INSTRUCTION MANUAL

FM-AM
SIGNAL GENERATOR
MODEL 102D

BOONTON
ELECTRONICS CORPORATION ROUTE 287, PARSIPPANY, NEW JERSEY 07054
TELEPHONE: 201 – 887-5110 TWX: 710-986-8241

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WARRANTY

Boonton Electronics Corporation warrants its products to the original Purchaser to be free from defects in material and workmanship and to operate within applicable specifications for a period of one year from date of shipment, provided they are used under normal operating conditions. This warranty does not apply to active devices that have given normal service, to sealed assemblies which have been opened, or to any item which has been repaired or altered without our authorization.

We will repair or, at our option, replace at no charge any of our products which are found to be defective under the terms of this warranty. Except for such repair or replacement, we will not be liable for any incidental damages or for any consequential damages, as those terms are defined in Section 2-715 of the Uniform Commercial Code, in connection with products covered by this warranty.

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Figure 1-1 FM-AM Signal Generator, Model 102D

SECTION I
INTRODUCTION

1-1. SCOPE OF MANUAL

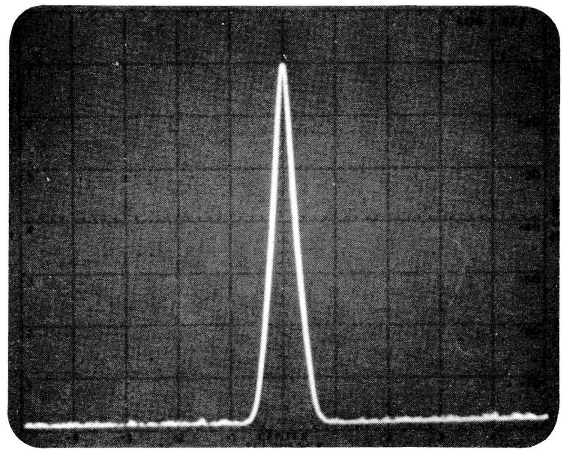
1-2. This handbook provides descriptive data, operating instructions, theory of operation, maintenance instructions, and a parts list for the Model 102D FM-AM Signal Generator. (See Figure 1-1). The Model 102D is manufactured by Boonton Electronics Corporation, Parsippany, New Jersey.

1-3. PURPOSE AND USE OF EQUIPMENT.

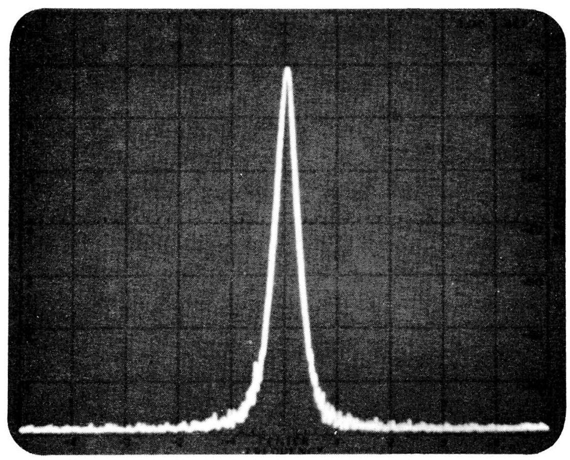
1-4. The Model 102D is a highly versatile, precision, solid-state instrument with features and performance characteristics especially suitable for laboratory and industrial applications. It covers the frequency range of 0.45 to 520 MHz. Human engineering considerations have been emphasized in both the mechanical and electrical design of the Model 102D. The result is an instrument that is easy and convenient to use, despite its flexibility. Among the outstanding design features are:

a. **Spectral Purity**. The spectral purity of the Model 102D is comparable to that of a crystal oscillator. (See Figure 1-2.) The output frequency is derived from an inductively tuned VFO with inherently low microphonism. Appropriate filters are electronically switched into the frequency generating circuits by means of PIN diodes to further suppress spurious frequencies. The supression of harmonics and other spurious frequencies provides assurance that test results obtained using this instrument will reflect selected test parameters only; erroneous test indications resulting from spurious frequencies are unlikely.

b. **Stability**. The Model 102D exhibits outstanding stability characteristics, both short-term and long-term. Electronic band-switching by means of PIN diodes eliminates a major source of instability and allows immediate use of each band without further stabilization. Design specifications limit drift (without phase locking) to a maximum of 20 ppm/10 min after 1 hour warm-up on bands 2 through 5, and 1.5 kHz/10 min after 1 hour warm-up on band 1. Actual drift of a production model is shown in Figure 1-3. Stability can be further improved through use of a built-in phase locking feature. Any frequency within the tuning



A. CRYSTAL OSCILLATOR



B. MODEL 102D

NOTES:
1. FREQUENCY — 100 MHz
2. SPECTRUM ANALYZER SETTINGS
IF BANDWIDTH — 100 Hz
SCAN WIDTH — 1 kHz/DIV
VIDEO FILTER — 10 Hz

Figure 1-2 Spectrum Comparison, Model 102D and Crystal Oscillator

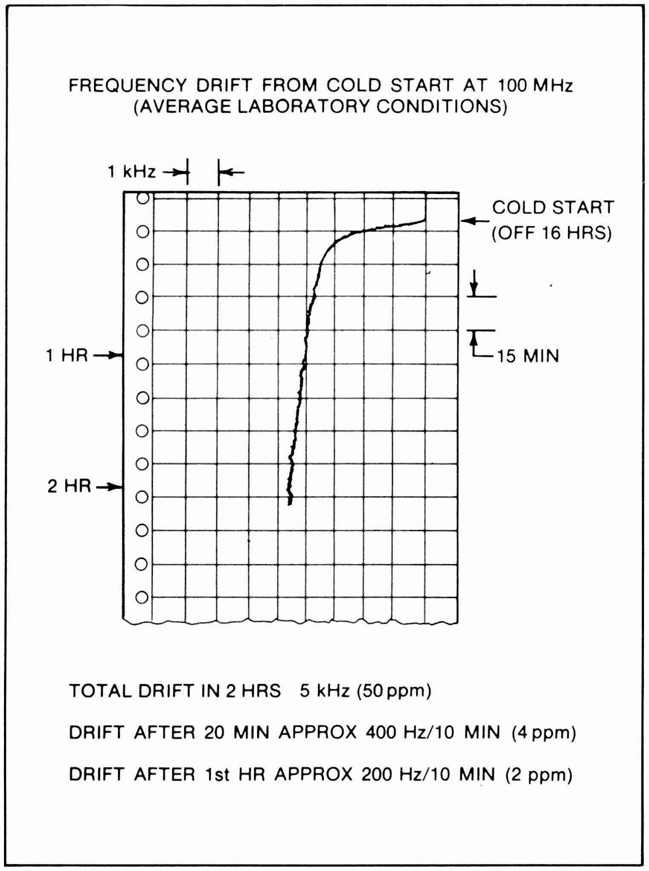


Figure 1-3 Stability Characteristics of Production Model (Without Phase Lock)

range of the Model 102D can be phase locked either to a very stable internal reference signal or to an external reference signal. When this phase locking feature is used, the frequency drift is limited to a maximum of 0.2 ppm/hr after 1 hour warm-up and 0.05 ppm/hr after 4 hours warm-up on bands 2 through 5, and to less than 100 Hz/hr after 1 hour warm-up on band 1. Frequency lock is maintained indefinitely once the instrument is warmed up and operated under reasonably stable environmental conditions. The excellent stability characteristics of the Model 102D minimize the need for extended, time-consuming warm-up periods and for constant readjustment of the output frequency during use.

c. **LED Frequency Display**. The output frequency of the Model 102D is continually displayed during use by means of a 6-digit LED display. The elimination of a tuning dial, with its recalibration problems and inherent reading uncertainty, removes a major source of operator error. The LED display provides clear, unambiguous readings with selectable resolution, minimizing the possibility of misinterpretation. (See Figure 1-4.) Resolution of 0.1, 1, or 10 kHz can be selected by means of a front-panel switch.

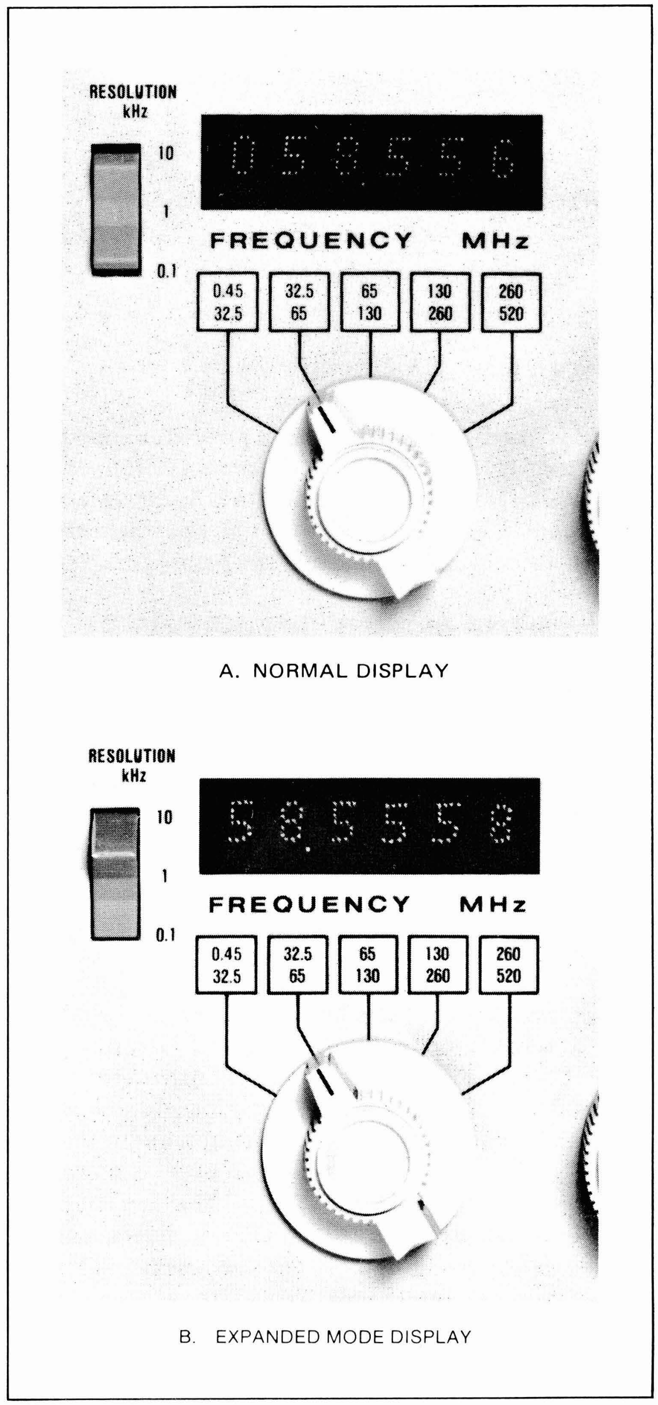


Figure 1-4 LED Frequency Display

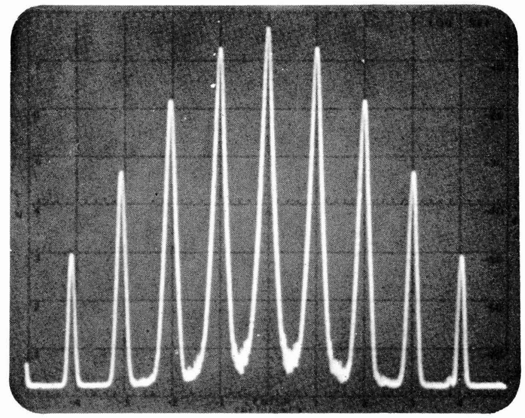
d. **FM/AM Modulation Capabilities.** (See Figure 1-5.) The Model 102D is the ideal instrument for a wide variety of test applications because of its flexible modulation capabilities. FM and AM, using either internal or external modulation signals, can be used either singly or simultaneously. FM deviation is calibrated to an exceptionally wide 300 kHz in five ranges, and can be increased to over 1 MHz uncalibrated. The FM bandwidth extends from 50 Hz to 200 kHz. Deviation is adjustable, metered, and constant with band and frequency changes. Distortion and residual and incidental FM are very low, thus the Model 102D is an excellent signal source for both wide-band measurements and narrow-band applications. AM is adjustable to 100 percent with low distortion (typically less than 3 percent Total Harmonic Distortion (THD) at 90 percent modulation). The AM bandwidth extends from dc to 20 kHz. Although the Model 102D has not been specifically designed for pulse modulation, good results have been obtained using external low-frequency pulses for modulation.

1-5. The features described in the preceding paragraph, together with those specified in Table 1-1, make the Model 102D particularly useful for design, production line, and field testing in the FM receiver, communications, aerospace, and navaid industries. Because of its flexibility, the Model 102D is also an excellent general-purpose signal generator for laboratory applications.

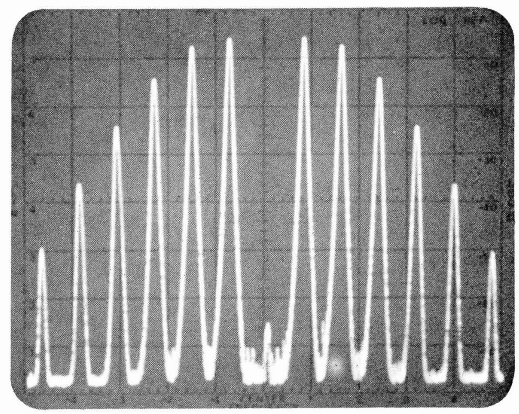
1-6. OPTIONS.

1-7. Nine options are currently available. They are:

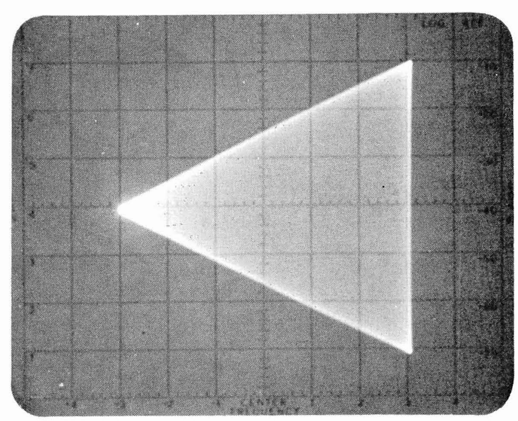
Option No.	Description
01	External modulation connectors and RF connector are mounted on the rear panel.
02	Special internal modulation frequencies within the range of 20 Hz to 100 kHz are provided.
03	Demodulated AM, isolated by a voltage follower, is available at a rear panel BNC connector.
04	RF output is fused to protect the Model 102D from serious damage when external power inadvertently applied to the r-f output connector exceeds 0.8 watt. Eleven fuses are supplied; one installed and ten spares.
05	High impedance (10k ohm) AM input on front panel.
06	High impedance (10k ohm) FM input on front panel.
07	A combination of Options 05 and 06 described above.
08	Permits the use of an external time base generator as well as the internal time base. The external time base generator is connected to the Model 102D via a BNC connector on the rear panel. The associated toggle switch (INT/EXT) should be placed in the EXT position.



A. FM SIDEBANDS
MODULATION FREQ — 20 kHz
FM DEVIATION — 22.5 kHz PEAK



B. FM WITH CARRIER AT FIRST BESSEL ZERO
MODULATION FREQ — 41.58 kHz
FM DEVIATION — 100 kHz PEAK
MODULATION INDEX — 2.4048



C. 100% AM TRAPEZOID
FREQ — 105 MHz
MODULATION FREQ — 3 kHz
OUTPUT LEVEL — +10 dBm

Figure 1-5 FM/AM Modulation Characteristics

TABLE 1-1. PERFORMANCE SPECIFICATIONS

Parameter	Specifications
OUTPUT FREQUENCY:	
Range	0.45 to 520 MHz in 5 bands: Band 1 – 0.45 to 32.5 MHz; Band 2 – 32.5 to 65 MHz; Band 3 – 65 to 130 MHz; Band 4 – 130 to 260 MHz; and Band 5 – 260 to 520 MHz
Accuracy	± (resolution + 1 ppm) at 15°C to 35°C when calibrated at 25°C every 3 months
Resolution	Selectable, 0.1 kHz, 1 kHz, or 10 kHz
Display	6-digit LED
*Stability:	
Bands 2 through 5	Drift less than 10 ppm/10 min after 2 hour warm-up
Band 1	Drift, without phase lock, less than 1.5 kHz/10 min after 1 hour warm-up; drift, with phase lock, less than 100 Hz/hr after 1 hour warm-up
Fine Tuning (Unlocked)	Electronic vernier, approximate range of 12.5 kHz on bands 1 and 2, 25 kHz on band 3, 50 kHz on band 4, and 100 kHz on band 5. Vernier ranges are accurate to ±30%
Fine Tuning (Phase Locked)	Electronic vernier, range more than ±20 ppm, all bands.
Residual FM	Less than 15 Hz peak, band 1; less than 0.2 ppm peak, bands 2 through 5 (both in 20 Hz to 15 kHz post-detection bandwidth)
RF OUTPUT:	
Power Level	-130 dBm to +13 dBm (0.07 microvolt to 1 volt into 50 ohms)
Attenuator	13 steps in 10 dB/step plus variable 13 dB calibrated on output meter
Accuracy	±(1.0 dB + attenuator accuracy) (Attenuator accuracy is 0.1 dB/10 dB step, with maximum cumulative error of ±1.0 dB) (If fitted with 04 option, accuracy on band 5 only is ±(1.5 dB + attenuator accuracy)
Leveling	±0.5 dB maximum variation across each band (If fitted with -04 option, leveling on band 5 only is ±0.8 dB max. variation
Spurious Outputs	Harmonics, better than -30 dB (-25 dB below 5 MHz) Sub-harmonically related, better than -40 dB Mixing products (band 1), better than -30 dB (All at setting between 0 and -10 dBm on output vernier range)
Impedance	50 ohms, with VSWR less than 1.5: 1 at levels below 0 dBm
Single Sideband Total Noise	Bands 1 through 3, more than 120 dB/Hz below carrier, typically 125 dB/Hz, 20 kHz off carrier Bands 4 and 5, more than 105 dB/Hz below carrier, typically 115 dB/Hz, 20 kHz off carrier
Single Sideband Noise Floor	Typically 135 dB/Hz below carrier

*Phase lock stability specifications apply under constant ambient temperatures in 15°C to 35°C range, and constant line voltage.

TABLE 1-1. PERFORMANCE SPECIFICATIONS (Cont.)

Parameter	Specifications
FREQUENCY MODULATION:	
Deviation	0 to 300 kHz peak, calibrated; more than 1 MHz peak, uncalibrated (all bands)
Ranges	3 kHz, 10 kHz, 30 kHz, 100 kHz, and 300 kHz peak fs, metered by true peak reading meter
Accuracy	±10%fs, 20 Hz to 200 kHz
Bandwidth	DC to 200 kHz (3 dB bandwidth, ref. to 10 kHz), unlocked 50 Hz to 200 kHz, locked
Distortion (at 100 kHz peak deviation)	1.0% maximum THD, bands 1 and 2; 0.5% maximum THD, band 3; 0.25% maximum THD, band 4; 0.15% maximum THD, band 5
External Modulation Input	Nominal 1 volt rms into 600 ohms for fs deviation
Incidental AM with FM	Less than 0.2% AM at 100 kHz deviation
AMPLITUDE MODULATION:	
Percent	0 to 100 for less than +10 dBm at settings between 0 and -10 dBm on output vernier
Calibrated Ranges	30% and 100% fs, true peak reading meter
Accuracy	±3% AM at 30% and 50% AM (at 400 Hz and 1 kHz rates)
Bandwidth	DC to 20 kHz (-3.0 dB, ref. to 1 kHz)
Distortion (at 1 kHz modulation rate)	Less than 1.0% THD at 30% AM Less than 2.0% THD at 70% AM Typically less than 3% at 90% AM
External Modulation Input	Nominal 1 volt rms into 600 ohms for 30% AM
Incidental FM with 30% AM	Less than 50 Hz peak on bands 1 and 2 Less than 1 ppm peak on bands 3 through 5
INTERNAL MODULATION:	
Frequencies	400 Hz, 1 kHz, 3 kHz, 10 kHz, and 19 kHz
Accuracy	±3%
Distortion	Less than 0.25% THD
Output	Nominal 1.0 volt rms into 600 ohms (rear panel BNC connector)
SIMULTANEOUS MODULATION CAPABILITY	External FM, internal AM External FM, external AM Internal FM, external AM
PHASE LOCKING:	
Temperature Influence:	
Bands 2 through 5	Less than 2 ppm 15°C to 35°C
Band 1	Less than 5 kHz, 15°C to 35°C

TABLE 1-1. PERFORMANCE SPECIFICATIONS (Cont.)

Parameter	Specifications
Line Voltage Influence:	
Bands 2 through 5	Less than 0.1 ppm for nominal ±10%
Band 1	Less than 50 Hz for nominal ±10%
Internal Reference Oscillator:	
Frequency	1 MHz
Accuracy	±1 ppm, 15°C to 35°C
Drift Rate	Less than 0.05 ppm/hr after 4 hour warm-up; less than 2 ppm/year after 4 hour warm-up
Output Level	1V rms, nominal
Source Resistance	1000 ohms, nominal
External Reference Input:	
Frequency	1 MHz, nominal
Level	0.2 to 5V rms into 1000 ohms
GENERAL:	
Power	100, 120, 220, or 240 volts, 50 to 400 Hz, 30 watts
Dimensions	See Figure 1-6
Weight	30 pounds (13.6 kg)
Temperature range	0°C to +50°C operating

External clocks must furnish a minimum of 1 volt peak-to-peak into a nominal 5k ohm load; either sine or square wave input is usable.

The external generator may be left connected when not in use; switching the INT/EXT switch to INT disconnects it.

10 Band 3 has RF output frequency range extended to cover 65-136 MHz for aircraft communications applications without switching bands.

NOTE

Options 01 and 08 cannot be ordered at the same time (except RF connector).

1-8. Inquiries regarding special applications of the Model 102D to specific customer requirements are invited. Direct such inquiries to the Applications Engineering Department of Boonton Electronics Corporation.

1-9. SPECIFICATIONS.

1-10. Pertinent performance specifications of the Model 102D are listed in Table 1-1.

1-11. OUTLINE DIMENSIONS.

1-12. Outline dimensions of the Model 102D are shown in figure 1-6.

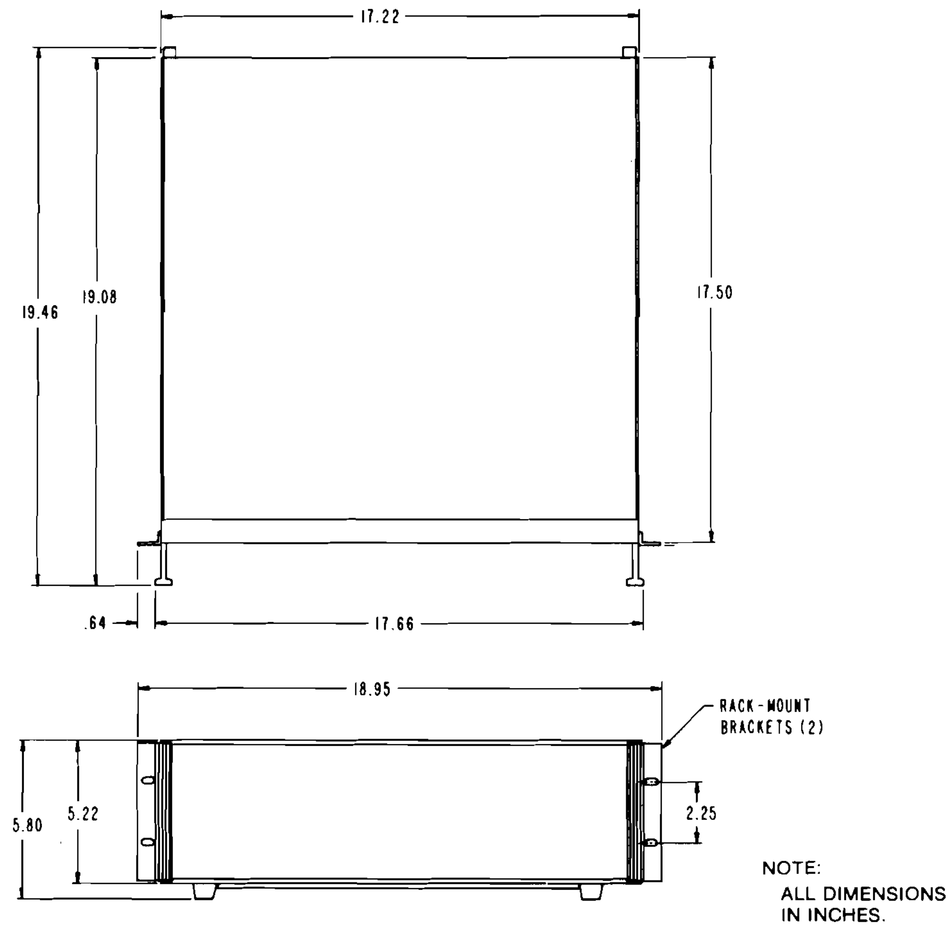


Figure 1-6 Outline Dimensions

SECTION II
OPERATION

2-1. GENERAL

2-2. This section contains instructions for the installation and operation of FM-AM Signal Generator, Model 102D. Although the design of the Model 102D reflects careful attention to human engineering factors regarding ease of use, it is strongly recommended that the operator familiarize himself with the material in this section before attempting to operate the equipment; otherwise, the full capabilities of the equipment may not be realized in use.

2-3. INSTALLATION

2-4. **Unpacking.** The Model 102D is shipped complete and is ready for use upon receipt. Packaging details are shown in Figure 2-1. Unpack the equipment from the shipping container and inspect it for damage that may have occurred during shipment. Check that all operating controls operate over their full range without binding.

NOTE

Save the packing material and container for possible use in reshipment of the equipment.

2-5. **Mounting.** For bench mounting, choose a clean, sturdy, uncluttered mounting surface. See Figure 1-6 for space requirements. For rack-mounting, an accessory package is supplied. It consists of two angle mounting brackets (730548), four 8-32 binder-head screws, and four lockwashers. The procedure below should be followed for rack mounting a Model 102D:

a. The Model 102D cabinet has one slotted handle at each end of the front panel. On the outside surfaces of these handles, where they join the cabinet, are two strips of green pressure-sensitive tape. These must be removed or perforated, exposing the tapped mounting holes for the angle mounting brackets.

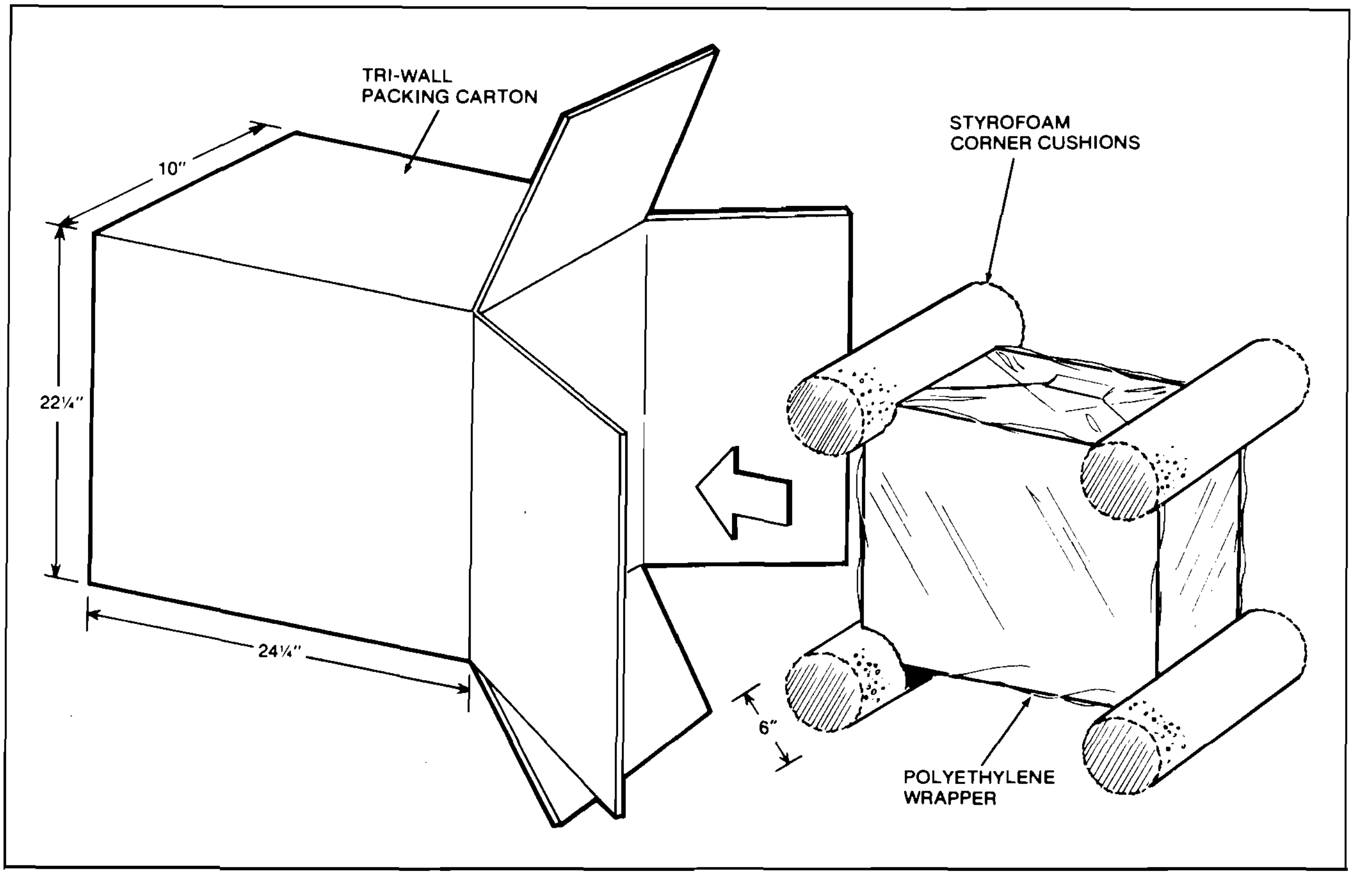


Figure 2-1 Packaging Diagram

b. Refer to the drawing in the accessory package for the proper orientation of the two mounting brackets. Make certain that the slotted holes are facing to the front, and mount the brackets with the 8-32 screws as shown in the drawing.

c. The Model 102D may then be mounted in the rack with standard rack-mounting screws through the slotted holes in the angle brackets.

NOTE

Feet and bail may be removed from bottom cover to clear adjacent rack mounted units.

2-6. **Power Requirements.** A 50 to 400 Hz, single phase, ac power source, rated at 100, 120, 220, or 240 volts, is required for operation of the Model 102D. Power required is 30 watts.

CAUTION

Always make certain that the line voltage switch on the rear panel of the Model 102D is set to the position corresponding to the available line voltage, and that a fuse of the proper rating (0.50 A for 100 or 120 volts; 0.25 A for 220 or 240 volts) is installed in the fuse holder before connecting the Model 102D to any ac power source.

2-7. **Cable Connections.** Various cable connections, depending upon the operating mode of the Model 102D, are required. Connecting cables are not supplied with the equipment. Cable connections that may be required are as follows:

a. **Output.** The r-f output of the Model 102D is available at the front panel OUTPUT connector (type N). Output impedance is 50 ohms. For operation with load impedances other than 50 ohms, refer to paragraph 2-22.

b. **FM Input.** If the Model 102D is to be frequency modulated by an external signal, connect the external signal source to the front panel EXT FM connector (type BNC). Input impedance is 600 ohms, and a nominal 1-volt rms signal is required for fs deviation.

c. **AM Input.** If the Model 102D is to be amplitude modulated by an external signal, connect the external signal source to the front panel EXT AM connector (type BNC). Input impedance is 600 ohms, and a nominal 1-volt rms signal is required for 30 percent AM.

d. **Modulating Signal Output.** An isolated output signal from the internal modulation oscillator is available at the rear-panel MOD FREQ OUT connector (type BNC). Output impedance is 600 ohms, and the nominal amplitude of the signal is 1 volt rms.

e. **Phase Lock External Reference Input.** If the Model 102D is to be phase locked to an external reference signal, connect the 1 MHz external signal source to the 1 MHz IN/OUT connector (type BNC) on the rear panel. Input impedance is 1000 ohms, and an input signal level of 0.2 to 5 volts rms is required.

2-8. OPERATING CONTROLS, INDICATORS, AND CONNECTORS.

2-9. All controls, indicators, and connectors used during operation of the Model 102D are shown in Figures 2-2 and 2-3. Table 2-1 lists their functions.

TABLE 2-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS

Control, Indicator or Connector	Figure and Index No.	Function
DEVIATION kHz switch	2-2, 1	Permits operator to select peak deviation limit for either external or internal FM. Actual FM deviation is adjustable from zero to selected limit by means of FM control.
METER switch	2-2, 2	Permits operator to select MODULATION meter function. When switch is set to either AM position, MODULATION meter indicates percentage of AM; when switch is set to FM, meter indicates frequency deviation.

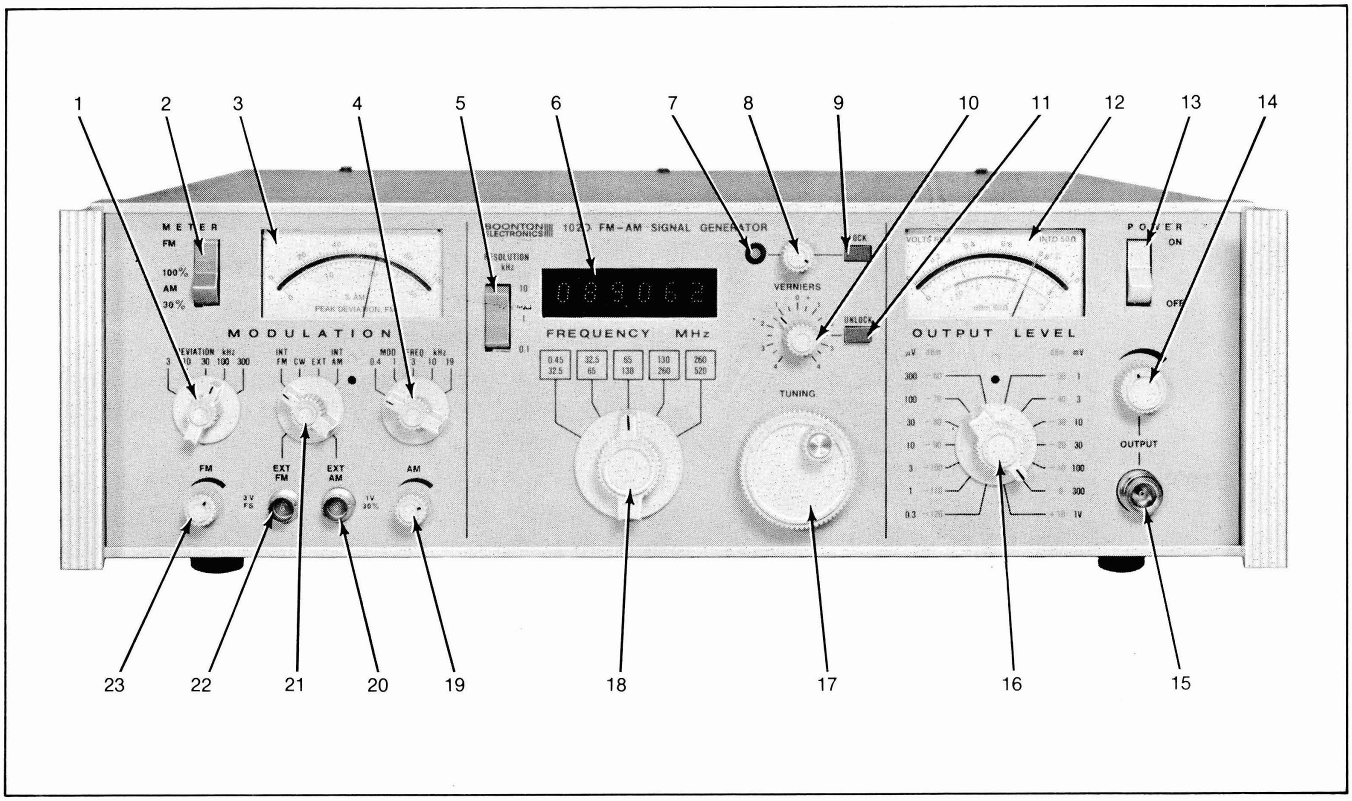


Figure 2-2 Model 102D, Front View

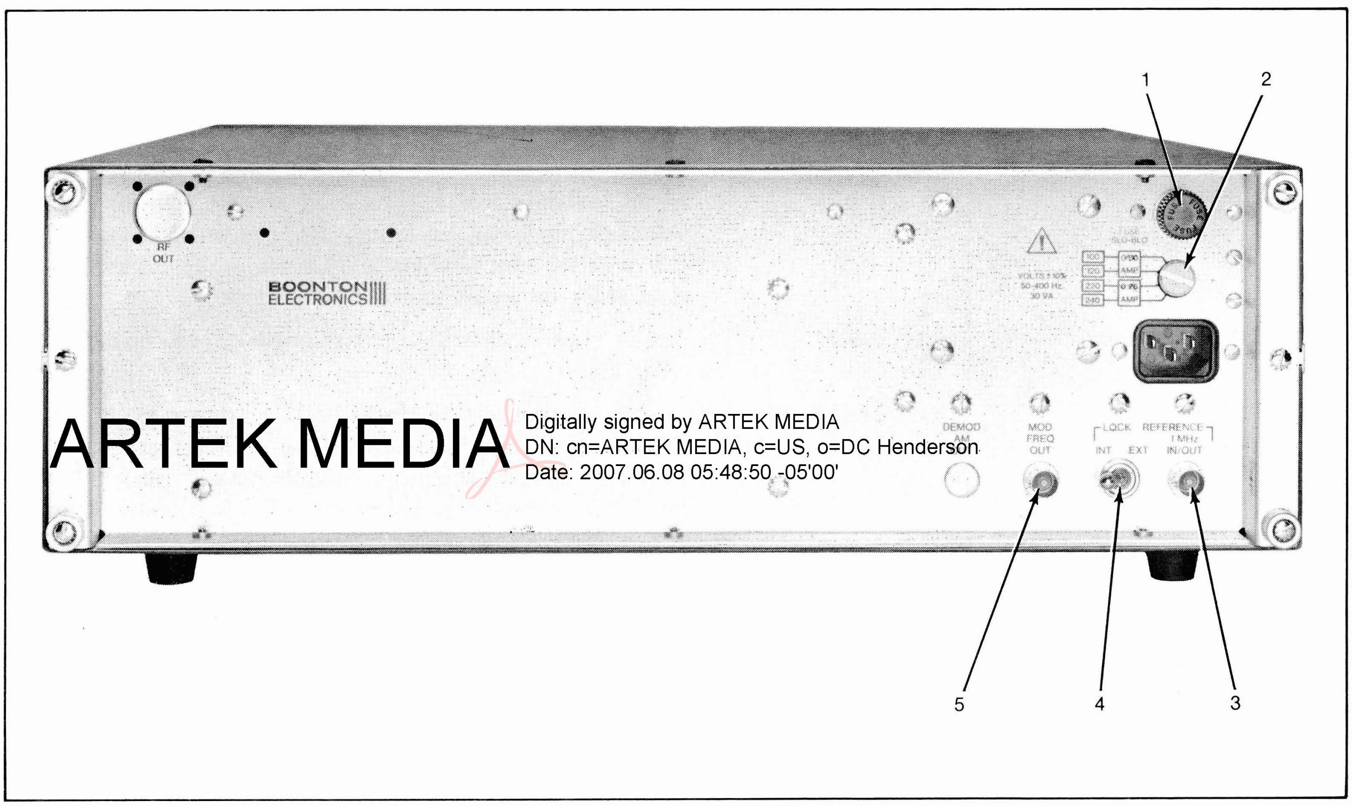


Figure 2-3 Model 102D, Rear View

TABLE 2-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS (Cont.)

Control, Indicator or Connector	Figure and Index No.	Function
MODULATION meter	2-2, 3	Measures either percentage of AM, or frequency deviation, as determined by setting of METER switch. Percentage of AM is indicated on lower scale for 30% AM switch position, and on upper scale for 100% switch position. Frequency deviation is indicated on lower scale for DEVIATION kHz switch settings of 3, 30 and 300 kHz, and on upper scale for switch settings of 10 and 100 kHz.
MOD FREQ kHz switch	2-2, 4	Permits operator to select any one of five internal modulating frequencies (0.4 kHz, 1 kHz, 3 kHz, 10 kHz, or 19 kHz) for either AM or FM.
RESOLUTION kHz switch	2-2, 5	Permits operator to select resolution of output frequency indicator display for precise measurement of output frequency. In 10 position, output frequency indicator display includes 2 decimal places; in 1 position, 3 decimal places; and in 0.1 position, 4 decimal places.
Output frequency indicator	2-2, 6	Indicates output frequency of Model 102D by means of 6 digit LED display. Resolution is determined by setting of RESOLUTION kHz switch.
Phase lock indicator	2-2, 7	When lighted steadily, indicates that phase lock has been achieved and is being maintained. When blinking, indicates loss of phase lock. (Operates only when LOCK switch has been actuated.)
Phase lock VERNIERS control	2-2, 8	Permits operator to adjust output frequency of Model 102D over limited range (approximately 20 ppm) in phase-locked mode of operation using internal reference signal.
LOCK pushbutton	2-2, 9	Permits operator to select phase-locked mode of operation.
VERNIERS control	2-2, 10	Permits operator to fine tune output frequency over range of approximate ±0.01 percent of output frequency in unlocked mode of operation. On bands 2 through 5, clockwise rotation increases output frequency; on band 1, clockwise rotation decreases output frequency.
UNLOCK pushbutton	2-2, 11	Permits operator to terminate phase-locked mode of operation.
OUTPUT LEVEL meter	2-2, 12	Indicates output level of Model 102D in either volts of dBm into 50 ohms. Top scale is used for 10-series settings of OUTPUT LEVEL attenuator, middle scale is used for 3-series settings, and bottom scale for dBm indications. dBm output level is sum of meter reading and dBm setting of OUTPUT LEVEL attenuator. Red area on output meter indicates limits for AM.
POWER switch	2-2, 13	Permits operator to control application of input ac power.
OUTPUT control	2-2, 14	Permits operator to adjust output level to values between those obtainable using OUTPUT LEVEL attenuator, or to calibrate output level to values corresponding to OUTPUT LEVEL attenuator setting.

TABLE 2-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS (Cont.)

Control, Indicator or Connector	Figure and Index No.	Function
OUTPUT connector	2-2, 15	Provides means for connecting output signal of Model 102D to load. Output impedance is 50 ohms.
OUTPUT LEVEL attenuator	2-2, 16	Permits operator to adjust output level in 10 dB steps.
TUNING control	2-2, 17	Permits operator to select output frequency within band selected by means of FREQUENCY MHz switch. On bands 2 through 5, output frequency increases with clockwise rotation of TUNING control; on band 1, frequency decreases with clockwise rotation.
FREQUENCY MHz switch	2-2, 18	Permits operator to select desired output frequency band.
AM control	2-2, 19	Permits operator to adjust percentage of AM.
EXT AM connector	2-2, 20	Provides means for connecting external modulating signal source for external AM funcions of Model 102D.
MODULATION function switch	2-2, 21	Permits operator to select modulation mode as detailed below: INT FM – FM, using internal modulation oscillator, is selected. External AM can be used simultaneously. CW – Unmodulated output signal is selected. EXT – AM and FM, using external modulation signals, can be used, either singly or simultaneously. INT AM – AM, using internal modulation oscillator, is selected. External FM can be used simultaneously.
EXT FM connector	2-2, 22	Provides means for connecting external modulation signal source for external FM functions of Model 102D.
FM control	2-2, 23	Permits operator to adjust deviation to peak deviation level determined by setting of DEVIATION kHz switch when FM mode is selected.
Power fuse	2-3, 1	Protects Model 102D against overloads.
Line voltage switch	2-3, 2	Connects power input circuits of Model 102D for operation from 100, 120, 220, or 240 volt ac power source.
1 MHz IN/OUT connector	2-3. 3	Provides means for connecting external reference signal for phase-locked mode of operation when INT/EXT switch is set to EXT; when switch is set to INT, internal 1 MHz phase lock reference signal of Model 102D is available at this connector for synchronization of two or more signal generators.
INT/EXT switch	2-3, 4	Permits operator to select either internal or external reference signal for control of phase lock loop.
MOD FREQ OUT connector	2-3, 5	Provides isolated output signal from internal modulation oscillator at output impedance of 600 ohms and nominal signal level of 1 volt rms. **NOTE** When INT reference is used this connector is a source. Any external reference signal must be removed from this connector.

2-10. POWER APPLICATION.

2-11. The Model 102D is designed for operation from a 100, 120, 220, or 240 volt, 50 to 400 Hz, ac power source. To apply power, proceed as follows:

a. Determine the line voltage at the ac power output receptacle and set the rear panel line voltage switch to the corresponding position.

b. Check the value of the fuse in the rear panel fuseholder. For 100 or 120 volt operation, the fuse should be a 0.5-ampere, MDL Slo-Blo type; for 220 or 240 volt operation, a 0.25-ampere, MDL Slo-Blo type. If the rating of the fuse is incorrect for the available line voltage, install a fuse of the proper rating in the fuseholder.

WARNING

The Model 102D is designed to operate from a 3-terminal (one ground) ac power receptacle. To eliminate a potential shock hazard to operating personnel, use a 3-prong to 2-prong adapter if only a 2-terminal ac power receptacle is available. Connect the ground wire of the adapter to the power receptacle ground.

c. Connect the power cord of the Model 102D (with adapter, if required) to the ac power receptacle and the power connector on the rear panel of the Model 102D.

2-12. PRELIMINARY CHECK.

2-13. Before using the Model 102D, perform a preliminary check as follows:

NOTE

The following checkout procedure is intended merely to ensure that all circuits are operating. If a detailed performance check against major performance specifications is desired, refer to paragraph 2-35.

a. Set the POWER switch to ON.

b. Rotate the OUTPUT control while observing the OUTPUT LEVEL meter. The OUTPUT LEVEL meter indication should be adjustable from full scale down to near zero by means of the OUTPUT control.

c. Set the FREQUENCY MHz switch to 32.5 – 65, and the TUNING control to any arbitrary setting. Ascertain that the output frequency indicator provides a readout that falls within the selected frequency band. Rotate the VERNIERS control and ascertain that the last digit of the output frequency indicator display changes.

d. Set the RESOLUTION kHz switch successively to each of its three positions. With the switch set to 10, the output frequency indicator display should include two digits to the right of the decimal point; with the switch set to 1, three digits; and with the switch set to 0.1, four digits.

e. Set the MODULATION function switch to INT FM, the MOD FREQ kHz switch to 1, and the METER switch to FM. Rotate the FM control and ascertain that peak deviation, as indicated on the MODULATION meter, is adjustable to the peak value indicated by the DEVIATION kHz switch.

f. Set the MODULATION function switch to INT AM and the METER switch to 100% AM. Rotate the AM control and ascertain that the modulation level, as indicated on the MODULATION meter, is adjustable to at least 100 percent.

g. Adjust the OUTPUT control to obtain a 0 dBm indication on the OUTPUT LEVEL meter. Using the TUNING control, tune the Model 102D over one entire band, and ascertain that the indication of the OUTPUT LEVEL meter remains essentially constant over the entire band.

h. Set the FREQUENCY MHz switch successively to each of the four remaining positions and ascertain that, at each switch position, the readout of the output frequency indicator falls within the selected band.

i. Set rear panel INT/EXT switch to INT. Remove any external reference signal from INT/EXT connector.

j. Set the front panel FREQUENCY MHz switch to 65-130 and the RESOLUTION kHz switch to 0.1. Using the TUNING control, adjust the output frequency to 100 MHz, as indicated on the output frequency indicator.

k. Press the LOCK pushbutton and ascertain that the phase lock indicator lights continuously, and that the frequency indication of the output frequency indicator remains constant within 1 count.

l. Rotate the phase lock VERNIERS control, and ascertain that the output frequency can be shifted by 2 kHz (20 ppm).

m. Rotate the TUNING control and ascertain that the phase lock indicator blinks when phase lock is lost.

n. Using an oscilloscope or frequency counter, ascertain that a 1 MHz (nominal) signal is available at the rear panel 1MHz IN/OUT connector.

o. Set the rear panel INT/EXT switch to EXT. Connect a 1 MHz signal with an amplitude of 0.2 to 5 volts rms to the 1MHz IN/OUT connector. Check operation of the phase lock loop by repeating preceding steps j, k, and m.

2-14. OPERATING PROCEDURE.

2-15. **General.** Because of the flexibility of the Model 102D, a number of different operating modes is possible. Regardless of the operating mode selected, however, operation can be divided into four distinct basic steps: output frequency selection, modulation mode selection, adjustment of modulation levels, and adjustment of output level. In addition to these four basic steps, the output frequency may be phase locked to either an internal or external reference signal. Procedures for these operations are given in paragraphs 2-16 through 2-20.

2-16. **Output Frequency Selection.** To energize the Model 102D and select a particular output frequency, proceed as follows:

a. Set the POWER switch to ON.

b. Set the RESOLUTION kHz switch to 10, and the VERNIER control to 0.

c. Set the FREQUENCY MHz switch to the position that covers the desired output frequency, and adjust the TUNING control until the output frequency indicator displays the desired output frequency. Use the VERNIERS control for fine adjustments of the output frequency.

NOTE

On the four uppermost frequency bands, clockwise rotation of the TUNING and VERNIERS controls results in an increase in output frequency; on band 1, clockwise rotation of the two controls results in a decrease in the output frequency.

d. If greater resolution of the output frequency indicator display is required, set the RESOLUTION kHz switch to 1 or 0.1, as applicable, and adjust the output frequency precisely to the desired value using the VERNIERS control.

NOTE

Operation of the RESOLUTION kHz switch from 1 to 0.1 effectively shifts the display on the output frequency indicator one digit to the left, adding one additional decimal digit. If the selected output frequency is 100 MHz or higher, the most significant digit will be shifted out of the display when the resolution is increased from 1 to 0.1 kHz.

2-17. **Phase-Locked Operation.** In applications where extreme stability is required, the output frequency of the Model 102D can be phase locked to either an internal reference signal or to an external reference signal.

a. To operate the Model 102D in the internal phase-locked mode, proceed as follows:

1. Set the rear panel INT/EXT switch to INT, press the front panel UNLOCK pushbutton, and adjust the phase lock VERNIERS control to its fully counterclockwise setting. Remove any external reference signal from the INT/EXT connector.

2. Tune the Model 102D to the desired output frequency, using the procedures of paragraph 2-16.

3. Press the LOCK pushbutton. The phase lock indicator will light continuously to indicate phase lock.

4. If necessary, readjust the output frequency of the Model 102D to the desired value using the phase lock VERNIERS control.

NOTE

The output frequency can be adjusted only over a limited range (approximately 20 ppm) by means of the phase lock VERNIERS control.

5. During operation, monitor the phase lock indicator. Blinking of the phase lock indicator indicates loss of lock. To relock, press the UNLOCK pushbutton, retune the Model 102D to the desired output frequency, and relock in accordance with preceding steps 3 and 4. If loss of lock occurs with wide deviation FM, remove the modulation, press the UNLOCK pushbutton, repeat preceding steps 2 through 4, and reapply the modulation.

b. To operate the Model 102D in the external phase-locked mode, proceed as follows:

1. Set the rear panel INT/EXT switch to EXT.

2. Connect the external 1 MHz standard to the rear panel 1 MHz IN/OUT connector. Set the level of the external reference signal to between 0.2 and 5 volts rms. (Two or more Models 102D can be phase locked to the same reference signal.)

NOTE

The phase lock VERNIERS control is ineffective in the external phase-locked mode of operation.

3. Press the UNLOCK pushbutton and tune the Model 102D to the desired output frequency, using the procedures of paragraph 2-16.

4. Press the LOCK pushbutton. The phase lock indicator will light continuously to indicate phase lock.

5. During operation monitor the phase lock indicator to make certain that it remains lighted. If the external reference signal should be lost, the phase lock indicator will extinguish and the Model 102D will be operating in the unlocked mode. To restore phase lock, restore the external reference signal and repeat preceding steps 3 and 4.

2-18. **Modulation Mode Selection.** After adjusting the output frequency, select the modulation mode, using the MODULATION function switch. The various possible modulation modes, together with the appropriate switch positions, are as follows:

Modulation Mode	MODULATION Function Switch Position
CW	CW
External AM	EXT
External FM	EXT
External AM, external FM	EXT
Internal AM	INT AM
Internal AM, external FM	INT AM
Internal FM	INT FM
Internal FM, external AM	INT FM

2-19. **Adjustment of Modulation Levels.** After selecting the modulation mode, adjust the modulation levels in accordance with the following procedures, as applicable:

a. **AM.** Adjust the percentage of AM as follows:

NOTE

Red area on output level meter indicates limits for AM.

1. If the internal AM mode has been selected, select the desired modulation frequency using the MOD FREQ kHz switch.

2. If the external AM mode has been selected, ascertain that the external signal source is connected to the EXT AM connector, that the frequency (20 kHz maximum) of the external signal source has been adjusted to the desired value, and that the external AM signal level has been adjusted to a value adequate for the desired modulation level (1 volt rms for 30% AM).

3. Set the METER switch to 100% AM.

4. Using the AM control, adjust the percentage of modulation, as indicated on the MODULATION meter, to the desired level. For low modulation levels, set the meter switch to 30% when the indication on the upper scale of the meter drops below 30%.

NOTE

When the METER switch is set to 100% AM, read the upper scale of the MODULATION meter; when the switch is set to 30% AM, read the lower scale.

b. **FM.** Adjust FM deviation as follows:

1. If the internal FM mode has been selected, select the desired modulation frequency using the MOD FREQ kHz switch.

2. If the external FM mode has been selected, ascertain that the external signal source is connected to the EXT FM connector, that the frequency (200 kHz maximum) of the external signal source has been adjusted to the desired value, and that the external FM signal level has been adjusted to a value adequate for the desired deviation (1 volt rms for fs).

3. Select the peak deviation limit, using the DEVIATION kHz switch.

4. Set the METER switch to FM.

5. Using the FM control, adjust the deviation, as indicated on the MODULATION meter, to the desired level.

NOTE

Read the upper scale of the MODULATION meter when the DEVIATION kHz switch is set to 10 or 100; read the lower scale for DEVIATION kHz switch settings of 3, 30, and 300.

2-20. **Adjustment of Output Level.** Adjust the output level of the Model 102D as follows:

a. The output level, in dBm, is the algebraic sum of the dBm value selected by means of the OUTPUT LEVEL attenuator and the dBm indication on the lowest scale of the OUTPUT LEVEL meter. To obtain a calibrated dBm level corresponding exactly to one of the OUTPUT LEVEL attenuator step values, set the OUTPUT LEVEL attenuator to the desired position, and set the pointer of the OUTPUT LEVEL meter to 0 dBm, using the OUTPUT control. To obtain a dBm output level between the step values of the OUTPUT LEVEL attenuator, set the OUTPUT LEVEL attenuator to the dBm setting nearest the desired output level, and adjust the OUTPUT control, as required, until the difference between the desired dBm value and the OUTPUT LEVEL attenuator setting is indicated on the lowest scale of the OUTPUT meter. For example: to obtain an output level of -32 dBm, set the OUTPUT LEVEL attenuator to -30 dBm, and adjust the OUTPUT control to obtain a -2 dB indication on the OUTPUT LEVEL meter.

NOTE

All output dBm levels are calibrated for a 50-ohm load impedance. The dBm indications are invalid for other load impedances. Refer to paragraph 2-23 if the Model 102D is to be used with load impedances other than 50 ohms.

b. Output voltage levels are indicated directly on the upper scale (for 10-series OUTPUT LEVEL attenuator settings) or the middle scale (for 3-series settings) of the OUTPUT LEVEL meter, using multipliers appropriate for the selected OUTPUT LEVEL attenuator setting. For calibrated output voltage levels corresponding to the OUTPUT LEVEL attenuator step values, set the OUTPUT LEVEL attenuator to the desired position, and adjust the OUTPUT LEVEL meter pointer to 1.0 on the upper scale (10-series attenuator settings) or to 3.0 on the middle scale (3-series attenuator settings), using the OUTPUT control. For output voltage levels between the step values of the OUTPUT LEVEL attenuator, set the attenuator to the output voltage position immediately above the desired output voltage level, and adjust the OUTPUT control as required to obtain the desired output voltage level indication on the appropriate scale of the OUTPUT LEVEL meter. For example: to obtain an output level of 5 mV, set the OUTPUT LEVEL attenuator to 10 mV, and adjust the OUTPUT control to obtain an indication of 0.5 on the top scale of the OUTPUT LEVEL meter.

NOTE

Output voltage indications are not affected by load impedances, but are only correct for 50 ohm loading.

2-21. APPLICATION NOTES.

2-22. **General.** Paragraphs 2-23 through 2-34 present typical application data for the Model 102D. The Model 102D is an extremely versatile instrument with many possible test applications, including circuit characterization, transmitter simulation, local oscillator substitution, and receiver measurements. Use of the Model 102D is, therefore, in no way restricted to the applications covered in the following paragraphs: the data is included merely to cover a few typical or specialized applications.

2-23. **Impedance Matching.** The output circuits of the Model 102D are designed for operation into unbalanced, 50 ohm loads; therefore, the Model 102D can be used to drive most loads directly. The output circuit design, however, does not preclude use with balanced loads, or with loads having impedances other than 50 ohms. When a matching network is employed, an appropriate correction factor must be applied to the readings of the output voltage monitor.

NOTE

The output monitor of the Model 102D will correctly indicate the level at the output terminals of the generator when an impedance matching network is used. The actual signal level at the load, however, may be greater or smaller, according to the nature of the network. Proper correction factors can be calculated provided the circuit parameters are accurately known. In the event the characteristics of the network are unknown, measurements should be made with a sensitive r-f millivoltmeter, such as the Boonton Electronics Model 92B, between input and output under loaded conditions.

2-24. Consider the case where an output load impedance higher than 50 ohms is required. A network similar to that shown in Figure 2-4 can be employed.

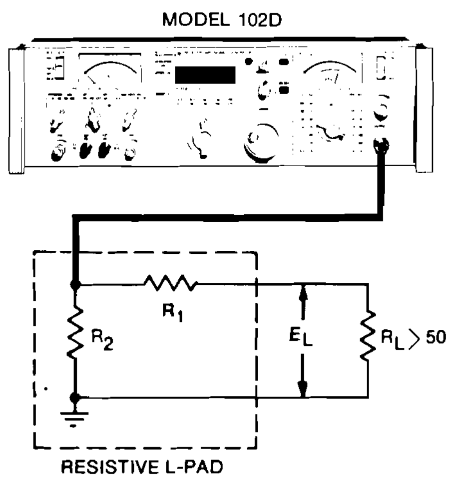
2-25. For example, if the output load (and source impedance) desired is 75 ohms; R_1 = 43.3 ohms, R_2 = 86.6 ohms and a correction factor of 0.634 or 3.96 dB must be applied to the reading indicated on the Model 102D output voltage indicator. A different correction factor must be applied to determine power delivered to the load because the impedance has been changed.

$$\text{Power loss (in dB)} = 20 \log_{10} (R_1 + R_L)/R_L + 10 \log_{10} R_L/50$$

or the delivered power can simply be calculated from:

$$P = \frac{E_L^2}{R_L}$$

In this example, power loss in dB = 3.96 dB + 1.76 dB = 5.72 dB. If the Model 102D output monitor indicates the output level is -10 dBm, the power in the load is -10 dBm -5.72 dBm = -15.72 dBm.



ELEMENT VALUES

$$R_1 = R_L\left[1 - \frac{50}{R_L}\right]^{1/2}$$

$$R_2 = \frac{50}{\left[1 - \frac{50}{R_L}\right]^{1/2}}$$

$$\text{OUTPUT VOLTAGE CORRECTION } E_L = \frac{R_L}{R_1 + R_L} \times E_{\text{indicated}}$$

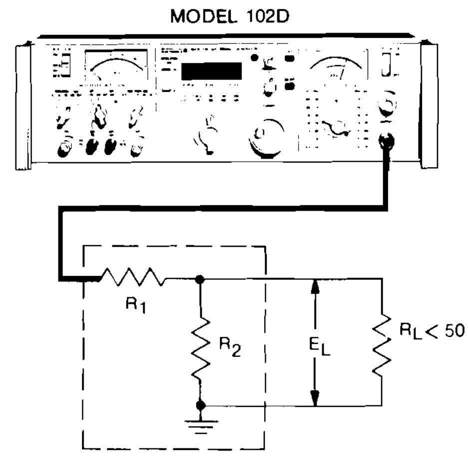
$$\text{VOLTAGE LOSS IN dB} = 20 \log \frac{R_1 + R_L}{R_L}$$

Figure 2-4 Impedance Matching Network for Output Load Impedance Higher Than 50 Ohms

2-26. In cases where a source impedance of less than 50 ohms is required to drive a low impedance load, a minimum loss matching pad of the configuration shown in Figure 2-5 is recommended. The formulas for calculating the values of the matching pad are included as part of Figure 2-5.

2-27. Several standard tests for measuring receiver sensitivity (as defined by EIA Std RS-204-Minimum Standards for Land-Mobile Communication FM or PM Receivers) define the source voltage as that developed at the generator output under open circuit conditions where the generators source impedance is 50 ohms. In Figure 2-6, this will be the voltage measured across terminals A and B when the load is disconnected.

2-28. The Model 102D, however, is calibrated to read the voltage appearing at terminals A and B with a matched 50 ohm load connected. To facilitate this measurement, a matched 6 dB pad of the form shown in Figure 2-7 should be used. With this network connected between the Model 102D and the receiver, the Model 102D output monitor correctly indicates the open circuit voltage supplied to a 50 ohm *unbalanced* receiver input.



ELEMENT VALUES

$$R_1 = 50\left[1 - \frac{R_L}{50}\right]^{1/2}$$

$$R_2 = \frac{R_L}{\left[1 - \frac{R_L}{50}\right]^{1/2}}$$

OUTPUT VOLTAGE CORRECTION:

$$R_{EQ} = \frac{R_2 R_L}{R_2 + R_L}$$

$$E_L = \frac{R_{EQ}}{R_1 + R_{EQ}} \times E_{\text{indicated}}$$

$$\text{VOLTAGE LOSS IN dB} = 20 \log \frac{R_1 + R_{EQ}}{R_{EQ}}$$

$$\text{POWER LOSS IN dB} = 20 \log_{10} \frac{R_1 + R_{EQ}}{R_{EQ}} - 10 \log_{10} \frac{50}{R_L}$$

Figure 2-5 Impedance Matching Newwork for Output Load Impedance Lower Than 50 Ohms

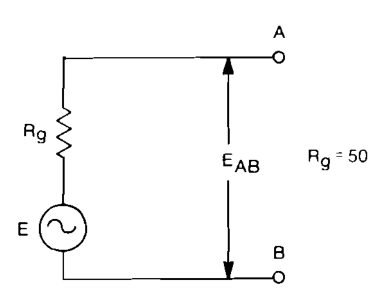


Figure 2-6 Generator Open Circuit Source Voltage

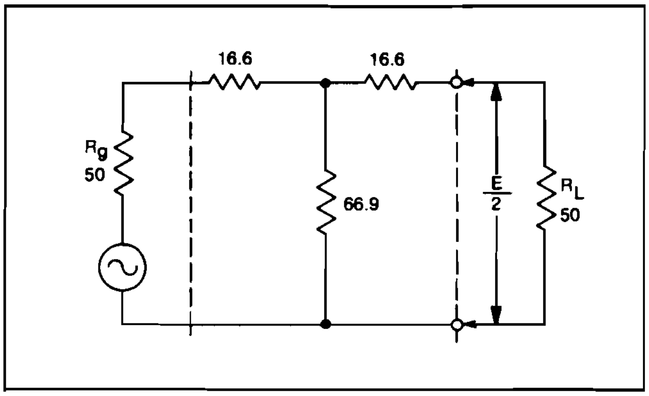


Figure 2-7 Matched 6 dB Pad

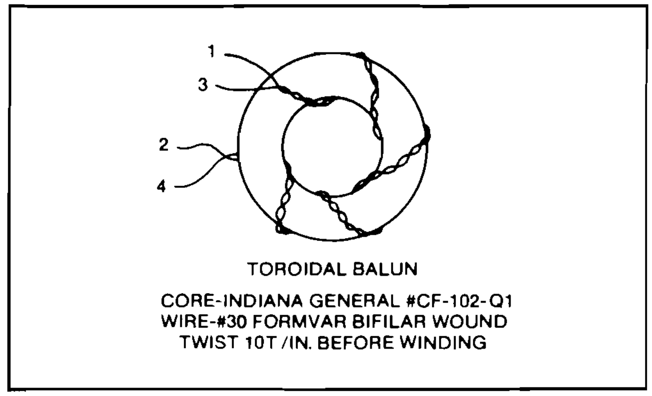


Figure 2-8 Toroidal Balun Construction Details

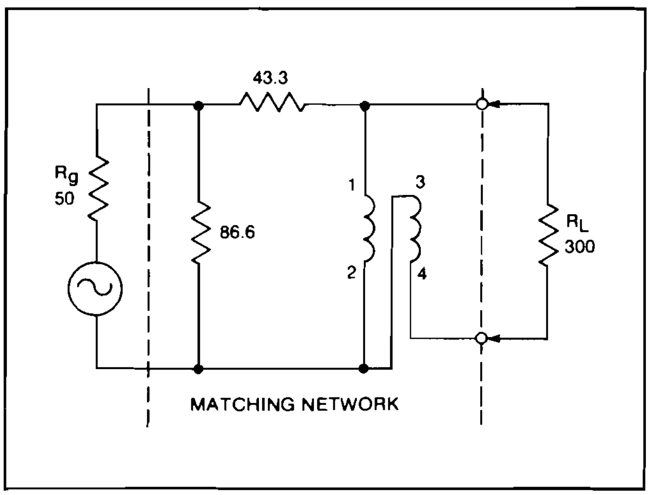


Figure 2-9 300 Ohm Balanced Matching Network

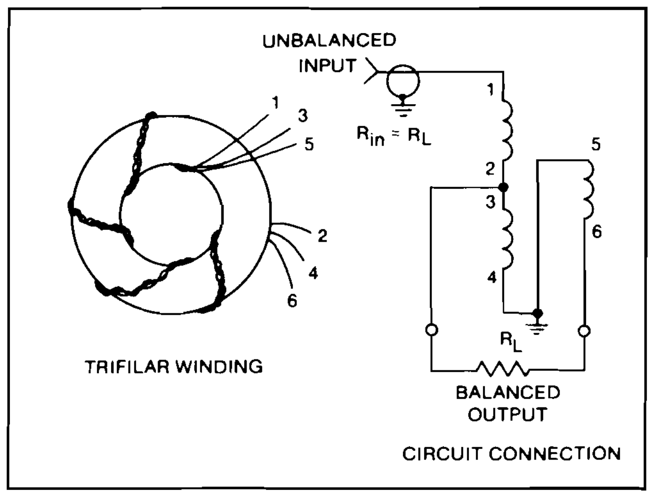


Figure 2-10 Wideband Response 1:1 Toroidal Balun

2-29. For connection to receivers with *balanced* input terminals, a balun should be used to provide a balanced output voltage from the Model 102D. For example, assume it is desired to match the Model 102D to a 300 ohm balanced receiver input. First the 50 ohm source impedance of the generator can be converted to a 75 ohm source in a manner described in paragraph 2-25. Next, the 75 ohm unbalanced load output can be connected to a 300 ohm balanced output by use of a 4:1 balun transformer as shown in Figure 2-8. The entire network can then be represented by Figure 2-9. A correction factor for the output voltage must be applied. The 75 ohm section drops the output voltage approximately 4 dB below that indicated by the Model 102D output monitor. The balun, conversely, increases the voltage by 6 dB, assuming it to be lossless. The overall result is a load voltage 2 dB higher than that indicated on the output meter.

