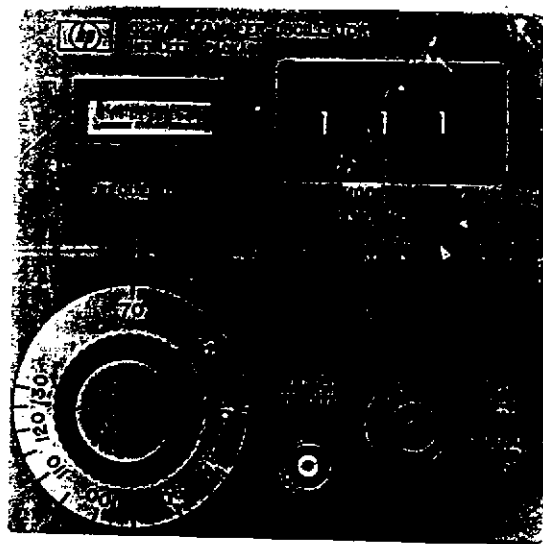


TRANSFER OSCILLATOR

5257A



HEWLETT  PACKARD

TRANSFER OSCILLATOR 5257A

SERIAL PREFIX: 1104A

This Operating and Service Manual applies to HP 5257A instruments with serial number prefix 1104A.

SERIAL PREFIXES NOT LISTED

For serial prefixes above 1104A, a "Manual Changes" sheet is included with this manual. For serial prefixes 748-, 804-, 820-, 848-, 928-, and 976-, see Section VII.

HP 5245L MODIFICATION

See Paragraph 2-15 for HP 5257A use in HP 5245L Counters having serial prefix numbers 516-, 402-, or 335- and below.

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HEWLETT  PACKARD

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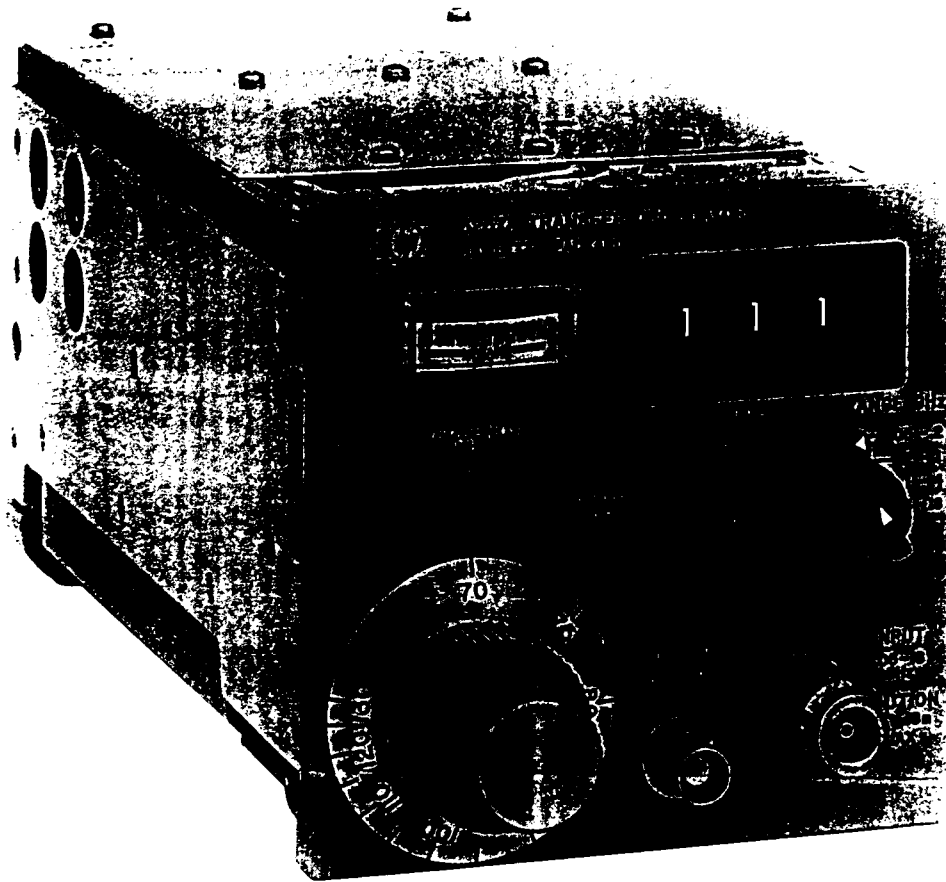
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Figure 1-1. Model 5257A



SECTION I

GENERAL INFORMATION

1-1. DESCRIPTION

1-2. The Hewlett-Packard Model 5257A Transfer Oscillator plug-in extends to 18 GHz the frequency measuring capability of Hewlett-Packard counters: series 5245L, 5245M, 5246L, 5247M, 5248L/M, and the 5345A. It features simple one-dial tuning, direct readout of input frequency, and a front panel meter for zero beat detection. Both cw and pulsed rf signals can be quickly and easily measured with this unit. For cw signals, an automatic phase control (APC) circuit securely locks the internal VFO to the input frequency which aids tuning and allows measurement of noisy, frequency modulated, and rapidly drifting signals. A lock detector for cw signals causes the counter to display all zeros until the Model 5257A is properly tuned to phase lock. The Model 5257A has a frequency range from 50 MHz to 18 GHz and replaces several narrower range units. It also has the advantage of measuring a specific frequency while rejecting sidebands and spurious signals.

1-3. The instrument uses a wideband sampler to compare the input signal waveform with the internal VFO. This eliminates the need for a harmonic generator following the VFO and requires far less power than other methods. In operation the VFO is tuned to a subharmonic of the input signal to produce a dc voltage at the sampler output when the input and internal waveforms are coincident each time the sampling gate opens. The automatic phase control circuit operates from this dc voltage. The circuitry has a wide capture range and it is only necessary to tune through the proper frequency and the VFO will "lock in". Therefore, tuning is rapid and uncritical. If the lock is lost due to an intermittent signal, the Model 5257A will automatically relock when the signal again appears.

1-4. The front panel meter deflection is used to adjust input signal level, to detect zero beat for both cw and pulsed rf measurements, and to observe the dc error voltage in the phase lock loop. The meter eliminates the need for an oscilloscope to detect zero beat, such as needed for conventional transfer oscillators.

1-5. A jack on the front panel, connected to the sampler output circuitry, permits use of the Model 5257A for down conversion to extend the range of low frequency instruments and devices such as oscilloscopes, FM discriminators, etc. Also, an oscilloscope can be connected to this jack for very precise observation of zero beat when measuring pulsed rf signals.

1-6. Thumbwheel switches automatically perform harmonic computation for the counter by extending the counter's gate time by the factor N. In this way, the counter's readout is the actual input frequency. At an N setting of 001 the counter either reads the VFO frequency or the VFO frequency divided by four in the lowest range. (The VFO range of 66.7 to 133.3 MHz must be prescaled for the 50 to 200 MHz input range.) N can be determined exactly, and verified, by simple procedures to be described later in this manual.

1-7. SPECIFICATIONS

1-8. Table 1-1 contains all technical specifications for the Model 5257A when operated in HP Electronic Counters.

1-9. IDENTIFICATION

1-10. Hewlett-Packard uses a two-section serial number mounted on the rear panel. Earlier instruments use an 8-digit serial number (000-00000). The first three digits are a serial prefix number; the last five digits refer to the specific instrument. Later instruments use a 9-digit serial number (0000A00000). The first four digits are the serial prefix and the last five digits refer to the specific instrument.

1-11. If the serial prefix of your instrument differs from that listed on the title page of this manual, there are differences between this manual and your instrument. Lower serial prefixes are documented in Section VII, and higher serial prefixes are covered with manual change sheets included with the manual. If the change sheet is missing, contact the nearest Hewlett-Packard Sales and Service Office listed on the inside rear cover of this manual.

1-12. COOLING

1-13. The Model 5257A is cooled by the ventilation system of the counter in which it is installed. See counter service manual for cooling system maintenance instructions.

Table 1-1. Specifications *

FREQUENCY RANGE: 50 MHz to 18 GHz.

INPUT SIGNAL CAPACITY: CW signals. Pulsed RF signals. Signals with high FM content.

CW MEASUREMENT ACCURACY: Retains Counter accuracy.

INPUT SENSITIVITY: 100 mV rms (-7 dBm) for input frequencies of 50 MHz to 15 GHz. 140 mV rms (-4 dBm) for input frequencies of 15 to 18 GHz and VFO frequency of 125 to 133.3 MHz.

INPUT IMPEDANCE: 50 ohms nominal.

MAXIMUM INPUT: +10 dBm for CW signals. 2 V peak-to-peak for pulsed RF signals.

APC LOCK RANGE: Approximately $\pm 0.2\%$ of input frequency.

METER: APC Mode: indicates loop phase error under locked conditions.
Pulsed RF Mode: zero beat indicator.

PULSED RF OUT: For external oscilloscope, 0.5 volt peak-to-peak.

PULSE CARRIER FREQUENCY MEASUREMENTS:
Minimum Pulse Width: 0.5 μ sec.
Minimum Repetition Rate: 10 pulses per sec.
Accuracy: 0.01 cycle per pulse width (typical error ± 20 kHz or less for pulse width $> 2 \mu$ s; ± 50 kHz $< 2 \mu$ s)

VFO: Frequency Range: 66.7 to 133.3 MHz.
Drift: (With constant temperature in operational range of 0° to 55°C) typically ± 2 parts in 10^5 per minute immediately after turn on. Typically ± 1 part in 10^7 per minute after 2 hours of operation.
Temperature Variation: Typically 1 part in 10^4 per degree C.

INPUT CONNECTOR: Precision Type N female.

WEIGHT: Net 7-1/4 lbs. (3, 3 kg);
Shipping 10 lbs (4, 5 kg).

OPTION 001: Precision Type APC-7 input connector.

*When used with HP 5245M, 5245L (serial prefix 402 or above), 5246L, M54-5245L, or 5247M Counters. Modification Kit (05293-6030) available to adapt HP 5245L serial prefix 335 and below.

When used with 5345A an HP 10590A Plug-in Adapter is required.

SECTION II

INSTALLATION

2-1. INTRODUCTION

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

2-3. UNPACKING AND INSPECTION

2-4. If the shipping carton is damaged, ask that the carrier's agent be present when the instrument is unpacked. Inspect the instrument for damage (dents, scratches, broken knobs, etc). If the instrument is damaged or fails to meet specification (Performance Check, Table 5-3), notify the carrier and the nearest Hewlett-Packard sales and service office immediately (sales and service offices are listed at the back of this manual). Retain the shipping carton and the padding material for the carrier's inspection. The sales and service office will arrange for the repair or replacement of your instrument without waiting for the claim against the carrier to be settled.

2-5. STORAGE AND SHIPMENT

2-6. **PACKAGING.** To protect your instrument during shipment or storage, use the best packaging methods available. Your Hewlett-Packard sales and service office can provide materials similar to those used for original factory packaging. Contract packaging companies can provide dependable custom packaging on short notice.

a. If possible, use the original container designed for the instrument. Otherwise, use a strong carton (350 lb/sq inch bursting strength) or wooden box to house the instrument.

b. Wrap the instrument in heavy paper or plastic before placing it in the shipping container.

c. Use plenty of packing material around all sides of the instrument and protect the front panel with cardboard strips.

d. Seal the package with strong tape or metal bands; mark "Delicate Instrument".

e. Refer to the address list at the rear of this manual and check with your Hewlett-Packard sales and service office for shipping instructions. All correspondence should refer to an instrument by model number and the full eight-digit serial number.

2-7. **ENVIRONMENT.** Conditions during storage and shipment should normally be limited as follows:

a. Maximum temperature 167°F (75°C).

b. Minimum temperature -40°F (-40°C).

CAUTION

TURN COUNTER POWER OFF BEFORE INSTALLING OR REMOVING FREQUENCY CONVERTER.

2-8. INSTALLATION

2-9. The Model 5257A plugs into the rectangular compartment at the right-hand side of the front panel of the Electronic Counter. To install unit in counter, first check that retaining latch is turned fully counterclockwise, then push unit firmly into compartment until front panel of plug-in is flush with front panel of counter. Then turn retaining latch clockwise until it is tight.

2-10. To remove unit from counter, turn retaining latch counterclockwise to its stop. Then grasp input connector and oscillator knob and firmly pull unit from counter. If any difficulty is encountered with installation or removal, check that retaining latch is fully counterclockwise.

2-11. Power Requirements

2-12. All electrical power required to operate the Model 5257A is supplied by the counter in which the unit is installed.

2-13. Electrical Connections

2-14. The INPUT and PULSED RF OUT connectors on front panel of plug-in (see Figure 3-9) are the only external electrical connections to the unit. All other connections are made through the 50-pin connector at the rear of plug-in when installed in counter.

2-15. Modifications

2-16. When Model 5257A is used with an HP 5245L Counter having a serial prefix number between 402- and 516-, A22R38 on 5245L Gate Control Assembly (5243A-65R) should be changed to 4700 ohms (HP Part No. 0683-4725).

2-17. When Model 5257A is used with an HP 5245L Counter with serial prefix 335 and below, HP 5245L must be modified. A Modification Kit (HP Part No. 05243-6030) is available from your Hewlett-Packard Sales and Service office, complete with instructions for modification.

NOTE

HP 5245L Counters displaying the sticker "ACCEPTS HP MODELS 5251 THRU 5256" inside the plug-in compartment do not require the modifications listed in Paragraph 2-17.

SECTION III

OPERATION

3-1. DESCRIPTION

3-2. Model 5257A Transfer Oscillator plug-in unit increases to 18 GHz the frequency measuring capability of Hewlett-Packard counters: 5245L/M, 5246L, 5247M, 5248L/M, and 5345A. The measured frequency is displayed on the counter for all types of radio frequency carriers including cw, fm, and pulsed. Controls and jacks are described in detail in Paragraphs 3-13 through 3-22. Step by step operating procedures are given in Figures 3-9 and 3-10.

3-3. An internal VFO, tunable from 66.7 to 133.3 MHz, functions as a transfer oscillator to reduce the input frequencies to within the counter's input frequency limitations. The VFO frequency is high to maintain a 66.7 MHz or more separation between harmonics on the three highest frequency ranges. A four-to-one divider (prescaler) reduces the VFO frequency for counting and sampling in the .05 to .2 GHz range. The VFO is inherently very stable which is useful when using the unit as a down converter. But as a transfer oscillator, the automatic phase control mode for cw signals eliminates any drift effects and in the pulsed rf mode the short time it takes for a measurement makes drift effects negligible.

3-4. To compensate for wide variations in input signal levels and the very wide range of input frequencies for which the Model 5257A is designed, a level adjustment is provided on the front panel. This control, labeled LEVEL ADJ, should be turned fully counterclockwise before applying the input signal. When tuning into zero beat, with the MODE switch in the PULSED RF position, the meter pointer will rise and reach a maximum at zero beat. LEVEL ADJ is then turned clockwise until the maximum meter deflection sits at the red scale line (located at nine-tenths of full scale). An exception may occur with very stable cw input signals. In these cases, the meter reading might drop to zero at exact zero beat so the level adjustment is made when tuned outside the dip.

3-5. At all times observe the maximum allowable input signal power of +10 dBm for cw carriers and 2 volts peak-to-peak voltage for any signal. Exceeding these limits may seriously damage the hot carrier diodes of the 18 GHz input sampler. Use caution, especially for pulsed signals, where peak voltages may be quite high even at low power. When in doubt, use an attenuator and decrease attenuation until the Model 5257A responds to the signal.

3-6. In the APC Mode a cw signal may be phase locked by tuning the FREQUENCY MHz control through any subharmonic of the input frequency. The meter reads the phase lock error voltage near mid-scale deflection. Mid-scale deflection representing 0 phase error may drift slightly due to the dc amplifier circuitry. (This does not affect instrument accuracy.) The de-

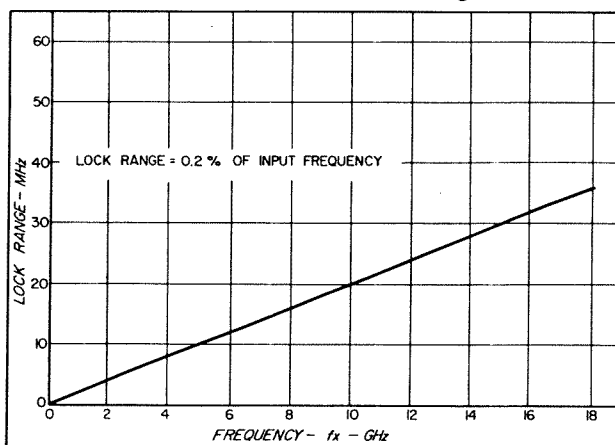
flexion for 0 phase error may be checked by observing the meter while tuned between adjacent phase lock frequencies. Deflection for zero error may be adjusted to mid-scale with the APC adjustment potentiometer reached through a hole in the top cover. See Page 5-4 for APC adjustment. After phase lock, FREQUENCY MHz should be adjusted until the meter reads the 0 error deflection previously determined. Once the signal has been captured or phase locked, the VFO frequency will be independent of movement of the FREQUENCY MHz control corresponding to a lock of approximately 0.2% of the input frequency. APC lock range versus input frequency is shown in Figure 3-1.

3-7. Counter display is controlled by an inhibit gate operated from the Model 5257A phase-lock loop. In the APC Mode when phase lock is not present the counter display is all zeros. When phase lock occurs the display is a frequency count. In the PULSED RF mode the counter reads frequency continually.

3-8. The PULSED RF mode of operation is available for frequency measurement of signals which cannot be phase locked. These include pulsed rf signals as well as very heavily frequency modulated carriers. Typical fm performance curves for the Model 5257A are shown in Figure 3-2. Signals with modulation in the area above the curves usually require the PULSED RF mode while those falling below the curve can be measured in the APC mode.

3-9. With pulsed rf input signals the minimum error in frequency measurement is dependent upon the pulse width due to imperfect zero beat. The Model 5257A has a typical error of 0.01 cycle per pulse width. Pulse width versus error is shown in Figure 3-3. For example, with a $1 \mu\text{s}$ pulse: cycles error/pulse width = 10^{-2} cycles/ 10^{-6} = 10^4 cycles or 10 kHz error. For a 10 GHz carrier this becomes 10^4 Hz error/ 10^{10}

Figure 3-1. APC Lock Range



Hz carrier = 1×10^{-6} error in measurement at this frequency. Operation of the 5257A is specified for a minimum pulse width of $0.5 \mu\text{sec}$. Therefore, absolute error in measurement can always be less than $\pm 20 \text{ kHz}$.

3-10. The front panel jack labeled PULSED RF OUT is useful for down conversion applications of the Model 5257A as well as for visual zero beat tuning in the PULSED RF mode. This jack makes available the amplified sampler output for connection to other equipment. In the frequency measurement of pulsed rf signals an oscilloscope can be used to supplement the meter tuning indicator. Typical waveforms observed in tuning for zero beat are shown in Figure 3-4. In down conversion the transfer oscillator and sampler produce signals suitable for driving low frequency equipment. Figure 3-5 is a block diagram showing the set up for measuring fm demodulation characteristics with a Hewlett-Packard 302A Wave Analyzer. In these applications it is useful to show the frequency spectral density of the transfer oscillator. From this the noise contributed by the VFO may be calculated:

$$[S_{f_v}(f)]^{1/2} N B_{eq}^{1/2} = \Delta f_{\text{rms}}(f)$$

where $S_{f_v}(f)$ is the frequency spectral density of the VFO, N is the harmonic number of the VFO to the input

Figure 3-2. Maximum FM in APC Mode

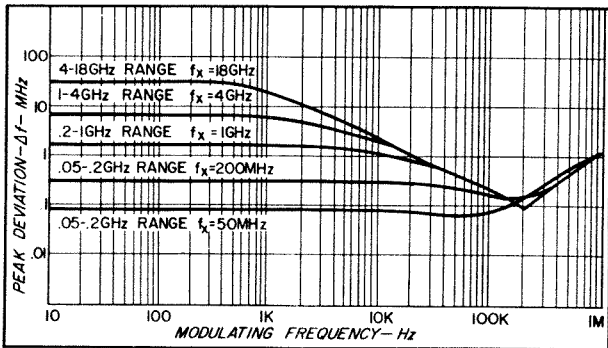
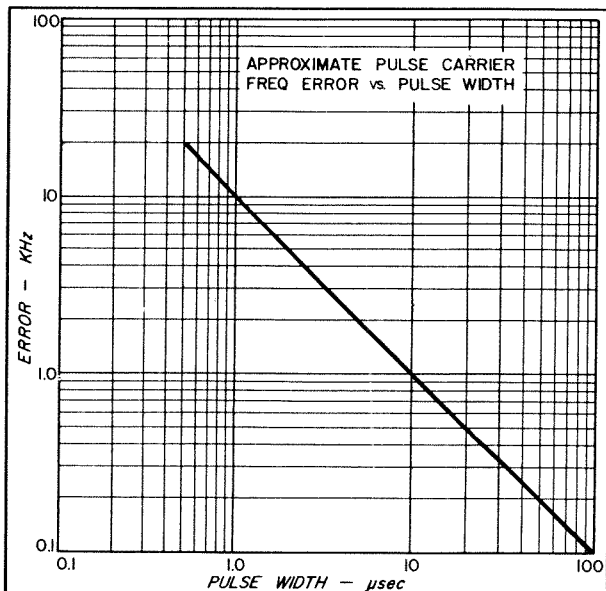


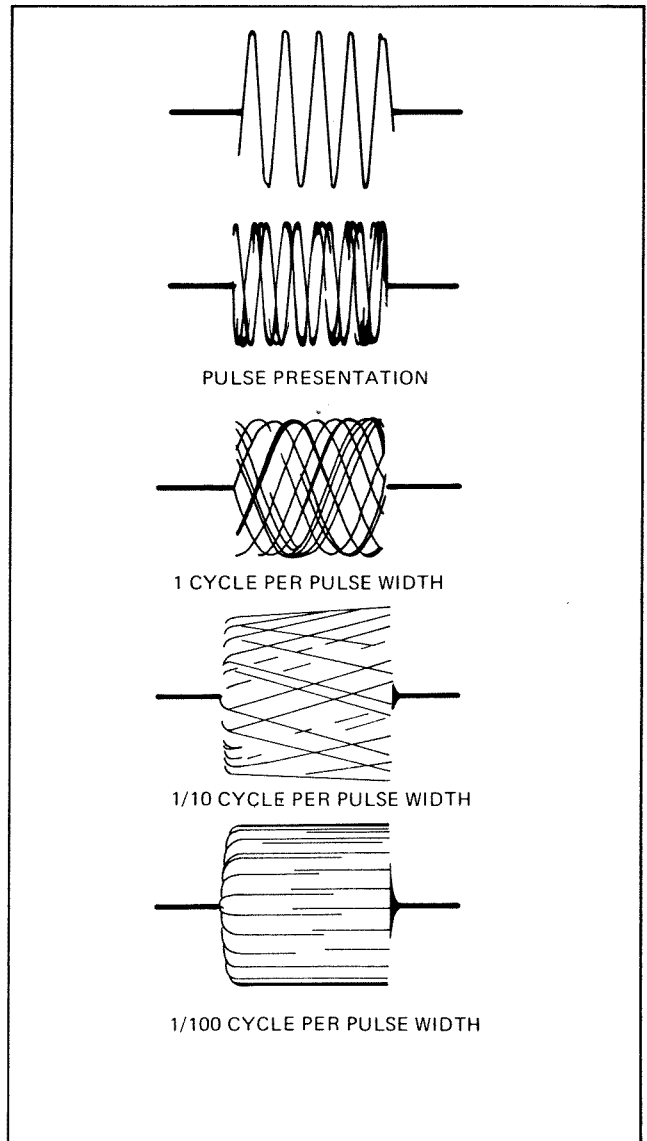
Figure 3-3. Pulsed Carrier Measurement Error



frequency, and B_{eq} is the equivalent power bandwidth. The values of $S_{f_v}(f)$ for the Model 5257A VFO can be obtained from the curves of Figure 3-6. (Refer to Hewlett-Packard Journal, March 1967; Application Note No. 87; and HP 5210A Manual.)

3-11. The thumbwheels extend the counter gate time in increments of units, tens, and hundreds causing the counter to read directly the sampling frequency and its multiples. With the thumbwheels set at 001 the counter reads the fundamental sampling frequency. At any other setting the counter reads a multiple of the sampling frequency. Thus, to directly read the frequency it is only necessary to find the proper harmonic "N" number and set the thumbwheels to this number. Calculation of "N" is described in Paragraphs 3-26 through 3-30.

Figure 3-4. Zero Beat at PULSED RF OUT



3-12. For basic set up of the counter used with the Model 5257A plug-in unit, refer to the appropriate counter operating manual. When the counter's FUNCTION switch is positioned at PLUG IN the counter's accessory connector plug is activated and the counter receives its input signal from the Model 5257A. Also the counter's gate time control is taken over by the Model 5257A but the setting of the counter's

Figure 3-5. 5257A Down Conversion

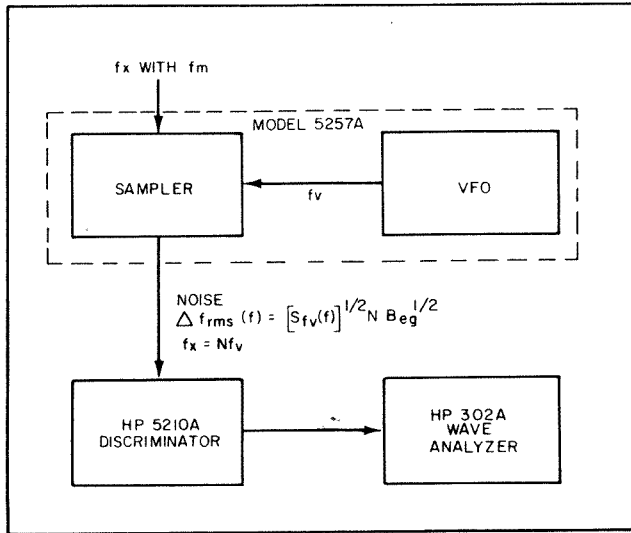
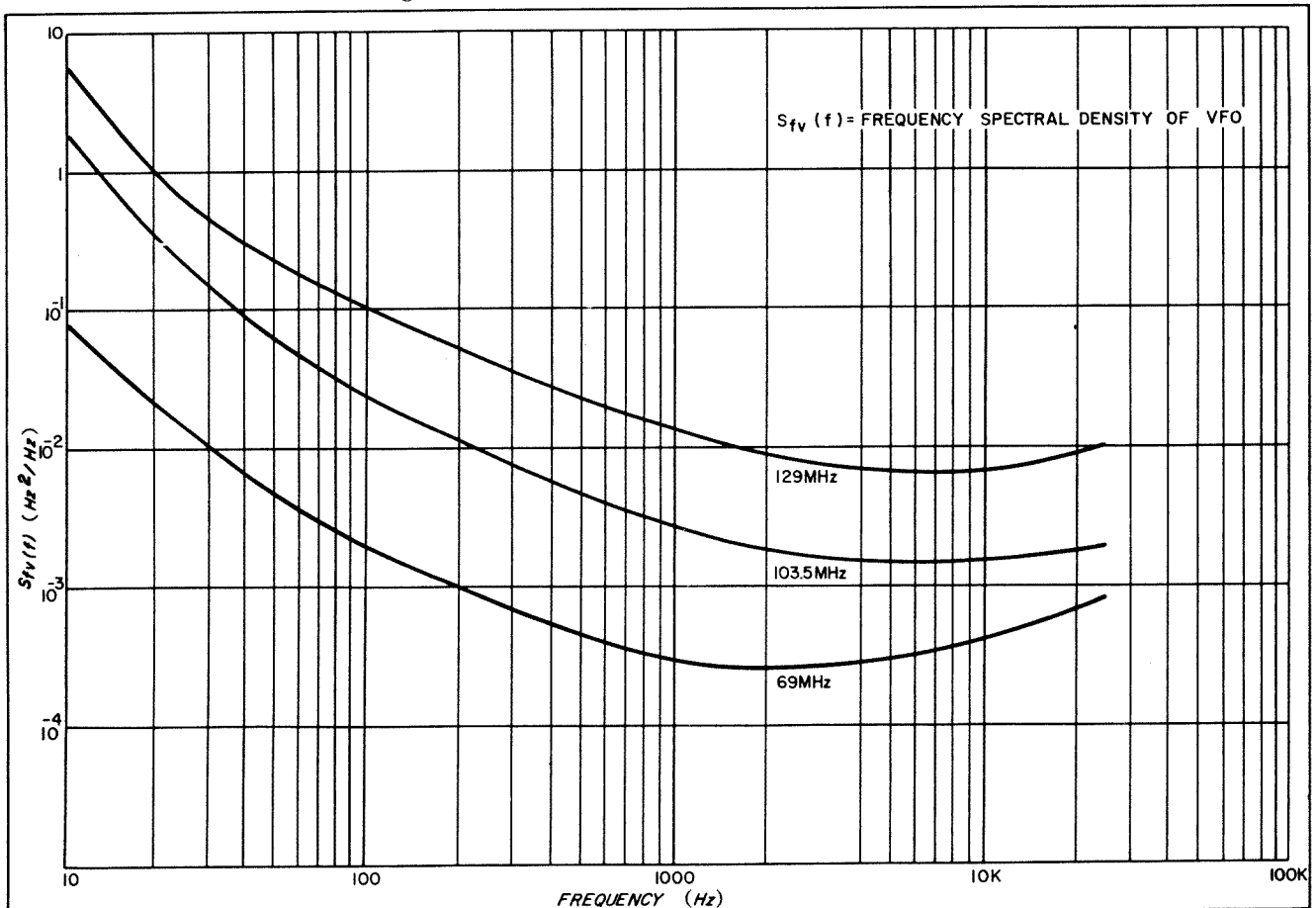


Figure 3-6. Frequency Spectral Density of VFO



TIME BASE determines frequency resolution. A TIME BASE of 1 ms provides ± 1 kHz resolution, the ± 1 count of the last digit in the display. This time base is generally suitable for the whole frequency range from .05 to 18 GHz with 8 digit readout counters. In the microwave range where this degree of resolution is not required, a 0.1 ms TIME BASE will shorten counting time and give a ± 10 kHz resolution. Likewise on lower frequencies the TIME BASE can be lengthened for the maximum resolution the 8 digit readout allows.

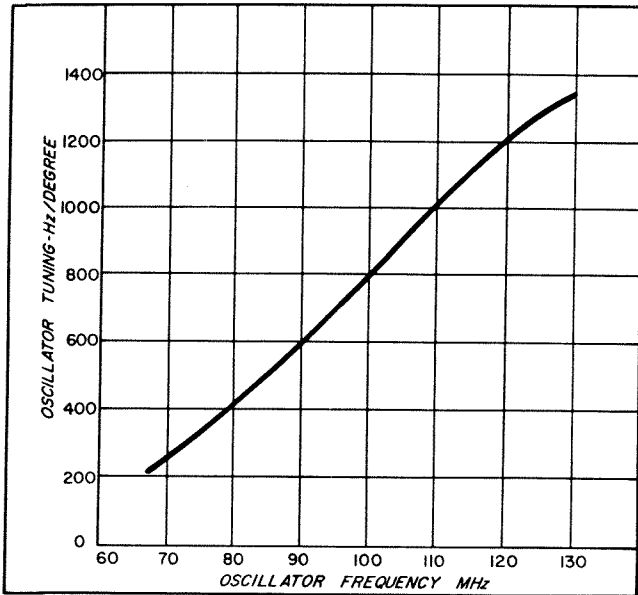
3-13. CONTROLS AND INPUTS

3-14. GENERAL. The function of the front-panel tuning control, input connector, mode selector, level control, meter and pulsed rf output connector are described in Paragraphs 3-15 through 3-22.

3-15. INPUT CONNECTOR. Signal input impedance is 50Ω nominal for connection to an unknown frequency source. The connector is a precision "N" type female connector. An exploded view of the input connector is shown in Figure 6-1. Changing two parts of the assembly converts the "N" type to the APC-7 or vice versa. See Paragraphs 3-24 and 3-25 for allowable input voltages.

3-16. FREQUENCY MHz CONTROL. The dial reads the VFO frequency. For convenience however, the counter readout provides the sampling frequency measurement used for calculations. (Do not use the dial reading for calculations.) Concentric knobs on this dial provide coarse and fine tuning. Coarse tuning

Figure 3-7. Oscillator Tuning



has a 63 to 1 gear reduction while the fine tuning has a 632 to 1 reduction. The oscillator is settable to 1/20 of a degree with fine tuning. See Figure 3-7 for oscillator tuning characteristics.

3-17. METER. In the PULSED RF mode the meter reads the relative amplitude of the difference frequency (beat) between the VFO harmonic and the input signal. At nine-tenths of full scale a red division line marks the optimum level at zero beat for Model 5257A frequency measurements. In the APC MODE, the meter monitors phase error of the phase-lock loop. Zero phase error deflection is nominally at mid-scale. When out of phase lock, in the APC MODE, the meter reads the nominal mid-scale deflection. In phase lock the meter reads above, below, or at the zero phase error deflection depending upon phase error.

3-18. MODE. Selects PULSED RF and APC modes. This is the red knob concentric with the RANGE selector knob.

3-19. THUMBWHEEL SWITCHES. The thumbwheels are set to harmonic numbers N of the sampling frequency. They actuate switches which preset a counter decade assembly in the Model 5257A to extend the counter gate in increments of units, tens, and hundreds. At a setting of 001 the counter reads the sampling frequency (N = 1).

3-20. LEVEL ADJ. This control adjusts amplifier gain to compensate for wide variations in input signal levels and the wide frequency range of the instrument. Initially, LEVEL ADJ is turned fully counterclockwise and after tuning to zero beat it is turned clockwise until the meter reads at the red division line.

3-21. RANGE. Range is selected with the black knob which is concentric with the MODE switch knob. It includes four ranges: .05-.2 GHz, .2-1 GHz, 1-4 GHz, and 4-18 GHz. This switch compensates the phase-lock loop for the wide frequency range of the instrument.

It also selects a gate time extension factor for the counter: the scale is 1N in the .05 to .2 GHz range and 4N in the higher ranges.

3-22. PULSED RF OUT. This BNC connector goes to the sampler output circuitry. It may be used for applications other than frequency measurement such as down conversion to extend the frequency range of low frequency instruments. An oscilloscope may be connected for viewing the sampler output waveform during zero beat tuning in the PULSED RF MODE.

3-23. INPUT VOLTAGES

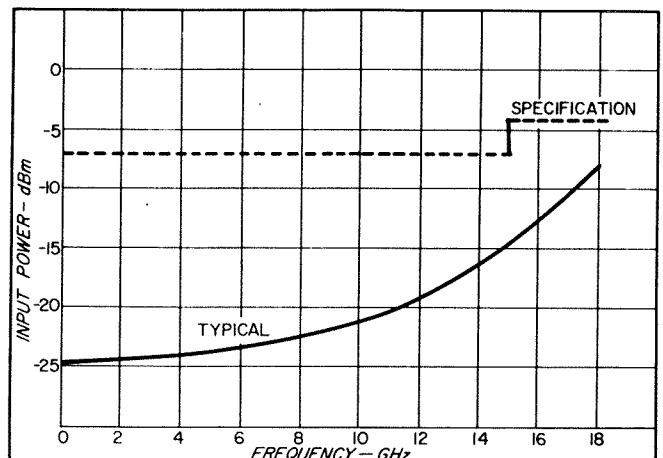
3-24. MAXIMUM INPUT VOLTAGE. The maximum input voltage must not be exceeded to prevent hot carrier diode damage in the sampler. Peak voltage is the critical quantity rather than average or rms values. Know the signal voltage before applying it to the INPUT jack. Use attenuators as a precautionary measure where the input voltage is questionable. Extra care should be taken with pulsed signals, since short voltage spikes can be just as damaging as steady state values. The maximum permissible input voltage is 2 volts, peak to peak - equivalent to 0.707 volts rms (+10 dBm) for a cw carrier.

3-25. MINIMUM INPUT VOLTAGE. A minimum input amplitude is specified to assure proper instrument operation, even though it may respond to lower amplitudes. Figure 3-8 gives typical system sensitivity versus input frequency. The Model 5257A will measure input signals from .05 to 15 GHz with amplitudes in excess of 100 mV (-7 dBm), and from 15 to 18 GHz with amplitudes in excess of 140 mV (-4 dBm) using a VFO frequency of 125 to 133.3 MHz. The input level should be sufficient to allow adjustment of meter deflection to the red indicator line.

3-26. CALCULATION OF N

3-27. For frequency ranges above .2 GHz, if the input signal frequency is known to within the sampling frequency (from 66.7 to 133.3 MHz), the harmonic number N can be found directly. In this case, estimated input frequency f_x is divided by sampling frequency f_s as read on the counter with the thumbwheels set at 001. The answer is N: $f_x/f_s = N$, where f_s equals VFO frequency f_v .

Figure 3-8. Typical System Sensitivity



3-28. In the .05 to .2 GHz range, sampling frequency f_s is VFO frequency f_v prescaled by four. The counter reads this sampling frequency, not the VFO frequency. Therefore, for direct calculation of N the estimated input signal frequency f_x should be known to within the sampling frequency (from 16.3 to 33.3 MHz). Hence the procedure is the same as in Paragraph 3-27. The estimated input frequency f_x is divided by the counter reading f_s and the answer is N : $f_x/f_s = N$, where f_s equals VFO frequency f_v divided by 4.

3-29. Briefly, the frequency measurement procedure using direct calculation of N is as follows: set the thumbwheels at 001. Tune FREQUENCY MHz for an indication of zero beat or phase lock, observing LEVEL ADJ and MODE switch positions described in Paragraph 3-4. Read sampling frequency on the counter. Divide the sampling frequency into the estimated frequency to obtain N (slide rule accuracy is permissible). Turn thumbwheels to N . Read actual input frequency on counter's display.

3-30. When input frequency f_x is known to be outside the limits for direct calculation of N stated in Paragraphs 3-27 and 3-28, a different procedure is followed. The thumbwheels are set to 001, FREQUENCY MHz is tuned to zero beat or phase lock while observing LEVEL ADJ and MODE switch position described in Paragraph 3-4, and the counter readout is recorded as f_1 . FREQUENCY MHz is retuned to an adjacent zero beat or phase lock and the counter readout is recorded as f_2 . The first frequency f_1 divided by the difference in the frequencies yields harmonic number N of the second frequency f_2 (slide rule accuracy is permissible):

EXAMPLE 1. Assume unknown f_x is approximately 11.9 GHz; Time Base = 1 ms.

a. Where f_2 is lower than f_1 :

$$f_x = (N - 1) f_1 \text{ and } f_x = N f_2,$$

$$N = f_1 / (f_1 - f_2).$$

$$f_1 = 119532. \text{ kHz (read on counter)}$$

tuning lower in frequency gives

$$f_2 = 118349. \text{ kHz (read on counter)}$$

$$f_1 - f_2 = \overset{1183}{\cancel{1183}} \text{ kHz}$$

$$N = 119.5 / 1.183 = 101, \text{ set thumbwheels to 101,}$$

$$f_x = 101 \times 118.349 = 11953261. \text{ kHz}$$

(read on counter).

b. Where f_2 is higher than f_1 :

$$f_x = (N + 1) f_1 \text{ and } f_x = N f_2,$$

$$N = f_1 / (f_2 - f_1).$$

$$f_1 = 119532. \text{ kHz (read on counter)}$$

tuning higher in frequency gives

$$f_2 = 120740. \text{ kHz (read on counter)}$$

$$f_2 - f_1 = 1208. \text{ kHz}$$

$$N = 119.5 / 1.208 = 99, \text{ set thumbwheels to 99, } f_x = 120.740 \times 99 = 11953261. \text{ kHz (read on counter).}$$

EXAMPLE 2. Assume unknown f_x is approximately 1.1 GHz; Time Base = 1 ms.

a. Where f_2 is lower than f_1 :

$$f_1 = 110000 \text{ kHz (read on counter)}$$

tuning lower in frequency gives

$$f_2 = 100000 \text{ kHz (read on counter)}$$

$$f_1 - f_2 = 10000 \text{ kHz}$$

$$N = 110 / 10 = 11. \text{ Set thumbwheels to 11;}$$

$$f_x = 11 \times 100000 = 1100000 \text{ kHz.}$$

b. Where f_2 is higher than f_1 :

$$f_1 = 1100000 \text{ kHz (read on counter)}$$

tuning higher in frequency gives

$$f_2 = 122000 \text{ kHz (read on counter)}$$

$$f_1 - f_2 = 12000 \text{ kHz}$$

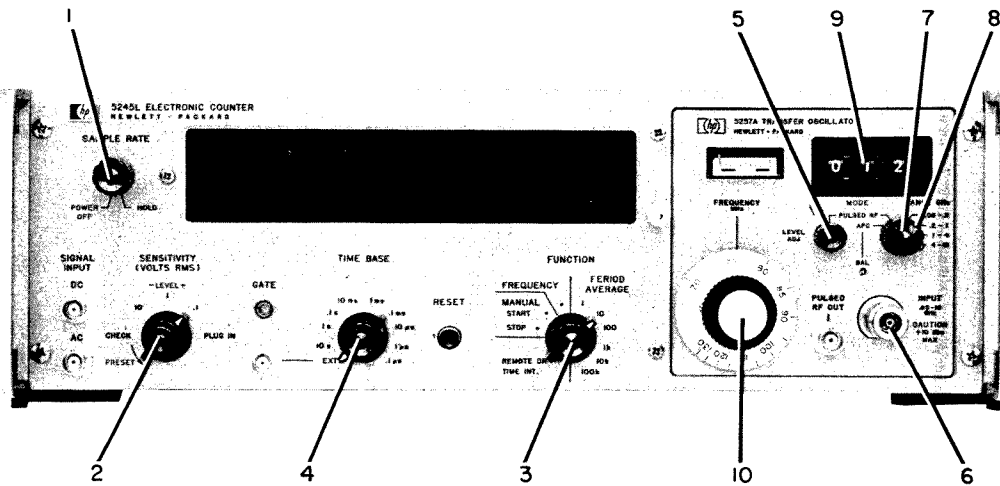
$$N = 110 / 12 = 9$$

$$f_x = 122000 \times 9 = 1100000 \text{ kHz.}$$

3-31. VERIFICATION OF HARMONIC NUMBER N

3-32. The transfer oscillator method of measuring frequencies higher than the counter's capability requires that harmonic number " N " be known exactly. Since there are many harmonics to choose from, the operating procedures in Figures 3-9 and 3-10 outline a foolproof method of verifying the selected harmonic number. In use, harmonic number " N " is either increased or decreased by 1 on the thumbwheel switches and the internal VFO is retuned for zero beat or phase lock at an adjacent harmonic to match the change on the switches. Thus, the measured frequency displayed is the same in both cases if the choice was correct.

Figure 3-9. Pulsed RF and FM Measurement

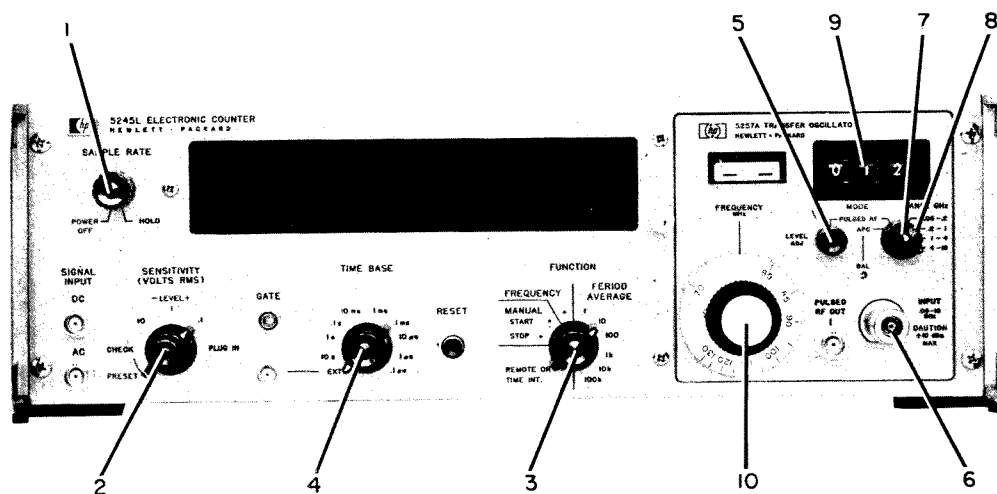


CAUTION: Do not apply more than +10 dBm (2 V peak-to-peak) to 5257A INPUT connector.

1. Turn power on by turning SAMPLE RATE control cw out of POWER OFF.
2. Set switch on Counter to PLUG-IN.
3. Set switch on Counter to FREQUENCY.
4. Set switch on Counter to 0.1 ms. Note: Other gate times may be used.
5. Turn 5257A LEVEL control fully ccw.
6. Connect signal to be counted to 5257A INPUT (f_x).
7. Set MODE switch to PULSED RF.
8. Set RANGE switch to correct range for input frequency.
9. Set N switches to 001.
10. Tune FREQUENCY dial for maximum meter reading.
11. Turn LEVEL control cw for meter reading of 9/10 full scale.
12. Read sampling frequency f_1 on Counter and record.
13. a. Omit this step if input frequency f_x is known within the sampling frequency f_1 , step 12.
 - b. When f_x falls outside the limits of step 12, find adjacent zero beat to calculate N. Tune FREQUENCY dial higher or lower to adjacent zero beat and carefully tune for maximum meter reading. Read Counter and record this second frequency f_2 .
14. Calculate N (Paragraph 3-26)*. With slide rule accuracy:
 - a. Input frequency f_x known within sampling frequency: Divide f_x by f_1 to obtain N: $N = f_x/f_1$.
 - b. Input frequency f_x not known within sampling frequency: Find difference between f_1 and f_2 . Divide f_1 by the difference to obtain N: $N = f_1/(f_2 - f_1)$ or $N = f_1/(f_1 - f_2)$.
15. Set N switches to calculated N number and read input frequency on Counter.
16. Verify N. Turn N switches up one unit (e.g., 080 to 081) or down one unit (e.g., 080 to 079).
17. Tune FREQUENCY dial for adjacent zero beat (indicated by peak on meter) corresponding to the direction N switches were turned in step 16, (lower for N + 1) and (higher for N - 1). Counter should display the same frequency as step 15.

* Maximum N setting is typically 144 from 15 to 18 GHz and 225 from .05-15 GHz, Paragraph 3-25.

