HEWLETT-PACKARD COMPANY / OPERATING AND SERVICE MANUAL

# 101A

## 1 MC OSCILLATOR

## 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.

hp FURTHER CERTIFIES THAT ITS CALIBRATION MEASUREMENTS ARE TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS TO THE EXTENT ALLOWED BY THE BUREAU'S CALIBRATION FACILITY.

OPERATING AND SERVICE MANUAL

# MODEL 101A

SERIALS PREFIXED: 220 -

# 1-MC OSCILLATOR



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# SECTION I
# GENERAL INFORMATION

## 1-1. GENERAL.

1-2. The Hewlett-Packard Model 101A 1 MC Oscillator (figure 1-1) is a high-stability, crystal-controlled oscillator providing low-distortion 1-mc and 100-kc outputs. Long-term stability of 5 parts in $10^8$ per week is attained by careful oscillator design and by housing a high-quality crystal in a constant-temperature oven. A front panel adjustment allows oscillator adjustments of approximately 1 part in $10^6$. Internal adjustment allows approximately 6 parts in $10^6$ total range.

## 1-3. USES.

1-4. The Model 101A supplies at least 1 volt rms into a 50-ohm load. As many as 20 Hewlett-Packard Model 5275A Time Interval Counters can be supplied time base signals by the Model 101A(assuming counters are at oscillator location). It can be used as a high-performance secondary frequency standard or as an external time base for many types of electronic counters. The low output impedance of the Model 101A makes it compatible with 50-ohm distribution systems, allowing one precision oscillator to supply signals to several systems. This eliminates errors caused by using timing signals from different oscillators.

## 1-5. SERIAL PREFIX.

1-6. The Model 101A carries a five-digit serial number with a three-digit prefix (000-00000). If the prefix number on the instrument agrees with the prefix number noted on the title page, this manual applies to that instrument directly. Manual changes may be included with the manual to describe changes which are necessary so that it can be used with instruments having other serial prefixes.

Table 1-1. Specifications

STABILITY:
Short term, 3 parts in $10^8$
Long term, 5 parts in $10^8$ per week

OUTPUT FREQUENCY:
1 mc, 100 kc (sinusoidal), rear BNC connectors

OUTPUT VOLTAGES:
1-volt rms minimum into 50-ohm load

SOURCE IMPEDANCE:
Approximately 21 ohms; value depends on load; shunt capacity of 3000 pf will not appreciably load output

DISTORTION:
Less than 4% into rated load

OVEN TEMPERATURE INDICATOR:
Front panel dial thermometer

FREQUENCY ADJUSTMENT:
Front panel: screwdriver adjustment with range of approximately 1 part in $10^6$ for calibration from primary standard

INTERNAL:
Coarse adjustment inside oven sets range of front panel adjustment; total range approximately 6 parts in $10^6$

POWER:
115 or 230 volts ±10%, 50 to 1000 cps, 2 to 15 watts depending on oven cycle

ACCESSORIES FURNISHED:
Power cable, 7-1/2 feet long: three-conductor cable equipped with molded NEMA grounding-type plug and three-pin polarized connector

Signal cable, RG-58C/U, 51-1/2 inches long overall; each end equipped with UG-88/U connectors

Plug-in etched board extender, type M65A (for easy maintenance)

Set of rack-mounting hardware

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DIMENSIONS:
3-15/32 in. (8.81 cm) high, 16-3/4 in. (42.55 cm) wide, 11-1/2 in. (29.24 cm) deep behind panel

WEIGHT:
Net 12.5 lb (5.675 kg)
Shipping 19 lb (8.64 kg)

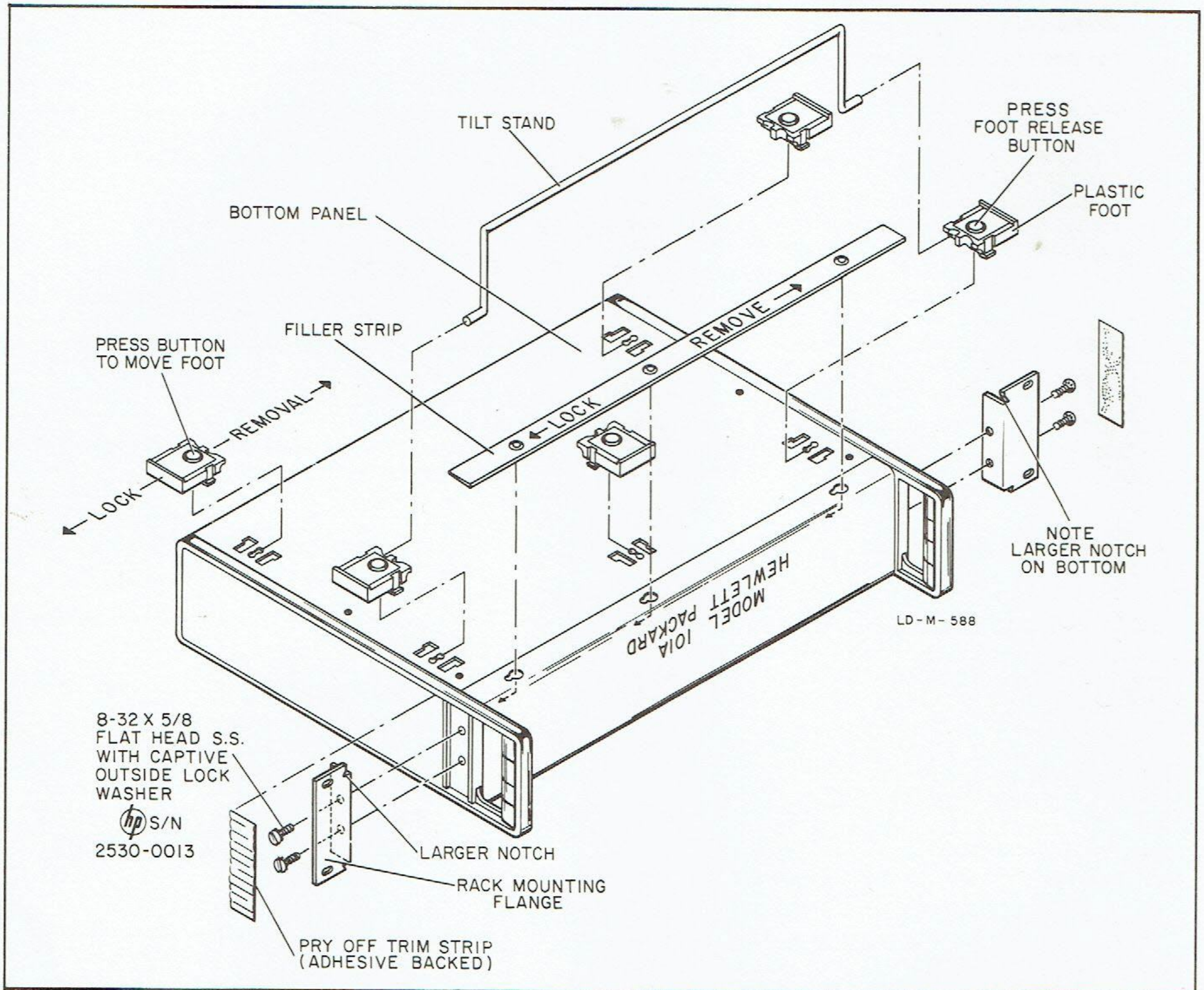



Figure 2-1. Conversion to Rack Mount

# SECTION II
# INSTALLATION

## 2-1. INTRODUCTION.

2-2. This section contains information on unpacking, inspection, repacking, storage, installation, and operation.

## 2-3. UNPACKING AND INSPECTION.

2-4. Inspect instrument for shipping damage as soon as it is unpacked. If reshipment is expected, save all packing materials to simplify repackaging. Check for broken connectors; inspect cabinet and panel surfaces for dents, scratches, and abraided areas. An electrical check of specifications is given in paragraph 5-55. If instrument is damaged in any way or fails to operate properly, notify carrier immediately to report damage (see warranty sheet or rear of manual). Carrier will arrange for repair or replacement, as necessary. Remember that your local Hewlett-Packard sales representative is ready to give assistance with any problem.

## 2-5. STORAGE AND RESHIPMENT.

2-6. PACKAGING.

2-7. To protect valuable electronic equipment during storage or shipment, always use the best packaging methods available. Your Hewlett-Packard sales representative can provide packing material such as that used in factory packaging. Contract packaging companies in many cities can provide dependable custom packaging on short notice. Here are a few recommended packaging methods:

a. ORIGINAL. Place instrument in original container. Replace fillers in the exact position which they originally occupied.

b. RUBBERIZED HAIR. Cover painted surfaces of instrument with protective wrapping paper. Pack instrument securely in strong corrugated container (350 lb/sq in. bursting test) with 2-inch rubberized hair pads placed along all surfaces of instrument. Insert fillers between pads and container to insure a snug fit.

c. EXCELSIOR. Cover painted surfaces of instrument with protective wrapping paper. Pack instrumen in strong corrugated container (350 lb/sq in. bursting test) with a layer of excelsior about six inches thick packed firmly against all surfaces of the instrument.

2-8. ENVIRONMENT LIMITS.

2-9. Conditions during storage and shipment should normally be limited as follows:

a. Maximum altitude 25,000 feet (7,620 meters).

b. Minimum temperature -40°F (-40°C).

c. Maximum temperature 167°F (75°C).

## 2-10. INITIAL INSTALLATION.

2-11. BENCH OPERATION.

2-12. The Model 101A is ready for bench operation as shipped from the factory. The instrument should be left connected to a source of power to obtain best crystal stability.

Note

The oscillator may not operate until the oven approaches normal operating temperature. This is normal.

2-13. RACK INSTALLATION.

2-14. Additional parts necessary for rack mounting are packaged with the instrument. To convert for rack installation, refer to figure 2-1 and proceed as follows:

a. Remove tilt stand.

b. Remove feet (press the foot-release button and slide foot off).

c. Remove adhesive-backed trim strips at front end of sides.

d. Attach flanges to front end of sides (larger corner-notch down).

e. Attach filler strip along bottom edge of front panel. Instrument is now ready to mount in standard 19-inch rack.

CAUTION

Ambient temperature in rack during operation should not be less than 32°F(0°C) or a maximum of 131°F (55°C).

## 2-15. OPERATION FROM 115 OR 230 VOLTS.

CAUTION

Do not connect oscillator to a 230-volt supply without first selecting 230-volt operation on rear slide switch (see below).

2-16. The Model 101A may be operated from either 115- or 230-volt (±10%) power supply. A slide switch on the rear panel permits quick conversion for operation from either voltage. Insert a narrow-blade screwdriver in the switch slot and slide switch to left for 230-volt operation ("230" marking exposed) or to the right for 115-volt operation ("115" marking exposed). The Model 101A is supplied with 115-volt fuse; be sure to replace this fuse for 230-volt operation; see table 2-1.

Table 2-1. 115/230 Volt Conversion

| Conversion | 115 volts | 230 volts |
|---|---|---|
| Slide switch (S7) | Right ("115") | Left ("230") |
| AC LINE fuse (F1) | 1/4-ampere slow-blow (hp 2110-0018) | 1/8-ampere slow-blow (hp 2110-0027) |

## 2-17. ELECTRICAL CONNECTIONS.

2-18. POWER CABLE. Model 101A is equipped with a detachable three-wire power cable. Proceed as follows for installation:

a. Connect flat plug (3-contact connector) to AC LINE jack at rear of instrument.

b. Connect plug (two-blade with round grounding pin) to three-wire (grounded) power outlet. Exposed portions of instrument are grounded through the round pin on the plug for personnel safety, when a two-blade outlet is available, use connector adapter (hp Stock No. 1251-0048), and connect short green wire from side of adapter to ground.

Note

Power is supplied continuously to oven heater circuits while cable is connected to power outlet.

2-19. OUTPUT CABLE. A 51.5-inch long, 50-ohm coaxial cable equipped with BNC male fittings is furnished which can be used to connect the oscillator output to a load.

## 2-20. OUTPUT LOADING CONSIDERATIONS.

2-21. GENERAL. The output circuits are designed for low impedance operation with a 50-ohm load. The actual value of source impedance depends somewhat on the connected load. When terminated in a 50-ohm resistive load, the 1-mc output source impedance, for example, will be 6 or 7 ohms. In the region of 50- to 25-ohm output load, the source impedance is approximately 30 ohms. A 25-ohm resistive load will reduce the output voltage to about 0.75 volt. Thus operation over the region of open circuit to 25 ohms resistive load should be satisfactory.

2-22. MAXIMUM CABLE LENGTH. The use of long unterminated lengths of cable should be limited to approximately 100 feet. Shunt capacity of 3000 pf will not appreciably affect output voltage. Longer lengths may result in inadequate voltage levels at load.

2-23. SUPPLYING MULTIPLE ELECTRONIC COUNTERS. Remember that the velocity of propagation of coaxial cable is approximately 66% of free space. The cable lengths feeding more than one counter should be as short as possible and approximately the same length. This is important when you want to avoid phase differences between time-base signals such as in multiple installation of hp Model 5275 100 MC Time Interval Counters. For example, 6 feet of cable represents approximately 10 nanoseconds of time delay.

# SECTION III
# OPERATION

## 3-1. OPERATING CONTROLS.

3-2. Figure 3-1 shows the operating controls and connectors and lists the function of each.

## 3-3. FREQUENCY CORRECTION TECHNIQUES.

3-4. To maintain the Model 101A as an accurate frequency standard, a methodical system for frequency checks and adjustment must be established. Some of the problems of frequency correction and suggested methods for precise adjustment are discussed below.

3-5. Most oscillators will slowly drift higher in frequency. For the Model 101A the maximum long-term drift is specified 5 parts in $10^8$ per week. Superimposed on this slow drift is a random, short-time frequency fluctuation. For the Model 101A the maximum short-term fluctuation is specified as ±3 parts in $10^8$.

3-6. To determine the long-term drift for a given oscillator, make daily frequency checks for perhaps a week, plot the results on a time-frequency graph, and visually average the plots. Frequency correction for the oscillator can then be made. To allow for long-term drift, reset oscillator frequency somewhat below its nominal value; see figure 3-2.

3-7. Frequency checks can be made by comparing oscillator frequency with radio station WWV or other standard-frequency broadcasting stations. The received frequency at locations within ground-wave range of the transmitter is essentially the transmitted frequency. Stations receiving a sky-wave (i.e., more than about 50 miles) may find that the received frequency differs from the transmitted frequency because of Doppler-effect frequency shift caused by both random and diurnal movement of the ionospheric reflection layers.

Note

The short time error in the received signal frequency may be as much as several parts in $10^7$ over long paths.

Since the stability of this oscillator is approximately 10 times this value, you may reduce the oscillator accuracy by indiscriminate recalibration by simple zero-beating techniques with WWV or other hf standards.

3-8. Diurnal Doppler effects may be minimized by making frequency comparisons at a time of day when the sun is about halfway between the transmitter and the receiver. For example, comparisons with WWV transmissions are usually made in California between 10:00 and 11:00 (either A.M. or P.M.). The effect of random fluctuation in received frequency can be minimized by graphic averaging of observations for perhaps a week. Omit exceptionally erratic results when averaging the plots. Refer to figure 3-2.

3-9. For additional information on frequency and time comparison systems and methods, refer to Hewlett-Packard Company Application Note 52, "Frequency and Time Standards".

## 3-10. METHODS OF CHECKING FREQUENCY.

3-11. HETERODYNE (WWV) FREQUENCY CHECK.

3-12. The following method is simple and may be used with confidence within ground-wave range of WWV (or other 20-mc standard). Using this technique at 10 or 15 mc is doubtful as excessive amounts of time are required to resolve an error of 1 part in $10^9$ (see figure 3-3).

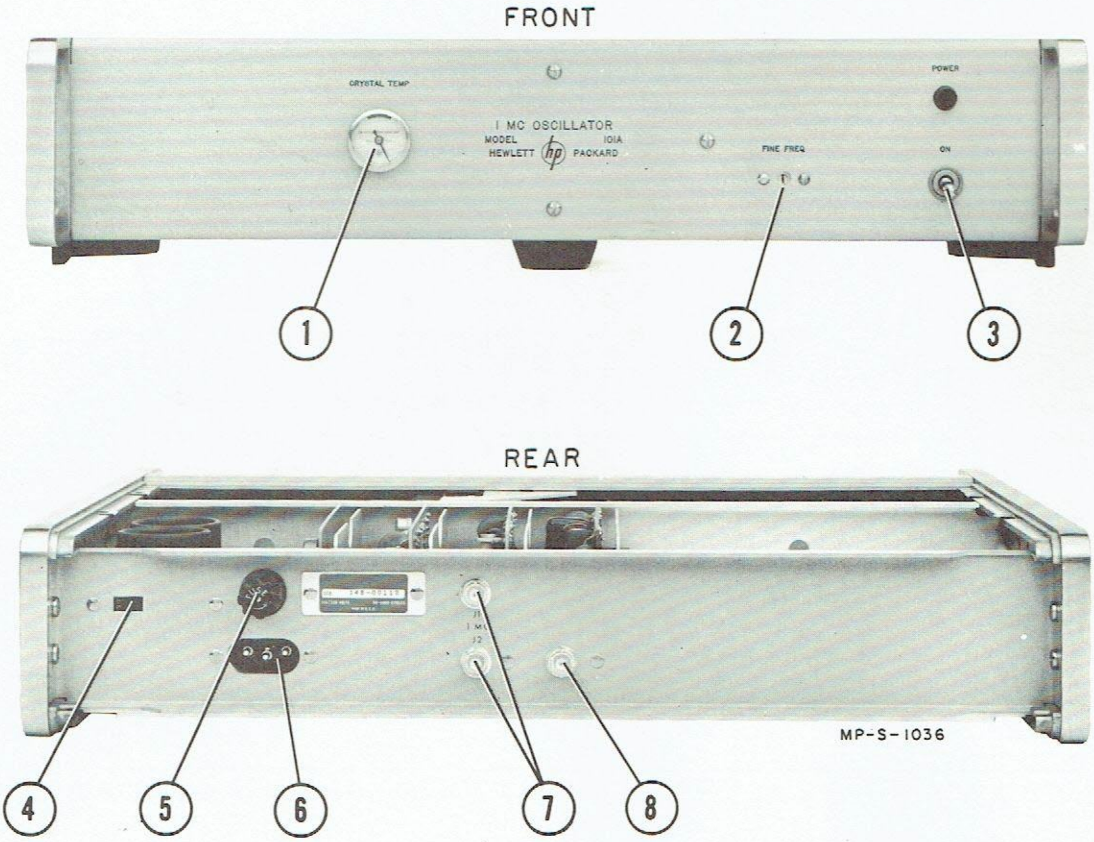
a. Couple the Model 101A output to the input of the WWV receiver by twisting the Model 101A output lead around the receiver antenna lead. A small crystal diode connected between the Model 101A output and ground will generate harmonics to allow frequency comparison at 20 mc. The coupled signal from the diode should be approximately the same strength as the incoming signal to obtain most pronounced "beat" effect.

b. Choose a time when the audio tone is off to avoid false zero beat with modulation sidebands. Estimate the beat-note frequency. The beat note will be of rather low frequency and can be sensed by watching the rise and fall of the receiver "S" meter or by listening to the rise and fall of receiver background noise.

c. Determine oscillator error. Beat frequency at 20 mc may be interpreted in terms of fractional error with the help of table 3-1.

Table 3-1. Relation of Difference Frequency at 20 mc to Standard Frequency

| Difference Frequency at 20 mc/s | Difference Ratio |
|---|---|
| 20 cycles per sec | $1/10^6$ |
| 10 cycles per sec | $5/10^7$ |
| 2 cycles per sec | $1/10^7$ |
| 1 cycle per sec | $5/10^8$ |
| 1 cycle per 5 sec | $1/10^8$ |
| 1 cycle per 10 sec | $5/10^9$ |
| 1 cycle per 50 sec | $1/10^9$ |




Front Panel

1. CRYSTAL TEMP. Indicates crystal oven temperature. Pointer should indicate at mark in green portion of scale.

2. FINE FREQ. Adjusts oscillator frequency. Caution: Read paragraph 2-16 before disturbing this control.

3. POWER ON. Applies power to oscillator (power is supplied to oven whenever oscillator is connected to ac power even with power switch in OFF position).

Rear Panel

4. 115-230 Volt Switch. Selects operation from either 115- or 230-volt ac power.

5. FUSE. 1/4-ampere slow-blow for 115-volt operation; 1/8-ampere for 230-volt operation.

6. AC POWER CONNECTOR. AC power cable connector.

7. J1, J2. 1-mc outputs.

8. J3. 100-kc output.

Note

Oscillator may not start when first turned on until oven approaches normal operating temperature. This is normal.

CAUTION

The high stability of this instrument requires that special calibration techniques be used to adjust oscillator frequency. Study paragraphs 3-3 through 3-27 before adjusting the FINE FREQ control.

Figure 3-1. Controls and Terminals

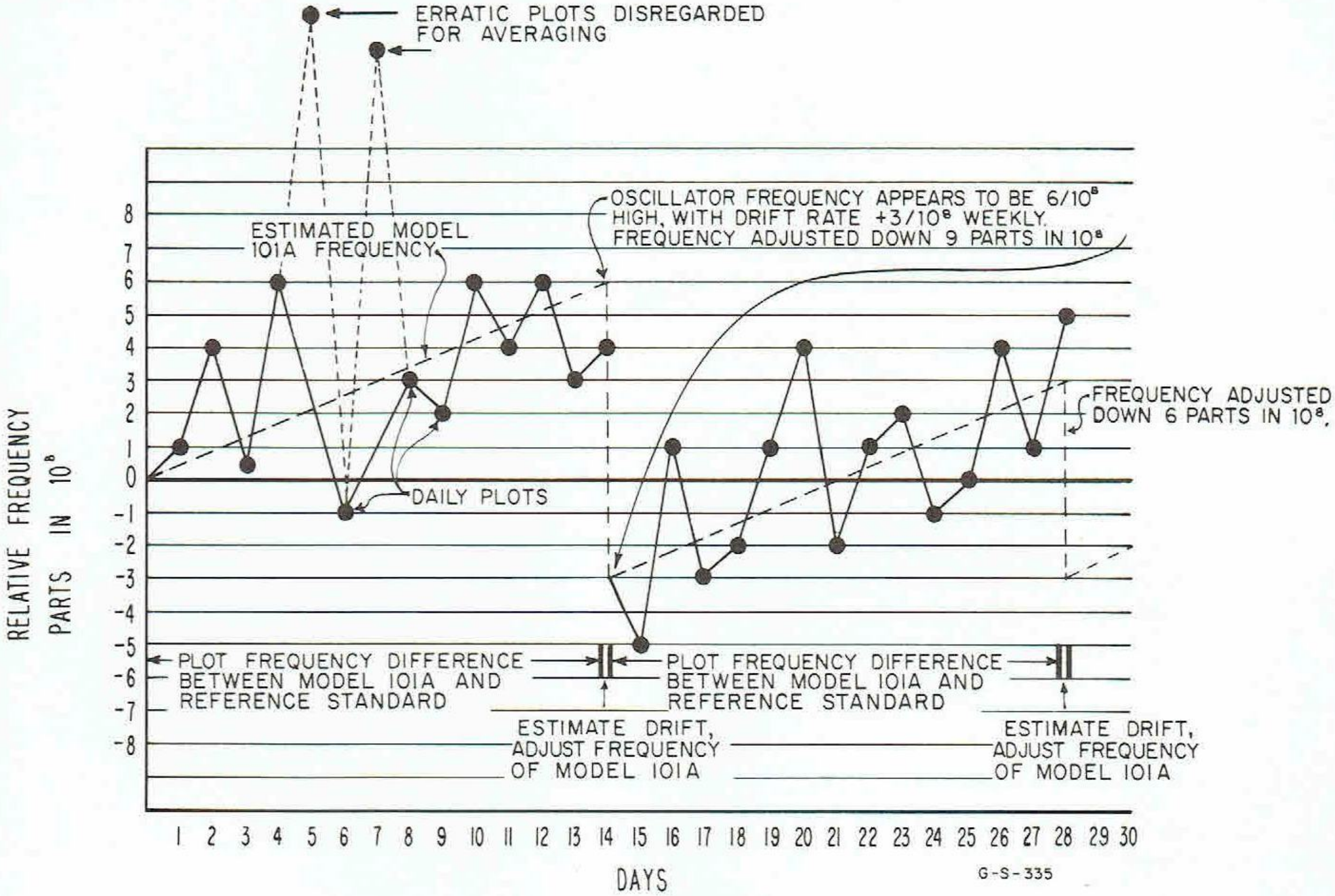



Figure 3-2. Sample Plot of Measured Frequency vs Time

d. Plot the frequency difference as shown in figure 3-2. After keeping records for perhaps a week, determine frequency correction. Adjust FINE FREQ control (screwdriver) for desired frequency. Frequency output may be determined during adjustment by measuring difference in frequency between Model 101A and WWV or by comparing Model 101A output with another more stable oscillator (see paragraph 3-17 or 3-23).

## 3-13. CARRIER SUBSTITUTION (WWV OR LOL) FREQUENCY CHECK.

3-14. Tone modulation on WWV alternates every five minutes between 440 cps and 600 cps. The carrier and upper sideband only are transmitted. The carrier substitution method involves mixing the 20-mc harmonic from Model 101A with the WWV sideband at 20 mc. By measuring the apparent shift in frequency of the transmitted 440-cps or 600-cps signal, the difference between the receiver WWV signal and the Model 101A can be determined.

