OPERATING AND SERVICE MANUAL

5501B
Laser Head

HEWLETT PACKARD

LIST OF FIGURES

Figure	Title	Page
1-1.	HP 5501B Laser Head	1-0
2-1.	HP 10778B Power Cable	2-3
2-2.	HP 10779B Reference Cable	2-4
2-3.	Typical Transducer System Interconnections	2-5
2-4.	Interconnecting Plug Details	2-5
2-5.	HP 5501B Laser Head Interconnect Wire Fabrication	2-6
2-6.	Mounting Details and Physical Characteristics	2-8
3-1.	HP 5501B Front Panel Controls	3-2
3-2.	HP 5501B Rear Panel Connectors and Indicators	3-3
4-1.	HP 5501B Power Connections	4-2
5-1.	A1 Connector Board, TEST-NORM Switch and Adjustment Locations	5-2
5-2.	A3 Controller/Ref Board, Jumpers, Test Points, and Adjustment Locations	5-3
5-3.	5501B High Voltage Area and Anode Lead	5-6
6-1.	5501B Laser Head Exploded View	6-15
8-1.	Schematic Diagram Notes	8-2
8-2.	HP 5501B Laser Head Block Diagram	8-5
8-3.	Flow Diagram for State Machine	8-6
8-4.	Feedback Loop During Warmup Mode	8-7
8-5.	Warmup Mode Timing Diagram	8-8
8-6.	Feedback Loop During Optical Mode	8-8
8-7.	A6 Sampler Assembly, Exploded View	8-9
8-8.	Liquid Crystal Timing Diagram (Optical Mode)	8-10
8-9.	Logic Clip Monitoring of Test IC U9	8-13
8-10.	HP 5501B Front Panel and Side Cover Removal	8-15
8-11.	Factory-adjusted Sampler Mount (MP1)	8-17
8-12.	Laser Tube Tuning Characteristics	8-18
8-13.	Quick Tuning Check Test Setup	8-19
8-14.	Quick Tuning Check Waveform Display	8-20
8-15.	Liquid Crystal Removal	8-20
8-16.	Liquid Crystal Test Setup	8-21
8-17.	HP 5501B TEST-NORM Switch A1S2	8-22
8-18.	High Voltage Power Supply, Schematic Diagram	8-30
8-19.	State Machine Timing Diagram	8-32
8-20.	Test Point 11 Waveform (HEATER SENSE)	8-43
8-21.	E-REF [U20 (Pin 9)]	8-44
8-22.	REFerence Signal Waveforms	8-46
8-23.	A1 Connector Board (05501-60028) Schematic Diagram	8-51
8-24.	A3 Controller/Reference Board (05501-60027) and A4 Sampler Board (05501-60029), Schematic Diagram (Sheet 1 of 2)	8-53
8-24.	A3 Controller/Reference Board (05501-60027) and A4 Sampler Board (05501-60029), Schematic Diagram (Sheet 2 of 2)	8-55

m. With settings same as step l, check that U4 pins 1, 2, 9, 12, 13, and 16 are all high. If not, U4 is bad. At this point, the digital section should be OK.

n. Set REF ON to HI, HTR OK to "X", ALL other jumpers to left. U9 (Pin 13) (HTRQ) should be high. If not, check U8A. If so go to step o.

o. Keep ~REF ON to HI, set HTR OK to LO. U9 (Pin 13) (HTRQ) should be low. If not, U8A is bad. If so, go to step p.

p. Set ~REF ON to LO. U9 (Pin 9) (POR) should be low. If not, U2B is bad. If so, go to step q.

q. Turn the power off. Set ~REF ON to HI, HTR OK to HI, HEATER to NRM. Check that U9 (Pin 9) comes on then blinks at a few Hz or so at power on. If OK go to step r. If not, replace C1 and check CR1, R5A, R5I, and R48A.

r. Return HTR OK and ~REF ON jumpers to NRM. The READY LED should start blinking in a minute or two. If yes, go to step s. If no, check A1R18 and A1DS8.

s. Turn power off. Set ~REF ON to HI. Set POWER AMP jumper to UP. Turn power on and allow the laser to run for five minutes. Observe the voltage level at U2C Pin 8 with an oscilloscope. Pin 8 will be at TTL low and will periodically go high (>2.4 Vdc) for a few seconds (approximately 2 seconds). The laser head will go through the following cycle and can be monitored by observing the rear panel READY and LASER ON (or the corresponding LEDs mounted on A3) and the oscilloscope display. The cycle begins with both LEDs off and the voltage at U2C (Pin 8) at TTL low. The READY LED begins flashing and continues to do so for approximately 150 seconds. About 100 seconds into the cycle the laser beam and the LASER ON LED turn on. The READY LED continues to flash. After 150 seconds, the READY LED stops flashing and remains on steady. Both LEDs remain on only momentarily. At this point, the DISABLE line goes high, and the laser beam and both LEDS turn off. This cycle is repetitive with the test jumpers set as they are. If the cycle occurs as described, remove power return all jumpers to their NRM position. The Digital Section is OK. If Pin 8 doesn't go high, check divider and state machine circuitry. See A3 Power Amp section for additional information.

t. Signature Analysis:

CAUTION

WHEN TAKING SIGNATURES, ENSURE THAT THE TEST-NORM SWITCH (A1S2) IS SET TO NORM AND THAT HEATER TEST JUMPER IS IN THE OFF POSITION. DAMAGE TO THE HIGH VOLTAGE POWER SUPPLY OR LASER ASSEMBLY COULD RESULT IF THESE INSTRUCTIONS ARE NOT ADHERED TO.

With the power (±15 Vdc) disconnected, set the HP 5501B switches and test jumpers as follows:

TEST-NORM = NORM, HTR OK = HI, ~REF ON = HI, RESET = TEST, CLK FREQ = Remove, HEATER = OFF; TP2, TP3, and Pin "X" of HTR OK jumper to ground.

Connect the signature analyzer (HP 5005A/B) test pod leads as follows:

START = A3TP7, STOP = A3TP6, CLOCK = A3TP5, GND = A3TP4

Set signature analyzer front panel controls as follows:

CLOCK, START, and STOP Polarity set for falling edge.

Table 8-4. Signature Table

Pin	U1	U2	U3	U4	U5	U6	U8	U9	U19
1	41A5	4UHP	CCPC	6678	4CCA	41A5	CCPC	4CCA	F9C3
2	0000	7U30	41A5	0000	FP96	0000	41A5	4H86	8816
3	8816	41A5	FP96	8A5F	P861	FO9F	27HH	A5P7	41A5
4	F9C3	4A39	41A5	0000	4UHP	CU8C	0000	4UHP	0000
5	UA4P	41A5	FP96	2OH3	P861	267H	41A5	7130	4A39
6	CCPC	4A39	8U33	FP96	4H86	9CHA	UA4P	6678	3721
7	0000	0000	0000	UA4P	0000	0000	0000	7C10	0000
8	27HH	7130	3P95	0000	41A5	4UHP	34FP	0000	0000
9	6678	8U33	7U30	6678	41A5	4CCA	7C10	UA4P	41A5
10	OP7C	6678	41A5	AOHO	41A5	4A39	4UHP	34FP	3721
11	4UHP	538U	20H3	88F5	A5P7	FF57	41A5	7U30	7U30
12	7U30	F9C3	FP96	0000	P861	0000	34FP	FP96	0000
13	3P95	41A5	CCPC	538U	OP7C	9CHA	4UHP	41A5	CCPC
14	41A5	41A5	41A5	0000	41A5	41A5	41A5	0000	41A5
15	NC	NC	NC	4UHP	NC	NC	NC	XXXX	NC
16	NC	NC	NC	41A5	NC	NC	NC	41A5	NC

NC = A3U1-3, A3U5-6, and A3U19 are 14-pin package configuration.

8-140. Photodiode and Amplifier Troubleshooting

8-141. This procedure assumes that the power supplies are functioning properly. Use a dedicated digital voltmeter, not the signature analyzer voltmeter function.

a. Bypass high-voltage interlock by setting A1S2 to TEST. Set HTR OK jumper to LO, PHOTO DIODE jumper to TEST, LIQ CRYS jumper to PASS. Is voltage at TP16 more negative than –4V? If no, go to step c. If yes, go to step b.

b. Set LIQ CRYS jumper to ACT. Is voltage at TP16 more positive than –1V? If no, go to step c. If yes, go to step d.

c. Verify U11 (Pin 13) is 0 V ±10 mV. If not, replace U11. Verify voltage at TP16 is 6/11 of that at U11D pin 14 and voltage at junction of R20 - R22 is 1/11 of that at U11D (Pin 14). If not, check A3R6, R17, R20, R22, and R24. Also U12A or U12D may be incorrectly loading this node.

d. Amplifier is OK. Check photodiode. Verify laser is on. Set PHOTO DIODE jumper to NRM. Measure TP16 voltage. If it is ≥+0.5V then photodiode A4CR1 is good. If it is approximately –6V then either the photodiode is shorted or U11 is bad. If it is –0.5V to +0.5V go to step e.

e. Remove PHOTO DIODE jumper and check for diode action between the left hand pin of the jumper and ground. If no diode action is observed, replace A4CR1. Otherwise, not enough light is reaching the photodiode. Remove the A6 Sampler Assembly and inspect the liquid crystal, beam splitters and A4CR1 for dirt, scratches, etc. If O.K., see Liquid Crystal Troubleshooting.

8-142. Liquid Crystal Troubleshooting

8-143. This procedure assumes the digital circuits and the photodiode and amplifier circuit are functioning properly.

a. Set A1S2 to TEST. Verify laser is on. Set all jumpers on A3 to left except LIQ CRYS to PASS. Insert test polarizer (HP Part Number 1000-0616) between laser assembly and sampler assembly. The bottom edge of the polarizer should be parallel to the base of the HP 5501B. Measure TP16 voltage. Is it <0.2V? If yes, go to step c. If not, go to step b.

b. Rotate polarizer 90 degrees. Is TP16 voltage <0.2V? If yes, go to step c. If no, go to step f.

c. Rotate polarizer 90 degrees. Is TP16 voltage >0.5V? If yes, go to step d. If not, go to step f.

d. Set LIQ CRYS jumper to ACT. Is TP16 voltage <0.2V? If yes, go to step e. If not, go to step f.

e. Rotate polarizer 90 degrees. Is TP16 voltage >0.5V? If yes, the liquid crystal is OK. If no, go to step f.

f. Liquid crystal may not be working. See paragraph 8-61, Liquid Crystal Test. Check that the elastomeric connectors are connecting A4 and liquid crystal.

NOTE

If contact problems develop, remove elastomeric connectors and clean both sets of contacts at A4 and the liquid crystal with isopropyl alcohol. Reinstall the elastomeric connectors (HP Part Number 8160-0530) in A4 Assembly.

8-144. Subtracting Sample and Hold Troubleshooting

8-145. This procedure assumes the digital circuit and photodiode and amplifier are functioning properly.

a. Set ~REF ON jumper to LO and HTR OK to HI. Wait for READY LED to remain on. Set HTR OK to NRM. Set PHOTO DIODE jumper to TEST, and LIQ CRYS jumper to ACT. Using a dedicated DC voltmeter, check that the voltage at TP16 is –50 mV to +50 mV? If yes, go to step c. If no, go to step b.

b. The circuitry connected to Pin 2 or Pin 15 (outputs) of U12 is incorrectly loading photodiode amp when switch U12A or U12D is closed. Check U11, C13, and C14.

c. Is voltage at TP13 equal to voltage at TP16 within 10 mV? If no, go to step d. If yes, go to step e.

d. Verify U12 (Pin 8) is low. Measure voltage from U11B (Pin 5) to TP13. Is it –10 mV to +10 mV? If yes, go to step i. If no, U11B is defective or its output is incorrectly loaded.

e. Is voltage at TP14 equal to voltage at TP16 within 10 mV. If yes, go to step g. If no, go to step f.

f. Verify U12 (Pin 9) is low. Measure voltage from U11C (Pin 10) to TP14. Is it –10 mV to +10 mV? If yes, go to step i. If no, U11C is defective or its output is incorrectly loaded.

g. Set POWER AMP jumper to UP. Is voltage at TP12 between –20 mV and +20 mV? If yes, go to step i. If no, go to step h.

h. Verify U11A (Pin 3) voltage is about 1/2 that of TP13 voltage. Verify U11A (Pin 2) voltage = U11A (Pin 3) voltage. If not, U11A, R10, R12, R14, or R15 may be bad.

i. Place LIQ CRYS jumper to NRM. TP16 will alternate between about 0 V to about –5 V. Record these voltages (the ΔV function of the HP 5005A/B is useful here). Measure voltage at TP13. It should be the same 0 V reading as at TP16, within 20 mV. If OK, go to step k. If not, go to step j.

j. Measure the voltage on C13. During and just after the switch (U12A) is closed (DELAYED ACTIVE signal on Test IC U9 (Pin 3)), the voltage should equal the approximate zero voltage at TP16. If it is not, or if the voltage rapidly goes to zero, then C13 is shorted or the switch U12A does not work. Also check that U12B is open and U11B is not shorting this node.

k. Is the voltage at TP14 within 20 mV of the approximate –5V voltage at TP16. If yes, go to step m. If not, go to step l.

l. Measure the voltage on C14. During and just after the switch (U12D) is closed (DELAYED PASSIVE signal on Test IC U9 (Pin 2)), the voltage should equal the approximate –5V at TP16. If it is not, or the voltage rapidly goes to zero, then C14 is shorted or U12D is faulty. Also check that U12C is open and U11C is not shorting this node.

m. Set PHOTO DIODE jumper to TEST, LIQ CRYS to PASS, POWER AMP to UP. Verify TP16 voltage is approximately –5V. Measure voltage at TP14 and record as V_{14}. Measure voltage at U11A (Pin 3) and record as V_3. Measure voltage at TP12. Is it equal to $[2 \times V_3] - V_{14}$ within 30 mV? If yes, go to step o. If no, go to step n.

n. Verify U11A (Pin 2) is at the same voltage as U11A pin 3. If not, U11A or R15 bad. Also check R14, R10, and R11.

o. This procedure thus far has shown that the Subtracting Sample and Hold circuitry works during optical mode. Next the operation during warmup is checked. Remove power from HP 5501B. Move all A3 jumpers to NRM except ~REF ON to HI. Connect an ohmmeter between Pins 6 and 7 of U12B. Turn 5501B on. Meter should read open-circuit when the DISABLE signal [Test IC U9 (Pin 5)] is low. Meter should read less than 250 Ohms when DISABLE is high. (The HP 5005A/B measures Ohms to ground, therefore Pin 6 or Pin 7 of U12B will have to be grounded for this test). If the result is satisfactory, go to step p. If not, U12B is defective.

p. Connect an ohmmeter between U12 (Pin 10) and ground. Ohmmeter should read less than 250 Ohms while OPTICAL (U9, pin 12) is low. If it does, go to step q. If not, U12C is faulty.

q. Set ~REF ON to LO, HTR OK to HI and wait for ready LED to stay on. Ohmmeter should read open. If not, U12C is bad or the node is shorted. If it reads open, the Sample and Hold is OK.

8-146. Power Amplifier Troubleshooting

8-147. The heart of the power amplifier is A3U20, a fixed-frequency pulse-width-modulator control unit. The IC operates at a fixed frequency set by A3R63 and C38. The outputs are used to control the amount of ±15V current supplied to the laser assembly during the warmup and optical modes of operation. To troubleshoot the power amp, theory of operation, schematics diagrams and waveforms, and the following procedure have been provided.

a. Set HTR OK jumper to HI, ~REF ON to LO and wait for READY LED to stay on. Set POWER AMP jumper to UP. Remove HEATER jumper. Is voltage at U13 (Pin 3) approximately 0.1V? If not, check A3R27, R31, R49, R50, R51, C18, and U13. If so, go to step b.

b. Within 1 minute of setting POWER AMP to UP, is voltage at A3TP11 a nonsymmetrical square wave with ±peak voltages >13 Volts? (See *Figure 8-20.*) If yes, go to step d. If not, go to step c.

NOTE

Figure 8-20 oscilloscope settings are as follows:

Time/Division: 10 microseconds/division
Volts/Division: 5 Volts/division
Coupling: DC

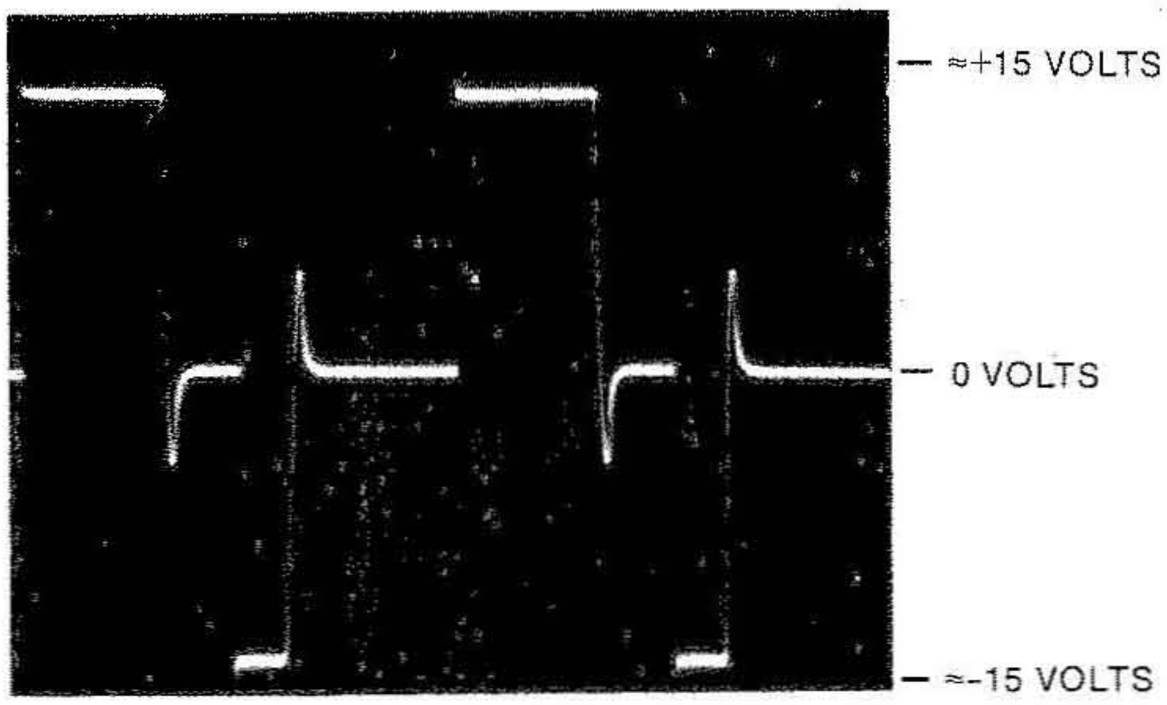


Figure 8-20. Test Point 11 Waveform (HEATER SENSE)

c. Is U13 (Pin 6) > +13 Vdc? If yes, go to step j. If no, check feedback path through R65B, C20, and R32, or replace U13.

d. Set POWER AMP jumper to DWN. Is voltage at A3TP11 <0.6 Vdc within 1 minute? If yes, go to step g. If no, go to step e.

e. Is U13 (Pin 6) < –10 Vdc (i.e., more negative)? If yes, go to step l. If no, go to step f.

f. Is U13 (Pin 3) approximately –0.1 Vdc? If yes, check R33 or U13. If no, check R49, R50, R51, U13.

g. While observing voltage at A3TP11, move POWER AMP jumper from DWN to UP. TP11 voltage should change from 0 Vdc to waveform of *Figure 8-20*. If OK, go to step h. If not, check U20 (Pins 11, 12, 13, and 14) for activity (see A3 schematic for waveforms). If waveform activity is not present, check U20 (Pins 3 and 7) for clock activity (see A3 schematic for waveforms). If waveforms and clock activity are OK, check A1 power amp transistors for (A1Q5-9) proper operation. Check E-REF input to U20 (Pin 9). Waveform should be as in *Figure 8-21*.

NOTE

Figure 8-21 oscilloscope settings are as follows:

Time/Division: 20 microseconds/division
Volts/Division: 1 Volt/division
Coupling: DC

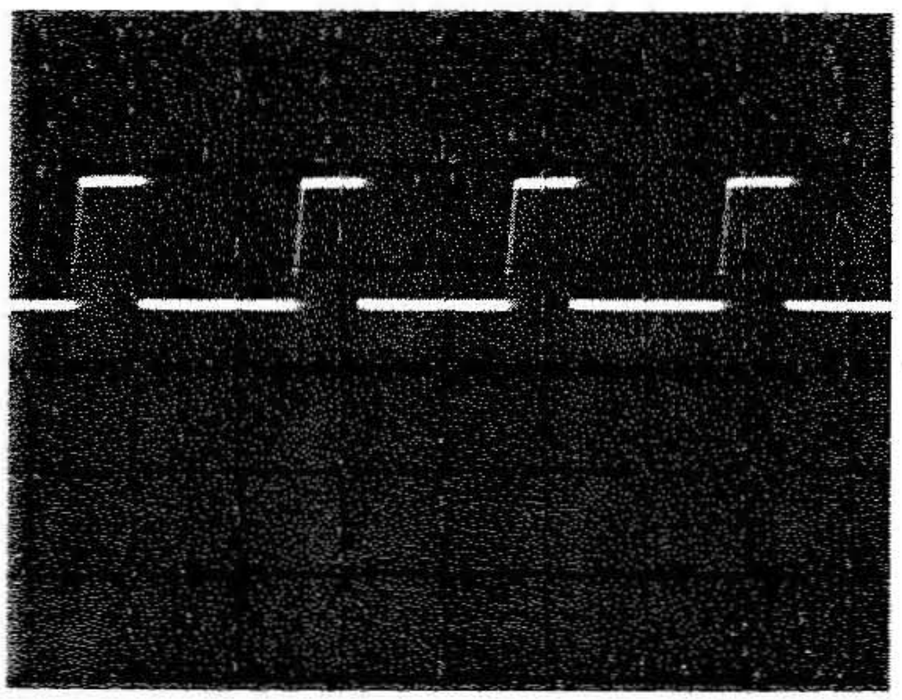


Figure 8-21. E-REF [U20 (Pin 9)]

h. Set HEATER jumper to OFF. This applies +5V through A1R62 to U20 (Pin 10), via the DISABLE line, disabling U20. If voltage at U20 (Pin 20) reads between 2 and 3 Vdc, go to step i. If voltage is < 2 Vdc, U20 (Pin 10) could be shorted. If U20 (Pin 10) measures approximately +5 Vdc, that input is open.

i. Set POWER AMP to UP, HEATER jumper to NRM. U13 (Pin 6) should read > +13 Vdc.

8-148. Warm-Up Error Amplifier Troubleshooting

8-149. This procedure assumes the power amplifier is functioning properly.

a. Set HEATER jumper to OFF. A3TP11 waveform (see *Figure 8-20*) changes to 0 Vdc. If yes, go to step b. If no, go to power amplifier servicing.

b. Is A3TP15 voltage +0.2 to +0.6 Vdc? If yes, go to step c. If no, A3R18, R19 or U14 is faulty.

c. Check A3R16 (SET TEMP potentiometer) to see if it is shorted. Short A3TP15 to TP11. Measure U14 (Pin 6). Does the voltage stabilize between –1.5 V and +1.5 Vdc? If yes, go to step d. If no, A3R21, R23 or U14 is faulty. Remove short.

d. Short A3TP15 to ground (TP18). Is A3U14 (Pin 6) more negative negative than –12 V? If yes, go to step e. If no, U14 is faulty. Remove short.

e. Is voltage at A3U15 (Pin 3) approximately half of U14 (Pin 6) voltage? If yes, go to step f. If no, A3R25, R26, U12 or U15 is faulty.

f. Is voltage at A3U15 (Pin 2) between +1.2 Vdc and +1.3 Vdc? If yes, go to step g. If no, A3R28, R29, R30 or U15 is faulty.

g. Is A3U15 (Pin 7) > +3 Vdc? If yes, go to step h. If no, A3R5E, R48D, U8A, or U15 is bad.

h. Remove TP15 short and short TP11 to ground. Is A3U14 (Pin 6) voltage > +12 Vdc? If yes, go to step i. If not, U14 is bad.

i. Is A3U15 (Pin 7) between 0.05 and 0.15? If yes, the warmup error amplifier is OK. If no, A3R5E, R48D, U8A or U15 is faulty.

8-150. Power Supply Troubleshooting

8-151. If the correct voltage is not observed on A3TP8, 9, or 10, typical power supply troubleshooting should be followed. +15 V, –15V, and +5V test points must meet the limits listed in *Table 8-5*.

Table 8-5. Voltage Testpoints and Limits

A3 Test Points	Voltage Limits
TP8	+14V ± 0.3 Vdc
TP9	–15V ± 0.3 Vdc
TP10	+5V ± 0.25 Vdc

The following are suggested points to check:

a. External system power source.

b. A3L1 and A3L2 are in series with the ±15V power supplies.

c. There should be >200 Ohms from +15V to ground.

d. If A1F2 blows (-15V line, 1.5A), check for open in A1R11, A1R12, or thermally caused damage to WHT/ORN wire lead to [A1J3 (Pin 2)], or excessive current being drawn by the High Voltage Power Supply. (See High Voltage Power Supply Troubleshooting in paragraph 8-89.)

e. Power supply components are located on both A1 and A3.

