OPERATING AND SERVICE MANUAL

5501A

LASER TRANSDUCER (LASER HEAD)

SERIAL PREFIX: 2020A

This manual applies directly to Hewlett-Packard Model 5501A Laser Transducers having serial prefix 2020A.

SERIAL PREFIXES NOT LISTED

For serial prefixes above 2020A, a Manual Change sheet is included with this manual. For lower serial prefixes, refer to Section VI of this manual.

Manual Part No. 05501-90025
Microfiche No. 05501-90026

Printed: MAY 1981

HEWLETT PACKARD

OPERATING AND SERVICE MANUAL

5501A

LASER TRANSDUCER (LASER HEAD)

SERIAL PREFIX: 2020A

This manual applies directly to Hewlett-Packard Model 5501A Laser Transducers having serial prefix 2020A.

SERIAL PREFIXES NOT LISTED

For serial prefixes above 2020A, a Manual Change sheet is included with this manual. For lower serial prefixes, refer to Section VI of this manual.

Manual Part No. 05501-90025
Microfiche No. 05501-90026

Printed: MAY 1981

HEWLETT PACKARD

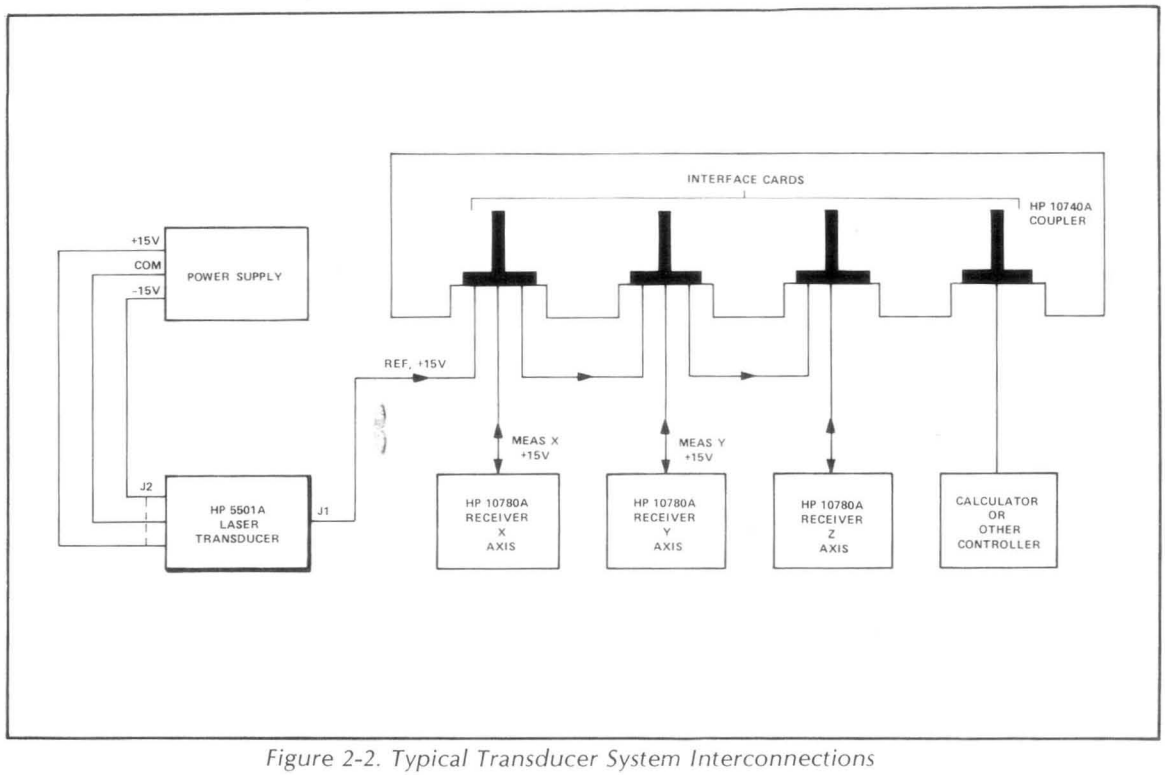


Figure 2-2. Typical Transducer System Interconnections

2-15. Cable Fabrication

2-16. Power and signal interconnecting cables of suitable length must be fabricated using the three plugs included with the laser head. Figure 2-3 illustrates the physical details of the three supplied plugs and gives part numbers for both the plugs and the recommended cables. Refer to Table 2-1 for rear-panel connector pin numbers of all available power and signal lines.

2-17. OPERATION

2-18. The following paragraphs describe the laser head controls, connectors, and indicators, and describe the steps necessary to apply power to the laser head and to verify that the laser beam is aligned through the optical components of the system.

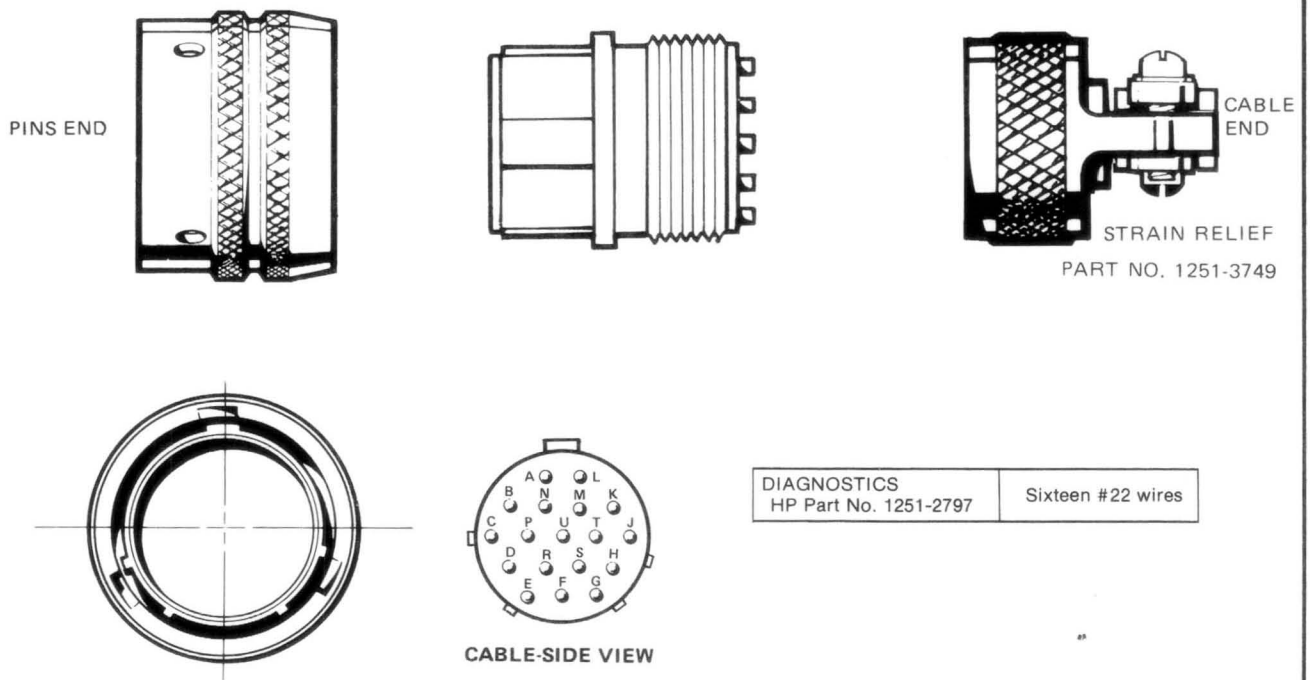
2-19. Controls, Connectors, and Indicators

2-20. Figure 2-4 identifies and describes each of the operating controls, connectors, and indicators. Refer to Table 2-1 for information regarding the specific power and signal lines that are available at each of the connectors.

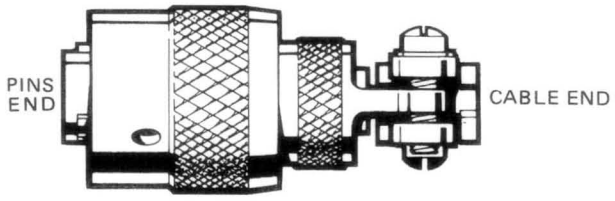
2-21. Power Application

2-22. The installed laser head unit is activated when +15 Vdc and -15 Vdc are applied to the unit. After connecting the POWER plug, measure the voltage at pins A and B of the diagnostics connector and ensure that the power source is adjusted to conform to the following requirements.

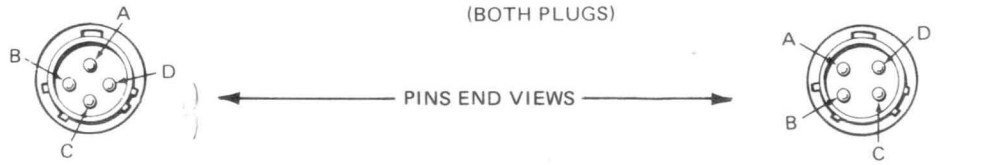
Pin (+)	Pin (-)	Measured Voltage
A	D	+15V ± 0.25 Vdc
D	B	-15V ± 0.25 Vdc



DIAGNOSTICS HP Part No. 1251-2797	Sixteen #22 wires



SIDE VIEW
(BOTH PLUGS)



REFERENCE SIGNAL

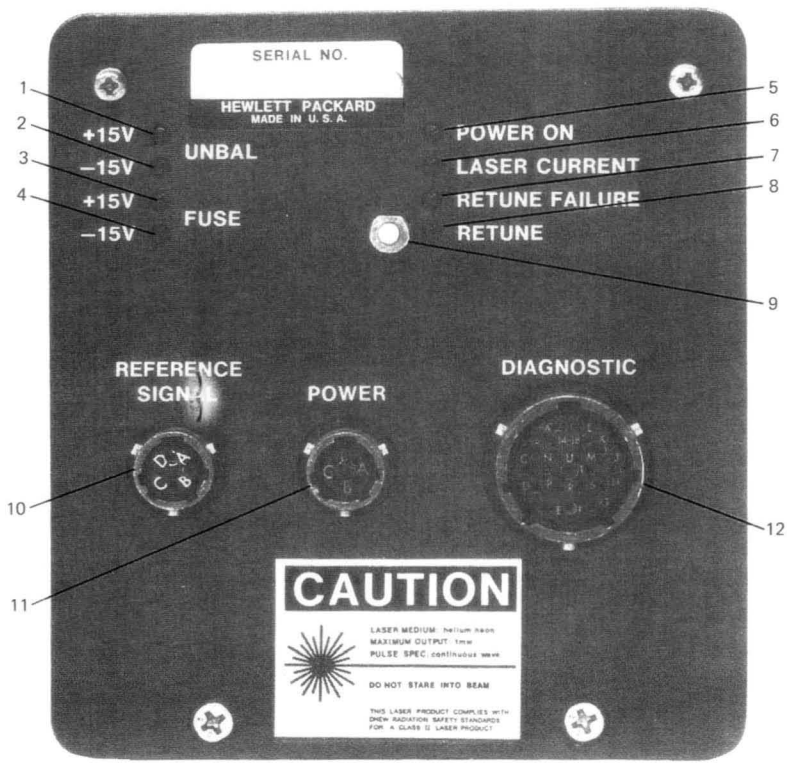
POWER

PLUG	CABLE	DESCRIPTION
REFERENCE SIGNAL HP Part No. 1251-3447	HP10779A/B/C or equivalent	Dual coax; two #22 power wires. Everything enclosed by a second insulated shield.
POWER HP Part No. 1251-3450	HP10778A/B/C or equivalent	Three #20 wires

Figure 2-3. Interconnecting Plugs and Cable Details

Table 2-1. Laser Head System Signal Chart

Input	Output	Signal Name	Function	Source	Destination
	J1-A	Fused +15V	Accessory +15V Operating Power		Accessory Equipment
	J1-B	Fused +15V RET	Accessory +15V Return		Accessory Equipment
	J1-C J1-D	$\overline{\text{REF}}$ REF	System Reference Measurement signal, equal to the difference in frequency between the Laser f_1 and f_2 components.		Accessory Equipment
J2-A		+15V	External +15V power input	Ext. Pwr. Sup.	
J2-B		-15V	External -15V power input	Ext. Pwr. Sup.	
	J2-C	+5V	+5V power test point		Accessory Equipment (test use only)
J2-D		GND	Power Ground	Ext. Pwr. Sup.	
	J3-A	+15 TEST	+15V sample for diagnostics		Accessory Equipment
	J3-B	-15 TEST	-15V sample for diagnostics		Accessory Equipment
	J3-C	+5 TEST	+5V sample for diagnostics		Accessory Equipment
	J3-D	SYS COM	System Common return		Accessory Equipment
J3-E		$\overline{\text{RETUNE}}$ $\overline{\text{CMD}}$	Active low signal; external input to initiate PZT Tune/Check cycle	Accessory Equipment	
	J3-F	RETUNE FAILURE	Active high diagnostic signal indicating failure of the PZT Tuning/Check cycle		Accessory Equipment
	J3-J	RETUNE STATUS	Active high diagnostic signal indicating PZT Tuning/Check cycle is in process		Accessory Equipment
	J3-K	LASER CURRENT ERROR	Active high diagnostic signal indicating Laser Tube current is not within minimum and maximum limits		Accessory Equipment
	J3-L	ERROR	Active high diagnostic signal indicating any or all of the following conditions: 1. Laser Tube current out of specifications 2. PZT voltage out of specifications 3. Retune/Check cycle in process		Accessory Equipment
	J3-M	L I MON TEST	Laser current sample for diagnostics		Accessory Equipment
	J3-N	PZT MON TEST	PZT voltage sample for diagnostics		Accessory Equipment
	J3-P	REF OK STATUS	Active low diagnostic signal indicating Laser is properly tuned		Accessory Equipment



1.	+15 UNBAL (LED Lamp)	Lights when +15 Vdc power is high by approximately one volt or more; or when the –15 Vdc power input is low (i.e., less negative) by one volt or more.
2.	–15 UNBAL (LED Lamp)	Lights when –15 Vdc power is high (i.e., more negative) by approximately one one volts or more; or when the +15 Vdc power input is low (i.e., less positive) by one volt or more.
3.	+15 FUSE (LED Lamp)	Lights when +15 Vdc fuse blows.
4.	–15 FUSE (LED Lamp)	Lights when –15 Vdc fuse blows.
5.	POWER ON (LED Lamp)	Lights when external power has been applied to Laser Head.
6.	LASER CURRENT (LED Lamp)	Lights to indicate Laser Tube current is not within appropriate operating limits.
7.	RETUNE FAILURE (LED Lamp)	Lights to indicate the Laser Tube is not properly tuned or that retune cycle did not retune the laser.
8.	RETUNE (LED Lamp)	Lights to indicate that retuning is required or that retune cycle is in progress. Light should go out approximately 9 seconds after the RETUNE pushbutton is depressed. If light remains on, a tuning fault is indicated.
9.	RETUNE (Pushbutton)	Manually activates Retune sequence.
10.	REFERENCE SIGNAL (Connector, J1)	Allows the reference signals (REF and $\overline{\text{REF}}$) and +15V power to be interconnected to other system components.
11.	POWER (Connector, J2)	Provides connection point for external power supply input.
12.	DIAGNOSTIC (Connector, J3)	Allows monitoring of diagnostic signals and application of RETUNE command by external equipment.

Figure 2-4. Controls, Connectors, and Indicators

SECTION III
THEORY OF OPERATION

3-1. INTRODUCTION

3-2. This section provides the theory of operation for the laser head. The first part presents general laser theory as it applies to the laser head. Subsequent paragraphs described detailed laser head operation; functional analysis of the laser head is included.

3-3. GENERAL DESCRIPTION

3-4. The laser head transmits a coherent light beam (all light waves are in phase) that is used by the laser transducer system to generate displacement measurement signals. In addition to this beam, the laser head generates an electrical reference (REF) signal, and accepts and produces interface and diagnostic signals for accessory equipment. The laser head accepts +15 Vdc and -15 Vdc operating power from an external source and distributes fused +15 Vdc and -15 Vdc to other units of the transducer system.

3-5. The laser head basically consists of a laser tube assembly, regulator circuits that ensure optimum laser operation, and diagnostic circuits.

3-6. The laser tube contains a Helium-Neon gas that is excited when high voltage is supplied. A laser current control circuit maintains the appropriate laser tube current by monitoring cathode current and adjusting the high voltage accordingly.

3-7. The laser tube consists of the anode, cathode, mirrors, a spring, and a piezoelectric transducer. These elements are enclosed in the Helium-Neon environment. As a result of the exictation, light energy in the form of photons are spontaneously emitted by the excited Neon atoms. These photons, traveling approximately at the speed of light, are reflected by the mirrors and collide with Neon atoms that are in a metastable state. This collision results in the stimulated emission of several photons by the Neon atoms. This event occurs repeatedly and is responsible for the laser phenomenon; Light Amplification by Stimulated Emission of Radiation. Further photon collisions cause increased coherent emission. These chain reactions, ultimately create an in-phase, or coherent light energy level which is sufficient to generate a beam through the laser tube aperture.

3-8. The laser frequency is determined by the transition between energy levels of the Neon atoms. The distance between mirrors establishes a cavity length which is adjusted to support longitudinal oscillations at a wavelength of 6328 Angstroms (5×10^{14} Hz). This wavelength lies in the red region of the visible light spectrum.

