# Errata

**Title & Document Type: 3410A AC Microvoltmeter Operating and Service Manual**

**Manual Part Number: 03410-90002**

**Revision Date: April 1969**

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## HP References in this Manual

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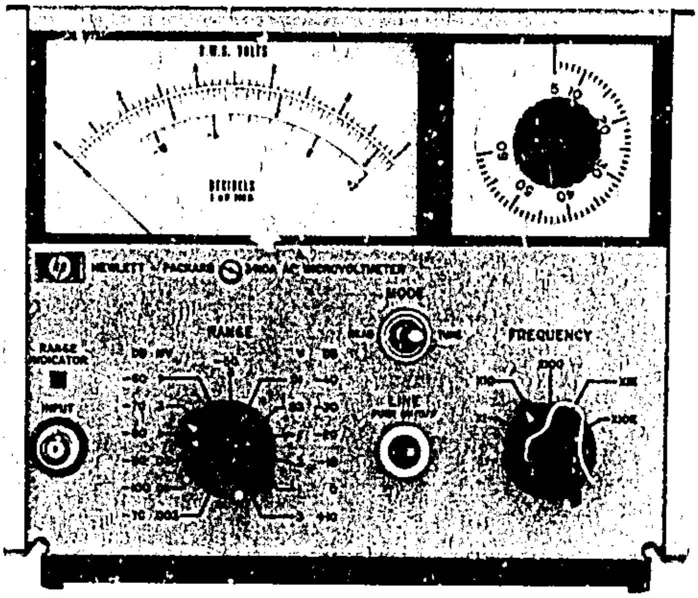
Agilent Technologies

HP 3410

OPERATING AND SERVICE MANUAL

# AC MICROVOLTMETER
## 3410A

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HP 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

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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-.


P.O. Box 301, Loveland, Colorado, 80537, U.S.A.

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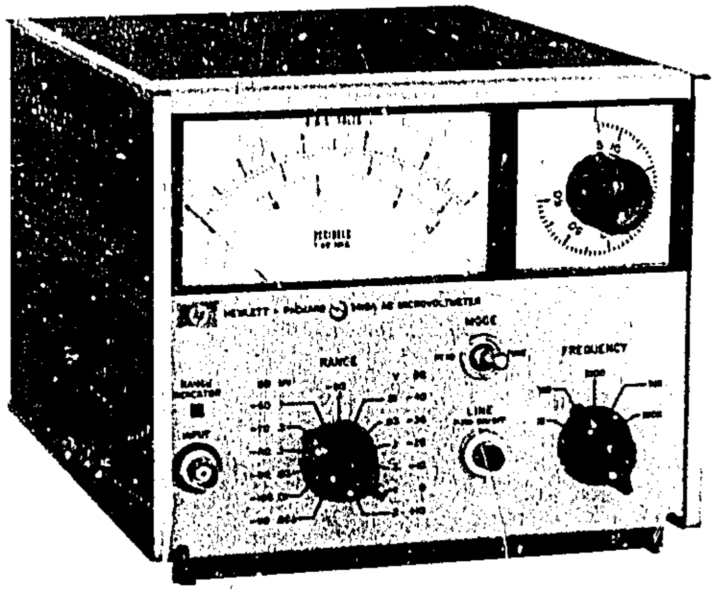



Figure 1-1. Model 3410A AC Microvoltmeter

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 | 10Hz–25Hz | 25Hz–100Hz | 100Hz–50kHz | 50kHz–600kHz |
|---|---|---|---|---|---|
| 30$\mu$V to 3V | ±10% | ±3% | | | ±5% |
| 10$\mu$V | ±15%* | ±10%* | ±3% | | ±5% |
| 3$\mu$V | | ±20%* | ±10% | ±3% | ±10% |

FREQUENCY DIAL ACCURACY: ±10% full scale (unlocked).

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

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

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

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 600Ω).

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

RECORDER OUTPUT: +1 V into 1000Ω for full scale deflection. ±0.5 V adjustable offset level.

AC POWER: 115 or 230 V ±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 kΩ 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 mars 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. <u>BENCH MOUNTING.</u>

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

2-14. <u>RACK MOUNTING.</u>

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. <u>COMBINATION MOUNTING.</u>

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.

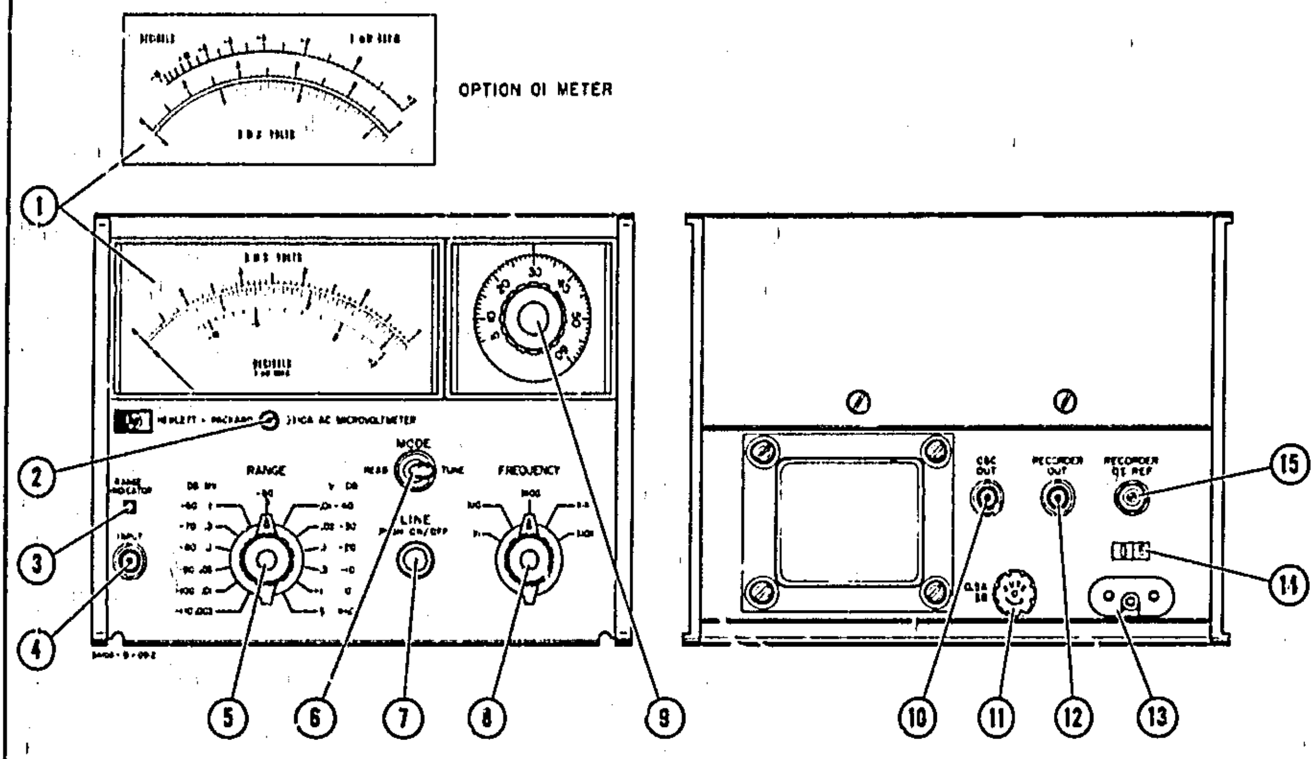
2-21. If original container is not to be used, proceed as follows:

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 ±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.

CAUTION

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.

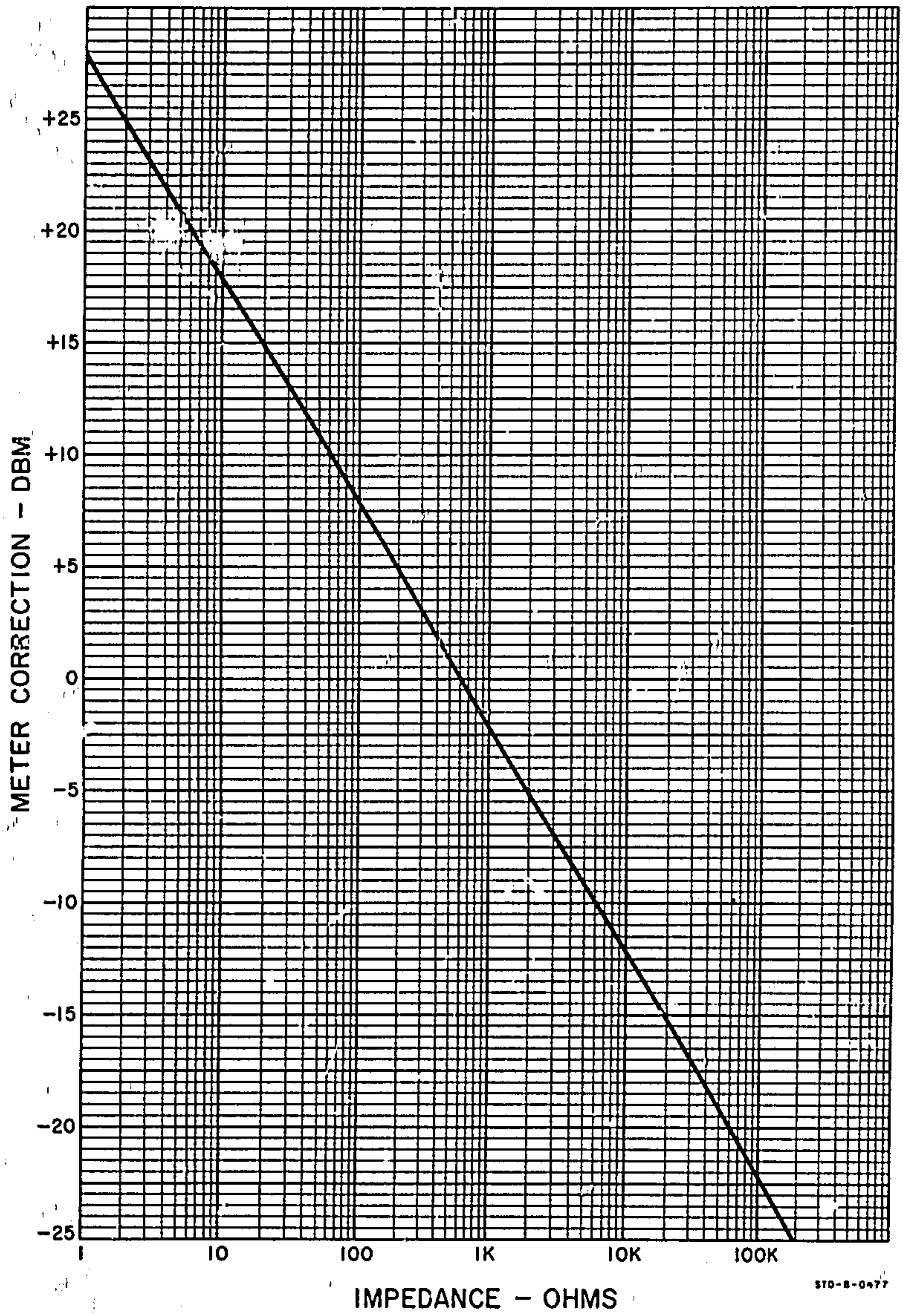



Figure 3-2. Impedance Correction Graph

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.

**CAUTION**

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

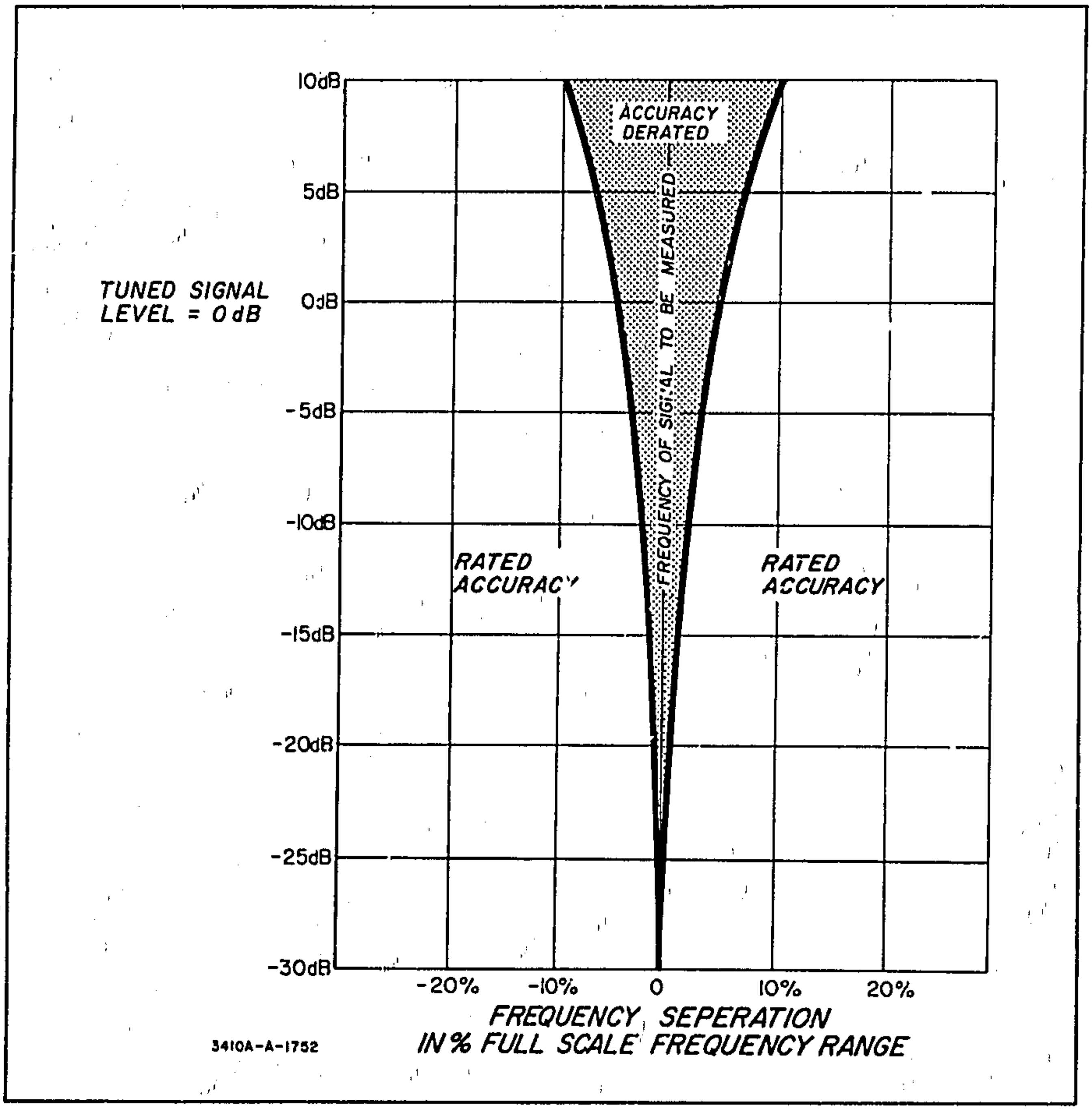



Figure 3-3. Effect of Close Interfering Signals

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 derating 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° out of phase with the tuned signal cause the greatest error in reading. An interfering signal 90° 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.

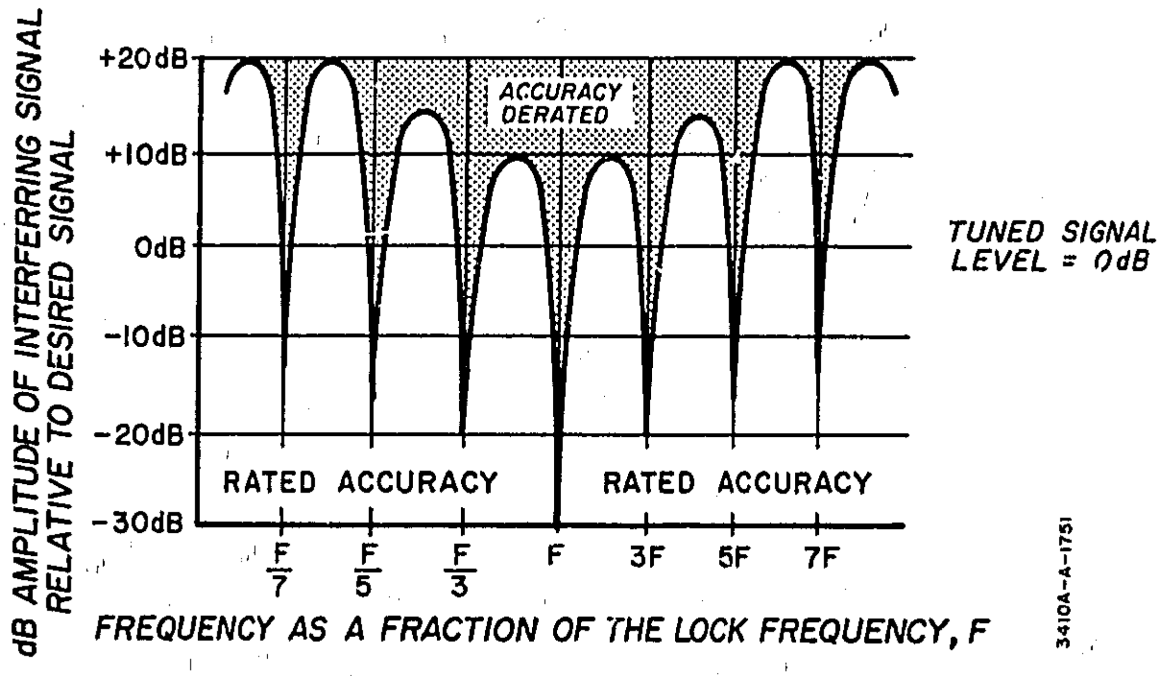



Figure 3-4. Effect of Odd Harmonics and Submultiples

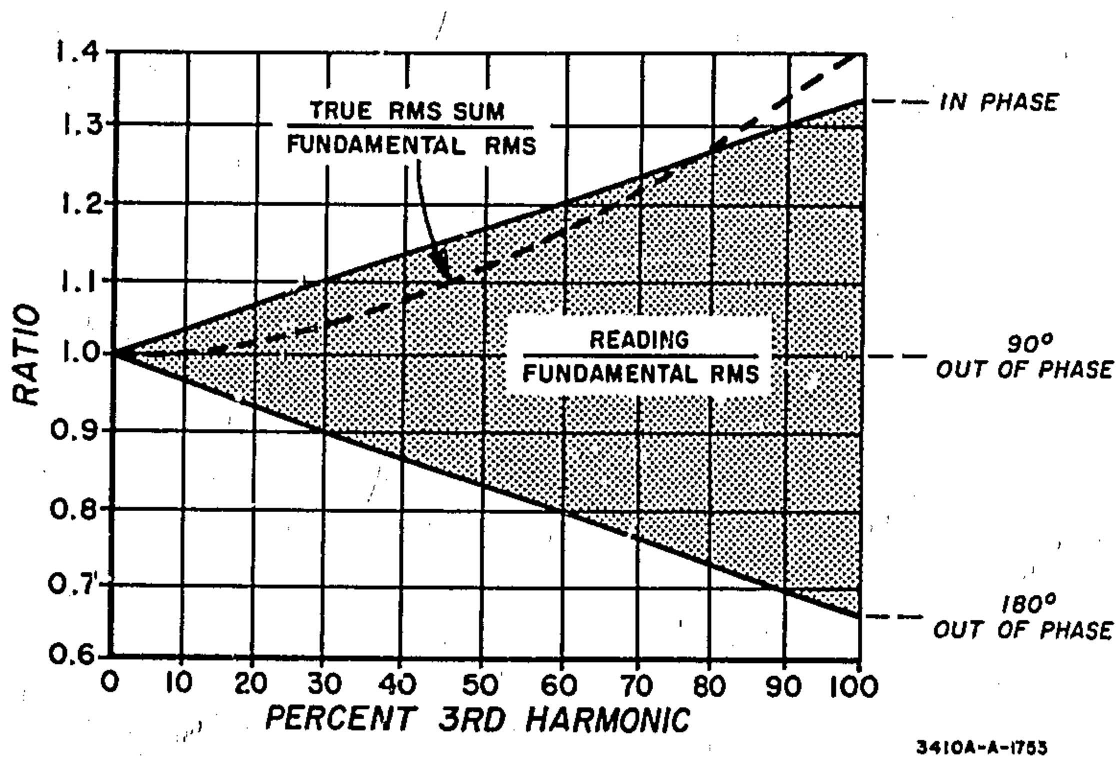



Figure 3-5. Effect of Third Harmonic

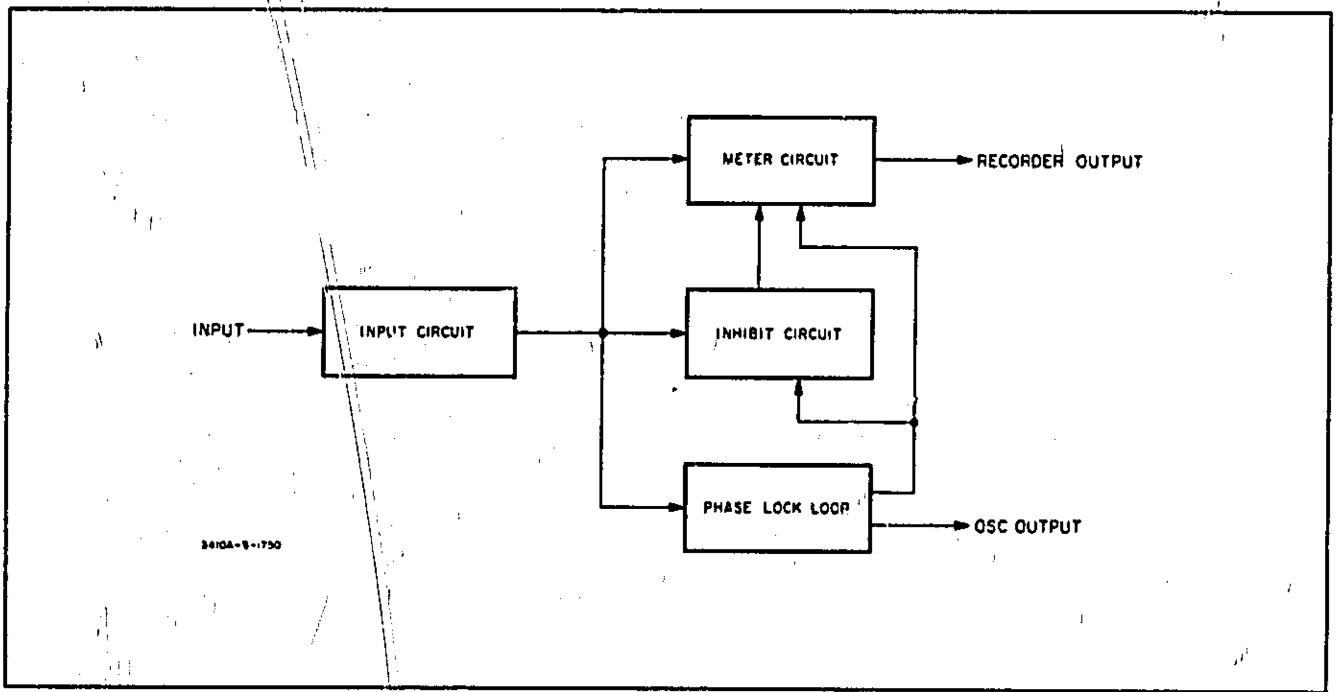



Figure 4-1. Simplified Block Diagram

# 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 furnishe 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 µV 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

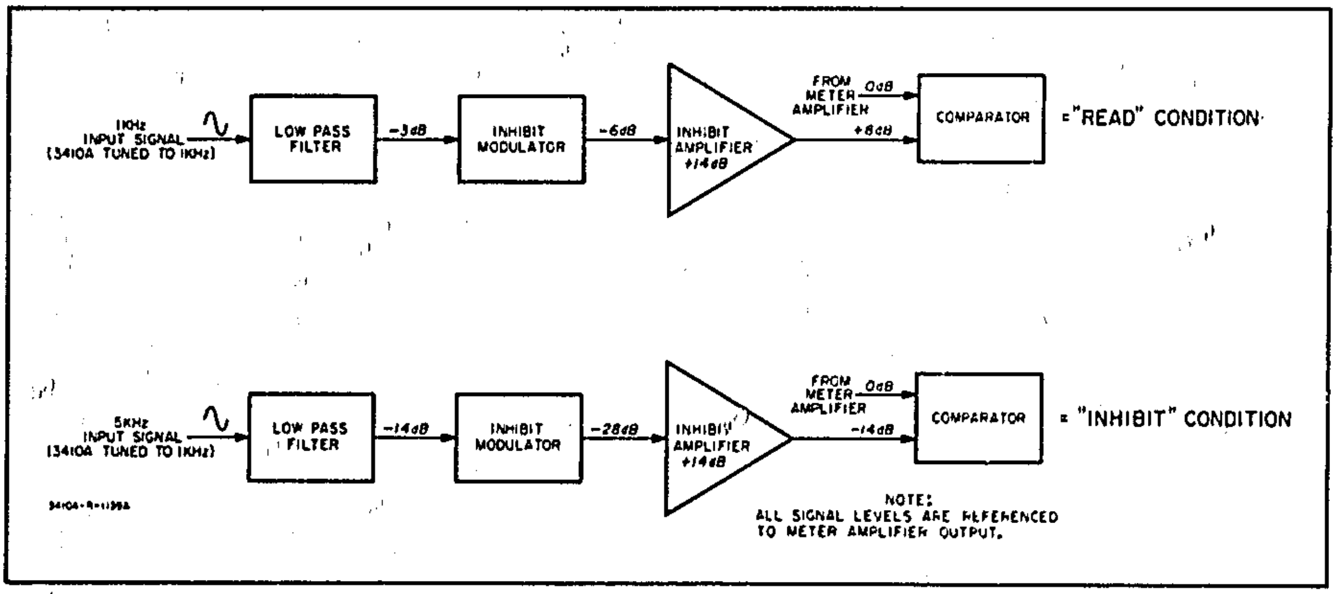



Figure 4-2. Inhibit Circuit Operation

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. <u>PHASE LOCK LOOP.</u>

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 flip flops 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.

