

Errata

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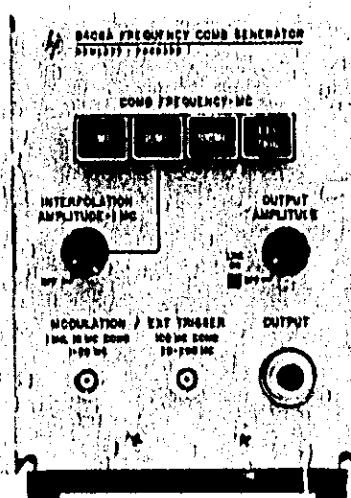
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Agilent Technologies

OPERATING AND SERVICE MANUAL

FREQUENCY COMB GENERATOR 8406A



**HEWLETT
PACKARD**

CERTIFICATION

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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HEWLETT
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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 532- and 541-

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1400 FOUNTAIN GROVE PARKWAY, SANTA ROSA, CALIFORNIA, 95403, U.S.A.

HP Part No. 08406-90001

Printed: MAY 1965

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 auto-transformer (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: $\pm 0.01\%$ (0° to 50°C).

Peak Amplitude*:

	1 Mc Comb	10 Mc Comb	100 Mc Comb
10-500 Mc	>-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	>-82 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.

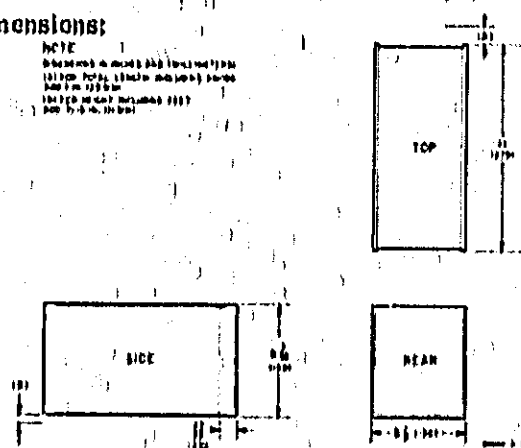
External Modulation: External modulation signals can be used to phase modulate any of the combs to produce sidebands for interpolation between fixed comb markers¹. BNC female connector.

External Trigger: External signals (normally sine waves) between 1 Mc and 200 Mc can be used to produce combs spaced at frequency of trigger signals². BNC female connector.

Power: 115 or 230 volts $\pm 10\%$, 50-400 cps, 2 watts

Dimensions:

NOTE
Dimensions are given in inches and millimeters.
(1 inch = 25.4 mm, 1 mm = 0.03937 inch)
All dimensions are maximum unless noted.
See 1-5-1, 1-5-2, 1-5-3.



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.

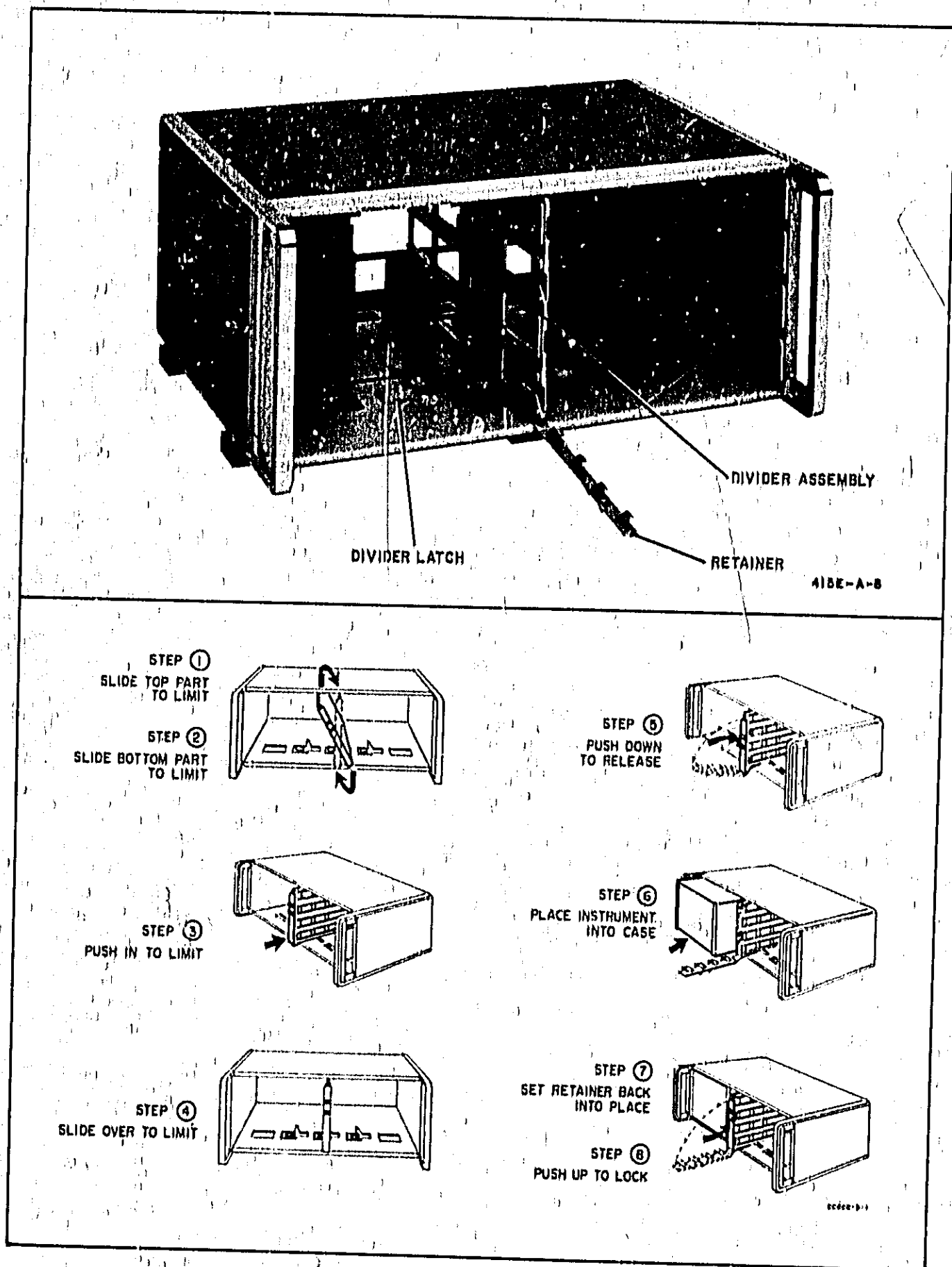


Figure 2-1. Combining Case

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 $\pm 10\%$, 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.

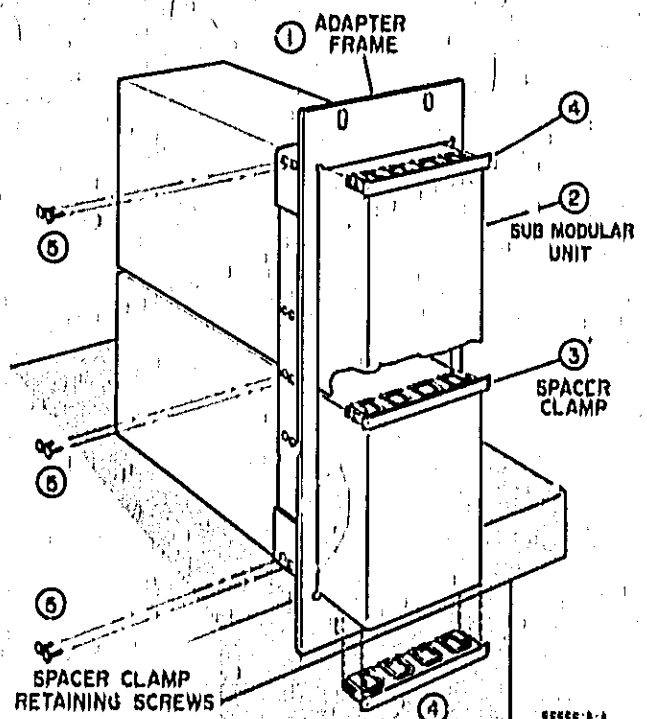


Figure 2-2. Adapter Frame

OPERATION

AND

THEORY

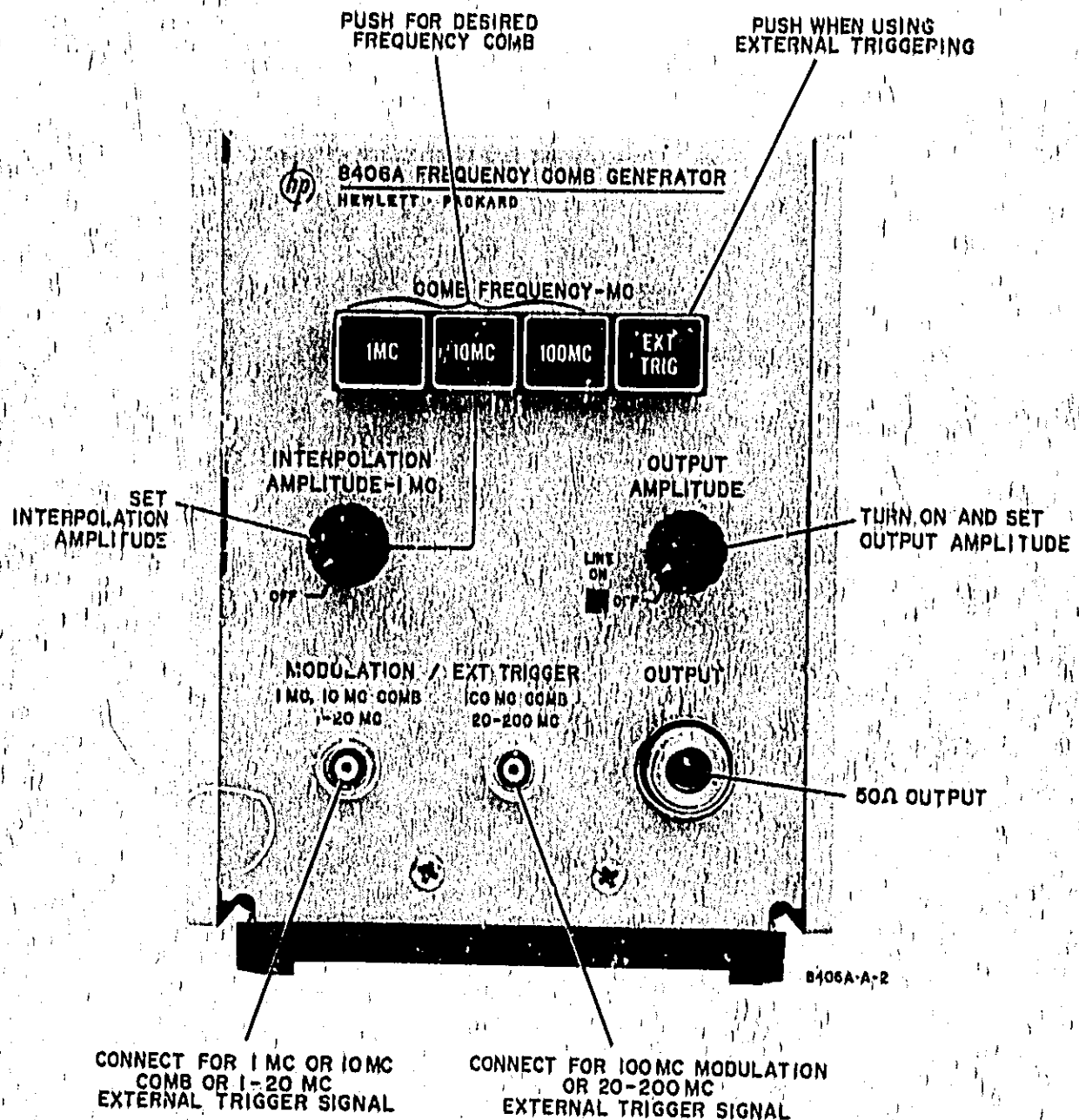


Figure 3-1. Operating Controls

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 A1C11. 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