3-9. A small amount of resonant cavity length tuning is provided by the piezoelectric transducer (PZT) which is in front of the rear mirror. A spring behind the mirror forces it against the PZT. The PZT has the property of expanding to a thickness which is proportional to the amount of positive dc voltage applied through a stem connection at the rear of the tube. The expanding PZT pushes the mirror to the rear of the tube, thereby creating a longer resonant cavity. The longer cavity sustains oscillations at a slightly lower frequency. Therefore, the laser tube responds to a more positive PZT voltage by tuning to a slightly lower frequency. Conversely, the tube responds to a less positive PZT voltage by tuning to a higher laser frequency. This PZT control potential ranges from +270V to +1800V.

3-10. A magnet that surrounds the laser tube causes Zeeman splitting of its frequency symmetrically about f_0, the normal laser center frequency. This results in two circularly polarized frequency components existing in the same beam. One component is left-hand circularly polarized (LHCP) and is approximately 1 MHz from the center operating frequency of the tube (f_0). The other beam frequency component is right-hand circularly polarized (RHCP) and is approximately 1 MHz from f_0, in the other direction.

3-11. The laser beam, containing the two circularly polarized frequency components (f_1 and f_2), passes through a $\lambda/4$ plate (λ = wavelength). This causes the f_1 and f_2 components to become linearly polarized and mutually perpendicular, or orthogonal. These frequency components then pass through a $\lambda/2$ plate which is factory-adjusted to compensate for the imperfect orthogonal positioning of the f_1 and f_2 signals.

3-12. The laser beam, containing the vertically polarized f_1 (the lower of the two frequencies) and the horizontally polarized f_2 components, passes through a collimating telescope. This device consists of a compound lens which spreads the extremely narrow laser beam into a parallel 0.28 inch (7 mm) output beam.

3-13. A device called a beam splitter diverts a small portion of the output beam and routes this sample to a polarizing beam splitter. This splitter partially separates and applies the f_1 and f_2 signals to the PZT control circuit. The PZT control circuit compares the signal level of the f_1 and f_2 samples. If the levels of these samples are not equal, an appropriate (dc) PZT control voltage is generated to tune the laser tube and cause equalization of the f_1 and f_2 components. In addition to providing this automatic tuning control, the control circuits extract the difference frequency between f_1 and f_2 and generate an electrical reference measurment signal for use by the transducer accessory equipment.

3-14. Additional circuits within the laser head monitor PZT voltage, laser current, and performance of the automatic tuning circuits, as well as external operating power inputs. These circuits drive fault lights and provide diagnostic signals to accessory equipment. A retune command signal, from accessory equipment or manually activated at the laser head, interrupts the automatic PZT tuning and forces the laser to tune to the center of its mechanical range for 3 seconds. Control is then returned to the automatic control circuits. This retune capability is provided to bring the laser operating frequency within the range of automatic control when, due to extreme environmental changes, the laser attempts to tune beyond the automatic tuning range.

3-15. GENERAL FUNCTIONAL DESCRIPTION

3-16. The following text provides a detailed functional analysis of laser head operation. All descriptions relate to Figure 7-4 unless otherwise specified. Operation of the laser head can be grouped into the following functions:

- Power Distribution
- Laser Current Regulation
- Automatic (PZT) Tuning
- Control and Diagnostic Monitoring

3-17. Power Distribution

3-18. When +15 Vdc and -15 Vdc are applied to the laser head, the POWER ON light-emitting-diode indicator (on the A1 Connector Board) is forward biased and illuminates. The dc input potentials also produce a virtual ground level at the junction of two 15K ohm resistors. This balanced condition results in an open circuit at both outputs of the comparator switch. An unbalanced condition exists when either the positive or negative dc input deviates from 15 volts by approximately 1 volt or more. This offset causes a corresponding comparator switch output to go to ground, resulting in a lit UNBAL indicator. Table 3-1 lists the unbalanced dc voltage conditions and the resulting unbalanced indications.

Table 3-1. DC Unbalanced Failures

DC Input Voltage	Unbalanced Condition (See Note)	Unbalanced Indicators	
		+15V UNBAL	-15V UNBAL
+15 Vdc	High (more positive)	ON	OFF
	Low (less positive)	OFF	ON
-15 Vdc	High (more negative)	OFF	ON
	Low (less negative)	ON	OFF

3-19. If either the +15 Vdc or -15 Vdc two-amp fuse opens, current is diverted through the associated LED indicator, turning that fuse indicator on.

3-20. System operating power is distributed to the laser head and other transducer units via the connector board. Safety switch S2 opens when the laser head cover is removed. This disconnects -15 Vdc from the piezoelectric transducer (PZT) power supply and the high voltage power supply. As a result, these power supplies become inoperative. The +15 Vdc input is applied to a regulator on the A7 Control Board. This regulator provides +5 volts for use within the laser head.

NOTE

High or low indicates voltage deviation of approximately 1 volt, or more. For example, consider the +15 volt input going more positively by 1 volt. The inverted input to the comparator switch goes high (i.e., more positive than ground). This results in the cathode of LED DS1 switch going to ground, activating the UNBAL +15V indicator. The cathode of LED DS2 output remains open. Conversely, if the -15 volt input goes more negative by approximately 1 volt, the unbalance condition causes the comparator switch inverting input to go negative, grounding the cathode of DS2 and opening the DS1 cathode. As a result, the -15V unbalance indicator is lit.

3-21. Laser Current Regulation

3-22. The laser current regulation circuit is a control loop consisting of an error sensing circuit and the high voltage power supply. A 390-ohm resistor on the A1 Connector Board provides a current path for the laser tube cathode. The resulting voltage drop across this resistor provides a monitoring input to a difference amplifier on the Connector Board. This difference amplifier functions as a voltage comparator. The other comparator input is a reference voltage which is determined by the adjustment of potentiometer A1R11. Laser current is adjusted by monitoring A7TP2 (i.e., the laser cathode current test point on the Control Board) or A1TP1 (adjacent to A1R11) and setting A1R11 for the appropriate reading. Once set, any change in laser current results in a comparator error output signal. This error signal changes the conduction of driver A1Q3. Transistor A1Q3 drives a series regulator Q1, which acts as a variable resistance to control the amount of drive to the High Voltage Power Supply A2.

3-23. The A2 High Voltage Power Supply consists of an oscillator and a high voltage multiplier circuit. The oscillator is activated when -15 volts is supplied via safety switch A1S2. Oscillation is maintained by internal switching transistors that alternately drive magnetic core transformer T1 in and out of saturation at a rate that depends on the amount of voltage delivered by series regulator Q1. Higher drive voltage results in a higher oscillator frequency and a higher peak-to-peak amplitude. Less voltage reduces oscillator frequency and amplitude. The typical oscillator output range is 12.5 kHz at 50 volts (peak-to-peak) to 25 kHz at 125 volts (peak-to-peak). The oscillator output signal determines the amount of high voltage dc output that is produced by the high voltage multiplier circuit.

3-24. The high voltage multiplier consists of voltage doubler circuits that are wired in series to produce a net high voltage output of up to 10K Vdc. This variable output is applied to the anode of the laser tube to control tube current. The high voltage circuit responds to a variation in cathode current by providing a change in anode high voltage. This high voltage change brings laser tube current back to the appropriate level.

3-25. Automatic PZT Tuning

3-26. The laser tube is automatically fine tuned by a control loop, which consists of the Beam Splitter Assembly (A4), Lock Reference Assembly (A5), and the PZT Power Supply Assembly (A6). These circuits sample the output beam and provide PZT control voltages that maintain the appropriate dual-frequency beam emission.

3-27. The Beam Splitter Assembly diverts approximately 20% of the laser tube output beam and applies this portion of the beam to a polarized beam splitter. The polarized splitter extracts the orthogonal frequency components from the beam sample and provides separated f_1 and f_2 frequency inputs to the Lock Reference Assembly photodetector diodes.

3-28. The polarized beam splitter allows a small portion of the f_2 component to be mixed with the f_1 photodiode input. A small amount of f_1 signal is also combined with the f_2 photodiode sample. As a result, each photodiode detects a difference frequency signal (approximately 2 MHz). One photodiode output signal, designated comp-f_1 consists of a dominant f_1 signal, and a small amount of f_2. As a result the amplitude of the comp-f_1 signal is a function of the f_1 component of the beam sample. The comp-f_2 amplitude is determined by the f_2 level of the input beam sample. Comp-f_1 is applied to the negative difference integrator input, while comp-f_2 is applied to the positive input. The difference integrator compares these inputs and provides a resultant negative dc output signal. The magnitude of this signal depends on the relative amplitude of the comp-f_1 and comp-f_2 signals. Typical levels range from -3 Vdc to -7 Vdc.

3-29. The FREQ potentiometer, A5R4, is an offset adjustment that provides the appropriate difference integrator output when equal comp-f_1 and comp-f_2 signals are applied. This adjustment compensates forthe fact that the two photodiodes are not perfectly matched.

3-30. A $\overline{\text{RETUNE CLAMP}}$ input signal from the A7 Control Assemby activates the clamp switch circuits; this results in a -6 volts difference integrator output. This $\overline{\text{RETUNE CLAMP}}$ signal is provided when the manual $\overline{\text{RETUNE}}$ button is pressed or when the $\overline{\text{RETUNE CMD}}$ signal is received. The clamp signal lasts 3 seconds, after which time the automatic circuits resume control of the difference integrator output.

3-31. The dc difference integrator control signal is applied through an emitter follower to the PZT Power Supply. The PZT Power Supply operates in a manner similar to the High Voltage Power Supply and consists of an oscillator and one voltage doubler. This power supply responds to control input by providing a dc output that varies from 1 to 2 kV. This output directly controls the laser tube PZT, and ultimately causes equalization of the laser beam f_1 and f_2 frequency components.

3-32. To demonstrate PZT control loop operation, consider an f_0 (center frequency) drift towards a lower frequency (f_1). The resulting increase in f_1 signal level is sensed by the Lock Reference Assembly circuits. These circuits respond by applying a more negative PZT control signal to the PZT Power Supply, causing a PZT voltage decrease. The tuned laser tube frequency is inversely proportional to PZT control voltage input. A decreasing PZT voltage therefore tunes the laser tube towards a higher frequency. As a result, the f_1 amplitude decreases and the f_1 component becomes equal to the f_2 component signal level.

3-33. The Lock Reference Assembly also performs the function of providing the system with a reference signal. The comp-f_2 signal is applied to an over-driven RF amplifier. The resulting output is applied to a differential line driver and a detector circuit. The detector provides a dc signal which is proportional to the RF comp-f_2 signal strength. When this dc output signal exceeds +0.3 volt, a sufficient signal requirement is satisfied. As a result, the threshold detector output goes high enabling the differential driver which produces a true $\overline{\text{REF OK}}$ signal. The enabled driver provides complementary (REF and $\overline{\text{REF}}$) reference signals to the transducer accessory modules.

3-34. Control and Diagnostic Monitoring

3-35. The A6 Control Assembly generates diagnostic signals and provides timing and control signals for the retune function.

3-36. RETUNE FUNCTION (refer to Figure 3-1 and 7-4). The retune function is initiated when the RETUNE pushbutton, S1, is depressed or an external $\overline{\text{RETUNE CMD}}$ signal is received from a transducer controller. The high-to-low transition of this signal clears the tune fault latch and sets the tune latch on the Control Board. The tune latch then provides a low $\overline{\text{RETUNE}}$ output signal that activates the error gate, resulting in a true (high) ERROR diagnostic output signal. The logic high RETUNE signal, (also generated by the tune latch) provides drive that lights the RETUNE LED indicator. The ERROR diagnostic signal stays high and the RETUNE indicator remain lit during the complete retune cycle. If the laser head successfully retunes, the ERROR signal goes low and the RETUNE indicator goes out.

3-37. At time t_1 (the positive transition of the $\overline{\text{RETUNE CMD}}$ signal) the retune timing circuits generate a 3-second $\overline{\text{RETUNE CLAMP}}$ signal which is applied to the Lock Reference Assembly. The Lock Reference Assembly tuning circuits respond to this input by ultimately driving the PZT-controlled laser frequency towards center (f_0). Upon termination of the $\overline{\text{RETUNE CLAMP}}$ signal (3 seconds after t_1), the automatic PZT tune circuits resume control of the laser tuning. Successful retuning is accomplished when the comp-f_2 input signal to the Lock Reference Assembly provides proportional dc drive that exceeds a +0.3 Vdc threshold level. When his condition is satisfied, a low $\overline{\text{REF OK}}$ signal is generated. This signal is applied to the Control

Assembly test gate, inhibiting the gate. This disabled gate prevents a set signal (generated during time t_2) from reaching the fault latch. As a result, the fault latch remains cleared and provides a low enable signal to the clear gate. During time t_3 (approximately 9 seconds after the retune cycle started), a 10-microsecond CLR signal is inverted by the enabled clear gate and the resulting $\overline{CLR}$ trigger clears the tune latch.

3-38. If the retuning process is not successfully accomplished, the threshold detector output (on the Lock Reference Assembly) remains low. This signal prevents generation of a system reference signal and provides a false (high) $\overline{REF\ OK}$ signal. This high signal enables the test gate (on the Control Assembly) during times t_2 to t_3. As a result, the t_2 signal (from the retune timing circuits) drives the test gate output low. This low signal sets the tune fault latch. The set latch:

a. Provides drive to light the RETUNE FAILURE LED indicator.

b. Inhibits the clear gate; thereby keeping the tune latch set. As a result the RETUNE LED indicator remains ON.

c. Maintains an active (high) ERROR output signal.

3-39. DIAGNOSTIC SIGNALS AND INDICATORS. Improper laser current, PZT voltage or beam sampling inputs results in an active (high) diagnostic ERROR output signal. The laser cathode resistor on the Connector Board provides an input voltage which serves as a monitoring signal to the Control Board Laser Current Fault Detector. This fault detector is a dual comparator which is activated when the monitoring voltage (representing laser current) exceeds an upper limit of +2.0 volts, or falls below the lower limit of +1.0 volt. The resulting low $\overline{LI\ FAULT}$ signal activates the error gate, turns the LASER CURRENT fault indicator on, and provides a subsystem LASER CURRENT fault diagnostic output signal.

3-40. A part of the PZT Power Supply output voltage (approximately 1/1000th) is sampled and applied to the PZT fault detector on the Control Assembly. This circuit is also a dual comparator which is activated when the PZT sample input exceeds +1.8 volts, or falls below +0.27 volt. A low $\overline{PZT}$ output signal sets the tune latch activating the ERROR diagnostic output signal. In addition, the set tune latch output lights the RETUNE indicator and provides an active RETUNE diagnostic output signal. This signal indicates a laser retune requirement.

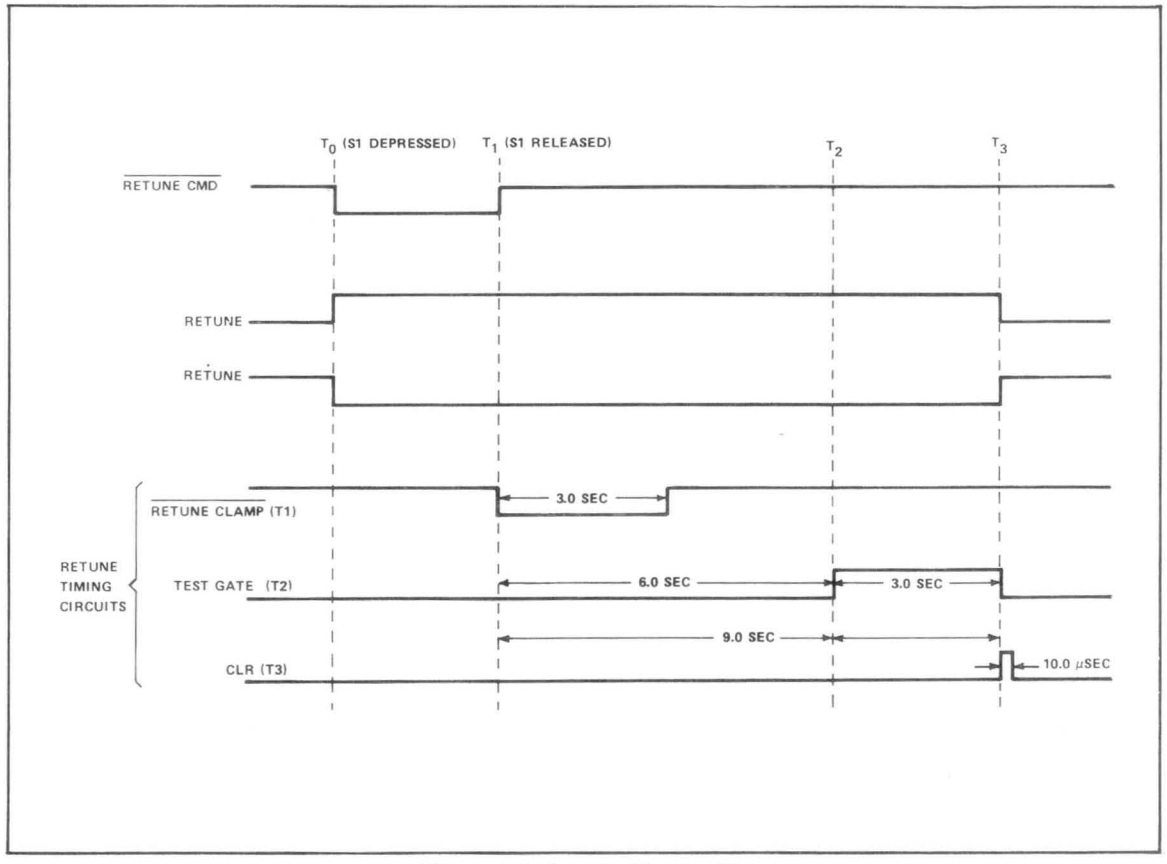


Figure 3-1. Retune Timing Diagram

SECTION IV
MAINTENANCE

4-1. INTRODUCTION

4-2. This section provides information to facilitate 5501A laser head maintenance at the replaceable module level. Included are performance checks, instrument access procedures, a troubleshooting flow chart, troubleshooting diagrams, and adjustment procedures. When a faulty module is isolated, the trouble may be further isolated to the component level by using the functional theory provided in Section III of this manual.