2-30. Alternate configurations for balun construction are shown by Figures 2-10 and 2-11. The configuration shown by Figure 2-10 will exhibit a relatively wideband response, while the one shown in Figure 2-11 will have a fairly narrowband range due to the use of a resonant line section.

2-31. **IF Response.** The wide bandwidth required of many i-f amplifiers is often attained through use of stagger-tuned, or overcoupled, double-tuned circuits. Alignment of such circuits, or checking of their response characteristics is facilitated through use of the Model 102D as a sweep generator. A typical test arrangement is shown in Figure 2-12. For such applications, the external FM mode is generally used. Modulation frequencies from 20 Hz to 100 Hz are recommended. The Model 102C output frequency is adjusted to the center of the i-f pass band, and the deviation is adjusted to the point where the entire response curve of the i-f amplifier is displayed on the oscilloscope. The DEVIATION kHz switch is set at 300 and the METER switch to AM to prevent off-scale reading. Since the horizontal deflection circuits of the oscilloscope are driven by the modulating signal voltage from the Model 102D, a linear division of frequencies along the horizontal axis of the oscilloscope display is produced. The response curve may be marked in

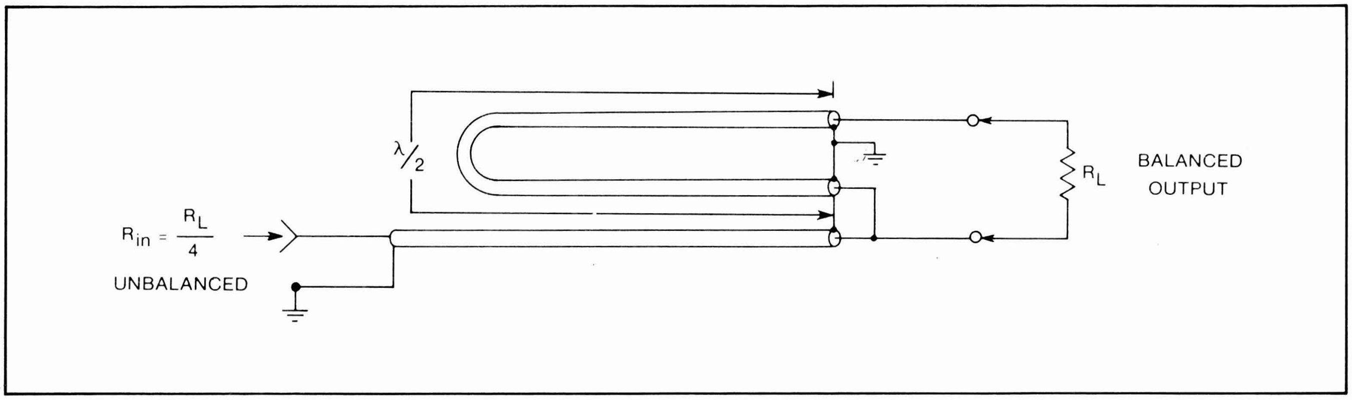


Figure 2-11 Narrowband Response 4:1 Coaxial Balun

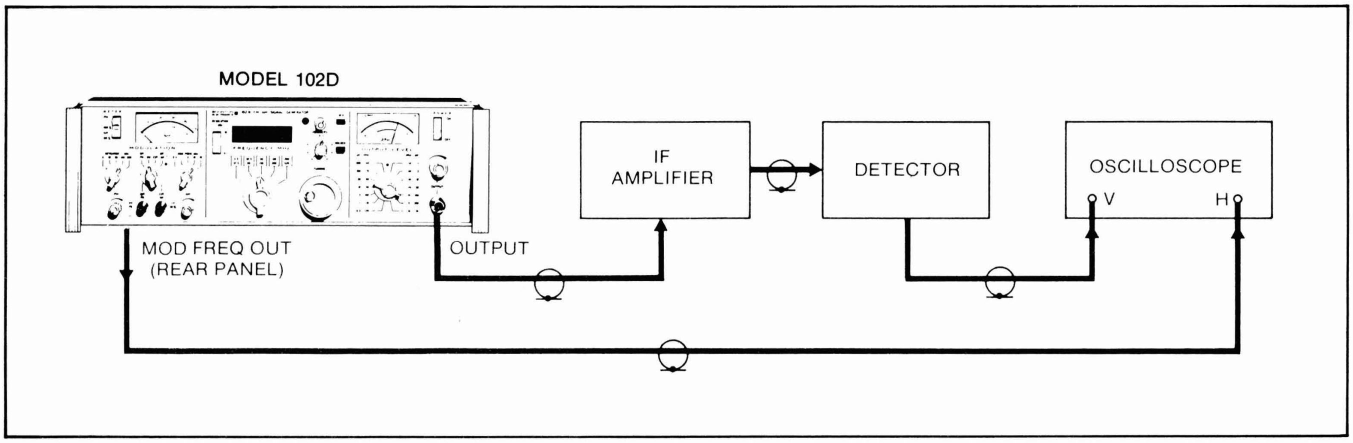


Figure 2-12 IF Response Measurement, Typical Equipment Connection

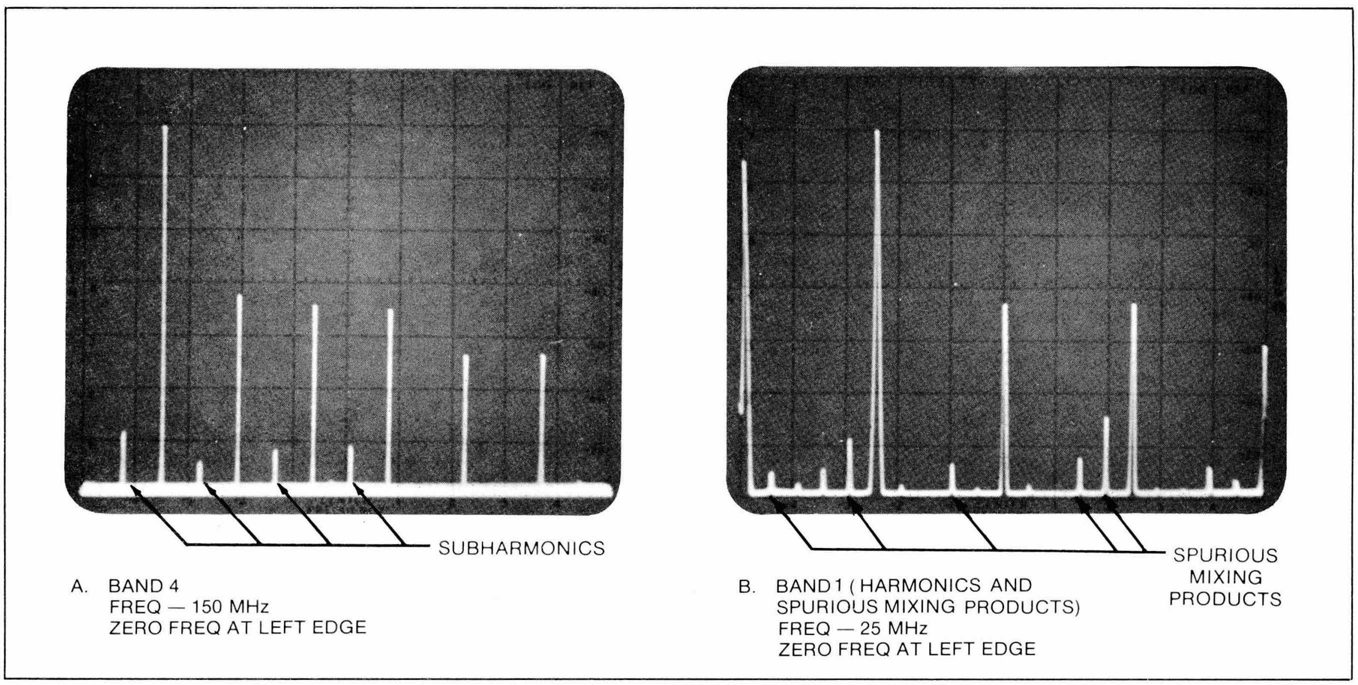


Figure 2-13 Typical Spectrum Display, Showing Harmonics

terms of frequency in order to measure the bandwidth and indicate important frequency points. This can be accomplished by loosely coupling the output of a marker generator to the signal input of the i-f amplifier. Small pips will appear on the oscilloscope screen at the marker generator frequency to indicate the frequency at a particular point on the response curve.

2-32. **Avoidance and Identification of Harmonics.** Careful consideration to the suppression of harmonics has been given in the design of the Model 102D. The extent to which harmonics and other spurious signals are suppressed is typified in Figure 2-13. Harmonics should not normally present a problem in the use of the Model 102D. The direct-reading output frequency indicator provides assurance that equipment being tested will not be tuned inadvertently to a harmonic. A quick visual check to ascertain that the frequency setting of the equipment being tested corresponds to the output frequency indication on the Model 102D is all that is normally required.

2-33. **Visual Frequency Response Checks.** Automatically leveled output, and its direct-reading output frequency display, are two features of the Model 102D which make it extremely useful for quick visual checks of the frequency response characteristics of filters, amplifiers, and similar equipment. Figure 2-14 shows a typical equipment arrangement for such an application. Because the output of the Model 102D is automatically leveled, tuning the instrument changes only one test parameter, the output frequency. To perform a quick visual check of response characteristics, the Model 102D is tuned slowly over the frequency range of interest, while the signal level at the output of the device under test is monitored. At points where the signal level deviates from normal, or at points where the signal level reaches predetermined limits, the corresponding frequency can be read directly on the output frequency indicator of the Model 102D.

2-34. **EIA Sensitivity Measurement.** The Model 102D qualifies in every respect as a standard input signal source for EIA receiver sensitivity measurements. A typical equipment arrangement for such an application is shown in Figure 2-15. Measurement of the minimum usable sensitivity of land-mobile FM communications receivers involves the following steps:

NOTE

EIA Receiver sensitivity measurements should be performed at standard temperature (+20 to +35°C) and standard relative humidity (0 to 90% at +20 to +30°C, 0 to 70% at +30 to +35°C).

a. The equipment is connected as shown in Figure 2-15.

b. The receiver squelch control, if any, is unsquelched to the maximum possible extent.

c. The Model 102D is tuned to the receiver frequency, the modulation controls are adjusted to provide standard test modulation, and the output level is adjusted to 1000 microvolts. Standard test modulation is defined as ±2/3 of the maximum applicable rated system deviation listed below, at 1 kHz.

Frequency Range	Channel Spacing	Maximum Rated System Deviation
25 to 54 MHz	40 kHz	±15 kHz
25 to 54 MHz	20 kHz	±5 kHz
144 to 174 MHz	60 kHz	±15 kHz
144 to 174 MHz	30 kHz	±5 kHz
400 to 470 MHz	100 kHz	±15 kHz
400 to 470 MHz	50 kHz	±10 kHz

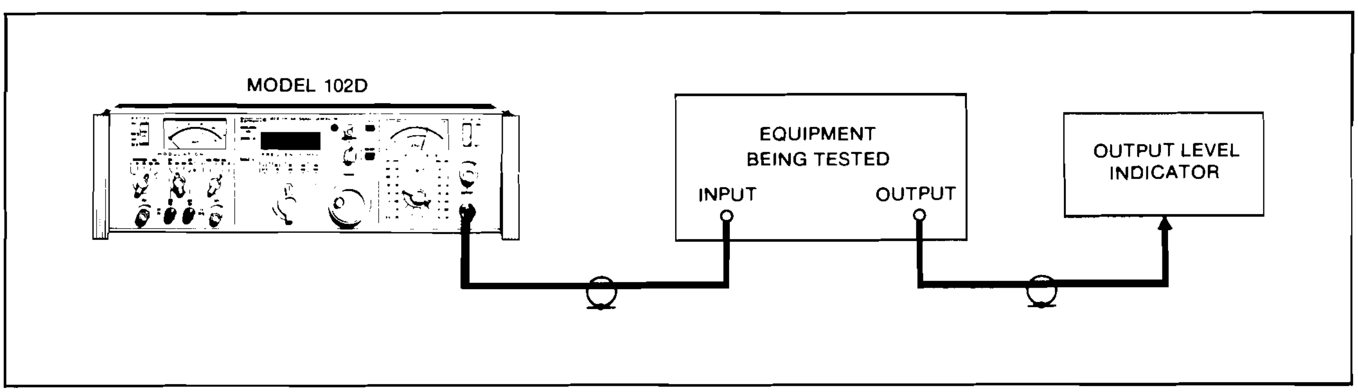


Figure 2-14 Frequency Response Checks, Typical Equipment Connection

d. The receiver volume control is adjusted to provide rated output.

e. The output level of the Model 102D is adjusted until the ratio of signal plus noise plus distortion to noise plus distortion is 12 dB. At this signal level, the audio output of the receiver should be at least 50% of rated audio output without readjustment of the receiver volume control. If the audio output is less than 50% of the rated audio output, increase the output level of the Model 102D until 50% of rated audio output is obtained, and this value of RF signal input is used to specify sensitivity. Minimum usable sensitivity should be as follows:

Band	Microvolts (Open Circuit)
25 to 54 MHz	1.0
144 to 174 MHz	1.5
400 to 470 MHz	2.5

NOTE

Open circuit generator voltage is twice that which is indicated by the 102D output monitor and attenuator. The Model 102D will indicate the open circuit voltage, as defined in the EIA test procedure, if a 6 dB matching pad is inserted between the output of the Model 102D and the 50 ohm input impedance of the receiver.

2-35. MINIMUM PERFORMANCE CHECKS.

2-36. Test Equipment Required. Table 2-2 lists all test equipment required to perform minimum performance checks of the Model 102D.

TABLE 2-2. TEST EQUIPMENT LIST

Amplifier	Hewlett-Packard 465A
Band Pass Filter	f_0=10 kHz (see Figure 2-26 for circuit description)
Crystal-Controlled Sources	100 MHz
Directional Coupler	Anzac DCG 20-4
Distortion Analyzer	Hewlett-Packard 331A
Double Balanced Mixer	Hewlett-Packard 10514A
FM-AM Signal Generator	Boonton Electronics 102D
Frequency Counter	Systron Donner 6052 (8 digit, option 11 time base), recently calibrated
Frequency Meter	Hewlett-Packard 5210A
Low Pass Filter	Itel (15 kHz)
Microwattmeter	Boonton Electronics 42B
Oscillator	Hewlett-Packard 200CD
Oscilloscope	Tektronix 5103N (5A20N Vertical Amplifier, 5B10N Time Base)
Power Divider	Microlab DA-3FB
Precision Attenuator	AIL32
Precision Voltage Calibrator	Ballantine 421A

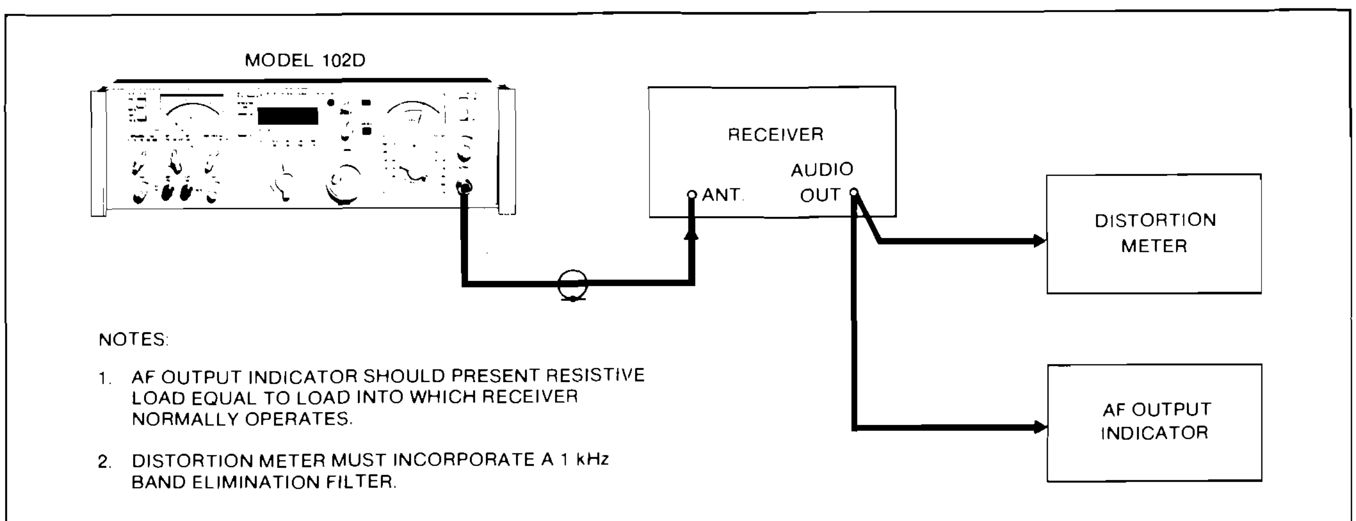


Figure 2-15 EAI Sensitivity Check, Typical Equipment Connection

TABLE 2-2. TEST EQUIPMENT LIST (Cont.)

Probe	Tektronix P6060
RF Amplifier	Avantek UTO-502
RF Pickup Loop	See Figure 2-24 for circuit description
Spectrum Analyzer	Hewlett-Packard 141T/8552B/8556A
Spectrum Analyzer	Hewlett-Packard 141T/8552/8554
Step Attenuator	Hewlett-Packard 355D
Strip Chart Recorder	Rustrak Model A
Voltmeter	Boonton Electronics 93A
10 dB Attenuator	Microlab AB-10B
50-Ohm Termination	Boonton Electronics 91-15A

2-37. **Frequency Accuracy Check.** To check the accuracy of the Model 102D output frequency indicators, proceed as follows:

a. Connect the Model 102D and test equipment as shown in Figure 2-16.

b. Set the controls of the Model 102D as follows:

Control	Position
FREQUENCY MHz switch	Band 3 (65-130)
RESOLUTION kHz switch	0.1
MODULATION function switch	CW
TUNING control	100 MHz indication on output frequency indicator
OUTPUT LEVEL attenuator	0 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter
INT/EXT switch	INT
LOCK pushbutton	Pressed

c. Set the frequency counter controls for a range of 20 Hz to 200 MHz, resolution of 1 Hz, and X1 attenuation.

d. With the Model 102D warmed up fully at an ambient temperature of 25 ±1°C and a line voltage of 120 ±1 volt (or 240 ±2 volts), adjust the phase lock VERNIERS control as required to obtain an indication of 100 MHz ±10 Hz on the frequency counter.

NOTE

Make certain that phase lock is maintained.

e. Check the indication on the output frequency indicator of the Model 102D. The indication should be (1)00.0000. Occasional jumping to 99.9999 or (1)00.0001 is normal, since the frequency counter circuits of the Model 102D have an inherent uncertainty of ±1 count.

2-38. **Frequency Range Check.** To check the tuning range of the Model 102D, proceed as follows:

a. Set the MODULATION function switch to CW, the RESOLUTION kHz switch to 10, the FREQUENCY MHz switch to band 1 (.45 – 32.5), and the VERNIERS control to 0.

b. Rotate the TUNING control to its fully clockwise position and record the display on the output frequency indicator. *The output frequency should be 0.450 MHz or lower.*

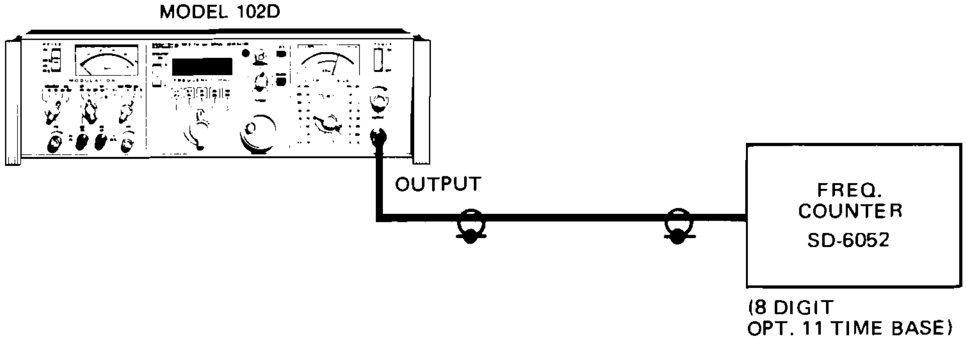


Figure 2-16 Frequency Accuracy and Locked Frequency Stability Checks, Test Setup

c. Rotate the TUNING control to its fully counterclockwise position and record the display on the output frequency indicator. *The output frequency should be 32.50 MHz or higher.*

d. Using procedures similar to those in steps b and c, record the lowest frequency (fully counterclockwise setting of the TUNING control) and the highest frequency (fully clockwise setting of the TUNING control) obtainable on each of the four upper bands of the Model 102D. *Output frequency limits should be as follows:*

Band	Lowest Frequency	Highest Frequency
2	32.50 MHz or lower	65.00 MHz or higher
3	65.00 MHz or lower	130.00 MHz or higher
4	130.00 MHz or lower	260.00 MHz or higher
5	260.00 MHz or lower	520.00 MHz or higher

2-39. Output Level Accuracy Check. To check output level accuracy, proceed as follows:

a. Connect the power detector of a microwattmeter, Boonton Electronics Model 42B to the OUTPUT connector of the Model 102D.

b. Set the MODULATION function switch to CW, the FREQUENCY MHz switch to band 1 (.45 – 32.5), and the RESOLUTION kHz switch to 10. Using the TUNING control, tune the Model 102D to an output frequency of 5 MHz, as indicated on the output frequency indicator.

c. Set the OUTPUT LEVEL attenuator to 0 dBm. Using the OUTPUT control, position the pointer of the OUTPUT LEVEL meter to 0 dBm on the appropriate bottom scale of the meter.

d. Check the power indication of the microwattmeter. *Indicated power level should be 0 dBm, ±1 dBm.*

e. Using the TUNING control, tune the Model 102D successively to each of the check frequencies listed below, and repeat steps c and d at each check frequency. *The power level indication of the microwattmeter should be 0±1 dBm at each of the listed frequencies.*

Check Frequencies

20 MHz	200 MHz	400 MHz
50 MHz	250 MHz	450 MHz
100 MHz	300 MHz	500 MHz
150 MHz	350 MHz	520 MHz

f. Using the FREQUENCY MHz switch and the TUNING control, tune the Model 102D to an output frequency of 100 MHz, as indicated on the output frequency indicator. Using the OUTPUT control, adjust the output level in 2.0 dB decrements from -2.0 to -10.0 dBm, as indicated on the lowest scale of the OUTPUT LEVEL meter. At each point, note the power level indication of the microwattmeter. *The microwattmeter indication should be within ±1.0 dB of the OUTPUT LEVEL meter indication at each point.*

g. Repeat step f with the Model 102D tuned to an output frequency of 500 MHz. *The microwattmeter indication should be within ±1.0 dB of the OUTPUT LEVEL meter indication at each power level check point.*

h. Connect the Model 102D and test equipment as shown in Figure 2-17. Set the controls of the test Model 102D and the reference Model 102D as shown in Table 2-3.

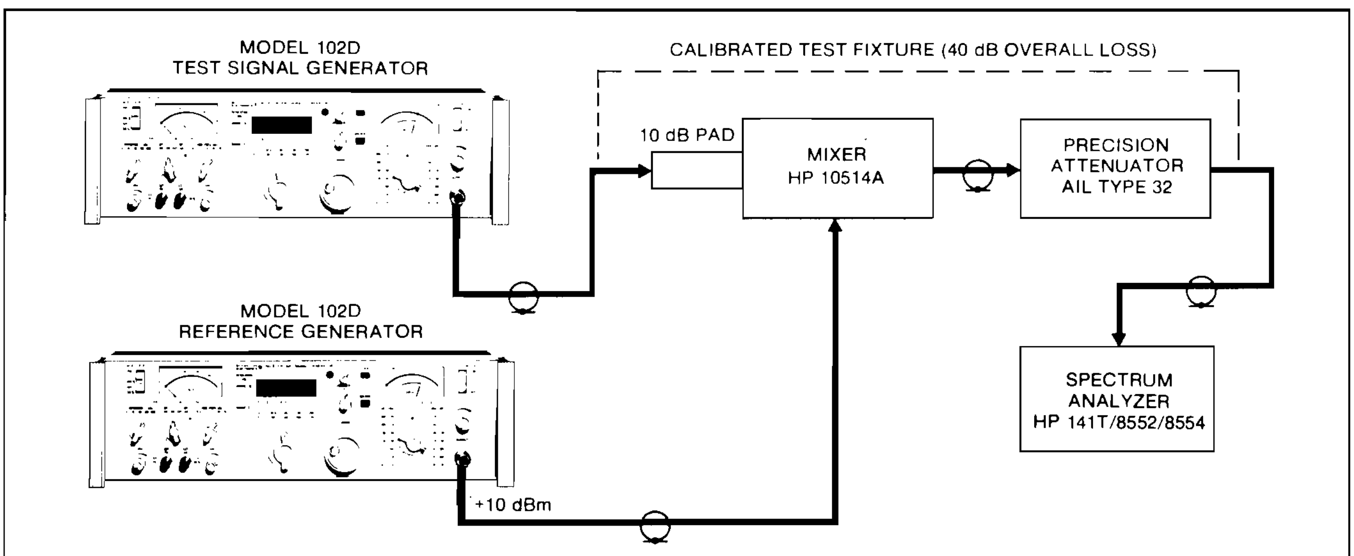


Figure 2-17 Output Level Accuracy Check, Test Setup

TABLE 2-3. CONTROL SETTINGS FOR OUTPUT LEVEL ACCURACY CHECK

Control	Test Model 102D	Reference Model 102D
MODULATION function switch	CW	CW
FREQUENCY MHz switch	Band 5 (260–520)	Band 5 (260–520)
RESOLUTION kHz switch	10	10
TUNING control	450.0 MHz on output frequency indicator	480.0 MHz on output frequency indicator
OUTPUT LEVEL attenuator	-60 dBm	±10 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter	0 dB on OUTPUT LEVEL meter

i. Set the precision attenuator to the point previously calibrated to produce a 40.0 dB overall loss through the calibrated test fixture.

j. Set the spectrum analyzer controls for the linear mode of operation and to provide a display of the 30 MHz i-f signal. Using the i-f and video gain controls of the spectrum analyzer, align the peak of the 30 MHz i-f signal with the 1.0 graticule of the spectrum analyzer display.

k. Increase the attenuation of the precision attenuator by 60.00 dB. Set the OUTPUT LEVEL attenuator of the test Model 102D to 0 dBm. Note the amplitude of the 30 MHz i-f signal on the spectrum analyzer display. *The amplitude should be 0.93 to 1.07.*

2-40. **Output Leveling Check.** To check the automatic leveling circuits of the Model 102D, proceed as follows:

a. Connect the power detector of a microwattmeter, Boonton Electronics Model 42B to the OUTPUT connector of the Model 102D.

b. Set the MODULATION function switch to CW, the FREQUENCY MHz switch to band 1 (.45 – 32.5), and the OUTPUT LEVEL attenuator to +10 dBm. Using the OUTPUT control, position the pointer of the OUTPUT LEVEL meter to 0 dBm on the lowest scale of the meter.

c. Using the TUNING control, tune the Model 102D slowly from 0.45 MHz to 32.5 MHz, and record the maximum and minimum indications of the microwattmeter. *The difference between the manimum and minimum power level indications should not exceed 1.0 dB.*

d. Position the pointer of the OUTPUT LEVEL meter to -10 dBm on the bottom scale, using the OUTPUT control, and repeat step c. *The difference between the maximum and minimum power level indications should not exceed 1.0 dB.*

e. Set the FREQUENCY MHz switch successively to each of bands 2 through 5 and repeat steps c and d for each band, tuning the Model 102D over the following frequency ranges:

Band	Tuning Range
2	32.5 to 65.0 MHz
3	65.0 to 130.0 MHz
4	130.0 to 260.0 MHz
5	260.0 to 520.0 MHz

The difference between the maximum and minimum power level indications on the microwattmeter should not exceed 1.0 dB on any band.

2-41. **Spurious Output Check.** To check for spurious output signals from the Model 102D, proceed as follows:

a. Set the FREQUENCY MHz switch to band 1 (.45 – 32.5), the MODULATION function switch to CW, and the OUTPUT LEVEL attenuator to +10 dBm. Using the OUTPUT control, position the pointer of the output LEVEL meter to 0 dBm on the lowest scale of the meter.

b. On a spectrum analyzer, Hewlett Packard 141T/8552/8554, set 20 dB of RF attenuation, and connect the spectrum analyzer to the OUTPUT connector of the Model 102D. Adjust the i-f bandwidth of the spectrum analyzer to 100 kHz, the scan width to 10 MHz per centimeter, and the i-f gain controls to provide a display with the main r-f signal peak aligned with the -10 dB graticule.

c. Using the TUNING control, tune the Model 102D slowly from 0.45 MHz to 32.5 MHz, noting all signals whose amplitude is within 40 dB of the desired output on the spectrum analyzer. At output frequencies above 5 MHz, all spurious signal amplitudes should be at least 30 dB below the main output signal amplitude. Ascertain that these signals are either harmonics of the main output signal (related by an integer) or spurious mixing products. Below 5 MHz, harmonics should be at least 25 dB below the main output. Spurious mixing products will move at a rate equal to the rate of movement of the main output signal as the TUNING control is rotated or at integral multiples of this rate.

d. Set the FREQUENCY MHz switch on the Model 102D to band 2 (32.5 -- 65). Set the scan width of the spectrum analyzer to 30 MHz per centimeter, and adjust the i-f gain controls to obtain an output signal display with its peak aligned with the -10 dB graticule on the spectrum analyzer.

e. Repeat step c, except tune the Model 102D slowly from 32.5 MHz to 65 MHz. *Ascertain that all signals less than 40 dB below the main output are harmonics. These should be at least 30 dB below the main output.*

f. Set the FREQUENCY MHz switch on the Model 102D to bands 3, 4, and 5 in sequence. Set the scan width of the spectrum analyzer to 30 MHz per centimeter, 50 MHz per centimeter, and 50 MHz per centimeter, respectively, and adjust the i-f gain controls as in step d.

g. Repeat step c on each of bands 3, 4, and 5, except tune the Model 102D over the following frequency ranges:

Band	Tuning Range
3	65 MHz to 130 MHz
4	130 MHz to 260 MHz
5	260 MHz to 520 MHz

All test results should be the same as in step e.

h. Using the OUTPUT control on the Model 102D, position the pointer of the OUTPUT LEVEL meter to -10 dBm on the bottom scale. Repeat steps b through g. *All test requirements are the same.*

2-42. **Modulation Oscillator Output Check.** To check the signal amplitude of the internally generated modulation signals, proceed as follows:

a. Connect the Model 102D and test equipment as shown in Figure 2-18.

b. Set the MODULATION function switch to INT FM. Set the function switch on the distortion analyzer to the voltmeter position.

c. Set the MOD FREQ kHz switch on the Model 102D to 0.4, 1, 3, 10, and 19, in sequence. Note the voltage indication on the distortion analyzer meter for each switch position. *The voltage should be 1.0 volt rms minimum in each case.*

2-43. **Modulation Frequency Accuracy Check.** To check the frequency accuracy of the internally generated modulation signals, proceed as follows:

a. Connect a frequency counter, Systron Donner SD-6052, to the MOD FREQ OUT connector on the rear panel of the Model 102D.

b. Set the MODULATION function switch to INT FM.

c. Set the MOD FREQ kHz switch to each of its five positions in sequence, and measure the frequency of the modulation signal for each switch setting, using the frequency counter. *Modulation frequencies should be within the limits specified below.*

Switch Position	Modulation Frequency Limits
0.4	0.388 to 0.412 kHz
1	0.970 to 1.030 kHz
3	2.910 to 3.090 kHz
10	9.700 to 10.300 kHz
19	18.430 to 19.570 kHz

2-44. **Modulation Oscillator Distortion Check.** To check distortion of the internal modulation oscillator, proceed as follows:

a. Connect the Model 102D and test equipment as shown in Figure 2-18.

b. Set the MODULATION function switch to INT FM. Set the function switch on the distortion analyzer to the set level position.

c. Set the MOD FREQ kHz switch to each of its five positions in sequence. At each switch position, measure the distortion with the distortion analyzer. *Distortion should not exceed 0.25% THD.*

2-45. **FM Measurements.** This paragraph provides instructions for measurement of the FM characteristics of the Model 102D. Proceed from one check to the next, without disturbing test setups or control settings, unless specifically directed otherwise.

a. **FM Sensitivity Check.** To check FM sensitivity, proceed as follows:

1. Connect the Model 102D and test equipment as shown in Figure 2-19.

2. Set the controls on the Model 102D as follows:

Control	Position
DEVIATION kHz switch	100
MODULATION function switch	EXT
FREQUENCY MHz switch	Band 3 (65-130)
TUNING control	100.00 MHz as indicated on output frequency indicator
OUTPUT LEVEL attenuator	0 dBm
OUTPUT control	0 dB as indicated on OUTPUT LEVEL meter
FM control	Fully counterclockwise

3. Adjust the spectrum analyzer scan width to 30 kHz per centimeter and the i-f bandwidth to 1 kHz. Adjust the i-f gain controls as required to obtain a display in which the peak of the carrier signal is aligned with the -10 dB graticule. Center the carrier signal on the spectrum analyzer display.

4. Set the oscillator frequency to 41.58 kHz, using the frequency counter to check the frequency. Adjust the FM control on the Model 102D to the fully clockwise position.

5. Set the oscillator amplitude control to minimum, then advance it slowly clockwise until the amplitude of the carrier in the spectrum analyzer display drops to a minimum or null, at least below -40 dB. Using the frequency counter, ascertain that the oscillator frequency is still 41.58 kHz. The actual FM deviation of the Model 102D is now 100 kHz ±1 kHz.

6. Replace the frequency counter in the test set-up with the voltmeter, and measure the oscillator output voltage. *The voltage should be 1.0 volt rms or less.*

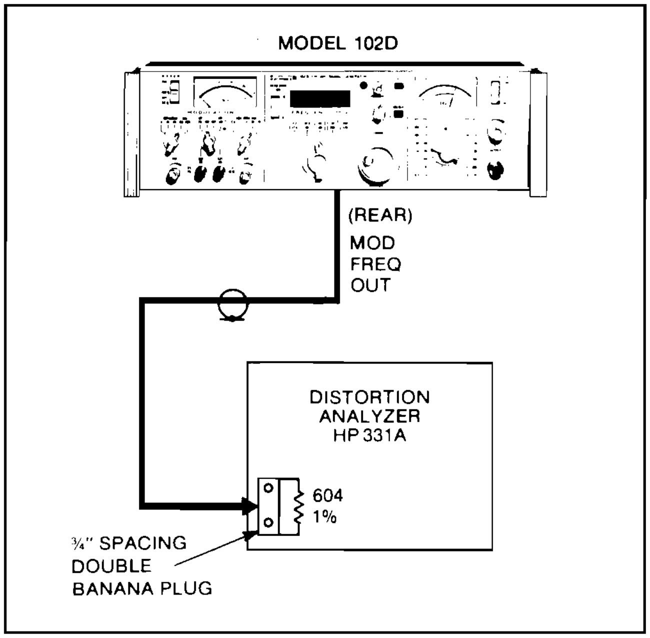


Figure 2-18 Modulation Oscillator Output Check, Test Setup

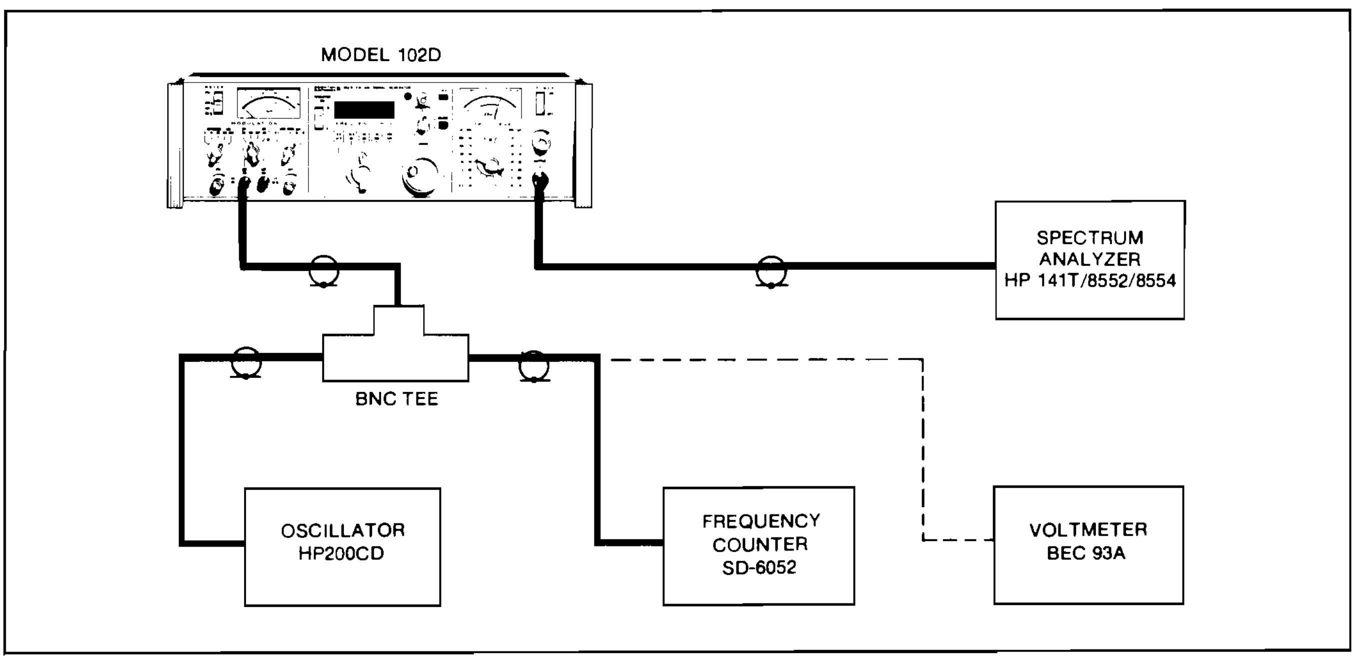


Figure 2-19 FM Sensitivity Check, Test Setup

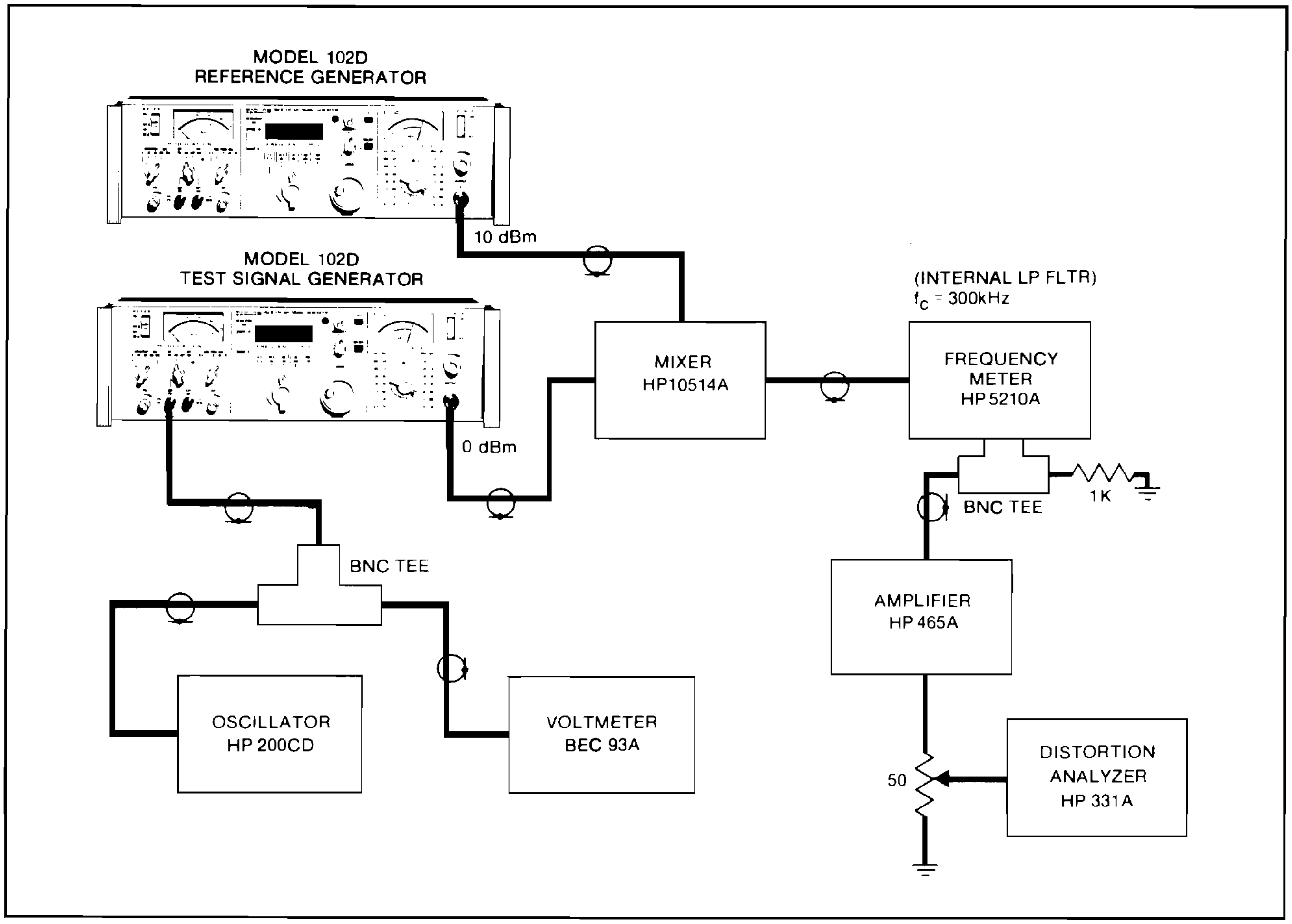


Figure 2-20 FM Bandwidth and Distortion Checks, Test Setup

b. **FM Bandwidth Check**. Upon completion of the FM sensitivity check, perform the following FM bandwidth check without disturbing any control settings of the Model 102D or the test equipment:

1. Connect the test Model 102D and test equipment as shown in Figure 2-20.

2. Set the controls of the *reference* Model 102D as follows:

Control	**Position**
FREQUENCY MHz	Band 3 (65-130)
TUNING control	108.0 MHz on output frequency indicator
MODULATION function switch	CW
OUTPUT LEVEL attenuator	+10 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter

3. Set the range switch of the frequency meter to the 10 MHz position.

4. Set the function switch of the distortion analyzer to the voltmeter position and the meter range switch to the 1 volt position. Adjust the 50 ohm potentiometer as required to obtain a 0.80 volt rms indication on the distortion analyzer meter. (The distortion analyzer meter is now calibrated as a frequency deviation meter, with a scale factor of 125 kHz per volt rms.)

5. Set the oscillator frequency to 10 kHz and adjust the amplitude control as required to obtain a 6.00 volt rms indication on the voltmeter. Adjust the FM control on the test Model 102D in a counterclockwise direction until the distortion analyzer meter again indicates 0.80 volt rms.

6. Set the oscillator frequency to 200 kHz and adjust the amplitude control as required to obtain an indication of 0.80 volt rms on the distortion analyzer meter. Note the oscillator output voltage indication on the voltmeter. *The oscillator output voltage should be 5.65 to 8.45 volts rms.*

c. **FM Accuracy Check.** Without disturbing the test set-up or any control settings, except as specified, check the FM accuracy of the Model 102D as follows:

1. Set the oscillator frequency to 10 kHz. Set the METER switch on the *test* Model 102D to FM.

2. Using the FM control on the *test* Model 102D, position the pointer of the MODULATION meter to exactly 100. Check the voltage indication on the distortion analyzer meter. *The voltage should be 0.72 to 0.88 volt rms.*

3. Set the oscillator frequency to 20 kHz and repeat step 2. *The voltage indication on the distortion analyzer meter should be 0.72 to 0.88 volt rms.*

4. Set the oscillator frequency to 200 kHz and repeat step 2. *The voltage indication on the distortion analyzer meter should be 0.72 to 0.88 volt rms.*

5. Set the oscillator frequency to 10 kHz. Set the FREQUENCY MHz switch on the *test* Model 102D and the *reference* Model 102D to band 2, (32.5 – 65). Using the TUNING controls of the respective instruments, tune the *test* Model 102D to 32.5 MHz, and the *reference* Model 102D to 40.5 MHz, as indicated on the respective output frequency indicators. Using the FM control on the *test* Model 102D, position the pointer of the MODULATION meter to exactly 100. Observe the voltage indication on the distortion analyzer meter. *The voltage indication should be 0.72 to 0.88 volt rms.*

6. Set the output frequencies of the *test* Model 102D and the *reference* Model 102D to the following frequencies, in sequence.

Test Model 102D	Reference Model 102D
35 MHz	43 MHz
40 MHz	48 MHz
45 MHz	53 MHz
50 MHz	58 MHz
55 MHz	63 MHz
60 MHz	68 MHz
65 MHz	73 MHz

At each of the test frequencies, position the pointer of the MODULATION meter on the *test* Model 102D to exactly 100, using the FM control, and observe the voltage indication on the distortion analyzer meter. *The voltage indication should be 0.72 to 0.88 volt rms in each instance.*

d. **Range Ratio Check.** To check the FM range ratios, proceed as follows:

1. Connect the output of a precision voltage calibrator, Ballantine Model 421A, to the EXT FM connector of the Model 102D. Connect an rms voltmeter, Boonton Electronics Model 93A, to the FM terminal at the top left side of the VFO housing in the Model 102D. (The FM terminal has a shielded wire soldered to it.)

2. Set the Model 102D controls as follows:

Control	Position
MODULATION function switch	EXT
DEVIATION kHz switch	300
FREQUENCY MHz switch	Band 1 (.45 – 32.5)

3. Set the full scale switch of the rms voltmeter to the 10 millivolt position. Set the mode switch on the precision voltage calibrator to the 1 kHz rms position, the output to 10.000 millivolts, and the range switch to 100 millivolts.

4. Using the FM control on the Model 102D, position the pointer of the rms voltmeter to exactly 5.00 millivolts.

5. Set the FREQUENCY MHz switch on the Model 102D to each of the four upper bands in sequence. At each switch position, adjust the output of the precision voltage calibrator as required to maintain the 5.00 millivolt indication on the rms voltmeter, and record the output voltage of the precision voltage calibrator. *The output voltage required for a 5.00 millivolt indication on the rms voltmeter should be as follows:*

Band	Output Voltage Limits
2	9.80 to 10.20 millivolts
3	19.60 to 20.40 millivolts
4	39.20 to 40.80 millivolts
5	78.40 to 81.60 millivolts

6. Set the FREQUENCY MHz switch on the Model 102D to band 1 (.45 – 32.5). Readjust the output voltage of the precision voltage calibrator to 10.00 millivolts. Set the DEVIATION kHz switch on the Model 102D to each of its four lower settings in sequence. At each switch setting, adjust the output voltage of the precision voltage calibrator as required to maintain a 5.00 millivolt indication on the rms voltmeter, and record the output voltage of the precision voltage calibrator. *The output voltage required for a 5.00 millivolt indication on the rms voltmeter should be as follows:*

DEVIATION kHz Switch Setting	Output Voltage Limits
100	31.00 to 32.20 millivolts
30	98.00 to 102.00 millivolts
10	310.00 to 322.00 millivolts
3	980.00 to 1020.00 millivolts

e. **Meter Linearity Check.** To check the FM linearity of the MODULATION meter, proceed as follows:

1. Connect a precision voltage calibrator, Ballantine Model 421A, to the EXT FM connector of the Model 102D. Set the precision voltage calibrator mode switch to the 1 kHz p-p position, the range switch to the 10 volt position, and the output to 10.00 volts.

2. Set the controls of the Model 102D as follows:

Control	Position
MODULATION function switch	EXT
DEVIATION kHz switch	100
METER switch	FM
FREQUENCY MHz switch	Band 3 (65 - 130)

3. Using the FM control on the Model 102D, position the pointer of the MODULATION meter to exactly 100.

4. Reduce the output voltage of the precision voltage calibrator as required to reduce the indication on the MODULATION meter in 10-division decrements. Record the output voltage of the precision voltage calibrator at each point. *The output voltage should be as follows:*

MODULATION Meter Indication	Output Voltage Limits
90	8.80 to 9.20 volts
80	7.80 to 8.20 volts
70	6.80 to 7.20 volts
60	5.80 to 6.20 volts
50	4.80 to 5.20 volts
40	3.80 to 4.20 volts
30	2.80 to 3.20 volts
20	1.80 to 2.20 volts
10	0.80 to 1.20 volts

f. **FM Distortion Check.** To check FM distortion, proceed as follows:

1. Connect the test Model 102D and test equipment as shown in Figure 2-20.

2. Set the controls of the test Model 102D and the reference Model 102D as shown in Table 2-4.

3. Set the oscillator controls to provide an output frequency of 10 kHz. Using the amplitude control of the oscillator, position the pointer of the MODULATION meter on the *test* Model 102D to exactly 100. Measure the distortion analyzer. *Distortion should not exceed 1.0% THD.*

4. Set the oscillator controls to provide an output frequency of 200 kHz. If necessary, readjust the amplitude control on the oscillator to maintain the MODULATION meter indication of 100 on the *test* Model 102D. Measure the distortion with the distortion analyzer. *Distortion should not exceed 1.0% THD.*

5. Repeat step 4 with the *test* Model 102D and the *reference* Model 102D tuned in sequence to each of the following frequencies:

Test Model 102D	Reference Model 102D
35 MHz	43 MHz
40 MHz	48 MHz
45 MHz	53 MHz
50 MHz	58 MHz
55 MHz	63 MHz
60 MHz	68 MHz
65 MHz	73 MHz

Distortion should not exceed 1.0% THD.

2-46. **AM Measurements.** This paragraph provides instructions for measurement of AM characteristics of the Model 102D. Proceed from one AM check to the next without changing the test setup or disturbing control settings unless specifically directed otherwise.

a. **AM Sensitivity Check.** To check AM sensitivity, proceed as follows:

1. Connect the test Model 02D and test equipment as shown in Figure 2-21

2. Set the controls of the *test* Model 102D and the *reference* Model 102D per Table 2-5.

3. Set the function switch of the distortion analyzer to the voltmeter position, and the range switch to the 1 volt position.

TABLE 2-4. CONTROL SETTINGS FOR FM DISTORTION CHECK

Control	Test Model 102D	Reference Model 102D
DEVIATION kHz switch	100	(Not applicable)
MODULATION function switch	EXT	CW
FREQUENCY MHz switch	Band 2 (32.5 -- 65)	Band 2 (32.5 -- 65)
TUNING control	32.5 MHz on output frequency indicator	40.5 on output frequency indicator
OUTPUT LEVEL attenuator	0 dBm	+10 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter	0 dB on OUTPUT LEVEL meter
FM control	Fully clockwise	(Not applicable)
METER switch	FM	(Not applicable)

4. Set the oscillator controls to provide an output frequency of 1 kHz. Adjust the amplitude control of the oscillator to produce a trapezoid of 8 divisions (dimension A, Figure 2-21) by 4.3 divisions (dimension B) on the oscilloscope. This corresponds to 30% AM. Observe the voltage indication on the distortion analyzer meter. *The voltage should not exceed 1.0 volt rms.*

b. **AM Bandwidth Check.** Upon completion of the AM sensitivity check, perform an AM bandwidth check as follows:

1. Adjust the amplitude control on the oscillator as required to produce a 2.00 volt rms indication on the distortion analyzer meter. Adjust the AM control on the *test* Model 102D as required to produce a 30% AM trapezoid (8 divisions by 4.3 divisions) on the oscilloscope.

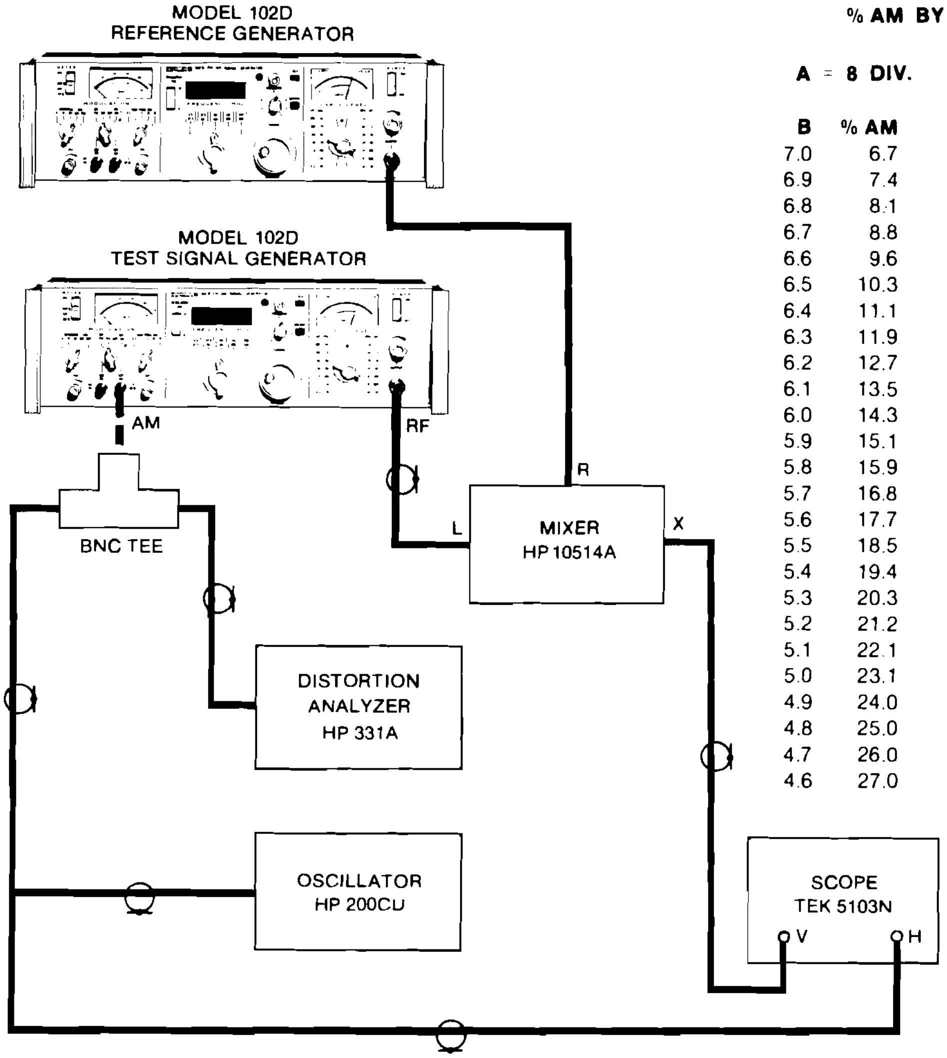
2. Set the oscillator frequency controls to provide an output frequency of 20 kHz. Adjust the oscillator amplitude control to produce the 30% AM trapezoid (8 divisions by 4.3 divisions) on the oscilloscope. Observe the voltage indication on the distortion analyzer meter. *The voltage should be 1.90 to 2.50 volts rms.*

c. **AM Accuracy Check.** When the AM bandwidth check has been completed, check AM accuracy as follows:

1. Set the METER switch on the *test* Model 102D to 30% AM. Set the oscillator frequency controls to provide a 1 kHz output frequency. Adjust the oscillator amplitude control as required to position the pointer of the MODULATION meter on the *test* Model 102D to exactly 30 on the lower scale. Adjust the vertical gain on the oscilloscope as required to produce a trapezoid with an A amplitude (Figure 2-21) of 8 divisions. Measure and record the B dimension of the trapezoid. Calculate the actual percentage of AM, using the formula given in Figure 2-21. *The actual percentage of AM should be 27.0 to 33.0%.*

TABLE 2-5. CONTROL SETTINGS FOR AM SENSITIVITY CHECK

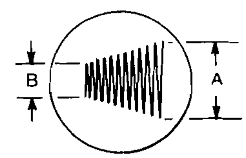
Control	Test Model 102D	Reference Model 102D
MODULATION function switch	EXT	CW
FREQUENCY MHz switch	Band 3 (65 – 130)	Band 3 (65 – 130)
TUNING control	100.0 MHz on output frequency indicator	100.2 MHz on output frequency indicator
OUTPUT LEVEL attenuator	-10 dBm	+10 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter	0 dB on OUTPUT LEVEL meter
AM control	Fully clockwise	(Not applicable)
METER switch	100% AM	(Not applicable)



% AM BY TRAPEZOID METHOD

A = 8 DIV. $\qquad$ **$\%\,AM = \frac{A - B}{A + B} \times 100$**

B	% AM	B	%AM	B	%AM
7.0	6.7	4.5	28.0	2.0	60.0
6.9	7.4	4.4	29.0	1.9	61.6
6.8	8.1	4.3	30.1	1.8	63.3
6.7	8.8	4.2	31.1	1.7	65.0
6.6	9.6	4.1	32.2	1.6	66.7
6.5	10.3	4.0	33.3	1.5	68.4
6.4	11.1	3.9	34.4	1.4	70.1
6.3	11.9	3.8	35.6	1.3	72.0
6.2	12.7	3.7	36.8	1.2	73.9
6.1	13.5	3.6	38.0	1.1	75.8
6.0	14.3	3.5	39.1	1.0	77.7
5.9	15.1	3.4	40.3	0.9	79.8
5.8	15.9	3.3	41.5	0.8	81.8
5.7	16.8	3.2	42.8	0.7	83.9
5.6	17.7	3.1	44.1	0.6	86.1
5.5	18.5	3.0	45.5	0.5	88.2
5.4	19.4	2.9	46.8	0.4	90.5
5.3	20.3	2.8	48.1	0.3	92.8
5.2	21.2	2.7	49.5	0.2	95.1
5.1	22.1	2.6	51.0	0.1	97.5
5.0	23.1	2.5	52.5		
4.9	24.0	2.4	53.9		
4.8	25.0	2.3	55.4		
4.7	26.0	2.2	56.9		
4.6	27.0	2.1	58.4		



$$\%AM = \frac{A - B}{A + B} \times 100$$

Figure 2-21 AM Sensitivity Check, Test Setup

2. Set the METER switch on the *test* Model 102D to 100% AM and observe the percentage of AM, as indicated on the top scale of the meter. *The meter indication should be 29.0 to 31.0%.*

3. Adjust the OUTPUT control of the *test* Model 102D as required to position the pointer of the OUTPUT LEVEL meter to -10 dBm. Repeat step 1. *The actual percentage of AM should be 27.0 to 33.0%.*

4. Using the amplitude control on the oscillator, position the pointer of the MODULATION meter on the *test* Model 102D to exactly 50 on the upper scale. Measure the A and B dimensions of the trapezoid displayed on the oscilloscope and calculate the actual percentage of AM. *The actual percentage of AM should be 47.0 to 53.0%.*

5. Using the OUTPUT control on the *test* Model 102D, position the pointer of the OUTPUT LEVEL meter to 0 dB. Repeat step 4. *The actual percentage of AM should be 47.0 to 53.0%.*

6. Tune the *test* Model 102D and the *reference* Model 102D to each of the frequencies listed below, in sequence. Using the OUTPUT controls, maintain an indication of 0 dB on the OUTPUT LEVEL meter of each instrument. Repeat step 4 for each of the listed frequencies.

Test Model 102D	Reference Model 102D
50.0 MHz	50.2 MHz
150.0 MHz	150.2 MHz
200.0 MHz	200.2 MHz
250.0 MHz	250.2 MHz
300.0 MHz	300.2 MHz
350.0 MHz	350.2 MHz
400.0 MHz	400.2 MHz
450.0 MHz	450.2 MHz
500.0 MHz	500.2 MHz
520.0 MHz	520.2 MHz

The actual percentage of AM should be 47.0 to 53.0% at each output frequency.

d. **AM Distortion Check.** Check AM distortion as follows:

1. Set the controls of a distortion analyzer, Hewlett-Packard Model 331A, for distortion measurement of a 1 kHz signal. Using a probe, Tektronix Model P6060, connect the input terminals of the distortion analyzer to the junction of resistors R2019 and R2021 on the output amplifier and modulator circuit board of the Model 102D.

NOTE

If option 03 is incorporated in the Model 102D, connect the distortion analyzer directly to the DEMOD AM OUT connector on the rear panel of the Model 102D.

2. Set the controls of the Model 102D as follows:

Control	Position
MODULATION function switch	INT AM
MOD FREQ kHz switch	1
METER switch	100% AM
AM control	30% indication on MODULATION meter
FREQUENCY MHz switch	Band 1 (.45 – 32.5)
TUNING control	20.00 MHz on output frequency indicator
OUTPUT LEVEL attenuator	0 dBm

3. Using the OUTPUT control of the Model 102D, position the pointer of the OUTPUT LEVEL meter to 0 dB. Measure the distortion with the distortion analyzer. *Distortion should not exceed 1.0% THD.*

4. Using the OUTPUT control of the Model 102D, position the pointer of the OUTPUT LEVEL meter to -10 dBm, and measure the distortion. *Distortion should not exceed 1.0% THD.*

5. Using the AM control on the Model 102D, position the pointer of the MODULATION meter to 70 on the top scale. Measure the distortion with the distortion analyzer. *Distortion should not exceed 2.0% THD.*

6. Using the OUTPUT control on the Model 102D, position the pointer of the OUTPUT LEVEL meter to 0 dB, and measure the distortion. *Distortion should not exceed 2.0% THD.*

7. Using the TUNING control, tune the Model 102D to each of the following output frequencies in sequence, and repeat steps 3 through 6 at each output frequency:

Output Frequencies	
100.0 MHz	400.0 MHz
200.0 MHz	450.0 MHz
300.0 MHz	520.0 MHz
350.0 MHz	

Distortion at each of the listed output frequencies should not exceed that specified in steps 3 through 6.

2-47. **Incidental AM With FM Check.** To check incidental AM, proceed as follows:

a. Using a probe, Tektronix Model P6060, connect the vertical input of an oscilloscope, Tektronix Model 5103N, to the junction of resistors R2019 and R2021 on the output circuit board of the Model 102D.