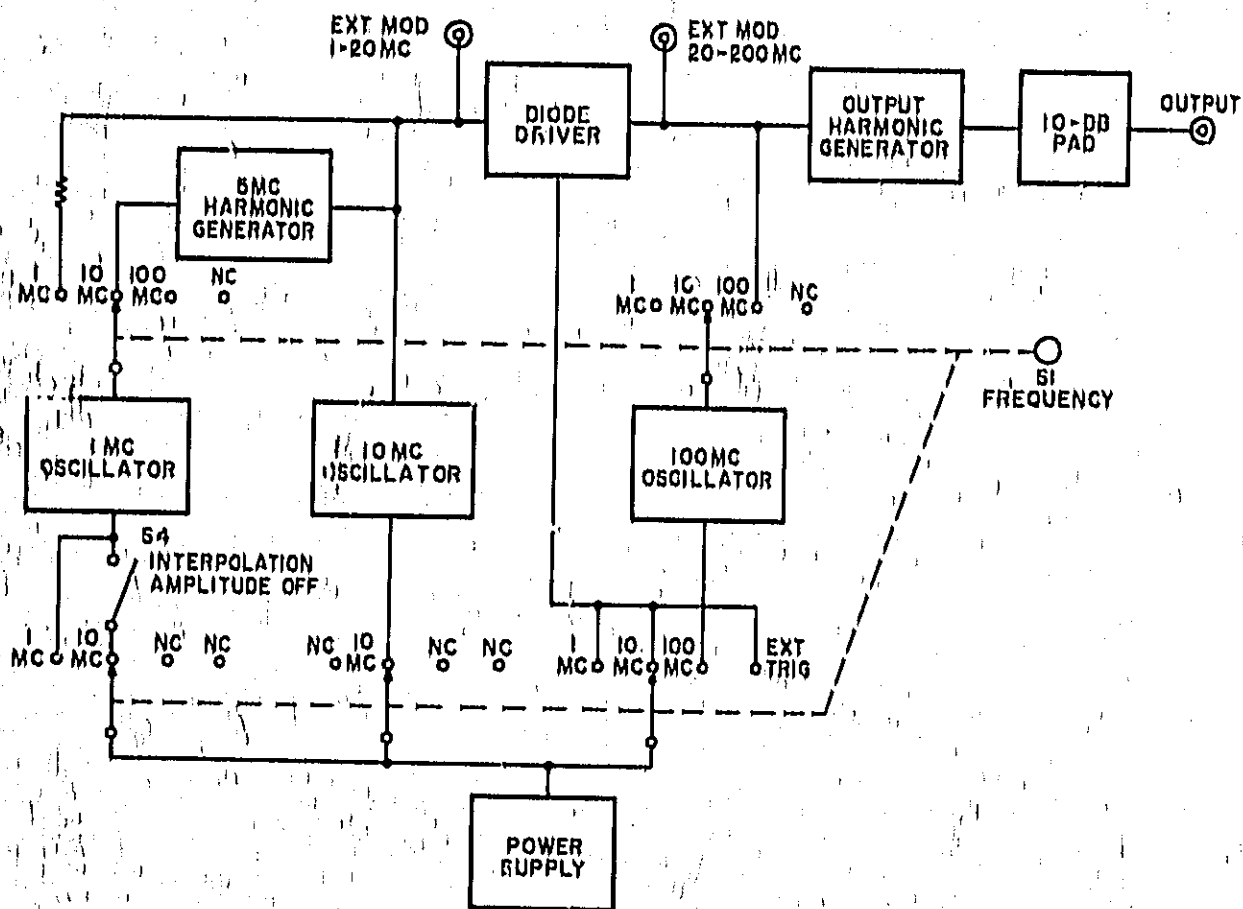


Figure 4-1. Block Diagram.

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 sine wave 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 8400 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:

- As part of an incoming inspection check of instrument specifications;
- periodically, for instruments used in systems where maximum reliability is of utmost importance;
- as part of a troubleshooting procedure to locate out-of-tolerance operation;
- 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 $\pm 10\%$ from nominal (115 or 230 Vac) to assure proper operation of the Generator under various supply conditions.

Table 5-1. Test Equipment Required

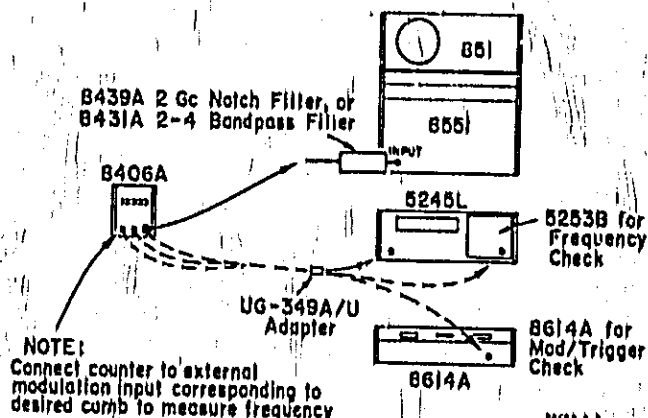
Instrument Type	Critical Specifications	Instrument Recommended
AC Voltmeter	Range: to 1 mV. Frequency Range: 40-200 cps	hp Model 400D/H/L/E/EL
DC Voltmeter	Range: 14 volts Resolution: 0.2 volts	hp Model 405BR
Electronic Counter	Range: 1 to 100 Mc Accuracy: $\pm 0.005\%$	hp Model 5254L with hp Model 5253B 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 B431A 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 -82 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 in-

strument (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.

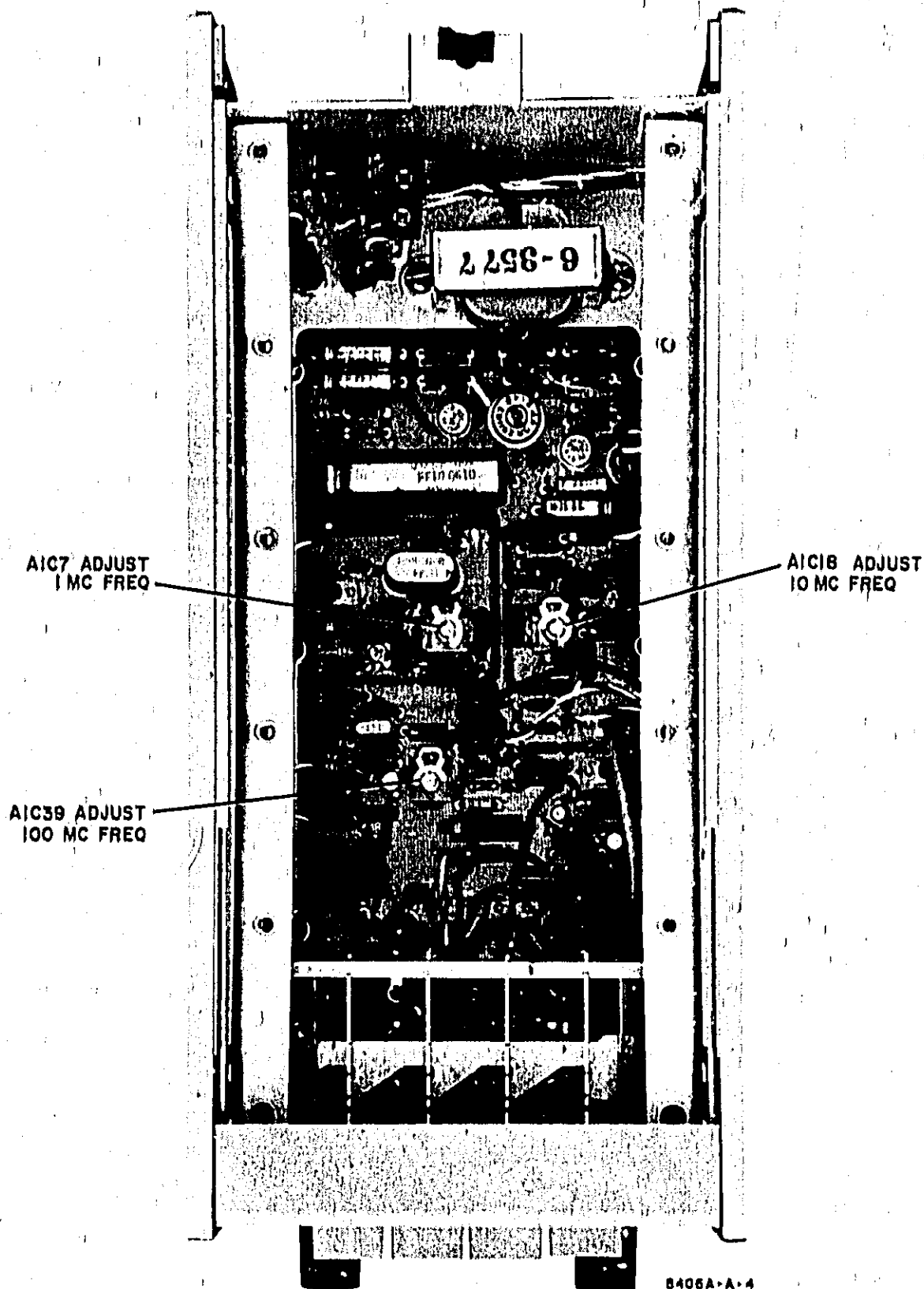


Figure 5-2, Location Diagram

Table 5-3. Performance Check Test Card

Description	
Output	
100 Mc	Level deviation $\pm$ db Frequency
10 Mc	Level deviation $\pm$ 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

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

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

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.

