Errata

Title & Document Type: **8406A Frequency Comb Generator Operating and Service Manual**

Manual Part Number: **08406-90001**

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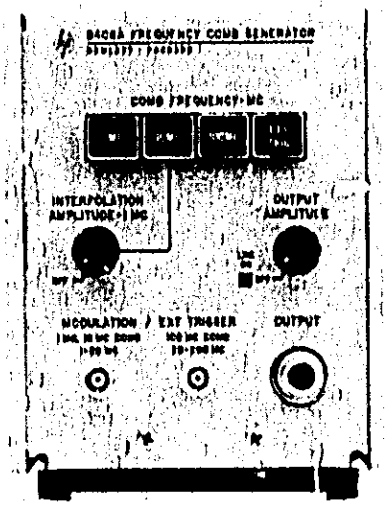
Agilent Technologies

OPERATING AND SERVICE MANUAL

FREQUENCY COMB GENERATOR

8406A



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Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

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HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

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OPERATING AND SERVICE MANUAL

MODEL 8406A
FREQUENCY COMB GENERATOR

SERIALS PREFIXED: 649- 737-

Refer to Appendix I for Instruments
Serial Prefixed 632- and 641-

HP Part No. 08406-90001

Printed: MAY 1980

SAFETY CONSIDERATIONS

GENERAL – This is a Safety Class I instrument (provided with terminal for protective earthing).

OPERATION – BEFORE APPLYING POWER verify that the power transformer primary is matched to the available line voltage, the correct fuse is installed, and Safety Precautions are taken (see the following warnings). In addition, note the instrument's external markings which are described under "Safety Symbols."

WARNINGS

Servicing instructions are for use by service-trained personnel only. To avoid dangerous electric shock, do not perform any servicing unless qualified to do so.

BEFORE SWITCHING ON THE INSTRUMENT, the protective earth terminal of the instrument must be connected to the protective conductor of the (mains) power cord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two conductor outlet, is not sufficient protection.

If this instrument is to be energized via an autotransformer (for voltage reduction) make sure the common terminal is connected to the earth terminal of the power source.

Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury.

Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short circuited fuseholders. To do so could cause a shock or fire hazard.

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Do not install substitute parts or perform any unauthorized modification to the instrument.

Adjustments described in the manual are performed with power supplied to the instrument while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible, and when inevitable, should be carried out only by a skilled person who is aware of the hazard involved.

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

SAFETY SYMBOLS

Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the product.

Indicates hazardous voltages.

Earth terminal (sometimes used in manual to indicate circuit common connected to grounded chassis).

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

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Figure 1-1. Frequency Comb Generator

SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The hp Model 8406A supplies a frequency comb with a selectable spectral line spacing of 1 Mc, 10 Mc, 100 Mc, or the frequency of an external trigger signal. The frequency comb generated is usable to at least 4 Gc.

1-3. The Model 8406A provides these additional features:

a. Output level is continuously variable by a front panel control.

b. Interpolation amplitude level is continuously variable by a front panel control.

c. Comb frequency or external trigger frequency is selectable by front panel pushbuttons. This switch will not permit more than one button to be actuated at a time to avoid confusion in the output signal.

d. Front panel BNC jacks are provided for modulation and external trigger frequencies.

e. A switch is provided on the rear apron to switch the instrument to 230-volt operation.

1-4. INSTRUMENT IDENTIFICATION.

1-5. Hewlett-Packard uses a two-section, eight-digit serial number (on instrument rear panel) to identify instruments (000-00000). The first three digits are a serial prefix number, and the last five digits refer to a specific instrument. If the serial prefix on your instrument does not appear on the title page of this manual, there are differences between the manual and your instrument which are described in a Manual Change sheet included with this manual or in the Appendix (if any). If this information is missing, it can be supplied by your nearest Hewlett-Packard field office.

Table 1-1. Specifications

Comb Fundamental Frequencies: 1, 10, and 100 Mc, pushbutton selected, generate harmonically related signals usable to beyond 5 Gc.

Comb Frequency Accuracy: ±0.01% (0° to 50°C).

Peak Amplitude*:

	1 Mc Comb	10 Mc Comb	100 Mc Comb
10-500Mc	>-80 dBm	>-60 dBm	–
0.1-1.0 Gc	–	–	>-45 dBm
0.5-2.0 Gc	>-70 dBm	>-50 dBm	–
1-2 Gc	–	–	>-35 dBm
2-4 Gc	>-62 dBm	>-62 dBm	>-47 dBm

*Peak signal level defined in terms of equipment cw signal level (as measured on hp 8551B/851B Spectrum Analyzer).

OUTPUT AMPLITUDE control permits continuous level adjustment.

Comb Output Connector: Type N female, source impedance approximately 50 ohm.

Maximum External Signal at Comb Output: Signals exceeding 1 watt (pk and av) may cause damage.

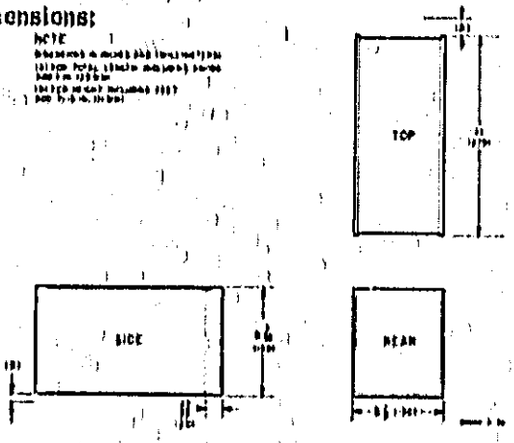
Interpolation Function: 10-Mc and 1-Mc combs can be combined into primary-secondary comb; Interpolation Amplitude control adjusts level of secondary (1 Mc) signal.

External Modulation: External modulation signals can be used to phase modulate any of the combs to produce sidebands for interpolation between fixed comb markers[1]. BNC female connector.

External Trigger: External signals (normally sine waves) between 1 Mc and 200 Mc can be used to produce combs spaced at frequency of trigger signals[2]. BNC female connector.

Power: 115 or 230 volts ±10%, 50-400 cps, 2 watts

Dimensions:



Weight: Net 6 lb (2.7 Kg); shipping 9 lb (4.1 Kg)

[1] External modulation: Modulation frequencies can be as low as 5 kc. Although the level of modulation voltage required varies with modulating frequency and the harmonic number of the comb being modulated, the information here will serve as a guide:

To produce sidebands approximately 20 db below the main comb marker at the 1 Gc harmonic of the appropriate comb (comb output amplitude at maximum), typical modulation voltages are:

1-2 mv rms at 200 kc for the 1 Mc comb
5-10 mv rms at 2 Mc for the 10 Mc comb
50-100 mv rms at 20 Mc for the 100 Mc comb

Signals greater than 5v rms at modulation input may cause damage.

[2] External Trigger: Typical input signal levels to generate externally triggered combs at the frequency of the external trigger are in the range of 1-3 volts rms. Input signals greater than 5 volts rms may cause damage. With input triggers in the 1-20 Mc frequency span, the OUTPUT AMPLITUDE control of the 8406A can be used to adjust the output comb level. When using signals in the frequency span from 20-200 Mc, output comb amplitude is a function of the input signal level.

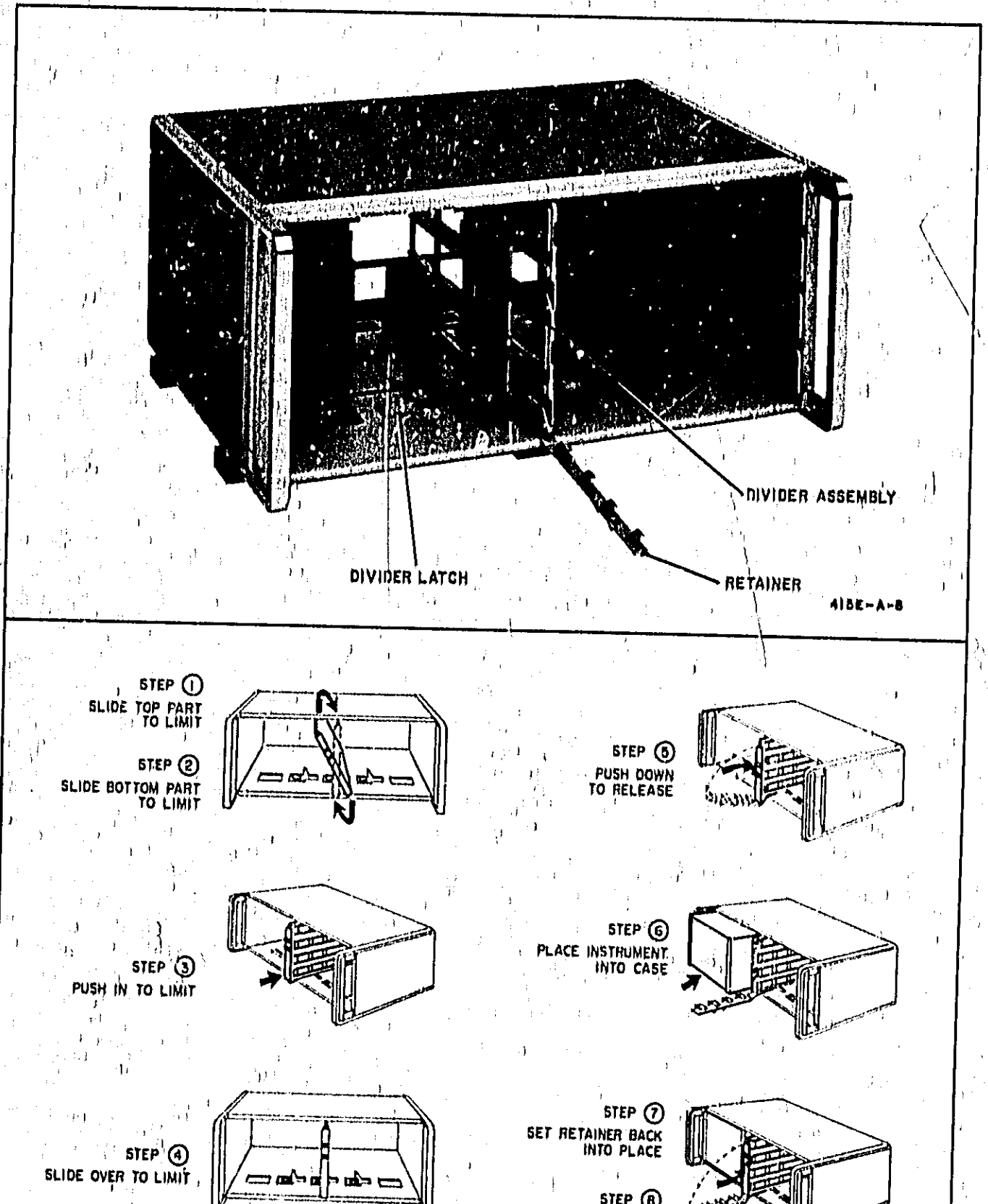


Figure 2-1. Combining Case

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. Inspect instrument for shipping damage as soon as it is unpacked. Check for broken knobs and connectors; inspect cabinet and panel surfaces for dents and scratches. A performance check is given in Table 5-2. If instrument is damaged in any way or fails to operate properly, notify carrier and your nearest Hewlett-Packard field office. For assistance of any kind, including help with instruments under warranty, contact your Hewlett-Packard field office (see list at rear of this manual).

2-5. STORAGE AND SHIPMENT.

2-6. PACKAGING. To protect valuable electronic equipment during storage or shipment, always use the best packaging methods available. Your Hewlett-Packard field office can provide packing material such as that used for original factory packaging. Contract packaging companies in many cities can provide dependable custom packaging on short notice. Whatever packing method is used, be sure to attach a tag to the instrument itself giving your name, address, and pertinent details.

2-8. RACK INSTALLATION.

2-9. When the Model 8406A is to be rack-mounted, a combining case (Paragraph 2-10) or adapter frame (Paragraph 2-11) is required. These items are available through your Hewlett-Packard field office. The two methods for rack mounting are discussed in the following paragraphs.

2-10. COMBINING CASE. The combining case (hp 1051A) shown in Figure 2-1 is a full-module unit which accepts varying combinations of submodule units such as the 1/3 module Model 8406. The combining case can be used as a bench model or it can be rack-mounted. A rack-mounting kit (hp part number 5060-0777) is supplied to rack mount the combining case. Instructions for using the case are given in Figure 2-1. When only one-third of the case is used, a blank filler panel (hp part number 5060-0793) is available to enclose the unused front panel space.

2-11. ADAPTER FRAME. The adapter frame (hp part number 5060-0797) in Figure 2-2 is a rack frame that accepts any combination of submodule units;

a. Place adapter frame on edge of bench as shown in step 1, Figure 2-2. (Only two submodule units are illustrated for clarity. The method of operation is the same for three.)

b. Stack units in frame as shown in step 2. Place spacer clamp between units, step 3.

c. Place end spacer clamps as shown in step 4, and push units into frame.

d. Insert screws on either side of frame, step 5, and tighten until units are tight in frame.

e. The complete assembly is now ready for rack mounting.

2-12. OPERATING FROM 115 OR 230 VOLTS.

2-13. The Model 8406 may be operated from either 115- or 230-volt ±10%, 50- to 400-cps power lines. A slide switch on the rear panel permits quick conversion for operating from either voltage. Insert a narrow-blade screwdriver in the switch slot and slide the switch to expose "115" marking for 115-volt operation or "230" marking for 230-volt operation. A 1/16 amp fuse is used for both voltages.

CAUTION: Be sure this switch is in proper position before turning on.

2-14. POWER CABLE. The Model 8406 is equipped with a detachable 3-wire power cable. Proceed as follows for installation:

a. Connect flat plug (three-socket connector) to ac line jack at rear of instrument.

b. Connect plug (two-blade with round grounding pin) to three-wire (grounded) power outlet. Exposed portions of the instrument are grounded for safety; when only a two-blade outlet is available, use connector adapter (hp part number 1251-0048), and connect short wire from side of adapter to ground.

