LAMPKIN LABORATORIES, INC.

TYPE 107B
DIGITAL FREQUENCY METER
AND
TYPE 107C
COMMUNICATION SERVICE MONITOR

OPERATION
AND
SERVICING
INSTRUCTIONS

GUARANTEE
Lampkin equipment is guaranteed against defects in material and workmanship, for one year from date of sale. The equipment is honestly described and we will give the best possible service long after the sale.

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October 1972

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107C INFORMATION NOTE

This manual covers the Type 107B Digital Frequency Meter/Signal Generator and the Type 107C Communication Service Monitor. The two units are functionally similar. However, the 107C has added capabilities in the measurement of FM deviation, and aural monitoring, which make it a complete, self-contained monitoring unit for many two-way radio service applications.

The basic manual describes the 107B. Section 8 provides additional information to make the manual complete for the 107C Communication Service Monitor.

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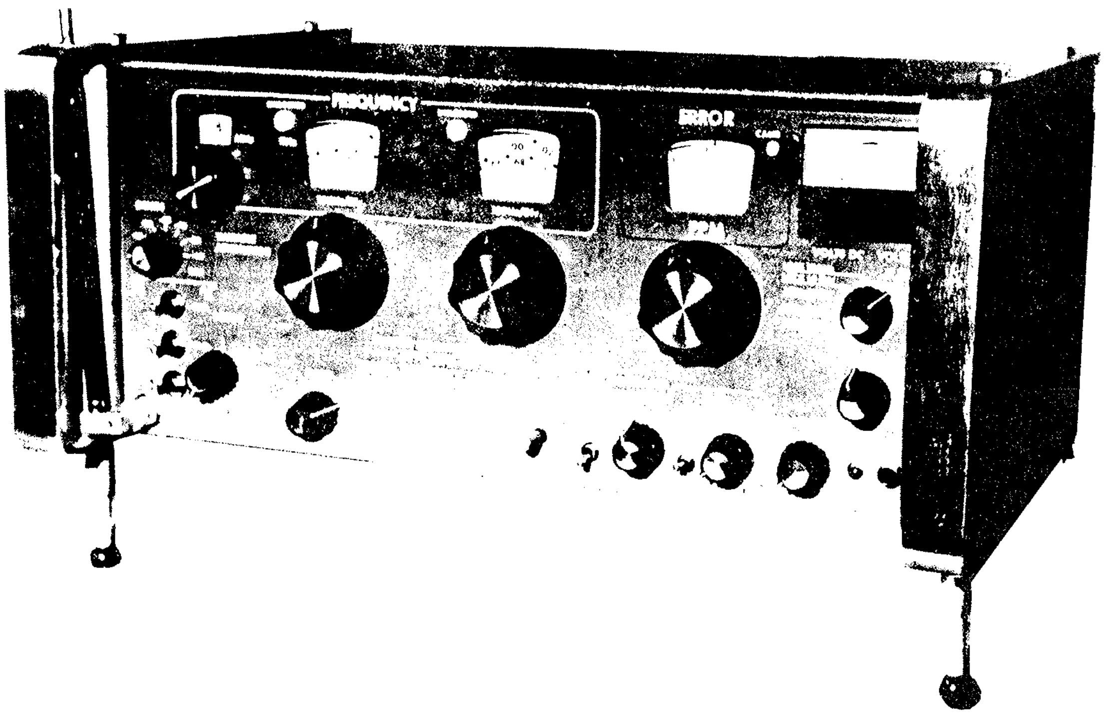


Figure 1-1. Lampkin Type 107B Digital Frequency Meter and Signal Generator

SECTION 1

GENERAL DESCRIPTION

1-1 APPLICATION (See 107C Information Note - on preceding page)

The Lampkin Type 107B Digital Frequency Meter/Generator (DFM) is a precision instrument for frequency measurement and signal generation on any frequency between 10 kHz and 1000 Mhz, with no gaps. Signals with crystal-locked stability are provided in 100 Hz increments throughout this band. However, at frequencies of 2 MHz or higher the 107B signal can be adjusted to zero with any frequency, with percentage deviation indicated from the nearest 100 Hz increment digital setting. The 107B may be used wherever precise frequency measurement or accurate signal generator functions are required. Typical areas of application are calibration, alignment, testing, and adjustment of equipment in the following activities:

- Mobile and Public Safety radio service
- AM, FM, and TV broadcast service
- CATV frequency alignment and checks
- Marine radio service
- Aircraft transceiver service
- Commercial frequency measurement services

The 107B provides a heterodyne detector for comparing frequency meter signals with the signals of transmitters or other rf devices. The detector output is available for aural checking on a speaker or visual checking (near zero beat) on a meter which can be switched in for this function. For receiver checking, rf signal from the 107B common input/output rf connector can be fed through suitable load networks (or directly) to the receiver under test, as required for the particular test needs. A telescoping antenna is also supplied. This can be used for radiating signals to receivers, or intercepting signals from transmitters or rf-generating devices in the immediately adjacent area, as practicable. With a separate receiver, the 107B may be used to check frequencies of distant transmitters within the working range of the receiver. For information on specific operating methods, refer to Section 3.

1-2 DESCRIPTION

Using an extremely stable crystal-controlled oscillator as its basic signal source for developing all output frequencies, the Lampkin 107B produces crystal-stable outputs in steps of 100 Hz over its complete operating spectrum of 10 kHz through 1000 MHz. All circuitry is solid state and primary power requirements are minimal (see specifications). All outputs can be either amplitude or frequency modulated at any audio frequency from 50 to 6000 Hz from an internal audio generator. Input arrangements are also provided for accepting a modulating signal from an external source at any frequency from 50 to 10,000 Hz. A separate, highly stable crystal-controlled 3 MHz oscillator provides a calibrating standard for the instrument. This oscillator can be referenced to prime standard frequency signals such as WWV or WWVB, or National Bureau of Standards.

The 107B provides internal generation of an audio frequency for squelch tone modulation of a test signal. The unit also includes circuitry (front panel turn-on) for nulling transmitter tone modulation effects while measuring the transmitter frequency, thus eliminating the need to disable transmitter tone modulation during frequency check.

Primary power input can be either 115 volts, 50 to 400 Hz ac, or 12 volts dc. Separate power cords (individually fused) are used for ac and dc operation, respectively. (See specifications for special-order dc inputs.)

Construction of the unit provides maximum internal mechanical stability along with a durable exterior. Protection for the front panel controls and indicators is afforded by the design of the carrying handles. Two slide-out tilt-support legs are included so that the unit may be tilted backward for convenient viewing and operation. Controls and indicators are functionally located and clearly marked. All input and output connectors are standard items.

A. Equipment Supplied

Except for a separate antenna, the 107B Digital Frequency Meter/Generator is complete for all its functional applications in one package.

A 40-inch telescoping antenna is supplied as an accessory. It connects directly into the 107B input/output rf coaxial connector.

Separate ac and dc power cords are permanently connected to the 107B.

B. Specifications

Specifications for the Lampkin Type 107B Digital Frequency Meter are given in the following listing.

FREQUENCY RANGE

For measurement of transmitting frequencies or of received signals, and for generation:

Band 1: 10 kHz to 9,999.9 kHz
Band 2: 10 MHz to 1000 MHz

All frequencies are tunable ± 50 parts per million.
All frequencies are direct reading, in 100 Hz steps.

RESOLUTION: Better than ±1 Hz.

FREQUENCY METER ACCURACY

Better than 1 part per million (±0.0001%) for three month periods or more without reference to WWV over range of PPM dial: ±0.5 PPM over ±20 PPM range.

INTERNAL STANDARD ACCURACY

Aging rate is less than 3 parts in 10^9 per day; stability is better than 1 in 10^8 (voltage and temperature). Internal crystal reference standard with proportional oven-temperature control operates at 3.0 MHz nominal; can be corrected to WWV, if needed, from the front panel.

VXO

The DFM has a 1 MHz variable frequency crystal oscillator (VXO), proportional oven-temperature controlled, with a calibrated dial ±50 parts per million easily correctable to the internal standard, if needed. All synthesized frequencies are derived from this VXO.

WARMUP TIME

About 35 minutes from 70°F room ambient, for stabilization of the two proportional ovens. Thereafter, the 107B ovens can be kept warm on the bench or in the vehicle, with little power.

INPUT SENSITIVITY: 5 mV worst case, 1 mV nominal.

OUTPUT LEVEL

Band 1: Fundamental frequency, 1.0 volt rms to less than 0.1 microvolt, controlled by a step attenuator, 0 to 60 dB in 10 dB steps, by a variable panel control and 3 switched 20 dB pads. Attenuator accuracy is ±2 dB, output impedance is 50 ohms resistive.
Band 2: 1 millivolt to 0.1 microvolt (±2 dB), continuous to 700 MHz, 100 uV (±5 dB) above 700 MHz.

Above 10 MHz, output is through a variable attenuator calibrated in dBm and referred to absolute microvolts; and 3 switched 20 dB pads. A 40 inch telescoping antenna is also supplied.

MODULATION

Internal, two band, 50 to 600 Hz, and 500 to 6000 Hz, frequency accuracy ±15%. External, 50 to 10,000 Hz, requires 3 to 4V rms into 1,000 ohm load, socket and switch on rear panel. Frequency of both internal and external sources can be self checked, or set, to less than 1 Hz.

AM variable from zero to over 50%

FM variable up to 15 kHz peak deviation at 150 MHz and in direct proportion at other carrier frequencies.

AMBIENT TEMPERATURE

The DFM will operate to specifications in ambient temperatures from 0°C (32°F) to +50°C (+122°F).

SPURIOUS PRODUCTS

Will be greater than 30 dB down, referred to carrier, within ±100 kHz or ±0.1% of the desired frequency.

POWER SUPPLY

115 VAC 50-400 Hz 8 watts nominal, and 12.5 VDC nominal, option of 25 or 33 VDC nominal. DFM will operate over ±20% range from nominal voltages. Unit internally wired for any one of these at no charge. All 3 are available on special order. Nominal dc drain, 13 watts. DC is diode protected against reverse voltage. Separate power cords supplied for ac and dc individually fused.

NET WEIGHT: 22.3 pounds.

SIZE

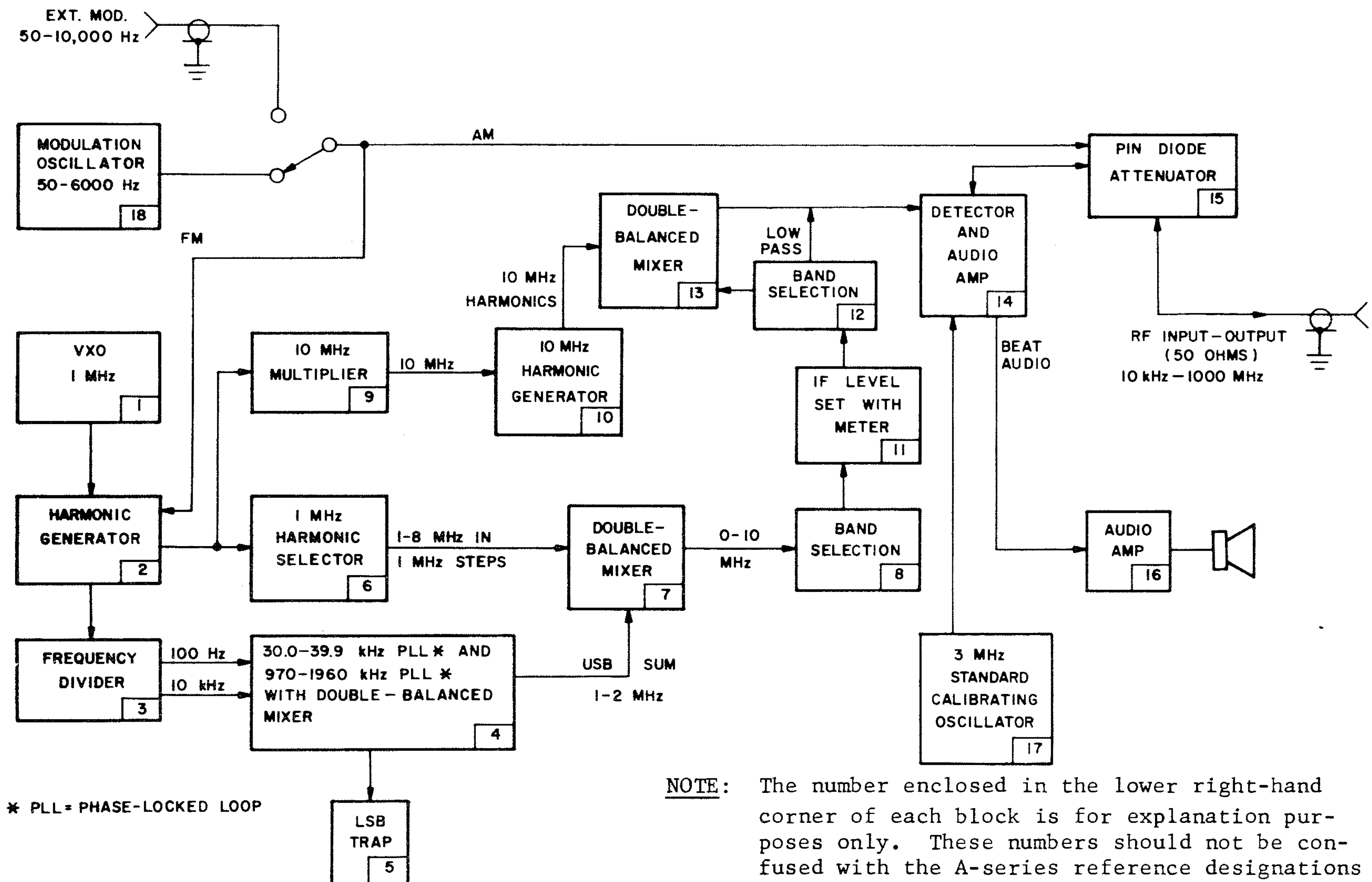
7-3/8 inches high x 17-3/8 inches wide x 11 inches deep - An 8-3/4 inch high standard relay rack mounting kit is available.

C. Basic Circuit Operation

Refer to figure 1-2, a simplified functional block diagram of the Digital Frequency Meter/Generator. It illustrates main signal paths.

The 107B develops its crystal-locked output frequencies in a synthesizing process, using harmonic generators, harmonic selectors, beat frequency generators, filters, etc. - and addition of appropriate signal components in balanced mixers. Band selection is made manually with selective tuning elements. For simplicity, switching arrangements are not shown.

In figure 1-2, the 1 MHz crystal oscillator (1) is the very stable initial source from which all output frequencies are developed. Its output (in one path) drives harmonic generator (2). One output from the harmonic generator drives a frequency divider (3). The frequency divider provides (among others) 100 Hz and 10 kHz outputs. These outputs are fed to two variable frequency oscillators in block (4). One tunes from 30.0 to 39.9 kHz and the other from 970 to 1960 kHz. The oscillators are set close to the desired frequency setting by manual selection and then electrically swept to lock in phase with harmonics of 100 Hz and 10 kHz signals, respectively. When a phase-lock condition is reached, the sweep is automatically disabled - with front panel indication. The two oscillator outputs are mixed (4) in a double-balanced mixer, the lower sideband and input signals are filtered out (5) and the sum frequency used to obtain a signal adjustable over the range of approximately 1 to 2 MHz in 100 Hz increments. This is one signal element that is mixed with other signals in the synthesizing process.



NOTE: The number enclosed in the lower right-hand corner of each block is for explanation purposes only. These numbers should not be confused with the A-series reference designations used in Section 4 and the schematic diagram titles.

Figure 1-2. Simplified Functional Block Diagram (Power supplies and most switching not shown for simplicity)

Note that the harmonic generator (2) also feeds signal to a 1 MHZ step harmonic selector (6). Through front-panel manual control, this selects any 1 MHz harmonic from 1 to 8 MHz. The harmonic chosen is mixed in double balanced mixer (7) with the output of the oscillator-mixer combination (4) previously described, to develop a range of signals from 0 to 9.9999 MHz in phase-locked 100 Hz increments. This signal is used for output, or for mixing with other signals to develop higher frequency outputs, depending on the band selected.

The output from double-balanced mixer (7) is fed through manually-set band selection (8) and (12), and an attenuator calibrating circuit (IF Level Set) (11) for appropriate transmission. This output can be either mixed in double-balanced mixer (13) for a 10-1000 MHz output, or directly fed to beat detector/audio element (14) and attenuator (15) for a 0-10 MHz output.

The harmonic generator (2) also drives a 10 MHz multiplier (9) which, in turn, drives a 10 MHz harmonic generator (10). The harmonic generator (10) provides a harmonic train sufficient to provide all frequency requirements for output to 1000 MHz - when mixed appropriately in mixer (13) with the IF output (0-10 MHz) from band-selection element (12).

The detector in element (14) is the beat frequency detector used for comparing synthesized frequency-meter signal with an incoming transmitter signal, or with the standard 3 MHz reference oscillator during calibration. Its output is fed through audio amplification in element (14) and audio amplifier (16) to a built-in speaker, front panel phone-jack, and metering circuit. The 10 to 1000 MHz output is self-leveled at 1 millivolt input to the attenuators by means of a controlled output from the 10 MHz generators.

The 3 MHz calibrating oscillator (17) is a highly-stable crystal-controlled unit in a temperature-controlled oven and can be standardized with an external primary input such as WWV or WWVB - or a foreign counterpart. Switching arrangements are omitted for simplicity.

The pin-diode attenuator (15) with related networks provides the adjustable, calibrated output levels for signal generator usage. It may also be used to attenuate strong incoming signals during reception of external signals for comparison in the detector (14). The pin-diode circuit, being electrically controlled, also provides the medium for amplitude modulating the output signal with audio signal from the 50-6000 Hz oscillator (18) or from an external source. Switching and biasing arrangements are omitted from this diagram for simplicity.

For a more detailed functional description refer to Section 4.

1-3 ABBREVIATIONS AND DEFINITIONS

The following abbreviations and terms are used at various places in this manual. For other definitions common to the electronic industry, consult appropriate handbooks.

ABBREVIATION	MEANING/DEFINITION
AM	Amplitude modulation
cal	Calibrate
COSMOS	Complementary symmetry metal oxide silicon
cw	Continuous wave
db or dB	Decibel
dbm or dBm	Decibels referred to one milliwatt
DBM	Double-balanced mixer
DFM	Digital Frequency Meter
Div.	Division
EDC	Voltage dc
FET	Field effect transistor
FM	Frequency Modulation
FREQ	Frequency
Hz	Hertz, (cycles-per-second)
IC	Integrated circuit
IF	Intermediate Frequency
K	1000, also 1000 ohms
kHz	1000 Hz, 1000 cps
LSB	Lower sideband
MAX	Maximum
MHz	MegaHertz, 10^6 Hz
Mod	Modulation
MOSFET	Metal oxide silicon field effect transistor
ms	Millisecond
mv	Millivolt
n	Nano (10^{-9})
Op Amp	Operational amplifier
PLL	Phase-locked loop
PPM	Parts per million
P-P	Peak-to-Peak
p/o	Part of
rms	Root mean square
SN	Serial number
T	Temperature
UHF	Ultra-high frequency 300-3000 MHz
USB	Upper sideband
u	Micro (10^{-6})
VCO	Variable frequency (controlled) oscillator
VHF	Very high frequency 30-300 MHz
VOL	Volume
VXO	Variable crystal oscillator
wvdc	working voltage dc

DEFINITIONS

Attenuator	Device which reduces amplitude, ideally without introducing distortion.
Double-Balanced Mixer	Frequency mixer, or converter, which tends to cancel one or more input frequencies.
Calibration	Comparison of an unknown quantity, such as a frequency, with a known quantity; and adjustment (if necessary) to make the unknown quantity agree with the known quantity.
Drift	The tendency of a signal frequency to move away from a preset value. Normally, drift is associated with long time intervals.
dbm or dBM	Voltage level referred to zero dbm (one milliwatt across 50 ohms). Zero dbm = 224 millivolts, -47 dbm = 1 millivolt.
Hot Carrier Diode	Schottky diode used as a very fast switch or high frequency mixer.
Intermediate Frequency (in DFM)	"Fundamental" intermediate frequency signal of DFM before high-frequency mixing.
Jitter	Short term instability, or tendency to move rapidly away from a preset value.
Noise	Extraneous electrical disturbances.
Phase Lock	Phase synchronization of an oscillator with a stable reference frequency.
Primary Standard	Standard with an inherent stability, such that it does not require frequent calibration. (Example: Frequency signals from WWV or WWVB.)
Resolution	The ability to discern or distinguish between two closely adjacent frequency settings (in this application).
Secondary Standard	Standard with good short term stability, but which requires occasional calibration to a primary standard value. Sometimes called a "working standard".
Sensitivity (in DFM)	Input voltage required to produce a designated voltage across the speaker terminals.
Spectrum	Relative power distribution along a frequency axis.
Standard	A quantity set as a measure to which other quantities are referred.

<u>DEFINITIONS</u> (continued)

Spurious	Undesired mixing products resulting from internally generated signals, distortion products, and/or circuit malfunction.
Step recovery diode	A diode which has an abrupt termination of reverse recovery current. These diodes generate voltage steps with transition times shorter than 1 nanosecond.
P.I.N. (PIN) diode	A diode which has a characteristic similar to a current controlled resistor, usable to microwave frequencies.
VXO (Variable Crystal Oscillator)	Crystal oscillator tunable by external means (such as a variable capacitor) over a limited frequency range.

SECTION 2
PREPARATION FOR USE

2-1 UNPACKING AND INSPECTION

Before unpacking the 107B Frequency Meter, check the carton for shipping damage. If damage is present, arrange to have the package opened in the presence of an agent of the carrier to determine possible equipment damage responsibility. If damage has occurred during shipment, file a claim with the carrier in accordance with local procedures.

If the carton is in good condition, open the top of the container and remove paperwork. Check contents.

Remove the four upper corner blocks and carefully lift out the instrument. If practicable, retain the carton and packing for possible reuse. Check the instrument for concealed damage. Be sure to locate and remove the auxiliary antenna, before storing the packing and carton.

2-2 SETUP FOR USE

Since the 107B is a portable unit, no actual installation is required. All that is needed is a level bench, table, or shelf area with access to the ac or dc power to be used, and sufficient overhead space to accommodate the auxiliary antenna when extended to its full 40 inch height.

Slide-out tilt legs are provided which are recessed when not in use. With these, the 107B may be tilted upward for operational convenience. To use the legs, lift the front of the unit to approximately the desired tilt angle, release the springs retaining the legs, and allow the legs to drop out to the nearest detent groove (in the legs) to accommodate the desired height.

To recess the legs, merely release the springs again and lower the unit front to the table or bench surface.

If the antenna is to be used, and it is recessed, disconnect the antenna base from the 107B input/output BNC connector. Push the antenna up through the hole in the left-hand handle so that the top may be grasped for extension. Extend the antenna as required and reconnect the base to the BNC connector.

The 107B operates on either 115 volts 50-400 Hz, single-phase ac, or from 12 volts dc. A standard ac plug (with ground) is used for ac input. A connector that will fit in a vehicle's cigarette-lighter is provided for dc input.

CAUTION

> To avoid possible instrument damage, check power source before plugging 107B into power receptacle.

2-3 ENERGIZING AND BASIC ELECTRICAL CHECK

For information on the controls and indicators to be used in the following check, refer to the particular items in Section 3, where the controls are illustrated in figure 3-1 and explained in table 3-1. See also paragraph 3-2.

To make a brief electrical check, proceed in the following steps.

1. Connect the instrument to the selected primary power, ac or dc.

NOTE

> When using power from a vehicle cigarette lighter (or equivalent) the 107B chassis may be safely grounded to the vehicle without danger.

2. Turn on prime power by rotating AF VOLUME control clockwise to actuate attached switch.

3. Turn VOLTS D.C.-VOLTS A.C. meter selector switch to REGULATED position. Meter should indicate approximately 10.5 volts dc. Using dc power, if there is no reading, power input polarity may be wrong. In the case of incorrect polarity, nothing happens, since the input circuit is diode-protected.

4. Turn selector switch to 1 MHz OVEN and 3 MHz OVEN settings, respectively. When unit has just been turned on, voltage read in these positions should be near 10.5 volts dc. As the ovens stabilize, the voltages will drop. After 30 to 45 minutes ovens will stabilize and each of the readings should be between 3 and 4 volts. Readings are not significant until ovens stabilize.

NOTE

> Once the ovens have stabilized, current drain to keep them warm - from a vehicle or other supply - is negligible (approximately 450 ma for total 107B).

For further electrical tests, refer to Section 3, Operating Instructions. See paragraphs 3-2 and 3-3.

2-4 EQUIPMENT SHUTDOWN

If the 107B is to be used within the next few hours (or possibly the next few days) it is better to keep the unit warm, and not shut off power. This will avoid a wait of 30 to 45 minutes when it is needed for operation.

If the 107B will not be used for a considerable period of time (days or weeks) power is shut off by rotating the AF VOLUME control knob completely counter-clockwise to turn off the attached switch. Power cord may be disconnected from the power source, as convenient.

SECTION 3

OPERATING INSTRUCTIONS

3-1 INTRODUCTION

This section provides all the information necessary to operate the Lampkin Type 107B Digital Frequency Meter/Generator. Controls and indicators are explained. Usage of the 107B is described with the unit applied as an extremely accurate frequency meter and also as a precision signal generator. General background information on equipment functions is provided where necessary for understanding of operational steps.

3-2 CONTROLS, INDICATORS, AND RELATED DEVICES

Most controls and indicators are mounted on the front panel of the 107B. An exception is a modulator control switch on the rear panel, labeled Int-Ext.

A. Front Panel Controls and Indicators

Figure 3-1 illustrates all front panel controls, indicators, connectors, etc., and each item is referenced by a numbered callout. Table 3-1 references each item to the numbered callout on figure 3-1 and provides identification, description, and functional information.

B. MHz Dial Frequency Interpretation

At frequencies below 1 MHz, the MHz dial (callout 1 or figure 3-1) is set to 0. At frequencies from 1 MHz through 9 MHz (plus any fraction), the MHz dial is set to the actual number of MHz in the desired frequency. However, because of harmonic usages and relationships in the 107B, the MHz dial indicates only the "units" digit for frequencies of 10 MHz or higher. Any digits for "tens", "hundreds", etc. normally appearing to the left of a unit digit may be assumed. For example:

If desired frequency is:	Set MHz dial to:	Assume left digits:
10 MHz	0	1
213 MHz	3	21
1000 MHz	0	100
437 MHz	7	43

In all these cases, the 10 KHz/Div. and 100 Hz/Div. dials will perform their normal functions of providing fractional increments of the basic MHz reading. For example:

Frequency	Dial Settings		
1.0352	1	03	52
4.7830	4	78	30
28.9263	8	92	63
430.2845	0	28	45

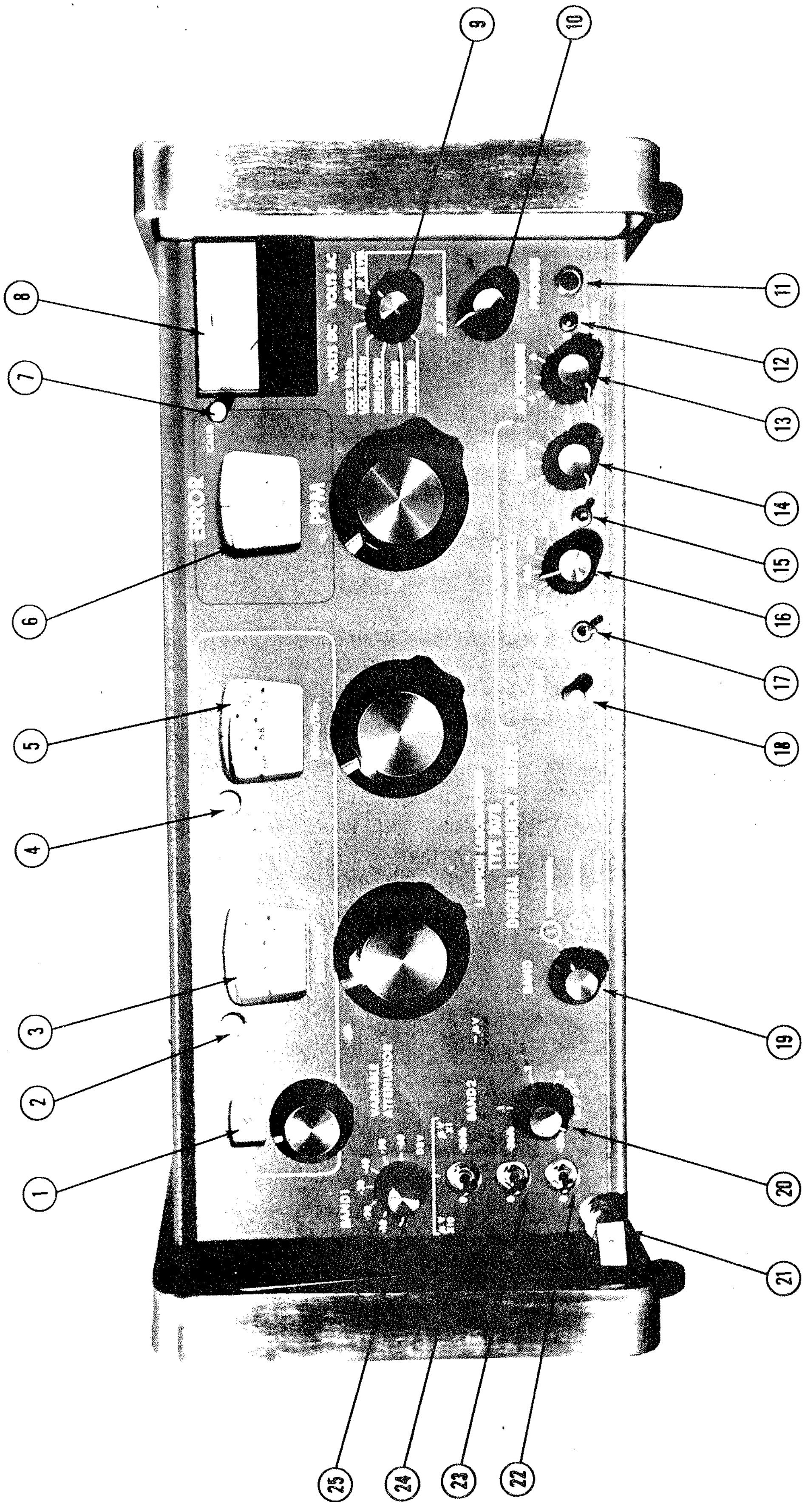


Figure 3-1. Front Panel Controls and Indicators

TABLE 3-1. CONTROLS AND INDICATORS

Fig. 3-1 Ref.	Control/ Indicator	Description	Function
1	FREQUENCY, MHz	Rotary Band-Switch Settings 0-9	When operating in band 1 (10 kHz to 9,999.9 kHz), sets the single MHz digit of desired frequency setting. If frequency is less than 1 MHz, dial is set to 0. When operating in band 2 (10 MHz to 1000 MHz), sets the least significant MHz digit - to which are added (to the left) any assumed digits required to meet the desired frequency setting. (See paragraph 3-2 B).
2	FREQUENCY, UNLOCKED, KHz	Indicating Lamp	Lighted when 970 - 1960 kHz variable frequency oscillator is sweeping, searching for lock-in (10 kHz harmonic).
3	FREQUENCY, 10 KHz/Div.	Variable Tuning Capacitor. Tunes 970-1960 kHz variable frequency oscillator 720° dial.	Indicates first two digits to right of decimal point, for desired frequency setting.
4	FREQUENCY, UNLOCKED	Indicating Lamp	Lighted when 39.0 - 39.9 kHz variable frequency oscillator is sweeping, searching for lock-in (100 Hz harmonic).
5	FREQUENCY, 100 Hz/Div.	Variable Tuning Capacitor. Tunes 39.0 - 39.9 kHz variable frequency oscillator 720° dial.	Indicates third and fourth digits to right of decimal point for desired frequency setting.

TABLE 3-1. CONTROLS AND INDICATORS (Continued)

Fig. 3-1 Ref.	Control/ Indicator	Description	Function
6	ERROR, PPM	Variable Capacitor. Tunes 1 MHz Crystal oscillator.	Is used to vary the 1 MHz crystal frequency up to ±50 parts-per-million (PPM) with dial indication of variation in PPM.
7	CALIB	Variable Capacitor Control	When band switch 19 is set to CALIBRATE 3.0 MHz, this control is used to reset 1 MHz oscillator, as required. Reference may be either internal 3 MHz standard, oscillator, or external standard, such as WWV or WWVB.
8	Meter VOLTS D.C. VOLTS A.C.	Multi-Purpose (switch-selected) voltmeter	Provides various readings, as related to selector switch (9), below it.
9	Meter Switch	Rotary Selector Switch	Settings of switch have the following significance: REGULATED - Meter reads regulated power supply voltage, nominal 10.5 vdc. 1 MHz OVEN - Meter reads dc voltage to 1 MHz crystal oscillator oven, 3-6 vdc. 3 MHz OVEN - Meter reads dc voltage to 3 MHz crystal oscillator oven, 3-6 vdc.

TABLE 3-1. CONTROLS AND INDICATORS (Continued)

Fig. 3-1 Ref.	Control/ Indicator	Description	Function
			LOCK 10 kHz - Indicates locked condition when meter indicates within 0.3 from calibrated dial reading for this condition. In unlocked condition, meter pointer swings back and forth. NOTE Best lock is obtained when pointer is in green sector of meter scale. LOCK 100 Hz - Same as for Lock 10 kHz but for 100 Hz harmonic variable frequency oscillator. AF VOL. - Reads audio voltage appearing across speaker. IF LEVEL - Indicates "IF" signal level.
10	IF LEVEL	Rotary Potentiometer Control	Sets IF Level as indicated on meter when switched to IF LEVEL. Is used to make standard level setting for attenuator calibration. When the control is completely CCW and switch actuated, a 10 MHz "comb" output will be obtained at 107B output connector with level adjustable by output attenuator.

TABLE 3-1. CONTROLS AND INDICATORS (Continued)

Fig. 3-1 Ref.	Control/ Indicator	Description	Function
11	PHONES	Standard Phone-Jack	For connecting headphones when headphone operation is desired, or for external speaker (approx. 8 ohms).
12	PUSH AF NULL	Switch	Provides a sharp null on speaker ac voltmeter. Used to minimize squelch modulation tone on a transmitter, during zero-beat check on transmitter frequency. Allows measurement of tone-modulated transmitters without disabling the tone module.
13	AF VOLUME	Potentiometer Volume Control	Controls level of audio output signal and turns on prime power at beginning of rotation.
14	MODULATOR, LEVEL	Potentiometer Modulation Level Control	Controls level of modulation applied to 107B output signal, AM or FM, internal or external audio.
15	MODULATOR, AM FM	Toggle Switch	Selects FM or AM modulation, respectively. Center position - no modulation. (cw)
16	MODULATOR FREQUENCY	Rotary Frequency Control	Modulation frequency control, approximately 50 to 600 Hz when Hz x 10 switch (17) set to "down" position.
17	HZ x 10	Toggle Switch	When set to HZ x 10 (up) multiplies MODULATOR FREQUENCY scale by 10. (500 - 6000 Hz).
18	HZ FINE	Rotary Adjustment	Over 320 degrees of rotation, control provides fine adjustment of modulation frequency. Provides 3-4 Hz variation at 150 Hz; more at higher frequencies.

TABLE 3-1. CONTROLS AND INDICATORS (Continued)

Fig. 3-1 Ref.	Control/ Indicator	Description	Function
19	BAND	Rotary Selector Switch	Selects Band 1, Band 2, or Calibrate mode (against 3 MHz standard internal oscillator), as indicated on panel.
20	VARIABLE ATTENUATOR, BAND 2	Rotary, continuously variable attenuator	Variable attenuator, operational on Band 1 and Band 2; calibrated on Band 2 in DBM and microvolts - 20 db range. Effective on both input and output signals.
21	RADIO FREQUENCY OUTPUT CONNECTOR	BNC Receptacle	Output and input connector for all rf signals.
22 23 24	0 -20 db 0 -20 db 0 -20 db	Three step attenuator with 20 db switched in by each toggle switch	This attenuation is additive to calibrated DBM on Band 2. Effective on Band 1 and Band 2 on both input and output signals. NOTE Attenuators can be combined to obtain 20, 40, or 60 db of attenuation (X10, X100, or X1000).
25	VARIABLE ATTENUATOR, BAND 1	Rotary Step Attenuator	Step attenuation 0 to 60 db in 10 db steps. Effective only on Band 1 and only on output. NOTE For units up to serial No. 289: During operation on band 2, set this attenuator to -10 db and do not change. For units serial no. 290 and higher: On band 2, set this attenuator to 0 and do not change.

C. Rear Panel Switch, Connectors, and Fuses

A MODULATION switch is mounted on the rear panel. When set to Ext., it disables the internal audio modulator signal output.

Three BNC connectors are provided. J3 is used for injecting external modulation. J4 is an output connector for internally generated audio signal. J5 is a high-level (1 volt when loaded with 50 ohms) output connector for 1-10 MHz signal.

Line cord and fuse markings are self-explanatory.

NOTE

At the user's option, any one of three dc prime power input voltages may be selected. See Section 1, Specifications.

D. Test Signal Reference Frequency Output Jacks

On the left end of the 107B, a snap-out panel can be removed to expose six pin jacks which provide six test signal outputs. These are as follows:

Frequency	Approx. Waveform	Signal Level P-P Volts
100 Hz	Square	7.5-9.5
1000 Hz	Square	7.5-9.5
10 kHz	Square	7.5-9.5
100 kHz	Square	7.5-9.5
1 MHz	Sawtooth	Approx. 2.0
10 MHz	Sine	Approx. 0.3 *

* The 10 MHz output is available only when the 107B is set up for band 2 operation. Output impedance in all cases is approximately 50K ohms.

3-3 INITIAL OPERATION AND CHECKS

The following procedures cover energizing and preliminary checks that are desirable before using the equipment for frequency checking or signal generating functions.

A. Turn-On and Voltage Checks

Proceed as follows:

1. Connect the instrument to the selected primary power, ac or dc.

NOTE

When using power from a vehicle cigarette lighter (or equivalent) 107B chassis may be safely grounded to vehicle without danger.

2. Turn on prime power by rotating AF VOLUME control clockwise to actuate attached switch.

3. Turn VOLTS D.C. - VOLTS A.C. meter selector switch to REGULATED position. Meter should indicate approximately 10.5 volts dc. With dc power use, if there is no reading, power input polarity may be wrong. In the case of incorrect polarity, nothing happens, since the input circuit is diode-protected.

4. Turn selector switch to 1 MHz and 3 MHz oven settings, respectively. When unit has just been turned on, voltage read on these positions should be near 10.5 volts dc. As the ovens stabilize, the voltages will drop. After 30 to 45 minutes ovens will stabilize and each of the readings should be between 3 and 4 volts (in average ambient temperatures. With an ambient on the order of 30 degrees F, the voltages read may stabilize as high as 6 to 7 volts).

NOTE

Once the ovens have stabilized, current drain to keep them warm - from a vehicle or other supply - is negligible.

B. Phase-Lock Setting and Check

Proceed in the following steps:

1. Set meter function selector switch (VOLTS D.C. - VOLTS A.C.) to LOCK 10 kHz, and set BAND switch to (1) 10 kHz - 10 MHz.

2. Rotate the 10 kHz/Div. knob to the desired setting for a selected frequency. When the dial is set to a division mark, the UNLOCKED lamp for this dial should extinguish.

3. Rotate dial back and forth slightly (±0.3 division) and observe meter. Meter should indicate within green portion of scale.

Any setting within the green arc is satisfactory for phase lock if the UNLOCK lamp is extinguished. An unlock condition causes the UNLOCK lamp to light and the meter pointer to swing back and forth.

4. Set meter selector switch to LOCK 100 Hz.

5. Rotate 100 Hz/Div. knob to desired dial setting.

6. Check and set phase-lock in the same manner as described for 10 kHz/Div. dial (steps 1 through 3, above).

C. Calibration

NOTE

Do not attempt to calibrate the 107B in any manner until certain that both oscillator ovens have stabilized (oven voltages 3-4 volts dc).

When ovens are stabilized, proceed as follows:

1. Set BAND switch to calibrate 3.0 MHz.

2. Set FREQUENCY dials to 3 00 00 for 3.0 MHz.

3. Set meter selector switch to IF LEVEL position.

4. Using IF LEVEL rotary control, set IF level for a reading between 0.5 and 1.0 volts rms on the meter.

5. Set all attenuators for zero attenuation.

6. Confirm that the FM-AM (modulation) switch is centered for no modulation.

7. Set ERROR PPM dial toward +50 PPM, and increase AF VOLUME setting (clockwise) to a point where a beat note is heard in the speaker (or headphones if headphones are used).

8. Turn PPM dial to the red reference line marked CAL. 3 MHz.

9. To emphasize the rise and fall of the signal when approaching zero beat set the FM-AM toggle switch to AM and adjust internal modulation frequency to about 500 Hz on the MODULATOR frequency control.

10. Adjust the CALIB (calibrate) control trimmer for zero beat (or less than 1 Hz in three seconds). If desirable, the meter selector switch may be set to AF VOL and the audio level monitored on the meter.

NOTE

> Calibration to an external prime standard (such as WWV) is covered in a later paragraph.

3-4 OBTAINING SPECIFIC TEST SIGNALS AND TEST CONDITIONS

Following paragraphs describe how to obtain desired signal outputs (cw, AM, FM, etc.) and how to use the attenuator system to obtain specific signal levels.

A. CW (Unmodulated) Signal Output

To obtain an unmodulated signal between 10 kHz and 10 MHz, proceed in the following steps. It is assumed that the instrument has been turned on and warmed up in accordance with paragraph 3-3A.

1. Set all attenuators to zero.

2. Set BAND switch to (1) .

3. Set MODULATOR AM-FM switch to center position (no modulation).

4. Set up the desired frequency on the frequency dials as follows:

MHz dial	-	0 through 9 MHz, as required
10 kHz/Div. dial	-	First and second decimal values of desired frequency in MHz
100 Hz/Div. dial	-	Third and fourth decimal values of desired frequency in MHz

Example: 3.1837 MHz would set up as 3 18 37 on the three dials, respectively.

5. Set VOLTS DC, VOLTS AC meter selector switch to IF LEVEL.

6. Adjust IF LEVEL gain control for a reading of 0.5 to 1.0 volt.

Attenuation settings are discussed in a later paragraph. To set up a signal between 10 MHz and 1000 MHz, execute steps 1 and 3 above, and then set frequency dials as follows:

MHz dial	-	Significant unit digit only (see paragraph 3-2B)
10 kHz/Div. dial	-	First and second decimal values of desired frequency in MHz
100 Hz/Div. dial	-	Third and fourth decimal values of desired frequency in MHz

Example: 342.1865 MHz would set up as 2 18 65. (The 34 proceding 2.1865 is assumed.)

Set IF level to above 0.5 volt.

B. Amplitude-Modulated (AM) Signal

To obtain an AM signal, set up the basic unmodulated signal as described in paragraph 3-4A, above; then proceed as follows:

1. Set the rear-panel MODULATION switch to Int. (turns on internal audio modulation oscillator).

2. Set MODULATOR FM-AM switch to AM.

3. Adjust MODULATOR FREQUENCY, Hz x 10, and Hz FINE controls for the desired audio modulating frequency.

4. Adjust modulation to the desired level with the MODULATOR LEVEL control. This provides for internal modulation. For external modulation, perform steps 5 through 7.

5. Set rear-panel MODULATION switch to Ext.

6. Connect external audio source (50-10,000 Hz) to the rear-panel connector provided.

7. Adjust modulation level with the MODULATOR LEVEL control which is still active in this mode (or with external generator control).

C. Frequency-Modulated (FM) Signal

The procedure for setting up FM with internal modulation is the same as that described for AM, except that the FM-AM switch is set to FM. To change to external modulation execute steps 5, 6, and 7, above.

D. Output Level Adjustment (Use of Attenuators), Band 1

To attain any level of attenuation between 0 and 120 db (in 10 db steps) use the 0-60 db step attenuator (item 25 on figure 3-1) in conjunction with the three-stage attenuator made up of the three 20 db sections (items 22, 23, and 24, on figure 3-1). For values in between the 10 db steps, adjust the IF LEVEL, using the panel meter. A change from 1.0 volt to 0.3 volt is approximately 10 db. Refer to a db-vs-voltage table for intermediate values.

NOTE

The 0-60 db rotary step attenuator is effective only on output signals. On band 1, the three-stage toggle-switched group (20 db per stage) is effective on both input and output signals. (On SN 290 and higher, note that this applies to front panel output only.)

E. Output Level Adjustment (Attenuator Usage) Band 2

NOTE

For units up to SN 289, it is important that during band 2 operation, the band 1 0-60 db step attenuator is set to -10 db (and not disturbed). For units 290 and higher, set this attenuator to 0 db for band 2 operation.

Band 2 uses a combination of the three-stage toggle-switched 20-db elements (items 22, 23, 24, figure 3-1) and the continuously variable BAND 2 attenuator calibrated in microvolts and dbm (item 20, figure 3-1). Outputs may be adjusted in db increments or in voltage levels.

After setting the IF LEVEL above 0.5 volt, attain any value of attenuation between 0 and 130 db using the three-stage toggle-switched elements in conjunction with the 0-70 dbm continuously variable attenuator. These readings are additive.

If a voltage reading is desired, set all the three toggle switches to -20 db and read the variable attenuator scale directly in microvolts. If the toggle switches are all set to 0 db, the variable attenuator scale will read directly in millivolts (60 db = a 1000:1 voltage ratio). The three toggle-switched elements and the variable attenuator are effective on both input and output signals.