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		Measure Resistance (ohms)
		Pos. lead to	Neg. lead to	
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.

5-10. 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:

- Depress 10 MC COMB FREQUENCY pushbutton.
- 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	tune	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	wire
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	TD	terminal board		
E	misc electronic part	MK	microphone	TP	test point		

ABBREVIATIONS

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

Table 6-1, Reference Designation Index

Reference Designation	Stock No.	Description #	Note
A1	08406-6001	BOARD ASSY., ETCHED CIRCUIT	
A1C1	0160-0174	CIFXD CER 0.47UF +80-20% 25VDCW	
A1C2	0160-0127	CIFXD CER 1UF 20% 25VDCW	
A1C3	0160-0134	CIFXD MICA 220PF 5% 300VDCW	
A1C4	0160-0194	CIFXD MY 0.015UF 10%	
A1C5	0150-0050	CIFXD CER 1000PF 600 VDCW	
A1C6	0140-0145	CIFXD MICA 22 PF 5% 500 VDCW	
A1C7	0121-0127	CIVAR AIR 1.7-14PF	
A1C8	0150-0121	CIFXD CER 0.1UF +80%-20% 50VDCW	
A1C9	0150-0093	CIFXD CER 0.01UF +80-20% 100VDCW	
A1C10	0140-0192	CIFXD MICA 68PF 5% 300VDCW	
A1C11	0160-0179	CIFXD MICA 33PF 5% 300VDCW	
A1C12	0140-0192	CIFXD MICA 68PF 5% 300VDCW	
A1C13	0150-0096	CIFXD CER 0.05UF 100VDCW	
A1C14	0150-0121	CIFXD CER 0.1UF +80%-20% 50VDCW	
A1C15	0140-0204	CIFXD MICA 47PF 5% NPO 500VDCW	
A1C16	0140-0232	CIFXD MICA 460PF 1% 300VDCW	
A1C17	0160-0178	CIFXD MICA 27PF 5% 300VDCW	
A1C18	0121-0127	CIVAR AIR 1.7-14PF	
A1C19	0140-0176	CIFXD MICA 100 PF 2% 300 VDCW	
A1C20	0150-0050	CIFXD CER 1000PF 600 VDCW	
A1C21	0140-0204	CIFXD MICA 47PF 5% NPO 500VDCW	
A1C22	0150-0093	CIFXD CER 0.01UF +80-20% 100VDCW	
A1C23	0150-0121	CIFXD CER 0.1UF +80%-20% 50VDCW	
A1C24	0160-0340	CIFXD MICA 600 PF 1% 300VDCW	
A1C25	0150-0050	CIFXD CER 1000PF 600 VDCW	
A1C26	0180-0119	CIFXD ELECT 1UF -10+100% 25VDCW	
A1C27	0150-0050	CIFXD CER 1000PF 600 VDCW	
A1C28	0140-0209	CIFXD MICA 5PF 10% 500VDCW	
A1C29	0160-2197	CIFXD MICA 10PF 5%	
A1C30	0150-0050	CIFXD CER 1000PF 600 VDCW	
A1C31	0150-0050	CIFXD CER 1000PF 600 VDCW	
A1C32	0140-0209	CIFXD MICA 5PF 10% 500VDCW	
A1C33	0140-0232	CIFXD MICA 460PF 1% 300VDCW	
A1C34	0150-0050	CIFXD CER 1000PF 600 VDCW	
A1C35	0180-0138	CIFXD ELECT 100UF -10+100% 40VDCW	
A1C36	0180-0059	CIFXD ELECT 10UF -10%+100% 25VDCW	
A1C37	0180-0059	CIFXD ELECT 10UF -10%+100% 25VDCW	
A1C38	0180-0059	CIFXD ELECT 10UF -10%+100% 25VDCW	
A1C39	0121-0127	CIVAR AIR 1.7-14PF	
A1C40	0150-0050	CIFXD CER 1000PF 600 VDCW	
A1C41	0160-2140	CIFXD 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 IFXD RF 10 NH	

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 5W	
A1L5	9140-0210	COIL:FXD RF 100 UH 5W	
A1L6	9140-0210	COIL:FXD RF 100 UH 5W	
A1L7	9140-0210	COIL:FXD RF 100 UH 5W	
A1L8	9140-0158	COIL:FXD 1.0UH 10W	
A1L9	9100-1612	COIL:FXD RF 0.33 UH 20W	
A1L10	9140-0210	COIL:FXD RF 100 UH 5W	
A1L11	9100-1613	COIL:FXD RF 0.47 UH 20W	
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	RIFXD MET FLH 14.7K OHM 1W 1/8W	
A1R2	0757-0439	RIFXD MET FLH 6.81K OHM 1W 1/8W	
A1R3	0698-0082	RIFXD MET FLH 464 OHM 1W 1/8W	
A1R4	0698-3441	RIFXD MET FLH 215 OHM 1W 1/8W	
A1R5	0698-0083	RIFXD MET FLH 1960 OHM 1W 1/8W	
A1R6	0757-0465	RIFXD MET FLH 100K OHM 1W 1/8W	
A1R7	0698-0082	RIFXD MET FLH 464 OHM 1W 1/8W	
A1R8	0757-0280	RIFXD MET FLH 1.00K OHM 1W 1/8W	
A1R9	0698-3136	RIFXD MET FLH 17.8K OHM 1W 1/8W	
A1R10	0757-0439	RIFXD MET FLH 6.81K OHM 1W 1/8W	
A1R11	0698-0082	RIFXD MET FLH 464 OHM 1W 1/8W	
A1R12	0698-3441	RIFXD MET FLH 215 OHM 1W 1/8W	
A1R13	0698-0084	RIFXD MET FLH 2150 OHM 1W 1/8W	
A1R14	0698-0084	RIFXD MET FLH 2150 OHM 1W 1/8W	
A1R15	0757-0280	RIFXD MET FLH 1.00K OHM 1W 1/8W	
A1R16	0757-1094	RIFXD MET FLH 1.47K OHM 1W 1/8W	
A1R17	0757-0401	RIFXD MET FLH 200 OHM 1W 1/8W	
A1R18	0698-3441	RIFXD MET FLH 215 OHM 1W 1/8W	
A1R19	0757-0401	RIFXD MET FLH 100 OHM 1W 1/8W	
A1R20	0757-0441	RIFXD MET FLH 8.25K OHM 1W 1/8W	
A1R21	0698-3154	RIFXD MET FLH 4220 OHM 1W 1/8W	
A1R22	0757-0417	RIFXD MET FLH 562 OHM 1W 1/8W	
A1R23	0698-3440	RIFXD MET FLH 196 OHM 1W 1/8W	
A1R24	0698-3441	RIFXD MET FLH 215 OHM 1W 1/8W	
A1R25	0698-3430	RIFXD MET FLH 215 OHM 1W 1/8W	
A1R26	0698-3430	RIFXD MET FLH 21.5 OHM 1W 1/8W	
A1R27	0757-0349	RIFXD MET FLH 10.0 OHM 1W 1/8W	
A1R28	0698-0084	RIFXD MET FLH 2150 OHM 1W 1/8W	
A1R29	0698-0084	RIFXD MET FLH 2150 OHM 1W 1/8W	
A1P30	0757-0346	RIFXD MET FLH 10.0 OHM 1W 1/8W	
A1R31	0698-3445	RIFXD MET FLH 346 OHM 1W 1/8W	
A1R32	0757-0416	RIFXD MET FLH 511 OHM 1W 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:IRF(AMPLIFIER)	
A1VR1	1902-0055	DIODE BREAKDOWN: SILICON 14.7V 10A	
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	CIFXD CER 6800 PF 1000 VDCW	
C2	0150-0019	CIFXD CER 1000PF 20W	
C3	0150-0019	CIFXD CER 1000PF 20W	
C4	0150-0097	CIFXD CER 6800 PF 1000 VDCW	
CR1	1801-0169	SEMICON DEVICE: DIODE	
CRIMP1	08406-1002	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	
CRIMP2	08551-2041	POST, DIODE	
CRIMP3	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	RIVAR COMP 1.5K OHM 20W LIN 1/2W	
R2	0687-6831	RIFXD COMP 68K OHM 10W 1/2W	
R3	2100-0350	RIVAR COMP 1500 OHM 20W 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 JAG	
Z1	08406-6012	ATTENUATOR PAD ASSEMBLY INCLUDES:	
	1460-0297	SPRING: COMPRESSION	
	08491-6000	CARTRIDGE ASSEMBLY	
	08491-2101	CONNECTOR: FEMALE	
	08491-2102	SPACER (QTY 2)	

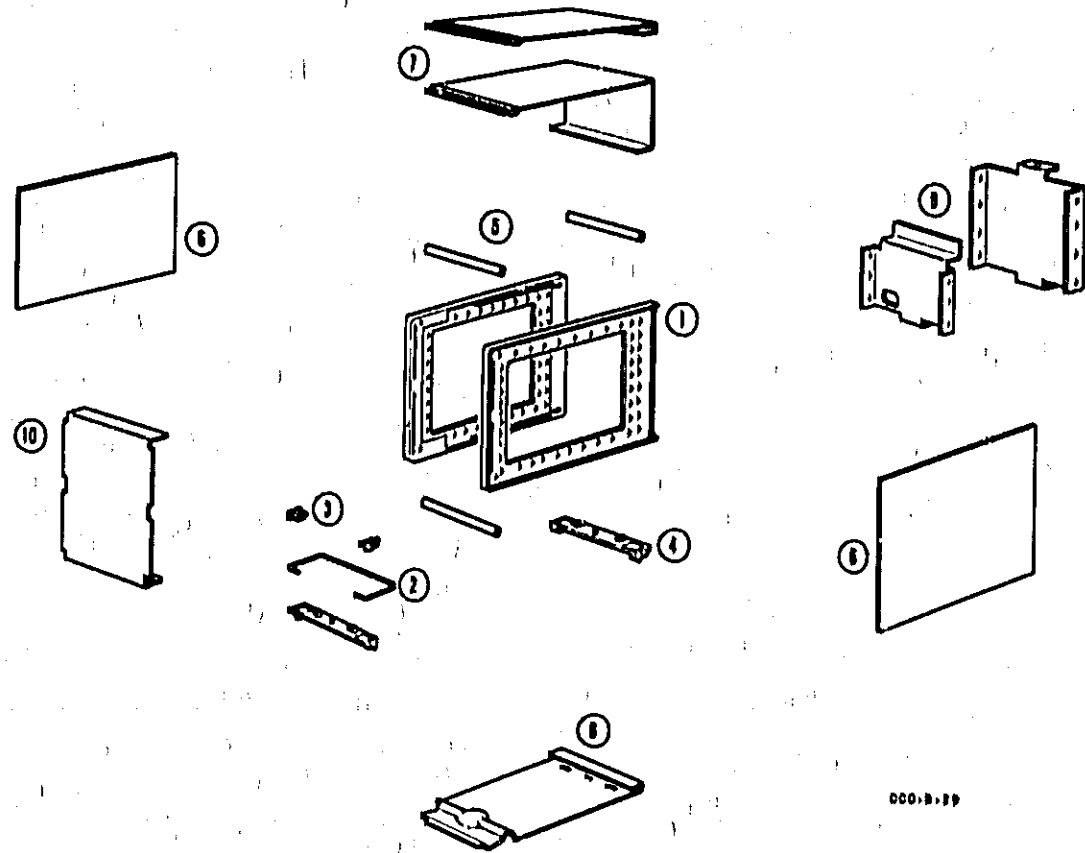
= See list of abbreviations in introduction to this section