Figure 3-10. CW and FM Measurement

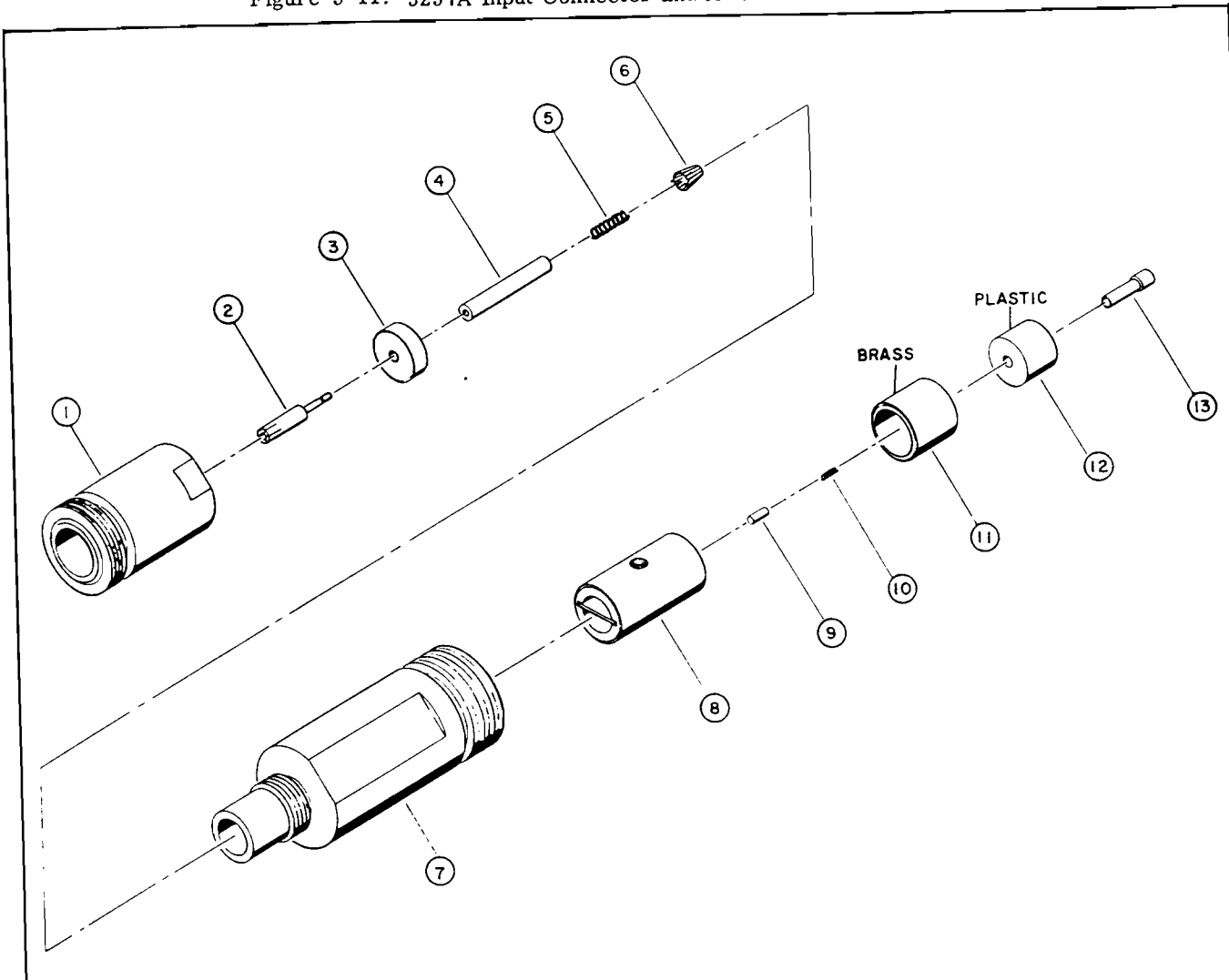


CAUTION: Do not apply more than +10 dBm (2 V peak-to-peak) to 5257A to INPUT connector.

1. Turn power on by turning SAMPLE RATE control cw out of POWER OFF.
2. Set switch on Counter to PLUG-IN.
3. Set switch on Counter to FREQUENCY.
4. Set switch on Counter to 0.1 ms. Note: Other gate times may be used.
5. Turn 5257A LEVEL control fully cw, then back off one turn.
6. Connect signal to be counted to 5257A INPUT.
7. Set MODE switch to PULSED RF.
8. Set RANGE switch to correct range for input frequency (f_x).
9. Set N switches to 001.
10. Tune FREQUENCY dial for maximum meter reading.
11. Turn LEVEL control cw for a meter reading of 9/10 full scale.
12. Set MODE switch to APC. Note that meter will read near mid-scale between phase-lock points and Counter will display all zeros.
13. Tune FREQUENCY dial for phase lock. Meter now reads about mid-scale \pm phase error and Counter displays the sampling frequency.
14. Tune FREQUENCY dial for zero phase error (exactly mid-scale on meter).
15. Read sampling frequency f_1 on Counter and record.
16. a. Omit this step if input frequency f_x is known to be within the sampling frequency f_1 , step 15 above.
b. When f_x falls outside the limits of step 15 above, find adjacent phase lock point to calculate N. Tune FREQUENCY dial higher or lower to adjacent phase lock point and adjust for zero phase error. Read Counter and record this second frequency f_2 .
17. Calculate N (Paragraphs under 3-26)*. With slide rule accuracy:
 - a. Input frequency f_x known within sampling frequency: Divide f_x by f_1 to obtain N: $N = f_x/f_1$.
 - b. Input frequency f_x not known within sampling frequency: Find difference between f_1 and f_2 . Divide f_1 by the difference to obtain N. $N = f_1/(f_2 - f_1)$ or $N = f_1/(f_1 - f_2)$.
18. Set N switches to calculated N number and read input frequency on Counter.
19. Verify N. Set N switches up one unit (e.g., 080 to 081) or down one unit (e.g., 080 to 079).
20. Tune FREQUENCY dial to adjacent phase lock point corresponding to the direction N switches were turned in step 19, (lower for N + 1) and (higher for N - 1). Counter should display the same frequency as step 18 above.

* Maximum N setting is typically 144 from 15 to 18 GHz and 225 from .05-15 GHz, Paragraph 3-25.

Figure 3-11. 5257A Input Connector and Attenuator



"N"	APC-7	"N"	APC-7
1. BODY - RF CONNECTOR 1250-0914	(1250-0816)	8. ATTENUATOR ASSEMBLY 6 db - 05255-6031	←
2. CONTACT - RF CONN. 1250-0915	(1250-0909)	9. CONTACT - SLIDING REAR 05255-2020	←
3. INSULATOR 1250-0815	←	10. SPRING - COMPRESSION 1460-0268	←
4. CENTER CONDUCTOR 05257-20030	←	11. SLEEVE 05257-20055	←
5. SPRING COMPRESSION 1460-0298	←	12. BEAD 08740-2100	←
6. CONTACT - SLIDING 5020-3297	←	13. CENTER CONDUCTOR, REAR - 05257-20061	←
7. HOLDER - PAD 05257-20029	←		

SECTION IV

THEORY OF OPERATION

4-1. GENERAL

4-2. The Model 5257A is a plug-in transfer oscillator for use with Hewlett-Packard 5245L, 5245M, 5246L, and the 5247M counters. It includes gate time pre-setting circuits for display on the counter of the actual measured frequency. This section describes operation of the Model 5257A system in Paragraphs 4-3 through 4-12 and its individual circuits in Paragraphs 4-14 through 4-58.

NOTE

After installing plug-in unit and turning power on; depress counter RESET button to ensure valid count or measurement.

4-3. FUNCTIONAL BLOCK DIAGRAM

4-4. There are ten functional sections to the Model 5257A. These are shown connected as a system in the functional block diagram of Figure 4-1. For circuit details refer to schematic diagrams in Figures 8-3 through 8-15.

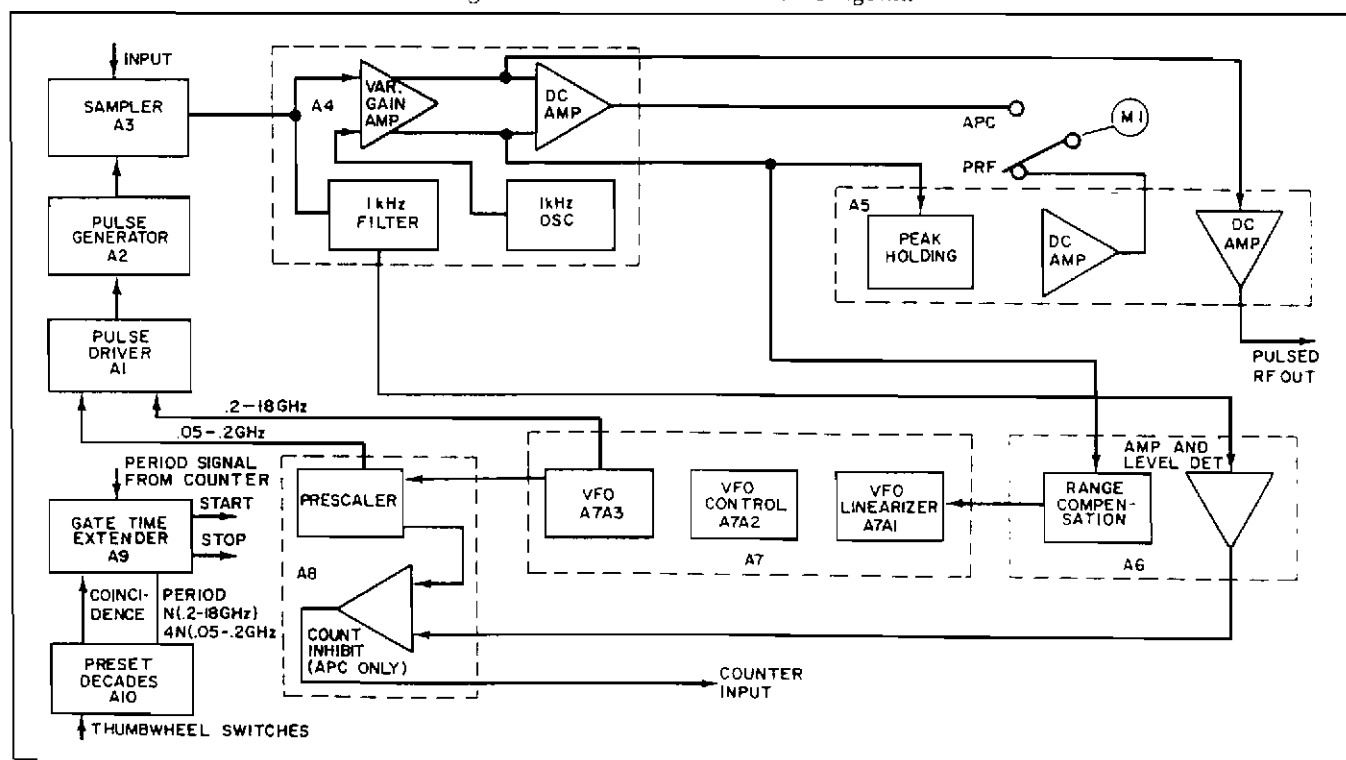
4-5. The frequency to be measured is applied to wide-band sampler A3. The sampler is switched by pulse generator A2 at a rate determined by internal VFO A7A3. The sampler output represents phase difference between the sampler switching time and the input frequency. If the internal VFO harmonic is phase locked to the input frequency, the sampler output will be a dc voltage proportional to phase error.

4-6. There are many harmonics of frequencies tunable within the internal VFO range that will zero

beat or phase lock with an input signal. In operation, the internal VFO can be tuned to any one of these. The sampler output is amplified in the variable gain and dc amplifiers of A4. The gain is set by front panel LEVEL ADJ control. The output of A4 goes to A5 and A6 assemblies. A5 dc amplifier provides the sampler output waveform at front panel jack J2. A5 peak holding circuit develops a dc voltage proportional to the amplitude of the beat signal from the sampler with pulsed rf input signals. This level is amplified and applied to meter M1 when operating in PULSED RF MODE. In the APC mode the meter is switched directly to A4 dc amplifier for reading the phase error of the phase-lock loop.

4-7. The variable-gain amplifier in A4 includes a reference voltage to establish 0 phase error in the phase-lock error voltage loop. In the APC mode, a 1 kHz oscillator is turned on and its signal is injected into the phase-lock loop at the reference mode. The 1 kHz signal appears at the output of sampler A3 and is taken from this point by a 1 kHz filter, located in A4, for amplification and level detection in assembly A6. If phase-lock has not occurred, this signal is below the required detection level and the signal to the counter is inhibited by the inhibit amplifier in A8. Therefore, the counter readout is all zeros. When phase-lock is achieved, the 1 kHz signal is above the required level, and the inhibit to the counter is removed for a frequency readout. In the PULSED RF mode the inhibit amplifier is biased to continually pass the counter input signal.

Figure 4-1. Functional Block Diagram



4-8. The feedback loop output of the variable gain amplifier goes through a range compensation circuit in A6, which connects to VFO linearizer A7A1. Range compensation is varied in steps with the range switch for optimum phase-locking from 0.05 to 18 GHz. The linearizer compensates for the non-linear VFO gain characteristics over the tuning range. In the PULSED RF mode, the feedback loop is disabled in the linearizer. Linearizer output is a dc voltage applied to VFO control A7A2. Voltage controlled capacitors in VFO control A7A2 hold the VFO frequency in phase lock when in the APC mode. Thus, the APC loop is completed.

4-9. VFO A7A3 is tunable between 66.7 to 133.3 MHz and its output goes to two buffers. The first buffer provides input to pulse driver A1 when the Model 5257A is switched to the frequency ranges above 200 MHz. The second buffer provides VFO input to a divide-by-four prescaler A8. Output C of the prescaler goes to pulse driver A1 when the Model 5257A is switched to the 50 to 200 MHz range. This gives a tunable sampling rate from 16.7 to 33.3 MHz. The other prescaler output, if passed by the inhibit amplifier, goes to the counter input gate on line A for frequency counting on all ranges. Thus on the lowest range, counter prescale is N and on the three highest ranges the counter prescale is 4N.

4-10. The thumbwheel switches, A8 preset decades, and A9 gate-time extender control the counter's start-stop and are separate from the transfer oscillator portion. The thumbwheels are set to the transfer oscillator (VFO) harmonic number N which zero beats with the input signal being measured. The thumbwheels activate switches which set the conditions of the three binary decades of A8 in units, tens, and hundreds. The decades start counting at start and provide a coincidence gating pulse to the gate time extender when the count period is completed for stop. In this way, gate time extender A9 controls the counter's start-stop time so the readout is the actual measured frequency. Range switch S1 turns off divide-by-four in A9 for the 50 to 200 MHz range and turns it on in the other ranges to give a correct count when A8 prescaler is switched. Therefore, when the thumbwheels are set at 001 the counter will display the sampling frequency to pulse driver A1 in all ranges.

4-11. COMPONENT IDENTIFICATION

4-12. The complete reference designator for a component mounted on an assembly consists of the assembly designation plus the designator number of the component in that assembly. Components that are not part of any assembly (chassis parts) are identified by component numbers only. For example, A7A1R1 refers to resistor (R1) in the VFO linearizer sub-assembly (A1) which is part of the VFO assembly (A7). A resistor numbered R1 mounted on the chassis is simply designated R1.

4-13. Complete reference designators will be used in this manual only when necessary to avoid confusion with other components or assemblies having similar designators. For a complete reference designator where an abbreviated one is used in the text, add the designator for the assembly as given in the heading immediately preceding that paragraph.

4-14. PULSE DRIVER A1

4-15. VFO buffer output from A3P3 is applied to the input switching network consisting of CR1, CR2 and CR3. When switch S1 is in the three highest ranges for frequencies from 200 MHz to 18 GHz, a -15 volt bias is applied to turn CR2 off and CR1 and CR3 on so that the VFO signal drives transistor Q1 of the driver amplifier. The prescaled, divided-by-four, VFO signal from prescaler A8(C) is applied to switching diodes CR4 and CR5. In the three highest frequency ranges, CR5 clamps the input to ground and CR4 is virtually an open circuit so that the prescaled input is prevented from appearing at Q1 base. When S1 is switched to the 50 to 200 MHz range, the -15 volts is removed from CR1, CR2, and CR3. This opens the signal path and clamps it to ground. This action turns off the input from A3P3. At the same time, the -15 volts turns CR4 on and CR5 off so the prescaled VFO signal appears at Q1 base.

4-16. Amplifiers Q1 and Q2 are feedback amplifiers for low impedance drive to Q3. Q3 and Q4 raise the level of VFO signals and drive the Q5 and Q6 wideband driver stage which is essentially a current mode switch configuration. This high level Q5 and Q6 driver turns on and off at the frequency of the input signal forming steep sloped square waves for driving stripline pulse generator A2. Auto transformers T1 and T2 couple between Q4 and Q5, and Q6 and pulse generator A2, respectively. Because of the high frequency pulse components generated in this assembly, both the +13 volt and -15 volt dc power lines are isolated by pi filter networks consisting of bypass capacitors and a filter coil.

4-17. PULSE GENERATOR A2

4-18. CR1 in a stripline assembly is driven by pulse amplifier A1 through C1. C1 is independently mounted between the assemblies. CR1 is a step recovery diode which has the unique property of conducting for a few nanoseconds after the driving signal reverse biases the diode junction and then turning off sharply. This characteristic generates the pulses for sampler drive. They go through R1 to A3 sampler assembly.

4-19. SAMPLER A3

4-20. The sampler is designed for harmonic mixing of very high frequency and microwave signals. The assembly consists of a 6 dB attenuator for the input signal, hot carrier diodes CR1 and CR2, sampling capacitors C1 and C2, and shorted stubs. The pulse train, representing the VFO harmonics from pulse generator A2, switch diodes CR1 and CR2 on and off with a 180° phase difference. The hot carrier diodes have picosecond switching times and can sample signals as high as 18 GHz. A driving pulse closes switch CR1 and a sample is taken. C1 charges to some fraction of the input voltage according to the phase relationship of the input signal with the sampling pulse. CR2 switching out-of-phase with CR1 charges C2 in the opposite polarity from C1. Thus, phase detection results when the two outputs are combined at the input to automatic phase control assembly A4.

**4-21. AUTOMATIC PHASE
CONTROL ASSEMBLY A4**

4-22. VARIABLE GAIN AMPLIFIER. The outputs from sampler A3 through isolation resistors R1 and R2 are combined at the gate of Q2A. The Q2A gate input is the summing junction for the two sides of the sampler and the resultant voltage is the algebraic sum of the voltages on A3C1 and A3C2. Q2A and Q2B are a matched pair of field effect transistors (FET's) packaged in a single can. FET Q2A is a source-follower (comparable to an emitter-follower transistor circuit) which presents a high input impedance for minimal loading on the sampler. Bipolar transistor Q3 is in an emitter-follower circuit which feeds back an in-phase signal voltage from Q2A's source to its drain for effective reduction of Q2A's gate-to-drain capacitance. FET Q2B provides a dc reference level to variable gain amplifier at Q5 base. The reference level is adjusted with front-panel APC BAL control R2.

4-23. The reference dc voltage and a 1 kHz signal are amplified by Q5 while the sampler output from Q2A is amplified by Q7, the opposite side of the A4 balanced variable-gain amplifier. Q6A and Q6B are current sources for Q5 and Q7, respectively, and provide dc stability. Q5 and Q7 emitters are bridged by LEVEL ADJ, R1 (chassis part), to adjust amplifier gain for wide variations in input signal levels and frequency range. Lower values of R1 reduce the emitter resistance of Q5 and Q7 and increase gain, and vice versa. Ac and dc gain are both varied yet dc balance between the two sides of the amplifier is maintained.

4-24. 1 kHz OSCILLATOR. The 1 kHz oscillator includes Q1, Q4, and Q10, and is switched on in the APC Mode by removing the ground from the 1000 ohm RC feedback circuit. The RC feedback consists of C6, R25, R22, C5, and R16. Q4 has a split load. Collector resistor R12 is of low value to provide a low amplitude 1 kHz output signal going through C4 to the reference node at Q2B. C1 and C3 bypass high frequencies to improve the 1 kHz sinewave. Q4 emitter load resistor R8 couples the feedback signal to Q1 emitter. Q1 is a common-base stage which drives Q10. Q10 is a common-emitter amplifier which completes the oscillator loop.

4-25. DC AMPLIFIER. Q8-Q11A is the upper section and Q9-Q11B the lower section of a balanced dc amplifier. Due to coupling of the emitters between sections, the outputs of the upper and lower halves are equal and out of phase. Q8 and Q9 are emitter-followers for both the dc error voltage on the APC loop and the ac beat frequencies in the PULSED RF MODE. From Q8, ac beat frequencies are applied to A5 (8) through A4 (3) for input to the pulsed rf output amplifier. From Q9, ac beat frequencies are applied to A5 (10) through A4 (6) for the peak holding circuit which drives the meter in the PULSED RF MODE. Input to A6 (10) range compensation is also taken from Q9. Q11A is the dc amplifier for meter drive in the APC Mode. Q11B provides circuit balance.

**4-26. REGULATOR AND PULSED
RF OUTPUT ASSEMBLY A5**

4-27. PULSED RF OUT. Terminal A5 (8) connects the base input of amplifier Q10 to the upper section of the dc amplifier in APC assembly A4. Q10 is an emitter follower and its output is ac coupled through C10 to the BNC jack labeled PULSED RF OUT.

4-28. PEAK HOLDING CIRCUIT. Terminal A5 (10) connects the base input of Q1 to the lower section of the dc amplifier in assembly A4. Q1 and Q2 are an ac amplifier for the beat frequency signal. They provide a peak-to-peak signal of sufficient amplitude for peak holding circuit operation. The peak holding circuit consists of Q3A, Q3B, Q4, Q5, Q6, and Q7. The collector of Q3A couples the signal to the base of Q7 which, in turn, drives Q6. Q6 is an emitter-follower which charges C2. The long time constant of C2 and R9 holds the dc level developed between pulses. Q4 and Q5 are a Darlington pair with a high input impedance so that the loading on R9, C2 is minimal. The resultant voltage on the emitter of Q4 and the bases of Q3B and Q8A is the dc level across R9, C2 plus the base-emitter drops of Q4 and Q5. Q3A and Q3B are emitter coupled so this dc voltage is compared with the peak ac voltage on the base of Q3A. The difference is fed back through Q7 until the loop is stabilized at the peak ac voltage.

4-29. DC AMPLIFIER. Q8A and Q8B are a dc amplifier to drive the meter. The dc voltage level from the peak holding circuit is applied to the base of Q8A. This voltage is negative going with increasing amplitude. With no signal input Q8A is conducting heavily. Q8B is biased slightly negative by voltage divider R17 and R16 and is virtually held off. Meter current derived from the voltage drop across R15 is negligible. With increasing input signal the base-emitter bias on Q8A drops, its conduction decreases, and its emitter voltage goes negative. This increases the conduction of Q8B, the voltage across R15 increases, and the meter deflection rises.

4-30. +13 VOLT REGULATOR. The series regulator for +13 volts consists of Q14 as the series regulating device, Q12 voltage feedback amplifier, and CR1 combined with amplifier Q9 as a reference voltage. The unregulated +20 volt input is dropped by R28 and Q14, and appears on the -13 volt output line. Voltage divider R29 and R30 samples the output voltage and applies 9 volts to the base of Q12. Zener diode CR1 holds the base of Q9 to 9 volts to set a fixed voltage for the emitters of Q9 and Q12. If the output voltage tends to rise over 13 volts, the base bias on Q12 increases, Q12 conduction increases and its collector drops in voltage. This decreases the base bias, and thus conduction of Q14, so that the output voltage on the -13 volt line decreases to remain constant. For a decrease in output voltage the opposite action takes place. C13 prevents transients in the load from affecting regulator operation.

4-31. -10 VOLT REGULATOR. Q16 is the series regulating device whose bias is controlled by Q15. Q11 and Q12 are a differential pair. CR2 establishes a reference voltage at the base of Q11 and the voltage

at the base of Q13, derived from voltage divider R32 and R33 across the -10 volt output, must equal the reference. Any change in output voltage tending to change this balance will be corrected by a change in bias on Q15 which changes the conduction of Q16.

4-32. AUTOMATIC PHASE CONTROL ASSEMBLY A6

4-33. RANGE COMPENSATION. APC loop compensation for each of the four ranges of 0.05-0.2, 0.2-1.0, 1.0-4.0, and 4.0-18 GHz is provided across the signal line from APC No. 1, A4 (6), to VFO linearizer input P3 (A). The circuit consists of Q1 amplifier accepting the input signal and a series of switched loads for Q1. The loads are Q4, Q6, Q9, and Q12 with their associated resistors and capacitors. Diodes connected to these transistors (e.g., CR1, CR2) switch the loads for Q1 either on or off according to range switch S1 setting. As an example, the operation of Q4 load is described; the others are identical. Initially, CR1 is biased on from +13 volts through R4 to -10 volts through R9. The base of PNP transistor Q4 is then slightly positive due to the voltage divider ratio of R9/R8, and CR2 is off as well as Q4. When range switch S1 is set to .05-.2 GHz: CR1 is biased off by the -10 volts applied to R3, Q4 base goes negative to turn on Q4 which acts as an emitter follower to the output line, and CR2 goes on which connects Q1 to this load. C6 and R11 furnish the required loop compensation for the 0.05 to 0.2 GHz range.

4-34. AMPLIFIER AND LEVEL DETECTOR. Transistors Q2 and Q3 are a feedback amplifier for the 1 kHz inhibit signal from APC No. 1, A4 (1). Q2 is a common emitter, NPN transistor amplifier with feedback coupling resistor R8 in the emitter circuit. The collector signal of Q2 drives PNP transistor Q3. Q3 collector connects through R10 to Q2 emitter completing the negative feedback loop. Q3 output signal is coupled to Q5A through C7.

4-35. Transistors Q5, Q7, and Q8 are a peak holding circuit for the 1 kHz inhibit signal which appears at phase-lock in the APC mode. When the signal is absent, the base of Q5A and Q5B are at 0 volt. Since R14 goes to ground, the transistors are mutually coupled by their emitters. A 1 kHz input signal is amplified by Q5A and Q8, and C10 is charged negatively through CR7. R24 gives a long time constant. PNP transistor Q7 is an emitter-follower. The C10 charge plus Q7 base-emitter voltage appears on the base of Q5B. Through the coupling to Q5A, the voltage on Q5B base goes negative up to the peak amplitude of the input signal and remains constant at that voltage.

4-36. The level detector consists of PNP transistors Q10 and Q11. With mode switch S1 set to PULSED RF, +13 volts is applied to R35 and Q11 is biased off to disable the circuit. In the APC position of S1, -15 volts is applied to Q11 and it turns on. Q11 then supplies bias current to the inhibit signal output going to the prescaler and inhibit assembly A8 (D) when the input to the level detector is 0 volts. Q10 is biased off until its base voltage goes more negative in response to an input signal to the peak holding circuit. This turns Q10 on which moves the emitter of Q10 and Q11 in the negative direction and Q11 turns off. Thus, the bias current to the inhibit signal output line to A8 (D) is applied.

4-37. VARIABLE FREQUENCY OSCILLATOR ASSEMBLY A7

4-38. LINEARIZER A7A1. Input to the linearizer at P3 (A) comes from APC No. 2. The input signal is the APC error at phase lock in the APC mode and the sampler beat frequencies in the PULSED RF mode. The input is applied to the base of Q1. Q1 and Q3 are a balanced pair with Q2A and Q2B current sources in their emitter circuits. Q3 base is at ground and Q1 base is 0 volt, plus or minus the APC error voltage. The emitters of Q1 and Q3 are bridged by R4 plus resistance R8 through R17. These resistors are switched sequentially by S1 with the VFO FREQUENCY MHz control, to compensate feedback loop gain for the decreasing VFO gain as it is tuned from high to lower frequencies. The total resistance is maximum at the highest frequency of 133 MHz for lowest gain and resistance is minimum at the lowest frequency of 67 MHz for highest gain. Q4 is an emitter-follower for isolation of Q1 voltage amplifier and the VFO voltage control circuit. In the PULSED RF mode, -15 volts is applied through R7 turning off Q2, Q1, and Q3 to disable the APC loop. Base bias is applied to Q4 in the PULSED RF mode from divider R6 and R3 by turning on CR1 through part of mode switch S1.

4-39. VFO CONTROL A7A2. CR1 and CR2 are voltage controlled capacitor diodes which shunt the VFO tuning capacitor to ground through C1. The diodes are reverse biased such that an increase in bias decreases capacitance and vice versa. Network CR3, R4, and C2 sets the limits of swing on the VFO and provide an improved sinusoidal waveshape at the VFO output. The anode of CR3 is approximately -2 volts and prevents the signal on the cathode of CR3 from going more negative than -2.7 volts.

4-40. VARIABLE FREQUENCY OSCILLATOR A7A3. Q1 and Q2 are a modified Colpitts oscillator circuit with a tank consisting of tuning inductor L1, special air dielectric tuning capacitor C2, and feedback capacitors C4 and C5. Q2 adds current gain in the feedback loop to Q1 emitter and raises the Q of the tank circuit because of the high impedance of Q2 base. Q3 is a buffer to reduce the effect of load variations

upon the oscillator. Buffer amplifiers Q4-Q6 and Q5-Q7 are identical. These are feedback type circuits to drive the 50-ohm output lines through transformers T1 and T2.

4-41. PRESCALER AND INHIBIT ASSEMBLY A8

4-42. DIFFERENTIAL AMPLIFIER AND SCHMITT TRIGGER. The prescaler input is a 67 to 133 MHz signal from the VFO assembly A7A3. This signal is capacitively coupled through C2 into differential amplifier Q1 and Q2. CR1 and Q3 provide a current source for the differential amplifier. The output of Q1 is input to integrated circuit Schmitt-trigger U1. R8 provides a broad bias adjustment for U1.

4-43. BINARIES, LEVEL SHIFT AND OUTPUT AMPLIFIER. Binary counter integrated circuits U2 and U3 accept the direct-coupled positive spikes from the Schmitt-trigger. The Q and \bar{Q} outputs of U3 are square waves of opposite polarity between 16.7 and 33 MHz, which is the input frequency divided by 4. Q5 and Q6 are emitter-follower level shifters to the output amplifiers Q4 and Q7, which also provide isolation of the two prescaler outputs.

4-44. INHIBIT AMPLIFIER. The Inhibit input from A6 is applied to the base of Q8. In the Pulsed RF mode, there is bias current through R2 and Q8 is cut off. No inhibit signal is present and the prescaler output is applied to the counter. In the APC mode, the inhibit signal is present; Q8 is turned on, and the output signal at Q7C is shorted to ground through low impedance bypass Q8. When phase-lock occurs in the APC mode, the inhibit signal again goes low, Q8 is turned off and the prescaler output signal is applied to the counter.

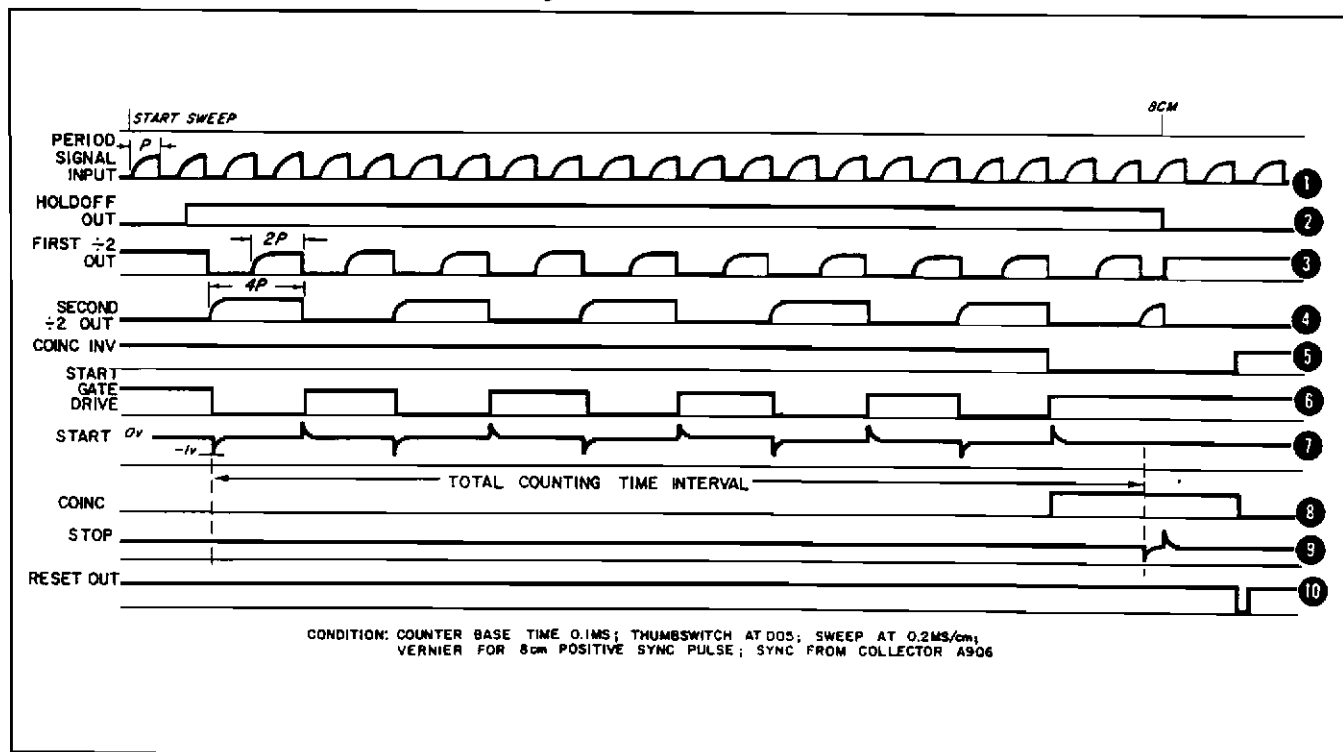
4-45. GATE TIME EXTENDER A9 *

4-46. Enable voltage (plug-in bias) is applied to Q1 base when the counter FUNCTION switch is turned to PLUG IN. Q1 conducts and its collector voltage rises to -15 volts. The -15 volts is the supply for Q9 and Q10. CR1 turns on and applies -15 volts to gate-inhibit line P6 (23).

4-47. Waveforms at key points in the gate time extender are shown in Figure 4-2. Waveform numbers refer to circled points in A9 schematic, Figure 8-9.

* High and low are logic designations for a positive voltage (high) of 4 volts and zero voltage (low) representing logic 1 and logic 0, respectively.

Figure 4-2. Waveforms



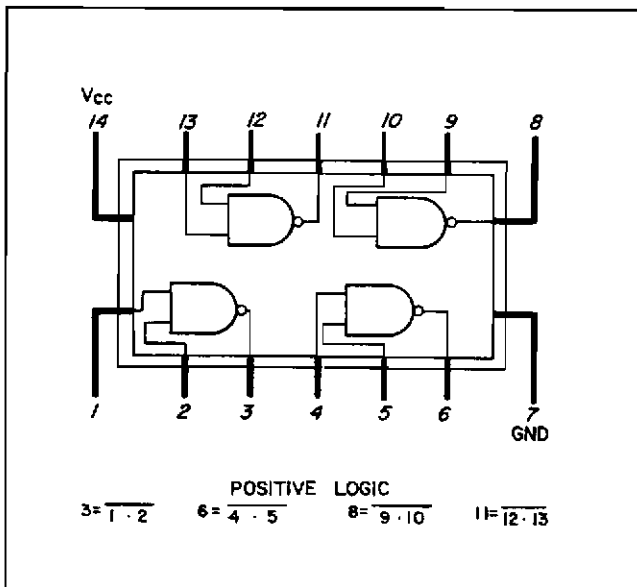
The counter period signal has a time interval P determined by the counter TIME BASE selector. This signal is applied to PNP transistor Q4 base which amplifies and inverts the signal. When the input square wave goes positive, Q4 turns off. CR2 prevents Q7 base from swinging below ground. Q7 amplifies again, inverts period P signal, and shifts the signal level to be compatible with the logic states (0 to 4.0 volts).

4-48. A schematic of IC logic parts is shown in Figure 4-3. Frequency division is performed by integrated circuit flip-flops IC1 and IC4. Between counting periods the hold-off pulse from the counter is a positive level applied through R9 to Q6 base. Q6 inverts the input so its output is low (near 0 volts). This voltage applied to IC1 (S_D) sets IC1 output (Q) high or logical "1". This high applied to IC4 (C_D) sets IC2 output (Q) low or logical "0". When the hold-off input goes low (0 volts), the count period begins. Q6 output rises positive to enable gates IC2A(2) and IC3A(1) and removes the 0 volt set level from IC1 (S_D) and IC4 (C_D). They can now change their binary states with changing input levels.

4-49. One-half cycle of a period after the end of hold-off period P signal goes low at IC1 (CP) and Q output of IC1 goes low. Immediately output Q of IC4 goes high. Two half-cycles of the input signal later output Q of IC1 again changes state and goes high. Thus it divides the input pulse frequency by two to give a period of 2P. Output Q of IC4 remains high and does not change state until the 2P input from IC1 (CP, clock pulse) goes negative one-half cycle later. Thus IC4 divides its 2P input by two for a total division of four. The new time interval at the Q output of IC4 is 4P, where P is the input time interval from the counter at P6 (48).

4-50. IC3A, B, C, D, and IC2D perform control logic for start and stop gates Q9 and Q10. Initially their conduction is low due to positive levels from IC3C and IC2D, respectively. Hold-off (see Paragraph 4-49) enabled IC3C through IC3A with inversion by IC3B.

Figure 4-3. IC Logic Gate



Thus, the leading edge of new period 4P from IC4 (Q) appears at IC3C (9) and IC3C (8) abruptly goes low. This generates a sharp negative pulse output from Q9 to P6 (21) and the counter start circuit. The 4P signal also goes to IC2D (10), but IC2D (9) is low so there is no change in IC2D (8). At the end of count time, determined by preset decade A10, a coincidence pulse appears at IC2D (9) and inverter IC3D (12). IC2D is enabled so that when IC2 (Q) goes high one-half cycle 4P later, output IC2D (8) abruptly changes from high to low. As a result, Q10 generates a negative stop pulse to P6 (22) and the counter stop circuit. Less than 150 microseconds later the hold-off pulse from the counter appears and disables these gates and resets the IC's for the next counting period. Note that the coincidence pulse which enabled the stop circuit through gate IC2D also disabled the start gate IC3C through inverter IC3D and gate IC3A.

4-51. When range switch S1 is placed in the 50 to 200 MHz position, IC4 (C2) is grounded to eliminate the 4P period. The ground is applied to IC2B (12) inverter and its output (11) goes high. This allows period P signal from IC2A to be inverted by IC2C and provides a signal of period P to preset decade A10. Output pulses from IC2C are applied to start-stop gates IC3C and IC2D. Their operation is as previously described in Paragraph 4-51 for the 4P period.

4-52. RESET AMPLIFIER. PNP transistor Q8 is driven at its base with a negative spike from the counter at P6 (44). Q8 base voltage is unclamped from the +4 volt supply by CR3 and gives an output pulse. The output pulse goes to the thumbwheel switches to reset the preset decade assembly at the end of sampling time.

4-53. +4 VOLT POWER SUPPLY. The +13 volt line is dropped to +4 volts by R7 and Q5. Voltage divider R1 and R3 places +2 volts on Q2 base. Voltage divider R12 and R15 places +2 volts on Q3 base when the output voltage is +4 volts. Q2 and Q3 form a differential amplifier which controls the voltage on Q5 base to a level that satisfies these conditions. Changes in output load which would change the +4 volts are cancelled out by a corresponding increase or decrease in conductance of Q3 which adjusts the bias of Q5. This changes the series resistance of the circuit to provide voltage regulation.

4-54. PRESET DECADE ASSEMBLY A10

4-55. Figure 4-5 shows block diagrams for the IC's and an IC decade. The dividers are preset by the thumbwheel "N" switch shown in Figure 4-4. This decade divider is an arrangement of four binary integrated circuit (IC) flip-flops which give an output pulse for every ten input pulses. During its operation a decade divider would ordinarily pass through ten different operating states. A10 preset divider is a modified decade divider which is preset by thumbwheel switches to give a coincident output when it reaches a selected number. The divider logic states of a decade for the thumbwheel settings are shown in Table 4-1.

Figure 4-4. "N" Switch Diagram

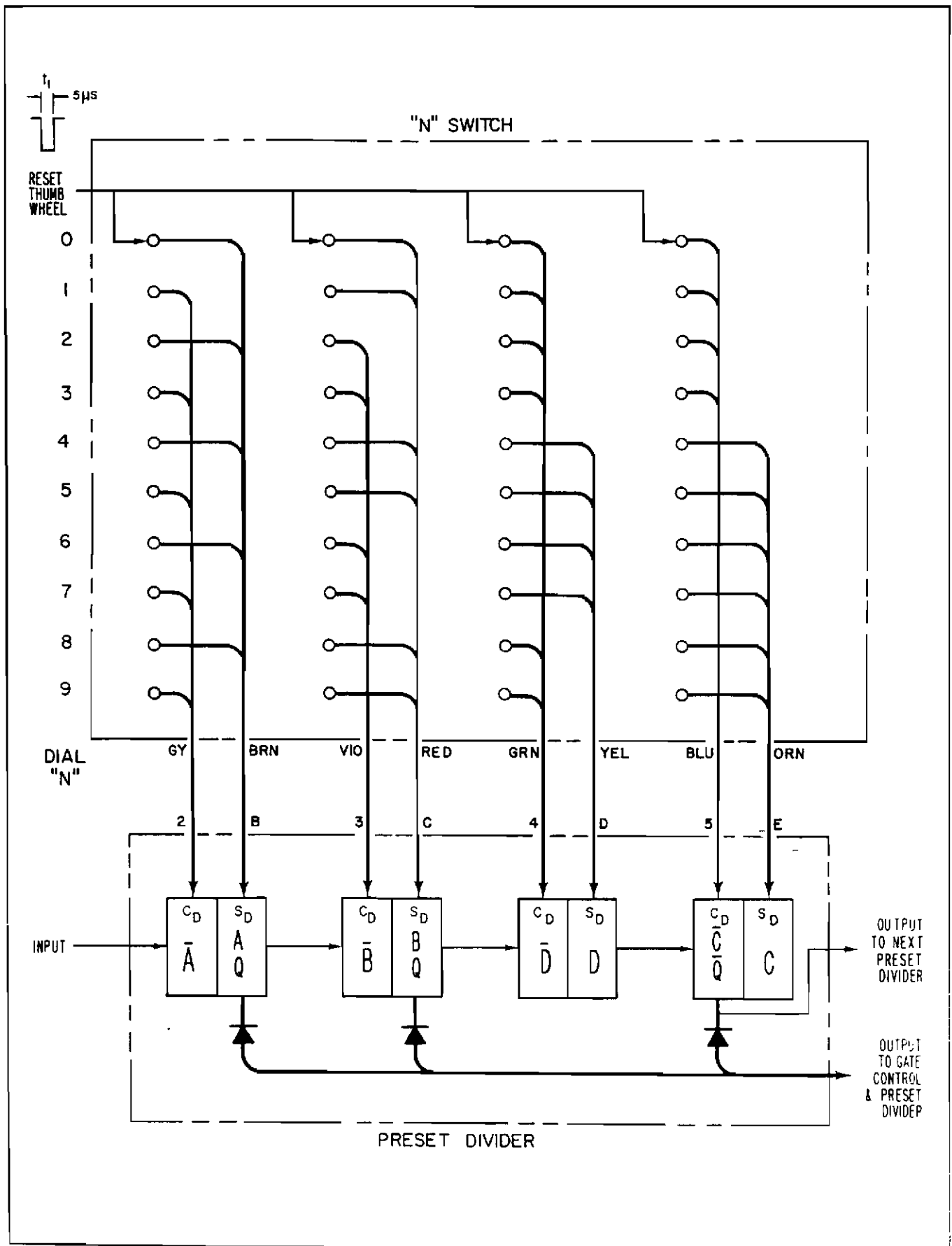


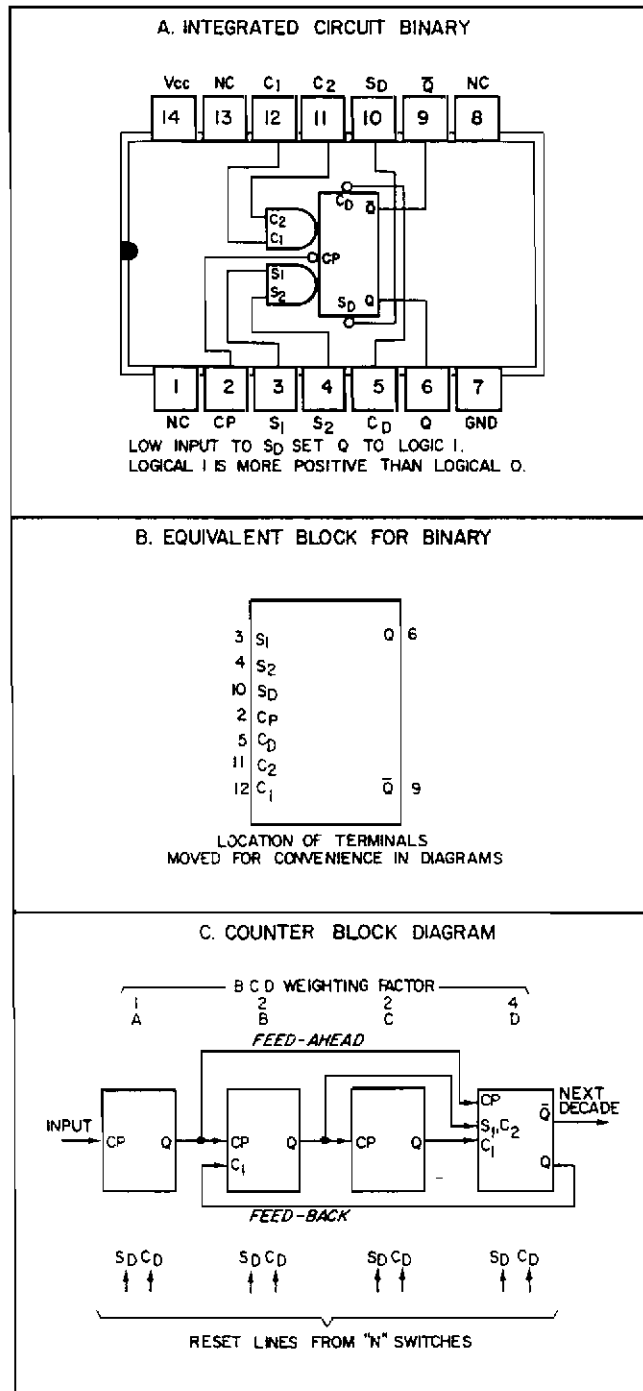
Table 4-1. Truth Table

"N" Switch	A	B	D	C
0	1	1	0	0
1	0	1	0	0
2	1	0	0	0
3	0	0	0	0
4	1	1	1	1
5	0	1	1	1
6	1	0	1	1
7	0	0	1	1
8	1	1	0	1
9	0	1	0	1

4-56 The logic states of the divider flip-flops are sensed by the diode in the Q or \bar{Q} output lines of the binaries. When all the diodes reach the same potential, or "coincidence" state of the preset divider, this information is passed along to gate extender at A9 (15) as a positive pulse.

4-57. For example, if a coincidence output is desired after four counts, 004 is preset into thumbwheel switches S2 to set the dividers. After four input pulses the divider reaches the full count and a coincidence pulse results. If a coincidence pulse is desired after 11 counts, the thumbwheels are set to read 011. After one input pulse the first preset divider is in its coincidence state, but there is no coincidence pulse at this time because the second preset divider has a count preset into it and is out of coincidence. The first preset divider must count 19 more pulses before a pulse will be sent to the second preset divider. The 10th input pulse sends a carry pulse to the second preset divider and brings it to coincidence state. The 11th pulse brings the first divider back to coincidence state and the output line to A9 goes high because all binary outputs are at coincidence. This action generates the coincidence gating pulse in A9 gate extender assembly.

Figure 4-5. Preset Divider



SECTION V MAINTENANCE AND TROUBLESHOOTING

5-1. INTRODUCTION

5-2. This section gives maintenance, adjustment, and troubleshooting information for the Model 5257A Transfer Oscillator.

5-3. ASSEMBLY CONNECTION AND IDENTIFICATION

5-4. Throughout the manual, connections to printed circuit assemblies are referred to in abbreviated form. For example, the connection to pin 12 of assembly A4 is A4(12).

5-5. ASSEMBLY DESIGNATIONS

5-6. A list of assemblies is given in Table 5-1.

5-7. RECOMMENDED TEST EQUIPMENT

5-8. Recommended test equipment is listed in Table 5-2. Test instruments other than those listed may be used if their specifications equal the required characteristics.

5-9. IN-CABINET PERFORMANCE CHECK

5-10. An in-cabinet performance check is given in Table 5-3.