NOTE

If option 03 is installed in the Model 102D, connect the oscilloscope directly to the DET AM OUT connector on the rear panel of the Model 102D.

b. Set the controls on the Model 102D as follows:

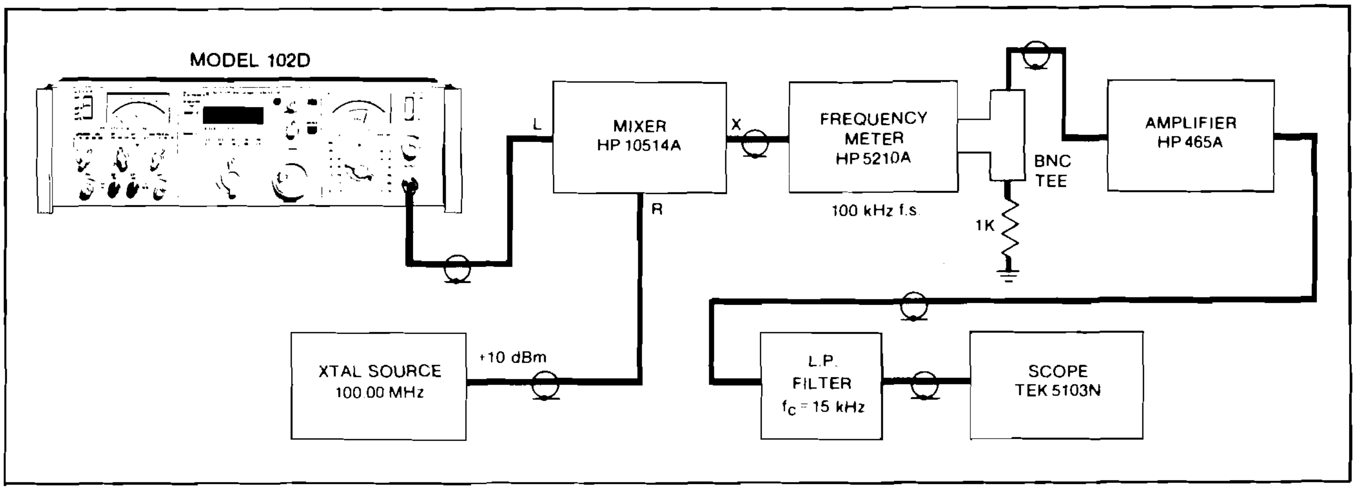


Figure 2-22 Incidental FM with AM Check, Test Setup

Control	Position
MODULATION function switch	INT AM
MOD FREQ kHz switch	1
METER switch	30% AM
AM control	5% AM on MODULATION meter
OUTPUT LEVEL attenuator	0 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter
DEVIATION kHz switch	100

c. With the oscilloscope vertical attenuator set at 20 mV per division, adjust the vertical gain control of the oscilloscope as required to obtain a 5 division, peak-to-peak, display of the demodulated 1 kHz signal. Then, set the oscilloscope vertical attenuator to 2 mV per division. The oscilloscope is now calibrated for percentage of AM, with a scale factor of 0.1% per division.

d. Set the MODULATION function switch on the Model 102D to INT FM. Set the METER switch to FM and position the pointer of the MODULATION meter to exactly 100, using the FM control. Using the scale factor of 0.1% per division, measure the incidental AM displayed on the oscilloscope. *Incidental AM should not exceed 0.2%.*

2-48. Incidental FM With AM. To measure incidental FM, proceed as follows:

a. Connect the Model 102D and test equipment as shown in Figure 2-22.

b. Set the controls of the Model 102D as follows:

Control	Position
MODULATION function switch	INT FM
DEVIATION kHz switch	3
MOD FREQ kHz switch	1
FREQUENCY MHz switch	Band 3 (65 – 130)
TUNING control	100.08 MHz on output frequency indicator
METER switch	FM
FM control	10 on lower scale of MODULATION meter
OUTPUT LEVEL attenuator	0 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter

c. With the oscilloscope vertical attenuator set at 0.1 volt per division, adjust the vertical gain control as required to produce a 5 division, peak-to-peak, display of the demodulated 1 kHz signal on the oscilloscope. Set the oscilloscope vertical attenuator to 10 millivolts per division. The oscilloscope is now calibrated to measure FM deviation, with a scale factor of 20 Hz peak deviation per division.

d. Set the MODULATION function switch on the Model 102D to INT AM, and the METER switch to 30% AM. Position the pointer of the MODULATION meter to exactly 30 on the lower scale, using the AM control. Using the scale factor of 20 Hz peak deviation per division, measure the incidental FM on the oscilloscope. *Incidental FM should not exceed 100 Hz.*

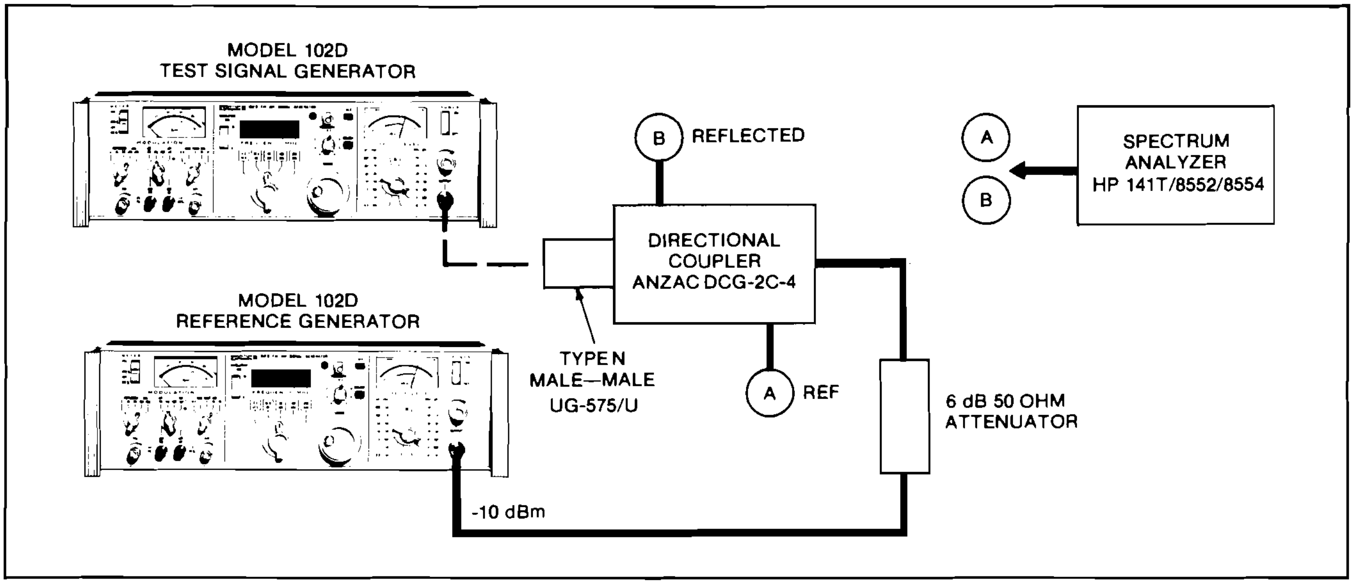


Figure 2-23 Output Impedance Check, Test Setup

2-49. Residual FM Check. To measure residual FM, proceed as follows:

a. Calibrate an oscilloscope to measure FM deviation in accordance with steps a through c of paragraph 2-48.

b. Set the oscilloscope vertical attenuator to 5 millivolts per division. The oscilloscope is now calibrated to measure FM deviation, with a scale factor of 10 Hz peak deviation per division.

c. Set the MODULATION function switch on the Model 102D to CW. Using the scale factor of 10 Hz peak deviation per division, measure the residual FM on the oscilloscope. *Residual FM should not exceed 20 Hz.*

2-50. Output Impedance Check. To perform an output impedance check, proceed as follows:

a. Connect the Model 102D and test equipment as shown in Figure 2-23.

b. Set the controls of the *test* Model 102D and the *reference* Model 102D as indicated in Table 2-6.

c. Connect the spectrum analyzer to point A in Figure 2-23. Adjust the spectrum analyzer controls as required to align the peak of the reference signal generator signal with the -30 dB graticule in the log display mode.

d. Connect the spectrum analyzer to point B in Figure 2-23 and observe the amplitude of the reference generator signal on the spectrum analyzer display. *The return loss, which is the difference between the amplitude observed in this step and the -30 dB amplitude of step c, should be at least 14 dB.*

TABLE 2-6. CONTROL SETTINGS FOR OUTPUT IMPEDANCE CHECK

Control	Test Model 102D	Reference Model 102D
MODULATION function switch	CW	CW
FREQUENCY MHz switch	Band 1 (.45 – 32.5)	Band 1 (.45 – 32.5)
TUNING control	10.0 MHz on output frequency indicator	10.3 MHz on output frequency indicator
OUTPUT LEVEL attenuator	0 dBm	-10 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter	0 dB on OUTPUT LEVEL meter

e. Tune the *test* Model 102D and the *reference* Model 102D to each of the frequencies listed below in sequence, and repeat steps c and d at each frequency. *The return loss should be as specified in step d.*

Test Model 102D	Reference Model 102D
100.0 MHz	100.3 MHz
200.0 MHz	200.3 MHz
300.0 MHz	300.3 MHz
400.0 MHz	400.3 MHz
520.0 MHz	520.3 MHz

2-51. RF Leakage Check. To check RF leakage, proceed as follows:

a. Connect the Model 102D and test equipment as shown in Figure 2-24.

b. Calibrate the RF amplifier-spectrum analyzer combination as follows:

1. Set the controls of the Model 102D as follows:

Control	Position
FREQUENCY MHz switch	Band 5 (360 – 520)
TUNING control	450.0 on output frequency indicator
OUTPUT LEVEL attenuator	-100 dBm
OUTPUT control	-7 dB on OUTPUT LEVEL meter
MODULATION function switch	CW

2. Adjust the spectrum analyzer scan width to 10 kHz per division, and the i-f bandwidth to 1 kHz. Phase lock the spectrum analyzer to the 450 MHz signal, and adjust the i-f attenuator as required to align the peak of the 450 MHz signal with the -40 dB graticule on the spectrum analyzer display. Set the OUTPUT LEVEL attenuator on the Model 102D to -120 dBm, and position the pointer of the OUTPUT LEVEL meter to -10 dB, using the OUTPUT control. Ascertain that the signal displayed on the spectrum analyzer is lower in amplitude.

c. Without disturbing any control settings, disconnect the r-f amplifier from the OUTPUT connector of the Model 102D, and connect the 50-ohm termination to the OUTPUT connector. Connect the r-f pickup loop to the input connector of the r-f amplifier.

d. Probe the surface of the Model 102D with the r-f pickup loop and observe the amplitude of the signal of the spectrum analyzer display. *The amplitude should not exceed -40 dB (1 microvolt), as measured on the spectrum analyzer display, at any position of the r-f pickup loop within 1 inch of the cabinet.*

2-52. Frequency Stability Check (Without Phase Lock). To check frequency stability without phase lock, proceed as follows:

a. Connect the Model 102D and test equipment as shown in Figure 2-25.

b. Set the FREQUENCY MHz switch of the Model 102D to band 3 (65 – 130) and the MODULATION function switch to CW. Using the TUNING control, tune the Model 102D to 100.07 MHz, as indicated on the output frequency indicator. Correct tuning will be indicated by a frequency indication of approximately 70 kHz on the frequency meter. Allow all equipment to warm up for 1 hour before proceeding further.

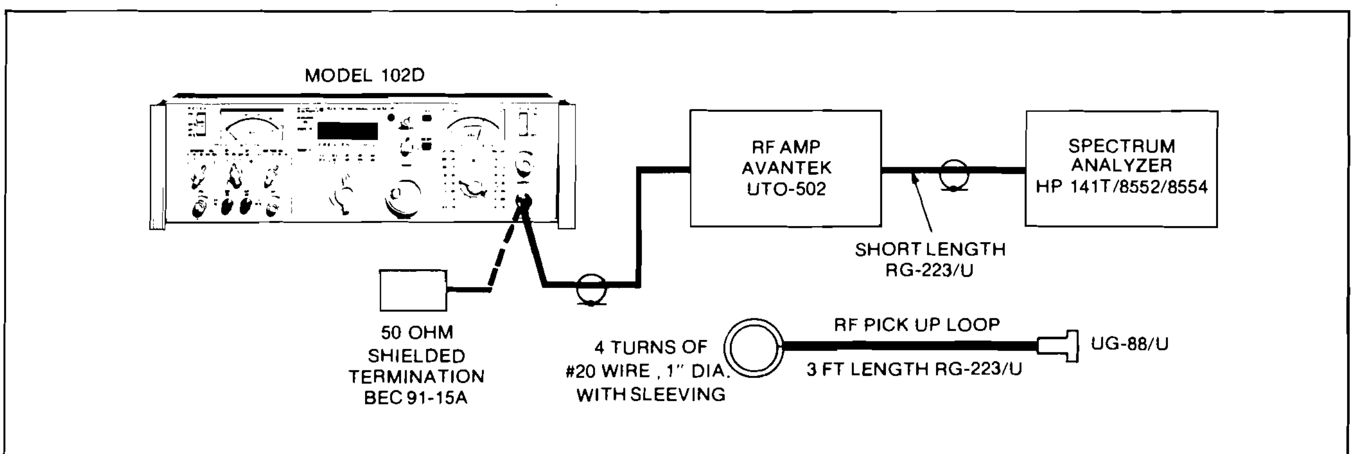


Figure 2-24 RF Leakage Check, Test Setup

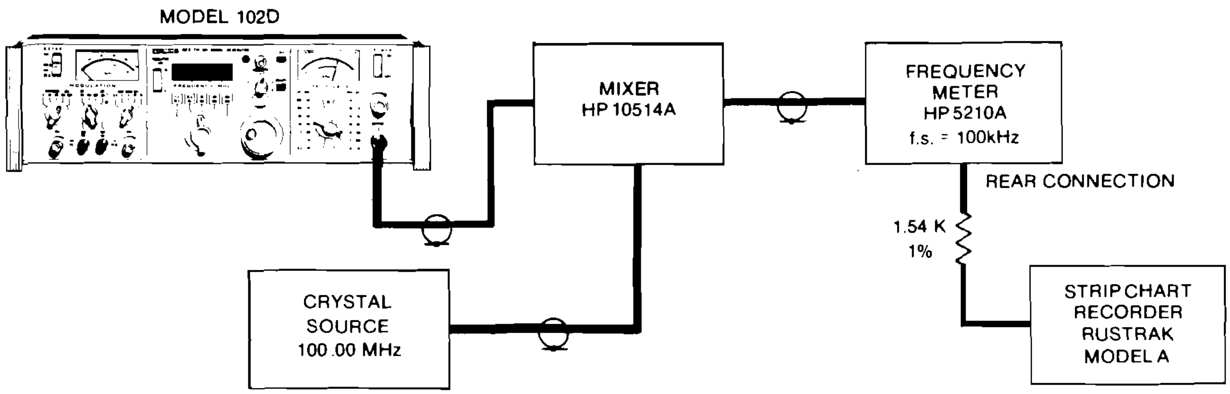


Figure 2-25 Frequency Stability Check, Test Setup

c. Readjust the TUNING control on the Model 102D as required to obtain a 70 kHz frequency indication on the frequency meter. Set the meter switch of the frequency meter to the expand 10X position, and adjust the offset control as required to obtain an indication of 5 on the meter. The strip chart recorder is now calibrated for a full-scale sensitivity of 10 kHz, or 1 kHz per division.

d. Operate the equipment over the desired time span, making certain that the Model 102D is not subjected to excessive vibration during this period.

e. At the end of the measurement period, examine the strip chart recording. *The maximum frequency excursion in any 10 minute period should not exceed 2.0 kHz.*

NOTE

If this band meets specification, all remaining bands will be within specification limits.

2-53. Frequency Stability Check (With Phase Lock). This paragraph provides instruction for checking the frequency stability of the Model 102D in the phase-locked mode of operation. Frequency stability checks should be performed for band 3 and for band 1. The frequency stability check for band 3 suffices for bands 2 through 5, and should be performed before the band 1 frequency stability check.

a. **Warm Up Drift.** To check the warm up drift, proceed as follows:

NOTE

Prior to this test, the Model 102D should have been off for at least 4 hours. A stable ambient temperature of 25 ±1°C and a stable line voltage of 120 ±1 volts (or 240 ±2 volts) must be maintained throughout this test.

1. Connect the Model 102D and the test equipment as shown in Figure 2-16.

2. Set the frequency counter controls for a range of 20 Hz to 200 MHz, resolution of 1 Hz, and X1 attenuation.

3. Set the controls of the Model 102D as follows:

Control	Position
INT/EXT switch	INT
FREQUENCY MHz switch	Band 3 (65 – 130)
RESOLUTION kHz switch	0.1
MODULATION function switch	CW
TUNING control	100 MHz indication on output frequency indicator
OUTPUT LEVEL attenuator	0 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter
LOCK pushbutton	Actuated

4. Record the output frequency of the Model 102D, as indicated on the frequency counter, immediately after turn on and lock, and each hour thereafter for a period of at least 5 hours. *The output frequency drift rate on band 3 should not exceed 20 Hz/hr after 1 hour, and 5 Hz/hr after 4 hours.*

5. Repeat this test with the FREQUENCY MHz switch set to band 1 (.45 – 32.5) and the TUNING control set to provide a 20 MHz output frequency indication on the output frequency indicator. *The output frequency drift rate on band 1 should not exceed 100 Hz/hr throughout the test period.*

b. **Line Voltage Influence.** To check the effect of line voltage variations on output frequency, proceed as follows:

1. Connect the Model 102D and the test equipment as shown in Figure 2-16.

2. Set the frequency counter controls for a range of 20 Hz to 200 MHz, resolution of 0.1 Hz, and X1 attenuation.

3. Set the controls of the Model 102D as follows:

Control	Position
INT/EXT switch	INT
FREQUENCY MHz switch	Band 3 (65 – 130)
RESOLUTION kHz switch	0.1
MODULATION function switch	CW
TUNING control	100 MHz indication on output frequency indicator
OUTPUT LEVEL attenuator	0 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter
LOCK pushbutton	Actuated

4. Allow the Model 102D to warm up fully at a line voltage of 120 ±1 volts (or 240 ±2 volts). At the end of this warmup period, record the output frequency indication on the frequency counter.

5. Adjust the line voltage to 108 ±1 volts (or 216 ±2 volts). Record the output frequency indication on the frequency meter.

6. Adjust the line voltage to 132 ±1 volts (or 264 ±2 volts). Record the output frequency indication on the frequency meter.

7. *The output frequency indications obtained in steps 5 and 6 should differ from the indication obtained in step 4 by 10 Hz or less.*

8. Repeat this check with the FREQUENCY MHz switch set to band 1 (.45 – 32.5), the TUNING control set to provide a 20 MHz output frequency indication on the output frequency indicator, and the frequency counter controls set for 1 Hz resolution. *The output frequency variations with the specified line voltage changes should not exceed 50 Hz.*

c. **Temperature Influence.** To check the effect of temperature variation on the output frequency, proceed as follows:

1. Place the Model 102D in a temperature chamber.

2. Connect the Model 102D and the test equipment as shown in Figure 2-16.

3. Set the frequency counter controls for a range of 20 Hz to 200 MHz, resolution of 1 Hz, and X1 attenuation.

4. Set the controls of the Model 102D as follows:

Control	Position
INT/EXT switch	INT
FREQUENCY MHz switch	Band 3 (65 –130)
RESOLUTION kHz switch	0.1
MODULATION function switch	CW
TUNING control	100 MHz indication on output frequency indicator
OUTPUT LEVEL attenuator	0 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter
LOCK pushbutton	Actuated

5. Maintain a constant line voltage of 120 ±1 volts (or 240 ±2 volts). Maintain the temperature in the temperature chamber at 25 ±1°C for a period of 6 hours. At the end of this period, record the output frequency indication on the frequency counter.

6. Set the temperature of the temperature chamber to 15 ±1°C and maintain this temperature for a period of at leats 6 hours. At the end of this period, record the output frequency indication on the frequency counter.

7. Set the temperature of the temperature chamber to 35 ±1°C and maintain this temperature for a period of at least 6 hours. At the end of this period, record the output frequency indication on the frequency counter.

8. *The total change in output frequency on band 3 should not exceed 200 Hz.*

9. Repeat this test with the FREQUENCY MHz switch set to band 1 (.45 – 32.5) and the TUNING control set to provide a 20 MHz indication on the output frequency indicator. *The total change in output frequency on band 1 should not exceed 5 kHz.*

2-54. Frequency Counter Stability Check.

a. **Warm Up Drift.** To check the warm up drift of the Model 102D frequency counter circuits, proceed as follows:

NOTE

Prior to this test, the Model 102D should have been off for at least 4 hours. A stable ambient temperature of 25 ±1°C and a stable line voltage of 120 ±1 volts (or 240 ±2 volts) must be maintained throughout this test.

1. Connect the Model 102D and the test equipment as shown in Figure 2-16.

2. Set the frequency counter controls for a range of 20 Hz to 200 MHz, resolution of 1 Hz, and X1 attenuation.

3. Set the controls of the Model 102D as follows:

Control	Position
INT/EXT switch	INT
FREQUENCY MHz switch	Band 3 (65 – 130)
RESOLUTION kHz switch	0.1
MODULATION function switch	CW
TUNING control	100 MHz indication on output frequency indicator
OUTPUT LEVEL attenuator	0 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter
LOCK pushbutton	Actuated

4. Record the indications of both the output frequency indicator on the Model 102D and the frequency counter immediately after turn on and lock, and each hour thereafter for a period of at least 6 hours. *The change in the indication on the output frequency indicator should not exceed the change in the frequency counter indication by more than ±1 count (±100 Hz).*

b. **Line Voltage Influence.** To check the effect of line voltage variations on the frequency counter circuits of the Model 102D, proceed as follows:

1. Maintain the same test setup and control settings as in the preceding warm up drift test.

2. Allow the Model 102D to warm up fully at a line voltage of 120 ±1 volts (or 240 ±2 volts). At the end of this warmup period, record the indications on both the output frequency indicator of the Model 102D and the frequency counter.

3. Adjust the line voltage to 108 ±1 volts (or 216 ±2 volts). Record the indications on both the output frequency indicator and the frequency counter.

4. Adjust the line voltage to 132 ±1 volts (or 264 ±2 volts). Record the indications on both the output frequency indicator and the frequency counter.

5. *The change in the indication on the output frequency indicator in steps 3 and 5 should not exceed the change in the frequency counter indication by more than ±1 count (±100 Hz).*

c. **Temperature Influence.** To check the effect of temperature variations on the frequency counter circuits of the Model 102D, proceed as follows:

1. Maintain the same test setup and control settings as in the preceding test.

2. Place the Model 102D in a temperature chamber.

3. Maintain a constant line voltage of 120 ±1 volts (or 240 ±2 volts). Maintain the temperature in the temperature chamber at 25 ±1°C for a period of 6 hours. At the end of this period, record the indications on both the output frequency indicator of the Model 102D and the frequency counter.

4. Set the temperature of the temperature chamber to 15 ±1°C and maintain this temperature for a period of at least 6 hours. At the end of this period, record the indications on both the output frequency indicator and the frequency counter.

5. Set the temperature of the temperature chamber to 35 ±1°C and maintain this temperature for a period of at

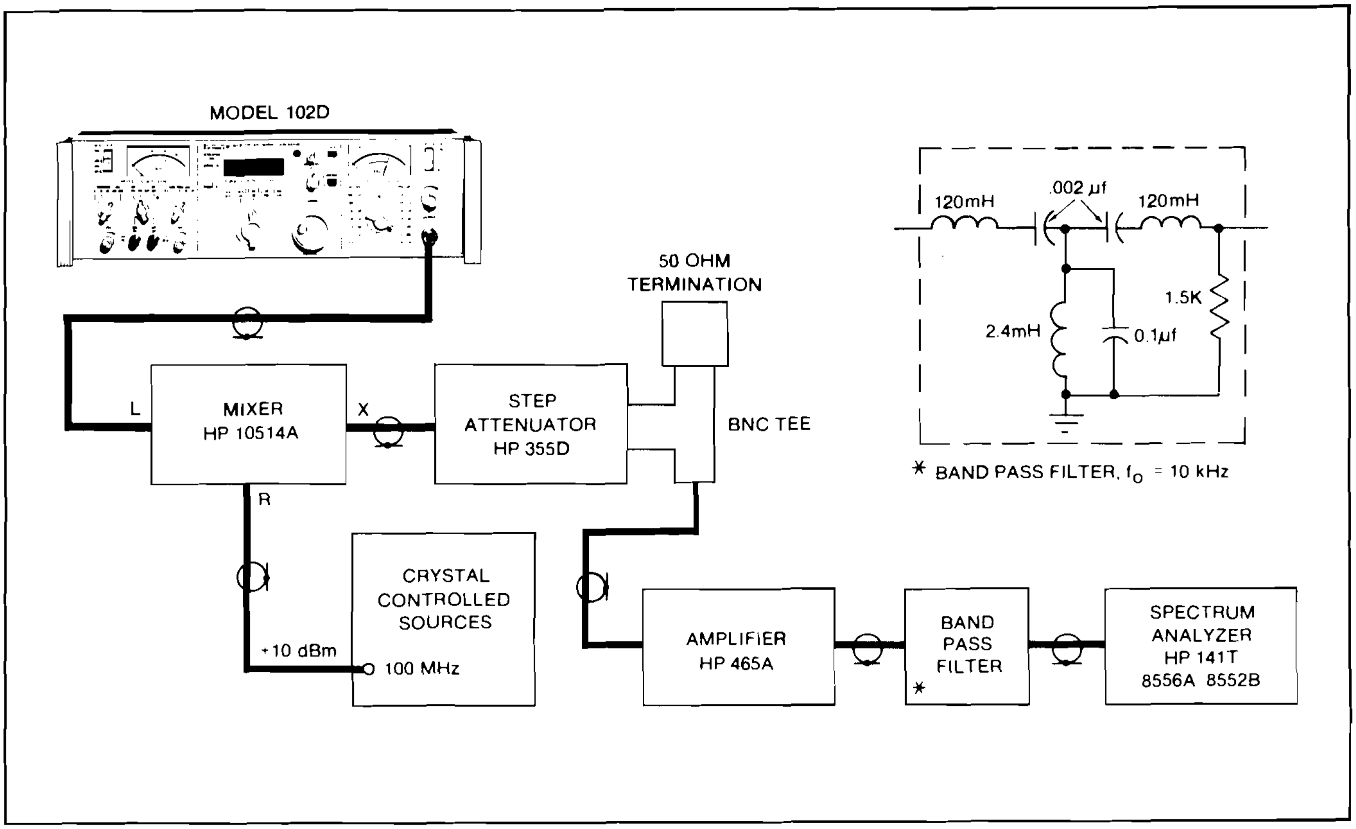


Figure 2-26 Single Sideband Total Noise Check, Test Setup

least 6 hours. At the end of this period, record the indications on both the output frequency indicator and the frequency counter.

6. *The total change in the indications of the Model 102D output frequency indicator should not exceed that of the frequency counter by more than 2 counts (200 Hz).*

2-55. Single Sideband Total Noise Check. To check single sideband total noise, proceed as follows:

a. Connect the Model 102D and test equipment as shown in Figure 2-26.

b. Set the MODULATION function switch on the Model 102D to CW, the FREQUENCY MHz switch to band 3 (65 – 130), and the TUNING control to the setting required to produce a 100.010 MHz indication on the output frequency indicator. Set the OUTPUT LEVEL attenuator to 0 dBm, and position the pointer of the OUTPUT LEVEL to -7 dB, using the OUTPUT control.

c. Set the step attenuator to 70 dB.

d. Set the spectrum analyzer bandwidth to 1 kHz, the scan width to 5 kHz per division, the center frequency to 10 kHz, the video filter to 10 Hz, the scan time to 1 second per division, and the input level control to the -40 dBm position.

e. The 10 kHz i-f signal should appear on the spectrum analyzer display. Using the display reference level controls, align the peak of the 10 kHz signal display with the top graticule.

f. Using the TUNING control on the Model 102D, set the output frequency to 100.030 MHz, and set the step attenuator to 0 dB. The spectrum analyzer is now calibrated for measurement of noise, with the top graticule representing a value of 100 dB per Hz. The i-f signal should appear at the 30 kHz position on the spectrum analyzer display. Measure the noise level at the 10 kHz position (20 kHz off the i-f signal) on the display. *The noise level should be at least 20 dB below the top graticule.*

SECTION III
THEORY OF OPERATION

3-1. GENERAL.

3-2. FM-AM Signal Generator, Model 102D, is a compact, versatile, solid-state instrument that covers the frequency range of .45 to 520 MHz in five bands. The primary signal source is a very stable, spectrally pure, solid-state VFO, optimized for operation over one of the five frequency bands. Output frequencies for the other four bands are derived from the VFO output frequency through frequency division, frequency multiplication, and heterodyne techniques.

3-3. The output frequency of the Model 102D can be synchronized to a very stable internal reference oscillator or to an external reference standard by means of a built-in phase lock circuit. Any output frequency within the tuning range of the Model 102D can be phase locked to achieve excellent frequency stability. Phase lock is maintained almost indefinitely once the instrument is warmed up and operated under reasonably stable environmental conditions. The phase lock feature imposes no restrictions regarding modulation capabilities of the instrument except to limit FM bandwidth to above 50 Hz.

3-4. A six-digit LED display provides a direct, continuous display of output frequency. Selectable resolution capabilities of 0.1, 1, and 10 kHz are included, thereby providing direct frequency readout of up to six digits. This feature provides excellent resetability and accuracy.

3-5. A 130 dB step attenuator and an adjustable output level control provide a total output level range of -130 to +13 dBm. The selected output level is automatically maintained throughout the frequency range, independently of frequency tuning, through use of a PIN diode modulator and feedback loop. The diode modulator also provides AM modulation capability. FM modulation capability is provided through use of a varactor in the VFO resonant circuit. AM and FM can be used either separately or simultaneously, using internal and external modulating signals.

3-6. SIMPLIFIED BLOCK DIAGRAM.
(See Figure 3-1.)

3-7. **General.** For purposes of this discussion, the circuits of the Model 102D can be grouped by function as follows: frequency generating circuits, phase lock circuits, signal processing circuits, output circuits, modulation circuits, frequency counter circuits, and power supply circuits. The interrelationship of these functional groups is shown in Figure 3-1, and discussed in paragraphs 3-8 through 3-24. In order to simplify the discussion, switching details are not covered at this level. For a detailed description of the functional groups, refer to paragraphs 3-25 through 3-79.

3-8. **Frequency Generating Circuits.** The basic frequency of the Model 102D is developed by a solid-state VFO, which is tunable inductively over a range of 65 to 131.2 MHz. A varactor in the VFO resonant circuit permits electronic tuning of the VFO over a frequency range of approximately 25 kHz for vernier adjustment of output frequency. The varactor is also used to automatically maintain the selected VFO frequency during phase-locked operation, and to modulate the VFO for FM applications. Isolation between the VFO and the signal processing circuits is provided by a single-stage buffer amplifier. This isolation reduces incidental modulation effects which might otherwise be produced by a change in the circuit impedance of following stages because of leveling or AM operations.

3-9. Since the VFO operates over only one of the output bands, circuit design has been optimized for operation over this range, and the VFO consequently exhibits excellent frequency stability characteristics and relative freedom from residual FM. Frequency variation due to line voltage changes and supply ripple is minimized through use of a highly regulated and filtered supply voltage. The entire VFO is housed in a shielded compartment to minimize RF leakage. Frequency stability can be further improved through use of the built-in phase lock feature.

3-10. **Phase Lock Circuits.** The phase lock circuits provide means for synchronizing the VFO to a very stable internal reference oscillator or to an external reference standard for applications where extreme frequency stability is required. Switching between the unlocked and phase-locked modes of operation is simply accomplished through actuation of front panel controls. A front panel indicator provides a positive indication of phase lock. When the phase-locked mode of operation is selected, the VFO output signal is used to clock an internal counter, which is gated by an extremely stable 1 MHz internal oscillator, or by the external frequency standard. If the frequency of the VFO tends to shift from the phase-locked value, an error voltage is developed by the phase lock circuits. This error voltage is applied to the varactor in the VFO resonant circuit, thereby causing an opposite shift in the VFO output frequency to compensate for the original change. The phase lock circuits have a low-pass output with a roll-off starting at approximately 5 Hz, thereby permitting frequency modulation rates as low as 50 Hz.

3-11. **Signal Processing Circuits.** The signal processing circuits encompass all circuit elements required to derive the final output frequencies from the VFO output frequency. Electronic band switching is accomplished by means of PIN diodes, thus eliminating one of the major sources of instability in other signal generators and allowing use of each band without the need for extended warmup periods. Wideband circuits are employed; therefore, tracked tuning is not required, minimizing maintenance problems and improving long-term stability.

3-12. The output frequencies for the five bands of the Model 102D are derived from the VFO output frequency as follows:

a. The frequency range of 0.45 to 32.5 MHz (band 1) is derived through heterodyne action. The VFO output frequency is divided in a binary divider circuit, and the resulting signal is heterodyned with the output of a highly-stable, crystal-controlled 66.025 MHz oscillator.

b. The frequency range of 32.5 to 65 MHz (band 2) is derived from the VFO output through frequency division.

c. The frequency range of 65 to 130 MHz (band 3) is derived directly from the VFO output.

d. The frequency range of 130 to 260 MHz (band 4) is derived from the VFO output through frequency multiplication.

e. The frequency range of 260 to 520 MHz (band 5) is derived from the VFO output through additional frequency multiplication.

3-13. Harmonics and other spurious signals generated as a result of frequency division, frequency multiplication, or heterodyning are suppressed by means of low-pass, high-pass, or band-pass filters. PIN diodes are used to switch the filters into the circuits electronically at the appropriate points. The output signals from the signal processing circuits exhibit excellent spectral purity because of the filtering employed.

3-14. **Output Circuits.** The output circuits control the amplitude of the output signal of the Model 102D. Included in the output circuits are a PIN diode modulator, RF amplifiers, a diode detector, and output level attenuating and metering circuits. All output rf circuits are wide band, covering the full 0.45 to 520 MHz range.

3-15. Signal processing circuit output signals are switched to the output circuits by means of PIN diodes. These signals are routed through a PIN diode modulator and an RF amplifier to the output level attenuator and to a diode detector. The diode detector samples the output signal amplitude and feeds back a control voltage to the diode modulator for automatic leveling of the output signal amplitude. (The diode modulator is also used for AM.) The leveling loop virtually eliminates variations in output amplitude due to changes in VFO or signal processing circuit output levels. The diode detector also supplies a DC voltage to the output level metering circuits to provide an indication of output level. Output level is adjustable in 10 dB steps by means of a precision step attenuator, and between these steps by means of the variable OUTPUT control.

3-16. **Modulation Circuits.** The modulation circuits process the audio voltages used for AM and FM applications. AM and FM can be used separately or simultaneously. An internal modulation oscillator is included to provide an internal modulation signal capability. Distortion, residual and incidental FM, and residual AM are exceptionally low in the Model 102D. The modulation mode is selected by means of the front panel MODULATION function switch.

3-17. When the CW mode is selected, the modulation circuits are disabled. The varactor in the VFO circuit is used only for vernier adjustments of the output frequency, and the diode modulator in the output circuits is used only for automatic leveling. The output of the Model 102D is, therefore, a stable, automatically leveled, unmodulated RF signal.

3-18. When the INT AM mode is selected, the internal modulation oscillator is energized, and the modulation circuits supply an internally generated AF modulating signal to the diode modulator. Any one of five modulation frequencies, 0.4 kHz, 1 kHz, 3 kHz, 10 kHz or 19 kHz, can be selected by means of a front panel switch. The amplitude of the modulating voltage (and thus the percentage of modulation) is ad-

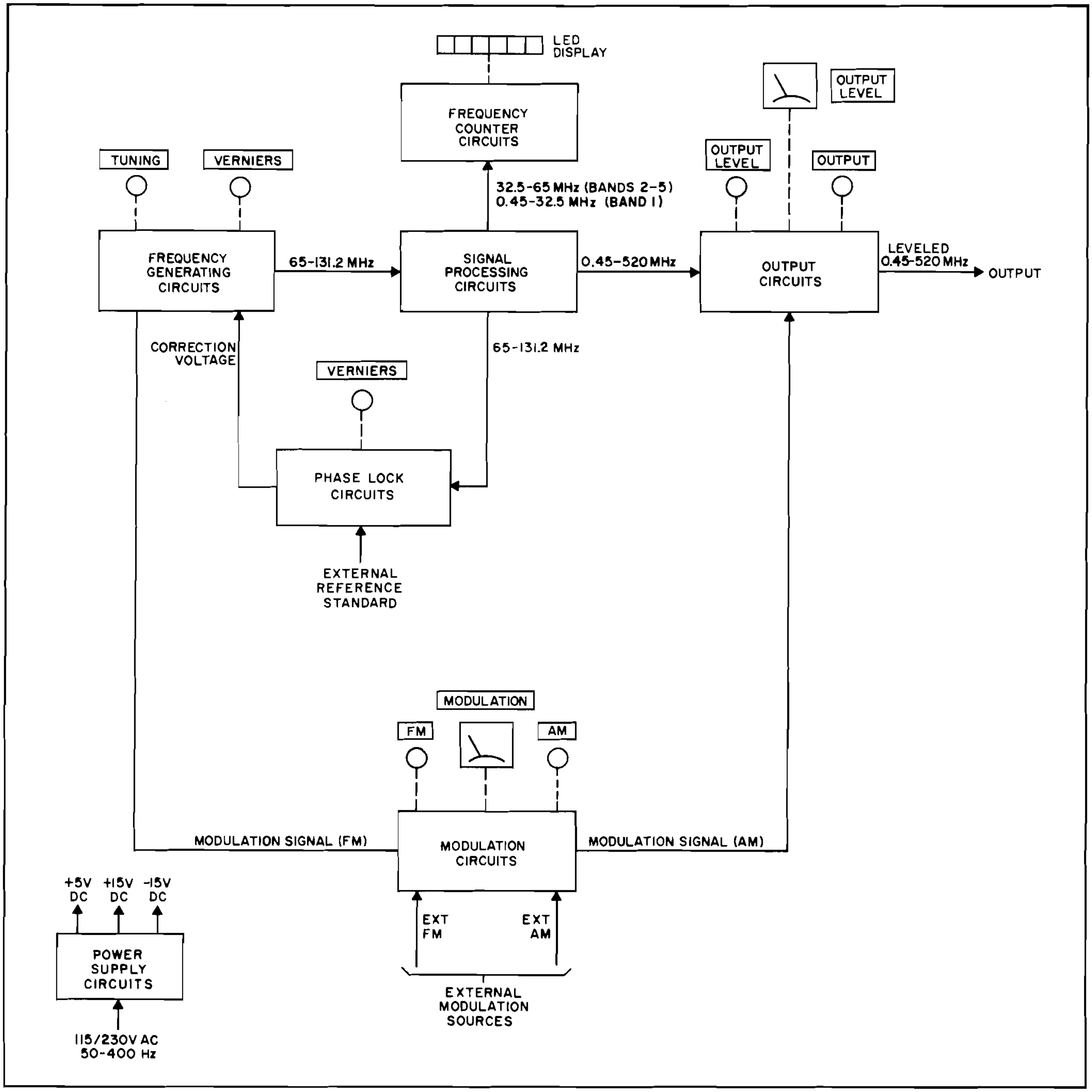


Figure 3-1 Simplified Block Diagram

justable by means of the AM control. The MODULATION meter can be switched into the AM portion to provide a direct indication of the percentage of modulation. AM is accomplished by varying the effective shunt and series impedances of the diode modulator in the output circuits. The diode modulator provides AM modulation capabilities up to 100 percent with low distortion. Along with the internal AM, simultaneous FM using an external modulation signal source is possible. FM is accomplished by applying the external modulation signals to the varactor in the VFO. The calibrated full scale peak deviation for FM is adjustable from 3 kHz to 300 kHz, in five steps, by means of a front panel switch. The actual deviation is adjustable up to the selected full scale value by means of the FM control. The MODULATION meter can be switched into the FM portion to provide a direct indication of deviation. Because FM is accomplished at the VFO and the VFO output frequency is subject to multiplication or division in the signal processing circuits, the amplitude of the modulation signal voltage is automatically adjusted for the different output bands by means of attenuation networks switched into the FM portion by the front panel band switch. This feature ensures that deviation will remain constant, regardless of the frequency band selected.

3-19. When the INT FM mode is selected, operation of the modulation circuits is reversed in terms of the modulation signal sources. The internal modulation oscillator provides the modulation signal for the FM portion. Simultaneous AM, using an external modulation signal source, is possible. Except for the modulation signal sources, operation of the FM and AM portions of the modulation circuits is identical to that described in paragraph 3-18.

3-20. When the EXT mode is selected, the internal modulation oscillator is disabled. AM and FM can be used either individually or simultaneously, but external modulation signals must be provided for both AM and FM. Except for the modulation signal sources, operation of the FM and AM portions of the modulation circuits is identical to that described in paragraph 3-18.

3-21. **Frequency Counter Circuits.** The frequency counter circuits provide a continuous, unambiguous display of the output frequency of the Model 102D. Resolutions of 10, 1, or 0.1 kHz are selectable by means of a front panel switch. The 10 kHz resolution provides a frequency display, in MHz, accurate to two decimal places; the 1 kHz resolution, a frequency display accurate to three decimal places; and the 0.1 kHz resolution, a frequency display accurate to four decimal places.

NOTE

Because only six digits can be accomodated by the LED frequency display, the most significant digit will be shifted out of the display when resolution is switched to 0.1 kHz at frequencies of 100 MHz and higher.

3-22. Input signals are supplied to the frequency counter circuits from the signal processing circuits. On band 1 the input signal frequency is the same as the output frequency of the Model 102D. On bands 2 through 5, the input signal frequency is one-half the VFO output frequency. A prescaler divides the input frequency by 10 to minimize the possibility of signal radiation from the frequency counter circuits. The frequency counter circuits generate a gate pulse, which enables a group of decade counters to count the applied signal pulses during the gate interval. Following the gate interval, six LED diodes are strobed to display the count; then, the counter circuits are reset for the next cycle of operation.

3-23. The actual number of pulses counted in the frequency counter circuits bear only a decimal relationship to the actual output frequency of the Model 102D. Note also that the input signal frequency is not affected as the Model 102D is switched from band 2 to bands 3 through 5. In order to produce a frequency display that reflects the actual output frequency, the gate pulse interval is changed as the band switch is rotated. For example, the band 3 output frequency range is twice that of band 2; therefore, the gate pulse interval is doubled when the Model 102D is switched from band 2 to band 3. Although the frequency of the pulses applied to the frequency counter circuits has not changed, twice as many pulses will be counted because of the doubled gate pulse interval, and the LED diode display will be twice that on band 2. The gate pulse interval is again doubled in switching from band 3 to band 4, and once again doubled in switching from band 4 to band 5. The LED diode display thus corresponds to the actual output frequency of the Model 102D.

3-24. **Power Supply Circuits.** The power supply circuits develop the DC voltages required for operation of the internal circuits of the Model 102D. Three separate rectifier-regulator combinations are employed, providing regulated output voltages of +5 volts, +15 volts, and -15 volts. The +5 volt, +15 volt, and -15 volt supplies are very closely regulated and well filtered in order to minimize residual FM and to enhance the stability of the Model 102D. The power supply circuits are designed for operation from an ac power source of 100, 120, 220, or 240 volts. A switch on the rear panel of the Model 102D alters circuit connections as required to accomodate either power source.

NOTE

The input current at 100 and 120 volts is twice that at 220 and 240 volts; therefore, the line fuse must also be changed when switching from a 100 or 120 volt power source to a 220 or 240 volt power source, or vice versa.

3-25. DETAILED THEORY OF OPERATION, FREQUENCY GENERATING CIRCUITS.

(See Figure 3-2.)

3-26. The basic frequency source of the Model 102D is the VFO, which is a highly stable, solid-state oscillator, optimized for operation over the frequency range of 65 to 131.2 MHz. Main tuning is accomplished by means of a variable inductor, thereby reducing microphonism to a very low level. A varactor in the resonant circuit of the VFO provides FM, phase lock, and electronic fine tuning capabilities. The effective capacitance of the varactor is controlled by a DC bias that is adjustable by means of the unlocked VERNIERS control, by the phase lock correction

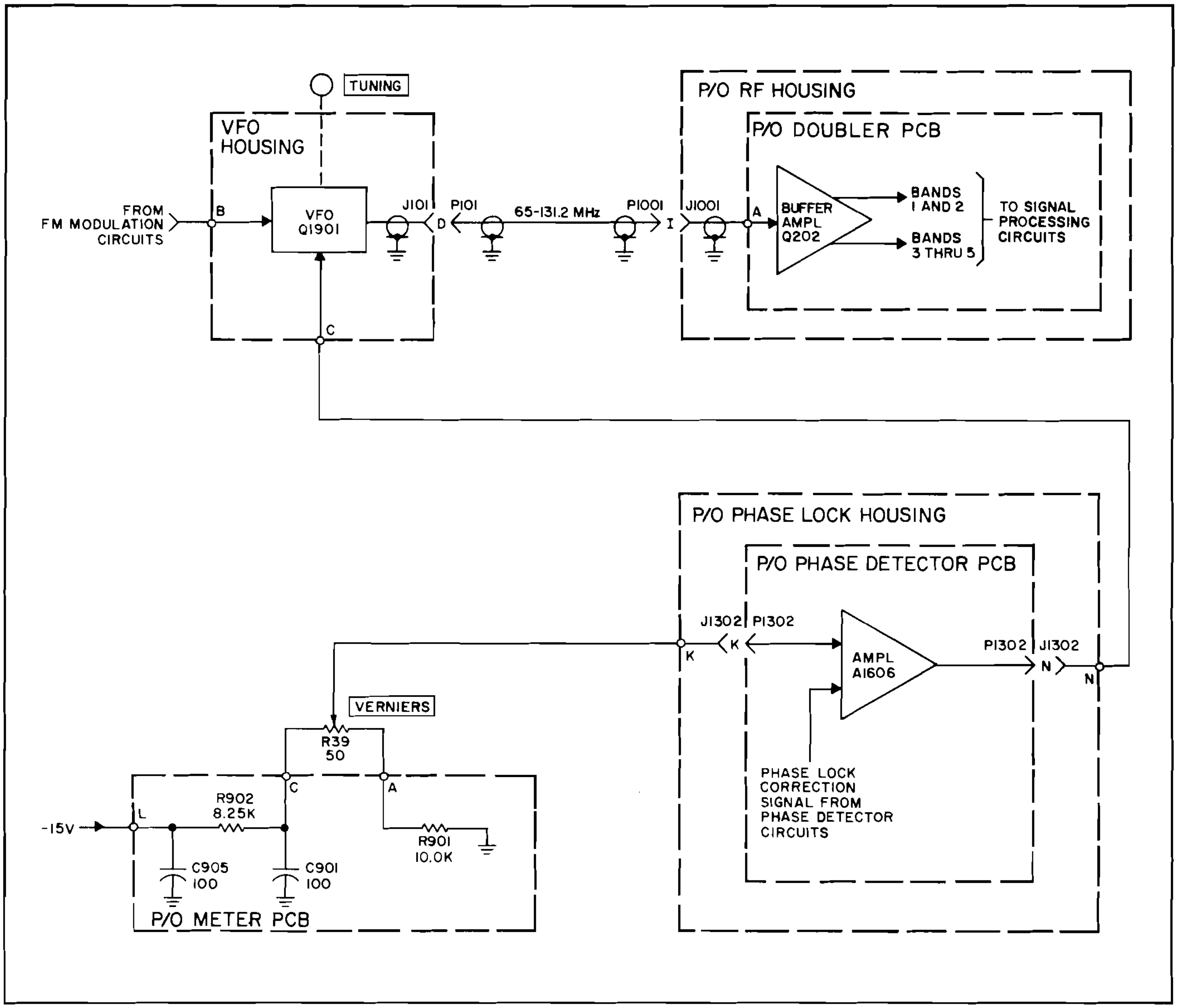


Figure 3-2 Frequency Generating Circuits, Detailed Block Diagram

signal, and by the FM modulation signal. When the Model 102D is operating in the phase locked mode, adjustment of the unlocked VERNIERS control generally does not cause loss of lock or change of frequency because the phase lock circuits have sufficient dynamic range to compensate for such adjustment. However, adjustment of the unlocked VERNIERS control will reduce the dynamic range of the phase lock loop in one direction; therefore, this control should not be adjusted after phase lock is achieved. A variable capacitor tracked to the TUNING control maintains the deviation sensitivity of the VFO varactor essentially constant over the entire tuning range of the VFO. The VFO is completely shielded to prevent r-f radiation.

3-27. The r-f signal generated by the VFO is applied to a single-stage buffer amplifier which provides isolation between the VFO and the following signal processing circuits. This isolation reduces incidental modulation effects which might be produced by changes in the input impedance of the diode modulator in the output circuits as a result of leveling and AM operations. The buffer amplifier supplies a 1 Vrms signal to the signal processing circuits for bands 3 through 5, and a separate 1 Vrms signal to the signal processing circuits for bands 1 and 2.

3-28. DETAILED THEORY OF OPERATION, PHASE LOCK CIRCUITS.

(See figure 3-3)

3-29. For the phase-locked mode of operation, the Model

102D uses an individual counter and time base, together with a phase detector, filter, and amplifier. Selection of the phase-locked mode or unlocked mode is accomplished by means of the front panel LOCK and UNLOCK pushbuttons.

3-30. In the unlocked mode of operation, monostable multivibrator IC1704 is in its normal quiescent state, and the output levels of the multivibrator establish circuit conditions for the unlocked mode. The VFO frequency is divided by 16 and is then applied to the counter circuits. The counter circuits are gated by 50 Hz counter gate pulses. These counter gate pulses are derived from the very stable 1 MHz output of oscillator Y1501 (INT/EXT switch set to the INT position) or from an external 1 MHz reference signal applied to connector J25 (INT/EXT switch set to the EXT position). The 1 MHz reference frequency is divided by dividers IC1502 through IC1506 to provide a 50 Hz counter gate signal. The dividers also generate a 10 Hz output signal that is used in the phase lock indicator drive circuits.

3-31. During the count gate interval, the pulses derived from the VFO output are counted by counters IC1707, IC1710, IC1713, IC1715, and IC1718. At the end of the count gate interval, the count is loaded into latches IC1706, IC1709, IC1712, IC1714, and IC1717, and the counters are cleared for the next cycle of operation. The latch output lines are so selected that the complement of the count appears on these output lines. As long as the Model 102D is operated in the unlocked mode, this action repeats with each counter gate pulse; therefore, at any time, the complement of the counter output count is stored in the latches.

3-32. When the LOCK pushbutton is pressed, monostable multivibrator IC1704 can be triggered by the 50 Hz counter gate pulses, and the phase-locked circuit configuration is established. The latches contain the complement of the last count. When a full-count condition is reached in the counters, a load pulse is generated, and the complement count from the latches is loaded into the counter. The counter then counts the same number of input pulses as it had in the unlatched mode, at which point a full-count condition is again reached and another load pulse is generated. To illustrate this process, consider a decade counter that had counted to 4. The complement of this count would be 6, and this 6 count would be stored in the corresponding latch and loaded into the counter when a load pulse occurred. The counter could then count only 4 pulses (the same number as its original count) before the full-count condition again occurred and another load pulse was generated. Note that termination of the count in the counters is no longer determined by the counter gate pulse duration, but is determined instead by the full-count condition. If the frequency of the input pulses to the counter remains constant, the period of the load pulses would remain constant; however, if the frequency of the input pulses tended to shift, the period of the load pulses would shift correspondingly, and more or less load pulses would tend to be generated in any fixed period of time.

3-33. The load pulses are compared with the counter gate pulses in the phase detector. If the period of the load pulses tends to shift, an error voltage is generated. This error voltage is amplified, integrated, and filtered, and is applied to the varactor in the VFO tuning circuit with the correct polarity and magnitude to correct the VFO frequency to that existing at the time that the phase locked mode was established. Filtering of the error voltage is of the low-pass type, with roll off starting at approximately 5 Hz. This permits frequency modulation rates as low as 50 Hz in the Model 102D with phase-locked operation. A null type filter tuned to 50 Hz is also incorporated to reduce undesirable effects when the carrier is modulated at or near 50 Hz. Differential amplifier A1606 permits use of the same varactor in the VFO tuned circuit for frequency vernier purposes in the unlocked mode and for frequency correction in the phase-locked mode. The 1 MHz crystal oscillator from which the counter gate pulses are derived is adjustable over a range of approximately 20 ppm to permit locking at all frequencies in the tuning range of the Model 102D. When the internal 1 MHz reference signal is selected, this same reference signal is available at connector J25 for possible use in synchronizing other instruments.

3-34. The phase lock indicator drive circuits supply a drive signal to the front panel phase lock indicator. If phase lock is lost, the error voltage exceeds a predetermined value, and the 10 Hz signal from divider IC1506 is gated through to cause blinking of the front panel phase lock indicator to indicate loss of lock. As long as phase lock is maintained, the 10 Hz signal is blocked, and the front panel phase lock indicator is lighted continuously.

3-35. DETAILED THEORY OF OPERATION, SIGNAL PROCESSING CIRCUITS.

3-36. **Bands 1 and 2.** (See Figure 3-4.) The output frequency range of 32.5 to 65 MHz (band 2) is derived from the VFO output frequency range by means of frequency division. The output frequency range of 0.45 to 32.5 MHz (band 1) is obtained by heterodyning the divided output of the VFO with the output of a highly stable, crystal controlled, 66.025 MHz oscillator.

3-37. The output r-f signal of the VFO, within the frequency range of 65 to 131.2 MHz, is applied through a four-stage isolation amplifier to a binary divider. The isolation amplifier is employed because the binary divider has little input-output isolation, and the output of the binary divider appears as a subharmonic of the output frequency on the three highest bands of the Model 102D. The binary divider consists basically of an astable multivibrator, which is synchronized by the 65 to 131.2 MHz signal supplied by the isolation amplifier. The 32.5 to 65.6 MHz output of the binary divider is used on all bands of the Model 102D. On bands 1 and 2, it is used in the signal processing circuits to develop the output frequency of the Model 102D. On bands 2 through 5, it is applied to the frequency counter circuits to produce a display of the output frequency of the Model 102D.

3-38. Because the binary divider employs a multivibrator circuit, the output is rich in harmonics. If the spectral purity of the Model 102D is to be maintained, these harmonics must be suppressed. Two low-pass filters are employed for this purpose, one covering the frequency range of 0 to 47 MHz, and the second, the frequency range of 0 to 68 MHz. Selection of the appropriate filter is accomplished electronically by means of PIN diodes and a cam-operated switch coupled to the TUNING control. When the TUNING control is set to a frequency between 32.5 and 45 MHz, +15 volts DC is applied by the cam-operated switch to the diodes, forward-biasing diodes CR405 and CR407, and reverse-biasing diodes CR404 and CR406. The binary divider output signal is then routed through conducting diodes CR405 and CR407 and the 0 to 47 MHz filter to a section of the FREQUENCY MHz switch. When the TUNING control is set to a frequency between 45 and 65 MHz, -15 volts DC is applied by the cam-operated switch to the diodes, diodes CR404 and CR406 are forward-biased, and the 0 to 68 MHz filter is connected into the signal path. Note that two filters are required because of the harmonic relationship between the low-frequency and high-frequency ends of the tuning range. If one filter covering a frequency range of 0 to 68 MHz were employed, the second harmonic of a 32.5 MHz output signal, for example, would fall within the pass band of the filter and would not be suppressed. Depending upon the setting of the FREQUENCY MHz switch, the output r-f signal from the selected low-pass filter is applied either to the output circuits (band 2) or to mixer Z401 (band 1).

3-39. When the FREQUENCY MHz switch is set to .45 – 32.5 (band 1), the filtered 32.5 to 65.6 MHz signal is applied to one input of mixer Z401, and +15 volts DC is supplied to energize crystal oscillator Q414 and dual amplifier Q410 through Q413. The second input to the mixer consists of the 66.025 MHz output signal from the crystal oscillator. The difference signal (0.45 to 32.5 MHz) developed by the mixer is applied to separate channels of dual channel amplifier Q410 through Q413. One channel supplies a 0.45 to 32.5 MHz signal to the output circuits, and the second channel supplies a 0.45 to 32.5 MHz signal to the frequency counter circuits. The separate input to the frequency counter circuits on band 1 is required because the integer relationship that exists between the Model 102D output frequency and the binary divider output frequency on the four higher bands is voided by the mixing process.

NOTE

Because the crystal oscillator frequency is above the binary divider output frequency, the difference frequency will decrease as the VFO frequency is increased; therefore, on band 1, clockwise rotation of the TUNING control results in a decrease in the output frequency of the Model 102D. On all other bands, clockwise rotation of the TUNING control results in an increase in the output frequency.

3-40. **Bands 3 through 5**. (See Figure 3-5.) The output frequency range for band 3 falls within the tuning range of the VFO. The signal processing circuits for band 3, therefore, consist only of two low-pass filters, which are electronically switched into the output signal path by means of diodes. One filter has a pass band of 0 to 93 MHz, and the second, a pass band of 0 to 135 MHz. When the FREQUENCY MHz switch is set to band 3 and the TUNING control is set to an output frequency from 65 to 90 MHz, a cam-operated switch coupled to the TUNING control applies +15 volts DC to diodes CR202, CR203, CR205, and CR206, and the 0 to 93 MHz filter is effectively connected into the signal path by forward-biased diodes CR202 and CR205 to suppress harmonics and other spurious signals. When the TUNING control is set to an output frequency from 90 to 130 MHz, -15 volts DC is supplied to the diodes by the cam-operated switch, and the 0 to 135 MHz filter is effectively connected into the signal path by forward-biased diodes CR203 and CR206. The filtered 65 to 130 MHz output signal is switched electronically to either the output circuits (band 3) or to the band 4 signal processing circuits (band 4 and 5) by means of diodes CR204 and CR207, respectively. Control voltage for the diodes is supplied through a section of the FREQUENCY MHz switch.

3-41. The band 4 frequency range of 130 to 260 MHz is derived by means of a wide-band, full-wave, frequency doubler circuit, driven at the VFO frequency. The filtered 65 to 130 MHz output of the band 3 signal processing circuits is applied to first doubler CR208A-CR208B when the FREQUENCY MHz switch is set to band 4. This input frequency and undesired harmonics are filtered from the 130 to 260 MHz output of the first doubler by electronically switched band-pass filters. A 130 to 158 MHz, 158 to 205 MHz, or 205 to 260 MHz band-pass filter is automatically switched into the signal path at appropriate points in the output frequency range by means of diodes, powered by DC voltages applied from cam-operated switches coupled to the TUNING control. Additional filtering of the 65 to 130

MHz first doubler input frequency is provided by a high-pass filter. The filtered, 130 to 260 MHz r-f output signal is applied either to the output circuits (band 4) or to the band 5 signal processing circuits (band 5). A section of the FREQUENCY MHz switch supplies appropriate DC voltages to diodes CR215 and CR216 to accomplish the output signal switching electronically.

3-42. The 260 to 520 MHz output frequency range for band 5 is derived in a manner similar to that for band 4. When the FREQUENCY MHz switch is set to band 5, -15 volt DC operating power is supplied to band 5 driver Q206 – Q207, and the 130 to 260 MHz output of the band 4 signal processing circuits is switched to the band 5 driver through diode CR216. The band 5 driver is a two-stage amplifier that provides the approximately 5 milliwatt input power level required for operation of second doubler CR208C-CR208D. The applied 130 to 260 MHz input frequency is doubled by the second doubler, and the resulting 260 to 520 MHz r-f output signal is applied to band-pass filters which provide suppression of harmonic and subharmonically related components. Three band-pass filters of interdigital stripline design are used for band 5. The filters are switched into the signal path at appropriate points in the frequency range by diodes powered by DC voltages supplied by cam-operated switches coupled to the TUNING control. The filtered 260 to 520 MHz output from the filters is applied to the output circuits.

3-43. DETAILED THEORY OF OPERATION, OUTPUT CIRCUITS.

(See Figure 3-6.)

3-44. The output circuits of the Model 102D provide wide-band r-f amplification, automatic leveling, amplitude modulation, and output level adjusting and metering capabilities. Input r-f signals are supplied to the output circuits from the signal processing circuits.

3-45. Input signal switching is accomplished electronically by means of diodes CR2001 through CR2005. The diodes are powered individually by DC voltages supplied through one section of the FREQUENCY MHz switch. The selected r-f input signal is coupled through the corresponding forward-biased diode and amplifier A2001 to the AM modulator. The AM modulator performs two functions: automatic leveling and amplitude modulation. The AM modulator consists of series connected PIN diodes, whose impedance is determined by a control voltage supplied by differential amplifier A2002. By varying the impedances of the diodes, the amplitude of the r-f output signal of the Model 102D can be varied.

3-46. For automatic leveling operations, a level determined by the setting of the OUTPUT control is applied as one input to differential amplifier A2002. The second input is a DC voltage derived from detecting the r-f output signal of the Model 102D, and having a magnitude proportional to the r-f output signal amplitude. As long as the dc level corresponds to the level selected by means of the OUTPUT control, the output r-f level remains constant. If the output level of the Model 102D should tend to deviate from the present level, a feedback signal is developed by the differential amplifier, and the feedback signal changes the impedances of the diodes in the AM modulator in the proper direction to compensate for the change in the output level. The feedback loop maintains the output level of the Model 102D within ± 0.5 dBm of the selected value regardless of frequency changes within a particular band.

3-47. For AM operation, the modulation signal voltage is superimposed upon the DC level applied from the OUTPUT CONTROL. The output of differential amplifier A2002 is, therefore, a signal that corresponds to the modulation signal. The impedances of the diodes in the AM modulator vary in accordance with the modulation signal, and the r-f output of the AM modulator is an AM signal. When this signal is detected by diode demodulator CR2014 a modulation signal component will be present in the diode demodulator output along with the DC component, and negative feedback at the modulation signal frequency occurs. This negative feedback improves the linearity of AM, especially at low modulation signal frequencies where the loop gain is high.

3-48. The output signal of the AM modulator is amplified by wide-band r-f amplifier A2003, then applied to the OUTPUT LEVEL attenuator through a 50 ohm resistor which establishes the source impedance. The r-f amplifier also supplies the input signal for diode demodulator CR2014. In addition to its leveling function previously mentioned, the diode demodulator supplies DC to the OUTPUT LEVEL meter to provide a direct indication of the output level of the Model 102D. The scale of the OUTPUT LEVEL meter is calibrated to indicate both dBm and voltage levels for a 50 ohm load. Potentiometer R915 provides a means for electrical zeroing of the OUTPUT LEVEL meter, potentiometer R905 is used to calibrate the meter on band 5, and potentiometer R904 is used to calibrate the meter on the four remaining bands. If the Model 102D is equipped with option 03, the detected AM modulation signal developed in the diode demodulator circuit is also applied to amplifier A2004. Amplifier A2004 is a voltage follower, which provides an isolated demodulated AM output signal that is available at a rear panel connector of the Model 102D.