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

Reference Designation	Stock No.	Description #	Note
	08742-0006 08491-2002 08491-4001 08491-2009	SPACER BEAD PIN, FEMALE CONTACT, SLIDING	
		MISCELLANEOUS	
	08406-0003 08406-0004 08406-0005 08406-0006 08406-6004	BRACKET, BOTTOM COVER BRACKET, RIGHT SUPPORT BRACKET, LEFT SUPPORT BRACKET, SWITCH CABLE ASSY., COAX(ORANGE)	
	08406-6005 08406-6006 08406-6007 08406-6009 08406-6010	CABLE ASSY., COAX(RED) CABLE ASSY., COAX(BROWN) CABLE ASSY., COAX(BLACK) CABLE ASSY., COAX(YELLOW) CABLE ASSY., COAX(GREEN)	
	08406-6011 8120-0078 5040-0235 5040-0234 0370-0118	CABLE ASSY., COAX(BLUE) CABLE ASSY., POWER BASE/LAMPHOLDER LAMPHOLDER KNOB GRAY PUSHBUTTON 11/16 IN DIA 1MC 10MC 100MC EXT TRIG	
	5000-3227 5000-3228 5000-3229 5000-3248 08406-0001	LABEL/PUSHBUTTON (1 MC) LABEL/PUSHBUTTON(10 MC) LABEL/PUSHBUTTON(100 MC) LABEL/PUSHBUTTON(EXT. TRIG) SUPPORT, LEFT	
	08406-0002 0370-0103	SUPPORT, RIGHT 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 20			
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	5050-0709	COVER ASSEMBLY;TOP	
	5060-0706	UNPERFORATED FULL RECESS	
	5060-0715	UNPERFORATED HALF RECESS	
	5060-0712	PERFORATED FULL RECESS	
		PERFORATED HALF RECESS	
8	5000-0711	COVER ASSEMBLY;BOTTOM	
	5000-0714	UNPERFORATED	
		PERFORATED	
9	SEE MAT'L. LIST	PANEL;REAR	
10	SEE MAT'L. LIST	PANEL;FRONT	

See list of abbreviations in introduction to this section

Table G-2, Replaceable Parts (Cont'd)

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ
0121-0127	CIVAR AIR 1.7-14PF	28480	0121-0127	3
0140-0145	CIFXD NICA 22 PF 5N 500 VDCW	04062	RDH15C220J5C	1
0140-0176	CIFXD NICA 100 PF 2N 300 VDCW	04062	RDH15F101G3C	1
0140-0192	CIFXD NICA 68PF 5N 300VDCW	04062	RDH15E680J3C	2
0140-0204	CIFXD NICA 47PF 5N NPO 500VDCW	04062	RDH15E470J5C	2
0140-0209	CIFXD NICA 5PF 10N 500VDCW	04062	RDH15C050D5C	2
0140-0232	CIFXD NICA 460PF 1N 300VDCW	04062	RDH15F461F3C	2
0150-0019	CIFXD CER 1000PF 20N	72982	J27005XBU0102M	2
0150-0050	CIFXD CER 1000PF 600 VDCW	84411	TYPE E	8
0150-0093	CIFXD CER 0.01UF +80-20N 100VDCW	91418	TA	2
0150-0096	CIFXD CER 0.05UF 100VDCW	91418	-TA	1
0150-0097	CIFXD CER 6800 PF 1000 VDCW	91418	B	2
0150-0121	CIFXD CER 0.1UF +80N-20N 50VDCW	56289	5C50A	3
0160-0127	CIFXD CER 1UF 20N 25VDCW	56289	5C13	1
0160-0134	CIFXD NICA 220PF 5N 300VDCW	14555	RDH15F221J3C	1
0160-0174	CIFXD CER 0.47UF +80-20N 25VDCW	56289	5C11A	1
0160-0178	CIFXD NICA 27PF 5N 300VDCW	04062	RDH15E270J35	1
0160-0179	CIFXD NICA 33PF 5N 300VDCW	04062	RDH15E330J35	1
0160-0144	CIFXD HY 0.015UF 10N	28480	0160-0194	1
0160-0340	CIFXD NICA 600 PF 1N 300VDCW	04062	RDH15F601F3C	1
0160-2140	CIFXD CER 470 PF +80-20% 1000VDCW	91418	TYPE B	1
0160-2197	CIFXD NICA 10PF 5N	28480	0160-2197	1
0180-0059	CIFXD ELECT 10UF -10N+100N 25VDCW	56289	30D106G025BB4	3
0180-0119	CIFXD ELECT 1UF -10+100N 25VDCW	56289	30D105G025AA4	1
0180-0138	CIFXD ELECT 100UF -10+100N 40VDCW	56289	036254	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	RIFXD COMP 68K OHM 10W 1/2W	01121	EB-6831	1
0698-0082	RIFXD MET FLN 464 OHM 1N 1/8W	28480	0698-0082	3
0698-0083	RIFXD MET FLN 1960 OHM 1N 1/8W	28480	0698-0083	1
0698-0084	RIFXD MET FLN 2150 OHM 1N 1/8W	28480	0698-0084	4
0698-3136	RIFXD MET FLN 17.8KOHM 1N 1/8W	28480	0698-3136	1
0698-3154	RIFXD MET FLN 4220 OHM 1N 1/8W	28480	0698-3154	1
0698-3156	RIFXD MET FLN 14.7KOHM 1N 1/8W	28480	0698-3156	1
0698-3430	RIFXD MET FLN 21.5 OHM 1N 1/8W	28480	0698-3430	2
0698-3440	RIFXD MET FLN 196 OHM 1N 1/8W	28480	0698-3440	1
0698-3441	RIFXD MET FLN 215 OHM 1N 1/8W	28480	0698-3441	4
0698-3445	RIFXD MET FLN 348 OHM 1N 1/8W	28480	0698-3445	1
0757-0280	RIFXD MET FLN 1.0KOHM 1N 1/8W	28480	0757-0280	2
0757-0346	RIFXD MET FLN 10.0 OHM 1N 1/8W	28480	0757-0346	2
0757-0401	RIFXD MET FLN 100 OHM 1N 1/8W	28480	0757-0401	2
0757-0416	RIFXD MET FLN 511 OHM 1N 1/8W	28480	0757-0416	1
0757-0417	RIFXD MET FLN 562 OHM 1N 1/8W	28480	0757-0417	1
0757-0439	RIFXD MET FLN 6.81K OHM 1N 1/8W	28480	0757-0439	2
0757-0441	RIFXD MET FLN 8.25KOHM 1N 1/8W	28480	0757-0441	1
0757-1094	RIFXD MET FLN 1.47K OHM 1N 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 IBNC	28480	1250-0083	2
1251-0148	CONNECTOR POWER 3 PIN MALE	60427	H-1061-2	1
1400-0084	HOLDER FUSE POST TYPE JAG	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 15MA 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 10M	28480	1902-0055	1
1912-0007	DIODE: TUNNEL EIA TYPE 1N3714	03508	1N3714 SPEC	1
2100-0350	RIVAR COMP 1500 OHM 20N LIN 1/2W	28480	2100-0350	1
2100-1624	RIVAR COMP 2.5K OHM 20N 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 0.6 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	LAMP HOLDER: (FOR 4 LAMPS)	28480	5040-0234	1
5040-0235	BASE: LAMP HOLDER	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 20N	28480	9100-1612	1
9100-1678	TRANSFORMER: OSCILLATOR	28480	9100-1678	1
9100-1679	TRANSFORMER: IRF 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	1
9140-0158	COIL: FXD 1.0UH 10N	28480	9140-0131	3
9140-0181	COIL: FXD RF 22UH 5N	99800	1025-20	1
9140-0210	COIL: FXD RF 100 UH 5N	78526	12201M	1
		28480	9140-0210	4
9170-0019	CORE: TOROID	72656	CF104 0-1	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 G-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 Handbook 114-1 (Name to Code) and 114-2 (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 114 Handbooks.

