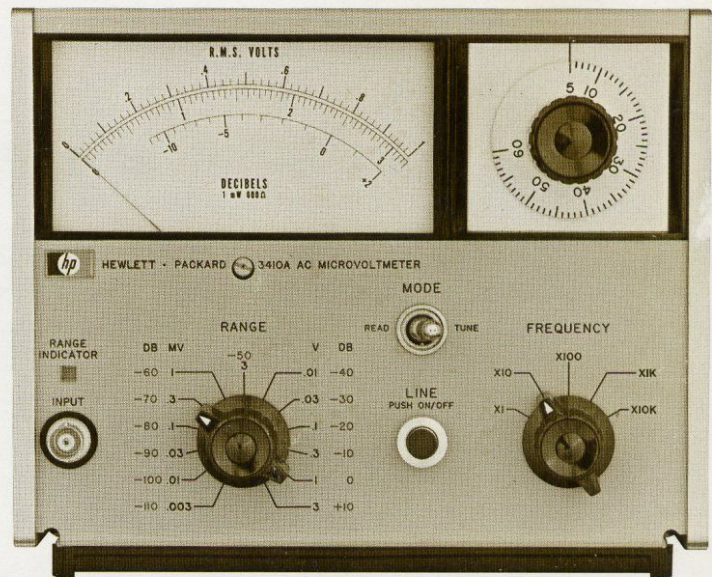


# AC MICROVOLTMETER

## 3410A



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## CERTIFICATION

*The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.*

## WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.



**OPERATING AND SERVICE MANUAL**

**(HP PART NO. 03410-90002)**

**MODEL 3410A  
AC MICROVOLTMETER**

**SERIALS PREFIXED: 842-**

Appendix C, Manual Backdating Changes (in the back of the manual), adapts this manual to instruments with Serials Prefixed: 648-, 719-, 728-, 731-, 735-, and 752-.

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Figure 1-1. Model 3410A AC Microvoltmeter

Table 1-1. Specifications

VOLTAGE RANGE: 3  $\mu$ V full scale to 3 V full scale in 13 ranges.

FREQUENCY RANGE: 5 Hz to 600 kHz in 5 decade ranges.

VOLTAGE ACCURACY: % FULL SCALE

FREQUENCY

	5Hz	10Hz	25Hz	100Hz	50kHz	600kHz
30 $\mu$ V to 3V	$\pm 10\%$	$\pm 3\%$			$\pm 5\%$	
10 $\mu$ V	$\pm 15\%*$	$\pm 10%*$	$\pm 3\%$		$\pm 5\%$	
3 $\mu$ V	$\pm 20%*$	$\pm 10\%$	$\pm 3\%$		$\pm 10\%$	

FREQUENCY DIAL ACCURACY:  $\pm 10\%$  full scale (unlocked).

METER: Responds to average value of input waveform; calibrated in rms value of sine wave. Linear voltage scales 0 to 1 and 0 to 3; dB scale -12 to +2 dB (0dB = 1 mW into 600 $\Omega$ ).

PHASE LOCK RANGE: Pull in,  $\pm 1\%$  of full scale frequency. Track,  $\pm 5\%$  of full scale frequency. Tracking speed, 0.5% of full scale/second

LOCAL OSCILLATOR OUTPUT: 4 V square wave into open circuit at the same frequency as the phase locked input signal.

MAXIMUM NOISE REJECTION: 20 dB rms above full scale on all ranges for rated accuracy.

RECORDER OUTPUT: +1 V into 1000 $\Omega$  for full scale deflection.  $\pm 0.5$  V adjustable offset level.

INPUT IMPEDANCE: 10 mV to 3 V range, 10 M $\Omega$  shunted by 10 pF. 3  $\mu$ F to 3 mV range, 10 M $\Omega$  shunted by 20 pF.

AC POWER: 115 or 230 V  $\pm 10\%$ , 50 to 400 Hz, 22 W.

DIMENSIONS: Standard 1/2 module, 6-1/2" high, 7-3/4" wide, 11-1/2" deep, (164x196.9x292 mm).

\* At lower frequencies and microvolt signal levels, meter fluctuations in the READ MODE may give the impression of an unstable lock condition. However, the 3410A will lock and track at these lower frequencies and provide a usable voltage indication.

## SECTION I

### GENERAL INFORMATION

#### 1-1. DESCRIPTION.

1-2. The Hewlett-Packard Model 3410A AC Microvoltmeter is a tuneable phase locking voltmeter designed to measure ac voltages from 3 microvolts to 3 volts full scale. When tuned to any discrete frequency between 5 Hz and 600 kHz, the 3410A will indicate the amplitude of the signal present at that frequency, rejecting all noise and non-harmonically related signals.

1-3. Two outputs are provided on the rear panel to extend the usefulness of the 3410A. The RECORDER OUT terminal provides a dc output that is proportional to meter deflection. This output, 1 V into 1 k $\Omega$  for full scale deflection, may be used to drive a pen recorder or other auxiliary equipment. A 5 V square wave at the tuned frequency, which may be used to drive an electronic counter for making precise frequency measurements, is available at the OSC OUT terminal.

1-4. The Model 3410A AC Microvoltmeter is shown in Figure 1-1, and Table 1-1 gives a list of its performance specifications.

#### 1-5. OPTION.

1-6. Option 01 is a standard -hp- Model 3410A that has the dB scale placed uppermost on the meter face. This option is used to obtain greater resolution when making dB measurements.

#### 1-7. INSTRUMENT AND MANUAL IDENTIFICATION.

1-8. Hewlett-Packard instruments are identified by a two-section eight-digit serial number (000-00000). If the first three digits of the serial number on your instrument do not agree with those on the title page of this manual, change sheets supplied with the manual will define differences between your instrument and the Model 3410A described in this manual.

1-9. If a letter prefixes the serial number, the instrument was manufactured outside the United States.

## SECTION II

### INSTALLATION

#### 2-1. INTRODUCTION.

2-2. This section contains information and instructions necessary for the installation and shipping of the Model 3410A Microvoltmeter. Included are initial inspection procedures, power and grounding requirements, installation information, and instructions for repackaging for shipment.

#### 2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be physically free of marks or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage received in transit. Also check for supplied accessories, and test the electrical performance of the instrument using the procedure outlined in the Performance Checks found in Paragraph 5-. If there is damage or deficiency, see the warranty on the inside front cover of this manual.

#### 2-5. POWER REQUIREMENTS.

2-6. The Model 3410A can be operated from any source of 115 or 230 volts at 50 to 1000 Hz. The 115/230 V slide switch on the rear panel sets the instrument to operate from the desired line voltage. Power dissipation is less than 25 watts.

#### 2-7. GROUNDING REQUIREMENTS.

2-8. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground wire.

2-9. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

#### 2-10. INSTALLATION.

2-11. The Model 3410A is fully transistorized; therefore, no special cooling is required. However, the instrument should not be operated where the ambient temperature exceeds 55°C (131°F) or the relative humidity exceeds 95%.

#### 2-12. BENCH MOUNTING.

2-13. The Model 3410A is shipped with plastic feet and tilt stand in place, ready for use as a bench instrument.

#### 2-14. RACK MOUNTING.

2-15. The Model 3410A may be rack mounted by using an adapter frame (-hp- Part No. 5060-0797). The

adapter frame is a rack frame that accepts any combination of submodular units. It can be rack mounted only. For additional information, address inquiries to your -hp- Sales and Service Office. (See Appendix B for office locations.)

#### 2-16. COMBINATION MOUNTING.

2-17. The Model 3410A may be mounted in combination with other submodular units by using a Combining Case (-hp- Model 1051A or 1052A). The Combining Case is a full module unit which accepts various combinations of submodular units. This full module unit can be bench or rack mounted and is analogous to any full module instrument.

#### 2-18. REPACKAGING FOR SHIPMENT.

2-19. The following paragraphs contain a general guide for repackaging of the instrument for shipment. Refer to Paragraph 2-20 if the original container is to be used; 2-21 if it is not. If you have any questions, contact your local -hp- Sales and Service Office. (See Appendix for office locations.)

#### NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach to the instrument a tag identifying the owner, indicating the service or repair to be accomplished, and giving the serial number of the instrument. In any correspondence, identify the instrument by model number and serial number.

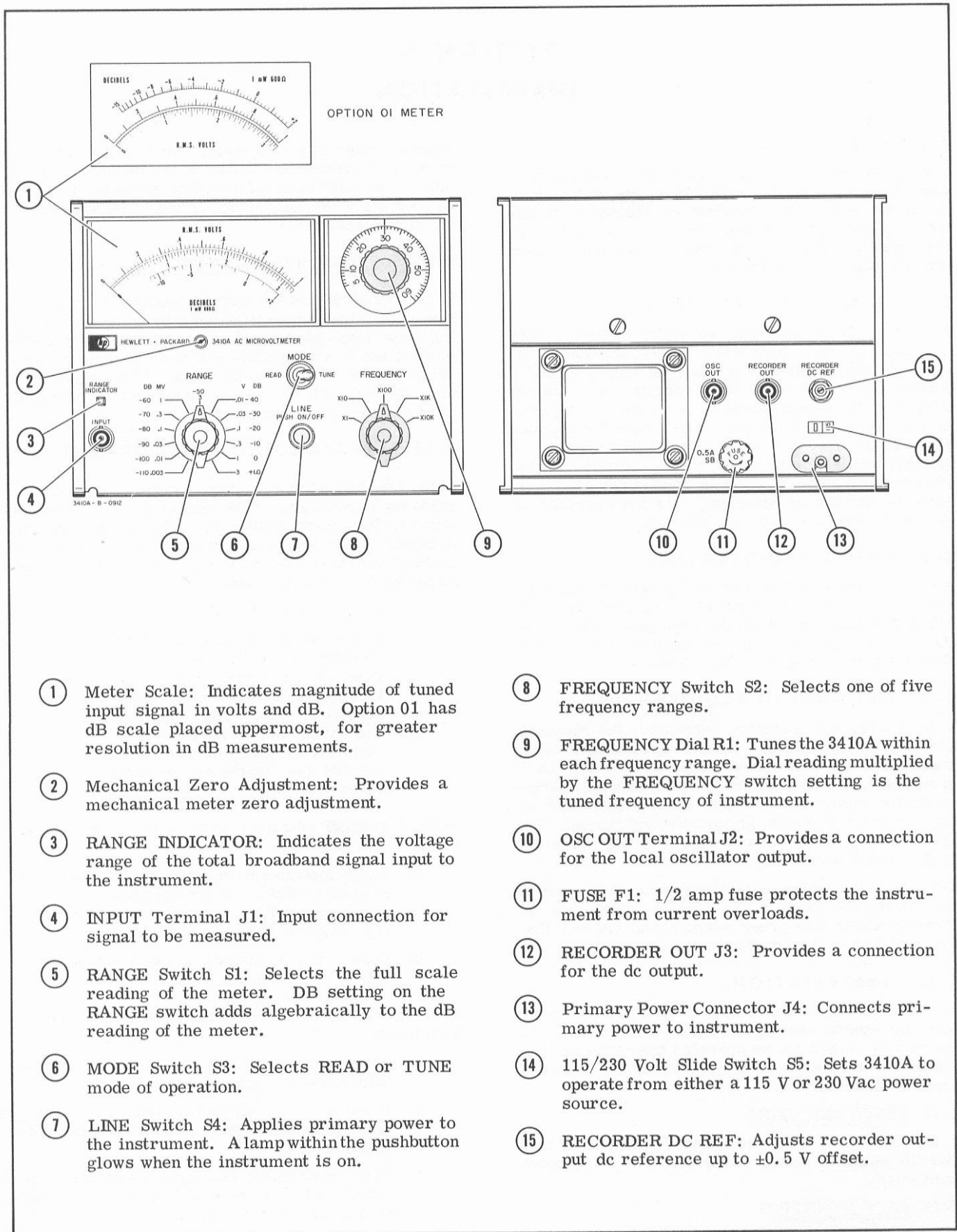
2-20. If original container is to be used, proceed as follows:

- a. Place instrument in original container. If original container is not available, a similar container can be purchased from your nearest -hp- Sales and Service Office.
- b. Ensure that container is well sealed with strong tape or metal bands.

2-21. If original container is not to be used, proceed as follows:

- a. Wrap instrument in heavy paper or plastic before placing in an inner container.
- b. Place packing material around all sides of instrument and protect panel face with cardboard strips.
- c. Place instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.
- d. Mark shipping container with "DELICATE INSTRUMENT," "FRAGILE" etc.





- ① **Meter Scale:** Indicates magnitude of tuned input signal in volts and dB. Option 01 has dB scale placed uppermost, for greater resolution in dB measurements.
- ② **Mechanical Zero Adjustment:** Provides a mechanical meter zero adjustment.
- ③ **RANGE INDICATOR:** Indicates the voltage range of the total broadband signal input to the instrument.
- ④ **INPUT Terminal J1:** Input connection for signal to be measured.
- ⑤ **RANGE Switch S1:** Selects the full scale reading of the meter. DB setting on the RANGE switch adds algebraically to the dB reading of the meter.
- ⑥ **MODE Switch S3:** Selects READ or TUNE mode of operation.
- ⑦ **LINE Switch S4:** Applies primary power to the instrument. A lamp within the pushbutton glows when the instrument is on.
- ⑧ **FREQUENCY Switch S2:** Selects one of five frequency ranges.
- ⑨ **FREQUENCY Dial R1:** Tunes the 3410A within each frequency range. Dial reading multiplied by the FREQUENCY switch setting is the tuned frequency of instrument.
- ⑩ **OSC OUT Terminal J2:** Provides a connection for the local oscillator output.
- ⑪ **FUSE F1:** 1/2 amp fuse protects the instrument from current overloads.
- ⑫ **RECORDER OUT J3:** Provides a connection for the dc output.
- ⑬ **Primary Power Connector J4:** Connects primary power to instrument.
- ⑭ **115/230 Volt Slide Switch S5:** Sets 3410A to operate from either a 115 V or 230 Vac power source.
- ⑮ **RECORDER DC REF:** Adjusts recorder output dc reference up to  $\pm 0.5$  V offset.

Figure 3-1. Location and Description of Controls and Indicators

## SECTION III

### OPERATING INSTRUCTIONS

#### 3-1. INTRODUCTION.

3-2. This section contains instructions and information necessary for the operation of the 3410A AC Microvoltmeter. Included are identification of controls, indicators and connectors; turn on procedure; mechanical meter zero adjustment steps; and operating instructions.

#### 3-3. CONTROLS, INDICATORS AND CONNECTORS.

3-4. Figure 3-1 identifies and describes the function of each operating control, indicator and connector of the Model 3410A.

#### 3-5. OPERATION.

##### 3-6. TURN ON PROCEDURES.

- a. Set 115/230 volt slide switch, (14), to agree with the voltage of the primary power to be used.
- b. Connect primary power to receptacle (13).
- c. Depress LINE switch, (7). Lamp DS1, within switch pushbutton (7), will glow, indicating application of primary power.

##### 3-7. MECHANICAL METER ZERO ADJUSTMENT.

3-8. The 3410A meter is properly zero-set when the meter pointer rests over the zero mark, with the instrument in normal operating position, at normal operating temperature, and turned off. Zero-set the meter as follows to obtain maximum accuracy and mechanical stability:

- a. Turn instrument on and allow it to operate for 20 minutes, to ensure that meter movement reaches normal operating temperature.
- b. Turn instrument off, and wait at least one minute for all capacitors to discharge.
- c. Rotate the mechanical zero adjustment screw clockwise until the pointer is to the left of zero, and moving upscale toward zero. Stop when the pointer is exactly on zero; if the pointer overshoots, repeat this step.
- d. When the pointer is exactly over zero, rotate the adjustment screw slightly counterclockwise to relieve tension on the pointer suspension. If the pointer moves left, repeat steps c and d, but make the counterclockwise adjustment smaller.

##### 3-9. VOLTAGE MEASUREMENTS.

###### NOTE

Ground loops, due to unbalances between chassis grounds of instruments, may be present during usage of the

3410A on the more sensitive ranges. To prevent ground loops, isolate the 3410A from power line ground by attaching a three-prong to two-prong adapter to the power cord and leaving the adapter pigtail unconnected.

- a. Turn on the 3410A and mechanically zero the meter, according to steps in Paragraph 3-7.
- b. Set RANGE switch to 3 V, and set MODE switch to TUNE.

###### NOTE

Never place the mode switch to read position while tuning the instrument; because the instrument may respond to the wrong signal, thus giving a false reading.

- c. Set the FREQUENCY range switch to the range of the signal to be measured.



DO NOT APPLY MORE THAN 100 V RMS TO INPUT. IF THIS LIMIT IS EXCEEDED, THE INSTRUMENT MAY BE DAMAGED.

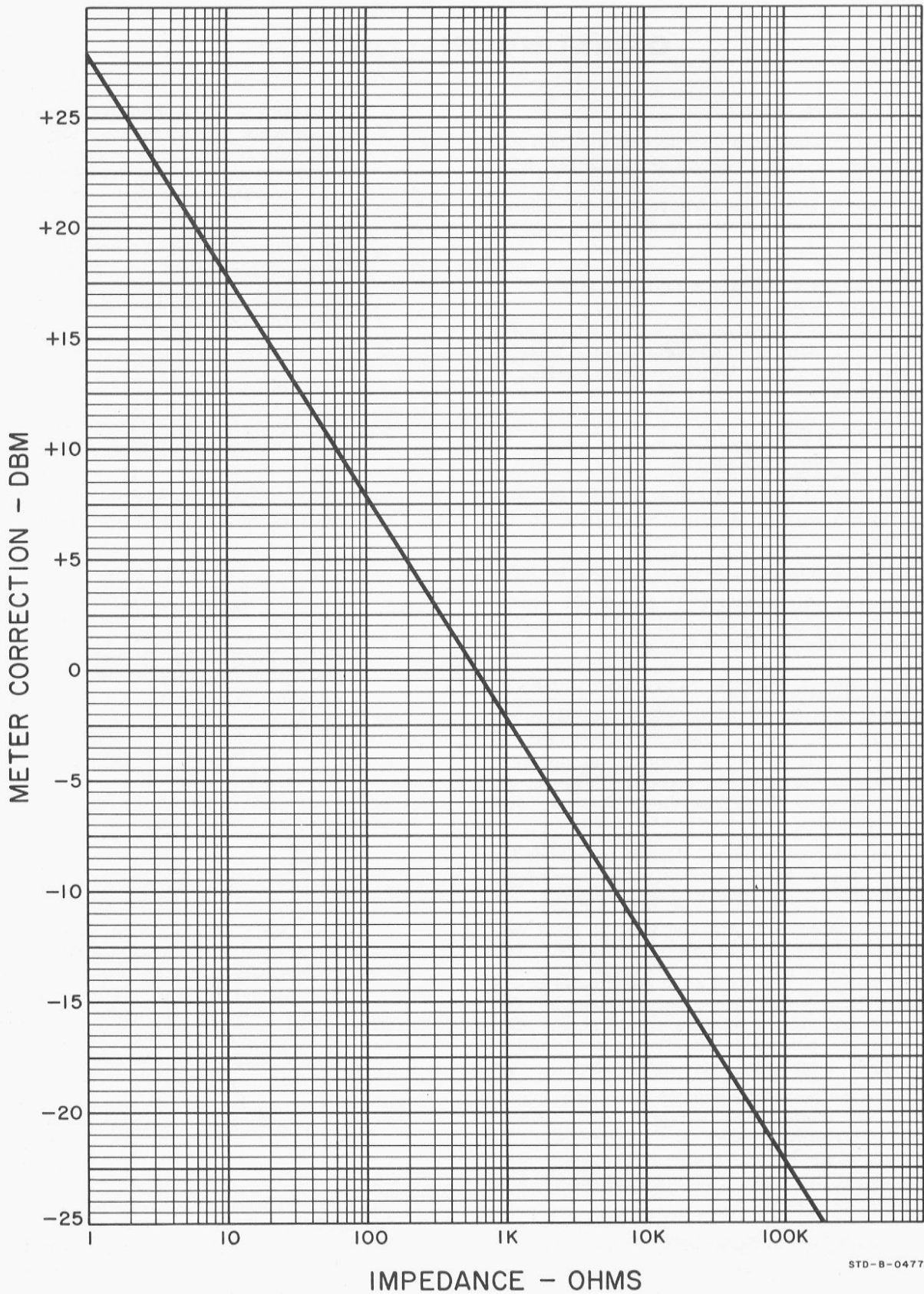
- d. Connect the signal to be measured to the 3410A, and downrange the RANGE switch until the RANGE INDICATOR lights.
- e. Slowly tune the FREQUENCY dial through the frequency of interest, until a meter reading is obtained. If the meter pegs, uprange the RANGE switch to obtain an on-scale reading.

###### NOTE

If the instrument is upranged to obtain an on-scale reading, the RANGE INDICATOR lamp may go out. This is a normal indication which will happen whenever the signal being measured is larger than the summation of noise and other signals present.

If the instrument is downranged from the range on which the RANGE INDICATOR lights, it may not operate with rated accuracy.

- f. After on-scale reading is obtained, place the MODE switch to READ position. The meter will indicate the RMS voltage amplitude of the sinusoidal input signal. The meter indication in READ position may be same as in TUNE position. If so, this indicates that input signal contains relatively little low frequency noise.



STD-B-0477

Figure 3-2. Impedance Correction Graph

3-10. DB MEASUREMENTS.

- a. A dB measurement is equal to the algebraic sum of the meter indication and the RANGE setting. For example: if the RANGE setting is +10 dB and the meter indication is -3 dB, the actual dB measurement is +7 dB.
- b. The dB scale of the 3410A is calibrated to read in dBm when a 600Ω load is used. 0 dBm is equivalent to 1 milliwatt dissipated by a 600Ω load. Therefore, all dBm measurements must be made across a total impedance of 600Ω. Measurements across all other impedances will be in dB, but not dBm.
- c. A reading in dB may be converted to dBm by using the Impedance Correction Graph (Figure 3-2). For example: to convert a -30 dB reading across 200 ohms to dBm, locate the 200Ω impedance on the bottom of the graph. Follow the impedance line to the heavy black line, and read the meter correction at that point. The correction for 200 ohms is +5 dBm; thus the corrected reading is -25 dBm.

3-11. LOW LEVEL, LOW FREQUENCY MEASUREMENT TECHNIQUE.

3-12. Due to the difficulty of filtering very low level, low frequency signals and noise, a special technique is required when locking the 3410A to signals between 10 Hz and 100 Hz on the 3 μV range and between 5 Hz and 25 Hz on the 10 μV range. Use the following procedure when making measurements in this voltage and frequency range:

- a. Turn the 3410A on and mechanically zero meter, according to the steps in paragraph 3-6.
- b. Set the RANGE switch to the voltage range of the signal (3 μV or 10 μV).
- c. Set the FREQUENCY range switch to the range of the signal.
- d. Set the MODE switch to TUNE, and slowly tune the FREQUENCY dial until a meter swing greater than 1/10 of full scale is obtained. This indicates that the 3410A is tuned within the capture range of the input signal.
- e. Place the MODE switch to READ, and allow 30 seconds for the 3410A to lock to the signal, and indicate the amplitude of it.
- f. If the 3410A does not lock to the signal within 30 seconds, leave the MODE switch in READ position and tune the instrument first slightly above and then slightly below the previous frequency setting. After each change in frequency, allow 30 seconds for the instrument to lock to the signal.

3-13. OPTION 01 INSTRUMENT.

3-14. Operating procedures for the 3410A with Option 01 are the same as the operating procedures for the standard instrument. The only difference between the two models is the scale layout. The 3410A with Option 01 has a dB scale that reads from -15 to +2, instead of from -12 to +2. Also, the dB scale is the upper scale on the meter face for better resolution.

3-15. USE OF OUTPUTS.

DO NOT CONNECT MORE THAN 5 V RMS TO THE OUTPUT TERMINALS. IF THIS LIMIT IS EXCEEDED, THE INSTRUMENT MAY BE DAMAGED.

3-16. OSC. OUT.

3-17. Connect OSC. OUT to the sync input of an oscilloscope, to the input of a counter to make precise frequency measurement, or to any other instrument where a square wave which is phase locked to the input signal is useful.

3-18. RECORDER OUT.

- a. Connect the RECORDER OUT terminal to the input of a recorder, using a 1000Ω load resistor to obtain rated output of 1 mV for full scale meter deflection.
- b. Adjust the RECORDER DC REF pot to offset the output up to ± 0.5 Vdc.

3-19. EFFECT OF INTERFERING SIGNALS AND HARMONICS.3-20. INTERFERING SIGNALS.

3-21. The graph of Figure 3-3 shows how the accuracy of the 3410A is affected by the relationship of the amplitude to percent of frequency separation between an interfering signal and the desired signal. The shaded portion of the graph indicates the conditions under which the accuracy of the 3410A would be less than specified. For example: Assume that the 3410A is locked to a signal at 10 kHz, and that an interfering signal at 16 kHz is present. The interfering signal is separated from the tuned signal by +6 kHz, thus the frequency separation in percent of full scale frequency of the range is +10%. As shown on the graph, the amplitude of this signal could be as much as 10 dB above the amplitude of the tuned signal without degrading the specified accuracy of measurement.

3-22. HARMONICS.

3-23. Even harmonics or submultiples of the tuned frequency do not seriously affect the accuracy of the 3410A. However, relatively large signals at or near a harmonic or a submultiple frequency can substantially

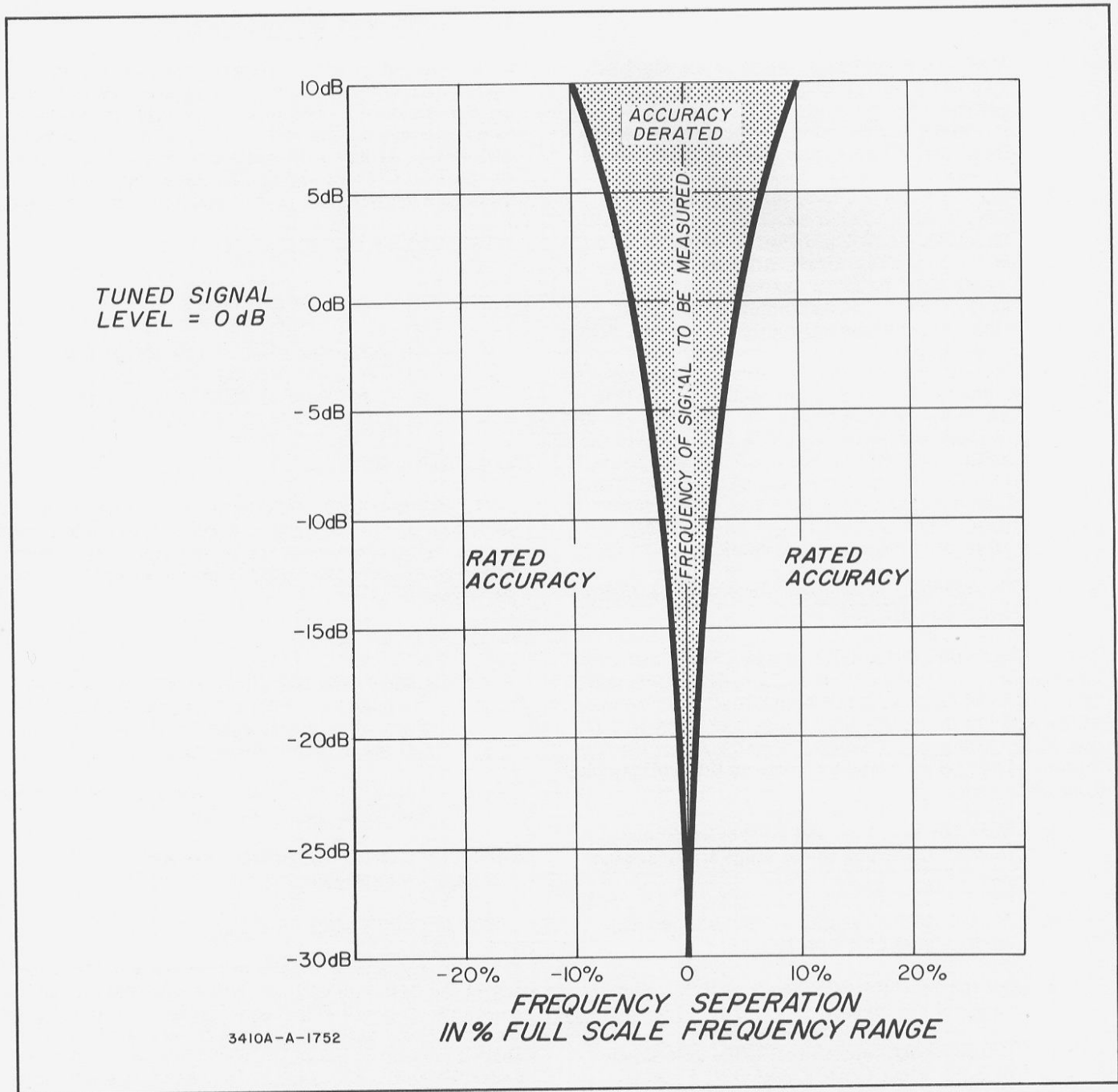


Figure 3-3. Effect of Close Interfering Signals

effect the reading. Figure 3-4 shows the greatest effect that interfering harmonics and submultiples should ever have. In many cases, interfering signals of larger amplitudes can be tolerated without degrading the accuracy of the 3410A. This is dependent upon where in the decade range the tuned frequency falls, and also upon the phase relationship between the tuned signal and the interfering signal.

3-24. Figure 3-5 shows the effect of third harmonic

signals of various phases. Interfering signals in phase and those  $180^\circ$  out of phase with the tuned signal cause the greatest error in reading. An interfering signal  $90^\circ$  out of phase would have no effect on the meter indication. A signal having 30% third harmonic distortion would have a 1.1 ratio, or read 110% of the actual rms value of the tuned signal. The dashed line on Figure 3-5 shows the effect that third harmonic distortion, regardless of phase, has upon average-responding instruments. This completes Section III except for Figure 3-5.