3-5 CHECKING TRANSMITTER FREQUENCIES

A. General Considerations

The particular method used in picking up a transmitter signal for frequency measurement will depend upon a number of factors such as transmitter power, frequency band used (propagation characteristics and obstacles), transmitter location accessibility, practical location of 107B for needed checks, the proximity of potential interference sources such as AM or FM broadcast stations, etc.

In many cases, satisfactory pickup will be possible using the telescoping 40-inch whip-type antenna supplied with the 107B. At times it may be more effective to set up a quarter-wave whip (for the checking frequency) and feed it via nominal 50-ohm coaxial line to the 107B. This usually minimizes interference from AM or FM broadcast stations while providing more checking signal.

When using the telescoping antenna at the 107B input and working in the 450 MHz band, the antenna set to a quarter-wave is quite short and may be subject to shielding by the 107B handle and chassis. This is another case where use of a higher quarter-wave antenna and a 50-ohm transmission line is desirable.

The best way of obtaining desired signal pickup in your particular operational area will be found with practice, using the above considerations as a guide.

Another way of making frequency checks, when it is difficult to get the 107B close to the transmitter under check, is to use a remote speaker or headphones with a suitable long connecting cord. Any speaker from 8 to 50 ohms impedance or any headphones up to 2000 ohms may be used effectively when plugged into the 107B headphone jack.

The sensitivity of the broadband detector in the 107B is sufficient to monitor transmitters located in the adjacent area. In the case of high power broadcast transmitters this may be as much as 1 to 5 miles away, again depending upon frequency, power, etc., and the antenna configuration at both ends of the path.

A separate receiver can be used with the 107B for checking distant transmitters within the receiver's solid reception range. This is done by beating the transmitter signal against the 107B reference signal in the receiver. If the receiver beat/frequency oscillator (BFO) is set a few hundred cycles away from the transmitter frequency, it will provide an audio tone which will enhance aural or visual (on 107B panel meter) detection of zero beat. Any transmitter within solid receiving range of the receiver can be checked using this method.

Before starting to check frequencies, be sure to read paragraph 3-2 with its associated illustration and table explaining the 107B controls and indicators.

B. Transmitter Frequency Tolerances

Transmitter frequency tolerance formerly was specified in the station license, issued by the FCC and posted in the station. The tolerance was shown as 0.01% or 0.005%, or as applicable. More recently, the frequency tolerance may not be shown in the license - only the class of service in which the station is to operate, and an emission designator which specifies the type of modulation to be used. In such case, one then must go to the FCC Rules and Regulations to find the transmitter tolerance. For instance, in Industrial Radio Services, 50 to 450 MHz, frequency tolerance is 0.0005% per FCC Rules and Regulations, paragraph 91.102. Another example is Public Safety Service, paragraph 89.103: for frequencies 450 to 470 MHz the transmitter frequency tolerance is 0.00025% or 2.5 parts per million (PPM), for transmitters of above 3 watts.

Frequency readout on the 107B is in parts-per-million (PPM) for a very particular reason. The FCC station frequency tolerance almost always is stated in percent - for instance, 0.0005 percent is equal to 5 parts per million. Therefore - whenever the transmitter frequency measures less than 5 PPM deviation on the ERROR PPM dial, either plus or minus, the carrier frequency is within tolerance. There is no need to do calculations of any kind. In contrast, suppose the assigned transmitter frequency is 157.530 MHz, and it is measured on a counter at 157.529447 MHz. Since the measured frequency is less than the assigned frequency, the transmitter deviation is minus. The difference between assigned and measured frequencies is:

157.530,000 MHz assigned
<u>157.529,447 MHz measured</u>
.000 553 MHz deviation, or -553 Hz

The percentage deviation is 553 Hz divided by the assigned frequency, thus:

$$\frac{553 \text{ Hz} \times 100}{157{,}530{,}000 \text{ Hz}} = 0.00035\%, \text{ or } 3.5 \text{ PPM}$$

which is within tolerance. <u>Calculations such as these are unnecessary with the 107B and one can readily see the convenience of a dial reading directly in PPM</u>.

C. Frequency Measurement

When arrangements have been made for satisfactory signal pickup from a transmitter, its frequency may be measured.

NOTE

> If the transmitter to be measured incorporates tone-squelch, read paragraph D before proceeding with the following check.

To check transmitter frequency proceed in the following steps:

1. Set the BAND switch to the proper band for the frequency of the transmitter to be checked and set up FREQUENCY dials to the transmitters assigned operating frequency (see paragraph 3-2).

2. Set the AF VOLUME control at 1/4 to 1/2 full-scale setting.

3. Adjust attenuators (as required for band 1 or band 2) and antenna to obtain satisfactory monitoring signal from transmitter under check (generally the loudest beat note without overdriving the 107B audio amplifier).

4. With transmitter keyed on, tune ERROR PPM control for zero beat.

5. Observe deviation in parts-per-million from transmitter-assigned frequency directly on ERROR PPM dial.

NOTE

> Since the 107B is a precision instrument, its measurements are applicable mainly to transmitters with stable crystal-controlled quality signals. Unstable exciters and transmitters do not lend themselves to precise frequency measurement, since they are not continuously on one specific frequency.

D. Tone-Squelch Transmitters

A transmitter operating in an FM tone-squelch system preferably should have its squelch tone signal disabled before any attempt is made to measure the transmitter's frequency. This is because beats from the squelch-tone-generated multiple side-bands tend to mask the beat note of the basic carrier during frequency measurement. However, if it is not possible to disable the squelch tone, frequency measurement can still be accomplished with the 107B. To accomplish this, modify the procedure of paragraph C, above.

After step 3, proceed as follows:

4. With the meter selector switch set to AF VOL., set the AF VOLUME control for a full-scale (or slightly over full-scale) reading on the 0-1.5 volts ac black scale.

5. As the ERROR PPM dial is turned through the carrier zero beat area, the voltmeter will indicate a null.

6. Press the AF NULL button near the phone jack. This will cause the null to be much sharper.

Using this null, together with the aural null observed by ear, it will be possible to zero beat the carrier frequency for the required check.

3-6 CHECKING RECEIVERS

As indicated in the specifications, the 107B provides not only precise digital frequency settings, but also accurately calibrated output levels, AM and FM at frequencies from 50 to 6000 Hz (at various levels), and accurately set audio tones for either modulation or other test output. This combination of capabilities provides for almost any periodical or initial quality check required for FM or AM (or CW) receivers. For example, in addition to regular rf signal input (modulated or unmodulated), accurate tone modulation can be set up for checking tone-squelch response in receivers designed for this type of operation. Various types of receiver tests are discussed in following paragraphs.

CAUTION

> When making tests on the receiver section of a transceiver, DISABLE the transmitter keying function in some reliable manner. Keying the transmitter during receiver tests could cause serious damage to the 107B.

A. Local Oscillator and IF Characteristic Checks

The local oscillator center frequency of a mobile FM receiver is easily checked with the 107B by dialing in the assigned center frequency and observing receiver output.

IF bandwidth characteristics are also easy to measure - working from the receiver front end. Figure 3-2 shows the bandwidth pattern usually desired, a nearly flat top with steep sides 60 or 100 db (or more) down at the base. To check, proceed as follows:

1. Set the receiver output level to just below limiting - that is - the point where noise first appears in the output - or where squelch cuts in at low level.

2. Increase the signal level by 20 db (one toggle switch).

3. Turn the ERROR PPM dial first in the positive direction and then in the negative direction.

4. Note the PPM reading when the noise first appears (or the squelch cuts in) as shown at B and C. The true center is one-half the difference between the positive and negative readings, and the IF bandwidth is the sum of the readings multiplied by the assigned frequency.

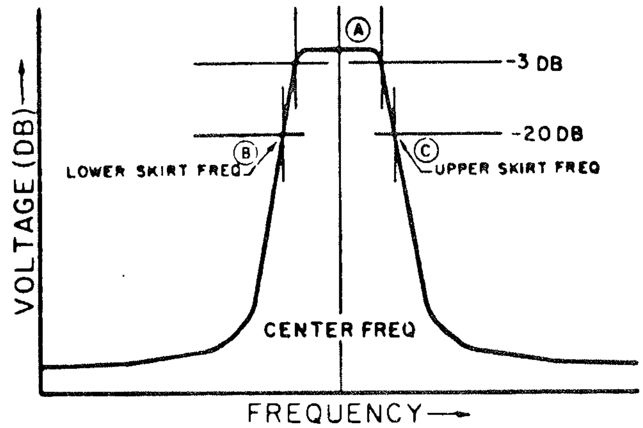


Figure 3-2. Typical IF Pass Band Characteristic

B. Discriminator Centering and Linearity Checks

To perform a discriminator centering and linearity check, proceed as follows.

1. Set the 107B to the receiver's assigned center frequency for output with no modulation.

2. Adjust signal level for suitable discriminator monitoring.

3. Balance the discriminator until its output is within tolerance.

4. Check linearity by tuning the 107B up and down about 5 kHz (PPM dial or 100 Hz/Div.) and noting any discriminator imbalance that still exists. If the positive and negative readings are not equal in absolute value, the discriminator can be rebalanced by switching on 107B frequency modulation.

C. Sensitivity Checks

To check receiver sensitivity, dial the receiver center frequency on the 107B and use the manufacturer's recommended test levels for checking (for example: 20 db quieting, minimum discernible signal, 12 db SINAD, etc.) to a standard output level, as applicable.

On band 2 (10 MHz to 1000 MHz) sensitivity in microvolts can be read directly on the BAND 2 continuously variable attenuator, when the three-stage (toggle-switched) attenuator group is set toward the side marked uV X1. (The three toggle switches thrown to -20 db each.) Note that the 107B will exhibit no carrier shift when you adjust FM or change attenuator settings.

If the receiver operates on tone squelch, the 107B will generate the proper frequency for modulating its rf output signal. (See paragraph 3-7).

3-7 CALIBRATION OF 107B TO WWV (OR OTHER PRIME STANDARD)

To check the 107B against a prime standard, such as WWV or WWVB, proceed in the following steps.

1. Turn on and warm up a short wave receiver capable of receiving WWV or other prime standard station.

NOTE

> This procedure assumes the use of WWV or WWVB. For any other prime standard station, merely make a 107B frequency setting suited to the station.

2. Set the 107B FREQUENCY dials for a reading of 2 50 00.

3. Set BAND switch to band 1 or band 2 (NOT on CALIBRATE).

4. If necessary, arrange for coupling signal (via a piece of wire) from the 107B output BNC connector of the 107B to the antenna input of the receiver.

5. Tune in WWV or WWVB on 2.5, 5, 10, 15, 20 MHz, etc., as suitable for good reception in your location.

6. Offset the ERROR PPM dial to generate an audible beat with WWV or WWVB in the receiver.

7. Adjust the 107B output to obtain loudest beat note.

8. Set ERROR PPM dial to 00. During a period of no modulation on WWV or WWVB, a low flutter beat should be heard between the 107B signal and the prime standard signal.

9. Adjust the ERROR PPM CALIB control to obtain best zero beat (anything less than 1 Hz in 2 to 3 seconds).

10. After attaining the best zero beat practicable in this manner, listen to WWV or WWVB when tone modulation returns. This permits easier identification of the beat flutter on the audio tone. The same effect can be obtained by turning on modulation for the 107B output. To turn on 107B modulation, set the FM AM toggle switch to AM, set the MODULATOR frequency controls for desired audio tone, and set LEVEL for a suitable intensity as monitored in the receiver.

When a good zero beat has been attained, the 1 MHz synthesizing source oscillator is calibrated. Next, check the 3 MHz internal standard oscillator, using the following steps.

11. Set the BAND switch to CALIBRATE 3 MHz.

12. Set the FREQUENCY dials to 3 00 00.

13. Set the meter selector switch to IF LEVEL, and adjust the IF LEVEL control for a reading of 0.5 to 1.0 volt on the meter.

14. Set all attenuators to zero attenuation.

NOTE

In the next step do NOT touch the CALIB control. Use only the main PPM dial.

15. Turn the PPM dial for zero beat against the 3 MHz internal standard signal. A zero beat should occur at the red-line calibration mark.

If the internal 3 MHz standard appears to be in error by 0.1 or 0.2 of a dial division, make a note of the condition with date of check. Try the check again a week or two later. It should be noted that the frequency accuracy of the WWV high-frequency transmissions, as received in different parts of the country, can be off as much as 0.2 or 0.3 of a part per million, due to instabilities in the transmission medium. The received accuracy is worst when there is heavy fading; also when there is sunrise or sunset between the receiving location and the WWV location at Ft. Collins, Colorado. The received accuracy is best when the signal is free of fading, and it is all sunlight, or all dark, between the two locations. Under good conditions the received accuracy can be better than one part in 10^8 (0.01 PPM).

The red calibrator line on the PPM dial, at 3.00 MHz, is drawn on a plastic disc overlay. Should the internal calibrator crystal age over a period of time, say six to twelve months, and the calibrator line show a consistent error of 0.2 division or more, the plastic overlay disc can be slipped to coincide with the new reading. The change is made by removing the knob from the PPM dial shaft, which will expose a lock screw on the PPM dial which holds the plastic overlay disc. After loosening the lock screw, the plastic overlay can be slipped to the new reading, and relocked in position.

3-8 ACCURATE CALIBRATION OF AUDIO FREQUENCIES

The frequency calibration (figure 3-1, 16, 17, 18) of the 107B internal audio modulating oscillator is ±15 percent. However, the 107B provides for the setting or checking of audio frequencies to within 1 Hz. An accurately measurable audio tone can be generated by beating the 3 MHz (internal reference standard) oscillator against a 107B synthesized signal at a frequency close to 3 MHz to obtain a difference audio signal. This measured audio tone can then be compared with the modulation audio (either internal or from an external source). For example, if an audio modulation tone of 135.6 Hz is desired, it can be developed using the following procedure.

1. **Set the BAND switch to CALIBRATE 3.0 MHz.**

2. **Set the FREQUENCY dials for 3 00 00.**

3. Adjust the CALIB trimmer (near ERROR PPM dial) for a zero beat when the ERROR PPM dial is set at the red CAL line.

4. Change the FREQUENCY dials to 3. 00 01. This generates a 100 Hz difference which is 35.6 Hz away from the desired comparison tone. The 35.6 Hz can be added, using the PPM dial.

Because the synthesized beat frequency is being generated at 3.00 MHz a PPM dial division equals 3 Hz. 35.6 Hz is equal to $\frac{35.6}{3}$ or 11.9 parts-per-million (PPM).

Thus, setting the PPM dial 11.9 divisions higher (clockwise) than the red line will bring the beat frequency to the desired value of 135.6 Hz.

5. Confirm that the rear-panel modulation switch is set for internal modulation.

6. Set the MODULATOR FREQUENCY Hz x 10 to x 1.

7. Set MODULATOR FREQUENCY rotary control to 136 on the panel scale.

8. Set FM AM switch to AM.

9. Set meter-selector switch to AF VOL.

10. Advance the MODULATION LEVEL and AF VOLUME controls to obtain a tone in the speaker.

With the modulation frequency and the synthesized audio frequency both present, a beat will be heard and also observed on the front panel meter.

11. Adjust the MODULATOR FREQUENCY and Hz FINE controls to bring this beat to zero.

When this setting is made, the modulation frequency will be 135.6 Hz. The same method can be used to check an external audio source, by switching to external modulation. This method is good up to about 4000 Hz or more simply by adding steps of 100 Hz on the 100 Hz/Div. dial and finishing adjustment with the PPM dial, with an accuracy within 1 Hz.

SECTION 4
PRINCIPLES OF OPERATION

4-1 INTRODUCTION

This section provides an explanation of the circuit operation in the Lampkin Type 107B Digital Frequency Meter/Generator:

1. So that the user may be thoroughly familiar with the instrument for most efficient application.

2. So that the user may accomplish maintenance with a minimum of lost time.

NOTE

For information on the method of assigning reference designations, refer to the REFERENCE DESIGNATION paragraph following the Introduction in Section 6.

The basic operation of the 107B circuitry is described in Section 1, paragraph 1-20. Read this explanation before proceeding with the contents of this section. The schematic diagrams referenced in this section are located in Section 7, DIAGRAMS.

For the flow of the following explanation, refer to the overall schematic diagram in combination with individual subassembly schematics referenced in following paragraphs. Figure 7-1 is the overall schematic diagram. Since the general operation of the 107B was covered in Section 1, this section deals with the more detailed operation of individual circuits represented by blocks and other circuitry indicated in the overall schematic diagram.

4-2 1 MHz VARIABLE CRYSTAL OSCILLATOR (VXO) AND OVEN, A14

Refer to figure 7-15, the VXO schematic diagram. A silicon transistor is used in an oscillator circuit design for extreme stability in a temperature controlled oven. Note that three variable capacitors C1, C2, and C3 are connected in combination across the crystal, capacitor C1 is the PPM (parts per million) front panel control. Capacitor C2 is the front panel CALIB (calibrate) control. Capacitor C4 is an internal element used to set up the range of the PPM control. Fixed capacitors are included for padding and temperature compensation, respectively. The slug-tuned coil L1 provides an internal calibration adjustment which is normally set at the factory. The PPM control range is ±50.

The VXO is mounted in a temperature-controlled oven. Refer to figure 7-22, the oven-control schematic diagram. Transistor Q1, transformer T1, and related circuit elements make up a bridge type oscillator. The temperature sensor thermistor is inserted in a bridge leg in such a manner that as it senses higher temperature, the amplitude of the oscillations change. Since the oscillator output is used to develop control bias for the amplifiers driving the oven heater, temperature control is accomplished. The oven temperature is controlled in the vicinity of 55°C (about 130°F) within a fraction of a degree, once the oven has warmed up and stabilized.

Adjustment to the desired control temperature is made at the factory by selection of R1 and R2 values. Once set, it needs no further adjustment.

4-3 SCHMITT TRIGGER, A17

The Schmitt Trigger circuit is a device to obtain an essentially square wave output from the 1 MHz sinusoidal output from the VXO. This provides the rich harmonic content needed to develop the various synthesized signals for 107B functions. Referring to schematic diagram figure 7-18, Q1 and Q2 are the actual Schmitt Trigger. Emitter followers Q3 and Q4 provide the outputs indicated on the schematic diagram. As shown, one output is used to drive a frequency divider, one output drives a harmonic selector, one drives a 10 MHz multiplier, and one output is fed to a test signal output jack. Output waveforms and the test signal output voltage are indicated on the schematic diagram. Refer to figure 7-1 for paths of these outputs. For frequency modulation purposes (when it is required) a signal is received from the AM-FM oscillator (modulator) A13 and introduced to the Schmitt Trigger input via terminal 9.

4-4 HARMONIC SELECTOR AND BAND TUNER A1

The A1 circuit board includes two separate but related functions. They are (1) the harmonic selector made up of Q3, switched tuning circuits, and an output FET source follower Q4; and (2) the band tuner made up of Q1, tuned collector tanks for Q1, and the output FET source follower Q2. The switching of these two circuits occurs simultaneously, so that their functions are properly interrelated as a particular MHz setting is selected on the front-panel MHz switch. Operation of these circuits is described in following subparagraphs.

A. Harmonic Selector

Referring to schematic diagram, figure 7-2, the 1 MHz square wave is received from the Schmitt Trigger A17 at terminal 2 and applied across the tuned tank L1 and C7 to the base of amplifier Q3. The output of Q3 and the input circuit of FET output amplifier Q4 are simultaneously switched to the proper tuned circuit for selection of the desired harmonic of 1 MHz, in each switch position, as applicable. In the 1 MHz position, the harmonic selector is inoperative, since the harmonic selector does not contribute to 107B output in the 1 MHz switch position. In the 0 position of the MHz switch, the same 2 MHz selective coils are used as for the 2 MHz setting. The lower side-band is taken from Double Balanced Mixer A5 (to be described) and applied to output terminal 7 from the Q4 source. In all remaining switch positions, the upper side band is used.

B. Band Tuner

The band tuner includes tuned amplifier Q1 - with selectable collector tuned tanks - and FET source follower Q2. In the 0 position, the switch shorts the Q1 base and emitter and this circuit is inoperative. In the 1 MHz position, the switch applies signal received from the Upper Sideband Tuner (A8) via a strapped-through connection in the DBM A5. Operation of these circuits is explained later. In the 2-8 MHz settings, selected outputs are received from the DBM A5 as developed from its signal inputs. As shown in the schematic, switch S1 sections B and C select the various tuned tanks for the Q1 collector circuit. Section A selects input to take care of the special requirements for the 0 and 1 MHz settings. Band tuner output is applied to output terminal 4 from the Q2 source.

4-5 DECADE FREQUENCY DIVIDERS A18

As shown on the block and interconnection diagram, figure 7-1, the Schmitt Trigger A17 provides drive for a decade frequency divider A18. Referring to figure 7-19, the A18 schematic diagram, the 1 MHz square wave from A17 is introduced at terminal 2 and drives a series of IC frequency divider elements, ICs 4, 3, 2, and 1. The frequency division logic is complete in each IC for its particular division function. The remainder of the circuitry is to pick off the required outputs and provide extra drive power where needed. Emitter followers Q1 and Q2 provide additional power for the 100 Hz and 10 kHz outputs, respectively, which are used as reference frequencies for phase-lock of variable frequency oscillators A7 and A2, respectively. Signal output terminals, waveforms, and pertinent signal voltages are indicated on the schematic diagram.

4-6 10 MHz MULTIPLIER A16

Referring to the block and interconnection diagram, figure 7-1, it will be noted that one output from the Schmitt Trigger A17 is used to drive a 10 MHz multiplier, A16. See figure 7-17, the 10 MHz multiplier schematic diagram. 1 MHz square wave signal is received from the Schmitt Trigger A17, and applied via input terminal 2 to amplifier Q3. Q3 and Q1 are both tuned stages to accentuate the 10 MHz component of the input signal. The tanks L2 and L3 in their respective collector circuits are both tuned to 10 MHz. Emitter follower Q2 provides power for driving a harmonic generator (p/o A20). The 10.8 volt supply to the multiplier is switched on only during use of band 2.

4-7 0.97-TO-1.96 MHz OSCILLATOR (VCO) AND RELATED CIRCUITS

In the block and interconnection diagram figure 7-1, note that A2 is a voltage controlled oscillator (VCO) and that associated with it are phase discriminator A3, beat-frequency detector and sweeper A4, and lamp lighter A6. This group of circuit elements, working from a 10 kHz reference signal from frequency divider A18, develop a 0.97-to-1.96 MHz signal that is manually adjustable over this range in phase-locked 10 kHz increments. This is done as follows.

The VCO is brought within a few kHz of a desired frequency by manual setting of the 10 kHz/Div. dial on the 107B front panel. When this occurs the beat frequency detector will generate a beat signal between the VCO frequency and the nearest harmonic of the 10 kHz input. This beat note is used to trigger a sweep generator which applies a sweeping voltage (approximately one sweep per second) that will sweep the VCO frequency sufficiently to bring it within the "capture" range of the phase discriminator A3. Once this occurs, the phase discriminator will apply a dc control voltage to bring the oscillator toward a phase lock condition with the 10 kHz reference signal. This will result in zero beat in the beat frequency detector and the absence of a beat signal will disable the sweep oscillator. The VCO is then in a phase-locked condition. This extinguishes a panel lamp which is lighted when the sweep is activated.

The "lock voltmeter" circuit which is part of A3 is a device for feeding dc sweep voltage to the panel meter in the LOCK 10 KHz setting. While the sweep is operative, the meter pointer will follow the sweep voltage. When phase-lock occurs, the meter pointer stops sweeping. Details of these individual circuit operations are given in following paragraphs.

A. Variable Frequency Oscillator A2

Refer to the schematic diagram for A2, figure 7-3. Transistor Q1 and its related circuit elements make up the actual oscillator circuit. This includes the two varicap diodes D1 and D2 which vary in capacity as a varying sweep voltage is applied to them, and also respond to the "capture" control voltage of the phase discriminator A3. Main frequency selection over the oscillator operating range of 0.97 to 1.96 MHz is done by the front panel (10 KHz/Div. control) capacitor with its trimmer and temperature compensation - shown in dotted lines at the top of the schematic. Q2 is an FET follower which provides driving power and impedance matching for signal transmission and mixing in the balanced mixer which is part of A7. The series combination of L2 and C6 provides equalization to minimize variation of oscillator signal amplitude over its frequency range. Variable capacitor C4 is used to set up the oscillator's basic operating range.

B. Phase Discriminator A3

Refer to the schematic diagram, figure 7-4. Transistor Q2, discriminator transformer T1, diodes D1 and D2, and associated resistors and capacitors make up the actual discriminator circuit. A 10 kHz reference signal is brought in at terminal 2 and fed through amplifier Q3. A higher level signal (of two collector outputs) is transmitted via terminal 1 to the beat-frequency detector A4 for comparison with the VCO output also present in the detector. A lower level output is connected to the discriminator transformer secondary for comparison of the nearest 10 kHz harmonic with the VCO. When a difference exists, the rectifiers and filter network will produce a dc error voltage which is transmitted to VCO A2 via terminal 7. This output works against a dc reference bias received from a voltage divider and zener diode network. FET transistor Q1 is a dual gate voltage amplifier to provide an amplified dc for operation of the front-panel meter lock indication. It responds to whatever voltage is present at terminal 7. This is a sweep voltage when the oscillator is not locked in and a steady voltage when the oscillator is phase-locked. Variable resistor R16 provides zero setting for the panel meter in this function (LOCK 10 KHz).

C. Beat Frequency Detector and Sweeper A4

Refer to the schematic diagram, figure 7-5. A 10 kHz input is received on terminal 1 from the frequency divider A18 (via an input peaking amplifier on A3) and the VCO input is received at terminal 2 from VCO A2. These two signals are combined in the beat frequency detector, diode D1, and the resultant output fed through an active low-pass filter which includes amplifier IC 1. Further amplification is provided by IC 2, after which the signal is rectified by diode D2, and applied as a triggering bias to the unijunction relaxation oscillator Q1. Q1 operates at a frequency of approximately 1 Hz whenever the signal from the beat frequency detector causes development of the dc triggering bias. In turn, the Q1 output triggers the flip-flop made up of Q2 and Q3 with associated circuitry. The flip-flop follows the 1 Hz timing of the relaxation oscillator and generates the sweep voltage waveform shown on the schematic diagram. This sweep voltage is transmitted via terminal 3 to the VCO.

D. Dual Lamp Lighter and 3 MHz Amplifier A6

Refer to the schematic diagram, figure 7-7. The dual lamp-lighter is in the top portion of the diagram and consists of four transistors, two diodes, and associated circuitry. There are actually two lamp-lighter circuits, one for the 0.97-to-1.96 MHz oscillator unlock indication, and the other for the 30.0 kHz-to-39.9 kHz oscillator unlock indication. For the 0.97-to-1.96 MHz oscillator, a beat frequency signal is received from A4 via terminal 5. The signal is rectified by diode D1 and applied as control bias to turn on amplifiers Q3 and Q4. These, in turn, light the associated front panel UNLOCKED lamp for the 10 KHz/Div. dial function. When the 0.97-1.96 MHz VCO phase-locks with a suitable 10 kHz harmonic, the beat frequency disappears, the two transistors are cut off, and the lamp extinguishes to indicate a locked condition. The diode D3 provides some fixed bias to enhance operation of the two-transistor Darlington arrangement.

On the lower portion of the schematic diagram, a 3 MHz amplifier is shown which is used to amplify the output of the 3 MHz standard reference oscillator A15 (oven and oscillator). The reference oscillator output is received at terminal 10 and amplified through Q1 and Q2. The collector circuit is tuned to 3 MHz by L1 and C4. Input voltage at terminal 10 is 8 millivolts nominal. Output from Q2 at terminal 7 is 150 millivolts nominal. This amplifier is used to obtain a suitable signal level for heterodyne use in the A20 beat frequency detector. This is the detector used for frequency measuring and calibration.

4-8 30.0-to-39.9 kHz OSCILLATOR (VCO) AND RELATED CIRCUITS

Refer to the block and interconnection diagram, figure 7-1. The 39.0-to-39.9 kHz VCO, phase discriminator A9, and related beat frequency detector, etc., perform in a manner similar to that described for the 0.97-to-1.96 MHz oscillator A2. The main difference is that this VCO locks into a 100 Hz reference signal (rather than 10 kHz) and is manually tunable from 39.0-to-39.9 kHz in 100 Hz increments. The mixing of functions in circuitry on the boards is somewhat different in this group, and is explained in the following subparagraphs.

A. Variable Frequency Oscillator, Mixer, and LSB Trap (Ref) A7

Refer to the schematic diagram, figure 7-8. The 39.0-to-39.9 kHz oscillator circuit uses a Clapp configuration and consists of transistor Q1, and external tank coil mounted near the related front-panel tuning capacitors (shown dotted near bottom of diagram), tunable voltage variable capacitors D1 and D2, and associated resistors and capacitors. Aside from the frequency differences, operation of this VCO is similar to that of VCO A2. Sweep or phase correction voltage is received via input terminal 4 and applied to the two voltage-variable capacitors. Output from this VCO is fed through an adjustable coupling capacitor to FET source follower, Q2. The output from Q2 is applied to the front panel IF LEVEL gain control and thence to the balanced mixer consisting of transformer T1 and diodes D3 and D4. Output from FET Q2 is also applied via terminal 5 to the phase discriminator (part of A9) for phase lock with harmonics of a 100 Hz input.

Input from the 0.97-to-1.96 MHz oscillator is received via input terminal 19, amplified by Q1, and mixed with the 30.0-to-39.9 kHz VCO signal in the T1, D1, D2 mixer. Trimpot R9 is a balance adjustment. The upper and lower sidebands of this process are transmitted via output terminal 8. A tunable series-resonant lower-sideband trap which tracks with other tuning capacitors attenuates the lower sideband (LSB) and the remaining upper sideband signal is transmitted to double-balanced-mixer A5 for further application in the 107B frequency-synthesizing process.

B. Sweeper and USB Tuner A8

Refer to the block and interconnection diagram figure 7-1. The 1 Hz sweeper which sweeps the 30.0-to-39.9 kHz oscillator A7 is part of the A8 board. The remainder of A8 is an upper-side-band (USB) tuner which is a manually tuned circuit for selecting the USB output of the A7 mixer described in paragraph A, above.

Refer to the schematic diagram for A8, figure 7-9. Operation of the sweeper is essentially the same as that described for the A4 sweeper in paragraph 4-7C. Signal received from the beat frequency detector A10 is received at input terminal 8. It is rectified by diode D1 and becomes the triggering bias for the 1 Hz relaxation oscillator Q3. Signal from Q3 triggers the flip-flop Q4-Q5 which generates the desired sweep. The sweep output at terminal 9 is applied to the VCO A7 voltage-tuned capacitors which, in turn, sweep the VCO frequency whenever a beat-frequency-detector signal of sufficient amplitude is present at input terminal 8 of the sweeper.

The upper side-band tuner is on the left end of the schematic diagram. It consists of amplifier Q2 and a tuned circuit which is part of the tuning system controlled by the front panel 10 KHz/Div. dial. Output from tuned amplifier Q2 drives FET source follower Q1. From the source follower, signal is fed via output terminal 5 to double-balanced mixer A5 for further processing.

C. 30.0-to-39.9 KHz Phase Discriminator, Pulser, and Lock Voltmeter, A9

Refer to the A9 schematic diagram, figure 7-10. Although the circuitry differs somewhat, the operation is similar to that given for A3 in paragraph 4-7B. Pulse amplifier Q1 receives 100 Hz signal from frequency divider A18 and provides a high level signal, through output terminal 3, to the associated beat frequency detector A10, and a low level signal to the discriminator, Q3 and network. In this case, a balanced resistor/capacitor/diode circuit is used (instead of transformer, diodes, etc. as in A3) for the discriminator, but basic operation is the same. Signal from the VCO A7 is received via input terminal 5 and phase-compared with the nearest harmonic of 100 Hz from amplifier Q1. A dc error (lock) voltage is developed and applied via terminal 7 to the VCO A7 to drive it to phase-lock. The lock voltmeter circuit Q2 and associated circuitry work in the same manner as that described for the 0.97-to-1.96 MHz lock voltmeter (paragraph 4-7B). when its output is selected for display on the panel meter by the meter selector switch.

D. Beat Frequency Detector and 5-to-50 Hz Amplifier, A10

Refer to the schematic diagram for A10, Figure 7-11. The A10 beat frequency detector operates in essentially the same manner as the A4 beat frequency detector (paragraph 4-7C). Its audio amplifier differs in circuitry but accomplishes a similar function. A 100 Hz pulse signal is received from frequency divider A18 via an A9 pulse amplifier and input terminal 1. The signal output from the 30.0-to-39.9 kHz VCO A7 is brought in through input terminal 2 and mixed with the 100 Hz signal in diode detector D1. When a beat note results, it is amplified by the Q1 through Q5 combination which includes a filter favoring frequencies from 5 to 50 Hz. The filtered beat signal output is transmitted via terminal 7 for two applications, (1) to turn on the 1 Hz sweeper (part of A8), and (2) to operate the lamp lighter (part of A6). When a beat signal is present, the lamp lighter turns on the 100 Hz/Div. UNLOCKED lamp. The lamp extinguishes when the VCO A7 achieves a phase-lock condition, and no beat frequency is generated in the D1 detector.

E. Dual Lamp Lighter and 3 MHz Amplifier, A6

The A6 circuit board operation was described earlier in paragraph 4-7D for its operation in connection with the 0.97-to-1.96 MHz VCO. The lamp lighter used in this 30.0-to-39.9 kHz VCO operation is the right-hand half of the lamp lighter circuit in the upper portion of the diagram (figure 7-7). Beat frequency input is received at terminal 1. Lamp driver output is transmitted to the 100 Hz/Div. UNLOCK lamp through output terminal 3.

4-9 DOUBLE-BALANCED MIXER (DBM) A5

Refer to the block and interconnection diagram, figure 7-1. The USB tuner (p/o A8) was described in paragraph 4-8B. Its signal is derived from the USB portion of the signal mixture of VCO A7 and VCO A2 outputs in the balanced mixer p/o A7. It is a signal that can be adjusted between 1 MHz and 1.999 MHz (referred to hereafter as 1-2 MHz) and is used to mix with the output of the harmonic selector A1 in the 107B frequency synthesizing process.

Refer to the A5 schematic diagram, figure 7-6. A selected 1 MHz harmonic (1-8 MHz) is received via terminal 1 from the harmonic selector (p/o A1). Through amplifier Q2, it is fed to the mixer made up of balanced transformer T1 and associated balance control R5, diode bridge D1 through D4, and balanced transformer T1. The 1-2 MHz tunable input to the mixer is received from the USB tuner (p/o A8) via input terminal 10, amplified by Q1, and applied to the mixer. The result of this mixture (plus selection of the proper harmonic in the harmonic selector) is an output signal that may be set for any frequency up to 10 MHz. The 1-10 MHz signal is transmitted via output terminal 17 to the band tuner (p/o A1) where it is applied to taps 2 through 8 on the band-select switch, section A. Essentially, the same signal is sent through terminal 5 to an external low-pass filter, then returned to mixer board A5 for transmittal via output terminal 13. Because of the 1 MHz low-pass filter, this signal may be adjusted only to values up to 1 MHz. It is transmitted via terminal 13 to the band tuner (p/o A1) and connected to tap 0 of the tuner's band switch, section B. The frequencies from 0 to 1 MHz are selected in the 0 position of the band switch. The 1-2 MHz signal mentioned earlier is received on input terminal 10 and fed through a resistor capacitor isolation network to output terminal 19. These selectable frequencies are for band 1 and are transmitted to tap 1 of the USB tuner band switch section A.

4-10 ATTENUATOR AND IF METERING, A19

Refer to the block and interconnection diagram, figure 7-1. Output (designated IF) from the band tuner (p/o A1) is transmitted to the Attenuator and IF Metering card A19. A19 contains provisions for connecting into the 60 db (10 db steps) front panel attenuator, a meter drive circuit, some provision for amplitude modulation injection, and drive arrangements for following circuitry. Refer to the A19 schematic diagram, figure 7-20. IF output from the band tuner (p/o A1) is received via input terminal 7 and transmitted along two paths, (1) to the emitter follower Q1 which drives a meter circuit, and (2) to terminal 6 for transmission to an external attenuator. Regarding the first path, the emitter follower Q1 output drives a bridge rectifier. DC output from the rectifiers D1 through D4 activates the front panel meter to indicate IF level setting when the panel meter select switch is set to IF LEVEL. The thermistor across the meter is inserted to compensate for diode thermal characteristics. In the second path, the signal transmitted via terminal 6 goes to the front panel 60 db attentuator (in ten db steps) and returns via input terminal 8. This signal is amplified by the dual-gate FET, Q2, which drives a complementary emitter follower circuit (Q3, Q4). The second gate of Q2 is used to introduce amplitude modulation on Band 1 in certain 107B models. (On other models AM is introduced later in the diode attenuator for both bands 1 and 2.) The diodes D5 and D6 establish an operating and stabilizing bias for the emitter-followers Q3, Q4. L1 with R1 is an equalizing input network. Output from the emitter-follower circuit is transmitted via terminal 5 to the BAND switch which selects band 1, band 2, or calibrate operation. On figure 7-1, note that the output level of the A7 VCO is set by an IF LEVEL panel control. This effectively sets the level of the IF signal at A19.

4-11 MULTIPLIER, MIXER, AND DETECTOR, A20

The multiplier, mixer, and detector board consists of the circuitry for generating 10 MHz harmonics, a double-balanced mixer for mixing 10 MHz harmonics with IF output to extend the signal range to 1000 MHz, a beat frequency detector for signal frequency comparisons, a voltage-controlled pin-diode attenuator, and related circuit elements.

Refer to the A20 schematic diagram, figure 7-21. 10 MHz is received from the 10 MHz multiplier A16 and applied to the input amplifier Q1. Coils L1 (with capacitors C1 and C2) and autotransformer T1 are impedance matching devices. Output from Q1 drives a harmonic generating network consisting of diode D1 and related R, L, and C components. The resultant harmonics of 10 MHz are used to mix with IF signal in the double-balanced mixer (DBM).

When the band-switch is set to band 2, IF signal from the IF metering board A19 is brought in and mixed with the output of the 10 MHz harmonic generator. In the band 1 and calibrate settings of the band switch, the DBM is not used, and generated signal (IF or 3 MHz standard oscillator) is applied directly through the low-pass filter made up of L4 and R17. Note the connections made by various band switch settings. Another function of a band switch section is to remove voltage from input amplifier Q1 when band 2 is not in use and thus deactivate the 10 MHz harmonic generator. This minimizes spurious signal generation during calibration and band 1 operation.

In all band settings the generated reference signal is compared with a signal to be measured (in frequency) in the beat frequency detector, diode D2 and its related circuitry. The beat frequency output of the detector is fed through an impedance matching stage, Q2, and then through the front panel AF VOLUME control to the audio amplifier board A12.

The IF, or mixed, generated signal, besides being applied to the beat frequency detector, is also transmitted through the voltage-controlled attenuator made up of pin diodes D3 and D4 with associated network, and then to the 107B's rf output connector. The attenuation introduced by these diodes is a function of control voltage applied to them by the front panel continuously variable attenuation control.

The diodes are also used as a means of applying amplitude modulation to the generated signal, when such modulation is needed. With the front panel FM AM switch set to AM, an additional bias is applied to provide for symmetrical mcdulation.

4-12 AUDIO AMPLIFIER A12

Signal from the audio preamplifier on board A20, after passing through the AF VOLUME front panel gain control, is applied to driver amplifier Q1-Q2 in the audio amplifier board A12. Refer to the A12 schematic diagram figure 7-13. Output from Q1-Q2 then drives the IC power amplifier which, in turn, provides power for internal speaker operation, external headphone operation or external speaker operation. The internal speaker is disabled by an output jack contact when either headphones or external speaker are used.

The audio output is also applied to a rectifier, diodes D1-D4. The rectified audio output is applied to the 107B front panel voltmeter whenever the meter selector switch is set to AF VOL.

4-13 AM FM MODULATOR A13

The audio source for both amplitude and frequency (internal) modulation is an oscillator on A13. Refer to the schematic diagram, figure 7-14. The oscillator consists of two IC amplifiers with suitable feedback networks. A fine frequency adjustment is provided by a 20,000 ohm potentiometer. The X10 and X1 selection of the front panel Hz X10-X1 toggle switch is accomplished by switching capacitor values as indicated. Zener diodes at the output of the second IC provide amplitude stabilization over the oscillators band of operation (approximately 50 to 6000 Hz). The oscillator signal is brought up to a practical application level by an output IC amplifier. The two diodes at the input of the output amplifier are wave shapers, since oscillator output is not directly a sine wave. Final audio output is transmitted via output terminal 6 to the front panel MODULATOR LEVEL control. This is also a common connection point for external modulation from the rear panel connector. Change from internal to external modulation is done by merely shutting off the A13 oscillator. This is done by the rear panel switch with internal and external settings. The modulation level control is therefore effective for both external and internal modulation. For frequency modulation an equalizing network is provided. Its input is externally connected to the front panel modulation level control, and its output is through terminal 4 to the Schmitt Trigger A17. As applied to the Schmitt Trigger, it is phase modulation. However, this is effectively frequency modulation because of the equalizing network.

4-14 3 MHz (STANDARD) CRYSTAL OSCILLATOR AND OVEN A15

The 3 MHz crystal oscillator is contained in the proportional oven A15. The oven circuitry and operation are exactly the same as described for the 1 MHz oscillator oven in paragraph 4-2.

Refer to the 3 MHz crystal oscillator schematic diagram, figure 7-16. The oscillator uses high quality parts in a Colpitts circuit with zener regulated supply. For the oscillator, the 10.5 volt supply is dropped to a zener-regulated level (D1) of 6.8 volts, then dropped via series resistor to 5.5 volts. Since the crystal is in a vacuum-sealed container with extremely stable components and construction, and a regulated supply, its output is maintained within very close limits at 3 MHz. (See specifications, section 1.)

There are no electrical adjustments on this oscillator. Any corrections made to WWV (or equivalent standard) are accomplished mechanically on the front panel dial. A separate 6.8 volt zener diode D2 provides regulation for the oven.

4-15 POWER SUPPLY A11

The 107B operates from either an ac or dc prime power source. AC input is 115 volts or single-phase ac. DC is optionally any one of either 12.5, 25, or 33 volts dc. Operation is essentially the same, regardless of the selection of any of these prime power voltages.

Refer to the schematic diagram figure 7-12. For ac prime power operation, the equipment is grounded to the center conductor (ground) of the ac line cord. For dc operation, ground is isolated through the oscillator-power transformer so that the 107B can be operated safely in a vehicle with either positive or negative grounded supply.

During operation from an ac prime source, the power supply is enabled by operation of switch SW 1 in series with line fuse F1. The switch is a part of the AF LEVEL front panel control and is activated during the first few degrees of clockwise rotation.

The rectified dc output results from conventional full-wave rectification and filtering, plus voltage regulation. Power transistor Q2 is the series controlling conductor and is itself controlled by amplifier Q1 and amplifier IC1 which works against zener reference voltages. Basic output voltage level is controlled by adjustment of the value of R4.

When operating from a dc source, the power supply is active as soon as the prime dc supply is connected. Transistors Q3 and Q4 are a push-pull oscillator operating with feedback windings on the oscillator-power transformer T2. Full-wave rectification is also used here. The remainder of the filter and regulation circuitry is common with the ac supply.

SECTION 5
MAINTENANCE

5-1 INTRODUCTION

This section describes the general maintenance philosophy of the 107B frequency meter and signal generator from the customer's or user's viewpoint. If a malfunction should occur, in many cases the user can troubleshoot, isolate the malfunction; and make an adjustment, repair, or replacement without the necessity of returning the unit to the factory.

For certain repairs and adjustments, the unit must be returned to the factory. These are as follows. Do not attempt to do any of these operations.

Adjust or repair the 1 MHz variable crystal oscillator, A14 (VCO)

Adjust or repair the 3 MHz calibration crystal oscillator, A15

Replace or repair the oscillator coil of the 30-to-39.9 kHz variable frequency oscillator (part of A7)

Replace or repair the oscillator coil of the 0.97-to-1.96 MHz variable frequency oscillator (part of A2).

5-2 PREVENTIVE MAINTENANCE

Aside from reasonable care and protection of the 107B from exposure to degrading or corrosive environmental conditions, very little preventive maintenance is required. If the unit is to be stored or out of use for any considerable length of time, it should be placed in a secure, dry area where it will not be handled roughly or subjected to extremes of temperatures. Treat the 107B as any precision instrument should be treated and it will continue to serve you well.

5-3 TROUBLESHOOTING AND REPAIR

Since the 107B contains many signal paths, troubleshooting any malfunction is essentially the use of signal-tracing techniques.

Figure 5-1 is a block diagram showing the main paths of r-f signal generation in the 107B. The various blocks are shown in the same general location as indicated in the overall block and schematic diagram, figure 7-1, but only the major r-f signal flow is shown, with pertinent terminals and connections. The signal may be traced in any manner desired, depending on the particular malfunction. That is, all the terminals indicated may be considered test points. (See also paragraph 5-4.) Refer to the overall schematic/interconnection diagram figure 7-1, and to the individual board or subassembly schematics, figures 7-2 through 7-22 for more detailed information.