8-152. Reference Receiver Troubleshooting

a. With power removed from the HP 5501B, set the ~REF ON jumper on A3 to LO and HTR OK to HI. Apply power to 5501B. Does the READY LED eventually start blinking then remain on continuously? If no, see HP 5501B Trouble Isolation Procedure, paragraph 8-72 and procedures recommended therein.

b. Are TTL level signals present at A3U16 (Pins 1 and 3) at a frequency between 1.5 and 2.0 MHz? If so the reference receiver may be working properly. If not, trace the signal path from U17 (Pin 16), through A3Q6, to U16 (Pins 5, 6, and 7 (TP22) and check for the following:

U17 (Pin 16): 0.3 to 0.7 Volt square wave at the Reference frequency of 1.5 to 2.0 MHz.

TP22: TTL level square wave at the REFerence frequency of 1.5 to 2.0 MHz.

A5J6 Rear Panel Connector: Monitor Pins C and D with an oscilloscope. Waveforms should be similar to those in *Figure 8-22*.

NOTE

Figure 8-22 oscilloscope settings are as follows:

Time/Division: 0.2 microseconds/division
Volts/Division: 2 Volts/division
Coupling: DC

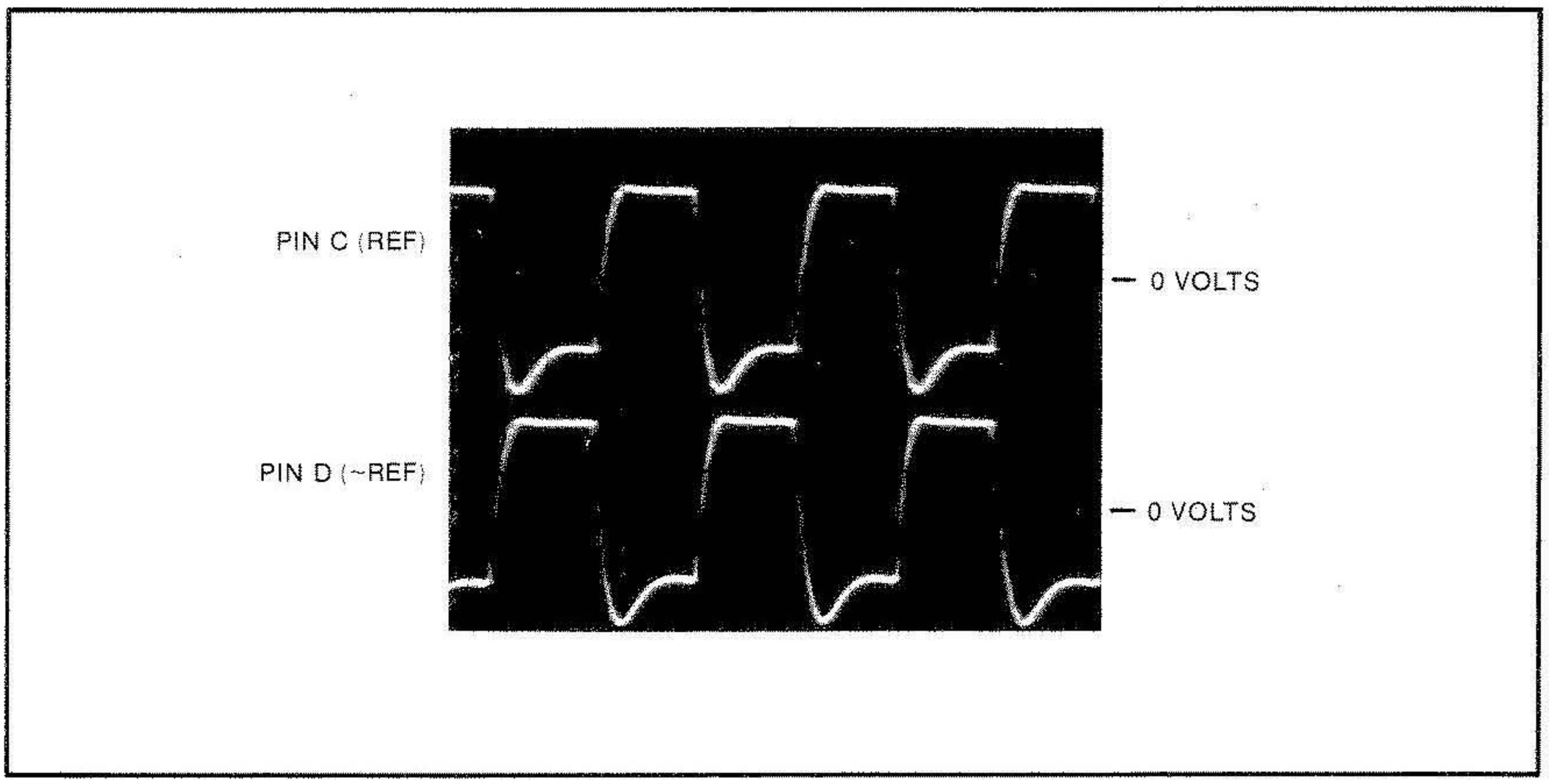


Figure 8-22. REFerence Signal Waveforms

If no activity is found, check U17 (Pin 2). If Pin 2 is at a TTL high level or changing states, then either the laser is not tuned properly, the Reference Receiver is failing or not receiving adequate signal. Verify laser tuning according to step c before continuing with step d. If U17 Pin 2 is at a TTL low level and there is no output activity as described above, then U17 may be bad or it's output may be shorted. Go to step d.

c. Align an HP 10780A Receiver so that the laser beam is incident on the photodiode lens. If the laser is properly tuned, the LED on top of the 10780A should light and the 10780A should output a square wave at the REFerence frequency. This test can be performed with the laser installed using one of the axes' receivers. In this case, if the axis interferometer is installed, vibration (etc.) will modulate the REFerence frequency but a frequency in the range of 1.5 to 2.0 MHz should still be present. If a steady REFerence frequency signal is not detected by the HP 10780A Receiver, then a laser tuning failure is indicated which is independent of the Reference Receiver. See HP 5501B Trouble Isolation Procedure, paragraph 8-72. Otherwise proceed with step d.

d. Measure and record the DC voltages at A3U17 (Pin 10) and the ACR5-R46 node. With ~REF ON jumper still set to LO, place a piece of paper between the laser assembly and the sampler assembly to block the laser beam. The voltage at U17 (Pin 10) should drop by 250 mV or more, indicating adequate signal, and the DC voltages listed in *Table 8-6* should be measured on the pins of A3U17 with the beam blocked:

Table 8-6. A3U17 Reference Receiver Test Voltages

PIN	DC VOLTAGE	POSSIBLE TROUBLE
9 , 12, 14	Vcc (+5 Vdc)	+15V External Power Source, +5 Volt Regulator (A3U7).
1, 15	GRD	Ground
11	TTL HIGH	A3U17, A3U1F, A3U3B, or Digital Circuits
8	+0.7 Vdc ±0.1V	A3CR5,A3U17, or associated passive components.
7	+4.8 Vdc ±0.1V	A3C22 or A3U17
6	+0.7 Vdc ±0.1V [2 mVp-p noise (nominal)]	A3U17, or associated passive components (A3R43, A3R44,A3C23 etc.).
5	+2.3 Vdc ±0.2V	A3C24 or A3U17
4	+0.8 Vdc ±0.1V	A3C23 or A3U17
10	+1.6 Vdc ±0.2V	A3C28 or A3U17
3	Vcc +0/–0.1V	A3U17
2	Vcc +0/–0.1V	A3U17
13	<80 mVdc	A3U17
16	+0.7 Vdc ±0.1V	A3Q6 or A3U17

If any voltage is incorrect, check or replace the part listed.

If the voltage at Pin 10 does not drop according to the above, measure the DC voltage at the CR5-R46 node with the beam blocked. It should be approximately 15 Volts and should have increased at least 6 mV above the value measured and recorded previously when the laser beam was unblocked. If not, check R46, C27, or CR5. CR5 can be checked by removing power from the 5501B and checking

for diode action of CR5 using a DC ohmmeter. Resistance measured in the reverse direction should be much larger than the resistance measured in the forward direction. If CR5 is OK replace U17.

e. In cases of marginal signal strength, the following factors should be checked:

- Laser assembly output power
- Sampler assembly function

The laser assembly output power should be checked according to Laser Power Output Test, paragraph 4-12.

The sampler assembly can be checked as follows:

1. Remove power from the HP 5501B.

2. Remove A4.

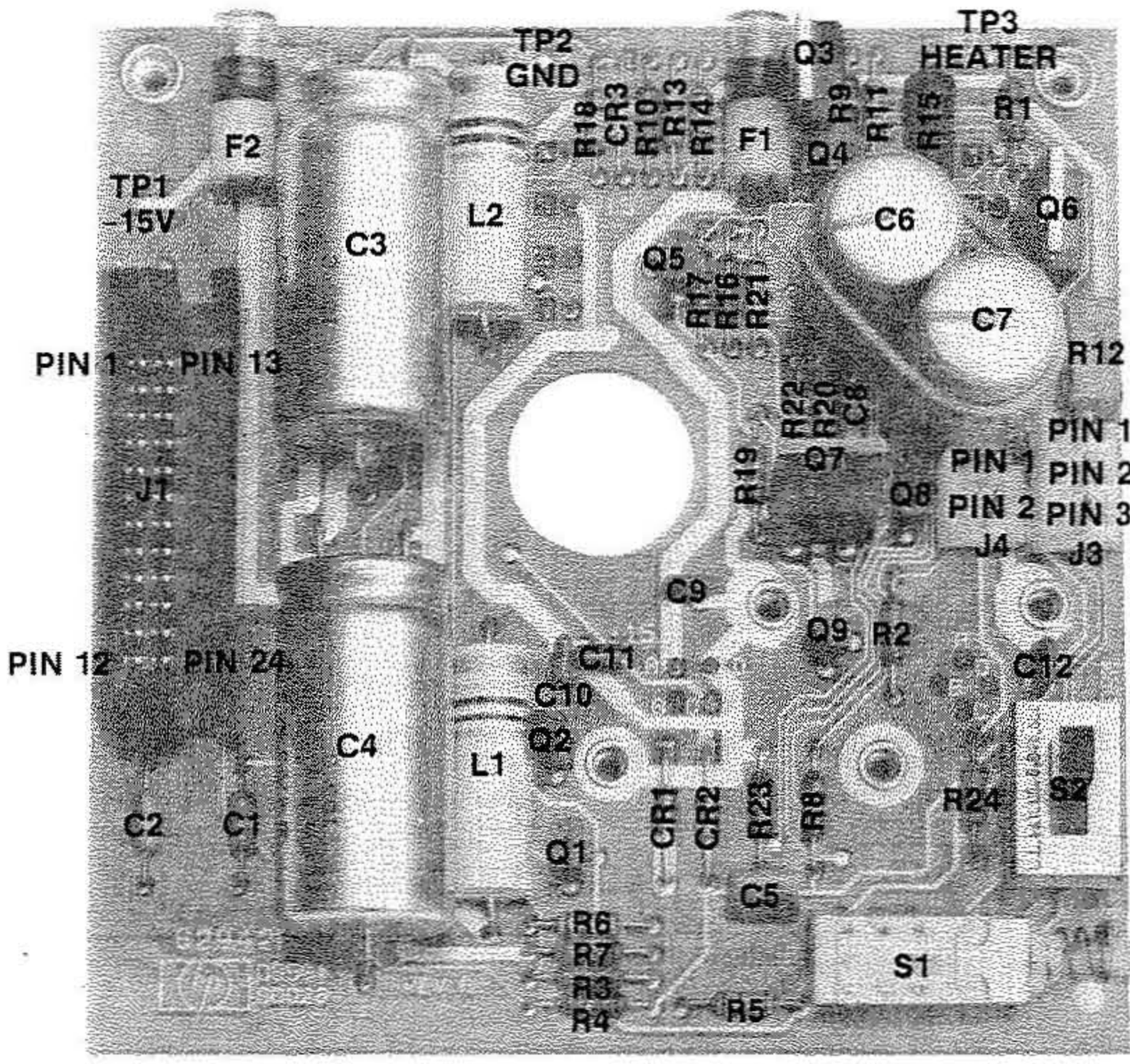
3. Rest the test polarizer, HP Part Number 1000-0616 (supplied with the 5501B), against the exposed Reference Receiver exit port of the sampler. The test polarizer will serve as a viewing screen in order to examine the laser beam which is normally incident on the Reference Receiver photodiode. Apply power to the 5501B. Examine the laser beam cross section illuminating the polarizer. It should be circular and centered within a few millimeters with respect to the exit port. Slight eclipsing is normal. If any intensity variations are visible across the beam diameter they should be straight, regularly spaced lines of high and low intensity, not spots or irregular shapes. Rotate the polarizer 90 degrees and repeat the above observations. The sampler can be removed and the internal beam splitters and polarizers examined for scratches dirt or cloudiness. Check the A3CR5 lens for scratches, dirt, or cloudiness. Also, see Liquid Crystal Troubleshooting, step f.

Figure 1-1. HP 5501B Laser Head

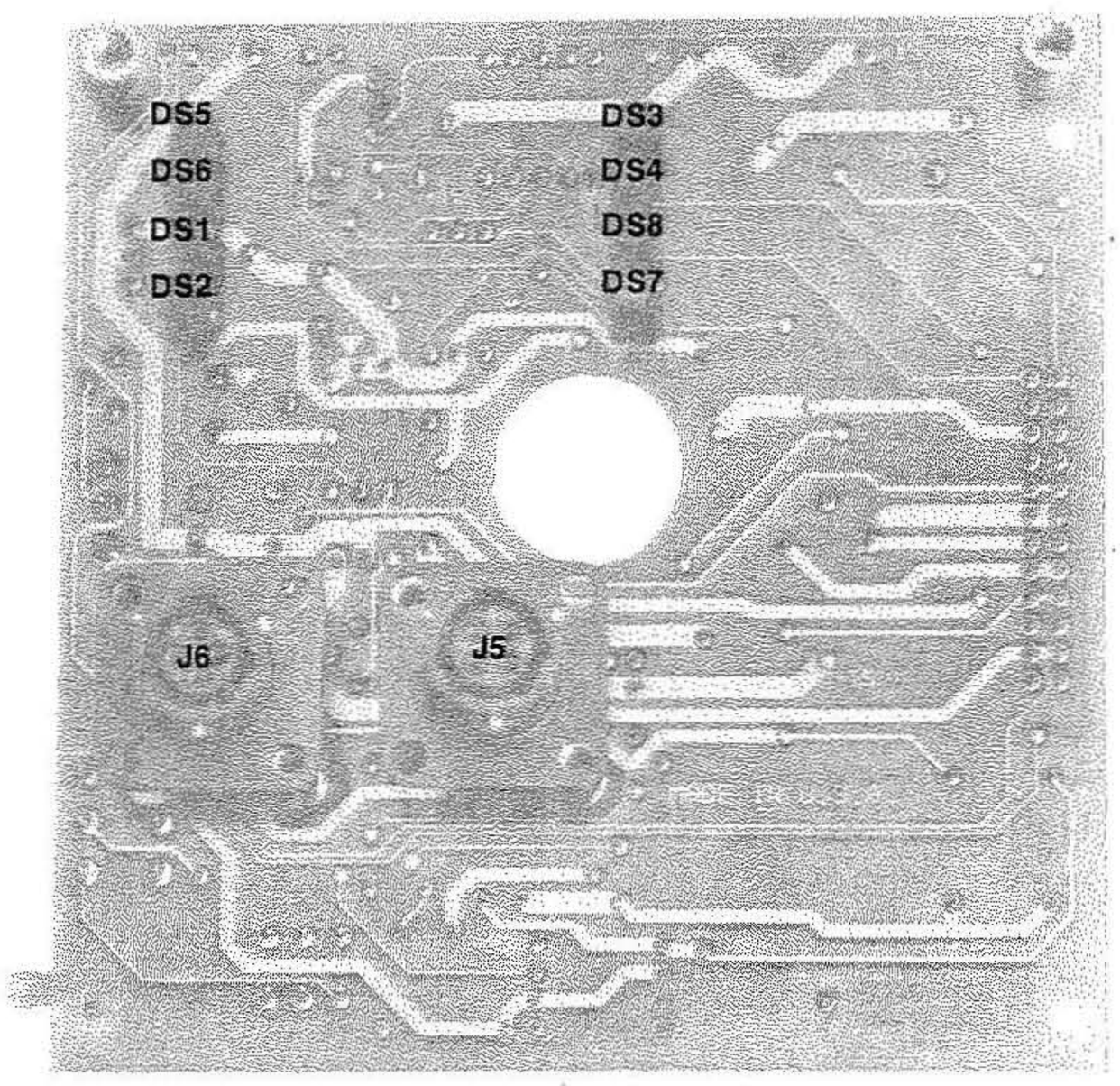
A1 ↔ A3 Connections

A1J1 PIN	A3J1 PIN	DESCRIPTION	TO	FROM	BLOCK
1	13	Warmup	Through A1R10 to A1Q4	A3U3B(6)	Ⓕ
2	14	+5V	Through A1R18 to A1CR3, and A1J5(C)	A3U7(3)	Ⓒ
3	15	Digital Ground	5501B Circuitry	A1J5(D)	Ⓒ
4	16	—	—	—	—
5	17	+15V Heater Control Drive	A1Q8	A3U20(12)	Ⓘ
6	18	+15V	5501B Circuitry	A1J5(A)	Ⓒ
7	19	Digital Ground	5501B Circuitry	A1J5(D)	Ⓒ
8	20	–15V	5501B Circuitry	A1J5(B)	Ⓒ
9	21	–15V Heater Control Drive	A1Q5	A3U20(13)	Ⓘ
10	22	—	—	—	—
11	23	+15V Signal Return Ground (Analog)	A5 Cathode, Line Driver Analog Ground	A1J6(B)	Ⓚ
12	24	REF	Through A3C34, A3L5, to A3U16(1,2)	A1J6(C)	Ⓚ
13	1	READY	READY LED A1DS8 and A3DS1	Flashing: A3U19(6) On Steady: A3U19(10)	Ⓕ
14	2	HEATER SENSE	Through A3R21 to A3U14(2)	A5 Heater Control (A1TP3 or A3TP11)	Ⓙ
15	3	Digital Ground	5501B Circuitry	A1J5(D)	Ⓒ
16	4	—	—	—	—
17	5	+15V Heater Control Drive	A1Q8	A3U20(12)	Ⓘ
18	6	+15V	5501B Circuitry	A1J5(A)	Ⓒ
19	7	Digital Ground	5501B Circuitry	A1J5(D)	Ⓒ
20	8	–15V	5501B Circuitry	A1J5(B)	Ⓒ
21	9	–15V Heater Control Drive	A1Q5	A3U20(13)	Ⓘ
22	10	—	—	—	—
23	11	+15V Signal Return Ground (Analog)	A5 Cathode, Line Driver Analog Ground	A1J6(B)	Ⓚ
24	12	~REF	Through A3C32, A3L4 to A3U16(3,4)	A1J6(D)	Ⓚ

Part of Figure 8-23. A1 ↔ A3 Connector Pin Table



COMPONENT SIDE



CIRCUIT SIDE

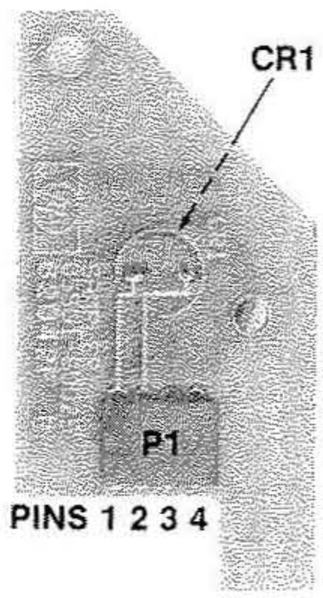
SERIES 2632, REV A

Part of Figure 8-23. A1 Connector Board Component Locator

Figure 8-23

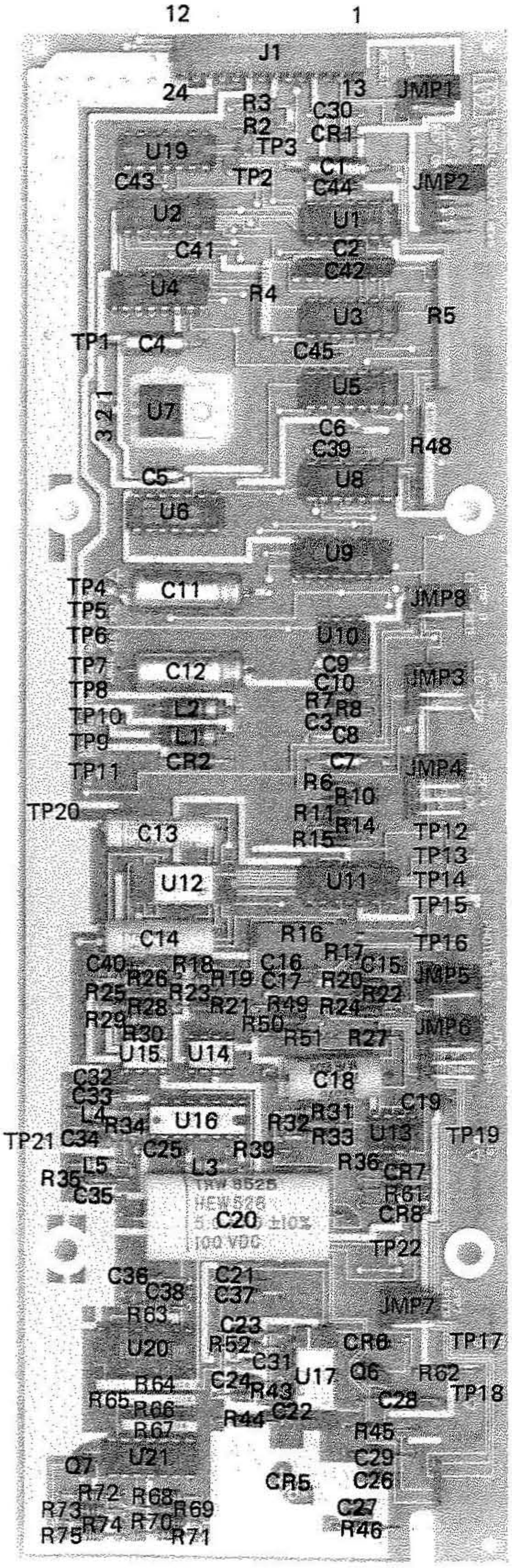
A1 CONNECTOR BOARD (05501-60028) SCHEMATIC DIAGRAM (INCLUDES COMPONENT LOCATOR)

(See Page 8-51)



A4 SAMPLER BOARD
COMPONENT LOCATOR

SERIES 2632, REV B



A3 CONTROLLER/REFERENCE
BOARD COMPONENT LOCATOR

SERIES 2632, REV A

Part of Figure 8-24. A3 Controller/Reference Board and A4 Sampler Board Component Locators

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

1-2. This Operating and Service Manual contains information required to install, operate, test, adjust, and service the Hewlett-Packard Model 5501B Laser Head. The information in this manual is specific to the HP 5501B and supplements other publications available for Hewlett-Packard Laser Transducer products. Also available is the HP 5501A Laser Transducer System Manual (HP Part Number 05501-90028) that describes how to setup, align, and use the laser system to make interferometer measurements.

1-3. The HP part number of this manual is listed on the title page. Also listed is a microfiche part number for ordering 4 × 6" microfilm transparencies of this manual. The microfiche package also includes the latest "Manual Changes" supplement and any pertinent Service Notes.

1-4. EQUIPMENT DESCRIPTION

1-5. The HP 5501B Laser Head consists of a thermally-tuned laser tube, control circuits, a reference receiver, and a high-voltage power supply. The laser head requires ±15 Volt supplies, each with a minimum capacity of 1 Amp. The 5501B produces a frequency stabilized laser beam, a balanced reference output (see paragraph 1-6), a +15 Volt fused output, and a +5 Volt output. Diagnostic LEDs, mounted on the 5501B's rear panel, provide status information on power supply input (±15 Volts), fuses, laser output and tuning, and the reference frequency output.

1-6. The 5501B laser beam consists of two linearly polarized and mutually perpendicular (orthogonal) components separated in frequency by approximately 1.8 MHz. The two components have light frequencies of F1 and F2. The higher frequency component (F2) is oriented parallel to the laser base, while the lower frequency component (F1) is perpendicular to the laser base. An optical receiver inside the 5501B detects the 1.8 MHz frequency difference and places it at the rear panel REFERENCE SIGNAL connector as a balanced output (called the REFerence Frequency). The reference output is one signal used by the external electronics to measure distance traveled.

1-7. During a typical measurement application, the laser beam travels through external optics where the horizontal and vertical components of the beam are separated. One component travels along a fixed path and returns to an external optical receiver. The other component travels along the path (axis) to be measured and then returns to the external receiver. The external receiver detects the frequency difference between the two components and outputs a signal called the MEASure Frequency. The MEASure Frequency from the external receiver and the the REFerence Frequency from the laser head are compared by external, customer-selected electronics. If the distance between the external optics is fixed, the MEASure and REFerence frequencies are equal. As the relative distance between the external optics changes, the MEASure Frequency changes due to a Doppler frequency shift. This relative change between the MEASure and REFerence Frequencies is used by the system electronics to compute distance traveled. The laser transducer system can be configured for computer control of open- and closed-loop positioning and measuring applications, having single or multiple axes. For more detailed information, refer to the HP 5501A Laser Transducer System manual (HP Part Number 05501-90028).