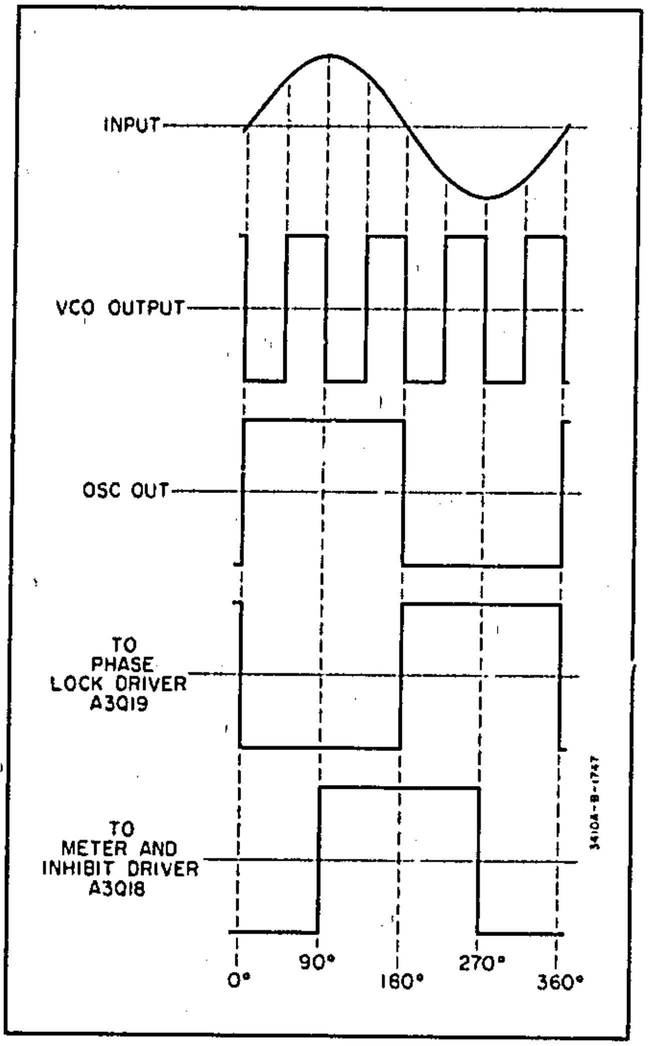



Figure 4-3. Local Oscillator Waveforms

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.

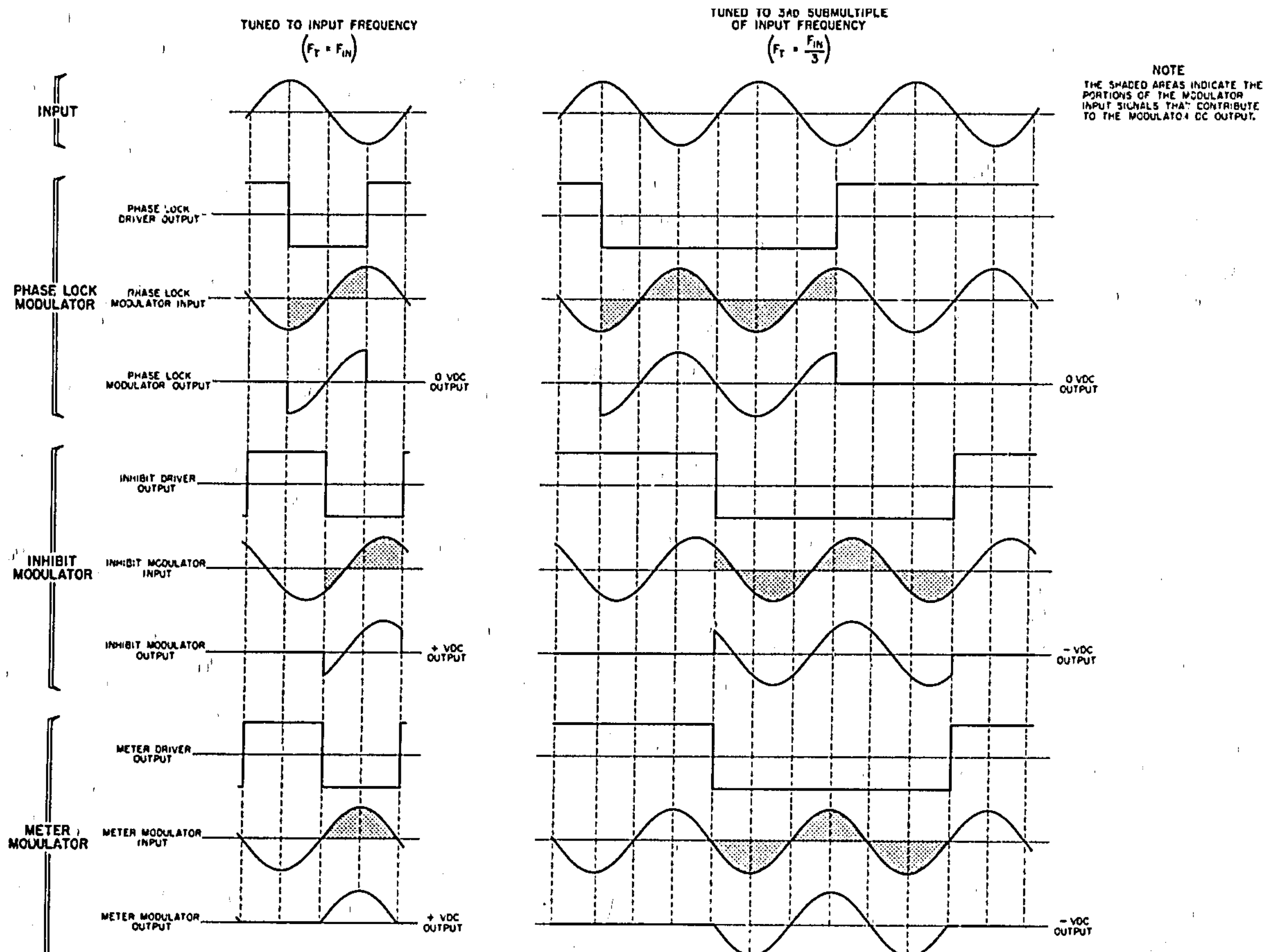



Figure 4-4. Modulator Waveforms

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° in phase, and attenuates it by 3 dB. The filtered signal is then applied through a buffer amplifier, A3 Q21 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° 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° 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 A4R2[illegible] 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° 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 ± 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<br>Accuracy: ±2 counts | -hp- Model 5532A Electronic Counter |
| AC Voltmeter Calibrator | Voltage Range: 3 mV to 3 V<br>Accuracy: ± 0.2% at 400 Hz | -hp- Model 738BR Voltmeter Calibrator |
| Test Oscillator | Voltage Range: 3 mV to 3 V<br>Frequency Range: 10 Hz to 600 kHz<br>Flatness: ±0.25% | -hp- Model 652A Test Oscillator |
| Attenuator | Attenuation Range: 0dB to 60 dB<br>Frequency Range: 10 Hz to 600 kHz | -hp- Model 355D Attenuator Set |
| Function Generator | Voltage Range (sine wave): 1 V<br>Frequency Range: 45 kHz to 55 kHz<br><br>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<br>Voltage Range: DC - 100 mV to 100 V<br>AC - 10 mV to 100 V<br>Accuracy (AC and DC): ±2% full scale | -hp- Model 427A Voltmeter |
| Oscilloscope | Bandwidth: 5 Hz to 600 kHz<br>Sensitivity: 5 mV/cm | -hp- Model 140A Oscilloscope with 1405A plug in |
| Terminating Resistance | Feedthrough: 50 Ω ± 1% | -hp- Model 11048B Feedthrough Termination |
| Resistor | Fxd: 200 KΩ ± 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

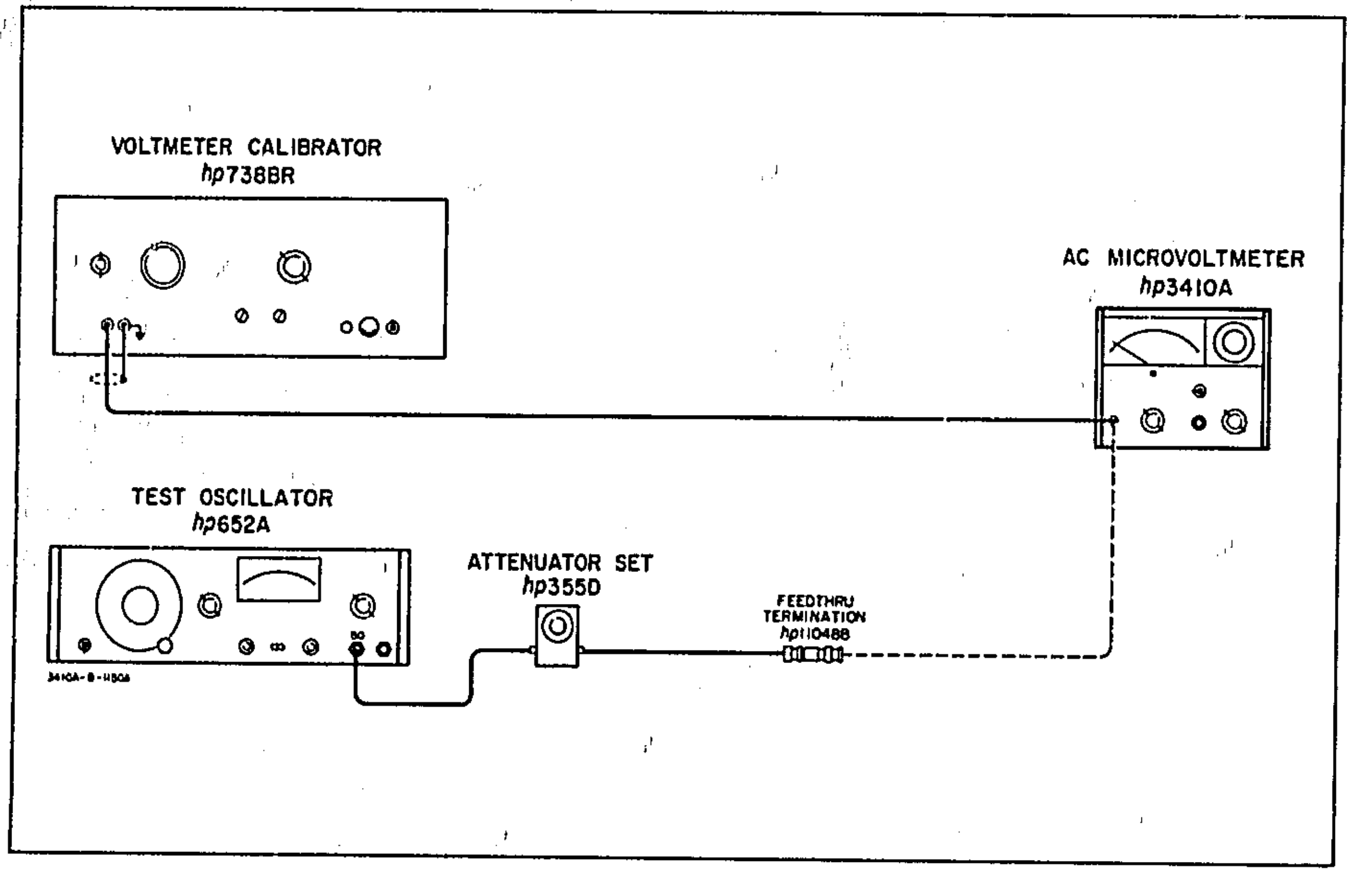



Figure 5-1. Accuracy and Frequency Response Check

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.

5-1[illegible]. 3 MV RANGE.

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

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.

Table 5-2. Meter Tolerances

| 3V RANGE | | | 3 MV | | | .003 MV | | |
|---|---|---|---|---|---|---|---|---|
| FREQ. (Hz) | METER INDICATION MIN. | MAX. | FREQ. (Hz) | METER INDICATION MIN. | MAX. | FREQ. (Hz) | METER INDICATION 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.[illegible]5 | 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 50Ω 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 50Ω output of the test oscillator to the counter. (Connect a 50Ω 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 ± 6 kHz.

i. Set the FREQUENCY dial to 50. The counter should read 50 kHz ± 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 0.6% 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 ± 5% of full scale frequency at a rate of 0.6% of full scale per second.

5-17. INPUT IMPEDANCE CHECK.

5-18. This check requires the following test equipment: Test Oscillator (-hp- Model 652A), 50Ω Feed-through Termination (-hp- Model 11048B), 200 kΩ ± 1% Resistor (-hp- Part No. 0757-0782).

5-19. RESISTANCE CHECK.

a. Connect the 50Ω output of the test oscillator to 3410A using a 50Ω feedthrough termination.

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 kΩ 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 MΩ.

5-20. CAPACITANCE CHECK.

a. Connect the test oscillator (terminated in 50Ω) and a 200 kΩ 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 50Ω termination should be as close as possible to the 200 kΩ resistor.

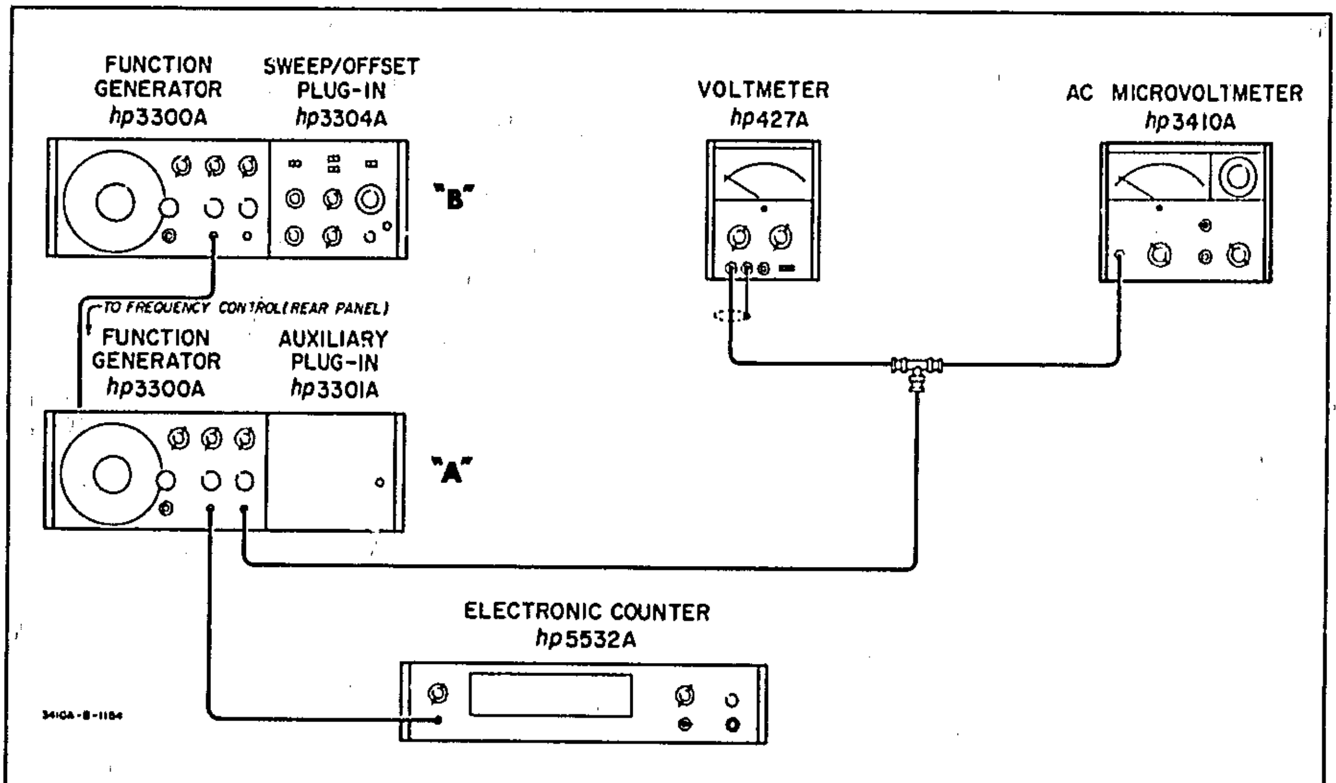



Figure 5-2. Tracking Check

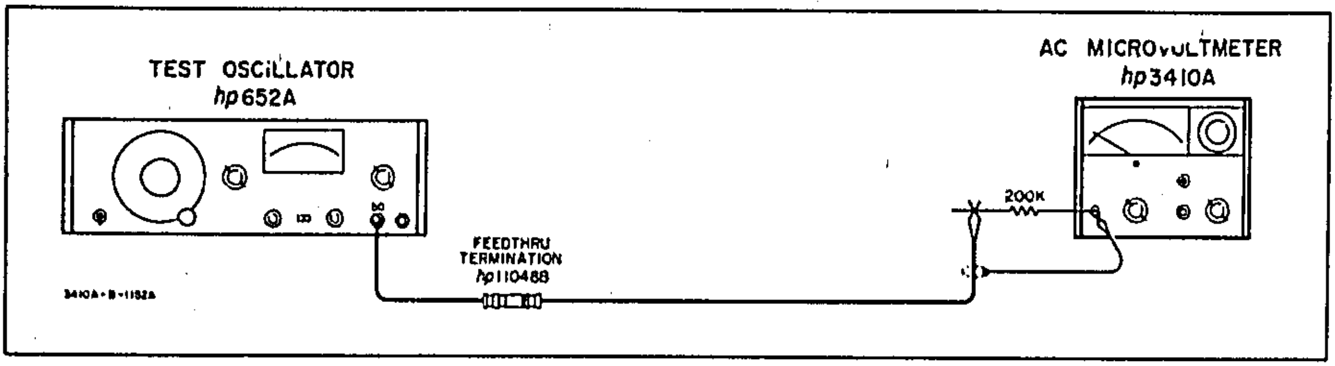



Figure 5-3. Input Impedance Check

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.

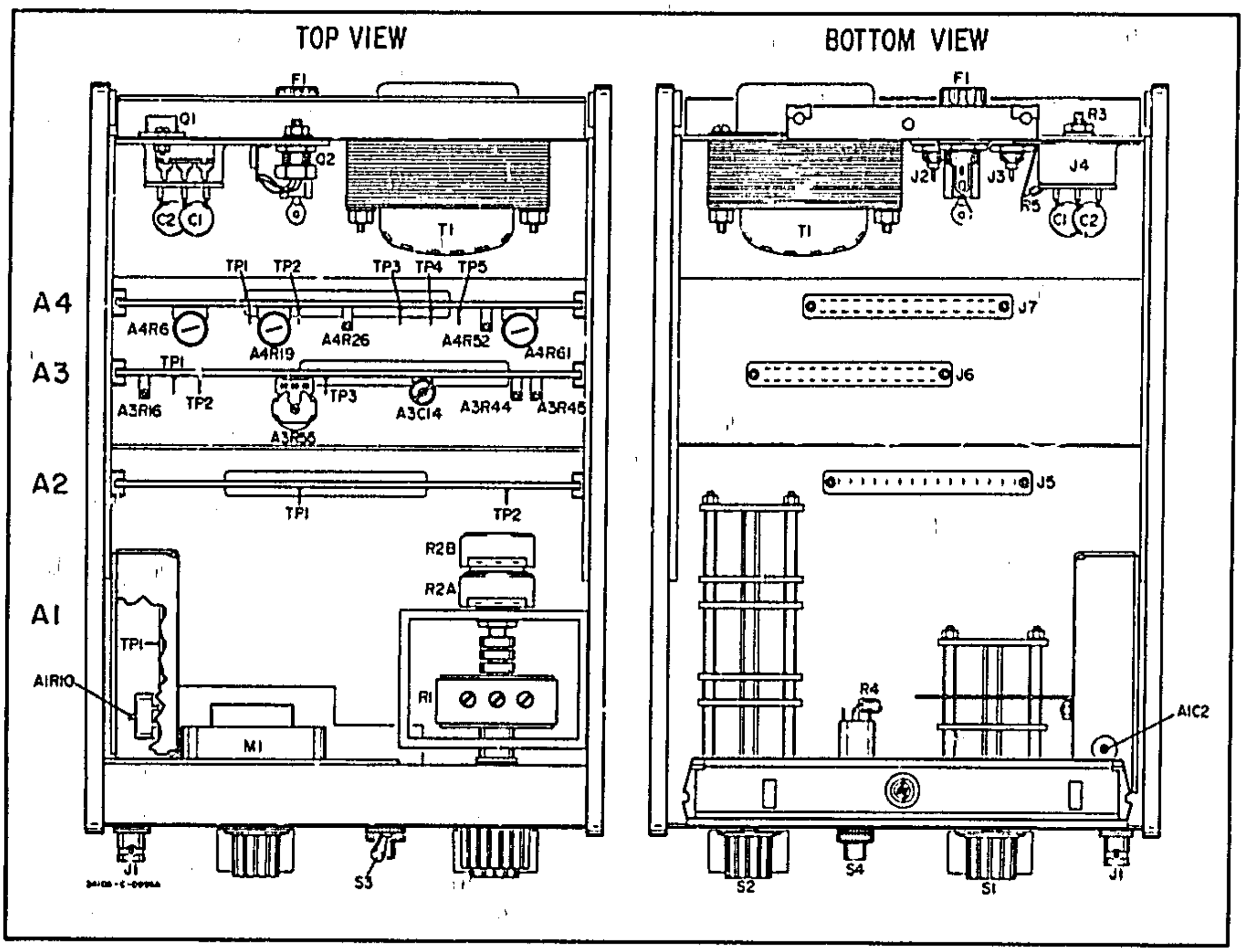



Figure 5-4. Adjustment and Chassis Mounted Components Location

e. Adjust A4R19 for a dc voltmeter indication of -24.8V ± 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 ± 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 ± 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 ± 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 kHz ± 180 Hz.

d. Set the 3410A FREQUENCY dial to 5.

e. Adjust A3R45 for an electronic counter indication of 500 Hz ± 50 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 kHz ± 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. <u>600 kHz METER ZERO.</u>

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. <u>POST AMPLIFIER RESPONSE.</u>

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. <u>PREATTENUATOR FLATNESS ADJUSTMENT.</u>

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.

INITIAL CONDITIONS:

MODE Switch . . . . . . . . . . . TUNE
FREQ Dial . . . . . . . . . . . . 40
FREQUENCY . . . . . . . . . . . X10
VOLTAGE RANGE . . . . . . . 1V
Input Signal . . . . . . . 1V rms, 400 Hz

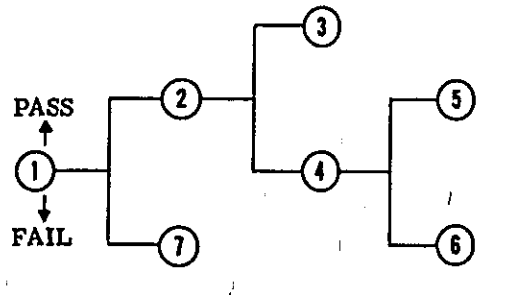



Figure 5-5. Front Panel Troubleshooting

## 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 6K and 6.2K.

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

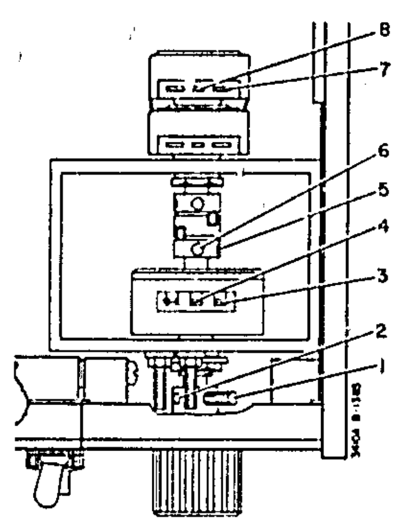



Figure 5-6. R1 and R2 Replacement

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 6 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.