3-15. This procedure offers a rather precise method for oscillator correction. It allows short-time shifts in received frequency to be averaged out at the time of measurement (the effect of longer-term frequency shift can be reduced by correction based on graphic averaging). This method is recommended for locations where there is a problem due to Doppler effect frequency shift in the received WWV signal.

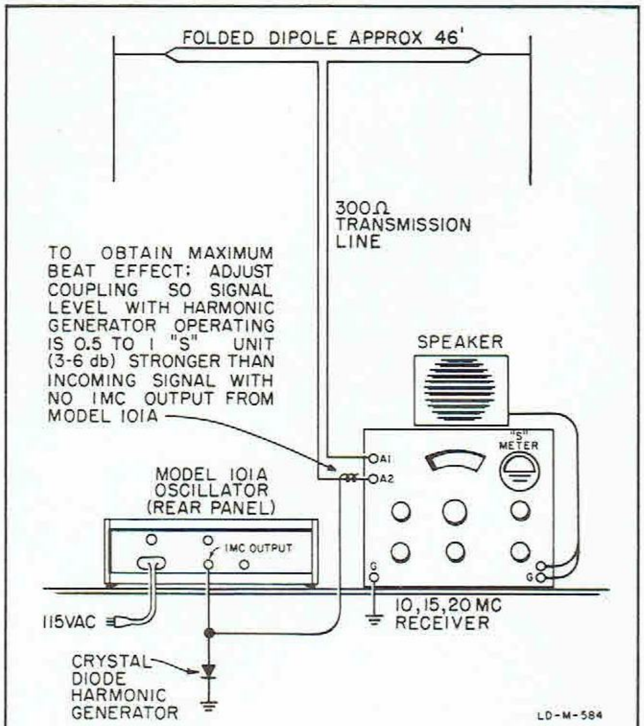



Figure 3-3. Setup for Checking Frequency within Ground-Wave Range (50 mi) of a HF Standard

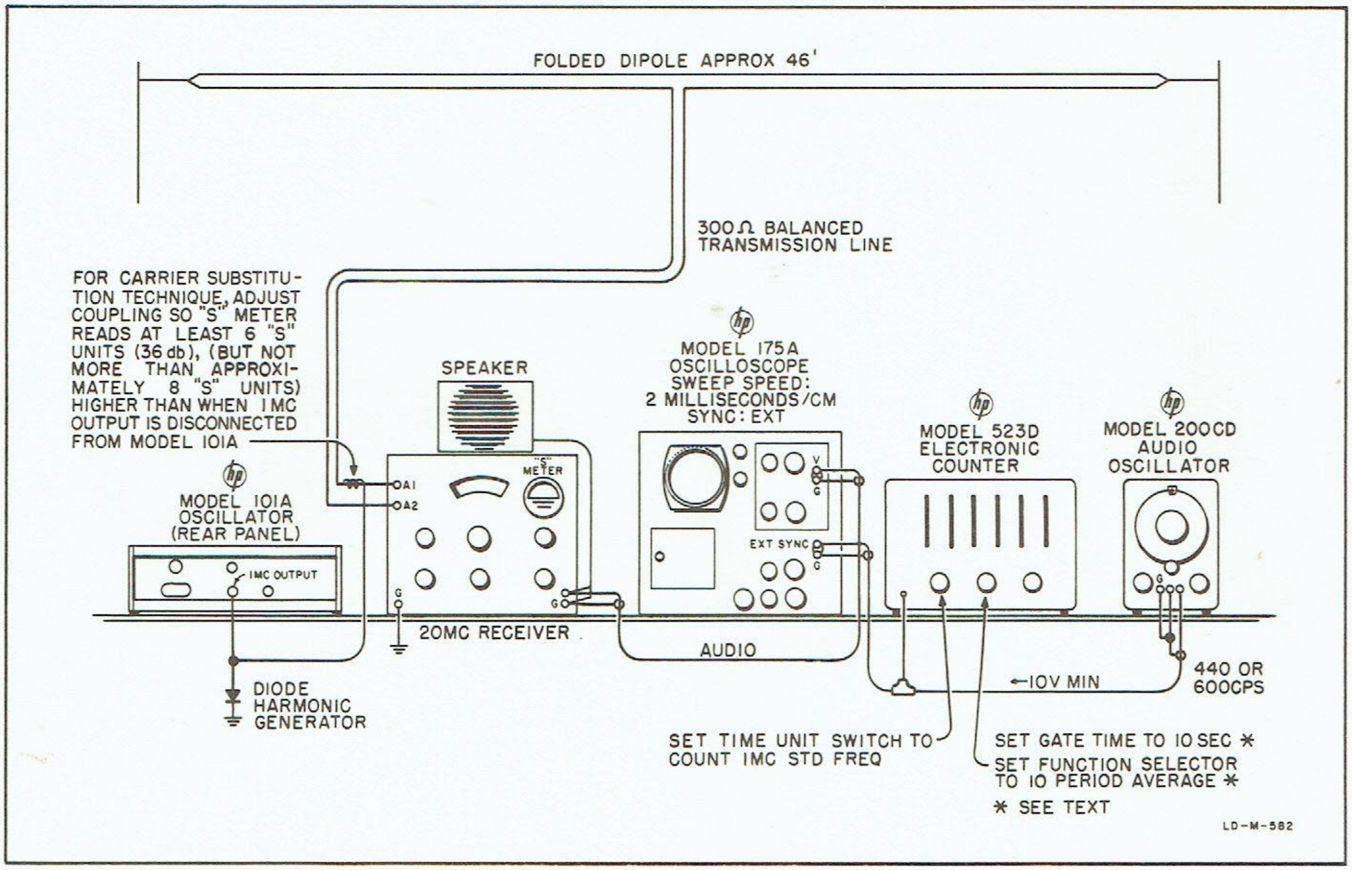



Figure 3-4. Setup for Checking Oscillator Frequency with Sky-Wave Signals from a HF Broadcast Standard (use where distance exceeds 50 miles)

3-16. Figure 3-4 is a block diagram of a typical set-up. Proceed as follows:

a. Couple the 1-mc output from Model 101A to the antenna of the WWV receiver. A small crystal diode connected between Model 101A output and ground will generate harmonics to allow frequency comparison at 20 mc. Adjust coupling so that Model 101A harmonic is much stronger than the WWV carrier but not strong enough to block the receiver. The local signal should be 30 to 40 db (5 to 7 "S" units) stronger than the received signal, otherwise false measurements may result.

b. Connect receiver audio output to vertical input of an oscilloscope with a stable sweep triggering circuit. Any hp oscilloscope may be used.

c. Connect output from a stable audio oscillator to external sync input of oscilloscope. Any hp series 200 oscillator may be used. Allow 30 minutes warmup.

Note

The power line voltage supplying the audio oscillator must be as constant and free of transients as possible to prevent oscillator frequency changes.

d. Connect output from audio oscillator to an electronic counter. Any hp (1 or 10 mc) counter which is capable of period measurement may be used.

e. Adjust oscilloscope controls for a clear presentation of the 440-cps or 600-cps WWV tone. (Vertical sensitivity: 1 volt/cm; sweep speed: 2 ms/cm.)

f. Adjust audio oscillator to 440 cps (or 600 cps) to stop pattern on oscilloscope. Short-term frequency shift of received signal may cause pattern to drift alternately to the right and left. Carefully set the audio oscillator so that the net drift of oscilloscope pattern is zero.

g. Note audio frequency indicated on electronic counter. Use 10-second gate to make measurements to minimize error due to ±1 count ambiguity in counter.

h. Repeat steps f and g every two minutes over a 20-minute period.

i. Subtract the counted frequency from WWV modulation frequency for each measurement. The average of the results is the difference frequency between average received WWV frequency and the 20-mc harmonic of Model 101A output. This may be converted to difference ratio; refer to table 3-1.

j. Plot frequency difference. After a sufficient number of daily frequency checks and plots, average the results graphically and determine oscillator correction.

## 3-17. CORRECTING OSCILLATOR FREQUENCY.

### 3-18. CARRIER SUBSTITUTION METHOD.

3-19. The Model 101A Oscillator may be adjusted using the test setup described in paragraph 3-16. Be sure that the day selected for oscillator adjustment permits a stable oscilloscope presentation. Postpone the adjustment if radio reception is not good.

3-20. If the measured frequency difference falls very close to the curve plotted from previous measurements, you can assume that the received frequency is nearly equal to the actual WWV frequency. Under this condition, monitor the audio oscillator output period on the counter and proceed as follows:

a. Adjust the audio oscillator for an output period of 1666.67 microseconds if WWV is modulating at 600 cps, or 2227.73 microseconds with 440 cps modulation. (Use 10 PERIOD AVERAGE on counter.) Counter controls should be set to: 1 MC STD. FREQ. COUNTED; 10 PERIOD AVERAGE. Output from audio oscillator should be at least 1 volt rms to obtain high signal-to-noise ratio for stable period measurements.

3-21. If accuracy within 1 part in $10^7$ is acceptable, the frequency may be set 1 part in $10^7$ low. The actual frequency will drift higher with time. At the end of four weeks the frequency will be less than 1 part in $10^7$ high. Recalibration at the end of one month can be made to reset the oscillator to 1 part in $10^7$ low. This is done as follows:

3-22. The Model 101A frequency is to be set one part in $10^7$ low. This is equivalent to 2 cps at 20 mc (table 3-1). The desired audio frequency from mixing the 20-mc harmonic of Model 101A and the 440- or 600-cps WWV modulation is therefore 442 or 602 cps respectively. (WWV transmits upper side band only.) The equivalent period is 1/442 cps = 1661.12 microseconds and 1/602 cps = 2262.44 microseconds. Set audio oscillator frequency for appropriate period indication on counter. Adjust FINE FREQ of the Model 101A control to stop oscilloscope pattern.

### 3-23. FREQUENCY ADJUSTMENT WITH LISSAJOUS.

3-24. Model 101A can be set to the frequency of a local primary standard with a simple Lissajous-figure frequency comparison. The check requires 17 minutes to resolve 1 part in $10^9$ error. Proceed as follows:

a. Connect the 1-mc output to one oscilloscope axis.

b. Connect the 1-mc from the primary standard to the other oscilloscope input.

c. Adjust FINE FREQ control of Model 101A to stop oscilloscope pattern. Extremely small frequency differences can be determined if you adjust Model 101A so that oscilloscope pattern is a very narrow ellipse. Increase both horizontal and vertical gain. Watch diagonal lines carefully and adjust FINE FREQ control to keep lines stationary (see figure 3-5). One cycle of drift in 17 minutes represents 1 part in $10^9$ error.

### 3-25. FREQUENCY ADJUSTMENT WITH TRIGGERED OSCILLOSCOPE.

3-26. This is a variation of the Lissajous-figure comparison method. This method provides rather accurate determination of frequency, and it allows accurate adjustment to a frequency slightly different from that of the local primary standard to allow for anticipated drift. This method can be used with any oscilloscope having a stable triggering circuit and 1-mc or higher frequency response.

a. Connect Model 101A and primary standard to oscilloscope as shown in figure 3-6.

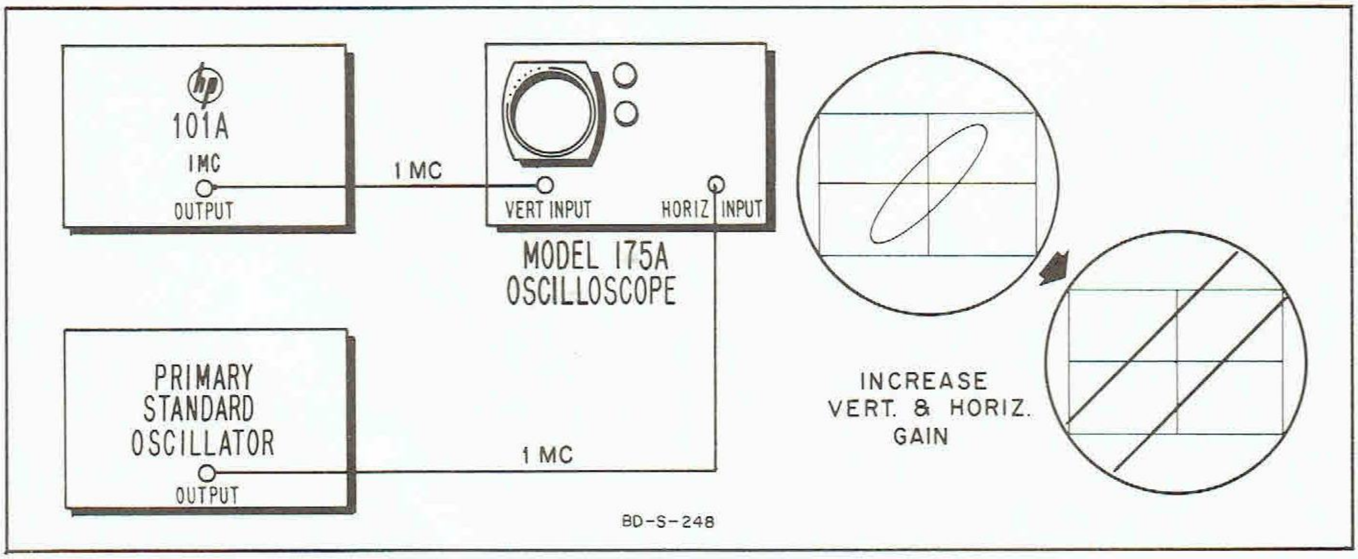



Figure 3-5. Setup for Checking Oscillator Frequency with a Local Standard using Lissajous Pattern

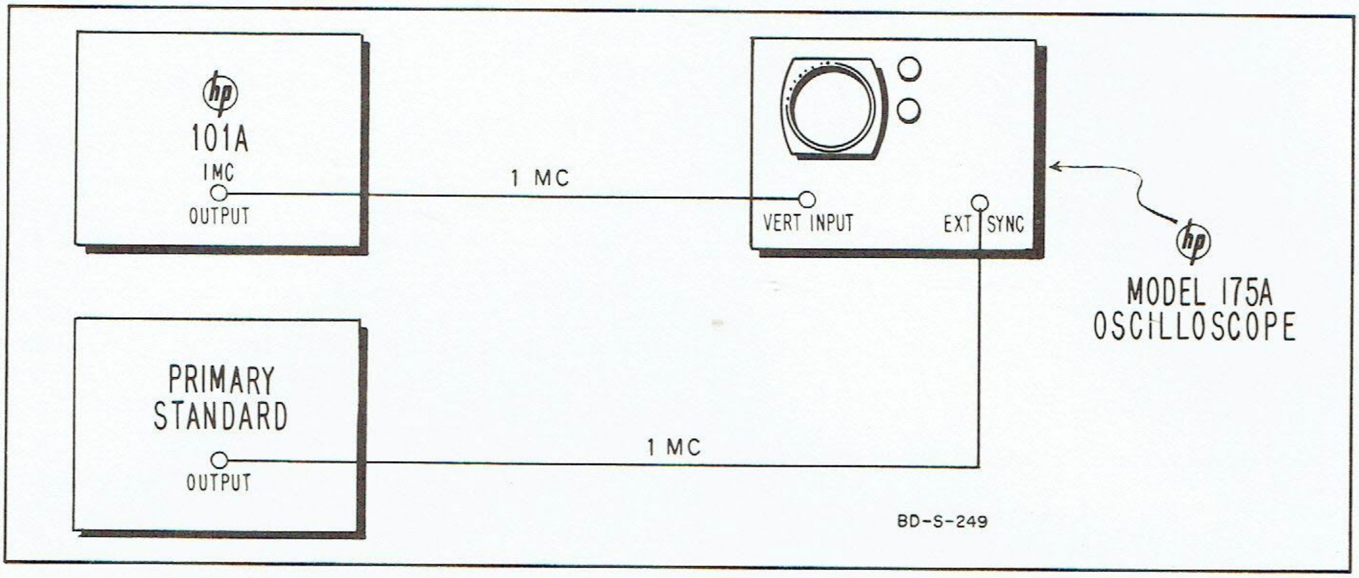



Figure 3-6. Setup for Checking Oscillator Frequency with a Local Standard using Oscilloscope Triggered Sweep Technique

b. Adjust oscilloscope to show five complete cycles (sweep speed = 2 $\mu$s/cm).

c. Oscillator error may be determined by observing the rate of drift of oscilloscope pattern. If pattern moves to the right, Model 101A frequency is low compared to the primary standard. If pattern moves to the left, Model 101A frequency is high compared to the primary standard. Movement of pattern may be accurately checked using an oscilloscope with calibrated sweeps. You can increase the resolution on oscilloscope by using an expanded display. Expand horizontal sweep; increase vertical gain; time the movement of point at which the oscilloscope trace crosses base line.

3-27. MEASURING DIFFERENCE FREQUENCY. The reciprocal of time in seconds for oscilloscope pattern to move the apparent width of one cycle equals frequency difference in parts in $10^6$ with 1-mc inputs. For example, if oscilloscope pattern drifts to the left at a rate of one cycle's width every 10 seconds (1/10 "cycle" every second) with 1-mc inputs, Model 101A oscillator frequency is 1/10 part in $10^6$ or 1 part in $10^7$ high.

3-28. MEASUREMENT TIME FOR SPECIFIED ACCURACY. One cycle of drift in 100 seconds equals 1 part in $10^8$ error. One cycle of drift in 1000 seconds, or approximately 16.7 minutes, equals 1 part in $10^9$ error.

# SECTION IV
# CIRCUIT DESCRIPTION

## 4-1. GENERAL DESCRIPTION.

4-2. Refer to the overall block diagram in figure 4-1. The Model 101A consists of four basic sections. They are:

a. 1-mc crystal oscillator and amplifier;

b. 1-mc output amplifier;

c. frequency-divider chain and 100-kc output amplifier; and

d. -20 volt output regulated power supply.

## 4-3. CRYSTAL OSCILLATOR.

4-4. The crystal oscillator used a quartz crystal in a modified Pierce circuit which operates at 1 mc.

4-5. CRYSTAL OSCILLATOR OVEN. The crystal oven contains two bifilar-wound 500-ohm resistors which operate from a nominal 115 volts ac whenever the instrument is connected to a 115/230-volt source of power. The 115-volt input is supplied from a 2:1 step-down autotransformer (T1) when instrument is supplied from a 230-volt source. The bifilar winding cancels out the inductance in the winding which would otherwise introduce transients into the oscillator circuit whenever the thermostat opens.

4-6. OVEN THERMOSTAT. The oven contains a bimetallic thermostat which holds the temperature constant within ±0.5°C. The actual temperature is between 62° and 75°C. The exact temperature is set at the factory to match the particular temperature at which the crystal temperature coefficient is zero.

4-7. Each crystal has its frequency vs temperature curve measured and the exact temperature at which the coefficient goes from negative to positive is recorded. The thermostat operating temperature is then set to maintain that temperature.

4-8. THERMOSTAT CONSTRUCTION. The thermostat is enclosed in a glass capsule to prevent contamination. The temperature is factory-set by using a small powerful permanent magnet to rotate a tee-shaped adjusting screw inside the glass tube. The special equipment needed to measure crystal frequency vs temperature precludes doing this in the field. Factory matched crystals and ovens are available if replacement ever becomes necessary.

## 4-9. 1-MC CRYSTAL OSCILLATOR CIRCUITS.

4-10. OSCILLATOR EQUIVALENT CIRCUIT.

4-11. The oscillator circuit consists of A2Q1, C2, C10, and Y1. Operation can be easily understood by referring to the basic circuit shown in figure 4-4. Capacitors C2, C6, and C10 constitute a capacitive voltage divider which feeds back part of the signal to the emitter. The base is effectively grounded to ac through C5. Crystal Y1 electrically behaves as an inductance in series with a few ohms resistance. Y1, together with C2 and C10, forms a circuit resonant at 1 mc.

4-12. Capacitors A3C3 and A3C5 (refer to figure 5-11), together with their respective shunt trimmers A3C4 and C11, bring the whole circuit into exact resonance at 1 mc. Inductor A2L1 shunts A3C2 to prevent oscillation on a spurious mode at 173 kc. At 1 mc the reactance of A2L1 is high and does not affect the circuit.

4-13. OSCILLATOR AMPLIFIER.

4-14. The crystal oscillator is followed by an isolation amplifier, A2Q2 and A2Q3, and an output amplifier and emitter follower A2Q4. The two-stage amplifier is stabilized by negative feedback from the junction of A2R16 and A2R17 through A2C9 to the emitter of A2Q2. The negative feedback stabilizes amplifier gain and raises its input impedance to minimize loading the crystal oscillator A2Q1.

4-15. The last stage, A2Q4, is both an amplifier and an emitter follower. An output is taken from the collector load A2L2 which is fed back to supply the automatic gain control circuit (described below). In addition, the emitter supplies the output signal from the oscillator circuit board, A2, to pin 14 of the circuit board connector.

4-16. AUTOMATIC GAIN CONTROL CIRCUIT.

4-17. GENERAL DESCRIPTION. In order to obtain a highly stable output frequency, it is necessary to operate the crystal at a very low and constant oscillation level. This is accomplished with a high gain amplifier following the oscillator together with a sensitive oscillator gain control system.

4-18. Capacitor A2C16, together with diodes A2CR1, A2CR2, and capacitors A2C1 and A2C2 constitute a voltage doubler circuit. A negative output voltage is developed across A2C2 which is proportional to the 1-mc output level at A2Q4. A2R2 and A2R3 provide fixed bias current to the base of A2Q1.

4-19. Resistor A2R7 (a fairly high value) is a constant current source for the emitter of A2Q1. The current flow out of A2R7 divides between the emitter of A2Q1 and the agc supply at A2C2.

4-20. At this point it is well to remember that the gain (beta) of a transistor is a function of the emitter current.

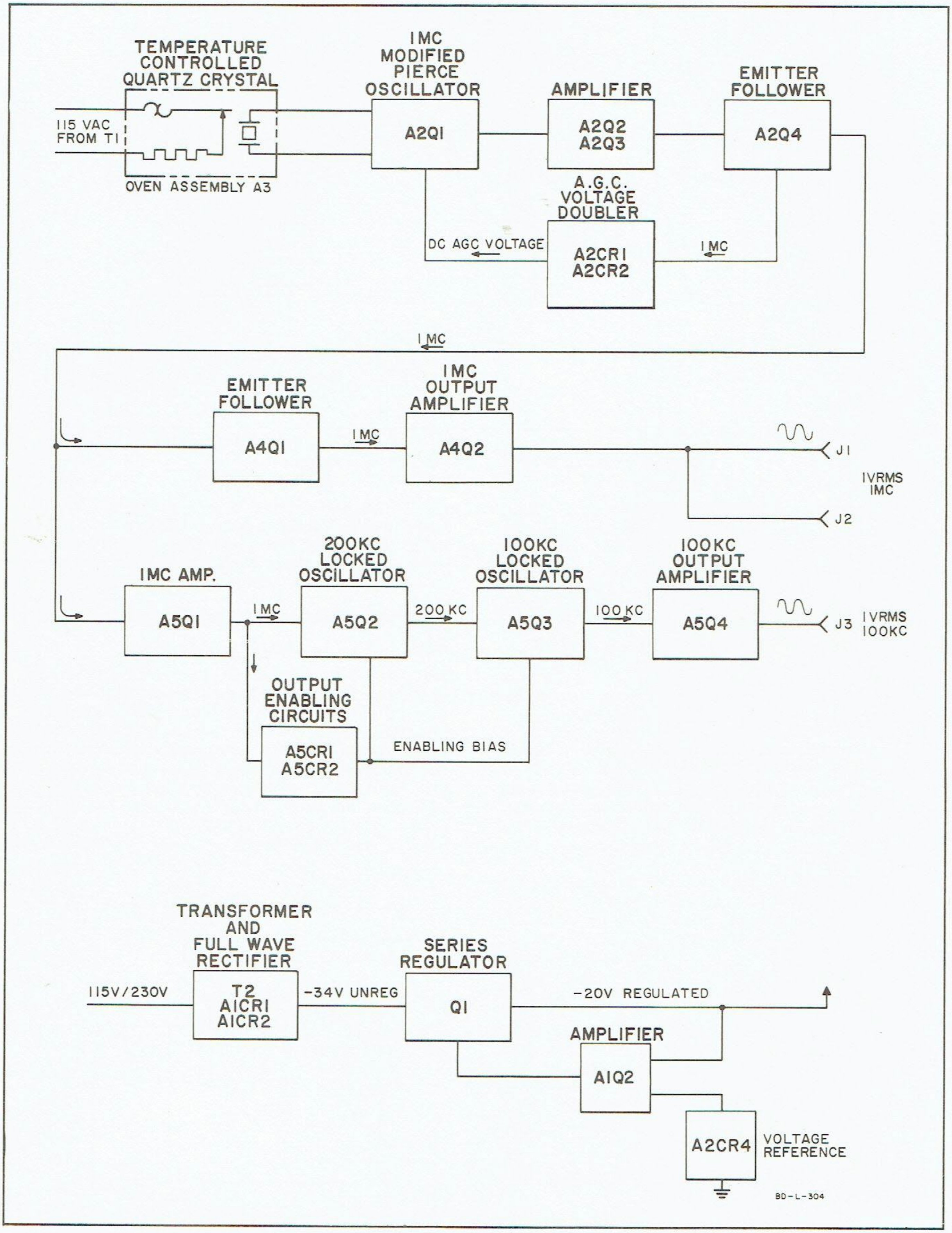



Figure 4-1. Overall Block Diagram

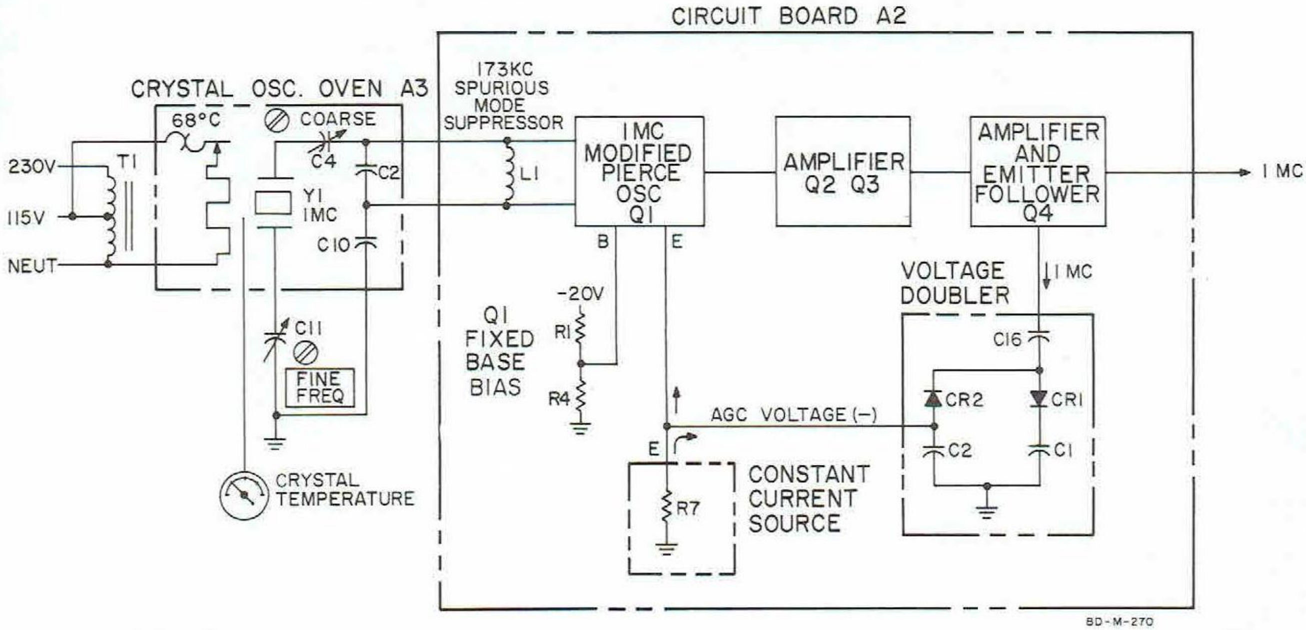



Figure 4-2. Block Diagram of 1-MC Crystal Oscillator

4-21. HOW THE AGC CIRCUIT OPERATES. Suppose that the 1-mc output level increases. The dc voltage at the junction of A2CR2 and A2C2 also increases - - in a negative direction.