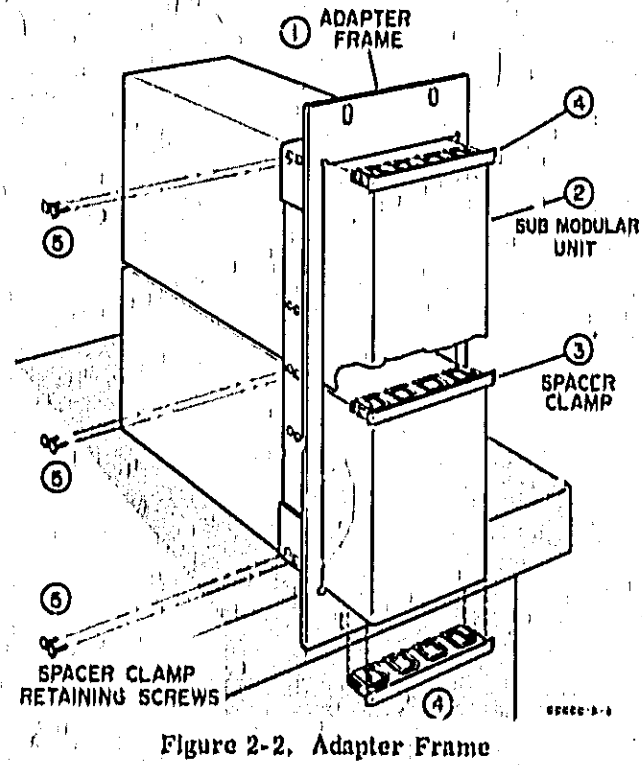


Figure 2-2. Adapter Frame

OPERATION AND THEORY

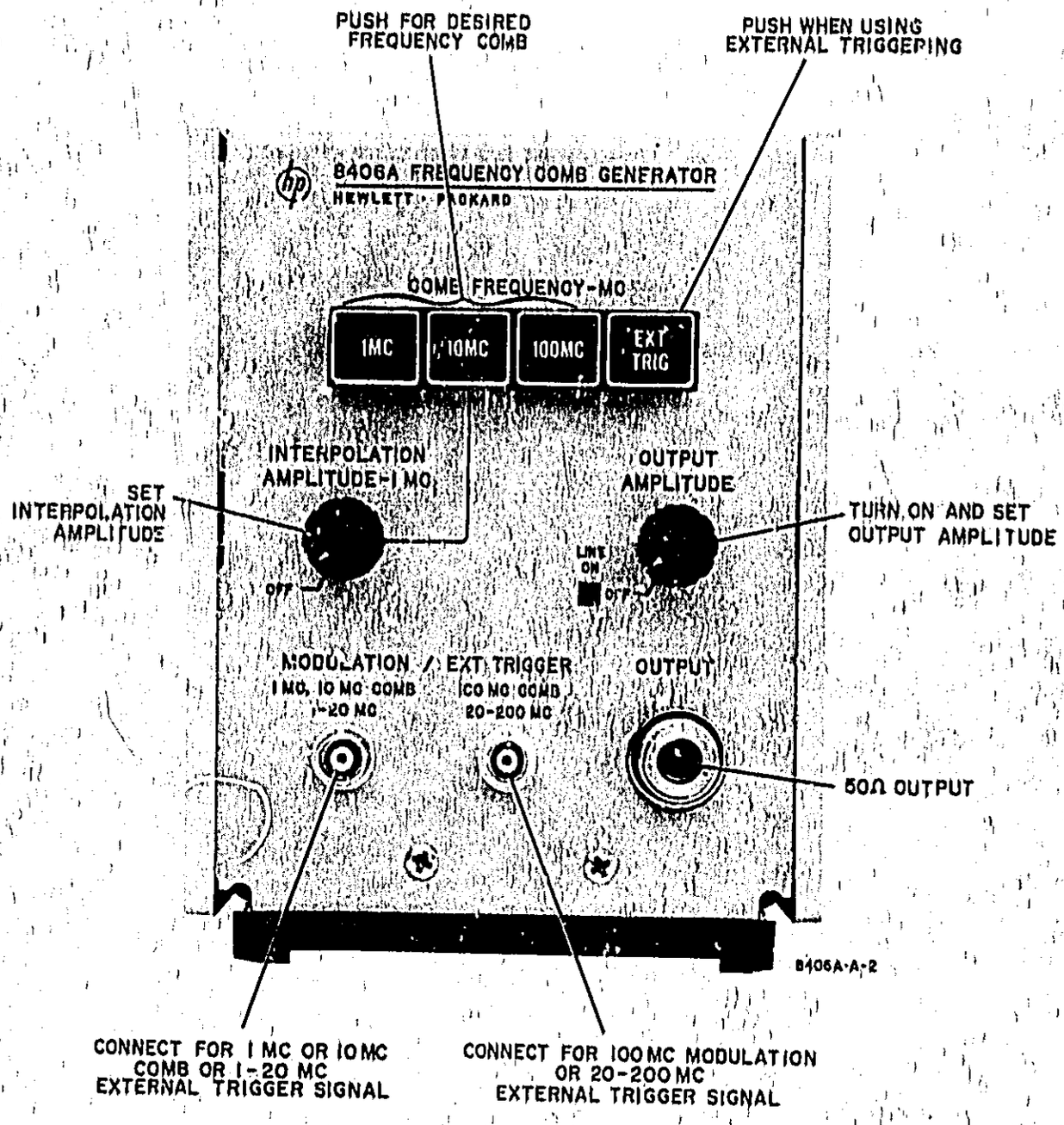


Figure 3-1. Operating Controls

SECTION III

OPERATION

3-1. INTRODUCTION.

3-2. The Model 8406 Frequency Comb Generator is used to calibrate other instruments which display the frequency domain. It is usually used with Spectrum Analyzers to calibrate their frequency and output characteristics. The illustration on the facing page, Figure 3-1, shows in general the operation of the Model 8406. The following paragraphs discuss special points which are not covered in the general explanation.

3-3. INTERPOLATION MODULATION. Usually to calibrate an instrument, the 10-Mc comb is used first to determine which lines correspond to the 10-Mc markers. If a finer determination is required, the INTERPOLATION AMPLITUDE control is turned on and the amplitude adjusted. This will give ten times more lines, each marking a 1-Mc point, in addition to the 10-Mc lines. If the 1-Mc Oscillator only were used, the same accuracy would be obtained but there is the possibility that a wrong line would be chosen if the instrument being tested is badly out of calibration.

3-4. EXTERNAL MODULATION. If a modulation spectrum other than 1 Mc on the internally generated comb is desired, feed the output from an external oscillator into the appropriate MODULATION jack (1 Mc and 10 Mc or 100 Mc COMB). The level should be adjustable around 10 millivolts. Depress the COMB FREQUENCY pushbutton for the main frequency spectrum desired. The output will now contain major spectral lines spaced at the frequency of the external oscillator.

3-5. FREQUENCY CONSIDERATIONS. At low levels of modulation (phase modulation), a single pair of sidebands appear - variable with modulation for precise frequency determination. At higher levels of modulation more sidebands appear which permit calibration of devices (spectrum analyzers, frequency meters, etc.) in arbitrary frequency increments. As with all modulation, the absolute accuracy of the generator must be increased by the multiple of the harmonic used in order to obtain the required accuracy at the operating frequency (the percentage accuracy is the same for all harmonics).

3-6. EXTERNAL TRIGGER. The external trigger voltage is fed in by means of the EXT TRIGGER jacks, either 1-20 Mc or 20-200 Mc, depending upon frequency. The signal used for external triggering should be adjustable in amplitude around 2 volts. Note that in the EXTernal TRIGger position the OUTPUT AMPLITUDE control is operable when the signal is fed into the 1-20 MC EXT TRIGGER jack. The OUTPUT AMPLITUDE control may be used to adjust the output level when this jack is used. If the 20-200 Mc jack is used, the output level must be adjusted by varying the input level of the external trigger signal. The input from this jack does not go through the Diode Driver and therefore the OUTPUT AMPLITUDE control will have no effect. In fact, the instrument does not even have to be on if the 20-200 Mc jack is used. However, more power is needed (10-20 millivolts).

SECTION IV

THEORY OF OPERATION

4-1. GENERAL.

4-2. The Model 8406 generates a train of sharp pulses at a repetition frequency of 1 Mc, 10 Mc, or 100 Mc supplied internally or at the frequency of an external oscillator. The frequency spectrum of the output is a comb with spectral lines spaced by the repetition frequency, 1-Mc, 10-Mc, 100-Mc or the frequency of an external oscillator.

4-3. BLOCK DIAGRAM.

4-4. Figure 4-1 is a block diagram which shows the inter-connections between the main sections of the instrument. Note that only one oscillator is on at any one time, except when the 1-Mc Interpolation Oscillator is used to interpolate between the main spectral lines of the 10-Mc Oscillator. In the case of the 1-Mc and 10-Mc Oscillators the signal is passed through a Diode Driver before it is applied to the Output Harmonic Generator (low-frequency signals do not generate harmonics with sufficient amplitude when applied directly to the Output Harmonic Generator). The Diode Driver sharpens the transition so that higher amplitude harmonics are generated. The 100-Mc Oscillator-Amplifier generates high-level harmonics without shaping and thus triggers the step-recovery diode directly.

4-5. INDIVIDUAL CIRCUITS.

4-6. 1-MC AND 10-MC OSCILLATORS.

4-7. Since these oscillators are similar they will be described together. Both of these oscillators consist of a Colpitts-type oscillator in a common-emitter configuration. Crystal control is used in both oscillators. The output of the 10-Mc Oscillator goes directly to the Diode Driver. Output of the 1-Mc Oscillator goes either directly to the Diode Driver or to the 5-Mc Harmonic Generator Diode A1CR1. The filter following removes all harmonics above 5 Mc when the 1-Mc signal is used for interpolation between the spectral line of the 10-Mc Oscillator. The Interpolation Oscillator phase-modulates the 10-Mc signal producing upper and lower sidebands. Line overlap would be produced if signals above 5 Mc were used for modulation. To

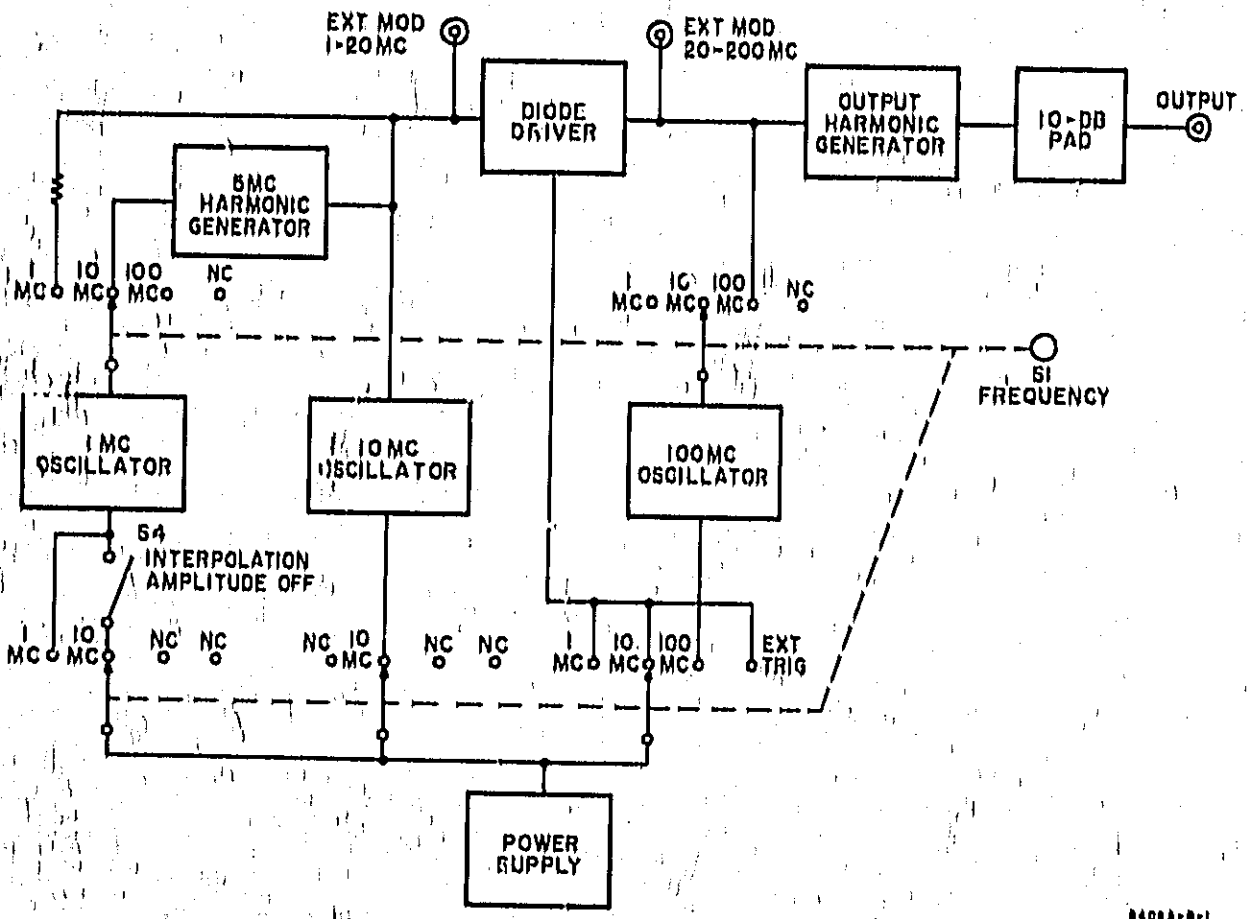


Figure 4-1. Block Diagram

reduce the confusion caused by two sets of signals, only modulating frequencies 5 Mc or below are permitted to modulate the 10- Mc signal.

4-8. 100-MC OSCILLATOR.

4-9. This oscillator is also of the Colpitts type with a tuned tank circuit. Series tuning of the crystal is used to adjust the frequency.

4-10. 100-MC AMPLIFIER.

4-11. This Amplifier is of standard configuration with a tuned input and a tuned output. The Amplifier is energized only in the 100-Mc switch position, since it is not needed otherwise.

4-12. DIODE DRIVER AND EMITTER FOLLOWER.

4-13. The Diode Driver generates a fast-rise pulse for each cycle sinewave fed to the tunnel diode, CR2. This fast-rise pulse produces a large current in the reverse direction of the Output Harmonic Generator, CR1. When the stored charge in the diode is depleted, the diode opens, producing a step of voltage on the transmission line of the Harmonic Generator. The Emitter Follower is used as a source of variable voltage to the Diode Driver. As the output of the Diode Driver is varied, the level of the output frequency comb varies.

4-14. STEP-RECOVERY DIODE.

4-15. Diode CR1 is a step-recovery diode used for harmonic generation. Step-recovery diodes operate somewhat differently than normal diodes. In the forward-biased condition they act as any diode. However when back-biased, these diodes continue to conduct due to stored carriers. When the diode runs out of stored carriers it shuts off abruptly. This sharp cutoff generates a multitude of harmonics. The step function produced is formed into a impulse by the shorted transmission-line stub at the diode output. The diode must conduct in the forward direction after each pulse to replace the stored charge. A biasing network (R10, L10) sets the voltage at the diode so that conduction takes place. The step-recovery diode may be used by itself for harmonic generation. This is the situation when using the 20-200 MC EXTERNAL TRIGGER jack. For this application the instrument does not have to be turned on.

4-16. ATTENUATOR ASSEMBLY.

4-17. This attenuator isolates the step-recovery diode from the output connector to give a 50-ohm output impedance.

MAINTENANCE

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section provides maintenance and service information for the Model 8406 Frequency Comb Generator. Included are a table of recommended test equipment, troubleshooting procedures, repair and adjustment procedures, and an in-cabinet performance check which may be used to verify proper operation of the Generator.

5-3. TEST EQUIPMENT.

5-4. Recommended test equipment for performance checking, troubleshooting, and repair is listed in Table 5-1. Other test instruments may be used if their specifications satisfy the required characteristics.

5-5. IN-CABINET PERFORMANCE CHECK.

5-6. GENERAL. The In-Cabinet Performance Checks, Table 5-2, and Performance Check Test Card (to be filled out during incoming inspection), verify specifications and provide a permanent record of the performance of the instrument. The In-Cabinet Performance Check verifies the proper operation of all circuits in the Generator and may be used:

a. As part of an incoming inspection check of instrument specifications;

b. periodically, for instruments used in systems where maximum reliability is of utmost importance;

c. as part of a troubleshooting procedure to locate out-of-tolerance operation;

d. after any repairs or adjustments, before returning instrument to regular service.

5-7. VARIABLE LINE VOLTAGE.

5-8. During the Performance Check, Table 5-2, connect the Generator to a power source through a variable voltage device so that line voltage may be varied ±10% from nominal (115 or 230 Vac) to assure proper operation of the Generator under various supply conditions.

Table 5-1. Test Equipment Required

Instrument Type	Critical Specifications	Instrument Recommended
AC Voltmeter	Range: to 1 mV. Frequency Range: 40-200 cps	hp Model 400D/H/L/E/EL
DC Voltmeter	Range: 14 volts Resolution: 0.2 volts	hp Model 405BR
Electronic Counter	Range: 1 to 100 Mc Accuracy: ±0.005%	hp Model 5254L with hp Model 5253B plug-in
Spectrum Analyzer	Range: 10 Mc - 4 Gc	hp Model 8551 with hp Model 851
Notch Filter	Rejects 2 Gc	hp Model 8439A
RF Voltmeter	Range: 100 Mc	hp Model 411A
Variable Autotransformer	Power: 1 amp Voltage: 102 to 128 volts	Ohmite VT8F
Signal Generator	Range: 200 Kc to 50 Mc	hp Model 606
Signal Generator	Frequency: 1-2 Gc	hp Model 8614A
Bandpass Filter	Pass: 2-4 Gc, reject other	hp Model 8431A
ACCESSORIES		
UG-274A/U	BNC T Connector	hp part number 1250-0072
UG-349A/U	Female N-Male BNC connector	hp part number 1250-0077
Tuning Wand		Walsco 2947
Plastic Tuning Wand		General Cement Company GC 8271

Table 5-2. In-Cabinet Performance Check

OUTPUT

a. Connect 1-2 Gc Signal Generator to Notch Filter at the input to the Spectrum Analyzer.

b. Set Spectrum Analyzer controls as follows:

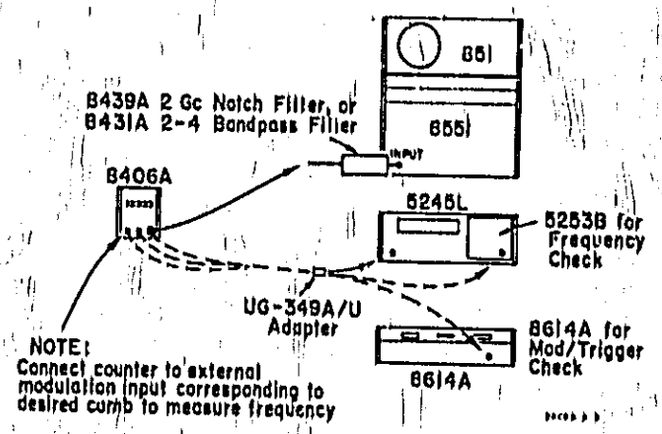
TUNE	1 Gc (.01-2 Gc FREQUENCY range)
IF	2 Gc
VERT DISPLAY	LOG
SWEEP TIME	1 SEC/CM
SPECTRUM WIDTH	200 MC/CM
ATTENUATOR	10 DB (to start)
IF BANDWIDTH	10 KC

c. Set Signal Generator for -35-dBm output at 1 Gc.

d. Adjust the Spectrum Analyzer for a display 6 cm high.

e. Increase the Signal Generator frequency at approximately 200-Mc intervals to 2 Gc, observing the display amplitude at each frequency. If the amplitude changes, mark the level with a grease pencil on the face of the Spectrum Analyzer.

f. Connect the 8406A as shown in Figure 5-1.



h. Leave Spectrum Analyser controls as in b and d. The frequency comb should be smooth in output with an output level of greater than -35 dBm from 1-2 Gc and greater than -45 dBm from 100 Mc to 1 Gc.

i. Depress the 10 Mc pushbutton on the 8406.

j. The frequency comb should be smooth in output with an output level of greater than -50 dBm from 500 Mc to 2 Gc and greater than -60 dBm from 10 Mc to 500 Mc.

k. Depress the 1 Mc pushbutton on the 8406.

m. The frequency comb should be smooth in output with a level of greater than -70 dBm from 500 Mc to 2 Gc and greater than -80 dBm from 10 Mc to 500 Mc (ATTENUATOR may have to be switched to 0 DB).

n. Connect the counter and measure the frequency. Must be within 100 cycles.

o. Depress the 10 MC pushbutton on the 8406. The frequency must be within 1000 cps.

p. Depress the 100 MC pushbutton on the 8406. The frequency must be within 10 kc.

q. Set the Spectrum Analyzer so that two successive 10-Mc harmonics are displayed, widely spaced.

r. Turn the INTERPOLATION AMPLITUDE control on the 8406 fully clockwise. Ten 1-Mc pulses should appear in the space between the two 10-Mc pulses.