Table 5-1. Assembly Designations

Assembly Number and Description	HP Part No.
A1 Pulse Driver	05257-60008
A2 Stripline Pulse Generator	05257-60211
A3 Sampler Attenuator	0901-0573 05255-6020
A4 APC No. 1	05257-60038
A5 Regulator & Pulsed RF	05257-60007
A6 APC No. 2	05257-60006
A7 Var. Freq. Oscillator	05257-60044
A7A1 VFO Linearizer	05257-60004
A7A2 VFO Control	05257-60012
A7A3 VFO	05257-60003
A8 Prescaler and Inhibit	05257-60039
A9 Gate Time Extender	05257-60002
A10 Preset Decade	05257-60001
A11 Power Supply	05257-60031
A12 Master Interconnector	05257-60032
A13 Thumbwheel Cable	05257-60033

5-11. TROUBLESHOOTING

5-12. Troubleshooting aids are given in Paragraphs 5-15 through 5-37.

5-13. GEAR TRAIN REMOVAL AND REPLACEMENT

5-14. Instructions on gear train removal and replacement are given in Paragraphs 5-38 through 5-43.

5-15. TROUBLESHOOTING AIDS

5-16. If instrument is not operating properly refer to troubleshooting chart Table 5-4 and perform the following checks as necessary. Also refer to schematic diagrams and waveforms given in Section VIII. Use extender to make waveform and voltage checks on circuit boards that plug in to 12 and 15 pin connectors.

5-17. Gate Extender Check

5-18. A7 VFO assembly and A8 prescaler assembly must be operating to complete this test.

- a. Set Counter controls as follows:
 - SENSITIVITY PLUG-IN
 - TIME BASE 0.1 ms
 - FUNCTION FREQUENCY
- b. Set 5257A controls as follows:
 - FREQUENCY 100 MHz
 - MODE PULSED RF
 - thumbwheels 001
 - RANGE any range above .05-.2 GHz

5-19. With controls set as in 5-18a and b, adjust thumbwheels from 001 to 009 (001, 002, etc.). Counter should read 100 MHz to 900 MHz in steps of 100 MHz.

- a. Adjust thumbwheels from 010 to 090. Counter should read 1000 MHz to 9000 MHz in steps of 1000 MHz.
- b. Adjust thumbwheels from 100 to 300. Counter should read 10000 MHz to 30000 MHz in steps of 10000 MHz.
- c. Repeat the above steps with the 5257A RANGE switch in the .05 to .2 GHz position. Counter readout should be 1/4 the readings shown above.

5-20. If the readings in the previous test are correct A7 (Q5 and Q6), A7 VFO, A8, A9, A10, and thumbwheels are operating properly.

- a. If only some thumbwheel settings are correct, check A10 and wiring to thumbwheels.
- b. If the previous check can be made in the .05-.2 GHz range or any range above .05-.2 GHz but not in all ranges, check A9.

c. If there is no readout, check to see that Gate light is cycling.

d. If Gate light is cycling it is a good indication that A9 and A10 are operating. Make sampling test to determine that VFO is operating.

e. If Gate light is not cycling, A9, A10, or Counter is defective. Suggested checks for Counter are: 1) self check, 2) sensitivity check and adjustment if necessary, 3) 50 MHz response check, and 4) check power supply voltages with 5257A plugged in.

5-21. Sampling Check

5-22. This check is made by observing the output of the PULSED RF OUT connector on the front panel with an oscilloscope.

a. Set 5257A controls as follows:
 LEVEL ADJ clockwise
 MODE APC

b. Observe the 1 kHz inhibit signal. A level of 400 to 500 mV peak-to-peak indicates correct sampling. If the level is 5 to 6 V peak-to-peak no sampling is

Table 5-2. Recommended Test Equipment

Instrument	Characteristics	Recommended Type
Oscilloscope	50 MHz bandwidth with external sync capability	HP 180A with 1801A and 1820A plug-ins
Divider Probe	10:1, 10 pF dc to 50 MHz	HP 10004A
RF Millivoltmeter	Voltage Range: 10 mV to 10 V rms Frequency Range: 500 kHz to 1 GHz	HP 411A
DC VTVM	Range: 1 mV to 1 kV; Impedance: 200 Megohms	HP 412A
Power Meter	Range: 10 μ W to 10 mW	HP 431C
Thermistor Mounts	Frequency Range: 12.4 to 18 GHz; Max SWR: 1.5:1	HP P486A
VHF Signal Generator	Range: 10 MHz to 480 MHz	HP 608C/D/E/F
UHF Signal Generator	Range: .8 GHz to 2.1 GHz	HP 614A
SHF Signal Generator	Range: 7 GHz to 11 GHz, capable of pulsed output Pulse Rate: 400 sec; Pulse Width: .5 μ s to 10 μ s	HP 620B
Electronic Counter	Range: dc to 50 MHz (serial no. 402 or above)	HP 5245L
Cable	BNC connectors on both ends 48 inches long	HP 10503A
Extender Cable	50 Pin male to 50 Pin female	HP 10506B
Cable	Type N male connector on both ends 6 feet long	HP 11500A
BNC "T"		HP 1250-0781
Adapter	Waveguide to APC-7 female	HP P281B
Adapter	BNC female to Type N	HP 1250-0780
SHF Signal Generator	Range: 15 to 21 GHz	HP 628A
UHF Signal Generator	Range: 1.8 to 4.2 GHz	HP 616B
Adapter	APC-7 male to Type N male	HP 1250-0749
Coupler	3 dB Directional coupler P band	HP P752A
Waveguide	Flexible waveguide P band	HP 11503A
Extender Board	15 Pin male to 15 Pin female	HP 5060-0049
Extender Board	12 Pin male to 12 Pin female	HP 5060-0092

taking place. Possible causes are: 1) A2CR1 open, 2) shorted stripline. See waveforms and notes on assembly A1 and A2 in Section VIII. Sampling and non-sampling waveforms for A5 are found in Section VIII.

- c. There will be no signal present if A3CR1 is open.
- d. If 1 kHz osc. is bad (on A4) this test will not work.

The above test has checked the following assemblies and components: A3 attenuator, A4Q11, Q5, and A6. A7Q5 and Q7, A8Q8 were checked in .05-.2 GHz range only.

5-23. PRF With Fx Input Check

5-24. This test requires an input of 0 dBm. Adjust FREQUENCY control and set LEVEL control for 9/10 full scale on meter. Set RANGE switch to appropriate range for input frequency used. Set thumbwheels to 001 and observe zero beat on oscilloscope. If no meter reading is obtained with zero beat on oscilloscope, A5 and meter should be checked.

5-25. If there is no indication on meter or oscilloscope Fx is not getting through. With an HP 412A measure the resistance from the center of the INPUT connector to ground. It should be $50\Omega \pm 2\Omega$. An incorrect reading here indicates a sampler or attenuator problem and a factory repair will be required.

5-26. APC With Fx Input Check

5-27. In the APC mode all circuits in the 5257A are being used except A5 peak holding circuit.

5-28. Set LEVEL control clockwise with no input signal. Check to see that meter is at midscale. If meter is not at midscale adjust A4R10 (refer to APC adjustment Page 5-4). Apply input signal and adjust LEVEL control for 9/10 full scale on meter. Set MODE to APC, select the appropriate range for input frequency used and set FREQUENCY for lock. If phase lock cannot be obtained check A4 and A6.

5-29. A1 and A2 Check

5-30. If there is no sampling, check A1 and A2. Remove side cover for access to these assemblies. Refer to Section VIII for waveforms. This is a critical area and is often the cause of no sampling. Obtain sampling before continuing tests. Remember that a shorted stripline cannot be detected by a waveform. An open step recovery diode can be found and replaced. Note that the diode is spring loaded and the sliding contact over the spring is cut to fit. Do not exert too much pressure on plastic screw as diode may crack. Apply just enough to obtain the desired waveform. Do not attempt to solder or unsolder parts on A2.

5-31. Input Resistance Check

5-32. Check the resistance from the center of the INPUT connector to ground. This should be $50\Omega \pm 2\Omega$. See A3CR1 and CR2 check Paragraph 5-33.

5-33. A3CR1 and A3CR2 Check

CAUTION

The sampler diodes can be damaged by either 0.2 erg (static discharge or leakage current) or 5 volts reverse-bias.

5-34. To prevent damage to diodes when working in the sampler circuits:

- a. Ground probes before making measurements.
- b. Avoid strong RF fields. A cable attached to the INPUT connector or diodes may act as an antenna, and pick up enough RF energy to damage the diodes.
- c. Avoid static discharges through the diodes. Touch 5257A casing before touching diodes.
- d. To prevent leakage currents that might damage the diodes, unplug soldering iron before working in this part on the circuit.

5-35. Remove A4 from its connector to expose pins 11 and 12. These are the two leads on the connector closest to the front panel. Remove 5257A from Counter and be sure no leads are connected to it. Using an HP 412A on the 10K range, measure from the center conductor of the INPUT connector to pin 11. Reverse ohmmeter leads and repeat. A ratio of infinity to 10K Ω is normal. Perform the same test from pin 12. Pin 11 checks A3CR1 and Pin 12 checks A3CR2.

5-36. Sensitivity Check

5-37. Refer to performance check, Table 5-3.

5-38. GEAR TRAIN

CAUTION

Gear train alignment is critical. Individual gear replacement or adjustment is not recommended. The gear train should be replaced as a complete unit (HP Part No. 05257-60019).

5-39. Removal

- a. Remove "fine adj" FREQUENCY knob and its retainer ring behind it.
- b. Remove screws holding side brackets to front panel.
- c. Remove the two screws holding the side bracket to the plug-in guide.
- d. Remove right rear side bracket.
- e. Disconnect Winchester connector (P3-J3) from VFO housing.
- f. Remove the four screws holding the VFO housing to the main housing.

Table 5-3. In-Cabinet Performance Check

FREQUENCY DIAL CHECK

1. With Counter OFF connect 5257A to Counter plug-in compartment using 10506B cable.
2. Turn Counter ON and set controls on Counter as follows:

SENSITIVITY	PLUG IN
TIME BASE	0.1 ms
FUNCTION	FREQUENCY
3. Set controls on 5257A as follows:

thumbwheels	001
MODE	PULSED RF
RANGE2-1 GHz
FREQUENCY	100 MHz
4. Counter should read approximately 100.00 MHz.

COUNTER GATE EXTENSION

1. With controls set as above adjust thumbwheels from 001 to 009 (001, 002, etc.).
2. Counter should read 100 MHz to 900 MHz in steps of 100 MHz.
3. Adjust thumbwheels from 010 to 090.
4. Counter should read 1000 MHz to 9000 MHz in steps of 1000 MHz.
5. Adjust thumbwheels from 100 to 300.
6. Counter should read 10000 MHz to 30000 MHz in steps of 10000 MHz.

APC ADJUSTMENT

Set 5257A MODE to APC and LEVEL ADJ fully clockwise. The 5257A meter should read center scale. If meter reading is incorrect turn Counter off and remove 5257A from plug-in compartment. Connect 10506B extender cable to 5257A and jack in Counter plug-in compartment. Turn Counter on. With 5257A controls set as above, adjust front-panel APC BAL control for center reading on meter. Turn Counter off and remove extender cable. Plug 5257A into Counter and turn Counter on. Set FREQUENCY MHz dial to 100 and allow 10 min. warmup.

50 MHz CHECK

1. Connect Signal Generator and RF Millivoltmeter to 5257A INPUT through BNC "T" and BNC female to type N adapter.
2. Connect Oscilloscope to 5257A PULSED RF OUT.
3. Set Oscilloscope to 0.1 V/cm (vertical) and 1 ms/cm (horizontal).
4. Set 5257A controls as follows:

thumbwheels	001
MODE	APC
RANGE05-.2 GHz
5. Set Signal Generator output to 50 MHz at -50 dBm and adjust 5257A LEVEL ADJ for 0.35 V peak-to-peak (1 kHz) on Oscilloscope.
6. Set 5257A MODE to PULSED RF and increase Signal Generator output to -25 dBm.

PERFORMANCE CHECK TEST CARD

Hewlett-Packard Model 5257A Transfer Oscillator Serial No. _____ - _____	Tests Performed By _____
DESCRIPTION	CHECK
First Check FREQUENCY Dial Check Counter Gate Extension 50 MHz Check 200 MHz Check 1 GHz Check 4 GHz Check 8 GHz Check Pulsed Carrier Check 15 GHz Check 18 GHz Check Oscillator Stability Check	Date _____ Counter reads 100 MHz <input type="checkbox"/> OK <input type="checkbox"/> Meter reads 9/10 with -7 dBm input <input type="checkbox"/> Meter reads 9/10 with -7 dBm input <input type="checkbox"/> Meter reads 9/10 with -7 dBm input <input type="checkbox"/> Meter reads 9/10 with -7 dBm input <input type="checkbox"/> Meter reads 9/10 with -7 dBm input <input type="checkbox"/> Meter reads 5/10 with .5 μ s pulse <input type="checkbox"/> Meter reads 9/10 with -4 dBm input <input type="checkbox"/> Meter reads 9/10 with -4 dBm input <input type="checkbox"/> Deviation less than 2 kHz in 3 minutes <input type="checkbox"/>
Second Check FREQUENCY Dial Check Counter Gate Extension 50 MHz Check 200 MHz Check 1 GHz Check 4 GHz Check 8 GHz Check Pulsed Carrier Check 15 GHz Check 18 GHz Check Oscillator Stability Check	Date _____ Counter reads 100 MHz <input type="checkbox"/> OK <input type="checkbox"/> Meter reads 9/10 with -7 dBm input <input type="checkbox"/> Meter reads 9/10 with -7 dBm input <input type="checkbox"/> Meter reads 9/10 with -7 dBm input <input type="checkbox"/> Meter reads 9/10 with -7 dBm input <input type="checkbox"/> Meter reads 9/10 with -7 dBm input <input type="checkbox"/> Meter reads 5/10 with .5 μ s pulse <input type="checkbox"/> Meter reads 9/10 with -4 dBm input <input type="checkbox"/> Meter reads 9/10 with -4 dBm input <input type="checkbox"/> Deviation less than 2 kHz in 3 minutes <input type="checkbox"/>

PERFORMANCE CHECK TEST CARD

DESCRIPTION	CHECK
<p>Third Check</p> <p>FREQUENCY Dial Check</p> <p>Counter Gate Extension</p> <p>50 MHz Check</p> <p>200 MHz Check</p> <p>1 GHz Check</p> <p>4 GHz Check</p> <p>8 GHz Check</p> <p>Pulsed Carrier Check</p> <p>15 GHz Check</p> <p>18 GHz Check</p> <p>Oscillator Stability Check</p>	<p align="right">Date _____</p> <p>Counter reads 100 MHz <input type="checkbox"/></p> <p align="right">OK <input type="checkbox"/></p> <p>Meter reads 9/10 with -7 dBm input <input type="checkbox"/></p> <p>Meter reads 9/10 with -7 dBm input <input type="checkbox"/></p> <p>Meter reads 9/10 with -7 dBm input <input type="checkbox"/></p> <p>Meter reads 9/10 with -7 dBm input <input type="checkbox"/></p> <p>Meter reads 9/10 with -7 dBm input <input type="checkbox"/></p> <p>Meter reads 5/10 with .5 μs pulse <input type="checkbox"/></p> <p>Meter reads 9/10 with -4 dBm input <input type="checkbox"/></p> <p>Meter reads 9/10 with -4 dBm input <input type="checkbox"/></p> <p>Deviation less than 2 kHz in 3 minutes <input type="checkbox"/></p>
<p>Fourth Check</p> <p>FREQUENCY Dial Check</p> <p>Counter Gate Extension</p> <p>50 MHz Check</p> <p>200 MHz Check</p> <p>1 GHz Check</p> <p>4 GHz Check</p> <p>8 GHz Check</p> <p>Pulsed Carrier Check</p> <p>15 GHz Check</p> <p>18 GHz Check</p> <p>Oscillator Stability Check</p>	<p align="right">Date _____</p> <p>Counter reads 100 MHz <input type="checkbox"/></p> <p align="right">OK <input type="checkbox"/></p> <p>Meter reads 9/10 with -7 dBm input <input type="checkbox"/></p> <p>Meter reads 9/10 with -7 dBm input <input type="checkbox"/></p> <p>Meter reads 9/10 with -7 dBm input <input type="checkbox"/></p> <p>Meter reads 9/10 with -7 dBm input <input type="checkbox"/></p> <p>Meter reads 9/10 with -7 dBm input <input type="checkbox"/></p> <p>Meter reads 9/10 with -7 dBm input <input type="checkbox"/></p> <p>Meter reads 5/10 with .5 μs pulse <input type="checkbox"/></p> <p>Meter reads 9/10 with -4 dBm input <input type="checkbox"/></p> <p>Meter reads 9/10 with -4 dBm input <input type="checkbox"/></p> <p>Deviation less than 2 kHz in 3 minutes <input type="checkbox"/></p>

50 MHz CHECK Cont'd.

7. Adjust 5257A FREQUENCY for maximum meter deflection with Counter reading close to 16.7 MHz.
8. Adjust Signal Generator output for 9/10 full scale on 5257A meter.
9. RF Millivoltmeter should read -7 dBm or less.
10. Set 5257A MODE to APC and adjust FREQUENCY for phase lock (observe zero beat on Oscilloscope).

200 MHz CHECK

1. Set Signal Generator to 200 MHz at -50 dBm.
2. Adjust 5257A LEVEL ADJ for 0.35 V peak-to-peak on Oscilloscope.
3. Set 5257A MODE to PULSED RF and increase Signal Generator output to -25 dBm.
4. Adjust 5257A FREQUENCY for maximum meter deflection with Counter reading close to 33.3 MHz.
5. Adjust Signal Generator output for 9/10 full scale on 5257A meter.
6. RF Millivoltmeter should read -7 dBm or less.
7. Set 5257A MODE to APC and adjust FREQUENCY for phase lock (observe zero beat on Oscilloscope).

1 GHz CHECK

1. Remove RF Millivoltmeter and coaxial adapters used in the preceding steps and connect Signal Generator directly to 5257A INPUT.
2. Set Signal Generator output to 1 GHz at -25 dBm.
3. Set 5257A RANGE to .2-1 GHz and adjust LEVEL ADJ for 0.35 V peak-to-peak on Oscilloscope.
4. Set 5257A MODE to PULSED RF and adjust FREQUENCY for maximum deflection with Counter reading close to 71.5 MHz.
5. Adjust Signal Generator output for 9/10 full scale on 5257A meter.
6. Signal Generator output should be -7 dBm or less.
7. Set 5257A MODE to APC and adjust FREQUENCY for phase lock (observe zero beat on Oscilloscope).

4 GHz CHECK

1. Set Signal Generator output to 4 GHz at -25 dBm.
2. Set 5257A RANGE to 1-4 GHz and adjust LEVEL ADJ for 0.35 V peak-to-peak on Oscilloscope.
3. Set 5257A MODE to PULSED RF and adjust FREQUENCY for maximum meter deflection with Counter reading close to 70 MHz.

Table 5-3. In-Cabinet Performance Check Cont'd.

4 GHz CHECK Cont'd.

4. Adjust Signal Generator output for 9/10 full scale on 5257A meter.
5. Signal Generator output should be -7 dBm or less.
6. Set 5257A MODE to APC and adjust FREQUENCY for phase lock (observe zero beat on Oscilloscope).

8 GHz CHECK

1. Set Signal Generator to 8 GHz at -25 dBm.
2. Set 5257A RANGE to 4-18 GHz and adjust LEVEL ADJ for 0.35 V peak-to-peak on Oscilloscope.
3. Set 5257A MODE to PULSED RF and adjust FREQUENCY for maximum meter deflection with Counter reading close to 68 MHz.
4. Adjust Signal Generator for 9/10 full scale on 5257A meter.
5. Signal Generator output should be -7 dBm or less.
6. Set 5257A MODE to APC and adjust FREQUENCY for phase lock (observe zero beat on Oscilloscope).

PULSED CARRIER CHECK

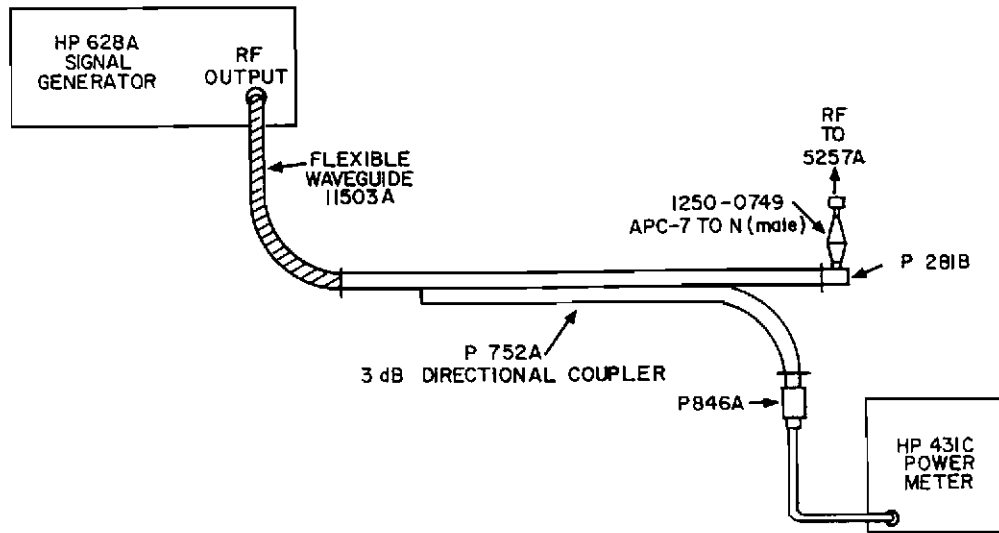
1. Set 5257A MODE to PULSED RF.
2. Adjust Signal Generator output for pulsed RF output as follows: pulse width 10 μ s and rate 400/sec.
3. Adjust 5257A FREQUENCY for zero beat on Oscilloscope.
4. Adjust 5257A LEVEL ADJ for 9/10 full scale on 5257A meter.
5. Set Signal Generator pulse width to 0.5 μ s.
6. 5257A meter should still read 5/10 full scale or more.

15 GHz CHECK

1. Connect 15 GHz at -16 dBm and Power Meter to 5257A INPUT as shown in Figure 5-1.
2. Set 5257A MODE to APC and adjust LEVEL ADJ for 0.35 V peak-to-peak on Oscilloscope.
3. Set 5257A MODE to PULSED RF and adjust FREQUENCY for maximum meter deflection with Counter reading close to 68 MHz.
4. Adjust Signal Generator for 9/10 full scale on 5257A meter.
5. Power Meter should read -4 dBm or less.
6. Set 5257A MODE to APC and adjust FREQUENCY for phase lock (observe zero beat on Oscilloscope).

Table 5-3. In-Cabinet Performance Check Cont'd.

Figure 5-1. 15-18 GHz Check



18 GHz CHECK

1. With test equipment connected as above, set Signal Generator frequency to 18 GHz at -16 dBm.
2. Adjust LEVEL ADJ for 0.35 V peak-to-peak on Oscilloscope.
3. Set 5257A MODE to PULSED RF and adjust FREQUENCY for maximum meter deflection with Counter reading close to 125 MHz.
4. Adjust Signal Generator output for 9/10 full scale on 5257A meter.
5. Power Meter should read -4 dBm or less.
6. Set 5257A MODE to APC and adjust FREQUENCY for phase lock (observe zero beat on Oscilloscope).

OSCILLATOR STABILITY

1. Set Counter TIME BASE to .1 sec.
2. Set 5257A MODE to PULSED RF and adjust FREQUENCY for 100 MHz.
3. Record Counter readings at intervals of one minute for three minutes.
4. Frequency change should not be greater than ± 2 kHz.
5. Temperature should be constant at a value between 0° and $+55^{\circ}\text{C}$.

Figure 5-2. Top, Bottom, and Side Internal Views

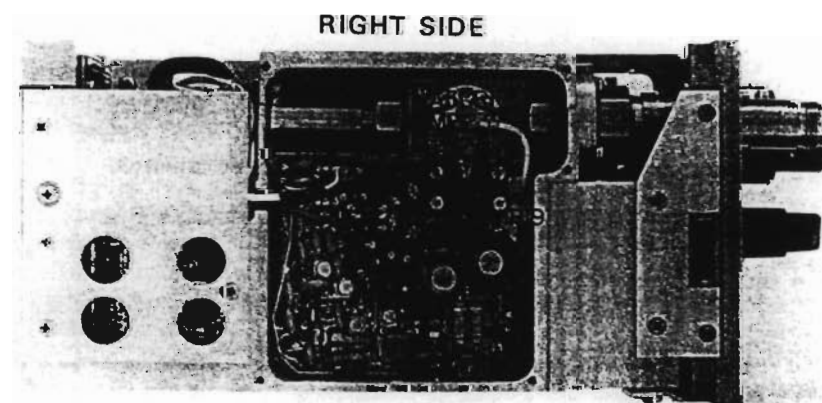
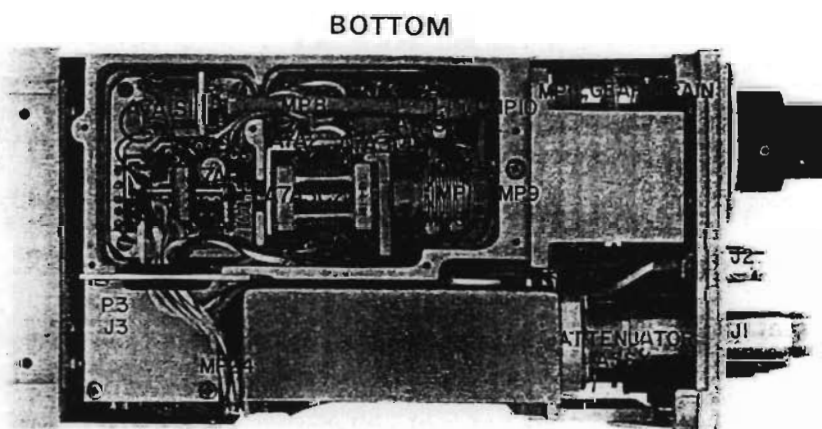
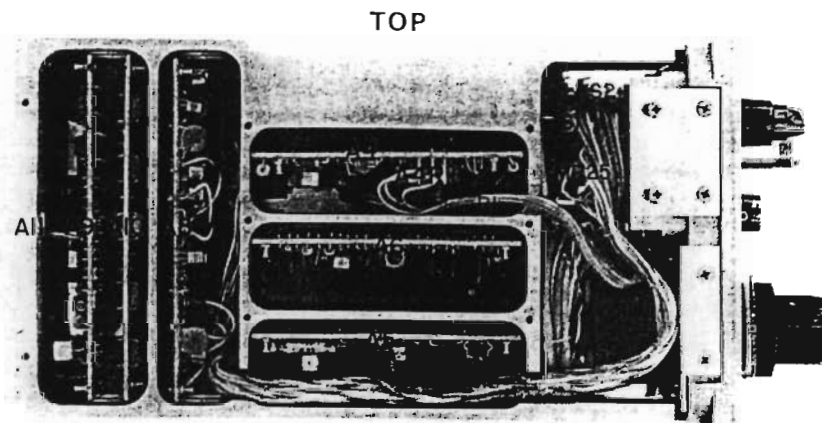
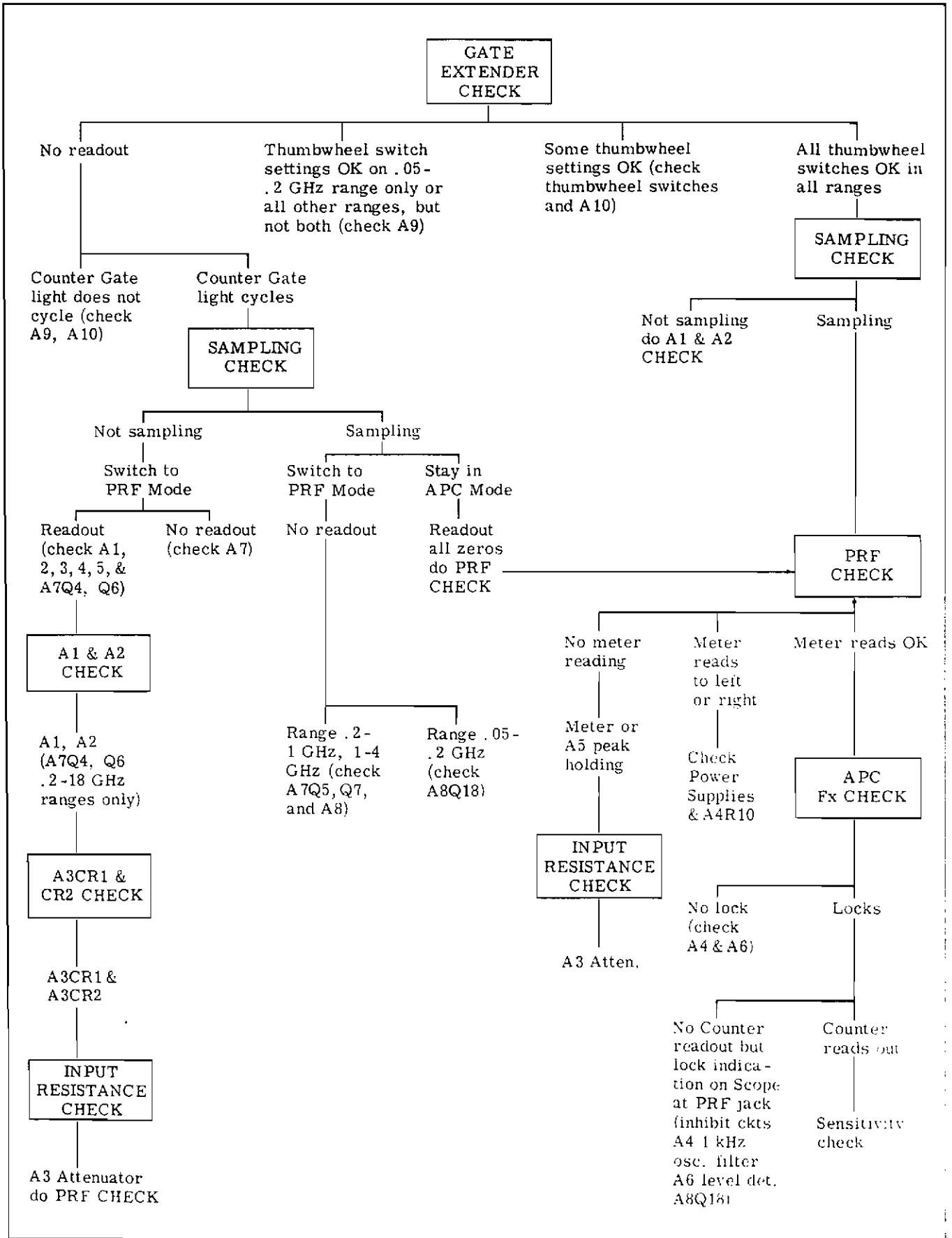


Table 5-4. Troubleshooting Chart



Section V
Maintenance and Troubleshooting

g. Set instrument up-side down on bench and carefully pull front panel out far enough to free VFO tuning drive shaft from the panel.

h. Carefully position plastic plug-in guide to allow removal of VFO gear train. Do not bend out plug-in guide more than absolutely necessary as cables connected to the power supply filter board can be broken easily.

i. Carefully lift out the VFO gear train by lifting gear train end far enough for rear portion of the assembly to clear that part of the main housing containing the sampler.

CAUTION

When removing this assembly be careful not to bump housing against sampler diode protruding through side of main housing. Also do not scrape gears against any portion of main housing.

j. After the gear train is removed set it down in such a way as to prevent any damage to gear teeth.

5-40. Gear Train Replacement

5-41. Reverse disassembly procedure after doing the following:

a. Check main housing wiring for shorts, broken wires, etc. Make sure cables are dressed properly so they will not be pinched during assembly.

b. Install paper insulators over exposed main housing connector. Make sure paper stays in place when installing gear train.

5-42. During assembly, while fitting front panel over gear train, check that LEVEL ADJ shaft is correctly inserted in hole on main casting. Also make sure gears on gear train clear the gears on main housing.

5-43. After assembly, the FREQUENCY dial will have to be repositioned for correct reading. Refer to FREQUENCY dial check Table 5-3.

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 part number of each part, together with any applicable notes. Table 6-2 lists parts in alpha-numerical order of their HP part number 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 Table 6-3.
- c. Manufacturer's part number.
- d. Total quantity used in the instrument (TQ column).

6-3. Miscellaneous parts are listed at the end of Table 6-1.

6-4. ORDERING INFORMATION

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Sales and Service office (see lists at rear of this manual for addresses). Identify parts by their Hewlett-Packard part numbers.

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

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

REFERENCE DESIGNATORS			
<p>A = assembly B = motor BT = battery C = capacitor CP = coupler CR = diode DL = delay line DS = device signaling (lamp) E = misc electronic part</p>	<p>F = fuse FL = filter IC = integrated circuit J = jack K = relay L = inductor LS = loud speaker M = meter MK = microphone</p>	<p>MP = mechanical part P = plug Q = transistor R = resistor RT = thermistor S = switch T = transformer TB = terminal board TP = test point</p>	<p>V = vacuum, tube, neon bulb, photoceil, etc. VR = voltage regulator W = cable X = socket Y = crystal Z = tuned cavity, network</p>
ABBREVIATIONS			
<p>A = amperes AFC = automatic frequency control AMPL = amplifier BFO = beat frequency oscillator BE CU = beryllium copper BH = binder head BP = bandpass BRS = brass BWO = backward wave oscillator CCW = counter-clockwise CER = ceramic CMO = cabinet mount only COEF = coefficient COM = common COMP = composition COMPL = complete CONN = connector CP = cadmium plate CRT = cathode-ray tube CW = clockwise DEPC = deposited carbon DR = drive ELECT = electrolytic ENCAP = encapsulated EXT = external F = farads FH = flat head FIL H = fillister head FXD = fixed G = giga (10⁹) GE = germanium GL = glass GRD = ground(ed)</p>	<p>H = henries HDW = hardware HEX = hexagonal HG = mercury HR = hour(s) HZ = hertz IF = intermediate freq IMPG = impregnated INCD = incandescent INCL = include(s) INS = insulation(ed) INT = internal K = kilo = 1000 LH = left hand LIN = linear taper LK WASH = lock washer LOG = logarithmic taper LPF = low pass filter M = milli = 10⁻³ MEG = meg = 10⁶ MET FLM = metal film MET OX = metallic oxide MFR = manufacturer MHZ = mega hertz MINAT = miniature MOM = momentary MTG = mounting MY = "mylar" N = nano (10⁻⁹) N/C = normally closed NE = neon NI PL = nickel plate</p>	<p>N/O = normally open NPO = negative positive zero (zero temperature coefficient) NPN = negative-positive-negative NRFR = not recommended for field replacement NSR = not separately replaceable OBD = order by description OH = oval head OX = oxide P = peak PC = printed circuit PF = picofarads = 10⁻¹² farads PH BRZ = phosphor bronze PHL = Phillips PIV = peak inverse voltage PNP = positive-negative-positive P/O = part of POLY = polystyrene PORC = porcelain POS = position(s) POT = potentiometer PP = peak-to-peak PT = point PWV = peak working voltage RECT = rectifier RF = radio frequency RH = round head or right hand</p>	<p>RMO = rack mount only RMS = root-mean square RWV = reverse working voltage S-B = slow-blow SCR = screw SE = selenium SECT = section(s) SEMICON = semiconductor SI = silicon SIL = silver SL = slide SPG = spring SPL = special SST = stainless steel SR = split ring STL = steel TA = tantalum TD = time delay TGL = toggle THD = thread TI = titanium TOL = tolerance TRIM = trimmer TWT = traveling wave tube U = micro = 10⁻⁶ VAR = variable VDCW = dc working volts W/ = with W = watts WIV = working inverse voltage WW = wirewound W/O = without</p>

Table 6-1. Reference Designation Index

Reference Designation	Part No.	Description #	Note
A1	05257-60008	BOARD ASSY:PULSE DRIVER	
	05257-20008	BOARD:BLANK PC	
A1C1	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C2	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C3	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C4	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C5	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C6	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C7	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C8	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C9	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C10	0150-0011	C:FXD TI 1.5 PF 20% 500VDCW	
A1C11	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C12	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C13	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C14	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C15	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C16	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C17	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C18	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C19	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C20	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C21		NOT ASSIGNED	
A1C22	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C23	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C24	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A1C25	0150-0031	C:FXD TI 2 PF - 5% 500VDCW REACTORY SELECTED	
A1CR1	1901-0179	DIODE:SILICON 15WIV	
A1CR2	1901-0179	DIODE:SILICON 15WIV	
A1CR3	1901-0179	DIODE:SILICON 15WIV	
A1CR4	1901-0179	DIODE:SILICON 15WIV	
A1CR5	1901-0179	DIODE:SILICON 15WIV	
A1E1	9170-0029	CORE: FERRITE BEAD	
A1E2	9170-0029	CORE: FERRITE BEAD	
A1L1	9140-0158	COIL:FXD RF 1 UH 10%	
A1L2	9140-0138	COIL/CHOKE 180 UH 5%	
A1L3	9140-0138	COIL/CHOKE 180 UH 5%	
A1L4	9140-0138	COIL/CHOKE 180 UH 5%	
A1L5	9140-0138	COIL/CHOKE 180 UH 5%	
A1L6	9140-0158	COIL:FXD RF 1 UH 10%	
A1Q1	1854-0238	TRANSISTOR:SILICON NPN 2N3933	
A1Q2	1854-0238	TRANSISTOR:SILICON NPN 2N3933	

See introduction to this section for ordering information

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

Reference Designation	Part No.	Description #	Note
A1Q3	1854-0073	TRANSISTOR:SILICON NPN 2N3933	
A1Q4	1854-0220	TRANSISTOR:SILICON NPN 2N3959	
A1Q5	1854-0273	TRANSISTOR:SILICON NPN	
A1Q6	1854-0273	TRANSISTOR:SILICON NPN	
A1R1	0757-0893	R:FXD MET FLM 51 OHM 2% 1/4W	
A1R2	0698-6381	R:FXD COMP 11K OHM 5% 1/8W	
A1R3	0698-5179	R:FXD COMP 1800 OHM 5% 1/8W	
A1R4	0698-6381	R:FXD COMP 11K OHM 5% 1/8W	
A1R5	0698-5179	R:FXD COMP 1800 OHM 5% 1/8W	
A1R6	0675-3321	R:FXD COMP 3300 OHM 10% 1/8W	
A1R7	0757-0952	R:FXD MET FLM 15K OHM 2% 1/4W	
A1R8	0757-0945	R:FXD MET FLM 7500 OHM 2% 1/4W	
A1R9	0757-0898	R:FXD MET FLM 82 OHM 2% 1/4W	
A1R10	0698-6242	R:FXD COMP 1200 OHM 5% 1/8W	
A1R11	0757-0926	R:FXD MET FLM 1200 OHM 2% 1/4W	
A1R12	0757-0914	R:FXD MET FLM 390 OHM 2% 1/4W	
A1R13	0698-6242	R:FXD COMP 1200 OHM 5% 1/8W	
A1R14	0757-0915	R:FXD MET FLM 430 OHM 2% 1/4W	
A1R15	0698-5997	R:FXD COMP 12K OHM 5% 1/8W	
A1R16	0698-5993	R:FXD COMP 8200 OHM 5% 1/8W	
A1R17	0757-0898	R:FXD MET FLM 82 OHM 2% 1/4W FACTORY SELECTED PART	
A1R18	0757-0915	R:FXD MET FLM 430 OHM 2% 1/4W	
A1R19	0757-0917	R:FXD MET FLM 510 OHM 2% 1/4W	
A1R20	0757-0337	R:FXD MET FLM 432 OHM 1% 1/4W	
A1R21	0757-0917	R:FXD MET FLM 510 OHM 2% 1/4W	
A1R22	0760-0022	R:FXD MET FLM 330 OHM 2% 1W	
A1R23	0760-0022	R:FXD MET FLM 330 OHM 2% 1W	
A1R24	0757-0346	R:FXD Met Flm 10Ω 1% 1/8W Factory Selected Component	
A1T1	05257-60015	TRANSFORMER ASSY:PULSE DRIVE	
A1T2	05257-60014	TRANSFORMER ASSY:PULSE DRIVE	
A2	05257-60211	BOARD ASSY:PULSE GENERATOR	
	05257-20211	BOARD:BLANK PC	
A2CR1	1901-0567	DIODE:SILICON	
A2R1	0698-5666	R:FXD ALUMINA-CER 20 OHM 5% 1/10W	
A3	1901-0573	SAMPLER ASSY	
A3CR1	1901-0617	SAMPLER DIODE ASSY MATCHED PAIR	
A3CR2	1901-0617	SAMPLER DIODE ASSY MATCHED PAIR	
A4	05257-60038	BOARD ASSY:APC #1	
	05257-20038	BOARD:BLANK PC	
A4C1	0160-3060	C:FXD CER 0.1 UF 20% 25VDCW	
A4C2	0160-3060	C:FXD CER 0.1 UF 20% 25VDCW	
A4C3	0180-0100	C:FXD ELECT TA 4.7UF 10% 35VDCW	
A4C4	0160-3060	C:FXD CER 0.1 UF 20% 25VDCW	
A4C5	0160-0194	C:FXD MY 0.015UF 10%	
A4C6	0160-0194	C:FXD MY 0.015UF 10%	
A4C7	0180-0218	C:FXD ELECT .15 UF 10% 35VDCW	

See introduction to this section for ordering information

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

Reference Designation	Part No.	Description #	Note
A4C8	0160-0194	C:FXD MY 0.015UF 10%	
A4Q1	1854-0071	TRANSISTOR:SILICON NPN	
A4Q2	1855-0038	TRANSISTOR:DUAL 2N3922	
A4Q3	1853-0036	TRANSISTOR:SILICON PNP 2N3906	
A4Q4	1854-0071	TRANSISTOR:SILICON NPN	
A4Q5	1854-0215	TRANSISTOR:SILICON NPN 2N3904	
A4Q6	1854-0221	TRANSISTOR DUAL:SILICON NPN	
A4Q7	1854-0215	TRANSISTOR:SILICON NPN 2N3904	
A4Q8	1854-0215	TRANSISTOR:SILICON NPN 2N3904	
A4Q9	1854-0215	TRANSISTOR:SILICON NPN 2N3904	
A4Q10	1854-0071	TRANSISTOR:SILICON NPN	
A4Q11	1854-0221	TRANSISTOR DUAL:SILICON NPN	
A4Q12	1854-0071	TRANSISTOR:SILICON NPN	
A4R1	0757-0953	R:FXD MET FLM 16K OHM 2% 1/4W	
A4R2	0757-0953	R:FXD MET FLM 16K OHM 2% 1/4W	
A4R3	0757-0948	R:FXD MET FLM 10K OHM 2% 1/4W	
A4R4	0757-0938	R:FXD MET FLM 3.9K OHM 2% 1/4W	
A4R5	0757-0953	R:FXD MET FLM 16K OHM 2% 1/4W	
A4R6	0757-0927	R:FXD MET FLM 1.3K OHM 2% 1/4W	
A4R7	0757-0952	R:FXD MET FLM 15K OHM 2% 1/4W	
A4R8	0757-0940	R:FXD MET FLM 4.7K OHM 2% 1/4W	
A4R9	0757-0975	R:FXD MET OX 130K OHM 2% 1/4W	
A4R10	2100-1760	R:VAR WW 5K OHM 10% LIN 1/2W	
A4R11	0757-0972	R:FXD MET FLM 100K OHM 2% 1/4W	
A4R12	0698-6681	R:FXD COMP 9.1 OHM 5% 1/8W	
A4R13	0757-0927	R:FXD MET FLM 1.3K OHM 2% 1/4W	
A4R14	0757-0938	R:FXD MET FLM 3.9K OHM 2% 1/4W	
A4R15	0757-0953	R:FXD MET FLM 16K OHM 2% 1/4W	
A4R16	0757-0948	R:FXD MET FLM 10K OHM 2% 1/4W	
A4R17	0757-0942	R:FXD MET FLM 5.6K OHM 2% 1/4W	
A4R18	0698-3113	R:FXD CARBON 100 OHM 5% 1/8W	
A4R19	0757-0941	R:FXD MET FLM 5.1K OHM 2% 1/4W	
A4R20	0757-0941	R:FXD MET FLM 5.1K OHM 2% 1/4W	
A4R21	0757-0942	R:FXD MET FLM 5.6K OHM 2% 1/4W	
A4R22	0757-0941	R:FXD MET FLM 5.1K OHM 2% 1/4W	
A4R23	0757-0924	R:FXD MET FLM 1.0K OHM 2% 1/4W	
A4R24	0757-0952	R:FXD MET FLM 15K OHM 2% 1/4W	
A4R25	0757-0941	R:FXD MET FLM 5.1K OHM 2% 1/4W	
A4R26	0757-0948	R:FXD MET FLM 10K OHM 2% 1/4W	
A4R27	0757-0963	R:FXD MET FLM 43K OHM 2% 1/4W	
A4R28	0757-0924	R:FXD MET FLM 1.0K OHM 2% 1/4W	
A4R29	0757-0924	R:FXD MET FLM 1.0K OHM 2% 1/4W	
A4R30	0757-0952	R:FXD MET FLM 15K OHM 2% 1/4W	
A4R31	0757-0940	R:FXD MET FLM 4.7K OHM 2% 1/4W	
A4R32	0757-0955	R:FXD MET FLM 20K OHM 2% 1/4W	

See introduction to this section for ordering information

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

Reference Designation	Part No.	Description #	Note
A4R33	0757-0924	R:FXD MET FLM 1.0K OHM 2% 1/4W	
A4R34	0757-0935	R:FXD MET FLM 3.0K OHM 2% 1/4W	
A4R35	0757-0921	R:FXD MET FLM 750 OHM 2% 1/4W	
A4R36	0757-0921	R:FXD MET FLM 750 OHM 2% 1/4W	
A4R37	0757-0953	R:FXD MET FLM 16K OHM 2% 1/4W	
A5	05257-60007	BOARD ASSY:REGULATOR PULSED RF	
	05257-20007	BOARD:BLANK PC	
A5C1	0180-0387	C:FXD ELECT 47 UF 5% 20VDCW	
A5C2	0160-3060	C:FXD CER 0.1 UF 20% 25VDCW	
A5C3	0180-0116	C:FXD ELECT 6.8 UF 10% 35VDCW	
A5C4	0180-0116	C:FXD ELECT 6.8 UF 10% 35VDCW	
A5C5	0180-0116	C:FXD ELECT 6.8 UF 10% 35VDCW	
A5C6	0180-0116	C:FXD ELECT 6.8 UF 10% 35VDCW	
A5C7	0180-0116	C:FXD ELECT 6.8 UF 10% 35VDCW	
A5C8	0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	
A5C9	0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	
A5C10	0180-0116	C:FXD ELECT 6.8 UF 10% 35VDCW	
A5C11	0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	
A5C12	0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	
A5C13	0180-0116	C:FXD ELECT 6.8 UF 10% 35VDCW	
A5C14	0180-0116	C:FXD ELECT 6.8 UF 10% 35VDCW	
A5CR1	1902-0685	DIODE BREAKDOWN:9.0V 2%	
A5CR2	1902-0686	DIODE BREAKDOWN:6.2V 2%	
A5L1	9140-0138	COIL/CHOKE 180 UH 5%	
A5L2	9140-0138	COIL/CHOKE 180 UH 5%	
A5L3	9140-0138	COIL/CHOKE 180 UH 5%	
A5Q1	1853-0036	TRANSISTOR:SILICON PNP 2N3906	
A5Q2	1853-0036	TRANSISTOR:SILICON PNP 2N3906	
A5Q3	1854-0221	TRANSISTOR DUAL:SILICON NPN	
A5Q4	1853-0020	TRANSISTOR:SILICON PNP	
A5Q5	1853-0020	TRANSISTOR:SILICON PNP	
A5Q6	1853-0020	TRANSISTOR:SILICON PNP	
A5Q7	1853-0036	TRANSISTOR:SILICON PNP 2N3906	
A5Q8	1854-0221	TRANSISTOR DUAL:SILICON NPN	
A5Q9	1854-0215	TRANSISTOR:SILICON NPN 2N3904	
A5Q10	1854-0215	TRANSISTOR:SILICON NPN 2N3904	
A5Q11	1853-0036	TRANSISTOR:SILICON PNP 2N3906	
A5Q12	1853-0036	TRANSISTOR:SILICON PNP 2N3906	
A5Q13	1854-0215	TRANSISTOR:SILICON NPN 2N3904	
A5Q14	1854-0053	TRANSISTOR:SILICON NPN 2N2218	
A5Q15	1853-0020	TRANSISTOR:SILICON PNP	
A5Q16	1853-0010	TRANSISTOR:SILICON PNP	

