Contents

WARRANTY

We warrant that each new instrument manufactured and sold by us is free from defects in material and workmanship, and that, properly used, it will perform in full accordance with applicable specifications for a period of two years after original shipment. Any instrument or component that is found within the two-year period not to meet these standards after examination by our factory, District Office, or authorized repair agency personnel, will be repaired or, at our option, replaced without charge, except for tubes or batteries that have given normal service.

The two-year warranty stated above does not apply to either the Tektronix Type RM564 Oscilloscope or the Tektronix Type 2B67 Time Base; these sections are covered by the one-year Tektronix warranty.

NOTE: The Tektronix Type RM564 Storage Oscilloscope and Type 2B67 Time Base Instruction Manuals must be used to supplement this manual.

Type 1124
Receiver

A

West Concord, Massachusetts U.S.A. 01781
Form 1124-0100-A
January, 1969
ID-B100

Condensed Operating Instructions

INSTRUMENT TURN-ON.
Turn the SCALE ILLUM switch to the ON position.

MEASUREMENT PROCEDURE.

Determine the resolution desired for the measurement (Section 4).

Determine whether a LORAN-C or a WWV-type signal should be used (Section 4).

Line the μs MARKER up with the LORAN-C pulse (paragraph 3.4) or line the WWV-type signal up with the 8 ms PEDESTAL (paragraph 3.5).

RECORD THE RESULTS.
Record the delay reading from the syncronometer in a log (paragraph 3.4.1).

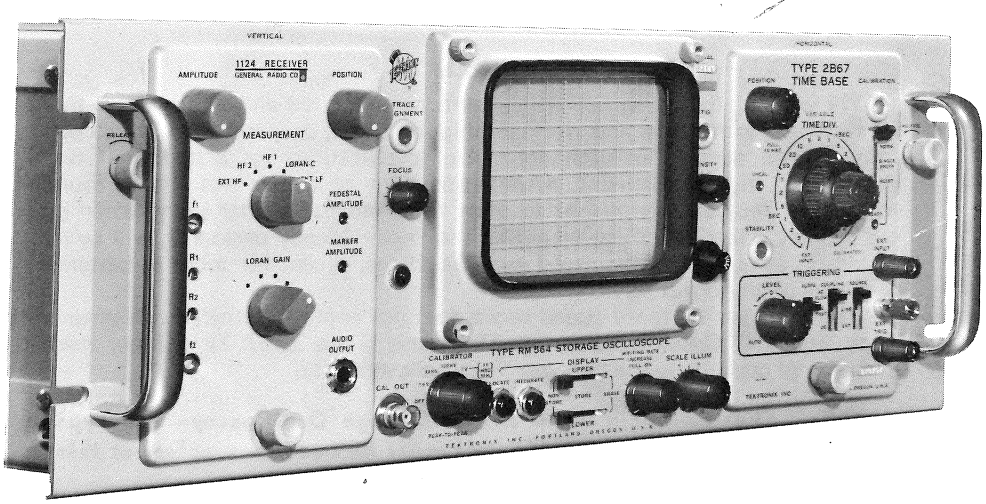

Figure 1-1. Panel view of 1124 Receiver.

Specifications

HIGH-FREQUENCY RECEIVERS

Rf Frequencies: 2.5, 3.33, 5.0, 7.335, and 10 MHz. Any two are selected by a front-panel switch.

Sensitivity: Better than 3 μV.

Input Impedance: Approx 50 Ω.

Max Input Signal: >100 mV.

Bandwidth: I-f 3-dB bandwidth approx 3 kHz; 3.0 MHz center frequency of i-f amplifier and crystal filter.

Automatic Gain Control: Receiver output is within 6 dB for signal change of 10 μV to 100 mV.

Image and I-f Rejection: >80 dB; all other spurious responses at least 70 dB down.

LORAN-C RECEIVER

Center Frequency: 100 kHz; 3-dB bandwidth approx 20 kHz.

Sensitivity: 3 μV for S/N >2.

Input Impedance: Approx 50 Ω.

Max Input Signal: >100 mV.

Gain Control: 4 fixed steps, 60-dB total range.

Notch Filters: Two, front-panel screwdriver-control, 80 to 90 kHz and 110 to 125 kHz (other ranges with internal-capacitor change). Rejection >40 dB; 6-dB bandwidth <3 kHz.

EXTERNAL INPUT Intended for comparing other timing signals with the GR 1123 comparator.

Sensitivity: Approx 0.5 V for full-screen deflection.

GENERAL

Front-Panel Controls: Amplitude (20-dB range), vertical position, input-channel selector, gain; screwdriver controls: notch-filter tuning (2), 1123 pedestal amplitude, and 1123 marker amplitude.

Connections: Front panel: audio output, approx 1 V, for monitoring hf receiver. Rear panel (BNC connectors): Loran antenna, hf antenna, ext-signal input, and pedestal, sync, and marker pulses from 1123.

Power Required: 105 to 125 or 210 to 250 V, 50 to 60 Hz, 240 W.

Accessories Supplied: Storage-oscilloscope accessories, shielded-cable set, 1124-P1 Antenna.

Mounting: 19-inch rack-mount.

Dimensions (width x height x depth): 19 x 7 x 18½ in. (485 x 180 x 470 mm).

Weight: Net, 42 lb (19.5 kg); shipping, c 70 lb (32 kg).

specifications — 1124-P1 Antenna

Center Frequency: 100 kHz.

Bandwidth: Approx 20 kHz at 3-dB points, with 50-Ω load.

Dimensions (width x height x depth): 58 x 86 x 3¾ in. (1480 x 2200 x 96 mm).

Catalog Number	Description
1124-9701	**1124 Receiver**

General Radio Experimenter, March, 1968

DOF-RLW-MLG

Introduction–Section 1

1.1 PURPOSE.

The purpose of the 1124 Receiver (Figure 1-1) is to provide a convenient means of using transmitted standard time and frequency signals for the purpose of frequency standard calibration and time measurement. The receiver assembly is designed to be used with the GR Type 1123 Digital Syncronometer® time comparator and a standard-frequency oscillator, such as the GR Type 1115 Standard-Frequency Oscillator. Broadcast time information from WWV, CHU, or Loran-C can be used directly for setting and maintaining an accurate local-time reference for synchronization of data, satellite measurements or other applications requiring a known time standard. In addition, regular comparisons of the time kept locally with the standard-time transmissions allow frequency calibration of the local oscillator.

1.2 DESCRIPTION.

The 1124 Receiver is a Tektronix RM564 Storage Oscilloscope with the Tektronix Type 2B67 Time Base and a General Radio receiver plug-in providing two high-frequency channels, Loran-C, or external signal for display with timing signals from the Type 1123 Digital Syncronometer. All receiver, sync and timing signals are switched automatically when the measurement switch is set for the desired function. Three other high-frequency channel boards are supplied and can be plugged in, replacing those installed for further frequency changes. All connections to the receiver are made through a terminal box on the rear of the oscilloscope.

1.3 CONTROLS.

The controls and connectors for the Type 1124 Receiver plug-in are shown in Figures 1-2 and 1-3, and identified in Tables 1-1 and 1-2. The controls for the Tektronix Type RM564 Storage Oscilloscope and the Tektronix Type 2B67 Time Base, shown in Figure 1-1, are explained in their respective manuals.

1.4 ACCESSORIES SUPPLIED.

The 1124 Receiver has two high-frequency rf circuit boards mounted in the receiver plug-in. Three high-frequency rf circuit boards of different frequencies are supplied as accessories. Each board is packaged in a plastic case with a suitable pad for protection. The two most commonly used frequencies, as determined by the user, would be left in the receiver.

A Type 1124-P1 Antenna is supplied for use in Loran-C reception.

Three shielded cables, thirty-six inches long with BNC connectors, are supplied for connections between the Type 1123 Digital Syncronometer and the 1124 Receiver (Figure 1-4).

1.5 EQUIPMENT REQUIRED.

The receiver is a companion instrument to the Type 1123 Digital Syncronometer and Type 1115 Standard-Frequency Oscillator. The circuits are designed to accept the pulses generated by the Type 1123 and it is recommended that it be used. An oscillator with specifications equivalent to those of the 1115 Oscillator can be used to drive the 1123 Syncronometer.

A length of 50-Ω coaxial cable to connect the Type 1124-P1 Antenna to the 1124 Receiver is required. If the high-frequency rf boards are to be used, a hf antenna will have to be constructed for the desired frequency (Section 2).

1.6 ACCESSORIES AVAILABLE.

The time information from the 1123 Syncronometer can be printed for permanent record of an event's happening by using the GR Type 1137 Data Printer.

The 1125 Parallel-Storage Unit to store time-of-day information from the 1123 and the 1399 Digital Divider/Period and Delay Generator are also available for use in a system.

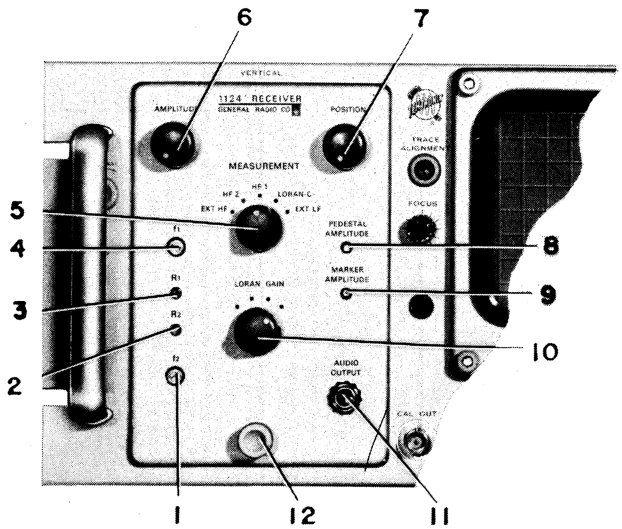

Figure 1-2. Front panel controls and connectors of the receiver plug-in.

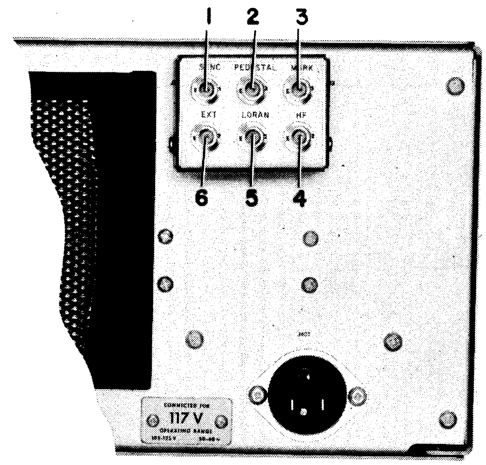

Figure 1-3. Rear panel control box jacks.

TABLE 1-1
FRONT PANEL CONTROLS AND CONNECTORS

Figure 1-2 Reference	*Name*	*Description*
1	f_2	Screwdriver adjustment for lower frequency Loran-C notch filter (sets center frequency).
2	R_2	Screwdriver adjustment for lower frequency Loran-C notch filter (adjusts null).
3	R_1	Screwdriver adjustment for higher frequency Loran-C notch filter (adjusts null).
4	f_1	Screwdriver adjustment for higher frequency Loran-C notch filter (sets center frequency).
5	MEASUREMENT	Knob controlled rotary switch to select measurement mode.
6	AMPLITUDE	Knob controlled potentiometer to adjust amplitude of receiver waveform on screen.
7	POSITION	Knob controlled potentiometer to adjust position of waveform on screen.
8	PEDESTAL AMPLITUDE	Screwdriver adjustment to control the pedestal amplitude from the Type 1123 Digital Syncronometer.
9	MARKER AMPLITUDE	Screwdriver adjustment to control marker amplitude from Type 1123 Digital Syncronometer.
10	LORAN GAIN	Knob controlled rotary switch with 60-dB total gain in four steps.
11	AUDIO OUTPUT	Telephone jack. (Accepts Switchcraft No. 440 plug.)
12	———	Plug-in securing knob.

TABLE 1-2
REAR PANEL CONNECTORS

Figure 1-3 Reference	*Name*	*Description*
1	SYNC	BNC jack for SYNC input from Type 1123 Syncronometer.
2	PEDESTAL	BNC jack for 8 ms PEDESTAL input from Type 1123 Syncronometer.
3	MARK	BNC jack for μs MARKER input from Type 1123 Syncronometer.
4	HF	BNC jack for high-frequency antenna input.
5	LORAN	BNC jack for Loran antenna input.
6	EXT	BNC jack for external input of another time signal for comparison with Type 1123 Syncronometer.

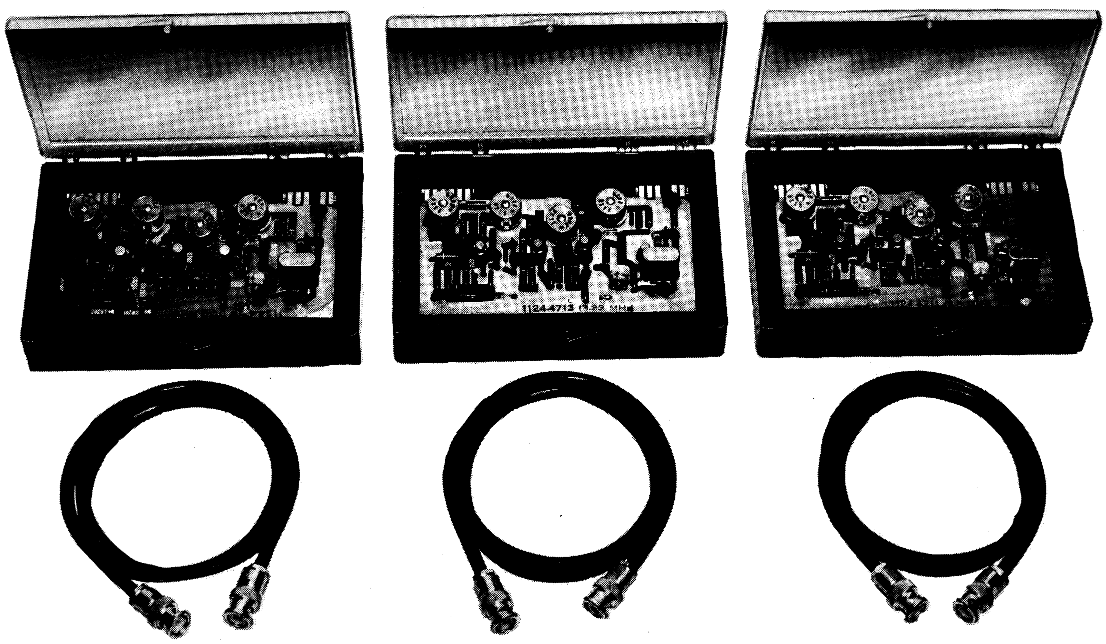

Figure 1-4. Etched-circuit boards and shielded cables.

Installation—Section 2

2.1 RACKMOUNTING THE RECEIVER.

The 1124 Receiver as supplied is to be mounted according to Method 1 as outlined in the Rackmounting Section of the Tektronix RM564 Instruction Manual. Slideout tracks or a cradle assembly are available from Tektronix for mounting the receiver in a configuration other than that offered by the direct mounting method. The over-all dimensions of the receiver are given in Figure 2-1.

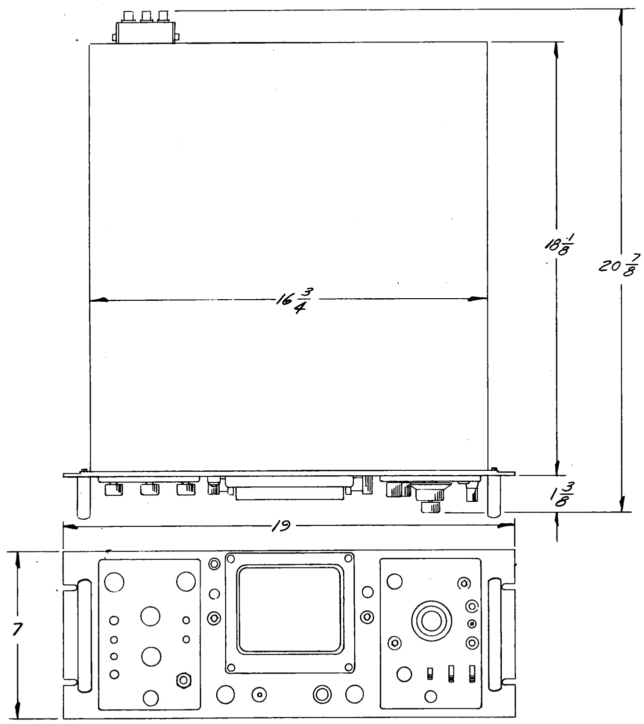

Figure 2-1. Dimensions of the 1124 Receiver (inches).

2.2 POWER CONNECTIONS.

The ac power is supplied to the instrument through the three-wire power cable and the three-pronged plug at the rear of the instrument. Conversion for 230-V operation is explained in the Tektronix Type RM564 Instruction Manual, Section 2. The power is turned on by rotating the SCALE ILLUM control clockwise, away from the PWR OFF position.

2.3 ANTENNAS.

2.3.1 GENERAL.

The location of a receiving antenna should be out in the open, away from any shielding effects, for best operation. Power lines must be avoided to eliminate interference from radiation of power line frequencies. If a permanent installation is used, make certain that the antenna is oriented in the direction of maximum signal strength from the station to be received.

CAUTION

A suitable grounding system and lightning arrestor should be installed in any system to protect the measurement equipment.

2.3.2 LORAN-C.

The Type 1124-P1 Antenna supplied with the receiver is designed for the reception of Loran-C signals. It can be installed for reception from a fixed direction or mounted on a rotator for direction adjustment. Under normal conditions, the antenna can be installed in a fixed direction determined by the location of the nearest Loran-C station. The maximum signal is received when either end of the antenna (A or B, Figure 2-2) is in the direction of the transmitting station.

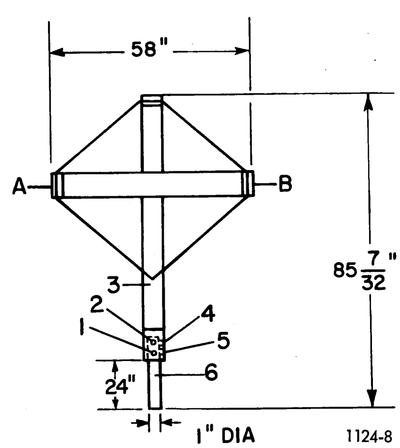

Figure 2-2. Mounting the Type 1124-P1 Antenna.

To mount the antenna in a permanent direction, install the short section of pipe (6, Figure 2-2) supplied into the bottom of the vertical antenna support (3, Figure 2-2) and tighten the four set screws (1, 2, 4, 5, Figure 2-2). Mount the antenna into a permanent antenna mount.

To mount the antenna on a rotator that accepts a pipe adaptor, install the adaptor supplied (6, Figure 2-2) into the bottom of the vertical antenna support (3, Figure 2-2) and tighten the four set screws (1, 2, 4, 5, Figure 2-2). Mount the pipe adaptor into rotator clamps. If the rotator comes supplied with a piece of pipe, attach this pipe to the bottom of the vertical antenna support and tighten the four set screws.

The feedline to the antenna should be 50-Ω coax (such as RG-58 C/U) with BNC connectors at each end for connection to the antenna and receiver. The line should be as short as possible, but any length up to 50 feet will not introduce much feedline loss into the system (refer to the specifications for the feedline used).

2.3.3 HF ANTENNA.

The reception of high-frequency time signals will necessitate the installation of an antenna for the desired frequency. The common one-half wavelength long-wire antenna is the easiest to construct and install. The impedance at the end of a one-half wavelength wire is 70 ohms, therefore, if an exact impedance match is desired a balancing unit (balun) can be constructed for conversion to 50 ohms. However, in locations where the signal strength is reasonable, the loss due to mismatch will not affect reception considerably. Table 2-1 gives the lengths of one-half wavelengths at the standard frequencies.

TABLE 2-1
ONE-HALF WAVELENGTH ANTENNA LENGTH

Frequency (MHz)	*Length*
2.5	188' 2"
3.33	141' 3"
5.0	94' 1"
7.335	64' 1"
10.0	47'

Horizontal polarization of the antenna is recommended to maintain a good signal-to-noise ratio. This configuration minimizes ground absorption losses and attenuates many man-made interferences.

2.4 CONNECTING THE TIMING PULSES.

Connect one of the thirty-six inch length leads of the Type 1124-0320 Shielded Cable set between the 8-ms PEDESTAL jack on the 1124 Receiver and the 8-ms PEDESTAL jack on Type 1123 Digital Syncronometer (Figure 2-3). In the same manner, connect the μs MARKER jacks and the SYNC jacks from the 1123 Syncronometer to the 1124 Receiver.

2.5 INSTALLING A HF BOARD.

The receiver has two high-frequency rf boards installed at shipping, 3.33 MHz and 5.0 MHz. To install a different frequency board, 2.5, 7.335, or 10 MHz, one of the present boards must be removed and the desired frequency board installed. Refer to paragraphs 5.5, 5.6 and 5.7 for replacement instructions.

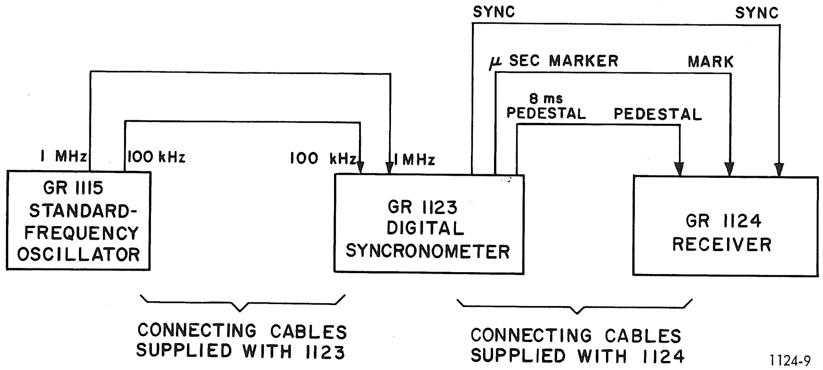

Figure 2-3. Connecting the timing pulses.

Operation—Section 3

3.1 GENERAL.

This section gives a step-by-step procedure for the operation of the receiver. Procedures for both Loran-C and WWV-type signals used for time and frequency calibration are given in detail. It is assumed that the installation procedures of Section 2 have been completed. The general principles involved are the same regardless of the station or receiver frequency used: a standard-time signal is compared with a local-time signal for the purpose of frequency calibration or time determination. Section 4 should be consulted for a detailed explanation of the procedures used in this section.

3.2 SELECTING THE DESIRED FREQUENCY.

To select the frequency to be used for standardization, rotate the MEASUREMENT control on the receiver plug-in to the desired setting (HF1, HF2, or LORAN-C). Note that the operator can initially select which of the five available rf boards will occupy positions HF1 and HF2 (paragraph 2.5). All Loran-C stations are on the same frequency, i.e. 100 kHz. Three WWV frequencies and two CHU frequencies are provided to allow use of a receiver frequency that will provide the best signal in a particular geographical area.

LORAN C 100 kHz Nantucket						WWV 5 MHz			CHU 7335 kHz		
DATE	*TIME*	*t*	*TIME DELAY*	*Δt (μs)*	*ERROR (parts in 10^{10})*	*TIME*	*TIME DELAY*	*Δt (μs)*	*TIME*	*TIME DELAY*	*Δt (μs)*
Oct 29	1000	24 h	X27397.5	28.9	+3.35	1015	198370.0	30.0	1030	385630.0	30.0
Nov 1	1000	72 h	X27457.3	59.8	+2.30	1015	198430.0	60.0	1030	385690.0	60.0
2	1000	24 h	X27474.5	17.2	+1.99	1015	198450.0	20.0	1030	385710.0	20.0
3	1000	24 h	X27489.7	15.2	+1.76	1015	198470.0	20.0	1030	385720.0	10.0
4	1000	24 h	X27500.6	10.9	+1.26	1015	198480.0	10.0	1030	385730.0	10.0
5	1000	24 h	X27508.3	7.7	+0.893	1015	198490.0	10.0	1030	no difference	
8	1000	72 h	X27503.6	4.7	-0.181	1015	198480.0	10.0	1030	no difference	
9	1000	no measurement				1015	fading		1030	fading	
10	1000	[illegible]	X27488.4	15.2	-0.879	1015	198470.0	10.0	1030	missed	
11	1000	24 h	X27477.9	10.5	-1.22	1015	198460.0	10.0	1030	385710.0	20.0
12	1000	24 h	X27464.5	13.4	-1.55	1015	198450.0	10.0	1030	385700.0	10.0
15	1000	72 h	X27497.5	66.8	-2.58	1015	198380.0	70.0	1030	385640.0	60.0
16	1500	receiver inoperative				1015	198350.0	30.0	1030	missed	
17	1000	48h	X27341.0	56.7	-3.28	1015	198320.0	30.0	1030	385590.0	50.0
18	1000	24 h	X27309.3	31.7	-3.68	1015	198290.0	30.0	1030	385560.0	30.0
19	1000	24 h	X27275.4	33.9	-3.93	1015	198260.0	30.0	1030	385530.0	30.0
22	1000	72 h	X27262.5	129	-4.98	1015	198130.0	130.0	1030	385400.0	130.0
23	1000	no measurement				1015	obscured		1030	obscured	
24	1000	48 h	X27162.8	99.7	-5.76	1015	missed		1030	fading	
25	1000	24 h	X27110.0	52.8	-6.12	1015	197980.0	150.0	1030	385250.0	150.0
25	1030	RESET - OSCILLATOR		+13	(from 1425 to 1438)						
25	1100		X27112.2								
25	1200	1 h	X27114.4	2.2	+6.12						
26	1200	24 h	X27163.7	49.3	+5.72	1215	198030.0	50.0	1230	385300.0	50.0
29	1200	72 h	X27282.7	119	+4.59	1215	198150.0	120.0	1230	385420.0	120.0

Figure 3-1. Sample log for standard-time and frequency measurements.

3.3 ANTENNA ADJUSTMENTS.

A stationary antenna will not need adjustment, however, if the receiving antenna has been installed on a rotator, rotate the antenna in the direction of the transmitting station for maximum signal strength from the transmitting station.

3.4 LORAN-C MEASUREMENTS.

3.4.1 GENERAL.

The general measurement technique is to align the Type 1123 Syncronometer μSEC MARKER pulse with a reference point (positive or negative peak, or zero crossing) of a 100-kHz Loran-C pulse. A record log (Figure 3-1), should be made of the delay reading and, after a time interval sufficient for the precision desired, the alignment is repeated. The difference in delay readings, Δt, divided by the measurement interval, t, gives the oscillator frequency offset, $\frac{\Delta f}{f}$ (i.e. $\frac{\Delta f}{f} = \frac{\Delta t}{t}$). A regular measurement (daily, etc.) will give the drift rate of the oscillator. The logged values of frequency offset can be plotted to give a visual representation of the oscillator's drift rate (Figure 3-2). The precision of the measurement and the minimum interval required are dependent on the quality of the received signal and on the frequency offset and drift rate of the oscillator. For a given available-signal resolution, an oscillator with a larger frequency offset will require a shorter interval to produce a detectable time error (Figure 3-3).

Until January 6, 1969, the US East Coast Loran-C transmission will be on the 10-group-per-second (SSO) repetition rate. With this rate, relatively simple time comparisons can be made with the 10-Hz timing pulses from the 1123 Digital Syncronometer. An example of using this measurement technique for frequency standardization with any chain operating at the 10-group-per-second rate is given in paragraph 3.4.2. After January 6, 1969 or for use of any other Loran-C rate for time or frequency calibration, refer to paragraph 3.4.3.

The measurement resolution available will depend considerably on the quality of the signal received. With strong signals (distances under a few hundred miles, Figure 4-2), resolution of about 100 ns is possible, while greater distances will decrease the signal-to-noise ratio so that at 600 to 700 miles only a few μs resolution may be possible (Figure 3-7). At considerable distances (greater than 1000 miles) noise can be great enough to prevent identification of a particular cycle of the Loran signal and limit resolution to ±10 μs (i.e., ±1 cycle, Figure 3-4).

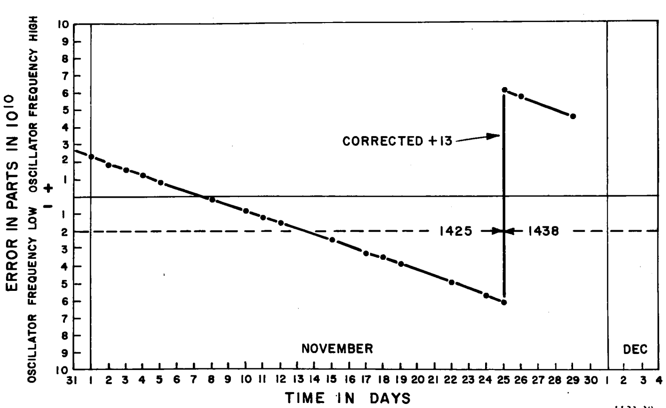

Figure 3-2. Typical curve plotted from data taken during a drift run.

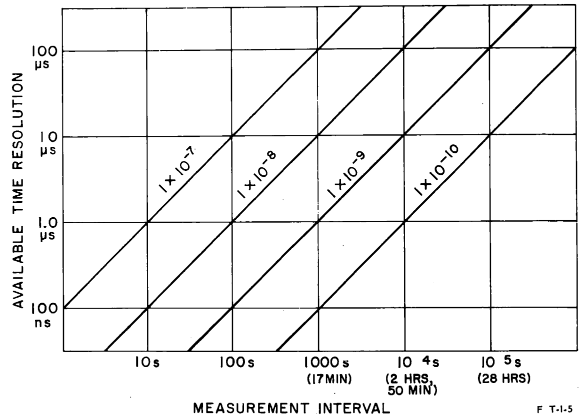

Figure 3-3. Precision of measurement versus resolution and time interval.

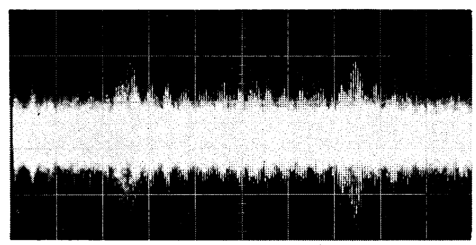

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Figure 3-4. Typical Loran-C signal reception when the envelope is used for measurement (200 μs/div).

3.4.2 TYPICAL MEASUREMENTS (10 GROUP/SECOND RATE).

To make a measurement with any 10-group-per-second repetition rate chain, such as the US East Coast Chain before January 6, 1969, proceed as follows:

a. Set the MEASUREMENT switch to LORAN-C.

b. Set the LORAN GAIN control to the second position in the clockwise direction. (Can be increased by clockwise rotation as required.)

NOTE

Use the minimum fixed gain that will allow a sufficient vertical deflection with the AMPLIFIER control.

c. Turn the receiver power ON.

d. Set the STORE switches to the NON STORE position.

e. Set the SLOPE to +.

f. Set the COUPLING to AC SLOW.

g. Set the SOURCE to INT.

h. Set the MODE to NORM.

i. Set the INTENSITY control for mid range.

j. Set the TIME/DIV. control to 10 μ SEC CALIBRATED.

k. Adjust the TRIGGERING LEVEL for a display on the oscilloscope.

l. Observe the Loran signal(s) on the oscilloscope screen of the receiver. Note that there can be several signals appearing on the screen, each from a different Loran station. The strongest signal should be used for measurements.

m. Move the start of one of the strongest pulse groups to the left-hand edge of the screen with the delay switches on the clock (100 ms, 10 ms, and 1 ms).

n. Increase the TIME/DIV. switch to 1 μ SEC CALIBRATED.

o. Adjust the delay on the Type 1123 so that the μ SEC MARKER PULSE leading edge is at a zero crossing (Figure 3-5), at a positive peak (Figure 3-6), or a negative peak of the LORAN-C signal. Increase the VERT GAIN or LORAN-GAIN, if necessary. The storage facilities of the oscilloscope can be used for better signal identification.

CAUTION

The storage screen of the oscilloscope may be damaged if the display is left on for any length of time in the storage position. Read pages 2-6 through 2-11 of the Tektronix Type RM564 Instruction Manual for storage operation.

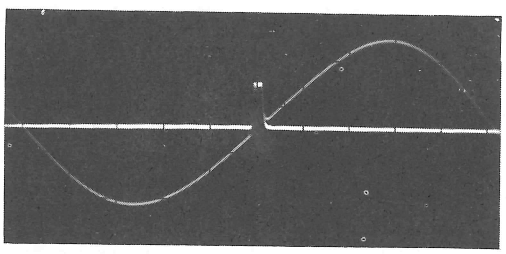

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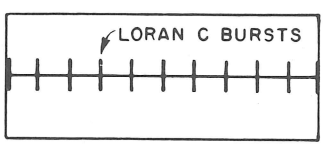
Figure 3-5. Typical Loran-C Signal with 1 μs. MARKER set at zero crossing (1 μs/div).

An example of lining up the Loran-C pulse and the μs MARKER at a zero crossing is as follows:

1. Set the 100-ms TIME DELAY control to X (for 10-Hz repetition rate) and set the others to zero. Set the 1124 Receiver sweep rate to 100 ms/cm.

TIME DELAY MICROSECONDS

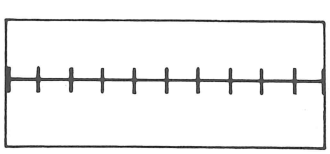
100 ms	10 ms	1 ms	100 μs	10 μs	1 μs	0.1 μs
X	0	0	0	0	0	0



100 ms/cm

2. Increase the delay with the 10-ms and 1-ms TIME DELAY controls to move the Loran-C pulses left toward the start of the oscilloscope trace.