4-3. PERFORMANCE CHECK

4-4. When a new 5501A is received, or normal operation is in doubt, this test may be performed to determine if the unit is operating properly. The +15 Vdc and -15 Vdc are derived from external power supplies. If necessary, adjust these power supplies to conform to parameters in Tables 4-1 and 4-2. The following test equipment is recommended:

HP 1707 Oscilloscope or equivalent (2 MHz measurements)

HP 5300/5306 Multimeter/Counter (+15V measurements)

4-5. Check the 5501A voltages in the following manner:

a. Disconnect the POWER cable.

b. Measure the voltages at the disconnected cable plug as outlined in Table 4-1.

Table 4-1. Input Voltage

Plug Pin	Voltage
A(+) , D(-)	+15 ±0.25V
D(+) , B(-)	-15 ±0.25V

c. Connect the plug to the 5501A POWER connector. Disconnect the DIAGNOSTIC plug and perform the voltage measurements according to Table 4-2.

Table 4-2. Voltages at Diagnostic Connector

DIAGNOSTIC Connector Pin	Voltage
A(+) , D(-)	+15V ±1V
D(+) , B(-)	-15V ±1V
C(+) , D(-)	*+15V ±0.25V

*Voltage provided by 5501A circuits.

d. Observe the rear-panel indicators of the 5501A while depressing, then releasing, the RETUNE switch. The indicators should be as described in Table 4-3.

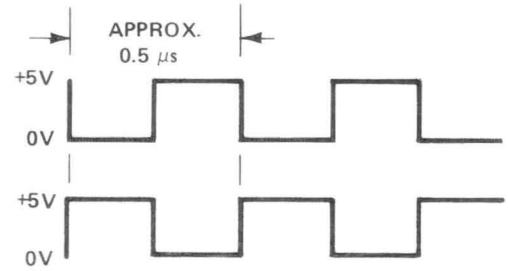
Table 4-3. Indicator Conditions During Retune

Indicator	Condition
+15V UNBAL	OFF
-15V UNBAL	OFF
+15V FUSE	OFF
-15V FUSE	OFF
POWER ON	ON
LASER CURRENT	OFF
RETUNE FAILURE	If on, should go off after RETUNE switch is depressed.
RETUNE	Light goes off approximately 9 seconds after switch is released.

e. Disconnect plug to 5501A REFERENCE SIGNAL connector and check for a proper signal as shown in Table 4-4.

f. Reconnect all cables and observe red beam emitted from 5501A. DO NOT STARE DIRECTLY INTO BEAM.

Table 4-4. Reference Signal

Reference Signal Connector Pin	Signal
C D	

4-6. INSTRUMENT ACCESS

4-7. Access to the assemblies within the laser head is required to troubleshoot or adjust the laser head circuits. The following paragraphs describe how to remove the laser head covers and how to remove and reinstall the major assemblies.

WARNING

HIGH VOLTAGES ARE GENERATED WITHIN THE LASER HEAD HOUSING. THE COVER OF THE LASER HEAD CONTROLS A SAFETY INTERLOCK SWITCH TO PREVENT ACCIDENTAL ACCESS TO THESE VOLTAGES; TO ENSURE SAFETY AND POSSIBLE EQUIPMENT DAMAGE, HOWEVER, ALWAYS DISCONNECT THE POWER SOURCE FROM THE LASER HEAD BEFORE REMOVING THE COVERS.

4-8. To remove the front panel and side covers from the laser head, perform the following steps:

a. Rotate the front-panel turret so that the large opening is at the bottom and the slotted, 1/4-turn fastener is visible through the opening.

b. Using a suitable screwdriver, rotate the fastener 1/4-turn in the counterclockwise direction.

c. Remove the front panel by gently pulling the panel straight away from the laser head.

d. Remove the two half-covers by gently pulling each cover outward and forward. This releases the edges of the covers from the retaining grooves along the edges of the rear panel.

4-9. To remove the A5 Lock Reference Board Assembly, perform the following steps:

a. Remove the two machine screws that secure the lock reference board to the A4 Beam Splitter Assembly. These two screws also retain the circular shroud that covers the two photodiodes mounted on the board.

b. Remove the two machine screws that secure the lock reference board to the U-shaped, sheet-metal sub-panel.

c. Gently remove the board from the mating connector.

4-10. To remove the A7 Control Board Assembly, perform the following steps:

a. Remove the two machine screws that secure the control board to the U-shaped, sheet-metal sub-panel.

b. Gently remove the board from the mating connector.

4-11. To remove the A1 Connector Board Assembly, perform the following steps:

a. Remove the four machine screws that secure the rear panel and remove the panel.

b. Remove the two machine screws that mount the connector board to the cast base plate of the unit.

c. Label and remove the eight wires that connect to the back side of the connector board. These wires use separate pin connectors and should be disconnected by gently pulling the wires straight away from the connector board.

d. Remove the two machine screws and nuts that attach the 21-pin, molded-plastic connector to the connector board and remove the connector board.

4-12. Remove the laser tube according to the following procedure:

WARNING

THE FOLLOWING PROCEDURE REQUIRES THE REMOVAL OF HIGH VOLTAGE POWER CONNECTIONS FROM THE LASER TUBE. IT IS POSSIBLE FOR SOME VOLTAGE POTENTIAL TO REMAIN ON THESE CONNECTIONS, AND IF THE POTENTIAL IS NOT DISCHARGED ACCORDING TO THE FOLLOWING PROCEDURE, INJURY TO SERVICE PERSONNEL CAN RESULT.

a. Disconnect the high voltage power supply connection from the laser tube by rotating the white, knurled fastener in the counterclockwise direction; hold the wire from rotating with the fastener. DO NOT TOUCH THE SPRING-LOADED CONTACT.

b. Momentarily place the spring-loaded high voltage contact on a suitable power supply return point such as the cast base plate on which the laser tube is mounted.

c. Remove the laser tube cathode connection (located on the side of the glass portion of the laser tube) by pulling the connector cap straight away from the laser tube.

d. Place the laser head on its side and, while supporting the tube with one hand, remove the four tube mounting screws, which are accessible from the bottom of the cast base plate. When installing the laser tube, tighten the two countersunk, crosspoint screws first, then tighten the two allen head cap screws. This ensures that the laser tube is properly aligned.

e. Gently remove the laser tube far enough to disconnect the PZT anode lead, which is located at the rear center of the tube, then remove the tube.

4-13. Remove the A6 PZT Power Supply Assembly according to the following procedure:

WARNING

THE FOLLOWING PROCEDURE REQUIRES THE REMOVAL OF HIGH VOLTAGE POWER CONNECTIONS FROM THE LASER TUBE. IT IS POSSIBLE FOR SOME VOLTAGE POTENTIAL TO REMAIN ON THESE CONNECTIONS, AND IF THE POTENTIAL IS NOT DISCHARGED ACCORDING TO THE FOLLOWING PROCEDURE, INJURY TO SERVICE PERSONNEL CAN RESULT.

a. Remove the A1 Connector Board Assembly as previously described in this section of the manual.

b. Disconnect the PZT anode connection from the rear of the laser tube. DO NOT TOUCH THE METAL TIP OF THE CONNECTOR.

c. Momentarily place the metal connector tip to a suitable power supply return point such as the cast base plate on which the laser tube is mounted. This will remove the possibility of a shock hazard from the anode lead.

d. Remove the three recessed machine screws (from the top) that secure the PZT power supply to the cast base plate, and remove the power supply from the unit.

4-14. Remove the A2 High Voltage Power Supply Assembly according to the following procedure:

WARNING

THE FOLLOWING PROCEDURE REQUIRES THE REMOVAL OF HIGH VOLTAGE POWER CONNECTIONS FROM THE LASER TUBE. IT IS POSSIBLE FOR SOME VOLTAGE POTENTIAL TO REMAIN ON THESE CONNECTIONS, AND IF THE POTENTIAL IS NOT DISCHARGED ACCORDING TO THE FOLLOWING PROCEDURE, INJURY TO SERVICE PERSONNEL CAN RESULT.

a. Remove the high voltage power supply connector from the laser tube by rotating the white, knurled fastener in the counterclockwise direction; hold the wire from rotating with the fastener. DO NOT TOUCH THE SPRING-LOADED CONTACT.

b. Momentarily place the spring-loaded high voltage contact to a suitable power supply return point such as the cast base plate on which the laser tube is mounted.

c. Disconnect the three remaining power supply leads from the pin connectors on the A1 Connector Board Assembly.

d. Using a suitable allen wrench, loosen the three screws on each forward side of the cast base plate. These screws secure the U-shaped, sheet-metal sub-panel in a retaining groove at the front of the cast base plate.

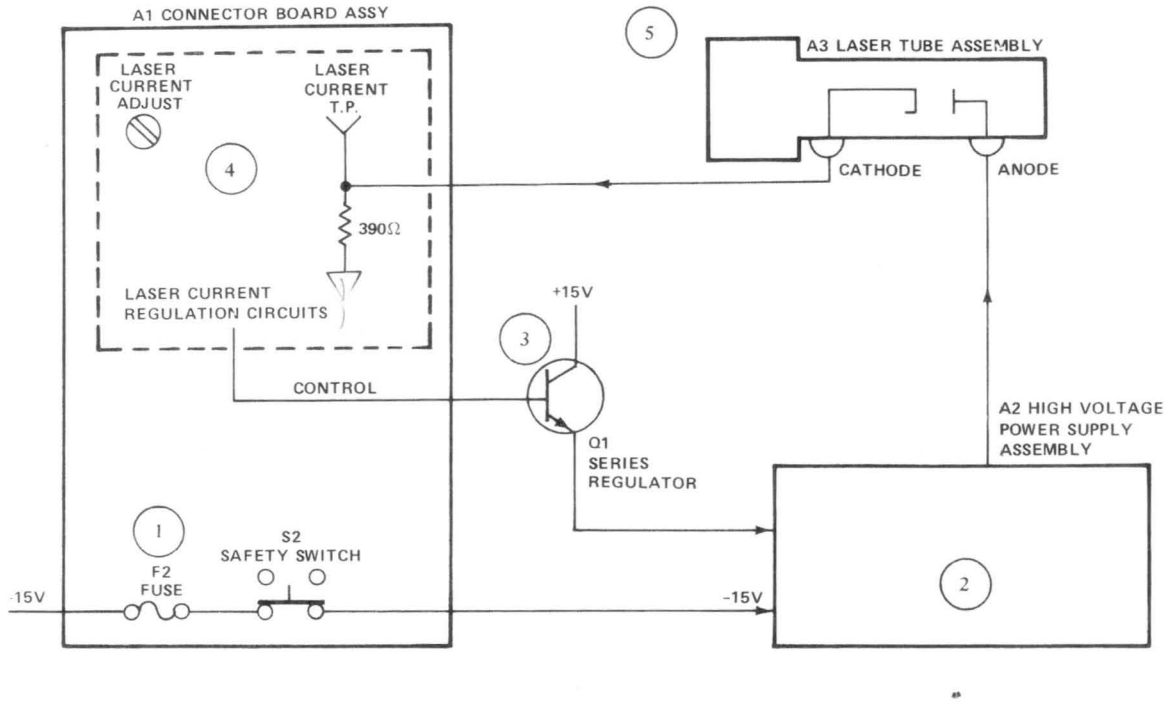
e. Carefully lift and rotate the U-shaped sub-panel (with circuit board assemblies attached) until it can be gently rested on top of the laser tube.

f. Remove the two recessed machine screws (from the top) that attach the high voltage power supply to the cast base plate.

g. Remove the encapsulated power supply module from the unit.

4-15. TROUBLESHOOTING

4-16. If the 5501A fails any part of the performance check or an operational failure occurs, use the Troubleshooting Flow Chart (Figure 4-1) to isolate the failure to the faulty module. Further fault isolation to the component level may then be accomplished by referring to the functional diagram of Figure 7-4 and the accompanying theory in Section III. In the Troubleshooting Flow Chart (Figure 4-1), adjustment procedures are referenced when required. The module location and schematic diagrams (in Section VII of this manual) are also provided to help the troubleshooter.



Items listed in order of *most probable* cause of failure:

(1) a. Check -15V input.
b. Check Fuse F2.
c. Check that safety switch S2 is engaged and functioning correctly.

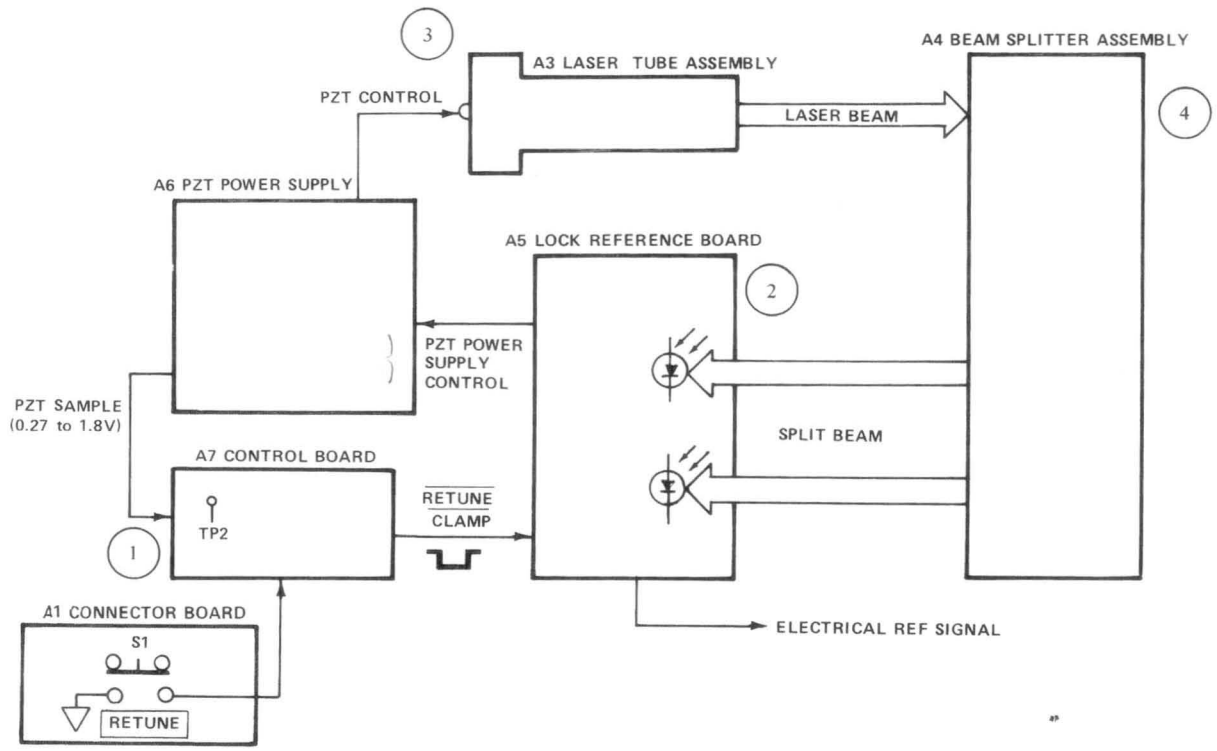
(2) a. Check A2 High Voltage Power Supply.
b. If A2 is replaced, perform *laser current adjustment.*

(3) a. Check Q1 series regulator.
b. If replaced, perform *laser current adjustment.*

(4) a. Check A1 connector board assembly.
b. If replaced, perform *laser current adjustment.*

(5) a. Check A3 laser tube.
b. Perform *laser current adjustment.*
c. Perform *reference threshold adjustment.*

Figure 4-2. Laser Current Loop Failure Analysis



Items listed in order of *most probable* cause of failure:

(1) a. Check PZT Power Supply by measuring +0.27V to +1.8V at A7(TP2).
b. Replace power supply if readings are incorrect.

(2) a. Check/Replace A5 Lock Reference Board Assembly.
b. Perform *reference threshold adjustment.*
c. Perform *photo-diode off-set adjustment.*

(3) a. Check/Replace A3 Laser Tube Assembly.
b. Perform *laser current adjustment.*
c. Perform *reference threshold adjustment.*

(4) a. Replace A5 Lock Reference Assembly.
b. Perform *reference threshold adjustment.*

Figure 4-3. Automatic Retune Loop Failure Analysis

Table 4-5. Module Adjustment Requirements

Module Replaced	Adjustment Required
A1 Connector Board	Laser Current Adj.
A2 High Voltage Power Supply	Laser Current Adj.
A3 Laser Tube Assembly	Laser Current Adj. Reference Threshold Adj.
A4 Beam Splitter Assembly	Reference Threshold Adj.
A5 Lock Reference Board	Reference Threshold Adj. Photodiode Off-set Adj.
A6 PZT Power Supply	Reference Threshold Adj.

4-17. ADJUSTMENT PROCEDURES

4-18. The Lock Reference Board Assembly (05501-60204) and the Connector Board Assembly (05501-60201) are the only 5501A field-adjustable modules. Perform the adjustment procedures either as a trouble-shooting check or when certain modules are replaced. Table 4-5 lists the 5501A modules and the adjustment requirements that result from replacement of these modules.

4-19. Lock Reference Board Adjustments

4-20. Two adjustments are performed on the A5 Lock Reference Board Assembly: the reference threshold adjustment, and the photodiode offset adjustment.