3-49. The 0.45 to 520 MHz r-f output signal of r-f amplifier A2003 is applied through the OUTPUT LEVEL attenuator to the front panel OUTPUT connector. The

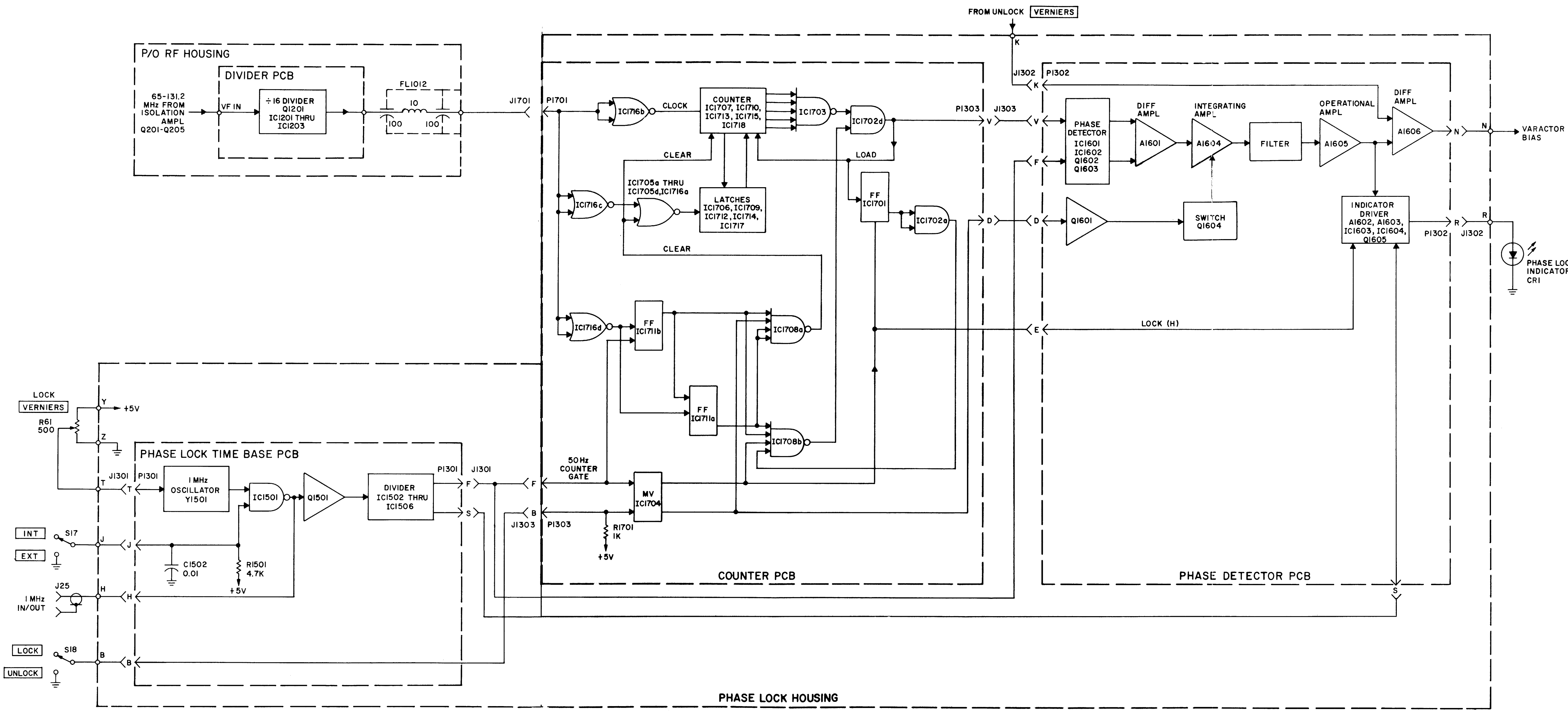


Figure 3-3 Phase Lock Circuits, Detailed Block Diagram

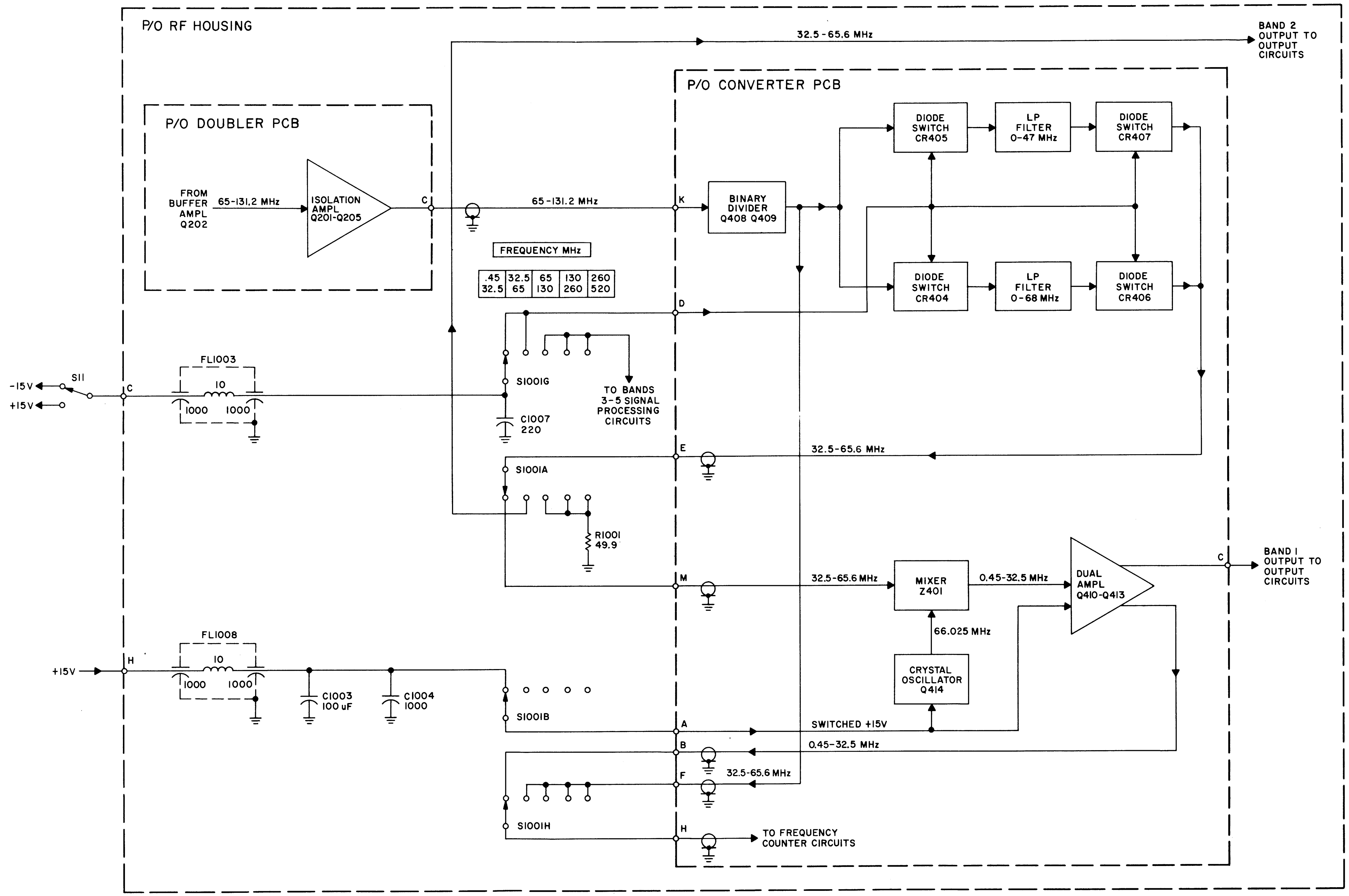


Figure 3-4 Signal Processing Circuits
Bands 1 and 2, Detailed Block Diagram

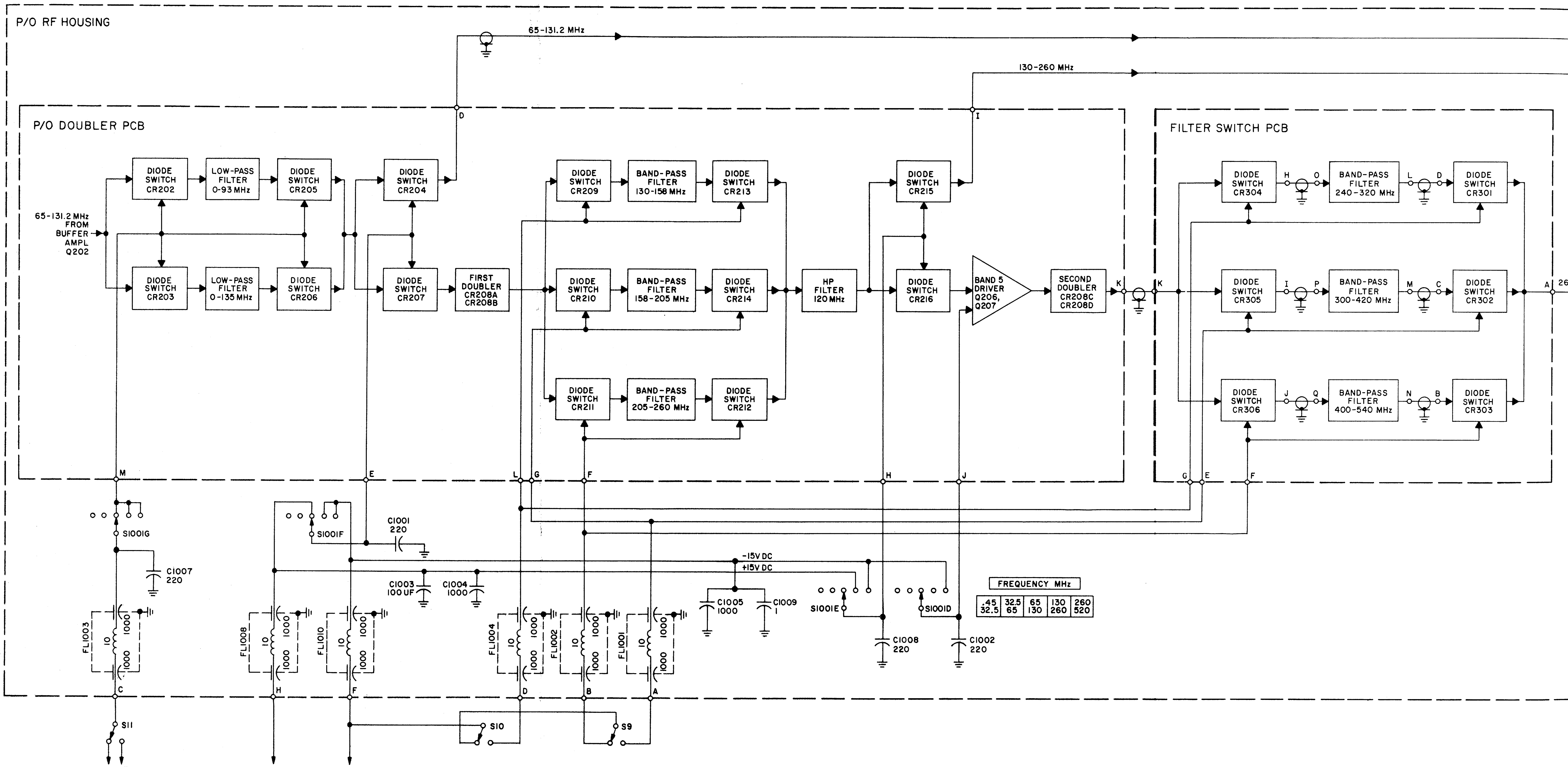


Figure 3-5 Signal Processing Circuits, Bands 3 th

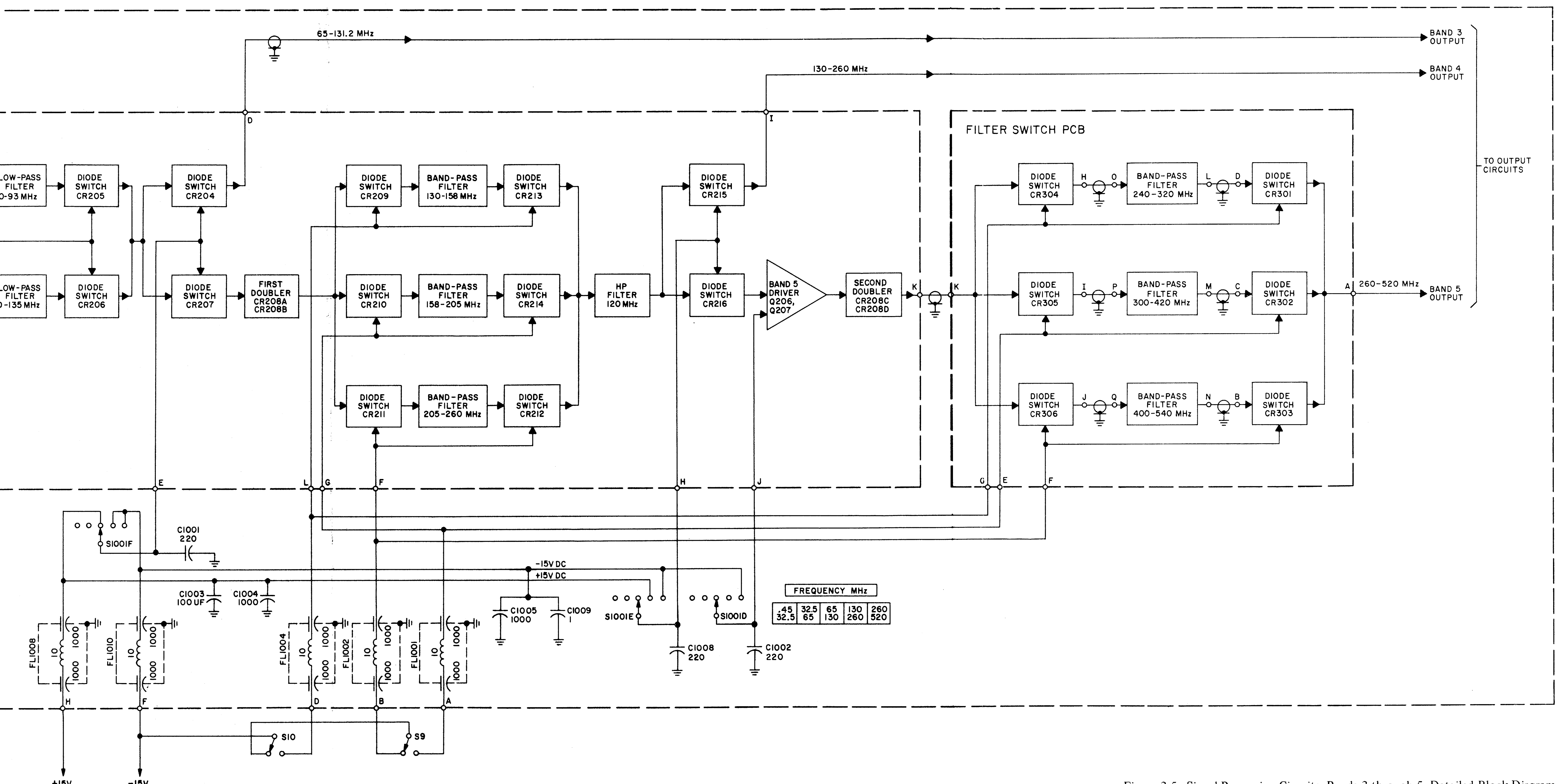
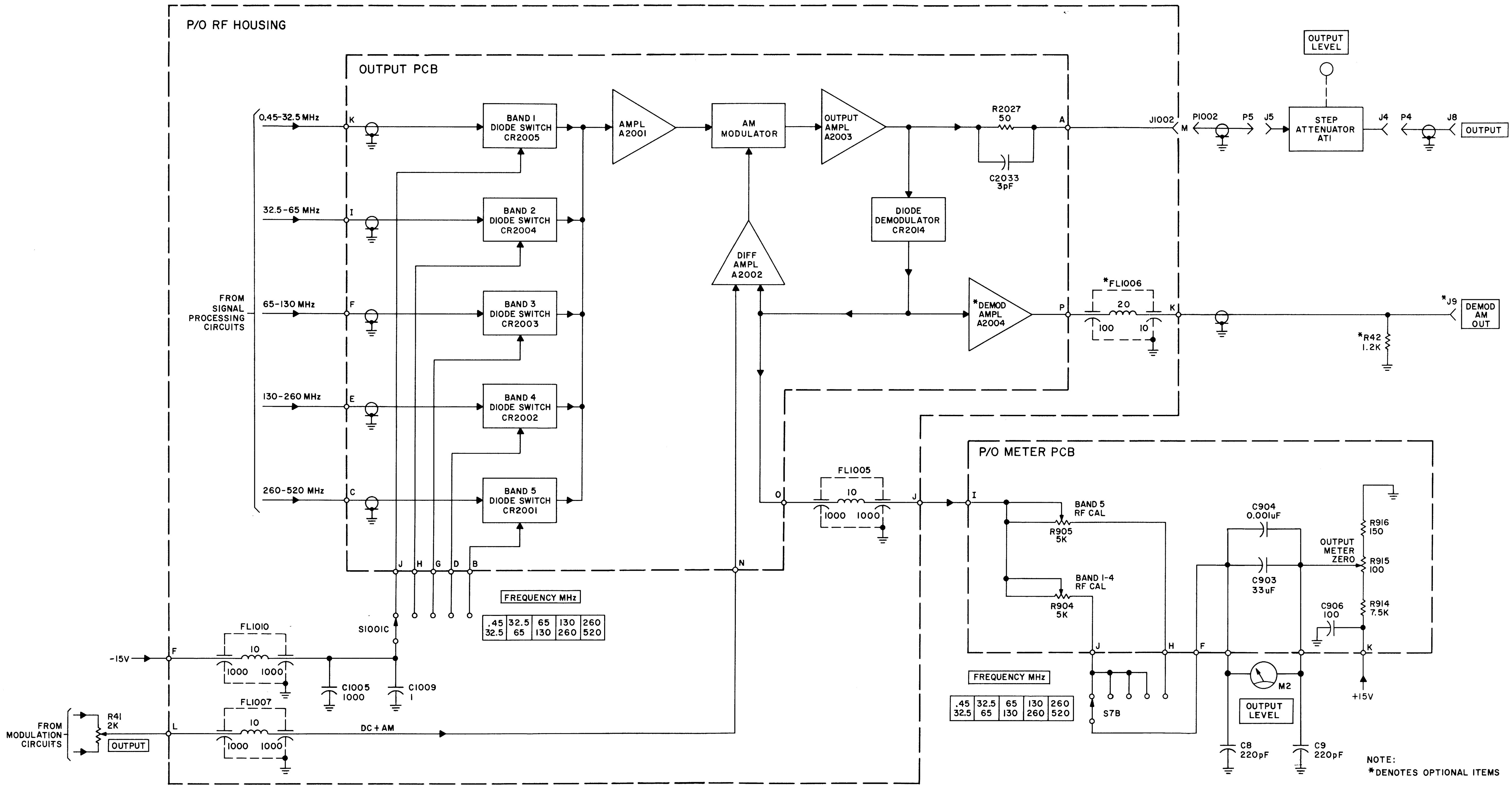


Figure 3-5 Signal Processing Circuits, Bands 3 through 5, Detailed Block Diagram



.45	32.5	65	130	260
32.5	65	130	260	520

Figure 3-6 Output Circuits, Detailed Block Diagram

OUTPUT LEVEL attenuator is a precision step attenuator, providing output levels of -120 dBm to +10 dBm in 10 dBm steps. The OUTPUT control discussed in paragraph 3-45 provides a means for further adjustment of the output level. Using the OUTPUT LEVEL attenuator and the OUTPUT control, the output level of the Model 102D can be adjusted to any value within the range of -130 dBm to +13 dBm.

3-50. DETAILED THEORY OF OPERATION, MODULATION CIRCUITS.

(See Figure 3-7.)

3-51. **General.** The modulation circuits process the modulation signals required for amplitude modulation and frequency modulation of the Model 102D output signal. The modulation circuits also include a modulation oscillator, which provides an internal modulation signal. FM is accomplished through use of the varactor in the VFO tank circuit; AM, through use of the diode modulator in the output circuits.

3-52. **Internal FM.** When the MODULATION function switch is set to INT FM, the Model 102D output signal can be frequency modulated using the internal modulation oscillator as the modulation signal source. Simultaneous AM, using an external modulation signal source, is also possible. Two sections of the MODULATION function switch supply +15 volt and -15 volt DC operating power to modulation oscillator A1803 and emitter follower Q1801. Modulation oscillator A1803 uses a Wein-bridge circuit to generate the modulation signal. The frequency of oscillation is determined by the resistance-capacitance network connected into the modulation oscillator circuit. The MOD FREQ kHz switch provides means for selecting any one of five different resistance networks, allowing selection of modulation signal frequencies of 0.4 kHz, 1 kHz, 3 kHz, 10 kHz, or 19 kHz. Emitter follower Q1801 provides an isolated modulation signal output to the rear panel MOD FREQ OUT connector for synchronization of external equipment.

3-53. The internally generated modulation signal is applied through a section of the MODULATION function switch to the FM modulation circuits. The amplitude of the modulation signal (and thus the FM deviation) is adjustable by means of the constant impedance FM control. The maximum calibrated deviation is established by the setting of the DEVIATION kHz switch, which inserts appropriate constant-impedance, resistive attenuation networks into the circuit. A second series of constant-impedance resistive attenuation networks is controlled by the FREQUENCY MHz switch. Frequency multiplication or frequency division of an FM signal, as occurs in the Model 102D, results in a corresponding multiplication or division of the deviation. The resistive attenuation networks inserted into the FM modulation signal path by the FREQUENCY MHz switch adjust the amplitude of the FM modulation signal to compensate for this effect. On bands 1 and 2, no attenuation network is used. The band 3 output frequency range is twice that of band 2; therefore, the FM deviation at the VFO is reduced to half the value on band 2 through insertion of an appropriate resistive attenuation network. On band 4, the deviation at the VFO is again reduced by a factor of two, and another reduction occurs in switching from band 4 to band 5. The deviation at the output of the Model 102D thus remains constant regardless of the band selected.

3-54. The actual deviation in FM applications is determined by the setting of the DEVIATION kHz switch and the FM control. Because deviation is proportional to the amplitude of the modulation signal, an indirect indication of deviation can be obtained by measuring the modulation signal amplitude. A portion of the modulation signal is applied through calibrating potentiometer R1809 and the METER switch (FM position) to modulation detector A1801-A1802, and the modulation detector output is applied to the front panel MODULATION meter to provide an indication of the actual deviation. (The meter scale is calibrated to indicate deviation.)

3-55. Simultaneous AM, using an external modulation signal source, can also be used with internal FM. Operation of the AM modulation circuits using an external modulation signal source is described in paragraph 3-60.

3-56. **Internal AM.** When the MODULATION function switch is set to INT AM, the Model 102D output signal can be amplitude modulated using the internally generated modulation signal. Simultaneous FM, using an external modulation signal source, is also possible. Two sections of the MODULATION function switch apply DC operating power to modulation oscillator A1803 and emitter follower Q1801, and these circuits operate as described in paragraph 3-51.

3-57. The internally generated modulation signal is applied through a section of the MODULATION function switch to the AM control, which provides a means for varying the amplitude of the modulation signal and thus the percentage of AM. The modulation signal is then amplified by audio amplifier A901, and the output of the audio amplifier is applied through the OUTPUT control to the modulation circuits. The voltage at the arm of the OUTPUT control consists of a DC component, which establishes the reference level of the Model 102D output signal, and an a-f component, which produces the AM. Both the a-f and DC components vary as the OUTPUT control is adjusted; therefore, the percentage of modulation remains constant regardless of the output level selected.

3-58. A portion of the modulation signal is applied from the input circuit of the audio amplifier by potentiometer R907 through the METER switch (30% AM or 100% AM position) to the metering circuits to provide an indication of the percentage of AM. Two meter ranges are provided for AM, 0 to 30%, and 0 to 100%. An appropriate scaling resistor is inserted into the meter circuit by the METER switch when the switch is set to the 100% AM position.

3-59. Simultaneous FM, using an external modulation signal source, can be used with internal AM. Operation of the FM modulation circuits using an external modulation signal source is described in paragraph 3-60.

3-60. **External.** When the MODULATION function switch is set to EXT, both AM and FM can be used simultaneously, but external modulation signal sources are required for both AM and FM. Internal modulation oscillator A1803 and emitter follower Q1801 are disabled through removal of DC operating power. Modulation signals from external signal sources are applied through the front panel EXT AM and EXT FM connectors, and are routed through separate sections of the MODULATION function switch. Except for the modulation signal sources, the FM and AM modulation circuits function as described in paragraphs 3-53 through 3-54, and 3-57 through 3-58, respectively.

3-61. **CW.** When the MODULATION function switch is set to CW, the Model 102D produces an unmodulated output signal. With the switch in the CW position, DC operating power is removed from modulation oscillator A1803 and emitter follower Q1801, and the FM and AM modulation circuit inputs are grounded. The varactor in the VFO is, therefore, affected only by the DC voltage supplied from the VERNIERS control and phase lock circuits, and the diode modulator in the output circuits is affected only by the DC reference voltage supplied from the OUTPUT control.

3-62. DETAILED THEORY OF OPERATION, FREQUENCY COUNTER CIRCUITS.

(See Figure 3-8.)

3-63. The frequency counter circuits provide a continuous display of the output frequency of the Model 102D. The elimination of a tuning dial, with its recalibration problems and inherent reading uncertainty, eliminates one major source of operator error and maintenance problems. A six-digit LED display with adjustable resolution is used for the output frequency indicator. The output frequency is displayed in a clear, unambiguous manner, simplifying tuning and enhancing resettability.

3-64. The input frequency to the frequency counter circuits is one-half the VFO operating frequency (bands 2 through 5) or the actual output frequency (band 1). The input signal is applied from the signal processing circuits to a seven-stage driver amplifier. The output of the driver amplifier drives a prescaler, which divides the applied frequency by a factor of 10. The signal frequency employed in the actual frequency counter circuits and the LED display is thus at a much lower frequency than the output frequency of the Model 102D, minimizing the possibility of unwanted r-f radiation. To obtain a frequency display that corresponds to the actual output frequency, a suitable gate time is selected so that the number of pulses counted bears a decimal relationship to the output frequency on each band.

3-65. The sequence of events involved in each cycle of operation is as follows:

a. A gate pulse of suitable duration is generated.

b. The number of input signal pulses applied during the gate pulse interval is counted and stored by six decade counters.

c. After the gate pulse has been terminated, a strobe pulse is applied to the LED displays, and the count stored by each of the decade counters is displayed and stored by the corresponding LED display.

d. A reset pulse is then generated, and the decade counters are reset for the next cycle of operation.

3-66. Crystal oscillator Y1401 provides a stable 1 MHz frequency which establishes the timing of the gate, strobe, and reset pulses. The crystal oscillator is a temperature compensated type with a low aging rate, and may be reset as necessary. Three other timing frequencies, 0.5 MHz, 0.25 MHz, and 0.125 MHz, are derived from the 1 MHz output frequency of the crystal oscillator through frequency division in 4-bit binary counter IC1402. Selection of the proper timing frequency is accomplished by means of one section of the FREQUENCY MHz switch.

3-67. The selected timing frequency is further divided by either four or five decade counters, depending upon the setting of the RESOLUTION kHz switch. The gate time corresponds to the period (1/f) of the output of the last decade counter employed. For resolutions of 10 kHz or 1 kHz, the output of decade counter IC1406 is gated through tri-state buffer IC1409 to masterslave flip-flop IC1405. The flip-flop is switched on and off alternately by the applied timing pulses to develop the gate pulses. Gate durations for 10 kHz and 1 kHz resolutions are 10 milliseconds for bands 1 and 2, 20 milliseconds for band 3, 40 milliseconds for band 4, and 80 milliseconds for band 5. During the gate interval, the Q output of flip-flop IC1405 is

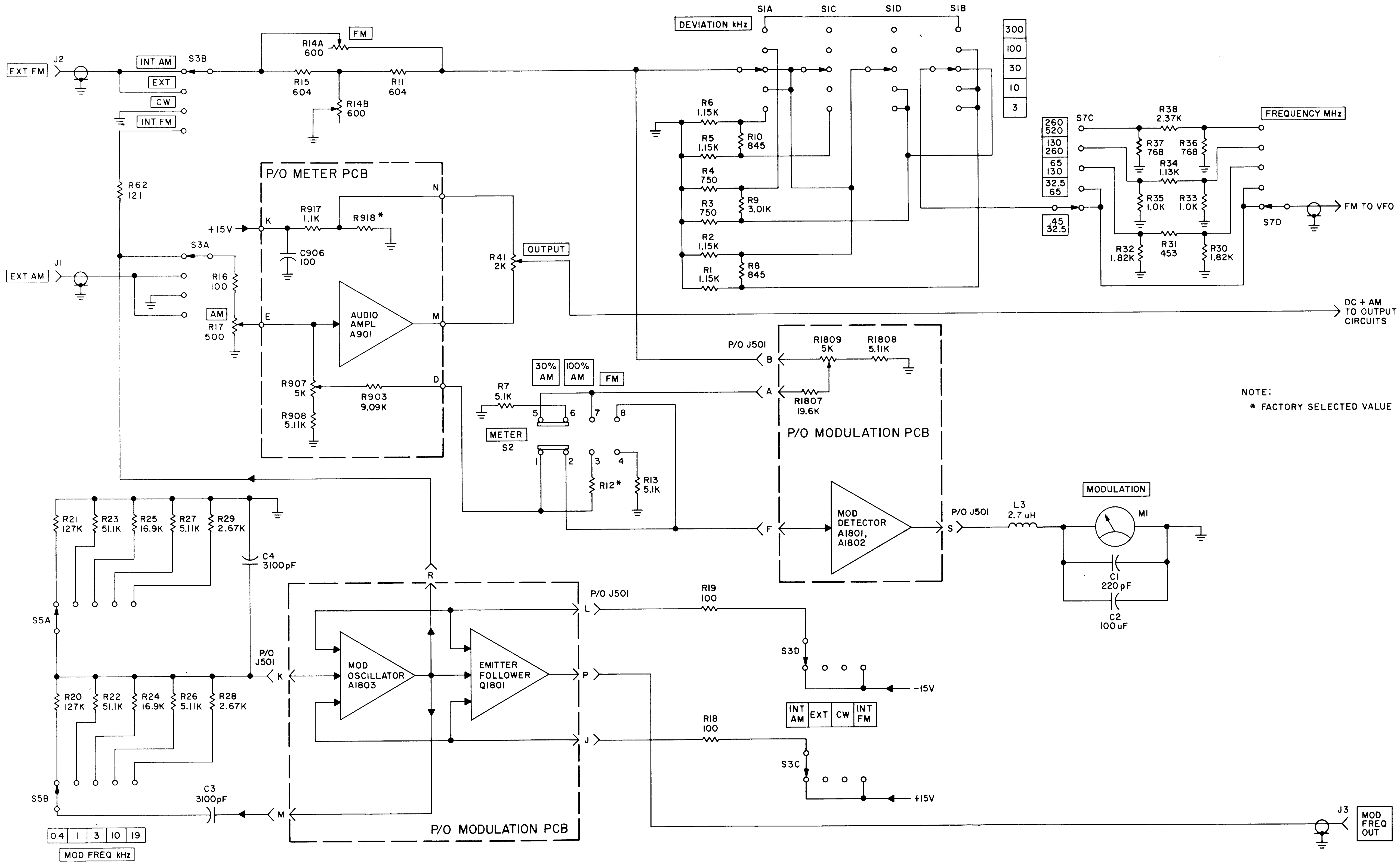


Figure 3-7 Modulation Circuits, Detailed Block Diagram

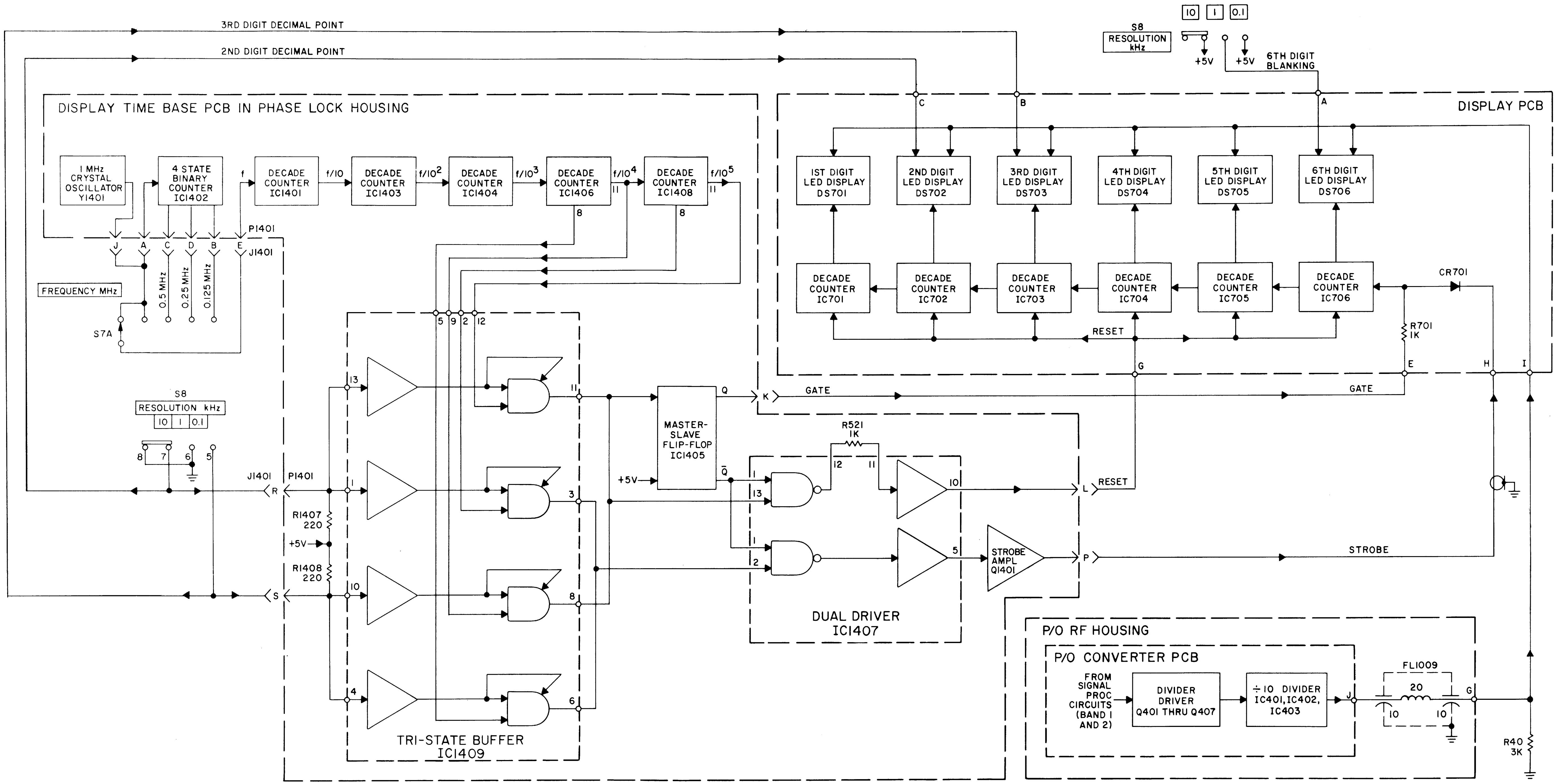


Figure 3-8 Frequency Counter Circuits, Detailed Block Diagram

at a logical 1 level, diode CR701 is forward biased, and decade counters IC701 through IC706 are toggled according to the number of incoming pulses passing through the diode.

3-68. Master-slave flip-flop IC1405 is then triggered again and reverses its state. The Q output drops, and the $\bar{Q}$ output switches to a logical 1 level. At this time, diode CR701 is gated off and no additional count of frequency pulses can occur. During this period, a logical 1 level clock pulse is developed at terminal 8 of decade counter IC1406 and is gated through tri-state buffer IC1409 to one section of dual driver IC1407. Since the $\bar{Q}$ signal input to this section is also at a logical 1 level at this time, an output pulse is developed at the output of this section of the dual driver. After amplification and inversion by Q1401, this strobe pulse is applied to the LED displays, and the LED's display and store the count registered in the corresponding decade counters.

3-69. As the pulse at terminal 8 of decade counter IC1406 is terminated, an output pulse at terminal 11 is generated and gated through tri-state buffer IC1409 to the second section of dual driver IC1407. Since both inputs to this dual driver section are at a logical 1 level, a reset pulse is generated and applied to decade counters IC701 through IC706, resetting them to zero. As soon as master-slave flip-flop IC1405 changes its state, the reset pulse is terminated, the Q output of the flip-flop switches to a logical 1 level, and the next counting cycle begins.

3-70. The operations described in paragraphs 3-66 through 3-68 are the same for RESOLUTION kHz switch settings of 10 or 1. In the 10 position of the switch, +5 volt DC operating voltage is disconnected from 6th digit LED display DS706, and the 6th digit LED display is blank. The output frequency display consists of five digits; three to the left of the decimal point, and two to the right. When the RESOLUTION kHz switch setting is changed from 10 to 1, +5 volt DC is applied to 6th digit LED display DS706, and one additional decimal value is displayed.

3-71. When the RESOLUTION kHz switch setting is changed from 1 to 0.1, one additional decimal place must be displayed on the output frequency indicator of the Model 102D. This is accomplished by increasing the gate time by a factor of 10, so that 10 times as many frequency pulses are counted, and shifting the decimal point in the output frequency display one place to the left. Because of the change in RESOLUTION kHz switch setting, a different pair of circuits in tri-state buffer IC1409 is gated on, and the timing of the gate, strobe, and reset pulses is controlled by the output signals from decade counter IC1408 instead of those from decade counter IC1406. Since one additional decade counter is employed in the timing chain, the timing signal frequency is decreased by a factor of 10, and the period is increased by a factor of 10. Except for the change in input timing signals, the gate, strobe, and reset pulses are developed as described in the preceding paragraphs. In the 0.1 position of the RESOLUTION kHz switch, the decimal point in 2nd digit LED display DS702 is activated, the decimal point in the output frequency display is effectively shifted one place to the left, and the output frequency display includes four decimal digits.

3-72. To summarize frequency counter circuit operation, assume that the Model 102D is tuned to an output frequency of 91.8362 MHz, and the RESOLUTION kHz switch is set to 10. Because the FREQUENCY MHz switch is set to band 3 for this output frequency, the gate pulses developed in the frequency counter circuits have a duration of 20 milliseconds. The frequency counter input signal frequency, which is one-half the VFO frequency, is 45.9181 MHz. After prescaling (division by 10) the frequency of the signal applied to diode CR701 is 4.59181 MHz. With a gate interval of 20 milliseconds, 91,836 input pulses will be applied to the decade counters during the gate interval. When the LED displays are strobed on, the 2nd through 5th digit LED displays will provide a frequency indication of 91.83. (The decimal point of 3rd digit LED display DS703 is activated, and 6th digit LED display DS706 is blanked for a 10 kHz resolution.) The displayed frequency thus corresponds to the actual output frequency of the Model 102D.

3-73. When the RESOLUTION kHz switch setting is changed from 10 to 1, 6th digit LED display DS706 is activated. In all other respects, count operation is the same. When the LED displays are strobed on, the 2nd through 6th digit LED displays will provide an output frequency indication of 91.836.

3-74. When the RESOLUTION kHz switch setting is changed from 1 ot 0.1, the gate pulse duration is changed from 20 milliseconds to 200 milliseconds. The number of signal frequency pulses counted during the gate interval is thus increased from 91,836 to 918,362, and the 1st through 6th digit LED displays will provide an output frequency of 91.8362. (The decimal point of 2nd digit LED DS702 is activited through the RESOLUTION kHz switch.)

NOTE

If the output frequency of the Model 102D is 100 MHz or higher and a resolution of 0.1 kHz is selected, the number of signal pulses occurring during the gate interval exceeds the capacity of the decade counters and overflow results. The most significant digit of the output frequency is effectively shifted out of the LED displays, and the LED displays will display only the six least significant digits.

3-75. DETAILED THEORY OF OPERATION, POWER SUPPLY CIRCUITS.

(See Figure 6-6.)

3-76. The power supply circuits provide d-c operation power for all other circuits of the Model 102D. Regulated output voltages of +5 volts, -15 volts, and +15 volts are provided. The power supply circuits are designed to operate from a-c power sources of 100, 120, 220, or 240 volts.

3-77. Input a-c power is supplied to the primary windings of the power transformer through the POWER switch and line voltage switch. The line voltage switch connects the primary windings of the power transformer in series for operation from a 220 or 240 volt a-c power source, and in parallel for operation from a 100 or 120 volt a-c power source. The power supply circuits are protected against overload by the line fuse. The a-c voltages developed in the three secondary windings of the power transformer are applied to three similar rectifier-regulator circuits.

3-78. The 11 volt a-c output of the power transformer is rectified by bridge rectifier CR805. The resulting d-c voltage is filtered and then regulated by voltage regulator IC801. The effective impedance of the series regulator is varied as required to compensate for any variations in the output voltage.

3-79. The +15 and -15 volt supplies are similar. Input to each supply consists of 20 volts a-c, supplied by separate secondary windings of the power transformer. The applied a-c is rectified by a bridge rectifier, filtered, and regulated by a series regulator. Potentiometer R2209 provides means for adjusting the output voltages of the +15 volt and -15 volt supplies, simultaneously.

SECTION IV
MAINTENANCE

4-1. GENERAL

4-2. This section contains maintenance and calibration instruction for the Model 102D. Included is a list of test equipment required for maintenance, symptomatic and systematic troubleshooting procedures designed to localize a malfunction to an individual subassembly or circuit, and alignment and adjustment instructions for restoring the Model 102D to proper operating condition after repairs have been completed.

NOTE

For minimum performance tests of the Model 102D, refer to Section II of the instruction manual.

4-3. TEST EQUIPMENT REQUIRED.

4-4. Test equipment required for maintenance is listed in Table 4-1. Equipment of equivalent characteristics may be substituted for any item listed.

4-5. PRELIMINARY INSPECTION.

4-6. **Visual Check.** If equipment malfunction occurs, perform a visual check of the Model 102D before performing electrical tests. Visual checks often help to isolate the cause of the malfunction quickly and simply. Inspect the Model 102D for signs of damage caused by excessive shock or vibration, such as: broken leadwires, loose hardware and parts, and loose electrical connections. Then check for

TABLE 4-1. TEST EQUIPMENT LIST

Item No.	Nomenclature	Model No.
1	Amplifier	Hewlett Packard 465A
2	Crystal-Controlled Sources	Boonton Electronics Corporation (500.0000 MHz and 100.0000 MHz)
3	Distortion Analyzer	Hewlett Packard 331A
4	Double Balanced Mixer	Hewlett Packard 10514A
5	FM-AM Signal Generator	Boonton Electronics Corporation 102D
6	Frequency Counter	Systron Donner 6052 (8 digit, option 11 time base recently calibrated)
7	Frequency Meter	Hewlett Packard 5210A
8	Microwattmeter	Boonton Electronics Corporation 42B
9	Audio Oscillator	Hewlett Packard 200CD
10	Oscilloscope	Tektronix 561B/3A6
11	RF Millivoltmeter	Boonton Electronics Corporation 92B
12	Spectrum Analyzer	Hewlett Packard 141T/8552/8554
13	Voltmeter	Weston 1240
14	Probe	Tektronix P6060-00
15	Extender Card	Boonton Electronics Corporation 92-69

signs of overheating which may be caused by electrical short circuits, or accumulations of dirt and other foreign matter. Correct any problems discovered through the visual check. If trouble persists, proceed with electrical checks.

4-7. **Power Supply Check.** Improper operation of the Model 102D may be caused by incorrect DC operating voltages. Before proceeding with any other electrical checks, perform the power supply checks in accordance with Table 4-2.

WARNING

Line voltages up to 240 volts AC may be encountered in the power supply circuits. To protect against electrical shock, abserve suitable precautions when connecting and disconnecting test equipment, or when making voltage measurements.

4-8. MAJOR ASSEMBLY LOCATION.

4-9. See Figures 4-1 and 4-2 for the location of the major assemblies of the Model 102D.

4-10. TROUBLE LOCALIZATION.

NOTE

Logical trouble localization involves three major procedures: symptomatic troubleshooting, used to localize the cause of malfunction to a major circuit group; systematic troubleshooting within the affected circuit group, used to localize the cause of malfunction to a circuit or stage; and voltage and/or waveform measurements, used to isolate the defective part.

4-11. **Symptomatic Troubleshooting.** The versatility built into the Model 102D facilitates symptomatic troubleshooting. Various groups of circuits can be switched into or out of the operating chain through manipulation of the operating controls. Also, different circuit configurations are employed on each of the five output frequency bands. With a thorough understanding of the detailed block diagrams (Figures 3-2 through 3-8), it is possible to localize the cause of most malfunctions to one of the major circuit groups by manipulating the operating controls and observing the results. (Refer to Table 4-3.) When the cause of malfunction has been localized to a major circuit group, refer to the systematic troubleshooting chart for the affected circuit group.

TABLE 4-2. POWER SUPPLY CHECK

Step	Procedure	Normal Indication
1	Set the Model 102D POWER switch to ON. Using voltmeter, Weston Model 1240, measure the DC voltage between terminal H (+) and terminal G (-) of the power supply printed circuit board.	+5 ±0.2 volts DC
2	Using oscilloscope, Tektronix Model 5103N, measure the AC ripple voltage between terminals H and G of the power supply printed circuit board.	5 millivolts peak-to-peak or less
3	Using the voltmeter, measure the DC voltage, in sequence, between each of terminals A, and B (+) and terminal C (-) of the power supply printed circuit board.	+15 ±0.2 volts DC
4	Using the oscilloscope, measure the AC ripple voltage between terminals A and C of the power supply printed circuit board.	3.0 millivolts peak-to-peak or less
5	Using the voltmeter, measure the DC voltage, in sequence, between each of terminals D, and E (-) and terminal C (+) of the power supply printed circuit board.	-15 ±0.2 volts DC
6	Using the oscilloscope, measure the AC ripple voltage between terminals D and C of the power supply printed circuit board.	2.0 millivolts peak-to-peak or less

TABLE 4-3. SYMPTOMATIC TROUBLESHOOTING CHART

Symptom	Probable Cause of Malfunction
No output on all frequency bands; output frequency indicator also inoperative	Defective frequency generating circuits. (Refer to Table 4-4.)
No output on all frequency bands; output frequency indicator operates normally	Defective output circuits. (Refer to Table 4-7.)
No output or low output on bands 1 and 2 only; output frequency indicator operates normally	Defective signal processing circuits (bands 1 and 2). (Refer to Table 4-5.)
No output or low output on band 2 only; output frequency indicator operates normally	Defective signal processing circuits. (Refer to Table 4-5.) Defective output circuits. (Refer to Table 4-7.)
No output or low output on band 1 only; output frequency indicator inoperative on band 1 only	Defective signal processing circuits (bands 1 and 2). (Refer to Table 4-5.)
No output or low output on band 1 only; output frequency indicator operates normally	Defective signal processing circuits (bands 1 and 2). (Refer to Table 4-5.) Defective output circuits. (Refer to Table 4-5.)
No output or low output over portions of bands 1 and 2 only; output frequency indicator inoperative over same portions of bands	Defective signal processing circuits (bands 1 and 2). (Refer to Table 4-5.)
No output or low output on bands 4 and 5 only; output frequency indicator operates normally	Defective signal processing circuits (bands 3 through 5). (Refer to Table 4-6.)
No output or low output on only one of bands 3, 4, or 5; output frequency indicator operates normally	Defective signal processing circuits (bands 3 through 5). (Refer to Table 4-6.) Defective output circuits. (Refer to Table 4-7.)
No output or low output over only portions of any or all of bands 3, 4, and 5; output frequency indicator operates normally	Defective signal processing circuits (bands 3 through 5). (Refer to Table 4-6.)
Output level varies excessively as band and/or output frequency is changed	Defective output circuits. (Refer to Table 4-7.)
OUTPUT LEVEL meter indication is normal, but no output available at OUTPUT connector	Defective output circuits. (Refer to Table 4-7.) **NOTE** If Model 102D incorporates option 04, r-f fuse could be defective.
No AM; OUTPUT control ineffective in control of output level	Defective output circuits. (Refer to Table 4-7.)
AM operation normal; no FM	Defective modulation circuits. (Refer to Table 4-8.) Defective frequency generating circuits. (Refer to Table 4-4.)

TABLE 4-3. SYMPTOMATIC TROUBLESHOOTING CHART (Cont.)

Symptom	Probable Cause of Malfunction
FM operation normal; no AM; OUTPUT control operates normally	Defective modulation circuits. (Refer to Table 4-8.)
External modulation normal; no internal modulation	Defective modulation circuits. (Refer to Table 4-8.)
Output normal on all bands, but output frequency indicator display incorrect or erratic	Defective frequency counter circuits. (Refer to Table 4-9.)
Output frequency indicator display incorrect or erratic for one or more positions of RESOLUTION kHz switch; output normal	Defective frequency counter circuits. (Refer to Table 4-9.)
Operation normal in unlocked mode but Model 102D will not phase lock or loses lock	Defective phase lock loop circuits. (Refer to Table 4-10.)

4-12. **Systematic Troubleshooting.** When the cause of an equipment malfunction has been localized to a major group of circuits, refer to the appropriate systematic troubleshooting chart (Tables 4-4 through 4-10). The systematic troubleshooting charts provide instructions for further localization of the cause of the malfunction to a stage or circuit within the major circuit group. When the cause of the malfunction has been localized to a particular stage or circuit, isolate the defective part through voltage and/or waveform measurements. Refer to paragraph 4-31 for typical voltage data. Waveform data is included on the appropriate schematic diagrams. (See Figures 6-1 through 6-17.)

NOTE

Unless otherwise indicated, all voltage values given in Tables 4-4 through 4-10 are nominal values; also, all voltages are measured with reference to ground.

4-13. ALIGNMENT AND ADJUSTMENT PROCEDURES.

4-14. **General.** Paragraphs 4-15 through 4-25 provide instructions for all alignments and adjustments required. Alignment or adjustment is not a substitute for troubleshooting; make certain that all other possible causes of equipment malfunction have been eliminated before undertaking alignment or adjustment. Also, make certain that all required test equipment is available. See Figures 4-1 and 4-2 and the printed circuit board photographs on the aprons of the schematic diagrams for the location of alignment and adjustment controls.

4-15. **Test Equipment Required.** Items 1 through 13 of Table 4-1 are required for complete alignment and adjustment of the Model 102D. Test equipment having equivalent performance characteristics may be substituted for any item.

4-16. **Power Supply Adjustments.** To adjust the output voltages of the power supply, proceed as follows:

a. Connect voltmeter, Weston Model 1240, between terminal A (+) and terminal C (-) of the power supply printed circuit board. Connect the Model 102D to the AC power source and set the POWER switch to ON. Adjust potentiometer R2209 as required to obtain an indication of +15.00 ± 0.1 volts DC on the voltmeter.

b. Connect the voltmeter between terminal D (-) and terminal C (+) of the power supply printed circuit board. Verify that the voltage indication is -15.00 ±0.1 volts DC.

4-17. **Modulation Oscillator Amplitude Adjustment.** To adjust the amplitude of the internally generated modulation signal, proceed as follows:

a. Connect a 604 ohm resistor across the input terminals of distortion analyzer, Hewlett Packard Model 331A. Connect a cable between the MOD FREQ OUT connector on the rear panel of the Model 102D and the input terminals of the distortion analyzer.

b. Set the function switch on the distortion analyzer to the voltmeter position. Set the MODULATION function switch on the Model 102D to INT FM.

TABLE 4-4. SYSTEMATIC TROUBLESHOOTING CHART, FREQUENCY GENERATING CIRCUITS

Step	Procedure	Normal Indication	If Indication is Normal	If Indication is Abnormal
1	Remove cover shields from top of r-f housing. Set POWER switch to ON, and TUNING control to fully counterclockwise setting. Using r-f millivoltmeter, Boonton Electronics Corp. Model 92B with probe, Model 91-12F, and probe tip, Model 91-13B, measure r-f signal level at terminal I of r-f housing.	0.3 volt rms (nominal)	Proceed to step 2.	Isolate defective part in VFO circuit through voltage measurements. Check VERNIERS control and associated circuitry on meter printed circuit board.
2	Using same test equipment as in step 1, measure r-f signal levels at junction of transformer T202 and resistor R210, and at junction of transformer T202 and resistor R214 on doubler printed circuit board.	1.0 volt rms (nominal at both measurement points.)	Frequency generating circuits are functioning normally.	Isolate defective part in buffer amplifier Q202 circuit through voltage measurements.

TABLE 4-5. SYSTEMATIC TROUBLESHOOTING CHART, SIGNAL PROCESSING CIRCUITS (BANDS 1 and 2)

Step	Procedure	Normal Indication	If Indication is Normal	If Indication is Abnormal
1	Remove cover shields from r-f housing. Set FREQUENCY MHz switch to 32.5 – 65 (band 2), TUNING control approximately to mid-range and POWER switch to ON. Using r-f millivoltmeter, Boonton Electronics Corporation Model 92B, with r-f probe, Model 91-12F, and probe tip, Model 91-13B, measure r-f signal level at terminal K of converter printed circuit board.	0.7 volt rms (nominal)	Proceed to step 2.	Isolate defective part in isolation amplifier Q201, Q203, Q204, Q205 circuits through voltage measurements.

TABLE 4-5. SYSTEMATIC TROUBLESHOOTING CHART, SIGNAL PROCESSING CIRCUITS (Cont.) (BANDS 1 and 2)

Step	Procedure	Normal Indication	If Indication is Normal	If Indication is Abnormal
2	Using same test equipment and control settings as in step 1, measure r-f signal level at terminal E of converter printed circuit board.	0.07 volt rms (nominal)	Proceed to step 4.	Check diodes CR404 through CR407. Proceed to step 3.
3	Using same test equipment and control settings as in step 1, measure r-f signal at terminal F of converter printed circuit board.	0.2 volt rms (nominal)	Proceed to step 4.	Isolate defective part in binary divider Q408-Q409 circuit through voltage measurements.
4	Using voltmeter, Weston Model 1240, measure DC voltage at terminal D of converter printed circuit board as TUNING control is rotated over entire tuning range.	+15 volts DC over lower portion of tuning range; -15 volts DC over upper portion	If DC voltage is normal but indication for step 2 is still abnormal, isolate defective part in 0-47 MHz and 0-68 MHz filters and associated diode switch circuitry on converter printed circuit board.	Check cam-operated switch S11 on main frame. filter FL1003 and switch section S1001G in r-f housing, and capacitors C417 and C418 on converter printed circuit board.
5	Set FREQUENCY MHz switch to .45 - 32.5 (band 1). Using same test equipment as in step 1, measure r-f signal level at terminal C of converter printed circuit board.	0.05 volt rms (nominal)	Proceed to step 8.	Proceed to step 6.
6	Using same test equipment as in step 1, measure r-f signal level at terminal M of converter printed circuit board.	0.07 volt rms (nominal)	Proceed to step 7.	Check switch section S1001A in r-f housing.
7	Using voltmeter, Weston Model 1240, measure DC voltage at terminal A of converter printed circuit board.	+15 volts DC	Isolate defective part in crystal oscillator Q414, mixer Z401, or dual amplifier Q410-Q411 circuit through voltage measurements.	Check filter FL1008, capacitors C1003 and C1004, and switch section S1001B in r-f housing; check capacitors C450, C451, C453, and C454 on converter printed circuit board.
8	Using same test equipment as in step 1, measure r-f signal level at terminal B of converter printed circuit board.	0.1 volt rms (nominal)	Signal processing circuits (bands 1 and 2) are operating normally.	Isolate defective part in dual amplifier Q412-Q413 through voltage measurements.

TABLE 4-6. SYSTEMATIC TROUBLESHOOTING CHART, SIGNAL PROCESSING CIRCUITS (BANDS 3 THROUGH 5)

Step	Procedure	Normal Indication	If Indication is Normal	If Indication is Abnormal
1	Remove cover shields from r-f housing. Set FREQUENCY MHz switch to 65 – 130 (band 3) and POWER switch to ON. Using r-f millivoltmeter, Boonton Electronics Corporation Model 92B, with r-f probe, Model 91-12F and probe tip, Model 91-13B (with short ground lead), measure r-f signal level at terminal D of doubler printed circuit board while slowly rotating TUNING control over entire tuning range.	0.05 volt rms (nominal) at 100 MHz; approximately 0.05 volt rms over entire tuning range.	Proceed to step 5.	If abnormal over only lower or upper portion of tuning range, check appropriate filter (0-93 MHz or 0-135 MHz) and associated diode switch circuitry on doubler printed circuit board; if abnormal over entire tuning range, proceed to step 2.
2	Using voltmeter, Weston Model 1240, measure DC voltage at terminal M of doubler printed circuit board while rotating TUNING control.	+15 volts DC from 65 to 90 MHz; -15 volts DC over remainder of band.	Proceed to step 3.	Check cam-operated switch S11 on main frame, filter FL1003, capacitor C1007, and switch section S1001G in r-f housing.
3	Using same test equipment as in step 1, measure r-f signal level at junction of diodes CR204 and CR207 on doubler printed circuit board.	Approximately 0.5 volt rms	Proceed to step 4.	Check diode switches CR202, CR203, CR205, and CR206, 0-93 MHz and 0-135 MHz filters, and associated circuitry on doubler printed circuit board.
4	Using voltmeter, Weston Model 1240, measure DC voltage at terminal E of doubler printed circuit board.	+15 volts DC	Check diode switch CR204 and associated circuitry.	Check filter FL1008, switch section S1001F, and capacitors C1001, C1003, and C1004 in r-f housing; check capacitors C225 and C226 on doubler printed circuit board.
5	Set FREQUENCY MHz switch to 130 – 260 (band 4). Using same test equipment as in step 1, measure r-f signal level at terminal I of doubler printed circuit board, while slowly rotating TUNING control over entire tuning range.	0.07 volt rms (nominal at 200 MHz; approximately 0.07 volt rms over entire tuning range.	Proceed to step 14.	If abnormal over only frequency range of 130 to 157.5 MHz, 157.5 to 205.0 MHz, or 205.0 to 260.0 MHz, proceed to step 6, 7 or 8, respectively; if abnormal over entire tuning range, proceed to step 9.

TABLE 4-6. SYSTEMATIC TROUBLESHOOTING CHART, SIGNAL PROCESSING CIRCUITS (BANDS 3 THROUGH 5) (Cont.)

Step	Procedure	Normal Indication	If Indication is Normal	If Indication is Abnormal
6	Using voltmeter, Weston Model 1240, measure DC voltage at terminal L of doubler printed circuit board while rotating TUNING control.	-15 volts DC over frequency range of 130.0 to 157.5 MHz; 0 volt DC at all other frequencies.	Check diode switches CR209, and CR213, 130 to 158 MHz filter, and associated circuitry on doubler printed circuit board.	Check filter FL1004 in r-f housing; cam-operated switch S10 in main frame; capacitors C301 and C308 on filter switch printed circuit board.
7	Using voltmeter, Weston Model 1240, measure DC voltage at terminal G of doubler printed circuit while rotating TUNING control.	-15 volts DC over frequency range of 157.5 to 205.0 MHz; 0 volt DC at all other frequencies.	Check diode switches CR211 and CR212, 205 to 260 MHz filter, and associated circuitry on doubler printed circuit board.	Check filter FL1001 in r-f housing; cam-operated switches S10 and S9 in main frame; capacitor C306 on filter switch printed circuit board.
8	Using voltmeter, Weston Model 1240, measure DC voltage at terminal F of doubler printed circuit board while rotating TUNING control.	-15 volts DC over frequency range of 205.0 to 260.0 MHz; 0 volt DC at all other frequencies.	Check diode switches CR211 and CR212, 205 to 260 MHz filter, and associated circuitry on doubler printed circuit board.	Check filter FL1002 in r-f housing; cam-operated switch S9 in main frame; capacitor C307 on filter switch printed circuit board.
9	Using voltmeter, Weston Model 1240, measure DC voltage at terminal E of doubler printed circuit board.	-15 volts DC	Proceed to step 10.	Check filter FL1010, capacitors C1009 and C1005, and switch section S1001E in r-f housing.
10	Using voltmeter, Weston Model 1240, measure DC voltage at terminal H of doubler printed circuit board.	+15 volts DC	Proceed to step 11.	Check switch section S1001E and capacitor C1008 in r-f housing; capacitors C255, C256, and C257 on doubler printed circuit board.
11	Using same test equipment as in step 1, measure r-f signal level at junction of resistor R227 and capacitor C227 on doubler printed circuit board.	Approximately 0.5 volt rms	Proceed to step 12.	Check diode switch CR207 and associated circuitry on doubler printed circuit board.
12	Using same test equipment as in step 1, measure r-f signal level at junction of capacitor C229 and resistor R229 on doubler printed circuit board.	0.15 volt rms (nominal)	Proceed to step 13.	Isolate defective part in first doubler CR208A-CR208B circuit on doubler printed circuit board.

TABLE 4-6. SYSTEMATIC TROUBLESHOOTING CHART, SIGNAL PROCESSING CIRCUITS (BANDS 3 THROUGH 5) (Cont.)

Step	Procedure	Normal Indication	If Indication is Normal	If Indication is Abnormal
13	Using same test equipment as in step 1, measure r-f signal level at junction of diode switches CR215 and CR216 on doubler printed circuit board.	Approximately 0.07 volt rms	Check diode switch CR215 and associated circuitry on doubler printed board.	Check high-pass filter and associated circuitry on doubler printed circuit board.
14	Set FREQUENCY MHz switch to 260 - 520 (band 5). Using same test equipment as in step 1, measure r-f signal level at terminal A of filter switch printed circuit board.	0.05 volt rms (nominal at 400 MHz; approximately 0.05 volt rms over remainder of band.	Signal processing circuits (bands 3 through 5) are operating normally.	If abnormal over entire band, proceed to step 15. If abnormal only over 260 to 315 MHz range, check diode switches CR301 and CR304, 240 to 320 MHz filter, and associated circuitry on filter switch printed circuit board. If abnormal only over 315 to 410 MHz range, check diode switches CR302 and CR305, 300 to 420 MHz filter, and associated circuitry on filter switch printed circuit board. If abnormal only over 410 to 520 MHz range, check diode switches CR303 and CR306, 400 to 540 MHz filter, and associated circuitry on filter switch printed circuit board.
15	Using voltmeter, Weston Model 1240, measure DC voltages at terminal H and at terminal J on doubler printed circuit board.	-15 volts DC at each point	Proceed to step 16.	If abnormal at terminal H, check switch section S1001E in r-f housing; if abnormal at terminal J, check switch section S1001D and capacitor C1002 in r-f housing.
16	Using TUNING control, adjust output frequency to 400 MHz. Measure r-f signal level at junction of transformer T206 and resistor R252 on doubler printed circuit board, using same test equipment as in step 1.	0.5 volts rms (nominal)	Proceed to step 17.	Isolate defective part in diode switch CR216 circuit or band 5 driver Q206-Q207 circuit on doubler printed circuit board through voltage measurements.
17	Using same test equipment as in step 1, measure r-f signal level at terminal K of doubler printed circuit board.	0.15 volt rms (nominal)	Check capacitors C305 and C312 and associated circuitry on filter switch printed circuit board.	Isolate defective part in 2nd doubler CR208C-CR208D circuit through voltage and resistance measurements.

TABLE 4-7. SYSTEMATIC TROUBLESHOOTING CHART, OUTPUT CIRCUITS

Step	Procedure	Normal Indication	If Indication is Normal	If Indication is Abnormal
1	Set MODULATION function switch to CW and POWER switch to ON. Using r-f millivoltmeter, Boonton Electronics Corporation Model 92B, with r-f probe, Model 92-12F, and probe tip, Model 91-13B (with short ground lead), measure r-f signal level at terminal A of output printed circuit board for each position of FREQUENCY MHz switch.	Level adjustable to 1 volt rms, minimum, on each band, using OUTPUT control.	Proceed to step 4.	Proceed to step 2.
2	Using same test equipment as in step 1, measure r-f signal level at junction of diode switches CR2001 through CR2005 on output printed circuit board for each position of FREQUENCY MHz switch.	0.05 volt rms (nominal)	Proceed to step 3.	Check diode switch CR2001 through CR2005 and associated circuitry on output printed circuit board for affected band; check filter FL1010 and switch section S1001C in r-f housing.
3	Temporarily connect jumper from junction of resistors R2019 and R2021 to ground. Using voltmeter, Weston Model 1240, measure DC voltage at terminal 6 of amplifier A2002 on output printed circuit board.	DC voltage adjustable over range of +13 to -13 volts by means of OUTPUT control.	Isolate defective part in AM modulator or output amplifier A2003 circuit on output printed circuit board through voltage measurements.	Isolate defective part in amplifier A2002 circuit on output printed circuit board through voltage measurements.
4	Rotate OUTPUT control and note effect on OUTPUT LEVEL meter indication.	Meter pointer adjustable over full scale.	Proceed to step 5.	Isolate defective part in diode demodulator CR2014 circuit on output printed circuit board, or in OUTPUT LEVEL meter circuit on meter printed circuit board.
5	Set FREQUENCY MHz switch successively to each of its five positions. For each position, tune slowly across the band, using TUNING control, and note effect on OUTPUT LEVEL meter indication.	Meter indication remains constant within ±0.5 dB	Proceed to step 6.	Isolate defective part in amplifier A2002 circuit on output printed circuit board through voltage measurements.

TABLE 4-7. SYSTEMATIC TROUBLESHOOTING CHART, OUTPUT CIRCUITS (Cont.)

Step	Procedure	Normal Indication	If Indication is Normal	If Indication is Abnormal
6	Connect power detector of microwattmeter, Boonton Electronics Corporation Model 42B, to OUTPUT connector. Rotate OUTPUT LEVEL attenuator successively to each of its positions, and note indication on microwattmeter.	Microwattmeter indication corresponds to output level indicated by attenuator setting and OUTPUT LEVEL meter indication	Proceed to step 7.	Check OUTPUT LEVEL attenuator. (If Model 102D is equipped with option 04, also check r-f fuse.)
7	Set MODULATION function switch to INT AM, METER switch to 100% AM, and MOD FREQ kHz switch to 0.4. Using AM control, position pointer of MODULATION meter to 50. Using OUTPUT control, position pointer of OUTPUT LEVEL meter to 0 dBm. Set function switch of distortion analyzer, Hewlett Packard Model 331A, to voltmeter position and measure a-f voltage at junction of resistors R2019 and R2021 on output printed circuit board with distortion analyzer.	0.5 volts rms (nominal)	Output circuits are functioning normally.	Ascertain that modulation circuits are operating normally. Then, isolate defective part in amplifier A2002, AM modulator, or diode demodulator CR2014 circuit on output printed circuit board through voltage measurements.

TABLE 4-8. SYSTEMATIC TROUBLESHOOTING CHART, MODULATION CIRCUITS

Step	Procedure	Normal Indication	If Indication is Normal	If Indication is Abnormal
		FM PORTION		
1	Set FREQUENCY MHz switch to .45 – 32.5 (band 1), MODULATION function switch INT FM, MOD FREQ kHz switch to 0.4, DEVIATION kHz switch to 300, FM control fully clockwise, and POWER switch to ON. Set function switch of Hewlett Packard Model 331A distortion analyzer to voltmeter position, and measure a-f signal level at terminal B of VFO housing.	2.5 volts rms, (minimum)	Proceed to step 4.	Proceed to step 2.

TABLE 4-8. SYSTEMATIC TROUBLESHOOTING CHART, MODULATION CIRCUITS (Cont.)

Step	Procedure	Normal Indication	If Indication is Normal	If Indication is Abnormal
		FM PORTION		
2	Connect distortion analyzer to MOD FREQ OUT connector on rear panel. Rotate MOD FREQ kHz successively to each of its positions.	2.0 volts rms, minimum for each switch position.	Check switch sections S1A, S1B, and S3B, FM control R14, and associated circuitry on main frame.	Proceed to step 3.
3	Using voltmeter, Weston Model 1240, measure DC voltages at terminals P501-J and P501-L of modulation printed circuit board.	+15 volts at terminal P501-J; -15 volts at terminal P501-L.	Isolate defective part in modulation oscillator A1803 or voltage follower Q1801 circuit through voltage measurements.	Check switch sections S3C and S3D, respectively.
4	Set FM control to produce 2.0 volts rms at terminal B of the VFO housing. Set FREQUENCY MHz switch successively to bands 2 through 5 and measure a-f signal amplitude at terminal B of VFO housing, using distoriton analyzer.	2.0 volts rms, band 2; 1.0 volts rms, band 3; 0.5 volts rms, band 4; 0.25 volts rms, band 5 (nominal).	Proceed to step 5.	Check switch sections S1A through S1D and associated resistance networks (R1 through R6 and R8 through R10) on main frame.
5	Set FREQUENCY MHz switch to .45 – 32.5 (band 1). Set DEVIATION kHz switch successively to each of its positions, and measure a-f signal amplitude at terminal B of VFO housing, using distortion analyzer.	0.63 volt rms, 100 position; 0.2 volt rms, 30 position; 0.063 volt rms, 10 position; 0.02 volt rms, 3 position; (nominal).	Proceed to step 6.	Check switch sections S7C and S7D and associated resistance networks (R30 through R38) on main frame.
6	Set METER switch to FM and DEIVATION kHz switch to 100. Rotate FM control and observe effect on MODULALATION meter.	MODULATION meter pointer adjustable to full scale.	Proceed to step 7.	If MODULATION meter operates normally for AM, check resistors R1807 and R1808, and potentiometer R1809 on modulation printed circuit board, and switch S2 on main frame. If MODULATION meter operation is abnormal for both FM and AM, check modulation detector A1801-A1802 and associated circuitry on modulation printed circuit board, and switch S3, meter M1, and associated circuitry on main frame.

TABLE 4-8. SYSTEMATIC TROUBLESHOOTING CHART, MODULATION CIRCUITS (Cont.)

Step	Procedure	Normal Indication	If Indication is Normal	If Indication is Abnormal
		FM PORTION		
7	Set MODULATION function switch to EXT. Using audio oscillator, Hewlett Packard Model 200CD, apply a 1 kHz, 1-volt rms signal to EXT FM connector. Rotate FM control and observe effect on MODULATION meter. Then, set MODULATION function switch to INT AM, rotate FM control, and observe effect on MODULATION meter.	MODULATION meter pointer adjustable to full scale for both switch positions	FM portion of modulation circuits is operating normally; if FM output of Model 102D is still not normal, check varactor circuit in VFO. Proceed to step 8 for AM portion troubleshooting.	Check switch section S3B and associated circuitry on main frame.
		AM PORTION		
8	Set MODULATION function switch to INT AM, and AM control fully clockwise. Using OUTPUT control, set pointer of OUTPUT LEVEL meter to 0 dBm. Using distortion analyzer, measure a-f signal level at wiper arm of OUTPUT control or at FL1007 on the r-f housing.	1.2 volts rms or more	Proceed to step 9.	Isolate defective part in audio amplifier A901 and associated circuitry on meter printed circuit board through voltage measurements; check switch section S3A, AM control R17, and associated circuitry on main frame.
9	With distortion analyzer connected as in step 8, adjust AM control as required to obtain 0.5 volt rms indication on distortion analyzer meter. Set METER switch to 100% AM and observe indication on MODULATION meter.	Approximately 50 on MODULATION meter	Proceed to step 10.	Check switch S2 and associated circuitry on main frame.
10	Set MODULATION function switch to EXT. Using audio oscillator, Hewlett Packard Model 200CD, apply a 1 kHz, 1-volt rms signal to AM connector. Set METER switch to 30% AM. Rotate AM control and observe effect on MODULATION meter. Then, set MODULATION function switch to INT FM, rotate AM control, and observe effect on MODULATION meter.	MODULATION meter pointer adjustable to full scale for both switch positions.	AM monitor portion of modulation circuits is operating normally; if AM output of Model 102D is still not normal, check output circuits.	Check switch section S3A and associated circuitry on main frame.

TABLE 4-9. SYSTEMATIC TROUBLESHOOTING CHART, FREQUENCY COUNTER CIRCUITS

Step	Procedure	Normal Indication	If Indication is Normal	If Indication is Abnormal
1	Using oscilloscope, Tektronix Model 561B/3A6, with probe, Model P6060-00, check signal waveform at pin 8 of IC403 on converter printed circuit board with FREQUENCY MHz switch set to 65 – 130 MHz and TUNING control turned down 6 turns from high frequency stop.	Waveform as shown in Figure 6-10.	Proceed to step 4.	Proceed to step 2.
2	Using r-f millivoltmeter, Boonton Electronics Corporation Model 92B with probe, Model 91-12F, and probe tip, Model 91-13B, measure r-f signal level at terminal H of converter printed circuit board with FREQUENCY MHz switch set successively to each of its 5 positions.	0.1 volts rms (nominal on band 1); 0.2 volt rms (nominal on bands 2 through 5.)	Proceed to step 3.	Check switch section S1001H in r-f housing.
3	Set FREQUENCY MHz switch to .45 – 32.5 (band 1) and TUNING control fully clockwise. Check waveform at terminal 1 of flip-flop IC401 on converter printed circuit board, using same test equipment as in step 1.	Pulses with frequency of approximately 4 MHz.	Isolate defective part in ÷10 divider circuit on converter printed circuit board through voltage measurements.	Isolate defective part in divider driver (Q401 through Q407) circuitry on converter printed circuit board through voltage measurements.
4	Using same test equipment as in step 1, check signal waveform at terminal 8 of flip-flop IC1405 on display time base printed circuit board with FREQUENCY MHz switch set successively to each of its 5 positions. Set RESOLUTION switch to 1 kHz.	Waveform as shown in Figure 6-14; pulses with durations of 10, 20, 40 and 80 milliseconds, respectively for bands 1 through 5.	Proceed to step 8.	Proceed to step 5.
5	Using same test equipment as in step 1, check waveform at test point TP1401 on display time base printed circuit board.	Waveform as shown in Figure 6-14.	Proceed to step 6.	Check voltage measurements, replace Y1401 as necessary.