4-22. Since the current out of A2R7 is constant, more of it flows toward A2C2 through A2R1 and A2R5, and less into the emitter of A2Q1. With a decrease in emitter current, the gain of A2Q1 decreases which in turn tends to return the oscillator level to the previous value. A similar action but in the reverse direction is true if oscillator level tends to decrease.

## 4-23. 1-MC OUTPUT AMPLIFIER.

4-24. The 1-mc output amplifier consists of transistors A4Q1 and A4Q2. Transistor A4Q1 is an emitter follower which minimizes loading effects on the crystal oscillator amplifier (A2Q4) and provides a low impedance driving source for output amplifier A4Q2. The collector load for A4Q2 consists of A4C4, A2L1, and A4C5. These components constitute a pi-network which lowers the transistor impedance down to approximately 17 ohms output source impedance.

## 4-25. 100-KC LOCKED OSCILLATOR/DIVIDER.

4-26. 100-KC LOCKED OSCILLATOR.

4-27. The 100-kc output is obtained by synchronizing two free-running oscillators from the 1-mc signal output from the crystal oscillator board assembly A2. The 1-mc signal is first amplified by A5Q1 and then applied to the base of A5Q2 which is a free-running 200-kc Colpitts oscillator. The 1-mc signal pulses lock the 200-kc oscillator frequency to the crystal oscillator derived 1 mc. In turn, the 200-kc signal at the junction of A5R13 and A5R14 is coupled to the base of A5Q3 through A5C14. A5Q3 is a free-running

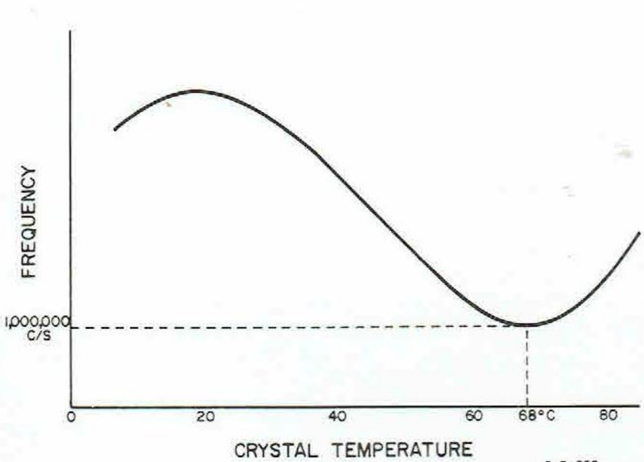



Figure 4-3. Quartz Crystal

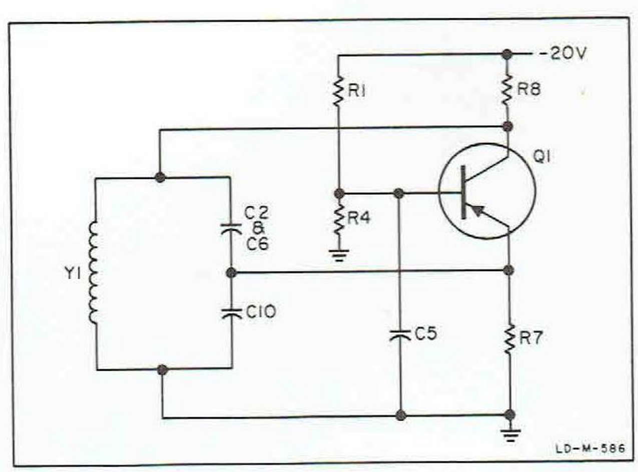



Figure 4-4. Crystal Oscillator Equivalent Circuit

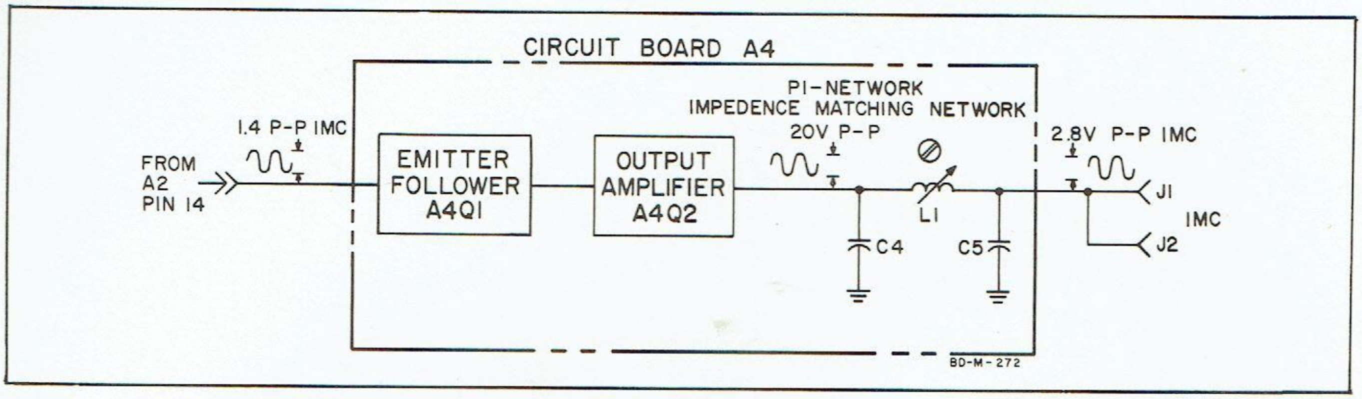



Figure 4-5. Block Diagram of 1-MC Output Amplifier

100-kc Colpitts oscillator. The 200-kc signal from A5Q2 synchronizes this oscillator so that its output is also synchronized with the 1-mc signal.

4-28. The 100-kc output at the junction of A5R22 and A5R23 is coupled to a 100-kc tuned amplifier A5Q4. The collector load is a pi-network which matches the collector load impedance to the low output impedance of 17 ohms. The pi-network also reduces any harmonic energy which might be present.

4-29. FAIL-SAFE OUTPUT CUT-OFF CIRCUIT.

4-30. The 100-kc output signal is supplied by a free-running oscillator which is synchronized from a precision 1-mc source. If the 1-mc source should fail, an erroneous output signal of approximately 100 kc would result. To prevent this, protective circuits cut off the 100-kc putput if the 1-mc drive fails or falls below a satisfactory level.

4-31. Capacitor A5C3 and diodes A5CR2 and A5CR3 constitute a voltage doubler. With 1-mc drive present at the collector of A5Q1, a negative forward bias is developed across capacitor A5C10. This negative forward bias is applied to A5Q2 and A5Q3 through resistors A5R12 and A5R20 respectively. This negative bias turns on transistors A5Q2 and A5Q3 so the circuits oscillate. Since the junction of A5R12 and A5R20 is returned to ground through A5R11 and A5R10, failure of the bias voltage due to loss of 1-mc drive will turn off both A5Q2 and A5Q3, preventing an erroneous 100-kc output frequency.

## 4-32. REGULATED POWER SUPPLY.

4-33. The regulated power supply is fairly conventional in operation. A fraction of the output voltage is sampled at A1R5. A1CR4 is a breakdown diode which maintains a constant voltage drop across itself. A1R1 is a constant current source for the base of driver transistor A1Q1. The current divides between the collector of amplifier A2Q2 and the base of A1Q2.

4-34. Driver transistor A1Q1 controls the base current in series regulator transistor Q1 which is a power transistor. If the output voltage tends to become more negative, amplifier transistor A1Q2 is turned on harder which increases its collector

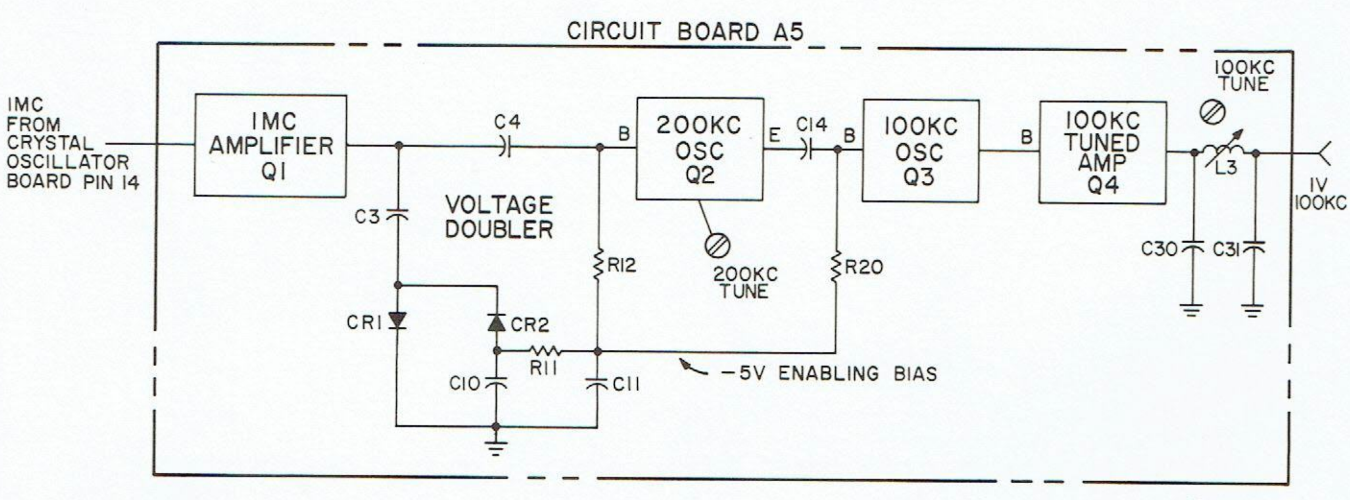



Figure 4-6. Block Diagram of 100-KC Locked Oscillator/Divider and Output

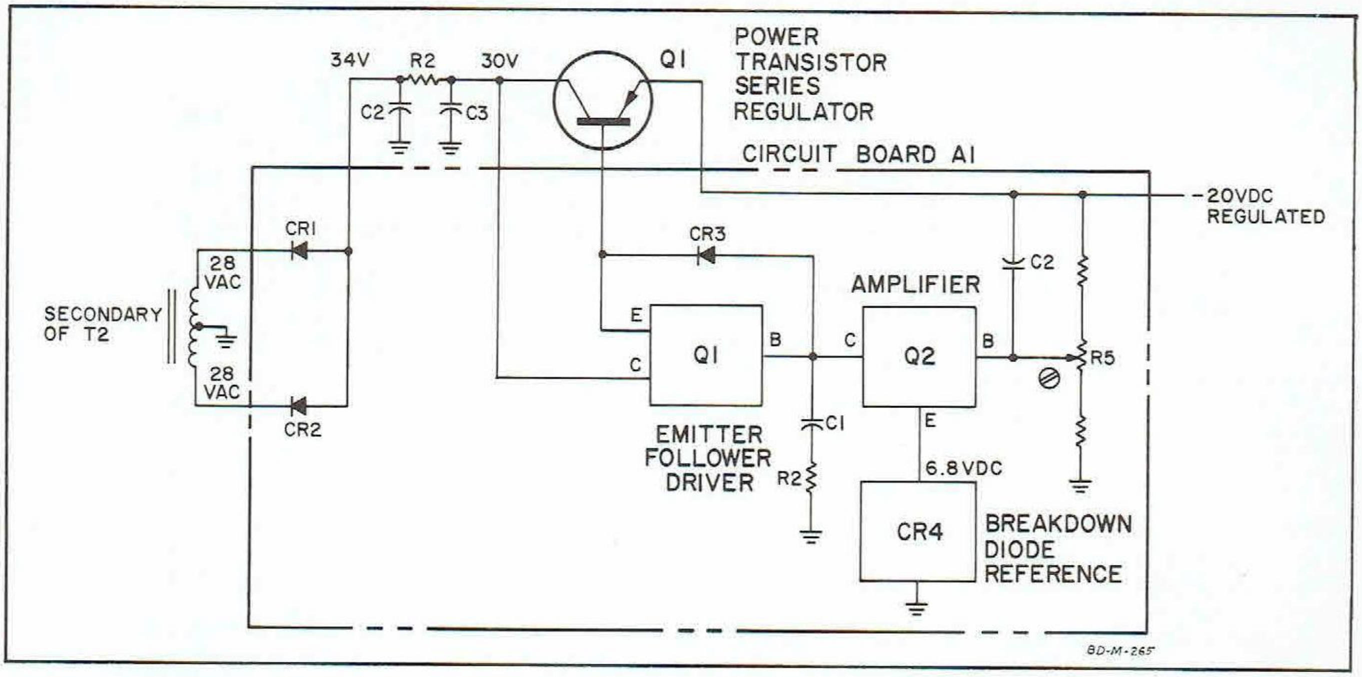



Figure 4-7. Block Diagram of Power Supply

current. Since A1R1 is a constant current source, less base current can flow in A1Q1, reducing its conduction which in turn does the same thing to Q1. The reduction in the conduction of Q1 returns the regulated output to its correct value.

4-35. Capacitor A1C2 couples ac signals directly to the base of the amplifier to lower dynamic impedance and reduce ripple. Capacitor A1C1 and A1R2 comprise a high-frequency roll off network to prevent power supply oscillation at some high frequency where the electrolytic capacitors become inductive. Diode A1CR3 is a silicon diode. Silicon diodes have a work function of 0.6 volt which means there will be no conduction until the forward bias is 0.6 volt. Regulator transistor Q1 is a germanium type. The normal base current is approximately 1 ma. Under extremely high temperature conditions, the $I_{CBO}$ leakage current of Q1 can be as high as 2 ma. Since leakage current is in the opposite direction of normal base current, driver transistor A1Q1 would be reverse-biased and cut off. Under this condition, there would be no regulation. Diode A1CR3, under these conditions, becomes conducting and connects the base of Q1 effectively to collector of A1Q2 which maintains regulation even though A1Q1 is effectively out of the circuit.

Table 5-1. Recommended Test Equipment

| Instrument Type | Required Characteristics | Recommended Instrument |
|---|---|---|
| DC Electronic Multimeter | Range: 0.1 volt to 100 volts full scale<br>Accuracy: ±1% | ⓗⓟ Model 412A |
| AC Electronic Voltmeter | Range: 0.001 volt to 300 volts full scale<br>Accuracy: ±1% | ⓗⓟ Model 400H |
| Dual Trace Oscilloscope | Frequency Response: dc to 10 mc or more<br>Sensitivity: 50 mv/cm maximum | ⓗⓟ Models 175A/1750A |
| Divider Probe | 10-megohm, 10:1 division ratio | ⓗⓟ Model AC-21A |
| Autotransformer | Continuously adjustable; equipped with monitor voltmeter accurate within 1 volt over range 100 to 130 volts | General Radio Type W10MT3A |
| Frequency Comparator | 100-kc and 1-mc inputs; capable of resolving 1 part in $10^{11}$. Chart Recorder to record difference frequency | Montronics Model 100 Comparator and Model 100A Discriminator and Chart Recorder |
| Reference Frequency Standard | Output: 1 mc<br>Short Time Stability: 1 part in $10^{10}$ | ⓗⓟ Model 104A Quartz Oscillator |
| Electronic Counter | Frequency and Period Measurements: up to 1 mc | ⓗⓟ Model 523D |
| Audio Oscillator | Stable output frequency over range of 390 to 610 cps | ⓗⓟ Model 200CD |
| Communications Receiver | Tunable to 10, 15, and 20 mc; equipped with signal strength meter | Specific Products Model SR-7 |

SPECIAL TOOLS

Oscillator Frequency Adjusting Tool. Polystyrene shaft 1/4-inch diameter. Overall length 5 inches. Equipped with 1/8-inch wide exposed metal blade. General Cement #5003 (cut handle to make overall length 5 inches). (ⓗⓟ Stock Number 8730-0013)

Ferrite Core Adjusting Tool. Non-metallic. .075-inch hexagon tip (#8 allen size) Walsco #2547

3/8-inch x 5/16-inch Open-End Wrench. 3 x 3/4 inch long

# SECTION V
# MAINTENANCE

## 5-1. GENERAL INFORMATION.

5-2. This section contains instructions for trouble localization, repair, calibration and final testing. The test instruments listed in table 5-1, or their equivalent, are recommended for troubleshooting and adjustment. Calibration is also considered a part of Section II, Operation, because of the nature of the instrument. Figure 3-4 shows equipment and setup required. Paragraphs 3-11 through 3-17 describe the technique most generally useful. This procedure will not prove the stability of the instrument, however.

## 5-3. GENERAL MAINTENANCE PRECAUTIONS.

5-4. ACCIDENTAL SHORT CIRCUITS. The Model 101A has fairly high density construction. You can easily cause instantaneous failure of several transistors if adjacent leads or terminals are momentarily short-circuited. BE CAREFUL. A good way to minimize this possibility is to make a tiny sharp-pointed prod out of 20-gage solid insulated wire and attach it to a standard voltmeter or oscilloscope probe. Experience has shown that failure to do this is very likely to result in an accidental momentary short circuit with disasterous results.

5-5. REMOVING INDIVIDUAL CIRCUIT BOARDS. Always turn off power for at least 30 seconds before disturbing etched circuit boards. This gives the power supply time to discharge.

5-6. PLUG-IN EXTENDER. Never attempt to work on etched circuit boards when they are in place. You can easily cause a short circuit. Always use the plug-

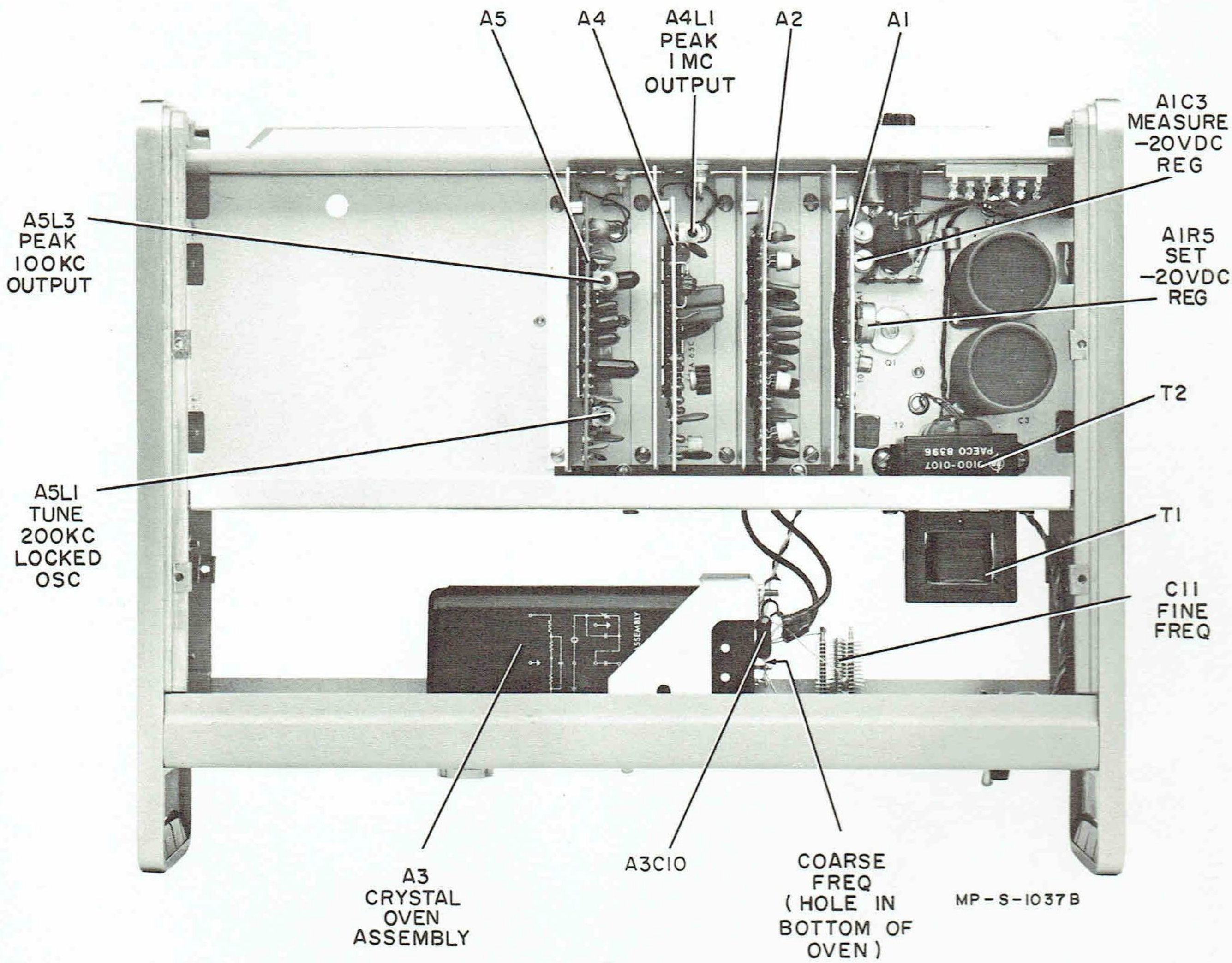



Figure 5-1. Top Internal View Showing Adjustments and Major Components Locations

in extender furnished with the instrument. The extender can short out on the metal shield if horizontal pressure is applied. To prevent this, a strip of plastic electrical tape should be wrapped around the extender. The position should be located so that when the extender is installed in one of the connectors, the tape will prevent a short circuit if the extender is pressed against the adajcent metal shield.

## 5-7. ACCESS TO CIRCUITRY

5-8. Access to the circuitry is obtained by removing four phillips flat-head screws from the top and bottom plates. Slide top and bottom plates toward the rear and lift off.

## 5-9. TEST EQUIPMENT.

5-10. Table 5-1 lists the test equipment needed to troubleshoot and repair this instrument. Required equipment for calibration with a broadcast frequency standard such as WWV is also listed in section III, figure 3-4.

## 5-11. TROUBLE LOCALIZATION.

5-12. IDENTIFICATION OF GENERAL CIRCUIT AREA. Trouble in the instrument can be quickly sectionalized by simple signal tracing techniques. This can best be done by using a 10-mc oscilloscope equipped with a 10:1 high impedance divider probe. The presence or absence of signals of the proper amplitude on the mounting connector terminal strip will quickly localize the trouble. (See figures 5-1 and 5-2.)

5-13. PROCEDURE. Check for 1 volt, 1 mc at rear output jack J1. If present, oscillator and 1-mc amplifier sections are normal. If not, check for 1 volt, 1 mc at pin 14 of A2. If present, trouble is in 1-mc output amplifier. If not, trouble is in crystal oscillator section. If 1-mc output is normal but 100-kc output at rear panel connector J3 is low or missing, trouble is in the locked oscillator-divider section.

