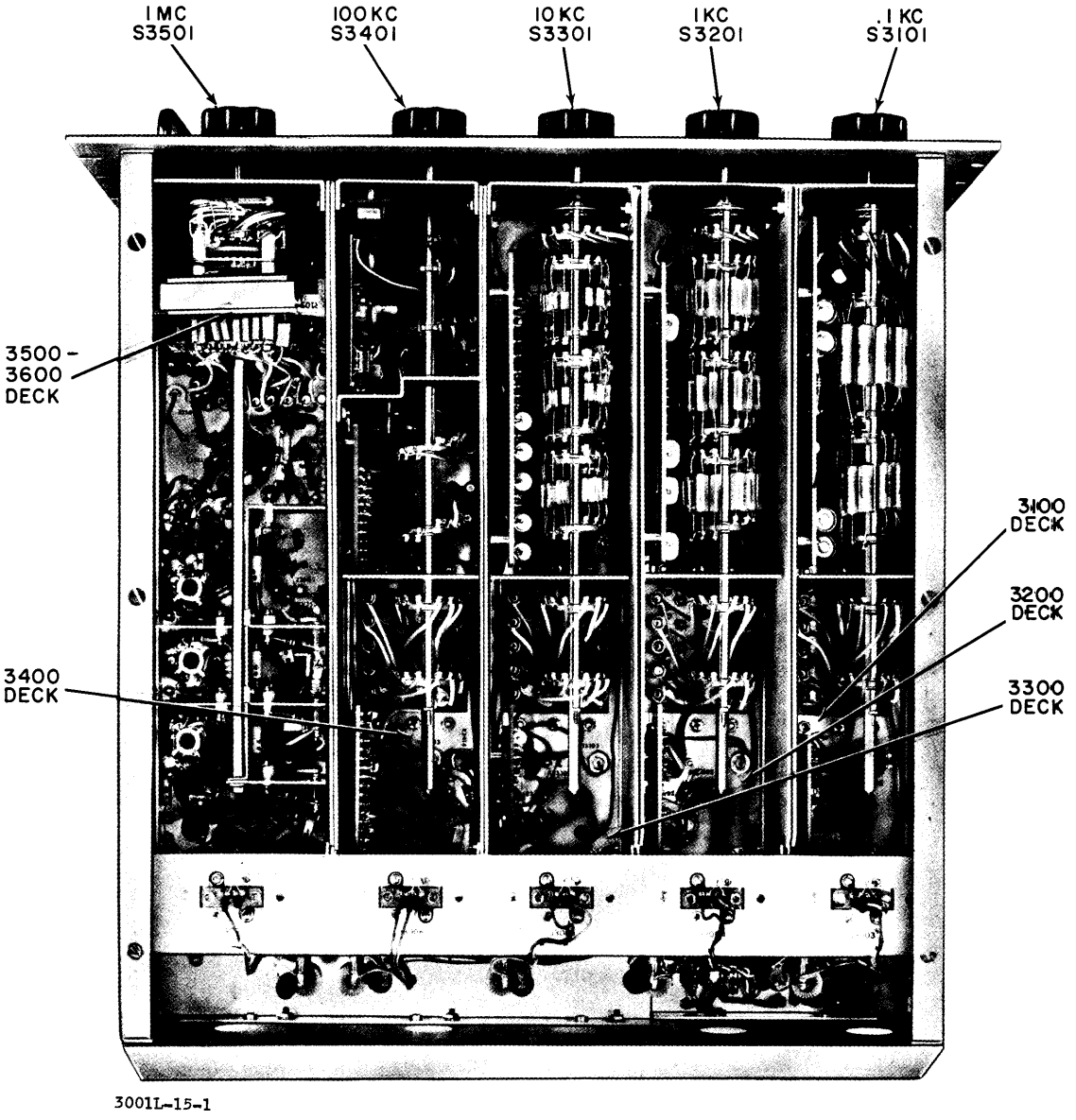


Figure 5-2. HFS, Bottom View Showing Decks

62 9.14-18/MOD

WARNING

Make sure that power supply is turned off before performing step 7. If power supply is turned on, 200 vdc will be present on the exposed contacts of the adapter when it is plugged in.

(7) Plug test socket adapter into tube socket, and plug tube into adapter.

(8) With power supply off, measure resistances from test socket adapter contacts to ground, and compare with readings in table 5-5.

(9) Remove meter leads from test socket adapter.

(10) (a) Connect first signal generator to J3009 on rear of HFS chassis.

(b) Adjust first signal generator output to 3.75 mc at 20 mv.

(11) (a) Connect signal generator to J3020 on rear of HFS chassis.

(b) Adjust second signal generator output to 1 mc at approximately 1.5 v.

(12) Turn power supply on.

(13) Set HFS front panel controls to bring 2.0000 reading on digital display.

(14) Measure voltages from test socket adapter contacts to ground and compare with readings in table 5-5.

(15) Remove meter leads from test adapter.

(16) Turn power supply off.

(17) Remove test socket adapter and replace tube in socket.

(18) Remove dummy loads and signal generators.

e. VISUAL INSPECTION. Table 5-6 lists a visual inspection procedure for the HFS. Before performing this check, disconnect the power input cable at J3001 on rear of chassis.

TABLE 5-6. VISUAL INSPECTION PROCEDURES

WHAT TO INSPECT	DEFECTS TO LOOK FOR	REMEDIES
All electrical connections at rear of equipment	Open connections, dirt, oil, frayed cables.	Replace or clean as necessary.
Knobs, screws, connectors.	Loose or missing hardware.	Tighten or replace.
Wiring	Loose or frayed wires.	Resolder or rewire.
Solder joints	Loose or cold solder connections.	Resolder or clean as necessary.
Switches	Bad connections, broken wipers.	Fix or replace as necessary.
Frequency Indicator	Burned out lamps or loose connections.	Replace lamps or fix connection as necessary.
Resistors	Cracks, chipping, blistering, discolorations, and other signs of overheating.	Replace defective resistor.
Capacitors	Leaks, bulges, discoloration.	Replace defective capacitor.
Tubes	Poor seating. Burned out or shorted.	Press tube firmly in socket. Replace defective tube.
Cables	Broken or loose cabling or connectors.	Tighten or replace.
Front panel meter.	Bent indicators, cracked case, broken glass.	Replace defective meter.

f. CHECKING PRINTED CIRCUIT CONDUCTORS. Breaks in the conducting strip (foil) on a printed circuit card can cause permanent or intermittent trouble. In many instances, these breaks will be so small that they cannot be detected by the naked eye. These almost invisible cracks (breaks) can be located only with the aid of a powerful magnifying glass.

To check out and locate trouble in the conducting strips of a printed circuit board, set up a multimeter (one which does not use a current in excess of 1 ma) for making point-to-point resistance tests, using needle point probes. Insert one point into the conducting strip, close to the end of terminal, and place the other probe on the terminal or opposite end of the conducting strip. The multimeter should indicate continuity. If the multimeter indicates an open circuit, drag the probe along the strip (or if the conducting strip is coated, puncture the coating at intervals) until the multimeter indicates continuity. Mark this area; then use a magnifying glass to locate the fault in the conductor.

CAUTION

Before using an ohmmeter for testing a circuit containing transistors or other voltage-sensitive semiconductors, check the current it passes under test on all ranges. DO NOT use a range that passes more than 1 ma.

5-3. REPAIR AND REPLACEMENT.

Section 6, PARTS LIST, lists all replaceable parts by their circuit symbol numbers. Care should be taken in replacing polarized components (diodes, polarized capacitors, etc.). Refer to schematic, in section 7, for proper orientation before soldering component into position.

Repair of HFS circuitry follows standard laboratory procedure, with the exception of printed circuitry. To repair a break in a printed conductor proceed as follows:

If the break in the conductor strip is small, lightly scrape away any coating covering the area of the conducting strip to be repaired. Clean the area with a firm-bristle brush and approved solvent. Then repair the cracked or broken area of the conducting strip by flowing solder over the break. Considerable care must be exercised to keep the solder from flowing onto an adjacent strip.

If a strip is burned out, or fused, cut and remove the damaged strip. Connect a length of insulated wire across the breach or from solder-point to solder-point.

After the repairs are completed, clean the repaired area with a stiff brush and solvent. Allow the board to dry thoroughly, and then coat the repaired area with an epoxy resin or similar compound. This coating not only will protect the repaired area, but will help to strengthen it.

CAUTION

After repairs, check the board for solder drippings; they may cause shorts.

Frequently, a low-resistance leakage path will be created by moisture and/or dirt that has carbonized onto the phenolic board. This leakage can be detected by measuring the suspected circuit with a multimeter. To overcome this condition, thoroughly clean the carbonized area with solvent and a stiff brush. If this does not remove it, use a scraping tool (spade end of a solder-aid tool or its equivalent) to remove the carbon, or drill a hole through the leakage path to break the continuity of the leakage. When the drilling method is used, be careful not to drill into a part mounted on the other side.

5-4. ALIGNMENT PROCEDURE

a. GENERAL. The HFS is fully aligned at the factory for peak performance and should not be re-aligned indiscriminately. Re-alignment may be necessary only when a setting has been inadvertently moved or, in some cases, when a tube has been replaced. The alignment procedure in the following paragraphs is the factory procedure modified for use in the field.

b. TEST EQUIPMENT AND TOOLS. Table 5-7 lists the test equipment and tools necessary for alignment.

c. PRELIMINARY ALIGNMENT PROCEDURES. Before attempting any alignment procedures, make sure that the following steps are performed.

(1) Unit is completely installed in the system and all cables and interconnections are made.

(2) The HFS must have had at least six hours warm-up prior to alignment.

(3) The voltage from the power supply must read exactly 200 volts dc. If it is not, adjust regulators as necessary.

(4) Connect an oscilloscope to 1 mc int. std. jack J3019 at rear of HFS. Scope should indicate a "clean" 1-mc signal with a peak-to-peak voltage of 5 volts. If any abnormal indication is present, refer to paragraph 5-2 before continuing.

(5) Connect an oscilloscope to TP3401 and check waveform. See step 17 in table 5-3 for correct waveform.

(6) Connect an oscilloscope to TP3402 and check waveform. See step 18 in table 5-3 for correct waveform.

(7) Connect an oscilloscope to TP3403 and check waveform. See step 19 in table 5-3 for correct waveform. If abnormal indication exists, unlock R3411 and adjust it until proper waveform exists.

TABLE 5-7. TEST EQUIPMENT AND TOOLS, ALIGNMENT

EQUIPMENT OR TOOL	MODEL
RF signal generator	Measurements Corp., Model 82 or equivalent
Frequency counter	Hewlett-Packard, Model 424C or equivalent
Oscilloscope	Tektronics Type 545A or equivalent
RF Vtvm	Ballantine 314 or equivalent
47-ohm, 1/2 watt, resistor with miniature RG-174/U cable and TMC-PL-204 Plug	
JFD Tool No. 5824 3/16 hollow spintite with concentric screwdriver	
5/16 hollow spintite to receive concentric screwdriver	

(8) Connect oscilloscope to TP3301 and check waveform. See step 12 in table 5-3.

(9) Connect oscilloscope to TP3302 and check waveform. See step 13 in table 5-3. If abnormal indication exists, unlock and readjust R3303 until proper waveform is indicated.

(10) Connect oscilloscope to TP3201 and check waveform. See step 7 in table 5-3.

(11) Connect oscilloscope to TP3202 and check waveform. See step 8 in table 5-3. If abnormal indication is present, unlock and adjust R3203 until proper waveform exists.

(12) Connect oscilloscope to TP3101 and check waveform. See step 4 in table 5-3.

(13) Connect oscilloscope to TP3102 and check waveform. See step 5 in table 5-3. If abnormal indication is present, unlock and adjust R3103 until proper waveform exists.

NOTE

The alignment of the 3500 deck should be undertaken before the alignment of the 3400 deck in order to simplify overall procedures.

d. ALIGNMENT OF 3100 DECK.

(1) Disconnect P3102 from J3102. Connect a 47-ohm resistor (1/2 watt) load at J3102. Connect oscilloscope across J3102.

(2) Set .1 KC switch so front panel indicator reads "0." With the alignment tool, adjust C3128. The waveform should be a "clean" 4-kc signal with a peak-to-peak amplitude between 0.5 and 0.8 volts. Adjust for maximum amplitude.

(3) Set the .1 KC switch to the indicator position listed in table 5-8 below and adjust the particular capacitor to its corresponding frequency and for maximum amplitude. The oscilloscope should indicate signals between 0.5 and 0.8 volts at each frequency.

(4) Remove dummy load and reconnect P3102 to J3102.

e. ALIGNMENT OF 3200 DECK

(1) Connect the oscilloscope to TP3203. Set 1 KC selector switch to "0."

(2) Adjust C3232 and C3272 for a maximum indication of TP3203.

(3) Set the 1 KC switch to the positions indicated in table 5-9 and adjust corresponding capacitors for a maximum amplitude indication at TP3203.

(4) Set the 1 KC selector to "0." Then run the selector through all positions, observing the amplitude of the waveform at TP3203. Adjust C3272 to maintain the amplitudes of the signals within ±1.5 db of each other.

TABLE 5-8. CAPACITORS TO BE ALIGNED, 3100 DECK

SWITCH INDICATION	CAPACITOR	FREQUENCY (KC)
1	C3129	3.9
2	C3130	3.8
3	C3131	3.7
4	C3132	3.6
5	C3133	3.5
6	C3134	3.4
7	C3135	3.3
8	C3136	3.2
9	C3137	3.1

TABLE 5-9. CAPACITORS TO BE ALIGNED, 3200 DECK

SWITCH INDICATION	CAPACITOR	TP3203 FREQUENCY (KC)
1	C3233	35
2	C3234	34
3	C3235	33
4	C3236	32
5	C3237	31
6	C3238	30
7	C3239	29
8	C3240	28
9	C3241	27

(5) Remove P3103 from J3203 and connect oscilloscope to J3203. Adjust balance adjust control R3219 for a minimum amplitude indication on the oscilloscope. Then reconnect P3103 to J3203.

(6) Set the .1 KC selector on the 3100 deck to "8" and the 1 KC selector to "0." Connect the oscilloscope to TP3204 and adjust C3273 for a maximum indication at TP3204.

(7) Rotate the 1 KC selector through positions "1" through "9" and observe the signal amplitude on the oscilloscope at each position. If necessary, readjust C3273 to maintain the amplitudes within ±1.5 db of each other.

(8) Connect the oscilloscope to TP3205. Set the .1 KC selector to "1" and 1 KC selector to "0." Adjust C3274 for a maximum amplitude indication at TP3205.

(9) Rotate the 1 KC selector through positions "1" through "9" and observe the signal amplitude on the oscilloscope at each position. If necessary, readjust C3274 to assure that the amplitudes remain within ±1.5 db of each other.

(10) Remove P3204 from J3303. Connect the 47-ohm dummy load to J3303 and connect the oscilloscope across the dummy load.

(11) Set the 1 KC selector to "0" and the .1 KC selector to "9." Rotate the .1 KC selector through all positions. The output voltage should be at least 0.56 volts peak-to-peak.

(12) Set the 1 KC selector to "0" and the .1 KC selector to "9." Rotate the 1 KC to all positions. The output voltage should be at least 0.56 volts peak-to-peak.

(13) Remove the oscilloscope and dummy load from J3303. Reconnect P3204 to J3303.

f. ALIGNMENT OF 3300 DECK

(1) Connect the oscilloscope to TP3303. Set the 10 KC selector to "0" (410 kc).

(2) Adjust C3328 and then C3370 for a maximum amplitude indication at TP3303. Then set the 10 KC selector to the positions indicated in table 5-10, and adjust corresponding capacitors for a maximum amplitude indication at TP3303.

TABLE 5-10. CAPACITORS TO BE ALIGNED, 3300 DECK

SWITCH INDICATION	CAPACITOR	TP3303 FREQUENCY (KC)
1	C3329	400
2	C3330	390
3	C3331	380
4	C3332	370
5	C3333	360
6	C3334	350
7	C3335	340
8	C3336	330
9	C3337	320

(3) Move the 10 KC selector through positions "9" through "0" again, observing the indications at TP3303. If necessary, adjust C3370 to maintain the amplitudes within 3 db of each other.

(4) Disconnect P3203 from J3204 and connect oscilloscope to J3204. Adjust R3330 for a minimum indication on the oscilloscope. Then remove oscilloscope and reconnect P3203 to J3204.

(5) Set the .1 KC switch to "0" (4 kc), the 1 KC switch to "9" (27 kc), and the 10 KC switch to "9" (320 kc). These settings correspond to a frequency of 351 kc.

(6) Connect the oscilloscope to TP3304 and adjust C3371 for a maximum indication.

(7) Move the 10 KC selector through the remaining nine positions, observing the amplitudes of the signals at TP3304. If necessary, readjust C3371 to maintain the amplitudes within 3 db of each other.

(8) Connect the oscilloscope to TP3305. Set the .1 KC selector to "0" (4 kc), the 1 KC selector to "1" (35 kc), and the 10 kc to "0" (410 kc). These settings correspond to a frequency of 449 kc.

(9) Adjust C3372 for a maximum indication with the oscilloscope at TP3305.

(10) Move the 10 KC selector through the remaining nine positions, observing the signal at TP3305. If necessary, readjust C3372 to maintain the signal amplitudes within 3 db of each other.

(11) Disconnect P3304 from J3304 and connect the 47-ohm load to J3304. Connect the oscilloscope across the load.

(12) Set the .1 KC selector to "0" (4 kc), the 1 KC selector to "0" (36 kc), and 10 KC selector to "0" (410 kc). This corresponds to a frequency of 450 kc.

(13) While observing the indication on the oscilloscope, rotate the .1 KC selector through all its positions to "9." Then rotate the 1 KC selector through all its positions to "9." The signal amplitude at each position should be 0.56 volts peak-to-peak.

(14) Place the 10 KC selector in position "1." Then, as in step (13), while observing the indication on the oscilloscope, rotate the .1 KC selector through all its positions to "9." Then rotate the 1 KC selector through all its positions to "9." The signal amplitude should be 0.56 volts peak-to-peak.

(15) Move the 10 KC selector to position "2." Repeat step (13), with the 10-kc selector in this position.

(16) Continue this procedure for the remaining positions of the 10 KC selector.

(17) Remove oscilloscope, dummy load, and reconnect P3304 to J3304.

g. ALIGNMENT OF 3500 DECK.

(1) GENERAL.

a. Disconnect P3011 from J3503. This removes the HFO input. Set MC selector to a blank position (position #32).

b. Disconnect P3014 from J3501. This removes the 1-mc input to the 3500 deck.

(2) 40.5-MC IF AMPLIFIER CHAIN.

a. Connect an RF generator to TP3509 and set the generator frequency to 40.5-mc. Reduce the signal generator output to a minimum required for an adequate indication to prevent overloading and oscillation.

b. Connect an oscilloscope to TP3504 and adjust C3623 for a maximum amplitude indication of the 40.5 mc.

c. Connect the oscilloscope to TP3505 and adjust C3628 for a maximum indication.

d. Connect the oscilloscope to TP3506 and adjust C3634 for a maximum indication.

e. Connect the frequency counter to TP3506. Counter should read 40.5 mc ±3 kc. Then remove the signal generator and counter. (This "strip" will be "peaked" again after alignment of the 3400 deck.)