If it is desired to check the output level from 2-4 Gc, fundamental mixing must be used to increase sensitivity in order that the lower levels may be observed. Proceed as follows:

a. Repeat Analyzer Calibration steps a-d, using a 2-4 Gc Signal Generator with a 8431A Bandpass Filter and set the Spectrum Analyzer controls as follows:

TUNE	2.8/3.2 Gc (1.8-4.2 Gc FREQUENCY range)
IF	200 Mc
VERT DISPLAY	LOG
SWEEP TIME	1 SEC/CM
SPECTRUM WIDTH	200 MC/CM
ATTENUATOR	10 DB (to start)
IF BANDWIDTH	10 Kc

Table 5-2. In-Cabinet Performance Check (cont'd)

b.	Measure 8406 comb output level,	100-Mc comb should be greater than -47 dBm over 2-4 Gc range 10-Mc comb should be greater than -62 dBm over 2-4 Gc range 1-Mc comb should be greater than -62 dBm over 2-4 Gc range (may have to reduce ATTENUATOR to 0 DB to see this sensitivity on last measurement).
MODULATION/EXT 1-20 MC Input		
a.	Connect the instrument as shown in Figure 5-1.	
b.	Depress the 1 Mc pushbutton.	
c.	Set the Spectrum Analyzer to a center frequency of 1 Gc and a spectrum width of about 3 Mc with an IF bandwidth of 1 Kc.	
d.	Connect a Signal Generator to 1 MC, 10 MC COMB MODULATION jack on 8406.	
e.	Set frequency of signal generator to 200 Kc and adjust output amplitude so that the sidebands displayed on Spectrum Analyzer are 20 db below the amplitude of the 1-Mc comb.	
f.	Read the output level of the signal generator. This level should be less than 1 mV. (Actual modulating voltage required will be approximately twice this since the input impedance at this jack is high.)	
g.	Depress the 10 MC pushbutton on the 8406.	
h.	Set the Spectrum Analyzer to a spectrum width of 100 Mc and an IF bandwidth of 10 Kc.	
i.	Set the frequency of signal generator to 2 Mc and level so that the sidebands displayed on spectrum analyzer are 20 db below carrier frequency. Signal Generator output level should be less than 6 mV.	
j.	Insert a BNC T connector at the 1-20 Mc input and connect an RF Millivoltmeter to the open arm of the T to measure the input signal.	
k.	Depress EXT TRIG pushbutton on 8406, set Signal Generator to 20 Mc and increase output level until 8406 triggers. This level should be less than 4 volts.	
m.	Connect Signal Generator to the 100 MC COMB MODULATION jack of 8406 with the same set-up as in step k.	
n.	Depress 100 MC pushbutton on 8406, set Signal Generator to 20 Mc and increase output level until 8406 triggers. This level should be less than 200 mV.	
o.	Set Signal Generator frequency to 50 Mc, depress EXT TRIG pushbutton on 8406, and increase output level of Signal Generator until Comb Generator triggers. This level should be less than 2 volts.	

CAUTION

TO AVOID DAMAGE, REMOVE POWER FROM INSTRUMENT BEFORE REMOVING OR REPLACING INSTRUMENT COVERS, ASSEMBLIES, OR COMPONENTS.

5-9. INSTRUMENT COVER REMOVAL.

5-10. To remove top or bottom cover, unscrew and remove the countersunk Phillips-head screws which secure cover to the instrument at the rear. Then slide cover toward rear of instrument.

WARNING: 115/230 VAC AND DC SUPPLY WIRES ARE EXPOSED WHEN EITHER TOP OR BOTTOM INSTRUMENT COVER IS REMOVED. BE CAREFUL DURING TROUBLESHOOTING, ADJUSTMENTS, OR REPAIR.

5-11. TROUBLESHOOTING AND REPAIR.

5-12. PRELIMINARY TROUBLESHOOTING.

5-13. The first step is to decide if the trouble is catastrophic or marginal. If catastrophic, start with the power supply and then trace the signal through the instrument (the block diagram, Figure 4-1, will help here). If marginal, perform the In-cabinet Performance Check to determine the circuit which is causing the marginal performance. The instrument is straightforward except for the Diode Driver. Note that the Diode Driver is energized in the EXT TRIG position of the COMB FREQUENCY switch in addition to the 1 MC and 10 MC positions. This permits the use of the Diode Driver to "square" up the incoming trigger signal when using external trigger.

5-14. TRANSISTOR TROUBLESHOOTING.

5-15. When troubleshooting transistor circuits certain precautions must be observed. Transistors can be damaged by small voltages or by heat! Be very careful not to short the circuit and thereby apply excessive voltage to the transistors. When using a VTVM measure emitter-to-base voltages to a common point, such as the chassis (there may be enough loop current between the leads of the VTVM to damage transistors). When measuring resistance use only the ranges on the ohmmeter which have 1.5 volts or less between the leads and whose short-circuit current is less than 3 mA. See Table 5-4 for the safe ranges of popular ohmmeters.

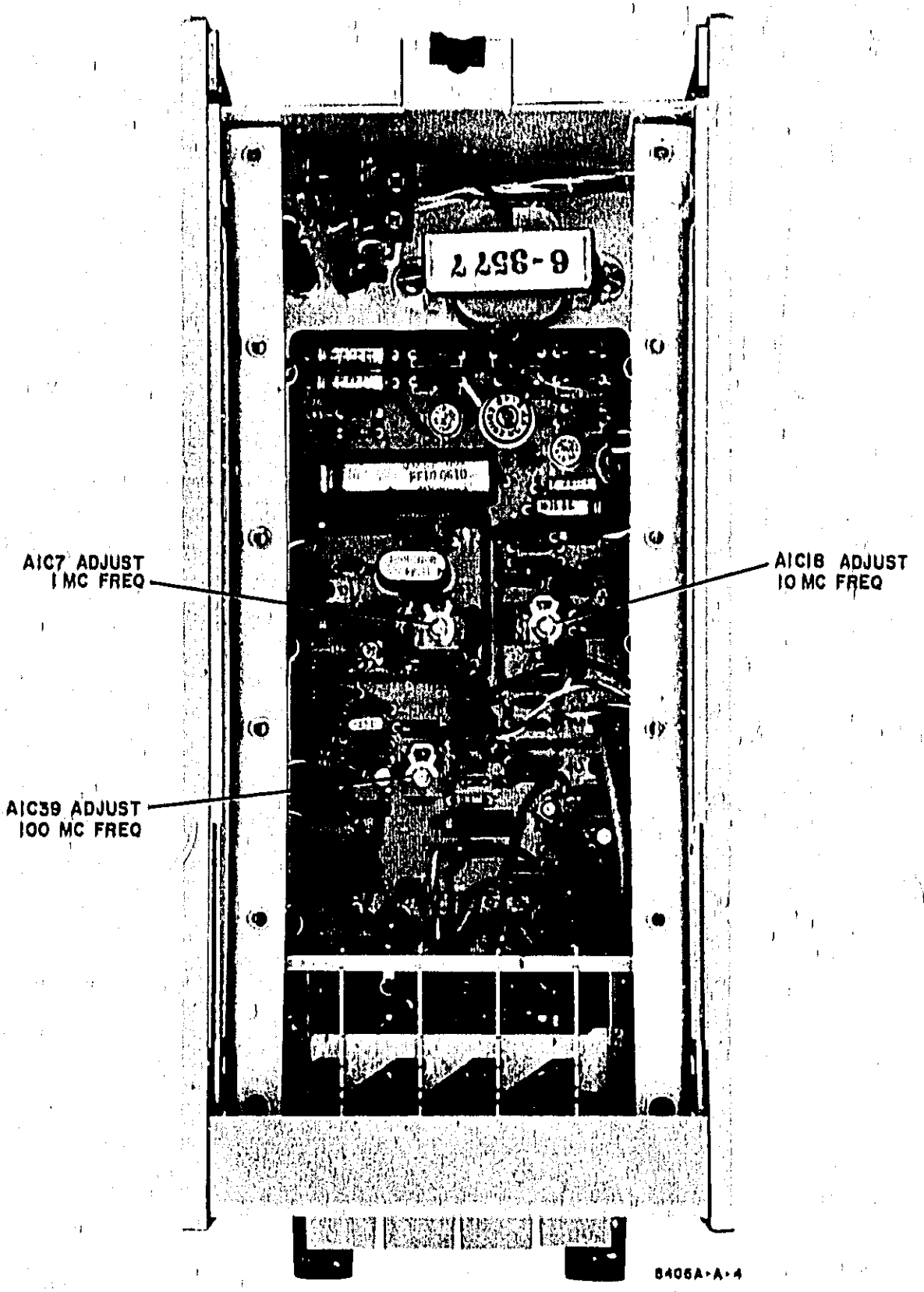


Figure 5-2. Location Diagram

Table 5-3. Performance Check Test Card

Description	
Output	
100 Mc	Level deviation ± db Frequency
10 Mc	Level deviation ± db Frequency Interpolation frequency
1 Mc	Frequency
Modulation/External Trigger	
1-20 Mc Input	
200 Kc	Input level volts
2 Mc	Input level volts
20 Mc	Input level volts
2-200 Mc Input	
20 Mc	Trigger voltage volts

5-16. IN-CIRCUIT TESTING. The most common causes of transistor failures are internal short- and open-circuits. In transistor circuit testing the most important consideration is the transistor base-emitter junction. Like the control grid of a vacuum tube, the base is the control point of the transistor. The emitter-base voltage should be a fraction of a volt, the polarity and exact value depending upon the material of the transistor and the current carried. Short the emitter to the base. If the transistor is working, the voltage on the collector should go toward the supply voltage.

Table 5-4. Safe Ohmmeter Ranges for Transistor Resistance Measurements

Ohmmeter	Safe Range(s)	Open Ckt Voltage	Short Ckt Current	Lead Color	Lead Polarity
HP 412A	R x 1K R x 10K R x 100K R x 1M R x 10M	1.0V 1.0V 1.0V 1.0V 1.0V	1 ma 100 μa 10 μa 1 μa 0.1 μa	Red Black	+ -
HP 410C	R x 1K R x 10K R x 100K R x 1M R x 10M	1.3V 1.3V 1.3V 1.3V 1.3V	0.57 ma 57 μa 5.7 μa 0.5 μa 0.05 μa	Red Black	+ -
HP 410B	R x 100 R x 1K R x 10K R x 100K R x 1M	1.1V 1.1V 1.1V 1.1V 1.1V	1.1 ma 110 μa 11 μa 1.1 μa 0.11 μa	Black Red	+ -
Simpson 260	R x 100	1.5V	1 ma	Red Black	+ -
Simpson 269	R x 1K	1.5V	0.82ma	Black Red	+ -
Triplett 630	R x 100 R x 1K	1.5V 1.5V	3.25 mA 325 μA	Varies with Serial Number	
Triplett 310	R x 10 R x 100	1.5V 1.5V	750 μa 75 μa		

5-17. OUT-OF-CIRCUIT TESTING. While it is not recommended to remove the transistors from the instrument for troubleshooting as a general rule, sometimes it is impossible to isolate troubles to a particular transistor. In such case it may be necessary to remove the suspected transistor and test it on a curve tracer. Do NOT remove a transistor for testing without some indication that this particular transistor is at fault. Use a heat sink, such as a pair of long-nosed pliers, between the soldering iron and the transistor. When soldering a transistor back in the circuit use the same precautions as when unsoldering. If a particular transistor is all right but the circuit still does not work, try the transistor ahead and behind the suspected one. Table 5-5 gives typical resistance measurements of transistors.

5-18. PRINTED CIRCUIT COMPONENT REPLACEMENT. Component lead holes in the Model 8403 circuit board have plated walls to ensure good electrical contact between conductors on the opposite sides of the board. To prevent damage to this plating and to the replacement component, apply heat sparingly and work carefully. The following replacement procedure is recommended:

a. Remove defective component.

b. Melt solder in component lead holes. Use clean, dry soldering iron to remove excess solder. Clean holes with toothpick or wooden splinter. Do not use metal tool for cleaning as this may damage through-hole plating.

Table 5-5. Output-of-Circuit Transistor Resistance Measurement

Transistor Type		Connect Ohmmeter Pos. lead to	Connect Ohmmeter Neg. lead to	Measure Resistance (ohms)
PNP Germanium	Small Signal	emitter	base*	200-500
		emitter	collector	10K-100K
	Power	emitter	base*	30-50
		emitter	collector	several hundred
NPN Silicon	Small Signal	base	emitter	1K-3K
		collector	emitter	very high (might read open)
	Power	base	emitter	200-1000
		collector	emitter	high, often greater than 1M

*To test for transistor action, add collector-base short. Measured resistance should decrease.

c. Bend lead of replacement component to correct shape and insert component leads into lead holes. Using heat and solder sparingly, solder leads in place. Heat may be applied to either side of the board. Use heat sink (long-nose pliers, commercial heat-sink tweezers, etc.) when replacing transistors and diodes in order to prevent conduction of excessive heat from the soldering iron to the component. Firm application of heat for the shortest possible time is the rule.

d. Through-hole plating breaks are indicated by the separation from the board of the round conductor pad on either side of the board. To repair breaks, press conductor pads against board and solder replacement component lead to conductor pad on both sides of the board.

5-19. ADJUSTMENTS.

5-20. Rarely, if ever, will it be necessary to perform adjustments on a particular instrument. Do NOT perform these adjustments as a performance check. Use the performance check. Test limits given here should not be construed as part of the specifications.

5-21. POWER SUPPLY. Perform the following tests at either 115 or 230 volt 50-400 cps, unless otherwise noted. When line voltage variations are specified, the test limits apply at the following voltages:

	115 VOLTS	230 VOLTS
Low line	103 volts	207 volts
Normal line	115 volts	230 volts
High line	127 volts	253 volts

Proceed as follows:

a. Depress 10 MC COMB FREQUENCY pushbutton.

b. Set INTERPOLATION AMPLITUDE fully clockwise.

c. Set OUTPUT AMPLITUDE fully clockwise.

d. Connect a dc and an ac voltmeter to the -14 volt supply. This is a violet wire on top of the printed circuit, third terminal from the rear (see Figure 5-2 for location).

e. Vary the line voltage from low to high while watching the meters. The dc voltage should stay in regulation within 0.5 Vdc and the ac voltage (ripple) should be below 3 millivolts.

5-22. OSCILLATOR FREQUENCIES. Connect the instrument as shown in Figure 5-1. The 2 Gc Notch Filter prevents overloading of 851/8551 Spectrum Analyzer at the intermediate frequency, but may not be necessary with all Spectrum Analyzers. Set Generator controls as follows:

COMB FREQUENCY . . . . . 100 MC
INTERPOLATION AMPLITUDE . . . . . OFF
OUTPUT AMPLITUDE . . . . . fully clockwise

a. Set Spectrum Analyzer to a center frequency of 1 Gc with spectrum width of 2 Gc. The frequency comb should be smooth in output. If not, tune A1T1 (see location diagram, Figure 5-2) with a Walsco 2547 tuning wand for a stable frequency and A1T2 for maximum flat output in the 400-Mc region as the OUTPUT AMPLITUDE control is varied from maximum to minimum.

b. Connect counter and tune A1C30 (see location diagram, Figure 5-2) for 100-Mc frequency.

c. Depress 10 Mc pushbutton and use counter to measure frequency. Tune A1C18 with a General Cement 8271 plastic tuning wand to 10 Mc.

d. Depress 1 Mc pushbutton and use counter to measure frequency. Tune A1C7 to 1 Mc.