1-8. MANUAL ORGANIZATION

1-9. This Service Manual is organized as follows:

SECTION I, GENERAL INFORMATION: covers Equipment Description, Manual Organization, Instruments Covered by this Manual, Safety Considerations, Equipment Supplied, Available Accessories, Specifications, Recommended Test Equipment, and Warranty Information.

SECTION II, INSTALLATION: covers Grounding Considerations, Power Requirements, Interconnecting Cabling, Operating and Storage Environments, Storage and Shipment, and Packaging.

SECTION III, OPERATION: provides operating information and covers Equipment Front and Rear Panel Features, Warmup Time Considerations, and Program Notes.

SECTION IV, PERFORMANCE TESTS: provides Safety Considerations, Performance Tests, and a Test Record.

SECTION V, ADJUSTMENTS: covers Safety Considerations, Test Equipment Required, Adjustment Procedures, and an Adjustment Record.

SECTION VI, REPLACEABLE PARTS: includes Tables of Replaceable Parts including illustrated parts breakdowns of chassis and mechanical assemblies, Abbreviations, Ordering Information, and the HP Direct Mail Order System.

SECTION VII, MANUAL CHANGES: describes how to update or backdate the manual for prefixes other than those listed on the title page.

SECTION VIII, SERVICE: contains Safety Considerations, Theory and Block Diagram Descriptions, Trouble Isolation, Troubleshooting, Schematics, and Component Locations.

1-10. INSTRUMENTS COVERED BY THIS MANUAL

1-11. Attached to each instrument is a serial plate. The serial number is in the form: 0000A00000. It is in two parts; the first four digits and the letter are the serial number prefix and the last five digits are the suffix. The prefix is the same for all identical instruments; it changes only when a change is made to the instrument. The suffix is assigned sequentially and is unique to the individual instrument. This manual applies to instruments with the serial number prefix listed on the title page of this manual.

1-12. An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates the instrument is different from those described in this manual. The manual for this newer instrument is accompanied by a yellow "Manual Changes" supplement. This supplement contains updating information that explains how to change the manual to be applicable to newer instruments.

1-13. In addition to the new serial number prefix change information, the supplement may contain information for correcting errors in the manual (errata). To keep this manual as current and as accurate as possible, Hewlett-Packard recommends that you periodically request the latest "Manual Changes" supplement. The supplement for this manual is identified with the manual print date and part number, both of which appear on the manual title page. Complementary copies of the supplement are available.

1-14. SAFETY CONSIDERATIONS

1-15. The HP 5501B Laser Head is designed to receive its power from a Safety Class I product. It is designed and tested in accordance with international safety standard IEC* 348. It is also a Class II Laser Product certified as conforming to U.S. National Center for Devices and Radiological Health Regulations 21 CFR** 1040.10 and 1040.11. The instrument and the manual should be inspected and reviewed for safety markings and instructions before operation. A safety summary is included on the page following the title page.

1-16. EQUIPMENT SUPPLIED

1-17. The HP 5501B Laser Head is supplied with a test polarizer and two 4-pin connectors for use in fabricating the power and reference cables. The HP Part Numbers for the three items are:

- Test Polarizer 1000-0616
- Reference Signal Connector (P1) 1251-3450
- Power Connector (P2) 1251-3447

1-18. AVAILABLE ACCESSORIES

1-19. The HP 10778B and HP 10779B cables may be ordered from Hewlett-Packard. *Figures 2-1* and *2-2* show photos of the cables, identify the connector markings, and give the pin numbers and corresponding wire color codes.

*IEC, International Electrotechnical Commission
**CFR, Code of Federal Regulations (U.S.A.)

1-20. SPECIFICATIONS

1-21. *Table 1-1* lists the specifications and performance characteristics for the HP 5501B Laser Head.

Table 1-1. HP 5501B Laser Head Specifications and Performance Characteristics

Description: The HP 5501B Laser Head contains an automatically tuned Helium-Neon laser, circuits to control the laser, and a reference optical receiver. The laser generates a coherent, collimated, two-frequency beam of light. This is a Class II Laser Product conforming to U.S. National Center for Devices and Radiological Health Regulations 21 CFR 1040.10 and 1040.11.

Environmental Conditions:

Temperature (Operating): 0 to 40°C (32 to 104°F)
Temperature (Non Operating): Can be stored or shipped in environments within the range of −40 to +75°C.

NOTE

This unit should also be protected from temperature extremes that could cause condensation within the instrument.

Relative Humidity (Operating): 0 to 95% Non-condensing

Vacuum Wavelength (Nominal): 632.991372 nanometres

Vacuum Wavelength Accuracy: $\pm 1 \times 10^{-7}$

Vacuum Wavelength Stability: $\pm 2 \times 10^{-8}$, typical

Beam Diameter: 6 mm typical

Maximum Beam Power Output: 1 milliwatt

Minimum Beam Power Output: 120 microwatts

Warm Up Time: less than 10 minutes

Power Requirements:

The HP 5501B requires the following power inputs:

+15 Volts ±0.3 Volts at 0.8 Amperes maximum
−15 Volts ±0.3 Volts at 0.7 Amperes maximum

NOTE

Internal laser head 1.5 amp fuses permit power distribution to other laser equipment.

Safety Features:

1. Front shutter to block Laser Beam.
2. Safety switch that disables high voltage when cover is removed.

Outputs:

Reference signal: Differential squarewave at approximately 1.8 MHz. Levels compatible with all Laser Transducer System inputs.

Enclosure: NEMA Type 12

Dimensions: 32.5 × 13.2 × 12.7 cm

Weight: 3.4 Kg (7.5 lb)

1-22. RECOMMENDED TEST EQUIPMENT

1-23. Equipment required to maintain the HP 5501B Laser Head is listed in *Table 1-2*. Other equipment may be substituted if it meets or exceeds the critical specifications listed in the table.

Table 1-2. Recommended Test Equipment

INSTRUMENT	USE*	CRITICAL SPECIFICATIONS	RECOMMENDED EQUIPMENT (Equipment Having Equivalent Characteristics May Be Substituted)
Signature Multimeter	T	Detect TTL level signals	HP 5005A/B
Oscilloscope	T	100 MHz Bandwidth	HP 1740A (if available)
Laser Power Meter	T	Range: 1 microwatt to 1 milliwatt Accuracy: ±10%	United Detector Technology Model 351L
Clip-on Milliammeter	T,A	10 ma range accuracy ±0.1 ma	HP 428B
Logic Pulser	T	TTL level	HP 546A
Current Tracer	T	Sensitivity: 1 ma to 1 amp	HP 547A
Logic Clip	T	TTL Compatible 16-pin I.C. mounting	HP 548A
Logic Probe	T	TTL/CMOS Capability with Pulse Memory	HP 545A
Digital Voltmeter	T	DC Volts: Floating Inputs Input Resistance: >10 MΩ Range: 1, 10, 20 Volts DC Accuracy: 0.1%	HP 3435A

*P = Performance Test; C = Calibration; A = Adjustments; T = Troubleshooting; S = Shortened Performance Test

1-24. WARRANTY

1-25. The warranty statement for the instrument including the laser tube is located on the inside cover of this manual.

SECTION II
INSTALLATION

2-1. INTRODUCTION

2-2. This section provides installation instructions for the HP 5501B Laser Head including unpacking, inspection and reshipment, installation, operating environment, and storage. Installation includes information on grounding considerations, power supply requirements, power dissipation, fusing, dimensions, and mounting and fixturing.

2-3. UNPACKING, INSPECTION, AND RESHIPMENT

2-4. The following paragraphs contain information for unpacking and inspection, warranty claims, laser tube shipment, tagging for service, and packaging for reshipment.

WARNING

TO AVOID HAZARDOUS ELECTRIC SHOCK, DO NOT PERFORM ELECTRICAL TESTS WHEN THERE ARE SIGNS OF SHIPPING DAMAGE TO ANY PORTION OF THE OUTER ENCLOSURE (COVERS, PANELS, CONNECTORS, LEDS, ETC.).

2-5. Unpacking and Inspection

2-6. Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. Procedures for checking electrical performance are given in Section IV. If the contents are incomplete, if there is mechanical damage or defect, or if the instrument or some component fails the performance tests, notify the nearest Hewlett-Packard office. If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping materials for the carrier's inspection. The HP office will arrange for repair or replacement at HP's option without waiting for a claim settlement.

2-7. Warranty Claims

2-8. Contact the nearest HP Sales and Support Office (see list at the end of this manual) for information relative to warranty claims.

2-9. Laser Tube Shipment

NOTE

The laser tube assembly MUST be shipped in an approved HP container.

2-10. The laser tube assembly (HP Part Number 05501-60102) should only be shipped in an HP container designed for that purpose. In addition, the container must indicate that the laser tube contains magnetic material. If it is necessary to ship a laser tube, contact your nearest HP Sales and Support Office for an approved container.

2-11. Tagging for Service

2-12. If the instrument is being returned to Hewlett-Packard for service, please complete one of the blue repair tags (HP Part Number 9320-3896) located at the end of this manual and attach it to the instrument.

2-13. Packaging for Reshipment

1. Original Packaging

   a. The same containers and materials used in factory packaging can be obtained through Hewlett-Packard Sales and Support Offices listed at the rear of this manual.

   b. In any correspondence refer to the equipment by model number.

2. Other Packaging Methods

   a. If it becomes necessary to reship equipment, good commercial packing should be used. Contract packaging companies can provide dependable custom packaging on short notice. The following general instructions should be followed when repackaging with commercially available materials.

   b. If shipping to a Hewlett-Packard Support Office or Center, attach a blue tag indicating the type of service required, return address, and model number.

   c. Wrap the equipment in heavy paper or plastic.

   d. Use a strong shipping container. A double-wall carton made of 350 pound test material is adequate.

   e. Use enough shock-absorbing material (three to four inch layer) around all sides of the equipment to provide a firm cushion and prevent movement inside the container.

   f. Seal the shipping container securely.

   g. Mark the shipping container FRAGILE to assure careful handling.

2-14. INSTALLATION

2-15. The following paragraphs provide installation information for the HP 5501B Laser Head including system cabling, grounding considerations, power supply requirements, power dissipation, fusing, and mounting and fixturing.

2-16. System Cabling

2-17. The HP 5501B Laser Head is designed for use with the HP 5501A Laser Transducer System and is a direct replacement for the HP 5501A Laser Head. The HP 10778B Power and HP 10779B Reference cables (*Figures 2-1* and *2-2* respectively), are available for connecting the laser head to the laser transducer system.

2-18. The HP 10778B and 10779B cables are both 10 Metres (32.8 ft) in length.

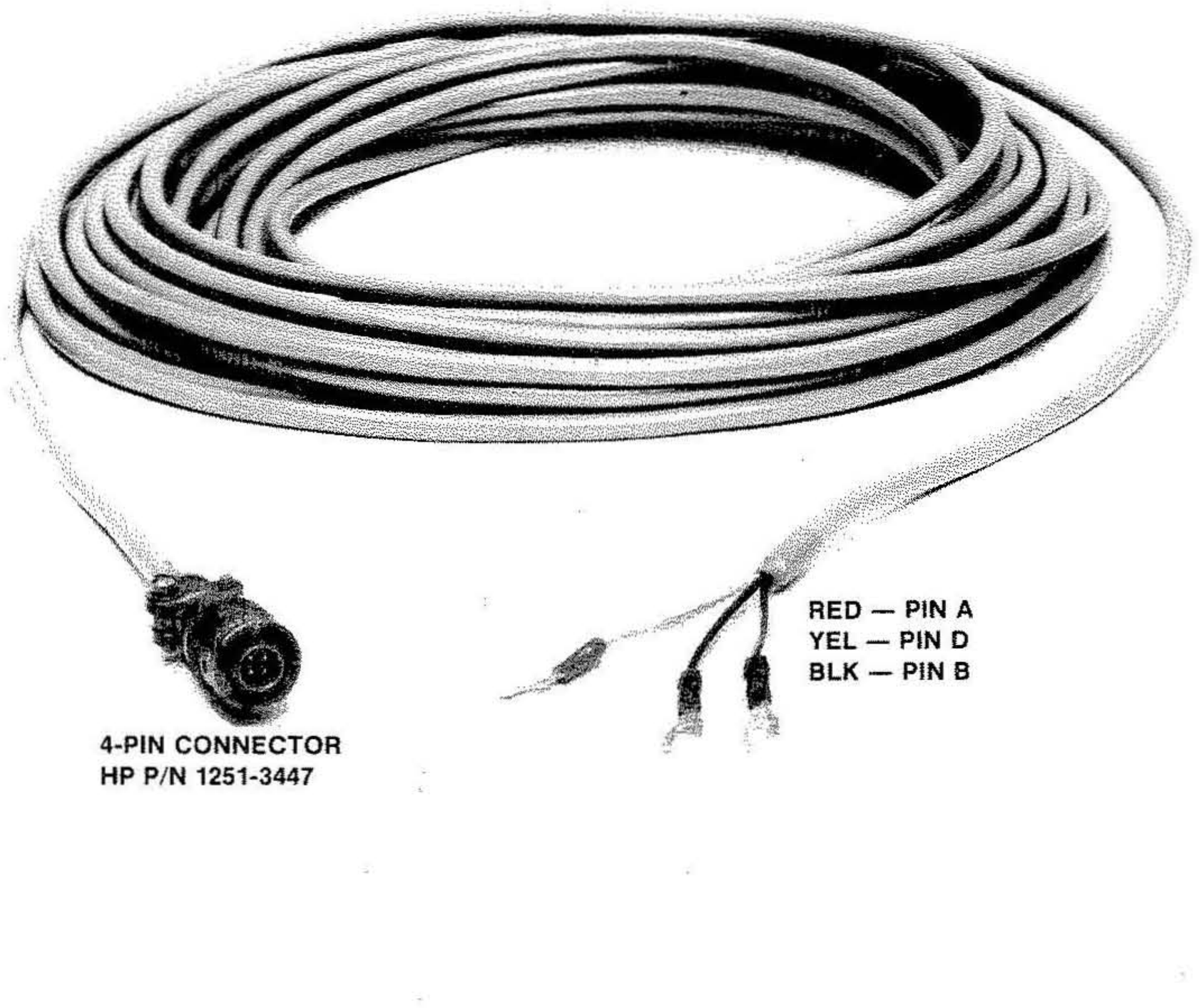


Figure 2-1. HP 10778B Power Cable

HEWLETT PACKARD

OPERATING AND SERVICE MANUAL

HP 5501B
LASER HEAD

SERIAL NUMBER PREFIX: 2632A

This manual applies directly to HP 5501B Laser Heads with serial numbers prefixed 2632A. Lower number serial prefixes are covered in Section VII while higher number serial prefixes are documented with "Manual Changes" Supplements described in Section VII.

© HEWLETT-PACKARD COMPANY 1986
5301 Stevens Creek Blvd., Santa Clara, CA 95051-7299

MANUAL PART NUMBER 05501-90035
Microfiche Part Number 05501-90036

Printed: SEPTEMBER 1986

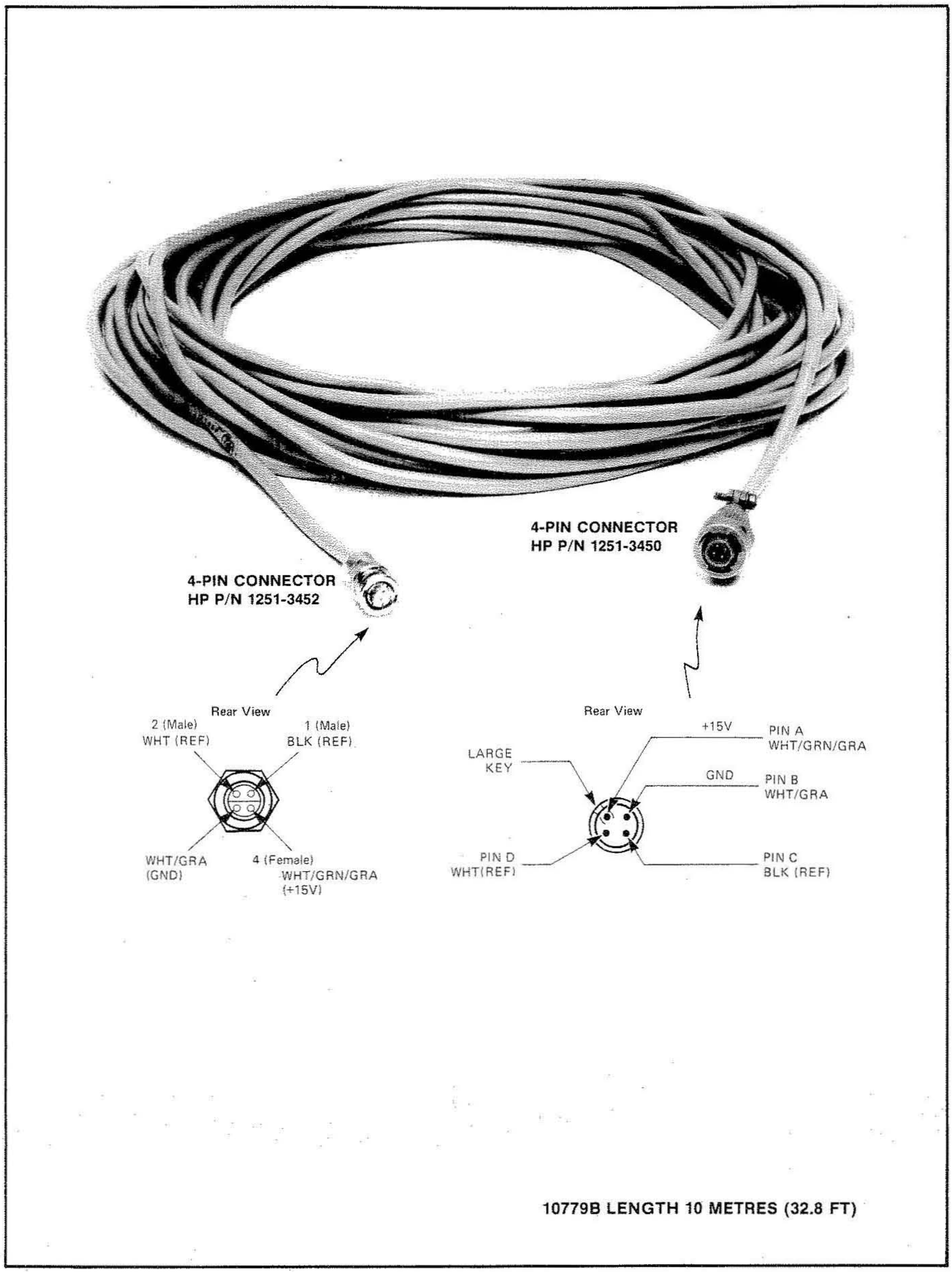


Figure 2-2. HP 10779B Reference Cable

2-19. Power and Signal Connections

2-20. The laser head rear panel contains two multi-pin connectors used for connecting HP 5501B power and signal lines to other laser transducer system components. (Refer to *Figure 2-3* for an interconnection diagram of a typical system.) *Table 2-2* lists all power and signal lines that are available at the rear-panel connectors. The laser transducer system manual gives additional system wiring information.

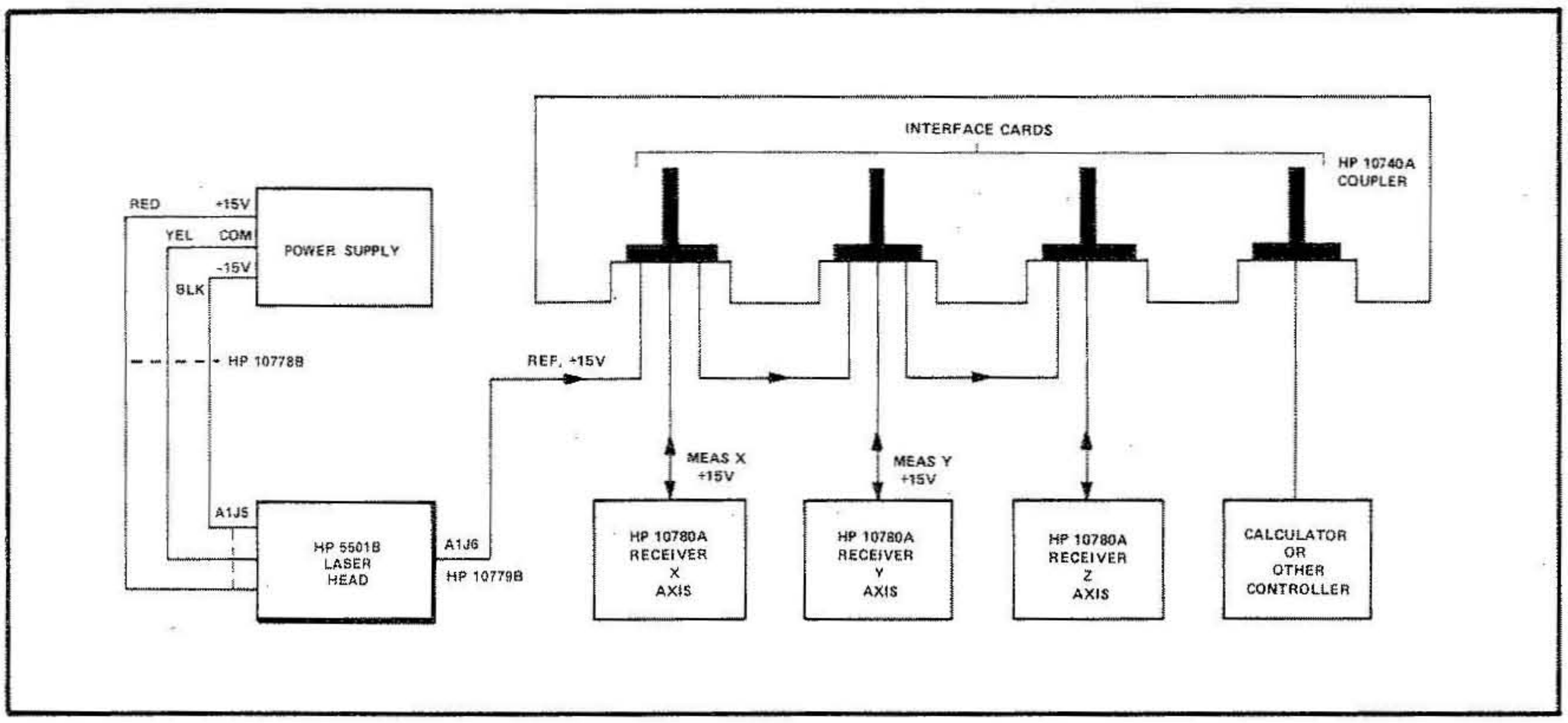
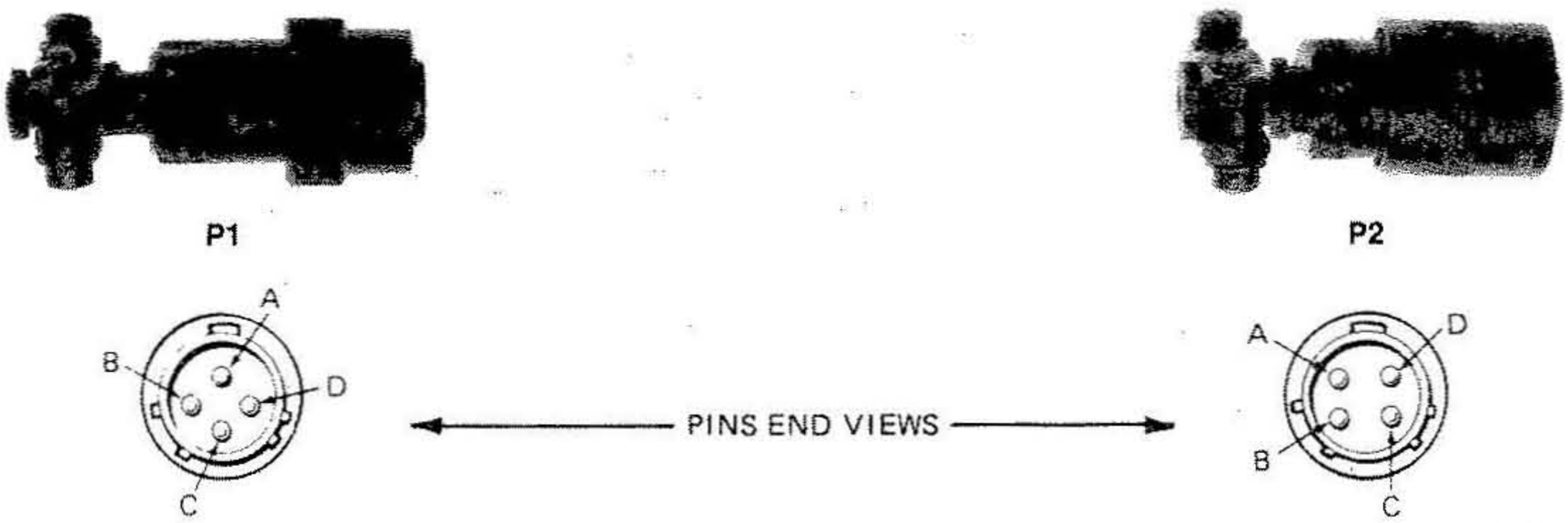


Figure 2-3. Typical Transducer System Interconnections

2-21. Cable Fabrication

2-22. Power and signal interconnecting cables of suitable length may be fabricated using the two plugs included with the laser head. *Figures 2-4* and *2-5* illustrate the physical details of the two plugs supplied and give 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.