4-21. REFERENCE THRESHOLD ADJUSTMENT. Perform the reference threshold adjustment when trouble-shooting the laser head or when any of the following assemblies are replaced:

A3 Laser Tube Assembly

A4 Beam Splitter Assembly

A5 Lock Reference Board Assembly

A6 PZT Power Supply Assembly

4-22. The recommended test equipment is:

HP 1707 Oscilloscope or equivalent (ac noise measurments)

HP 5300/5306 Multimeter/Counter (dc voltage measurements)

NOTE

Since the laser head covers are removed, the connector board safety switch, A1S2, must be closed for the laser head to operate.

4-23. Make the adjustment according to the following procedure (refer to Figure 4-4):

a. Block laser beam as shown in Figure 4-5.

b. Measure peak-to-peak ambient noise at A5TP3 with oscilloscope.

c. Divide this peak-to-peak value by two.

d. Measure static dc level at A5TP7 with oscilloscope or voltmeter.

e. Record the larger of the values obtained in steps c and d.

f. Monitor A5TP8 with a DVM or oscilloscope, and adjust the threshold potentiometer, A5R42, for a dc voltage equal to *twice* the value recorded in step e (see Figure 4-4).

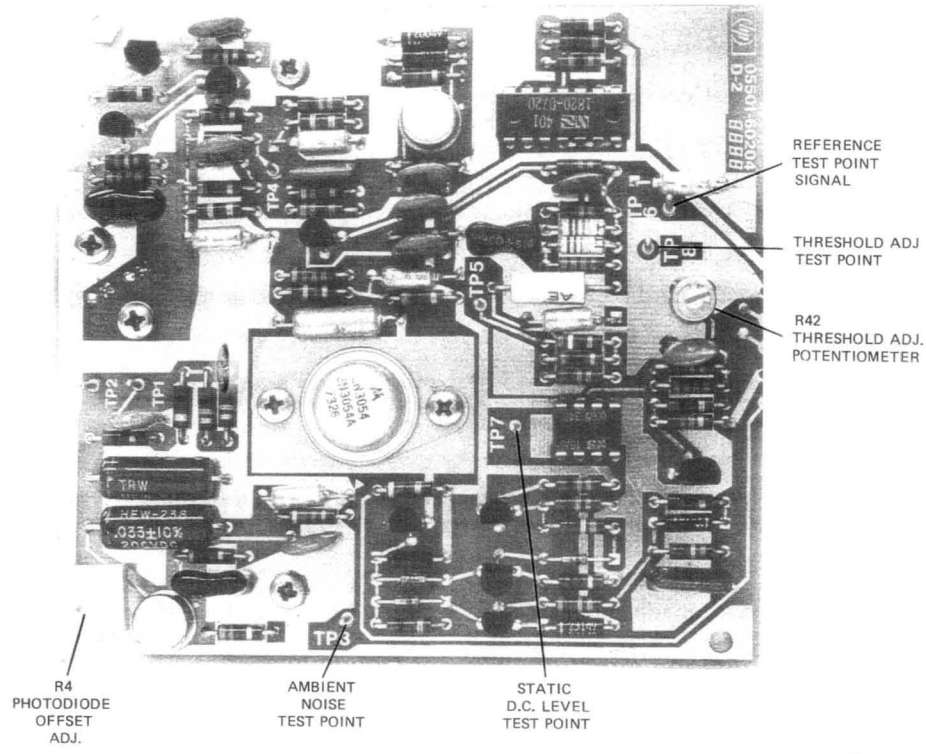


Figure 4–4. A5 Lock Reference Board Adjustment Locations

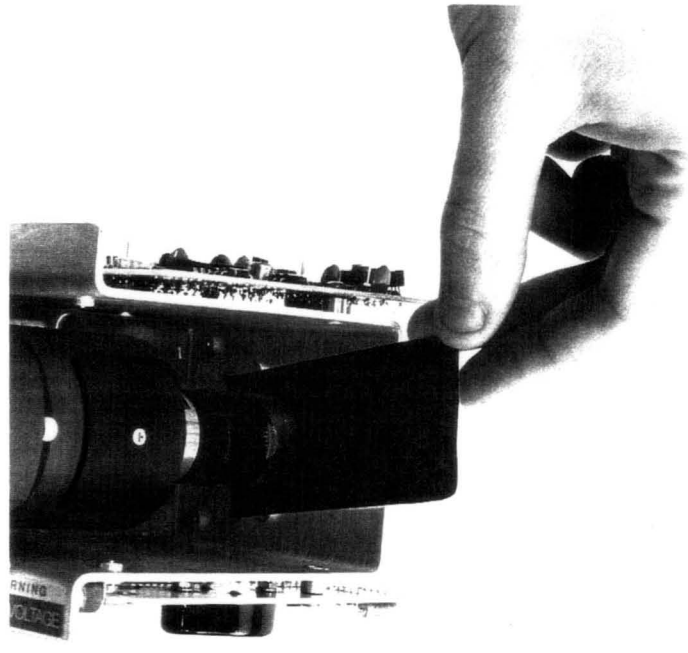


Figure 4–5. Laser Beam Blocking Method

g. Remove beam obstruction (inserted in step a).

h. Depress RETUNE pushbutton. Proper indications are:

1) RETUNE FAILURE indicator extinguishes immediately.

2) RETUNE indicator goes out nine seconds after switch is depressed.

4-24. PHOTODIODE OFFSET ADJUSTMENT. This adjustment must be performed when the Lock Reference Board Assembly is replaced. The HP 5300/5306 (2 MHz frequency counter capability) or equivalent is recommended. (An oscilloscope can also be used to measure the 2 MHz signal by expanding the horizontal scale.)

4-25. Make the adjustment according to the following procedure (refer to Figure 4-4):

a. Connect counter probe to A5TP6.

b. Adjust A5R4 for maximum frequency (or minimum period if an oscilloscope is used).

4-26. Laser Tube Current Adjustment

4-27. Although all laser tubes appear to be identical, each has a slightly different current rating. Adjusting the laser current regulator circuits for the correct current ensures optimum tube operation and output beam bandwidth.

4-28. Perform the laser current adjustment when the laser tube is operating improperly (i.e., flashing on and off) or when any of the following are replaced:

A1 Connector Board Assembly

A2 High Voltage Power Supply Assembly

A3 Laser Tube Assembly

A1 chassis-mounted series regulator

4-29. Recommended Test Equipment:

HP 5300/5306 Multimeter/Counter (dc voltage measurement)

4-30. This procedure is performed by adjusting the current regulator circuit while monitoring voltage across the laser tube cathode resistor, A1R16 (refer to Figure 4-6). The regulator circuits and the cathode resistor are mounted on the A1 Connector Board Assembly. The voltage across the 390-ohm cathode resistor is determined by the laser tube current. Therefore the correct voltage is calculated by multiplying the rated tube current by 390. Adjust current as follows:

NOTE

Since the laser head covers are removed, the safety switch, A1S2 (located on the connector board), must be actuated for the laser current circuits to operate.

a. Read the rated current stamped on the tube plate (this value is typically 2.6 mA to 5.1 mA).

b. Multiply this value by 390 (calculated value is typically 1.0 to 2.0 volts).

c. While monitoring the laser current test point, adjust the laser current potentiometer, A1R11, for the value obtained in step b.

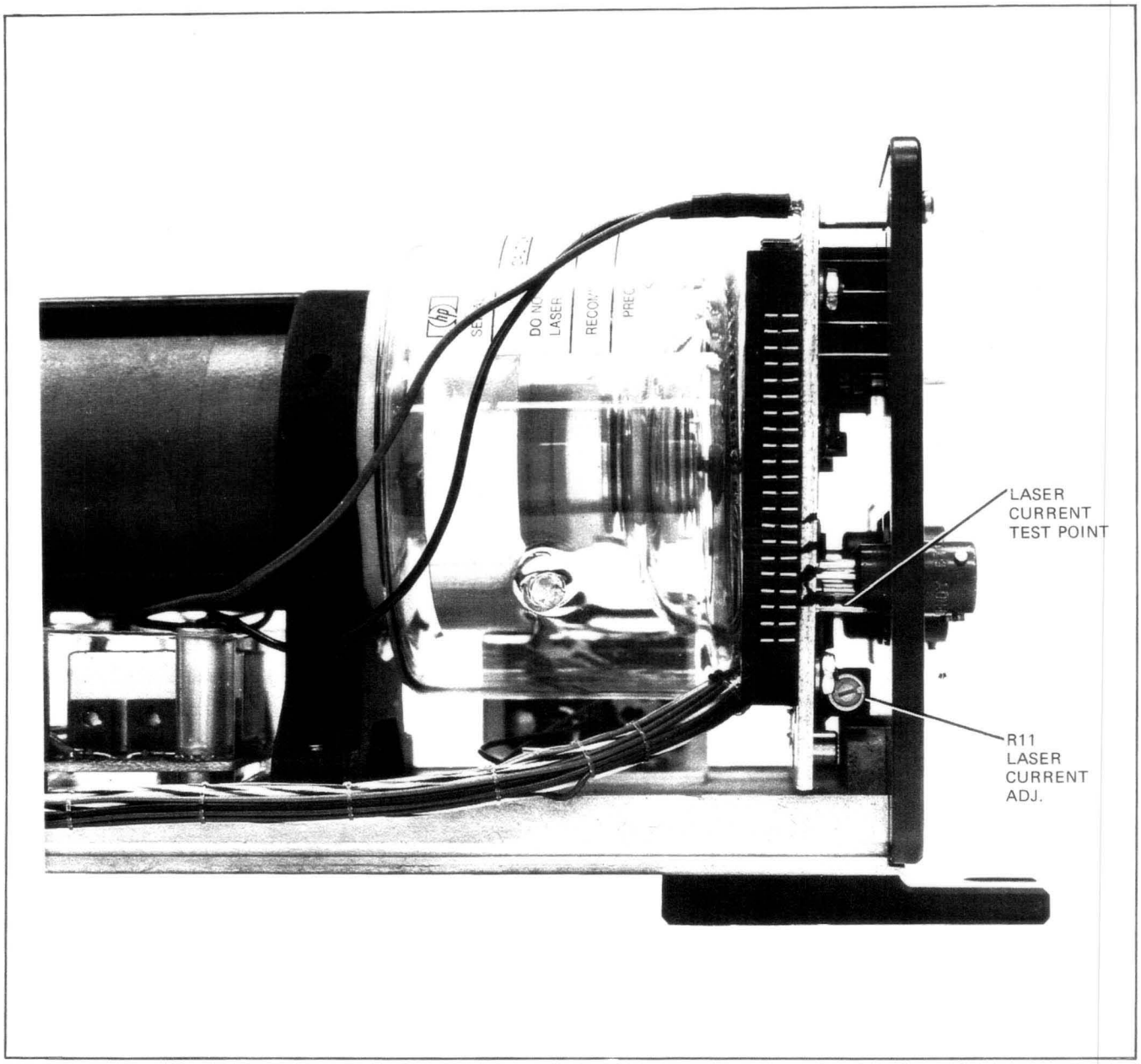


Figure 4-6. Laser Current Adjustment Locations

SECTION V
REPLACEABLE PARTS

5-1. INTRODUCTION

5-2. This section contains information for ordering replacement parts. Table 5-1 lists parts in alphanumeric order of reference designations and provides the following information on each part:

a. Hewlett-Packard part number.

b. Description of part (see abbreviations below).

c. Total quantity used in the instrument. (The total quantity appears after the first entry for a given part.)

d. Typical manufacturer of the part in a five-digit code (see list of manufacturers in Table 5-2).

e. Manufacturer's part number.

5-3. Miscellaneous parts are listed at the end of Table 5-1.

5-4. ORDERING INFORMATION

5-5. To obtain replacement parts, address order to your local Hewlett-Packard Sales and Service Office listed at the back of this manual. Identify parts by their Hewlett-Packard part number. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

REFERENCE DESIGNATIONS

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

ABBREVIATIONS

A	= ampere	BCD	= binary coded decimal	COMP	= composition	°K	= degree Kelvin
ac	= alternating current	BD	= board	COMPL	= complete	DEPC	= deposited carbon
ACCESS	= accessory	BE	= beryllium copper	CONN	= connector	DET	= detector
ADJ	= adjustment	BFO	= beat frequency oscillator	CP	= cadmium plate	diam	= diameter
A/D	= analog-to-digital	BH	= binder head	CRT	= cathode-ray tube	DIA	= diameter (used in parts list)
AF	= audio frequency	BKDN	= breakdown	CTL	= complementary transistor logic	DIFF AMPL	= differential amplifier
AFC	= automatic frequency control	BP	= bandpass	CW	= continuous wave	div	= division
AGC	= automatic gain control	BPF	= bandpass filter	cw	= clockwise	DPDT	= double-pole, double-throw
AL	= aluminum	BRS	= brass	D/A	= digital-to-analog	DR	= drive
ALC	= automatic level control	BWO	= backward-wave oscillator	dB	= decibel	DSB	= double sideband
AM	= amplitude modulation	CAL	= calibrate	dBm	= decibel referred to 1 mW	DTL	= diode transistor logic
AMPL	= amplifier	ccw	= counterclockwise	dc	= direct current	DVM	= digital voltmeter
APC	= automatic phase control	CER	= ceramic	deg	= degree (temperature interval or difference)	ECL	= emitter coupled logic
ASSY	= assembly	CHAN	= channel	...°	= degree (plane angle)	EMF	= electromotive force
AUX	= auxiliary	cm	= centimeter	°C	= degree Celsius (centrigrade)	EDP	= electronic data processing
avg	= average	CMO	= coaxial	°F	= degree Fahrenheit	ELECT	= electrolytic
AWG	= american wire gauge	COEF	= coefficient				
BAL	= balance	COM	= common				

Table 5-1. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	05501-60201	1	CONNECTOR BOARD ASSEMBLY	28480	05501-60201
A1C1	0180-1746	4	CAPACITOR-FXD; 15UF+-10% 20VDC TA-SOLID	56289	150D156X9020B2
A1C2	0180-1746		CAPACITOR-FXD; 15UF+-10% 20VDC TA-SOLID	56289	150D156X9020B2
A1C3	0180-0230	4	CAPACITOR-FXD; 1UF+-20% 50VDC TA-SOLID	56289	150D105X0050A2
A1C4	0180-0228	1	CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A1C5	0180-0097	2	CAPACITOR-FXD, 47UF ± 10% 35VDC TA	04200	150D476X9035S2
A1C6	0180-1746		CAPACITOR-FXD; 15UF+-10% 20VDC TA-SOLID	56289	150D156X9020B2
A1C7	0160-2327	2	CAPACITOR-FXD 1000PF +-20% 100WVDC CER	28480	0160-2327
A1C8	0160-0137	2	CAPACITOR-FXD .33UF ± 20% 25WVDC CER	28480	0160-0137
A1C9	0160-0137		CAPACITOR-FXD .33UF ± 20% 25WVDC CER	28480	0160-0137
A1CR1	1901-0040	8	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1CR2	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1CR3	1902-3002	1	DIODE-ZNR 2.37V 5% DO-7 PD=.4W TC=-.074%	04713	SZ 10939-2
A1CR4	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1CR5	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1CR6	1902-0556	1	DIODE-ZNR 20V 5% DO-15 PD=1W TC=+.073%	28480	1902-0556
A1DS1	1990-0485	8	LED-VISIBLE	28480	1990-0485
A1DS2	1990-0485		LED-VISIBLE	28480	1990-0485
A1DS3	1990-0485		LED-VISIBLE	28480	1990-0485
A1DS4	1990-0485		LED-VISIBLE	28480	1990-0485
A1DS5	1990-0485		LED-VISIBLE	28480	1990-0485
A1DS6	1990-0485		LED-VISIBLE	28480	1990-0485
A1DS7	1990-0485		LED-VISIBLE	28480	1990-0485
A1DS8	1990-0485		LED-VISIBLE	28480	1990-0485
A1F1	2110-0002	2	FUSE 2A 250V 1.25X.25 IEC	71400	AGC-2
A1F2	2110-0002		FUSE 2A 250V 1.25X.25 IEC	71400	AGC-2
A1J1	1251-3449	1	CONNECTOR; 4-CONT; FEM; CIRCULAR	09922	BT02E8-4SWH41
A1J2	1251-3448	1	CONNECTOR; 4-CONT; FEM; CIRCULAR	09922	BT02E8-4SH41
A1J3	1251-3140	1	CONNECTOR:CIRCULAR	28480	1251-3140
A1Q1	1854-0071	10	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q2	1853-0020	2	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A1Q3	1853-0016	1	TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A1Q4	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q5	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1R1	0757-0446	2	RESISTOR 15k 1% .125W, FTC = 0 ± 100	03292	C4-1/8-TO-1502F
A1R2	0757-0446	2	RESISTOR 15k 1% .125W, FTC = 0 ± 100	03292	C4-1/8-TO-1502F
A1R3	0683-1325	4	RESISTOR 1.3K 5% .25W FC TC=-400/+700	01121	CB1325
A1R4	0683-1325		RESISTOR 1.3K 5% .25W FC TC=-400/+700	01121	CB1325
A1R5	0683-1325		RESISTOR 1.3K 5% .25W FC TC=-400/+700	01121	CB1325
A1R6	0683-1325		RESISTOR 1.3K 5% .25W FC TC=-400/+700	01121	CB1325
A1R7	0683-3615	3	RESISTOR 360 5% .25W FC TC=-400/+600	01121	CB3615
A1R8	0683-3615		RESISTOR 360 5% .25W FC TC=-400/+600	01121	CB3615
A1R9	0683-3615		RESISTOR 360 5% .25W FC TC=-400/+600	01121	CB3615
A1R10	0757-0924	3	RESISTOR 1K 2% .125W F TC=0+-100	24546	C4-1/8-TO-1001-G
A1R11	2100-2522	1	RESISTOR-VAR TRMR 10KOHM 10% C SIDE ADJ	19701	ET50X103
A1R12	0757-0926	1	RESISTOR 1.2K 2% .125W F TC=0+-100	24546	C4-1/8-TO-1201-G
A1R13	0757-0446	1	RESISTOR 15k 1% .125W FTC = 0 ± 100	03292	C4-1/8-TO-1502F
A1R14	0683-1035	14	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R15	0757-0902	1	RESISTOR 120 2% .125W F TC=0+-100	24546	C4-1/8-TO-121-G
A1R16	0757-0914	1	RESISTOR 390 2% .125W F TC=0+-100	24546	C4-1/8-TO-391-G
A1R17	0683-3015	1	RESISTOR 300 5% .25W FC TC=-400/+600	01121	CB3015
A1R18	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R19	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R20	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R21	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1S1	3101-0647	1	SWITCH; PB 1-STA RECT SPDT	09353	P8121CX
A1S2	3101-2116	1	SWITCH-SENS SPDT 5A 250VAC	28480	3101-2116
A1U1	1820-0174	1	IC SN74 04 N	01295	SN7404N
A1XF1	2110-0269	2	FUSEHOLDER-CLIP TYPE .25FUSE	28480	2110-0269
A1XF2	2110-0269		FUSEHOLDER-CLIP TYPE .25FUSE	28480	2110-0269
A2	05501-60208	1	HIGH VOLTAGE POWER SUPPLY ASSEMBLY (NON-REPAIRABLE)	28480	05501-60208
A3	05501-60006	1	LASER TUBE ASSEMBLY	28480	05501-60006
A4	05501-60005	1	BEAM SPLITTER ASSEMBLY	28480	05501-60005