CAUTION

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, nonmetallic 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 ____________

| 1. ACCURACY AND FREQUENCY RESPONSE: | METER INDICATION: | Min. | Max. |
|---|---|---|---|
| **3V Range** | | | |
| 10 Hz | ☐ | 2.20 | 2.80 |
| 60 Hz | ☐ | 2.91 | 3.09 |
| 400 Hz | ☐ | 2.91 | 3.09 |
| 1 kHz | ☐ | 2.91 | 3.09 |
| 10 kHz | ☐ | 2.91 | 3.09 |
| 100 kHz | ☐ | 2.85 | 3.15 |
| 600 kHz | ☐ | 2.85 | 3.15 |
| **3 mV Range** | | | |
| 10 Hz | ☐ | 2.20 | 2.80 |
| 60 Hz | ☐ | 2.91 | 3.09 |
| 400 Hz | ☐ | 2.91 | 3.09 |
| 1 kHz | ☐ | 2.91 | 3.09 |
| 10 kHz | ☐ | 2.91 | 3.09 |
| 100 kHz | ☐ | 2.85 | 3.15 |
| 600 kHz | ☐ | 2.85 | 3.15 |
| **.003 mV Range** | | | |
| 25 Hz | ☐ | 1.90 | 3.10 |
| 100 Hz | ☐ | 2.20 | 2.80 |
| 400 Hz | ☐ | 2.91 | 3.09 |
| 1 kHz | ☐ | 2.91 | 3.09 |
| 50 kHz | ☐ | 2.91 | 3.09 |
| 100 kHz | ☐ | 2.20 | 2.80 |
| 600 kHz | ☐ | 2.20 | 2.80 |

| 2. PHASE LOCK RANGE: | |
|---|---|
| Pull in | ☐ 1% full scale |
| Tracking | ☐ 5% full scale at 0.5% |
| | ☐ full scale per second |

| 3. INPUT IMPEDANCE: | |
|---|---|
| Resistance | ☐ 10 MΩ or greater |
| Capacitance | ☐ 20 pF or less, .003 mV to 3 mV |
| | ☐ 10 pF or less, 10 mV to 3 V |

# SECTION VI
# REPLACEABLE PARTS

## 6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alphameric 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.

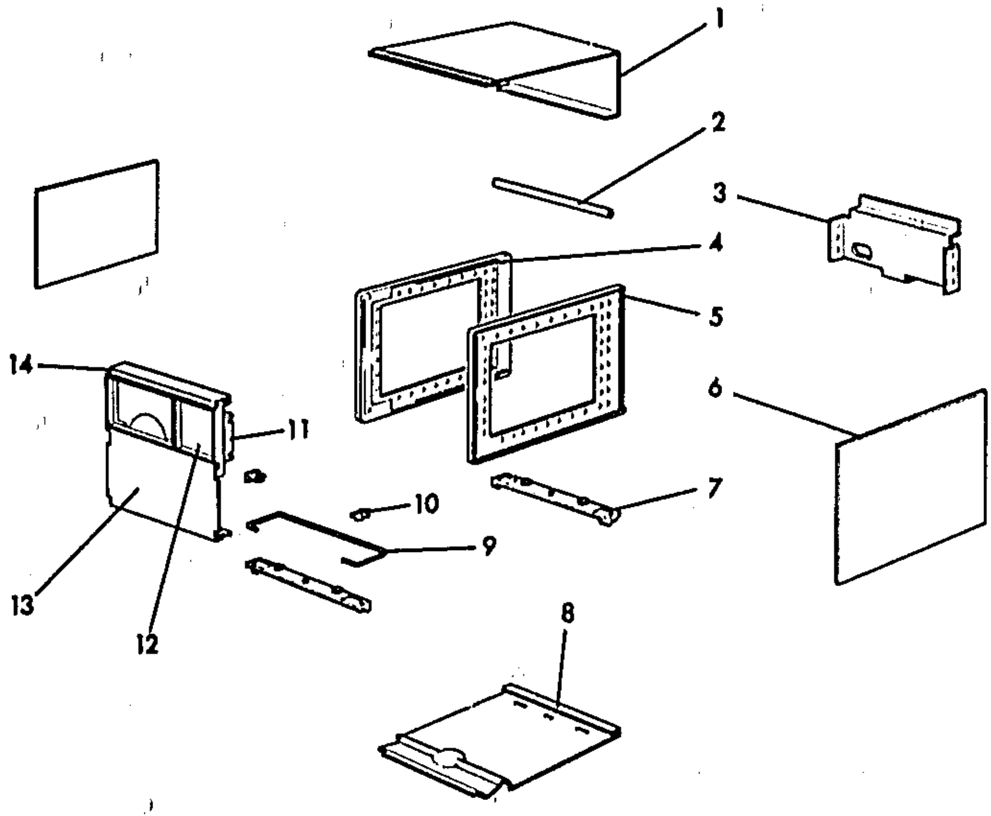
### DESIGNATORS

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

### ABBREVIATIONS

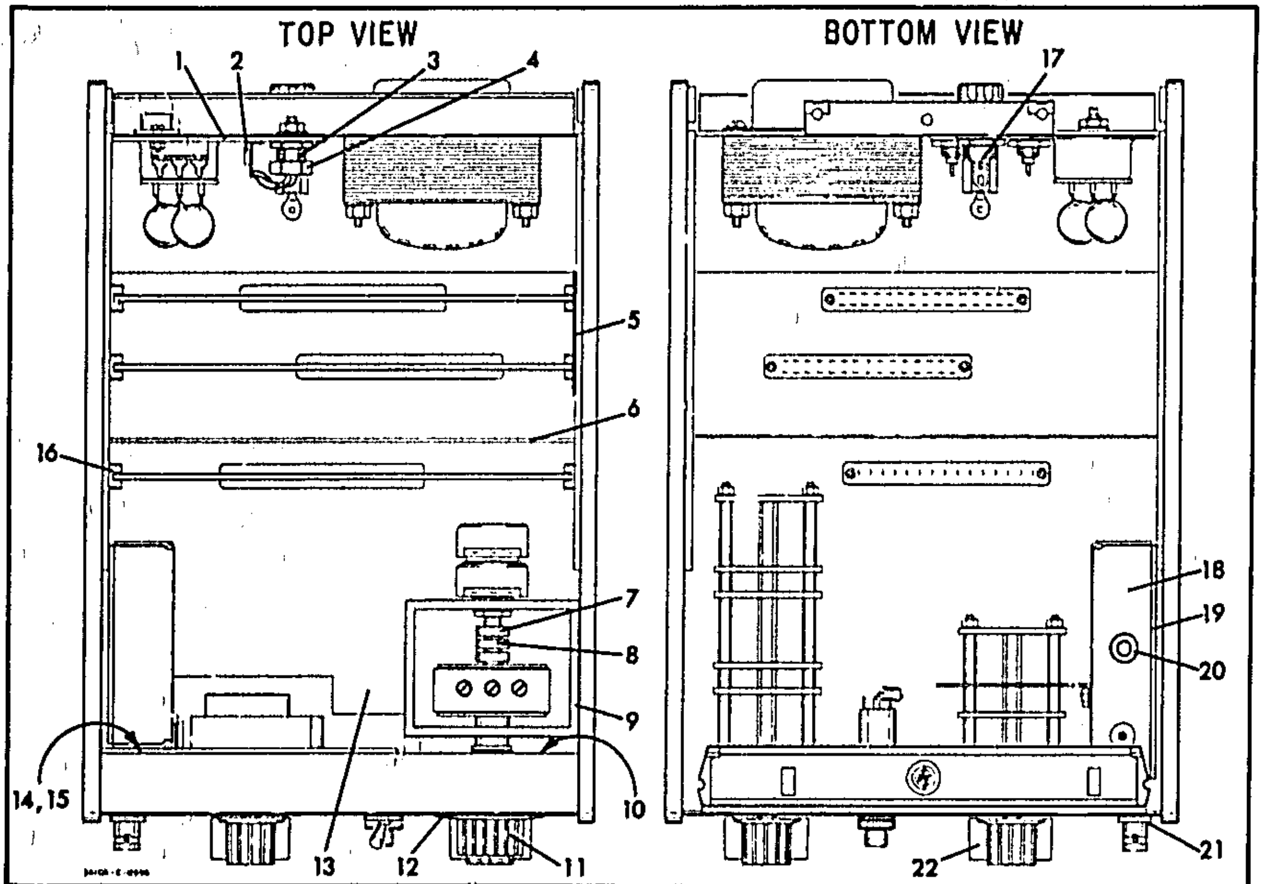
| | |
|---|---|
| Ag | = silver |
| Al | = aluminum |
| A | = ampere (s) |
| Au | = gold |
| C | = capacitor |
| cer | = ceramic |
| coef | = coefficient |
| com | = common |
| comp | = composition |
| conn | = connection |
| dep | = deposited |
| DPDT | = double-pole double-throw |
| DPST | = double-pole single-throw |
| elect | = electrolytic |
| encap | = encapsulated |
| F | = farad (s) |
| FET | = field effect transistor |
| fxd | = fixed |
| GaAs | = gallium arsenide |
| GHz | = gigahertz = $10^{+9}$ hertz |
| gd | = guard (ed) |
| Ge | = germanium |
| grd | = ground (ed) |
| H | = henry (ies) |
| Hg | = mercury |
| Hz | = hertz (cycle (s) per second) |
| ID | = inside diameter |
| impg | = impregnated |
| incd | = incandescent |
| ins | = insulation (ed) |
| kΩ | = kilohm (s) = $10^{+3}$ ohms |
| kHz | = kilohertz = $10^{+3}$ hertz |
| L | = inductor |
| lin | = linear taper |
| log | = logarithmic taper |
| m | = milli = $10^{-3}$ |
| mA | = milliampere (s) = $10^{-3}$ amperes |
| MHz | = megahertz = $10^{+6}$ hertz |
| MΩ | = megohm (s) = $10^{+6}$ ohms |
| met flm | = metal film |
| mfr | = manufacturer |
| mtg | = mounting |
| mV | = millivolt (s) = $10^{-3}$ volts |
| μ | = micro = $10^{-6}$ |
| μV | = microvolt (s) = $10^{-6}$ volts |
| my | = Mylar ® |
| nA | = nanoampere (s) = $10^{-9}$ amperes |
| NC | = normally closed |
| Ne | = neon |
| NO | = normally open |
| NPO | = negative positive zero (zero temperature coefficient) |
| ns | = nanosecond (s) = $10^{-9}$ seconds |
| nsr | = not separately replaceable |
| Ω | = ohm (s) |
| obd | = order by description |
| OD | = outside diameter |
| p | = peak |
| pc | = printed circuit |
| pF | = picofarad (s) = $10^{-12}$ farads |
| piv | = peak inverse voltage |
| p/o | = part of |
| pos | = position (s) |
| poly | = polystyrene |
| pot | = potentiometer |
| p-p | = peak-to-peak |
| ppm | = parts per million |
| prec | = precision (temperature coefficient, long term stability, and/or tolerance) |
| R | = resistor |
| Rh | = rhodium |
| rms | = root-mean-square |
| rot | = rotary |
| Se | = selenium |
| sect | = section (s) |
| Si | = silicon |
| sl | = slide |
| SPDT | = single-pole double-throw |
| SPST | = single-pole single-throw |
| Ta | = tantalum |
| TC | = temperature coefficient |
| $TiO_2$ | = titanium dioxide |
| tog | = toggle |
| tol | = tolerance |
| trim | = trimmer |
| TSTR | = transistor |
| V | = volt (s) |
| vacw | = alternating current working voltage |
| var | = variable |
| vdcw | = direct current working voltage |
| W | = watt (s) |
| w/ | = with |
| wiv | = working inverse voltage |
| w/o | = without |
| ww | = wirewound |
| * | = optimum value selected at factory, average value shown (part may be omitted) |
| ** | = no standard type number assigned (selected or special type) |