PLUG	CABLE	DESCRIPTION
REFERENCE SIGNAL HP Part No. 1251-3450	HP 10779B or equivalent	Dual coax; two #22 power wires. Everything enclosed by a second insulated shield.
POWER HP Part No. 1251-3447	HP 10778B or equivalent	Three #20 wires

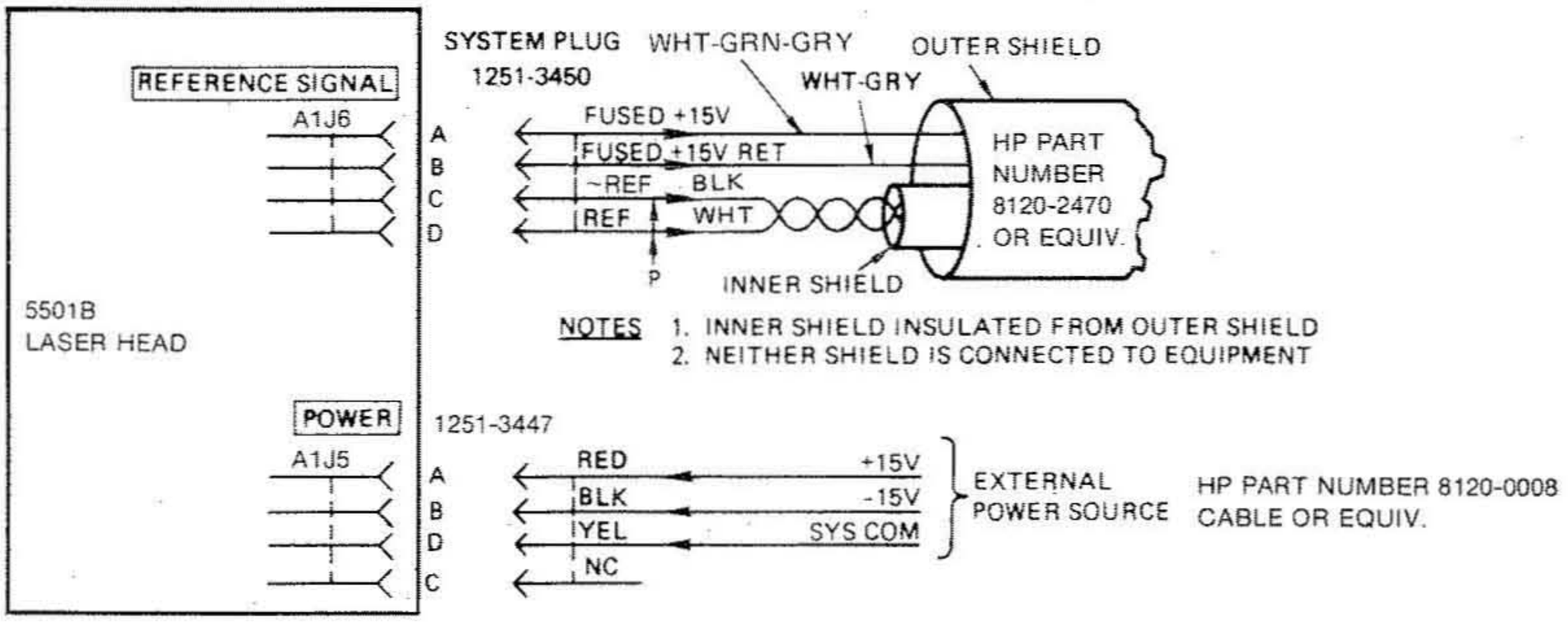
Figure 2-4. Interconnecting Plug Details

Table 2-1. Laser Head System Signal Chart

Input	Output	Signal Name	Function	Source	Destination
	A1J6-A	Fused +15V	Accessory +15V Operating Power		Accessory Equipment
	A1J6-B	Fused +15V RET	Accessory +15V Return		Accessory Equipment
	A1J6-C A1J6-D	REF ~REF	System REFerence signal, equal to the difference in frequency between laser beam components F1 and F2.		Accessory Equipment
A1J5-A		+15V	External +15V Power Input	Ext. Pwr. Sup.	
A1J5-B		-15V	External -15V Power Input	Ext. Pwr. Sup.	
	A1J5-C	+5V	+5V power test point		Accessory Equipment (test use only)
A1J5-D		GND	Power Ground	Ext. Pwr. Sup.	

CAUTION

REF AND ~REF OUTPUTS ARE CAPABLE OF DRIVING ONLY ONE UNIT.



NOTES 1. INNER SHIELD INSULATED FROM OUTER SHIELD
2. NEITHER SHIELD IS CONNECTED TO EQUIPMENT

NOTE

THE RUBBER COLLAR WHICH GOES OVER THE CABLES IS A VERY TIGHT FIT. USE SILICON GREASE TO FACILITATE INSTALLATION ON CABLE.

Figure 2-5. HP 5501B Laser Head Interconnect Wire Fabrication

CAUTION

Observe the current and grounding requirements described below.

2-23. Grounding Considerations

2-24. In order to avoid ground loops, the laser head base should be the only connection to earth ground. To accomplish this, the outputs of the ±15 Volt power supplies used to power the laser head should be floating. The +5 Volt power supply output required for either the HP 10740A-based electronics or HP 10781A Pulse Converters, should also be floating. Alternatively, any other single point earth ground connection can be used to satisfy grounding requirements.

2-25. Power Supply Requirements

2-26. *Table 2-2* lists the supply voltages, currents, and tolerances required by the HP 5501B Laser Head. Note that other components of the system also use ±15 Volts. Add these to the laser head current requirements to obtain the overall system requirements.

Table 2-2. HP 5501B Power Supply Requirements

Supply Voltage	Tolerance	Current Requirement
+15 Volts	±0.3 Volts	0.8 Amperes 3.5 Amperes peak surge for approximately 2 milliseconds at power-up
–15 Volts	±0.3 Volts	0.7 Amperes
Other Power Supply Requirements		
Line Regulation	0.01%	
Load Regulation	0.01%	
Ripple + Noise	60 millivolts peak-to-peak	
Isolated Output		
Over Voltage Protection (Recommended)		
Under Voltage Protection (current limited) (Recommended)		

2-27. Power Dissipation

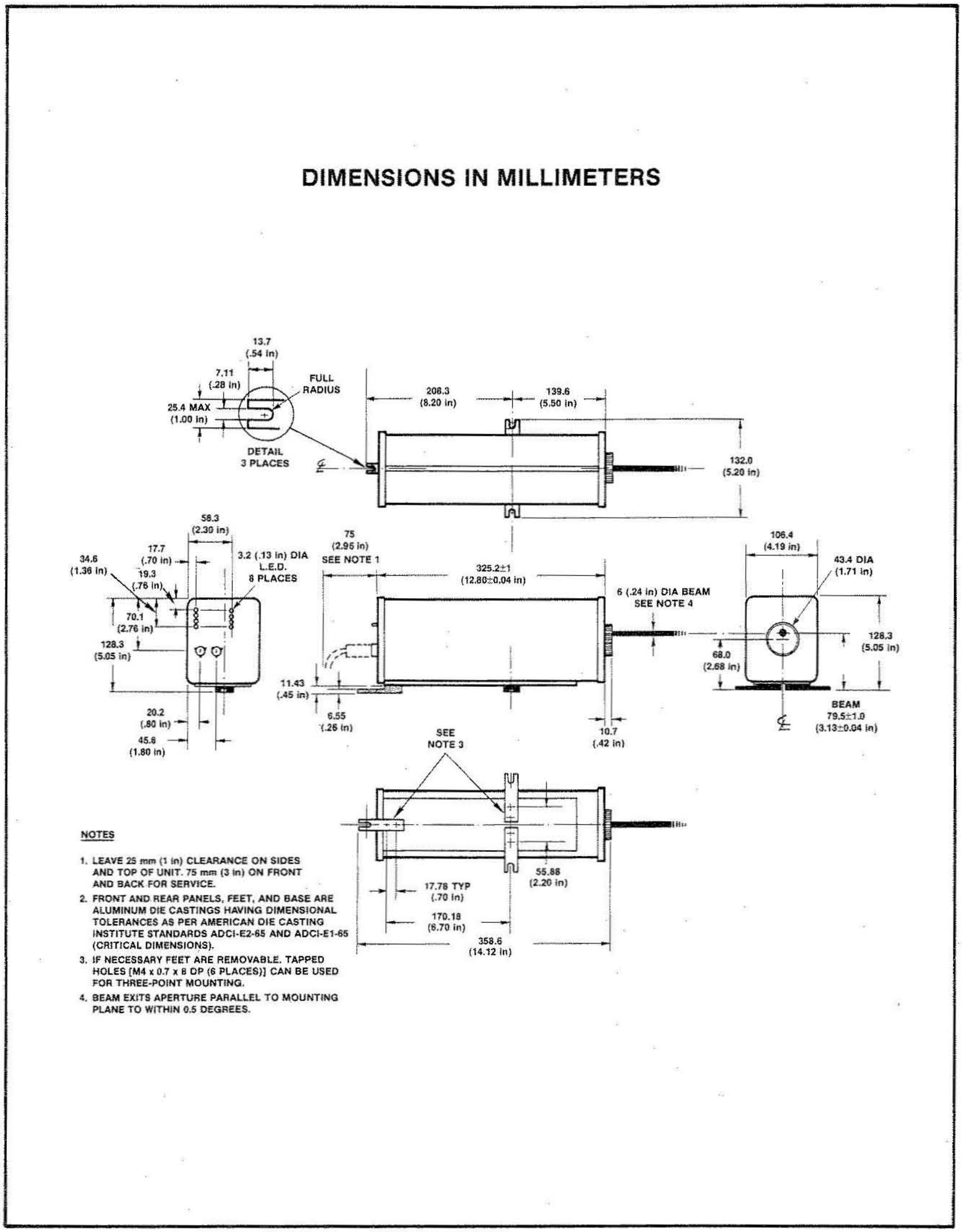
2-28. The HP 5501B dissipates approximately 21 watts during operation.

2-29. Fusing

2-30. The HP 5501B has two internal 1.5 Ampere fuses to protect the ±15V lines. Both fuses are located on the A1 Connector Board and are accessible by removing the left and right covers of the laser head.

2-31. Dimensions

2-32. *Figure* 2-6 shows the HP 5501B Laser Head dimensions.



NOTES

1. LEAVE 25 mm (1 in) CLEARANCE ON SIDES AND TOP OF UNIT. 75 mm (3 in) ON FRONT AND BACK FOR SERVICE.
2. FRONT AND REAR PANELS, FEET, AND BASE ARE ALUMINUM DIE CASTINGS HAVING DIMENSIONAL TOLERANCES AS PER AMERICAN DIE CASTING INSTITUTE STANDARDS ADCI-E2-65 AND ADCI-E1-65 (CRITICAL DIMENSIONS).
3. IF NECESSARY FEET ARE REMOVABLE. TAPPED HOLES [M4 x 0.7 x 8 DP (6 PLACES)] CAN BE USED FOR THREE-POINT MOUNTING.
4. BEAM EXITS APERTURE PARALLEL TO MOUNTING PLANE TO WITHIN 0.5 DEGREES.

Figure 2-6. Mounting Details and Physical Characteristics

2-33. Mounting and Fixturing

2-34. Heat Flow Considerations. The laser tuning technique of the HP 5501B requires efficient heat exchange with the ambient. Heat flow is primarily through the base of the laser head assembly to the surrounding environment. An external heat sink is not required but free air circulation around the laser head will ensure good performance.

2-35. In cases where vertical mounting of the HP 5501B is desired, care should be taken to minimize laser beam disturbances due to air turbulence caused by the HP 5501B heat exchange. It is most important to prevent differential effects which can occur due to turbulence in the beam path between a polarizing beam splitter and a retroreflector or plane mirror. Differential turbulence causes fluctuations in the optical path length difference that is being measured. Both differential and common mode turbulence can cause fluctuations in alignment by bending the light beam. Common mode turbulence is turbulence that is present in the beam path between the HP 5501B and a polarizing beam splitter. In either case some amount of noise can be present in the interferometer measurement due to turbulence.

2-36. If interferometer components (optics) are mounted very close to the HP 5501B such that the operating temperature of the optics are affected, it is recommended that alignment and operation of the interferometer be performed after the HP 5501B has been running for a sufficient period of time to allow thermal equilibrium to be established. In well ventilated installations, one hour of running time should be sufficient. When enclosures are used and the ambient temperature is changed by several degrees (centigrade) by the HP 5501B, thermal equilibrium is not established as quickly and the laser should be run for a longer period of time.

2-37. Mounting. Mount the laser head by means of the three slotted tabs that extend outward from the bottom edges of the unit (refer to *Figure 2-1* for exact locations and dimensions). The mounting tabs may be secured to the work surface in any fashion that will not transmit stresses to the main enclosure and, consequently, to the laser tube or printed-circuit assemblies. If necessary, the tabs can be removed and the unit mounted on a flat surface with 4 mm machine screws; use the same tapped holes that are used to secure the tabs, ensuring that the mounting method does not stress the base casting and that the screws do not penetrate the base casting more than 7 mm.

2-38. Beam Alignment. Rotate the turret at the front of the laser head so that the beam exits through the large aperture. DO NOT STARE DIRECTLY INTO THE BEAM APERTURE. Presence of the red laser beam can be verified by placing a piece of paper in the beam path and observing the beam reflection on the paper. The components of the laser transducer system must now be aligned so that the laser beam strikes the photodetector of the receiver (HP Model 10780A). Refer to the HP 10780A Receiver documentation and the Laser Transducer System Manual for further alignment information.

2-39. Pointing Stability. The angle at which the laser beam exits the HP 5501B can change from turn-on through the time when the HP 5501B and its surroundings reach thermal equilibrium.

2-40. The HP 5501B should not be exposed to ambient temperature changes greater than ±5° Centigrade during operation to keep pointing stability variations to a minimum during interferometer measurements.

2-41. OPERATIONAL VERIFICATION CHECK

2-42. Refer to Section IV, Performance Tests.

2-43. OPERATING ENVIRONMENT

Temperature (Operating): 0 to 40°C (32 to 104°F)

Relative Humidity (Operating): 0 to 95% Non-condensing

Vibration: The HP 5501B Laser Head has been tested to withstand 0.25 mm (0.015 inch) peak-to-peak excursion at 15 to 55 Hz for 15 minutes.

Shock: 30 g shock for 11 milliseconds on each of the orthogonal axes.

2-44. STORAGE

2-45. Environment

2-46. The instrument can be stored or shipped in environments within the following limits:

Temperature	−40 to 75°C (−40 to 167°F)
Altitude	15,240 metres (50,000 feet)

2-47. The instrument should also be protected from temperature extremes which could cause condensation within the instrument.

SECTION III
OPERATION

3-1. INTRODUCTION

3-2. This section provides operating information for the HP 5501B Laser Head. Included are operation features of the instrument's front and rear panel controls and connectors. Also provided is supplemental operating information for HP 5501A Laser Transducer Systems equipped with HP 5501B Laser Heads.

3-3. Installation instructions for the HP 5501B Laser Head are given in Section II of this manual.

3-4. Power Application

3-5. The laser head installed is activated when +15 Vdc and -15 Vdc are applied to the unit. ±15 Volts is applied by connecting the power cable (HP 10778B or fabricated equivalent) to the rear panel POWER connector (A1J5). Ensure that the power source is adjusted to conform to the following requirements before connecting it to the HP 5501B:

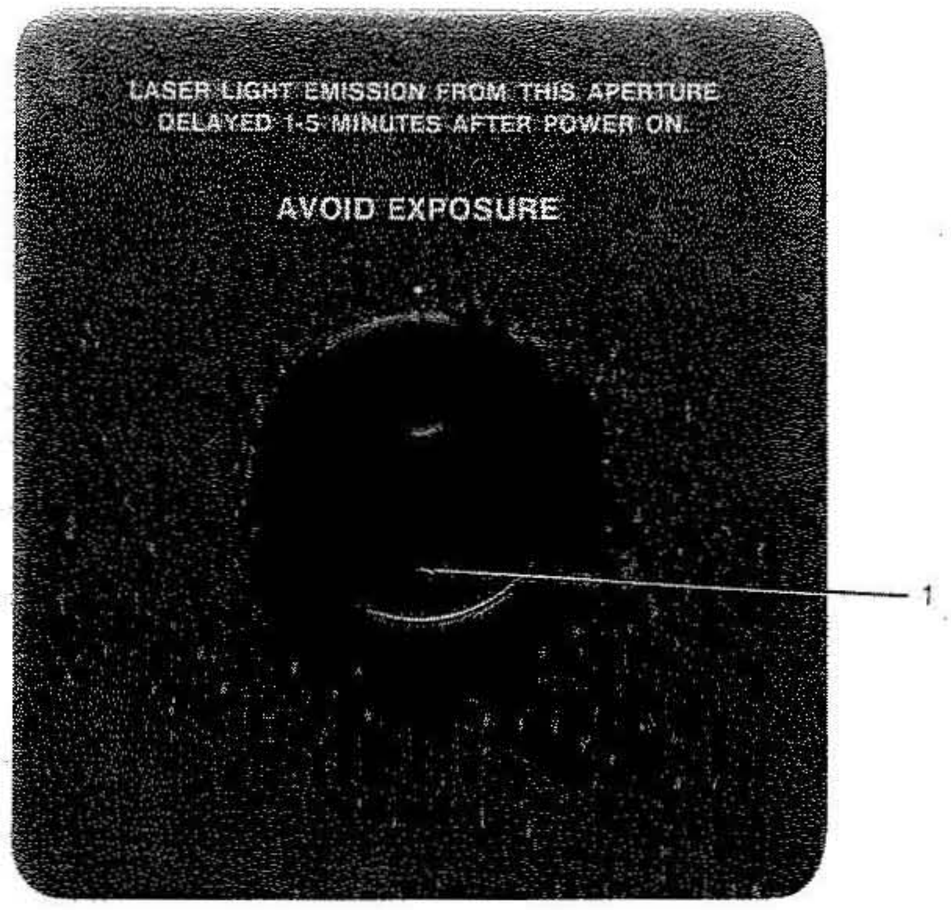
Measured Voltage
+15V ± 0.3 Vdc
-15V ± 0.3 Vdc

NOTE

REPETITIVE POWER-UP CYCLING SHOULD BE AVOIDED. THIS WILL REDUCE THE EXPECTED LIFE OF THE HIGH VOLTAGE COMPONENTS.

3-6. HP 5501B LASER HEAD FRONT PANEL CONTROLS

3-7. *Figure 3-1* 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 at each of the connectors.



1. Shutter. The shutter, also known as the aperture ring, allows for three aperture settings: open, reduced, and closed. The open aperture position is used during normal operation and the reduced aperture is used during alignment of measurement axes.

Figure 3-1. HP 5501B Front Panel Controls

3-8. HP 5501B LASER HEAD REAR PANEL INDICATORS AND CONNECTORS

NOTE

A TILDE ("~") PRECEDING A SIGNAL NAME INDICATES NEGATIVE-TRUE LOGIC LEVELS.

3-9. Following are descriptions of the HP 5501B rear panel features shown in *Figure 3-2*.

2.	+15V SUPPLY UNBALANCE	RED LED	LED lights if the ±15V input voltages are unbalanced in the positive direction by one Volt or more. For example: a. When the positive supply measures +16 Volts (or more positive) and the negative supply remains at –15 Volts. b. When the positive supply measures +15 Volts and the negative supply is –14 Volts (or less negative).
3.	–15V SUPPLY UNBALANCE	RED LED	LED lights if the ±15V input voltages are unbalanced in the negative direction by one Volt or more. For For example: a. When the negative supply measures –16 Volts (or more negative) and the positive supply remains at +15 Volts. b. When the negative supply measures –15 Volts and the positive supply is +14 Volts (or less positive).

Both ±15V SUPPLY UNBALANCE LEDs light if the TEST-NORM switch (A1S2) is in NORM position with cover off or in TEST with cover on.

Figure 3-2. HP 5501B Rear Panel Connectors and Indicators

ELECTRICAL SAFETY CONSIDERATIONS

GENERAL

The product and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

This product is a Safety Class I instrument (provided with a protective earth terminal).

BEFORE APPLYING POWER

Verify that the product is set to match the available line voltage and the correct fuse is installed. Refer to Section II, Installation.

SAFETY EARTH GROUND

An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set.

SAFETY SYMBOLS

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

Indicates hazardous voltages.

Indicates earth (ground) terminal.

WARNING

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

CAUTION

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

WARNING

Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury. (Grounding one conductor of a two conductor outlet is not sufficient protection).

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

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

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

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

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

For continued protection against the fire hazard, replace the line fuse(s) only with 125V fuse(s) of the same current rating and type (for example, normal blow, time delay, etc.). Do not use repaired fuses or short circuited fuseholders.

From 1.2 kilovolts to 12 kilovolts dc is present on the anode of the laser tube in the 5501B. Exercise extreme caution when working inside the instrument. The high voltage could cause serious personal injury if contacted. Any adjustments performed should be by service trained personnel only.

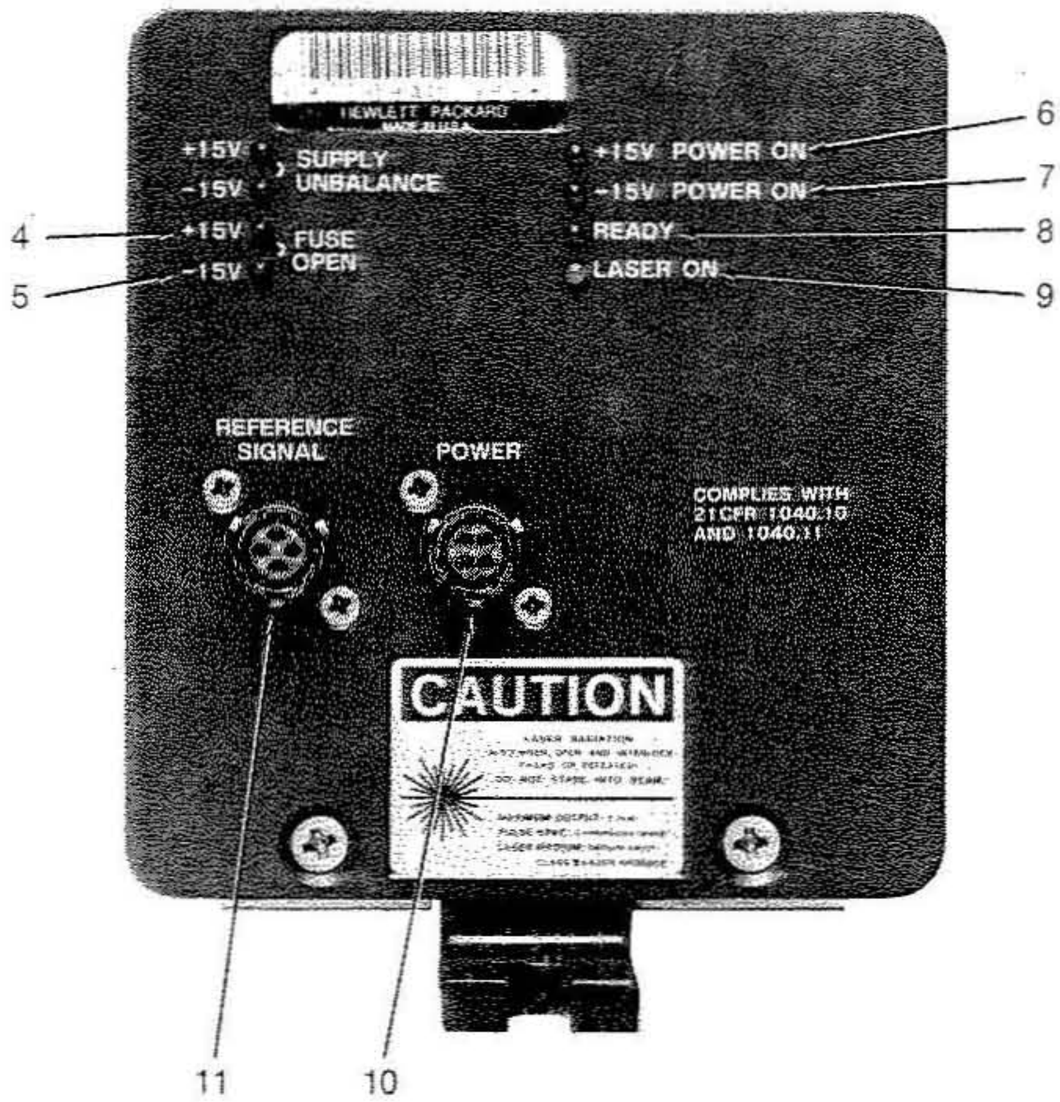
LASER HEAD SAFETY CONSIDERATIONS

CAUTION

LASER RADIATION IS EMITTED FROM THE APERTURE ON THE 5501B LASER HEAD AS ILLUSTRATED ON THE FOLLOWING PAGE. DO NOT STARE INTO BEAM. THIS PRODUCT IS A CLASS II LASER PRODUCT CONFORMING TO U.S. NATIONAL CENTER FOR DEVICES AND RADIOLOGICAL HEALTH REGULATIONS 21 CFR 1040.10 AND 1040.11. THE MAXIMUM RADIANT POWER OUTPUT IS 1 MILLIWATT, THE PULSE SPECIFICATION IS CONTINUOUS WAVE, THE LASER MEDIUM IS HELIUM-NEON, AND THE WAVELENGTH IS 632.991 NANOMETRES.