See introduction to this section for ordering information

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

Reference Designation	Part No.	Description #	Note
A5R1	0757-0938	R:FXD MET FLM 3.9K OHM 2% 1/4W	
A5R2	0757-0948	R:FXD MET FLM 10K OHM 2% 1/4W	
A5R3	0757-0944	R:FXD MET FLM 6.8K OHM 2% 1/4W	
A5R4	0757-0948	R:FXD MET FLM 10K OHM 2% 1/4W	
A5R5	0757-0948	R:FXD MET FLM 10K OHM 2% 1/4W	
A5R6	0757-0944	R:FXD MET FLM 6.8K OHM 2% 1/4W	
A5R7	0757-0940	R:FXD MET FLM 4.7K OHM 2% 1/4W	
A5R8	0757-0972	R:FXD MET FLM 100K OHM 2% 1/4W	
A5R9	0683-1065	R:FXD COMP 10M OHM 5% 1/4W	
A5R10	0757-0935	R:FXD MET FLM 3000 OHM 2% 1/4W	
A5R11	0757-0941	R:FXD MET FLM 5100 OHM 2% 1/4W	
A5R12	0757-0917	R:FXD MET FLM 510 OHM 2% 1/4W	
A5R13	0757-0946	R:FXD MET FLM 8200 OHM 2% 1/4W	
A5R14	0757-0917	R:FXD MET FLM 510 OHM 2% 1/4W	
A5R15	0757-0935	R:FXD MET FLM 3000 OHM 2% 1/4W	
A5R16	0757-0935	R:FXD MET FLM 3000 OHM 2% 1/4W	
A5R17	0757-0965	R:FXD MET FLM 51K OHM 2% 1/4W	
A5R18	0757-0917	R:FXD MET FLM 510 OHM 2% 1/4W	
A5R19	0757-0926	R:FXD MET FLM 1200 OHM 2% 1/4W	
A5R20	0757-0934	R:FXD MET FLM 2700 OHM 2% 1/4W	
A5R21	0757-0921	R:FXD MET FLM 750 OHM 2% 1/4W	
A5R22	0757-0921	R:FXD MET FLM 750 OHM 2% 1/4W	
A5R23	0757-0934	R:FXD MET FLM 2700 OHM 2% 1/4W	
A5R24	0757-0930	R:FXD MET FLM 1800 OHM 2% 1/4W	
A5R25	0757-0934	R:FXD MET FLM 2700 OHM 2% 1/4W	
A5R26	0757-0893	R:FXD MET FLM 51 OHM 2% 1/4W	
A5R27	0757-0929	R:FXD MET FLM 1600 OHM 2% 1/4W	
A5R28	0757-0900	R:FXD MET FLM 100 OHM 2% 1/4W	
A5R29	0757-0942	R:FXD MET FLM 5600 OHM 2% 1/4W	
A5R30	0757-0950	R:FXD MET FLM 12K OHM 2% 1/4W	
A5R31	0757-0893	R:FXD MET FLM 51 OHM 2% 1/4W	
A5R32	0757-0943	R:FXD MET FLM 6200 OHM 2% 1/4W	
A5R33	0757-0948	R:FXD MET FLM 10K OHM 2% 1/4W	
A6	05257-60006	BOARD ASSY:APC #2	
	05257-20006	BOARD:BLANK PC	
A6C1	0180-0291	C:FXD ELECT 1UF 10% 35VDCW	
A6C2	0160-0174	C:FXD CER 0.47 UF +80-20% 25VDCW	
A6C3	0180-0387	C:FXD ELECT 47 UF 5% 20VDCW	
A6C4	0180-0228	C:FXD ELECT 22 UF 10% 15VDCW	
A6C5	0140-0192	C:FXD MICA 68 PF 5% 300VDCW	
A6C6	0160-2205	C:FXD MICA 120 PF 5%	
A6C7	0160-0174	C:FXD CER 0.47 UF +80-20% 25VDCW	
A6C8	0180-0195	C:FXD ELECT 0.33 UF 20% 35VDCW	

See introduction to this section for ordering information

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

Reference Designation	Part No.	Description #	Note
A6C9	0160-0939	C: FXD MICA 430 PF 5% 300 VDCW	
A6C10	0160-3060	C:FXD CER 0.1 UF 20% 25VDCW	
A6C11	0180-0387	C:FXD ELECT 47 UF 5% 20VDCW	
A6C12	0160-0147	C:FXD MICA 2500PF 2% 300VDCW	
A6C13	0160-0207	C:FXD MYLAR 0.01UF 5% 200VDCW	
A6C14	0160-0196	C:FXD MICA 24PF 5% 300VDCW	
A6CR1	1901-0040	DIODE:SILICON 30MA 30WV	
A6CR2	1901-0040	DIODE:SILICON 30MA 30WV	
A6CR3	1901-0040	DIODE:SILICON 30MA 30WV	
A6CR4	1901-0040	DIODE:SILICON 30MA 30WV	
A6CR5	1901-0040	DIODE:SILICON 30MA 30WV	
A6CR6	1901-0040	DIODE:SILICON 30MA 30WV	
A6CR7	1901-0040	DIODE:SILICON 30MA 30WV	
A6CR8	1901-0040	DIODE:SILICON 30MA 30WV	
A6CR9	1901-0040	DIODE:SILICON 30MA 30WV	
A6L1	9140-0138	COIL/CHOKE 180 UH 5%	
A6Q1	1853-0036	TRANSISTOR:SILICON PNP 2N3906	
A6Q2	1854-0071	TRANSISTOR:SILICON NPN	
A6Q3	1853-0020	TRANSISTOR:SILICON PNP	
A6Q4	1853-0036	TRANSISTOR:SILICON PNP 2N3906	
A6Q5	1854-0221	TRANSISTOR DUAL:SILICON NPN	
A6Q6	1853-0036	TRANSISTOR:SILICON PNP 2N3906	
A6Q7	1853-0020	TRANSISTOR:SILICON PNP	
A6Q8	1853-0020	TRANSISTOR:SILICON PNP	
A6Q9	1853-0036	TRANSISTOR:SILICON PNP 2N3906	
A6Q10	1853-0020	TRANSISTOR:SILICON PNP	
A6Q11	1853-0020	TRANSISTOR:SILICON PNP	
A6Q12	1853-0036	TRANSISTOR:SILICON PNP 2N3906	
A6R1	0757-0957	R:FXD MET FLM 24K OHM 2% 1/4W	
A6R2	0757-0954	R:FXD MET FLM 18K OHM 2% 1/4W	
A6R3	0757-0939	R:FXD MET FLM 4.3K OHM 2% 1/4W	
A6R4	0757-0950	R:FXD MET FLM 12K OHM 2% 1/4W	
A6R5	0757-0950	R:FXD MET FLM 12K OHM 2% 1/4W	
A6R6	0757-0948	R:FXD MET FLM 10K OHM 2% 1/4W	
A6R7	0757-0951	R:FXD MET FLM 13K OHM 2% 1/4W	
A6R8	0757-0893	R:FXD MET FLM 51 OHM 2% 1/4W	
A6R9	0757-0955	R:FXD MET FLM 20K OHM 2% 1/4W	
A6R10	0757-0948	R:FXD MET FLM 10K OHM 2% 1/4W	
A6R11	0757-0952	R:FXD MET FLM 15K OHM 2% 1/4W	
A6R12	0757-0941	R:FXD MET FLM 5.1K OHM 2% 1/4W	
A6R13	0757-0957	R:FXD MET FLM 24K OHM 2% 1/4W	
A6R14	0757-0948	R:FXD MET FLM 10K OHM 2% 1/4W	
A6R15	0757-0939	R:FXD MET FLM 4.3K OHM 2% 1/4W	

See introduction to this section for ordering information

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

Reference Designation	Part No.	Description #	Note
A6R16	0757-0950	R:FXD MET FLM 12K OHM 2% 1/4W	
A6R17	0757-0944	R:FXD MET FLM 6.8K OHM 2% 1/4W	
A6R18	0757-0945	R:FXD MET FLM 7.5K OHM 2% 1/4W	
A6R19	0757-0955	R:FXD MET FLM 20K OHM 2% 1/4W	
A6R20	0757-0931	R:FXD MET FLM 2000 OHM 2% 1/4W	
A6R21	0757-0972	R:FXD MET FLM 100K OHM 2% 1/4W	
A6R22	0757-0939	R:FXD MET FLM 4.3K OHM 2% 1/4W	
A6R23	0757-0950	R:FXD MET FLM 12K OHM 2% 1/4W	
A6R24	0683-1055	R:FXD COMP 1 MEGOHM 5% 1/4W	
A6R25	0757-0955	R:FXD MET FLM 20K OHM 2% 1/4W	
A6R26	0757-0914	R:FXD MET FLM 390 OHM 2% 1/4W	
A6R27	0757-0935	R:FXD MET FLM 3.0K OHM 2% 1/4W	
A6R28	0757-0945	R:FXD MET FLM 7.5K OHM 2% 1/4W	
A6R29	0757-0939	R:FXD MET FLM 4.3K OHM 2% 1/4W	
A6R30	0757-0950	R:FXD MET FLM 12K OHM 2% 1/4W	
A6R31	0757-0936	R:FXD MET FLM 3.3K OHM 2% 1/4W	
A6R32	0757-0955	R:FXD MET FLM 20K OHM 2% 1/4W	
A6R33	0757-0899	R:FXD MET FKM 91 OHM 2% 1/4W	
A6R34	0757-0924	R:FXD MET FLM 1.0K OHM 2% 1/4W	
A6R35	0757-0957	R:FXD MET FLM 24K OHM 2% 1/4W	
A7	05257-60044	VFO LINEARIZER ASSY INCL A7A1,A7A2,A7A3.	
A7A1	05257-60004	BOARD ASSY:VFO LINEARIZER	
	05257-20004	BOARD:BLANK PC	
	05257-6C021	SWITCH ASSY:VFO LINEARIZER	
A7A1C1	0180-0291	C:FXD ELECT 1UF 10% 35VDCW	
A7A1C2	0180-0291	C:FXD ELECT 1UF 10% 35VDCW	
A7A1C3	0180-0291	C:FXD ELECT 1UF 10% 35VDCW	
A7A1C4	0180-0160	C:FXD ELECT 22UF 35VDCW	
A7A1C5	0180-0291	C:FXD ELECT 1UF 10% 35VDCW	
A7A1CR1	1901-0040	DIODE:SILICON 30MA 30MV	
A7A1L1	9140-0138	COIL/CHOKE 180 UH 5%	
A7A1Q1	1854-0215	TRANSISTOR:SILICON NPN 2N3904	
A7A1Q2	1854-0221	TRANSISTOR DUAL:SILICON NPN	
A7A1Q3	1854-0215	TRANSISTOR:SILICON NPN 2N3904	
A7A1Q4	1854-0215	TRANSISTOR:SILICON NPN 2N3904	
A7A1R1	0757-0934	R:FXD MET FLM 2.7K OHM 2% 1/4W	
A7A1R2	0757-0972	R:FXD MET FLM 100K OHM 2% 1/4W	
A7A1R3	0757-0939	R:FXD MET FLM 4300 OHM 2% 1/4W	
A7A1R4	0757-0920	R:FXD MET FLM 680 OHM 2% 1/4W	
A7A1R5	0757-0963	R:FXD MET FLM 43K OHM 2% 1/4W	
A7A1R6	0757-0934	R:FXD MET FLM 2.7K OHM 2% 1/4W	

See introduction to this section for ordering information

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

Reference Designation	Part No.	Description #	Note
A7A1R7	0757-0938	R:FXD MET FLM 3.9K OHM 2% 1/4W	
A7A1R8	0698-3375	R:FXD COMP 33 OHM 5% 1/8W	
A7A1R9	0698-3379	R:FXD COMP 68 OHM 5% 1/8W	
A7A1R10	0698-3379	R:FXD COMP 68 OHM 5% 1/8W	
A7A1R11	0698-5562	R:FXD CARBON 120 OHM 5% 1/8W	
A7A1R12	0698-5075	R:FXD COMP 130 OHM 5% 1/4W	
A7A1R13	0698-5174	R:FXD COMP 200 OHM 5% 1/8W	
A7A1R14	0698-3114	R:FXD COMP 300 OHM 5% 1/8W	
A7A1R15	0698-6649	R:FXD COMP 390 OHM 5% 1/8W	
A7A1R16	0698-6648	R:FXD COMP 620 OHM 5% 1/8W	
A7A1R17	0698-6648	R:FXD COMP 620 OHM 5% 1/8W	
A7A1R18	0757-0952	R:FXD MET FLM 15K OHM 2% 1/4W	
A7A1R19	0757-0934	R:FXD MET FLM 2.7K OHM 2% 1/4W	
A7A1R20	0757-0948	R:FXD MET FLM 10K OHM 2% 1/4W	
A7A1R21	2100-1773	R:VAR WW 1000 OHM 5% 1W	
A7A1S1	3100-2420	SWITCH	
A7A2	05257-60012	BOARD ASSY:VFO CONTROL	
	05257-20012	BOARD:BLANK PC	
A7A2C1	0160-0183	C:FXD MICA 130PF 5% 300VDCW	
A7A2C2	0160-2327	C:FXD CER 1000 PF 20% 75VDCW	
A7A2CR1	0122-0301	C:VOLTAGE VAR 6.8 PF 10%	
A7A2CR2	0122-0301	C:VOLTAGE VAR 6.8 PF 10%	
A7A2CR3	1901-0179	DIODE:SILICON 15W1V	
A7A2L1	05257-60022	COIL ASSY:VFO	
A7A2R1	0757-0482	R:FXD MET FLM 511K OHM 1% 1/8W	
A7A2R2	0757-0946	R:FXD MET FLM 8200 OHM 2% 1/4W	
A7A2R3	0757-0482	R:FXD MET FLM 511K OHM 1% 1/8W	
A7A2R4	0757-0932	R:FXD MET FLM 2200 OHM 2% 1/4W	
A7A3	05257-60003	BOARD ASSY:VFO	
	05257-20003	BOARD:BLANK PC	
A7A3C1	0160-3060	C:FXD CER 0.1 UF 20% 25VDCW	
A7A3C2	0121-0405	C:VAR 3.5-53.5 PF	
A7A3C3	0160-2327	C:FXD CER 1000 PF 20% 75VDCW	
A7A3C4	0150-0031	C:FXD TI 2 PF 5% 500VDCW	
A7A3C5	0150-0034	C:FXD TI 3.9 PF 10% 500VDCW	
A7A3C6	0160-2327	C:FXD CER 1000 PF 20% 75VDCW	
A7A3C7	0160-2327	C:FXD CER 1000 PF 20% 75VDCW	

See introduction to this section for ordering information

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

Reference Designation	Part No.	Description #	Note
A7A3C8	0160-0183	C:FXD MICA 130PF 5% 300VDCW	
A7A3C9	0150-0011	C:FXD TI 1.5 PF 10% 500VDCW	
A7A3C10	0160-2327	C:FXD CER 1000 PF 20% 75VDCW	
A7A3C11	0160-2327	C:FXD CER 1000 PF 20% 75VDCW	
A7A3C12	0160-2327	C:FXD CER 1000 PF 20% 75VDCW	
A7A3C13	0160-2327	C:FXD CER 1000 PF 20% 75VDCW	
A7A3C14	0160-2327	C:FXD CER 1000 PF 20% 75VDCW	
A7A3C15	0160-2327	C:FXD CER 1000 PF 20% 75VDCW	
A7A3C16	0150-0029	C:FXD TI 1 PF 10% 500VDCW	
A7A3C17	0150-0029	C:FXD TI 1 PF 10% 500VDCW	
A7A3C18	0160-2327	C:FXD CER 1000 PF 20% 75VDCW	
A7A3C19	0160-2327	C:FXD CER 1000 PF 20% 75VDCW	
A7A3C20	0160-2327	C:FXD CER 1000 PF 20% 75VDCW	
A7A3C21	0160-2327	C:FXD CER 1000 PF 20% 75VDCW	
A7A3L1	05257-60022	COIL ASSY:VFO	
A7A301	1854-0345	TRANSISTOR:SILICON NPN 2N5179	
A7A302	1854-0345	TRANSISTOR:SILICON NPN 2N5179	
A7A303	1854-0238	TRANSISTOR:SILICON NPN 2N3933	
A7A304	1854-0238	TRANSISTOR:SILICON NPN 2N3933	
A7A305	1854-0238	TRANSISTOR:SILICON NPN 2N3933	
A7A306	1854-0238	TRANSISTOR:SILICON NPN 2N3933	
A7A307	1854-0238	TRANSISTOR:SILICON NPN 2N3933	
A7A3R1	0757-0379	R:FXD MET FLM 12.1 OHM 1% 1/8W	
A7A3R2	0757-0948	R:FXD MET FLM 10K OHM 2% 1/4W	
A7A3R3	0757-0941	R:FXD MET FLM 5.1K OHM 2% 1/4W	
A7A3R4	0757-0942	R:FXD MET FLM 5.6K OHM 2% 1/4W	
A7A3R5	0757-0931	R:FXD MET FLM 2000 OHM 2% 1/4W	
A7A3R6	0757-0946	R:FXD MET FLM 8.2K OHM 2% 1/4W	
A7A3R7	0757-0924	R:FXD MET FLM 1.0K OHM 2% 1/4W	
A7A3R8	0757-0926	R:FXD MET FLM 1.2K OHM 2% 1/4W	
A7A3R9	0757-0926	R:FXD MET FLM 1.2K OHM 2% 1/4W	
A7A3R10	0757-0930	R:FXD MET FLM 1800 OHM 2% 1/4W	
A7A3R11	0757-0955	R:FXD MET FLM 20K OHM 2% 1/4W	
A7A3R12	0757-0955	R:FXD MET FLM 20K OHM 2% 1/4W	
A7A3R13	0698-5994	R:FXD COMP 6.8K OHM 5% 1/8W	
A7A3R14	0698-5994	R:FXD COMP 6.8K OHM 5% 1/8W	
A7A3R15	0757-0905	R:FXD MET FLM 160 OHM 2% 1/4W	
A7A3R16	0757-0922	R:FXD MET FLM 820 OHM 2% 1/4W	
A7A3R17	0757-0905	R:FXD MET FLM 160 OHM 2% 1/4W	
A7A3R18	0698-5177	R:FXD COMP 820 OHM 5% 1/8W	
A7A3R19	0757-0914	R:FXD MET FLM 390 OHM 2% 1/4W	
A7A3R20	0757-0914	R:FXD MET FLM 390 OHM 2% 1/4W	
A7A3R21	0698-5565	R:FXD CARBON 2.2K OHM 5% 1/8W	
A7A3R22	0698-5565	R:FXD CARBON 2.2K OHM 5% 1/8W	

See introduction to this section for ordering information

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

Reference Designation	Part No.	Description #	Note
A7A3R23	0757-0927	R:FXD MET FLM 1.3K OHM 2% 1/4W	
A7A3R24	0757-0927	R:FXD MET FLM 1.3K OHM 2% 1/4W	
A7A3T1	05257-60017	TRANSFORMER ASSY: VFO	
A7A3T2	05257-60017	TRANSFORMER ASSY: VFO	
A8	05257-60039 05257-20039	BOARD ASSY: PRESCALER BOARD: BLANK PC	
A8C1	0160-2327	C:FXD 0.001 UF 100 VDCW	
A8C2	0150-0093	C:FXD 0.01 UF +80-20% 100 VDCW	
A8C3	0150-0093	C:FXD 0.01 UF +80-20% 100 VDCW	
A8C4	0160-2743	C:FXD 33 PF 10% 200 VDCW	
A8C5	0160-3277	C:FXD 0.01 UF 20% 50 VDCW	
A8C6	0160-3277	C:FXD 0.01 UF 20% 50 VDCW	
A8C7	0150-0093	C:FXD 0.01 UF +80-20% 100 VDCW	
A8C8	0150-0093	C:FXD 0.01 UF +80-20% 100 VDCW	
A8C9	0150-0093	C:FXD 0.01 UF +80-20% 100 VDCW	
A8C10	0150-0093	C:FXD 0.01 UF +80-20% 100 VDCW	
A8CR1	1902-3104	DIODE: BRKDOWN 5.62V 5%	
A8CR2	1901-0179	DIODE: SIL	
A8Q1	1854-0048	TRANSISTOR: NPN 2N2857	
A8Q2	1854-0048	TRANSISTOR: NPN 2N2857	
A8Q3	1854-0039	TRANSISTOR: PNP 2N3053	
A8Q4	1853-0034	TRANSISTOR: PNP SIL	
A8Q5	1853-0034	TRANSISTOR: PNP SIL	
A8Q6	1853-0034	TRANSISTOR: PNP SIL	
A8Q7	1853-0034	TRANSISTOR: PNP SIL	
A8Q8	1854-0215	TRANSISTOR: PNP 2N3904	
A8R1	0683-2025	R:FXD COMP 2000 OHM 5% 1/4W	
A8R2	0683-2025	R:FXD COMP 2000 OHM 5% 1/4W	
A8R3	0698-3374	R:FXD COMP 20 OHM 5% 1/8W	
A8R4	Not Assigned		
A8R5	0698-5996	R:FXD COMP 560 OHM 5% 1/8W	
A8R6	0698-5996	R:FXD COMP 560 OHM 5% 1/8W	
A8R7	0757-0928	R:FXD FLM 1500 OHM 2% 1/8W	
A8R8	2100-2521	R:VAR 2000 OHM LIN 10% 1/2W	
A8R9	0698-3378	R:FXD COMP 51 OHM 5% 1/8W	
A8R10	0698-3111	R:FXD COMP 30 OHM 5% 1/8W	
A8R11	0757-0918	R:FXD FLM 560 OHM 2% 1/8W	
A8R12	0698-5996	R:FXD COMP 560 OHM 5% 1/8W	
A8R13	0757-0893	R:FXD FLM 51 OHM 2% 1/8W	
A8R14	0758-0024	R:FXD FLM 100 OHM 5% 1/4W	
A8R15	0758-0024	R:FXD FLM 100 OHM 5% 1/4W	
A8R16	0757-0926	R:FXD FLM 1200 OHM 2% 1/8W	
A8R17	0757-0937	R:FXD FLM 3600 OHM 2% 1/8W	
A8R18	0698-3378	R:FXD COMP 51 OHM 5% 1/8W	
A8R19	0757-0893	R:FXD FLM 51 OHM 2% 1/8W	
A8R20	0757-0923	R:FXD FLM 910 OHM 2% 1/8W	
A8R21	Not Assigned		
A8R22	0698-3378	R:FXD COMP 51 OHM 5% 1/8W	
A8R23	0757-0909	R:FXD FLM 240 OHM 2% 1/8W	
A8U1	1820-0286	CIRCUIT: INTEGRATED SCHMITT	
A8U2	1820-0712	CIRCUIT: INTEGRATED BINARY	
A8U3	1820-0712	CIRCUIT: INTEGRATED BINARY	

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

Reference Designation	Part No.	Description #	Note
A9	05257-60002	BOARD ASSY: GATE EXTENDER	
	05257-20002	BOARD: BLANK PC	
A9C1	0180-0116	C:FXD ELECT 6.8 UF 10% 35 VDCW	
A9C2	0180-0116	C:FXD ELECT 6.8 UF 10% 35 VDCW	
A9C3	0180-0230	C:FXD ELECT 1.0 UF 20% 50 VDCW	
A9C4	0160-2055	C:FXD CER 0.01 UF +80-20% 100 VDCW	
A9C5	0160-2055	C:FXD CER 0.01 UF +80-20% 100 VDCW	
A9C6	0160-2055	C:FXD CER 0.01 UF +80-20% 100 VDCW	
A9C7	0180-0116	C:FXD ELECT 6.8 UF 10% 35 VDCW	
A9C8	0140-0198	C:FXD MICA 200 PF 5% 300 VDCW	
A9C9	0140-0198	C:FXD MICA 200 PF 5% 300 VDCW	
A9CR1	1901-0040	DIODE: SILICON 30 MA 30 WV	
A9CR2	1901-0040	DIODE: SILICON 30 MA 30 WV	
A9CR3	1901-0040	DIODE: SILICON 30 MA 30 WV	
A9IC1	1820-0399	INTEGRATED CIRCUIT	
A9IC2	1820-0094	INTEGRATED CIRCUIT	
A9IC3	1820-0094	INTEGRATED CIRCUIT	
A9IC4	1820-0399	INTEGRATED CIRCUIT	
A9L1	9140-0138	COIL/CHOKE 180 UH 5%	
A9L2	9140-0138	COIL/CHOKE 180 UH 5%	
A9Q1	1854-0215	TRANSISTOR: SILICON NPN 2N3904	
A9Q2	1854-0215	TRANSISTOR: SILICON NPN 2N3904	
A9Q3	1854-0215	TRANSISTOR: SILICON NPN 2N3904	
A9Q4	1853-0036	TRANSISTOR: SILICON PNP 2N3906	
A9Q5	1854-0053	TRANSISTOR: SILICON NPN 2N2218	
A9Q6	1854-0215	TRANSISTOR: SILICON NPN 2N3904	
A9Q7	1854-0215	TRANSISTOR: SILICON NPN 2N3904	
A9Q8	1853-0036	TRANSISTOR: SILICON PNP 2N3906	
A9Q9	1853-0036	TRANSISTOR: SILICON PNP 2N3906	
A9Q10	1853-0036	TRANSISTOR: SILICON PNP 2N3906	
A9R1	0757-0200	R:FXD MET FLM 5.62K OHM 1% 1/8W	
A9R2	0757-0940	R:FXD MET FLM 4.7K OHM 2% 1/4W	
A9R3	0757-0280	R:FXD MET FLM 1K OHM 1% 1/8W	
A9R4	0757-0925	R:FXD MET FLM 1.1K OHM 2% 1/4W	
A9R5	0757-0921	R:FXD MET FLM 750 OHM 2% 1/4W	
A9R6	0757-0906	R:FXD MET FLM 180 OHM 2% 1/4W	
A9R7	0761-0042	R:FXD MET OX 68 OHM 5% 1W	
A9R8	0757-0921	R:FXD MET FLM 750 OHM 2% 1/4W	
A9R9	0757-0960	R:FXD MET FLM 33K OHM 2% 1/4W	
A9R10	0757-0955	R:FXD MET FLM 20K OHM 2% 1/4W	
A9R11	0757-0948	R:FXD MET FLM 10K OHM 2% 1/4W	

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

Reference Designation	Part No.	Description #	Note
A9R12	0757-0424	R:FXD MET FLM 1.10K OHM 1% 1/8W	
A9R13	0757-0943	R:FXD MET FLM 6.2K OHM 2% 1/4W	
A9R14	0757-0948	R:FXD MET FLM 10K OHM 2% 1/4W	
A9R15	0757-0280	R:FXD MET FLM 1K OHM 1% 1/8W	
A9R16	0757-0952	R:FXD MET FLM 15K OHM 2% 1/4W	
A9R17	0757-0938	R:FXD MET FLM 3.9K OHM 2% 1/4W	
A9R18	0757-0938	R:FXD MET FLM 3.9K OHM 2% 1/4W	
A9R19	0757-0924	R:FXD MET FLM 1.0K OHM 2% 1/4W	
A9R20	0757-0958	R:FXD MET FLM 27K OHM 2% 1/4W	
A9R21	0757-0934	R:FXD MET FLM 2.7K OHM 2% 1/4W	
A9R22	0757-0934	R:FXD MET FLM 2.7K OHM 2% 1/4W	
A9R23	0757-0939	R:FXD MET FLM 4.3K OHM 2% 1/4W	
A9R24	0757-0939	R:FXD MET FLM 4.3K OHM 2% 1/4W	
A10	05257-60001	BOARD ASSY:PRESET DECADER	
	05257-20001	BOARD:BLANK PC	
A10CR1	1901-0040	DIODE:SILICON 30MA 30V	
A10CR2	1901-0040	DIODE:SILICON 30MA 30V	
A10CR3	1901-0040	DIODE:SILICON 30MA 30V	
A10CR4	1901-0040	DIODE:SILICON 30MA 30V	
A10CR5	1901-0040	DIODE:SILICON 30MA 30V	
A10CR6	1901-0040	DIODE:SILICON 30MA 30V	
A10CR7	1901-0040	DIODE:SILICON 30MA 30V	
A10CR8	1901-0040	DIODE:SILICON 30MA 30V	
A10IC1	1820-0399	INTEGRATED CIRCUIT	
A10IC2	1820-0399	INTEGRATED CIRCUIT	
A10IC3	1820-0399	INTEGRATED CIRCUIT	
A10IC4	1820-0399	INTEGRATED CIRCUIT	
A10IC5	1820-0399	INTEGRATED CIRCUIT	
A10IC6	1820-0399	INTEGRATED CIRCUIT	
A10IC7	1820-0399	INTEGRATED CIRCUIT	
A10IC8	1820-0399	INTEGRATED CIRCUIT	
A10IC9	1820-0399	INTEGRATED CIRCUIT	
A10IC10	1820-0399	INTEGRATED CIRCUIT	
A10MP1	1251-1115	KEY:POLARIZING FOR CKT BD SOCKETS	
A10R1	0757-0918	R:FXD MET FLM 560 OHM 2% 1/4W	
A11	05257-60031	BOARD ASSY:POWER SUPPLY FILTER	
	05257-20031	BOARD:BLANK PC	
A11C1	0180-0097	C:FXD ELECT 47UF 10% 35VDCW	
A11C2	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A11C3	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A11C4	0180-0387	C:FXD ELECT 47 UF 5% 20VDCW	
A11C5	0180-0387	C:FXD ELECT 47 UF 5% 20VDCW	
A11C6	0180-0291	C:FXD ELECT 1UF 10% 35VDCW	
A11L1	9140-0096	COIL:FXD RF 1 UH	
A11L2	9140-0096	COIL:FXD RF 1 UH	
A11L3	9140-0138	COIL/CHOKE 180 UH 5%	

See introduction to this section for ordering information

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

Reference Designation	Part No.	Description #	Note
C1	0150-0122	C:FXD CER 2000 PF 20% 500VDCW	
C2	0150-0122	C:FXD CER 2000 PF 20% 500VDCW	
C3	0150-0122	C:FXD CER 2000 PF 20% 500VDCW	
J2	1250-0102	CONNECTOR:BNC	
J3	1251-1915	BODY:R & P CONNECTOR 14 CONTACTS	
M1	1120-1495	METER:0-1MA	
MP1	1500-0014	COUPLING BELLOWS	
MP2	2190-0325	WASHER:FLAT FOR 1/4" HDW	
MP3	2190-0325	WASHER:FLAT FOR 1/4" HDW	
MP4	2190-0325	WASHER:FLAT FOR 1/4" HDW	
MP5	2190-0325	WASHER:FLAT FOR 1/4" HDW	
MP6	3050-0161	WASHER:SPRING STL WAVY TYPE	
MP7	3050-0161	WASHER:SPRING STL WAVY TYPE	
MP8	5040-0157	COUPLER:SHAFT NYLON	
MP9	00107-2001	HUB:BUSHING	
MP10	00107-2001	HUB:BUSHING	
MP11	05257-60019	GEAR BOX ASSY	
MP12	0370-0472	KNOB:RED BAR	
MP13	0370-0139	KNOB:RED ROUND 1/8" SHAFT	
MP14	0370-0463	KNOB:BLACK ROUND	
MP15	0370-0464	KNOB:BLACK ROUND	
MP16	0370-0479	KNOB:BLACK POINTER	
MP17	5020-3297	CONTACT:SLIDING	
MP18	05260-2016	SEAL:OUTSIDE	
MP19	05260-4002	CLAMP:DIODE	
MP20	05257-00004	RETAINER:DIAL	
MP21	05257- 20003 20092	PANEL:FRONT <i>STANDARD MINT GRAY</i>	
MP22	05257-20024	HOLDER:STRIP LINE	
MP23	1251-1511	CONNECTOR:DIODE FEMALE CLIP	
MP24	1251-1913	JACKSCREWS:R & P CONNECTOR	
MP25	05257-20054	GEAR:POT DRIVE	
MP26	05257-20092	PANEL:FRONT <i>OPTION 485 (MINT GRAY)</i>	
P3	1251-1914	BODY:R & P CONNECTOR 14 CONTACTS	
P6	1251-0099	CONNECTOR:RF 50 PIN	
R1	2100-2075	R:VAR WW 5K OHM 3% LIN 1W	
R2	2100-2075	R:VAR WW 5K OHM 3% LIN 1W	
S1	3100-2406	SWITCH:ROTARY	
S2	3100-2409	SWITCH:ROTARY	
XA4	1251-0382	CONNECTOR:12 PIN PC	
XA5	1251-0160	CONNECTOR:15 PIN	
XA6	1251-0160	CONNECTOR:15 PIN	
XA8	1251-0159	CONNECTOR:30 CONTACT	
XA9	1251-0160	CONNECTOR:15 PIN	
XA10	1251-0159	CONNECTOR:30 CONTACT	

See introduction to this section for ordering information

Table 6-2. Replaceable Parts

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ
0121-0405	C:VAR 3.5-53.5 PF	28480	0121-0405	1
0122-0301	C:VOLTAGE VAR 6.8 PF 10%	28480	0122-0301	2
0140-0192	C:FXD MICA 68 PF 5% 300VDCW	28480	0140-0192	1
0140-0193	C:FXD MICA 82 PF 5% 300VDCW	28480	0140-0193	1
0140-0198	C:FXD MICA 200 PF 5% 300VDCW	28480	0140-0198	2
0150-0011	C:FXD TI 1.5 PF 20% 500VDCW	78488	TYPE GA	1
0150-0029	C:FXD TI 1 PF 10% 500VDCW	78488	TYPE GA	3
0150-0031	C:FXD TI 2 PF 5% 500VDCW	78488	TYPE GA	2
0150-0034	C:FXD TI 3.9 PF 10% 500VDCW	78488	TYPE GA	1
0150-0035	C:FXD CER 20 PF 10% 600VDCW	71590	TYPE DD 200	1
0150-0061	C:FXD CER 20 PF 10% 100VDCW	56289	53C47	1
0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA	20
0150-0122	C:FXD CER 2000 PF 20% 500VDCW	72982	801-000-Y5S-202M	3
0160-0147	C:FXD MICA 2500PF 2% 300VDCW	04062	RDM20F252G3S	1
0160-0174	C:FXD CER 0.47 UF +80-20% 25VDCW	56289	5C1187	2
0160-0183	C:FXD MICA 130PF 5% 300VDCW	14655	RDM15F131J3S	2
0160-0194	C:FXD MY 0.015UF 10%	28480	0160-0194	3
0160-0196	C:FXD MICA 24PF 5% 300VDCW	04062	RDM15C240J3S	1
0160-0207	C:FXD MYLAR 0.01UF 5% 200VDCW	28480	0160-0207	1
0160-0939	C:FXD MICA 430 PF 5% 300 VDCW	28480	0160-0939	1
0160-2055	C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA	3
0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	91418	TYPE B	24
0160-2205	C:FXD MICA 120 PF 5% 300VDCW	28480	0160-2205	1
0160-2327	C:FXD CER 1000 PF 20% 75VDCW	28480	0160-2327	24
0160-3060	C:FXD CER 0.1 UF 20% 25VDCW	56289	3C42A-CML	6
0180-0097	C:FXD ELECT 47UF 10% 35VDCW	56289	150D476X9035S2	1
0180-0100	C:FXD ELECT TA 4.7UF 10% 35VDCW	56289	150D475X9035B2	1
0180-0116	C:FXD ELECT 6.8 UF 10% 35VDCW	56289	150D685X9035B2	12
0180-0160	C:FXD ELECT 22UF 35VDCW	56289	150D226X0035R2	1
0180-0195	C:FXD ELECT 0.33 UF 20% 35VDCW	56289	150D334X0035A2	1
0180-0218	C:FXD ELECT .15 UF 10% 35VDCW	56289	150D154X9035A2	1
0180-0228	C:FXD ELECT 22 UF 10% 15VDCW	28480	0180-0228	1
0180-0230	C:FXD ELECT 1.0 UF 20% 50VDCW	28480	0180-0230	2
0180-0291	C:FXD ELECT 1UF 10% 35VDCW	56289	150D105X9035A2	6
0180-0387	C:FXD ELECT 47 UF 5% 20VDCW	28480	0180-0387	5
0370-0472	KNOB:RED BAR	28480	0370-0472	1
0370-0139	KNOB:RED ROUND 1/8" SHAFT	28480	0370-0139	1
0370-0463	KNOB:BLACK ROUND	28480	0370-0463	1
0370-0464	KNOB:BLACK ROUND	28480	0370-0464	1
0370-0479	KNOB:BLACK POINTER	28480	0370-0479	1
0675-3321	R:FXD COMP 3.3K OHM 10% 1/8W	28480	0675-3321	1
0683-1055	R:FXD COMP 1 MEGOHM 5% 1/4W	01121	CB 1055	1
0683-1065	R:FXD COMP 10M OHM 5% 1/4W	01121	CB 1065	1
0698-3111	R:FXD COMP 30 OHM 5% 1/8W	28480	0698-3111	1
0698-3113	R:FXD CARBON 100 OHM 5% 1/8W	28480	0698-3113	2
0698-3114	R:FXD COMP 300 OHM 5% 1/8W	28480	0698-3114	1
0698-3375	R:FXD COMP 33 OHM 5% 1/8W	28480	0698-3375	1
0698-3376	R:FXD COMP 43 OHM 5% 1/8W	28480	0698-3376	2
0698-3378	R:FXD CARBON 51 OHM 5% 1/8W	28480	0698-3378	4
0698-3379	R:FXD COMP 68 OHM 5% 1/8W	28480	0698-3379	1
0698-3380	R:FXD CARBON 75 OHM 5% 1/8W	28480	0698-3380	1
0698-3381	R:FXD COMP 150 OHM 5% 1/8W	28480	0698-3381	2
0698-5075	R:FXD COMP 130 OHM 5% 1/8W	28480	0698-5075	1

See list of abbreviations in introduction to this section

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

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ
0698-5173	R:FXD COMP 36 OHM 5% 1/8W	28480	0698-5173	1
0698-5174	R:FXD COMP 200 OHM 5% 1/8W	28480	0698-5174	1
0698-5177	R:FXD COMP 820 OHM 5% 1/8W	28480	0698-5177	1
0698-5178	R:FXD COMP 1.5K OHM 5% 1/8W	28480	0698-5178	1
0698-5179	R:FXD COMP 1800 OHM 5% 1/8W	28480	0698-5179	2
0698-5562	R:FXD CARBON 120 OHM 5% 1/8W	28480	0698-5562	1
0698-5565	R:FXD CARBON 2.2K OHM 5% 1/8W	28480	0698-5565	2
0698-5666	R:FXD ALUMINA-CER 20 OHM 5% 1/10W	28480	0698-5666	1
0698-5993	R:FXD COMP 8.2K OHM 5% 1/8W	28480	0698-5993	1
0698-5994	R:FXD COMP 6.8K OHM 5% 1/8W	28480	0698-5994	2
0698-5997	R:FXD COMP 12K OHM 5% 1/8W	28480	0698-5997	1
0698-6242	R:FXD COMP 1.2K OHM 5% 1/8W	28480	0698-6242	2
0698-6381	R:FXD COMP 11K OHM 5% 1/8W	28480	0698-6381	2
0698-6648	R:FXD COMP 620 OHM 5% 1/8W	28480	0698-6648	2
0698-6649	R:FXD COMP 390 OHM 5% 1/8W	28480	0698-6649	1
0698-6681	R:FXD COMP 9.1 OHM 5% 1/8W	28480	0698-6681	1
C757-0200	R:FXD MET FLM 5.62K OHM 1% 1/8W	28480	0757-0200	1
0757-0280	R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280	2
0757-0337	R:FXD MET FLM 432 OHM 1% 1/4W	28480	0757-0337	1
0757-0346	R:FXD MET FLM 10 OHM 1% 1/8W	28480	0757-0346	1
0757-0379	R:FXD MET FLM 12.1 OHM 1% 1/8W	28480	0757-0379	1
0757-0424	R:FXD MET FLM 1.10K OHM 1% 1/8W	28480	0757-0424	1
C757-0482	R:FXD MET FLM 511K OHM 1% 1/8W	28480	0757-0482	2
0757-0893	R:FXD MET FLM 51 OHM 2% 1/4W	28480	0757-0893	7
0757-0898	R:FXD MET FLM 82 OHM 2% 1/4W	28480	0757-0898	2
0757-0899	R:FXD MET FLM 91 OHM 2% 1/4W	28480	0757-0899	1
0757-0900	R:FXD MET FLM 100 OHM 2% 1/4W	28480	0757-0900	3
0757-0904	R:FXD MET FLM 150 OHM 2% 1/4W	28480	0757-0904	2
C757-0905	R:FXD MET FLM 160 OHM 2% 1/4W	28480	0757-0905	2
0757-0906	R:FXD MET FLM 180 OHM 2% 1/4W	28480	0757-0906	1
0757-0909	R:FXD MET FLM 240 OHM 2% 1/4W	28480	0757-0909	1
0757-0914	R:FXD MET FLM 390 OHM 2% 1/4W	28480	0757-0914	4
0757-0915	R:FXD MET FLM 430 OHM 2% 1/4W	28480	0757-0915	2
0757-0917	R:FXD MET FLM 510 OHM 2% 1/4W	28480	0757-0917	4
0757-0918	R:FXD MET FLM 560 OHM 2% 1/4W	28480	0757-0918	1
0757-0920	R:FXD MET FLM 680 OHM 2% 1/4W	28480	0757-0920	2
0757-0921	R:FXD MET FLM 750 OHM 2% 1/4W	28480	0757-0921	6
0757-0922	R:FXD MET FLM 820 OHM 2% 1/4W	28480	0757-0922	2
0757-0923	R:FXD MET FLM 910 OHM 2% 1/4W	28480	0757-0923	4
0757-0924	R:FXD MET FLM 1.0K OHM 2% 1/4W	28480	0757-0924	8
0757-0925	R:FXD MET FLM 1.1K OHM 2% 1/4W	28480	0757-0925	7
0757-0926	R:FXD MET FLM 1.2K OHM 2% 1/4W	28480	0757-0926	5
0757-0927	R:FXD MET FLM 1.3K OHM 2% 1/4W	28480	0757-0927	4
0757-0929	R:FXD MET FLM 1.6K OHM 2% 1/4W	28480	0757-0929	1
C757-0930	R:FXD MET FLM 1800 OHM 2% 1/4W	28480	0757-0930	2
0757-0931	R:FXD MET FLM 2.3K OHM 2% 1/4W	28480	0757-0931	6
0757-0932	R:FXD MET FLM 2.2K OHM 2% 1/4W	28480	0757-0932	1
0757-0934	R:FXD MET FLM 2.7K OHM 2% 1/4W	28480	0757-0934	9
0757-0935	R:FXD MET FLM 3.0K OHM 2% 1/4W	28480	0757-0935	5
0757-0936	R:FXD MET FLM 3.3K OHM 2% 1/4W	28480	0757-0936	1
0757-0938	R:FXD MET FLM 3.9K OHM 2% 1/4W	28480	0757-0938	7
0757-0939	R:FXD MET FLM 4.3K OHM 2% 1/4W	28480	0757-0939	8
C757-0940	R:FXD MET FLM 4.7K OHM 2% 1/4W	28480	0757-0940	4
0757-0941	R:FXD MET FLM 5.1K OHM 2% 1/4W	28480	0757-0941	8
0757-0942	R:FXD MET FLM 5.6K OHM 2% 1/4W	28480	0757-0942	5

= See list of abbreviations in introduction to this section

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

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ
0757-0943	R:FXD MET FLM 6.2K OHM 2% 1/4W	28480	0757-0943	2
0757-0944	R:FXD MET FLM 6.8K OHM 2% 1/4W	28480	0757-0944	3
0757-0945	R:FXD MET FLM 7.5K OHM 2% 1/4W	28480	0757-0945	4
0757-0946	R:FXD MET FLM 8.2K OHM 2% 1/4W	28480	0757-0946	3
0757-0948	R:FXD MET FLM 10K OHM 2% 1/4W	28480	0757-0948	14
0757-0950	R:FXD MET FLM 12K OHM 2% 1/4W	28480	0757-0950	6
0757-0951	R:FXD MET FLM 13K OHM 2% 1/4W	28480	0757-0951	1
0757-0952	R:FXD MET FLM 15K OHM 2% 1/4W	28480	0757-0952	7
0757-0953	R:FXD MET FLM 16K OHM 2% 1/4W	28480	0757-0953	5
0757-0954	R:FXD MET FLM 18K OHM 2% 1/4W	28480	0757-0954	1
0757-0955	R:FXD MET FLM 20K OHM 2% 1/4W	28480	0757-0955	8
0757-0957	R:FXD MET FLM 24K OHM 2% 1/4W	28480	0757-0957	3
0757-0958	R:FXD MET FLM 27K OHM 2% 1/4W	28480	0757-0958	1
0757-0960	R:FXD MET FLM 33K OHM 2% 1/4W	28480	0757-0960	1
0757-0963	R:FXD MET FLM 43K OHM 2% 1/4W	28480	0757-0963	2
0757-0965	R:FXD MET FLM 51K OHM 2% 1/4W	28480	0757-0965	1
0757-0972	R:FXD MET FLM 100K OHM 2% 1/4W	28480	0757-0972	4
0757-0975	R:FXD MET OX 130K OHM 2% 1/4W	28480	0757-0975	1
0760-0022	R:FXD MET FLM 330 OHM 2% 1W	28480	0760-0022	2
0761-0042	R:FXD MET OX 68 OHM 5% 1W	28480	0761-0042	1
0890-0048	SLEEVE:TEFLON 1.3 LONG	28480	0890-0048	5
1120-1495	METER:0-1MA	28480	1120-1495	1
1250-0102	CONNECTOR:8NC	28480	1250-0102	1
1251-0099	CONNECTOR:RF 50 PIN	28480	1251-0099	1
1251-0159	CONNECTOR:30 CONTACT	28480	1251-0159	2
1251-0160	CONNECTOR:15 PIN	28480	1251-0160	3
1251-0382	CONNECTOR:12 PIN PC	28480	1251-0382	1
1251-1115	KEY:POLARIZING FOR CKT BD SOCKETS	71785	456-99-99-193	1
1251-1511	CONNECTOR:DIODE FEMALE CLIP	28480	1251-1511	1
1251-1913	JACKSCREWS:R & P CONNECTOR	81312	JT605	1
1251-1914	BODY:R & P CONNECTOR 14 CONTACTS	81312	MRAC 14P6	1
1251-1915	BODY:R & P CONNECTOR 14 CONTACTS	81312	MRAC-1456	1
1500-0014	COUPLING BELLOWS	28480	1500-0014	1
1820-0094	INTEGRATED CIRCUIT	04713	MC846N TI SN15346N	2
1820-0399	INTEGRATED CIRCUIT	01295	SN4631 MOTOROLA	12
1853-0009	TRANSISTOR:SILICON PNP	28480	1853-0009	2
1853-0010	TRANSISTOR:SILICON PNP	28480	1853-0010	1
1853-0015	TRANSISTOR:SILICON PNP 2N3640	28480	1853-0015	2
1853-0020	TRANSISTOR:SILICON PNP	28480	1853-0020	9
1853-0036	TRANSISTOR:SILICON PNP	28480	1853-0036	15
1853-0054	TRANSISTOR:SILICON PNP	28480	1853-0054	2
1854-0003	TRANSISTOR:NPN SILICON	28480	1854-0003	1
1854-0005	TRANSISTOR:SILICON NPN 2N708	02735	2N708	2
1854-0019	TRANSISTOR:SILICON NPN	28480	1854-0019	4
1854-0048	TRANSISTOR:SILICON NPN 2N2857	28480	1854-0048	1
1854-0053	TRANSISTOR:SILICON NPN 2N2218	04713	2N2218	2
1854-0071	TRANSISTOR:SILICON NPN	28480	1854-0071	5
1854-0073	TRANSISTOR:SILICON NPN	28480	1854-0073	3
1854-0215	TRANSISTOR:SILICON NPN 2N3904	28480	1854-0215	16
1854-0221	TRANSISTOR DUAL:SILICON NPN	28480	1854-0221	6
1854-0238	TRANSISTOR:SILICON NPN 2N3933	02735	2N3933	10
1854-0273	TRANSISTOR:SILICON NPN	28480	1854-0273	2
1854-0323	TRANSISTOR:NPN 2N2857	02735	2N2857	4
1854-0345	TRANSISTOR: NPN 2N5179		2N5179	2