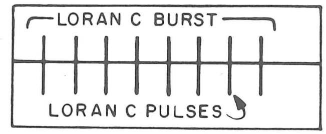
X 4 8 0 0 0 0



100 ms/cm

3. Increase the sweep rate of the receiver to 1 ms/cm for increased resolution.

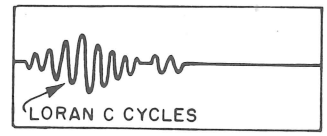
X 4 8 0 0 0 0



1 ms/cm

4. Increase the TIME DELAY to move a Loran-C pulse to the start of the oscilloscope display. Increase the receiver sweep rate to increase the resolution.

X 4 9 1 9 0 0

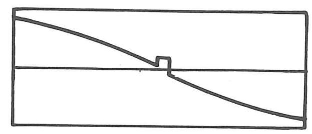


20 μs/cm

5. Increase the delay to move the third cycle of a Loran-C pulse to the center of the display. Increase the receiver sweep rate to increase the resolution. Position the ms MARKER exactly at the zero crossing with the 1 μs and 0.1 μs TIME DELAY controls.

X 4 9 1 9 3 4

CONTROL μs MARKER POSITION



1 μs/cm

1124-10

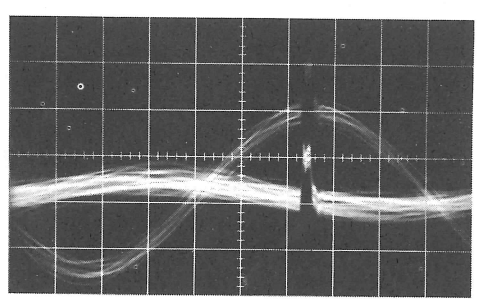
It is not necessary to start the measurement with an oscilloscope sweep rate as slow as 100 ms/cm. The slow sweep rate was chosen for this example to ensure that the pulses appeared on the display. Nor is it necessary to preset all TIME DELAY controls to zero. This was done here to ensure that delay was always added so that it was unnecessary to hunt back and forth for the time tick.

Any pulse can be selected for measurement. It is desirable, however, to make the measurement on the third or fourth cycle of a pulse because the first few are not as well defined and those after the fourth may be contaminated by sky waves and may contain more noise.

p. Record the delay setting on the Type 1123.

q. After a measured interval, determined by the accuracy desired (Figure 3-3), reset the delay switches for marker line-up and record the new figures.

r. The change in delay is the change in time caused by the standard oscillator's drift.



1124-17

Figure 3-6. Typical Loran-C Signal over a 600 mile distance (500 μs/div).

3.4.3 BASE RATE CONSIDERATIONS.

For various reasons the base rate of the US East Coast Chain has been changed several times in the past few years. Either the 12 1/2 or 10 group-per-second rate has been suitable with relatively simple comparison techniques to provide time and frequency calibrations. With all other rates and with the US East Coast Chain after January 6, 1969, when it will transmit with a 99,300 μs repetition period, there is no convient time coincidence between the Loran-C rate and the local decimal timekeeping. The use of Loran-C stations then requires either the addition of a local rate generator, such as the GR 1399, or the use of the 1-s pulses transmitted by an increasing number of Loran-C master stations.

Table 3-1

CHAINS SYNCHRONIZED TO ±25 μs UTC*
East Coast**
Norwegian Sea
Northwest Pacific
Hawaiian**

*As kept by the US Naval Observatory.

**This chain transmits 1-s pulses. The Norwegian Sea and Northwest Pacific chains will in the future.

3.4.4 1s MARKER MEASUREMENTS.

With the Type 1123, precise determination of UTC may be obtained from the Loran-C transmissions. For this use the repetition rate of the marker output pulse is set to 1 Hz and a procedure similar to that of paragraph 3.4.2 is used. If the beginning of the Loran-C 1-s pulse is aligned in time with the reference pulse from the Type 1123, the time delay between the local 1-second and the received Loran 1-second will be indicated on the Syncronometer's digital-delay switches. This time can now be corrected for the transmission delay between the transmitter and the receiver. The Type 1123 Digital Syncronometer allows automatic synchronization (to 10 μs) to the received timetick or to the transmitted timetick when the delay is known. Identification of the second can be made by the less stable transmissions of WWV. Absolute accuracy is limited by the calculation of the propagation delay and the ambiguity in cycle determination in both of these methods. Table 3-1 lists the chains that are presently synchronized to ±25 μs UTC and transmitting 1-s identifying pulses. These pulses are transmitted "on time", that is, not offset by 2 ms as was the case on the US East Coast Chain. When a coincidence (TOC) with the regular transmission occurs, the 1-s pulse is deleted.

In the future as more stations add 1-s pulses, the use of Loran-C as worldwide time system will be even greater. Information about changes can be obtained from the U.S. Naval Observatory.

3.5 WWV-TYPE MEASUREMENTS.

Measurements made with high-frequency signals will give a resolution of about 100 μs, maximum, under optimum conditions, and can be as poor as ±5 ms. The procedure for making this type of measurement is as follows:

a. Turn the receiver power ON.

b. Set the MEASUREMENT switch to HF-1 or HF-2.

c. Set the STORE switches to the NON STORE position.

d. Set the SLOPE to +.

e. Set the COUPLING to AC SLOW.

f. Set the SOURCE to INT.

g. Set the MODE to NORM.

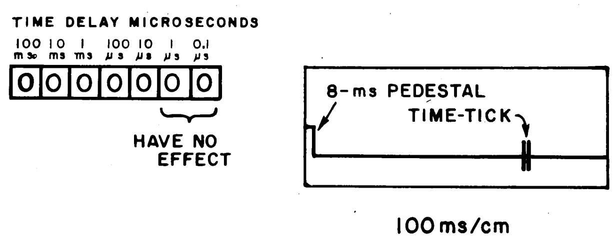
h. Set the INTENSITY control for mid-range.

i. Set the TIME/DIV. control to 0.1 SEC CALIBRATED.

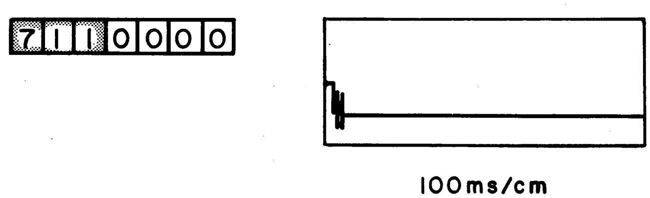
j. Adjust the TRIGGERING LEVEL for a display on the oscilloscope.

k. Adjust the delay switches on the Type 1123 in the following manner so that the signal pulse will coincide with the 8-ms PEDESTAL:

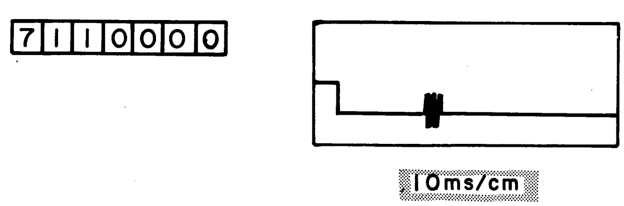
1. Set the TIME DELAY controls to zero and set the receiver sweep rate to 100 ms/cm. The 1-μs and 0.1-μs controls have no effect and can be set anywhere.



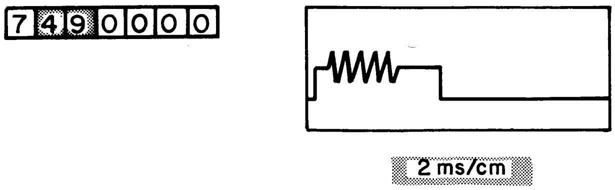
2. Increase the delay with the ms TIME DELAY controls to move the time tick left towards the 8-ms PEDESTAL.



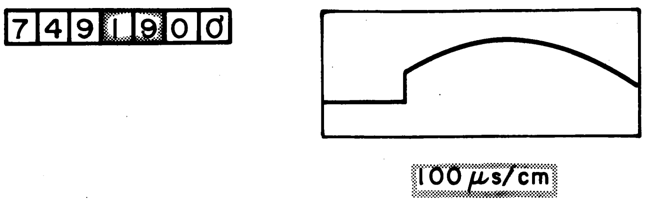
3. Increase the receiver sweep rate to increase the resolution.



4. Increase the delay to superimpose the time tick on the 8-ms PEDESTAL. Increase the receiver sweep rate to increase the resolution.



5. Increase the delay with the 100-μs and 10-μs TIME DELAY controls to move the 8-ms PEDESTAL to the right until the leading edges of the time tick and the 8-ms PEDESTAL coincide exactly. Increase the receiver sweep rate to increase the resolution.



1123-59

The final setting of the TIME DELAY controls is the amount of time the received time tick is delayed from the 1 SEC TICK of the Syncronometer.

It is not necessary to start the measurement with an oscilloscope sweep rate as slow as 100 ms/cm. The slow sweep rate was chosen for this example to ensure the time tick appeared on the display. Nor is it necessary to preset all of the TIME DELAY controls to zero. This was done to ensure that delay was always added and that it was unnecessary to hunt back and forth for the time tick.

The storage facilities of the oscilloscope may be used for better signal identification.

CAUTION

The storage screen of the oscilloscope may be damaged if the display is left on for any length of time in the storage position. Read pages 2-6 through 2-11 of the Tektronix Type RM564 Instruction Manual for storage operation.

1. Record the delay reading on the Type 1123.

m. After the desired time interval, determined by the accuracy desired (Figure 3-3), repeat the pulse-alignment procedure and record the new delay reading. The difference between the two readings gives the change in time caused by the standard oscillator's drift.

Theory–Section 4

4.1 GENERAL.

Frequency can be established to a high degree of precision by direct comparison of time intervals derived from the frequency to be calibrated and from a standard. The time interval compared is usually one second, derived from the standard to be calibrated by a precision electronic clock such as the Type 1123 Digital Syncronometer. An example of this method is the comparison of locally produced one-second pulses with the one-second timing pulses transmitted by Radio Station WWV. There are two distinct advantages of this method of comparison over others: (1) Individual measurements do not have to have great accuracy since the accuracy is increased by taking longer time intervals between measurements. (2) The measurement results in an accurately set local clock. Local time is known to the extent that the propagation time of the radio signal is known.

The basic principle of the measurement lies in the integrating character of the clock. If the clock frequency is low, the time between successive zero crossings of the driving frequency is a little longer than standard, and at each cycle the clock will lose a fixed increment of time. Obviously, the longer the measurement interval, the larger the time error (Figure 4-1a). The case of a clock driven by too high a frequency is shown in Figure 4-1b; the clock steadily gains time with respect to standard time.

The assumption of an absolutely constant frequency with a fixed error with respect to the primary standard leading to a linear change in local time is not the situation usually encountered in practice. The local standard will generally have some drift, which will cause the time error to depart from linear as shown in Figure 4-1. If the drift in frequency is constant with time for example $f = (f_0 + kt)$, and the initial frequency setting, f_0, is low, it is obvious that at some future instant of time f will become equal to the standard frequency, and the time intervals will be precisely correct. The curves of time error are now parabolic. Figure 4-1c shows the shape of time error when the local frequency has a positive drift.

As an example of the use of this method of frequency calibration, assume that in your locality WWV can be received with a reproducibility of one millisecond. (This figure must be established by experiment.) Then, a one-day interval, a change in the local frequency of $10^{-3}/86{,}400$ or approximately $1{:}10^8$ can be established.

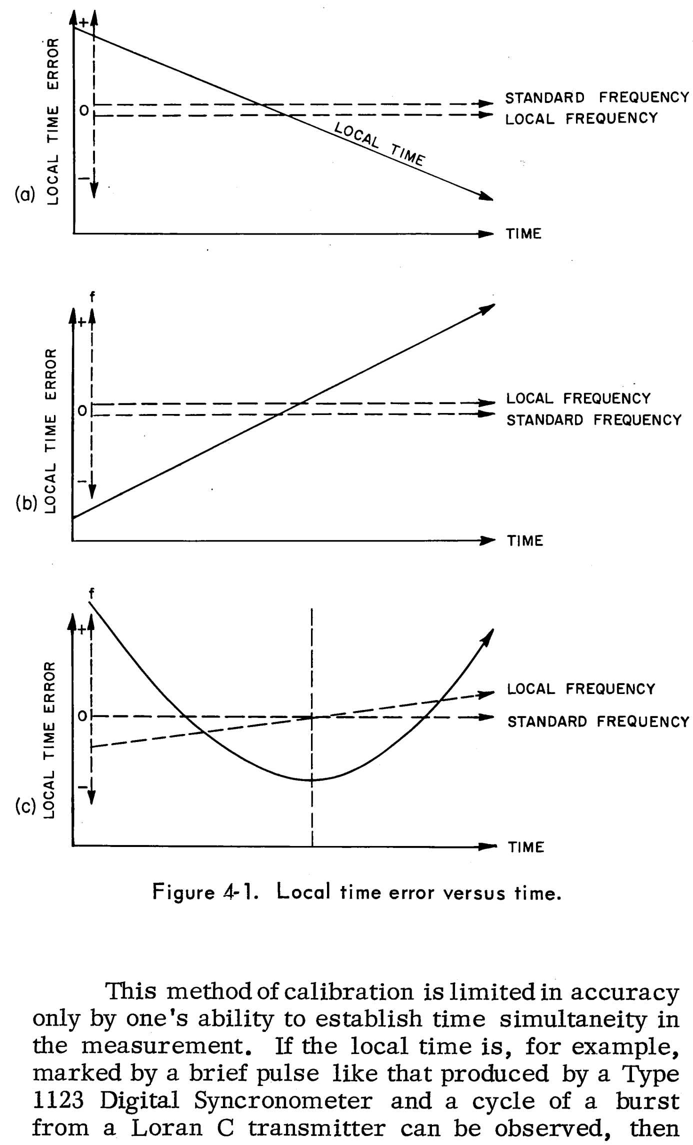


Figure 4-1. Local time error versus time.

This method of calibration is limited in accuracy only by one's ability to establish time simultaneity in the measurement. If the local time is, for example, marked by a brief pulse like that produced by a Type 1123 Digital Syncronometer and a cycle of a burst from a Loran C transmitter can be observed, then time can be compared to a fraction of a microsecond*, and the local frequency can be established to within a few parts in 10^{10} in a time interval of only a few minutes (Figure 4-2).

*D. O. Fisher and R. W. Frank, "A New Approach to Precision Time Measurements," General Radio Experimenter, February-March 1965.

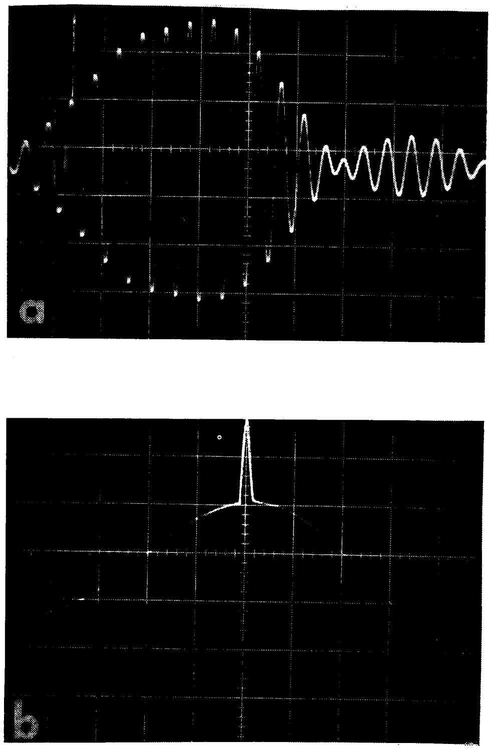


Figure 4-2. Time comparison of marker pulse and Loran-C 100-kHz pulses.
a. Sweep rate 20 μs/cm. (Note marker on third cycle.)
b. Sweep rate 1 μs/cm, pulse centered.

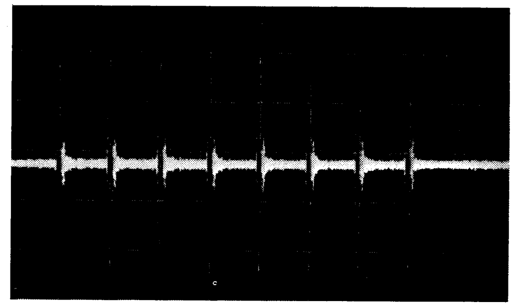
4.2 LORAN-C CHARACTERISTICS.

4.2.1 GENERAL.

Loran-C transmissions are provided by the United States Coast Guard primarily for navigational use, however, their 100-kHz frequency and their signal stability make them a unique source of precise frequency and time for the calibration of a local standard system. The 100-kHz pulse transmissions bridge the gap between the use of VLF for frequency calibration and WWV-type signal transmissions for limited-resolution time-calibration. With the GR Type 1123 Digital Synchronometer, calibration of a standard frequency oscillator to 1 part in 10^{10} can be accomplished in as little as seventeen minutes. Under optimum conditions, a time setting accurate to 100 ns can be maintained using the time transmitted by the Loran-C master station.

4.2.2 SYSTEM OPERATION.

A Loran-C chain is composed of a master station and two or more slave stations. The slave stations are locked both in frequency and phase to the transmissions of the master by automatic means (cross-correlation detection and cycle matching). All stations transmit pulses of a common 100-kHz carrier frequency and are identified by individual group repetition-rates for each Loran-C chain and by phase and delay coding within a chain. The basic transmission, as shown in Figure 4-3, is a group of eight pulses comprised of



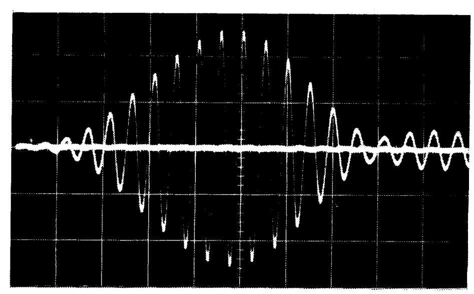
1124-21

Figure 4-3. Loran-C Pulse Group.

several cycles of the 100-kHz master frequency at 1-ms intervals. The master station is identified by the addition of a ninth pulse following each group by 2 ms. Blinking or time-shifting of this pulse signals users that the Loran-C system may not be fully operational (see paragraph 4.2.6). The station locations and designations for the East Coast chain are given in Table 4-1.

4.2.3 PULSE CHARACTERISTICS.

The characteristics of the 100-kHz pulse are closely controlled to enable detection by automatic navigation equipment. The pulse envelope (Figure 4-4) is approximately Gaussian, with eight cycles in the rise so that greater than 99% of the transmitted power is in the allotted 90-110-kHz band. It is required that the bandwidth of a Loran-C receiver be at least 20 kHz to maintain this pulse shape for timing purposes. The decay of the pulse is of little importance and its shape is largely a result of antenna characteristics, since the transmitter is keyed off at the peak of the pulse.



1124-22

Figure 4-4. Individual pulse waveform.

4.2.4 PHASE AND DELAY CODING.

The individual station transmissions in any chain are distinguished by emission delays and phase coding of the pulse groups. The emission delays are the time intervals between receipt of the master station's signal at a slave, and the slave's transmission of the corresponding pulse group. The delays of each slave are different and are calculated to avoid simultaneous reception of stations in a given service area.

Individual pulses of a group are phase coded, in that the phase of the 100-kHz carrier is reversed in a prescribed pattern to obtain pulses beginning with either a positive or negative-going cycle of the carrier. Alternate groups of the Loran transmissions are uniquely coded as are the transmissions of master and slave. This phase coding allows identification of the signals by automatic equipment and distinguishes a received ground wave pulse from a delayed skywave pulse of opposite phase (see paragraph 4.2.7). The master and slave codes, which are the same for all chains, are shown in Table 4-2.

4.2.5 TIME TRANSMISSION.

The over-all timing of an increasing number of Loran-C chains is being controlled to within ±25 μs of UTC as kept at the U.S. Naval Observatory (Table 3-1). In addition, a number of master stations transmit 1-s pulses for time synchronization use. These pulses are transmitted "on time" and are pre-empted at the times of coincidence with the normal station rate.

4.2.6 SYSTEM ACCURACY AND RESOLUTION.

In the East Coast Chain, frequency and time calibration for the master station are obtained from the U. S. Naval Observatory. A rubidium vapor cell frequency standard at the Cape Fear master is corrected daily on the basis of time comparison measurements made at the Naval Observatory of the Loran-C transmissions. The precision of the station measurement capability (synchronization of master and slave stations) is stated to be less than 0.1 μs. The pulse-blink warning system (blinking or shifting of the ninth pulse of the master station) is usually initiated for a ±0.15-μs phase error or a ±3 μs envelope error if either lasts for one minute or longer.

4.2.7 PROPAGATION.

Owing to the relative phase stability of propagation at 100 kHz, both the groundwave and skywave transmission modes of Loran-C are usable. The groundwave signal, that portion of the radio energy traveling parallel to the earth's surface, is the more stable of the two modes. Its stability depends primarily on the refractivity of the atmosphere and the earth's conductivity, both of which are relatively constant at this frequency. In addition to the groundwave propagation, some transmitted signal is reflected from the ionosphere and will reach a receiver after one or more hops or reflections. This signal arrives delayed from the groundwave, due to the extra distance travelled. The relative amplitude of groundwave, one-hop, and multiple-hop modes depends on the distance from the transmitter.

When more than one transmission mode is received, the observed signal would be a composite of these components (Figure 4-5). The minimum time delays for the skywave models within the groundwave range are such that at least the first 30 μs of a received pulse will be groundwave only and should be used for precise measurement. Visual techniques, however, cannot usually separate the various modes and at distances greater than 400 to 500 miles the observed signal would be primarily skywave.

4.3 WWV-TYPE SIGNAL CHARACTERISTICS.

4.3.1 GENERAL.

The National Bureau of Standards (NBS) Standard Frequency Stations of WWV and WWVH transmit high frequency (hf) signals for frequency calibration that are precisely referenced to the NBS Atomic Standard. Transmissions are made from WWV on 2.5, 5, 10, 15, 20, and 25 MHz, and from WWVH on 5, 10, and 15 MHz. The locations and characteristics of various stations throughout the world that transmit WWV-type time signals are given in Table 4-3.

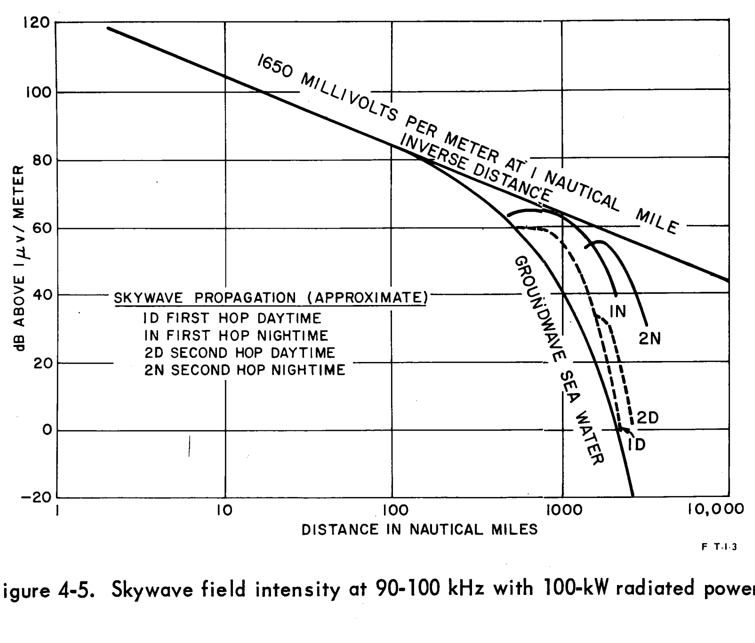


Figure 4-5. Skywave field intensity at 90-100 kHz with 100-kW radiated power.

Table 4-1

EAST COAST LORAN-C CHAIN

Rate: SSO (1) Repetition Rate: 100,000 μs (1)

Station and Location			*Baseline (BC)*		*Coding Delay (CD)*	*Emission Delay (2) (BC + CD)*
			μs	*Nautical Miles*	μs	μs
Cape Fear, North Carolina	(M)	34°03'46"N, 77°54'46"W	0000000	0.0	000000	00000000
Jupiter Inlet, Florida	(W)	27°01'59"N, 80°06'53"W	2,695.5	436.0	11,000	13,695.5
Cape Race, Newfoundland	(X)	46°46'32"N, 53°10'29"W	8,389.6	1,356.8	28,000	36,389.6
Nantucket Island, Mass.	(Y)	41°15'12"N, 69°58'39"W	3,541.3	572.8	49,000	52,541.3
Dana, Indiana	(Z)	39°51'08"N, 87°29'11"W	3,560.7	575.9	65,000	68,560.7
Wildwood, New Jersey	(T)	38°56'58"N, 74°52'01"W	2,026.2	327.7	82,000	84,026.2

NOTES:

(1) The repetition rate of the East Coast Loran-C Chain will be changed on 6 January 1969 at 1500 UT, from SSO (100,000 μs) to SS7 (99,300 μs). Coding delays, and therefore emission delays will remain unchanged.

(2) Relative to master station.

(3) M denotes Master Station; W, X, Y, Z denote slave stations; T denotes test station.

(4) All baselines are assumed to be seawater paths, i.e. not corrected for overland propagation conditions.

(5) Mercury Datum has been used for all computations.

Table 4-2

PULSE PHASE CODING

	First Group	*Second Group*
Master	+--+++++	++--+-+-
Slaves	+-+-++--	+++++--+

+ begins with positive-going cycle
- begins with negative-going cycle

TABLE 4-3

COORDINATED HF STANDARD FREQUENCY AND TIME TRANSMISSIONS

Call Sign	Site	Latitude	Longitude	Freq. MHz	Power* kW	Operation		Accuracy** (parts in 10^{10})	Time Signal			Audio Tones Hz
						Days/Week	Hours/Day		Number (per day)	Duration (Minutes)	Method of Adjustment	
ATA	New Delhi, India	28°34'N	77°19'E	10	2	5	5	±200 ±50	Continuous		Steering by the frequency	1; 1000
CHU	Ottawa, Canada	45°17'N	75°45'W	3.330; 7.335; 14.670	3	7	24	±50	Continuous		Steps of 100 ms	Nil
FFH	Paris, France	48°32'N	02°27'E	2.5	5	5	8 1/2	±2	48	30	Steps of 100 ms	1; 1000
HBN	Neuchatel, Switzerland	47°00'N	06°57'E	5	0.5	7	24	±1	144	5	Steps of 100 ms	1
IAM	Roma, Italy	41°52'N	12°27'E	5	1	6	1	±1	96	10	Steps of 100 ms	1; 1000
IBF	Torino, Italy	45°02'N	07°46'E	5	5	7	2 3/4	±1	Continuous		Steps of 100 ms	1
JJY	Tokyo, Japan	35°42'N	139°31'E	2.5; 5; 10; 15	2	7	24	±1	Continuous		Steps of 100 ms	1; 1000
LOL	Buenos Aires, Argentina	34°37'S	58°21'W	5; 10; 15	2	6	5	±200	24	4	Steps of 100 ms	1; 440; 1000
MSF	Rugby, United Kingdom	52°22'N	01°11'W	2.5; 5; 10	0.5	7	24	±1	144	5	Steps of 100 ms	1
OMA	Praha, Czechoslovak S. R.	50°07'N	14°35'E	2.5	1	7	24	±10	48	15	Steps of 50 ms	1; 1000
RWM RES	Moskva, U. S. S. R.	55°45'N	37°18'E	5; 10; 15	20	7	19	±50	12	10	Multiples of 10 ms	1; 1000
WWV	Fort Collins, Colorado U. S. A.	40°41'N	105°02'W	2.5; 5; 10; 15; 20; 25	2.5 to 10	7	24	±0.5	Continuous†		Steps of 100 ms	1; 440; 600
WWVH	Maui, Hawaii, U. S. A.	20°46'N	156°28'W	2.5; 5; 10; 15	1 to 2	7	24	±1	Continuous		Steps of 100 ms	1; 440; 600
ZLFS	Lower Hutt, New Zealand	41°14'S	174°55'E	2.5	0.3	1	3	±500	Nil	Nil	Nil	Nil
ZUO	Olifantsfontein, Republic of South Africa	25°58'S	28°14'E	5	4	7	24	±5	Continuous		Steps of 100 ms	1
ZUO	Johannesburg, Republic of South Africa	26°11'S	28°04'E	10	0.25	7	24	±5	Continuous		Steps of 100 ms	1

*Carrier power to antenna.

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**Offset from atomic time (A.1) approximately -300 parts in 10^{10} during 1969. Offset value announced annually by Bureau International de l'Heure.

†Time code (BCD) 10 times per hour.

4.3.2 RADIO-FREQUENCY ACCURACY.

The frequencies transmitted by WWV, Fort Collins, Colorado, USA, are held stable to 5 parts in 10^{11} at all times. Deviations at WWV are normally less than 1 part in 10^{11} from day to day. Incremental frequency adjustments not exceeding 1 part in 10^{11} are made at WWV as necessary. Frequency adjustments made at WWVH do not exceed 5 parts in 10^{10}. These accuracy figures will vary with changes in the propagation medium causing fluctuations in the carrier frequencies as received.

4.3.3 FREQUENCY OFFSET.

All carrier and modulation frequencies at WWV are derived from precision quartz oscillators with stabilities as stated in paragraph 4.3.2. These oscillators are intentionally offset from the United States Frequency Standard (USFS) by a small but precisely known amount to reduce departure between the time signals as broadcast and astronomical time (UT2). Although UT2 is subject to unpredictable changes readily noted at this level of precision, it is expected that a particular offset from the USFS will remain in effect for the entire calendar year. The offset for 1967 and 1968 was -300 parts in 10^{10} and the same offset is being maintained for 1969. Corrections to the transmitted frequency are continuously determined with respect to the USFS and are published monthly in the Proceedings of the IEEE.

4.3.4 STANDARD AUDIO FREQUENCIES.

Standard audio frequencies of 440 Hz and 600 Hz are broadcast on each radio carrier frequency at WWV. The audio frequencies are transmitted alternately at 5-minute intervals, starting with 600 Hz, on the hour. The first tone period of 600 Hz is of 3-minute duration, with the remaining 600-Hz and 440-Hz durations being 2-minutes. A 440-Hz transmission is omitted during the silent period at the 45-minute mark (Figure 4-6).

4.3.5 AUDIO FREQUENCY ACCURACY.

The accuracy of the audio frequencies, as transmitted, is the same as that of the carrier. The frequency offset mentioned in paragraph 4.3.3 applies. Changes in the propagation medium will sometimes result in fluctuations in the audio frequencies as received.

THE HOURLY BROADCAST SCHEDULES OF WWV, WWVH, WWVB AND WWVL

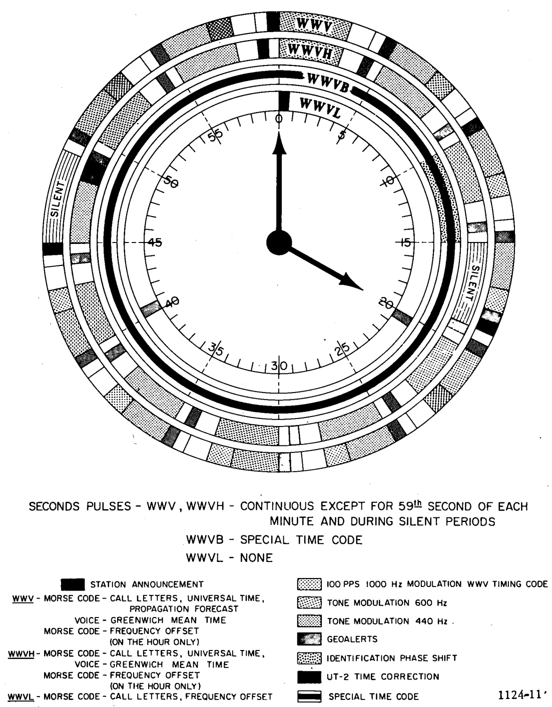

Figure 4-6. The hourly broadcast schedules of WWV, WWVH, WWVB, and WWVL (Courtesy, NBS).

While 1 kHz is not considered one of the standard audio frequencies, the time code that is transmitted 10 times an hour from WWV does contain this frequency and may be used as a standard with the same accuracy as the other audio frequencies.

4.3.6 STANDARD MUSICAL PITCH.

The frequency 440 Hz for the note A, above middle C, is the standard in the music industry in many countries including the United States. The periods of transmission of the 440 Hz can be determined from Figure 4-6. Since the majority of musical instruments manufactured can be tuned to this frequency, they can be adjusted to this standard pitch in terms of the unvarying WWV standard.

4.3.7 STANDARD TIME INTERVALS.

Seconds pulses at precise intervals are derived from the same oscillator that controls the radio carrier frequencies, e.g., they commence at intervals of 5,000,000 cycles of the 5-MHz carrier. They are given by means of double-sideband amplitude-modulation on each radio carrier frequency. Intervals of 1 minute are marked by the omission of the pulse at the beginning of the last second of every minute with two pulses spaced by 0.1 second.

The first pulse marks the beginning of the minute. The 2-minute, 3-minute and 5-minute intervals are synchronized with the seconds pulses and are marked by the beginning or ending of the periods when the audio frequencies are not transmitted. The pulse duration is 5 milliseconds. The pulse waveform is shown in Figure 4-7. At WWV each pulse contains 5 cycles of 1-kHz frequency. The pulse spectrum is composed of discrete frequency components at intervals of 1 Hz. The components have maximum amplitudes at approximately 995 Hz for WWV. The tone is interrupted 40 ms for each second's pulse. The pulse starts 10 ms after commencement of the interruption.

4.3.8 TIME SIGNALS.

The audio frequencies are interrupted at precisely 3 minutes before each hour at WWV. They are resumed on the hour and at 5- and 10-minute intervals throughout the hour as indicated in Figure 4-6.

Universal Time (referenced to the zero meridian at Greenwich, England) is announced each 5 minutes in International Morse Code from WWV. A voice announcement of Greenwich Mean Time is given during the last half of every fifth minute during the hour. These two identifications provide a ready reference to correct time when a clock may be in error by a few minutes. The 0-to-24-hour system is used starting with 0000 at midnight at longitude zero. The time announcement refers to the time when the audio frequencies resume.