(3) ALIGNMENT OF MC SELECTOR (See figure 5-3).

a. Connect an RF VTVM at pin 6 of V3505.

b. Set the MC selector to the positions indicated in table 5-11, and adjust corresponding capacitor for a maximum indication. See figure 5-3 for capacitor locations.

TABLE 5-11. CAPACITORS TO BE ALIGNED, 3500 DECK

SWITCH INDICATION	CAPACITOR	FREQUENCY (KC)
3	C3502	49.5
4	C3503	50.5
5	C3504	51.5
6	C3505	52.5
7	C3506	53.5
8	C3507	54.5
9	C3508	55.5
10	C3509	56.5
11	C3510	57.5
12	C3511	58.5
13	C3512	59.5
14	C3513	60.5
15	C3514	61.5
16	C3515	62.5
17	C3516	63.5
18	C3517	64.5
19	C3518	65.5
20	C3519	66.5
21	C3520	67.5
22	C3521	68.5
23	C3522	69.5
24	C3523	70.5
25	C3524	71.5
26	C3525	72.5
27	C3526	73.5
28	C3527	74.5
29	C3528	75.5
30	C3529	76.5
31	C3530	77.5

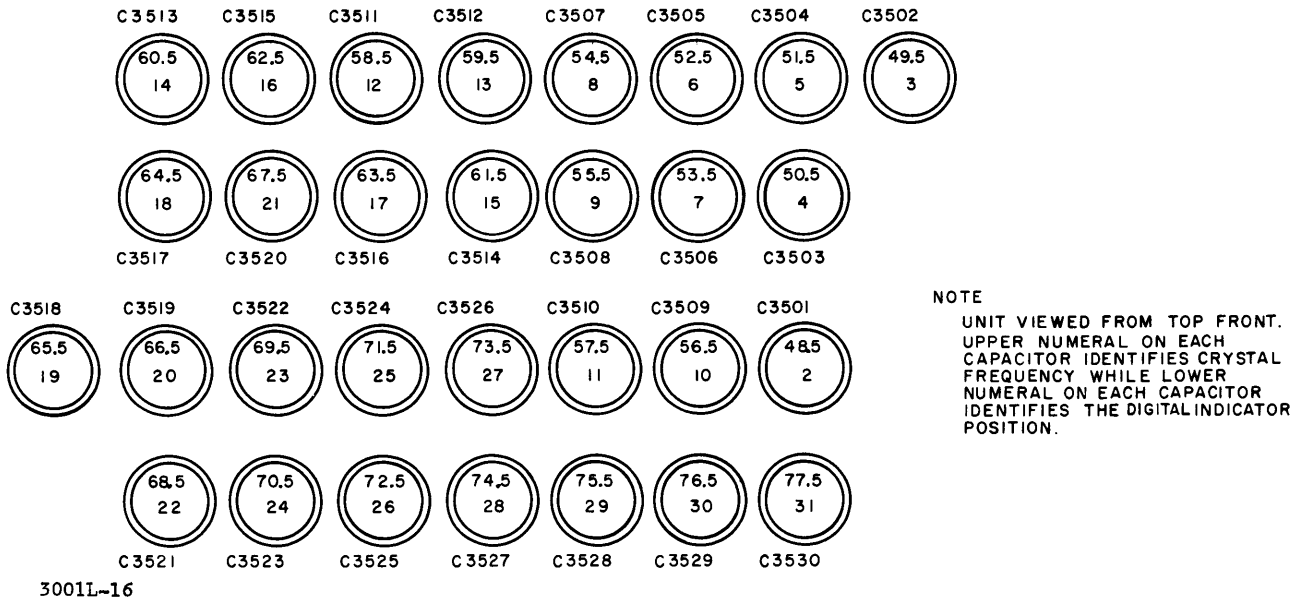


Figure 5-3. Identification of Piston Capacitors on 3500 Deck

(4) ALIGNMENT OF 43.75 - 44.75-MC AMPLIFIER.

a. Connect an RF generator at TP3508 and set the frequency to 44.25 mc (the amplifier mean frequency). Maintain the generator output of the minimum required for an indication of tuning during subsequent steps. Set the 1 MC selector to a blank position (position #32).

b. Connect the RF VTVM to TP3501 and adjust C3581 for a maximum indication. Reduce the RF generator signal output to zero. The VTVM should indicate zero; if it does not, the stage is oscillating. Repeat this step at another point in the circuit until an indication can be obtained which follows the signal generator output amplitude. Then adjust C3582 for a minimum indication.

c. Connect the RF VTVM to TP3502 and adjust C3588 for a maximum indication and C3590 for a minimum indication.

d. Connect the RF VTVM to TP3503 and adjust C3593 for a maximum indication. Then remove VTVM.

e. Reconnect P3011 to J3503 and P3014 to J3501. Connect the frequency counter to TP3503. Remove signal generator.

f. Set the receiver or transmitter tuning control for 2.0 mc. Set up the HFS selectors to the same frequency: 02.0000.

g. The counter should read in the vicinity of 44.75 mc. Set the tuning control to 2.99 mc and the HFS to 02.9900. The counter should now read in the vicinity of 43.75 mc.

(5) ALIGNMENT OF T3504 AND T3406 (3400, 3500 DECK).

a. Connect a VTVM to TP3507.

b. Set the HFS selectors to 02.0000 and the tuning control to 2.5 mc.

c. Adjust T3504 for a maximum indication.

d. Connect VTVM to TP3408 and adjust T3406 for maximum indication.

e. Rotate the tuning control between 2.0 and 2.99 mc. The indication should be constant, with a peak at 2.5 mc. If the drop-off at the ends is extreme, T3504 and T3406 may be adjusted to emphasize either the "highs" or "lows."

(6) ALIGNMENT OF 1 AND 2-MC CIRCUITS.

a. Connect an oscilloscope to rear panel jack J3019. Adjust T3505 for a maximum indication.

b. Connect the oscilloscope to 2-mc output jacks J3010, J3011, J3012, or J3013. Adjust T3503 for a maximum indication. Note the waveform and compare it with the 2-mc signal shown in step 27, table 5-3, then remove the oscilloscope.

h. ALIGNMENT OF 3400 DECK (See figure 5-4).

(1) Connect oscilloscope to TP3404. Place the 100 KC selector in the "0" position. Adjust C3454 and C3463 for a maximum amplitude indication.

(2) Set the 100 KC selector to the positions listed in table 5-12 and adjust the corresponding

capacitors for maximum amplitude indication on the oscilloscope. See figure 5-4 for capacitor locations.

(3) Remove P3303 from J3404. Connect the oscilloscope to J3404. Adjust R3432 for MINIMUM indication on the oscilloscope. Then remove oscilloscope and reconnect P3303 and J3404.

(4) Connect the oscilloscope to TP3405. Set the .1 KC selector to "5" (3.5 kc); the 1 KC selector to "5" (31 kc) the 10 KC selector to "5" (360 kc); and the 100 KC selector to "0" (3.8 mc). This corresponds to a frequency of 4.19 mc.

(5) Locate CR3413 on the terminal board beneath the 3400 deck and ground its anode. This disables the AGC loop to obtain an indication of tuning.

(6) Adjust C3473 for a maximum amplitude indication on the oscilloscope.

(7) Set the 100 KC selector to the positions listed in table 5-13 and adjust the corresponding capacitors for maximum amplitude indication on the oscilloscope. See figure 5-4 for capacitor locations.

TABLE 5-12. CAPACITORS TO BE ALIGNED, 3400 DECK

SWITCH INDICATION	CAPACITORS	TP3404 FREQUENCY (MC)
1	C3453 C3462	3.7
2	C3452 C3461	3.6
3	C3451 C3460	3.5
4	C3450 C3459	3.4
5	C3449 C3458	3.3
6	C3448 C3464	3.2
7	C3457 C3465	3.1
8	C3456 C3466	3.0
9	C3455 C3467	2.9

TABLE 5-13. CAPACITORS TO BE ALIGNED, 3400 DECK

SWITCH INDICATION	CAPACITORS	TP3405 FREQUENCY (MC)
1	C3472	4.06
2	C3471	3.96
3	C3470	3.86
4	C3469	3.76
5	C3468	3.66
6	C3474	3.56
7	C3475	3.46
8	C3476	3.36
9	C3477	3.26

(8) Connect the oscilloscope to TP3406. Set the .1 KC selector to "0" (4 kc); the 1 KC selector to "0" (36 kc); the 10 KC selector to "0" (410 kc); and 100 KC selector to "0" (3.8 mc). This corresponds to a frequency of 4.25 mc. Adjust C3483 for a maximum amplitude indication.

(9) Turn the 100 KC selector to "1" (4.14 mc) and adjust C3482 for a maximum amplitude indication.

(10) Advance the 100 KC selector to the positions indicated in table 5-14 and adjust the corresponding capacitors for a maximum indication on the oscilloscope. See figure 5-4 for capacitor locations.

(11) Remove the ground from the anode of CR3413. Leave the scope probe at TP3406. Set the 100 KC, 10 KC, 1 KC, and .1 KC selectors to "0."

(12) While observing the oscilloscope, advance the 10 KC, 1 KC and .1 KC selectors, in succession, to "9." The amplitude should not change more than 3 db.

(13) Advance the 100 KC selector to "1." Then retard in succession the 10 KC, 1 KC, and .1 KC selectors to "0." The amplitude should not change more than 3 db.

(14) Advance the 100 KC selector to "2." Then advance in succession the 10 KC, 1 KC, and .1 KC selectors to "9." The amplitude should not change more than 3 db.

(15) Advance the 100 KC selector to "3." Then retard in succession the 10 KC, 1 KC, and .1 KC selectors to "8." The amplitude should not change more than 3 db.

(16) Continue this procedure for the remaining positions ("4" to "9") of the 100 KC selector.

(17) Alignment of the 4.25- to 3.25-mc amplifier.

a. Disconnect P3303 from J3404.

b. Set tuning control (in receiver or transmitter) for 10 mc and HFS switches for 10.0000 mc.

TABLE 5-14. CAPACITORS TO BE ALIGNED, 3400 DECK

SWITCH INDICATION	CAPACITORS	TP3406 FREQUENCY (MC)
2	C3481	4.04
3	C3480	3.94
4	C3479	3.84
5	C3478	3.74
6	C3484	3.64
7	C3485	3.54
8	C3486	3.44
9	C3487	3.34

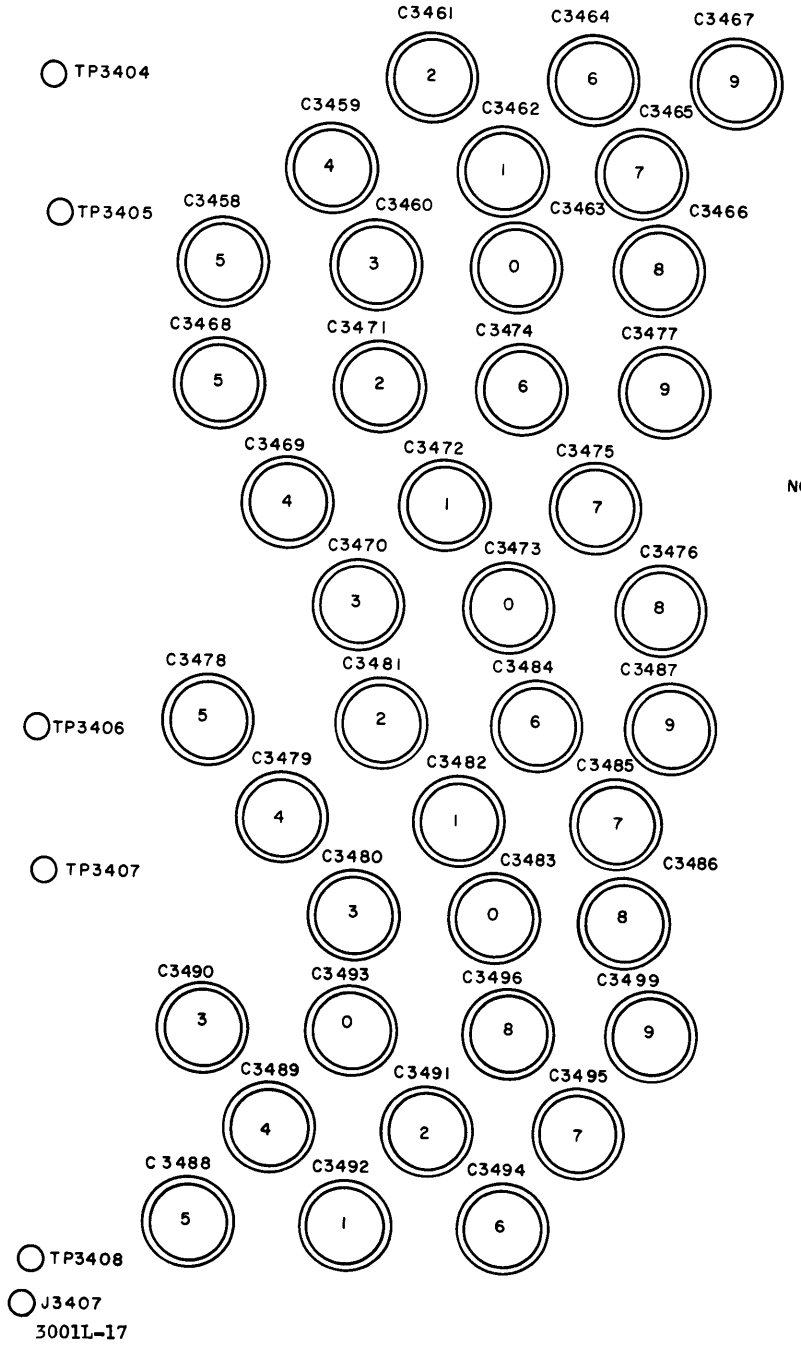


Figure 5-4. Identification of Piston Capacitors on 3400 Deck

c. Connect oscilloscope to TP3408.

d. Vary the tuning control from 10- to 11-mc and note level at TP3408. It should not vary more than 3 db total. If the variance is more than 3 db, proceed to step e; if not, proceed to step i.

e. With oscilloscope at TP3408, set tuning control for 10.15 mc and HFS switches for 10.0000 mc.

f. Connect RF VTVM at TP3507. Adjust T3504 for maximum level on VTVM.

g. Connect RF VTVM at TP3408 and adjust T3406 for maximum level on VTVM.

h. Observing oscilloscope, move tuning control to 10.8 mc and note level. Then move tuning control back and forth between 10.15 mc and 10.8 mc, adjusting T3504 and T3406 until both frequencies give as close to the same amplitude as possible. These levels should be 2.0 V; the response should appear approximately as shown in figure 5-5.

i. Connect oscilloscope to TP3407. Set tuning control for 2.05 mc and HFS switches for 2.0000 mc.

j. Adjust C3493 for maximum amplitude on oscilloscope.

k. Set HFS 100 KC switch for position "1" and set tuning control for 2.15 mc. Then adjust C3492 for maximum amplitude.

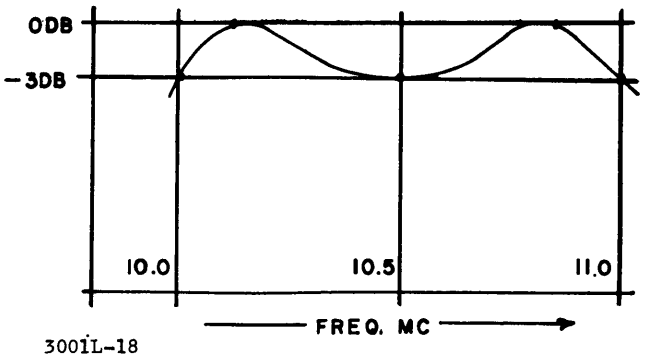
l. Repeat step k for positions 2 thru 9 of the 100 KC switch, adjusting capacitors C3491 thru C3488 and C3494 thru C3497, each time advancing the tuning control by 0.1 mc, as shown in table 5-15. In each case, the level at TP3407 should be at least 4 volts, peak-to-peak. If it is not, replace V3406 tube.

m. Reconnect P3303 to J3404.

(18) Adjustment of Phase Detectors.

NOTE

This alignment procedure is on the assumption that the receiver or transmitter includes a sync meter calibrated to at least +5 and -5 volts on either side of 0 V and that this meter circuit reads the d-c connection output at J3008 jack. Another assumption is that the equipment also includes a sync lamp ignited by the energization of K3001 relay. If the equipment does not include these indicators, a VTVM may be substituted for the meter and K3001 may be observed instead of the lamp.



NOTE: ODB = APPROX. 2.0V PEAK TO PEAK
Figure 5-5. Frequency Response Curve at TP3408

a. Ascertain that the receiver or transmitter sync meter is adjusted to zero-center-scale with its d-c correction voltage input grounded.

b. Set R3442 to the middle of its total adjustment range. Set receiver or transmitter tuning control for 2.5 mc and HFS switches for 2.5000 mc.

c. Readjust tuning control to obtain "0" on sync meter. Then slowly increase frequency setting on tuning control, observing needle movement away from "0." When needle flips back towards "0" this indicates one end of detector "capture range." At this point, adjust R3442 to bring needle to exactly "0."

d. Readjust tuning control back towards 2.5 mc. Needle will reverse action in c., this time moving towards "0." Continue to adjust control until needle reaches "0." Then continue to slowly decrease tuning control to frequencies under 2.5 mc, until needle jumps back to "0" indicating other end of capture range. The range should extend from -2.5v to +2.5v.

e. Leave HFS switches at 2.5000 mc and move tuning control to 2.9 mc.

f. Adjust R3460 until sync lamp comes on.

g. Decrease tuning control to 2.5 mc and to obtain "0" on meter. Then increase tuning control until needle flips back to "0." Readjust R3460 until sync lamp goes off. This indicates the high end of the "sync range." Note the reading on the meter; it should be at least +2.5V.

TABLE 5-15. CAPACITORS TO BE ALIGNED, 3400 DECK

SWITCH INDICATION	CAPACITORS	TUNING CONTROL FREQUENCY (MC)
1	C3492	2.15
2	C3491	2.25
3	C3490	2.35
4	C3489	2.45
5	C3488	2.55
6	C3494	2.65
7	C3495	2.75
8	C3496	2.85
9	C3497	2.95

h. Check the lamp at the low end of the "sync range" by decreasing the tuning control until the lamp goes out. The meter should now read at least -2.5V.

i. If voltage readings are not correct in steps g and h, repeat these steps until they are. Then perform a similar check with HFS and tuning control synchronized at 2.0 thru 2.9 mc, in 100-kc steps. Also check at 2.9990 mc.

i. ALIGNMENT OF 3700 DECK.

(1) Connect a 47-ohm resistor (1/2 watt) across J3702. Connect oscilloscope to pin 1 of V3703.

(2) Connect a signal generator to pin 9 of V3703. Set frequency of generator to 750-kc at an amplitude of 0.2 volts rms.

(3) Tune L3702 for a maximum output (approximately 1.8 volts peak-to-peak) on the scope.

(4) Connect the signal generator to J3701 and tune it to an output frequency of 250-kc at an amplitude of 50 millivolts (rms).

(5) Tune L3701 for a maximum output (approximately 3.3 volts peak-to-peak) on the scope.

(6) Retune the signal generator to 1-mc at an amplitude of 3 volts rms (as measured at TP3701). Connect oscilloscope to TP3702.

(7) Tune L3703 for maximum output (approximately 3.5 volts peak-to-peak) on the scope.

(8) Retune L3701, L3702, and L3703 and lock tuning adjustments carefully.