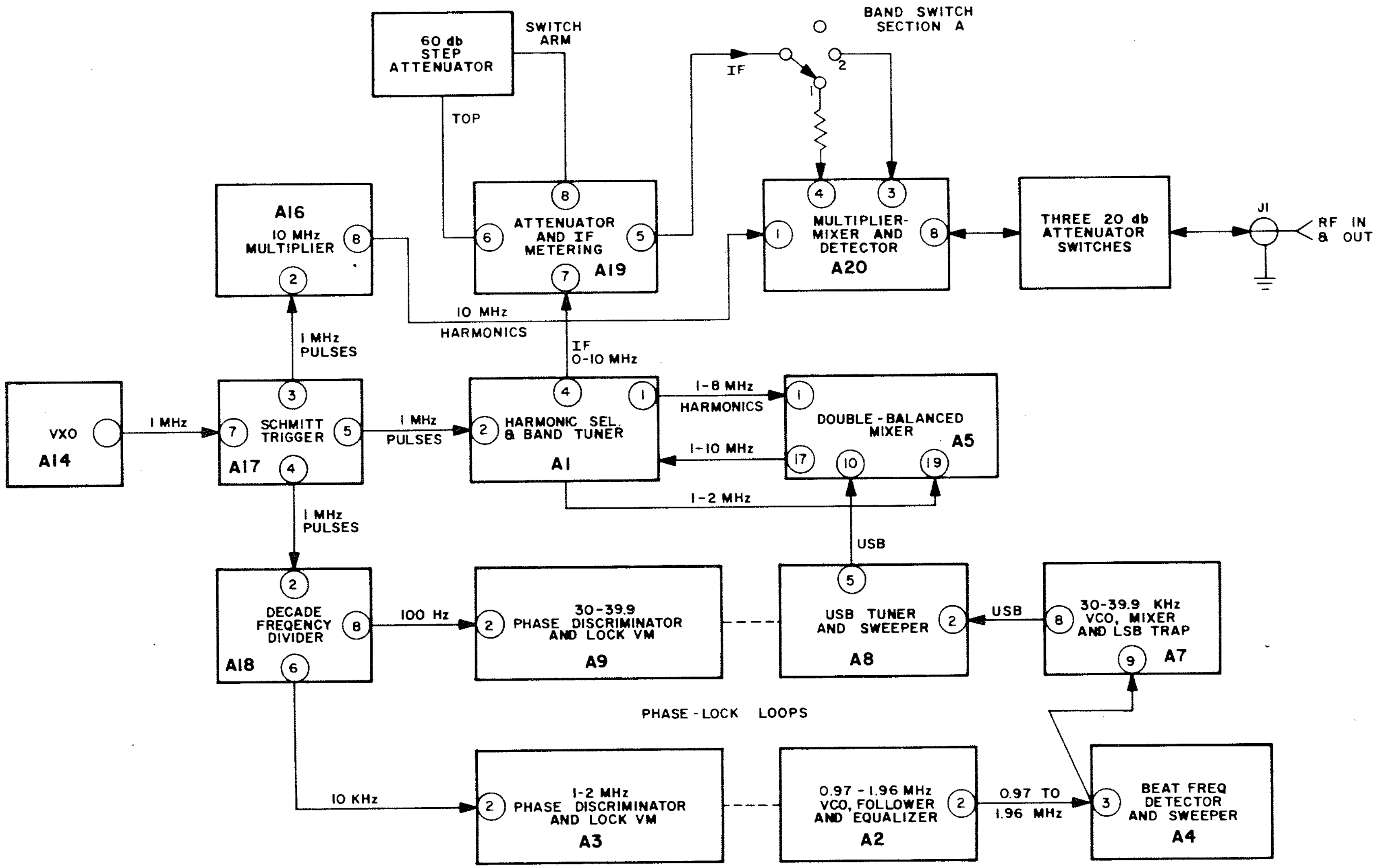


Figure 5-1. Main RF Signal Paths in the 107B, showing Board Terminals

NOTE

In some 107B units, subassemblies were identified with "Z" series, or equivalent numbers. Subassemblies now carry "A" prefix reference designations. Table 5-1 provides cross-reference information between the older Z numbers and the new A reference designations.

For physical parts location, refer to the parts list and its accompanying illustrations. Almost all parts are called out in one illustration or another. Those that do not appear can be located easily by checking the assembly, switch, etc. to which they are related. For example, resistor R22 mounted on the meter selector switch S8 is not shown on the parts illustrations, but can be located by checking switch S8 section A.

CAUTION

In servicing the 107B, observe the following basic precautions, as described in each subparagraph.

A. Grounded Soldering Iron

Always use a grounded soldering iron when unsoldering or soldering leads during tests, fault isolation, and repairs. An ungrounded iron can under some circumstances develop stray voltages which can damage components such as FETs, ICs, and some diodes.

B. Insulated Gate FET Handling

Insulated gate FETs are used in some 107B circuits. On such an FET the insulation between the gate and the other FET elements is so thin that when an FET is out of the 107B unit it can be damaged by electronstatic voltages developed on the body or tools.

When removing, installing, or otherwise handling an insulated gate FET, keep the body as much as possible at ground potential by placing one hand on the 107B chassis - or ground at the circuit where the FET is used. Do not place an uninstalled IG FET adjacent to any devices or circuit that use or generate high voltages, transient or otherwise.

C. 107B Service Work Area

Because of the considerations mentioned in paragraphs A and B above, do not work on a 107B unit immediately adjacent to devices that use or generate high voltages or high voltage transients.

TABLE 5-1. IDENTIFICATION NUMBER CROSS-REFERENCE

Subassembly	Reference Designation	"Z" Number or Equiv.
Harmonic Selector and Band Tuner	A1	Z2-200
0.97-to-1.96 MHz VCO, Follower, Equalizer	A2	Z3-200
1-2 MHz Phase Discriminator & Lock Voltmeter	A3	Z3-300
Beat Frequency Detector and Sweeper	A4	Z3-400
Double-Balanced Mixer	A5	Z4-200
Dual Lamp Lighter and 3 MHz Amplifier	A6	Z4-300
30-39.9 kHz VCO, Mixer, & (Ref.) LSB Trap	A7	Z5-200
30-39.9 kHz USB Tuner and Sweeper	A8	Z5-300
30-39.9 kHz Phase Discr. & Lock Voltmeter	A9	Z5-400
Beat Frequency Detector & 5-50 Hz Amplifier	A10	Z5-500
Power Supply	A11	Z6-200
Audio Amplifier	A12	Z8-200
AM-FM Modulator	A13	Z8-300 00230
Proportional Oven, 1 MHz VXO	A14	Z9-300
Proportional Oven, 3 MHz Oscillator	A15	Z10-300
10 MHz Multiplier	A16	Z11-200
1 MHz Schmitt Trigger	A17	Z11-300
Decade Frequency Divider	A18	Z11-400
Attenuator and IF Metering	A19	0079
Multiplier, Mixer, and Detector	A20	0082

D. Check Operating Procedure First

Before starting any troubleshooting or repair operations, make sure your operating procedure is correct, by checking instructions in Section 3. Sometimes apparent malfunctions are the result of failure to set certain controls correctly for the desired result. For example: if the rear panel Ext/Int switch is set to Ext, the internal audio modulator is inoperative.

Note also that, if all FREQUENCY dials are set to zero, no IF LEVEL reading is obtained on the meter. However, when the 107B is set to band 2, output is still present in 10 MHz increments out to the full 1000 MHz range of the instrument.

5-4 STANDARD FREQUENCY TEST JACKS

On the left end of the 107B unit, a snap-out panel provides access to six standard frequency test jacks. These are outputs from the decade frequency divider A18, except for the 10 MHz output. The 10 MHz output is derived from the 10 MHz multiplier A16 and is enabled only when the 107B is set for band 2 operation. Signal frequencies are marked on the panel near the jacks. Following is a listing of the test points and output characteristics.

Test Jack	Signal Frequency	Approx. Waveform	Volts P-P Signal Level
TP1	100 Hz	Square	7.5-9.5
TP2	1000 Hz	Square	7.5-9.5
TP3	10 kHz	Square	7.5-9.5
TP4	100 kHz	Square	7.5-9.5
TP5	1 MHz	Sawtooth	Approx. 2
TP6	10 MHz	Sine	Approx. 0.3

Output impedance in all cases is approximately 50K ohms.

SECTION 6
PARTS LIST

6-1 INTRODUCTION

This section lists and illustrates the location of maintenance-significant electrical parts. The parts are listed in reference designation alpha-numerical order beginning with the main assembly and proceeding through to detail parts. The main 107B assembly is listed first with subassemblies and detail parts located on the main assembly. Then subassemblies such as circuit boards, oven-assemblies, etc. are listed. As each subassembly is listed, it is followed immediately by the detail parts mounted on it. Accompanying illustrations show significant part locations, identified by reference designations.

NOTE

Parts breakdowns for the 1 MHz VXO and the 3 MHz calibration oscillator are not provided, since these are factory repair items.

6-2 REFERENCE DESIGNATION USAGE

On the 107B Frequency Meter and Signal Generator, the ASA unit-numbering method is used to develop reference designation numbers. An exception is that the 107B itself, being the only main unit involved, carries no numerical reference designation. Thus, electrical parts mounted on the 107B itself (not mounted on boards) are listed in their usual series (C1, C2, C3, etc. for capacitors, R1, R2, R3, etc. for resistors, and so on). Included with these individual parts, and at the same level, are the reference designations for the circuit boards (electrical subassemblies) which are in the "A" series (A1, A2, A3, etc.).

On each circuit board (electrical subassembly), an individual series of reference designations is used for each category of parts mounted on the circuit board. In this case, the complete reference designation for a part on a particular circuit board is the circuit board's "A" series designation followed by the reference designation of the individual part.

For example:
Resistor R1 on circuit board A3 would be A3R1, Capacitor C7 on board A1 would be A1C7, Inductance L1 on board A20 would be A20L1, and so on.

Usually, in discussing the individual parts on a particular board or subassembly the prefix is not mentioned, since it is normally evident that discussion is about that particular board or subassembly.

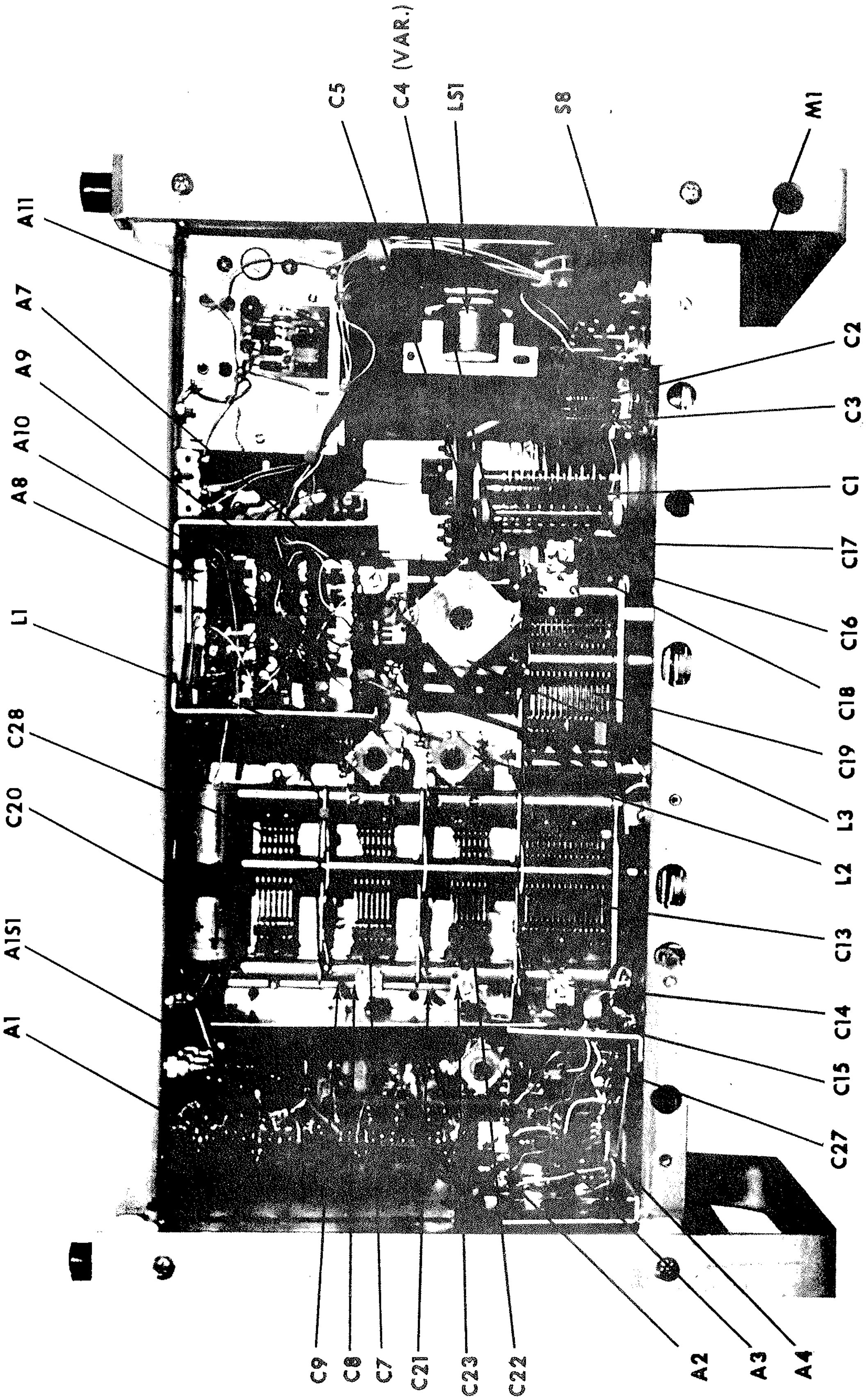


Figure 6-1. Type 107B Digital Frequency Meter/Signal Generator, Subassembly and Parts Location (Sheet 1 of 5, Top View)

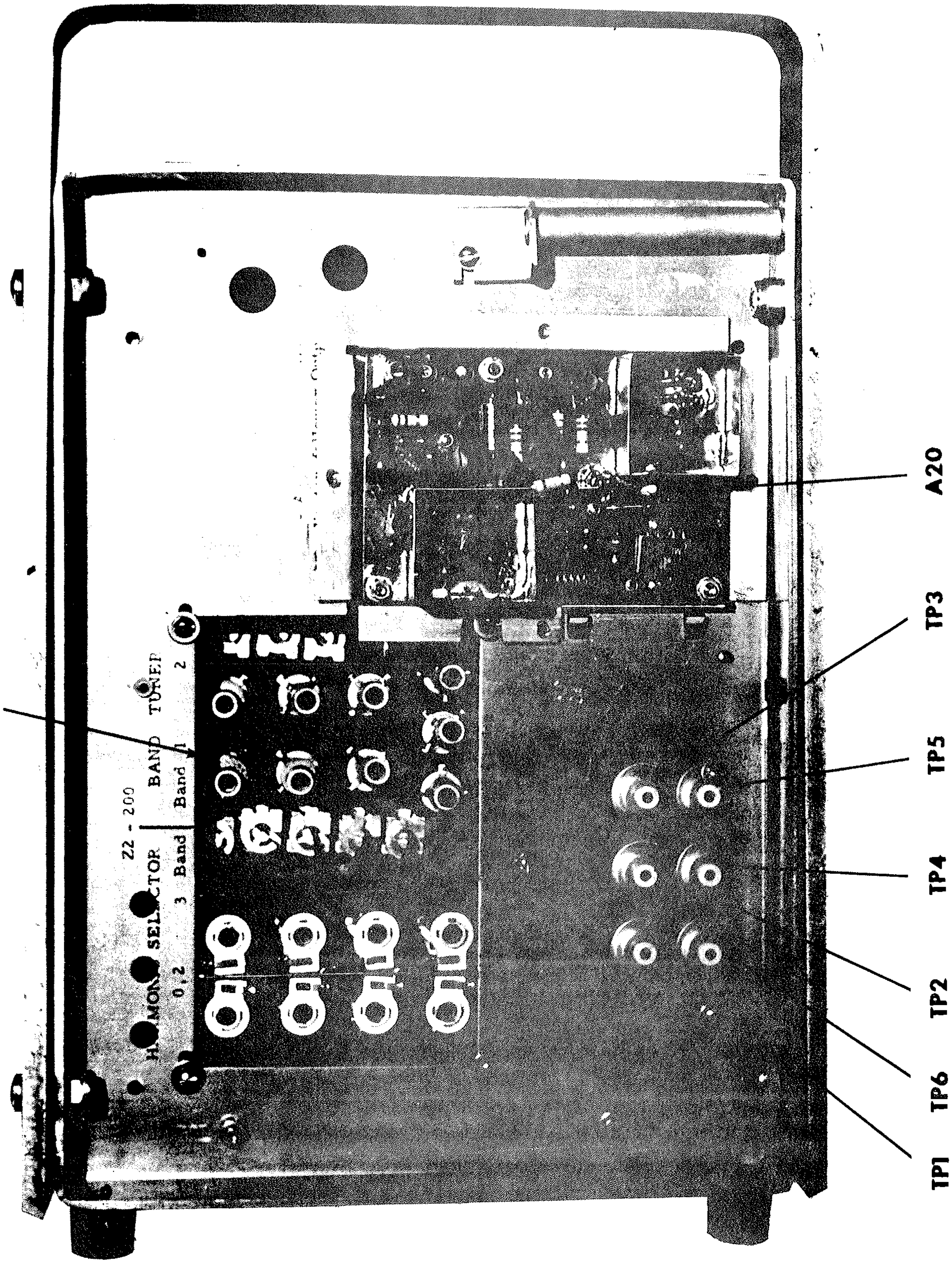


Figure 6-1. Type 107B Digital Frequency Meter/Signal Generator, Subassembly and Parts Location (Sheet 2 of 5, Left Side View)

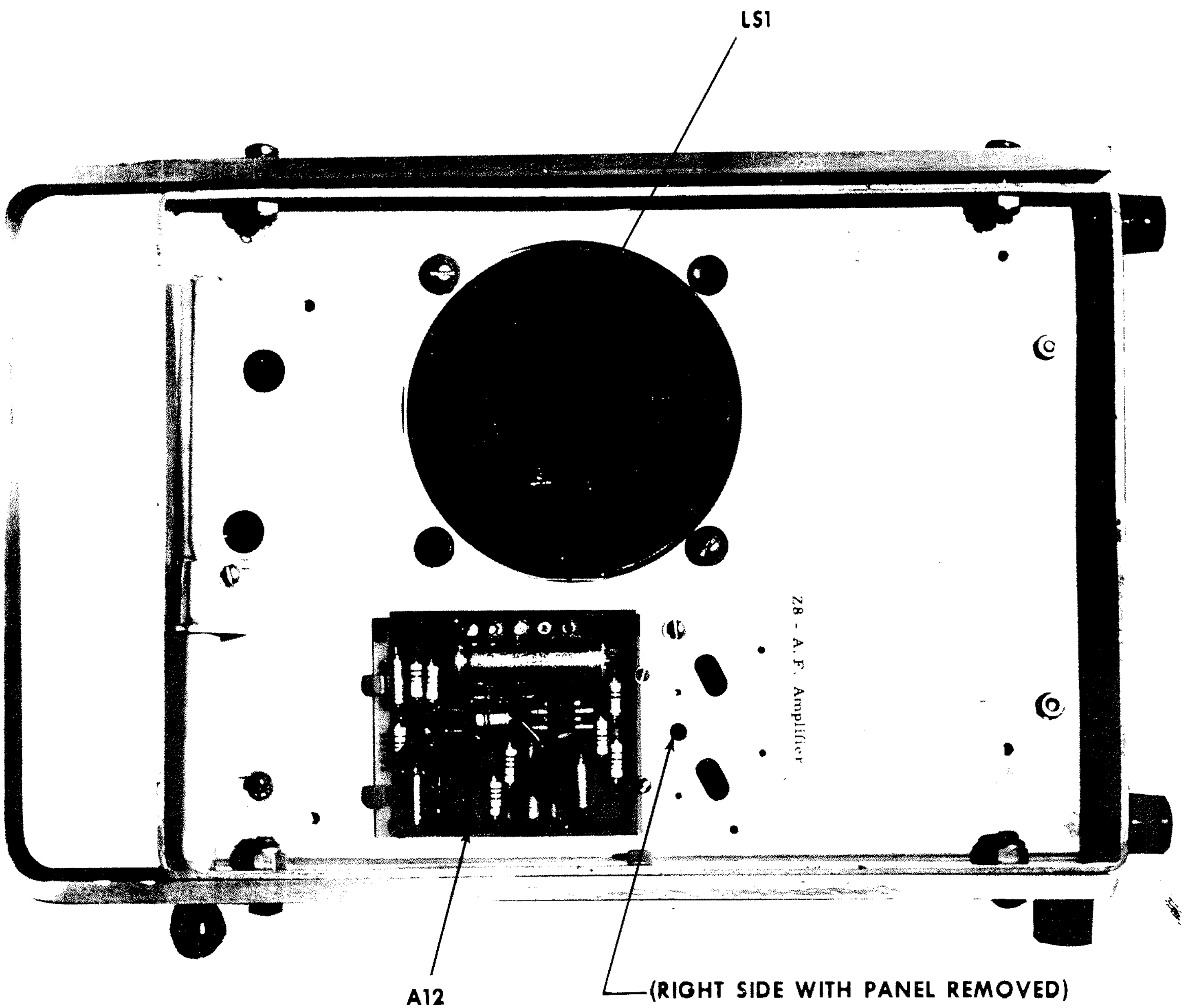


Figure 6-1. Type 107B Digital Frequency Meter/Signal Generator, Subassembly and Parts Location (Sheet 3 of 5, Right Side View)

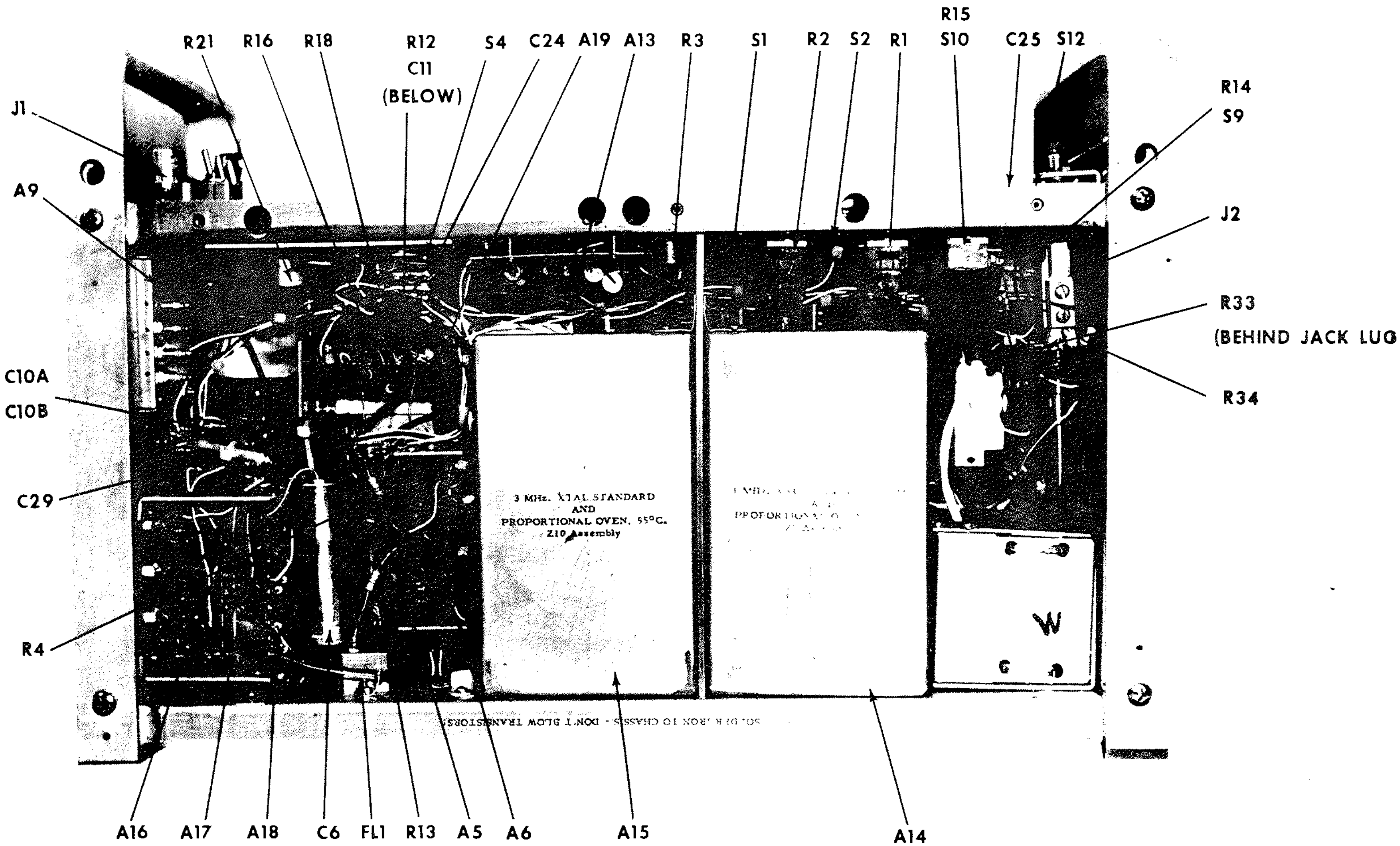


Figure 6-1. Type 107B Digital Frequency Meter/Signal Generator, Subassembly and Parts Location (Sheet 4 of 5, Bottom View)

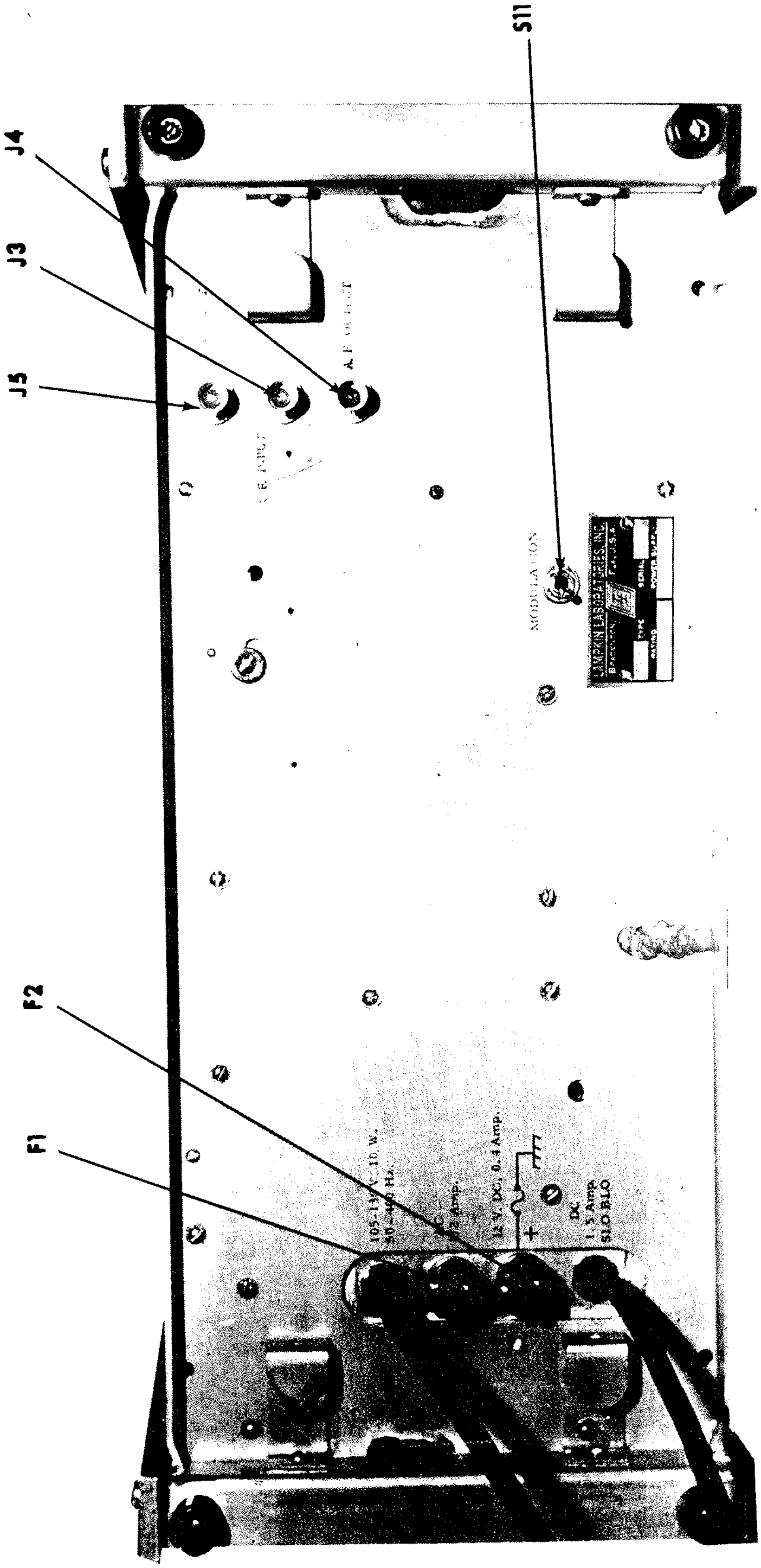


Figure 6-1. Type 107B Digital Frequency Meter/Signal Generator, Subassembly and Parts Location (Sheet 5 of 5, Rear View)

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
-	Lampkin Type 107B Digital Frequency Meter/Generator	107B
A1	Harmonic Selector and Band Tuner	00245
A2	0.96 to 1.96 MHz VCO, Follower, and Equalizer	00205
A3	30-39.9 kHz Phase Discriminator and Lock Voltmeter	00211
A4	Beat Frequency Detector, 5 kHz Sweeper	00200
A5	Double-Balanced Mixer	00202
A6	Dual Lamplighter, 3 MHz Amplifier	00207
A7	30-39.9 kHz VCO, Mixer, and LSB Trap	00208
A8	30-39.9 kHz USB Tuner and Sweeper	00209
A9	30-39.9 kHz Phase Discriminator and Lock Voltmeter	00201
A10	Beat Frequency Detector, 5 to 50 Hz Amplifier	00210
A11	Power Supply	00212
A12	Audio Amplifier	00214
A13	AM, FM, Modulator	00216
A14	Proportional Oven, for 1 MHz VXO	00198
A15	Proportional Oven, for 3 MHz Calibration Oscillator	00217
A16	10 MHz Multiplier	00199
A17	1 MHz Schmitt Trigger	00203
A18	Decade Dividers	00206
A19	Attenuator and IF Metering	00213
A20	Multiplier, Mixer, and Detector	00215
C1	Capacitor, Variable, VXO (PPM) Tuning, 50 pf max.	Hammarlund 9404-18-00072
C2	Capacitor, Variable, 2.7-19.6 pf (VXO CALIB Control)	Johnson 160-110
C3	Capacitor, Ceramic, 0-20 pf (Selected) NPO, 1 kv	
C4	Capacitor, Variable, 1.7-14.1 pf, Type U	Johnson 189-505-4
C5	Capacitor, Ceramic, 30 pf, NPO, 1 kv	
C6	Capacitor, Electrolytic, 1100 uf, 30 wvdc	Sprague 39D
C7	Capacitor, Variable P/O C13 Assembly (USB Tuning) 162 pf max	
C8	Capacitor, Variable 1.7-14.1 pf, Type U	Johnson 189-505-4

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
-	Lampkin Type 107B Digital Frequency Meter/Generator (continued)	107B
C9	Capacitor, Fixed, Ceramic, 18 pf, NPO, 1 kv	
C10A	Capacitor, Electrolytic, 100 uf, 50 wvdc	
C10B	Capacitor, Electrolytic, 100 uf, 50 wvdc	
C11	Capacitor, Ceramic, 100 pf	
C12	Capacitor, Electrolytic, 68 uf, 50 wvdc	
C13	Capacitor, Variable, 378 pf max (10 KHz/Div.)	Hammarlund 9441-60-30027
C14	Capacitor, Variable, 1.7-14.1 pf, Type U	Johnson 189-505-4
C15	Capacitor, Ceramic, 56 pf, NPO, 1 kv	
C16	Capacitor, Fixed Ceramic, 100 pf, NPO, 1 kv	
C17	Capacitor, Fixed, Ceramic, 270 pf, NPO, 1 kv	
C18	Capacitor, Variable, 1.7-14.1 pf, Type U	Johnson 189-505-4
C19	Capacitor, Variable, Tuning 378 pf max	Hammarlund 9441-60-30026
C20	Capacitor, Electrolytic, 1100 uf, 30 wvdc	Sprague 39D
C21	Capacitor, Fixed, Ceramic, 25 pf, N080, 1 kv	
C22	Capacitor, Variable, P/O C13 Assembly (LSB Trap) 162 pf max	
C23	Capacitor, Variable, 1.7-14.1 pf, Type U	Johnson 189-505-4
C24	Capacitor, Fixed, Tantalum, 3.3 uf, 35 wvdc	
C25	Capacitor, Fixed, Ceramic, 0.005 uf	
C26	Capacitor, Tantalum, 3.3 uf, 35 wvdc (meter damping)	
C27	Capacitor, Fixed, Ceramic, 0.1 uf	
C28	Capacitor, Variable, P/O C13 Assembly, 378 pf max (Band Tuner)	
C29	Capacitor, Fixed, Electrolytic, 100 uf, 50 wvdc	
DS1	Lamp	MURA L6 50
DS2	Lamp	MURA L6 50

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
-	Lampkin Type 107B Digital Frequency Meter/Generator (continued)	107B
F1	Fuse, 0.5 Amp, SLO-BLO (115 ac circuit)	Littelfuse 3133AG 1/2A 125V
F2	Fuse, 1.5 Amp, SLO-BLO (12 vdc circuit)	Littelfuse 3133AG 1-1/2A 125V
J1	Connector, RF, BNC (RF Input/Output)	UG657/U
J2	Jack, Headphone	
J3	Connector, BNC (Ext Modulation In)	UG657/U
J4	Connector, BNC (AF Out)	UG657/U
J5	Connector, BNC (IF Out)	UG657/U
L1	Coil, RF, 44.5 uh	Lampkin 46A
L2	Coil, RF, 90-160 uh	Lampkin 68B
L3	Coil, RF, 35.3 uh	Lampkin 68C
M1	Meter, 200 ua (Basic)	Modutec 15-DUA-200
R1	Resistor, Variable, 10K, 2W, Linear (Mod. Level)	AB 70C1N132P-103B
R2	Resistor, Variable, 20K, Logarithmic (Mod. Freq.)	
R3	Resistor, Variable, 500 ohms Linear (Mod. Fine Freq.)	AB WA2G056P-501MA
R4	Resistor, Film, 20 ohms, 1/2 watt, 10 percent	
R5	Resistor, Film, 4200 ohms, 1/2 watt, 1 percent	
R6	Resistor, Film, 1330 ohms, 1/2 watt, 1 percent	
R7	Resistor, Film, 422 ohms, 1/2 watt, 1 percent	
R8	Resistor, Film, 133 ohms, 1/2 watt, 1 percent	
R9	Resistor, Film, 42.2 ohms, 1/2 watt, 1 percent	
R10	Resistor, Film, 13.3 ohms, 1/2 watt, 1 percent	
R11	Resistor, Film, 20 ohms, 1/2 watt, 1 percent	
R11A	Resistor, Film, 10 ohms, 1/2 watt, 1 percent	
R12	Resistor, Film, 1000 ohms, 1/2 watt, 10 percent	
R13	Resistor, Film, 47 ohms, 1/2 watt, 10 percent	

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
-	Lampkin Type 107B Digital Frequency Meter/Generator (continued)	107B
R14	Resistor, Variable, 10K, 2W (with switch) (IF Level)	AB 70C1N132P-103B
R15	Resistor, Variable, 1000 ohms, 2W (with switch) (AF Volume)	AB 70K1N-200P-102M
R16	Resistor, Film, 1800 ohms, 1/2 watt, 10 percent	
R17	Resistor, Film, 4.7K, 1/2 watt, 10 percent	
R18	Resistor, Film, 27K, 1/2 watt, 10 percent	
R19	Resistor, Film, 270 ohms, 1/2 watt, 10 percent	
R20	Resistor, Film, 1800 ohms, 1/2 watt, 10 percent	
R21	Resistor, Variable, 2500 ohm, 2W (Var. Attenuator)	AB 70A1N-200P-252U
R22	Resistor, Film, 75K, 1/2 watt, 10 percent	
R23	Resistor, Film, 56 ohms, 1/2 watt, 1 percent	
R24	Resistor, Film, 220 ohms, 1/2 watt, 1 percent	
R25	Resistor, Film, 56 ohms, 1/2 watt, 1 percent	
R26	Resistor, Film, 220 ohms, 1/2 watt, 1 percent	
R27	Resistor, Film, 56 ohms, 1/2 watt, 1 percent	
R28	Resistor, Film, 56 ohms, 1/2 watt, 1 percent	
R29	Resistor, Film, 220 ohms, 1/2 watt, 1 percent	
R30	Resistor, Film, 56 ohms, 1/2 watt, 1 percent	
R31	Resistor, Film, 56 ohms, 1/2 watt, 1 percent	
R32	Resistor, Film, 1000 ohms, 1/2 watt, 10 percent	
R33	Resistor, Film, 200 ohms, 1/2 watt, 10 percent	
R34	Resistor, Film, 10K, 1/2 watt, 10 percent	
R35	Resistor, Film, 680 ohms, 1/2 watt, 10 percent	
S1	Switch, Toggle, Toggle, SPDT (Mod. Freq. X1-X10)	MST 105D
S2	Switch, Toggle, Toggle, DPST (AM-FM)	MST 205P
S3	Switch, Rotary Selector (60 db Step Atten.)	Oak 399523-F
S4	Switch, Rotary Selector (Band Switch)	Lampkin 00229
S5, S6, S7	Switch, Toggle, DPDT (20 db Attenuator Steps)	MST 205N

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
	Lampkin Type 107B Digital Frequency Meter/Generator (continued)	107B
S8	Switch, Rotary Selector (Meter Switch)	
S9	Switch, SPST, P/O IF LEVEL Control, R14 (Comb. Output)	
S10	Switch, SPST, P/O AF VOLUME Control, R15 (Power On-Off)	
S11	Switch, Toggle, SPDT (Ext.-Int. Modulation)	MST 105D
S12	Switch, Pushbutton, Normally Closed	Grayhill 30-Z
TP1	Jack, Test (100 Hz)	CTC 450-4355-01-0319
TP2	Jack, Test (1000 Hz)	CTC 450-4355-01-0319
TP3	Jack, Test (10 kHz)	CTC 450-4355-01-0319
TP4	Jack, Test (100 kHz)	CTC 450-4395-01-0319
TP5	Jack, Test (1 MHz)	CTC 450-4355-01-0319
TP6	Jack, Test (10 MHz)	CTC 450-4355-01-0319

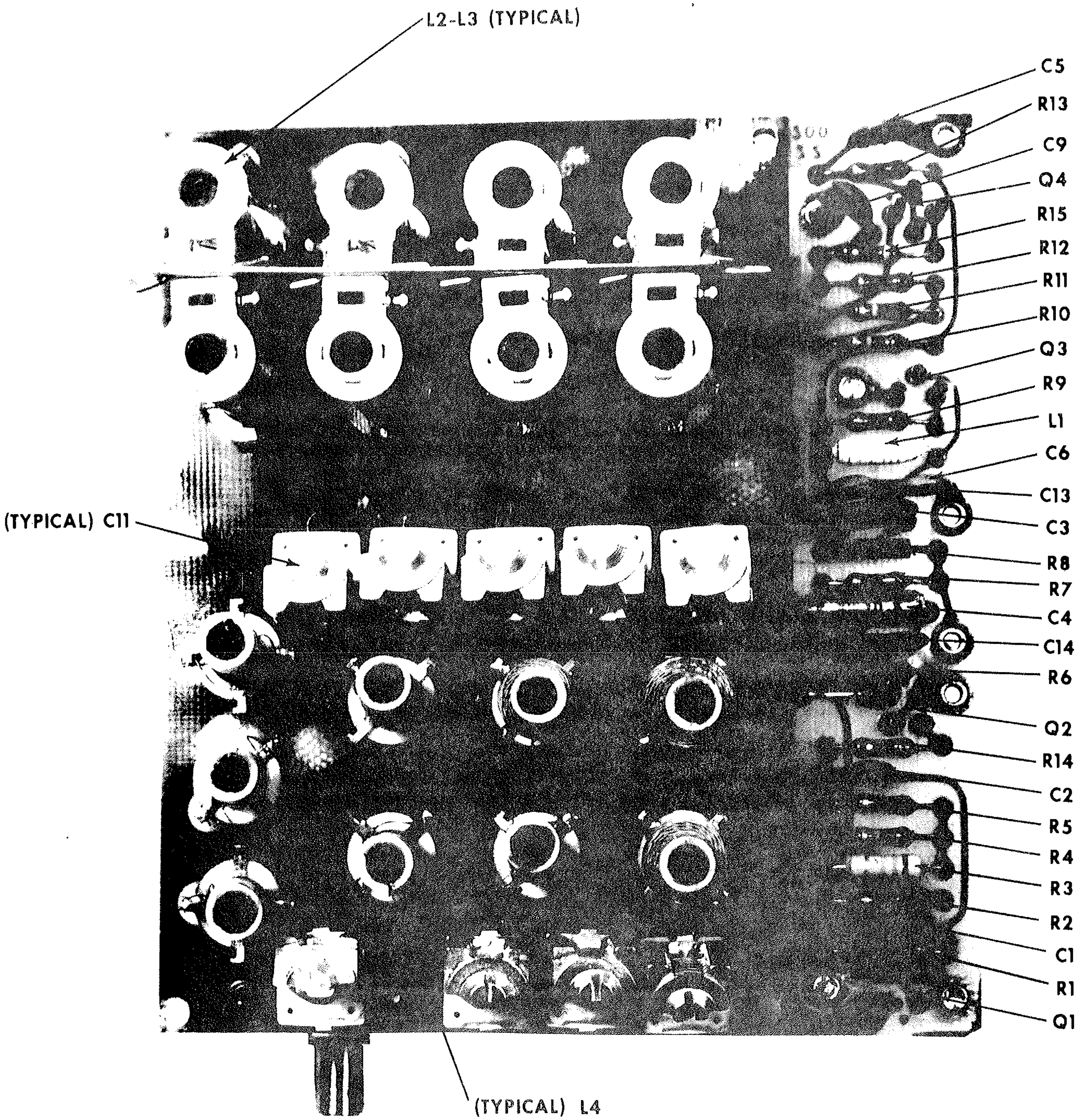


Figure 6-2. Harmonic Selector and Band Tuner, A1, Parts Location (Sheet 1 of 2)

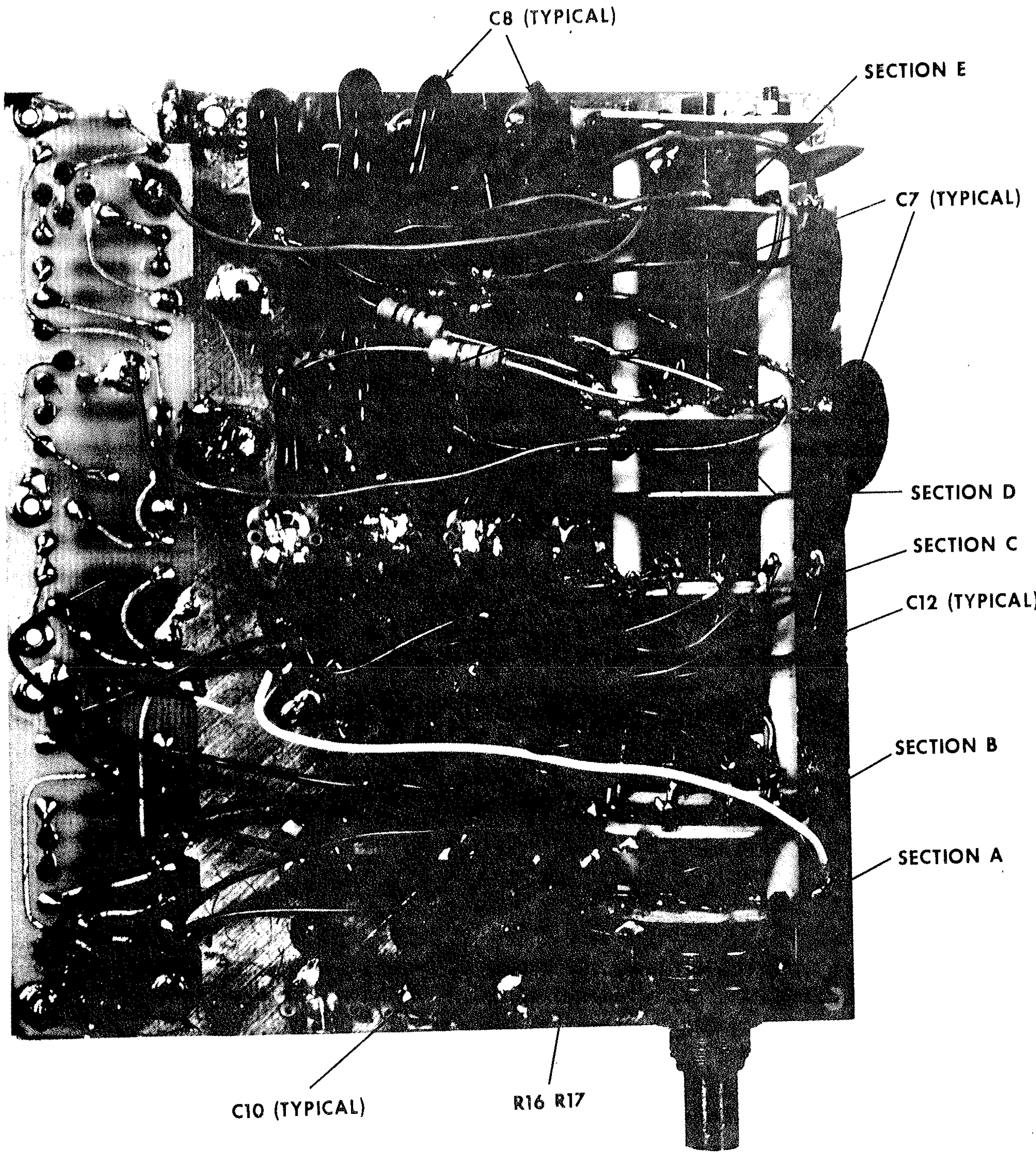


Figure 6-2. Harmonic Selector and Band Tuner, A1, Parts Location (Sheet 2 of 2)