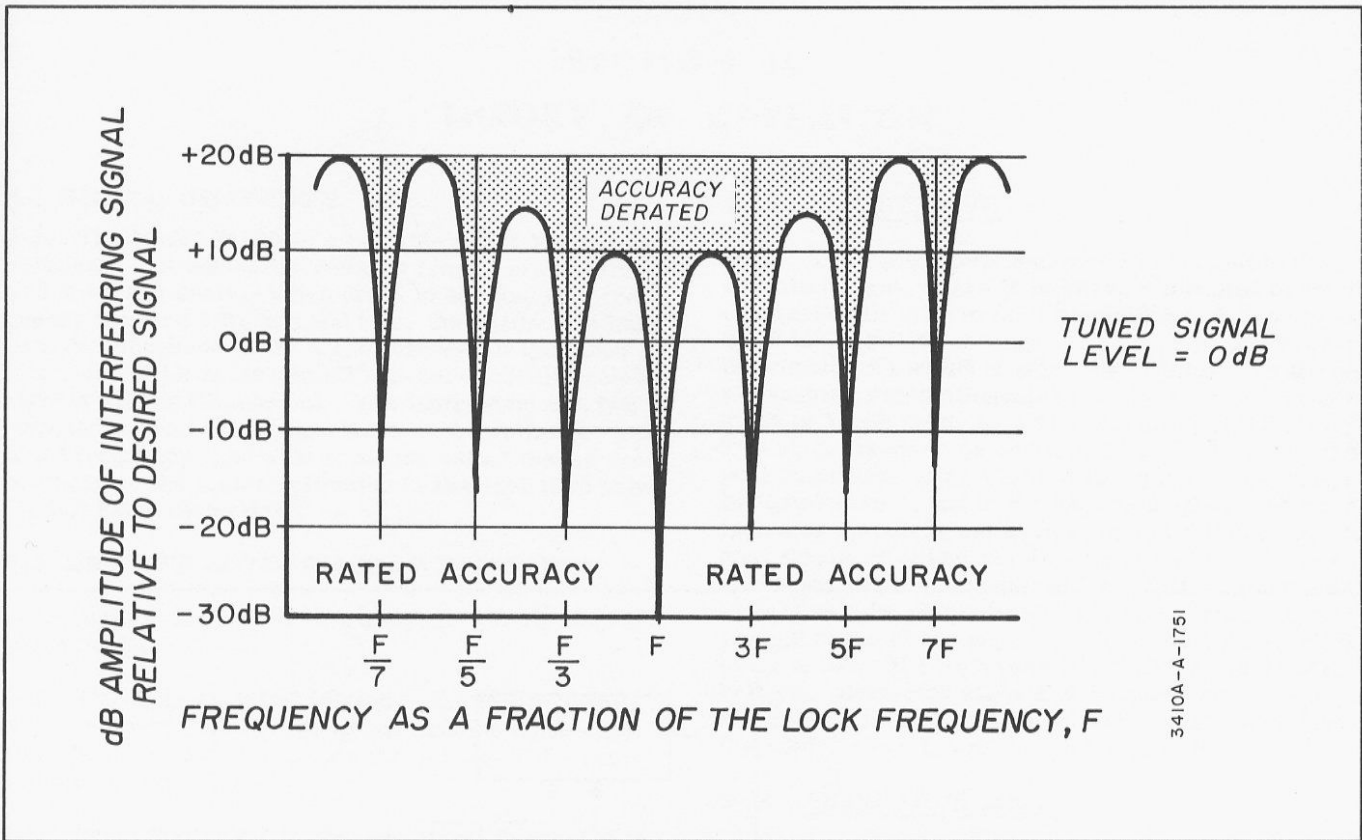


Figure 3-4. Effect of Odd Harmonics and Submultiples

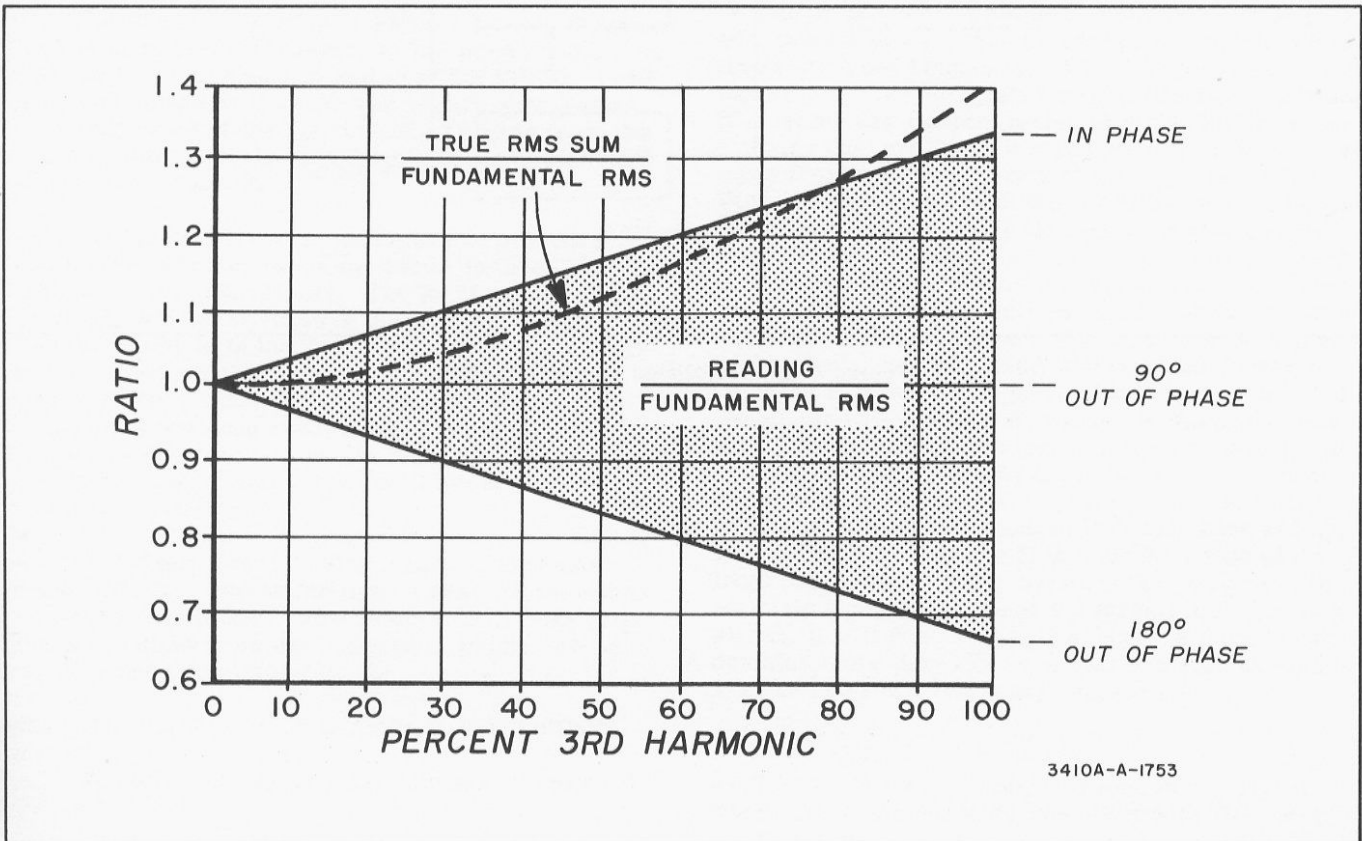


Figure 3-5. Effect of Third Harmonic

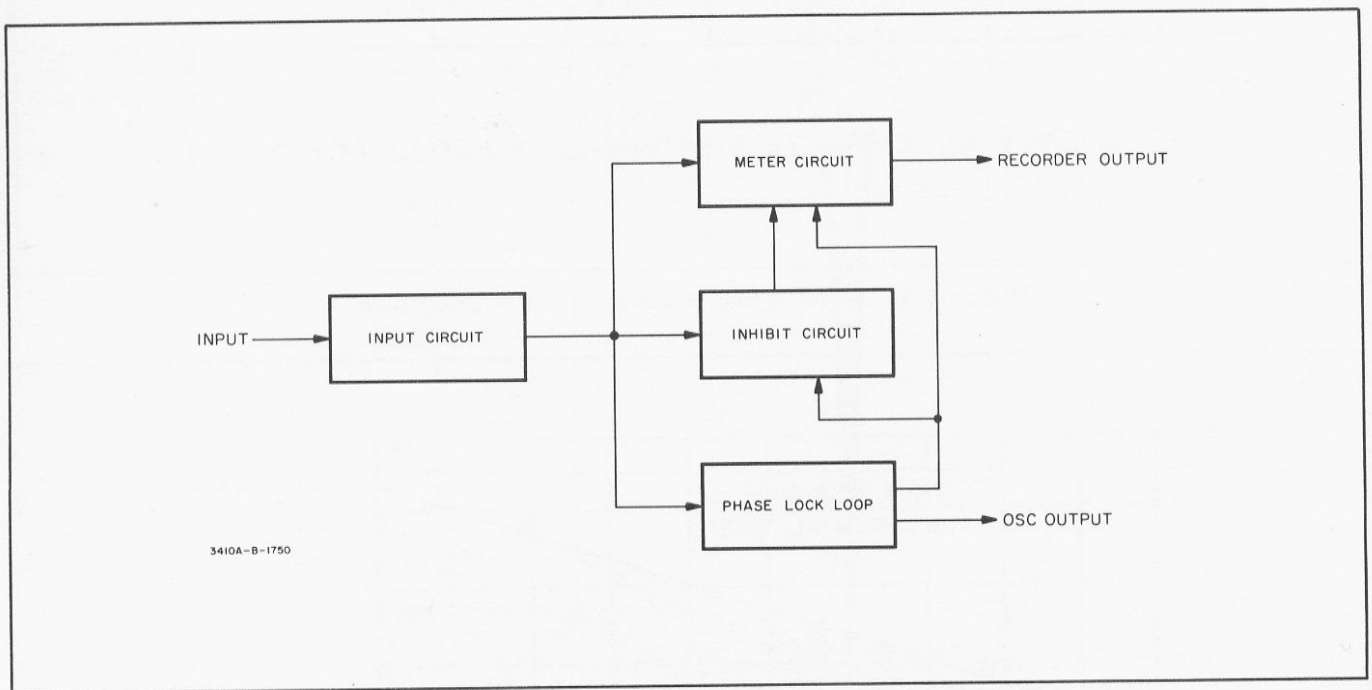


Figure 4-1. Simplified Block Diagram

## SECTION IV

### THEORY OF OPERATION

#### 4-1. GENERAL DESCRIPTION.

4-2. The Model 3410A is a tuneable phase locking ac voltmeter that measures voltages from 3 microvolts to 3 volts full scale. When tuned to any discrete frequency between 5 Hz and 600 kHz, the 3410A will indicate the amplitude of the signal present at the tuned frequency ( $F_T$ ); noise and all non-harmonically related signals will be filtered out. The instrument has two outputs: A four volt square wave at the voltmeter's tuned frequency, and a dc recorder output that is proportional to the meter deflection (1 mA into 1000 ohms for full scale deflection).

#### 4-3. SIMPLIFIED BLOCK DIAGRAM DESCRIPTION.

4-4. Refer to Figure 4-1 for a simplified block diagram of the 3410A.

4-5. The input signal is applied to the Input Circuit; which furnishes the proper amount of attenuation and amplification, depending upon the setting of the range selector switch.

4-6. From the Input Circuit, the signal is coupled to the Meter Circuit, the Inhibit Circuit, and the Phase Lock Loop.

4-7. The Phase Lock Loop contains a local oscillator, which is tuned to the frequency of the input signal. The local oscillator is phase locked in phase with the input signal and furnishes the four volt square wave output at the rear panel of the instrument. Outputs from the local oscillator are also supplied to the Inhibit Circuit and the Meter Circuit.

4-8. The Inhibit Circuit is necessary to prevent a false meter indication when the 3410A is tuned to submultiples of the input signal. The local oscillator will lock to any odd submultiple of the input frequency. When the 3410A is in the TUNE mode, the Inhibit Circuit will short out the meter when the instrument is tuned to any odd submultiple of the input signal, preventing any erroneous reading from being present. When the instrument is tuned to the frequency of the input signal, the Inhibit Circuit will allow the meter to indicate a reading.

4-9. The Meter Circuit, using a square wave from local oscillator, detects the input signal and furnishes a dc level to the meter. The Meter Circuit also provides a dc output from the instrument which may be used as a recorder input.

#### 4-10. FUNCTIONAL BLOCK DIAGRAM DESCRIPTION.

4-11. The following description refers to Figure 7-1 on Page 7-3/7-4.

#### 4-12. INPUT CIRCUIT.

4-13. The signal to be measured is applied to the pre-attenuator, where it is either attenuated by 60 dB or coupled directly to the preamplifier, depending on the RANGE switch setting. The preamplifier provides the signal with 20 dB of gain, and applies it to the post attenuator, which attenuates the signal in progressive steps of 10 dB each, as a function of the RANGE switch. The signal is given an additional 80 dB of gain by the post amplifier, after which it is applied to the range indicator circuit and to the high pass filter. The range indicator circuit is set to light lamp DS2 whenever the post amplifier output amplitude goes 10 dB or more above the amplitude required for a full scale meter indication. Its purpose is to aid in determining the voltage range of the signal to which the instrument is being tuned. The high pass filter with a single pole roll-off, attenuates signals of frequencies below  $F_T$ , and applies the filtered output to the phase lock loop, the inhibit circuit, and the meter circuit.

#### 4-14. PHASE LOCK LOOP.

4-15. The phase lock loop locks to the signal at  $F_T$ , and provides a square wave to drive the modulators in the inhibit and meter circuits at the proper frequency and phase. The voltage controlled oscillator (VCO) generates a square wave at a frequency which is four times the tuned frequency. The VCO provides a clock input for the two integrated circuit flip-flops, IC1 and IC2, which are interconnected to divide the frequency by four, thus providing two square wave outputs at the tuned frequency which are 90° out of phase. (The VCO, in conjunction with the two flip-flops, is herein referred to as the "local oscillator.") One square wave drives the phase lock modulator, and the other drives the meter and inhibit modulators. When the square wave to the phase lock modulator is 90° out of phase with the input signal, the modulator dc output will be zero, and the 3410A will be phase locked to the input signal. If the phase of the input shifts, the modulator will supply a dc voltage to the phase lock amplifier. The polarity and amplitude of this dc voltage will be determined by the direction and amount, respectively, of the shift in phase. This dc voltage will be amplified by the phase lock amplifier and applied to the VCO, causing it to shift the phase of the local oscillator output in the direction necessary to maintain phase lock. Once the circuit is locked to a signal, it will remain locked unless the input frequency deviates more than ±5% or varies at a rate exceeding 1/2% of full scale frequency per second.

#### 4-16. PHASE LOCK LOOP.

4-17. The phase lock loop will lock to any signal which will translate to dc when beat with the local



oscillator output. If the instrument is tuned to an odd submultiple of the input signal, the phase lock loop will lock to it, and the meter circuit will produce a reading which is not meaningful. Therefore, all such signals must be inhibited before reaching the meter. The inhibit modulator is preceded by a tuned low pass filter. The low pass filter has a cutoff frequency equal to  $F_T$ . When the input signal is at  $F_T$ , the relative gain of the meter and inhibit circuits is such that the inhibit amplifier produces the larger voltage, causing the comparator to allow the meter to read.

4-18. When the instrument is tuned to any odd submultiple of the input signal, the output amplitude of the inhibit amplifier is less positive than that of the meter amplifier; and the comparator will not allow the meter to indicate a reading if the instrument is in TUNE mode. If it is in READ mode, a false indication will read on the meter. Figure 4-2 shows the circuit conditions present when the instrument is tuned to the input frequency and when it is tuned to the fifth submultiple of the input frequency.

#### 4-19. METER CIRCUIT.

4-20. The filtered input signal is applied to the meter modulator, which is driven at  $F_T$  by a square wave from the local oscillator. The square wave causes the meter modulator to produce half-wave rectification of the signal. The dc output of the modulator is amplified by the meter amplifier and applied to both the meter and the comparator. If the MODE switch is in the TUNE position, the comparator will let the meter indicate the amplitude of only the tuned signal. For all other signals, the comparator will close a relay and place a short across the meter. If the MODE switch is in the READ position, the inhibit circuit is deactivated; also, the meter response time is increased by a factor of 1,000.

#### 4-21. DETAILED CIRCUIT DESCRIPTION.

4-22. Refer to Figures 7-2 through 7-6 for the following discussion.

#### 4-23. INPUT CIRCUITRY.

4-24. The preattenuator is comprised of an RC voltage divider and two reed relays. Reed relay A1K1 is energized by -25 V from the RANGE switch on the 3  $\mu$ V through 3 mV ranges, routing the input signal directly to the preamplifier with no attenuation. On the higher ranges, A1K2 is energized, directing the signal through the voltage divider, thus attenuating it by 60 dB.

4-25. The preamplifier provides the signal with 20 dB of gain and matches the high impedance of the preattenuator to the much lower impedance of the post attenuator. A field effect transistor, A1Q1 is used as the input stage of the amplifier because of its low noise characteristics and high input impedance. The signal is taken from the drain of A1Q1 and is further amplified by A1Q2 and A1Q3. Feedback from the emitter of A1Q2 bootstraps the value of A1R14, the drain load of A1Q1. Feedback from the source of A1Q1 bootstraps the input impedance of the preamplifier and keeps it at a high level over all ranges of inputs. Gain stability and linearity of the circuit are maintained by feedback from the emitter of A1Q3. A1R10 provides a bias adjustment for the field effect transistor, A1Q1.

4-26. The post attenuator is a precision resistive voltage divider that operates as a function of the RANGE switch. On the lowest voltage range, the signal from the preamplifier is applied through resistor S1R1 to the post amplifier, and is not attenuated. The resistive divider network attenuates the signal in six progressive steps of 10 dB each, for the twelve higher ranges. Each of the six steps is used twice (in conjunction with the preattenuator) to obtain a total signal attenuation range of 0 to 120 dB.

4-27. Figure 7-2 shows the post amplifier which is made up of two separate sections, providing a total of 40 dB of gain. The section including A2Q1 through A2Q4 has a gain of 40 dB. The gain of this section is

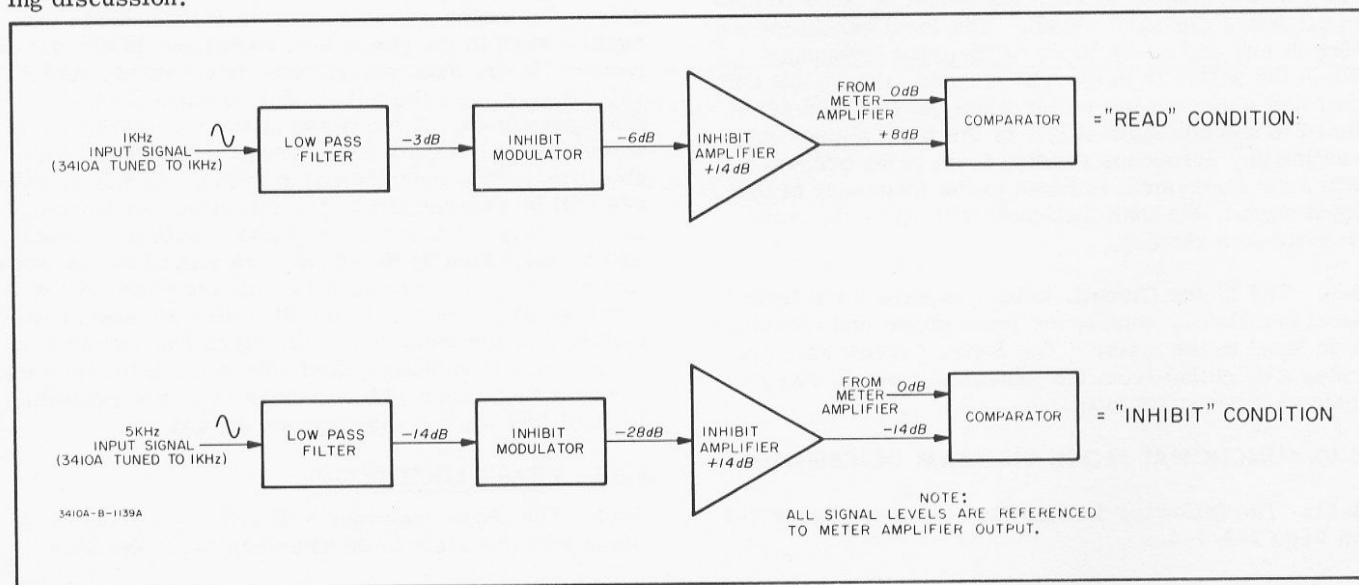


Figure 4-2. Inhibit Circuit Operation

controlled by feedback applied through A2R6 to the base of A2Q2. The second section, including A2Q5 through A2Q10, has a gain of 40 dB, controlled by feedback through A2R22 to the base of A2Q5.

4-28. It should be noted that the +45 V is decoupled from the +45 V, and that the -25 V is decoupled from the -25 V. The decoupling takes place in LC filters shown at the left of Figure 7-3. When the A2 board is in the instrument, all grounds on the board are common. However, if the board is out of the instrument, there are two separate ground circuits. These ground circuits are shown on Figure 7-3 as  $\nabla_2$  and  $\nabla_{12}$ , being numbered like the pin number to which each circuit is connected.

4-29. The amplitude of the signal at the output of the post amplifier is approximately 400 mV RMS, for a full scale meter indication. The signal at this point is the composite signal which contains the desired signal as well as any noise or signals of other frequencies that may be present. This signal includes the noise generated in the 3410A input amplifiers, and may vary from 360 mV to 420 mV. If the composite signal amplitude becomes greater than approximately 1.2 V RMS (10 dB above full scale), the range indicator circuit will light lamp DS2.

4-30. When the post amplifier output exceeds 1.2 V peak, suppressor diodes A2CR3 through A2CR6 will conduct, and apply the signal to A2Q11, where it will be amplified. The ac signal will then be converted to a positive dc by A2CR7 and filtered by A2C14. This dc signal is applied through emitter follower A2Q12 to a Schmitt trigger circuit, causing A2Q13 to conduct and draw current through lamp DS2. The Schmitt trigger will remain in this state, lighting the RANGE INDICATOR lamp, until the voltage level at the post amplifier output drops below 1.2 V RMS and causes it to switch back to its original state.

4-31. The high pass filter has a single-pole roll off (6 dB per octave) which is initiated at the tuned frequency, thus attenuating signals of frequencies below  $F_T$ . Selection of a certain frequency range is made by switching to one of five capacitors (S2C1 through S2C5), selected by the FREQUENCY range switch. The FREQUENCY dial (R2A) is then tuned to the frequency of interest, establishing the roll off point of the filter.

#### 4-32. PHASE LOCK LOOP.

4-33. The heart of the phase lock loop is the voltage controlled oscillator, which generates a square wave at four times the tuned frequency. The VCO frequency may be linearly tuned over a decade range by changing the position of the FREQUENCY dial (R1), consequently changing the bias voltage on A3Q17. Range switching of the four lower frequency ranges is accomplished by switching capacitors S2C22 through S2C25 and S2C26 through S2C29, which are ganged to the FREQUENCY range switch. On the highest frequency range, capacitors A3C12 and A3C16 provide phase adjusted feedback to sustain oscillations. Resistors A3R44 and A3R45 adjust the VCO frequency to track the FREQUENCY dial indication. A3C14 adjusts the oscillator

frequency on the highest range, to compensate for stray capacitance. A3Q13 and A3Q14 act as current sources for charging S2C22 through S2C29. If the VCO does not start oscillating immediately upon turn-on, A3Q11 turns off, turning on A3Q10. This causes A3Q13 and A3Q14 to be turned off momentarily. The VCO is thus recycled and oscillations should begin. Normally, A3Q11 is conducting.

4-34. The purpose for the VCO frequency being four times the tuned frequency is to obtain a 90° phase shift through flipflops IC1 and IC2. As shown in Figure 4-3, the leading edge of every negative pulse from the VCO changes the state of first one and then the other flip flop. As the time between each positive pulse is always the same, a perfect 90° phase shift between the local oscillator outputs is assured.

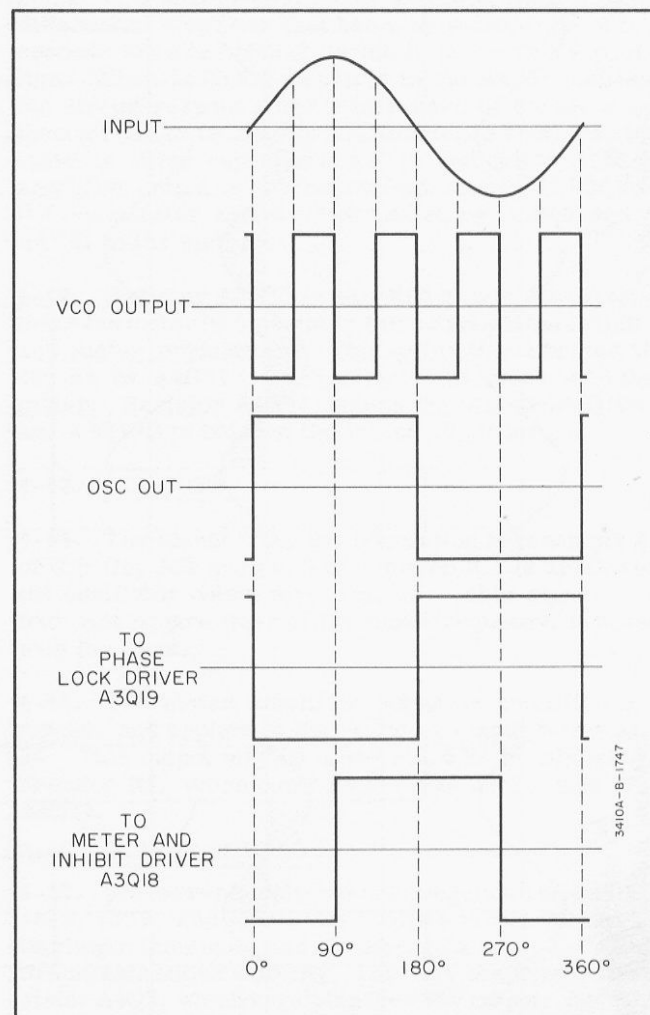


Figure 4-3. Local Oscillator Waveforms

4-35. One of the local oscillator outputs, a square wave at the tuned frequency, is applied through driver transistor A3Q19 to the base of the phase lock modulator, A3Q3. Refer to Figure 4-4 for modulator waveforms. The positive half of the square wave gates A3Q1 on, and shorts to ground the portion of the input signal present at that time. Therefore, only during the negative portion of the square wave will the input signal be passed to the phase lock amplifier.

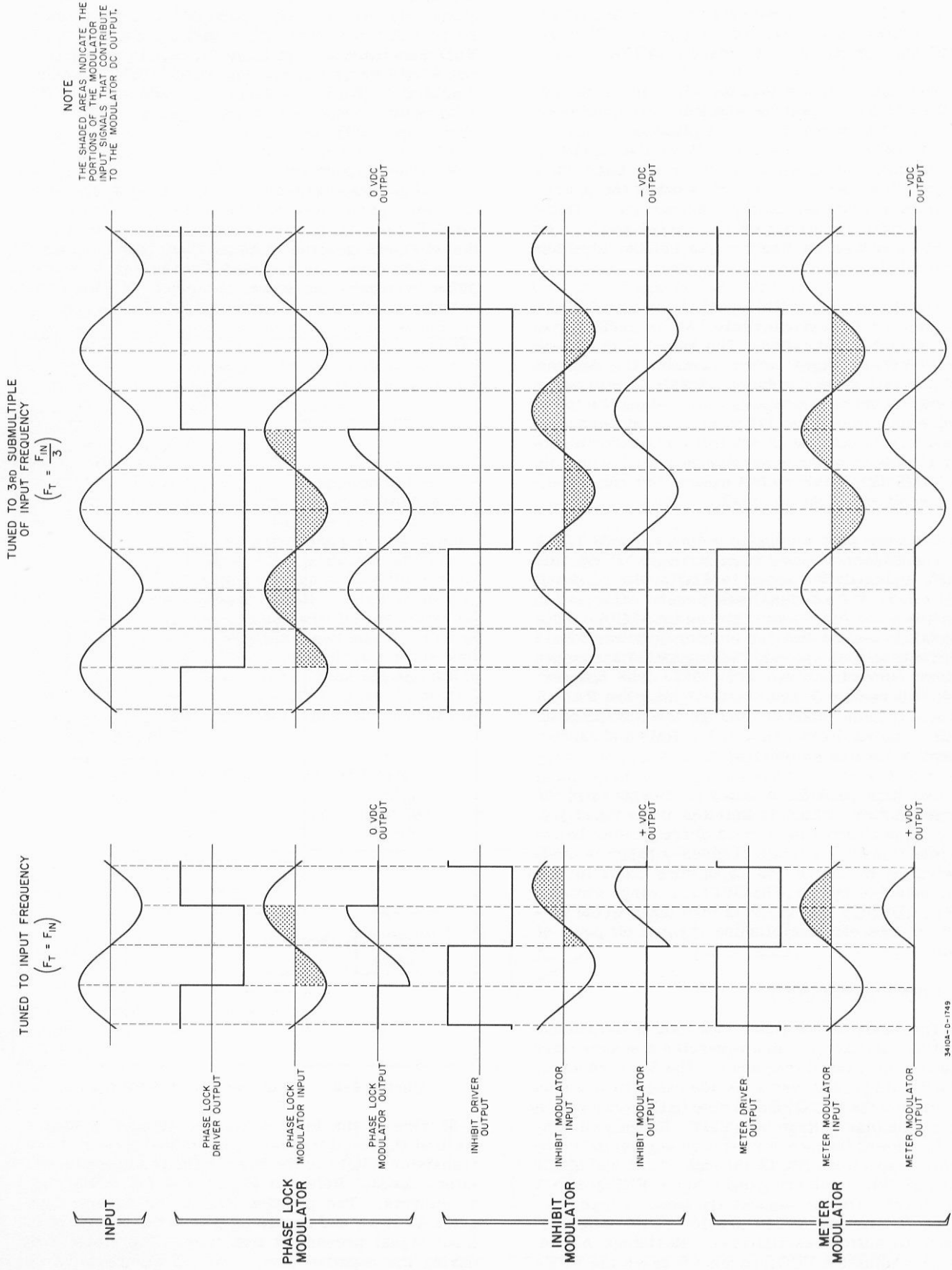


Figure 4-4. Modulator Waveforms

4-36. The phase lock amplifier is a low pass differential amplifier that uses feedback to achieve a low pass filtering action. The feedback is taken from the emitter of A3Q6 and is amplified by A3Q7 and A3Q8 before being applied to the filter capacitors. This feedback network determines the gain with respect to frequency, of the phase lock amplifier, therefore determining the overall gain of the phase lock loop. The output of the phase lock amplifier is applied through emitter follower A3Q9 to the bases of A3Q13 and A3A14, causing the oscillator to shift phase until the input to the phase lock amplifier returns to the quiescent state. Thus the VCO remains locked to the input signal. Resistor A3R15 adjusts the bias on A3Q4A and A3Q4B.