(9) Measure output voltage. It should be between 1 and 1.5 volts rms at J3702.

SECTION 6
PARTS LIST

6-1. INTRODUCTION.

The parts list presented in this section is a cross-reference list of parts identified by a reference designation and TMC part number. In most cases, parts appearing on schematic diagram are assigned reference designations in accordance with MIL-STD-16. Wherever practicable, the reference designation is marked on the equipment, close to the part it identifies. In most cases, mechanical and electro-mechanical parts have TMC part numbers stamped on them.

To expedite delivery when ordering any part, specify the following:

a. Generic name.

b. Reference designation.

c. TMC part number.

d. Model and serial numbers of the equipment containing the part being replaced, this can be obtained from the equipment nameplate.

For replacement parts not covered by warranty (refer to warranty sheet in front of manual), address all purchase orders to:

The Technical Materiel Corporation
Attention: Sales Department
700 Fenimore Road
Mamaroneck, New York

Assembly or Subassembly

FRONT PANEL AND MAIN FRAME ASSEMBLY

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
AT3000	DUMMY LOAD, ELECTRICAL: 47 ohms, ±10%; 1/2 watt; BNC connector type; 3-1/2" chain.	DL100-4
AT3001	Same as AT3000.	
C3001 A,B,C	CAPACITOR, FIXED, ELECTROLYTIC: triple section; 20 uf each section; 450 VDCW; polarized; tubular case; plug-in type.	CE108-1
C3002	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 uuf; GMV 500; VDCW.	CC100-16
C3003 thru C3011	Same as C3002	
C3012	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100,000 uuf, +80% -20%; 500 VDCW.	CC100-32

FRONT PANEL AND MAIN FRAME ASSEMBLY

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C3013	Same as C3002.	
DS3001	INDICATOR, DIGITAL DISPLAY: ionization voltage, 170 VDC min; anode current 4.0 ma individual cathode wattage, 0.4 watts max; plug-in type; 13 pins.	BI109-2
DS3002	Same as DS3001.	
DS3003	LAMP, GLOW: 110/125 v, 1/15 watts; midget flange base; T-2 bulb.	BI111-1
DS3004 thru DS3007	Same as DS3001.	
J3001	CONNECTOR, RECEPTACLE, ELECTRICAL: 14 #16 contacts, rated at 17.0 amperes.	JJ200-2
J3002	CONNECTOR, RECEPTACLE, ELECTRICAL: 11 round #20 female contacts, straight type.	JJ242-1S
J3003	CONNECTOR, RECEPTACLE, ELECTRICAL: 7 round #16 female contacts, straight type.	JJ216
J3004 thru J3007	Same as J3003.	
J3008	CONNECTOR, RECEPTACLE, ELECTRICAL: RF type; 1 round female contact; straight type; series BNC to BNC.	UG625*/U
J3009 thru J3021	Same as J3008.	
J3022 thru J3038	NOT USED	
J3039	Same as J3008.	
K3001	RELAY, ARMATURE: coil operating voltage 26.5 VDC coil resistance, 1825 ohms dc; current rating low level; double pole, double throw, min. operating amps .012.	RL143-2
L3001	COIL, RADIO FREQUENCY: fixed; 50,000 uuf, ±5%; 110 ohms dc resistance, 75 ma current.	CL226-5
L3002 thru L3005	Same as L3001.	
M3001	METER, ARBITRARY SCALE: movement 0-50 microamps; approximate resistance 2000 ohms ±5%; black scale on white background; rectangular case.	MR162
P3001	CONNECTOR, PLUG, ELECTRICAL: 11 round #20 contacts; straignt type; with hood.	PL225-3P

FRONT PANEL AND MAIN FRAME ASSEMBLY

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
P3002 thru P3006	Same as P3001.	
P3007	CONNECTOR, PLUG, ELECTRICAL: two flat male contacts; polarized; with cable clamp; straight type.	PL105-1
P3008	CONNECTOR, PLUG, ELECTRICAL: 1 round female coaxial contact; straignt type.	PL204
P3009 thru P3021	Same as P3008.	
Q3001	NOT USED	
Q3002	TRANSISTOR: NPN; silicon mesa; collector to base voltage 60 V; collector to emitter voltage 40V; emitter to base voltage 5 V; collector current 175 ma; power dissipation 2 watts at 25°C; junction temperature 175°C; hermetically sealed meter case.	2N697
R3001	RESISTOR, FIXED, COMPOSITION: 100,000 ohms ±5%; 1/2 watt.	RC20GF104J
R3002	RESISTOR, FIXED, COMPOSITION: 12 ohms ±5%; 1/2 watt.	RC20GF120J
R3003	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, ±5%; 1/2 watt.	RC20GF102J
R3004	RESISTOR, FIXED, COMPOSITION: 1 meg ohm; ±5% 1/2 watt.	RC20GF105J
W3001	WIRING HARNESS: consists of 1 connector symbol P3001, 1 socket electron tube symbol XDS3001 and various lengths and colors of MIL type MWC wire.	CA667
W3002	WIRING HARNESS: consists of 1 connector symbol P3002, 1 socket electron tube symbol XDS3002; and 6.75 in. of various colors of MIL type MWC wire.	CA668
W3003	Same as W3002, uses 1 connector P3003, socket XDS3004.	
W3004	Same as W3002, uses 1 connector P3004, socket XDS3005.	
W3005	Same as W3002, uses 1 connector P3005, socket XDS3006.	
W3006	WIRING HARNESS: consists of 1 connector symbol P3006, 1 socket electron tube symbol XDS3007; and 11.75 in. of various colors of MIL type MWC wire.	CS695
W3007	CABLE ASSEMBLY, RADIO FREQUENCY: consists of 7 in. of RF wire RG174/U; and 1 connector symbol P3021.	CA480-71-7.00
W3008	CABLE ASSEMBLY, SPECIAL PURPOSE ELECTRICAL BRANCHED: consists of various lengths and colors of insulated standard MIL type MWC wire, various lengths of coaxial cable MIL type RG174/U, connectors symbols P3007 thru P3020.	CA700
XC3001 A,B,C	SOCKET, ELECTRON TUBE: octal type.	TS101P01
XDS3001	SOCKET, ELECTRON TUBE: 13 pin.	TS157

FRONT PANEL AND MAIN FRAME ASSEMBLY

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
XDS3002	Same as XDS3001.	
XDS3003	LAMPHOLDER: accommodates midget flange base T-2 type lamp; consists of holder, TMC No. TS-159, and lamp retaining bushing, TMC No. PO-230-1.	TS156
XDS3004 thru XDS3007	Same as XDS3001.	
XQ3001	NOT USED	
XQ3002	SOCKET, TRANSISTOR: 4 silver plated beryllium copper w/gold clash contacts; molded mica filled phenolic.	TS147

100 CYCLE SELECTOR DECK

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C3101	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 1,000 uuf; ±10%; 500 VDCW.	CC100-9
C3102	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 uuf; GMV: 500 VDCW.	CC100-16
C3103	CAPACITOR, FIXED, MICA DIELECTRIC: 4,700 uuf; ±5%; 500 VDCW.	CM35B472J
C3104	CAPACITOR, FIXED, MICA DIELECTRIC: 100 uuf, ±5%; 500 VDCW.	CM15F101J03
C3105	CAPACITOR, FIXED, ELECTROLYTIC: polarized; 8 uf, 250 WVDC; hermetically sealed aluminum case with black vinyl sleeve.	CE116-1VN
C3106	Same as C3101.	
C3107	CAPACITOR, FIXED, MICA DIELECTRIC: 6,200 PF, ±2%; 500 WVDC.	CM112F622G5S
C3108	Same as C3105.	
C3109	Same as C3104.	
C3110	CAPACITOR, FIXED, MICA DIELECTRIC: 1,000 uuf, ±10%; 500 WVDC.	CM20B102K
C3111	Same as C3105.	
C3112	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100,000 uuf, +80% -20%; 300 WVDC.	CC100-37
C3113	Same as C3105.	
C3114	Same as C3101.	
C3115	Same as C3105.	

100 CYCLE SELECTOR DECK

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C3116	NOT USED	
C3117	CAPACITOR, FIXED PLASTIC DIELECTRIC: mylar, metalized; 0.10 uf; ±20%; 400 VDCW.	CN114R10-4M
C3118	NOT USED	
C3119	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 20,000 uuf; +80% -20%; 500 VDCW.	CC100-24
C3120	CAPACITOR, FIXED, MICA DIELECTRIC: 5 uuf; ±20%; 500 VDCW.	CM15B050M
C3121	Same as C3104.	
C3122	Same as C3119.	
C3123	NOT USED	
C3124	Same as C3102.	
C3125 A,B,C	CAPACITOR, FIXED, ELECTROLYTIC: triple section; 20 uf each section; 450 VDCW; polarized; tubular case; plug-in type.	CE108-1
C3126	Same as C3119.	
C3127	Same as C3119.	
C3128	CAPACITOR, VARIABLE, GLASS DIELECTRIC: 1 to 30 uuf; 1,000 VDCW.	CV108-4
C3129 thru C3137	Same as C3128.	
C3138	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 5,400 uuf; ±1%; 200 VDCW.	CX104-55
C3139	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 5,000 uuf; ±1%; 200 VDCW.	CX104-54
C3140	CAPACITOR, FIXED, PLASTIC DIELETRIC: 4,500 uuf; ±1%; 200 VDCW.	CX104-53
C3141	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 4,250 uuf; ±1%; 200 VDCW.	CX104-52
C3142	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 3,750 uuf; ±1%; 200 VDCW.	CX104-51
C3143	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 3,500 uuf; ±1%; 200 VDCW.	CX104-50
C3144	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 3,300 uuf; ±1%; 200 VDCW.	CX104-49
C3145	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 3,000 uuf; ±1%; 200 VDCW.	CX104-48

100 CYCLE SELECTOR DECK

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C3146	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 2,700 uuf; ±1%; 200 VDCW.	CX104-47
C3147	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 53,000 uuf; ±1%; 200 VDCW.	CX104-56
C3148	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 14,500 uuf; ±1%; 200 VDCW.	CX104-45
C3149	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 13,900 uuf; ±1%; 200 VDCW.	CX104-44
C3150	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 12,500 uuf; +1%; 200 VDCW.	CX104-43
C3151	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 11,100 uuf; ±1%; 200 VDCW.	CX104-42
C3152	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 10,200 uuf; +1%; 200 VDCW.	CX104-41
C3153	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 9,400 uuf; ±1%; 200 VDCW.	CX104-40
C3154	CAPACITOR, FIXED, PLASTIC DIELECTIC: 8,600 uuf; ±1%; 200 VDCW.	CX104-39
C3155	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 8,000 uuf; ±1%; 200 VDCW.	CX104-38
C3156	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 7,300 uuf; ±1%; 200 VDCW.	CX104-46
C3157	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 142,000 uuf; ±1%; 200 VDCW.	CX104-57
C3158	Same as C3102.	
C3159	Same as C3119.	
C3160	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 20,000 uuf; +60% -40%; 150 VDCW.	CC100-35
C3161	Same as C3102.	
C3162	NOT USED	
C3163	CAPACITOR, FIXED, ELECTROLYTIC: tantalum; 6.8 uf; ±20%; 6 VDCW; polarized, insulated tubular case.	CE106
C3164	CAPACITOR, FIXED, MICA DIELECTRIC: 10 uuf; ±5%; 500 VDCW.	CM15C100J03YY
CR3101	SEMICONDUCTOR DEVICE, DIODE: silicon; 175 v max. peak inverse voltage; 30 ma at 25°C and 15 ma at 150°C, two axial wire lead type terminals; hermetically sealed glass case.	1N463
CR3102	Same as CR3101.	
CR3103	Same as CR3101.	

100 CYCLE SELECTOR DECK

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
EV3101 thru EV3104	NOT USED	
EXV3105	SHIELD ELECTRON TUBE	TS103U03
J3101	CONNECTOR, RECEPTACLE, ELECTRICAL: RF type; 1 round male contact; straight type; series BNC to BNC.	JJ211
J3102	Same as J3101.	
J3103	Same as J3101.	
J3104	CONNECTOR, RECEPTACLE, ELECTRICAL: 7 round #16 male contacts; straight type.	JJ245
J3105	CONNECTOR, RECEPTACLE, ELECTRICAL: 11 round #20 female contacts; straight type.	JJ242-3S
J3106	CONNECTOR, RECEPTACLE, ELECTRICAL: 2 female contacts; straight type.	JJ119-2
J3107	Same as J3101.	
L3101	COIL, RADIO FREQUENCY: fixed; 29.82 mh, ±1%; 1 ohm dc resistance; 200 ma current rating, hermetically sealed metal case.	CL286
P3101	CONNECTOR, PLUG, ELECTRICAL: RF; 1 round female coaxial contact; straight type; series miniature bayonet lock. (Part of W3101)	PL204
P3102	Same as P3101. (Part of W3101)	
P3103	Same as P3101. (Part of W3102)	
P3104	Same as P3101. (Part of W3102)	
R3101	RESISTOR, FIXED, COMPOSITION: 2.2 megohm; ±5%; 1/2 watt.	RC20GF225J
R3102	RESISTOR, FIXED, COMPOSITION: 100,000 ohms; ±5%; 1/2 watt.	RC20GF104J
R3103	RESISTOR, VARIABLE, COMPOSITION: 100,000 ohms; +10%; 1/2 watt.	RV106UX8B104A
R3104	Same as R3101.	
R3105	Same as R3102.	
R3106	RESISTOR, FIXED, COMPOSITION: 6,800 ohms; ±5%; 1/2 watt.	RC20GF682J
R3107	RESISTOR, FIXED, COMPOSITION: 2,200 ohms; ±5%; 1/2 watt.	RC20GF222J
R3108	Same as R3102.	
R3109	RESISTOR, FIXED, COMPOSITION: 15,000 ohms; ±5%; 1 watt.	RC32GF153J
R3110	Same as R3102.	
R3111	RESISTOR, FIXED, COMPOSITION: 15,000 ohms; ±5%; 1/2 watt.	RC20GF153J

100 CYCLE SELECTOR DECK

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R3112	RESISTOR, FIXED, COMPOSITION: 1 meg. ohm, ±5%; 1/2 watt.	RC20GF105J
R3113	RESISTOR, FIXED, COMPOSITION: 22,000 ohms; ±5%; 1/2 watt.	RC20GF223J
R3114	Same as R3102.	
R3115	RESISTOR, FIXED, COMPOSITION: 150 homs; ±5%; 1/2 watt.	RC20GF151J
R3116	RESISTOR, FIXED, COMPOSITION: 3,300 ohms; ±5%; 1/2 watt.	RC20GF332J
R3117	Same as R3116.	
R3118	Same as R3102.	
R3119	Same as R3111.	
R3120	Same as R3113.	
R3121	RESISTOR, FIXED, COMPOSITION: 47 ohms; +5%; 1/2 watt.	RC20GF470J
R3122	Same as R3102.	
R3123	NOT USED	
R3124	Same as R3102.	
R3125	Same as R3113.	
R3126	Same as R3115.	
R3127	Same as R3107.	
R3128	Same as R3115.	
R3129	Same as R3102.	
R3130	RESISTOR, FIXED, COMPOSITION: 2,200 ohms; ±5%; 1 watt.	RC32GF222J
R3131	RESISTOR, FIXED, COMPOSITION: 2,200 ohms; ±5%; 2 watts.	RC42GF222J
R3132	Same as R3113.	
R3133	Same as R3102.	
R3134	Same as R3121.	
R3135	RESISTOR, FIXED, COMPOSITION: 470 ohms; ±5%; 1/2 watt.	RC20GF471J
R3136	Same as R3102.	
R3137	Same as R3106.	
R3138	RESISTOR, FIXED, COMPOSITION: 3,900 ohms; ±5%; 1/2 watt.	RC20GF392J
R3139	Same as R3107.	
R3140	RESISTOR, VARIABLE, COMPOSITION: 10,000 ohms; ±10%; 1/2 watt.	RV106UX8B103A
R3141	RESISTOR, FIXED, COMPOSITION: 27,000 ohms; ±5%; 1/2 watt.	RC20GF273J

100 CYCLE SELECTOR DECK

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R3142	RESISTOR, FIXED, COMPOSITION: 10,000 ohms; ±5%; 1/2 watt.	RC20GF103J
S3101 A,B,C, D,E,F, G	SWITCH, ROTARY: 7 sections; 12 position; non-shorting type contacts; contacts rated 1 amp, 28 volts dc or 5 amp at 110 volts ac.	SW293
S3102	SWITCH, TOGGLE: SPDT: 5A-125 vac; 5A-250 vac.	ST106
T3101	TRANSFORMER, RADIO FREQUENCY: inductance 11.4 mh; hermetically sealed metal case.	TZ104
T3102	TRANSFORMER PULSE: 3 windings; winding no. 1, 4.7 mh; turns ratio 5:5;1.	TF228-K15
TB3101	TERMINAL BOARD ASSEMBLY, DIVIDER	A4461-4
TB3102	TERMINAL BOARD ASSEMBLY, AMPLIFIER	A2271-5
TP3101	TERMINAL, FEEDTHRU, INSULATED: 0.740" lg. x 3/16" dia.; 3.32 press-fit stud; teflon insulated, 2,000 v.	TE169-1
TP3102	Same as TP3101.	
TP3103	Same as TP3101.	
V3101	TUBE, ELECTRON: radio frequency amplifier pentode; 7 pin miniature.	6AS6
V3102	TUBE, ELECTRON: high-mu triode; 7 pin miniature.	6AB4
V3103	TUBE, ELECTRON: sharp-cutoff pentode; 7 pin miniature.	6AU6
V3104	Same as V3103.	
V3105	TUBE, ELECTRON: high-mu triode sharp-cutoff pentode; 9 pin miniature.	6AW8A
W3101	CABLE ASSEMBLY, RADIO FREQUENCY: consists of 7" of RF cable RG174/U and two connectors symbol #P3101, P3102.	CA480-68-7
W3102	Same as W3101. Consists of two connectors symbol #P3103, P3104.	
XC3101 thru XC3124	NOT USED	
XC3125 A,B,C	SOCKET, ELECTRON TUBE: octal type.	TS101P01
XV3101	SOCKET, ELECTRON TUBE: 7 pin miniature.	TS102P01
XV3102 thru XV3104	Same as XV3101.	
XV3105	SOCKET, ELECTRON TUBE: 9 pin miniature.	TS103P01