TABLE 4-9. SYSTEMATIC TROUBLESHOOTING CHART, FREQUENCY COUNTER CIRCUITS (Cont.)

Step	Procedure	Normal Indication	If Indication is Normal	If Indication is Abnormal
6	Using same test equipment as in step 1, check waveform at terminals 8 and 11 of decade counter IC1406 on display time base printed circuit board. (Set RESOLUTION switch to 1 kHz.)	Pulse outputs at both points with frequency of 100 50, 25, or 12.5 Hz for bands 1 through 5 respectively.	Proceed to step 7.	If abnormal for one band, check switch section S7A on main frame; if abnormal for all bands, isolate defective decade counter (IC1401, IC1403, IC1404, or EC1407) on display time base printed circuit board by checking output board by checking output waveforms and voltage measurements.
7	With FREQUENCY MHz switch set to .45 – 32.5 (band 1), check signal waveform at terminal 12 of flip-flop IC1405 on display time base printed circuit board, using same test equipment as in step 1.	10 Hz pulses	Isolate defective part in circuit of flip-flop IC1405 through voltage measurements.	Isolate defective part in tri-state buffer IC1409 circuit on display time base printed circuit board through voltage measurements; also, check switch S8 and associated circuitry on main frame.
8	Using same test equipment as in step 1, check signal waveform at collector of transistor Q1401 on display time base printed circuit board.	Waveform as shown in Figure 6-14.	Proceed to step 10.	Proceed to step 9.
9	Using same test equipment as in step 1, check signal waveform at terminal 2 of dual driver IC1407 on display time base printed circuit board. (Set FREQUENCY MHz control to 65 – 130 and RESOLUTION kHz switch to 1 kHz).	Waveform as shown in Figure 6-14.	Isolate defective part in dual driver IC1407 or amplifier Q1401 circuit through voltage measurements.	Isolate defective part in tri-state buffer IC1409 circuit on display time base printed circuit board through voltage measurements.
10	Using same test equipment as in step 1, check signal waveform at terminal 10 of dual driver IC1407 on display time base printed circuit board.	Waveform as shown in Figure 6-14.	Proceed to step 11.	Isolate defective part in dual driver IC1407 circuitry on display time base printed circuit board through voltage measurements.

TABLE 4-9. SYSTEMATIC TROUBLESHOOTING CHART, FREQUENCY COUNTER CIRCUITS (Cont.)

Step	Procedure	Normal Indication	If Indication is Normal	If Indication is Abnormal
11	With FREQUENCY MHz switch set to .45 – 32.5 (band 1), set RESOLUTION kHz switch to 0.1 and check signal waveform at terminal 8 of flip-flop IC1405 on display time base printed circuit board.	Waveform as shown in Figure 6-14; pulse duration, 100 milliseconds.	If normal, but output frequency indicator of Model 102D still does not function normally, isolate defective part on display printed circuit board through voltage measurements.	Isolate defective part in circuitry of tri-state buffer IC1409 or decade counter IC1408 on display time base printed circuit board through voltage measurements; also, check switch S8 and associated circuitry on main frame.

TABLE 4-10. SYSTEMATIC TROUBLESHOOTING CHART, PHASE LOCK CIRCUITS

Step	Procedure	Normal Indication	If Indication is Normal	If Indication is Abnormal
1	If spare phase lock counter, phase detector, and phase lock time base printed circuit boards are available, localize problem by replacing printed circuit boards one at a time. If spares are not available, proceed to step 2.	Normal lock operation	Replace or repair defective printed circuit board.	Proceed to step 1.
2	Using Oscilloscope, Tektronix Model 561B/3A6, with probe, Model P6060-00, check clock input at test point TP4 on counter printed circuit board.	Waveform as shown in Figure 6-17	Proceed to step 3.	Localize defective circuit in divider printed circuit board in RF housing through waveform and DC voltage checks. Check transistor Q1201, and integrated circuits IC1201 through IC1203. Replace defective parts.
3	Disconnect clock lead remove counter board, and install extender card, Model 92-6A in its place. Install counter printed circuit board on card extender. Using short clip lead, connect clock input to counter printed circuit board, and check waveforms, using same test equipment as in step 2.	Waveforms as shown in Figure 6-17.	Proceed to step 5.	If waveform at TP3 is not normal, proceed to step 4. If waveform at TP5 is not normal, check for defective integrated circuit IC1704 and/or defective LOCK/UNLOCK switch. Replace defective part. If waveform at TP1 is not normal, check for defective integrated circuit IC1716, IC1718, IC1715, IC1713,

TABLE 4-10. SYSTEMATIC TROUBLESHOOTING CHART, PHASE LOCK CIRCUITS (Cont.)

Step	Procedure	Normal Indication	If Indication is Normal	If Indication is Abnormal
				IC1710, IC1707, IC1711, or IC1708. Replace defective part. If waveform at TP2 is not normal, check for defective integrated circuit IC1703, IC1702, IC1701, IC1708, IC1716, IC1705, IC1717, IC1714, IC1712, IC1709, IC1706, or IC1711. Replace defective part.
4	Install counter printed circuit board in its normal location. Remove phase lock time base printed circuit board and install extender card, Model 92-6A in its place. Install phase lock time base printed circuit board on extender card and check waveforms, using same test equipment as in step 2.	Waveforms as shown in Figure 6-15	Proceed to step 5.	If waveform at TP1 is not normal, check DC voltages (Table 4-18); if normal, check for defective integrated circuit IC1501 or Y1501. Replace defective part. If waveform at TP2 is not normal, check for defective IC1501, Q1501, or associated circuit parts. If waveform at TP3 and/or TP4 is not normal, check for defective integrated circuit IC1502, IC1503, IC1504, IC1505, or IC1506. Replace defective part.
5	Install phase lock time base printed circuit board in its normal location. Remove phase detector printed circuit board and install extender card, Model 92-6A, in its place. Install phase detector printed circuit board on extender card and check waveforms, using same equipment as in step 2.	Waveforms as shown in Figure 6-16	Instrument should be locking properly.	If waveform at TP1, TP2, and/or TP3 is not normal, check for defective IC1601, IC1602, Q1602, Q1603, A1601, A1604, A1605, or A1606. Replace defective part. If waveform at TP4 is not normal, check for defective integrated circuit IC1603. Replace defective part. If instrument locks but phase lock indicator malfunctions, check for defective A1602, A1603, IC1604, Q1605, CR1601, CR1602, or CR1. Replace defective part.

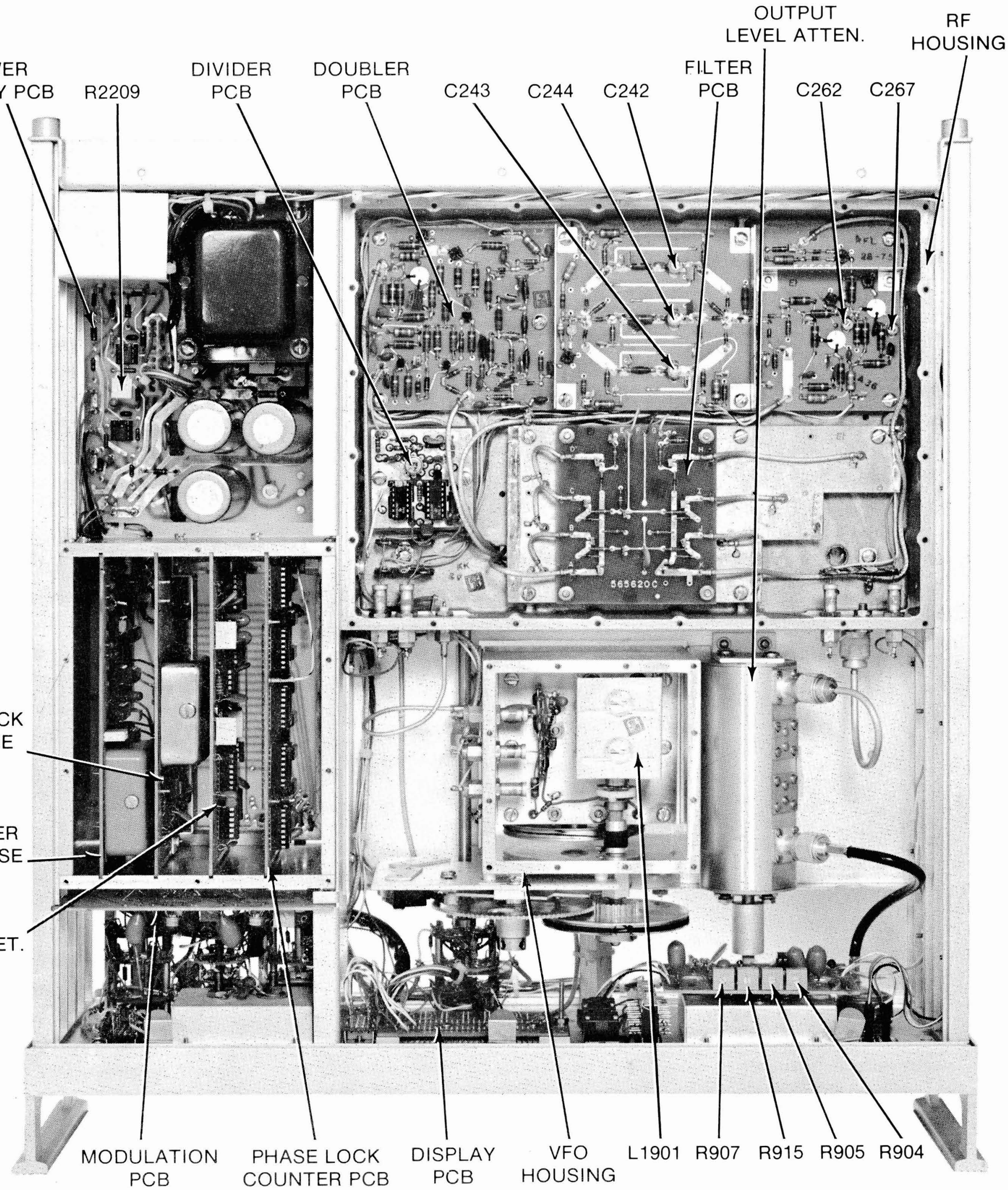


Figure 4-1 Model 102D, Top View with Cover Shields Removed

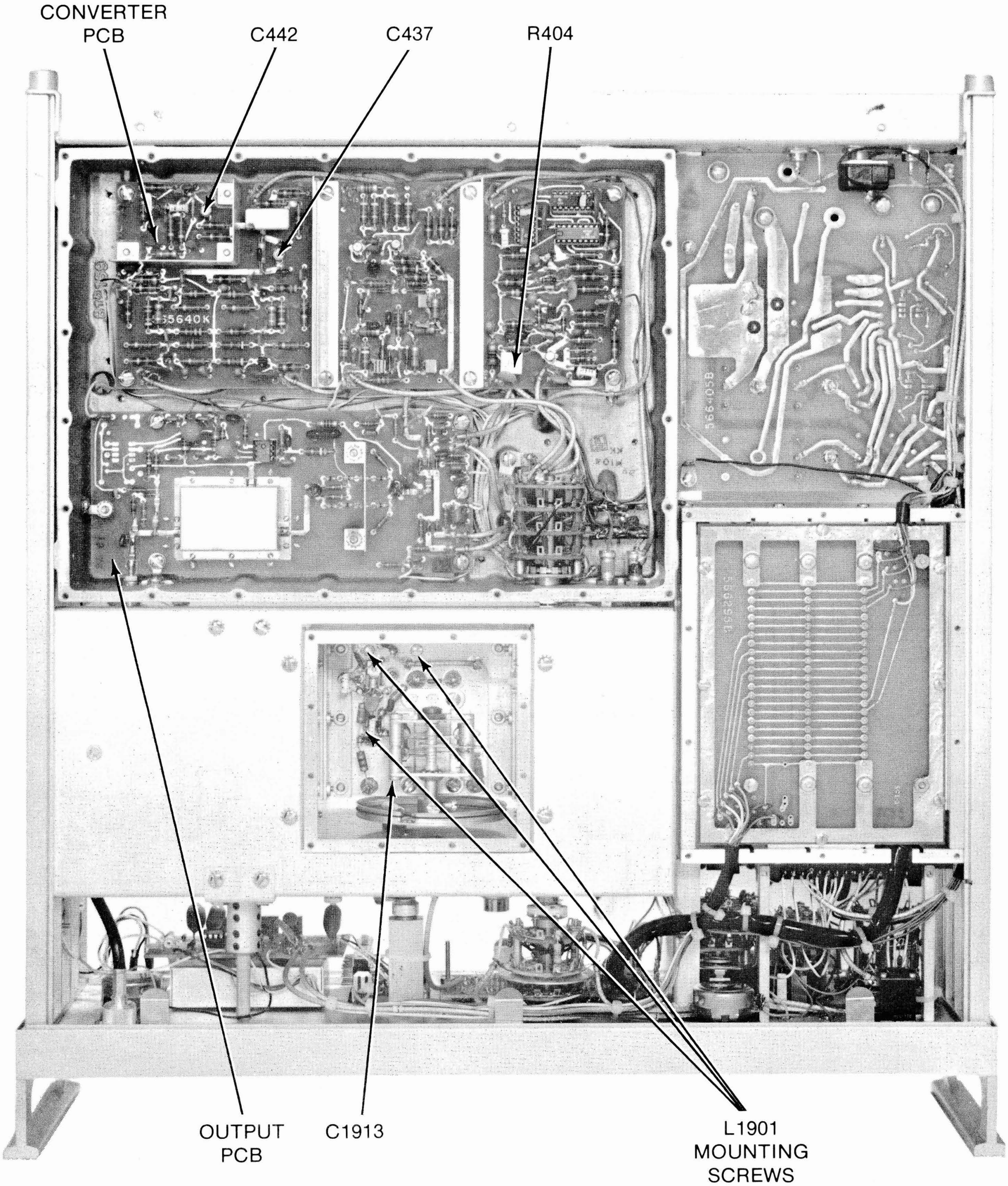


Figure 4-2 Model 102D, Bottom View with Cover Shields Removed

c. Set the MOD FREQ kHz switch to 1. Adjust potentiometer R1810 on the modulation printed circuit board as required to obtain an indication of 1.25 volts rms on the distortion analyzer meter.

d. Set the MOD FREQ kHz switch successively to 0.4, 3, 10, and 19, and note the indication on the distortion analyzer meter for each switch position. The meter indication should be 1.15 volts rms or greater for each of the specified switch positions.

4-18. Counter Amplifier Gain Adjustment. To adjust the gain of the divider driver amplifier in the frequency counter circuits, proceed as follows:

a. Set the FREQUENCY MHz switch on the Model 102D to 32.5 – 65 (band 2), the MODULATION function switch to CW, and the RESOLUTION kHz switch to 1.

b. Rotate the TUNING control clockwise until the stop at the high-frequency end of the tuning range is encountered.

c. Adjust potentiometer R404 on the converter printed circuit board through its entire range, and note the points at which the output frequency indicator display becomes erratic or incorrect. (The correct output frequency indicator display is approximately 66.000 MHz.)

d. Set potentiometer R404 midway between the points noted in preceding step c.

e. Rotate the TUNING control slowly counterclockwise to the low-frequency end of the tuning range while observing the output frequency indicator display. The output frequency indicator display should be stable and correct throughout the tuning range.

f. Set the FREQUENCY MHz switch to .45 – 32.5 (band 1). Rotate the TUNING control slowly through the entire tuning range and ascertain that the output frequency indicator display is stable and correct throughout the tuning range.

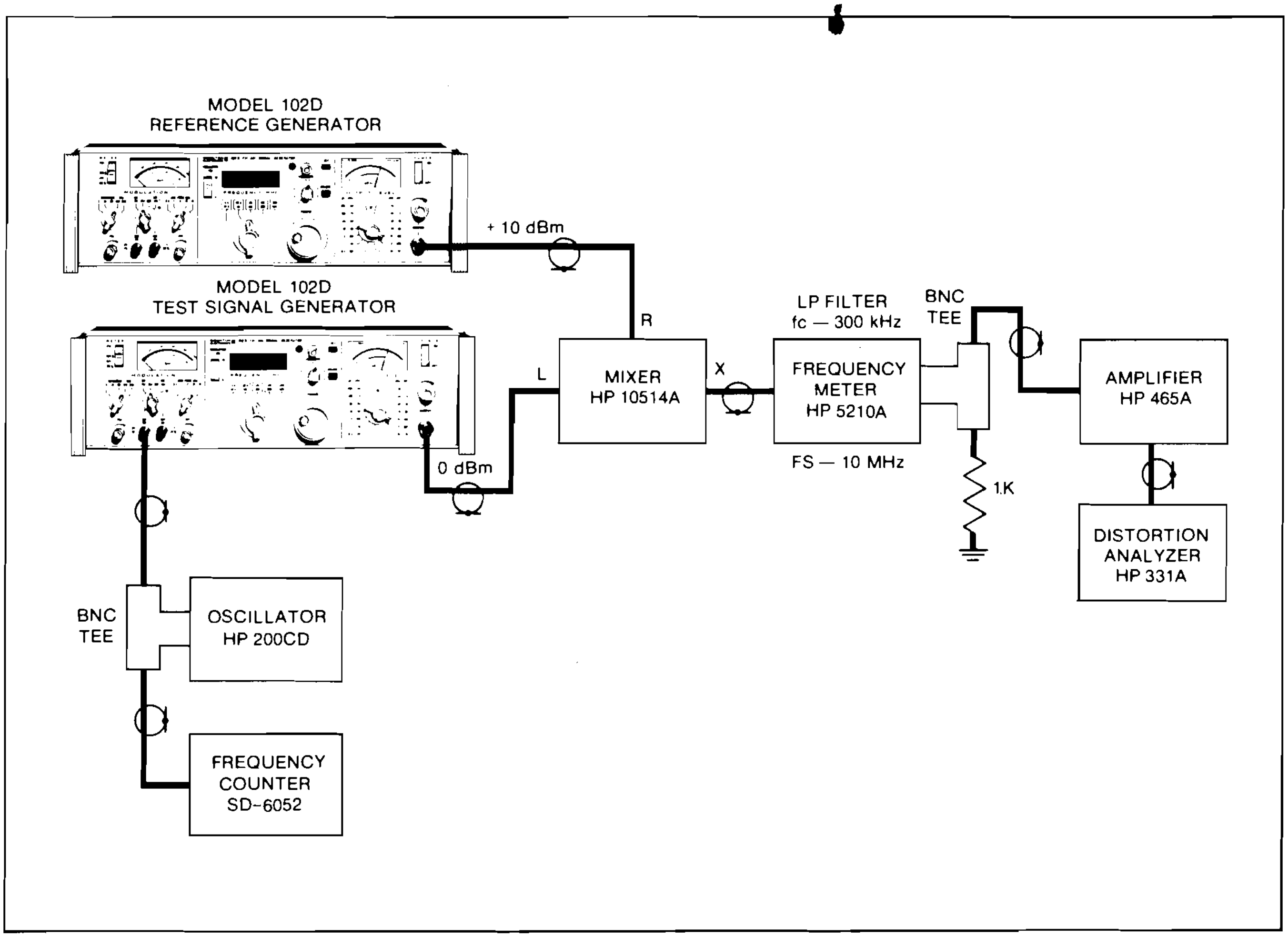


Figure 4-3 FM Deviation Tracking and Calibration, Test Setup

4-19. Counter Frequency Accuracy Adjustment. If the indication obtained for the counter frequency accuracy check (paragraph 2-37) is not as specified, adjustment of the clock frequency for the frequency counter circuits may be required. Proceed as follows:

a. Connect the Model 102D and test equipment as shown in Figure 2-16.

b. Set the controls on the Model 102D as follows:

Control	Position
FREQUENCY MHz switch	Band 3 (65 – 130)
RESOLUTION kHz switch	0.1
MODULATION function switch	CW
TUNING control	100 MHz indication on output frequency indicator
OUTPUT LEVEL attenuator	0 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter
INT/EXT switch	INT
LOCK pushbutton	Actuated

c. Set the frequency counter controls for a range of 20 Hz to 200 MHz, resolution of 1 Hz, and X1 attenuation.

d. Remove the screws that attach the top cover of the Model 102D, and remove the top cover.

e. Locate the opening in the top cover of the phase lock housing, and remove the access screw from this opening.

f. Insert a small jeweller's screwdriver into the access opening and adjust the Model 102D for an indication of (1)00.0000 on the output frequency indicator.

g. Replace the access screw and the top cover.

4-20. FM Deviation Tracking and Calibration. Proceed as follows:

a. Connect the Model 102D and test equipment as shown in Figure 4-3.

b. Set the *test* Model 102D controls as follows:

Control	Position
DEVIATION kHz switch	100
MODULATION function switch	EXT
FM control	Fully clockwise
FREQUENCY MHz switch	65 -- 130 (band 3)
TUNING control	130.00 on output frequency indicator
OUTPUT LEVEL attenuator	0 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter
METER switch	FM

c. Set the *reference* Model 102D controls as follows:

Control	Position
MODULATION function switch	CW
FREQUENCY MHz switch	130 – 260 (band 4)
OUTPUT LEVEL attenuator	+10 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter

d. Set potentiometer R1809 on the modulation printed circuit board to the fully clockwise position.

e. Adjust the output frequency of the audio oscillator to 1 kHz, as indicated on the frequency counter, and adjust the amplitude control of the audio oscillator as required to obtain a full-scale indication on the MODULATION meter of the *test* Model 102D.

f. Tune the *reference* Model 102D to 138.00 MHz, using the TUNING control.

g. Adjust the four segmented rotor wafers at the high-frequency end of capacitor C1913 to produce equal spacing from the stator plates.

h. Set the function switch of the distortion analyzer to the set level position and the meter range switch to the 100 position. Adjust the sensitivity control on the distortion analyzer as required to obtain an indication of 0.8 on the distortion analyzer meter.

i. Decrease the output frequency of the *test* Model 102D and the *reference* Model 102D in 5 MHz decrements. (Make certain that the *reference* Model 102D output frequency is 8 MHz higher than that of the *test* Model 102D at each interval.) At each 5 MHz interval, adjust the rotor wafers of capacitor C1913 uniformly as required to produce an indication of 0.80 ± 0.02 on the distortion analyzer meter.

j. Rotate the TUNING control of the *test* Model 102D slowly across the entire band, tracking the *reference* Model 102D 8 MHz above the *test* Model 102D output frequency at all points. Ascertain that the indication on the distortion analyzer meter is within the range of 0.76 to 0.84 at all points throughout the band. If necessary, readjust the segmented rotor wafers of capacitor C1913 uniformly to obtain this indication.

k. Set the POWER switch on the *test* Model 102D to OFF. Using the adjusting screw of the MODULATION meter, position the meter pointer exactly at the zero mark on the meter dial.

l. Disconnect the mixer from the OUTPUT connector of the *test* Model 102D. Connect spectrum analyzer, Hewlett Packard Model 141T/8552/8554, to the OUTPUT connector.

m. Set the POWER switch on the *test* Model 102D to ON, and the MODULATION function switch to CW. Using the TUNING control, adjust the output frequency to 100.00 MHz, as indicated on the output frequency indicator. Set the spectrum analyzer controls for a scan width of 10 kHz per centimeter and an i-f bandwidth of 1 kHz. Locate the 100.00 MHz signal on the spectrum analyzer display, and center the signal on the display.

n. Adjust potentiometer R1805 on the modulation printed circuit board as required to position the pointer of the MODULATION meter on the *test* Model 102D exactly on the zero mark on the meter dial.

o. Set the MODULATION function switch on the *test* Model 102D to EXT. Adjust the output frequency of the audio oscillator to 41.58 kHz, as indicated on the frequency counter. Adjust the audio oscillator amplitude control from a minimum setting to the point where the carrier frequency signal on the spectrum analyzer display is at a null. Ascertain that the carrier frequency amplitude on the spectrum analyzer display is at least 40 dB below its unmodulated amplitude. Then, adjust potentiometer R1809 on the modulation printed circuit board as required to obtain a deviation indication of exactly 100 kHz on the MODULATION meter of the *test* Model 102D.

p. Set the MODULATION function switch on the *test* Model 102D to CW. Rotate the TUNING control slowly across the band and note the output frequency indication at the points where the microswitches on the VFO tuning mechanism are actuated. If necessary, readjust the microswitches to actuate at the following frequencies: 78.8 MHz, 90.0 MHz, and 102.5 MHz.

q. Rotate the TUNING control on the *test* Model 102D first to the low-frequency end of the band, then to the high-frequency end, noting the display on the output frequency indicator at the points where the mechanical end stops are encountered. The band end frequencies should be 63.8 ±0.1 MHz and 131.25 ±0.025 MHz. If necessary, readjust the end stops as required to obtain the specified band end frequencies.

4-21. Band-Pass Filter Alignment. To align the band-pass filters on the doubler printed circuit board, proceed as follows:

a. Using the 50-ohm termination probe of r-f millivoltmeter, Boonton Electronics Corporation Model 92A, connect the r-f millivoltmeter to the OUTPUT connector of the Model 102D. Disable the automatic leveling loop of the Model 102D by connecting a clip lead from the junction of resistors R2019 and R2021 on the output printed circuit board to ground.

b. Set the FREQUENCY MHz switch to 130 – 260 (band 4), the OUTPUT LEVEL attenuator to 0 dBm, and the MODULATION function switch to CW.

c. While observing the indication on the r-f millivoltmeter, adjust the output frequency of the Model 102D slowly, using the TUNING control, from 130 MHz to the frequency at which the first microswitch on the VFO tuning mechanism is actuated (approximately 157.5 MHz). Adjust capacitor C242 as required to minimize variations in the r-f millivoltmeter indication over this tuning range.

d. While observing the indication on the r-f millivoltmeter, adjust the output frequency of the Model 102D slowly, using the TUNING control, from the point where the first microswitch was actuated in step c (approximately 157.5 MHz) to the point where the third microswitch is actuated (approximately 205.0 MHz). Adjust capacitor C244 as required to minimize variations in the r-f millivoltmeter over this tuning range.

e. While observing the indication on the r-f millivoltmeter, adjust the output frequency of the Model 102D slowly, using the TUNING control, from the point where the third microswitch was actuated in step d (approximately

205.0 MHz) to 260.0 MHz. Adjust capacitor C243 as required to minimize the variations in the r-f millivoltmeter indication over this tuning range.

f. Disconnect the clip lead connected in step a.

4-22. **Band 5 Driver Adjustment.** To adjust the band 5 driver on the doubler printed circuit board, proceed as follows:

a. Using the 50-ohm termination probe of r-f millivoltmeter, Boonton Electronics Corporation Model 92A, connect the r-f millivoltmeter to the OUTPUT connector of the Model 102D. Disable the automatic leveling loop of the Model 102D by connecting a clip lead from the junction of resistors R2019 and R2021 on the output printed circuit board to ground.

b. Set the FREQUENCY MHz switch on the Model 102D to 260 – 520 (band 5), the OUTPUT LEVEL attenuator to 0 dBm, and the MODULATION function switch CW.

c. Using the TUNING control, adjust the output frequency of the Model 102D to 520.0 MHz and note the indication on the r-f millivoltmeter. Adjust capacitors C262 and C267 as required to maximize the r-f millivoltmeter indication. Ascertain that this maximized indication is greater than +5 dBm.

d. Disconnect the clip lead connected in step a.

4-23. **Band 1 Converter Alignment.** To align the band 1 converter on the converter printed circuit board, proceed as follows:

a. Connect spectrum analyzer, Hewlett Packard Model 141T/8552/8554, to the OUTPUT connector of the Model 102D. Set the input attenuator of the spectrum analyzer to 20 dB.

b. Set the FREQUENCY MHz switch on the Model 102D to .45 – 32.5 (band 1). Set the TUNING control fully counterclockwise against the high-frequency stop.

c. Adjust capacitor C442 as required to obtain a strong signal indication at approximately 34 MHz on the spectrum analyzer display. Set the OUTPUT LEVEL attenuator on the Model 102D to 0 dBm and position the pointer of the OUTPUT LEVEL meter to the 0 dB mark, using the OUTPUT control.

d. Using the TUNING control, tune the Model 102D across band 1, noting the spurious mixing products (non-harmonics) on the spectrum analyzer display. Readjust capacitor C442 as required to minimize the spurious mixing products. Ascertain that the amplitude of the spurious mixing products is 30 dB or more below the main output signal amplitude.

e. Locate the 66.025 MHz local oscillator signal on the spectrum analyzer display. Adjust capacitor C437 as required to minimize the 66.025 MHz local oscillator signal on the spectrum analyzer display.

f. Repeat step d.

4-24. **Output Level Calibration.** To calibrate the output level circuits on the meter printed circuit board, proceed as follows:

a. Set the POWER switch on the Model 102D to OFF. Using the adjusting screw, position the pointer of the OUTPUT LEVEL meter exactly on the zero mark.

b. Disconnect the r-f cable from the VFO at terminal I of the r-f housing. Set the POWER switch to ON, and adjust potentiometer R915 as required to position the pointer of the OUTPUT LEVEL meter exactly on the zero mark. Then, reconnect the r-f cable to terminal I of the r-f housing.

c. Connect the power detector of microwattmeter, Boonton Electronics Corporation Model 42B, to the OUTPUT connector of the Model 102D. Set the FREQUENCY MHz switch on the Model 102D to 65 – 130 (band 3), adjust the TUNING control as required to obtain an indication of 100.00 on the output frequency indicator, and set the OUTPUT LEVEL attenuator to 0 dBm.

d. Adjust the OUTPUT control as required to obtain an indication of exactly 0 dBm on the microwattmeter. Adjust potentiometer R904, if necessary, to obtain an indication of exactly 0 dB on the OUTPUT LEVEL meter.

e. Using the OUTPUT control, position the pointer of the OUTPUT LEVEL meter at the +3 dB mark. Tune across bands 1 through 4 of the Model 102D, and ascertain that the indication on the microwattmeter remains within the range of 0 ± 0.5 dBm throughout the tuning range of each of the four bands.

f. Set the FREQUENCY MHz switch to 260 – 520 (band 5), and adjust the TUNING control to obtain an indication of 365.00 on the output frequency indicator.

g. Adjust the OUTPUT control as required to obtain an indication of exactly 0 dBm on the microwattmeter. Adjust potentiometer R905 as required to obtain an indication of exactly 0 dB on the OUTPUT LEVEL meter.

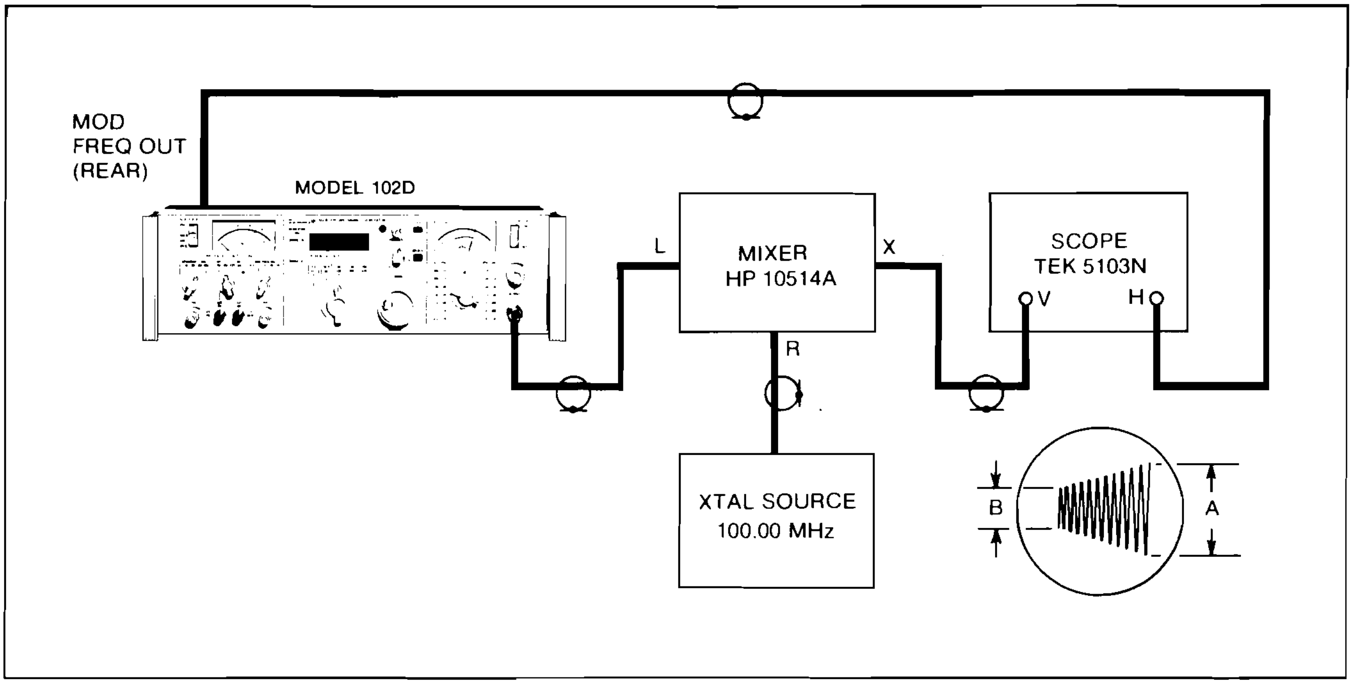


Figure 4-4 AM Calibration, Test Setup

h. Using the TUNING control, tune across the entire band and ascertain that the indication on the microwattmeter remains within the limits of 0 ± 0.5 dBm over the entire tuning range.

4-25. **AM Calibration.** To calibrate the AM circuits on the meter printed circuit board, proceed as follows:

a. Connect the Model 102D and the test equipment as shown in Figure 4-4.

b. Set the Model 102D controls as follows:

Control	Position
METER switch	100% AM
MODULATION function switch	INT AM
MOD FREQ kHz switch	1
FREQUENCY MHz switch	65 130 (band 3)
TUNING control	100.20 on output frequency indicator
OUTPUT LEVEL attenuator	-10 dBm
OUTPUT control	0 dB on OUTPUT LEVEL meter

c. Adjust the AM control as required to produce a trapezoid with an A dimension (Figure 4-4) of 8 divisions on the oscilloscope display and a B dimension of 2.65 divisions.

d. Adjust potentiometer R907 as required to obtain an indication of exactly 50 on the MODULATION meter.

e. Using the OUTPUT control, position the pointer of the OUTPUT LEVEL meter to the -10 dBm mark on the meter. Adjust the oscilloscope sensitivity so that the A dimension of the trapezoid on the oscilloscope display is 8 divisions. Ascertain that the B dimension is 2.60 to 2.70 divisions. If the B dimension is not within these limits, replace resistor R918 with a resistor of a different value, as follows:

1. If the B dimension of the trapezoid is less than 2.60 divisions, decrease the resistance of resistor R918.

2. If the B dimension of the trapezoid is more than 2.70 divisions, increase the resistance of resistor R918.

f. If the value of resistor R918 had to be changed in preceding step e, repeat steps c through e.

4-26. PARTS REMOVAL.

4-27. **General.** Careful attention has been paid in the design of the Model 102D to maintainability. Most parts are readily accessible for checking and replacement when

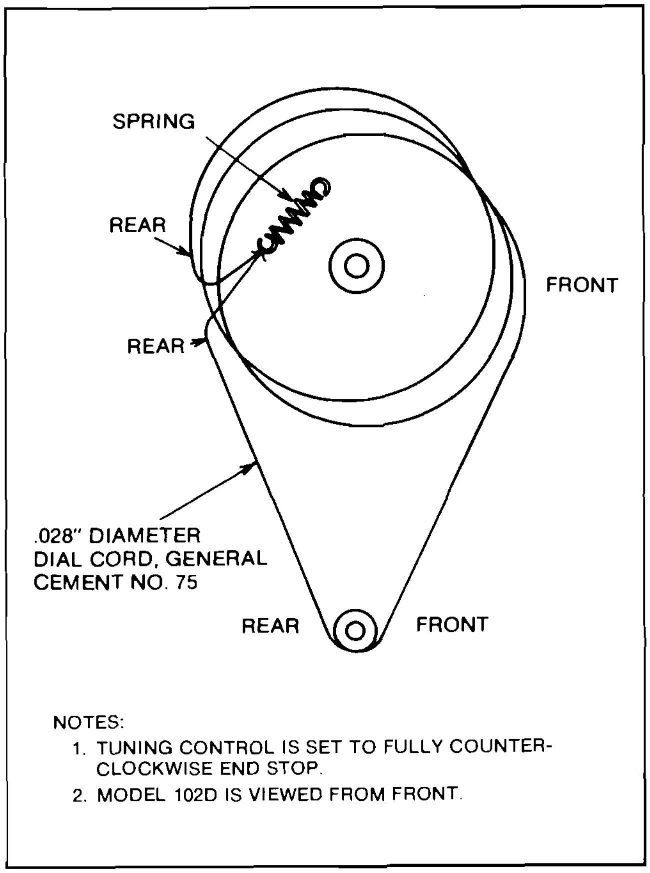


Figure 4-5 TUNING Control Drive, Dial Cord Installation

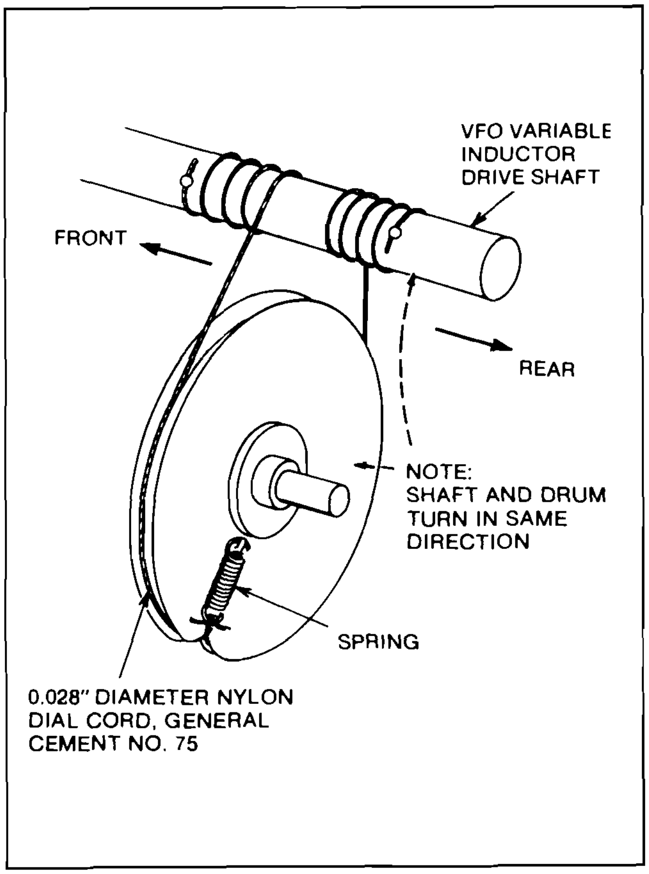


Figure 4-6 Varactor Tracking Capacitor, Dial Cord Installation

the case and cover shields are removed. Solid-state circuit components, mounted on printed circuit boards, are used throughout the equipment. Standard printed circuit board maintenance techniques are required for removal and replacement of parts. Excessive heat must be avoided; a low-wattage soldering iron and suitable heat sinks should be used for all soldering and unsoldering operations.

4-28. VFO Variable Inductor Removal. (See Figures 4-1 and 4-2.) Variable inductor L1901 is mounted inside the VFO housing on the Model 102D chassis. To remove the variable inductor, proceed as follows:

a. Remove the shield covers from the top and bottom of the VFO housing.

b. Unsolder all leadwires from variable inductor L1901.

c. Loosen the setscrews that attach the flexible coupling to the shaft of the variable inductor.

d. Remove the three screws that attach the variable inductor case to the chassis.

e. Press back the flexible coupling from the variable inductor shaft until the coupling clears the end of the shaft, and lift the variable inductor out of the VFO housing.

4-29. Tuning Control Drive, Dial Cord Replacement. The TUNING control drives the VFO tuning elements by means of a dial cord arrangement. If replacement of the dial cord becomes necessary, set the TUNING control fully counterclockwise against the stop and install the dial cord as shown in Figure 4-5. Use 0.028 inch diameter nylon dial cord, General Cement part number 75, or equivalent.

4-30. Varactor Tracking Capacitor, Dial Cord Replacement. Varactor tracking capacitor C1913 is driven from the VFO variable inductor drive shaft by means of a dial cord arrangement. If replacement of a dial cord becomes necessary, proceed as follows:

a. Set the TUNING control to the middle of its tuning range.

b. Remove the shield covers from the top and bottom of the VFO housing.

c. Position the pulley on the shaft of capacitor C1913 so that the slot in the pulley faces directly downward.

d. Install the replacement dial cord as shown in Figure 4-6. Use 0.028-inch diameter nylon dial cord, General Cement part number 75, or equivalent.

e. Rotate the TUNING control fully counterclockwise against the end stop. Verify that the rotor plates of capacitor C1913 are 1/16 inch from full mesh. If necessary, loosen the setscrews in the capacitor drive pulley and rotate the capacitor shaft to achieve the specified degree of mesh; then, tighten the setscrews.

f. Check FM deviation tracking and calibration in accordance with paragraph 4-20.

4-31. VOLTAGE MEASUREMENTS.

4-32. Tables 4-11 through 4-17 list typical DC voltages at the terminals of transistors and integrated circuits. All voltage measurements were made using a Weston Model 1240 voltmeter. Unless otherwise indicated, all voltages are positive, and were measured with reference to chassis ground.

TABLE 4-11. DC VOLTAGES, DOUBLER PCB

	Terminal Voltages*		
Transistor	E	B	C
Q201	- 2.9	-3.7	-3.1
Q202	- 9.8	-9.1	0.0
Q203	- 6.5	-5.7	-3.7
Q204	- 6.5	-6.8	-0.4
Q205	- 1.7	-2.5	-6.8
Q206	- 9.8	-9.1	0.0
Q207	-10.2	-9.4	0.0

TABLE 4-12. DC VOLTAGES, MODULATION PCB

	Terminal Voltage*										
Component	E	B	C	1	2	3	4	5	6	7	8
Q1801	0.8	0.1	15.0								
A1803				10.9	0.0	0.0	-13.5	10.9	0.0	13.5	-12.2
A1801				0.0	0.0	0.0	-15.0			15.0	15.0
A1802				15.0	0.0	0.0	-15.0		15.0	15.0	15.0

*Voltage values for components A1801 and A1802 were obtained under no signal conditions; all other voltage values with normal signals.

TABLE 4-13. DC VOLTAGES, CONVERTER PCB

	Component Voltage*															
Terminal	Q401	Q402	Q403	Q404	Q405	Q406	Q407	Q408	Q409	Q410	Q411	Q412	Q413	IC401	IC402	IC403
S	1.7															
D	13.9															
G	0.0															
E		14.6	1.0	6.4	6.8	6.8	2.8	7.7	7.7	0.6	0.6	0.6	0.6			
B		13.9	1.7	7.0	6.4	6.0	3.6	7.3	7.3	1.3	1.3	1.3	1.3			
C		1.7	7.0	15.0	0.5	3.6	3.4	0.0	0.0	12.8	9.4	3.3	12.8			
1														1.9	0.0	0.0
2														5.0	5.0	5.0
3														5.0	5.0	1.4
4														5.0	5.0	1.5
5														1.7	5.0	5.0
6														1.7	2.5	2.9
7														2.1	0.0	0.0
8														0.0	1.5	0.8
9														1.5	5.0	5.0
10														5.0	5.0	5.0
11														2.9	5.0	5.0
12														5.0	1.4	1.7
13														1.7	5.0	5.0
14														5.0	5.0	5.0
15														5.0		
16														5.0		

*Voltage values for transistors Q401 through Q407 were obtained under no-signal conditions; all other voltage values, with normal signals.

TABLE 4-14. DC VOLTAGES, OUTPUT PCB

	Terminal Voltage*							
Component	1	2	3	4	5	6	7	8
A2002	9.7	-1.6	-1.6	-14.9	-14.1	-5.6	14.6	10.5
A2004	12.4	0.0	0.0	-15.0	12.4	5.0	14.6	-13.6

*All voltage values were obtained with Model 102D controls set for CW, output frequency of 100 MHz, and power level of +10 dBm.

TABLE 4-15. DC VOLTAGES, POWER SUPPLY PCB

				Terminal Voltage*							
Component	In	Out	Control	1	2	3	4	5	6	7	8
IC2201	23.6	15.0	10.0								
IC2202	8.9	0.0	-5.0								
IC2203	11.9	5.0	0.0								
A2201				-4.5	6.2	6.2	-15.0	-20.0	9.9	15.0	9.6
A2202				-4.5	0	0	-15.0	-20.0	-5.0	15.0	-5.3

TABLE 4-16. DC VOLTAGES, METER PCB

	Terminal Voltage	
Component	3	6
A901	4.3	3.2

TABLE 4-17. DC VOLTAGES, DIVIDER PCB

	Terminal Voltage		
Component	E	B	C
Q1201	-52.	-6.2	-15

TABLE 4-18. DC VOLTAGES, PHASE LOCK TIME BASE PCB

	Terminal Voltage										
Component	E	B	C	1	2	3	4	5	6	7	8
Y1501					+5		0 to +5*				
Q1501	0	0.07	2								

*Function of setting of lock VERNIERS control

TABLE 4-19. DC VOLTAGES, PHASE DETECTOR PCB

				Terminal Voltages								
Component	E	B	C	1	2	3	4	5	6	7	8	Remarks
IC1601				0.2								UL
				3.6								L
IC1602						3.6						UL
						0.2						L
IC1604				0.2								UL
				3.6								L
A1601									<±0.05			UL
A1602					7.5							
A1603						-7.5						
A1604									<±0.05			UL
A1605									<±0.05			UL
A1606						-5			-10			UL
						-5			–			L
Q1601	0.7	0	0.7									UL
	0.1	0	-15									L
Q1602	≅300μV	–	11									UL
	≅400μV	–	11									L
Q1603	≅300μV	–	11									UL
	≅400μV	–	11									L
Q1604		≅0*										UL
		-14.5										L
Q1605	≅0	0.2	5									UL
	4	4.8	5									L

UL = Unlocked L = Locked * = Gate voltage

SECTION V
PARTS LIST

TABLE OF REPLACEABLE PARTS

Reference	Description		BEC Part No.
FRAME			
AT1	VHF Step Attenuator	Boonton Electronics	562000
P4	Connector, TNC	Solitron Microwave 4000-0010	477277
P5	Connector, TNC	General 4009-0001	477279
P6	Connector, TNC	Solitron Microwave 4000-0010	477277
P101	Connector, SMA	Specialty 39P125-1	477290
P1001	Connector, SMA	Specialty 39P125-1	477290
P1002	Connector, TNC	General 4009-0001	477279
FL1012	RFI Filter Assy. (2) Red	Boonton Electronics	102019-1
SUB PANEL			
C1	Capacitor, Cer.	220 pF 20% 500 V RMC JG	224212
C2	Capacitor, Tant.	100 μF 20% 10 V Sprague 196D107X0010LA3	283291
C8	Capacitor, Cer.	220 pF 20% 500 V RMC JG	224212
C9	Capacitor, Cer.	220 pF 20% 500 V RMC JG	224212
CR1	Solid State Lamp	MV5025 Monsanto	536000
J1	Connector, BNC	Dage 081-1	479123
J2	Connector, BNC	Dage 081-1	479123
J7 & J8	Adapter, TNC to N	Gremar 6098-Z	481009
J501	Connector, PC	Amphenol 143-015-01 (15 Pin)	479297
L3	Choke, RF	2.7 μH 10% Jeffers 4425-11K	400249
M1	Meter & Scale	Modulation (Ammon) Modified Boonton Electronics	554272
M1	Meter & Scale	Modulation (Alternate) (Hoyt) Modified Boonton Electronics	554310
M2	Meter & Scale	RF (Ammon) Modified Boonton Electronics	554269
M2	Meter & Scale	RF (Alternate) (Hoyt) Modified Boonton Electronics	554314
R7	Resistor, Comp.	5.1 kΩ 5%	344368
R11	Resistor, MF	604 Ω 1%	341275
R12*	Resistor, MF	31.6 kΩ 1%	341448
R12*	Resistor, MF	30.9 kΩ 1%	341447
R12*	Resistor, MF	32.4 kΩ 1%	341449
R12*	Resistor, MF	33.2 kΩ 1%	341450
R12*	Resistor, MF	34.0 kΩ 1%	341451
R13	Resistor, Comp.	5.1 kΩ 5%	344368
R14	Resistor, Var.	600 Ω Bridge-T Attenuator	311310
R15	Resistor, MF	604 Ω 1%	341275
R16	Resistor, Comp.	100 Ω 5%	343200
R17	Resistor, Var.	500 Ω 10% 2 W	311309
R18	Resistor, Comp.	100 Ω 5%	343200
R19	Resistor, Comp.	100 Ω 5%	343200
R39	Resistor, Var.	50 Ω 10% 1 W	311329
R41	Resistor, Var.	2 kΩ 10% 2 W	311317
R61	Resistor, Var.	500 Ω 10% 1 W	311356
R62	Resistor, MF	121 Ω 1%	341208

* One of the above to be selected during calibration

Reference	Description		BEC Part No.
S2	Switch, Rocker, Modified	UID 02-469-0005	465185
S3	Switch, Rotary	Ledex Series 212	466240
S6	Switch, Rocker	UID RSW-04-22-SD-BB-S-W1-BK	465203
S8	Switch, Rocker, Mod.	UID 02-469-0005	465185
REAR PANEL			
C5	Capacitor, Ceramic	1 nF 20% 1000 V RMC Type B	224229
C6	Capacitor, Ceramic	1 nF 20% 1000 V RMC Type B	224229
F1	Fuse, Slo-Blo	3/4 A, 115 V Buss MDL	545533
F1	Fuse, Slo-Blo	3/8 A, 230 V Buss MDL	545532
J3	Connector, BNC	Dage 081-1	479123
J25	Connector, BNC	Dage 081-1	479123
J801	Connector, Housing	Molex 0306-1081 (8 Pin)	479258
L1	Choke, RF	1 μH 10% Jeffers 4425-6K	400248
L2	Choke, RF	1 μH 10% Jeffers 4425-6K	400248
P24	Connector, Line Cord	Belden 17252	477281
S4	Switch, Rotary	Ledex Series 210	466230
T1	Power Transformer	Boonton Electronics	446082
DEVIATION SWITCH			
R1	Resistor, MF	1.15 kΩ 1%	341306
R2	Resistor, MF	1.15 kΩ 1%	341306
R3	Resistor, MF	750 Ω 1%	341284
R4	Resistor, MF	750 Ω 1%	341284
R5	Resistor, MF	1.15 kΩ 1%	341306
R6	Resistor, MF	1.15 kΩ 1%	341306
R8	Resistor, MF	845 Ω 1%	341289
R9	Resistor, MF	3.01 kΩ 1%	341346
R10	Resistor, MF	845 Ω 1%	341289
S1	Switch, Rotary	5 Position 4 Pole Ledex Series 312	466617
MODULATION SWITCH			
C3	Capacitor, Mica	3.1 nF 0.5% 500 V General Inst. RDM19FD312E03	200521
C4	Capacitor, Mica	3.1 nF 0.5% 500 V General Inst. RDM19FD312E03	200521
R20	Resistor, MF	127 kΩ 1%	341510
R21	Resistor, MF	127 kΩ 1%	341510
R22	Resistor, MF	51.1 kΩ 1%	341468
R23	Resistor, MF	51.1 kΩ 1%	341468
R24	Resistor, MF	16.9 kΩ 1%	341422
R25	Resistor, MF	16.9 kΩ 1%	341422
R26	Resistor, MF	5.11 kΩ 1%	341368
R27	Resistor, MF	5.11 kΩ 1%	341368
R28	Resistor, MF	2.67 kΩ 1%	341341
R29	Resistor, MF	2.67 kΩ 1%	341341
S5	Switch, Rotary	5 Position 2 Pole Ledex Series 312	466614
BAND SWITCH			
R30	Resistor, MF	1.82 kΩ 1%	341325
R31	Resistor, MF	453 Ω 1%	341263

TABLE OF REPLACEABLE PARTS (cont)

Reference		Description	BEC Part No.
		BAND SWITCH	
R32	Resistor, MF	1.82 kΩ 1%	341325
R33	Resistor, MF	1.0 kΩ 1%	341300
R34	Resistor, MF	1.13 kΩ 1%	341305
R35	Resistor, MF	1.0 kΩ 1%	341300
R36	Resistor, MF	768 Ω 1%	341285
R37	Resistor, MF	768 Ω 1%	341285
R38	Resistor, MF	2.37 kΩ 1%	341336
S7	Switch, Rotary	5 Position 4 Pole Ledex Series 312	466615
		DOUBLER P. C. BOARD	
C201	Capacitor, Cer.	220 pF 20% 500 V RMC JG	224212
C202	Capacitor, Mica	56 pF 5% 300 V Arco DM5-EC560J	205031
C203	Capacitor, Tant.	1.0 μF 20% 35 V Sprague 196D105X9035HA1	283216
C204	Capacitor, Cer.	220 pF 20% 500 V RMC JG	224212
C205	Capacitor, Cer.	220 pF 20% 500 V RMC JG	224212
C206	Capacitor, Mica	82 pF 5% 300 V Arco DM5-EC820J	205016
C207	Capacitor, Cer.	220 pF 20% 500 V RMC JG	224212
C208	Capacitor, Mica	100 pF 5% 300 V Arco DM5-FC101J	205006
C209	Capacitor, Mica	180 pF 5% 300 V Arco DM5-FA181J	205023
C210	Capacitor, Mica	68 pF 5% 500 V Arco DM15-680J	200031
C211 through C214	Capacitor, Cer.	220 pF 20% 500 V RMC JG	224212
C215	Capacitor, Mica	47 pF 5% 300 V Arco DM5-EC470J	205018
C216	Capacitor, Mica	33 pF 5% 300 V Arco DM5-EC330J	205010
C217	Capacitor, Mica	75 pF 5% 300 V Arco DM5-EC750J	205043
C218	Capacitor, Mica	56 pF 5% 300 V Arco DM5-EC560J	205031
C219	Capacitor, Mica	75 pF 5% 300 V Arco DM5-EC750J	205043
C220	Capacitor, Mica	56 pF 5% 300 V Arco DM5-EC560J	205031
C221	Capacitor, Mica	47 pF 5% 300 V Arco DM5-EC470J	205018
C222	Capacitor, Mica	33 pF 5% 300 V Arco DM5-EC330J	205010
C223 through C227	Capacitor, Cer.	220 pF 20% 500 V RMC JG	224212
C228 through C235	Capacitor, Mica	150 pF 5% 100 V Arco DM5-FA151J	205009
C236	Capacitor, Mica	82 pF 5% 300 V Arco DM5-EC820J	205016
C237	Capacitor, Mica	150 pF 5% 100 V Arco DM5-FA151J	205009
C238	Capacitor, Mica	43 pF 5% 200 V Arco DM5-EC430J	205014
C239	Capacitor, Mica	27 pF 300 V Arco DM5-EC270J	205008
C240	Capacitor, Mica	36 pF 5% 300 V Arco DM5-EC360J	205003
C241	Capacitor, Mica	150 pF 5% 100 V Arco DM5-FA151J	205009
C242	Capacitor, Var.	1.7 -6 pF 250 V Johanson 9300	281013
C243	Capacitor, Var.	1.7 -6 pF 250 V Johanson 9300	281013
C244	Capacitor, Var.	1.7 -6 pF 250 V Johanson 9300	281013
C245	Capacitor, Mica	43 pF 5% 200 V Arco DM5-EC430J	205014
C246	Capacitor, Mica	27 pF 5% 300 V Arco DM5-EC270J	205008
C247	Capacitor, Mica	39 pF 5% 300 V Arco DM5-EC390J	205044
C248	Capacitor, Mica	82 pF 5% 300 V Arco DM5-EC820J	205016
C249 through C253	Capacitor, Mica	150 pF 5% 100 V Arco DM5-FA151J	205009
C254	Capacitor, Mica	27 pF 5% 300 V Arco DM5-EC270J	205008
C255	Capacitor, Mica	150 pF 5% 100 V Arco DM5-FA151J	205009
C256	Capacitor, Mica	150 pF 5% 100 V Arco DM5-FA151J	205009
C257	Capacitor, Mica	27 pF 5% 300 V Arco DM5-EC270J	205008
C258	Capacitor, Mica	150 pF 5% 100 V Arco DM5-FA151J	205009
C259	Capacitor, Mica	150 pF 5% 100 V Arco DM5-FA151J	205009
C260	Capacitor, Mica	150 pF 5% 100 V Arco DM5-FA151J	205009
C261	Capacitor, Cer.	1 nF GMV 500 V RMC BG	224114
C262	Capacitor, Var.	3.5 -18 pF 250 V Johanson 9313	281011
C263	Capacitor, Mica	30 pF 5% 300 V Arco DM5-EC300J	205019
C264	Capacitor, Mica	82 pF 5% 300 V Arco DM5-EC820J	205016
C265	Capacitor, Mica	150 pF 5% 100 V Arco DM5-FA151J	205009
C266	Capacitor, Mica	33 pF 5% 300 V Arco DM5-EC330J	205010
C267	Capacitor, Var.	3.5 -18 pF 250 V Johanson 9313	281011
C268	Capacitor, Mica	160 pF 5% 50 V Arco DM5-FY161J	205004
C269	Capacitor, Cer.	1 nF GMV 500 V RMC BG	224114
C270	Capacitor, Mica	150 pF 5% 100 V Arco DM5-FA151J	205009
C271	Capacitor, Cer.	2.2 pF 10% 500 V Quality Components MC	218001
C272	Capacitor, Var.	1.0 -4.5 pF 250 V Johanson	281016

Reference		Description	BEC Part No.
C273	Capacitor, Cer.	2.2 pF 10% 500 V Quality Components MC	218001
C274	Capacitor, Var.	1.0 -4.5 pF 250 V Johanson	281016
C275	Capacitor, Mica	10 pF 5% 300 V Arco DM5-CC100J	205002
CR201	Diode, Zener	1N752A (5.6 V) Centralab	530134
CR202 through CR207	Diode, Pin	HP 5082-3080 Hewlett Packard	530137
CR208a through CR208d	Diode Quad	Matched Hewlett Packard	530903
	NOTE: two diodes from same quad must be used for each doubler circuit.		
CR209 through CR216	Diode, Pin	HP 5082-3080 Hewlett Packard	530137
L201	Choke, RF	150 nH 20% Jeffers 4415-1M	400246
L202	Choke, RF	2.7 μH 10% Jeffers 4425-11K	400249
L203	Choke, RF	2.7 μH 10% Jeffers 4425-11K	400249
L204	Choke, RF	100 nH 10% Caddell-Burns 26-660-1	400242
L205	Coil, RF	70 nH Boonton Electronics	400260
L206	Choke, RF	100 nH 10% Caddell-Burns 26-660-1	400242
L207	Coil, RF	70 nH Boonton Electronics	400260
L208	Choke, RF	100 nH 10% Caddell-Burns 26-660-1	400242
L209	Coil, RF	70 nH Boonton Electronics	400260
L210	Choke, RF	2.7 μH 10% Jeffers 4425-11K	400249
L211	Choke, RF	470 nH 20% Jeffers 4425-2K	400252
L212	Choke, RF	2.7 μH 10% Jeffers 4425-11K	400249
L213	Choke, RF	2.7 μH 10% Jeffers 4425-11K	400249
L214	Choke, RF	2.7 μH 10% Jeffers 4425-11K	400249
L215	Choke, RF	300 nH 10% Caddell-Burns 30-660-3	400244
L216	Choke, RF	100 nH 10% Caddell-Burns 26-660-1	400242
L217	Choke, RF	150 nH 20% Jeffers 4415-1M	400246
L218	Choke, RF	2.7 μH 10% Jeffers 4425-11K	400249
L219	Coil, RF	36 nH Boonton Electronics	400259
L220	Choke, RF	150 nH 20% Jeffers 4415-1M	400246
L221	Choke, RF	470 nH 20% Jeffers 4425-2K	400252
L222	Choke, RF	150 nH 20% Jeffers 4415-1M	400246
L223	Choke, RF	470 nH 20% Jeffers 4425-2K	400252
L224	Choke, RF	1 μH 10% Jeffers 4425-6K	400248
Q201	Transistor, PNP	MPS3640 Motorola	528079
Q202	Transistor, NPN	2N5109 RCA Only	528073
Q203	Transistor, NPN	MPS6507 Motorola	528070
Q204	Transistor, NPN	MPS6507 Motorola	528070
Q205	Transistor, PNP	MPS3640 Motorola	528079
Q206	Transistor, NPN	2N5109 RCA Only	528073
Q207	Transistor, NPN	2N5109 RCA Only	528073
R201	Resistor, Comp.	3 kΩ 5%	344346
R202	Resistor, Comp.	2 kΩ 5%	344329
R203	Resistor, Comp.	620 Ω 5%	344276
R204	Resistor, Comp.	150 Ω 5%	344217
R205	Resistor, Comp.	220 Ω 5%	344233
R206	Resistor, Comp.	5.6 Ω 5%	344072
R207	Resistor, Comp.	150 Ω 5%	344217
R208	Resistor, Comp.	270 Ω 5%	344241
R209	Resistor, Comp.	1.2 kΩ 5%	344308
R210	Resistor, Comp.	47 Ω 5%	344165
R211	Resistor, Comp.	47 Ω 5%	344165
R212	Resistor, Comp.	470 Ω 5%	344265
R213	Resistor, Comp.	47 Ω 5%	343165
R214	Resistor, Comp.	5.6 Ω 5%	344072
R215	Resistor, Comp.	100 Ω 5%	343200
R216	Resistor, Comp.	680 Ω 5%	343280
R217	Resistor, Comp.	680 Ω 5%	344280
R218	Resistor, Comp.	150 Ω 5%	344217

TABLE OF REPLACEABLE PARTS (cont)