LASER RADIATION IS ACCESSIBLE WHEN THE 5501B COVERS ARE REMOVED AND THE TEST-NORM SWITCH, A1S2, IS IN THE TEST POSITION.

USE OF CONTROLS OR ADJUSTMENTS OR PERFORMANCE OF PROCEDURES OTHER THAN THOSE SPECIFIED HEREIN MAY RESULT IN HAZARDOUS RADIATION EXPOSURE.



4.	+15V FUSE OPEN	RED LED	LED lights if +15 Vdc fuse opens.
5.	–15V FUSE OPEN	RED LED	LED lights if –15 Vdc fuse opens.
6.	+15V POWER ON	GREEN LED	LED lights when +15 Vdc power is applied to the HP 5501B.
7.	–15V POWER ON	GREEN LED	LED lights when –15 Vdc power is applied to the HP 5501B.
8.	READY	GREEN LED	LED remains off while heating rod to normal operating temperature. At this point the READY LED begins to flash and continues to do so until the laser head reaches operating temperature. When the laser head is ready for use, the READY LED stays on steady (i.e., Laser has achieved lock and is now generating a stable reference signal).
9.	LASER ON	AMBER LED	LED lights to indicate that the high voltage power supply (HVPS) is on and that laser light is being emitted.
10.	POWER	CONNECTOR (A1J5)	Provides connection point for external power supply input (i.e.,10778B Power Cable connector).
11.	REFERENCE	CONNECTOR (A1J6)	Allows the reference signals (REF and ~REF) and +15 power to be connected to other system components (i.e., 10779B Reference Cable connector).

Figure 3-2. HP 5501B Rear Panel Connectors and Indicators (Continued)

3-10. OPERATING MODES

3-11. When power is applied to the HP 5501B, an internal state machine resets the laser head to a warmup mode. This mode is used to establish the initial operating temperature of a glass rod that controls the laser cavity length. When this temperature is reached, the state machine switches to an optical tuning mode. Upon successfully switching from warmup to optical mode, the laser head enables the REFerence signal and lights a READY LED indicator on the rear panel to indicate that the laser head is ready for use. The following table will give the proper operating sequence for the HP 5501B rear panel LEDs from initial power-up (warmup mode) to when the laser is ready to use (optical mode).

Table 3-1. Proper 5501B Rear Panel LED Power-up Sequence

LEDs	OPERATING MODES*			
	WARMUP		OPTICAL	
	PREHEAT	HEATER QUALIFIED	LOCKING	LOCKED
	←3-6 Min**→	←100 sec→	←50 sec→	Continuous Use
+15V SUPPLY UNBALANCE (Red LED)	OFF	OFF	OFF	OFF
-15V SUPPLY UNBALANCE (Red LED)	OFF	OFF	OFF	OFF
+15V FUSE OPEN (Red LED)	OFF	OFF	OFF	OFF
-15V FUSE OPEN (Red LED)	OFF	OFF	OFF	OFF
+15V POWER ON (Green LED)	ON	ON	ON	ON
-15V POWER ON (Green LED)	ON	ON	ON	ON
READY (Green LED)	OFF	FLASHING (2 Hz Rate)	FLASHING (2 Hz Rate)	ON
LASER ON (Amber LED)	OFF	OFF	ON	ON
	↑ ±15V Applied to Laser Head. Heater Full On	↑ Glass Rod Reaches Temperature (Begin 100 sec Stabilization period)	↑ HVPS Turns On Laser Beam On	↑ Reference Signal Present Laser Now Ready For Use

*Time intervals reflect that laser tube was cold at turn-on; shorter times can be expected if tube is warm at turn-on.

**Refer to paragraph 8-100 for further explanation of laser operating modes.

3-12. Warmup Time Operating Notes

- Allow a full 10 minute warmup period for the HP 5501B.
- Warmup completion is indicated by the READY LED on the HP 5501B rear panel.
- If warmup is not complete after 10 minutes, a failure may be indicated.
- If the READY indication at the laser head is not convenient to use because of the mounting scheme, try the alternate monitoring suggestions that follow.

3-13. HP 10740A Coupler Based Systems — Manual Monitoring

- The REFerence and MEASurement signals terminate at either the HP 10760A Counter Card or the HP 10764A/B/C Fast Pulse Converter Card.
- Each of these cards includes an LED to monitor the presence of the REFerence and MEASurement signals.
- The REFERENCE LED will be extinguished until the HP 5501B is ready for use.

HOWEVER, FOR SYSTEMS WITH MULTIPLE HP 10760A CARDS

- Every ODD HP 10760A that uses the replicated REF and ~REF will have their REFERENCE LED lit during the laser head warmup period. (This is due to inversion in the replication circuitry.) Note that this does not apply to multiple HP 10764A/B/C card installations.
- The MEASUREMENT LED will momentarily light several times during the laser head warmup period provided that the HP 10780A Receiver is aligned properly with the beam. (This occurs because the laser periodically produces functional optical frequencies during warmup.)

NOTE

The above monitoring scheme assumes no reversal of the REF and ~REF lines in the cabling.

3-14. Systems with HP 10745A or HP 10746A Cards — Automatic Monitoring

3-15. Systems with these cards can use the system computer and software to monitor the laser head warmup. Before describing the software, it will be helpful to examine some background information on the HP 10740A Coupler, HP 10745A HP-IB Interface, and HP 10746A Binary Interface.

3-16. HP 10740A Coupler — Error Signal Information

- Four error signal lines are provided on the HP 10740A Backplane:
  - REFERENCE ERROR BIT
  - MEASUREMENT ERROR BIT
  - V.O.L. ERROR BIT
  - OVFL BIT

3-17. HP 10746A Error Signal Processing

- If any of the HP 10740A backplane error bits are true, the four most significant bits of the most significant word in a data transfer from the HP 10746A to the host computer will be all ones. These four bits are normally the decimal point bits.
- Errors are not the only condition that can set these bits to all ones. When the difference output of an addressed HP 10762A is within tolerance, these bits will also be set.
- After detecting all ones, the host computer must check the next four MSB's to differentiate between an error condition and the within tolerance condition.
- If the tolerance condition is true, these next four bits will also be all ones. Otherwise, each of these bits corresponds to one of the backplane error bits.

3-18. HP 10745A Background Information

- When a backplane error bit is true, the HP 10745A asserts SRQ. The STATUS BYTE of the HP 10745A can be read to determine the source of SRQ. In the STATUS BYTE, bit 0 corresponds to the REFERENCE ERROR-BIT.

3-19. Program Modifications

3-20. To monitor warmup time, the following program modifications can be added to the example programs contained in *Tables 4-12* and *4-13* of the HP 5501A Laser Transducer Operating and Service Manual, HP Part Number 05501-90028. If desired, some form of time-out algorithm can be added to check if the HP 5501B warms up within 10 minutes.

3-21. *Table 3-1* shows the program steps used to modify *Table 4-12* in the HP 5501A System Manual. The program uses the HP 10760A x-axis card to monitor the laser warmup.

3-22. *Table 3-2* shows the program steps used to modify *Table 4-13* in the System Manual. The program is for a two axis system with the HP HP 10746A in 16-bit mode and using positive-true logic. The program uses the x-axis card to monitor the laser warmup.

3-23. *Tables 3-3, 3-4,* and *3-5* are complete listings of the modified versions of *Tables 4-12* and *4-13* found in the HP 5501A System Manual.

Table 3-1. Program Modifications for Table 4-12 in the HP 5501A System Manual

`0: ssb "warmup"`	**Branch to subroutine to monitor laser status**
`38: "warmup":clr 7;rem 7`	**Send Device Clear; Send Remote Enable**
`39: wrt 709,"000 %"`	**Send 10740A Backplane Reset, preset x-axis counter and select normal resolution**
`40: wrt 709,"1%2 %30"`	**Transfer x-axis counter (10760A) contents, including error bits, to 10745A**
`41: if rds(7)<12 8;ret`	**If SRQ false; REFERENCE ERROR BIT must be false; laser ready**
`42: rds(709)→B`	**Read 10745A STATUS BYTE to verify that it is asserting SRQ**
`43: if B<64;sto "bus error"`	**If 10745A not asserting SRQ; alert operator**
`44: B-112→B`	
`45: if B>=8;B- 8→B`	**Isolate REFERENCE ERROR BIT**
`46: if B>=4;B- 4→B` `47: if B>=2;B- 2→B`	
`48: if B=1 dsp "LASER NOT READ Y"`	**If true; 5517A not READY**
`49: if B=1;sto - 11`	**Try again**
`50: ssb "check"`	**Otherwise, use subroutine "check" to identify remaining error**
`51: ret`	**Return to step one if only OVF ERROR true**
`52: "bus error":`	**Alert operator that SRQ asserted by other device**
`53: prt "SRQ ASSERTED BUT 10745A STATUS BYTE•BIT6 CLEAR "` `54: stp`	
`55: sto 0`	**Return to step 0 if CONTINUE pressed**
`56: end`	

Table 3-2. Program Modifications for Table 4-13 in the HP 5501A System Manual

`0: asb "warmup"`	**Branch to warmup subroutine monitor laser status**
`66: "warmup":wtb 2,0,0,0`	**System reset — 10746A 16 bit mode**
`67: wtb 2,1,130, 3`	**1 = simultaneous sample 130 = transfer X Comparator Counter contents to 10746A 3 = prepare for output to host computer**
`68: rdb(2)→B;if B<0;65536+B→B`	**Read first word**
`69: if B<61440; ret`	**If 4 MSB's are clear, 5517A is READY**

`70: int(B/256)- 240→B;15-B→B`
`71: if B>=8;B- 8→B`
`72: if B>=4;B- 4→B`
	Otherwise isolate $\overline{\text{REFERENCE ERROR BIT}}$

`73: if B>=2;dsp "LASER NOT READ Y"`	
`74: if B>=2;sto -8`	**If $\overline{\text{REFERENCE ERROR BIT}}$ true, try again**
`75: wtb 2,1,130, 3`	**Abort transfer and set-up new transfer in order to read first word again.**
`76: rdb(2)→B;if B<0;65536+B→B`	**Use subroutine "er" to identify remaining error**
`77: asb "er"`	
`78: ret`	**Return to program step 1 if only $\overline{\text{OVL ERROR BIT}}$ true**
`79: end`	

Table 3-3. Modified HP 10745A HP-IB Interface Program
(Replaces Table 4-12 in the HP 5501A System Manual)

```
0: gsb "warmup"
1: wrt 709,"006X"
2: wrt 709,"2V30"
3: red 709,C
4: 0)E
5: "loop":E+1)E;if E=10;gto -3
6: wrt 709,"102X30"
7: red 709,X
8: if rds(7)<128;gto +2
9: 0)A;gsb "status"
10: (X-16)*6.23023e-6+C)X
11: fmt 1,f12.6
12: dsp X
13: gto "loop"
14: "status":rds(709))B
15: if B>=64;gsb "check"
16: wrt 709,"0P"
17: ret
18: "check":B-112)B
19: if B>=8;gsb "ovf"
20: if B>=4;prt "VOL OUT OF RANGE";B-4)B;0)D
21: if B>=2;prt "MEAS ERROR";B-2)B;0)D
22: if B=1;prt "REF ERROR";0)D
23: if D=1;ret
24: if A=0;prt "X-AXIS ERROR"
25: if A=1;prt "Y-AXIS ERROR"
26: dsp "GO TO GAGE";stp
27: gto 0
28: "ovf":B-8)B;1)D
29: if A=0;X-2^28/10)X
30: if A=1;Y-2^28)Y
31: ret
32: "warmup":clr 7;rem 7
33: wrt 709,"000X"
34: wrt 709,"1X2X30"
35: if rds(7)<128;ret
36: rds(709))B
37: if B<64;gto "bus error"
38: B-112)B
39: if B>=8;B-8)B
40: if B>=4;B-4)B
41: if B>=2;B-2)B
42: if B=1;dsp "LASER NOT READY"
43: if B=1;gto -11
44: gsb "check"
45: ret
46: "bus error":
47: prt "SRQ ASSERTED BUT 10745A STATUS BYTE,BIT6 CLEAR"
48: stp
49: gto 0
50: end
```

Table 3-4. Modified HP 10746A Binary Interface Program
(Replaces Table 4-13 in the HP 5501A System Manual)

```
0: gsb "warmup"
1: wtb 2,0,0,0,98,3
2: gsb "in"
3: B)C
4: ent "X TOLERANCE IN MICRONS?",r1
5: ent "Y TOLERANCE IN MICRONS?",r2
6: "newdest":0)X;ent "X DESTINATION IN MM?",X
7: 0)Y;ent "Y DESTINATION IN MM?",Y
8: "comp":wtb 2,98,3
9: gsb "in"
10: B)C
11: X)A;gsb "cnv"
12: A)X
13: Y)A;gsb "cnv"
14: A)Y
15: int(r1/1.58248e-1)+2^28+X)A
16: gsb "out"
17: wtb 2,131
18: int(r2/1.58248e-1)+2^28+Y)A
19: gsb "out"
20: wtb 2,147
21: "newsample":wtb 2,1,130,3
22: 0)F
23: gsb "in"
24: B)r3
25: wtb 2,146,3
26: 1)F
27: gsb "in"
28: B)r4
29: fmt 1,2f10.0,f10.7
30: wrt .1,r3-160,r4-160,C
31: if abs(X-r3)<=r1/(.158*C) and abs(Y-r4)<=r2/(.158*C);gto "newdest"
32: gto "newsample"
33: "in":rdb(2)>B;if B<0;65536+B)B
34: if B>=61440;gto "er"
35: rdb(2)>G;if G<0;65536+G)G
36: int(B/4096))D
37: B-4096*D)B
38: (65536*B+G)*tn^(2-D))B;ret
39: "cnv":A/(1.58248e-4*C)+160)A;ret
40: "out":wtb 2,4
41: int(A/65536))B;if B>32767;B-65536)B
42: wtb 2,B
43: A-65536*int(A/65536))B;if B>32767;B-65536)B
44: wtb 2,B
45: ret
46: "er":int(B/256)-240)B;15-B)B
47: if B>=8;prt "vel error";B-8)B;0)D
48: if B>=4;B-4)B;1)D
49: if B>=2;prt "ref error";0)D
50: if B=1;prt "meas error";0)D
51: if D=0;gto "prterr"
52: rdb(2))B
```

Table 3-4. Modified HP 10746A Binary Interface Program
(Replaces Table 4-13 n the HP 5501A System Manual) (Continued)

```
53: wtb 2,240,3
54: rdb(2)>B;if B<0;65536+B>B
55: rdb(2)>G;if G<0;65536+G>G
56: int(B/4096)>D
57: B-4096*D>B
58: (65536*B+G)*tn^(2-D)>B
59: if F=0 and B-160#0;B-2^28>B
60: if F=1 and B-160#0;B-2^28>B
61: ret
62: "prterr":if F=0;prt "X-AXIS ERROR"
63: if F=1;prt "Y-AXIS ERROR"
64: dsp "GO TO GAGE";stp
65: gto 0
66: "warmup":wtb 2,0,0,0
67: wtb 2,1,130,3
68: rdb(2)>B;if B<0;65536+B>B
69: if B<61440;ret
70: int(B/256)-240>B;15-B>B
71: if B>=8;B-8>B
72: if B>=4;B-4>B
73: if B>=2;dsp "LASER NOT READY"
74: if B>=2;gto -8
75: wtb 2,1,130,3
76: rdb(2)>B;if B<0;65536+B>B
77: gsb "er"
78: ret
79: end
```

SECTION IV
PERFORMANCE TESTS

4-1. INTRODUCTION

4-2. This section contains a performance test for the HP 5501B Laser Head. A test record is included to record test results for future comparison.

4-3. RECOMMENDED TEST EQUIPMENT

4-4. Test equipment requirements are included in the following procedure. Detailed critical specifications for the required test equipment are contained in *Table 1-2,* Recommended Test Equipment. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended model(s).

4-5. TEST RECORD

4-6. Results of the performance test may be tabulated on the test record at the end of these procedures.

4-7. HP 5501B PERFORMANCE TEST

4-8. The HP 5501B performance test consists of measuring the 5501B input voltages and laser power output.

4-9. Input Voltage Check

4-10. Check the 5501B 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
A1J5 (A)	+15 ±0.3 Vdc
A1J5 (B)	-15 ±0.3 Vdc

LASER HEAD SAFETY LABELS

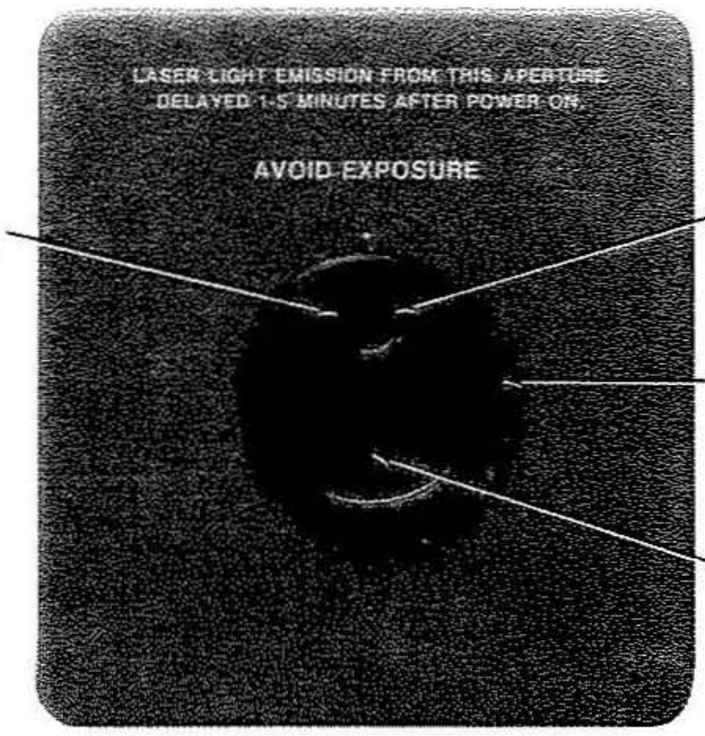
CAUTION

LASER RADIATION
(ALSO WHEN OPEN AND INTERLOCK
FAILED OR DEFEATED)
DO NOT STARE INTO BEAM

MAXIMUM OUTPUT: 1 mw
PULSE SPEC: continuous wave
LASER MEDIUM: helium neon
CLASS II LASER PRODUCT

CAUTION

Laser radiation present when exit port open and interlock failed or defeated. DO NOT STARE INTO BEAM.



4-11. Laser Power Output Test

4-12. Test Equipment Required. The following test equipment is required to test the laser output power.

Laser Power Meter, United Detector Technology (Model No. 351L)

4-13. Procedure

a. Connect the HP 5501B to the HP 5501A system (or any suitable dual DC voltage power supply such as the HP 6255A) using HP 10778B Power Cable as shown in *Figure 4-1.*

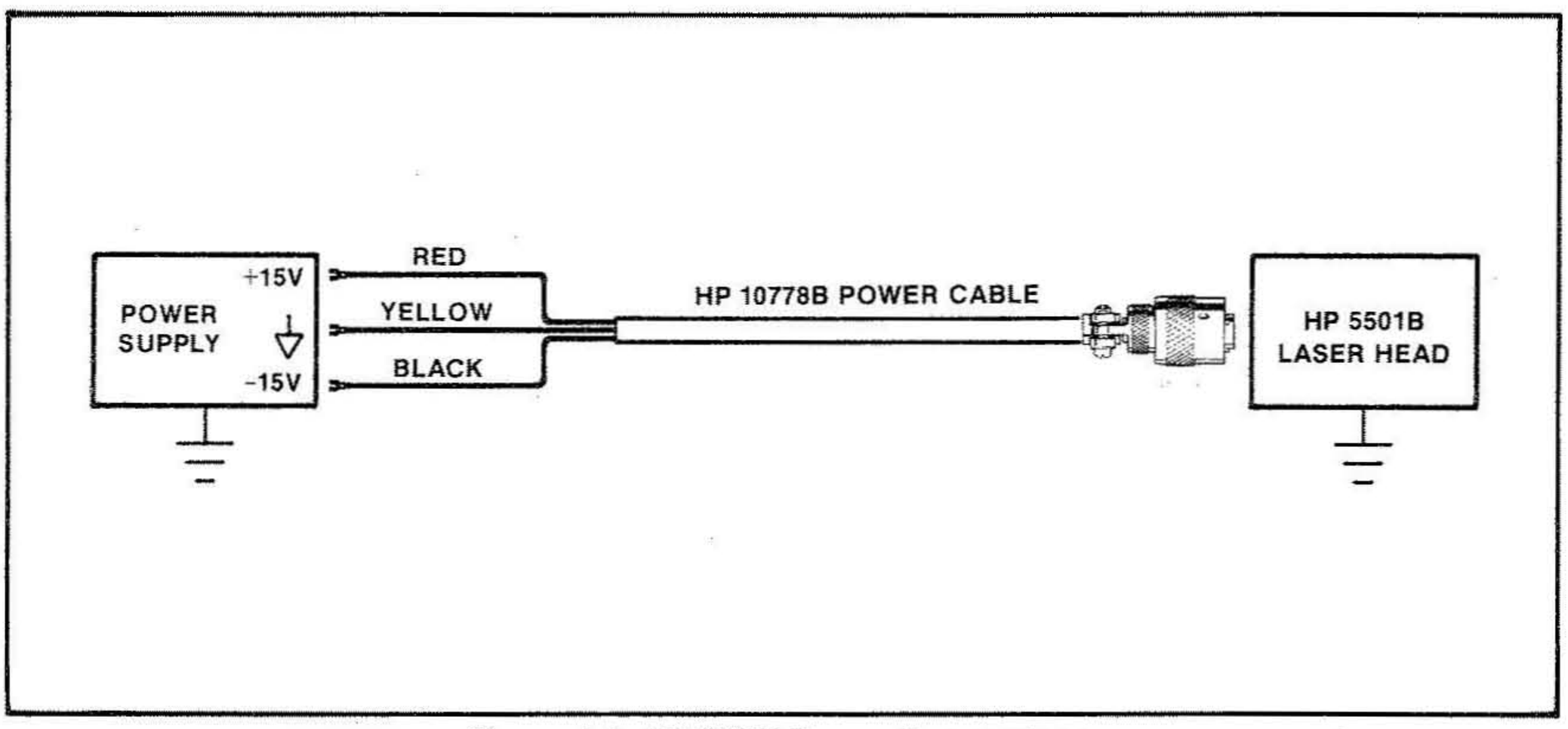


Figure 4-1. HP 5501B Power Connections

b. On the HP 5501B, set the exit shutter of the turret assembly to its open aperture position.

c. Turn the ±15 Volt power supply on and wait until the READY indicator is on, not blinking. This should occur less than 10 minutes after power is applied.

d. Using the Laser Power Meter, align the power meter detector for maximum reading.

NOTE

Laser beam must fall totally within the active region of the power meter's detector.

e. If the laser power output is less than 120 microwatts, perform the laser tube current adjustment procedure in Section V.

Page _____ of _____

TEST RECORD CARD

Description	Date Measured	Actual Reading	Limits
Laser Power Output Test	_____	_____ μW	>120 μW
Voltage Input Check			
+15V	_____	_____ V	+15 ±0.3 Vdc
-15V	_____	_____ V	-15 ±0.3 Vdc
Laser Power Output Test	_____	_____ μW	>120 μW
Voltage Input Check			
+15V	_____	_____ V	+15 ±0.3 Vdc
-15V	_____	_____ V	-15 ±0.3 Vdc
Laser Power Output Test	_____	_____ μW	>120 μW
Voltage Input Check			
+15V	_____	_____ V	+15 ±0.3 Vdc
-15V	_____	_____ V	-15 ±0.3 Vdc
Laser Power Output Test	_____	_____ μW	>120 μW
Voltage Input Check			
+15V	_____	_____ V	+15 ±0.3 Vdc
-15V	_____	_____ V	-15 ±0.3 Vdc

Page _____ of _____

TEST RECORD CARD

Description	Date Measured	Actual Reading	Limits
Laser Power Output Test	_____	_____ μW	>120 μW
Voltage Input Check			
+15V	_____	_____ V	+15 ±0.3 Vdc
−15V	_____	_____ V	−15 ±0.3 Vdc
Laser Power Output Test	_____	_____ μW	>120 μW
Voltage Input Check			
+15V	_____	_____ V	+15 ±0.3 Vdc
−15V	_____	_____ V	−15 ±0.3 Vdc
Laser Power Output Test	_____	_____ μW	>120 μW
Voltage Input Check			
+15V	_____	_____ V	+15 ±0.3 Vdc
−15V	_____	_____ V	−15 ±0.3 Vdc
Laser Power Output Test	_____	_____ μW	>120 μW
Voltage Input Check			
+15V	_____	_____ V	+15 ±0.3 Vdc
−15V	_____	_____ V	−15 ±0.3 Vdc

SECTION V
ADJUSTMENTS

5-1. INTRODUCTION

5-2. This section describes adjustments and checks required to return the HP 5501B Laser Head to peak operating capabilities when repairs have been made. Included in this section are the test equipment required, equipment setups, and procedures to perform the adjustments.