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
00000	U. S. A. Common	Any supplier of U. S.	05397	Union Carbide Corp., Linde Div.	Kew-Forest, N.Y.	11747	Ray Electronics Corp.	Waltham, Mass.
00136	McCoy Electronics	Mount Holly Springs, Pa.				11748	Teleplex Inc., Victorian Div.	Palo Alto, Calif.
00213	Sage Electronics Corp.	Rochester, N.Y.	05593	Illuminant Engineering Co.	San Jose, Calif.	11749	Duncan Electronics Inc.	Costa Mesa, Calif.
00287	Comco Inc.	Danville, Conn.	05616	Comco Plastic		11751	General Instrument Corp., Semiconductor Div., Products Group	Newark, N.J.
00326	Humidist	Calicut, Calif.		(See Electrical Eng. Co.)	Cleveland, Ohio	11752	Imperial Electronic, Inc.	Buena Park, Calif.
00328	Microlon Co., Inc.	Valley Stream, N.Y.	05626	Baird Corp.	Rockford, Ill.	11753	Verity, Inc.	Palo Alto, Calif.
00373	Galtech Inc., Electronics Products Div.	Camden, N.J.	05778	Tiffin Optical Co.		11756	Philosophy Hand Co.	Camden, N.J.
00636	Aerovox Corp.	New Bedford, Mass.		Radiant Heights, Long Island, N.Y.		11761	Grove Mfg. Co., Inc.	Shady Grove, Pa.
00779	Amp. Inc.	Harrisburg, Pa.	05779	Walter-Tel Corp.	Westbury, N.Y.	11774	Gullon Inc., Inc., CG Elect. Div.	Albuquerque, N.M.
00781	Allcraft Radio Corp.	Bouquet, N.J.	05783	Stewart Engineering Co.	San Jose, Calif.			
00816	Northrup Engineering Laboratories, Inc.	Burlington, Wis.	05870	Wetfield Engineering Inc.	Wetfield, Mass.	11787	Chlorostat Mfg. Co.	Dorset, N.H.
00853	Saugus Electric Co., Pichana Div.	Pichana, S.C.	05884	Bausch & Lomb	Bridgeport, Conn.	11788	Elmer Filter Corp.	W. Haven, Conn.
00866	Gee Engineering Co.	Los Angeles, Calif.	05890	Raychem Corp.	Redwood City, Calif.	11789	Nissan Electric Co., Ltd.	Tokyo, Japan
00881	Carl E. Helms Corp.	Los Angeles, Calif.	05976	Bausch & Lomb Optical Co.	Rochester, N.Y.	11789	Moran Electronics Corp.	Clark, N.J.
00939	Microlab Inc.	Livingston, N.J.	05402	E. T. A. Products Co. of America	Chicago, Ill.	11790	Orion Semiconductor Inc.	Long Beach, Calif.
01007	General Electric Co., Capacitor Dept.		05410	Amelan Electronic Equipment Co., Inc.	New Rochelle, N.Y.	11794	Diagraph Electronics Corp.	Scottsdale, Arizona
01009	Alden Products Co.	Hudson Falls, N.Y.	05555	Beede Electrical Instrument Co., Inc.	Phoenix, Ariz.	11803	Thermalloy	Dallas, Texas
01121	Allen Bradley Co.	Blackton, Mass.	05565	General Device Co., Inc.	Phoenix, Ariz.	11836	Telephon (GmbH)	Hannover, Germany
01165	Lifton Industries, Inc.	Milwaukee, Wis.	05781	Ernst Div. Components Inc.	Indianapolis, Ind.	11839	Midland-Night Div. of Pacific Industries, Inc.	
01281	TAM Semiconductors, Inc.	Beverly Hills, Calif.	05817	Torrington Mfg. Co., West Div.	Phoenix, Ariz.	11859	Sam-Tech	Kansas City, Kansas
01295	Toshiba Instruments, Inc., Transistor Products Div.	Lombard, Calif.	05980	Valian Assoc. Elmac Div.	Van Nuys, Calif.	11893	Calif. Resistor Corp.	Newbury Park, Calif.
01349	The Alliance Mfg. Co.	Alliance, Ohio	07088	Kelvin Electric Co.	San Carlos, Calif.	11898	American Components, Inc.	San Jose, Calif.
01359	Pacific Relay, Inc.	Van Nuys, Calif.	07126	Digital Co.	Van Nuys, Calif.	11903	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	Conshohocken, Pa.
01530	Amtech Corp.	Rockford, Ill.	07137	Transistor Electronics Corp.	Minneapolis, Minn.	11903	Hamill Products Company	West Palm Beach, Fla.
01561	Pulse Engineering Co.	San Jose, Calif.	07138	Washington Electric Corp.	Elmira, N.Y.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Fairchild Corp. of America	Sunnyvale, N.Y.	07149	Filmtech Corp.	Elmira, N.Y.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Whetlock Signals, Inc.	Long Beach, N.Y.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Colt Rubber and Plastics Inc.	Sunnyvale, Calif.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Amphenol-Ray Electronics Corp.	Chicago, Ill.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Radio Corp. of America, Semiconductor and Materials Div.	San Jose, Calif.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Vacuum Co. of America, Inc.	San Jose, Calif.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Hughes Engineering Co.	San Jose, Calif.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	G. E. Semiconductor Prod. Dept.	Syracuse, N.Y.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Apex Machine & Tool Co.	Dayton, Ohio	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Eldon Corp.	Camden, N.J.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Translun Electric Corp.	Wetfield, Mass.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Singer Co., Dept. Div.	Flushing Plant	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Fluorine Plant	Summitville, N.J.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Atton, Hall and Hageman Elect. Co.	Hartford, Conn.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Taurus Corp.	Lombard, Ill.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Hi-Q Division of Aerovox	Wylie Beach, S.C.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Precision Paper Tube Co.	Chicago, Ill.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Dynac Division of H. J. Muller-Packard Co.	Palo Alto, Calif.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Microlab, Inc., Semiconductor Prod. Div.	Phoenix, Arizona	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Fillion Co., Inc. Western Div.	Calicut, Calif.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Automatic Electric Co.	Northridge, Ill.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Sequoia Wire Co.	Redwood City, Calif.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Precision Coil Spring Co.	El Monte, Calif.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	P. W. Moler Company	Westchester, Ill.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Component Mfg. Service Co.	W. Bridgewater, Mass.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Tennishall Catalytic Plastics, Inc.	Los Angeles, Calif.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.
01561	Ultronic, Inc.	San Mateo, Calif.	07161	Avant Corp.	City of Industry, Calif.	11903	Conrail Doublet Electric Corp.	Longland, Colo.

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

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
21335	Fairfax Bearing Co., The	New Britain, Conn.	21450	CTS Corp.	Elkhart, Ind.	22075	Pacific Metals Co.	San Francisco, Calif.
21336	Fansteel Metallurgical Corp.	N. Chicago, Ill.	21451	ITT Canock Electric Inc.	Los Angeles, Calif.	22076	Phonastion Instrument and Electronic Co.	South Pasadena, Calif.
21337	British Radio Electronics Ltd.	Washington, D.C.	21452	Cincomp, Div. Autovar Corp.	Burbank, Calif.	22077	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
21435	G. E. Lamp Division	Nela Park, Cleveland, Ohio	21453	C. P. Corp. & Co.	Chicago, Ill.	22312	American Machine & Foundry Co. Puller	Pittsfield, Ind.
21436	General Radio Co.	West Concord, Mass.	21454	Commercial Plastics Co.	Wilkesbarre, Pa.	22313	TAM Electronic Components Div.	Cosden, N.J.
21437	Globe Radio Corp.	New Rochelle, N.Y.	21455	Cornish Wire Co., The	New York, N.Y.	22314	General Instrument Corp., Rochester Div.	Rochester, N.Y.
21438	Hamilton Watch Co.	Coventry, N.J.	21456	Coto Cell Co., Inc.	Providence, R.I.	22315	Resistance Products Co.	Harrisburg, Pa.
21439	Hawthorn-Patterson Co.	Palo Alto, Calif.	21457	Chicago Wireline Lamp Works	Chicago, Ill.	22316	Hubbards Corp. of Calif.	Torrance, Calif.
21440	Hayman Mfg. Co.	Northbrook, Ill.	21458	A.O. Smith Corp., Specialty Div.	West Chicago, N.J.	22317	Industrial Division of Illinois Tool Works	Elgin, Ill.
21441	G. E. Receiving Tube Dept.	Oregon, Ore.	21459	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.	22318	Signal Indicator Corp.	New York, N.Y.
21442	Loctite Inc.	Chicago, Ill.	21460	Dow Corning Corp.	Midland, Mich.	22319	Stanhope-Dunn Inc.	Pittsfield, N.J.
21443	Stamysch Cell Products Ltd.	Northbrook, Ontario, Canada	21461	Electric Motor Mfg. Co., Inc.	Williamsville, Conn.	22320	Thompson-Brown & Co.	Chicago, Ill.
21444	Cunningham, W. H. & Hill, Ltd.	Toronto, Ontario, Canada	21462	John E. Felt Co., Div. Victoria Instr. Co.	Chicago, Ill.	22321	Tillley Mfg. Co.	San Francisco, Calif.
21445	P. H. Mallory & Co. Inc.	Jacksonville, Ind.	21463	Dialight Corp.	Brooklyn, N.Y.	22322	Stockpile Carbon Co.	St. Marys, Pa.
21446	Mechanical Industries Prod. Co.	Akron, Ohio	21464	Indiana General Corp., Electronics Div.	Health, N.J.	22323	Standard Thomson Corp.	Baltimore, Md.
21447	Minilature Precision Drilling, Inc.	Kearse, N.H.	21465	General Instrument Corp., Cap. Div. Newark, N.J.	Chicago, Ill.	22324	Tenneco Products, Inc.	Cleveland, Ohio
21448	Muller Co.	Chicago, Ill.	21466	Drake Mfg. Co.	Chicago, Ill.	22325	Transformer Engineers	San Gabriel, Calif.
21449	C. A. Morgan Co.	Englewood, Colo.	21467	Hugh H. Eby Inc.	Philadelphia, Pa.	22326	Uconite Co.	Newark, N.J.
21450	Omni Mfg. Co.	Isabel, Ill.	21468	Gudeman Co.	Chicago, Ill.	22327	Welding Machine Inc.	Long Island City, N.Y.
21451	Penn. Eng. & Mfg. Corp.	Dayton, Ohio	21469	Robert M. Hadley Co.	Los Angeles, Calif.	22328	Vander Real, Inc.	Hartford, Conn.
21452	Polaroid Corp.	Cambridge, Mass.	21470	Eric Technological Products, Inc.	Eliz., Pa.	22329	Waco Mfg. Co.	Chicago, Ill.
21453	Precision Thermometer & Inst. Co.	Southampton, Pa.	21471	Hansen Mfg. Co., Inc.	Princeton, Ind.	22330	Continental-Wire Electronics Corp.	Philadelphia, Pa.
21454	Microwave & Power Tube Div.	Yonkers, N.Y.	21472	H. W. Hansen Co.	Chicago, Ill.	22331	Zenith Mfg. Corp.	New Rochelle, N.Y.
21455	Roman Control Co.	Westchester, Md.	21473	Holger Div. of Rockman Inst., Inc.	Fallston, Calif.	22332	Wagon Division of Sessions Clock Co.	Wilmington, N.J.
21456	Sandair Company	Waltham, Mass.	21474	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.	22333	Schnitzer Alloy Products Co.	Elizabeth, N.J.
21457	Shallcross Mfg. Co.	Island, N.C.	21475	Amperon Electronic Co., Div. of North American Phillips Co., Inc.	Richville, N.Y.	22334	Electronic Industries Association, Any brand	Any brand
21458	Simpson Electric Co.	Chicago, Ill.	21476	Bradley Semiconductor Corp.	New Haven, Conn.	22335	Tube meeting EIA Standards-Washington, DC.	Washington, DC.
21459	Songline Corp.	Elmsford, N.Y.	21477	Carling Electric, Inc.	Hartford, Conn.	22336	Unimac Switch, Div. Waco Electronics Corp.	Wallingford, Conn.
21460	Raytheon Co. Commercial Apparatus & Systems Div.	St. Helms, Conn.	21478	Circle F Mfg. Co.	Trenton, N.J.	22337	United Transformer Corp.	New York, N.Y.
21461	Spaulding Fibre Co., Inc.	Tenaford, N.Y.	21479	George H. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.	22338	Oxford Electric Corp.	Chicago, Ill.
21462	Spigone Electric Co.	North Adams, Mass.	21480	Federal Steel Products Inc.	Chicago, Ill.	22339	Bosma Inc.	Riverside, Calif.
21463	Telan, Inc.	St. Paul, Minn.	21481	Fincher Special Mfg. Co.	Cincinnati, Ohio	22340	Acro Div. of Rehabilitation Controls Co.	Columbus, Ohio
21464	Thomas & Bolts Co.	Elizabeth, N.J.	21482	General Industries Co., The	Elgin, Ohio	22341	All Star Products Inc.	Delaware, Ohio
21465	Triplet Electrical Inst. Co.	Buffalo, Ohio	21483	Sophen Stamping & Tool Co.	Cosham, Ind.	22342	Avary Adhesive Label Corp.	Menasha, Calif.
21466	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.	21484	JFD Electronics Corp.	Brooklyn, N.Y.	22343	Hammilland Co., Inc.	New York, N.Y.
21467	Universal Electric Co.	Ottawa, Mich.	21485	Jennings Radio Mfg. Corp.	San Jose, Calif.	22344	Glosson, Arnold, Co., Inc.	Boston, Mass.
21468	Ward-Leonard Electric Co.	Wt. Virginia, N.Y.	21486	Signalite Inc.	Hopkinton, N.J.	22345	International Instruments Inc.	Orange, Conn.
21469	Western Electric Co., Inc.	New York, N.Y.	21487	J. H. Wynn, and Son	Winchester, Mass.	22346	Grayhill Co.	LaGrange, Ill.
21470	Weston Inst. Inc. Weston-Henrich	Humboldt, N.J.	21488	Industrial Condenser Corp.	Chicago, Ill.	22347	Triad Transformer Corp.	Yonkers, Calif.
21471	Wilco Mfg. Co.	Chicago, Ill.	21489	R. F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.	22348	Winchester Elec. Div. Lillian Ind., Inc.	Oshtemo, Conn.
21472	Wynco Electronics Div. Waco, Mining & Mfg. Co.	St. Paul, Minn.	21490	E. F. Johnson Co.	Madison, Wis.	22349	Military Specification	El Segundo, Calif.
21473	Allen Mfg. Co.	Hartford, Conn.	21491	International Resistance Co.	Philadelphia, Pa.	22350	Avary Electronics, Inc.	Cambridge, Mass.
21474	Allied Control	New York, N.Y.	21492	CTS Knight Inc.	Sandwich, Ill.	22351	Barco Controls, Div. Ray-Wright Corp.	Waltham, Mass.
21475	Allmetal Screen Product Co., Inc.	Garden City, N.Y.	21493	Ashton Electric Corporation	Wt. Virginia, N.Y.	22352	Carter Precision Electric Co.	Shelby, Ill.
21476	Atlantic India Rubber Works, Inc.	Chicago, Ill.	21494	Leak Electric Mfg. Co.	Chicago, Ill.	22353	Specht Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
21477	Amperite Co., Inc.	Union City, N.J.	21495	Littell, Inc.	Des Plaines, Ill.	22354	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
21478	APC Products Inc.	Minneapolis, Minn.	21496	Lord Mfg. Co.	Eliz., Pa.	22355	Fairchild Camera & Inst. Corp., Defense Prod. Division	Chilton, N.J.
21479	Belden Mfg. Co.	Chicago, Ill.	21497	C. W. Mawer	San Francisco, Calif.	22356	Magnate Industries, Inc.	Greenwich, Conn.
21480	Bird Electronic Corp.	Cleveland, Ohio	21498	General Instrument Corp., Microfilm Division	Newark, N.J.	22357	Sylvania Electric Prod. Inc., Electronic Tube Division	Emporium, Pa.
21481	Blumhach Radio Co.	New York, N.Y.	21499	Weller Electric Co.	Cleveland, Ohio	22358	Aslico Corp.	Easton, N.J.
21482	Boston Gear Works Div. of Morley Co.	Quincy, Mass.	21500	National Union	Newark, N.J.	22359	Smithell, Inc.	Chicago, Ill.
21483	Bud Radio, Inc.	Wilkesbury, Ohio	21501	Pak Manufacturing Co.	Clyde, Ohio	22360	Metals & Controls Inc. Spencer Products	Attleboro, Mass.
21484	Camelot Fastener Corp.	Patuxent, N.J.	21502	Sengis Corp., The	N. Hollywood, Calif.	22361	Phillips-Advance Control Co.	Juliet, Ill.
21485	Caldwell Condenser Corp.	Linden, N.J.						
21486	Dussmann Mfg. Div. of McGraw-Hill	St. Louis, Mo.						
21487	Chicago Condenser Corp.	Chicago, Ill.						
21488	Calit, Spring Co., Inc.	Pico-Rivera, Calif.						