Reference	Description		BEC Part No.
	DOUBLER P. C. BOARD		
R219	Resistor, Comp.	5.6 kΩ 5%	344372
R220	Resistor, Comp.	1.2 kΩ 5%	344308
R221	Resistor, Comp.	680 Ω 5%	343280
R222	Resistor, Comp.	75 Ω 5%	343184
R223	Resistor, Comp.	75 Ω 5%	343184
R224	Resistor, Comp.	180 Ω 5%	343225
R225	Resistor, Comp.	680 Ω 5%	343280
R226	Resistor, Comp.	680 Ω 5%	343280
R227	Resistor, Comp.	680 Ω 5%	343280
R228	Not Used		
R229	Resistor, Comp.	56 Ω 5%	343172
R230	Resistor, Comp.	56 kΩ 5%	343472
R231	Resistor, Comp.	680 Ω 5%	343280
R232	Resistor, Comp.	680 Ω 5%	343280
R233	Resistor, Comp.	680 Ω 5%	343280
R234	Resistor, Comp.	56 kΩ 5%	343472
R235	Resistor, Comp.	680 Ω 5%	343280
R236	Resistor, Comp.	56 kΩ 5%	343472
R237	Resistor, Comp.	100 Ω 5%	343200
R238 through R243	Resistor, Comp.	680 Ω 5%	343280
R244	Resistor, Comp.	150 Ω 5%	344217
R245	Resistor, Comp.	2 kΩ 5%	344329
R246	Resistor, Comp.	3 kΩ 5%	344346
R247	Resistor, Comp.	15 Ω 5%	344117
R248	Resistor, Comp.	150 Ω 5%	344217
R249	Resistor, Comp.	56 Ω 5%	343172
R250	Resistor, Comp.	2 kΩ 5%	344329
R251	Resistor, Comp.	3 kΩ 5%	344346
R252	Resistor, Comp.	150 Ω 5%	344217
R253	Resistor, Comp.	18 Ω 5%	344125
R254	Resistor, Comp.	150 Ω 5%	344217
T201 through T206	Transformer, Toroid RF	Boonton Electronics	410064
	FILTER SWITCH P. C. BOARD		
C301 through C312	Capacitor, Mica	33 pF 5% 300 V Arco DM5-EC330J	205010
C313	Capacitor, Cer.	0.01 µF 100 V Erie 805-Y5V0103Z	224119
CR301 through CR306	Diode, Pin	HP 5082-3080 Hewlett Packard	530137
R301	Resistor, Comp.	680 Ω 5%	343280
R302	Resistor, Comp.	680 Ω 5%	343280
R303	Resistor, Comp.	680 Ω 5%	343280
R304	Resistor, Comp.	56 kΩ 5%	343472
R305	Resistor, Comp.	680 Ω 5%	343280
R306	Resistor, Comp.	56 kΩ 5%	343472
R307	Resistor, Comp.	56 kΩ 5%	343472
R308 through R311	Resistor, Comp.	680 Ω 5%	343280
	CONVERTER P. C. BOARD		
C401	Capacitor, Cer.	100 nF -20% +80% 25 V Erie 5815-000-104Z	224124
C402	Capacitor, Cer.	5 nF 20% 500 V RMC SM	224213
C403	Capacitor, Cer.	5 nF 20% 500 V RMC SM	224213
C404	Capacitor, Tant.	10 µF 20% 25 V Sprague 196D106X0025KA1	283293
C405	Capacitor, Cer.	100 nF -20% +80% 25 V Erie 5815-000-104Z	224124
C406	Capacitor, Tant.	10 µF 20% 25 V Sprague 196D106X0025KA1	283293
C407	Capacitor, Cer.	12 pF 5% 500 V Erie 301-000-COGO-120J	220124
C408	Capacitor, Cer.	100 nF -20% +80% 25 V Erie 5815-000-104Z	224124
C409	Capacitor, Cer.	220 pF 20% 500 V RMC JG	224212
C410	Capacitor, Tant.	10 µF 20% 25 V Sprague 196D106X0025KA1	283293
C411	Capacitor, Cer.	100 nF -20% +80% 25 V Erie 5815-000-104Z	224124
C412	Capacitor, Cer.	8.2 pF ±0.25 pF 500 V Erie 301-000-COHO-829C	220123
C413	Capacitor, Cer.	5 nF 20% 500 V RMC SM	224213
C414	Capacitor, Tant.	10 µF 20% 25 V Sprague 196D106X0025KA1	283293
C415	Capacitor, Cer.	1 nF GMV 500 V RMC BG	224114
C416	Not Used		
C417	Capacitor, Cer.	1 nF GMV 500 V RMC BG	224114
C418	Capacitor, Cer.	1 nF GMV 500 V RMC BG	224114
C419	Not Used		
C420	Capacitor, Mica	75 pF 5% 300 V Arco DM5-EC750J	205043
C421	Capacitor, Mica	100 pF 5% 300 V Arco DM5-FC101J	205006
C422	Capacitor, Mica	100 pF 5% 300 V Arco DM5-FC101J	205006
C423	Capacitor, Mica	160 pF 5% 50 V Arco DM5-FY161J	205004
C424	Capacitor, Mica	100 pF 5% 300 V Arco DM5-FC101J	205006
C425	Capacitor, Mica	160 pF 5% 50 V Arco DM5-FY161J	205004
C426	Not Used		
C427	Capacitor, Mica	75 pF 5% 300 V Arco DM5-EC750J	205043
C428	Capacitor, Mica	100 pF 5% 300 V Arco DM5-FC101J	205006
C429	Capacitor, Cer.	1 nF GMV 500 V RMC BG	224114
C430	Capacitor, Cer.	1 nF GMV 500 V RMC BG	224114
C431	Capacitor, Cer.	1 nF GMV 500 V RMC BG	224114
C432	Capacitor, Cer.	0.1 µF 20% 50 V AVX 3420-050E-104M	224268
C433	Capacitor, Cer.	100 nF -20% +80% 25 V Erie 5815-000-104Z	224124
C434	Capacitor, Cer.	0.1 µF 20% 50 V AVX 3420-050E-104M	224268
C435	Capacitor, Mica	68 pF 5% 300 V Arco DM5-EC680J	205007
C436	Capacitor, Cer.	0.1 µF 20% 50 V AVX 3420-050E-104M	224268
C437	Capacitor, Var.	3.5 -18 pF 250 V Johanson 9313	281011
C438	Capacitor, Tant.	1 µF 20% 35 V Sprague 196D105X9035HA1	283216
C439	Capacitor, Mica	68 pF 5% 300 V Arco DM5-EC680J	205007
C440	Capacitor, Tant.	1 µF 20% 35 V Sprague 196D105X9035HA1	283216
C441	Capacitor, Tant.	1 µF 20% 35 V Sprague 196D105X9035HA1	283216
C442	Capacitor, Var.	3 -10 pF 250 V Johanson 9312	281014
C443	Capacitor, Cer.	8.2 pF ±0.25 pF 500 V Erie 301-000-COHO-829C	220123
C444	Capacitor, Mica	33 pF 5% 300 V Arco DM5-EC330J	205010
C445	Capacitor, Tant.	1 µF 20% 35 V Sprague 196D105X9035HA1	283216
C446	Capacitor, Cer.	0.1 µF 20% 50 V AVX 3420-050E-104M	224268
C447	Capacitor, Cer.	100 nF -20% +80% 25 V Erie 5815-000-104Z	224124
C448	Capacitor, Cer.	0.1 µF 20% 50 V AVX 3420-050E-104M	224268
C449	Capacitor, Cer.	1 nF GMV 500 V RMC BG	224114
C450	Capacitor, Cer.	0.1 µF 20% 50 V AVX 3420-050E-104M	224268
C451	Capacitor, Cer.	1 nF GMV 500 V RMC BG	224114
C452	Capacitor, Cer.	0.1 µF 20% 50 V AVX 3420-050E-104M	224268
C453	Capacitor, Cer.	0.1 µF 20% 50 V AVX 3420-050E-104M	224268
C454	Capacitor, Cer.	1 nF GMV 500 V RMC BG	224114
C455	Capacitor, Mica	100 pF 5% 500 V Arco DM15-F101J	200001
C456	Capacitor, Cer.	0.01 µF 100 V Erie 805-Y5V0103Z	224119
C457	Capacitor, Mica	10 pF 5% 300 V Arco DM5-CC100J	205002
C458	Capacitor, Mica	160 pF 5% 50V Arco DM5-FY161J	205004
C459	Capacitor, Mica	160 pF 5% 50V Arco DM5-FY161J	205004
CR401	Diode, Sil.	FD-777 Fairchild	530127
CR402	Diode, Sil.	FD-777 Fairchild	530127
CR403	Diode, Zener	1N752A (5.6 V) Centralab	530134
CR404 through CR407	Diode, Pin	5082-3080 Hewlett Packard	530137
CR408	Diode, Sig.	1N4148 T. I.	530058
IC401	Integrated Circuit	SN74S112N (Flip-Flop) T. I.	534036
IC402	Integrated Circuit	SN74H102N (Flip-Flop) T. I.	534037
IC403	Integrated Circuit	SN74H102N (Flip-Flop) T. I.	534037
IC404	Integrated Circuit	MC1034P	534133
L401	Choke, RF	10 µH 10% Jeffers 4445-2K	400245
L402	Choke, RF	10 µH 10% Jeffers 4445-2K	400245
L403	Choke, RF	2.7 µH 10% Jeffers 4425-11K	400249
L404	Choke, RF	10 µH 10% Jeffers 4445-2K	400245
L405	Choke, RF	150 nH 20% Jeffers 4415-1M	400246
L406	Choke, RF	200 nH 10% Caddell-Burns 28-660-2	400243
L407	Choke, RF	150 nH 20% Jeffers 4415-1M	400246
L408	Choke, RF	220 nH 20% Jeffers 4415-2M	400247
L409	Choke, RF	150 nH 20% Jeffers 4415-1M	400246
L410	Choke, RF	200 nH 10% Caddell-Burns 28-660-2	400243
L411	Choke, RF	10 µH 10% Jeffers 4445-2K	400245
L412	Choke, RF	0.33 µH 10% Jeffers 4425-1K	400294
L413	Choke, RF	2.7 µH 10% Jeffers 4425-11K	400249
L414	Choke, RF	2.7 µH 10% Jeffers 4425-11K	400249
L415	Choke, RF	0.82 µH 10% Jeffers 4425-5K	400293
L416	Choke, RF	270 nH 10% Jeffers 4416-6K	400250
L417	Choke, RF	10 µH 10% Jeffers 4445-2K	400245
L418	Choke, RF	2.7 µH 10% Jeffers 4425-11K	400249

TABLE OF REPLACEABLE PARTS (cont)

Reference	Description		BEC Part No.
CONVERTER P. C. BOARD			
Q401	Transistor, FET	2N4416 Motorola	528072
Q402	Transistor, PNP	2N3906 Motorola	528076
Q403	Transistor, NPN	MPS6507 Motorola	528070
Q404	Transistor, NPN	MPS6520 Motorola	528077
Q405	Transistor, PNP	MPS3640 Motorola	528079
Q406	Transistor, PNP	MPS3640 Motorola	528079
Q407	Transistor, NPN	MPS6507 Motorola	528070
Q408	Not Used		
Q409	Not Used		
Q410 through Q414	Transistor, NPN	2N3904 Motorola	528071
R401	Resistor, Comp.	1 MΩ 5%	344600
R402	Resistor, Comp.	680 Ω 5%	344280
R403	Resistor, Comp.	1 kΩ 5%	344300
R404	Resistor, Var.	500 Ω 10% 1/2 W	311305
R405	Resistor, Comp.	270 Ω 5%	344241
R406	Resistor, Comp.	220 Ω 5%	344233
R407	Resistor, Comp.	68 Ω 5%	344180
R408	Resistor, Comp.	100 Ω 5%	343200
R409	Resistor, Comp.	1 kΩ 5%	344300
R410	Resistor, Comp.	120 Ω 5%	344208
R411	Resistor, Comp.	100 Ω 5%	343200
R412	Resistor, Comp.	1 kΩ 5%	344300
R413	Resistor, Comp.	7.5 kΩ 5%	344384
R414	Resistor, Comp.	620 Ω 5%	344276
R415	Resistor, Comp.	56 Ω 5%	344172
R416	Resistor, Comp.	1 kΩ 5%	344300
R417	Resistor, Comp.	220 Ω 5%	344233
R418	Resistor, Comp.	620 Ω 5%	344276
R419	Resistor, Comp.	150 Ω 5%	344217
R420	Resistor, Comp.	47 Ω 5%	344165
R421	Resistor, Comp.	47 Ω 5%	344165
R422	Resistor, Comp.	680 Ω 5%	344280
R423	Resistor, Comp.	47 Ω 5%	344165
R424	Resistor, Comp.	27 Ω 5%	344141
R425	Not Used		
R426	Not Used		
R427	Not Used		
R428	Not Used		
R429	Not Used		
R430	Not Used		
R431	Not Used		
R432	Not Used		
R433	Resistor, Comp.	390 Ω 5%	344257
R434	Not Used		
R435	Resistor, Comp.	5.6 Ω 5%	344072
R436	Resistor, Comp.	680 Ω 5%	344280
R437	Resistor, Comp.	68 Ω 5%	344180
R438	Resistor, Comp.	36 Ω 5%	344153
R439	Resistor, Comp.	1.2 kΩ 5%	344308
R440	Resistor, Comp.	56 Ω 5%	344172
R441	Resistor, Comp.	1.2 kΩ 5%	344308
R442	Resistor, Comp.	3.3 kΩ 5%	344350
R443	Resistor, Comp.	56 Ω 5%	344172
R444	Resistor, Comp.	100 Ω 5%	344200
R445	Resistor, Comp.	12 kΩ 5%	344408
R446	Resistor, Comp.	470 Ω 5%	344265
R447	Resistor, Comp.	15 Ω 5%	344117
R448	Resistor, Comp.	68 Ω 5%	344180
R449	Resistor, Comp.	9.1 kΩ 5%	344392
R450	Resistor, Comp.	200 Ω 5%	344229
R451	Resistor, Comp.	100 Ω 5%	344200
R452	Resistor, Comp.	56 Ω 5%	344172
R453	Resistor, Comp.	12 kΩ 5%	344408
R454	Resistor, Comp.	330 Ω 5%	344250
R455	Resistor, Comp.	820 Ω 5%	344288
R456	Resistor, Comp.	12 kΩ 5%	344408
R457	Resistor, Comp.	3.3 kΩ 5%	344350
R458	Resistor, Comp.	62 Ω 5%	344176
R459	Resistor, Comp.	56 Ω 5%	344172
R460	Resistor, Comp.	1.2 kΩ 5%	344308
R461	Resistor, Comp.	7.5 kΩ 5%	344384

Reference	Description		BEC Part No.
R462	Resistor, Comp	750 Ω 5%	344284
R463	Resistor, Comp	18 Ω 5%	344125
R464	Resistor, Comp.	1.2 kΩ 5%	344308
R465	Resistor, Comp.	68 Ω 5%	344180
R466	Resistor, Comp.	10 kΩ 5%	344400
R467	Resistor, Comp.	100 Ω 5%	343200
R468	Resistor, Comp.	51 Ω 5%	344168
R469	Resistor, Comp.	120 Ω 5%	344208
R470	Resistor, Comp.	390 Ω 5%	344257
R471	Resistor, Comp.	1.5 kΩ 5%	344317
Y401	Quartz Crystal	66.025 MHz Type CR56A/U	547027
Z401	Mixer, Bal.	SRA-1 Mini-Circuits Lab	432000
DISPLAY P. C. BOARD			
C701	Capacitor, Tant.	10 μF 20% 25 V Sprague 196D106X0025KA1	283293
CR701	Diode, Sig.	FD-777 Fairchild	530127
IC701 through IC706	Integrated Circuit	SN7490N (Decade Counter) T. I.	534035
DS701 through DS706	Display, Numeric	5082-7356 Hewlett Packard	536801
R701	Resistor, Comp.	1 kΩ 5%	343300
METER P. C. BOARD			
A901	Op. Amp.	LM301AN National Semiconductor	535012
C901	Capacitor, Tant.	100 μF 20% 20 V Sprague 196D107X0020TE4	283313
C902	Capacitor, Cer.	10 nF 20% 500 V RMC SM	224271
C903	Capacitor, Tant.	33 μF 20% 15 V Sprague 196D336X0015FD	283206
C904	Capacitor, Cer.	1 nF GMV 500 V RMC BG	224114
C905	Capacitor, Tant.	100 μF 20% 20 V Sprague 196D107X0020TE4	283313
C906	Capacitor, Tant.	100 μF 20% 20 V Sprague 196D107X0020TE4	283313
C907	Capacitor, Mica	150 pF 5% 100V Arco DM5-FA151J	205009
C908	Capacitor, Cer.	3 pF ±0.25 pF 500 V Erie 301-000-COJO-309C	220122
C909	Capacitor, Mica	33 pF 5% 300 V Arco DM5-EC330J	205010
R901	Resistor, MF	10.0 kΩ 1%	341400
R902	Resistor, MF	8.25 kΩ 1%	341388
R903	Resistor, MF	9.09 kΩ 1%	341392
R904	Resistor, Var.	5 kΩ 10% 1/2 W	311307
R905	Resistor, Var.	5 kΩ 10% 1/2 W	311307
R906	Not Used		
R907	Resistor, Var.	5 kΩ 10% 1/2 W	311307
R908	Resistor, MF	5.11 kΩ 1%	341368
R909	Resistor, MF	750 Ω 1%	341284
R910	Resistor, Comp.	1.8 kΩ 5%	343325
R911	Resistor, MF	9.53 kΩ 1%	341394
R912	Resistor, MF	30.1 kΩ 1%	341446
R913	Resistor, MF	47.5 kΩ 1%	341465
R914	Resistor, MF	6.19 kΩ 1%	341376
R915	Resistor, Var.	100 Ω 10% 1/2 W	311306
R916	Resistor, MF	100 Ω 1%	341200
R917	Resistor, MF	1.10 kΩ 1%	342304
R918	Resistor, MF	31.6 Ω 1%	341148
RF HOUSING			
C1001	Capacitor, Cer.	220 pF 20% 500 V RMC JG	224212
C1002	Capacitor, Cer.	220 pF 20% 500 V RMC JG	224212
C1003	Capacitor, Tant.	100 μF 20% 20 V Sprague 196D107X0020TE4	283313
C1004	Capacitor, Cer.	1 nF GMV 500 V RMC BG	224114
C1005	Capacitor, Cer.	1 nF GMV 500 V RMC BG	224114
C1006	Capacitor, Cer.	220 pF 20% 500 V RMC JG	224212
C1007	Capacitor, Cer.	220 pF 20% 500 V RMC JG	224212
C1008	Capacitor, Cer.	220 pF 20% 500 V RMC JG	224212
C1009	Capacitor, Cer.	1 μF 20% 50 V AVX 3420-050E-105M	224264
C1010	Capacitor, Cer.	1 μF 20% 50 V AVX 3420-050E-105M	224264

TABLE OF REPLACEABLE PARTS (cont)

Reference	Description		BEC Part No.
RF HOUSING			
FL1001 through FL1005	RFI Filter Assembly	3 (ORN) Boonton Electronics	102020-1
FL1006	Not Used		
FL1007	RFI Filter Assembly	3 (ORN) Boonton Electronics	102020-1
FL1008	RFI Filter Assembly	3 (ORN) Boonton Electronics	102020-1
FL1009	RFI Filter Assembly	1 (BRN) Boonton Electronics	102018-1
FL1010	RFI Filter Assembly	3 (ORN) Boonton Electronics	102020-1
FL1011	RFI Filter Assembly	3 (ORN) Boonton Electronics	102020-1
J1001	Connector, SMA	Specialty 39JR117-1	479328
J1002	Connector, TNC	Specialty 24JR120-2	479304
R40	Resistor, Comp.	3 kΩ 5%	344346
R1001	Resistor, MF	49.9 Ω 1%	341167
S1001	Band Switch (Rear)	5 Position 8 Pole Ledex Series 312	466613
DIVIDER P. C. BOARD			
C1201	Capacitor, Cer.	1 nF 500 V GMV RMC BG	224114
C1202	Capacitor, Cer.	0.01 μF 100 V Erie 805-Y5V0103Z	224119
C1203	Capacitor, Cer.	1 nF 500 V GMV RMC BG	224114
C1204	Capacitor, Cer.	0.01 μF 100 V Erie 805-Y5V0103Z	224119
C1205	Capacitor, Cer.	1 μF 20% 50 V AVX 3420-050E-105M	224264
C1206	Capacitor, Cer.	1 μF 20% 50 V AVX 3420-050E-105M	224264
IC1201	Integrated Circuit	SP601B (Counter) Plessey	534085
IC1202	Integrated Circuit	SN74S00N (NAND Gate) T. I.	534082
IC1203	Integrated Circuit	SN7493N (Binary Counter) T. I.	534033
Q1201	Transistor, PNP	MPSA66 Motorola	528048
R1201	Resistor, MF	64.9 kΩ 1%	341478
R1202	Resistor, MF	86.6 kΩ 1%	341490
R1203	Resistor, Comp.	130 Ω 5%	343211
R1204	Resistor, Comp.	750 Ω 5%	343284
R1205	Resistor, Comp.	1.8 kΩ 5%	343325
R1206	Resistor, Comp.	1 kΩ 5%	343300
R1207	Resistor, Comp.	10 kΩ 5%	343400
MASTER P. C. BOARD			
C1301 through C1310	Capacitor, Cer.	0.01 μF 100 V Erie 805-Y5V0103Z	224119
J1301	Connector, P. C.	Amphenol 143-022-03 (22 Pin)	479231
J1302	Connector, P. C.	Amphenol 143-022-03 (22 Pin)	479231
J1303	Connector, P. C.	Amphenol 143-022-03 (22 Pin)	479231
DISPLAY TIME BASE P. C. BOARD			
C1401	Capacitor, Mylar	0.1 μF 20% 250 V Mepco/Electra C280MAH/A100K	234080
C1402	Capacitor, Elec.	10 μF 20% 25 V Sprague 196D106X0025KA1	283293
C1403	Capacitor, Mica	680 pF 10% 500 V General Inst. RDM19FD681K03	200520
C1404	Capacitor, Mylar	0.1 μF 20% 250 V Mepco/Electra C280MAH/A100K	234080
IC1401	Integrated Circuit	SN74L90N (Decade Counter) T. I.	534079
IC1402	Integrated Circuit	SN7493N (Binary Counter) T. I.	534033
IC1403	Integrated Circuit	SN74L90N (Decade Counter) T. I.	534079
IC1404	Integrated Circuit	SN74L90N (Decade Counter) T. I.	534079
IC1405	Integrated Circuit	SN7472N (Flip-Flop) T. I.	534032
IC1406	Integrated Circuit	SN7490N (Decade Counter) T. I.	534035
IC1407	Integrated Circuit	SN75450N (Driver) T. I.	535009
IC1408	Integrated Circuit	SN7490N (Decade Counter) T. I.	534035
IC1409	Integrated Circuit	DM8094N (Buffer) National Semiconductor	534060
L1401	Choke, RF	10 μH 10% Jeffers 4445-2K	400245
Q1401	Transistor, NPN	2N3904 Motorola	528071

Reference	Description		BEC Part No.
R1401 through R1405	Resistor, Comp.	1 kΩ 5%	344300
R1406	Resistor, Comp.	390 Ω 5%	344257
R1407	Resistor, Comp.	220 Ω 5%	344233
R1408	Resistor, Comp.	220 Ω 5%	344233
Y1401	Crystal Oscillator	CO-251 Vectron Labs	547901
PHASE LOCK TIME BASE P. C. BOARD			
C1501 through C1504	Capacitor, Cer.	0.01 μF 100 V Erie 805-Y5V0103Z	224119
C1505	Capacitor, Cer.	1000 pF 500 V GMV RMC BG	224114
C1506	Capacitor, Elec.	6.8 μF 10% 35 V Sprague 196D685X9035KA1	283217
CR1501	Diode, Sig.	1N914 T. I.	530124
CR1502	Diode, Sig.	1N914 T. I.	530124
IC1501	Integrated Circuit	SN74L00N (NAND Gate) T. I.	534002
IC1502 through IC1505	Integrated Circuit	SN74L90N (Decade Counter) T. I.	534079
IC1506	Integrated Circuit	SN7490N (Decade Counter) T. I.	534035
Q1501	Transistor, NPN	2N3904 Motorola	528071
Q1502	Transistor, PNP	2N3906 Motorola	528076
R1501	Resistor, Comp.	4.7 kΩ 5%	343365
R1502	Resistor, Comp.	680 Ω 5%	343280
R1503	Resistor, Comp.	680 Ω 5%	343280
R1504	Resistor, Comp.	27 kΩ 5%	343441
R1505	Resistor, Comp.	3.3 kΩ 5%	343350
R1506	Resistor, Comp.	5.1 kΩ 5%	343368
R1507	Resistor, Comp.	5.1 kΩ 5%	343368
Y1501	Crystal Oscillator	251-2258 Vectron Labs	547902
PHASE DETECTOR P. C. BOARD			
A1601 through A1605	Op. Amp.	LM301AN National Semiconductor	535012
A1606	Op. Amp.	CA6741T RCA	535020
C1601	Capacitor, Cer.	1 nF GMV 500 V RMC BG	224114
C1602	Capacitor, Cer.	0.01 μF 100 V Erie 805-Y5V0103Z	224119
C1603	Capacitor, Cer.	0.01 μF 100 V Erie 805-Y5V0103Z	224119
C1604	Capacitor, Elec.	6.8 μF 10% 35 V Sprague 196D685X9035KA1	283217
C1605	Capacitor, Cer.	1 nF GMV 500 V RMC BG	224114
C1606	Capacitor, PE	0.1 μF 20% 250 V Mepco/Electra C280MAH/A100K	234080
C1607	Capacitor, PE	0.1 μF 20% 250 V Mepco/Electra C280MAH/A100K	234080
C1608	Capacitor, Cer.	33 pF 5% 1 kV Sprague C030B102G330J	224139
C1609	Capacitor, Cer.	33 pF 5% 1 kV Sprague C030B102G330J	224139
C1610	Capacitor, Cer.	33 pF 5% 1 kV Sprague C030B102G330J	224139
C1611	Capacitor, Elec. 47	47 μF 10% 20 V Sprague 196D476X9020LA3	283219
C1612	Capacitor, Cer.	33 pF 5% 1 kV Sprague C030B102G330J	224139
C1613	Capacitor, Elec. 47	47 μF 10% 20 V Sprague 196D476X9020LA3	283219
C1614	Capacitor, PE	0.1 pF 20% 250 V Mepco/Electra C280MAH/A100K	234080
C1615	Capacitor, PE	0.033 μF 10% 200 V Sprague 192P33392	234045
C1616	Capacitor, PE	0.068 μF 5% 200 V Sprague 192P68352	234051
C1617	Capacitor, PE	0.033 μF 10% 200 V Sprague 192P33392	234045
C1618	Capacitor, PE	0.068 μF 5% 200 V Sprague 192P68352	234051
C1619	Capacitor, Cer.	33 pF 5% 1 kV Sprague C030B102G330J	224139
CR1601	Diode, Zener	1N5227B (3.6 V) Motorola	530095
CR1602	Diode, Zener	1N5227B (3.6 V) Motorola	530095
CR1603	Diode, Sig.	1N914 T. I.	530124
CR1604	Diode, Sig.	1N914 T. I.	530124
CR1605	Diode, Sig.	1N914 T. I.	530124
IC1601	Integrated Circuit	SN7474N (Flip-Flop) T. I.	534080

TABLE OF REPLACEABLE PARTS (cont)

Reference	Description		BEC Part No.
	PHASE DETECTOR P. C. BOARD		
IC1602	Integrated Circuit	SN74L02N (NOR Gate) T. I.	534086
IC1603	Integrated Circuit	SN74L00N (NAND Gate) T. I.	534002
IC1604	Integrated Circuit	SN74L10N (NAND Gate) T. I.	534029
Q1601	Transistor, PNP	2N5087 Motorola	528042
Q1602	Transistor, NPN	2N5088 Motorola	528047
Q1603	Transistor, NPN	2N5088 Motorola	528047
Q1604	Transistor, FET	2N5949 T. I.	528019
Q1605	Transistor, NPN	2N5088 Motorola	528047
R1601	Resistor, Comp.	220 Ω 5%	343233
R1602	Resistor, Comp.	4.7 kΩ 5%	343365
R1603	Resistor, MF	309 kΩ 1%	341547
R1604	Resistor, MF	1 kΩ 1%	341300
R1605	Resistor, MF	1 kΩ 1%	341300
R1606	Resistor, MF	309 kΩ 1%	341547
R1607	Resistor, MF	100 kΩ 1%	341500
R1608	Resistor, MF	100 kΩ 1%	341500
R1609 through R1612	Resistor, MF	10 kΩ 1%	341400
R1613	Resistor, MF	866 kΩ 1%	342590
R1614	Resistor, MF	866 kΩ 1%	342590
R1615	Resistor, MF	100 kΩ 1%	341500
R1616	Resistor, Comp.	100 kΩ 5%	343500
R1617	Resistor, Comp.	120 kΩ 5%	343508
R1618	Resistor, MF	100 kΩ 1%	341500
R1619	Resistor, MF	100 kΩ 1%	341500
R1620	Resistor, MF	49.9 kΩ 1%	341467
R1621	Resistor, MF	100 kΩ 1%	341500
R1622	Resistor, MF	33.2 kΩ 1%	341450
R1623	Resistor, Comp.	4.7 kΩ 5%	343365
R1624	Resistor, MF	604 Ω 1%	341275
R1625	Resistor, MF	100 kΩ 1%	341500
R1626	Resistor, MF	100 kΩ 1%	341500
R1627	Resistor, Comp.	220 Ω 5%	343233
R1628	Resistor, MF	100 kΩ 1%	341500
R1629	Resistor, MF	100 kΩ 1%	341500
	COUNTER P. C. BOARD		
C1701	Capacitor, Elec.	6.8 μF 10% 35 V Sprague 196D685X9035KA1	283217
C1702	Capacitor, Elec.	6.8 μF 10% 35 V Sprague 196D685X9035KA1	283217
C1703	Capacitor, Cer.	1000 pF 500 V GMV RMC BG	224114
CR1701	Diode, Sig.	1N914 T. I.	530124
IC1701	Integrated Circuit	SN7474N (Flip-Flop) T. I.	534080
IC1702	Integrated Circuit	SN7408N (AND Gate) T. I.	534083
IC1703	Integrated Circuit	SN7430N (NAND Gate) T. I.	534045
IC1704	Integrated Circuit	SN74L122N (Monostable) T. I.	534063
IC1705	Integrated Circuit	SN7402N (NOR Gate) T.I.	534027
IC1706	Integrated Circuit	SN74L75N (Latch) T. I.	534081
IC1707	Integrated Circuit	SN74163N (Counter) T. I.	534077
IC1708	Integrated Circuit	SN7420N (NAND Gate) T. I.	534058
IC1709	Integrated Circuit	SN74L75N (Latch) T. I.	534081
IC1710	Integrated Circuit	SN74163N (Counter) T. I.	534077
IC1711	Integrated Circuit	SN7474N (Flip-Flop) T. I.	534080
IC1712	Integrated Circuit	SN74L75N (Latch) T. I.	534081
IC1713	Integrated Circuit	SN74163N (Counter) T. I.	534077
IC1714	Integrated Circuit	SN74L75N (Latch) T.I.	534081
IC1715	Integrated Circuit	SN74163N (Counter) T. I.	534077
IC1716	Integrated Circuit	SN7402N (NOR Gate) T. I.	534027
IC1717	Integrated Circuit	SN74L75N (Latch) T. I.	534081
IC1718	Integrated Circuit	SN74163N (Counter) T. I.	534077
R1701	Resistor, Comp.	1 kΩ 5%	343300
R1702	Resistor, Comp.	1 kΩ 5%	343300
R1703	Resistor, MF	15 kΩ 1%	341417
	MODULATION P. C. BOARD		
A1801	Op. Amp. Comparator	LM311 National Semiconductor	535006
A1802	Op. Amp.	LM310 National Semiconductor	535005
A1803	Op. Amp.	LM318H National Semiconductor	535010
C1801	Capacitor, Tant.	10 μF -15% +75% 15 V Mallory CL23BE100UNE	283294
C1802	Capacitor, Tant.	100 μF 20% 20 V Sprague 196D107X0020TE4	283313
C1803	Capacitor, Mica	82 pF 5% 300 V Arco DM5-EC820J	205016
C1804	Capacitor, Tant.	22 μF 10% 25 V Sprague 196D226X9025LA3	283308
C1805	Capacitor, Tant.	100 μF 20% 20 V Sprague 196D107X0020TE4	283313
C1806	Capacitor, Mica	100 pF 5% 500 V Arco DM15-F101J	200001
C1807	Capacitor, Tant.	10 μF -15% +75% 15 V Mallory CL23BE100UNE	283294
C1808	Capacitor, Tant.	100 μF 20% 20 V Sprague 196D107X0020TE4	283313
C1809	Capacitor, Tant.	100 μF 20% 20 V Sprague 196D107X0020TE4	283313
C1810	Capacitor, Tant.	10 μF -15% +75% 15 V Mallory CL23BE100UNE	283294
C1811	Capacitor, Tant.	10 μF -15% +75% 15 V Mallory CL23BE100UNE	283294
DS1801	Lamp	Chicago No. 1869 (10 V)	545123
Q1801	Transistor, NPN	2N3904 Motorola	528071
R1801	Resistor, MF	5.11 kΩ 1%	341368
R1802	Resistor, Comp.	2 kΩ 5%	344329
R1803	Resistor, Comp.	3.9 MΩ 5%	344657
R1804	Resistor, Comp.	10 kΩ 5%	344400
R1805	Resistor, Var.	1 kΩ 10% 1/2 W	311340
R1806	Resistor, MF	82.5 Ω 1%	341188
R1807	Resistor, MF	10.0 kΩ 1%	341400
R1808	Resistor, Var.	5.11 kΩ 1%	341368
R1809	Resistor, Var.	5 kΩ 10% 1/2 W	311307
R1810	Resistor, Var.	500 Ω 10% 1/2 W	311357
R1811	Resistor, Comp.	180 Ω 5%	344225
R1812	Resistor, Comp.	2.2 kΩ 5%	344333
R1813	Resistor, Comp.	1.8 kΩ 5%	344325
R1814	Resistor, Comp.	560 Ω 5%	344272
	VFO BOARD, VFO HOUSING		
C1901	Capacitor, FT	470 pF Modified Allen Bradley SS5D-4712	227116
C1902	Capacitor, FT	470 pF 20% 500 V Allen Bradley FA5C-4712	227112
C1903	Capacitor, Tant.	100 μF 20% 20 V Sprague 196D107X0020TE4	283313
C1904	Capacitor, Cer.	8.2 pF 5% N470 Sprague C035B102S8R2D	224225
C1905	Capacitor, Mica	100 pF 5% 300 V Arco DM5-FC101J	205006
C1906	Capacitor, Mica	100 pF 5% 300 V Arco DM5-FC101J	205006
C1907	Capacitor, Cer.	20 pF 5% 500 V Erie 301	220114
C1908	Capacitor, FT	470 pF Modified Allen Bradley SS5D-4712	227116
C1909	Capacitor, Cer.	15 pF 5% 500 V Erie 301-000-COGO-150J	220126
C1910	Capacitor, Cer.	3 pF ±0.25 pF 500 V Erie 301-000-COJO-309C	220122
C1911	Capacitor, FT	470 pF 20% 500 V Allen Bradley FA5C-4712	227112
C1912	Capacitor, Tant.	10 μF 20% 25 V Sprague 196D106X0025 KA1	283293
C1913	Capacitor, Var.	3.5 -18 pF Jackson	275152
C1914	Capacitor, FT	10 pF 10% 500 V Allen Bradley FA5C-1001	227115
C1915	Capacitor, Mica	68 pF 5% 300 V Arco DM5-EC680J	205007
CR1901	Diode, Varactor	DKV6520B Alpha Industries	530757
CR1902	Diode, Varactor	DKV6520B Alpha Industries	530757
CR1903	Diode, Sig.	HP 5082-2800	530132
FL101	RFI Filter Assembly	3 (ORN) Boonton Electronics	102020-1
FL102	RFI Filter Assembly	3 (ORN) Boonton Electronics	102020-1
FL103	RFI Filter Assembly	2 (RED) Boonton Electronics	102019-1
J101	Connector, SMA	Specialty 39JR117-1	479328
L1901	Coil, Var.	Mallory 516X235	400253
L1902	Choke, RF	4.7 μH 10% Jeffers 4425-14K	400292
L1903	Choke, RF	1 μH 10% Jeffers 4425-6K	400248
L1904	Choke, RF	3.3 μH 10% Jeffers 4425-12K	400332
L1905	Choke, RF	4.7 μH 10% Jeffers 4425-14K	400292
L1906	Choke, RF	10 μH 10% Jeffers 4445-2K	400245
Q1901	Transistor, FET	2N4416 Motorola Only	528072
R1901	Resistor, MF	51.1 kΩ 1%	341468
R1902	Resistor, MF	243 Ω 1%	341237
R1903	Resistor, MF	1.0 kΩ 1%	341300
R1904	Resistor, Comp.	150 Ω 5%	343217
R1905	Resistor, Comp.	62 Ω 5%	343176

TABLE OF REPLACEABLE PARTS (cont)

Reference	Description		BEC Part No.
VFO BOARD, VFO HOUSING			
R1906	Resistor, Comp.	150 Ω 5%	343217
R1907	Resistor, MF	1.0 kΩ 1%	341300
R1908	Resistor, MF	604 Ω 1%	341275
S9	Switch, Micro	Unimax 2TMA15-1	465500
S10	Switch, Micro	Unimax 2TMA15-1	465000
S11	Switch, Micro	Unimax 2TMA15-1	465000
OUTPUT P. C. BOARD			
A2001	Op. Amp.	GPD 463 Avantek	535030
A2002	Op. Amp.	LM318N National Semiconductor	535031
C2001	Capacitor, Cer.	1000 pF GMV 500 V RMC BG	224114
C2002	Capacitor, Cer.	1.0 μF 20% 50 V AVX 3420-050E-105M	224264
C2003	Capacitor, Cer.	1000 pF GMV 500 V RMC BG	224114
C2004	Capacitor, Cer.	1000 pF GMV 500 V RMC BG	224114
C2005	Capacitor, Mica	33 pF 5% 300 V Arco DM5-EC330J	205010
C2006	Capacitor, Mica	150 pF 5% 100 V Arco DM5-FA151J	205009
C2007	Capacitor, Cer.	1.0 μF 20% 50 V AVX 3420-050E-105M	224264
C2008	Capacitor, Cer.	1.0 μF 20% 50 V AVX 3420-050E-105M	224264
C2009	Capacitor, Cer.	1.0 μF 20% 50 V AVX 3420-050E-105M	224264
C2010	Capacitor, Mica	33 pF 5% 300 V Arco DM5-EC330J	205010
C2011	Capacitor, Mica	150 pF 5% 100 V Arco DM5-FA151J	205009
C2012	Capacitor, Mica	220 pF 5% 50 V Arco DM5-FY221J	205012
C2013	Capacitor, Cer.	1000 pF GMV 500 V RMC BG	224114
C2014	Capacitor, Cer.	0.1 μF 20% 50 V AVX 3420-050E-104M	224268
C2015	Capacitor, Cer.	0.022 μF 10% 50 V Kemet C1210C223K5XAH	224284
C2016	Capacitor, Cer.	0.1 μF 20% 50 V AVX 3420-050E-104M	224268
C2017	Capacitor, Cer.	0.1 μF 20% 50 V AVX 3420-050E-104M	224268
C2018	Capacitor, Cer.	1.0 μF 20% 50 V AVX 3420-050E-104M	224268
C2019	Capacitor, Cer.	0.022 μF 10% 50 V Kemet C1210C223K5XAH	224284
C2020	Capacitor, Cer.	0.1 μF 20% 50 V AVX 3420-050E-104M	224268
C2021	Capacitor, Cer.	0.1 μF 20% 50 V AVX 3420-050E-104M	224268
C2022	Capacitor, Tant.	100 μF 20% 20 V Sprague 196D107X0020TE4	283313
C2023	Capacitor, Mica	220 pF 5% 50 V Arco DM5-FY221J	205012
C2024	Capacitor, Cer.	0.1 μF 20% 50 V AVX 3420-050E-104M	224268
C2025	Capacitor, Mica	220 pF 5% 50 V Arco DM5-FY221J	205012
C2026	Capacitor, Tant.	100 μF 20% 20 V Sprague 196D107X0020TE4	283313
C2027	Capacitor, Mica	7500 pF 5% 100 V Arco DM19-752J	200530
C2028	Capacitor, Comp.	1.5 pF 10% 500 V Quality Components MC	218002
C2029	Not Used		
C2030	Capacitor, Cer.	0.022 μF 10% 50 V Kemet C1210C223K5XAH	224284
C2031	Capacitor, Cer.	1500 pF 5% 50 V Kemet C1210C152J5XAH	224274
C2032	Not Used		
C2033	Capacitor, Mica	7 pF 5% 300 V Arco DM5-CC030D	205030
C2034	Not Used		
C2035	Capacitor, Cer.	0.022 μF 10% 50 V Kemet C1210C223K5XAH	224284
C2036	Capacitor, Cer.	0.1 μF 20% 50 V AVX 3420-050E-104M	224268
C2037	Capacitor, Mica	33 pF 5% 300 V Arco DM5-EC330J	205010
CR2001 through CR2005	Diode, Pin	5082-3080 Hewlett Packard	530137
CR2006 through CR2013	Diode, Pin	PMS702-08 Parametric Industries	530162
CR2014	Diode, Pin	5082-2811 Hewlett Packard	530161
L2001	Choke, RF	10 μH 10% Jeffers 4445-2K	400245
L2002	Choke, RF	10 μH 10% Jeffers 4445-2K	400245
L2003	Choke, RF	10 μH 10% Jeffers 4445-2K	400245
R2001	Resistor, Comp.	680 Ω 5%	343280
R2002	Resistor, Comp.	56 kΩ 5%	343472
R2003	Resistor, Comp.	680 Ω 5%	343280
R2004	Resistor, Comp.	56 kΩ 5%	343472
R2005	Resistor, Comp.	680 Ω 5%	343280
R2006	Resistor, Comp.	56 kΩ 5%	343472
R2007	Resistor, Comp.	680 Ω 5%	343280
R2008	Resistor, Comp.	56 kΩ 5%	343472

Reference	Description		BEC Part No.
R2009	Resistor, Comp.	680 Ω 5%	343280
R2010	Resistor, Comp.	56 kΩ 5%	343472
R2011	Resistor, Comp.	680 Ω 5%	343280
R2012	Resistor, Comp.	270 Ω 5%	343241
R2013	Resistor, Comp.	270 Ω 5%	343241
R2014	Resistor, Comp.	470 Ω 5%	343265
R2015	Resistor, Comp.	470 Ω 5%	343265
R2016	Resistor, Comp.	680 Ω 5%	344280
R2017	Resistor, MF	1 MΩ 1%	341600
R2018	Resistor, Comp.	10 kΩ 5%	343400
R2019	Resistor, Comp.	100 kΩ 5%	343500
R2020	Resistor, Comp.	10 kΩ 5%	343400
R2021	Resistor, Comp.	3.9 kΩ 5%	343357
R2022	Not Used		
R2023	Not Used		
R2024	Resistor, Comp.	470 Ω 5%	343265
R2025	Resistor, Comp.	100 Ω 5%	343200
R2026	Not Used		
R2027	Resistor, CF	30 Ω 1% 1/10 W	335801
R2028	Resistor, MF	6.19 kΩ 1%	341376
T2001	Transformer, RF	Boonton Electronics	410074
T2002	Transformer, RF	Boonton Electronics	410074
POWER SUPPLY P. C. BOARD			
A2201	Op. Amp.	LM301AN National Semiconductor	535012
A2202	Op. Amp.	LM301AN National Semiconductor	535012
C2201	Capacitor, Cer.	0.01 μF 20% 500 V RMC SM	224271
C2202	Capacitor, Cer.	0.01 μF 20% 500 V RMC SM	224271
C2203	Capacitor, Cer.	0.01 μF 20% 500 V RMC SM	224271
C2204	Capacitor, Elec.	2000 μF 40 V Mallory PFP	283320
C2205	Capacitor, Elec.	2000 μF 40 V Mallory PFP	283320
C2206	Capacitor, Elec.	5000 μF 20 V Mallory PFP	283321
C2207	Capacitor, Mica	33 pF 5% 300 V Arco DM5-EC330J	205010
C2208	Capacitor, Mica	33 pF 5% 300 V Arco DM5-EC330J	205010
C2209	Capacitor, Tant.	10 μF 20% 25 V Sprague 196D106X0025KA1	283293
C2210	Capacitor, Tant.	10 μF 20% 25 V Sprague 196D106X0025KA1	283293
C2211	Capacitor, Tant.	10 μF 20% 25 V Sprague 196D106X0025KA1	283293
CR2201	Diode, Bridge	KBP-02 General Instrument	532013
CR2202	Diode, Bridge	KBP-02 General Instrument	532013
CR2203	Diode, Bridge	VJ148 Varo	532012
CR2204 through CR2208	Diode, Sig.	1N4001 Motorola	530151
CR2209	Diode, Zener	1N827 (5.9 – 6.5 V) Motorola	530072
CR2210	Diode, Sig.	1N4001 Motorola	530151
CR2211	Diode, Sig.	1N4001 Motorola	530151
IC2201	Integrated Circuit	μA7805 (Regulator) Fairchild	535011
IC2202	Integrated Circuit	μA7805 (Regulator) Fairchild	535011
IC2203	Integrated Circuit	LM323K (Regulator) National Semiconductor	535024
R2201	Resistor, Comp.	10 kΩ 5%	343400
R2202	Resistor, Comp.	10 kΩ 5%	343400
R2203	Resistor, Comp.	3.3 kΩ 5%	343350
R2204	Resistor, MF	1.10 kΩ 1%	341304
R2205	Resistor, MF	1.10 kΩ 1%	341304
R2206	Resistor, MF	10.0 kΩ 1%	341400
R2207	Resistor, MF	10.0 kΩ 1%	341400
R2208	Resistor, MF	1.10 kΩ 1%	341304
R2209	Resistor, Var.	200 Ω 10% 1/2 W	311304
R2210	Resistor, MF	750 Ω 1%	341284
R2211	Resistor, MF	4.99 kΩ 1%	341367
R2212	Resistor, MF	1.10 kΩ 1%	341304
WIDE BAND AMPLIFIER P. C. BOARD			
A2301	Op. Amp.	GPD-462 Avantek	535019
C2301	Capacitor, Cer.	0.022 μF 10% 50 V Kemet C1210C223K5XAH	224284
C2302	Capacitor, Cer.	0.01 μF 10% 100 V AVX 3419-100C-103K	224269
C2303	Capacitor, Cer.	0.1 μF 10% 50 V Kemet C1808C104K5XAH	224272
C2304	Capacitor, Cer.	0.01 μF 10% 100 V AVX 3419-100C-103K	224269

TABLE OF REPLACEABLE PARTS (cont)

Reference		Description	BEC Part No.
WIDE BAND AMPLIFIER P. C. BOARD			
C2305	Capacitor, Var.	3.5 -10 pF 50 V Matsushita ECV-1NW-10T18B	281017
C2306	Capacitor, Cer.	0.1 μF 10% 50 V Kemet C1808C104K5XAH	224272
C2307	Capacitor, Cer.	1000 pF 10% 100 V AVX 3418-100C-102K	224270
C2308	Capacitor, Mica	36 pF 5% 300 V Arco DM5-EC360J	205003
C2309	Capacitor, Mica	36 pF 5% 300 V Arco DM5-EC360J	205003
C2310	Capacitor, Cer.	0.1 μF 10% 50 V Kemet C1808C104K5XAH	224272
C2311	Capacitor, Cer.	0.1 μF 10% 50 V Kemet C1808C104K5XAH	224272
C2312	Capacitor, Cer.	0.1 μF 10% 50 V Kemet C1808C104K5XAH	224272
C2313	Not Used		
C2314	Capacitor, Mica	150 pF 5% 100 V Arco DM5-FA151J	205009
C2315	Capacitor, Cer.	0.1 μF 10% 50 V Kemet C1808C104K5XAH	224272
C2316	Not Used		
C2317	Capacitor, Cer.	15 pF 10% 50 V Kemet C1006C150K5GAH	224273
C2318*	Capacitor, Mica	5 pF 10% 300 V Arco DM5-CC050K	205000
C2318*	Capacitor, Mica	3 pF ±0.5 pF 300 V Arco DM5-CC030D	205013
L2301	Choke, RF	10 μH 10% Jeffers 4445-2K	400245
L2302	Choke, RF	100 μH 10% Jeffers 1326-7K	400291
L2303	Coil, RF	Boonton Electronics	400276
Q2301	Transistor, NPN	25C1251 Nippon Electric	528098

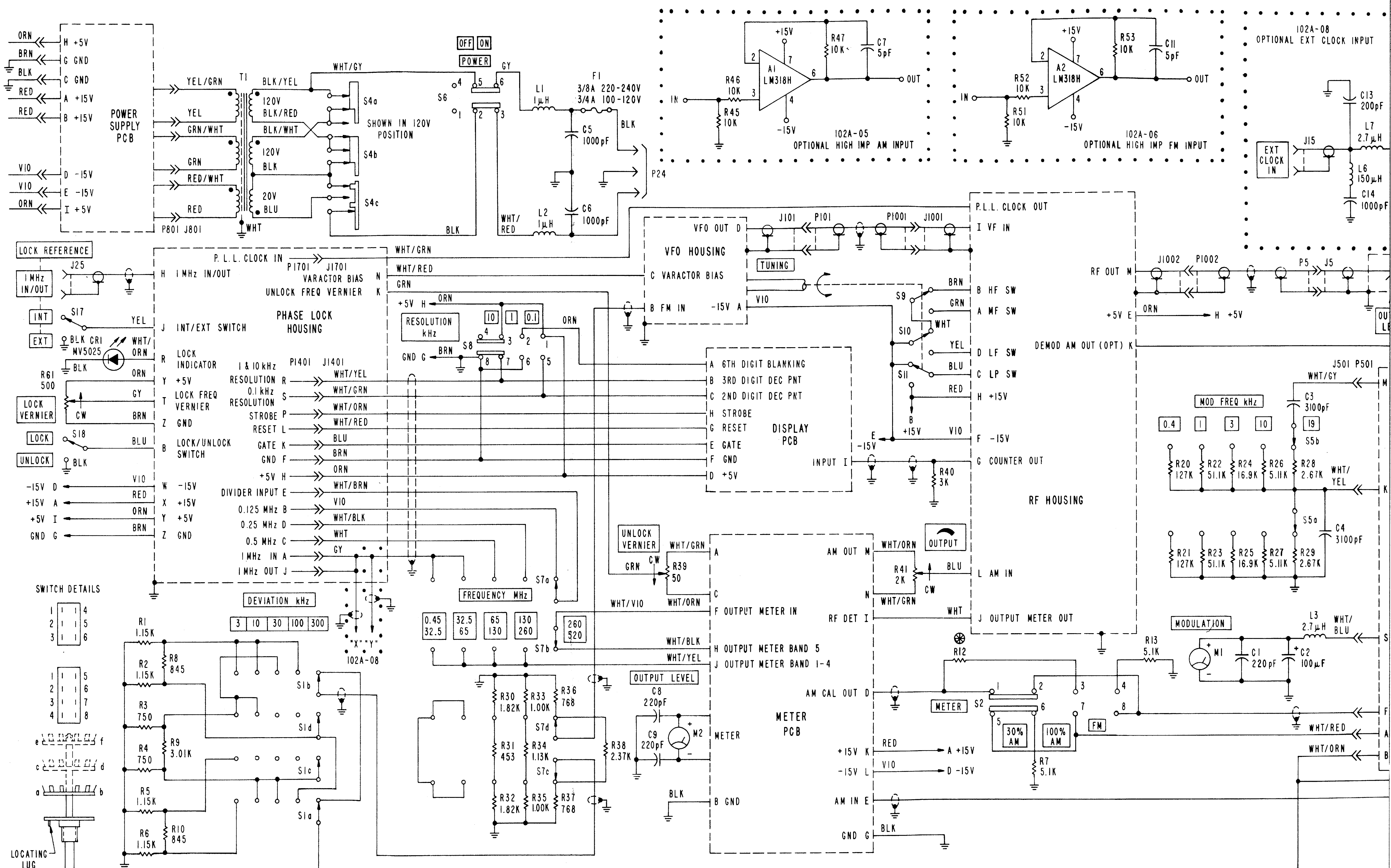
Reference		Description	BEC Part No.
Q2302	Transistor, NPN	25C1251 Nippon Electric	528098
R2301	Resistor, Comp.	240 Ω 5%	343237
R2302	Resistor, Comp.	1.2 kΩ 5%	343308
R2303	Resistor, Comp.	1.2 kΩ 5%	343308
R2304	Resistor, Comp.	12 Ω 5%	343108
R2305	Resistor, Comp.	100 Ω 5%	344200
R2306	Resistor, Comp.	39 Ω 5%	343157
R2307	Resistor, Comp.	15 Ω 5%	343117
R2308	Resistor, Comp.	470 Ω 5%	343265
R2309*	Resistor, Comp.	2.7 kΩ 5%	343341
R2309*	Resistor, Comp.	3.3 kΩ 5%	343350
R2310	Resistor, Comp.	680 Ω 5%	343280
R2311	Resistor, Comp.	470 Ω 5%	343265
R2312	Resistor, Comp.	18 Ω 5%	343125
R2313*	Resistor, Comp.	2.2 kΩ 5%	343333
R2313*	Resistor, Comp.	2.7 kΩ 5%	343341
R2314	Not Used		
R2315*	Resistor, Comp.	10 Ω 5%	343100
R2315*	Resistor, Comp.	18 Ω 5%	343125
T2301	Transformer, Toroid	Boonton Electronics	410072
T2302	Transformer, Toroid	Boonton Electronics	410073

*One of the above to be selected during calibration

SECTION VI
SCHEMATIC DIAGRAMS

NOTES:

1. RESISTANCE VALUES IN OHMS
2. ⊛ FACTORY SELECTED
3. [ ] EXTERNAL MARKING.
4. • • • • • SIGNIFIES OPTIONAL COMPONENTS.
5. LAST NUMBERS USED:
   R62 C18 L7
6. R14 600Ω BRIDGED "T" ATTEN.
7. NUMBERS NOT USED:
   R43, R44, R48-R50, R54, R55   C10, C12   L4, L5   S12-S14, S16   J10-J14, J20-J24   P1-P3, P8-P23



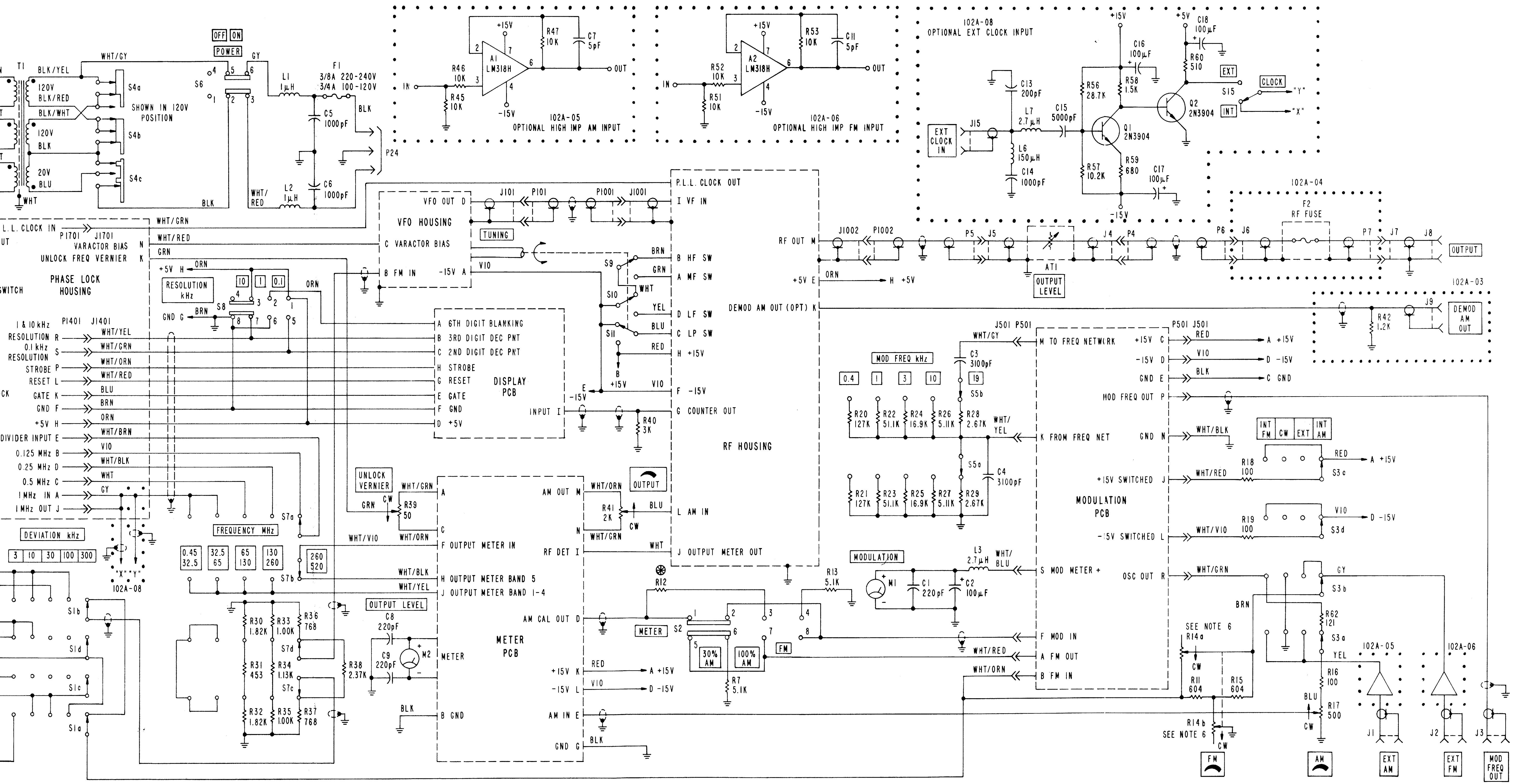
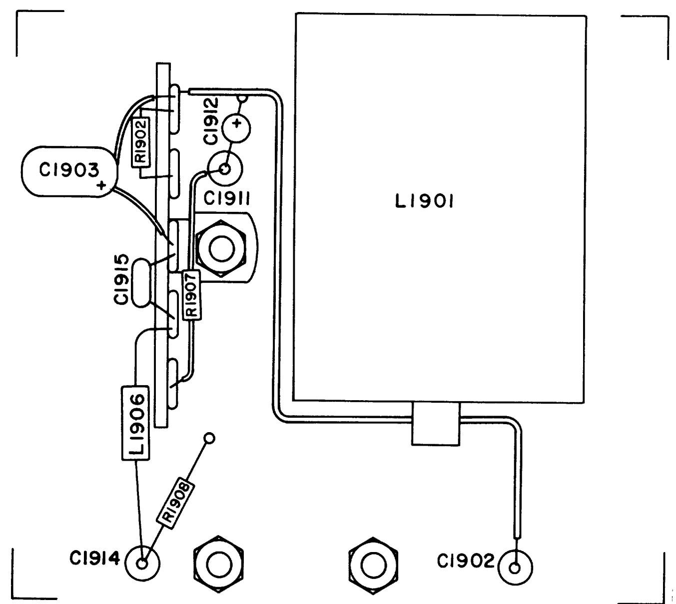
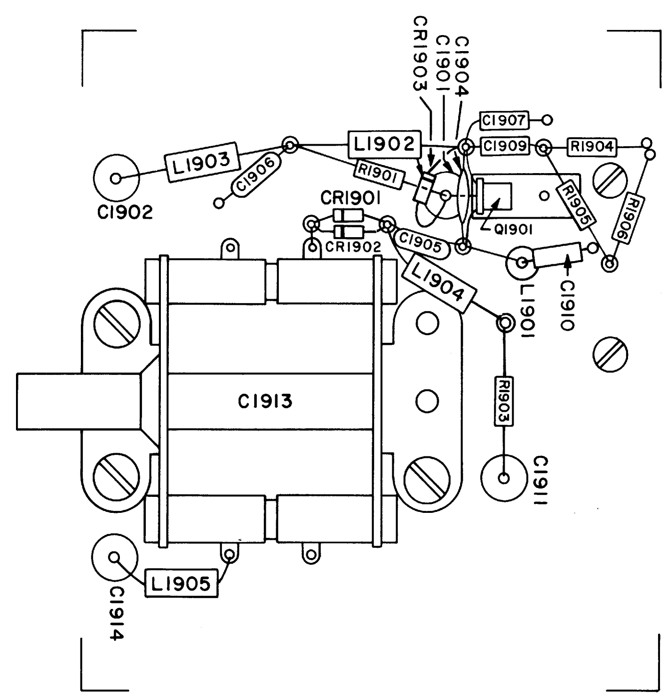
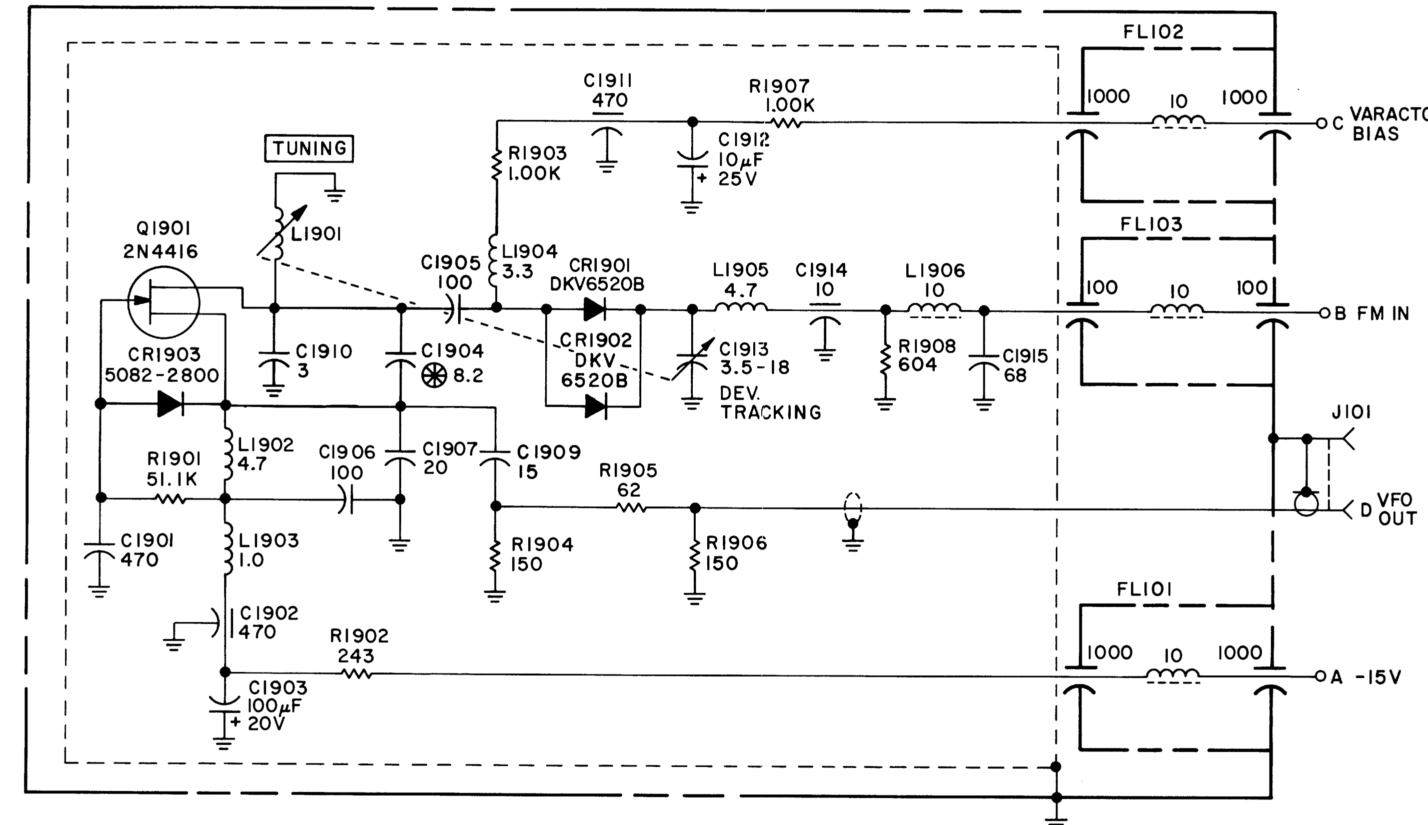


Figure 6-1 Main Frame, Schematic Diagram

830799F

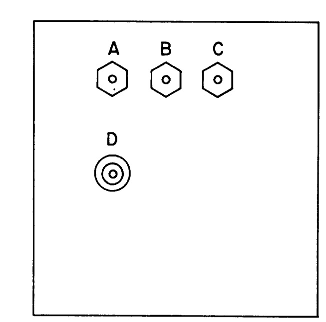






NOTES:

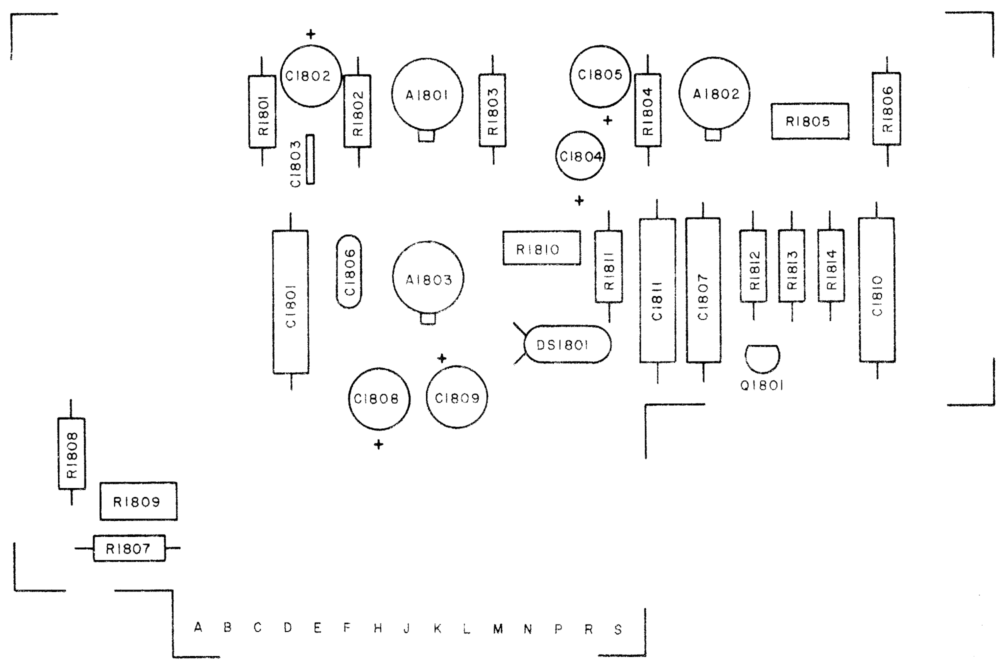
1. CAPACITANCE VALUES IN pF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. INDUCTANCE VALUES IN μH, UNLESS OTHERWISE SPECIFIED.
4.
5. [ ] EXTERNAL MARKINGS
6. LAST NUMBERS USED:
   C1915 L1906 R1908
7. NUMBERS NOT USED:
   C1908
8. ❋ FACTORY SELECTED

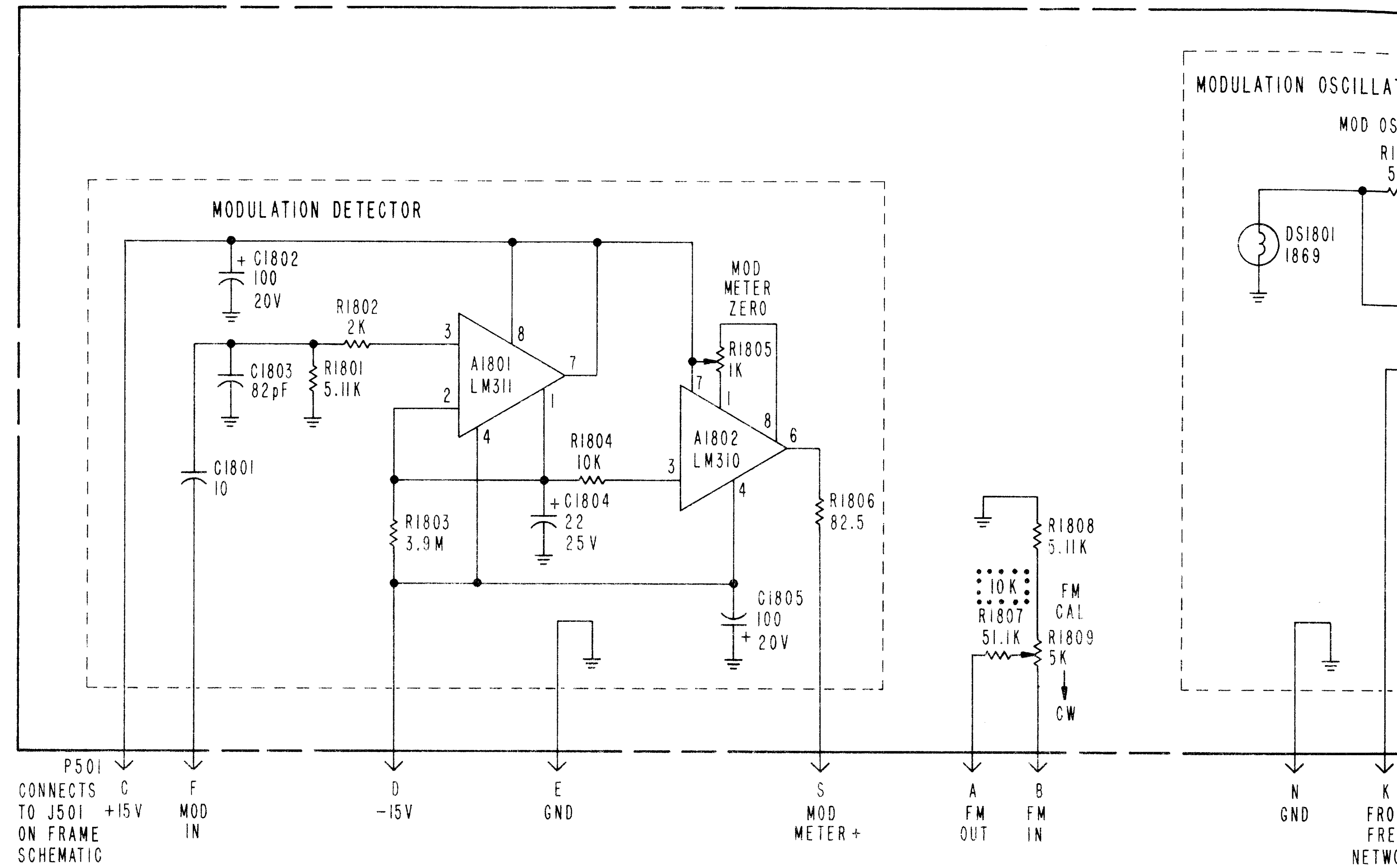


VFO HOUSING IDENTIFICATION

Figure 6-2 VFO Housing, Schematic Diagram

830744D

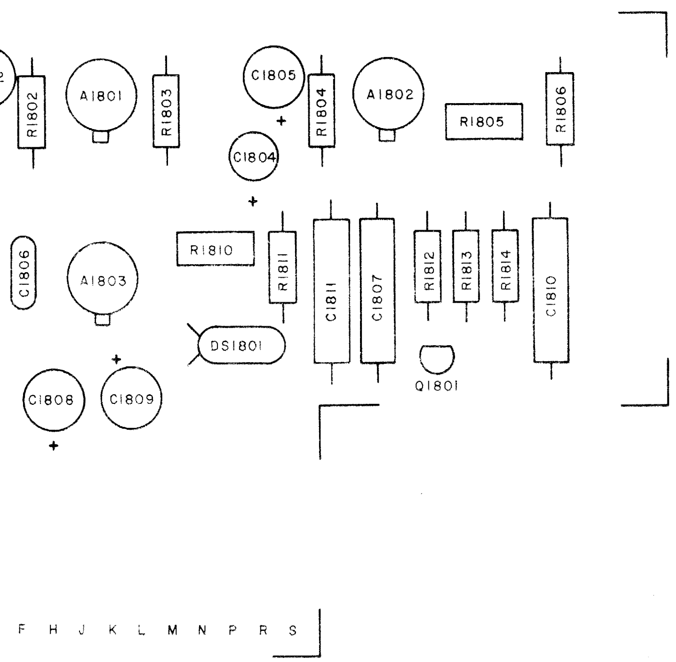


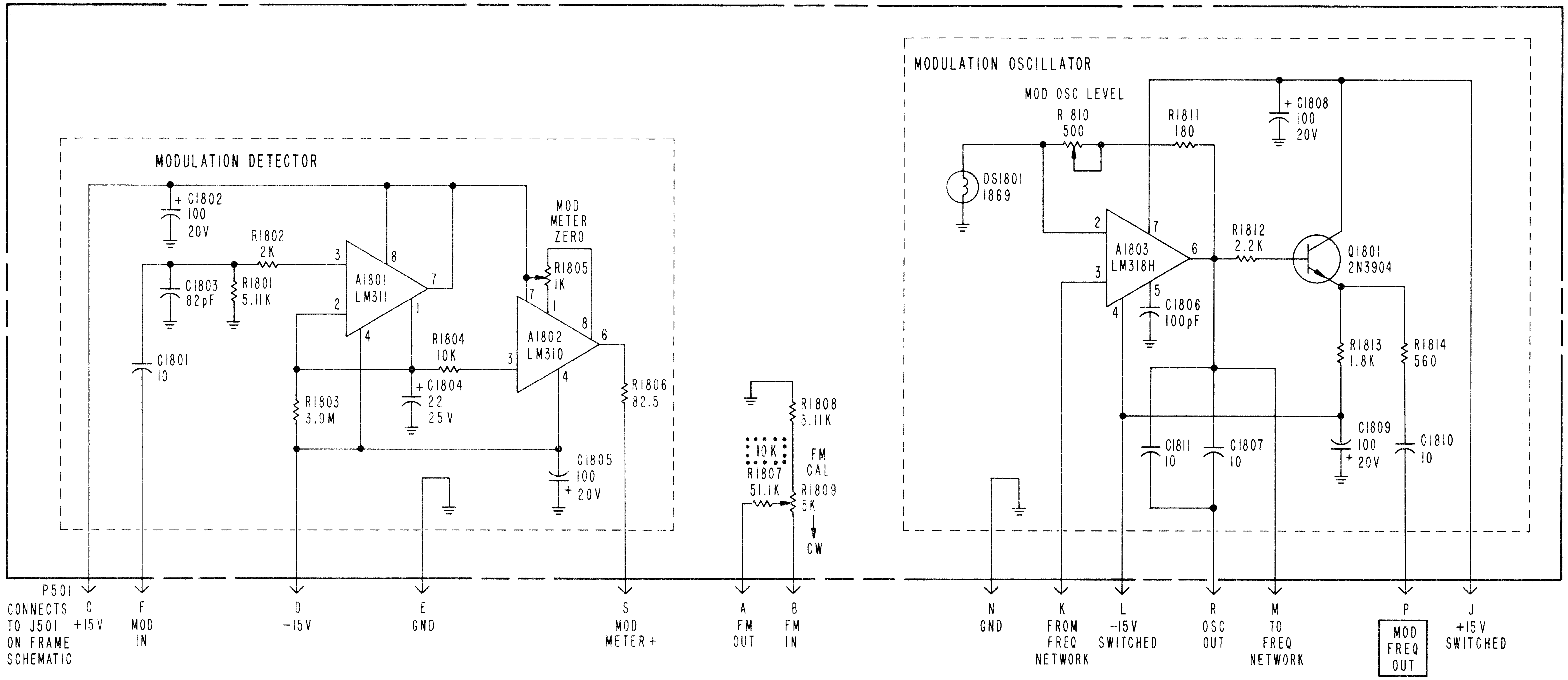


NOTES:

1. CAPACITANCE VALUES IN µF UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.

4. [ ] EXTERNAL MARKINGS.
5. LAST NUMBERS USED: R1814 C1811
6. [dotted box] FOR MODEL 102 C, D ONLY.