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A1	Harmonic Selector and Band Tuner	00245
C1,C3, C14	Capacitor, Ceramic, 0.1 uf, 25 wvdc	
C2	Capacitor, Ceramic, 0.01 uf, 100 wvdc	
C4	Capacitor, Tantalum, 10 uf, 20 wvdc	NC1
C5	Capacitor, Ceramic, 0.01 uf, 100 wvdc	
C6, C13	Capacitor, Ceramic, 15 pf, 1 kv	NPO
C7, C8	Capacitor, Silver Mica CDE, 5%, or Ceramic NPO, 1200V (See Harmonic Selector Table on Section 7 Assy. A1 Schematic Diagram for Values).	
C9	Capacitor, Ceramic, 0.001 uf, 1 kv	
C10, C12	Capacitor, Ceramic, 1 kv (See Band Tuner Table on Section 7 A1 Schematic Diagram for Values).	NPO
C11	Capacitor, Variable, 1.7-14.1 pf, Type U (One for each band)	Johnson 189-505-4
L1	Coil, RF, 1 Millihenry	Lampkin
L2, L3	Coil, RF, (See Harmonic Selector Table on Section 7 A1 Schematic Diagram)	Lampkin
L4	Coil, RF, (See Band Tuner Table on Section 7 A1 Schematic Diagram)	Lampkin
Q1	Transistor	2N3293
Q2,Q4	Transistor, FET	3N128
Q3	Transitor, Silicon Signal	2N708
R1	Resistor, Film, 470 ohms, 1/2 watt, 10 percent	
R2,R6	Resistor, Film, 1000 ohms, 1/2 watt, 10 percent	
R3	Resistor, Film, 68K, 1/2 watt, 10 percent	
R4,R10, R11	Resistor, Film, 100K, 1/2 watt, 10 percent	
R5,R12	Resistor, Film, 1 Megohm, 1/2 watt, 10 percent	
R7	Resistor, Film, 150 ohms, 1/2 watt, 10 percent	
R8	Resistor, Film, 330 ohms, 1/2 watt, 10 percent	
R9	Resistor, Film, 10 ohms, 1/2 watt, 10 percent	
R13	Resistor, Film, 2.7K, 1/2 watt, 10 percent	

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A1	Harmonic Selector and Band Tuner (continued)	00245
R14, R15	Resistor, Film, 4.7K, 1/2 watt, 10 percent	
R16, R17	Resistor, Film, 82K, 1/2 watt, 10 percent	

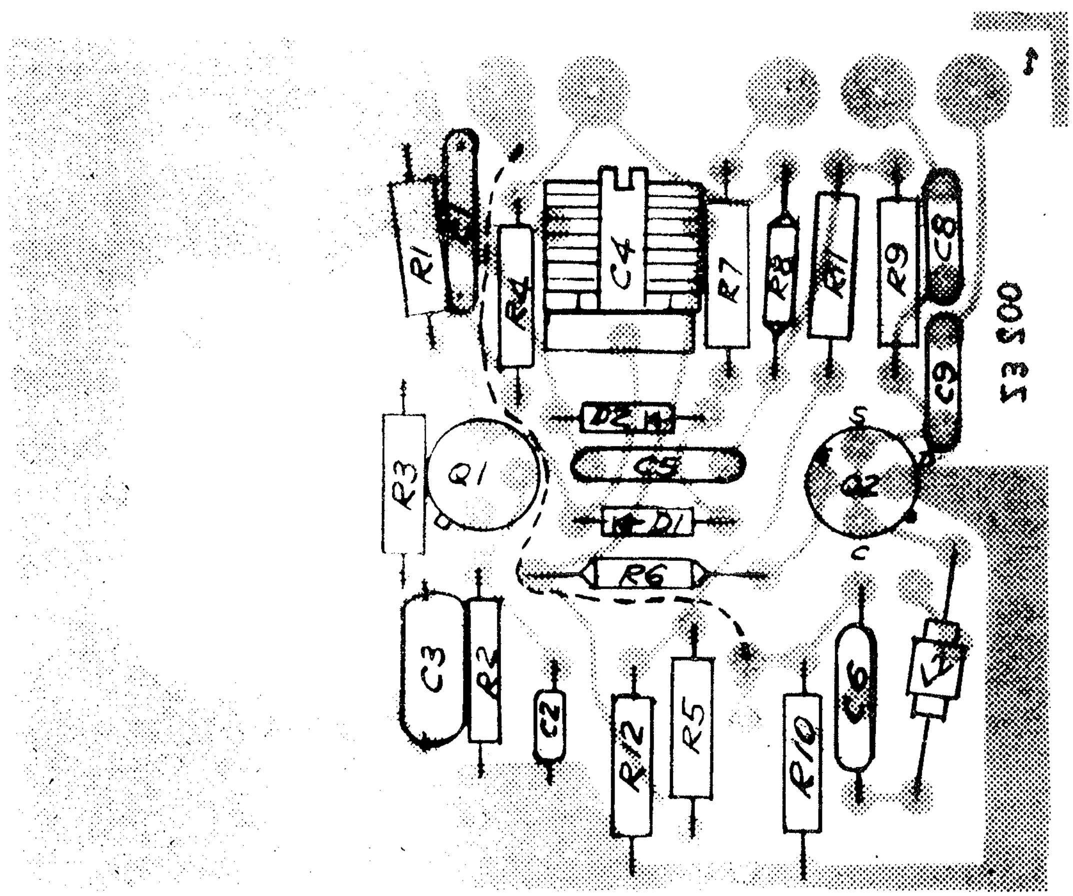


Figure 6-3. 0.97 to 1.96 MHz VCO, Equalizer, and Follower, A2, Parts Location

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A2	0.97 to 1.96 MHz VCO, Equalizer, and Follower	00205
C1	Capacitor, 0.1 ufd, 25 wvdc, 20 percent	Erie Transcap
C2	Capacitor, 330 pf, Silver Mica 500 wvdc, 5 percent	CDE Type CD15
C3	Capacitor, 3000 pf, Silver Mica, 500 wvdc, 5 percent	CDE Type CD19 or ARCO Type DM19
C4	Capacitor, Variable, 14.1 pf, Side-Mount	Johnson Type U 189-505-105
C5	Capacitor, 0.1 ufd, 25 wvdc, 20 percent	Erie Transcap
C6	Capacitor, 47 pf, NPO, 1000 wvdc, 5 percent	Sprague 10 TCC
C7	Not Used	
C8	Capacitor, 0.01 ufd, 100 wvdc, 20 percent	Ceramite
C9	Capacitor, 0.01 ufd, 100 wvdc, 20 percent	Ceramite
D1, D2	Diodes, 33 pf, Tuning, 10 percent (Voltage Variable Capacitors)	Motorola Epi-cap MV 1638
L1	Not Used	
L2	Coil, 1 Millihenry, Sub-Miniature R-F Choke	
Q1	Transistor, Silicon Signal	2N708
Q2	Transistor	3N153
R1	Resistor, 1.5K Film, 1/2 Watt, 10 percent	
R2	Resistor, 150K Film, 1/2 Watt, 10 percent	
R3	Resistor, 10K, Film, 1/2 Watt, 10 percent	
R4	Resistor, 2.2K, Film, 1/2 Watt, 10 percent	
R5	Resistor, 1 Meg, Film, 1/2 Watt, 10 percent	
R6	Resistor, 150 ohms, Film, 1/2 Watt, 10 percent	
R7	Resistor, 150K, Film, 1/2 Watt, 10 percent	
R8	Resistor, 150 ohms, Film, 1/2 Watt, 10 percent	
R9	Resistor, 2.7K, Film, 1/2 Watt, 10 percent	
R10	Resistor, 3.3K, Film, 1/2 Watt, 10 percent	
R11	Resistor, 47K, Film, 1/2 Watt, 10 percent	
R12	Resistor, 100K, Film, 1/2 Watt, 10 percent	

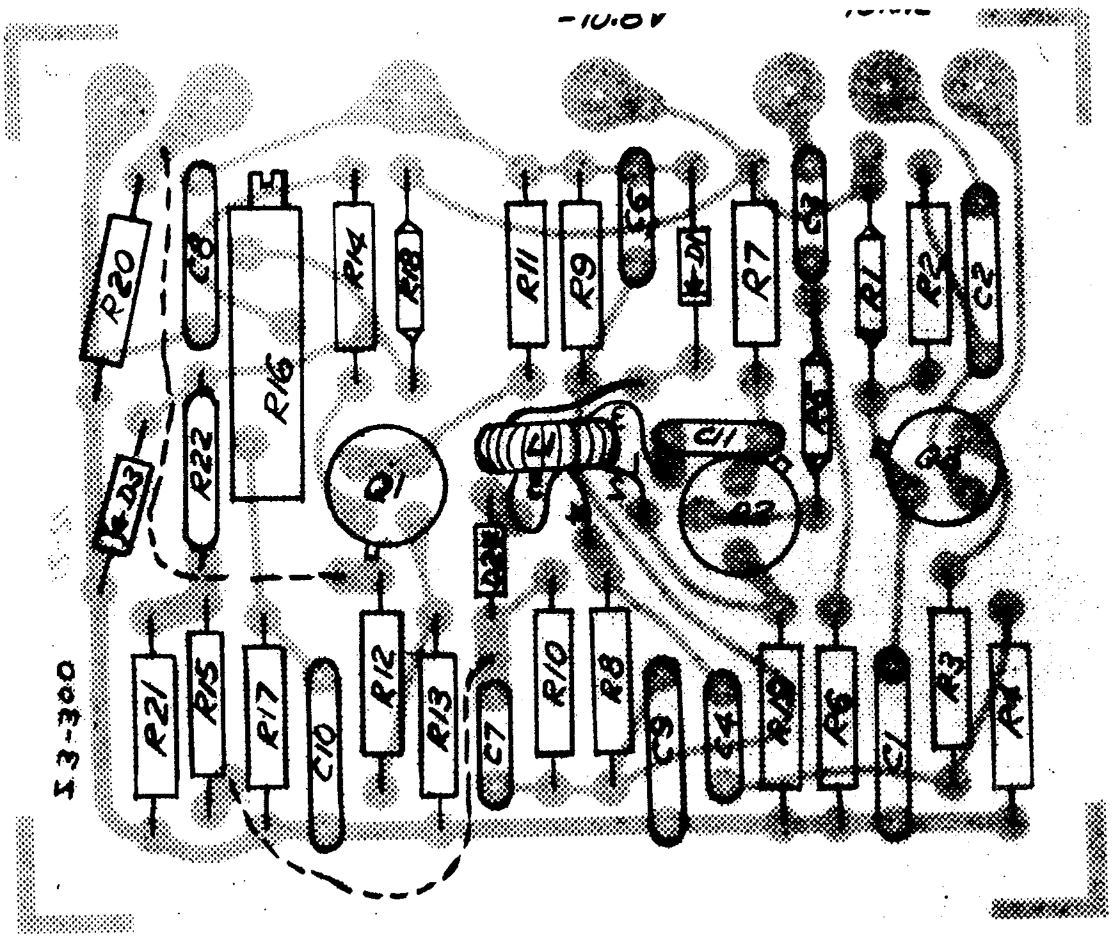


Figure 6-4. 0.97 to 1.96 MHz Phase Discriminator and Lock Voltmeter, A3, Parts Location

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A3	0.97 to 1.96 MHz Phase Discriminator and Lock Voltmeter	00211
C1,C8, C9, C10	Capacitor, Ceramic, 0.1 ufd, 25 wvdc, 20 percent	Erie Transcap
C2	Capacitor, Ceramic Temp. Comp. NPO, 47 pf, 1000 wvdc, 5 percent	Sprague 10TCC
C3,C4, C11	Capacitor, Ceramite, 0.001 ufd, 1000 wvdc, 20 percent	Sprague 5GA-D10
C5	Not Used	
C6,C7	Capacitor, Ceramite, 0.01 ufd, 100 wvdc, 20 percent	Sprague TG-S10
D1,D2	Diode, Silicon Signal	1N4454
D3	Diode, 8.2 volt Zener, 1 watt, 5 percent	1N4738A
Q1	Transistor, Field Effect	MFE 3006
Q2,Q3	Transistor, Silicon Signal	2N708
R1,R5, R18*	Resistor, Film, 150 ohms, 1/2 watt, 10 percent	
R2	Resistor, Film, 820 ohms, 1/2 watt, 10 percent	
R3,R4	Resistor, Film, 470 ohms, 1/2 watt, 10 percent	
R6	Resistor, Film, 100K, 1/2 watt, 10 percent	
R7	Resistor, Film, 910 ohms, 1/2 watt, 10 percent	
R8	Resistor, Film, 4.7K, 1/2 watt, 10 percent	
R9, R10, R11	Resistor, Film, 2.2 Megohms, 1/2 watt, 10 percent	
R12	Resistor, Film, 8.2K, 1/2 watt, 10 percent	
R13	Resistor, Film, 6.8K, 1/2 watt, 10 percent	
R14	Resistor, Film, 2.7K, 1/2 watt, 10 percent	
R15	Resistor, Film, 47K, 1/2 watt, 10 percent	
R16	Resistor, Variable Trimpot, 500 ohms, 10 percent	Amphenol 3800P
R17*	Resistor, Film, 680 ohms, 1/2 watt, 10 percent	
R19, R20	Resistor, Film, 1K, 1/2 watt, 10 percent	

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A3	0.97 to 1.96 MHz Phase Discriminator and Lock Voltmeter (continued)	00211
R21	Resistor, Film, 82K, 1/2 watt, 10 percent	
R22	Resistor, Film, 30K, 1/2 watt, 10 percent	
T1	Transformer, Bifilar Toroid	Lampkin 80X
	*NOTE Values shown for R17, R18, and R22 are nominal. Selected in production.	

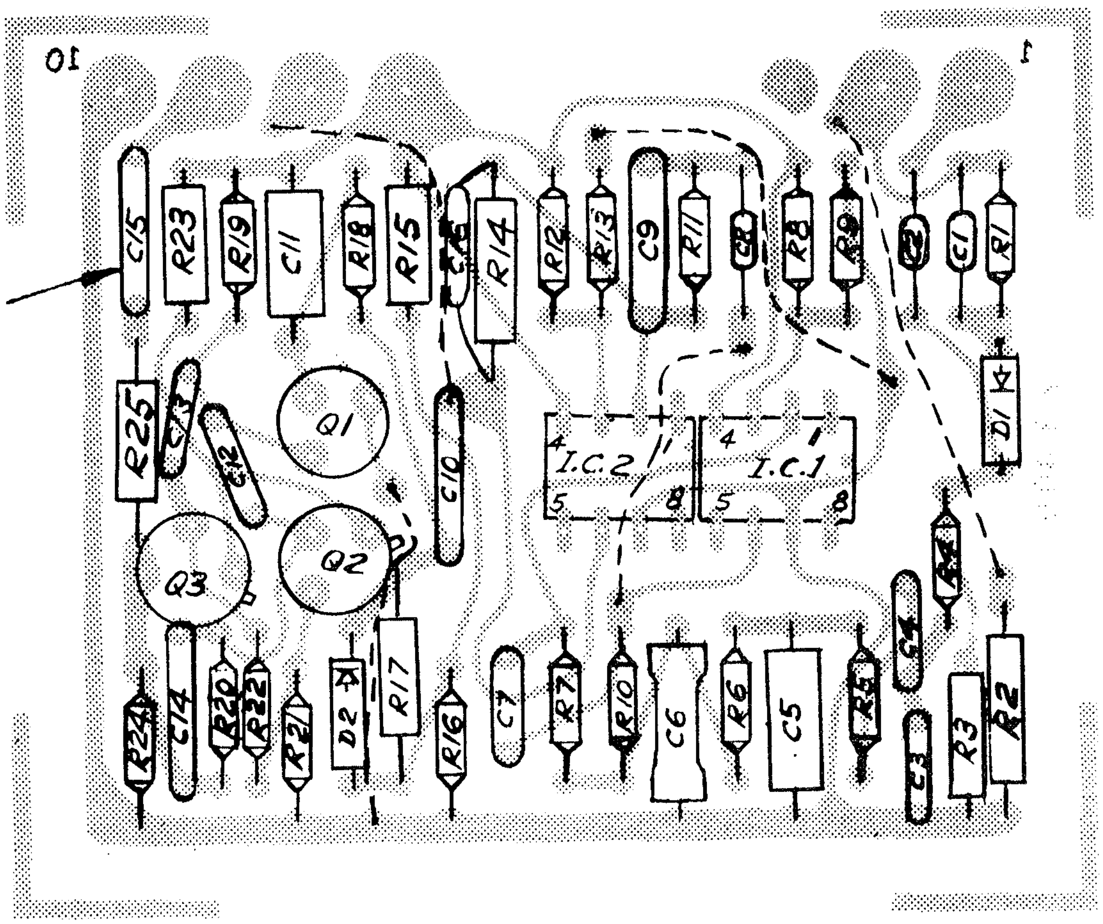


Figure 6-5. Beat Frequency Detector, 5 kHz Sweeper, A4, Parts Location

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A4	Beat Frequency Detector, 5 kHz Sweeper	00200
C1,C2, C7,C13	Capacitor, Ceramic Disc, 470 pf, 1000 wvdc, 20 percent	Sprague 5GA-T47
C3	Capacitor, Ceramite, 0.001 ufd, 1000 wvdc, 20 percent	Sprague 5GA-D10
C4	Capacitor, Ceramic Disc, 0.01 ufd, 25 wvdc, 20 percent	Sprague TG-510
C5	Capacitor, Pacer, 0.0082 ufd, 80 wvdc, 10 percent	Sprague 192P8229R8
C6	Capacitor, Pacer, 0.012 ufd, 80 wvdc, 10 percent	Sprague 192P1239R8
C8	Capacitor, Disc Ceramic, 0.22 ufd, 100 wvdc	Erie 813105061224M
C9	Capacitor, Disc Ceramic, 0.005 ufd, 1000 wvdc, 20 percent	
C10	Capacitor, Disc Ceramic, 0.1 ufd	Erie
C11	Capacitor, Tantalum, 3.3 ufd, 35 wvdc, 10 percent	
C12	Capacitor, Ceramite, 470 pf, 1000 wvdc, 20 percent	Sprague 5GA-D10
C14	Capacitor, Ceramic, 1000 pf, 1 kv wv	
C15	Capacitor, Ceramic Disc, 0.02-0.05 pf, 500 wvdc NOTE: Selected for desired sweep speed.	
IC1,IC2	Integrated Circuit	U9T7741393
Q1	Transistor, Unijunction	2N2646
Q2,Q3	Transistor, Silicon, Signal	2N708
R1,R4 thru R10, R12, R13, R21, R22, R24	Resistor, Film, 10K, 1/2 watt, 10 percent	
R2,R14, R25	Resistor, Film, 1 Megohm, 1/2 watt, 10 percent	

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A4	Beat Frequency Detector, 5 kHz Sweeper (continued)	00200
R3	Resistor, Film, 220K, 1/2 watt, 10 percent	
R11	Resistor, Film, 8.2K, 1/2 watt, 10 percent	
R15	Resistor, Film, 6.8K, 1/2 watt, 10 percent	
R16	Resistor, Film, 2.7K, 1/2 watt, 10 percent	
R17	Resistor, Film, 270K, 1/2 watt, 10 percent	
R18	Resistor, Film, 150K, 1/2 watt, 10 percent	
R19	Resistor, Film, 1000 ohms, 1/2 watt, 10 percent	
R20	Resistor, Film, 27K, 1/2 watt, 10 percent	
R23	Resistor, Film, 470 ohms, 1/2 watt, 10 percent	

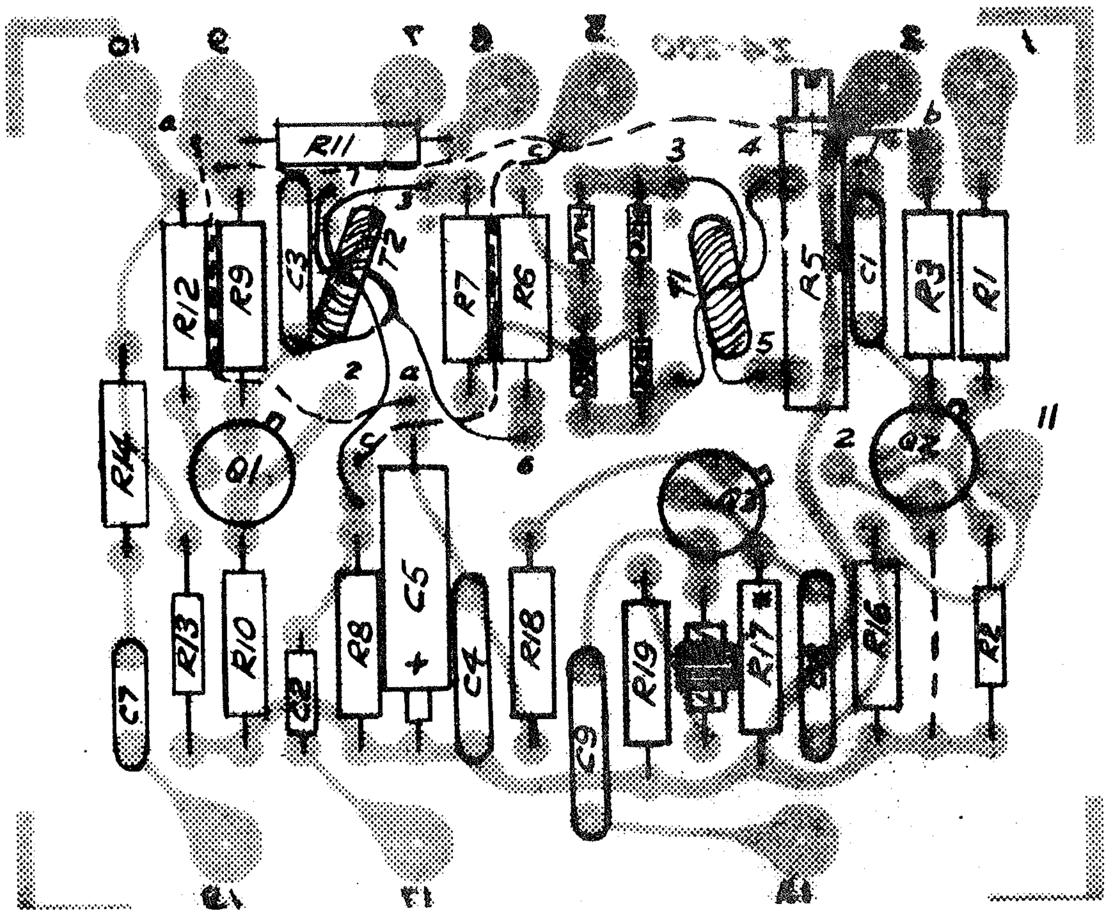


Figure 6-6. Double-Balanced Mixer, A5, Parts Location

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A5	Double-Balanced Mixer	00202
C1,C3, C4,C8, C9	Capacitor, Gen. Purpose Ceramic, 0.1 ufd, 25 wvdc	Erie Transcap
C2	Capacitor, Silver Mica, 270 pf	
C5	Capacitor, Tantalum, 68 ufd, 15 wvdc, 10 percent	Sprague 150D
C6	Not Used	
C7	Capacitor, Ceramic, 10 pf, NPO, 1000 wvdc, 5 percent	
D1,D2, D3,D4	Diode, Hot Carrier, (Matched)	H.P. 5082-2800
L1	RF Choke, Subminiature, 680 uh	Miller 70F-684AI
Q1,Q2, Q3	Transistor, Silicon Signal	2N708
R1,R6, R7,R11, R12	Resistor, Film, 150 ohms, 1/2 watt, 10 percent	
R2,R13	Resistor, Film, 120K, 1/2 watt, 10 percent	
R3,R9	Resistor, Film, 910 ohms, 1/2 watt, 10 percent	
R4	Not Used	
R5	Trimpot, 50 ohms, 10 percent	Amphenol 3800
R8,R18	Resistor, Film, 51 ohms, 1/2 watt, 10 percent	
R10	Resistor, Film, 1000 ohms, 1/2 watt, 10 percent	
R14	Resistor, Film, 10K, 1/2 watt, 10 percent	
R15	Not Used	
R16	Resistor, Film, 1.8K, 1/2 watt, 10 percent	
R17	Resistor, (Selected Value)	
R19	Resistor, Film, 6.8K, 1/2 watt, 10 percent	
T1	Transformer, RF, Split Tap	Lampkin 80X
T2	Transformer, RF	Lampkin 80Z

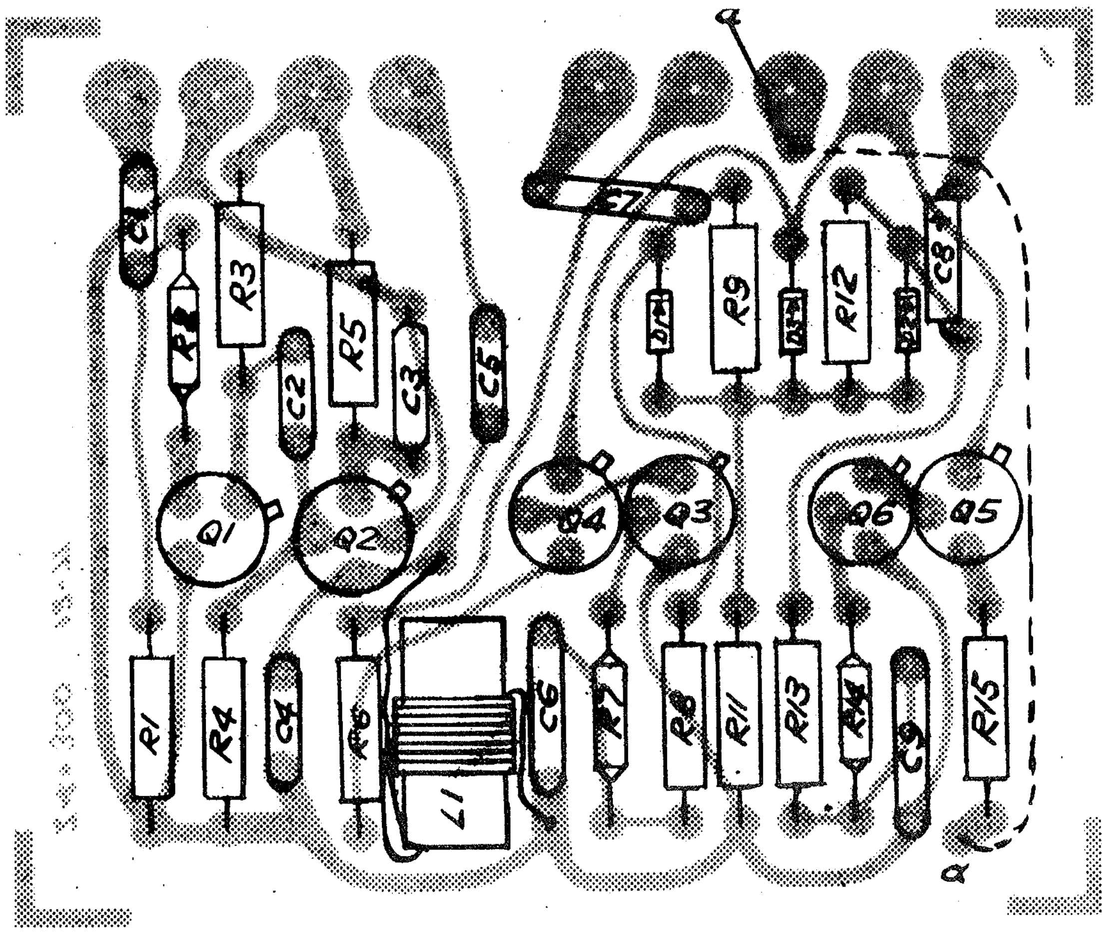


Figure 6-7. Dual Lamplighter and 3 MHz Amplifier, A6, Parts Location

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A6	Dual Lamplighter and 3 MHz Amplifier	00207
C1,C2	Capacitor, Ceramic Disc, 0.001 ufd, 1000 wvdc, 20 percent	Sprague 5GA-D10
C3	Capacitor, Ceramic Disc, 0.01 ufd, 100 wvdc, 20 percent	Sprague TG-S10
C4	Capacitor, Ceramic, Temp. Comp., NPO, 82 pf, 1000 wvdc, 5 percent	Sprague 10TCC
C5	Capacitor, Ceramic, Temp. Comp., NPO, 15 pf, 1000 wvdc, 5 percent	Sprague 10TCC
C6,C7, C9	Capacitor, 0.1 ufd, 25 wvdc	Erie Transcap
C8	Capacitor, Tantalum, 3.3 ufd, 35 wvdc, 10 percent	
D1,D2, D3	Diode, Silicon Signal	1N4454
L1	Coil, RF	Lampkin #75
Q1,Q3 thru Q6	Transistor, Silicon Signal	2N708
Q2	Transistor, Silicon RF	2N3293
R1	Resistor, Film, 1 Megohm, 1/2 watt, 10 percent	
R2,R7, R14	Resistor, Film, 150 ohms, 1/2 watt, 10 percent	
R3,R11	Resistor, Film, 10K, 1/2 watt, 10 percent	
R4,R8, R13	Resistor, Film, 100K, 1/2 watt, 10 percent	
R5	Resistor, Film, 330 ohms, 1/2 watt, 10 percent	
R6	Resistor, Film, 100 ohms, 1/2 watt, 10 percent	
R9,R12	Resistor, Film, 270K, 1/2 watt, 10 percent	
R10	Not Used	
R15	Resistor, Film, 51 ohms, 1/2 watt, 10 percent	

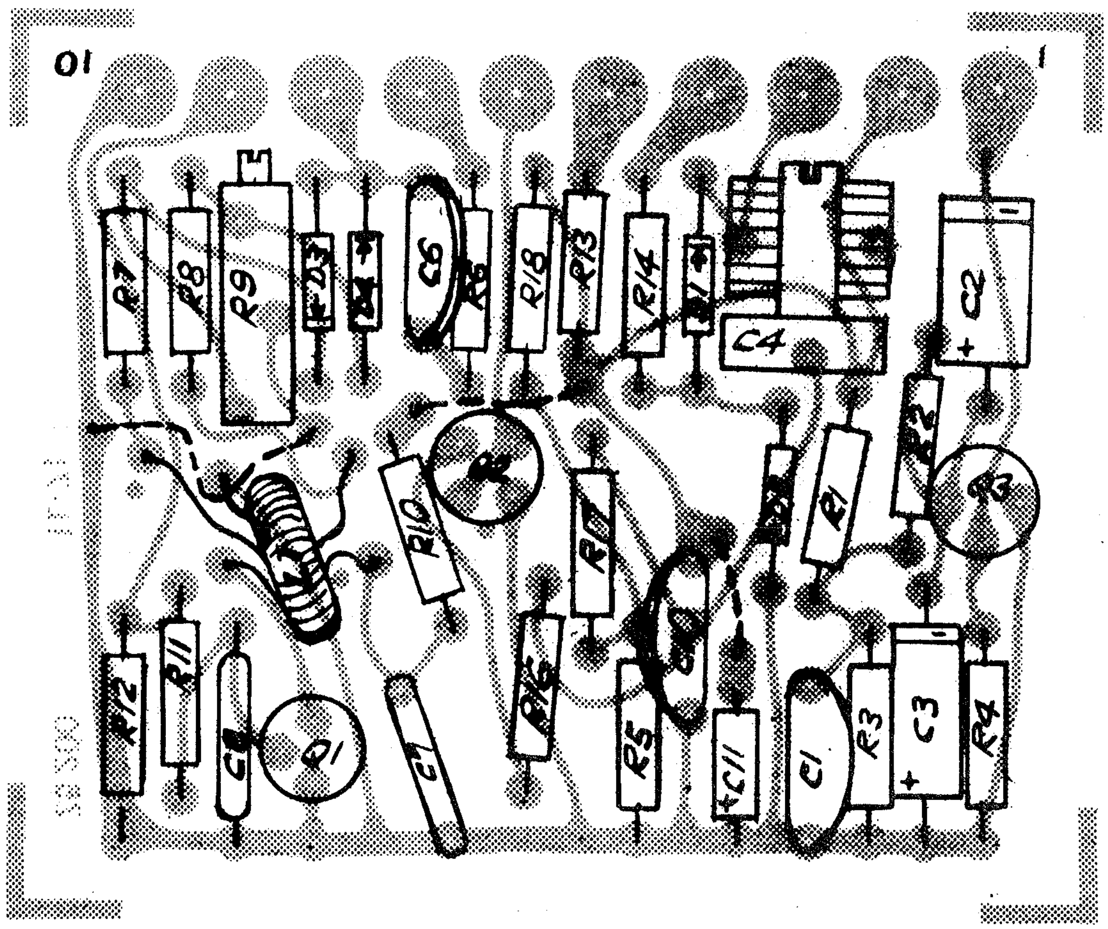


Figure 6-8. 30.0 to 39.9 kHz VCO, Mixer, LSB Trap, A7, Parts Location

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A7	30 kHz VCO, Mixer, LSB Trap	00208
C1,C6, C10	Capacitor, 0.1 ufd, 25 wvdc	Erie Transcap
C2,C3	Capacitor, .027 ufd	Midwec Type 12F 100V521
C4	Capacitor, Variable, 14.1 pf, Side Mount	Johnson Type U 189-505-105
C5	Not Used	
C7	Capacitor, Ceramic Disc, 0.01 ufd, 100 wvdc, 20 percent	Sprague TG-S10
C8	Capacitor, Ceramic, Temp. Comp., NPO, 33 pf, 1000 wvdc, 5 percent	Sprague 10-TCC
C9	Not Used	
C11	Capacitor, Tantalum, 10 uf, 20 wvdc, 10 percent	Sprague 150D
D1,D2	Diode, Econocap, 68 pf, 10 percent (Voltage Variable Capacitor)	Motorola MV-1646
D3,D4	Diode	1N34A5
Q1,Q3	Transistor, Silicon Signal	2N708
Q2	Transistor, MOSFET	3N153
R1	Resistor, Film, 6.8K, 1/2 watt, 10 percent	
R2	Resistor, Film, 1.5K, 1/2 watt, 10 percent	
R3	Resistor, Film, 4.7K, 1/2 watt, 10 percent	
R4	Resistor, Film, 27K, 1/2 watt, 10 percent	
R5	Resistor, Film, 180K, 1/2 watt, 10 percent	
R6	Resistor, Film, 3.9K, 1/2 watt, 10 percent	
R7,R8	Resistor, Film, 470 ohms, 1/2 watt, 10 percent	
R9	Resistor, Trimpot, 1000 ohms, 10 percent	Amphenol 3800P
R10	Resistor, Film, 1000 ohms, 1/2 watt, 10 percent	
R11,R13, R16	Resistor, Film, 150 ohms, 1/2 watt, 10 percent	
R12	Resistor, Film, 47K, 1/2 watt, 10 percent	

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A7	30 kHz VCO, Mixer, LSB Trap (continued)	00208
R14	Resistor, Film, 2.2 Megohms, 1/2 watt, 10 percent	
R15	Not Used	
R17	Resistor, Film, 1 Megohm, 1/2 watt, 10 percent	
R18	Resistor, Film, 68K, 1/2 watt, 10 percent	
T1	Transformer, RF	Lampkin 80X

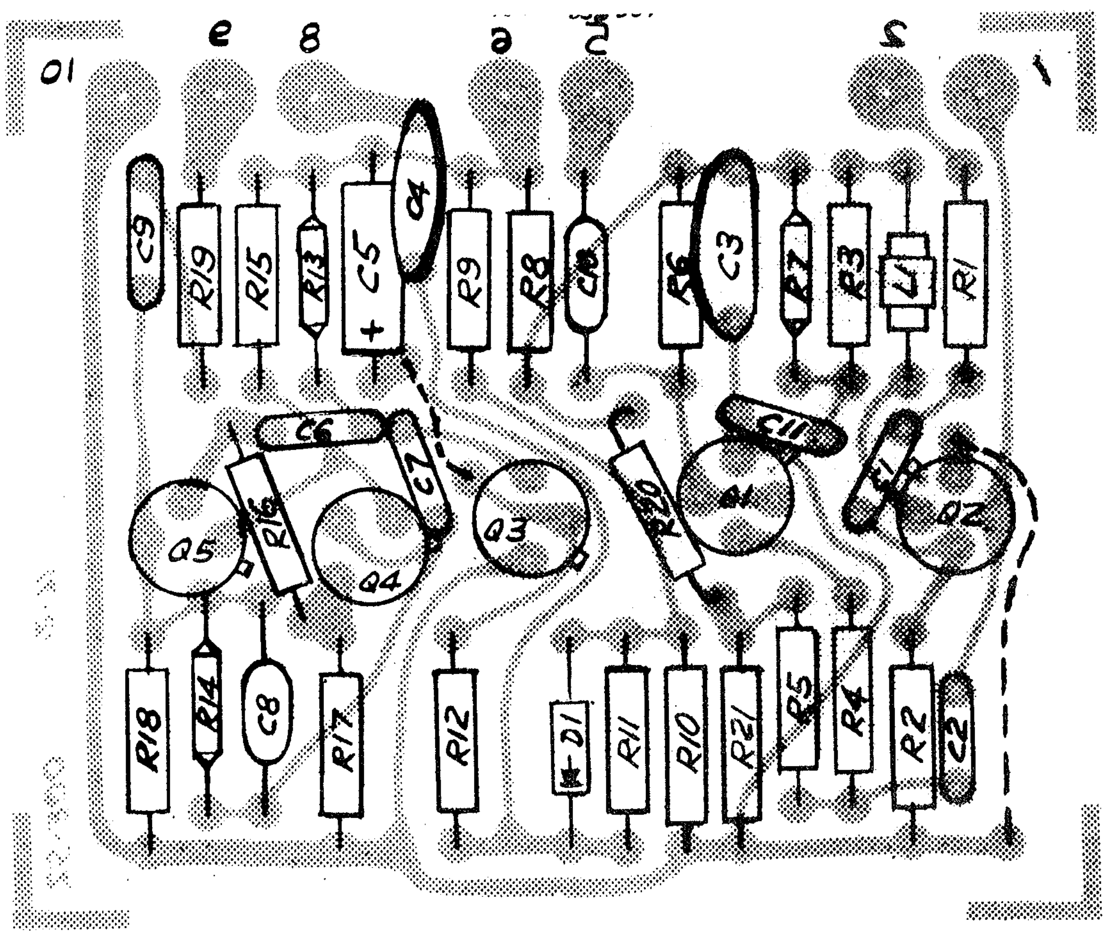


Figure 6-9. 30 kHz USB Tuner, and Sweeper, A8, Parts Location

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A8	30 kHz USB Tuner and Sweeper	00209
C1,C2, C8	Capacitor, Ceramic Disc, 0.001 ufd, 1000 wvdc, 20 percent	Sprague 5GA-D10
C3,C4, C11	Capacitor, Ceramic, 0.1 ufd, 25 wvdc, 20 percent	Erie Transcap
C5	Capacitor, Tantalum, 3.3 ufd, 35 wvdc, 10 percent	
C6,C7	Capacitor, Ceramic Disc, 470 pf, 1000 wvdc, 20 percent	Sprague 5GA-T47
C9	Capacitor, Ceramic, 0.05 ufd, 25 wvdc	Erie Transcap
C10	Capacitor, Ceramic Disc, 0.01 ufd, 1000 wvdc, 20 percent	Sprague TG-510
D1	Diode	1N34A5
L1	Choke, RF, 150 uh, Subminiature	Miller 70F154A1
Q1	Transistor, MOSFET	3N153
Q2	Transistor, Silicon RF	2N2193
Q3	Transistor, Unijunction	2N2646
Q4,Q5	Transistor, Silicon Signal	2N708
R1	Resistor, Film, 100 ohms, 1/2 watt, 10 percent	
R2	Resistor, Film, 82K, 1/2 watt, 10 percent	
R3	Resistor, Film, 680 ohms, 1/2 watt, 10 percent	
R4,R10	Resistor, Film, 2.7K, 1/2 watt, 10 percent	
R5	Resistor, Film, 470K, 1/2 watt, 10 percent	
R6	Resistor, Film, 4.7K, 1/2 watt, 10 percent	
R7,R13	Resistor, Film, 1000 ohms, 1/2 watt, 10 percent	
R8	Resistor, Film, 150 ohms, 1/2 watt, 10 percent	
R9	Resistor, Film, 6.8K, 1/2 watt, 10 percent	

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A8	30 kHz USB Tuner and Sweeper (continued)	00209
R11	Resistor, Film, 270K, 1/2 watt, 10 percent	
R12	Resistor, Film, 150K, 1/2 watt, 10 percent	
R14	Resistor, Film, 27K, 1/2 watt, 10 percent	
R15	Resistor, Film, 470 ohms, 1/2 watt, 10 percent	
R16, R17, R18	Resistor, Film, 10K, 1/2 watt, 10 percent	
R19	Resistor, Film, 1 Megohm, 1/2 watt, 10 percent	
R20	Resistor, Film, 47K, 1/2 watt, 10 percent	
R21	Resistor, Film, 100K, 1/2 watt, 10 percent	

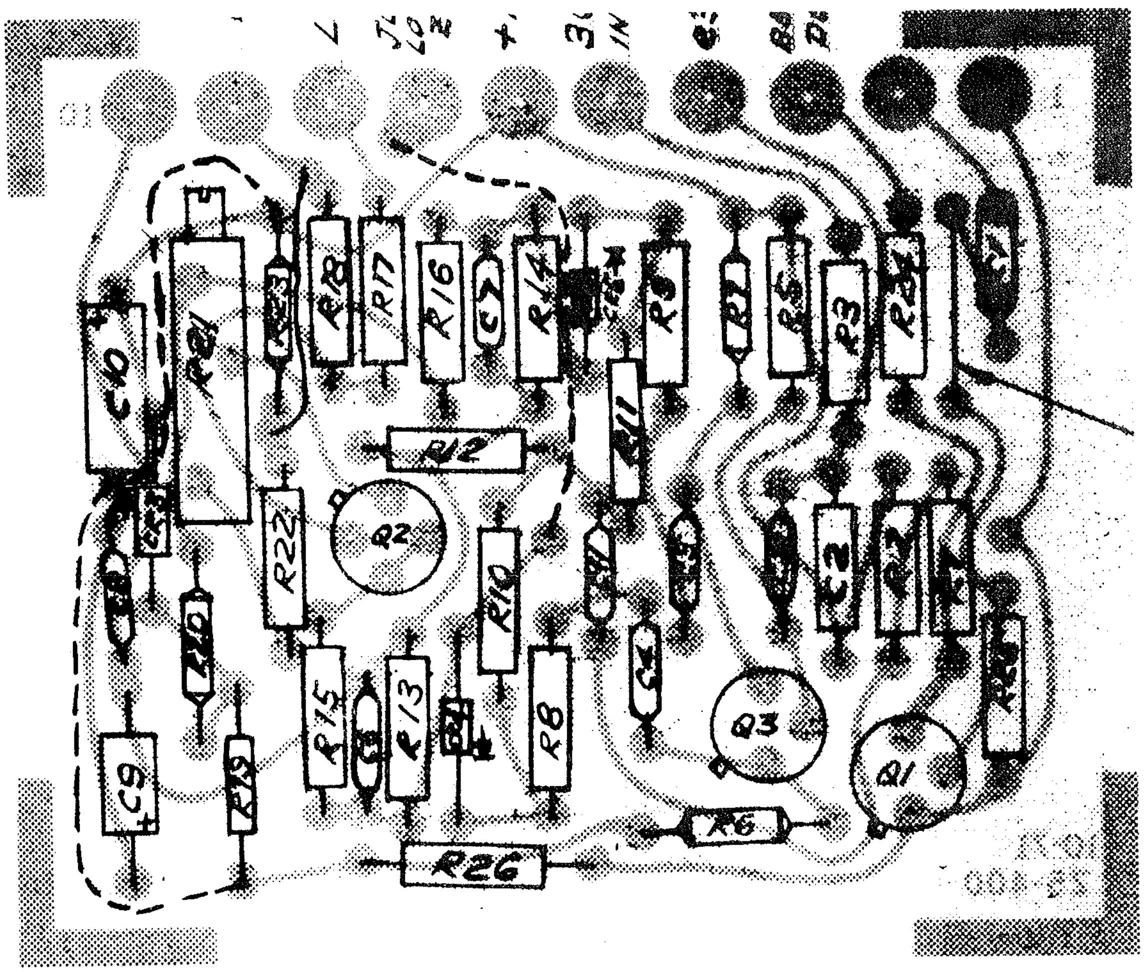


Figure 6-10. 30.0 to 39.9 kHz Phase Discriminator, Lock Voltmeter, A9, Parts Location

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A9	30-39.9 kHz Phase Discriminator, Lock Voltmeter	00201
C1,C2	Capacitor, Fixed, 3300 pf, 20 percent	
C3,C4, C5,C6, C7,C8, C11	Capacitor, Fixed, 0.1 ufd, 25 wvdc, 20 percent	
C9	Capacitor, Fixed, Tantalum, 1 uf, 35 wvdc, 10 percent	
C10	Capacitor, Fixed, Tantalum, 3 uf, 35 wvdc, 10 percent	
CR1,CR2	Not Used	
CR3	Diode, 6.8 volt Zener	1N4736
CR4,CR6	Diode, Silicon Signal	1N4454
Q1,Q3	Transistor, Silicon Signal	2N708
Q2	Transistor, Field Effect	MFE 3006
R1,R10, R11	Resistor, Film, 470 ohms, 1/2 watt, 10 percent	
R3	Resistor, Film, 2700 ohms, 1/2 watt, 10 percent	
R4	Not Used	
R5	Resistor, Film, 100K, 1/2 watt, 10 percent	
R6,R7, R20, R23	Resistor, Film, 680 ohms, 1/2 watt, 10 percent	
R8,R9	Resistor, Film, 720 ohms, 1/2 watt, 10 percent	
R12, R25	Resistor, Film, 4.7K, 1/2 watt, 10 percent	
R13, R14	Resistor, Film, 2 Megohm, 1/2 watt, 10 percent	
R15	Resistor, Film, 2.2 Megohm, 1/2 watt, 10 percent	
R16	Resistor, Film, 27K, 1/2 watt, 10 percent	
R17	Resistor, Film, 5100 ohms, 1/2 watt, 10 percent	
R18	Resistor, Film, 2.2K, 1/2 watt, 10 percent	

