

Errata

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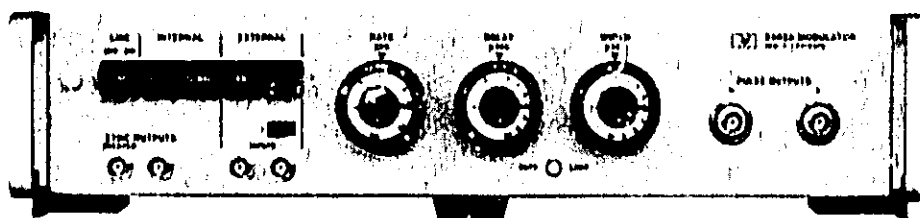
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Agilent Technologies

OPERATING AND SERVICE MANUAL

HP 8403A MODULATOR



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HP 8403A MODULATOR

(Including Options 002, 004, 006, 008 and 009)

SERIAL NUMBERS

This Operating and Service Manual applies directly to HP 8403A instruments with serial numbers prefixed 2036A.

For instruments with serial number prefixes 2014A and below, a "Backdating Appendix" section is supplied in the back of this manual.



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Table 1-1. Specifications

Output Characteristics

AM and Pulse Output for Driving 8730 PIN Modulators: Pulse output specially shaped for optimum rise and decay times.

Pulse Output for General Pulse Applications: Positive de-coupled pulse 25 to 30 volts peak-to-peak, approximately symmetrical about 0 volt; source impedance, approximately 1000 ohms. No AM signal. Output signals available concurrently from separate front-panel connectors.

Internal Modulation**Square Wave**

Frequency: Continuously variable from 50 Hz to 50 kHz, 3 decade ranges.

Symmetry: Better than 45/55%.

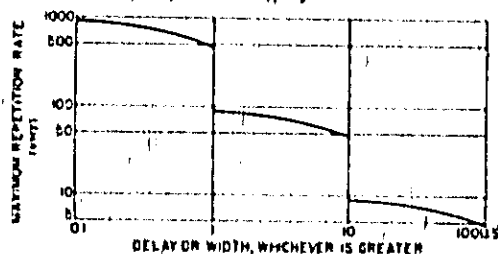
Pulse

Repetition Frequency: Continuously variable from 50 Hz to 50 kHz in 3 decade ranges.

Delay: Continuously variable from 0.1 to 100 μ sec in 3 decade ranges between sync out pulse and rf output pulse.

Width: Continuously variable from 0.1 to 100 μ sec in 3 decade ranges.

Maximum Duty Cycle: See graph.

**External Sync**

Amplitude: 5 to 20 volts peak.

Waveform: Pulse or sine wave.

Polarity: Either positive or negative.

Input Impedance: Approximately 2000 ohms, de-coupled.

Rate: Subject to internal recovery time considerations; see graph.

Trigger Out

Sync Out: 0.1 to 100 μ sec in advance of the spiked or rf pulse, as set by DELAY control (internal pulse mode); simultaneous with rf pulse (internal square wave and external pulse mode).

Delayed Sync Out: Simultaneous with output pulse (internal pulse mode only).

Amplitude: Approximately -2 volts.

Source Impedance: Approximately 330 ohms.

External Modulation**Pulse**

Input: 5 to 20 volts, either positive or negative.

Repetition Frequency: Maximum average prf, 500 kHz.

Input Impedance: Approximately 2000 ohms, de-coupled.

Minimum RF Pulse Width: 0.1 μ sec.

Maximum RF Pulse Width: $\frac{1}{prf} - 0.1 \mu$ sec.

Continuous Amplitude Modulation (with 8730 Series)

Frequency Response: DC to approximately 10 MHz (3 dB).

Sensitivity: Approximately 10 dB/volt with 8730A series, approximately 20 dB/volt with 8730B series.

Input Impedance: Approximately 1000 ohms.

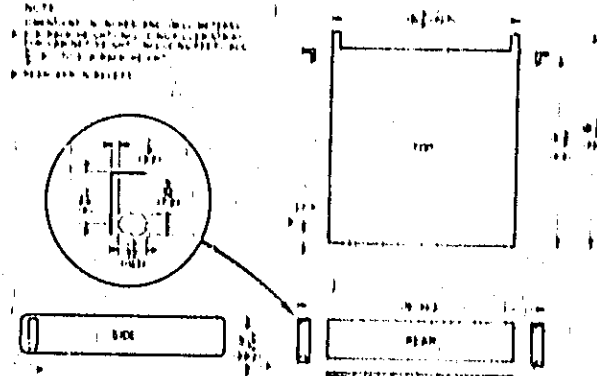
Level Control: AM input is de-coupled, permitting control by bias of AM input; rear panel control for use with ac-coupled modulation.

General

Power Requirements: 115/230 volts $\pm 10\%$, 48-66 Hz, 115V $\pm 10\%$ 300-440 Hz 20 VA max.

Dimensions:

NOTE: DIMENSIONS ARE GIVEN IN INCHES AND MILLIMETERS. DIMENSIONS ARE GIVEN IN INCHES AND MILLIMETERS. DIMENSIONS ARE GIVEN IN INCHES AND MILLIMETERS.



Weight: Net, 16 1/2 lbs. (7.4 kg). Shipping, 20 lbs. (9 kg).

Options:

002. Model 8731B PIN Modulator

004. Model 8732B PIN Modulator

006. Model 8733B PIN Modulator

008. Model 8734B PIN Modulator

009. Sync output and external modulation input connectors on rear panel in parallel with front-panel connectors; pulse output (or rf input and output) connectors on rear panel only.

SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. The Hewlett-Packard Model 8403A Modulator (Figure 1-1) is a dual function modulation unit that can be used to provide two simultaneous modulation output signals. One modulation output provides pulse and square-wave modulation signals for general applications, such as modulating an RF signal generator. The other modulation output provides specially shaped modulating signals for modulating the HP Model 8730 series of PIN Modulators. Internally generated pulse and square-wave modulating signals, which are adjustable in rate from 50 Hz to 50 KHz, are available at either modulation output. In addition, externally applied pulse- and amplitude-modulation signals may be applied to the Model 8403A. However, amplitude modulation signals will only be available at the modulation output for use with PIN Modulators, while the externally applied pulse modulation signals are available at both outputs.

1-3. For internally generated pulse modes of operation (internally or externally synchronized) synchronizing and delayed synchronizing pulse outputs are available. In all other modes of operation, except AM where no sync output is available, only a synchronizing output which is coincident with the leading edge of the modulating output signal is available. A complete listing of the operating specifications for the Model 8403A is given in Table 1-1.

1-4. SUPPLEMENTARY INSTRUMENTS.

1-5. A series of instruments capable of extending the operating parameters of the Modulator are the Hewlett-Packard 8730 series of PIN Modulators (refer to Appendix). With a PIN modulator, the Model

8403A can be used to pulse with 30- to 40-nanosecond rise and decay time characteristics, level, or amplitude modulate with sinusoidal and complex waveforms. In addition, with a PIN modulator leveling and amplitude modulation of RF signals can be accomplished simultaneously.

1-6. INSTRUMENT OPTIONS.

1-7. Options 002, 004, 006, 008 and 009. General purpose pulse output connector mounted on rear panel; a PIN pulse Modulator installed with RF input and output connectors protruding from front panel in the place normally occupied by the pulse output connectors. Note that since the specially shaped output is used to modulate a PIN Modulator and since the PIN Modulator is mounted internally, this output is connected to the PIN Modulator internally and not brought out to either the front or rear panel. In all other respects, operation of this instrument is the same as for the standard instrument and the information in this manual applies directly (see Table 1-1 for listed options). See Appendix II at the rear of this manual for complete description.

1-8. INSTRUMENT IDENTIFICATION.

1-9. This instrument has a two-part serial number. This two-part serial number has two forms (000-00000 and 0000A00000). If the first three digits or the first four digits of the serial number on your instrument do not agree with the serial number on the title page they will be described either with a yellow MANUAL, CHANGES supplement or in the APPENDIX BACK-DATING section of this manual.

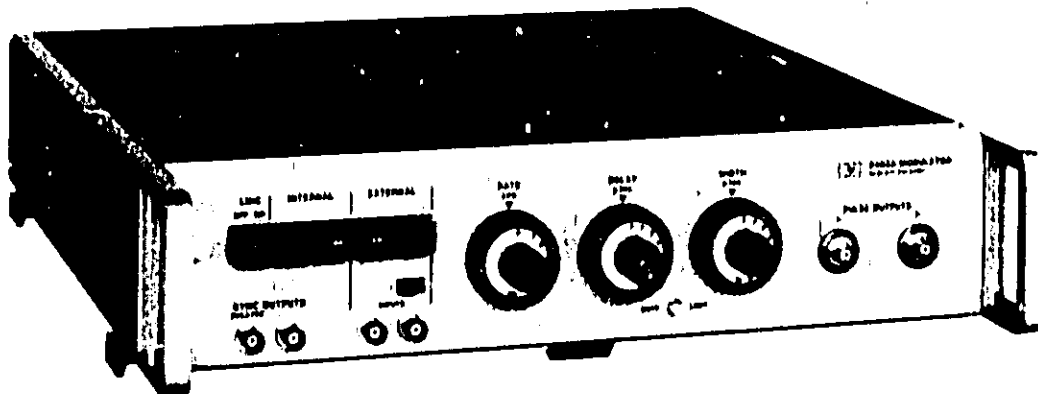


Figure 1-1. Model 8403A Modulator

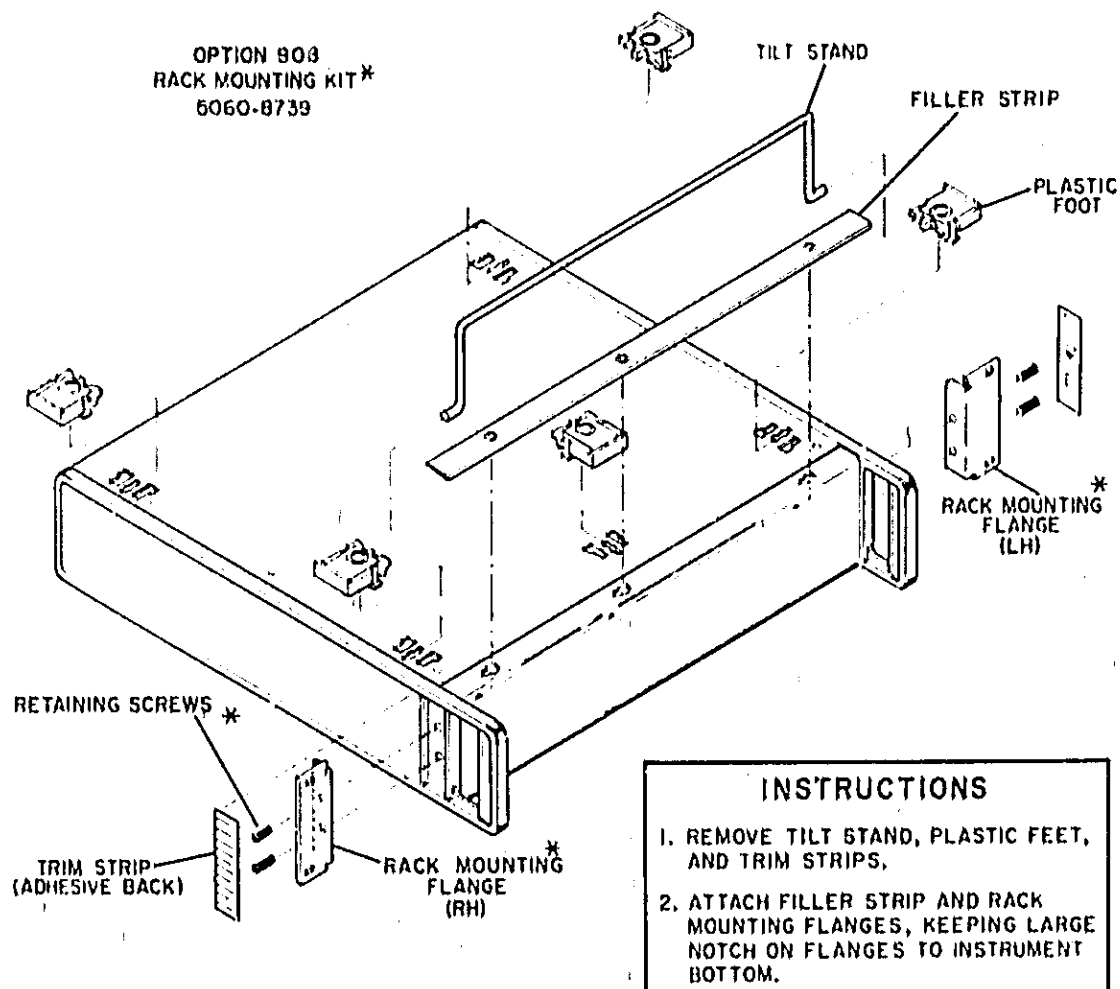


Figure 2-1. Conversion to Rack Mount

SECTION II

INSTALLATION

2-1. INCOMING INSPECTION.

2-2. This instrument was inspected, both mechanically and electrically, before shipment. To confirm this, the instrument should be inspected for physical damage in transit. Also test the electrical performance of the instrument, using the procedure given in paragraph 5-3. If there is damage or deficiency, see the warranty on the inside front cover of this manual.

2-3. INSTALLATION.

2-4. The Model 8403A is of modular design and is shipped as a cabinet mount instrument. A kit is supplied with the instrument for conversion from cabinet to rack mount.

2-5. Whether the instrument is cabinet- or rack-mounted, provisions should be made to insure that there is adequate air circulation around the instrument. When installing the instrument, see that the ambient temperature does not exceed 55°C (131°F).

2-6. CONVERSION TO RACK MOUNT.

- a. Remove trim strip on sides of instrument (see Figure 2-1).
- b. Remove tilt stand by pressing two sides of stand toward center of instrument and lifting it out.
- c. Remove the five feet at bottom of instrument (press button in center of each foot, slide foot forward toward center of instrument, and lift it out).
- d. Place rack mounting flanges (two) where trim strips were and secure with screws provided.
- e. Add filler strip to bottom of instrument.

2-7. POWER REQUIREMENTS.

2-8. The Model 8403A can be operated from a 115/230 volts $\pm 10\%$ 48 to 66 Hz or from a 115 volts $\pm 10\%$ 360--440 Hz source. A slide switch (LINE VOLTAGE S2) located on rear panel, converts the instrument for operation from 115 or 230 volts. A 1/4 ampere slo-blo fuse is used for 115 volt operation; a 1/8 ampere slo-blo fuse is used for 230 volt operation.

CAUTION

NEVER SWITCH LINE VOLTAGE SWITCH
FROM ONE PRIMARY POWER POSITION
TO THE OTHER WHEN INSTRUMENT IS
IN OPERATION.

2-9. POWER CABLE.

2-10. To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground pin.

2-11. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

2-12. REPACKAGING FOR SHIPMENT.

2-13. The following is a general guide for repackaging an instrument for shipment. If you have any questions, contact your local Hewlett-Packard sales and service office.

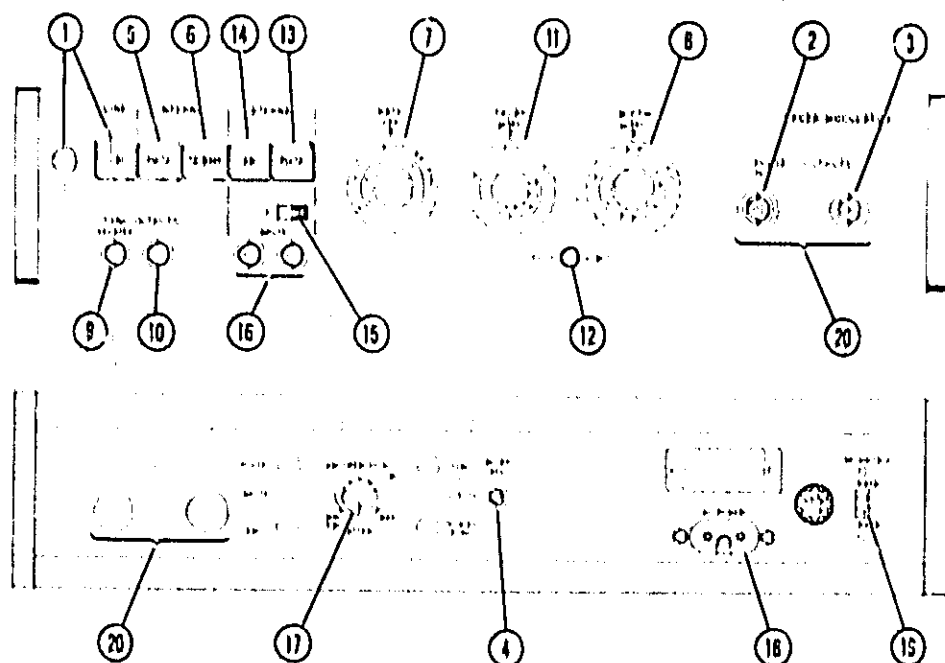
- a. If possible, use the original container designed for the instrument. Note: Carton, etc., can be ordered if desired.
- b. Wrap instrument in heavy paper or plastic before placing it in shipping container.
- c. Use plenty of packing material around all sides of instrument and protect panel faces with cardboard strips.
- d. Use a heavy cardboard carton or wooden box to house the instrument, and use heavy tape or metal bands to seal the container. Bind all carton joints and seams with heavy paper tape.
- e. Mark the packing box "FRAGILE - DELICATE INSTRUMENT", etc., as appropriate.

Note

If the instrument is to be shipped for service or repair, attach to the instrument a tag identifying the owner, model number, full serial number, and indicating the service or repair to be accomplished.

OPERATION

THEORY



1. **LINE.** Applies primary power.
2. **Special output.** Provides specially shaped current signals for driving hp Model 8730-series PIN Modulators.
3. **General Purpose Output.** For general purpose pulse and square-wave rectangular outputs. No output in AM mode of operation.
4. **ON/OFF ADJ.** Sets DC current level of special output (item 2 above).
5. **INTERNAL PULSE.** Sets instrument for internal pulse operation.
6. **INTERNAL SQ WAVE.** Sets instrument for internal square wave operation.
7. **RATE CPS.** For internal pulse or square-wave operation only, sets repetition rate, EXT SYNC position allows external synchronization of internal pulse rate.
8. **WIDTH μ SEC.** Sets pulse output signal width; Operative for internal pulse operation only.
9. **DELAYED Sync Output.** Reference output pulse coincident with leading edge of pulse output signal. Output available for internal pulse operation only.
10. **Sync Output.** Reference pulse output; undelayed output in advance of pulse output signals (internal pulse operation only); coincident with the leading edge of pulse output signal (square-wave and external pulse operation only).
11. **DELAY μ SEC.** Sets delay between sync output signal and pulse output signal; Operative for internal pulse operation only.
12. **DUTY LIMIT.** Lamp is illuminated when duty cycle limit is exceeded; operative for internal pulse operation only.
13. **EXTERNAL PULSE.** Sets instrument for external pulse operation.
14. **EXTERNAL AM.** Sets instrument for external AM operation.
15. **Polarity Switch.** Sets instrument to accept either negative or positive pulse signals.
16. **INPUTS.** Input beneath AM button accepts signals when AM button depressed; Input beneath EXTERNAL PULSE button accepts signals when EXTERNAL PULSE button is depressed or INTERNAL PULSE button is depressed for EXT SYNC.
17. **AM OPER POINT.** For AM operation only, sets reference level about which AM signal is superimposed.
18. **AC POWER.** Power cable receptacle.
19. **LINE VOLTAGE.** Sets instrument to operate with 115- or 230-Vac line; insert narrow blade and slide up for 115V, slide down for 230V.
20. **OPTIONS 002, 004, 006, 008 and 009.** hp Model 8730-series PIN Modulator installed internally (see Table 1-1); PULSE OUTPUTS connectors replaced with PIN Modulator RF input and output connectors (female type N); general purpose output (item 3 above) mounted on rear panel.

Figure 3-1. Controls and Indicators

SECTION III OPERATION

3-1. INTRODUCTION.

3-2. The Model 8403A Modulator is a dual output modulation source providing internal pulse and square-wave modes of operation with rates variable from 50 to 50,000 Hz. In addition, external amplitude and pulse modes are also available. In the external pulse mode, pulse rates as great as 1 MHz average and 2 MHz/sec peak can be used; in the external AM mode, the 8403A becomes a single output source providing specially shaped signals for driving hp Model 8730-series PIN Modulators. Pushbutton controls select the mode of operation. Input connectors, for AM or pulse operation, are located directly beneath the pushbutton to which they apply.

3-3. CONTROLS AND INDICATORS.

3-4. Functions of all front and rear panel controls and indicators are given in Figure 3-1. The function of each control and indicator is keyed to the illustration of the instrument front and rear panels which appears in Figure 3-1.

3-5. BASIC OPERATING PROCEDURE.

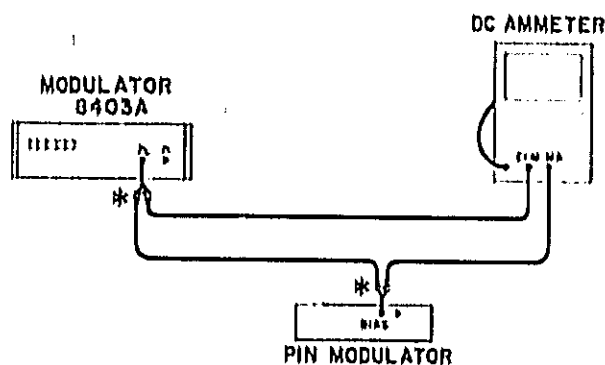
3-6. TURN-ON.

- Set rear-panel 115-230 LINE VOLTAGE switch to match line voltage.
- Release any front panel buttons that may be depressed.
- Connect Modulator to power source.
- Depress front-panel LINE button. The line indicator lamp (located directly above the LINE button) should glow indicating line power applied to instrument. Failure of indicator to glow is an indication of a bad indicator lamp, lack of line voltage, or trouble within the instrument.

3-7. ON/OFF ADJ.

3-8. When an hp Model 8731/32/33/34 or 8735 PIN Modulator is used with the 8403A, the preliminary operating adjustment detailed below must be made. **Note:** This adjustment should be for any individual PIN Modulator used with the 8403A.

- Connect equipment as shown in Figure 3-2.
- Set 8403A as follows:
 LINE depressed
 EXTERNAL PULSE depressed
- Note rated current value stamped on label on underside of PIN Modulator. Adjust 8403A rear panel ON/OFF ADJ adjustment for a DC Ammeter reading equal to rated current value.
- The 8403A Modulator is now adjusted to provide one specific PIN Modulator with optimum operating currents.



* BNC-TO-BANANA POST ADAPTER

Figure 3-2. On/Off Ratio Adjustment

3-9. MODULATION SIGNAL DISTORTION.

3-10. Cable connections between the 8403A Modulator PULSE OUTPUTS and a PIN Modulator or other driven equipment should always be as short as possible to avoid modulation distortion caused by excessive cable length capacity.

CAUTION

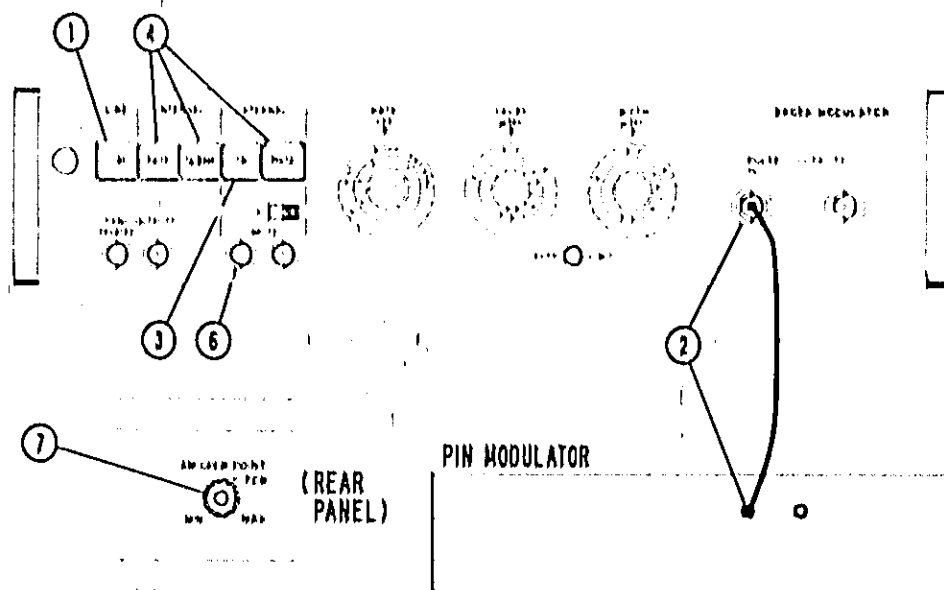
Do not apply external shorts to either of the General Pulse Outputs, to do so could cause damage to transistors Q603 and Q605.

3-11. MODULATION FUNCTIONS.

3-12. The Modulator has four modulation functions which are designated Internal Pulse, Internal Square-Wave, External AM, and External Pulse. Four separate pushbuttons, each labeled for the function it selects, determine the type of modulation-operation. The Modulator will not operate properly if more than one modulation function button is depressed at the same time.

3-13. INTERNAL PULSE FUNCTION.

3-14. For the internal pulse function, rate is adjustable from 50 Hz to 50 KHz and width is adjusted from 0.1 to 100 microseconds. In addition, two synchronized pulse outputs are available: one is the DELAYED SYNC OUTPUT, a -2 volt pulse which is coincident with the leading edge of the pulse output signal; the other is the SYNC OUTPUT, a -2 volt pulse which is undelayed or leads the pulse output signals from 0.1 to 100 microseconds depending upon the front panel DELAY μ SEC control setting. Depressing the INTERNAL PULSE button selects mode of operation, RATE CPS control selects pulse repetition rate, and WIDTH μ SEC control selects pulse width. The DELAY μ SEC control selects delay between undelayed sync output (available at connector directly beneath INTERNAL PULSE button) and DELAYED sync output.



1. LINE depressed.
2. Connect Special output to PIN Modulator BIAS output.
3. Depress AM button.
4. Release AM button by depressing any other function and then depress AM button again.

CAUTION

Do not apply RF power in excess of 1 watt (peak or CW) to PIN Modulator.

5. Apply unmodulated RF power to either PIN Modulator end port.
6. Apply AM signal to AM INPUT.
7. Using the rear panel AM OPER POINT control, observe modulated RF output from PIN Modulator with an Oscilloscope and adjust RF attenuation level to avoid peak signal clipping and minimize signal distortion.

Figure 3-3. External AM Operation

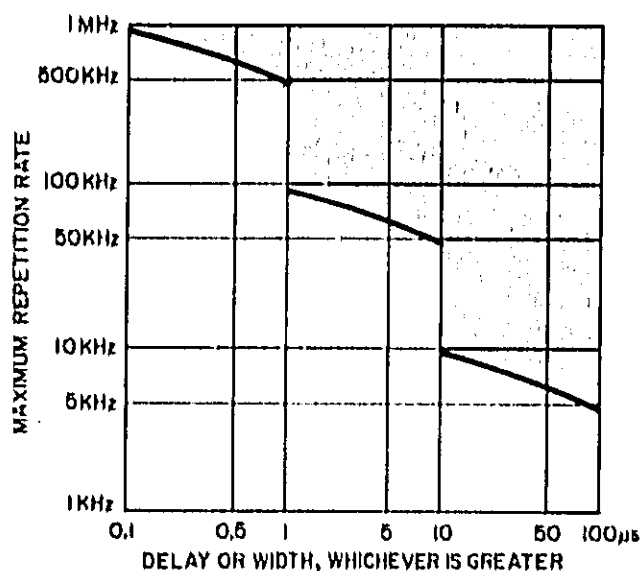


Figure 3-4. Duty-Cycle Limit Graph

Note

When delay rate and width combination exceeds duty limit of instrument, the DUTY LIMIT lamp is illuminated. Duty-cycle limit is exceeded when RATE multiplier is X1000 and DELAY and/or WIDTH multiplier are at 10 (see Figure 3-4)

3-15. INTERNAL PULSE/EXTERNAL SYNC FUNCTION.

3-16. The internal pulse/external sync function consists of an externally applied pulse or AM signal whose leading edge determines the pulse repetition rate of the pulse output signals and the two sync output signals. The externally applied synchronizing signal is applied at the INPUT connector located directly beneath EXTERNAL PULSE button. This external synchronizing function is selected by setting the RATE CPS control to the EXT SYNC position and depressing the INTERNAL PULSE button. The EXTERNAL PULSE is not depressed. Pulse width and delay is adjusted as described for INTERNAL PULSE operation above.

Note

DUTY LIMIT lamp is inoperative when rate is externally controlled. Refer to Figure 3-4 for duty-cycle-limits.

3-17. INTERNAL SQ WAVE FUNCTION.

3-18. For internal square-wave function, rate is adjustable from 50 Hz to 50 KHz and a synchronizing pulse signal which is coincident with the leading edge of the square-wave signal is available at the SYNC output connector located directly beneath the INTERNAL PULSE button. Depressing the INTERNAL SQ WAVE button selects mode of operation, and the RATE CPS control selects modulating signal frequency rate. No undelayed or leading sync output signal is available and the WIDTH µSEC and DELAY µSEC controls are inoperative.

3-19. EXTERNAL PULSE FUNCTION.

3-20. For external pulse function, the rate is dependent upon the externally applied pulse rate and may be as great as 1 MHz, average, and 2 MHz peak. Pulse width is dependent upon the width and rate of the externally applied pulse signal and is limited to a minimum of 0.1 microsecond and a maximum of $\frac{1}{\text{rate}}$ minus 0.4 microseconds. In addition, a -2 volt sync pulse, coincident with the leading edge of the pulse output signals, is available at the sync output connector located directly beneath the INTERNAL PULSE button but, no undelayed or leading sync output is available.

Note

To ensure proper operation, EXTERNAL PULSE button must be depressed, released (by depressing any other function button) and depressed again.

Depressing the EXTERNAL PULSE button selects mode of operation. RATE CPS, WIDTH µSEC, and DELAY µSEC controls are inoperative.

3-21. EXTERNAL AM FUNCTION.

3-22. For the AM function, the 8403A Modulator has only one signal output. This single output is at the special pulse output connector only and is designed for modulating hp Model 8730 series PIN Modulators. The sinusoidal frequency response is 10 MHz. The AM function is selected by depressing the EXTERNAL AM button and a rear panel control allows selection of the DC level upon which the AM signal is to be superimposed (see Figure 3-3).

3-23. LIMITED PEAK PULSE POWER FUNCTION.

3-24. For special applications of the 8403A, when using an hp Model 8730A B PIN modulator with the 8403A, where peak power level of pulse modulation signals must be limited, it is necessary to modify the 8403A as explained below.

a. Remove capacitor C611 from Duty Limit circuit board (A600).

b. Connect CW signal source to PIN Modulator RF input. Note: Input power to PIN Modulator must not exceed 100 watt.

c. Connect PIN Modulator BIAS connector to special 8403A pulse output connector.

d. Depress 8403A LINE button.

e. Depress 8403A AM button.

f. Using 8403A, Channel AM OPER POINT control, adjust RF output from 8730 for desired output power level (peak power level).

g. Connect pulse modulating signal to 8403A INPUT located directly beneath the EXTERNAL AM button.

SECTION IV

PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. The Model 8403A Modulator consists of five basic sections as indicated in Figure 4-1. These are the control circuits, modulation drive circuit, general pulse circuit, input AM circuit, and power supply. The control circuits set the instrument mode of operation and trigger the modulation drive circuit operation. The modulation drive circuit provides the compensated output signal for driving PIN Modulators and triggers the general pulse circuit which provides rectangular pulse output signals for general use. The input AM circuit adds a DC voltage to an externally-applied AM signal and delivers this combined signal to the modulation drive circuit output. The power supply provides the regulated DC voltages to operate the circuits in the instrument.

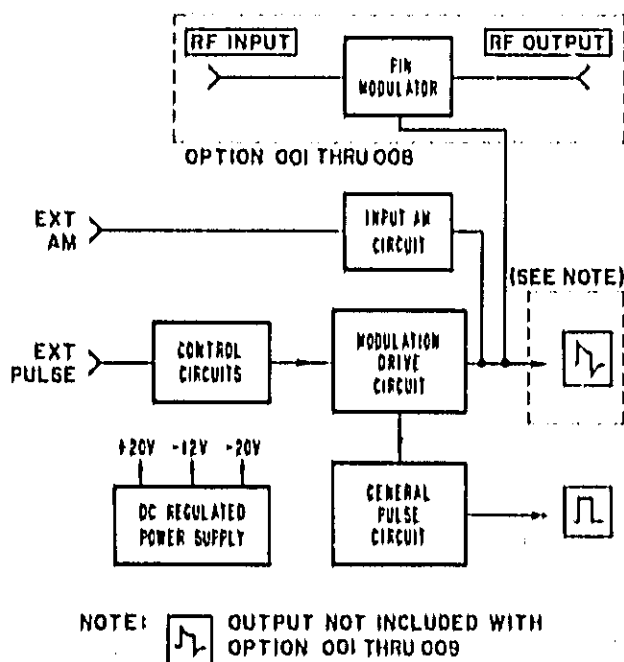


Figure 4-1. Basic Block Diagram

4-3. MODULATION OUTPUTS.

4-4. The primary purpose of the 8403A is to provide two simultaneous pulse or square wave modulation output signals: a general purpose rectangular pulse signal and a specially shaped PIN Modulator driving signal. The general purpose rectangular pulse signal is a positive going 25 to 30 volt DC signal which can be used as a modulation or synchronizing signal. The PIN Modulator driving signal is a compensated current-voltage signal for use with the Hewlett-Packard Model 8730-series PIN Modulators (see paragraph 4-5 for a brief description).

4-5. PIN MODULATORS.

4-6. The Model 8730-series of PIN Modulators, designed for use with the 8403A, are basically quick-response current-controlled variable-RF attenuators. The types of driving signals used are described below. A complete discussion of the PIN Modulators and their principles of operation is included in the appendix at the rear of this manual.

a. For Pulse and SQ Wave operation: A rectangular pulse signal whose leading and lagging edges are impulsive to provide best rise and decay time characteristics is provided (see Page 5-2, Table 5-3, for a picture of this waveform).

b. For AM operation: The desired AM signal superimposed upon a DC signal level is provided.

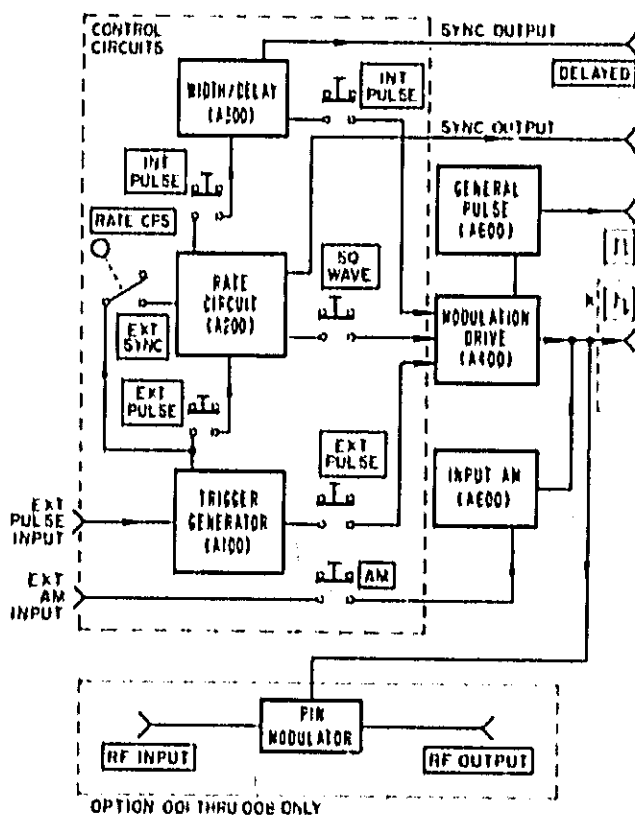


Figure 4-2. Control Circuit Arrangement

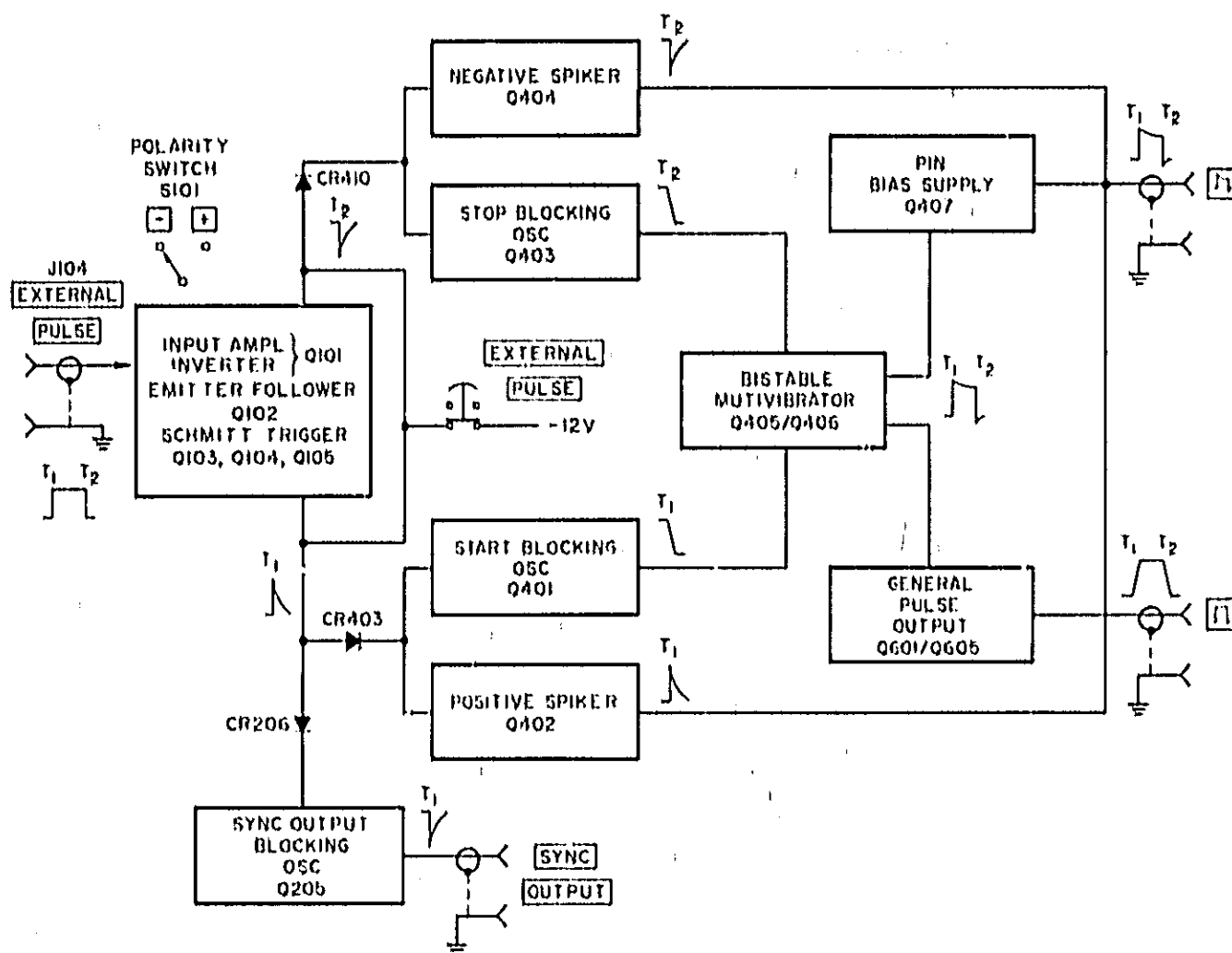


Figure 4-3. External Pulse Operation

4-7. CONTROL CIRCUITS.

4-8. The arrangement of the control circuits depends upon the mode of operation. Actual switching from one mode of operation to another is accomplished when the associated panel button or control is operated as indicated in Figure 4-2.

Note

Figure 4-2 illustrates all modulation function buttons released and the RATE CPS control set to any position but EXTSYNC. Hence, from the illustration it can be seen that the modulation drive circuit (A400 assembly) is the only internal circuit common to all modes of operation (excepting Power Supply).

4-9. EXTERNAL AM. External AM circuit is shown in Figure 4-4. With AM button depressed and no AM signal applied, the output signal is approximately +7.4 volts DC providing the AM OPER POINT control is at the MIN position. This +7.4 volts DC biases the PIN Modulator for minimum attenuation. Since the PIN Modulator is a variable-RF attenuator, when biased for minimum attenuation condition only negative going AM signals will be impressed upon the RF

signal through the PIN Modulator and all positive-going AM signals will be clipped. To allow positive-going AM signals to be impressed upon the RF signal, the AM OPER POINT control must be used to decrease the +7.4 volt DC level sufficiently to attenuate the RF signal through the PIN Modulator by an amount at least equal to the peak amplitude of the positive-going AM signal.

4-10. With the 8403A set for AM operation, an input AM signal is superimposed upon the set DC level and fed to the PIN Modulator. This AM signal varies the DC bias level to the PIN Modulator and thereby impresses the AM signal upon the RF by varying the attenuation level of the PIN Modulator. The AM frequency response of the 8403A depends upon the RC network of C608 and R607. By increasing the value of C608 the frequency response and input amplitude of the AM signal can be increased; by decreasing the value of C608 the frequency response and input amplitude of the AM signal can be decreased. This C608 value is normally selected for a 10 MHz frequency response.