PARTS LIST

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

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

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

b. Typical manufacturer of the part in a five-digit code; see list of manufacturers in Table 6-3.

c. Manufacturer's stock number.

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

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

6-4. ORDERING INFORMATION.

6-5. To order a replacement part, address order or inquiry to your nearest Hewlett-Packard field office.

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

a. Model and complete serial number of instrument.

b. Hewlett-Packard stock number.

c. Circuit reference designation.

d. Description.

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

REFERENCE DESIGNATORS

A	= assembly	F	= fuse	MP	= mechanical part	V	= vacuum, tube, neon bulb, photocell, etc.
B	= motor	FL	= filter	P	= plug	VR	= voltage regulator
BT	= battery	IC	= integrated circuit	Q	= transistor	W	= cable
C	= capacitor	J	= jack	R	= resistor	X	= socket
CP	= coupler	K	= relay	RT	= thermistor	Y	= crystal
CR	= diode	L	= inductor	S	= switch	Z	= tuned cavity, network
DL	= delay line	LS	= loud speaker	T	= transformer		
DS	= device signaling (lamp)	M	= meter	TB	= terminal board		
E	= misc electronic part	MK	= microphone	TP	= test point		

ABBREVIATIONS

A	= amperes	H	= henries	N/O	= normally open	RMO	= rack mount only
AFC	= automatic frequency control	HDW	= hardware	NPO	= negative positive zero (zero temperature coefficient)	RMS	= root-mean square
AMPL	= amplifier	HEX	= hexagonal			RWV	= reverse working voltage
		HG	= mercury	NPN	= negative-positive-negative		
BFO	= beat frequency oscillator	HR	= hour(s)			S-B	= slow-blow
BE CU	= beryllium copper	HZ	= hertz	NRFR	= not recommended for field replacement	SCR	= screw
BH	= binder head					SE	= selenium
BP	= bandpass	IF	= intermediate freq	NSR	= not separately replaceable	SECT	= section(s)
BRS	= brass	IMPG	= impregnated			SEMICON	= semiconductor
BWO	= backward wave oscillator	INCD	= incandescent			SI	= silicon
		INCL	= include(s)	OBD	= order by description	SIL	= silver
CCW	= counter-clockwise	INS	= insulation(ed)	OH	= oval head	SL	= slide
CER	= ceramic	INT	= internal	OX	= oxide	SPG	= spring
CMO	= cabinet mount only					SPL	= special
COEF	= coefficient	K	= kilo = 1000	P	= peak	SST	= stainless steel
COM	= common			PC	= printed circuit	SR	= split ring
COMP	= composition	LH	= left hand	PF	= picofarads = 10^{-12} farads	STL	= steel
COMPL	= complete	LIN	= linear taper	PH BRZ	= phosphor bronze	TA	= tantalum
CONN	= connector	LK WASH	= lock washer	PHIL	= Phillips	TD	= time delay
CP	= cadmium plate	LOG	= logarithmic taper	PIV	= peak inverse voltage	TGL	= toggle
CRT	= cathode-ray tube	LPF	= low pass filter	PNP	= positive-negative-positive	THD	= thread
CW	= clockwise					TI	= titanium
		M	= milli = 10^{-3}	P/O	= part of	TOL	= tolerance
DEPC	= deposited carbon	MEG	= meg = 10^{6}	POLY	= polystyrene	TRIM	= trimmer
DR	= drive	MET FLM	= metal film	PORC	= porcelain	TWT	= traveling wave tube
		MET OX	= metallic oxide	POS	= position(s)		
ELECT	= electrolytic	MFR	= manufacturer	POT	= potentiometer	U	= micro = 10^{-6}
ENCAP	= encapsulated	MHZ	= mega hertz	PP	= peak-to-peak	VAR	= variable
EXT	= external	MINAT	= miniature	PT	= point	VDCW	= dc working volts
		MOM	= momentary	PWV	= peak working voltage		
F	= farads	MTG	= mounting			W/	= with
FH	= flat head	MY	= "mylar"	RECT	= rectifier	W	= watts
FILH	= fillister head			RF	= radio frequency	WIV	= working inverse voltage
FXD	= fixed	N	= nano (10^{-9})	RH	= round head or right hand	WW	= wirewound
		N/C	= normally closed			W/O	= without
G	= giga (10^{9})	NE	= neon				
GE	= germanium	NI PL	= nickel plate				
GL	= glass						
GRD	= ground(ed)						

01194-13

02293-1

Table 6-1, Reference Designation Index

Reference Designation	Stock No.	Description #	Note
A1	08406-6001	BOARD ASSY:: ETCHED CIRCUIT	
A1C1	0160-0174	C:FXD CER 0.47UF +80-20% 25VDCW	
A1C2	0160-0127	C:FXD CER 1UF 20% 25VDCW	
A1C3	0160-0134	C:FXD MICA 220PF 5% 300VDCW	
A1C4	0160-0194	C:FXD MY 0.015UF 10%	
A1C5	0150-0050	C:FXD CER 1000PF 600 VDCW	
A1C6	0140-0145	C:FXD MICA 22 PF 5% 500 VDCW	
A1C7	0121-0127	C:VAR AIR 1.7-14PF	
A1C8	0150-0121	C:FXD CER 0.1UF +80%-20% 50VDCW	
A1C9	0150-0093	C:FXD CER 0.01UF +80-20% 100VDCW	
A1C10	0140-0192	C:FXD MICA 68PF 5% 300VDCW	
A1C11	0160-0179	C:FXD MICA 33PF 5% 300VDCW	
A1C12	0140-0192	C:FXD MICA 68PF 5% 300VDCW	
A1C13	0150-0096	C:FXD CER 0.05UF 100VDCW	
A1C14	0150-0121	C:FXD CER 0.1UF +80%-20% 50VDCW	
A1C15	0140-0204	C:FXD MICA 47PF 5% NPO 500VDCW	
A1C16	0140-0232	C:FXD MICA 460PF 1% 300VDCW	
A1C17	0160-0178	C:FXD MICA 27PF 5% 300VDCW	
A1C18	0121-0127	C:VAR AIR 1.7-14PF	
A1C19	0140-0176	C:FXD MICA 100 PF 2% 300 VDCW	
A1C20	0150-0050	C:FXD CER 1000PF 600 VDCW	
A1C21	0140-0204	C:FXD MICA 47PF 5% NPO 500VDCW	
A1C22	0150-0093	C:FXD CER 0.01UF +80-20% 100VDCW	
A1C23	0150-0121	C:FXD CER 0.1UF +80%-20% 50VDCW	
A1C24	0160-0340	C:FXD MICA 600 PF 1% 300VDCW	
A1C25	0150-0050	C:FXD CER 1000PF 600 VDCW	
A1C26	0180-0119	C:FXD ELECT 1UF -10+100% 25VDCW	
A1C27	0150-0050	C:FXD CER 1000PF 600 VDCW	
A1C28	0140-0209	C:FXD MICA 5PF 10% 500VDCW	
A1C29	0160-2197	C:FXD MICA 10PF 5%	
A1C30	0150-0050	C:FXD CER 1000PF 600 VDCW	
A1C31	0150-0050	C:FXD CER 1000PF 600 VDCW	
A1C32	0140-0209	C:FXD MICA 5PF 10% 500VDCW	
A1C33	0140-0232	C:FXD MICA 460PF 1% 300VDCW	
A1C34	0150-0050	C:FXD CER 1000PF 600 VDCW	
A1C35	0180-0138	C:FXD ELECT 100UF -10+100% 40VDCW	
A1C36	0180-0059	C:FXD ELECT 10UF -10%+100% 25VDCW	
A1C37	0180-0059	C:FXD ELECT 10UF -10%+100% 25VDCW	
A1C38	0180-0059	C:FXD ELECT 10UF -10%+100% 25VDCW	
A1C39	0121-0127	C:VAR AIR 1.7-14PF	
A1C40	0150-0050	C:FXD CER 1000PF 600 VDCW	
A1C41	0160-2140	C:FXD CER 470 PF +80-20% 1000VDCW	
A1CR1	1901-0040	DIODE:SILICON 30 MA AT 1V 30 PIV	
A1CR2	1912-0007	DIODE:TUNNEL EIA TYPE 1N3714	
A1CR3	1901-0026	DIODE:SILICON 200 PIV 0.5 AMP	
A1CR4	1901-0026	DIODE:SILICON 200 PIV 0.5 AMP	
A1CR5	1901-0025	DIODE:JUNCTION:5MA AT 1V 100 PIV	
A1CR6	1901-0025	DIODE:JUNCTION:5MA AT 1V 100 PIV	
A1CR7	1901-0025	DIODE:JUNCTION:5MA AT 1V 100 PIV	
A1L1	9140-0131	COIL:FXD RF 10 MH	

See list of abbreviations in introduction to this section.

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

Reference Designation	Stock No.	Description #	Note
A1L2	9140-0131	COIL:FXD RF 10 MH	
A1L3	9140-0131	COIL:FXD RF 10 MH	
A1L4	9140-0181	COIL:FXD RF 22UH 5%	
A1L5	9140-0210	COIL:FXD RF 100 UH 5%	
A1L6	9140-0210	COIL:FXD RF 100 UH 5%	
A1L7	9140-0210	COIL:FXD RF 100 UH 5%	
A1L8	9140-0158	COIL:FXD 1.0UH 10%	
A1L9	9100-1612	COIL:FXD RF 0.33 UH 20%	
A1L10	9140-0210	COIL:FXD RF 100 UH 5%	
A1L11	9100-1613	COIL:FXD RF 0.47 UH 20%	
A1Q1	1854-0005	TRANSISTOR:2N708 NPN SILICON	
A1Q2	1854-0005	TRANSISTOR:2N708 NPN SILICON	
A1Q3	1850-0099	TRANSISTOR:GERMANIUM 2N964 PNP	
A1Q4	1854-0019	TRANSISTOR:SILICON NPN	
A1Q5	1854-0073	TRANSISTOR:SILICON NPN 2N3478	
A1Q6	1850-0062	TRANSISTOR:GERMANIUM PNP 2N404	
A1Q7	1854-0073	TRANSISTOR:SILICON NPN 2N3478	
A1Q8	1850-0062	TRANSISTOR:GERMANIUM PNP 2N404	
A1Q9	1850-0064	TRANSISTOR:GERMANIUM PNP 2N1183	
A1R1	0698-3156	R:FXD MET FLM 14.7K OHM 1% 1/8W	
A1R2	0757-0439	R:FXD MET FLM 6.81K OHM 1% 1/8W	
A1R3	0698-0082	R:FXD MET FLM 464 OHM 1% 1/8W	
A1R4	0698-3441	R:FXD MET FLM 215 OHM 1% 1/8W	
A1R5	0698-0083	R:FXD MET FLM 1960 OHM 1% 1/8W	
A1R6	0757-0465	R:FXD MET FLM 100K OHM 1% 1/8W	
A1R7	0698-0082	R:FXD MET FLM 464 OHM 1% 1/8W	
A1R8	0757-0280	R:FXD MET FLM 1.00K OHM 1% 1/8W	
A1R9	0698-3136	R:FXD MET FLM 17.8K OHM 1% 1/8W	
A1R10	0757-0439	R:FXD MET FLM 6.81K OHM 1% 1/8W	
A1R11	0698-0082	R:FXD MET FLM 464 OHM 1% 1/8W	
A1R12	0698-3441	R:FXD MET FLM 215 OHM 1% 1/8W	
A1R13	0698-0084	R:FXD MET FLM 2150 OHM 1% 1/8W	
A1R14	0698-0084	R:FXD MET FLM 2150 OHM 1% 1/8W	
A1R15	0757-0280	R:FXD MET FLM 1.00K OHM 1% 1/8W	
A1R16	0757-1094	R:FXD MET FLM 1.47K OHM 1% 1/8W	
A1R17	0757-0401	R:FXD MET FLM 100 OHM 1% 1/8W	
A1R18	0698-3441	R:FXD MET FLM 215 OHM 1% 1/8W	
A1R19	0757-0401	R:FXD MET FLM 100 OHM 1% 1/8W	
A1R20	0757-0441	R:FXD MET FLM 8.25K OHM 1% 1/8W	
A1R21	0698-3154	R:FXD MET FLM 4220 OHM 1% 1/8	
A1R22	0757-0417	R:FXD MET FLM 562 OHM 1% 1/8W	
A1R23	0698-3440	R:FXD MET FLM 196 OHM 1% 1/8W	
A1R24	0698-3441	R:FXD MET FLM 215 OHM 1% 1/8W	
A1R25	0698-3430	R:FXD MET FLM 21.5 OHM 1% 1/8W	
A1R26	0698-3430	R:FXD MET FLM 21.5 OHM 1% 1/8W	
A1R27	0757-0346	R:FXD MET FLM 10.0 OHM 1% 1/8W	
A1R28	0698-0084	R:FXD MET FLM 2150 OHM 1% 1/8W	
A1R29	0698-0084	R:FXD MET FLM 2150 OHM 1% 1/8W	
A1R30	0757-0346	R:FXD MET FLM 10.0 OHM 1% 1/8W	
A1R31	0698-3445	R:FXD MET FLM 348 OHM 1% 1/8W	
A1R32	0757-0416	R:FXD MET FLM 511 OHM 1% 1/8W	
A1T1	08406-6013	TRANSFORMER:RF(OSCILLATOR)	

See list of abbreviations in introduction to this section

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

Reference Designation	Stock No.	Description #	Note
A1T2	08406-6014	TRANSFORMER:RF(AMPLIFIER)	
A1VR1	1902-0055	DIODE BREAKDOWN:SILICON 14.7V 10%	
A1XY1	1200-0028	SOCKET:CRYSTAL 2-CONTACT	
A1Y1	0410-0013	CRYSTAL UNIT:QUARTZ 1000KC	
A1Y2	0410-0109	CRYSTAL:QUARTZ 10 MC	
A1Y3	0410-0108	CRYSTAL:QUARTZ 100 MC	
	5000-0011	CLIP:ELECTRICAL RETAINING	
C1	0150-0097	C:FXD CER 6800 PF 1000 VDCW	
C2	0150-0019	C:FXD CER 1000PF 20%	
C3	0150-0019	C:FXD CER 1000PF 20%	
C4	0150-0097	C:FXD CER 6800 PF 1000 VDCW	
CR1	1901-0169	SEMICON DEVICE: DIODE	
CR1MP1	08406-6002	HOLDER ASSEMBLY, DIODE INCLUDES:	
	1250-0014	CONTACT: OUTER N MALE CONNECTOR	
	1250-0016	RING: LOCKING FOR TYPE N CONNECTOR	
	5020-0306	NUT: CONNECTOR	
	08406-2002	BODY, DIODE HOLDER	
	08406-2003	CENTER CONDUCTOR	
	08406-2005	SPACER	
CR1MP2	08651-2041	POST, DIODE	
CR1MP3	1460-0300	SPRING: COMPRESSION	
DS1	2140-0047	LAMP:GLOW 1/10W 0.8 MA 68K OHM	
F1	2110-0040	FUSE:CARTRIDGE 1/16 AMP SLOW BLOW	
J1	1250-0001	CONNECTOR:BNC	
J2	1250-0001	CONNECTOR:BNC	
J3	1251-0148	CONNECTOR:POWER 3 PIN MALE	
J4		NSR PART OF STEP DIODE ASSY.	
J5	08406-2004	CONNECTOR: PANEL	
L1	9170-0019	CORE:TOROID	
L2	9170-0019	CORE:TOROID	
P1		NSR PART OF ATTENUATOR ASSY	
R1	2100-0350	R:VAR COMP 1.5K OHM 20% LIN 1/2W	
R2	0687-6831	R:FXD COMP 68K OHM 10% 1/2W	
R3	2100-0350	R:VAR COMP 1500 OHM 20% LIN 1/2W	
S1	3101-0186	SWITCH:PUSHBUTTON:FREQUENCY)	
S2	3101-0033	SWITCH:SLIDE DPDT 115V-230V	
S3	3101-1248	SWITCH: PUSHBUTTON (LINE)	
S4		NSR PART OF R3	
T1	9100-1680	TRANSFORMER:POWER	
XF1	1400-0084	HOLDER:FUSE POST TYPE 3AG	
Z1	08406-6012	ATTENUATOR PAD ASSEMBLY INCLUDES:	
	1460-0297	SPRING:COMPRESSION	
	08491-6000	CARTRIDGE ASSEMBLY	
	08491-2101	CONNECTOR:FEMALE	
	08491-2102	SPACER (QTY 2)	