#### 4-37. INHIBIT CIRCUIT.

4-38. The inhibit signal is taken from the output of the buffer amplifier A3Q1 and A3Q2, and passed through the low pass filter. The low pass filter passes the signal to which the instrument is tuned, shifts it  $45^\circ$  in phase, and attenuates it by 3 dB. The filtered signal is then applied through a buffer amplifier, A3Q21 and A3Q22, to the inhibit modulator, A3Q23. Driver transistor A3Q18 applies a square wave from the local oscillator to A3Q23, gating it on during the positive half cycle, and off during the negative half cycle. When A3Q23 is gated on, the signal is shorted to ground. Hence, the signal is passed to the inhibit amplifier only during the negative portion of the square wave. The signal and the square wave are  $135^\circ$  out of phase; consequently the signal passed by the modulator is a net positive dc, as shown in Figure 4-4. The amplitude of this dc signal will be approximately 3 dB less than the average value of the signal had it been perfectly half-wave rectified (as in the meter circuit). Thus the inhibit modulator output is a total of 6 dB less than the meter modulator output. This signal is then applied to the inhibit amplifier, which has 14 dB more gain than the meter amplifier. Therefore, the dc signal applied through emitter follower A4Q10 to the comparator is 8 dB greater than the meter circuit signal to the comparator. Under these conditions, the Schmitt trigger, A4Q11 and A4Q12, will switch states and open relay A4K1, allowing the meter to read.

4-39. If the instrument is locked to a submultiple of the input signal, the inhibit circuit input to the comparator will be considerably less than the input from the meter circuit and will not allow a "read" condition. This occurs because the inhibit signal will be attenuated more than 6 dB by the frequency discriminator and inhibit modulator. For example, if the input signal is at 5 kHz, and the 3410A is tuned to 1 kHz, the discriminator will attenuate the 5 kHz signal 14 dB and shift it  $78^\circ$  in phase. (Refer to Figure 4-2 for a diagram of the inhibit circuit operation). This phase shift will cause an efficiency loss of 14 dB in the

modulator, effecting a total loss of 28 dB, as compared with the meter circuit output. The inhibit amplifier will make up only 14 dB of the difference; hence the comparator will not open the reed relay, and the meter will remain inhibited. Resistor A4R26 adjusts the bias on A4Q9A and A4Q9B, to balance the inhibit amplifier.

#### 4-40. METER CIRCUIT.

4-41. The high pass filter output is applied through buffer amplifier A3Q24 and A3Q25 to the meter modulator, A3Q26. A3Q18 drives the modulator at the tuned frequency with a square wave from the local oscillator. The square wave is  $180^\circ$  out of phase with the tuned signal, affording perfect half wave rectification, as shown in Figure 4-4. The rectified signal is applied to the meter amplifier, a low pass differential amplifier that has a response time of 0.1 seconds when the MODE switch is in the TUNE position. When the MODE switch is in the READ position, the circuit response time is increased to 100 seconds, through use of feedback amplification to bootstrap the value of filter capacitors A4C19 and A4C20. The amplifier output is applied through diode A4CR26 to the comparator and through resistors A4R60 and A4R61 to the meter.

4-42. Resistor A3R55 is adjusted at 600 kHz to calibrate the meter by smoothing the outputs of the inhibit and meter modulators. The meter is calibrated at 400 Hz by A4R61, which adjusts the current to the meter. Resistor A4R52 adjusts the bias on A4Q19A and A4Q19B to balance the meter amplifier.

#### 4-43. OUTPUTS.

4-44. The signal from the connection between pin 3 of flip-flop IC2 and pin 5 of flip-flop IC1 is applied to the oscillator output terminal, J2. This signal is a four volt square wave at the tuned frequency, in phase with the input.

4-45. The meter amplifier output is amplified by A4Q20, and applied to the recorder output terminal, J3. This output may be offset  $\pm 0.5$  V, by adjusting resistor R3, which controls the bias on the base of A4Q21.

#### 4-46. POWER SUPPLY.

4-47. The power supply provides regulated outputs of +45V, +30V, and -25V. The positive supply utilizes a Darlington configuration series regulator, A4Q1 and Q1, to maintain output stability. The +45V is applied to transistor A4Q3, which regulates the +35V output. A4CR12 is selected to make the +30V output between +2.8V and 29.8V. Resistor A4R6 adjusts the +45V output, and as a result adjusts the +30V output. The -25V supply operates similarly to the +45V supply, and may be adjusted by A4R19.

Table 5-1. Required Test Equipment

Instrument Type	Specifications	Recommended Model
Electronic Counter	Frequency Range: 5 Hz to 600 kHz Accuracy: $\pm 2$ counts	-hp- Model 5532A Electronic Counter
AC Voltmeter Calibrator	Voltage Range: 3 mV to 3 V Accuracy: $\pm 0.2\%$ at 400 Hz	-hp- Model 738BR Voltmeter Calibrator
Test Oscillator	Voltage Range: 3 mV to 3 V Frequency Range: 10 Hz to 600 kHz Flatness: $\pm 0.25\%$	-hp- Model 652A Test Oscillator
Attenuator	Attenuation Range: 0dB to 60 dB Frequency Range: 10 Hz to 600 kHz	-hp- Model 355D Attenuator Set
Function Generator	Voltage Range (sine wave): 1 V Frequency Range: 45 kHz to 55 kHz  Sweep Frequency (triangle wave): 0.025 Hz	-hp- Model 3300A Function Generator with 3301A plug in and -hp-Model 3300A Function Generator with 3304A plug in
AC/DC Voltmeter	Frequency Range: 10 Hz to 600 kHz Voltage Range: DC - 100 mV to 100 V AC - 10 mV to 100 V Accuracy (AC and DC): $\pm 2\%$ full scale	-hp- Model 427A Voltmeter
Oscilloscope	Bandwidth: 5 Hz to 600 kHz Sensitivity: 5 mV/cm	-hp- Model 140A Oscilloscope with 1405A plug in
Terminating Resistance	Feedthrough: $50\ \Omega \pm 1\%$	-hp- Model 11048B Feedthrough Termination
Resistor	Fxd: $200\ \text{K}\Omega \pm 1\%$	-hp- Part No. 0757-0782
Extender Board	15 pin	-hp- Part No. 5060-0049

## SECTION V MAINTENANCE

### 5-1. INTRODUCTION.

5-2. This section contains maintenance and service information for the -hp- Model 3410A AC Microvoltmeter. Included are Performance Checks, Adjustment and Calibration Procedures, and Troubleshooting information.

### 5-3. REQUIRED TEST EQUIPMENT.

5-4. The equipment needed to perform the checks and adjustments in this section is listed in Table 5-1. If the recommended model is not available, any instrument having specifications equal to or better than those listed in Table 5-1 may be used.

### 5-5. PERFORMANCE CHECKS.

5-6. The Performance Checks are provided as a guide for checking the Model 3410A against published specifications. These checks may be used for incoming inspection, periodic maintenance, and specification checks after repair. A Performance Check Test Card is provided at the end of this section for recording the results of the Performance Checks. If the instrument fails to meet any of its specifications, perform the Adjustment and Calibration Procedures.

————— NOTE —————

Before beginning the Performance Checks, mechanically zero the meter according to the steps in Paragraph 3-7.

### 5-7. VOLTAGE ACCURACY.

5-8. This check requires the following test equipment. Voltmeter Calibrator (-hp- Model 738BR), Attenuator (-hp- Model 355D), and a Test Oscillator (-hp- Model 652A).

5-9. Connect the voltmeter calibrator to the 3410A, as shown in Figure 5-1. The test oscillator and attenuator shown in the figure will be used later in the check.

### 5-10. 3 V RANGE.

- a. Set the 3410A controls as follows:

MODE . . . . . TUNE  
 RANGE . . . . . 3 V  
 FREQUENCY . . . . . X10  
 FREQUENCY Dial . . . . . 40

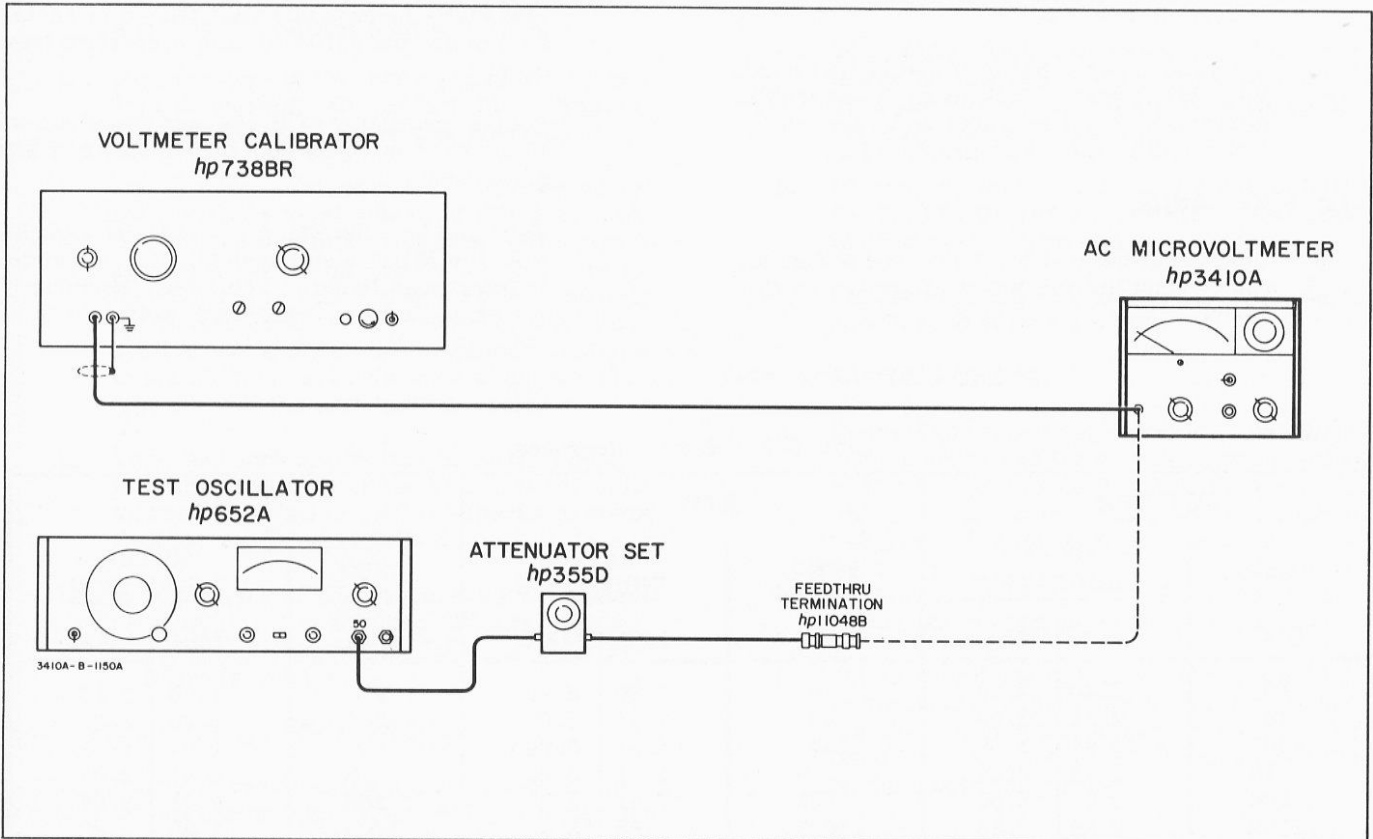


Figure 5-1. Accuracy and Frequency Response Check

- b. Set the voltmeter calibrator for a 3 V rms output at 400 Hz.
- c. If necessary, tune the 3410A FREQUENCY dial until the instrument locks to the signal; then place the MODE switch to READ position.
- d. Note the 3410A meter indication; if not within tolerances listed in Table 5-2, perform meter calibration, Paragraph 5-40. Record this indication.
- e. Disconnect the voltmeter calibrator, and connect the test oscillator and attenuator to the 3410A using the 50Ω oscillator output and 50Ω termination.
- f. Set the attenuator to 0 dB attenuation. Set the test oscillator to 400 Hz, and adjust the amplitude controls until the 3410A meter indication is the same as in step d of this paragraph. Set a reference on the test oscillator meter and use the amplitude control to maintain the set reference whenever the frequency of the oscillator is varied.
- g. Repeat step d of this paragraph for frequencies 60 Hz through 600 kHz, (listed in Table 5-2) tuning the 3410A to each respective frequency.
- h. Set the test oscillator to 10 Hz, and adjust oscillator amplitude to .5 V less than the indication in step d.
- i. Tune and lock the 3410A to the 10 Hz signal. Note 3410A meter indication; if not within tolerances listed in Table 5-2, perform meter calibration, Paragraph 5-40.

- b. Set 3410 A controls as follows:

```

MODE . . . . . TUNE
RANGE . . . . . 3 MV
FREQUENCY . . . . . X10
FREQUENCY Dial. . . . . 40
    
```

- c. Set the voltmeter calibrator for a 3 mV rms output at 400 Hz.
- d. If necessary, tune the 3410A FREQUENCY Dial until the instrument locks to the signal; then place the MODE switch to READ position.
- e. Note the 3410A meter indication; if not within tolerances listed in Table 5-2, perform meter calibration, Paragraph 5-40. Record this indication.
- f. Disconnect the voltmeter calibrator and connect the test oscillator and attenuator to the 3410A
- g. Set the attenuator to 0 dB attenuation. Set the test oscillator to 400 Hz, and adjust the amplitude controls until the 3410A meter indication is same as in step e of this paragraph. Set a reference on the test oscillator meter, and use the amplitude controls to maintain the set reference whenever the frequency of the oscillator is varied.
- h. Repeat step e of this paragraph for frequencies 60 Hz through 600 kHz, (listed in Table 5-2) tuning the 3410A to each respective frequency.
- i. Set test oscillator to 10 Hz, and adjust amplitude to .5 mV less than that in step e of this paragraph.
- j. Tune and lock the 3410A to the 10 Hz signal. Note the 3410A meter indication; if not within tolerances listed in Table 5-2, perform meter calibration, Paragraph 5-40.

5-11. 3 MV RANGE.

- a. Disconnect the test oscillator and attenuator, and connect the voltmeter calibrator to th 3410A.

Table 5-2. Meter Tolerances

3V RANGE			3 MV			.003 MV		
FREQ.	METER INDICATION		FREQ.	METER INDICATION		FREQ.	METER INDICATION	
	(Hz)	MIN.   MAX.		(Hz)	MIN.   MAX.		(Hz)	MIN.   MAX.
10	2.20	2.80	10	2.20	2.80	25	1.90	3.10
60	2.91	3.09	60	2.91	3.09	100	2.20	2.80
400	2.91	3.09	400	2.91	3.09	400	2.91	3.09
1K	2.91	3.09	1K	2.91	3.09	1K	2.91	3.09
10K	2.91	3.09	10K	2.91	3.09	50K	2.91	3.09
100K	2.85	3.15	100K	2.85	3.15	100K	1.90	2.80
600K	2.85	3.15	600K	2.85	3.15	600K	1.90	2.80

5-12. .003 MV RANGE.

- a. Set the 3410A controls as follows:
  - MODE . . . . . TUNE
  - RANGE . . . . . 3 MV
  - FREQUENCY . . . . . X10
  - FREQUENCY Dial . . . . . 40
- b. Set the attenuator to 60 dB attenuation.
- c. Set the test oscillator output to 3 V at 400 Hz.
- d. If necessary, tune the 3410A FREQUENCY until the instrument locks to the signal; then place the MODE switch to READ position.
- e. Adjust the test oscillator amplitude controls until the 3410A meter indication is the same as in step e of Paragraph 5-11. Set a reference on the test oscillator meter, and use the amplitude controls to maintain the set reference whenever the frequency of the oscillator is varied.
- f. Set the test oscillator output attenuator to 3 mV range. (The signal applied to the 3410A will be 3  $\mu$ V, due to the 60 dB of attenuation in the attenuator set).
- g. Set the 3410A RANGE switch to .003 mV.
- h. Note 3410A meter indication; if not within tolerances listed in Table 5-2, perform meter calibration, Paragraph 5-40.
- i. Repeat step h of this paragraph for frequencies 1K and 50K, (listed in Table 5-2) tuning the 3410A to each respective frequency.
- j. Set the test oscillator to 25 Hz, and adjust the oscillator amplitude to .5 mV less than that in step e of this paragraph. (The signal applied to the 3410A will be 2.5  $\mu$ V, due to the 60 dB of attenuation in the attenuator set). Set a reference on the meter of the test oscillator, and use the amplitude controls to maintain the set reference whenever the frequency of the oscillator is varied.
- k. Tune and lock the 3410A to 25 Hz signal. Note the 3410A meter indication; if not within tolerances listed in Table 5-2 perform meter calibration, Paragraph 5-40.
- l. Repeat step k of this paragraph for frequencies 100 Hz, 100 kHz and 600 kHz, (listed in Table 5-2) tuning the 3410A to each respective frequency.

5-13. PHASE LOCK RANGE CHECK.

5-14. This check requires the following test equipment: Test Oscillator (-hp- Model 652A), Electronics Counter (-hp- Model 5532A), Two Function Generators (-hp- Model 3300A), Sweep-Offset Plug-in (-hp-

Model 3304A), Auxiliary Plug-in (-hp- Model 3301), AC-DC Voltmeter (-hp- Model 427A, and 50 $\Omega$  Feed-through Termination (-hp- Model 11048B).

5-15. PULL-IN CHECK.

- a. Connect 3410A OSC OUT terminal to the electronic counter.
- b. Set 3410A controls as follows:
  - MODE . . . . . TUNE
  - RANGE . . . . . 1 V
  - FREQUENCY . . . . . X1K
  - FREQUENCY Dial. . . . . 10
- c. Adjust the 3410A FREQUENCY dial until the electronic counter indicates 10 kHz. Do not readjust the 3410A frequency controls.
- d. Disconnect the 3410A from the electronic counter, and connect the 50 $\Omega$  output of the test oscillator to the counter. (Connect a 50 $\Omega$  feedthru termination, -hp- Model 11048B between instruments). Set the test oscillator output to 1 V.
- e. Adjust the frequency of the test oscillator until electronic counter indicates 9.4 kHz. Do not readjust the test oscillator frequency controls.
- f. Disconnect the test oscillator from the electronic counter, and connect the test oscillator to the 3410A input.
- g. The 3410A should lock to the signal and the meter should indicate approximately 1 V. This verifies a phase lock pull in range of 1% of full scale frequency.
- h. Disconnect the test oscillator from the 3410A. Set the FREQUENCY dial to 15. The counter indication should be 15 kHz  $\pm$  6 kHz.
- i. Set the FREQUENCY dial to 50. The counter should read 50 kHz  $\pm$  6 kHz.

5-16. TRACKING CHECK.

- a. Connect two function generators, the electronic counter and the ac voltmeter as shown in Figure 5-2. (Note that function generator "A" is set up for external frequency control, using output of function generator "B").
- b. Set function generator "A" for 1 V sine wave output, as monitored on the ac voltmeter.
- c. Set the amplitude of function generator "B" to minimum. Adjust the negative dc offset (on plug-in) to obtain a frequency of 50 kHz from function generator "A", as monitored on the electronic counter.
- d. Set function generator "B" for a triangle wave output at .025 Hz. Monitor generator



"A" output with the electronic counter, and adjust the triangle wave amplitude (generator "B") until function generator "A" is sweeping from 47 kHz to 53 kHz. A full sweep cycle, from 47 kHz to 53 kHz and back to 47 kHz, requires 40 seconds. The frequency thus changes 12 kHz in 40 seconds or 300 Hz in one second. This is equal to 0.5% of full scale per second.

e. Set 3410A controls as follows:

```

MODE . . . . . TUNE
RANGE . . . . . 1 V
FREQUENCY . . . . . X1K
FREQUENCY Dial . . . . . 50
    
```

f. Connect the 3410A to the output of function generator "A". This test verifies that the 3410A will track  $\pm 5\%$  of full scale frequency at a rate of 0.5% of full scale per second.

b. Set the 3410A controls as follows:

```

MODE . . . . . TUNE
RANGE . . . . . 1V
FREQUENCY . . . . . X10
FREQUENCY Dial . . . . . 40
    
```

c. Set the test oscillator for a full scale meter deflection of the 3410A at 400 Hz. If necessary, tune the 3410A FREQUENCY dial until the instrument locks to the signal; then place the MODE switch to READ. Record the indication.

d. Connect a 200 k $\Omega$  resistor between the test oscillator and the 3410A as shown in Figure 5-3.

e. The 3410A meter indication should not drop more than one small division from full scale. This verifies an input resistance of 10 M $\Omega$ .

5-17. INPUT IMPEDANCE CHECK.

5-18. This check requires the following test equipment: Test Oscillator (-hp- Model 652A), 50 $\Omega$  Feedthrough Termination (-hp- Model 11048B), 200 k $\Omega$   $\pm 1\%$  Resistor (-hp- Part No. 0757-0782).

5-19. RESISTANCE CHECK.

a. Connect the 50 $\Omega$  output of the test oscillator to 3410A using a 50 $\Omega$  feedthrough termination.

5-20. CAPACITANCE CHECK.

a. Connect the test oscillator (terminated in 50 $\Omega$ ) and a 200 k $\Omega$  resistor to 3410A as shown in Figure 5-3. Insert the resistor lead directly into the BNC connector on the 3410A, and connect the ground lead to the outer shield of the connector. Do not use an adapter, as it would add input capacitance. The 50 $\Omega$  termination should be as close as possible to the 200 k $\Omega$  resistor.

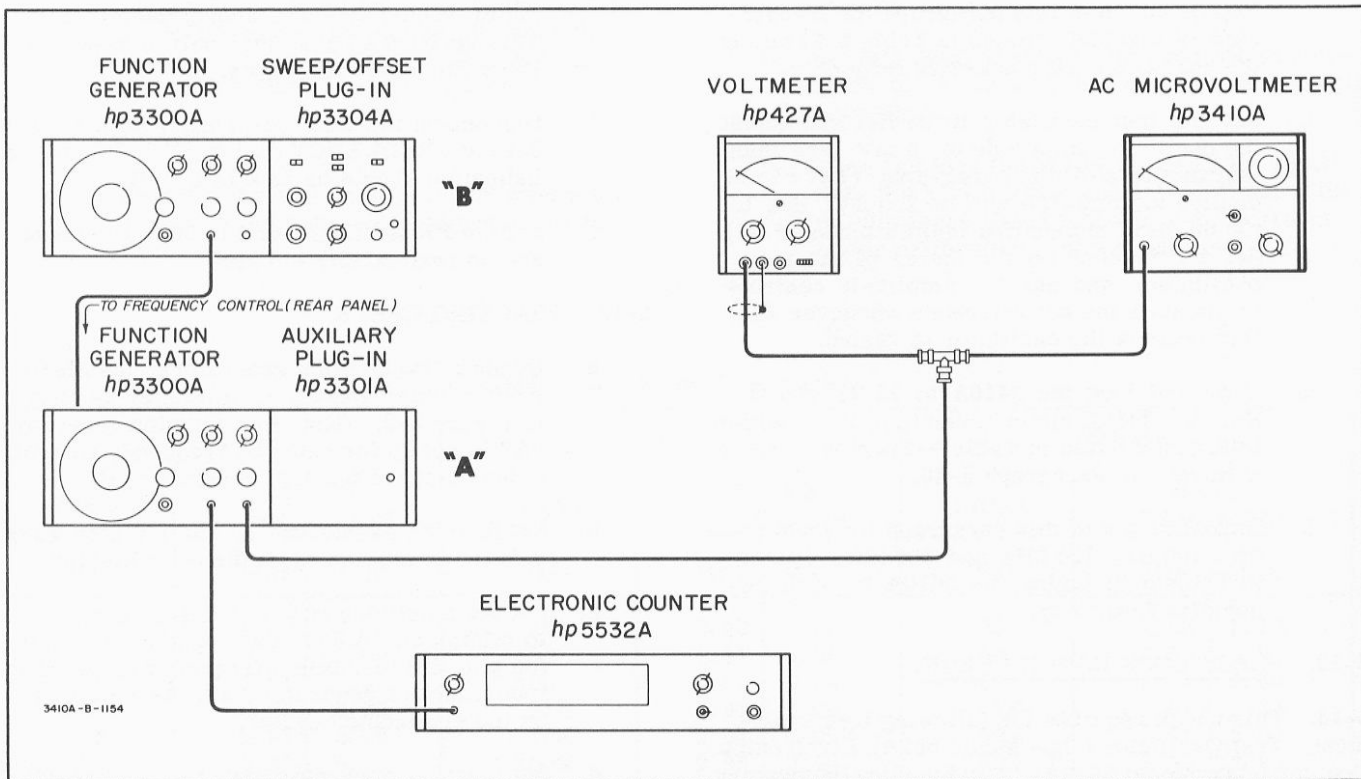


Figure 5-2. Tracking Check

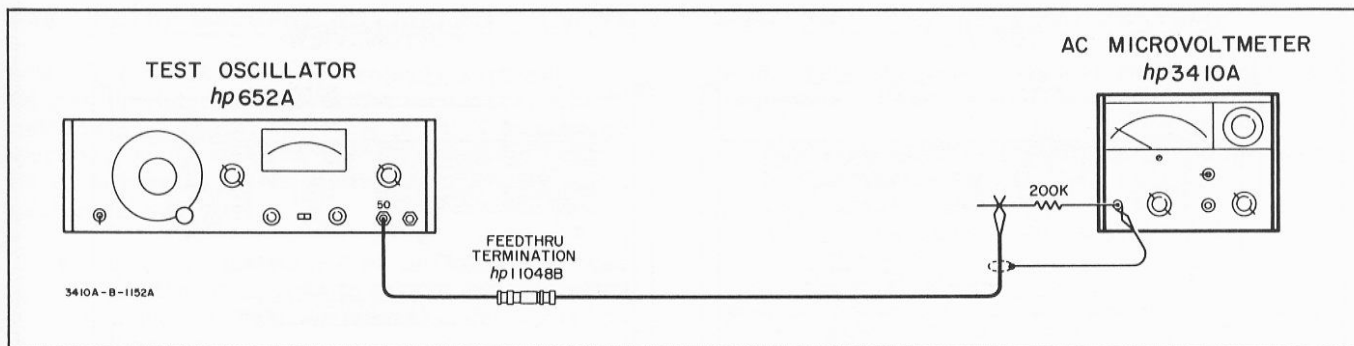


Figure 5-3. Input Impedance Check

- b. Set the 3410A controls as follows:  
 MODE . . . . . TUNE  
 RANGE . . . . . 1 MV  
 FREQUENCY . . . . . X10  
 FREQUENCY Dial . . . . . 40
- c. Set the test oscillator for a full scale meter deflection of the 3410A at 400 Hz. If necessary, tune the 3410A FREQUENCY dial until the instrument locks to the signal; then place the MODE switch to READ.
- d. Increase the frequency of the test oscillator to 40 kHz; tune and lock the 3410A to the 40 kHz signal. The 3410A meter indication should be 0.707 mV or greater, verifying an input capacitance of 20 pF or less on the 1 mV range.
- e. Set the 3410A controls as follows:  
 MODE . . . . . TUNE  
 RANGE . . . . . .01 V  
 FREQUENCY . . . . . X10  
 FREQUENCY Dial . . . . . 40
- f. Set the test oscillator for a full scale meter deflection of the 3410A at 400 Hz. If necessary, tune the 3410A FREQUENCY dial until the instrument locks to the signal; then place the MODE switch to READ.
- g. Increase the frequency of the test oscillator to 80 kHz; tune and lock the 3410A to 80 kHz signal. The 3410A meter indication should be 7.07 mV or greater, verifying an input capacitance of 10 pF or less on the 10 mV range.

5-21. LOCAL OSCILLATOR OUTPUT.

5-22. This check requires the following equipment: Oscilloscope (-hp- Model 140A/1405A), 10:1 Probe (-hp- Model 10001A).

- a. Set the 3410A controls as follows:  
 MODE . . . . . TUNE  
 RANGE . . . . . 3 V  
 FREQUENCY . . . . . X10K  
 FREQUENCY Dial . . . . . 50

- b. Connect the OSC OUT to the oscilloscope, using the 10:1 probe. The observed square wave should be greater than four volts peak to peak.

5-23. ADJUSTMENT AND CALIBRATION PROCEDURES.

5-24. The following paragraphs contain a complete adjustment and calibration procedure for the 3410A. This procedure should be performed only if it has been determined by the Performance Checks that the instrument is not operating within specifications. Figure 5-4 shows the location of all internal adjustments and test points.

NOTE

Before beginning the Adjustment and Calibration Procedure, mechanically zero the meter according to the steps in Paragraph 3-7.

5-25. COVER REMOVAL.

5-26. To remove the top or bottom cover, remove the two screws from the back of the cover, slide it about 1/2 inch to the rear, and lift it off. To remove a side cover, remove the four screws from the cover, and lift it off. To replace either cover, reverse the removal procedure.

5-27. POWER SUPPLY VOLTAGE ADJUSTMENT.

5-28. This adjustment requires a DC Voltmeter (-hp- Model 427A).

- a. Connect a dc voltmeter to A4TP3.
- b. Adjust A4R6 for an indication of +45V ± 0.5V on the dc voltmeter.
- c. Connect the dc voltmeter to A4TP2. The voltmeter should indicate between +28.5V and +29.8V. If not, A4CR12 should be replaced. More than one diode may have to be tried to get the proper voltage range.
- d. Connect the dc voltmeter to A4TP1.