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A9	30-39.9 kHz Phase Discriminator, Lock Voltmeter (continued)	00201
R19	Resitor, Film, 330 ohms, 1/2 watt, 10 percent	
R21	Resistor, Variable, Trimpot, 500 ohms, 10 percent	Amphenol 3800
R22	Resistor, Film, 270 ohms, 1/2 watt, 10 percent	
R24	Resistor, Film, 8.2K, 1/2 watt, 10 percent	
R26	Resistor, Film, 150 ohms, 1/2 watt, 10 percent	

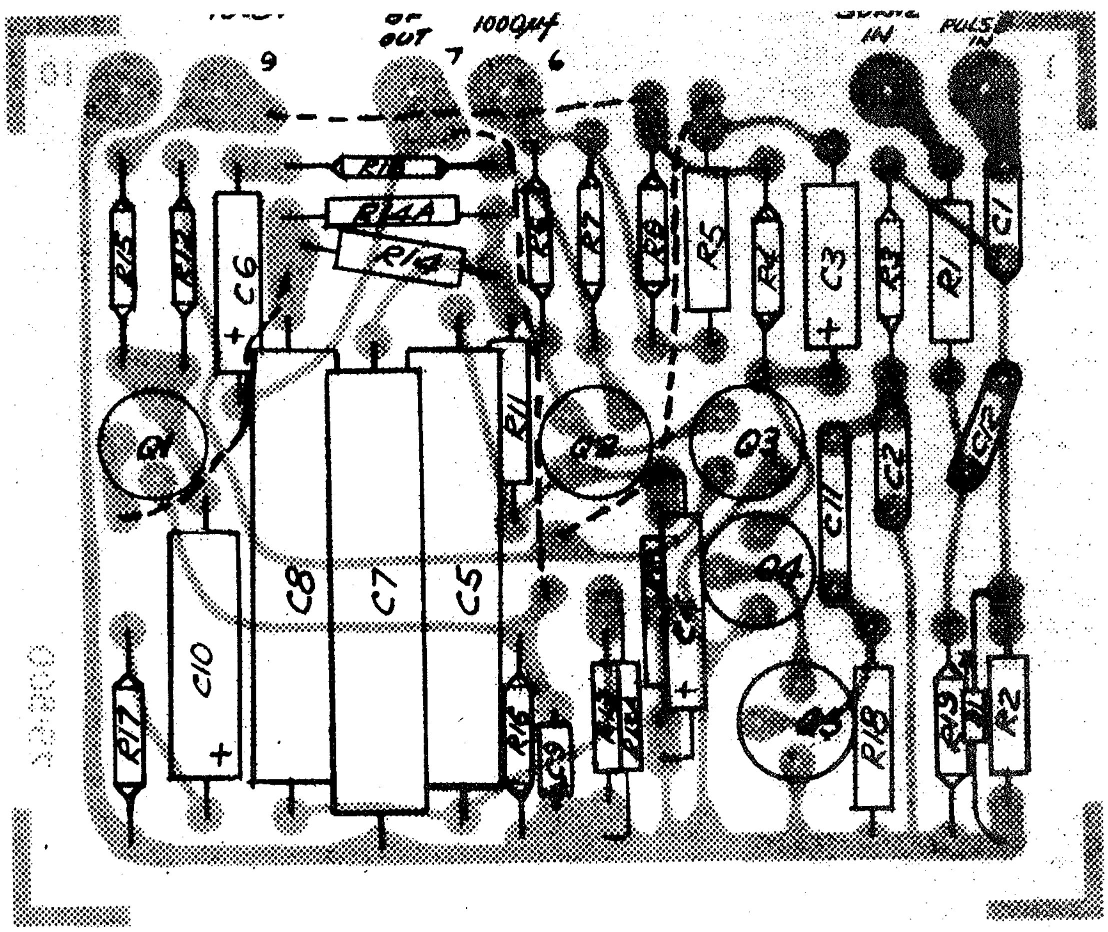


Figure 6-11. Beat Frequency Detector, 5 to 50 MHz Amplifier, A10, Parts Location

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A10	Beat Frequency Detector, 5 to 50 MHz Amplifier	00210
C1	Capacitor, Ceramic Disc, 0.001 ufd, 100 wvdc, 20 percent	
C2	Capacitor, Ceramic Disc, 0.01 ufd, 100 wvdc, 20 percent	
C3	Capacitor, Tantalum, 22 ufd, 15 wvdc, 10 percent	
C4,C9	Capacitor, Tantalum, 0.47 ufd, 35 wvdc, 10 percent	
C5,C7, C8	Capacitor, Mylar Film, 0.47 ufd, 80 wvdc, 10 percent	Pacer
C6	Capacitor, Tantalum, 10 ufd, 20 wvdc, 10 percent	
C10	Capacitor, Tantalum, 100 ufd, 10 wvdc, 10 percent	
C11	Capacitor, Ceramic, 0.1 ufd, 25 wvdc, 10 percent	
C12	Capacitor, Ceramic Disc, .005 ufd, 1000 wvdc, 20 percent	
D1	Diode, Silicon Signal	1N4454
Q1 thru Q5	Transistor, Silicon Signal	2N708
R1	Resistor, Film, 6.8K, 1/2 watt, 10 percent	
R2	Resistor, Film, 1 Megohm, 1/2 watt, 10 percent	
R3	Resistor, Film, 100K, 1/2 watt, 10 percent	
R4,R6, R16, R19	Resistor, Film, 10K, 1/2 watt, 10 percent	
R5	Resistor, Film, 220K, 1/2 watt, 10 percent	
R6	Resistor, Film, 10K, 1/2 watt, 10 percent	
R7,R17	Resistor, Film, 100 ohms, 1/2 watt, 10 percent	
R8	Resistor, Film, 15K, 1/2 watt, 10 percent	

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A10	Beat Frequency Detector, 5 to 50 MHz Amplifier (continued)	00210
R9	Resistor, Film, 680 ohms, 1/2 watt, 10 percent	
R10	Resistor, Film, 27K, 1/2 watt, 10 percent	
R11	Resistor, Film, 4.3K, 1/2 watt, 10 percent	
R12	Resistor, Film, 47K, 1/2 watt, 10 percent	
R13	Resistor, Film, 1500 ohms, 1/2 watt, 10 percent	
R13A	Resistor, Film, Nominal 3900 ohms, - Selected in Production	
R14	Resistor, Film, 5600 ohms, 1/2 watt, 10 percent	
R14A	Resistor, Film, - Selected in Production	
R15	Resistor, Film, 1.5K, 1/2 watt, 10 percent	
R18	Resistor, Film, 2.2 Megohms, 1/2 watt, 10 percent	

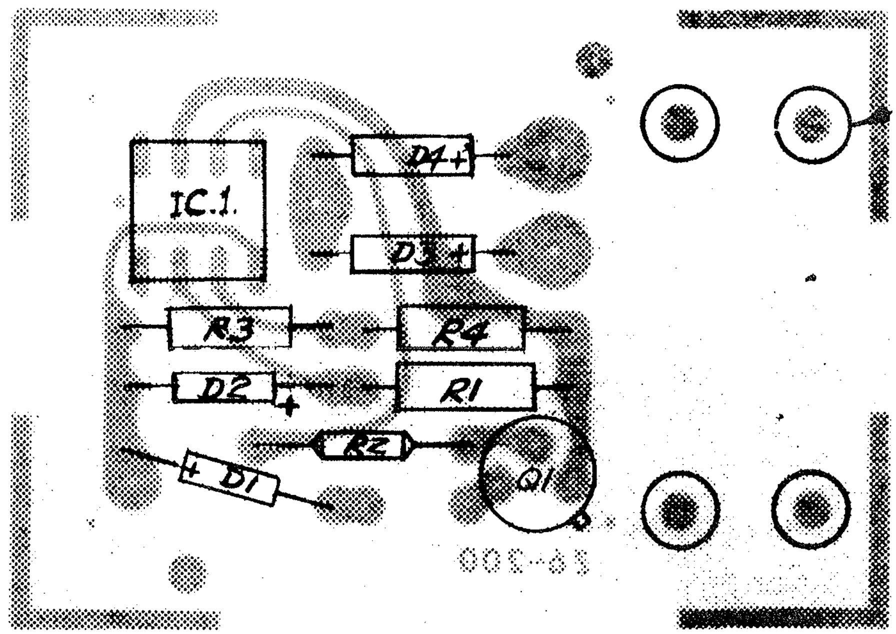


Figure 6-12. Power Supply A11, Parts Location

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A11	Power Supply	00212
D1	Diode, Zener, Glass Case, 7.0 ohms max, 1 watt	1N4740
D2	Diode, Zener, Glass Case, 4.3 to 5.4 v, 250 milliwatt	1N705
D3,D4	Diode, Silicon Power	1N4002
IC1	Integrated Circuit	RC741DN
Q1	Transistor	2N3638
Q2	Transistor	40250
R1	Resistor, Film, 470 ohms, 1/2 watt, 10 percent	
R2	Resistor, Film, 4.7K, 1/2 watt, 10 percent	
R3	Resistor, Film, 4.53K, 1/2 watt, 1 percent	
R4	Resistor, Film, 4.53K, 1/2 watt, 1 percent	

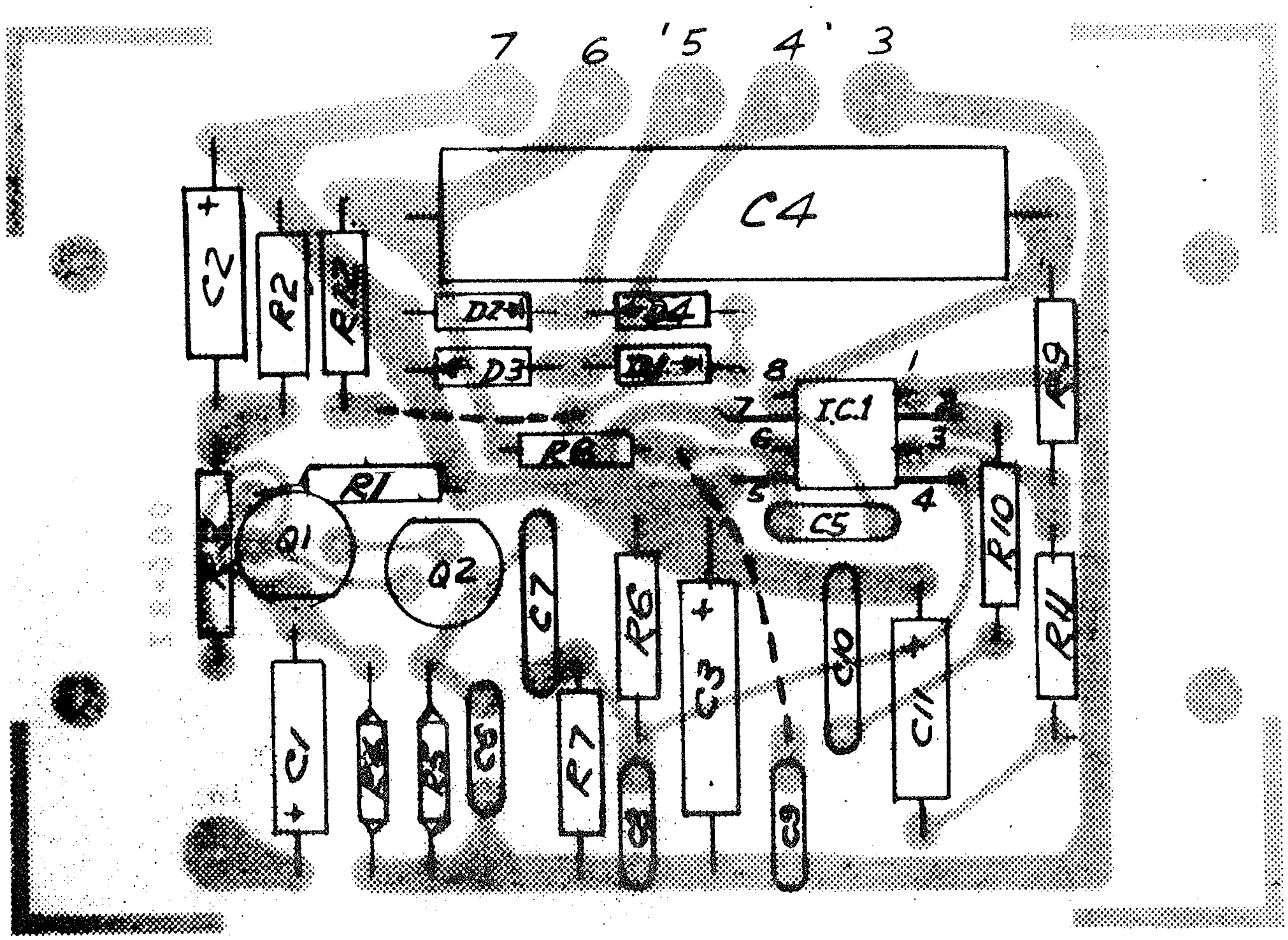


Figure 6-13. Audio Amplifier A12, Parts Location

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A12	Audio Amplifier	00214
C1	Capacitor, Tantalum, 3.3 ufd, 35 wvdc, 20 percent	Sprague 150D
C2,C11	Capacitor, Tantalum, 10 ufd, 20 wvdc, 20 percent	Sprague 150D
C3	Capacitor, Tantalum, 100 ufd, 10 wvdc, 20 percent	Sprague 150D
C4	Capacitor, Electrolytic, 450 ufd, 10 wvdc, +75 -10 percent	Cornell-Dubilier Electromite
C5	Capacitor, Ceramic Disc, 200 pf, 1000 wvdc, 20 percent	Sprague Ceramite Z5U Type
C6	Capacitor, Ceramic Disc, 100 pf, 1000 wvdc, 20 percent	Sprague Ceramite Z5U Type
C7,C10	Capacitor, Ceramic Disc, 0.1 ufd, 25 wvdc, 20 percent	Erie Transcap
C8,C9	Capacitor, Ceramic Disc, 100 pf, 1000 wvdc, 20 percent	Sprague Ceramite Type Z5U
D1 thru D4	Diode	1N34AS
IC1	Integrated Circuit (Motorola) 1 watt	MFC 8010
Q1	Transistor, Silicon Signal	2N5086
Q2	Transistor, Silicon Signal	2N5088
R1,R5 R12	Resistor, Film, 4.7K, 1/2 watt, 10 percent	
R2	Resistor, Film, 1000 ohms, 1/2 watt, 10 percent	
R3	Resistor, Film, 100 ohms, 1/2 watt, 10 percent	
R4	Resistor, Film, 27K, 1/2 watt, 10 percent	
R6	Resistor, Film, 1.0 Megohm, 1/3 watt, 10 percent	
R7	Resistor, Film, 1.0 Megohm, 1/2 watt, 10 percent	
R8,R9	Resistor, Film, 10K, 1/2 watt, 10 percent	
R10	Resistor, Film, 100 ohms, 1/2 watt, 10 percent	

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A12	Audio Amplifier (continued)	00214
R11	Resistor, Film, 100 ohms, 1/2 watt, 10 percent	
R12	Resistor, Film, 4.7K, 1/2 watt, 10 percent	

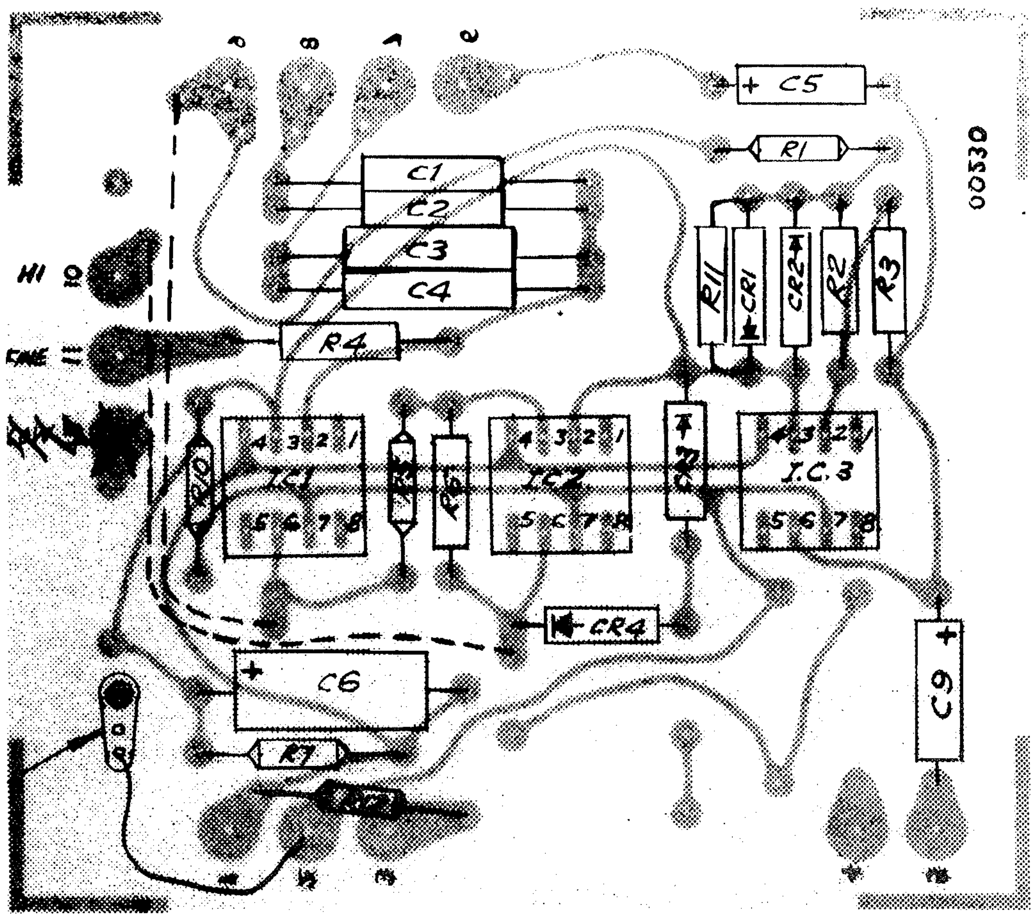


Figure 6-14. AM-FM Modulator A13, Parts Location

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A13	AM-FM Modulator	00216
C1,C2	Capacitor, 0.033 ufd, 200 wvdc	MCR 2S33
C3,C4	Capacitor, 0.33 ufd, 100 wvdc	MCR 1P33
C5,C9	Capacitor, Tantalum, 3.3 ufd, 35 wvdc, 10 percent	
C6	Capacitor, Tantalum, 68.0 ufd, 15 wvdc, 20 percent	
C7	Not Used	
C8	Not Used	
CR1,CR2	Diode, Silicon Signal	1N4454
CR3,CR4	Diode	1N5226
IC1,IC2, IC3	Integrated Circuit	RC741DN
R1,R4, R7, R10	Resistor, Film, 1000 ohms, 1/2 watt, 10 percent	
R2,R11	Resistor, Film, 2.7K, 1/2 watt, 10 percent	
R3	Resistor, Film, 18K, 1/2 watt, 10 percent	
R5	Resistor, Film, 2.2K, 1/2 watt, 10 percent	
R6	Resistor, Film, 6.8K, 1/2 watt, 10 percent	
R8	Not Used	
R9	Not Used	

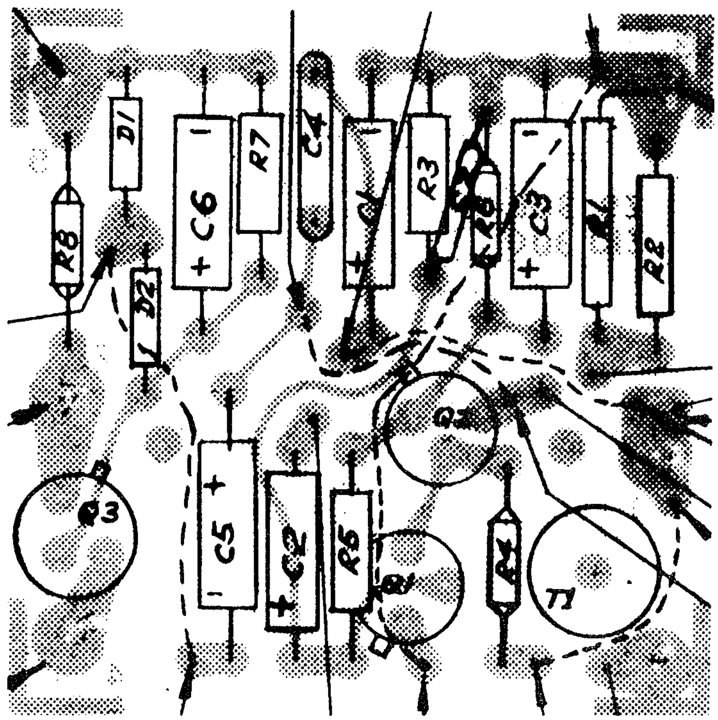


Figure 6-15. Proportional Oven (1) for 1 MHz oscillator, A14, (2) for 3 MHz oscillator, A15

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A14,	Proportional Oven, for 1 MHz oscillator	00198
A15	Proportional Oven, for 3 MHz oscillator	00217
C1	Capacitor, Tantalum, 22 ufd, 15 wvdc, 10 percent	Sprague 150D
C2	Capacitor, Tantalum, 3.3 ufd, 20 wvdc, 10 percent	Sprague 150D
C3,C6	Capacitor, Tantalum, 10 ufd, 20 wvdc, 10 percent	Sprague 150D
C4,C7	Capacitor,Ceramic, 0.1 ufd, 25 wvdc, 20 percent	Erie Transcap
C5	Capacitor, Tantalum, 4.7 ufd, 35 wvdc, 10 percent	Sprague 150D
D1,D2	Diode, Crystal	1N34AS
Q1,Q2, Q3	Transistor, NPN, Silicon Signal	2N708
Q4	Transistor	40250
R1	Resistor, Wire-wound, One of 390, 400, 425,450, or 470 ohms, Selected in Production	Dalohm RS-1B
R2	Resistor, Film, One of 1K to 6K, 1/2 watt, 10 percent, Selected in Production	
R3,R5, R7	Resistor, Film, 12K, 1/2 watt, 10 percent	
R4	Resistor, Film, 2.7K, 1/2 watt, 10 percent	
R6,R8	Resistor, Film, 1000 ohms, 1/2 watt, 10 percent	
T1	Transformer, Pri. 10K-12K, Sec. 500-600 ohms	UTC DO-T9

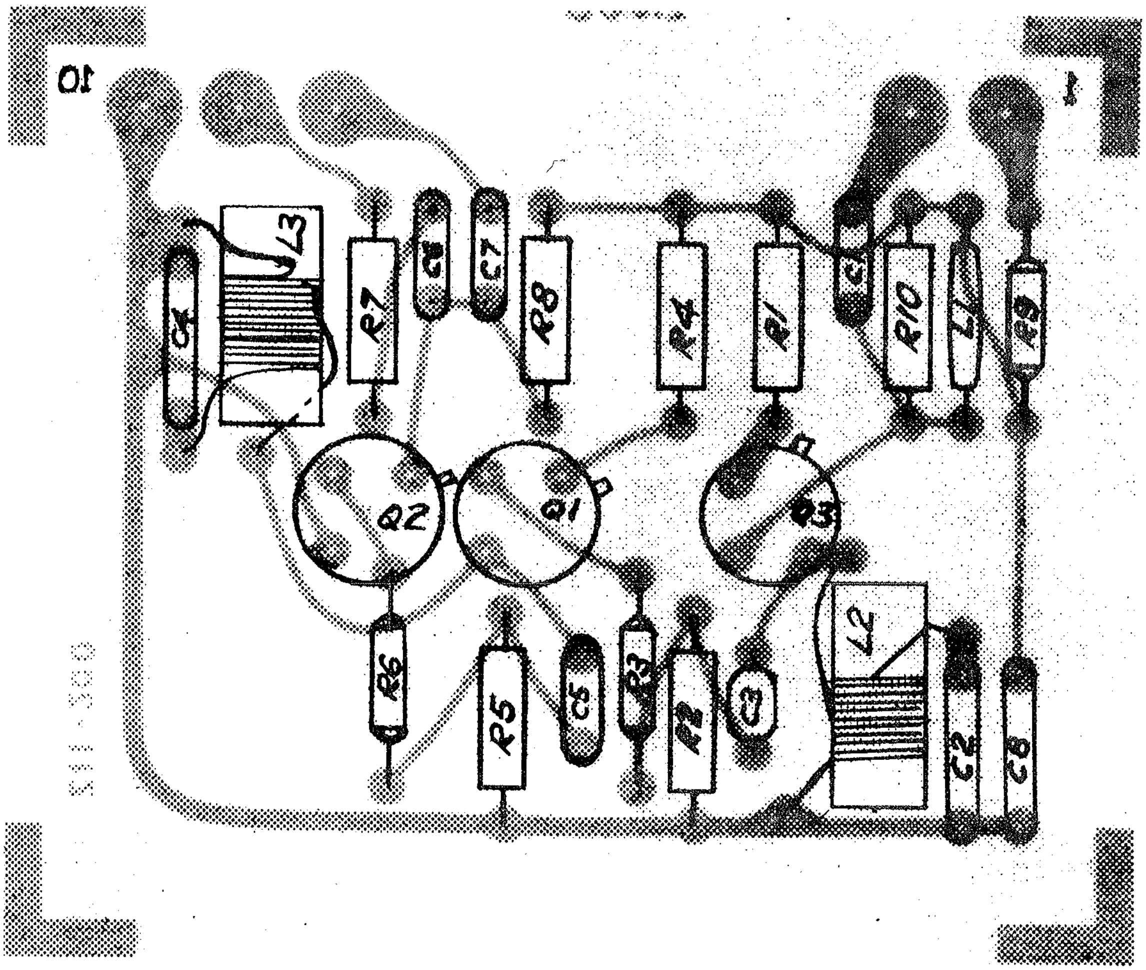


Figure 6-16. 10 MHz Multiplier, A16, Parts Location

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A16	10 MHz Multiplier	00199
C1	Capacitor, Ceramic, Temp. Comp., NPO, 15 pf, 1000 wvdc, 5 percent	Sprague Type 10TCC
C2,C4	Capacitor, Ceramic, Temp. Comp., NPO, 68 pf, 1000 wvdc, 5 percent	Sprague Type 10TCC
C3,C6, C7	Capacitor, Ceramic, 100 pf, 100 wvdc, 10 percent, G.P.	
C5	Capacitor, Ceramic, 0.001 ufd, 1000 wvdc, 10 percent	Sprague Ceramite 5GA-D10
C8	Capacitor, Ceramic, 0.1 ufd, 25 wvdc, 10 percent	Erie Transcap
L1	Choke, R.F., 100 uf, Subminiature	Miller 70F104A1
L2,L3	Coil, Tapped	Lampkin #69
Q1,Q2, Q3	Transistor, Silicon Signal	2N708
R1	Resistor, Film, 10 ohms, 1/2 watt, 10 percent	
R2,R5, R7	Resistor, Film, 47K, 1/2 watt, 10 percent	
R3,R6, R9	Resistor, Film, 150 ohms, 1/2 watt, 10 percent	
R4,R8	Resistor, Film, 1000 ohms, 1/2 watt, 10 percent	
R10	Resistor, Film, 3.3K, 1/2 watt, 10 percent	

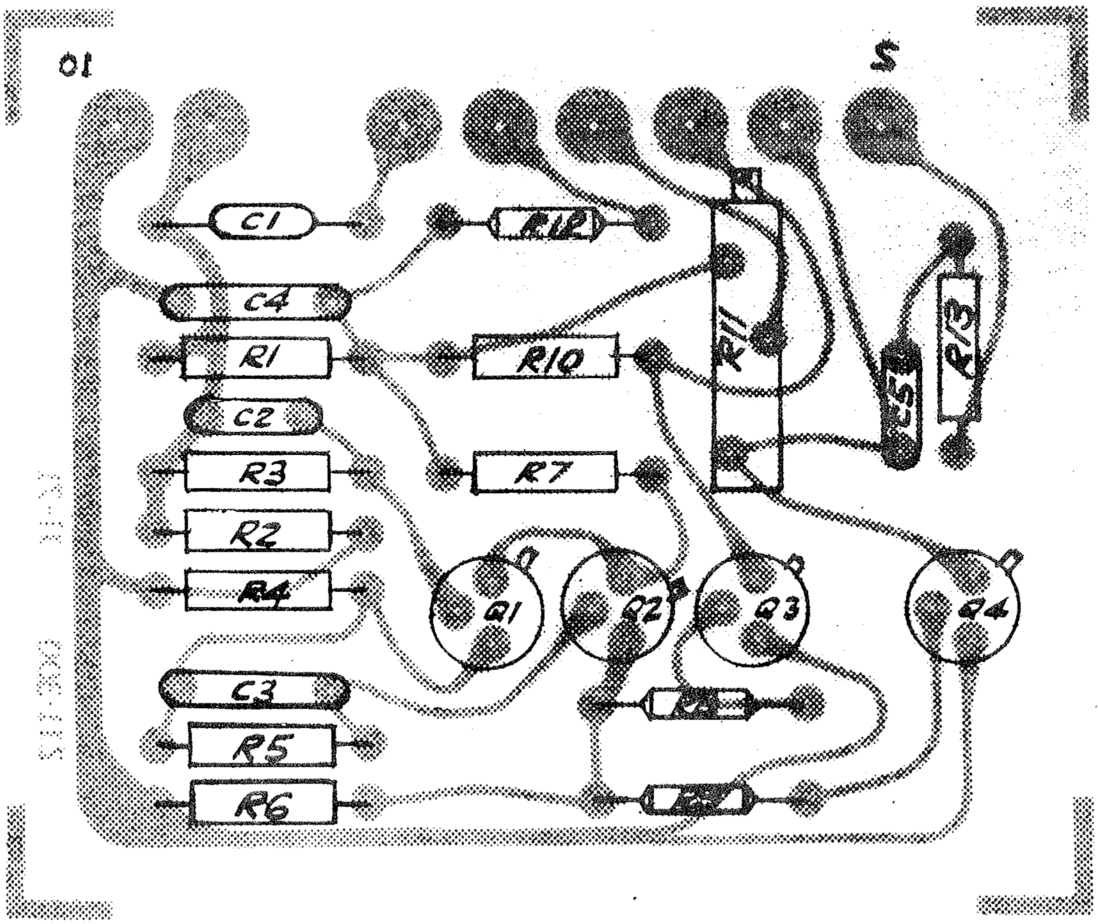


Figure 6-17. 1 MHz Schmitt Trigger, A17, Parts Location

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A17	1 MHz Schmitt Trigger	00203
C1	Capacitor, Ceramic, 0.001 ufd, 1000 wvdc, 20 percent	Sprague 5GA-D10
C2	Capacitor, Ceramic, Temp. Comp., NPO, 22 pf, 1000 wvdc, 5 percent	Sprague 10TCC
C3	Capacitor, Ceramic, Temp. Comp., NPO, 56 pf, 1000 wvdc, 5 percent	Sprague 10TCC
C4	Capacitor, Ceramic, 0.1 ufd, 25 wvdc, 20 percent	Erie Transcap
C5	Capacitor, Ceramic, 100 pf, GP, 1000 wvdc, 10 percent	Centralab DD-101
Q1,Q2, Q3,Q4	Transistor, Silicon Signal	2N708
R1	Resistor, Film, 2.2K, 1/2 watt, 10 percent	
R2	Resistor, Film, 15K, 1/2 watt, 10 percent	
R3	Resistor, Film, 4.7K, 1/2 watt, 10 percent	
R4	Resistor, Film, 1.8K, 1/2 watt, 10 percent	
R5	Resistor, Film, 4.7K, 1/2 watt, 10 percent	
R6	Resistor, Film, 680 ohms, 1/2 watt, 10 percent	
R7	Resistor, Film, 20 ohms, 1/2 watt, 10 percent	
R8,R9, R12	Resistor, Film, 150 ohms, 1/2 watt, 10 percent	
R10	Resistor, Film, 1000 ohms, 1/2 watt, 10 percent	
R11	Resistor, Variable Trimpot, 1000 ohms, 10 percent	Amphenol 3800
R13	Resistor, Film, 47K, 1/2 watt, 10 percent	

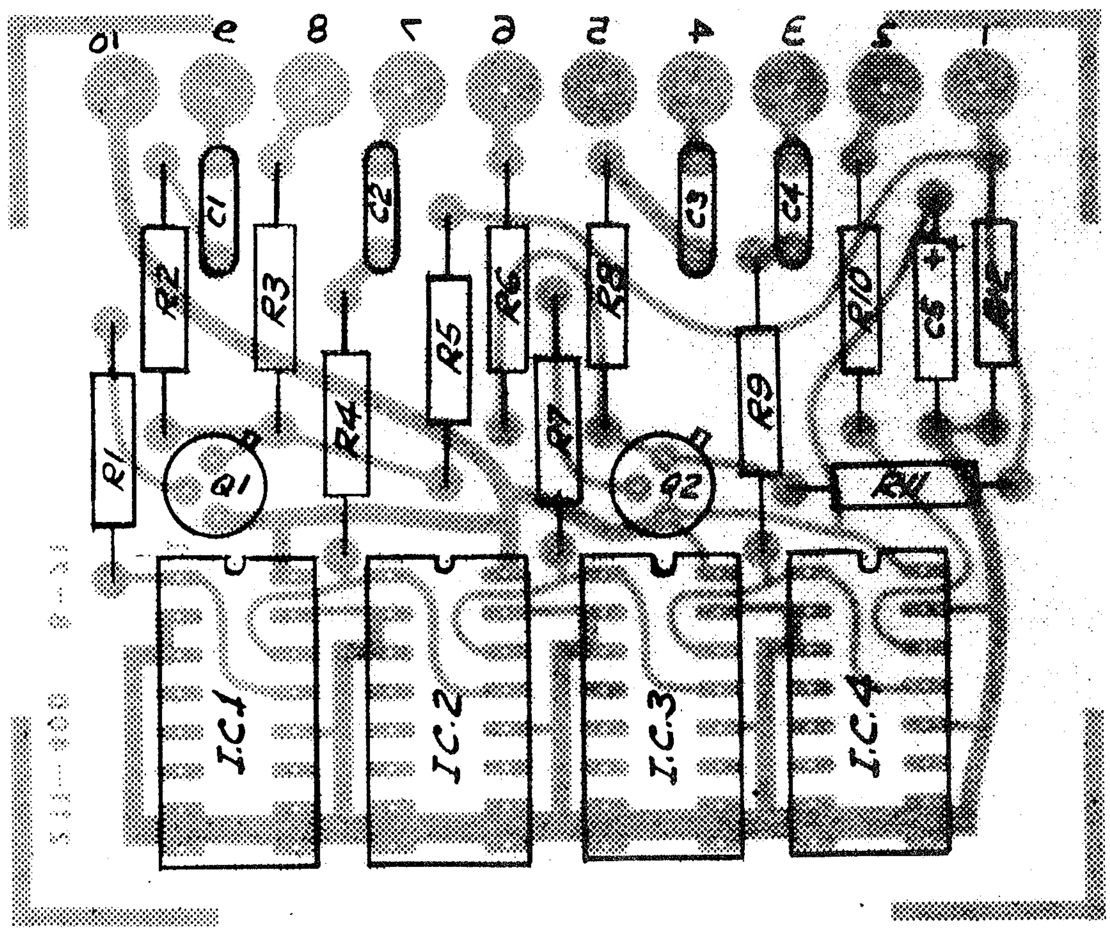


Figure 6-18. Decade Divider, A18, Parts Location

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A18	Decade Frequency Dividers	00206
C1,C2	Capacitor, Ceramic Disc, 0.05 ufd, 25 wvdc, 20 percent	Sprague
C3,C4	Capacitor, Ceramic Disc, 470 pf, 100 wvdc, 20 percent	Sprague
C5	Capacitor, Tantalum, 1.0 ufd, 35 wvdc, 20 percent	Sprague
IC1,IC2, IC3, IC4	Integrated Circuit, COS/MOS - Monolithic	RCA CD-4018 AE
Q1,Q2	Transistor, Silicon	2N708
R1,R7	Resistor, Film, 3.3K, 1/2 watt, 10 percent	
R2,R4	Resistor,Film, 47K, 1/2 watt, 10 percent	
R3,R6	Resistor,Film, 470 ohms, 1/2 watt, 10 percent	
R5,R11	Resistor, Film, 1.5K, 1/2 watt, 10 percent	
R8,R9	Resistor, Film, 27K, 1/2 watt, 10 percent	
R10	Resistor, Film, 1K, 1/2 watt, 10 percent	
R12	Resistor, Film, 150 ohms, 1/2 watt, 10 percent	

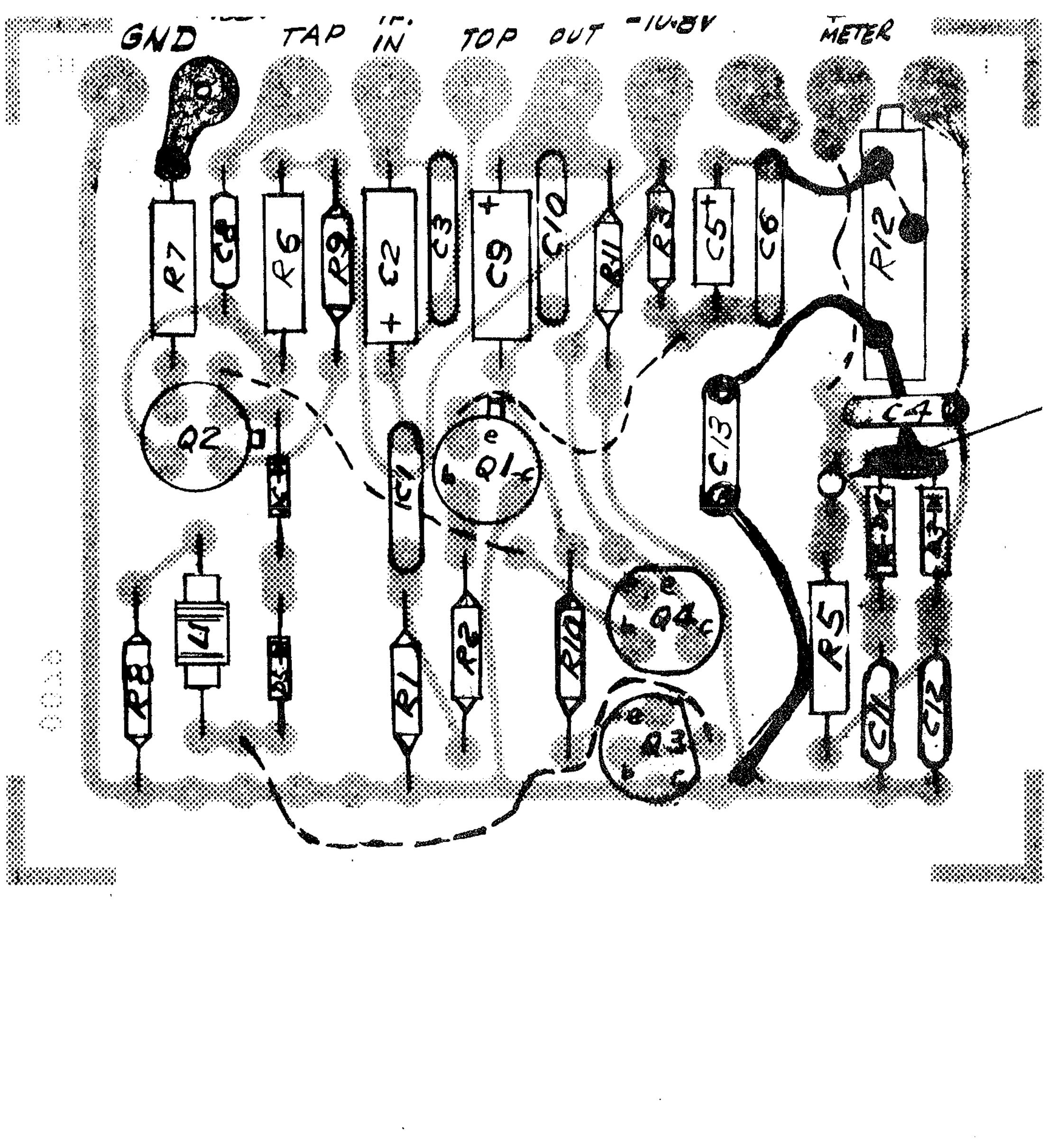


Figure 6-19. Attenuator and IF Metering, A19, Parts Location

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A19	Attenuator and IF Metering	00213
C1,C3, C4,C6, C10, C11, C12	Capacitor, Ceramic, 0.1 ufd, 25 wvdc,	Erie Transcap
C2,C9	Capacitor, Tantalum, 10 ufd, 20 wvdc, 10 percent	
C5	Capacitor, Tantalum, 1.0 ufd, 35 wvdc, 20 percent	
C7	Capacitor, Variable	Johnson 189-505-4
C8	Capacitor, Ceramic, 0.22 ufd, 25 wvdc, 20 percent	Erie Transcap
D1,D2	Not Used	
D3,D4	Diode	1N34AS
D5,D6	Diode, Silicon Signal	1N4454
L1	Choke, RF, 15 uh	Miller 70F155A1
R1	Resistor, Film, 82K, 1/2 watt, 10 percent	
R2	Resistor, Film, 150 ohms, 1/2 watt, 10 percent	
R3,R4	Resistor, Film, 2.7K, 1/2 watt, 10 percent	
R5	Resistor, Film, 1.8K, 1/2 watt, 10 percent	
R6	Resistor, Film, 150K, 1/2 watt, 10 percent	
R7	Resistor, Film, 10K, 1/2 watt, 10 percent	
R8,R11	Resistor, Film, 1000 ohms, 1/2 watt, 10 percent	
R9	Resistor, Film, 100 ohms, 1/2 watt, 10 percent	
R10	Resistor, Film, 10 ohms, 1/2 watt, 10 percent	
R12	Resistor, Variable, Trimpot, 500 ohms	Veco 31A18
RT1	Thermistor	Veco 31A18

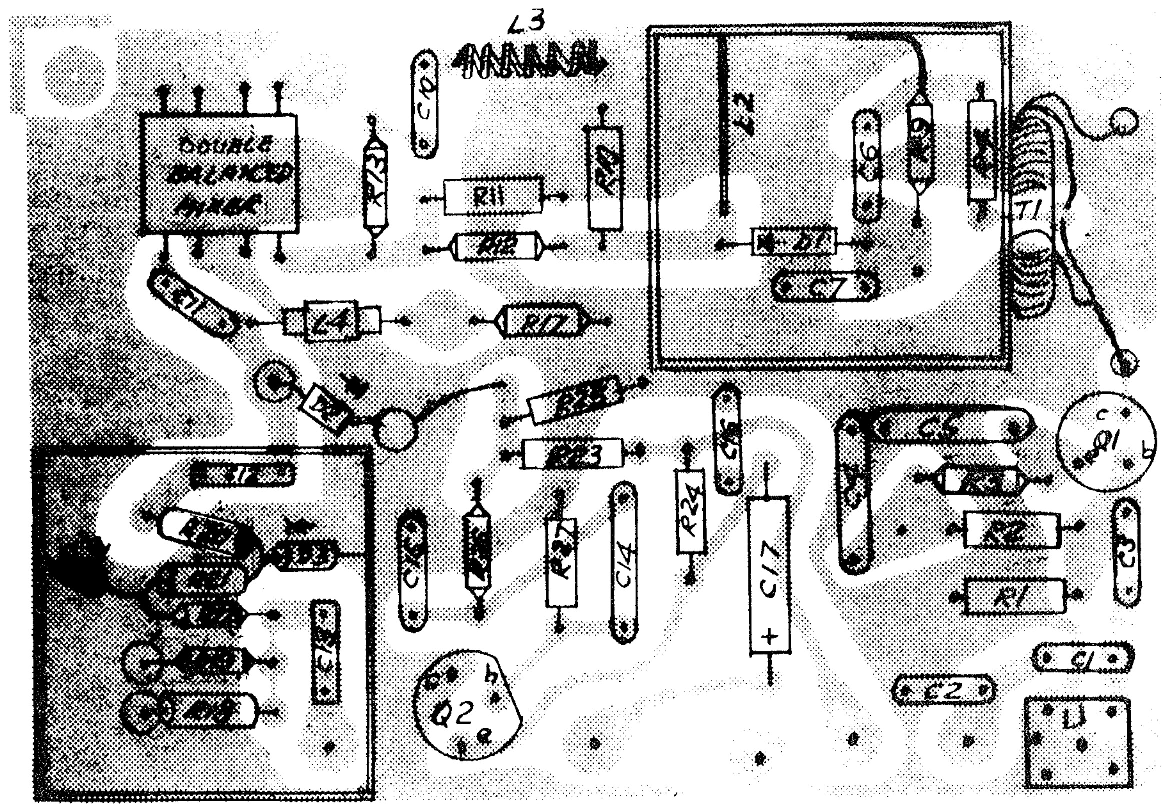


Figure 6-20. Multiplier, Mixer, and Detector, A20, Parts Location

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A20	Multiplexer, Mixer and Detector	00215
C1,C2, C6	Capacitor, Ceramic Disc, 470 pf, 1000 wvdc, 20 percent	Erie Transcap
C3	Capacitor, Ceramic, 170 pf	
C4,C5, C14	Capacitor, Ceramic Disc, 0.1 ufd, 10 percent	Erie Transcap
C7	Capacitor, Ceramic, 6.8 to 10 pf, 1kv, Selected in Production	Sprague Type Z5U
C8,C9	Not Used	
C10	Capacitor, Ceramic Disc (Nominal 470 pf), (Selected in Production)	Erie Transcap
C11	Capacitor, Ceramic, 150 pf, 5 percent	
C12,C13	Capacitor, Ceramic, 0.01 uf, 50 wvdc	Erie
C15,C16	Capacitor, Ceramic Disc, 1000 pf, 1 kv wvdc, 10 percent	
C17	Capacitor, Tantalum, 3.3 ufd, 35 wvdc, 10 percent	Sprague
D1	Diode	5082-0180
D2	Diode	
D3,D4	Diode, PIN	UTR-4001
L1	Coil, RF	Lampkin
L2	Coil, RF	Lampkin
L3	Coil, RF, Value Selected in Production	Lampkin
L4	Choke, RF, 1 uh	
Q1	Transistor	2N3643
Q2	Transistor, Silicon Signal	2N5089
R1,R24, R26	Resistor, Film, 10K, 1/2 watt, 10 percent	
R2	Resistor, Film, 2.2K, 1/2 watt, 10 percent	
R3	Resistor, Film, 82 ohms, 1/2 watt, 10 percent	
R4	Resistor, Film, 10 ohms, 1/2 watt, 10 percent	
R5 thru R8	Not Used	

PARTS LIST

Ref. Des.	Description	Part or Type Ident.
A20	Multiplexer, Mixer and Detector (continued)	00215
R9	Resistor, Film, 51 ohms, 1/2 watt, 10 percent	
R10,R11	Resistor, Film, 100 ohms, 1/2 watt, 10 percent	
R12	Resistor, Film, 82 ohms, 1/2 watt, 10 percent	
R13	Resistor, Film, 47 ohms (Nominal) 1/2 watt, 10 percent, Selected in Production	
R14 thru R16	Not Used	
R17,R19	Resistor, Film, 1000 ohms, 1/2 watt, 10 percent	
R18	Resistor, Film, 15K, 1/2 watt, 10 percent	
R20,R21, R22	Resistor, Film, 20 ohms, 1/2 watt, 10 percent	
R23	Resistor, Film, 5.6 Megohms, 1/2 watt, 10 percent	
R25	Resistor, Film, 680K, 1/2 watt, 10 percent	
R27	Resistor, Film, 1 Megohm, 1/2 watt, 10 percent	
T1	Transformer, Toroidal	Lampkin
Z1 (Ref.)	Double-Balanced Mixer Module	

SECTION 7

DIAGRAMS

This section contains major diagrams referenced in the text and not located elsewhere. Diagrams are schematic, unless otherwise indicated, and are listed as follows.