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
91266	Research Products Corp.	Madison, Wis.	91345	Miller Dial & Nameplate Co.	El Monte, Calif.	96281	Microway Associates, Inc.	Burlington, Mass.
91277	Rohlin Mfg. Co., Inc.	Westfield, N.Y.	91410	Radio Materials Co.	Chicago, Ill.	96301	Excel Transformer Co.	Oakland, Calif.
91283	Vactor Electronic Co.	Glendale, Calif.	91506	Augel Inc.	Attleboro, Mass.	97464	Industrial Retaining Ring Co.	Irvine, N.J.
91553	Western Washer Mfg. Co.	Los Angeles, Calif.	91637	Dale Electronics, Inc.	Columbus, Miss.	97535	Automatic & Precision Mfg.	Englewood, N.J.
91558	Cair Fastener Co.	Cambridge, Mass.	91662	Elco Corp.	Willow Grove, Pa.	97979	Ryan Resistor Corp.	Yonkers, N.Y.
93076	New Hampshire Ball Bearing, Inc.	Portland, N.H.	91737	Gramer Mfg. Co., Inc.	Waltham, Mass.	97983	Lillian System Inc., Adler-Westro	New Rochelle, N.Y.
93135	General Instrument Corp., Capacitor Div.	Darlington, S.C.	91827	V F Development Co.	Redwood City, Calif.	98341	R-Francis, Inc.	Jersey City, N.J.
93146	ITT Wire and Cable Div.	Los Angeles, Calif.	91846	Waco Mfg. Co., Inc.	Chicago, Ill.	98359	Rubber Tech, Inc.	Gardena, Calif.
93186	Victory Eng. Corp.	Springfield, N.J.	91925	Honeywell Inc., Micro Switch Div.	Chicago, Ill.	98770	Hewlett-Packard Co., Wavley Div.	Menlo Park, Calif.
93296	Bondco Corp., Fed Bush Div.	Red Oak, N.J.	91961	Mahm-Bros. Spring Co.	Oakland, Calif.	98778	Microdot, Inc.	San Francisco, Calif.
93315	Huttall Corp.	Madison, Ill.	92120	Trio-Connector Corp.	Peabody, Mass.	98791	Seaflex Corp.	Wilmington, N.Y.
93320	Smith, Herman H., Inc.	Brooklyn, N.Y.	92367	Elger Optical Co., Inc.	Rochester, N.Y.	98796	Zero Mfg. Co.	Burbank, Calif.
93332	Toch Labs	Palisade Park, N.J.	92736	Universal Industries, Inc.	City of Industry, Calif.	98797	General Mills Inc., Electronics Div.	Minneapolis, Minn.
93366	Central Screw Co.	Chicago, Ill.	92807	Toughite Insulated Wire Co., Inc.	Tarrytown, N.Y.	98798	Pasco Div. of Hewlett-Packard Co.	Palo Alto, Calif.
93501	Gavitt Wire and Cable Co.	Brightfield, Mass.	92702	JMC Magnetics Corp.	Westbury Long Island, N.Y.	98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
93594	Butterbaugh Corp. Electronic Tube Div.	Plainfield, N.J.	92866	Hudson Lamp Co.	Kearney, N.J.	98978	International Electronic Research Corp.	Burbank, Calif.
93740	Union Carbide Corp. Consumer Prod. Div.	New York, N.Y.	93332	Sylvania Electric Prod. Inc.	Woburn, Mass.	99109	Columbia Technical Corp.	New York, N.Y.
93771	Model Eng. and Mfg., Inc.	Huntington, Ind.	93369	Robbins and Myers, Inc.	New York, N.Y.	99312	Varian Associates	Palo Alto, Calif.
93821	Lloyd Schlegel Co.	Foshton, Mo.	93410	Stevens Mfg. Co., Inc.	Wardfield, Ohio	99370	Allen Corp.	Winchester, Mass.
93947	Aerological Inst. & Prod. Co.	Lodi, N.J.	93939	G.V. Coalfields	Liverpool, N.J.	99515	Marshall Ind. Elect. Products Div.	San Marino, Calif.
94171	Aero Electronics Inc.	Great Neck, N.Y.	94137	General Cable Corp.	Bayonne, N.J.	99707	Control Switch Division, Controls Co.	El Segundo, Calif.
94196	A. J. Glenister Co., Inc.	San Francisco, Calif.	94144	Raytheon Co., Comp. Div., Ind.	Quincy, Mass.	99800	Delavan Electronics Corp.	East Aurora, N.Y.
94411	TNW Capacitor Div.	Upland, Ind.	94148	Scientific Electronics Products, Inc.	Loveland, Colo.	99828	Wilco Corporation	Indianapolis, Ind.
94570	Birken Trazian, Inc.	Bloomington, Ind.	94154	Tung-Sol Electric, Inc.	Newark, N.J.	99934	Rexbrandt, Inc.	Boston, Mass.
94584	Beaton Welding Company	Beaumont, N.J.	94197	Culham-Wright Corp. Electronics Div.	East Paterson, N.J.	99947	Helfman Electronics Corp.	El Monte, Calif.
94741	A. B. Boyd Co.	San Francisco, Calif.	94222	South Chelton Corp.	Chesler, Pa.	99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.
94774	R. M. Bracamonte & Co.	San Francisco, Calif.	94310	Tro-Ohm Products Womcor Components Div.	Huntington, Ind.			
94860	Heitold Harts, Inc.	Hawthorne, Conn.	94330	Wire Cloth Products, Inc.	Bellwood, Ill.			
94911	Seaflex Rubber Co.	Chicago, Ill.	94687	Worcester Pressed Aluminum Corp.	Worcester, Mass.			
94979	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.	94686	Magnecraft Electric Co.	Chicago, Ill.			
95127	Precision Rubber Products Corp.	Dayton, Ohio	95023	George A. Philbrick Researchers, Inc.	Boston, Mass.			
95284	Radio Corp. of America, Electronic	Harrison, N.J.	95226	Allies Products Corp.	Miami, Fla.			
	Camp. & Devices Div.	Amherst, Calif.	95238	Continental Connector Corp.	Woodside, N.Y.			
97034	Marco Industries	Leedsdale, Pa.	95263	Loxall Mfg. Co., Inc.	Long Island, N.Y.			
97216	Philco Corporation (Lansdale Division)	San Francisco, Calif.	95264	Lenco Electronics, Inc.	Burbank, Calif.			
97473	Western Fibrous Glass Products Co.	San Francisco, Calif.	95265	National Coil Co.	Secaucus, N.J.			
97664	Van Waters & Rogers Inc.	San Francisco, Calif.	95276	Vishman, Inc.	Bridgeport, Conn.			
97930	Tammy Mfg. Corp.	Providence, R.I.	95348	Gordon Corp.	Bloomfield, N.J.			
98140	Culler-Hammer, Inc.	Liverpool, Ill.	95354	Method Mfg. Co.	Chicago, Ill.			
98270	Gold-National Batteries, Inc.	St. Paul, Minn.	95366	Arnold Engineering Co.	Waukegan, Ill.			
98421	Federal Telephone & Radio Corp.	Clifton, N.J.	95712	Dodge Electric Co., Inc.	Pasadena, Ind.			
98598	General Mills, Inc.	Buffalo, N.Y.	95944	Siemon Mfg. Co.	Wayne, Ill.			
98731	Grapher Electric Co.	Oakland, Calif.	95987	Wheeler Corp.	Chicago, Ill.			
98665	United Transformer Co.	Chicago, Ill.	96047	Huggins Laboratories	Sunnyvale, Calif.			
98779	US Rubber Co., Container Ind. & Plastics	Pasadena, N.J.	96055	H-Q Div. of Aerovox Corp.	Alhambra, N.Y.			
98779	Prod. Div.	Pasadena, N.J.	96256	Thorderson-Weissner Inc.				