® Dupont de Nemours




| 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:<br>C1 thru C15 L1 thru L2<br>CR1 thru CR4 Q1 thru Q3<br>K1 thru K2 R1 thru R21 | -hp- | |
| A1C1 | 0150-0096 | | 1 | C: fxd cer 0.05 µF +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 ±2% | 04062 | RDM19F102G3C |
| A1C4 | 0140-0156 | | 1 | C: fxd mica 1500 pF ±2% | 04062 | RDM19F152G3C |
| A1C5, A1C6 | 0150-0093 | | 4 | C: fxd cer 0.01 µF +80% -20% 100 vdcw | 91418 | TA obd |
| A1C7 | 0160-0170 | | 1 | C: fxd cer 22 µF +80% -20% 25 vdcw | 56289 | 5C9BS-CML obd |
| A1C8 | 0180-0224 | | 2 | C: fxd Al elect 10 µF +75% -10% 15 vdcw | 56289 | D32441 |
| A1C9 | 0180-0354 | | 4 | C: fxd Ta elect 40 µF ±5% 10 vdcw | 56289 | 150D406X5010B2 |
| A1C10, A1C11 | 0140-0198 | | 2 | C: fxd mica 200 pF ±5% | 04062 | RDM15F201J3C |
| A1C12 | 0180-0224 | | | C: fxd Al elect 10 µF +75% -10% 15 vdcw | 56289 | 30D106G015BA4 |
| A1C13, A1C14 | 0180-0100 | | 9 | C: fxd Ta elect 4.7 µF ±10% 35 vdcw | 56289 | 150D475X9035B2 |
| A1C15 | 0180-0060 | | 1 | C: fxd Al elect 200 µF +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 µH ±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 MΩ ±1/4% 1/2 W | 56289 | 420E T-2 obd |
| A1R2 | 0698-5441 | | 1 | R: fxd prec met flm 10.01 kΩ ±1/4% 1/8 W | 75042 | CEA T-2 obd |
| A1R3 | 0683-0625 | | 1 | R: fxd comp 6.2 Ω ±5% 1/4 W | 01121 | CB 6225 |
| A1R4 thru A1R6 | 0683-3015 | | 3 | R: fxd comp 300 Ω ±5% 1/4 W | 01121 | CB 3015 |
| A1R7, A1R8 | 0683-1635 | | 2 | R: fxd comp 16 kΩ ±5% 1/4 W | 01121 | CB 1635 |
| A1R9 | 0683-2745 | | 2 | R: fxd comp 270 kΩ ±5% 1/4 W | 01121 | CB 2745 |
| A1R10 | 2100-0094 | | 1 | R: var comp lin 50 kΩ ±30% | 71450 | URM70RE (hp) |
| A1R11 | 0683-2045 | | 1 | R: fxd comp 200 kΩ ±5% 1/4 W | 01121 | CB 2045 |
| A1R12 | 0683-2265 | | 1 | R: fxd comp 22 MΩ ±5% 1/4 W | 01121 | CB 2265 |
| A1R13 | 0683-1535 | | 4 | R: fxd comp 15 kΩ ±5% 1/4 W | 01121 | CB 1535 |
| A1R14 | 0683-4725 | | 2 | R: fxd comp 4700 Ω ±5% 1/4 W | 01121 | CB 4725 |
| A1R15 | 0698-5438 | | 1 | R: fxd prec met flm 100 Ω ±1/4% 1/8 W | 75042 | CEA T-2 obd |
| A1R16 | 0698-5439 | | 1 | R: fxd prec met flm 1000 Ω ±1/4% 1/8 W | 75042 | CEA T-2 obd |
| A1R17 | 0683-3915 | | 1 | R: fxd comp 390 Ω ±5% 1/4 W | 01121 | CB 3915 |
| A1R18 | 0683-5635 | | 2 | R: fxd comp 56 kΩ ±5% 1/4 W | 01121 | CB 5635 |
| A1R19 | 0683-4735 | | 1 | R: fxd comp 47 kΩ ±5% 1/4 W | 01121 | CB 4735 |
| A1R20 | 0683-7505 | | 1 | R: fxd comp 75 Ω ±5% 1/4 W | 01121 | CB 7505 |
| A1R21 | 0683-5625 | | 1 | R: fxd comp 5600 Ω ±5% 1/4 W | 01121 | CB 5625 |
| A2 | 03410-66512 | | 1 | Assembly: Pc Board, includes:<br>C1 thru C15 Q1 thru Q14<br>CR1 thru CR7 R1 thru R34<br>L1 thru L4 | -hp- | |
| A2C1 | 0160-0938 | | 3 | C: fxd mica 1000 pF ±5% | 72136 | obd |
| A2C2, A2C3 | 0180-0100 | | | C: fxd Ta elect 4.7 µF ±10% 35 vdcw | 56289 | 150D475X9035B2 |
| A2C4 | 0180-0294 | | 1 | C: fxd Ta elect 390 µF ±20% 10 vdcw | 56289 | 109D397X0010T2 |
| A2C5 | 0180-0100 | | | C: fxd Ta elect 4.7 µF ±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 | | | C: fxd mica 1000 pF ±5% | 72136 | obd |
| A2C7 | 0160-0362 | | 2 | C: fxd mica 510 pF ±5% | 04062 | RDM15F511J3C |
| A2C8 | 0160-0938 | | | C: fxd mica 1000 pF ±5% | 72136 | obd |
| A2C9 | 0180-0091 | | 1 | C: fxd Al elect 10 μF +50% -10% 100 vdcw | 56289 | 30D106F100DC2-DSM |
| A2C10 | 0150-0031 | | 1 | C: fxd $TiO_2$ 2.0 pF ±5% 500 vdcw | 78488 | obd |
| A2C11 | 0180-0119 | | 1 | C: fxd Al elect 1.0 μF +75% -10% 25 vdcw | 56289 | 5C13C obd |
| A2C12 | 0180-1846 | | 1 | C: fxd Ta elect 2.2 μF ±10% 35 vdcw | 56289 | 150D225X9035B2-DYS |
| A2C13 | 0180-0033 | | 1 | C: fxd Al elect 50 μF +100% -10% 6 vdcw | 56289 | 30D506G006CB2-DSM |
| A2C14 | 0180-0155 | | 1 | C: fxd Ta elect 2.2 μF ±20% 20 vdcw | 56289 | 150D225X0020A2-DYS |
| A2C15 | 0180-0269 | | 1 | C: fxd Al elect 1 μF +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 μH ±5% | 82142 | 10178-8 |
| A2L4 | 9140-0179 | | 1 | Inductor: 22 μH ±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 | | | TSTR: Si NPN 2N3904 | 04713 | obd |
| A2Q5 | 1854-0092 | | 1 | TSTR: Si NPN 2N3563 | 04713 | MPS3653 |
| A2Q6 | 1854-0039 | | 4 | 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 | | | TSTR: Si PNP 2N2904A | 04713 | 2N2904A |
| A2Q11 thru A2Q13 | 1854-0022 | | 11 | TSTR: ** | -hp- | |
| A2Q14 | 1854-0215 | | | TSTR: Si NPN 2N3904 | 04713 | obd |
| A2R1 | 0683-7515 | | 2 | R: fxd comp 750 Ω ±5% 1/4 W | 01121 | CB 7515 |
| A2R2 | 0683-3905 | | 2 | R: fxd comp 39 Ω ±5% 1/4 W | 01121 | CB 3905 |
| A2R3 | 0683-3035 | | 1 | R: fxd comp 30 kΩ ±5% 1/4 W | 01121 | CB 3035 |
| A2R4 | 0683-1235 | | 3 | R: fxd comp 12 kΩ ±5% 1/4 W | 01121 | CB 1235 |
| A2R5 | 0757-0410 | | 2 | R: fxd met flm 301 Ω ±1% | 91637 | MFF 1/8 T-1 obd |
| A2R6 | 0757-0454 | | 2 | R: fxd met flm 33.2 kΩ ±1% 1/8 W | 75042 | CEA T-0 obd |
| A2R7 | 0683-7525 | | 1 | R: fxd comp 7500 Ω ±5% 1/4 W | 01121 | CB 7525 |
| A2R8 | 0757-0410 | | | R: fxd met flm 301 Ω ±1% | 91637 | MFF 1/8 T-1 obd |
| A2R9 | 0683-5635 | | | R: fxd comp 56 kΩ ±5% 1/4 W | 01121 | CB 5635 |
| A2R10 | 0683-1035 | | 9 | R: fxd comp 10 kΩ ±5% 1/4 W | 01121 | CB 1035 |
| A2R11 | 0683-2235 | | 3 | R: fxd comp 22 kΩ ±5% 1/4 W | 01121 | CB 2235 |
| A2R12 | 0683-1015 | | 2 | R: fxd comp 100 Ω ±5% 1/4 W | 01121 | CB 1015 |
| A2R13 | 0683-2025 | | 3 | R: fxd comp 2000 Ω ±5% 1/4 W | 01121 | CB 2025 |
| A2R14 | 0683-7515 | | | R: fxd comp 750 Ω ±5% 1/4 W | 01121 | CB 7515 |
| A2R15 | 0683-4705 | | 3 | R: fxd comp 47 Ω ±5% 1/4 W | 01121 | CB 4705 |
| A2R16 | 0683-5125 | | 3 | R: fxd comp 5100 Ω ±5% 1/4 W | 01121 | CB 5125 |
| A2R17 | 0683-1015 | | | R: fxd comp 100 Ω ±5% 1/4 W | 01121 | CB 1015 |
| A2R18 | 0683-3935 | | 2 | R: fxd comp 39 kΩ ±5% 1/4 W | 01121 | CB 3935 |
| A2R19 | 0683-1035 | | | R: fxd comp 10 kΩ ±5% 1/4 W | 01121 | CB 1035 |
| A2R20, A2R21 | 0683-4705 | | | R: fxd comp 47 Ω ±5% 1/4 W | 01121 | CB 4705 |
| A2R22 | 0757-0454 | | | R: fxd met flm 33.2 kΩ ±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 | 0683-1035 | | | R: fxd comp 10 kΩ ±5% 1/4 W | 01121 | CB 1035 |
| A2R25 | 0683-5115 | | 4 | R: fxd comp 510 Ω ±5% 1/4 W | 01121 | CB 5115 |
| A2R26 | 0683-1235 | | | R: fxd comp 12 kΩ ±5% 1/4 W | 01121 | CB 1235 |
| A2R27 | 0683-1035 | | | R: fxd comp 10 kΩ ±5% 1/4 W | 01121 | CB 1035 |
| A2R28 | 0683-1235 | | | R: fxd comp 12 kΩ ±5% 1/4 W | 01121 | CB 1235 |
| A2R29 | 0683-3925 | | 9 | R: fxd comp 3900 Ω ±5% 1/4 W | 01121 | CB 3925 |
| A2R30 | 0757-0401 | | 4 | R: fxd prec met flm 100 Ω ±1% 1/8 W | 75042 | CEA T-0 obd |
| A2R31 | 0757-0339 | | 1 | R: fxd prec met flm 3010 Ω ±1% 1/4 W | 19701 | MF6C T-0 obd |
| A2R32 | 0683-2035 | | 1 | R: fxd comp 20 kΩ ±5% 1/4 W | 01121 | CB 2035 |
| A2R33 | 0683-3935 | | | R: fxd comp 39 kΩ ±5% 1/4 W | 01121 | CB 3935 |
| A2R34 | 0757-0831 | | 1 | R: fxd prec met flm 4320 Ω ±1% 1/2 W | 01121 | CB 0831 |
| A3 | 03410-66503 | | 1 | Assembly: Phase Lock Board, includes:<br>C1 thru C22 Q1 thru Q26<br>CR1 thru CR18 R1 thru R67<br>IC1 thru IC2 | -hp- | |
| A3C1, A3C2 | 0150-0084 | | 2 | C: fxd cer 0.1 µF +80% -20% 50 vdcw | 56289 | 33C41 obd |
| A3C3 | 0180-0137 | | 3 | C: fxd Ta elect 100 µF ±20% 10 vdcw | 56289 | 150D107X0010R2 |
| A3C4 | 0160-2201 | | 2 | C: fxd mica 51 pF ±5% | 04062 | RDM15E510J3C |
| A3C5 | | | | Not assigned | | |
| A3C6 | 0180-0100 | | | C: fxd Ta elect 4.7 µF ±10% 35 vdcw | 56289 | 150D475X9035B2-DYS |
| A3C7 | 0160-0362 | | | C: fxd mica 510 pF ±5% | 04062 | RDM15F511J3C |
| A3C8 | 0140-0145 | | 2 | C: fxd mica 22 pF ±5% | 04062 | RDM15C220J5C |
| A3C9, A3C10 | 0150-0050 | | 5 | C: fxd cer 1000 pF 600 vdcw | 18486 | Type E obd |
| A3C11 | 0180-0309 | | 1 | C: fxd Ta elect 4.7 µF ±20% 10 vdcw | 56289 | 150D475X0010A2-DYS |
| A3C12 | 0160-2201 | | | C: fxd mica 51 pF ±5% | 04062 | DDM15E510J3C |
| A3C13 | 0180-0100 | | | C: fxd Ta elect 4.7 µF ±10% 35 vdcw | 56289 | 150D475X9035B2-DYS |
| A3C14 | 0121-0105 | | 1 | C: var cer 9-35 pF N650 | 72982 | 538-006 E2PO 94R |
| A3C15 | | | | Not assigned | | |
| A3C16 | 0140-0145 | | | C: fxd mica 22 pF ±5% | 04062 | RDM15C220J5C |
| A3C17 | 0180-0354 | | | C: fxd Ta elect 40 µF ±5% 10 vdcw | 56289 | 150D406X5010B2 |
| A3C18 | 0180-0387 | | | C: fxd Ta elect 47 µF ±5% 20 vdcw | 56289 | 150D476X5020B2 |
| A3C19 | 0140-0192 | | 1 | C: fxd mica 68 pF ± 5% | 72136 | obd |
| A3C20 | 0180-0387 | | | C: fxd Ta elect 47 µF ±5% 20 vdcw | 56289 | 150D476X5020B2 |
| A3C21, A3C22 | 0180-0137 | | | C: fxd Ta elect 100 µF ±20% 10 vdcw | 56289 | 150D107X0010R2 |
| A3CR1 | 1902-3104 | | 1 | Diode: Si breakdown 5.62 V ±5% 400 mW | 04713 | SZ10939-110 |
| A3CR2 | 1902-3073 | | 3 | Diode: Si breakdown 4.32 V ±5% | 04713 | SZ10939-77 |
| A3CR3 | 1901-0040 | | 9 | Diode: Si 30 wiv 30 mA 2 pF 2 ns | 07263 | FDG 1088 |
| A3CR4, A3CR5 | 1902-0048 | | 11 | Diode: breakdown 6.81 V ±5% 400 mW | 04713 | SZ10939-134 |
| A3CR6 | | | | Not assigned | | |
| A3CR7 thru A3CR9 | 1901-0040 | | | Diode: Si 30 wiv 30 mA 2 pF 2 ns | 07263 | FDG 1088 |
| A3CR10 | 1902-0049 | | 2 | Diode: breakdown 6.19 V ±5% 400 mW | 04713 | SZ10939-122 |
| A3CR11 | 1901-0040 | | | Diode: Si 30 wiv 30 mA 2 pF 2 ns | 07263 | FDG 1088 |
| A3CR12 | | | | Not assigned | | |
| A3CR13, A3CR14 | 1901-0040 | | | Diode: Si 30 wiv 30 mA 2 pF 2 ns | 07263 | FDG 1088 |
| A3CR15 | 1902-3073 | | | Diode: Si breakdown 4.32 V ±5% | 04713 | SZ10939-77 |
| A3CR16 | 1901-0040 | | | Diode: Si 30 wiv 30 mA 2 pF 2 ns | 03877 | SG 5050 |
| A3CR17 | 1902-3073 | | | Diode: Si breakdown 4.32 V ±5% | 04713 | SZ10939-77 |
| A3CR18 | 1901-0040 | | | Diode: Si 30 wiv 30 mA 2 pF 2 ns | 03877 | 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-1146 |
| 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 Ω ±5% 1/4 W | 01121 | CB 5115 |
| A3R2 | 0683-2425 | | 2 | R: fxd comp 2400 Ω ±5% 1/4 W | 01121 | CB 2425 |
| A3R3 | 0683-5135 | | 4 | R: fxd comp 51 kΩ ±5% 1/4 W | 01121 | CB 5135 |
| A3R4 | 0698-3629 | | 1 | R: fxd met oxide ± 200 PPM/C 2 W | 07115 | LPI-3 |
| A3R5 | 0683-2425 | | | R: fxd comp 2400 Ω ±5% 1/4 W | 01121 | CB 2425 |
| A3R6 | 0683-3925 | | | R: fxd comp 3900 Ω ±5% 1/4 W | 01121 | CB 3925 |
| A3R7, A3R8 | 0698-4435 | | 6 | R: fxd prec met flm 2490 Ω ±1% 1/8 W | 75042 | CEA T-0 obd |
| A3R9 | 0698-4391 | | 2 | R: fxd prec met flm 69.8Ω ±1% 1/8 W | 75042 | CEA T-0 obd |
| A3R10 | 0757-0469 | | 6 | R: fxd prec met flm 150 kΩ ±1% 1/8 W | 75042 | CEA T-0 obd |
| A3R11, A3R12 | 0698-4481 | | 2 | R: fxd prec met flm 16.5 kΩ ±1% 1/8 W | 75042 | CEA T-0 obd |
| A3R13 | 0757-0469 | | | R: fxd prec met flm 150 kΩ ±1% 1/8 W | 75042 | CEA T-0 obd |
| A3R14 | 0698-4391 | | | R: fxd prec met flm 69.8Ω ±1% 1/8 W | 75042 | CEA T-0 obd |
| A3R15 | 2100-1702 | | 3 | R: var ww 100 Ω ±10% 1 W | 74868 | 2600 Series obd |
| A3R16 | 0757-0200 | | 1 | R: fxd prec met flm 5620Ω ±1% 1/8 W | 19701 | MF5C T-0 obd |
| A3R17 | 0683-1535 | | | R: fxd comp 15 kΩ ±5% 1/4 W | 01121 | CB 1535 |
| A3R18 | 0683-5105 | | 1 | R: fxd comp 51 Ω ±5% 1/4 W | 01121 | CB 5105 |
| A3R19 | 0683-1035 | | | R: fxd comp 10 kΩ ±5% 1/4 W | 01121 | CB 1035 |
| A3R20 | | | | Not assigned | | |
| A3R21 | 0683-3325 | | 1 | R: fxd comp 3300 Ω ±5% 1/4 W | 01121 | CB 3325 |
| A3R22 | 0683-1525 | | 3 | R: fxd comp 1500 Ω ±5% 1/4 W | 01121 | CB 1525 |
| A3R23 | 0683-3335 | | 3 | R: fxd comp 33 kΩ ±5% 1/4 W | 01121 | CB 3335 |
| A3R24 | 0683-3025 | | 1 | R: fxd comp 3000 Ω ±5% 1/4 W | 01121 | CB 3025 |
| A3R25 | 0683-3305 | | 1 | R: fxd comp 33 Ω ±5% 1/4 W | 01121 | CB 3305 |
| A3R26 | 0683-5115 | | | R: fxd comp 510 Ω ±5% 1/4 W | 01121 | CB 5115 |
| A3R27 | 0683-1035 | | | R: fxd comp 10 kΩ ±5% 1/4 W | 01121 | CB 1035 |
| A3R28 | 0683-1535 | | | R: fxd comp 15 kΩ ±5% 1/4 W | 01121 | CB 1535 |
| A3R29 | 0683-6225 | | 5 | R: fxd comp 6200 Ω ±5% 1/4 W | 01121 | CB 6225 |
| A3R30 | | | | Not assigned | | |
| A3R31 | 0683-6225 | | | R: fxd comp 6200 Ω ±5% 1/4 W | 01121 | CB 6225 |
| A3R32 | 0698-4435 | | | R: fxd prec met flm 2490 Ω ±1% 1/8 W | 75042 | CEA T-0 obd |
| A3R33 | 0757-0283 | | 3 | R: fxd prec met flm 2000 Ω ±1% 1/8 W | 19701 | MF7C T-0 obd |
| A3R34 | 0698-0062 | | 2 | R: fxd prec met flm 464 Ω ±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. |
|---|---|---|---|---|---|---|
| A3R35 | 0757-0453 | | 2 | R: fxd prec met flm 30.1 kΩ ±1% 1/8 W | 19701 | MF5C T-0 obd |
| A3R36 | 0812-0095 | | 1 | R: fxd ww 2 kΩ ± 3% 3 W | 91637 | RS2B-95 obd |
| A3R37 | 0683-2435 | | 1 | R: fxd comp 24 kΩ ±5% 1/4 W | 01121 | CB 2435 |
| A3R38 | 0757-0453 | | | R: fxd prec met flm 30.1 kΩ ±1% 1/8 W | 75042 | CEA T-0 obd |
| A3R39 | 0698-0082 | | | R: fxd prec met flm 464 Ω ±1% 1/8 W | 19701 | MF5C T-0 obd |
| A3R40 | 0698-3630 | | 1 | R: fxd met oxide 300Ω ± 5% 2 W | 75042 | L42 obd |
| A3R41 | 0698-4435 | | | R: fxd prec met flm 2490 Ω ±1% 1/8 W | 75042 | CEA T-0 obd |
| A3R42 | 0757-0283 | | | R: fxd prec met flm 2000 Ω ±1% 1/8 W | 19701 | MF7C T-0 obd |
| A3R43 | 0683-5135 | | | R: fxd comp 51 kΩ ±5% 1/4 W | 01121 | CB 5135 |
| A3R44,* A3R45 | 2100-1739 | | 2 | R: var ww 20 turn 5000 Ω ±10% 1 W | 02660 | 2610 Series |
| A3R46 | 0683-1535 | | | R: fxd comp 15 kΩ ±5% 1/4 W | 01121 | CB 1535 |
| A3R47 | 0683-1025 | | 3 | R: fxd comp 1000 Ω ±5% 1/4 W | 01121 | CB 1025 |
| A3R48, A3R49 | 0683-3925 | | | R: fxd comp 3900 Ω ±5% 1/4 W | 01121 | CB 3925 |
| A3R50 | | | | Not assigned | | |
| A3R51 | 0683-8225 | | 1 | R: fxd comp 8200 Ω ±5% 1/4 W | 01121 | CB 8225 |
| A3R52 | 0757-0830 | | 1 | R: fxd comp 3920 Ω ±5% 1/2 W | 01121 | CB 3925 |
| A3R53 | 0683-6225 | | | R: fxd comp 6200 Ω ±5% 1/4 W | 01121 | CB 6225 |
| A3R54 | 0683-1025 | | | R: fxd comp 1000 Ω ±5% 1/4 W | 01121 | CB 1025 |
| A3R55 | 2100-1435 | | 1 | R: var comp lin 3300 Ω ±10% 1/8 W | 71450 | QS 200 |
| A3R56 | 0683-5115 | | | R: fxd comp 510 Ω ±5% 1/4 W | 01121 | CB 5115 |
| A3R57 | 0683-5135 | | | R: fxd comp 51 kΩ ±5% 1/4 W | 01121 | CB 5135 |
| A3R58, A3R59 | 0683-1045 | | 2 | R: fxd comp 100 kΩ ±5% 1/4 W | 01121 | CB 1045 |
| A3R60 | 0683-5135 | | | R: fxd comp 51 kΩ ±5% 1/4 W | 01121 | CB 5135 |
| A3R61, A3R62 | 0683-3925 | | | R: fxd comp 3900 Ω ±5% 1/4 W | 01121 | CB 3925 |
| A3R63 thru A3R65 | 0698-4435 | | | R: fxd prec met flm 2490 Ω ±1% 1/8 W | 75042 | CEA T-0 obd |
| A3R66 | 0683-1025 | | | R: fxd comp 1000 Ω ±5% 1/4 W | 01121 | CB 1025 |
| A3R67 | 0698-4435 | | | R: fxd prec met flm 2490 Ω ±1% 1/8 W | 75042 | CEA T-0 obd |
| A4 | 03410-66504 | | 1 | Assembly: Power Supply and Meter Amplifier Board, includes:<br>C1 thru C27 Q1 thru Q21<br>CR1 thru CR29 R1 thru R64<br>K1 | -hp- | |
| A4C1 | 0150-0014 | | 2 | C: fxd cer 0.005 µF 500 vdcw | 04222 | D1-4 obd |
| A4C2 | 0180-0110 | | 1 | C: fxd Al elect 80 µF 75 vdcw | 56289 | Type 41D D33191 |
| A4C3 | 0150-0093 | | | C: fxd cer 0.01 µF +80% -20% 100 vdcw | 91418 | TA obd |
| A4C4 | 0180-0049 | | 1 | C: fxd Al elect 20 µF +75% -10% 50 vdcw | 56289 | 30D206G050CC2-DSM |
| A4C5 | 0180-0050 | | 3 | C: fxd Al elect 40 µF +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 µF +100% -15% 50 vdcw | 56289 | 150D406X5010B2 |
| A4C8 | | | | Not assigned | | |
| A4C9 | 0150-0014 | | | C: fxd cer 0.005 µF 500 vdcw | 04222 | D1-4 obd |
| A4C10 | 0180-0149 | | 1 | C: fxd Al elect 65 µF +100% -10% 60 vdcw | 56289 | Type 30D D36978-DSM |
| A4C11 | 0150-0093 | | | C: fxd cer 0.01 µF +80% -20% 100 vdcw | 91418 | TA obd |
| A4C12 | 0180-0045 | | 2 | C: fxd Al elect 20 µF +75% -10% 25 vdcw | 56289 | 30D206G025CB2 DSM |
| A4C13 | 0180-0058 | | 1 | C: fxd Al elect 50 µF +75% -10% 25 vdcw | 56289 | 30D506G025CC2-DSM |
| A4C14 | 0180-1719 | | 1 | C: fxd Ta elect 22 µF ±10% 25 vdcw | 56289 | 109D226X9025C2 |
| A4C15 | 0180-0374 | | 1 | C: fxd Ta elect 10 µF ± 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 μF +100% -10% 25 vdcw | 56289 | 30D106G025BB2-DSM |
| A4C19, A4C20 | 0160-0128 | | 2 | C: fxd cer 2.2 μF ±20% 25 vdcw | 56289 | 5C 15C2 |
| A4C21 | 0180-0374 | | 1 | C: fxd Ta elect 10 μF ± 10% 20 vdcw | 56289 | 150106X9020B2-DYS |
| A4C22 | 0180-0022 | | 1 | C: fxd Ta elect 3.9 μF ±10% 35 vdcw | 56289 | 150D395X9035B2-DYS |
| A4C23 | 0140-0203 | | 1 | C: fxd mica 30 pF ±5% | 04062 | RDM15E300J5C |
| A4C24 | 0150-0050 | | | C: fxd cer 1000 pF 600 vdcw | 84411 | obd |
| A4C25 | 0180-0050 | | | C: fxd Al elect 40 μF +75% -10% 50 vdcw | 56289 | 150D406X5010B2 |
| A4C26 | 0150-0024 | | 1 | C: fxd cer 0.02 μF ±10% 600 vdcw | 72982 | 841-000-Z5U-203Z |
| A4C27 | 0180-0045 | | | C: fxd 20 μF +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 ±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 ±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 ±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 ±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 ±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 ±5% 400 mW | 04713 | SZ 10939-135 |
| A4CR29 | 1902-0049 | | | Diode: breakdown 6.2 V 1N821 5.9 to 6.5 V 0.01%/°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 Ω ±5% 1/4 W | 01121 | CB 2025 |
| A4R2 | 0683-1005 | | 2 | R: fxd comp 10 Ω ±5% 1/4 W | 01121 | CB 1005 |
| A4R3 | 0683-0275 | | 1 | R: fxd comp 2.7 Ω ±5% 1/4 W | 01121 | CB 27G5 |
| A4R4 | 0683-3925 | | | R: fxd comp 3900 Ω ±5% 1/4 W | 01121 | CB 3925 |
| A4R5 | 0698-3161 | | 1 | R: fxd prec met flm 38.3 kΩ ±1% 1/8 W | 19701 | MF5C T-0 obd |
| A4R6 | 2100-1759 | | 2 | R: var ww lin 2000 Ω ±10% 1/2 W | 75042 | Type 506 obd |
| A4R7 | 0757-0439 | | 2 | R: fxd prec met flm 6810 Ω ±1% 1/8 W | 19701 | MF5C T-0 obd |
| A4R8 | | | | Not assigned | | |
| A4R9 | 0683-5125 | | | R: fxd comp 5100 Ω ±5% 1/4 W | 01121 | CB 5125 |
| A4R10 | 0683-0335 | | 1 | R: fxd comp 3.3 Ω ±5% 1/4 W | 01121 | CB 33G5 |
| A4R11 | 0757-0450 | | | R: fxd 22.1 kΩ ±1% 1/8 W | 07115 | MF07CC4 |
| A4R12 | 0757-0440 | | | R: fxd prec met flm 7500 Ω ±1% 1/8 W | 19701 | MF5C T-0 obd |
| A4R13 | 0683-2025 | | | R: fxd comp 2000 Ω ±5% 1/4 W | 01121 | CB 2025 |
| A4R14 | 0683-1005 | | | R: fxd comp 10 Ω ±5% 1/4 W | 01121 | CB 1005 |
| A4R15 | 0683-0755 | | 1 | R: fxd comp 7.5 Ω ±5% 1/4 W | 01121 | CB 75G5 |
| A4R16 | | | | Not assigned | | |
| A4R17 | 0683-3925 | | | R: fxd comp 3900 Ω ±5% 1/4 W | 01121 | CB 3925 |
| A4R18 | 0757-0447 | | 1 | R: fxd prec met flm 16.2 kΩ ±1% 1/8 W | 75042 | CEA T-0 obd |
| A4R19 | 2100-1759 | | | R: var ww lin 2000 Ω ±10% 1/2 W | 75042 | Type 506 obd |
| A4R20 | 0757-0439 | | | R: fxd prec met flm 6810 Ω ±1% 1/8 W | 19701 | MF5C T-0 obd |
| A4R21 | 0757-0469 | | | R: fxd prec met flm 150 kΩ ±1% 1/8 W | 75042 | CEA T-0 obd |
| A4R22, A4R23 | 0757-0449 | | 2 | R: fxd prec met flm 20 kΩ ±1% 1/8 W | 19701 | MF5C T-0 obd |
| A4R24 | 0757-0469 | | | R: fxd prec met flm 150 kΩ ±1% 1/8 W | 75042 | CEA T-0 obd |
| A4R25 | | | | Not assigned | | |
| A4R26 | 2100-1702 | | | R: var ww 100 Ω ±10% 1 W 20 turn | 74868 | 2600 Series |
| A4R27 | 0698-4477 | | 1 | R: fxd prec met flm 10.5 kΩ ±1% 1/8 W | 75042 | CEA T-0 obd |
| A4R28 | 0683-1525 | | | R: fxd comp 1500 Ω ±5% 1/4 W | 01121 | CB 1525 |
| A4R29 | 0683-6225 | | | R: fxd comp 6200 Ω ±5% 1/4 W | 01121 | CB 6225 |
| A4R30 | 0683-1035 | | | R: fxd comp 10 kΩ ±5% 1/4 W | 01121 | CB 1035 |
| A4R31 | 0757-0804 | | 1 | R: fxd prec met flm 200 Ω ±1% 1/2 W | 19701 | MF6C T-0 obd |
| A4R32 | 0683-3335 | | | R: fxd comp 33 kΩ ±5% 1/4 W | 01121 | CB 3335 |
| A4R33 | 0683-8215 | | 1 | R: fxd comp 820 Ω ±5% 1/4 W | 01121 | CB 8215 |
| A4R34 | 0683-6225 | | | R: fxd comp 6200 Ω ±5% 1/4 W | 01121 | CB 6225 |
| A4R35 | | | | Not assigned | | |
| A4R36, A4R37 | 0683-2235 | | | R: fxd comp 22 kΩ ±5% 1/4 W | 01121 | CB 2235 |
| A4R38 | 0683-3905 | | | R: fxd comp 39 Ω ±5% 1/4 W | 01121 | CB 3905 |
| A4R39 | 0683-3625 | | 1 | R: fxd comp 3600 Ω ±5% 1/4 W | 01121 | CB 3625 |
| A4R40 | 0683-4725 | | | R: fxd comp 4700 Ω ±5% 1/4 W | 01121 | CB 4725 |
| A4R41 | 0683-2215 | | 1 | R: fxd comp 220 Ω ±5% 1/4 W | 01121 | CB 2215 |
| A4R42 | 0683-5125 | | | R: fxd comp 5100 Ω ±5% 1/4 W | 01121 | CB 5125 |
| A4R43 | 0683-6825 | | 1 | R: fxd comp 6800 Ω ±5% 1/4 W | 01121 | CB 6825 |
| A4R44 | 0683-1805 | | 1 | R: fxd 18 Ω ±5% 1/4 W | 01121 | CB 1805 |
| A4R45 | | | | Not assigned | | |
| A4R46 | 0683-9135 | | 1 | R: fxd comp 91 kΩ ±5% 1/4 W | 01121 | CB 9135 |
| A4R47 | 0683-2745 | | | R: fxd comp 270 kΩ ±5% 1/4 W | 01121 | CB 2745 |
| A4R48 | 0683-3005 | | 1 | R: fxd comp 30 Ω ±5% 1/4 W | 01121 | CB 3005 |
| A4R49 | 0683-1035 | | | R: fxd comp 10 kΩ ±5% 1/4 W | 01121 | CB 1035 |
| A4R50 | 0757-0469 | | | R: fxd prec met flm 150 kΩ ±1% 1/8 W | 75042 | CEA T-0 obd |
| A4R51 | 0757-0401 | | | R: fxd prec met flm 100 Ω ±1% 1/8 W | 75042 | CEA T-0 obd |
| A4R52 | 2100-1702 | | | R: var ww 100 Ω ±10% 1 W | 74868 | 2600 Series |
| A4R53 | 0757-0290 | | 1 | R: fxd prec met flm 6190 Ω ±1% 1/8 W | 75042 | CEA T-0 obd |
| A4R54, A4R55 | 0757-0445 | | 2 | R: fxd 13 kΩ ±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 kΩ ±1% 1/8 W | 75042 | CEA T-0 obd |
| A4R57 | 0757-0404 | | 1 | R: fxd prec met flm 130 Ω ±1% 1/8 W | 19701 | obd |
| A4R58 | 0683-1525 | | | R: fxd comp 1500 Ω ±5% 1/4 W | 01121 | CB 1525 |
| A4R59, A4R60 | 0698-3162 | | 2 | R: fxd prec met flm 46.4 kΩ ±1% 1/8 W | 75042 | CEA T-0 obd |
| A4R61 | 2100-1762 | | 1 | R: var ww lin 20 kΩ ±10% 1/2 W | 75042 | Type 506 obd |
| A4R62 | 0757-0283 | | | R: fxd prec met flm 2 kΩ ±1% 1/8 W | 19701 | MF5C T-0 obd |
| A4R63 | 0757-0280 | | 1 | R: fxd prec met flm 2000 Ω ±1% 1/8 W | 19701 | MF5C T-0 obd |
| A4R64 | 0757-0411 | | 1 | R: fxd met flm 332 Ω ±1% 1/8 W | 75042 | CEA T-0 obd |
| A4R65 | 0683-1525 | | 2 | R: fxd comp 15 kΩ ± 5% 1/4 W | 01121 | CB 1525 |
| C1, C2 | 0160-3333 | | 2 | C: fxd cer 5000 pF ±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 μA | -hp- | |
| M1 (Opt. 01) | 1120-0933 | | 1 | Meter: calibrated 100 μA | -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 kΩ ±5% 3 W | 02660 | Type 3461B |
| R2A, R2B | 2100-1944 | | 2 | R: var comp 50 kΩ ±20% 1.12 W | 01121 | Type J obd |
| R3 | 2100-0261 | | 1 | R: var lin 2000 Ω ±20% 3/10 W | 71450 | obd |
| R4 | 0683-3335 | | | R: fxd comp 33 kΩ ±5% 1/4 W | 01121 | CB 3335 |
| R5 | 0757-0274 | | 1 | R: fxd comp 1210 Ω ±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 ±10% | 72136 | obd |
| S1R1 | 0757-0284 | | 1 | R: fxd prec met flm 150 Ω ±1% 1/8 W | 75042 | CEA T-0 obd |
| S1R2 thru S1R6 | 0698-3138 | | 5 | R: fxd prec met flm 277.5 Ω ±1/4% 1/4 W | 19701 | MF6C T-0 obd |
| S1R7 thru S1R12 | 0698-3139 | | 6 | R: fxd prec met flm 410.26 Ω ±1/4% 1/4 W | 19701 | MF6C T-0 obd |
| S1R13 | 0698-3137 | | 1 | R: fxd prec met flm 189.72 Ω ±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 μF ±10% 35 vdcw | 56289 | 150D475X9035B2-DYS |
| S2C2 | 0180-0376 | | 1 | C: fxd Ta elect 0.47 μF ±10% 35 vdcw | 56289 | 150D474X9035A2-DYS |
| S2C3 | 0170-0040 | | 1 | C: fxd my 0.047 μF ±10% 200 vdcw | 56289 | 192P47392-PTS |
| S2C4 | 0160-0161 | | 2 | C: fxd my 0.01 μF ±10% | 56289 | 192P10392-PTS |
| S2C5 | 0160-0155 | | 3 | C: fxd my 0.0033 μF ±10% 200 vdcw | 56289 | 192P33292-PTS |
| S2C6 | 0160-2376 | | 1 | C: fxd 0.1 μF ±5% 100 vdcw | 01884 | LP7A1B105J |
| S2C7 | 0160-0168 | | 2 | C: fxd my 0.1 μF ±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 μF ±10% 200 vdcw | 56289 | 192P10392-PTS |
| S2C9 | 0160-0153 | | 1 | C: fxd my 0.001 μF ±10% 200 vdcw | 56289 | 192P10292-PTS |
| S2C10 | 0160-0990 | | 1 | C: fxd mica 100 pF ±2% | 04062 | RDM15F101G3S |
| S2C11 | 0180-1799 | | 1 | C: fxd Ta elect 20 μF ±10% 35 vdcw | 56289 | 150D206X0035R2-DYS |
| S2C12 | 0180-0100 | | | C: fxd Ta elect 4.7 μF ±10% 35 vdcw | 56289 | 150D475X9035B2-DYS |
| S2C13 | 0180-0291 | | 1 | C: fxd Ta elect 1.0 μF ±10% 35 vdcw | 56289 | 150D105X9035A2-DYS |
| S2C14 | 0160-0889 | | 2 | C: fxd my 0.33 μF ±10% 80 vdcw | 56289 | 192P3349R8-PTS |
| S2C15 | 0160-0163 | | 2 | C: fxd my 0.033 μF ±10% 200 vdcw | 56289 | 192P33392-PTS |
| S2C16 | 0160-0155 | | | C: fxd my 0.0033 μF ±10% 200 vdcw | 56289 | 192P33292-PTS |
| S2C17 | 0180-0161 | | 1 | C: fxd Ta elect 3.3 μF ±20% 35 vdcw | 56289 | 150D335X0035B2-DYS |
| S2C18 | 0160-0889 | | | C: fxd my 0.33 μF ±10% 80 vdcw | 56289 | 192P334948-PTS |
| S2C19 | 0160-0163 | | | C: fxd my 0.033 μF ±10% 200 vdcw | 56289 | 192P33392-PTS |
| S2C20 | 0160-0155 | | | C: fxd my 0.0033 μF ±10% 200 vdcw | 56289 | 192P33292-PTS |
| S2C21 | 0160-2012 | | 1 | C: fxd mica 330 pF ±5% | 72136 | obd |
| S2C22 | 0160-2375 | | 2 | C: fxd 0.47 μF ±2% 100 vdcw | 01884 | LP7A1B474G |
| S2C23 | 0160-2374 | | 2 | C: fxd 0.047 μF ±2% 100 vdcw | 01884 | LP7A1B473G |
| S2C24 | 0160-2373 | | 2 | C: fxd mica 4700 pF ±2% 300 vdcw | 04062 | RDM19F472G3S |
| S2C25 | 0160-2939 | | 2 | C: fxd mica 420 pF ±2% 500 vdcw | 04062 | RDM15F421G5S |
| S2C26 | 0160-2375 | | | C: fxd 0.47 μF ±2% 100 vdcw | 01884 | LP7A1B474G |
| S2C27 | 0160-2374 | | | C: fxd 0.047 μF ±2% 100 vdcw | 01884 | LP7A1B473G |
| S2C28 | 0160-2373 | | | C: fxd mica 4700 pF ±2% 300 vdcw | 04062 | RDM19F472G3S |
| S2C29 | 0160-2939 | | | C: fxd mica 420 pF ±2% 500 vdcw | 04062 | RDM15F421G5S |
| S2C30 | 0160-0168 | | | C: fxd my 0.1 μF ±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 | 294b34 |