5-14. CHECKING THE -20 VOLT REGULATED POWER SUPPLY.

5-15. DC REGULATION. The power supply can be quickly checked for correct operation by determining dc regulation versus line voltage change and measuring the ac ripple voltage present on the output bus. Connect instrument to a variable transformer and measure output voltage at top end of capacitor C3 on power supply board A1. Use an accurate meter such as an ⓗⓟ Model 412A. The voltage should be -20 volts with respect to the chassis. Changing input voltage over the range of 103 to 127 volts should produce less than approximately 0.25-volt change.

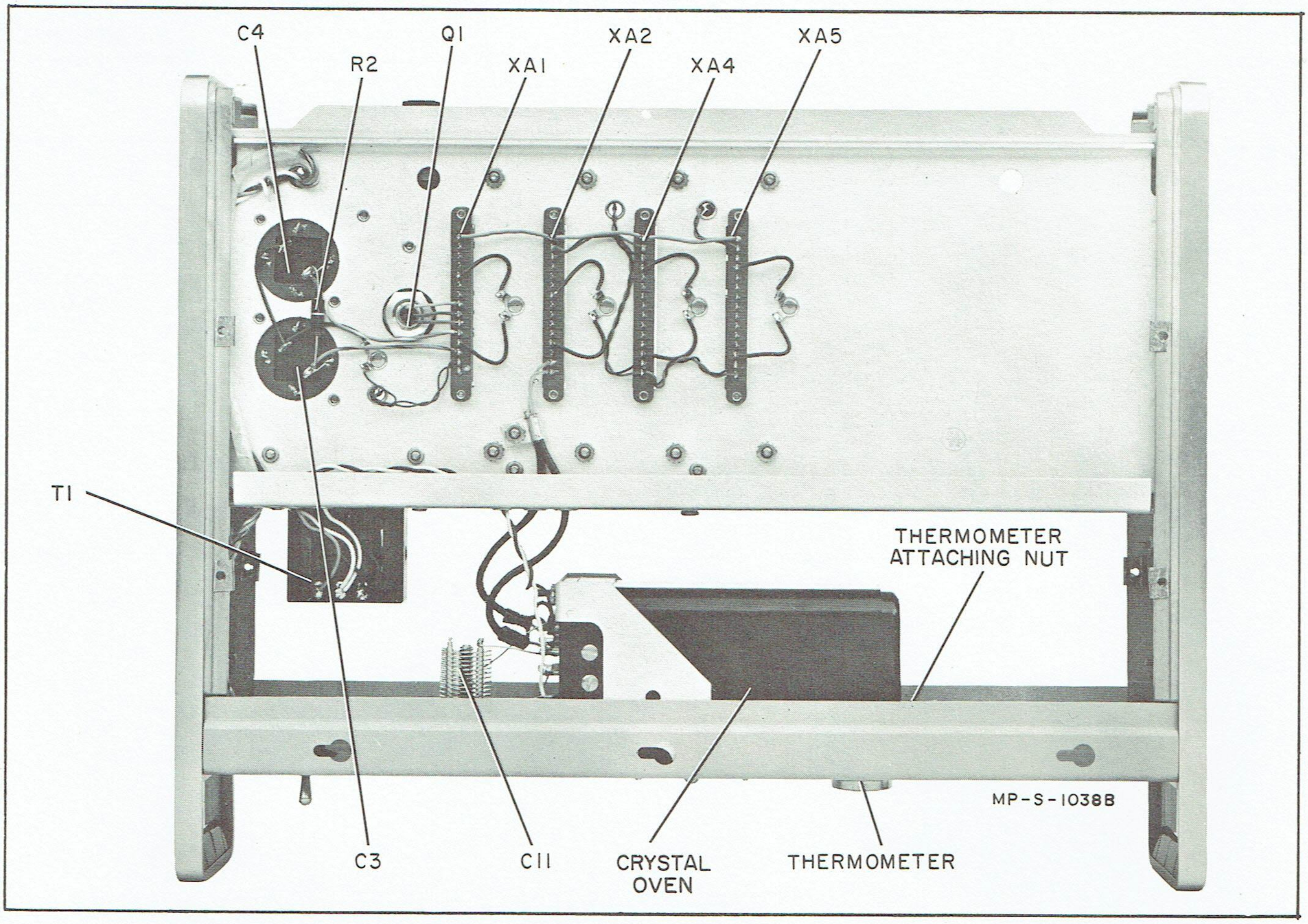



Figure 5-2. Bottom Internal View Showing Component Locations

5-16. AC RIPPLE. Connect an ac electronic voltmeter to top of C3. Use a twisted pair or a shielded input lead. The ripple voltage should be less than 0.5 millivolt for any supply voltage over the range of 103 to 127 volts.

5-17. POSSIBLE POWER SUPPLY TROUBLES.

5-18. Table 5-2 lists some troubles in the power supply and their possible causes.

5-19. POSSIBLE CRYSTAL OSCILLATOR TROUBLES.

5-20. Table 5-3 lists some troubles in the oscillator circuitry and their possible causes.

5-21. POSSIBLE LOCKED OSCILLATOR/DIVIDER TROUBLES.

5-22. Table 5-4 lists some troubles in the 100-kc divider circuitry and their possible causes.

Table 5-2. Power Supply Troubleshooting Chart

| Symptom | Possible Cause | Remedy |
|---|---|---|
| Output approximately 6 volts | One or more transistors defective in power supply (typically caused by accidental short circuit between adjacent terminals on output terminals) | Check transistors on a Tektronix curve tracer or other good transistor checker. |
| Loss of regulation under high ambient temperature conditions | Power transistor Q1 too hot caused by poor thermal conductivity to chassis | Use silicon grease on both sides of mica insulating washer and tighten mounting nut securely. |
| | Diode CR3 defective | Replace with correct silicon unit. Note: this component is only effective under extreme heat environments. It may be defective and operation will be normal at normal room temperatures. |

Table 5-3. Crystal Oscillator-Amplifier Troubleshooting Chart

| Symptom | Possible Cause | Remedy |
|---|---|---|
| No output, low output, distorted output | Defective transistor | Check for proper signal levels at collector of each transistor on etched board A2. Loss of signal identifies defective stage. DC voltages should be checked against typical values shown on schematic diagrams. |
| Output frequency not stable. High short time drift. | Oven thermostat defective | Replace oven, crystal, and thermometer assembly |

Table 5-4. Locked Oscillator Troubleshooting Chart

| Symptom | Possible Cause | Remedy |
|---|---|---|
| No 100-kc output | Defective A5Q3 or A5Q4<br>Insufficient 1-mc drive to A5Q1<br>Failure of enabling bias | Check dc voltages<br>Check waveshape and amplitude<br>Check for -5 volts at A5C10 |
| Output frequency unstable. Lissajous pattern between 1-mc and 100-kc outputs not normal | L1 misadjusted | Check for stable locked oscillator operation by feeding 1 mc from J1 to horizontal input of an oscilloscope and observe Lissajous pattern with signal at collector of A5Q2 (5:1) and A5Q3 (10:1)<br>Adjust L1 |
| Low output with J3 terminated by 50-ohm load | A5L3 mistuned<br>A5Q4 defective | Check for correct dc voltages<br>Adjust L3<br>Replace A5Q4 |

## 5-23. REPAIR TECHNIQUES.

5-24. REPAIRING ETCHED CIRCUIT BOARDS.

5-25. The etched circuit boards in this instrument are of the "plated through hole" variety. (Some instruments have eyelet type boards). The correct procedures must be used to replace parts or the boards will be damaged. This will result in poor reliability.

5-26. Use a small soldering iron. Excessive heat will lift the foil off the board. Always use a miniature iron (under 50 watts) equipped with a small, freshly tinned tip.

5-27. Clean hole with a soft wood object. After removing a component, clean hole with wood object such as a toothpick or a sharpened wood match.

CAUTION

DO NOT USE AN AWL OR METAL PICK. To do so will damage plating in the hole and will result in an intermittent or no connection joint. Careful workmanship will result in a reliable repair.

5-28. Use a good solder. When installing a new part always use best quality solder and a clean soldering iron tip. The optimum alloy is 63/37. The solder must not have an excessive amount of flux. The hp factory uses ALPHA 0.050" diameter 63/37 alloy, type CG wire solder which contains energized rosin flux. ERSIN 5-core 364 flux 60/40 solder is also satisfactory.

5-29. REPLACING POWER TRANSISTOR Q1.

5-30. Power transistor Q1 (in the regulated power supply section) is furnished mounted in a stud bolt assembly. The assembly is operated at about -34 volts with respect to the chassis and therefore most be carefully insulated electrically, but not thermally, from the chassis. A mica washer is used on top side of chassis to insulate stud mounting assembly and a fiber bushing is used on bottom side to center assembly in mounting hole and insulate attaching nut. When replacing power transistor, it is desirable to coat both sides of mica washer and fiber bushing washer with Dow-Corning No.5 compound silicone grease. This grease can reduce thermal resistance by a factor of 4 or 5. This can materially increase transistor life -- especially where high ambient temperature exist. Always tighten nut securely to insure best possible heat transfer. (See figure 5-3.)

5-31. REMOVING CRYSTAL OVEN ASSEMBLY.

5-32. To remove crystal oven assembly, proceed as follows:

a. Make a detailed sketch of terminals and attaching wires. Note that the three in-line lug terminals associated with the heater circuit are located at the bottom. Be sure to identify wire colors and address of each wire. Bare ground jumpers and bare wires to trimmer must be connected a certain way to avoid ground loop problems.

b. Remove three #6 x 3/8 in. SS round head screws with 7/32 in. flat washers in center area of front panel. Note: The screw on the right side nearest the FINE FREQ trimmer capacitor is attached with a #6 nut with captive lockwasher.

c. Carefully slide oven assembly toward rear on the thermometer stem to gain access to thermometer attaching nut.

d. Using a small 3/8 in. open end wrench, remove 3/8 in. nut and flat washer attaching thermometer to panel.

e. Carefully unsolder all wires from oven terminals and remove oven.

f. Remove four #6 x 1/2 in. SS binding head screws from oven base.

g. Remove two #8 nuts with captive lockwashers. Note that ground lug next to the panel also has an outside lockwasher under it.

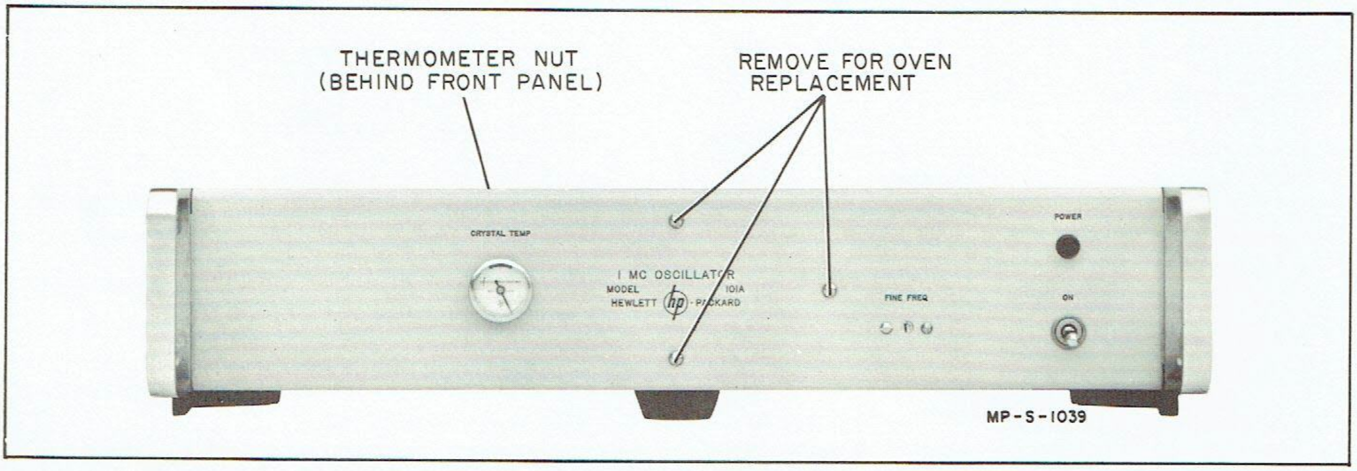



Figure 5-3. Front View Showing Oven Attaching Screws

h. Remove oven mounting bracket. Save bracket and all attaching parts except four #6 x 1/2 in. binding head screws which should be reinstalled in oven base to hold it together for reshipment.

i. Carefully pack oven assembly and thermometer in a strong box which is at least 12 in. on a side. Be certain to use sufficient packing material. Return to the Hewlett-Packard Company for credit.

5-33. INSTALLING A NEW CRYSTAL OVEN ASSEMBLY.

5-34. To install a new crystal oven assembly, proceed as follows:

a. Remove four #6 base attaching screws and install oven assembly in mounting bracket with the three lug terminal for the 115-volt supply on the bottom.

b. Reinstall four #6 x 1/2 in. long SS binding head screws with captive lockwashers in oven base.

c. Install a #8 nut with captive lockwasher on rear #8 stud screw.

d. Install: (1) outside lockwasher, (2) soldering lug, and (3) #8 nut with captive lockwasher, in that order, on the oven #8 stud screw next to front panel.

e. Attach all bare jumper wires, insulated wires, and cables according to the sketch previously made. If a question arises, the power supply schematic diagram (figure 5-10) includes a pictorial insert which shows the connections in a semi-schematic form.

f. Install new crystal oven thermometer furnished with replacement oven. The center mark should be on top. The thermometer stem should be threaded through the large (15/16 in.) flat washer, 1/4 in. attaching nut and into oven hole. Start thermometer nut on the threads but do not tighten yet.

g. Start the #6 x 3/8 in. SS round head screws with 7/32 in. flat washers in oven mounting bracket holes at center of panel. Do not fully install yet.

h. With oven assembly still loose but attached, line up thermometer in its mounting hole and tighten its attaching nut. Use a short 3/8 in. open end wrench. Hold outside case of the thermometer to maintain correct position (center mark in green zone on top).

i. Install third #6 round head screw and flat washer through front panel. Use a #6 nut with a captive lockwasher on back side. The nut can be held in place with long-noise pliers while threads are starred.

j. Tighten all three screws on front panel.

k. Connect instrument to a source of 115 to 230 volts and turn on.

m. Check that 1-mc voltage at board connector A2 pin 1 is 32 to 36 mv rms. Use twisted pair test leads and ⓗⓟ Model 400H AC VTVM. If too high or too low, change value of pad resistor A2-R2A (across A2-R2).

Caution: Excessive crystal drive level can damage crystal if allowed to continue.

n. Allow instrument to warm up for two hours. The thermometer should be very close to mark at center of green zone. Follow procedure for crystal oscillator calibration (paragraph 5-50).

## 5-35. ADJUSTMENT AND CALIBRATION.

5-36. MAINTENANCE SCHEDULE.

5-37. The adjustments other than frequency calibration in this instrument should not need attention unless parts are changed. Frequency recalibration is necessary at periodic intervals if a specified level of performance is to be obtained. Since maximum drift rate is specified, it is possible to determine a recalibration schedule which will maintain the degree of accuracy desired. The actual drift rate is better than specified and generally improves with age, so any schedule based on published specifications will be conservative.

5-38. SUGGESTED CALIBRATION INTERVAL.

5-39. Since the specified drift rate is 5 parts in $10^8$ per week, in two weeks the drift will be 1 part in $10^7$. If this level of accuracy is acceptable, a good schedule would be to check and reset frequency every 30 days. When resetting, the frequency should be adjusted 1 part in $10^7$ low. In four weeks it will have drifted up 2 parts in $10^7$ and thus will be 1 part in $10^7$ high. By keeping accurate records as to the actual performance of the oscillator over a period of months, you can modify this suggested program to obtain higher overall accuracy. REMEMBER - THIS OSCILLATOR IS A PRECISION DEVICE. THE ACCURACY OF THE OUTPUT WILL BE NO BETTER THAN THE PRECISION WITH WHICH IT IS CALIBRATED AND MAINTAINED.

5-40. COMPLETE ADJUSTMENT PROCEDURE.

5-41. This procedure should be used only after complete overhaul. Performing the following adjustments is not normally necessary and will destroy oscillator calibration. If this is done, previous records lose significance since the measured frequency will be due to adjustment changes and not crystal aging alone.

5-42. ADJUSTING THE REGULATED POWER SUPPLY.

5-43. To set output voltage of the regulated power supply, proceed as follows:

a. Connect the Model 101A to an adjustable transformer. Set output to 115 volts ac.

b. Connect a high accuracy dc voltmeter such as ⓗⓟ Model 412A between chassis and top of capacitor A1C3 on regulator etched board.

c. Set output voltage to exactly -20 volts using potentiometer A1R5.

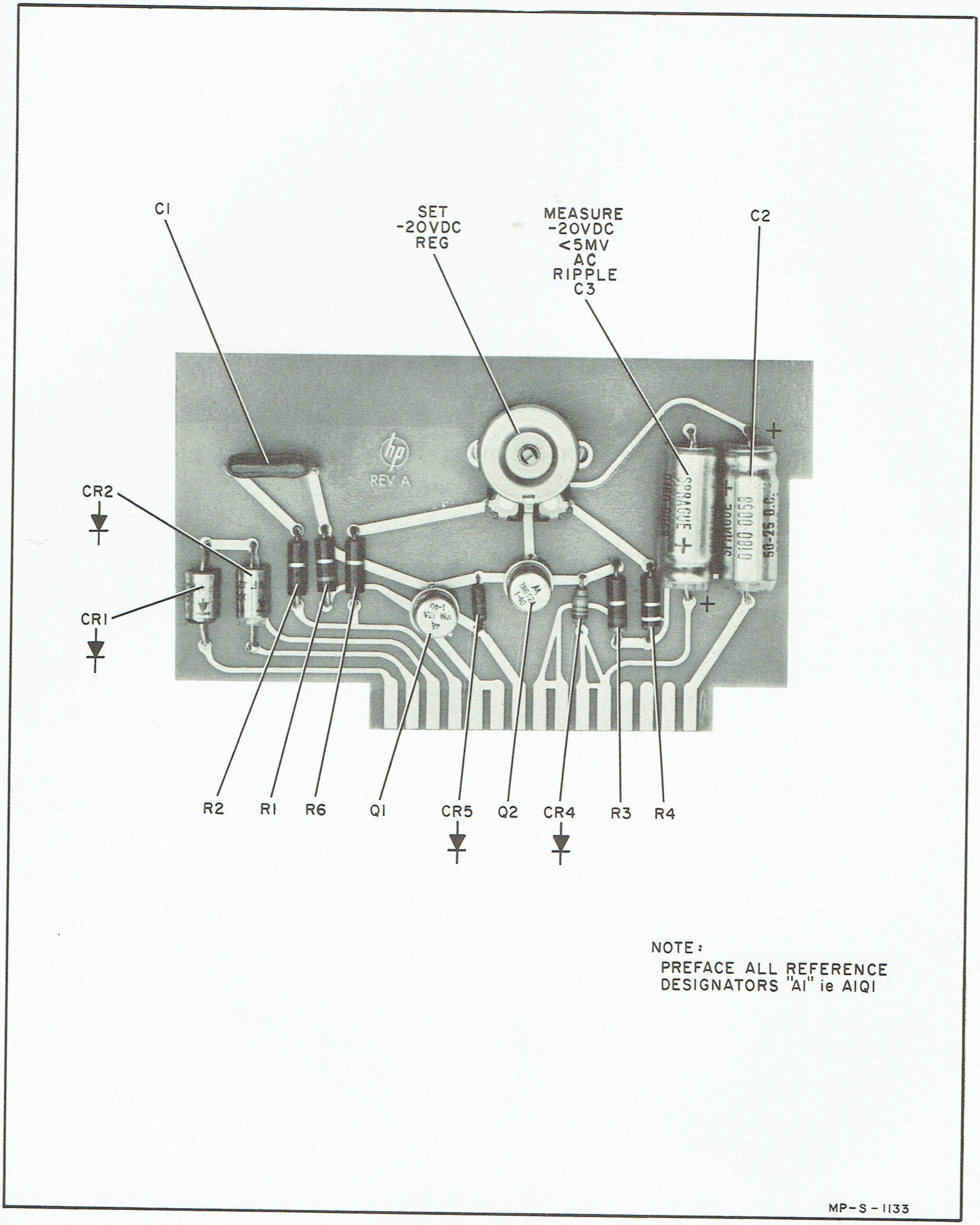



Figure 5-4. Power Supply Circuit Board A1 Parts Locations

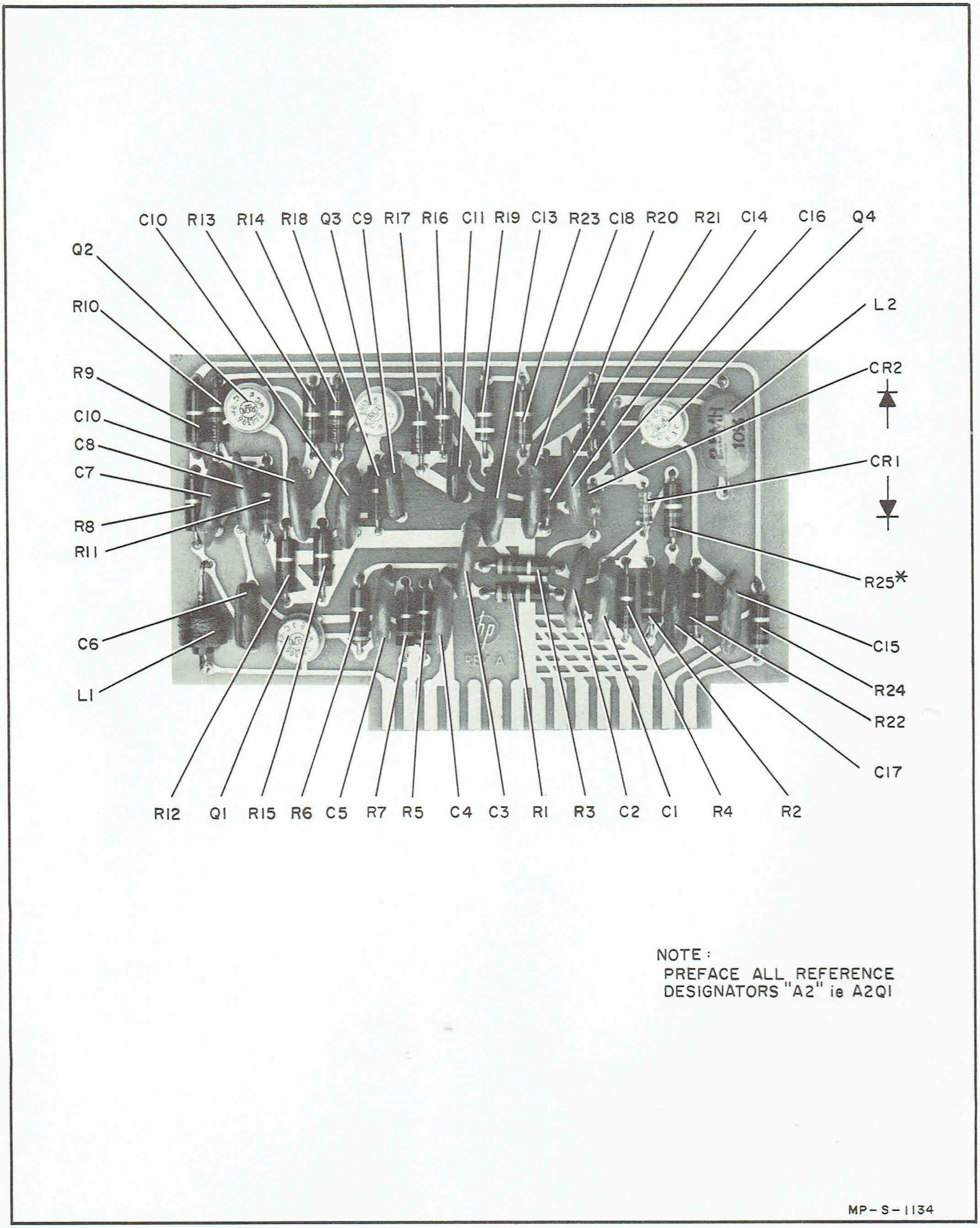
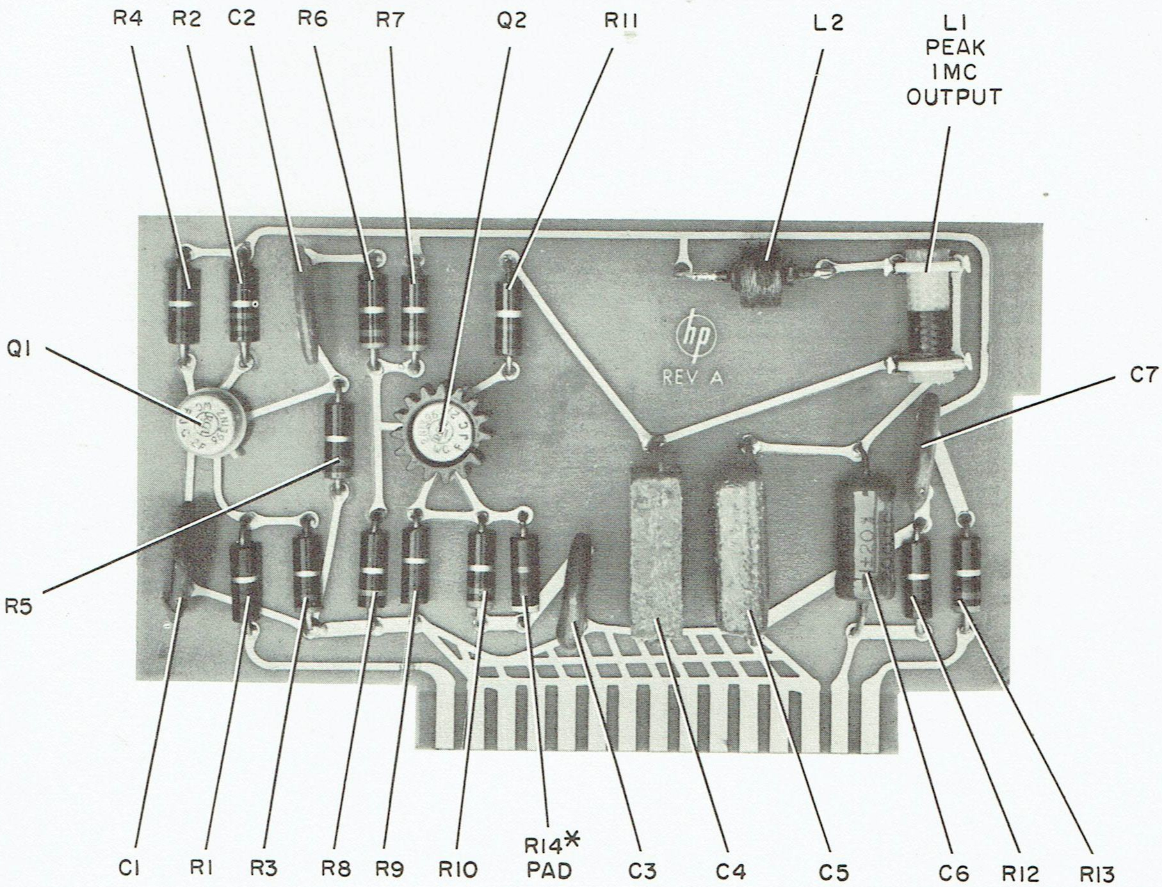