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

0000F	Malco Tool and Die	Los Angeles, Calif.
0000Z	Willow Leather Products Corp.	Newark, N. J.
000AB	ETA	England
000BB	Precision Instrument Components Co.	
000CS	Hemphill-Packard Co.,	Vsa Nuyt, Calif.
	Colorado Springs	Colorado Springs, Colorado
000MW	Rubber Eng. & Development	Hayward, Calif.
000NY	A "M" Mfg. Co.	San Jose, Calif.
000QQ	Coallion	Oakland, Calif.
000QQ	California Eastern Lab.	Northridge, Calif.
000YY	S. K. Smith Co.	Los Angeles, Calif.

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.

2. 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.

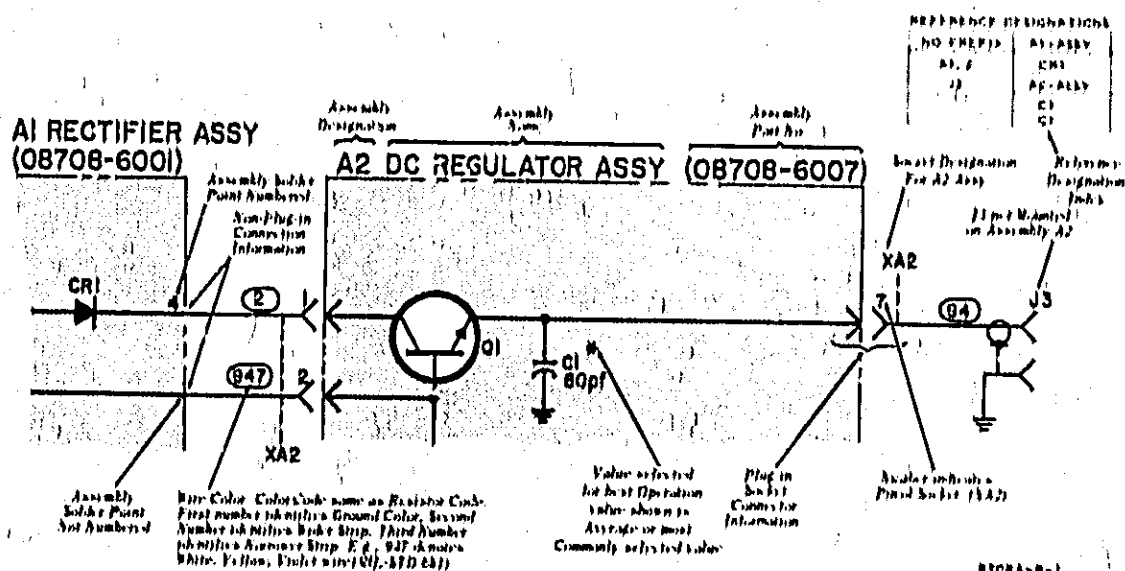
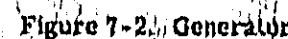
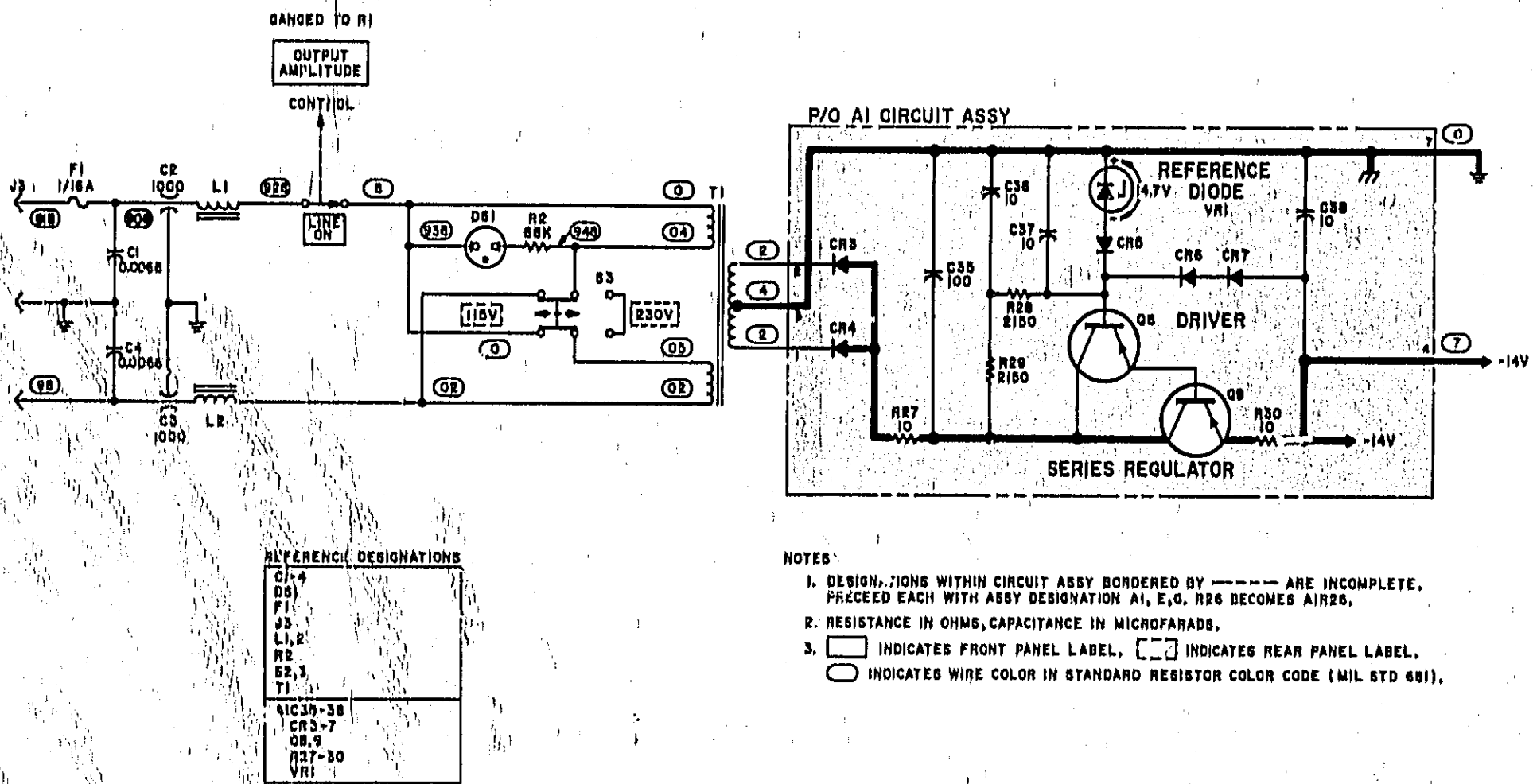


Figure 7-1. Schematic Information Illustration





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5104A-PS-910A

Figure 7-3. Power Supply
7-5/7-6

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 632-, and 641-.

Instrument
Serial No. Prefix Change Number

641-	1
632-	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
"	"	"	"	A1C18	"	"
"	"	"	"	A1C30	"	"

CHANGE 2:

6-7	6-7	7-3/7-4	Change	A1C29	0160-0370	20 pF 5%
6-3		"	"	A1L11	0100-1012	0.33 μ H
"		"	"	A1Q5	1854-0031	2N2805
"		"	"	A1Q7	1854-0031	2N2865
"		"	"	A1R20	0698-3156	14.7 K Ω
"		"	"	A1R21	0698-3155	4640 Ω
"		"	"	A1R22	0698-0084	2150 Ω
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	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		

► 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

HEWLETT  PACKARD

Printed in U.S.A.

► 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 1500 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 3.3 OHM 5% 1/4W.

Page 6-4, Table 6-1:
Change A1VR1 to 1902-3203, DIODE BREAKDOWN: SILICON 14.7V 5% 10 mW.
Add A1HP1, 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 8120-7078 to read: 8120-1348, CABLE ASSY: POWER.

Delete 5040-0234, LAMP HOLDER.

Delete 5040-0235, BASE: LAMP HOLDER.

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 INC, 10MC, 100MC EXT TRIG.

Page 6-6, Table 6-1, Cabinet Parts:

Change items 6 through 10 as follows:

Change 6 to 5000-8555, 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% 300V (factory-selected part).

Change A1C17 to 0140-0145, C: FXD MICA 22 pF 5% 500 VDC (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 08406-0018, BRACKET, BOTTOM COVER.