4-11. EXTERNAL PULSE. A simplified block diagram of external pulse operation is shown in Figure 4-3. With EXTERNAL PULSE button depressed and

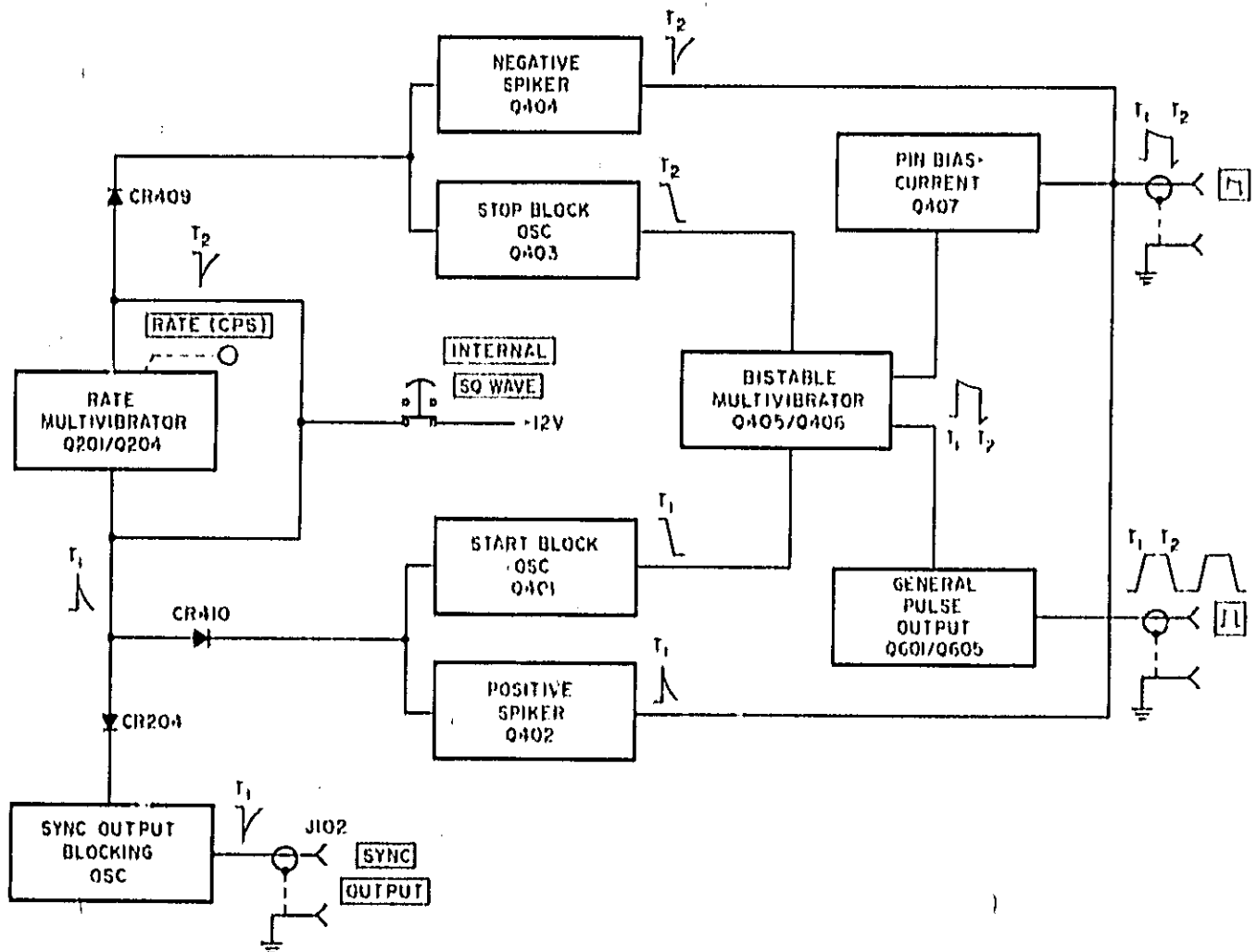


Figure 4-5. Internal Square-Wave Operation

no external pulse signal applied, modulation output conditions are as follows: At the specially shaped PIN Modulator output, approximately -0.8 volt DC signal causing RF signal through PIN Modulator to be attenuated by at least maximum rated attenuation; at general purpose output, approximately -11 volt DC

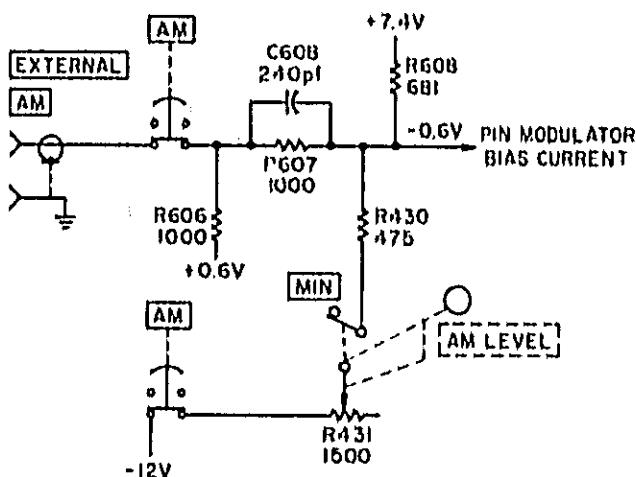


Figure 4-4. External AM Circuit

signal level. The externally-applied pulse is applied through input amplifier Q101 and emitter follower Q102 to the trigger generator (Schmitt triggers Q103/Q104 and Q103/Q105). The Schmitt triggers reshape and differentiate the input pulse and apply it through diode CR206 to sync output blocking oscillator Q205, and through diode CR410 to stop blocking oscillator Q403 and negative spiker Q404, and through diode CR403 to start blocking oscillator Q401 and positive spiker Q402. The start blocking oscillator triggers bistable multivibrator Q405/Q406 off at time T_1 ; the stop blocking oscillator triggers the bistable multivibrator on at time T_2 . The time interval between T_1 and T_2 is determined by the width of the externally applied pulse. The positive spiker sends a positive pulse to the PIN Modulator at time T_1 to switch the PIN Modulator from a condition of maximum attenuation to a condition of minimum attenuation. Conversely the negative spiker provides a negative pulse to the PIN Modulator at time T_2 to switch PIN Modulator back to a condition of maximum attenuation.

4-12. From time T_1 to time T_2 the pulse from the bistable multivibrator holds the PIN bias supply Q407 off and the general pulse output emitter follower Q604 saturated, resulting in the following output conditions:

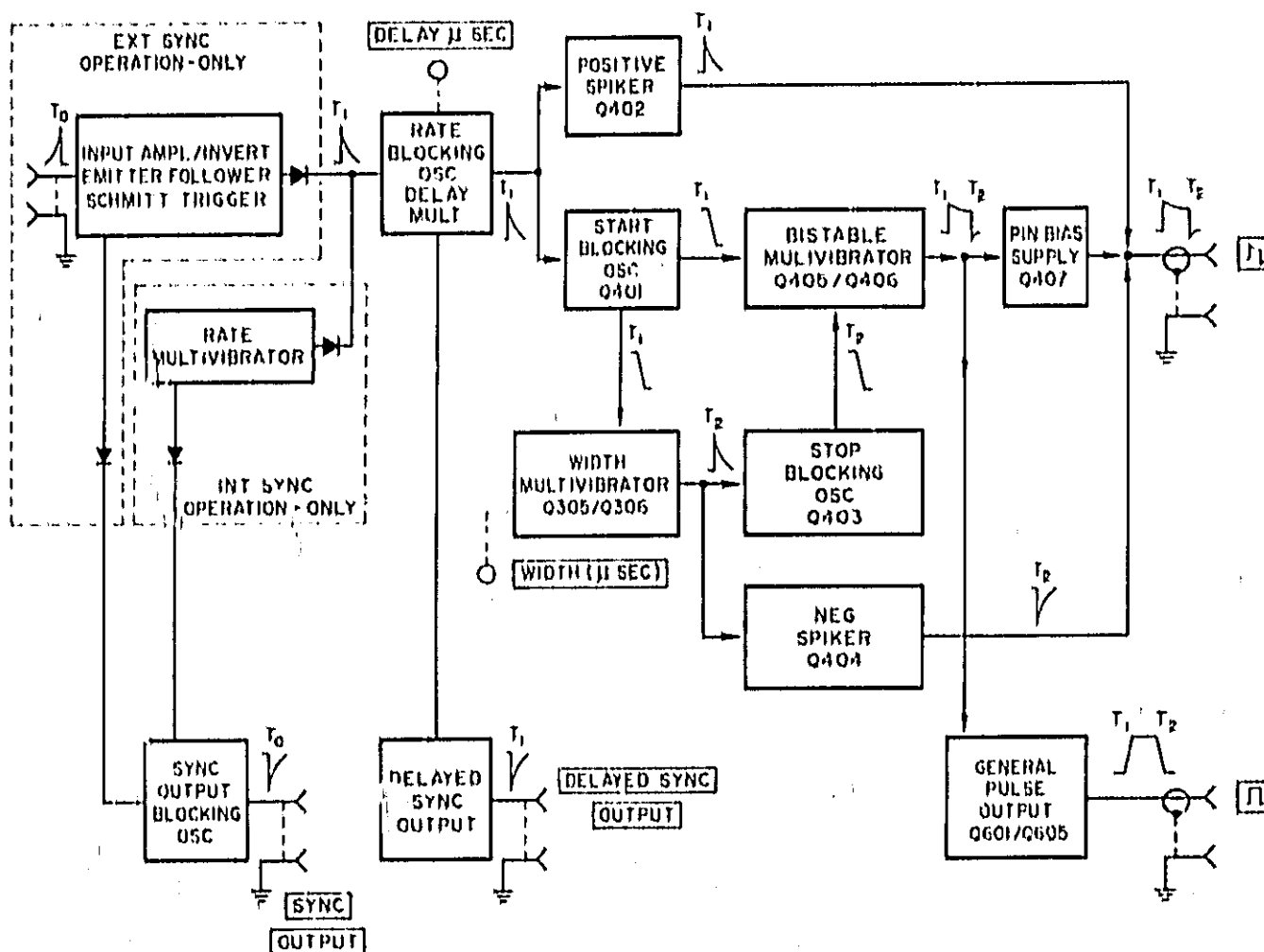


Figure 4-6. Internal Pulse and External Sync Operation.

Q407 provides approximately +1 volt DC signal reverse-biasing the PIN Modulator which allows the RF signal to pass through the PIN Modulator with only residual attenuation (minimum insertion loss); Q604 saturated provides approximately +10 volt DC signal at the general pulse output. From time T_2 until time T_1 recurs, the bistable multivibrator (Q405/Q406) holds Q407 and Q605 on. With Q407 conducting, the proper bias current is supplied to the PIN Modulator to maintain a maximum RF attenuation condition. With Q605 conducting, Q604 is cut off and approximately -11 volts DC is applied to the general pulse output. The waveform present at the specially shaped PIN Modulator output then, is a composite of the signals from the positive and negative spikers and the bistable multivibrator (Q405/Q406). The waveform present at the general pulse output is a composite of the push-pull type operation of Q604 and Q605 in switching the DC output level between approximately one DC supply (+20 volt) and another (-12 volt).

4-13. INTERNAL SQUARE WAVE. A simplified block diagram of internal square-wave operation is shown in Figure 4-5. In this mode of operation the input amplifier, emitter follower, and Schmitt trigger are replaced by rate multivibrator Q201-Q204. The

rate multivibrator determines the modulation frequency; the RATE CPS control varies this frequency. The rate multivibrator's outputs are differentiated and applied to the start and stop blocking oscillators and sync output blocking oscillator. In all other respects, internal square-wave operation is the same as external pulse operation.

4-14. INTERNAL PULSE AND EXTERNAL SYNC

A simplified block diagram of internal pulse and external sync modes of operation is shown in Figure 4-6. In the internal pulse mode the rate multivibrator is a variable time base generator. It provides an output to the rate blocking oscillator and sync output blocking oscillator. The rate blocking oscillator applies a pulse to the delay multivibrator. The delay multivibrator provides an output at time T_1 , which follows the pulse at time T_0 by a time determined by the DELAY USEC control. This output at time T_1 is applied to the delayed sync output blocking oscillator Q304, and start blocking oscillator. The start blocking oscillator applies a pulse to width multivibrator Q305, Q306, and bistable multivibrator at a time equivalent to time T_1 . The width multivibrator provides a pulse at time T_2 that follows the pulse at

time T_1 by a time determined by the WIDTH μ SEC control. The pulse at time T_2 is applied to the stop blocking oscillator. From this point on, circuit operation is the same as that given for the external pulse mode, Paragraph 4-11.

4-15. When operating in internal pulse mode of operation with the RATE (CPS) control set to EXT SYNC, operation of the circuit is the same as described above except that the rate multivibrator is replaced by the input amplifier/inverter, emitter follower, and Schmitt trigger. An externally generated signal applied to the pulse input acts as the basic timing pulse (equivalent to time T_0).

4-16. EXTERNAL PULSE POLARITY CIRCUIT.

4-17. The external pulse polarity circuit includes Q101 and CR101-CR108. The transistor Q101 operates as a grounded-emitter amplifier when polarity switch S101 is in the (-) position; it operates as a grounded-base amplifier when the polarity switch is in the (+) position.

4-18. **NEGATIVE PULSE OPERATION.** Refer to the simplified diagram of external negative pulse operation, Figure 4-7. When in the external pulse mode of operation with polarity switch set to (-) position, the external pulse is applied to the base of Q101. Diode CR107 limits input signals to -20 volts; CR103 prevents application of positive signals to the base of Q101. Diode CR104 is an electronic switch that is biased on by the -20 volts applied through polarity switch S101.

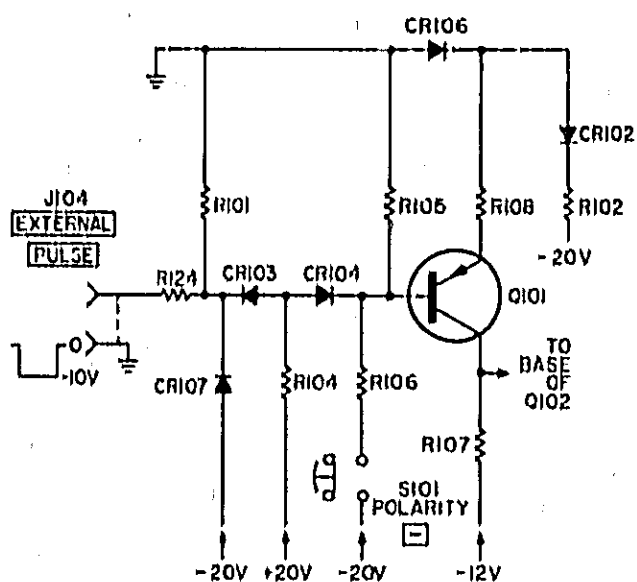


Figure 4-7. Negative Input Pulse Operation

4-19. **POSITIVE PULSE OPERATION.** Refer to the simplified diagram of external positive pulse operation, Figure 4-8. When in the external pulse mode of operation with polarity switch S101 set to (+) position, the externally-applied pulse is applied to the emitter of Q101. CR108 limits input signals to +20 volts;

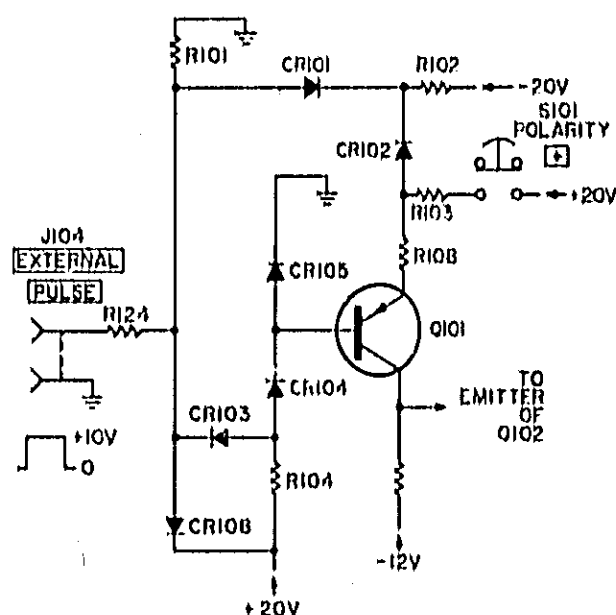


Figure 4-8. Positive Input Pulse Operation

CR101 prevents application of negative signals to the emitter of Q101. Diode CR102 is an electronic switch that is biased on by the +20 volts supplied through polarity switch S101. Diode CR105 clamps the base of Q101 near ground potential.

4-20. RATE MULTIVIBRATOR.

4-21. The rate multivibrator, an unstable multivibrator, is used as a variable time base generator in the internal pulse and square-wave modes of operation. Its output frequency is set by the RATE multiplier S201 and RATE vernier R206.

4-22. Refer to Figure 4-9, Rate Multivibrator. The rate multivibrator includes Q201-Q204. Transistors Q201 and Q204 operate as a pair, as do transistors Q202 and Q203. When the circuit is first placed in operation either transistor pair can conduct. Which transistor pair will conduct first, will depend on the characteristics of the transistors and circuit components.

4-23. Consider the instant when C208 is charged and transistor pair Q202 and Q203 go into conduction. The conduction of Q202 charges C205 and places 0 volts at the emitter of Q204, back-biasing it, base-to-emitter. In addition, since C208 is charged to 12 volts and its reference has changed from -12 volts to 0 volts, a +12 volt pulse is applied to Q201 back-biasing it, base-to-emitter. At this time then, transistor pair Q202 and Q203 is forward-biased; transistor pair Q201 and Q204 is back-biased. The circuit will remain in this state until capacitor C208 discharges sufficiently to allow Q201 to become forward-biased. The discharge path for capacitor C208 is R207, R206 (RATE vernier) and Q203 to the -12 volt supply. The conduction of Q201 back-biases Q202 and Q203, base-to-emitter. At this point transistor pair Q201 and Q204 is forward-biased. The circuit will remain in this condition until C205 discharges through R205, R206 (RATE vernier) and Q204 to -12 volts.

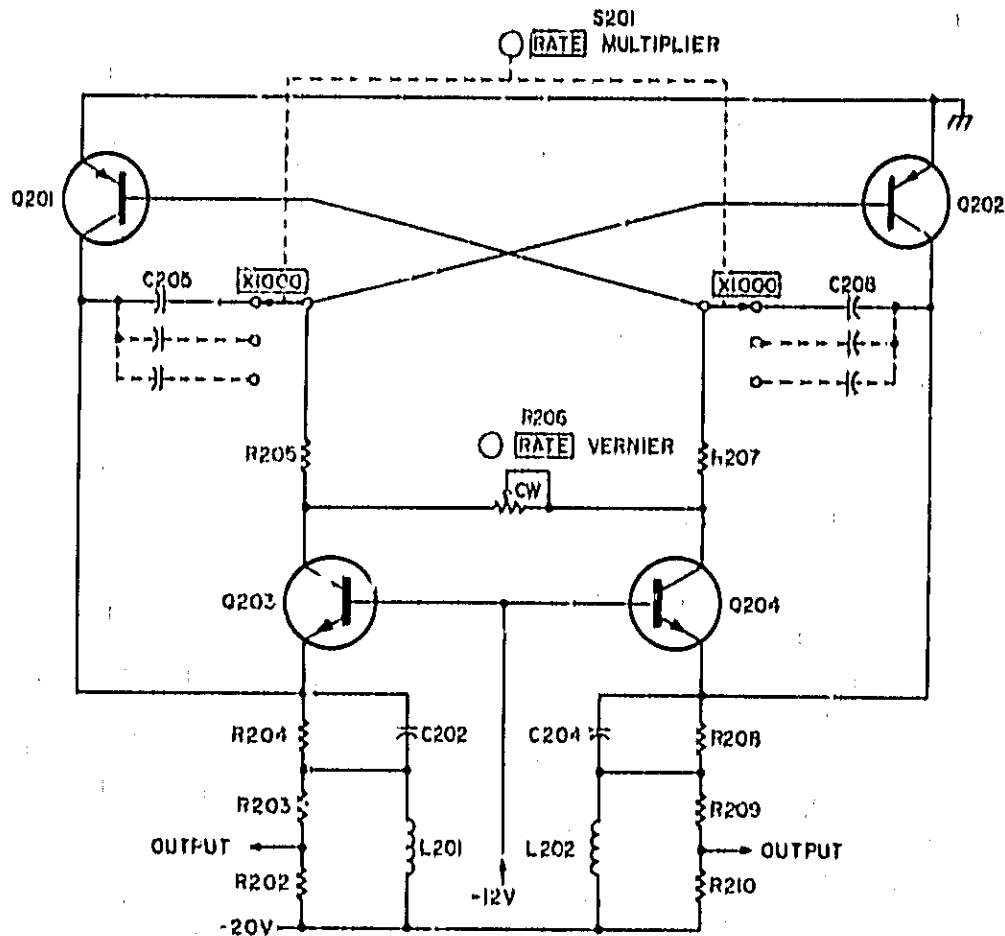


Figure 4-9. Rate Multivibrator

4-24. Rate multivibrator outputs are taken at emitters of Q203 and Q204. The two emitter networks are identical.

4-25. The emitter output, designed to maintain a constant impedance, provides a differentiated output regardless of multivibrator frequency. To accomplish this, the emitter network includes an integrating and differentiating circuit. Normally the differentiated voltage waveform would affect multivibrator operation, but the integrator waveform combines with the differentiated waveform to produce a resultant square-wave voltage at transistor emitter. Thus the desired differentiated output is obtained as is the desired square-wave voltage at the emitter of the transistor.

4-26. THE TRIGGERED BLOCKING OSCILLATOR.

4-27. There are several blocking oscillators in the Model B403A. The prime function of each oscillator is to provide triggering pulses with a fast rise time thus minimizing modulating-pulse jitter. Since the blocking oscillators used in the instrument are all basically the same, the rate blocking oscillator has been chosen for discussion.

4-28. Refer to Figure 4-10, Rate Blocking Oscillator. The triggered blocking oscillator transistor Q301 does not conduct until a pulse is applied. A transformer T301 connected between base and collector of Q301 provides regenerative feedback to the circuit.

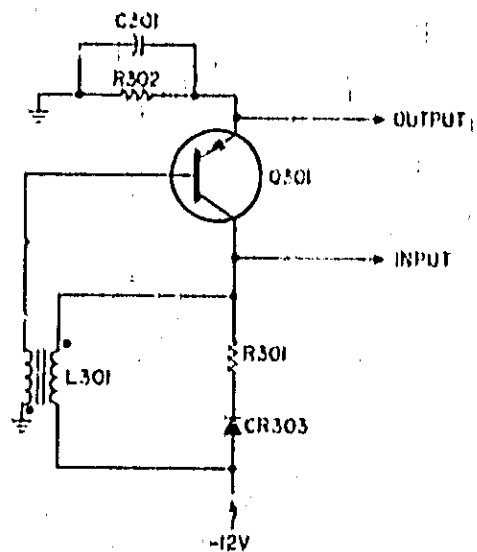


Figure 4-10. Rate Blocking Oscillator

4-29. When the blocking oscillator is triggered into conduction it provides regenerative feedback from collector to base of Q301 through transformer T301. Once Q301 saturates, lines of force built up in the windings of the transformer collapse, which in turn return the circuit to its quiescent state. Thus, once the circuit is triggered it quickly goes through its cycle due to the effects of regenerative feedback.

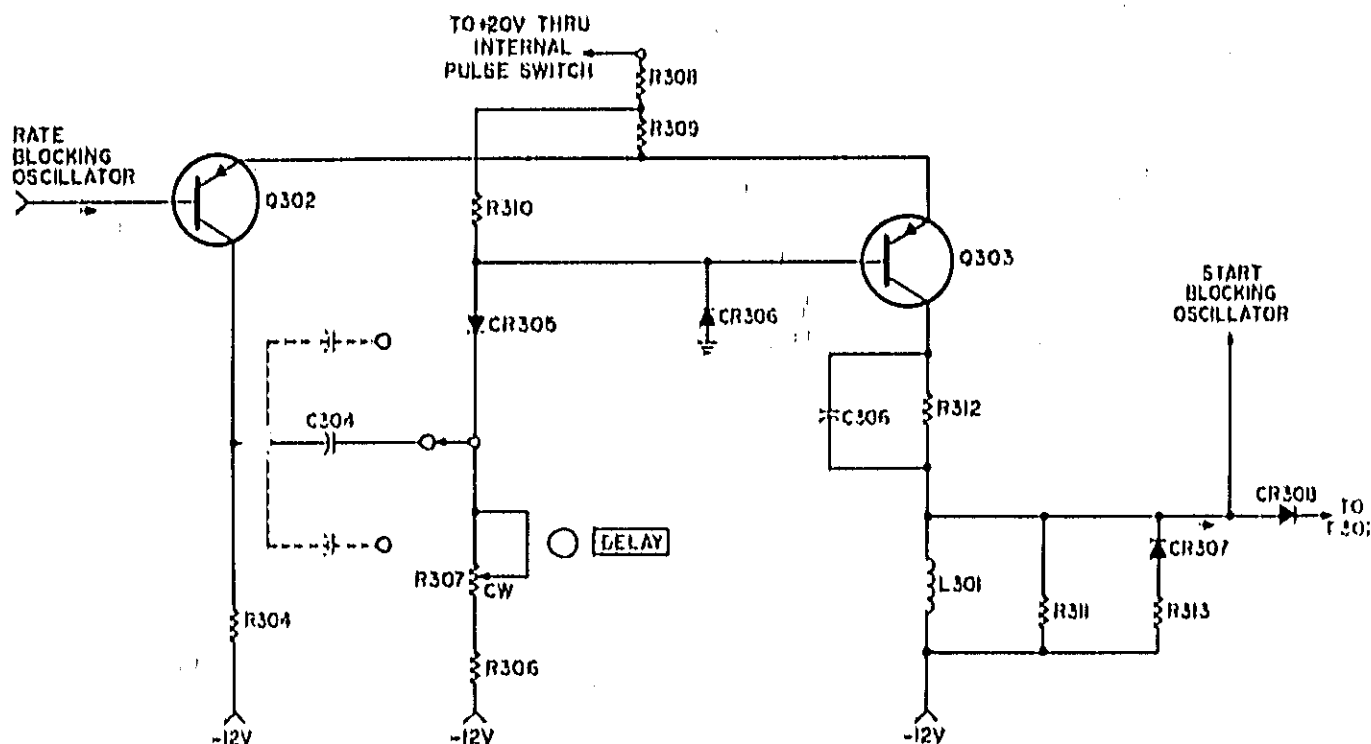


Figure 4-11. Delay Multivibrator

4-30. DELAY AND WIDTH MULTIVIBRATOR.

4-31. The delay and width multivibrator are identical. The delay multivibrator (see Figure 4-11) is monostable and includes Q302 and Q303. Before a trigger pulse is applied to the circuit, Q303 is conducting. The base of Q303 is at about -0.7 volt due to conduction of CR305 and CR306, and capacitor C304 is charged. When the trigger is applied, Q302 conducts and C304 discharges through DELAY (SEC) vernier R307. Discharge of C304 back-biases CR305, causing the base of Q303 to go positive with respect to the emitter. This cuts Q303 off and it remains off until C304 discharges enough to allow CR305 to conduct and forward-bias Q303. Another cycle will not start until triggered again by the rate blocking oscillator.

4-32. An integrating-differentiating circuit is placed in the collector circuit of Q303. Its purpose is to maintain a constant impedance at the collector yet obtain a differentiated output from the circuit.

4-33. DISTABLE MULTIVIBRATOR CIRCUIT.

4-34. Shown in Figure 4-12, the bistable multivibrator provides the pulse required to turn the pin bias circuit on or off and switch the general pulse output circuit from one state to the other. Each half of the circuit when conducting holds the other half off.

4-35. The RC networks C103, R115, and C104, R110 provide trigger pulses when either the AM or pulse switches are depressed to set bistable multivibrator operation. In the AM mode of operation, the bistable multivibrator is set to produce a minimum attenuation condition at one PIN modulator. In the external pulse mode of operation, the bistable multivibrator is set to produce a maximum attenuation condition at PIN Modulator at 1-11 volt DC signal at general pulse output.

4-36. PIN BIAS CURRENT SUPPLY.

4-37. A simplified drawing of the PIN bias supply is shown in Figure 4-13. The PIN bias supply provides the proper current to the PIN modulator to produce attenuation of 80 dB or more. Q407 is an electronic switch which is controlled by the bistable multivibrator. When Q407 is conducting, current determined by the setting of PIN diode bias adjust R417 is applied to the PIN modulator. When Q407 is biased off, approximately +7.4 volts is applied to the PIN modulator. Thus the circuit looks like a current source when Q407 is conducting, and it looks like a voltage source when Q407 is not conducting.

4-38. DUTY LIMIT INDICATOR CIRCUIT

4.30. The duty limit circuit is shown in Figure 4-14. The maximum duty cycle of the instrument is dependent on pulse-rate, delay and width range switch settings. To ensure that control settings do not result in a pulse which exceeds the duty cycle limit, a duty-limit circuit is provided for the internal pulse mode only. If duty limit is exceeded, the Duty Limit Lamp (D32) will light.

4-40. The circuit is powered by the -12V supply, through R2, INTERNAL pulse switch S3 and rate, delay and width multiplexer switches. When rate multiplier is in the X1000 position and delay and/or width multipliers are in the X10 position, the lamp will light.

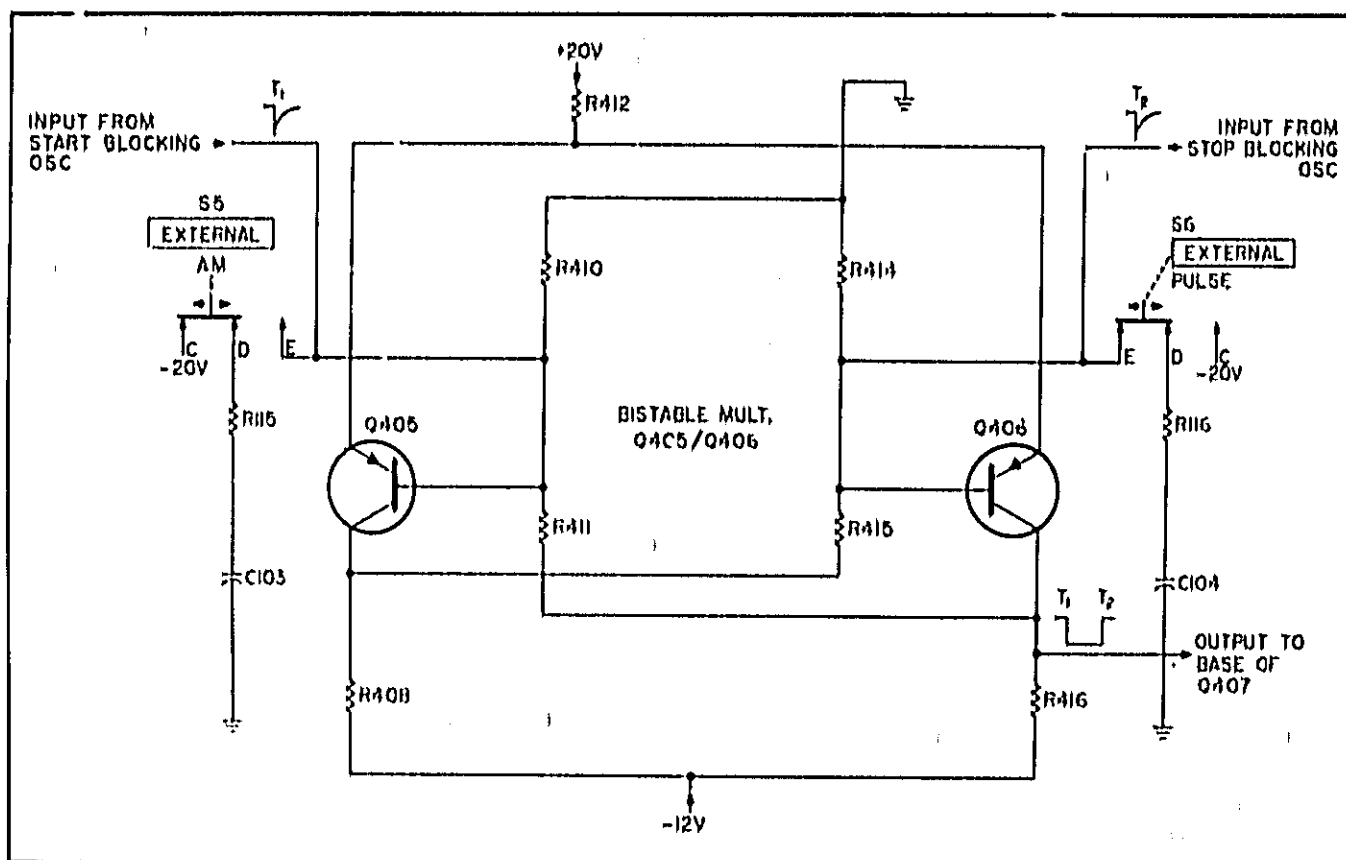


Figure 4-12. Bistable Multivibrator

4-41. REGULATED POWER SUPPLY.

4-42. The regulated power includes three power supplies: the +20 volt supply, the -20 volt supply, and the -12 volt supply. All three supplies are conventional series-regulated types. The series regulator is connected in series with the main load. The output voltage is monitored and compared to a reference voltage. The voltage differential between the monitored and reference voltage is applied through a control amplifier to the series regulator. This differential voltage changes the effective resistance of the series regulator which in turn holds the output voltage constant (see Figure 4-15).

4-43. Basically all three of the power supplies operate in the manner described above although differences do exist in the +20 and -20 volt supplies. The +20 volt supply uses a differential amplifier as the control amplifier. This arrangement produces greater gain and ripple rejection, thus a more stable power supply. The -20 volt supply, referenced to the low impedance +20 volt supply, does not need a differential amplifier. The -20 volt supply uses a reference amplifier, Q501, to provide a constant DC collector voltage to Q508 and Q510.

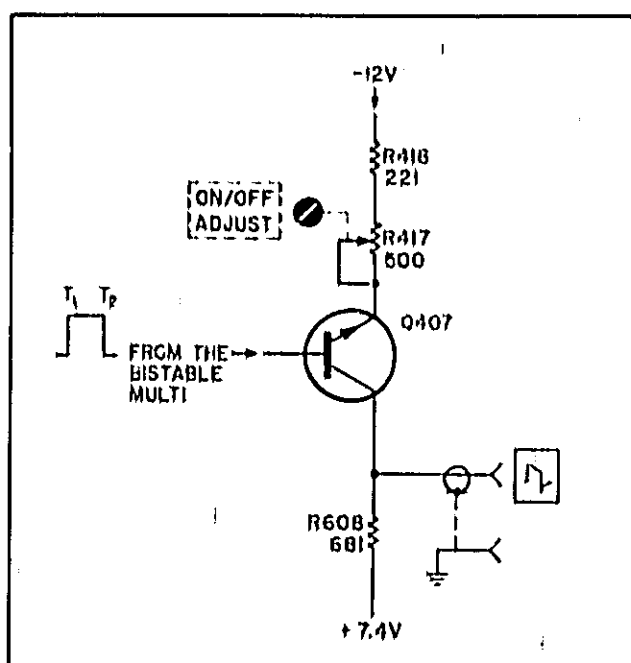


Figure 4-13. PIN Bias Circuit

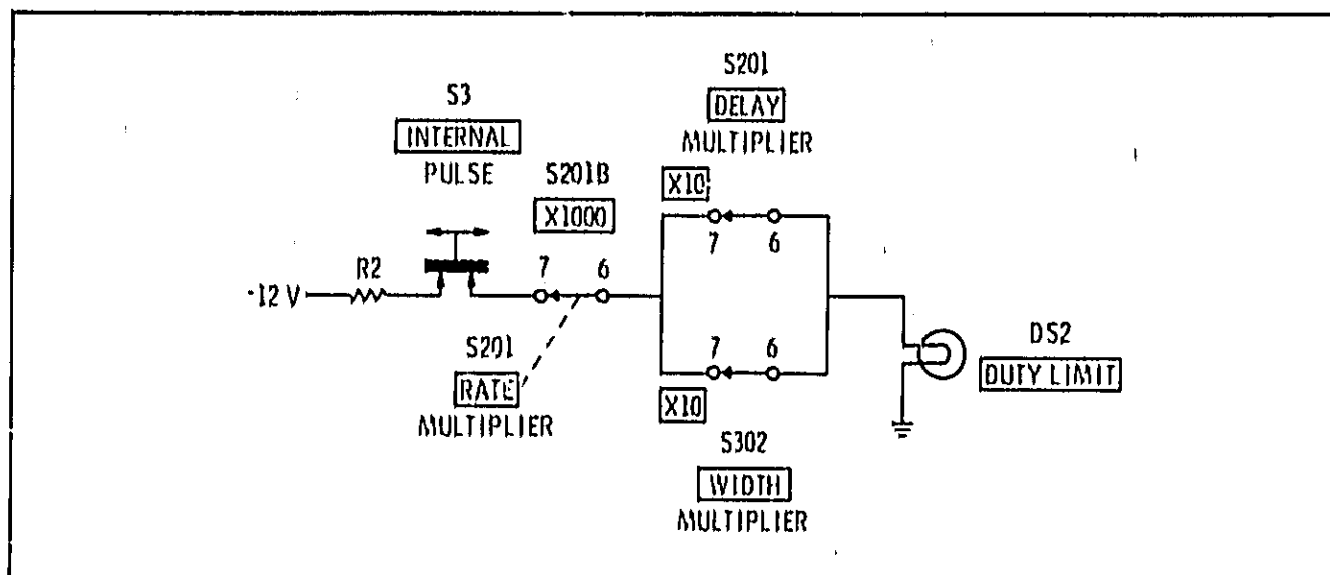


Figure 4-14. Duty Limit Circuit

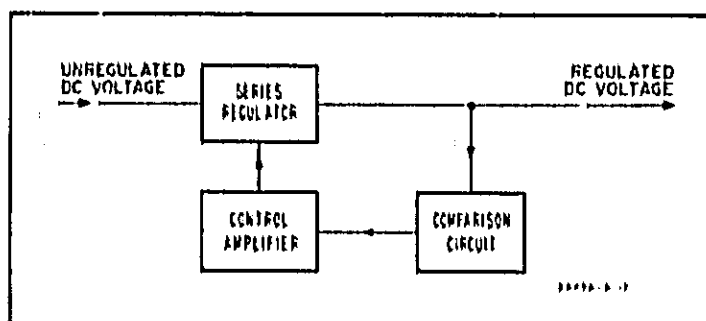


Figure 4-15. Regulated Power Supply

MAINTENANCE

Table 5-1. Test Equipment Recommended

Instrument Type	Test Use	Critical Specifications	Recommended hp Model
Oscilloscope	Performance, Calibration, Troubleshooting	Range: 0.1-5 μ sec/cm Sweep Accuracy: $\pm 5\%$ Attenuator Accuracy: $\pm 3\%$ Dual Channel Rise Time: 7 nsec Bandwidth: 40 MHz	HP 1740A (Oscilloscope) with HP 10041A 10:1 probe.
Test Oscillator	Performance	Range: 10 Hz to 10 MHz Output: 0.5 to 3.0V RMS, sinusoidal, into 600 ohms.	HP 654A
DC Voltmeter (see footnote)	Calibration, Troubleshooting	Range: 1 to 45V DC Accuracy: $\pm 0.3\%$	HP 3435A (Digital Multimeter)
General Purpose Multimeter (see footnote)	Calibration, Troubleshooting	Range: 1 to 45V DC Range: 0.5 to 150 mA Accuracy: $\pm 3\%$	HP 3435A or HP 410C
BNC Tee connectors	Performance	Three connector BNC junction: one male and two female connectors	UG-274A/U (HP Part No. 1250-0781)
BNC to Banana Post Adapter	Performance	Male BNC connector to dual banana plug (binding post)	HP 10110A
AC Voltmeter	Calibration	Range: 0.001 to 0.010 VAC Accuracy: $\pm 2\%$	HP 400E
Variable Power Transformer	Troubleshooting, Calibration	Range: 103 to 254 VAC at 7-1/2 A Voltmeter Range: 103 - 254 VAC Voltmeter Accuracy: $\pm 1V$	General Radio W10MT3A or Superior Electric UC1M
NOTE: The Model 3435A may be used as both the DC voltmeter and the general purpose multimeter.			

SECTION V MAINTENANCE

5-1. INTRODUCTION.

5-2. This section provides instructions for performance testing, calibrating, troubleshooting, and repairing the Modulator.

5-3. PERFORMANCE TESTS.

5-4. **PURPOSE.** The procedures listed in Table 5-3 check Modulator performance for incoming inspection, periodic evaluation, calibration, and troubleshooting. The tests can be performed without access to the Modulator interior. The specifications of Table 1-1 are the performance standards. For PIN Modulators which may be included as Options 002, 004, 006, 008, and 009, refer to Table 2 of the PIN Modulator Operating Note which is included in the Appendix section at the rear of this manual.

5-5. **TEST EQUIPMENT REQUIRED.** The test instruments required to make the performance checks are listed in Table 5-1. Test instruments other than the ones listed may be used provided their performance equals or exceeds the Critical Specifications.

Note

It is not necessary to remove pin modulators from B403A unit in order to conduct Performance Tests.

5-6. CALIBRATION.

5-7. POWER SUPPLY.

a. Remove instrument top and bottom covers.

b. Connect AC power line to a variable AC power source. Set AC voltage at 115 VAC (or 230 VAC as appropriate).

c. Set B403A as follows:

LINE	depressed
INTERNAL PULSE	depressed
RATE multiplier	X1000
RATE vernier	5.0
DELAY multiplier	X1.0
WIDTH multiplier	X1.0

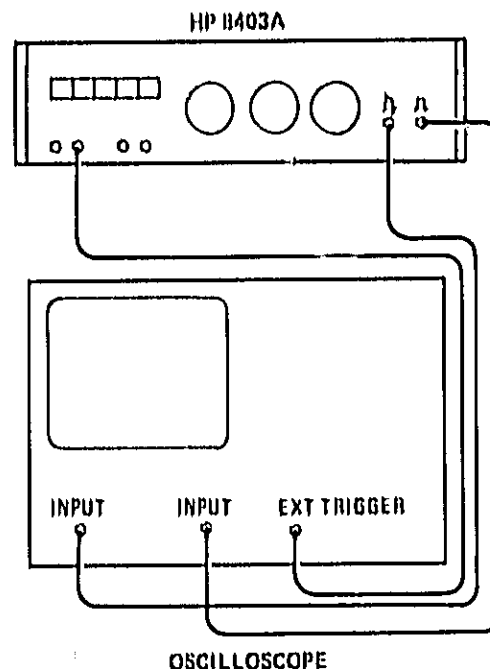


Figure 5-1. Dial Calibration

d. Using a DC digital voltmeter and an AC VTVM in parallel make the measurements indicated in Table 5-2.

5-8. RATE DIAL.

a. Connect B403A as shown in Figure 5-1.

b. Set B403A as follows:

LINE	depressed
INTERNAL PULSE	depressed
RATE multiplier	X100
DELAY multiplier	X1.0
WIDTH multiplier	X1.0

c. Adjust RATE vernier for a 1-KHz indication on oscilloscope.

d. Loosen allen set screws on RATE vernier, slip dial to read 10, and tighten one allen set screw.

e. Check RATE from 50 to 50,000 Hz and reslip dial if necessary to minimize error. Tighten both allen set screws.

Table 5-2. Power Supply Adjustment

Supply	Measure Point	Adjust	Measure	Ripple	Line Voltage
+20V	+20V bus to ground	R507*	+20 $\pm$ 0.2V	0.005 V (RMS)	103 to 127 VAC
-20V	-20V bus to ground	R510*	-20 $\pm$ 0.2V	0.010 V (RMS)	or
-12V	-12V bus to ground	R507*	-12 $\pm$ 0.1V	0.005 V (RMS)	207 to 253 VAC

* Set the +20 volt supply adjustment R507 first. Set the +20 volt supply adjustment R510 second. The -12 volt supply adjustment R507 should not need adjustment as it is referenced to the +20 volt supply. If R507 is adjusted for the +12 volt supply, all supplies should be checked again.