# 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.

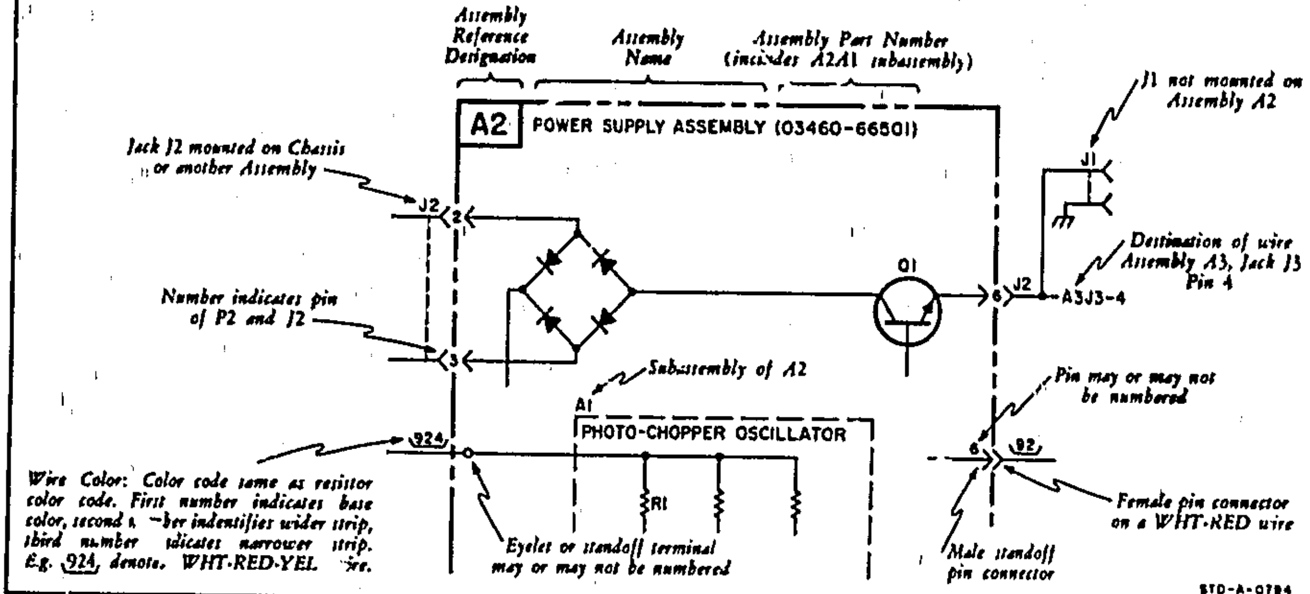
7-3. General schematic notes, which apply to all the schematic diagrams, are listed on Page 7-2.

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 |

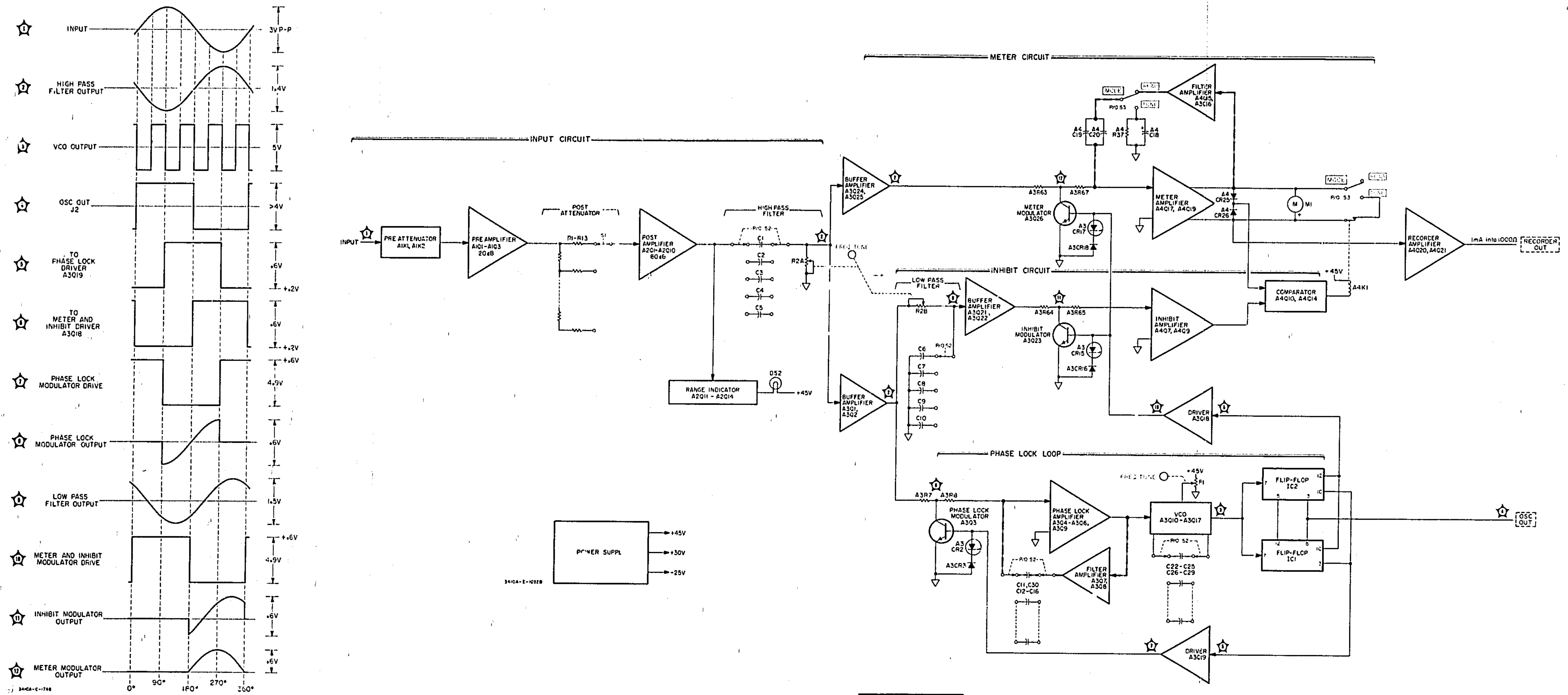


## SCHEMATIC NOTES

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. 924 DENOTES WIRE COLOR: COLOR CODE SAME AS RESISTOR COLOR CODE. (e. g. 924 = WHITE, RED, YELLOW.)
13. TRANSISTORS ARE ALL CONNECTED TO CIRCUIT BOARD IN TO-5 CONFIGURATION, e. g. E C B 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.

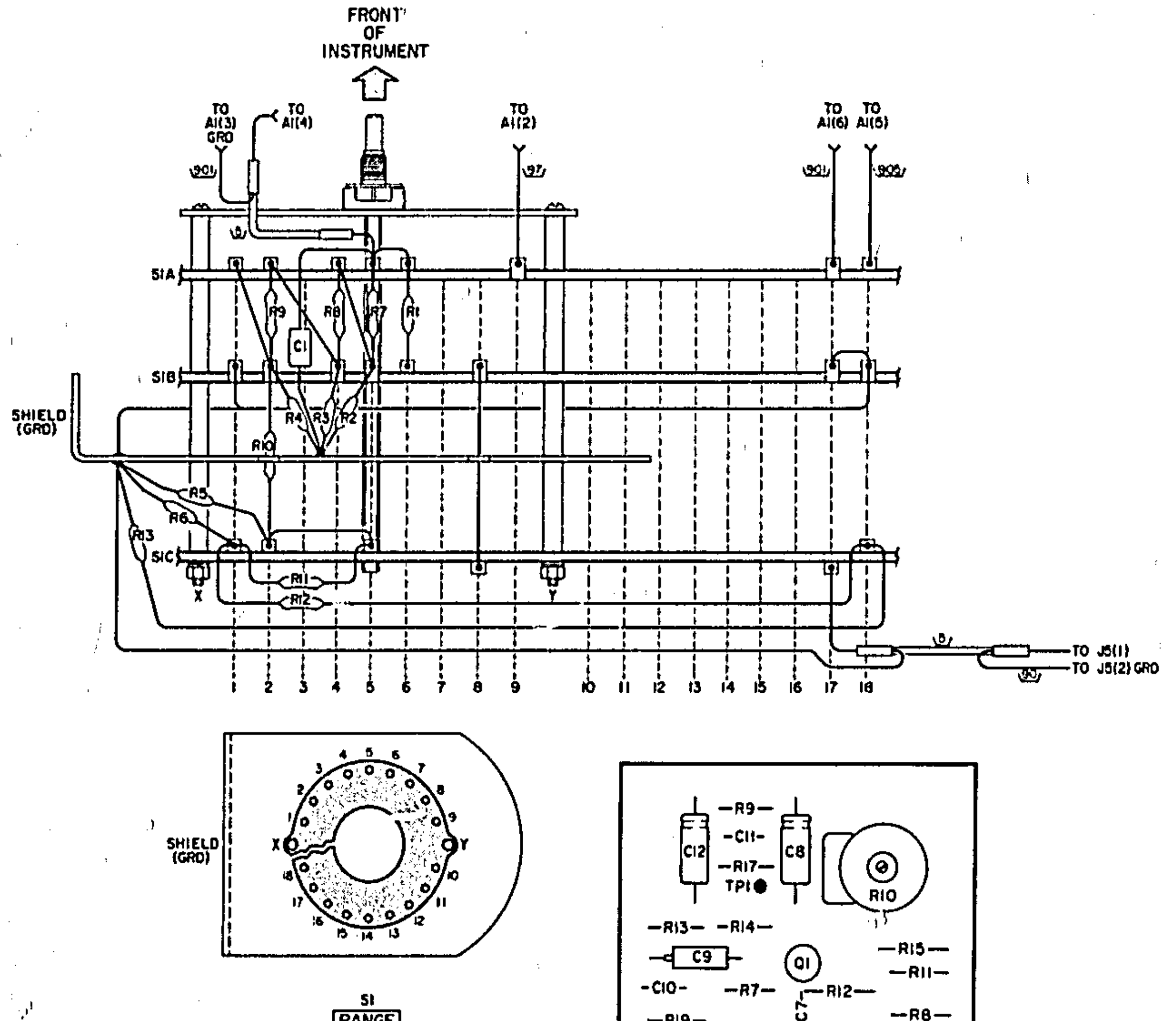


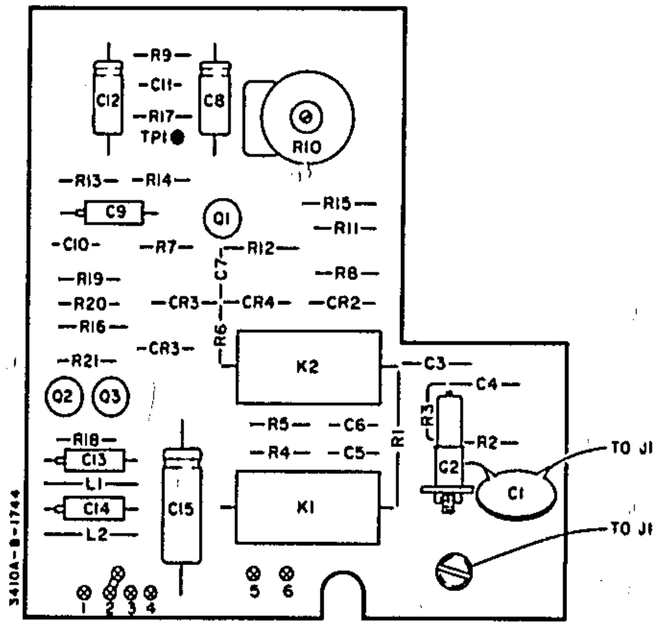

**NOTE**

WAVEFORMS TAKEN WITH FULL SCALE 1 KHZ INPUT SIGNAL.

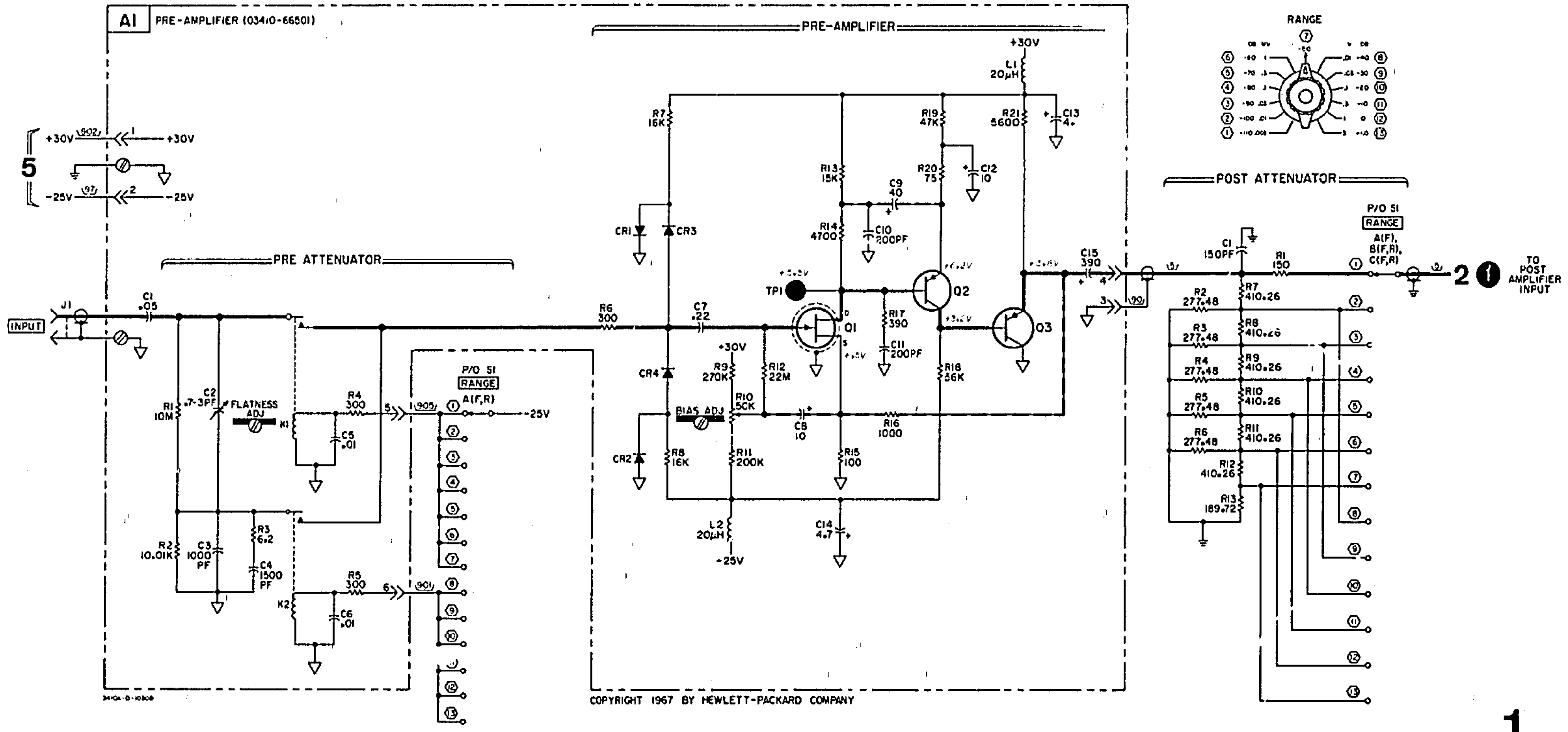
WIRE DESTINATIONS
2 ❷
SCHEMATIC NUMBER
LOCATOR NUMBER

Figure 7-1. Functional Block Diagram




A1
hp Part No. 03410-66501




1

**NOTE**

VOLTAGES SHOWN IN RED ARE DC VOLTAGES, WITH OR WITHOUT INPUT SIGNAL. WAVEFORMS ARE ON FIGURE 7-1.

WIRE DESTINATIONS
2 ❷
SCHEMATIC NUMBER
LOCATOR NUMBER

01825-1

Figure 7-2. Preamplifier

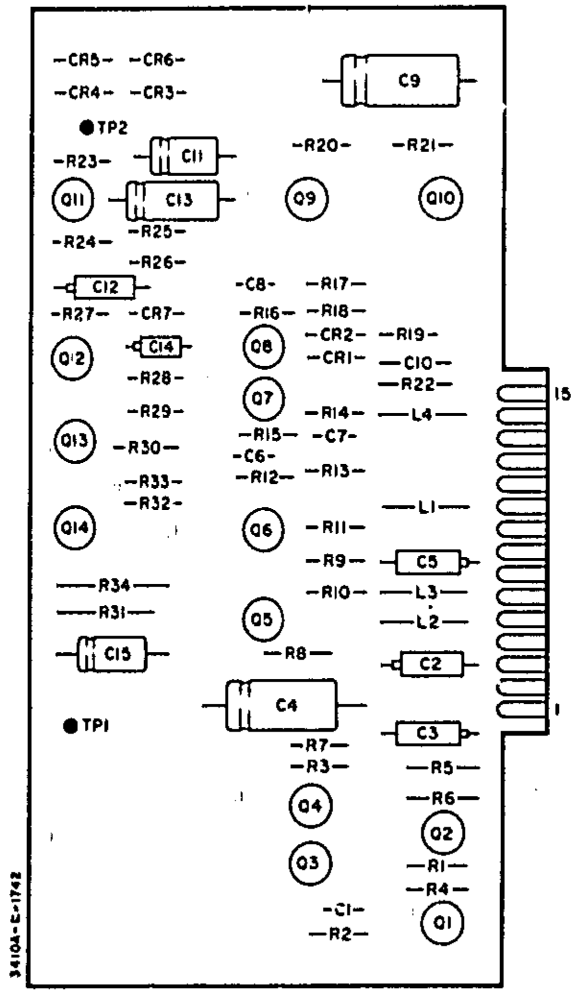
## 7-5. DETAILED TROUBLESHOOTING.

### 7-6. INPUT CIRCUIT TROUBLESHOOTING.

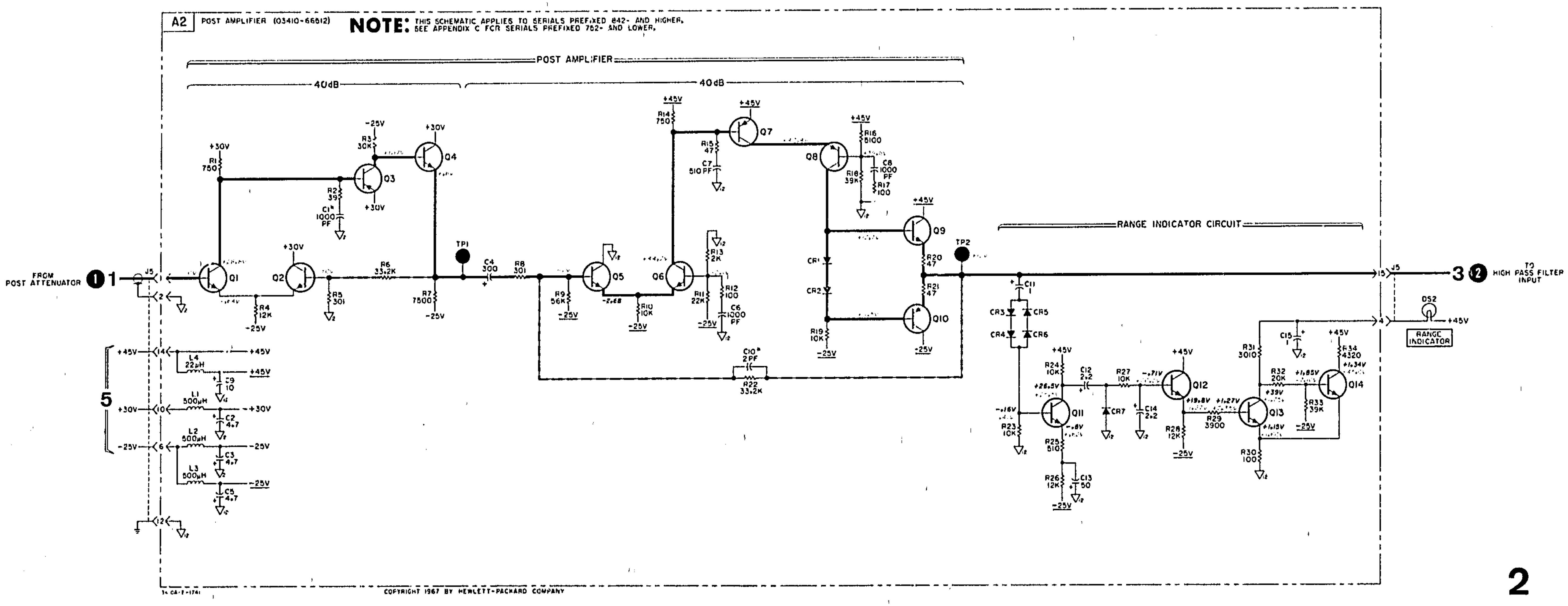
7-7. Using the Test Oscillator, apply a 3 V 400 Hz signal to the 3410A input. The RANGE INDICATOR should light on the .3V range and all ranges below it. If the RANGE INDICATOR lights only on the 3 mV range and lower, there is a problem in the pre-attenuator.

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.



A2
*hp* Part No. 03410-66512




2

**NOTE**

VOLTAGES SHOWN ARE DC. RED INDICATES NO INPUT SIGNAL, BLACK INDICATES FULL SCALL 1 KHZ INPUT SIGNAL. WAVEFORMS ARE ON FIGURE 7-1.

| WIRE DESTINATIONS | |
|---|---|
| 2 SCHEMATIC NUMBER | ❷ LOCATOR NUMBER |

01825-1

Figure 7-3. Post Amplifier

## 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 5 V 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 kΩ 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 Vdc or 0 Vdc, 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 (3) 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.

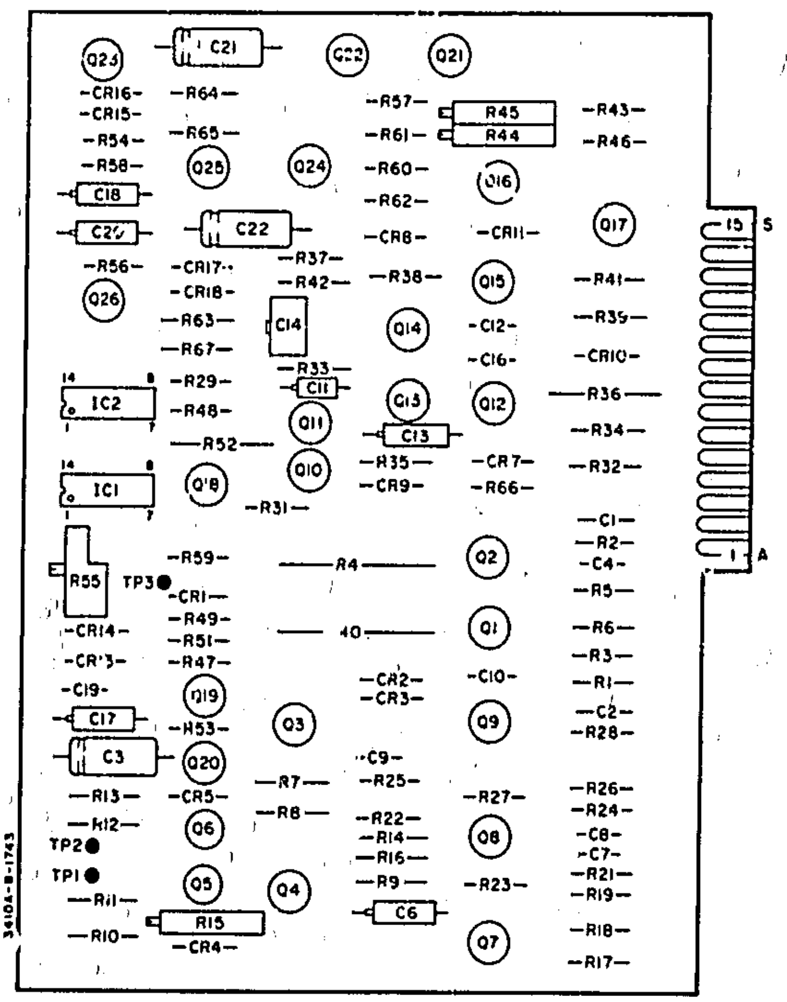
b. If there is no square wave present, check dc voltage levels on the transistors. Refer to Figure 7-4 for typical voltages.