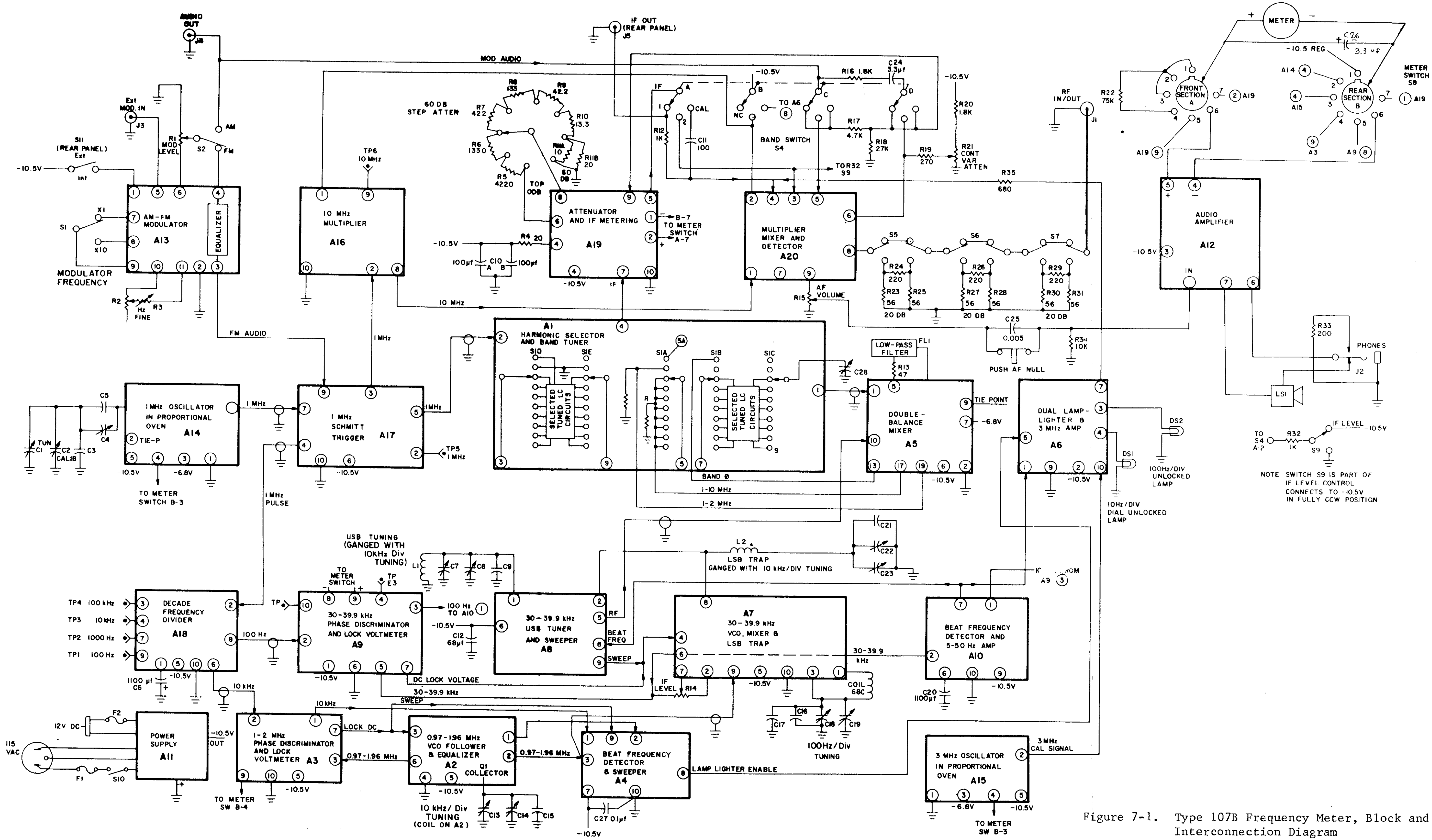
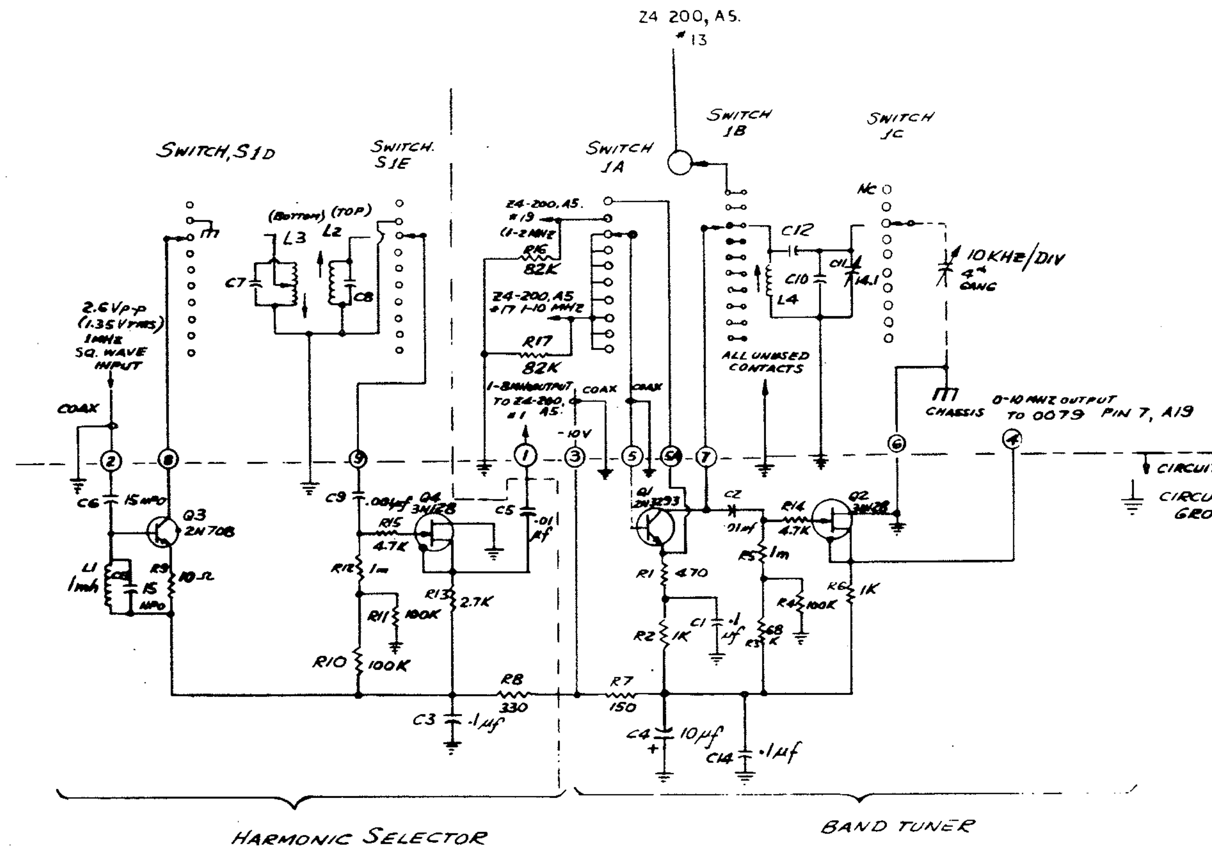


Figure 7-1. Type 107B Frequency Meter, Block and Interconnection Diagram



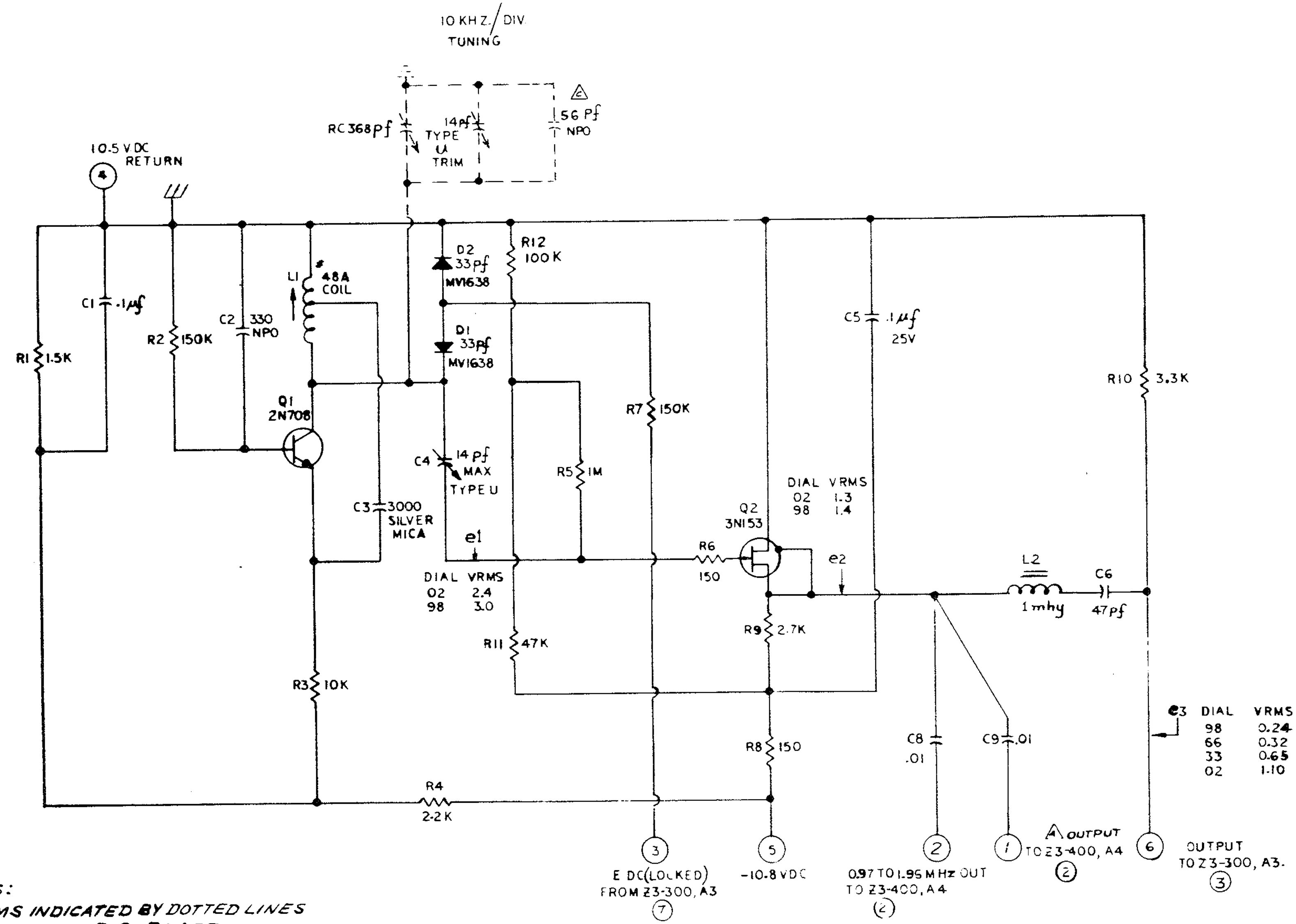
BAND TUNER					
Rs	DIAL	FREQ.	L4	C12	C10
	0	UNTUNED			
	1	1-2	74-1	[illegible]	18
	2	2-3	74-2	220	22
	3	3-4	74-3	100	18
	4	4-5	74-4	82	33
	5	5-6	74-5	75	39
	6	6-7	74-6	56	39
	7	7-8	74-7	56	47
	8	8-9	74-8	56	39
	9	9-10	74-9	39	39

HARMONIC SELECTOR					
Rs	DIAL	FREQ	L3 & L2	C7	C8
680	0	1m	73-1	2200	2200
	1	NOT USED			
	2	1m	SAME AS BAND ∅		
1000	3	2m	73-2	560	560
680	4	3M	73-3	330	330
330	5	4M	73-4	200	200
470	6	5M	73-5	150	150
—⊖—	7	6M	73-6	120	120
100	8	7M	73-7	120	120
51	9	8M	73-8	100	100

NOTES:

1. ITEMS INDICATED BY DOTTED LINES ARE NOT ON P.C BOARD
2. ALL RESISTOR VALUES ARE IN OHMS EXCEPT AS INDICATED
3. ALL CAPACITORS ARE IN PF EXCEPT AS INDICATED

Figure 7-2. Harmonic Selector and Band Tuner, A1, Schematic Diagram



NOTES:
1. ITEMS INDICATED BY DOTTED LINES ARE NOT ON P.C. BOARD.
2. ALL RESISTORS ARE ½ WATT FILM TYPE EXCEPT AS INDICATED, ⅓ WATT RESISTORS ARE AN ACCEPTABLE SUBSTITUTE.
3. ALL CAPACITOR VALUES ARE IN Pf EXCEPT AS NOTED

Figure 7-3. VCO, Follower, and Equalizer, A2, Schematic Diagram

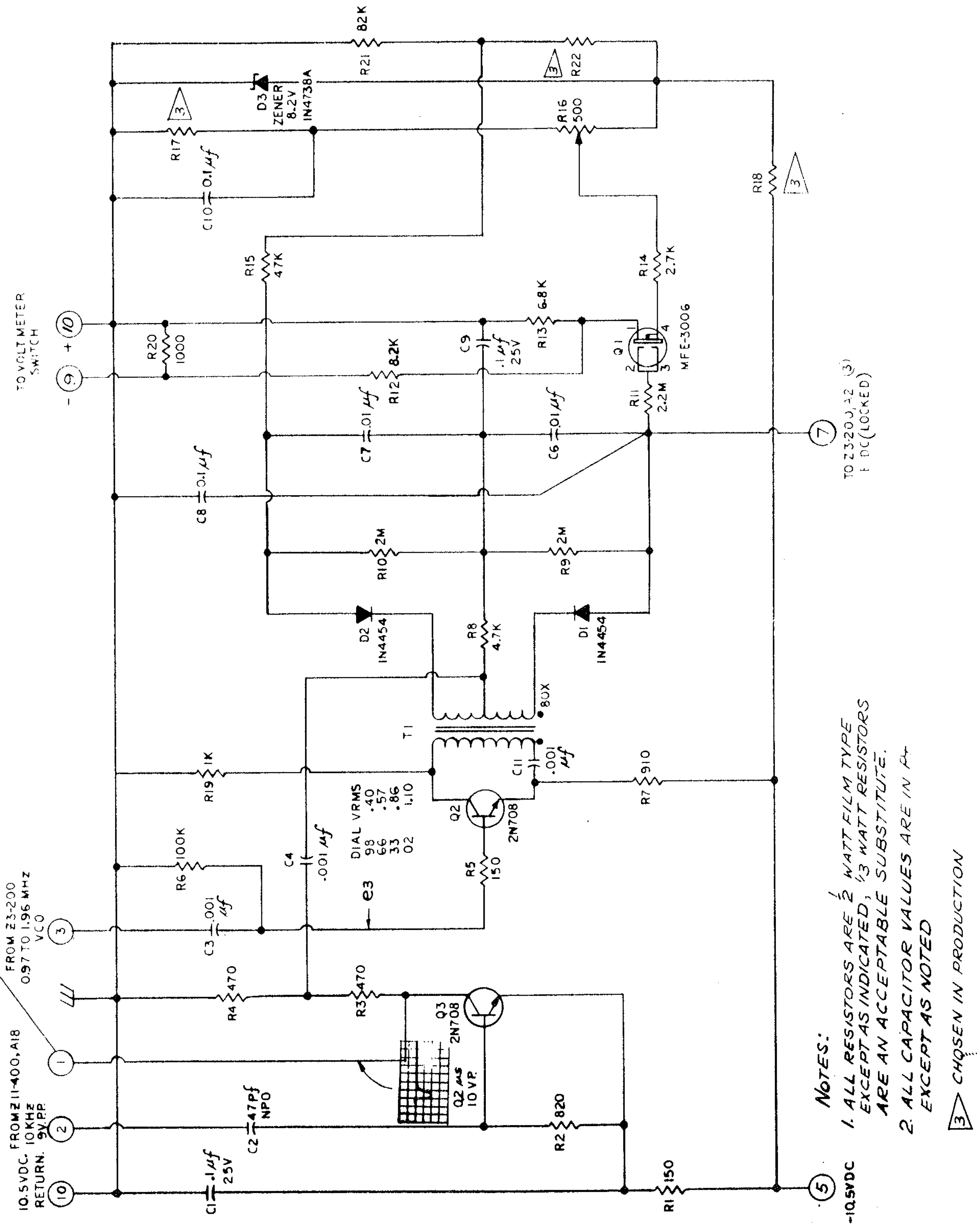
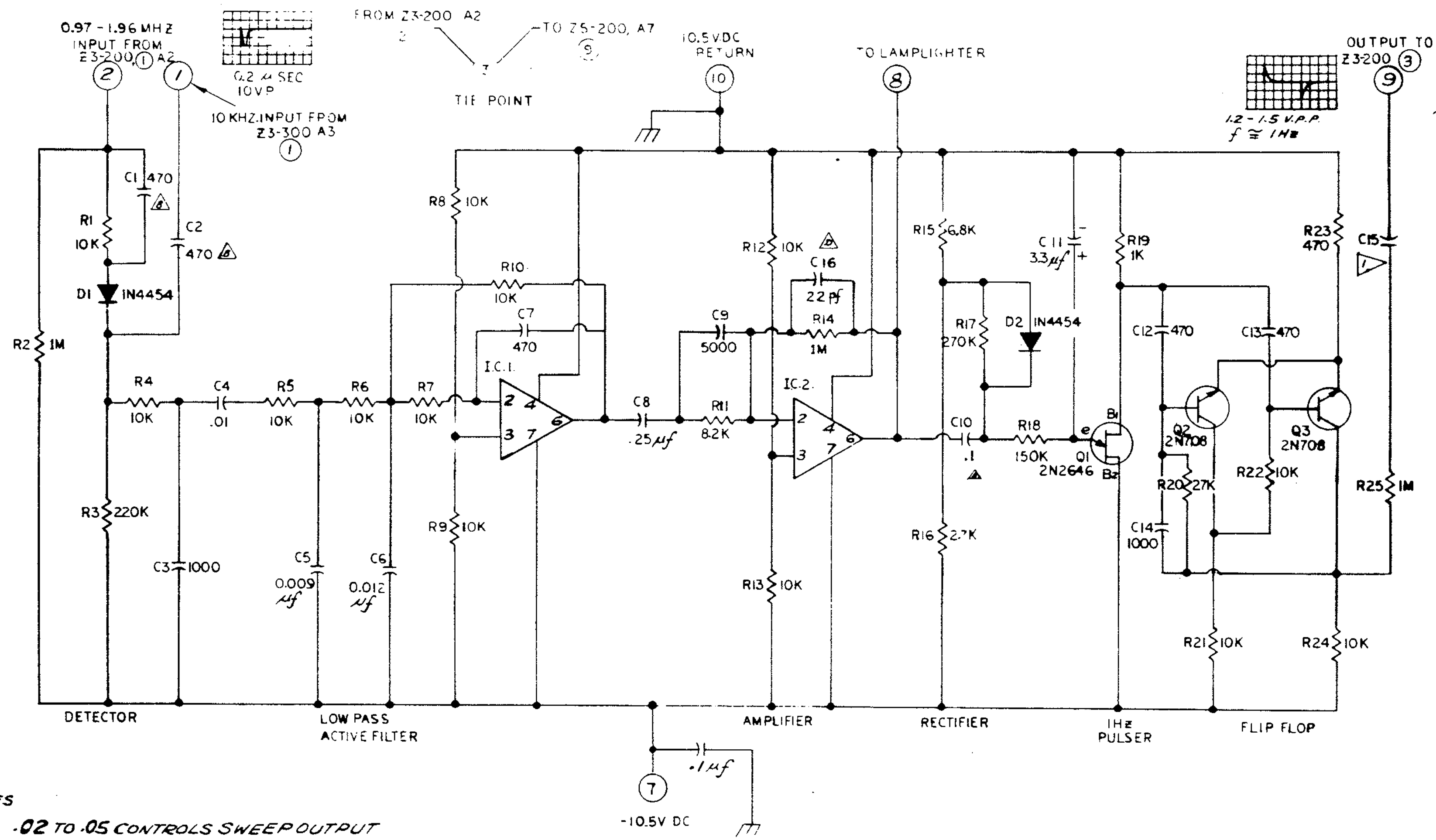


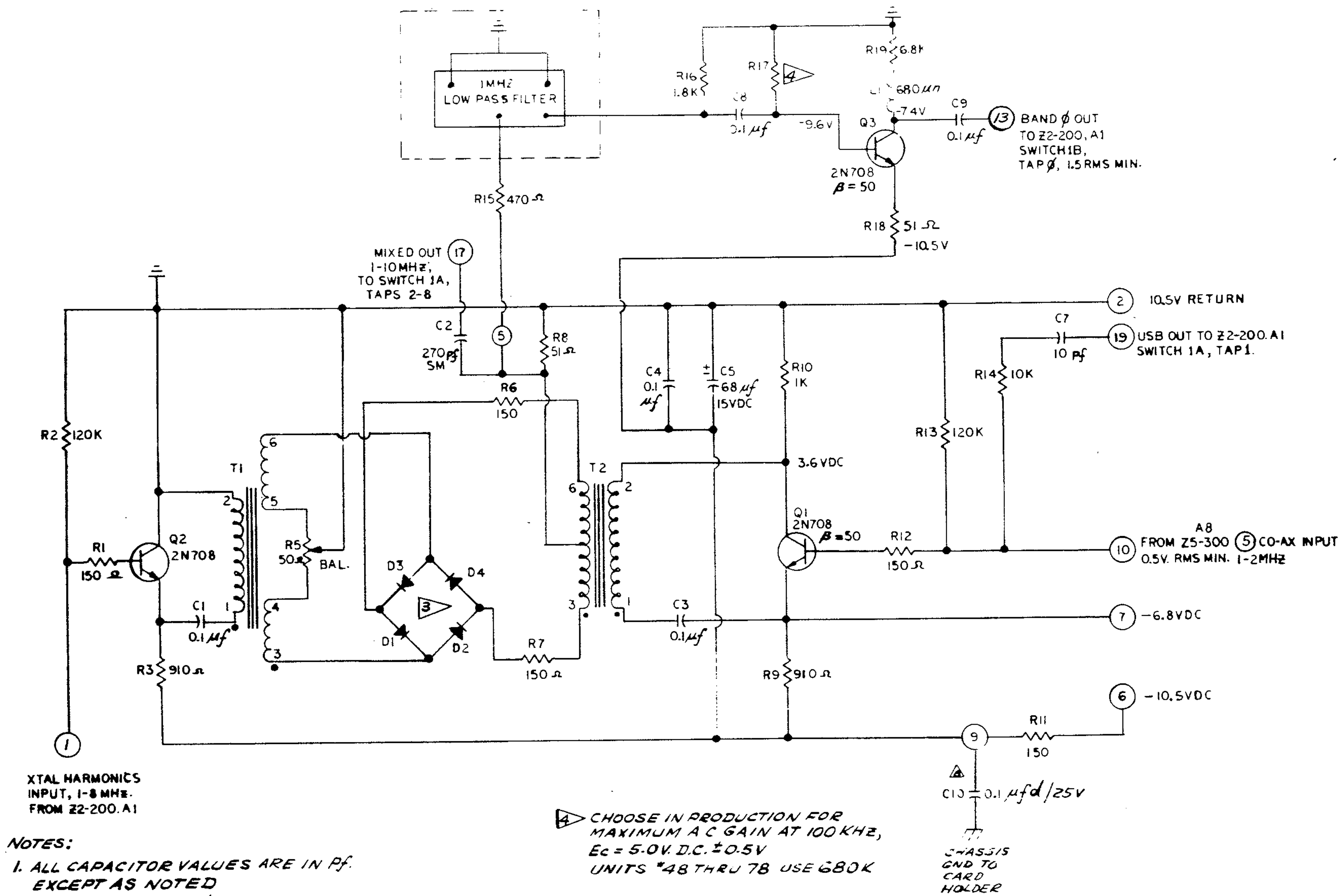
Figure 7-4. 1-2 MHz Phase Discriminator and Lock Voltmeter, A3, Schematic Diagram



NOTES

1. .02 TO .05 CONTROLS SWEEP OUTPUT 1.0 TO 1.3 VOLTS
2. ALL RESISTORS ARE ½ WATT FILM TYPE, EXCEPT AS INDICATED
3. ⅓ WATT RESISTORS ARE AN ACCEPTABLE SUBSTITUTE
4. ALL CAPACITOR VALUES ARE IN PF EXCEPT AS INDICATED

Figure 7-5. Beat Frequency Detector and Sweeper, A4, Schematic Diagram



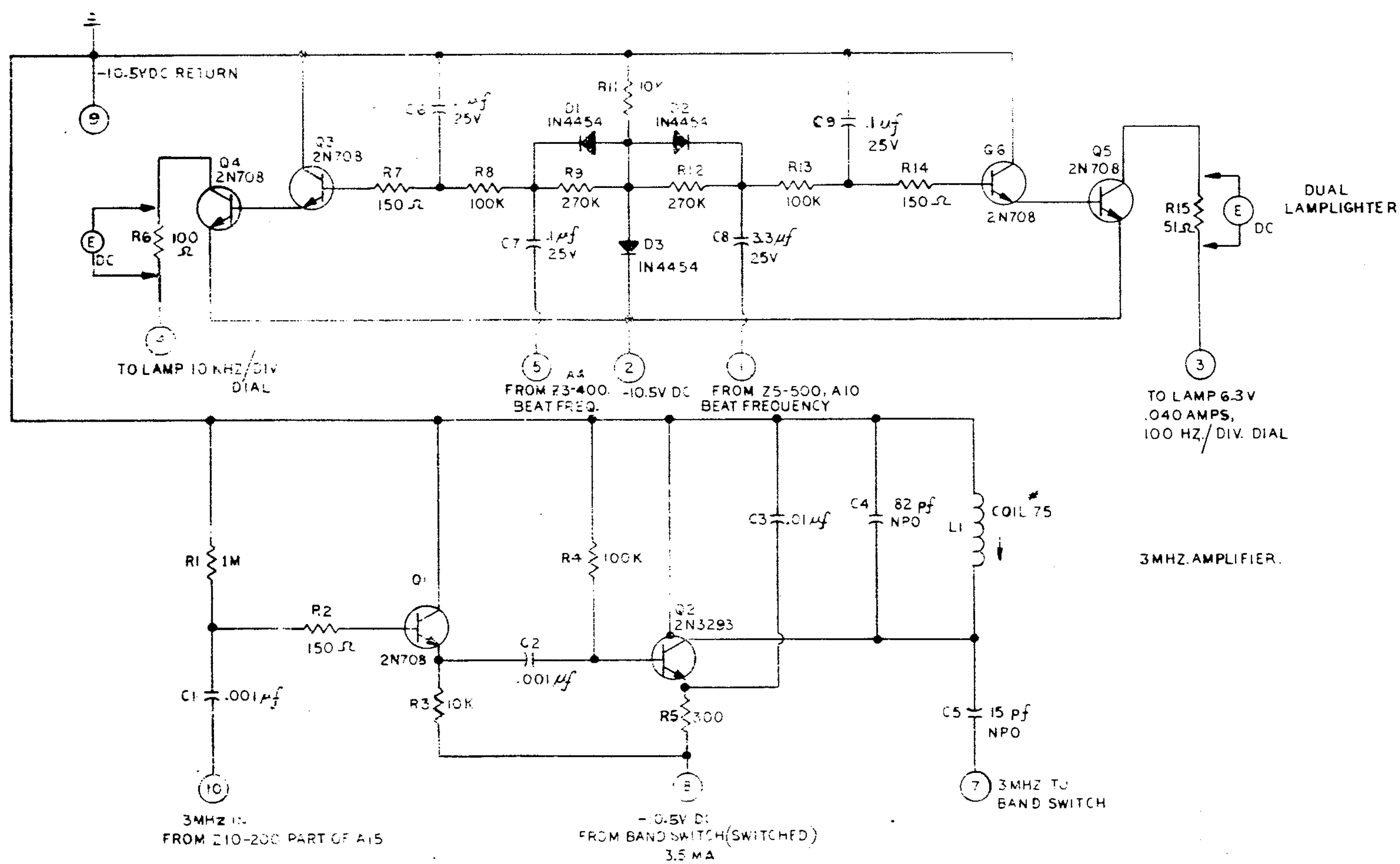
NOTES:

1. ALL CAPACITOR VALUES ARE IN Pf. EXCEPT AS NOTED
2. RESISTORS ARE ½ WATT FILM TYPE, EXCEPT AS NOTED. 1/3 WATT RESISTORS ARE AN ACCEPTABLE SUBSTITUTE

3▷ FOUR (4) HOT CARRIER DIODES, hp 2800, MATCHED, D.C, (WESTON #980, RX10, TO ±5%)

4▷ CHOOSE IN PRODUCTION FOR MAXIMUM A C GAIN AT 100 KHZ, Ec = 5.0V. D.C. ±0.5V UNITS #48 THRU 78 USE 680K

Figure 7-6. Double Balanced Mixer, A5, Schematic Diagram

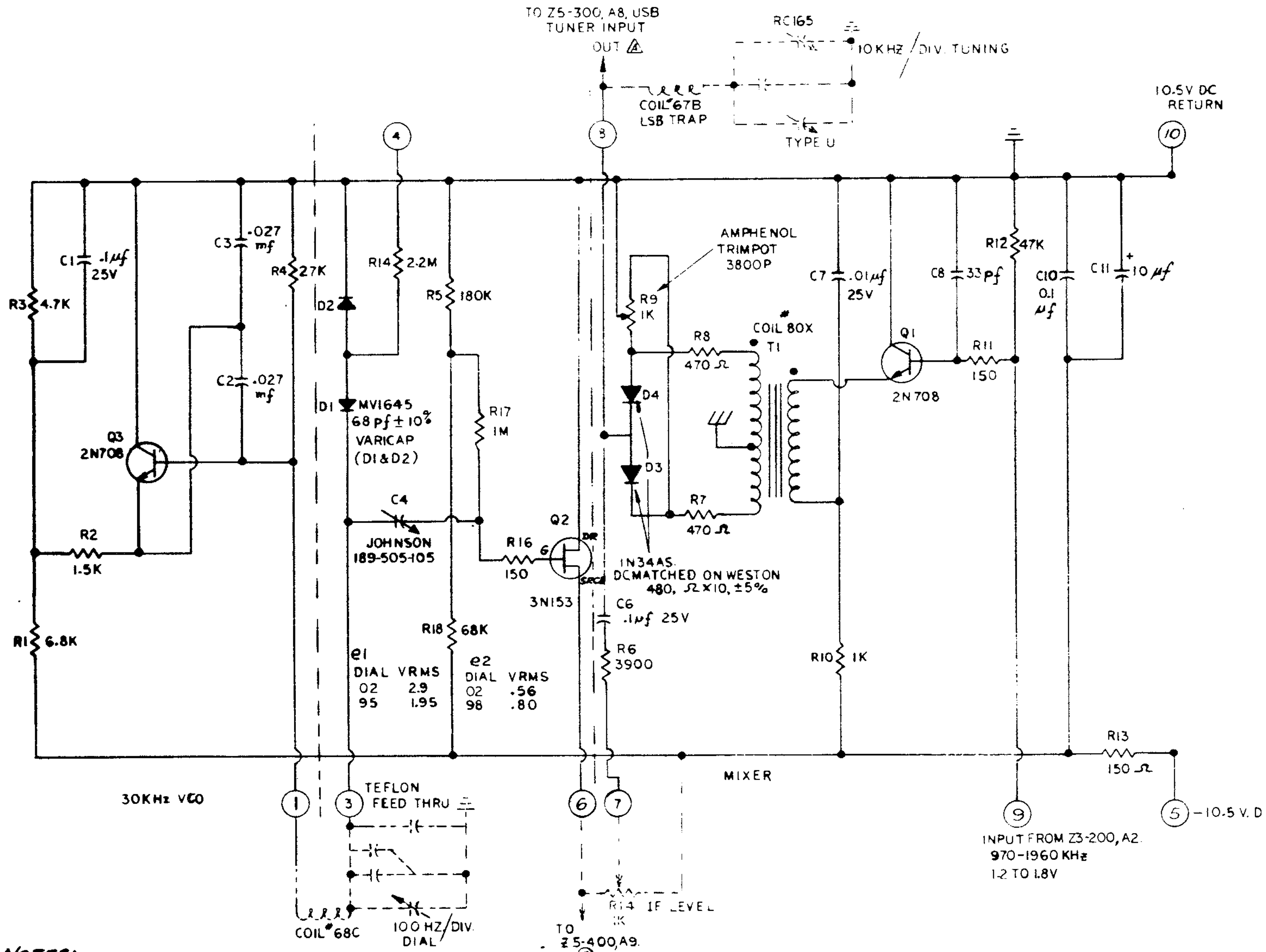


NOTES

1. RESISTORS ARE ½ WATT FILM TYPE, EXCEPT AS NOTED. 1/3 WATT RESISTORS ARE AN ACCEPTABLE SUBSTITUTE.

2. ALL CAPACITOR VALUES ARE IN Pf EXCEPT AS NOTED

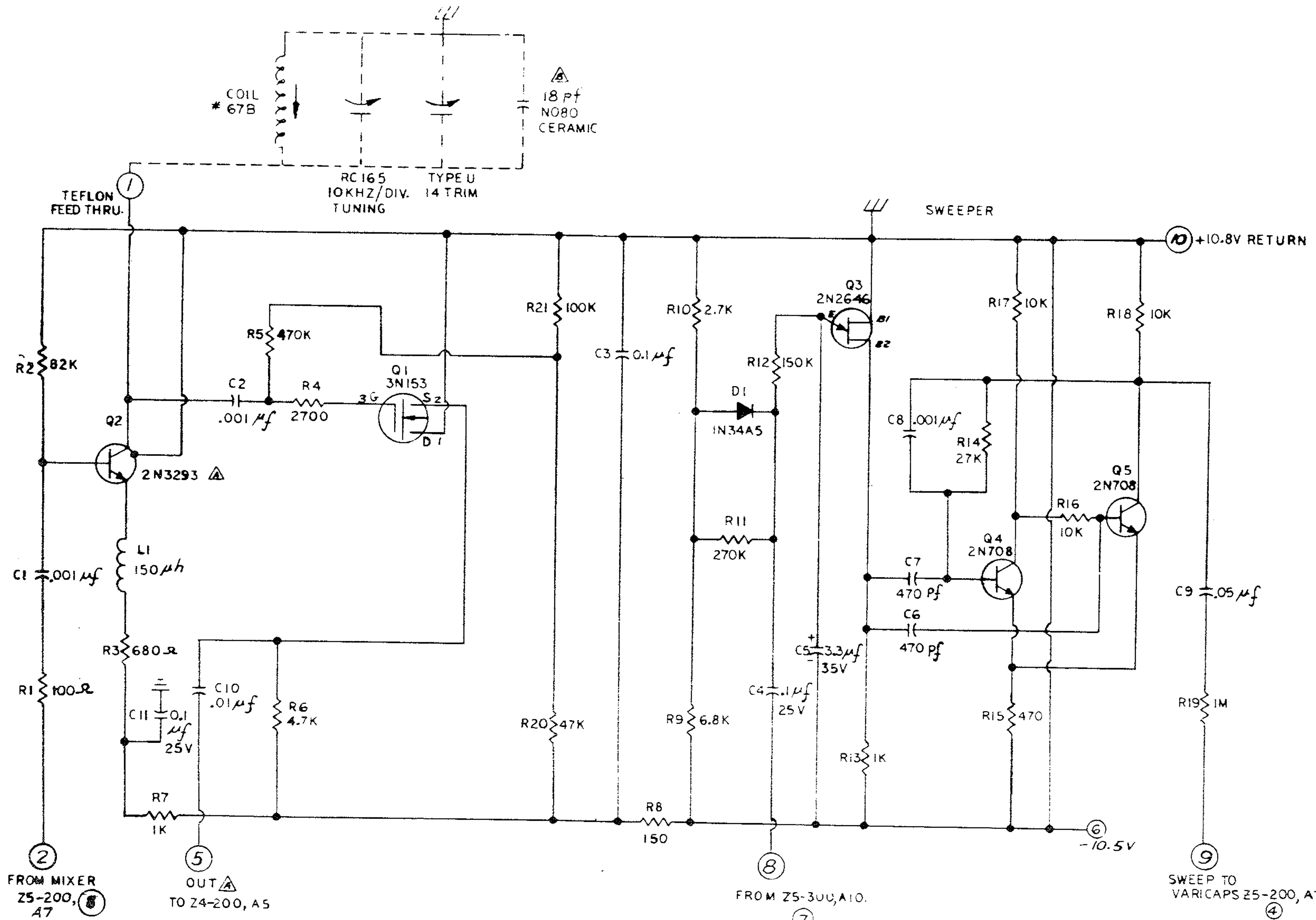
Figure 7-7. Dual Lamplighter and 3 MHz Amplifier, A6, Schematic Diagram



NOTES:

1. ITEMS INDICATED BY DOTTED LINES ARE NOT ON P.C. BOARD.
2. ALL RESISTORS ARE 1/4 WATT FILM TYPE EXCEPT AS INDICATED.
3. 1/3 WATT RESISTORS ARE AN ACCEPTABLE SUBSTITUTE.
4. ALL CAPACITOR VALUES ARE IN Pf EXCEPT AS INDICATED

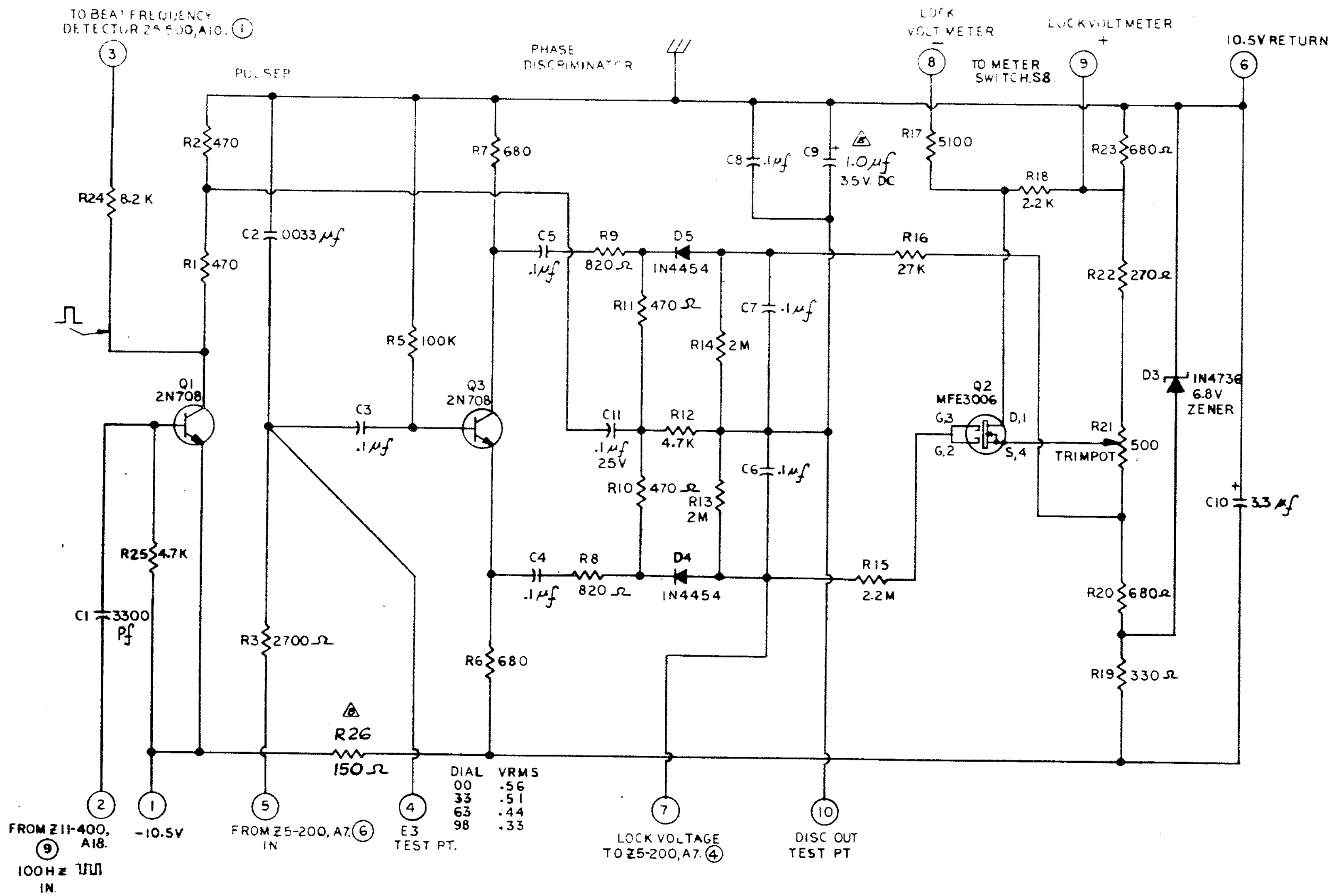
Figure 7-8. 30.0 to 39.9 kHz VCO and Mixer, A7, and LSB Trap, Schematic Diagram



NOTES:

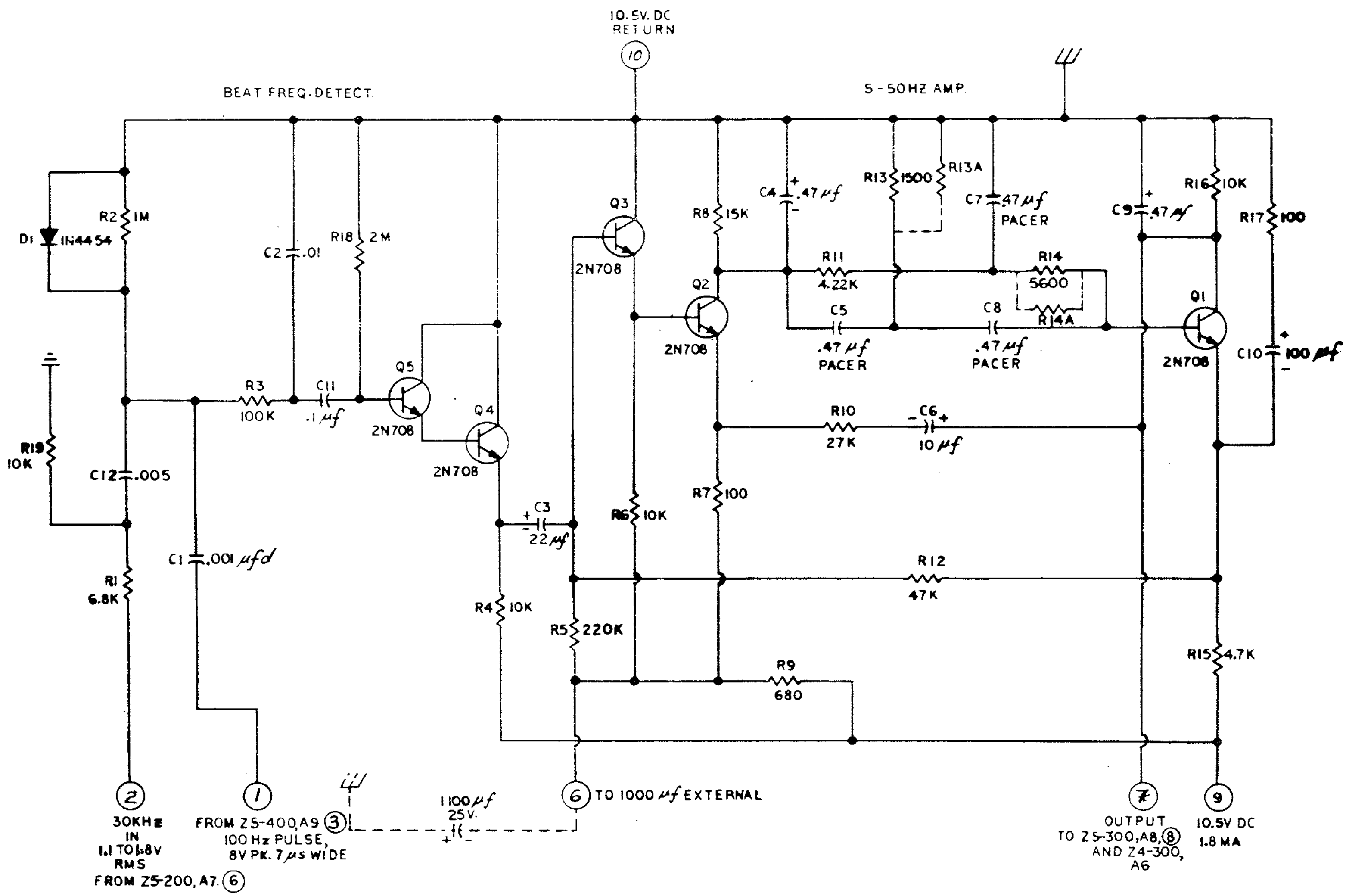
1. ITEMS INDICATED BY DOTTED LINES ARE NOT ON PC. BOARD
2. ALL RESISTORS ARE ½ WATT FILM TYPE, EXCEPT AS INDICATED.
3. ALL CAPACITOR VALUES ARE IN pf EXCEPT AS INDICATED.
4. ⅓ WATT RESISTORS ARE AN ACCEPTABLE SUBSTITUTE

Figure 7-9. 30.0 to 39.9 kHz USB Tuner and Sweeper, A8, Schematic Diagram



NOTES:
1. ALL RESISTORS ARE ¼ WATT FILM TYPE EXCEPT AS INDICATED
2. ⅓ WATT RESISTORS ARE AN ACCEPTABLE SUBSTITUTE.
3. ALL CAPACITOR VALUES ARE IN Pf EXCEPT AS INDICATED

Figure 7-10. 30.0 to 39.9 kHz Phase Discriminator and Lock Voltmeter, A9, Schematic Diagram



NOTES:

1. ITEMS INDICATED BY DOTTED LINES ARE NOT ON P.C. BOARD.
2. ALL RESISTORS ARE 1/2 WATT FILM TYPE EXCEPT AS INDICATED, 1/3 WATT RESISTORS ARE AN ACCEPTABLE SUBSTITUTE.
3. ALL CAPACITOR VALUES ARE IN Pf EXCEPT AS NOTED.