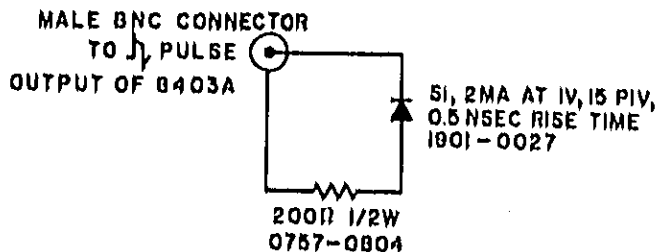
5-9. DELAY DIAL.

- a. Connect B403A as shown in Figure 5-1.
- b. Set B403A as follows:

LINE	depressed
INTERNAL PULSE	depressed
RATE multiplier	X1000
RATE vernier	5
DELAY multiplier	X1.0
WIDTH multiplier	X1.0
- c. Adjust DELAY vernier for a 5- μ sec delay presentation on oscilloscope.
- d. Loosen DELAY vernier allen setserews and slip dial to indicate 5. Tighten one allen setserew.
- e. Check dial accuracy for 0.1 to 100 μ sec at 100 Hz. Reslip dial for best overall accuracy. Tighten both setserews.

5-10. WIDTH DIAL.

- a. Connect B403A as shown in Figure 5-1 using 10041A (X 10 Voltage Divider Probe) in place of coaxial leads going to J_1 and J_2 pulse outputs from oscilloscope.
- b. Connect dummy load to J_2 PULSE OUTPUT at J105. Leave J_1 PULSE OUTPUT unloaded.

 J_2 Output Dummy Load

- c. Connect one probe to center conductor of J_1 OUTPUT J105 and the other probe to the J_1 OUTPUT.

- d. Set B403A as follows:

LINE	depressed
INTERNAL	depressed
RATE multiplier	1000
RATE vernier	5
DELAY multiplier	X1
DELAY vernier	5
WIDTH multiplier	X1.0

- e. Adjust WIDTH vernier for a 5- μ sec presentation on Oscilloscope.

- f. Loosen two allen setserews holding WIDTH vernier dial and slip dial to indicate 5. Tighten one allen setserew.

- g. Check dial accuracy from 0.1 to 100 μ sec at a rate of 5000 Hz. Reslip dial for best accuracy obtainable. Tighten both allen setserews.

5-11. DUTY LIMIT LAMP.

- a. To check operation of duty limit lamp, connect B403A power cord to a Variable Power Transformer.
- b. Set Variable Power Transformer to high-line voltage (i.e., 127 VAC - 115 VAC operation or 253 VAC - 230 VAC operation).

- c. Set B403A as follows:

LINE	depressed
INTERNAL PULSE	depressed
RATE multiplier	X1000
RATE vernier	10
DELAY multiplier	X10

- d. The DUTY LIMIT lamp should light.

Table 5-3. Performance Test Procedure

1. OUTPUT CHARACTERISTICS. One pulse output specially shaped for optimum RF rise and decay times; one pulse output for general pulse applications; positive DC-coupled 25 to 30 volts in amplitude, approximately symmetrical about 0 volt DC.	
PROCEDURE a. Using an Oscilloscope, with 50 MHz Vertical Amplifier and X10 Attenuator Divider Probe, measure PULSE OUTPUTS as follows: (1) Depress LINE and INT PULSE buttons and set RATE CPS to X100. (2) Connect a Dual Banana post to BNC adapter to appropriate PULSE OUTPUT connector and connect Oscilloscope Probe to adapter. (3) Observed waveforms should be about as shown in Figure to the right.	
NOTES	

Table 5-3. Performance Test Procedure (cont'd)

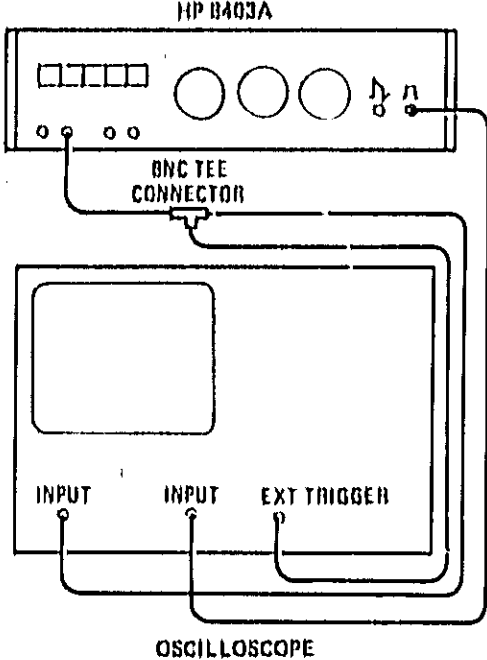
2 INTERNAL SQUARE WAVE MODULATION: Frequency variable from 50 Hz to 50 KHz; better than 45/55%.													
PROCEDURE - Connect 8403A as shown on next page. - Depress LINE and SQ WAVE buttons. - Set RATE CPS to 50 X1000. - Set Oscilloscope sweep time to 2 μsec/cm. - Readjust RATE CPS control to display one complete square wave cycle on Oscilloscope. Square wave symmetry should be better than 45/55%. - Set RATE CPS to 5 kHz and Oscilloscope sweep time to 0.2 msec/cm. - Readjust RATE control, if necessary, for one complete cycle display.	 NOTES												
3. INTERNAL PULSE MODULATION. Repetition rate variable from 50 Hz to 50 KHz.													
PROCEDURE - Connect 8403A as shown for square wave check. - Set 8403A as follows: <table border="0" data-bbox="292 1635 864 1816"> <tr> <td>LINE</td> <td>depressed</td> </tr> <tr> <td>INTERNAL PULSE</td> <td>depressed</td> </tr> <tr> <td>WIDTH</td> <td>X1.0</td> </tr> <tr> <td>DELAY</td> <td>X1.0</td> </tr> <tr> <td>RATE (vernier)</td> <td>full clockwise</td> </tr> <tr> <td>RATE</td> <td>X10</td> </tr> </table> - Set Oscilloscope sweep time to 5 ms/cm. - Observed pulses should be at least 20 ms apart. - Set RATE vernier fully counterclockwise and RATE to X1000. - Set Oscilloscope sweep time to 20 μsec/cm. - Observed pulses should not be greater than 20 μsec apart.	LINE	depressed	INTERNAL PULSE	depressed	WIDTH	X1.0	DELAY	X1.0	RATE (vernier)	full clockwise	RATE	X10	NOTES
LINE	depressed												
INTERNAL PULSE	depressed												
WIDTH	X1.0												
DELAY	X1.0												
RATE (vernier)	full clockwise												
RATE	X10												

Table 5-3. Performance Test Procedure (cont'd)

4. INTERNAL PULSE MODULATION. Delay variable from 0.1 to 100 μ seconds between sync output pulse and pulse output	
PROCEDURE a. Connect B403A as shown under INTERNAL SQUARE WAVE MODULATION except connect output cable to B403A spiked pulse output. b. Set B403A as follows: LINE depressed INTERNAL PULSE depressed RATE X100 DELAY 0.1 μsec c. Set Oscilloscope sweep time to 0.1 μsec/cm. d. The measured pulse delay should be not greater than 0.1 μsec plus Oscilloscope delay time of 0.25 μsec. e. Set DELAY time to 100 μs. f. Set Oscilloscope sweep time to 20 μsec/cm. g. The measured pulse delay should be greater than 100 μsec minus Oscilloscope delay time.	NOTES
5. INTERNAL PULSE MODULATION: Width variable from 0.1 to 100 μ sec.	
PROCEDURE a. Connect B403A as shown for internal square wave check. b. Set B403A as follows: LINE depressed INTERNAL PULSE depressed RATE X100 DELAY 0.1 μsec WIDTH (vernier) full counter-clockwise WIDTH 0.1 μsec c. Set Oscilloscope sweep time to 0.02 μsec. d. Pulse width should be less than 0.1 μsec. e. Set WIDTH time to 100 μs. f. Set Oscilloscope sweep time to 20 μsec/cm. g. Pulse width should be greater than 100 μsec.	NOTES
6. EXTERNAL SYNC. Amplitude and Polarity: 5 to 15V peak, either positive or negative. Waveform: Pulse or sine wave (see Note 1) Rate (see Note 1): Maximum average prf, 1 MHz Maximum peak prf, 2 MHz	
PROCEDURE a. Connect B403A as shown for square wave check. b. Set B403A as follows: LINE depressed INTERNAL PULSE depressed RATE CPS EXT SYNC c. Set polarity switch (located beneath EXTERNAL PULSE button) to +.	NOTES

Table 5-3. Performance Test Procedure (cont'd)

d. Apply synchronizing 5 to 15V peak sine wave signal to input connector located beneath EXTERNAL PULSE button. e. Pulse presentation on Oscilloscope should be variable in delay and width. No jitter should be present if 8403A dutycycle limit is not exceeded. f. Set polarity switch to -. Pulse presentation should not change.							
7. TRIGGER OUT. FOR INTERNAL PULSE OPERATION ONLY: Sync Out: 0.1 to 100 μsec in advance of PULSE OUTPUTS, as set by DELAY control (-2V amplitude). DELAYED sync out: Coincident with PULSE OUTPUTS (-2V amplitude).							
<u>PROCEDURE</u> a. For checking Sync Out, refer to instruction number 4 in this table. b. For checking DELAYED sync output, move 8403A cable connection from sync output connector to the DELAYED sync output connector. c. The Oscilloscope pulse presentations should be coincident.	<u>NOTES</u>						
8. EXTERNAL PULSE MODULATION. Repetition rate variable up to 1 MHz average prf, 2 MHz peak prf (see Note 1)							
<u>PROCEDURE</u> a. Check 8403A operation using procedure outlined for EXTERNAL SYNC check except that EXTERNAL PULSE button should be depressed instead of INTERNAL PULSE button.	<u>NOTES</u>						
9. CONTINUOUS AMPLITUDE MODULATION: Max Frequency response: 10 MHz, sinusoidal Input Impedance: 1000 ohms Level Control: rear panel AM OPER POINT control sets average DC input level.							
<u>PROCEDURE</u> a. Connect special shaped PULSE OUTPUT connector to Oscilloscope and set Oscilloscope for internal sync. b. Set 8403A as follows: <table border="0"> <tr> <td>LINE</td> <td>depressed</td> </tr> <tr> <td>RATE</td> <td>EXT SYNC</td> </tr> <tr> <td>AM</td> <td>depressed</td> </tr> </table>	LINE	depressed	RATE	EXT SYNC	AM	depressed	PULSE OUTPUT: AM OPERATION (1KHz, 1v RMS INPUT SIGNAL; SWEEP TIME .2ms/cm)
LINE	depressed						
RATE	EXT SYNC						
AM	depressed						

Table 5-3. Performance Test Procedure (cont'd)

e. Apply a 1 KHz, sine wave signal, approximately 1 volt (RMS amplitude) to the AM input (directly beneath AM button). d. Set Oscilloscope sweep time to 0.2 ms/cm and vertical input for 0.5 V/cm (AC coupled). e. Adjust rear panel AM OPER POINT control for a distorted signal similar to that pictured on previous page. f. Adjust AM OPER POINT control to eliminate distortion. Note: If input signal amplitude is too large, the distortion can not be eliminated. g. Change Oscilloscope sweep time to 2 μsec/cm and AM signal input frequency to 10 MHz. Adjust input signal amplitude to obtain about a 1.5 volt peak-to-peak Oscilloscope display. Repeat steps e and f. h. Repeat above procedure optionally at all other frequencies of interest.	NOTES
NOTE 1. The maximum externally-applied pulses-per-second rating of the 8403A is 1,000,000 pps. Application of more than 1,000,000 pulses within a one-second interval can destroy internal components. However, the 8403A can be triggered for short durations at an externally-applied 2,000,000 pps rate provided the number of applied pulses does not exceed 1,000,000 pulses within one second. For example: pulse spacing as low as 0.5 μsec (2,000,000 pps rate) may be used provided there are not more than one million pulses during one second.	

5-12. TROUBLESHOOTING.

5-13. The troubleshooting procedure given for the 8403A isolates trouble to a stage. The procedure should be performed in three (four for 8403A-Option 001 through 008 instruments) sequential steps.

Note

For a complete discussion of transistor troubleshooting techniques, refer to Paragraph 5-14.

a. Step 1: Power Supplies. The +20 and -20 volt supplies are interrelated. The -12 volt supply is referenced to the +20 volt supply. Thus trouble in the +20 volt supply will affect all supplies. Trouble in the -12 volt supply will not affect the other supplies. A power supply malfunction will usually affect all modes of operation (see Table 5-4).

CAUTION

NEVER REMOVE OR INSTALL POWER SUPPLY PLUG-IN A500 WITH AC POWER ON. THE TRANSISTORS IN THE 8403A CAN BE DAMAGED.

b. Step 2: Troubleshooting Chart. Check instrument trouble symptoms against those listed in Table 5-5, Troubleshooting.

Table 5-4. Troubleshooting Power Supplies

Supply	Test Point	Measure	Possible Cause
+20 V	+20 V bus	+20 $\pm$ 0.2 Vdc +20 $\pm$ 2.0 Vdc +20 $\pm$ 20 Vdc	Supply OK Q500 shorted, CR500 Q501 shorted, CR504 or open
-20 V	-20 V bus	-20 $\pm$ 0.2 Vdc -20 $\pm$ 3.0 Vdc -20 $\pm$ 20 Vdc	Supply OK Q501 shorted Q500 shorted or open
-12 V	-12 V bus	-12 $\pm$ 0.1 Vdc -12 $\pm$ 1.0 Vdc -12 $\pm$ 12 Vdc	Supply OK Q501 shorted Q505 shorted or open

c. Step 3: Isolating Trouble to a Specific Circuit. Because each mode of operation uses different circuit combinations, trouble can be isolated to a specific circuit by checking the operation of each in a prescribed sequence. In addition, waveforms are given with critical voltage at key circuit points on each schematic diagram.

Note: For Option Instruments including an internally mounted PIN Modulator, remove instrument bottom cover and disconnect J105-to-BIAS connector cable. Use J105 as Specially Shaped output for testing purposes.

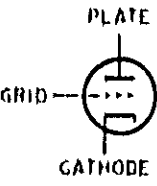
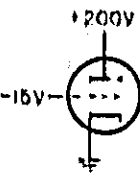
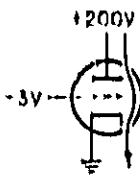
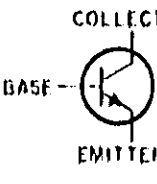
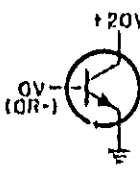
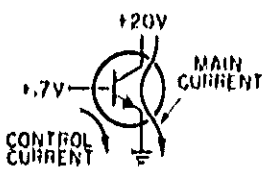
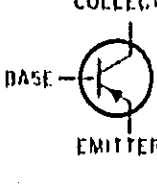
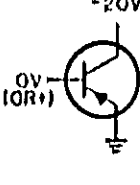
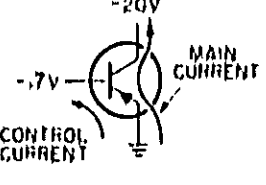
- (1) Use procedure given in Table 5-3 to check operation of the external pulse circuit. If the circuit is not functioning properly, the trouble could be in the Schmitt trigger circuit, positive or negative spiker, or bistable multivibrator circuits. Use an oscilloscope to check waveforms shown at key circuit points to isolate the trouble.
- (2) Use procedure given in Table 5-3 to check square wave circuit. If the circuit is not functioning properly, the trouble is located in the rate circuit. If circuit is functioning properly, proceed to step (3).
- (3) Check delay and width circuits (see Table 5-3). If circuits are functioning properly, proceed to step (4).
- (4) Use procedure given in Table 5-3 to check external AM circuit. If circuit is not functioning properly, check R606, S6, and CR603.
 - d. Step 4: For Option 01 through 08 Instruments ONLY. Once instrument circuit operation has been found satisfactory, refer to MAINTENANCE section of TUN Modulator Operating Note which is included in Appendix II at rear of this manual for performance check procedure.

5-14. TRANSISTOR TROUBLESHOOTING.

5-15. The following procedures and data are given to aid in determining whether a transistor is operational. Tests are given for both in-circuit and out-of-circuit transistors.

Table 5-5. Troubleshooting

Symptom	Trouble Location	Check
External functioning in positive and negative	Input Amplifier-Inverter	CR101, CR102, CR103, CR104
Spiker output becomes distorted with sine and square wave inputs @ 500 kHz	Positive Spiker	Q402
	Negative Spiker	Q404
No external pulse No external syne	Schmitt trigger circuit	Q101, Q102, Q103, Q104
No negative external trigger or syne	Trigger circuit	CR103, CR104, S101
No positive external trigger or syne	Trigger circuit	CR101, CR102, S101
Weak syne signal	Syne output blocking oscillator	CR203 through CR206
No square wave No internal pulse	Rate multivibrator	Q201, Q202, Q203, Q204
No syne out pulse in external pulse, internal pulse or external syne	Syne out blocking oscillator	Q205, CR203, CR204
Double syne	Delayed syne output blocking oscillator	Q304, Reverse T302
No external syne No internal pulse No delayed syne pulse output	Delay multivibrator, rate blocking oscillator	Q301, Q302, Q303
No external syne No internal pulse, delayed syne pulse OK RF on continuously in external syne and internal pulse	Width multivibrator	Q305, Q306, CR405
No external syne	Rate blocking oscillator	CR302
No internal syne	Rate blocking oscillator	CR301
No signal on collector of Q401 and Q403	Start Blocking Oscillator	CR401, CR402, CR403
	Stop Blocking Oscillator	CR406, CR409, CR410
Multivibrator doesn't flip	Start Blocking Oscillator	CR406
	Stop Blocking Oscillator	CR413
Spiker output distorted or insufficient DC level	Positive Spiker	Q402, CR407
	Negative Spiker	Q404, CR412
Poor rise time on RF pulses	Positive Spiker	Q402
Poor delay time on RF pulses	Negative Spiker	Q404
RF on or off continuously, syne out OK, delayed syne OK	Bistable circuits Start blocking oscillator	Q405, Q406

A. TRANSISTOR BIASING			
DEVICE	SYMBOL	CUTOFF	CONDUCTING
VACUUM TUBE			
NPN TRANSISTOR			
PNP TRANSISTOR			

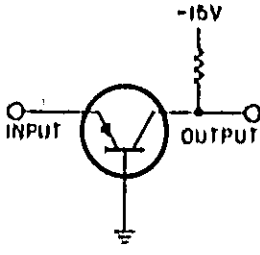
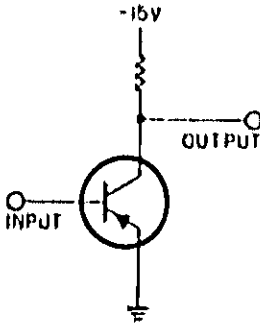
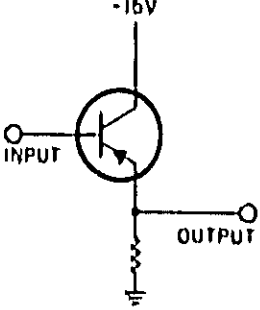
B. AMPLIFIER CHARACTERISTICS			
CHARACTERISTIC	COMMON BASE	COMMON EMITTER	COMMON COLLECTOR
INPUT Z	30-50 Ω	500-1500 Ω	20-500K Ω
OUTPUT Z	300-500K Ω	30-50K Ω	50-1000 Ω
VOLTAGE GAIN	500-1500	300-1000	<1
CURRENT GAIN	<1	25-50	25-50
POWER GAIN	20-30 dB	25-40 dB	10-20 dB
			

Figure 5-2. Transistor Operation

5-10. IN-CIRCUIT TESTING.

5-17. The 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, this is the operational control point in the transistor. This junction is essentially a solid state diode. For the transistor to conduct, the diode must conduct; that is, the diode must be forward-biased. As with simple diodes, the forward-bias polarity is determined by the materials forming the junction. Use the transistor symbol on the schematic diagram to determine the bias polarity required to forward-bias the base-emitter junction. The A part of Figure 5-2 shows transistor symbols with terminals labeled. Notice that the emitter arrow conventionally points toward the type N material. The other two columns of the illustration compare the biasing required to cause conduction and cut-off in transistors and vacuum tubes. If the transistor base-emitter diode (junction) is forward-biased the transistor conducts. If the diode is heavily forward-biased the transistor saturates. However, if the base-emitter diode is reverse-biased the transistor is cut off. The voltage drop across a forward-biased emitter-base diode varies with transistor collector current. For example, a germanium transistor has a typical forward-bias, base-emitter voltage of 0.2 - 0.3 volts when collector current is 1 - 10 mA, and 0.4 - 0.5 volts when collector current is 10 - 100 mA. In contrast, forward bias voltage for silicon transistors is about twice that for germanium types: about 0.5 - 0.6 volts when collector current is low, and about 0.8-0.9 volts when collector current is high.

5-18. Figure 5-2, part B, shows simplified versions of the three basic transistor circuits and gives the operating characteristics of each. When examining a transistor stage, first determine if the emitter-base diode is biased for conduction (forward-biased) by measuring the voltage difference between emitter and base. When using an electronic voltmeter, do not measure directly between emitter and base: there may be sufficient loop current between the voltmeter leads to damage the transistor. Instead, measure each voltage separately with respect to a voltage common point (e. g., chassis). If the emitter-base diode is forward-biased, check for amplifier action by short-circuiting base to emitter while observing collector voltage. The short-circuit eliminates base-emitter bias and should cause the transistor to stop conducting (cut off). Collector voltage should then shift to near the supply voltage. Any difference is due to leakage current through the transistor and in general, the smaller this current, the better the transistor. If collector voltage does not change, the transistor has either an emitter-collector short circuit or emitter-base open circuit.

5-10. TESTING TRANSISTORS WITH AN OHMMETER.

5-20. The two common causes of transistor failure are internal short- and open-circuits. Remove the transistor from the circuit and use an ohmmeter to measure internal resistance. See Table 5-6 for measurement data.

Table 5-6. Out-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
		emitter	base*	30 - 50
	Power	emitter	collector	several hundred
NPN Silicon	Small Signal	base	emitter	1K - 3K
		collector	emitter	very high (might read open)
		base	emitter	200 - 1000
	Power	collector	emitter	high, often greater than 1 M
*To test for transistor action, add collector-base short. Measured resistance should decrease.				

CAUTION

Most ohmmeters can supply enough current or voltage to damage a transistor. Before using an ohmmeter to measure transistor forward or reverse resistance, check open-circuit voltage and short-circuit current output ON THE RANGE TO BE USED. Open circuit voltage must not exceed 1.5 volts and short-circuit current must be less than 3 mA. See Table 5-7 for safe resistance ranges for some common ohmmeters.

5-21. ETCHED CIRCUITS.

5-22. The etched circuit board is a plated-through type consisting of metallic conductors bonded to both sides of insulating material. The metallic conductors are extended through the component mounting holes by a plating process. Soldering can be done from either side of the board with equally good results. Table 5-8 lists recommended tools and materials. Following are recommendations and precautions pertinent to etched circuit repair work:

- Avoid unnecessary component substitution; it can result in damage to the circuit board and/or adjacent components.
- Do not use a high-power soldering iron on etched circuit boards. Excessive heat may lift a conductor or damage the board.
- Use a suction device (Table 5-8) or wooden toothpick to remove solder from component mounting holes. DO NOT USE A SHARP METAL OBJECT SUCH AS AN AWL OR TWIST DRILL FOR THIS PURPOSE. SHARP OBJECTS MAY DAMAGE THE PLATED-THROUGH CONDUCTOR.
- After soldering, remove excess flux from the soldered area and apply a protective coating to prevent contamination and corrosion. See Table 5-8.

Table 5-7. Safe Ohmmeter Range for Transistor Resistance Measurements

Ohmmeter	Safe Range(s)	Open Ckt Voltage	Short Ckt Current	Lead	
				Color	Polarity
412A	R x 1K	1.0V	1 mA	Red	+
	R x 10K	1.0V	100 μ A	Blk	-
	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		
410C	R x 1K	1.3V	0.57mA	Red	+
	R x 10K	1.3V	57 μ A	Blk	-
	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		
410B	R x 100	1.1V	1.1 mA	Blk	+
	R x 1K	1.1V	110 μ A	Red	-
	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	+
				Blk	-
Simpson 269	R x 1K	1.5V	0.02 mA	Blk	+
				Red	-
Triplet 030	R x 100	1.5V	3.25mA	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		

5-23. COMPONENT REPLACEMENT.

- a. Remove defective component from circuit board.

b. Remove solder from mounting holes using a suction desoldering aid (Table 5-8) or wooden toothpick.

c. Shape leads of replacement component to match mounting hole spacing.

d. Insert component leads into mounting holes, and position component as original was positioned. DO NOT FORCE LEADS OF REPLACEMENT COMPONENT INTO MOUNTING HOLES. Sharp lead ends may damage plated-through conductor.

Note

Axial lead components, such as resistors and tubular capacitors, can be replaced without unsoldering. Clip leads near body of defective component, remove component and straighten leads left in board. Wrap leads of replacement component one turn around original leads. Solder wrapped connection, and clip off excess lead.

5-24. ETCHED CONDUCTOR REPAIR. A broken or burned section of conductor can be repaired by bridging the damaged section with a length of tinned copper wire. Allow adequate overlap and remove any varnish from etched conductor before soldering wire into place.

5-25. TRANSISTOR REPLACEMENT.

a. Do not apply excessive heat. See Table 5-8 for soldering tool specifications.

b. Use a heat sink such as pliers or hemostat between transistor body and hot soldering iron.

c. When installing a replacement transistor, ensure sufficient lead length to dissipate heat of soldering by maintaining about the same length of exposed lead as used for original transistor.

Table 5-8. Etched Circuit Soldering Equipment

Item	Use	Specification	Item Recommended
Soldering Tool	Soldering Unsoldering	Wattage rating: 37.5 Tip Temp: 750 - 800° F Tip Size: 1/8" OD	Ungar #776 handle with Ungar #1237 Heating Unit
Soldering Tip, general purpose	Soldering Unsoldering	Shape: chisel Size: 1/8"	Ungar #PL113
De-soldering aid	Unsoldering multi- connection components te. g., tube sockets	Suction device to remove molten solder from connection	Soldapull by the Edsyn Company, Arleta, California
Resin (flux) solvent	Remove excess flux from soldered area before application of protective coating	Must not dissolve etched circuit base board mate- rial or conductor bond- ing agent	Freon Acetone Lacquer Thinner Isopropyl Alcohol (100% dry)
Solder	Component replacement Circuit board repair Wiring	Resin (flux) core, high tin content (60/40 tin, lead), 18 gauge (SWG) preferred	
Protective Coating	Contamination, corro- sion protection after soldering	Good electrical insulation, corrosion-prevention properties	Krylon * #1302 Humiseal Protective Coating, Type 1B12 by Columbia Technical Corp, Woodside 77, New York
*Krylon Inc., Norristown, Pennsylvania			

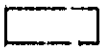
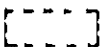
1. Resistance in ohms, capacitance in microfarads unless otherwise indicated
2.  screwdriver adjust
 panel control
3.  front panel designation
 rear panel designation
4.  etched circuit borderline
 signal path  feedback path
5.  wiper moves toward CW with clockwise rotation of control
6.  test point. Number in circle matches TP number on circuit board illustration.
7.   Voltage regulator (breakdown) diode

Figure 5-3. Schematic Diagram Notes

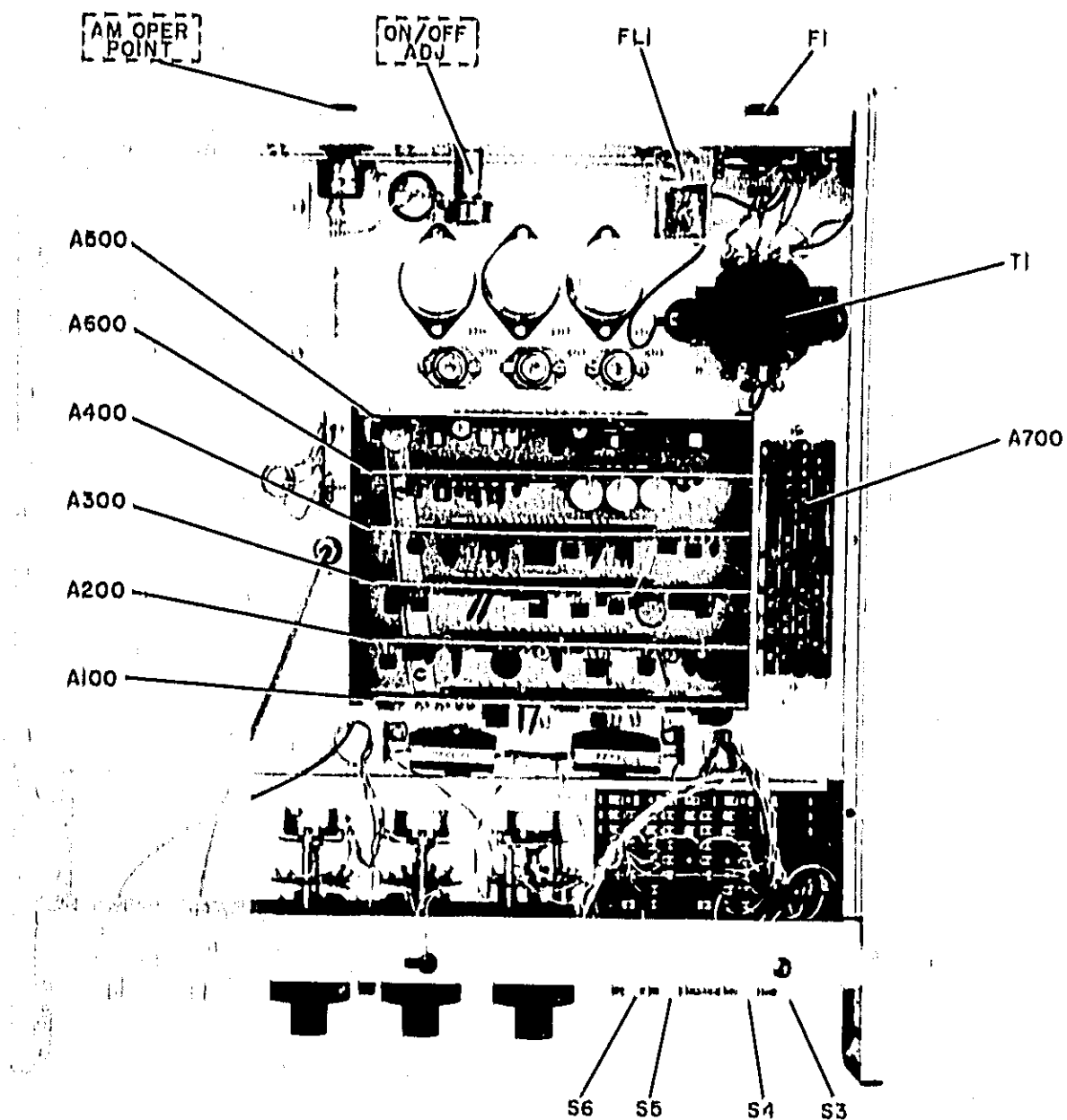


Figure 5-4. Model B403A, Bottom View

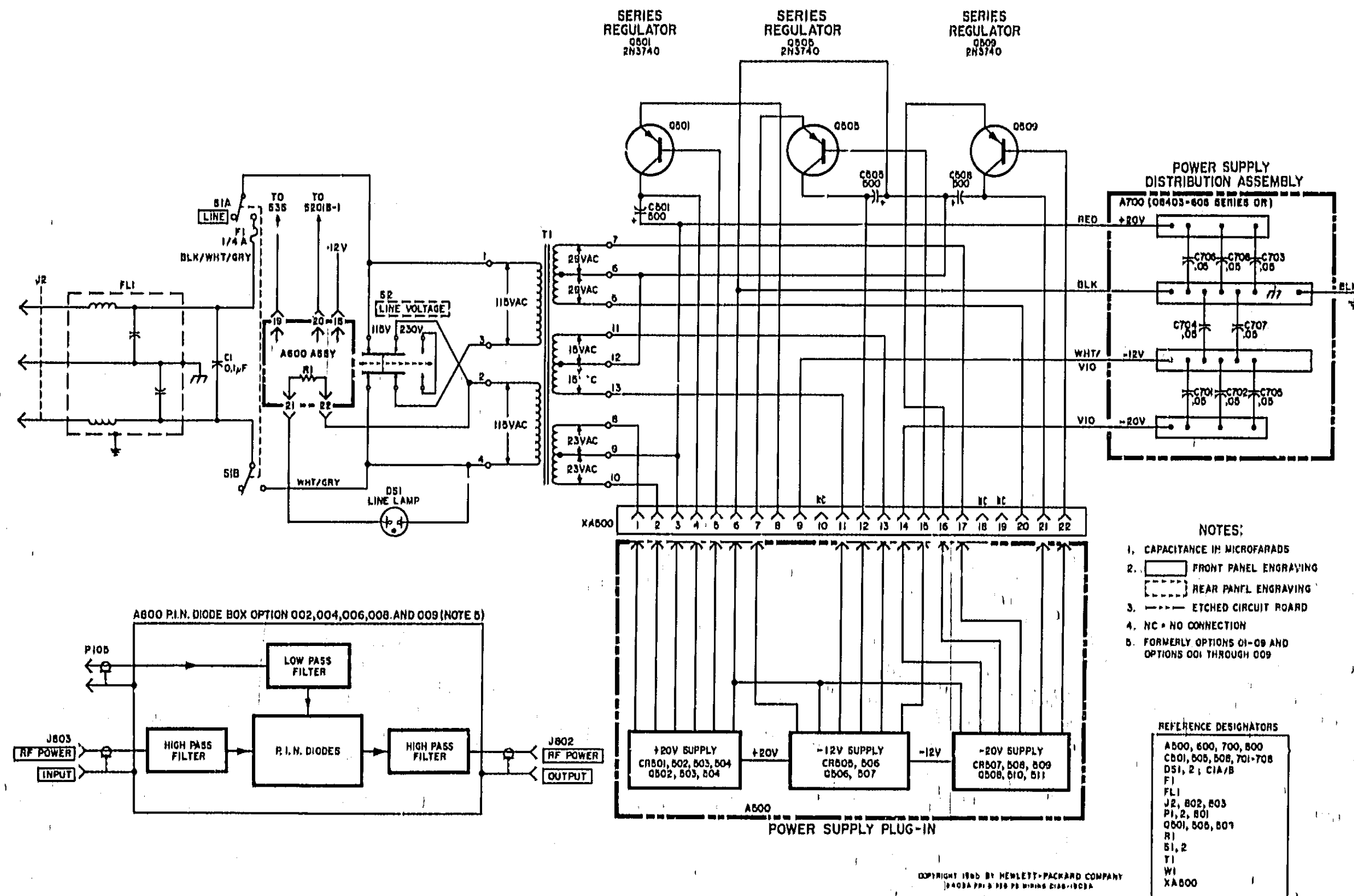


Figure 5-5. Power Supply Wiring Diagram

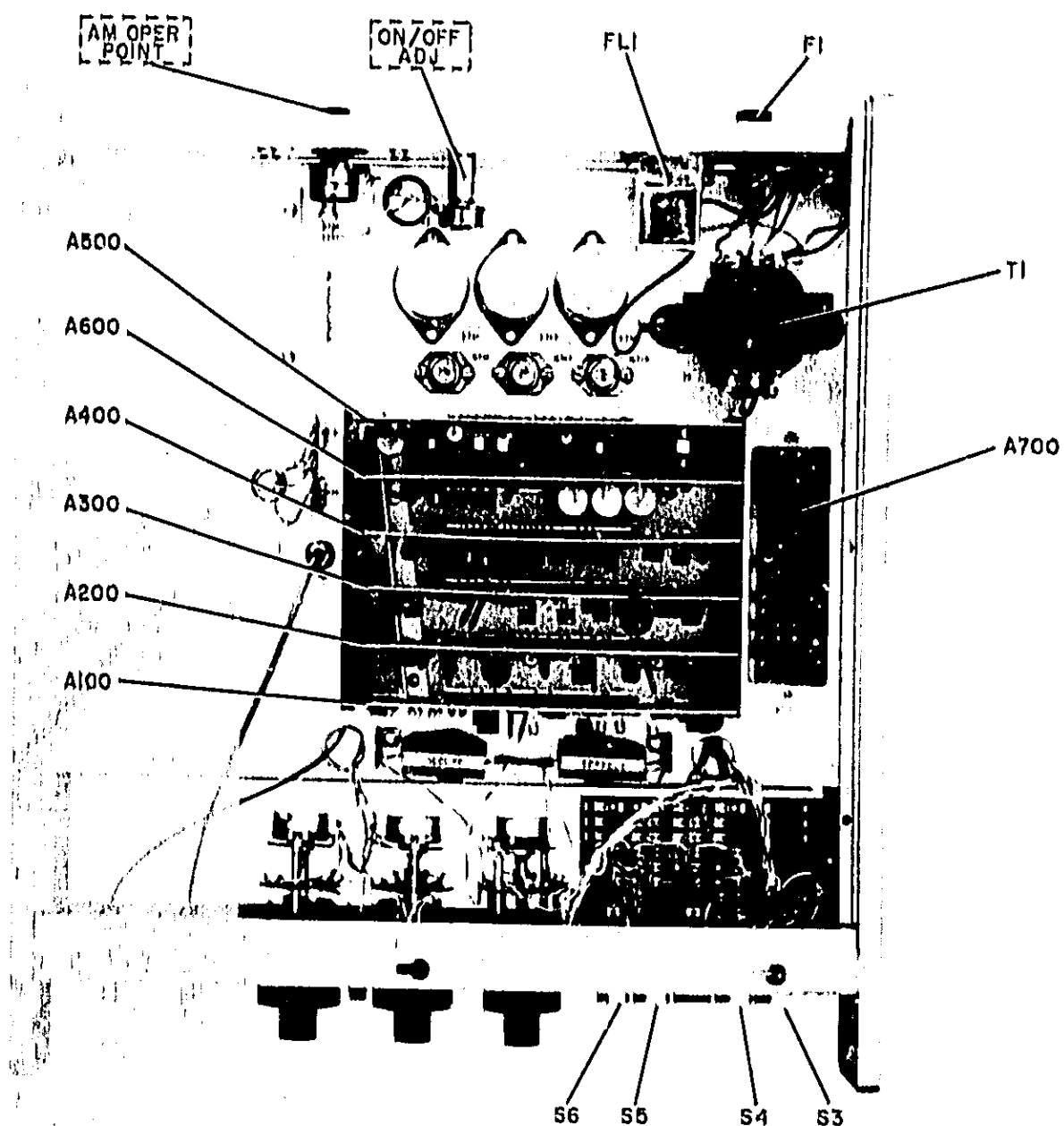


Figure 5-6, Model B403A, Bottom View

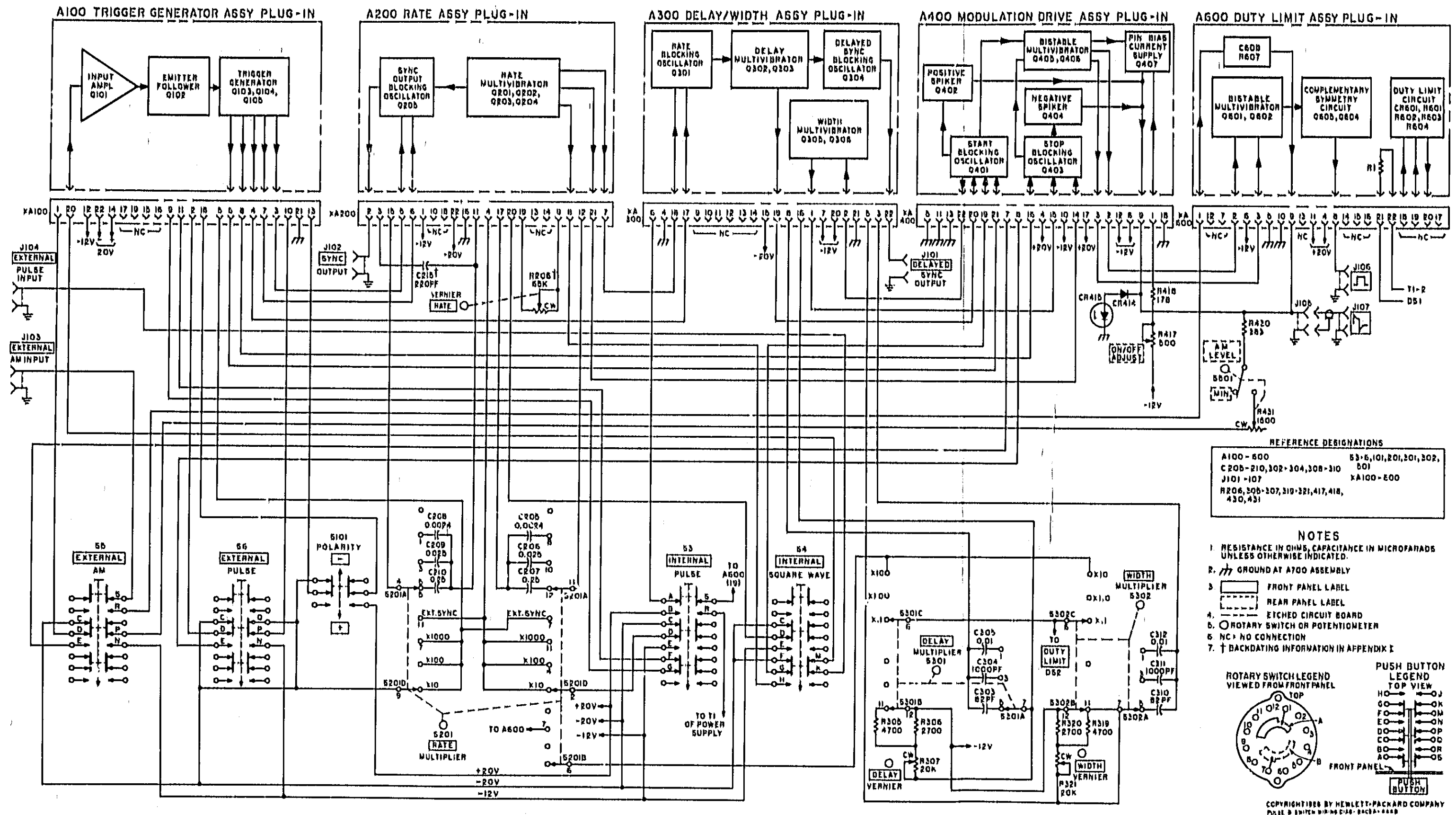


Figure 5-7. Modulation Circuit Wiring Diagram

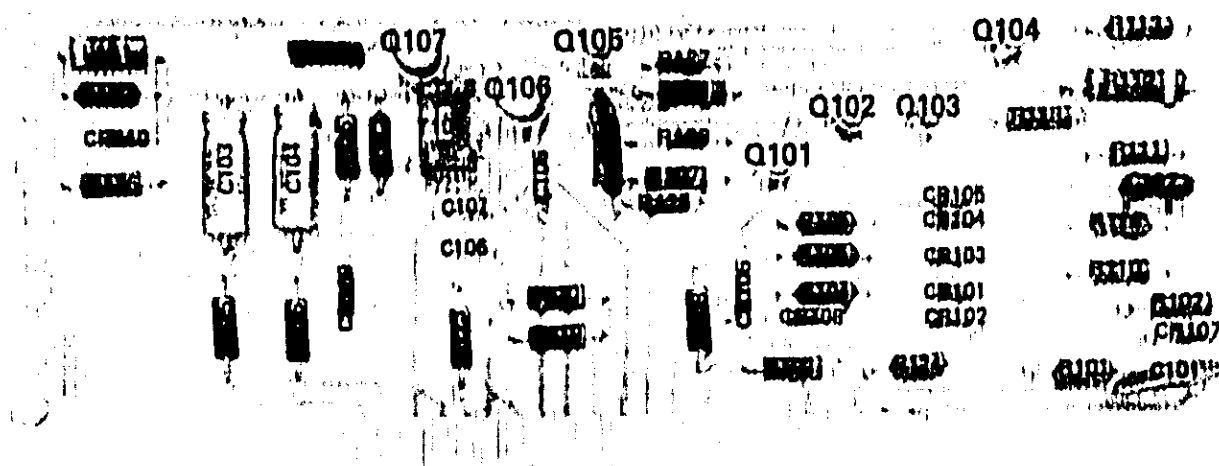


Figure 5-8. Trigger Generator Assembly (A100)