= See list of abbreviations in introduction to this section

Section VI
Parts

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

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ
1855-0038	TRANSISTOR:DUAL 2N3922	15818	2N3922	1
1901-0040	DIODE:SILICON 30MA 30WV	28480	1901-0040	21
1901-0179	DIODE:SILICON 15WV	28480	1901-0179	7
1901-0567	DIODE:SILICON	28480	1901-0567	1
1901-0573	SAMPLER ASSY	28480	1901-0573	1
1901-0581	SAMPLER DIODE ASSY MATCHED PAIR	28480	1901-0581	2
1902-0685	DIODE BREAKDOWN:9.0V 2%	04713	1N938	1
1902-0686	DIODE BREAKDOWN:6.2V 2%	04713	1N825	1
1902-3079	DIODE BREAKDOWN:SILICON 4.53V	28480	1902-3079	4
1912-0012	DIODE GERMANIUM TUNNEL:10MA	28480	1912-0012	1
2100-1760	R:VAR WW 5K OHM 10% LIN 1/2W	28480	2100-1760	1
2100-2075	R:VAR WW 5K OHM 3% LIN 1W	28480	2100-2075	1
2190-0325	WASHER:FLAT FUR 1/4" HDW	00000	080	4
3050-0161	WASHER:SPRING STL WAVY TYPE	28480	3050-0161	2
3100-2406	SWITCH:ROTARY	28480	3100-2406	1
3100-2409	SWITCH:THUMB-WHEEL	28480	3100-2409	1
3100-2420	SWITCH	28480	3100-2420	1
5020-3297	CONTACT:SLIDING	28480	5020-3297	1
5040-0157	COUPLER:SHAFT NYLON	28480	5040-0157	1
8180-0224	WIRE:#24 1.6 LONG	28480	8180-0224	5
9100-0346	COIL:FXD 0.05 UH 20%	36196	H-10886	1
9100-0368	COIL:FXD 0.33 UH 10%	36196	1A-3303M	1
9100-1724	COIL:FXD 0.22 UH 10%	99800	1025-04	1
9140-0096	COIL:FXD RF 1 UH	28480	9140-0096	2
9140-0138	COIL/CHOKE 180 UH 5%	28480	9140-0138	12
9140-0158	COIL:FXD RF 1 UH 10%	99800	1025-20	5
9170-0029	CORE: FERRITE BEAD	02114	56-590-654/A	2
00107-2001	HUB:BUSHING	28480	00107-2001	2
05257-00004	RETAINER:DIAL	28480	05257-00004	1
05257-20001	BOARD:BLANK PC	28480	05257-20001	1
05257-20002	BOARD:BLANK PC	28480	05257-20002	1
05257-20003	BOARD:BLANK PC	28480	05257-20003	1
05257-20004	BOARD:BLANK PC	28480	05257-20004	1
05257-20005	BOARD:BLANK PC	28480	05257-20005	1
05257-20006	BOARD:BLANK PC	28480	05257-20006	1
05257-20007	BOARD:BLANK PC	28480	05257-20007	1
05257-20008	BOARD:BLANK PC	28480	05257-20008	1
05257-20211	BOARD:BLANK PC	28480	05257-20211	1
05257-20011	BOARD:BLANK PC	28480	05257-20011	1
05257-20012	BOARD:BLANK PC	28480	05257-20012	1
05257-20013	BOARD:BLANK PC	28480	05257-20013	1
05257-20023	PANEL:FRONT	28480	05257-20023	1
05257-20024	HOLDER:STRIP LINE	28480	05257-20024	1
05257-20054	GEAR:POT DRIVE	28480	05257-20054	1
05257-60001	BOARD ASSY:PRESET DECADER	28480	05257-60001	1
05257-60002	BOARD ASSY:GATE EXTENDER	28480	05257-60002	1
05257-60003	BOARD ASSY:VFO	28480	05257-60003	1
05257-60004	BOARD ASSY:VFO LINEARIZER	28480	05257-60004	1
05257-60005	BOARD ASSY:APC #1	28480	05257-60005	1
05257-60006	BOARD ASSY:APC #2	28480	05257-60006	1
05257-60007	BOARD ASSY:REGULATOR PULSED RF	28480	05257-60007	1
05257-60008	BOARD ASSY:PULSE DRIVER	28480	05257-60008	1
05257-60211	BOARD ASSY:PULSE GENERATOR	28480	05257-60211	1
05257-60011	BOARD ASSY:POWER SUPPLY FILTER	28480	05257-60011	1
05257-60012	BOARD ASSY:VFO CONTROL	28480	05257-60012	1

= See list of abbreviations in introduction to this section

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

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ
05257-60013	BOARD ASSY:PRESCALER	28480	05257-60013	1
05257-60014	TRANSFORMER ASSY:PULSE DRIVE	28480	05257-60014	1
05257-60015	TRANSFORMER ASSY:PULSE DRIVE	28480	05257-60015	1
05257-60017	TRANSFORMER ASSY:VFO	28480	05257-60017	2
05257-60018	VFO LINEARIZER ASSY	28480	05257-60018	1
05257-60019	GEAR BOX ASSY	28480	05257-60019	1
05257-60021	SWITCH ASSY:VFO LINEARIZER	28480	05257-60021	1
05257-60022	COIL ASSY:VFO	28480	05257-60022	2
05260-2016	SEAL:OUTSIDE	28480	05260-2016	1
C5260-4002	CLAMP:DIODE	28480	05260-4002	1
05379-60014	DIODE: TUNNEL	28480	05379-60014	1

= See list of abbreviations in introduction to this section

Table 6-3. Code List of Manufacturers

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

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
00000	U. S. A. Common	Any supplier of U. S.	05397	Union Carbide Corp., Linde Div.	Kemet Dept. Cleveland, Ohio	11242	Bay State Electronics Corp.	Waltham, Mass.
00136	McCoy Electronics	Mount Holly Springs, Pa.	05593	Humitronic Engineering Co	Sunnyvale, Calif.	11312	Teledyne Inc., Microwave Div.	Palo Alto, Calif.
00213	Sage Electronics Corp	Rochester, N. Y.	05616	Cosmo Plastic	Cleveland, Ohio	11314	National Seal	Downey, Calif.
00287	Cemco Inc.	Danielson, Conn.	05624	Barber Colman Co	Rockford, Ill.	11534	Duncan Electronics Inc.	Costa Mesa, Calif.
00334	Humidial	Colton, Calif.	05728	Triflen Optical Co	Roslyn Heights, Long Island, N. Y.	11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N. J.
00348	Microtron Co., Inc.	Valley Stream, N. Y.	05729	Metro-Tel Corp.	Westbury, N. Y.	11717	Imperial Electronic, Inc.	Buena Park, Calif.
00373	Garlock Inc.	Cherry Hill, N. J.	05783	Stewart Engineering Co	Santa Cruz, Calif.	11870	Metabs, Inc.	Palo Alto, Calif.
00556	Aerovox Corp.	New Bedford, Mass.	05820	Wakelief Engineering Inc.	Wakelief, Mass.	12136	Philadelphia Handle Co	Camden, N. J.
00779	Amp. Inc.	Harrisburg, Pa.	06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.	12861	Grove Mfg. Co., Inc.	Shady Grove, Pa.
00781	Aircraft Radio Corp.	Boonton, N. J.	06090	Raychem Corp.	Redwood City, Calif.	12574	Gulton Ind. Inc. Data System Div.	Albuquerque, N. M.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.	06175	Bausch and Lomb Optical Co.	Rochester, N. Y.	12697	Clarostat Mfg. Co.	Dover, N. H.
00853	Sangamo Electric Co.	Pickens Div. Pickens, S. C.	06402	E. T. A. Products Co of America	Chicago, Ill.	12728	Elmar Filter Corp.	W. Haven, Conn.
00866	Goe Engineering Co.	City of Industry, Cal.	06540	Amaton Electronic Hardware Co., Inc.	New Rochelle, N. Y.	12859	Nippon Electric Co., Ltd.	Tokyo, Japan
00891	Carl E. Holmes Corp.	Los Angeles, Calif.	06555	Beece Electrical Instrument Co., Inc.	Penacook, N. H.	12881	Metex Electronics Corp.	Clark, N. J.
00929	Microlab Inc.	Livingston, N. J.	06656	General Devices Co., Inc.	Indianapolis, Ind.	12930	Delta Semiconductor Inc.	Newport Beach, Calif.
01002	General Electric Co.	Capacitor Dept. Hudson Falls, N. Y.	06751	Sencor Div. Components Inc	Phoenix, Ariz.	12954	Dickson Electronics Corp.	Scottsdale, Arizona
01009	Alden Products Co.	Brockton, Mass.	06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.	13103	Thermolloy	Dallas, Texas
01121	Allen Bradley Co.	Milwaukee, Wis.	06980	Varian Assoc. Ermac Div	San Carlos, Calif.	13396	Telefunken GmbH	Hanover, Germany
01255	Litton Industries, Inc.	Beverly Hills, Calif.	07088	Keivin Electric Co	Van Nuys, Calif.	13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
01281	TRW Semiconductors, Inc.	Lawndale, Calif.	07126	Digitran Co	Pasadena, Calif.	14099	Sem-Tech	Newbury Park, Calif.
01295	Texas Instruments, Inc.	Transistor Products Div. Dallas, Texas	07137	Transistor Electronics Corp	Minneapolis, Minn.	14193	Calif. Resistor Corp.	Santa Monica, Calif.
01349	The Alliance Mfg. Co.	Alliance, Ohio	07138	Westinghouse Electric Corp	Electronic Tube Div. Elmira, N. Y.	14296	American Components, Inc.	Conshohocken, Pa.
01589	Pacific Relays, Inc.	Van Nuys, Calif.	07149	Filmtron Corp.	New York, N. Y.	14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
01930	Amerock Corp.	Rockford, Ill.	07233	Cinch-Graphix Co	City of Industry, Calif.	14493	Hewlett-Packard Company	Loveland, Colo.
01961	Falze Engineering Co.	Santa Clara, Calif.	07261	Avnet Corp	Culver City, Calif.	14655	Cornell Dublier Electric Corp	Newark, N. J.
02114	Ferroxcube Corp. of America	Saugerties, N. Y.	07263	Fairchild Camera & Inst. Corp	Semiconductor Div. Mountain View, Calif.	14674	Corning Glass Works	Corning, N. Y.
02116	Wheelock Signals, Inc.	Long Branch, N. J.	07322	Minnesota Rubber Co	Minneapolis, Minn.	14752	Electro Cube Inc	San Gabriel, Calif.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.	07367	Birther Corp. The	Monterey Park, Calif.	14960	Williams Mfg. Co.	San Jose, Calif.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.	07397	Sylvania Elect. Prod. Inc.	Mt. View Operations. Mountain View, Calif.	15103	Webster Electronics Co.	New York, N. Y.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N. J.	07707	Technical Wire Products Inc	Cranford, N. J.	15267	Scionics Corp.	Northridge, Calif.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.	07910	Continental Device Corp	Hawthorne, Calif.	15291	Adjustable Bushing Co	H. Hollywood, Calif.
02777	Hopkins Engineering Co.	San Fernando, Calif.	07931	Raytheon Mfg. Co	Semiconductor Div. Mountain View, Calif.	15558	Micron Electronics	Garden City, Long Island, N. Y.
03508	G. E. Semiconductor Prod. Dept.	Syracuse, N. Y.	07951	Hewlett-Packard Co., Boonton Radio Div.	Boonton, N. J.	15566	Amprobe Inst. Corp.	Lynbrook, N. Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio	08146	U. S. Engineering Co	Los Angeles, Calif.	15631	Cabletronics	Costa Mesa, Calif.
03797	Eidema Corp.	Compton, Calif.	08229	Blinn, Delbert Co	Pomona, Calif.	15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
03877	Transitron Electric Corp.	Wakelief, Mass.	08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada	15801	Fenwal Elect. Inc.	Framingham, Mass.
03888	Pyrofilm Resistor Co. Inc.	Cedar Knolls, N. J.	08524	Deutch Fastener Corp.	Los Angeles, Calif.	15816	Amelco Inc.	Mt. View, Calif.
03954	Singer Corp., Diehl Div. Finderne Plant	Sumerville, N. J.	08664	Bristol Co., The	Waterbury, Conn.	16037	Spruce Pine Mica Co	Spruce Pine, N. C.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.	08711	Sloan Company	Sun Valley, Calif.	16179	Omni-Spectra Inc.	Detroit, Ill.
04013	Taurus Corp.	Lambertville, N. J.	08713	ITT Cannon Electric Inc.	Phoenix Div. Phoenix, Arizona	16352	Computer Diode Corp.	Lodi, N. J.
04062	Arco Electronic Inc	Great Neck, N. Y.	08751	CBS Electronics Semiconductor Operations, Div. of C. B. S. Inc.	Lowell, Mass.	16668	Ideal Prec. Meter Co. Inc. De Jur Meter Div.	Brooklyn, N. Y.
04222	H-Q Division of Aerovox	Myrtle Beach, S. C.	08924	Mel-Rain	Indianapolis, Ind.	16756	Delco Radio Div. of G. M. Corp.	Kokoma, Ind.
04354	Precision Paper Tube Co.	Wheeling, Ill.	09076	Babcock Relays Div.	Costa Mesa, Calif.	17109	Thermonetics Inc.	Canoga Park, Calif.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.	09134	Texas Capacitor Co.	Houston, Texas	17474	Tranex Company	Mountain View, Calif.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.	09145	Tech. Ind. Inc. Alohm Elect	Burbank, Calif.	17675	Hamlin Metal Products Corp	Akron, Ohio
04713	Motorola, Inc. Semiconductor Prod. Div.	Phoenix, Arizona	09250	Electro Assemblies, Inc.	Chicago, Ill.	17745	Angstrom Prec. Inc	No. Hollywood, Calif.
04732	Faltron Co., Inc. Western Div.	Culver City, Calif.	09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada	17873	McGraw-Edison Co	Manchester, N. H.
04773	Automatic Electric Co.	Northlake, Ill.	10214	General Transistor Western Corp.	Los Angeles, Calif.	18042	Power Design Pacific Inc	Palo Alto, Calif.
04796	Sequoia Wire Co	Redwood City, Calif.	10411	Ti-Tel Inc	Berkeley, Calif.	18083	Clevite Corp., Semiconductor Div.	Palo Alto, Calif.
04811	Precision Coil Spring Co	El Monte, Calif.	10645	Carborundum Co	Niagara Falls, N. Y.	18324	Signetics Corp.	Sunnyvale, Calif.
04870	P. M. Motor Company	Westchester, Ill.	11256	C.T.S. of Berne, Inc.	Berne, Ind.	18476	Ty-Cat Mfg. Co., Inc	Holliston, Mass.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.	11233	Chicago Telephone of California, Inc.	So. Pasadena, Calif.	18486	TRN Elect. Comp. Div.	Des Plaines, Ill.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.				18583	Curtis Instrument, Inc	Mt. Kisco, N. Y.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.				18673	E. I. DuPont and Co., Inc.	Wilmington, Del.
05347	Ultronix, Inc	San Mateo, Calif.				18911	Durant Mfg. Co.	Milwaukee, Wis.
						19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N. J.
						19500	Thomas A. Edison Industries Div. of McGraw-Edison Co	West Orange, N. J.
						19569	Concoa	Baldwin Park, Calif.
						19644	LRC Electronics	Horseheads, N. Y.
						19701	Electra Mfg. Co	Independence, Kansas

From FSC Handbooks Supplements
H4-1 Dated AUGUST 1962
H4-2 Dated NOV. 1962

Table 6-3. Code List of Manufacturers Cont'd.

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
20183	General Altronics Corp.	Philadelphia, Pa.	71436	Chicago Condenser Corp.	Chicago, Ill.	77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N. Y.	71447	Calif. Spring Co., Inc.	Pico-Rivera, Calif.	77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
21335	Falnr Bearing Co., The	New Britain, Conn.	71450	CTS Corp.	Eikhart, Ind.	77630	TRW Electronic Components Div.	Camden, N. J.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.	71468	ITT Cannon Electric Inc.	Los Angeles, Calif.	77638	General Instrument Corp., Rectifier Div.	Brooklyn, N. Y.
23783	British Radio Electronics Ltd.	Washington, D. C.	71471	Cinema, Div. Aerovox Corp.	Burbank, Calif.	77764	Resistance Products Co.	Harrisburg, Pa.
24455	G. E. Lamp Division	Nela Park, Cleveland, Ohio	71482	C. P. Clare & Co.	Chicago, Ill.	77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
24655	General Radio Co.	West Concord, Mass.	71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.	78139	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.	71616	Commercial Plastics Co.	Chicago, Ill.	78283	Signal Indicator Corp.	New York, N. Y.
26365	Gires Reproducer Corp.	New Rochelle, N. Y.	71700	Cornish Wire Co., The	New York, N. Y.	78290	Struthers-Dunn Inc.	Pitman, N. J.
26462	Grobet File Co. of America, Inc.	Carlstadt, N. J.	71707	Coto Coil Co., Inc.	Providence, R. I.	78452	Thompson-Bremer & Co.	Chicago, Ill.
26992	Hamilton Watch Co.	Lancaster, Pa.	71744	Chicago Miniature Lamp Works	Chicago, Ill.	78471	Talley Mfg. Co.	San Francisco, Calif.
28480	Hewlett-Packard Co.	Palo Alto, Calif.	71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.	78488	Stackpole Carbon Co.	St. Marys, Pa.
28520	Heyman Mfg. Co.	Kenilworth, N. J.	71984	Dow Corning Corp.	Midland, Mich.	78493	Standard Thomson Corp.	Waltham, Mass.
33173	G. E. Receiving Tube Dept.	Owensboro, N. Y.	72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.	78553	Tinnerman Products, Inc.	Cleveland, Ohio
35434	Lectrohm Inc.	Chicago, Ill.	72619	Dialight Corp.	Brooklyn, N. Y.	78790	Transformer Engineers	San Gabriel, Calif.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada	72656	Indiana General Corp., Electronics Div.	Keasby, N. J.	78947	Uconite Co.	Newtonville, Mass.
36287	Cunningham, W. H. & Hill, Ltd.	Toronto Ontario, Canada	72699	General Instrument Corp., Cap. Div.	Newark, N. J.	79136	Waldes Konimol Inc.	Long Island City, N. Y.
37942	P. R. Mallory & Co. Inc.	Indianapolis, Ind.	72765	Drake Mfg. Co.	Harwood Heights, Ill.	79142	Veeder Root, Inc.	Hartford, Conn.
39543	Mechanical Industries Prod. Co.	Akron, Ohio	72825	Hugh H. Eby Inc.	Philadelphia, Pa.	79251	Wenco Mfg. Co.	Chicago, Ill.
40920	Miniature Precision Bearings, Inc.	Keene, N. H.	72928	Gudeman Co.	Chicago, Ill.	79727	Continental-Witt Electronics Corp.	Philadelphia, Pa.
42190	Muter Co.	Chicago, Ill.	72964	Robert M. Hadley Co.	Los Angeles, Calif.	79953	Zierick Mfg. Corp.	New Rochelle, N. Y.
43990	C. A. Norgren Co.	Englewood, Colo.	72982	Erle Technological Products, Inc.	Erle, Pa.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
44655	Ohmite Mfg. Co.	Skokie, Ill.	73061	Hansen Mfg. Co., Inc.	Princeton, Ind.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.	73076	H. M. Harper Co.	Chicago, Ill.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
47924	Polaroid Corp.	Cambridge, Mass.	73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Calif.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.	73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
49856	Microwave & Power Tube Div	Waltham, Mass.	73445	Amperex Elect Co.	Hicksville, L. I., N. Y.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
50290	Rowan Controller Co	Westminster, Md.	73506	Bradley Semiconductor Corp.	New Haven, Conn.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
50353	Sanborn Company	Waltham, Mass.	73559	Carling Electric, Inc.	Hartford, Conn.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
51294	Shaffcross Mfg. Co.	Selma, N. C.	73586	Circle F. Mfg. Co.	Trenton, N. J.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
55026	Simpson Electric Co.	Chicago, Ill.	73682	George K. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
55933	Sonotone Corp.	Elmsford, N. Y.	73734	Federal Screw Products Inc.	Chicago, Ill.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
55933	Raytheon Co. Commercial Apparatus & Systems Div.	So. Norwalk, Conn.	73743	Fischer Special Mfg. Co.	Cincinnati, Ohio	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
56137	Saulding Fibre Co., Inc.	Tonawanda, N. Y.	73793	General Industries Co. The	Elyria, Ohio	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
56289	Sprague Electric Co.	North Adams, Mass.	73846	Goshen Stamping & Tool Co.	Goshen, Ind.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
59446	Telex Corp.	Tulsa, Okla.	73899	JFD Electronics Corp.	Brooklyn, N. Y.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
59730	Thomas & Betts Co.	Elizabeth, N. J.	73905	Jennings Radio Mfg. Corp.	San Jose, Calif.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio	73957	Groov-Pin Corp.	Ridgefield, N. J.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
61775	Union Switch and Signal Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.	74276	Signalite Inc.	Neptune, N. J.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
62119	Universal Electric Co.	Owosso, Mich.	74455	J. H. Winns, and Sons	Winchester, Mass.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N. Y.	74861	Industrial Condenser Corp.	Chicago, Ill.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
64959	Western Electric Co., Inc.	New York, N. Y.	74868	R. F. Products Division of Amphenol-Electronics Corp.	Danbury, Conn.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
65092	Weston Inst. Inc. Weston-Newark	Newark, N. J.	74970	E. F. Johnson Co.	Waseca, Minn.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
65295	Wiltek Mfg. Co.	Chicago, Ill.	75042	International Resistance Co.	Philadelphia, Pa.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
66346	Minnesota Mining & Mfg. Co. Revere Mincon Div.	St. Paul, Minn.	75378	CTS Knights Inc.	Sandwich, Ill.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
70276	Allen Mfg. Co.	Hartford, Conn.	75382	Kulka Electric Corporation	Mt. Vernon, N. Y.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
70359	Allied Control	New York, N. Y.	75815	Lenz Electric Mfg. Co.	Chicago, Ill.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
70318	Allnetel Schem. Product Co., Inc.	Garden City, N. Y.	75915	Littelluse, Inc.	Des Plaines, Ill.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.	76005	Lord Mfg. Co.	Erle, Pa.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
70563	Amperite Co., Inc.	Union City, N. J.	76210	C. W. Marwedel	San Francisco, Calif.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
70674	ADC Products Inc.	Minneapolis, Minn.	76433	General Instrument Corp., Micromini Division	Newark, N. J.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
70903	Belden Mfg. Co.	Chicago, Ill.	76487	James Millen Mfg. Co., Inc.	Malden, Mass.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
70998	Bird Electronic Corp.	Cleveland, Ohio	76493	J. W. Miller Co.	Los Angeles, Calif.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
71002	Birnbach Radio Co.	New York, N. Y.	76530	Cinch-Monadnock Div. of United Carr Fastener Corp.	San Leandro, Calif.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.	76545	Mueller Electric Co.	Cleveland, Ohio	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
71218	Bud Radio, Inc.	Willoughby, Ohio	76703	National Union	Newark, N. J.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
71286	Camloc Fastener Corp.	Paramus, N. J.	76854	Oak Manufacturing Co.	Crystal Lake, Ill.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
71313	Cardwell Condenser Corp.	Lindenhurst L. I., N. Y.	77066	The Bendix Corp. Electrodynamics Div.	N. Hollywood, Calif.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.	77075	Pacific Metals Co.	San Francisco, Calif.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.
			77071	Phanotron Instrument and Electronic Co.	South Pasadena, Calif.	80031	Mecco Division of Sessions Clock Co.	Morristown, N. J.

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H4-1 Dated AUGUST 1966
H4-2 Dated NOV. 1962

Table 6-3. Code List of Manufacturers Cont'd.

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
83058	Carr Fastener Co.	Cambridge, Mass.	91418	Radio Materials Co.	Chicago, Ill.	97464	Industrial Retaining Ring Co.	Irvington, N. J.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N. H.	91506	Augat Inc.	Attleboro, Mass.	97539	Automatic & Precision Mfg.	Englewood, N. J.
83125	General Instrument Corp., Capacitor Div.	Darlington, S. C.	91637	Dale Electronics, Inc.	Columbus, Nebr.	97979	Reon Resistor Corp.	Yonkers, N. Y.
83148	ITT Wire and Cable Div.	Los Angeles, Calif.	91662	Eico Corp.	Willow Grove, Pa.	97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N. Y.
83186	Victory Eng. Corp.	Springfield, N. J.	91737	Gremar Mfg. Co., Inc.	Wakelield, Mass.	98141	R-Tronics, Inc.	Jamaica, N. Y.
83298	Bendix Corp., Red Bank Div.	Red Bank, N. J.	91827	K F Development Co.	Redwood City, Calif.	98159	Rubber Teck, Inc.	Gardena, Calif.
83315	Hubbell Corp.	Mundelein, Ill.	91886	Malco Mfg. Co., Inc.	Chicago, Ill.	98270	Hewlett-Packard Co., Moseley Div.	Pasadena, Calif.
83330	Smith, Herman H., Inc.	Brooklyn, N. Y.	91929	Honeywell Inc., Micro Switch Div.	Freeport, Ill.	98278	Microdot, Inc.	So Pasadena, Calif.
83332	Tech Labs	Palisades Park, N. J.	91961	Nahm-Bros. Spring Co.	Oakland, Calif.	98291	Sealectro Corp.	Mamaroneck, N. Y.
83385	Central Screw Co.	Chicago, Ill.	92180	Tru-Connector Corp.	Peabody, Mass.	98376	Zero Mfg. Co.	Burbank, Calif.
83501	Gavitt Wire and Cable Co. Div. of Amerace Corp.	Brookfield, Mass.	92367	Elgeet Optical Co. Inc.	Rochester, N. Y.	98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
83594	Burroughs Corp. Electronic Tube Div.	Plainfield, N. J.	92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N. Y.	98734	Paeco Div. of Hewlett-Packard Co.	Palo Alto, Calif.
83740	Union Carbide Corp. Consumer Prod. Div.	New York, N. Y.	92702	IMC Magnetics Corp.	Wesbury Long Island, N. Y.	98821	North Hills Electronics, Inc.	Burbank, Calif.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.	92966	Hudson Lamp Co.	Kearney, N. J.	98978	International Electronic Research Corp.	Burbank, Calif.
83821	Loyd Scruggs Co.	Festus, Mo.	93332	Sylvania Electric Prod. Inc. Semiconductor Div.	Woburn, Mass.	99109	Columbia Technical Corp.	New York, N. Y.
83942	Aeronautical Inst. & Radio Co.	Lodi, N. J.	93369	Robbins & Myers Inc.	Palisades Park, N. J.	99313	Varian Associates	Palo Alto, Calif.
84171	Arco Electronics Inc.	Great Neck, N. Y.	93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio	99378	Altee Corp.	Winchester, Mass.
84396	A. J. Glesener Co., Inc.	San Francisco, Calif.	93929	G. V. Controls	Livingston, N. J.	99515	Marshall Ind., Capacitor Div.	Monrovia, Calif.
84411	TRW Capacitor Div.	Ogallala, Neb.	94137	General Cable Corp.	Bayonne, N. J.	99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
84970	Sarkis Tarzian, Inc.	Bloomington, Ind.	94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.	99800	Delevan Electronics Corp.	East Aurora, N. Y.
85454	Boonton Molding Company	Boonton, N. J.	94148	Scientific Electronics Products, Inc.	Lovejano, Colo.	99848	Wilco Corporation	Indianapolis, Ind.
85471	A. B. Boyd Co.	San Francisco, Calif.	94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N. J.	99934	Renbrandt, Inc.	Boston, Mass.
85474	R. M. Bracamonte & Co.	San Francisco, Calif.	94197	Curtiss-Wright Corp. Electronics Div.	East Paterson, N. J.	99942	Hoffman Electronics Corp Semiconductor Div.	El Monte, Calif.
85660	Koviled Kords, Inc.	Hamden, Conn.	94222	South Chester Corp.	Chester, Pa.	99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.
85911	Seamless Rubber Co.	Chicago, Ill.	94330	Wire Cloth Products, Inc.	Bellwood, Ill.			
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.	94652	Worcester Pressed Aluminum Corp.	Worcester, Mass.			
86579	Precision Rubber Products Corp.	Dayton, Ohio	94696	Magnecraft Electric Co.	Chicago, Ill.			
86684	Radio Corp. of America, Electronic Comp. & Devices Div.	Harrison, N. J.	95023	George A. Philbrick Researchers, Inc.	Boston, Mass.			
87034	Marco Industries	Anaheim, Calif.	95236	Allres Products Corp.	Dania, Fla.			
87216	Phitco Corporation (Lansdale Division)	Lansdale, Pa.	95238	Continental Connector Corp.	Woodside, N. Y.			
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.	95243	Leecraft Mfg. Co., Inc.	Long Island, N. Y.			
87664	Van Waters & Rogers Inc.	San Francisco, Calif.	95253	National Coil Co.	Sheridan, Wyo.			
87930	Tower Mfg. Corp.	Providence, R. I.	95271	Vitramon, Inc.	Bridgeport, Conn.			
88140	Cutler-Hammer, Inc.	Lincoln, Ill.	95348	Gordos Corp.	Bloomfield, N. J.	1005F	Malco Tool and Die	Los Angeles, Calif.
88220	Could-National Batteries, Inc.	St. Paul, Minn.	95354	Methode Mfg. Co.	Rolling Meadows, Ill.	10082	Willow Leather Products Corp.	Newark, N. J.
88698	General Mills, Inc.	Buffalo, N. Y.	95566	Arnold Engineering Co.	Marengo, Ill.			
89231	Graybar Electric Co.	Oakland, Calif.	95712	Dage Electric Co., Inc.	Franklin, Ind.	100AB	ETA	England
89473	G. E. Distributing Corp.	Schenectady, N. Y.	95964	Stemon Mfg. Co.	Wayne, Ill.	100BB	Precision Instrument Components Co.	Van Nuys, Calif.
89665	United Transformer Co.	Chicago, Ill.	95987	Weckesser Co.	Chicago, Ill.	100CS	Hewlett-Packard Co., Colorado Springs	Colorado Springs, Colorado
90179	US Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N. J.	96067	Huggins Laboratories	Sunnyvale, Calif.	100MM	Rubber Eng. & Development	Hayward, Calif.
90970	Beatty Engineering Co.	San Francisco, Calif.	96095	Hi-Q Div. of Aerovox Corp.	Olean, N. Y.	100NN	A "N" D Mfg. Co.	San Jose, Calif.
91146	ITT Cannon Elect. Inc.	Salem Div. Salem, Mass.	96256	Thordarson-Weissner Inc.	Mt. Carmel, Ill.	100QQ	Cooltron	Oakland, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.	96296	Solar Manufacturing Co.	Los Angeles, Calif.	100WW	California Eastern Ltd.	Burlington, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.	96330	Carlton Screw Co.	Chicago, Ill.	100YY	S. K. Smith Co.	Los Angeles, Calif.
			96341	Microwave Associates, Inc.	Burlington, Mass.			
			96501	Excel Transformer Co.	Oakland, Calif.			

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

1005F	Malco Tool and Die	Los Angeles, Calif.
10082	Willow Leather Products Corp.	Newark, N. J.
100AB	ETA	England
100BB	Precision Instrument Components Co.	Van Nuys, Calif.
100CS	Hewlett-Packard Co., Colorado Springs	Colorado Springs, Colorado
100MM	Rubber Eng. & Development	Hayward, Calif.
100NN	A "N" D Mfg. Co.	San Jose, Calif.
100QQ	Cooltron	Oakland, Calif.
100WW	California Eastern Ltd.	Burlington, Calif.
100YY	S. K. Smith Co.	Los Angeles, Calif.

SECTION VII MANUAL CHANGES

7-1. MANUAL CHANGES

7-2. Current Instruments

7-3. This manual applies directly to standard Model 5257A Transfer Oscillator having the following serial prefix number (refer to Paragraph 1-10): 976-.

7-4. Older Instruments

7-5. Backdating information to cover older instruments is included in this section. Instrument serial prefix numbers are shown under the CHANGE number heading the changes required to adapt this manual to those instruments.

7-6. Newer Instruments

7-7. As changes are made in the Model 5257A, newer instruments may have serial prefix numbers not listed in this manual. The manuals for these instruments will be supplied with an additional "Manual Changes" sheet containing the required information; contact your nearest Hewlett-Packard sales and service office for information if this sheet is missing.

CHANGE 1 Page 6-16, Table 6-1:
(804-) Change MP12 part number from 0370-0472 to 0370-0102.

Page 6-17, Table 6-2:
Change 0370-0472 to 0370-0102.

CHANGE 2 Page 8-5, Figure 8-3, A1 schematic;
(820-) Make the following changes:
A1R19 to 680 ohms.
A1Q3 to 2N3933
A1Q4 to 2N2857; delete series #820.

Page 6-3, Table 6-1;
Change A1R19 to 0757-0920 R: FXD
MET FLM 680 OHM 2% 1/4W
Change A1Q3 to 1854-0238 TRANSIS-
TOR: SIL NPN 2N3933
Change A1Q4 to HP Part No.
1854-0048

Page 8-15, Figure 8-8. A8 schematic:
Make the following changes:
A8C4 to 82 PF
Add A8C8 0.01 UF: connected Q3
emitter to ground.
Change A8C3, 5, and 10 to 1000 PF
Change A8R5 to 30 ohms
Remove asterisk from A8R12
Change A8R14, 18, 25, and 29 to
910 ohms

Change A8R16, 20, 27, and 31 to
1100 ohms
Change A8Q1, 7, and 8 to 1854-0323
Change A8Q3 to 1854-0073
Delete series number (820)

Page 6-11, Table 6-1:
Change A8C4 to 0140-0193 C: FXD
MICA 82 PF 5% 300VDCW
Add A8C8 0150-0093C: FXD CER
0.01 UF +80-20 100VDCW
Change A8C3, 5, and 10 to 0160-2327
C: FXD CER 1000 PF 20% 75VDCW

Page 6-12, Table 6-1:
Change A8R5 to 0698-3111 R: FXD
COMP 30 OHM 5% 1/8W
Change A8Q3 to HP Part No.
1854-0073
Change A8Q1, 7, and 8 to 1854-0323

Page 6-13, Table 6-1:
Change A8R14, 18, 25, and 29 to:
0757-0923 R: FXD MET FLM 910
OHM 2% 1/4W
Change A8R16, 20, 27, and 31 to:
0757-0925 R: FXD MET FLM 1100
OHM 2% 1/4W

CHANGE 3 Page 6-2, Table 6-1:
(848-) Add A1C21 0160-2143 C: FXD CER
2000 PF +80-20% 1000VDCW
Delete A1C25 0150-0031 C: FXD TI
2 PF 5% 500VDCW

Page 6-8, Table 6-1:
Change A7A1R3 0757-0939 R: FXD
MET FLM 4300 OHM 2% 1/4W

Page 6-17, Table 6-2:
Change 0150-0031 TQ to 1
Change 0160-2143 TQ to 25

Page 6-18, Table 6-2:
Change 0757-0938 TQ to 6
Change 0757-0939 TQ to 8

Page 8-5, Figure 8-3
Add A1C21: connect from junction
R22, R23, L5 to ground
Delete A1C25

Page 8-13, Figure 8-7:
Change A7A1R3 to 4300 ohms, delete
A7A1R21, connect R3 in parallel
with C4.

Section VII
Manual Changes

CHANGE 4 Page 6-3, Table 6-1:
(928-) Change A2 from 05257-60211 to
05257-60009
Change 05257-20211 to 05257-20009

Page 4-3, Paragraph 4-22, last sen-
tence: Change to read: The reference
level is adjusted with APC ADJ,
A4R10 (screw driver control).

Page 5-4, Table 5-3, APC ADJUST-
MENT, 6th sentence: Change to
read: With 5257A controls set as
above, adjust A4R10 (through top
center reading on meter).

Page 5-8: Delete Figure 5-2, Bottom
and Sides Internal View; Add Figure
7-1, Bottom and Sides Internal View

Page 6-3, Table 6-1:
Delete A4 05257-60038 BOARD ASSY:
APC 1
Add A4 05257-60005 BOARD ASSY:
APC 1
Delete A1R17 0757-0895 R: FXDMET
FLM 62 OHM 2% 1/4W*
Add A1R17 0757-0898 R: FXD MET
FLM 82 OHM 2% 1/4W
Delete A1R24 0698-6283 R: FXD
COMP 5% 1/8W

Page 6-8, Table 6-1:
Delete A7 05257-60044 VFO LINEAR-
IZER ASSY: INCL A7A1, A7A2,
A7A3
Add A7 05257-60018 VFO LINEAR-
IZER ASSY: INCL A7A1, A7A2,
A7A3

Pages 6-10, Table 6-1:
Delete A7A3C9 0150-0011C: FXD TI
1.5 PF 10% 500VDCW*

Add A7A3C9 0150-0029 C: FXD TI
1 PF 10% 500VDCW

Pages 6-15, Table 6-1:
Delete A11 05257-60031 BOARD
ASSY: POWER SUPPLY FILTER
Add A11 05257-60011 BOARD ASSY:
POWER SUPPLY FILTER

Delete A12 05257-60032 BOARD
ASSY: MASTER INTERCONNECTOR
Delete A13 05257-60033 CABLE
ASSY: THUMBWHEEL SWITCH
Delete C1 0160-2327 C: FXD CER
1000 PF 20% 100VDCW
Add C1 0150-0122 C: FXD CER 2000
PF 20% 500VDCW

Page 8-5, Figure 8-3, A1 Pulse Driver
schematic:
Delete A1R24
Change C1 to 2000 PF

Page 8-6, 5th paragraph:
Change to read: APC adjustment
A4R10 is accessible through the top
cover plate. This control is set to
give mid-scale meter reading in the
APC mode with the VFO at 100 MHz,
LEVEL full cw, and no input signal.
Change A4 APC NO. 1 block diagram
to indicate potentiometer referenced
as R2 (APC BAL) is now A4R10

Page 8-7, Figure 8-4, A3/A4
schematics:
Replace schematic with Figure 7-2
Delete A4 component locator; re-
place with Figure 7-3

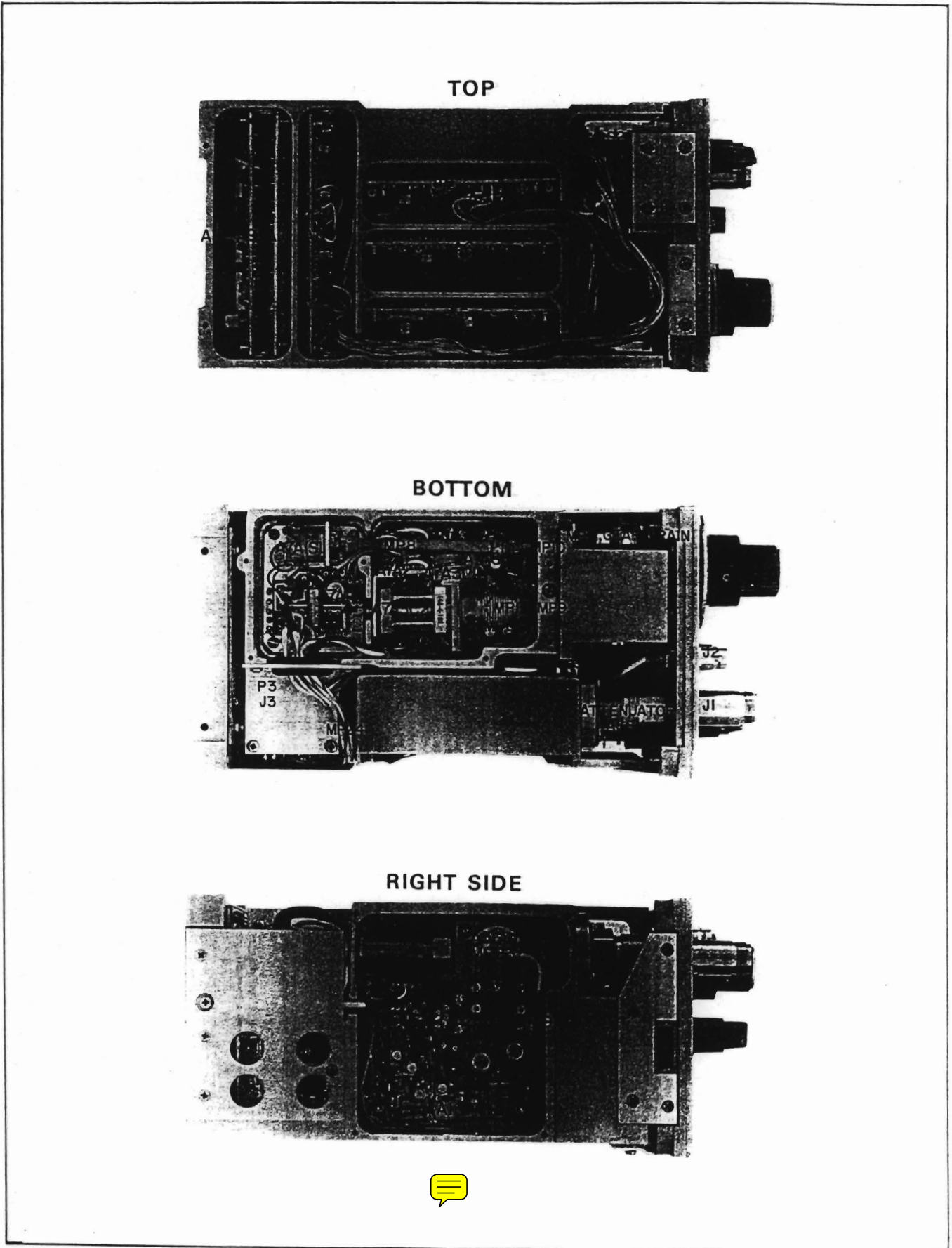
Page 8-9:
Delete A11 component locator photo:
replace with Figure 7-4

Page 8-13, Figure 8-7, A7A3
schematic
Change value of C9 from 1.5 to 1

CHANGE 5 Page 6-11, 12, 13, Table 6-1:
(0976-) Change A8 05257-60039 to 05257-
60013.
Change A8 05257-20039 to 05257-
20013.
Replace A8 components with those
listed in Table 7-1.

Page 8-15, Figure 8-8:
Replace A8 Component locator with
Figure 7-5.
Replace A8 Schematic (05257-60039)
with Figure 7-6.