100 CYCLE SELECTOR DECK

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
XY3101	SOCKET, CRYSTAL: 2 contacts; 0.050" dia. spaced 0.486" c to c.	TS104-2
XY3102 thru XY3110	Same as XY3101.	
XZ3101	Same as XC3125A, B, C.	
Y3101	CRYSTAL UNIT, QUARTZ: 4.000 kc, ±.005%; 0° to +50°C operating temperature range; parallel resonance, 10 uuf, ±0.5 uuf load capacitance; fundamental operation; type HC-13/U holder.	CR109-15
Y3102	CRYSTAL UNIT, QUARTZ: 3.900 kc, ±.005%; 0° to +50°C operating temperature range; parallel resonance, 10 uuf, ±0.5 uuf load capacitance; fundamental operation; type HC-13/U holder.	CR109-14
Y3103	CRYSTAL UNIT, QUARTZ: 3.800 kc, ±.005%; 0° to +50°C operating temperature range; parallel resonance, 10 uuf, +0.5 uuf load capacitance; fundamental operation; type HC-13/U holder.	CR109-13
Y3104	CRYSTAL UNIT, QUARTZ: 3.700 kc, ±.005%; 0° to +50°C operating temperature range; parallel resonance, 10 uuf; +0.5 uuf load capacitance; fundamental operation; type HC-13/U holder.	CR109-12
Y3105	CRYSTAL UNIT, QUARTZ: 3.600 kc, ±.005%; 0° to +50°C operating temperature range; parallel resonance, 10 uuf, ±0.5 uuf load capacitance; fundamental operation; type HC-13/U holder.	CR109-11
Y3106	CRYSTAL UNIT, QUARTZ: 3.500 kc, ±.005%; 0° to +50°C operating temperature range; parallel resonance, 10 uuf, ±0.5 uuf load capacitance; fundamental operation; type HC-13/U holder.	CR109-10
Y3107	CRYSTAL UNIT, QUARTZ: 3.400 kc, ±.005%; 0° to +50°C operating temperature range; parallel resonance, 10 uuf, ±0.5 uuf load capacitance, fundamental operation; type HC-13/U holder.	CR109-9
Y3108	CRYSTAL UNIT, QUARTZ: 3,300 kc, ±.005%; 0° to +50°C operating temperature range; parallel resonance, 10 uuf, ±0.5 uuf load capacitance; fundamental operation; type HC-13/U holder.	CR109-8
Y3109	CRYSTAL UNIT, QUARTZ: 3.200 kc, ±.005%; 0° to +50°C operating temperature range; parallel resonance, 10 uuf, ±0.5 uuf load capacitance, fundamental operation; type HC-13/U holder.	CR109-7
Y3110	CRYSTAL UNIT, QUARTZ: 3.100 kc, ±.005%; 0° to +50°C operating temperature range; parallel resonance, 10 uuf, ±0.5 uuf load capacitance; fundamental operation; type HC-13/U holder.	CR109-6
Z3101	CALIBRATOR, FREQUENCY: operating frequency 1 mc; frequency stability 1 x 10-8 after 24 hours warm-up period; ambient temperature range +15°C to +65°C, hermetically sealed metal case; standard 6 pin plug-in type.	NF109-1

1 KC SELECTOR DECK

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C3201	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 1,000 uuf; ±10%; 500 VDCW.	CC100-9
C3202	CAPACITOR, FIXED, MICA DIELECTRIC: 100 uuf; ±10%; 500 VDCW.	CM15C101K
C3203	CAPACITOR, FIXED, MICA DIELECTRIC: 560 uuf; ±5%; 500 VDCW.	CM20B561J
C3204	CAPACITOR, FIXED, MICA DIELECTRIC: 100 uuf, ±2%; 500 VDCW.	CM51F101G03
C3205	CAPACITOR, FIXED, PLASTIC DIELECTRIC: mylar, metalized; 1.0 uf; ±10%; 200 VDCW.	CN112A105K2
C3206	Same as C3201.	
C3207	CAPACITOR, FIXED, MICA DIELECTRIC: 1,000 uuf, ±2%; 500 VDCW.	CM20F102G03
C3208	NOT USED	
C3209	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 uuf; GMV; 500 VDCW.	CC100-16
C3210	CAPACITOR, FIXED, MICA DIELECTRIC: 330 uuf, ±2%; 500 VDCW.	CM15F331G03
C3211	Same as C3204.	
C3212	Same as C3205.	
C3213	CAPACITOR, FIXED, ELECTROLYTIC: tantalum; 6.8 uf, ±20%; 6 VDCW polarized; insulated tubular case.	CE106
C3214	CAPACITOR, FIXED, MICA DIELECTRIC: 3 uuf; ±5%; 500 VDCW.	CM15C050J
C3215	Same as C3202.	
C3216	NOT USED	
C3217	Same as C3214.	
C3218	Same as C3205.	
C3219	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 20, 000 uuf; +80% -20%; 500 VDCW.	CC100-24
C3220	Same as C3205.	
C3221	Same as C3213.	
C3222	Same as C3219.	
C3223	Same as C3214.	
C3224	CAPACITOR, FIXED, METALIZED PAPER DIELECTRIC: 2.0 uf; ±20%; 200 VDCW.	CP106H205-4
C3225	NOT USED	
C3226	Same as C3214.	
C3227	Same as C3202.	

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REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C3228	NOT USED	
C3229 A,B,C	CAPACITOR, FIXED, ELECTROLYTIC: triple section; 20 uf each section; 450 VDCW; polarized, tubular case, plug-in type.	CE108-1
C3230	Same as C3205.	
C3231	CAPACITOR, FIXED, MICA DIELECTRIC: 20 uuf; ±5%; 500 VDCW.	CM15C200J
C3232	CAPACITOR, VARIABLE GLASS DIELECTRIC: 1 to 30 uuf; 1,000 VDCW.	CV108-4
C3233 thru C3241	Same as C3232.	
C3242	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 9,400 uuf; ±1%; 200 VDCW.	CX104-40
C3243	CAPACITOR, FIXED, GLASS DIELECTRIC: 595 uuf; ±1%; 500 VDCW.	CY15C5950F
C3244	CAPACITOR, FIXED, GLASS DIELECTRIC: 645 uuf; ±%; 500 VDCW.	CY15C6450F
C3245	CAPACITOR, FIXED, GLASS DIELECTRIC: 705 uuf; ±1%; 500 VDCW.	CY15C7050F
C3246	CAPACITOR, FIXED, GLASS DIELECTRIC: 770 uuf; ±1%; 500 VDCW.	CY15C771F
C3247	CAPACITOR, FIXED, GLASS DIELECTRIC: 885 uuf; ±1%; 500 VDCW.	CY15C8850F
C3248	CAPACITOR, FIXED, GLASS DIELECTRIC: 930 uuf; ±1%; 500 VDCW.	CY15C931F
C3249	CAPACITOR, FIXED, GLASS DIELECTRIC: 1,035 uuf; ±1%; 500 VDCW.	CY20C10350F
C3250	CAPACITOR, FIXED, GLASS DIELECTRIC: 1,145 uuf; ±1%; 500 VDCW.	CY20C11450F
C3251	CAPACITOR, FIXED, GLASS DIELECTRIC: 1,275 uuf; ±1%; 500 VDCW.	CY20C12750F
C3252	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 12,500 uuf; ±1%; 200 VDCW.	CX104-43
C3253	CAPACITOR, FIXED, GLASS DIELECTRIC: 740 uuf; ±1%; 500 VDCW.	CY15C741F
C3254	CAPACITOR, FIXED, GLASS DIELECTRIC: 790 uuf; ±1%; 500 VDCW.	CY15C791F
C3255	CAPACITOR, FIXED, GLASS DIELECTRIC: 865 uuf; ±1%; 500 VDCW.	CY15C8650F
C3256	CAPACITOR, FIXED, GLASS DIELECTRIC: 940 uuf; ±1%; 500 VDCW.	CY15C941F
C3257	CAPACITOR, FIXED, GLASS DIELECTRIC: 1,025 uuf; ±1%; 500 VDCW.	CY20C10250F
C3258	CAPACITOR, FIXED, GLASS DIELECTRIC: 1,110 uuf; ±1%; 500 VDCW.	CY20C1111F
C3259	CAPACITOR, FIXED, GLASS DIELECTRIC: 1,230 uuf; +1%; 500 VDCW.	CY20C1231F
C3260	CAPACITOR, FIXED, GLASS DIELECTRIC: 1,345 uuf. ±1%; 500 VDCW.	CY20C13450F
C3261	CAPACITOR, FIXED, GLASS DIELECTRIC: 1,470 uuf; ±1%; 500 VDCW.	CY20C1471F
C3262	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 8,600 uuf; ±1%; 500 VDCW.	CX104-39

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REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C3263	CAPACITOR, FIXED, GLASS DIELECTRIC: 490 uuf; ±1%; 500 VDCW.	CY15C491F
C3264	CAPACITOR, FIXED, GLASS DIELECTRIC: 535 uuf; ±1%; 500 VDCW.	CY15C5350F
C3265	CAPACITOR, FIXED, GLASS DIELECTRIC: 575 uuf; ±1%; 500 VDCW.	CY15C5750F
C3266	CAPACITOR, FIXED, GLASS DIELECTRIC: 620 uuf; ±1%; 500 VDCW.	CY15C621F
C3267	CAPACITOR, FIXED, GLASS DIELECTRIC: 675 uuf; ±1%; 500 VDCW.	CY15C6750F
C3268	CAPACITOR, FIXED, GLASS DIELECTRIC: 735 uuf; ±1%; 500 VDCW.	CY15C7350F
C3269	CAPACITOR, FIXED, GLASS DIELECTRIC: 810 uuf; ±1%; 500 VDCW.	CY15C811F
C3270	CAPACITOR, FIXED, GLASS DIELECTRIC: 880 uuf; ±1%; 500 VDCW.	CY15C881F
C3271	CAPACITOR, FIXED, GLASS DIELECTRIC: 970 uuf; ±1%; 500 VDCW.	CY15C971F
C3272	CAPACITOR, VARIABLE, MICA DIELECTRIC: compression type; capacitance less than 190 uuf to more than 900 uuf; 350 VDCW.	CV111-11
C3273	CAPACITOR, VARIABLE, MICA DIELECTRIC: compression type; capacitance less than 390 uuf to more than 1400 uuf; 350 VDCW.	CV111-16
C3274	Same as C3272.	
C3275	CAPACITOR, FIXED, METALIZED PLASTIC: 1.0 uf; ±5%; 50 VDCW; epoxy case.	CN114-1R0-5J
CR3201	SEMICONDUCTOR DEVICE, DIODE: silicone; 175 V max. peak inverse voltage; 30 ma at 25°C and 15 ma at 150°C; two axial wire lead type terminals; heremetically sealed glass case.	1N463
CR3202	SEMICONDUCTOR DEVICE, SET: 4 matched diodes; 80 V max. continuous working voltage; peak rectified current, 90 ma; max. power dissipation 80 mw; max. FWD current plus 1 volt, 4 ma; max. reverse current at minus 5 volts, 5 ua; min. reverse voltage for zero dynamic resistance 100 volts.	DD100
CR3203	Same as CR3201.	
CR3204	Same as CR3201.	
EV3201	SHIELD, ELECTRON TUBE	TS102-U01
EV3202	SHIELD, ELECTRON TUBE	TS102-U02
EV3203	Same as EV3202.	
EV3204	Same as EV3202.	
J3201	CONNECTOR, RECEPTACLE, ELECTRICAL: RF type; 1 round male contact; straing type; series BNC to BNC.	JJ211
J3202 thru J3204	Same as J3201.	

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REF SYMBOL	DESCRIPTION	TMC PART NUMBER
J3205	CONNECTOR, RECEPTACLE, ELECTRICAL: 7 round #16 male contacts; straight type.	JJ245
J3206	CONNECTOR, RECEPTACLE, ELECTRICAL: 11 round #20 female contacts; straight type.	JJ242-3S
P3201	CONNECTOR, PLUG, ELECTRICAL: RF; 1 round female coaxial contact; straight type; series miniature bayonet lock. Part of W3201.	PL204
P3202	Same as P3201. Part of W3201	
P3203	Same as P3201. Part of W3202	
P3204	Same as P3201. Part of W3202	
R3201	NOT USED	
R3202	RESISTOR, FIXED, COMPOSITION: 100,000 ohms; ±5%; 1/2 watt.	RC20GF104J
R3203	RESISTOR, VARIABLE, COMPOSITION: 100,000 ohms; ±20%; 1/2 watt.	RV106UX8B104B
R3204	RESISTOR, FIXED, COMPOSITION: 1.5 megohms; ±5%; 1/2 watt.	RC20GF155J
R3205	Same as R3202.	
R3206	RESISTOR, FIXED, COMPOSITION: 6,800 ohms; ±5%; 1/2 watt.	RC20GF682J
R3207	RESISTOR, FIXED, COMPOSITION: 2,200 ohms; ±5%; 1/2 watt.	RC20GF222J
R3208	Same as R3202.	
R3209	RESISTOR, FIXED, COMPOSITION: 15,000 ohms; ±5%; 1 watt.	RC32GF153J
R3210	Same as R3202.	
R3211	RESISTOR, FIXED, COMPOSITION: 1 megohm; ±5%; 1/2 watt.	RC20GF105J
R3212	RESISTOR, FIXED, COMPOSITION: 470 ohms; ±5%; 1/2 watt.	RC20GF471J
R3213	RESISTOR, FIXED, COMPOSITION: 4,700 ohms; ±5%; 1/2 watt.	RC20GF472J
R3214	Same as R3202.	
R2315	RESISTOR, FIXED, COMPOSITION: 47 ohms; ±5%; 1/2 watt.	RC20GF470J
R3216	RESISTOR, FIXED, COMPOSITION: 22,000 ohms; ±5%; 1/2 watt.	RC20GF223J
R3217	Same as R3215.	
R3218	Same as R3215.	
R3219	RESISTOR, VARIABLE, COMPOSITION: 100 ohms; ±20%; 1/2 watt.	RV106UX8B101B
R3220	Same as R3202.	
R3221	Same as R3213.	
R3222	Same as R3215.	

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REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R3223	RESISTOR, FIXED, COMPOSITION: 150 ohms; ±5%; 1/2 watt.	RC20GF151J
R3224	Same as R3216.	
R3225	RESISTOR, FIXED, COMPOSITION: 3,300 ohms; ±5%; 1/2 watt.	RC20GF322J
R3226	RESISTOR, FIXED, COMPOSITION: 2,200 ohms; ±5%; 1 watt	RC32GF222J
R3227	Same as R3226.	
R3228	Same as R3216.	
R3229	Same as R3215.	
R3230	Same as R3225.	
R3231	Same as R3211.	
R3232	RESISTOR, FIXED, COMPOSITION: 15,000 ohms; ±5%; 1/2 watt.	RC20GF153J.
S3201 A, B, C, D, E, F	SWITCH, ROTARY: 9 sections; 12 positions; non-shorting type contacts rated for 1 amp at 28 volts dc or 5 amp at 110 vac.	SW291
T3201	TRANSFORMER, RADIO FREQUENCY: operation frequency range 27 kc to 36 kc; inductance 1.90 mh; hermetically sealed metal case.	TZ103-4
T3202	TRANSFORMER, RADIO FREQUENCY: operating frequency range 30.5 to 39.5 kc; inductance 1.20 mh; hermetically sealed metal case.	TZ103-5
T3203	TRANSFORMER, RADIO FREQUENCY: operating frequency range 30.5 kc to 39.5 kc; inductance 1.65 mh; hermetically sealed metal case.	TZ103-6
TB3201	TERMINAL BOARD ASSEMBLY	A2263-5
TB3202	TERMINAL BOARD ASSEMBLY	A2268-4
TP3201	TERMINAL, FEEDTHRU, INSULATED: 0.740" lg. x 3/16" dia.; 3/32 press-fit stud; teflon insulated, 2,000 v.	TE169-1
TP3202 thru TP3205	Same as TP3201.	
V3201	TUBE, ELECTRON: radio frequency amplifier pentode; 7 pin miniature.	6AS6
V3202	TUBE, ELECTRON: sharp-cutoff pentode; 7 pin miniature.	6AU6
V3203	TUBE, ELECTRON: sharp-cutoff pentode; 7 pin miniature.	6AH6
V3204	Same as V3202.	
W3201	CABLE ASSEMBLY RADIO FREQUENCY: consists of 7" of RF cable RG174/U, and two connectors symbol #P3201, P3202.	CA480-68-7
W3202	Same as W3201; consists of two connectors symbol #P3202, P3204.	

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REF SYMBOL	DESCRIPTION	TMC PART NUMBER
XC3201 thru XC3228	NOT USED	
XC3229	SOCKET, ELECTRON TUBE: octal type.	TS101P01
XCR3201	NOT USED	
XCR3202	SOCKET, ELECTRON TUBE: 7 pin miniature.	TS130-MBW
XV3201	SOCKET, ELECTRON TUBE: 7 pin miniature.	TS102P01
XV3202 thru XV3204	Same as XV3201.	
XY3201	SOCKET, CRYSTAL: 2 contacts' 0.050" dia. spaced 0.486" c to c.	TS104-2
XY3202 thru XY3210	Same as XY3201.	
Y3201	CRYSTAL UNIT, QUARTZ: 36.000 kc, ±.005%; 0° to +50°C operating temperature range; parallel resonance; 10 uuf; ±0.5 uuf load capacitance; fundamental operation; type HC-13/U holder.	CR109-25
Y3202	CRYSTAL UNIT, QUARTZ: 35.000 kc, ±.005%; 0° to +50°C operating temperature range; parallel resonance 10 uuf; ±0.5 uuf load capacitance; fundametal operation; type HC-13/U holder.	CR109-24
Y3203	CRYSTAL UNIT, QUARTZ: 34.000 kc, ±.005%; 0° to +50°C operating temperature range; parallel resonance; 10 uuf ±0.5 uuf load capacitance; fundamental operation; type HC-13/U holder.	CR109-23
Y3204	CRYSTAL UNIT, QUARTZ: 33.000 kc, ±.005%; 0° to +50°C operating temperature range; parallel resonance 10 uuf ±0.5 uuf load capacitance; fundamental operation; type HC-13/U holder.	CR109-22
Y3205	CRYSTAL UNIT, QUARTZ: 32.000 kc, ±.005%; 0° to +50°C operating temperature range; parallel resonance; 10 uuf ±0.5 uuf load capacitance; fundamental operation; type HC-13/U holder.	CR109-21
Y3206	CRYSTAL UNIT, QUARTZ: 31.000 kc, ±.005%; 0° to +50°C operating temperature range; parallel resonance 10 uuf ±0.5 uuf load capacitance; fundamental operation; type HC-13/U holder.	CR109-20
Y3207	CRYSTAL UNIT, QUARTZ: 30.000 kc, ±.005%; 0° to +50°C operating temperature range; parallel resonance; 10 uuf ±0.5 uuf load capacitance; fundamental operation; type HC-13/U holder.	CR109-19
Y3208	CRYSTAL UNIT, QUARTZ: 29.000 kc, ±.005%; 0° to +50°C operating temperature range; parallel resonance 10 uuf ±0.5 uuf load capacitoance; fundamental operation; type HC-13/U holder.	CR109-18
Y3209	CRYSTAL UNIT, QUARTZ: 28.000 kc, ±.005%; 0° to +50°C operating temperature range; parallel resonance; 10 uuf ±0.5 uuf load capacitance; fundamental operation; type HC-13/U holder.	CR109-17

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REF SYMBOL	DESCRIPTION	TMC PART NUMBER
Y3210	CRYSTAL UNIT, QUARTZ: 27.000 kc, ±.005%; 0° to +50°C operating temperature range; parallel resonance; 10 uuf ±0.5 uuf load capacitance; fundamental operation; type HC-13/U holder.	CR109-17

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REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C3301	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 1,000 uuf; ±10%; 500 VDCW.	CC100-9
C3302	CAPACITOR, FIXED, MICA DIELECTRIC: 100 uuf; ±10%; 500 VDCW.	CM15B101K
C3303	CAPACITOR, FIXED, MICA DIELECTRIC: 56 uuf; ±5%; 500 VDCW.	CM15B560J
C3304	Same as C3303.	
C3305	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100,000 uuf; +80% -20%; 300 VDCW.	CC100-37
C3306	Same as C3301.	
C3307	Same as C3302.	
C3308	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 uuf; GMV; 500 VDCW.	CC100-16
C3309 A,B,C	CAPACITOR, FIXED, ELECTROLYTIC: triple section; 20 uf each section; 450 VDCW; polarized; tubular case; plug-in type.	CE108-1
C3310	CAPACITOR, FIXED, MICA DIELECTRIC: 68 uuf; ±5%; 500 VDCW.	CM15B680J
C3311	CAPACITOR, FIXED, MICA DIELECTRIC: 430 uuf; ±5%; 500 VDCW.	CM15B431J
C3312 thru C3314	Same as C3305.	
C3315	CAPACITOR, FIXED, COMPOSITION: 05 uuf; ±10%; 500 VDCW.	CM15B050K
C3316	Same as C3302.	
C3317	Same as C3305.	
C3318	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 220,000 uuf; +80% -20%; 10 VDCW.	CC100-33
C3319	Same as C3308.	
C3320	CAPACITOR, FIXED, METALIZED PAPER DIELECTRIC: 2.0 uf; ±20%; 200 VDCW.	CP106H205-4
C3221	Same as C3305.	