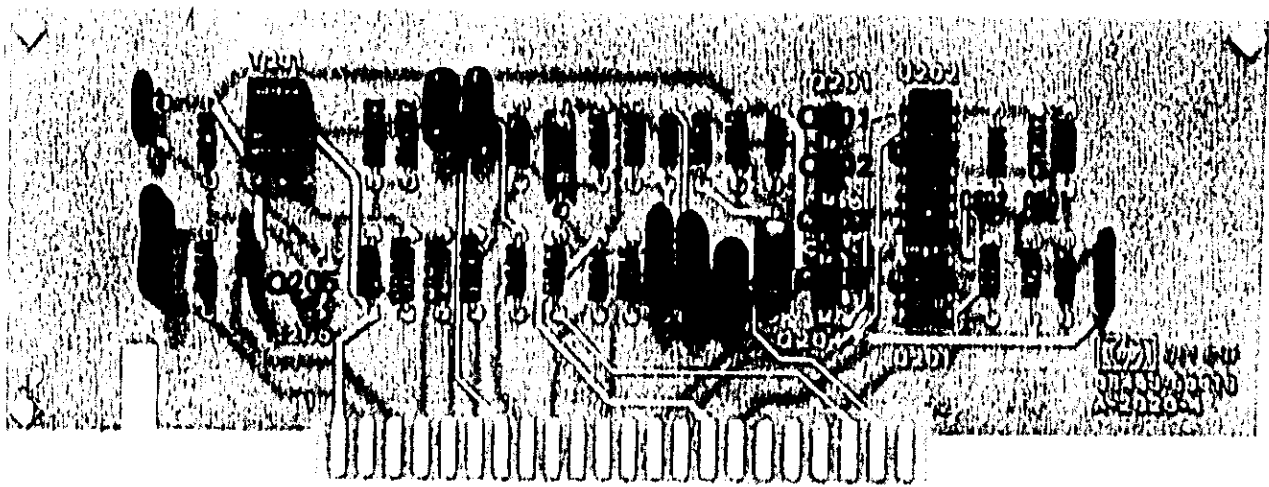
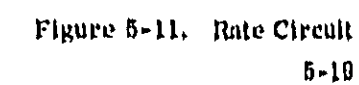


Figure 5-10, Rate Assembly Component Locations



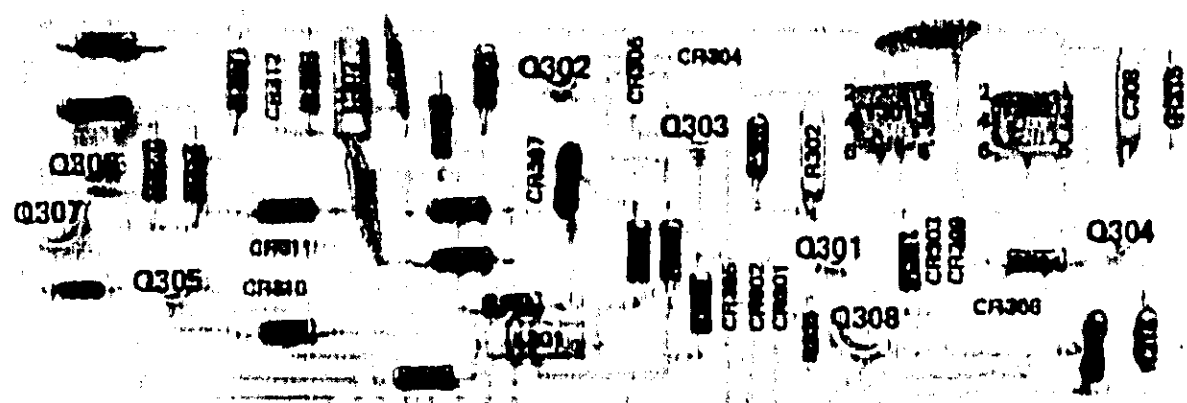


Figure 1-11. Delay Width Assembly (A100)



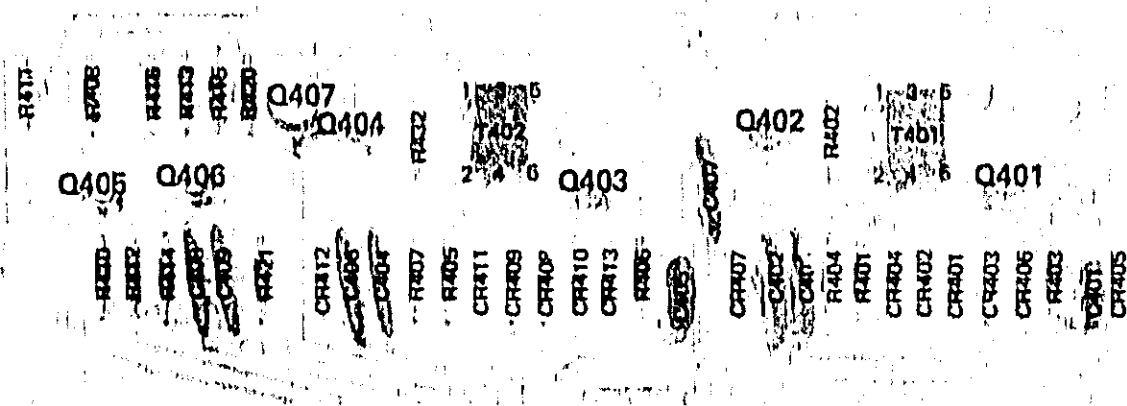


Figure 5-14. Modulator Drive Assembly (A400)

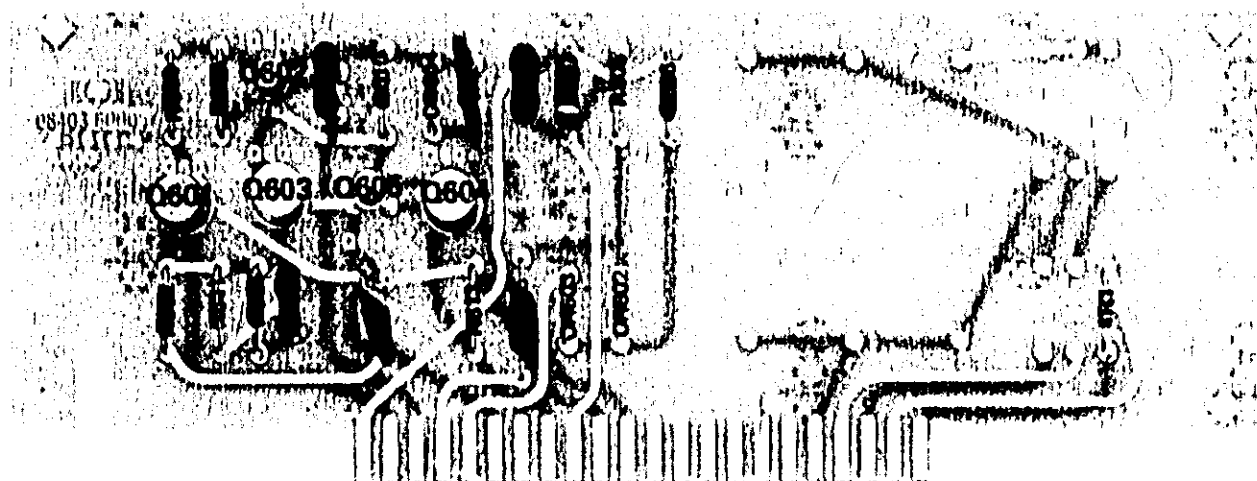


Figure 5-15. Duty Limit Assembly (A600)

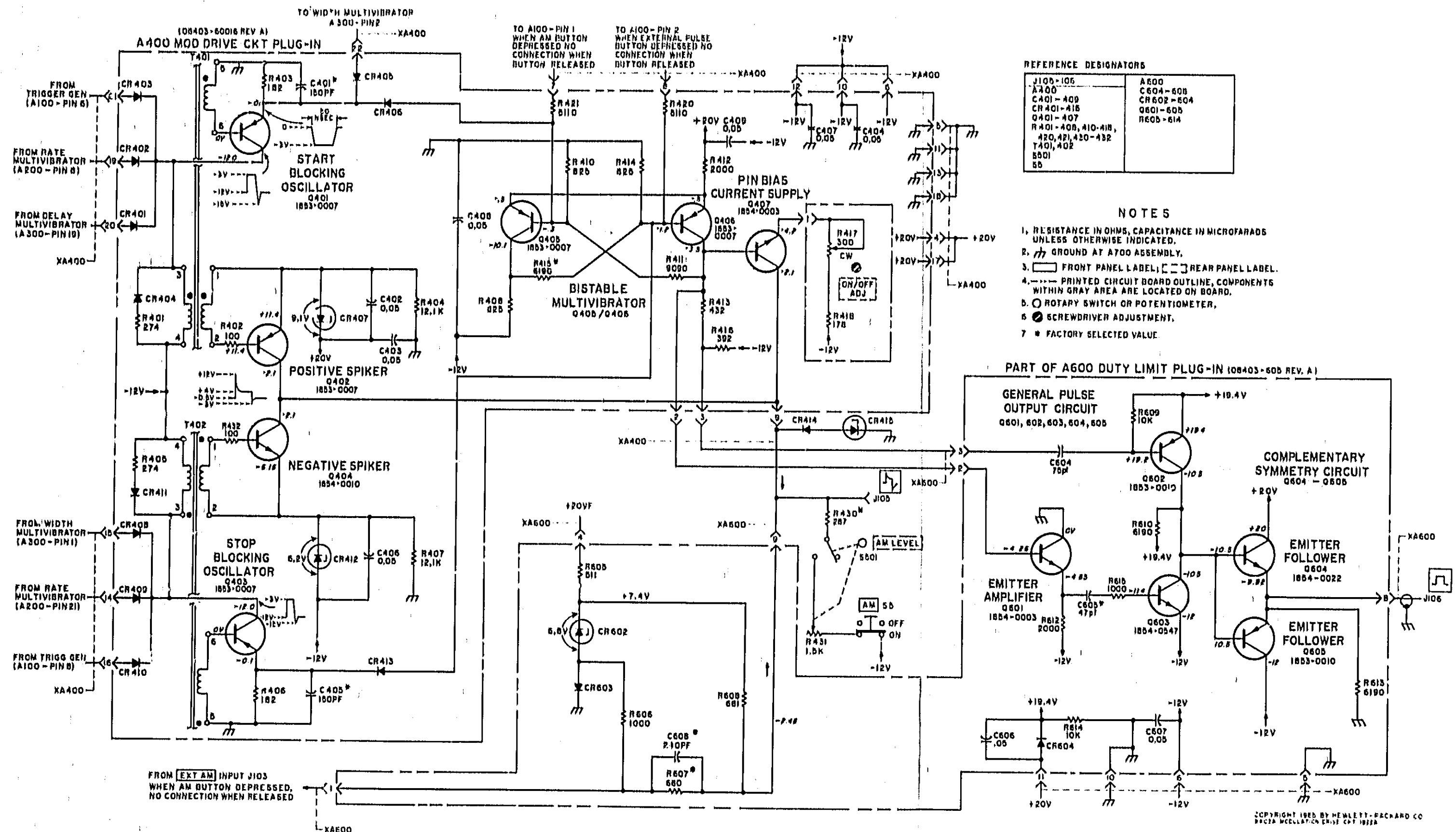


Figure 5-16, Modulation Drive Circuit

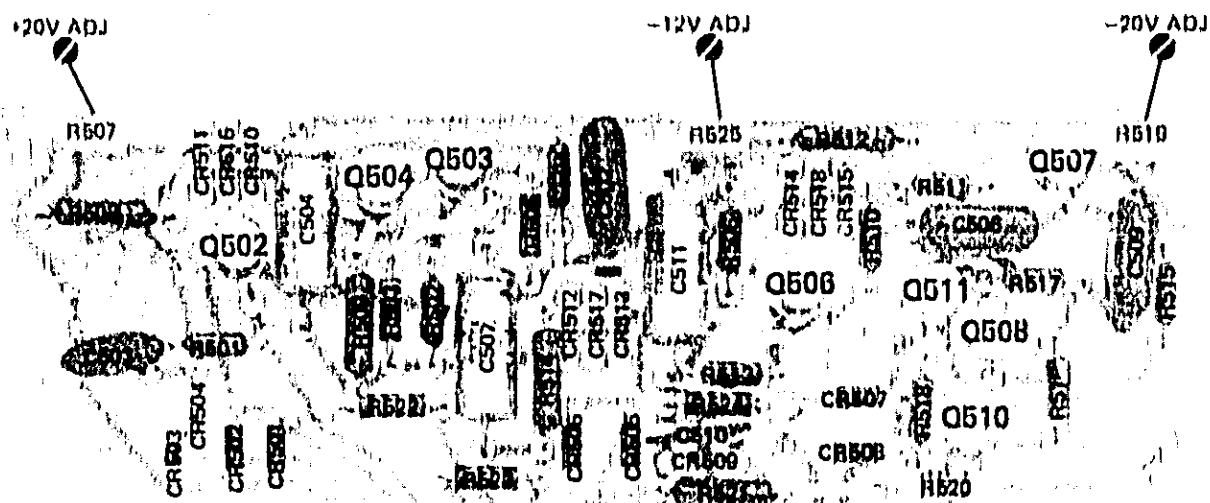


Figure 5-17. Power Supply Assembly (A500)

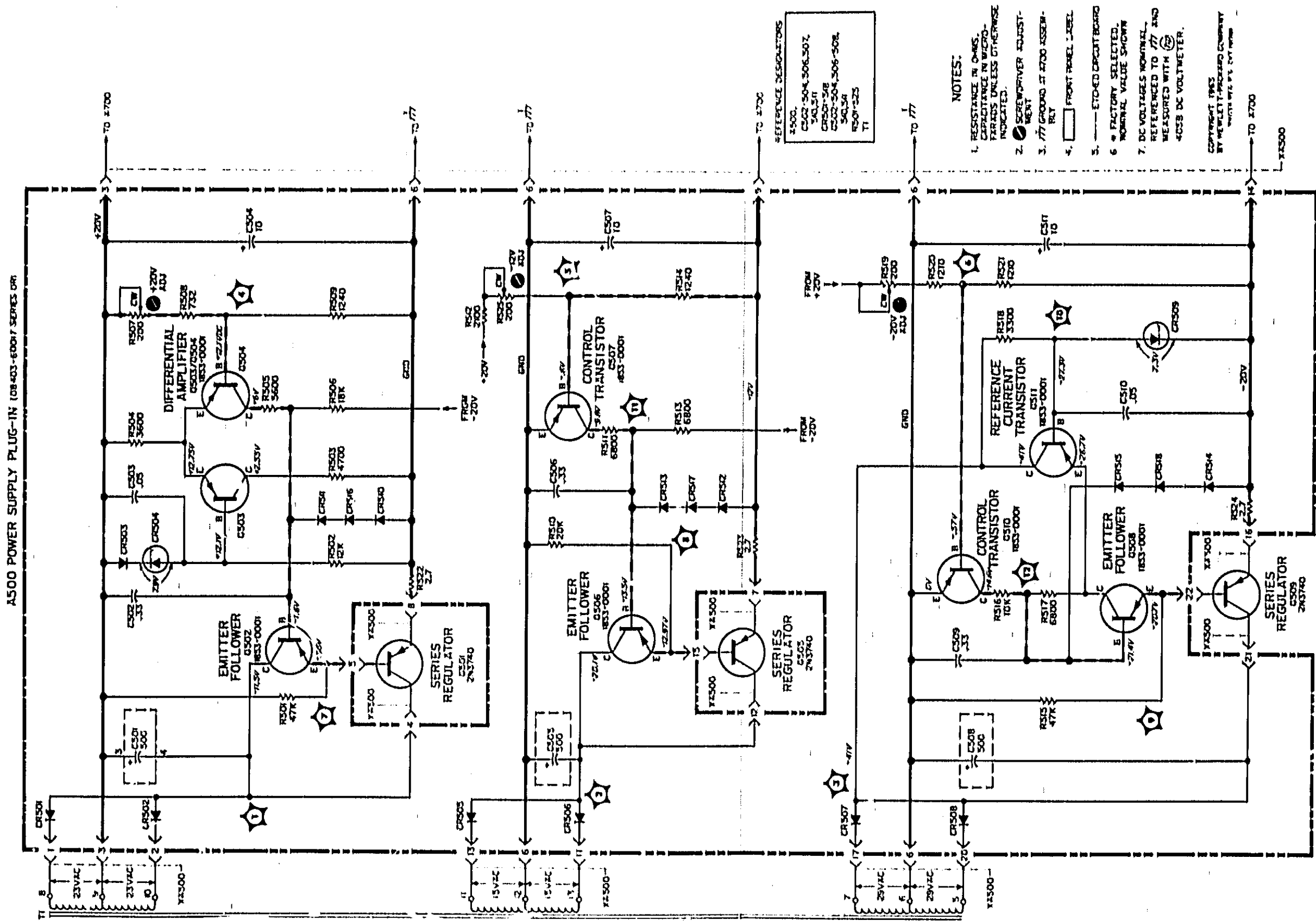


Figure 5-18. Regulated Power Supply
5-25/5-20

PARTS LIST

SECTION VI REPLACEABLE PARTS

6-1. INTRODUCTION

This section contains information for ordering parts. Table 6-1 lists abbreviations used in the parts list and throughout the manual. Table 6-2 lists all replaceable parts in reference designator order. Table 6-3 contains the names and addresses that correspond to the manufacturer's code numbers.

6-2. ABBREVIATIONS

Table 6-1 lists abbreviations used in the parts list, schematics, and throughout the manual. In some cases, two forms of the abbreviation are used, one all in capitals letters, and one partial or no capitals. This occurs because the abbreviations in the parts list are always all capitals. However, in the schematics and other parts of the manual, other abbreviation forms are used with both lower case and upper case letters.

6-3. REPLACEABLE PARTS LIST

Table 6-2 is the list of replaceable parts and is organized as follows:

- a. Electrical assemblies and their components in alphanumeric order by reference designation.
- b. Chassis-mounted parts in alphanumeric order by reference designation
- c. Mechanical parts.

The information given for each part consists of the following:

- a. The Hewlett-Packard part number.
- b. Part number check digit (CD).
- c. The total quantity (Qty) for the entire instrument except for option assemblies.
- d. The description of the part.
- e. A typical manufacturer of the part in a five-digit code.
- f. The manufacturer's number for the part.

6-4. FACTORY SELECTED PARTS (*)

Parts marked with an asterisk (*) are factory selected parts. The value listed in the parts list is the nominal value. Refer to Section V of this manual for information on determining what value to use for replacement.

6-5. PARTS LIST BACKDATING (†)

Parts marked with a dagger (†) are different in Modulators with serial number prefixes lower than the one that this manual applies to directly. The backdating changes are contained in Appendix I.

6-6. PARTS LIST UPDATING (Change Sheet)

Production changes to Modulators made after the publication date of this manual are accompanied by a change in the serial number prefix. Changes to the parts list are recorded by serial number prefix on a MANUAL CHANGES supplement. Also, parts list errors are noted in the ERRATA portion of the MANUAL CHANGES supplement.

6-7. ORDERING INFORMATION

To order a part listed in the replaceable parts table, quote the Hewlett-Packard part number (with the check digit), indicate the quantity required, and address the order to the nearest Hewlett-Packard office. The check digit will ensure accurate and timely processing of your order.

To order a part that is not listed in the replaceable parts table, include the instrument model number, instrument serial number, description and function of the part, and the number of parts required. Address the order to the nearest Hewlett-Packard office.

6-8. RECOMMENDED SPARES LIST

Stocking spare parts for an instrument is often done to ensure quick return to service after a malfunction occurs. Hewlett-Packard prepares a "Recommended Spares" list for this instrument. The

contents of the list are based on failure reports and repair data. Quantities given are for one year of parts support. A complimentary copy of the "Recommended Spares" list may be requested from your nearest Hewlett-Packard office.

When stocking parts to support more than one Modulator or to support a variety of Hewlett-

Packard Instruments, it may be more economical to work from one consolidated list rather than simply adding together stocking quantities from the individual instrument lists. Hewlett-Packard will prepare consolidated "Recommended Spares" lists for any number or combination of instruments. Contact your nearest Hewlett-Packard office for details.

Table G-1. Reference Designations and Abbreviations (1 of 2)

REFERENCE DESIGNATIONS

A assembly	E miscellaneous electrical part	P electrical connector (movable portion); plug	U integrated circuits; microcircuit
AT attenuator; isolator; termination	F fuse	Q transistor; SCR; diode thyristor	V electron tube
B fan; motor	FL filter	R resistor	VR voltage regulator; breakdown diode
BT battery	H hardware	RT thermistor	W cable; transmission path; wire
C capacitor	HY circulator	S switch	X socket
CP coupler	J electrical connector (stationary portion); jack	T transformer	Y crystal unit (piezo electric or quartz)
CR diode; diode thyristor; varactor	K relay	TD terminal board	Z tuned cavity; tuned circuit
DC directional coupler	L coil; inductor	TE thermocouple	
DL delay line	M meter	TP test point	
DS annunciator; signaling device (audible or visual); lamp; LED	MP miscellaneous mechanical part		

ABBREVIATIONS

A ampere	COEF coefficient	EDP electronic data processing	INT internal
ac alternating current	COM common	ELECT electrolytic	kg kilogram
ACCESS accessory	COMP composition	ENCAP encapsulated	kHz kilohertz
ADJ adjustment	COMPL complete	EXT external	kΩ kilohm
A/D analog-to-digital	CONN connector	F fatal	kV kilovolt
AF audio frequency	CP cathium plate	FET field-effect transistor	lb pound
AFC automatic frequency control	CRT cathode-ray tube		LC inductance-capacitance
AGC automatic gain control	CTL complementary transistor logic	F/F flip-flop	LED light-emitting diode
AL aluminum	CW continuous wave	FI flat head	LF low frequency
ALC automatic level control	cw clockwise	FI, H filister head	LG long
AM amplitude modulation	cm centimeter	FM frequency modulation	LH left hand
AMPL amplifier	D/A digital-to-analog	FP front panel	LIM limit
APC automatic phase control	dB decibel	FREQ frequency	LIN linear taper (used in parts list)
ASSY assembly	dBm decibel referred to 1 mW	FSD fixed	lin linear
AUX auxiliary	dc direct current	G gram	LR WASH lock washer
avg average	deg degree (temperature interval or difference)	GE germanium	LO low-level oscillator
AWG American wire gauge	° degree (plane angle)	GHz gigahertz	LOG logarithmic taper (used in parts list)
BAL balance	°C degree Celsius (centigrade)	GL glass	log logarithmic
BCD binary coded decimal	°F degree Fahrenheit	GRD grounded)	LPF low pass filter
BD board	°K degree Kelvin	H henry	LV low voltage
BE CU beryllium copper	DEPC deposited carbon	h hour	m meter (distance)
BFO beat frequency oscillator	DET detector	HET heterodyne	mA milliamperes
BH binder head	diam diameter	HES hexagonal	MAX maximum
BKDN breakdown	DIA diameter (used in parts list)	HD head	MΩ megohm
BP bandpass	DIFF AMPL differential amplifier	HDW hardware	MEG meg (10 ⁶) (used in parts list)
BPF bandpass filter	div division	HF high frequency	MET FILM metal film
BRS brass	DPDT double-pole, double-throw	HG mercury	MET OS metallic oxide
BWO backward-wave oscillator	DR drive	HI high	MF medium frequency, microlared (used in parts list)
CAL calibrate	DSB double sideband	HP Hewlett-Packard	MFR manufacturer
ccw counterclockwise	DTL diode transistor logic	HPF high pass filter	mg milligram
CER ceramic	DVM digital voltmeter	HR hour (used in parts list)	MHz megahertz
CHAN channel	ECI emitter coupled logic	HV high voltage	mH millihenry
cm centimeter	EMF electromotive force	Hz Hertz	mho mho
CMO cabinet mount only		IC integrated circuit	MIN minimum
COAX coaxial		ID inside diameter	min minute (time)
		IF intermediate frequency	° minute (plane angle)
		IMPG impregnated	MINAT miniature
		in inch	mm millimeter
		INCJ incandescent	
		INCL include(s)	
		INP input	
		INS insulation	

NOTE

All abbreviations in the parts list will be in upper-case.

Table 6-1 Reference Designations and Abbreviations (2 of 2)

MOD modulator	OD outside diameter	PWV peak working voltage	TD time delay
MOM momentary	OH oval head	RE resistance	TEHM terminal
MOS metal-oxide-semiconductor	OP AMPL operational amplifier	REC recathode capacitor	TEF thin-film capacitor
m milliercond	OPT option	REF reference	TGL toggle
MTH mounting	OSC oscillator	REF reference	THD thread
MTR meter (indicating device)	OX oxide	REG regulated	THRU through
mV millivolt	oz ounce	REP replaceable	TI titanium
mV _{ac} millivolt, ac	Ω ohm	RF radio frequency	TOL tolerance
mV _{dc} millivolt, dc	P peak (used in parts list)	RFL radio frequency interference	TRIM trimmer
mV _{pk} millivolt, peak	PAM pulse-amplitude modulation	RH round head (right hand)	TRN transistor-transistor logic
mV _{pp} millivolt, peak-to-peak	PC printed circuit	RLC resistance-inductance-capacitance	TV television
mVrms millivolt, rms	PCM pulse-code modulation	RMO rack mount only	TWI television interference
mW milliwatt	PDM pulse-duration modulation	RMS root-mean-square	TWT traveling wave tube
MUX multiplex	PF proofed	RND round	U micro (10 ⁻⁶) (used in parts list)
MY mylar	PH BRZ phosphor bronze	RPM read-only memory	UF microfarad (used in parts list)
μA microampere	PHI Philips	RAP rack and panel	UHF ultrahigh frequency
μF microfarad	PIN positive-intrinsic-negative	RWV reverse working voltage	UNREG unregulated
μH microhenry	PIV peak inverse voltage	S scattering parameter	V volt
μho microhm	pk peak	k second (time)	V _{ac} volt, ac
μs microsecond	PL phase lock	° second (plane angle)	V _{dc} volt, dc
μV microvolt	PLD phase lock oscillator	h hour	V _{dr} volt, de
μV _{ac} microvolt, ac	PM phase modulation	SCR silicon controlled rectifier (screw)	V _{FW} volt, dc, working (used in parts list)
μV _{dc} microvolt, dc	PSD positive-negative-positive	SE selenium	V _{LF} volt, filtered
μV _{pk} microvolt, peak	Pat pat of	SEMI-CON semiconductor	V _{FD} variable-frequency oscillator
μV _{pp} microvolt, peak-to-peak	POLY polystyrene	SHF superhigh frequency	VHF very-high frequency
μVrms microvolt, rms	PORTE porcelain	SL silicon	V _{pk} volt, peak
μW microwatt	PDS positive (position) (used in parts list)	SL silver	V _{pp} volt, peak-to-peak
NA nanampere	POSN position	SL slide	Vrms volt, rms
NC no connection	POT potentiometer	SNR signal-to-noise ratio	VSWR voltage standing wave ratio
N/C normally closed	P-P peak-to-peak	SPDT single-pole, double-throw	VTO voltage-tuned oscillator
NE neon	PP peak-to-peak (used in parts list)	SPB spring	VUVM vacuum-tube voltmeter
NEG negative	PPM pulse-position modulation	SR split ring	V _{SW} volt, switched
NF nanofarad	PREAMPL preamplifier	SPST single-pole, single-throw	W watt
NIP nickel plate	PRF pulse-repetition frequency	SSB single sideband	W with
N/O normally open	PRR pulse-repetition rate	SSF stainless steel	WV working inverse voltage
NOM nominal	PS picosecond	STL steel	WW wirewound
NORM normal	PT point	SWR standing-wave ratio	W/O without
NPN negative-positive-negative	PTM pulse-time modulation	SYN synchronize	YIG yttrium-iron-garnet
NPO negative-positive-zero (zero temperature coefficient)	PWM pulsewidth modulation	T timed (shallow time)	Z ₀ characteristic impedance
NRE not recommended for field replacement		TA tantalum	
NSR not separately replaceable		TC temperature compensating	

NOTE

All abbreviations in the parts list will be in uppercase.

MULTIPLIERS

Abbreviation	Prefix	Multiple
T	tera	10 ¹²
G	giga	10 ⁹
M	mega	10 ⁶
k	kilo	10 ³
da	deka	10
d	deci	10 ⁻¹
c	centi	10 ⁻²
m	milli	10 ⁻³
μ	micro	10 ⁻⁶
n	nano	10 ⁻⁹
p	pico	10 ⁻¹²
f	femto	10 ⁻¹⁵
a	atto	10 ⁻¹⁸

Table B.2. Replaceable Parts

Reference Designation	HP Part Number	QTY	Description	Mfr Code	Mfr Part Number
A100 A101 A102 A103 A104 A105	0100-0001 0100-0002 0100-0003 0100-0004 0100-0005 0100-0006	1 1 1 1 1 1	THROTTLE GENERATOR PLUG IN ASSEMBLY NOT ASSIGNED BALL ASSEMBLY COILS, SWITCH UNIT THROTTLE SWITCH, LAMP UNIT, ETC. ETC.	0100 0100 0100 0100 0100 0100	0100-0001 0100-0002 0100-0003 0100-0004 0100-0005 0100-0006
A107 A108 A109 A110 A111 A112	0100-0007 0100-0008 0100-0009 0100-0010 0100-0011 0100-0012	1 1 1 1 1 1	NOT ASSIGNED DELAY/STOP PLUG IN ASSEMBLY SWITCH ASSEMBLY, DELAY UNIT SWITCH ASSEMBLY, WITH TUNING	0100 0100 0100 0100 0100 0100	0100-0007 0100-0008 0100-0009 0100-0010 0100-0011 0100-0012
A113 A114 A115 A116 A117 A118 A119 A120 A121 A122	0100-0013 0100-0014 0100-0015 0100-0016 0100-0017 0100-0018 0100-0019 0100-0020 0100-0021 0100-0022	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED MODULATION UNIT, TUNING PLUG IN ASSEMBLY NOT ASSIGNED POWER SUPPLY PLUG IN NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0013 0100-0014 0100-0015 0100-0016 0100-0017 0100-0018 0100-0019 0100-0020 0100-0021 0100-0022
A123 A124 A125 A126 A127 A128 A129 A130 A131 A132	0100-0023 0100-0024 0100-0025 0100-0026 0100-0027 0100-0028 0100-0029 0100-0030 0100-0031 0100-0032	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0023 0100-0024 0100-0025 0100-0026 0100-0027 0100-0028 0100-0029 0100-0030 0100-0031 0100-0032
A133 A134 A135 A136 A137 A138 A139 A140 A141 A142	0100-0033 0100-0034 0100-0035 0100-0036 0100-0037 0100-0038 0100-0039 0100-0040 0100-0041 0100-0042	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0033 0100-0034 0100-0035 0100-0036 0100-0037 0100-0038 0100-0039 0100-0040 0100-0041 0100-0042
A143 A144 A145 A146 A147 A148 A149 A150 A151 A152	0100-0043 0100-0044 0100-0045 0100-0046 0100-0047 0100-0048 0100-0049 0100-0050 0100-0051 0100-0052	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0043 0100-0044 0100-0045 0100-0046 0100-0047 0100-0048 0100-0049 0100-0050 0100-0051 0100-0052
A153 A154 A155 A156 A157 A158 A159 A160 A161 A162	0100-0053 0100-0054 0100-0055 0100-0056 0100-0057 0100-0058 0100-0059 0100-0060 0100-0061 0100-0062	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0053 0100-0054 0100-0055 0100-0056 0100-0057 0100-0058 0100-0059 0100-0060 0100-0061 0100-0062
A163 A164 A165 A166 A167 A168 A169 A170 A171 A172	0100-0063 0100-0064 0100-0065 0100-0066 0100-0067 0100-0068 0100-0069 0100-0070 0100-0071 0100-0072	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0063 0100-0064 0100-0065 0100-0066 0100-0067 0100-0068 0100-0069 0100-0070 0100-0071 0100-0072
A173 A174 A175 A176 A177 A178 A179 A180 A181 A182	0100-0073 0100-0074 0100-0075 0100-0076 0100-0077 0100-0078 0100-0079 0100-0080 0100-0081 0100-0082	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0073 0100-0074 0100-0075 0100-0076 0100-0077 0100-0078 0100-0079 0100-0080 0100-0081 0100-0082
A183 A184 A185 A186 A187 A188 A189 A190 A191 A192	0100-0083 0100-0084 0100-0085 0100-0086 0100-0087 0100-0088 0100-0089 0100-0090 0100-0091 0100-0092	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0083 0100-0084 0100-0085 0100-0086 0100-0087 0100-0088 0100-0089 0100-0090 0100-0091 0100-0092
A193 A194 A195 A196 A197 A198 A199 A200 A201 A202	0100-0093 0100-0094 0100-0095 0100-0096 0100-0097 0100-0098 0100-0099 0100-0100 0100-0101 0100-0102	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0093 0100-0094 0100-0095 0100-0096 0100-0097 0100-0098 0100-0099 0100-0100 0100-0101 0100-0102
A203 A204 A205 A206 A207 A208 A209 A210 A211 A212	0100-0103 0100-0104 0100-0105 0100-0106 0100-0107 0100-0108 0100-0109 0100-0110 0100-0111 0100-0112	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0103 0100-0104 0100-0105 0100-0106 0100-0107 0100-0108 0100-0109 0100-0110 0100-0111 0100-0112
A213 A214 A215 A216 A217 A218 A219 A220 A221 A222	0100-0113 0100-0114 0100-0115 0100-0116 0100-0117 0100-0118 0100-0119 0100-0120 0100-0121 0100-0122	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0113 0100-0114 0100-0115 0100-0116 0100-0117 0100-0118 0100-0119 0100-0120 0100-0121 0100-0122
A223 A224 A225 A226 A227 A228 A229 A230 A231 A232	0100-0123 0100-0124 0100-0125 0100-0126 0100-0127 0100-0128 0100-0129 0100-0130 0100-0131 0100-0132	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0123 0100-0124 0100-0125 0100-0126 0100-0127 0100-0128 0100-0129 0100-0130 0100-0131 0100-0132
A233 A234 A235 A236 A237 A238 A239 A240 A241 A242	0100-0133 0100-0134 0100-0135 0100-0136 0100-0137 0100-0138 0100-0139 0100-0140 0100-0141 0100-0142	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0133 0100-0134 0100-0135 0100-0136 0100-0137 0100-0138 0100-0139 0100-0140 0100-0141 0100-0142
A243 A244 A245 A246 A247 A248 A249 A250 A251 A252	0100-0143 0100-0144 0100-0145 0100-0146 0100-0147 0100-0148 0100-0149 0100-0150 0100-0151 0100-0152	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0143 0100-0144 0100-0145 0100-0146 0100-0147 0100-0148 0100-0149 0100-0150 0100-0151 0100-0152
A253 A254 A255 A256 A257 A258 A259 A260 A261 A262	0100-0153 0100-0154 0100-0155 0100-0156 0100-0157 0100-0158 0100-0159 0100-0160 0100-0161 0100-0162	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0153 0100-0154 0100-0155 0100-0156 0100-0157 0100-0158 0100-0159 0100-0160 0100-0161 0100-0162
A263 A264 A265 A266 A267 A268 A269 A270 A271 A272	0100-0163 0100-0164 0100-0165 0100-0166 0100-0167 0100-0168 0100-0169 0100-0170 0100-0171 0100-0172	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0163 0100-0164 0100-0165 0100-0166 0100-0167 0100-0168 0100-0169 0100-0170 0100-0171 0100-0172
A273 A274 A275 A276 A277 A278 A279 A280 A281 A282	0100-0173 0100-0174 0100-0175 0100-0176 0100-0177 0100-0178 0100-0179 0100-0180 0100-0181 0100-0182	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0173 0100-0174 0100-0175 0100-0176 0100-0177 0100-0178 0100-0179 0100-0180 0100-0181 0100-0182
A283 A284 A285 A286 A287 A288 A289 A290 A291 A292	0100-0183 0100-0184 0100-0185 0100-0186 0100-0187 0100-0188 0100-0189 0100-0190 0100-0191 0100-0192	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0183 0100-0184 0100-0185 0100-0186 0100-0187 0100-0188 0100-0189 0100-0190 0100-0191 0100-0192
A293 A294 A295 A296 A297 A298 A299 A300 A301 A302	0100-0193 0100-0194 0100-0195 0100-0196 0100-0197 0100-0198 0100-0199 0100-0200 0100-0201 0100-0202	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0193 0100-0194 0100-0195 0100-0196 0100-0197 0100-0198 0100-0199 0100-0200 0100-0201 0100-0202
A303 A304 A305 A306 A307 A308 A309 A310 A311 A312	0100-0203 0100-0204 0100-0205 0100-0206 0100-0207 0100-0208 0100-0209 0100-0210 0100-0211 0100-0212	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0203 0100-0204 0100-0205 0100-0206 0100-0207 0100-0208 0100-0209 0100-0210 0100-0211 0100-0212
A313 A314 A315 A316 A317 A318 A319 A320 A321 A322	0100-0213 0100-0214 0100-0215 0100-0216 0100-0217 0100-0218 0100-0219 0100-0220 0100-0221 0100-0222	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0213 0100-0214 0100-0215 0100-0216 0100-0217 0100-0218 0100-0219 0100-0220 0100-0221 0100-0222
A323 A324 A325 A326 A327 A328 A329 A330 A331 A332	0100-0223 0100-0224 0100-0225 0100-0226 0100-0227 0100-0228 0100-0229 0100-0230 0100-0231 0100-0232	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0223 0100-0224 0100-0225 0100-0226 0100-0227 0100-0228 0100-0229 0100-0230 0100-0231 0100-0232
A333 A334 A335 A336 A337 A338 A339 A340 A341 A342	0100-0233 0100-0234 0100-0235 0100-0236 0100-0237 0100-0238 0100-0239 0100-0240 0100-0241 0100-0242	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0233 0100-0234 0100-0235 0100-0236 0100-0237 0100-0238 0100-0239 0100-0240 0100-0241 0100-0242
A343 A344 A345 A346 A347 A348 A349 A350 A351 A352	0100-0243 0100-0244 0100-0245 0100-0246 0100-0247 0100-0248 0100-0249 0100-0250 0100-0251 0100-0252	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0243 0100-0244 0100-0245 0100-0246 0100-0247 0100-0248 0100-0249 0100-0250 0100-0251 0100-0252
A353 A354 A355 A356 A357 A358 A359 A360 A361 A362	0100-0253 0100-0254 0100-0255 0100-0256 0100-0257 0100-0258 0100-0259 0100-0260 0100-0261 0100-0262	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0253 0100-0254 0100-0255 0100-0256 0100-0257 0100-0258 0100-0259 0100-0260 0100-0261 0100-0262
A363 A364 A365 A366 A367 A368 A369 A370 A371 A372	0100-0263 0100-0264 0100-0265 0100-0266 0100-0267 0100-0268 0100-0269 0100-0270 0100-0271 0100-0272	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100 0100 0100 0100 0100 0100 0100 0100	0100-0263 0100-0264 0100-0265 0100-0266 0100-0267 0100-0268 0100-0269 0100-0270 0100-0271 0100-0272
A373 A374 A375 A376 A377 A378 A379 A380 A381 A382	0100-0273 0100-0274 0100-0275 0100-0276 0100-0277 0100-0278 0100-0279 0100-0280 0100-0281 0100-0282	1 1 1 1 1 1 1 1 1 1	NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED NOT ASSIGNED	0100 0100 0100	

See introduction to this section for ordering information
*Indicates factory selected value
†For backdating information see Appendix I

Table B-2. Replaceable Parts

[illegible]

*Indicates factory selected value

For backdating information see Appendix I

Table 8-2. Replaceable Parts

[illegible]

See introduction to this section for ordering information

*Indicates factory order back value

For backslating information see Appendix I

Table B.2. Replaceable Parts

Reference Designation	HP Part Number	QTY	Description	Mfr Code	Mfr Part Number
01					
0101	0101-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0101	0101-0001
0102	0102-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0102	0102-0001
0103	0103-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0103	0103-0001
0104	0104-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0104	0104-0001
0105	0105-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0105	0105-0001
0106	0106-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0106	0106-0001
0107	0107-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0107	0107-0001
0108	0108-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0108	0108-0001
0109	0109-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0109	0109-0001
0110	0110-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0110	0110-0001
0111	0111-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0111	0111-0001
0112	0112-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0112	0112-0001
0113	0113-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0113	0113-0001
0114	0114-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0114	0114-0001
0115	0115-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0115	0115-0001
0116	0116-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0116	0116-0001
0117	0117-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0117	0117-0001
0118	0118-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0118	0118-0001
0119	0119-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0119	0119-0001
0120	0120-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0120	0120-0001
0121	0121-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0121	0121-0001
0122	0122-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0122	0122-0001
0123	0123-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0123	0123-0001
0124	0124-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0124	0124-0001
0125	0125-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0125	0125-0001
0126	0126-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0126	0126-0001
0127	0127-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0127	0127-0001
0128	0128-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0128	0128-0001
0129	0129-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0129	0129-0001
0130	0130-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0130	0130-0001
0131	0131-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0131	0131-0001
0132	0132-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0132	0132-0001
0133	0133-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0133	0133-0001
0134	0134-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0134	0134-0001
0135	0135-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0135	0135-0001
0136	0136-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0136	0136-0001
0137	0137-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0137	0137-0001
0138	0138-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0138	0138-0001
0139	0139-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0139	0139-0001
0140	0140-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0140	0140-0001
0141	0141-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0141	0141-0001
0142	0142-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0142	0142-0001
0143	0143-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0143	0143-0001
0144	0144-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0144	0144-0001
0145	0145-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0145	0145-0001
0146	0146-0001	1	TRANSISTOR PNP 100MA 10 TO 100V 100W	0146	0146-0001

See introduction to this section for ordering information

^a Indicates factory extracted value.