Figure 7-1. Top, Bottom, and Side Internal Views



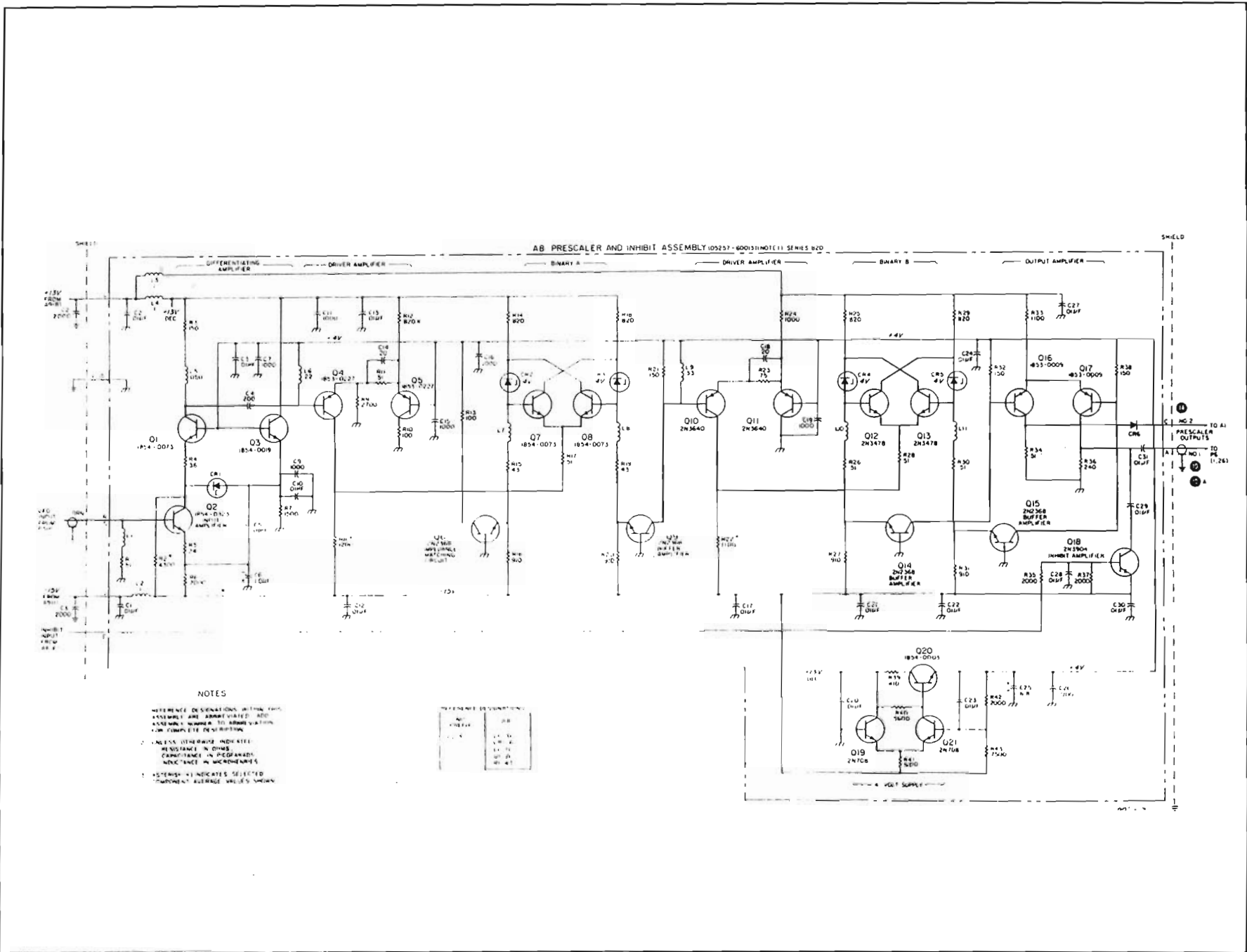


Figure 7-6. A8 Schematic

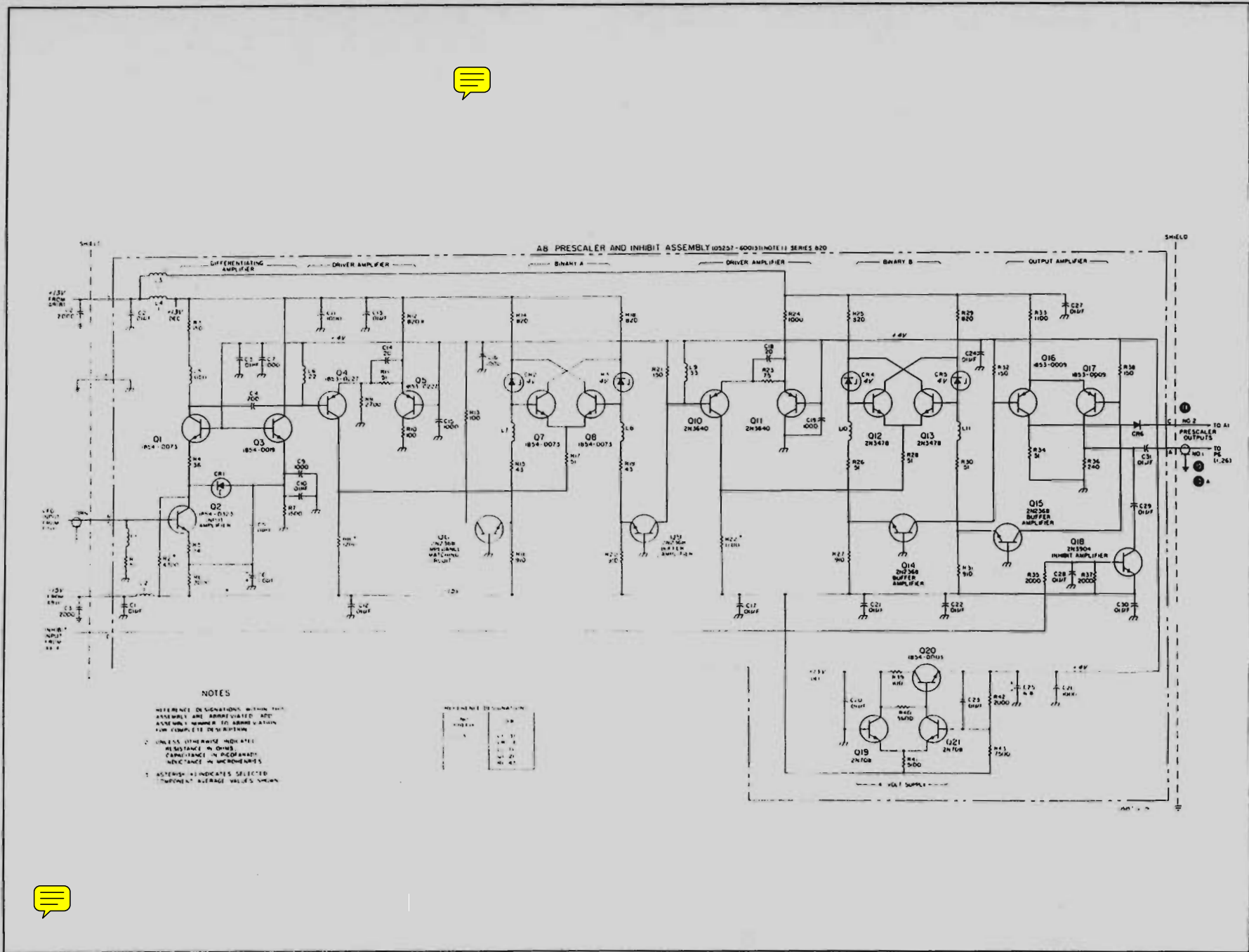


Figure 7-6. A8 Schematic

Table 7-1. A8 Prescaler Assembly (05257-60013)

Reference Designation	Part No.	Description #	Note
A8C1			
A8C2	0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	
A8C3	0160-3277	C:FXD CER .01 UF 20% 50VDCW	
A8C4	0140-0220	C:FXD MICA 200 PF 5% 300VDCW	
A8C5	0160-3277	C:FXD CER .01 UF 20% 50VDCW	
A8C6	0180-0230	C:FXD ELECT 1.0 UF 20% 50VDCW	
A8C7	0160-2327	C:FXD CER 1000 PF 20% 75VDCW	
A8C8			
A8C9	0160-2327	C:FXD CER 1000 PF 20% 75VDCW	
A8C10	0160-3277	C:FXD CER .01 UF 20% 50VDCW	
A8C11	0160-2327	C:FXD CER 1000 PF 20% 75VDCW	
A8C12	0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	
A8C13	0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	
A8C14	0150-0061	C:FXD CER 20 PF 10% 100VDCW	
A8C15	0160-2327	C:FXD CER 1000 PF 20% 75VDCW	
A8C16	0160-2327	C:FXD CER 1000 PF 20% 75VDCW	
A8C17	0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	
A8C18	0150-0035	C:FXD CER 20 PF 10% 600VDCW	
A8C19	0160-2327	C:FXD CER 1000 PF 20% 75VDCW	
A8C20	0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	
A8C21	0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	
A8C22	0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	
A8C23	0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	
A8C24	0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	
A8C25	0180-0116	C:FXD ELECT 6.8 UF 10% 35VDCW	
A8C26	0160-2327	C:FXD CER 1000 PF 20% 75VDCW	
A8C27	0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	
A8C28	0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	
A8C29	0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	
A8C30	0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	
A8C31	0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	
A8CR1	1912-0024	DIODE GERMANIUM TUNNEL:10MA	
A8CR2	1902-3079	DIODE BREAKDOWN:SILICON 4.53V	
A8CR3	1902-3079	DIODE BREAKDOWN:SILICON 4.53V	
A8CR4	1902-3079	DIODE BREAKDOWN:SILICON 4.53V	
A8CR5	1902-3079	DIODE BREAKDOWN:SILICON 4.53V	
A8CR6	1901-0179	DIODE:SILICON 15WIV	
A8L1	8180-0224	WIRE:#24 1.6" LONG	
	0890-0048	SLEEVE:TEFLON 1.3" LONG	
A8L2	9140-0158	COIL:FXD RF 1 UH 10%	
A8L3	9140-0158	COIL:FXD RF 1 UH 10%	
A8L4	9140-0158	COIL:FXD RF 1 UH 10%	
A8L5	9100-0346	COIL:FXD 0.05 UH 20%	
A8L6	9100-1724	COIL:FXD 0.22 UH 10%	
A8L7	8180-0224	WIRE:#24 1.6" LONG	
	0890-0048	SLEEVE:TEFLON 1.3" LONG	
A8L8	8180-0224	WIRE:#24 1.6" LONG	
	0890-0048	SLEEVE:TEFLON 1.3" LONG	
A8L9	9100-0368	COIL:FXD 0.33 UH 10%	
A8L10	8180-0224	WIRE:#24 1.6" LONG	
	0890-0048	SLEEVE:TEFLON 1.3" LONG	
A8L11	8180-0224	WIRE:#24 1.6" LONG	
	0890-0048	SLEEVE:TEFLON 1.3" LONG	
A8Q1	1854-0073	TRANSISTOR:NPN 2N2857	
A8Q2	1854-0323	TRANSISTOR:NPN 2N2857	
A8Q3	1854-0019	TRANSISTOR:SILICON NPN	
A8Q4	1853-0227	TRANSISTOR:SILICON PNP	

See introduction to this section for ordering information

Table 7-1. A8 Prescaler Assembly (05257-60013) (Cont'd)

Reference Designation	Part No.	Description #	Note
A805	1853-0227	TRANSISTOR:SILICON PNP	
A806	1854-0019	TRANSISTOR:SILICON NPN	
A807	1854-0073	TRANSISTOR:NPN 2N2857	
A808	1854-0073	TRANSISTOR:NPN 2N2857	
A809	1854-0019	TRANSISTOR:SILICON NPN	
A8Q10	1853-0015	TRANSISTOR:SILICON PNP 2N3640	
A8Q11	1853-0015	TRANSISTOR:SILICON PNP 2N3640	
A8Q12	1854-0073	TRANSISTOR:SILICON NPN	
A8Q13	1854-0073	TRANSISTOR:SILICON NPN	
A8Q14	1854-0019	TRANSISTOR:SILICON NPN	
A8Q15	1854-0019	TRANSISTOR:SILICON NPN	
A8Q16	1853-0009	TRANSISTOR:SILICON PNP	
A8Q17	1853-0009	TRANSISTOR:SILICON PNP	
A8Q18	1854-0215	TRANSISTOR:SILICON NPN 2N3904	
A8Q19	1854-0005	TRANSISTOR:SILICON NPN 2N708	
A8Q20	1854-0003	TRANSISTOR:NPN SILICON	
A8Q21	1854-0005	TRANSISTOR:SILICON NPN 2N708	
A8R1	0698-3378	R:FXD CARBON 51 OHM 5% 1/8W	
A8R2	0757-0939	R:FXD MET FLM 4300 OHM 2% 1/4W FACTORY SELECTED PART	
A8R3	0698-3381	R:FXD COMP 150 OHM 5% 1/8W	
A8R4	0698-5173	R:FXD COMP 36 OHM 5% 1/8W	
A8R5	0674-2405	R:FXD COMP 24 OHM 5% 1/8W	
A8R6	0757-0931	R:FXD MET FLM 2000 OHM 2% 1/4W	
A8R7	0698-5178	R:FXD COMP 1500 OHM 5% 1/8W	
A8R8	0757-0925	R:FXD MET FLM 1100 OHM 2% 1/4W	
A8R9	0757-0934	R:FXD MET FLM 2.7K OHM 2% 1/4W	
A8R10	0757-0900	R:FXD MET FLM 100 OHM 2% 1/4W	
A8R11	0698-3378	R:FXD CARBON 51 OHM 5% 1/8W	
A8R12	0757-0922	R:FXD MET FLM 820 OHM 2% 1/4W	
A8R13	0698-3113	R:FXD CARBON 100 OHM 5% 1/8W	
A8R14	0757-0922	R:FXD MET FLM 820 OHM 2% 1/4W	
A8R15	0698-3376	R:FXD COMP 43 OHM 5% 1/8W	
A8R16	0757-0923	R:FXD MET FLM 910 OHM 2% 1/4W	
A8R17	0698-3378	R:FXD CARBON 51 OHM 5% 1/8W	
A8R18	0757-0922	R:FXD MET FLM 820 OHM 2% 1/4W	
A8R19	0698-3376	R:FXD COMP 43 OHM 5% 1/8W	
A8R20	0757-0923	R:FXD MET FLM 910 OHM 2% 1/4W	
A8R21	0698-3381	R:FXD COMP 150 OHM 5% 1/8W	
A8R22	0757-0925	R:FXD MET FLM 1.1K OHM 2% 1/4W	
A8R23	0698-3380	R:FXD CARBON 75 OHM 5% 1/8W	
A8R24	0757-0924	R:FXD MET FLM 1.0K OHM 2% 1/4W	
A8R25	0757-0922	R:FXD MET FLM 820 OHM 2% 1/4W	
A8R26	0757-0893	R:FXD MET FLM 51 OHM 2% 1/4W	
A8R27	0757-0923	R:FXD MET FLM 910 OHM 2% 1/4W	
A8R28	0698-3378	R:FXD CARBON 51 OHM 5% 1/8W	
A8R29	0757-0922	R:FXD MET FLM 820 OHM 2% 1/4W	
A8R30	0757-0893	R:FXD MET FLM 51 OHM 2% 1/4W	
A8R31	0757-0923	R:FXD MET FLM 910 OHM 2% 1/4W	
A8R32	0757-0904	R:FXD MET FLM 150 OHM 2% 1/4W	
A8R33	0757-0925	R:FXD MET FLM 1.1K OHM 2% 1/4W	
A8R34	0757-0893	R:FXD MET FLM 51 OHM 2% 1/4W	
A8R35	0757-0931	R:FXD MET FLM 2000 OHM 2% 1/4W	
A8R36	0757-0909	R:FXD MET FLM 240 OHM 2% 1/4W	
A8R37	0757-0931	R:FXD MET FLM 2000 OHM 2% 1/4W	
A8R38	0757-0904	R:FXD MET FLM 150 OHM 2% 1/4W	
A8R39	0757-0900	R:FXD MET FLM 100 OHM 2% 1/4W	
A8R40	0757-0942	R:FXD MET FLM 5600 OHM 2% 1/4W	
A8R41	0757-0941	R:FXD MET FLM 5100 OHM 2% 1/4W	
A8R42	0757-0931	R:FXD MET FLM 2000 OHM 2% 1/4W	
A8R43	0757-0945	R:FXD MET FLM 7500 OHM 2% 1/4W	

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SECTION VIII CIRCUIT DIAGRAMS

8-1. INTRODUCTION

8-2. This section includes the following:

a. General Notes for Schematic Diagrams are given in Figure 8-1.

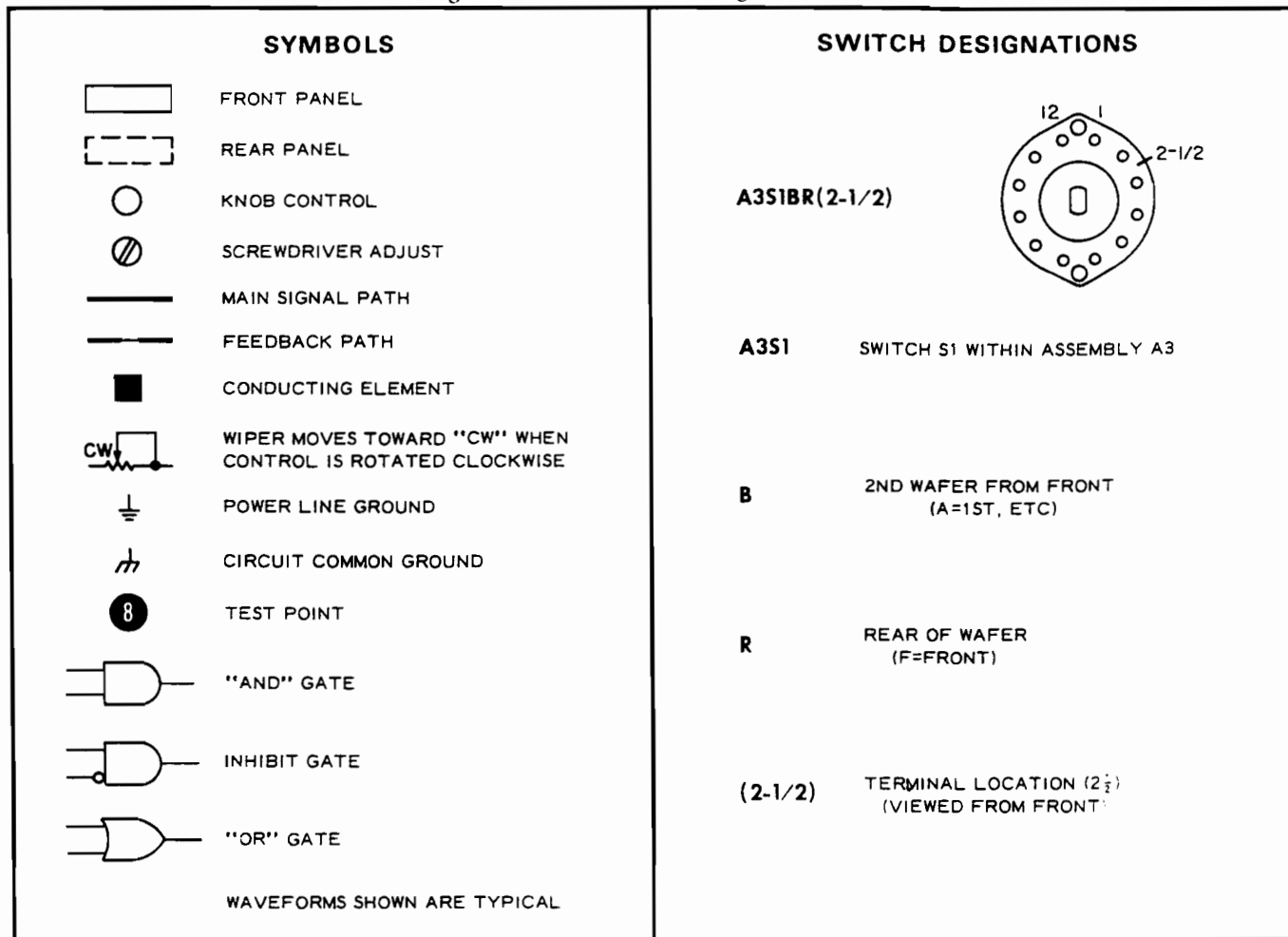
b. Block Diagram (Figure 8-2).

c. Schematic Diagrams and Component Location illustrations of Model 5257A circuits, assemblies and connectors in the order of their assembly designation (A1 through A11, Figures 8-3 through 8-10). These figures also include voltages.

8-3. The Block Diagram or any schematic diagram, when unfolded, can be used with any other part of this manual, or with the manual closed.

8-4. Dc voltages are measured with a HP Model 412A DC Voltmeter. Typical voltages are shown.

Figure 8-1. Schematic Diagram Notes



REFERENCE DESIGNATIONS

REFERENCE DESIGNATIONS WITHIN ASSEMBLIES ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.

ASSEMBLY	ABBREVIATION	COMPLETE DESCRIPTION
A25	C1	A25C1
A25A1	CR1	A25A1CR1
NO PREFIX	J3	J3

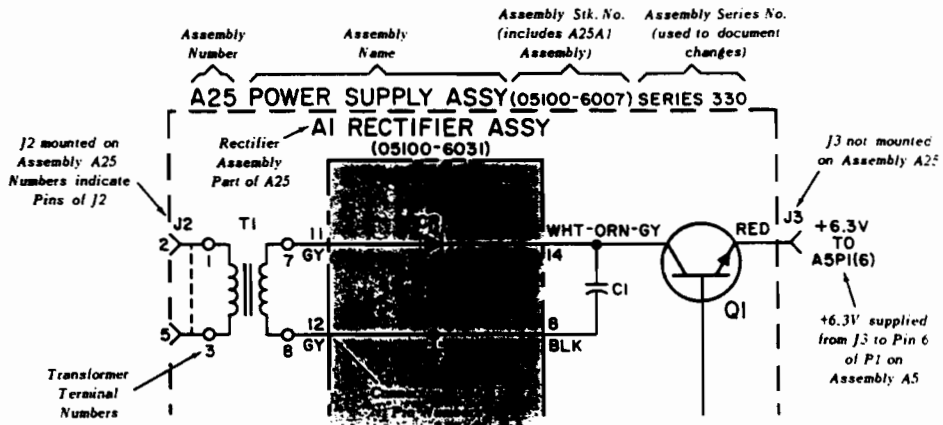


Figure 7-3. A4 Component Locator

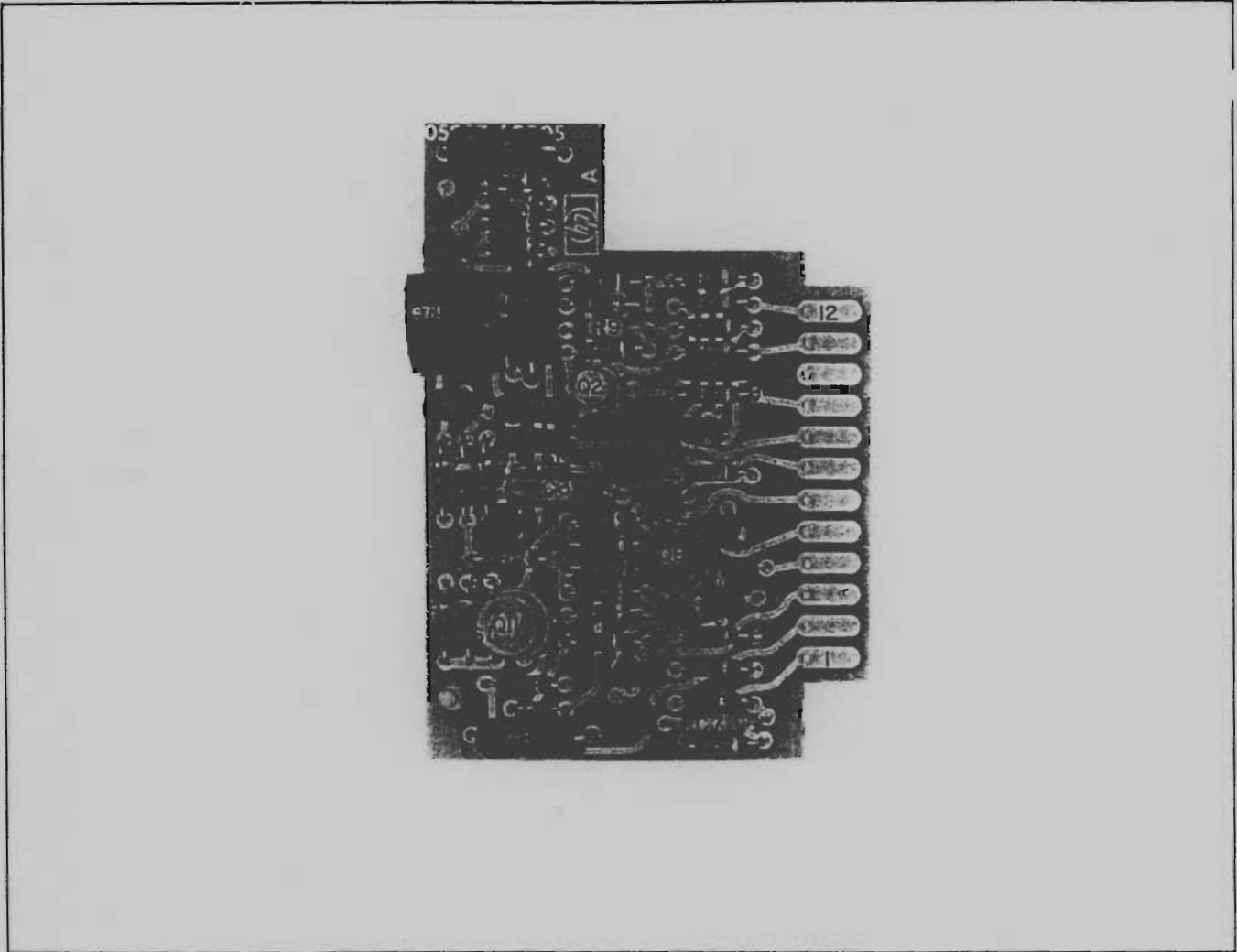


Figure 7-4. A11 Component Locator

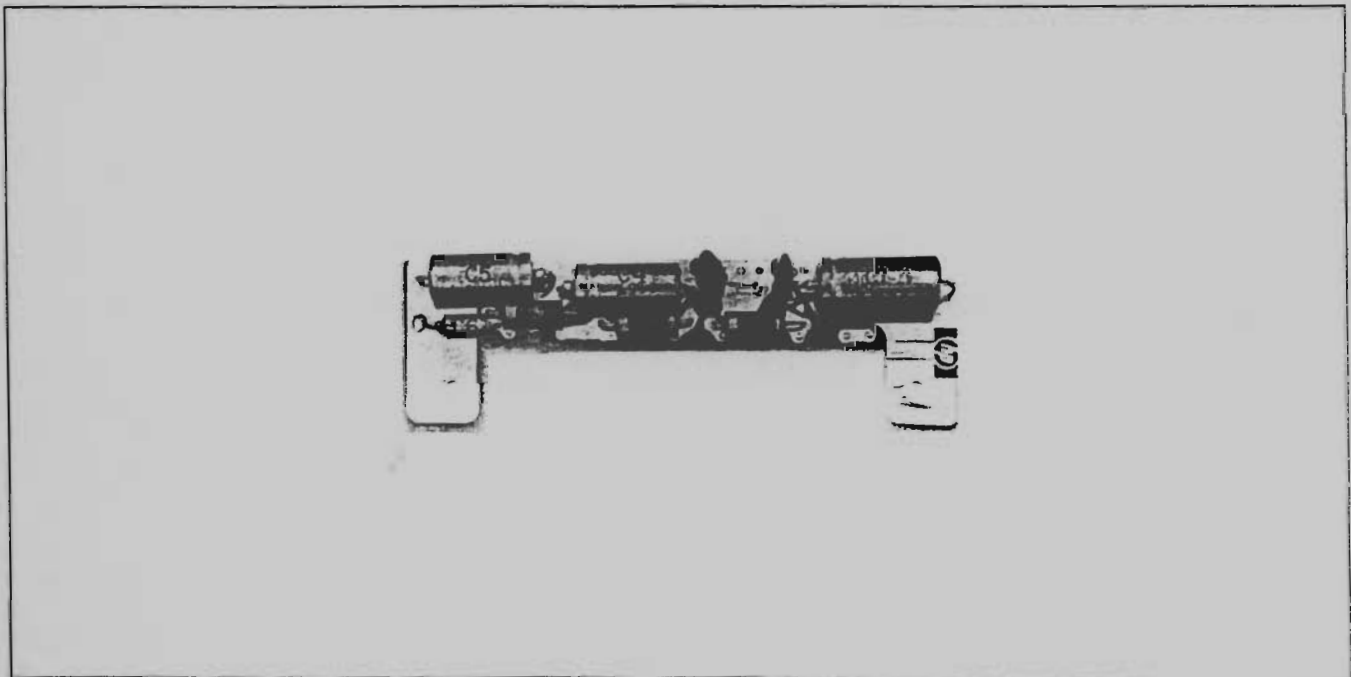
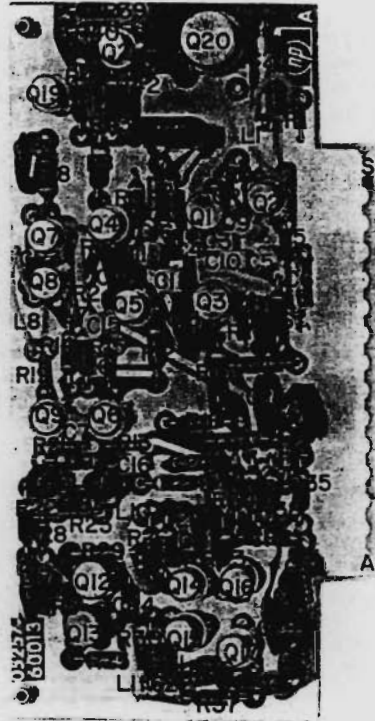
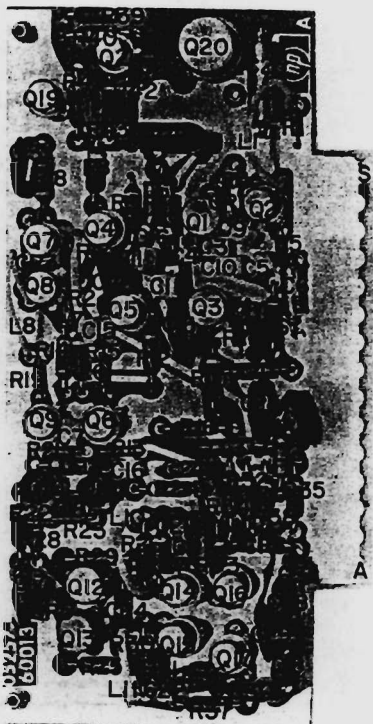
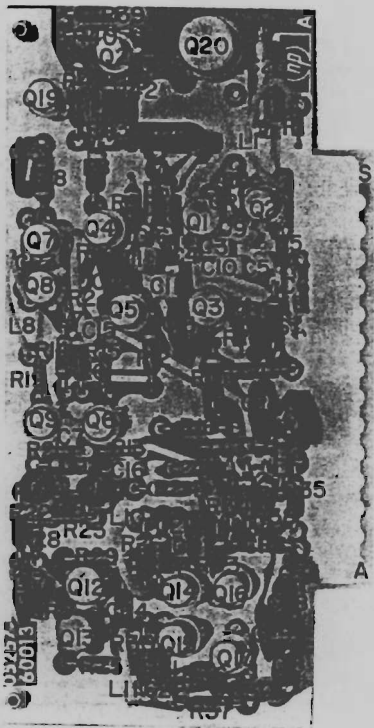


Figure 7-5. A8 Component Locator







MANUAL CHANGES

MODEL 5257A
TRANSFER OSCILLATOR

Manual Serial Prefix: 1104A

Manual Printed: APRIL 1971

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
1124A	1		

CHANGE 1
(1124A)

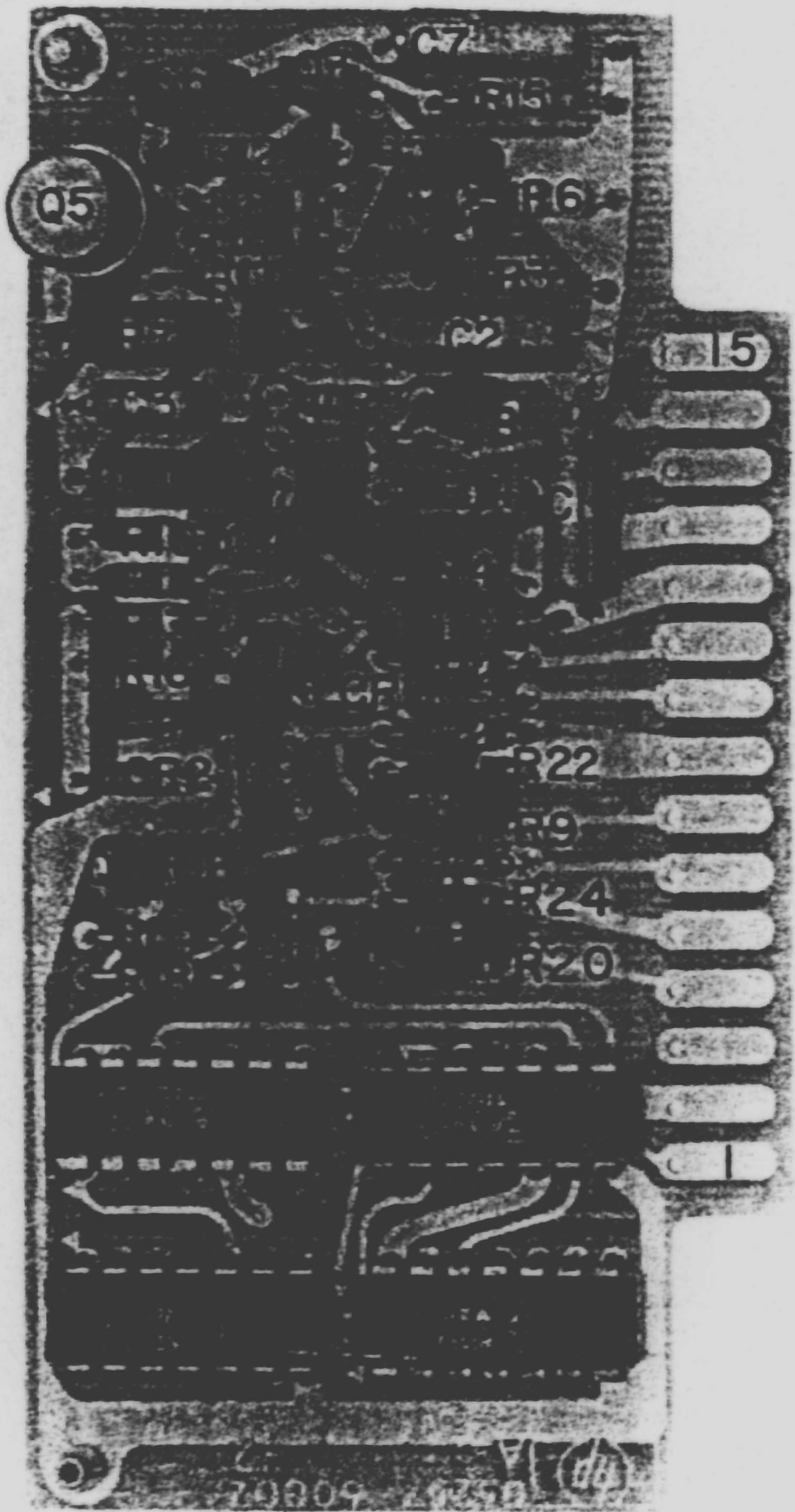
NOTE

This change provides for the new standard panel color (MINT GRAY), for plug-in instruments. The former standard color (LIGHT GRAY) is available as color option A85.

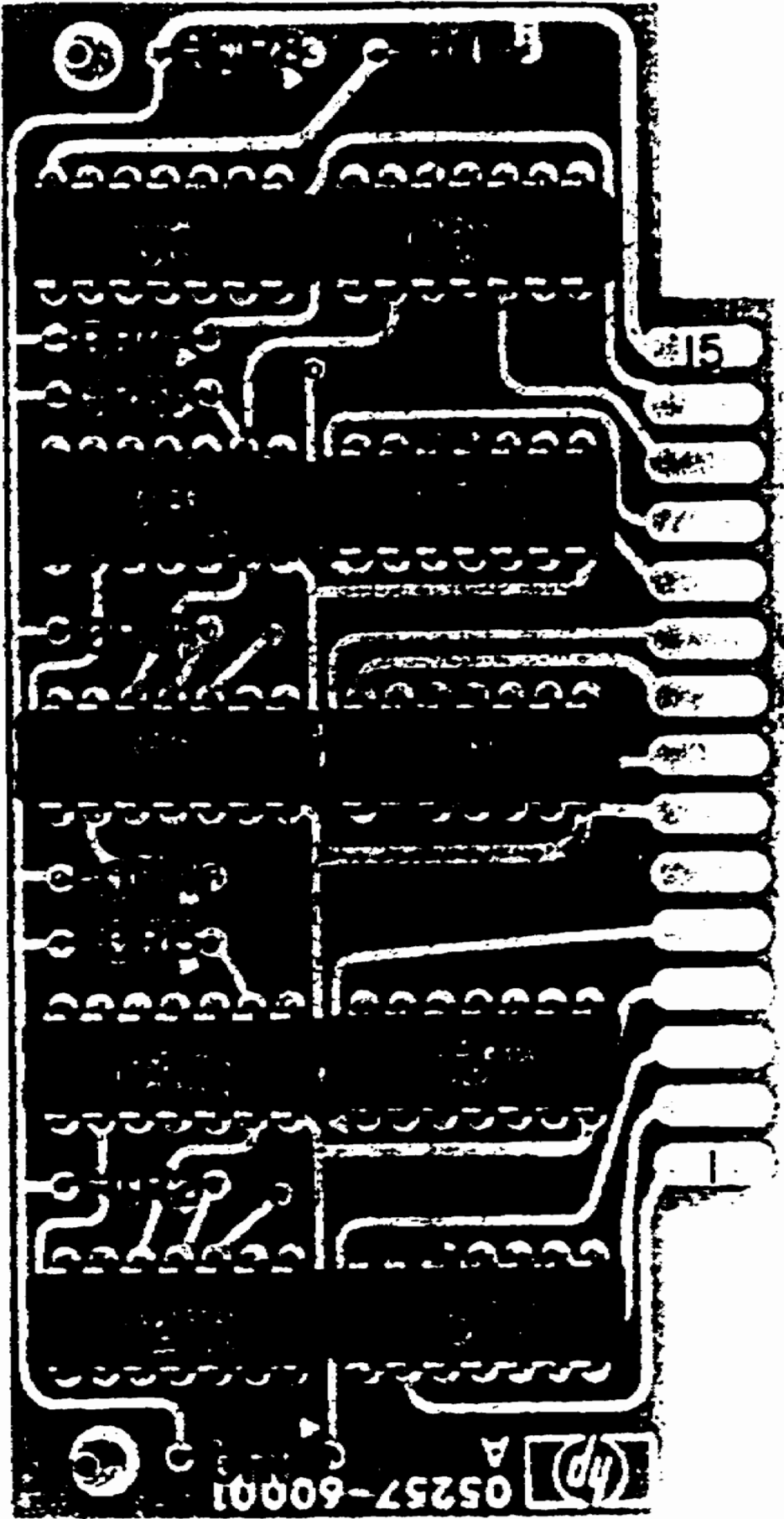
Page 6-14, Table 6-1:

Change MP21 to 05257-20085; add to description STANDARD (MINT GRAY).

Add MP20 05257-20082 PANEL: FRONT OPTION A85 (LIGHT GRAY).

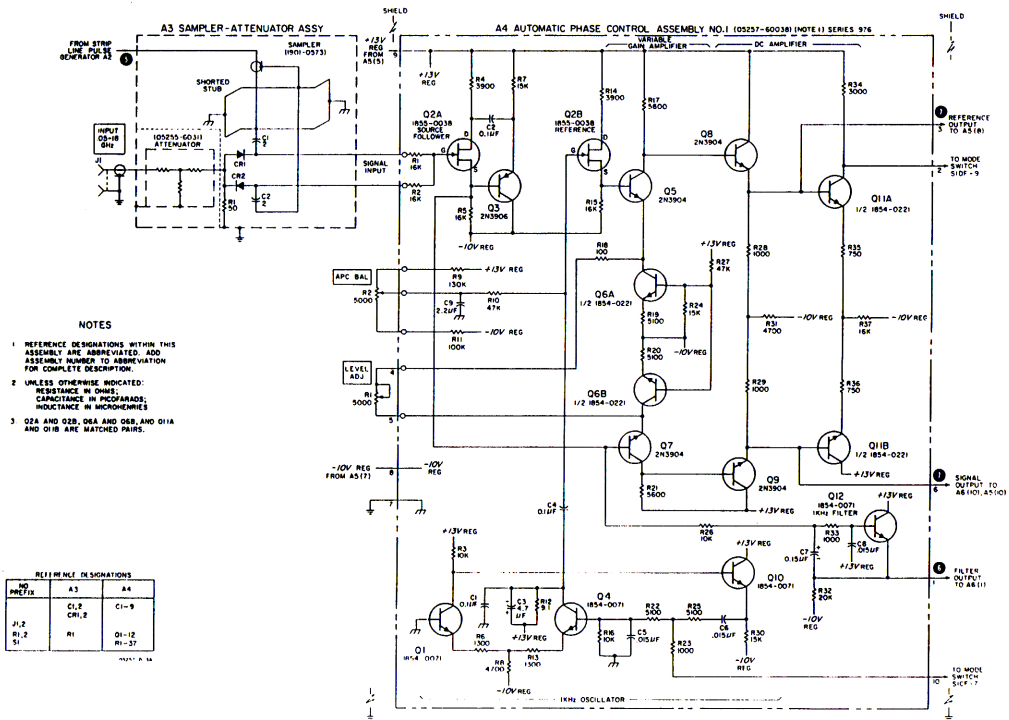


A9



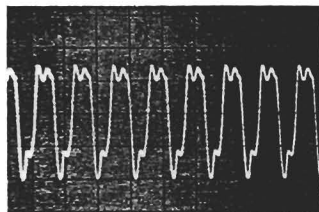
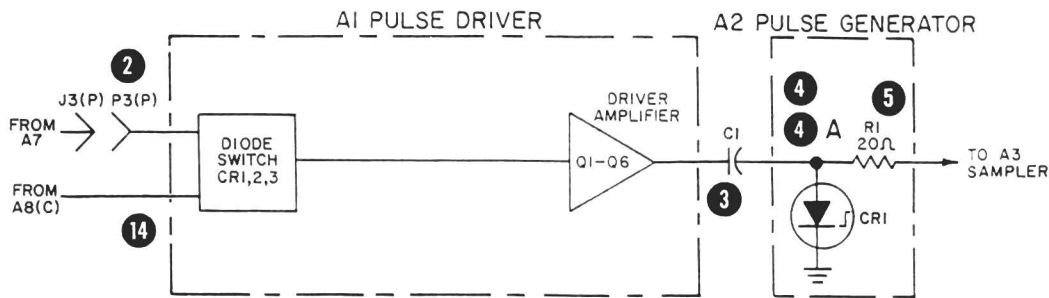
A10

Figure 7-2. A3/A4 Assembly Schematic

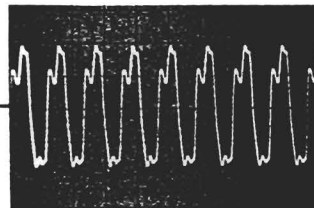


A1 operates at either the VFO frequency or 1/4 the VFO frequency. A1 gives the signal that generates the sampling pulses via the stripline pulse generator A2. In the .05-.2 GHz range, -15 V is removed from CR1, CR2, and CR3, and applied to CR4 and CR5 so that only the VFO signal that is divided by 4 is allowed to trigger the pulse driver. The reverse occurs on all other ranges. R17 is selected for best sensitivity at 18 GHz. Its value ranges from 82Ω to 240Ω . The signal at Q6 collector is about 6 volts peak-to-peak.

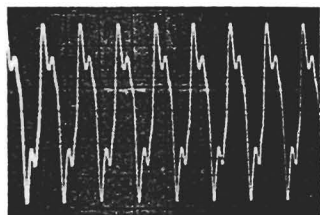
A2 generates pulses that drive the sampling diodes. A2CR1 can be open-circuited by turning the plastic screw above it ccw. This will simulate a non-sampling condition as shown by waveform 4A. The A2 output waveform 5 cannot be used to determine an RF shorted stripline. Do not attempt any repairs on A2 other than replacing CR1. Do not unsolder C1 at A2, always unsolder at A1. The contact under A2CR1 is cut to fit. A shorted stripline is usually caused by a fine wire coming through the hole on the board and touching the ground plane on the bottom causing a non-sampling condition.



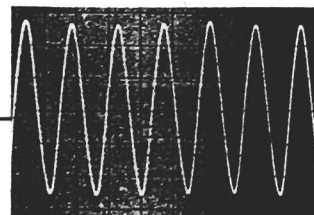
3.5 V p-p @ 17 MHz
A2CR1 OK



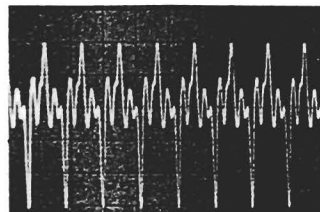
6 V p-p @ 17 MHz
collector of Q6 to grd



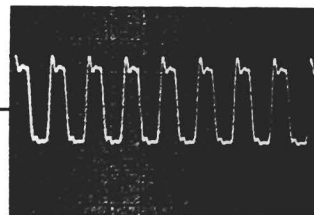
5.5 V p-p @ 17 MHz
A2CR1 open



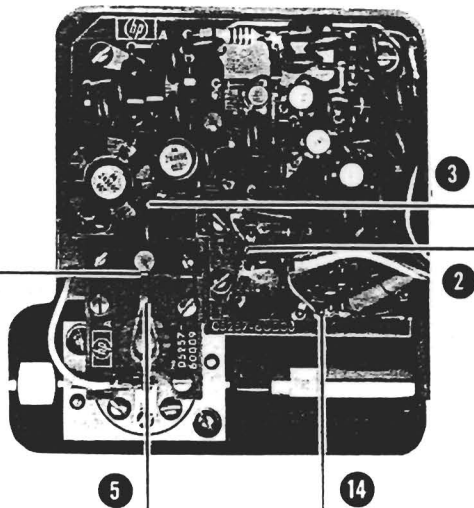
.5 V p-p @ 70 MHz
.2 GHz - 18 MHz range



.4 V p-p @ 17 MHz
after 20Ω resistor



.5 V p-p @ 17 MHz
.05-.2 GHz range



Waveforms taken with HP 180A, 1801A Vertical Amplifier and a 10004A 10 to 1 Divider Probe. The 5257A is in APC mode with no fx input, VFO at 70 MHz, .05 to .2 GHz range, LEVEL fully CW, N = 001 and sampling. Waveform notes indicate exceptions to these conditions.

A3 contains the sampling diodes which receive their input from the attenuator INPUT signal and the stripline pulse generator A2. A3 output is a low level signal that is the difference between the VFO and the sampled INPUT signal.

To check resistance at INPUT connector measure from center of INPUT connector to ground with an HP 412A. Resistance should be $50\Omega \pm 2\Omega$. If resistance is not within this range factory repair will be necessary.

Sampling diodes A3CR1 and A3CR2 may be checked with an HP 412A on the 10K range. To check A3CR1 measure from the center of INPUT connector to pin 11 on A4 circuit board connector with A4 removed. To check A3CR2 measure from the center of INPUT connector to pin 12 on A4 circuit board connector with A4 removed. The diodes should have a front to back resistance ratio of 10K to infinity. During the above tests be sure that there are no other connections to the 5257A. Replacement

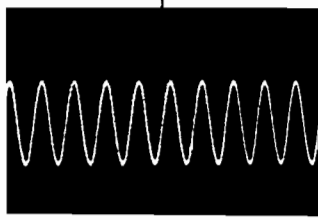
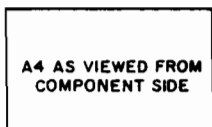
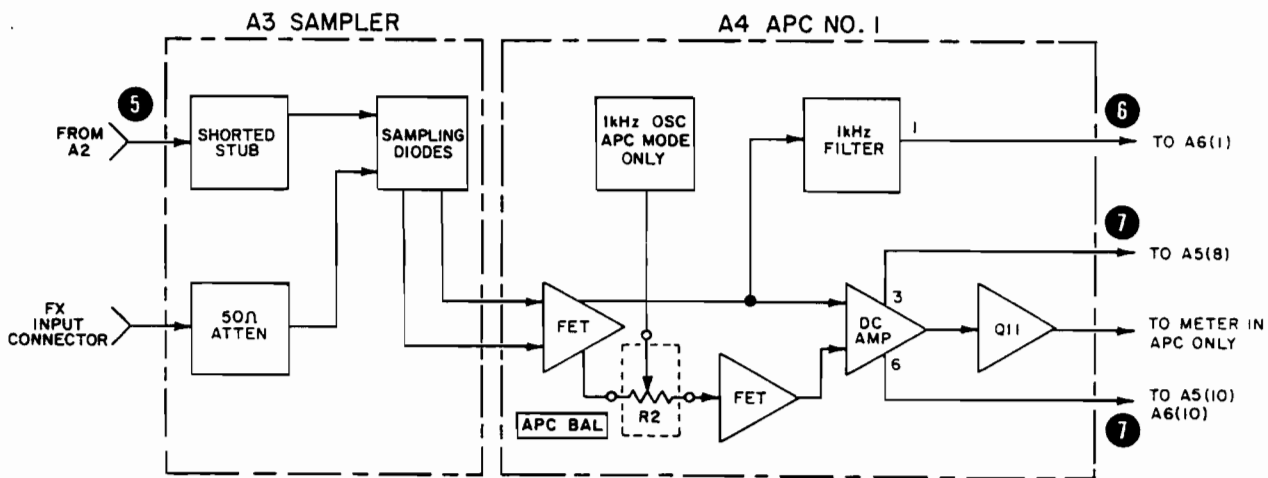
part no. for A3CR1 and A3CR2 is 1901-0617 and includes CR1, CR2, plus holder and resistor in a matched pair.

A4 circuits amplify the sampling diodes output. Amplifier bandwidth is about 1 kHz to 4 MHz. Also included on A4 are a 1 kHz oscillator and a 1 kHz filter which are part of the lock sensing circuit in the APC mode.

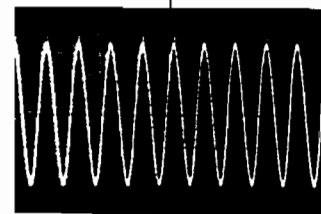
The front-panel APC BAL control is set to give midscale meter reading in the APC mode with the VFO at 100 MHz, LEVEL ADJ full cw, and no input signal.

Lock sensing can be checked by checking the dc voltage at A6(6). A voltage of -15 V indicates phase lock and Counter enabled; -7V indicates no phase lock and Counter is disabled.

A4 output waveforms at pins 3 and 6 are shown below as waveform no. 7.



* If sampling there is a small, <20 mV signal here in no lock condition.