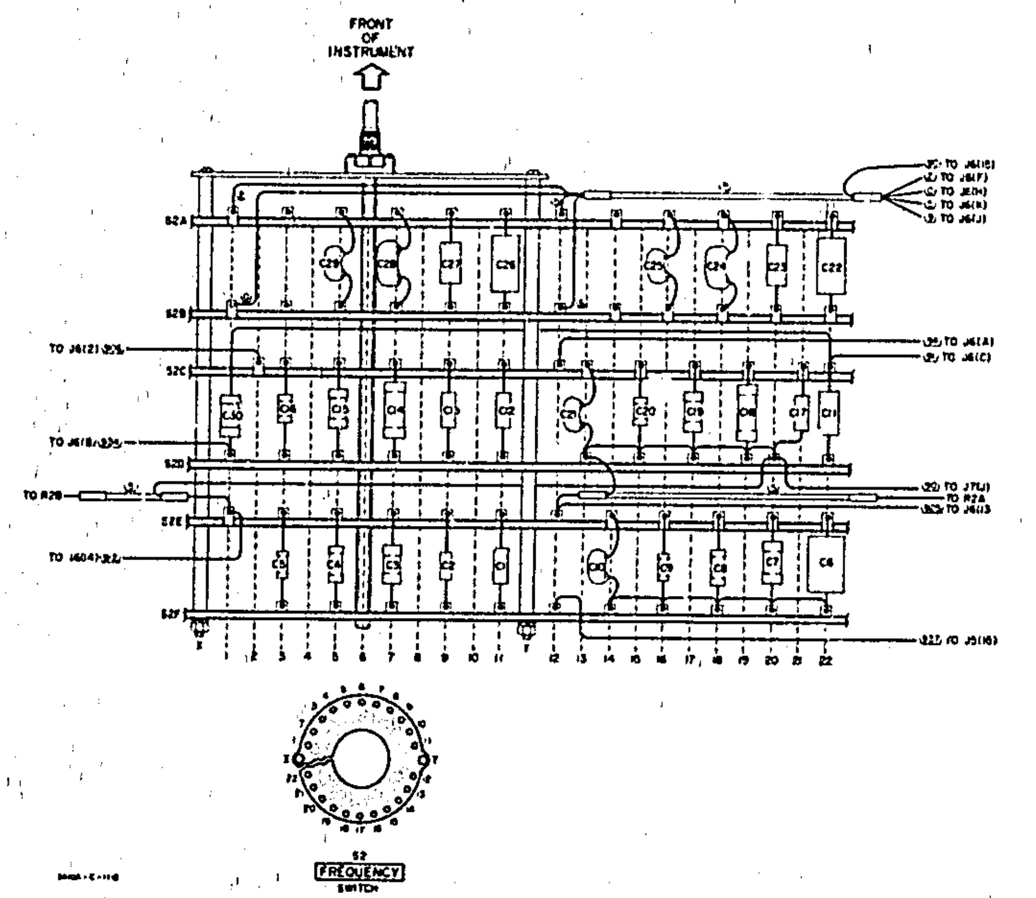
7-13. To troubleshoot the Phase Lock Amplifier, use the following procedure:

a. Observe the waveform (1) at the base of A3 Q3. A 4.9V square wave should be present.

b. Observe the waveform (2) at pin D of the pc assembly connector. A 1.4V p-p sine wave should be present.

c. Observe the waveform (3) 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.




**NOTE**

VOLTAGES SHOWN IN RED ARE DC VOLTAGES, WITH OR WITHOUT INPUT SIGNAL. WAVEFORMS ARE ON FIGURE 7-1.

| UNASSIGNED REFERENCE DESIGNATORS |
|---|
| A3C5, A3C15 |
| A3CR6, A3CR12 |
| A3R20, A3R30<br>A3R40, A3R50 |

WIRE DESTINATIONS

2 ② — SCHEMATIC NUMBER, LOCATOR NUMBER


3

Figure 7-4. Phase Lock Circuit

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.

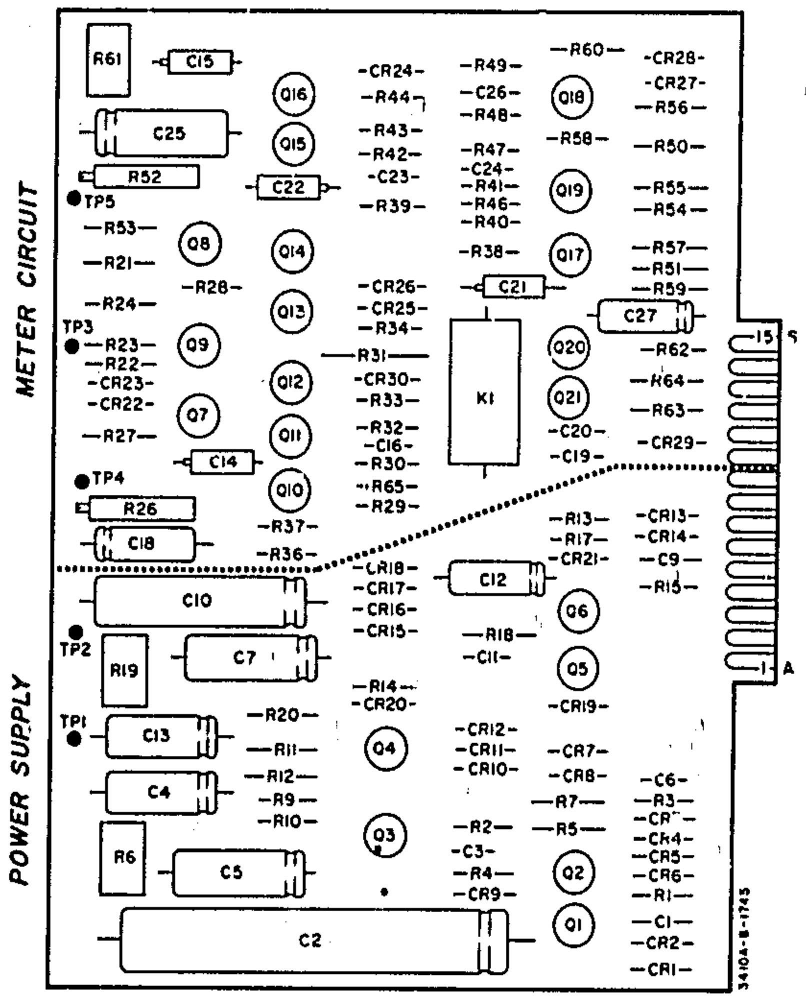
7-16. METER CIRCUIT TROUBLESHOOTING.

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 (12) on Figure 7-1).

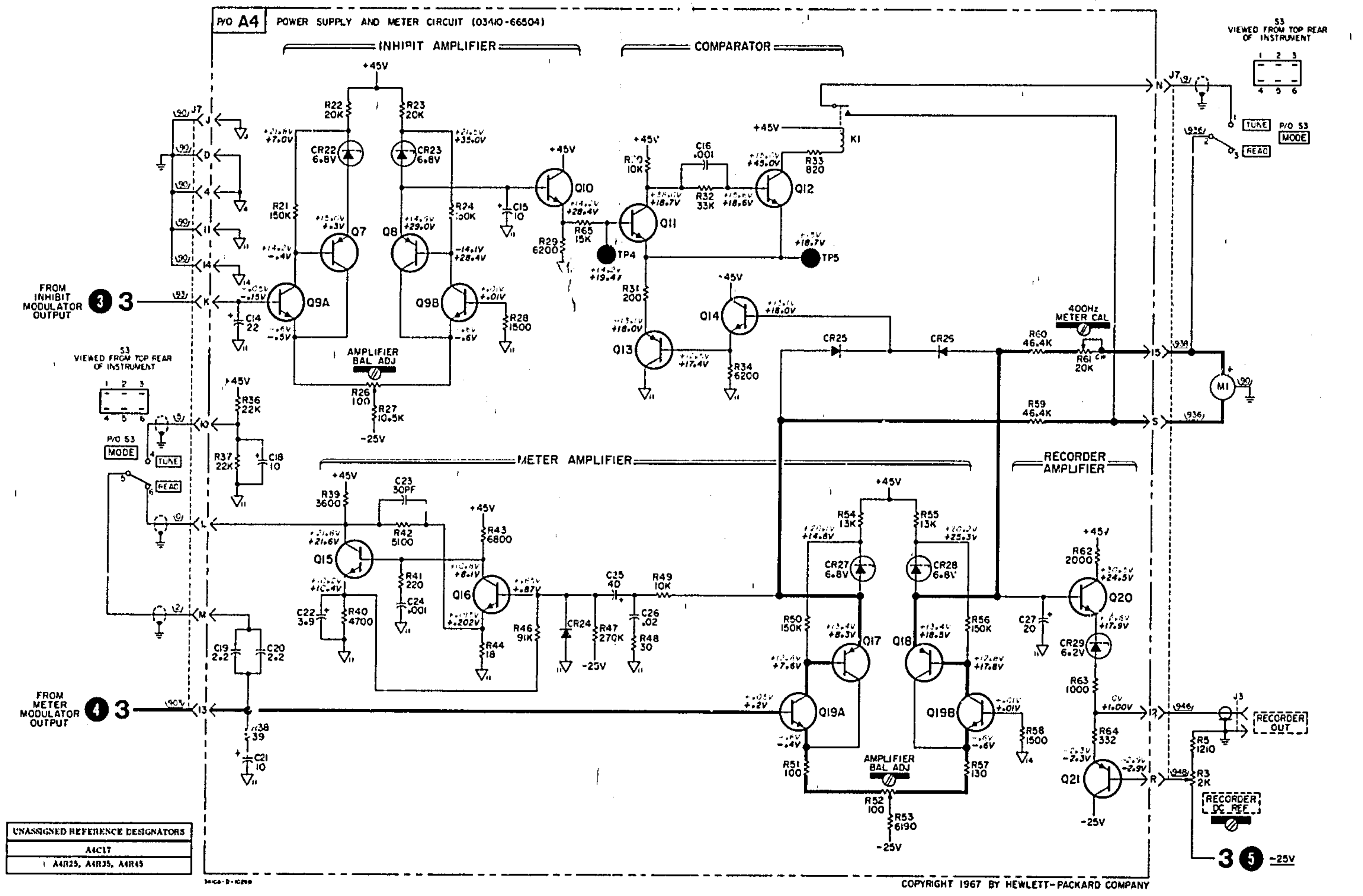
7-18. Check the differential amplifier as follows:

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.




A4
hp Part No. 03410-66504
REV C




| UNASSIGNED REFERENCE DESIGNATORS |
| --- |
| A4C17 |
| A4R25, A4R35, A4R45 |

4

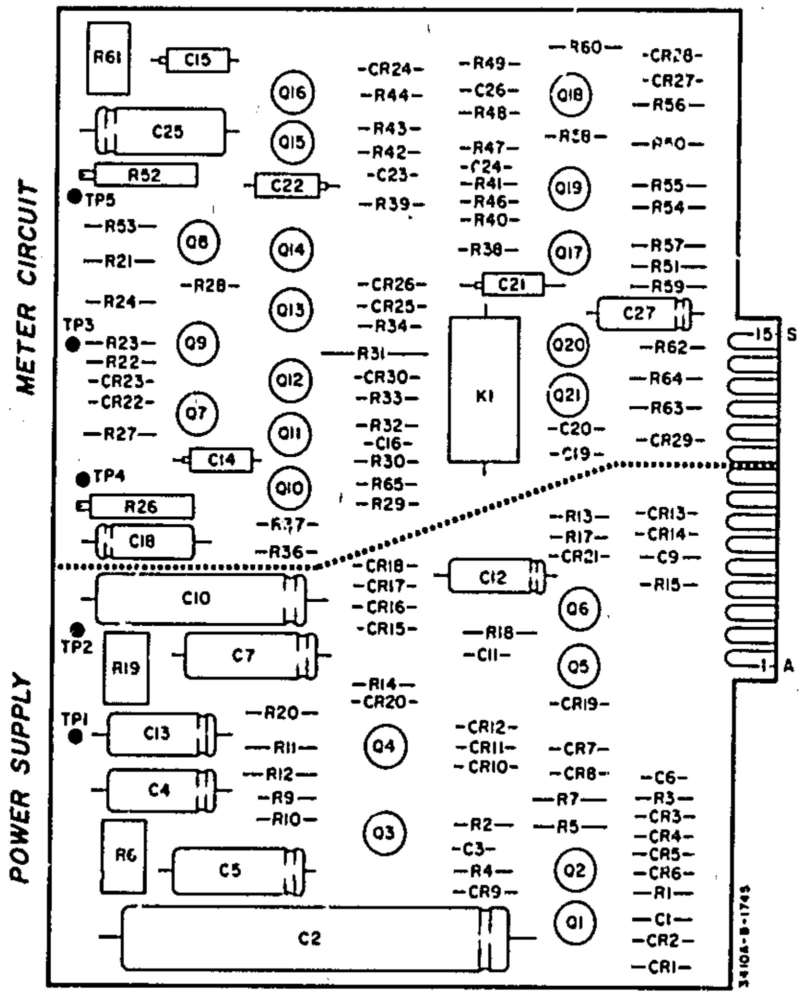
**NOTE**

VOLTAGES SHOWN ARE DC. RED INDICATES NO INPUT SIGNAL, BLACK INDICATES FULL SCALE 1 KHZ INPUT SIGNAL. WAVEFORMS ARE ON FIGURE 7-1.

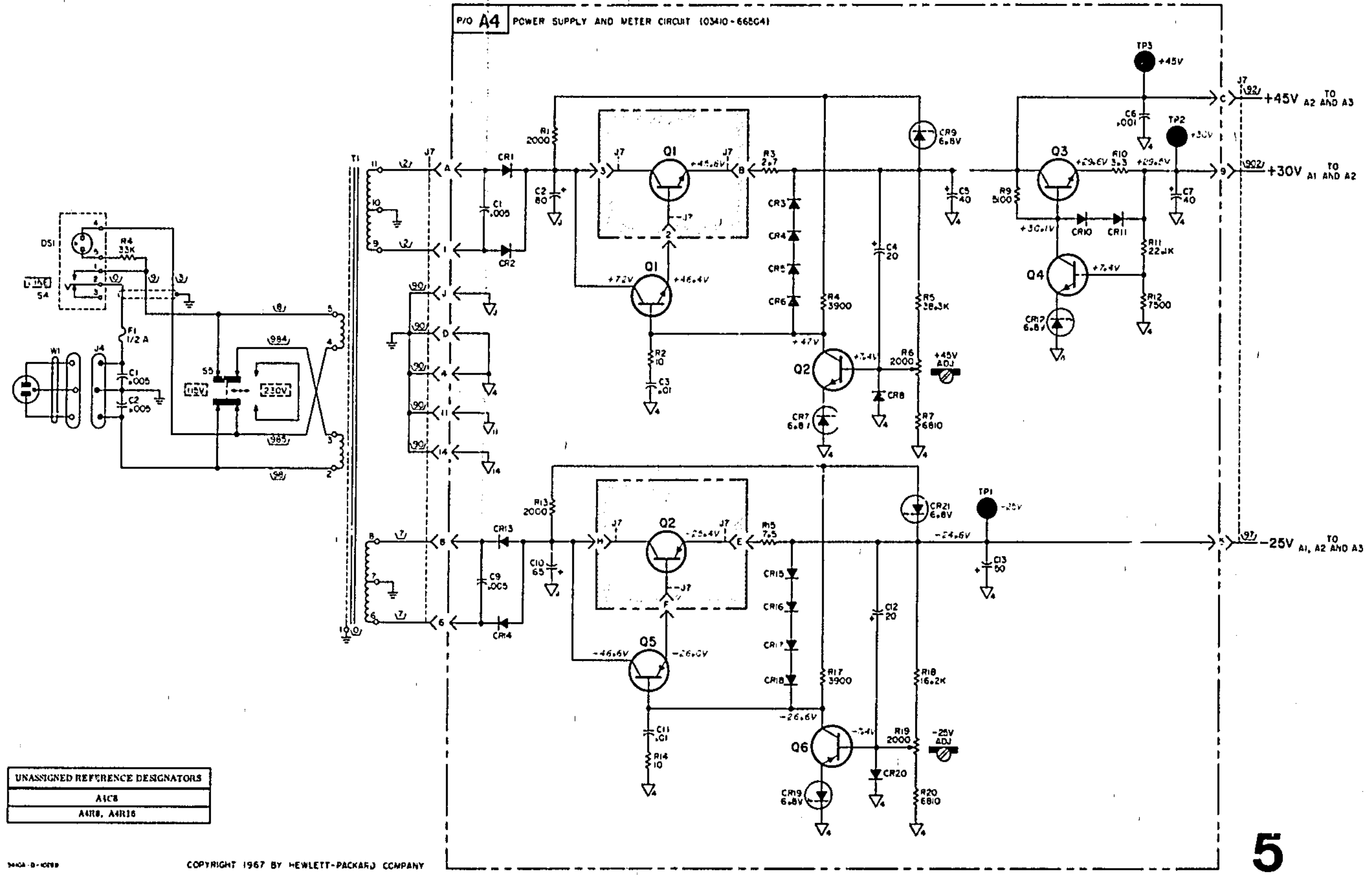
WIRE DESTINATIONS
2 ❷
SCHEMATIC NUMBER — LOCATOR NUMBER

01825-1

Figure 7-5. Meter Circuit




A4
hp Part No. 03410-66504
REV C




5

**NOTE**

VOLTAGES SHOWN IN RED ARE DC. ADJUST +45 V FOR +45.0 V AT TP3. ADJUST -25 V TO -24.8 V AT TP1. TP2 SHOULD READ BETWEEN +28.5 V AND +29.8 V.