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REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C3322	NOT USED	
C3323	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 20,000 uuf; +80% -20%; 500 VDCW.	CC100-24
C3324	CAPACITOR, FIXED, MICA DIELECTRIC: 22 uuf; ±5%; 500 VDCW.	CM15B220J
C3325	Same as C3315.	
C3326	Same as C3315.	
C3327	Same as C3302.	
C3328	CAPACITOR, VARIABLE, GLASS DIELECTRIC: 1 to 30 uuf; ±100%; 1,000 VDCW.	CV108-4
C3329 thru C3337	Same as C3328.	
C3338	CAPACITOR, FIXED, MICA DIELECTRIC: 1,100 uuf; ±5%; 500 VDCW.	CM20B112J
C3339	CAPACITOR, FIXED, GLASS DIELECTRIC: 75 uuf; ±1%; 500 VDCW.	CY10C750F
C3340	CAPACITOR, FIXED, GLASS DIELECTRIC: 91 uuf; ±1%; 500 VDCW.	CY10C910F
C3341	CAPACITOR, FIXED, GLASS DIELECTRIC: 96 uuf; ±1%; 500 VDCW.	CY10C960F
C3342	CAPACITOR, FIXED, GLASS DIELECTRIC: 106 uuf; ±1%; 500 VDCW.	CY10C1060F
C3343	CAPACITOR, FIXED, GLASS DIELECTRIC: 114 uuf; ±1%; 500 VDCW.	CY10C1140F
C3344	CAPACITOR, FIXED, GLASS DIELECTRIC: 126 uuf; ±1%; 500 VDCW.	CY10C1260F
C3345	CAPACITOR, FIXED, GLASS DIELECTRIC: 145 uuf; ±1%; 500 VDCW.	CY10C1450F
C3346	CAPACITOR, FIXED, GLASS DIELECTRIC: 150 uuf; ±1%; 500 VDCW.	CY10C151F
C3347	CAPACITOR, FIXED, GLASS DIELECTRIC: 180 uuf; ±1%; 500 VDCW.	CY10C181F
C3348	CAPACITOR, FIXED, MICA DIELECTRIC: 820 uuf; ±5%; 500 VDCW.	CM20B821J
C3349	CAPACITOR, FIXED, GLASS DIELECTRIC: 52 uuf; ±1%; 500 VDCW.	CY10C520F
C3350	CAPACITOR, FIXED, GLASS DIELECTRIC: 56 uuf; ±1%; 500 VDCW.	CY10C560F
C3351	CAPACITOR, FIXED, GLASS DIELECTRIC: 64 uuf; ±1%; 500 VDCW.	CY10C640F
C3352	CAPACITOR, FIXED, GLASS DIELECTRIC: 66 uuf; ±1%; 500 VDCW.	CY10C660F
C3353	CAPACITOR, FIXED, GLASS DIELECTRIC: 73 uuf; ±1%; 500 VDCW.	CY10C730F
C3354	CAPACITOR, FIXED, GLASS DIELECTRIC: 76 uuf; ±1%; 500 VDCW.	CY10C760F
C3355	CAPACITOR, FIXED, GLASS DIELECTRIC: 89 uuf; ±1%; 500 VDCW.	CY10C890F
C3356	CAPACITOR, FIXED, GLASS DIELECTRIC: 88 uuf; ±1%; 500 VDCW.	CY10C880F
C3357	CAPACITOR, FIXED, GLASS DIELECTRIC: 100 uuf; ±1%; 500 VDCW.	CY10C101F

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C3358	CAPACITOR, FIXED, MICA DIELECTRIC: 390 uuf; ±5%; 500 VDCW.	CM20B391J
C3359	CAPACITOR, FIXED, GLASS DIELECTRIC: 34 uuf; ±1%; 500 VDCW.	CY10C340F
C3360	Same as C3359.	
C3361	CAPACITOR, FIXED, GLASS DIELECTRIC: 38 uuf; ±1%; 500 VDCW.	CY10C380F
C3362	CAPACITOR, FIXED, GLASS DIELECTRIC: 40 uuf; ±1%; 500 VDCW.	CY10C400F
C3363	CAPACITOR, FIXED, GLASS DIELECTRIC: 44 uuf; ±1%; 500 VDCW.	CY10C440F
C3364	CAPACITOR, FIXED, GLASS DIELECTRIC: 47 uuf; ±1%; 500 VDCW.	CY10C470F
C3365	Same as C3349.	
C3366	Same as C3350.	
C3367	CAPACITOR, FIXED, GLASS DIELECTRIC: 61 uuf; ±1%; 500 VDCW.	CY10C610F
C3368	NOT USED	
C3369	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 2 uuf; ±.5 uuf; 500 VDCW.	CC21SL020C
C3370	CAPACITOR, VARIABLE, MICA DIELECTRIC: compression type; capacitance less than 140 uuf to more than 68 uuf; 350 VDCW.	CV111-9
C3371	CAPACITOR, VARIABLE MICA DIELECTRIC: compression type; capacitance less than 50 uuf to more than 380 uuf; 380 VDCW.	CV111-6
C3372	Same as C3371.	
C3373	Same as C3305.	
CR3301	SEMICONDUCTOR DEVICE, DIODE: silicon; 175 v max. peak inverse voltage; 30 ma at 25°C, two axial wire lead type terminals; hermetically sealed glass case.	1N463
CR3302	SEMICONDUCTOR DEVICE, SET: 4 matched diodes; 80 v max. continuous working voltage; peak rectified current 90 ma; max. power dissipation, 80 mw, max. forward current plus 1 volt 4 ma; max. reverse voltage for zero dynamic resistance 100 volts.	DD100
CR3303	SEMICONDUCTOR DEVICE, DIODE: silicon; 100 v max. reverse voltage; 40 ma at 25°C; and 10 ma at 150°C; hermetically sealed metal case.	1N303
CR3304	Same as CR3303.	
EV3301	SHIELD, ELECTRON TUBE	TS102U01
EV3302	SHIELD, ELECTRON TUBE	TS102U02
EV3303	Same as EV3302.	
EV3304	Same as EV3302.	
J3301	CONNECTOR, RECEPTACLE, ELECTRICAL: Rf type; 1 round male contact; straight type; series BNC to BNC.	JJ211

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REF SYMBOL	DESCRIPTION	TMC PART NUMBER
J3302 thru J3304	Same as J3301	
J3305	CONNECTOR, RECEPTACLE, ELECTRICAL: 7 round #16 male contacts; straight type.	JJ245
J3306	CONNECTOR, RECEPTACLE, ELECTRICAL: 14 round #20 female contacts; straight type.	JJ242-3S
P3301	CONNECTOR, PLUG, ELECTRICAL: RF; 1 round female coaxial contact; straight type; series miniature bayonet lock. Part of W3301	PL204
P3302	Same as P3301. Part of W3301.	
P3303	Same as P3301. Part of W3302.	
P3304	Same as P3301. Part of W3302.	
R3301	RESISTOR, FIXED, COMPOSITION: 2.2 megohms; ±5%; 1/2 watt.	RC20GF225J
R3302	RESISTOR, FIXED, COMPOSITION: 100,000 ohms; ±5%; 1/2 watt.	RC20GF104J
R3303	RESISTOR, VARIABLE, COMPOSITION: 100,000 ohms; ±10%; 1/2 watt.	RV106UX8B104A
R3304	RESISTOR, FIXED, COMPOSITION: 1.5 megohms; ±5%; 1/2 watt.	RC20GF155J
R3305	Same as R3302.	
R3306	NOT USED	
R3307	RESISTOR, FIXED, COMPOSITION: 2,200 ohms; ±5%; 1/2 watt.	RC20GF222J
R3308	Same as R3302.	
R3309	RESISTOR, FIXED, COMPOSITION: 15,000 ohms; ±5%; 1 watt.	RC32GF153J
R3310	Same as R3302.	
R3311	RESISTOR, FIXED, COMPOSITION: 4,700 ohms; ±5%; 1/2 watt.	RC20GF472J
R3312	Same as R3307.	
R3313	RESISTOR, FIXED, COMPOSITION: 1 megohm; ±5%; 1/2 watt.	RC20GF105J
R3314	Same as R3302.	
R3315	RESISTOR, FIXED, COMPOSITION: 150 ohms; ±5%; 1/2 watt.	RC20GF151J
R3316	RESISTOR, FIXED, COMPOSITION: 3,300 ohms; ±5%; 1/2 watt.	RC20GF332J
R3317	RESISTOR, FIXED, COMPOSITION: 22,000 ohms; ±5%; 1/2 watt.	RC20GF223J
R3318	RESISTOR, FIXED, COMPOSITION: 47 ohms; ±5%; 1/2 watt.	RC20GF470J
R3319	Same as R3318.	
R3320	RESISTOR, FIXED, COMPOSITION: 470,000 ohms; ±5%; 1/2 watt.	RC20GF474J

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REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R3321	Same as R3302.	
R3322	Same as R3311.	
R3323	Same as R3318.	
R3324	Same as R3315.	
R3325	Same as R3317.	
R3326	Same as R3316.	
R3327	Same as R3317.	
R3328	RESISTOR, FIXED, COMPOSITION: 2,200 ohms; ±5%; 1 watt.	RC32GF222J
R3329	Same as R3328.	
R3330	RESISTOR, VARIABLE, COMPOSITION: 100 ohms; ±10%; 1/2 watt.	RV106UX8B101A
R3331	Same as R3318.	
R3332	Same as R3302.	
S3301 A, B, C, D, E, F	SWITCH, ROTARY: 9 section; 12positions; non-shorting type contact rated for 1 amp at 28 volts dc or 5 amp at 110 volts ac.	SW291
T3301	TRANSFORMER, RADIO FREQUENCY: operating frequency range 320 kc to 410 kc; inductance 96 uh; hermetically sealed metal case.	TZ103-1
T3302	TRANSFORMER, RADIO FREQUENCY: operating frequency range 355 kc to 455 kc; inductance 116 uh; hermetically sealed metal case.	TZ103-2
T3303	TRANSFORMER, RADIO FREQUENCY: operating frequency range 355 kc to 455 kc; inductance 191 uh; hermetically sealed metal case.	TZ103-3
TB3301	TERMINAL BOARD ASSEMBLY	A2248-5
TB3302	TERMINAL BOARD ASSEMBLY	A2264-4
TP3301	TERMINAL, FEEDTHRU, INSULATED: 0.740" lg. x 3/16" dia.; 3/32 press-fit stud; teflon insulated 2,000 v.	TE169-1
TP3302 thru TP3305	Same as TP3301	
V3301	TUBE, ELECTRON: radio frequency amplifier pentode; 7 pin miniature.	6AS6
V3302	TUBE, ELECTRON: sharp-cutoff pentode; 7 pin miniature	6AU6
V3303	TUBE, ELECTRON: sharp-cutoff pentode; 7 pin miniature	6AH6
V3304	Same as V3302	
W3301	CABLE ASSEMBLY, RADIO FREQUENCY: consists of 7" of RF cable RG174/U and two connectors symbol P3301, P3302.	CA480-68-7

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REF SYMBOL	DESCRIPTION	TMC PART NUMBER
W3302	Same as W3301 consists of two connectors symbol # P3303, P3304.	
XC3301 thru XC3308	NOT USED	
XC3309	SOCKET, ELECTRON: octal type.	TS101P01
XCR3301	NOT USED	
XCR3302	SOCKET, ELECTRON TUBE: 7 pin miniature.	TS130-MBW
XV3301	SOCKET, ELECTRON TUBE: 7 pin miniature.	TS102P01
XV3302 thru XV3304	Same as XV3301.	
XY3301	SOCKET, CRYSTAL: 2 contacts; 0.050 in. dia. spaced 0.468 in. c to c.	TS104-2
XY3302 thru XY3310	Same as XY3301.	
Y3301	CRYSTAL UNIT, QUARTZ: 410.000 kc, ±.001%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf; ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder.	CR109-35
Y3302	CRYSTAL UNIT, QUARTZ: 400.000 kc, ±.001%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf; ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder.	CR109-34
Y3303	CRYSTAL UNIT, QUARTZ: 390.000 kc, ±.001%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf; ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder.	CR109-33
Y3304	CRYSTAL UNIT, QUARTZ: 380.000 kc, ±.001%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf; ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder.	CR109-32
Y3305	CRYSTAL UNIT, QUARTZ: 370.000 kc, ±.001%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf; ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder.	CR109-31
Y3306	CRYSTAL UNIT, QUARTZ: 360.000 kc, ±.001 %; 0° to + 50 °C operating temperature range; parallel resonance; 10 uuf; ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder.	CR109-30
Y3307	CRYSTAL UNIT, QUARTZ: 350.000 kc, ±.001%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf; ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder.	CR109-29
Y3308	CRYSTAL UNIT, QUARTZ: 340.000 kc, ±.001%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf; ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder.	CR109-28
Y3309	CRYSTAL UNIT, QUARTZ: 330.000 kc, ±.001%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf; ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder.	CR109-27

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REF SYMBOL	DESCRIPTION	TMC PART NUMBER
Y3310	CRYSTAL UNIT, QUARTZ: 320.000 kc, ±.001%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf; ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder.	CR109-26

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REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C3401	CAPACITOR, FIXED, MICA DIELECTRIC: 100 uuf; ±10%; 500 VDCW.	CM15B101K
C3402	Same as C3401.	
C3403	CAPACITOR, FIXED MICA DIELECTRIC: 20 uuf; ±5%; 500 VDCW.	CM15B200J
C3404	Same as C3403.	
C3405	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 uuf; GMV; 500 VDCW.	CC100-16
C3406	Same as C3401.	
C3407	Same as C3401.	
C3408	CAPACITOR, FIXED, MICA DIELECTRIC: 18 uuf; ±5%; 500 VDCW.	CM15B180J
C3409	CAPACITOR, FIXED, MICA DIELECTRIC: 33 uuf; ±5%; 500 VDCW.	CM15B330J
C3410	CAPACITOR, FIXED CERAMIC DIELECTRIC: 100,000 uuf; +80% -20%; 300 VDCW.	CC100-37
C3411	Same as C3405.	
C3412	Same as C3410.	
C3413	Same as C3401.	
C3414	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 1,000 uuf; ±10%; 500 VDCW.	CC100-9
C3415	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 20,000 uuf; +80% -20%; 500 VDCW.	CC100-24
C3416	CAPACITOR, FIXED, MICA DIELECTRIC: 68 uuf; ±5%; 500 VDCW.	CM15B680J
C3417	CAPACITOR, FIXED, MICA DIELECTRIC: 6,200 uuf; ±10%; 300 VDCW.	CM112E622K3S
C3418	Same as C3415.	
C3419	CAPACITOR, FIXED, MICA DIELECTRIC: 91 uuf; ±10%; 500 VDCW.	CM15B910K
C3420	CAPACITOR, FIXED, MICA DIELECTRIC: 05 uuf; ±5%; 500 VDCW.	CM15C050J03YY
C3421	Same as C3401.	
C3422	Same as C3420.	

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REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C3423	CAPACITOR, FIXED, MICA DIELECTRIC: 22 uuf; ±5%; 500 VDCW.	CM15C220J03
C3424	Same as C3416.	
C3425	Same as C3417.	
C3426 thru C3428	Same as C3415.	
C3429	CAPACITOR, FIXED, MICA DIELECTRIC: 75 uuf; ±5%; 500 VDCW.	CM15B750J
C3430	Same as C3420.	
C3431	CAPACITOR, FIXED, MICA DIELECTRIC: 5 uuf; ±10%; 500 VDCW.	CM111C050K5S
C3432	Same as C3431.	
C3433	CAPACITOR, FIXED, MICA DIELECTRIC: 47 uuf; ±5%; 500 VDCW.	CM15B470J
C3434	Same as C3401.	
C3435	Same as C3420.	
C3436	CAPACITOR, FIXED, MICA DIELECTRIC: 15 uuf; ±5%; 500 VDCW.	CM15D150J03YY
C3437	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100,000 uuf; +80% -20%; 100 VDCW.	CC100-28
C3438	NOT USED	
C3439	NOT USED	
C3440	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 2,200 uuf; GMV; 500 VDCW.	CC100-11
C3441	Same as C3414.	
C3442 thru C3444	Same as C3415.	
C3445	Same as C3423.	
C3446	Same as C3409.	
C3447	Same as C3420.	
C3448	CAPACITOR, VARIABLE, GLASS DIELECTRIC: 2 to 30 uuf; ±100%; 1,000 VDCW.	CV108-4
C3449 thru C3457	Same as C3448.	
C3458	CAPACITOR, VARIABLE, GLASS DIELECTRIC: 0.1 to 12 uuf; ±100% 1,000 VDCW.	CV108-2

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C3459 thru C3497	Same as C3458	
C3498	Same as C3405.	
C3499	Same as C3420.	
C3801	Same as C3420.	
C3802	Same as C3415.	
C3803	Same as C3405.	
C3804	Same as C3414.	
C3805	Same as C3414.	
C3806	Same as C3405.	
C3807	NOT USED	
C3808	Same as C3440.	
C3809	NOT USED	
C3810	Same as C3420.	
CR3401	SEMICONDUCTOR DEVICE, DIODE: germanium; 100 v min. peak inverse voltage; 60 ma at 250° C; axial wire lead type terminals; hermetically sealed glass case.	1N100
CR3402	Same as CR3401.	
CR3403	SEMICONDUCTOR DEVICE, DIODE: silicon; 175 v max. peak inverse voltage; 30 ma at 25° C and 15 ma at 150° C; two axial wire lead type terminals; hermetically sealed glass case.	1N463
CR3404 thru CR3407	Same as CR3401.	
CR3408	NOT USED	
CR3409	Same as CR3401.	
CR3410	Same as CR3401.	
CR3411	NOT USED	
CR3412	Same as CR3403.	
CR3413	Same as CR3403.	
CR3414	SEMICONDUCTOR DEVICE, DIODE: silicon; 180 v zener voltage tolerance 5%; 68 ma. max. zener impedance 90 ohms; one solder stud and one 10-32 thd stud type terminal; hermetically sealed metal and glass case.	1N2845B
CR3415	Same as CR3403.	