Table 5-1. Replaceable Parts (cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A5R31	0683-3325	1	RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A5R32	0683-3925	1	RESISTOR 3.9K 5% .25W FC TC=-400/+700	01121	CB3925
A5R33	0683-2415	1	RESISTOR 240 5% .25W FC TC=-400/+600	01121	CB2415
A5R34	0683-3025		RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A5R35	0683-1035	1	RESISTOR 10K 5% .25W FC TC=-400/+600	01121	CB1035
A5R36	0683-4725	1	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A5R37	0683-2235	1	RESISTOR 22K 5% .25W FC TC=-400/+800	01121	CB2235
A5R38	0683-5115	1	RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R39	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R40	0683-3335	2	RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A5R41	0683-1535		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A5R42	2100-1986	1	RESISTOR-VAR TRMR 1KOHM 10% C TOP ADJ	84048	170-102
A5R43	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A5R44	0683-1535		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A5R45	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A5R46	0683-2025		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A5R47	0698-8812	1	RESISTOR 1 5% .25W F TC = 0 + - 100	28480	0698-8812
A5R48	0683-3025		RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A5R49	0683-1815		RESISTOR 180 5% .25W FC TC=-400/+700	01121	CB1815
A5U1	1826-0035	1	IC LM308AH	27014	LM308AH
A5U2	1820-0475	1	IC LM306H	27014	LM306H
A5U3	1820-0720	1	IC DM88 30N	27014	DM8830N
A5U4	1826-0065	6	IC LM311N	27014	LM311N
A6	05501-60203	1	PZT POWER SUPPLY ASSEMBLY (NON-REPAIRABLE)	28480	05501-60203
A7	05501-60205	1	Control Board Assembly	28480	05501-60205
A7C1	0180-0160		Capacitor-Fxd; 22UF, ± 20%, 35VDC	04200	150D226X0035R2
A7C2	0180-0160		Capacitor-Fxd; 22UF, ± 20%, 35VDC	04200	150D226X0035R2
A7C3	0160-3879		Capacitor-Fxd; .01UF, 100VDC	28480	0160-3879
A7C4	0180-0106		Capacitor-Fxd; 60UF, 6VDC	56289	150D606X0006B2
A7C5	0160-3879		Capacitor-Fxd; .01UF, 100VDC	28480	0160-3879
A7C6	0160-3879		Capacitor-Fxd; .01UF, 100VDC	28480	0160-3879
A7C7	0160-2327		Capacitor-Fxd; 1000PF+-20%	28480	0160-2327
A7C8	0180-0210		Capacitor-Fxd; 3.3UF, 15VDC	56289	150D335X0015A2
A7C9	0180-0210		Capacitor-Fxd; 3.3UF, 15VDC	56289	150D335X0015A2
A7C10	0180-0291		Capacitor-Fxd; 1UF, 35VDC	56289	150D105X9035A2
A7C11	0160-2055		Capacitor-Fxd; .01UF+80-20% 100VDC	28480	0160-2055
A7C12	0180-0210		Capacitor-Fxd; 3.3UF, 15VDC	56289	150D335X0015A2
A7C13	0160-3879		Capacitor-Fxd; .01UF, 100VDC	28480	0160-3879
A7C14	0160-3879		Capacitor-Fxd; .01UF, 100VDC	28480	0160-3879
A7C15	0180-1746		Capacitor-Fxd; 15UF, 20VDC	56289	150D156X9020B2
A7C16	0180-1746		Capacitor-Fxd; .22UF, 35VDC	56289	150D224X9020B2
A7C17	0180-0291		Capacitor-Fxd; 1UF, 35VDC	56289	150D105X9035A2
A7C18	0180-0291		Capacitor-Fxd; 1UF, 35VDC	56289	150D105X9035A2
A7C19	0160-3879		Capacitor-Fxd; .01UF, 100VDC	28480	0160-3879
A7CR1	1901-0040		Diode, 30V 50MA	28480	1901-0040
A7Q1	1854-0071		Transistor NPN SI PD=300MW FT=200MHz	28480	1854-0071
A7Q2	1854-0071		Transistor NPN SI PD=300MW FT=200MHz	28480	1854-0071
A7Q3	1854-0071		Transistor NPN SI PD=300MW FT=200MHz	28480	1854-0071
A7R1	0683-1025		Resistor 1K 5% .25W	01121	CB1025
A7R2	0683-3935		Resistor 39K 5% .25W	01121	CB3935
A7R3	0683-1035		Resistor 10K 5% .25W	01121	CB1035
A7R4	0683-2025		Resistor 2K 5% .25W	01121	CB2025
A7R5	0683-6235		Resistor 62K 5% .25W	01121	CB6235
A7R6	0683-2755		Resistor 2.7M 5% .25W	01121	CB2755
A7R7	0683-1025		Resistor 1K 5% .25W	01121	CB1025
A7R8	0698-3132		Resistor 261 1% .125W	03292	C4-1/8-TO-2610F
A7R9	0683-1035		Resistor 10K 5% .25W	01121	CB1025
A7R10	0757-0278		Resistor 1.78k 1% .125W	03292	C4-1/8-TO-1781-F
A7R11	0757-1093		Resistor 3k 1% .125W	03292	C4-1/8-TO-3001-F
A7R12	0683-4735		Resistor 47K 5% .25W	01121	CB4735
A7R13	0683-1035		Resistor 10K 5% .25W	01121	CB1025
A7R14	0683-2755		Resistor 2.7M 5% .25W	01121	CB2755
A7R15	0683-3035		Resistor 30K 5% .25W	01121	CB3035
A7R16	0683-2035		Resistor 20K 5% .25W	01121	CB2035
A7R17	0683-6835		Resistor 68K 5% .25W	01121	CB6835
A7R18	0683-1025		Resistor 1K 5% .25W	01121	CB1025
A7R19	0683-1025		Resistor 1K 5% .25W	01121	CB1025
A7R20	0757-1093		Resistor 3k 1% .125W	03292	C4-1/8-TO-3001-F
A7R21	0683-1035		Resistor 10K 5% .25W	01121	CB1035
A7R22	0683-1025		Resistor 1K 5% .25W	01121	CB1025
A7R23	0683-6235		Resistor 62K 5% .25W	01121	CB6235
A7R24	0683-2755		Resistor 2.7M 5% .25W	01121	CB6235
A7R25	0683-6235		Resistor 62K 5% .25W	01121	CB6235
A7U1	1820-0587	1	IC DM74L 10N	27014	DM74L10N
A7U2	1826-0065		IC LM311N	27014	LM311N
A7U3	1826-0065		IC LM311N	27014	LM311N
A7U4	1820-0511	1	IC SN74 08N	01295	SN7408N
A7U5	1826-0065		IC LM311N	27014	LM311N
A7U6	1826-0065		IC LM311N	27014	LM311N
A7U7	1820-0583	2	IC DM74L 00N	27014	DM74L00N
A7U8	1820-0583		IC DM74L 00N	27014	DM74L00N
A7U9	1826-0065		IC LM311N	27014	LM311N
A7U10	1820-0730		IC MULTIVIBRATOR	34335	96L02DC
A7U11	1820-0730		IC MULTIVIBRATOR	34335	96L02DC
A7U12	1820-0430	1	+5V REGULATOR	27014	LM309K

ABBREVIATIONS (CONTINUED)

ENCAP = encapsulated
EXT = external
F = farad
FET = field-effect transistor
F/F = flip-flop
FH = flat head
FOL H = fillister head
FM = frequency modulation
FP = front panel
FREQ = frequency
FXD = fixed
g = gram
GE = germanium
GHz = gigahertz
GL = glass
GND = ground(ed)
H = henry
h = hour
HET = heterodyne
HEX = hexagonal
HD = head
HDW = hardware
HF = high frequency
HG = mercury
HI = high
HP = Hewlett-Packard
HPF = high pass filter
HR = hour (used in parts list)
HV = high voltage
Hz = Hertz
IC = integrated circuit
ID = inside diameter
IF = intermediate frequency
IMPG = impregnated
in = inch
INCD = incandescent
INCL = include(s)
INP = input
INS = insulation
INT = internal
kg = kilogram
kHz = kilohertz
kΩ = kilohm
kV = kilovolt
lb = pound
LC = inductance-capacitance
LED = light-emitting diode
LF = low frequency
LG = long
LH = left hand
LIM = limit
LIN = linear taper (used in parts list)
lin = linear
LK WASH = lockwasher
LO = low; local oscillator
LOG = logarithmic taper (used in parts list)
log = logarithm(ic)
LPF = low pass filter
LV = low voltage
m = meter (distance)
mA = milliampere
MAX = maximum
MΩ = megohm
MEG = meg (10^6) (used in parts list)
MET FLM = metal film
MET OX = metal oxide
MF = medium frequency; microfared (used in parts list)
MFR = manufacturer
mg = milligram
MHz = megahertz
mH = millihenry
mho = mho
MIN = minimum
min = minute (time)
... = minute (plane angle)
MINAT = miniature
mm = millimeter
MOD = modulator
MOM = momentary
MOS = metal-oxide semiconductor
ms = millisecond
MTG = mounting
MTR = meter (indicating device)
mV = millivolt
mVac = millivolt, ac
mVdc = millivolt, dc
mVpk = millivolt, peak
mVp-p = millivolt, peak-to-peak
mVrms = millivolt, rms
mW = milliwatt
MUX = multiplex
MY = mylar
μA = microampere
μF = microfarad
μH = microhenry
μmho = micromho
μs = microsecond
μV = microvolt
μVac = microvolt, ac
μVdc = microvolt, dc
μVpk = microvolt, peak
μVp-p = microvolt, peak-to-peak
μVrms = microvolt, rms
μW = microwatt
nA = nanoampere
NC = no connection
N/C = normally closed
NE = neon
NEG = negative
nF = nanofarad
NI PL = nickel plate
N/O = normally open
NOM = nominal
NORM = normal
NPN = negative-positive-negative
NPO = negative-positive zero (zero temperature coefficient)
NRFR = not recommended for field replacement
NSR = not separately replaceable
ns = nanosecond
nW = nanowatt
OBD = order by description
OD = outside diameter
OH = oval head
OP AMPL = operational amplifier
OPT = option
OSC = oscillator
OX = oxide
oz = ounce
Ω = ohm
P = peak (used in parts list)
PAM = pulse-amplitude modulation
PC = printed circuit
PCM = pulse-code moudulation; pulse-count modulation
PDM = pulse-duration modulation
pF = picofarad
PH BRZ = phosphor bronze
PHL = Phillips
PIN = positive-instrinsic-negative
PIV = peak inverse voltage
pk = peak
PL = phase lock
PLO = phase lock oscillator
PM = phase modulation
PNP = positive-negative-positive
P/O = part of
POLY = polystyrene
PORC = porcelain
POS = positive; position(s) (used in parts list)
POSN = position
POT = potentiometer
p-p = peak-to-peak
PP = peak-to-peak (used in parts list)
PPM = pulse-position modulation
PREAMPL = preamplifier
PRF = pulse-repetition frequency
PRR = pulse repetition rate
ps = picosecond
PT = point
PTM = pulse-time modulation
PWM = pulse-width modulation
PWV = peak working voltage
RC = resistance capacitance
RECT = rectifier
REF = reference
REG = regulated
REPL = replaceable
RF = radio frequency
RFI = radio frequency interference
RH = round head; right hand
RLC = resistance-inductance-capacitance
RMO = rack mount only
rms = root-mean-square
RND = round
ROM = read-only memory
R&P = rack and panel
RWV = reverse working voltage
S = scattering parameter
s = second (time)
... = second (plane angle)
S-B = slow-blow (fuse (used in parts list)
SCR = silicon controlled rectifier; screw
SE = selenium
SECT = sections
SEMICON = semiconductor
SHF = superhigh frequency
SI = silicon
SIL = silver
SL = slide
SNR = signal-to-noise ratio
SPDT = single-pole, double-throw
SPG = spring
SR = split ring
SPST = single-pole, single-throw
SSB = single sideband
SST = stainless steel
STL = steel
SQ = square
SWR = standing-wave ratio
SYNC = synchronize
T = timed (slow-blow fuse)
TA = tantalum
TC = temperature compensating
TD = time delay
TERM = terminal
TFT = thin-film transistor
TGL = toggle
THD = thread
THRU = through
TI = titanium
TOL = tolerance
TRIM = trimmer
TSTR = transistor
TTL = transistor-transistor logic
TV = television
TVI = television interference
TWT = traveling wave tube
U = micro (10^{-6}) (used in parts list)
UF = microfarad (used in parts list)
UHF = ultrahigh frequency
UNREG = unregulated
V = volt
VA = voltampere
Vac = volts ac
VAR = variable
VCO = voltage-controlled oscillator
Vdc = volts dc
VDCW = volts dc, working (used in parts list)
V(F) = volts, filtered
VFO = variable-frequency oscillator
VHF = very-high frequency
Vpk = volts peak
Vp-p = Volts peak-to-peak
Vrms = volts rms
VSWR = voltage standing wave ratio
VTO = voltage-tuned oscillator
VTVM = vacuum-tube voltmeter
V(X) = volts, switched
W = watt
W/ = with
WIV = working inverse voltage
WW = wirewound
W/O = without
YIG = yttrium-iron-garnet
Zo = characteristic impedance