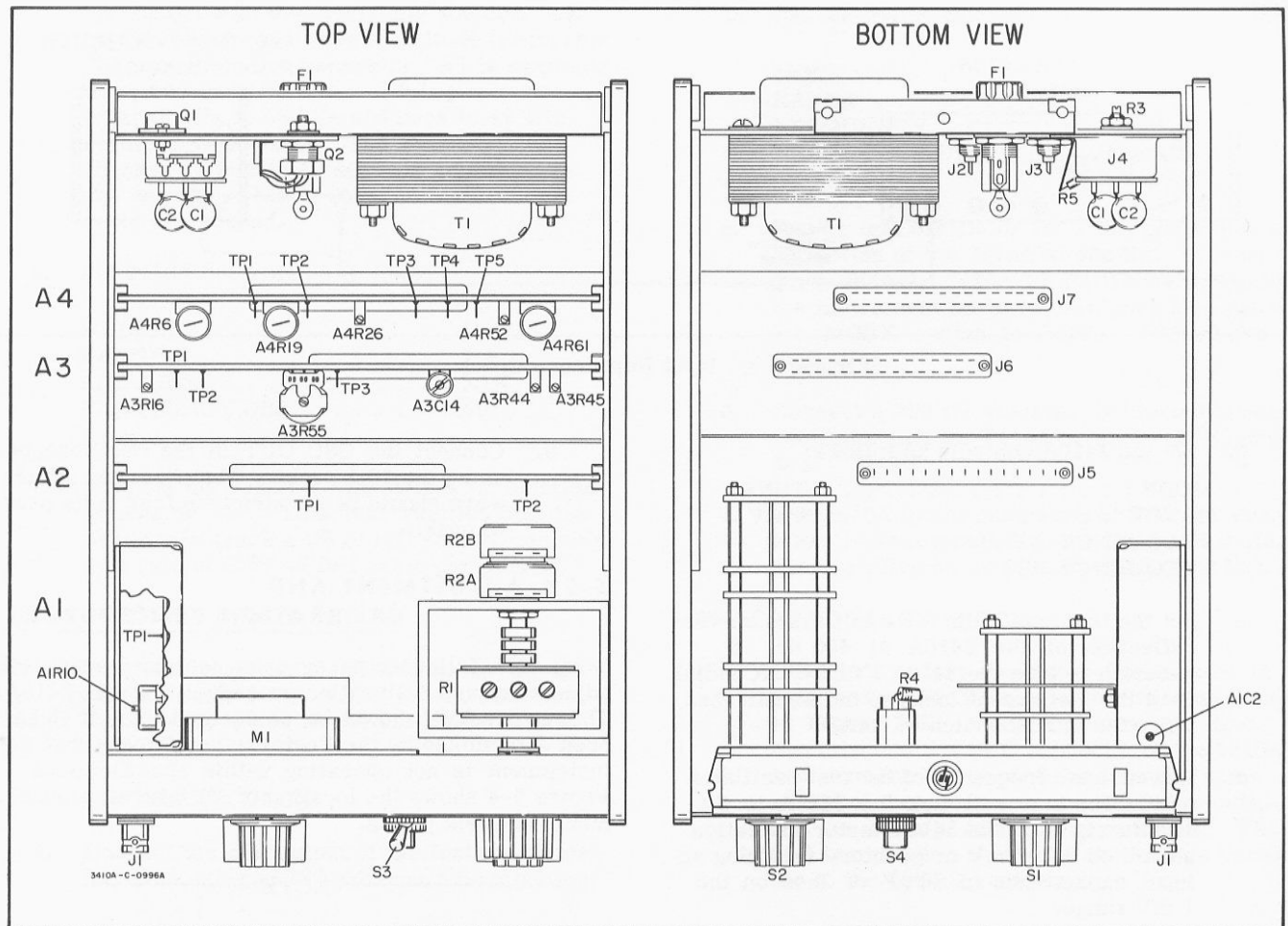


Figure 5-4. Adjustment and Chassis Mounted Components Location

- e. Adjust A4R19 for a dc voltmeter indication of  $-24.8V \pm 0.1V$ .
- f. If instrument is operated from high or low line (102V to 128V for 115V line, 204V to 356V for 230V line), the test point readings in the above steps should remain within tolerances.

#### 5-29. PREAMPLIFIER BIAS ADJUSTMENT.

5-30. This adjustment requires a DC Voltmeter (-hp- Model 427A). The bottom cover and side cover adjacent to the INPUT jack must be removed. The shield over the preamplifier board must be removed to perform this adjustment. To remove the shield, remove the four screws in the top and bottom of the shield and lift it off through the side of the instrument. Replace the shield when the adjustment is completed.

- a. Connect the dc voltmeter to A1TP1.

#### NOTE

This is a sensitive adjustment, and 30 seconds should be allowed between adjustments.

- b. Adjust A1R10 for a dc voltmeter indication of  $+5.5V \pm 0.5V$ .

#### 5-31. PHASE LOCK AMPLIFIER BALANCE ADJUSTMENT.

5-32. This adjustment requires a DC Voltmeter (-hp- Model 427A).

- a. Set the 3410A FREQUENCY range switch to X100 range and the voltage RANGE switch to the 3 V range with no input signal.
- b. Measure the voltage at A3TP1 and A3TP2, referenced to circuit ground.

#### NOTE

Do not attempt to make a differential measurement between A3TP1 and A3TP2 with a power line operated voltmeter because of grounding problems. Adjust A3R15 until A3TP1 and A3TP2 are within .1V of each other. Allow two minutes for the voltages at A3TP1 and A3TP2 to stabilize. The normal range of voltages at A3TP1 and A3TP2 when balanced is from +2.5V to +3.2V.

5-33. METER MECHANICAL ZERO ADJUSTMENT.

5-34. The 3410A meter is properly zero-set when the meter pointer rests over the zero mark, with the instrument in normal operating position at normal operating temperature and turned off. Adjust zero-set as follows to obtain maximum accuracy and mechanical stability:

- a. Turn the instrument on and allow it to operate for 20 minutes to ensure that the meter movement reaches normal operating temperature.
- b. Turn the instrument off and allow at least one minute for all capacitors to discharge.
- c. Rotate the mechanical zero adjustment screw clockwise until the pointer is left of zero and moving upscale toward zero. Stop when the pointer is exactly on zero; if the pointer overshoots, repeat this step.
- d. When the pointer is exactly over zero, rotate the adjustment screw slightly counterclockwise to relieve tension on the pointer suspension. If the pointer moves to the left, repeat the procedure, but make the counterclockwise rotation less.

5-35. METER AND INHIBIT AMPLIFIER BALANCE ADJUSTMENTS.

5-36. This adjustment requires a DC Voltmeter (-hp- Model 427A).

- a. Set the MODE switch to READ position.
- b. Connect the dc voltmeter to A4TP4.
- c. Adjust A4R26 for an indication of  $+12V \pm 0.5V$  on the dc voltmeter. This assures that A4Q11 is not conducting, so that the measurement made in the following step will be accurate.
- d. Adjust A4R52 for an indication of zero on the 3410A meter.
- e. Connect the dc voltmeter to A4TP5; the voltmeter should indicate  $+15V \pm 0.5V$ . Record the indication.
- f. Connect the dc voltmeter to A4TP4.
- g. Adjust A4R26 for a dc voltmeter indication that is 0.8 V less than that obtained in step e of this paragraph.

————— NOTE —————

Do not attempt to make a differential measurement between A4TP4 and A4TP5 with a power line operated voltmeter because of grounding problems.

5-37. VCO FREQUENCY CALIBRATION.

5-38. This adjustment requires an Electronic Counter (-hp- Model 5532A).

- a. Connect an electronic counter to the 3410A oscillator output.
- b. Set the 3410A controls as follows:  
MODE . . . . . TUNE  
RANGE . . . . . 1V  
FREQUENCY . . . . . X100  
FREQUENCY Dial . . . . . 60
- c. Adjust A3R44 for an electronic counter indication of  $6 \text{ kHz} \pm 180 \text{ Hz}$ .
- d. Set the 3410A FREQUENCY dial to 5.
- e. Adjust A3R45 for an electronic counter indication of  $500 \text{ Hz} \pm 50 \text{ Hz}$ .

————— NOTE —————

The 500 Hz calibration interacts with the 6 kHz calibration. Therefore, it may be necessary to repeat the two adjustments to bring both end frequencies within specifications.

————— NOTE —————

If difficulty is encountered in making this adjustment, measure the voltage at the center terminal of the FREQUENCY dial potentiometer and preset A3R44 for a +38V reading at 6 kHz dial setting. Then preset A3R45 for +6V at 500 Hz dial setting. Then repeat steps c through e.

- f. Set the FREQUENCY switch to X10K, and set the FREQUENCY dial to 60.
- g. Adjust A3C14 for an electronic counter indication of  $600 \text{ kHz} \pm 5\%$ .

5-39. METER CALIBRATION.

5-40. This adjustment requires a Voltmeter Calibrator (-hp- Model 738BR) and a Test Oscillator (-hp- Model 652A).

- a. Connect the -hp- Model 738BR voltmeter calibrator to Model 3410A.
- b. Set the 3410A controls as follows:  
MODE . . . . . TUNE  
RANGE . . . . . 3 MV  
FREQUENCY . . . . . X10  
FREQUENCY Dial . . . . . 40
- c. Set the voltmeter calibrator for a 3 mV rms output at 400 Hz.

- d. If necessary, tune the 3410A FREQUENCY dial until the instrument locks to the signal; then place the MODE switch to READ position.
- e. Adjust A4R61 for a 3410A meter indication of 3.0 mV.
- f. Disconnect the -hp- Model 738BR voltmeter calibrator and connect the 50 ohm output of the Model 652A Test Oscillator to the 3410A. Set the Test Oscillator to 400 Hz and adjust the amplitude controls until the 3410A meter indicates 3.0 mV. Set a reference on the Test Oscillator meter, and use the amplitude control to maintain the set reference whenever the frequency of the oscillator is varied.
- g. Set the Test Oscillator to 50 Hz, 300 Hz, and 600 Hz, tuning the 3410A to each respective frequency. If the meter indication for each frequency is not between 2.91 and 3.09 adjust A4R61 to split the difference in error across the X10 frequency range.

5-41. 600 kHz METER ZERO.

5-42. This adjustment requires a DC Voltmeter (-hp- Model 427A).

- a. Set the 3410A MODE switch to READ position, VOLTAGE range to the 3 mV, and the FREQUENCY controls to 600 kHz with no input signal.
- b. Adjust A3R55 for a zero indication on the meter.
- c. Set the 3410A to TUNE mode and check the voltages at A4RP4 and A4TP5 for the same voltage relationship as in the Meter and Inhibit Amplifier Balance Adjustment (app. .8 V higher at A4TP5 than A4TP4).
- d. If the A4TP4 and A4TP5 voltage relationship is not the same as stated in step c, slightly readjust A3R55 for the .8V ± .2V reading.
- e. Check the zero at 300 kHz and split the error with A3R55 and still maintain approximately .8V higher at A4TP5 than at A4TP4.

5-43. POST AMPLIFIER RESPONSE.

5-44. This adjustment requires a Test Oscillator (-hp- Model 652A).

- a. Set the 3410A controls as follows:  
 MODE . . . . . TUNE  
 RANGE . . . . . 3 MV  
 FREQUENCY . . . . . X10  
 FREQUENCY Dial . . . . . 40
- b. Set the Test Oscillator for a 3 mV output at 400 Hz.

- c. Connect the Test Oscillator to the 3410A input using a 50 ohm load.
- d. Adjust the oscillator output for a 30 mV reading on the 3410A and set a reference on the Test Oscillator.
- e. Set the frequency controls on both instruments to 300 kHz. The 3410A meter should indicate between 2.85 mV and 3.15 mV.
- f. Set the frequency controls on both instruments to 600 kHz. The 3410A meter should indicate between 2.85 mV and 3.15 mV.

5-45. The response at both 300 kHz and 600 kHz may be increased by decreasing the value of A1C1\*. The change at 600 kHz is greater than that at 300 kHz. Additional response increase at 600 kHz may be obtained by decreasing the value of A1C10\*.

5-46. PREATTENUATOR FLATNESS ADJUSTMENT.

5-47. This adjustment requires a Test Oscillator (-hp- Model 652A) and a 50Ω feedthrough termination (-hp- 11048B).

- a. Connect the 50Ω output of Test Oscillator to 3410A using the 50Ω feedthrough termination. (-hp-
- b. Set the 3410A controls as follows:  
 MODE . . . . . TUNE  
 RANGE . . . . . 3 MV  
 FREQUENCY . . . . . X10K  
 FREQUENCY Dial . . . . . 60
- c. Set the Test Oscillator to 600 kHz and set the output attenuator to the 3 mV range. Adjust the oscillator amplitude controls for a 3 mV output on the oscillator meter.
- d. If necessary, tune the 3410A FREQUENCY dial until instrument locks to signal; then place the MODE switch to READ position.
- e. Adjust the Test Oscillator amplitude controls for a 3410A meter indication of 3 mV.
- f. Set the 3410A RANGE switch to 3 V and set the Test Oscillator output attenuator to 3 V. Do not readjust Test Oscillator amplitude controls.
- g. Adjust A1C2 for a 3410A meter indication of 3 V.
- h. Check the ranges 1 V through .01 V. If, on any range, the error on 3410A is greater than ± 5% of F. S., split the error using A1C2.
- i. Repeat steps c through h at 300 kHz and 50 kHz (5 X10K). If any error on the 3410A is greater than ± 5% of F. S., split the error using A1C2 among all ranges and frequencies.

**5-48. TROUBLESHOOTING PROCEDURES.**

**5-49. FRONT PANEL TROUBLESHOOTING.**

5-50. Refer to Figure 5-5, Front Panel Troubleshooting Tree, and Figure 4-0, Simplified Block Diagram, for this procedure; which is applicable when it is not possible to obtain a meter indication on the 3410A.

- ① Apply an input signal equal to full scale on an upper 3410A voltage range. Downrange the 3410A voltage RANGE switch 20 dB below the input signal level. The RANGE INDICATOR should glow. If not, troubleshoot the Input Circuit, Paragraph 7-6. ⑦
- ② If the RANGE INDICATOR does light, switch out the Inhibit Circuit by placing the MODE switch in READ position. Try to obtain a meter indication by slowly tuning the frequency dial back and forth.
- ③ If the meter responds to the signal, there is trouble in the Inhibit Circuit. Refer to Paragraph 7-14.
- ④ If there is no meter deflection, connect an electronic counter or oscilloscope to the OSC OUT jack on the 3410A rear panel. Observe the counter or oscilloscope while varying the frequency around the input frequency. The Local Oscillator should lock to the input.
- ⑤ If the 3410A locks to the input signal, there is trouble in the Meter Circuit. Refer to Paragraph 7-16.
- ⑥ If the 3410A will not lock to the input signal, there is trouble in the Phase Lock Loop. Refer to Paragraph 7-10.

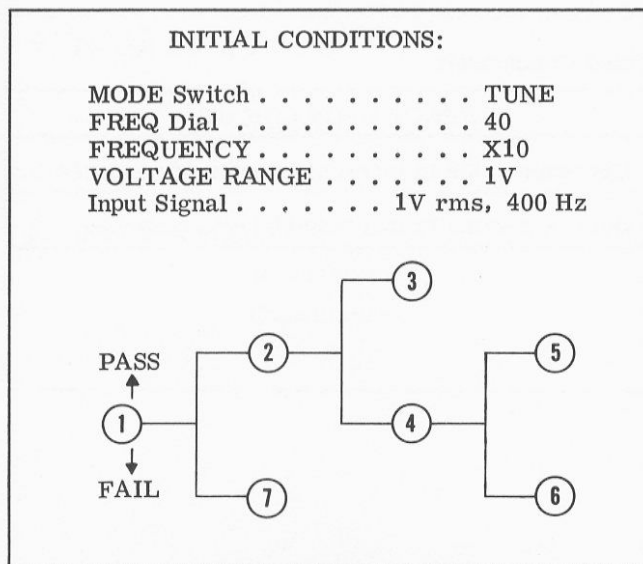


Figure 5-5. Front Panel Troubleshooting

**5-51. REPAIR PROCEDURES.**

**5-52. PROCEDURE FOR REPLACING R1 AND R2.**

**5-53. DISASSEMBLY OF 3410A.**

1. Remove all covers.
2. Remove left side gusset (side gusset near the frequency tuning dial).
3. Remove screw holding meter trim on right side gusset and slide off meter trim (refer to Figure 6-1 in Operating and Service Manual).
4. Replace left side gusset with sufficient screws to hold the left side gusset and bracket for R1 and R2 in place.

**5-54. CALIBRATING DIAL TO R1.**

1. Loosen set screws number 1 and 2 on collar of dial assembly.
2. Rotate dial to 60 and adjust resistance of R1 between contacts 3 and 4 for approximately 700 ohms (shaft at the rear of potentiometer is a convenient place to rotate R1). Tighten set screw number 1.
3. Rotate dial to 25 and check resistance between contacts 3 and 4. Resistance should read between 6 K and 6.2 K.

**5-55. CALIBRATING DIAL TO R2.**

1. Loosen set screws 5 and 6 on forward coupler connecting R1 to R2.
2. Rotate dial to 5 and adjust resistance of R2 between contacts 7 and 8 for 33 K (shaft coupler on R2 is a convenient place to rotate

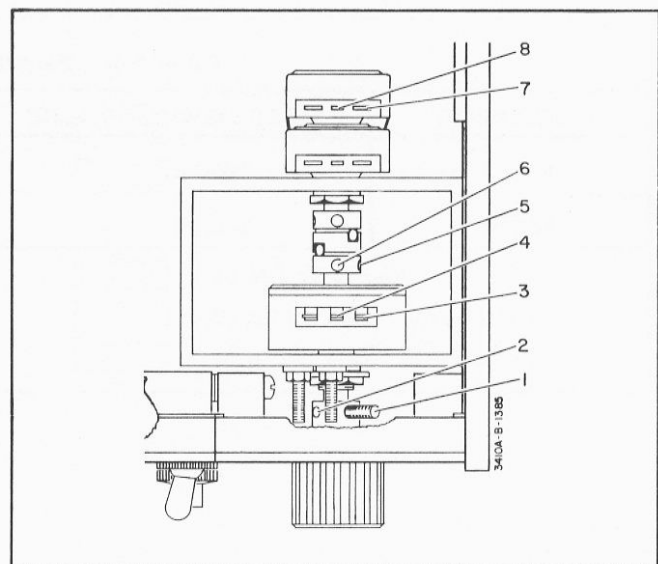


Figure 5-6. R1 and R2 Replacement

R2). Tighten either set screw 5 or 6, whichever is convenient.

3. Rotate dial to extreme CCW position. Set screw 1 should hit the upper stop (9).
4. If set screw 1 does not hit the upper stop (9), loosen set screw tightened in step 2 and rotate dial until it hits the stop. Then tighten either set screw 5 or 6, whichever is convenient. Recheck the resistance between contact 7 and 8 for 26.4 K to 39.6 K on 5 on dial. If out of test limit, replace R2.
5. Tighten set screws 5 and 6.

5-56. REASSEMBLY OF 3410A.

1. Remove left side gusset being held on by a few screws.
2. Replace meter trim by sliding it over meter and replace screw holding the meter trim to right side gusset.
3. Replace the left side gusset and replace all screws holding the left side gusset.
4. Replace all covers.

5-57. SERVICING ETCHED CIRCUIT BOARDS.

5-58. The Model 3410A contains four plated-through, double-sided, etched circuit boards. When working on these boards, observe the following rules to prevent damage to the circuit board or components:

- a. Use a low-heat (25 to 50 watts) soldering iron with a small tip.
- b. To remove a component, clip a heat sink (long nose pliers, commercial heat sink tweezers, etc.) on the component lead as close to the component as possible. Place

the soldering iron directly on the component lead, and pull up on the lead. If a component is obviously damaged or faulty, clip the leads close to the component, and remove the leads from the board.



EXCESSIVE OR PROLONGED HEAT CAN LIFT THE CIRCUIT FOIL FROM THE BOARD OR CAUSE DAMAGE TO COMPONENTS.

- c. Clean the component lead holes by heating the solder in the hole, quickly removing the soldering iron, and inserting a pointed, non-metallic object such as a toothpick.
- d. To mount a new component, shape the leads and insert them in the holes. Clip a heat sink on the component, heat with the soldering iron, and add solder as necessary to obtain a good electrical connection.

5-60. SERVICING ROTARY SWITCHES.

5-61. The Model 3410A contains two rotary type switches: FREQUENCY and RANGE. When working on these switches, observe the following rules:

- a. Use a low heat (25 to 50 watts) soldering iron with a small tip.
- b. When replacing components, attempt to dress them as nearly to their original alignment as possible.
- c. Clean excessive flux from the connection and adjoining area.
- d. After cleaning the switch, apply a light coat of lubriplate to the switch detent balls. DO NOT apply lubricant to switch contacts or allow lubricant to contaminate components.

Table 5-3. Factory Selected Components

COMPONENT	MOST COMMON VALUE	EFFECT UPON CIRCUIT
A2C1*	1000 pF	Decrease value to increase broadband response
A2C10*	2.0 pF	Decrease value to increase 600 kHz response

**PERFORMANCE CHECK TEST CARD**

Hewlett-Packard Model 3410A  
 AC Microvoltmeter  
 Serial No. \_\_\_\_\_

Tests performed by \_\_\_\_\_  
 Date \_\_\_\_\_

<p><b>1. ACCURACY AND FREQUENCY RESPONSE:</b></p> <p><u>3V Range</u></p> <p>10 Hz</p> <p>60 Hz</p> <p>400 Hz</p> <p>1 kHz</p> <p>10 kHz</p> <p>100 kHz</p> <p>600 kHz</p> <p><u>3 mV Range</u></p> <p>10 Hz</p> <p>60 Hz</p> <p>400 Hz</p> <p>1 kHz</p> <p>10 kHz</p> <p>100 kHz</p> <p>600 kHz</p> <p><u>.003 mV Range</u></p> <p>25 Hz</p> <p>100 Hz</p> <p>400 Hz</p> <p>1 kHz</p> <p>50 kHz</p> <p>100 kHz</p> <p>600 kHz</p>	<p><b>METER INDICATION:</b></p> <table border="0"> <thead> <tr> <th></th> <th align="center"><u>Min.</u></th> <th align="center"><u>Max.</u></th> </tr> </thead> <tbody> <tr><td><input type="text"/></td><td align="center">2.20</td><td align="center">2.80</td></tr> <tr><td><input type="text"/></td><td align="center">2.91</td><td align="center">3.09</td></tr> <tr><td><input type="text"/></td><td align="center">2.91</td><td align="center">3.09</td></tr> <tr><td><input type="text"/></td><td align="center">2.91</td><td align="center">3.09</td></tr> <tr><td><input type="text"/></td><td align="center">2.91</td><td align="center">3.09</td></tr> <tr><td><input type="text"/></td><td align="center">2.85</td><td align="center">3.15</td></tr> <tr><td><input type="text"/></td><td align="center">2.85</td><td align="center">3.15</td></tr> <tr><td> </td><td></td><td></td></tr> <tr><td><input type="text"/></td><td align="center">2.20</td><td align="center">2.80</td></tr> <tr><td><input type="text"/></td><td align="center">2.91</td><td align="center">3.09</td></tr> <tr><td><input type="text"/></td><td align="center">2.91</td><td align="center">3.09</td></tr> <tr><td><input type="text"/></td><td align="center">2.91</td><td align="center">3.09</td></tr> <tr><td><input type="text"/></td><td align="center">2.91</td><td align="center">3.09</td></tr> <tr><td><input type="text"/></td><td align="center">2.85</td><td align="center">3.15</td></tr> <tr><td><input type="text"/></td><td align="center">2.85</td><td align="center">3.15</td></tr> <tr><td> </td><td></td><td></td></tr> <tr><td><input type="text"/></td><td align="center">1.90</td><td align="center">3.10</td></tr> <tr><td><input type="text"/></td><td align="center">2.20</td><td align="center">2.80</td></tr> <tr><td><input type="text"/></td><td align="center">2.91</td><td align="center">3.09</td></tr> <tr><td><input type="text"/></td><td align="center">2.91</td><td align="center">3.09</td></tr> <tr><td><input type="text"/></td><td align="center">2.91</td><td align="center">3.09</td></tr> <tr><td><input type="text"/></td><td align="center">2.20</td><td align="center">2.80</td></tr> <tr><td><input type="text"/></td><td align="center">2.20</td><td align="center">2.80</td></tr> </tbody> </table>		<u>Min.</u>	<u>Max.</u>	<input type="text"/>	2.20	2.80	<input type="text"/>	2.91	3.09	<input type="text"/>	2.91	3.09	<input type="text"/>	2.91	3.09	<input type="text"/>	2.91	3.09	<input type="text"/>	2.85	3.15	<input type="text"/>	2.85	3.15	 			<input type="text"/>	2.20	2.80	<input type="text"/>	2.91	3.09	<input type="text"/>	2.91	3.09	<input type="text"/>	2.91	3.09	<input type="text"/>	2.91	3.09	<input type="text"/>	2.85	3.15	<input type="text"/>	2.85	3.15	 			<input type="text"/>	1.90	3.10	<input type="text"/>	2.20	2.80	<input type="text"/>	2.91	3.09	<input type="text"/>	2.91	3.09	<input type="text"/>	2.91	3.09	<input type="text"/>	2.20	2.80	<input type="text"/>	2.20	2.80
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<p><b>2. PHASE LOCK RANGE:</b></p> <p>Pull in</p> <p>Tracking</p>	<table border="0"> <tr><td><input type="text"/></td><td>1% full scale</td></tr> <tr><td><input type="text"/></td><td>5% full scale at 0.5%</td></tr> <tr><td><input type="text"/></td><td>full scale per second</td></tr> </table>	<input type="text"/>	1% full scale	<input type="text"/>	5% full scale at 0.5%	<input type="text"/>	full scale per second																																																																		
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<p><b>3. INPUT IMPEDANCE:</b></p> <p>Resistance</p> <p>Capacitance</p>	<table border="0"> <tr><td><input type="text"/></td><td>10 MΩ or greater</td></tr> <tr><td><input type="text"/></td><td>20 pF or less, .003 mV to 3 mV</td></tr> <tr><td><input type="text"/></td><td>10 pF or less, 10 mV to 3 V</td></tr> </table>	<input type="text"/>	10 MΩ or greater	<input type="text"/>	20 pF or less, .003 mV to 3 mV	<input type="text"/>	10 pF or less, 10 mV to 3 V																																																																		
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## SECTION VI REPLACEABLE PARTS

### 6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alphabetic order of their reference designators and indicates the description, -hp- part number of each part, together with any applicable notes, and provides the following:

- a. Total quantity used in the instrument (TQ column). The total quantity of a part is given the first time the part number appears.
- b. Descriptions of the part. (See list of abbreviations below.)
- c. Typical manufacturer of the part in a five-digit code. (See Appendix A for list of manufacturers.) Parts that are manufactured by Hewlett-Packard are identified by the abbreviation -hp-.
- d. Manufacturer's part number.

6-3. Figure 6-1 illustrates the modular cabinet parts, and Figure 6-2 illustrates the replaceable mechanical parts used in the 3410A. Miscellaneous parts are listed at the end of Table 6-1.

### 6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (See Appendix B for list of office locations.) Identify parts by their Hewlett-Packard part numbers. Include instrument model and serial numbers.

### 6-6. NON-LISTED PARTS.

6-7. To obtain a part that is not listed, include:

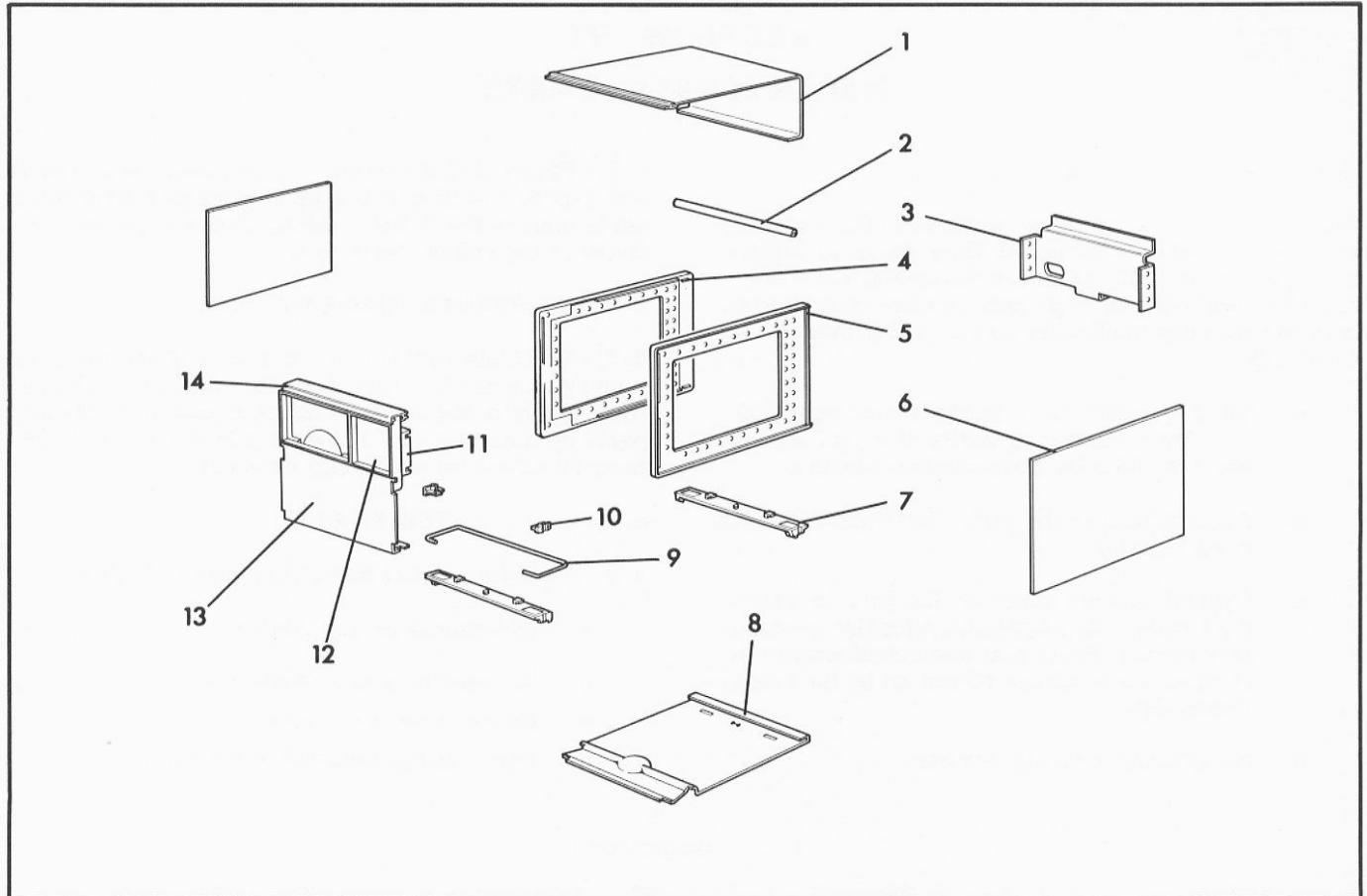
- a. Instrument model number.
- b. Instrument serial number.
- c. Description of the part.
- d. Function and location of the part.