Time signals broadcast from WWV are kept in close agreement with UT2 (astronomical time) by step adjustments of 100 ms, as necessary. These adjustments are made at 0000 UT on the first day of a month. Advance notice of such adjustments is given to the public, upon advice by the Bureau International de l'Heure in Paris that an adjustment is to be made. Decision to adjust time signals is based upon observations by a network of international observatories and is made by an international committee. Corrections to the time signals are published periodically by the U. S. Naval Observatory.

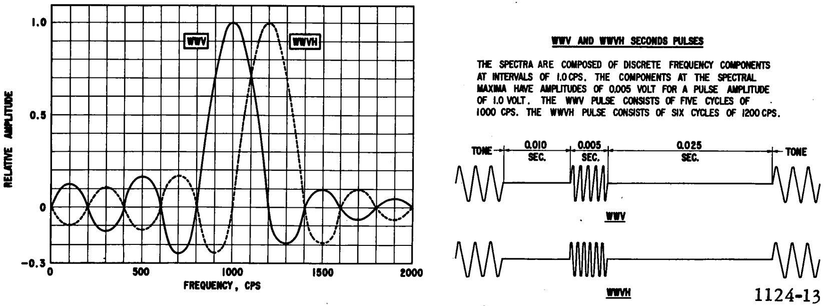

Figure 4-7. Sample characteristics of time pulses broadcast from NBS stations WWV and WWVH (Courtesy, NBS)

4.3.9 UT2 CORRECTIONS.

Since a majority of time users do not require UT2 information to better than 100 ms, the systems described in paragraph 4.3.8 are quite satisfactory. An additional service is provided in cooperation with the U. S. Naval Observatory that makes available the best values of UT2 on a daily basis. Corrections to be applied to the time signals as broadcast are given in International Morse Code during the last half of the 19th minute of each hour from WWV.

The symbols which are broadcast are as follows:

"UT2" then "AD" or "SU"

followed by a three digit number. This number is the correction in milliseconds. To obtain UT2, add the correction to the time indicated by the Time Signal pulse if "AD" is broadcast. Subtract if "SU" is broadcast. Thus, a clock keeping step with the time signals being broadcast will be fast with respect to UT2 if "SU" is the symbol used.

The corrections are extrapolated values of the difference of UT2 time minus the Time Signal furnished by the U. S. Naval Observatory. The probable error is ±3 ms. Final corrections, with a probable error of ±1 ms, are published in the Time Service Bulletins of the Naval Observatory.

These corrections will be revised daily, the new value appearing for the first time during the hour after 0000 UT, and will remain unchanged for the following 24-hour period.

4.3.10 WWV TIME CODE.

The time code being broadcast by WWV is generally known as the NASA 36-Bit Time Code (Figure 4-8). The code is produced at a 100 pps rate and is carried on 1-kHz modulation. Transmission is made one minute out of each five, ten times an hour (Figure 4-6). The code contains time-of-year information (Universal Time) in seconds, minutes, hours and day of year. The code is synchronous with the frequency and time signals.

The binary coded decimal (BCD) system is used. Each second contains 9 BCD groups in this order: 2 groups for seconds, 2 groups for minutes, 2 groups for hours, and 3 groups for day of year. The code digit weighting is 1-2-4-8 for each BCD group multiplied by 1, 10, or 100 as the case may be.

A complete time frame is 1 second. The binary groups follow the 1-s reference marker.

"On time" occurs at the leading edge of all pulses.

The code contains 100/second clocking rate, 10/second index markers, and a 1/second reference marker. The 1 kHz is synchronous with the code pulses, so that millisecond resolution is obtained readily.

The 10/second index markers consist of "binary one" pulses preceding each code group except at the beginning of the second, where a "binary zero" pulse is used.

The 1/second reference marker consists of five "binary one" pulses followed by a "binary zero" pulse. The second begins at the leading edge of the "binary zero" pulse.

The code is a spaced code format, that is, a binary group follows each of the 10/second index markers. The last index marker is followed by an unused 4-bit of "binary zero" pulses just preceding the 1/second reference marker.

A "binary zero" pulse consists of 2 cycles of 1 kHz amplitude modulation. The leading edges of the time code pulses coincide with positive-going zero-axis-crossings of the 1-kHz modulating frequency.

4.3.11 CHU TIME TRANSMISSIONS.

The Dominion Observatory, Ottawa, Canada, transmits continuously on three frequencies (Table 4-3). Transmitted frequencies from CHU are synthesized from a rubidium frequency standard that is referred daily to the Canadian cesium standard.

Seconds' pulses are derived electronically from the same standard oscillator and consist of 200 cycles of a 1000-hertz tone. The beginning of the pulse marks the exact second. The zero pulse of each minute is 0.5 second long, and the zero pulse of the hour is one second long. The pulses occur at the rate of one each mean-time second with the following exceptions:

1. the 29th pulse of each minute is omitted;

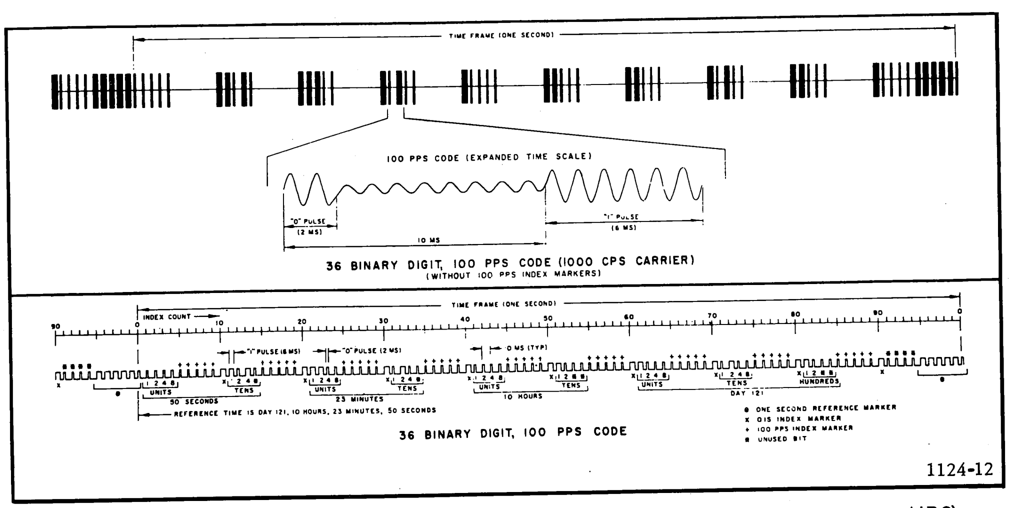

Figure 4-8. Chart of time code transmissions from NBS radio station WWV. (Courtesy, NBS).

2. the 51st to 59th pulses inclusive of each minute are omitted;

3. the 1st to 10th pulses inclusive are omitted on the first minute of each hour.

A voice announcement of the time occurs each minute in the ten second gap between the 50th and 60th second. It refers to the beginning of the minute pulse that follows. The announcement is on the 24-hour system. It is given in both English and French, and takes the form, "CHU, Canada, Eastern Standard Time, ---hours, ---minutes, ---heures, ---minutes," followed the next minute by a statement in which the English and French are interchanged. On the hour the statement is "---hours exactly, ---heures précise."

The official second is derived from the annual motion of the earth about the sun, and is provisionally evaluated as 9,192,631,770 hertz of the cesium atomic resonator. The second of Universal Time (UT2) is measured by the rotation of the earth on its axis, and as of January 1, 1966 it is longer than the official second by 300 parts in 10^{10}. A divergence can develop between the time derived from the official second and that determined by the rotation of the earth. When such a divergence reaches 100 ms, a step adjustment of 100 ms is made on the first day of the following month. This is usually done on an international basis. The time-and-frequency signals transmitted by CHU conform to the unified time service initiated by the United Kingdom and the United States of America, whereby national time signals maintain synchronism to a millisecond. Time Service Notice Bulletins are printed by the Dominion Observatory when a time change is made.

4.4 CIRCUIT DESCRIPTION.

4.4.1 GENERAL.

Many of the signals transmitting time information mentioned in paragraphs 4.2 and 4.3 can be received by the 1124. The circuits used to receive and amplify these signals are described in the following paragraphs. Block diagrams are used, where appropriate, to explain the signal flow through a circuit.

4.4.2 LORAN RECEIVER.

The Loran-C receiver is composed of two sections: 1. the input amplifier-notch filter assembly mounted in a shielded compartment on the front panel, and 2. the plug-in Loran amplifier circuit.

The Loran antenna is ac coupled into the 100 kHz input amplifier (Q401) and is matched with a 50-Ω input resistor (Figure 4-9). The input amplifier, which is similar to the other tuned stages in the receiver, is a grounded-emitter stage with an LC-tuned collector load. This amplifier drives the first notch filter (f_1-R_1), a bridged-T network adjustable over the approximate range of 80-95 kHz. Control of the center frequency is by C404, while R407 is adjusted for maximum rejection. A buffer amplifier (Q402/Q403) isolates the first notch filter from the second. This second filter is identical in structure to the first, but has a tuned range of 105-125 kHz. Under normal conditions these filters should not be set to frequencies inside the 90-110 kHz Loran-C band because they will distort the waveform. However, if serious interference is encountered in the band, such adjustment may be required. The final stage of the input amplifier circuit is the output buffer amplifier consisting of Q404 and Q405.

The Loran amplifier circuit is composed of three tuned-amplifier stages with transistor switches for gain control and an output buffer. These amplifiers are common-emitter circuits with RLC-tuned collector loads. Circuit Q is limited by the collector resistor to maintain at least a 20-kHz bandwidth in the receiver. Emitter degeneration resistors are switched in by transistors Q704, Q705, and Q706 to adjust the total gain. The 100-kHz amplifiers (Q701, Q702, and Q703)

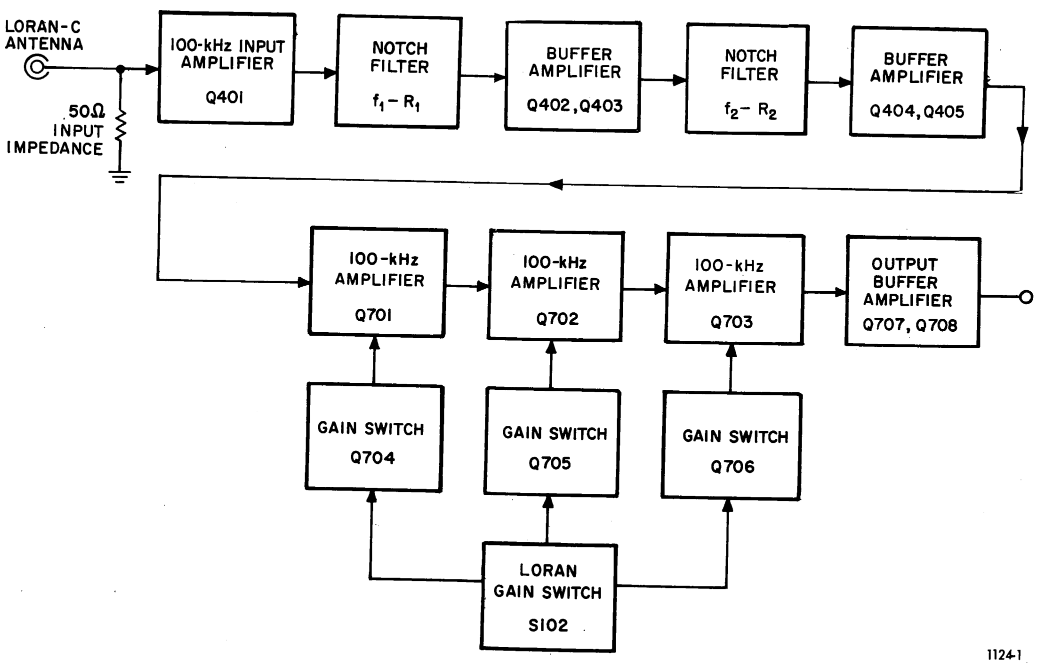

Figure 4-9. Loran-C receiver block diagram.

are switched on in succession by S102 to produce a total range of about 60 dB of gain. An output buffer circuit, composed of Q707 and Q708, adds a fixed output gain and isolates the last tuned amplifier from the deflection amplifier.

4.4.3 RF RECEIVER.

The rf receiver is composed of: an rf circuit board (one for each operating frequency); a crystal i-f circuit board (Figure 4-10). The operation of all the rf boards is the same except for different values of tuning elements and a different crystal oscillator.

The rf circuit can be broken down into an input stage, three rf amplifier stages, a diode mixer, and a crystal-controlled local oscillator. The input stage is a tuned impedance-matching transformer (T201) and capacitor (C201). The three rf amplifier stages are identical in structure although component values vary. Each stage is a tuned transformer-coupled grounded-emitter amplifier with a diode attenuator. The ferrite transformer is tuned to the particular operating frequency and provides proper impedance matching between stages. A diode attenuator at the base of each transistor allows limiting of the signal amplitude over a wide range under the control of the AGC circuit. The output of Q203, the third rf stage, is fed to a balanced diode-mixer along with the local-oscillator signal from Q204. In all cases, the difference in frequency between the input rf and the local oscillator is 3.0 MHz, the desired i-f frequency.

The output from the rf circuit selected by the measurement switch is connected to the crystal i-f filter, FL101. Unwanted sideband components are removed, leaving only the amplitude-modulated 3 MHz intermediate frequency.

The i-f circuit is composed of an input buffer, two tuned i-f amplifiers, a diode detector, an output buffer and an automatic gain control (AGC). The input buffer (Q301) provides proper impedance matching for the crystal filter. Transistors Q302 and Q303 comprise tuned 3-MHz amplifiers with a fixed gain. The output transformer from Q303 feeds a diode detector that reproduces the amplitude modulation. The audio output goes to a buffer amplifier composed of Q304 and Q305, whose output is switched to the deflection amplifier. The front-panel AUDIO OUTPUT (J156) is buffered by Q309, an emitter follower, to prevent loading of the audio signal. The detector output is also connected to the AGC circuit (Q306, Q307, Q308). This is a peak-detector and averaging circuit that controls the current through the diodes in the rf attenuator circuits. The more current through the diodes, the lower their impedance, and the more the input signal to the amplifier transistors' bases is reduced.

4.4.4 DEFLECTION AMPLIFIER.

The vertical deflection amplifier (Figure 6-6) is basically composed of an input buffer (Q101) and a balanced driver, V101 and V102. Transistor Q101 amplifies the signal selected by the measurement control and has adjustable feedback (R110) to provide a vertical gain control. The output of Q101 is ac coupled to one side of the balanced amplifier, the grid-bias voltage is set by R107 to provide position control. The other side of the balanced amplifier, the grid of V102, receives the timing pulse signal from the Type 1123 Syncronometer. The plates of V101 and V102 drive the upper and lower vertical-deflection plates. Transistor Q102 provides a constant-current source for the deflection amplifier.

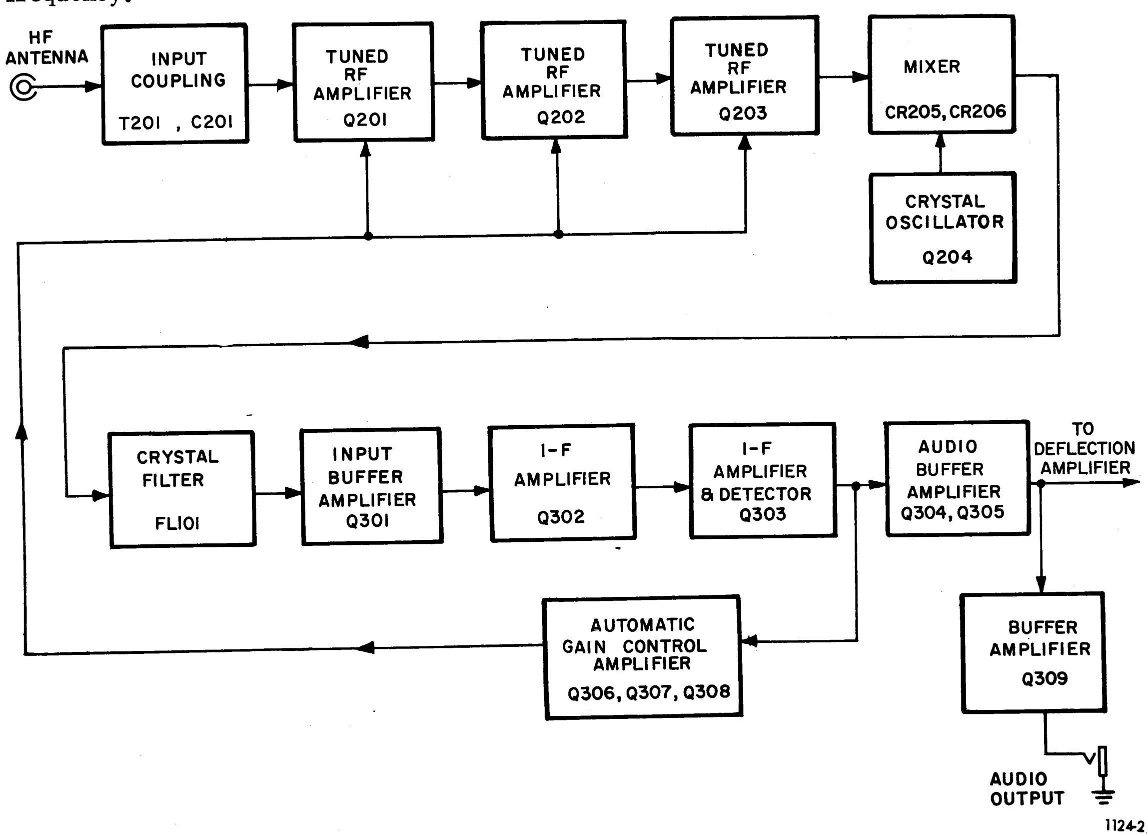

Figure 4-10. RF receiver block diagram.

Service and Maintenance—Section 5

5.1 SERVICE.

The two-year warranty stated above attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible. If the difficulty cannot be eliminated by use of the following service instructions, please write or phone our Service Department (see last page of manual), giving full information of the trouble and of steps taken to remedy it. Be sure to mention the type, ID and serial numbers of the instrument.

Before returning an instrument to General Radio for service, please contact our Service Department or nearest District Office, requesting a "Returned Material Tag." Use of this tag will ensure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

5.2 MINIMUM PERFORMANCE STANDARDS.

5.2.1 GENERAL.

The following checks are designed for incoming inspection groups and general maintenance groups to check the operation of the 1124 Receiver. Table 5-1 lists the test instruments necessary to perform these checks.

5.2.2 EQUIPMENT SETTINGS.

To perform the checks of paragraph 5.2.3, set the equipment as follows:

a. 1003 Signal Generator (Use the recommended 6-dB attenuator if the signal generator is calibrated for volts into 50 Ω.)
F-MONITOR - ON
OUTPUT RANGE - 300 mV
CARRIER LEVEL - 100 mV
MODULATION SELECTOR - 1-kHz INT
MODULATION LEVEL - 50%
RF OUTPUT - Connect to 1124 connector box at rear as required (Figure 5-1).

b. 1115 Oscillator and 1123 Syncronometer
Connect as shown in Figure 5-1.

c. 1191 Counter
INPUT CHANNEL - A
POLARITY-ATTEN - +1 (AC)
DISPLAY TIME - 100 µs
COMMON-SEPARATE - SEPARATE
RANGE - 10^6/0.1 s
MEASUREMENT - FREQUENCY
Connect A input to F-MONITOR on 1003.

d. RMS Voltmeter
Range - 1 V (0 dB)

e. 1124 Receiver
Connect as shown in Figure 5-1.

f. Headphones
Connect as shown in Figure 5-1.

5.2.3 RECEIVER CHECKS.

Proceed as follows:

a. Set the 2B67 Plug-in to NORMAL MODE and AC, INT, + triggering. Set the MEASUREMENT switch on the 1124 to HF 1 and supply a 3.33-MHz signal from the 1003 to the HF jack at the rear of the 1124.

b. Set the 2B67 TRIGGERING LEVEL and observe the signal on the oscilloscope. Adjust the 1124 AMPLITUDE and POSITION controls as necessary.

c. Listen with the headphones for a 1-kHz tone.

d. Note the reading in dB on the rms voltmeter.

e. Set the 1003 OUTPUT RANGE control to 30 µV (without changing the setting of the carrier level control) and note the reading on the rms voltmeter. The second reading should be less than 6-dB down from the previous reading on the rms voltmeter.

Table 5-1
TEST EQUIPMENT

Name	*Minimum Use Specifications*	*Recommended Unit**
Signal Generator	Capable of producing 100-kHz, 2.5-MHz, 3.33-MHz, 5.0-MHz, 7.335-MHz and 10-MHz signals with 1-kHz modulation. Variable ±20 kHz about 100 kHz and ±3 kHz about the other five input frequencies. Output voltage level behind 50 Ω variable from 10 μV to 0.5 V. If generator is rated in volts into 50 Ω, use a GR 874-G6L 6-dB Fixed Attenuator at the output jack. Calibration accuracy ±0.25%.	GR 1003 Standard-Signal Generator
Standard Oscillator	Precision standard-frequency oscillator generating at least 0.5 V at 100 kHz and 0.5 V at 1 MHz (sinusoid or square wave) to drive the clock.	GR 1115 Standard-Frequency Oscillator
Clock	Generates sync, 8-ms pedestal and marker pulses to make the measurements.	GR 1123 Digital Syncronometer® (P/N 1123-9763)
EVM	Capable of reading dc voltages up to 420 V and ac voltages up to 165 V.	GR 1806 Electronic Voltmeter (P/N 1806-9701)
Counter	Capable of indicating the necessary frequencies from the 1003 (i.e., 100 kHz through 10 MHz) with Tektronix P6006 Probe.	GR 1191 Counter
Oscilloscope	Capable of reading the audio output signal from the 1124 Receiver plug-in.	Tektronix Model 543 Oscilloscope with Type B Plug-in.
RMS Voltmeter	Unit must have a 1-V scale with a corresponding scale in dB.	HP 3400 A RMS Voltmeter
Headphones	Capable of reproducing 1-kHz audio signals.	Lincoln general-purpose headphones with phone tips.
Patch Cord	BNC plug to GR874 coaxial connector.	GR 776-B Patch Cord (P/N 0776-9702)
Patch Cord	GR 274 Double Plug to telephone plug connector.	GR 1560-P95 Adaptor Cable (P/N 1560-9695)
BNC/GR874 Locking Adaptor	Converts GR874 locking connector to BNC plug.	GR 874-QBPAL Adaptor (P/N 0874-9801)
BNC/GR874 Non-Locking Adaptor	Converts GR874 connector to BNC plug (2 required).	GR 874-QBPA Adaptor (P/N 0874-9800

Table 5-1 (Cont)
TEST EQUIPMENT

Name	*Minimum Use Specifications*	*Recommended Unit**
GR 274/GR874 Adaptor	Converts GR 274 Double Plug to GR874 coaxial connector.	GR 874-Q2 Adaptor (P/N 0874-9870
GR 874 Tee Connector	Junction for three GR874 coaxial connectors.	GR 874-T Tee (P/N 0874-9910)
50- Ω Termination	A 50-Ω termination.	GR 874-W50B 50-ohm Termination (P/N 0874-9954)
50-Ω Resistor	A 50-Ω precision resistor, 1%, 7.5 W.	DALE Series RH-5, 50 Ω
Flexible Adaptor Cable	30-in. adaptor cable for connecting power to a plug-in unit outside the oscilloscope frame.	Tektronix P/N 012-066
Alignment Tool	Insulated-shaft screwdriver with a blade end.	G-C Electronics Type 5000 Alignment Screwdriver.
8.2-kΩ Resistor	An 8.2-kΩ carbon resistor, ±5%, 1 W.	Ohmite "Little Devil" 8200 Ω, 5%, 1 W

*or equivalent

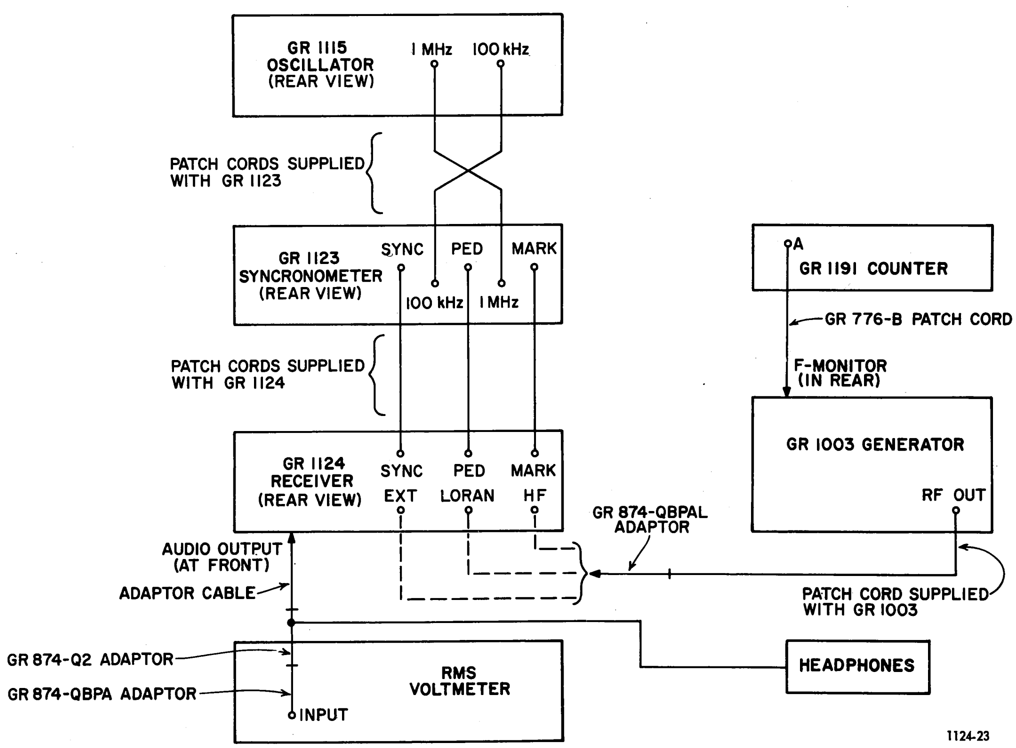

Figure 5-1. Typical setup for testing the 1124 Receiver.

f. Switch the MEASUREMENT switch on the 1124 to HF 2 and change the frequency of the 1003 to 5.0 MHz. Repeat steps b through e.

g. Connect the 1003 to the EXT input on the rear of the 1124 and set the 1124 MEASUREMENT switch to EXT HF.

h. Set the 1003 FREQUENCY RANGE switch to the 67-156 kHz range and set the MODULATION SELECTOR to the CW NORM position.

i. Set the 1003 for an output of 0.5 V and adjust the AMPLITUDE control on the 1124 to check that the trace can reach full scale on the oscilloscope.

j. Repeat step i with the MEASUREMENT switch set to EXT LF.

k. Connect the 1003 to the LORAN antenna input and set the 1124 MEASUREMENT switch to LORAN-C.

l. Set the frequency of the 1003 to 100 kHz.

m. Observe the 100-kHz signal on the oscilloscope screen.

n. Reduce the frequency setting of the 1003 until a minimum deflection point occurs on the oscilloscope screen. This should occur between 80 and 90 kHz. Repeat on the high side where the minimum deflection should occur between 110 and 120 kHz. Paragraph 5.7.8 details the complete Loran Filter calibration.

o. Set the 1124 MEASUREMENT switch to HF 1.

p. Set the 2B67 Time Base TIME/DIV control to 10 mSEC.

q. Use the positioning controls to observe that the 8-ms pedestal can be positioned to rise at the left-hand side of the graticule and that a second pedestal is starting at the right-hand side. The 1123 must be in an "X" position. A 100-ms period checks full-scale horizontal calibration.

r. Check that the pedestal is visible when the 1124 MEASUREMENT is in the HF 2 and EXT HF positions. positions.

s. Set the 2B67 Time Base TIME/DIV control to 1 μsec and set the 1124 MEASUREMENT switch to LORAN-C.

t. Connect the 1003 to the LORAN input and inject a 100-kHz, 0.5-V signal.

u. Adjust the oscilloscope triggering level to obtain a stable pattern and observe the μs marker.

NOTE

The marker is of short duration and has low intensity and can often be found by looking for a discontinuity in the signal trace.

v. Connect the 1003 to the EXT terminal on the rear of the 1124 and inject a 100-kHz, 0.5-V signal.

w. Set the 1124 MEASUREMENT switch to EXT LF.

x. Repeat step u.

5.2.4 LORAN ANTENNA CHECKS.

To check the operation of the Loran-C antenna proceed as follows:

a. Set the 1003 Signal Generator as follows:
FREQUENCY RANGE - 67-156 kHz
OUTPUT RANGE - 3 V
MODULATION SELECTOR - CW HIGH
F MONITOR - ON
FREQUENCY - 100 kHz

b. Set the 1191 Counter as follows:
SEPARATE-COMMON - SEPARATE
DISPLAY TIME - 1 s
RANGE - 10^6/0.1 s
MEASUREMENT - FREQUENCY
POLARITY AND ATTEN - +1

c. Set the rms voltmeter to the 0.001 volts/-60dB range.

d. Terminate the RF OUTPUT from the 1003 in a length of wire and 50-Ω resistor. Loop the wire around one side of the antenna a couple of times (for coupling).

e. Connect the antenna output to the rms voltmeter and a 50-Ω termination with the use of a GR874 connector.

f. With the 1003 set at 100 kHz, set the carrier level to obtain 0-dB reading on the rms voltmeter panel meter. This may require a range change of the voltmeter or extra loops of wire around the antenna.

g. Tune the 1003 until the rms voltmeter indication is -3 dB. With the 1191 Counter INPUT A connected to the F-MON jack of the 1003, record the frequency.

h. Tune the 1003 in the opposite direction until the rms voltmeter again indicates -3 dB. Record this frequency as read on the 1191. The difference between these two frequencies should be approximately 20 kHz.

5.3 PLUG-IN REMOVAL.

If it becomes necessary to completely remove the plug-in from the storage oscilloscope, proceed as follows:

a. Turn the power off.

b. Turn the INTENSITY control fully ccw.

c. Rotate the locking knob at the bottom of the front panel ccw until the latch releases (Figure 5-2).

d. Pull the plug-in unit forward carefully.

CAUTION

There are six coaxial cables connected to the rear of the front panel that can be damaged if the unit is pulled out too fast.

e. Locate the six coaxial cables with the miniature coaxial connectors attached and disconnect each of the coaxial cables at the rear of the front panel (Figure 5-2).

f. Remove the plug-in unit completely from the cabinet, while making sure that the coaxial cables are clear and not pulled tight.

5.4 PLUG-IN INSTALLATION.

a. Place the plug-in unit in the left side of the 1124 Receiver.

CAUTION

Feed the six coaxial cables through the plug-in toward the front so that they will not become damaged.

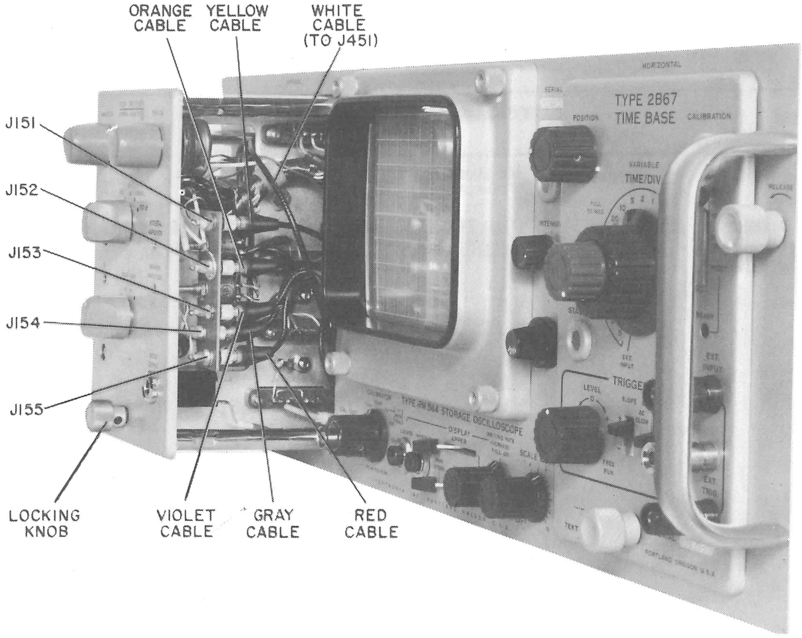

Figure 5-2. Receiver plug-in partially pulled out of main chassis.

b. Connect each of the six coaxial cables to the jacks provided according to the colorcoding (Figure 5-2).

c. Push the plug-in completely into the receiver carefully so that the coaxial cables do not jam and rotate the locking knob cw, until the latch is secure.

5.5 BOARD REPLACEMENT.

When it is necessary to replace a plug-in board, proceed as follows:

a. Follow steps a through d in paragraph 5.3. This will allow the plug-in unit to be pulled out far enough to change a board without disconnection of the six coaxial cables.

b. Remove the hold-down screw on the board to be removed.

c. Unplug the board.

d. Install the new board into the sockets.

e. Replace the hold-down screw.

f. Slowly push the plug-in back into the oscilloscope housing,being careful not to jam the coaxial cables.

g. Rotate the locking knob cw until the latch is secure.

5.6 TROUBLE ANALYSIS.

5.6.1 GENERAL.

The detailed trouble analysis given here is for the General Radio receiver plug-in unit. Refer to the Tektronix Type RM564 Manual, Section 4 and the Tektronix Type 2B67 Manual, Section 5 for additional analysis information.