Figure 5-5. Crystal Oscillator Circuit Board A2 Parts Locations




NOTE:
PREFACE ALL REFERENCE DESIGNATORS "A4" ie A4Q1

MP-S-1135

Figure 5-6. 1-MC Output Amplifier Circuit Board A4 Parts Locations

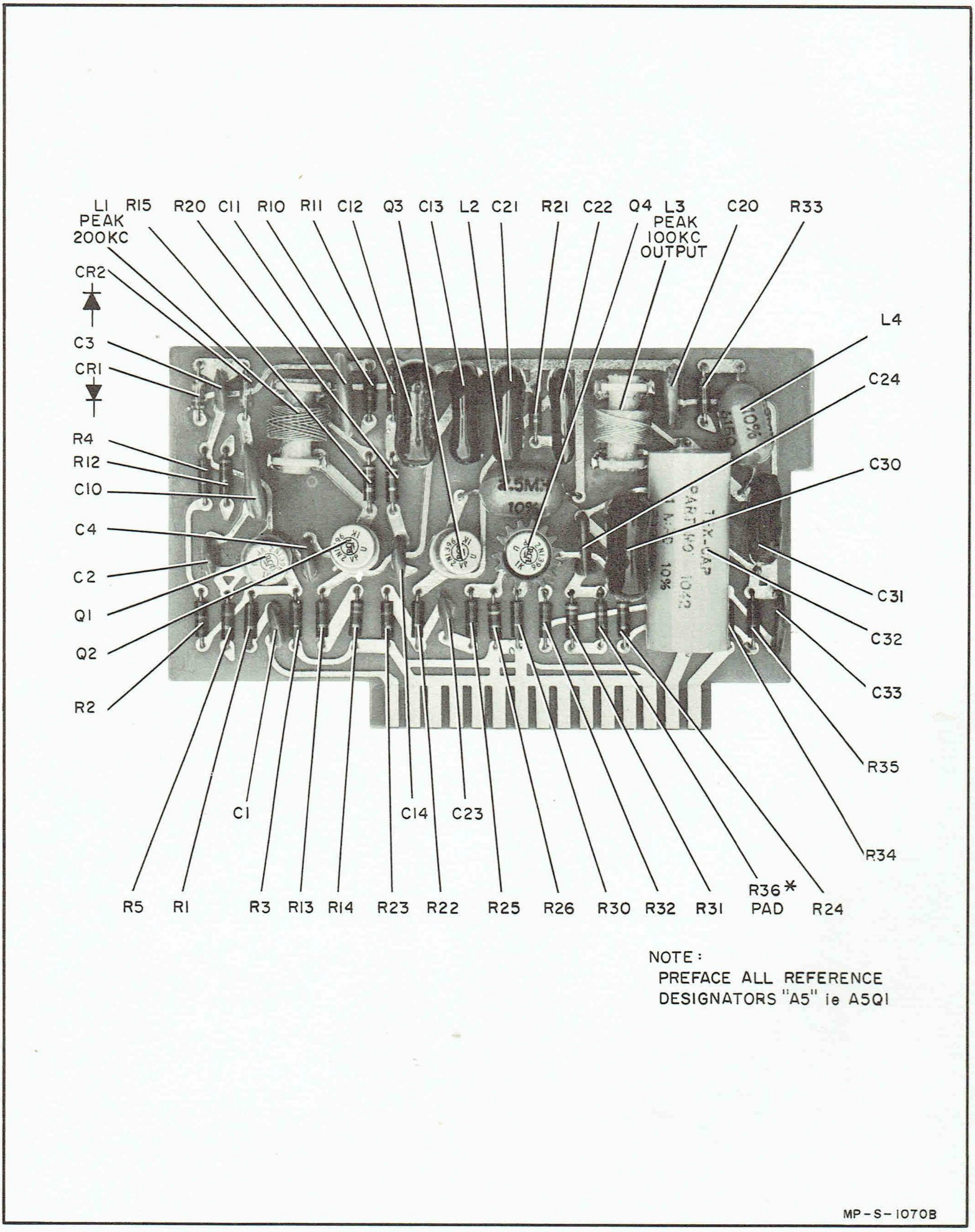



Figure 5-7. 100-KC Locked Oscillator/Divider Circuit Board A5 Parts Locations

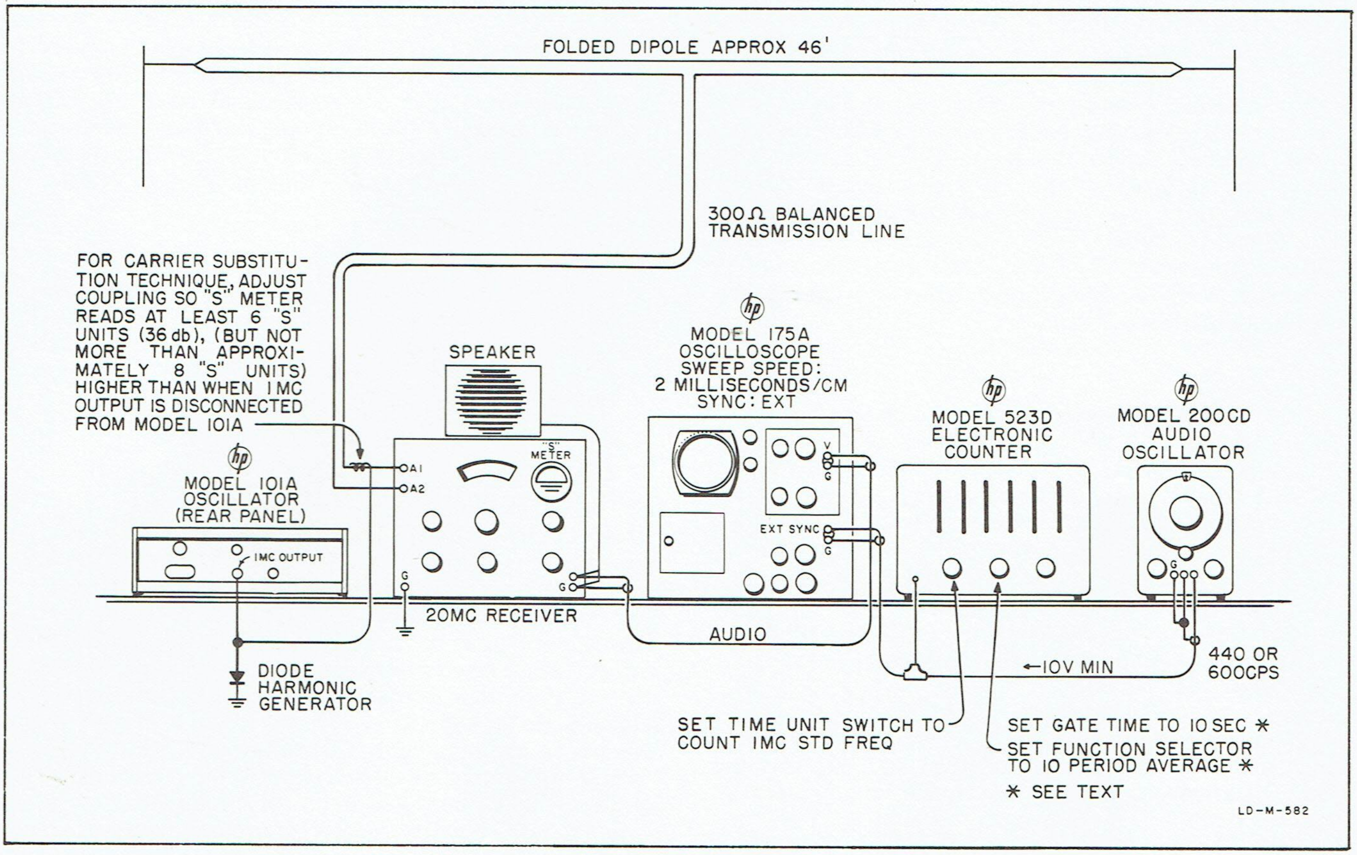



Figure 5-8. Carrier Substitution Frequency Check Test Equipment Setup

5-44. DC REGULATION CHECK. Check power supply regulation by varying the supply voltage over the range of 103 to 127 volts ac. The regulated dc output voltage should not change more than approximately 0.25 volt.

5-45. AC RIPPLE CHECK. Measure ac ripple voltage from A1C3 to ground using a hp Model 400H AC VTVM. The ripple voltage should be less than 0.5 millivolt for any line voltage between 103 and 127 volts. Note: The ripple voltage will be higher if the board is mounted on an extender. The above values apply when the board is installed in the instrument in the normal way.

5-46. ADJUSTING THE 1-MC OUTPUT TUNING.

5-47. To properly adjust the 1-mc output amplifier, proceed as follows:

a. Terminate 1-mc OUTPUT jack J1 with a 50-ohm resistive load.

b. Connect hp Model 400H AC VTVM or an AC-21A Divider Probe and 10-mc oscilloscope across output (use J2).

c. Adjust A4L1 for maximum output. Maximum output should exceed 1 volt rms. Note: Be sure to use a non-metallic tool to avoid false adjustment of A4L1.

5-48. ADJUSTING THE 100-KC LOCKED OSCILLATOR/DIVIDER AND OUTPUT CIRCUITS.

5-49. To adjust locked oscillator/divider circuits, proceed as follows:

a. Connect 1-mc OUTPUT jack J2 to the vertical input of an oscilloscope.

b. Connect 100-kc OUTPUT jack J3 to the horizontal input of oscilloscope.

c. Terminate J3 with a 50-ohm resistive load.

d. Adjust A5L1 to obtain a 10:1 Lissajous pattern.

e. Rotate L1 tuning slug clockwise until pattern becomes unstable and note aligning tool position.

f. Rotate tuning slug counterclockwise until pattern becomes unstable and note aligning tool position.

g. Rotate tuning slug to mid-position of the range. This setting gives maximum range of stability of 200-kc locked oscillator/divider stage.

h. Adjust inductor A5L3 for maximum width of oscilloscope pattern (maximum 100-kc output). Maximum output should be at least 2.8 volts peak-to-peak into 50-ohm load.

5-50. ADJUSTING CRYSTAL OSCILLATOR FREQUENCY.

5-51. GENERAL. Proper setting of oscillator frequency requires a reference frequency which is known to be accurate within 1 part in $10^9$ or better. The short time stability of the reference should also be approximately 1 part in $10^9$. Otherwise, no faith can be assumed in the accuracy of the calibration process. While a local standard with known performance is preferred, probably the arrangement shown in figure 5-8 is more readily available.

Note

The simple process of zero-beating a harmonic of the Model 101A with a standard frequency broadcast station such as WWV will not guarantee rated accuracy. The error in the signal received from WWV (or other high frequency standard) under poor conditions may be as much as 1 part in $10^7$ on a short time basis. Fortunately, it is possible to eliminate this error by more sophisticated techniques and recover the original transmitted accuracy.

5-52. Initial Adjustment. The front panel trimmer capacitor should first be adjusted for half capacity and all calibration adjustments made with a non-metallic tool (see table 5-1) inserted into the oven Coarse Frequency trimmer access hole. This step will allow maximum operator range of adjustment after initial shop calibration.

5-53. Initial Warmup. The instrument should be operated continuously for at least two hours before attempting a precise calibration. The associated test equipment should also be operated during this time to insure best stability.

5-54. The detailed procedures for calibration are covered under instrument operation in paragraphs 3-9 through 3-25. For this reason, they are not repeated here.

**5-55. FINAL TEST PROCEDURE.**

5-56. The final test procedure is designed to verify the proper operation of the instrument by checking the most vital specifications. The procedure involves checking the output voltage level, distortion, and short and long-term frequency stability. All tests are performed with the instrument in its case. Allow two hours warmup before commencing tests.

5-57. PROCEDURE.

a. OVEN TEMPERATURE. Verify that OVEN TEMP indicator is at mark in green zone.

b. OUTPUT VOLTAGE AND DISTORTION. Terminate 1-mc OUTPUT jack on the instrument with a 50-ohm non-inductive load resistor and observe the amplitude and purity of the signal on a laboratory type oscilloscope with at least 10-mc bandwidth. Specifications: Amplitude at least 2.8 volts peak-to-peak (1-volt rms); Distortion: none observable on oscilloscope.

c. Terminate 100-kc OUTPUT jack on instrument with a 50-ohm non-inductive resistor and repeat a and b. Note: Tests have been made that indicate a trained observer will begin to notice distortion in a sine wave which has 4% distortion.

5-58. SHORT-TERM FREQUENCY STABILITY.

5-59. This test verifies that the short time variation in output frequency is less than 3 parts in $10^8$. The short-term stability of the oscillator is mainly affected by variations in crystal temperature caused by the cycling of the oven thermostat. Short-term variations can be excessive if the thermostat is sticky and results in greater than normal temperature variation. The variations are small enough that the only easy way to measure them is with a frequency multiplier system which multiplies the 1 MC OUTPUT frequency by 1000 times so that variations are easily measured. A simple frequency multiplier system could be used except that the final frequency would be too high. A more sophisticated multiplying and heterodyning/dividing system will magnify the instability yet will maintain the operating frequencies at a maximum of 1 mc. The Montronics Model 100 Frequency Comparator operates in this way and is recommended for this test. Figure 5-9 shows a suggested test setup. By proper range selection on the frequency comparator, the frequency variation from the reference standard can be directly read on the chart recorder. The test should be run with input voltage adjusted at 102, 115 and 127 volts ac. Allow 10 minutes of operation at each voltage. The overall change in frequency must be less than 3 parts in $10^8$.

5-60. LONG-TERM FREQUENCY STABILITY.

5-61. Long-term stability can only be determined by keeping a permanent record of observed frequency which extends for a month or more. The equipment used to check short-term stability also will display long term variation with respect to the reference standard. Since this is not too practical, a more desirable method is to accurately measure oscillator frequency at convenient intervals and plot the results. Careful measurements and record keeping will enable you to determine a precise value for the drift rate of the oscillator. The technique is discussed in paragraph 3-15 (see figure 3-2).

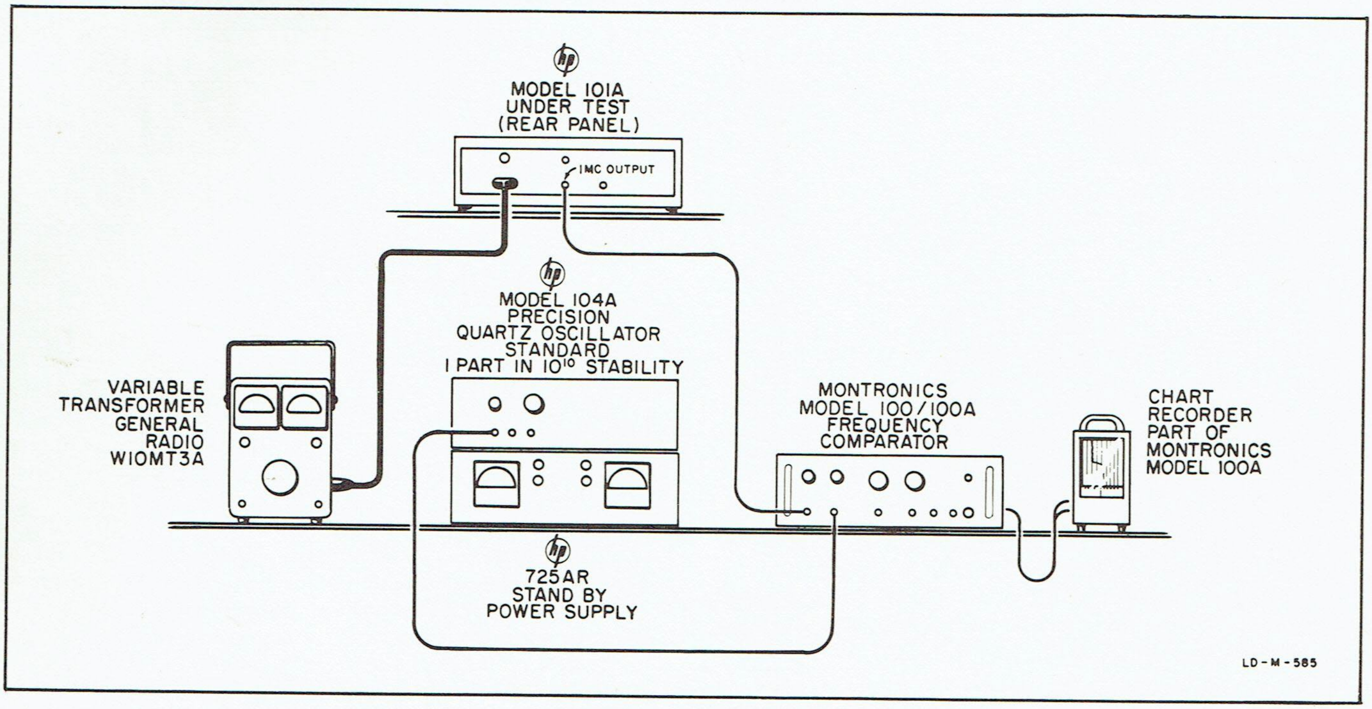
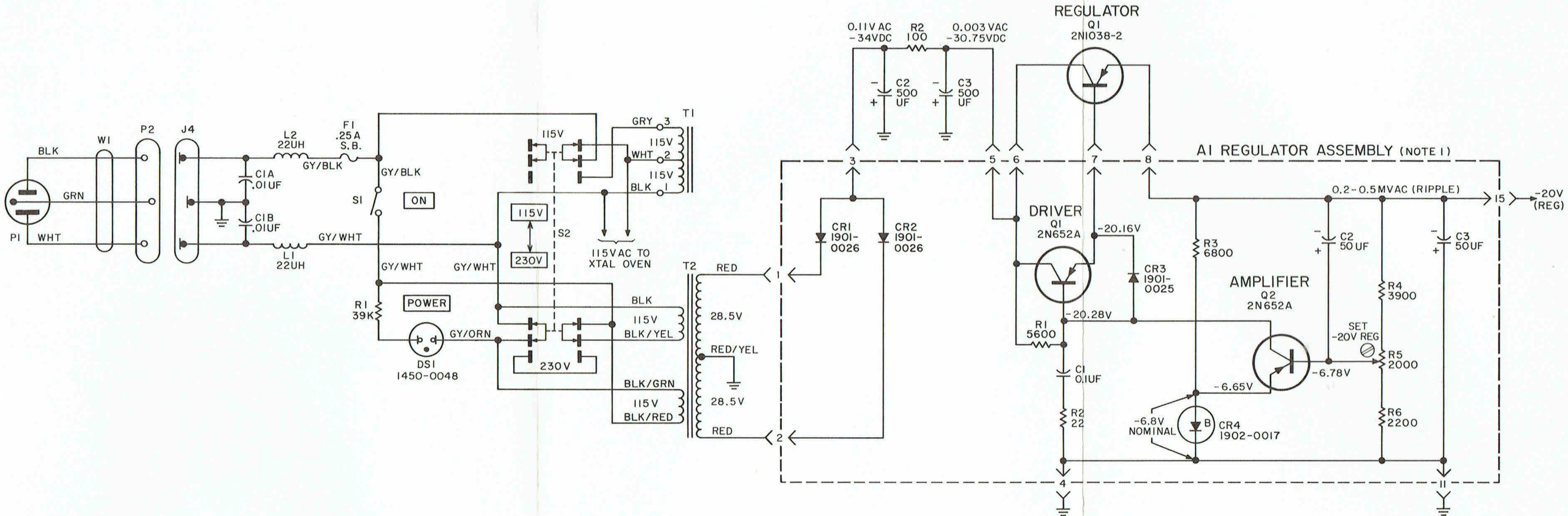



Figure 5-9. Short Term Stability Check Test Equipment Setup




## NOTES:

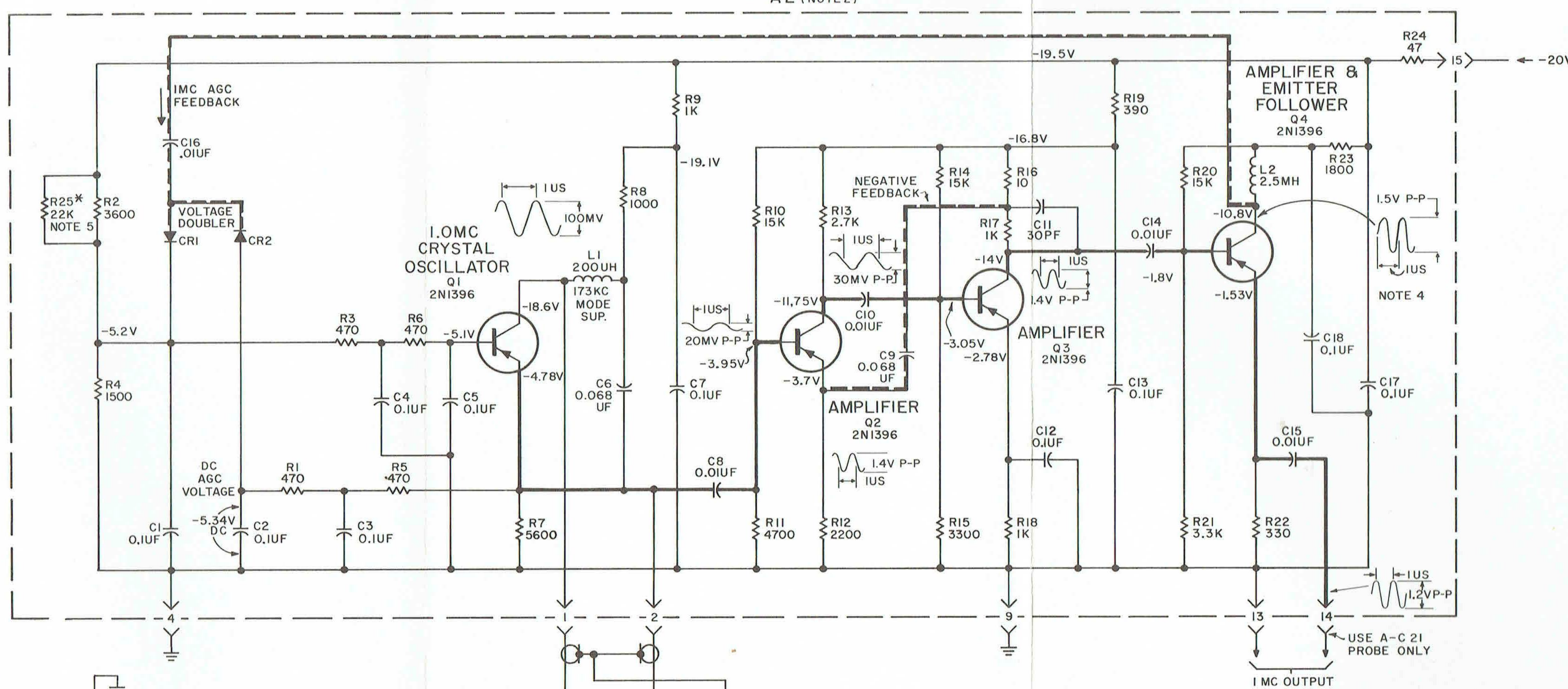
1. REFERENCE DESIGNATIONS IN REGULATOR ASSEMBLY ARE ABBREVIATED; TO FORM COMPLETE DESIGNATION ADD PREFIX A1 TO INDICATED DESIGNATION.
2. DC VOLTAGES MEASURED ON A TYPICAL INSTRUMENT WITH -hp- MODEL 412A VTVM. ACCURACY ± 1%
3. AC RIPPLE VOLTAGES MEASURED WITH -hp- MODEL 400D
4. LINE VOLTAGE ADJUSTED TO 115VAC FOR MEASURED VALUES