#### DESIGNATORS

A = assembly	F = fuse	MP = mechanical part	TC = thermocouple
B = motor	FL = filter	P = plug	V = vacuum tube, neon bulb, photocell, etc.
BT = battery	HR = heater	Q = transistor	W = cable
C = capacitor	IC = integrated circuit	QCR = transistor-diode	X = socket
CR = diode	J = jack	R = resistor	XDS = lampholder
DL = delay line	K = relay	RT = thermistor	XF = fuseholder
DS = lamp	L = inductor	S = switch	Z = network
E = misc electronic part	M = meter	T = transformer	

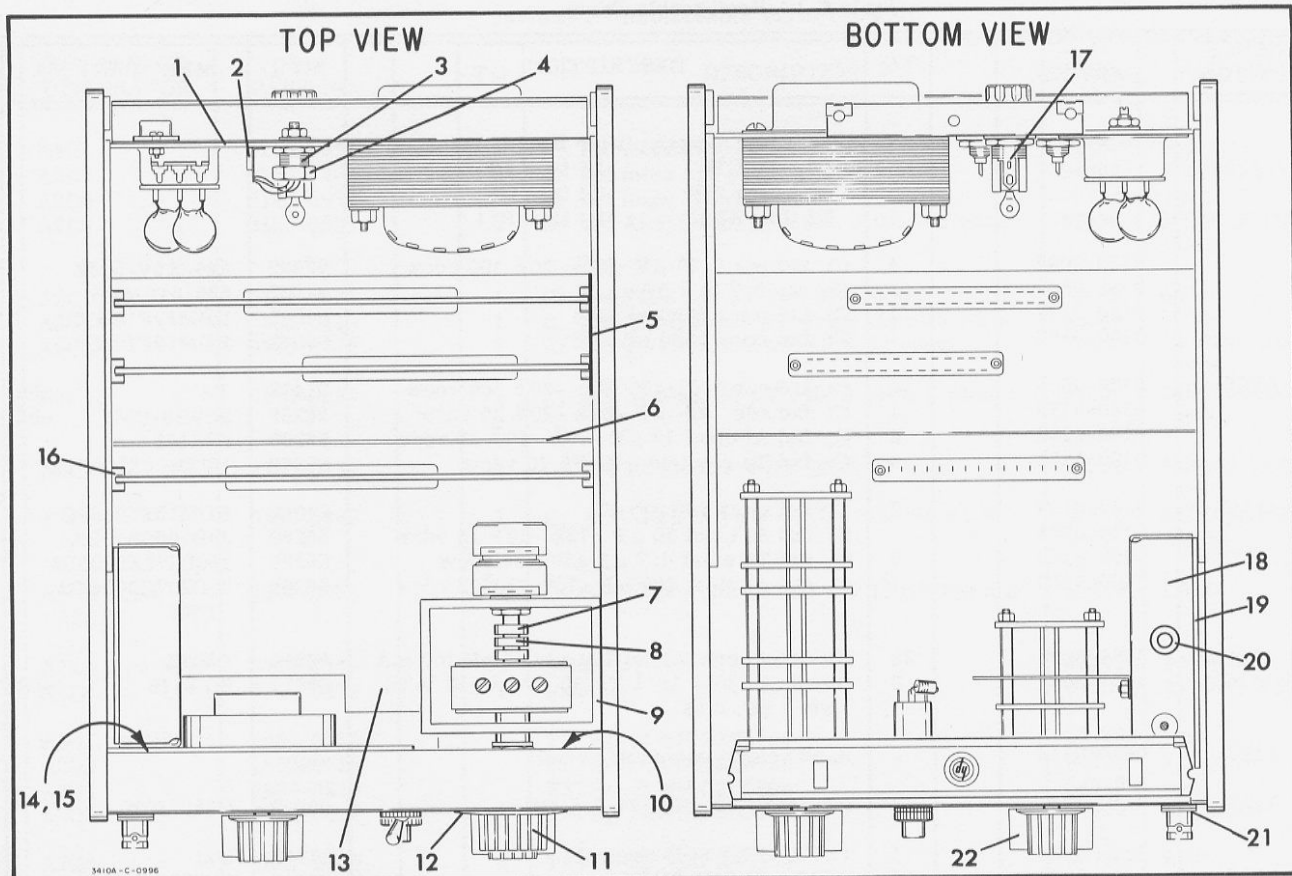
#### ABBREVIATIONS

Ag = silver	ID = inside diameter	ns = nanosecond (s) = 10 <sup>-9</sup>	sl = slide
Al = aluminum	imp = impregnated	seconds	SPDT = single-pole double-throw
A = ampere (s)	incd = incandescent	nsr = not separately replaceable	SPST = single-pole single-throw
Au = gold	ins = insulation (ed)		
C = capacitor	kΩ = kilohm (s) = 10 <sup>+3</sup> ohms	Ω = ohm (s)	Ta = tantalum
cer = ceramic	kHz = kilohertz = 10 <sup>+3</sup> hertz	obd = order by description	TC = temperature coefficient
coef = coefficient		OD = outside diameter	TiO <sub>2</sub> = titanium dioxide
com = common	L = inductor	p = peak	tog = toggle
comp = composition	lin = linear taper	pc = printed circuit	tol = tolerance
conn = connection	log = logarithmic taper		trim = trimmer
dep = deposited	m = milli = 10 <sup>-3</sup>	pF = picofarad (s) = 10 <sup>-12</sup>	TSTR = transistor
DPDT = double-pole double-throw	mA = milliampere (s) = 10 <sup>-3</sup> amperes	farads	V = volt (s)
DPST = double-pole single-throw	MHz = megahertz = 10 <sup>+6</sup> hertz	piv = peak inverse voltage	vacw = alternating current working voltage
elect = electrolytic	MΩ = megohm (s) = 10 <sup>+6</sup> ohms	pos = position (s)	var = variable
encap = encapsulated	met flm = metal film	poly = polystyrene	vdcw = direct current working voltage
	mfr = manufacturer	pot = potentiometer	
F = farad (s)	mtg = mounting	p-p = peak-to-peak	
FET = field effect transistor	mV = millivolt (s) = 10 <sup>-3</sup> volts	ppm = parts per million	W = watt (s)
fxd = fixed	μ = micro = 10 <sup>-6</sup>	prec = precision (temperature coefficient, long term stability, and/or tolerance)	w/ = with
GaAs = gallium arsenide	μV = microvolt (s) = 10 <sup>-6</sup> volts		wiv = working inverse voltage
GHz = gigahertz = 10 <sup>+9</sup> hertz	my = Mylar (R)	R = resistor	w/o = without
gd = guard (ed)	nA = nanoampere (s) = 10 <sup>-9</sup> amperes	Rh = rhodium	ww = wirewound
Ge = germanium	NC = normally closed	rms = root-mean-square	* = optimum value selected at factory, average value shown (part may be omitted)
grd = ground (ed)	Ne = neon	rot = rotary	** = no standard type number assigned (selected or special type)
H = henry (ies)	NO = normally open		
Hg = mercury	NPO = negative positive zero (zero temperature coefficient)	Se = selenium	
Hz = hertz (cycle (s) per second)		sect = section (s)	
		Si = silicon	



INDEX NO.	-hp- PART NO.	TQ	DESCRIPTION
1	5060-0718	1	Top Cover Assembly
2	5020-0701	2	Cab Spacer-Half Mod.
3	03410-00202	1	Panel-Rear
4	5060-0703	1	Frame Assembly
5	5060-0703	1	Frame Assembly
6	5000-0703	2	Side Cover
7	5060-0728	2	Foot Assembly-Half Mod
8	5000-0717	1	Bottom Cover
9	1490-0032	1	Stand Tilt
10	5040-0700	2	Hinge
11	5040-0697	1	Extender-Meter Case
12	03410-04301	1	Panel-Insert
13	03410-00201	1	Panel-Front
14	5020-5367	1	Meter Trim-Half Mod

Figure 6-1. Modular Cabinet Parts



INDEX NO.	-hp- PART NO.	TQ	DESCRIPTION
1	03410-00105	1	Chassis-Rear
2	0360-1327	1	Terminal Board
3	1205-0008	1	Heat Dissipator
4	1205-0007	1	Heat Dissipator-Nut
5	03410-01201	1	Bracket Guide
6	03410-00102	1	Deck-Rear
7	1500-0005	2	Coupler-Hub
8	1500-0004	1	Coupler-Insulator
9	03410-21201	1	Bracket-Pot Mtg. Freq. Contr.
10	1500-0051	1	Ball Drive 6:1
11	0370-0028	1	Knob-1 In.
12	03410-04001	1	Dial-Frequency
13	03410-00101	1	Deck-Front
14	5040-0235	1	Lamp Holder-Base
15	5040-0234	1	Lamp Holder-Lens
16	5040-0601	6	P. C. Board Guide
17	1400-0084	1	Fuse Post
18	03410-00103	1	Chassis-Preamp
19	03410-00106	1	Shield
20	0340-0060	9	Insulator-Feed Thru
21	5040-0425	4	Washer Insulator
22	0370-0112	2	Knob-Bar

Figure 6-2. Mechanical Parts

Table 6-1. Replaceable Parts

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A1	03410-66501	1	Assembly: Preamplifier Board, includes: C1 thru C15           L1 thru L2 CR1 thru CR4         Q1 thru Q3 K1 thru K2            R1 thru R21	-hp-	
A1C1	0150-0096	1	C: fxd cer 0.05 $\mu$ F +80% -20% 100 vdcw	72982	845-X5V-503Z
A1C2	0132-0003	1	C: var 0.7 to 3 pF	72982	535-016-4R
A1C3	0140-0179	1	C: fxd mica 1000 pF $\pm$ 2%	04062	RDM19F102G3C
A1C4	0140-0156	1	C: fxd mica 1500 pF $\pm$ 2%	04062	RDM19F152G3C
A1C5, A1C6	0150-0093	4	C: fxd cer 0.01 $\mu$ F +80% -20% 100 vdcw	91418	TA            obd
A1C7	0160-0170	1	C: fxd cer 22 $\mu$ F +80% -20% 25 vdcw	56289	5C9BS-CML   obd
A1C8	0180-0224	2	C: fxd Al elect 10 $\mu$ F +75% -10% 15 vdcw	56289	D32441
A1C9	0180-0354	4	C: fxd Ta elect 40 $\mu$ F $\pm$ 5% 10 vdcw	56289	150D406X5010B2
A1C10, A1C11	0140-0198	2	C: fxd mica 200 pF $\pm$ 5%	04062	RDM15F201J3C
A1C12	0180-0224		C: fxd Al elect 10 $\mu$ F +75% -10% 15 vdcw	56289	30D106G015BA4
A1C13, A1C14	0180-0100	9	C: fxd Ta elect 4.7 $\mu$ F $\pm$ 10% 35 vdcw	56289	150D475X9035B2
A1C15	0180-0060	1	C: fxd Al elect 200 $\mu$ F +75% -10% 3 vdcw	56289	30D207G003CC2-DSM
A1CR1, A1CR2	1901-0025	22	Diode: Si breakdown 100 wiv 15 pF 100 mA	82219	D3072
A1CR3, A1CR4	1901-0044	2	Diode: Si 20 mA/+1 V: 10 NA at -10 V/50 wiv 2 pF; 6 ns	03877	SG 5178       obd
A1K1, A1K2	0490-0343	3	Reed relay: sealed dry reed	-hp-	
A1L1, A1L2	9140-0047	2	Inductor: 20 $\mu$ H $\pm$ 10% 2.5 MHz	99848	H51074020
A1Q1	1855-0033	1	TSTR: FET Si N channel	83740	obd
A1Q2, A1Q3	1853-0036	14	TSTR: Si PNP 2N3906	04713	2N3906-5
A1R1	0698-4128	1	R: fxd prec met flm 10.0 M $\Omega$ $\pm$ 1/4% 1/2 W	56289	420E T-2       obd
A1R2	0698-5441	1	R: fxd prec met flm 10.01 k $\Omega$ $\pm$ 1/4% 1/8 W	75042	CEA T-2       obd
A1R3	0683-0625	1	R: fxd comp 6.2 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 6225
A1R4 thru A1R6	0683-3015	3	R: fxd comp 300 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 3015
A1R7, A1R8	0683-1635	2	R: fxd comp 16 k $\Omega$ $\pm$ 5% 1/4 W	01121	CB 1635
A1R9	0683-2745	2	R: fxd comp 270 k $\Omega$ $\pm$ 5% 1/4 W	01121	CB 2745
A1R10	2100-0094	1	R: var comp lin 50 k $\Omega$ $\pm$ 30%	71450	URM70RE (hp)
A1R11	0683-2045	1	R: fxd comp 200 k $\Omega$ $\pm$ 5% 1/4 W	01121	CB 2045
A1R12	0683-2265	1	R: fxd comp 22 M $\Omega$ $\pm$ 5% 1/4 W	01121	CB 2265
A1R13	0683-1535	4	R: fxd comp 15 k $\Omega$ $\pm$ 5% 1/4 W	01121	CB 1535
A1R14	0683-4725	2	R: fxd comp 4700 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 4725
A1R15	0698-5438	1	R: fxd prec met flm 100 $\Omega$ $\pm$ 1/4% 1/8 W	75042	CEA T-2       obd
A1R16	0698-5439	1	R: fxd prec met flm 1000 $\Omega$ $\pm$ 1/4% 1/8 W	75042	CEA T-2       obd
A1R17	0683-3915	1	R: fxd comp 390 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 3915
A1R18	0683-5635	2	R: fxd comp 56 k $\Omega$ $\pm$ 5% 1/4 W	01121	CB 5635
A1R19	0683-4735	1	R: fxd comp 47 k $\Omega$ $\pm$ 5% 1/4 W	01121	CB 4735
A1R20	0683-7505	1	R: fxd comp 75 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 7505
A1R21	0683-5625	1	R: fxd comp 5600 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 5625
A2	03410-66512	1	Assembly: Pc Board, includes: C1 thru C15           Q1 thru Q14 CR1 thru CR7         R1 thru R34 L1 thru L4	-hp-	
A2C1	0160-0938	3	C: fxd mica 1000 pF $\pm$ 5%	72136	obd
A2C2, A2C3	0180-0100		C: fxd Ta elect 4.7 $\mu$ F $\pm$ 10% 35 vdcw	56289	150D475X9035B2
A2C4	0180-0294	1	C: fxd Ta elect 390 $\mu$ F $\pm$ 20% 10 vdcw	56289	109D397X0010T2
A2C5	0180-0100		C: fxd Ta elect 4.7 $\mu$ F $\pm$ 10% 35 vdcw	56289	150D475X9035B2

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A2C6	0160-0938	2	C: fxd mica 1000 pF $\pm 5\%$	72136	obd
A2C7	0160-0362		C: fxd mica 510 pF $\pm 5\%$	04062	RDM15F511J3C
A2C8	0160-0938		C: fxd mica 1000 pF $\pm 5\%$	72136	obd
A2C9	0180-0091		C: fxd Al elect 10 $\mu$ F $+50\%$ $-10\%$ 100 vdcw	56289	30D106F100DC2-DSM
A2C10	0150-0031	1	C: fxd TiO <sub>2</sub> 2.0 pF $\pm 5\%$ 500 vdcw	78488	obd
A2C11	0180-0119	1	C: fxd Al elect 1.0 $\mu$ F $+75\%$ $-10\%$ 25 vdcw	56289	5C13C obd
A2C12	0180-1846	1	C: fxd Ta elect 2.2 $\mu$ F $\pm 10\%$ 35 vdcw	56289	150D225X9035B2-DYS
A2C13	0180-0033	1	C: fxd Al elect 50 $\mu$ F $+100\%$ $-10\%$ 6 vdcw	56289	30D506G006CB2-DSM
A2C14	0180-0155	1	C: fxd Ta elect 2.2 $\mu$ F $\pm 20\%$ 20 vdcw	56289	150D225X0020A2-DYS
A2C15	0180-0269	1	C: fxd Al elect 1 $\mu$ F $+75\%$ $-10\%$ 150 vdcw	56289	30D105G150BA2-DSM
A2CR1 thru A2CR7	1901-0025		Diode: Si breakdown 100 wiv 15 pF 100 mA	82219	D3072
A2L1 thru A2L3	9140-0118	3	Inductor: 500 $\mu$ H $\pm 5\%$	82142	10178-8
A2L4	9140-0179	1	Inductor: 22 $\mu$ H $\pm 10\%$	07261	15-4445-7J
A2Q1, A2Q2	1854-0215	5	TSTR: Si NPN 2N3904	04713	obd
A2Q3	1853-0036		TSTR: Si PNP 2N3906	04713	2N3906-5
A2Q4	1854-0215	1	TSTR: Si NPN 2N3904	04713	obd
A2Q5	1854-0092		TSTR: Si NPN 2N3563	04713	MPS3653
A2Q6	1854-0039		TSTR: Si NPN 2N3053	04713	2N3053 obd
A2Q7	1853-0015	1	TSTR: Si PNP 2N3640	04713	MPS3640-5
A2Q8	1853-0012	2	TSTR: Si PNP 2N2904A	04713	2N2904A
A2Q9	1854-0039		TSTR: Si NPN 2N3053	04713	2N3053 obd
A2Q10	1853-0012	11	TSTR: Si PNP 2N2904A	04713	2N2904A
A2Q11 thru A2Q13	1854-0022		TSTR: **	-hp-	
A2Q14	1854-0215		TSTR: Si NPN 2N3904	04713	obd
A2R1	0683-7515	2	R: fxd comp 750 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 7515
A2R2	0683-3905	2	R: fxd comp 39 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 3905
A2R3	0683-3035	1	R: fxd comp 30 k $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 3035
A2R4	0683-1235	3	R: fxd comp 12 k $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 1235
A2R5	0757-0410	2	R: fxd met flm 301 $\Omega$ $\pm 1\%$	91637	MFF 1/8 T-1 obd
A2R6	0757-0454	2	R: fxd met flm 33.2 k $\Omega$ $\pm 1\%$ 1/8 W	75042	CEA T-0 obd
A2R7	0683-7525	1	R: fxd comp 7500 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 7525
A2R8	0757-0410		R: fxd met flm 301 $\Omega$ $\pm 1\%$	91637	MFF 1/8 T-1 obd
A2R9	0683-5635	9	R: fxd comp 56 k $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 5635
A2R10	0683-1035		R: fxd comp 10 k $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 1035
A2R11	0683-2235		R: fxd comp 22 k $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 2235
A2R12	0683-1015		R: fxd comp 100 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 1015
A2R13	0683-2025	3	R: fxd comp 2000 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 2025
A2R14	0683-7515	3	R: fxd comp 750 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 7515
A2R15	0683-4705		R: fxd comp 47 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 4705
A2R16	0683-5125		R: fxd comp 5100 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 5125
A2R17	0683-1015		2	R: fxd comp 100 $\Omega$ $\pm 5\%$ 1/4 W	01121
A2R18	0683-3935	R: fxd comp 39 k $\Omega$ $\pm 5\%$ 1/4 W		01121	CB 3935
A2R19	0683-1035	R: fxd comp 10 k $\Omega$ $\pm 5\%$ 1/4 W		01121	CB 1035
A2R20, A2R21	0683-4705	R: fxd comp 47 $\Omega$ $\pm 5\%$ 1/4 W		01121	CB 4705
A2R22	0757-0454		R: fxd met flm 33.2 k $\Omega$ $\pm 1\%$ 1/8 W	75042	CEA T-0 obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A2R23, A2R24 A2R25 A2R26 A2R27	0683-1035 0683-5115 0683-1235 0683-1035	4	R: fxd comp 10 k $\Omega$ $\pm$ 5% 1/4 W R: fxd comp 510 $\Omega$ $\pm$ 5% 1/4 W R: fxd comp 12 k $\Omega$ $\pm$ 5% 1/4 W R: fxd comp 10 k $\Omega$ $\pm$ 5% 1/4 W	01121 01121 01121 01121	CB 1035 CB 5115 CB 1235 CB 1035
A2R28 A2R29 A2R30 A2R31	0683-1235 0683-3925 0757-0401 0757-0339	9 4 4 1	R: fxd comp 12 k $\Omega$ $\pm$ 5% 1/4 W R: fxd comp 3900 $\Omega$ $\pm$ 5% 1/4 W R: fxd prec met flm 100 $\Omega$ $\pm$ 1% 1/8 W R: fxd prec met flm 3010 $\Omega$ $\pm$ 1% 1/4 W	01121 01121 75042 19701	CB 1235 CB 3925 CEA T-0 obd MF6C T-0 obd
A2R32 A2R33 A2R34	0683-2035 0683-3935 0757-0831	1 1 1	R: fxd comp 20 k $\Omega$ $\pm$ 5% 1/4 W R: fxd comp 39 k $\Omega$ $\pm$ 5% 1/4 W R: fxd prec met flm 4320 $\Omega$ $\pm$ 1% 1/2 W	01121 01121 01121	CB 2035 CB 3935 CB 0831
A3	03410-66503	1	Assembly: Phase Lock Board, includes: C1 thru C22 Q1 thru Q26 CR1 thru CR18 R1 thru R67 IC1 thru IC2	-hp-	
A3C1, A3C2 A3C3 A3C4 A3C5	0150-0084 0180-0137 0160-2201	2 3 2	C: fxd cer 0.1 $\mu$ F +80% -20% 50 vdcw C: fxd Ta elect 100 $\mu$ F $\pm$ 20% 10 vdcw C: fxd mica 51 pF $\pm$ 5% Not assigned	56289 56289 04062	33C41 obd 150D107X0010R2 RDM15E510J3C
A3C6	0180-0100		C: fxd Ta elect 4.7 $\mu$ F $\pm$ 10% 35 vdcw	56289	150D475X9035B2-DYS
A3C7 A3C8 A3C9, A3C10	0160-0362 0140-0145 0150-0050	2 5	C: fxd mica 510 pF $\pm$ 5% C: fxd mica 22 pF $\pm$ 5% C: fxd cer 1000 pF 600 vdcw	04062 04062 18486	RDM15F511J3C RDM15C220J5C Type E obd
A3C11	0180-0309	1	C: fxd Ta elect 4.7 $\mu$ F $\pm$ 20% 10 vdcw	56289	150D475X0010A2-DYS
A3C12 A3C13	0160-2201 0180-0100		C: fxd mica 51 pF $\pm$ 5% C: fxd Ta elect 4.7 $\mu$ F $\pm$ 10% 35 vdcw	04062 56289	DDM15E510J3C 150D475X9035B2-DYS
A3C14	0121-0105	1	C: var cer 9-35 pF N650	72982	538-006 E2PO 94R
A3C15 A3C16 A3C17 A3C18 A3C19 A3C20 A3C21, A3C22	0140-0145 0180-0354 0180-0387 0140-0192 0180-0387 0180-0137	1	Not assigned C: fxd mica 22 pF $\pm$ 5% C: fxd Ta elect 40 $\mu$ F $\pm$ 5% 10 vdcw C: fxd Ta elect 47 $\mu$ F $\pm$ 5% 20 vdcw C: fxd mica 68 pF $\pm$ 5% C: fxd Ta elect 47 $\mu$ F $\pm$ 5% 20 vdcw C: fxd Ta elect 100 $\mu$ F $\pm$ 20% 10 vdcw	04062 56289 56289 72136 56289 56289	RDM15C220J5C 150D406X5010B2 150D476X5020B2 obd 150D476X5020B2 150D107X0010R2
A3CR1 A3CR2 A3CR3 A3CR4, A3CR5	1902-3104 1902-3073 1901-0040 1902-0048	1 3 9 11	Diode: Si breakdown 5.62 V $\pm$ 5% 400 mW Diode: Si breakdown 4.32 V $\pm$ 5% Diode: Si 30 wiv 30 mA 2 pF 2 ns Diode: breakdown 6.81 V $\pm$ 5% 400 mW	04713 04713 07263 04713	SZ10939-110 SZ10939-77 FDG 1088 SZ10939-134
A3CR6 A3CR7 thru A3CR9 A3CR10 A3CR11	1901-0040 1902-0049 1901-0040	2	Not assigned Diode: Si 30 wiv 30 mA 2 pF 2 ns Diode: breakdown 6.19 V $\pm$ 5% 400 mW Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263 04713 07263	FDG 1088 SZ10939-122 FDG 1088
A3CR12 A3CR13, A3CR14 A3CR15 A3CR16	1901-0040 1902-3073 1901-0040		Not assigned Diode: Si 30 wiv 30 mA 2 pF 2 ns Diode: Si breakdown 4.32 V $\pm$ 5% Diode: Si 30 wiv 30 mA 2 pF 2 ns	07263 04713 03877	FDG 1088 SZ10939-77 SG 5050
A3CR17 A3CR18	1902-3073 1901-0040		Diode: Si breakdown 4.32 V $\pm$ 5% Diode: Si 30 wiv 30 mA 2 pF 2 ns	04713 03877	SZ10939-77 SG 5050

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A3IC1, A3IC2	1820-0078	2	Integrated Circuit: JK flip flop	18324	obd
A3Q1, A3Q2	1854-0022		TSTR: **	-hp-	
A3Q3	1854-0094	7	TSTR: Si NPN 2N3646	07263	obd
A3Q4	1854-0221	3	TSTR: Si NPN dual	83740	BD-1148
A3Q5, A3Q6	1853-0036		TSTR: Si PNP 2N3906	04713	2N3906-5
A3Q7, A3Q8	1854-0087	8	TSTR: Si NPN 2N3417	04713	MPS 3417
A3Q9 thru A3Q11	1854-0071	5	TSTR: Si NPN 2N3391	04713	MPS 3391
A3Q12	1854-0094		TSTR: Si NPN 2N3646	07263	obd
A3Q13, A3Q14	1853-0036		TSTR: Si PNP 2N3906	04713	2N3906-5
A3Q15	1854-0094		TSTR: Si NPN 2N3646	07263	obd
A3Q16	1854-0022		TSTR: **	-hp-	
A3Q17	1853-0036		TSTR: Si PNP 2N3906	04713	2N3906-5
A3Q18, A3Q19	1854-0094		TSTR: Si NPN 2N3646	07263	obd
A3Q20	1854-0215		TSTR: Si NPN 2N3904	04713	obd
A3Q21, A3Q22	1854-0022		TSTR: **	-hp-	
A3Q23	1854-0094		TSTR: Si NPN 2N3646	07263	obd
A3Q24, A3Q25	1854-0022		TSTR: **	-hp-	
A3Q26	1854-0094		TSTR: Si NPN 2N3646	07263	2N3646
A3R1	0683-5115		R: fxd comp 510 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 5115
A3R2	0683-2425	2	R: fxd comp 2400 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 2425
A3R3	0683-5135	4	R: fxd comp 51 k $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 5135
A3R4	0698-3629	1	R: fxd met oxide $\pm 200$ PPM/C 2 W	07115	LPI-3
A3R5	0683-2425		R: fxd comp 2400 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 2425
A3R6	0683-3925		R: fxd comp 3900 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 3925
A3R7, A3R8	0698-4435	8	R: fxd prec met flm 2490 $\Omega$ $\pm 1\%$ 1/8 W	75042	CEA T-0
A3R9	0698-4391	2	R: fxd prec met flm 69.8 $\Omega$ $\pm 1\%$ 1/8 W	75042	CEA T-0
A3R10	0757-0469	6	R: fxd prec met flm 150 k $\Omega$ $\pm 1\%$ 1/8 W	75042	CEA T-0
A3R11, A3R12	0698-4481	2	R: fxd prec met flm 16.5 k $\Omega$ $\pm 1\%$ 1/8 W	75042	CEA T-0
A3R13	0757-0469		R: fxd prec met flm 150 k $\Omega$ $\pm 1\%$ 1/8 W	75042	CEA T-0
A3R14	0698-4391		R: fxd prec met flm 69.8 $\Omega$ $\pm 1\%$ 1/8 W	75042	CEA T-0
A3R15	2100-1702	3	R: var ww 100 $\Omega$ $\pm 10\%$ 1 W	74868	2600 Series
A3R16	0757-0200	1	R: fxd prec met flm 5620 $\Omega$ $\pm 1\%$ 1/8 W	19701	MF5C T-0
A3R17	0683-1535		R: fxd comp 15 k $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 1535
A3R18	0683-5105	1	R: fxd comp 51 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 5105
A3R19	0683-1035		R: fxd comp 10 k $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 1035
A3R20			Not assigned		
A3R21	0683-3325	1	R: fxd comp 3300 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 3325
A3R22	0683-1525	3	R: fxd comp 1500 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 1525
A3R23	0683-3335	3	R: fxd comp 33 k $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 3335
A3R24	0683-3025	1	R: fxd comp 3000 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 3025
A3R25	0683-3305	1	R: fxd comp 33 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 3305
A3R26	0683-5115		R: fxd comp 510 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 5115
A3R27	0683-1035		R: fxd comp 10 k $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 1035
A3R28	0683-1535		R: fxd comp 15 k $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 1535
A3R29	0683-6225	5	R: fxd comp 6200 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 6225
A3R30			Not assigned		
A3R31	0683-6225		R: fxd comp 6200 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 6225
A3R32	0698-4435		R: fxd prec met flm 2490 $\Omega$ $\pm 1\%$ 1/8 W	75042	CEA T-0
A3R33	0757-0283	3	R: fxd prec met flm 2000 $\Omega$ $\pm 1\%$ 1/8 W	19701	MF7C T-0
A3R34	0698-0082	2	R: fxd prec met flm 464 $\Omega$ $\pm 1\%$ 1/8 W	19701	MF5C T-0

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A3R35	0757-0453	2	R: fxd prec met flm 30.1 k $\Omega$ $\pm$ 1% 1/8 W	19701	MF5C T-0 obd
A3R36	0812-0095	1	R: fxd ww 2 k $\Omega$ $\pm$ 3% 3 W	91637	RS2B-95 obd
A3R37	0683-2435	1	R: fxd comp 24 k $\Omega$ $\pm$ 5% 1/4 W	01121	CB 2435
A3R38	0757-0453		R: fxd prec met flm 30.1 k $\Omega$ $\pm$ 1% 1/8 W	75042	CEA T-0 obd
A3R39	0698-0082		R: fxd prec met flm 464 $\Omega$ $\pm$ 1% 1/8 W	19701	MF5C T-0 obd
A3R40	0698-3630	1	R: fxd met oxide 300 $\Omega$ $\pm$ 5% 2 W	75042	L42 obd
A3R41	0698-4435		R: fxd prec met flm 2490 $\Omega$ $\pm$ 1% 1/8 W	75042	CEA T-0 obd
A3R42	0757-0283		R: fxd prec met flm 2000 $\Omega$ $\pm$ 1% 1/8 W	19701	MF7C T-0 obd
A3R43	0683-5135		R: fxd comp 51 k $\Omega$ $\pm$ 5% 1/4 W	01121	CB 5135
A3R44, A3R45	2100-1739	2	R: var ww 20 turn 5000 $\Omega$ $\pm$ 10% 1 W	02660	2610 Series
A3R46*	0683-1535		R: fxd comp 15 k $\Omega$ $\pm$ 5% 1/4 W	01121	CB 1535
A3R47	0683-1025	3	R: fxd comp 1000 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 1025
A3R48, A3R49	0683-3925		R: fxd comp 3900 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 3925
A3R50			Not assigned		
A3R51	0683-8225	1	R: fxd comp 8200 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 8225
A3R52	0757-0830	1	R: fxd comp 3920 $\Omega$ $\pm$ 5% 1/2 W	01121	CB 3925
A3R53	0683-6225		R: fxd comp 6200 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 6225
A3R54	0683-1025		R: fxd comp 1000 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 1025
A3R55	2100-1435	1	R: var comp lin 3300 $\Omega$ $\pm$ 10% 1/8 W	71450	QS 200
A3R56	0683-5115		R: fxd comp 510 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 5115
A3R57	0683-5135		R: fxd comp 51 k $\Omega$ $\pm$ 5% 1/4 W	01121	CB 5135
A3R58, A3R59	0683-1045	2	R: fxd comp 100 k $\Omega$ $\pm$ 5% 1/4 W	01121	CB 1045
A3R60	0683-5135		R: fxd comp 51 k $\Omega$ $\pm$ 5% 1/4 W	01121	CB 5135
A3R61, A3R62	0683-3925		R: fxd comp 3900 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 3925
A3R63 thru A3R65	0698-4435		R: fxd prec met flm 2490 $\Omega$ $\pm$ 1% 1/8 W	75042	CEA T-0 obd
A3R66	0683-1025		R: fxd comp 1000 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 1025
A3R67	0698-4435		R: fxd prec met flm 2490 $\Omega$ $\pm$ 1% 1/8 W	75042	CEA T-0 obd
A4	03410-66504	1	Assembly: Power Supply and Meter Amplifier Board, includes: C1 thru C27 Q1 thru Q21 CR1 thru CR29 R1 thru R64 K1	-hp-	
A4C1	0150-0014	2	C: fxd cer 0.005 $\mu$ F 500 vdcw	04222	D1-4 obd
A4C2	0180-0110	1	C: fxd Al elect 80 $\mu$ F 75 vdcw	56289	Type 41D D33191
A4C3	0150-0093		C: fxd cer 0.01 $\mu$ F +80% -20% 100 vdcw	91418	TA obd
A4C4	0180-0049	1	C: fxd Al elect 20 $\mu$ F +75% -10% 50 vdcw	56289	30D206G050CC2- DSM
A4C5	0180-0050	3	C: fxd Al elect 40 $\mu$ F +100% -15% 50 vdcw	56289	30D406G050DF6M1
A4C6	0150-0050		C: fxd cer 1000 pF 600 vdcw	84411	obd
A4C7	0180-0050		C: fxd Al elect 40 $\mu$ F +100% -15% 50 vdcw	56289	150D406X5010B2
A4C8			Not assigned		
A4C9	0150-0014		C: fxd cer 0.005 $\mu$ F 500 vdcw	04222	D1-4 obd
A4C10	0180-0149	1	C: fxd Al elect 65 $\mu$ F +100% -10% 60 vdcw	56289	Type 30D D36978- DSM
A4C11	0150-0093		C: fxd cer 0.01 $\mu$ F +80% -20% 100 vdcw	91418	TA obd
A4C12	0180-0045	2	C: fxd Al elect 20 $\mu$ F +75% -10% 25 vdcw	56289	30D206G025CB2 DSM
A4C13	0180-0058	1	C: fxd Al elect 50 $\mu$ F +75% -10% 25 vdcw	56289	30D506G025CC2- DSM
A4C14	0180-1719	1	C: fxd Ta elect 22 $\mu$ F $\pm$ 10% 25 vdcw	56289	109D226X9025C2
A4C15	0180-0374	1	C: fxd Ta elect 10 $\mu$ F $\pm$ 10% 20 vdcw	56289	150D106X9020B2- DYS



Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A4C16	0150-0050		C: fxd cer 1000 pF 600 vdcw	84411	obd
A4C17			Not assigned		
A4C18	0180-0059	1	C: fxd Al elect 10 $\mu$ F +100% -10% 25 vdcw	56289	30D106G025BB2- DSM
A4C19, A4C20	0160-0128	2	C: fxd cer 2.2 $\mu$ F $\pm$ 20% 25 vdcw	56289	5C 15C2
A4C21	0180-0374	1	C: fxd Ta elect 10 $\mu$ F $\pm$ 10% 20 vdcw	56289	150106X9020B2-DYS
A4C22	0180-0022	1	C: fxd Ta elect 3.9 $\mu$ F $\pm$ 10% 35 vdcw	56289	150D395X9035B2- DYS
A4C23	0140-0203	1	C: fxd mica 30 pF $\pm$ 5%	04062	RDM15E300J5C
A4C24	0150-0050		C: fxd cer 1000 pF 600 vdcw	84411	obd
A4C25	0180-0050		C: fxd Al elect 40 $\mu$ F +75% -10% 50 vdcw	56289	150D406X5010B2
A4C26	0150-0024	1	C: fxd cer 0.02 $\mu$ F $\pm$ 10% 600 vdcw	72982	841-000-Z5U-203Z
A4C27	0180-0045		C: fxd 20 $\mu$ F +75% -10% 25 vdcw	56289	30D206G025CB2- DSM
A4CR1, A4CR2	1901-0158	6	Diode: Si 200 piv	04713	SR 1358-8
A4CR3 thru A4CR6	1901-0025		Diode: Si 100 wiv 12 pF 100 mA	07263	FD 2387
A4CR7	1902-0048		Diode: breakdown 6.81 V $\pm$ 5% 400 mW	04713	SZ 10939-134
A4CR8	1901-0158		Diode: Si 200 piv	04713	SR 1358-8
A4CR9	1902-0048		Diode: breakdown 6.81 V $\pm$ 5% 400 mW	04713	SZ 10939-134
A4CR10, A4CR11	1901-0025		Diode: Si 100 wiv 12 pF 100 mA	07263	FD 2387
A4CR12	1902-0048		Diode: breakdown 6.81 V $\pm$ 5% 400 mW	04713	SZ 10939-134
A4CR13, A4CR14	1901-0158		Diode: Si 200 piv	04713	SR 1358-8
A4CR15 thru A4CR18	1901-0025		Diode: Si 100 wiv 12 pF 100 mA	07263	FD 2387
A4CR19	1902-0048		Diode: breakdown 6.81 V $\pm$ 5% 400 mW	04713	SZ 10939-135
A4CR20	1901-0158		Diode: Si 200 piv	04713	SR 1358-8
A4CR21 thru A4CR23	1902-0048		Diode: breakdown 6.81 V $\pm$ 5% 400 mW	04713	SZ 10939-135
A4CR24 thru A4CR26	1901-0025		Diode: Si 100 wiv 12 pF 100 mA	07263	FD 2387
A4CR27, A4CR28	1902-0048		Diode: breakdown 6.81 V $\pm$ 5% 400 mW	04713	SZ 10939-135
A4CR29	1902-0049		Diode: breakdown 6.2 V 1N821 5.9 to 6.5 V 0.01%/ $^{\circ}$ C	04713	obd
A4K1	0490-0343		Relay Reed: sealed dry reed	-hp-	
A4Q1	1854-0022		TSTR: **	-hp-	
A4Q2	1854-0087		TSTR: Si NPN 2N3417	04713	MPS 3417
A4Q3	1854-0039		TSTR: Si NPN 2N3053	04713	2N3053
A4Q4	1854-0087		TSTR: Si NPN 2N3417	04713	MPS 3417
A4Q5	1853-0045	3	TSTR: Si PNP**	04713	obd
A4Q6 thru A4Q8	1853-0036		TSTR: Si PNP 2N3906	04713	2N3906-5
A4Q9	1854-0221		TSTR: Si NPN Dual	83740	BD-1148
A4Q10	1854-0039		TSTR: Si NPN 2N3053	04713	2N3053
A4Q11, A4Q12	1854-0087		TSTR: Si NPN 2N3417	04713	MPS 3417
A4Q13	1853-0045		TSTR: Si PNP**	04713	obd
A4Q14	1854-0087		TSTR: Si NPN 2N3417	04713	MPS 3417
A4Q15, A4Q16	1854-0071		TSTR: Si NPN 2N3391	04713	MPS 3391
A4Q17, A4Q18	1853-0036		TSTR: Si PNP 2N3906	07263	2N3906-5
A4Q19	1854-0221		TSTR: Si NPN Dual	83740	BD-1148
A4Q20	1854-0087		TSTR: Si NPN 2N3417	04713	MPS 3417
A4Q21	1853-0036		TSTR: Si PNP 2N3906	04713	2N3906-5

Table -1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A4R1	0683-2025		R: fxd comp 2000 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 2025	
A4R2	0683-1005	2	R: fxd comp 10 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 1005	
A4R3	0683-0275	1	R: fxd comp 2.7 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 27G5	
A4R4	0683-3925		R: fxd comp 3900 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 3925	
A4R5	0698-3161	1	R: fxd prec met flm 38.3 k $\Omega$ $\pm 1\%$ 1/8 W	19701	MF5C T-0	obd
A4R6	2100-1759	2	R: var ww lin 2000 $\Omega$ $\pm 10\%$ 1/2 W	75042	Type 506	obd
A4R7	0757-0439	2	R: fxd prec met flm 6810 $\Omega$ $\pm 1\%$ 1/8 W	19701	MF5C T-0	obd
A4R8			Not assigned			
A4R9	0683-5125		R: fxd comp 5100 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 5125	
A4R10	0683-0335	1	R: fxd comp 3.3 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 33G5	
A4R11	0757-0450		R: fxd 22.1 k $\Omega$ $\pm 1\%$ 1/8 W	07115	MF07CC4	
A4R12	0757-0440		R: fxd prec met flm 7500 $\Omega$ $\pm 1\%$ 1/8 W	19701	MF5C T-0	obd
A4R13	0683-2025		R: fxd comp 2000 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 2025	
A4R14	0683-1005		R: fxd comp 10 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 1005	
A4R15	0683-0755	1	R: fxd comp 7.5 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 75G5	
A4R16			Not assigned			
A4R17	0683-3925		R: fxd comp 3900 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 3925	
A4R18	0757-0447	1	R: fxd prec met flm 16.2 k $\Omega$ $\pm 1\%$ 1/8 W	75042	CEA T-0	obd
A4R19	2100-1759		R: var ww lin 2000 $\Omega$ $\pm 10\%$ 1/2 W	75042	Type 506	obd
A4R20	0757-0439		R: fxd prec met flm 6810 $\Omega$ $\pm 1\%$ 1/8 W	19701	MF5C T-0	obd
A4R21	0757-0469		R: fxd prec met flm 150 k $\Omega$ $\pm 1\%$ 1/8 W	75042	CEA T-0	obd
A4R22, A4R23	0757-0449	2	R: fxd prec met flm 20 k $\Omega$ $\pm 1\%$ 1/8 W	19701	MF5C T-0	obd
A4R24	0757-0469		R: fxd prec met flm 150 k $\Omega$ $\pm 1\%$ 1/8 W	75042	CEA T-0	obd
A4R25			Not assigned			
A4R26	2100-1702		R: var ww 100 $\Omega$ $\pm 10\%$ 1 W 20 turn	74868	2600 Series	
A4R27	0698-4477	1	R: fxd prec met flm 10.5 k $\Omega$ $\pm 1\%$ 1/8 W	75042	CEA T-0	obd
A4R28	0683-1525		R: fxd comp 1500 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 1525	
A4R29	0683-6225		R: fxd comp 6200 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 6225	
A4R30	0683-1035		R: fxd comp 10 k $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 1035	
A4R31	0757-0804	1	R: fxd prec met flm 200 $\Omega$ $\pm 1\%$ 1/2 W	19701	MF6C T-0	obd
A4R32	0683-3335		R: fxd comp 33 k $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 3335	
A4R33	0683-8215	1	R: fxd comp 820 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 8215	
A4R34	0683-6225		R: fxd comp 6200 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 6225	
A4R35			Not assigned			
A4R36, A4R37	0683-2235		R: fxd comp 22 k $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 2235	
A4R38	0683-3905		R: fxd comp 39 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 3905	
A4R39	0683-3625	1	R: fxd comp 3600 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 3625	
A4R40	0683-4725		R: fxd comp 4700 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 4725	
A4R41	0683-2215	1	R: fxd comp 220 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 2215	
A4R42	0683-5125		R: fxd comp 5100 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 5125	
A4R43	0683-6825	1	R: fxd comp 6800 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 6825	
A4R44	0683-1805	1	R: fxd 18 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 1805	
A4R45			Not assigned			
A4R46	0683-9135	1	R: fxd comp 91 k $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 9135	
A4R47	0683-2745		R: fxd comp 270 k $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 2745	
A4R48	0683-3005	1	R: fxd comp 30 $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 3005	
A4R49	0683-1035		R: fxd comp 10 k $\Omega$ $\pm 5\%$ 1/4 W	01121	CB 1035	
A4R50	0757-0469		R: fxd prec met flm 150 k $\Omega$ $\pm 1\%$ 1/8 W	75042	CEA T-0	obd
A4R51	0757-0401		R: fxd prec met flm 100 $\Omega$ $\pm 1\%$ 1/8 W	75042	CEA T-0	obd
A4R52	2100-1702		R: var ww 100 $\Omega$ $\pm 10\%$ 1 W	74868	2600 Series	
A4R53	0757-0290	1	R: fxd prec met flm 6190 $\Omega$ $\pm 1\%$ 1/8 W	75042	CEA T-0	obd
A4R54, A4R55	0757-0445	2	R: fxd 13 k $\Omega$ $\pm 1\%$ 1/8 W	19701	MF5C T-0	obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A4R56	0757-0469		R: fxd prec met flm 150 k $\Omega$ $\pm$ 1% 1/8 W	75042	CEA T-0	obd
A4R57	0757-0404	1	R: fxd prec met flm 130 $\Omega$ $\pm$ 1% 1/8 W	19701	obd	
A4R58	0683-1525		R: fxd comp 1500 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 1525	
A4R59, A4R60	0698-3162	2	R: fxd prec met flm 46.4 k $\Omega$ $\pm$ 1% 1/8 W	75042	CEA T-0	obd
A4R61	2100-1762	1	R: var ww lin 20 k $\Omega$ $\pm$ 10% 1/2 W	75042	Type 506	obd
A4R62	0757-0283		R: fxd prec met flm 2 k $\Omega$ $\pm$ 1% 1/8 W	19701	MF5C T-0	obd
A4R63	0757-0280	1	R: fxd prec met flm 2000 $\Omega$ $\pm$ 1% 1/8 W	19701	MF5C T-0	obd
A4R64	0757-0411	1	R: fxd met flm 332 $\Omega$ $\pm$ 1% 1/8 W	75042	CEA T-0	obd
A4R65	0683-1525	2	R: fxd comp 15 k $\Omega$ $\pm$ 5% 1/4 W	01121	CB 1525	
C1, C2	0160-3333	2	C: fxd cer 5000 pF $\pm$ 20% 250 vacw	08988	THD-8-502M-1.4 KV	
DS1	1450-0106	1	Lamp: neon	87034	A1G	obd
DS2	2140-0053	1	Lamp: incandescent 10 V 14 mA	24446	1869D	obd
F1	2110-0008	1	Fuse: 0.5 amp 250 V	75915	312.500	obd
J1	1250-0083	1	Connector: series BNC bulkhead mount jack receptacle	95712	30624-1	obd
J2, J3	1250-0118	2	Connector: series BNC bulkhead mount jack receptacle	95712	30384-1	obd
J4	1251-0148	1	Connector: AC power 3 pin recessed power cord receptacle	82389	AC3G	obd
J5	1251-0135	1	Connector: printed circuit 15 pin	02660	143-015-08 (1158)	
J6, J7	1251-1263	2	Connector: printed circuit 30 pin	95354	FD6 30S-SF	
M1	1120-0923	1	Meter: calibrated 100 $\mu$ A	-hp-		
M1 (Opt. 01)	1120-0933	1	Meter: calibrated 100 $\mu$ A	-hp-		
Q1	1854-0072	1	TSTR: Si NPN 2N3054	02735	2N3054	
Q2	1853-0045		TSTR: Si PNP 2N4036	02735	2N4036	
R1	2100-1917	1	R: var prec ww 10 k $\Omega$ $\pm$ 5% 3 W	02660	Type 3461B	
R2A, R2B	2100-1944	2	R: var comp 50 k $\Omega$ $\pm$ 20% 1.12 W	01121	Type J	obd
R3	2100-0261	1	R: var lin 2000 $\Omega$ $\pm$ 20% 3/10 W	71450	obd	
R4	0683-3335		R: fxd comp 33 k $\Omega$ $\pm$ 5% 1/4 W	01121	CB 3335	
R5	0757-0274	1	R: fxd comp 1210 $\Omega$ $\pm$ 1% 1/8 W	75042	obd	
S1	03410-61901	1	Switch Assembly Attenuator, includes: C1 R1 thru R13	-hp-		
S1C1	0140-0055	1	C: fxd mica 150 pF $\pm$ 10%	72136	obd	
S1R1	0757-0284	1	R: fxd prec met flm 150 $\Omega$ $\pm$ 1% 1/8 W	75042	CEA T-0	obd
S1R2 thru S1R6	0698-3138	5	R: fxd prec met flm 277.5 $\Omega$ $\pm$ 1/4% 1/4 W	19701	MF6C T-0	obd
S1R7 thru S1R12	0698-3139	6	R: fxd prec met flm 410.26 $\Omega$ $\pm$ 1/4% 1/4 W	19701	MF6C T-0	obd
S1R13	0698-3137	1	R: fxd prec met flm 189.72 $\Omega$ $\pm$ 1/4% 1/4 W	19701	MF6C T-0	obd
S2	03410-61902	1	Frequency Range Switch Assembly, includes: C1 thru C30	-hp-		
S2C1	0180-0100		C: fxd Ta elect 4.7 $\mu$ F $\pm$ 10% 35 vdcw	56289	150D475X9035B2- DYS	
S2C2	0180-0376	1	C: fxd Ta elect 0.47 $\mu$ F $\pm$ 10% 35 vdcw	56289	150D474X9035A2- DYS	
S2C3	0170-0040	1	C: fxd my 0.047 $\mu$ F $\pm$ 10% 200 vdcw	56289	192P47392-PTS	
S2C4	0160-0161	2	C: fxd my 0.01 $\mu$ F $\pm$ 10%	56289	192P10392-PTS	
S2C5	0160-0155	3	C: fxd my 0.0033 $\mu$ F $\pm$ 10% 200 vdcw	56289	192P33292-PTS	
S2C6	0160-2376	1	C: fxd 0.1 $\mu$ F $\pm$ 5% 100 vdcw	01884	LP7A1B105J	
S2C7	0160-0168	2	C: fxd my 0.1 $\mu$ F $\pm$ 10% 200 vdcw	56289	192P10492-PTS	

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
S2C8	0160-0161		C: fxd my 0.01 $\mu$ F $\pm 10\%$ 200 vdcw	56289	192P10392-PTS
S2C9	0160-0153	1	C: fxd my 0.001 $\mu$ F $\pm 10\%$ 200 vdcw	56289	192P10292-PTS
S2C10	0160-0990	1	C: fxd mica 100 pF $\pm 2\%$	04062	RDM15F101G3S
S2C11	0180-1799	1	C: fxd Ta elect 20 $\mu$ F $\pm 10\%$ 35 vdcw	56289	150D206X9035R2-DYS
S2C12	0180-0100		C: fxd Ta elect 4.7 $\mu$ F $\pm 10\%$ 35 vdcw	56289	150D475X9035B2-DYS
S2C13	0180-0291	1	C: fxd Ta elect 1.0 $\mu$ F $\pm 10\%$ 35 vdcw	56289	150D105X9035A2-DYS
S2C14	0160-0889	2	C: fxd my 0.33 $\mu$ F $\pm 10\%$ 80 vdcw	56289	192P3349R8-PTS
S2C15	0160-0163	2	C: fxd my 0.033 $\mu$ F $\pm 10\%$ 200 vdcw	56289	192P33392-PTS
S2C16	0160-0155		C: fxd my 0.0033 $\mu$ F $\pm 10\%$ 200 vdcw	56289	192P33292-PTS
S2C17	0180-0161	1	C: fxd Ta elect 3.3 $\mu$ F $\pm 20\%$ 35 vdcw	56289	150D335X0035B2-DYS
S2C18	0160-0889		C: fxd my 0.33 $\mu$ F $\pm 10\%$ 80 vdcw	56289	192P334948-PTS
S2C19	0160-0163		C: fxd my 0.033 $\mu$ F $\pm 10\%$ 200 vdcw	56289	192P33392-PTS
S2C20	0160-0155		C: fxd my 0.0033 $\mu$ F $\pm 10\%$ 200 vdcw	56289	192P33292-PTS
S2C21	0160-2012	1	C: fxd mica 330 pF $\pm 5\%$	72136	obd
S2C22	0160-2375	2	C: fxd 0.47 $\mu$ F $\pm 2\%$ 100 vdcw	01884	LP7A1B474G
S2C23	0160-2374	2	C: fxd 0.047 $\mu$ F $\pm 2\%$ 100 vdcw	01884	LP7A1B473G
S2C24	0160-2373	2	C: fxd mica 4700 pF $\pm 2\%$ 300 vdcw	04062	RDM19F472G3S
S2C25	0160-2939	2	C: fxd mica 420 pF $\pm 2\%$ 500 vdcw	04062	RDM15F421G5S
S2C26	0160-2375		C: fxd 0.47 $\mu$ F $\pm 2\%$ 100 vdcw	01884	LP7A1B474G
S2C27	0160-2374		C: fxd 0.047 $\mu$ F $\pm 2\%$ 100 vdcw	01884	LP7A1B473G
S2C28	0160-2373		C: fxd mica 4700 pF $\pm 2\%$ 300 vdcw	04062	RDM19F472G3S
S2C29	0160-2939		C: fxd mica 420 pF $\pm 2\%$ 500 vdcw	04062	RDM15F421G5S
S2C30	0160-0168		C: fxd my 0.1 $\mu$ F $\pm 10\%$ 200 vdcw	56289	192P10492-PTS
S3	3101-0038	1	Switch: toggle DPDT	04009	83054-H
S4	3101-0100	1	Switch: pushbutton AC power SPDT	87034	54-61681-26 A1H
S5	3101-0033	1	Switch: 115/230 V slide DPDT	82389	11A-1009
T1	9100-1357	1	Transformer: power	-hp-	
W1	8120-0078	1	Assembly: cable 7.5 ft. power cord set	70903	KH-4147
<u>MISCELLANEOUS</u>					
	0400-0051	1	Grommet: polyethylene 3/8"	-hp-	
	03410-90000	1	Manual: operating and service	-hp-	
	0380-0059	4	Spacer: captive for No. 6 hardware	00866	obd
	1200-0080	4	Washer: insulator hard anodized aluminum 500 vdcw	76530	294834

## SECTION VII CIRCUIT DIAGRAMS

### 7-1. INTRODUCTION.

7-2. This section contains circuit diagrams to aid in the operation and maintenance of the Model 3410A. Figure 7-1 is a functional circuit diagram which shows the overall relationship between the basic circuits of the instrument. Figures 7-2 through 7-6 contain the detailed schematic diagrams as well as component

location drawings of each printed circuit board and the rotary switches.

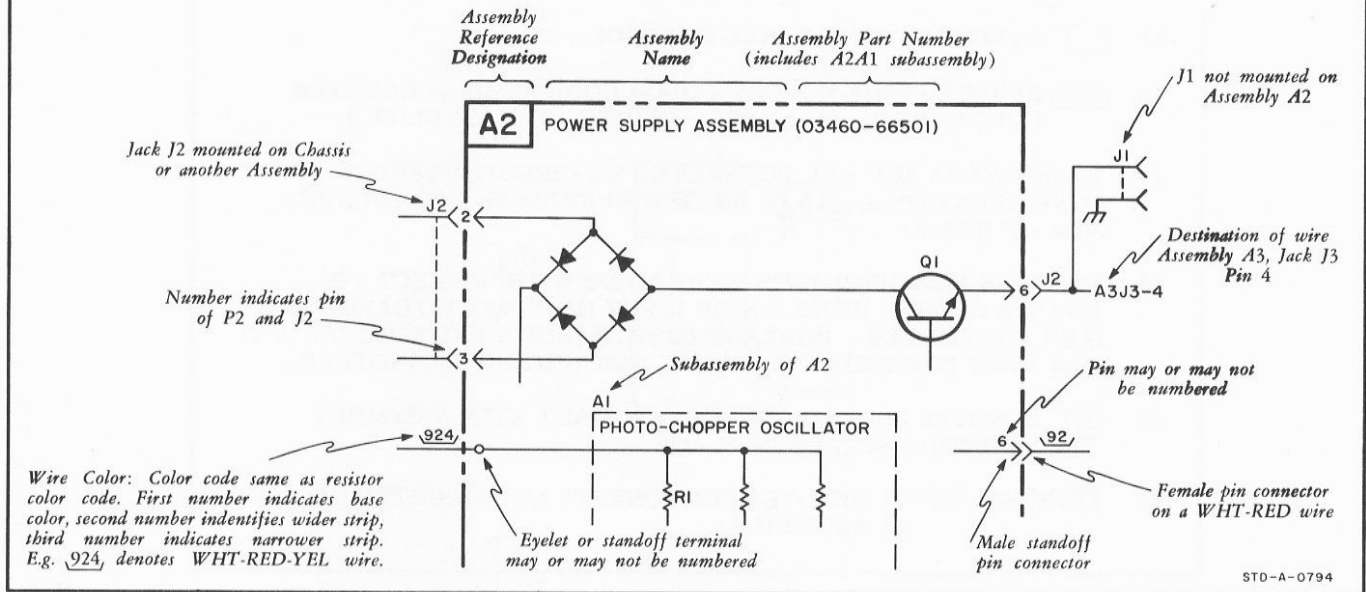
7-3. General schematic notes, which apply to all the schematic diagrams, are listed on Page 7-2.

7-4. An explanation of terms and symbols used on the schematic diagrams is given below.

### REFERENCE DESIGNATIONS






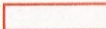








PARTIAL REFERENCE DESIGNATIONS ARE SHOWN: PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.

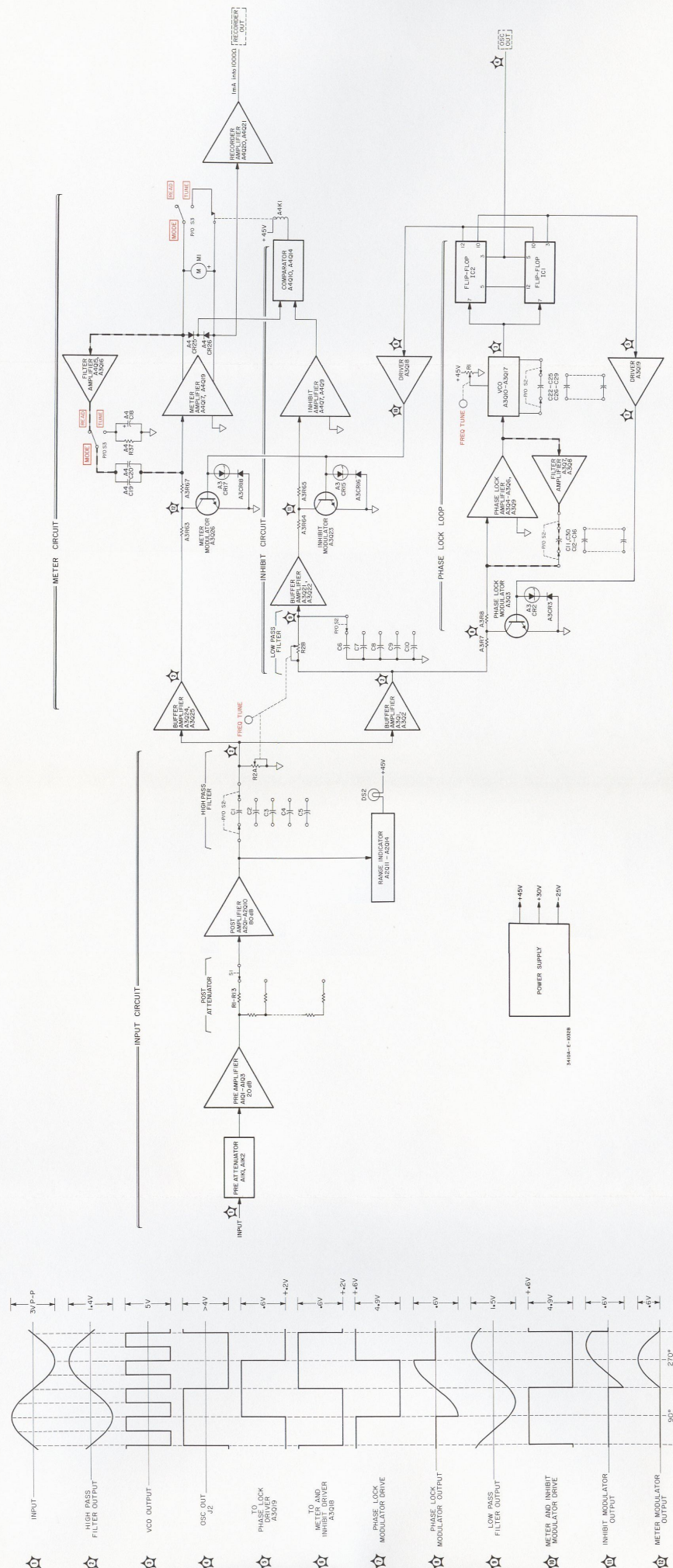
ASSEMBLY	SUBASSEMBLY	COMPONENT	COMPLETE DESIGNATION
A2	NONE	Q1	A2Q1
A2	A1	R1	A2A1R1
NONE	NONE	J1	J1



STD-A-0794

### SCHEMATIC NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.
2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED.  
     RESISTANCE IN OHMS  
     CAPACITANCE IN MICROFARADS
3.  DENOTES CHASSIS GROUND.
4.  DENOTES ASSEMBLY GROUND.
5.  DENOTES ASSEMBLY.
6.  DENOTES MAIN SIGNAL PATH.
7.  DENOTES FEEDBACK PATH.
8.  DENOTES FRONT PANEL MARKING.
9.  DENOTES REAR PANEL MARKING.
10.  DENOTES SCREWDRIVER ADJUST.
11.  DENOTES FRONT PANEL CONTROL.
12.  DENOTES WIRE COLOR: COLOR CODE SAME AS RESISTOR COLOR CODE. (e. g.  = WHITE, RED, YELLOW.)
13. TRANSISTORS ARE ALL CONNECTED TO CIRCUIT BOARD IN TO-5 CONFIGURATION, e. g.  AS VIEWED FROM THE COMPONENT SIDE OF BOARD.
14. VOLTAGE MEASUREMENTS WERE MADE WITH RESPECT TO CHASSIS GROUND USING A HIGH INPUT IMPEDANCE TRANSISTORIZED VOLTMETER. VOLTAGE LEVELS SHOWN ARE NOMINAL AND MAY VARY SOMEWHAT FROM ONE INSTRUMENT TO ANOTHER.
15.  DENOTES GROUND CONNECTION MADE WITH ASSEMBLY MOUNTING SCREWS IN PLACE.
16.  DENOTES COMPONENTS NOT MOUNTED ON ASSEMBLY.



WIRE DESTINATIONS

2

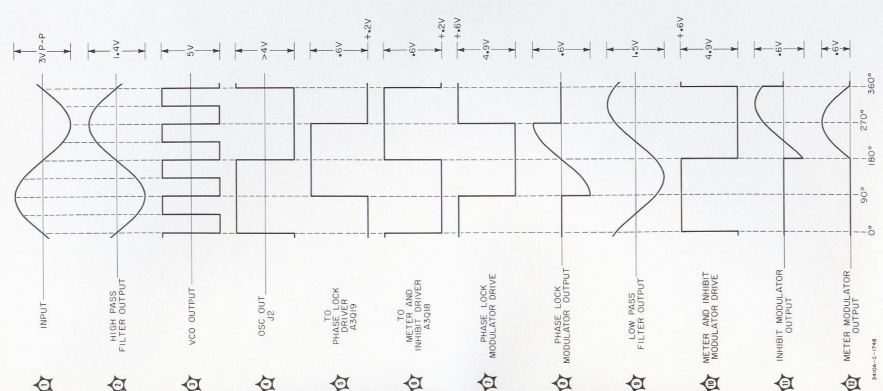
1

SCHEMATIC NUMBER

LOCATOR NUMBER

NOTE  
WAVEFORMS TAKEN WITH FULL SCALE 1 KHZ INPUT SIGNAL.