*For backdating information see Appendix I

Table B-2. Replaceable Parts

[illegible]

See introduction to this section for ordering information

*Indicates factory selected value

For backdating information see Appendix 1

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	QTY	Description	Mfr Code	Mfr Part Number
0010	0010 0010	1	RESISTOR 10K 1% 100W 100-00-100	0010	10 10 10 10 10
0011	0011 0011	1	RESISTOR 10K 1% 100W 100-00-100	0011	10 10 10 10 10
0012	0012 0012	1	RESISTOR 10K 1% 100W 100-00-100	0012	10 10 10 10 10
0013	0013 0013	1	RESISTOR 10K 1% 100W 100-00-100	0013	10 10 10 10 10
0014	0014 0014	1	RESISTOR 10K 1% 100W 100-00-100	0014	10 10 10 10 10
0015	0015 0015	1	RESISTOR 10K 1% 100W 100-00-100	0015	10 10 10 10 10
0016	0016 0016	1	RESISTOR 10K 1% 100W 100-00-100	0016	10 10 10 10 10
0017	0017 0017	1	RESISTOR 10K 1% 100W 100-00-100	0017	10 10 10 10 10
0018	0018 0018	1	RESISTOR 10K 1% 100W 100-00-100	0018	10 10 10 10 10
0019	0019 0019	1	RESISTOR 10K 1% 100W 100-00-100	0019	10 10 10 10 10
0020	0020 0020	1	RESISTOR 10K 1% 100W 100-00-100	0020	10 10 10 10 10
0021	0021 0021	1	RESISTOR 10K 1% 100W 100-00-100	0021	10 10 10 10 10
0022	0022 0022	1	RESISTOR 10K 1% 100W 100-00-100	0022	10 10 10 10 10
0023	0023 0023	1	RESISTOR 10K 1% 100W 100-00-100	0023	10 10 10 10 10
0024	0024 0024	1	RESISTOR 10K 1% 100W 100-00-100	0024	10 10 10 10 10
0025	0025 0025	1	RESISTOR 10K 1% 100W 100-00-100	0025	10 10 10 10 10
0026	0026 0026	1	RESISTOR 10K 1% 100W 100-00-100	0026	10 10 10 10 10
0027	0027 0027	1	RESISTOR 10K 1% 100W 100-00-100	0027	10 10 10 10 10
0028	0028 0028	1	RESISTOR 10K 1% 100W 100-00-100	0028	10 10 10 10 10
0029	0029 0029	1	RESISTOR 10K 1% 100W 100-00-100	0029	10 10 10 10 10
0030	0030 0030	1	RESISTOR 10K 1% 100W 100-00-100	0030	10 10 10 10 10
0031	0031 0031	1	RESISTOR 10K 1% 100W 100-00-100	0031	10 10 10 10 10
0032	0032 0032	1	RESISTOR 10K 1% 100W 100-00-100	0032	10 10 10 10 10
0033	0033 0033	1	RESISTOR 10K 1% 100W 100-00-100	0033	10 10 10 10 10
0034	0034 0034	1	RESISTOR 10K 1% 100W 100-00-100	0034	10 10 10 10 10
0035	0035 0035	1	RESISTOR 10K 1% 100W 100-00-100	0035	10 10 10 10 10
0036	0036 0036	1	RESISTOR 10K 1% 100W 100-00-100	0036	10 10 10 10 10
0037	0037 0037	1	RESISTOR 10K 1% 100W 100-00-100	0037	10 10 10 10 10
0038	0038 0038	1	RESISTOR 10K 1% 100W 100-00-100	0038	10 10 10 10 10
0039	0039 0039	1	RESISTOR 10K 1% 100W 100-00-100	0039	10 10 10 10 10
0040	0040 0040	1	RESISTOR 10K 1% 100W 100-00-100	0040	10 10 10 10 10
0041	0041 0041	1	RESISTOR 10K 1% 100W 100-00-100	0041	10 10 10 10 10
0042	0042 0042	1	RESISTOR 10K 1% 100W 100-00-100	0042	10 10 10 10 10
0043	0043 0043	1	RESISTOR 10K 1% 100W 100-00-100	0043	10 10 10 10 10
0044	0044 0044	1	RESISTOR 10K 1% 100W 100-00-100	0044	10 10 10 10 10
0045	0045 0045	1	RESISTOR 10K 1% 100W 100-00-100	0045	10 10 10 10 10
0046	0046 0046	1	RESISTOR 10K 1% 100W 100-00-100	0046	10 10 10 10 10
0047	0047 0047	1	RESISTOR 10K 1% 100W 100-00-100	0047	10 10 10 10 10
0048	0048 0048	1	RESISTOR 10K 1% 100W 100-00-100	0048	10 10 10 10 10
0049	0049 0049	1	RESISTOR 10K 1% 100W 100-00-100	0049	10 10 10 10 10
0050	0050 0050	1	RESISTOR 10K 1% 100W 100-00-100	0050	10 10 10 10 10
0051	0051 0051	1	RESISTOR 10K 1% 100W 100-00-100	0051	10 10 10 10 10
0052	0052 0052	1	RESISTOR 10K 1% 100W 100-00-100	0052	10 10 10

See introduction to this section for ordering information.

* Indicates factor(s) observed in value

For backdating information see Appendix I

Table B-2. Replaceable Parts

[illegible]

See a brochure to 1-800-368-6868 for ordering information.

* Indicates factory or field test value

For backdating information see Appendix 1

Table 6-2. Replacable Parts

Reference Designation	HP Part Number	QTY	Description	Mfr Code	Mfr Part Number
1	1000 0000	1	1000 0000	1000	1000 0000
2	1000 0001	1	1000 0001	1000	1000 0001
3	1000 0002	1	1000 0002	1000	1000 0002
4	1000 0003	1	1000 0003	1000	1000 0003
5	1000 0004	1	1000 0004	1000	1000 0004
6	1000 0005	1	1000 0005	1000	1000 0005
7	1000 0006	1	1000 0006	1000	1000 0006
8	1000 0007	1	1000 0007	1000	1000 0007
9	1000 0008	1	1000 0008	1000	1000 0008
10	1000 0009	1	1000 0009	1000	1000 0009
11	1000 0010	1	1000 0010	1000	1000 0010
12	1000 0011	1	1000 0011	1000	1000 0011
13	1000 0012	1	1000 0012	1000	1000 0012
14	1000 0013	1	1000 0013	1000	1000 0013
15	1000 0014	1	1000 0014	1000	1000 0014
16	1000 0015	1	1000 0015	1000	1000 0015

Cabinet Parts

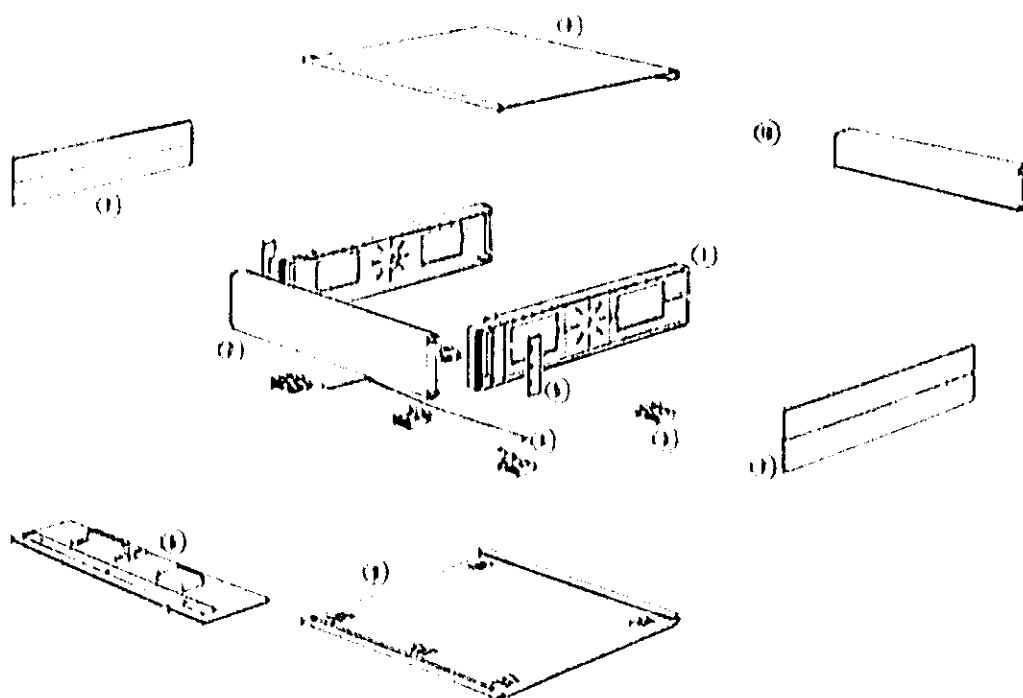


Table 6-3. Code List of Manufacturers

Mfr Code	Manufacturer Name	Address	Zip Code
00000	00000 00000	00000 00	
00001	00001 00001	00001 00	
00002	00002 00002	00002 00	
00003	00003 00003	00003 00	
00004	00004 00004	00004 00	
00005	00005 00005	00005 00	
00006	00006 00006	00006 00	
00007	00007 00007	00007 00	
00008	00008 00008	00008 00	
00009	00009 00009	00009 00	
00010	00010 00010	00010 00	
00011	00011 00011	00011 00	
00012	00012 00012	00012 00	
00013	00013 00013	00013 00	
00014	00014 00014	00014 00	
00015	00015 00015	00015 00	
00016	00016 00016	00016 00	
00017	00017 00017	00017 00	
00018	00018 00018	00018 00	
00019	00019 00019	00019 00	
00020	00020 00020	00020 00	
00021	00021 00021	00021 00	
00022	00022 00022	00022 00	
00023	00023 00023	00023 00	
00024	00024 00024	00024 00	
00025	00025 00025	00025 00	
00026	00026 00026	00026 00	
00027	00027 00027	00027 00	
00028	00028 00028	00028 00	
00029	00029 00029	00029 00	
00030	00030 00030	00030 00	
00031	00031 00031	00031 00	
00032	00032 00032	00032 00	
00033	00033 00033	00033 00	
00034	00034 00034	00034 00	
00035	00035 00035	00035 00	
00036	00036 00036	00036 00	
00037	00037 00037	00037 00	
00038	00038 00038	00038 00	
00039	00039 00039	00039 00	
00040	00040 00040	00040 00	
00041	00041 00041	00041 00	
00042	00042 00042	00042 00	
00043	00043 00043	00043 00	
00044	00044 00044	00044 00	
00045	00045 00045	00045 00	
00046	00046 00046	00046 00	
00047	00047 00047	00047 00	
00048	00048 00048	00048 00	
00049	00049 00049	00049 00	
00050	00050 00050	00050 00	
00051	00051 00051	00051 00	
00052	00052 00052	00052 00	
00053	00053 00053	00053 00	
00054	00054 00054	00054 00	
00055	00055 00055	00055 00	
00056	00056 00056	00056 00	
00057	00057 00057	00057 00	
00058	00058 00058	00058 00	
00059	00059 00059	00059 00	
00060	00060 00060	00060 00	
00061	00061 00061	00061 00	
00062	00062 00062	00062 00	
00063	00063 00063	00063 00	
00064	00064 00064	00064 00	
00065	00065 00065	00065 00	
00066	00066 00066	00066 00	
00067	00067 00067	00067 00	
00068	00068 00068	00068 00	
00069	00069 00069	00069 00	
00070	00070 00070	00070 00	
00071	00071 00071	00071 00	
00072	00072 00072	00072 00	
00073	00073 00073	00073 00	
00074	00074 00074	00074 00	
00075	00075 00075	00075 00	
00076	00076 00076	00076 00	
00077	00077 00077	00077 00	
00078	00078 00078	00078 00	
00079	00079 00079	00079 00	
00080	00080 00080	00080 00	
00081	00081 00081	00081 00	
00082	00082 00082	00082 00	
00083	00083 00083	00083 00	
00084	00084 00084	00084 00	
00085	00085 00085	00085 00	
00086	00086 00086	00086 00	
00087	00087 00087	00087 00	
00088	00088 00088	00088 00	
00089	00089 00089	00089 00	
00090	00090 00090	00090 00	
00091	00091 00091	00091 00	
00092	00092 00092	00092 00	
00093	00093 00093	00093 00	
00094	00094 00094	00094 00	
00095	00095 00095	00095 00	
00096	00096 00096	00096 00	
00097	00097 00097	00097 00	
00098	00098 00098	00098 00	
00099	00099 00099	00099 00	
00100	00100 00100	00100 00	
00101	00101 00101	00101 00	
00102	00102 00102	00102 00	
00103	00103 00103	00103 00	
00104	00104 00104	00104 00	
00105	00105 00105	00105 00	
00106	00106 00106	00106 00	
00107	00107 00107	00107 00	
00108	00108 00108	00108 00	
00109	00109 00109	00109 00	
00110	00110 00110	00110 00	
00111	00111 00111	00111 00	
00112	00112 00112	00112 00	
00113	00113 00113	00113 00	
00114	00114 00114	00114 00	
00115	00115 00115	00115 00	
00116	00116 00116	00116 00	
00117	00117 00117	00117 00	
00118	00118 00118	00118 00	
00119	00119 00119	00119 00	
00120	00120 00120	00120 00	
00121	00121 00121	00121 00	
00122	00122 00122	00122 00	
00123	00123 00123	00123 00	
00124	00124 00124	00124 00	
00125	00125 00125	00125 00	
00126	00126 00126	00126 00	
00127	00127 00127	00127 00	
00128	00128 00128	00128 00	
00129	00129 00129	00129 00	
00130	00130 00130	00130 00	
00131	00131 00131	00131 00	
00132	00132 00132	00132 00	
00133	00133 00133	00133 00	
00134	00134 00134	00134 00	
00135	00135 00135	00135 00	
00136	00136 00136	00136 00	
00137	00137 00137	00137 00	
00138	00138 00138	00138 00	
00139	00139 00139	00139 00	
00140	00140 00140	00140 00	
00141	00141 00141	00141 00	
00142	00142 00142	00142 00	
00143	00143 00143	00143 00	
00144	00144 00144	00144 00	
00145	00145 00145	00145 00	
00146	00146 00146	00146 00	
00147	00147 00147	00147 00	
00148	00148 00148	00148 00	
00149	00149 00149	00149 00	
00150	00150 00150	00150 00	
00151	00151 00151	00151 00	
00152	00152 00152	00152 00	
00153	00153 00153	00153 00	
00154	00154 00154	00154 00	
00155	00155 00155	00155 00	
00156	00156 00156	00156 00	
00157	00157 00157	00157 00	
00158	00158 00158	00158 00	
00159	00159 00159	00159 00	
00160	00160 00160	00160 00	
00161	00161 00161	00161 00	
00162	00162 00162	00162 00	
00163	00163 00163	00163 00	
00164	00164 00164	00164 00	
00165	00165 00165	00165 00	
00166	00166 00166	00166 00	
00167	00167 00167	00167 00	
00168	00168 00168	00168 00	
00169	00169 00169	00169 00	
00170	00170 00170	00170 00	
00171	00171 00171	00171 00	
00172	00172 00172	00172 00	
00173	00173 00173	00173 00	
00174	00174 00174	00174 00	
00175	00175 00175	00175 00	
00176	00176 00176	00176 00	
00177	00177 00177	00177 00	
00178	00178 00178	00178 00	
00179	00179 00179	00179 00	
00180	00180 00180	00180 00	
00181	00181 00181	00181 00	
00182	00182 00182	00182 00	
00183	00183 00183	00183 00	
00184	00184 00184	00184 00	
00185	00185 00185	00185 00	
00186	00186 00186	00186 00	
00187	00187 00187	00187 00	
00188	00188 00188	00188 00	
00189	00189 00189	00189 00	
00190	00190 00190	00190 00	
00191	00191 00191	00191 00	
00192	00192 00192	00192 00	
00193	00193 00193	00193 00	
00194	00194 00194	00194 00	
00195	00195 00195	00195 00	
00196	00196 00196	00196 00	
00197	00197 00197	00197 00	
00198	00198 00198	00198 00	
00199	00199 00199	00199 00	
00200	00200 00200	00200 00	
00201	00201 00201	00201 00	
00202	00202 00202	00202 00	
00203	00203 00203	00203 00	
00204	00204 00204	00204 00	
00205	00205 00205	00205 00	
00206	00206 00206	00206 00	
00207	00207 00207	00207 00	
00208	00208 00208	00208 00	
00209	00209 00209	00209 00	
00210	00210 00210	00210 00	
00211	00211 00211	00211 00	
00212	00212 00212	00212 00	
00213	00213 00213	00213 00	
00214	00214 00214	00214 00	
00215	00215 00215	00215 00	
00216	00216 00216	00216 00	
00217	00217 00217	00217 00	
00218	00218 00218	00218 00	
00219	00219 00219	00219 00	
00220	00220 00220	00220 00	
00221	00221 00221	00221 00	
00222	00222 00222	00222 00	
00223	00223 00223	00223 00	
00224	00224 00224	00224 00	
00225	00225 00225	00225 00	
00226	00226 00226	00226 00	
00227	00227 00227	00227 00	
00228	00228 00228	00228 00	
00229	00229 00229	00229 00	
00230	00230 00230	00230 00	
00231	00231 00231	00231 00	
00232	00232 00232	00232 00	
00233	00233 00233	00233 00	
00234	00234 00234	00234 00	
00235	00235 00235	00235 00	
00236	00236 00236	00236 00	
00237	00237 00237	00237 00	
00238	00238 00238	00238 00	
00239	00239 00239	00239 00	
00240	00240 00240	00240 00	
00241	00241 00241	00241 00	
00242	00242 00242	00242 00	
00243	00243 00243	00243 00	
00244	00244 00244	00244 00	
00245	00245 00245	00245 00	
00246	00246 00246	00246 00	
00247	00247 00247	00247 00	
00248	00248 00248	00248 00	
00249	00249 00249	00249 00	
00250	00250 00250	00250 00	
00251	00251 00251	00251 00	
00252	00252 00252	00252 00	
00253	00253 00253	00253 00	
00254	00254 00254	00254 00	
00255	00255 00255	00255 00	
00256	00256 00256	00256 00	
00257	00257 00257	00257 00	
00258	00258 00258	00258 00	
00259	00259 00259	00259 00	
00260	00260 00260	00260 00	
00261	00261 00261	00261 00	
00262	00262 00262	00262 0	

APPENDIX

I

APPENDIX I**BACKDATING****MANUAL CHANGES****MODEL 8403A
MODULATOR**

Make all backdating corrections in this manual according to changes below.

SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES	SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES
444-	A thru EE	1251A01516 to 02635	O thru EE
523-	B thru EE	1251A02636 to 02755	P thru EE
629-0065C and below	C thru EE	1413A02756 to 03015	Q thru EE
629-736-00875 and below	D thru EE	1413A03016 and above	R thru EE
736-01625 and below	E thru EE	1526A	S thru EE
736-	F thru EE	1541A	T thru EE
961-01825 and below	G thru EE	1611A	U thru EE
961-	H thru EE	1625A	V thru EE
1044A02055 and below	I thru EE	1734A03691 to 03760 and	W thru EE
1044A	J thru EE	03801 to 03840	
1150A and above	K thru EE	1734A03761 to 03800	X thru EE
1150A02276 to 02375	L thru EE	1734A03841 and above	Y thru EE
1150A02376 to 02475	M thru EE	1828A to 0400	Z thru EE
1150A02476 to	N thru EE	1828A04001 and above	AA thru EE
1251A02515		1903A	BB, CC, DD, EE
		1908A	CC, DD, EE
		1929A	DD, EE
		2014A	EE

CHANGE A:
(See Note 1)**Parts List:**

CR406 and CR413; Change to 1910-0016; Diode, Germanium; 100 Ma at 0.8V, 60 PIV.

NOTE

Diode CR406 is used with Transistor Q401 and Diode CR413 is used with Transistor Q403. If either transistor is replaced, then the diode used with it should be replaced with a diode type HP Stock No. 1901-0027 instead of the HP Stock No. 1910-0016.

CHANGE B:**Table 1-1:**

Change **EXTERNAL MODULATION, PULSE INPUT**, repetition rate to read, "Maximum average prf, 1 MC/sec. Maximum peak prf, 2 MC/sec."

Change graph to show curved "MAXIMUM REPETITION RATE" at 500 KHz between 0, 1 and 1 μ s "DELAY OR WIDTH, WHICHEVER IS GREATER."

CHANGE C:**Page 5-23, Figure 5-16 and Parts List:**

Change Q402 to 1850-0091.

CHANGE D:**Figure 5-16 and Parts List:**

Change stock number of Q407 to 1854-0010.

Change C604 to 200 pF, stock no. 0140-0198.

Change C605 to 62 pF, stock no. 0140-0205.

CHANGE E:

Parts List:

Change Q501, Q505, Q509 bushing transistor to 1200-0092.
Change Q501, Q505, Q509 insulator transistor to 1200-0076.

CHANGE F:

Page 2-1, Paragraph 2-7, under Power Requirements,
Delete Paragraph 2-8 and replace with the following:

2-8. The Model 8403A can be operated from either 115 or 230 volts, 50 to 100 Hz source. A slide switch (LINE VOLTAGE, S1) located on rear panel, converts the instrument for operation from 115 to 230 volts. A 1/4-ampere slow-blow fuse is used for both 115-volt and 230-volt operation.

Page 4-7, Paragraph 4-38, Duty Limit Indicator Circuit,
Replace Paragraphs 4-39 and 4-40 with the following:

4-39. The duty limit circuit is shown in Figure 14. The maximum duty cycle of the instrument is dependent on pulse-rate, delay, and width control settings. To insure that control settings do not result in a pulse which exceeds the duty cycle limit, a duty-limit circuit is provided for internal pulse mode only. If duty limit is exceeded the Duty Limit lamp will flash.

4-40. The circuit is supplied from primary power through INTERNAL pulse switch S3, half-wave rectifier (CR001), relaxation oscillator (R001-004, C001-0-3), and rate, delay, and width multiplier switches. When rate multiplier is in X1000 position and delay and/or width multipliers are in X10 positions, the relaxation oscillator drives Duty Limit lamp. This lamp is a neon lamp and some lamps will remain lit and not flash at high-line primary power (127 VAC - 115 VAC operation of 253 VAC - 230 VAC operation). For this reason resistor R002 is a selected value and will normally be either 681K ohm or any value between 000K ohm and 1 Megohm.

CHANGE F: (Cont'd)

Page 4-9, Figure 4-14:

Change Figure to Figure I1 below.

Page 5-13, Figure 5-5:

Change Figure with Figure I-2.

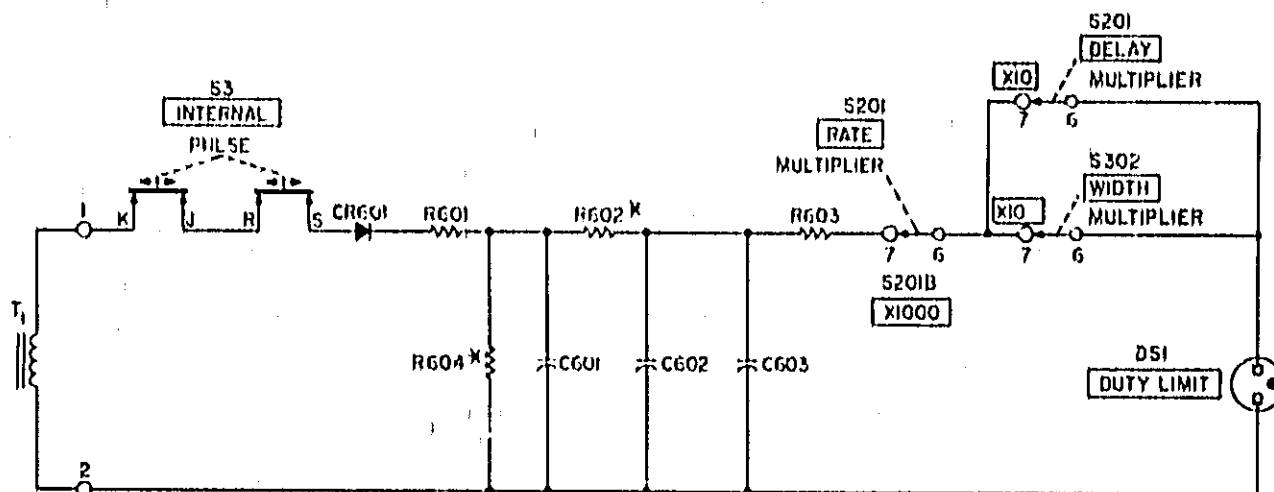
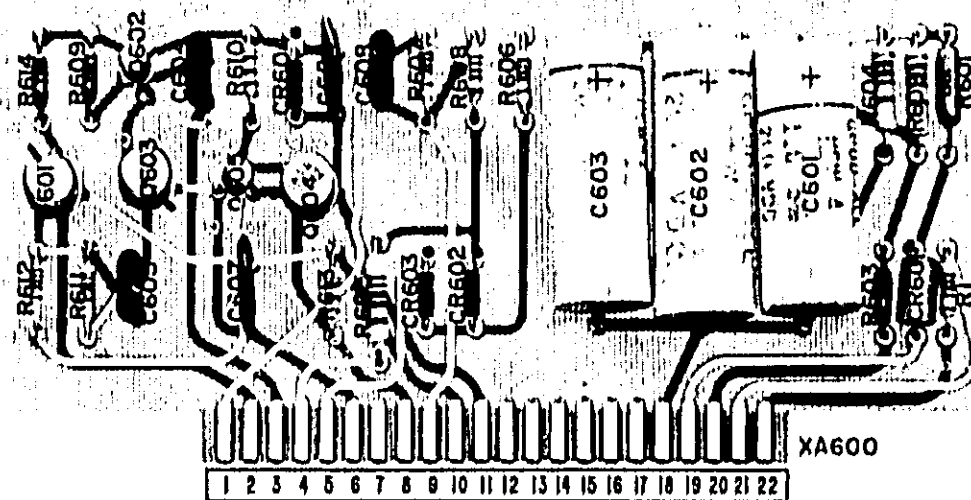


Figure I-1. Duty Limit Circuit (part of Change F)



CHANGE F: (Con'd)

Page 5-22, Figure 5-15:
Add pictorial shown below:



○-TRANSISTOR EMITTER
• DIODE CATHODE

Figure I-3. Duty Limit Assembly AG00 (part of Change F)

Page 5-15, Figure 5-18:

Add schematic describing "Part of A600 Duty Limit Assembly (08403-606).

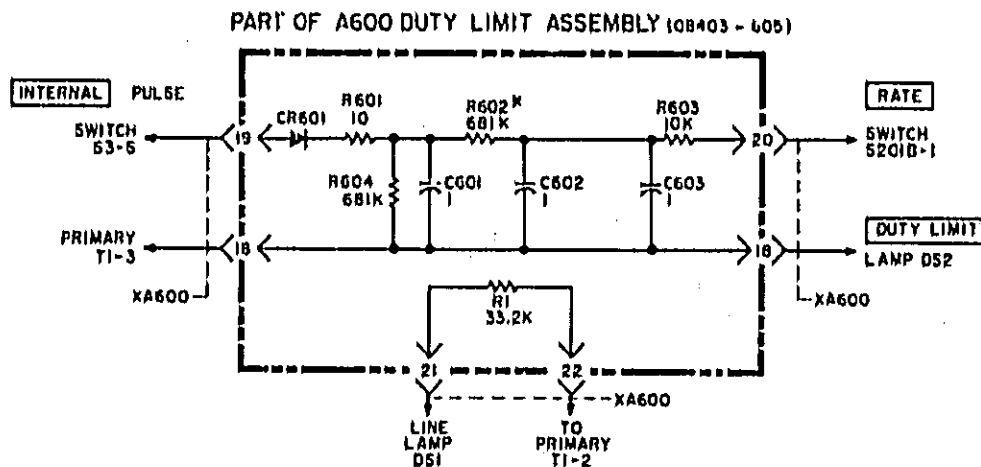


Figure I-4. Part of Regulated Power Supply (part of Change F)

Parts List:

Change: AGC Board Assembly: Duty Limit to HP No. 08403-605,
 Add: C601, C602, and C603, HP No. 0170-0018 CFXD MY 1uf, 5% 200 WVDC,
 Add: CR601, HP No. 1001-0020, Diode, Silicon 0.75A 400 PIV,
 Change: DS2 to HP No. 1450-0040,
 Change: F1 (115V) to HP No. 2110-0010,
 Change: FL1 to HP No. 0110-0006,
 Change: J2 to, "Part of FL1 NSR",
 Delete: R2
 Add: R601, HP No. 0757-0400, Rfxd MET FLM 10 ohm 1% 1/4W,
 R60 , HP No. 0757-0702, Rfxd MET FLM 681K ohm 1% 1/4W, factory
 selected,
 R603, HP No. 0757-0442, Rfxd MET FLM 10.0K ohm 1% 1/8W,
 R604, HP No. 0757-0702, Rfxd MET FLM 681K ohm 1% 1/4 W,
 Change: S2 to HP No. 3101-0033,
 Change: W1 to HP No. 8120-0070,
 Change: Front panel to HP No. 08403-001,
 Change: Rear panel to HP No. 08403-002,
 Delete: Cable Assy, AC, HP No. 08403-60000,

CHANGE G: Change DS1 to HP No. 1450-0040.

CHANGE H: Change DS1 to HP No. 1450-0410.

CHANGE I: Page 5-23, Figure 5-16 and Parts List
 Change C605 to 47pF HP Part No. 0160-0182

CHANGE J: Parts List:

Change 0370-1400 to 0370-0118,
 Change 0370-1877 to 0370-0028,
 Change 08403-00023 to 08403-00021,
 Change 5060-8580 to 5060-0740,
 Change 5060-8713 to 5060-0752,
 Change 5060-8739 to 5060-0774,
 Change 5000-8595 to 5000-0731.

NOTE

These numbers distinguish parts with different colors only. The parts described in Table 6-2 are functionally identical, more available and less expensive. They are the recommended replacement.

CHANGE K: Parts List:

Change DS1 to 1450-0420 4 LIGHT-IND WHITT. 4-DIA SLDREYE-TERM 28480 1450-0420
 Change R1 to 0757-0454 3 RESISTOR 33.2K 1% .125W F TC = 0 ±100 03202 C4-1/4-TC-3322-F

CHANGE L: Parts List:

Change R520 to 0757-0082 3 RESISTOR 1.21K 1% .5W MO TC=0 ±100 28480 0757-0082

CHANGE M: Parts List:

Change Q203 and Q204 to 1851-0023 3 TRANSISTOR NPN GE PD=75 MW 28480 1851-0023

CHANGE N: Parts List:

Change Q302, 3, 4, and 6 to 1850-0091 3 TRANSISTOR PNP 2N2048 GE TC=0 PD=150 MW
 28480 1850-0091

CHANGE O: Page 5-21, Figure 5-13:

Change the value of R320 and R360 to 2700Ω

Parts List:

Change the part number of C101, 106, 203, 213, 214, 302, 307, 309, 402—404, 406—409, 503, 510
 606, 607, 701—708 to 0160-2017
 Change R306 to R360 0757-0079 8 RESISTOR 2.7K 2% .25W F TC=0 ±100 03202
 C6-1/4-TC-2701-G

CHANGE P:

Page 5-15, Figure 5-7:

Change C205 and C208 to 0.0025 μ F.
 Change R430 to 475 Ω .

Parts List:

Change C205 and C208 to 0160-0147 6 CAPACITOR-FXD 2500 PF $\pm$ 2% 300VDC MICA
 28480 0160-0147

CHANGE Q:

Parts List:

Change the part number of C101, C108, C203, C213, C214, C302, C307, C309, C402-C404,
 C406-C409, C503, C510, C608, C607, and C701-C708 to 0160-3460.

CHANGE R:

Page 5-21, Figure 5-13:

Change R432* to CR416. The cathode should point to the base of Q404.

Parts List:

Change CR301, CR302, CR303, CR307, CR312, CR402, CR403, CR404, CR409 and CR411
 to 1910-0016 O DIODE-GE 80V 60MA 1US DO-7 28480 1910-0016.

Change Q302, Q303, Q305, and Q306 to 1850-0091 3 TRANSISTOR PNP 2N204B GE TO-9
 PD-150MW 28480 1850-0091

Delete: R432*

Add: CR416 1901-0347 1 DIODE-SCHOTTKY 8V 28480 1901-0347.

CHANGES:

Page 5-15, Figure 5-7:

Change the wiring diagram as shown in the partial schematic.

Page 5-17, Figure 5-9:

Change the diagram as shown in the partial schematic.

Parts List:

Change CR402 and CR403 to 1901-0050 DIODE-SWITCHING 2NS 80V 200MA, 28480,
 1901-0050

Change Q302, Q303, Q305, and Q306 to 1853-0307 7 TRANSISTOR PNP 2N3251 SI TO-18
 PD-360MW 02037 2N3251

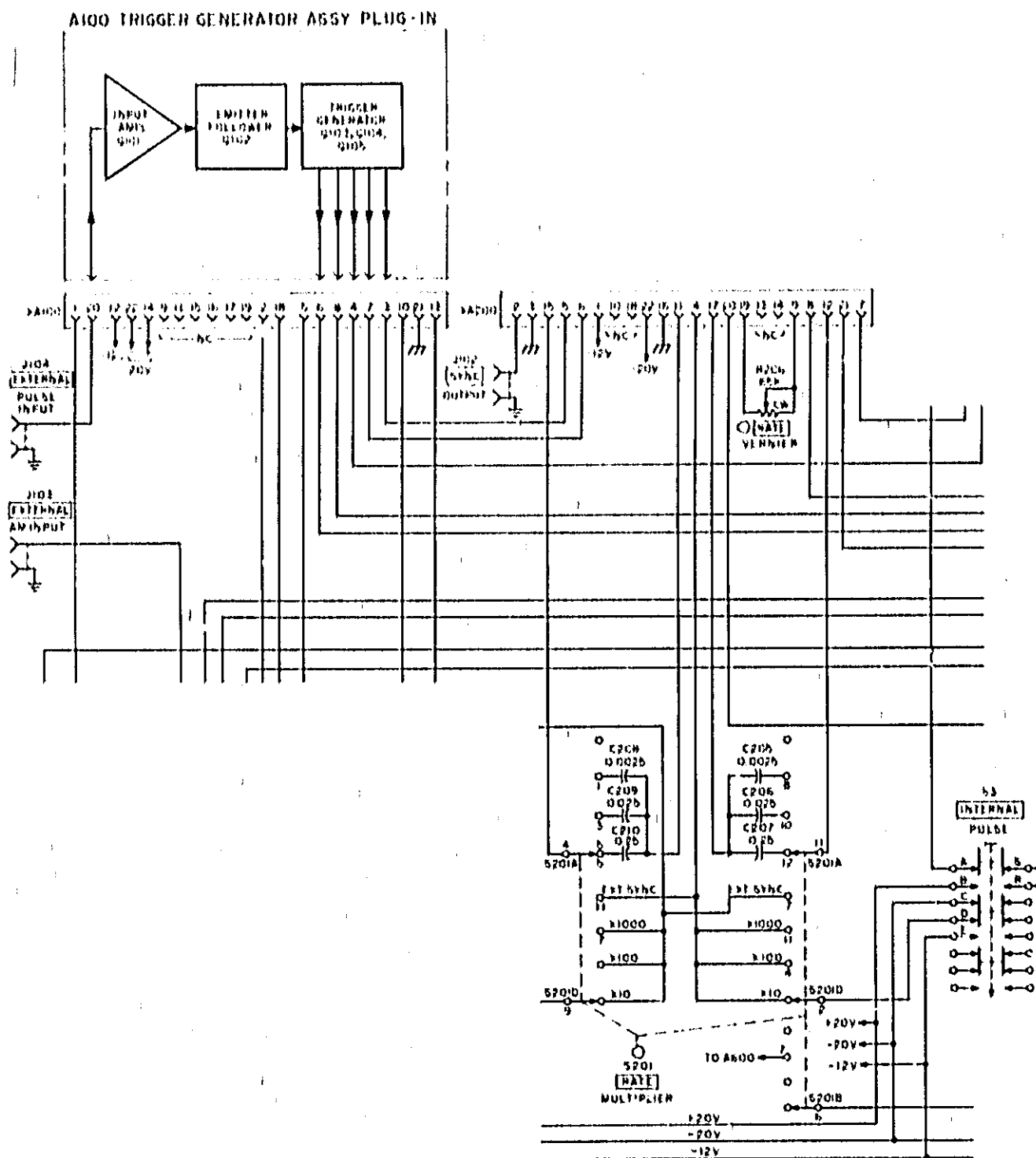


Figure I-5. Modulation Circuit Wiring Diagram (Partial Schematic; Part of Change S)

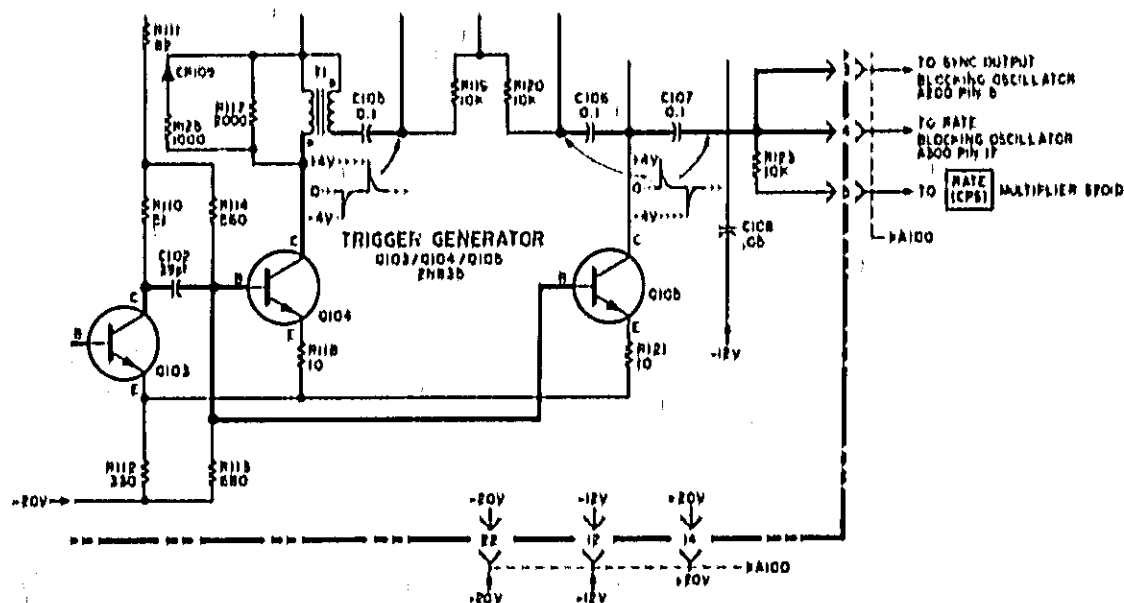


Figure I-6. Trigger Generator Circuit (Partial Schematic; Part of Change S)

CHANGE T:

Page 5-15, Figure 5-7:

Change the figure as shown in the partial schematic.

Parts List:

Change R415 to 0698-3258 5 RESISTOR 5.36K 1% .125W F TC-01100 03292
C4-1/8-TO-215R-F.

CHANGE U:

Page 5-15, Figure 5-7:

Change the figure as shown in the partial schematic.