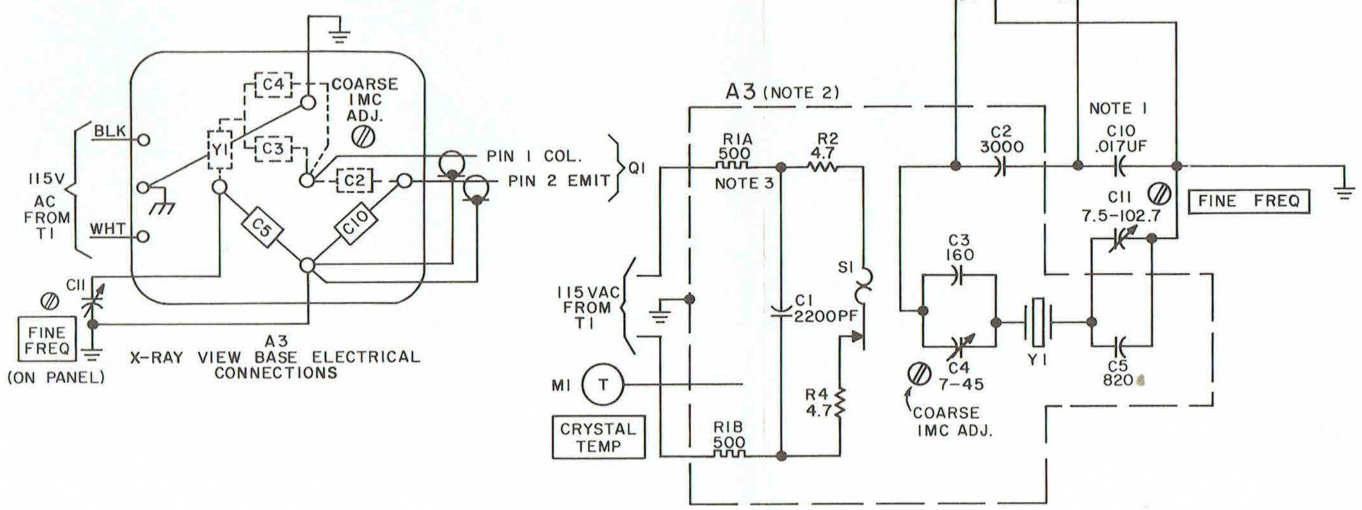
| REFERENCE DESIGNATORS |
| --- |
| A1 |
| A1C1-A1C3 |
| A1CR1-A1CR4 |
| A1Q1-A1Q2 |
| A1R1-A1R6 |
| C1-C3 |
| DS1 |
| F1 |
| J4 |
| L1-L2 |
| P1-P2 |
| Q1 |
| R1-R2 |
| S1-S2 |
| T1-T2 |
| W1 |

UNASSIGNED
A1CR5 – A1CR7



Figure 5-10. Regulated Power Supply




REFERENCE DESIGNATORS

| |
|---|
| A2 |
| A2C1-18 |
| A2CR1, 2 |
| A2L1, 2 |
| A2Q1-4 |
| A2R1-25 |
| A3 |
| A3C1-5, 10, 11 |
| A3R1-4 |
| A3S1 |
| A3Y1 |

DELETED: R3
UNASSIGNED:
A3C6-A3C9

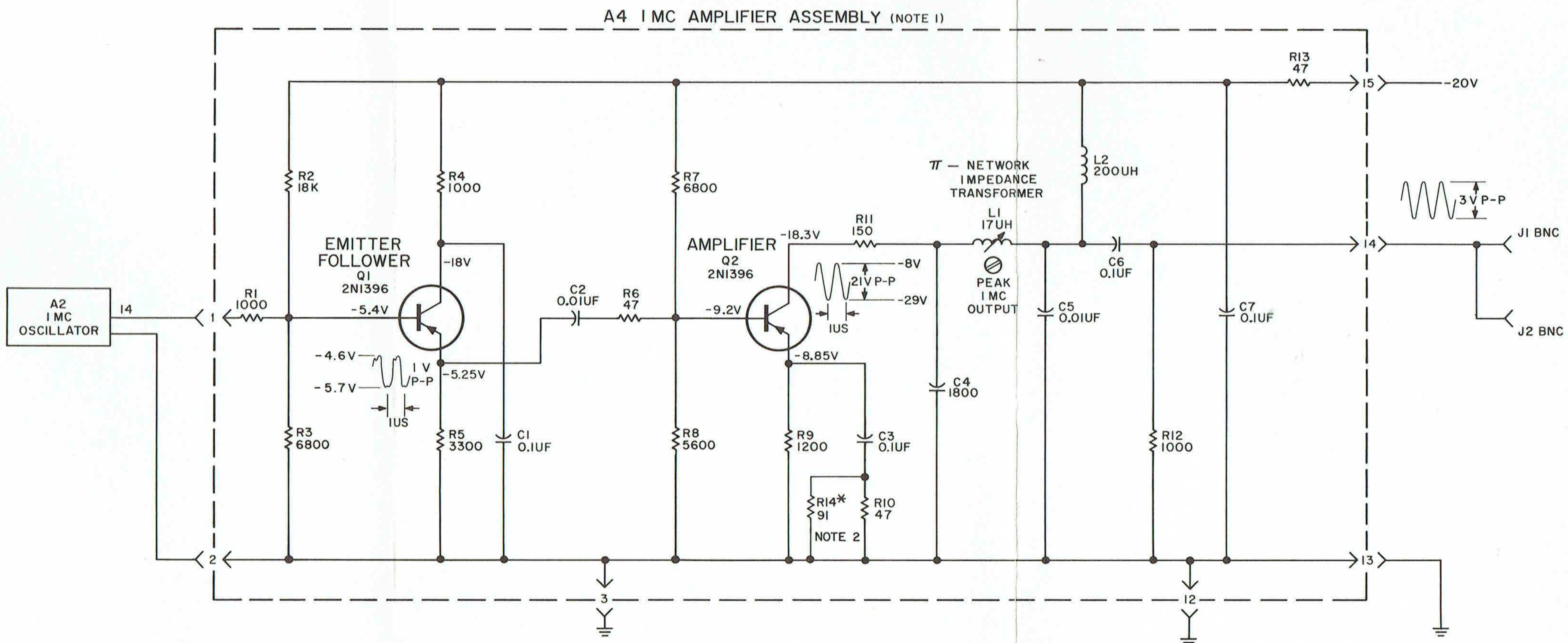
## NOTES:

1. PART OF A3
2. REFERENCE DESIGNATIONS ARE ABBREVIATED. TO FORM COMPLETE DESIGNATION, PREFIX A2 OR A3 (ASSEMBLY NO.) TO INDICATED DESIGNATION.
3. R1A AND B ARE BIFILAR WOUND AND ARE AN INTEGRAL PART OF OVEN CHAMBER.
4. AC SIGNAL LEVELS MEASURED WITH A 10MC OSCILLOSCOPE USING LOW CAPACITY LEADS TO MINIMIZE CIRCUIT LOADING.
   AC VOLTAGES ON Q4 MUST BE MEASURED WITH A LOW CAPACITY DIVIDER PROBE. HIGH SHUNT CAPACITY AND LONG LEADS MAY CAUSE A SPURIOUS 10MC OSCILLATION.
5. VALUE SELECTED TO MAINTAIN 32 TO 36 MV RMS 1MC AT PIN 1 OF A2. MEASURED WITH -HP- MODEL 400H AC-V.T.V.M.



101A-OSC-136E

Figure 5-11. 1-MC Crystal Oscillator




NOTES:

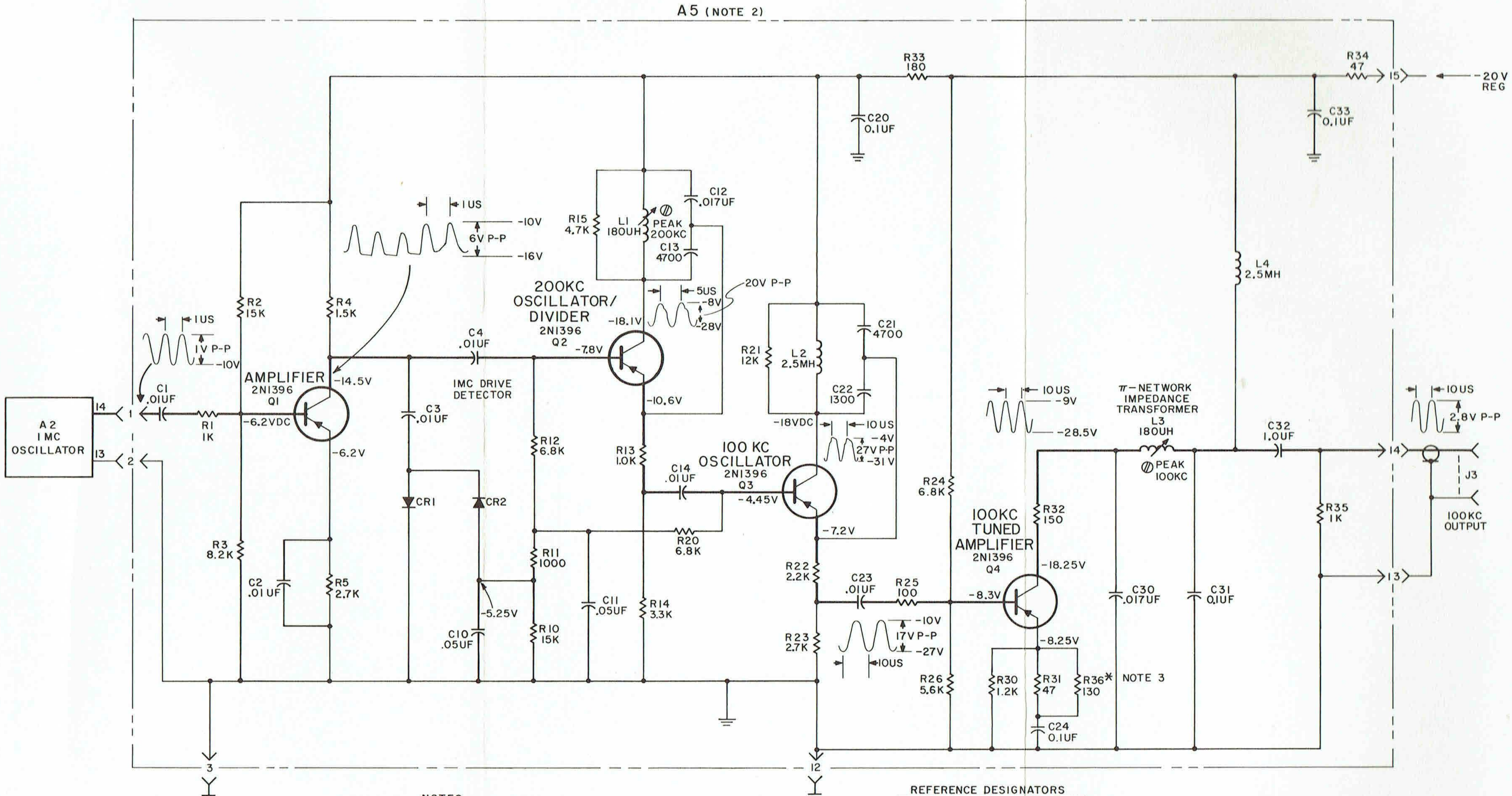
1. REFERENCE DESIGNATIONS ARE ABBREVIATED; TO FORM COMPLETE DESIGNATION ADD PREFIX A4 TO INDICATED DESIGNATION
2. ASTERISK (*) INDICATES SELECTED COMPONENT; AVERAGE VALUE SHOWN. VALUE SELECTED TO SET OUTPUT VOLTAGE TO APPROX. 1.1V RMS INTO 50 OHM LOAD.

REFERENCE DESIGNATORS

| A4 |
|---|
| A4C1-A4C7 |
| A4Q1-A4Q2 |
| A4R1-A4R14 |
| J1, J2 |



Figure 5-12. 1-MC Output Amplifier




NOTES

1. UNLESS OTHERWISE STATED, RESISTANCE IN OHMS, CAPACITY IN PICOFARADS.
2. REFERENCE DESIGNATIONS IN 100KC OUTPUT ASSEMBLY ARE ABBREVIATED; TO FORM COMPLETE DESIGNATION, ADD PREFIX A5 TO INDICATED DESIGNATION.
3. ASTERISK (*) INDICATES SELECTED VALUE COMPONENT; AVERAGE VALUE SHOWN. VALUE SELECTED TO SET OUTPUT VOLTAGE TO APPROX. 1.1V RMS INTO 50 OHM LOAD.

REFERENCE DESIGNATORS

A5
A5C1-4, 10-14, 20-24, 30-33
A5CR1, 2
A5L1-4
A5Q1-4
A5R1-5, 10-15, 20-26, 30-36
J3

UNASSIGNED
A5C5-A5C9
A5C15-A5C19
A5C25-A5C29
A5R16-A5R19
A5R27-A5R29


101A 100KC OUTPUT T144D

Figure 5-13. 100-KC Locked Oscillator/Divider and Output

# SECTION VI
# REPLACEABLE PARTS

## 6-1. INTRODUCTION.

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

a. Description of the part (see list of abbreviations below).

b. Typical manufacturer of the part in a five-digit code; see list of manufacturers in appendix.

c. Manufacturer's stock number.

d. Total quantity used in the instrument (TQ column).

e. Recommended spare part quantity for complete maintenance during one year of isolated service (RS column).

6-3. Miscellaneous parts not indexed in table 6-1 are listed at the end of table 6-2.

## 6-4. ORDERING INFORMATION.

6-5. To order a replacement part, address order or inquiry either to your authorized Hewlett-Packard sales representative or to

CUSTOMERS SERVICE
Hewlett-Packard Company
395 Page Mill Road
Palo Alto, California

or, in Western Europe, to

Hewlett-Packard S.A.
54-54bis Route des Acacias
Geneva, Switzerland

6-6. Specify the following information for each part:

a. Model and complete serial number of instrument.

b. Hewlett-Packard stock number.

c. Circuit reference designator.

d. Description.

6-7. To order a part not listed in tables 6-1 and 6-2, give a complete description of the part and include its function and location.

### REFERENCE DESIGNATORS

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

### ABBREVIATIONS

a = amperes
bp = bandpass
bwo = backward wave oscillator
c = carbon
cer = ceramic
cmo = cabinet mount only
coef = coefficient
com = common
comp = composition
conn = connection
crt = cathode-ray tube
dep = deposited
EIA = Tubes or transistors meeting Electronic Industries' Association standards will normally result in instrument operating within specifications; tubes and transistors selected for best performance will be supplied if ordered by (hp) stock numbers.
elect = electrolytic
encap = encapsulated
f = farads
fxd = fixed
Ge = germanium
grd = ground (ed)
h = henries
Hg = mercury
impg = impregnated
incd = incandescent
ins = insulation (ed)
K = kilo = 1000
lin = linear taper
log = logarithmic taper
m = milli = $10^{-3}$
M = megohms
ma = milliamperes
$\mu$ = micro = $10^{-6}$
minat = miniature
mfgl = metal film on glass
mfr = manufacturer
mtg = mounting
my = mylar
NC = normally closed
Ne = neon
NO = normally open
NPO = negative positive zero (zero temperature coefficient)
nsr = not separately replaceable
obd = order by description
p = peak
pc = printed circuit board
pf = picofarads = $10^{-12}$ farads
pp = peak-to-peak
piv = peak inverse voltage
pos = position(s)
poly = polystyrene
pot = potentiometer
rect = rectifier
rot = rotary
rms = root-mean-square
rmo = rack mount only
s-b = slow-blow
Se = selenium
sect = section(s)
Si = silicon
sil = silver
sl = slide
td = time delay
$TiO_2$ = titanium dioxide
tog = toggle
tol = tolerance
trim = trimmer
twt = traveling wave tube
var = variable
w/ = with
W = watts
ww = wirewound
w/o = without
* = optimum value selected at factory, average value shown (part may be omitted)

01194-4

Table 6-1. Reference Designation Index

| Circuit Reference | ⓗ Stock No. | Description # | Note |
|---|---|---|---|
| A1 | 101A-65A | Assy, power supply board: (includes all components listed under A1 prefix) | |
| A1C1 | 0170-0085 | C: fxd, my, 0.1 μf ±20%, 50 vdcw | |
| A1C2, A1C3 | 0180-0058 | C: fxd, elect, 50 μf -10% +100%, 25 vdcw | |
| A1CR1, A1CR2 | 1901-0026 | Diode, Si: 0.75A, PIV | |
| A1CR3 | 1901-0025 | Diode, Si: 50 ma @+1V, 100 PIV | |
| A1CR4 | 1902-0017 | Diode, Si: breakdown, 6.8 V, ±10% | |
| A1Q1, A1Q2 | 1850-0054 | Transistor: 2N652A | |
| A1R1 | 0687-5621 | R: fxd, comp, 5.6K ohms ±10%, 1/2 W | |
| A1R2 | 0687-2201 | R: fxd, comp, 22 ohms ±10%, 1/2 W | |
| A1R3 | 0687-6821 | R: fxd, comp, 6.8K ohms ±10%, 1/2 W | |
| A1R4 | 0687-3921 | R: fxd, comp, 3.9K ohms ±10%, 1/2 W | |
| A1R5 | 2100-0090 | R: var, comp, lin, 2K ohms ±30%, 1/2 W | |
| A1R6 | 0687-2221 | R: fxd, comp, 2.2K ohms ±10%, 1/2 W | |
| A2 | 101A-65B | Assy, AGC Osc. board: (includes all components listed under A2 prefix) | |
| A2C1 - A2C5 | 0150-0084 | C: fxd, cer, 0.1 μf +80% -20%, 50 vdcw | |
| A2C6 | 0170-0084 | C: fxd, my, 0.068 μf ±20%, 50 vdcw | |
| A2C7 | 0150-0084 | C: fxd, cer, 0.1 μf +80% -20%, 50 vdcw | |
| A2C8 | 0150-0098 | C: fxd, cer, 0.01 μf ±20% , 100 vdcw | |
| A2C9 | 0170-0084 | C: fxd, my, 0.068 μf ±20%, 50 vdcw | |
| A2C10 | 0150-0098 | C: fxd, cer, 0.01 μf ±20%, 100 vdcw | |
| A2C11 | 0140-0203 | C: fxd, mica, 30 pf ±5%, 500 vdcw | |
| A2C12, A2C13 | 0150-0084 | C: fxd, cer, 0.1 μf +80% -20%, 50 vdcw | |
| A2C14 - A2C16 | 0150-0098 | C: fxd, cer, 0.01 μf ±20%, 100 vdcw | |
| A2C17, A2C18 | 0150-0084 | C: fxd, cer, 0.01 μf +80% -20%, 50 vdcw | |
| A2CR1, A2CR2 | 1910-0011 | Diode, Ge: 5 ma @+1V, 60 PIV | |
| A2L1 | 9140-0019 | Inductor: fxd, 200 μh | |
| A2L2 | 9140-0041 | Inductor: 2.5 mh | |
| A2Q1 - A2Q4 | 1850-0074 | Transistor: 2N1396 | |

# See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

| Circuit Reference | ⓗ Stock No. | Description# | Note |
|---|---|---|---|
| A2R1 | 0687-4711 | R: fxd, comp, 470 ohms ±10%, 1/2 W | |
| A2R2 | 0686-3625 | R: fxd, comp, 3.6K ohms ±5%, 1/2 W | |
| A2R3 | 0687-4711 | R: fxd, comp, 470 ohms ±10%, 1/2 W | |
| A2R4 | 0687-1521 | R: fxd, comp, 1.5K ohms ±10%, 1/2 W | |
| A2R5, A2R6 | 0687-4711 | R: fxd, comp, 470 ohms ±10%, 1/2 W | |
| A2R7 | 0687-5621 | R: fxd, comp, 5.6K ohms ±10%, 1/2 W | |
| A2R8, A2R9 | 0687-1021 | R: fxd, comp, 1K ohms ±10%, 1/2 W | |
| A2R10 | 0687-1531 | R: fxd, comp, 15K ohms ±10%, 1/2 W | |
| A2R11 | 0687-4721 | R: fxd, comp, 4.7K ohms ±10%, 1/2 W | |
| A2R12 | 0687-2221 | R: fxd, comp, 2.2K ohms ±10%, 1/2 W | |
| A2R13 | 0687-2721 | R: fxd, comp, 2.7K ohms ±10%, 1/2 W | |
| A2R14 | 0687-1531 | R: fxd, comp, 15K ohms ±10%, 1/2 W | |
| A2R15 | 0687-3321 | R: fxd, comp, 3.3K ohms ±10%, 1/2 W | |
| A2R16 | 0687-1001 | R: fxd, comp, 10 ohms ±10%, 1/2 W | |
| A2R17, A2R18 | 0687-1021 | R: fxd, comp, 1K ohms ±10%, 1/2 W | |
| A2R19 | 0687-3911 | R: fxd, comp, 390 ohms ±10%, 1/2 W | |
| A2R20 | 0687-1531 | R: fxd, comp, 15K ohms ±10%, 1/2 W | |
| A2R21 | 0687-3321 | R: fxd, comp, 3.3K ohms ±10%, 1/2 W | |
| A2R22 | 0687-3311 | R: fxd, comp, 330 ohms ±10%, 1/2 W | |
| A2R23 | 0687-1821 | R: fxd, comp, 1.8K ohms ±10%, 1/2 W | |
| A2R24 | 0687-4701 | R: fxd, comp, 47 ohms ±10%, 1/2 W | |
| A2R25 | 0687-2231 | R: fxd, comp, 22* ohms ±10%, 1/2W | |
| A3 | 101A-95A | Assy, crystal oven: (includes all components listed under A3 prefix) | |
| A3A1 | G-69H | Assy, oven: includes oven, A3C1 thru A3C5, A3M1, A3S1, A3Y1 plus A3C10 | |
| A3C1 - A3C5 | | Nsr; part of A3 | |
| A3C6 - A3C9 | | Not assigned | |
| A3C10 | 0140-0166 | C: fxd, mica, 0.017 $\mu$f ±2%, 300 vdcw | |
| A3C11 | 0121-0008 | C: var, air, 7.5 - 102.7 pf | |
| A3M1 | 0440-0005 | Thermometer: nsr; part of A3A1 (scale factory matched to crystal and oven-operating temp.) | |

# See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

| Circuit Reference | hp Stock No. | Description # | Note |
|---|---|---|---|
| A3R1 - A3R4 | | Nsr; part of A3 | |
| A3S1 | | Nsr; part of A3 | |
| A3Y1 | | Nsr; part of A3 | |
| A4 | 101A-65C | Assy, 1 mc amplifier board: (includes all components listed under A4 prefix) | |
| A4C1 | 0150-0084 | C: fxd, cer, 0.1 μf +80% -20%, 50 vdcw | |
| A4C2 | 0150-0098 | C: fxd, cer, 0.01 μf ±20%, 100 vdcw | |
| A4C3 | 0150-0084 | C: fxd, cer, 0.1 μf +80% -20%, 50 vdcw | |
| A4C4 | 0140-0020 | C: fxd, mica, 1800 pf ±10%, 500 vdcw | |
| A4C5 | 0140-0008 | C: fxd, mica, 0.01 μf ±10%, 300 vdcw | |
| A4C6 | 0170-0055 | C: fxd, my, 0.1 μf ±20%, 100 vdcw | |
| A4C7 | 0150-0084 | C: fxd, cer, 0.1 μf +80% -20%, 50 vdcw | |
| A4L1 | 5243A-60A | Inductor: 8.3 - 18.7 μh | |
| A4L2 | 9140-0019 | Inductor: fxd, 200 μh | |
| A4Q1, A4Q2 | 1850-0074 | Transistor: 2N1396 | |
| A4R1 | 0687-1021 | R: fxd, comp, 1K ohms ±10%, 1/2W | |
| A4R2 | 0687-1831 | R: fxd, comp, 18K ohms ±10%, 1/2W | |
| A4R3 | 0687-6821 | R: fxd, comp, 6.8K ohms ±10%, 1/2W | |
| A4R4 | 0687-1021 | R: fxd, comp, 1K ohms ±10%, 1/2W | |
| A4R5 | 0687-3321 | R: fxd, comp, 3.3K ohms ±10%, 1/2W | |
| A4R6 | 0687-4701 | R: fxd, comp, 47 ohms ±10%, 1/2W | |
| A4R7 | 0687-6821 | R: fxd, comp, 6.8K ohms ±10%, 1/2W | |
| A4R8 | 0687-5621 | R: fxd, comp, 5.6K ohms ±10%, 1/2W | |
| A4R9 | 0687-1221 | R: fxd, comp, 1.2K ohms ±10%, 1/2W | |
| A4R10 | 0687-4701 | R: fxd, comp, 47 ohms ±10%, 1/2W | |
| A4R11 | 0687-1511 | R: fxd, comp, 150 ohms ±10%, 1/2W | |
| A4R12 | 0687-1021 | R: fxd, comp, 1K ohms ±10%, 1/2W | |
| A4R13 | 0687-4701 | R: fxd, comp, 47 ohms ±10%, 1/2W | |
| A4R14 | 0687-9101 | R: fxd, comp, 91* ohms ±10%, 1/2W | |
| A5 | 101A-65D | Assy, 100 kc circuitry board: (includes all components listed under A5 prefix) | |
| A5C1 - A5C4 | 0150-0093 | C: fxd, cer, 0.01 μf +80% -20%, 100 vdcw | |