Figure 7-1. Functional Block Diagram 7-3/7-4







### 7-5. DETAILED TROUBLESHOOTING.

#### 7-6. INPUT CIRCUIT TROUBLESHOOTING.

7-7. Using the Test Oscillator, apply a 3 V 400 Hz signal to the 3410A input. The RANGE INDICATOR should light on the .3V range and all ranges below it. If the RANGE INDICATOR lights only on the 3 mV range and lower, there is a problem in the pre-attenuator.

7-8. If the RANGE INDICATOR does not light at all, set the 3410A RANGE switch to .3V. The signal at A2TP1 should be about 0.1V p-p. If this signal is present, go to the next paragraph. If not, measure the dc voltages around A2Q1 through A2Q4. Refer to Figure 7-3 for typical voltage levels. If these voltages are normal, troubleshoot the A1 pc board assembly located just behind the input jack. Four screws hold the shield in place over the A1 assembly. Refer to Figure 7-2 for typical voltage levels.

7-9. If the 1V p-p signal was present at A2TP1, apply a 3V input signal with the 3410A RANGE set to 3V. A signal of approximately 1V p-p should be present at A2TP2. If not, measure the dc voltages around A2Q5 through A2Q10. Refer to Figure 7-3 for typical voltage levels.

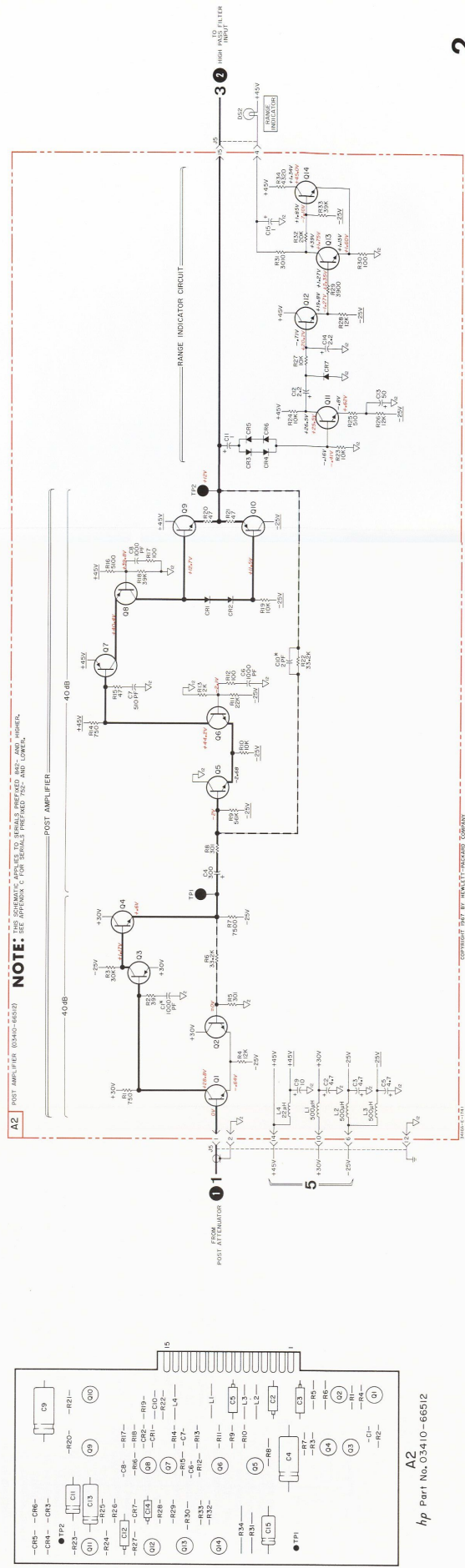


Figure 7-3. Post Amplifier

01825-1


7-10. PHASE LOCK LOOP TROUBLESHOOTING.

7-11. If there is a square wave output at the tuned frequency present at the OSC. OUT connector on the 3410A rear panel, go to Paragraph 7-13. If not, continue with the following steps to check out the flip-flops.




- a. Check pin 7 of each flip-flop for a 5V p-p square wave at four times the tuned frequency. If the square wave is present, go to step b. If not, check the VCO as in 7-12.
- b. Check pin 3 of IC1 and pin 12 of IC2 for a 5V peak to peak square wave at the tuned frequency. If the square wave is present, the flip-flops are operating normally. Go to 7-13. If the square wave is not present, go to step c.
- c. Check pin 8 of both flip-flops for approximately +5.6 V dc. If +5.6 V dc is present, go to step e. If not, go to step d.
- d. Lift the anode end of A3CR1 and measure the resistance from A3TP3 to ground. If approximately 2 k $\Omega$  is measured, check the +5.6V power supply, A3CR1. If some other resistance is found, go to step e. Reconnect A3CR1.
- e. Connect a dc voltmeter (-hp- Model 427A) to pin 3 of IC1, which should read either +5 V dc or 0 V dc, depending on which state the flip-flop is in.

- f. Using a clip lead, make alternate momentary contact from IC1 pin 7 to pin 8, and from IC1 pin 7 to ground. If IC1 changes state, it is good.
- g. Connect the dc voltmeter to pin 12 of IC2 and repeat step g.
- h. Connect the dc voltmeter to pin 12 of IC2 and repeat step g.

7-12. To troubleshoot the Voltage Controlled Oscillator, use the following procedure:

- a. Observe the waveform  at the collector of A3Q15. If a 5V p-p square wave is present at four times the tuned frequency, the VCO is operating normally. Go to Paragraph 7-13.
- b. If there is no square wave present, check dc voltage levels on the transistors. Refer to Figure 7-4 for typical voltages.

7-13. To troubleshoot the Phase Lock Amplifier, use the following procedure:

- a. Observe the waveform  at the base of A3Q3. A 4.9V square wave should be present.
- b. Observe the waveform  at pin D of the pc assembly connector. A 1.4V p-p sine wave should be present.
- c. Observe the waveform  at the collector of A3Q3. Refer to Figure 7-1 for the proper waveform. If no signal is present, check A3Q1 and A3Q2. If an unsynchronized signal is present, check dc voltage levels around A3Q4 through A3Q8.

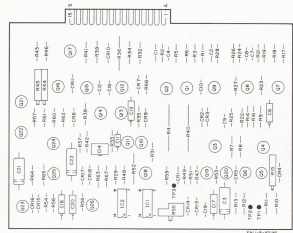
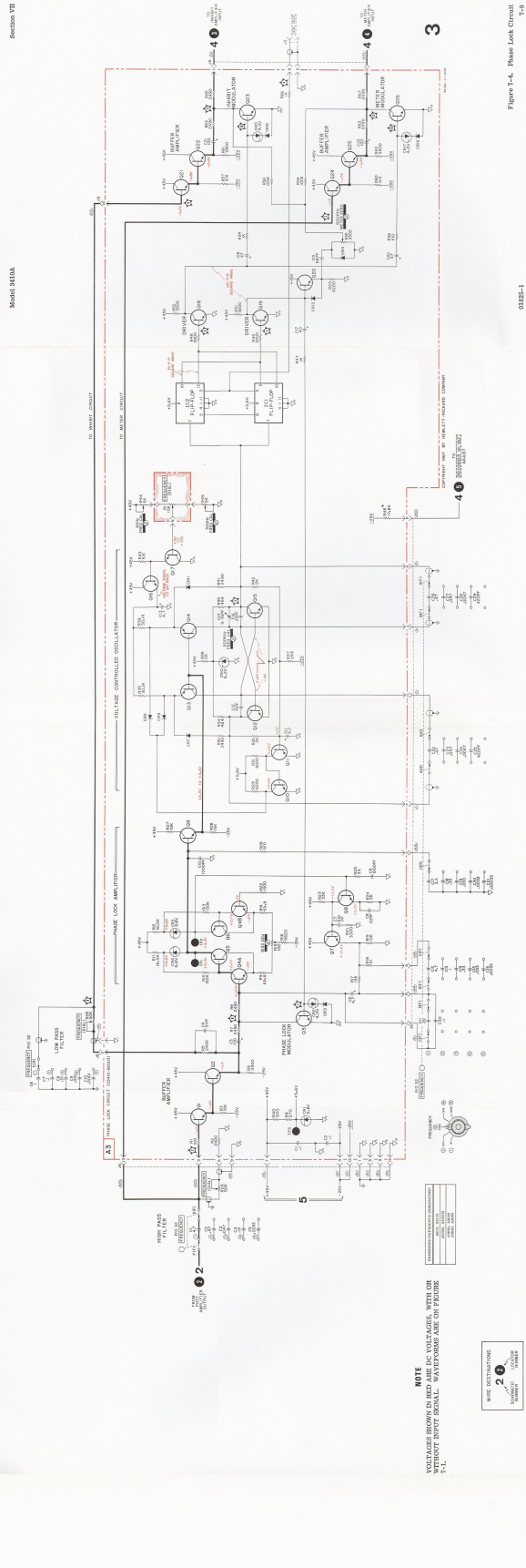
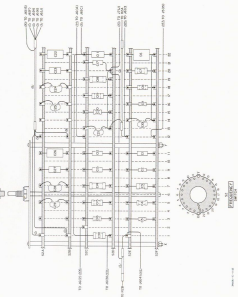


Figure 1-1



**NOTE**  
 THIS CIRCUIT IS NOT TO BE USED FOR  
 WITHOUT INPUT SIGNAL. MAINTAINANCE ON FIGURE  
 1-1.


WIRE IDENTIFICATION  
 2 0  
 NUMBER VALUE

#### 7-14. INHIBIT CIRCUIT TROUBLESHOOTING.

7-15. With no input signal and FREQUENCY set to the X100 range, the voltage at A4TP4 should be .8V less than that at A4TP5. If not, check transistors A4Q10, 11, and 13. Refer to Figure 7-5 for typical voltages. A4Q7, 8 and 9 may be checked using the general procedure for checking differential amplifiers as follows:

- a. Remove the output load from the differential amplifier (lift the base of A4Q10).
- b. Vary the Amplifier Bal Adj A4R26 while measuring the voltage at the emitters of A4Q7 and 8. If both voltages vary, the differential amplifier is operating.

#### 7-16. METER CIRCUIT TROUBLESHOOTING.

7-17. Apply a full scale sine wave input signal to the 3410A, which should be tuned to the input frequency. Use an oscilloscope and a 10:1 probe to observe the waveform at the collector of A3Q26. The positive half of a sine wave, .6V in amplitude, should be observed. (See  on Figure 7-1).

7-18. Check the differential amplifier as follows:

- a. Remove the output load from the differential amplifier (lift the base of A4Q20).
- b. Vary the Amplifier Bal Adj A4R52 while measuring the voltage at the emitters of A4Q17 and 18. If both voltages vary, the amplifier is operating.





## CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
00000	U. S. A. Common	Any supplier of U. S.	05277	Westinghouse Electric Corp.	Youngwood, Pa.	09250	Electro Assemblies, Inc.	Chicago, Ill.
00136	McCoy Electronics	Mount Holly Springs, Pa.		Semi-Conductor Dept.		09353	C & K Components Inc.	Newton, Mass.
00213	Sage Electronics Corp.	Rochester, N. Y.	05347	Ultronix, Inc.	San Mateo, Calif.	09569	Mallory Battery Co. of	
00287	Cemco Inc.	Danielson, Conn.	05397	Union Carbide Corp., Elect. Div.	New York, N. Y.		Canada, Ltd.	Toronto, Ontario, Canada
00334	Humidial	Colton, Calif.	05574	Viking Ind. Inc.	Canoga Park, Calif.	09922	Burdry Corp.	Norwalk, Conn.
00348	Microtron Co., Inc.	Valley Stream, N. Y.	05593	Icore Electro-Plastics Inc.	Sunnyvale, Calif.	10214	General Transistor Western Corp.	
00373	Garlock Inc.	Cherry Hill, N. J.	05616	Cosmo Plastic				Los Angeles, Calif.
00656	Aerovox Corp.	New Bedford, Mass.		(c/o Electrical Spec. Co.)	Cleveland, Ohio	10411	Ti-Tal, Inc.	Berkeley, Calif.
00779	Amp. Inc.	Harrisburg, Pa.	05624	Barber Colman Co.	Rockford, Ill.	10646	Carborundum Co.	Niagara Falls, N. Y.
00781	Aircraft Radio Corp.	Boonton, N. J.	05728	Tiffen Optical Co.		11236	CTS of Berne, Inc.	Berne, Ind.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.			Roslyn Heights, Long Island, N. Y.	11237	Chicago Telephone of California, Inc.	
00853	Sangamo Electric Co., Pickens Div.	Pickens, S. C.	05729	Metro-Tel Corp.	Westbury, N. Y.	11242	Bay State Electronics Corp.	So. Pasadena, Calif.
00866	Goe Engineering Co.	City of Industry, Cal.	05783	Stewart Engineering Co.	Santa Cruz, Calif.	11312	Teledyne Inc., Microwave Div.	Palo Alto, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.	05820	Wakefield Engineering Inc.	Wakefield, Mass.	11314	National Seal	Downey, Calif.
00929	Microlab Inc.	Livingston, N. J.	06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.	11453	Precision Connector Corp.	Jamaica, N. Y.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N. Y.	06090	Raychem Corp.	Redwood City, Calif.	11534	Duncan Electronics Inc.	Costa Mesa, Calif.
01009	Alden Products Co.	Brockton, Mass.	06175	Bausch and Lomb Optical Co.	Rochester, N. Y.	11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N. J.
01121	Allen Bradley Co.	Milwaukee, Wis.	06402	E. T. A. Products Co. of America	Chicago, Ill.	11717	Imperial Electronic, Inc.	Buena Park, Calif.
01255	Litton Industries, Inc.	Beverly Hills, Calif.	06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N. Y.	11870	Melabs, Inc.	Palo Alto, Calif.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.	06555	Beede Electrical Instrument Co., Inc.	Penacook, N. H.	12136	Philadelphia Handle Co.	Camden, N. J.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas	06666	General Devices Co., Inc.	Indianapolis, Ind.	12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
01349	The Alliance Mfg. Co.	Alliance, Ohio	06751	Components Inc., Ariz. Div.	Phoenix, Ariz.	12574	Gulton Ind. Inc. Data System Div.	Albuquerque, N. M.
01589	Pacific Relays, Inc.	Van Nuys, Calif.	06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.	12697	Clarostat Mfg. Co.	Dover, N. H.
01670	Gudebrod Bros. Silk Co.	New York, N. Y.	06980	Varian Assoc. Eimac Div.	San Carlos, Calif.	12728	Elmar Filter Corp.	W. Haven, Conn.
01930	Amerock Corp.	Rockford, Ill.	07088	Kelvin Electric Co.	Van Nuys, Calif.	12859	Nippon Electric Co., Ltd.	Tokyo, Japan
01961	Pulse Engineering Co.	Santa Clara, Calif.	07126	Digitran Co.	Pasadena, Calif.	12881	Metex Electronics Corp.	Clark, N. J.
02114	Ferroxcube Corp. of America	Saugerties, N. Y.	07137	Transistor Electronics Corp.	Minneapolis, Minn.	12930	Delta Semiconductor Inc.	Newport Beach, Calif.
02116	Wheelock Signals, Inc.	Long Branch, N. J.	07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N. Y.	12954	Dickson Electronics Corp.	Scottsdale, Arizona
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.	07149	Filmohm Corp.	New York, N. Y.	13103	Thermolloy	Dallas, Texas
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.	07233	Cinch-Graphix Co.	City of Industry, Calif.	13396	Telefunken (GmbH)	Hanover, Germany
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N. J.	07256	Silicon Transistor Corp.	Carle Place, N. Y.	13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.	07261	Avnet Corp.	Culver City, Calif.	14099	Sem-Tech	Newbury Park, Calif.
02777	Hopkins Engineering Co.	San Fernando, Calif.	07263	Fairchild Camera & Inst. Corp. Semiconductor Div.	Mountain View, Calif.	14193	Calif. Resistor Corp.	Santa Monica, Calif.
02875	Hudson Tool & Die	Newark, N. J.	07322	Minnesota Rubber Co.	Minneapolis, Minn.	14298	American Components, Inc.	Conshohocken, Pa.
03508	G. E. Semiconductor Prod. Dept.	Syracuse, N. Y.	07387	Bircher Corp., The	Monterey Park, Calif.	14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
03705	Apex Machine & Tool Co.	Dayton, Ohio	07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Calif.	14493	Hewlett-Packard Company	Loveland, Colo.
03797	Eldema Corp.	Compton, Calif.	07700	Technical Wire Products Inc.	Cranford, N. J.	14655	Cornell Dublier Electric Corp.	Newark, N. Y.
03818	Parker Seal Co.	Los Angeles, Calif.	07829	Bodine Elect. Co.	Chicago, Ill.	14674	Corning Glass Works	Corning, N. Y.
03877	Transitron Electric Corp.	Wakefield, Mass.	07910	Continental Device Corp.	Hawthorne, Calif.	14752	Electro Cube Inc.	San Gabriel, Calif.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N. J.	07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.	14960	Williams Mfg. Co.	San Jose, Calif.
03954	Singer Co., Diehl Div. FINDERNE Plant	Sumerville, N. J.	07980	Hewlett-Packard Co., Boonton Radio Div.	Rockaway, N. J.	15203	Webster Electronics Co.	New York, N. Y.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.	08145	U. S. Engineering Co.	Los Angeles, Calif.	15287	Scionics Corp.	Northridge, Calif.
04013	Taurus Corp.	Lambertville, N. J.	08289	Bliinn, Delbert Co.	Pomona, Calif.	15291	Adjustable Bushing Co.	N. Hollywood, Calif.
04062	Arco Electronic Inc.	Great Neck, N. Y.	08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada	15558	Micron Electronics	Garden City, Long Island, N. Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S. C.	08524	Deutsch Fastener Corp.	Los Angeles, Calif.	15566	Amprobe Inst. Corp.	Lynbrook, N. Y.
04354	Precision Paper Tube Co.	Wheeling, Ill.	08654	Bristol Co., The	Waterbury, Conn.	15631	Cabletronics	Costa Mesa, Calif.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.	08717	Sloan Company	Sun Valley, Calif.	15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.	08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona	15801	Fenwal Elect. Inc.	Framingham, Mass.
04673	Dakota Engr. Inc.	Culver City, Calif.	08727	National Radio Lab. Inc.	Paramount, N. J.	15818	Amelco Inc.	Mt. View, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona	08792	CBS Electronics Semiconductor Operations, Div. of C. B. S. Inc.	Lowell, Mass.	16037	Spruce Pine Mica Co.	Spruce Pine, N. C.
04732	Filltron Co., Inc. Western Div.	Culver City, Calif.	08984	Mel-Rain	Indianapolis, Ind.	16179	Omni-Spectra Inc.	Detroit, Ill.
04773	Automatic Electric Co.	Northlake, Ill.	09026	Babcock Relays Div.	Costa Mesa, Calif.	16352	Computer Diode Corp.	Lodi, N. J.
04796	Sequoia Wire Co.	Redwood City, Calif.	09134	Texas Capacitor Co.	Houston, Texas	16585	Boots Aircraft Nut Corp.	Pasadena, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.	09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Calif.	16688	Ideal Prec. Meter Co., Inc. De Jur Meter Div.	Brooklyn, N. Y.
04870	P. M. Motor Company	Westchester, Ill.				16758	Delco Radio Div. of G. M. Corp.	Kokoma, Ind.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.				17109	Thermonetics Inc.	Canoga Park, Calif.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.				17474	Tranex Company	Mountain View, Calif.
						17675	Hamlin Metal Products Corp.	Akron, Ohio
						17745	Angstrom Prec. Inc.	No. Hollywood, Calif.
						17870	McGraw-Edison Co.	Manchester, N. H.
						18042	Power Design Pacific Inc.	Palo Alto, Calif.
						18083	Clevite Corp., Semiconductor Div.	Palo Alto, Calif.



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Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
18324	Signetics Corp.	Sunnyvale, Calif.	70276	Allen Mfg. Co.	Hartford, Conn.	74970	E. F. Johnson Co.	Waseca, Minn.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.	70309	Allied Control	New York, N.Y.	75042	International Resistance Co.	Philadelphia, Pa.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.	70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.	75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.	70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.	75378	CTS Knights Inc.	Sandwich, Ill.
18612	Vishay Instruments Inc.	Malvern, Pa.	70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.	75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.	70563	Amperite Co., Inc.	Union City, N.J.	75818	Lenz Electric Mfg. Co.	Chicago, Ill.
18911	Durant Mfg. Co.	Milwaukee, Wis.	70674	ADC Products Inc.	Minneapolis, Minn.	75915	Littlefuse, Inc.	Des Plaines, Ill.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N.J.	70903	Belden Mfg. Co.	Chicago, Ill.	76005	Lord Mfg. Co.	Erie, Pa.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.	70998	Bird Electronic Corp.	Cleveland, Ohio	76210	C.W. Marwedel	San Francisco, Calif.
19589	Concoa	Baldwin Park, Calif.	71002	Birnback Radio Co.	New York, N.Y.	76433	General Instrument Corp., Micamold Division	Newark, N.J.
19644	LR Electronics	Horseheads, N.Y.	71034	Biley Electric Co., Inc.	Erie, Pa.	76487	James Millen Mfg. Co., Inc.	Malden, Mass.
19701	Electra Mfg. Co.	Independence, Kansas	71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.	76493	J.W. Miller Co.	Los Angeles, Calif.
20183	General Atomics Corp.	Philadelphia, Pa.	71218	Bud Radio, Inc.	Willoughby, Ohio	76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Calif.
21226	Executone, Inc.	Long Island City, N.Y.	71279	Cambridge Thermionics Corp.	Cambridge, Mass.	76545	Mueller Electric Co.	Cleveland, Ohio
21335	Fafnir Bearing Co., The	New Britain, Conn.	71286	Camloc Fastener Corp.	Paramus, N.J.	76703	National Union	Newark, N.J.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.	71313	Cardwell Condenser Corp.	Lindenhurst L.I., N.Y.	76854	Oak Manufacturing Co.	Crystal Lake, Ill.
23042	Texscan Corp.	Indianapolis, Ind.	71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.	77068	The Bendix Corp., Electroynamics Div.	N. Hollywood, Calif.
23783	British Radio Electronics Ltd.	Washington, D.C.	71436	Chicago Condenser Corp.	Chicago, Ill.	77075	Pacific Metals Co.	San Francisco, Calif.
24455	G.E. Lamp Division	Nela Park, Cleveland, Ohio	71447	Calif. Spring Co., Inc.	Pico-Rivera, Calif.	77221	Phanostran Instrument and Electronic Co.	South Pasadena, Calif.
24655	General Radio Co.	West Concord, Mass.	71450	CTS Corp.	Elkhart, Ind.	77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.	71468	ITT Cannon Electric Inc.	Los Angeles, Calif.	77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.	71471	Cinema, Div. Aerovox Corp.	Burbank, Calif.	77630	TRW Electronic Components Div.	Camden, N.J.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.	71482	C.P. Clare & Co.	Chicago, Ill.	77638	General Instrument Corp., Rectifier Div.	Brooklyn, N.Y.
26851	Compac/Hollister Co.	Hollister, Calif.	71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.	77764	Resistance Products Co.	Harrisburg, Pa.
26992	Hamilton Watch Co.	Lancaster, Pa.	71616	Commercial Plastics Co.	Chicago, Ill.	77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
28480	Hewlett-Packard Co.	Palo Alto, Calif.	71700	Cornish Wire Co., The	New York, N.Y.	78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
28520	Heyman Mfg. Co.	Kenilworth, N.J.	71707	Coto Coil Co., Inc.	Providence, R.I.	78277	Sigma	So. Braintree, Mass.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.	71744	Chicago Miniature Lamp Works	Chicago, Ill.	78283	Signal Indicator Corp.	New York, N.Y.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.	71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.	78290	Struthers-Dunn Inc.	Pitman, N.J.
35434	Lectrohm Inc.	Chicago, Ill.	71984	Dow Corning Corp.	Midland, Mich.	78452	Thompson-Bremer & Co.	Chicago, Ill.
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36287	Cunningham, W.H. & Hill, Ltd.	Toronto Ontario, Canada	72619	Dialight Corp.	Brooklyn, N.Y.	78488	Stackpole Carbon Co.	St. Marys, Pa.
37942	P.R. Mallory & Co. Inc.	Indianapolis, Ind.	72656	Indiana General Corp., Electronics Div.	Keasby, N.J.	78493	Standard Thomson Corp.	Waltham, Mass.
39543	Mechanical Industries Prod. Co.	Akron, Ohio	72699	General Instrument Corp., Cap. Div.	Newark, N.J.	78553	Tinnerman Products, Inc.	Cleveland, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.	72765	Drake Mfg. Co.	Harwood Heights, Ill.	78790	Transformer Engineers	San Gabriel, Calif.
42190	Muter Co.	Chicago, Ill.	72825	Hugh H. Eby Inc.	Philadelphia, Pa.	78947	Ucinite Co.	Newtonville, Mass.
43990	C.A. Norgren Co.	Englewood, Colo.	72928	Gudeman Co.	Chicago, Ill.	79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
44655	Ohmite Mfg. Co.	Skokie, Ill.	72962	Elastic Stop Nut Corp.	Union, N.J.	79142	Veeder Root, Inc.	Hartford, Conn.
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47904	Polaroid Corp.	Cambridge, Mass.	73061	Erie Technological Products, Inc.	Erie, Pa.	79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.	73076	Hansen Mfg. Co., Inc.	Princeton, Ind.	79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
49956	Microwave & Power Tube Div.	Waltham, Mass.	73138	H.M. Harper Co.	Chicago, Ill.	80031	Mecco Division of Sessions Clock Co.	Morristown, N.J.
52090	Rowan Controller Co.	Westminster, Md.	73293	Heliport Div. of Beckman Inst., Inc.	Fullerton, Calif.	80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
52983	Sanborn Company	Waltham, Mass.	73445	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.	80131	Electronic Industries Association. Any brand Tube meeting EIA Standards-Washington, DC.	
54294	Shallcross Mfg. Co.	Selma, N.C.	73506	Bradley Semiconductor Corp.	New Haven, Conn.	80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
55026	Simpson Electric Co.	Chicago, Ill.	73559	Carling Electric, Inc.	Hartford, Conn.	80223	United Transformer Corp.	New York, N.Y.
55933	Sonotone Corp.	Elmsford, N.Y.	73586	Circle F Mfg. Co.	Trenton, N.J.	80248	Oxford Electric Corp.	Chicago, Ill.
55938	Raytheon Co. Commercial Apparatus & Systems Div.	So. Norwalk, Conn.	73682	George K. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.	80294	Bourns Inc.	Riverside, Calif.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.	73734	Federal Screw Products Inc.	Chicago, Ill.	80411	Acro Div. of Robertshaw Controls Co.	Columbus, Ohio
56289	Sprague Electric Co.	North Adams, Mass.	73743	Fischer Special Mfg. Co.	Cincinnati, Ohio	80486	All Star Products Inc.	Defiance, Ohio
59446	Telex Corp.	Tulsa, Okla.	73793	General Industries Co., The	Elyria, Ohio	80509	Avery Label Co.	Monrovia, Calif.
59730	Thomas & Betts Co.	Elizabeth, N.J.	73846	Goshen Stamping & Tool Co.	Goshen, Ind.	80583	Hammarlund Co., Inc.	Mars Hill, N.C.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio	73899	JFD Electronics Corp.	Brooklyn, N.Y.	80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.	73905	Jennings Radio Mfg. Corp.	San Jose, Calif.	80813	Dimco Gray Co.	Dayton, Ohio
62119	Universal Electric Co.	Owosso, Mich.	73957	Groov-Pin Corp.	Ridgefield, N.J.	81030	International Instruments Inc.	Orange, Conn.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.	74276	Signalite Inc.	Neptune, N.J.	81073	Grayhill Co.	LaGrange, Ill.
64599	Western Electric Co., Inc.	New York, N.Y.	74455	J.H. Winns, and Sons	Winchester, Mass.	81095	Triad Transformer Corp.	Venice, Calif.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.	74861	Industrial Condenser Corp.	Chicago, Ill.			
66295	Witteck Mfg. Co.	Chicago, Ill.	74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.			
66346	Minnesota Mining & Mfg. Co. Revere	Minconv Div. St. Paul, Minn.						

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## SUPPLEMENTAL CODE LIST OF MANUFACTURERS

Code No.	Manufacturer	Address
01884	Dearborn Electronic Laboratories, Inc.	Chicago, Ill.
07115	Corning Glass Works	Bradford, Pa.
08988	Skottle Electronics Inc.	Peckville, Penn.
24446	General Electric Co.	Schenectady, N. Y.