Figure 7-11. Beat Frequency Detector and 5 to 50 Hz Amplifier A10, Schematic Diagram

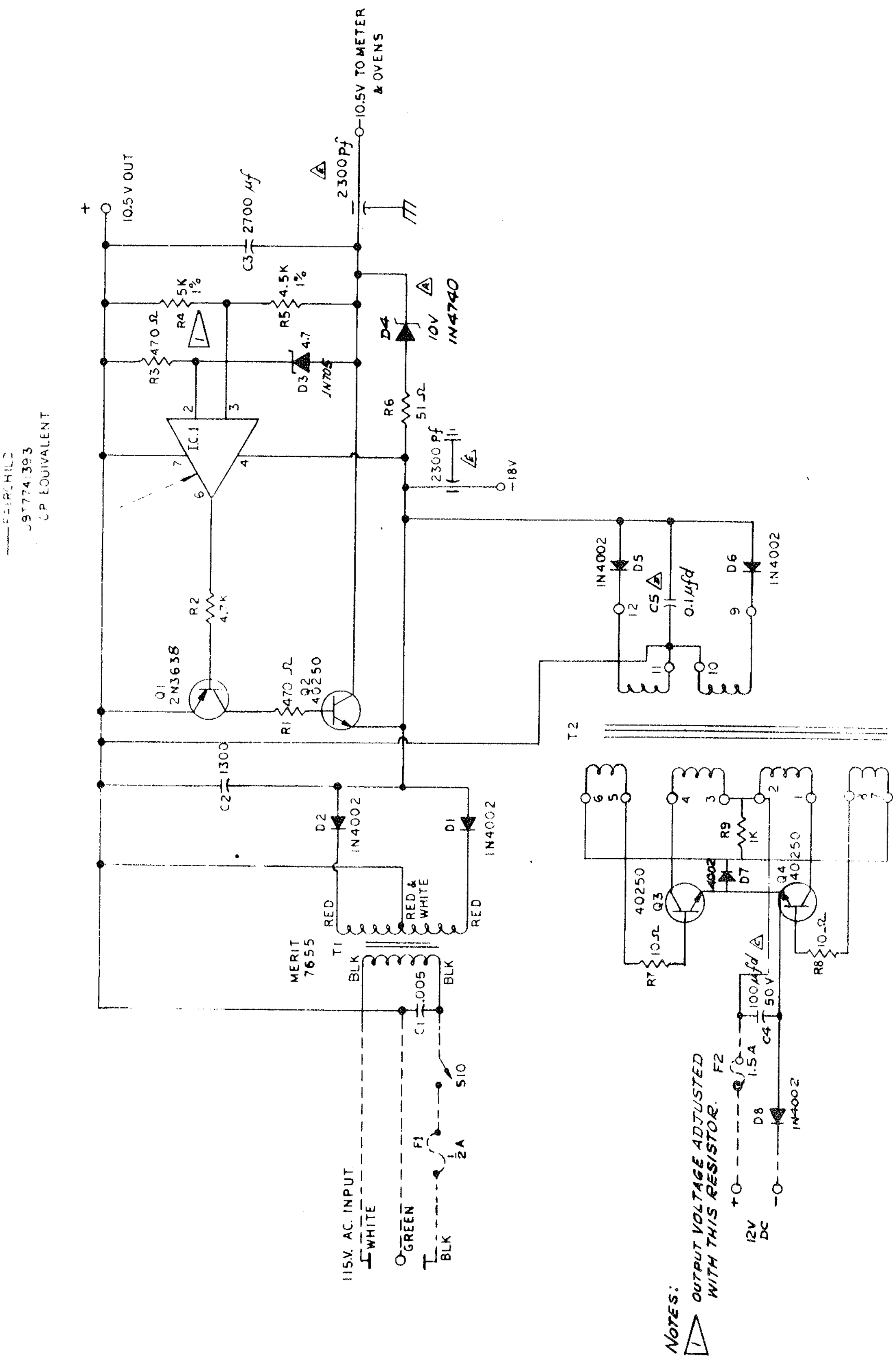
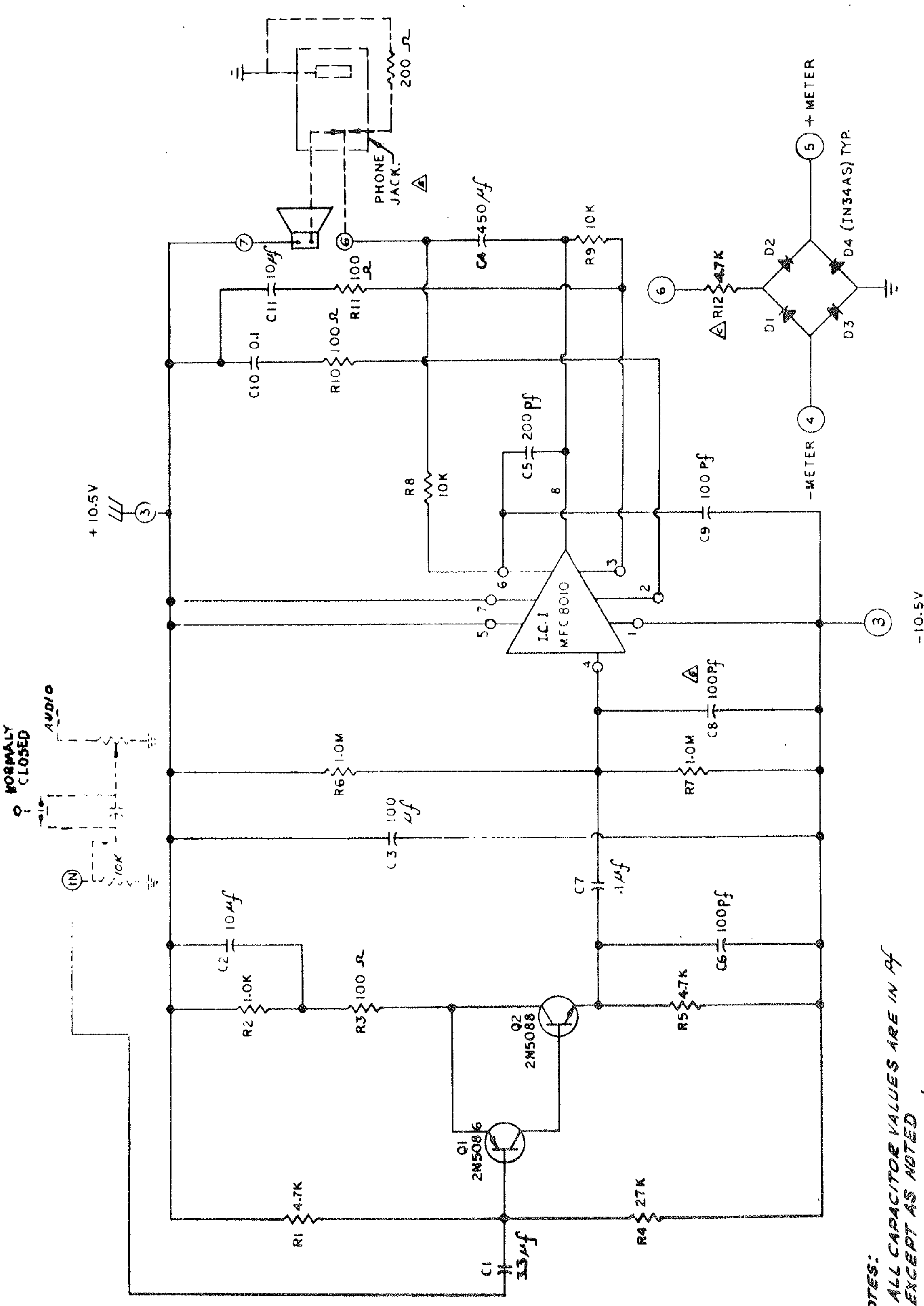


Figure 7-12. Power Supply, All, Schematic Diagram



NOTES:
1. ALL CAPACITOR VALUES ARE IN μf EXCEPT AS NOTED
2. ALL RESISTORS ARE 1/4 WATT FILM TYPE EXCEPT AS INDICATED.
3. 1/3 WATT RESISTORS ARE AN ACCEPTABLE SUBSTITUTE

Figure 7-13. Audio Amplifier, A12, Schematic Diagram

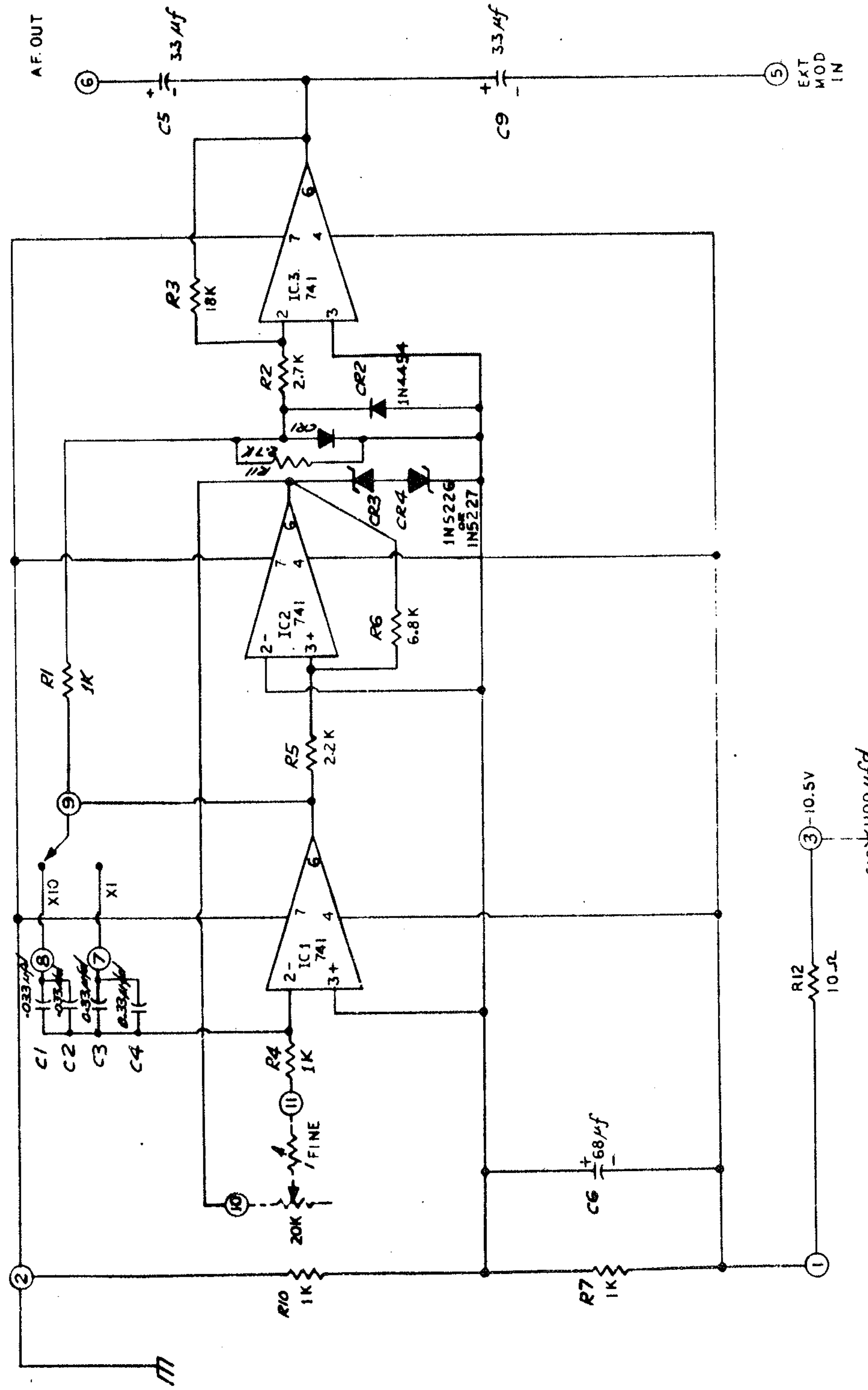
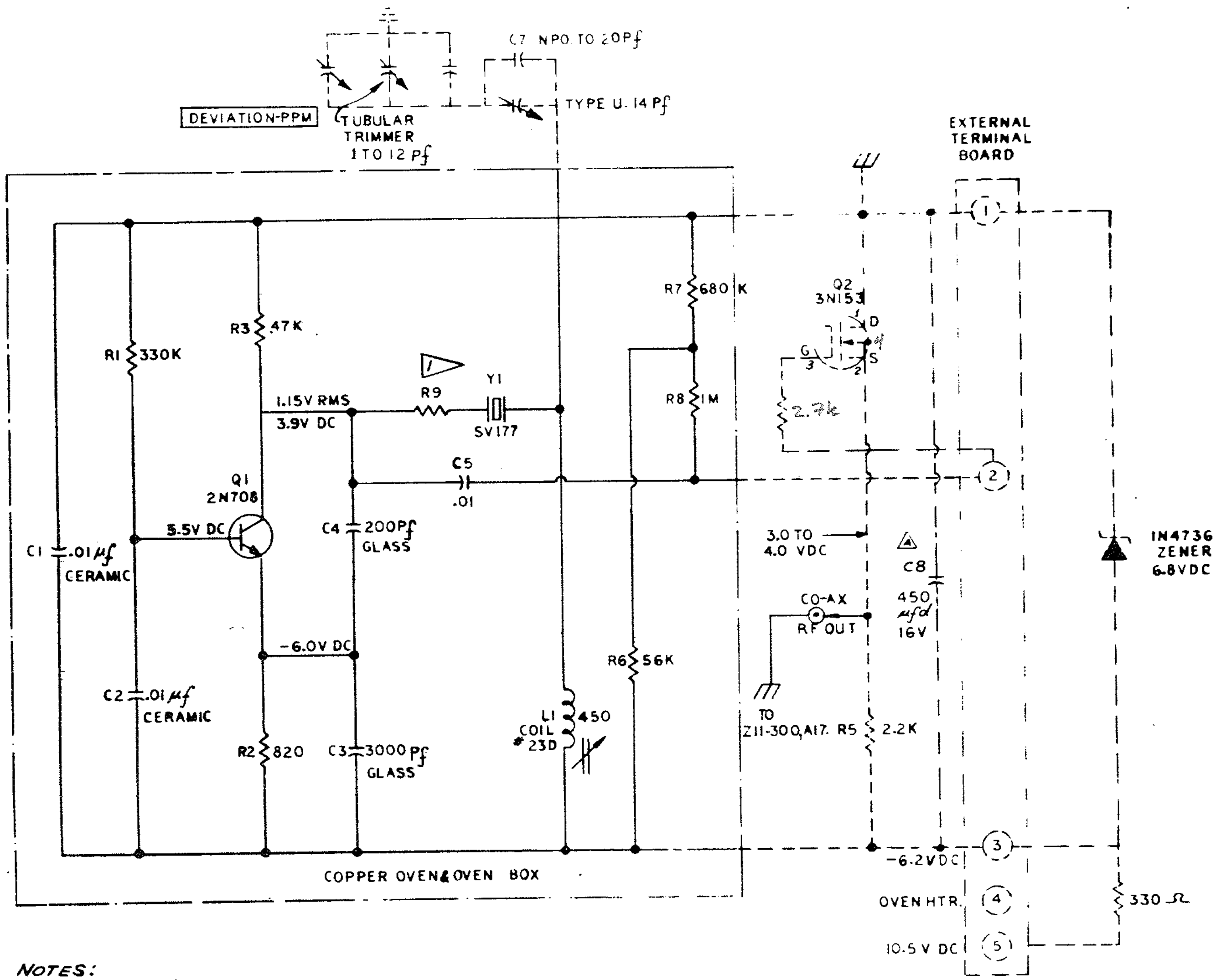


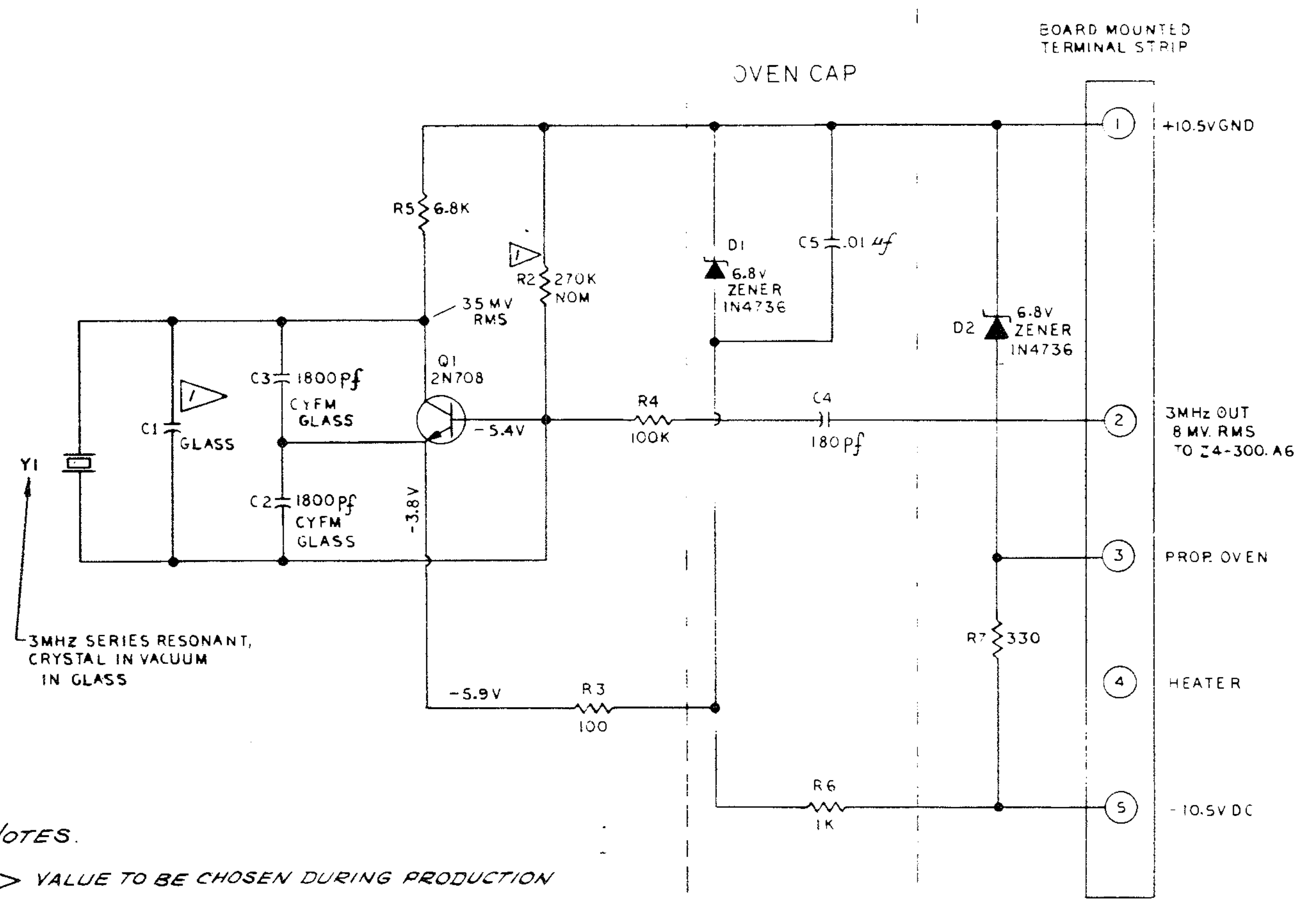
Figure 7-14. AM-FM Modulator, A13, Schematic Diagram



NOTES:

1. *CHOSEN IN PRODUCTION*
2. *ALL CAPACITOR VALUES ARE IN Pf, EXCEPT AS NOTED*
3. *ITEMS INDICATED BY DOTTED LINES ARE NOT ON BREAD BOARD.*

Figure 7-15. 1 MHz Oscillator (VXO) p/o A14, Schematic Diagram



NOTES.

1. *VALUE TO BE CHOSEN DURING PRODUCTION*
2. *ALL RESISTORS ARE ¼ WATT FILM TYPE EXCEPT AS INDICATED*
3. *ALL CAPACITOR VALUES ARE IN Pf EXCEPT AS INDICATED*

Figure 7-16. 3 MHz Oscillator p/o A15, Schematic Diagram

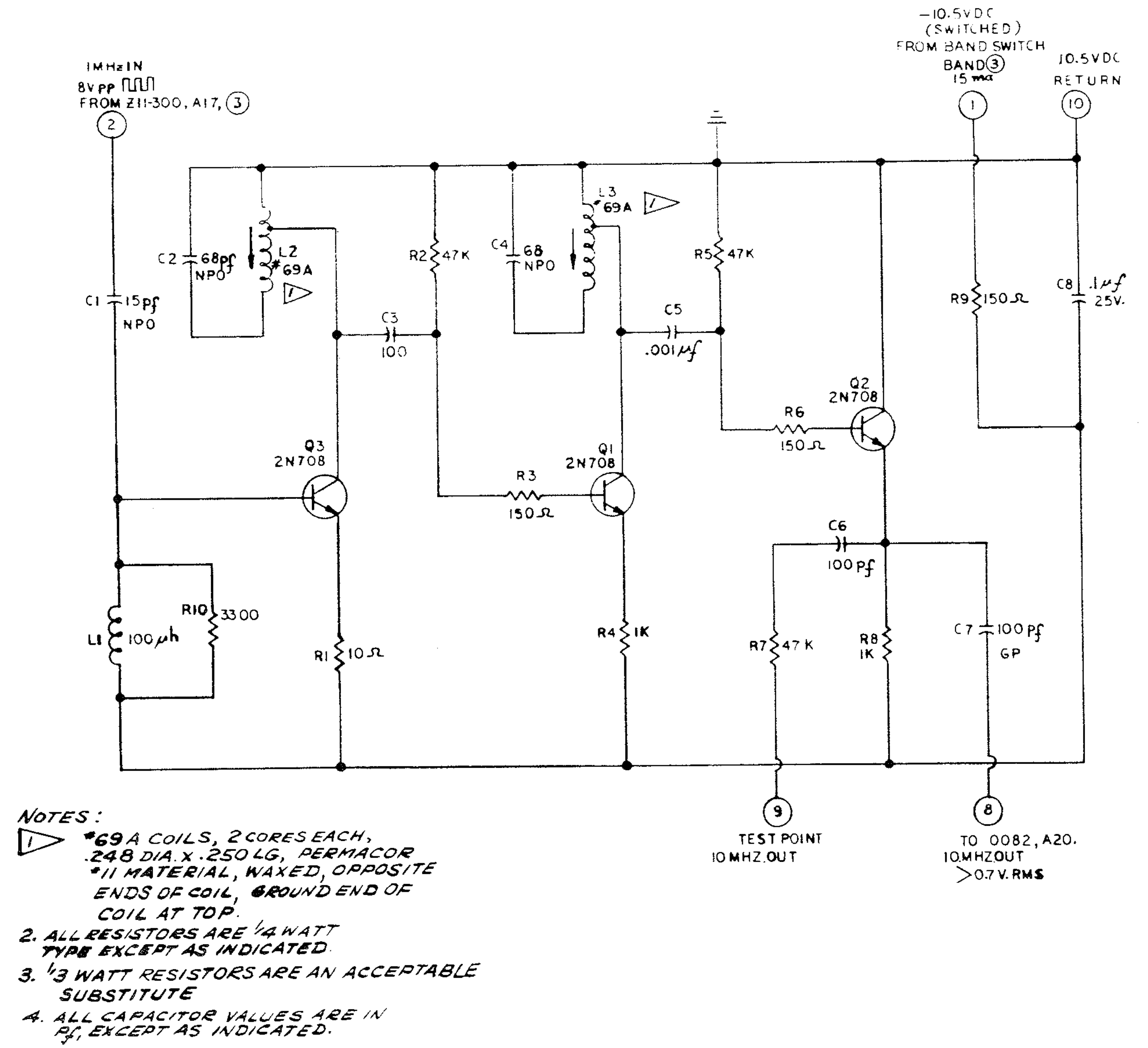
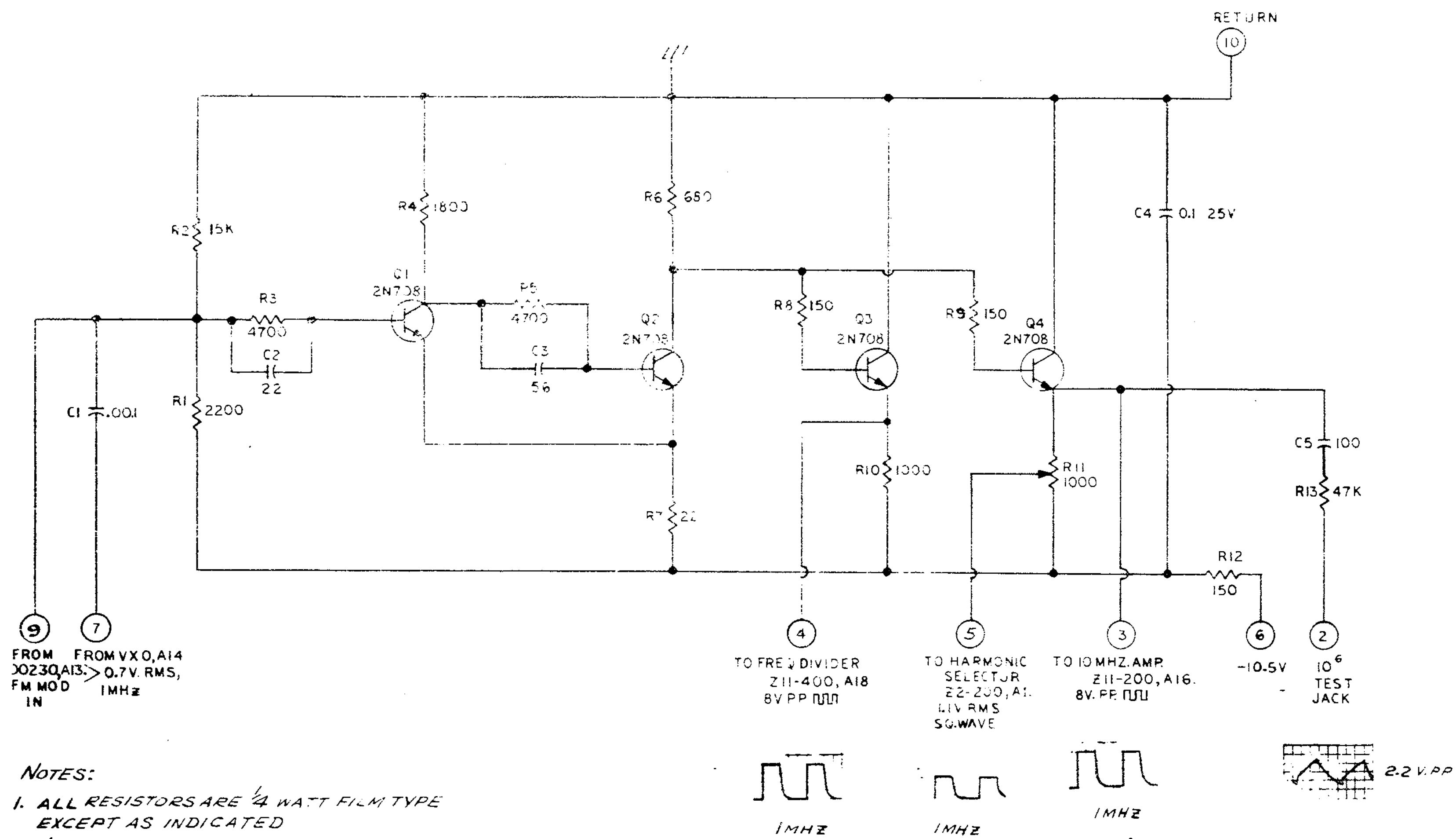


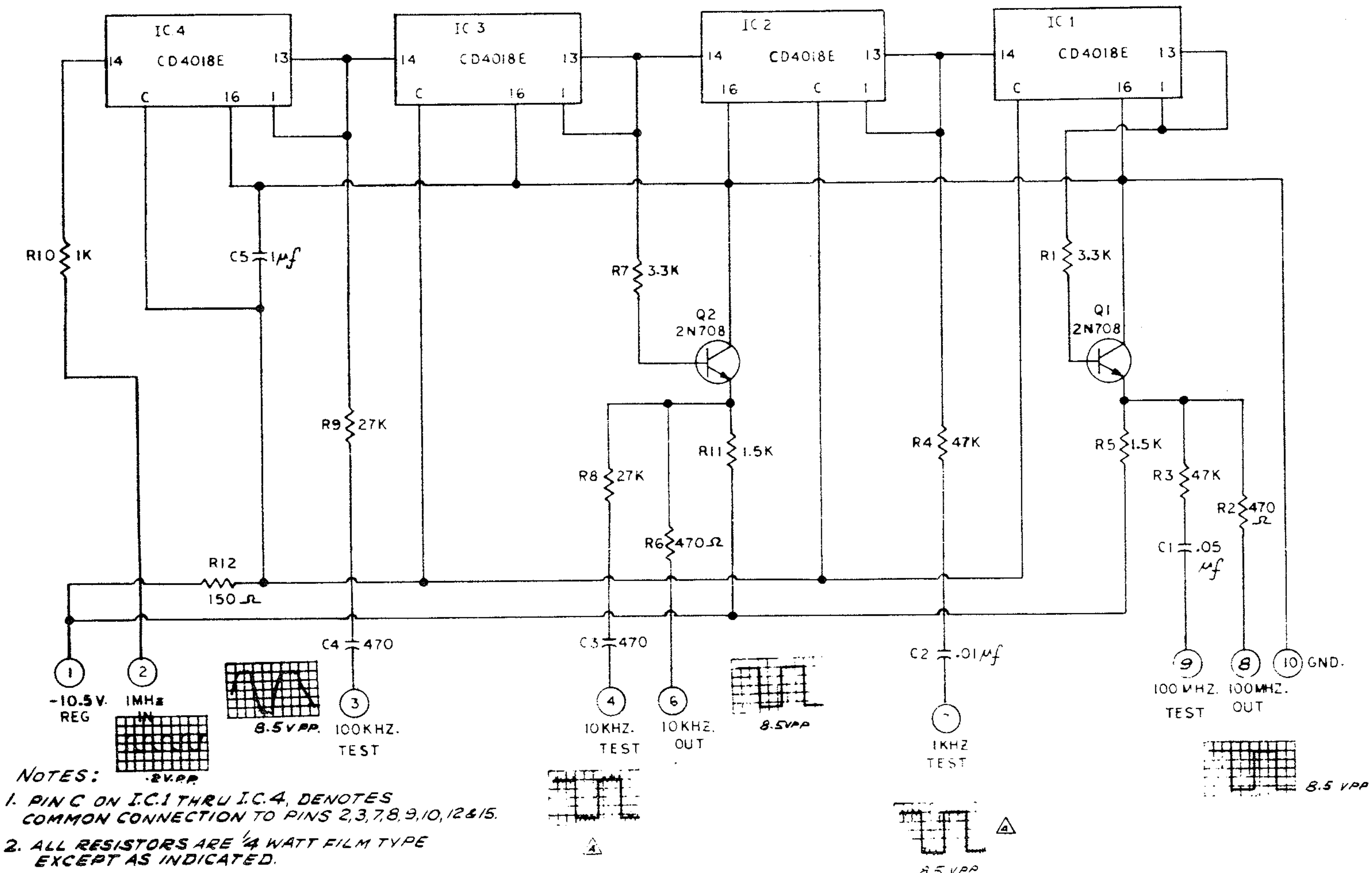
Figure 7-17. 10 MHz Multiplier, A16, Schematic Diagram



NOTES:

1. *ALL RESISTORS ARE 1/4 WATT FILM TYPE EXCEPT AS INDICATED*
2. *1/3 WATT RESISTORS ARE AN ACCEPTABLE SUBSTITUTE.*
3. *ALL CAPACITOR VALUES ARE IN Pf EXCEPT AS NOTED*

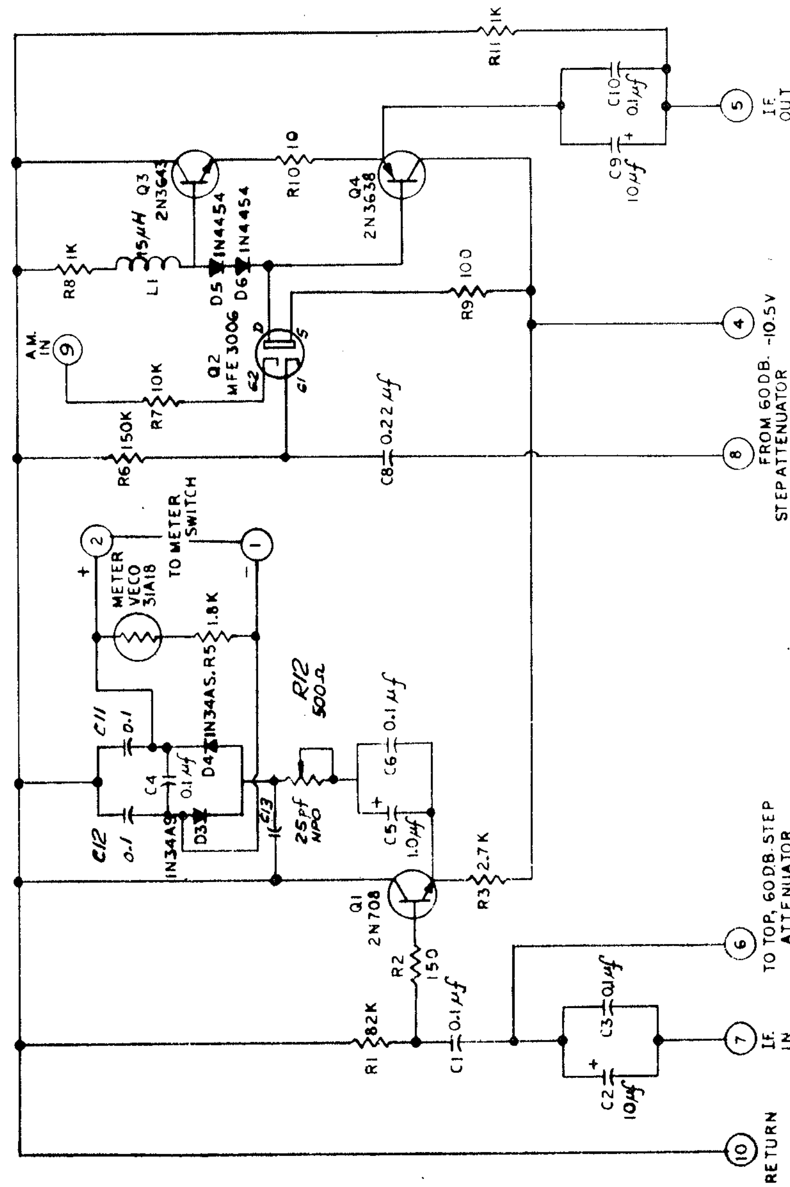
Figure 7-18. 1 MHz Schmitt Trigger, A17, Schematic Diagram



NOTES:

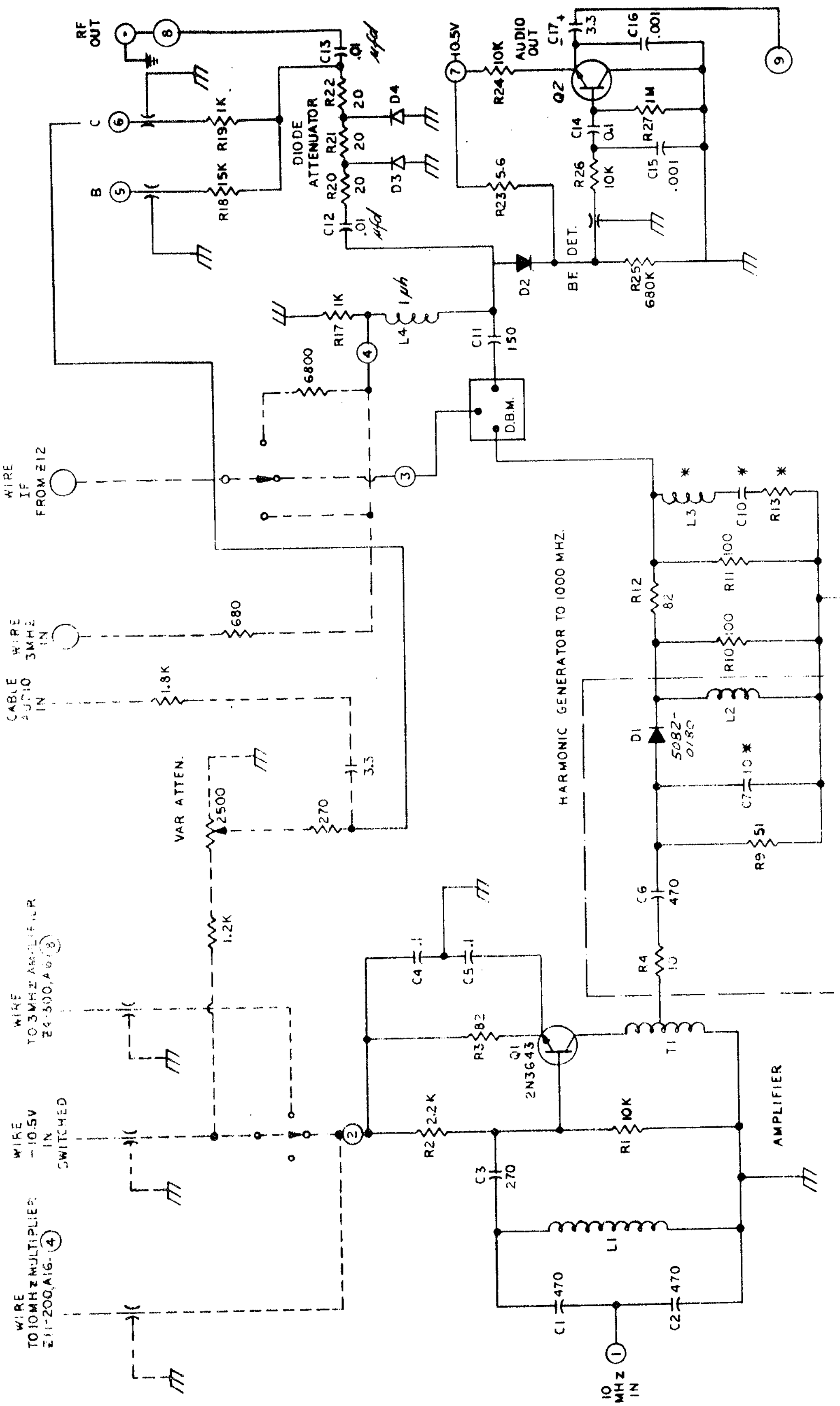
1. PIN C ON I.C.1 THRU I.C.4, DENOTES COMMON CONNECTION TO PINS 2,3,7,8,9,10,12 & 15.
2. ALL RESISTORS ARE 1/4 WATT FILM TYPE EXCEPT AS INDICATED.
3. 1/3 WATT RESISTORS ARE AN ACCEPTABLE SUBSTITUTE.
4. ALL CAPACITOR VALUES ARE IN Pf EXCEPT AS INDICATED.

Figure 7-19. Decade (Frequency) Divider, A18, Schematic Diagram



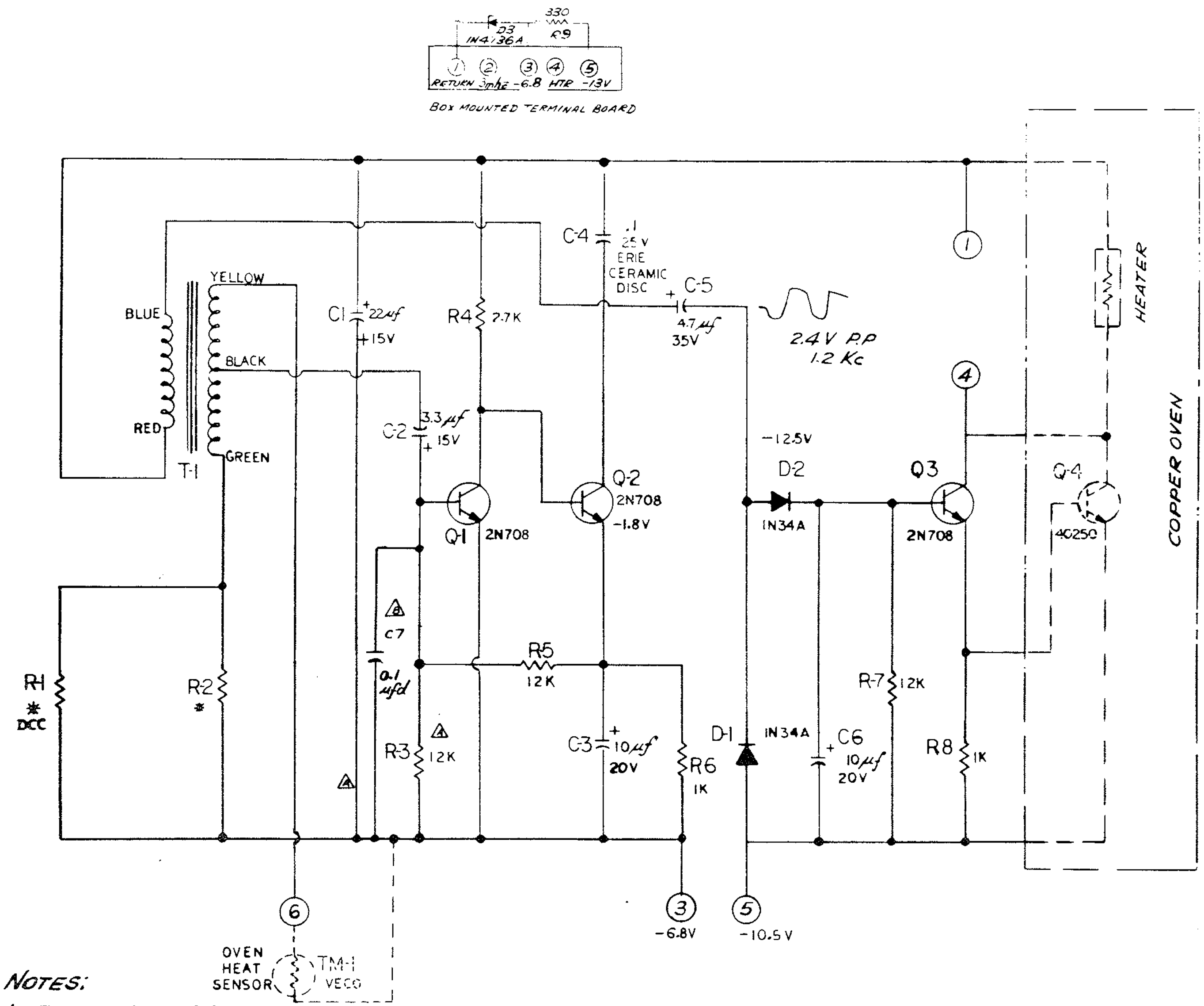
NOTES:
1. ALL RESISTOR VALUES ARE IN OHMS, EXCEPT AS INDICATED.
2. ALL CAPACITOR VALUES ARE IN Pf. EXCEPT AS INDICATED
3. D1, D2, D3, D4 ARE IN34A D5 & D6, IN4454

Figure 7-20. Attenuator and IF Metering, A19, Schematic Diagram



NOTES:
1. ITEMS INDICATED BY DOTTED LINES ARE NOT ON P.C BOARD
2. ALL CAPACITOR VALUES ARE IN Pf EXCEPT AS INDICATED.
3. ALL RESISTOR VALUES ARE IN OHMS EXCEPT AS INDICATED
*4 * DENOTES TEST VARIABLE*

Figure 7-21. Multiplier, Mixer, and Detector, A20, Schematic Diagram



NOTES:

1. ITEMS INDICATED BY DOTTED LINES ARE NOT ON P.C. BOARD.
2. ✻ VALUE CHOSEN IN PRODUCTION.
3. ALL RESISTORS ARE 1/4 WATT FILM TYPE EXCEPT AS INDICATED
4. 1/3 WATT RESISTORS ARE ACCEPTABLE SUBSTITUTES
5. ALL CAPACITOR VALUES ARE IN Pf, EXCEPT AS INDICATED

Figure 7-22. Proportional Ovens, A14, A15, Schematic Diagram

SECTION 8

SUPPLEMENTAL INFORMATION
TYPE 107C COMMUNICATION SERVICE MONITOR

INTRODUCTION

The information in this section is presented in the form of changes or additions to information in various sections of the basic 107B. Each paragraph in section 8 covers changes for a corresponding section in the 107B manual. Note that the title of each section 8 main paragraph is the same as the 107B manual section which is modified by the paragraph content. In using section 8, refer back to the appropriate section of the 107B manual, as required to understand the change.