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REF SYMBOL	DESCRIPTION	TMC PART NUMBER
CR3416	Same as CR3403.	
CR3417	Same as CR3401.	
CR3418	Same as CR3401.	
EV3401	SHIELD, ELECTRON TUBE	TS103-U02
EV3402	SHIELD, ELECTRON TUBE	TS102-U01
EV3403	Same as EV3401.	
EV3404	SHIELD, ELECTRON TUBE	TS102-U02
EV3405	Same as EV3404.	
EV3406	Same as EV3404.	
J3401	CONNECTOR, RECEPTACLE, ELECTRICAL: RF type; 1 round male contact; straight type; series BNC to BNC.	JJ211
J3402 thru J3407	Same as J3401.	
J3408	CONNECTOR, RECEPTACLE, ELECTRICAL: 14 round #20 female contacts; straight type.	JJ242-3S
J3409	CONNECTOR, RECEPTACLE, ELECTRICAL: 7 round #16 male contacts; straight type.	JJ245
L3401	NOT USED	
L3402	COIL, RADIO FREQUENCY: fixed	CL275-220J
L3403	COIL, RADIO FREQUENCY: fixed	CL275-100J
R3401	RESISTOR, FIXED, COMPOSITION: 56,000 ohms; ±5%; 1/2 watt.	RC20GF563J
R3402	RESISTOR, FIXED, COMPOSITION: 10,000 ohms; ±5%; 1/2 watt.	RC20GF103J
R3403	Same as R3402.	
R3404	RESISTOR, FIXED, COMPOSITION: 5,600 ohms; ±5%; 1/2 watt.	RC20GF562J
R3405	Same as R3401.	
R3406	Same as R3401.	
R3407	Same as R3404.	
R3408	Same as R3401.	
R3409	RESISTOR, FIXED, COMPOSITION: 820,000 ohms; ±5%; 1/2 watt.	RC20GF824J
R3410	RESISTOR, FIXED, COMPOSITION: 100,000 ohms; ±5%; 1/2 watt.	RC20GF104J
R3411	RESISTOR, FIXED, COMPOSITION: 390,000 ohms; ±5%; 1/2 watt.	RC20GF394J

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R3412	RESISTOR, FIXED, COMPOSITION: 120,000 ohms; ±5%; 1/2 watt.	RC20GF124J
R3413	RESISTOR, FIXED, COMPOSITION: 6,800 ohms; ±5%; 1/2 watt.	RC20GF682J
R3414	RESISTOR, VARIABLE, COMPOSITION: 100,000 ohms; ±10%; 1/2 watt.	RV106UX8B104A
R3415	Same as R3410.	
R3416	RESISTOR, FIXED, COMPOSITION: 2,200 ohms; ±5%; 1/2 watt.	RC20GF222J
R3417	RESISTOR, FIXED, COMPOSITION: 15,000 ohms; ±5%; 1 watt.	RC32GF153J
R3418	Same as R3402.	
R3419	RESISTOR, FIXED, COMPOSITION: 3,300 ohms; ±5%; 1/2 watt.	RC20GF332J
R3420	Same as R3419.	
R3421	Same as R3419.	
R3422	RESISTOR, FIXED, COMPOSITION: 1,500 ohms; ±5%; 1/2 watt.	RC20GF152J
R3423	RESISTOR, FIXED, COMPOSITION: 100 ohms; ±5%; 1/2 watt.	RC20GF101J
R3424	RESISTOR, FIXED, COMPOSITION: 4,700 ohms; ±5%; 1 watt.	RC32GF472J
R3425	RESISTOR, FIXED, COMPOSITION: 2.7 megohms; ±5%; 1/2 watt.	RC20GF275J
R3426	Same as R3409.	
R3427	RESISTOR, FIXED, COMPOSITION: 22,000 ohms; ±5%; 1/2 watt.	RC20GF223J
R3428	RESISTOR, FIXED, COMPOSITION: 47 ohms; ±5%; 1/2 watt.	RC20GF470J
R3429	Same as R3410.	
R3430	Same as R3419.	
R3431	Same as R3423.	
R3432	RESISTOR, VARIABLE, COMPOSITION: 100 ohms; ±10%; 1/2 watt.	RV106UX8B101A
R3433	Same as R3428.	
R3434	Same as R3428.	
R3435	RESISTOR, FIXED, COMPOSITION: 1.0 megohms; ±5%; 1/2 watt.	RC20GF105J
R3436	Same as R3410.	
R3437	Same as R3427.	
R3438	RESISTOR, FIXED, COMPOSITION: 330,000 ohms; ±5%; 1/2 watt.	RC20GF334J
R3439	Same as R3427.	
R3440	Same as R3419.	
R3441	RESISTOR, FIXED, COMPOSITION: 68 ohms; ±5%; 1/2 watt.	RC20GF680J

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REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R3442	RESISTOR, VARIABLE, COMPOSITION: 10,000 ohms; ±10%; 1/2 watt.	RV106UX8B103A
R3443 thru R3447	NOT USED	
R3448	RESISTOR, FIXED, COMPOSITION: 1,800 ohms; ±5%; 1/2 watt.	RC20GF182J
R3449	Same as R3427.	
R3450	Same as R3419.	
R3451	Same as R3435.	
R3452	RESISTOR, FIXED, COMPOSITION: 150 ohms; ±5%; 1/2 watt.	RC20GF151J
R3453	Same as R3428.	
R3454	Same as R3413.	
R3455	Same as R3427.	
R3456	RESISTOR, FIXED, COMPOSITION: 330 ohms; ±5%; 2 watt.	RC42GF331J
R3457	Same as R3410.	
R3458	RESISTOR, FIXED, COMPOSITION: 33,000 ohms; ±5%; 1/2 watt.	RC20GF333J
R3459	Same as R3458.	
R3460	RESISTOR, VARIABLE, COMPOSITION.	RV113-2
R3461	Same as R3402.	
R3462	Same as R3448.	
R3463	RESISTOR, FIXED, COMPOSITION: 4,700 ohms; ±5%; 1/2 watt.	RC20GF472J
R3464	Same as R3417.	
R3465	Same as R3402.	
R3466	Same as R3402.	
R3467	RESISTOR, FIXED, COMPOSITION: 120 ohms; ±5%; 1/2 watt.	RC20GF121J
S3401 A, B, C, D, E, F, G	SWITCH, ROTARY: 7 sections; 12 positions; non-shorting type contacts; contact rated at 1 amp at 28 volts dc or 5 amp at 110 volts ac.	SW292
T3401	TRANSFORMER, PULSE: 3 windings; winding no. 1, 4.7 mh; turns ration 5:5:1.	TF228K15
T3402	TRANSFORMER, PULSE: 3 windings; winding no. 1, 0.1 mh; turns ration 3:3:1.	TF228U13
T3403	TRANSFORMER, RADIO FREQUENCY: operating frequency range 2.9 mc to 3.8 mc; primary inductance 14.2 uh; molded bakelite case.	TZ105-1

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REF SYMBOL	DESCRIPTION	TMC PART NUMBER
T3404	TRANSFORMER, RADIO FREQUENCY: operating frequency range 3.25 mc to 4.25 mc; primary inductance 13.8 uh; molded bakelite case.	TZ105-2
T3405	TRANSFORMER, RADIO FREQUENCY: operating frequency range 3.25 mc to 4.25 mc; primary inductance 15.0 uh; molded bakelite case.	TZ102
T3406	TRANSFORMER, RADIO FREQUENCY: tuned; operating frequency range 3.25 - 4.25 mc; primary inductance 39.0 uh, ±2 uh.	TT177
T3407	TRANSFORMER, RADIO FREQUENCY	TZ213
T3408	TRANSFORMER, RADIO FREQUENCY	TZ214
TB3401	TERMINAL BOARD ASSEMBLY	A2262-4
TB3402	TERMINAL BOARD ASSEMBLY	A2439-4
TB3403	PC BD, PH DET.	A4454
TB3404	TERMINAL BOARD ASSEMBLY	A3061-4
TP3401	TERMINAL, FEEDTHRU, INSULATED: 0.740" lg. x 3/16" dia.; 3/32 press-fit stud; teflon insulated 200v.	TE169-1
TP3402 thru TP3409	Same as TP3401.	
V3401 A, B	TUBE, ELECTRON: high-mu twin-triode, 9 pin miniature	12AU7
V3402	TUBE, ELECTRON: radio frequency amplifier pentode; 7 pin miniature	6AS6
V3403 A, B	TUBE, ELECTRON: high-mu twin-triode; 9 pin miniature	12AT7
V3404	TUBE, ELECTRON: sharp-cutoff pentode; 7 pin miniature	6AH6
V3405	Same as V3404.	
V3406	Same as V3404.	
V3407	TUBE, ELECTRON	6DS4
XV3401	SOCKET, ELECTRON TUBE: 9 pin miniature	TS103P01
XV3402	SOCKET, ELECTRON TUBE: 7 pin miniature	TS102P01
XV3403	Same as XV3401.	
XV3404 thru XV3406	Same as XV3402.	
XV3407	SOCKET, ELECTRICAL TUBE	TS183-1
XY3401	SOCKET, CRYSTAL: 2 contacts, 0.050 in. dia., spaced 0.486 in. c to c.	TS104-2

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REF SYMBOL	DESCRIPTION	TMC PART NUMBER
XY3402 thru XY3410	Same as XY3401	
Y3401	CRYSTAL UNIT, QUARTZ: 3.800000 mc, ±.001%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder.	CR109-45
Y3402	CRYSTAL UNIT, QUARTZ: 3.700000 mc, ±.001%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder.	CR109-45
Y3403	CRYSTAL UNIT, QUARTZ: 3.600000 mc, ±.001%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±0.5 uuf load capacitance; fundamental operation; tyep HC-6/U holder.	CR109-43
Y3404	CRYSTAL UNIT, QUARTZ: 3.500000 mc, ±.001%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder.	CR109-42
Y3405	CRYSTAL UNIT, QUARTZ: 3.400000 mc, ±.001%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder.	CR109-41
Y3406	CRYSTAL UNIT, QUARTZ: 3.300000 mc, ±.001%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder.	CR109-40
Y3407	CRYSTAL UNIT, QUARTZ: 3.200000 mc, ±.001%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder.	CR109-39
Y3408	CRYSTAL UNIT, QUARTZ: 3.100000mc, ±.001%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder.	CR109-38
Y3409	CRYSTAL UNIT, QUARTZ: 3.000000 mc ±.001%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder.	CR109-37
Y3410	CRYSTAL UNIT, QUARTZ: 2.900000 mc ±.001%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±0.5 uuf load capacitance; fundamental operation; type HC-6/U holder.	CR109-36

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REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C3501	CAPACITOR, VARIABLE, GLASS DIELECTRIC: 1 to 30 uuf; 1,000 VDCW.	CV108-4
C3502 thru C3508	Same as C3501.	
C3509	CAPACITOR, VARIABLE, GLASS DIELECTRIC: 0.8 to 18 uuf; 1,000 VDCW.	CV108-3

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C3510 thru C3516	Same as C3509.	
C3517	CAPACITOR, VARIABLE, GLASS DIELECTRIC: 0.7 to 12 uuf; 1,000 VDCW.	CV108-2
C3518 thru C3530	Same as C3517.	
C3531	CAPACITOR, FIXED, MICA DIELECTRIC: 5 uuf; ±5%; 500 VDCW.	CM15B050J
C3532 thru C3560	Same as C3531.	
C3561	CAPACITOR, FIXED, MICA DIELECTRIC: 470 uuf; ±5%; 500 VDCW.	CM15B471J
C3562	CAPACITOR, FIXED, MICA DIELECTRIC: 24 uuf; ±5%; 500 VDCW.	CM15B240J
C3563	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100,000 uuf; +80% -20%; 500 VDCW.	CC100-32
C3564	Same as C3563.	
C3565	Same as C3563.	
C3566	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 20,000 uuf; +80% -20%; 500 VDCW.	CC100-24
C3567	Same as C3563.	
C3568	Same as C3566.	
C3569	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 uuf; GMV; 500 VDCW.	CC100-16
C3570	NOT USED	
C3571	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 1,000 uuf; ±10%; 500 VDCW.	CC100-9
C3572	Same as C3571.	
C3573	Same as C3571.	
C3574	CAPACITOR, FIXED, MICA DIELECTRIC: 10 uuf; ±5%; 500 VDCW.	CM15B100J
C3575	CAPACITOR, FIXED, MICA DIELECTRIC: 2,000 uuf; ±10%; 300 VDCW.	CM112C202K3S
C3576	Same as C3566.	
C3577	Same as C3569.	
C3578	Same as C3571.	
C3579	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 02 uuf; ±0.5 uuf; 500 VDCW.	CC21SL020D

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REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C3580	CAPACITOR, FIXED, MICA DIELECTRIC: 20 uuf; ±5%; 500 VDCW.	CM15B200J
C3581	Same as C3509.	
C3582	Same as C3509.	
C3583	Same as C3571.	
C3584	Same as C3569.	
C3585	Same as C3575.	
C3586	Same as C3571.	
C3587	Same as C3580.	
C3588	Same as C3509.	
C3589	Same as C3579.	
C3590	Same as C3509.	
C3591	Same as C3571.	
C3592	Same as C3575.	
C3593	Same as C3509.	
C3594	Same as C3531.	
C3595	Same as C3579.	
C3596	Same as C3569.	
C3597	Same as C3580.	
C3598	Same as C3571	
C3599	NOT USED	
C3600	CAPACITOR, FIXED, MICA DIELECTRIC: 39 uuf; ±5%; 500 VDCW.	CM15B390J
C3601	CAPACITOR, FIXED, MICA DIELECTRIC: 47 uuf; ±5%; 500 VDCW.	CM15B470J
C3602	Same as C3566.	
C3603	Same as C3563.	
C3604	Same as C3566.	
C3605	Same as C3566.	
C3606	CAPACITOR, FIXED, MICA DIELECTRIC: 27 uuf; ±5%; 500 VDCW.	CM15B270J
C3607	Same as C3561.	
C3608	Same as C3566.	
C3609	Same as C3563.	

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C3610	CAPACITOR, FIXED, MICA DIELECTRIC: 33 uuf; ±5%; 500 VDCW.	CM15B330J
C3611	Same as C3569.	
C3612	Same as C3569.	
C3613	Same as C3571.	
C3614	Same as C3571.	
C3615	Same as C3569.	
C3616	CAPACITOR, FIXED, MICA DIELECTRIC: 91 uuf; ±5%; 500 VDCW.	CM15B910J
C3617	Same as C3571.	
C3618	Same as C3571.	
C3619	Same as C3569.	
C3620	Same as C3575.	
C3621	CAPACITOR, FIXED, MICA DIELECTRIC: 22 uuf; ±5%; 500 VDCW.	CM15B220J
C3622	Same as C3621.	
C3623	Same as C3509.	
C3624	Same as C3571.	
C3625	Same as C3571.	
C3626	Same as C3575.	
C3627	Same as C3621.	
C3628	Same as C3509.	
C3629	Same as C3621.	
C3630	Same as C3571.	
C3631	Same as C3571.	
C3632	Same as C3575.	
C3633	Same as C3571.	
C3634	CAPACITOR, FIXED, MICA DIELECTRIC: 15 uuf; ±5%; 500 VDCW.	CM15B150J
C3635	Same as C3509.	
C3636	Same as C3531.	
C3637	Same as C3580.	
C3638 thru C3640	Same as C3566.	

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REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C3641	NOT USED	
C3642	Same as C3531.	
C3643	Same as C3634.	
C3644	CAPACITOR, FIXED, MICA DIELECTRIC: 200 uuf; ±5%; 500 VDCW	CM15B201J
C3645	Same as C3571.	
C3646	Same as C3531.	
C3647	CAPACITOR, VARIABLE, CERAMIC DIELECTRIC: 5.5 - 18 PF	CV112-1
EV3501	SHIELD, ELECTRON TUBE	TS103U03
EV3502	SHIELD, ELECTRON TUBE	TS102U02
EV3503	Same as EV3502.	
EV3504	SHIELD, ELECTRON TUBE	TS102U01
EV3505	Same as EV3501.	
EV3506 thru EV3510	Same as EV3504.	
EV3511	Same as EV3502.	
EV3512	Same as EV3502.	
J3501	CONNECTOR, RECEPTACLE, ELECTRICAL: RF type; 1 round male contact; straight type; series BNC to BNC.	JJ211
J3502 thru J3505	Same as J3501.	
J3506	CONNECTOR, RECEPTACLE, ELECTRICAL: 7 round #16 male contacts; straight type.	JJ245
J3507	CONNECTOR, RECEPTACLE, ELECTRICAL: 14 round #20 female contacts; straight type.	JJ242-3S
J3508	Same as J3507.	
L3501	COIL, RADIO FREQUENCY: fixed; 0.68 uh; ±20%; 0.08 ohms dc resistance; molded case.	CL270-0.68
L3502	COIL, RADIO FREQUENCY: fixed, 48 to 78 mc; 0.17 uh ±0.03 uh at 25.2 mc; phenolic.	CL309
L3503	COIL, RADIO FREQUENCY: fixed; 2.5 mh; ±10%; 26 ohms dc resistance; 100 ma current rating; molded case	CL140-1
L3504	COIL, RADIO FREQUENCY: fixed; .150 mh; ±10%; 4.0 ohms dc resistance; 100 ma current rating; molded case.	CL140-2

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
L3505.1	CORE, TOROID: bead type; powder iron.	CI120-1
L3505.2 thru L3505.6	Same as L3505.1.	
L3506	Same as L3503.	
L3507	COIL, RADIO FREQUENCY: fixed; 8.2 uh; 2.10 ohms dc resistance.	CL240-8.2
L3508	Same as L3507.	
L3509	COIL, RADIO FREQUENCY: fixed; 40.5 mc, ±1 mc; 1 amp current rating	CL293
L3510.1 thru L3510.6	Same as L3505.1.	
L3511.1 thru L3511.6	Same as L3505.1.	
L3512.1 thru L3512.6	Same as L3505.1.	
L3513	Same as L3507.	
L3514.1 thru L3514.6	Same as L3505.1.	
L3515	Same as L3504.	
L3516	Same as L3504.	
L3517	Same as L3503.	
L3518.1 thru L3518.6	Same as L3505.1.	
L3519.1 thru L3519.6	Same as L3505.1.	
L3520	COIL, RADIO FREQUENCY: fixed; .65 uh; ±10%; 1/2 ohm dc resistance; 10 amp current rating; 44 mc operating frequency.	CL295
L3521.1 thru L3521.6	Same as L3505.1.	
L3522	Same as L3509.	
L3523	Same as L3503.	
L3524	Same as L3503.	