5.6.2 DEFLECTION AMPLIFIER.

The deflection amplifier consists of two tubes and two transistors along with their associated components. The voltages for these components are listed in Table 5-2. Figure 6-6 will help in determining the location of a faulty component.

5.6.3 RF CIRCUITS.

An rf circuit can be checked by following the procedure given in paragraph 5.7.6. The voltages for the various transistors are given in Table 5-2. The local oscillator frequency can be checked at the junction of R217-R218 on the rf board.

Using the setup for paragraph 5.6.3, check that the 3-MHz signal is at S0101A, E5 as well as S0102B, E5. If the signal isn't being fed through the filter, another filter (FL101) will be needed.

5.6.4 I-F AMPLIFIER AND CRYSTAL FILTER.

Check that the input signal (3 MHz) is being fed through the amplifier stages of Figure 6-14. If there is no signal at the collector of Q302 and the transistor voltages as listed in Table 5-2 are correct, the crystal filter may be defective. (The output of the filter, S0101A E5, is approximately 10 mV.) The procedure outlined in paragraph 5.7.5 can be used to determine if the circuit is functioning properly. Table 5-2 lists the transistor voltages associated with this circuit.

5.6.5 LORAN FILTER.

If interference is present on the oscilloscope in the Loran-C mode, refer to paragraph 5.7.8 for front panel adjustments of the filter. If these adjustments fail to eliminate the interference according to specifications, refer to Figure 6-17. The signal can be traced through the filter circuit and a determination of the faulty component made. Table 5-2 lists the transistor voltages for this circuit.

5.6.6 LORAN AMPLIFIER.

Check this circuit by feeding a 100-kHz signal into the LORAN-C jack at the rear of the receiver and obtaining a 100-kHz display on the receiver screen. Rotate the front-panel LORAN GAIN control through its

Table 5-2
TYPICAL TEST VOLTAGES*

Circuit	Measurement Point			
		PIN 1	PIN 2	PIN 3
Deflection Amplifier (Figures 6-5, 6-6)	V101†	-1 to +1	-1 to +1	0.8 to 9
	V102†	-0.9	-0.9	0.8 to 9
		PIN 4	PIN 5	PIN 6
	V101	0.4 to 2.3	0.4 to 2.3	0
	V102	0.4 to 2.3	0.4 to 2.3	0
		PIN 7	PIN 8	PIN 9
	V101	35 to 120	35 to 120	90 to 110 to 90
	V102	35 to 120	35 to 120	90 to 110 to 90
		VALUE		
	AT102	12		
	AT104	-100		
	AT108	-12		
	AT112	300		
	AT114	125		
	AT115	6.3 AC		
	AT116	6.3 AC		
		EMITTER	BASE	COLLECTOR
	Q101	-15	-14.2	9
	Q102	-0.7 to 0.8	-0.1	0.4 to 2.2
RF AmplifierΔ (Figures 6-7 and 6-8 through 6-12)	Q201	-12	-11.3	0
	Q202	-12	-11.3	0
	Q203	-12	-11.3	0
	Q204	-10	-9.3	0
I-F Amplifier** (Figures 6-13, 6-14)	Q301	-10.4	-9.8	0
	Q302	-11.0	-10.5	0
	Q303	-9.0	-8.4	0
	Q304	-8.6	-8.0	-0.75
	Q305	0	-0.75	-6.4
	Q306	-12.5	-12.0	-0.57
	Q307	0	-0.58	-12.0
	Q308	-12.5	-12.0	-0.68
	Q309	-7.0	-6.4	0
Loran Filter (Figures 6-15, 6-16, 6-17)	Q401	10.0	-0.3	-0.75
	Q402	8.2	0.75	1.12
	Q403	6.2	8.2	10.0
	Q404	8.4	0.75	1.2
	Q405	7.6	8.4	10.1
Loran Amplifier (Figures 6-18, 6-19)	Q701	-1.7	-1.1	11.0
	Q702	-2.0	-1.4	11.0
	Q703	-1.9	-1.3	11.0
Positions 2, 3, 4††	Q704	-1.65	-1.95	-1.7
Position 1	Q704	0	11.0	-12.5
Positions 1, 2	Q705	0	11.0	-12.5
Positions 3, 4	Q705	-1.65	-1.95	-1.7
Positions 1, 2, 3	Q706	0	11	-12.5
Position 4	Q706	-1.65	-1.95	-1.7
	Q707	4.5	4.0	10.0
	Q708	11.0	10.3	4.5

*All voltages are dc except where noted and measured with a GR 1806 Electronic Voltmeter. Voltages are typical values only.

†Low values in the voltage range are with the POSITION control in the ccw position; high values are cw. The PIN 9 voltage is the same at each end of the POSITION control with a peak in the center.

Δ MEASUREMENT switch must be in position HF1 or HF2, whichever is appropriate for the board under test.

**MEASUREMENT switch must be in LORAN-C position.

††Positions are for the LORAN GAIN switch. The numbers increase in a cw direction starting from the full ccw position.

four positions and note that the signal amplitude increases with a cw rotation (approximately 20-dB per step). Figure 6-19 is the amplifier's schematic diagram and Table 5-2 lists the transistor voltages.

5.7 CALIBRATION.

5.7.1 GENERAL.

The detailed calibration procedure given here will be for the General Radio receiver plug-in with references to Tektronix instruction manuals given for the oscilloscope display portion and the horizontal time base. Equipment needed is listed in Table 5-1 and the general connections between instruments are shown in Figure 5-1. Figures 5-3 and 5-4 will assist in component location. The procedures that follow are to be done in sequence.

5.7.2 POWER SUPPLY.

The power supply for the receiver plug-in unit is the same as that for the oscilloscope unit. The schematic diagram with voltages is contained in the Tektronix RM564 Oscilloscope instruction manual.

5.7.3 TIME BASE.

The calibration of the Tektronix 2B67 Time Base is given in the Tektronix instruction manual enclosed with the unit.

5.7.4 DEFLECTION AMPLIFIER.

There are no internal adjustments for the deflection amplifier. The POSITION and AMPLITUDE controls (Figure 6-6) are located on the front panel and are knob controls.

5.7.5 I-F AMPLFIIER.

To calibrate the i-f board, proceed as follows:

a. Remove the receiver plug-in unit (refer to paragraph 5.3) and install a Tektronix 30-inch Flexible Cable *(Tektronix P/N 012-066)*. Turn the plug-in unit sideways in front of the 1124 and reconnect the coaxial cables.

b. Turn the receiver power on.

c. Connect the 1003 Signal Generator's RF OUTPUT to the HF antenna jack at the rear of the 1124. Set the controls on the 1003 as follows:

F-MONITOR - ON
MODULATION - 50% at 1 kHz
RANGE - 5-10 MHz
FREQUENCY - 3.00000 MHz
OUTPUT RANGE - 10 mV
CARRIER LEVEL - 0.5

d. Connect the 1191 Counter to the F-MONITOR jack on the 1003 and lock the counter time base to the 1115 Standard-Frequency Oscillator. Set the 1191 controls as follows:

INPUT - A
MEASUREMENT - FREQUENCY
RANGE - 10^8/10 s
DISPLAY TIME - 100 μs

e. Connect the rms voltmeter to the AUDIO OUTPUT jack at the front of the receiver plug-in. Set the meter to the 1-V/O-dB range.

f. Turn the gain control potentiometer (R311) to its ccw region.

g. Tune C301, T301 and T302 for a maximum reading on the rms voltmeter. Retune as needed to obtain the maximum gain.

h. Turn the gain control potentiometer cw to increase the gain and repeat step g until the meter is peaked at 500 mV ±10 mV.

5.7.6 RF CIRCUITS.

CAUTION

The calibration of the i-f circuits must be verified before the calibration of the rf circuits is attempted.

The five rf circuits are similar except for the value of some components that determine the frequency of the circuit. The general procedure for calibration is as follows:

a. Connect the RF OUTPUT of a GR 1003 Signal Generator to the HF antenna jack at the rear of the 1124. Set the controls as follows:

F MONITOR - ON
MODULATION SELECTOR - 1-kHz INT.
MODULATION LEVEL - 50%
OUTPUT RANGE and CARRIER LEVEL - 300 mV to 3 mV initially (enough to produce the audio output)
FREQUENCY - As marked on rf board being calibrated.

b. Connect an oscilloscope to the AUDIO OUTPUT jack and connect the EXT TRIGGER to the MOD OUTPUT (1 kHz) of the 1003. Set the oscilloscope to 0.5 ms/cm and 5 mV/cm.

c. Connect an rms voltmeter to the AUDIO OUTPUT jack in parallel with the oscilloscope.

d. Connect the X10 probe of the 1191 Counter to the junction of R217-R218 on the rf board to be calibrated. Be sure the MEASUREMENT switch is in the correct position. Lock the counter time base to the 1115 Standard-Frequency Oscillator. Set the counter as follows:

MEASUREMENT - FREQUENCY
RANGE - 10^6/0.1 s
DISPLAY TIME - 100 μs
POLARITY AND ATTEN - +1
INPUT - A, AC, SEPARATE

e. Adjust C218 for a frequency 20 Hz less than that marked on the crystal. The crystal frequency is the board frequency plus 3 MHz. The 20-Hz deviation compensates for the loading of the probe.

f. Remove the X10 probe and connect the 1191 directly (no probe) into the F-MONITOR jack on the 1003.

g. Set the 1003 frequency to the board frequency and monitor the frequency with the 1191.

h. Turn the AGC potentiometer (R228) on the rf board to its cw region.

i. Set the 1003 to 10 μV (Range 30 μV, Level 1).

j. Tune T201, T202, T203 and T204 for maximum output on the rms voltmeter.

k. Observe that the signal on the scope is clean.

l. Connect the GR 1806 Voltmeter between i-f board pin $\overline{E5}$ and ground with the + side grounded.

m. Observe the reading on the VTVM. If it indicates a voltage (showing AGC on) turn the AGC potentiometer on the rf board cw until the AGC turns off. The transformers should always be peaked with the AGC off (VTVM reading 0V). To do this it may also be necessary to decrease the output of the 1003.

n. After peaking the transformers, turn the AGC potentiometer on the rf board ccw until the AGC just turns on as indicated by the VTVM. This should be done with the 1003 output at 10 μV (30-μV range, level 1).

o. Note the dB reading of the rms voltmeter. It should be about -9 dB.

p. Turn the RANGE switch on the 1003 to the 300-mV range. Note the reading on the rms voltmeter in dB. The change from 10-μV to 100-mV input to the rf board should give no more than a 6-dB change in the audio output.

q. Unplug the rf cable that is at the HF antenna jack and observe the oscilloscope. The trace should be stable as indicated by a horizontal line. If the output is oscillating, turn the AGC potentiometer on the rf board cw until the oscillation stops. Re-check step p. If this fails, detune one of the transformers slightly. This may require an increase in the AGC to maintain the output within the 6-dB specification. Repeat steps p and q until the board meets both the AGC and stability requirements.

5.7.7 LORAN AMPLIFIER.

To check the Loran amplifier board, proceed as follows:

a. Set the MEASUREMENT switch on the 1124 to LORAN-C.

b. Connect the RF OUTPUT from the 1003 Signal Generator to the LORAN antenna jack on the 1124 and set the 1003 controls as follows:

FREQUENCY RANGE - 67-156 kHz
FREQUENCY - 100 kHz
MODULATION - CW NORM
OUTPUT LEVEL - 300 μV range
F MONITOR - ON

c. Connect the 1191 A INPUT to the F-MONITOR jack on the 1003. Set the 1191 controls as follows:

DISPLAY TIME - 100 μs
RANGE - 10^6/0.1 s
MEASUREMENT - FREQUENCY

d. Connect the rms voltmeter to the 100-kHz output of the board (S0104B, $\overline{C3}$) and set the range to 0.3V/-10 dB. Also, connect the oscilloscope to this point with the time base at 5 μs/cm and the trigger at INT +.

e. Set the LORAN GAIN switch to the full cw position.

f. Set the CARRIER LEVEL on the 1003 such that the voltmeter indicates 0 dB on the 0.3-V range.

g. Increase the frequency of the 1003 until the voltmeter indicates -3 dB. The frequency should be greater than 110 kHz.

h. Decrease the frequency until the meter indicates -3 dB. This should be less than 90 kHz.

i. Set the output level for a 0-dB indication on the voltmeter as in step f.

j. Set the LORAN GAIN switch to the next ccw position and the 1003 OUTPUT RANGE to -40 dB (don't touch the carrier level). The voltmeter should read between 0 and -2 dB.

k. Set the LORAN GAIN switch to the next ccw position and set the 1003 OUTPUT RANGE to -20 dB. The voltmeter should read between 0 and -4 dB.

l. Set the LORAN GAIN switch to full ccw position and set the 1003 OUTPUT RANGE to 0 dB. The voltmeter should read between 0 and -6 dB.

m. Set the LORAN GAIN switch to the full cw position, the 1003 OUTPUT RANGE to 300 μV, the CARRIER LEVEL to 100 μV and the rms voltmeter to the 0.3-V range. The voltmeter should read between 175 and 225 mV (gain ≈ 2000).

5.7.8 LORAN FILTER.

To check the range of the notch filter, proceed as follows:

a. Connect the 1003 Signal Generator to the LORAN antenna input and set the controls as follows:

F MONITOR - ON
MODULATION SELECTOR - CW NORM
FREQUENCY RANGE - 67 kHz - 156 kHz
OUTPUT RANGE - 100 mV
CARRIER LEVEL - ≈ 50 mV
FREQUENCY - 100 kHz

b. Connect the oscilloscope to S0104A, E5 and set the controls as follows:

TRIGGER - INT, AC
VOLTS/CM - 0.2 with X10 probe
TIME/CM - 50 μs

c. Connect the rms voltmeter to S0104A, E5 and use the 10-V/0-dB range.

d. Connect the 1191 Counter to the F MONITOR output at the rear of the 1003. Set the 1191 controls as follows:

INPUT - A
THRESHOLD - +1
DISPLAY TIME - 100 μs
TRIGGERING - AC, SEPARATE
RANGE - 10^6/0.1 s
MEASUREMENT - FREQUENCY

e. Set the MEASUREMENT switch on the 1124 to LORAN-C.

f. Adjust the CARRIER LEVEL from the 1003 to read 0 dB (0.77 V) on the voltmeter. This should require an output from the 1003 of 40-60 mV.

g. Set the 1003 to exactly 100 kHz by reading the frequency on the 1191.

h. Observe the oscilloscope and check that the output is clean and not disordered.

i. Check the low frequency range of nulls possible by adjusting the 1003 to about 85 kHz and adjusting F2 and R2 on the front panel of the 1124 to obtain a null as indicated on the rms voltmeter or the oscilloscope. Turn F2 slightly and null again, this time by changing the frequency of the 1003. Continue tuning F2 and nulling with the 1003 until the maximum and minimum frequencies are obtained as read on the 1191 Counter. This range should be about 82-88 kHz.

j. Repeat step i for frequencies above 100 kHz using F1 and R1. Start at a frequency of 115 kHz. This range should be about 112-123 kHz.

k. Set the 1003 FREQUENCY to 100 kHz and if needed reset the CARRIER LEVEL of the 1003 to obtain a 0-dB reading on the rms voltmeter.

l. Tune the 1003 to 85 kHz and null R2 and F2. The null should be greater than 40 dB down from the reference.

m. Tune the 1003 to 115 kHz and null R1 and F1. The null should be greater than 40 dB down from the reference.

n. Tune the 1003 back to 100 kHz and check that the rms voltmeter still reads 0 dB (adjust if necessary) and lower the frequency until the rms voltmeter reads -3 dB. The difference between these two frequencies should be greater than 20 kHz.

5.8 KNOB REMOVAL.

NOTE

Refer to the Tektronix manuals for knob removal information in relation to the oscilloscope portion and the time base.

If it should be necessary to remove the knob on a front-panel control of the receiver plug-in unit, either to replace one that has been damaged or to replace the associated control, proceed as follows:

a. Grasp the knob firmly with the fingers close into the panel, and pull the knob straight away from the panel.

b. Observe the position of the set screw in the bushing with respect to any panel markings (or at the full ccw position of a continuous control.)

c. Release the set screw with a 1/16 in. hex-socket key wrench and pull the bushing off the shaft.

NOTE

To separate the bushing from the knob, if for any reason they should be combined off the instrument, drive a machine tap a turn or two into the bushing for a sufficient grip for easy separation.

5.9 KNOB INSTALLATION (RECEIVER PLUG IN).

To install a snap-on knob on a control shaft, proceed as follows:

a. Mount the bushing on the shaft, using a small slotted piece of wrapping paper as a shim for adequate panel clearance.

b. Orient the set screw on the bushing with respect to the panel-marking index and lock the set screw with a 1/16 in. hex-socket key wrench.

NOTE

Make sure that the end of the shaft does not protrude through the bushing or the knob won't set properly.

c. Place the knob on the bushing with the retention spring opposite the set screw.

d. Push the knob in until it bottoms and pull it slightly to check that the retention spring is seated in the groove in the bushing.

NOTE

If the retention spring in the knob comes loose, reinstall it in the interior notch with the small slit in the outer wall.

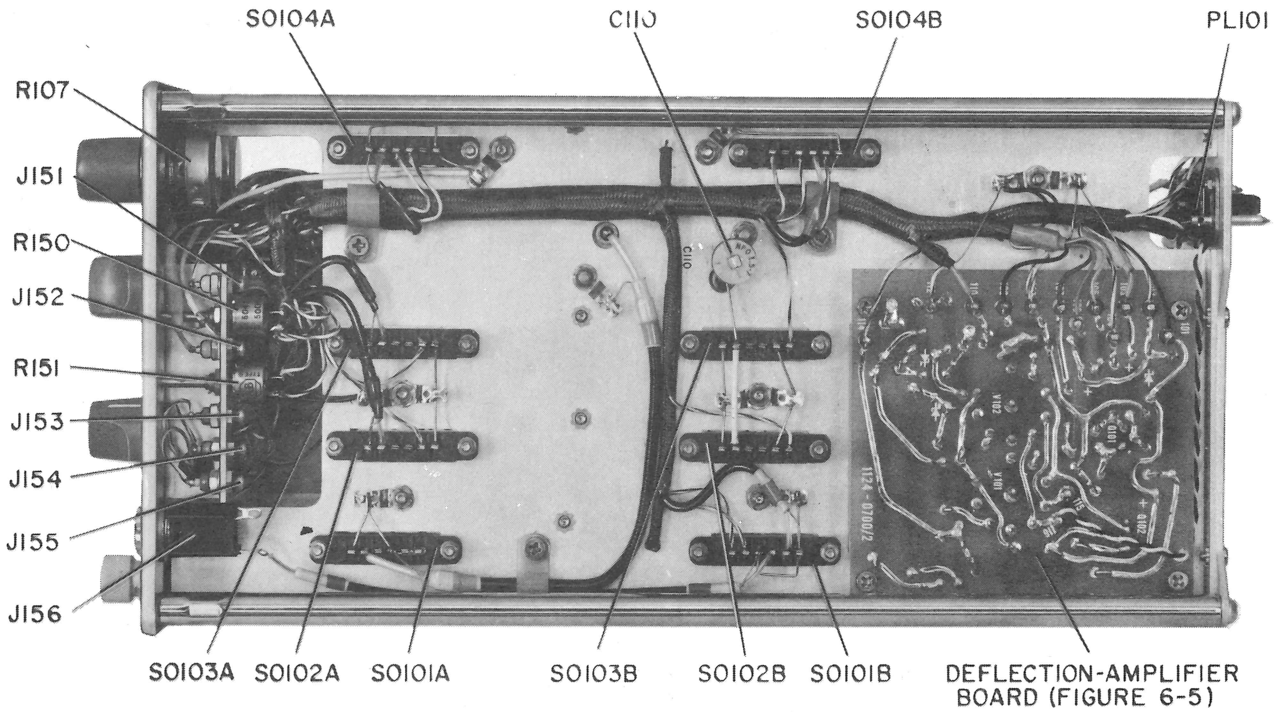

Figure 5-3. Bottom interior view of receiver plug-in.

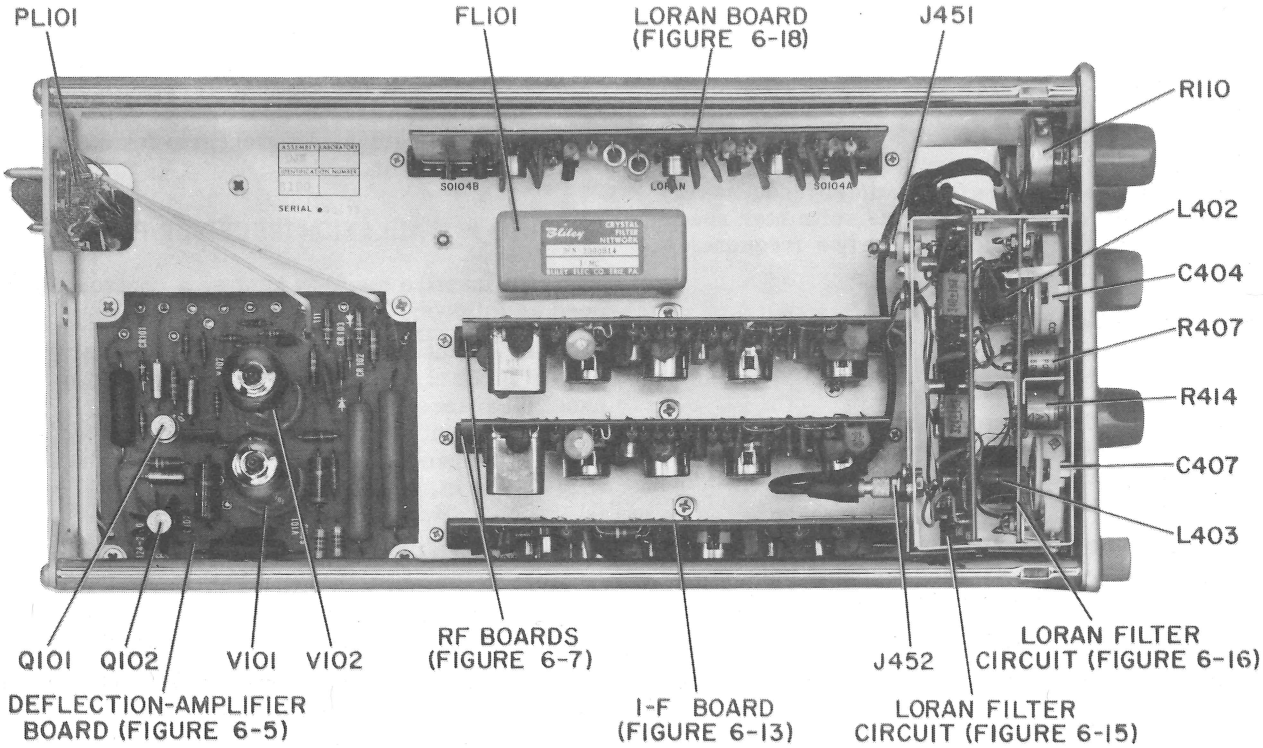

Figure 5-4. Top interior view of receiver plug-in.

Parts Lists and Diagrams—Section 6

The parts list, etched-board diagram and schematic diagram for a specific circuit are located on adjacent pages. The rf circuits have a common etched-board diagram.

CONTENTS

FEDERAL MANUFACTURER'S CODE

From Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) as supplemented through August, 1968.

Code	Manufacturer
00192	Jones Mfg. Co, Chicago, Illinois
00194	Walsco Electronics Corp, L.A., Calif.
00434	Schweber Electronics, Westburg, L.I., N.Y.
00656	Aerovox Corp, New Bedford, Mass.
01009	Alden Products Co, Brockton, Mass.
01121	Allen-Bradley, Co, Milwaukee, Wisc.
01295	Texas Instruments, Inc, Dallas, Texas
02114	Ferroxcube Corp, Saugerties, N.Y. 12477
02606	Fenwal Lab Inc, Morton Grove, Ill.
02660	Amphenol Electron Corp, Broadview, Ill.
02768	Fastex, Des Plaines, Ill. 60016
03508	G.E. Semicon Prod, Syracuse, N.Y. 13201
03636	Grayburne, Yonkers, N.Y. 10701
03888	Pyrofilm Resistor Co, Cedar Knolls, N.J.
03911	Clairex Corp, New York, N.Y. 10001
04009	Arrow-Hart & Hegeman, Hartford, Conn. 06106
04713	Motorola, Phoenix, Ariz. 85008
05170	Engr'd Electronics, Santa Ana, Calif. 92702
05624	Barber-Colman Co, Rockford, Ill. 61101
05820	Wakefield Eng, Inc, Wakefield, Mass. 01880
07126	Digitron Co, Pasadena, Calif.
07127	Eagle Signal (E.W. Bliss Co), Baraboo, Wisc.
07261	Avnet Corp, Culver City, Calif. 90230
07263	Fairchild Camera, Mountain View, Calif.
07387	Birtcher Corp, No. Los Angeles, Calif.
07595	Amer Semicond, Arlington Hts, Ill. 60004
07828	Bodine Corp, Bridgeport, Conn. 06605
07829	Bodine Electric Co, Chicago, Ill. 60618
07910	Cont Device Corp, Hawthorne, Calif.
07983	State Labs Inc, N.Y., N.Y. 10003
07999	Borg Inst., Delavan, Wisc. 53115
08730	Vemaline Prod Co, Franklin Lakes, N.J.
09213	G.E. Semiconductor, Buffalo, N.Y.
09408	Star-Tronics Inc, Georgetown, Mass. 01830
09823	Burgess Battery Co, Freeport, Ill.
09922	Burndy Corp, Norwalk, Conn. 06852
11236	C.T.S. of Berne, Inc, Berne, Ind. 46711
11599	Chandler Evans Corp, W. Hartford, Conn.
12040	National Semiconductor, Danbury, Conn.
12498	Crystalonics, Cambridge, Mass. 02140
12672	RCA, Woodbridge, N.J.
12697	Clarostat Mfg Co, Inc, Dover, N.H. 03820
12954	Dickson Electronics, Scottsdale, Ariz.
13327	Solitron Devices, Tappan, N.Y. 10983
14433	ITT Semiconductors, W.Palm Beach, Fla.
14655	Cornell-Dubilier Electric Co, Newark, N.J.
14674	Corning Glass Works, Corning, N.Y.
14936	General Instrument Corp, Hicksville, N.Y.
15238	ITT, Semiconductor Div, Lawrence, Mass.
15605	Cutler-Hammer Inc, Milwaukee, Wisc. 53233
16037	Spruce Pine Mica Co, Spruce Pine, N.C.
17771	Singer Co, Diehl Div, Somerville, N.J.
19396	Illinois Tool Works, Pakton Div, Chicago, Ill.
19644	LRC Electronics, Horseheads, N.Y.
19701	Electra Mfg Co, Independence, Kansas 67301
21335	Fafnir Bearing Co, New Briton, Conn.
22753	UID Electronics Corp, Hollywood, Fla.
23342	Avnet Electronics Corp, Franklin Park, Ill.
24446	G.E., Schenectady, N.Y. 12305
24454	G.E., Electronics Comp, Syracuse, N.Y.
24455	G.E. (Lamp Div), Nela Park, Cleveland, Ohio
24655	General Radio Co, W. Concord, Mass. 01781
26806	American Zettlet Inc, Costa Mesa, Calif.
28520	Hayman Mfg Co, Kenilworth, N.J.
28959	Hoffman Electronics Corp, El Monte, Calif.
30874	I.B.M, Armonk, New York
32001	Jensen Mfg. Co, Chicago, Ill. 60638
33173	G.E. Comp, Owensboro, Ky. 42301
35929	Constanta Co, Mont. 19, Que.
37942	P.R. Mallory & Co Inc, Indianapolis, Ind.
38443	Marlin-Rockwell Corp, Jamestown, N.Y.
40931	Honeywell Inc, Minneapolis, Minn. 55408
42190	Muter Co, Chicago, Ill. 60638
42498	National Co, Inc, Melrose, Mass. 02176
43991	Norma-Hoffman, Stanford, Conn. 06904
49671	RCA, New York, N.Y. 10020
49956	Raytheon Mfg Co, Waltham, Mass. 02154
53021	Sangamo Electric Co, Springfield, Ill. 62705
54294	Shallcross Mfg Co, Selma, N.C.
54715	Shure Brothers, Inc, Evanston, Ill.
56289	Sprague Electric Co, N. Adams, Mass.
59730	Thomas and Betts Co, Elizabeth, N.J. 07207
59875	TRW Inc, (Accessories Div), Cleveland, Ohio
60399	Torrington Mfg Co, Torrington, Conn.
61637	Union Carbide Corp, New York, N.Y. 10017
61864	United-Carr Fastener Corp, Boston, Mass.
63060	Victoreen Instrument Co, Inc, Cleveland, O.
63743	Ward Leonard Electric Co, Mt. Vernon, N.Y.
65083	Westinghouse (Lamp Div), Bloomfield, N.J.
65092	Weston Instruments, Newark, N.J.
70485	Atlantic-India Rubber, Chicago, Ill. 60607
70563	Amperite Co, Union City, N.J. 07087
70903	Belden Mfg Co, Chicago, Ill. 60644
71126	Bronson, Homer D, Co, Beacon Falls, Conn.
71294	Canfield, H.O. Co, Clifton Forge, Va. 24422
71400	Bussman (McGraw Edison), St. Louis, Mo.
71468	ITT Cannon Elec, L.A., Calif. 90031
71590	Centralab, Inc, Milwaukee, Wisc, 53212
71666	Continental Carbon Co, Inc, New York, N.Y.
71707	Coto Coil Co Inc, Providence, R.I.
71744	Chicago Miniature Lamp Works, Chicago, Ill.
71785	Cinch Mfg Co, Chicago, Ill. 60624
71823	Darnell Corp, Ltd, Downey, Calif. 90241
72136	Electro Motive Mfg Co, Wilmington, Conn.
72259	Nytronics Inc, Berkeley Heights, N.J. 07922
72619	Dialight Co, Brooklyn, N.Y. 11237
72699	General Instr Corp, Newark, N.J. 07104
72765	Drake Mfg Co, Chicago, Ill. 60656
72825	Hugh H. Eby Inc, Philadelphia, Penn. 19144
72962	Elastic Stop Nut Corp, Union, N.J. 07083
72982	Erie Technological Products Inc, Erie, Penn.
73138	Beckman Inc, Fullerton, Calif. 92634
73445	Amperex Electronics Co, Hicksville, N.Y.
73559	Carling Electric Co, W.Hartford, Conn.
73690	Elco Resistor Co, New York, N.Y.
73899	JFD Electronics Corp, Brooklyn, N.Y.
74193	Heinemann Electric Co, Trenton, N.J.
74861	Industrial Condenser Corp, Chicago, Ill.
74970	E.F. Johnson Co, Waseca, Minn. 56093
75042	IRC Inc, Philadelphia, Penn. 19108
75382	Kulka Electric Corp, Mt. Vernon, N.Y.
75491	Lafayette Industrial Electronics, Jamica, N.Y.
75608	Linden and Co, Providence, R.I.
75915	Littelfuse, Inc, Des Plaines, Ill. 60016
76005	Lord Mfg Co, Erie, Penn. 16512
76149	Mallory Electric Corp, Detroit, Mich. 48204
76487	James Millen Mfg Co, Malden, Mass. 02148
76545	Mueller Electric Co, Cleveland, Ohio 44114
76684	National Tube Co, Pittsburg, Penn.
76854	Oak Mfg Co, Crystal Lake, Ill.
77147	Patton MacGuyer Co, Providence, R.I.
77166	Pass-Seymour, Syracuse, N.Y.
77263	Pierce Roberts Rubber Co, Trenton, N.J.
77339	Positive Lockwasher Co, Newark, N.J.
77542	Ray-O-Vac Co, Madison, Wisc.
77630	TRW, Electronic Comp, Camden, N.J. 08103
77638	General Instruments Corp, Brooklyn, N.Y.
78189	Shakeproof (Ill. Tool Works), Elgin, Ill. 60120
78277	Sigma Instruments Inc, S.Braintree, Mass.
78488	Stackpole Carbon Co, St. Marys, Penn.
78553	Tinnerman Products, Inc, Cleveland, Ohio
79089	RCA, Rec Tube & Semicond, Harrison, N.J.
79725	Wiremold Co, Hartford, Conn. 06110
79963	Zierick Mfg Co, New Rochelle, N.Y.
80030	Prestole Fastener, Toledo, Ohio
80048	Vickers Inc, St. Louis, Mo.
80131	Electronic Industries Assoc, Washington, D.C.
80183	Sprague Products Co, No. Adams, Mass.
80211	Motorola Inc, Franklin Park, Ill. 60131
80258	Standard Oil Co, Lafeyette, Ind.
80294	Bourns Inc, Riverside, Calif. 92506
80431	Air Filter Corp, Milwaukee, Wisc. 53218
80583	Hammarlund Co, Inc, New York, N.Y.
80740	Beckman Instruments, Inc, Fullerton, Calif.
81030	International Insturment, Orange, Conn.
81073	Grayhill Inc, LaGrange, Ill. 60525
81143	Isolantite Mfg Corp, Stirling, N.J. 07980
81349	Military Specifications
81350	Joint Army-Navy Specifications
81751	Columbus Electronics Corp, Yonkers, N.Y.
81831	Filtron Co, Flushing, L.I., N.Y. 11354
81840	Ledex Inc, Dayton, Ohio 45402
81860	Barry-Wright Corp, Watertown, Mass.
82219	Sylvania Elec Prod, Emporium, Penn.
82273	Indiana Pattern & Model Works, LaPort, Ind.
82389	Switchcraft Inc, Chicago, Ill. 60630
82647	Metals & Controls Inc, Attleboro, Mass.
82807	Milwaukee Resistor Co, Milwaukee, Wisc.
83033	Meissner Mfg, (Maguire Ind) Mt. Carmel, Ill.
83058	Carr Fastener Co, Cambridge, Mass.
83186	Victory Engineering, Springfield, N.J. 07081
83361	Bearing Specialty Co, San Francisco, Calif.
83587	Solar Electric Corp, Warren, Penn.
83740	Union Carbide Corp, New York, N.Y. 10017
83781	National Electronics Inc, Geneva, Ill.
84411	TRW Capacitor Div, Ogallala, Nebr.
84835	Lehigh Metal Prods, Cambridge, Mass. 02140
84971	TA Mfg Corp, Los Angeles, Calif.
86577	Precision Metal Prods, Stoneham, Mass. 02180
86684	RCA (Elect. Comp & Dev), Harrison, N.J.
86687	REC Corp, New Rochelle, N.Y. 10801
86800	Cont Electronics Corp, Brooklyn, N.Y. 11222
88140	Cutler-Hammer Inc, Lincoln, Ill.
88219	Gould Nat. Batteries Inc, Trenton, N.J.
88419	Cornell-Dubilier, Fuquay-Varina, N.C.
88627	K & G Mfg Co, New York, N.Y.
89482	Holtzer-Cabot Corp, Boston, Mass.
89665	United Transformer Co, Chicago, Ill.
90201	Mallory Capacitor Co, Indianapolis, Ind.
90750	Westinghouse Electric Corp, Boston, Mass.
90952	Hardware Products Co, Reading, Penn. 19602
91032	Continental Wire Corp, York, Penn. 17405
91146	ITT (Cannon Electric Inc), Salem, Mass.
91293	Johanson Mfg Co, Boonton, N.J. 07005
91506	Augat Inc, Attleboro, Mass. 02703
91598	Chandler Co, Wethersfield, Conn. 06109
91637	Dale Electronics Inc, Columbus, Nebr.
91662	Elco Corp, Willow Grove, Penn.
91719	General Instruments, Inc, Dallas, Texas
91929	Honeywell Inc, Freeport, Ill.
92519	Electra Insul Corp, Woodside, L.I., N.Y.
92678	E.G.&G., Boston, Mass.
93332	Sylvania Elect Prods, Inc, Woburn, Mass.
93916	Cramer Products Co, New York, N.Y. 10013
94144	Raytheon Co, Components Div, Quincy, Mass.
94154	Tung Sol Electric Inc, Newark, N.J.
95076	Garde Mfg Co, Cumberland, R.I.
95121	Quality Components Inc, St. Mary's, Penn.
95146	Alco Electronics Mfg Co, Lawrence, Mass.
95238	Continental Connector Corp, Woodside, N.Y.
95275	Vitramon, Inc, Bridgeport, Conn.
95354	Methode Mfg Co, Chicago, Ill.
95412	General Electric Co, Schenectady, N.Y.
95794	Anaconda Amer Brass Co, Torrington, Conn.
96095	Hi-Q Div. of Aerovox Corp, Orlean, N.Y.
96214	Texas Instruments Inc, Dallas, Texas 75209
96256	Thordarson-Meissner, Mt. Carmel, Ill.
96341	Microwave Associates Inc, Burlington, Mass.
96791	Amphenol Corp, Jonesville, Wisc, 53545
96906	Military Standards
98291	Sealectro Corp, Mamaroneck, N.Y. 10544
98474	Compar Inc, Burlingame, Calif.
98821	North Hills Electronics Inc, Glen Cove, N.Y.
99180	Transitron Electronics Corp, Melrose, Mass.
99313	Varian, Palo Alto, Calif. 94303
99378	Atlee Corp, Winchester, Mass. 01890
99800	Delevan Electronics Corp, E. Aurora, N.Y.