= See list of abbreviations in introduction to this section

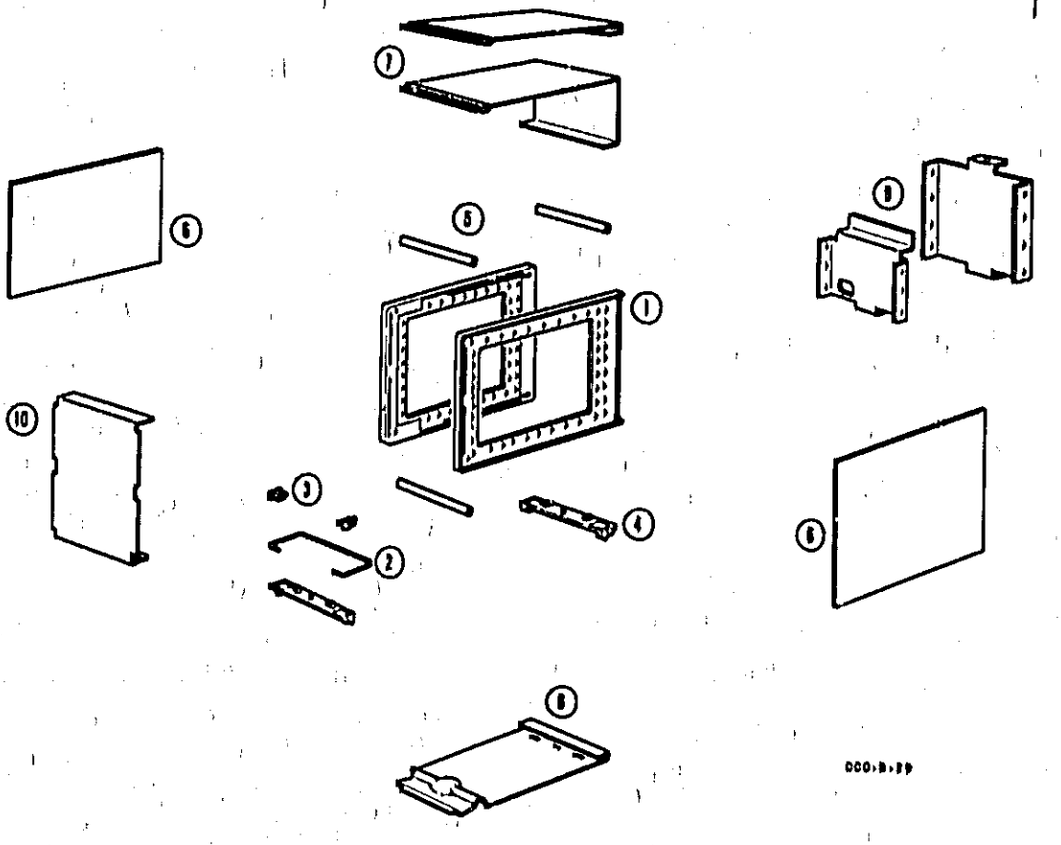
Table 6-1, Reference Designation Index (Cont'd)

Reference Designation	Stock No.	Description #	Note
	08742-0006	SPACER	
	08491-2002	BEAD	
	08491-4001	PIN, FEMALE	
	08491-2009	CONTACT, SLIDING	
		MISCELLANEOUS	
	08406-0003	BRACKET, BOTTOM COVER	
	08406-0004	BRACKET, RIGHT SUPPORT	
	08406-0005	BRACKET, LEFT SUPPORT	
	08406-0006	BRACKET, SWITCH	
	08406-6004	CABLE ASSY., COAX(ORANGE)	
	08406-6005	CABLE ASSY., COAX(RED)	
	08406-6006	CABLE ASSY., COAX(BROWN))	
	08406-6007	CABLE ASSY., COAX(BLACK))	
	08406-6009	CABLE ASSY., COAX(YELLOW)	
	08406-6010	CABLE ASSY., COAX(GREEN)	
	08406-6011	CABLE ASSY., COAX(BLUE)	
	8120-0078	CABLE ASSY:POWER	
	5040-0235	BASE(LAMPHOLDER	
	5040-0234	LAMPHOLDER	
	0370-0118	KNOB(GRAY PUSHBUTTON 11/16 IN DIA 1MC 10MC 100MC EXT TRIG	
	5000-3227	LABEL:PUSHBUTTON (1 MC)	
	5000-3228	LABEL:PUSHBUTTON(10 MC)	
	5000-3229	LABEL:PUSHBUTTON(100 MC)	
	5000-3248	LABEL:PUSHBUTTON(EXT. TRIG)	
	08406-0001	SUPPORT, LEFT	
	08406-0002	SUPPORT, RIGHT	
	0370-0103	KNOB:BLACK ROUND OUTPUT AMPLITUDE INTERPOLATION AMPLITUDE 1MC	

See list of abbreviations in Introduction to this section

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

Reference Designation	Stock No.	Description #	Note



MODULE SIZE 29

CABINET PARTS

1	5060-0703	FRAME ASSEMBLY
2	1490-0031	STAND:TILT
3	5040-0700	HINGE
4	5060-0727	FOOT ASSEMBLY
5	5020-0700	SPACER
6	5000-0703	COVER:SIDE
7	5060-0709	COVER ASSEMBLY:TOP
	5060-0706	UNPERFORATED FULL RECESS
	5060-0715	UNPERFORATED HALF RECESS
	5060-0712	PERFORATED FULL RECESS
		PERFORATED HAEF RECESS
8	5000-0711	COVER ASSEMBLY:BOTTOM
	5000-0714	UNPERFORATED
		PERFORATED
9	SEE MATL. LIST	PANEL:REAR
10	SEE MATL. LIST	PANEL:FRONT

See list of abbreviations in introduction to this section

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

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	
0121-0127	C:VAR AIR 1.7-14PF	28480	0121-0127	3	
0140-0145	C:FXD MICA 22 PF 5% 500 VDCW	04062	RDM15C220J5C	1	
0140-0176	C:FXD MICA 100 PF 2% 300 VDCW	04062	RDM15F101G3C	1	
0140-0192	C:FXD MICA 68PF 5% 300VDCW	04062	RDM15E680J3C	2	
0140-0204	C:FXD MICA 47PF 5% NPO 500VDCW	04062	RDM15E470J5C	2	
0140-0209	C:FXD MICA 5PF 10% 500VDCW	04062	RDM15C050D5C	2	
0140-0232	C:FXD MICA 460PF 1% 300VDCW	04062	RDM15F461F3C	2	
0150-0019	C:FXD CER 1000PF 20%	72982	327005X5U0102M	2	
0150-0050	C:FXD CER 1000PF 600 VDCW	84411	TYPE E	8	
0150-0093	C:FXD CER 0.01UF +80-20% 100VDCW	91418	TA	2	
0150-0096	C:FXD CER 0.05UF 100VDCW	91418	-TA	1	
0150-0097	C:FXD CER 6800 PF 1000 VDCW	91418	B	2	
0150-0121	C:FXD CER 0.1UF +80%-20% 50VDCW	56289	5C50A	3	
0160-0127	C:FXD CER 1UF 20% 25VDCW	56289	5C13	1	
0160-0134	C:FXD MICA 220PF 5% 300VDCW	14655	RDM15F221J3C	1	
0160-0174	C:FXD CER 0.47UF +80-20% 25VDCW	56289	5C11A	1	
0160-0178	C:FXD MICA 27PF 5% 300VDCW	04062	RDM15E270J3S	1	
0160-0179	C:FXD MICA 33PF 5% 300VDCW	04062	RDM15E330J3S	1	
0160-0194	C:FXD MY 0.015UF 10%	28480	0160-0194	1	
0160-0340	C:FXD MICA 600 PF 1% 300VDCW	04062	RDM15F601F3C	1	
0160-2140	C:FXD CER 470 PF +80-20% 1000VDCW	91418	TYPE B	1	
0160-2197	C:FXD MICA 10PF 5%	28480	0160-2197	1	
0180-0059	C:FXD ELECT 10UF -10%+100% 25VDCW	56289	30D106G025BB4	3	
0180-0119	C:FXD ELECT 1UF -10+100% 25VDCW	56289	30D105G025AA4	1	
0180-0138	C:FXD ELECT 100UF -10+100% 40VDCW	56289	D36254	1	
0370-0103	KNOB:BLACK ROUND	28480	0370-0103	2	
0370-0118	KNOB:GRAY PUSHBUTTON 11/16" DIA	28480	0370-0118	4	
0410-0013	CRYSTAL UNIT:QUARTZ 1000KC	28480	0410-0013	1	
0410-0108	CRYSTAL:QUARTZ 100 MC	28480	0410-0108	1	
0410-0109	CRYSTAL:QUARTZ 10 MC	28480	0410-0109	1	
0687-6831	R:FXD COMP 68K OHM 10% 1/2W	01121	EB-6831	1	
0698-0082	R:FXD MET FLM 464 OHM 1% 1/8W	28480	0698-0082	3	
0698-0083	R:FXD MET FLM 1960 OHM 1% 1/8W	28480	0698-0083	1	
0698-0084	R:FXD MET FLM 2150 OHM 1% 1/8W	28480	0698-0084	4	
0698-3136	R:FXD MET FLM 17.8KOHM 1% 1/8W	28480	0698-3136	1	
0698-3154	R:FXD MET FLM 4220 OHM 1% 1/8W	28480	0698-3154	1	
0698-3156	R:FXD MET FLM 14.7KOHM 1% 1/8	28480	0698-3156	1	
0698-3430	R:FXD MET FLM 21.5 OHM 1% 1/8W	28480	0698-3430	1	
0698-3440	R:FXD MET FLM 196 OHM 1% 1/8W	28480	0698-3440	2	
0698-3441	R:FXD MET FLM 215 OHM 1% 1/8W	28480	0698-3441	1	
0698-3445	R:FXD MET FLM 348 OHM 1% 1/8W	28480	0698-3445	4	
0757-0280	R:FXD MET FLM 1.0KOHM 1% 1/8W	28480	0757-0280	1	
0757-0346	R:FXD MET FLM 10.0 OHM 1% 1/8W	28480	0757-0346	2	
0757-0401	R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401	2	
0757-0416	R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416	1	
0757-0417	R:FXD MET FLM 562 OHM 1% 1/8W	28480	0757-0417	1	
0757-0439	R:FXD MET FLM 6.81K OHM 1% 1/8W	28480	0757-0439	2	
0757-0441	R:FXD MET FLM 8.25KOHM 1% 1/8W	28480	0757-0441	1	
0757-1094	R:FXD MET FLM 1.47K OHM 1% 1/8W	28480	0757-1094	1	
1200-0028	SOCKET:CRYSTAL 2-CONTACT	91662	430 BC	1	
1250-0014	CONTACT:OUTER N MALE CONNECTOR	28480	1250-0014	1	
1250-0016	RING:LOCKING FOR TYPE N CONNECTOR	28480	1250-0016	1	
1250-0083	CONNECTOR:BNC	28480	1250-0083	2	
1251-0148	CONNECTOR:POWER 3 PIN MALE	60427	H-1061-2	1	
1400-0084	HOLDER:FUSE POST TYPE 3AG	75915	342014	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
1460-0297	SPRING:COMPRESSION	28480	1460-0297	2
1490-0031	STAND:TILT	28480	1490-0031	1
1850-0062	TRANSISTOR:GERMANIUM PNP 2N404	28480	1850-0062	2
1850-0064	TRANSISTOR:GERMANIUM PNP 2N1183	02735	2N1183	1
1850-0099	TRANSISTOR:GERMANIUM 2N964 PNP	04713	2N964	1
1854-0005	TRANSISTOR:2N708 NPN SILICON	07263	2N708	2
1854-0019	TRANSISTOR:SILICON NPN	28480	1854-0019	1
1854-0073	TRANSISTOR:SILICON NPN 2N3478	93332	2N3478	2
1901-0025	DIODE:JUNCTION:5MA AT 1V 100 PIV	28480	1901-0025	3
1901-0026	DIODE:SILICON 200 PIV 0.5 AMP	28480	1901-0026	2
1901-0040	DIODE:SILICON 30 MA AT 1V 30 PIV	28480	1901-0040	1
1901-0169	SEMICON DEVICE:DIODE	28480	1901-0169	1
1902-0055	DIODE BREAKDOWN:SILICON 14.7V 10%	28480	1902-0055	1
1912-0007	DIODE:TUNNEL EIA TYPE 1N3714	03508	1N3714 SPEC	1
2100-0350	R:VAR COMP 1500 OHM 20% LIN 1/2W	28480	2100-0350	1
2100-1624	R:VAR COMP 2.5K OHM 20% LIN 1/2W	28480	2100-1624	1
2110-0040	FUSE:CARTRIDGE 1/16 AMP SLOW BLOW	75915	313.062	1
2140-0047	LAMP:GLOW 1/10W 0.8 MA 68K OHM	24455	A1C	1
3101-0033	SWITCH:SLIDE DPDT	42190	4633	1
3101-0186	SWITCH:PUSHBUTTON(FREQUENCY)	28480	3101-0186	1
5000-0011	CLIP:ELECTRICAL RETAINING	28480	5000-0011	1
5000-3227	LABEL:PUSHBUTTON (1 MC)	28480	5000-3227	1
5000-3228	LABEL:PUSHBUTTON(10 MC)	28480	5000-3228	1
5000-3229	LABEL:PUSHBUTTON(100 MC)	28480	5000-3229	1
5000-3248	LABEL:PUSHBUTTON(EXT. TRIG)	28480	5000-3248	1
5020-0306	NUT:CONNECTOR	28480	5020-0306	1
5040-0234	LAMPHOLDER:(FOR 4 LAMPS)	28480	5040-0234	1
5040-0235	BASE:LAMPHOLDER	28480	5040-0235	1
5040-0700	HINGE	28480	5040-0700	1
5060-0703	COVER:6 X 11 SIDE	28480	5060-0703	1
5060-0709	COVER ASSY:TOP 5 X 11 SH	28480	5060-0709	1
8120-0078	CABLE ASSY:POWER	70903	KH-4147	1
9100-1612	COIL:FXD RF 0.33 UH 20%	28480	9100-1612	1
9100-1678	TRANSFORMER:OSCILLATOR	28480	9100-1678	1
9100-1679	TRANSFORMER:RF AMPL	28480	9100-1679	1
9100-1613	COIL:FXD RF 0.47 UH 20%	28480	9100-1613	1
9100-1680	TRANSFORMER:POWER	28480	9100-1680	1
9140-0131	COIL:FXD RF 10 MH	28480	9140-0131	3
9140-0158	COIL:FXD 1.0UH 10%	99800	1025-20	1
9140-0181	COIL:FXD RF 22UH 5%	78526	12201M	1
9140-0210	COIL:FXD RF 100 UH 5%	28480	9140-0210	4
9170-0019	CORE:TOROID	72656	CF104 Q-1	2
08406-0001	SUPPORT, LEFT	28480	08406-0001	1
08406-0002	SUPPORT, RIGHT	28480	08406-0002	1
08406-0003	BRACKET, BOTTOM COVER	28480	08406-0003	1
08406-0004	BRACKET, RIGHT SUPPORT	28480	08406-0004	1
08406-0005	BRACKET, LEFT SUPPORT	28480	08406-0005	1
08406-0006	BRACKET, SWITCH	28480	08406-0006	1
08406-0007	COVER, TOP	28480	08406-0007	1
08406-0008	COVER, BOTTOM	28480	08406-0008	1
08406-0009	PANEL, REAR	28480	08406-0009	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	
08406-0010	PANEL, FRONT	28480	08406-0010	1	
08406-0011	CHASSIS	28480	08406-0011	1	
08406-2002	BODY, DIODE HOLDER	28480	08406-2002	1	
08406-2003	CENTER CONDUCTOR	28480	08406-2003	1	
08406-2004	CONNECTOR, PANEL	28480	08406-2004	1	
08406-2104	CONNECTOR:PANEL	28480	08406-2104	1	
08406-6001	BOARD ASSY., ETCHED CIRCUIT	28480	08406-6001	1	
08406-6002	HOLDER ASSEMBLY, DIODE	28480	08406-6002	1	
08406-6004	CABLE ASSY., COAX(ORANGE)	28480	08406-6004	1	
08406-6005	CABLE ASSY., COAX(RED)	28480	08406-6005	1	
08406-6006	CABLE ASSY., COAX(BROWN))	28480	08406-6006	1	
08406-6007	CABLE ASSY., COAX(BLACK))	28480	08406-6007	1	
08406-6009	CABLE ASSY., COAX(YELLOW)	28480	08406-6009	1	
08406-6010	CABLE ASSY., COAX(GREEN)	28480	08406-6010	1	
08406-6011	CABLE ASSY., COAX(BLUE)	28480	08406-6011	1	
08406-6012	ATTENUATOR PAD ASSEMBLY	28480	08406-6012	1	
08491-2101	CONNECTOR:FEMALE	28480	08491-2101	1	
08491-2002	BEAD	28480	08491-2002	2	
08491-2004	PIN, FEMALE	28480	08491-2004	2	
08491-2005	CONTACT, SLIDING	28480	08491-2005	2	
08491-6000	CARTRIDGE ASSEMBLY	28480	08491-6000	1	
08551-2041	POST:DIODE	28480	08551-2041	1	
08742-0006	SPACER	28480	08742-0006	1	
5000-0703	COVER:SIDE 6X11 SM	28480	5000-0703	2	
5000-0711	COVER:BOTTOM 5X11 SM	28480	5000-0711	1	
5060-0727	FOOT ASSY: 1/3 MOD	28480	5060-0727	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
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00287	Comco Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00338	Microlion Co., Inc.	Valley Stream, N.Y.
00373	Gudeck Inc., Electronics Products Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
00866	Gee Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
00939	Micristab Inc.	Livingston, N.J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N.Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amatech Corp.	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferrocube Corp. of America	Saugerties, N.Y.
02116	Wheelock Signals, Inc.	Long Branch, N.J.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vaccline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Prod. Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div. Finishing Plant	Somerville, N.J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04022	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04054	Precision Paper Tube Co.	Chicago, Ill.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04661	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Fillmore Co., Inc. Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05397	Union Carbide Corp., Linde Div., Kemet Dept.	Cleveland, Ohio
05683	Illumitronic Engineering Co.	Sunnyvale, Calif.
05816	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05874	Barber Colman Co.	Rockford, Ill.
05878	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05939	Metro-Tel Corp.	Westbury, N.Y.
05983	Stewart Engineering Co.	Santa Cruz, Calif.
05990	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., The	Bridgeport, Conn.
06090	Raytheon Corp.	Redwood City, Calif.
06179	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06540	Amalam Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Semtor Div. Components Inc.	Phoenix, Ariz.
06817	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
06980	Valpey Assoc. Elmac Div.	San Carlos, Calif.
07058	Kelvin Electric Co.	Van Nuys, Calif.
07126	Digitron Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07261	Avnet Corp.	Culver City, Calif.
07263	Fairchild Camera & Instl. Corp. Semiconductor Div.	Mountain View, Calif.
07272	Minnesota Rubber Co.	Minneapolis, Minn.
07287	Bliteher Corp., The	Monterey Park, Calif.
07297	Sylvania Elect. Prod. Inc., Ml. View Operations	Mountain View, Calif.
07700	Technical Wire Products Inc.	Cranford, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.
07980	Hewlett-Packard Co., Boonton Radio Div.	Rockaway, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Bliss, Detroit Co.	Fenton, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Calif.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Calif.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08792	CBS Electronics Semiconductor Operations, Div of C.B.S. Inc.	Lowell, Mass.
08984	Mal-Nam	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Alpha Electronics	Sun Valley, Calif.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Tri-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11737	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11747	Bay State Electronics Corp.	Waltham, Mass.
11797	Telepyne Inc., Micronave Div.	Palo Alto, Calif.
11828	Dracon Electronics Inc.	Costa Mesa, Calif.
11911	General Instrument Corp., Semiconductor Div., Products Group	Newark, N.J.
11917	Imprimis Electronic, Inc.	Buena Park, Calif.
11970	Mertek, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N.J.
12161	Greve Mfg. Co., Inc.	Shiley Grove, Pa.
12676	Gulton Ind. Inc., CG Elect. Div.	Albuquerque, N.M.
12697	Clarostat Mfg. Co.	Dover, N.H.
12728	Elmar Filter Corp.	N. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Meier Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13103	Thermalloy	Dallas, Texas
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Ross Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Bem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14483	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
14493	Hewlett Packard Company	Loveland, Colo.
14655	Cornell Dubilier Electric Corp.	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	So. Pasadena, Calif.
14936	Millipore Mfg. Co.	San Jose, Calif.
15003	Webster Electronics Co.	New York, N.Y.
15287	Sciences Corp.	Northridge, Calif.
15295	Adjustable Bushing Co.	N. Hollywood, Calif.
15555	Micron Electronics	Garden City, Long Island, N.Y.
15566	Ampere Instl. Corp.	Lyndhurst, N.Y.
15621	Cohlentronics	Costa Mesa, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15818	Amelco Inc.	Mt. View, Calif.
15909	Dawon Div. Thomas A. Edison Ind. McGraw-Edison Co.	Long Island City, N.Y.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Detroit, Ill.
16357	Computer Diode Corp.	Lodi, N.J.
16488	Ideal Pipe. Water Co., Inc. De Jai Motel Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokomo, Ind.
17109	Thermocouples Int.	Canoga Park, Calif.
17474	Tranco Company	Mountain View, Calif.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17715	Angstrohm Prec. Inc.	No. Hollywood, Calif.
18402	Power Design Pacific Inc.	Palo Alto, Calif.
18683	Circuits Corp., Semiconductor Div.	Palo Alto, Calif.
18876	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18885	TRW Elect. Comp. Div.	Des Plaines, Ill.
18983	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18972	E.I. DuPont and Co., Inc.	Wilmington, Del.
18991	Optical Mfg. Co.	Milwaukee, Wis.
19315	Breeze Corp., The Eclipse Pioneer Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19589	Corcom	Baldwin Park, Calif.
19644	LRC Electronics	Horsheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.