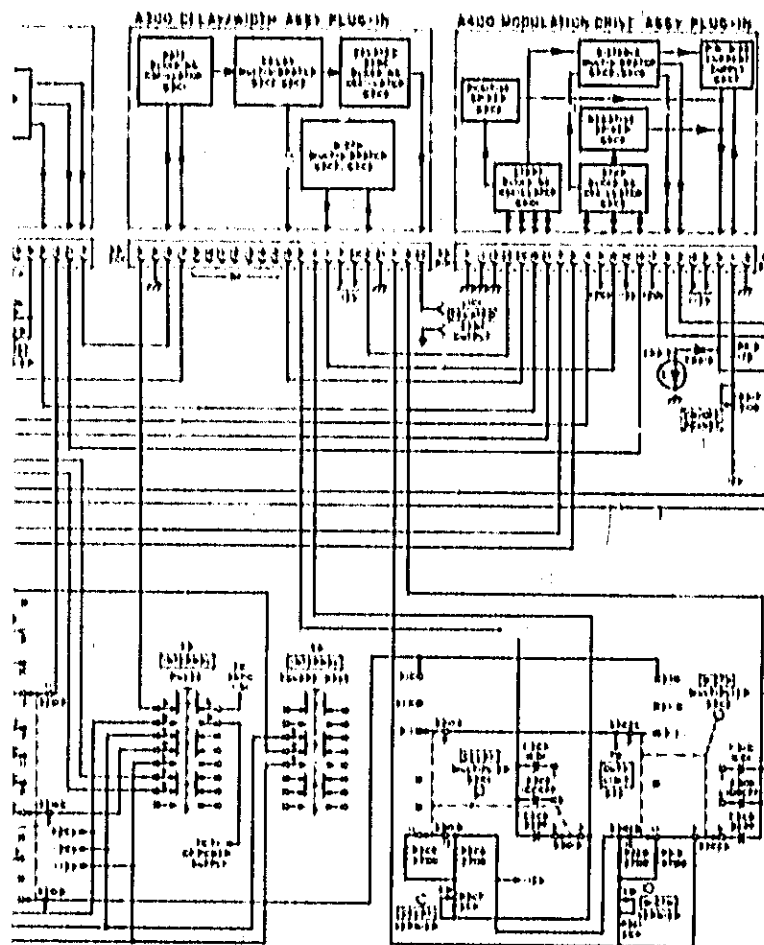


Figure I-7. Modulation Circuit Wiring Diagram (partial schematic; part of Change T)

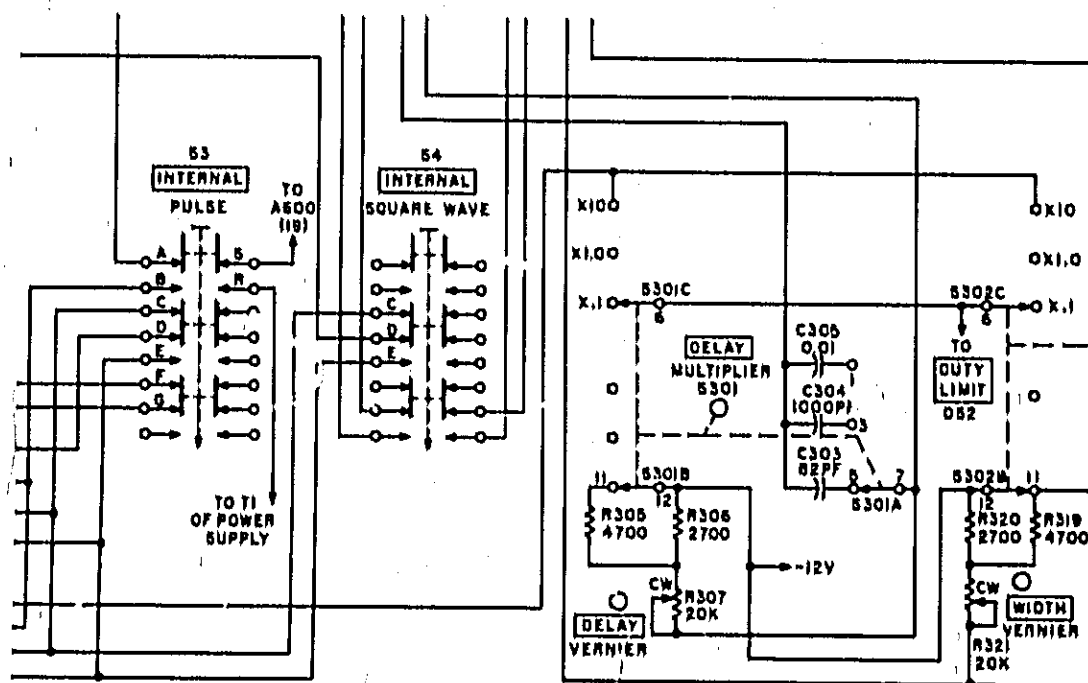


Figure I-8. Modulation Circuit Wiring Diagram (partial schematic; part of Change U)

CHANGE V:

Page 5-23, Figure 5-16:

Change C604 to 39 pF.

Change C605 to 47 pF.

Add R611, 4320 Ω , in parallel with C605.

Parts List:

Change C604 to 0140-0190 7 CAPACITOR-FXD 39PF $\pm$ 5% 300VDC MICA 04522

DM16E390J0300WV10R

Change C605 to 0160-0182 9 CAPACITOR-FXD 47PF $\pm$ 5% 300VDC MICA 28480

0160-0182

Change Q603 to 1854-0035 3 TRANSISTOR NPN SI TO-5 PD-800M μ 28480 1854-0035Add: R611 0757-0436 1 RESISTOR 4.32K 1% .125W F TC-0 $\pm$ 100 03292 C5-1/8-TO-4321-F

CHANGE W:

Page 5-17, Figure 5-9:

Add: R117, 2000 Ω , in parallel with the primary of T101Change R125 to 1000 Ω

Parts List:

Add R117 0758-0033 6 RESISTOR 2K 5% .25W F TC-0 $\pm$ 100 03292 C5-1/4-TO-2001-JChange R125 to 0758-0003 0 RESISTOR 1K 5% .25W F TC-0 $\pm$ 100 03292 C5-1/4-TO-1001-J

CHANGE X:

Page 5-13, Figure 5-5:

Change the figure as shown in the partial schematic below.

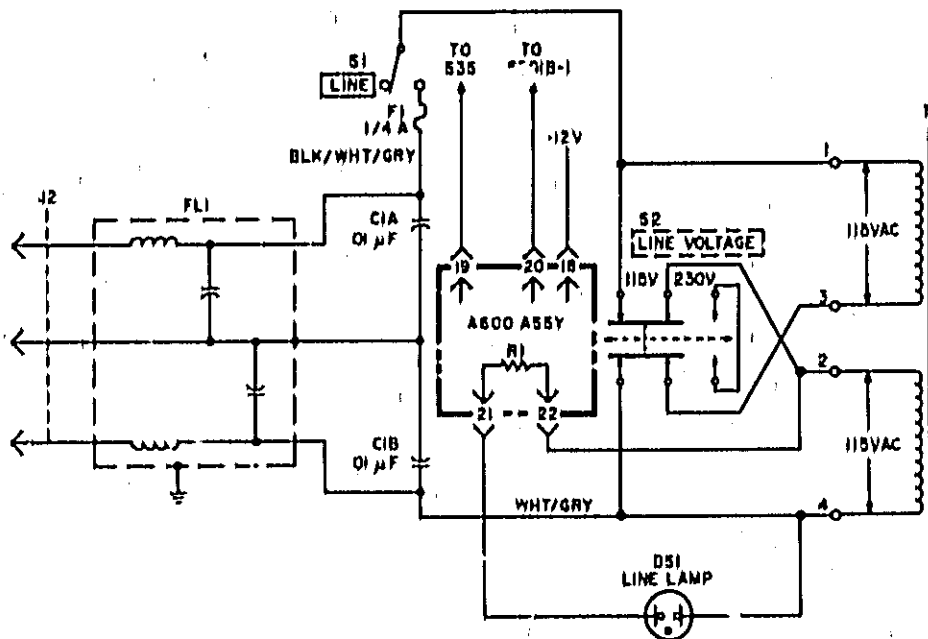


Figure I-9. Power Supply Wiring Diagram (partial schematic; part of Change X)

CHANGE Y:

Parts List:

Replace the fuseholder parts with the following:

YF1 2110-0470 5 FUSEHOLDER BODY EXTR POST; BAYONET IND 04703 345003-010

2110-0465 1 FUSEHOLDER CAP EXTR PST; BAYONET; 20A 28480 2110-0465

1400-0090 9 WASHER RUBBER 5/8" OD, 00000, OBD

2110-0467 0 NUT, HEX SINGLE CHAMFER 1/2-28 THREAD 75915, 903-070

CHANGE Z:

Parts List:

Change C604* to C604 0160-2204 0 CAPACITOR-FXD 100 PF $\pm$ 5% 300WVDC MICA

Change C605* to C605 same part number and description as C604.

CHANGE AA:

Parts List:

Change the Q501, Q505, and Q509 listing as follows:

1850-0061 0 TRANSISTOR PNP 2N1183 GE TO-8-PP-7 .5W 01021 2N1183

0340-0487 0 INSULATOR-XSTR ALUMINUM 28480 0340-0487

1200-0087 0 CLAMP-TRANSISTOR FOR TO-8 OUTLINE XSTR 28465 1 100-0087

CHANGE BB:

Page 5-1, Table 5-2:

Change the -12V adjustment to R507

Change the footnote at the bottom of the table to: "Set the +20 volt supply adjustment R507 first. Set the -20 volt supply adjustment R519 second. The -12 volt supply adjustment R507 should not need adjustment as it is referenced to the +20 volt supply. If R507 is adjusted for the -12 volt supply, all supplies should be checked again."

Page 5-1, paragraph 5-7:

Add the following to sub-paragraph a:

"Remove power supply, plug-in A500 and replace with a plug-in extender (supplied with instrument) to make power supply adjustments accessible."

CAUTION

**NEVER REMOVE OR INSTALL POWER SUPPLY PLUG-IN WITH POWER ON.
THE TRANSISTORS IN ALL THREE POWER SUPPLIES CAN BE DAMAGED.**

Page 5-25, Figure 5-18:

Change A500 part number to 08403-610.

Delete CR516, CR517, and CR518. Replace them with straight lines.

Change R507 to 250Ω.

Change R519 to 100Ω.

Change R512 to 1240Ω.

Delete R525. Replace it with a straight line.

Parts List:

Change A500 part number to 08403-610

Delete CR516, CR517, and CR518

Change Q502, Q503, Q504, Q506, Q507, Q508, Q510 and Q511 to 1850-0062 8

TRANSISTOR PNP GE TO-5 PD-150MW 28460 1850-0062

Change R507 to 2100-0128 0 RESISTOR-VAR CONTROL CP 250 20% LIN 28480 2100-0128

Change R519 to 2100-0108 5 RESISTOR-VAR CONTROL CP 100 30% LIN 28480 2100-0108

Change R521 to 0757-0083 4 RESISTOR 1.24K 1% .5W F TC-01100 28480 0757-0083

Delete R525.

CHANGE CC:

Page 5-13, Figure 5-5:

Change the line voltage input portion of the schematic according to the partial schematic below.

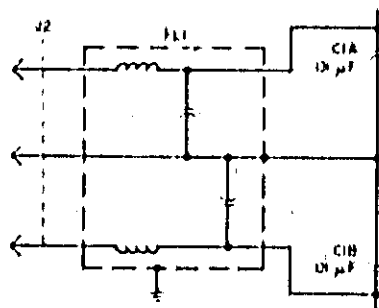


Figure I-10. Power Supply Wiring Diagram (partial schematic; part of Change CC)

Page 5-15, Figure 5-7:

Replace Figure 5-7 with Figure I-11.

APPENDIX

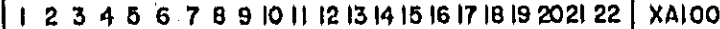
I

CON'T

CHANGE CC (Cont'd)

Page 5-16, Figure 5-8:

Replace Figure 5-8 with the one below.



- ### TRANSISTOR EMITTER

- ANODE

- + POSITIVE SIDE OF CAPACITOR

Figure 1-12. Trigger Generator Assembly (A100) (part of Change CC)

Page 5-16, Figure 5-9:

Replace Figure 5.9 with the one below,

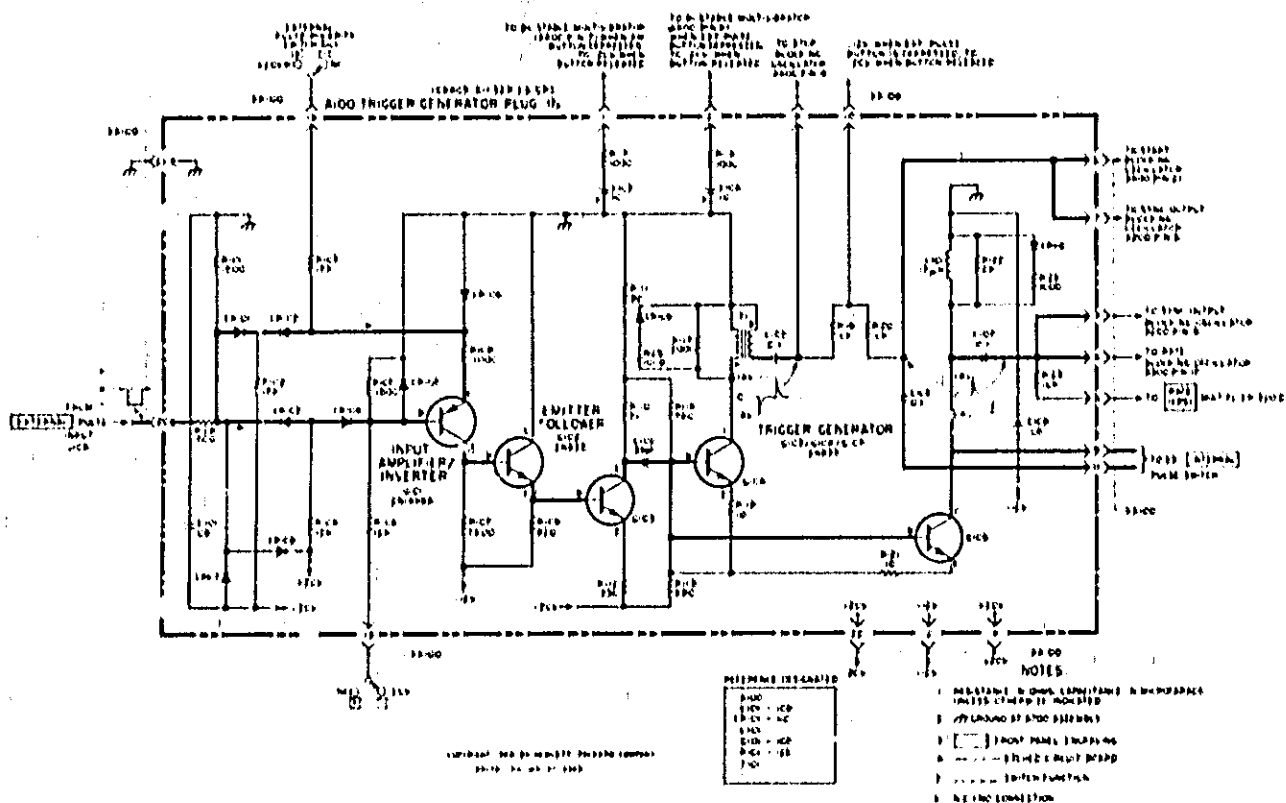
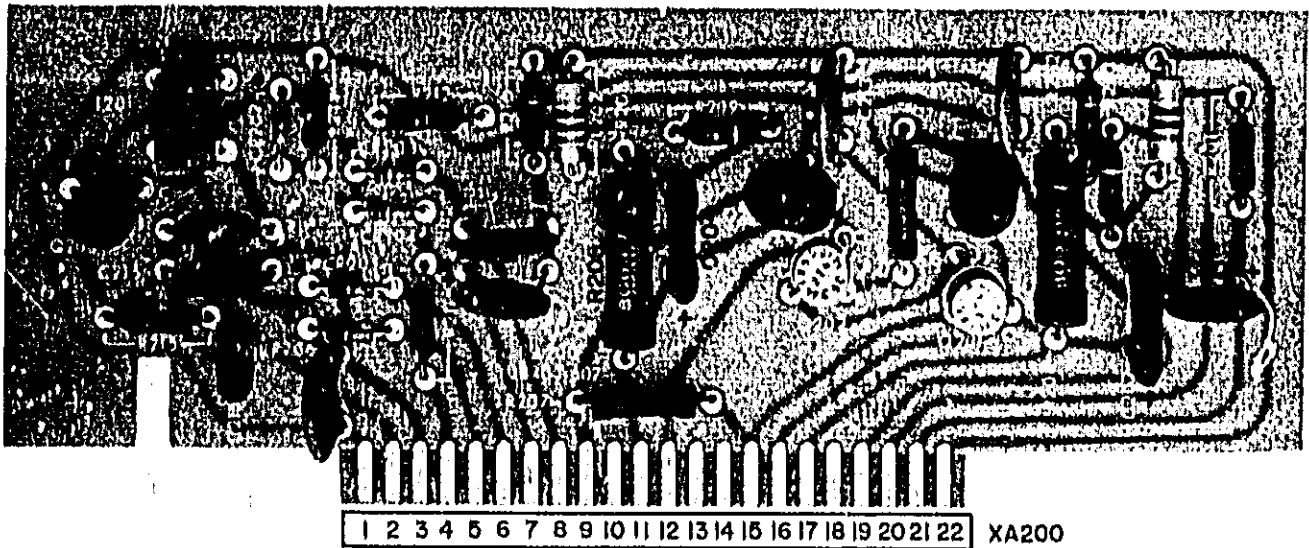


Figure I-13. Trigger Generator Circuit (part of Change CC)

CHANGE CC: (Cont'd) Page 5-18, Figure 5-10:

Replace Figure 5-10 with 1-14 in this change.

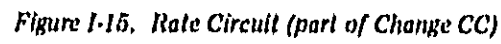


- ⊕ TRANSISTOR EMITTER
- ANODE
- + POSITIVE SIDE OF CAPACITOR

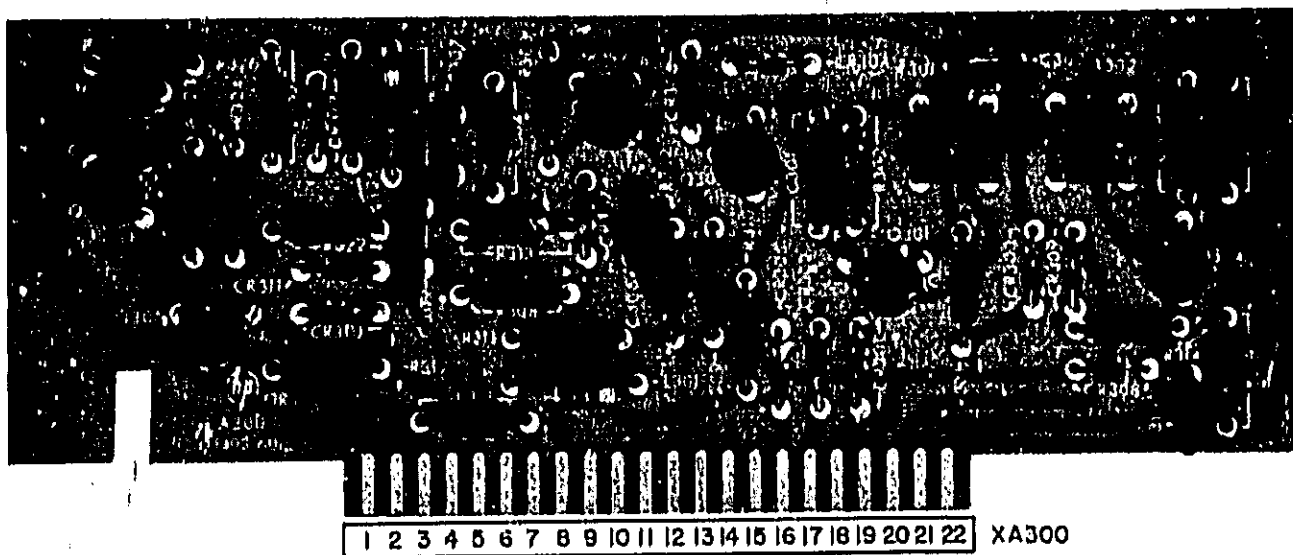
Figure 1-14. Rate Assembly (A200) (part of Change CC)

Page 5-19, Figure 5-11:

Replace Figure 5-11 with Figure 1-15 of this change.



CHANGE CC: (Cont'd) Page 5-20, Figure 5-12:
Replace Figure 5-12 with Figure I-16 in this change.



- TRANSISTOR EMITTER
 • ANODE
 † POSITIVE SIDE OF CAPACITOR

Figure I-16. Delay/Width Assembly (A300) (part of Change CC)

Page 5-21, Figure 5-13:

Replace Figure 5-13 with Figure I-17 in this change.

Change A100 part number to 08403.611.

Change C1 to 0150-0119 1 CAPACITOR-FXD 0,01 UF/0,01 UF $\pm$ 20% 28480 0150-0119.

Delete CR208 and CR209.

Delete Q106, Q107, Q307, and Q308.

Delete R127 and R128.

Delete R217 -219, R330, and R331.



CHANGE DD

Page 1-0, Table 1-1:

Change Power Requirements to 115 or 230 volts $\pm 10\%$ 50 to 440 Hz, approximately 20 watts.

Page 5-17, Figure 5-9:

Change Q107 to 1854-0637.

Page 5-19, Figure 5-11:

Replace Figure 5-11 with Figure I-18. Instruments with serial number prefixes 1908A and 1929A may have this circuit configuration.

Page 6-8, Table 6-2:

Change Q107 to 1854-0637 1 TRANSISTOR NPN 2N2219A SI TO-18 PD - 800 MW 01295 2N2219A.

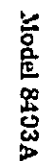


Figure 1-18, Rate Circuit (part of Change DD)

CHANGE EE

Page 5-18, Figure 5-10:

Replace Figure 5-10 with Figure I-10,

Page 5-19, Figure 5-11:

Replace Figure 5-11 with Figure I-20.

Page 6-5, Table 6-2:

Replace all A200 reference designators with those found in Table I-1.

Page 6-11, Table 6-2:

Change 08403-00030 to 08403-009 Rate Knob (vernier).

Delete 0360-0270 0 Terminal-Solder Lug.

Delete 2360-0115 4 Screw-Machine 6-32 x 0.31).

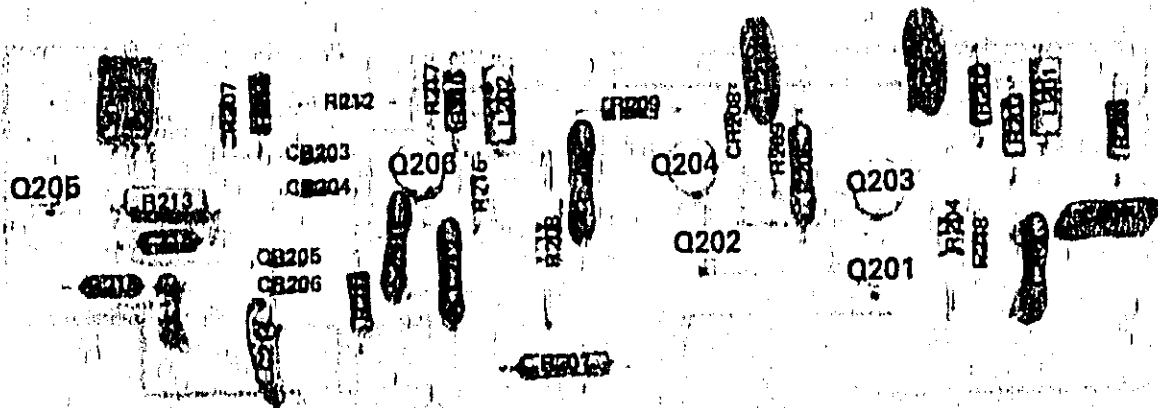


Figure I-18, Rate Assembly (A200) (part of Change EE)



APPENDIX

II

APPENDIX II - OPTIONS 001-009¹

References to Options 001 through 009 are made throughout this Appendix. However, Option 001, 003, 005 and 007 have been obsoleted and are no longer available. The references remain in the Appendix for information purposes only.

The 8403A-Option 001 through 008 instruments consist of a PIN Modulator mounted internally with the type N RF input and output connectors of the PIN Modulator protruding from the front panel in place of PULSE OUTPUTS connectors. The specially shaped output connector is removed from the instrument and the BIAS connector of the PIN Modulator is connected directly to the J105 internally. The general purpose output cable and connector assembly is mounted on the instrument rear panel.

SPECIFICATIONS

The specifications for the Model 8403A-Option 001 through 008 are the same as those of the standard Model 8403A except for the addition of RF, RF INPUT and OUTPUT CHARACTERISTICS (applied to RF input and output connectors of PIN MODULATOR protruding from front panel). Option 009 provides for the Sync output and external modulation input connectors to be located on the rear panel and for the pulse output (or RF input and output) connectors to also be located on the rear panel only. Additional specifications are listed in Table I.

Table II-1. RF Input/Output Specifications for Model 8403A — Options 001 to 008

	001	002	003	004	005	006	007	008
Frequency Range (GHz)	0.8-2.4	0.8-2.4	1.8-4.5	1.8-4.5	3.7-8.3	3.7-8.3	7.0-12.4	7.0-12.4
Dynamic Range (dB)	35	80	35	80	35	80	35	80
Max Residual Atten.(dB) ¹	< 2.0	< 2.0	< 2.5	< 3.5 ²	2.5	< 3.5	< 4.5	< 5.5
Typical Rise Time (nsec) ³	40	30	40	30	30	30	30	30
Typical Decay Time (nsec) ³	30	20	30	20	20	20	20	20
SWR, Min Attenuation	1.5	1.6	1.5	1.6 ⁴	1.8	2.0	1.8	2.0
SWR, Max Attenuation	1.8	2.0	1.8	2.0	2.0	2.2	2.0	2.2
Maximum Input Power, Peak or CW (watts)	1	1	1	1	1	1	1	1
1. +5V bias 2. <3.5 dB, 1.8 to 4 GHz; <4 dB, 4 to 4.5 GHz 3. Driven by HP 8403A Modulator 4. 1.6 SWR, 1.8 to 4 GHz; 2.0 SWR 4 to 4.5 GHz.								

A list of component parts and the PIN Modulator which is included with/or may be ordered for each 8403A-Option is given in Table 2. Details of mounting location, replaceable parts identification, and electrical adjustment of 8403A for use with internally mounted PIN Modulator are included in this appendix. Also, a discussion of operation, usage, and principles of operation for the PIN Modulators is included in the Operating Note (8730A/B-series), a copy of which has been printed into this appendix. Note: additional copies of this Operating Note can be obtained from your local Hewlett-Packard field office upon request.

INSTALLATION PROCEDURE.

1. TOOLS REQUIRED.

- a. Screwdriver
- b. Gas pliers with nylon teeth

2. 8403A PREPARATION

- a. Remove 8403A top and bottom covers and disconnect BNC-to-BNC cable assembly connected between J105 and J107 (Refer to Figure 1).
- b. Disconnect cable connection to J106.
- c. Disconnect both front panel BNC-to-BNC connector adapters (J106 and J107) from instrument.

¹ Formerly Options 01-09.

d. Remove one of the rear panel plug-buttons from 8403A and attach one of the BNC-to-BNC connector adapters (J106 or J107) in hole at rear panel.

e. Pull BNC cable removed from J106 through instrument deck hole indicated in Figure 1 and connect to newly installed rear panel connector (this connector is now the General Pulse Output J106).

3. OPTION INSTALLATION.

a. Refer to Figure 2 and remove spacer and lock nut from both PIN Modulator type N connectors.

b. For installation of 8403A Options 002 and 004, refer to Figure 3 for the following procedure. For installation of all other 8403A options, refer to Figure 4.

c. Attach rigid cable assembly to PIN Modulator as illustrated in Figure 4 (Note: for 8403A Options 002 and 004, the rigid cable assembly is not shown because it is not used).

NOTE

Before installation of PIN Modulator in 8403A, note current value stamped on label attached to underside of PIN Modulator. This value should be recorded since it will be needed for instrument adjustment prior to usage.

d. Place PIN Modulator in 8403A as illustrated.

e. Holding PIN Modulator in place, place 8403A on one side and attach mounting hardware to PIN Modulator through 8403A deck.

f. Place 8403A back on bottom and attach one lock nut to each type N connector protruding through 8403A front panel.

g. Be sure that both lock nuts and the two retaining screws are tightly attached.

h. Using the cable removed from J105 in the 8403A PREPARATION procedure above, connect J105 to PIN Modulator BIAS connector.

4. ELECTRICAL ADJUSTMENT.

a. Before instrument can be used, the ON/OFF ADJ adjustment procedure must be performed. For ON/OFF adjustment procedure, refer to Page 3-1 of this manual.

b. To perform adjustment procedure, remove cable connecting J105 to PIN Modulator BIAS connector. After adjustment, replace cable connection and replace 8403A top and bottom covers.

Table II-2. Parts Supplied for 8403A - Option Mounting

Option	PIN Modulator	Rigid Cable Assembly	Mounting Hardware (Req'd number - 2 ea.)
001	8731A	08403-20111	Machine screw, 6-32 x 3/8" (hp Stock No. 2390-0008)
002	8731B	not any	
003	8732A	08403-20011	
004	8732B	not any	Flat washer, #6 x 0.3125" O.D. (hp Stock No. 3050-0010)
005	8733A	08403-20012	
006	8733B	08403-20009	Lock washer, spring, #6 (hp Stock No. 2190-0018)
007	8734A	08403-20012	
008	8734B	08403-20009	

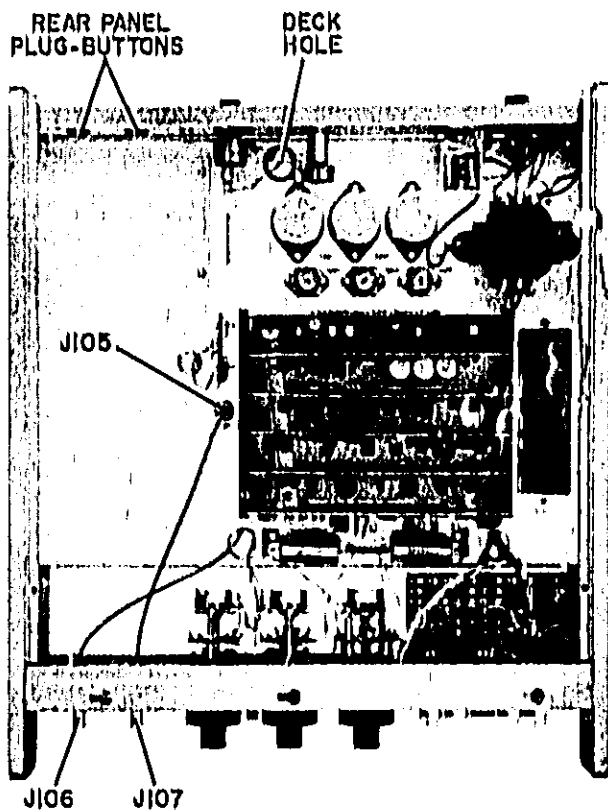


Figure 1. Model 8403A Bottom View
(No installed Options)

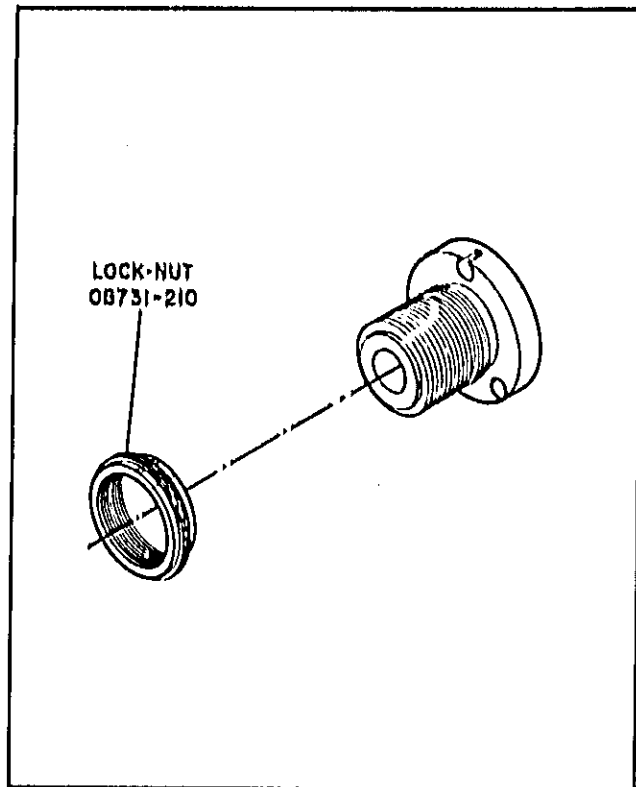


Figure 2. PIN Modulator Type N Connector

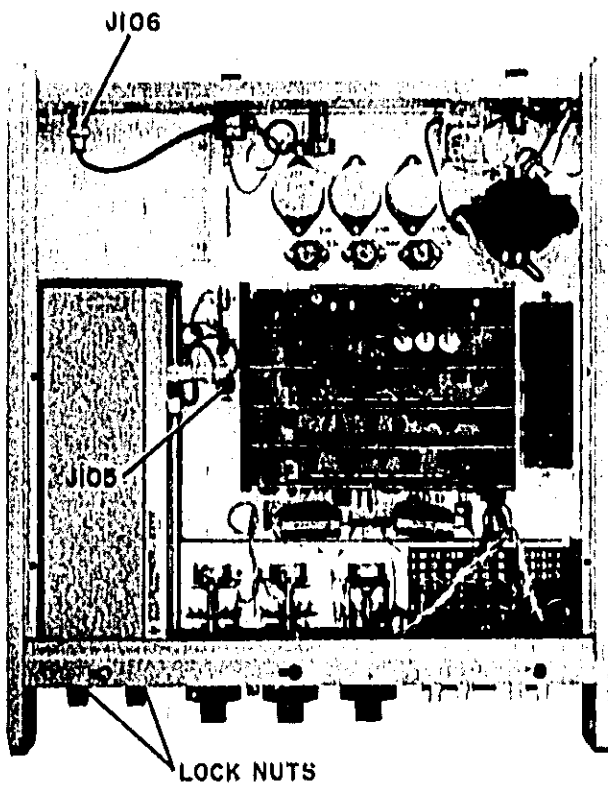


Figure 3. Model 8403A with Option 002 Installed
(Option 004 is mechanically identical)

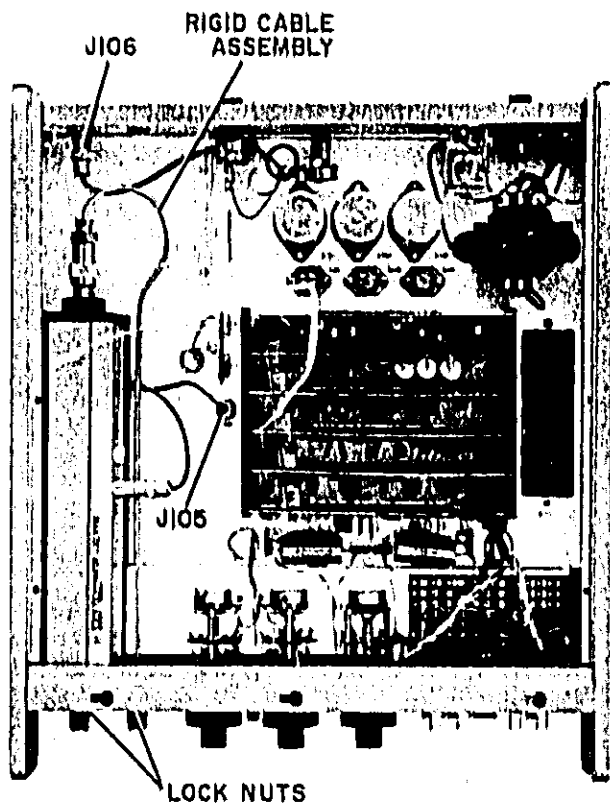


Figure 4. Model 8403A with Option 006 Installed
(Options 001, 003, 005, 007, 008 are mechanically similar)

APPENDIX

III

PIN MODULATORS

series
8730A/B

References to the HP 8730A series of PIN modulators are made throughout this appendix, however, they have been obsoleted and are no longer available. The references remain in the Appendix for information purposes only.

OPERATING NOTE 1 APR 65

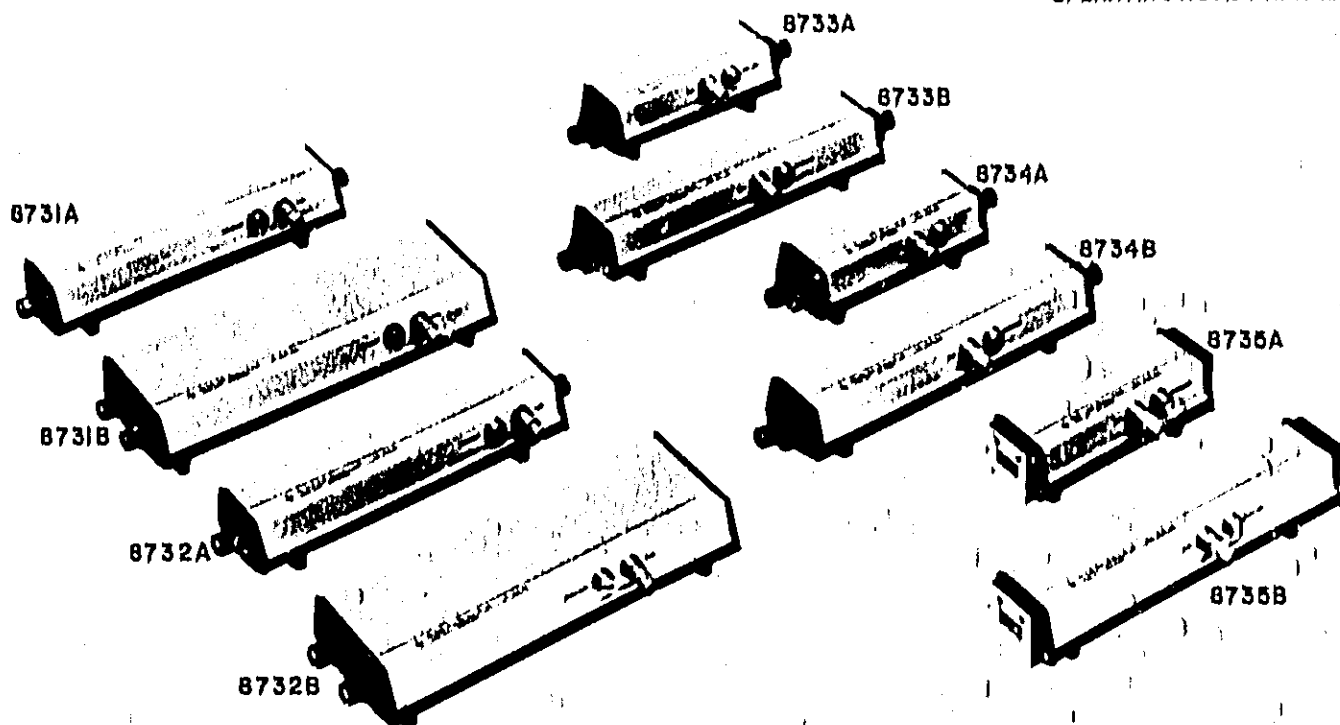


Figure 1. Model 8730 Series PIN Modulators

1. INTRODUCTION.

2. The Hewlett-Packard 8730 series of PIN modulators (Figure 1) are variable RF attenuators whose input and output impedance is nearly constant for all levels of attenuation. The 8730 PIN Modulators cover the coaxial range from 0.8 to 12.4 GHz in four overlapping bands in addition to X-band in waveguide. Two models are available in each band: an "A" model which provides at least 35 dB of attenuation range, and a "B" model which provides at least 80 dB. Typical uses include pulsing, switching, leveling, and amplitude modulating of RF signals. Table 1 lists complete PIN Modulator specifications.

3. PRECAUTIONS.

4. **MAXIMUM RF POWER.** The maximum input rating (peak or CW) for the PIN Modulators is 1 watt. Excessive RF power levels will cause internal damage.

5. **MAXIMUM BIAS INPUT.** DC voltage applied to the BIAS input must not exceed +20 volts or -10 volts. Excessive DC voltages may cause internal damage.

6. STORAGE AND SHIPMENT.

7. **ENVIRONMENT.** Temperature during storage or shipment should be limited as follows:

- a. Maximum temperature: 140°F (+65°C).
- b. Minimum temperature: -40°F (-40°C).
- c. Humidity Maximum: 95%.

8. **PACKAGING.** To protect the 8730 PIN Modulators during storage or shipment, always use the best packaging methods available. The following suggested steps can be used as a guide for packaging.

- a. The original carton, if undamaged, can be re-used.
- b. If the original carton is not usable, a double-walled carton (200 lb/sq inch bursting test) should be used.
- c. Wrap instrument in heavy protective paper to avoid abrasion.
- d. Place in carton, surrounded by at least four inches of tightly packed shock absorbing material.
- e. Seal carton with strong tape or metal bands.

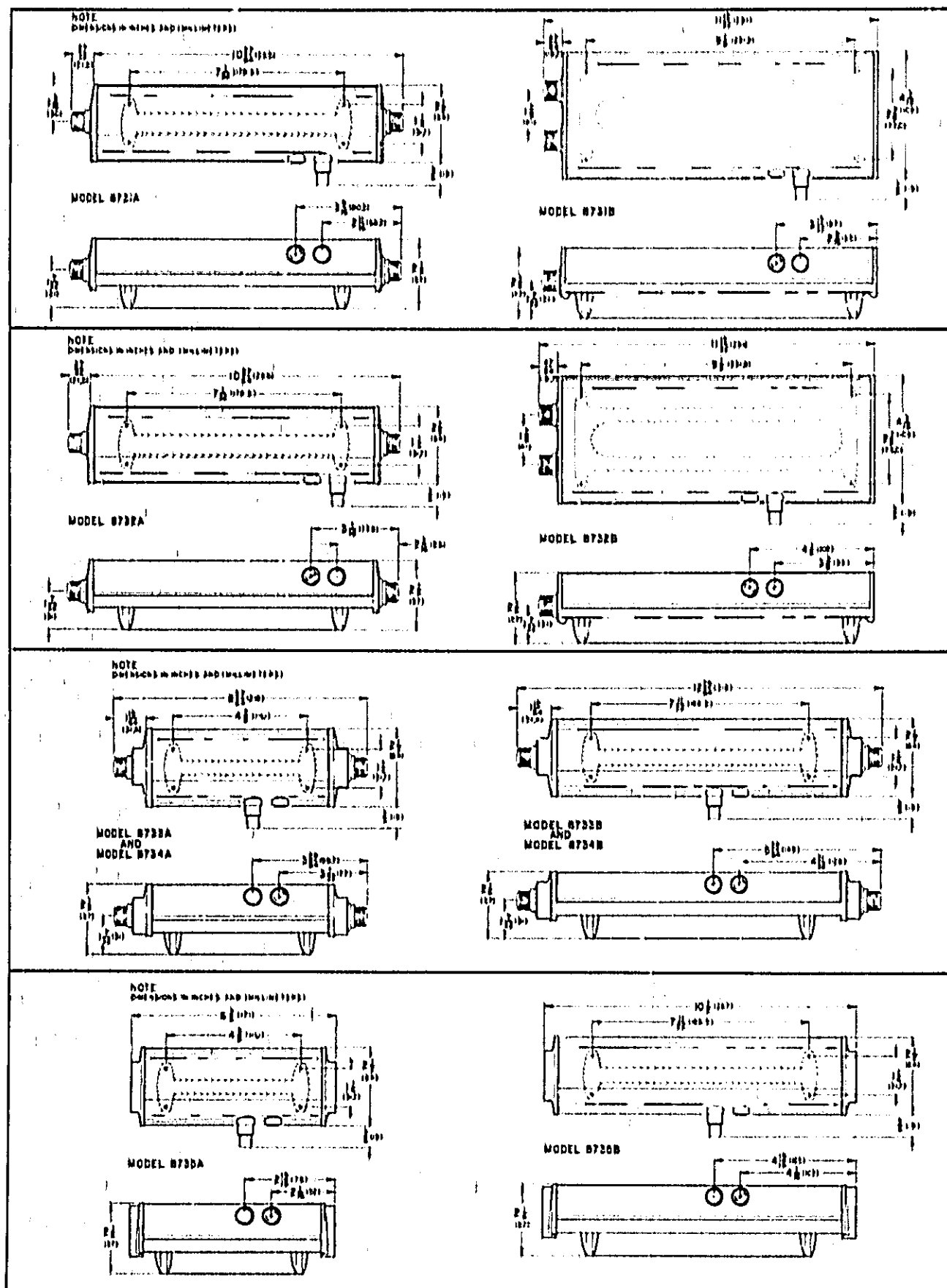


Figure 2. General Outside Dimensions

Table 1. Specifications

	8731A	8731B	8732A	8732B	8733A	8733B	8734A	8734B	8735A	8735B
Frequency Range (gc)	0.8-2.4	0.8-2.4	1.8-4.5	1.8-4.5	3.7-8.3	3.7-8.3	7.0-12.4	7.0-12.4	8.2-12.4	8.2-12.4
Dynamic Range (db)	35	40	35	40	35	40	35	40	35	40
Min. Insertion Loss (db) ¹	< 1.5	< 2.0	< 2.0	< 3.5 ²	2.0	< 3.0	< 4.0	< 5.0	< 4.0	< 5.0
Typical Rise Time (nsec) ³	40	30	40	30	30	30	30	30	30	30
Typical Decay Time (nec) ³	30	20	30	20	20	20	20	20	20	20
SWR, Minimum Attenuation	1.5	1.6	1.5	1.6 ⁴	1.8	2.0	1.8	2.0	1.7	1.9
SWR, Maximum Attenuation	1.8	2.0	1.8 ⁵	2.0	2.0	2.2	2.0	2.2	2.0	2.2
Maximum Input Power, Peak or CW (watts)	1	1	1	1	1	1	1	1	1	1
Bias Limits (volts) ⁶	+20, -10	+20, -10	+20, -10	+20, -10	+20, -10	+20, -10	+20, -10	+20, -10	+20, -10	+20, -10
Typical Forward Bias Input Resistance (ohms) ⁶	300	100	300	100	300	100	300	100	300	100
RF Connector Type	N ⁸	N ⁸	N ⁸	N ⁸	N ⁸	N ⁸	N ⁸	N ⁸	W G ⁷	W G ⁷
Weight (lbs)	2-3/4	5-1/2	2-3/4	5-1/2	2	3	2	3	2	3
(kg)	1.2	2.5	1.2	2.5	0.9	1.4	0.9	1.4	0.9	1.4
Dimensions	Illustrated in Figure 2									

1. +5 bias
2. 4.0, 4.0 to 4.5 GHz
3. Driven by HP 8403A Modulator
4. 2.0, 4.0 to 4.5 GHz

5. Negative voltage applies forward bias to diodes
6. At attenuation levels of 10 dB or more
7. Fits 1 x 1/2 in. (WR 90) waveguide
8. Standard female type N

9. 1.8, 1.8 to 4.0 GHz;
2.0, 4.0 to 4.5 GHz.