8-1 GENERAL DESCRIPTION

The information given for the 107B is applicable to the 107C with the following exceptions or additions. See figure 8-1 for the 107C configuration.

APPLICATION

The 107C Communication Service Monitor can be used to check FM peak deviation in two-way radio channels with meter indication. FM audio can also be monitored aurally.

DESCRIPTION

The 107C contains switching and discriminator/amplifier circuitry which operates to provide a meter indication of FM deviation, and related FM audio output, on a monitored communications channel FM signal.

<u>Specifications</u>

FM DEVIATION MONITORING

Input Signal Required: 30 millivolts
(for quieting sufficient for measurement)

Maximum Peak Deviation indication: 6 kHz , - Accuracy: ±5 percent

<u>Basic Circuit Operation</u>

Refer to figure 8-2 which is a diagram supplementary to figure 1-2. For FM deviation monitoring, a 100 kHz detected signal is derived from the detector in (14) and fed through amplification, discrimination, and metering circuits (18) to provide a meter indication of (selected) positive and negative peak deviation. FM audio is also developed and switched (19) through the audio amplifier (14) during this mode of operation.

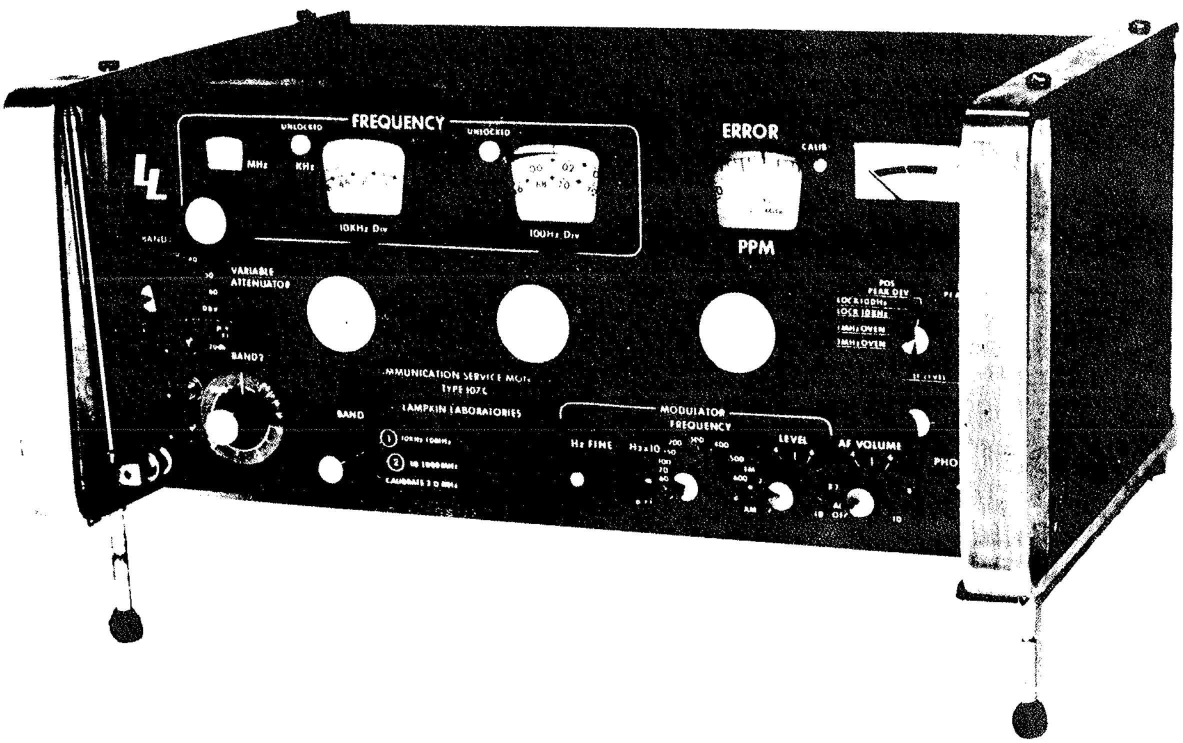


Figure 8-1. Lampkin Type 107C Communication Service Monitor

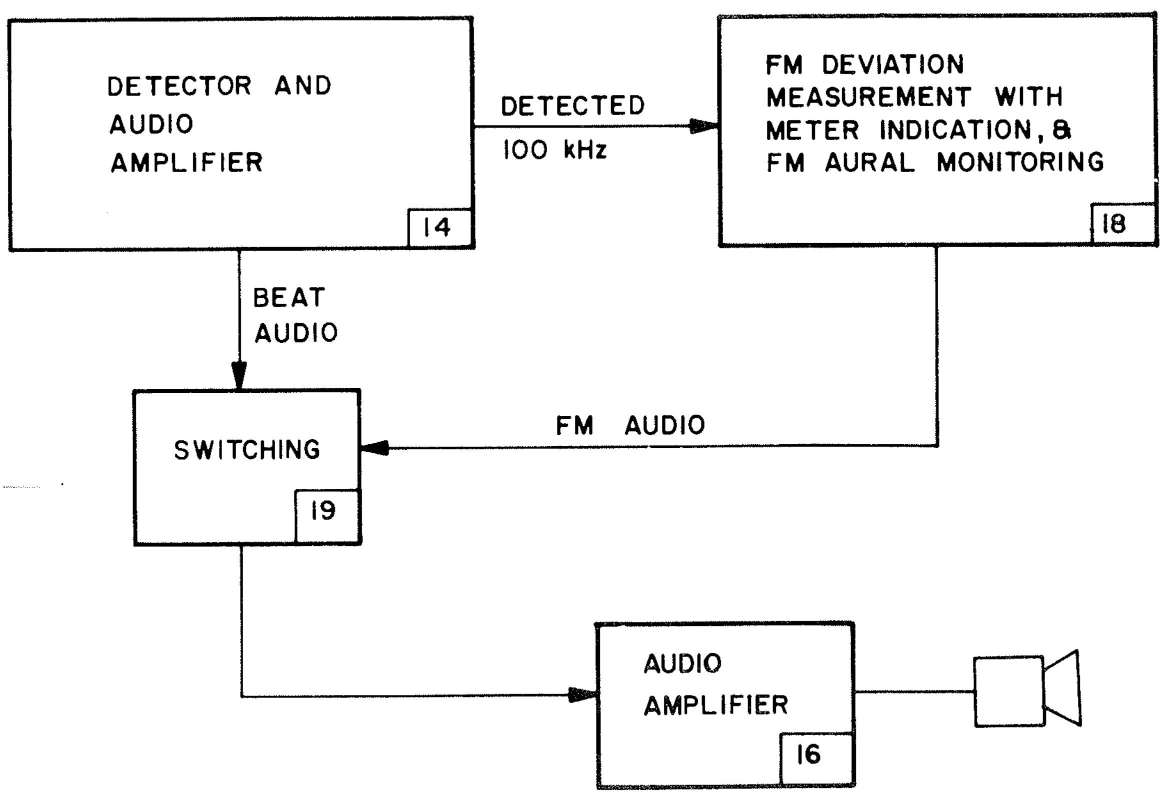


Figure 8-2. Supplement to Figure 1-2, Showing FM Deviation Indication and FM Aural Monitoring Functions (Blocks 18 and 19)

8-2 PREPARATION FOR USE

The information given for the 107B is applicable to the 107C with the following exceptions or additions.

ENERGIZING AND BASIC ELECTRICAL CHECK

For information on 107C controls and indicators (in addition to referenced paragraph 3-2), refer also to paragraph 8-3, below.

In making the brief electrical check, delete step 3. Meter selector switch positions have been modified. Use "OVEN" settings to confirm that power is normal, in addition to regular OVEN voltage monitoring.

8-3 OPERATING INSTRUCTIONS

The information given for the 107B is applicable to the 107C with the following exceptions or additions.

INTRODUCTION

The 107C unit also provides FM deviation indication and FM audio monitoring.

Front Panel Controls and Indicators

In addition to figure 3-1, refer also to figure 8-3 covering front panel control and indicator modifications for the 107C. Only the right end of the 107C panel is shown, since only the meter switch, the meter, and the AF NULL switch functions have changed. Note that the audio frequency null is no longer a push-button function, but is now a position (NULL) on the meter selector switch. This permits the operator to make checks using this feature without the necessity of holding a button pressed. The same callout numbers are used to identify controls/indicators as those used in figure 3-1.

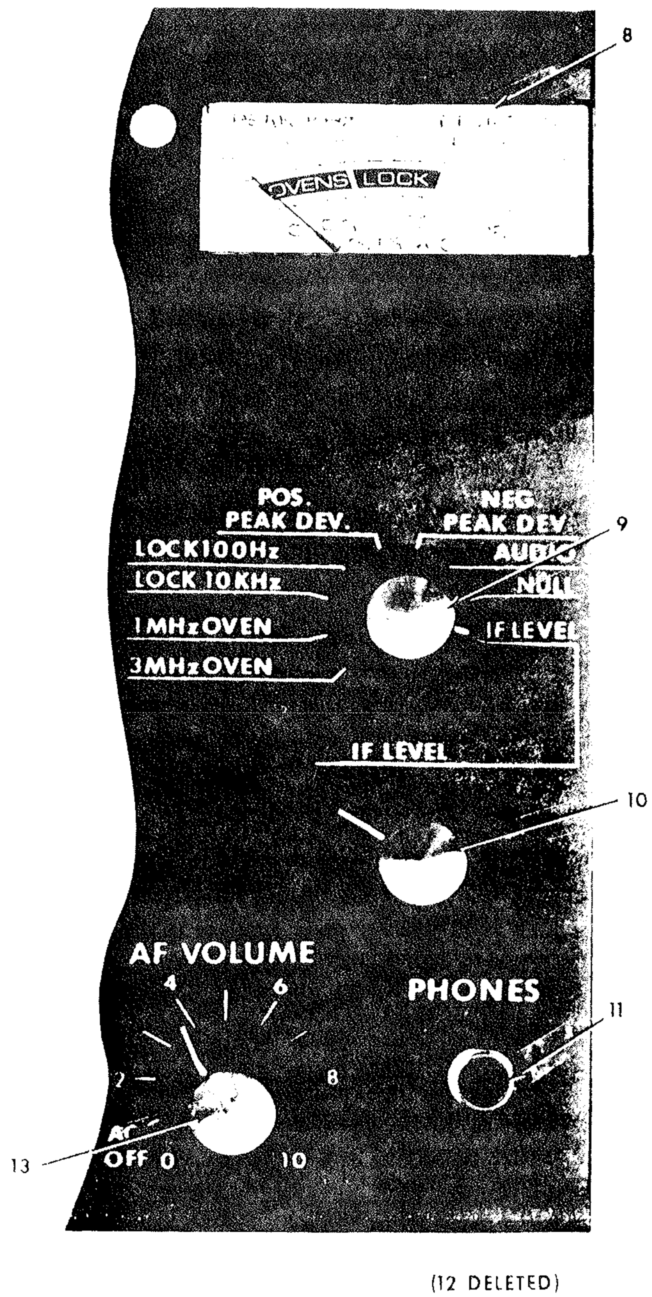


Figure 8-3. Control and Indicator Modifications for 107C (Meter, Meter Switching, and Null Switching)

TABLE 8-1. SUPPLEMENTARY 107C CONTROLS AND INDICATORS INFORMATION

Fig. 8-3 Ref.	Control/ Indicator	Description	Function
9	Meter Switch	Rotary Selector Switch	3 MHz OVEN - Meter reads dc voltage to 3 MHz crystal oscillator oven, 3-6 vdc. 1 MHz OVEN - Meter reads dc voltage to 1 MHz crystal oscillator oven, 3-6 vdc. LOCK 10 kHz - Indicates locked condition when meter indicates within 0.3 from calibrated dial reading for this condition. In unlocked condition, meter pointer swings back and forth. NOTE Best lock is obtained when pointer is in green sector of meter scale. LOCK 100 Hz - Same as for Lock 10 kHz but for 100 Hz harmonic variable frequency oscillator. POS. PEAK DEVIATION - In FM deviation monitoring mode indicates peak positive deviation swings. NEG. PEAK DEVIATION - In FM deviation monitoring mode indicates peak negative deviation swings.

TABLE 8-1. SUPPLEMENTARY 107C CONTROLS AND INDICATORS INFORMATION (continued)

Fig. 8-3 Ref.	Control/ Indicator	Description	Function
9 (cont'd)	Meter Switch (continued)	Rotary Selector Switch (continued)	AUDIO - Reads audio voltage appearing across speaker terminals or audio output jack, regardless of operational mode. NULL - Provides a sharp null on audio voltmeter reading. Used to minimize squelch modulation tone on a transmitter during zero-beat check on transmitter frequency. Allows measurement of tone-modulated transmitters without disabling transmitter tone module. (Same function as AF NULL push-button on 107B). IF LEVEL - Indicates "IF" Signal level.
12	AF NULL	Pushbutton	- Deleted -

INITIAL OPERATION AND CHECKS

Turn-On and Voltage Checks

Delete step 3 because of changed meter selector switch positions. Use OVEN voltage positions to ensure power is on, in addition to the "OVEN" checks specified in step 4.

NOTE

In any of the 107B procedures, references to the "AF VOL." meter switch setting should be interpreted as "AUDIO" meter switch settings on the 107C.

CHECKING TRANSMITTER FREQUENCIES

Observe the following note before using the 107C to check frequencies.

NOTE

When checking frequencies, be sure that the meter switch is NOT set to either POS. PEAK DEV. or NEG. PEAK DEV. When the meter switch is in either of these positions, the audio signal from the heterodyne beat detector is disabled.

With reference to Tone-Squelch Transmitters (page 3-15), in step 6 instead of pressing AF NULL button, - set meter selector switch to NULL.

Add the following information.

FREQUENCY MODULATION DEVIATION CHECK

To check a transmitter for its FM deviation characteristics, proceed in the following steps.

1. Turn on the transmitter to be checked with no modulation, and zero beat the 107C to the transmitter frequency (as explained for the 107B, except be sure the meter switch is not on either of the peak deviation settings). Adjust coupling to the transmitter to obtain a strong beat for this purpose. (If 107B/107C modulation is used, shut it off after this step.)

2. Offset the 10 KHz/Div. dial by 100 kHz (10 dial divisions) toward the center of the dial scale.

3. Modulate the transmitter for peak deviations in accordance with applicable transmitter instructions.

4. Set 107C meter selector switch to POS. PEAK DEV. and read positive deviation.

5. Set 107C meter selector switch to NEG. PEAK DEV. and read negative deviation.

During this test, the FM audio will be heard in the 107C speaker (at a level determined by the AF VOLUME control setting) and may be monitored aurally.

AF NULL USAGE

As noted under the CHECKING TRANSMITTER FREQUENCIES paragraph, when an audio frequency null is needed for checking a transmitter with squelch tone modulation, merely set the meter-selector switch to NULL.

8-4 PRINCIPLES OF OPERATION

As indicated in the block diagram, figure 8-2, a 100 kHz IF signal is developed by the same detector as that used to develop a beat note when making heterodyne frequency measurements. Refer to figure 7-21 in section 7 of the 107B basic instruction manual. This signal is taken from the detector at the junction of D2, R25 and a feedthrough capacitor terminal, and fed via coaxial line to input terminal 2 on board A21. Refer to the schematic diagram for A21 figure 8-7. The 100 kHz signal received at terminal 2 is applied to the FET source follower Q1 which includes a tuned output circuit (approximately 100 kHz) L1-C2. The developed signal is fed through the IC1 operational amplifier, and via another 100 kHz tuned circuit (L2-C7) to IC2 which provides a phase-lock-loop discriminator function, adjustable in center frequency by variable resistor R9.

Outputs from the phase-lock-loop discriminator are a fixed reference signal and a discrimination response signal. The reference signal is transmitted through an offset amplifier IC4 to produce an output dc reference voltage. The operating signal is fed through another offset amplifier IC3 to provide one input to the differential amplifier IC5. The other input for IC5 is the dc reference output from offset amplifier IC4. The reference level is also the "common" return for front panel meter indication. The signal output from differential amplifier IC5 is applied through a diode-and-RC network in such a manner that opposite polarity dc voltages are developed, one representing positive FM deviation and the other negative FM deviation, as viewed on the 100 kHz input. Since the 100 kHz signal is derived by conversion, its deviation values are the same as the original transmitter signal under check. The positive voltage is fed via meter driver IC6 for transmission via output terminal 7 to the front panel meter switch and then to the meter. Likewise, the negative voltage is fed through meter driver IC7 and via output terminal 8 to the meter switch and meter. The common reference dc is transmitted via output terminal 6 to the meter switch.

Diodes CR1 and CR2 provide non-linearity compensation for diodes CR3 and CR4, and variable resistor R18 adjusts the output level of differential amplifier IC5 through a degenerative feedback loop in IC5.

The 100 kHz IF signal used for this measurement is obtained by first zero-beating the 107C to the unmodulated carrier of the transmitter to be measured, and then offsetting the 10 KHz/Div. dial by 100 kHz (10 divisions). When this is done, the FM deviation monitoring function is selected by merely setting the meter switch to the appropriate deviation check function as indicated on the front panel.

8-5 MAINTENANCE

The information provided for the 107B is applicable to the 107C, except for additional requirements relative to the added FM deviation monitor circuitry and related circuit changes.

Figure 8-6 shows the changed wiring on the meter selector switch which is also partially a "function" selector switch in the 107C.

Figure 8-7 is the schematic diagram for A21, the FM Deviation Monitor circuit board.

NOTE

> Paragraph 5-3D "Check Operating Procedures First" is particularly applicable in the case of the 107C. If the meter selector switch is left in either the POS. PEAK DEV. or NEG. PEAK DEV. positions, audio from the beat frequency detector used for frequency checking is cut off and no beat tone will be obtained.

Paragraph 8-6 provides or references parts list information for the 107C modification.

Refer to the schematics and parts list and use the same signal tracing techniques recommended for the 107B.

8-6 PARTS LIST

Parts list information given for the 107B is applicable to the 107C with the following exceptions.

107B/107C MAIN ASSEMBLY CHANGES

AF NULL Switch

The AF NULL switch is deleted on the 107C. This function is now incorporated in a meter switch (S8) setting. The capacitor C25 associated with this function is changed in value to 0.22 uf and is mounted on the meter switch.

Meter Selector Switch Changes

The meter selector switch S8 is changed in its settings for particular functions and is now a 3-deck switch in the 107C. The 107B REGULATED (10.5 volt) setting is deleted, two settings have been added for positive and negative FM deviation monitoring, and the NULL position has been added.

FM Deviation Monitor Addition

A board A21 is added to provide the circuitry for the added FM deviation monitoring function (with FM aural monitoring). Figure 8-4 shows the location of A21 on the main unit. Figure 8-5 shows the parts location on A21, and a list of parts on A21 is provided.

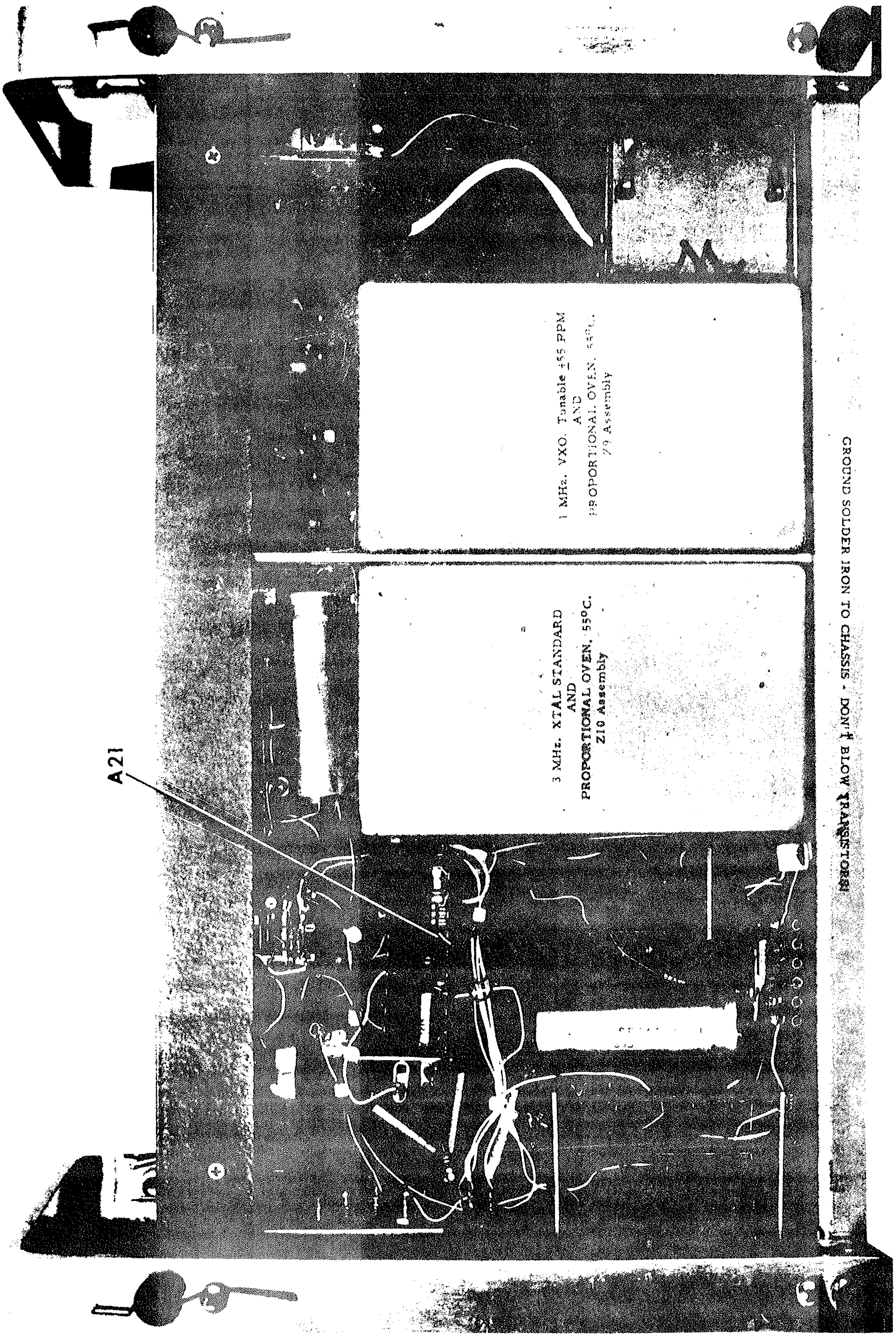


Figure 8-4. Location of FM Deviation Monitor A21 on Main Unit of 107C

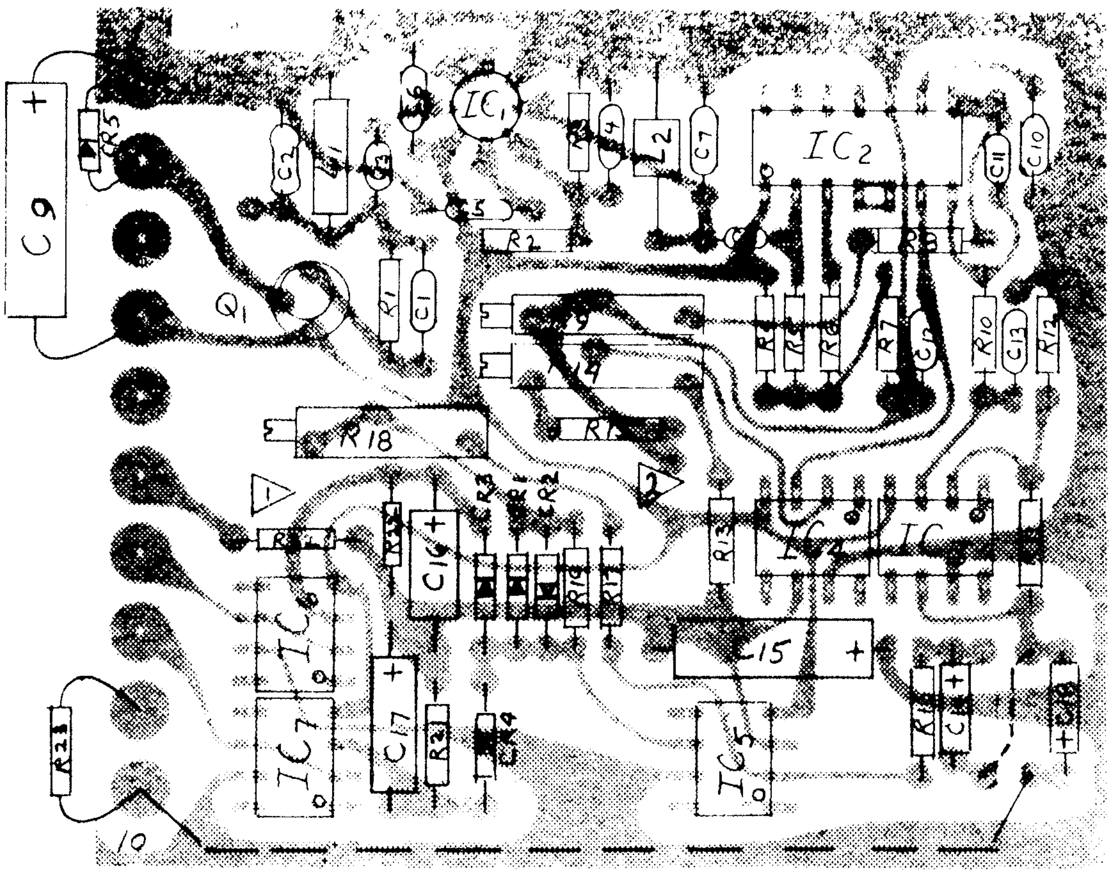


Figure 8-5. FM Deviation Monitor, A21 Parts Location

FM DEVIATION MONITOR PARTS LIST

Ref. Des.	Description	Part or Type
A21	FM Deviation Monitor	00251
C1,C3, C8	Capacitor, Ceramic 0.001 uf, General Purpose	
C2	Capacitor, Silver Mica, 1500 pf	CM06
C4,C5, C6, C12	Capacitor, Ceramic, 0.1 uf, 25 wvdc	52U
C7	Capacitor, Silver Mica, 1300 pf	CM06
C9,C15	Capacitor, Tantalum, 100 uf, 10 wvdc	
C10	Capacitor, Silver Mica, 270 pf	CM06
C11	Capacitor, Silver Mica, 1000 pf	CM06
C13	Capacitor, Ceramic, 0.02 uf, 500 wvdc	
C14,C16, C17, C18	Capacitor, Tantalum, 3.3 uf, 15v or 35 wvdc	
IC1	Integrated Circuit, TO-5	CA3053
IC2	Integrated Circuit, In-Line, Phase-Lock-Loop	NE565
IC3,IC4, IC5, IC6, IC7	Integrated Circuit, Mini-Dip	RC741
L1	Coil, RF, 1.0 Mhy	
L2	Coil, RF, 2.2 Mhy	
Q1	Transistor, Silicon	2N4342
R1	Resistor, Film, 2.7K, 1/2 watt, 10 percent	
R2	Resistor, Film, 2.2K, 1/2 watt, 10 percent	
R3,R10, R15	Resistor, Film, 1000 ohms, 1/2 watt, 10 percent	
R4,R5, R6, R11, R13	Resistor, Film, 4.7K, 1/2 watt, 10 percent	
R7,R16	Resistor, Film, 10K, 1/2 watt, 10 percent	
R8	Resistor, Film, 8.2K, 1/2 watt, 10 percent	

FM DEVIATION MONITOR PARTS LIST

Ref. Des.	Description	Part or Type
A21	FM Deviation Monitor (continued)	00251
R9	Resistor, Variable, 5.0K Trimpot	Amphenol 3800P or equiv.
R12	Resistor, Film, 1.5K, 1/2 watt, 10 percent	
R14	Resistor, Variable, 1000 ohms, Trimpot	Amphenol 3800P or equiv.
R17	Resistor, Film, 56K, 1/2 watt, 10 percent	
R18	Resistor, Variable, 20K, Trimpot	Amphenol 3800P or equiv.
R19	Resistor, Film, 39K, 1/2 watt, 10 percent	
R20,R21	Resistor, Film, 470K, 1/2 watt, 10 percent	
R22	Resistor, Film, 15K, 1/2 watt, 10 percent	
R22A	Resistor, Film, (Selected), 1/2 watt, 10 percent	
CR1,CR2, CR3,CR4, CR5	Diode	1N4454

8-7 DIAGRAMS

Figure 8-6 shows the 107C wiring arrangement for the meter switch S8, and figure 8-7 is the schematic diagram for A21, the FM deviation monitor board. The connections indicated on the meter switch schematic can be correlated to the terminals on the A21 schematic. Other switch connections can be related to the indicated boards as they appear in the 107B overall schematic and interconnection block diagram, figure 7-1, or to individual board schematics in section 7, as required.

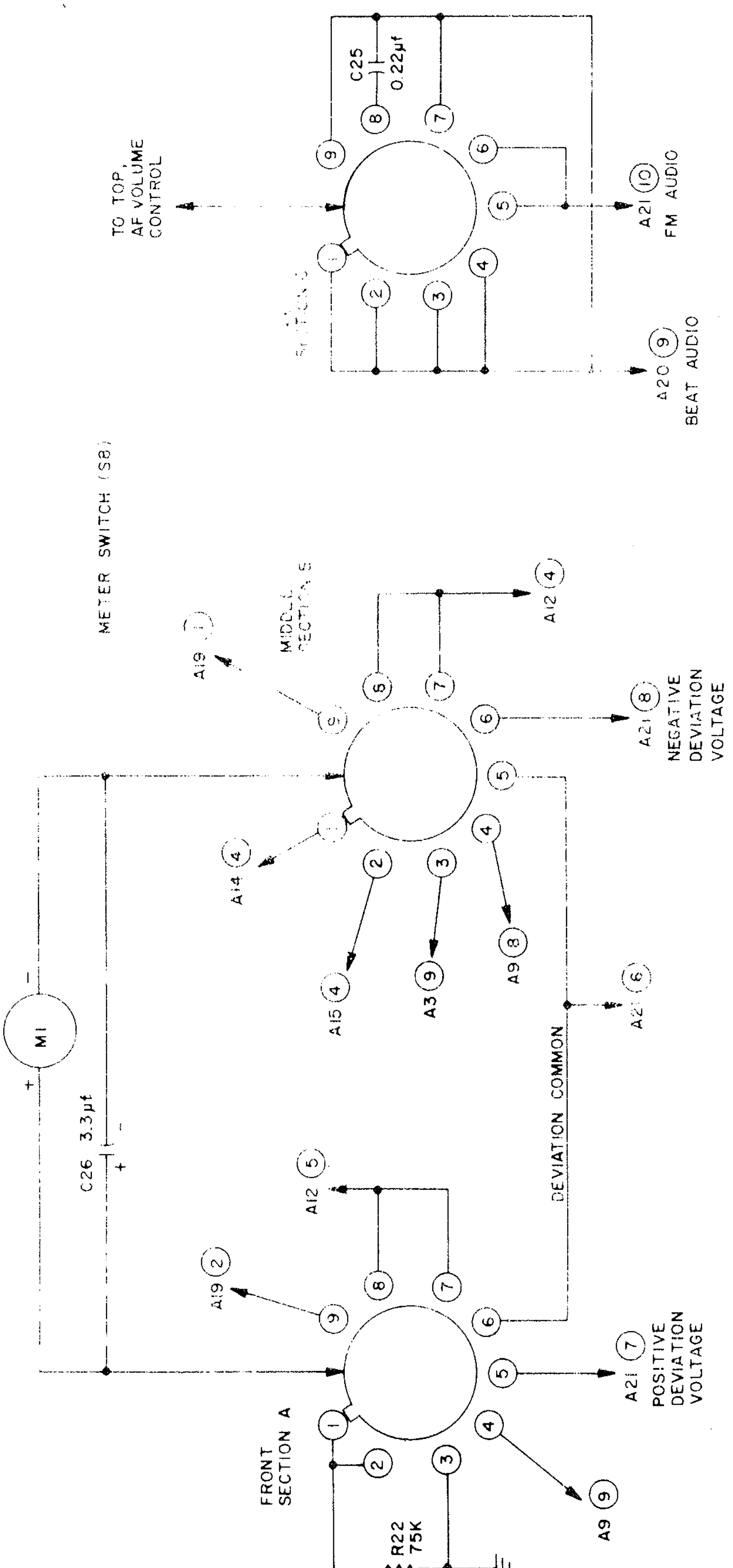


Figure 8-6. Meter Switch Wiring, Type 107C Communication Service Monitor

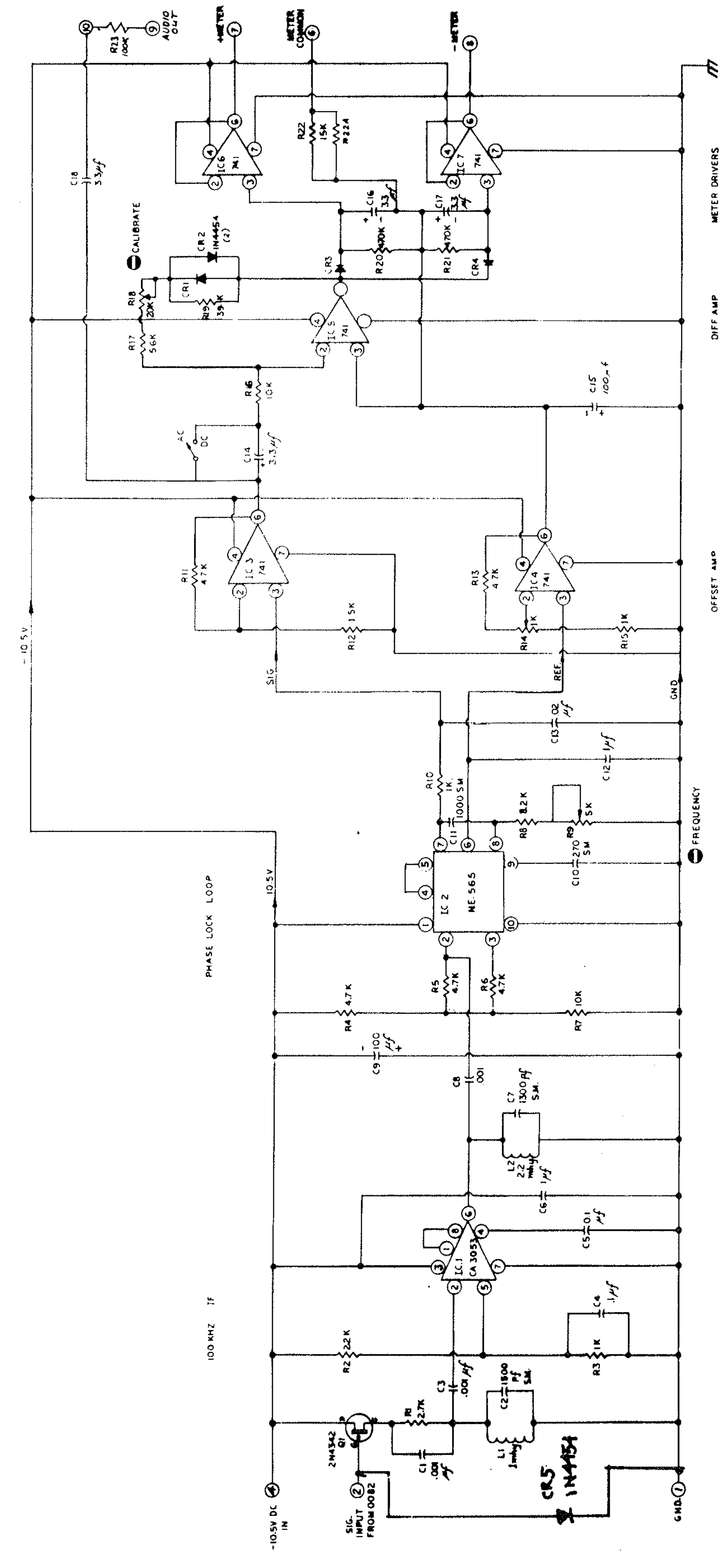


Figure 8-7. FM Deviation Monitor A21, Schematic Diagram

Easy method of setting up accurate amount of FM deviation on 107C generated FM signal.

In measuring FM peak deviation, the 107C measures FM on a 100 kHz IF developed by beating an internal cw signal against an external FM signal. The deviation measuring function will also work from an IF developed by beating an external cw signal with a 107C internal FM signal. To use this technique to set up desired deviation on a 107C FM signal, proceed as follows.

1. With no modulation, set the 107C to the frequency at which an FM output signal is desired and mix internal cw signal with an external stable cw signal (from some convenient source - transmitter, signal generator, etc.) and obtain a beat tone.

2. Offset the 107C 10kHz/Div. dial 100 kHz toward center of scale (10 divisions) and set FM-AM switch to FM.

3. While watching 107C panel meter PEAK KHZ DEVIATION scale, adjust 107C MODULATOR LEVEL control for desired deviation.

4. Return 10kHz/Div. dial to working frequency setting (that is, eliminate the offset) and disconnect external cw input.

The procedure described applies equally well, whether the FM signal is derived from internal 107B audio - or from an external modulation source - as when the rear panel modulation switch is set to "External".

 1/3/73

MANUAL UPDATES AND CORRECTIONS

Please correct your 107B or 107B/107C manual as follows:

In section 3, Operating Instructions:

Page 3-12, Paragraph E Output Level Adjustment (Attenuator Usage) Band 2. Add the following note at the end of the paragraph. This note is applicable for AM only.

NOTE

When amplitude modulation (only) is used on band 2 (only) the DFM output drops 6 dB because of a necessary bias change on the pin-diode output attenuator. Therefore, when using AM on band 2, and reading the microvolt scale on the variable attenuator, divide the reading by 2 to get the true voltage value. Thus, 10 microvolts is interpreted as 5 microvolts, 2 microvolts as 1 microvolt, etc. THIS DOES NOT APPLY WHEN FM IS USED.

Page 3-16, Paragraph A Local Oscillator and IF Characteristic Checks. Change step 1 to read:

1. Set the 107B (DFM) output level to ------ (etc)

Page 3-17. Paragraph C. Sensitivity Checks. Add the following note.

NOTE

The above applies when working with DFM frequency modulated output. See the correction note added to paragraph E, Page 3-12 regarding voltage readings when using AM.

Addendum 2

107C Supplement Update

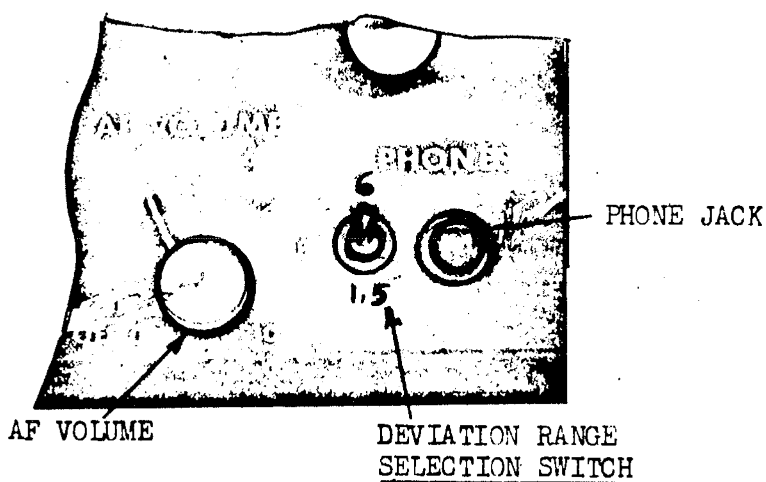
New FM Deviation Measurement Range and new Oscilloscope Output Connector

Please consider the following information part of the 107C manual supplement.

To accommodate deviation values related to "private-line" tone modulation, a new 1.5 kHz range has been added for 107C FM deviation measurement.

Operation is the same as for the 6 kHz range measurement, except that a toggle switch is used to select either the 6 kHz or 1.5 kHz range.

The toggle switch, designated 6-1.5, is located in the lower right-hand portion of the 107C front panel between the AF VOLUME control and the PHONES jack. See diagram.



Deviation range selection toggle switch location.

The procedure for making deviation measurements is modified to the extent that the range selection must be made (6 or 1.5 kHz full scale) before making any deviation measurement.

Use the 6 kHz range for regular voice or test modulation, and the 1,5 kHz range for private-line tone modulation.

The existing lower meter scale is used with the 1.5 kHz range.

A new BNC connector on the rear panel provides access to FM detector output for oscilloscope observation of pertinent waveforms.

MODEL 107C COMMUNICATION SERVICE MONITOR--ADDENDUM

Serial Numbers 1148 and up

Revision to attenuators -- front panel

Addition of internal panel fuse

Front panel attenuation is (two) 20 db switched attenuators and (one) 20 db calibrated variable attenuator. With included 20 db fused pad total attenuation is 80 db.

Output level at front panel BNC is 1000 microvolts.

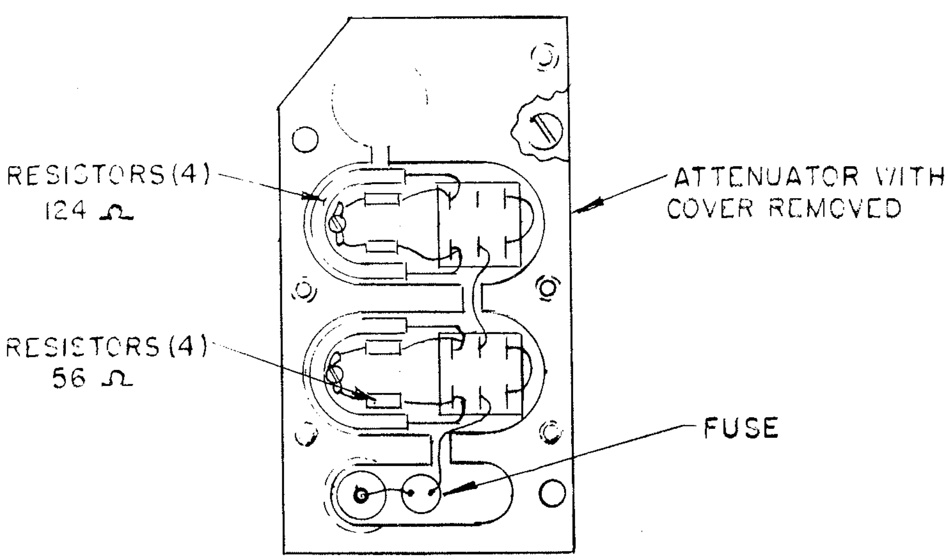
Band 1	10 kHz/10 MHz	Meter IF level set to 1 Volt.
Band 2	10 MHz/1000 MHz	

Output levels to receiver

Through fused pad	100 uv
(1) 20 db switched	10 uv
(2) 20 db switched	1 uv
Variable calibration	1 uv to 0.1 uv

The addition of a second in-line RF fuse mounted under the front panel trim plate should prevent extensive damage to the instrument due to misuse by the application of transmitter carrier direct to the input in those instances in which the fused pad was not used.

The fuse is available by removing the six screws on the attenuator cover plate. Pull the block out, disconnect the BNC Co-Ax cable connector. The fuse is mounted under the lid on the block. Trim and remount as the original fuse, using a low watt iron and heat sinking. Use Littlefuse Pt. #279-050, 50 ma, pig-tail lead. The fuse may be continuity checked from the front panel to ground; using the low (1 ½ v) ohms range of a meter, resistance should be 50 ohms with either 20 db pad switched in.



Model 107C Communications Service Monitor - ADDENDUM

MANUAL UPDATE

Power input to the Instrument

The Communications Service Monitor, as normally wired at the factory, is connected to operate at 115 volts, single phase AC, on frequencies from 50 Hz through 400 Hz.

The input primary to the power supply transformer is a split primary allowing parallel connection of primaries for 115 volt operation, and series connection for 220 volt operation. The transformer primary interconnections are located on a terminal block under the unit, near the right rear corner of the instrument.

To re-connect the instrument for 220 volt operation, follow the procedure below:

(1) Remove the bottom cover -- loosen 4 handle screws and slide cover back.

(2) Remove the insulating cover from the terminal block and remove the "2" jumpers, installed at factory, as shown at left.

(3) Re-install "1" jumper, between the center pair of terminals, as shown at right.

(4) Replace covers. The instrument is now connected for 220 volt operation.