# See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

| Circuit Reference | ⓗⓟ Stock No. | Description | Note |
|---|---|---|---|
| A5C5-A5C9 | | Not assigned | |
| A5C10, A5C11 | 0150-0096 | C: fxd, cer, 0.05 μf +80% -20%, 100 vdcw | |
| A5C12 | 0140-0166 | C: fxd, mica, 0.017 μf ±2%, 300 vdcw | |
| A5C13 | 0140-0162 | C: fxd, mica, 4700 pf ±10%, 300 vdcw | |
| A5C14 | 0150-0093 | C: fxd, cer, 0.01 μf +80% -20%, 100 vdcw | |
| A5C15 - A5C19 | | Not assigned | |
| A5C20 | 0150-0121 | C: fxd, cer, 0.1 μf +80% -20%, 50 vdcw | |
| A5C21 | 0140-0162 | C: fxd, mica, 4700 pf ±10%, 300 vdcw | |
| A5C22 | 0140-0154 | C: fxd, mica, 1300 pf ±5%, 500 vdcw | |
| A5C23 | 0150-0093 | C: fxd, cer, 0.01 μf +80% -20%, 100 vdcw | |
| A5C24 | 0150-0121 | C: fxd, cer, 0.1 μf +80% -20%, 50 vdcw | |
| A5C25-A5C29 | | Not assigned | |
| A5C30 | 0140-0166 | C: fxd, mica, 0.017 μf ±2%, 300 vdcw | |
| A5C31 | 0170-0085 | C: fxd, my, 0.1 μf ±20%, 50 vdcw | |
| A5C32 | 0170-0072 | C: fxd, my, 1 μf ±10%, 200 vdcw | |
| A5C33 | 0150-0121 | C: fxd, cer, 0.1 μf +80% -20%, 50 vdcw | |
| A5CR1, A5CR2 | 1910-0011 | Diode, Ge | |
| A5L1 | 101A-60A | Inductor: 180 μh | |
| A5L2 | 9140-0041 | Inductor: 2.5 mh | |
| A5L3 | 101A-60A | Inductor: 180 μh | |
| A5L4 | 9140-0041 | Inductor: 2.5 mh | |
| A5Q1 - A5Q4 | 1850-0074 | Transistor: 2N1396 | |
| A5R1 | 0683-1025 | R: fxd, comp, 1K ohms ±5%, 1/4 W | |
| A5R2 | 0683-1535 | R: fxd, comp, 15K ohms ±5%, 1/4 W | |
| A5R3 | 0683-8225 | R: fxd, comp, 8.2K ohms ±5%, 1/4 W | |
| A5R4 | 0683-1525 | R: fxd, comp, 1.5K ohms ±5%, 1/4 W | |
| A5R5 | 0683-2725 | R: fxd, comp, 2.7K ohms ±5%, 1/4 W | |
| A5R6 - A5R9 | | Not assigned | |
| A5R10 | 0683-1535 | R: fxd, comp, 15K ohms ±5%, 1/4 W | |
| A5R11 | 0683-1025 | R: fxd, comp, 1K ohms ±5%, 1/4 W | |
| A5R12 | 0683-6825 | R: fxd, comp, 6.8K ohms ±5%, 1/4 W | |
| A5R13 | 0683-1025 | R: fxd, comp, 1K ohms ±5%, 1/4 W | |
| A5R14 | 0683-3325 | R: fxd, comp, 3.3K ohms ±5%, 1/4 W | |

# See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

| Circuit Reference | ⓗⓟ Stock No. | Description | Note |
|---|---|---|---|
| A5R15 | 0683-4725 | R: fxd, comp, 4.7K ohms ±5%, 1/4 W | |
| A5R16-A5R19 | | Not assigned | |
| A5R20 | 0683-6825 | R: fxd, comp, 6.8K ohms ±5%, 1/4 W | |
| A5R21 | 0683-1235 | R: fxd, comp, 12K ohms ±5%, 1/4 W | |
| A5R22 | 0683-2225 | R: fxd, comp, 2.2K ohms ±5%, 1/4 W | |
| A5R23 | 0683-2725 | R: fxd, comp, 2.7K ohms ±5%, 1/4 W | |
| A5R24 | 0683-6825 | R: fxd, comp, 6.8K ohms ±5%, 1/4W | |
| A5R25 | 0683-1015 | R: fxd, comp, 100 ohms ±5%, 1/4 W | |
| A5R26 | 0683-5625 | R: fxd, comp, 5.6K ohms ±5%, 1/4 W | |
| A5R27-A5R29 | | Not assigned | |
| A5R30 | 0683-1225 | R: fxd, comp, 1.2K ohms ±5%, 1/4 W | |
| A5R31 | 0683-4705 | R: fxd, comp, 47 ohms ±5%, 1/4 W | |
| A5R32 | 0683-1515 | R: fxd, comp, 150 ohms ±5%, 1/4 W | |
| A5R33 | 0683-1815 | R: fxd, comp, 180 ohms ±5%, 1/4 W | |
| A5R34 | 0683-4705 | R: fxd, comp, 47 ohms ±5%, 1/4 W | |
| A5R35 | 0683-1025 | R: fxd, comp, 1K ohms ±5%, 1/4 W | |
| A5R36 | 0683-1315 | R: fxd, comp, 130* ohms ±5%, 1/4 W | |
| C1 | 0150-0119 | C: fxd, cer, 2sect, 0.01μf/sect ±20%, 250 vacw | |
| C2, C3 | 0180-0047 | C: fxd, elect, 500 μf, 75 vdcw | |
| DS1 | 1450-0048 | Lamp, neon: NE2H in transparent red plastic body | |
| F1 | 2110-0018 | Fuse, cartridge: 0.25 amp, s-b (for 115V operation) | |
| | 2110-0027 | Fuse, cartridge: 1/8 amp, s-b (for 230V operation) | |
| J1, J2, J3 | 1250-0083 | Connector, BNC: female, type UG-1094/U | |
| J4 | 1251-0148 | Connector, power: male, 3 pin | |
| L1, L2 | 9140-0115 | Inductor: fxd, 22 μh | |
| P1 | | Connector: 3 pin male, NEMA<br>Nsr; part of W1 | |
| P2 | 1251-0094 | European 3-wire type, 2 round pins, 2 earthing straps. Mfr: Siemens & Schucker & Werke AC c/o Siemens New York Inc.<br>Nsr; part of W1 | |

# See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

| Circuit Reference | ⓗⓟ Stock No. | Description | Note |
|---|---|---|---|
| Q1 | 1850-0076 | Transistor: 2N1038-2 | |
| R1 | 0687-3931 | R: fxd, comp, 39K ohms ±10%, 1/2 W | |
| R2 | 0690-1011 | R: fxd, comp, 100 ohms ±10%, 1W | |
| S1 | 3101-0036 | Switch, tog: SPST | |
| S2 | 3101-0034 | Switch, sl: 4PDT | |
| T1 | 9100-0155 | Autotransformer | |
| T2 | 9100-0107 | Transformer, power | |
| W1 | 8120-0078 | Assy, power cable: includes, P1, P2 | |
| XA1, XA2 | 1251-0135 | Connector: 15 pin, pc | |
| XA3 | | Not assigned | |
| XA4, XA5 | 1251-0135 | Connector: 15 pin, pc | |

# See introduction to this section

Table 6-2. Replaceable Parts

| ⓗⓟ Stock No. | Description # | Mfr. | Mfr. Part No. | TQ | RS | | |
|---|---|---|---|---|---|---|---|
| G69H | Assy oven includes:<br>oven A3C1 thru A3C5,<br>A3M1, A3S1, A3Y1<br>Plus A3C10 | 28480 | G69H | 1 | 1 | | |
| 101A-60A | Inductor: 180 μh | 28480 | 101A-60A | 2 | 1 | | |
| 101A-65A | Assy, power supply board: includes,<br>A1C1 - A1C3 A1CR8<br>A1CR1, A1CR2 A1Q1, A1Q2<br>A1CR4 A1R1 - A1R6 | 28480 | 101A-65A | 1 | 0 | | |
| 101A-65B | Assy, AGC Osc. board includes:<br>A2C1 - A2C18 A2Q1 - A2Q4<br>A2CR1, A2CR2 A2R1 - A2R4<br>A2L1, A2L2 | 28480 | 101A-65B | 1 | 0 | | |
| 101A-65C | Assy, 1 mc amplifier board: includes,<br>A4C1 - A4C7 A4Q1, A4Q2<br>A4L1, A4L2 A4R1 - A4R13 | 28480 | 101A-65C | 1 | 0 | | |
| 101A-65D | Assy, 100 kc circuitry board:<br>includes:<br>A5C1 - A5C4 A5Q1 - A5Q4<br>A5C10 - A5C14 A5R1 - A5R5<br>A5C20 - A5C24 A5R10 - A5R15<br>A5C30 - A5C33 A5R20 - A5R26<br>A5CR1, A5CR2 A5R30 - A5R35<br>A5L1 - A5L4 | 28480 | 101A-65D | 1 | 0 | | |
| 101A-95A | Assy, crystal oven: includes,<br>A3A1 A3M1<br>A3C1 thru A3C5 A3R1 thru A3C4<br>A3C10 A3S1<br>A3C11 A3Y1 | 28480 | 101A-95A | 1 | 1 | | |
| 5243A-60A | Inductor: 8.3 - 18.7 μh | 28480 | 5243A-60A | 1 | 1 | | |
| 0121-0008 | C: var, air, 7.5 -102.7 pf | 84970 | No. 2 term<br>position A-103L | 1 | 1 | | |
| 0140-0008 | C: fxd, mica, 10K pf ±10%, 300 vdcw | 76433 | RCM35B103K | 1 | 1 | | |
| 0140-0020 | C: fxd, mica, 1800 pf ±10%, 500 vdcw | 00853 | C1218B10 | 1 | 1 | | |
| 0140-0154 | C: fxd, mica, 1300 pf ±5%, 500 vdcw | 72136 | DM20F132J | 1 | 1 | | |
| 0140-0162 | C: fxd, mica, 4700 pf ±10%, 300 vdcw | 72136 | DM20F472K | 2 | 1 | | |
| 0140-0166 | C: fxd, mica, 0.017 μf ±2%, 300 vdcw | 72136 | DM30F173G | 3 | 1 | | |
| 0140-0203 | C: fxd, mica, 30 pf ±5%, 500 vdcw | 72136 | DM15E300J | 1 | 1 | | |
| 0150-0084 | C: fxd, cer, 0.1 μf +80% -20%, 50 vdcw | 56289 | 33C41 | 13 | 3 | | |

#See introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

| ℗ Stock No. | Description # | Mfr. | Mfr. Part No. | TQ | RS | | |
|---|---|---|---|---|---|---|---|
| 0150-0093 | C: fxd, cer, 0.01 μf +80% -20%, 100 vdcw | 91418 | TA obd# | 6 | 2 | | |
| 0150-0096 | C: fxd, cer, 0.05 μf +80%-20%, 100 vdcw | 91418 | TA obd# | 2 | 1 | | |
| 0150-0098 | C: fxd, cer, 0.01 μf ±20%, 100 vdcw | 91418 | B obd# | 6 | 2 | | |
| 0150-0119 | C: fxd, cer, 2 sect, 0.01 μf/sect, ±20%, 250 vacw | 56289 | 41C159A | 1 | 1 | | |
| 0150-0121 | C: fxd, cer, 0.1 μf +80%-20%, 50 vdcw | 56289 | 5C50A | 3 | 1 | | |
| 0170-0055 | C: fxd, my, 0.1 uf ±20%, 100 vdcw | 56289 | 148P10491 | 1 | 1 | | |
| 0170-0072 | C: fxd, my, 1 μf ±10%, 200 vdcw | 09134 | obd# | 1 | 1 | | |
| 0170-0084 | C: fxd, my, 0.068 μf ±20%, 50 vdcw | 84411 | 601PE, style 3, obd# | 2 | 1 | | |
| 0170-0085 | C: fxd, my, 0.1 μf ±20%, 50 vdcw | 84411 | 601PE, style 3 obd# | 2 | 1 | | |
| 0180-0047 | C: fxd, elect, 500 μf, 75 vdcw | 56289 | D32443 | 2 | 1 | | |
| 0180-0058 | C: fxd, elect, 50 μf -10% +100%, 25 vdcw | 56289 | 30D186A1 | 2 | 1 | | |
| 0440-0005 | Thermometer (scale factory matched to crystal and oven operated temp.) | 65092 | Model 2291 | 1 | 0 | | |
| 0683-1015 | R: fxd, comp, 100 ohms ±5%, 1/4 W | 01121 | CB1015 | 1 | 1 | | |
| 0683-1025 | R: fxd, comp, 1K ohms ±5%, 1/4 W | 01121 | CB1025 | 4 | 1 | | |
| 0683-1225 | R: fxd, comp, 1.2K ohms ±5%, 1/4 W | 01121 | CB1225 | 1 | 1 | | |
| 0683-1235 | R: fxd, comp, 12K ohms ±5%, 1/4 W | 01121 | CB1235 | 1 | 1 | | |
| 0683-1315 | R: fxd, comp, 130*K ohms ±5%, 1/4 W | 01121 | CB1315 | 1 | 1 | | |
| 0683-1515 | R: fxd, comp, 150 ohms ±5%, 1/4 W | 01121 | CB1515 | 1 | 1 | | |
| 0683-1525 | R: fxd, comp, 1.5K ohms ±5%, 1/4 W | 01121 | CB1525 | 1 | 1 | | |
| 0683-1535 | R: fxd, comp, 15K ohms ±5%, 1/4 W | 01121 | CB1535 | 2 | 1 | | |
| 0683-1815 | R: fxd, comp, 180 ohms ±5%, 1/4 W | 01121 | CB1815 | 1 | 1 | | |
| 0683-2225 | R: fxd, comp, 2.2K ohms ±5%, 1/4 W | 01121 | CB2225 | 1 | 1 | | |
| 0683-2725 | R: fxd, comp, 2.7K ohms ±5%, 1/4 W | 01121 | CB2725 | 2 | 1 | | |
| 0683-3325 | R: fxd, comp, 3.3K ohms ±5%, 1/4 W | 01121 | CB3325 | 1 | 1 | | |
| 0683-4705 | R: fxd, comp, 47 ohms ±5%, 1/4 W | 01121 | CB4705 | 2 | 1 | | |
| 0683-4725 | R: fxd, comp, 4.7K ohms ±5%, 1/4 W | 01121 | CB4725 | 1 | 1 | | |
| 0683-5625 | R: fxd, comp, 5.6K ohms ±5%, 1/4W | 01121 | CB5625 | 1 | 1 | | |
| 0683-6825 | R: fxd, comp, 6.8K ohms ±5%, 1/4 W | 01121 | CB6825 | 3 | 1 | | |
| 0683-8225 | R: fxd, comp, 8.2K ohms ±5%, 1/4 W | 01121 | CB8225 | 1 | 1 | | |
| 0686-3625 | R: fxd, comp, 3.6K ohms ±5%, 1/2 W | 01121 | EB3625 | 1 | 1 | | |
| 0687-1001 | R: fxd, comp, 10 ohms±10%, 1/2 W | 01121 | EB1001 | 1 | 1 | | |
| 0687-1021 | R: fxd, comp, 1K ohms ±10%, 1/2 W | 01121 | EB1021 | 7 | 2 | | |
| 0687-1221 | R: fxd, comp, 1.2K ohms ±10%, 1/2 W | 01121 | EB1221 | 1 | 1 | | |
| 0687-1511 | R: fxd, comp, 150 ohms ±10%, 1/2 W | 01121 | EB1511 | 1 | 1 | | |
| 0687-1521 | R: fxd, comp, 1.5K ohms ±10%, 1/2 W | 01121 | EB1521 | 1 | 1 | | |

#See introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

| ℎ𝑝 Stock No. | Description # | Mfr. | Mfr. Part No. | TQ | RS | | |
|---|---|---|---|---|---|---|---|
| 0687-1531 | R: fxd, comp, 15K ohms ±10%, 1/2 W | 01121 | EB1531 | 3 | 1 | | |
| 0687-1821 | R: fxd, comp, 1.8K ohms ±10%, 1/2 W | 01121 | EB1821 | 1 | 1 | | |
| 0687-1831 | R: fxd, comp, 18K ohms ±10%, 1/2 W | 01121 | EB1831 | 1 | 1 | | |
| 0687-2201 | R: fxd, comp, 22 ohms ±10%, 1/2 W | 01121 | EB2201 | 1 | 1 | | |
| 0687-2221 | R: fxd, comp, 2.2K ohms ±10%, 1/2 W | 01121 | EB2221 | 2 | 1 | | |
| 0687-2231 | R: fxd, comp.22K ohms ±10%, 1/2 W | 01121 | EB2231 | 1 | 1 | | |
| 0687-2721 | R: fxd, comp, 2.7K ohms ±10%, 1/2 W | 01121 | EB2721 | 1 | 1 | | |
| 0687-3311 | R: fxd, comp, 330 ohms ±10%, 1/2 W | 01121 | EB3311 | 1 | 1 | | |
| 0687-3321 | R: fxd, comp, 3.3K ohms ±10%, 1/2 W | 01121 | EB3321 | 3 | 1 | | |
| 0687-3911 | R: fxd, comp, 390 ohms ±10%, 1/2 W | 01121 | EB3911 | 1 | 1 | | |
| 0687-3921 | R: fxd, comp, 3.9K ohms ±10%, 1/2 W | 01121 | EB3921 | 1 | 1 | | |
| 0687-3931 | R: fxd, comp, 39K ohms ±10%, 1/2 W | 01121 | EB3931 | 1 | 1 | | |
| 0687-4701 | R: fxd, comp, 47 ohms ±10%, 1/2 W | 01121 | EB4701 | 4 | 1 | | |
| 0687-4711 | R: fxd, comp, 470 ohms ±10%, 1/2 W | 01121 | EB4711 | 4 | 1 | | |
| 0687-4721 | R: fxd, comp, 4.7K ohms ±10%, 1/2 W | 01121 | EB4721 | 1 | 1 | | |
| 0687-5621 | R: fxd, comp, 5.6K ohms ±10%, 1/2 W | 01121 | EB5621 | 3 | 1 | | |
| 0687-6821 | R: fxd, comp, 6.8K ohms ±10%, 1/2 W | 01121 | EB6821 | 3 | 1 | | |
| 0687-9101 | R: fxd, comp, 91 ohms ±10%, 1/2 W | 01121 | EB9101 | 1 | 1 | | |
| 0690-1011 | R: fxd, comp, 100 ohms ±10%, 1 W | 01121 | GB1011 | 1 | 1 | | |
| 1250-0083 | Connector: BNC, female, type UG-1094/U | 91737 | UG-1094/U | 3 | 1 | | |
| 1251-0135 | Connector: 15 pin, pc | 95354 | SD-615UR, special | 4 | 1 | | |
| 1251-0148 | Connector, power: male, 3 pin | 0000U | H-1061G-3L | 1 | 1 | | |
| 1450-0048 | Lamp, neon: NE-2H in transparent red plastic body | 08717 | 858-R | 1 | 1 | | |
| 1850-0054 | Transistor: 2N652A | 04713 | 2N652A | 2 | 2 | | |
| 1850-0074 | Transistor: 2N1396 | 02735 | 2N1396 | 10 | 10 | | |
| 1850-0076 | Transistor: 2N1038-2 | 01295 | 2N1038-2 | 1 | 1 | | |
| 1901-0025 | Diode, Si: 50 ma @+1V, 100 PIV | 07933 | RD1521 | 1 | 1 | | |
| 1901-0026 | Diode, Si: 0.75A, 200 PIV | 02735 | obd# | 2 | 2 | | |
| 1902-0017 | Diode, Si: breakdown, 6.8V, ±10% | 01281 | PS8135 | 1 | 1 | | |
| 1910-0011 | Diode, Ge: 5 ma @+1V, 60 PIV | 73293 | HD-2135A-5 | 4 | 4 | | |
| 2100-0090 | R: var, comp, lin, 2K ohms ±30%, 1/3 W | 11237 | UPE-70 special, obd# | 1 | 1 | | |

#See introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

| ⓗⓟ Stock No. | Description # | Mfr. | Mfr. Part No. | TQ | RS | | |
|---|---|---|---|---|---|---|---|
| 2110-0018 | Fuse, cartridge: 0.25 amp, s-b (for 115 V operation) | 75915 | 313.250 | 1 | 10 | | |
| 2110-0027 | Fuse, cartridge: 1/8 amp, s-b (for 230 V operation) | 75915 | obd# | 0 | 0 | | |
| 3101-0034 | Switch, sl: 4PDT | 42190 | 6633 | 1 | 1 | | |
| 3101-0036 | Switch, tog: SPST | 88140 | 8280K16 | 1 | 1 | | |
| 8120-0078 | Assy, power cable: includes, P1, P2 | 70903 | KH-4147 | 1 | 1 | | |
| 9100-0107 | Transformer, power | 98734 | 8396 | 1 | 1 | | |
| 9100-0155 | Autotransformer | 98734 | 6-1497 | 1 | 1 | | |
| 9140-0019 | Inductor: fxd, 200 μh | 99848 | 1200-15-201 | 2 | 1 | | |
| 9140-0041 | Inductor: 2.5 mh | 95265 | SA-2500-I | 3 | 1 | | |
| 9140-0115 | Inductor: fxd, 22 μh | 99800 | 2150-32 | 2 | 1 | | |
| | <u>MISCELLANEOUS</u> | | | | | | |
| 101A-16A | Cable, osc: coax | 28480 | 101A-16A | 2 | 1 | | |
| 1250-0002 | Heat, sink: for A4Q2, A5Q4 | 000II | 3AL635-2R | 2 | 2 | | |