NOTE

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

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 5-1. Replaceable Parts (cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A5	05501-60204	1	LOCK REFERENCE BOARD ASSEMBLY	28480	05501-60204
A5C1	0180-0116		CAPACITOR-FXD; 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A5C2	0180-0291	7	CAPACITOR-FXD; 1UF+-10% 35VDC TA-SOLID	56289	150D105X9035A2
A5C3	0150-0050	1	CAPACITOR-FXD 1000PF +80-20% 1000WVDC	28480	0150-0050
A5C4	0180-0291		CAPACITOR-FXD; 1UF+-10% 35VDC TA-SOLID	56289	150D105X9035A2
A5C5	0160-0945	1	CAPACITOR-FXD 910PF +-5% 100WVDC MICA	28480	0160-0945
A5C6	0180-0291		CAPACITOR-FXD; 1UF+-10% 35VDC TA-SOLID	56289	150D105X9035A2
A5C7	0160-2055	9	CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A5C8	0160-0163	2	CAPACITOR-FXD .033UF +-10% 200WVDC POLYE	56289	292P33392
A5C9	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A5C10	0160-0163		CAPACITOR-FXD .033UF +-10% 200WVDC POLYE	56289	292P33392
A5C11	0160-2204	2	CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A5C12	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A5C13	0180-0291		CAPACITOR-FXD; 1UF+-10% 35VDC TA-SOLID	56289	150D105X9035A2
A5C14	0160-3060	1	CAPACITOR-FXD .1UF +-20% 25WVDC CER	28480	0150-3060
A5C15	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A5C16	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A5C17	0180-0291		CAPACITOR-FXD; 1UF+-10% 35VDC TA-SOLID	56289	150D105X9035A2
A5C18	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A5C19	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A5C20	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A5C21	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A5C22	0160-0161	1	CAPACITOR-FXD .01UF +-10% 200WVDC POLYE	56289	292P10392
A5C23	0180-0155	1	CAPACITOR-FXD; 2.2UF+-20% 20VDC TA	56289	150D225X9020A2
A5C24	0160-0128	1	CAPACITOR-FXD; 2.2UF ± 20% 50VDC CER	28480	0160-0128
A5CR1	05500-80003	1	PHOTO-DIODE: SILICON (MATCHED PAIR FOR CR1 AND CR2)	28480	05500-80003
A5CR2	SEE A5CR1				
A5CR3	1902-0184	1	DIODE-ZNR 16.2V 5% DO-7 PD=.4W TC=+.066%	04713	SZ 10939-242
A5CR4	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A5CR5	1902-3149	1	DIODE-ZNR 9.09V 5% DO-7 PD=.4W TC=+.057%	04713	SZ 10939-170
A5CR6	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A5CR7	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A5CR8	1902-3252	1	DIODE-ZNR 22.6V 2%	28480	1902-3252
A5CR9	1902-0049	1	DIODE-ZNR 6.19V 5% DO-7 PD=.4W TC=+.022%	04713	SZ 10939-122
A5CR10	1910-0034	2	DIODE-SWITCHING 8NS 30V 80MA	28480	1910-0034
A5CR11	1910-0034		DIODE-SWITCHING 8NS 30V 80MA	28480	1910-0034
A5CR12	1902-3182	1	DIODE-ZNR 12.1V 5% DO-7 PD=.4W TC=+.064%	04713	SZ 10939-206
A5Q1	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A5Q2	1854-0215	4	TRANSISTOR NPN SI PD=310MW FT=300MHZ	04713	SPS 3611
A5Q3	1854-0215		TRANSISTOR NPN SI PD=310MW FT=300MHZ	04713	SPS 3611
A5Q4	1854-0215		TRANSISTOR NPN SI PD=310MW FT=300MHZ	04713	SPS 3611
A5Q5	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A5Q6	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A5Q7	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A5Q8	1854-0215		TRANSISTOR NPN SI PD=310MW FT=300MHZ	04713	SPS 3611
A5Q9	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A5Q10	1854-0072	1	TRANSISTOR NPN 2N3054 SI TO-66 PD=25W	02735	2N3054
A5R1	0683-1255	1	RESISTOR 1.2M 5% .25W FC TC=-900/+1100	01121	CB1255
A5R2	0683-1015	2	RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A5R3	0683-3945	1	RESISTOR 390K 5% .25W FC TC=-800/+900	01121	CB3945
A5R4	2100-0644	1	RESISTOR-VAR TRMR 2MOHM 20% C TOP ADJ	73138	72PR2M
A5R5	0683-5635	1	RESISTOR 56K 5% .25W FC TC=-400/+800	01121	CB5635
A5R6	0683-2425	2	RESISTOR 2.4K 5% .25W FC TC=-400/+700	01121	CB2425
A5R7	0683-4735	1	RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A5R8	0683-2035	2	RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A5R9	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A5R10	0683-5125	1	RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
A5R11	0683-1645	1	RESISTOR 160K 5% .25W FC TC=-800/+900	01121	CB1645
A5R12	0683-3635	2	RESISTOR 36K 5% .25W FC TC=-400/+800	01121	CB3635
A5R13	0683-4715	1	RESISTOR 470 5% .25W FC TC=-400/+600	01121	CB4715
A5R14	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A5R15	0683-3025		RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A5R16	0683-1535	1	RESISTOR 15k 5% .25W	01607	CB1535
A5R17	0683-6235	4	RESISTOR 62K 5% .25W FC TC=-400/+800	01121	CB6235
A5R18	0683-1545	2	RESISTOR 150K 5% .25W FC TC=-800/+900	01121	CB1545
A5R19	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A5R20	0683-1345	1	RESISTOR 130K 5% .25W FC TC=-800/+900	01121	CB1345
A5R21	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A5R22	0683-6835	2	RESISTOR 68K 5% .25W FC TC=-400/+800	01121	CB6835
A5R23	0683-2025	3	RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A5R24	0683-1535		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A5R25	0683-9125	1	RESISTOR 9.1K 5% .25W FC TC=-400/+700	01121	CB9125
A5R26	0683-2425		RESISTOR 2.4K 5% .25W FC TC=-400/+700	01121	CB2425
A5R27	0683-4315	1	RESISTOR 430 5% .25W FC TC=-400/+600	01121	CB4315
A5R28	0683-1025	4	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R29	0683-1545		RESISTOR 150K 5% .25W FC TC=-800/+900	01121	CB1545
A5R30	0683-3635		RESISTOR 36K 5% .25W FC TC=-400/+800	01121	CB3635

See introduction to this section for ordering information

Table 5-1. Replaceable Parts (cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			MISC. & CHASSIS MOUNTED PARTS		
Q1	1854-0063	1	TRANSISTOR NPN 2N3055 SI TO-3 PD=115W	28480	1854-0063
W1	05501-60001	1	CABLE ASSY, MAIN	28480	05501-60001
W2	05501-60004	1	CABLE ASSY, CATHODE	28480	05501-60004
XQ1	1200-0041	1	SOCKET, ELEC, XSTR 2-CONT TO-3 PKG SLDR	00014	PTS-1
			MISCELLANEOUS PARTS		
	0510-0027	1	RETAINER, PUSH ON, .25 DIA, CAD PLT STL	97464	6100-25-ST-CD
	1000-0352	1	WINDOW PLANE	28480	1000-0352
	1251-3447	1	CONNECTOR; 4-CONT; CIRCULAR (MATES WITH J1)	09922	BT06EC8-4P
	1251-3450	1	CONNECTOR: 4-CONT; MALE; CIRCULAR (MATES WITH J2)	09922	BT06EC8-4P
	1251-3749	1	STRAIN RELIEF	28480	1251-3749
	7120-2444	1	LABEL; IDENT; "5501A LASER TRANSDUCER"	28480	7120-2444
	7120-5180	1	LABEL; 'CAUTION"	28480	7120-5180
	7120-3731	1	LABEL, HV WARNING	28480	7120-3731
	7122-0097	1	SER PLT "SERIAL NO; HEWLETT PACKARD-	28480	7122-0097
	9320-1744	3	LABEL, MAGNETIC	28480	9320-1744
	05501-00001	1	SUPPORT, LATCH	28480	05501-00001
	05501-00003	1	COVER, LEFT	28480	05501-00003
	05501-00005	1	SHIELD	28480	05501-00005
	05501-20001	1	PANEL, FRONT	28480	05501-20001
	05501-20002	1	PANEL, REAR	28480	05501-20002
	05501-20003	3	FOOT, MOUNTING	28480	05501-20003
	05501-20006	1	BASE, LASER	28480	05501-20006
	05501-20014	1	INSULATOR, SHORT	28480	05501-20014
	05501-20015	1	INSULATOR, LONG	28480	05501-20015
	05501-40001	1	HOLDER, PHOTODIODE	28480	05501-40001
	05501-40003	1	MOUNT, SHUTTER	28480	05501-40003
	05501-40004	1	SHUTTER	28480	05501-40004
	05501-60007	1	COVER ASSEMBLY, RIGHT	28480	05501-60007
	05500-80002	1	LABEL; "HP AND DATE"	28480	05500-80002
Note 1	10778A,B,C		5, 10, 20 Metres Power Cable	28480	10778A,B,C
Note 1	10779A,B,C		5, 10, 20 Metres Reference Cable	28480	10779A,B,C

Note 1: These cables are not supplied, order separately.

Table 5-2. Manufacturers Code List

Mfr. Number	Manufacturer Name	City	ZIP Code
00014	Any Supplier of U.S.A.		
01121	Allen Bradley Co.	Milwaukee, WI	53212
01295	Texas Instruments, Inc., Semiconductor Component Div.	Dallas, TX	75231
02735	RCA Corp., Solid State Division	Sommerville, NJ	08876
04713	Motorola Semiconductor Products	Phoenix, AZ	85008
09353	C and K Components, Inc.	Watertown, MA	02172
09922	Brundy Corp.	Norwalk, CT	06852
11502	TRW, Inc., Boone Division	Boone, NC	28607
19701	Mepco/Electra Corp.	Mineral Wells, TX	76067
24546	Corning Glass Works (Bradford)	Bradford, PA	16701
27014	National Semiconductor Corp.	Santa Clara, CA	95051
28480	Hewlett-Packard Company, Corporate Headquarters	Palo Alto, CA	94304
34335	Advanced Micro Devices, Inc.	Sunnyvale, CA	94086
56289	Sprague Electric Co.	North Adams, MA	01247
71400	Bussman Mfg., Division of McGraw-Edison Co.	St. Louis, MO	63017
73138	Beckman Instruments Inc., Helipot Division	Fullerton, CA	92634
77820	Bendix Corp., Electronic Component Division	Sidney, NY	13838
84048	TRW Inc., St. Petersburg Division	St. Petersburg, FL	33702
97464	Industrial Retaining Ring Co.	Irvington, NJ	07111

SECTION VI

MANUAL CHANGES AND OPTIONS

6-1. INTRODUCITON

6-2. This section of the manual contains information necessary to update the manual to cover newer instruments and to backdate the manual to cover older instruments. Additionally, options available for the laser head are described in this section.

6-3. MANUAL CHANGES

6-4. This manual applies directly to units having serial number prefix 1736A, except for 1736A 00592 (see Table 6-1). For units with different serial number prefixes, refer to the following paragraphs.

6-5. Newer Instruments

6-6. Newer instruments may have higher serial number prefixes than those listed on the title page of this manual. The manuals for these units will include "Manual Changes" sheets that describe all required manual changes. If the updating information is missing, contact the local HP Sales and Service Office for information.

6-7. Older Instruments

6-8. Table 6-1 lists the serial numbers and serial number prefixes of units that differ electrically from the units documented in this manual. Find the prefix of range of serial numbers that corresponds to your unit, and make the manual changes specified in Table 6-1.

Table 6-1. Backdating

Serial Number or Prefix	Make These Manual Changes
1948	1
1736	1, 2
1736A00592	1, 2, 3
1732A	1, 2, 3, 4
1724A	1, 2, 3, 4, 5
1712A00396, 425, 427-430, 432, 433, 436, 439, 440	1, 2, 3, 4, 5
1712A	1, 2, 3, 4, 5, 6
1628A	1 thru 7
1620A	1-8
1616A	1-9
1612A	1-10
1604A	1-11
1544A	1-12
1436A (Note)	1-13
1424A and 1428A with serial numbers 00121 and above	1-14
1424A and 1428A with serial numbers below 00121	1 through 14. Also, some units require 15 through 17. Determine which changes are applicable by physical inspection of unit.
1404A	1 through 17

NOTE

Unit serial numbers 1436A00197, 1436A00199, 1436A00200, 1436A00208, 1436A00215, and 1436A00216 include change 11.

Change 1:

Page 1-1, Paragraph 1-12:
Change paragraph to read: "The Laser Head is supplied with a power cable 05501-60009 and a reference cable 05501-60008."

Page 5-6, Table 5-1, Replaceable Parts:
Delete 10778ABC listing. Delete 10779ABC listing. Delete Note 1. Add 05501-60009 Power Cable 28480 05501-60009. Add 05501-60008 Reference Cable 28480 05501-60008.

Change 2:

Page 1-1, Paragraph 1-12:
Change paragraph to read: "Three plugs that mate with the laser head rear-panel jacks are included with the laser head. System interconnection of the laser head is accomplished by fabricating suitable cables that terminate with these plugs. Refer to Section II of this manual for cable fabricating instructions.

Page 5-6, Table 5-1, Replaceable Parts:
Delete 05501-60009 and listing. Delete 05501-60008 and listing.

Change 3:

Page 5-3, Table 5-1, and page 7-13, Figure 7-13, change A2 from 05501-60208 to 05501-60206. (Parts list and Schematic Diagram)

Change 4:

Page 5-3, delete A1C8 and A1C9.
Page 7-11, replace A1C8 and A1C9 with straight through connections.

Change 5:

Page 5-7, change A7R11 to 0757-0289 RESISTOR 13.3K 1% .125W, 28480, 0757-0289.
Change A7R20 to 0683-1335 RESISTOR 13K 5% .25W, 28480, 0683-1335.
Page 7-19, change A7R11 to 13.3K. Change A7R20 to 13K.

Change 6:

Page 5-3, change A1R1 and A1R2 to 0683-1535 RESISTOR 15K 5% .25W, 28480, 0683-1535.
Change A1R13 to 0757-0952 RESISTOR 15K 2% .125W, 28480, 0757-0952.
Page 5-4, change A5C24 to 0160-0127 CAPACITOR-FXD; 1UF ±20% 25 WVDC CER, 28480, 0160-0127.
Change A5CR5 to 1902-0025 DIODE—ZNR 10V 5%, 28480, 1902-0025.
Change A5CR8 to 1902-3224 DIODE-ZNR 17.8V 5%, 28480, 1902-3224.
Page 5-7, change A7R8 to 0683-2715 RESISTOR 1.5K 5% .25W, 28480, 0683-2715.
Change A7R10 to 0683-1525 RESISTOR 1.5K 5% .25W, 28480, 0683-1525.
Change A7R11 to 0683-1335 RESISTOR 13K 5% .25W, 28480, 0683-1335.
Page 7-9, change A5CR8 to 17V. Change A5C24 to 1UF.
Page 7-19, change A7R11 to 13K. Change R10 to 1.5K. Change R8 to 270.

Change 7:

Page 5-3, change A1C5 to 0180-0116 CAPACITOR—FXD 6.8UF ± 10% 35VDL TA, 28480, 0180-0115.
Page 5-4, change A5C24 to 0160-0127 CAPACITOR-FXD 1UF ± 20% 25 WVDC CER, 28480, 0160-0127.
Change A5CR5 to 1902-3149 DIODE-ZNR 9.09V 5%, 28480, 1902-3149.
Page 5-4, change A5R16 to 0683-1535 RESISTOR 15K 5% .25W, 28480, 0683-1535.
Page 5-7, change A7C1 and A7C2 to 0180-0374 CAPACITOR-FXD 10UF 20 VDC, 28480, 0180-0374.
Page 7-11, change A1C5 to 6.8UF.
Page 7-15, change A5C24 to 1UF. Change A5CR5 to 9V. Change A5R16 to 3600.
Page 7-19, change A7C1 and A7C2 to 10UF 20V.

Change 8:

Page 5-4, Table 5-1:
Change A5CR1 from 05500-80003 to 1990-0338, 2, PHOTO-DIODE: SILICON, 28480, 1990-0338.
Obsolete pages 5-7 and 5-8 (Replaceable Parts for A7 Series 1628) but keep in your manual.

Page 7-19, Figure 7-12:
Mark this page as obsolete but keep it in the manual. After page 7-19 insert Figure 7-12A. This page can be found at the end of this manual section. (Be sure to change page number to read 7-19a.)

Change 9:

Page 7-13, Figure 7-7:
Make a note on this drawing to the effect the Resistors R7 and R8 are 47K in series 1616A and below.

Change 10:

Page 5-3, Table 5-1:
Change A1S2 HP Part Number and Mfr. Part Number from 3101-2116 to 3101-1676.

Page 7-11, Figure 7-6:
Change A1 Connector Board Series from 1616A to 1428A.

Change 11:

Page 7-13, Figure 7-7:
Delete the following note:

NOTE

A2 HV Power Supply board was series 1604A, which was replaced by series 1612A.

Change 12:

Page 5-3, Table 5-1:
Change A1DS1, DS2, DS3, DS4, DS5, DS6, DS7, and DS8 Part Numbers from 1990-0485 to 1990-0416. (Change both the HP Part Number and Mfr. Part Number columns.)

Page 5-6, Table 5-1:
Delete 7120-5180, 1, Label, "CAUTION" and 05500-80002, 1, Label, "HP and DATE".
Add HP Part Number 7210-2562, 1, Label "CAUTION: LASER MEDIUM; MAX", 28480, 7120-2562.

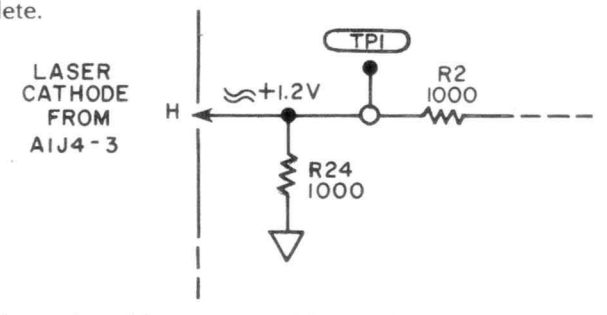
Change 13:

Page 5-3, Table 5-1:
Change A2 HP Part Number and Mfr. Part Number from 05501-60206 to 05501-60202.

Page 7-7, Table 7-1:
Change Part Number of Ref. Desig. A2 to 05501-60202.

Page 7-13, Figure 7-7:
Add Figure 7-7A which is located at the end of this manual section. (Be sure to change page number of Figure 7-7A to read 7-13a.)
Keep page 7-13, Figure 7-7 and mark it obsolete.

Page 7-19a, Figure 7-12A:
Add R24 resistor (1000 ohms) from pin "H" (LASER CATHODE) to ground.



Page 5-5, Table 5-1:
Change A7R1 to 0683-1035 (10K ohm).

Change 14:

On the schematic diagram of Figure 7-9 and in the replaceable parts list, Table 5-1, change resistor A5R1 from 1.2M (part number 0683-1255) to 2M (part number 0683-2055) and change resistor A5R3 from 390K (part number 0683-3945) to 1M (part number 0683-1055).

Change 15:

On the functional diagram of Figure 7-4, the schematic diagram of Figure 7-6, and in the replaceable parts list of Table 5-1, delete C1 (the 100 μF capacitor that is connected between the base of Q1 and the chassis common return connection).

Change 16:

On the schematic diagram of Figure 7-9 and in the replaceable parts list of Table 5-1, change resistor A5R47 from 1.3 ohms (part number 0698-8070) to 13 ohms (part number 0683-1305).

Change 17:

On the schematic diagram of Figure 7-6 and in the replaceable parts list of Table 5-1, delete A1C7 (the 0.001 μF capacitor connected to the base of A1Q3).

6-9. OPTIONS

6-10. Table 6-2 lists power supply options that are available for use with the laser head and associated system components. These options do not include the laser head and consist of power supplies only.