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Tel: (602) 945-7601  
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Tel: (602) 298-2313  
TWX: 910-952-1162

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3939 Lankershim Boulevard  
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Tel: (213) 877-1282  
TWX: 910-499-2170

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TWX: 910-373-1280

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TWX: 710-468-3750

### DELAWARE

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TWX: 510-666-2214

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Miami Shores 33153  
Tel: (305) 754-4565  
TWX: 810-848-7262

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Tel: (305) 841-3970  
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TWX: 910-223-3613

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TWX: 710-828-9684

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Tel: (313) 353-9100  
TWX: 810-232-1532

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St. Paul 55114  
Tel: (612) 645-9461  
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Tel: (816) 333-2445  
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Tel: (314) 962-5000  
TWX: 910-760-1670

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TWX: 710-990-4951

1060 N. Kings Highway  
Cherry Hill 08034  
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TWX: 710-892-4945

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P.O. Box 8366  
Station C  
6501 Lomas Boulevard N.E.  
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TWX: 510-252-0890

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TWX: 510-248-0012

39 Saginaw Drive  
Rochester 14623  
Tel: (716) 473-9500  
TWX: 510-253-5981

1025 Northern Boulevard  
Roslyn, Long Island 11576  
Tel: (516) 869-8400  
TWX: 510-223-0811

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3460 South Dixie Drive  
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TWX: 910-464-6103

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King of Prussia Industrial Park  
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TWX: 510-660-2670

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St. James  
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TWX: 610-492-2382

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Cable: HEWPACKARG

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grupo 203  
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Santiago  
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Instrumentacion  
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Ltda.  
Carrera 7 # 48-59  
Apartado Aereo 6287  
Bogota, 1 D.E.  
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Cable: AARIS Bogota

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San José  
Tel: 21-86-13  
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### ECUADOR

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Quito  
Tel: 12496  
Cable: HORVATH Quito

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Cable: ELECTRONICA  
San Salvador

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Apartado 1226  
7a. Calle, 0-22, Zona 1  
Guatemala City  
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Cable: ROTERAN Managua

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Tel: 30833  
Cable: ELECTRON Panama City

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Miraflores  
Casilla 3061  
Lima  
Tel: 50346  
Cable: FEPERU Lima

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Pda. 3-Plta. de Tierra  
San Juan, P.R. 00906  
Tel: (174) 725-3342  
Cable: SATRONICS San Juan  
Telex: SATRON 3450 332

### URUGUAY

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Casilla de Correo 370  
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Tel: 40-3102  
Cable: RADIUM Montevideo

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Tel: 71.88.05  
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TWX: 910-373-1267  
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Cable: LABORINSTRUMENT  
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Telex: 75 762

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Hewlett-Packard Benelux S.A.  
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Brussels 16  
Tel: 72 22 40  
Cable: PALOBEN Brussels  
Telex: 23 494

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Telex: 66 40

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Gyldenintie 3  
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Cable: HEWPACKOY-Helsinki  
Telex: 12-1563

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Hewlett-Packard France  
Box No. 6  
Quartier de Courtabouef  
Boite Postale No. 6  
91 Orsay  
Tel: 920 88 01  
Cable: HEWPACK Paris  
Telex: 60048 HEWPACK ORSAY

Hewlett-Packard France  
4 Qua des Etroits  
69 Lyon 5e  
Tel: 42 63 45

### GERMANY

Hewlett-Packard Vertriebs-GmbH  
Lietzenburgerstrasse 30  
1 Berlin W 30  
Tel: 24 86 36  
Telex: 18 34 05

Hewlett-Packard Vertriebs-GmbH  
Herrenbergerstrasse 110  
703 Böblingen, Württemberg  
Tel: 07031-6971  
Cable: HEPAG Böblingen  
Telex: 72 65 739

Hewlett-Packard Vertriebs-GmbH  
Achenbachstrasse 15  
4 Düsseldorf 1  
Tel: 68 52 58/59  
Telex: 85 86 533

Hewlett-Packard Vertriebs-GmbH  
Kurfürstenstrasse 95  
6 Frankfurt 50  
Tel: 52 00 36  
Cable: HEWPACKSA Frankfurt  
Telex: 41 32 49

### Hewlett-Packard Vertriebs-GmbH

Beim Strohhause 26  
2 Hamburg 1  
Tel: 24 05 51/52  
Cable: HEWPACKSA Hamburg  
Telex: 21 53 32

### Hewlett-Packard Vertriebs-GmbH

Reginfriedstrasse 13  
8 München 90  
Tel: 0811 69 59 71/75  
Cable: HEWPACKSA Munich  
Telex: 52 49 85

### GREECE

Kostos Karayannis  
18, Ermou Street  
Athens 126  
Tel: 230 301  
Cable: RAKAR Athens  
Telex: 5962

### IRELAND

Hewlett-Packard Ltd.  
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Slough, Bucks, England  
Tel: Slough 753-33341  
Cable: HEWPIE Slough  
Telex: 84413

### ITALY

Hewlett-Packard Italiana S.p.A.  
Viale Lunigiana 46  
20125 Milan  
Tel: 69 15 84  
Cable: HEWPACKIT Milan  
Telex: 32046

### Hewlett-Packard Italiana S.p.A.

Palazzo Italia  
Piazza Marconi 25  
00144 Rome - Eur  
Tel: 591 2544  
Cable: HEWPACKIT Rome  
Telex: 61514

### NETHERLANDS

Hewlett-Packard Benelux, N.V.  
de Boelelaan 1043  
Amsterdam, Z II  
Tel: 42 77 77  
Cable: PALOBEN Amsterdam  
Telex: 13 216

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Hewlett-Packard Norge A/A  
Nesveien 13  
Haflum  
Tel: 53 83 60  
Cable: HEWPACK Oslo  
Telex: 6621

### PORTUGAL

Telectra  
Rua Rodrigo da Fonseca 103  
P.O. Box 2531  
Lisbon 1  
Tel: 68 60 72  
Cable: TELECTRA Lisbon  
Telex: 1598

### SPAIN

Ataio Ingenieros  
Urgel, 259  
Barcelona, 11  
Tel: 230-69-88  
Ataio Ingenieros  
Enrique Larreta 12  
Madrid, 16  
Tel: 235 43 44  
Cable: TELEATAIO Madrid  
Telex: 2 72 49

### SWEDEN

Hewlett-Packard (Sverige) AB  
Hagakergatan 7  
431 04 Mölndal 4  
Tel: 031 - 27 68 00

Hewlett-Packard (Sverige) AB  
Svetsarvägen 7  
S171 20 Solna 1  
Tel: (08) 98 12 50  
Cable: MEASUREMENTS  
Stockholm  
Telex: 10721

### SWITZERLAND

Hewlett Packard (Schweiz) AG  
Zurcherstrasse 20  
8952 Schlieren  
Zurich  
Tel: (051) 98 18 21/24  
Cable: HEWPACKAG Zurich  
Telex: 53933

### Hewlett Packard (Schweiz) A.G.

Rue du Bois-du-Lan 7  
1217 Meyrin-Geneva  
Tel: (022) 41 54 00  
Telex: 2 24 86

### TURKEY

Telekom Engineering Bureau  
P.O. Box 376 - Galata  
Istanbul  
Tel: 49 40 40  
Cable: TELEMATION Istanbul

### UNITED KINGDOM

Hewlett-Packard Ltd.  
224 Bath Road  
Slough, Bucks  
Tel: Slough 753-33341  
Cable: HEWPIE Slough  
Telex: 84413

### YUGOSLAVIA

Belram S.A.  
83 avenue des Mimosas  
Brussels 15, Belgium  
Tel: 34 33 32, 34 26 19  
Cable: BELRAMEL Brussels  
Telex: 21790

### FOR AREAS NOT LISTED, CONTACT:

Hewlett-Packard S.A.  
Rue du Bois-du-Lan 7  
1217 Meyrin-Geneva  
Tel: (022) 41 54 00  
Cable: HEWPACKSA Geneva  
Telex: 2.24.86

## AFRICA, ASIA, AUSTRALIA

### ANGOLA

Telectra Empresa Técnica  
de Equipamentos Eléctricos  
SAR  
Rua de Barbosa Rodrigues  
42-1º  
Box 6487  
Luanda  
Cable: TELECTRA Luanda

### AUSTRALIA

Hewlett-Packard Australia  
Pty. Ltd.  
22-26 Weir Street  
Glen Iris, 3146  
Victoria  
Tel: 20.1371 (4 lines)  
Cable: HEWPARD Melbourne  
Telex: 31024

### Hewlett-Packard Australia

Pty. Ltd.  
61 Alexander Street  
Crows Nest 2065  
New South Wales  
Tel: 43.7866  
Cable: HEWPARD Sydney

### Hewlett-Packard Australia

Pty. Ltd.  
97 Churchill Road  
Prospect 5082  
South Australia  
Tel: 65.2366  
Cable: HEWPARD Adelaide

### Hewlett Packard Australia

Pty. Ltd.  
2nd Floor, Suite 13  
Casablanca Buildings  
196 Adelaide Terrace  
Perth, W.A.

### CEYLON

United Electricals Ltd.  
P.O. Box 681  
Yahala Building  
Staples Street  
Colombo 2  
Tel: 5496  
Cable: HOTPOINT Colombo

### CYPRUS

Kypronics  
19-19D Hommer Avenue  
P.O. Box 752  
Nicosia  
Tel: 6282-75628  
Cable: HE-I-NAMI

### ETHIOPIA

African Salespower & Agency  
Private Ltd., Co.  
P. O. Box 718  
58/59 Cunningham St.  
Addis Ababa  
Tel: 12285  
Cable: ASACO Addisababa

### HONG KONG

Schmidt & Co. (Hong Kong) Ltd.  
P.O. Box 297  
1511, Prince's Building  
10, Chater Road  
Hong Kong  
Tel: 240168, 232735  
Cable: SCHMIDTCO Hong Kong

### INDIA

The Scientific Instrument  
Co., Ltd.  
6, Tej Bahadur Sapru Road  
Allahabad 1  
Tel: 2451  
Cable: SICO Allahbad

The Scientific Instrument  
Co., Ltd.  
240, Dr. Dadabhai Naoroji Road  
Bombay 1  
Tel: 26-2642  
Cable: SICO Bombay

### The Scientific Instrument

Co., Ltd.  
11, Esplanade East  
Calcutta 1  
Tel: 23-4129  
Cable: SICO Calcutta

### The Scientific Instrument Co., Ltd.

30, Mount Road  
Madras 2  
Tel: 86339  
Cable: SICO Madras

### The Scientific Instrument Co., Ltd.

B-7, Ajmeri Gate Extn.  
New Delhi 1  
Tel: 27-1053  
Cable: SICO New Delhi

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Dialah Merdeka 29  
Bandung

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Teheran  
Tel: 43850, 48111  
Cable: BASCOM Teheran

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Div. of Motorola Israel Ltd.  
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Tel-Aviv  
Tel: 35021 (4 lines)  
Cable: BASTEL Tel-Aviv  
Telex: Bastel Tv 033-569

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Yokogawa-Hewlett-Packard Ltd.  
Nisei Ibaragi Bldg.  
2-2-8 Kasuga  
Ibaragi-Shi  
Osaka  
Tel: 23-1641  
Yokogawa-Hewlett-Packard Ltd.  
Ito Building  
No. 59, Kotori-cho  
Nakamura-ku, Nagoya City  
Tel: 551-0215

### Yokogawa-Hewlett-Packard Ltd.

Ohashi Building  
59 Yoyogi 1-chrome  
Shibuya-ku, Tokyo  
Tel: 370-2281  
Telex: 232-2024YHP  
Cable: YHPMARKET TOK 23-724

### KENYA

R. J. Tilbury Ltd.  
P. O. Box 2754  
Suite 517/518  
Hotel Ambassador  
Nairobi  
Tel: 25670, 26803, 68206, 58196  
Cable: ARJAYTEE Nairobi

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American Trading Co., Korea, Ltd.  
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170 Sejong Ro  
Chongro Ku  
Seoul (4 lines)  
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### LEBANON

Constantin E. Macridis  
Clemenceau Street  
Clemenceau Center  
Beirut  
Tel: 220846  
Cable: ELECTRONUCLEAR Beirut

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MECOMB Malaysia Ltd.  
2 Lorong 13/6A  
Section 13  
Petaling Jaya, Selangor  
Cable: MECOMB Kuala Lumpur

### NEW ZEALAND

Hewlett-Packard (N.Z.) Ltd.  
32-34 Kent Terrace  
P.O. Box 9443  
Wellington, N.Z.  
Tel: 56-409  
Cable: HEWPACK Wellington

### PAKISTAN (EAST)

Mushko & Company, Ltd.  
31, Jinnah Avenue  
Dacca  
Tel: 80058  
Cable: NEWDEAL Dacca

### PAKISTAN (WEST)

Mushko & Company, Ltd.  
Oosman Chambers  
Victoria Road  
Karachi 3  
Tel: 51027, 52927  
Cable: COOPERATOR Karachi

### PHILIPPINES

Electromex Inc.  
2129 Pasong Tamo  
Makati, Rizal  
P.O. Box 3419  
Manila  
Cable: ELEMEX

### SINGAPORE

Mechanical and Combustion  
Engineering Company Ltd.  
9, Jalan Kilang  
Singapore, 3  
Tel: 642361-3  
Cable: MECOMB Singapore

### SOUTH AFRICA

Hewlett Packard South Africa  
(Pty.) Ltd.  
Hill House  
43 Somerset Rd.  
Cape Town  
Tel: 3-6019  
Cable: AUTOPHONE Cape Town  
Telex: 7038CT

### Hewlett Packard South Africa

(Pty.) Ltd.  
P.O. Box 31716  
30 De Beer Street  
Braamfontein, Johannesburg  
Tel: 724-4172 724-4195  
Telex: 0226 JH  
Cable: HEWPACK Johannesburg

### TAIWAN

Hwa Sheng Electronic Co., Ltd.  
P. O. Box 1558  
Room 404  
Chia Hsin Building  
No. 96 Chung Shan  
North Road, Sec. 2  
Taipei  
Tel: 555211  
Cable: VICTRONIX Taipei

### TANZANIA

R. J. Tilbury Ltd.  
P.O. Box 2754  
Suite 517/518  
Hotel Ambassador  
Nairobi  
Tel: 25670, 26803, 68206, 58196  
Cable: ARJAYTEE Nairobi

### THAILAND

The International  
Engineering Co., Ltd.  
P. O. Box 39  
614 Sukhumvit Road  
Bangkok  
Tel: 910722  
Cable: GYSOM Bangkok

### UGANDA

R. J. Tilbury Ltd.  
P.O. Box 2754  
Suite 517/518  
Hotel Ambassador  
Nairobi  
Tel: 25670, 26803, 68206, 58196  
Cable: ARJAYTEE Nairobi

### VIETNAM

Peninsular Trading Inc.  
P.O. Box H-3  
216 Hien-Vuong  
Saigon  
Tel: 20.805  
Cable: LANBROCOMP Saigon

### ZAMBIA

R. J. Tilbury (Zambia) Ltd.  
P.O. Box 2792  
Lusaka  
Zambia, Central Africa

### FOR AREAS NOT LISTED, CONTACT:

Hewlett-Packard Export  
Marketing  
3200 Hillview Ave.  
Palo Alto, California 94304  
Tel: (415) 326-7000  
TWX: 910-373-1267  
Cable: HEWPACK Palo Alto  
Telex: 034-8461

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# MANUAL BACKDATING CHANGES

MODEL 3410A

AC MICROVOLTMETER

Manual Serials Prefixed: 842-  
-hp- Part No. 03410-90002

This manual backdating sheet makes this manual applicable to earlier instruments. Instrument-component values that differ from those in the manual, yet are not listed in the backdating sheet, should be replaced using the part number given in the manual.

Instrument Serial Prefix	Make Manual Changes	Instrument Serial Prefix	Make Manual Changes
648-00124 and below*	1, 2, 3, 4, 5		
728-, 719-, 648	2, 3, 4, 5		
731-	3, 4, 5		
735-, 752	4, 5		

\* Except the following serial numbers:

648-00102	648-00113
648-00104	648-00116 - 00119
648-00107	648-00121 - 00123

**CHANGE #1****Figure 7-5**

Delete R5, and put straight wire in its place.  
Change A4R62 to 4.3 k $\Omega$ .  
Change A4R63 to 2 k $\Omega$ .  
Change A4R64 to 1 k $\Omega$ .

**Table 6-1**

Delete R5.  
Change A4R62 to 0683-4325, 4.3 k $\Omega$   $\pm$  1% 1/4 W.  
Change A4R63 to 0757-0283, 2 k $\Omega$   $\pm$  1% 1/8 W.  
Change A4R64 to 0757-0280, 1 k $\Omega$   $\pm$  1% 1/8 W.

**CHANGE #2****Figure 7-4**

Change A3R9 and A3R14 to 100 $\Omega$ .  
Change A3R11 and A3R12 to 22.1 k $\Omega$ .  
Change A3R16 to 7500 $\Omega$ .

**Table 6-1**

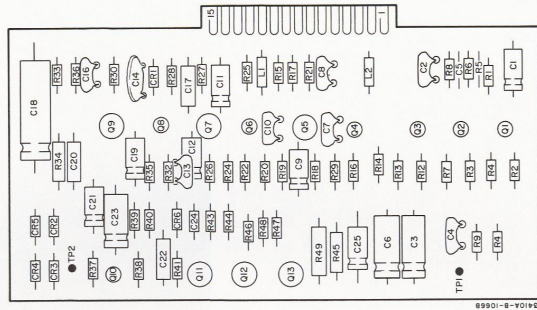
Change A3R9 and A3R14 to 0757-0401, 100 $\Omega$   $\pm$  1% 1/8 W.  
Change A3R11 and A3R12 to 0757-0450, 22.1 k $\Omega$   $\pm$  1% 1/8 W.  
Change A3R16 to 0757-0440, 7500 $\Omega$   $\pm$  1% met film 1/8 W.

————— NOTE —————

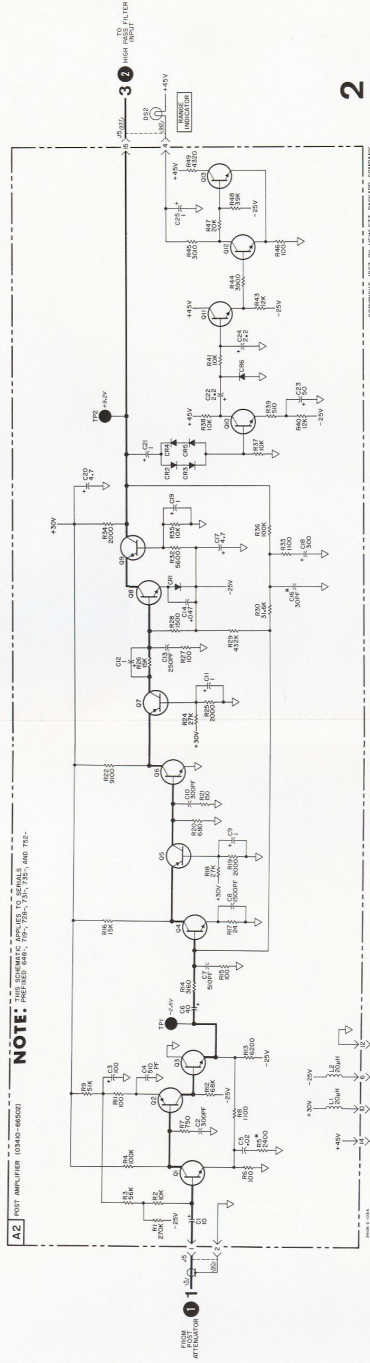
If any of the resistors are changed to the values shown in the manual, all five must be changed together.

**CHANGE #3****Figure 7-4**

Change the series combination of A3R4 and A3R40 to a single resistor A3R4, 0766-0013, 563 $\Omega$  3 W.



A2  
(hp Part No. 03410-66502)



UNLARGOED REFERENCE FABRICATIONS	
Q1	6X4
Q2	6X4
Q3	6X4
Q4	6X4
Q5	6X4
Q6	6X4
Q7	6X4
Q8	6X4
Q9	6X4
Q10	6X4

## Manual Backdating Changes Model 3410A Page 3

## CHANGE #4

Figure 7-4

Change A3CR2, A3CR15, A3CR17 to 4.32 V.

Table 6-1

Change A3CR2, A3CR15, A3CR17 to 1902-3073, 4.32 V.

Change A3Q3, A3Q18, A3Q19, A3Q23, A3Q26 to 1854-0094, 2N3646.

## NOTE

If any of these eight components are changed to values listed in the manual, all eight must be changed together.

## CHANGE #5

Figure 7-3, Page 7-7/7-8

This schematic diagram is not applicable. Use the backdating schematic.

Table 6-1

The A2 Assembly list is not applicable. Use the following Replaceable Parts List.

REFERENCE DESIGNATOR	-hp- PART NO.	T Q	DESCRIPTION	MFR.	MFR. PART NO.
A2	03410-66502	1	Assembly: Amplifier Board	-hp-	
A2C1	0180-0224		C: fxd Al elect 10 $\mu$ F +75% -10% 15 vdcw	56289	30D106G015BA4
A2C2	0160-2207	2	C: fxd mica 300 pF $\pm$ 5%	04062	RDM15F301J3C
A2C3	0180-0061	2	C: fxd Al elect 100 $\mu$ F +75% -10% 15 vdcw	56289	30D107G015DC2- DSM
A2C4	0160-0362	2	C: fxd mica 510 pF $\pm$ 5%	04062	RDM15F511J3C
A2C5			Not assigned		
A2C6	0180-0050	1	C: fxd Al elect 40 $\mu$ F +75% -10% 50 vdcw	56289	30D406G050DD2-DS
A2C7	0160-0362		C: fxd mica 510 pF $\pm$ 5%	04062	RDM15F511J3C
A2C8	0140-0156	1	C: fxd mica 1500 pF $\pm$ 2%	04062	RDM19F152G3C
A2C9	0180-0119	5	C: fxd Al elect 1.0 $\mu$ F +75% -10% 25 vdcw	56289	5C13C obd
A2C10	0160-2207		C: fxd mica 300 pF $\pm$ 5%	04062	RDM15F301J3C
A2C11, A2C12	0180-0119		C: fxd Al elect 1.0 $\mu$ F $\pm$ 20% 25 vdcw	56289	5C13C obd
A2C13	0160-2018	1	C: fxd mica 250 pF $\pm$ 5% 500 vdcw	04062	RDM15F251J5S
A2C14	0150-0052	1	C: fxd cer 0.05 $\mu$ F $\pm$ 20% 400 vdcw	56289	33C17A
A2C15			Not assigned		
A2C16	0140-0203	1	C: fxd mica 30 pF $\pm$ 5%	04062	RDM15E300J5C
A2C17	0180-0100	2	C: fxd Ta elect 4.7 $\mu$ F $\pm$ 10% 35 vdcw	56289	150D475X9035B2
A2C18	0180-0062		C: fxd Al elect 300 $\mu$ F +75% -10% 6 vdcw	56289	30D307G006DF2- DSM
A2C19	0180-0119		C: fxd Al elect 1.0 $\mu$ F $\pm$ 20% 25 vdcw	56289	5C13C
A2C20	0180-0100		C: fxd Ta elect 4.7 $\mu$ F $\pm$ 10% 35 vdcw	56289	150D475X9035B2
A2C21	0180-0119		C: fxd Al elect 1.0 $\mu$ F $\pm$ 20% 25 vdcw	56289	5C13C
A2C22	0180-1846	1	C: fxd Ta elect 2.2 $\mu$ F $\pm$ 10% 35 vdcw	56289	150D225X9035B2- DYS
A2C23	0180-0033	1	C: fxd Al elect 50 $\mu$ F +100% -10% 6 vdcw	56289	30D506G006CB2- DSM
A2C24	0180-0155	1	C: fxd Ta elect 2.2 $\mu$ F $\pm$ 20% 20 vdcw	56289	150D225X0020A2-DYS
A2C25	0180-0269		C: fxd Al elect 1 $\mu$ F +75% -10% 50 vdcw	56289	30D105G150BA2-DSM
A2CR1 thru A2CR6	1901-0025	6	Diode: Si 100 wiv 12 pF 100 mA	07263	FD 2387



REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A2L1, A2L2	9140-0047	1	Coil: RF 20 $\mu$ H 2.6 $\Omega$ 1/4"	99848	3100-15-101
A2Q1	1854-0215	4	TSTR: Si NPN 2N3904	04713	obd
A2Q2	1853-0036		TSTR: Si PNP 2N3906	04713	2N3906 -5
A2Q3, A2Q4	1854-0215		TSTR: Si NPN 2N3904	04713	obd
A2Q5	1853-0016	2	TSTR: Si PNP 2N3638	07263	2N3638
A2Q6	1854-0071	6	TSTR: Si NPN 2N3391	04713	MPS 3391
A2Q7	1853-0016		TSTR: Si PNP 2N3638	07263	2N3638
A2Q8	1854-0071		TSTR: Si NPN 2N3391	04713	MPS 3391
A2Q9	1854-0039	2	TSTR: Si NPN 2N3053	04713	2N3053 obd
A2Q10	1854-0215		TSTR: Si NPN 2N3904	04713	obd
A2Q11 thru A2Q13	1854-0022	11	TSTR: 2N2102	07263	S17843
A2R1	0683-2745	1	R: fxd prec met flm 270K $\pm$ 1% 1/4 W	19701	MF5C T-O obd
A2R2	0683-1035	5	R: fxd comp 10 K $\Omega$ $\pm$ 5% 1/4 W	01121	CB 1035
A2R3	0683-5635	1	R: fxd comp 56 K $\Omega$ $\pm$ 5% 1/4 W	01121	CB 5635
A2R4	0683-1045		R: fxd comp 100 K $\Omega$ $\pm$ 5% 1/4 W	01121	CB 2745
A2R5			Not assigned		
A2R6	0698-5438	1	R: fxd prec met flm 100 $\Omega$ $\pm$ 1/4% 1/8 W	75042	CEA T-2 obd
A2R7	0683-7515	1	R: fxd comp 750 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 7515
A2R8	0698-5444	2	R: fxd prec met flm 1100 $\Omega$ $\pm$ 1/4% 1/8 W	75042	CEA T-2 obd
A2R9	0683-5135	1	R: fxd comp 51K $\pm$ 5% 1/4 W	01121	CB 3035
A2R10			Not assigned		
A2R11	0683-1015	3	R: fxd comp 100 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 1015
A2R12	0683-6835	5	R: fxd comp 68K $\pm$ 5% 1/4 W	01121	CB 1525
A2R13	0683-6225	1	R: fxd comp 6200 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 6225
A2R14	0698-5440	1	R: fxd prec met flm 3160 $\Omega$ $\pm$ 1/4% 1/8 W	75042	CEA T-2 obd
A2R15	0683-1015		R: fxd comp 100 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 1015
A2R16	0683-1535		R: fxd comp 15 K $\Omega$ $\pm$ 5% 1/4 W	01121	CB 1535
A2R17	0683-2405		R: fxd comp 24 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 2405
A2R18	0683-2735	2	R: fxd comp 27 K $\Omega$ $\pm$ 5% 1/4 W	01121	CB 2735
A2R19	0683-2025	4	R: fxd comp 2000 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 2025
A2R20	0683-6815	1	R: fxd comp 680 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 6815
A2R21	0683-1515	1	R: fxd comp 150 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 1515
A2R22	0683-9125	1	R: fxd comp 9100 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 9125
A2R23			Not assigned		
A2R24	0683-2735		R: fxd comp 27K $\pm$ 5% 1/4 W	01121	CB 2735
A2R25	0683-2025		R: fxd comp 2000 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 2025
A2R26	0683-1535		R: fxd comp 15K $\Omega$ $\pm$ 5% 1/4 W	01121	CB 1535
A2R27	0683-1015		R: fxd comp 100 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 1015
A2R28	0683-1525	1	R: fxd comp 1500 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 1525
A2R29	0757-0480	1	R: fxd prec met flm 432 K $\Omega$ $\pm$ 1% 1/8 W	19701	MF5C T-O obd
A2R30	0698-5446	1	R: fxd prec met flm 31.6 K $\Omega$ $\pm$ 1/4% 1/8 W	75042	CEA T-2 obd
A2R31			Not assigned		
A2R32	0683-5625	1	R: fxd comp 5600 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 5625
A2R33	0698-5444		R: fxd prec met flm 1100 $\Omega$ $\pm$ 1/4% 1/8 W	75042	CEA T-2 obd
A2R34	0757-0739	1	R: fxd prec met flm 2000 $\Omega$ $\pm$ 1% 1/4 W	19701	MF5C T-O obd
A2R35	0683-1035		R: fxd comp 10 K $\Omega$ $\pm$ 5% 1/4 W	01121	CB 1035
A2R36	0698-3190	1	R: fxd prec met flm 100 K $\Omega$ $\pm$ 1/4% 1/8 W	75042	CEA T-2 obd
A2R37, A2R38	0683-1035		R: fxd comp 10 K $\Omega$ $\pm$ 5% 1/4 W	01121	CB 1035
A2R39	0683-5115		R: fxd comp 510 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 5115
A2R40	0683-1235		R: fxd comp 12K $\pm$ 5% 1/4 W	01121	CB 1235
A2R41	0683-1035		R: fxd comp 10 K $\Omega$ $\pm$ 5% 1/4 W	01121	CB 1035
A2R42			Not assigned		
A2R43	0683-1235	2	R: fxd comp 12K $\pm$ 5% 1/4 W	01121	CB 1235
A2R44	0683-3925	1	R: fxd comp 3900 $\Omega$ $\pm$ 5% 1/4 W	01121	CB 3925
A2R45	0757-0339	1	R: fxd prec met flm 3010 $\Omega$ $\pm$ 1% 1/4 W	19701	MF6C T-O obd
A2R46	0757-0401	1	R: fxd prec met flm 100 $\Omega$ $\pm$ 1% 1/8 W	75042	CEA T-O obd
A2R47	0683-2035	1	R: fxd comp 20 K $\Omega$ $\pm$ 5% 1/4 W	01121	CB 2035
A2R48	0683-3935	1	R: fxd comp 39 K $\Omega$ $\pm$ 5% 1/4 W	01121	CB 3935
A2R49	0757-0831		R: fxd prec met flm 4320 $\Omega$ $\pm$ 1% 1/2 W	01121	CB 0831

# hp MANUAL CHANGES

MODEL 3410A  
AC MICROVOLTMETER  
-hp- Part No. 03410-90002

## ► New or Revised Item

Instrument Serial Number	Make Manual Changes	Instrument Serial Number	Make Manual Changes
ERRATA	ALL		
953-00721 and above	#1		
953-00801 and above	#2		

## ERRATA

Page 2-1: In Paragraph 2-4 the Performance Checks should refer to Paragraph 5-5.  
Paragraph 2-6 should list power requirements as 50 to 400 Hz.

Page 5-6: Figure 5-4, change A3R16 to A3R15.  
Paragraph 5-30b, adjust A1R10 for  $7.5 \text{ V} \pm 5\text{V}$ .

Page 5-8: Paragraph 5-42c, line 2 should read A4TP4.

Page 5-8: Paragraph 5-45 should refer to A2C1\*, and A2C10\*.

Page 6-3: Change Mechanical Part No. 7 to -hp- Part No. 1500-0253.

Page 6-4: Change A1C15 to  $390 \mu\text{F}$  (0180-0294).  
Change A1R10 to Part No. 2100-2031.  
Change A2C1 to A2C1\*.

Page 6-5: Change A2C10 to A2C10\*.

Page 6-6: Change A3CR2, A3CR15, A3CR17 to 3.83 V Zener, (1902-3059).

Page 6-7: Change A3Q3, A3Q18, A3Q19, A3Q23, A3Q26, to 1854-0019 and delete 2N3646 from the description.

► Change A3Q4 to 1854-0475.

Add  $270 \Omega$  to description of A3R4.

Page 6-11: Change A4R65 Part No. to 0683-1535.

► Page 6-12: Change S5 to 3101-1234

Page 7-5: On the A1 Component Location Drawing, change CR3 near Q3 to read CR1.

Page 7-7: Change A1C4 value to 390.

Page 7-9: Change A3CR2, A3CR15, A3CR17, to 3.8 V.

CHANGE #1

Page 6-2: Change INDEX NO. 3 to 03410-00203.

Page 6-11: Change F1 to 2110-0202, 500 mA.  
Change J4 to 1251-2357.

Change A4R61 to 2100-2514.

Page 6-12: Change W1 to 8120-1348. Change S5 to Part No. 3101-1234.

CHANGE #2

Page 6-6: Change A3C17 to 0180-0387 C fxd 47  $\mu$ F