#See introduction to this section

# APPENDIX
## CODE LIST OF MANUFACTURERS (Sheet 1 of 2)

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 |
|---|---|---|
| 00334 | Humidial Co. | Colton, Calif. |
| 00335 | Westrex Corp. | New York, N.Y. |
| 00373 | Garlock Packing Co., Electronic Products Div. | Camden, N.J. |
| 00656 | Aerovox Corp. | New Bedford, Mass. |
| 00779 | Amp, Inc. | Harrisburg, Pa. |
| 00781 | Aircraft Radio Corp. | Boonton, N.J. |
| 00853 | Sangamo Electric Company, Ordill Division (Capacitors) | Marion, Ill. |
| 00866 | Goe Engineering Co. | Los Angeles, Calif. |
| 00891 | Carl E. Holmes Corp. | Los Angeles, Calif. |
| 01121 | Allen Bradley Co. | Milwaukee, Wis. |
| 01255 | Litton Industries, Inc. | Beverly Hills, Calif. |
| 01281 | Pacific Semiconductors, Inc. | Culver City, Calif. |
| 01295 | Texas Instruments, Inc. Transistor Products Div. | Dallas, Texas |
| 01349 | The Alliance Mfg. Co. | Alliance, Ohio |
| 01561 | Chassi-Trak Corp. | Indianapolis, Ind. |
| 01589 | Pacific Relays, Inc. | Van Nuys, Calif. |
| 01930 | Amerock Corp. | Rockford, Ill. |
| 01961 | Pulse Engineering Co. | Santa Clara, Calif. |
| 02114 | Ferroxcube Corp. of America | Saugerties, N.Y. |
| 02286 | Cole Mfg. Co. | Palo Alto, Calif. |
| 02660 | Amphenol-Borg Electronics Corp. | Chicago, 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. |
| 03508 | G.E. Semiconductor Products Dept. | Syracuse, N.Y. |
| 03705 | Apex Machine & Tool Co. | Dayton, Ohio |
| 03797 | Eldema Corp. | El Monte, Calif. |
| 03877 | Transitron Electronic Corp. | Wakefield, Mass. |
| 03888 | Pyrofilm Resistor Co. | Morristown, N.J. |
| 03954 | Air Marine Motors, Inc. | Los Angeles, Calif. |
| 04009 | Arrow, Hart and Hegeman Elect. Co. | Hartford, Conn. |
| 04062 | Elmenco Products Co. | New York, N.Y. |
| 04222 | Hi-Q Division of Aerovox | Myrtle Beach, S.C. |
| 04298 | Elgin National Watch Co., Electronics Division | Burbank, Calif. |
| 04404 | Dymec Division of Hewlett-Packard Co. | Palo Alto, Calif. |
| 04651 | Sylvania Electric Prods., Inc. Electronic Tube Div. | Mountain View, Calif. |
| 04713 | Motorola, Inc., Semiconductor Prod. Div. | Phoenix, Arizona |
| 04732 | Filtron Co., Inc. Western Division | Culver City, Calif. |
| 04773 | Automatic Electric Co. | Northlake, Ill. |
| 04870 | P M Motor Co. | Chicago, Ill. |
| 05006 | Twentieth Century Plastics, Inc. | Los Angeles, Calif. |
| 05277 | Westinghouse Electric Corp., Semi-Conductor Dept. | Youngwood, Pa. |
| 05347 | Ultronix, Inc. | San Mateo, Calif. |
| 05593 | Illumitronic Engineering Co. | Sunnyvale, Calif. |
| 05624 | Barber Colman Co. | Rockford, Ill. |
| 05729 | Metropolitan Telecommunications Corp., Metro Cap. Div. | Brooklyn, N.Y. |
| 05783 | Stewart Engineering Co. | Santa Cruz, Calif. |
| 06004 | The Bassick Co. | Bridgeport, Conn. |
| 06555 | Beede Electrical Instrument Co., Inc. | Penacook, N.H. |
| 06812 | Torrington Mfg. Co., West Div. | Van Nuys, Calif. |
| 07115 | Corning Glass Works Electronic Components Dept. | Bradford, Pa. |
| 07126 | Digitran Co. | Pasadena, Calif. |
| 07137 | Transistor Electronics Corp. | Minneapolis, Minn. |
| 07138 | Westinghouse Electric Corp. Electronic Tube Div. | Elmira, N.Y. |
| 07261 | Avnet Corp. | Los Angeles, Calif. |
| 07263 | Fairchild Semiconductor Corp. | Mountain View, Calif. |
| 07910 | Continental Device Corp. | Hawthorne, Calif. |
| 07933 | Rheem Semiconductor Corp. | Mountain View, Calif. |
| 07980 | Boonton Radio Corp. | Boonton, N.J. |
| 08145 | U.S. Engineering Co. | Los Angeles, Calif. |
| 08358 | Burgess Battery Co. | Niagara Falls, Ontario, Canada |
| 08717 | Sloan Company | Burbank, Calif. |
| 08718 | Cannon Electric Co. Phoenix Div. | Phoenix, Ariz. |
| 08792 | CBS Electronics Semiconductor Operations, Div. of C.B.S. Inc. | Lowell, Mass. |
| 09026 | Babcock Relays, Inc. | Costa Mesa, Calif. |
| 09134 | Texas Capacitor Co. | Houston, Texas |
| 09250 | Electro Assemblies, Inc. | Chicago, Ill. |
| 09569 | Mallory Battery Co. of Canada, Ltd. | Toronto, Ontario, Canada |
| 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. |
| 11312 | Microwave Electronics Corp. | Palo Alto, Calif. |
| 11711 | General Instrument Corporation Semiconductor Division | Newark, N.J. |
| 11717 | Imperial Electronics, Inc. | Buena Park, Calif. |
| 11870 | Melabs, Inc. | Palo Alto, Calif. |
| 12697 | Clarostat Mfg. Co. | Dover, N.H. |
| 14655 | Cornell Dubilier Elec. Corp. | So. Plainfield, N.J. |
| 15909 | The Daven Co. | Livingston, N.J. |
| 16688 | De Jur-Amsco Corporation | Long Island City 1, N.Y. |
| 16758 | Delco Radio Div. of G. M. Corp. | Kokomo, Ind. |
| 18873 | E. I. DuPont and Co., Inc. | Wilmington, Del. |
| 19315 | Eclipse Pioneer, Div. of Bendix Aviation Corp. | Teterboro, N.J. |
| 19500 | Thomas A. Edison Industries, Div. of McGraw-Edison Co. | West Orange, N.J. |
| 19701 | Electra Manufacturing Co. | Kansas City, Mo. |
| 20183 | Electronic Tube Corp. | Philadelphia, Pa. |
| 21520 | Fansteel Metallurgical Corp. | No. Chicago, Ill. |
| 21335 | The Fafnir Bearing Co. | New Britain, Conn. |
| 21964 | Fed. Telephone and Radio Corp. | Clifton, N.J. |
| 24446 | General Electric Co. | Schenectady, N.Y. |
| 24455 | G.E., Lamp Division | Nela Park, Cleveland, Ohio |
| 24655 | General Radio Co. | West Concord, Mass. |
| 26462 | Grobet File Co. of America, Inc. | Carlstadt, N.J. |
| 26992 | Hamilton Watch Co. | Lancaster, Pa. |
| 28480 | Hewlett-Packard Co. | Palo Alto, Calif. |
| 33173 | G.E. Receiving Tube Dept. | Owensboro, Ky. |
| 35434 | Lectrohm Inc. | Chicago, Ill. |
| 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. |
| 47904 | Polaroid Corp. | Cambridge, Mass. |
| 48620 | Precision Thermometer and Inst. Co. | Philadelphia, Pa. |
| 49956 | Raytheon Company | Lexington, Mass. |
| 54294 | Shallcross Mfg. Co. | Selma, N.C. |
| 55026 | Simpson Electric Co. | Chicago, Ill. |
| 55933 | Sonotone Corp. | Elmsford, N.Y. |
| 55938 | Sorenson & Co., Inc. | So. Norwalk, Conn. |
| 56137 | Spaulding Fibre Co., Inc. | Tonawanda, N.Y. |
| 56289 | Sprague Electric Co. | North Adams, Mass. |
| 59446 | Telex, Inc. | St. Paul, Minn. |
| 61775 | Union Switch and Signal, Div. of Westinghouse Air Brake Co. | Swissvale, Pa. |
| 62119 | Universal Electric Co. | Owosso, Mich. |
| 64959 | Western Electric Co., Inc. | New York, N.Y. |
| 65092 | Weston Inst. Div. of Daystrom, Inc. | Newark, N.J. |
| 66346 | Wollensak Optical Co. | Rochester, N.Y. |
| 70276 | Allen Mfg. Co. | Hartford, Conn. |
| 70309 | Allied Control Co., Inc. | New York, N.Y. |
| 70485 | Atlantic India Rubber Works, Inc. | Chicago, Ill. |
| 70563 | Amperite Co., Inc. | New York, N.Y. |
| 70903 | Belden Mfg. Co. | Chicago, Ill. |
| 70998 | Bird Electronic Corp. | Cleveland, Ohio |
| 71002 | Birnbach Radio Co. | New York, N.Y. |
| 71041 | Boston Gear Works Div. of Murray Co. of Texas | Quincy, Mass. |
| 71218 | Bud Radio Inc. | Cleveland, Ohio |
| 71286 | Camloc Fastener Corp. | Paramus, N.J. |
| 71313 | Allen D. Cardwell Electronic Prod. Corp. | Plainville, Conn. |
| 71400 | Bussmann Fuse Div. of McGraw-Edison Co. | St. Louis, Mo. |
| 71450 | CTS Corp. | Elkhart, Ind. |
| 71468 | Cannon Electric Co. | Los Angeles, Calif. |
| 71471 | Cinema Engineering Co. | Burbank, Calif. |
| 71482 | C. P. Clare & Co. | Chicago, Ill. |
| 71528 | Standard-Thomson Corp., Clifford Mfg. Co. Div. | Waltham, Mass. |
| 71590 | Centralab Div. of Globe Union Inc. | Milwaukee, Wis. |
| 71700 | The Cornish Wire Co. | New York, N.Y. |
| 71744 | Chicago Miniature Lamp Works | Chicago, Ill. |
| 71753 | A. O. Smith Corp., Crowley Div. | West Orange, N.J. |
| 71785 | Cinch Mfg. Corp. | Chicago, Ill. |
| 71984 | Dow Corning Corp. | Midland, Mich. |
| 72136 | Electro Motive Mfg. Co., Inc. | Willimantic, Conn. |
| 72354 | John E. Fast & Co. | Chicago, Ill. |
| 72619 | Dialight Corp. | Brooklyn, N.Y. |
| 72656 | General Ceramics Corp. | Keasbey, N.J. |
| 72758 | Girard-Hopkins | Oakland, Calif. |
| 72765 | Drake Mfg. Co. | Chicago, Ill. |
| 72825 | Hugh H. Eby Inc. | Philadelphia, Pa. |
| 72928 | Gudeman Co. | Chicago, Ill. |
| 72982 | Erie Resistor Corp. | Erie, Pa. |
| 73061 | Hansen Mfg. Co., Inc. | Princeton, Ind. |
| 73138 | Helipot Div. of Beckman Instruments, Inc. | Fullerton, Calif. |
| 73293 | Hughes Products Division of Hughes Aircraft Co. | Newport Beach, Calif. |
| 73445 | Amperex Electronic Co., Div. of North American Phillips Co., Inc. | Hicksville, N.Y. |
| 73506 | Bradley Semiconductor Corp. | Hamden, Conn. |
| 73559 | Carling Electric, Inc. | Hartford, Conn. |
| 73682 | George K. Garrett Co., Inc. | Philadelphia, Pa. |
| 73734 | Federal Screw Products Co. | Chicago, Ill. |
| 73743 | Fischer Special Mfg. Co. | Cincinnati, Ohio |
| 73793 | The General Industries Co. | Elyria, Ohio |
| 73905 | Jennings Radio Mfg. Co. | San Jose, Calif. |
| 74455 | J. H. Winns, and Sons | Winchester, Mass. |
| 74861 | Industrial Condenser Corp. | Chicago, Ill. |

From: F.S.C. Handbook Supplements
H4-1 Dated December 1961
H4-2 Dated December 1961

00015-21
Revised: 7 February 1962

# APPENDIX
## CODE LIST OF MANUFACTURERS (Sheet 2 of 2)

| CODE NO. | MANUFACTURER | ADDRESS |
|---|---|---|
| 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. |
| 75173 | Jones, Howard B., Division of Cinch Mfg. Corp. | Chicago, Ill. |
| 75378 | James Knights Co. | 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 | Micamold Electronic Mfg. Corp. | Brooklyn, N.Y. |
| 76487 | James Millen Mfg. Co., Inc. | Malden, Mass. |
| 76493 | J. W. Miller Co. | Los Angeles, Calif. |
| 76530 | Monadnock Mills | San Leandro, Calif. |
| 76545 | Mueller Electric Co. | Cleveland, Ohio |
| 76854 | Oak Manufacturing Co. | Chicago, Ill. |
| 77068 | Bendix Pacific Division of Bendix Corp. | No. Hollywood, Calif. |
| 77221 | Phaostron Instrument and Electronic Co. | South Pasadena, Calif. |
| 77342 | Potter and Brumfield, Div. of American Machine and Foundry | Princeton, Ind. |
| 77630 | Radio Condenser Co. | Camden, N.J. |
| 77638 | Radio Receptor Co., Inc. | Brooklyn, N.Y. |
| 77764 | Resistance Products Co. | Harrisburg, Pa. |
| 78189 | Shakeproof Division of Illinois Tool Works | Elgin, Ill. |
| 78283 | Signal Indicator Corp. | New York, N.Y. |
| 78471 | Tilley Mfg. Co. | San Francisco, Calif. |
| 78488 | Stackpole Carbon Co. | St. Marys, Pa. |
| 78553 | Tinnerman Products, Inc. | Cleveland, Ohio |
| 78790 | Transformer Engineers | Pasadena, Calif. |
| 78947 | Ucinite Co. | Newtonville, Mass. |
| 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 | Elizabeth, N.J. |
| 80130 | Times Facsimile Corp. | New York, N.Y. |
| 80131 | Electronic Industries Association Any brand tube meeting EIA standards | Washington, D.C. |
| 80207 | Unimax Switch, Div. of W. L. Maxson Corp. | Wallingford, Conn. |
| 80248 | Oxford Electric Corp. | Chicago, Ill. |
| 80294 | Bourns Laboratories, Inc. | Riverside, Calif. |
| 80411 | Acro Div. of Robertshaw Fulton Controls Co. | Columbus 16, Ohio |
| 80486 | All Star Products Inc. | Defiance, Ohio |
| 80583 | Hammerlund Co., Inc. | New York, N.Y. |
| 80640 | Stevens, Arnold, Co., Inc. | Boston, Mass. |
| 81030 | International Instruments, Inc. | New Haven, Conn. |
| 81415 | Wilkor Products, Inc. | Cleveland, Ohio |
| 81453 | Raytheon Mfg. Co., Industrial Components Div., Industr. Tube Operations | Newton, Mass. |
| 81483 | International Rectifier Corp. | El Segundo, Calif. |
| 81860 | Barry Controls, Inc. | Watertown, Mass. |
| 82042 | Carter Parts Co. | Skokie, Ill. |
| 82142 | Jeffers Electronics Division of Speer Carbon Co. | Du Bois, Pa. |
| 82170 | Allen B. DuMont Labs., Inc. | Clifton, N.J. |
| 82209 | Maguire Industries, Inc. | Greenwich, Conn. |
| 82219 | Sylvania Electric Prod. Inc., Electronic Tube Div. | Emporium, Pa. |
| 82376 | Astron Co. | East Newark, N.J. |
| 82389 | Switchcraft, Inc. | Chicago, Ill. |
| 82647 | Metals and Controls, Inc., Div. of Texas Instruments, Inc., Spencer Prods. | Attleboro, Mass. |
| 82866 | Research Products Corp. | Madison, Wis. |
| 82877 | Rotron Manufacturing Co., Inc. | Woodstock, N.Y. |
| 82893 | Vector Electronic Co. | Glendale, Calif. |
| 83053 | Western Washer Mfr. Co. | Los Angeles, Calif. |
| 83058 | Carr Fastener Co. | Cambridge, Mass. |
| 83086 | New Hampshire Ball Bearing, Inc. | Peterborough, N.H. |
| 83125 | Pyramid Electric Co. | Darlington, S.C. |
| 83148 | Electro Cords Co. | Los Angeles, Calif. |
| 83186 | Victory Engineering Corp. | Union, N.J. |
| 83298 | Bendix Corp., Red Bank Div. | Red Bank, N.J. |
| 83330 | Smith, Herman H., Inc. | Brooklyn, N.Y. |
| 83501 | Gavitt Wire and Cable Co., Div. of Amerace Corp. | Brookfield, Mass. |
| 83594 | Burroughs Corp., Electronic Tube Div. | Plainfield, N.J. |
| 83777 | Model Eng. and Mfg., Inc. | Huntington, Ind. |
| 83821 | Loyd Scruggs Co. | Festus, Mo. |
| 84171 | Arco Electronics, Inc. | New York, N.Y. |
| 84396 | A. J. Glesener Co., Inc. | San Francisco, Calif. |
| 84411 | Good All Electric Mfg. Co. | Ogallala, Neb. |
| 84970 | Sarkes Tarzian, Inc. | Bloomington, Ind. |
| 85454 | Boonton Molding Company | Boonton, N.J. |
| 85474 | R. M. Bracamonte & Co. | San Francisco, Calif. |
| 85660 | Koiled Kords, Inc. | New Haven, Conn. |
| 85911 | Seamless Rubber Co. | Chicago, Ill. |
| 86197 | Clifton Precision Products | Clifton Heights, Pa. |
| 86684 | Radio Corp. of America, RCA Electron Tube Div. | Harrison, N.J. |
| 87216 | Philco Corp. (Lansdale Division) | Lansdale, Pa. |
| 87473 | Western Fibrous Glass Products Co. | San Francisco, Calif. |
| 88140 | Cutler-Hammer, Inc. | Lincoln, Ill. |
| 88220 | Gould-National Batteries, Inc. | St. Paul, Minn. |
| 89473 | General Electric Distributing Corp. | Schenectady, N.Y. |
| 89636 | Carter Parts Div. of Economy Baler Co. | Chicago, Ill. |
| 89665 | United Transformer Co. | Chicago, Ill. |
| 90179 | U.S. Rubber Co., Mechanical Goods Div. | Passaic, N.J. |
| 90970 | Bearing Engineering Co. | San Francisco, Calif. |
| 91260 | Connor Spring Mfg. Co. | San Francisco, Calif. |
| 91418 | Radio Materials Co. | Chicago, Ill. |
| 91506 | Augat Brothers, Inc. | Attleboro, Mass. |
| 91637 | Dale Electronics, Inc. | Columbus, Nebr. |
| 91662 | Elco Corp. | Philadelphia, Pa. |
| 91737 | Gremar Mfg. Co., Inc. | Wakefield, Mass. |
| 91827 | K F Development Co. | Redwood City, Calif. |
| 91921 | Minneapolis-Honeywell Regulator Co., Micro-Switch Division | Freeport, Ill. |
| 92196 | Universal Metal Products, Inc. | Bassett Puente, Calif. |
| 93332 | Sylvania Electric Prod. Inc., Semiconductor Div. | Woburn, Mass. |
| 93369 | Robbins and Myers, Inc. | New York, N.Y. |
| 93410 | Stevens Mfg. Co., Inc. | Mansfield, Ohio |
| 93983 | Insuline-Van Norman Ind., Inc. Electronic Division | Manchester, N.H. |
| 94144 | Raytheon Mfg. Co., Industrial Components Div., Receiving Tube Operation | Quincy, Mass. |
| 94145 | Raytheon Mfg. Co., Semiconductor Div., California Street Plant | Newton, Mass. |
| 94148 | Scientific Radio Products, Inc. | Loveland, Colo. |
| 94154 | Tung-Sol Electric, Inc. | Newark, N.J. |
| 94197 | Curtiss-Wright Corp., Electronics Div. | East Paterson, N.J. |
| 94310 | Tru Ohm Prod. Div. of Model Engineering and Mfg. Co. | Chicago, Ill. |
| 94682 | Worcester Pressed Aluminum Corp. | Worcester, Mass. |
| 95236 | Allies Products Corp. | Miami, Fla. |
| 95238 | Continental Connector Corp. | Woodside, N.Y. |
| 95263 | Leecraft Mfg. Co., Inc. | New York, N.Y. |
| 95264 | Lerco Electronics, Inc. | Burbank, Calif. |
| 95265 | National Coil Co. | Sheridan, Wyo. |
| 95275 | Vitramon, Inc. | Bridgeport, Conn. |
| 95354 | Methode Mfg. Co. | Chicago, Ill. |
| 95987 | Weckesser Co. | Chicago, Ill. |
| 96067 | Huggins Laboratories | Sunnyvale, Calif. |
| 96095 | Hi-Q Division of Aerovox | Olean, N.Y. |
| 96256 | Thordarson-Meissner Div. of Maguire Industries, Inc. | Mt. Carmel, Ill. |
| 96296 | Solar Manufacturing Co. | Los Angeles, Calif. |
| 96330 | Carlton Screw Co. | Chicago, Ill. |
| 96341 | Microwave Associates, Inc. | Burlington, Mass. |
| 96501 | Excel Transformer Co. | Oakland, Calif. |
| 97464 | Industrial Retaining Ring Co. | Irvington, N.J. |
| 97539 | Automatic and Precision Mfg. Co. | Yonkers, N.Y. |
| 97966 | CBS Electronics, Div. of C.B.S., Inc. | Danvers, Mass. |
| 98141 | Axel Brothers Inc. | Jamaica, N.Y. |
| 98220 | Francis L. Mosley | Pasadena, Calif. |
| 98278 | Microdot, Inc. | So. Pasadena, Calif. |
| 98291 | Sealectro Corp. | Mamaroneck, N.Y. |
| 98405 | Carad Corp. | Redwood City, Calif. |
| 98734 | Palo Alto Engineering Co., Inc. | Palo Alto, Calif. |
| 98821 | North Hills Electric Co. | Mineola, N.Y. |
| 98925 | Clevite Transistor Prod. Div. of Clevite Corp. | Waltham, Mass. |
| 98978 | International Electronic Research Corp. | Burbank, Calif. |
| 99109 | Columbia Technical Corp. | New York, N.Y. |
| 99313 | Varian Associates | Palo Alto, Calif. |
| 99515 | Marshall Industries, Electron Products Division | Pasadena, 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. |
| 99934 | Renbrandt, Inc. | Boston, Mass. |
| 99942 | Hoffman Semiconductor Div. of Hoffman Electronics Corp. | Evanston, Ill. |
| 99957 | Technology Instrument Corp. of Calif. | Newbury Park, Calif. |

THE FOLLOWING H-P 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. |
| 0000I | Telefunken (c/o American Elite) | New York, N.Y. |
| 0000L | Winchester Electronics, Inc. | Santa Monica, Calif. |
| 0000M | Western Coil Div. of Automatic Ind., Inc. | Redwood City, Calif. |
| 0000N | Nahm-Bros. Spring Co. | San Leandro, Calif. |
| 0000P | Ty-Car Mfg. Co., Inc. | Holliston, Mass. |
| 0000T | Texas Instruments, Inc. Metals and Controls Div. | Versailles, Ky. |
| 0000U | Tower Mfg. Corp. | Providence, R.I. |
| 0000W | Webster Electronics Co. Inc. | New York, N.Y. |
| 0000X | Spruce Pine Mica Co. | Spruce Pine, N.C. |
| 0000Y | Midland Mfg. Co. Inc. | Kansas City, Kans. |
| 0000Z | Willow Leather Products Corp. | Newark, N.J. |
| 000AA | British Radio Electronics Ltd. | Washington, D.C. |
| 000BB | Precision Instrument Components Co. | Van Nuys, Calif. |
| 000CC | Computer Diode Corp. | Lodi, N.J. |
| 000EE | A. Williams Manufacturing Co. | San Jose, Calif. |
| 000FF | Carmichael Corrugated Specialties | Richmond, Calif. |
| 000GG | Goshen Die Cutting Service | Goshen, Ind. |
| 000HH | Rubbercraft Corp. | Torrance, Calif. |
| 000II | Birtcher Corporation, Industrial Division | Monterey Park, Calif. |

00015-21
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H4-1 Dated December 1961
H4-2 Dated December 1961

# (hp) MANUAL CHANGES

MODEL 101A

1-MC OSCILLATOR

Manual Serial Prefixed: 220-
Manual Printed: SEPT 1962

MAKE ALL CORRECTIONS IN THIS MANUAL ACCORDING TO ERRATA BELOW, THEN CHECK THE FOLLOWING TABLE FOR YOUR INSTRUMENT SERIAL PREFIX (3 DIGITS) OR SERIAL NUMBER (8 DIGITS) AND MAKE ANY LISTED CHANGE(S) IN THE MANUAL.

► NEW ITEM.

| SERIAL PREFIX OR NUMBER | MAKE MANUAL CHANGES | SERIAL PREFIX OR NUMBER | MAKE MANUAL CHANGES |
|---|---|---|---|
| 404- | 1 | | |
| | | | |
| | | | |
| | | | |

ERRATA:

Page 2-2, Table 2-1,
Change as follows:
AC Line Fuse, 230 volt operation: 150 ma slow-blow, (hp) S/N 2110-0017.

Page 4-1, Paragraph 4-4,
Fourth word should be: uses

Page 5-4, Paragraph 5-30,
Fourth line, last word should be: must

Page 5-7, Figure 5-5,
Capacitor C10, next to R13, should be C12.

Page 6-2,
Change value of A2C17, A2C18 to 0.1 $\mu f$; (hp) Stock No. 0150-0084.

Page 6-4,
A4L1 (hp) S/N is 9140-0127

Page 6-6, Table 6-1,
F1 second entry should read:
2110-0017 Fuse, cartridge: 150 ma s-b (for 230 volt operation)
Circuit Reference column: Change P2 to P1
Description column: Delete Nsr; part of W1

Page 6-8,
Delete 5243A-60A line entry

Page 6-9,
Add: 9140-0127 Inductor: 8.3-18.7 $\mu h$, Mfr. 28480, Mfr. Part No. 9140-0127; TQ 1; RS 1.

Page 6-11, Table 6-2,
Second entry 2110-0027 should be changed to:
2110-0017 Fuse, cartridge: 150 ma, s-b (for 230 volt operation); Mfr. 75915, Mfr. Part No. 313.150; RS 10.

---

CHANGE 1

Page 5-19, Figure 5-13,
Change C31 to .068 $\mu f$
R26 to 6.2K ohms

Page 6-5, Table 6-1,
Change A5C31 entry to read:
A5C31 0170-0084 C: fxd, my, .068 $\mu f$ ±20%, 50V
Change A5R26 entry to read:
A5R26 0683-6225 R: fxd, comp, 6.2K ohms ±5%, 1/4W

Page 6-9, Table 6-2,
Change total quantity (TQ) for 0170-0084 to 3.
Add 0683-6225 R: fxd, comp, 6.2K ohms ±5%, 1/4W

10/26/64

Supplement A for
101A-900
101A-901

## WARRANTY

*All our products are warranted against defects in materials and workmanship for one year from the date of shipment. Our obligation is limited to repairing or replacing products (except tubes) which prove to be defective during the warranty period. We are not liable for consequential damages.*

For assistance of any kind, including help with instruments under warranty, contact your authorized hp Sales Representative for instructions. Give full details of the difficulty and include the instrument model and serial numbers. Service data or shipping instructions will be promptly sent to you. There will be no charge for repair of instruments under warranty, *except transportation charges.* Estimates of charges for non-warranty or other service work will always be supplied, if requested, before work begins.

## CLAIM FOR DAMAGE IN SHIPMENT

Your instrument should be inspected and tested as soon as it is received. The instrument is insured for safe delivery. If the instrument is damaged in any way or fails to operate properly, file a claim with the carrier or, if insured separately, with the insurance company.

## SHIPPING

On receipt of shipping instructions, forward the instrument prepaid to the destination indicated. You may use the original shipping carton or any strong container. Wrap the instrument in heavy paper or a plastic bag and surround it with three or four inches of shock-absorbing material to cushion it firmly and prevent movement inside the container.

## GENERAL

Your authorized hp Sales Representative is ready to assist you in any situation, and you are always welcome to get directly in touch with Hewlett-Packard service departments:


**CUSTOMER SERVICE**

Hewlett-Packard Company
395 Page Mill Road
Palo Alto, California, U.S.A.
Telephone: (415) 326-1755
TWX No. PAL AL 117-U
Cable: "HEWPACK"

**OR (In Western Europe)**

Hewlett-Packard S.A.
54-54bis Route Des Acacias
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