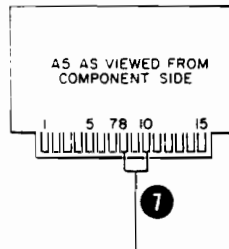
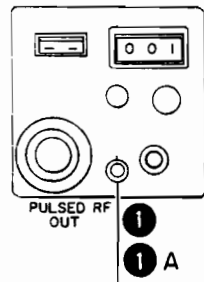
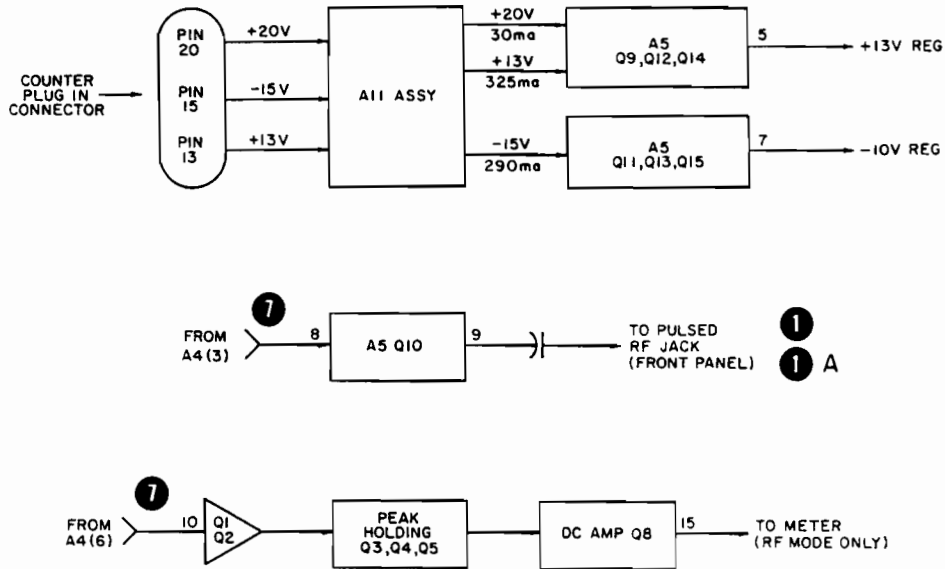


Waveforms taken with HP 180A, 1801A Vertical Amplifier and a 10004A 10 to 1 Divider Probe. The 5257A in APC mode with no fx input, VFO at 70 MHz, .05 to .2 GHz range, LEVEL fully CW, N = 001 and sampling.

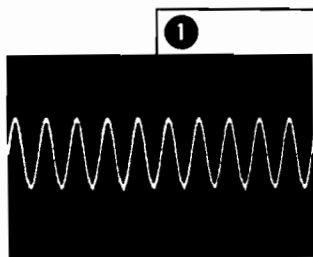
A11 assembly is located at the rear of the 5257A above the plug-in connector. It filters and feeds power supply voltages from Counter to the 5257A regulators. Check this assembly for burned coils.

A5 assembly regulates power supply voltages. The +13 V and -10 V can be $\pm .5$ V. These levels

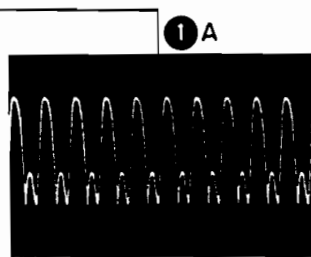
can affect adjustment of A4R10. Q10 is amplifier for isolation of pulses appearing at the Pulsed RF Out jack. The signal that appears at Q1, Q2 is converted by peak holding circuits so that the meter acts as a zero beat detector in the RF mode. The meter is not connected to this circuit in the APC mode.



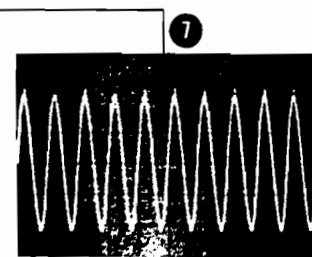
PIN 1 = -20V
PIN 5 = -13V
PIN 7 = -10V



.5V p-p @ 1 kHz, sampling



5.5V p-p @ 1 kHz, not sampling



.5V p-p @ 1 kHz, A4(6) or (3)

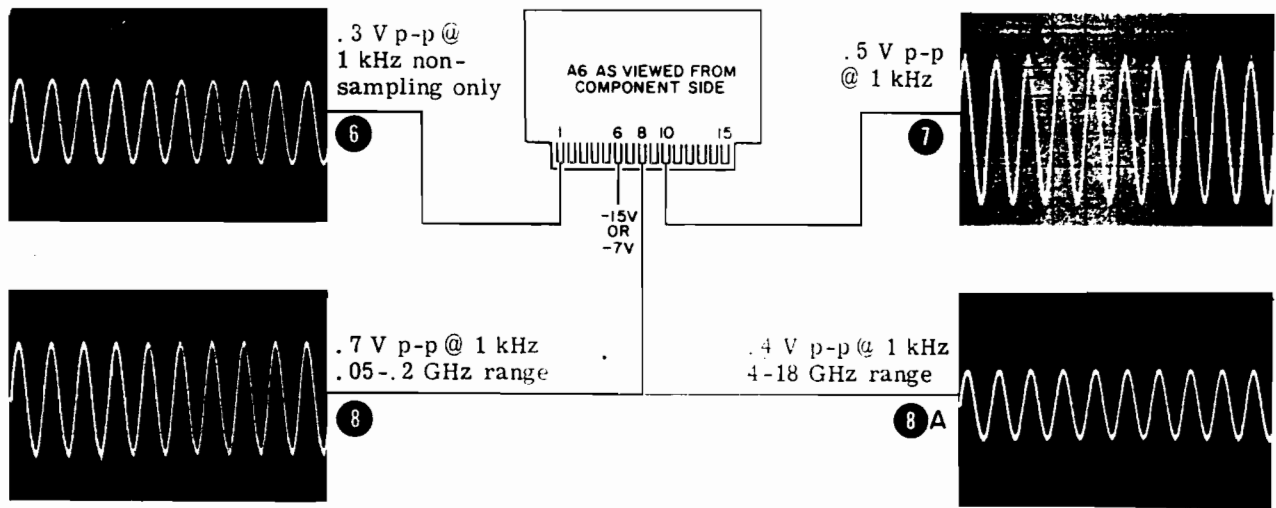
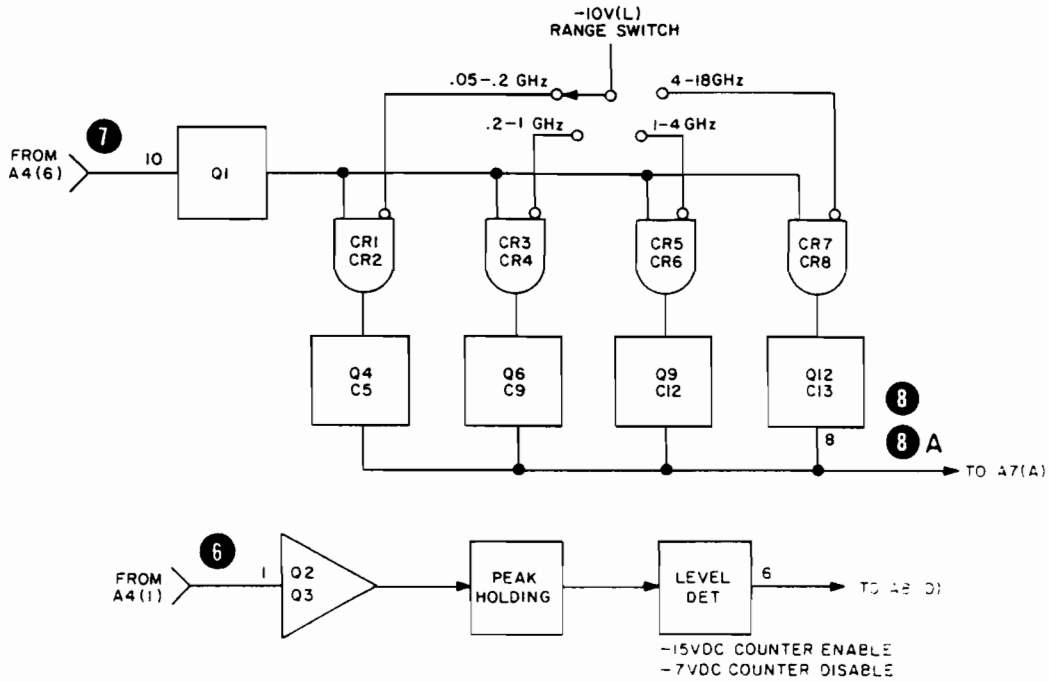
Waveforms taken with HP 180A, 1801A Vertical Amplifier and a 10004A 10 to 1 Divider Probe. The 5257A in APC mode with no fx input, VFO at 70 MHz, .05 to .2 GHz range, LEVEL fully CW, N = 001 and sampling.

A6 gives frequency compensation for the phase lock loop. Each range has a different time constant inserted into the loop to give the following -3 dB points: RANGE -3 dB
 .05 to .2 GHz 70 kHz
 .2 to 1 GHz 16 kHz
 1 to 4 GHz 3 kHz
 4 to 18 GHz 800 Hz

Note: This is not the loop bandwidth.

A6 also contains parts of the system lock indicator. In the APC mode with a phase lock condition a 1 kHz signal appears at Q2 input. The level must be greater than 20 mV and will cause -15 V at pin 6 to enable the Counter.

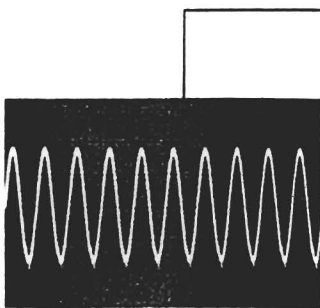
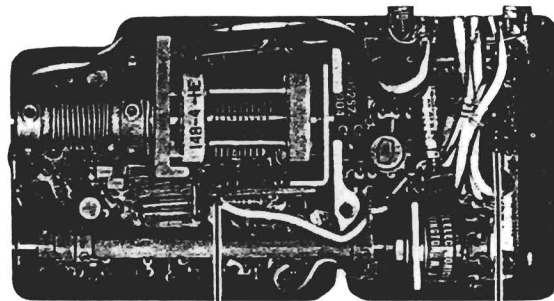
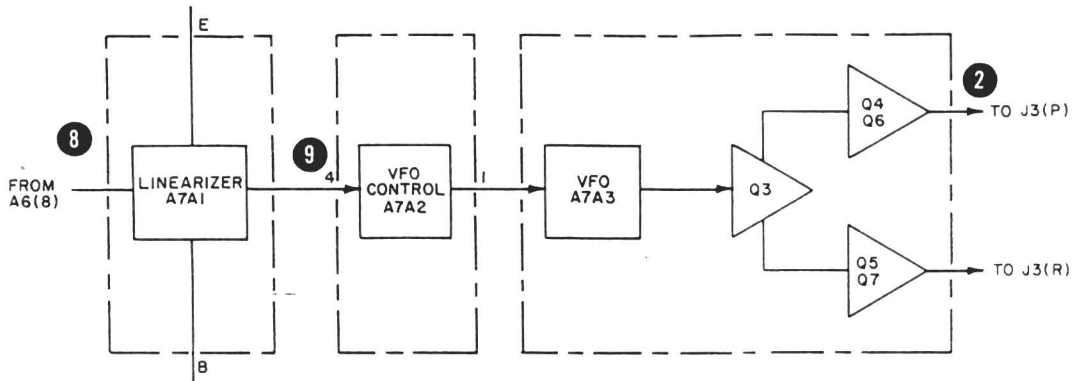
The waveform at point 6 was taken with the unit sampling. The level at this point is small so check the dc output voltage for proper indication.



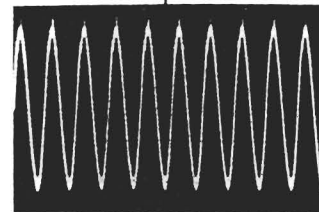
Waveforms taken with an HP 180A, 1801A Vertical Amplifier and a 10004A 10 to 1 Divider Probe. The 5257A in APC mode with no fx input, VFO at 70 MHz, .05 to .2 GHz range, LEVEL fully CW. N = 001 and sampling. Waveform 8A taken with RANGE set to 4-18 GHz.

A7 includes three circuit boards, 1) linearizer A7A1, 2) VFO control A7A2, and 3) VFO A7A3. The frequency range is 66.7 to 133.3 MHz and is the signal displayed by the Counter after prescaler A8. In the APC mode input is from A6. In the PRF mode pin E is grounded and -15 V is applied to pin B which sets point 9 at approximately +8 V as measured with an HP 412A. In the PRF mode

a signal from A6 has no effect on A7A2. The linearizer is enabled in the APC mode and holds the VFO level over the tuning range by inserting R8 through R17 into the loop. At 133.3 MHz all the resistors are used. The VFO control A7A2 uses two reverse biased varicaps CR1 and CR2. The capacitance is inversely proportional to the bias (an increase in bias decreases the capacitance).



2.5 V p-p @ 1 kHz
(PRF mode measure
approx. +8 V on HP 412A)



.7 V p-p @ 1 kHz

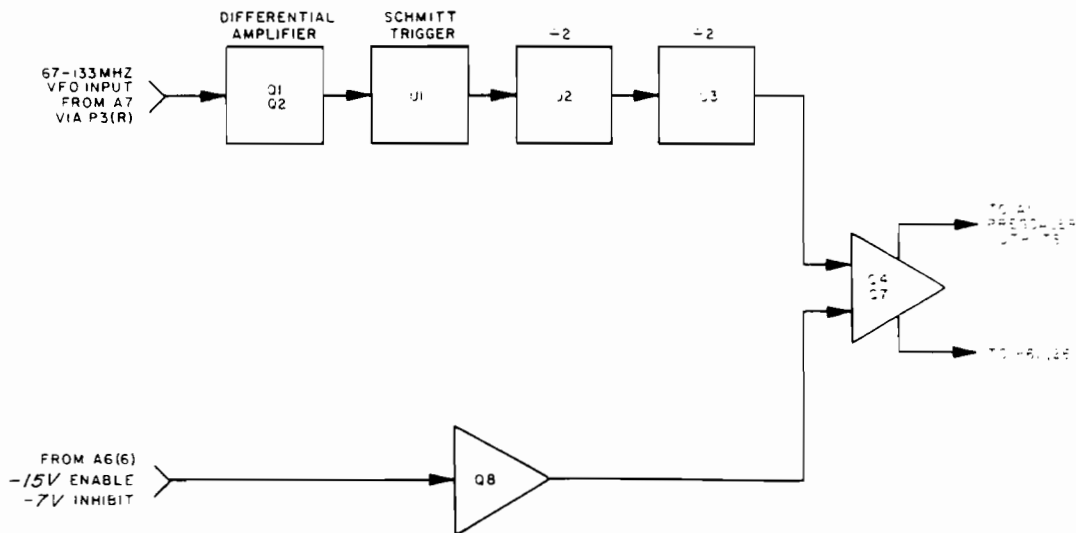
Waveforms taken with an HP 180A, 1801A Vertical Amplifier and a 10004A 10 to 1 Divider Probe. The 5257A in APC mode with no fx input, VFO at 70 MHz, .05 to .2 GHz range, LEVEL fully CW, N = 001 and sampling. Waveform 9 note indicates dc volts for PRF mode.

A8 (see block diagram below) converts the input signal into square waves of relatively constant amplitude at exactly 1/4 of the input frequency. That constant amplitude square wave is the counted signal. The other output is applied to the A1 pulse driver in the .05 to .2 GHz range only. R8 should be adjusted for a stable count at 200 MHz with an 80 mV input signal.

C81 and Q3 provide a current source for differential amplifier Q1 and Q2. U1 is a Schmitt Trigger which sharpens the waveform for divide-by-two integrated circuits U2 and U3. The square waves out of U3(4) and (6) and 1/4 of the input frequency. Emitter followers Q5 and Q6 level shift those

square waves which are then amplified by Q4 and A7.

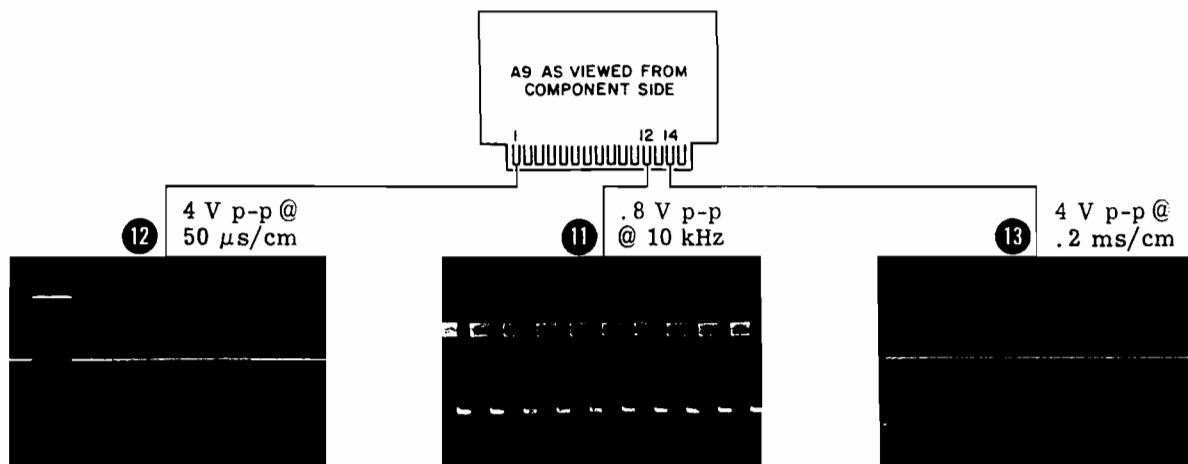
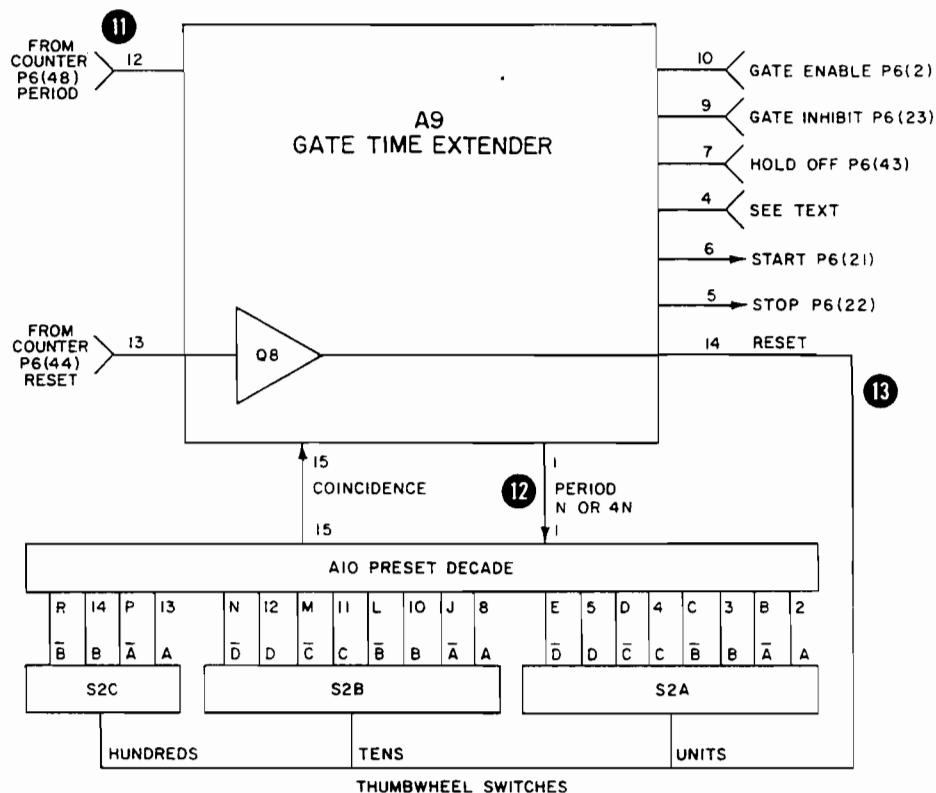
In the APC mode, when the VFO is not phase locked, an INHIBIT signal from the A6 assembly will prohibit the counted signal at the output of the prescaler from being applied to the counter. The -7V INHIBIT signal from A6 is applied to Q8, turning it on. During the time Q8 is on, there is a short circuit to ground through C8, Q8, and C9 at the counted frequency. If the VFO becomes phase locked, a -15V ENABLE signal from the A6 assembly cuts off Q8 and the counted signal is coupled through C7 to the counter. In the Pulsed RF mode of operation, the input to Q8 is always -15V.



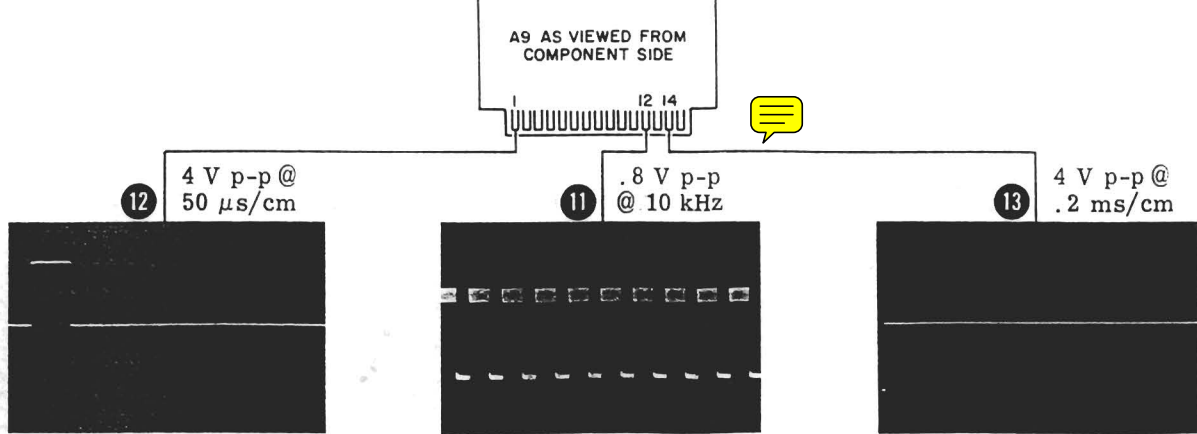
A9 gives start and stop signals for Counter gating. It receives reset, period, gate enable, gate inhibit, and holdoff from Counter. The output period is N on the .05-.2 GHz range with pin 4 grounded. On all other ranges the output period is 4N with pin 4 ungrounded. On the .05-.2 GHz range the counted signal will be 1/4 the FREQUENCY dial reading. On all other ranges, the counter signal is the FREQUENCY dial reading if the thumbwheel switches are set to 001. A10 extends the Counter gate time by any desired integer up to 227.

Note that integers up to 399 can be set, but are not used for practical measurements.

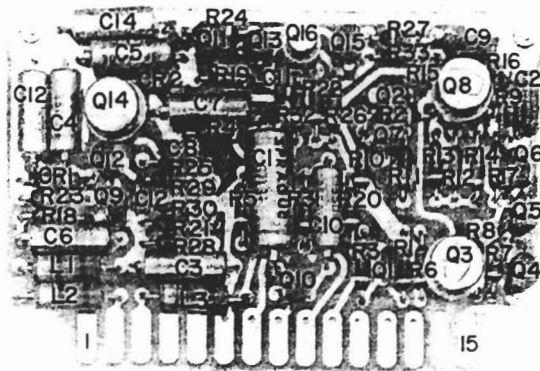
The thumbwheel switches on the front panel are used to dial the integer by which the Counter gate time is multiplied. These switches can be checked independently from the rest of the instrument by performing gate extender check in Paragraph 5-17. The VFO section must be operating for the complete test but if the gate light is cycling it is a good indication of proper operation of A9 and A10.



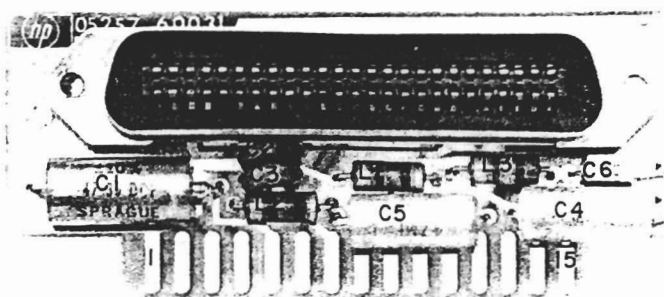
Waveforms taken with an HP 180A, 1801A Vertical Amplifier and a 10004A 10 to 1 Divider Probe. The 5257A in APC mode with no fx input, VFO at 70 MHz, .05 to .2 GHz range, LEVEL fully CW, N = 001 and sampling. Counter TIME BASE set to .1 ms.



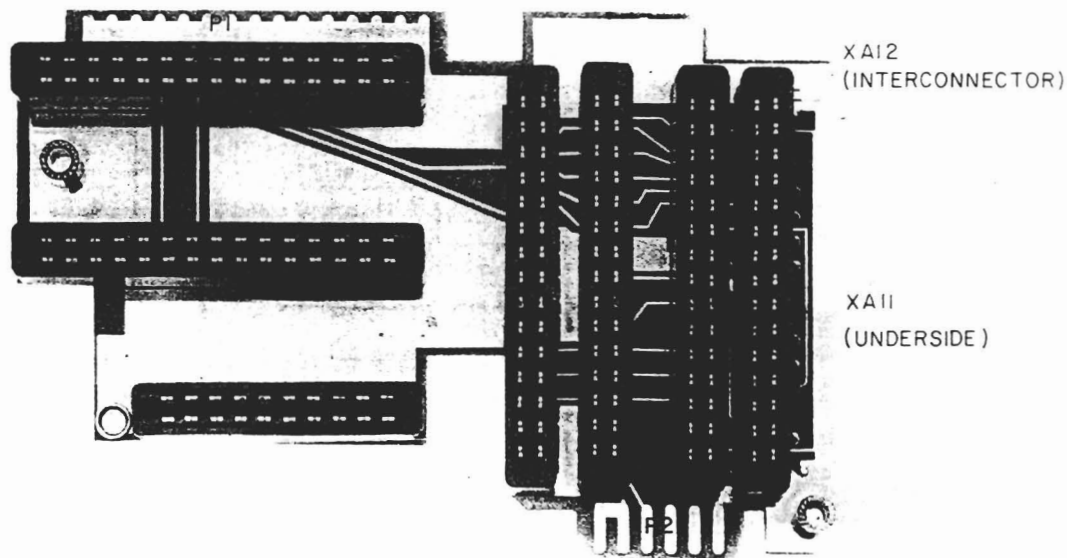
Waveforms taken with an HP 180A, 1801A Vertical Amplifier and a 10004A 10 to 1 Divider Probe. The 5257A in APC mode with no fx input, VFO at 70 MHz, .05 to .2 GHz range, LEVEL fully CW, N = 001 and sampling. Counter TIME BASE set to .1 ms.



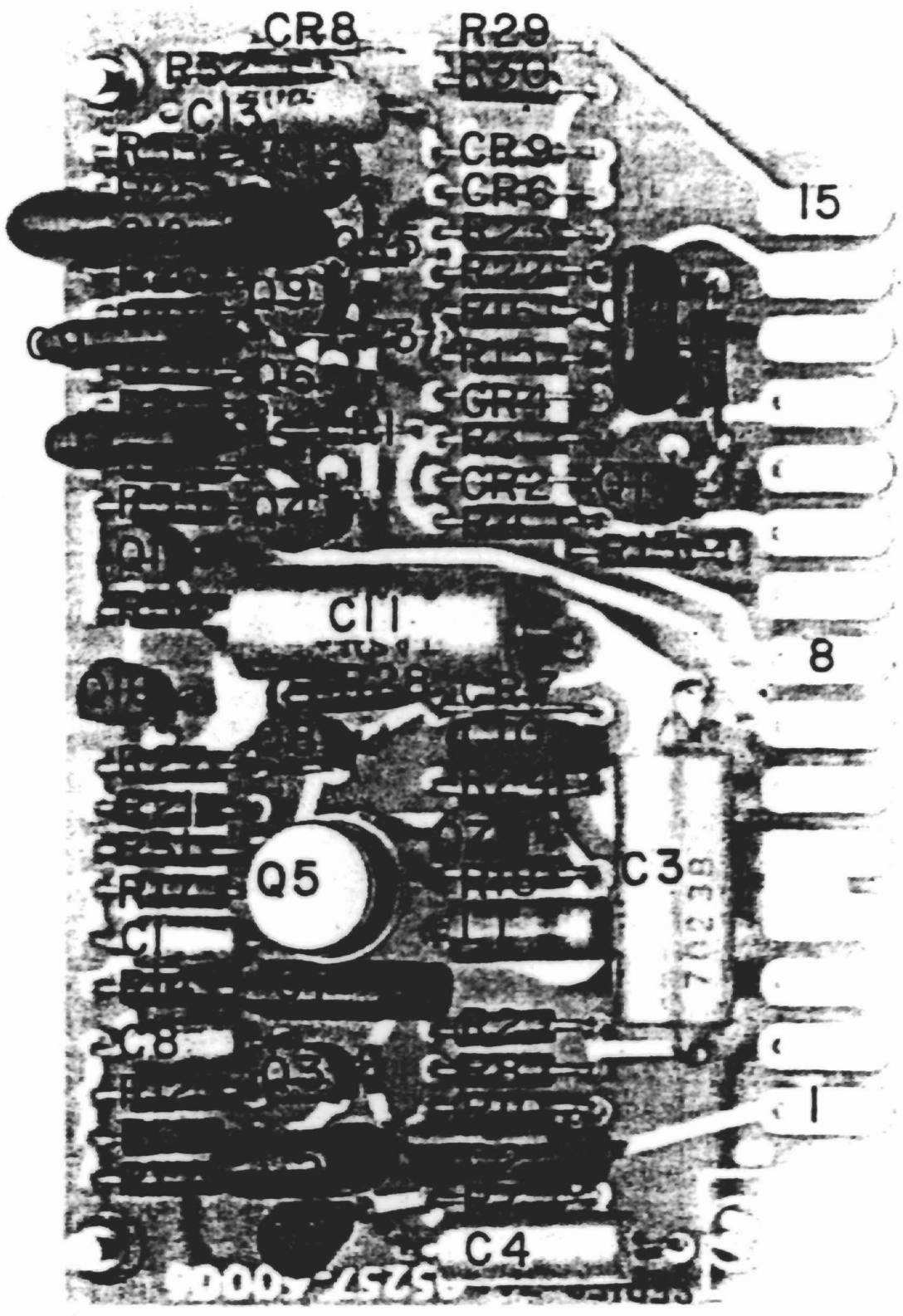
A5



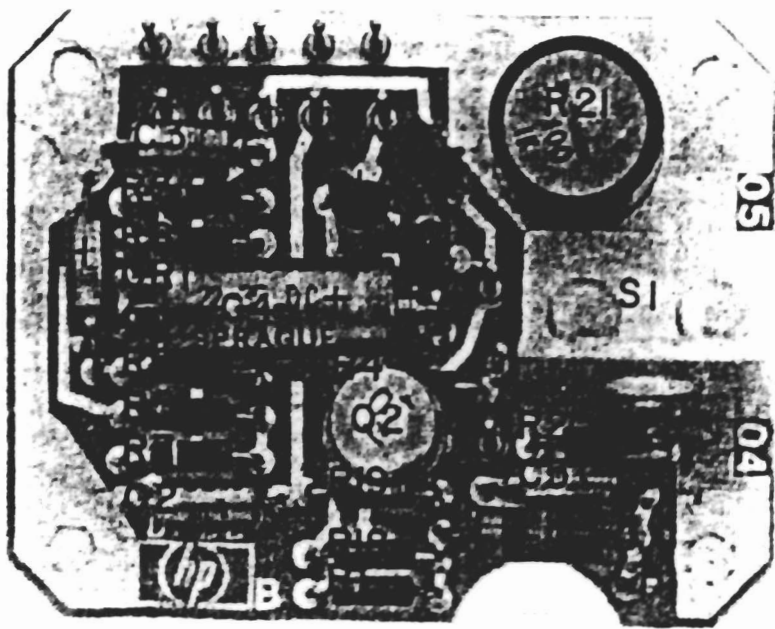
A11



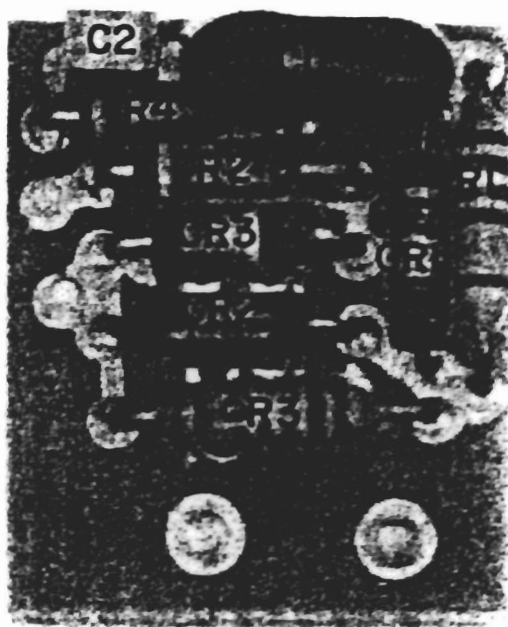
XA12



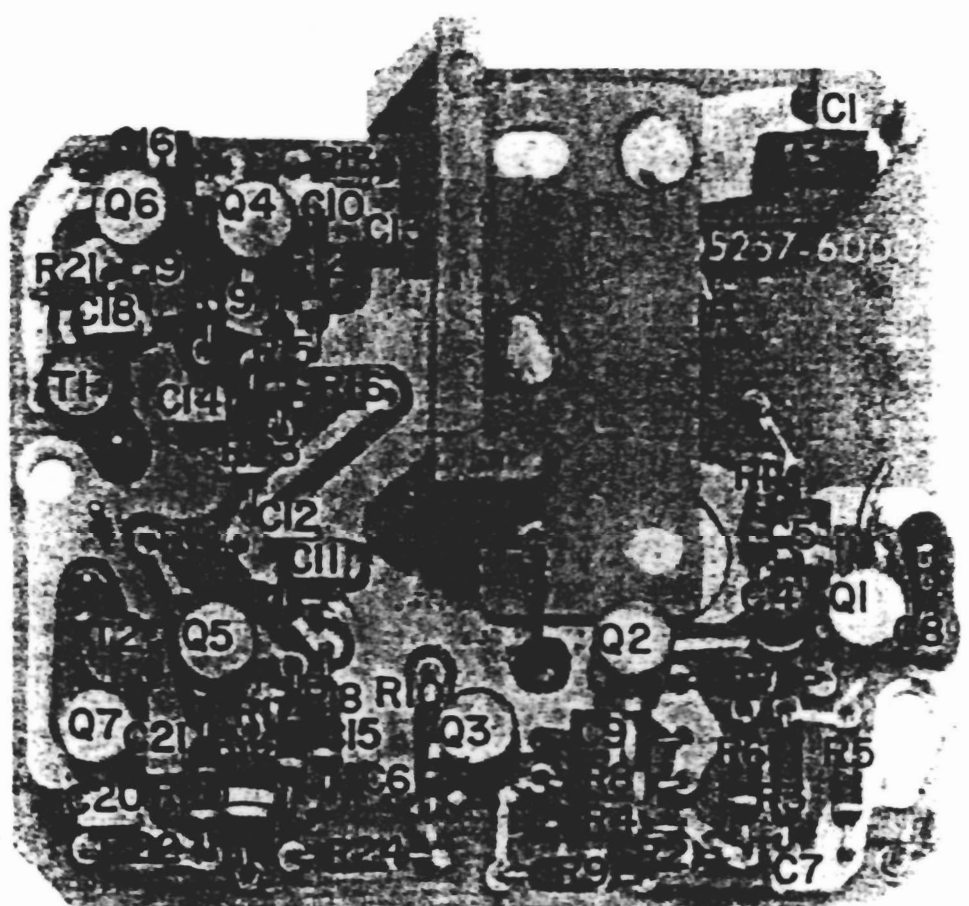
A6



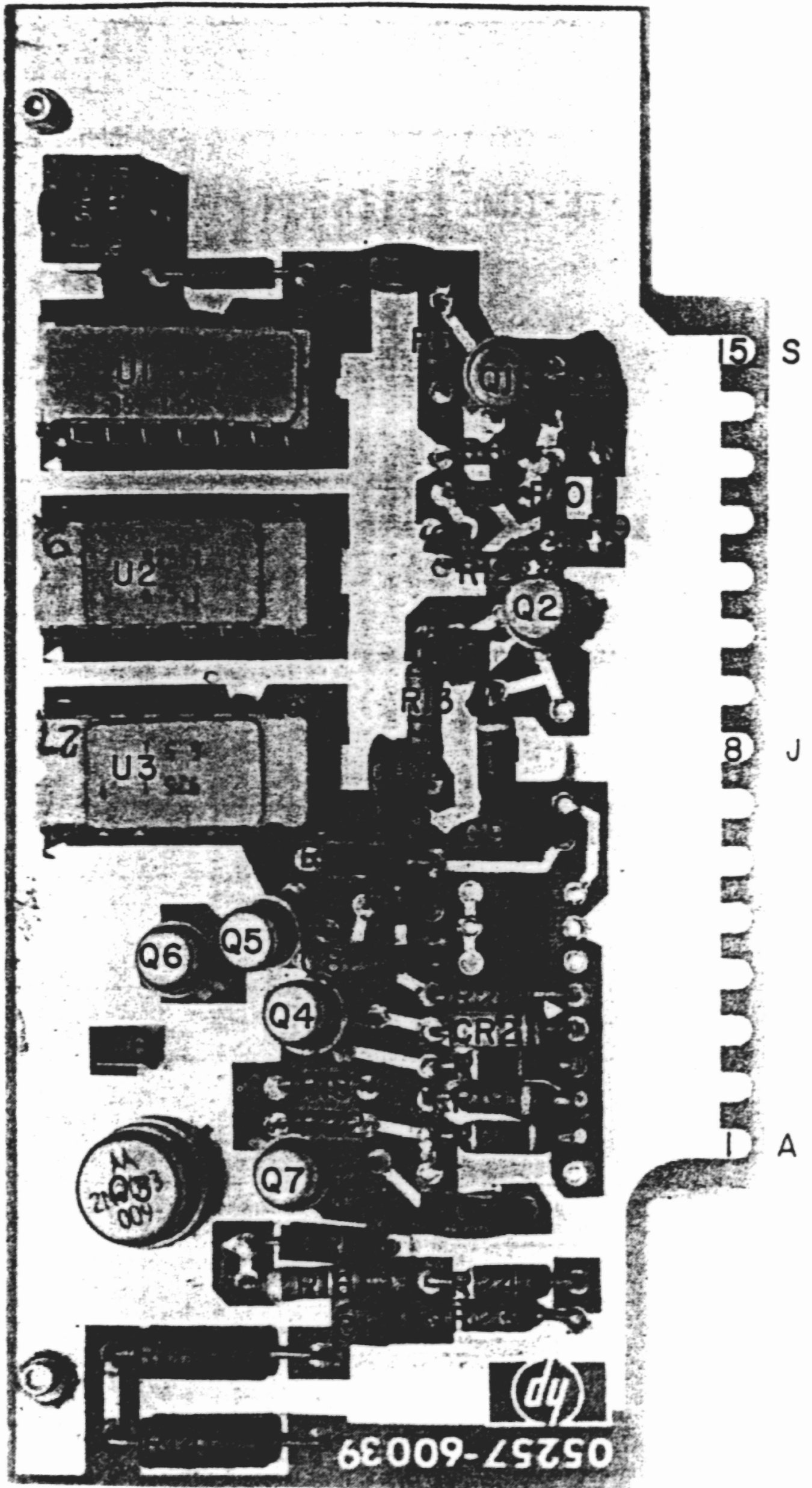
A7A1



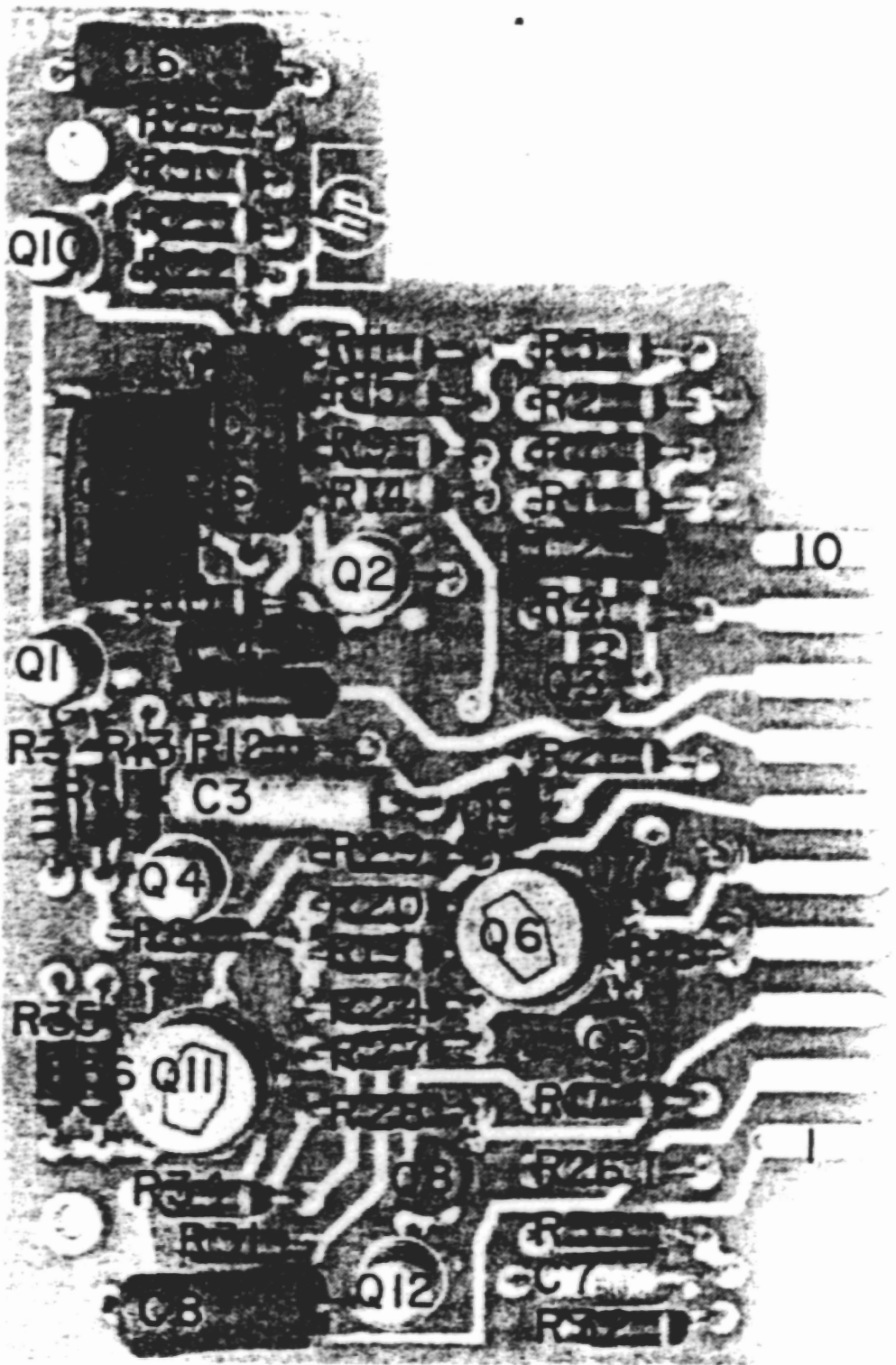
A7A2



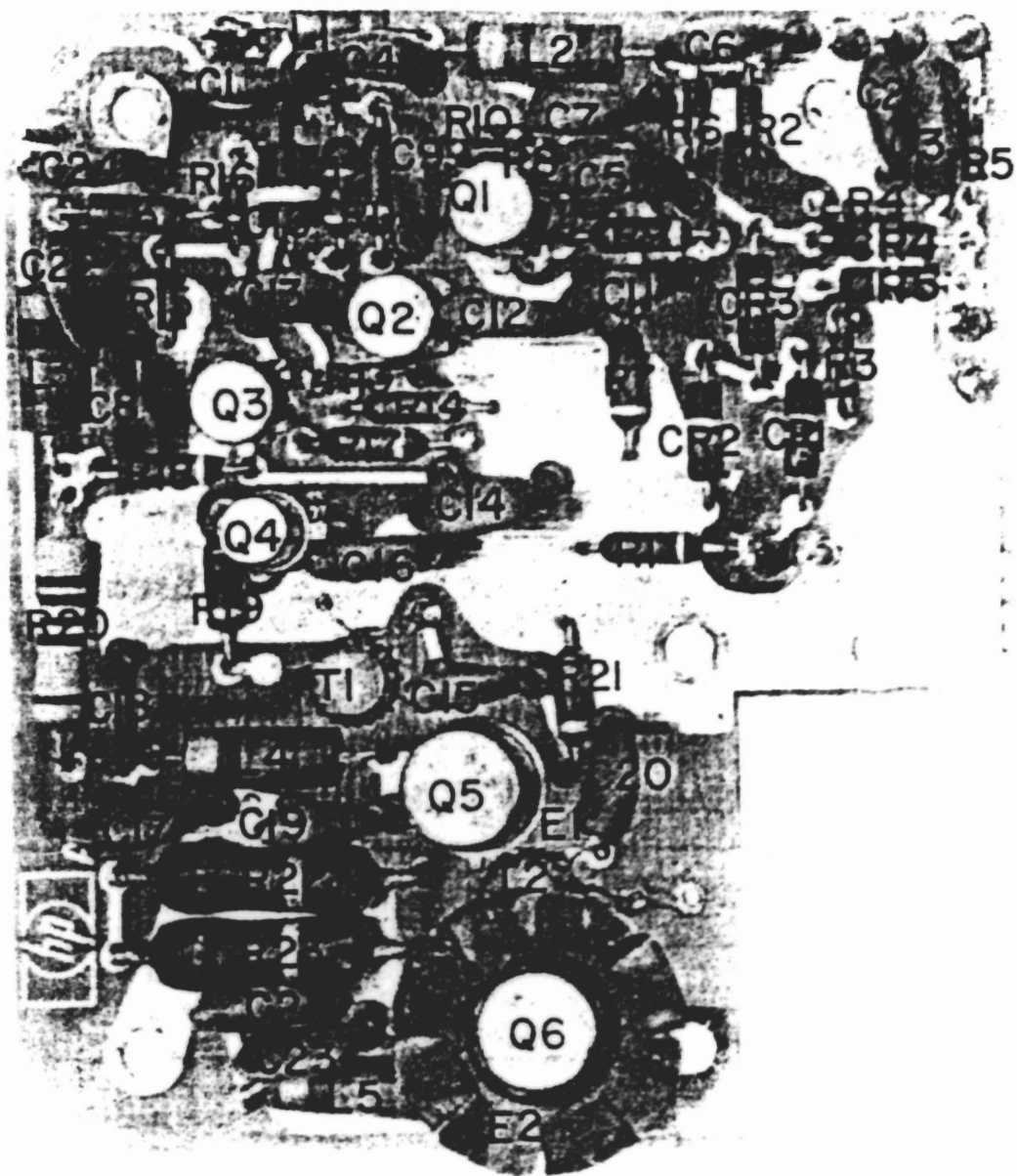
A7A3



A8



A4



A1



A2

THE END

Rather a challenge as the scanned material is much like you see here – some generations old.

MW March 2007

What follows is a useful download about nixie displays. About half way through there is a description of the display used in this counter.

NIXIE TUBE DISPLAYS

The Nixie tube ("Numerical Indicator eXperimental") was invented in 1952 by the Haydu brothers and soon commercialized by the Burroughs Corporation. The standard display consists of ten individual digit wires inside a vacuum tube. Applying a small amount of current at a relatively high voltage causes the wire to glow, illuminating the digit.