Figure 7-6. Power Supply

# 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 |
|---|---|---|
| 00000 | U.S.A. Common | Any supplier of U.S. |
| 00136 | McCoy Electronics | Mount Holly Springs, Pa. |
| 00213 | Sage Electronics Corp. | Rochester, N.Y. |
| 00287 | Cemco Inc. | Danielson, Conn. |
| 00334 | Humidial | Colton, Calif. |
| 00348 | Microtron Co., Inc. | Valley Stream, N.Y. |
| 00373 | Garlock Inc. | Cherry Hill, N.J. |
| 00656 | Aerovox Corp. | New Bedford, Mass. |
| 00779 | Amp, Inc. | Harrisburg, Pa. |
| 00781 | Aircraft Radio Corp. | Boonton, N.J. |
| 00815 | Northern Engineering Laboratories, Inc. | Burlington, Wis. |
| 00853 | Sangamo Electric Co., Pickens Div. | Pickens, S.C. |
| 00866 | Goe Engineering Co. | City of Industry, Cal. |
| 00891 | Carl E. Holmes Corp. | Los Angeles, Calif. |
| 00929 | Microlab Inc. | Livingston, N.J. |
| 01002 | General Electric Co., Capacitor Dept. | Hudson Falls, N.Y. |
| 01009 | Alden Products Co. | Brockton, Mass. |
| 01121 | Allen Bradley Co. | Milwaukee, Wis. |
| 01255 | Litton Industries, Inc. | Beverly Hills, Calif. |
| 01281 | TRW Semiconductors, Inc. | Lawndale, Calif. |
| 01295 | Texas Instruments, Inc., Transistor Products Div. | Dallas, Texas |
| 01349 | The Alliance Mfg. Co. | Alliance, Ohio |
| 01589 | Pacific Relays, Inc. | Van Nuys, Calif. |
| 01670 | Gudebrod Bros. Silk Co. | New York, N.Y. |
| 01930 | Amerock Corp. | Rockford, Ill. |
| 01961 | Pulse Engineering Co. | Santa Clara, Calif. |
| 02114 | Ferroxcube Corp. of America | Saugerties, N.Y. |
| 02116 | Wheelock Signals, Inc. | Long Branch, N.J. |
| 02286 | Cole Rubber and Plastics Inc. | Sunnyvale, Calif. |
| 02660 | Amphenol-Borg Electronics Corp. | Broadview, Ill. |
| 02735 | Radio Corp. of America, Semiconductor and Materials Div. | Somerville, N.J. |
| 02771 | Vocaline Co. of America, Inc. | Old Saybrook, Conn. |
| 02777 | Hopkins Engineering Co. | San Fernando, Calif. |
| 02875 | Hudson Tool & Die | Newark, N.J. |
| 03508 | G.E. Semiconductor Prod. Dept. | Syracuse, N.Y. |
| 03705 | Apex Machine & Tool Co. | Dayton, Ohio |
| 03797 | Eldema Corp. | Compton, Calif. |
| 03818 | Parker Seal Co. | Los Angeles, Calif. |
| 03877 | Transitron Electric Corp. | Wakefield, Mass. |
| 03888 | Pyrofilm Resistor Co., Inc. | Cedar Knolls, N.J. |
| 03954 | Singer Co., Diehl Div. Finderne Plant | Somerville, N.J. |
| 04009 | Arrow, Hart and Hegeman Elect. Co. | Hartford, Conn. |
| 04013 | Taurus Corp. | Lambertville, N.J. |
| 04062 | Arco Electronic Inc. | Great Neck, N.Y. |
| 04222 | Hi-Q Division of Aerovox | Myrtle Beach, S.C. |
| 04354 | Precision Paper Tube Co. | Wheeling, Ill. |
| 04404 | Dymec Division of Hewlett-Packard Co. | Palo Alto, Calif. |
| 04651 | Sylvania Electric Products, Microwave Device Div. | Mountain View, Calif. |
| 04673 | Dakota Engr. Inc. | Culver City, Calif. |
| 04713 | Motorola, Inc., Semiconductor Prod. Div. | Phoenix, Arizona |
| 04732 | Filtron Co., Inc. Western Div. | Culver City, Calif. |
| 04773 | Automatic Electric Co. | Northlake, Ill. |
| 04796 | Sequoia Wire Co. | Redwood City, Calif. |
| 04811 | Precision Coil Spring Co. | El Monte, Calif. |
| 04870 | P.M. Motor Company | Westchester, Ill. |
| 04919 | Component Mfg. Service Co. | W. Bridgewater, Mass. |
| 05006 | Twentieth Century Plastics, Inc. | Los Angeles, Calif. |
| 05277 | Westinghouse Electric Corp., Semi-Conductor Dept. | Youngwood, Pa. |
| 05347 | Ultronix, Inc. | San Mateo, Calif. |
| 05397 | Union Carbide Corp., Elect. Div. | New York, N.Y. |
| 05574 | Viking Ind. Inc. | Canoga Park, Calif. |
| 05593 | Icore Electro-Plastics Inc. | Sunnyvale, Calif. |
| 05616 | Cosmo Plastic (c/o Electrical Spec. Co.) | Cleveland, Ohio |
| 05624 | Barber Colman Co. | Rockford, Ill. |
| 05728 | Tiffen Optical Co. | Roslyn Heights, Long Island, N.Y. |
| 05729 | Metro-Tel Corp. | Westbury, N.Y. |
| 05783 | Stewart Engineering Co. | Santa Cruz, Calif. |
| 05820 | Wakefield Engineering Inc. | Wakefield, Mass. |
| 06004 | Bassick Co., Div. of Stewart Warner Corp. | Bridgeport, Conn. |
| 06090 | Raychem Corp. | Redwood City, Calif. |
| 06175 | Bausch and Lomb Optical Co. | Rochester, N.Y. |
| 06402 | E.T.A. Products Co. of America | Chicago, Ill. |
| 06540 | Amatom Electronic Hardware Co., Inc. | New Rochelle, N.Y. |
| 06555 | Beede Electrical Instrument Co., Inc. | Penacook, N.H. |
| 06666 | General Devices Co., Inc. | Indianapolis, Ind. |
| 06751 | Components Inc., Ariz. Div. | Phoenix, Ariz. |
| 06812 | Torrington Mfg. Co., West Div. | Van Nuys, Calif. |
| 06980 | Varian Assoc. Eimac Div. | San Carlos, Calif. |
| 07088 | Kelvin Electric Co. | Van Nuys, Calif. |
| 07126 | Digitran Co. | Pasadena, Calif. |
| 07137 | Transistor Electronics Corp. | Minneapolis, Minn. |
| 07138 | Westinghouse Electric Corp. Electronic Tube Div. | Elmira, N.Y. |
| 07149 | Filmohm Corp. | New York, N.Y. |
| 07233 | Cinch-Graphik Co. | City of Industry, Calif. |
| 07256 | Silicon Transistor Corp. | Carle Place, N.Y. |
| 07261 | Avnet Corp. | Culver City, Calif. |
| 07263 | Fairchild Camera & Inst. Corp. Semiconductor Div. | Mountain View, Calif. |
| 07322 | Minnesota Rubber Co. | Minneapolis, Minn. |
| 07387 | Birtcher Corp., The | Monterey Park, Calif. |
| 07397 | Sylvania Elect. Prod. Inc., Mt. View Operations | Mountain View, Calif. |
| 07700 | Technical Wire Products Inc. | Cranford, N.J. |
| 07829 | Bodine Elect. Co. | Chicago, Ill. |
| 07910 | Continental Device Corp. | Hawthorne, Calif. |
| 07933 | Raytheon Mfg. Co., Semiconductor Div. | Mountain View, Calif. |
| 07980 | Hewlett-Packard Co., Boonton Radio Div. | Rockaway, N.J. |
| 08145 | U.S. Engineering Co. | Los Angeles, Calif. |
| 08289 | Blinn, Delbert Co. | Pomona, Calif. |
| 08358 | Burgess Battery Co. | Niagara Falls, Ontario, Canada |
| 08524 | Deutsch Fastener Corp. | Los Angeles, Calif. |
| 08664 | Bristol Co., The | Waterbury, Conn. |
| 08717 | Sloan Company | Sun Valley, Calif. |
| 08718 | ITT Cannon Electric Inc., Phoenix Div. | Phoenix, Arizona |
| 08727 | National Radio Lab. Inc. | Paramus, N.J. |
| 08792 | CBS Electronics Semiconductor Operations Div of C.B.S. Inc. | Lowell, Mass. |
| 08806 | General Electric Co. Minist. Lamp Dept. | Cleveland, Ohio |
| 08984 | Mel-Rain | Indianapolis, Ind. |
| 09026 | Babcock Relays Div. | Costa Mesa, Calif. |
| 09134 | Texas Capacitor Co. | Houston, Texas |
| 09145 | Tech. Ind. Inc. Atohm Elect. | Burbank, Calif. |
| 09250 | Electro Assemblies, Inc. | Chicago, Ill. |
| 09353 | C & K Components Inc. | Newton, Mass. |
| 09569 | Mallory Battery Co. of Canada, Ltd. | Toronto, Ontario, Canada |
| 09922 | Burndy Corp. | Norwalk, Conn. |
| 10214 | General Transistor Western Corp. | Los Angeles, Calif. |
| 10411 | Ti-Tal, Inc. | Berkeley, Calif. |
| 10646 | Carborundum Co. | Niagara Falls, N.Y. |
| 11236 | CTS of Berne, Inc. | Berne, Ind. |
| 11237 | Chicago Telephone of California, Inc. | So. Pasadena, Calif. |
| 11242 | Bay State Electronics Corp. | Waltham, Mass. |
| 11312 | Teledyne Inc., Microwave Div. | Palo Alto, Calif. |
| 11314 | National Seal | Downey, Calif. |
| 11453 | Precision Connector Corp. | Jamaica, N.Y. |
| 11534 | Duncan Electronics Inc. | Costa Mesa, Calif. |
| 11711 | General Instrument Corp., Semiconductor Div., Products Group | Newark, N.J. |
| 11717 | Imperial Electronic, Inc. | Buena Park, Calif. |
| 11870 | Melabs, Inc. | Palo Alto, Calif. |
| 12136 | Philadelphia Handle Co. | Camden, N.J. |
| 12361 | Grove Mfg. Co., Inc. | Shady Grove, Pa. |
| 12574 | Gulton Ind. Inc. Data System Div. | Albuquerque, N.M. |
| 1269[illegible] | C[illegible] Mfg. Co. | Dover, N.H. |
| 12728 | Elma[illegible] Filt[illegible] Corp. | W. Haven, Conn. |
| 12859 | Nippon Electric Co., Ltd. | Tokyo, Japan |
| 12881 | Metex Electronics Corp. | Clark, N.J. |
| 12930 | Delta Semiconductor Inc. | Newport Beach, Calif. |
| 12954 | Dickson Electronics Corp. | Scottsdale, Arizona |
| 13103 | Thermalloy | Dallas, Texas |
| 13396 | Telefunken (GmbH) | Hanover, Germany |
| 13835 | Midland-Wright Div. of Pacific Industries, Inc. | Kansas City, Kansas |
| 14099 | Sem-Tech | Newbury Park, Calif. |
| 14193 | Calif. Resistor Corp. | Santa Monica, Calif. |
| 14298 | American Components, Inc. | Conshohocken, Pa. |
| 14433 | ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp. | West Palm Beach, Fla. |
| 14493 | Hewlett-Packard Company | Loveland, Colo. |
| 14655 | Cornell Dubilier Electric Corp. | Newark, N.J. |
| 14674 | Corning Glass Works | Corning, N.Y. |
| 14752 | Electro Cube Inc. | San Gabriel, Calif. |
| 14960 | Williams Mfg. Co. | San Jose, Calif. |
| 15203 | Webster Electronics Co. | New York, N.Y. |
| 15287 | Scionics Corp. | Northridge, Calif. |
| 15291 | Adjustable Bushing Co. | N. Hollywood, Calif. |
| 15558 | Micron Electronics | Garden City, Long Island, N.Y. |
| 15566 | Amprobe Inst. Corp. | Lynbrook, N.Y. |
| 15631 | Cabletronics | Costa Mesa, Calif. |
| 15772 | Twentieth Century Coil Spring Co. | Santa Clara, Calif. |
| 15801 | Fenwal Elect. Inc. | Framingham, Mass. |
| 15818 | Amelco Inc. | Mt. View, Calif. |
| 16037 | Spruce Pine Mica Co | Spruce Pine, N.C. |
| 16179 | Omni-Spectra Inc. | Detroit, Ill. |
| 16352 | Computer Diode Corp. | Lodi, N.J. |
| 16585 | Boots Aircraft Nut Corp. | Pasadena, Calif. |
| 16688 | Ideal Prec. Meter Co., Inc. De Jur Meter Div. | Brooklyn, N.Y. |
| 16758 | Delco Radio Div. of G.M. Corp. | Kokomo, Ind. |
| 17109 | Thermonetics Inc. | Canoga Park, Calif. |
| 17474 | Tranex Company | Mountain View, Calif. |
| 17675 | Hamlin Metal Products Corp. | Akron, Ohio |
| 17745 | Angstrohm 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. |

# CODE LIST OF MANUFACTURERS (Cont'd)

| Code No. | Manufacturer | Address |
|---|---|---|
| 18324 | Signetics Corp. | Sunnyvale, Calif. |
| 18476 | Ty-Car Mfg. Co., Inc. | Holliston, Mass. |
| 18486 | TRW Elect. Comp. Div. | Des Plaines, Ill |
| 18583 | Curtis Instrument, Inc. | Mt. Kisco, N.Y. |
| 18612 | Vishay Instruments Inc. | Malvern, Pa. |
| 18873 | E.I. DuPont and Co., Inc. | Wilmington, Del. |
| 18911 | Durant Mfg. Co. | Milwaukee, Wis. |
| 19315 | The Bendix Corp., Navigation & Control Div. | Teterboro, N.J. |
| 19500 | Thomas A. Edison Industries, Div. of McGraw-Edison Co. | West Orange, N.J. |
| 19589 | Concoa | Baldwin Park, Calif. |
| 19644 | LRC Electronics | Horseheads, N.Y. |
| 19701 | Electra Mfg. Co. | Independence, Kansas |
| 20183 | General Atronics Corp. | Philadelphia, Pa. |
| 21226 | Executone, Inc. | Long Island City, N.Y. |
| 21335 | Fafnir Bearing Co., The | New Britain, Conn. |
| 21520 | Fansteel Metallurgical Corp. | N. Chicago, Ill. |
| 23042 | Texscan Corp. | Indianapolis, Ind. |
| 23783 | British Radio Electronics Ltd. | Washington, D.C. |
| 24455 | G.E. Lamp Division | Nela Park, Cleveland, Ohio |
| 24655 | General Radio Co. | West Concord, Mass. |
| 24681 | Memcor Inc., Comp. Div. | Huntington, Ind. |
| 26365 | Gries Reproducer Corp. | New Rochelle, N.Y. |
| 26462 | Grobet File Co. of America, Inc. | Carlstadt, N.J. |
| 26851 | Compac/Hollister Co. | Hollister, Calif. |
| 26992 | Hamilton Watch Co. | Lancaster, Pa. |
| 28480 | Hewlett-Packard Co. | Palo Alto, Calif. |
| 28520 | Heyman Mfg. Co. | Kenilworth, N.J. |
| 30817 | Instrument Specialties Co., Inc. | Little Falls, N.J. |
| 33173 | G.E. Receiving Tube Dept. | Owensboro, Ky. |
| 35434 | Lectrohm Inc. | Chicago, Ill. |
| 36196 | Stanwyck Coil Products Ltd. | Hawkesbury, Ontario, Canada |
| 36287 | Cunningham, W.H. & Hill, Ltd. | Toronto Ontario, Canada |
| 37942 | P.R. Mallory & Co. Inc. | Indianapolis, Ind. |
| 39543 | Mechanical Industries Prod. Co. | Akron, Ohio |
| 40920 | Miniature Precision Bearings, Inc. | Keene, N.H. |
| 42190 | Muter Co. | Chicago, Ill. |
| 43990 | C.A. Norgren Co. | Englewood, Colo. |
| 44655 | Ohmite Mfg. Co. | Skokie, Ill. |
| 46384 | Penn Eng. & Mfg. Corp. | Doylestown, Pa. |
| 47904 | Polaroid Corp. | Cambridge, Mass. |
| 48620 | Precision Thermometer & Inst. Co. | Southampton, Pa. |
| 49956 | Microwave & Power Tube Div. | Waltham, Mass. |
| 52090 | Rowan Controller Co. | Westminster, Md. |
| 52983 | Sanborn Company | Waltham, Mass. |
| 54294 | Shallcross Mfg. Co. | Selma, N.C. |
| 55026 | Simpson Electric Co. | Chicago, Ill. |
| 55933 | Sonotone Corp. | Elmsford, N.Y. |
| 55938 | Raytheon Co. Commercial Apparatus & Systems Div. | So. Norwalk, Conn. |
| 56137 | Spaulding Fibre Co., Inc. | Tonawanda, N.Y. |
| 56289 | Sprague Electric Co. | North Adams, Mass. |
| 59446 | Telex Corp. | Tulsa, Okla. |
| 59730 | Thomas & Betts Co. | Elizabeth, N.J. |
| 60741 | Triplett Electrical Inst. Co. | Bluffton, Ohio |
| 61775 | Union Switch and Signal, Div. of Westinghouse Air Brake Co. | Pittsburgh, Pa. |
| 62119 | Universal Electric Co. | Owosso, Mich. |
| 63743 | Ward-Leonard Electric Co. | Mt. Vernon, N.Y. |
| 64959 | Western Electric Co., Inc. | New York, N.Y. |
| 65092 | Weston Inst. Inc. Weston-Newark | Newark, N.J. |
| 66295 | Wittek Mfg. Co. | Chicago, Ill. |
| 66346 | Minnesota Mining & Mfg. Co. Revere Mincom Div. | St. Paul, Minn. |
| 70276 | Allen Mfg. Co. | Hartford, Conn. |
| 70309 | Allied Control | New York, N.Y. |
| 70318 | Allmetal Screw Product Co., Inc. | Garden City, N.Y. |
| 70417 | Amplex, Div. of Chrysler Corp. | Detroit, Mich. |
| 70485 | Atlantic India Rubber Works, Inc. | Chicago, Ill. |
| 70563 | Amperite Co., Inc. | Union City, N.J. |
| 70674 | ADC Products Inc. | Minneapolis, Minn. |
| 70903 | Belden Mfg. Co. | Chicago, Ill. |
| 70998 | Bird Electronic Corp. | Cleveland, Ohio |
| 71002 | Birnbach Radio Co. | New York, N.Y. |
| 71034 | Bliley Electric Co., Inc. | Erie, Pa. |
| 71041 | Boston Gear Works Div. of Murray Co. of Texas | Quincy, Mass. |
| 71218 | Bud Radio, Inc. | Willoughby, Ohio |
| 71279 | Cambridge Thermionics Corp. | Cambridge, Mass. |
| 71286 | Camloc Fastener Corp. | Paramus, N.J. |
| 71313 | Cardwell Condenser Corp. | Lindenhurst L.I., N.Y. |
| 71400 | Bussmann Mfg. Div. of McGraw-Edison Co. | St. Louis, Mo. |
| 71436 | Chicago Condenser Corp. | Chicago, Ill. |
| 71447 | Calif. Spring Co., Inc. | Pico-Rivera, Calif. |
| 71450 | CTS Corp. | Elkhart, Ind. |
| 71468 | ITT Cannon Electric Inc. | Los Angeles, Calif. |
| 71471 | Cinema, Div. Aerovox Corp. | Burbank, Calif. |
| 71482 | C.P. Clare & Co. | Chicago, Ill. |
| 71590 | Centralab Div. of Globe Union Inc. | Milwaukee, Wis. |
| 71616 | Commercial Plastics Co. | Chicago, Ill. |
| 71700 | Cornish Wire Co., The | New York, N.Y. |
| 71707 | Coto Coil Co., Inc. | Providence, R.I. |
| 71744 | Chicago Miniature Lamp Works | Chicago, Ill. |
| 71765 | Cinch Mfg. Co., Howard B. Jones Div. | Chicago, Ill. |
| 71984 | Dow Corning Corp. | Midland, Mich. |
| 72136 | Electro Motive Mfg. Co., Inc. | Willimantic, Conn. |
| 72619 | Dialight Corp. | Brooklyn, N.Y. |
| 72656 | Indiana General Corp., Electronics Div. | Keasby, N.J. |
| 72699 | General Instrument Corp., Cap. Div. | Newark, N.J. |
| 72765 | Drake Mfg. Co. | Harwood Heights, Ill. |
| 72825 | Hugh H. Eby Inc. | Philadelphia, Pa. |
| 72928 | Gudeman Co. | Chicago, Ill. |
| 72962 | Elastic Stop Nut Corp. | Union, N.J. |
| 72964 | Robert M. Hadley Co. | Los Angeles, Calif. |
| 72982 | Erie Technological Products, Inc. | Erie, Pa. |
| 73061 | Hansen Mfg. Co., Inc. | Princeton, Ind. |
| 73076 | H.M. Harper Co. | Chicago, Ill. |
| 73138 | Helipot Div. of Beckman Inst., Inc. | Fullerton, Calif. |
| 73293 | Hughes Products Division of Hughes Aircraft Co. | Newport Beach, Calif. |
| 73445 | Amperex Elect Co. | Hicksville, L.I. N.Y. |
| 73506 | Bradley Semiconductor Corp. | New Haven, Conn. |
| 73559 | Carling Electric, Inc. | Hartford, Conn. |
| 73586 | Circle F Mfg. Co. | Trenton, N.J. |
| 73682 | George K. Garrett Co., Div. MSL Industries Inc. | Philadelphia, Pa. |
| 73734 | Federal Screw Products Inc. | Chicago, Ill. |
| 73743 | Fischer Special Mfg. Co. | Cincinnati, Ohio |
| 73793 | General Industries Co., The | Elyria, Ohio |
| 73846 | Goshen Stamping & Tool Co. | Goshen, Ind. |
| 73899 | JFD Electronics Corp. | Brooklyn, N.Y. |
| 73905 | Jennings Radio Mfg. Corp. | San Jose, Calif. |
| 73957 | Groov-Pin Corp. | Ridgefield, N.J. |
| 74276 | Signalite Inc. | Neptune, N.J. |
| 74455 | J.H. Winns, and Sons | Winchester, Mass. |
| 74861 | Industrial Condenser Corp. | Chicago, Ill. |
| 74868 | R.F. Products Division of Amphenol-Borg Electronics Corp. | Danbury, Conn. |
| 74970 | E.F. Johnson Co. | Waseca, Minn. |
| 75042 | International Resistance Co. | Philadelphia, Pa. |
| 75263 | Keystone Carbon Co., Inc. | St. Marys, Pa. |
| 75378 | CTS Knights Inc. | Sandwich, Ill. |
| 75382 | Kulka Electric Corporation | Mt. Vernon, N.Y. |
| 75818 | Lenz Electric Mfg. Co | Chicago, Ill. |
| 75915 | Littelfuse, Inc. | Des Plaines, Ill. |
| 76005 | Lord Mfg. Co. | Erie, Pa. |
| 76210 | C.W. Marwedel | San Francisco, Calif. |
| 76433 | General Instrument Corp., Micamold Division | Newark, N.J. |
| 76487 | James Millen Mfg. Co., Inc. | Malden, Mass. |
| 76493 | J.W. Miller Co. | Los Angeles, Calif. |
| 76530 | Cinch-Monadnock, Div. of United Carr Fastener Corp. | San Leandro, Calif. |
| 76545 | Mueller Electric Co. | Cleveland, Ohio |
| 76703 | National Union | Newark, N.J. |
| 76854 | Oak Manufacturing Co. | Crystal Lake, Ill. |
| 77068 | The Bendix Corp., Electrodynamics Div. | N. Hollywood, Calif. |
| 77075 | Pacific Metals Co. | San Francisco, Calif. |
| 77221 | Phanostran Instrument and Electronic Co. | South Pasadena, Calif. |
| 77252 | Philadelphia Steel and Wire Corp. | Philadelphia, Pa. |
| 77342 | American Machine & Foundry Co Potter & Brumfield Div. | Princeton, Ind. |
| 77630 | TRW Electronic Components Div. | Camden, N.J. |
| 77638 | General Instrument Corp., Rectifier Div. | Brooklyn, N.Y. |
| 77764 | Resistance Products Co. | Harrisburg, Pa. |
| 77969 | Rubbercraft Corp. of Calif. | Torrance, Calif. |
| 78189 | Shakeproof Division of Illinois Tool Works | Elgin, Ill. |
| 78277 | Sigma | So. Braintree, Mass. |
| 78283 | Signal Indicator Corp. | New York, N.Y. |
| 78290 | Struthers-Dunn Inc. | Pitman, N.J. |
| 78452 | Thompson-Bremer & Co. | Chicago, Ill. |
| 78471 | Tilley Mfg. Co. | San Francisco, Calif. |
| 78488 | Stackpole Carbon Co. | St. Marys, Pa. |
| 78493 | Standard Thomson Corp. | Waltham, Mass. |
| 78553 | Tinnerman Products, Inc. | Cleveland, Ohio |
| 78790 | Transformer Engineers | San Gabriel, Calif. |
| 78947 | Ucinite Co. | Newtonville, Mass. |
| 79136 | Waldes Kohinoor Inc. | Long Island City, N.Y. |
| 79142 | Veeder Root, Inc. | Hartford, Conn. |
| 79251 | Wenco Mfg. Co. | Chicago, Ill. |
| 79727 | Continental-Wirt Electronics Corp. | Philadelphia, Pa. |
| 79963 | Zierick Mfg. Corp. | New Rochelle, N.Y. |
| 80031 | Mepco Division of Sessions Clock Co. | Morristown, N.J. |
| 80120 | Schnitzer Alloy Products Co. | Elizabeth, N.J. |
| 8013? | Electronic Industries Association. Any brand Tube meeting EIA Standards | Washington, DC. |
| 80207 | Unimax Switch, Div. Maxon Electronics Corp. | Wallingford, Conn. |
| 80223 | United Transformer Corp. | New York, N.Y. |
| 80248 | Oxford Electric Corp. | Chicago, Ill. |
| 80294 | Bourns Inc. | Riverside, Calif. |
| 80411 | Acro Div. of Robertshaw Controls Co. | Columbus, Ohio |
| 80486 | All Star Products Inc. | Defiance, Ohio |
| 80509 | Avery Label Co. | Monrovia, Calif. |
| 80583 | Hammarlund Co., Inc. | Mars Hill, N.C. |
| 80640 | Stevens, Arnold, Co., Inc. | Boston, Mass. |
| 80813 | Dimeco Gray Co. | Dayton, Ohio |
| 81030 | International Instruments Inc. | Orange, Conn. |
| 81073 | Grayhill Co. | LaGrange, Ill. |
| 81095 | Triad Transformer Corp. | Venice, Calif. |



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## CODE LIST OF MANUFACTURERS (Cont'd)