Table 6-2. Power Supply Options

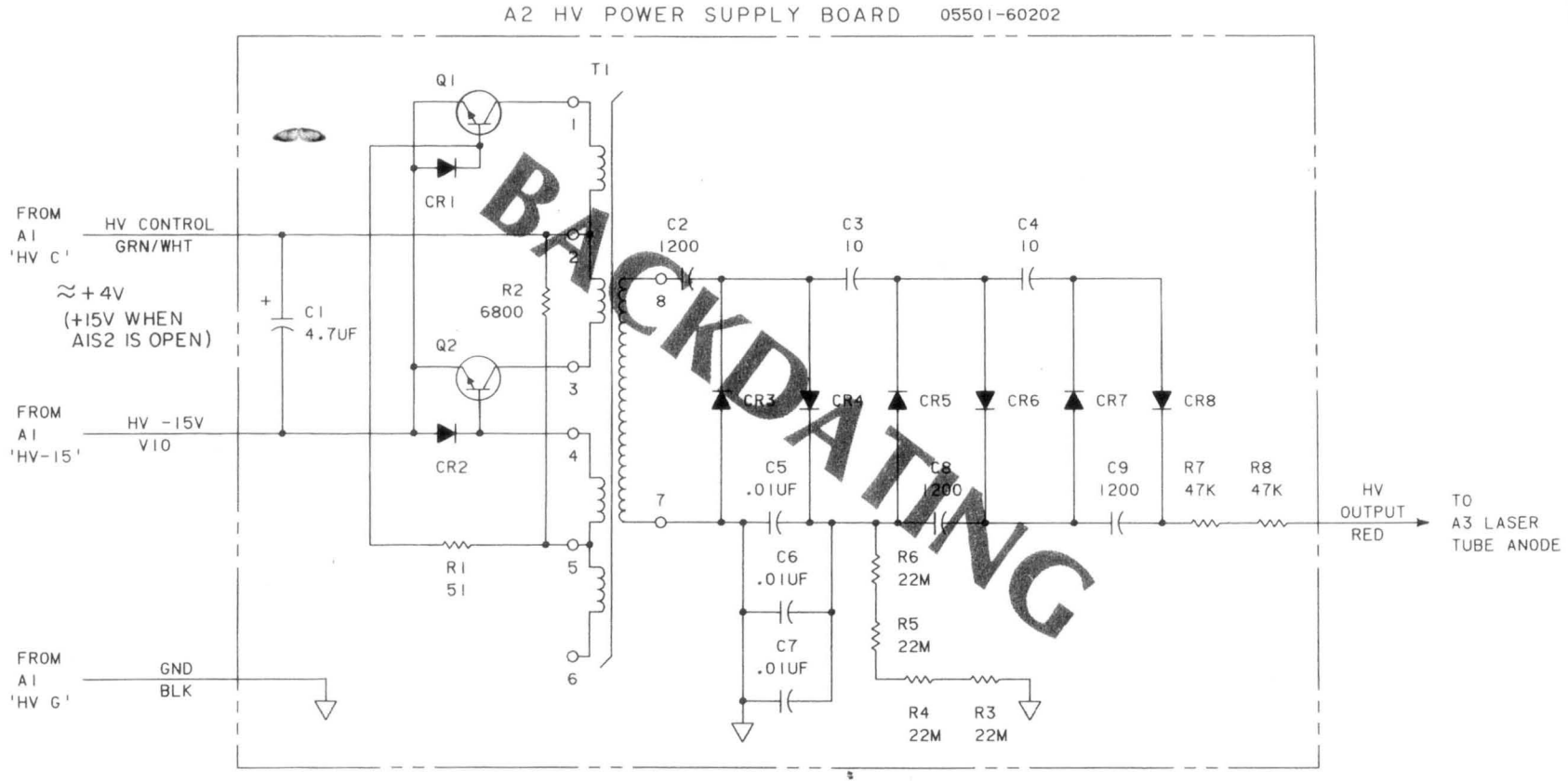
DUAL OUTPUT SUPPLIES

Option No.	Consists of:	Input Line Voltage	Maximum Input Power	Output Voltage	Output Current	Current Derating	Size
001	62215A-J27,011	115V	98W	±15V	1.25A each side	*	1/8 rack
011	62215A-J27,011,102	230V	98W	±15V	1.25A each side	*	1/8 rack
019	62215E-J27,011	115V	215W	±15V	3.0A	*	1/4 rack
020	62215E-J27,011,102	230V	215W	±15V	3.0A	*	1/4 rack

*Output current derated 20% with 50 Hz line input.
Temperature-dependent output current derating linear from 0% at 40° to 50% at 71°C.

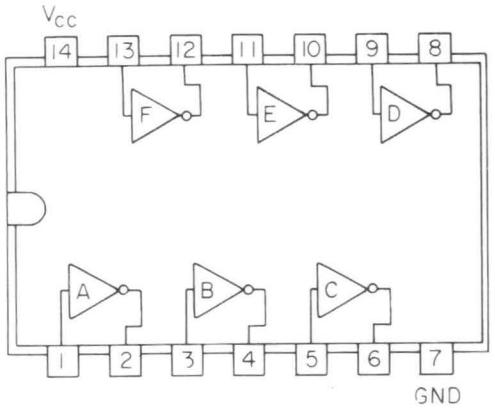
SINGLE OUTPUT SUPPLIES

Option No.	Consists of:	Input Line Voltage	Maximum Input Power	Output Voltage	Output Current	Size
005	62005A-011	115V	37W	5V	2.0A	1/8 rack
006	62005C-011	115V	80W	5V	4.0A	1/4 rack
007	62005E-011	115V	153W	5V	8.0A	1/4 rack
008	62005G-011	115V	301W	5V	16.0A	1/2 rack
015	62005A-011,102	230V	37W	5V	2.0A	1/8 rack
016	62005C-011,102	230V	80W	5V	4.0A	1/4 rack
017	62005E-011,102	230V	153W	5V	8.0A	1/4 rack
018	62005G-011,102	230V	301W	5V	16.0A	1/2 rack

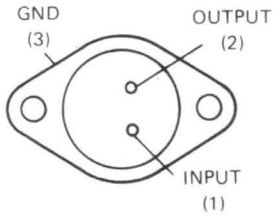


NOTE:
THIS ASSEMBLY IS NOT REPAIRABLE; SCHEMATIC FOR REFERENCE USE ONLY.

Figure 7-7A. A2 H.V. Power Supply Assembly Schematic Diagram

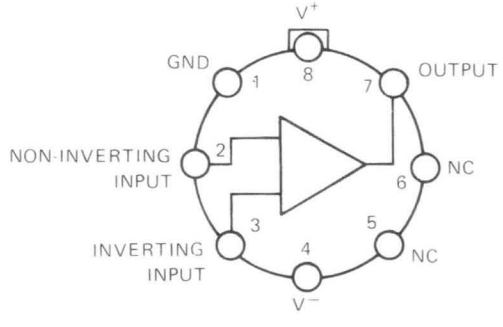


1820-0175 (7405)
HEX INVERTERS WITH OPEN COLLECTOR OUTPUTS



MAX INPUT VOLTAGE	35VDC
OUTPUT VOLTAGE	+5V ± 0.2 VOLTS

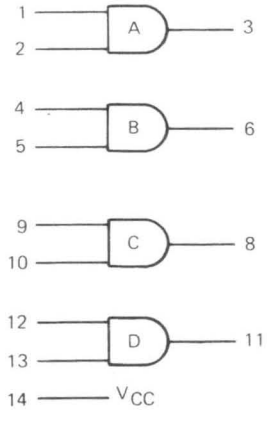
1820-0430 (LM309K)
FIVE VOLT REGULATOR



TRUTH TABLE	
INPUT	OUTPUT
+	HIGH
−	LOW

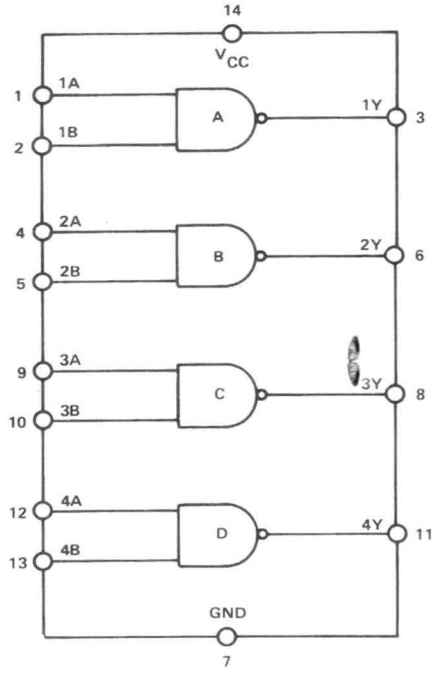
+ = PIN 2 INPUT MORE POSITIVE THAN PIN 3 INPUT
− = PIN 3 INPUT MORE POSITIVE THAN PIN 2 INPUT

1820-0321 (LM710)
VOLTAGE COMPARATOR

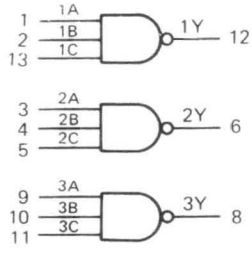


1820-0511 (7408)
QUAD 2-INPUT AND GATE

Figure 7-2. IC Diagrams

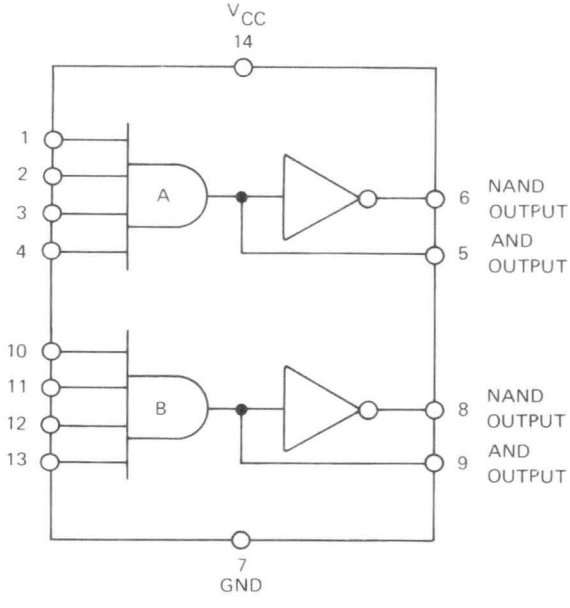


1820-0583 (74L00)
QUADRUPLE 2-INPUT POSITIVE-NAND GATES

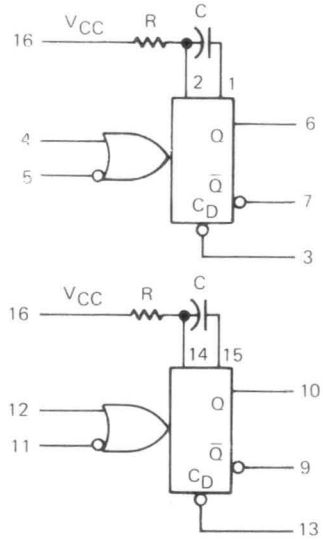


POSITIVE LOGIC:
$Y = \overline{ABC}$

1820-0587 (74L10)
TRIPLE 3-INPUT POSITIVE-NAND GATES

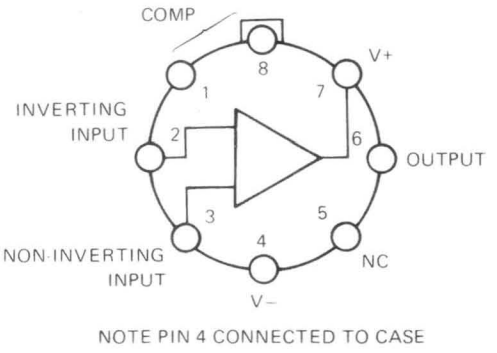


1820-0720 (8830)
DUAL DIFFERENTIAL LINE DRIVER



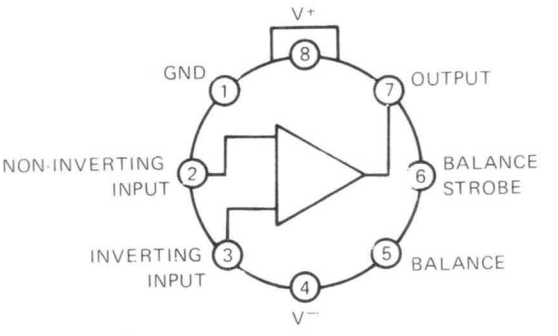
1820-0730 (96L02)
RETRIGGERABLE ONE-SHOT

Figure 7-2. IC Diagrams (cont'd)



NOTE PIN 4 CONNECTED TO CASE

1826-0035 (LM308A)
OPERATIONAL AMPLIFIER



TRUTH TABLE		
V_{IN}	STROBE	OUTPUT
+	H	H
+	L	L
–	H	H
–	L	L

NOTE +=NON-INVERTING INPUT (PIN 2) MORE POSITIVE THAN INVERTING INPUT (PIN 3)

–=INVERTING INPUT (PIN 3) MORE POSITIVE THAN NON-INVERTINGGINPUT

1826-0065 (LM311)
VOLTAGE COMPARATOR

Figure 7-2. IC Diagrams (cont'd)

Table 7-1. Laser Head Module Listing

Ref. Desig.	Name	Part No.
A1	Connector Board Assembly	05501-60201
A2	High Voltage Power Supply Assembly	05501-60206
A3	Laser Assembly	05501-60006
A4	Beam Splitter Assembly	05501-60005
A5	Lock Reference Board Assembly	05501-60204
A6	PZT Power Supply Assembly	05501-60203
A7	Control Board Assembly	05501-60205

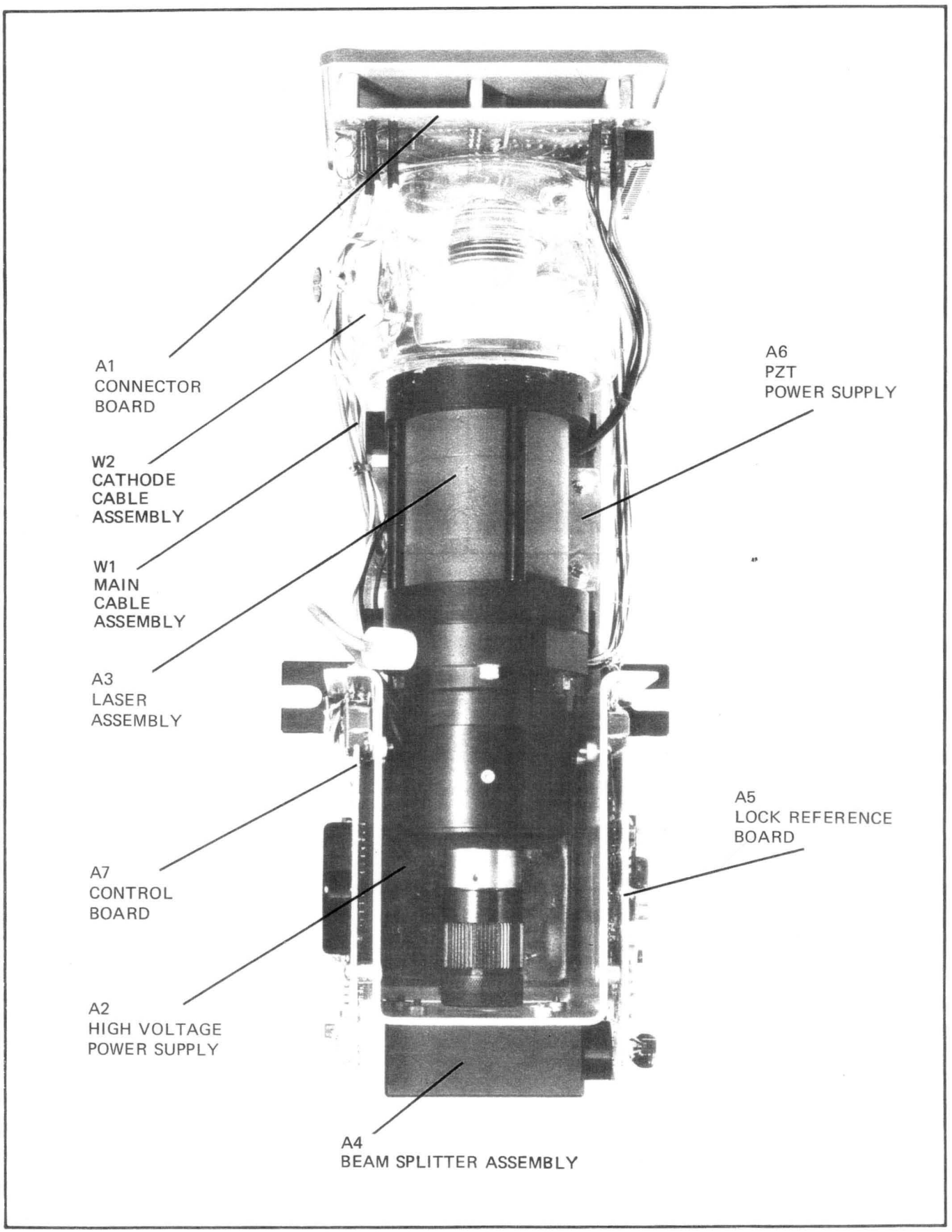
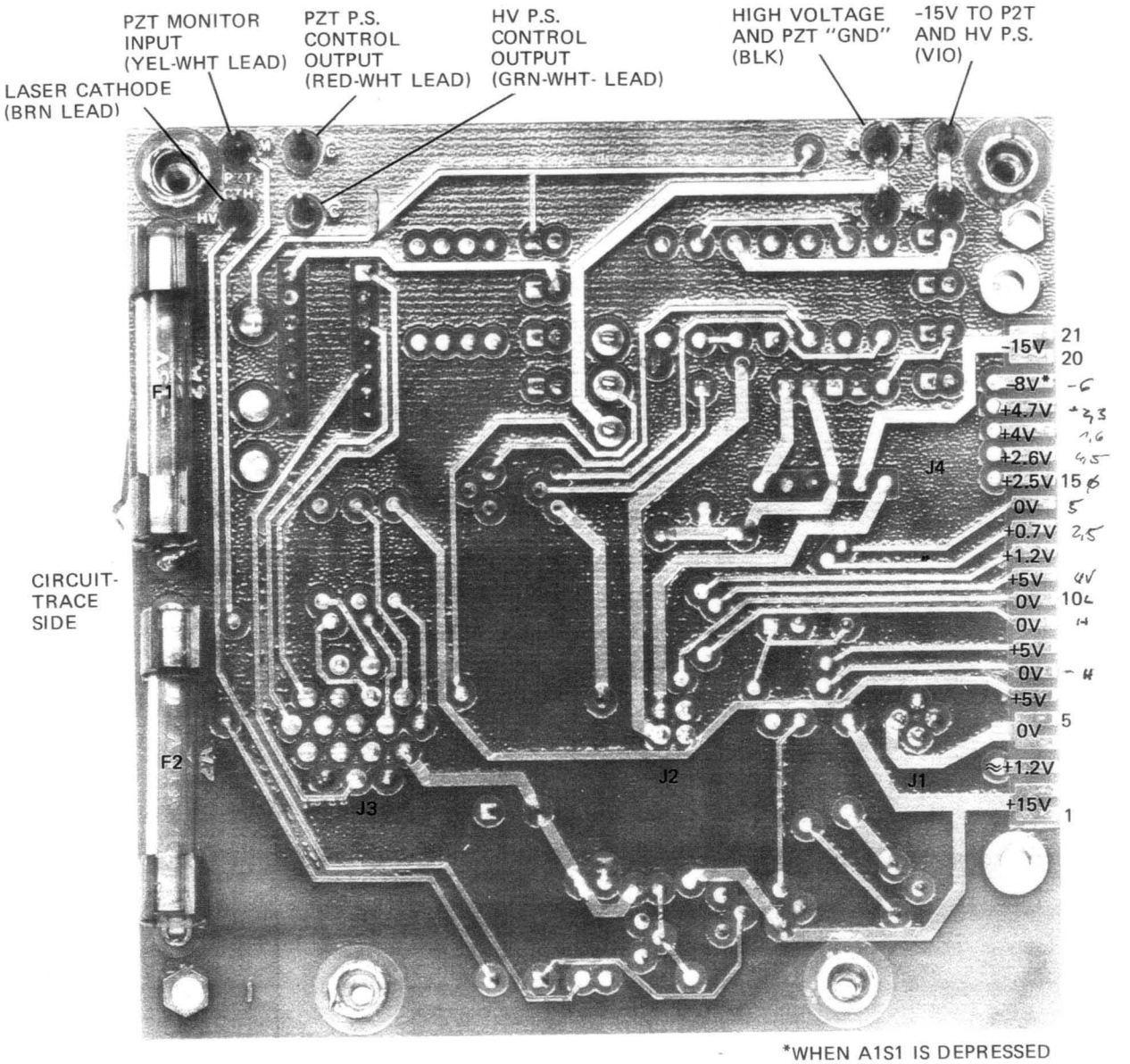