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Parts List–Mechanical*

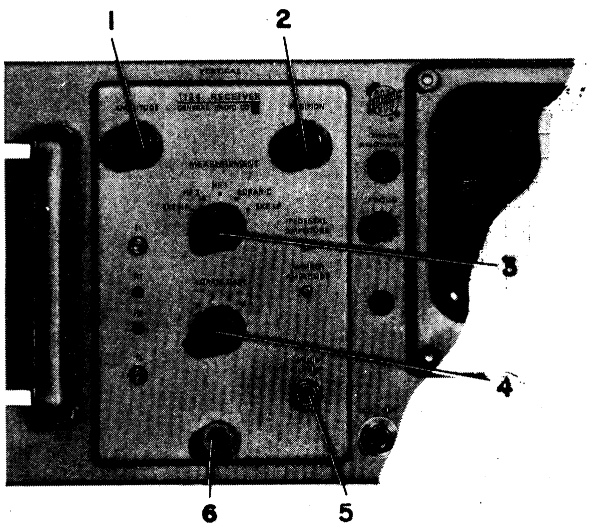


Figure 6-1. Replaceable mechanical parts.

Figure 6-1 Reference	*Name*	*Description*	*GR Part Number*	*Mfg. Part No.*	*FMC*	*FSN*
1	KNOB	Knob assembly with a white dot and line	5520-5221	24655	5520-5221	
		Assembly includes retainer	5220-5402	24655	5220-5402	
	BUSHING	Metal bushing for above knob	4143-3123	24655	4143-3123	
		Bushing includes No. 8-32, 1/8 in. setscrew	7250-0600	24655	7250-0600	5305-932-2095
2	KNOB	Knob assembly with a white dot and line	5520-5221	24655	5520-5221	
		Assembly includes retainer	5220-5402	24655	5220-5402	
	BUSHING	Metal bushing for above knob	4143-3123	24655	4143-3123	
		Bushing includes No. 8-32, 1/8 in. setscrew	7250-0600	24655	7250-0600	5305-932-2095
3	KNOB	Knob assembly with a white dot and line	5500-5221	24655	5500-5221	
		Assembly includes retainer	5220-5402	24655	5220-5402	
	BUSHING	Metal bushing for above knob	4143-3121	24655	4143-3121	
		Bushing includes No. 8-32, 1/8 in. setscrew	7250-0600	24655	7250-0600	5305-932-2095
4	KNOB	Knob assembly with a white dot and line	5500-5221	24655	5500-5221	
		Assembly includes retainer	5220-5402	24655	5220-5402	
	BUSHING	Metal bushing for above knob	4143-3121	24655	4143-3121	
		Bushing includes No. 8-32, 1/8 in. setscrew	7250-0600	24655	7250-0600	5305-932-2095
5	DRESS NUT	No. 3/8-32 dress nut	5800-0805	24655	5800-0805	
6	KNOB	Knob assembly for turning locking mechanism of plug-in unit	1124-0403	24655	1124-0403	

* Refer to the Tektronix oscilloscope and time base instruction manuals for additional mechanical parts.

PARTS LIST

Ref. No.	Description	GR Part Number	FMC	Manufacturers Part Number	FSN
CAPACITOR					
C101	0.0013 µF ±5% 500 V	4740-0100	00656	1464, 0.0013 µF ±5%	
RESISTOR					
R101	10 kΩ ±5% 1/2 W	6100-3105	01121	RC20GF103J	5905-185-8510
JACK					
J101		4230-2300	81349	UG-1094/u	

NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K - 1000 OHMS M 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT - ANCHOR TERMINAL
10. TP - TEST POINT

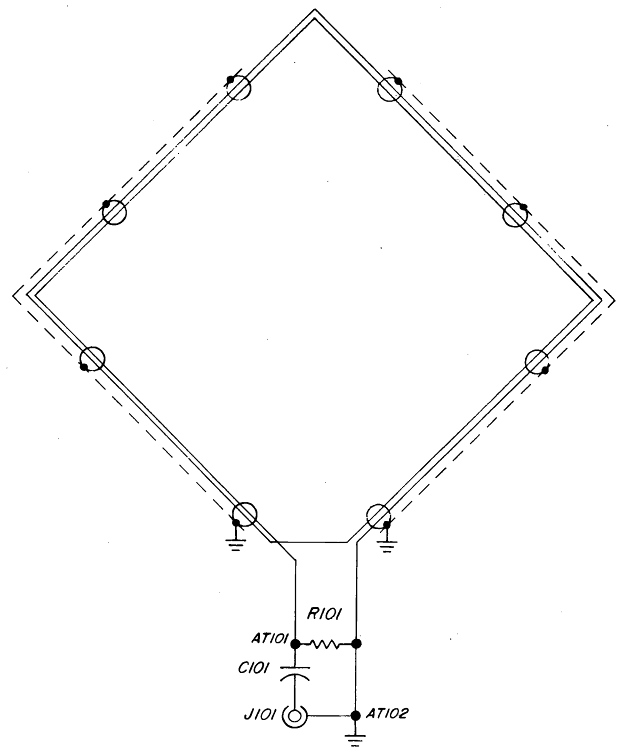


Figure 6-2. Type 1124-P1 Antenna schematic diagram.

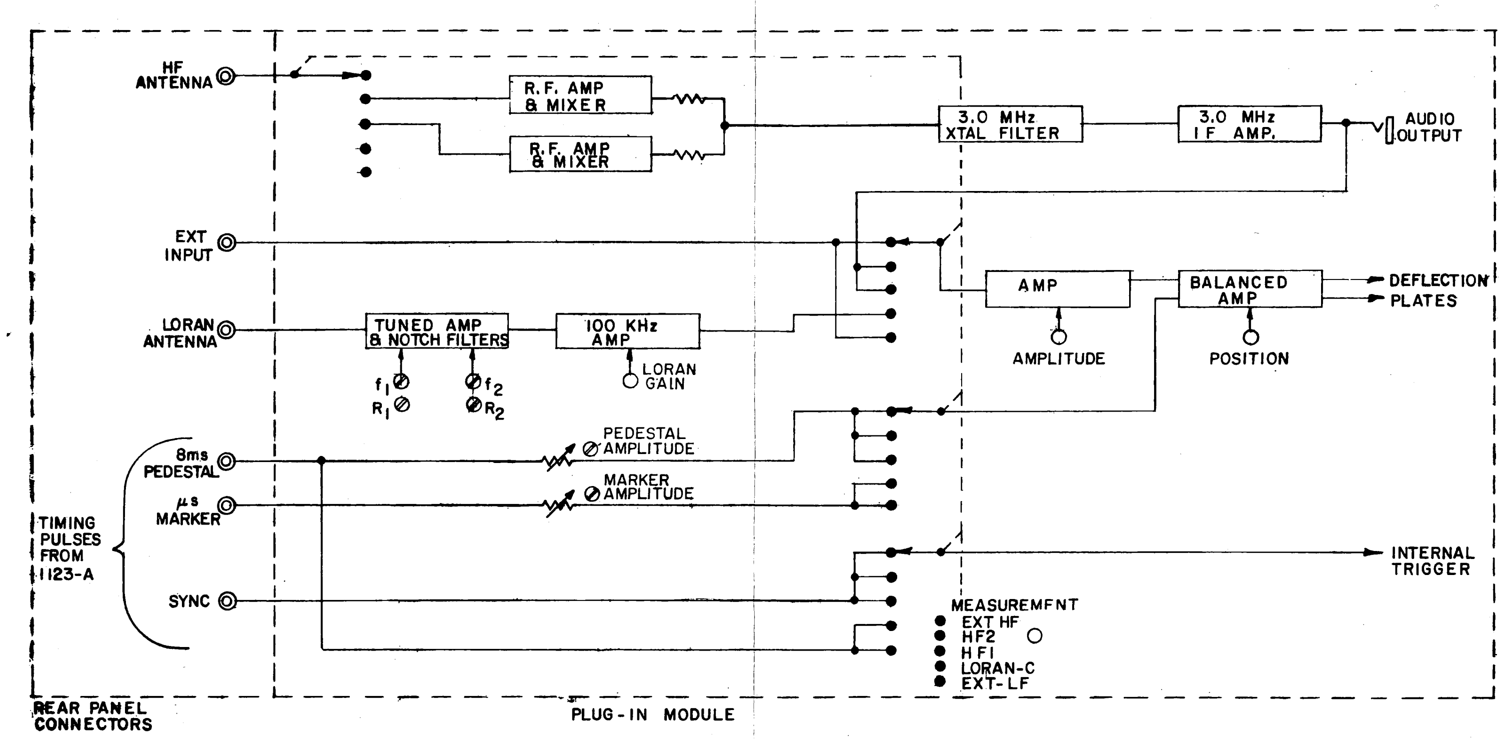
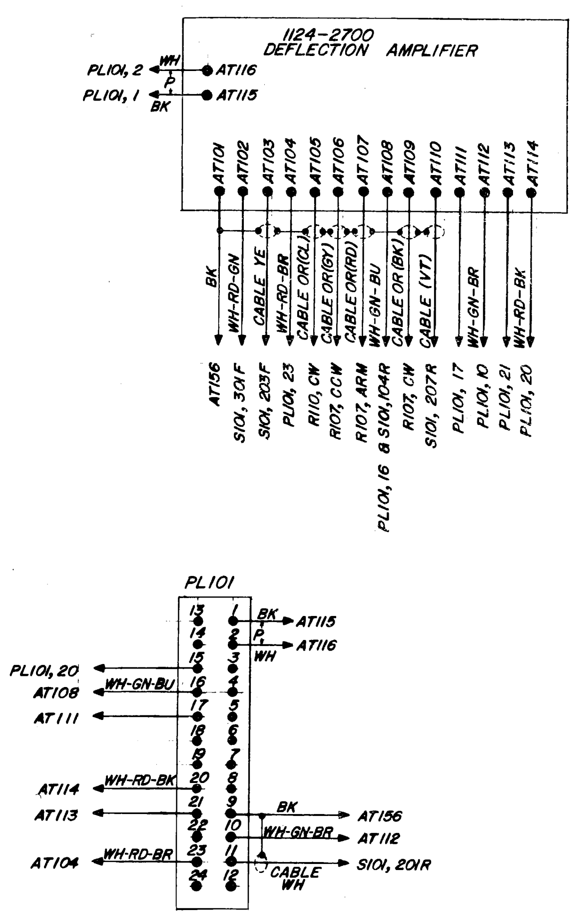
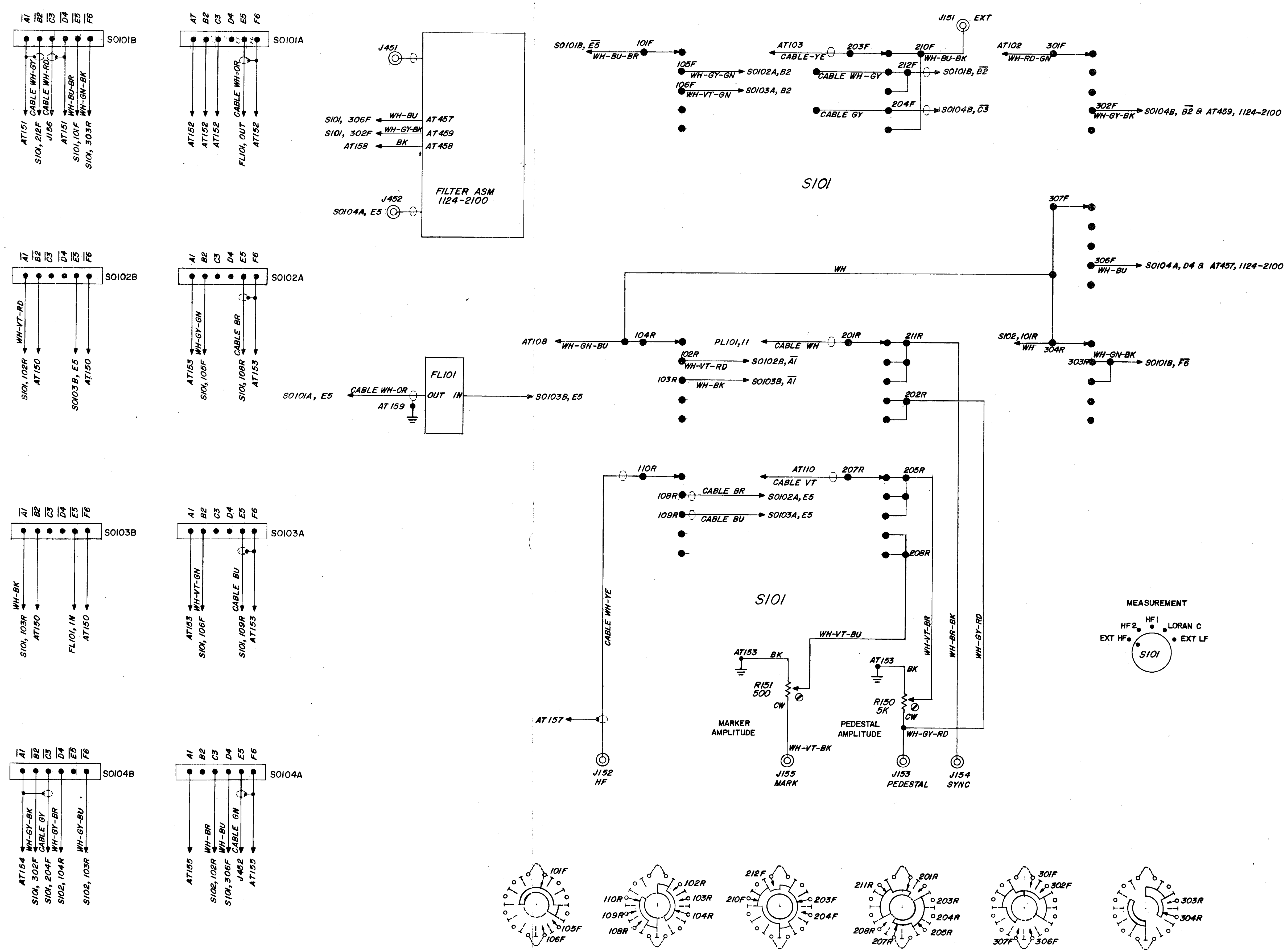


Figure 6-3. Type 1124 Receiver block diagram.





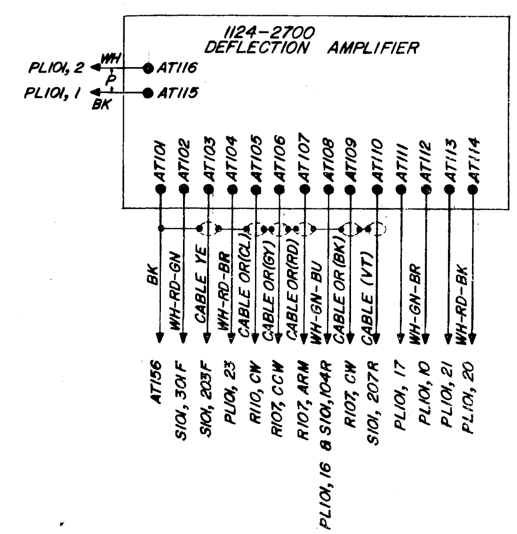
Rotary switch sections are shown as viewed from the panel end of the shaft. The first digit of the contact number refers to the section. The section nearest the panel is 1, the next section back is 2, etc. The next two digits refer to the contact. Contact 01 is the first position clockwise from a strut screw (usually the screw above the locating key), and the other contacts are numbered sequentially (02, 03, 04, etc), proceeding clockwise around the section. A suffix F or R indicates that the contact is on the front or rear of the section, respectively.

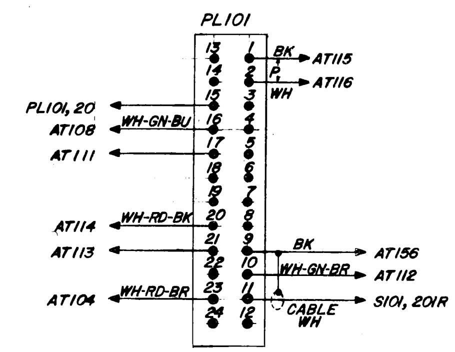
NOTE UNLESS SPECIFIED	
1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.	5. RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.	6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.	7. ◯ KNOB CONTROL
	8. ⊘ SCREWDRIVER CONTROL
	9. AT = ANCHOR TERMINAL
4. RESISTORS 1/2 WATT.	10. TP = TEST POINT

Figure 6-4. Type 1124 Receiver schematic diagram.

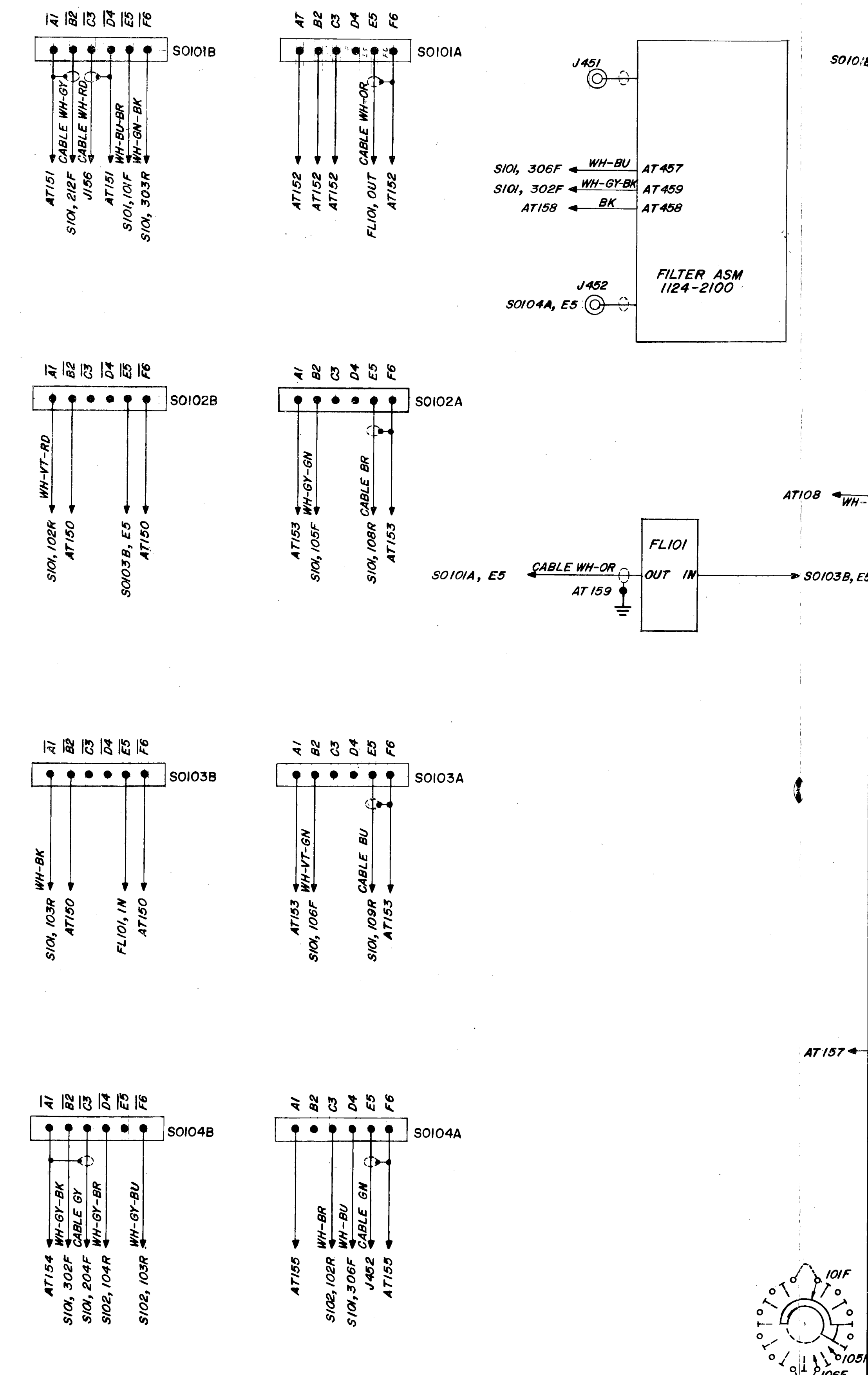
PARTS LIST

Ref. No.	Description	GR Part Number	FMC	Mfg. Part No.	FSN
SOCKETS					
SO101A		4230-2706	95354	91-6006-1201-00	
SO101B		4230-2706	95354	91-6006-1201-00	
SO102A		4230-2706	95354	91-6006-1201-00	
SO102B		4230-2706	95354	91-6006-1201-00	
SO103A		4230-2706	95354	91-6006-1201-00	
SO103B		4230-2706	95354	91-6006-1201-00	
SO104A		4230-2706	95354	91-6006-1201-00	
SO104B		4230-2706	95354	91-6006-1201-00	
JACKS					
J151 through J155		4260-1288	02660	5116058350	
J156		4260-1032	82389	L111	
FILTER					
FL101		1124-0417	24655	1124-0417	
RESISTORS					
R150	Variable, 5 kΩ ±10%	6041-2509	01121	GA4G056S5026A	
R151	Variable, 500 Ω ±10%	6041-1509	01121	GA4G056S5016A	
SWITCH					
S101		7890-4660	24655	7890-4660	





Rotary switch sections are shown as viewed from the panel end of the shaft. The first digit of the contact number refers to the section. The section nearest the panel is 1, the next section back is 2, etc. The next two digits refer to the contact. Contact 01 is the first position clockwise from a strut screw (usually the screw above the locating key), and the other contacts are numbered sequentially (02, 03, 04, etc), proceeding clockwise around the section. A suffix F or R indicates that the contact is on the front or rear of the section, respectively.



NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT = ANCHOR TERMINAL
10. TP = TEST POINT

PARTS LIST

Ref. No.	Description	GR Part Number	FMC	Mfg. Part No.	FSN
INDUCTORS					
L101	15 μH ±10%	4300-2400	99800	1537-40	5950-615-0091
L102	15 μH ±10%	4300-2400	99800	1537-40	5950-615-0091
CAPACITORS					
C101	Electrolytic, 6.8 μF ±20% 35 V	4450-5000	56289	150D685X0035B2	5910-814-5869
C102	Ceramic, 0.22 μF ±20% 25 V	4400-2052	80183	5C13, 22 μF ±20%	5910-974-5694
C103	Electrolytic, 15 μF ±20% 20 V	4450-5200	56289	150D156X0020B2	5910-855-6335
C104	Ceramic, 0.47 μF ±10% 200 V	4860-8247	84411	663UW, .47 μF ±10% 200 V	
C105	Ceramic, 0.47 μF ±10% 200 V	4860-8247	84411	663UW, .47 μF ±10% 200 V	
C106	Ceramic, 0.01 μF +80 -20% 500 V	4406-3109	72982	811, 000X5U103X	5910-977-7579
C107	Ceramic, 47 pF ±10% 500 V	4404-0478	72982	831, 47 pF ±10%	
C108	Electrolytic, 22 μF ±20% 15 V	4450-5300	56289	150D226X001582	5910-752-4270
C110	Trimmer, 1.5 - 7 pF 350 V	4910-1110	72982	557-051, 1.5 - 7 pF	
DIODES					
CR101	Type 1N759A	6083-1014	81349	1N759A	5961-846-9157
CR102	Type 1N986B	6083-1061	75042	1N986B	
CR103	Type 1N986B	6083-1061	75042	1N986B	
RESISTORS					
R101	Power, 3 kΩ ±5% 5 W	6660-2305	80183	246E, 3 kΩ ±5%	
R102	Power, 2.4 kΩ ±5% 5 W	6660-2245	80183	246E, 2.4 kΩ ±5%	
R103	Composition, 24 kΩ ±5% 1/2 W	6100-3245	01121	RC20GF243J	5905-279-1878
R104	Composition, 100 kΩ ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ ±5%	
R105	Composition, 33 kΩ ±5% 1/2 W	6100-3335	01121	RC20GF333J	5905-171-1998
R106	Composition, 5.1 kΩ ±5% 1/4 W	6099-2515	75042	BTS, 5.1 kΩ ±5%	5905-279-4623
R107	Variable, 50 kΩ ±10%	6040-1765	75042	BTS, 50 kΩ ±10%	
R108	Composition, 5.1 kΩ ±5% 1/4 W	6099-2515	75042	BTS, 5.1 kΩ ±5%	5905-279-4623
R109	Composition, 560 Ω ±5% 1/4 W	6099-1565	75042	BTS, 560 Ω ±5%	
R110	Variable, 5 kΩ ±10%	6048-2509	75042	BTS, 5 kΩ ±10%	
R111	Composition, 240 kΩ ±5% 1/4 W	6099-4245	75042	BTS, 240 kΩ	
R112	Composition, 27 Ω ±5% 1/4 W	6099-0275	75042	BTS, 27 Ω ±5%	
R113	Film, 1.2 kΩ ±10% 5 W	6228-2129	14674	LPI-7, 1.2 kΩ ±10%	
R114	Composition, 300 kΩ ±5% 1/2 W	6100-4305	01121	RC20GF304J	5905-185-6859
R115	Composition, 100 kΩ ±5% 1/2 W	6100-4105	01121	RC20GF104J	5905-195-6761
R116	Composition, 100 kΩ ±5% 1/2 W	6100-4105	01121	RC20GF104J	5905-195-6761
R117	Composition, 300 kΩ ±5% 1/2 W	6100-4305	01121	RC20GF304J	5905-185-6859
R118	Film, 1.2 kΩ ±10% 5 W	6228-2129	14674	LPI-7, 1.2 kΩ ±10%	
R119	Composition, 3 kΩ ±5% 1 W	6100-2305	01121	RC20GF302J	5905-279-1751
R120	Composition, 27 Ω ±5% 1/2 W	6110-0275	01121	GB, 27 Ω ±5%	
R121	Composition, 27 Ω ±5% 1/2 W	6099-0275	01121	RC20GF270J	5905-279-1879
R122	Composition, 27 Ω ±5% 1/4 W	6099-0275	75042	BTS, 27 Ω ±5%	
R123	Film, 120 Ω ±5% 2 W	6120-1125	01121	RC42GF121J	5905-279-2596
R124	Composition, 68 kΩ ±5% 1/4 W	6099-3685	75042	BTS, 68 kΩ ±5%	
R125	Composition, 56 kΩ ±5% 1/4 W	6099-3565	75042	BTS, 56 kΩ ±5%	
R126	Composition, 24 kΩ ±5% 1/4 W	6099-3245	75042	BTS, 24 kΩ ±5%	
TRANSISTORS					
Q101	Type 2N697	8210-1040	82219	2N697	5961-752-0150
Q102	Type 2N697	8210-1040	82219	2N697	5961-752-0150
TUBES					
V101	Type 6CW5	8360-4423	73445	6CW5	5960-087-3086
V102	Type 6CW5	8360-4423	73445	6CW5	5960-087-3086

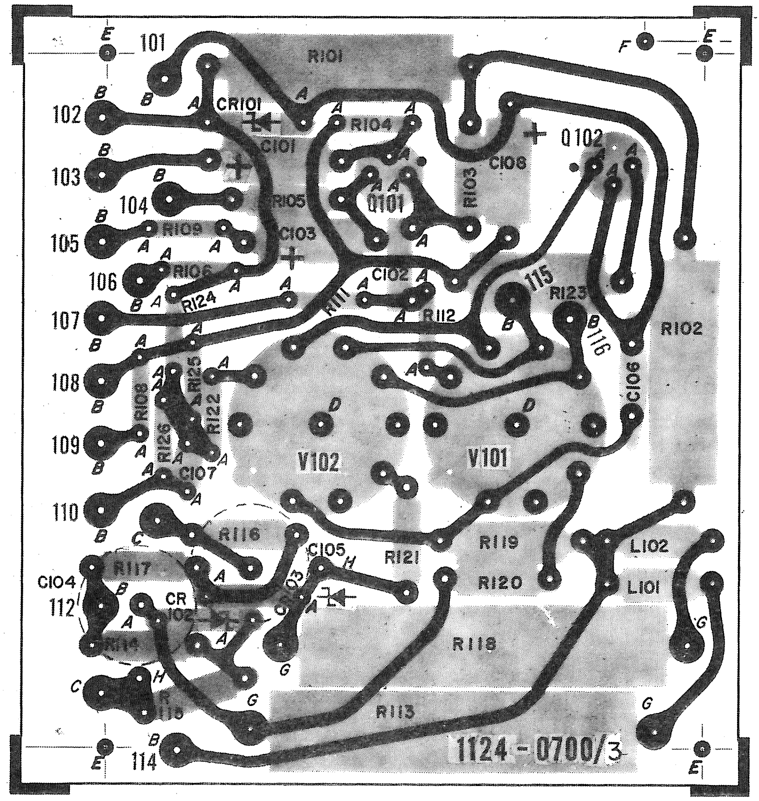
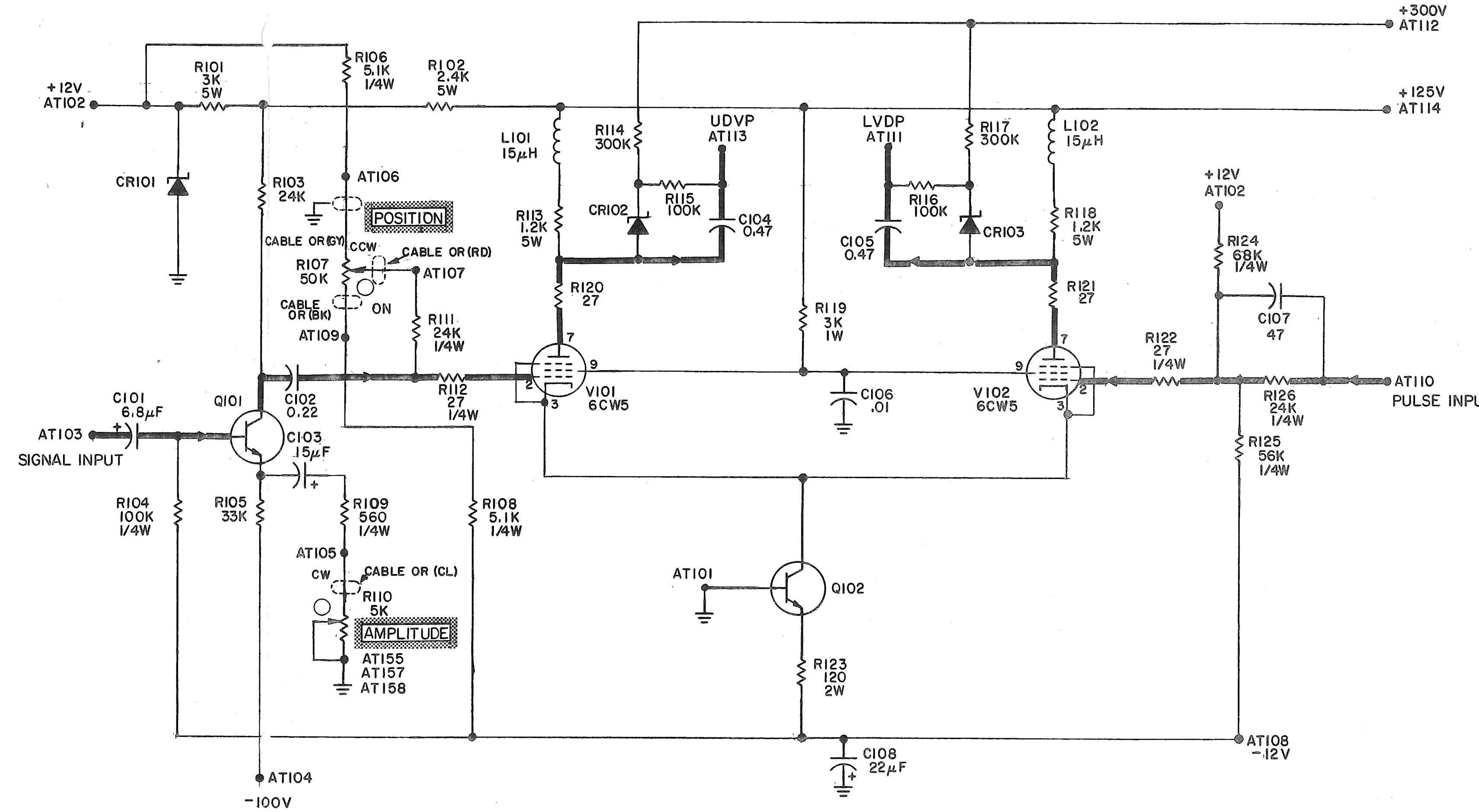
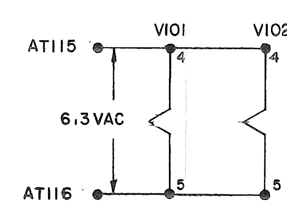


Figure 6-5. Deflection amplifier etched-board assembly (P/N 1124-2700).