1 MC SELECTOR DECK

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
L3525	Same as L3507.	
L3526	COIL, RADIO FREQUENCY: fixed; 47.0 uh; ±10%; 2.3 ohms dc resistance.	CL240-47
L3527	COIL, RADIO FREQUENCY: fixed; 22.0 uh; ±10%; 0.9 ohms dc resistance.	CL240-22
L3528	Same as L3509.	
L3529.1 thru L3529.6	Same as L3505.1.	
L3530.1 thru L3530.6	Same as L3505.1.	
L3531.1 thru L3531.6	Same as L3505.1.	
L3532.1 thru L3532.6	Same as L3505.1.	
PS3501	SUPPRESSOR, PARASITIC: 5 turns no. 22 wire on 47 ohm; 1/2 watt resistor.	AX163
PS3502 thru PS3508	Same as PS3501.	
R3501	RESISTOR, FIXED, COMPOSITION: 180 ohms; ±5%; 1/2 watt.	RC20GF181J
R3502	Same as R3501.	
R3503	RESISTOR, FIXED, COMPOSITION: 2,200 ohms; ±5%; 1/2 watt.	RC20GF222J
R3504	Same as R3503.	
R3505	Same as R3503.	
R3506	RESISTOR, FIXED, COMPOSITION: 330,000 ohms; ±5%; 1/2 watt.	RC20GF334J
R3507	RESISTOR, FIXED, COMPOSITION: 47,000 ohms; ±5%; 1/2 watt.	RC20GF473J
R3508	RESISTOR, FIXED, COMPOSITION: 22,000 ohms; ±5%; 1/2 watt.	RC20GF223J
R3509	RESISTOR, FIXED, COMPOSITION: 3,300 ohms; ±5%; 1/2 watt.	RC20GF332J
R3510	RESISTOR, FIXED, COMPOSITION: 47 ohms; ±5%; 1/2 watt.	RC20GF470J
R3511	RESISTOR, FIXED, COMPOSITION: 100,000 ohms; ±5%; 1/2 watt.	RC20GF104J
R3512	RESISTOR, FIXED, COMPOSITION: 1,500 ohms; ±5%; 1/2 watt.	RC20GF152J
R3513	Same as R3511	

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R3514	RESISTOR, FIXED, COMPOSITION: 33,000 ohms; ±5%; 1/2 watt.	RC20GF333J
R3515	Same as R3501.	
R3516	RESISTOR, FIXED, COMPOSITION: 4,700 ohms; ±5%; 1/2 watt.	RC20GF472J
R3517	Same as R3514.	
R3518	Same as R3516.	
R3519	RESISTOR, FIXED, COMPOSITION: 10,000 ohms; ±5%; 1/2 watt.	RC20GF103J
R3520	Same as R3501.	
R3521	Same as R3511.	
R3522	RESISTOR, FIXED, COMPOSITION: 8,200 ohms; ±5%; 1/2 watt.	RC20GF822J
R3523	RESISTOR, FIXED, COMPOSITION: 1,000 ohms; ±5%; 1/2 watt.	RC20GF102J
R3524	RESISTOR, FIXED, COMPOSITION: 150 ohms; ±5%; 1/2 watt.	RC20GF151J
R3525	Same as R3508.	
R3526	RESISTOR, FIXED, COMPOSITION: 12,000 ohms; ±5%; 1 watt.	RC32GF123J
R3527	RESISTOR, FIXED, COMPOSITION: 1.0 megohms; ±5%; 1/2 watt.	RC20GF105J
R3528	RESISTOR, FIXED, COMPOSITION: 120,000 ohms; ±5%; 1/2 watt.	RC20GF124J
R3529	Same as R3510.	
R3530	Same as R3524.	
R3531	RESISTOR, FIXED, COMPOSITION: 68,000 ohms; ±5%; 1/2 watt.	RC20GF683J
R3532	Same as R3501.	
R3533	RESISTOR, FIXED, COMPOSITION: 330 ohms; ±5%; 1/2 watt.	RC20GF331J
R3534	Same as R3516.	
R3535	Same as R3514.	
R3536	RESISTOR, FIXED, COMPOSITION: 10 ohms; ±5%; 1/2 watt.	RC20GF100J
R3537	Same as R3519.	
R3538	Same as R3519.	
R3539	RESISTOR, FIXED, COMPOSITION: 820,000 ohms; ±5%; 1/2 watt.	RC20GF824J
R3540	Same as R3531.	
R3541	Same as R3509.	
R3542	Same as R3524.	
R3543	Same as R3514.	

1 MC SELECTOR DECK

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R3544	Same as R3506.	
R3545	Same as R3501.	
R3546	Same as R3516.	
R3547	Same as R3506.	
R3548	Same as R3514.	
R3549	Same as R3516.	
R3550	Same as R3501.	
R3551	RESISTOR, FIXED, COMPOSITION: 27,000 ohms; ±5%; 1/2 watt.	RC20GF273J
R3552	Same as R3503.	
R3553	Same as R3524.	
R3554	Same as R3510.	
R3555	Same as R3511.	
R3556 thru R3558	Same as R3508.	
R3559	Same as R3510.	
S3501 A, B, C, D	SWITCH, ROTARY: 4 section; 32 positions; shorting type contacts; contact rating, 2 amps, 125 vac.	SW300
T3501	TRANSFORMER, RADIO FREQUENCY: fixed, 43 mc operating frequency; primary inductance .65 mh; ±10%; secondary inductance .60 mh, ±10%.	AT104
T3502	Same as T3501.	
T3503	TRANSFORMER, RADIO FREQUENCY: tuned; 2 mc operating frequency; primary inductance 140 uuf, ±10%; consists of one 12 uuf capacitor in primary.	TT176
T3504	TRANSFORMER, RADIO FREQUENCY: tuned; 3.25 to 4.25 mc operating frequency range; primary inductance 30.0 uh; consists of one 27,000 ohm 1/2 watt resistor and one 30 uuf capacitor in primary.	TT178
T3505	TRANSFORMER, RADIO FREQUENCY: tuned; 1 mc operating frequency; primary inductance 140 uh; ±10%; consists of 100 uuf capacitor in primary.	TT175
TP3501	TERMINAL, FEEDTHRU, INSULATED: 0.740" lg. x 3/16" dia.; 3/32 press-fit stud; teflon insulated 2,000 v.	TE169-1
TP3502 thru TP3509	Same as TP3501.	
V3501 A, B	TUBE, ELECTRON: high-mu triode sharp-cutoff pentode; 9 pin miniature	6AW8

1 MC SELECTOR DECK

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
V3502	TUBE, ELECTRON: sharp-cutoff pentode; 7 pin miniature.	6EW6
V3503	TUBE, ELECTRON: high-mu triode; 7 pin miniature.	6AB4
V3504	TUBE, ELECTRON: sharp-cutoff pentode; 7 pin miniature.	6AK5
V3505	TUBE, ELECTRON: medium-mu triode; 9 pin miniature.	6S4
V3506 thru V3510	Same as V3504.	
V3511	TUBE, ELECTRON: pentagrid converter; 7 pin miniature.	6BE6
V3512	TUBE, ELECTRON: sharp-cutoff pentode; 7 pin miniature.	6AU6
XV3501	SOCKET, ELECTRON TUBE: 9 pin miniature.	TS103P01
XV3502	SOCKET, ELECTRON TUBE: 7 pin miniature.	TS102P01
XV3503	Same as XV3502.	
XV3504	Same as XV3502.	
XV3505	Same as XV3501.	
XV3506 thru XV3512	Same as XV3502.	
XY3501 A, B	JACK, TIP: nominal RMS voltage at 60 cps, 750 v; 0.5 uuf; with white teflon body.	JJ219-18-9
XY3502 A, B thru XY3530 A, B	Same as XY3501A, B.	
Y3501	CRYSTAL UNIT, QUARTZ: 48.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-46
Y3502	CRYSTAL UNIT, QUARTZ: 49.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-47
Y3503	CRYSTAL UNIT, QUARTZ: 50.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-48
Y3504	CRYSTAL UNIT, QUARTZ: 51.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-49
Y3505	CRYSTAL UNIT, QUARTZ: 52.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonancae; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-50

1 MC SELECTOR DECK

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
Y3506	CRYSTAL UNIT, QUARTZ: 53.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-51
Y3507	CRYSTAL UNIT, QUARTZ: 54.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-52
Y3508	CRYSTAL UNIT, QUARTZ: 55.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-53
Y3509	CRYSTAL UNIT, QUARTZ: 56.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-54
Y3510	CRYSTAL UNIT, QUARTZ: 57.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-55
Y3511	CRYSTAL UNIT, QUARTZ: 58.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-56
Y3512	CRYSTAL UNIT, QUARTZ: 59.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-57
Y3513	CRYSTAL UNIT, QUARTZ: 60.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-58
Y3514	CRYSTAL UNIT, QUARTZ: 61.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-59
Y3515	CRYSTAL UNIT, QUARTZ: 62.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-60
Y3516	CRYSTAL UNIT, QUARTZ: 63.500 mc, ±.05% 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-61
Y3517	CRYSTAL UNIT, QUARTZ: 64.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-62
Y3518	CRYSTAL UNIT, QUARTZ: 65.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-63
Y3519	CRYSTAL UNIT, QUARTZ: 66.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-64

1 MC SELECTOR DECK

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
Y3520	CRYSTAL UNIT, QUARTZ: 67.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-65
Y3521	CRYSTAL UNIT, QUARTZ: 68.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-66
Y3522	CRYSTAL UNIT, QUARTZ: 69.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-67
Y3523	CRYSTAL UNIT, QUARTZ: 70.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-68
Y3524	CRYSTAL UNIT, QUARTZ: 71.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-69
Y3525	CRYSTAL UNIT, QUARTZ: 72.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-70
Y3526	CRYSTAL UNIT, QUARTZ: 73.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-71
Y3527	CRYSTAL UNIT, QUARTZ: 74.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-72
Y3528	CRYSTAL UNIT, QUARTZ: 75.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-73
Y3529	CRYSTAL UNIT, QUARTZ: 76.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-74
Y3530	CRYSTAL UNIT, QUARTZ: 77.500 mc, ±.05%; 0° to +50° C operating temperature range; parallel resonance; 10 uuf ±20 uuf load capacitance; fundamental operation; type HC-18/U holder.	CR109-75
Z3501	FILTER, LOWPASS: cutoff frequency 33.75 mc; input impedance 50 ohms; output impedance 50 ohms; hermetically sealed metal case.	FX179
Z3502	FILTER, LOWPASS: cutoff frequency 37 mc; input impedance 150 ohms; output impedance 150 ohms; hermetically sealed metal case.	FX180

REGENERATIVE DIVIDER

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C3701	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 uuf; GMV; 500 VDCW.	CC100-16
C3702	Same as C3701.	
C3703	CAPACITOR, FIXED, PAPER DIELECTRIC: mylar type; 100,000 uuf; ±20%; 300 VDCW.	CN106D104M
C3704	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100,000 uuf; +80% - 20%; 100 VDCW.	CC100-28
C3705	Same as C3703.	
C3706	Same as C3703.	
C3707	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 20,000 uuf; +80% - 20%; 500 VDCW.	CC100-24
C3708	CAPACITOR, FIXED MICA DIELECTRIC: 300 uuf, ±5%; 500 VDCW.	CM15B301J
C3709	Same as C3703.	
C3710	Same as C3707.	
C3711	CAPACITOR, FIXED, MICA DIELECTRIC: 10 uuf; ±10%; 500 VDCW.	CM15B100K
C3712	Same as C3703.	
C3713	Same as C3703.	
C3714	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100,000 uuf; +80% - 20%; 300 VDCW.	CC100-37
EV3701	SHIELD, ELECTRON TUBE	TS102-U02
EV3702	Same as EV3701.	
EV3703	SHIELD, ELECTRON TUBE	TS103-U02
J3701	CONNECTOR, RECEPTACLE, ELECTRICAL: RF type; 1 round male contact; straight type; series BNC to BNC.	JJ211
J3702	Same as J3701.	
L3701	COIL, RADIO FREQUENCY: molded; 100 ma; 2.5 mh; ±10%.	CL140-1
L3702	COIL, RADIO FREQUENCY: tuned; 250 kc operating frequency; includes one 680 uuf capacitor.	AC125
L3703	COIL, RADIO FREQUENCY: tuned; 750 kc operating frequency; includes one 3,000 uuf capacitor.	AC127
L3704	COIL, RADIO FREQUENCY: tuned; 250 kc operating frequency; includes two capacitors, one 680 uuf and 3,000 uuf.	AC126
L3705.1	CORE, TOROID: bead type; power iron.	CI120-1

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
L3705.2 thru L3705.6	Same as L3705.1.	
L3706.1 thru L3706.6	Same as L3705.1.	
L3707.1 thru L3707.6	Same as L3705.1.	
L3708.1 thru L3708.6	Same as L3705.1.	
L3709.1 thru L3709.6	Same as L3705.1.	
L3710.1 thru L3710.6	Same as L3705.1.	
P3701	CONNECTOR, PLUG, ELECTRICAL: 5 round 16 male contacts; straight type.	PL225-1P
R3701	RESISTOR, FIXED, COMPOSITION: 100,000 ohms; ±5%; 1/2 watt.	RC20GF104J
R3702	RESISTOR, FIXED, COMPOSITION: 680 ohms; ±5%; 1/2 watt.	RC20GF681J
R3703	RESISTOR, FIXED, COMPOSITION: 6,800 ohms; ±5%; 1/2 watt.	RC20GF682J
R3704	RESISTOR, FIXED, COMPOSITION: 2,200 ohms: ±5%; 1/2 watt.	RC20GF22J
R3705	RESISTOR, FIXED, COMPOSITION: 22,000 ohms; ±5%; 1/2 watt.	RC20GF223J
R3706	RESISTOR, FIXED, COMPOSITION: 150 ohms; ±5%; 1/2 watt.	RC20GF151J
R3707	Same as R3701.	
R3708	RESISTOR, FIXED, COMPOSITION: 12,000 ohms; ±5%; 1 watt.	RC32GF123J
R3709	RESISTOR, FIXED, COMPOSITION: 8,200 ohms; ±5%; 1/2 watt.	RC20GF822J
R3710	RESISTOR, FIXED, COMPOSITION: 330,000 ohms; ±5%; 1/2 watt.	RC20GF334J
R3711	Same as R3702.	
R3712	RESISTOR, FIXED, COMPOSITION: 220 ohms; ±5%; 1/2 watt.	RC20GF221J
R3713	Same as R3701.	
R3714	Same as R3712.	
R3715	RESISTOR, FIXED, COMPOSITION: 33,000 ohms; ±5%; 1/2 watt.	RC20GF333J
R3716	RESISTOR, FIXED, COMPOSITION: 1,000 ohms; ±5%; 1/2 watt.	RC20GF102J

REGENERATIVE DIVIDER

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
T3701	TRANSFORMER, PULSE: 3 windings; winding no. 1, 4.7 mh; turns ration 5:5:1.	TF228-K15
TP3701	TERMINAL, FEEDTHRU, INSULATED: 0.740" lg. x 3/16" dia.; 3/32 press-fit stud; teflon insulated 2,000 v.	TE169-2
TP3702	Same as TP3701.	
V3701	TUBE, ELECTRON: high mu-triode; 7 pin miniature.	6AB4
V3702	TUBE, ELECTRON: pentagrid amplifier; 7 pin miniature.	6CS6
V3703 A, B	TUBE, ELECTRON: medium mu-triode shart cutoff pentode; 9 pin miniature.	6U8A
XV3701	SOCKET, ELECTRON TUBE: 7 pin miniature.	TS102P01
XV3702	Same as XV3701.	
XV3703	SOCKET, ELECTRON TUBE: 9 pin miniature	TS103P01

SECTION 7
SCHEMATIC DIAGRAMS

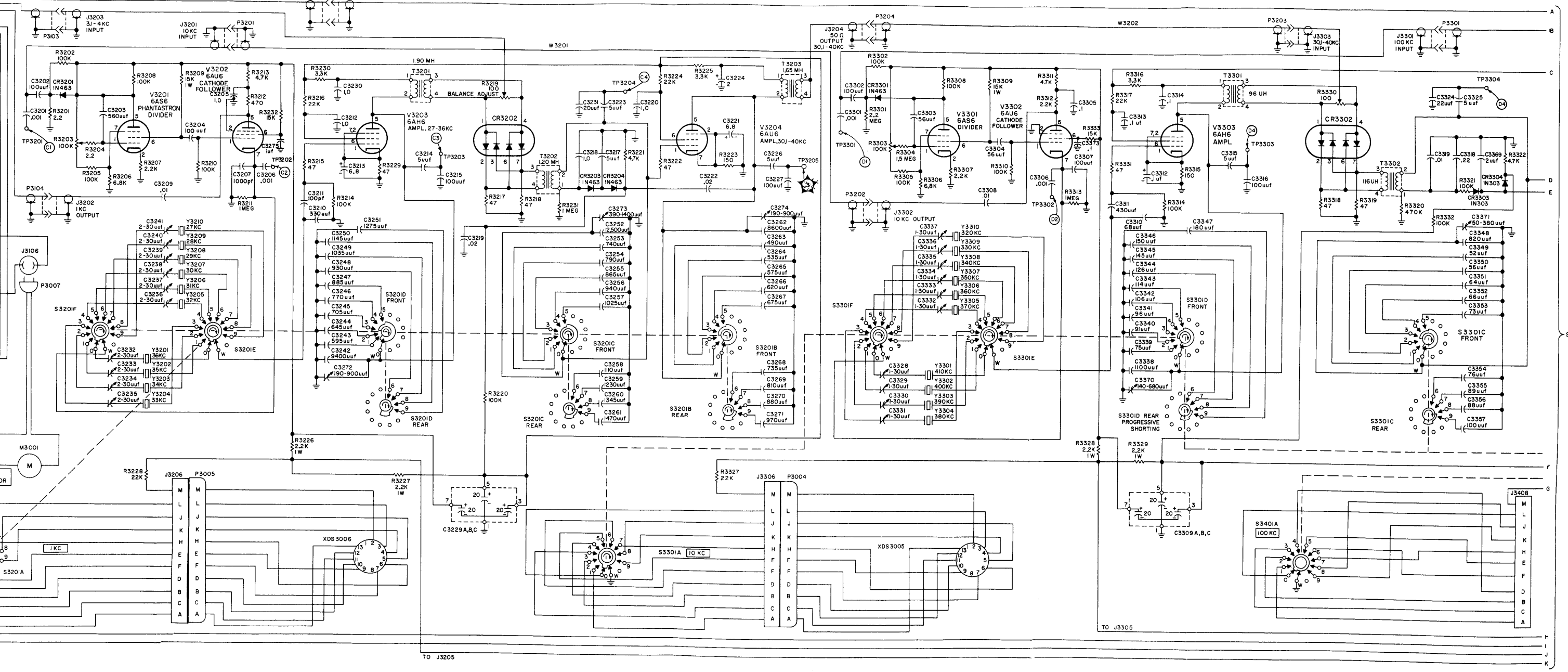
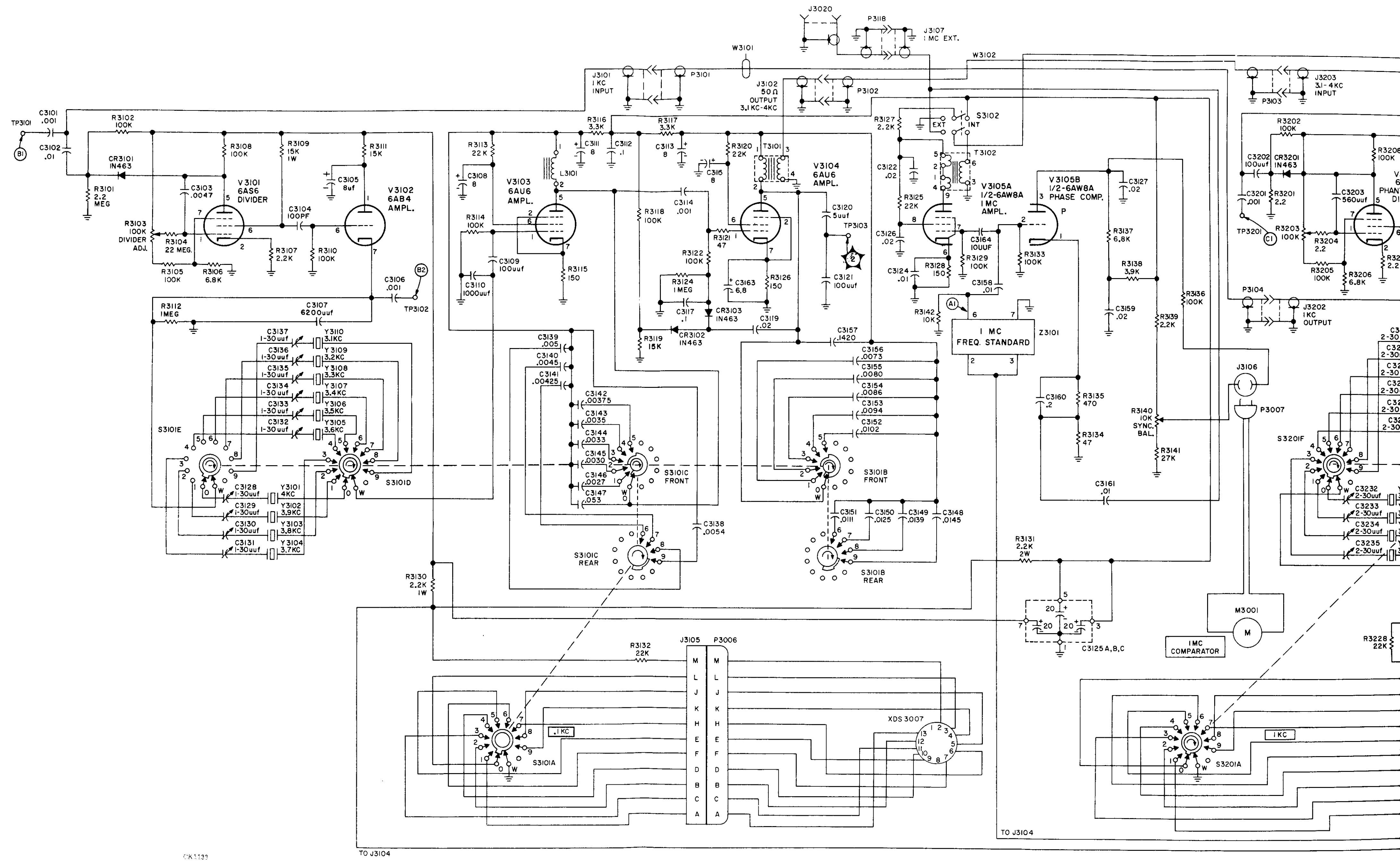