Figure 7-3. Laser Head Assembly Locations



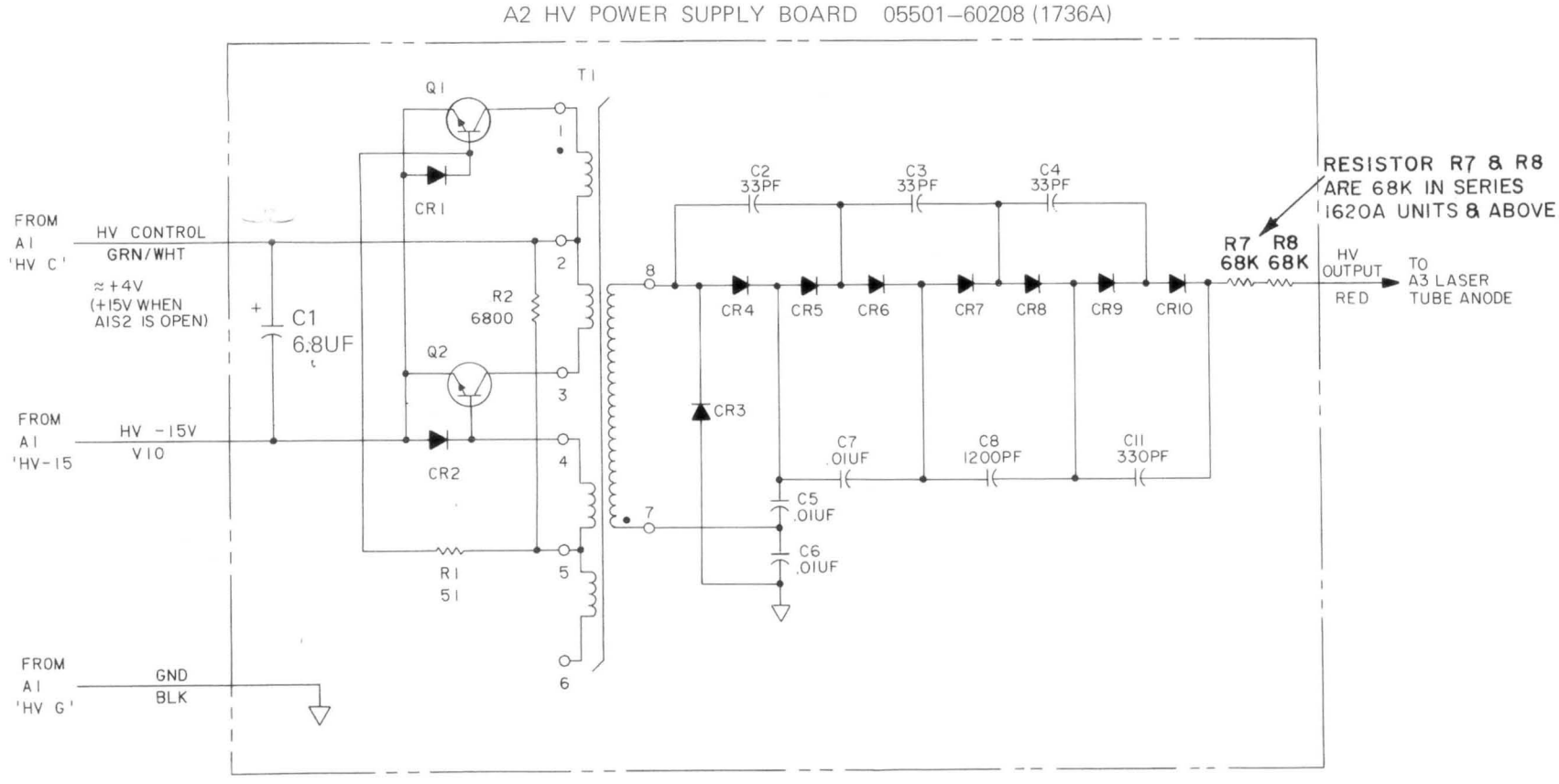
A1 Integrated Circuit Chart

Ref. Desig.	Vcc	Gnd	Part No.	
			HP	Vendor
U1	PIN 14	PIN 7	1820-0175	7405

Part of Figure 7-6. A1 Connector Board Component Locator (Circuit Side)

Table 7-3. A2 High Voltage Assembly Signal List

Input	Output	Signal Name	Function	Source	Destination
Green/ White Wire		HV CONTROL	High voltage power supply output level control	A1-HVC	
Purple Wire		HV-15	+15 volts operating power for high voltage power supply	A1-HV-15	
Black Wire		GND	Ground Reference	A1-HVG	
	Red	HV OUTPUT	High voltage output		A3, Laser Tube Assy Anode



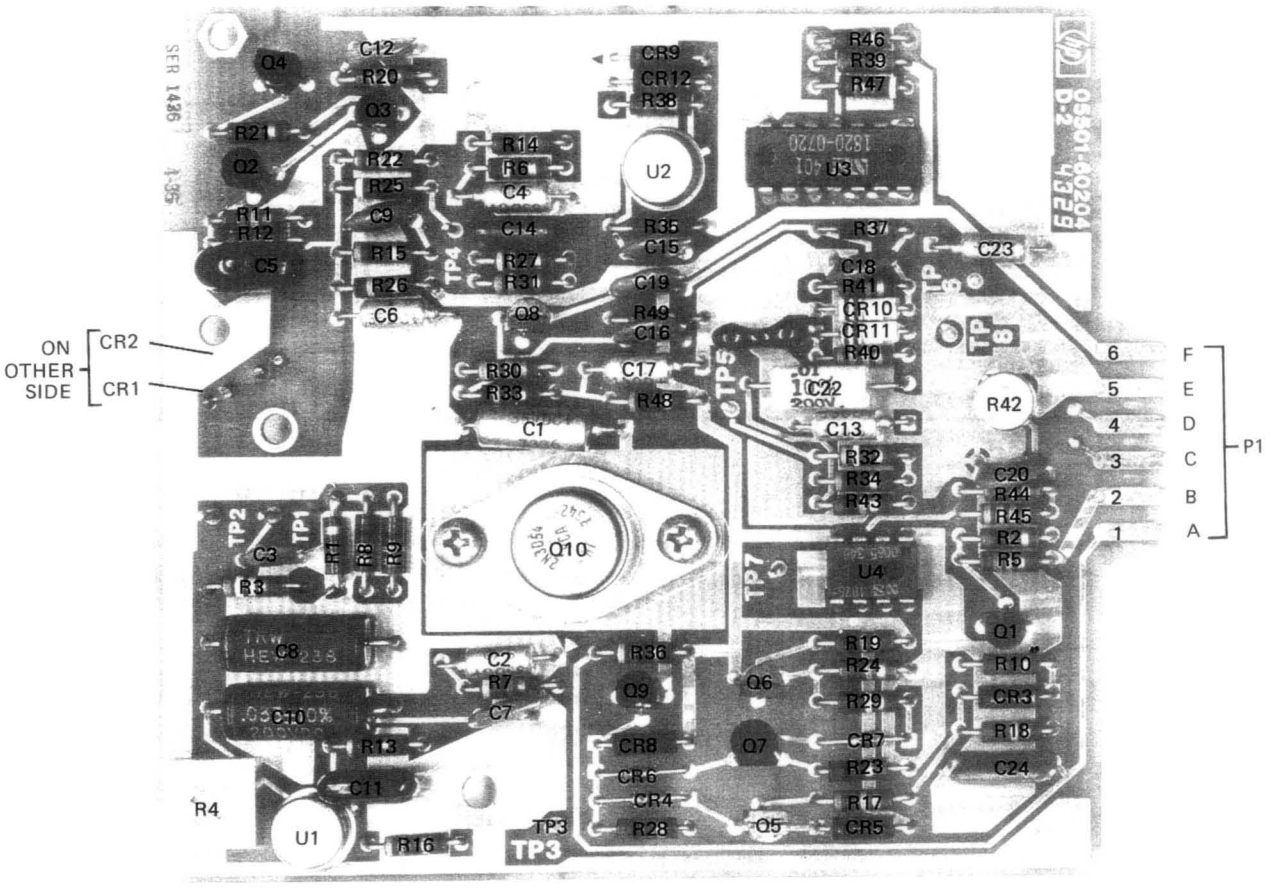
NOTE:

THIS ASSEMBLY IS NOT REPAIRABLE; SCHEMATIC FOR REFERENCE USE ONLY.

Figure 7-7. A2 H.V. Power Supply Assembly Schematic Diagram

Table 7-4. A5 Lock Reference Board Signal List

Input	Output	Signal Name	Function	Source	Destination
XA5-B,2		+15V	+15 volts operating power for Lock Reference Board	A1J4-1,2	
XA5-C		RETUNE CLAMP	Activates clamping switch that forces Laser tube to operate on proper tuning mode	XA7-4	
	XA5-D	REF	Complimented Reference Measurement Signal, equal to the difference in frequency between the Laser f_1 and f_2 components		A1J4-16
XA5-E,5		GND	Ground reference	A1J4-4,5	
XA5-F		+5V	+5 volts operating power for Lock Reference Board	XA7-B,2	
	XA5-3	REF OK	Active low signal indicating Laser properly tuned		XA7-K
	XA5-4	REF	Reference Measurement signal, equal to the difference in frequency between the Laser f_1 and f_2 components		A1J4-15
XA5-6		-15V	-15 volts operating power for Lock Reference Board	A1J4-20,21	



A5 Lock Reference Board Integrated Circuit Chart

Ref. Desig.	Vcc	Gnd	Part No.	
			HP	Vendor
U1	As shown on schematic	—	1826-0035	LM 308A
U2	As shown on schematic	As shown on schematic	1820-0321	LM 710
U3	As shown on schematic	As shown on schematic	1820-0720	DM 8830
U4	As shown on schematic	As shown on schematic	1826-0065	LM 311N

Figure 7-8. A5 Lock Reference Board Component Locator

Table 7-5. A6 PZT Power Supply Assembly Signal List

Input	Output	Signal Name	Function	Source	Destination
Red/ White Wire		PZT CONTROL	PZT power supply output level control	A1-PZT C	
Purple Wire		PZT -15	-15 volts operating power for PZT Power supply	A1-PZT-15	
Black Wire		GND	Ground reference	A1-PZT G	
	Red Wire	PZT OUTPUT	PZT control voltage		A3, Laser Tube PZT Connection
	Yel/ White Wire	PZT MON	PZT control voltage sample		A1-PZT M

Table 7-6. A7 Control Board Assembly Signal List

Input	Output	Signal Name	Function	Source	Destination
XA7-A,1		GND	Ground Reference	A1J4-4,5	
	XA7-B,2	+5V	Provides 5501A with +5 volts operating power		A1J4-6 XA5-F
XA7-C,3		-15V	-15 volts operating power for Control Board	A1J4-20,21	
	XA7-D	L I MON	Laser Current Sample output		A1J4-12
XA7-F		PZT MON	PZT voltage sample input	A1J4-13	
XA7-H		LASER CATHODE	Laser Cathode voltage sample input	A1J4-3	
XA7-J,8		+15V	+15 volts operating power for Control Board	A1J4-1,2	
XA7-K		REF OK	Active low signal input indicating Laser is properly tuned.	XA5-3	
	XA7-L	RETUNE CLAMP	Activates clamping switch that forces Laser tube to operate on proper tuning mode (f_0)		XA5-C
	XA7-4	LASER CURRENT	Active high signal indicating Laser Tube current is not within minimum and maximum limits		A1J4-10
	XA7-5	ERROR	Active high signal indicating any or all of the following conditions: 1. Laser Tube current out of specifications 2. PZT voltage out of specifications 3. Retune/check cycle in process		A1J4-11
	XA7-6	RETUNE FAILURE	Active high indicating failure of the Retune/Check cycle		A1J4-9
	XA7-7	RETUNE	Active high signal indicating PZT tuning/check cycle is in process		A1J4-7
XA7-9		RETUNE CMD	Active low input signal that initiates retune/check cycle	A1J4-8	
	XA7-10	REF OK	Active low output signal indicating Laser is properly tuned		A1J4-14

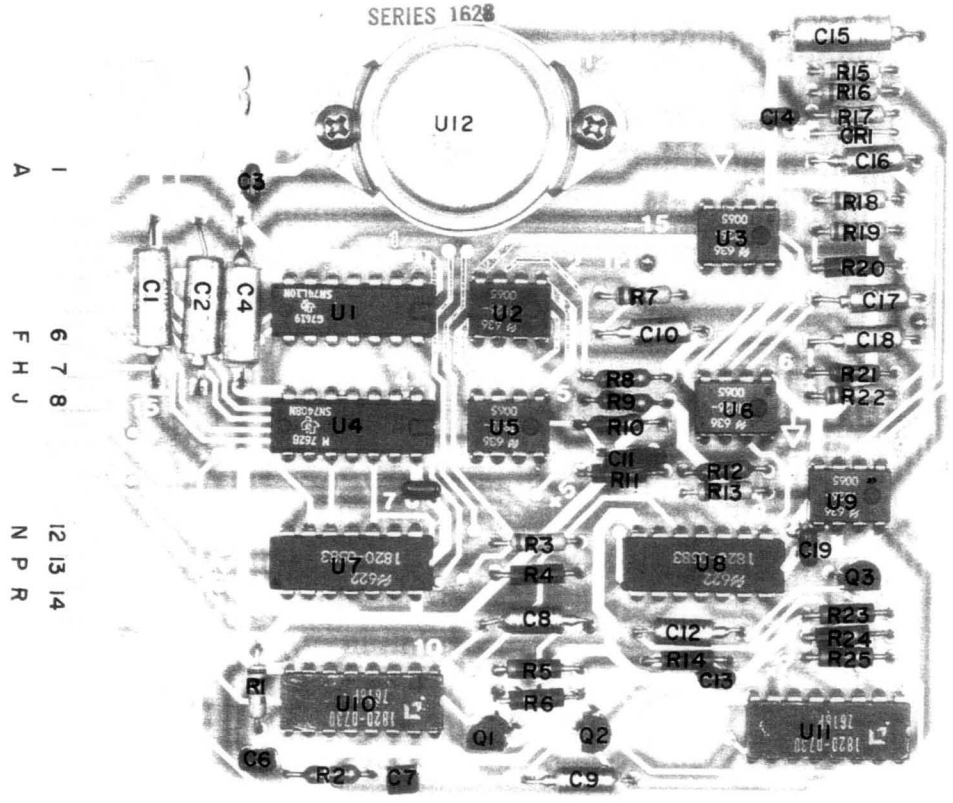


Figure 7-11. A7 Component Locator