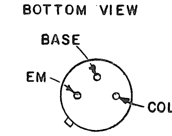
NOTE: The number appearing on the foil side is not the part number. The dot on the foil at the transistor socket indicates the collector lead.





NOTE UNLESS SPECIFIED	
1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.	5. RESISTANCE IN OHMS K - 1000 OHMS M - 1 MEGOHM
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.	6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.	7. ○ KNOB CONTROL
4. RESISTORS 1/2 WATT.	8. ⊘ SCREWDRIVER CONTROL
	9. AT - ANCHOR TERMINAL
	10. TP - TEST POINT

BOTTOM VIEW



Q101, Q102

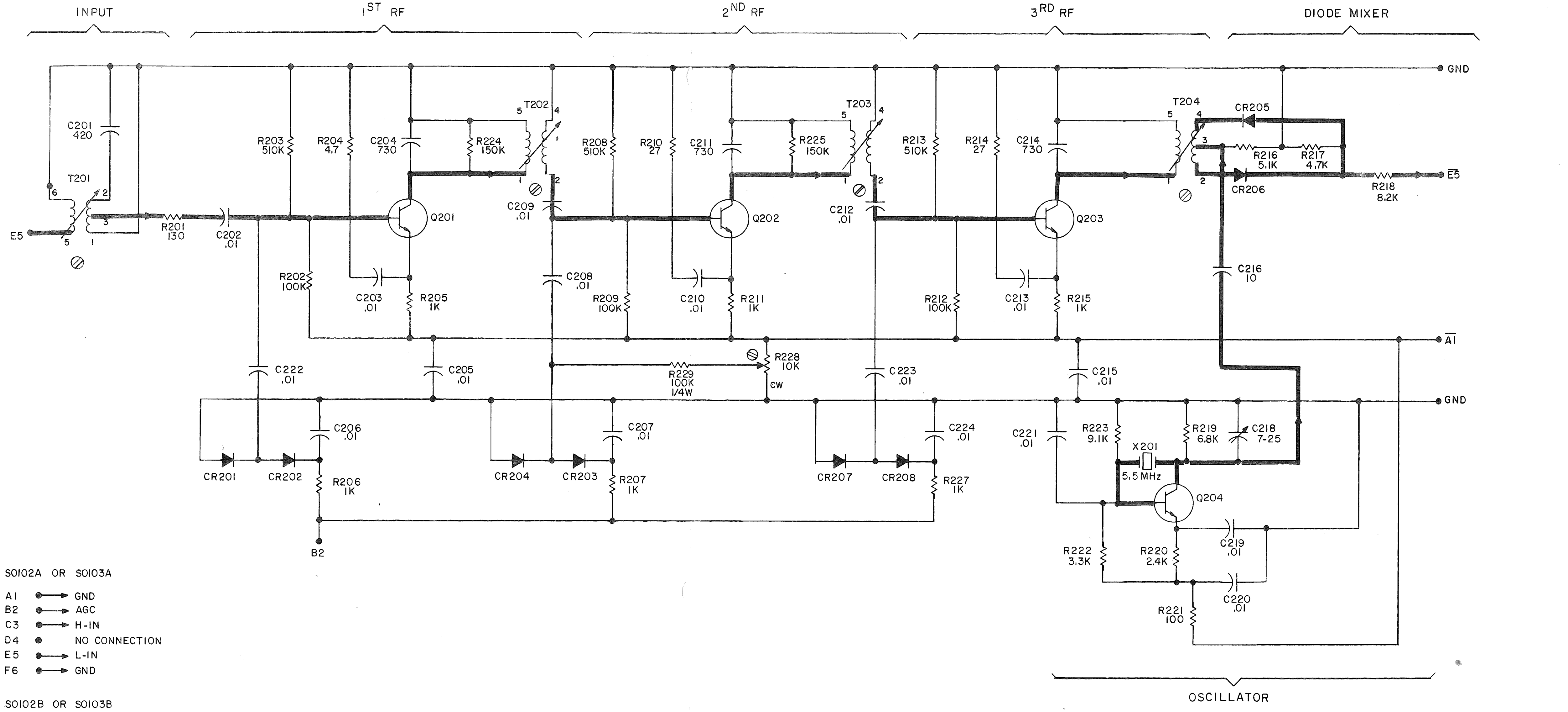
Rotary switch sections are shown as viewed from the panel end of the shaft. The first digit of the contact number refers to the section. The section nearest the panel is 1, the next section back is 2, etc. The next two digits refer to the contact. Contact 01 is the first position clockwise from a strut screw (usually the screw above the locating key), and the other contacts are numbered sequentially (02, 03, 04, etc), proceeding clockwise around the section. A suffix F or R indicates that the contact is on the front or rear of the section, respectively.

AT 101	GND
AT 102	+12V
AT 103	SIGNAL INPUT
AT 104	-100V
AT 105	AMPLITUDE-CW
AT 106	POSITION-CCW
AT 107	POSITION-ARM
AT 108	-12V
AT 109	POSITION-CW
AT 110	PULSE INPUT
AT 111	LVDP
AT 112	+300V
AT 113	UVDP
AT 114	+125V
AT 115	6.3VAC
AT 116	6.3VAC

Figure 6-6. Deflection amplifier schematic diagram.

PARTS LIST

Ref. No.	*Description*	*GR Part Number*	*FMC*	*Mfg. Part No.*	*FSN*
CAPACITORS					
C201	Mica, 420 pF ±1% 500 V	4710-0500	14655	22A, 420 pF ±1%	
C202	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C203	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C204	Mica, 730 pF ±1% 300 V	4710-0730	14655	22A, 730 pF ±1%	
C205	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C206	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C207	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C208	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C209	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C210	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C211	Mica, 730 pF ±1% 300 V	4710-0730	14655	22A, 730 pF ±1%	
C212	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C213	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C214	Mica, 730 pF ±1% 300 V	4710-0730	14655	22A, 730 pF ±1%	
C215	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C216	Mica, 10 pF ±5% 500 V	4710-0003	14655	22A, 10 pF ±5%	
C218	Trimmer, 7 - 25 pF 350 V	4910-2032	72982	538-006, 7 - 25 pF	
C219	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C220	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C221	Ceramic, 0.001 µF ±10%	4405-2108	72982	801, 0.001 µF ±10%	
C222	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C223	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C224	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
DIODES					
CR201 through CR208	1N4009	6082-1012	24446	1N4009	
CRYSTAL					
X201	5.5 MHz	1124-0410	24655	1124-0410	
RESISTORS					
R201	Composition, 130 Ω ±5% 1/2 W	6100-1135	01121	RC20GF131J	5905-252-5436
R202	Composition, 100 kΩ ±5% 1/2 W	6100-4105	01121	RC20GF104J	5905-195-6761
R203	Composition, 510 kΩ ±5% 1/2 W	6100-4515	01121	RC20GF514J	5905-279-2516
R204	Composition, 4.7 Ω ±5% 1/2 W	6100-9475	01121	EB, 4.7 Ω ±5%	
R205	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R206	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R207	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R208	Composition, 510 kΩ ±5% 1/2 W	6100-4515	01121	RC20GF514J	5905-279-2516
R209	Composition, 100 kΩ ±5% 1/2 W	6100-4105	01121	RC20GF104J	5905-195-6761
R210	Composition, 27 Ω ±5% 1/2 W	6100-0275	01121	RC20GF270J	5905-279-1879
R211	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R212	Composition, 100 kΩ ±5% 1/2 W	6100-4105	01121	RC20GF104J	5905-195-6761
R213	Composition, 510 kΩ ±5% 1/2 W	6100-4515	01121	RC20GF514J	5905-279-2516
R214	Composition, 27 Ω ±5% 1/2 W	6100-0275	01121	RC20GF270J	5905-279-1879
R215	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R216	Composition, 5.1 kΩ ±5% 1/2 W	6100-2515	01121	RC20GF512J	5905-279-2019
R217	Composition, 4.7 kΩ ±5% 1/2 W	6100-2475	01121	RC20GF472J	5905-279-3504
R218	Composition, 8.2 kΩ ±5% 1/2 W	6100-2825	01121	RC20GF822J	5905-299-1971
R219	Composition, 6.8 kΩ ±5% 1/2 W	6100-2685	01121	RC20GF682J	5905-279-3503
R220	Composition, 2.4 kΩ ±5% 1/2 W	6100-2245	01121	RC20GF242J	5905-279-1877
R221	Composition, 100 Ω ±5% 1/2 W	6100-1105	01121	RC20GF101J	5905-190-8889
R222	Composition, 3.3 kΩ ±5% 1/2 W	6100-2335	01121	RC20GF332J	5905-279-3506
R223	Composition, 9.1 kΩ ±5% 1/2 W	6100-2915	01121	RC20GF912J	5905-249-4200
R224	Composition, 150 kΩ ±5% 1/2 W	6100-4155	01121	RC20GF154J	5905-279-2522
R225	Composition, 150 kΩ ±5% 1/2 W	6100-4155	01121	RC20GF154J	5905-279-2522
R227	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R228	Variable, 10 k Ω ±10%	6049-0278	01121	2V1031	
R229	Composition, 100 kΩ ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ ±5%	5905-686-3129

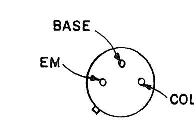


S0102A OR S0103A

A1	→	GND
B2	→	AGC
C3	→	H-IN
D4	•	NO CONNECTION
E5	→	L-IN
F6	→	GND

S0102B OR S0103B

$\overline{A1}$	→	-12
$\overline{B2}$	→	GND
$\overline{C3}$	•	KEY WAY
$\overline{D4}$	•	NO CONNECTION
$\overline{E5}$	→	I.F. OUT
$\overline{F6}$	→	GND



BOTTOM VIEW
Q201 THRU Q204

NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K - 1000 OHMS M - 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT - ANCHOR TERMINAL
10. TP - TEST POINT

Figure 6-8. Schematic diagram for 2.5-MHz rf circuit.

PARTS LIST (Cont)

Ref. No.	Description	GR Part Number	FMC	Mfg. Part No.	FSN
TRANSISTORS					
Q201 through Q204	Type 2N708	8210-3089	24454	2N708	
TRANSFORMERS					
T201		1124-2400	24655	1124-2400	
T202		1124-2450	24655	1124-2450	
T203		1124-2450	24655	1124-2450	
T204		1124-2420	24655	1124-2420	

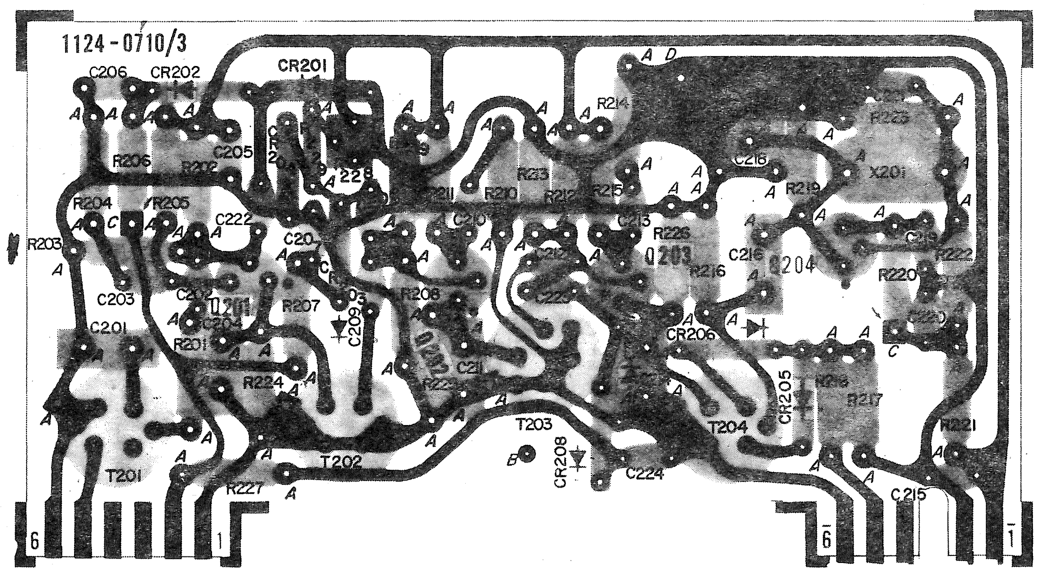
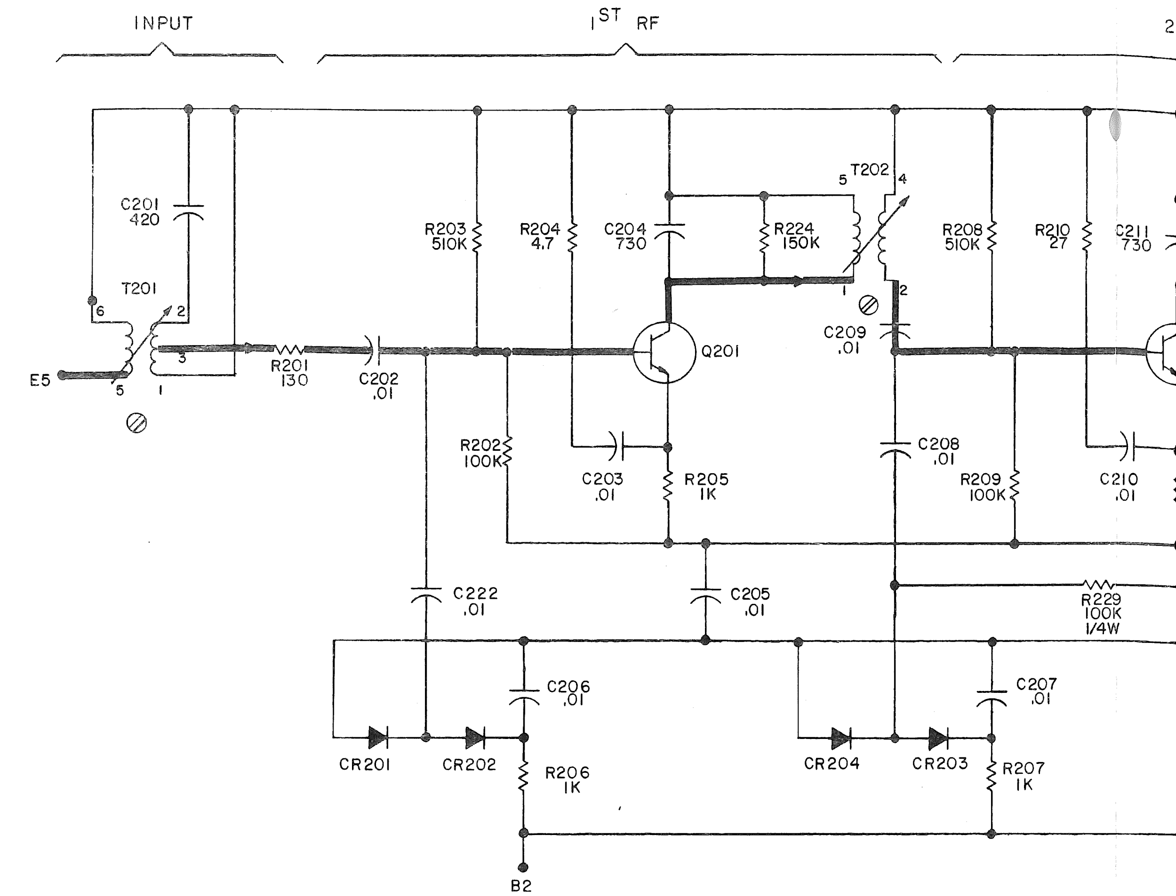


Figure 6-7. General etched-board assembly for rf circuits (2.5 MHz, P/N 1124-4711; 3.330 MHz, P/N 1124-4713; 5.0 MHz, P/N 1124-4715; 7.335 MHz, P/N 1124-4717; 10 MHz, P/N 1124-4719).

NOTE: The number appearing on the foil side is not the part number. The dot on the foil at the transistor socket indicates the collector lead.



SO102A OR SO103A

A1	→	GND
B2	→	AGC
C3	→	H-IN
D4	•	NO CONNECTION
E5	→	L-IN
F6	→	GND

SO102B OR SO103B

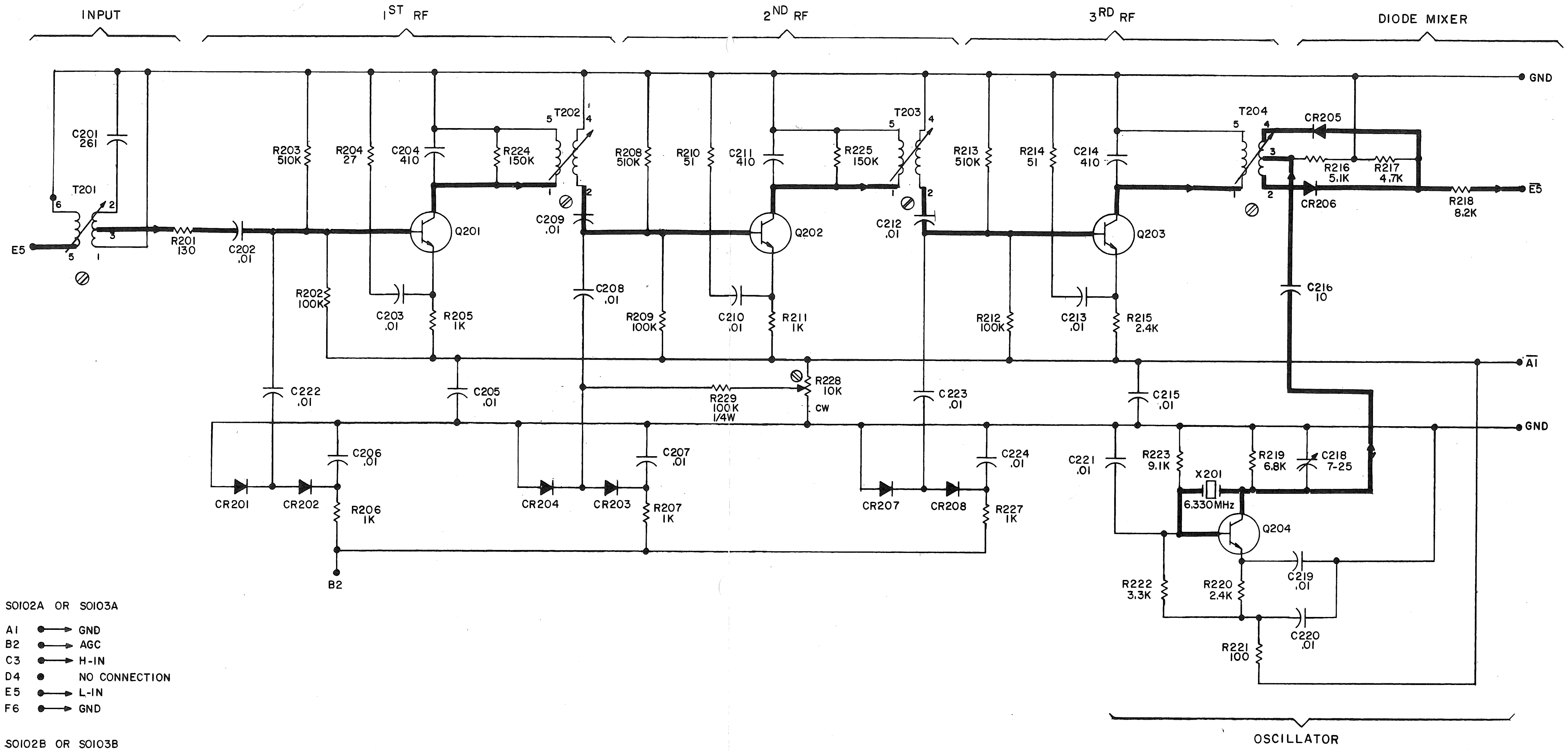
$\overline{A1}$	→	-12
$\overline{B2}$	→	GND
$\overline{C3}$	•	KEY WAY
$\overline{D4}$	•	NO CONNECTION
$\overline{E5}$	→	I.F. OUT
$\overline{F6}$	→	GND

NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ○ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT = ANCHOR TERMINAL
10. TP = TEST POINT

PARTS LIST

Ref. No.	Description	GR Part Number	FMC	Mfg. Part No.	FSN
CAPACITORS					
C201	Mica, 261 pF ±1% 500 V	4710-0441	14655	22A5T261FF	
C202	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C203	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C204	Mica, 410 pF ±1% 500 V	4710-0490	14655	22A, 410 pF ±1%	
C205	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C206	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C207	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C208	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C209	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C210	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C211	Mica, 410 pF ±1% 500 V	4710-0490	14655	22A, 410 pF ±1%	
C212	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C213	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C214	Mica, 410 pF ±1% 500 V	4710-0490	14655	22A, 410 pF ±1%	
C215	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C216	Mica, 10 pF ±5% 500 V	4710-0003	14655	22A, 10 pF ±5%	
C218	Trimmer, 7 - 25 pF 350 V	4910-2032	72982	538-006, 7-25 pF	5910-998-1621
C219	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C220	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C221	Ceramic, 0.001 µF +10% 500 V	4405-2108	72982	801, 0.001 µF ±10%	
C222	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C223	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C224	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20†	5910-974-5697
DIODES					
CR201 through CR208	Type 1N4009	6082-1012	24446	1N4009	
CRYSTAL					
X201	6.330 MHz	1124-0411	24655	1124-0411	
RESISTORS					
R201	Composition, 130 Ω ±5% 1/2 W	6100-1135	01121	RC20GF131J	5905-252-5436
R202	Composition, 100 kΩ ±5% 1/2 W	6100-4105	01121	RC20GF104J	5905-195-6761
R203	Composition, 510 kΩ ±5% 1/2 W	6100-4515	01121	RC20GF514J	5905-279-2516
R204	Composition, 27 Ω ±5% 1/2 W	6100-0275	01121	RC20GF270J	5905-279-1879
R205	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-105-6806
R206	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R207	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R208	Composition, 510 kΩ ±5% 1/2 W	6100-4515	01121	RC20GF514J	5905-279-2516
R209	Composition, 100 kΩ ±5% 1/2 W	6100-4105	01121	RC20GF104J	5905-195-6761
R210	Composition, 51 Ω ±5% 1/2 W	6100-0515	01121	RC20GF510J	5905-279-3517
R211	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R212	Composition, 100 kΩ ±5% 1/2 W	6100-4105	01121	RC20GF104J	5905-195-6761
R213	Composition, 510 kΩ ±5% 1/2 W	6100-4515	01121	RC20GF514J	5905-279-2516
R214	Composition, 51 Ω ±5% 1/2 W	6100-0515	01121	RC20GF510J	5905-279-3517
R215	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R216	Composition, 5.1 kΩ ±5% 1/2 W	6100-2515	01121	RC20GF512J	5905-279-2019
R217	Composition, 4.7 kΩ ±5% 1/2 W	6100-2475	01121	RC20GF472J	5905-279-3504
R218	Composition, 8.2 kΩ ±5% 1/2 W	6100-2825	01121	RC20GF822J	5905-299-1971
R219	Composition, 6.8 kΩ ±5% 1/2 W	6100-2685	01121	RC20GF682J	5905-279-3503
R220	Composition, 2.4 kΩ ±5% 1/2 W	6100-2245	01121	RC20GF242J	5905-279-1877
R221	Composition, 100 Ω ±5% 1/2 W	6100-1105	01121	RC20GF104J	5905-190-8889
R222	Composition, 3.3 kΩ ±5% 1/2 W	6100-2335	01121	RC20GF332J	5905-279-3506
R223	Composition, 9.1 kΩ ±5% 1/2 W	6100-2915	01121	RC20GF912J	5905-249-4200
R224	Composition, 150 kΩ ±5% 1/2 W	6100-4155	01121	RC20GF154J	5905-279-2522
R225	Composition, 150 kΩ ±5% 1/2 W	6100-4155	01121	RC20GF154J	5905-279-2522
R227	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R228	Variable, 10 kΩ ±10%	6049-0278	01121	2V1031	
R229	Composition, 100 kΩ ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ ±5%	5905-686-3129

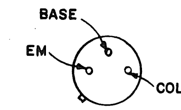


SO102A OR SO103A

A1	→	GND
B2	→	AGC
C3	→	H-IN
D4	●	NO CONNECTION
E5	→	L-IN
F6	→	GND

SO102B OR SO103B

Ā1	→	-12
B̄2	→	GND
C̄3	●	KEY WAY
D̄4	●	NO CONNECTION
Ē5	→	I.F. OUT
F̄6	→	GND



BOTTOM VIEW
Q201 THRU Q204

NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT = ANCHOR TERMINAL
10. TP = TEST POINT

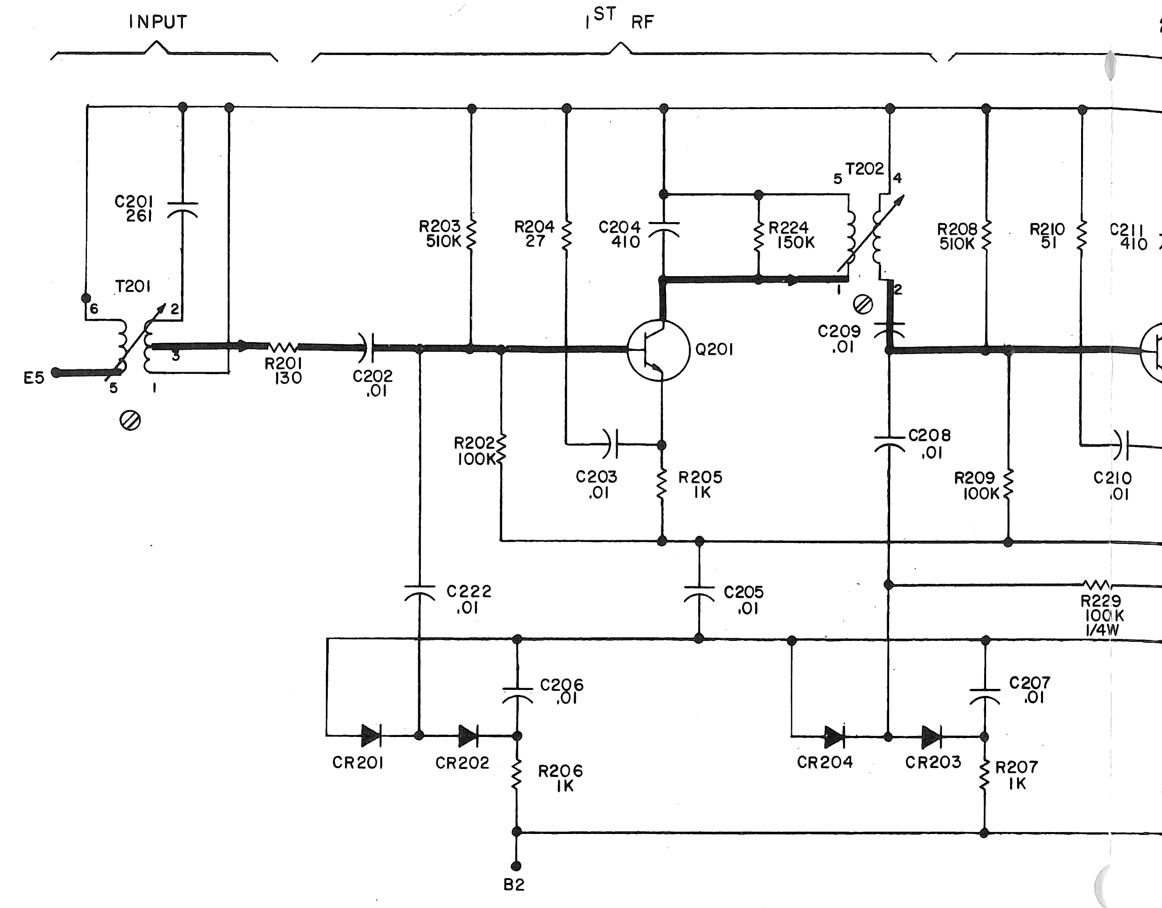
Figure 6-9. Schematic diagram for 3.330-MHz rf circuit.

PARTS LIST (Cont)

Ref. No.	Description	GR Part Number	FMC	Mfg. Part No.	FSN
TRANSISTORS					
Q201 through Q204	Type 2N708	8210-3089	24454	2N708	
TRANSFORMERS					
T201		1124-2400	24655	1124-2400	
T202		1124-2450	24655	1124-2450	
T203		1124-2450	24655	1124-2450	
T204		1124-2420	24655	1124-2420	

NOTE

Refer to Figure 6-7 for etched-circuit board layout.