9. PERMANENT MOUNTING.

10. Four 6-32 tapped mounting holes have been provided for mounting purposes. The location of these holes and the overall external dimensions of the PIN Modulators are illustrated in Figure 2.

CAUTION

Also on the PIN Modulator underside are the four cover retaining screws and the PIN diode retaining screws. Any movement or adjustment of diode retaining screws will cause permanent damage.

11. PRINCIPLES OF OPERATION.

12. The PIN Modulator is a high-speed, current-controlled absorption type attenuator. A simplified illustration of the modulator is shown in Figure 3. Each PIN unit includes a low-pass filter, two high-pass filters, a number of PIN diodes, and a 50-ohm strip transmission line (ridged waveguide in the higher frequency Model 8733, 8734, and 8735 units).

13. The PIN diode is a silicon junction diode whose P and N trace regions are separated by a layer of intrinsic (I) semiconductor (silicon). Thus the name PIN diode. At frequencies below about 100 MHz the PIN diode rectifies as a junction diode. However, at frequencies above 100 MHz, rectification ceases due to stored charge in the intrinsic (I) layer and the diode acts like a resistance by conducting current in both directions. This equivalent resistance is inversely proportional to the amount of charge in the I layer. An increase in forward bias current (current at a negative voltage) increases the stored charge and decreases the equivalent resistance of the PIN diodes. When reverse bias is applied, reverse current flows until stored charge is depleted at which time equivalent resistance becomes a maximum in the order of thousands of ohms.

14. PIN DIODES IN SHUNT. To understand how a PIN Modulator works, consider the following: the PIN diodes are mounted as shunt elements between the RF transmission path and ground. The transmission path has a characteristic impedance of 50 ohms. When the PIN diodes are forward-biased the equivalent diode resistance is about 30 ohms and most of the RF energy is absorbed by the diodes instead of propagating down the 50-ohm transmission path. However, when the diodes are reverse- or back-biased the equivalent diode resistance is in the order of thousands of ohms and the microwave currents will flow down the transmission path because diode resistance compared to the 50-ohm path impedance is negligible.

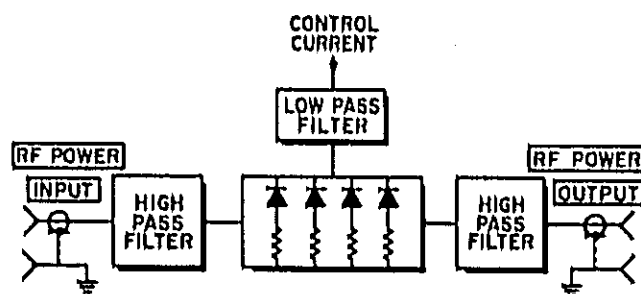


Figure 3. Simplified Block Diagram of PIN Modulator

15. BIASING.

16. Each individual PIN Modulator has a label attached to the underside of its casting body. This label has a DC bias current value stamped onto it. This stamped current is the forward-bias current required to produce rated RF attenuation across the frequency band. For "A" models, the bias current for at least 35 db is typically 3-1/2 to 5 milliamperes (about -0.7 volts DC at the BIAS input). For "B" models, the bias current

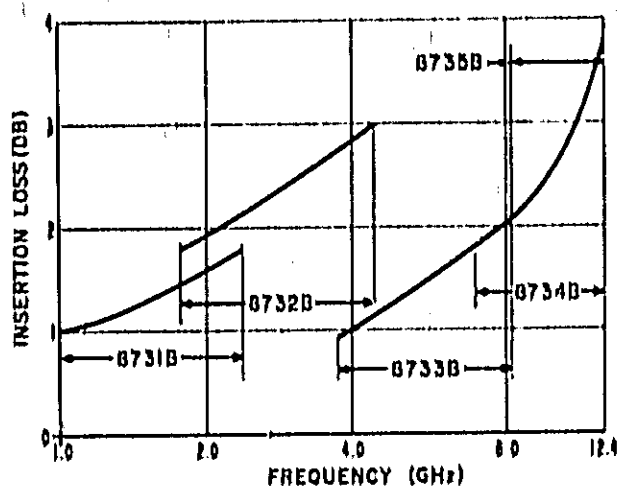
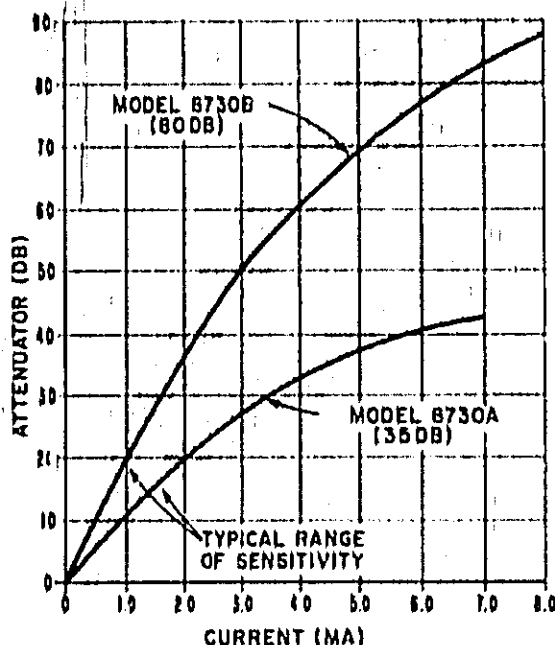


Figure 4. Typical Insertion Loss Curves

for at least 80 dB is typically 6 to 7 milliamperes (about -0.7 volts DC at the BIAS input). For applications where a minimum insertion loss is important, a back-bias of about +5 to 7 volts DC should be applied to the BIAS input. Back-biasing can result in as much as 1 dB improvement in insertion loss over zero bias. A typical plot of the maximum values of minimum insertion loss is shown in Figure 4. Note: A typical plot for the "A" models would be the same except that maximum losses are less.

Figure 5. Typical Sensitivity
(Plotted with frequency constant)

17. The attenuation increases with forward bias current almost linearly in dB until diode saturation occurs. The attenuation sensitivity varies from unit to unit but the sensitivity of a given unit is predictable. Therefore, intermediate values of attenuation can be derived once the current values for a low and high at-

tenuation are established. The range of expected sensitivities is shown as the shaded areas in the plots of typical 35-dB and 80-dB attenuation characteristics in Figure 5.

18. The attenuation with a constant forward-bias varies with frequency. This variation is small at low levels of attenuation and more noticeable at higher values of attenuation (see Figure 6). In addition, it should be noted that attenuation is a minimum at each end of the frequency band. Thus, the frequency band can be exceeded provided a degradation in attenuation range as well as other specifications is acceptable. Note: exceeding the band limits by a large degree is impractical.

19. IMPEDANCE MATCH

20. The PIN Modulator has a good impedance match at all levels of attenuation over its frequency range. This match is illustrated in Figure 7 which shows the SWR of a typical PIN Modulator measured under both zero bias and maximum forward bias conditions. Hence, with this constant match, frequency pulling effects due to the PIN Modulator is negligible. If the PIN Modulator is used outside specified frequency range, SWR characteristics will be degraded in addition to other operating specifications. However, spurious responses can result when exceeding specified frequency range. Note: exceeding band limits by a large degree is not generally practical.

21. TEMPERATURE STABILITY

22. The attenuation variation with applied bias current and bias voltage at different temperatures is illustrated, over a limited range, in Figure 8. Attenuation in dB varies almost linearly with current, while variation with voltage follows an almost perfect exponential curve. If a constant voltage is maintained, the attenuation rises with increasing temperature. With a constant current, the attenuation drops with increasing temperature. The fact that the attenuation varies oppositely with temperature for constant-voltage and constant-current operation suggests that an optimum voltage with a selected series resistor added between the source and the PIN Modulator would give temperature compensation over a limited operating range. This compensation is not built into the PIN Modulator.

23. GENERAL OPERATION

24. The PIN Modulators are three-port devices which accept RF power at either end-port and depending upon the BIAS signal applied, provide a modulated RF output at the other end-port. As an operating device, the PIN Modulator should be thought of as a variable RF attenuator whose attenuation level is controlled by DC current and voltage. By applying a +5 volt DC potential to the BIAS input connector, RF signals will be passed through the PIN Modulator with only minimum insertion loss. By applying a current equal to the value stamped on the instrument label (at about 0.7

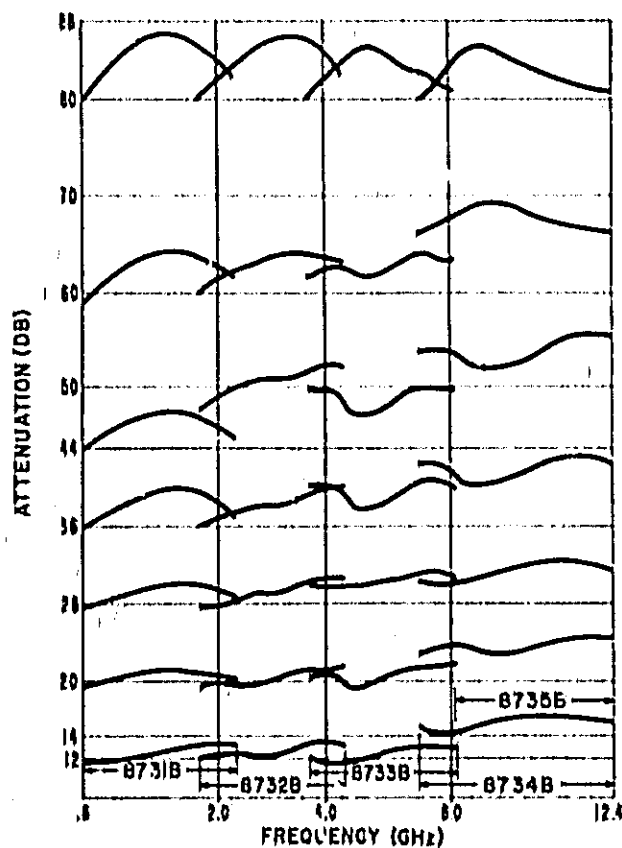
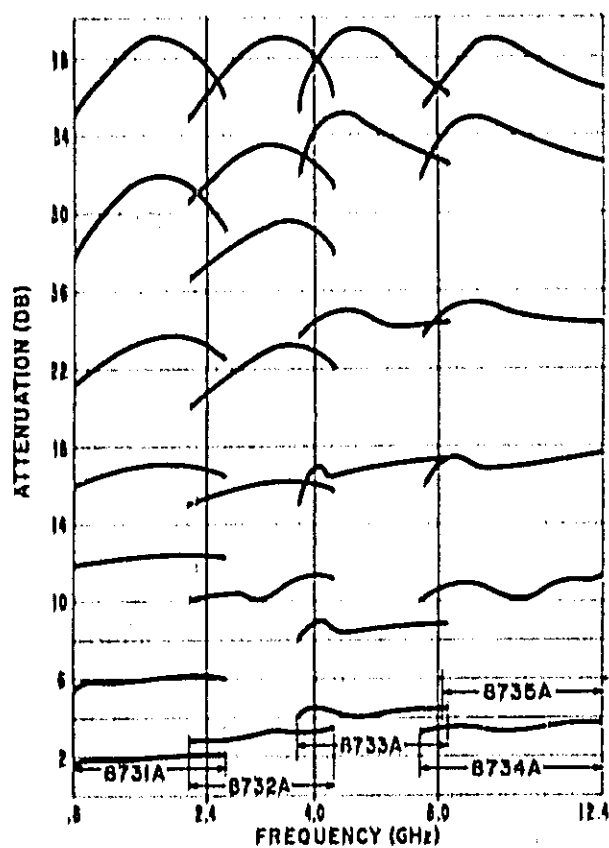


Figure 6. Typical Frequency Response

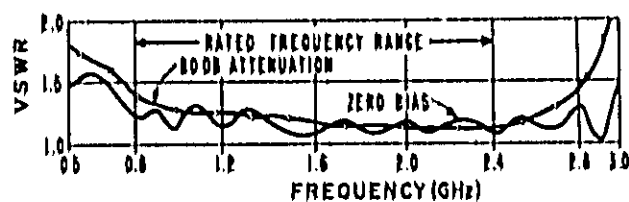


Figure 7. Typical SWR of a Pin Modulator (8731B)

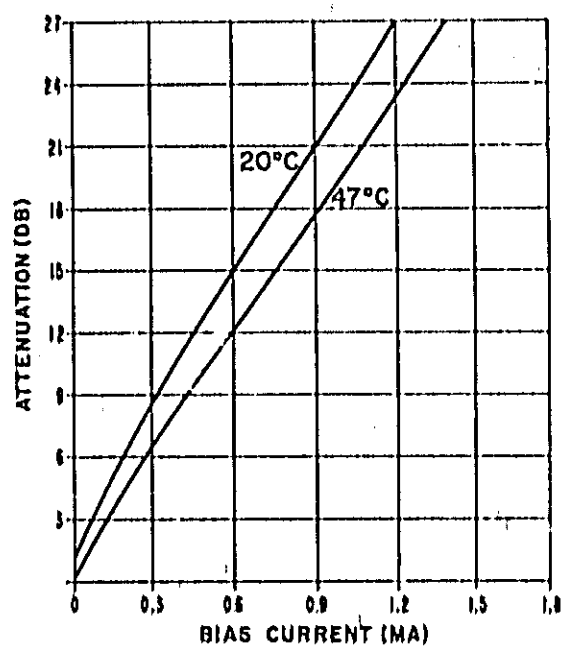
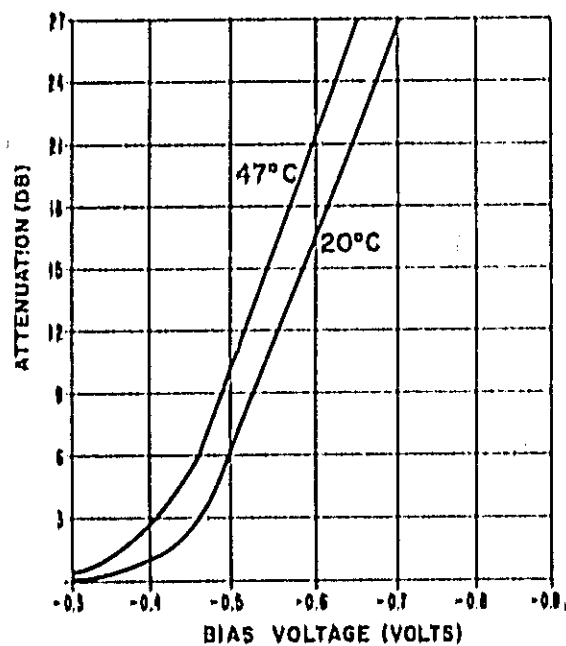


Figure 8. Typical Attenuation Variation at two Different Ambient Temperatures

volts DC) at the BIAS input, at least rated attenuation is provided at all points across the frequency band (i.e., for "A" models at least 35 dB and for "B" models at least 80 dB). The DC current at a negative voltage is forward-bias and typically is about 3 to 5 mA for "A" models and 6 to 7 mA for "B" models. By varying the forward bias current between the stamped value and zero, any level below maximum rated attenuation can be established.

25. CLOSED LOOP LEVELING.

26. The PIN Modulator can be used in a closed loop leveling system as the power limiting device for maintaining RF power levels constant. A simplified block diagram of a closed loop leveling system employing a PIN modulator is shown in Figure 9. The system consists of some sampling device which samples the main line RF power level; a detecting device provides a DC signal proportional to the sampled signal; some comparison device which compares the detected signal to what it should be when main line power is at its lowest point and then provides a bias current sufficient to increase PIN Modulator attenuation and maintain a constant RF power level.

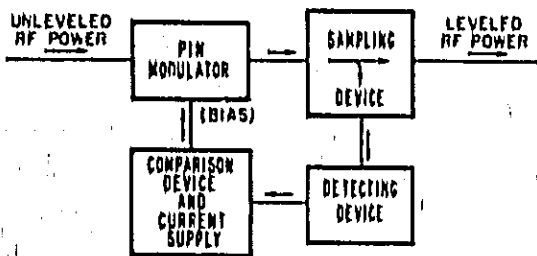


Figure 9. Simplified Block Diagram of a Closed Loop Leveling System

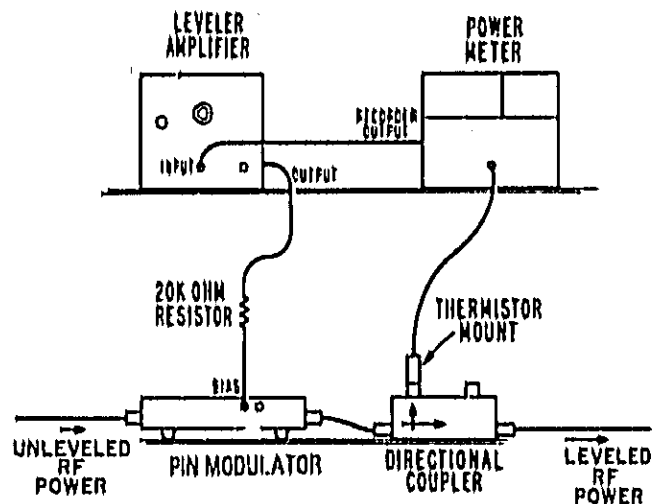


Figure 10. Typical Closed Loop Leveling System

rates always produce the best leveling. However, to determine whether or not any system is leveling properly an Oscilloscope should be used.

28. For faster leveled swept frequency rates, negative output detector and directional coupler combinations such as the hp Model 786D and 787D Directional Detectors can be used instead of the Power Meter and Thermistor Mount combination described above. Typically, for the Directional Detector and Leveler Amplifier combination, leveled power can be held constant with ± 0.2 dB (plus frequency response of Directional Detector). Note: the frequency response of the Directional Detector includes coupling variation and RF response of the crystal. For the Model 786D (0.06 to 2.11 GHz) this is ± 0.2 dB.

29. AMPLITUDE MODULATION.

30. The PIN Modulator can be used to amplitude-modulate the RF signal with almost any time-varying signal. Modulation is accomplished with a DC bias current to obtain a specific attenuation level and then superimposing a time varying current upon the bias current. The specific attenuation level upon which the modulating signal is superimposed must be equal to or greater than the peak amplitude of the modulating signal or peak clipping will occur. A control instrument designed for use in modulating applications with the PIN Modulators is the hp Model 8403A Modulator which provides frequency compensation for extending the PIN Modulator AM frequency response to 10 MHz. However, a typical setup for modulating applications, without the use of the hp Model 8403A Modulator, is illustrated in Figure 11.

31. MODULATION DISTORTION. When a PIN Modulator is used in an AM system, some envelope distortion occurs. This distortion is a function of the peak attenuation and total attenuation range covered by the modulating signal. To minimize RF envelope distortion, the reference level upon which the modu-

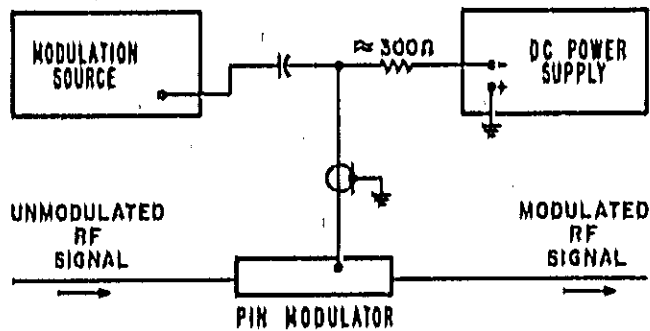


Figure 11. Typical General Modulation Setup

lating signal is superimposed should always be a minimum (i.e., reference level should be set at a point only slightly greater than the peak modulating signal amplitude). Under these conditions, a 50% sinusoidal modulating signal (9.5 dB total swing) will result in less than 0.1% distortion. A plot of measured AM distortion for a typical PIN Modulator is shown in Figure 12. Note: AM distortion was measured under the optimum conditions described above. Since distortion, as described here, is a function of the non-linear sensitivity relationship (shown in Figure 5), shaping circuits may be incorporated to limit overall distortion. Such a shaping circuit is shown in Figure 13.

32. AMPLITUDE MODULATION LIMITATION. In any AM system the modulating equipment limits RF modulating capabilities almost entirely. For example, the power supply and modulation signal source must both be capable of supplying sufficient current to the low impedance 8730 DIAS input. See Figure 5 for typical currents necessary for desired attenuation levels. In addition, the PIN Modulator itself limits the total percent of modulation obtainable. With 35 dB attenuation, AM percent of modulation is limited to a maximum of about 66.5%; with 80 dB attenuation the percent of modulation is for all practical purposes 100%.

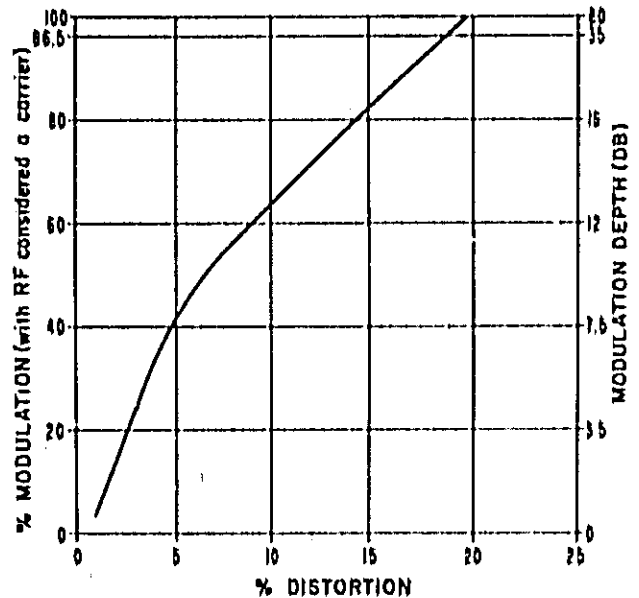


Figure 12. Typical AM Distortion

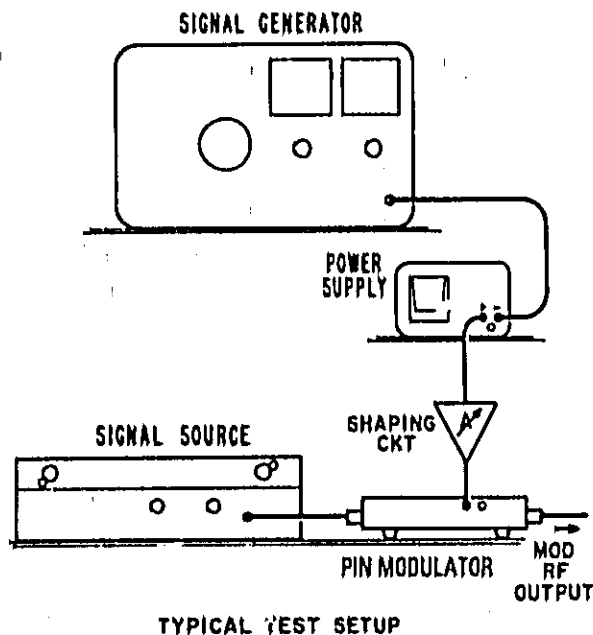
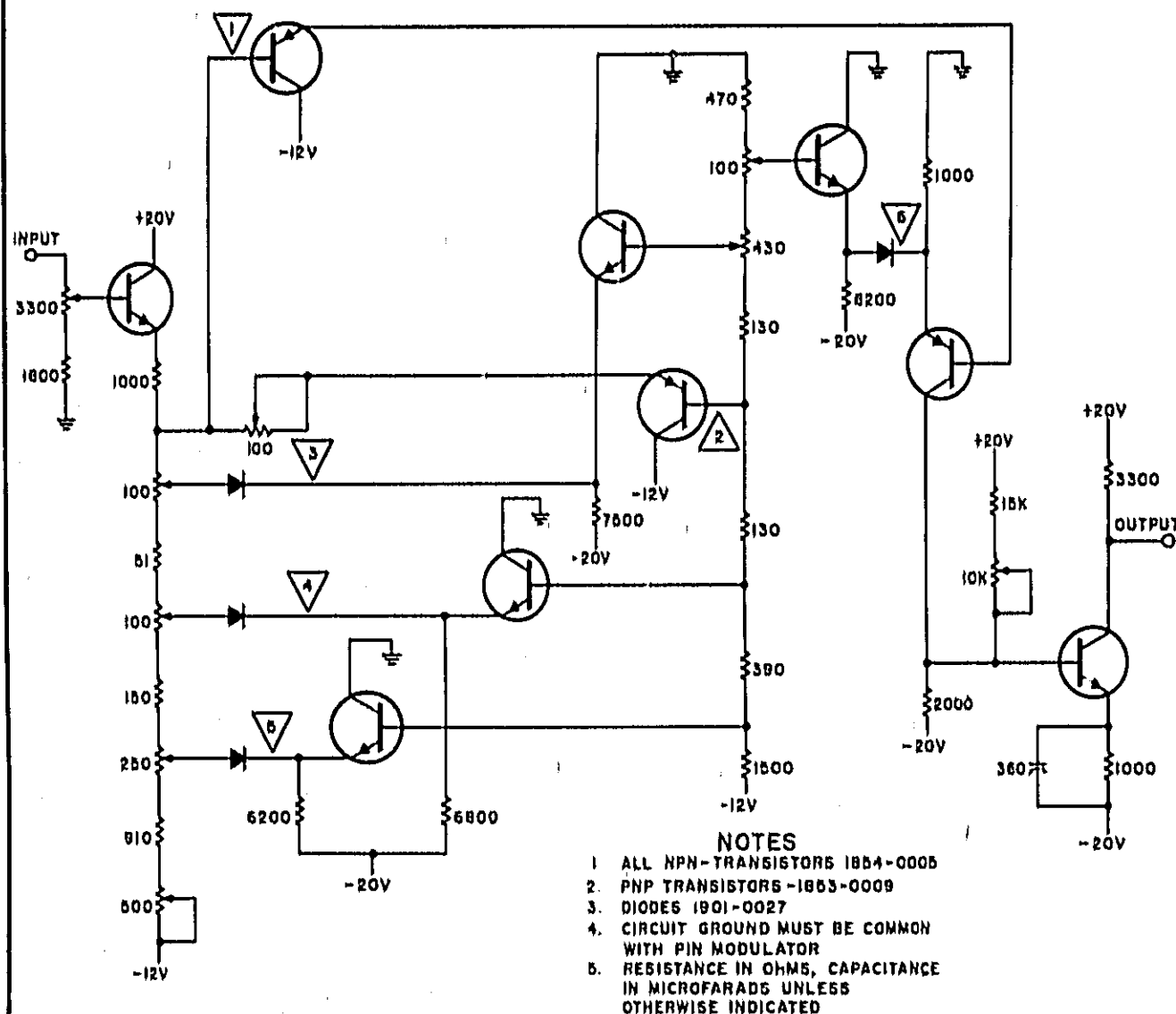


Figure 13A. Typical Test Setup (see Figure 13B)

INPUT VOLTAGE	TEST POINT VOLTAGES (DC)					
	1	2	3	4	5	6
10VDC	-3.30	-3.63 -4.36	-3.8 -4.5	-4.8 -5.5	-6.5 -7.0	
6.4VDC	-3.59	-3.75 -4.41	-3.98 -4.6	-4.9 -5.6	-6.5 -7.0	
3.0VDC	-3.92	-4.04 -4.42	-4.2 -4.6	-5.0 -5.6	-6.6 -7.0	
1.65VDC	-4.28	-4.38 -4.43	-4.5 -4.6	-5.3 -5.6	-6.7 -7.0	
0.85VDC	-4.63	-4.72 -4.44	-4.9 -4.6	-5.5 -5.6	-6.9 -7.0	-2.7 -3.1
0.5VDC						-2.7 -3.3
1	-4.94	-5.03 -4.45	-5.18 -4.51	-5.8 -5.5	-7.2 -6.9	-2.7 -3.5



1. The circuit illustrated above will typically meet the following performance features:
 - (a) The DC transfer characteristic is within 2% or so of linear at 1.5 GHz. Since the PIN Modulator attenuation bias current characteristic varies widely.
 - (b) The bandwidth of the circuit is limited to about 4 Mc (Modulating Signal Frequency).
 - (c) Total harmonic distortion should be greater than 20 dB down.
 - (d) For proper circuit operation, it is necessary to have an 8-volt signal on the base of the input transistor (8 volts positive and reference to ground).

2. **Circuit Adjustment.**
 (a) The circuit must be adjusted with the PIN Modulator that it is to be used with and at the RF signal frequency of interest.
 (b) To adjust, apply DC voltage to the input and adjust the appropriate potentiometer in the divider stick as indicated for the "initial setup voltages" (see Figure 13A).

Note

To properly adjust the divider stick, start by applying ground to the input and going positive.

(c) For final adjustment, observe RF output signal and adjust circuit for optimum operation.

Figure 13B, Typical Shaping Circuit

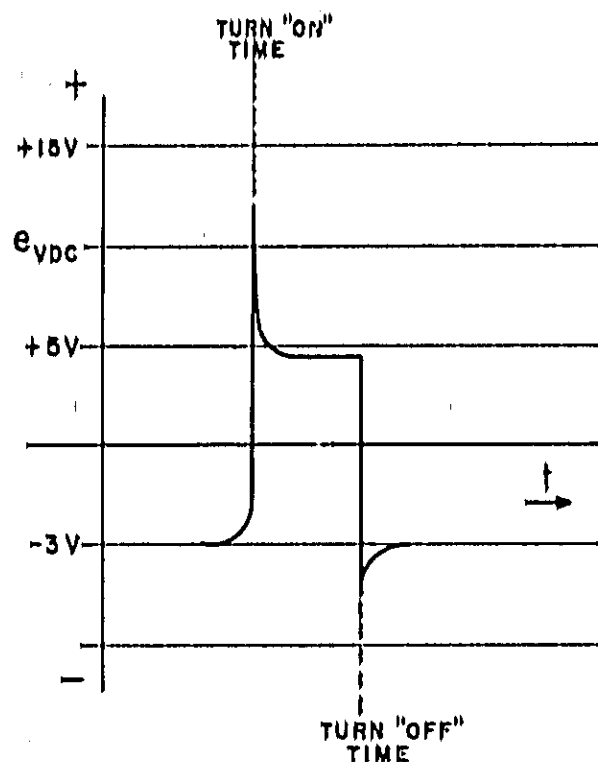


Figure 14. Dynamic Bias Switching Waveform

33. PULSE MODULATION.

34. The PIN Modulator can be used as a pulsing or switching device for RF power levels. Modulation is accomplished by applying rated forward bias (see label attached to underside of PIN Modulator) for a maximum attenuation. Once maximum attenuation level is established, the RF power may be pulsed "on" by applying a constant +5 to 6 volts to the BIAS input (voltage must be referenced to PIN Modulator ground).

At the end of desired pulse width, the +5 to 6 volt DC potential must be switched to a -0.8 volt level with rated bias current so that RF power level is pulsed "off".

35. To obtain pulsing with rise and fall times in the order of 15 to 40 nanoseconds, the PIN Modulator must be biased with the HP Model 8403A or from a specially shaped impulse waveform such as is illustrated in Figure 14. However, if rise and fall times in the order of 100 to 300 nanoseconds are satisfactory, a setup such as is shown in Figure 11 may be used. Note: in any modulating system, modulating capability depends upon the modulating waveform at the BIAS input connector. Hence, lead lengths should be as short as possible to avoid capacitive cable effects.

36. SIGNAL SEPARATION (GATING).

37. Figures 15 and 16, respectively, illustrate use of the PIN Modulator as an RF gating device for eliminating spurious or "ghost" signals in antenna range receivers (Figure 15) or multiple signal separation in a spectrum analysis system (Figure 16).

38. MULTIPLE FUNCTION.

39. For certain applications, it may be desirable to level and amplitude modulate a given RF power level with the same PIN Modulator. This can be accomplished by simply setting up a closed loop leveling system and adjusting the reference attenuation level to a point equal to the peak amplitude of the desired modulating signal. For this type of dual application the modulating signal can be applied directly to the leveler amplifier in the system shown in Figure 10.

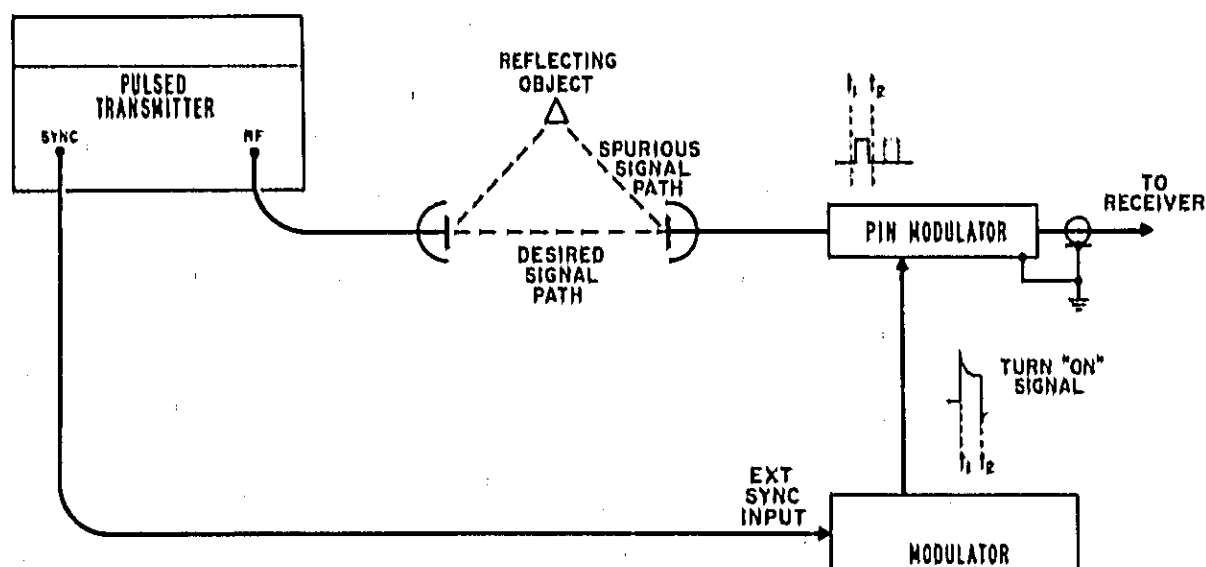


Figure 15. Typical Use of PIN Modulator as an RF Gating Device

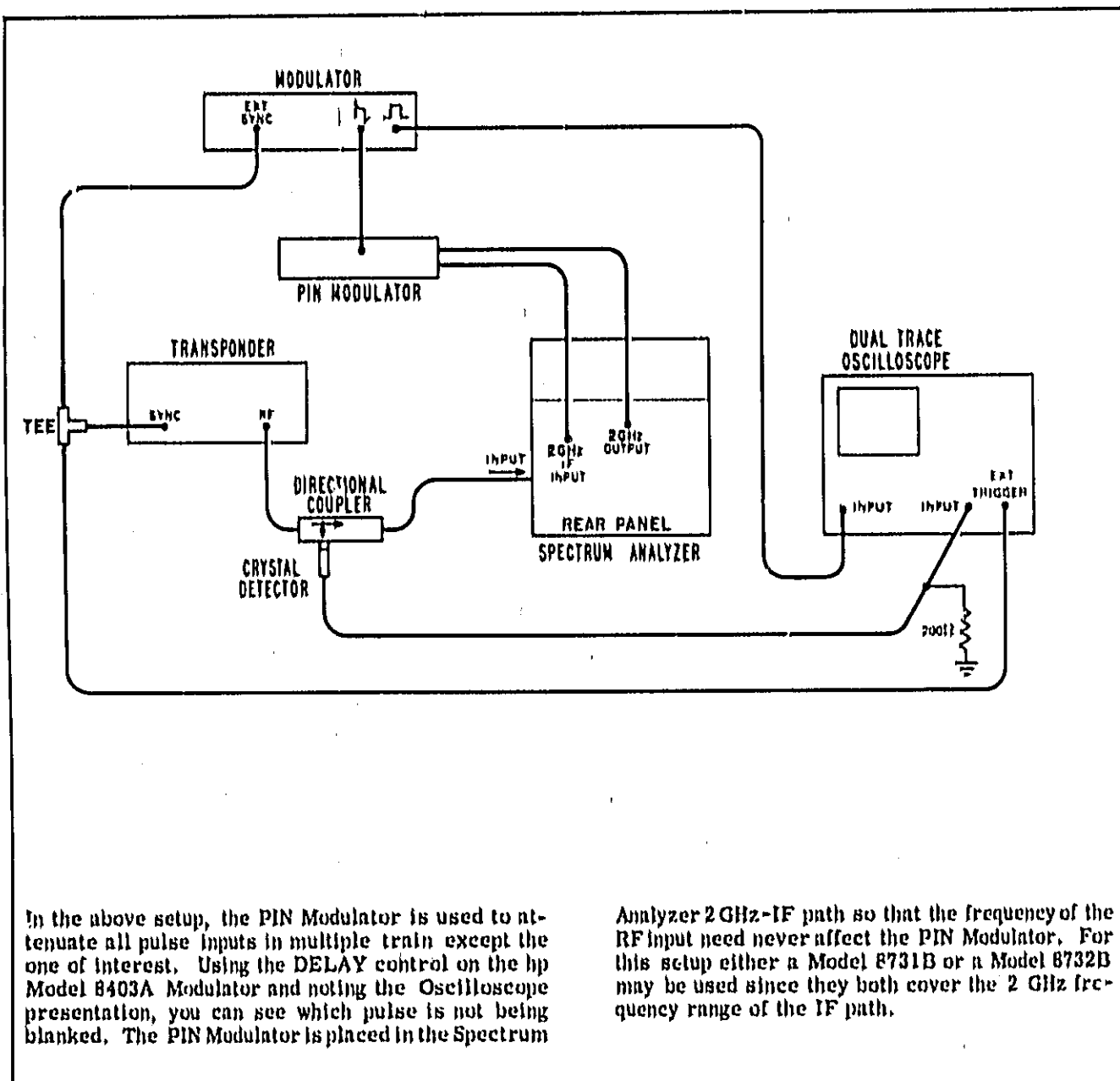


Figure 16. Multiple Signal Separation for Spectrum Analysis

40. MAINTENANCE.**41. PIN MODULATOR REMOVAL AND REPLACEMENT.**

42. The PIN modulator CANNOT be repaired in the field. If the PIN modulator is found to be faulty, it should be returned to the factory. Remove the four screws holding the PIN modulator only. Removal of screws holding the PIN diodes in place can cause contamination of PIN diodes, high SWR, etc.

- a. Remove power line from instrument.
- b. Remove top and bottom covers.
- c. Place instrument on its side (preferably the PIN modulator side).
- d. Remove retainer rings at RF POWER INPUT and OUTPUT connectors.
- e. Disconnect coaxial cable from PIN modulator at J105.
- f. Remove four screws holding PIN modulator to instrument chassis (located on top side of instrument).
- g. Remove PIN modulator from instrument.
- h. Carefully pack PIN modulator in a container and contact local IIP field office.
- i. To replace PIN modulator, reverse the above procedure.

43. BIAS INPUT CHECK AND REPAIR.

44. If any part of the bias input assembly (Figure 10) is damaged, it can be replaced separately. However, it is good practice to replace the entire assembly. To check bias input assembly, remove the PIN Modulator and measure its resistance with an ohmmeter.

straight through the filter resistance should be less than 5 ohms; resistance between BNC center conductor and shell should be infinite.

45. PERFORMANCE CHECK.

46. PURPOSE. The procedure detailed in Table 2 checks PIN Modulator performance for incoming inspection, periodic evaluation, and troubleshooting. The tests are performed without access to the PIN Modulator interior, there is no need to remove PIN MODULATOR for performance checks. The specifications of Table 1 are the performance standards.

47. CHECKING DESICCANT.

48. Inspect desiccant regularly (Figure 17) and, if it is pink or red in color, either remove and dry it or replace it.

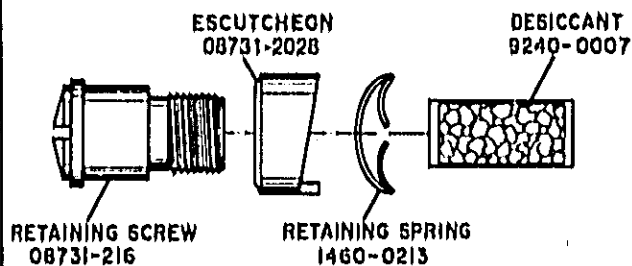


Figure 17. Desiccant Assembly

NOTE: Desiccant only found on 8731-5B; 815-models.