TABLE 6-3. CODE LIST OF MANUFACTURERS (Cont'd)

Code No.	Manufacturer	Address
21335	Fafnir Bearing Co., The	New Britain, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto Ontario, Canada
37942	P.R. Mallory & Co. Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	Sanborn Company	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & Systems Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Revere Wollensak Div. Minn. Mining & Mfg. Co.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Calif.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Calif.
71471	Cinema, Div. Aerovox Corp.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71753	A.O. Smith Corp., Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72354	John E. Fast Co., Div. Victoreen Instr. Co.	Chicago, Ill.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap. Div.	Newark, N.J.
72765	Drake Mfg. Co.	Chicago, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. of North American Phillips Co., Inc.	Hicksville, N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.
73734	Federal Screw Products Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Calif.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75378	CTS Knights Inc.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littelfuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	Bendix Corp., The Bendix Pacific Div.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phanostran Instrument and Electronic Co.	South Pasadena, Calif.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Div.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association, Any brand Tube meeting EIA Standards	Washington, DC.
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Adhesive Label Corp.	Monrovia, Calif.
80583	Hammarlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
81030	International Instruments Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	. . . .
81483	International Rectifier Corp.	El Segundo, Calif.
81541	Airpax Electronics, Inc.	Cambridge, Mass.
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp., Defense Prod. Division	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc., Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc. Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.

From: FSC. Handbook Supplements
H4-1 Dated AUGUST 1966
H4-2 Dated NOV. 1966

TABLE 6-3.
CODE LIST OF MANUFACTURERS (Cont'd)

Code No.	Manufacturer	Address
02866	Research Products Corp.	Madison, Wis.
02877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
02893	Vector Electronic Co.	Glendale, Calif.
03063	Western Washer Mfg. Co.	Los Angeles, Calif.
03068	Corr Fastener Co.	Cambridge, Mass.
03075	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
03135	General Instrument Corp., Capacitor Div.	Darlington, S.C.
03145	ITT Wire and Cable Div.	Los Angeles, Calif.
03186	Victory Eng. Corp.	Springfield, N.J.
03298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
03315	Hubbell Corp.	Muscatine, Ill.
03330	Smith, Herman H., Inc.	Brooklyn, N.Y.
03332	Tech Labs	Palisade's Park, N.J.
03385	Crellin Screw Co.	Chicago, Ill.
03501	Gavitt Wire and Cable Co. Div. of Amerace Corp.	Brookfield, Mass.
03594	Burroughs Corp. Electronic Tube Div.	Plainfield, N.J.
03749	Union Carbide Corp. Consumer Prod. Div.	New York, N.Y.
03777	Model Eng. and Mfg., Inc.	Huntington, Ind.
03821	Loyd Scruggs Co.	Fosten, Mo.
03947	Aeronautical Instr. & Radio Co.	Lodi, N.J.
04171	Arco Electronics Inc.	Great Neck, N.Y.
04296	A.J. Glesener Co., Inc.	San Francisco, Calif.
04411	TRW Capacitor Div.	Ogallala, Neb.
04970	Barbee Tarzian, Inc.	Bloomington, Ind.
05454	Beaulieu Welding Company	Beaulieu, N.J.
05471	A.B. Boyd Co.	San Francisco, Calif.
05474	R.W. Bracamonte & Co.	San Francisco, Calif.
05660	Kested Kards, Inc.	Hawden, Conn.
05911	Seamless Rubber Co.	Chicago, Ill.
06097	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
06579	Precision Rubber Products Corp.	Dayton, Ohio
06664	Radio Corp. of America, Electronic Comp. & Devices Div.	Harrison, N.J.
07024	Maico Industries	Anaheim, Calif.
07216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
07471	Western Fibrous Glass Products Co.	San Francisco, Calif.
07660	Van Waters & Rogers Inc.	San Francisco, Calif.
07910	Tower Mfg. Corp.	Providence, R.I.
08140	Cutler-Hammer, Inc.	Lincoln, Ill.
08220	Gould-National Batteries, Inc.	St. Paul, Minn.
08421	Federal Telephone & Radio Corp.	Clifton, N.J.
08698	General Mills, Inc.	Buffalo, N.Y.
09231	Gruphar Electric Co.	Oakland, Calif.
09665	United Transformer Co.	Chicago, Ill.
90179	US Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91146	ITT Cannon Elect, Inc., Salem Div.	Salem, Mass.
91760	Conner Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91886	Maico Mfg. Co., Inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Div.	Freeport Ill.
91961	Hahn-Bigs. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co. Inc.	Rochester, N.Y.
92196	Universal Industries, Inc.	City of Industry, Calif.
92607	Tompkins Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Westbury Long Island, N.Y.
92866	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93979	G.V Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.
94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtiss-Wright Corp, Electronics Div.	East Paterson, N.J.
94222	South Chester Corp	Chester, Pa.
94310	Tru-Ohm Products Memcor Components Div.	Huntington, Ind.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94482	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95073	George A. Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95264	Lorco Electronics, Inc.	Burbank, Calif.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Chicago, Ill.
95566	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Siemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Div. of Aeroyen Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Rosa Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Tronics, Inc.	Jamaica, N.Y.
98159	Rubber Tech, Inc.	Gardena, Calif.
98220	Hewlett-Packard Co., Moseley Div.	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98376	Zero Mfg. Co.	Burbank, Calif.
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Palco Div. of Hewlett-Packard Co.	Palo Alto, Calif.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind. Elect. Products Div.	San Marino, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Helfman Electronics Corp. Semiconductor Div.	El Monte, Calif.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

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

00009F	Maico Tool and Die	Los Angeles, Calif.
00009Z	Willow Leather Products Corp.	Newark, N.J.
00AAB	ETA	England
00BBB	Precision Instrument Components Co.	Van Nuys, Calif.
00BCS	Hewlett-Packard Co., Colorado Springs	Colorado Springs, Colorado
00BMM	Rubber Eng. & Development	Hayward, Calif.
00BNN	A "N" D Mfg. Co.	San Jose, Calif.
00BQQ	Coalition	Oakland, Calif.
00BWW	California Eastern Lab.	Burlington, Calif.
00BYY	S.K. Smith Co.	Los Angeles, Calif.

From: FSC. Handbook Supplements
H4-1 Dated AUGUST 1966
H4-2 Dated NOV. 1967

SCHEMATIC DIAGRAMS

APPENDIX

SECTION VII
SCHEMATIC DIAGRAMS

7-1. INTRODUCTION.

7-2. This section contains schematic diagrams. Figure 7-1 lists notes and symbols which apply to all schematic diagrams. Each diagram follows the guide lines listed below.

a. Schematics in this manual are meant to show electrical circuit operation and not intended as wiring diagrams.

b. Assembly sections of schematics may or may not be shaded as in the example shown.

7-3. REPLACEMENT INFORMATION.

7-4. For repair and replacement information, refer to the MAINTENANCE section of this manual which is Section V. For specific component descriptions and/or ordering information refer to page 6-1.