SO102A OR SO103A

A1	→ GND
B2	→ AGC
C3	→ H-IN
D4	NO CONNECTION
E5	→ L-IN
F6	→ GND

SO102B OR SO103B

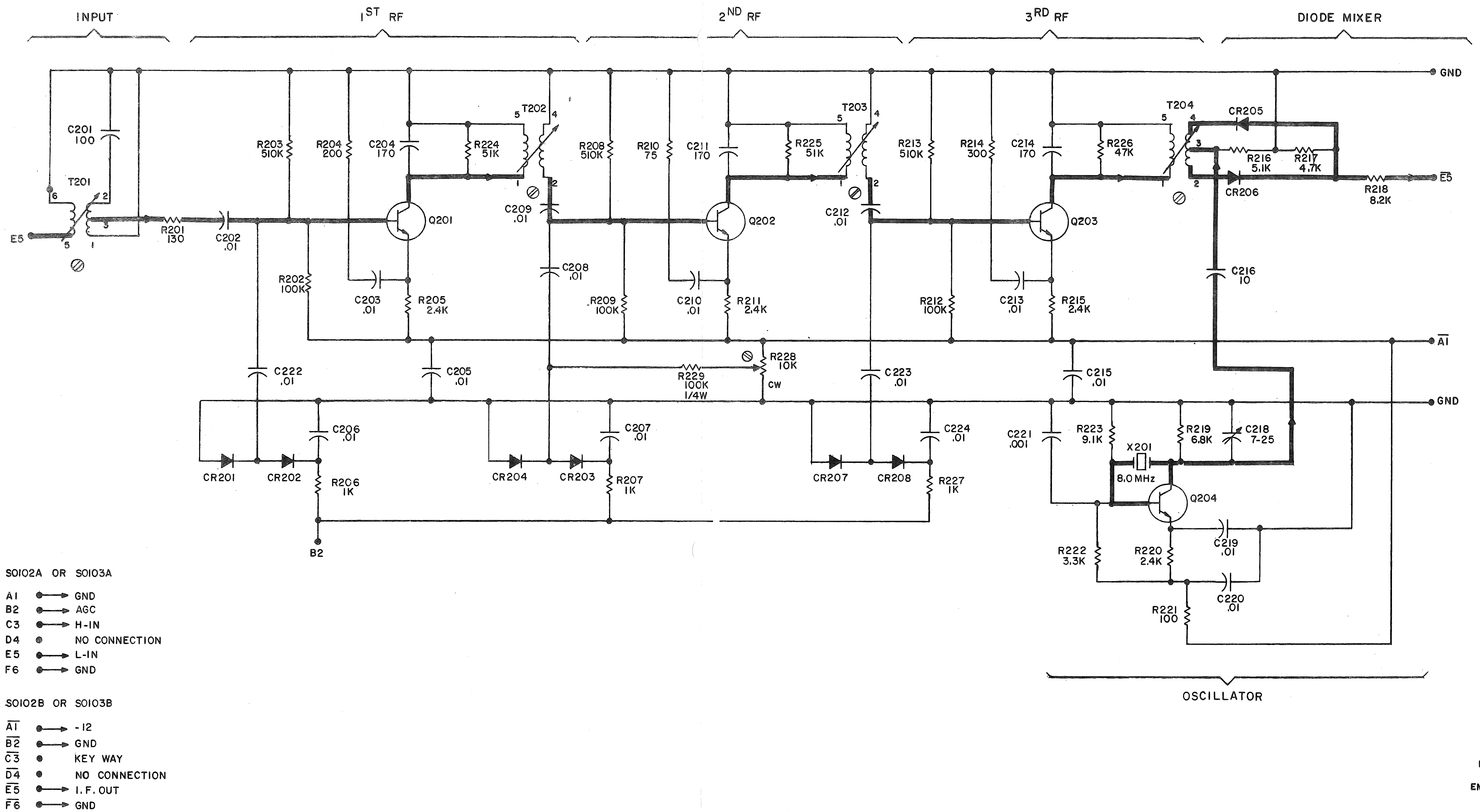
$\overline{A1}$	→ -12
$\overline{B2}$	→ GND
$\overline{C3}$	KEY WAY
$\overline{D4}$	NO CONNECTION
$\overline{E5}$	→ I.F. OUT
$\overline{F6}$	→ GND

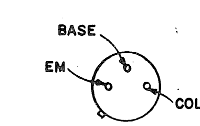
NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL.
8. ⊘ SCREWDRIVER CONTROL
9. AT - ANCHOR TERMINAL
10. TP - TEST POINT

PARTS LIST

Ref. No.	Description	GR Part Number	FMC	Mfg. Part No.	FSN
CAPACITORS					
C201	Mica, 100 pF ±1% 500 V	4710-0010	14655	22A, 100 pF ±1%	
C202	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C203	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C204	Mica, 170 pF ±1% 500 V	4710-0170	14655	22A, 170 pF ±1%	
C205	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C206	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C207	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C208	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C209	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C210	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C211	Mica, 170 pF ±1% 500 V	4710-0170	14655	22A, 170 pF ±1%	
C212	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C213	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C214	Mica, 170 pF ±1% 500 V	4710-0170	14655	22A, 170 pF ±1%	
C215	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C216	Mica, 10 pF ±5% 500 V	4710-0003	14655	22A, 10 pF ±5%	
C218	Trimmer, 7 - 25 pF 350 V	4910-2032	72982	538-006, 7 - 25 pF	
C219	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C220	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C221	Ceramic, 0.001 µF ±10% 500 V	4405-2108	72982	801, 0.001 µF ±10%	
C222	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C223	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C224	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
DIODES					
CR201 through CR208	Type 1N4009	6082-1012	24446	1N4009	
CRYSTAL					
X201	8.0 MHz	1124-0412	24655	1124-0412	
RESISTORS					
R201	Composition, 130 Ω ±5% 1/2 W	6100-1135	01121	RC20GF131J	5905-252-5436
R202	Composition, 100 kΩ ±5% 1/2 W	6100-4105	01121	RC20GF104J	5905-195-6761
R203	Composition, 510 kΩ ±5% 1/2 W	6100-4515	01121	RC20GF514J	5905-279-2516
R204	Composition, 200 Ω ±5% 1/2 W	6100-1205	01121	RC20GF201J	5905-279-2674
R205	Composition, 2.4 kΩ ±5% 1/2 W	6100-2245	01121	RC20GF242J	5905-279-1877
R206	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R207	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R208	Composition, 510 kΩ ±5% 1/2 W	6100-4515	01121	RC20GF514J	5905-279-2516
R209	Composition, 100 kΩ ±5% 1/2 W	6100-4105	01121	RC20GF101J	5905-195-6761
R210	Composition, 75 Ω ±5% 1/2 W	6100-0755	01121	RC20GF750J	5905-279-1758
R211	Composition, 2.4 kΩ ±5% 1/2 W	6100-2245	01121	RC20GF242J	5905-279-1877
R212	Composition, 100 kΩ ±5% 1/2 W	6100-4105	01121	RC20GF101J	5905-195-6761
R213	Composition, 510 kΩ ±5% 1/2 W	6100-4515	01121	RC20GF514J	5905-279-2516
R214	Composition, 300 Ω ±5% 1/2 W	6100-1305	01121	RC20GF301J	5905-279-5481
R215	Composition, 2.4 kΩ ±5% 1/2 W	6100-2245	01121	RC20GF242J	5905-279-1877
R216	Composition, 5.1 kΩ ±5% 1/2 W	6100-2515	01121	RC20GF512J	5905-279-2019
R217	Composition, 4.7 kΩ ±5% 1/2 W	6100-2475	01121	RC20GF472J	5905-279-3504
R218	Composition, 8.2 kΩ ±5% 1/2 W	6100-2825	01121	RC20GF822J	5905-299-1971
R219	Composition, 6.8 kΩ ±5% 1/2 W	6100-2685	01121	RC20GF682J	5905-279-3503
R220	Composition, 2.4 kΩ ±5% 1/2 W	6100-2245	01121	RC20GF242J	5905-279-1877
R221	Composition, 100 Ω ±5% 1/2 W	6100-1105	01121	RC20GF101J	5905-190-8889
R222	Composition, 3.3 kΩ ±5% 1/2 W	6100-2335	01121	RC20GF332J	5905-279-3506
R223	Composition, 9.1 kΩ ±5% 1/2 W	6100-2915	01121	RC20GF912J	5905-249-4200
R224	Composition, 51 kΩ ±5% 1/2 W	6100-3515	01121	RC20GF513J	5905-279-3496
R225	Composition, 51 kΩ ±5% 1/2 W	6100-3515	01121	RC20GF513J	5905-279-3496
R226	Composition, 47 kΩ ±5% 1/2 W	6100-3475	01121	RC20GF473J	5905-254-9201
R227	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R228	Variable, 10 kΩ ±10%	6049-0278	01121	2V1031	
R229	Composition, 1 kΩ ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ ±5%	5905-686-3129





BOTTOM VIEW
Q201 THRU Q204

NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K-1000 OHMS M-1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT-ANCHOR TERMINAL
10. TP-TEST POINT

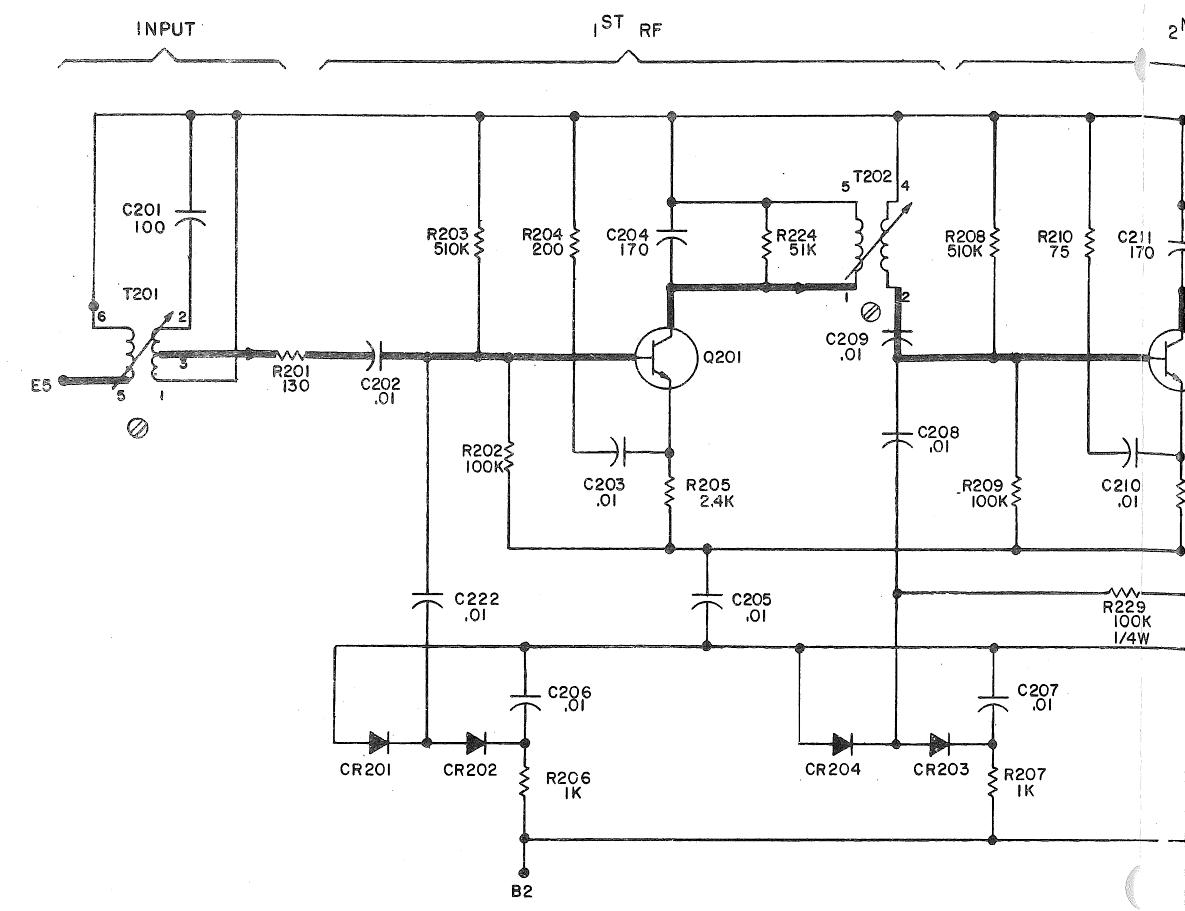
Figure 6-10. Schematic diagram for 5.0-MHz rf circuit.

PARTS LIST (Cont)

Ref. No.	*Description*	*GR Part Number*	*FSN*	*Mfg. Part No.*	*FSN*
TRANSISTORS					
Q201,					
Q202	Type 2N708	8210-3089	24454	2N708	
Q203	Type 2N3933	8210-1122	93916	2N3933	
Q204	Type 2N708	8210-3089	24454	2N708	
TRANSFORMERS					
T201		1124-2400	24655	1124-2400	
T202		1124-2450	24655	1124-2450	
T203		1124-2450	24655	1124-2450	
T204		1124-2420	24655	1124-2420	

NOTE

Refer to Figure 6-7 for etched-circuit board layout.



S0102A OR S0103A

A1	→	GND
B2	→	AGC
C3	→	H-IN
D4	•	NO CONNECTION
E5	→	L-IN
F6	→	GND

S0102B OR S0103B

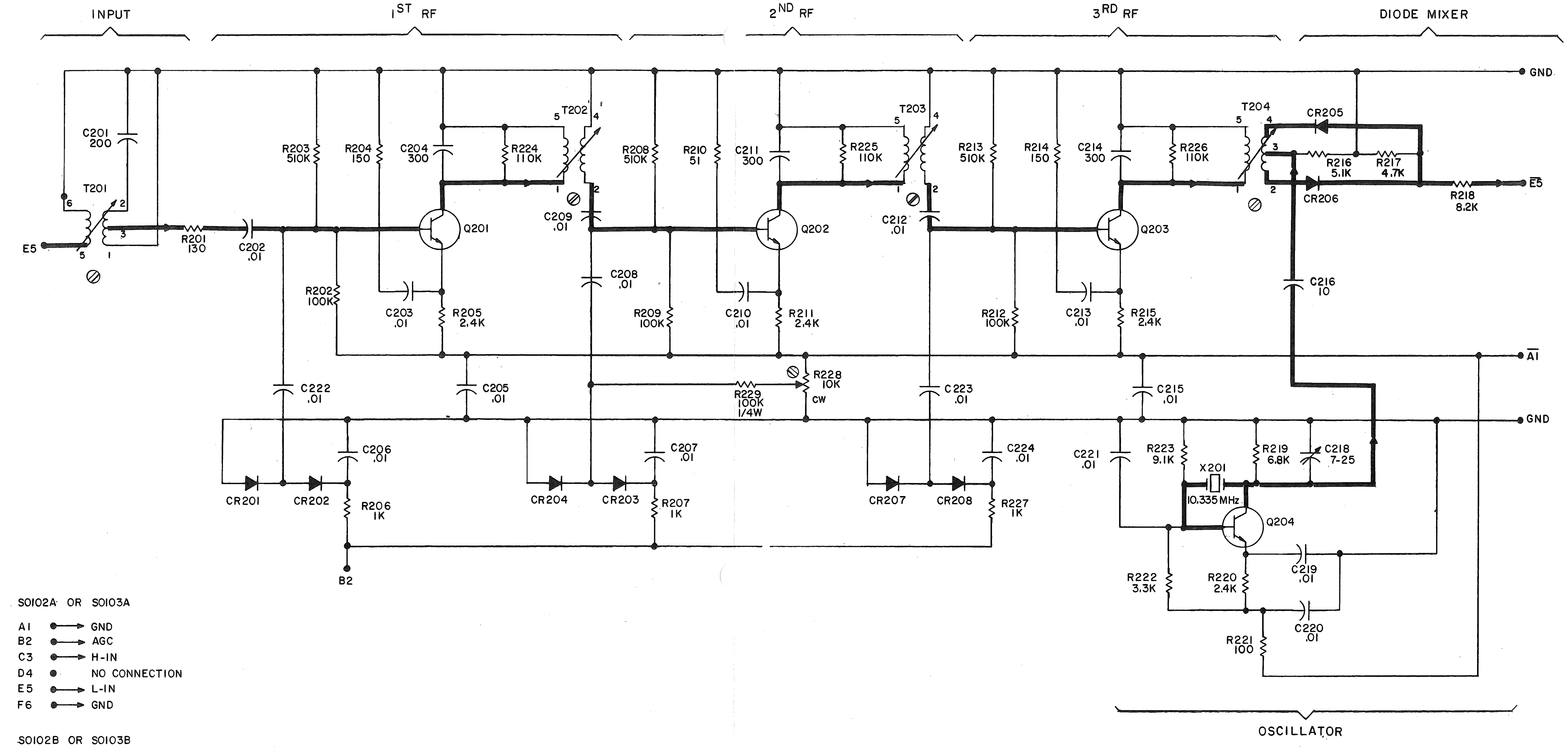
$\overline{A1}$	→	-12
$\overline{B2}$	→	GND
$\overline{C3}$	•	KEY WAY
$\overline{D4}$	•	NO CONNECTION
$\overline{E5}$	→	I.F. OUT
$\overline{F6}$	→	GND

NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ○ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT = ANCHOR TERMINAL
10. TP = TEST POINT

PARTS LIST

Ref. No.	*Description*	*GR Part Number*	*FMC*	*Mfg. Part No.*	*FSN*
CAPACITORS					
C201	Mica, 200 pF ±1% 500 V	4710-0379	14655	22A, 200 pF ±1%	
C202	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C203	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C204	Mica, 300 pF ±1% 500 V	4710-0461	14655	22A, 300 pF ±1%	
C205	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C206	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C207	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C208	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C209	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C210	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C211	Mica, 300 pF ±1% 500 V	4710-0461	14655	22A, 300 pF ±1%	
C212	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C213	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C214	Mica, 300 pF ±1% 500 V	4710-0461	14655	22A, 300 pF ±1%	
C215	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C216	Mica, 10 pF ±5% 500 V	4710-0003	14655	22A, 10 pF ±5%	
C218	Trimmer, 7 - 25 pF 350 V	4910-2032	72982	538-006, 7 - 25 pF	
C219	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C220	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C221	Ceramic, 0.001 µF ±10% 500 V	4405-2108	72982	801, 0.001 µF ±10%	
C222	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C223	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C224	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
DIODES					
CR201 through CR208	Type 1N4009	6092-1012	24446	1N4009	
CRYSTAL					
X201	10.335 MHz	1124-0413	24655	1124-0413	
RESISTORS					
R201	Composition, 130 Ω ±5% 1/2 W	6100-1135	01121	RC20GF131J	5905-252-5436
R202	Composition, 100 kΩ ±5% 1/2 W	6100-4105	01121	RC20GF104J	5905-195-6761
R203	Composition, 510 kΩ ±5% 1/2 W	6100-4515	01121	RC20GF514J	5905-279-2516
R204	Composition, 150 Ω ±5% 1/2 W	6100-1155	01121	RC20GF151J	5905-299-1541
R205	Composition, 2.4 kΩ ±5% 1/2 W	6100-2245	01121	RC20GF242J	5905-279-1877
R206	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R207	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R208	Composition, 510 kΩ ±5% 1/2 W	6100-4515	01121	RC20GF514J	5905-279-2516
R209	Composition, 100 kΩ ±5% 1/2 W	6100-4105	01121	RC20GF101J	5905-195-6761
R210	Composition, 51 Ω ±5% 1/2 W	6100-0515		RC20GF510J	5905-279-3517
R211	Composition, 2.4 kΩ ±5% 1/2 W	6100-2245	01121	RC20GF242J	5905-279-1877
R212	Composition, 100 kΩ ±5% 1/2 W	6100-4105	01121	RC20GF104J	5905-195-6761
R213	Composition, 510 kΩ ±5% 1/2 W	6100-4515	01121	RC20GF514J	5905-279-2516
R214	Composition, 150 Ω ±5% 1/2 W	6100-1155	01121	RC20GF151J	5905-299-1541
R215	Composition, 2.4 kΩ ±5% 1/2 W	6100-2245	01121	RC20GF242J	5905-279-1877
R216	Composition, 5.1 kΩ ±5% 1/2 W	6100-2515	01121	RC20GF512J	5905-279-2019
R217	Composition, 4.7 kΩ ±5% 1/2 W	6100-2475	01121	RC20GF472J	5905-279-3504
R218	Composition, 8.2 kΩ ±5% 1/2 W	6100-2825	01121	RC20GF822J	5905-299-1971
R219	Composition, 6.8 kΩ ±5% 1/2 W	6100-2685	01121	RC20GF682J	5905-279-3503
R220	Composition, 2.4 kΩ ±5% 1/2 W	6100-2245	01121	RC20GF242J	5905-279-1877
R221	Composition, 100 Ω ±5% 1/2 W	6100-1105	01121	RC20GF101J	5905-190-8889
R222	Composition, 3.3 kΩ ±5% 1/2 W	6100-2335	01121	RC20GF332J	5905-279-3506
R223	Composition, 9.1 kΩ ±5% 1/2 W	6100-2915	01121	RC20GF912J	5905-249-4200
R224	Composition, 110 kΩ ±5% 1/2 W	6100-4115	01121	RC20GF114J	5905-279-1867
R225	Composition, 110 kΩ ±5% 1/2 W	6100-4115	01121	RC20GF114J	5905-279-1867
R226	Composition, 110 kΩ ±5% 1/2 W	6100-4115	01121	RC20GF114J	5905-279-1867
R227	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R228	Variable, 10 kΩ ±10%	6049-0278	01121	2V1031	
R229	Composition, 100 kΩ ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ ±5%	5905-686-3129

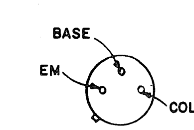


SO102A OR SO103A

A1	→	GND
B2	→	AGC
C3	→	H-IN
D4	•	NO CONNECTION
E5	→	L-IN
F6	→	GND

SO102B OR SO103B

Ā1	→	-12
B̄2	→	GND
C̄3	•	KEY WAY
D̄4	•	NO CONNECTION
Ē5	→	I.F. OUT
F̄6	→	GND



NOTE UNLESS SPECIFIED

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2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K-1000 OHMS M-1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT - ANCHOR TERMINAL
10. TP - TEST POINT

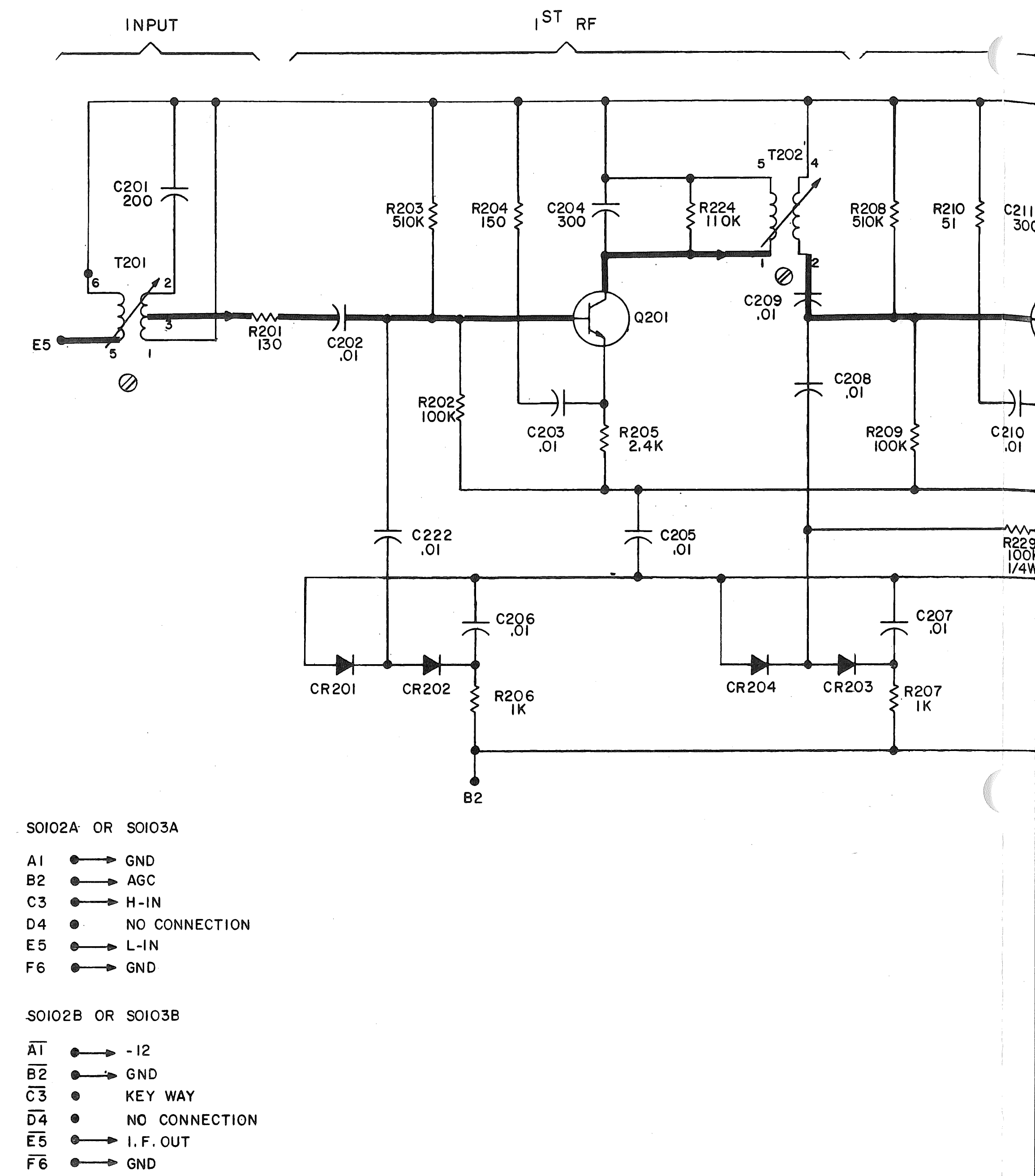
Figure 6-11. Schematic diagram for 7.335-MHz rf circuit.

PARTS LIST (Cont)

Ref. No.	Description	GR Part Number	FMC	Mfg. Part No.	FSN
TRANSISTORS					
Q201	Type 2N708	8210-3089	24454	2N708	
Q202	Type 2N708	8210-3089	24454	2N708	
Q203	Type 2N3933	8210-1122	93916	2N3933	
Q204	Type 2N708	8210-3089	24454	2N708	
TRANSFORMERS					
T201		1124-2410	24655	1124-2410	
T202		1124-2460	24655	1124-2460	
T203		1124-2460	24655	1124-2460	
T204		1124-2430	24655	1124-2430	

NOTE

Refer to Figure 6-7 for etched-circuit board layout.



NOTE UNLESS SPECIFIED

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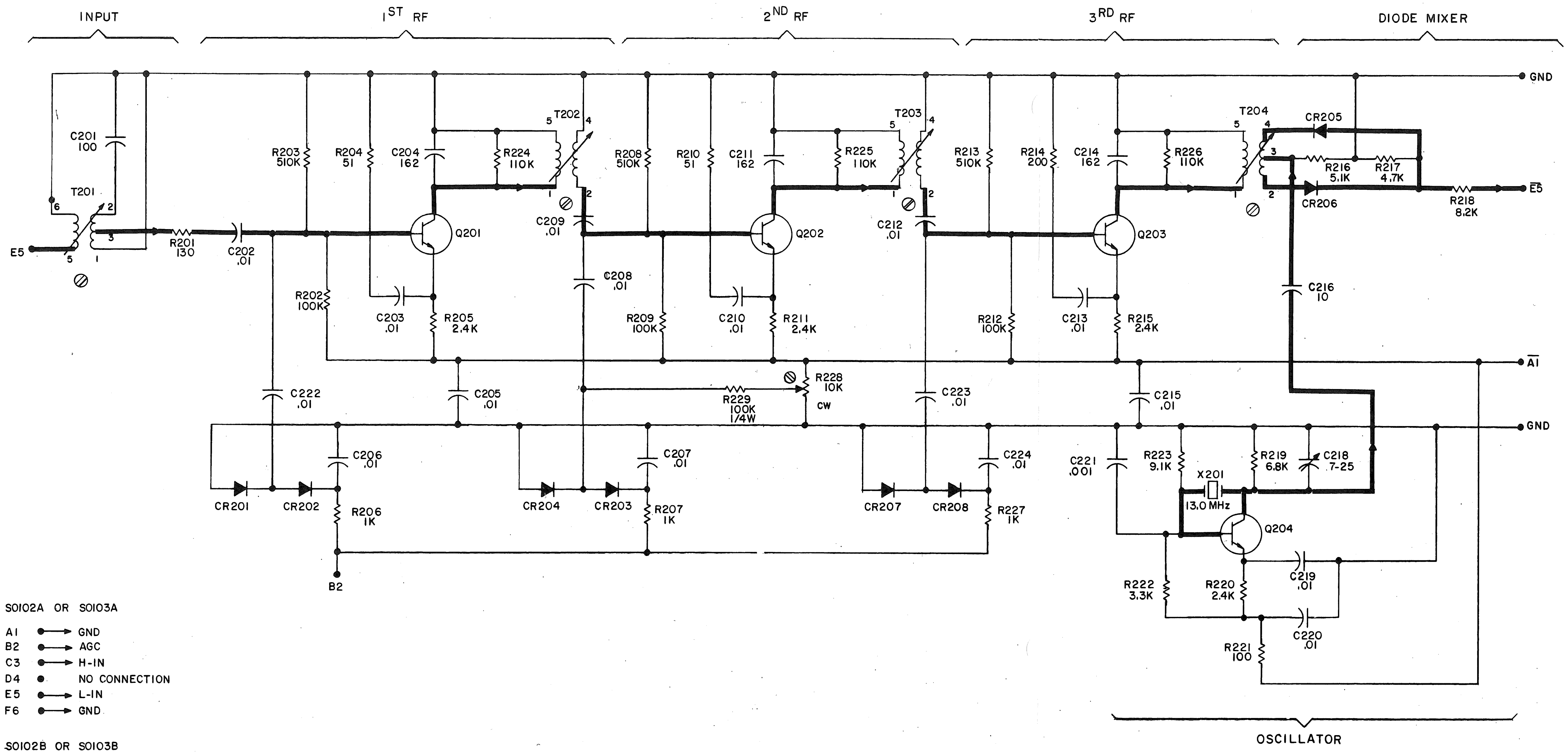
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K-1000 OHMS M-1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL.
8. ⊘ SCREWDRIVER CONTROL.
9. AT-ANCHOR TERMINAL.
10. TP-TEST POINT

PARTS LIST

Ref. No.	*Description*	*GR Part Number*	*FSN*	*Mfg. Part No.*	*FSN*
CAPACITORS					
C201	Mica, 100 pF ±1% 500 V	4710-0010	14655	22A, 100 pF ±1%	
C202	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C203	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C204	Mica, 162 pF ±1% 500 V	4710-0162	14655	22A, 162 pF ±1%	
C205	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C206	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C207	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C208	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C209	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C210	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C211	Mica, 162 pF ±1% 500 V	4710-0162	14655	22A, 162 pF ±1%	
C212	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C213	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C214	Mica, 162 pF ±1% 500 V	4710-0162	14655	22A, 162 pF ±1%	
C215	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C216	Mica, 10 pF ±5% 500 V	4710-0003	14655	22A, 10 pF ±5%	
C218	Trimmer, 7 - 25 pF 350 V	4910-2032	72982	538-006, 7-25 pF	
C219	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C220	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C221	Ceramic, 0.001 µF ±10% 500 V	4405-2108	72982	801, 0.001 µF ±10%	
C222	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C223	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C224	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
DIODES					
CR201 through CR208	Type 1N4009	6082-1012	24446	IN4009	
CRYSTAL					
X201	13 MHz	1124-0414	24655	1124-0414	
RESISTORS					
R201	Composition, 130 Ω ±5% 1/2 W	6100-1135	01121	RC20GF131J	5905-252-5436
R202	Composition, 100 kΩ ±5% 1/2 W	6100-4105	01121	RC20GF104J	5905-195-6761
R203	Composition, 510 kΩ ±5% 1/2 W	6100-4515	01121	RC20GF514J	5905-279-2516
R204	Composition, 51 Ω ±5% 1/2 W	6100-0515	01121	RC20GF510J	5905-279-3517
R205	Composition, 2.4 kΩ ±5% 1/2 W	6100-2245	01121	RC20GF242J	5905-279-1877
R206	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R207	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R208	Composition, 510 kΩ ±5% 1/2 W	6100-4515	01121	RC20GF514J	5905-279-2516
R209	Composition, 100 kΩ ±5% 1/2 W	6100-4105	01121	RC20GF104J	5905-195-6761
R210	Composition, 51 Ω ±5% 1/2 W	6100-0515	01121	RC20GF516J	5905-279-3517
R211	Composition, 2.4 kΩ ±5% 1/2 W	6100-2245	01121	RC20GF242J	5905-279-1877
R212	Composition, 100 kΩ ±5% 1/2 W	6100-4105	01121	RC20GF104J	5905-195-6761
R213	Composition, 510 kΩ ±5% 1/2 W	6100-4515	01121	RC20GF514J	5905-279-2516
R214	Composition, 200 Ω ±5% 1/2 W	6100-1205	01121	RC20GF201J	5905-279-2674
R215	Composition, 2.4 kΩ ±5% 1/2 W	6100-2245	01121	RC20GF242J	5905-279-1877
R216	Composition, 5.1 kΩ ±5% 1/2 W	6100-2515	01121	RC20GF512J	5905-279-2019
R217	Composition, 4.7 kΩ ±5% 1/2 W	6100-2475	01121	RC20GF472J	5905-279-3504
R218	Composition, 8.2 kΩ ±5% 1/2 W	6100-2825	01121	RC20GF822J	5905-299-1971
R219	Composition, 6.8 kΩ ±5% 1/2 W	6100-2685	01121	RC20GF682J	5905-279-3503
R220	Composition, 2.4 kΩ ±5% 1/2 W	6100-2245	01121	RC20GF242J	5905-279-1877
R221	Composition, 100 Ω ±5% 1/2 W	6100-1105	01121	RC20GF101J	5905-190-8889
R222	Composition, 3.3 kΩ ±5% 1/2 W	6100-2335	01121	RC20GF332J	5905-279-3506
R223	Composition, 9.1 kΩ ±5% 1/2 W	6100-2915	01121	RC20GF912J	5905-249-4200
R224	Composition, 110 kΩ ±5% 1/2 W	6100-4115	01121	RC20GF114J	5905-279-1867
R225	Composition, 110 kΩ ±5% 1/2 W	6100-4115	01121	RC20GF114J	5905-279-1867
R226	Composition, 110 kΩ ±5% 1/2 W	6100-4115	01121	RC20GF114J	5905-279-1867
R227	Composition, 1 kΩ ±5% 1/2 W	6100-2105	01121	RC20GF102J	5905-195-6806
R228	Variable, 10 kΩ ±10%	6049-0278	01121	2V1031	
R229	Composition 100 kΩ ±5%	6099-4105	75042	BTS, 100 kΩ ±5%	5905-686-3129

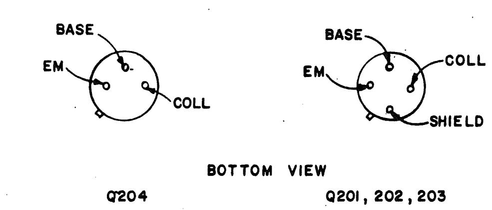


S0102A OR S0103A

A1	→	GND
B2	→	AGC
C3	→	H-IN
D4	•	NO CONNECTION
E5	→	L-IN
F6	→	GND

S0102B OR S0103B

$\overline{A1}$	→	-12
$\overline{B2}$	→	GND
$\overline{C3}$	•	KEY WAY
$\overline{D4}$	•	NO CONNECTION
$\overline{E5}$	→	I.F. OUT
$\overline{F6}$	→	GND



NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT - ANCHOR TERMINAL
10. TP - TEST POINT

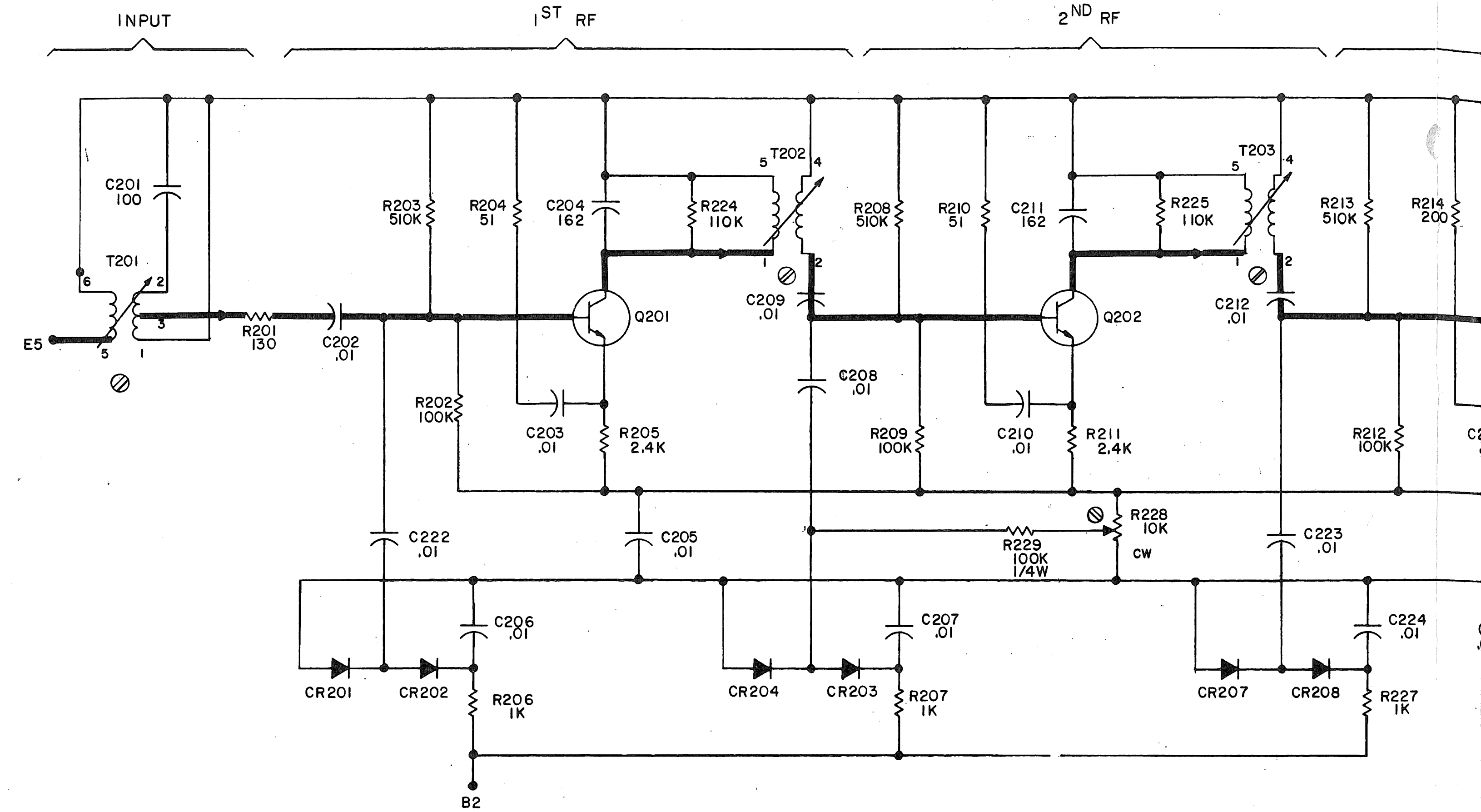
Figure 6-12. Schematic diagram for 10-MHz rf circuit.