49. TEST EQUIPMENT REQUIRED. The test equipment required to make the performance tests are listed in Table 3. Instruments and accessories other than the ones listed may be used provided their performance equals or exceeds the Critical Specifications.

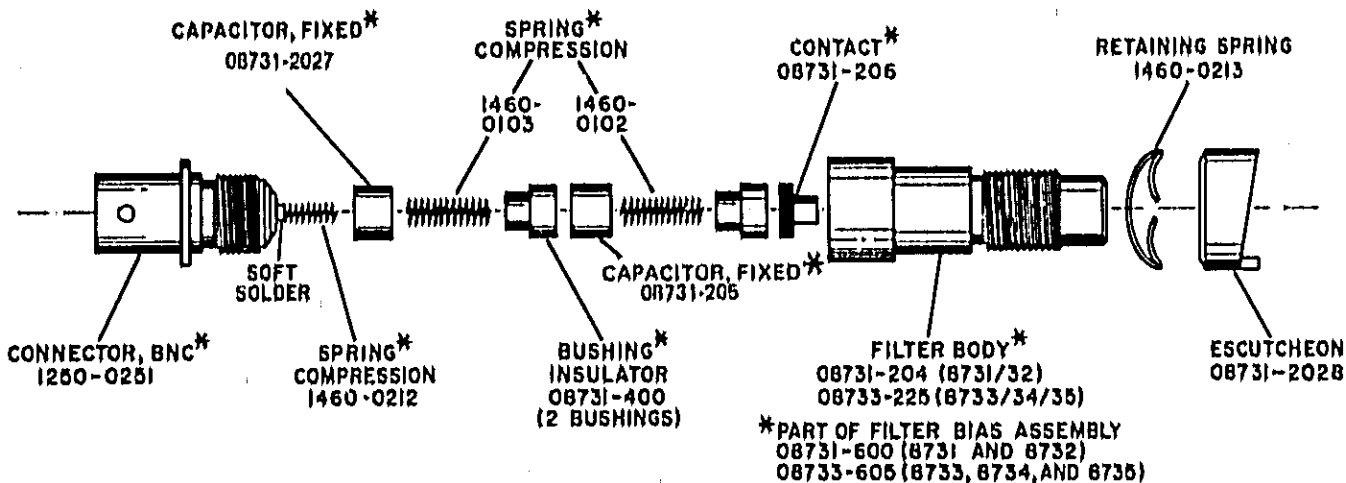


Figure 18. Bias Input Assembly

Table 2. Performance Check Procedure

1. LEAKAGE CURRENT. When back-biased less than 50 μ A for "A" models and less than 100 μ A for "B" models (see Note 4).	
PROCEDURE a. Apply +20 volts DC (referenced to PIN Modulator ground) to the BIAS input through a 100K 10% 1/4 W resistor. b. Using a DC voltmeter, measure voltage across resistor. For "A" models less than 5 V (less than 10 V for "B" models). c. If leakage current is excessive, the cause is either a defective BIAS input filter (see Paragraph 43) or internal damage.	TEST RESULTS (see Note 1) Date _____ PIN Mod Serial No. _____ Measured DC Voltage _____ Voltmeter used _____
COMMENTS (if any) _____ _____	
2. DYNAMIC RANGE (DB). For "A" models (ONLY) at 35 dB across frequency range	
PROCEDURE a. With a 5 V DC applied to BIAS input, attach a 30-dB attenuator to PIN Modulator RF output. b. Using a Power Meter, adjust RF power source for a near full scale reference. c. Turn off Power Supply and reconnect to PIN Modulator as shown on next page. Adjust Power Supply for rated current (stamped on label attached to underside of PIN Modulator). d. Remove 30-dB attenuator and measure attenuated RF power level; it should be at least 5 dB lower than original reference setting.	TEST RESULTS (see Note 1) Date _____ PIN Mod Serial No. _____ Attenuation _____ frequency _____ Power Meter used _____ Measure forward bias current _____
COMMENTS (if any) _____ _____	
3. DYNAMIC RANGE (DB). For "B" models (ONLY) at least 80 dB.	
PROCEDURE a. Set Spectrum Analyzer INPUT ATTENUATOR to 60dB and connect test equipment (NOT INCLUDING THE DC POWER SUPPLY OR DC AMMETER) as shown beneath step c. CAUTION For testing the 8733B, 8734B, or 8735B a TWT Amplifier must be used as part of the RF Source. Be careful not to apply more than 1 W of RF power to PIN Modulator. b. Apply +5 V DC (referenced in PIN Modulator ground) to BIAS input.	TEST RESULTS (see Note 1) Date _____ PIN Mod Serial No. _____ Attenuation _____ frequency _____ Attenuator used _____ Measured forward bias current _____

Table 2. Performance Check Procedure (cont'd)

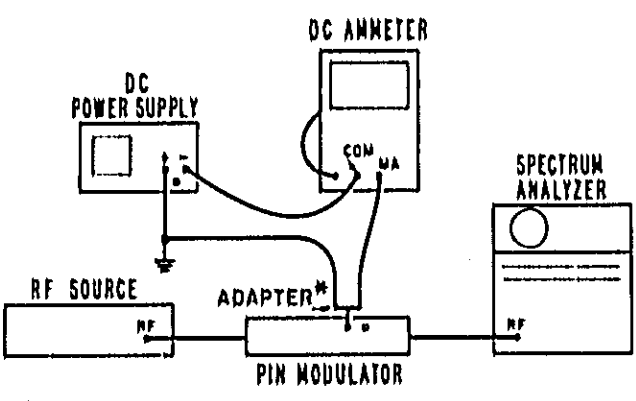
c. Set Spectrum Analyzer vertical display switch for logarithmic display. Adjust RF Source and Spectrum Analyzer for a convenient deflection reference on analyzer display.  *BNC-TO-BANANA POST ADAPTER 10110A d. Turn off DC Power Supply and connect with DC Ammeter as shown below. e. Turn on DC Power Supply and adjust for rated current (stamped on underside of PIN Modulator). f. Decrease Spectrum Analyzer INPUT ATTENUATOR and increase IF GAIN controls for a total increase in sensitivity of 80 dB (i.e., decreasing the INPUT ATTENUATOR from 60 to 30 dB and increasing the IF GAIN control from 20 to 70 dB is a total increase in sensitivity of 80 dB). Specification: Input signal deflection must be less than reference of step c. CAUTION If 1 watt of RF power is being applied, the Spectrum Analyzer ATTENUATOR must set to 60 dB in step c.									
COMMENTS (if any) _____ _____									
4. SWR, When back-biased less than <table><tr><td>1.5:1 - 8731A & 8732A</td><td>1.8:1 - 8733A & 8734A</td></tr><tr><td>1.6:1 - 8731B</td><td>2.0:1 - 8733B & 8734B</td></tr><tr><td>1.6:1</td><td>1.7:1 - 8735A</td></tr><tr><td>2.0:1 - 8732B (see Note 2)</td><td>1.9:1 - 8735B</td></tr></table>		1.5:1 - 8731A & 8732A	1.8:1 - 8733A & 8734A	1.6:1 - 8731B	2.0:1 - 8733B & 8734B	1.6:1	1.7:1 - 8735A	2.0:1 - 8732B (see Note 2)	1.9:1 - 8735B
1.5:1 - 8731A & 8732A	1.8:1 - 8733A & 8734A								
1.6:1 - 8731B	2.0:1 - 8733B & 8734B								
1.6:1	1.7:1 - 8735A								
2.0:1 - 8732B (see Note 2)	1.9:1 - 8735B								
PROCEDURE a. With a +5 volt DC (referenced to PIN Modulator ground) applied to BIAS input measure SWR at each end of the specified PIN Modulator frequency range and optionally at any other points of interest. b. If SWR is excessive, remove PIN Modulator from setup and clean RF end-ports of any dirt or oil or foreign matter. Repeat SWR measurements.	TEST RESULTS (see Note 1) Date _____ PIN Mod Serial No. _____ SWR _____ at a frequency of _____								

Table 2. Performance Check Procedure (cont'd)

COMMENTS (if any) _____ _____							
5. SWR. When forward-biased less than <table> <tr> <td>1.8:1 - 8731A & 8732A</td> <td>2.0:1 - 8735A</td> </tr> <tr> <td>2.0:1 - 8731B & 8732B</td> <td>2.2:1 - 8733B & 8734B</td> </tr> <tr> <td>2.0:1 - 8733A & 8734A</td> <td>2.2:1 - 8735B</td> </tr> </table>		1.8:1 - 8731A & 8732A	2.0:1 - 8735A	2.0:1 - 8731B & 8732B	2.2:1 - 8733B & 8734B	2.0:1 - 8733A & 8734A	2.2:1 - 8735B
1.8:1 - 8731A & 8732A	2.0:1 - 8735A						
2.0:1 - 8731B & 8732B	2.2:1 - 8733B & 8734B						
2.0:1 - 8733A & 8734A	2.2:1 - 8735B						
PROCEDURE a. With a DC voltage of about -0.8 volts and rated current (stamped on label - underside) applied to BIAS input, measure SWR at ends of specified frequency range. b. If SWR is excessive clean RF input and output connectors and recheck.	TEST RESULTS (see Note 1) Date _____ PIN Mod Serial No. _____ SWR _____ at a frequency of _____ Measured forward bias current _____						
COMMENTS (if any) _____ _____							
6. MINIMUM INSERTION LOSS (DB). When back-biased less than: <table> <tr> <td>1.5 dB - 8731A</td> <td>2.0 dB - 8731B, 8732A, 8733A</td> </tr> <tr> <td>3.0 dB - 8733B</td> <td>3.5 dB & 4.0 dB - 8732B (see Note 3)</td> </tr> <tr> <td>4.0 dB - 8734A & 8735A</td> <td>5.0 dB - 8734B & 8735B</td> </tr> </table>		1.5 dB - 8731A	2.0 dB - 8731B, 8732A, 8733A	3.0 dB - 8733B	3.5 dB & 4.0 dB - 8732B (see Note 3)	4.0 dB - 8734A & 8735A	5.0 dB - 8734B & 8735B
1.5 dB - 8731A	2.0 dB - 8731B, 8732A, 8733A						
3.0 dB - 8733B	3.5 dB & 4.0 dB - 8732B (see Note 3)						
4.0 dB - 8734A & 8735A	5.0 dB - 8734B & 8735B						
PROCEDURE a. With +5 volts DC applied to BIAS input, measure insertion loss at high end of frequency band and all other points of interest.	TEST RESULTS (see Note 1) Date _____ PIN Mod Serial No. _____ Insertion Loss _____ at a frequency of _____						
COMMENTS (if any) _____ _____							
NOTES - The test results column provided opposite each test procedure is not provided to allow a complete test record but rather to allow test result comparisons for a specific PIN Modulator measured under the same conditions at different time intervals. - When back-biased the SWR of the 8732B should be less than 1.6:1 for RF frequencies between 1.8 and 4.0 GHz and less than 2.0:1 between 4.0 and 4.5 GHz. - Minimum insertion loss for the 8732B is less than 3.5 dB for RF frequencies between 1.8 and 4.0 GHz and less than 4.0 dB between 4.0 and 4.5 GHz. - The leakage current although not an actual specification is the only method of checking diodes for leakage and general condition. - To check rise and decay times a Sampling Oscilloscope such as the hp Model 185B should be used. - Typical Forward Bias Input Resistance may be calculated by applying 3 or 4 milliamperes of DC current at a negative potential, measuring the negative potential. Specification: For "A" model PIN Modulators, approximately 300 ohms $\pm$ 100 ohms; For "B" model PIN Modulators, approximately 100 ohms $\pm$ 50 ohms.							

Table 3. Recommended Test Equipment

Instrument Type	Critical Specifications	Check	Recommended Model
<u>Equipment For All Models</u>			
DC Power Supply	Outputs: ± 0.2 to 20 Vdc ± 0.5 to 10 mA Impedance: 100 Ω	All	HP 6216B
DC Voltmeter and DC Ammeter	Voltage Range: ± 3 to 20 Vdc Current Range: 0.5 to 10 mA Accuracy: $\pm 3\%$	All	HP 410C
SWR Meter and Crystal Detector	Freq of PIN Modulator, Modulated at 1000 Hz $\pm 2\%$ rate Calibration: Square Law Freq Resp: ± 0.5 dB Accuracy: $\pm 1\%$	Minimum Insertion Loss	HP 415E (Meter) and HP 423A (Det.)
Resistor	100K Ω 1/4 W 10%	Leakage Current	- -
RF Source	Freq of PIN Modulator Residual FM: <50 KHz Power Out: 3 mW	All (except leakage current)	8614A (8731) 8616A (8732) 8683B 8684B
<u>Equipment For "A" Models Only</u>			
RF Attenuator	Freq of PIN Modulator Atten: 30 dB Accuracy: ± 2 dB	Dynamic Range	HP 8491A Opt. 030 (all coaxial models) HP X382A (8735A)
Power Meter	Power: up to 10 mW Freq of PIN Modulator Instrument Accuracy: $\pm 3\%$ Calibration: mW and dB	Dynamic Range	HP 432A (Meter) HP 478A (Mount 8731A thru 8734A) HP X480A* (Mount 8734A/8735A)
<u>Equipment For "B" Models Only</u>			
Power Meter	Freq of PIN Modulator Power: up to 2 W Accuracy: $\pm 6\%$	Dynamic Range	HP 435B Power Meter and HP 8481H Power Sensor
Spectrum Analyzer	Freq of PIN Modulator Calibration: logarithmic in dB/cm Sensitivity: -90 dBm (-65 dBm for 8733B/34B/35B)	Dynamic Range	HP 8565A
Microwave Amplifier	Freq Range: of 8733B/34B/ or 35B Power Out: 1 W from 1 mW input	Dynamic Range	HP 491C (8733B) HP 493A (8733B) HP 495A (8734B and 8735B)
* Note: For use with 8734A, an X281A Coaxial to waveguide and a male-to-male type N adapter must be used			

APPENDIX

IV

APPENDIX IV

BACKDATING

MANUAL CHANGES

MODEL SERIES 8730A/D PIN MODULATORS

Make all backdating corrections to Appendix III according to changes below.

SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES	SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES
8731-5B; 815-	A, B		
8732A; 816-	B		

CHANGE A:

Paragraph 41 and 42:

Add desiccant, stock no. 0240-0007; Escutcheon, stock no. 08731-203; Desiccant retaining screw, 08731-216.

Change bias input escutcheon stock no. 08731-202B to 08731-203.

CHANGE B:

Table 1; SWR specification:

Change SWR specification from "1.8, 1.8 to 4.0 GHz; 2.0, 4.0 to 4.5 GHz" to "1.8, 1.8 to 4.5 GHz".

MANUAL CHANGES

MANUAL CHANGES

MODULATOR

MANUAL IDENTIFICATION

Model Number: HP 8403A
Date Printed: February 1984
Part Number: 08403-90025

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
►2647A	1		

► NEW ITEM

ERRATA

Page 1-1, paragraph 1-6:

Add the following information after paragraph 1-6:

1-6a. **RACK MOUNT KIT (Option 008)**

1-6b. This kit contains all the necessary hardware and installation instructions for mounting the Modulator in a rack with standard 19-inch EIA (482.5 mm) spacing. The Modulator cabinet is 3 1/4 inches (88.1 mm) high. Order HP part number 5060-8739.

Page 2-1, paragraph 2-4:

Delete the second sentence in paragraph 2-4.

► Page 5-0, Table 5-1:

Add the following to Table 5-1.

Instrument Type	Test Use	Critical Specifications	Recommended HP Model
Frequency Counter	Replacement Factory Selected Components	Range: 0 to 100 kHz Attenuation: Internal X20	HP 5314A
Function Generator	Replacement Factory Selected Components	Range: 0 to 50 kHz Output Level: 0 to 5V Waveform: Sine	HP 3312A

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.

11 March 1986

11 Pages

Printed in U.S.A.



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PACKARD**

ERRATA (cont'd)

► Page 5-10, Table 5-9:

Add the following table to Page 5-10.

Table 5-9. Factory Selected Components

Reference Designator	Figure Number	Range of Values	Basis of Selection
R124	5-9	500—1000Ω	1. Put the Modulator in EXT SYNC mode. (See paragraph 3-16.) 2. Connect the input end of a BNC Tee to the function generator. 3. Connect the two outputs of the BNC Tee: one to the EXT PULSE INPUT; the other to the oscilloscope. 4. Set the oscilloscope: Voltage deflection: 2V/division Sweep: 2 mc/division. 5. Adjust amplitude of the generator (synchronizing signal) until a pulse appears on the oscilloscope. 6. Read the amplitude of synchronizing signal from the generator. It should be $\leq 5V$. 7. If the amplitude is greater than 5V, lower the resistance of R124 in ~100 ohm steps until the 5V limit is met.
R204	5-11	900—1000Ω	1. Put Modulator in INTERNAL mode. (See paragraph 3-14.) Set RATE to maximum. 2. Set frequency counter to X20 attenuation. 3. Monitor OUTPUT with frequency counter. It should be ≥ 50 kHz. 4. If frequency is < 50 kHz, reduce R204 in ~20 ohm steps until frequency is at least 50 kHz.

► Page 5-17, Figure 5-9:

Add " after R124 to indicate a factory selected value.
Change value to 500 to 1000 ohms.

► Page 5-19, Figure 5-11:

Add * after R204 to indicate a factory selected value.
Change value to 900 to 1000 ohms.

Page 6-6, Table 6-2:

CR101—CR110 If CR101 through CR110 need replacement, replace them with the recommended parts described in CHANGE 1.

CR202—CR206 If CR202 through CR206 need replacement, replace them with the recommended parts described in CHANGE 1.

ERRATA (cont'd)**►Page 6-9, Table 6-2:**

R124. Delete R124. Replace it with the following:

R124*, FACTORY SELECTED RESISTOR, 1%, 500—1000 ohms, .25W

R204. Delete R204. Replace it with the following:

R204*, FACTORY SELECTED RESISTOR, 1%, 900—1000 ohms, .125W

Page I-23, Table I-1:

CR103—CR207 If CR203 through CR207 need replacement, replace them with the recommended parts described in CHANGE 1.

CHANGE 1**Page 3-0, Figure 3-1:**

Replace the line art portion of Figure 3-1 with Figure 3-1A.

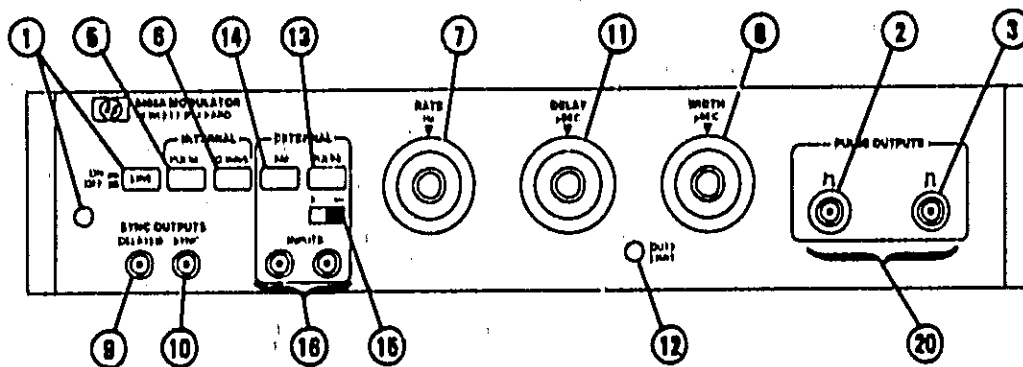


Figure 3-1A. Controls and Indicators

Page 3-2, Figure 3-3:

Replace the line art portion of Figure 3-3 with Figure 3-3A.

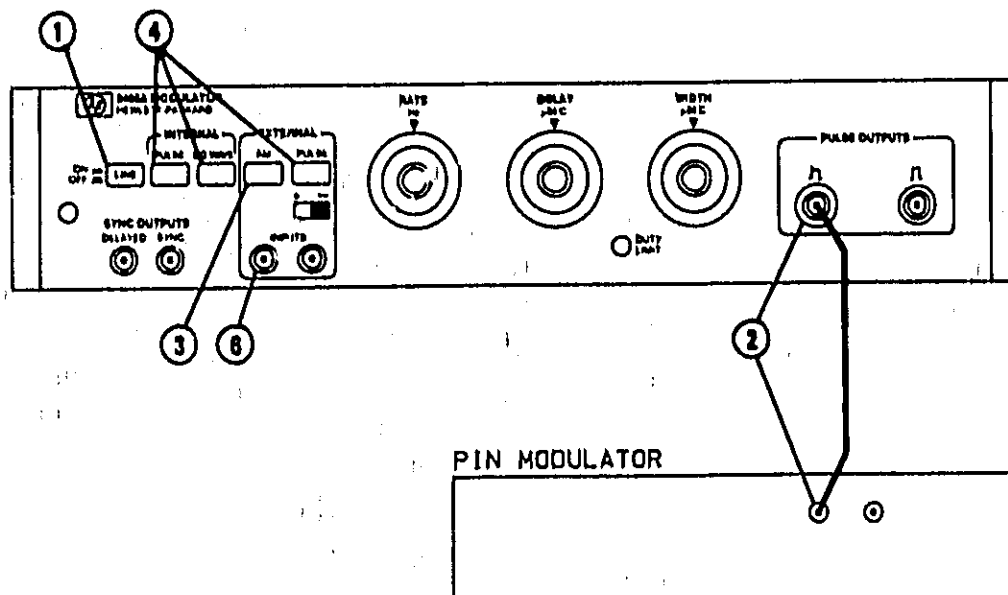


Figure 3-3A. External AM Operation

CHANGE 1 (cont'd)

Page 4-5, paragraph 4-15:

Change the first sentence in paragraph 4-15 to read as follows:

When operating in the internal pulse mode of operation with the RATE (Hz) control set to EXT SYNC, operation of the circuit is the same as described above except that the rate multivibrator is replaced by the input amplifier/inverter, emitter follower, and Schmitt trigger.

Page 4-6, Figure 4-9:

Add a resistor, R221, in parallel with resistor R206.

Page 5-12, Figure 5-4:

Replace Figure 5-4 with Figure 5-4A.

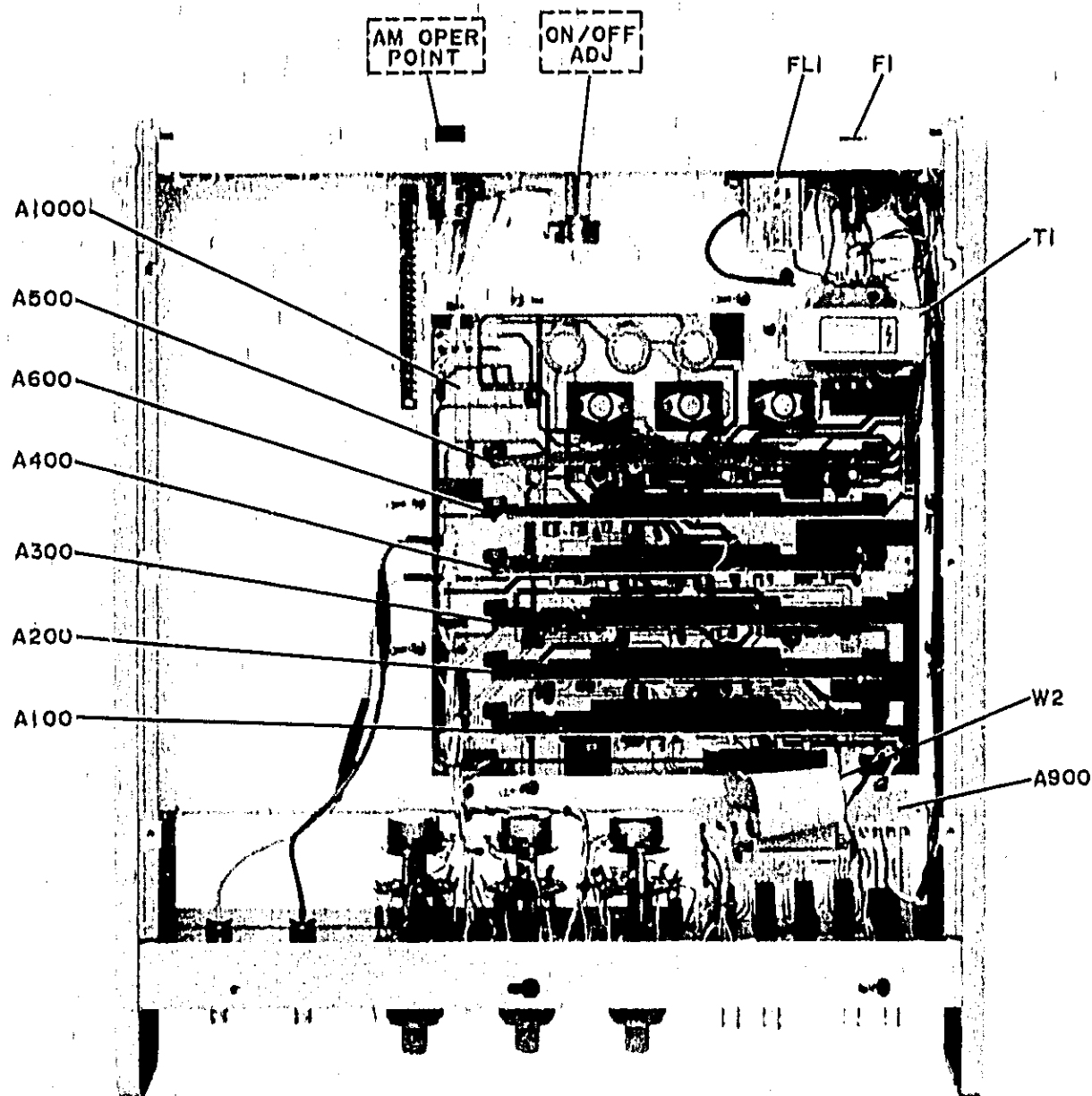


Figure 5-4A. HP 8403A Bottom Internal View

CHANGE 1 (cont'd)

Page 5-13, Figure 5-5:
Delete Figure 5-5.

Page 5-14, Figure 5-6:
Delete Figure 5-6.

Page 5-15, Figure 5-7:
Delete Figure 5-7.

Page 5-17, Figure 5-9:
Delete note 2 from the lower right side of the schematic.

Page 5-19, Figure 5-11:
Change the value of C208 to 1700 pF.

NOTE

Delete the asterisk () that is after C208. It is no longer a factory selected part.*

Change the value of R204 to 1.47 k Ω .
Change the value of R206 to 100 k Ω .
Add a resistor, R221; 422 k Ω , in parallel with R206.

Page 5-21, Figure 5-13:
Delete note 2 from the lower left side of the schematic.

Page 5-23, Figure 5-16:
Delete note 2 from the upper right side of the schematic.

Page 5-25, Figure 5-18:
Delete "TO A700" from XA500, pin 3 and add "+20V" in its place.
Delete "TO A700" from XA500, pin 9 and add "-12V" in its place.
Delete "TO A700" from XA500, pin 14 and add "-20V" in its place.
Delete note 3 from the upper right side of the schematic.
Add Figure 5-19 after Figure 5-18.

Page 6-6, Table 6-2:
Change CR101 through CR110 to 1901-0050, CD3, DIODE-SWITCHING 80V 200MA 2NS D0-35.
Change CR202 through CR206 to 1901-0050, CD3, DIODE-SWITCHING 80V 200MA 2NS D0-35.

Pages 6-5 to 6-12, Table 6-2:
Delete the parts listed in Table 6-2A from Table 6-2 and add the parts listed in Table 6-2B to Table 6-2.

Page I-23, Table I-1:
Change CR203 through CR207 to 1901-0050, CD3, DIODE-SWITCHING 80V 200MA 2NS D0-35.

Page II-3, Figure 1:
Replace Figure 1 with Figure 1A.

Page II-3, Figure 3:
Replace Figure 3 with Figure 3A.

Page II-3, Figure 4:
Replace Figure 4 with Figure 4A.

Table 6-2A. Parts Deleted for Change 1

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A700	08403-608	6	1	POWER SUPPLY DISTRIBUTION ASSEMBLY	28480	08403-608
C501	0180-0047	7	3	CAPACITOR-FKD 500UF*75-10% 75VDC AL	28480	0180-0047
C505	0180-0047	7		CAPACITOR-FKD 500UF*75-10% 75VDC AL	28480	0180-0047
C508	0180-0047	7		CAPACITOR-FKD 500UF*75-10% 75VDC AL	28480	0180-0047
J105	1250-0083	1	1	CONNECTOR-RF DMC FEM 5GL-HOLE-FR 60-OHM	28480	1250-0083
Q501	1853-0052	2	1	TRANSISTOR PHP 2N3740 SI 10-86 PD>25W	04713	2N3740
Q505†	1850-0064	0	1	TRANSISTOR PHP 2N1183 GE 10-8 PD>7.5W	3L585	2N1183
R430	0757-1092	7	1	RESISTOR 287 1K .5W F TC>0+-100	28480	0757-1092
S1	3104-0004	9	5	SWITCH-PB 5-STATION 19.05MM C-C SPACING	28480	3104-0004
S3	3104-0004	9		SWITCH-PB 5-STATION 19.05MM C-C SPACING	28480	3104-0004
S4	3104-0004	9		SWITCH-PB 5-STATION 19.05MM C-C SPACING	28480	3104-0004
S5	3104-0004	9		SWITCH-PB 5-STATION 19.05MM C-C SPACING	28480	3104-0004
S6	3104-0004	9		SWITCH-PB 5-STATION 19.05MM C-C SPACING	28480	3104-0004
XA100	1251-0172	1	5	CONNECTOR-PC EDGE 22-CONT/ROW 1-ROW	28480	1251-0172
XA200	1251-0172	1		CONNECTOR-PC EDGE 22-CONT/ROW 1-ROW	28480	1251-0172
XA300	1251-0172	1		CONNECTOR-PC EDGE 22-CONT/ROW 1-ROW	28480	1251-0172
XA400	1251-0172	1		CONNECTOR-PC EDGE 22-CONT/ROW 1-ROW	28480	1251-0172
XA500	1251-0172	1		CONNECTOR-PC EDGE 22-CONT/ROW 1-ROW	28480	1251-0172
XA600	1251-0172	1		CONNECTOR-PC EDGE 22-CONT/ROW 1-ROW	28480	1251-0172
MISCELLANEOUS PARTS						
	08403-011	4	2	KNOB, DELAY/WIDTH	28480	08403-011
	08403-010	3	1	KNOB, DELAY/WIDTH	28480	08403-010
	08403-008	9	1	KNOB, RATE	28480	08403-008
	08403-00030	5	1	KNOB, RATE (VERNIER)	28480	08403-00030
	0370-0118	5	1	PUSHBUTTON .505 X .725 X .550 IN H; GRAY	28480	0370-0118
	0370-1400†	1	1	PUSHBUTTON .505X.725X.550 IN H;JADE	28480	0370-1400
	08403-006	7	1	PLATE, SWITCH MOUNTING	28480	08403-006
CABINET PARTS						
2†	08403-00023	5	1	PANEL, FRONT	28480	08403-00023
5†	5050-8589	9	1	COVER ASSY: TOP 16L (OLIVE GRAY)	28480	5050-8589

See introduction to this section for ordering information
†Backdating information in Section VII

†Delete only the part number for the A700 assembly. Do not delete the part numbers for any other parts on this assembly. These parts will now be found on the A1000 Motherboard.

Table 6-2B. Parts Added for Change 1 (1 of 2)

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A900	08403-60024	3		1	FRONT ASSEMBLY	28480	08403-60024
	1261-0600	0		22	CONNECTOR-EGL CONT PIN 1,14-MM-BSC-52 50	28480	1261-0600
A1000	08403-60026	4		1	MOTHERBOARD ASSEMBLY	28480	08403-60026
	1261-0600	0			CONNECTOR-EGL CONT PIN 1,14-MM-BSC-52 50	28480	1261-0600
C601	0180-3661	7		3	CAPACITOR-PAD 660UF+100-10% 75VDC AL	04213	3740561H075HLEA
C605	0180-3661	7			CAPACITOR-PAD 660UF+100-10% 75VDC AL	04213	6740561H075HLEA
C608	0180-3661	7			CAPACITOR-PAD 660UF+100-10% 75VDC AL	04213	6740561H075HLEA
J1	1261-6720	5		2	CONNECTOR 24-PIN H POST TYPE	28480	1261-6720
J3	1262-0033	6		1	CONN-UTIL P-A-SKI 4-CAT 4-CONT	28480	1262-0033
J701	1261-3808	4		1	CONNECTOR 10-PIN H POST TYPE	28480	1261-3808
J702	1261-6720	5			CONNECTOR 24-PIN H POST TYPE	28480	1261-6720
J703	1262-1006	3		1	CONN-POST TYPE 100-PIN-SPCG 11 CONT	03261	68448-094
J704	1261-8281	9		2	CONN-POST TYPE 100-PIN-SPCG 5 CONT	28480	1261-8281
J705	1261-8281	9			CONN-POST TYPE 100-PIN-SPCG 5-CONT	28480	1261-8281
J706	1260-0836	1		2	CONNECTOR-RF 5HC H PC 60-OMI	28480	1260-0836
J707	1260-0836	1			CONNECTOR-RF 5HC H PC 60-OMI	28480	1260-0836
HP1001	6040-0170	6		12	GUIDE-PLUG-IN PC BOARD	28480	6040-0170
	2200-0105	4		12	SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
HP1002	6040-0170	6			GUIDE-PLUG-IN PC BOARD	28480	6040-0170
	2200-0105	4			SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
HP1003	6040-0170	6			GUIDE-PLUG-IN PC BOARD	28480	6040-0170
	2200-0105	4			SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
HP1004	6040-0170	6			GUIDE-PLUG-IN PC BOARD	28480	6040-0170
	2200-0105	4			SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
HP1005	6040-0170	6			GUIDE-PLUG-IN PC BOARD	28480	6040-0170
	2200-0105	4			SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
HP1006	6040-0170	6			GUIDE-PLUG-IN PC BOARD	28480	6040-0170
	2200-0105	4			SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
HP1007	6040-0170	6			GUIDE-PLUG-IN PC BOARD	28480	6040-0170
	2200-0105	4			SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
HP1008	6040-0170	6			GUIDE-PLUG-IN PC BOARD	28480	6040-0170
	2200-0105	4			SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
HP1009	6040-0170	6			GUIDE-PLUG-IN PC BOARD	28480	6040-0170
	2200-0105	4			SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
HP1010	6040-0170	6			GUIDE-PLUG-IN PC BOARD	28480	6040-0170
	2200-0105	4			SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
HP1011	6040-0170	6			GUIDE-PLUG-IN PC BOARD	28480	6040-0170
	2200-0105	4			SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
HP1012	6040-0170	6			GUIDE-PLUG-IN PC BOARD	28480	6040-0170
	2200-0105	4			SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
Q505	1853-0062	2		2	TRANSISTOR PHP 2N3740 SI TO-66 PD-25W	04713	2N3740
	1205-0085	8		2	HEAT SINK TO-66 CS	28480	1205-0085
Q509	1853-0062	2			TRANSISTOR PHP 2N3740 SI TO-66 PD-25W	04713	2N3740
	1205-0085	8			HEAT SINK TO-66 CS	28480	1205-0085
R3	0757-0401	0		1	RESISTOR 100 1K 125W F TC-0-100	24548	C4-1/8-TO-101-F
S1	3101-2833	0		1	SWITCH-PB 6-STATION 20MM C-C SPACING	03705	602420 W/O BUTTONS
XA100	1261-1365	6		6	CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1261-1365
XA200	1261-1365	6			CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1261-1365
XA300	1261-1365	6			CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1261-1365
XA400	1261-1365	6			CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1261-1365
XA500	1261-1365	6			CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1261-1365
XA600	1261-1365	6			CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1261-1365
MISCELLANEOUS PARTS							
	1261-3537	8		1	CONNECTOR 10-PIN F POST TYPE	28480	1261-3537
	1261-4490	4		1	CONNECTOR 12-PIN F POST TYPE	28480	1261-4490
	1261-4492	6		2	CONNECTOR 8-PIN F POST TYPE	28480	1261-4492
	1261-5180	1		1	CONNECTOR 4-PIN F UTILITY	28480	1261-5180
	08403-00036	1		1	MAIN CHASSIS	28480	08403-00036

See Introduction to this section for ordering information
 *Backdating information in Section VII

Table G-2B, Parts Added for Change 1 (2 of 2)

Reference Designation	HP Part Number	U D	Qty	Description	Mfr Code	Mfr Part Number
U2	08403-60026	5	1	CABLE, COAX-FROM 3706	28480	08403-60026
	08403-60027	5	1	CABLE, COAX-FROM 3707	28480	08403-60027
	00433-60031	7	1	CABLE, FIBER-FROM 3702 TO 11	28480	00433-60031
	0370-3073	8	2	KNOB, DELAY/WIDTH (RANGE)	28480	0370-3073
	0370-3074	9	1	KNOB, RATE (VERNIER)	28480	0370-3074
	0370-3075	7	1	KNOB, RATE (RANGE)	28480	0370-3075
	0370-3076	0	2	KNOB, DELAY/WIDTH (VERNIER)	28480	0370-3076
	5041-1682	9	1	KEY CAP	28480	5041-1682
	5041-0301	7	4	KEY CAP	28480	5041-0301
	08403-00035	0	1	SWITCH PLATE	28480	08403-00035
CABINET PARTS						
2 0	08403-00034	9	1	FRONT PANEL	28480	08403-00034
	08403-00037	2	1	TOP COVER ASSEMBLY	28480	08403-00037

See introduction to this section for ordering information
 †Backdating information in Section VII

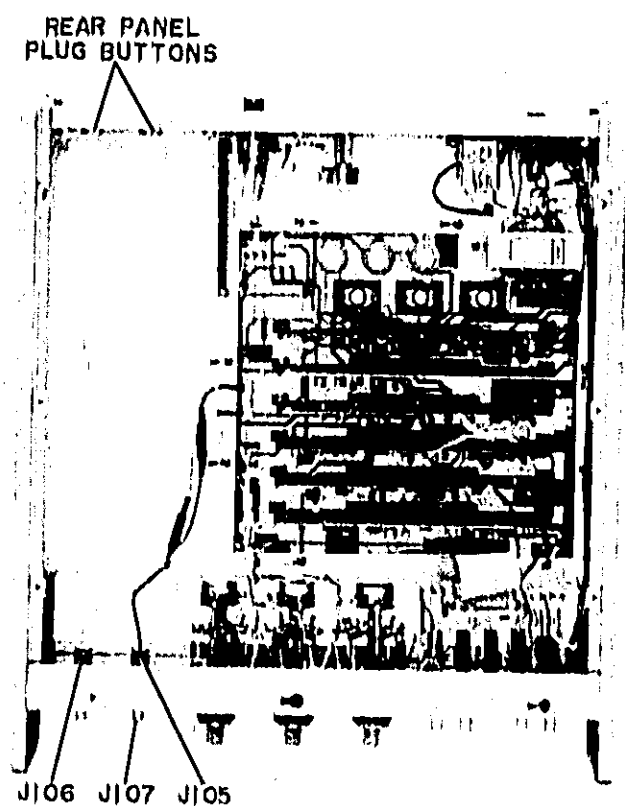


Figure 1A. HP 8403A, Bottom View (No installed options)

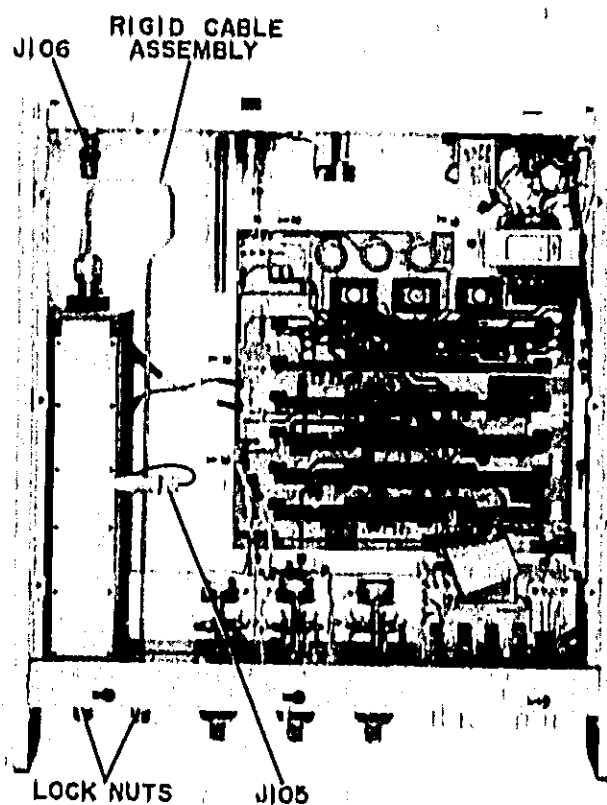


Figure 3A. HP 8403A with Option 002 Installed
(Option 004 is mechanically identical)

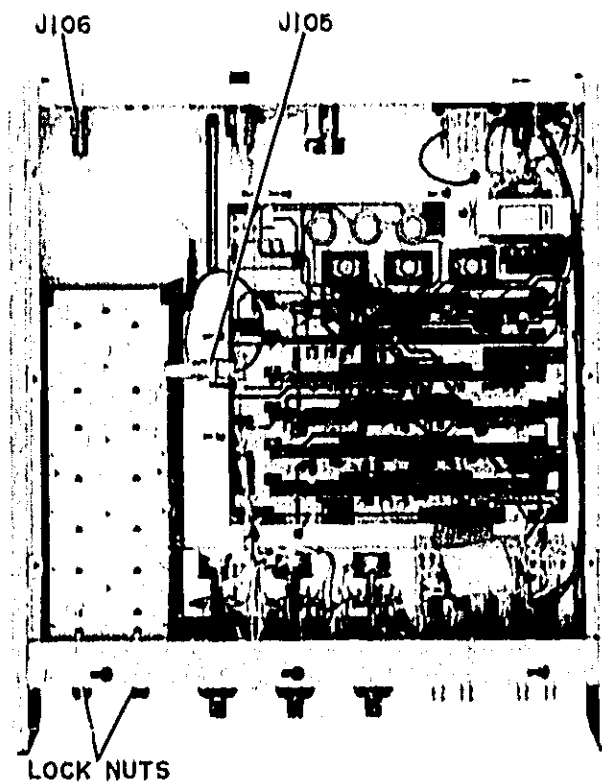


Figure 4A. HP 8403A with Option 006 Installed
(Options 001, 003, 005, 007, 008 are mechanically similar)