Figure 7-1. HFS-2 Schematic Diagram
(Sheet 1 of 3)


V3101 6AS6 DIVIDER
V3102 6AB4 AMPL.
V3103 6AU6 AMPL.
V3104 6AU6 AMPL.
V3105A 1/2-6AW8A 1MC AMPL.
V3105B 1/2-6AW8A PHASE COMP.
1 MC FREQ. STANDARD
Z3101
J3101 1KC INPUT
J3102 50Ω OUTPUT 3.1KC-4KC
J3107 1MC EXT.
J3202 1KC OUTPUT
J3203 3.1-4KC INPUT
S3101C FRONT
S3101C REAR
S3101B FRONT
S3101B REAR
S3101D
S3101E
S3101A
S3201A
S3201F
XDS 3007
J3105
P3006
M3001
1MC COMPARATOR
R3140 10K SYNC. BAL.
R3103 100K DIVIDER ADJ.
C3125 A,B,C
TO J3104

012663001L

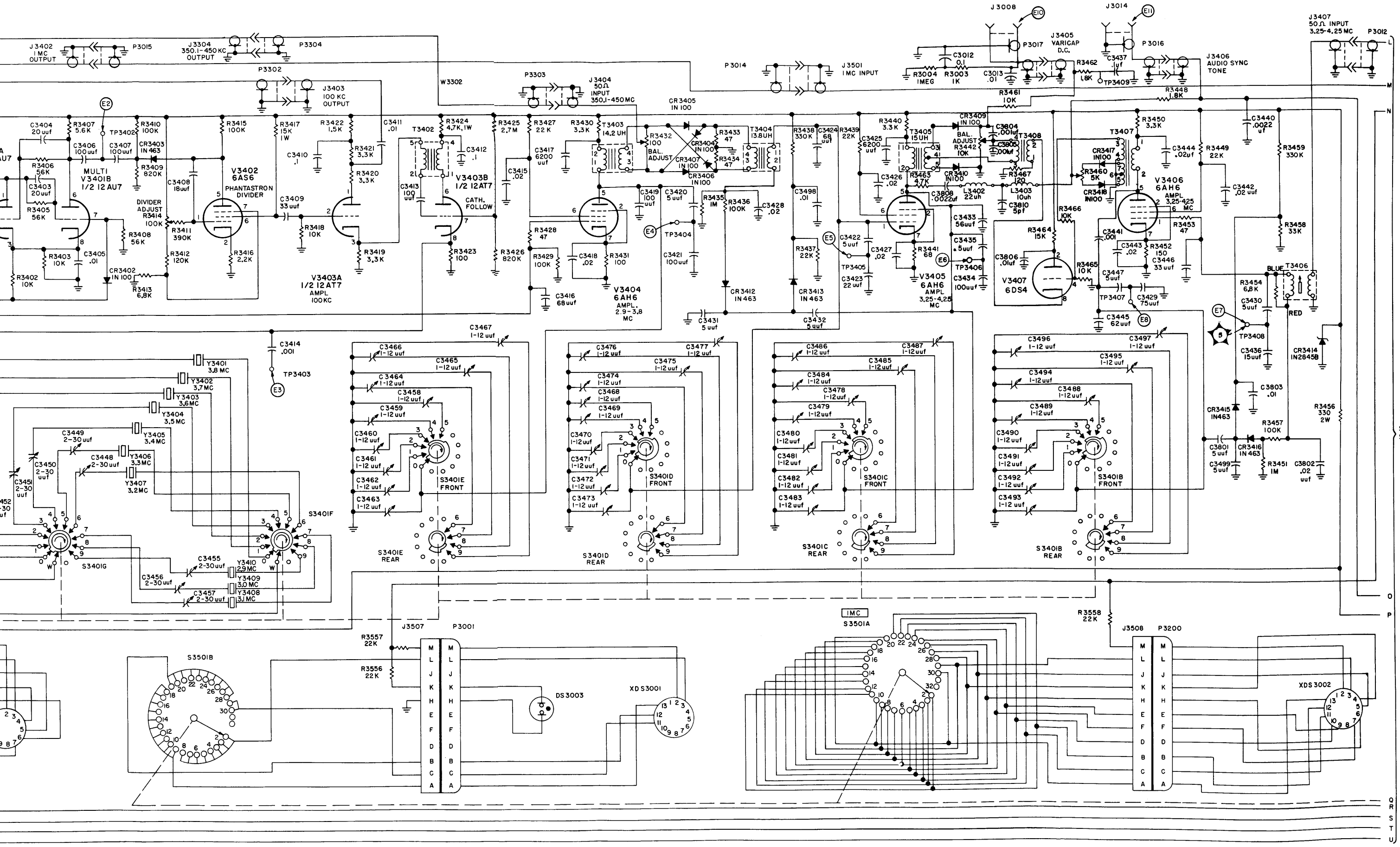
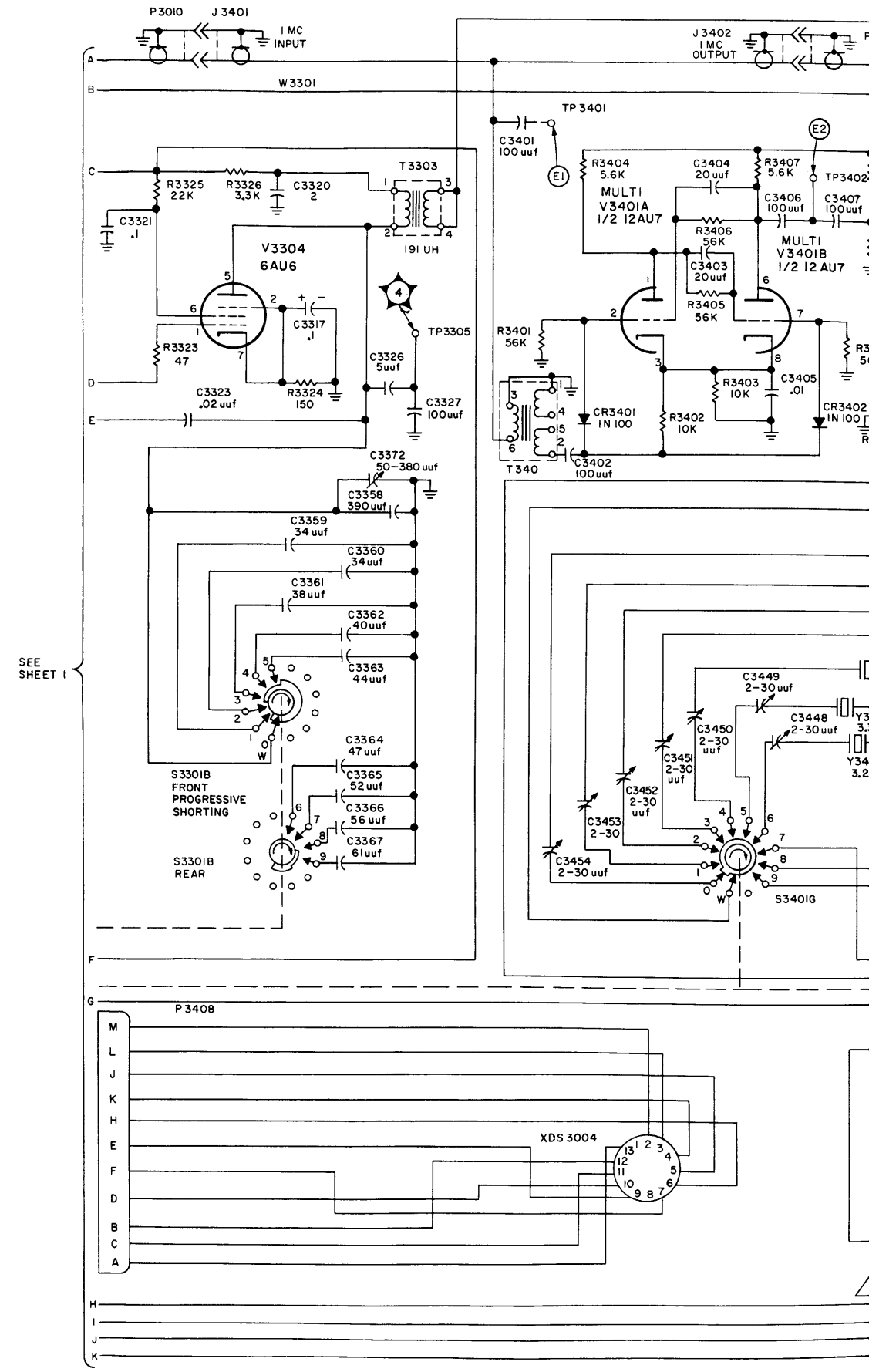


Figure 7-1. HFS-2 Schematic Diagram
(Sheet 2 of 3)



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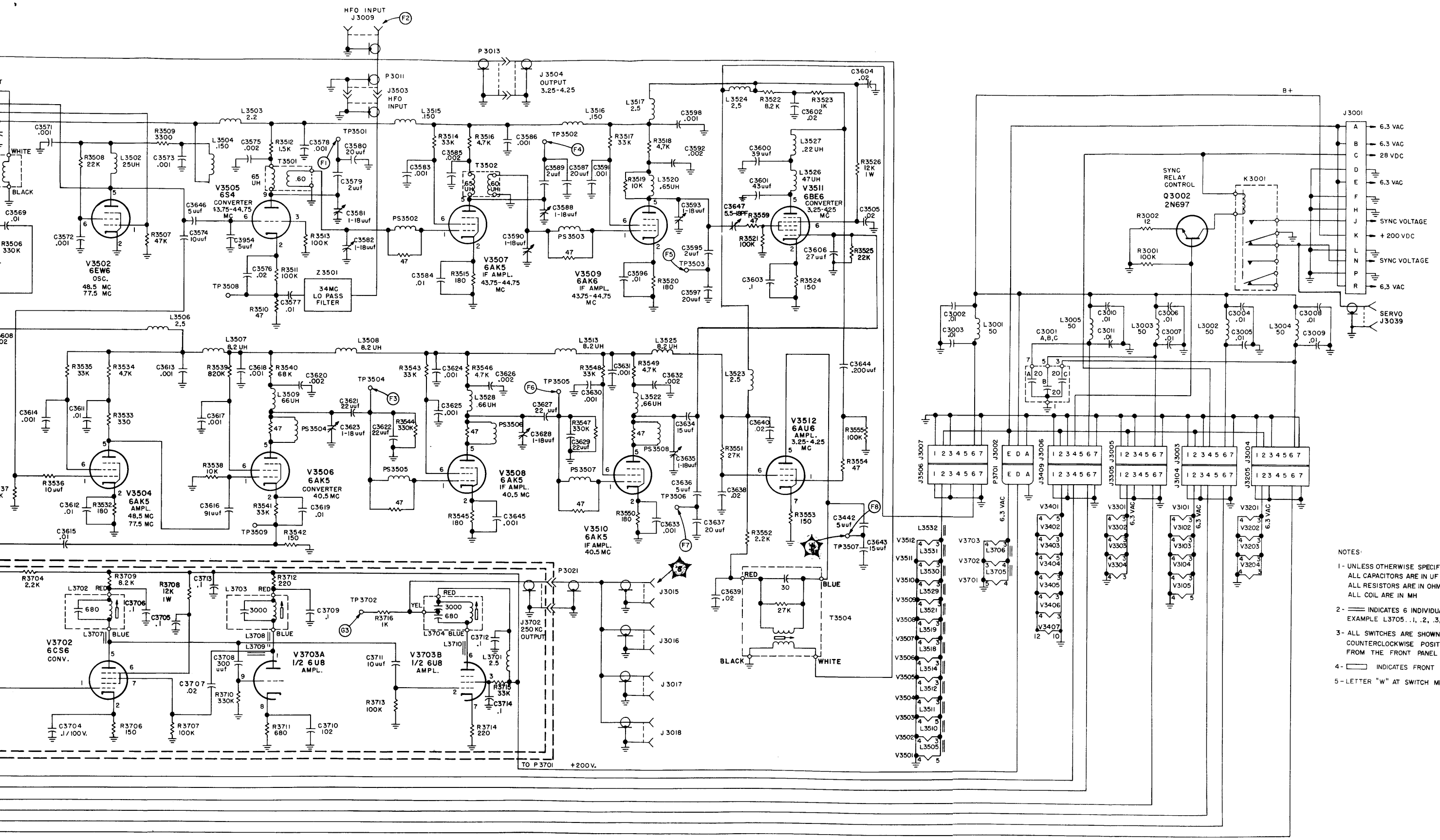


NOTES:

1 - UNLESS OTHERWISE SPECIFIED
ALL CAPACITORS ARE IN UF.
ALL RESISTORS ARE IN OHMS 1/2 WATT
ALL COIL ARE IN MH

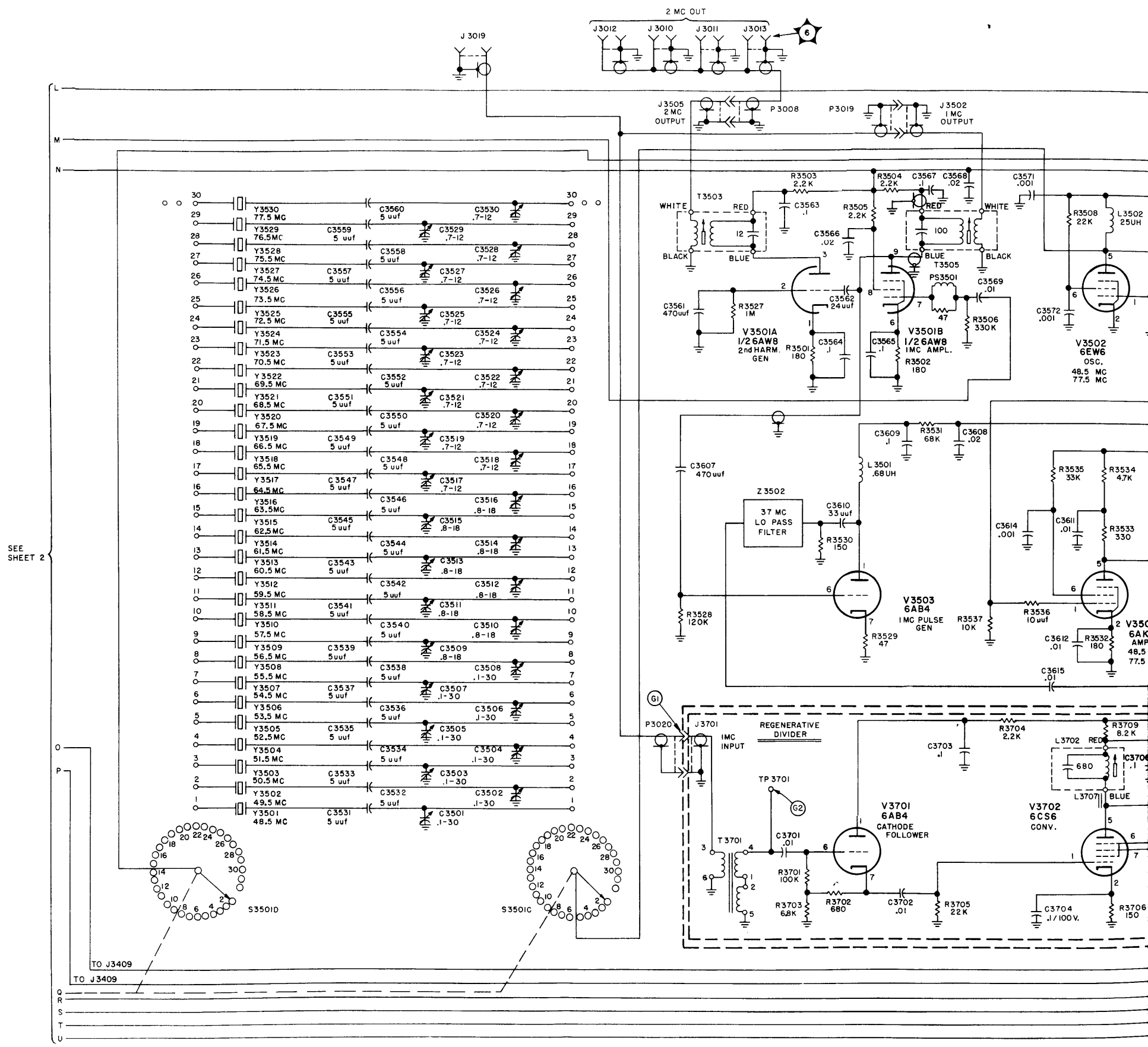
2 - ═══ INDICATES 6 INDIVIDUAL BEADS
EXAMPLE L3705...1, .2, .3, .4, .5, .6

3 - ALL SWITCHES ARE SHOWN IN THEIR FULLY COUNTERCLOCKWISE POSITIONS, AS VIEWED FROM THE FRONT PANEL

4 - ▭ INDICATES FRONT PANEL LETTERING

5 - LETTER "W" AT SWITCH MEANS WIPER.

Figure 7-1. HFS-2 Schematic Diagram
(Sheet 3 of 3)



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