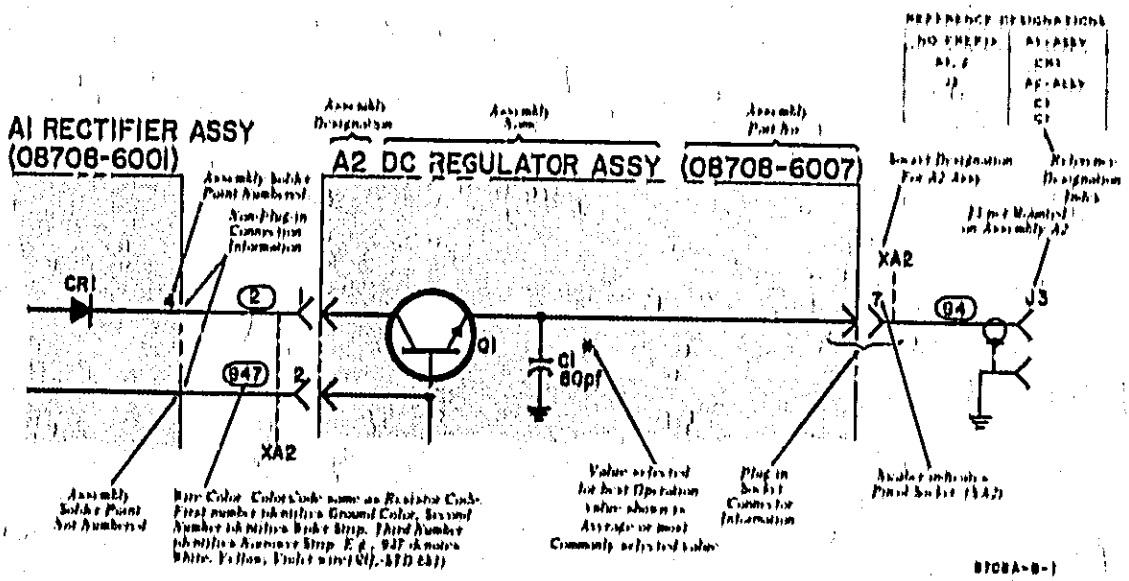


Figure 7-1. Schematic Information Illustration

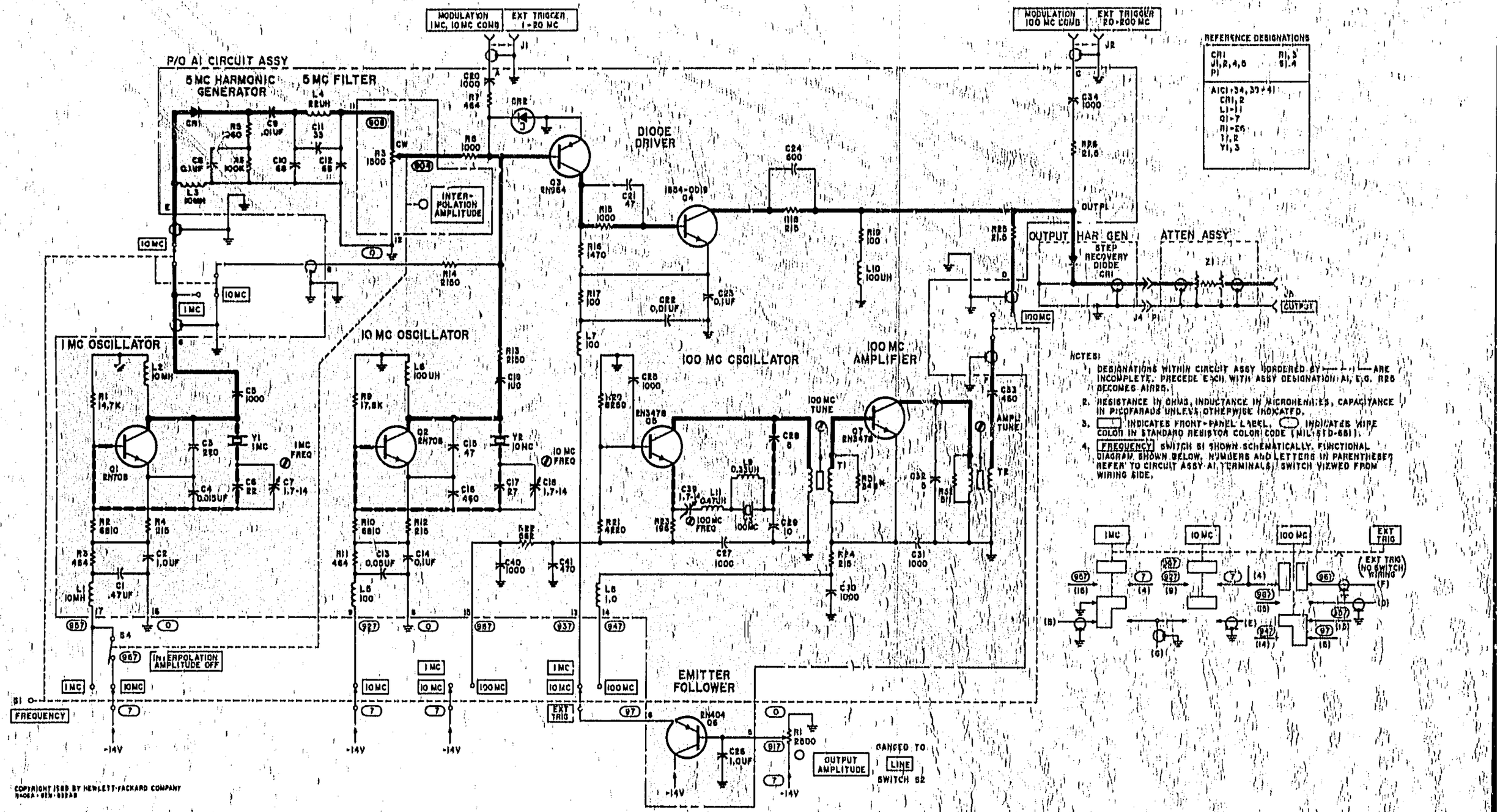
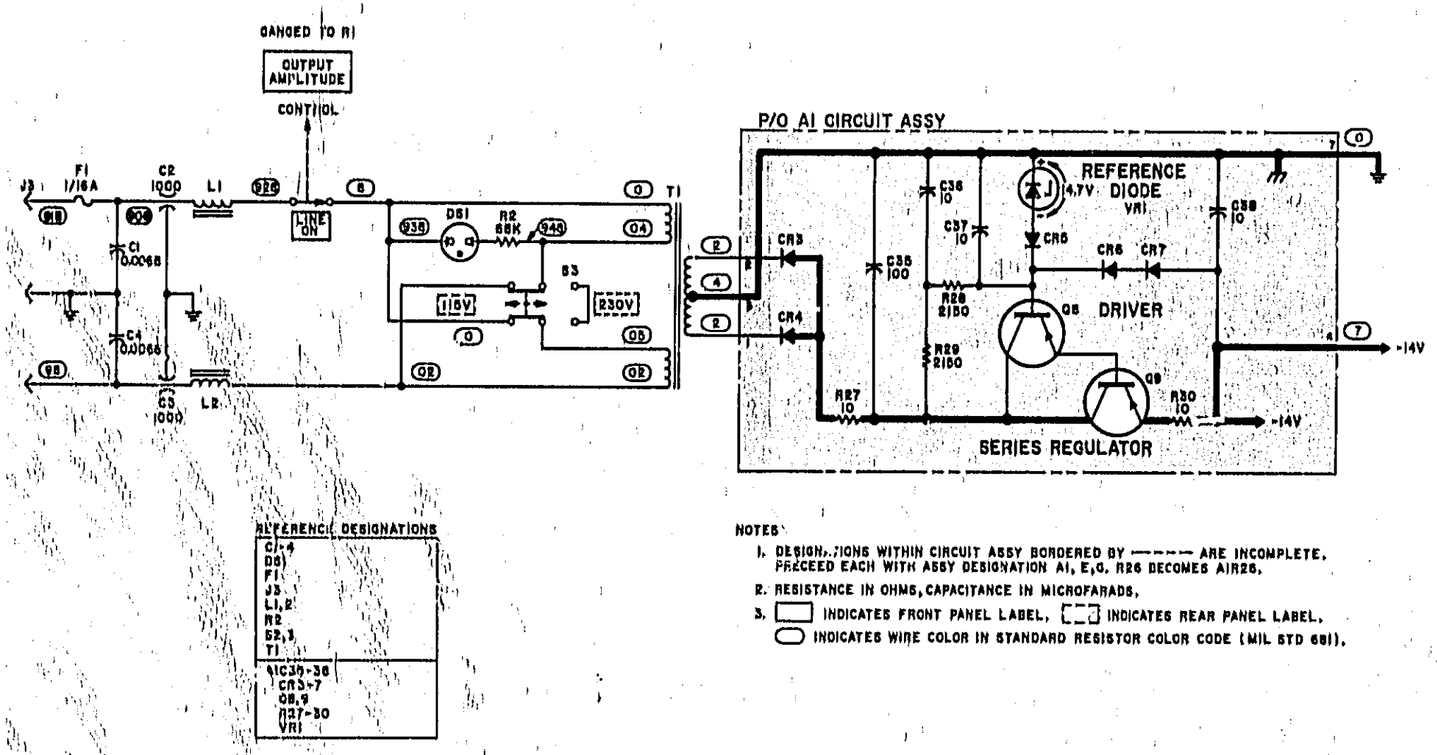


Figure 7-2. Generator



REFERENCE DESIGNATIONS

C1-4
DS1
F1
J3
L1,2
R2
S2,3
T1
A1C35-38
CR3-7
Q8,9
R27-30
VR1

NOTES:

1. DESIGNATIONS WITHIN CIRCUIT ASSY BORDERED BY ———— ARE INCOMPLETE. PRECEED EACH WITH ASSY DESIGNATION A1, E.G. R26 BECOMES A1R26.
2. RESISTANCE IN OHMS, CAPACITANCE IN MICROFARADS.
3. ▭ INDICATES FRONT PANEL LABEL, [▭] INDICATES REAR PANEL LABEL, ⬭ INDICATES WIRE COLOR IN STANDARD RESISTOR COLOR CODE (MIL STD 681).

Figure 7-3. Power Supply

APPENDIX I

BACKDATING INFORMATION

This manual applies to instruments with Serial Prefixes 649-, and 737-. Listed below are changes to be made to the manual so that it will apply directly to Prefixes 532-, and 541-.

Instrument Serial No. Prefix	Change Number
541-	1
532-	1 and 2

CHANGE 1:

Table 6-1 Page	Table 6-2 Page	Schematic Page	Delete, Change, or add	Circuit Ref.	Stk No.	Item Description
6-2	6-7	7-3/7-4	Change	A1C7	0121-0031	C: Var 1.85-10.38 pF
"	"	"	"	A1C16	"	"
"	"	"	"	A1C39	"	"

CHANGE 2:

6-7	6-7	7-3/7-4	Change	A1C29	0160-0370	20 pF 5%
6-3		"	"	A1L11	9100-1612	0.33 μH
"		"	"	A1Q5	1854-0031	2N2865
"		"	"	A1Q7	1854-0031	2N2865
"		"	"	A1R20	0698-3156	14.7 KΩ
"		"	"	A1R21	0698-3155	4640Ω
"		"	"	A1R22	0698-0084	2150Ω
6-2		"	Delete	A1C41	-	-
6-3		"	"	A1R31	-	-
"		"	"	A1R32	-	-

MANUAL CHANGES

MANUAL CHANGES

MANUAL IDENTIFICATION

Model Number: 8406A
Date Printed: MAY 1980
Part Number: 08406-90001

This supplement contains important information for correcting manual errors and for adapting the manual to instruments containing improvements made after the printing of the manual.

To use this supplement:

Make all ERRATA corrections

Make all appropriate serial number related changes indicated in the tables below.

Serial Prefix or Number	Make Manual Changes
737-00386 thru 737-00555	1, 2
737-00556 thru 737-00585	1, 2, 3
737-00586 thru 737-00675	2, 3, 4
961-, 0961A	3, 4, 5
1145A	3, 4, 5, 6
1441A01266 thru 1441A01275	3, 4, 5, 6, 7
1441A01276 thru 1441A prefix	3 – 8
1628A, 1632A	3 – 9
1711A	3 – 10
1915A	3 – 11

Serial Prefix or Number	Make Manual Changes

► NEW ITEM

NOTE

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of this supplement. Free copies are available from all HP offices. When requesting copies quote the manual identification information from your supplement, or the model number and print date from the title page of the manual.

1 SEPTEMBER 1982

4 Pages

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► ERRATA

Page 5-1, Table 5-1:
Delete Table 5-1.
Add Table 5-1 included in this Manual Changes supplement.

Page 5-2/5-3, Table 5-2:
Delete Table 5-2.
Add PERFORMANCE TESTS included in this Manual Changes supplement.
Add Figure 5-1 included in this Manual Changes supplement.

Page 5-5, Table 5-3:
Delete Table 5-3.
Add Table 5-3 included in this Manual Changes supplement.

Page 5-6, Paragraph 5-22:
Delete Paragraph 5-22.
Add ADJUSTMENT TEST included in this Manual Changes supplement.

CHANGE 1

Page 6-2, Table 6-1:
Page 6-7, Table 6-2:
Page 7-3/7-4, Figure 7-2:
Change A1C17 to C: FXD MICA 33 pF 300V 5% 0160-0179.

CHANGE 2

Page 6-4, Table 6-1:
Page 6-8, Table 6-2:
Page 7-3/7-4, Figure 7-2:
Change R1 to R: VAR COMP 500 OHM 20% LIN 1/2W 2100-0350.

CHANGE 3

Page 6-3, Table 6-1:
Page 7-5/7-6, Figure 7-3:
Change A1Q8 to 1850-0040, Transistor: Germanium PNP.
Change A1Q9 to 1853-0051, Transistor: Silicon 2N4037.
Change A1R30 to 0683-0395, R: FXD COMP 3.9 OHM 5% 1/4W.

Page 6-4, Table 6-1:
Change A1VR1 to 1902-3203, DIODE BREAKDOWN: SILICON 14.7V 5% 400 mW.
Add A1MP1, 1205-0011, HEAT DISSIPATOR: TO-5/9 CASE USED ON A1Q9.

CHANGE 4

Page 6-2, Table 6-1:
Page 7-3/7-4, Figure 7-2:
Change A1C7 to 0121-0166, C: VAR AIR, 2.4 TO 24.5 pF.
Change A1C17 to 0160-2263, C: FXD CER, 18 pF 5% 500 VDCW.
Change A1C18 to 0121-0166, C: VAR, AIR 2.4 TO 24.5 pF.

CHANGE 5

Page 6-4, Table 6-1:
Change DS1 to 2140-0244, LAMP: GLOW 1.0 mA TYPE A1H P/O S3.
Change F1 to 2100-0311, FUSE: CARTRIDGE 1/16 AMP TYPE MDL-1/16.
Change J3 to 1251-2357, CONNECTOR: POWER 3 PIN MALE.
Change R1 to 2100-0067, R: VAR COMP 2.5K OHM 20% LIN 1/2W.
Change S2 to 3101-1234, SWITCH: SLIDE DPDT 115/230V.

Change S3 to 3101-,248, SWITCH: PUSHBUTTON (LINE).

Page 6-5, Table 6-1:
Change 8120-0078 to read: 8120-1348, CABLE ASSY: POWER.
Delete 5040-0234, LAMPHOLDER.
Delete 5040-0235, BASE: LAMPHOLDER.

Page 6-6, Table 6-1:
Change 9 to 08406-0015, PANEL: REAR.
Change 10 to 08406-00016, PANEL: FRONT.

Page 7-5/7-6, Figure 7-3:
Change schematic as shown in P/O Figure 7-3 (CHANGE 5) included in this Manual Changes supplement.

CHANGE 6

Page 6-2, Table 6-1:
Page 7-3/7-4, Figure 7-2:
Change A1C17 to C: FXD MICA 60 pF 300V 5% 0140-0214 (*) (factory-selected component).

Page 6-5, Table 6-1:
Add 0370-1400, KNOB: MINT GRAY PUSHBUTTON 11/16 IN DIA 1MC, 10MC, 100MC EXT TRIG.

Page 6-6, Table 6-1, Cabinet Parts:
Change items 6 through 10 as follows:
Change 6 to 5000-8565, COVER: SIDE (OLIVE GRAY)
Change 7 to 5060-8555, COVER ASSEMBLY: TOP (OLIVE GRAY)
Change 8 to 5000-8571, COVER ASSEMBLY: BOTTOM (OLIVE GRAY)
Change 9 to 08406-00015, PANEL: REAR
Change 10 to 08406-00017, PANEL: FRONT (MINT GRAY)

CHANGE 7

Page 6-4, Table 6-1:
Change R1 to 2100-2769, R: VAR 2.5K OHM 20% 2W.

CHANGE 8

Page 6-2, Table 6-1:
Change A1C6 to 0160-2306, C: FXD CER 27 pF 5% 200V (factory-selected part).
Change A1C17 to 0140-0145, C: FXD MICA 22 pF 5% 500 VDCW (factory-selected part).

Page 7-3, Figure 7-2:
Change the value of A1C6 to A1C6* 27 pF.
Change the value of A1C17* to 22 pF.

CHANGE 9

Page 1-1, Table 1-1:
Change "Peak amplitude*" to "Typical amplitude*".

CHANGE 10

Page 6-4, Table 6-1:
Change S3 to 3101-1957, SWITCH: PUSHBUTTON DPST (LINE).

NOTE

For instruments with serial prefix 1632A or below, HP Part Number for replacement of line switch S3 is 3101-1248.

Change XF1 to 2110-0470, BODY: FUSEHOLDER.
Add the following parts under XF1:
2110-0465, CAP: FUSEHOLDER
2110-0467, NUT: HEX
1400-0090, WASHER: FLAT NEOPRENE

Page 7-5, Figure 7-3:
Change schematic as indicated in P/O Figure 7-3 (CHANGE 10) included in this Manual Changes supplement.

CHANGE 11

Page 6-4, Table 6-1:
Change C2 and C3 to 0160-3484, C: FXD 1000PF 20%
2100 VDCW (PREFERRED REPLACEMENT; REQUIRES NEW BOTTOM COVER BRACKET).

Page 6-5, Table 6-1:
Change 08406-0003 to 08406-00018, BRACKET, BOTTOM COVER.

Table 5-1. Test Equipment Required (ERRATA)

Instrument Type	Critical Specifications	Instrument Recommended
Electronic Counter	Range: 1 to 100 MHz Accuracy: ±0.0[illegible]%	HP Model 5340A
Spectrum Analyzer	Range: 10 MHz–4 GHz	HP Model 8565A or HP Model 8555A
RF Voltmeter	Range: 3 volts at 100 MHz	HP Model 3406A
Signal Generator	Range: 200 kHz to 50 MHz	HP Model 8640B
Bandpass Filter	Pass: 2–4 GHz	HP Model 8445B (If 8555A is used)

Table 5-3. Performance Test Record (ERRATA)

HP MODEL 8406A **Tested By** _____

Serial Number _____ **Date** _____

A. AMPLITUDE RESPONSE

100MC	100 MHz–1 GHz	_____ dBm
	1 GHz – 1.8 GHz	_____ dBm
	1.8 GHz – 2 GHz	_____ dBm
	2 GHz – 4 GHz	_____ dBm
10MC	10 MHz – 500 MHz	_____ dBm
	500 MHz – 1.8 GHz	_____ dBm
	1.8 GHz – 2 GHz	_____ dBm
	2 GHz – 4 GHz	_____ dBm
1MC	10 MHz – 500 MHz	_____ dBm
	500 MHz – 1.8 GHz	_____ dBm
	1.8 GHz – 2 GHz	_____ dBm
	2 GHz – 4 GHz	_____ dBm

B. FREQUENCY ACCURACY

1 MHz ±100 Hz	_____ MHz
10 MHz ±1 kHz	_____ MHz
100 MHz ±10 kHz	_____ MHz

C. 1 MHz INTERPOLATION

Operation Verification

D. EXTERNAL MODULATION AND TRIGGER

1MC	Modulation Sensitivity	_____ mV
	Modulation Sensitivity	_____ mV
	Trigger level 1–20 MHz	_____ V
	Trigger level 20–200 MHz	_____ V

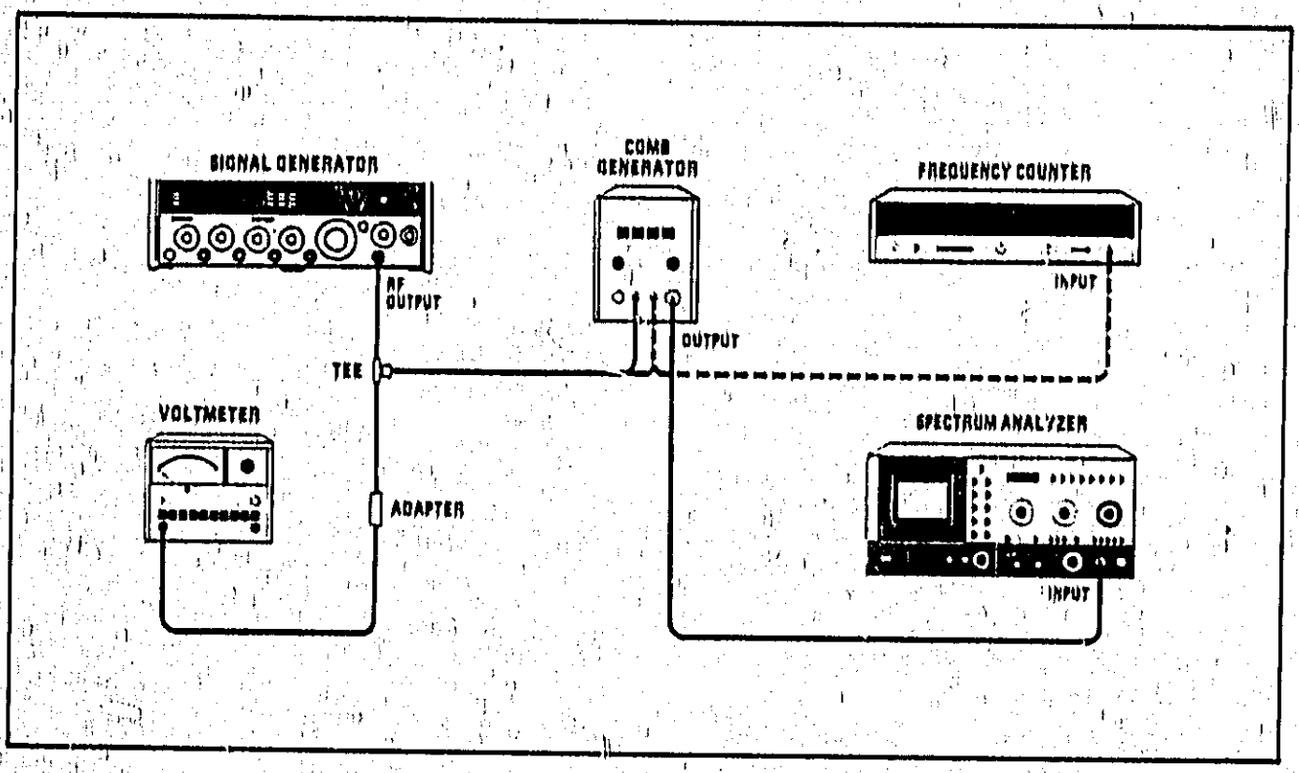


Figure 5-1. Test Setup (ERRATA)

PERFORMANCE TESTS

AMPLITUDE RESPONSE

SPECIFICATIONS:
Typical amplitude levels for each comb frequency are given in Table 1-1.