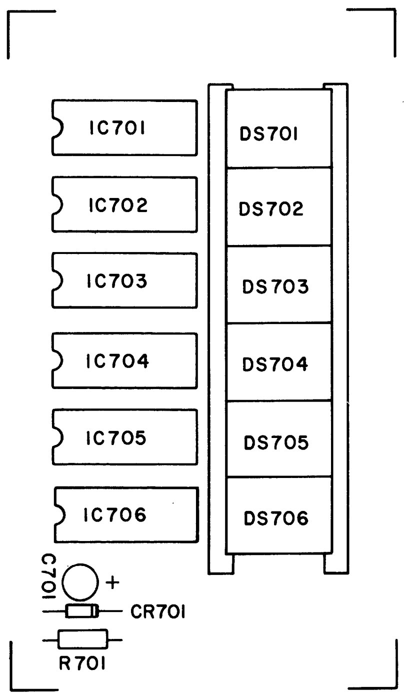


NOTES:
1. CAPACITANCE VALUES IN μF UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.

4. [ ] EXTERNAL MARKINGS.
5. LAST NUMBERS USED:
R1814 C1811
6. [dotted box] FOR MODEL 102 C, D ONLY.

Figure 6-3 Modulation PCB, Schematic Diagram

830594B



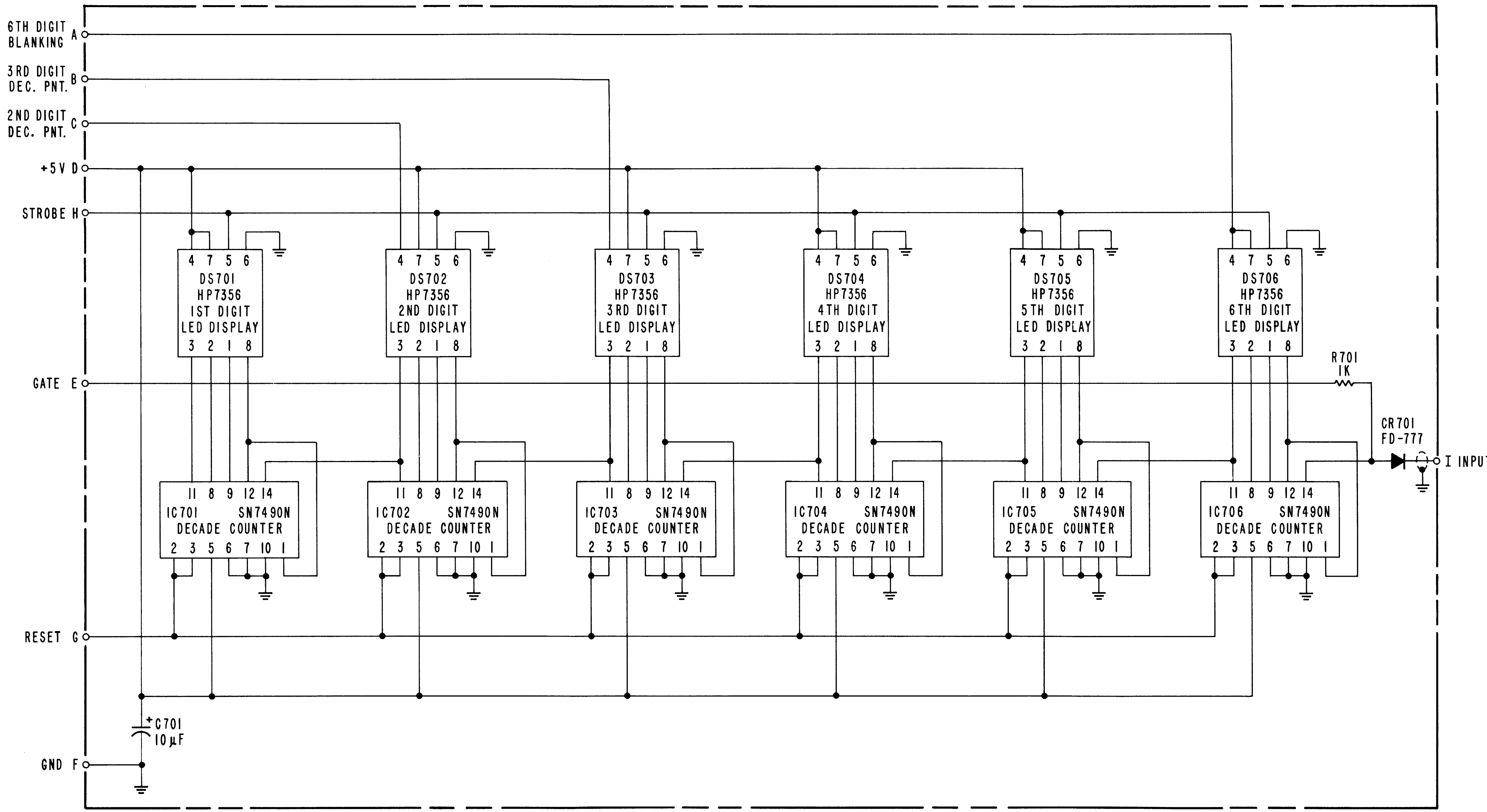
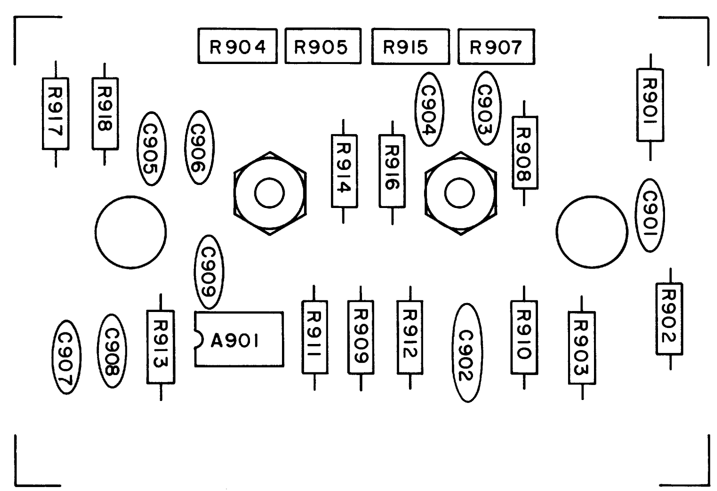
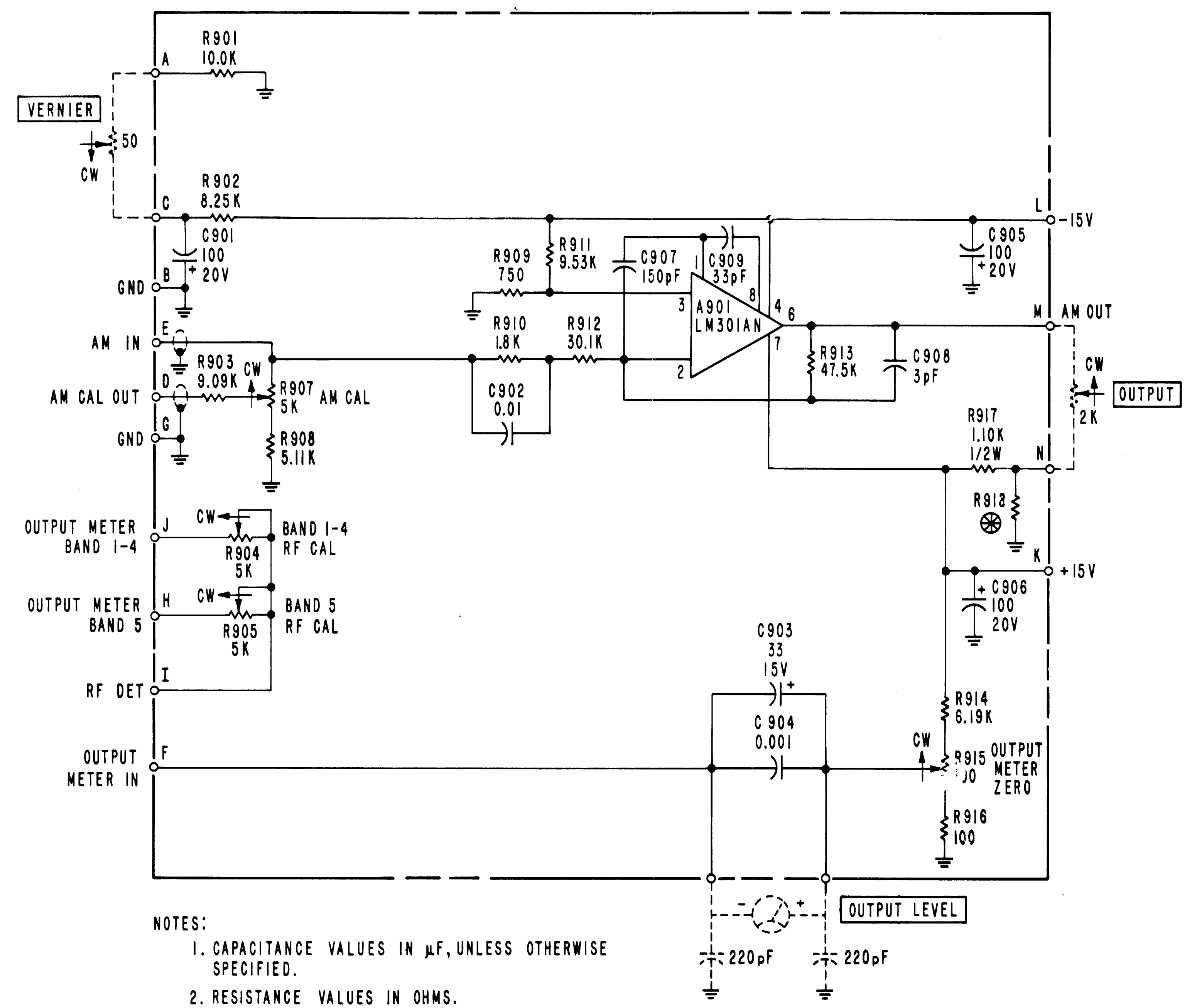


Figure 6-4 Display PCB, Schematic Diagram

830799C

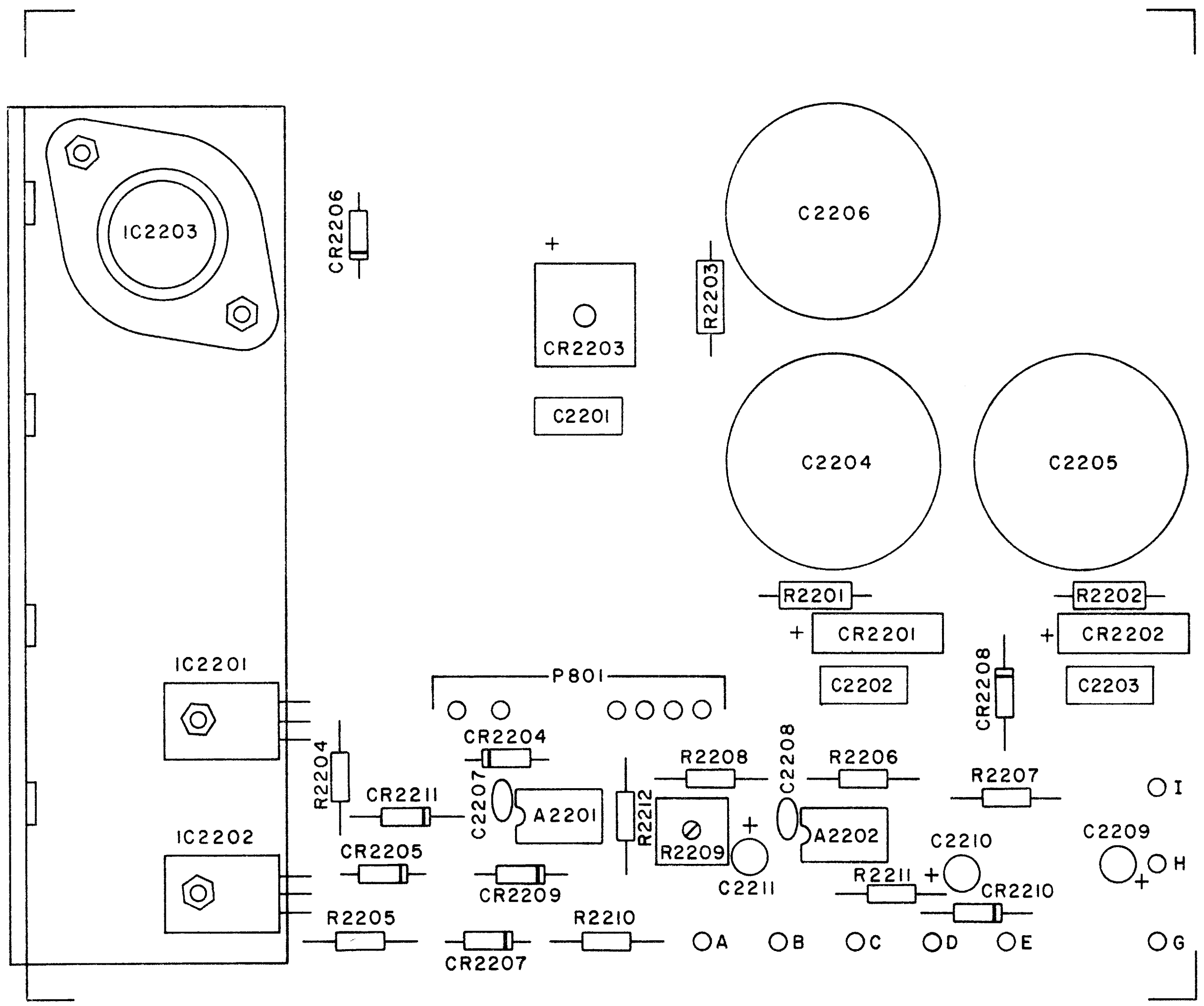


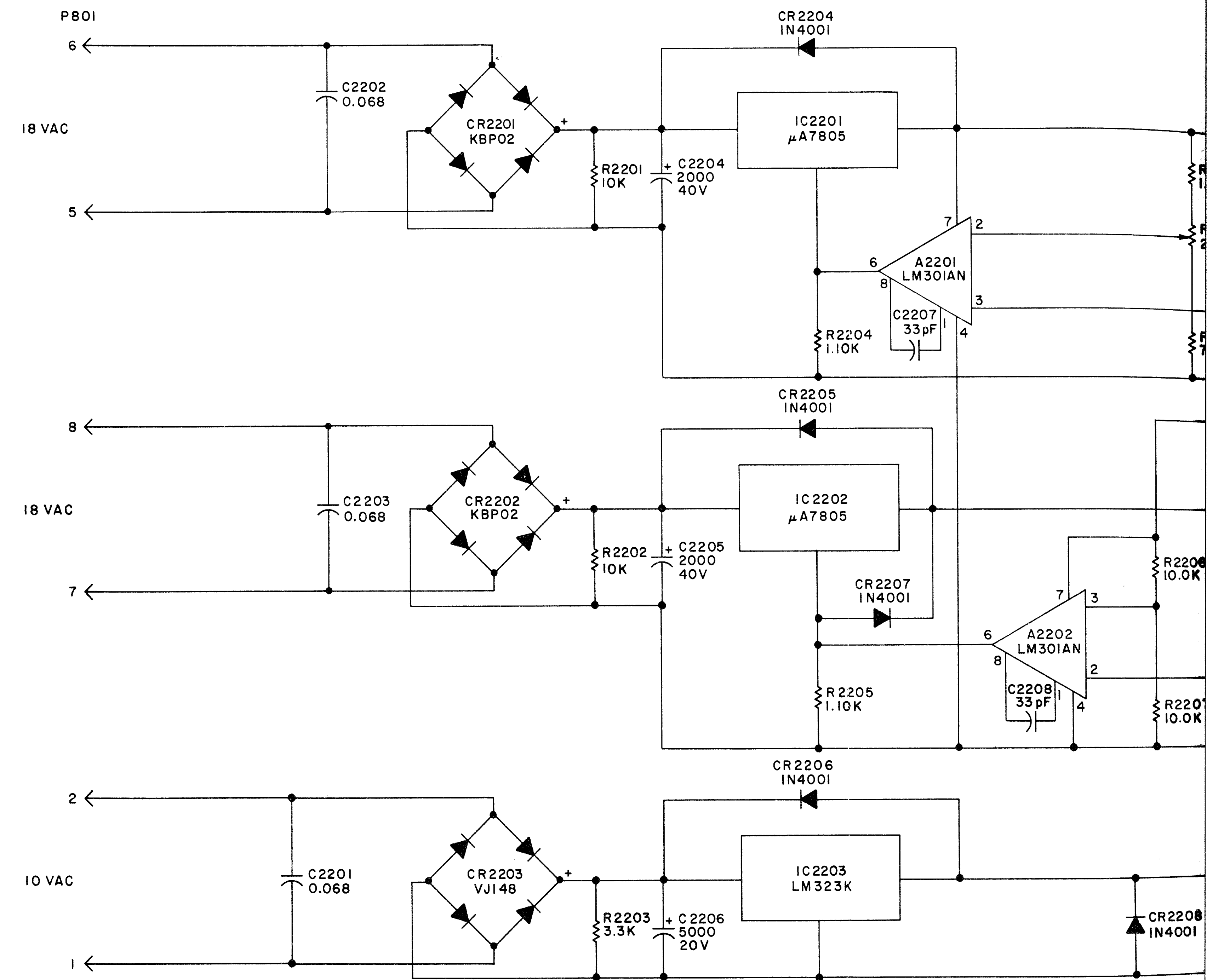


NOTES:

1. CAPACITANCE VALUES IN µF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3.
4. ☐ EXTERNAL MARKINGS.
5. LAST NUMBERS USED:
   R918 C909
6. ⊛ SELECTED VALUE.
7. NUMBERS NOT USED:
   R906

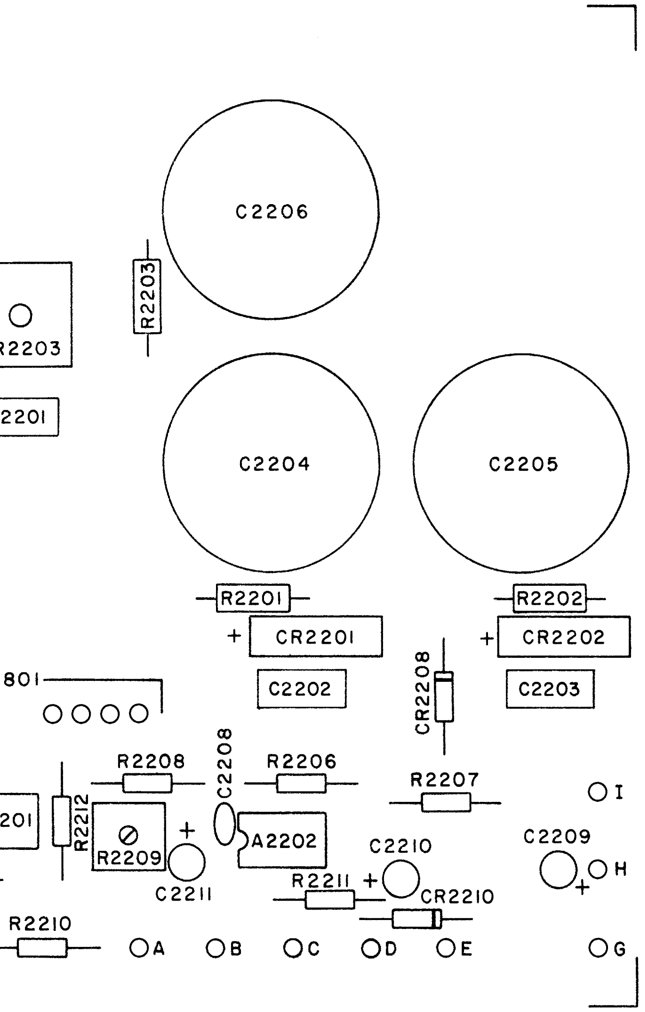
Figure 6-5 Meter PCB, Schematic Diagram

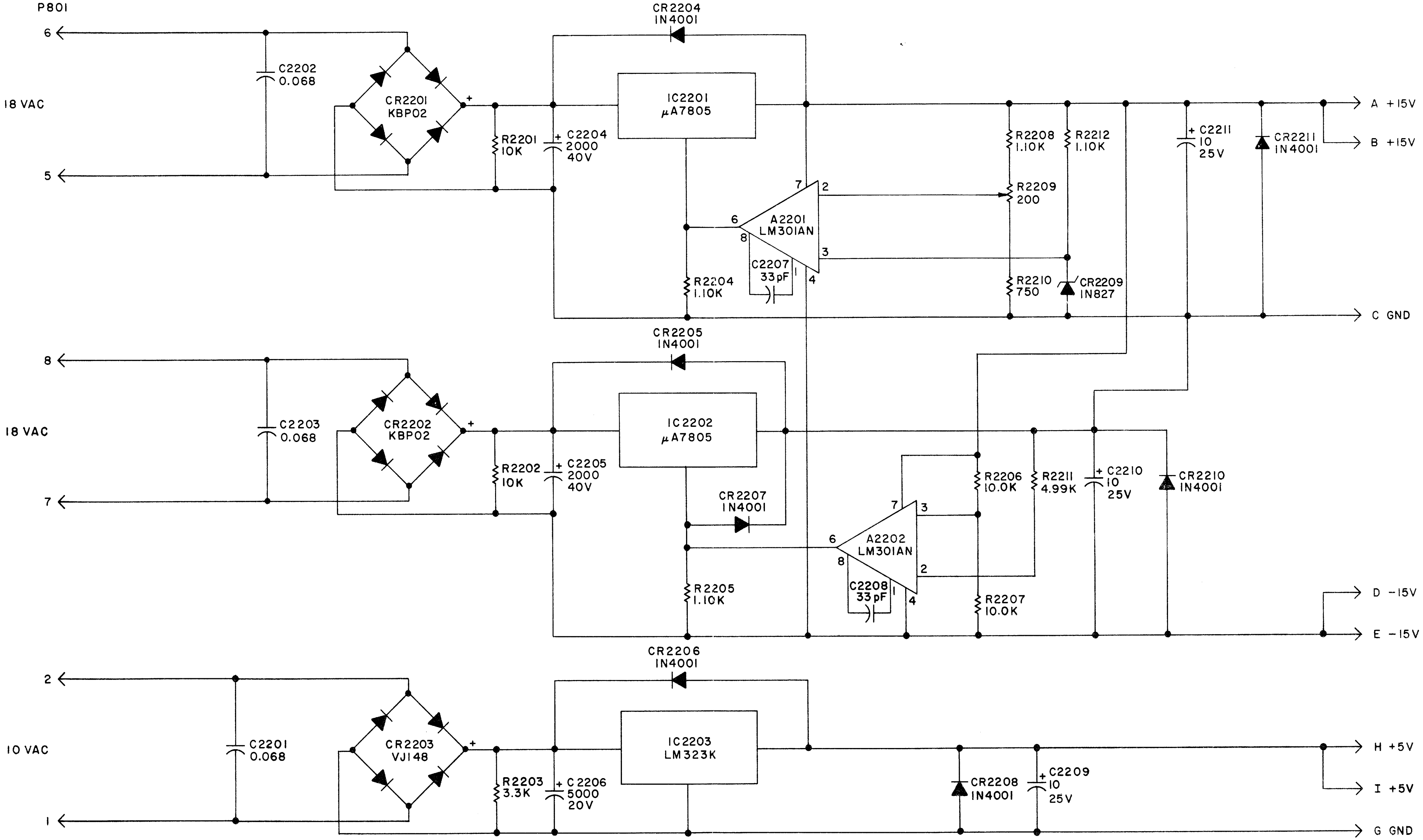




NOTES:

1. CAPACITANCE VALUES IN μF UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3.
4. LAST NUMBERS USED:
   R2212 C2211 CR2211



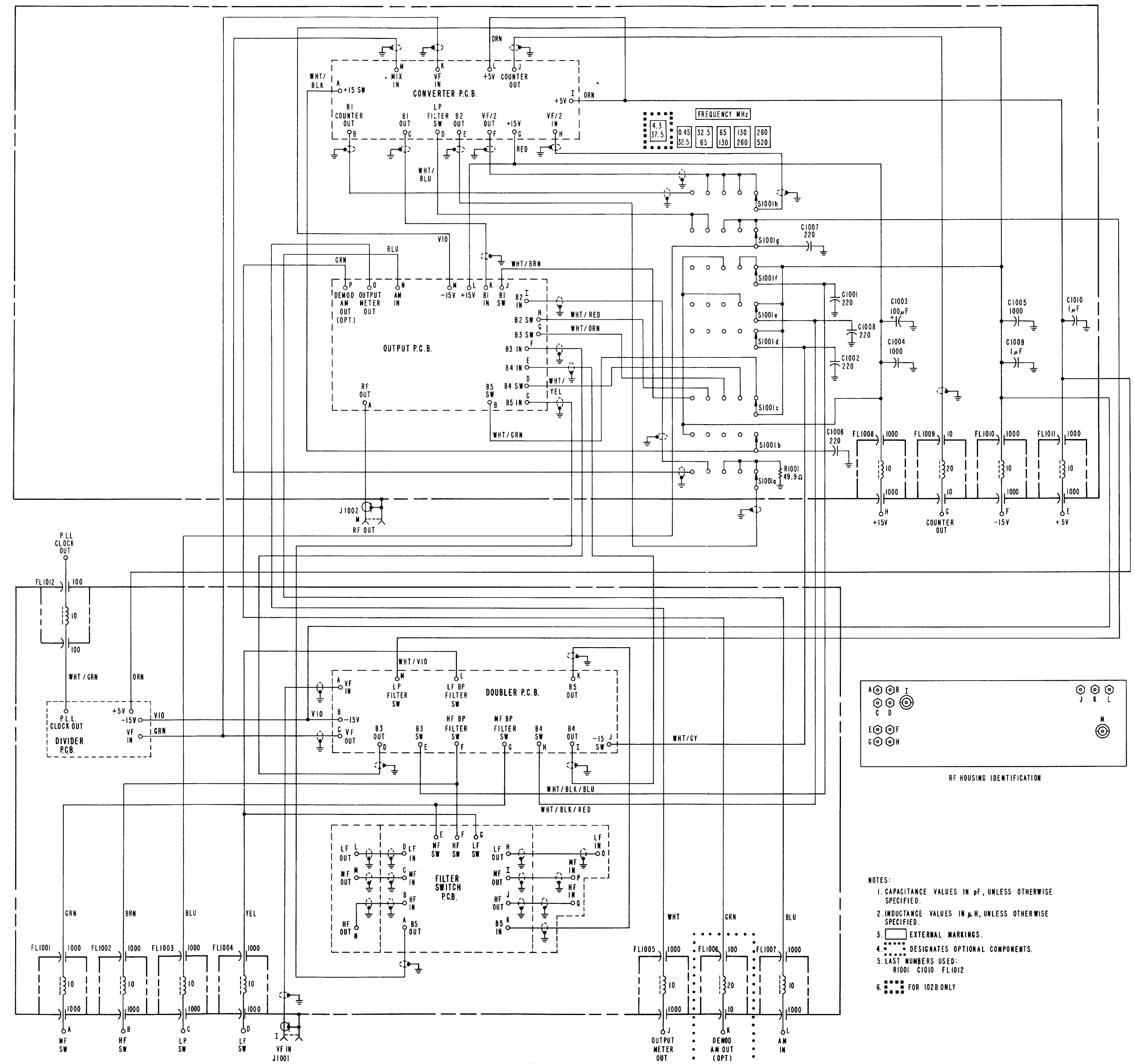


NOTES:

1. CAPACITANCE VALUES IN μF UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3.
4. LAST NUMBERS USED:
   R2212 C2211 CR2211

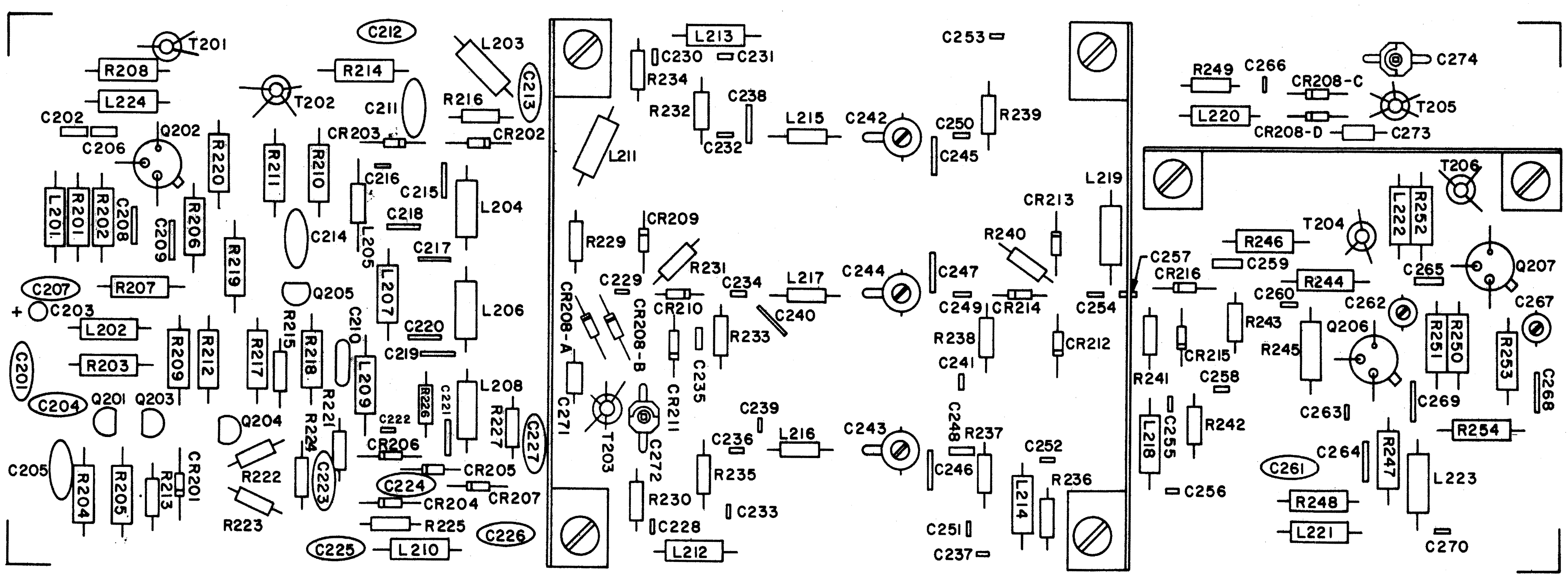
Figure 6-6 Power Supply PCB, Schematic Diagram

830744C



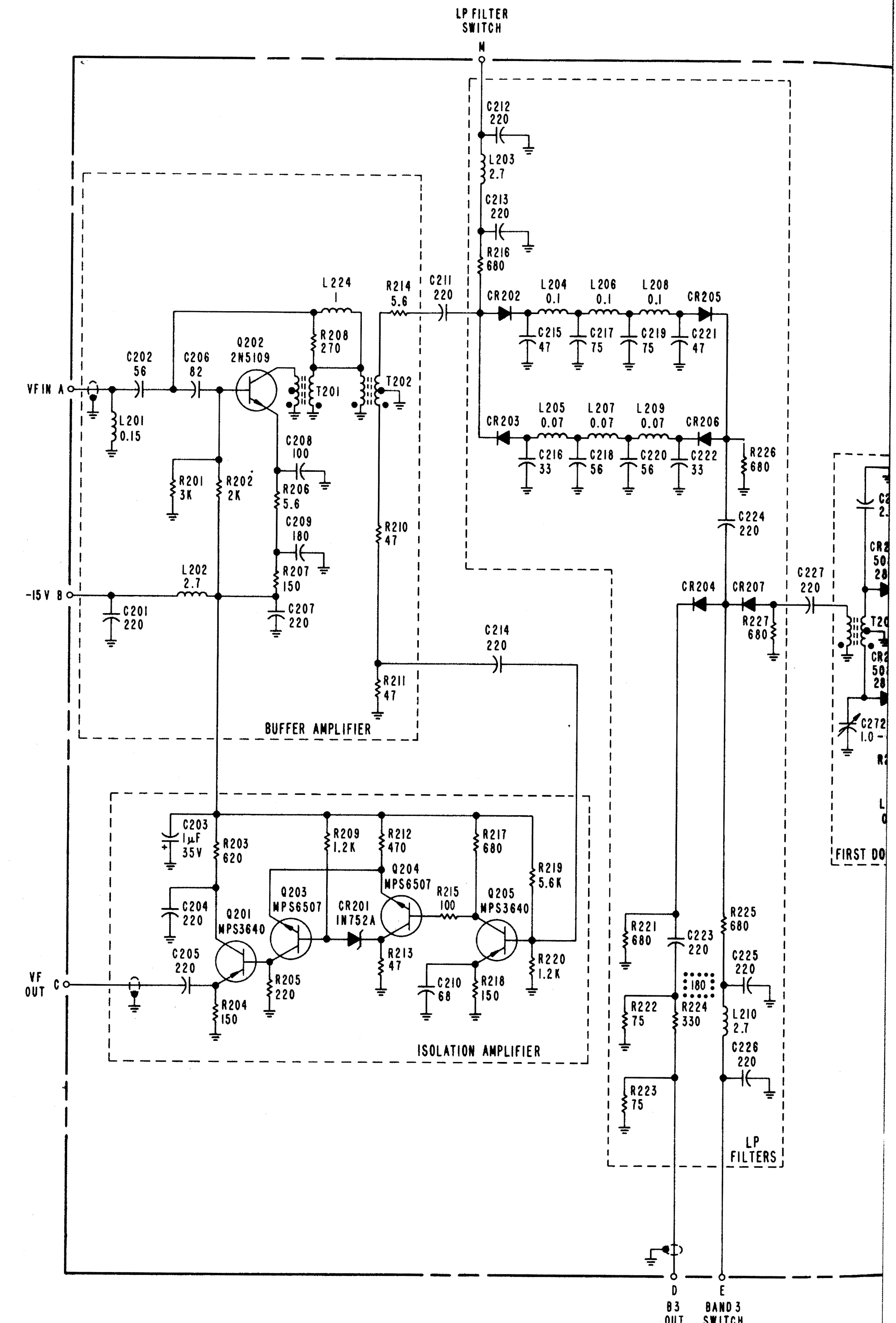
NOTES:
1. CAPACITANCE VALUES IN pF, UNLESS OTHERWISE SPECIFIED.
2. INDUCTANCE VALUES IN μH, UNLESS OTHERWISE SPECIFIED.
3. ☐ EXTERNAL MARKINGS.
4. ⬚ DESIGNATES OPTIONAL COMPONENTS.
5. LAST NUMBERS USED: R1001 C1010 FL1012
6. ⬚ FOR 1028 ONLY

Figure 6-7 RF Housing, Interconnection Diagram



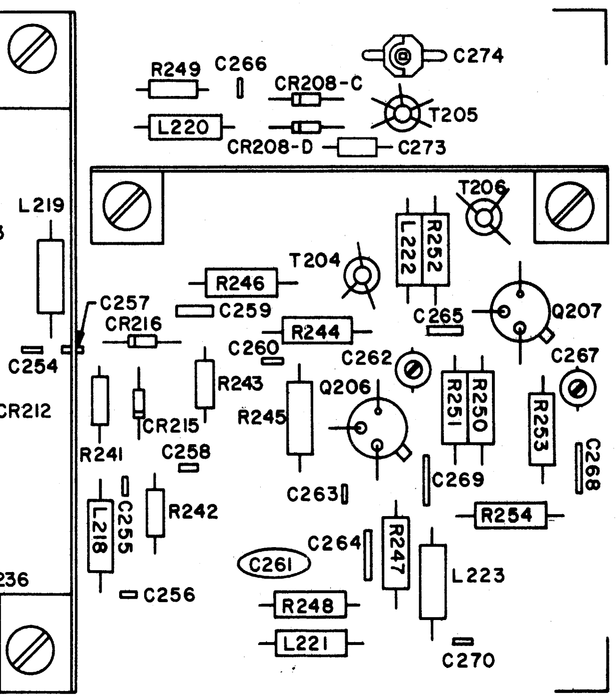
NOTES:

1. CAPACITANCE VALUES IN pF, UNLESS OTHERWISE SPECIFIED.
2. INDUCTANCE VALUES IN μH, UNLESS OTHERWISE SPECIFIED.
3. RESISTANCE VALUES IN OHMS.
4.
5. ⊛ FACTORY SELECTED.
6. ALL DIODES TO BE H.P.# 5082-3080, UNLESS OTHERWISE SPECIFIED.
7. LAST NUMBERS USED: R254 C275 L224 CR216 Q207 T206
8. NUMBERS NOT USED: R228
9. ⁝⁝⁝ FOR MODEL 102C,D ONLY.



NOTES:

1. CAPACITANCE VALUES IN pF, UNLESS OTHERWISE SPECIFIED.
2. INDUCTANCE VALUES IN μH, UNLESS OTHERWISE SPECIFIED.
3. RESISTANCE VALUES IN OHMS.
4.
5. ⊛ FACTORY SELECTED.
6. ALL DIODES TO BE H.P.# 5082-3080, UNLESS OTHERWISE SPECIFIED.
7. LAST NUMBERS USED:
   R254 C275 L224 CR216 Q207 T206
8. NUMBERS NOT USED:
   R228
9. ⁞⁞⁞ FOR MODEL 102C,D ONLY.



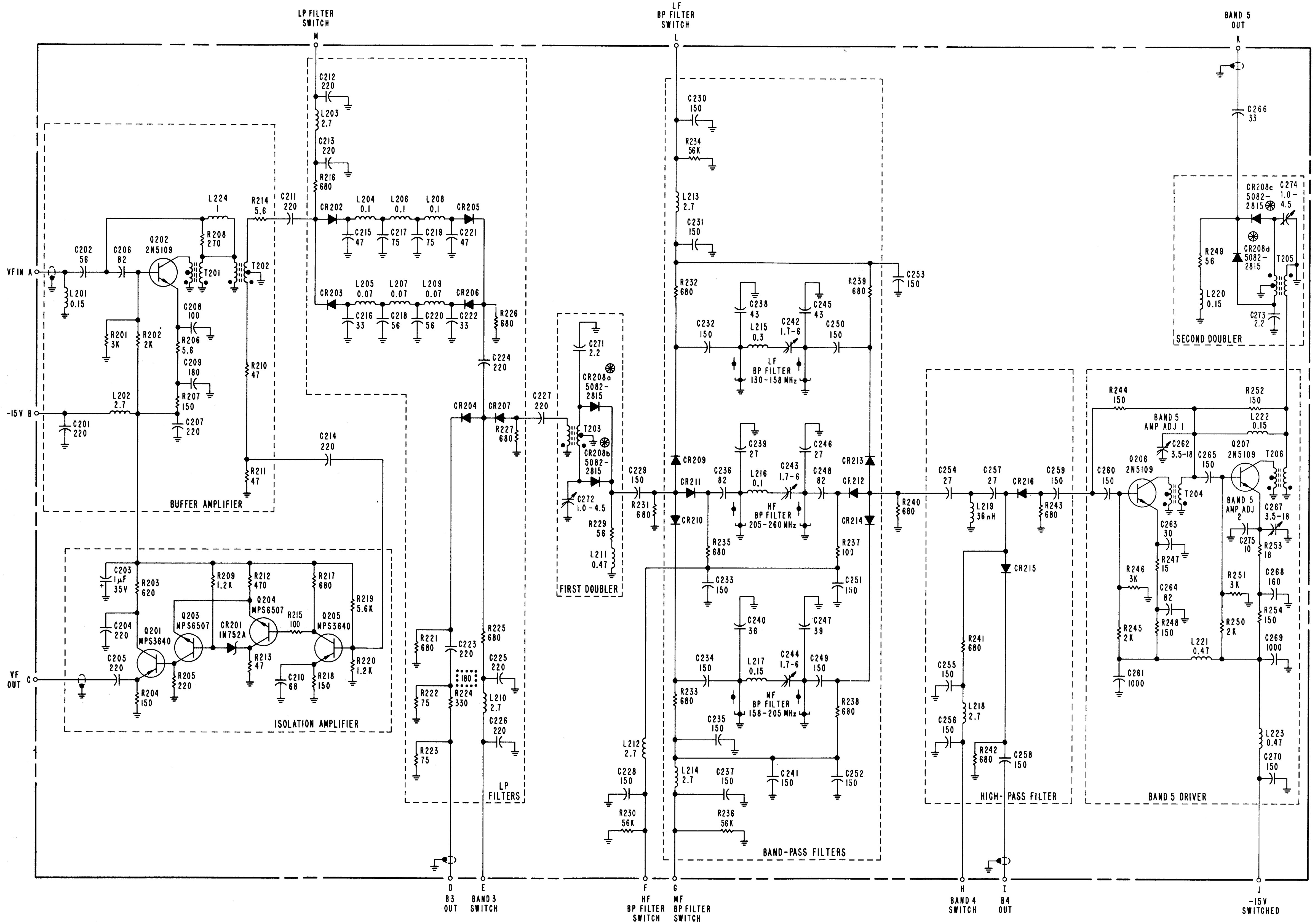
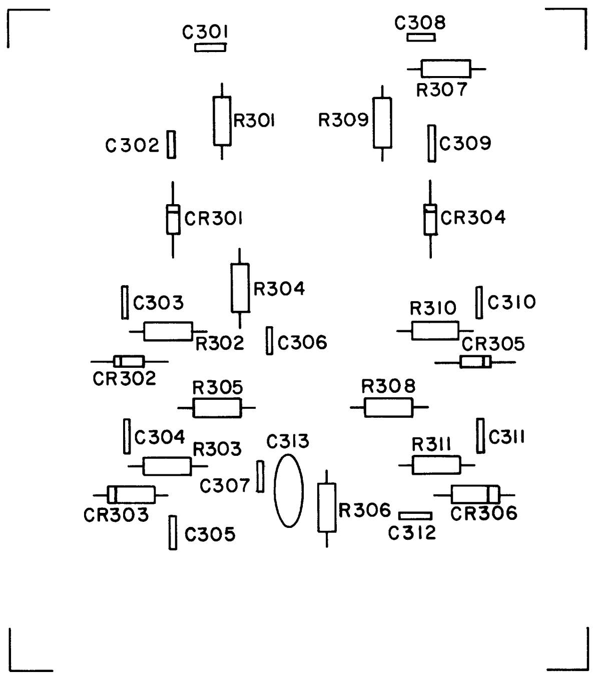
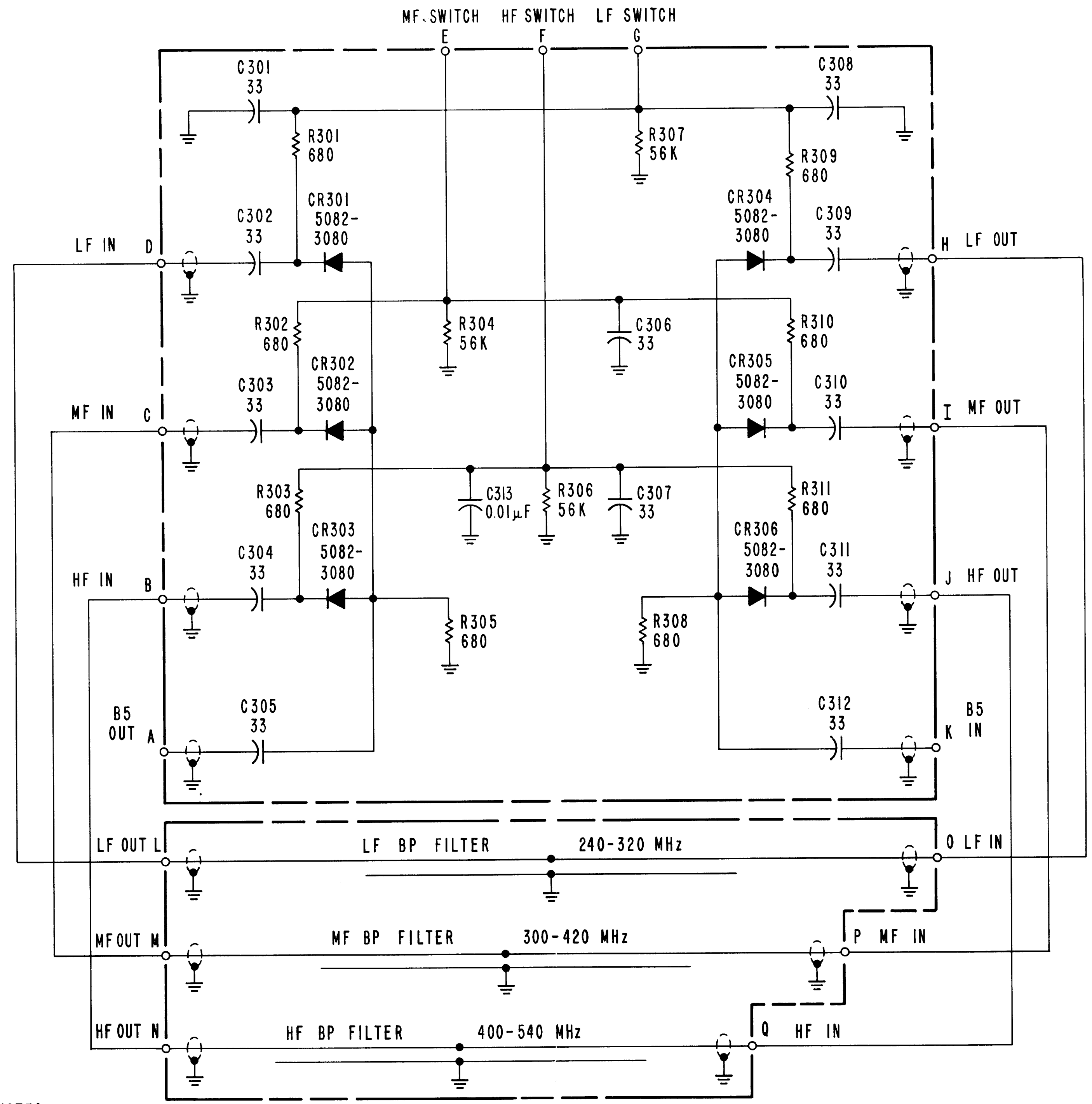


Figure 6-8 Doubler PCB, Schematic Diagram

830594B



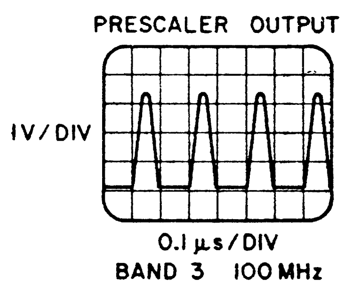


NOTES:

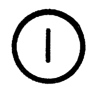
1. CAPACITANCE VALUES IN pF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS AND 1/4 WATT, UNLESS OTHERWISE SPECIFIED.
3. LAST NUMBERS USED: R311 C313 CR306

Figure 6-9 Filter Switch PCB, Schematic Diagram

WAVEFORM

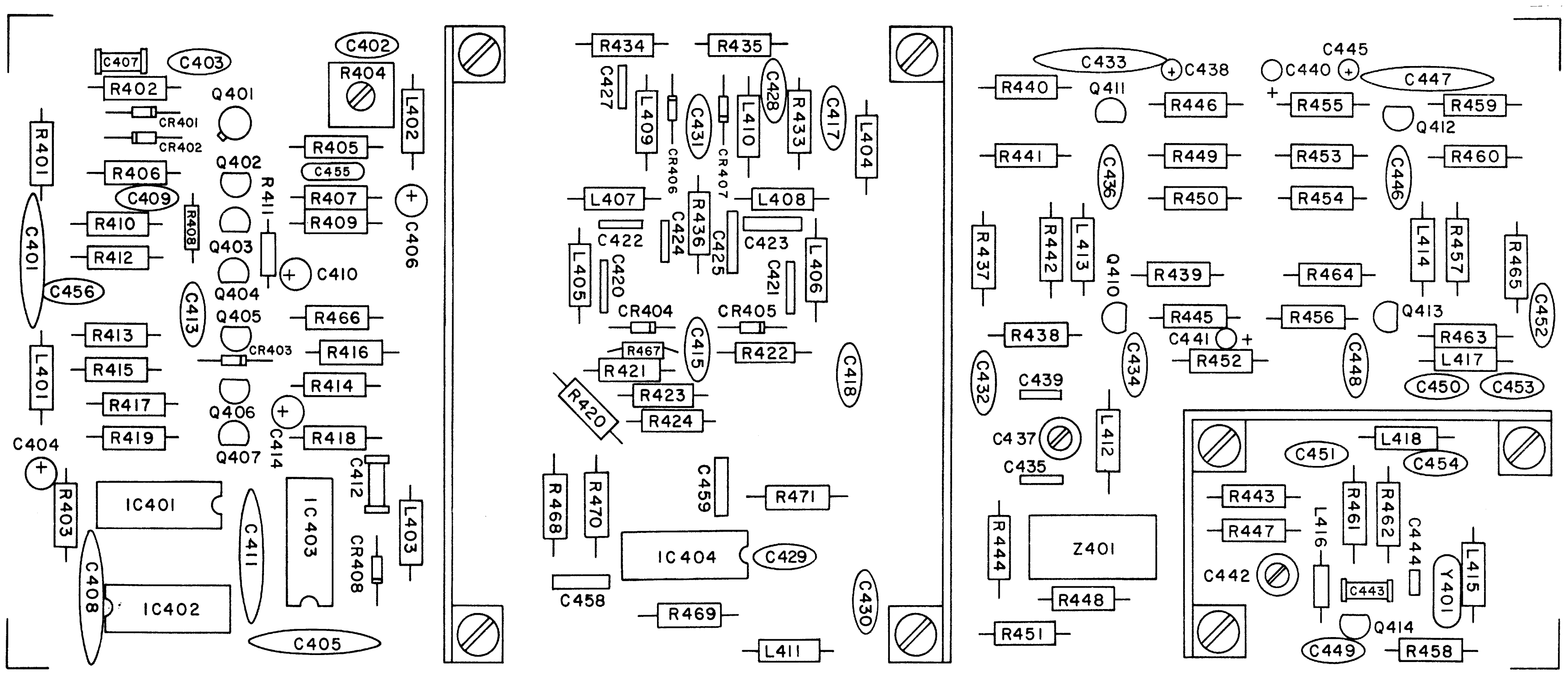


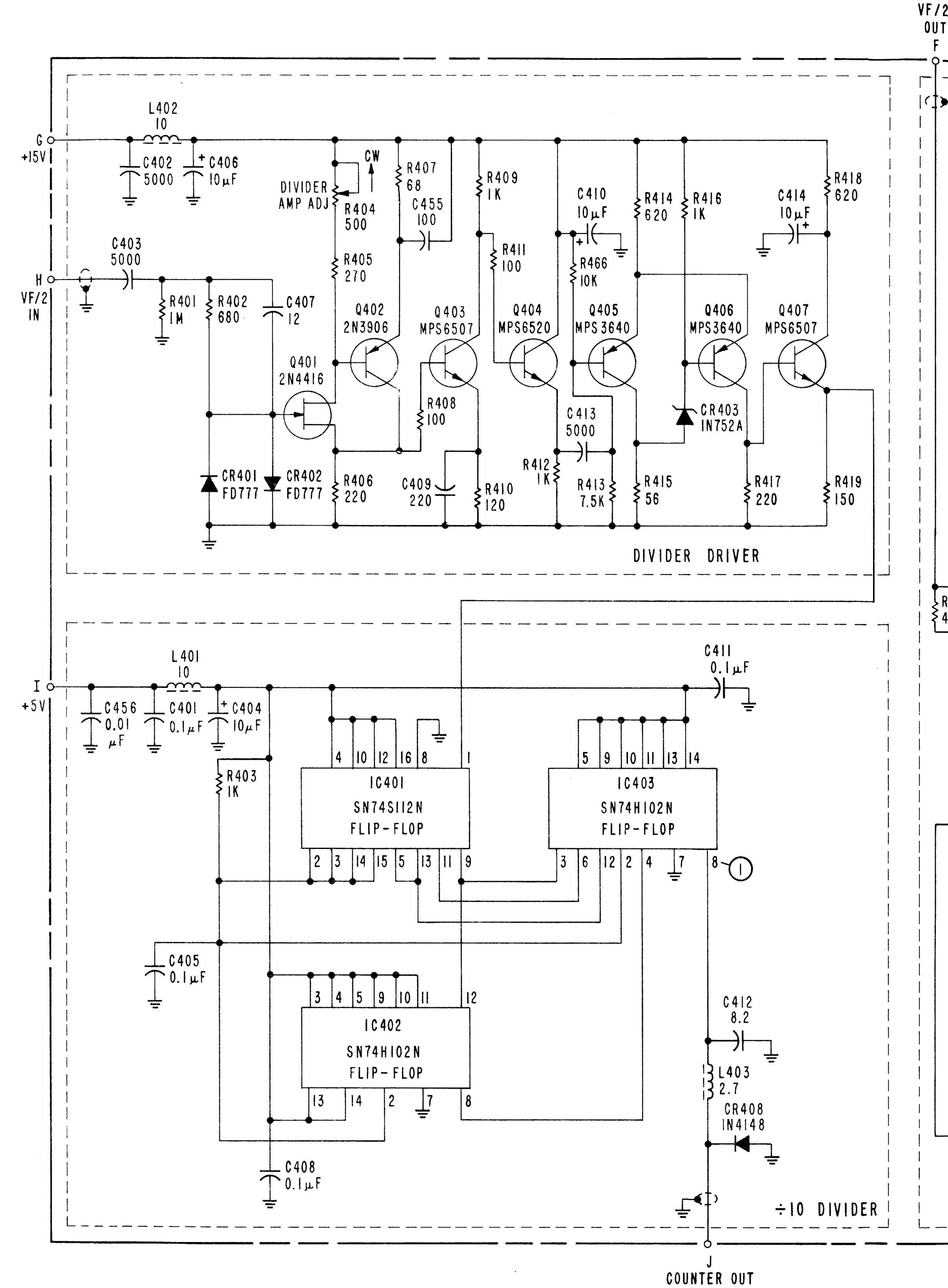
TEST POINT



NOTES:

1. CAPACITANCE VALUES IN pF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. INDUCTANCE VALUES IN µH, UNLESS OTHERWISE SPECIFIED.
4.
5. LAST NUMBER USED: R471, C459, L418, Q414, CR408
6. NUMBERS NOT USED: R429, R430, R431, R432, R425, R426, R427, R428, C416, C419, C426, T401, Q408, Q409
7. (dotted box) SIGNIFIES VALUE USED ON 102C AND 102D ONLY.
8. (dashed box) SIGNIFIES COMPONENT USED ON 102A AND 102B ONLY.





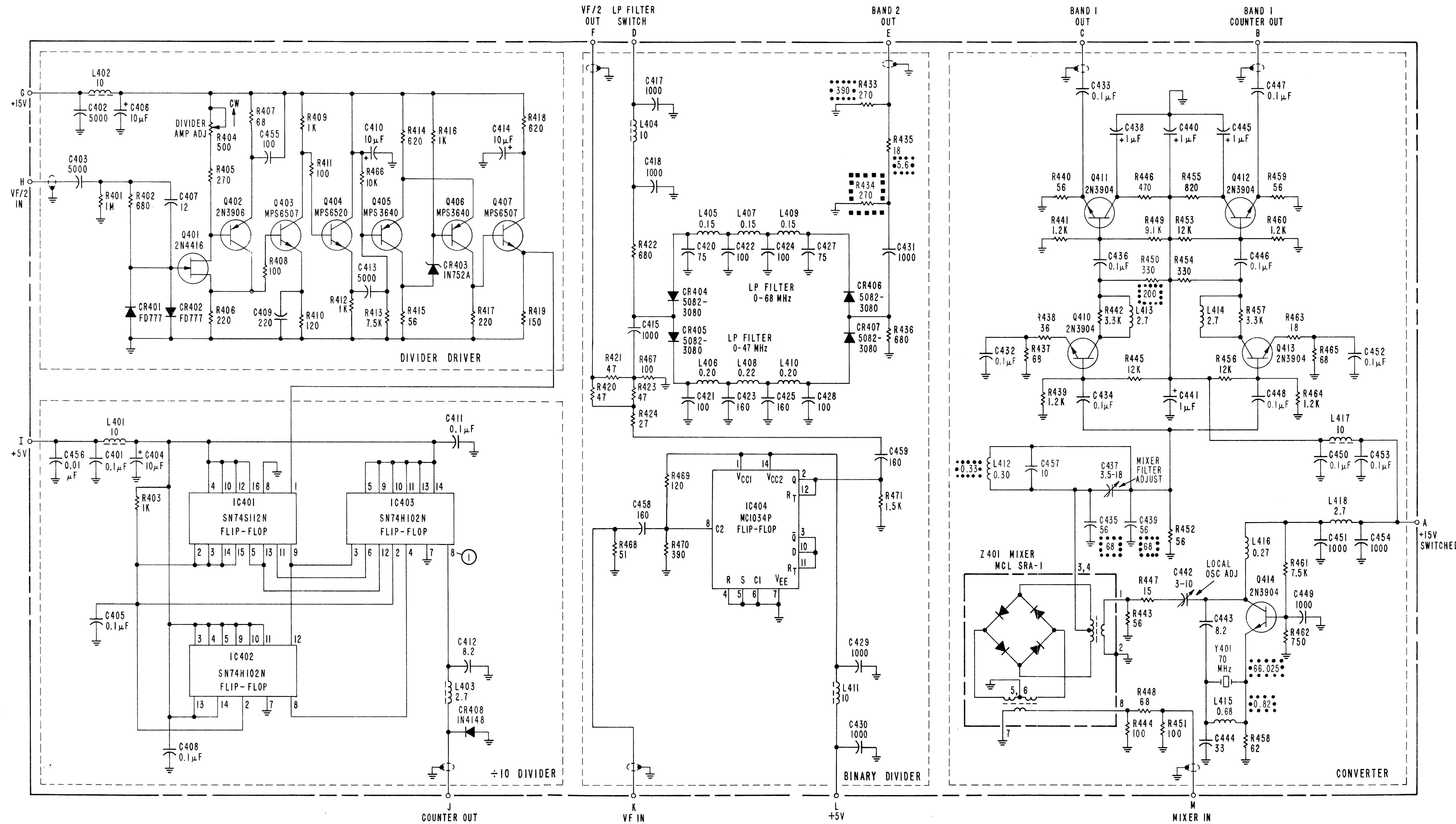
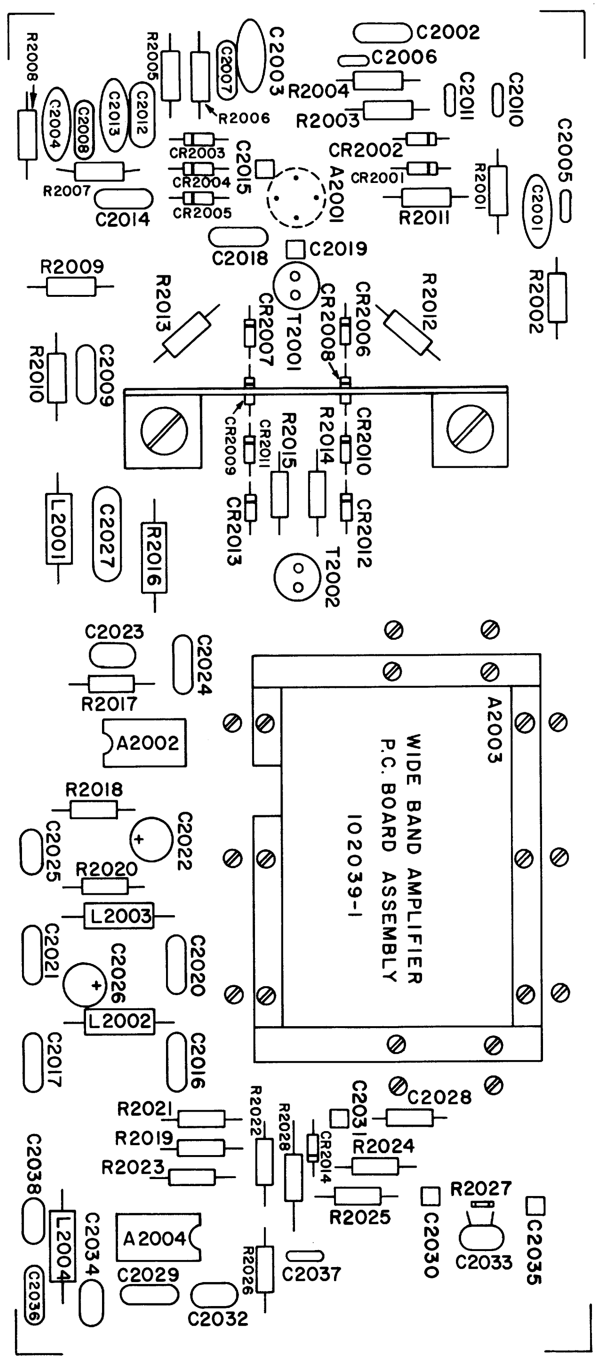
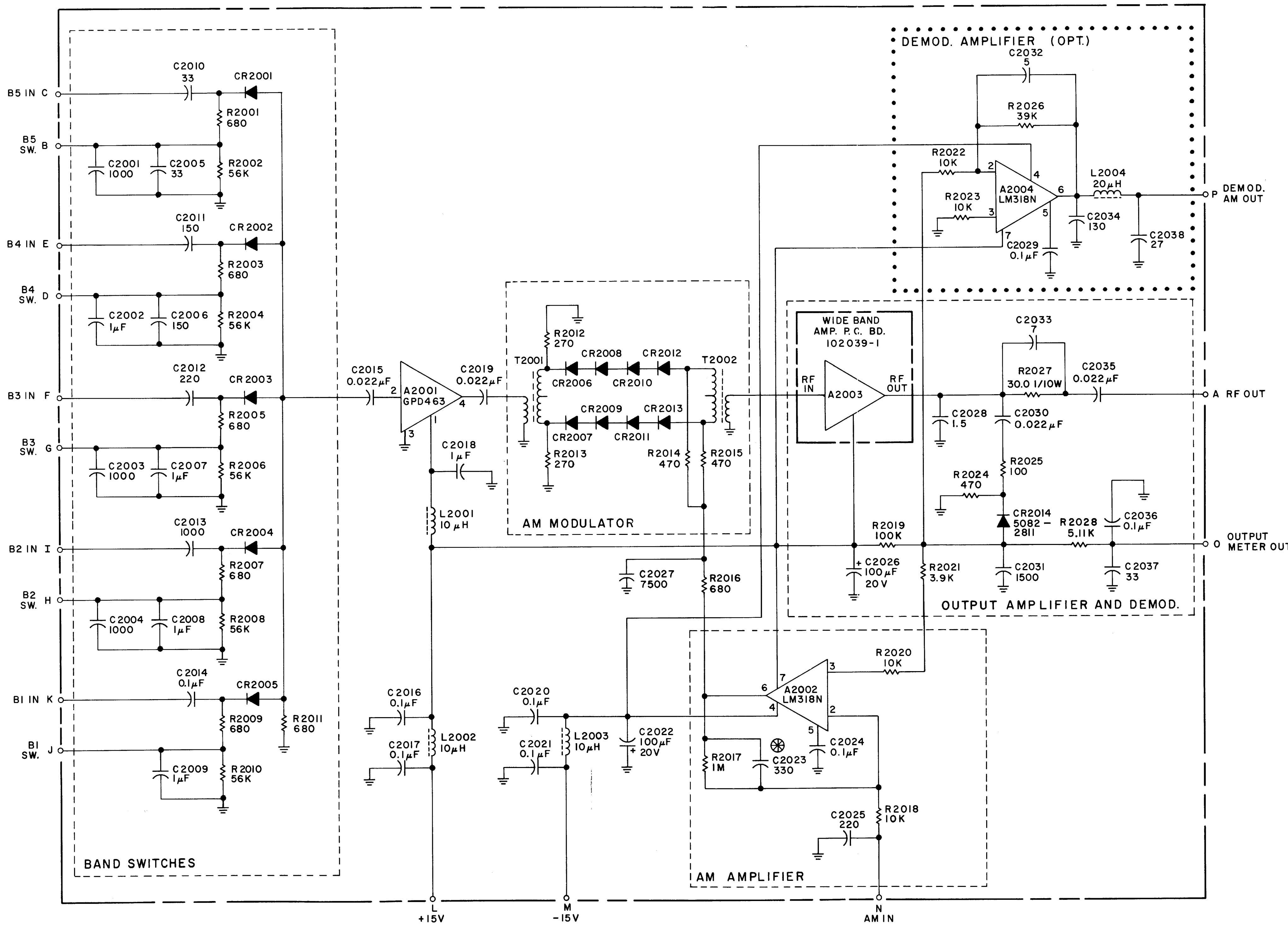


Figure 6-10 Converter PCB, Schematic Diagram

830799G



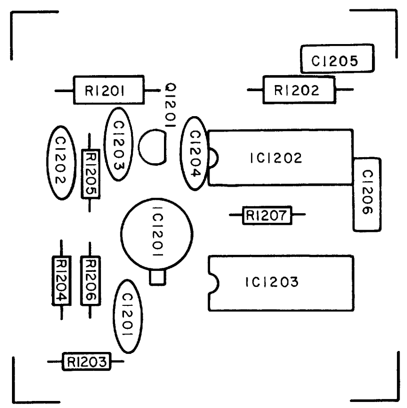


NOTES:

1. CAPACITANCE VALUES IN pF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. DIODES CR2001 – CR2005 TO BE 5082-3080 AND DIODES CR2006 – CR2013 TO BE PMS 702-08.
4. ⊛ SELECTED VALUE.
5. LAST NUMBERS USED:
   C2038 R2028 CR2014
6. (dotted outline) SIGNIFIES OPTIONAL COMPONENTS.