5-3. SAFETY CONSIDERATIONS

5-4. The following warnings contain information that must be understood for your safety.

WARNING

FROM 1.2 KILOVOLTS TO 12 KILOVOLTS DC IS PRESENT ON THE ANODE OF THE LASER TUBE IN THE HP 5501B. EXERCISE EXTREME CAUTION WHEN WORKING INSIDE THE INSTRUMENT. THE HIGH VOLTAGE COULD CAUSE SERIOUS PERSONAL INJURY IF CONTACTED. THE FOLLOWING ADJUSTMENTS SHOULD BE PERFORMED BY SERVICE-TRAINED PERSONNEL.

NOTE

The High Voltage Power Supply, A2, is disconnected automatically by A1S1, when the HP 5501B covers are removed. For Adjustments and Servicing purposes, the High Voltage Supply can be re-enabled by setting the TEST-NORM switch, A1S2, to TEST after the HP 5501B covers are removed.

WARNING

LASER RADIATION IS ACCESSIBLE WHEN THE HP 5501B COVERS ARE REMOVED AND THE TEST-NORM SWITCH, A1S2, IS IN THE TEST POSITION.

5-5. RECOMMENDED TEST EQUIPMENT

5-6 . Test equipment required for each adjustment is included in the adjustment procedure. Detailed critical specifications for the required test equipment are contained in *Table 1-2*. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended model(s).

5-7. FACTORY SELECTED COMPONENTS

5-8. As of the publication date on the title page of this manual there are no factory selected components.

5-9. ADJUSTMENT PROCEDURES

5-10. The following paragraphs contain the adjustment procedures for the HP 5501B Laser Head. A performance test is given in Section IV.

5-11. Reference Temperature Adjustments

5-12. This adjustment sets the laser preheat temperature to 105°C (221°F). The adjustment must be performed when the laser tube is at room temperature, 21 to 25°C (69.8 to 77.0°F).

5-13. Test Equipment Required. The reference temperature adjustment requires the following test equipment:

Digital Voltmeter, HP Model 3435A

5-14. Preliminary Procedure

5-15. This adjustment must be made with the laser tube at room temperature. If the laser High Voltage Power Supply (A2) or heater have been on, allow at least two hours with ±15 Volts off before performing this procedure. Regardless of whether power is on or off, observe the safety precautions in paragraph 5-4 and proceed as follows:

a. Remove the HP 5501B Laser Head covers by following the procedure outlined in paragraph 8-55.

b. Check that the TEST-NORM switch (A1S2) located on the A1 Connector Board is set to NORM. See *Figure 5-1.*

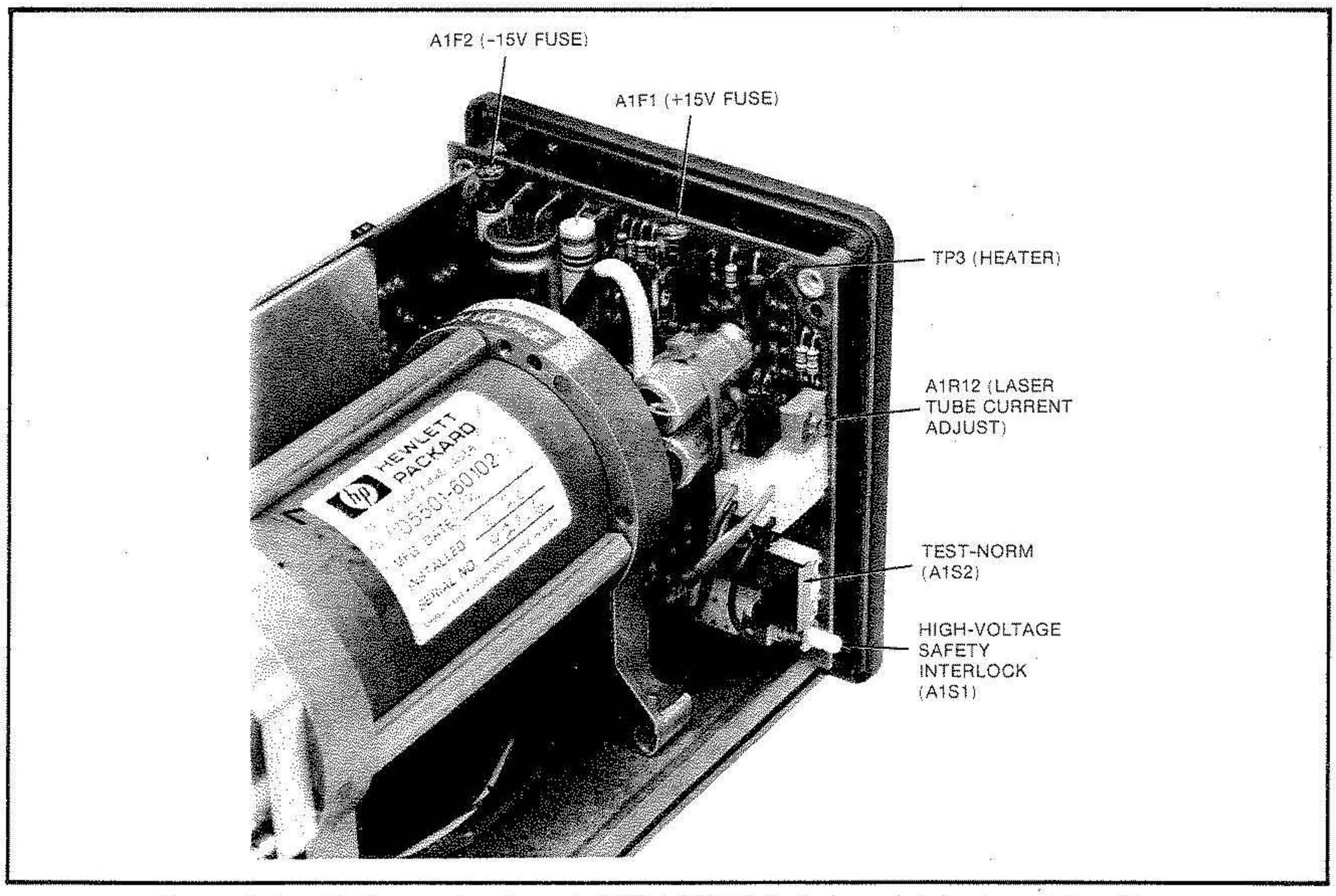


Figure 5-1. A1 Connector Board, TEST-NORM Switch and Adjustment Locations

c. On A3, change the HEATER jumper from NRM to OFF. See *Figure 5-2.*

d. Apply power to the Digital Voltmeter and set its controls to the 1 Volt DC range. Connect the positive lead of the Digital Voltmeter to A3TP11, connect the negative lead to A3TP1. See *Figure 5-2.*

e. If HP 5501B power has been disconnected for least 2 hours, reconnect ±15 Volts system power supplies and continue with the adjustment procedure in Paragraph 5-16.

5-16. Procedure. To adjust the reference temperature, proceed as follows:

a. Check that the Voltmeter reads between +0.22V and +0.31V. This voltage is V(A3TP11).

b. Record value of V(A3TP11) measured in step 5-16(a).

c. Calculate the heater adjust set point using the following equation:

$$Vset = 1.285 \times V(A3TP11)$$

d. Connect Digital Voltmeter plus lead to A3TP15. Connect the minus lead to A3TP1. See *Figure 5-2.*

e. Check that the voltage at A3TP15 equals Vset ± 1 millivolt as calculated in step b. If not, adjust A3R16 SET TEMP (see *Figure 5-2*).

f. Note and record the SET TEMP voltage in the "ADJUSTMENT RECORD" table located at the end of this section.

g. Disconnect ±15 Volts from HP 5501B Laser Head.

h. On A3, change the HEATER jumper back to NRM (left-most position). Remove the test equipment leads, and reinstall the laser head covers.

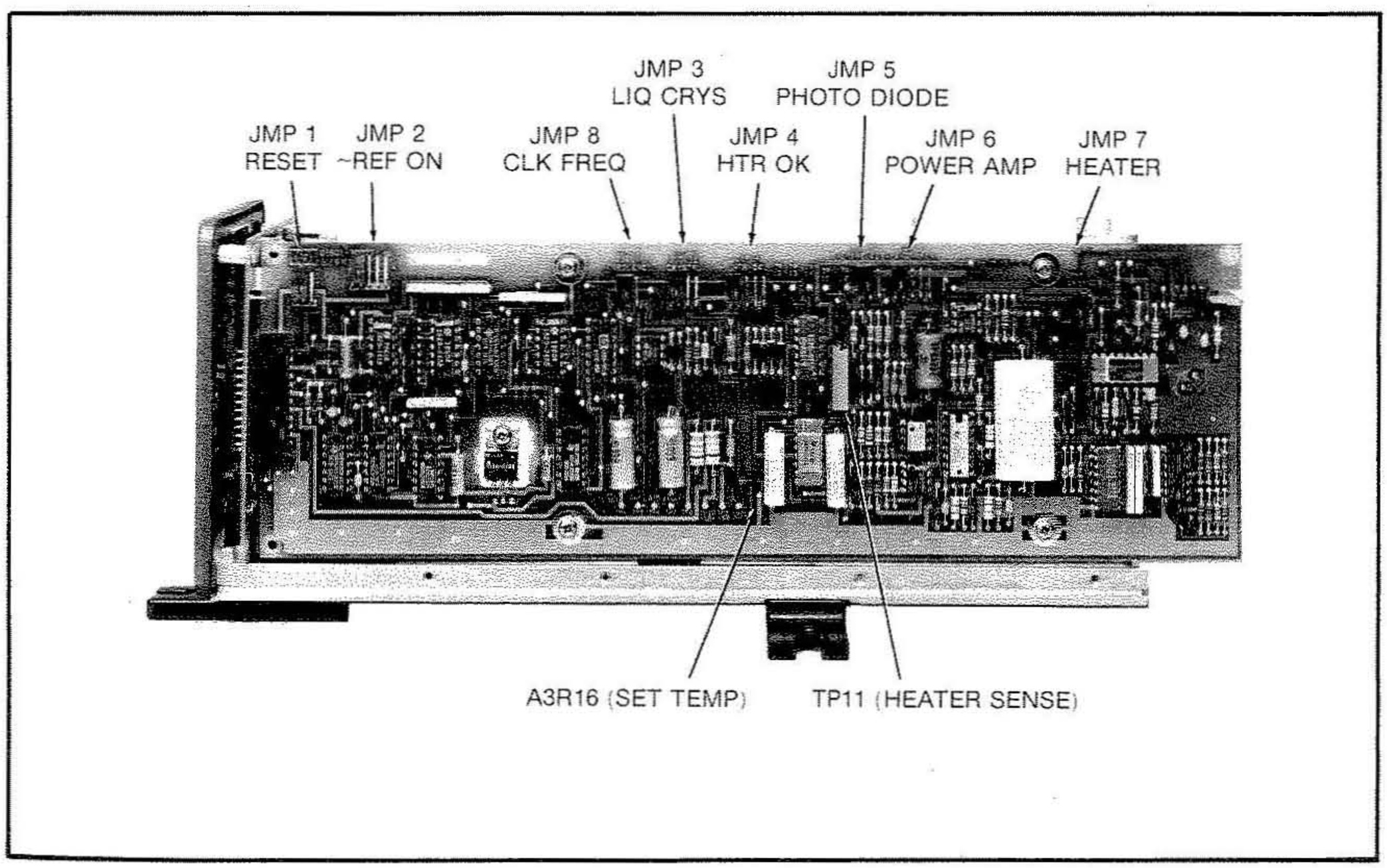


Figure 5-2. A3 Controller/Ref Board, Jumpers, Test Points, and Adjustment Locations

5-17. Laser Tube Current Adjustment

NOTE

A TILDE ("~") PRECEDING A SIGNAL NAME INDICATES NEGATIVE-TRUE LOGIC LEVELS.

5-18. This procedure adjusts the laser tube current to 3.5 milliamperes ± 0.1 milliampere.

5-19. Test Equipment Required. The laser current adjustment requires the following test equipment:

Clip-On DC Milliammeter, HP Model 428B

5-20. Procedure. To adjust the laser tube current, observe the safety precautions in Paragraph 5-4 and proceed as follows:

a. Turn the system power supplies OFF.

b. Remove the laser head covers by following the procedures outlined in paragraph 8-55.

c. On the A1 Connector Board, set TEST-NORM (A1S2) switch to TEST. See *Figure 5-1.*

d. Set indicated jumpers to the following positions:

1. JMP2 (~REF ON) ..... LO
2. JMP4 (HTR OK) ..... HI
3. JMP7 (HEATER) ..... OFF
4. JMP8 (CLK FREQ) ..... HI

NOTE

Setting the A3 jumpers causes the laser to come on soon after power is applied.

e. Set the milliammeter to the 10 milliampere range.

f. Clip the HP 428B probe around the red (Anode) High Voltage Power Supply wire located underneath the laser tube (See *Figure 5-3*). The arrow on the milliammeter probe should point away from the supply. Keep the probe as far as possible from and perpendicular to the magnet assemblies. It may be necessary to prop up the probe to achieve the perpendicular orientation.

g. On the milliammeter, adjust for zero indication. If zero indication cannot be obtained, degauss the probe as directed on the back of the milliammeter.

NOTE

After the zero setting has been made on the milliammeter, do not move the probe, this will affect the zero setting.

h. Apply power to the system power supplies.

NOTE

READY LED will flash rapidly for about 5 seconds. LASER LED illuminates followed almost immediately by emission of laser light.

i. Adjust A1R12 (*Figure 5-1*) for 3.5 milliamperes ± 0.1 milliampere. If the current cannot be adjusted to this value, see Laser High Voltage Troubleshooting in Section VIII. If the laser power output (as measured in paragraph 4-9) is not greater than 120 microwatts (at this current level), the laser assembly may require replacement.

j. Record the laser tube current in the "ADJUSTMENT RECORD" located at the end of this section.

k. Turn off the system power supplies, disconnect the probe, set the TEST-NORM switch to NORM, and reinstall the laser head covers.

l. Return all A3 jumpers, moved in step 5-20(d), back to NRM position (left-most position).

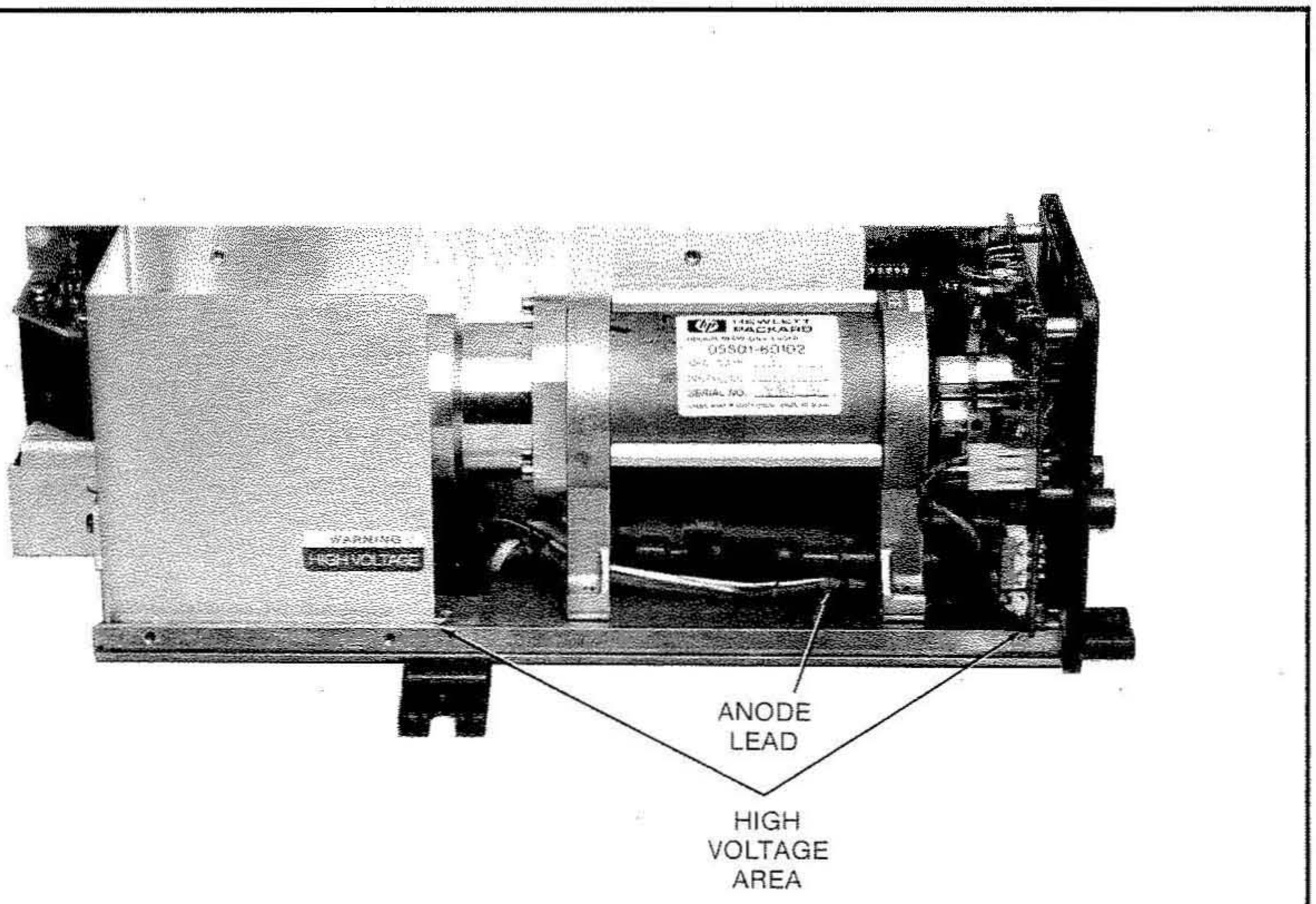


Figure 5-3. 5501B High Voltage Area and Anode Lead

Page _____ of _____

ADJUSTMENT RECORD

ADJUSTMENT	DATE MEASURED	VALUE MEASURED	LIMITS
Laser Output Power	_____	_____ μW	>120 μW
Vset	_____	_____ V	Vset (Calculated) ±1 mV
Laser Tube Current	_____	_____ mA	3.5 mA ± 0.1mA
Laser Output Power	_____	_____ μW	>120 μW
Vset	_____	_____ V	Vset (Calculated) ±1 mV
Laser Tube Current	_____	_____ mA	3.5 mA ± 0.1mA
Laser Output Power	_____	_____ μW	>120 μW
Vset	_____	_____ V	Vset (Calculated) ±1 mV
Laser Tube Current	_____	_____ mA	3.5 mA ± 0.1mA
Laser Output Power	_____	_____ μW	>120 μW
Vset	_____	_____ V	Vset (Calculated) ±1 mV
Laser Tube Current	_____	_____ mA	3.5 mA ± 0.1mA

END PRODUCT LASER SAFETY CONSIDERATIONS

The 5501B Laser Head complies with U.S. National Center for Devices and Radiological Health regulations 21 CFR 1040.10 and 1040.11.

These regulations may also apply to the end product into which the 5501B will be designed. Care must be taken to insure that the end product complies with all applicable national and local laser safety regulations.

ADJUSTMENT RECORD

ADJUSTMENT	DATE MEASURED	VALUE MEASURED	LIMITS
Laser Output Power	_____	_____ μW	>120 μW
Vset	_____	_____ V	Vset (Calculated) ±1 mV
Laser Tube Current	_____	_____ mA	3.5 mA ± 0.1mA
Laser Output Power	_____	_____ μW	>120 μW
Vset	_____	_____ V	Vset (Calculated) ±1 mV
Laser Tube Current	_____	_____ mA	3.5 mA ± 0.1mA
Laser Output Power	_____	_____ μW	>120 μW
Vset	_____	_____ V	Vset (Calculated) ±1 mV
Laser Tube Current	_____	_____ mA	3.5 mA ± 0.1mA
Laser Output Power	_____	_____ μW	>120 μW
Vset	_____	_____ V	Vset (Calculated) ±1 mV
Laser Tube Current	_____	_____ mA	3.5 mA ± 0.1mA

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION

6-2. This section contains information for ordering replacement parts. Part numbers for replacement parts are provided in either illustrated parts breakdown or tabulated listings depending on the type of part. Purchase Order and Direct Mail Order information are provided in Paragraphs 6-9 through 6-13.

6-3. *Table 6-1* is a list of exchange assemblies and *Table 6-2* gives gives abbreviations and reference designators used in the parts lists and throughout the manual. *Table 6-3* lists replaceable parts that are mounted on pc board assemblies. *Table 6-4* contains the names and addresses that correspond to the manufacturer's code numbers given in *Table 6-3*. *Figure 6-1* shows illustrated parts breakdowns showing the chassis mounted parts and assemblies for the HP 5501B.

6-4. EXCHANGE ASSEMBLIES

6-5. *Table 6-1* lists assemblies within the HP 5501B Laser Head that may be replaced on an exchange basis. Factory repaired and tested exchange assemblies are available on a trade-in basis; therefore the defective assemblies must be returned for credit. For this reason, assemblies required for on-site spare parts stock must be ordered by the "New Assembly" part number.

Table 6-1. Exchange Assemblies

Assembly	HP Part No.	New Assembly HP Part No.	Exchange Assembly HP Part No.
Laser Assembly	05501-60102	05501-60202	05501-69102

6-6. ABBREVIATIONS AND REFERENCE DESIGNATIONS

6-7. *Table 6-2* lists abbreviations used in the parts list, the schematics and throughout the manual. In some cases, two forms of the abbreviations are used, one in all capital letters, and one partial or no capital letters. This occurs because the abbreviations in the parts list are always all capital letters. However, in the schematics and the other parts of the manual, other abbreviation forms are used with both upper and lower case letters.

6-8. ORDERING INFORMATION

6-9. To order a part listed in the replaceable parts tables or figures, quote the Hewlett-Packard part number, indicate the quantity required, and address the order to the nearest Hewlett-Packard office.

6-10. To order a part that is not listed in this section, include the instrument model number, instrument serial number, the description and function of the part, and the number of parts required. Address the order to the nearest Hewlett-Packard office.

6-11. DIRECT MAIL ORDER SYSTEM

6-12. Within the USA, Hewlett-Packard can supply parts through a direct mail order system. Advantages of using the system are as follows:

a. Direct ordering and shipment from the HP Parts Center in Mountain View, California.

b. No maximum or minimum on any mail order (there is a minimum order amount for parts ordered through a local HP office when the orders require billing and invoicing).

c. Prepaid transportation (there is a small handling charge for each order).

d. No invoices — to provide these advantages, a check or money order must accompany each order.

6-13. Mail order forms and specific ordering information are available through your local HP office. Addresses and phone numbers are located at the back of this manual.