PARTS LIST (Cont)

Ref. No.	Description	GR Part Number	FMC	Mfg. Part No.	FSN
TRANSISTORS					
Q201	Type 2N3933	8210-1122	93916	2N3933	
Q202	Type 2N3933	8210-1122	93916	2N3933	
Q103	Type 2N3933	8210-1122	93916	2N3933	
Q204	Type 2N708	8210-3089	24454	2N708	
TRANSFORMERS					
T201		1124-2410	24655	1124-2410	
T202		1124-2460	24655	1124-2460	
T203		1124-2460	24655	1124-2460	
T204		1124-2430	24655	1124-2430	

NOTE

Refer to Figure 6-7 for etched-circuit board layout.



SO102A OR SO103A

A1	GND
B2	AGC
C3	H-IN
D4	NO CONNECTION
E5	L-IN
F6	GND

SO102B OR SO103B

$\overline{A1}$	-12
$\overline{B2}$	GND
$\overline{C3}$	KEY WAY
$\overline{D4}$	NO CONNECTION
$\overline{E5}$	I.F. OUT
$\overline{F6}$	GND

NOTE UNLESS SPECIFIED

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3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT - ANCHOR TERMINAL
10. TP - TEST POINT

PARTS LIST

Ref. No.	Description	GR Part Number	FMC	Mfg. Part No.	FSN
CAPACITORS					
C301	Trimmer, 1.5 - 7 pF 350 V	4910-1110	72982	557-051, 1.5 - 7 pF	
C302	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C303	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C304	Mica, 270 pF ±1% 500 V	4710-0450	14655	22A, 270 pF ±1%	
C305	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C306	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C307	Mica, 270 pF ±1% 500 V	4710-0450	14655	22A, 270 pF ±1%	
C308	Ceramic, 0.01 µF ±10% 500 V	4405-2108	72982	801, 0.001 µF ±10%	
C309	Ceramic, 1 µF ±20% 25 V	4400-2070	80183	5C13, 1 µF ±20%	
C310	Electrolytic, 10 µF ±20% 20 V	4450-5100	56289	150D156X0020B2	
C311	Ceramic, 1 µF ±20% 25 V	4400-2070	80183	5C13, 1 µF ±20%	
RESISTORS					
R301	Composition, 6.8 kΩ ±5% 1/2 W	6100-2685	01121	RC20GF682J	5905-279-3503
R302	Composition, 13 kΩ ±5% 1/2 W	6100-3135	01121	RC20GF133J	5905-279-2669
R303	Composition, 2 kΩ ±5% 1/2 W	6100-2205	01121	RC20GF202J	5905-190-8887
R304	Composition, 39 kΩ ±5% 1/2 W	6100-3395	01121	RC20GF393J	5905-279-3497
R305	Composition, 100 Ω ±5% 1/2 W	6100-1105	01121	RC20GF101J	5905-190-8889
R306	Composition, 680 Ω ±5% 1/2 W	6100-1685	01121	RC20GF681J	5905-195-6791
R307	Composition, 2 kΩ ±5% 1/2 W	6100-2205	01121	RC20GF202J	5905-190-8887
R308	Composition, 15 kΩ ±5% 1/2 W	6100-3155	01121	RC20GF153J	5905-279-2616
R309	Composition, 2 kΩ ±5% 1/2 W	6100-2205	01121	RC20GF202J	5905-190-8887
R310	Composition, 27 kΩ ±5% 1/2 W	6100-3275	01121	RC20GF273J	5905-279-3499
R311	Composition, 200 Ω ±10%	6049-0273	01121	2V2011	
R312	Composition, 18 kΩ ±5% 1/2 W	6100-3185	01121	RC20GF183J	5905-279-3500
R313	Composition, 120 kΩ ±5% 1/2 W	6100-4125	01121	RC20GF124J	5905-792-3981
R314	Composition, 200 kΩ ±5% 1/2 W	6100-4205	01121	RC20GF204J	5905-171-2003
R315	Composition, 680 Ω ±5% 1/2 W	6100-1685	01121	RC20GF681J	5905-195-6791
R316	Composition, 1.2 kΩ ±5% 1/2 W	6100-2125	01121	RC20GF122J	5905-190-8880
R317	Composition, 22 kΩ ±5% 1/2 W	6100-3225	01121	RC20GF223J	5905-171-2004
R318	Composition, 10 kΩ ±5% 1/2 W	6100-3105	01121	RC20GF103J	5905-185-8510
R319	Composition, 560 Ω ±5% 1/2 W	6100-1565	01121	RC20GF561J	5905-195-6800
R320	Composition, 47 kΩ ±5% 1/2 W	6100-3475	01121	RC20GF473J	5905-254-9201
R321	Composition, 10 kΩ ±5% 1/2 W	6100-3105	01121	RC20GF103J	5905-185-8501
R322	Composition, 5.1 kΩ ±5% 1/2 W	6100-2515	01121	RC20GF512J	5905-279-2019
DIODES					
CR301	Type 1N455	6082-1010	07910	1N455	5960-877-8255
CR302	Type 1N455	6082-1010	07910	1N455	5960-877-8255
TRANSISTORS					
Q301	Type 2N708	8210-3089	24454	2N708	
Q302	Type 2N708	8210-3089	24454	2N708	
Q303	Type 2N708	8210-3089	24454	2N708	
Q304	Type 2N708	8210-3089	24454	2N708	
Q305	Type 2N3702	8210-1106	01295	2N3702	
Q306	Type 2N708	8210-3089	24454	2N708	
Q307	Type 2N3702	8210-1106	01295	2N3702	
Q308	Type 2N708	8210-3089	24454	2N708	
Q309	Type 2N3414	8210-1047	24446	2N3414	5961-989-2749
TRANSFORMERS					
T301		1124-2470	24655	1124-2470	
T302		1124-2440	24655	1124-2440	

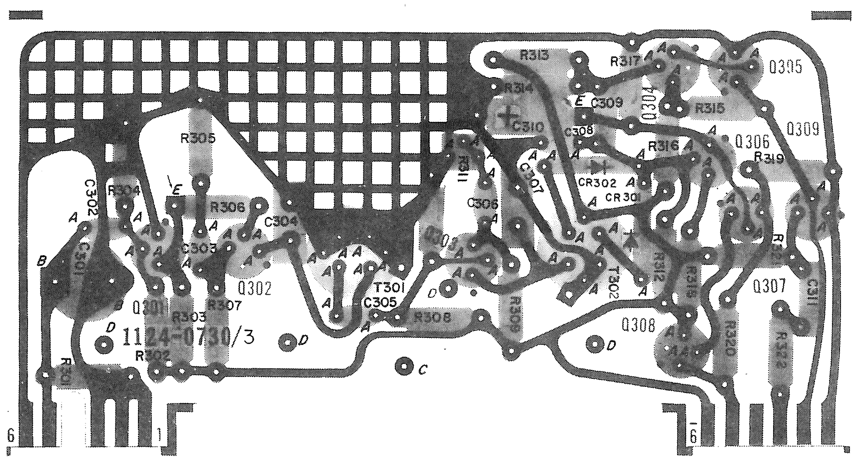
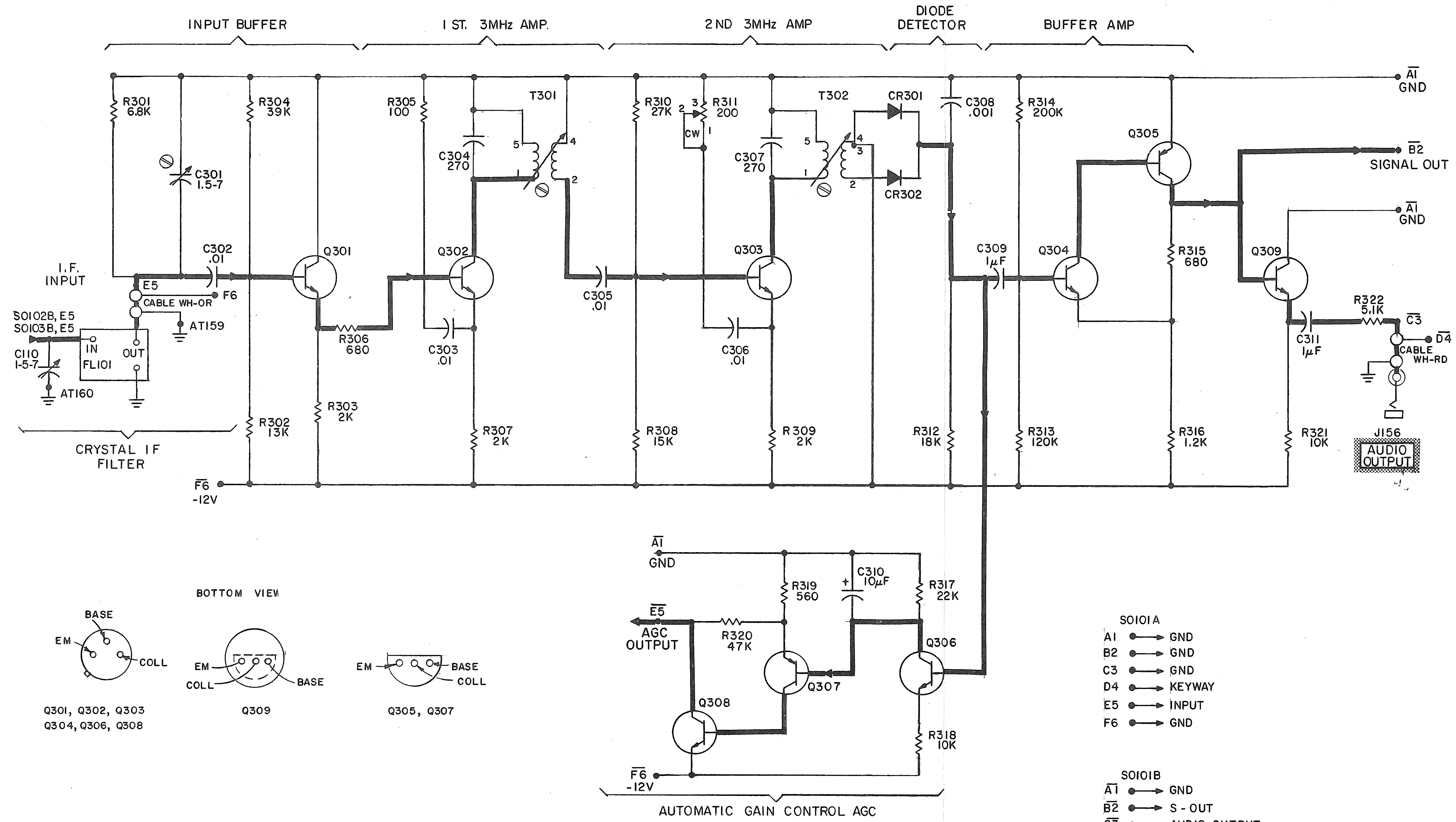


Figure 6-13. I-f circuit etched-board assembly (P/N 1124-4731).

NOTE: The number appearing on the foil side is not the part number. The dot on the foil at the transistor socket indicates the collector lead.



NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ○ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT = ANCHOR TERMINAL
10. TP = TEST POINT

Figure 6-14. I-f circuit schematic diagram.

PARTS LIST

Ref. No.	Description	GR Part Number	FMC	Mfg. Part No.	FSN
CAPACITORS					
C401	Plastic, 0.00536 µF ±2% 200 V	4860-7501	84411	663UW, 0.00536 µF ±2%	
C402	Electrolytic, 3.3 µF ±20% 15 V	4450-4600	56289	150D335X0015A2	5910-837-9325
C403	Electrolytic, 3.3 µF +20% 15 V	4450-4600	56289	150D335X0015A2	5910-837-9325
C404	Trimmer, 10 - 100 pF	4910-0700	71590	823-BN, 10 - 100 pF	
C405	Mica, 340 pF ±1% 500 V	4710-0480	14655	22A, 340 pF ±1%	
C406	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C407	Trimmer, 10 - 100 pF	4910-0700	71590	823-BN, 10 - 100 pF	
C408	Mica, 324 pF ±1% 500 V	4710-0470	14655	22A, 324 pF ±1%	
C409	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100	80131	CC61, 0.01 µF +80 -20%	5910-974-5697
C410	Electrolytic, 3.3 µF ±20% 15 V	4450-4600	56289	150D335X0015A2	5910-837-9325
RESISTORS					
R401	Composition, 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	
R402	Composition, 51 Ω ±5% 1/4 W	6099-0515	75042	BTS, 51 Ω ±5%	
R403	Composition, 3.9 kΩ ±5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ ±5%	
R404	Composition, 51 Ω ±5% 1/4 W	6099-0515	75042	BTS, 51 Ω ±5%	
R405	Composition, 62 kΩ ±5% 1/4 W	6099-3625	75042	BTS, 62 kΩ ±5%	
R406	Composition, 62 kΩ ±5% 1/4 W	6099-3625	75042	BTS, 62 kΩ ±5%	
R407	Variable, 50 kΩ ±20%	6040-0900	24655	6040-0900	
R408	Composition, 240 kΩ ±5% 1/4 W	6099-4245	75042	BTS, 240 kΩ ±5%	
R409	Composition, 51 kΩ ±5% 1/4 W	6099-3515	75042	BTS, 51 kΩ ±5%	5905-200-6731
R410	Composition, 2.2 kΩ ±5% 1/4 W	6099-2225	75042	BTS, 2.2 kΩ ±5%	
R411	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	
R412	Composition, 62 kΩ ±5% 1/4 W	6099-3625	75042	BTS, 62 kΩ ±5%	
R413	Composition, 75 kΩ ±5% 1/4 W	6099-3755	75042	BTS, 75 kΩ ±5%	
R414	Variable, 50 kΩ ±20%	6040-0900	24655	6040-0900	
R415	Composition, 240 kΩ ±5% 1/4 W	6099-4245	75042	BTS, 240 kΩ ±5%	
R416	Composition, 51 kΩ ±5% 1/4 W	6099-3515	75042	BTS, 51 kΩ ±5%	5905-200-6731
R417	Composition, 2.2 kΩ ±5% 1/4 W	6099-2225	75042	BTS, 2.2 kΩ ±5%	
R418	Composition, 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	
R419	Composition, 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R421	Composition, 510 kΩ ±5% 1/4 W	6099-4515	75042	BTS, 510 kΩ ±5%	
R422	Composition, 510 kΩ ±5% 1/4 W	6099-4515	75042	BTS, 510 kΩ ±5%	
TRANSISTORS					
Q401	Type 2N708	8210-3089	24454	2N708	
Q402	Type 2N708	8210-3089	24454	2N708	
Q403	Type 2N3905	8210-1114	04713	2N3905	
Q404	Type 2N708	8210-3089	24454	2N708	
Q405	Type 2N3905	8210-1114	04713	2N3905	
INDUCTORS					
L401	470 µH ±5%	4300-6380	99800	3500, 470 µH	
L402		1124-2480	24655	1124-2480	
L403		1124-2490	24655	1124-2490	
JACKS					
J451		4260-1288	02660	5116058350	
J452		4260-1288	02660	5116058350	

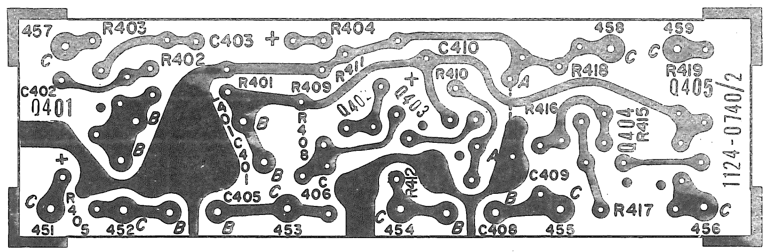


Figure 6-15. Loran filter circuit etched-board assembly (P/N 1124-2740).

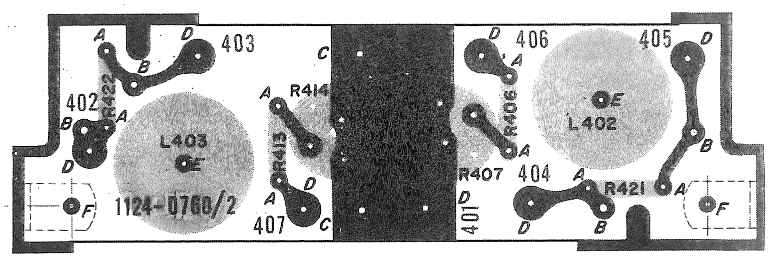
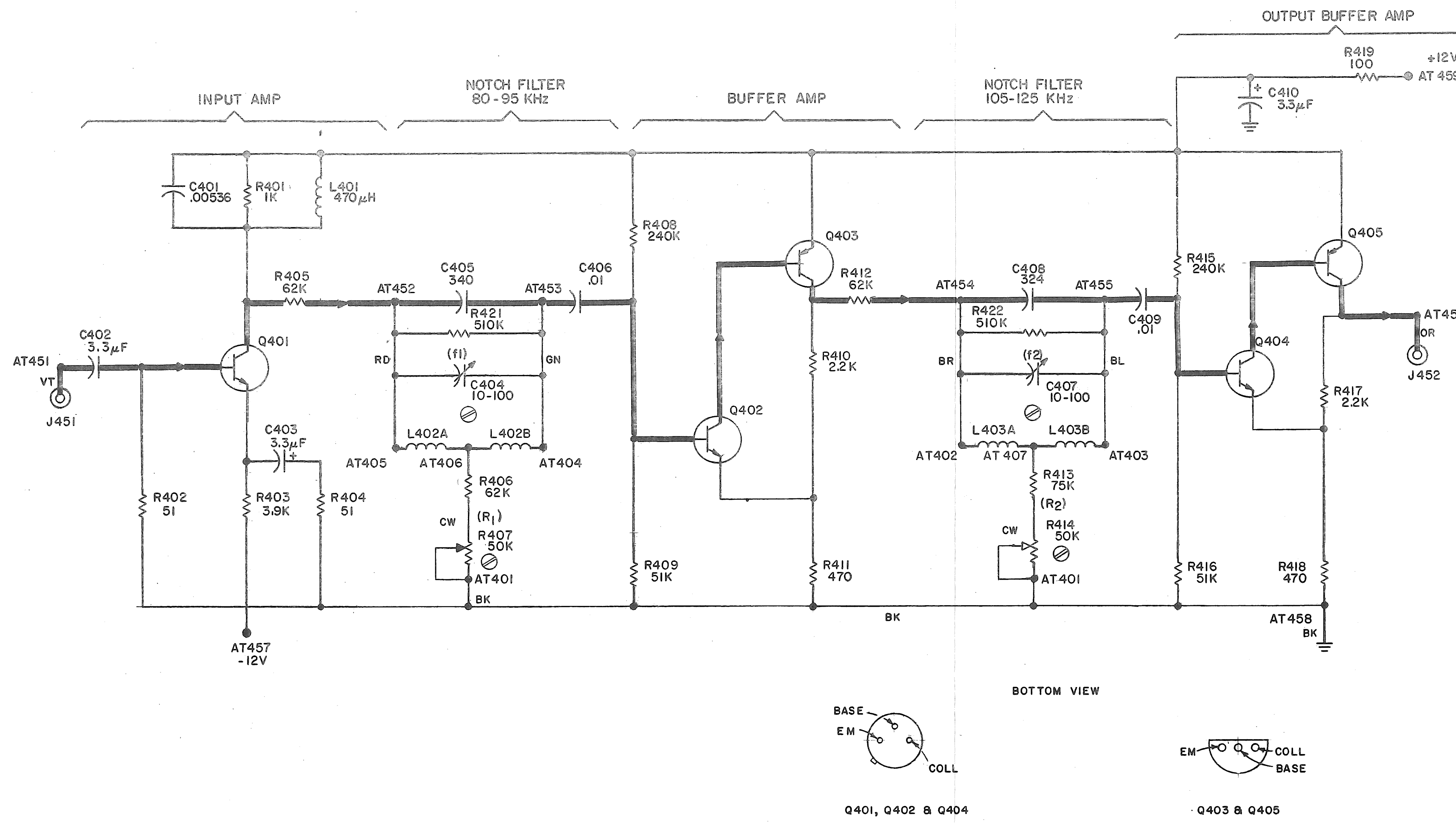


Figure 6-16. Loran filter circuit etched-board assembly (P/N 1124-2761).

NOTE: The number appearing on the foil side is not the part number. The dot on the foil at the transistor socket indicates the collector lead.



NOTE UNLESS SPECIFIED	
1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.	5. RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.	6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.	7. ◯ KNOB CONTROL
	8. ⊘ SCREWDRIVER CONTROL
	9. AT = ANCHOR TERMINAL
4. RESISTORS 1/4 WATT.	10. TP = TEST POINT

Figure 6-17. Loran filter circuit schematic diagram.

PARTS LIST

Ref. No.	Description	GR Part Number	FMC	Mfg. Part No.	FSN
CAPACITORS					
C701	Plastic, 0.00536 μF ±2% 200 V	4860-7501	84411	663UW, 0.00536 μF ±2%	
C702	Plastic, 0.00536 μF ±2% 200 V	4860-7501	84411	663UW, 0.00536 μF ±2%	
C703	Plastic, 0.00649 μF ±2% 200 V	4860-7504	84411	663UW, 0.00649 μF ±2%	
C704	Ceramic, 1 μF ±20% 25 V	4400-2070	80183	5C13, 1 μF ±20%	
C705	Ceramic, 0.47 μF ±20% 25 V	4400-2054	80183	5C13, 0.47 μF ±20%	
C706	Ceramic, 0.47 μF ±20% 25 V	4400-2054	80183	5C13, 0.47 μF ±20%	
C707	Ceramic, 0.47 μF ±20% 25 V	4400-2054	80183	5C13, 0.47 μF ±20%	
C708 through C713	Ceramic, 1 μF ±20% 25 V	4400-2070	80183	5C13, 1 μF ±20%	
C714	Electrolytic, 68 μF ±20% 15 V	4450-5615	80183	150D686X0015R2	
C715	Electrolytic, 68 μF ±20% 15 V	4450-5615	80183	150D686X0015R2	
INDUCTORS					
L701	470 μH ±5%	4300-6380			
L702	470 μH ±5%	4300-6380			
L703	470 μH ±5%	4300-6380			
RESISTORS					
R701	Composition, 680 Ω ±5% 1/4 W	6099-1685	75042	BTS, 680 Ω ±5%	
R702	Composition, 680 Ω ±5% 1/4 W	6099-1685	75042	BTS, 680 Ω ±5%	
R703	Composition, 680 Ω ±5% 1/4 W	6099-1685	75042	BTS, 680 Ω ±5%	
R704	Composition, 100 kΩ ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ ±5%	
R705	Composition, 100 kΩ ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ ±5%	
R706	Composition, 100 kΩ ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ ±5%	
R707	Composition, 56 kΩ ±5% 1/4 W	6099-3565	75042	BTS, 56 kΩ ±5%	
R708	Composition, 56 kΩ ±5% 1/4 W	6099-3565	75042	BTS, 56 kΩ ±5%	
R709	Composition, 56 kΩ ±5% 1/4 W	6099-3565	75042	BTS, 56 kΩ ±5%	
R710	Composition, 3.9 kΩ ±5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ ±5%	
R711	Composition, 3.9 kΩ ±5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ ±5%	
R712	Composition, 3.9 kΩ ±5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ ±5%	
R713	Composition, 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R714	Composition, 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R715	Composition, 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R716	Composition, 680 Ω ±5% 1/4 W	6099-1685	75042	BTS, 680 Ω ±5%	
R717	Composition, 680 Ω ±5% 1/4 W	6099-1685	75042	BTS, 680 Ω ±5%	
R718	Composition, 680 Ω ±5% 1/4 W	6099-1685	75042	BTS, 680 Ω ±5%	
R719	Composition, 8.2 kΩ ±5% 1/4 W	6099-2825	75042	BTS, 8.2 kΩ ±5%	
R720	Composition, 8.2 kΩ ±5% 1/4 W	6099-2825	75042	BTS, 8.2 kΩ ±5%	
R721	Composition, 8.2 kΩ ±5% 1/4 W	6099-2825	75042	BTS, 8.2 kΩ ±5%	
R722	Composition, 110 kΩ ±5% 1/4 W	6099-4115	75042	BTS, 100 kΩ ±5%	
R723	Composition, 82 kΩ ±5% 1/4 W	6099-3825	75042	BTS, 82 kΩ ±5%	
R724	Composition, 150 Ω ±5% 1/4 W	6099-1155	75042	BTS, 150 Ω ±5%	
R725	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R726	Composition, 510 Ω ±5% 1/4 W	6099-1515	75042	BTS, 510 Ω ±5%	
TRANSISTORS					
Q701	Type 2N3414	8210-1047	24446	2N3414	5961-989-2749
Q702	Type 2N3414	8210-1047	24446	2N3414	5961-989-2749
Q703	Type 2N3414	8210-1047	24446	2N3414	5961-989-2749
Q704	Type 2N1303	8210-1019	96214	2N1303	
Q705	Type 2N1303	8210-1019	96214	2N1303	
Q706	Type 2N1303	8210-1019	96214	2N1303	
Q707	Type 2N3414	8210-1047	24446	2N3414	5961-989-2749
Q708	Type 2N3905	8210-1114	04713	2N3905	

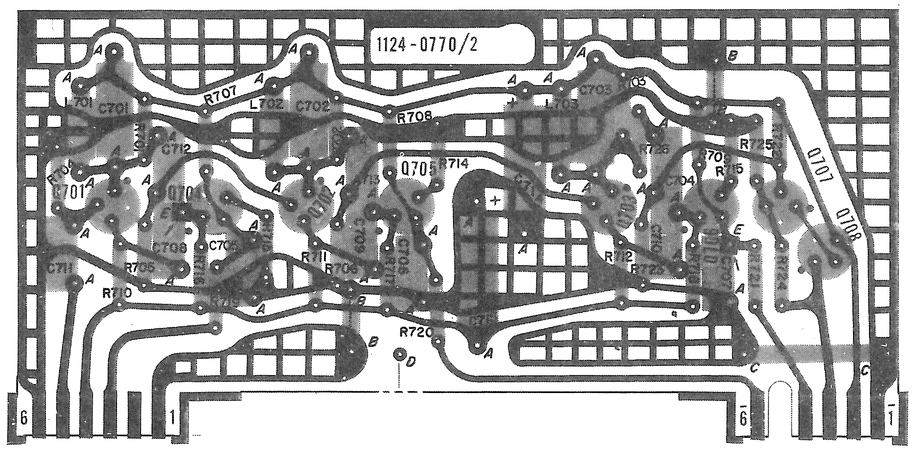


Figure 6-18. Loran amplifier etched-board assembly (P/N 1124-4771).

NOTE: The number appearing on the foil side is not the part number. The dot on the foil at the transistor socket indicates the collector lead.

Rotary switch sections are shown as viewed from the panel end of the shaft. The first digit of the contact number refers to the section. The section nearest the panel is 1, the next section back is 2, etc. The next two digits refer to the contact. Contact 01 is the first position clockwise from a strut screw (usually the screw above the locating key), and the other contacts are numbered sequentially (02, 03, 04, etc), proceeding clockwise around the section. A suffix F or R indicates that the contact is on the front or rear of the section, respectively.

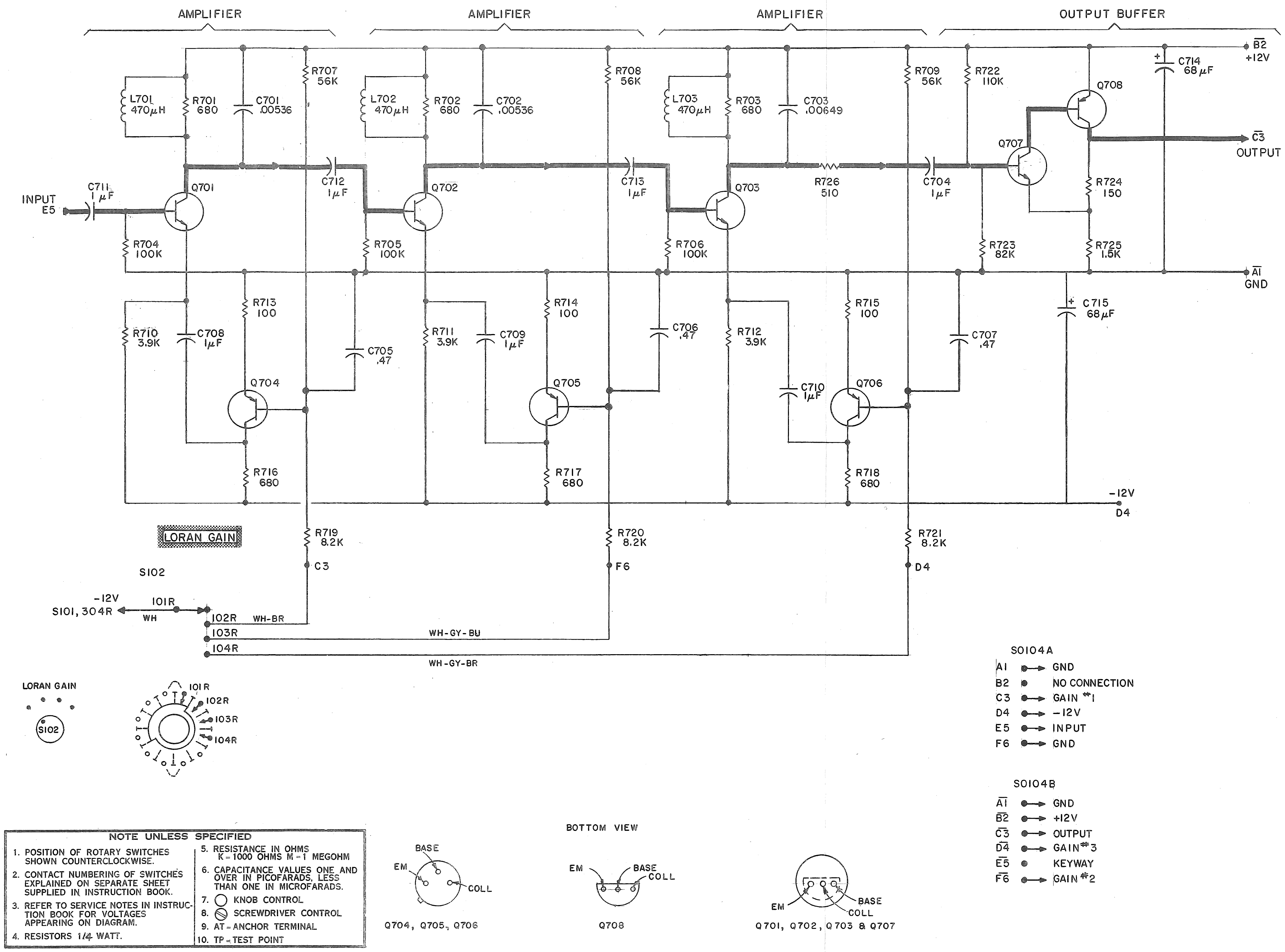


Figure 6-19. Loran amplifier schematic diagram.

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