DESCRIPTION:
The typical amplitude level for each comb frequency is measured from 10 kHz to 4 GHz.

EQUIPMENT:

Spectrum Analyzer	HP 8565A

PROCEDURE:

1. Set equipment controls as follows:

8406A:

COMB FREQUENCY-MHz	100MC
INTERPOLATION AMPLITUDE-1 MHz	OFF
OUTPUT AMPLITUDE	Full CW

8565A:
Set all normal (green) settings.

FREQUENCY BAND GHz	.01–1.8 GHz
FREQUENCY GHz	1.0 GHz
FREQUENCY SPAN/DIV	200 MHz
RESOLUTION BW	1 MHz
INPUT ATTEN	0 dBm
REFERENCE LEVEL	0 dBm

2. Connect OUTPUT of comb generator to INPUT of spectrum analyzer.

3. Frequency comb should have a typical amplitude greater than –45 dBm from 100 MHz to 1 GHz and greater than –35 dBm from 1.0 to 1.8 GHz.

4. Set FREQUENCY BAND GHz on spectrum analyzer to 1.7–4.1 and tune FREQUENCY GHz readout to 2.800. Frequency comb should have a typical amplitude greater than –35 dBm from 1.8 to 2.0 GHz.

5. Tune FREQUENCY GHz readout to 2.000. Frequency comb should have a typical amplitude greater than –47 dBm from 2 to 4 GHz.

6. Press 10MC pushbutton on the comb generator.

7. Set FREQUENCY BAND GHz on spectrum analyzer to .01–1.8 and tune FREQUENCY GHz readout to 1.000. Frequency comb should have a typical amplitude greater than –60 dBm from 10 MHz to 500 MHz and greater than –50 dBm from 0.5 MHz to 1.8 GHz.

8. Set FREQUENCY BAND GHz on spectrum analyzer to 1.7–4.1 and tune FREQUENCY GHz readout to 2.800. Frequency comb should have a typical amplitude greater than –60 dBm from 1.8 to 2.0 GHz.

9. Tune FREQUENCY GHz readout to 3.000. Frequency comb should have a typical amplitude level greater than –62 dBm from 2 to 4 GHz.

10. Press 1MC pushbutton on the comb generator.

11. Set FREQUENCY BAND GHz on spectrum analyzer to .01–1.8 and tune FREQUENCY GHz readout to 1.000. Frequency comb should have a typical amplitude greater than –80 dBm from 10 MHz to 500 MHz and greater than –70 dBm from 0.5 MHz to 1.8 GHz.

12. Set FREQUENCY BAND GHz on spectrum analyzer to 1.7–4.1 and tune FREQUENCY GHz readout to 2.800. Set REFERENCE LEVEL on spectrum analyzer to –10 dBm. Frequency comb should have a typical amplitude greater than –70 dBm from 1.8 to 2.0 GHz.

13. Tune FREQUENCY GHz readout to 3.000. Frequency comb should have a typical amplitude level greater than –82 dBm from 2 to 4 GHz.

FREQUENCY ACCURACY

SPECIFICATION:
±10% (0°C to +50°C).

DESCRIPTION:
A frequency counter is used to measure frequency accuracy from the 100 MHz COMB jack.

EQUIPMENT:

Frequency Counter . . . . . HP 5340A

PROCEDURE:

1. Set equipment controls as follows:

8406A:
COMB FREQUENCY-MHz 1MC
INTERPOLATION AMPLITUDE-1 MHz . . . . . OFF
OUTPUT AMPLITUDE . . . . . Full CW

2. Connect 100 MHz COMB jack from the comb generator to INPUT of the frequency counter.

3. Set RANGE of the frequency counter to 10 Hz–18 GHz. Frequency counter should read 1 MHz ±100 Hz.

4. Press 10MC pushbutton on the comb generator. Frequency counter should read 10 MHz ±1 kHz.

5. Press 100MC pushbutton on the comb generator. Frequency counter should read 100 MHz ±10 kHz.

1 MHz INTERPOLATION

SPECIFICATION:
Interpolation control must be operational.

DESCRIPTION:
A spectrum analyzer is used to test the ability of the comb generator to include 1– MHz teeth into a 10-MHz comb.

EQUIPMENT

Spectrum Analyzer . . . . . HP 8565A

PROCEDURE:

1. Set equipment controls as follows:

8406A:
COMB FREQUENCY 10MC
INTERPOLATION AMPLITUDE-1 MHz . . . . . OFF
OUTPUT AMPLITUDE . . . . . Full CW

8565A:
Set all normal (green) settings
FREQUENCY BAND GHz . . . . . .01–1.8 GHz
FREQUENCY SPAN/DIV . . . . . 1 MHz
RESOLUTION BW . . . . . 100 kHz
INPUT ATTEN . . . . . 0 dBm
REFERENCE LEVEL . . . . . –20 dBm

2. Connect OUTPUT of the comb generator to INPUT of the spectrum analyzer.

3. Tune FREQUENCY control of the spectrum analyzer so that two 10–MHz comb signals appear on the screen.

4. Turn INTERPOLATION AMPLITUDE-1MHz control on the comb generator fully clockwise.

5. 9 pulses should be observed between the two successive 10 MHz signals displayed on the spectrum analyzer.

EXTERNAL MODULATION AND EXTERNAL TRIGGER

SPECIFICATIONS:
Typical modulation voltages are given in Table 1-1, first footnote. Typical input signal levels to generate externally triggered combs at the frequency of the external trigger are given in Table 1-1, second footnote.

DESCRIPTION:
Signals from a signal generator are injected into the appropriate jacks of the comb generator to test the capability of the comb generator to modulate and trigger its OUTPUT with an external source.

EQUIPMENT:

Signal Generator	HP 8640A
Spectrum Analyzer	HP 8565A
Broadband Sampling Voltmeter	HP 3406A
BNC to Probe Adapter	HP 10218A

PROCEDURE:

WARNING

Signals greater than 5 Vrms at the modulation input may cause damage.

1. Set equipment controls as follows:

8406A:

COMB FREQUENCY-MHz	1MC
INTERPOLATION AMPLITUDE-1MHz	OFF
OUTPUT AMPLITUDE	Full CW

8565A:
Set all normal (green) settings

FREQUENCY BAND GHz	0 - 1.8 GHz
FREQUENCY GHz	1.0 GHz
FREQUENCY SPAN/DIV	.2 MHz
RESOLUTION BW	10 kHz
INPUT ATTEN	0 dBm
REFERENCE LEVEL	-50 dBm

2. Connect OUTPUT of the comb generator to INPUT of the spectrum analyzer. Adjust REF LEVEL fine control on spectrum analyzer to position the displayed 1 MHz signals at a graticule line for reference.

3. Connect RF OUTPUT of the signal generator to 1MHz/10MHz COMB MODULATION jack on the comb generator.

4. Tune FREQUENCY MHz readout of the signal generator to 0.500 and adjust OUTPUT LEVEL of the signal generator to position the displayed sidebands to a level 20 dB below the 1-MHz comb reference.

5. OUTPUT LEVEL of the signal generator should be less than 1 mV.

6. Press the 10MC pushbutton on the comb generator.

7. On the spectrum analyzer set FREQUENCY SPAN/DIV to 10 MHz and RESOLUTION BW to 100 kHz. Adjust REFERENCE LEVEL and REF LEVEL fine controls to display 10-MHz signals at a graticule line for reference.

8. On the signal generator tune FREQUENCY MHz readout to 2.000 and set its OUTPUT LEVEL so the sidebands displayed on the spectrum analyzer are 20 dB below the 10-MHz comb.

9. OUTPUT LEVEL of the signal generator should be less than 10 mV.

10. Set the RANGE of the sampling voltmeter to 3 VOLTS.

11. Attach the BNC to probe adapter to voltmeter probe. Use a BNC tee connector to connect the RF OUTPUT of the signal generator and the probe of the sampling voltmeter to the 1-20 MHz EXT TRIGGER jack on the comb generator.

12. Set FREQUENCY SPAN/DIV on the spectrum analyzer to 20 MHz and RESOLUTION BW to 300 kHz.

13. Press EXT TRIG pushbutton on the comb generator.

14. Tune the FREQUENCY MHz readout of the signal generator to 20 MHz and increase OUTPUT LEVEL until a comb signal appears on the spectrum analyzer. This level should read less than 3 VOLTS on the sampling voltmeter.

15. Connect the RF OUTPUT of the signal generator and the probe of the sampling voltmeter to the 20-200 MHz EXT TRIGGER jack on the comb generator.

16. On the signal generator decrease OUTPUT LEVEL so that no signal appears on the spectrum analyzer and then increase that level until a comb signal appears on the spectrum analyzer. Level should be less than 3V on the voltmeter.

ADJUSTMENT TEST

AMPLITUDE AND FREQUENCY ADJUSTMENT

REFERENCE:
A1 Circuit Assembly.

DESCRIPTION:
100 MHz comb is adjusted for a flat amplitude response and for a stable frequency response as the OUTPUT AMPLITUDE control is varied from maximum to minimum. COMB FREQUENCY–MHz outputs are adjusted for frequency accuracy.

EQUIPMENT:

Spectrum Analyzer	HP 8565A
Frequency Counter	HP 5340A

PROCEDURE:

1. Set equipment controls as follows:

8406A:

COMB FREQUENCY–MHz	100MC
INTERPOLATION AMPLITUDE–1 MHz	OFF
OUTPUT AMPLITUDE	Full CW

8565A:
Set all normal (green) settings

FREQUENCY BAND GHz	.01–1.8 GHz
FREQUENCY GHz	1 GHz
FREQUENCY SPAN/DIV	200 MHz
RESOLUTION BW	3 MHz
INPUT ATTEN	0 dBm
REFERENCE LEVEL	0 dBm

2. Connect OUTPUT of the comb generator to INPUT of the spectrum analyzer.

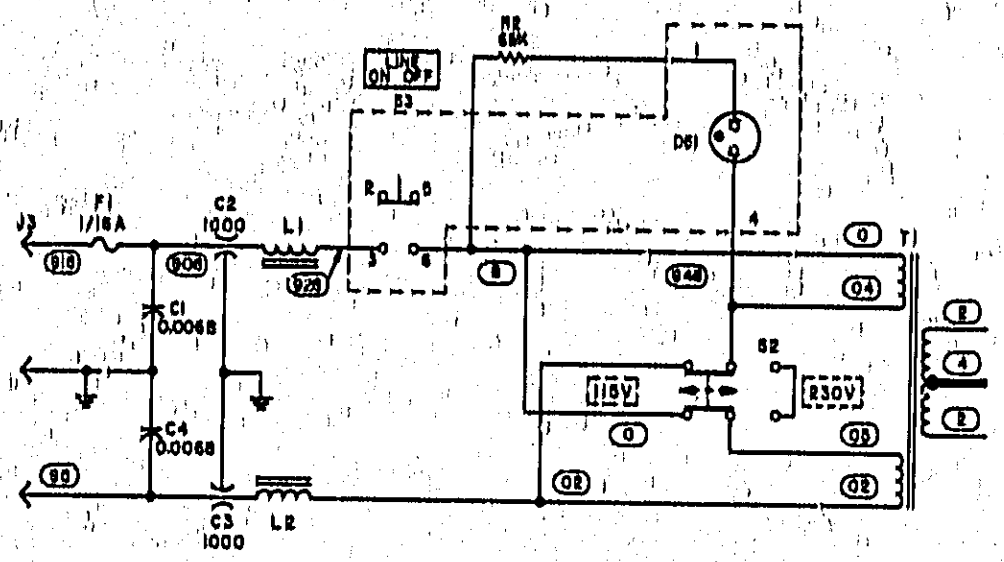
3. A typically flat amplitude response should be observed. If amplitude response is not flat, A1T1 is adjusted for a stable frequency response and A1T2 is adjusted for maximum flat amplitude in the 400 MHz region as OUTPUT AMPLITUDE is varied from maximum to minimum.

4. Connect 100 MHz COMB jack from the comb generator to INPUT of the frequency counter.

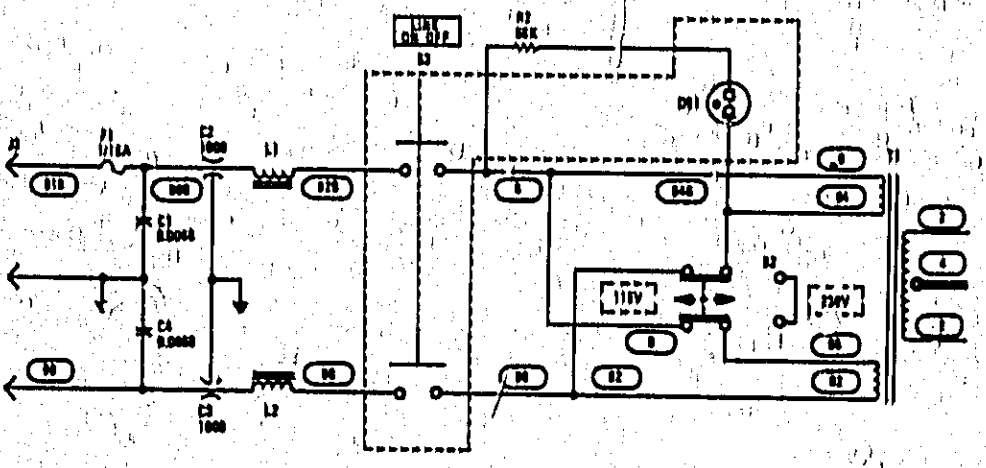
5. Set RANGE of the frequency counter to 10 Hz–18 GHz. Adjust A1C39 for a frequency display of 100 MHz ±10 kHz.

6. Press 10MC pushbutton on the comb generator. Adjust A1C18 for a frequency display of 10 MHz ±1 kHz on frequency counter.

7. Press 1 MHz pushbutton on comb generator. Adjust A1C7 for a frequency display of 1 MHz ±100 Hz on frequency counter.



P/O Figure 7-3. (CHANGE 5)



P/O Figure7-3. (CHANGE 10)

ADDENDUM

MANUAL CHANGES

This ADDENDUM contains important information of the kind normally contained in the attached MANUAL CHANGES supplement but received too late to be included. Use the ADDENDUM to correct your manual in the same way you use the MANUAL CHANGES supplement.

MANUAL IDENTIFICATION

Model Number: 8406A
Date Printed: MAY 1980
Part Number: 08406-90001

Serial Prefix or Number	Make Manual Changes
2246A	3-12

CHANGE 12

Page 6-2, Table 6-1:
Delete A1CR2.

Page 6-3, Table 6-1:
Change A1Q3 to HP Part Number 1853-0018, Check Digit 0, TRANSISTOR PNP SI TO-72 PD=200MW FT=1GHZ.
Change A1R19 to HP Part Number 0757-0346, Check Digit 2, RESISTOR NET FILM 10.0 OHM 1% 1/8W.

Page 7-3/7-4, Figure 7-2:
Delete A1CR2.
Change A1Q3 to HP Part Number 1853-0018.
Change value of A1R19 to 10.

Addendum Date: 23 NOVEMBER 1982
For Manual Changes Dated: 1 SEPTEMBER 1982

HEWLETT PACKARD

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