Table 6-2. Reference Designations and Abbreviations

REFERENCE DESIGNATIONS

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

ABBREVIATIONS

A	= ampere
ac	= alternating current
ACCESS	= accessory
ADJ	= adjustment
A/D	= analog-to-digital
AF	= audio frequency
AFC	= automatic frequency control
AGC	= automatic gain control
AL	= aluminum
ALC	= automatic level control
AM	= amplitude modulation
AMPL	= amplifier
APC	= automatic phase control
ASSY	= assembly
AUX	= auxiliary
AVG	= average
AWG	= american wire gauge
BAL	= balance
BCD	= binary coded decimal
BD	= board
BE CU	= beryllium copper
BFO	= beat frequency oscillator
BH	= binder head
BKDN	= breakdown
BP	= bandpass
BPF	= bandpass filter
BRS	= brass
BWO	= backward-wave oscillator
CAL	= calibrate
ccw	= counterclockwise
CER	= ceramic
CHAN	= channel
cm	= centimeter
CMO	= coaxial
COEF	= coefficient
COM	= common
COMP	= composition
COMPL	= complete
CONN	= connector
CP	= cadmium plate
CRT	= cathode-ray tube
CTL	= complementary transistor logic
CW	= continuous wave
cw	= clockwise
D/A	= digital-to-analog
dB	= decibel
dBm	= decibel referred to 1 mW
dc	= direct current
deg	= degree (temperature interval or difference)
... °	= degree (plane angle)
°C	= degree Celsius (centrigrade)
°F	= degree Fahrenheit
°K	= degree Kelvin
DEPC	= deposited carbon
DET	= detector
diam	= diameter
DIA	= diameter (used in parts list)
DIFF AMPL	= differential amplifier
div	= division
DPDT	= double-pole, double-throw
DR	= drive
DSB	= double sideband
DTL	= diode transistor logic
DVM	= digital voltmeter
ECL	= emitter coupled logic
EMF	= electromotive force
EDP	= electronic data processing
ELECT	= electrolytic
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	= metre (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; microfarad (used in parts list)
MFR	= manufacturer
mg	= milligram
MHz	= megahertz
mH	= millihenry
mho	= conductance
MIN	= minimum
min	= minute (time)
... '	= minute (plane angle)
MINAT	= miniature
mm	= millimetre
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
ns	= nanosecond
NSR	= not separately replaceable
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 modulation; pulse-count modulation
PDM	= pulse-duration modulation
pF	= picofarad
PH BRZ	= phosphor bronze
PHL	= phillips
PIN	= positive-intrinsic-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 6-3. 5501B Board Assemblies Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2	05518-60303	3	1	HIGH VOLTAGE POWER SUPPLY ASSEMBLY NOT FIELD REPAIRABLE	28480	05518-60303

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

Table 6-3. 5501B Board Assemblies Replaceable Parts (Continued)

Reference Designation	HP Part Number	CD	Qty	Description	Mfr Code	Mfr Part Number
A3	05501-60027	9	1	CONTROLLER/REFERENCE BOARD ASSEMBLY SERIES 2632, REVISION A	28480	05501-60027
A3C1	0180-2929	8	1	CAPACITOR-FXD 68UF+-10% 10VDC TA	28480	0180-2929
A3C2	0160-4554	7	15	CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C3	0160-4808	4	5	CAPACITOR-FXD 470PF +-5% 100VDC CER	28480	0160-4808
A3C4	0180-1746	5	1	CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A3C5	0180-0291	3	1	CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A3C6	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C7	0180-1735	2	1	CAPACITOR-FXD .22UF+-10% 35VDC TA	56289	150D224X9035A2
A3C8	0160-4824	4	1	CAPACITOR-FXD .022UF +-10% 100VDC CER	28480	0160-4824
A3C9	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C10	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C11	0180-0049	9	2	CAPACITOR-FXD 20UF+75-10% 50VDC AL	56289	30D206G050CC2
A3C12	0180-0049	9		CAPACITOR-FXD 20UF+75-10% 50VDC AL	56289	30D206G050CC2
A3C13	0160-3072	2	2	CAPACITOR-FXD 1UF +-10% 100VDC MET-POLYE	28480	0160-3072
A3C14	0160-3072	2		CAPACITOR-FXD 1UF +-10% 100VDC MET-POLYE	28480	0160-3072
A3C15	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C16	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C17	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C18	0160-2453	1	1	CAPACITOR-FXD .22UF +-10% 80VDC POLYE	28480	0160-2453
A3C19	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C20	0160-5237	5	1	CAPACITOR-FXD 5UF +/-10%	28480	0160-5237
A3C21	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C22	0160-0576	5	3	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3C23	0160-4557	0	7	CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C24	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C25	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C26	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3C27	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3C28	0180-0309	4	1	CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A3C29	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C30	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C31	0160-4824	4	1	CAPACITOR-FXD 680PF +-5% 100VDC CER	28480	0160-4824
A3C32	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C33	0160-4808	4		CAPACITOR-FXD 470PF +-5% 100VDC CER	28480	0160-4808
A3C34	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C35	0160-4808	4		CAPACITOR-FXD 470PF +-5% 100VDC CER	28480	0160-4808
A3C36	0160-4809	5	1	CAPACITOR-FXD 390PF +-5% 100VDC CER	28480	0160-4809
A3C37	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C38	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C39	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C40	0160-4557	0		CAPACITOR-FXD .1UF +-20% 50VDC CER	16299	CAC04X7R104M050A
A3C41	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C42	1810-0768	7	1	NETWORK-CAPACITOR SIP NETWORK CAPACITOR	56289	470C7C0G471K5DG
A3C43	0160-4808	4		CAPACITOR-FXD 470PF +-5% 100VDC CER	28480	0160-4808
A3C44	0160-4554	7		CAPACITOR-FXD .01UF +-20% 50VDC CER	28480	0160-4554
A3C45	0160-4808	4		CAPACITOR-FXD 470PF +-5% 100VDC CER	28480	0160-4808
A3CR1	1901-0050	3	3	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A3CR2	1901-0731	7	1	DIODE-PWR RECT 400V 1A	14433	1N4004G
A3CR5	1990-0770	1	1	PHOTODIODE ID=30NA-MAX	32694	OP 913 (SELECTED)
A3CR6	1901-0518	8	1	DIODE-SM SIG SCHOTTKY	28480	1901-0518
A3CR7	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A3CR8	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A3DS1	1990-0485	5	1	LED-LAMP LUM-INT=2MCD IF=30MA-MAX BVR=5V	28480	HLMP-1503
A3DS2	1990-0487	7	1	LED-LAMP LUM-INT=2MCD BVR=5V	28480	HLMP-1401
A3J1	1251-8603	9	1	CONN-POST TYPE .100-PIN-SPCG 24-CONT	28480	1251-8603
A3J2	1251-5801	3	1	CONNECTOR 4-PIN M POST TYPE	28480	1251-5801
A3JMP1	1251-4047	7	4	CONNECTOR 3-PIN M POST TYPE	28480	1251-4047
A3JMP2	1251-4813	5	3	CONNECTOR 5-PIN M POST TYPE	28480	1251-4813
A3JMP3	1251-6957	2	1	CONNECTOR 4-PIN M POST TYPE	28480	1251-6957
A3JMP4	1251-4813	5		CONNECTOR 5-PIN M POST TYPE	28480	1251-4813
A3JMP5	1251-4047	7		CONNECTOR 3-PIN M POST TYPE	28480	1251-4047

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

Table 6-3. 5501B Board Assemblies Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4	05501-60029	1	1	SAMPLER BOARD ASSEMBLY SERIES 2632, REVISION B	28480	05501-60029
A4CR1	1990-0770	1	1	PHOTODIODE ID=30NA-MAX	32694	OP 913 (SELECTED)
A4P1	1251-6778	5	1	CONNECTOR 4-PIN F POST TYPE	28480	1251-6778
				A4 MISCELLANEOUS PARTS AND HARDWARE		
	0340-0907	8	1	INSULATOR-XSTR NYLON	28480	0340-0907

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

Table 6-3. 5501B Board Assemblies Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5	05501-60102	1	1	LASER TUBE ASSEMBLY NOT FIELD REPAIRABLE SEE TABLE 6-1 FOR LASER TUBE REPLACEMENT PART NUMBERS.	28480	05501-60102
A6	05501-60101	0	1	SAMPLER ASSEMBLY	28480	05501-60101
	1990-0768	7	1	LIQUID CRYSTAL SWITCH	28480	1990-0768
	8160-0530	9	2	ELASTOMERIC CONNECTOR	28480	8160-0530

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

Table 6-3. 5501B Miscellaneous Chassis Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				LASER HEAD MISCELLANEOUS CHASSIS		
A1	05501-60028	0	1	CONNECTOR BD ASSEMBLY	28480	05501-60028
A2	05518-60303	3	1	HIGH VOLTAGE POWER SUPPLY ASSEMBLY	28480	05518-60303
A3	05501-60027	9	1	CONTROL/REFERENCE BD ASSEMBLY	28480	05501-60027
A4	05501-60029	1	1	SAMPLER BOARD ASSEMBLY	28480	05501-60029
A5	05501-60102	1	1	LASER TUBE ASSEMBLY	28480	05501-60102
A6	05501-60101	0	1	SAMPLER ASSEMBLY	28480	05501-60101
H1	0510-0054	7	1	RETAINER-RING GRPR EXT .25-IN-DIA STL	28480	0510-0054
H2	0510-0252	7	2	ER DIVISION	28480	0510-0252
H3	0515-0490	5	2	SCREW-SKT-HD-CAP M4 X 0.7 12MM-LG	28480	0515-0490
H4	0515-0530	4	6	SCREW-SET M4 X 0.7 5MM-LG PLAIN-CUP-PT	00000	ORDER BY DESCRIPTION
H5	0515-0886	3	7	SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	28480	0515-0886
H6	0515-0890	9	2	SCREW-MACH M3 X 0.5 6MM-LG 90-DEG-FLH-HD	28480	0515-0890
H7	0515-0896	5	2	SCREW-MACH M4 X 0.7 10MM-LG	28480	0515-0896
H8	0515-1129	9	8	SCREW-MACH M4 X 0.7 16MM-LG	28480	0515-1129
H9	0515-1322	4	2	SCREW-MACH M3 X 0.5 30MM-LG	28480	0515-1322
H10	0515-1351	9	4	SCREW-MACH M2.5 X 0.45 8MM-LG	28480	0515-1351
H11	1390-0314	7	1	FASTENER-1/4-TURN ASSY PANEL THKNS	28480	1390-0314
H12	2190-0584	0	2	WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
H13	2190-0586	2	2	WASHER-LK HLCL 4.0 MM 4.1-MM-ID	28480	2190-0586
H14	3050-0891	7	7	WASHER-FL MTLC 3.0 MM 3.3-MM-ID	28480	3050-0891
H15	3050-0893	9	2	WASHER-FL MTLC 4.0 MM 4.4-MM-ID	28480	3050-0893
MP1	05501-00008	0	1	SAMPLER MOUNT	28480	05501-00008
MP2	05501-20215	3	1	LASER BASE	28480	05501-20215
MP3	05501-20219	7	1	FRONT PANEL	28480	05501-20219
MP4	05501-20221	1	1	REAR PANEL	28480	05501-20221
MP5	05501-20222	2	3	FOOT	28480	05501-20222
MP6	05501-40003	9	1	SHUTTER MOUNT	28480	05501-40003
MP7	05501-40004	0	1	SHUTTER	28480	05501-40004
MP8	05501-60007	5	1	LEFT COVER (AS VIEWED FROM FRONT PANEL)	28480	05501-60007
MP9	05501-00003	5	1	RIGHT COVER (AS VIEWED FROM FRONT PANEL)	28480	05501-00003
MP10	05501-00007	9	1	SHIELD	28480	05501-00007
P1	1251-3450	4	1	CONNECTOR 4-PIN M CIRCULAR 45 (REFERENCE)	28480	1251-3450
P2	1251-3447	9	1	CONNECTOR 4-PIN M CIRCULAR (POWER)	28480	1251-3447
	5020-6770	2	1	WINDOW-1.0 AIR	28480	5020-6770
	1000-0616	7	1	TEST POLARIZER	28480	1000-0616
				LABELS AND NAMEPLATES		
	05501-80011	3	1	NAMEPLATE	28480	05501-80011
	5080-0098	1	1	LABEL-SERIAL NO.	28480	5080-0098
	7120-2444	3	1	LABEL-5501B LASER	28480	7120-2444
	7120-3731	3	2	LABEL-HIGH VOLTAGE WARNING	28480	7120-3731
	7120-5180	0	1	LABEL-WARNING	28480	7120-5180
	7121-1650	3	1	LABEL-MFG DATE	28480	7121-1650
	9320-1744	0	3	LABEL-MAGNETIC	28480	9320-1744
	05500-80007	6	2	LABEL-CAUTION	28480	05500-80007
	05500-80008	7	1	LABEL-REGULATION	28480	05500-80008

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

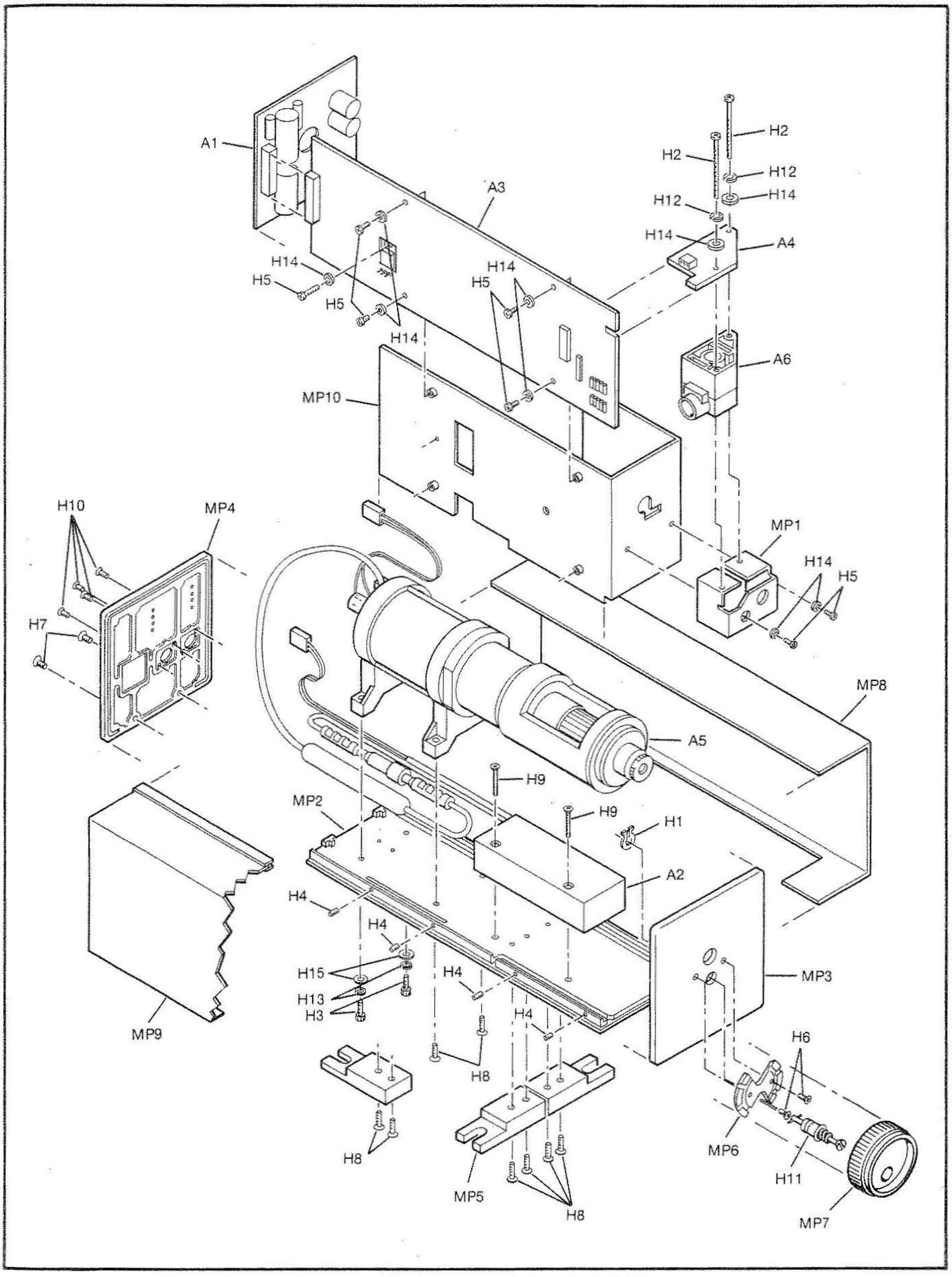


Figure 6-1. 5501B Laser Head Exploded View

TABLE OF CONTENTS

Section	Title		Page
I	**GENERAL INFORMATION**		1-1
	1-1.	Introduction	1-1
	1-4.	Equipment Description	1-1
	1-8.	Manual Organization	1-2
	1-10.	Instruments Covered by This Manual	1-2
	1-14.	Safety Considerations	1-3
	1-16.	Equipment Supplied	1-3
	1-18.	Available Accessories	1-3
	1-20.	Specifications	1-4
	1-22.	Recommended Test Equipment	1-5
	1-24.	Warranty	1-5
II	**INSTALLATION**		2-1
	2-1.	Introduction	2-1
	2-3.	Unpacking, Inspection, and Reshipment	2-1
	2-5.	Unpacking and Inspection	2-1
	2-7.	Warranty Claims	2-1
	2-9.	Laser Tube Shipment	2-1
	2-11.	Tagging for Service	2-2
	2-13.	Packaging for Reshipment	2-2
	2-14.	Installation	2-2
	2-16.	System Cabling	2-2
	2-19.	Power and Signal Connections	2-5
	2-21.	Cable Fabrication	2-5
	2-23.	Grounding Considerations	2-7
	2-25.	Power Supply Requirements	2-7
	2-27.	Power Dissipation	2-7
	2-29.	Fusing	2-7
	2-31.	Dimensions	2-8
	2-33.	Mounting and Fixturing	2-9
	2-41.	Operational Verification Check	2-10
	2-43.	Operating Environment	2-10
	2-44.	Storage	2-10
	2-45.	Environment	2-10
III	**OPERATION**		3-1
	3-1.	Introduction	3-1
	3-4.	Power Application	3-1
	3-6.	HP 5501B Laser Head Front Panel Controls	3-1
	3-8.	HP 5501B Laser Head Rear Panel Indicators and Connectors	3-3
	3-10.	Operating Modes	3-5
	3-12.	Warmup Time Operating Notes	3-6
	3-13.	HP 10740A Coupler Based Systems — Manual Monitoring	3-6
	3-14.	Systems with HP 10745A or HP 10746A Cards — Automatic Monitoring	3-6
	3-16.	HP 10740A Coupler — Error Signal Information	3-6
	3-17.	HP 10746A Error Signal Processing	3-7
	3-18.	HP 10745A Background Information	3-7
	3-19.	Program Modifications	3-7

Table 6-4. Manufacturer's Code List

Mfr Code	Manufacturer Name	Address		Zip Code
00000	ANY SATISFACTORY SUPPLIER			
01295	TEXAS INSTRUMENTS INC	DALLAS	TX US	75265
03508	GE CO SEMICONDUCTOR PROD DEPT	AUBURN	NY US	13201
04713	MOTOROLA INC SEMI-COND PROD	PHOENIX	AZ US	85008
07263	FAIRCHILD CORP	MOUNTAIN VIEW	CA US	94042
11236	CTS CORP BERNE DIV	BERNE	IN US	46711
14433	ITT SEMICONDUCTORS DIV	TUSTIN	CA US	92680
16299	CORNING ELECTRONICS	RALEIGH	NC US	27604
24546	CORNING ELECTRONICS	SANTA CLARA	CA US	95050
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA	CA US	95052
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO	CA	94304
31918	ITT SHADOW INC	EDEN PRAIRIE	MN US	55344
32293	INTERSIL INC	CUPERTINO	CA CA	95014
32694	TRW OPTOELECTRONICS DIV	CARROLLTON	TX	75006
32997	BOURNS INC	RIVERSIDE	CA US	92507
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS	MA	01247
73138	BECKMAN INDUSTRIAL CORP	FULLERTON	CA US	92632
9N171	UNITRODE CORP	LEXINGTON	MA US	02173
91637	DALE ELECTRONICS INC	EL PASO	TX US	79936

SECTION VII
MANUAL CHANGES

7-1. INTRODUCTION

7-2. This section normally contains information required to update or backdate this manual to cover newer or older instruments with serial prefixes different than those shown on the title page. Since this manual applies directly to new HP 5501B units having the serial number prefix listed on the title page, no change information is given here. Refer to INSTRUMENTS COVERED BY THIS MANUAL in Section I for additional important information about serial number coverage.

7-3. Newer Instruments

7-4. As engineering changes are made, newer instruments may have a higher serial number prefix than that listed for the particular instrument. The manual shipped with a HP 5501B Laser Head will include a "Manual Changes" sheet that describes all required changes to update the manual. If any of the instruments shipped with the system have a higher serial number than those listed on the title page and the "Manual Changes" sheet does not cover the prefix, contact your local HP Sales and Service Office for information.

SECTION VIII
SERVICE

8-1. INTRODUCTION

8-2. This section contains service information for the HP 5501B Laser Head. Also included are safety considerations, theory of operation, block diagrams, schematic diagrams, component locators, and troubleshooting and repair procedures. Other useful service information also provided in other sections of this manual include: performance tests in Section IV, adjustments in Section V, and exploded view illustrations and parts lists in Section VI.

8-3. Theory of Operation

8-4. The theory of operation is presented at two levels:

- Block Diagram Description. These paragraphs describe the laser head's major functional blocks and modes of operation. The description references the HP 5501B Laser Head Block Diagram, *Figure 8-2.*

- Board Level Theory of Operation. These paragraphs are arranged by assembly number order and describe the circuitry at the component level. The descriptions are used with schematic diagrams for A1, A2, and A3.

8-5. Recommended Test Equipment

8-6. *Table 1-2* in Section I lists the test equipment required for service. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended model(s).

8-7. Service Aids

8-8. This system uses both Metric and English hardware. *Figure 6-1* should be used to determine the correct hardware descriptions, part numbers and the proper tools to employ for assembly and disassembly.

8-9. Schematic Diagram Symbols and Reference Designations

8-10. The logic symbology used on the schematic diagrams conform to American National Standard ANSI/IEEE Std. 91-1984). This standard supersedes MIL-STD-806B.

8-11. *Figure 8-1* shows some of the symbols used on the schematic diagrams. In the center of this figure, the scheme for printed circuit board identification is presented. Also shown at the bottom of *Figure 8-1* is the method used to identify reference designators, assemblies, and subassemblies.

NOTE

A TILDE ("~") PRECEDING A SIGNAL NAME (I.E., ~REF ON) INDICATES NEGATIVE-TRUE LOGIC.

SYMBOLS

DANGEROUS VOLTAGE, EXCEEDS 1000 VOLTS

FRONT PANEL LABEL

REAR PANEL LABEL

INTERIOR AND PC BOARDS LABEL

WIPER MOVES TOWARD "CW" WHEN CONTROL IS ROTATED CLOCKWISE

OR PROTECTIVE CONDUCTOR TERMINAL

CIRCUIT COMMON

IDENTIFIED COMMON

OR CHASSIS TERMINAL

KNOB CONTROL

SCREWDRIVER ADJUST

MAIN SIGNAL PATH

FEEDBACK PATH

OR OR TEST POINT

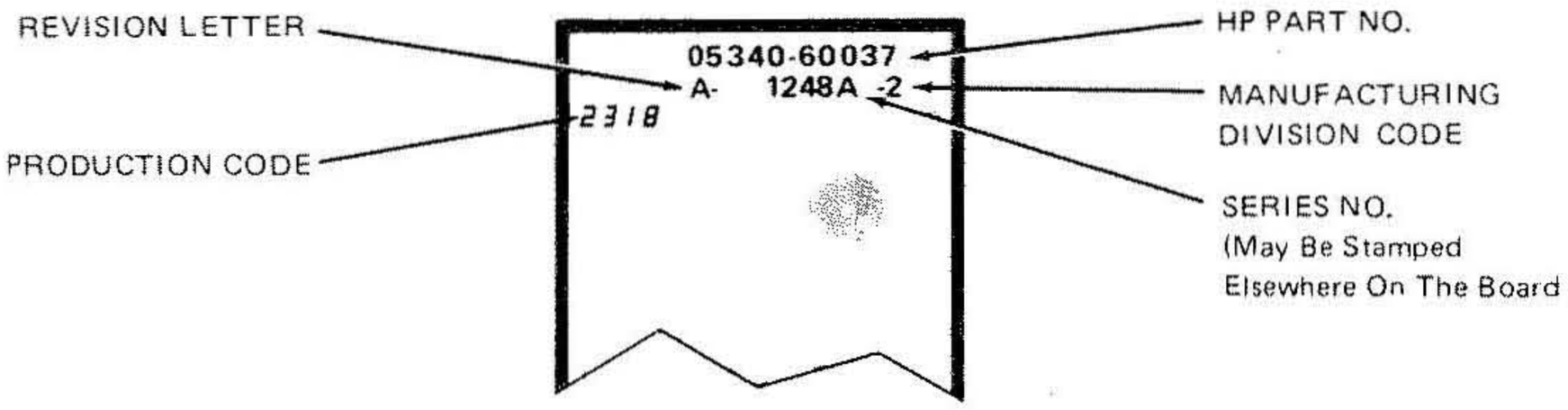
INSTRUCTION MANUAL F

ALTERNATING CURRENT

DIRECT CURRENT

ALTERNATING OR DIREC

PRINTED CIRCUIT BOARD IDENTIFICATION



REFERENCE DESIGNATIONS

REFERENCE DESIGNATIONS WITHIN ASSEMBLIES ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION. JACKS ARE THE STATIONARY CONNECTORS AND PLUGS ARE THE MORE MOVEABLE OF TWO CONNECTORS.