Nixies have long since been replaced by light-emitting diode (LED) and liquid crystal (LCD) displays, but I am interested in collecting and preserving these classic pieces of electronic history.

If you have any Nixie tube devices or drivers just gathering dust that you'd like to get rid of, please [send me an e-mail](#) and we can work something out!

I'd also love to find actual Nixie clocks, whether test equipment (such as the [Hewlett-Packard HP 571B](#)) or commercially made units.

NIXIE BASICS

[Excerpted from *Fundamentals and Applications of Digital Logic Circuits* by Sol Libes, 1975, Hayden Book Company.]

(Click on either Figure for a larger version.)

Gas-Discharge Display

More commonly referred to as Nixie, the gas-discharge tube was introduced by the Burroughs Corporation in 1955. It is basically a cold-cathode tube (Figure 9-14) with separate cathodes in the shape of characters. When a sufficient potential is applied (approximately 175 volts) between the selected cathode and plate, the gas surrounding the selected cathode is ionized and glows. Other types of gas-discharge displays are available having glow-bar segments to form in-plane characters and also cathode rods to illuminate a printed or cut-out character.

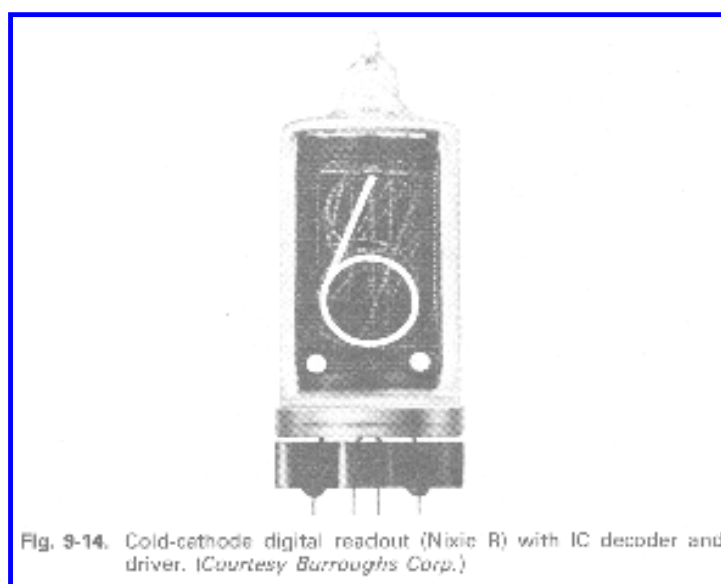


Fig. 9-14. Cold-cathode digital readout (Nixie R) with IC decoder and driver. (Courtesy Burroughs Corp.)

Figure 9-15 shows how a typical gas-charge display tube is driven from TTL logic. IC-7490 is a decade counter with parallel BCD output and serial count input. The overflow from the counter is used to operate the next more significant digit display. The BCD counter output is fed to a quad bistable latch (IC-7475) which acts as a memory storage. The count is stored in the IC until a strobe pulse allows the output of each latch to change. This prevents the display from being a blur of changing numbers. The BCD output of the latch is decoded by IC-7441 (BCD-to-decimal decoder/driver) to a one-of-ten decimal output. The IC also has high-voltage driver transistors to drive the cathodes of the tube.

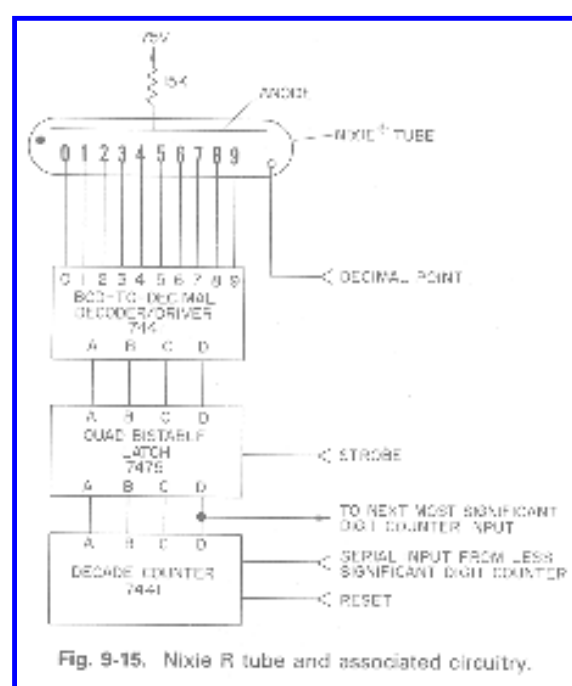


Fig. 9-15. Nixie R tube and associated circuitry.

NIXIE DRIVE CIRCUIT

The following is taken from *Circuits for Digital Equipment* by C. J. Dakin and C. E. G. Cooke (1967):

Where character readout is required multi-cathode gas discharge tubes are used. One method of construction is to make each cathode the shape of the character to be displayed. For example one tube might have 10 cathodes in the shape of numerals 0 to 9. To cause the required cathode to glow a suitable voltage is applied between the anode and the selected cathode.

Typically the discharge will strike at about 80V and burn at about 60V. The circuits to drive such tubes must therefore be able to supply such voltages.

A suitable circuit is shown in Fig. 16.9. Note that when Tr_1 is off the collector does not rise to +150V but is 'caught' at about +80V provided one of the other cathodes is energized.

The disadvantages of this type of indicator are:

1. The characters do not lie in the same plane.
2. The number of characters in one tube is limited to about 12.

The advantages of this type of indicator are:

1. The characters are well-shaped.
2. The characters are bright and can be large. (Tubes with characters up to 3 in high are available.)

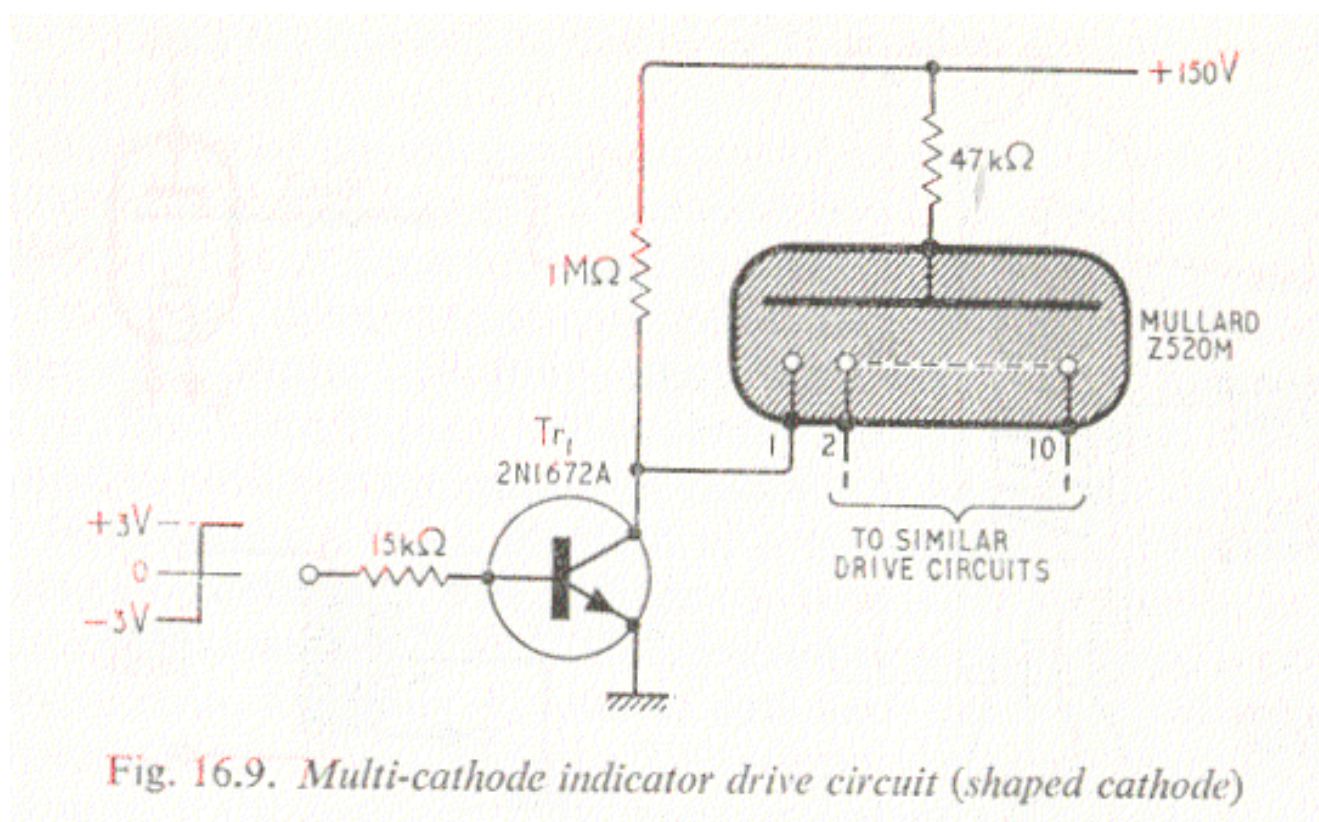
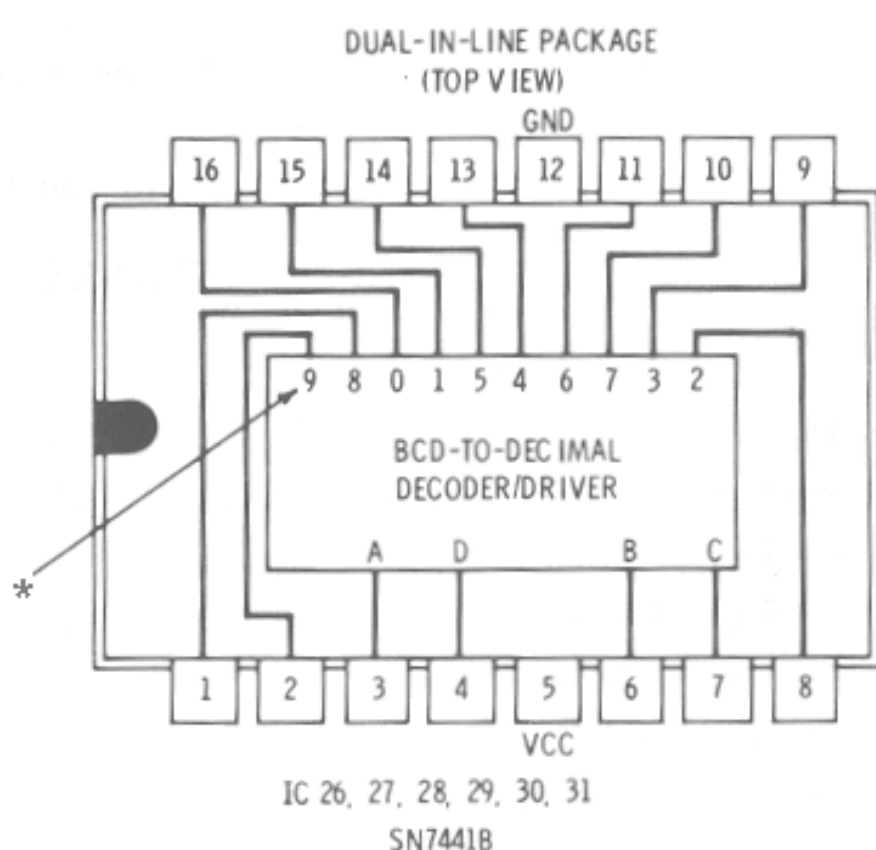


Fig. 16.9. Multi-cathode indicator drive circuit (shaped cathode)

DRIVERS

- **7441** - Early BCD Nixie driver



* THESE ARE THE DISPLAY TUBE NUMBERS WHICH WILL BE TURNED ON BY THE 10 DECODER-DRIVER OUTPUTS. THE ACTIVATED OUTPUT WILL BE "LOW" AND THE OTHER NINE OUTPUTS "HIGH". FOR EXAMPLE, IF THE NUMBER "7" IS ILLUMINATED IN THE DISPLAY TUBE, PIN 10 OF THE DECODER-DRIVER WILL BE "LOW" AND THE OTHER NINE OUTPUT PINS WILL BE "HIGH"

LOGIC LEVEL VOLTAGES

	MINIMUM	MAXIMUM
INPUT-HIGH	2 V	
INPUT-LOW		0.8 V
OUTPUT-HIGH	2.5 V	90.0 V

This part was also sold by Radio Shack as catalog number 276-1804.

- **74141** - BCD Nixie driver
- **8T** - Signetics Nixie Driver: Click [here](#) for the datasheet.

ARTICLES ABOUT DISPLAY TUBES

Electronics hobby magazines from the 1960's and 1970's occasionally ran articles on Nixie tubes and other cold cathode display devices. I've begun to scan the articles from old magazines and make them available.

Click [here](#) to view an index to several construction projects from the magazine *Radio-Electronics*.

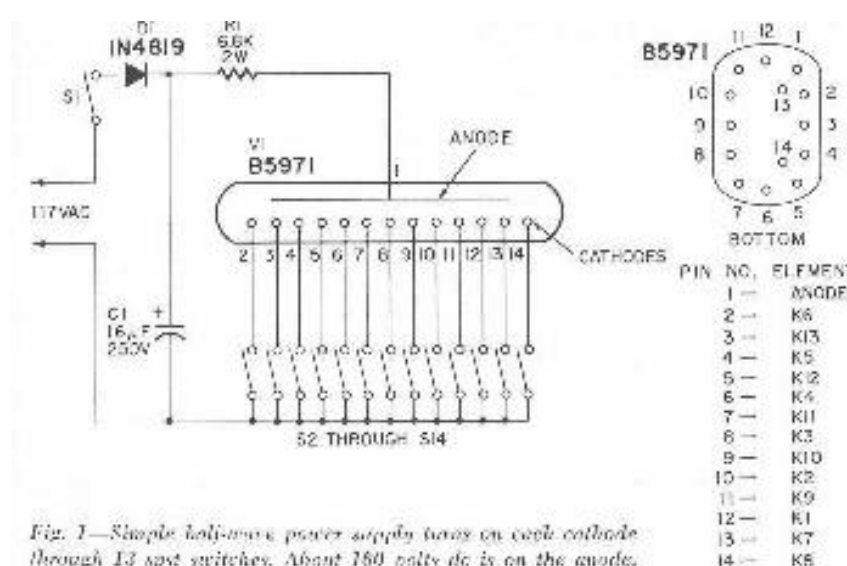


Fig. 1—Simple hobbyist power supply for cold cathode through 13 spst switches. About 150 volts dc is on the anode.

MULTIPLEXING NIXIE TUBES



In 1969 Signetics published an application memo entitled *Multiplex Operation Of Nixie® Tubes Using Signetics' Complex Arrays and Nixie Driver*. It describes an approach to minimizing parts count by using shift registers and Nixie drivers to multiplex a set of Nixie tubes.

You can read the note by clicking [here](#).

RADIO SHACK 276-048 NIXIE NUMERICAL INDICATOR

Yes, it's true, you used to be able to purchase nixie tubes at your local Radio Shack. I've got a few of these tubes in their original packaging.

From the data sheet:

The Radio Shack #276-048 is a cold cathode, side viewing numerical indicator tube. It displays the numerals 0 through 9 and has two internal, independently operable decimal points located to the left and right of the numeral. The desired numeral is lit when its corresponding cathode is energized. The color of the display is neon red. The brightness of the numerical indicator is dependent upon cathode current, and the horizontal viewing angle is 100 degrees.



Click [here](#) to see a scan of the datasheet.

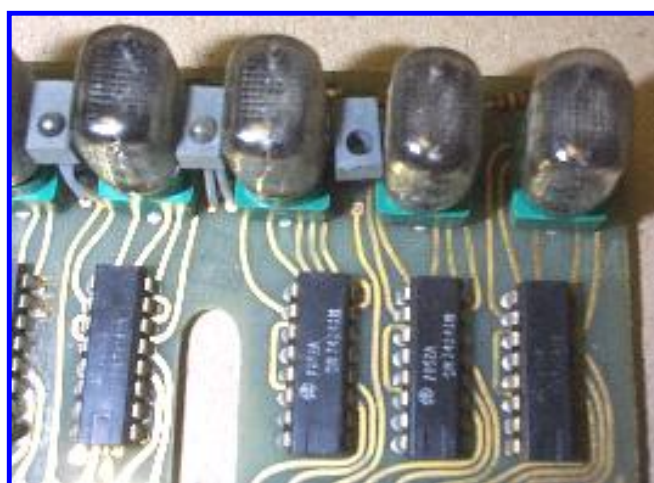
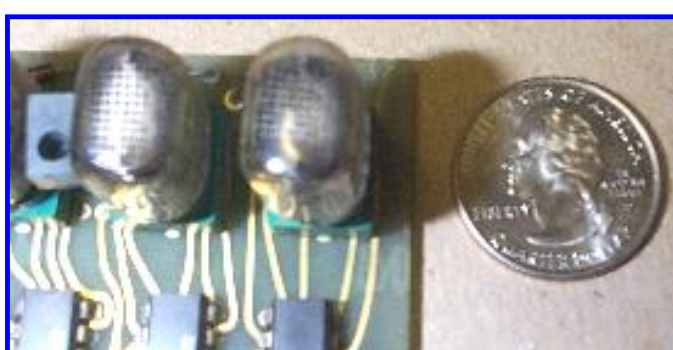
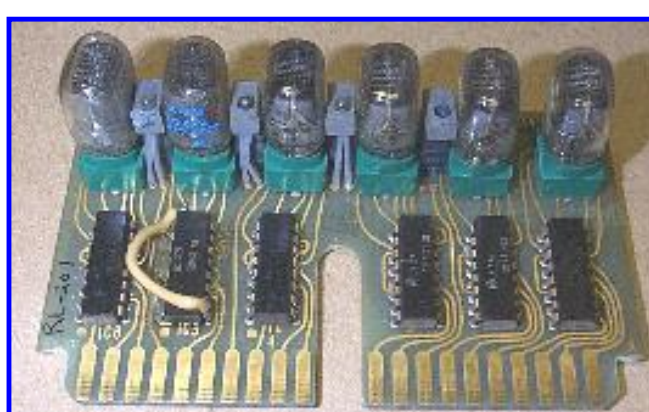
BURROUGHS 4998



One of the smallest Nixie tubes is the Burroughs B4998, a top-view design



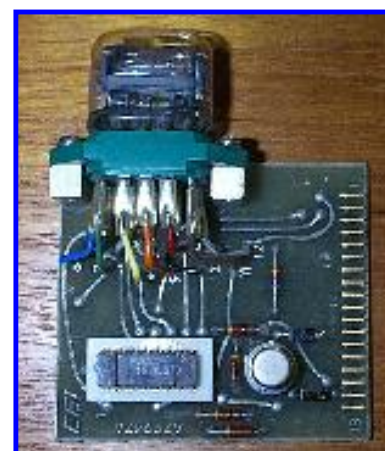
I have a display module from an old piece of test equipment that has six of these display tubes.



NIXIE TUBE ASSEMBLY

I have four of these Nixie tube assemblies but I don't have any documentation on the pinouts or even what equipment these were designed for.

Any help would be appreciated.



ANOTHER NIXIE TUBE ASSEMBLY

I have one of these Nixie tube assemblies and I'm looking for the pin-outs for the BIPCO 8806-3 Nixie driver/decoders it uses.

You can see more photos and information by clicking [here](#).



HEWLETT-PACKARD HP NIXIE MODULE



I have a handful of these HP Nixie boards, part number 05212-6016 Series 648.

They have a very interesting decoder design using neon lamps (hidden under the black lid just behind the Nixie tube).

This is description of the design from Tony Duell:

HP made a decade counter/display board where the counter flip-flops were made from pairs of transistors in the conventional way (8 transistors on the board). These were controlled with diodes to count in 1242 (not 1248) BCD code.

The outputs of these counters drove 8 neon bulbs,



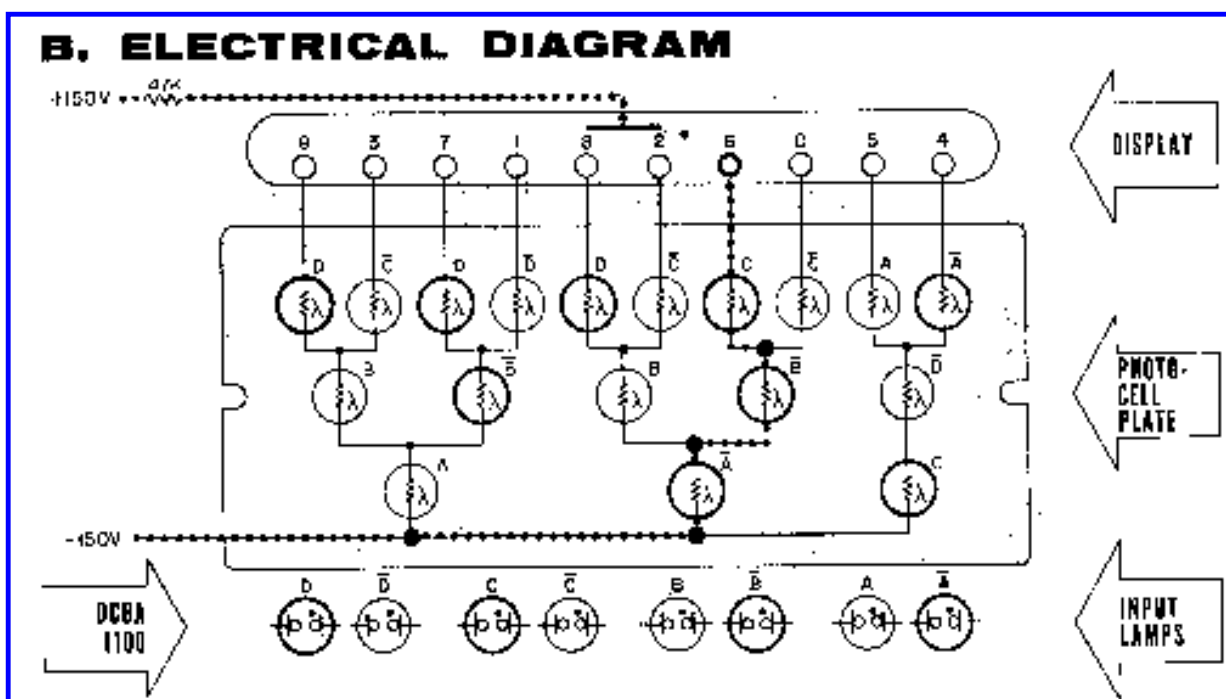
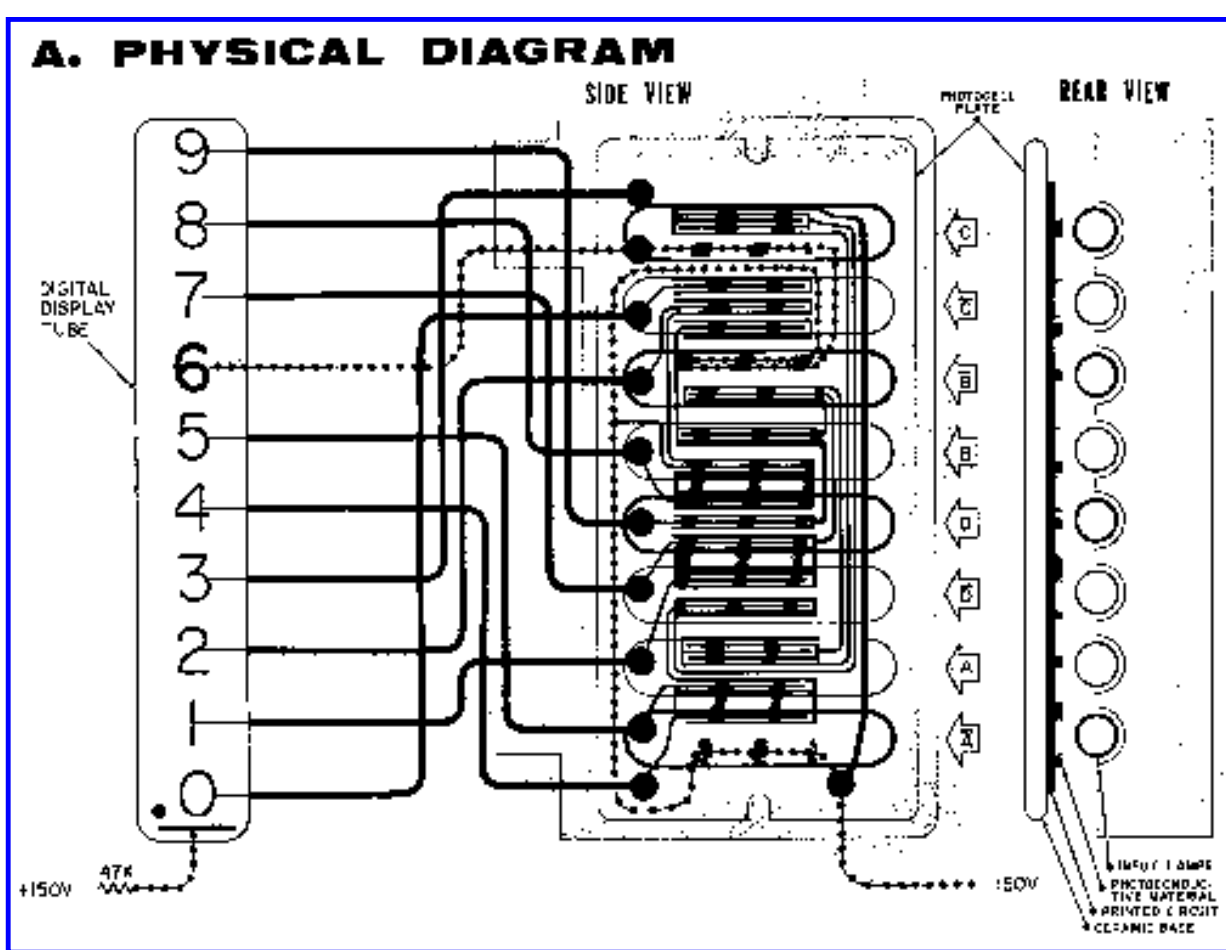
and by varying the bias applied, the state of the counter could be latched in the bulbs (that's why this is relevant here). These bulbs were mounted inside a plastic block on the PCB, and shone onto a thick-film circuit of CdS photoresistors. These were connected to form a binary to decimal decoder to drive a nixie tube.



Inside [the block] there are 8 neons. From the top, they are : C, C/, B/, B, D, D/, A, A/ (according to the manual). The neon wires are soldered to the PCB. On top of the block is the thick-film LDR array, and on top of that is a resistor network of 10 270k resistors. The top wire of that goes to the +20V rail, the wires on the left go to the nixie cathodes (there's a 270k resistor from each cathode to +20V). The LDRs also connect to the cathodes. The bottom wire from the resistor network is not used, but the pin it's connected to is the common of the LDR array, and goes to -130V.

I can provide a pinout of the 15 pin card edge, but the signals may not be too obvious without the complete service manual. Pin 1 is towards the front (nixie tube) end

- 1 : -130V
- 2 :
- 3 :
- 4 : +170V
- 5 : Transfer Input (latch enable)
- 6 : BCD Output A
- 7 : Signal Input
- 8 : Gate Input (Not used?)
- 9 : BCD Output B
- 10 : Signal Output to next decade
- 11 : +20V
- 12 : Reset Input
- 13 : BCD Output C
- 14 : BCD Output D
- 15 : -15V



And from Dave Brown, regarding model numbers:

The DCAs (Decimal Counter Assembly) in those counters (5243 series, 5245 series) came in low and high speed versions. The -6016 is the normal low speed 600kHz version used in most of the count positions and provides +1224 BCD output to the rear panel connector. The -6003 version is the option 03 variation of it that provided 1248 BCD output with the '1' state negative.(as opposed to the -6002 which was the same but with '1' state positive.)

This module was used in several pieces of HP test equipment, including the **5245L frequency counters.**

WIDBM COUNTER

While not strictly Nixie technology, I have a four-digit vacuum fluorescent counter.

You can see more photos by clicking [here](#).



MYSTERY TUBE



I have a dozen or so of these display tubes. They have five wire leads. The tube is marked SP8B, H.G.B. and were made in Japan.

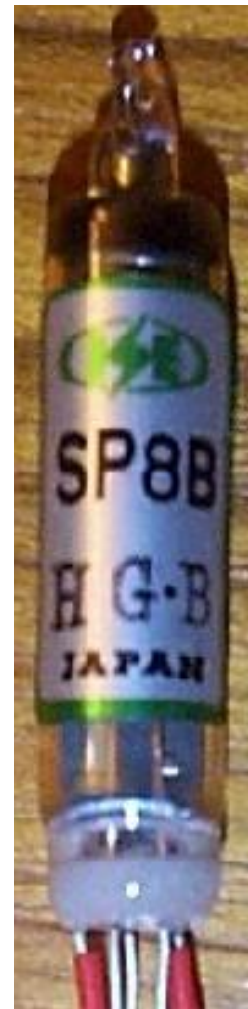
Does anyone recognize these tubes, and better, have a datasheet for them?

I received the following information via e-mail:

Those are single-digit vacuum fluorescent displays. "ISE" is a subsidiary of Noritake-Itron:

<http://www.noritake-elec.com/itron/>

Two wires are the filament connections (takes 1.5V, AC or DC), one is the control grid, and the remaining two are the symbol anodes (negative sign & overflow indicator), which should be biased at +25 to +35 volts DC w.r.t. either filament connection, through current-limiting resistors (10k or so).



Equipment Listing

The following is a list of some Nixie equipment in my collection.

CALCULATORS WITH NIXIE DISPLAYS

- Casio 121-B, AS-L and FX-1
- Commodore 512
- Marchant I
- Monroe 610, 1655, 1710, 1770, 1775
- SCM Cogito 412, 414
- Sharp CS-363R
- Silver Reed SE-702
- Singer Friden 1114, 1118
- Sony Sobax ICC-400W, ICC-500W
- Remington-Rand 1259S

The main calculator page is [here](#).

ANACONIC 390 DIGITAL MULTIMETER

Quantity one.
Uses four NL-840 type Nixies.

FAIRCHILD 7050 MULTIMETER

Quantity one.

FLUKE 8100A DIGITAL MULTIMETER

Quantity two.

HEATHKIT IB-101 FREQUENCY COUNTER

Quantity one.

HEATHKIT IB-102 FREQUENCY COUNTER

Quantity one.

HEATHKIT IB-1100 FREQUENCY COUNTER

Quantity one.

You can read a review of this counter [here](#).

HEATHKIT IB-1101 FREQUENCY COUNTER

Quantity one.

HEATHKIT IB-1102 FREQUENCY COUNTER

Quantity one.

This is an eight-digit, 120 MHz counter.

You can read a review of this counter [here](#).

HEATHKIT IB-1103 FREQUENCY COUNTER

Quantity one.

This is an eight-digit, 180 MHz counter with phase-locked multiplier.

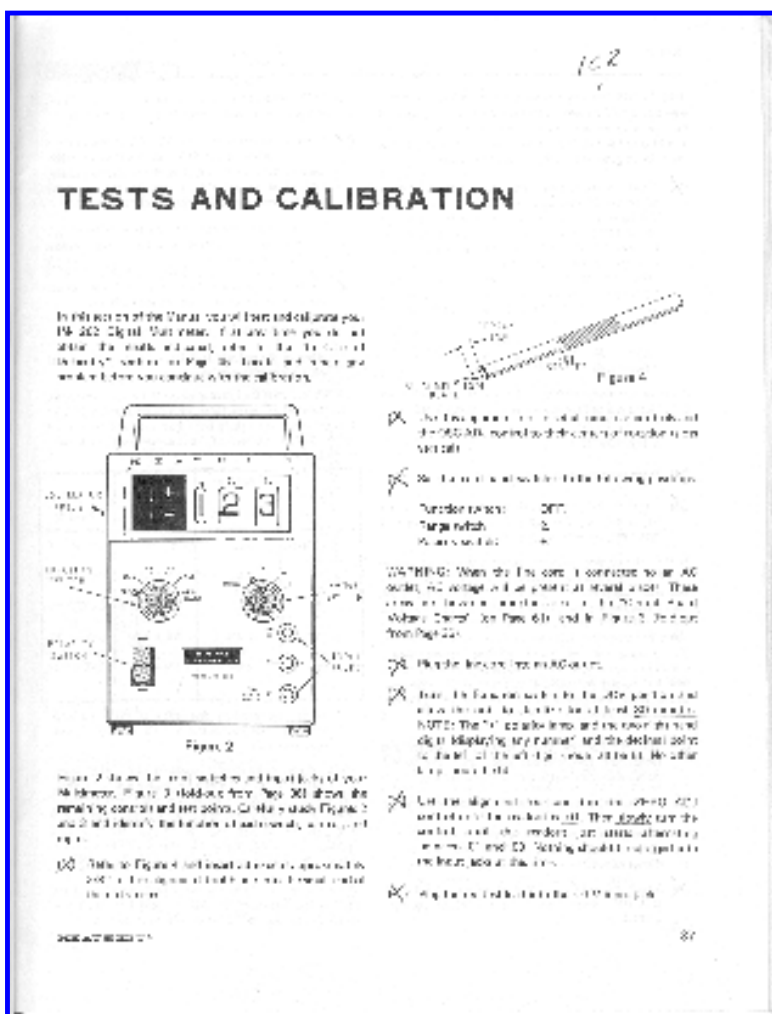
HEATHKIT IM-1202 DIGITAL MULTIMETER

Quantity five.

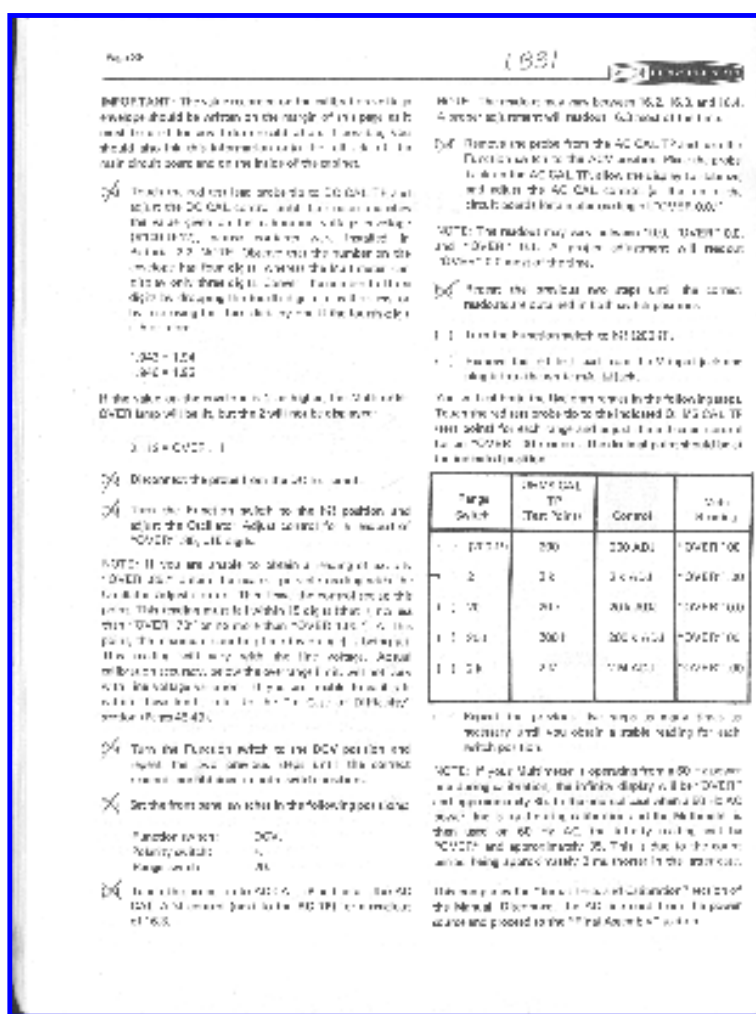
This is a neat little 2.5 digit multimeter.



The following two scanned pages are from the "TEST AND CALIBRATION" chapter of the manual.



[Medium] [Large]



[Medium] [Large]

HEWLETT-PACKARD HP 3430A DIGITAL VOLTMETER

Quantity three.

I've scanned parts of the Operating and Service Manual:

Calibration

- [Calibration section, page 1](#)
- [Calibration section, page 2](#)
- [Calibration section, page 3](#)
- [Calibration section, page 4](#)

Troubleshooting

- [Troubleshooting Tree](#)
- [Maintenance section, page 1](#)
- [Maintenance section, page 2](#)
- [Maintenance section, page 3](#)
- [Maintenance section, page 4](#)
- [Maintenance section, page 5](#)

Diagrams

- [Wiring Diagram](#)
- [Location of Chassis Mounted Components](#)
- [A1 Board Component Layout](#)

Schematics

These images are in PCX format. The original schematics come as fold-outs in the service manual, and are too large for my flatbed scanner. Each page has been scanned as two parts, a left side and a right side.

- [A1, Page 1, Left Side](#)
- [A1, Page 1, Right Side](#)
- [A1, Page 2, Left Side](#)
- [A1, Page 2, Right Side](#)

Parts List

- [A1 parts list, page 1](#)
- [A1 parts list, page 2](#)
- [A1 parts list, page 3](#)

HEWLETT-PACKARD 5245L COUNTER

Quantity one.

With 5252A Prescaler and 5265A Digital Voltmeter (plug-ins).

HEWLETT-PACKARD 5246L COUNTER

Quantity one.

With 5253B Frequency Converter (plug-in).

HEWLETT-PACKARD 5326 TIMER-COUNTER-DVM

Quantity one.

HEWLETT-PACKARD 5332A PRESET CONTROLLER/COUNTER

Quantity one.



ITRON 650 FREQUENCY COUNTER

Quantity one.



KEITHLEY 600 DIGITAL MULTIMETER

Quantity one.

MONSANTO 100C COUNTER/TIMER

Quantity one.



MONSANTO 106A REVERSIBLE COUNTER

Quantity one.

MONSANTO 1500A COUNTER/TIMER

Quantity one.

Send comments to [Dan Veeneman](#)

Click [here](#) to go to the **wanted** page.

Click [here](#) to go to the **home** page.

Last updated June 17, 2006

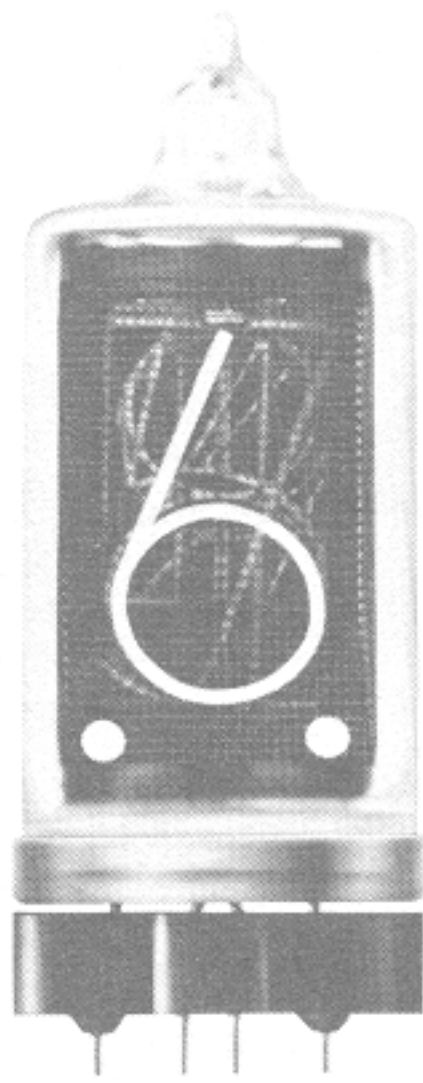


Fig. 9-14. Cold-cathode digital readout (Nixie R) with IC decoder and driver. (*Courtesy Burroughs Corp.*)

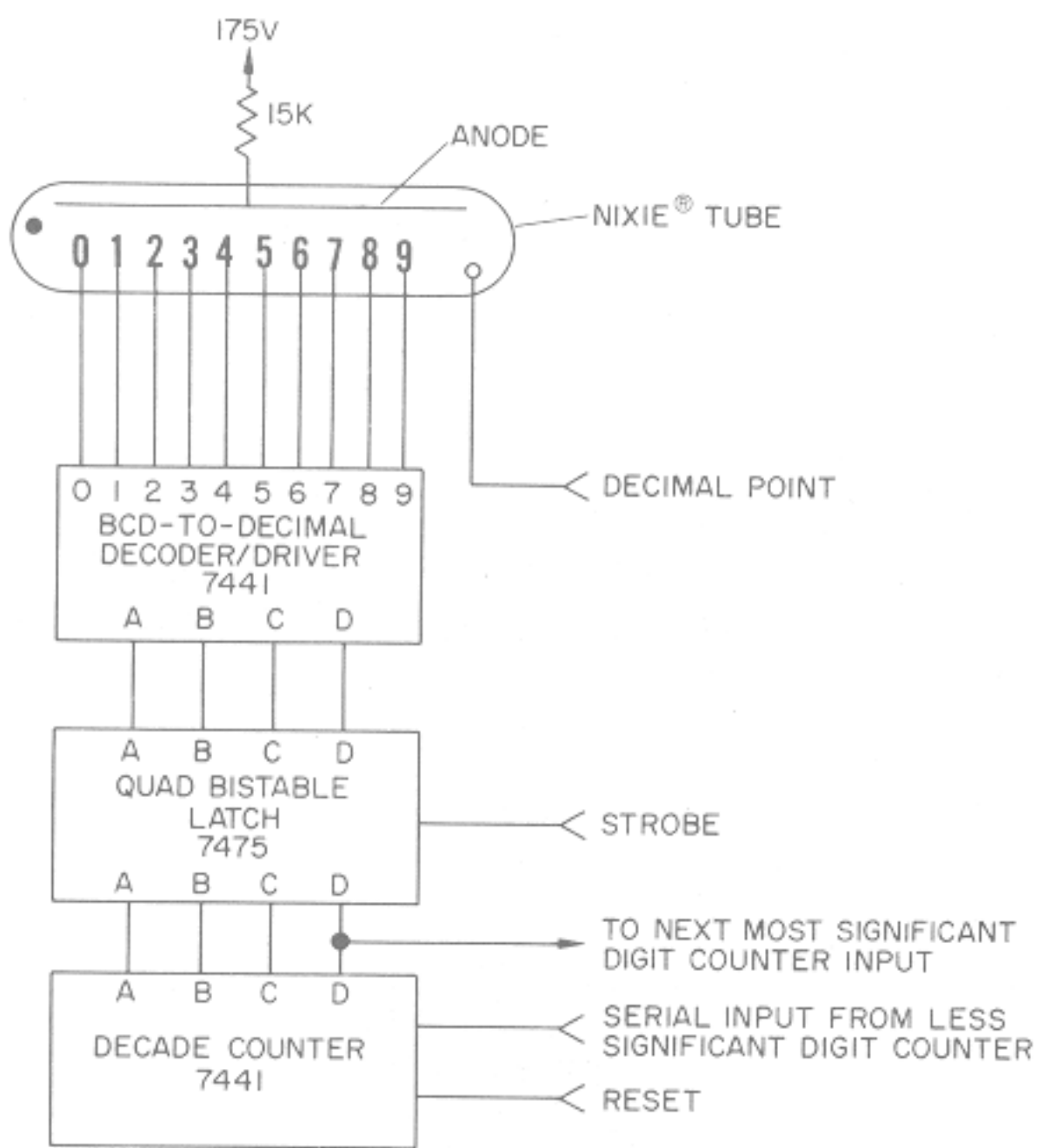
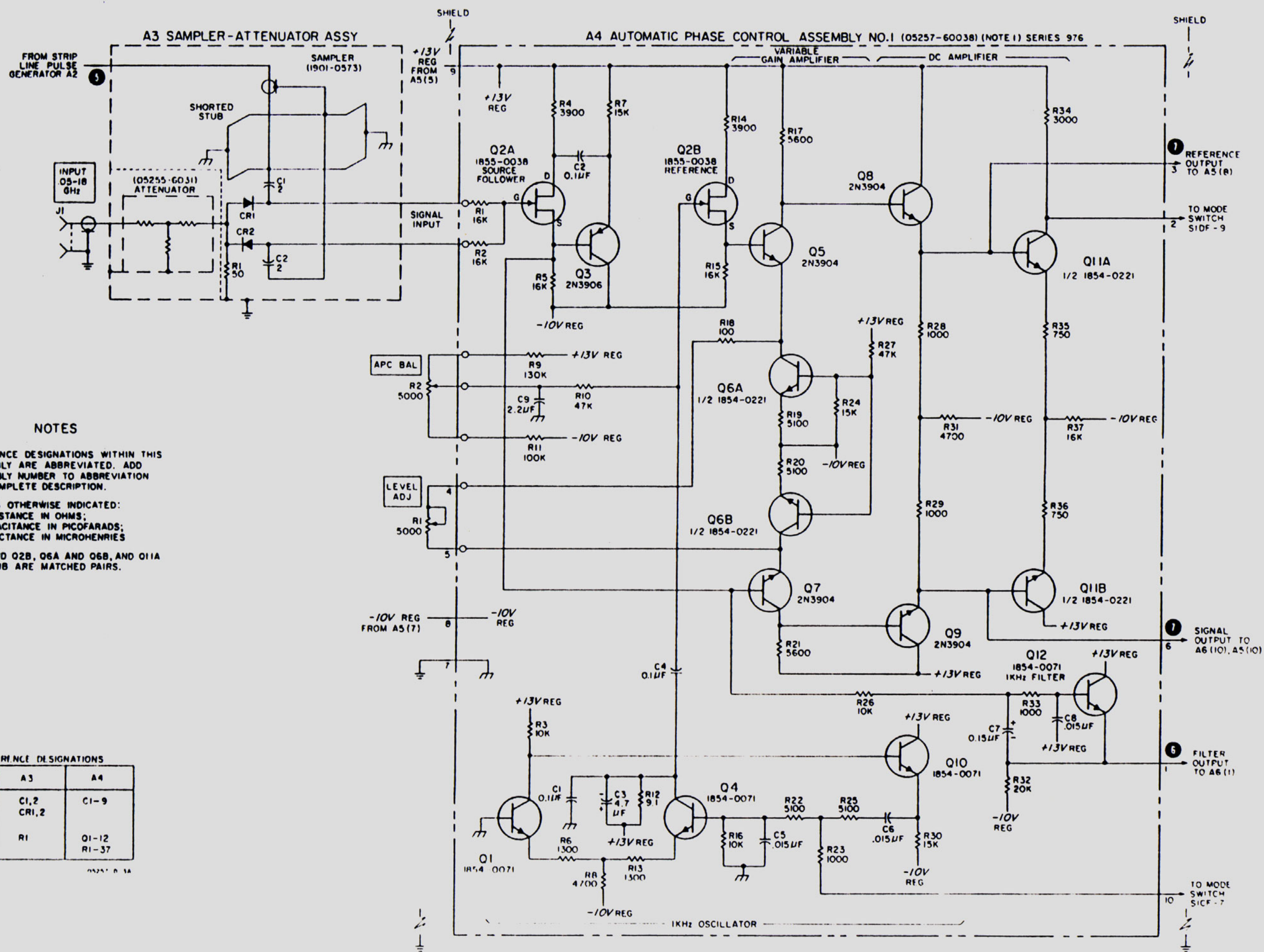


Fig. 9-15. Nixie R tube and associated circuitry.



Figure 7-2. A3/A4 Assembly Schematic



NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS; CAPACITANCE IN PICOFARADS; INDUCTANCE IN MICROHENRIES
3. Q2A AND Q2B, Q6A AND Q6B, AND Q11A AND Q11B ARE MATCHED PAIRS.

REFERENCE DESIGNATIONS

NO PREFIX	A3	A4
J1,2	C1,2	C1-9
R1,2	R1	Q1-12
S1		R1-37

K4XL's BAMA

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