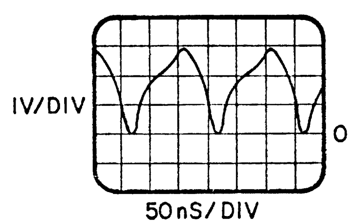
Figure 6-11 Output PCB, Schematic Diagram

830744C



TEST POINT (1)

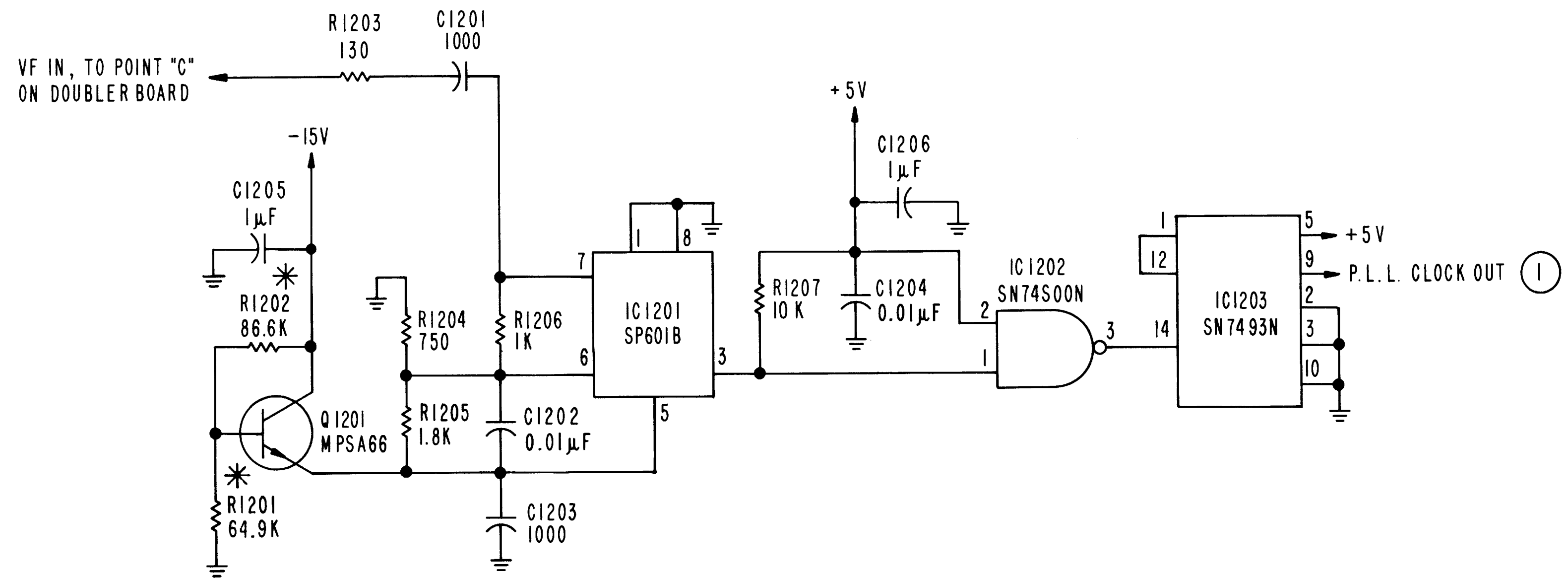
WAVEFORM



P.L.L. COUNTER CLOCK

TUNE GENERATOR TO 100MHz

OSCILLOSCOPE D.C. COUPLED FOR ALL WAVEFORMS.

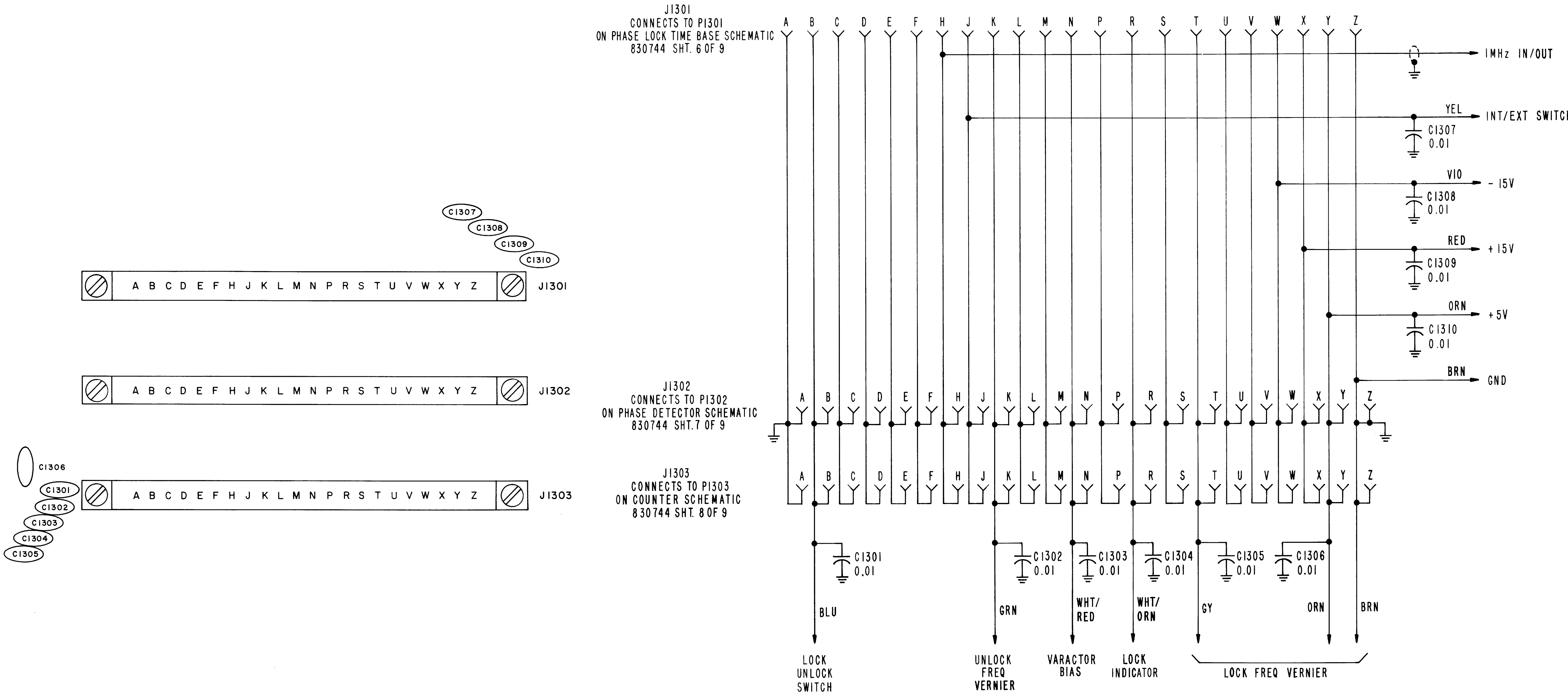


NOTES:

1. RESISTANCE VALUES IN OHMS AND 1/4W, UNLESS OTHERWISE SPECIFIED.
2. CAPACITANCE VALUES IN pF UNLESS OTHERWISE SPECIFIED.
3. LAST NUMBERS USED:
   R1207 C1206
4. ✳ PRECISION RESISTOR, 3/8 WATT.

Figure 6-12 Divider PCB, Schematic Diagram

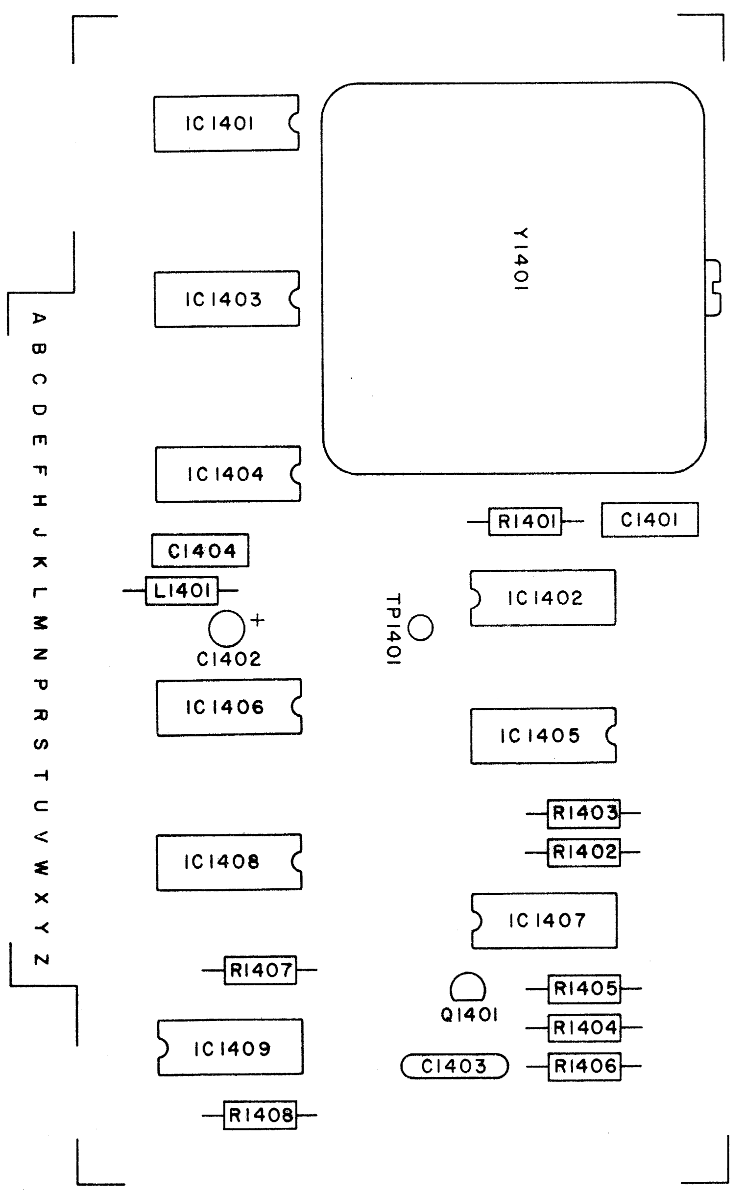
830744A



NOTES:

1. CAPACITANCE VALUES IN μF UNLESS OTHERWISE SPECIFIED.
2. LAST NUMBER USED: C1310

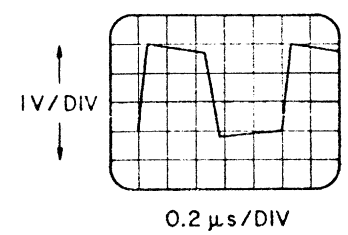
Figure 6-13 Phase Lock Master PCB, Schematic Diagram



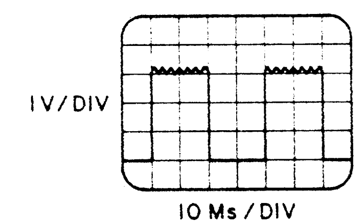
TEST POINT

WAVE FORM

(1) CLOCK OSCILLATOR OUTPUT

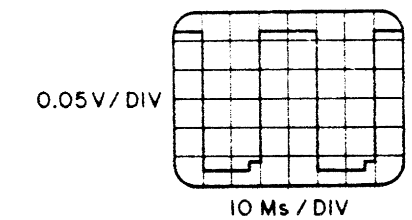


(2) GATE OUTPUT FROM FLIP-FLOP



BAND 3
1kHz RESOLUTION

(3) DUAL DRIVER INPUT

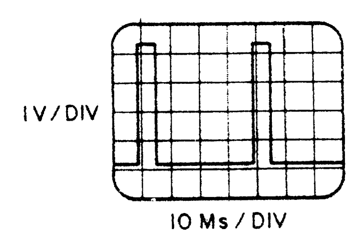


BAND 3
1kHz RESOLUTION

TEST POINT

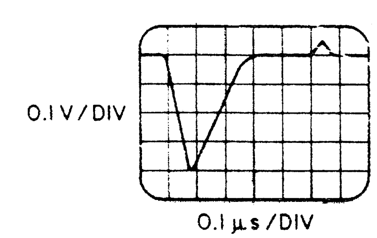
WAVE FORM

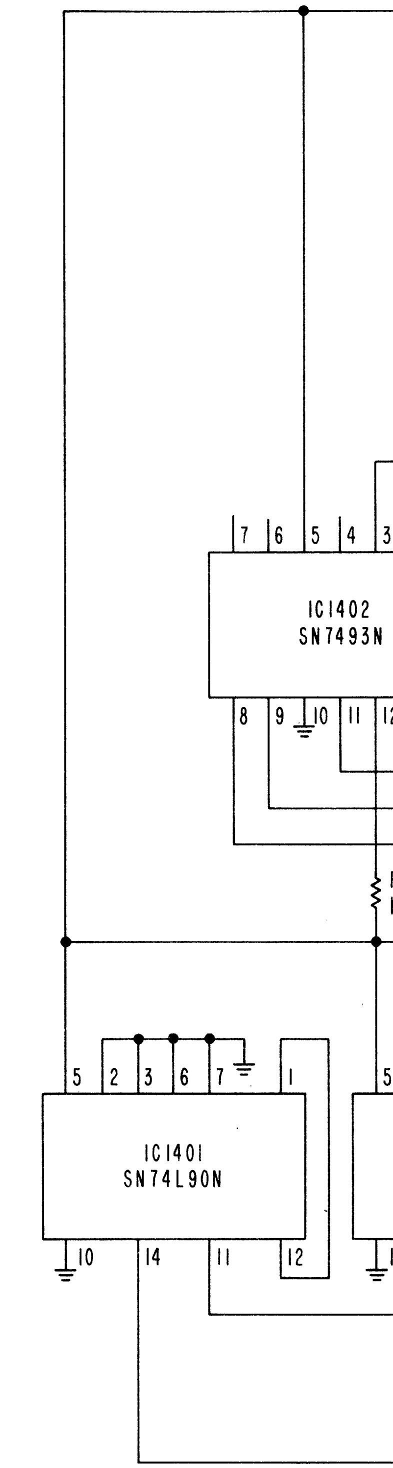
(4) RESET OUTPUT



BAND 3
1kHz RESOLUTION

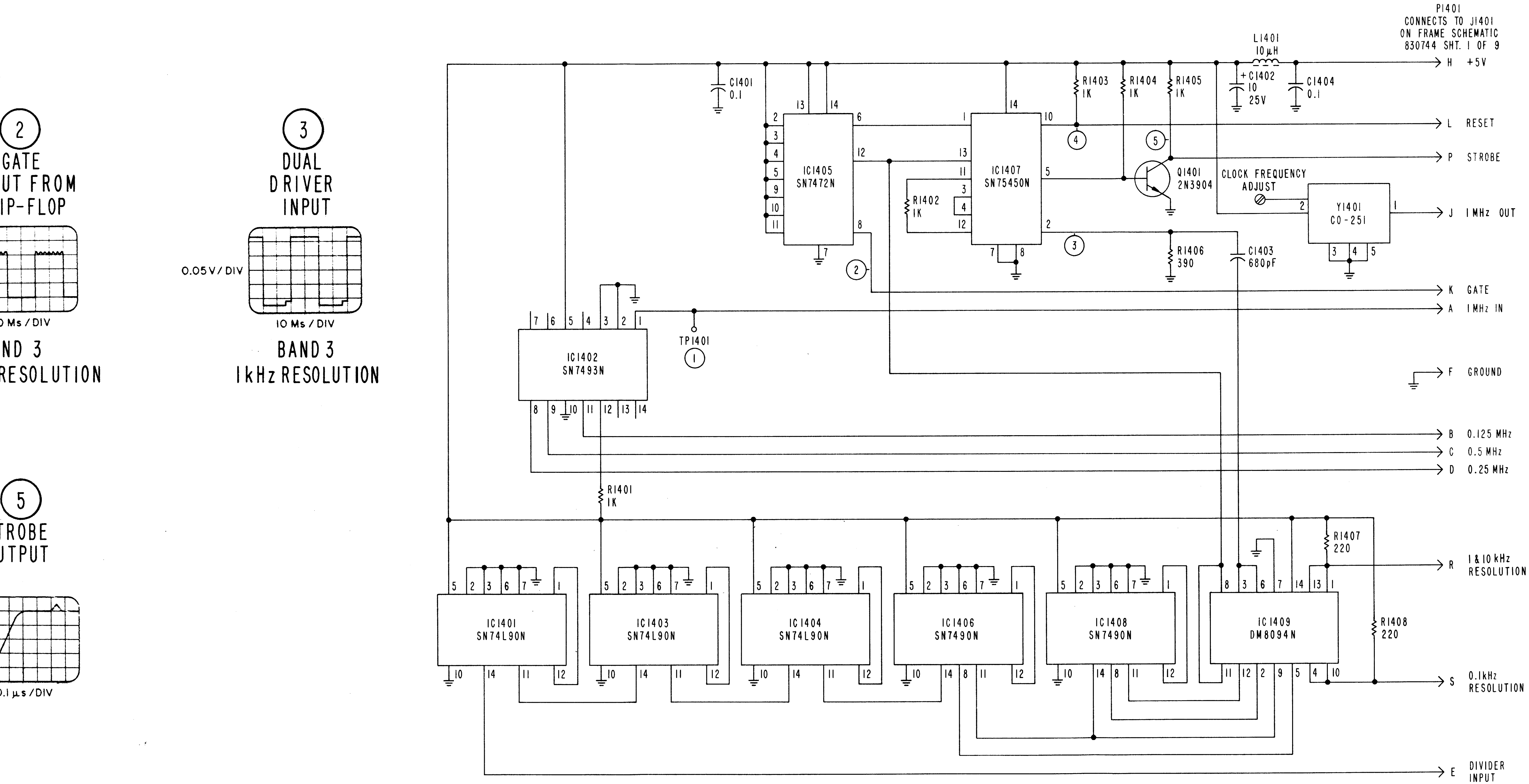
(5) STROBE OUTPUT





NOTES:

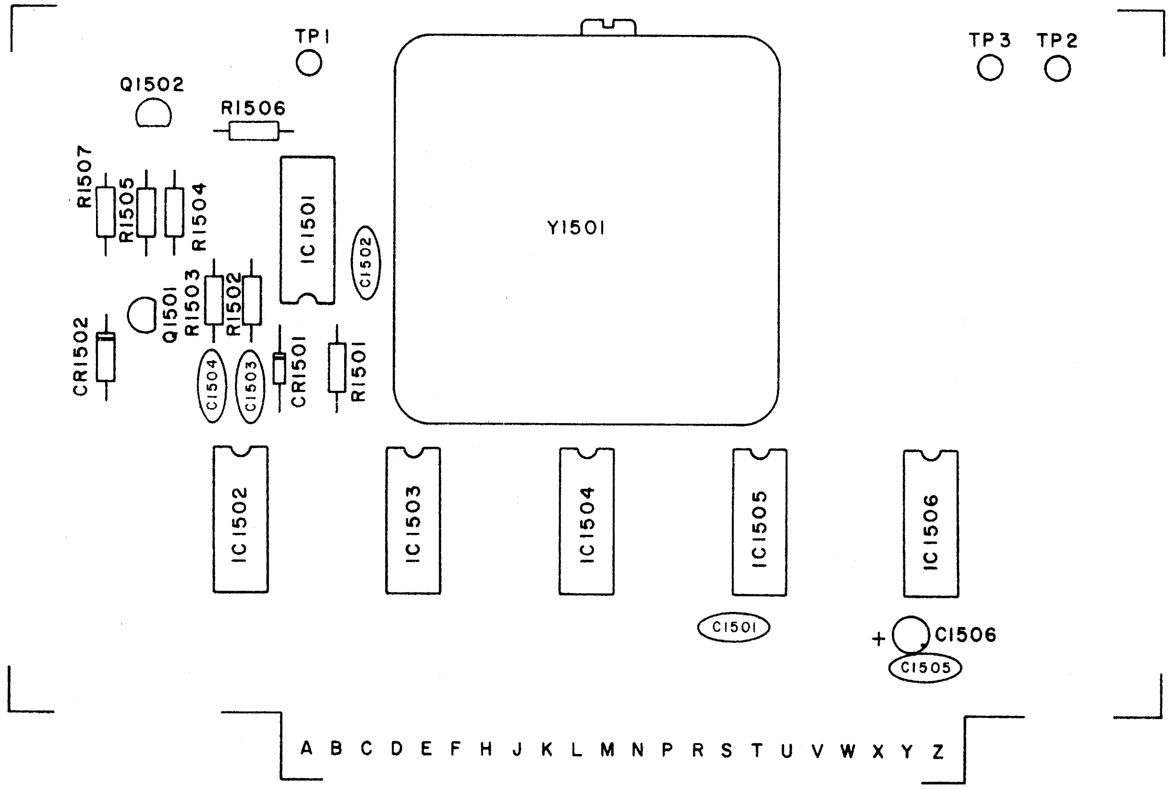
1. CAPACITANCE VALUES IN µF U
SPECIFIED.
2. RESISTANCE VALUES IN OHMS
OTHERWISE SPECIFIED.
3. LAST NUMBERS USED:
R1408 C1404 IC1409

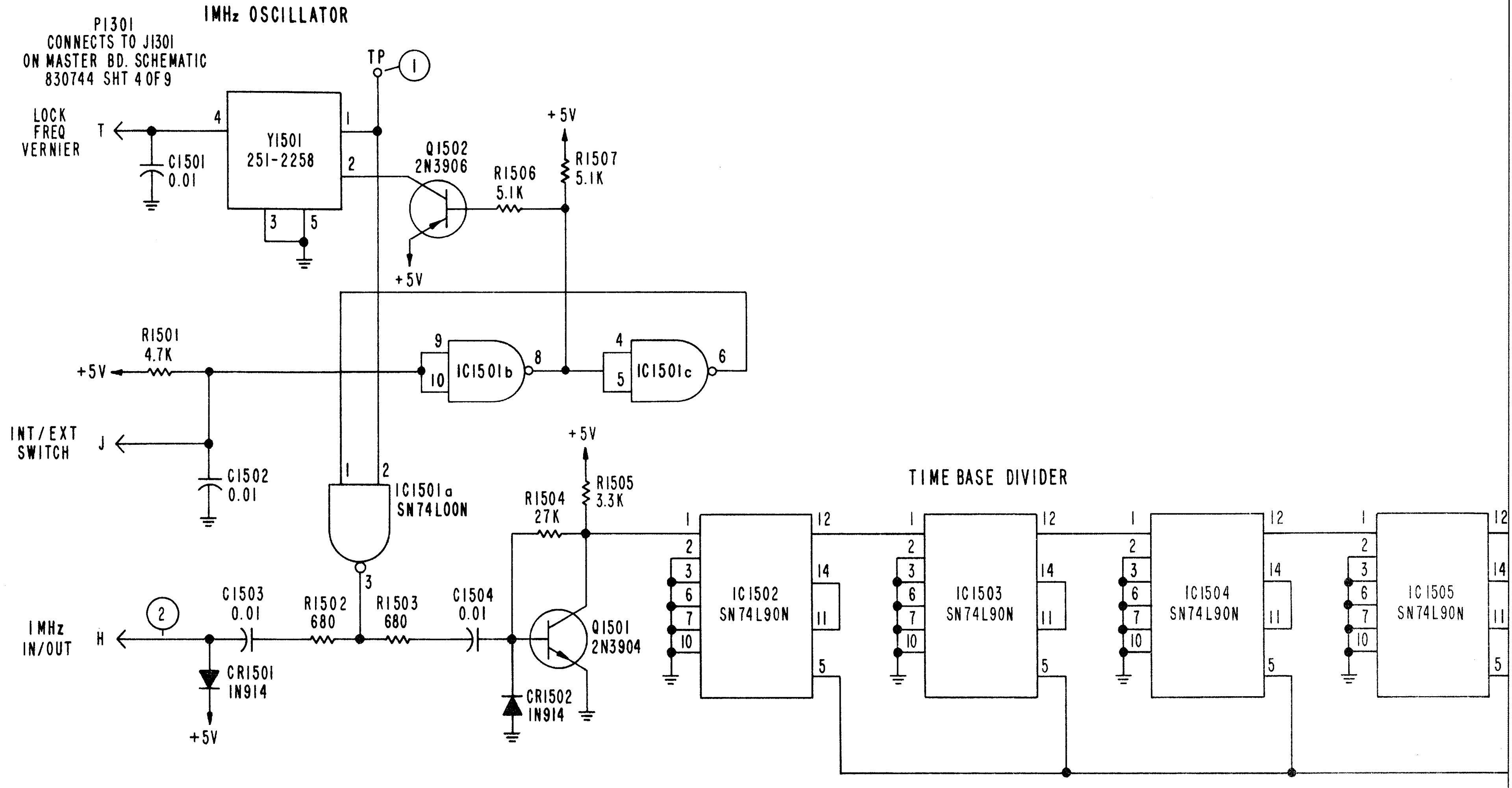


NOTES:

1. CAPACITANCE VALUES IN μF UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS AND 1/2 WATT, UNLESS OTHERWISE SPECIFIED.
3. LAST NUMBERS USED:
   R1408 C1404 IC1409

Figure 6-14 Display Time Base PCB, Schematic Diagram





NOTES:

1. RESISTANCE VALUES IN OHMS AND 1/4 WATT, UNLESS OTHERWISE SPECIFIED.
2. CAPACITANCE VALUES IN μF UNLESS OTHERWISE SPECIFIED.
3. LAST NUMBERS USED:
   C1506 R1507 IC1506

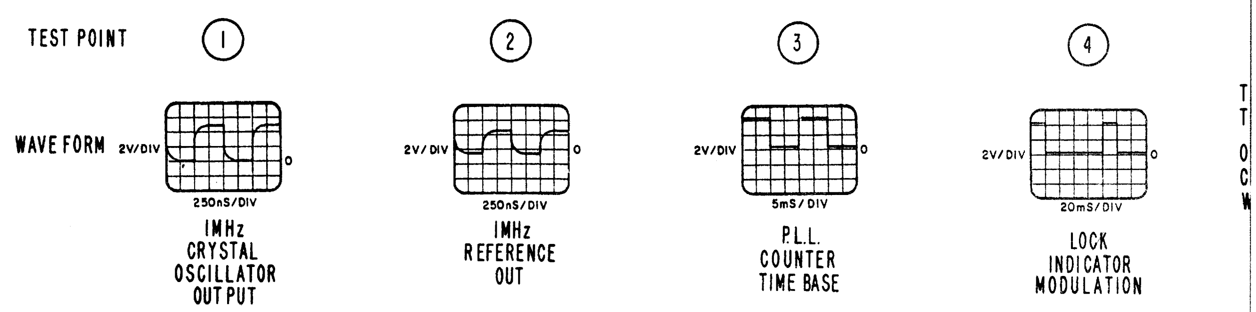


Figure 6-15

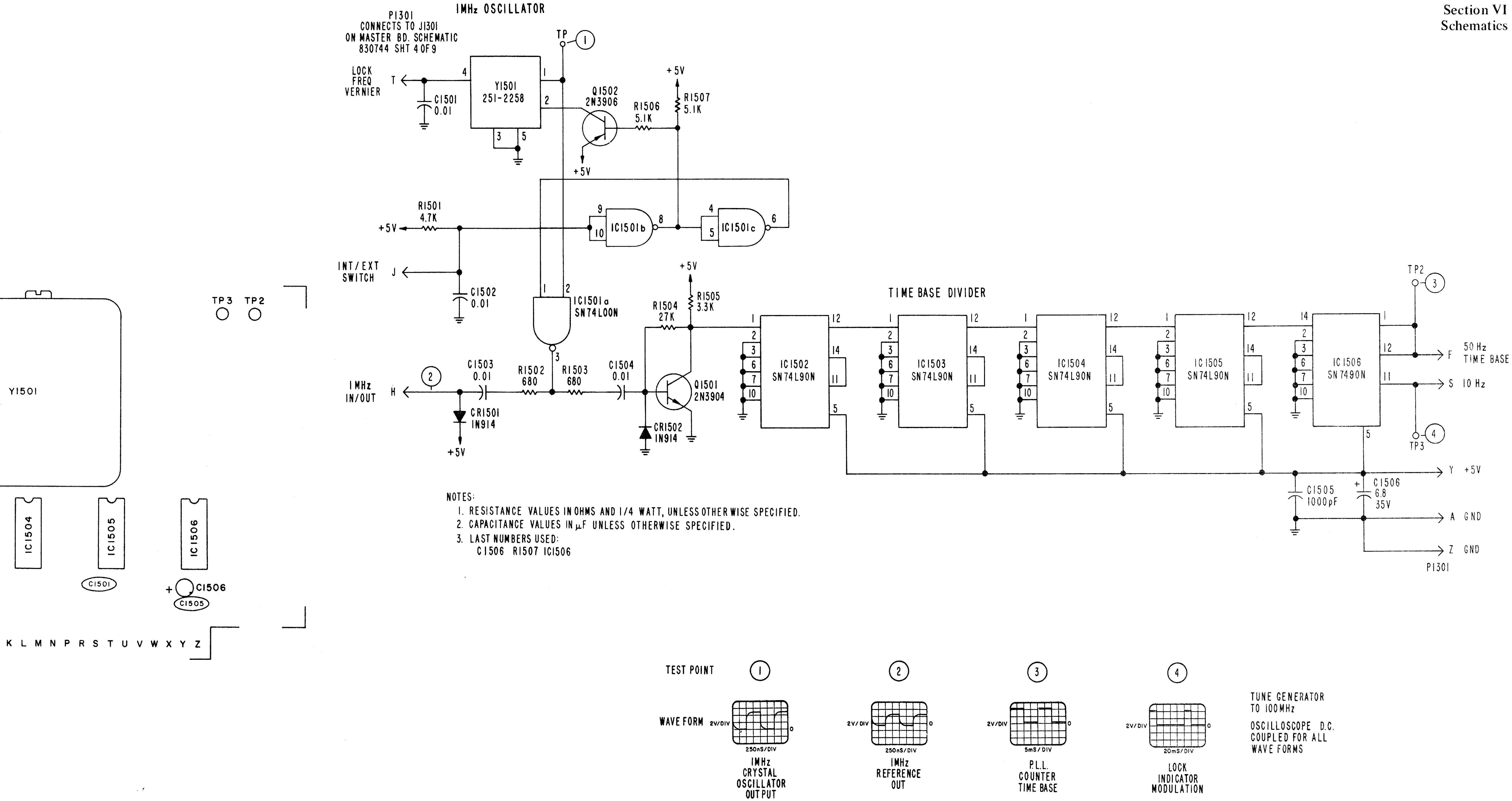
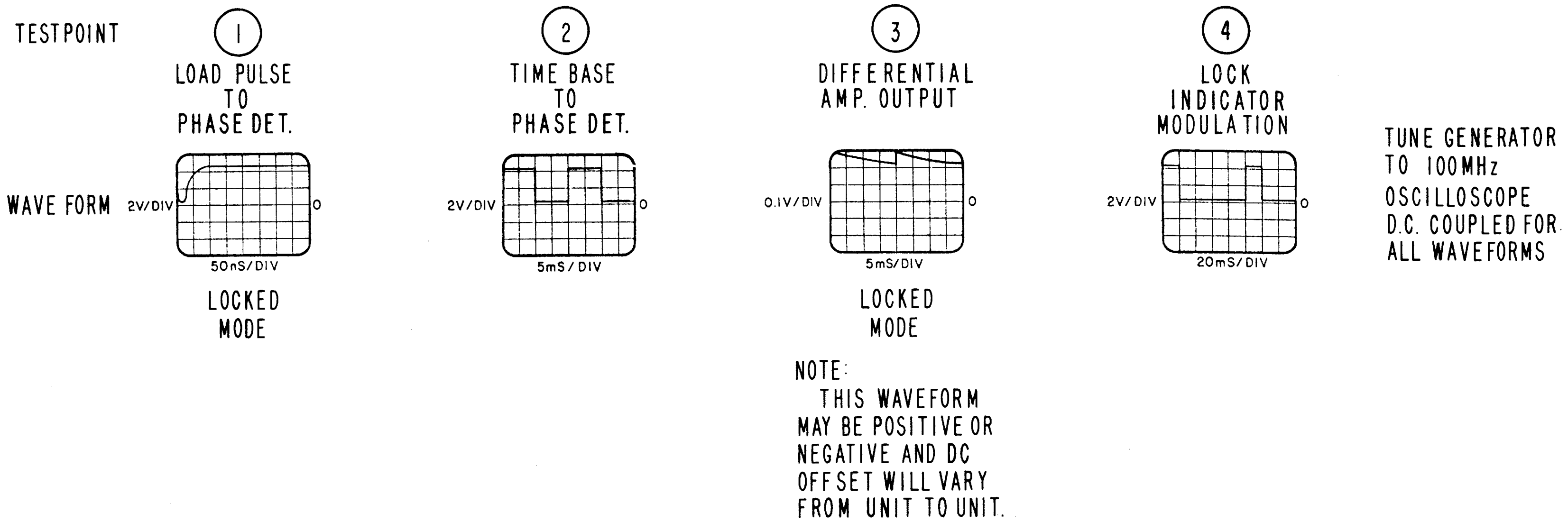
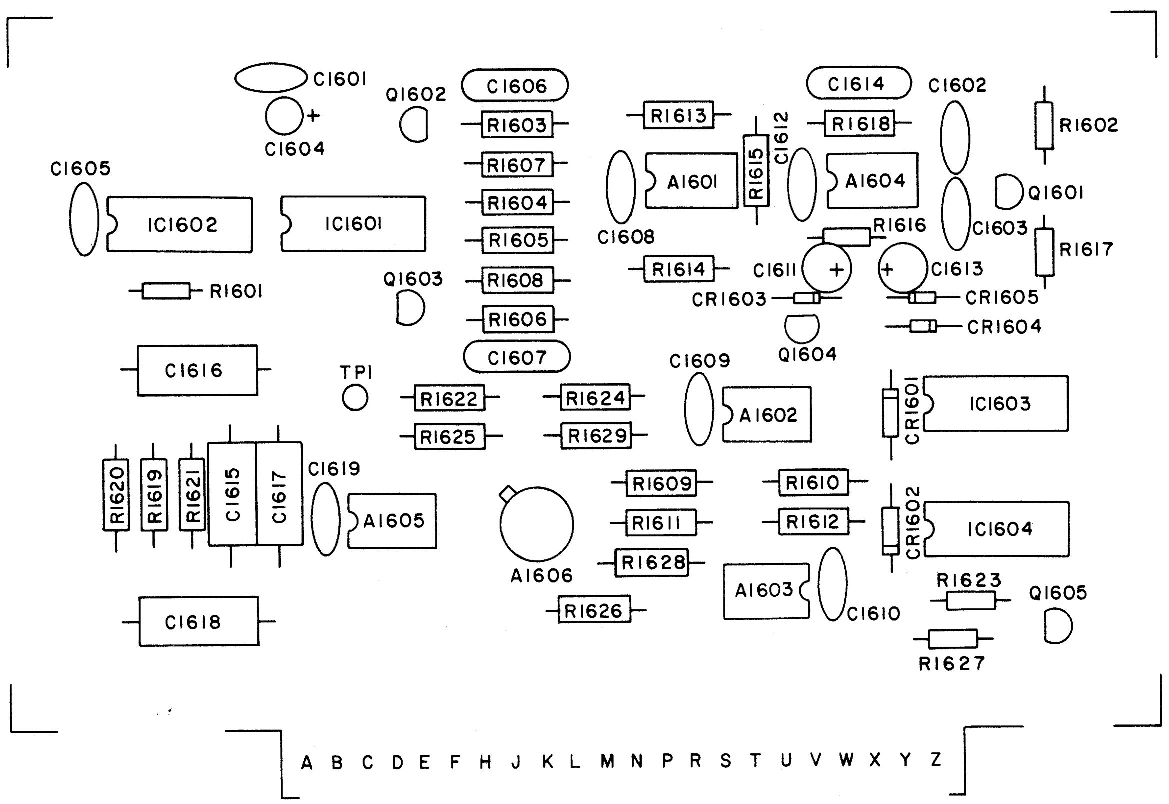


Figure 6-15 Phase Lock Time Base PCB, Schematic Diagram

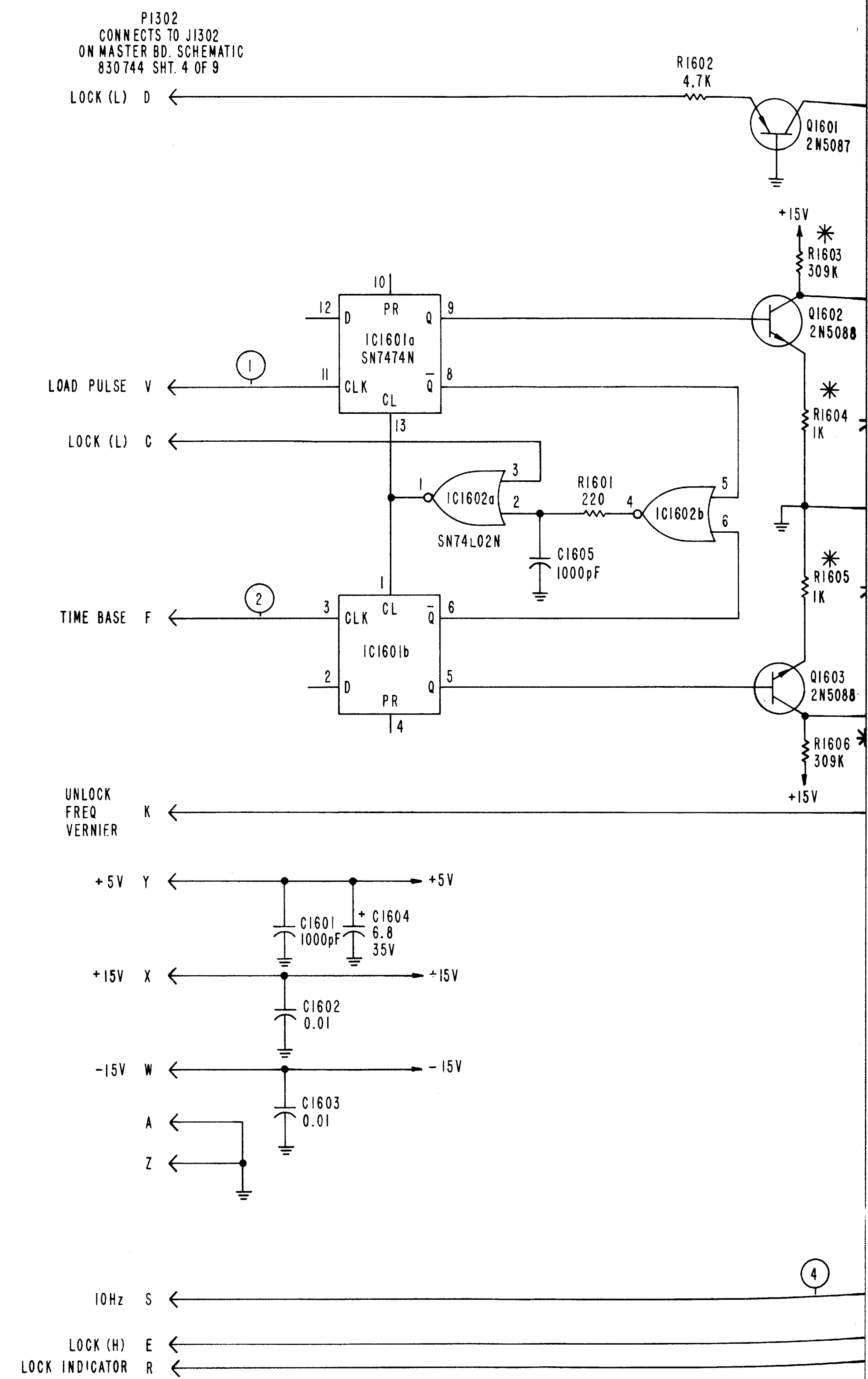




NOTES:

1. CAPACITANCE VALUES IN μF UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS AND 1/4 WATT, UNLESS OTHERWISE SPECIFIED.
3. ✳ PRECISION RESISTOR, 3/8 WATT.
4. LAST NUMBERS USED:

C1619	R1629
A1606	CR1605
Q1605	IC1604



NE GENERATOR
100MHz
CILLOSCOPE
C. COUPLED FOR
L WAVEFORMS

ES IN µF
SPECIFIED.
S IN OHMS AND 1/4WATT,
SPECIFIED.
ISTOR, 3/8 WATT.
ED:
9
05
04

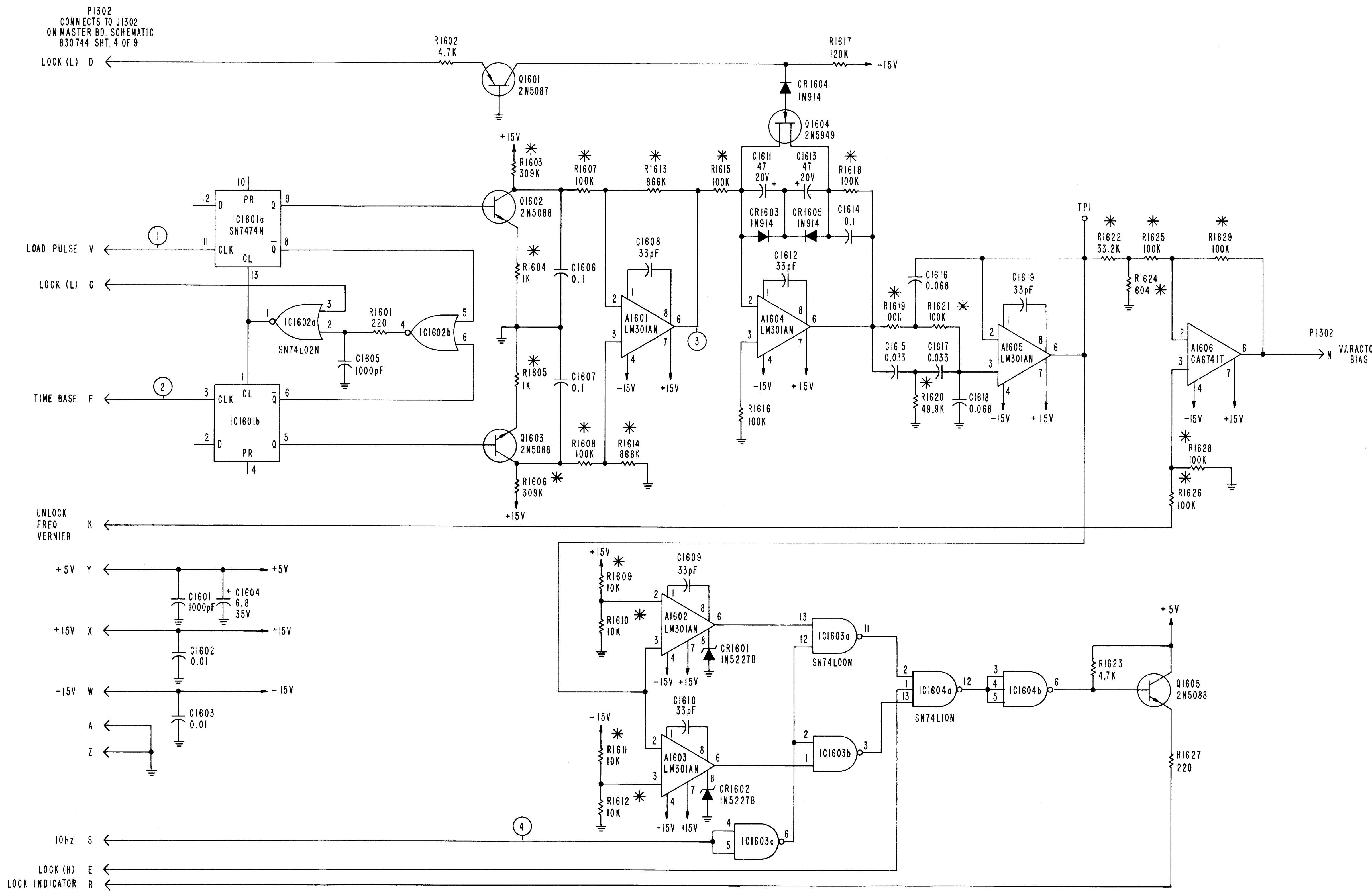
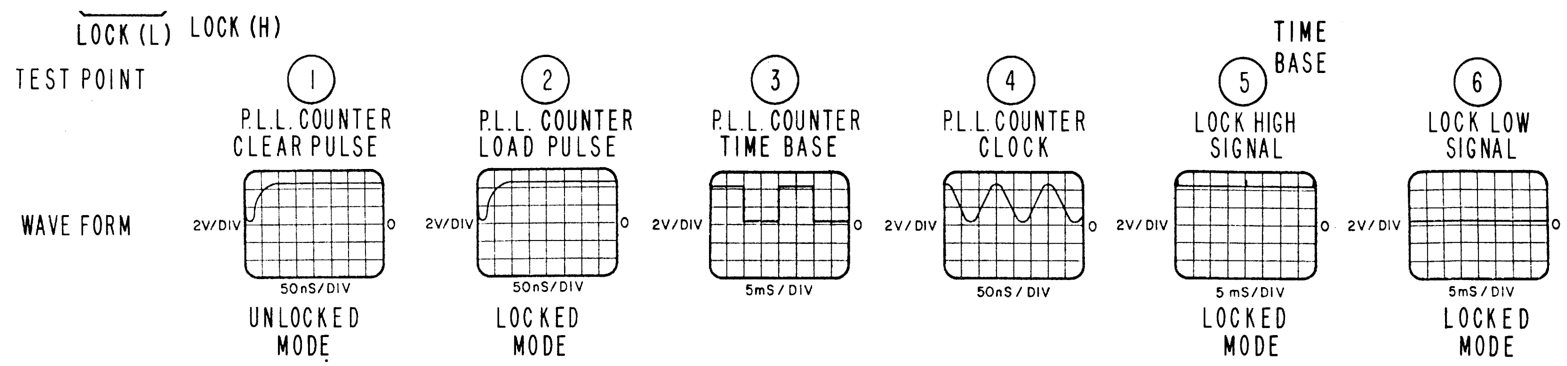
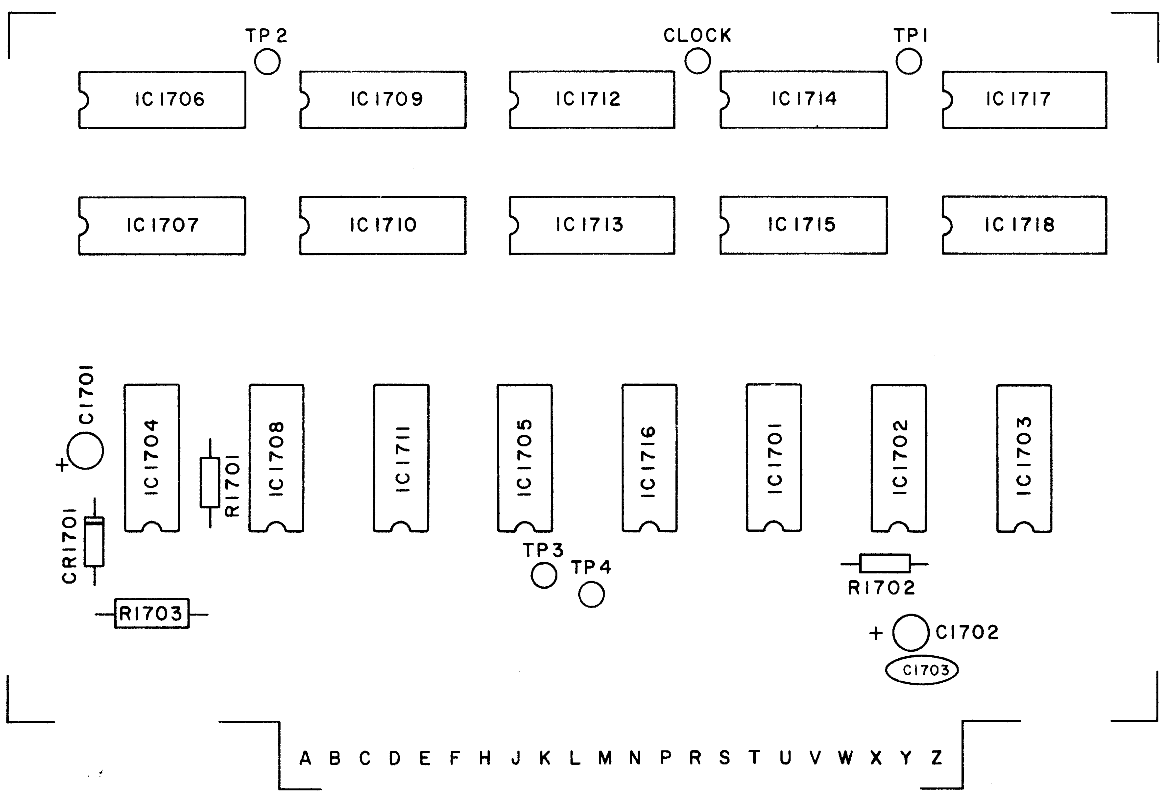


Figure 6-16 Phase Detector PCB, Schematic Diagram



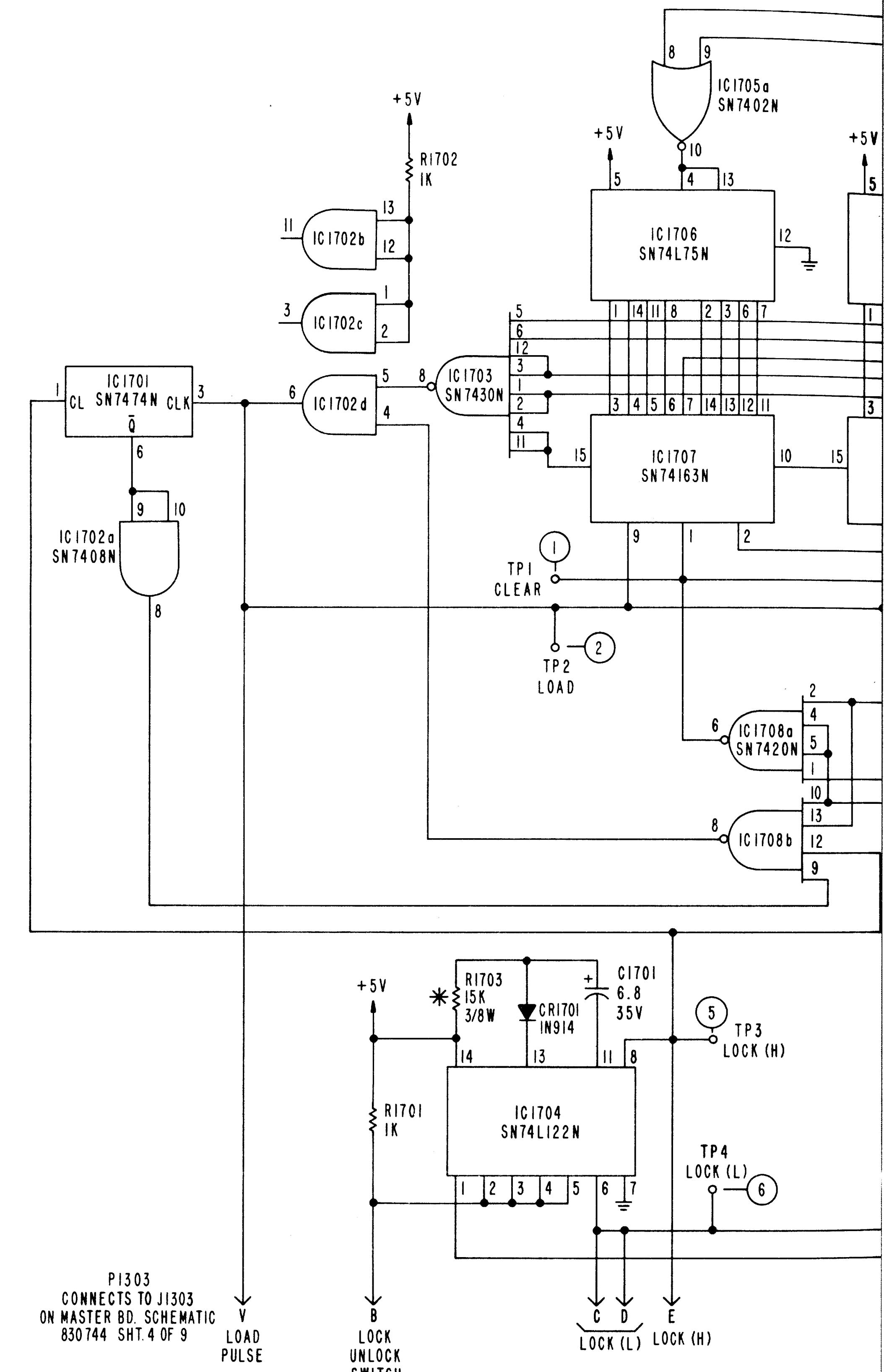
TUNE GENERATOR TO 100 MHz

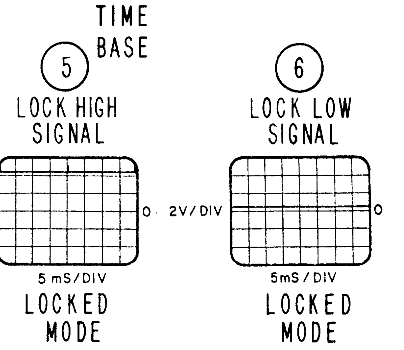
OSCILLOSCOPE D.C. COUPLED FOR ALL WAVE FORMS



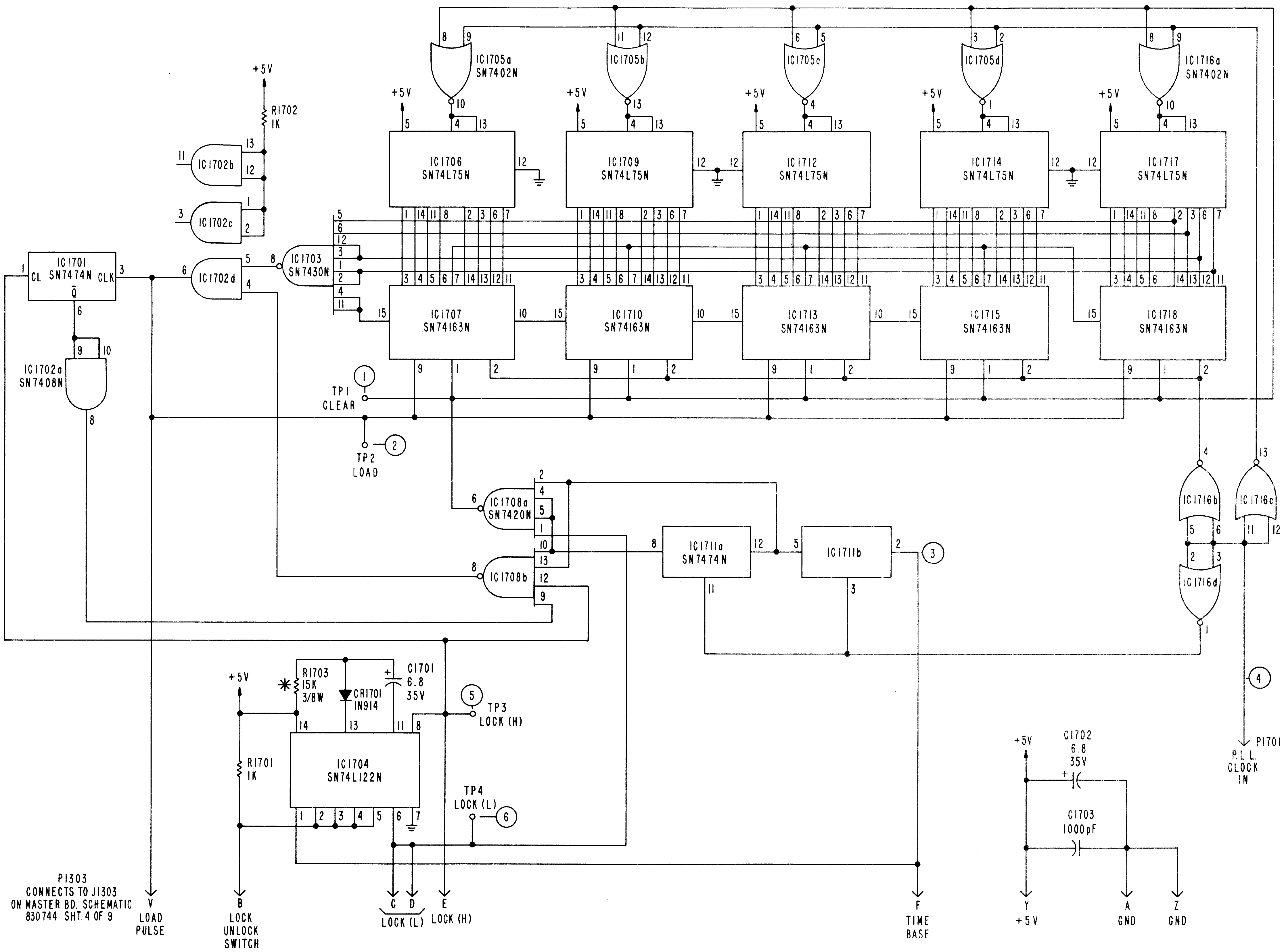
NOTES:

1. CAPACITANCE VALUES IN µF UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS AND 1/4 WATT, UNLESS OTHERWISE SPECIFIED.
3. ✳ PRECISION RESISTOR.
4. LAST NUMBERS USED: R1703 C1703 IC1718





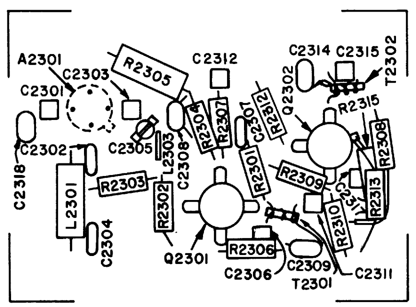
TUNE GENERATOR TO 100 MHz
OSCILLOSCOPE D.C. COUPLED FOR ALL WAVE FORMS

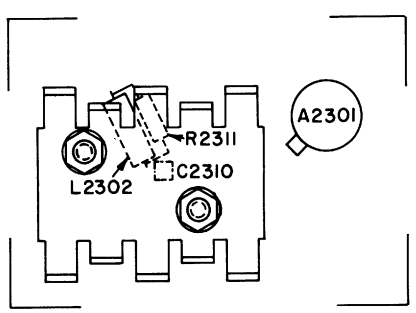


NOTES:

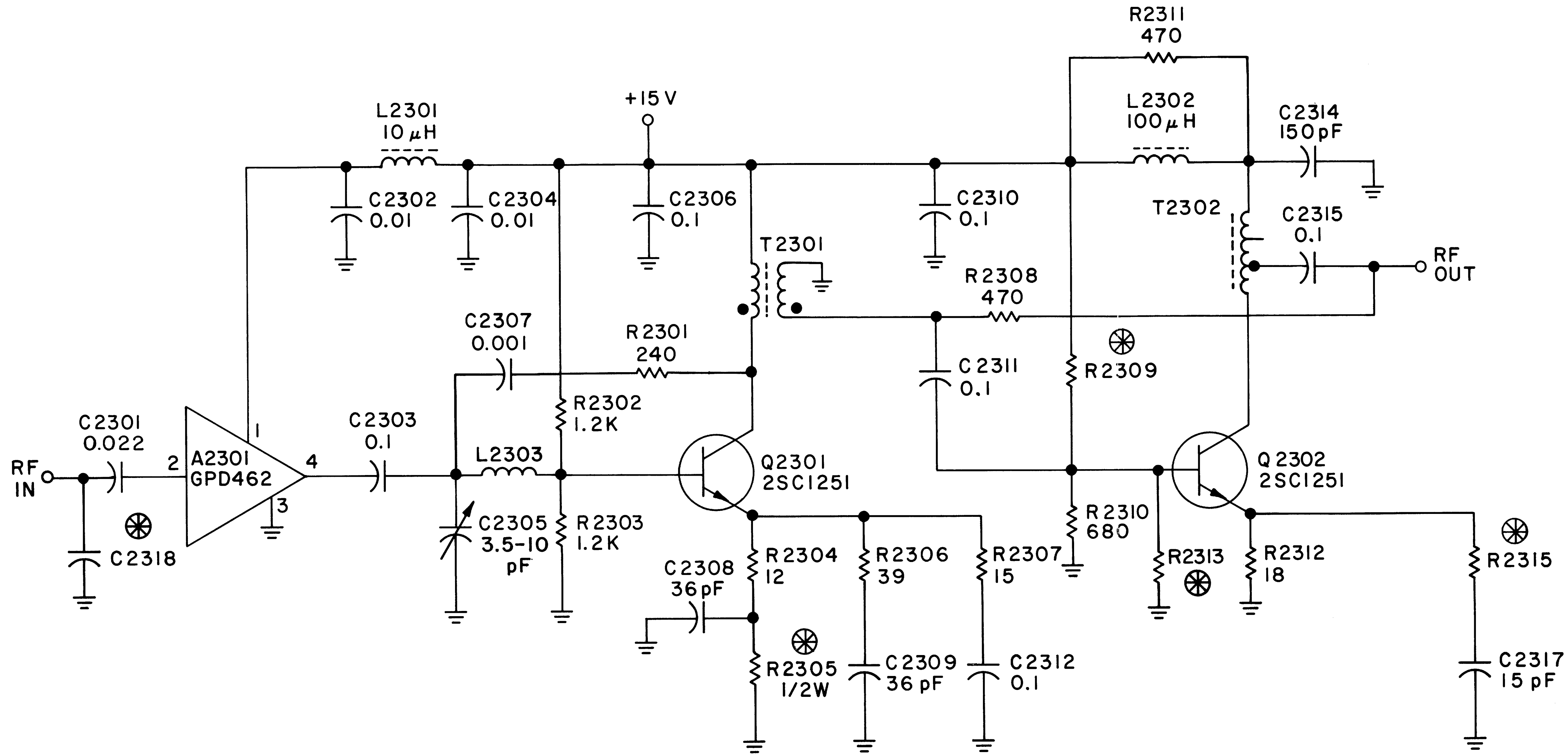
1. CAPACITANCE VALUES IN µF UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS AND 1/4 WATT, UNLESS OTHERWISE SPECIFIED.
3. ✳ PRECISION RESISTOR.
4. LAST NUMBERS USED: R1703 C1703 IC1718

Figure 6-17 Phase Lock Counter PCB, Schematic Diagram





830799D



NOTES:

1. CAPACITANCE VALUES IN μF UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. ⊛ SELECTED VALUE.
4. LAST NUMBERS USED:
   R2315 C2318
5. NUMBERS NOT USED:
   C2313 R2314
   C2316

Figure 6-18 Wide Band Amplifier, Schematic Diagram