| Code No. | Manufacturer | Address |
|---|---|---|
| 81312 | Winchester Elec. Div. Litton Ind., Inc. | Oakville, Conn. |
| 81349 | Military Specification | . . . . . . . |
| 81483 | International Rectifier Corp. | El Segundo, Calif. |
| 81541 | Airpax Electronics, Inc. | Cambridge, Maryland |
| 81860 | Barry Controls. Div. Barry Wright Corp. | Watertown, Mass. |
| 82042 | Carter Precision Electric Co. | Skokie, Ill. |
| 82047 | Sperti Faraday Inc., Copper Hewitt Electric Div. | Hoboken, N.J. |
| 82116 | Electric Regulator Corp. | Norwalk, Conn. |
| 82142 | Jeffers Electronics Division of Speer Carbon Co. | Du Bois, Pa. |
| 82170 | Fairchild Camera & Inst. Corp. Space & Defense System Div. | Paramus, N.J. |
| 82209 | Maguire Industries, Inc. | Greenwich, Conn. |
| 82219 | Sylvania Electric Prod. Inc. Electronic Tube Division | Emporium, Pa. |
| 82376 | Astron Corp. | East Newark, Harrison, N.J. |
| 82389 | Switchcraft, Inc. | Chicago, Ill. |
| 82647 | Metals & Controls Inc. Spencer Products | Attleboro, Mass. |
| 82768 | Phillips-Advance Control Co. | Joliet, Ill. |
| 82866 | Research Products Corp. | Madison, Wis. |
| 82877 | Rotron Mfg. Co., Inc. | Woodstock, N.Y. |
| 82893 | Vector Electronic Co. | Glendale, Calif. |
| 83058 | Carr Fastener Co. | Cambridge, Mass. |
| 83086 | New Hampshire Ball Bearing, Inc. | Peterborough, N.H. |
| 83125 | General Instrument Corp., Capacitor Div. | Darlington, S.C. |
| 83148 | ITT Wire and Cable Div. | Los Angeles, Calif. |
| 83186 | Victory Eng. Corp. | Springfield, N.J. |
| 83298 | Bendix Corp., Red Bank Div. | Red Bank, N.J. |
| 83315 | Hubbell Corp. | Mundelein, Ill. |
| 83324 | Rosan Inc. | Newport Beach, Calif. |
| 83330 | Smith, Herman H., Inc. | Brooklyn, N.Y. |
| 83332 | Tech Labs | Palisade's Park, N.J. |
| 83385 | Central Screw Co. | Chicago, Ill. |
| 83501 | Gavitt Wire and Cable Co. Div. of Amerace Corp. | Brookfield, Mass. |
| 83594 | Burroughs Corp. Electronic Tube Div. | Plainfield, N.J. |
| 83740 | Union Carbide Corp. Consumer Prod. Div. | New York, N.Y. |
| 83777 | Model Eng. and Mfg., Inc. | Huntington, Ind. |
| 83821 | Loyd Scruggs Co. | Festus, Mo. |
| 83942 | Aeronautical Inst. & Radio Co. | Lodi, N.J. |
| 84171 | Arco Electronics Inc. | Great Neck, N.Y. |
| 84396 | A.J. Glesener Co., Inc. | San Francisco, Calif. |
| 84411 | TRW Capacitor Div. | Ogallala, Neb. |
| 84970 | Sarkes Tarzian, Inc. | Bloomington, Ind. |
| 85454 | Boonton Molding Company | Boonton, N.J. |
| 85471 | A.B. Boyd Co. | San Francisco, Calif. |
| 85474 | R.M. Bracamonte & Co. | San Francisco, Calif. |
| 85660 | Koiled Kords, Inc. | Hamden, Conn. |
| 85911 | Seamless Rubber Co. | Chicago, Ill. |
| 86174 | Fafnir Bearing Co. | Los Angeles, Calif. |
| 86197 | Clifton Precision Products Co., Inc. | Clifton Heights, Pa. |
| 86579 | Precision Rubber Products Corp. | Dayton, Ohio |
| 86684 | Radio Corp. of America, Electronic Comp. & Devices Div. | Harrison, N.J. |
| 86928 | Seastrom Mfg. Co. | Glendale, Calif. |
| 87034 | Marco Industries | Anaheim, Calif. |
| 87216 | Philco Corporation (Lansdale Division) | Lansdale, Pa. |
| 87473 | Western Fibrous Glass Products Co. | San Francisco, Calif. |
| 87664 | Van Waters & Rogers Inc. | San Francisco, Calif. |
| 87930 | Tower Mfg. Corp. | Providence, R.I. |
| 88140 | Cutler-Hammer, Inc. | Lincoln, Ill. |
| 88220 | Gould-National Batteries, Inc. | St. Paul, Minn. |
| 88698 | General Mills, Inc. | Buffalo, N.Y. |
| 89231 | Graybar Electric Co. | Oakland, Calif. |
| 89473 | G. E. Distributing Corp. | Schenectady, N.Y. |
| 89665 | United Transformer Co. | Chicago, Ill. |
| 90030 | United Shoe Machinery Corp. | Beverly, Mass. |
| 90179 | US Rubber Co., Consumer Ind. & Plastics Prod. Div. | Passaic, N.J. |
| 90970 | Bearing Engineering Co. | San Francisco, Calif. |
| 91146 | ITT Cannon Elect, Inc., Salem Div. | Salem, Mass. |
| 91260 | Connor Spring Mfg. Co | San Francisco, Calif. |
| 91345 | Miller Dial & Nameplate Co. | El Monte, Calif. |
| 91418 | Radio Materials Co. | Chicago, Ill. |
| 91506 | Augat Inc. | Attleboro, Mass. |
| 91637 | Dale Electronics, Inc. | Columbus, Nebr. |
| 91662 | Elco Corp. | Willow Grove, Pa. |
| 91737 | Gremar Mfg. Co., Inc. | Wakefield, Mass. |
| 91827 | K F Development Co. | Redwood City, Calif. |
| 91886 | Malco Mfg. Co., Inc. | Chicago, Ill. |
| 91929 | Honeywell Inc., Micro Switch Div. | Freeport, Ill. |
| 91961 | Nahm-Bros. Spring Co. | Oakland, Calif. |
| 92180 | Tru-Connector Corp. | Peabody, Mass. |
| 92367 | Elgeet Optical Co. Inc. | Rochester, N.Y. |
| 92607 | Tensolite Insulated Wire Co., Inc. | Tarrytown, N.Y. |
| 92702 | IMC Magnetics Corp. | Westbury Long Island, N.Y. |
| 92966 | Hudson Lamp Co. | Kearney, N.J. |
| 93332 | Sylvania Electric Prod. Inc. Semiconductor Div. | Woburn, Mass. |
| 93369 | Robbins & Myers Inc. | Palisades Park, N.J. |
| 93410 | Stemco Controls, Div. of Essex Wire Corp. | Mansfield, Ohio |
| 93632 | Waters Mfg. Co. | Culver City, Calif. |
| 93929 | G. V. Controls | Livingston, N.J. |
| 94137 | General Cable Corp. | Bayonne, N.J. |
| 94144 | Raytheon Co., Comp. Div., Ind. Comp. Operations | Quincy, Mass. |
| 94148 | Scientific Electronics Products, Inc. | Loveland, Colo |
| 94154 | Wagner Elect. Corp., Tung-Sol Div. | Newark, N.J. |
| 94197 | Curtiss-Wright Corp. Electronics Div. | East Paterson, N.J. |
| 94222 | South Chester Corp. | Chester, Pa. |
| 94330 | Wire Cloth Products, Inc. | Bellwood, Ill. |
| 94375 | Automatic Metal Products Co. | Brooklyn, N.Y. |
| 94682 | Worcester Pressed Aluminum Corp. | Worcester, Mass. |
| 94696 | Magnecraft Electric Co. | Chicago, Ill. |
| 95023 | George A. Philbrick Researchers, Inc. | Boston, Mass. |
| 95236 | Allies Products Corp., | Dania, Fla. |
| 95238 | Continental Connector Corp. | Woodside, N.Y. |
| 95263 | Leecraft Mfg. Co., Inc. | Long Island, N.Y. |
| 95265 | National Coil Co. | Sheridan, Wyo. |
| 95275 | Vitramon, Inc | Bridgeport, Conn. |
| 95348 | Gordos Corp. | Bloomfield, N.J. |
| 95354 | Methode Mfg. Co. | Rolling Meadows, Ill. |
| 95566 | Arnold Engineering Co. | Marengo, Ill. |
| 95712 | Dage Electric Co., Inc. | Franklin, Ind. |
| 95984 | Siemon Mfg. Co. | Wayne, Ill. |
| 95987 | Weckesser Co. | Chicago, Ill. |
| 96067 | Microwave Assoc., West Inc. | Sunnyvale, Calif. |
| 96095 | Hi-Q Div. of Aerovox Corp. | Olean, N.Y. |
| 96256 | Thordarson-Meissner Inc. | Mt. Carmel, Ill. |
| 96296 | Solar Manufacturing Co. | Los Angeles, Calif. |
| 96306 | Microswitch, Div. of Minn.-Honeywell | Freeport, Ill. |
| 96330 | Carlton Screw Co. | Chicago, Ill. |
| 96341 | Microwave Associates, Inc. | Burlington, Mass. |
| 96501 | Excel Transformer Co. | Oakland, Calif. |
| 96733 | San Fernando Elect. Mfg. Co. | San Fernando, Calif. |
| 96881 | Thomson Ind. Inc. | Long Is., N.Y. |
| 97464 | Industrial Retaining Ring Co. | Irvington, N.J. |
| 97539 | Automatic & Precision Mfg. | Englewood, N.J. |
| 97979 | Reon Resistor Corp. | Yonkers, N.Y. |
| 97983 | Litton System Inc., Adler-Westrex Commun. Div. | New Rochelle, N.Y. |
| 98141 | R-Tronics, Inc. | Jamaica, N.Y. |
| 98159 | Rubber Teck, Inc. | Gardena, Calif. |
| 98220 | Hewlett-Packard Co., Moseley Div. | Pasadena, Calif. |
| 98278 | Microdot, Inc. | So. Pasadena, Calif. |
| 98291 | Sealectro Corp | Mamaroneck, N.Y. |
| 98376 | Zero Mfg. Co. | Burbank, Calif. |
| 98410 | Etc Inc. | Cleveland, Ohio |
| 98731 | General Mills Inc., Electronics Div. | Minneapolis, Minn. |
| 98734 | Paeco Div. of Hewlett-Packard Co. | Palo Alto, Calif. |
| 98821 | North Hills Electronics, Inc. | Glen Cove, N.Y. |
| 98978 | International Electronic Research Corp. | Burbank, Calif. |
| 99109 | Columbia Technical Corp. | New York, N.Y. |
| 99313 | Varian Associates | Palo Alto, Calif. |
| 99378 | Atlee Corp. | Winchester, Mass. |
| 99515 | Marshall Ind., Capacitor Div. | Monrovia, Calif. |
| 99707 | Control Switch Division, Controls Co. of America | El Segundo, Calif. |
| 99800 | Delevan Electronics Corp. | East Aurora, N.Y. |
| 99848 | Wilco Corporation | Indianapolis, Ind. |
| 99928 | Branson Corp. | Whippany, N.J. |
| 99934 | Renbrandt, Inc. | Boston, Mass. |
| 99942 | Hoffman Electronics Corp. Semiconductor Div. | El Monte, Calif. |
| 99957 | Technology Instrument Corp. of Calif. | Newbury Park, Calif. |

THE FOLLOWING HP VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

| Code No. | Manufacturer | Address |
|---|---|---|
| 0000F | Malco Tool and Die | Los Angeles, Calif. |
| 0000Z | Willow Leather Products Corp. | Newark, N.J. |
| 000AB | ETA | England |
| 000BB | Precision Instrument Components Co. | Van Nuys, Calif. |
| 000CS | Hewlett-Packard Co., Colorado Springs | Colorado Springs, Colorado |
| 000MM | Rubber Eng. & Development | Hayward, Calif. |
| 000NN | A "N" D Mfg. Co. | San Jose, Calif. |
| 000QQ | Cooltron | Oakland, Calif. |
| 000WW | California Eastern Lab. | Burlington, Calif. |
| 000YY | S.K. Smith Co. | Los Angeles, Calif. |

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# SUPPLEMENTAL CODE LIST OF MANUFACTURERS

| Code No. | Manufacturer | Address |
|---|---|---|
| 01684 | Dearborn Electronic Laboratories, Inc. | Chicago, Ill. |
| 07115 | Corning Glass Works | Bradford, Pa. |
| 04388 | Skottie Electronics Inc. | Peckville, Penn. |
| 24446 | General Electric Co. | Schenect'ady, N.Y. |

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

CHANGE #1

Figure 7-5
Delete R5, and put straight wire in its place.
Change A4R62 to 4.3 kΩ.
Change A4R63 to 2 kΩ.
Change A4R64 to 1 kΩ.

Table 6-1
Delete R5.
Change A4R62 to 0683-4325, 4.3 kΩ ± 1% 1/4 W.
Change A4R63 to 0757-0283, 2 kΩ ± 1% 1/8 W.
Change A4R64 to 0757-0280, 1 kΩ ± 1% 1/8 W.

CHANGE #2

Figure 7-4
Change A3R9 and A3R14 to 100Ω.
Change A3R11 and A3R12 to 22.1 kΩ.
Change A3R16 to 7500Ω.

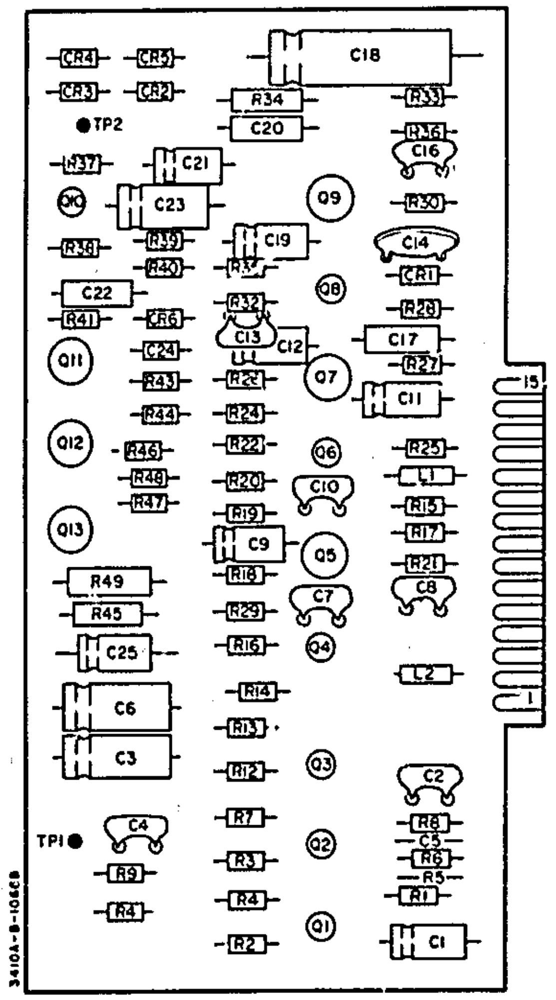
Table 6-1
Change A3R9 and A3R14 to 0757-0401, 100Ω ± 1% 1/8 W.
Change A3R11 and A3R12 to 0757-0450, 22.1 kΩ ± 1% 1/8 W.
Change A3R16 to 0757-0440, 7500Ω ± 1% met flm 1/8 W.

NOTE

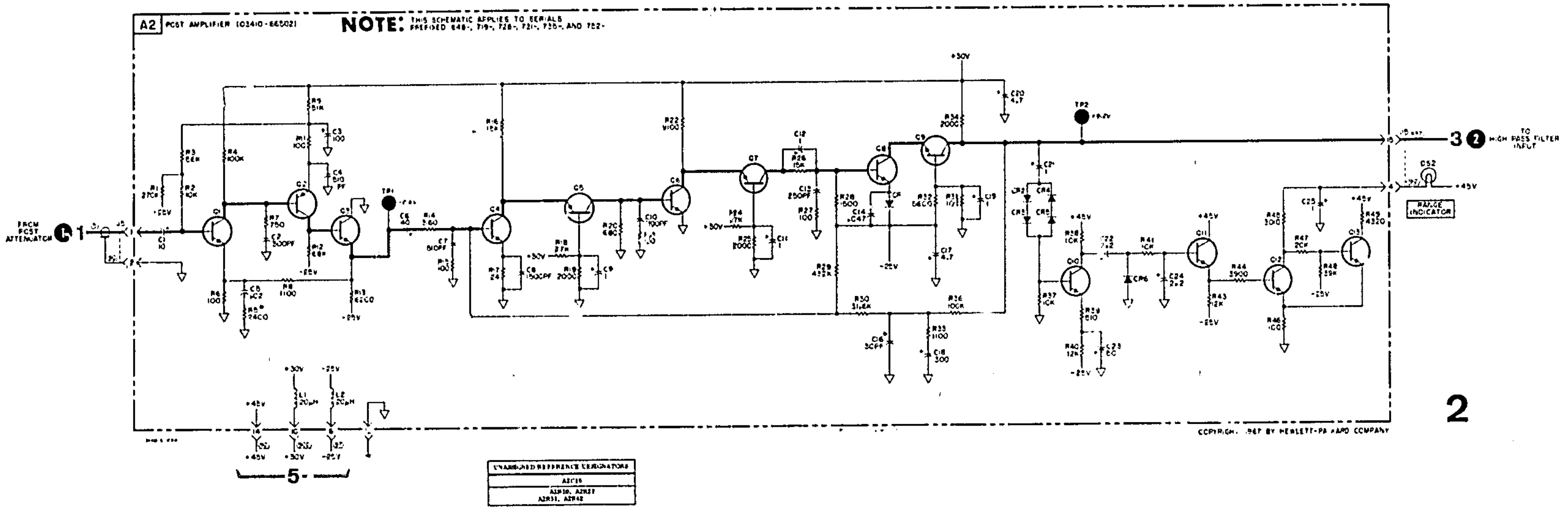
If any of the resistors are changed to the values shown in the manual, all five must be changed together.

CHANGE #3

Figure 7-4
Change the series combination of A3R4 and A3R40 to a single resistor A3R4, 0766-0013, 563Ω 3 W.



A2
(*hp* Part No. 03410-66502)



2

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 1902-3072, 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. | TQ | DESCRIPTION | MFR. | MFR. PART NO. |
|---|---|---|---|---|---|
| A2 | 03410-66502 | 1 | Assembly: Amplifier Board | -hp- | |
| A2C1 | 0180-0224 | | C: fxd Al elect 10 µF +75% -10% 15 vdcw | 56289 | 30D106G015BA4 |
| A2C2 | 0160-2207 | 2 | C: fxd mica 300 pF ±5% | 04062 | RDM15F301J3C |
| A2C3 | 0180-0061 | 2 | C: fxd Al elect 100 µF +75% -10% 15 vdcw | 56289 | 30D107G015DC2-DSM |
| A2C4 | 0160-0362 | 2 | C: fxd mica 51[illegible] ±5% | 04062 | RDM15F511J3C |
| A2C5 | | | Not assigned | | |
| A2C6 | 0180-0050 | 1 | C: fxd Al elect 40 µF +75% -10% 50 vdcw | 56289 | 30D406G050DD2-DS |
| A2C7 | 0160-0362 | | C: fxd mica 510 pF ±5% | 04062 | RDM15F511J3C |
| A2C8 | 0140-0156 | 1 | C: fxd mica 1500 pF ±2% | 04062 | RDM19F152G3C |
| A2C9 | 0180-0119 | 5 | C: fxd Al elect 1.0 µF +75% -10% 25 vdcw | 56289 | 5C13C obd |
| A2C10 | 0160-2207 | | C: fxd mica 300 pF ±5% | 04062 | RDM15F301J3C |
| A2C11, A2C12 | 0180-0119 | | C: fxd Al elect 1.0 µF ±20% 25 vdcw | 56289 | 5C13C obd |
| A2C13 | 0160-2018 | 1 | C: fxd mica 250 pF ±5% 500 vdcw | 04062 | RDM15F251J5S |
| A2C14 | 0150-0052 | 1 | C: fxd cer 0.05 µF ±20% 400 vdcw | 56289 | 33C17A |
| A2C15 | | | Not assigned | | |
| A2C16 | 0140-0203 | 1 | C: fxd mica 30 pF ±5% | 04062 | RDM15E300J5C |
| A2C17 | 0180-0100 | 2 | C: fxd Ta elect 4.7 µF ±10% 35 vdcw | 56289 | 150D475X9035B2 |
| A2C18 | 0180-0062 | | C: fxd Al elect 300 µF +75% -10% 6 vdcw | 56289 | 30D307G006DF2-DSM |
| A2C19 | 0180-0119 | | C: fxd Al elect 1.0 µF ±20% 25 vdcw | 58289 | 5C13C |
| A2C20 | 0180-0100 | | C: fxd Ta elect 4.7 µF ±10% 35 vdcw | 56289 | 150D4[illegible]5X9035B2 |
| A2C21 | 0180-0119 | | C: fxd Al elect 1.0 µF ±20% 25 vdcw | 56289 | 5C1[illegible]C |
| A2C22 | 0180-1846 | 1 | C: fxd Ta elect 2.2 µF ±10% 35 vdcw | 56289 | 150D225X9035B2-DYS |
| A2C23 | 0180-0033 | 1 | C: fxd Al elect 50 µF +100% -10% 6 vdcw | 56289 | 30D506G006CB2-DSM |
| A2C24 | 0180-0155 | 1 | C: fxd Ta elect 2.2 µF ±20% 20 vdcw | 56289 | 150D225X0020A2-DYS |
| A2C25 | 0180-0269 | | C: fxd Al elect 1 µF +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 μH 2.6Ω 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 | 1854-0216 | | TSTR: Si NPN 2N3904 | 04713 | obd |
| A2Q5 | 1853-0016 | 2 | TSTR: Si PNP 2N3638 | 07263 | 2N3638 |
| A2Q6 | 1854-0071 | 3 | 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 ±1% 1/4 W | 19701 | MF5C T-O obd |
| A2R2 | 0683-1035 | 5 | R: fxd comp 10 KΩ ±5% 1/4 W | 01121 | CB 1035 |
| A2R3 | 0683-5635 | 1 | R: fxd comp 56 KΩ ±5% 1/4 W | 01121 | CB 5635 |
| A2R4 | 0683-1045 | | R: fxd comp 100 KΩ ±5% 1/4 W | 01121 | CB 2745 |
| A2R5 | | | Not assigned | | |
| A2R6 | 0698-5438 | 1 | R: fxd prec met flm 100Ω ±1/4% 1/8 W | 75042 | CEA T-2 obd |
| A2R7 | 0683-7515 | 1 | R: fxd comp 750Ω ±5% 1/4 W | 01121 | CB 7515 |
| A2R8 | 0698-5444 | 2 | R: fxd prec met flm 1100Ω ±1/4% 1/8 W | 75042 | CEA T-2 obd |
| A2R9 | 0683-5135 | 1 | R: fxd comp 51K ±5% 1/4 W | 01121 | CB 3035 |
| A2R10 | | | Not assigned | | |
| A2R11 | 0683-1015 | 3 | R: fxd comp 100Ω ±5% 1/4 W | 01121 | CB 1015 |
| A2R12 | 0683-6835 | 5 | R: fxd comp 68K ±5% 1/4 W | 01121 | CB 1525 |
| A2R13 | 0683-6225 | 1 | R: fxd comp 6200Ω ±5% 1/4 W | 01121 | CB 6225 |
| A2R14 | 0698-5440 | 1 | R: fxd prec met flm 3160Ω ±1/4% 1/8 W | 75042 | CEA T-2 obd |
| A2R15 | 0683-1015 | | R: fxd comp 100Ω ±5% 1/4 W | 01121 | CB 1015 |
| A2R16 | 0683-1535 | | R: fxd comp 15 KΩ ±5% 1/4 W | 01121 | CB 1535 |
| A2R17 | 0683-2405 | | R: fxd comp 24Ω ±5% 1/4 W | 01121 | CB 2405 |
| A2R18 | 0683-2735 | 2 | R: fxd comp 27 KΩ ±5% 1/4 W | 01121 | CB 2735 |
| A2R19 | 0683-2025 | 4 | R: fxd comp 2000Ω ±5% 1/4 W | 01121 | CB 2025 |
| A2R20 | 0683-6815 | 1 | R: fxd comp 680Ω ±5% 1/4 W | 01121 | CB 6815 |
| A2R21 | 0683-1515 | 1 | R: fxd comp 150Ω ±5% 1/4 W | 01121 | CB 1515 |
| A2R22 | 0683-9125 | 1 | R: fxd comp 9100Ω ±5% 1/4 W | 01121 | CB 9125 |
| A2R23 | | | Not assigned | | |
| A2R24 | 0683-2735 | | R: fxd comp 27K ±5% 1/4 W | 01121 | CB 2735 |
| A2R25 | 0683-2025 | | R: fxd comp 2000Ω ±5% 1/4 W | 01121 | CB 2025 |
| A2R26 | 0683-1535 | | R: fxd comp 15KΩ ±5% 1/4 W | 01121 | CB 1535 |
| A2R27 | 0683-1015 | | R: fxd comp 100Ω ±5% 1/4 W | 01121 | CB 1015 |
| A2R28 | 0683-1525 | 1 | R: fxd comp 1500Ω ±5% 1/4 W | 01121 | CB 1525 |
| A2R29 | 0757-0480 | 1 | R: fxd prec met flm 432 KΩ ±1% 1/8 W | 19701 | MF5C T-O obd |
| A2R30 | 0698-5446 | 1 | R: fxd prec met flm 31.6 KΩ ±1/4% 1/8 W | 75042 | CEA T-2 obd |
| A2R31 | | | Not assigned | | |
| A2R32 | 0683-5625 | 1 | R: fxd comp 5600Ω ±5% 1/4 W | 01121 | CB 5625 |
| A2R33 | 0698-5444 | | R: fxd prec met flm 1100Ω ±1/4% 1/8 W | 75042 | CEA T-2 obd |
| A2R34 | 0757-0739 | 1 | R: fxd prec met flm 2000Ω ±1% 1/4 W | 19701 | MF5C T-O obd |
| A2R35 | 0683-1035 | | R: fxd comp 10 KΩ ±5% 1/4 W | 01121 | CB 1035 |
| A2R36 | 0698-3190 | 1 | R: fxd prec met flm 100 KΩ ±1/4% 1/8 W | 75042 | CEA T-2 obd |
| A2R37, A2R38 | 0683-1035 | | R: fxd comp 10 KΩ ±5% 1/4 W | 01121 | CB 1035 |
| A2R39 | 0683-5115 | | R: fxd comp 510Ω ±5% 1/4 W | 01121 | CB 5115 |
| A2R40 | 0683-1235 | | R: fxd comp 12K ±5% 1/4 W | 01121 | CB 1235 |
| A2R41 | 0683-1035 | | R: fxd comp 10 KΩ ±5% 1/4 W | 01121 | CB 1035 |
| A2R42 | | | Not assigned | | |
| A2R43 | 0683-1235 | 2 | R: fxd comp 12K ±5% 1/4 W | 01121 | CB 1235 |
| A2R44 | 0683-3925 | 1 | R: fxd comp 3900Ω ±5% 1/4 W | 01121 | CB 3925 |
| A2R45 | 0757-0339 | 1 | R: fxd prec met flm 3010Ω ±1% 1/4 W | 19701 | MF6C T-O obd |
| A2R46 | 0757-0401 | 1 | R: fxd prec met flm 100Ω ±1% 1/8 W | 75042 | CEA T-O obd |
| A2R47 | 0683-2035 | 1 | R: fxd comp 20 KΩ ±5% 1/4 W | 01121 | CB 2035 |
| A2R48 | 0683-3935 | 1 | R: fxd comp 39 KΩ ±5% 1/4 W | 01121 | CB 3935 |
| A2R49 | 0757-0831 | | R: fxd prec met flm 4320Ω ±1% 1/2 W | 01121 | CB 0831 |

# MANUAL CHANGES

MODEL 3410A

AC MICROVOLTMETER

-hp- Part No. 03410-90002

➡ New or Revised Item

**ERRATA: for all instruments**

**Page 2-1, Paragraph 2-4.** The Performance Checks should refer to Paragraph 5-5.

➡ **Page 2-1, Paragraph 2-6.** Power requirements should be listed as 48 to 440 Hz.

➡ **Page 3-1, Paragraph 3-9(d).** The RANGE INDICATOR will usually stay lit when on the lowest range.

**Page 5-6, Figure 5-4.** Change A3R16 to A3R15.

**Page 5-6, Paragraph 5-30(b).** Adjust A1R10 for 7.5 V ± 5 V.

**Page 5-8, Paragraph 5-42(c).** Line 2 should read A4TP4.

**Page 5-8, Paragraph 5-45.** Paragraph 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 µF (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 Ω to description of A3R4.

➡ **Page 6-9.** Change A4Q9, Q19 to 1854-0475.

**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.

➡ **Page 7-13/7-14.** On later instruments, the primary power wiring colors have been changed to conform to IEC standards.

➡ **CHANGE NO. 1: for Instrument Serial No.'s 842-00571 and Greater.**

**Page 6-9.** Add A4CR30, -hp- Part No. 1901-0025, description same as A4CR15.

**Page 7-11/7-12.** Add A4CR30 in series with R33. The cathode of CR30 is connected to Q12.

**CHANGE NO. 2: for Instrument Serial No.'s 953-00721 and Greater.**

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

**Page 6-11.** Change F1 to 2110-0202, 500 mAT.
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 NO. 3: for Instrument Serial No.'s 953-00801 and Greater.**

**Page 6-6.** Change A3C17 to 0180-0387, C: fxd 47 µF (Same as C18).

➡ **CHANGE NO. 4: for Instrument Serial No.'s 0953A00901 and Greater.**

**Page 6-12.** Change S4 to -hp- Part No. 3101-1248.