Table 5-1. Test Equipment Required (ERRATA)

Instrument Type	Critical Specifications	Instrument Recommended
Electronic Counter	Range: 1 to 100 MHz Accuracy: $\pm 0.02\%$	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 <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 15%;">100MC</td> <td style="width: 45%;">100 MHz - 1 GHz</td> <td style="width: 15%;">_____</td> <td style="width: 25%;">dBm</td> </tr> <tr> <td></td> <td>1 GHz - 1.8 GHz</td> <td>_____</td> <td>dBm</td> </tr> <tr> <td></td> <td>1.8 GHz - 2 GHz</td> <td>_____</td> <td>dBm</td> </tr> <tr> <td></td> <td>2 GHz - 4 GHz</td> <td>_____</td> <td>dBm</td> </tr> <tr> <td>10MC</td> <td>10 MHz - 500 MHz</td> <td>_____</td> <td>dBm</td> </tr> <tr> <td></td> <td>500 MHz - 1.8 GHz</td> <td>_____</td> <td>dBm</td> </tr> <tr> <td></td> <td>1.8 GHz - 2 GHz</td> <td>_____</td> <td>dBm</td> </tr> <tr> <td></td> <td>2 GHz - 4 GHz</td> <td>_____</td> <td>dBm</td> </tr> <tr> <td>1MC</td> <td>10 MHz - 500 MHz</td> <td>_____</td> <td>dBm</td> </tr> <tr> <td></td> <td>500 MHz - 1.8 GHz</td> <td>_____</td> <td>dBm</td> </tr> <tr> <td></td> <td>1.8 GHz - 2 GHz</td> <td>_____</td> <td>dBm</td> </tr> <tr> <td></td> <td>2 GHz - 4 GHz</td> <td>_____</td> <td>dBm</td> </tr> </table>		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 <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 60%;">1 MHz $\pm$ 100 Hz</td> <td style="width: 40%;">_____</td> <td style="width: 10%;">MHz</td> </tr> <tr> <td>10 MHz $\pm$ 1 kHz</td> <td>_____</td> <td>MHz</td> </tr> <tr> <td>100 MHz $\pm$ 10 kHz</td> <td>_____</td> <td>MHz</td> </tr> </table> C. 1 MHz INTERPOLATION Operation Verification _____		1 MHz $\pm$ 100 Hz	_____	MHz	10 MHz $\pm$ 1 kHz	_____	MHz	100 MHz $\pm$ 10 kHz	_____	MHz
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																																																									
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	1.8 GHz - 2 GHz	_____	dBm																																																									
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	1.8 GHz - 2 GHz	_____	dBm																																																									
	2 GHz - 4 GHz	_____	dBm																																																									
1 MHz $\pm$ 100 Hz	_____	MHz																																																										
10 MHz $\pm$ 1 kHz	_____	MHz																																																										
100 MHz $\pm$ 10 kHz	_____	MHz																																																										
D. EXTERNAL MODULATION AND TRIGGER <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 15%;">1MC</td> <td style="width: 45%;">Modulation Sensitivity</td> <td style="width: 15%;">_____</td> <td style="width: 25%;">mV</td> </tr> <tr> <td></td> <td>Modulation Sensitivity</td> <td>_____</td> <td>mV</td> </tr> <tr> <td></td> <td>Trigger level 1-20 MHz</td> <td>_____</td> <td>V</td> </tr> <tr> <td></td> <td>Trigger level 20-200 MHz</td> <td>_____</td> <td>V</td> </tr> </table>		1MC	Modulation Sensitivity	_____	mV		Modulation Sensitivity	_____	mV		Trigger level 1-20 MHz	_____	V		Trigger level 20-200 MHz	_____	V																																											
1MC	Modulation Sensitivity	_____	mV																																																									
	Modulation Sensitivity	_____	mV																																																									
	Trigger level 1-20 MHz	_____	V																																																									
	Trigger level 20-200 MHz	_____	V																																																									

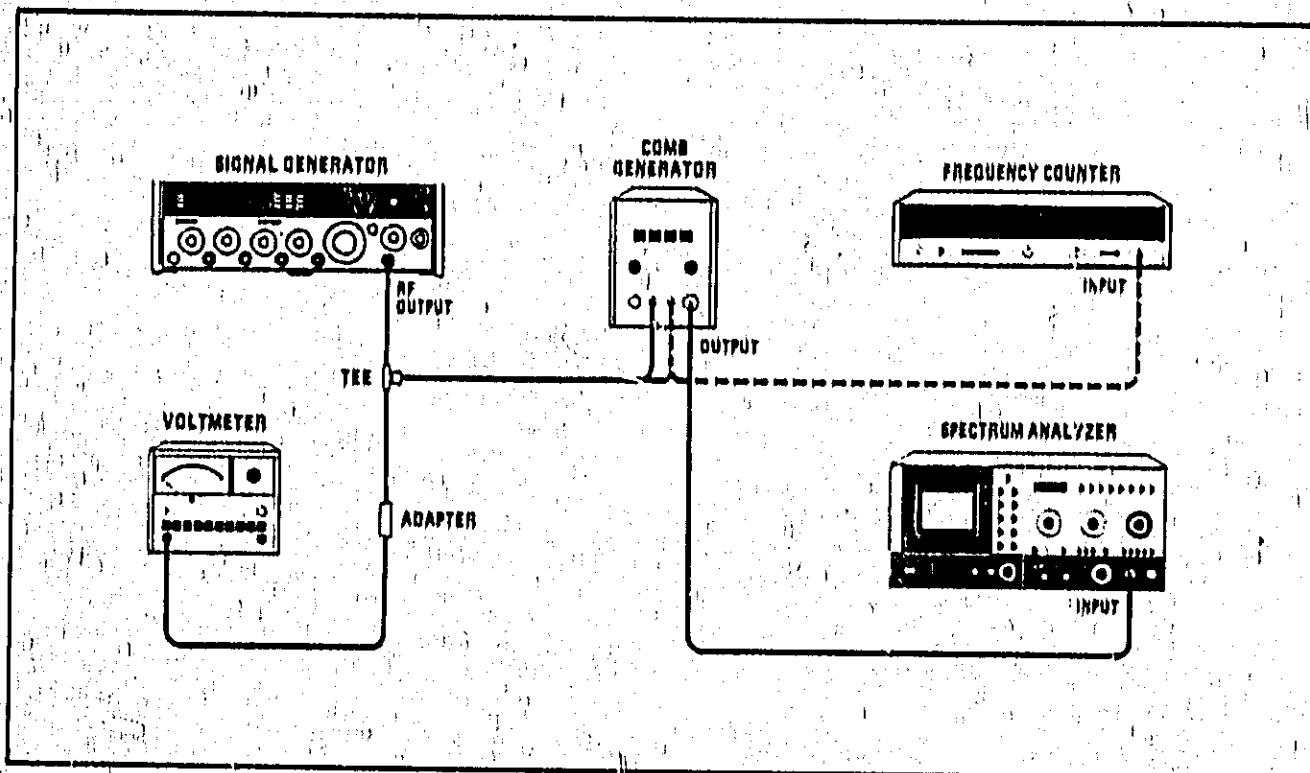


Figure 5-1, Test Setup (ERRATA)

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 0.1-1.8 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 1 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 GHz01-1.8 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 1021BA

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	0.01-1.8 CHz
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 0.1-1.8 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.

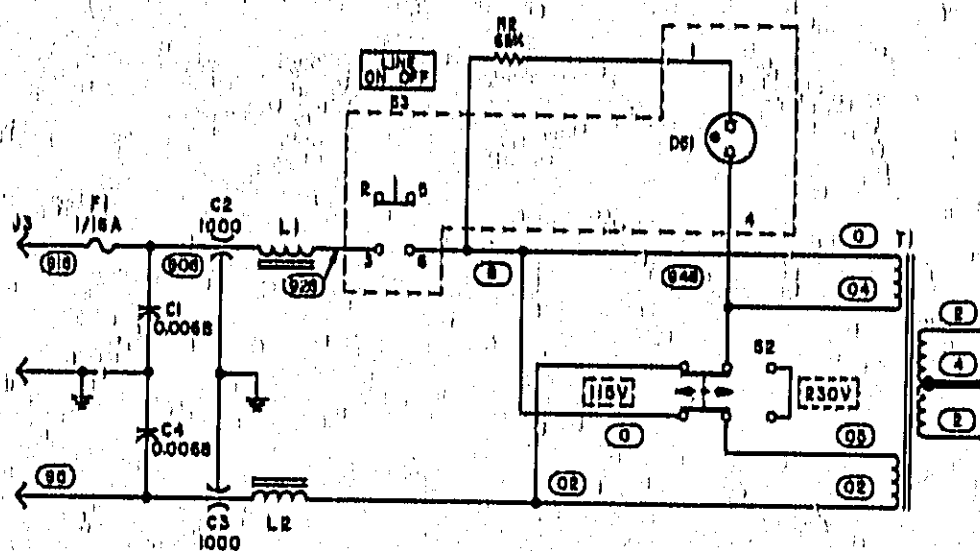
3. A typically flat amplitude response should be observed. If amplitude response is not flat, AIT1 is adjusted for a stable frequency response and AIT2 is adjusted for maximum flat amplitude in the 400 MHz region as OUTPUT AMPLITUDE is varied from maximum to minimum.

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

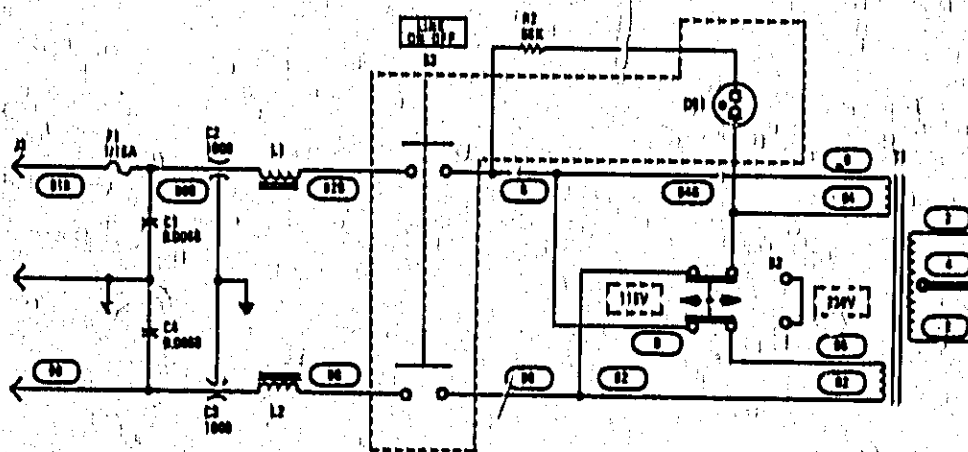
5. Set RANGE of the frequency counter to 10 Hz-18 GHz. Adjust AIC39 for a frequency display of 100 MHz ± 10 kHz.

6. Press 10MC pushbutton on the comb generator. Adjust AIC18 for a frequency display of 10 MHz ± 1 kHz on frequency counter.

7. Press 1 MHz pushbutton on comb generator. Adjust AIC7 for a frequency display of 1 MHz ± 100 Hz on frequency counter.



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



P/O Figure 7-3, (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, R:FXD NET FTH 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



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