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

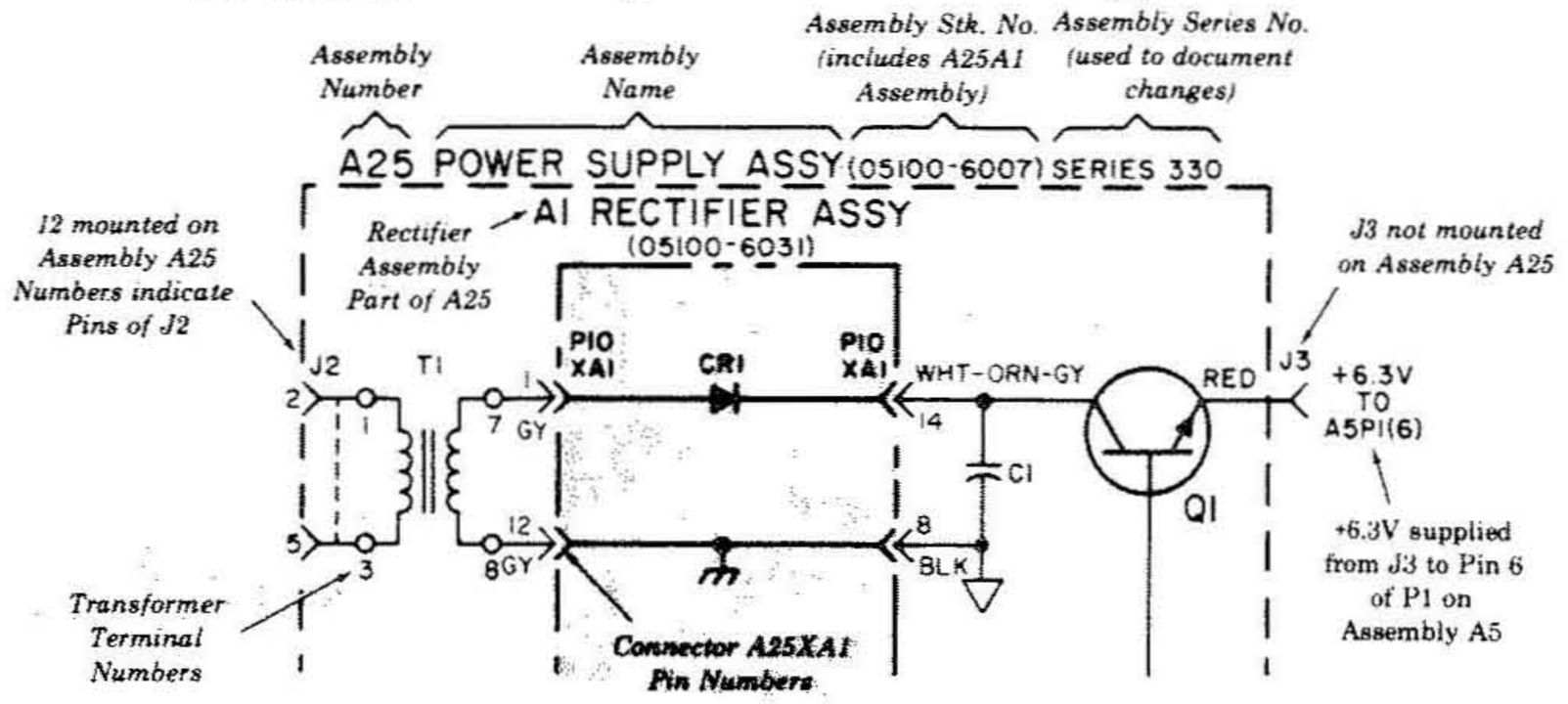


Figure 8-1. Schematic Diagram Notes

8-12. Safety Considerations

8-13. The following paragraphs contain warnings and cautions that must be followed for your protection and to avoid damage to the equipment.

WARNING

MAINTENANCE DESCRIBED HEREIN IS PERFORMED WITH POWER SUPPLIED TO THE EQUIPMENT AND WITH THE PROTECTIVE COVERS REMOVED. SUCH MAINTENANCE SHOULD BE PERFORMED ONLY BY SERVICE-TRAINED PERSONNEL WHO ARE AWARE OF THE HAZARDS INVOLVED (FOR EXAMPLE, FIRE AND ELECTRIC SHOCK). WHERE MAINTENANCE CAN BE PERFORMED WITHOUT POWER APPLIED, THE POWER TO THE EQUIPMENT SHOULD BE REMOVED.

BEFORE ANY REPAIR IS COMPLETED, ENSURE THAT ALL SAFETY FEATURES ARE INTACT AND FUNCTIONING, AND THAT ALL NECESSARY PARTS ARE CONNECTED TO THEIR PROTECTIVE GROUNDING MEANS.

WARNING

FROM 1.2 KILOVOLTS TO 12 KILOVOLTS DC IS PRESENT ON THE ANODE OF THE LASER TUBE IN THE HP 5501B. EXERCISE EXTREME CAUTION WHEN WORKING INSIDE THE INSTRUMENT. THE HIGH VOLTAGE COULD CAUSE SERIOUS PERSONAL INJURY IF CONTACTED. THE INSTRUMENT SERVICE SHOULD BE PERFORMED BY SERVICE-TRAINED PERSONNEL ONLY.

NOTE

When the HP 5501B covers are removed, the High Voltage Power Supply (HVPS), A2, is disconnected automatically by A1S1. For adjustments and servicing purposes, the High Voltage Power Supply can be re-enabled by setting the TEST-NORM switch, A1S2, to TEST after the HP 5501B covers are removed.

WARNING

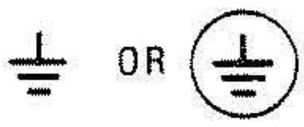
LASER RADIATION IS ACCESSIBLE WHEN THE HP 5501B COVERS ARE REMOVED AND THE TEST-NORM SWITCH, A1S2, IS IN THE TEST POSITION. AVOID EXPOSURE TO THE EYES.

8-14. Safety Symbols

8-15. The following safety symbols are used on the instrument or in this manual.

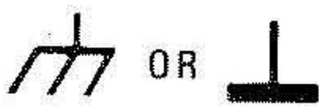
Instruction manual symbol. The product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to prevent damage to the instrument.

Indicates dangerous voltage at input or output terminals that may exceed 1000 volts.



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating the equipment.

Low-noise or noiseless, clean ground (earth) terminal. Used for signal common as well as providing protection against electrical shock in case of fault. A terminal marked with this symbol must be connected to ground as described in Section II Installation in this manual before operating the equipment.



Frame and chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Alternating current.

Direct current.

WARNING

The WARNING signal denotes a hazard. It calls attention to a procedure or practice which could result in personal injury if not adhered to or correctly performed.

CAUTION

The CAUTION signal denotes a hazard. It calls attention to an operating procedure or practice which could result in damage or destruction to part of or all of the product if not adhered to or correctly performed.

8-16. Before and After Service Product Safety Checks

8-17. Visually inspect the interior of the serviced instrument for any signs of abnormal internally generated heat, such as discolored printed circuit boards or components, damaged insulation, or evidence of electrical arcing. Determine and remedy the cause of any such condition.

8-18. LASER HEAD BLOCK DIAGRAM DESCRIPTION

8-19. The major structures of the HP 5501B are shown on the HP 5501B Laser Head Block Diagram in *Figure 8-2* and include the control electronics, laser assembly, sampler assembly, reference receiver, and the high voltage power supply. All of the necessary control signals for the operation of the HP 5501B are generated internally. Power requirements are ±15 Volts DC from external system power supplies.

8-20. Overall, the purpose of the laser head is to emit a collimated, dual frequency laser beam with a high degree of stability. A portion of the emitted beam (about 10%) is directed to the sampler assembly to establish a reference frequency while the main portion of the beam is directed to external optics and returned to an external measurement receiver to develop a measurement frequency. The system electronics compare the reference and measurement frequencies to calculate the relative displacement of the optics.

8-21. The control electronics determine the tuning of the laser assembly to ensure an accurate laser wavelength for making measurements. Two phases of tuning are used, warmup mode and optical mode. When the desired characteristics of the laser beam are obtained during the optical mode, the system is ready to make measurements.

8-22. The laser assembly optics ensure correct laser frequency polarizations and also collimate the laser beam. Collimating minimizes variations in the diameter of the beam as it travels away from the laser head. Laser frequency F2 is polarized in a plane parallel to the base of the HP 5501B chassis. The other laser frequency F1 is polarized perpendicular to F2. The difference between the two laser frequencies F1 and F2 is small compared to their optical frequencies. The exit aperture shutter of the turret assembly has three positions. The first blocks the laser beam entirely; the second allows a small diameter laser beam to exit for optical alignment purposes; and the third passes the entire laser beam.

8-23. Before the laser light is emitted from the HP 5501B, a portion of it is sampled by the sampler assembly. Most of this sample feeds into the reference receiver while the remainder is used to control laser tuning. The reference receiver generates the reference frequency signal by mixing the two laser frequencies. The reference frequency is a 1.5 to 2.0 MHz, TTL level square wave. When the laser tuning stabilizes, the reference frequency is sent to the system electronics.

8-24. During a measurement, the laser beam follows a path through external measurement optics and to the HP 10780A Receiver. If the optics remain stationary, the measurement frequency and the reference frequency are the same. Relative motion between the measurement optics result in a change of the measurement frequency. The electronics compare the measurement frequency to the reference frequency and calculate the displacement of the optics. The measurement frequency output from the HP 10780A system receiver requires proper alignment of measurement optics in addition to stable laser tuning.

8-25. The High Voltage Power Supply (HVPS) requires –15 Vdc as input. This supply generates up to 12 kilovolts DC at power-on. After the laser emission starts, the power supply output drops to approximately 1.2 kilovolts DC.

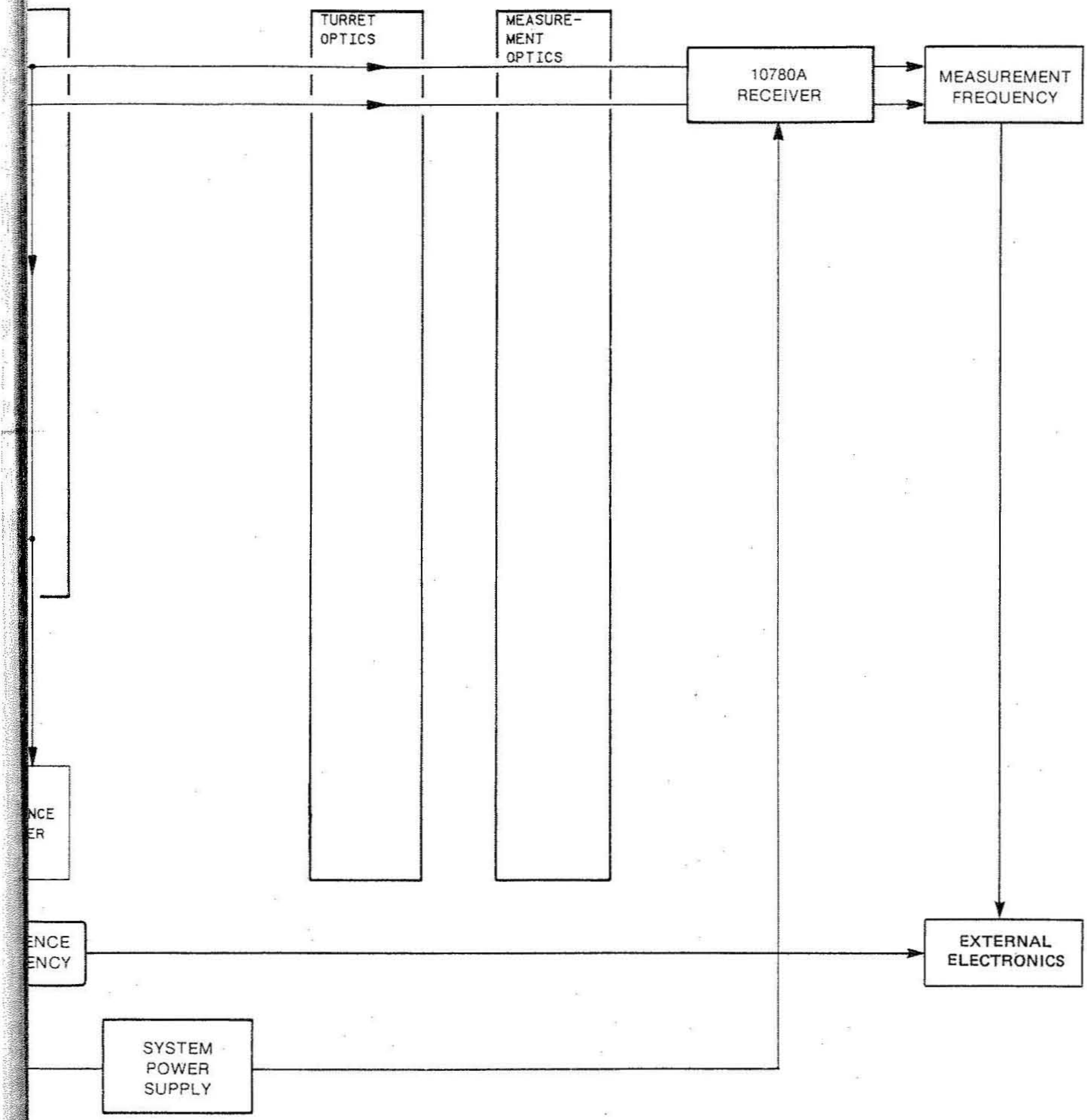


Figure 8-2. HP 5501B Laser Head Block Diagram

8-31. The heater coil is used both to heat the rod and to sense its temperature. For 2.56 seconds (nominal) out of every 25.6 seconds (nominal) of the warmup cycle (see *Figure 8-5*), the state machine disables the power amplifier and the heater allowing the heater coil to stabilize to the rod temperature. The heater coil and a resistor in the power amplifier (A1R15) form a voltage divider. As the heater resistance increases with rising temperature, the divider voltage increases. The difference between this voltage and the reference voltage is amplified to provide the warmup mode error signal.

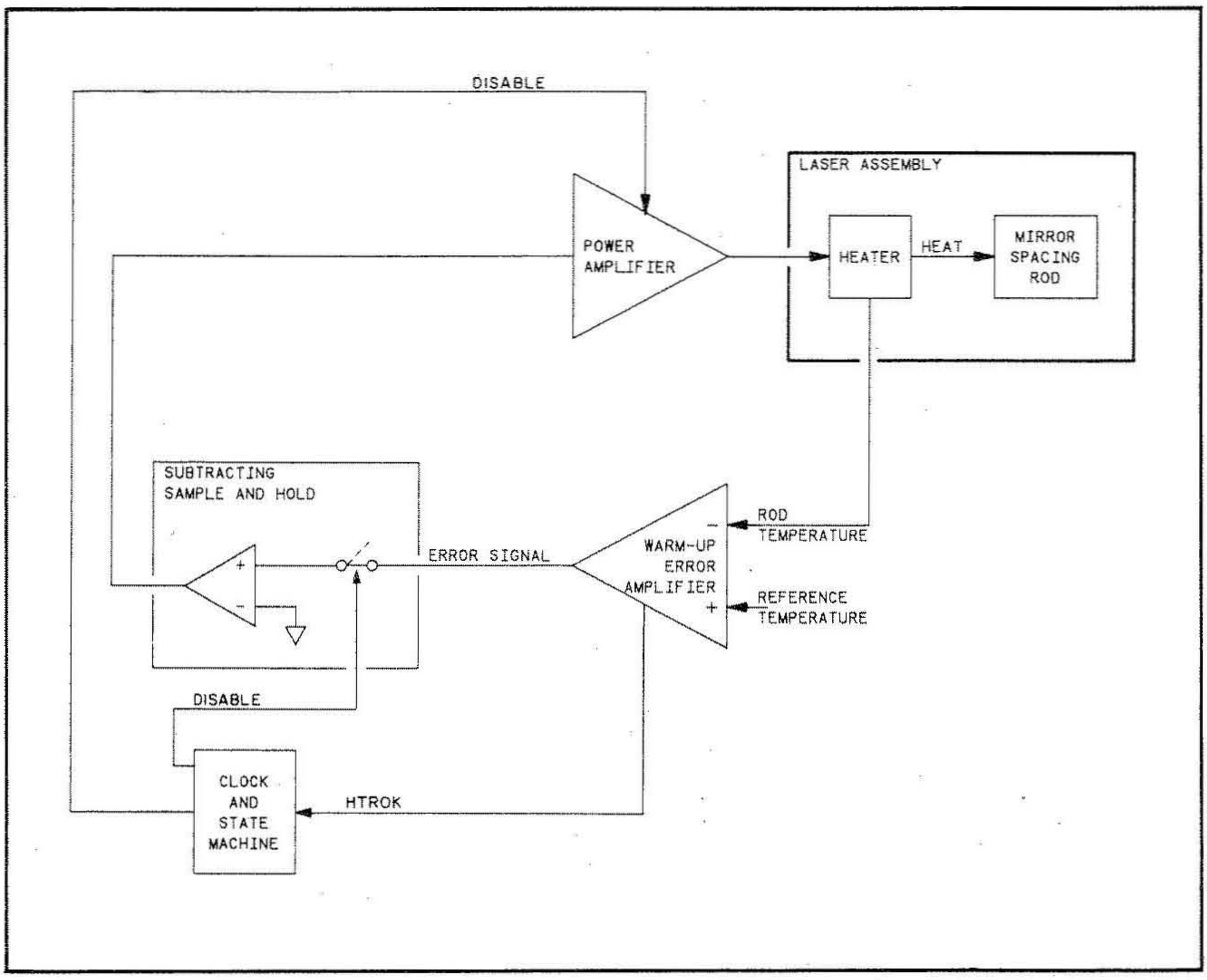


Figure 8-4. Feedback Loop During Warmup Mode

8-32. At the end of the 2.56 second disable period, the heater coil temperature has settled to the rod temperature. The error signal is sampled and held and the power amplifier is enabled. During the remainder of the 25.6 second period, the power amplifier, re-enabled and under control of the sampled error signal, drives the heater.

8-33. When the error signal gets close to zero, the warmup error amplifier sends a digital signal called HEATER OK (HTR OK) to the state machine. HTR OK is sampled by the state machine whenever the error signal is sampled. After HTR OK is sampled true, the state machine waits 100 seconds before switching to optical mode.

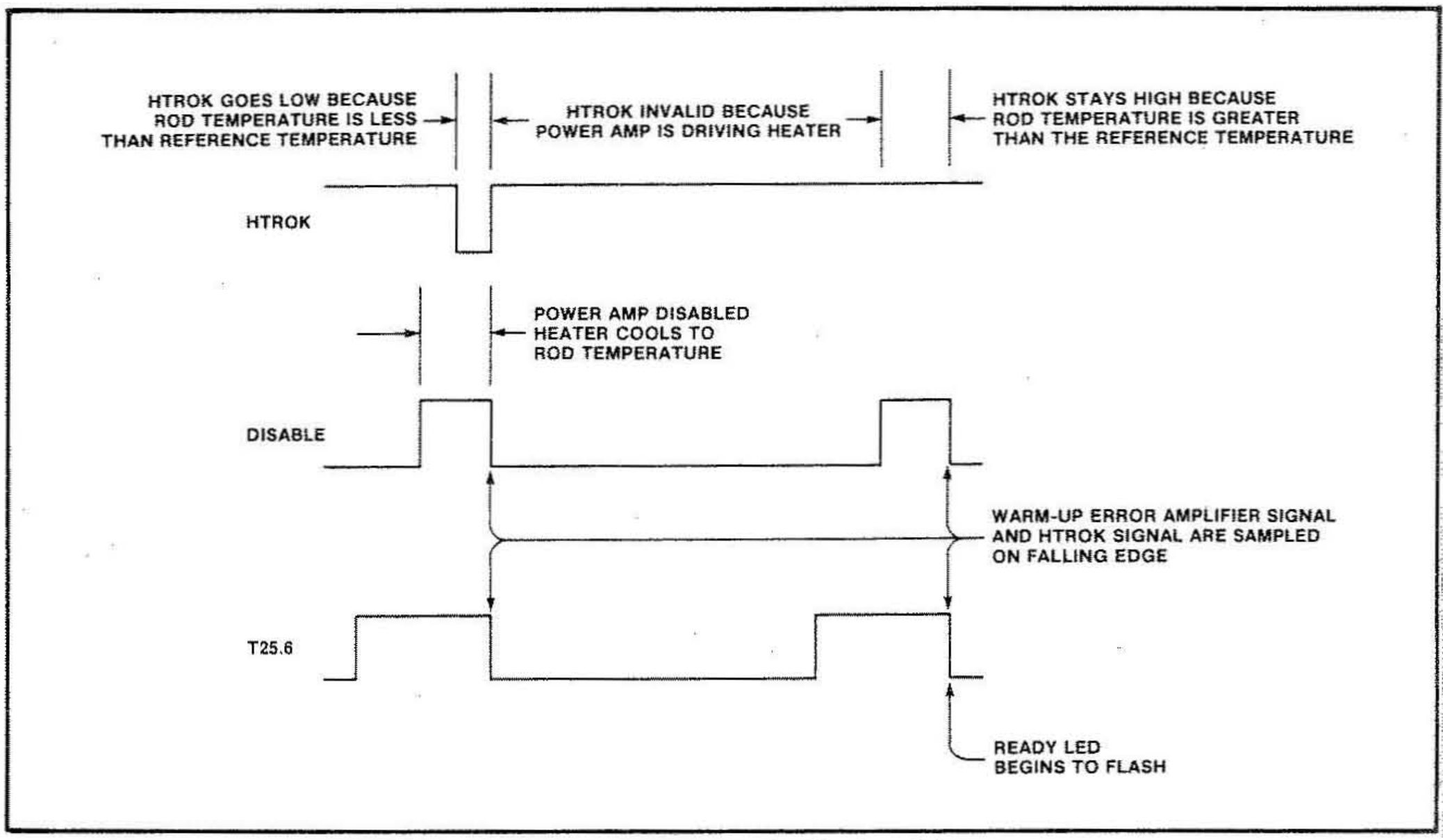


Figure 8-5. Warmup Mode Timing Diagram

8-34. Optical Mode Tuning

8-35. In optical mode, the state machine switches the subtracting sample and hold inputs from warmup feedback to optical feedback as shown in *Figure 8-6*. The optical mode feedback controls the laser cavity length by measuring and comparing the power of the two laser frequency components. Cavity length is controlled such that the difference in power is zero. When the difference is maintained at zero, the desired characteristics of the laser beam are established and a measurement can be performed.

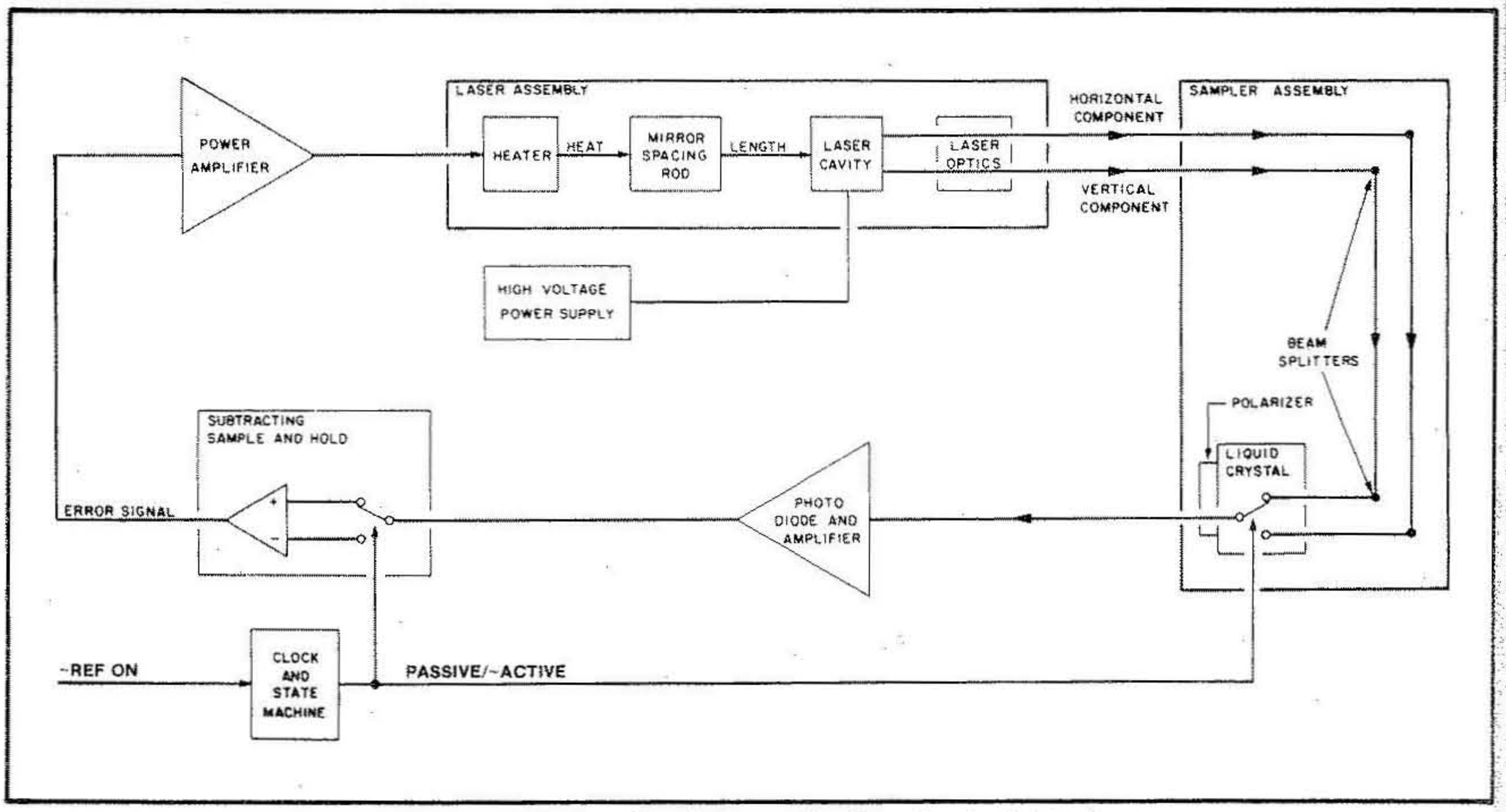


Figure 8-6. Feedback Loop During Optical Mode

TABLE OF CONTENTS (Continued)

Section	Title		Page
IV	**PERFORMANCE TESTS**		4-1
	4-1.	Introduction	4-1
	4-3.	Recommended Test Equipment	4-1
	4-5.	Test Record	4-1
	4-7.	HP 5501B Performance Test	4-1
	4-9.	Input Voltage Check	4-1
	4-11.	Laser Power Output Test	4-2
	4-13.	Procedure	4-2
V	**ADJUSTMENTS**		5-1
	5-1.	Introduction	5-1
	5-3.	Safety Considerations	5-1
	5-5.	Recommended Test Equipment	5-1
	5-7.	Factory Selected Components	5-1
	5-9.	Adjustment Procedures	5-2
	5-11.	Reference Temperature Adjustments	5-2
	5-14.	Preliminary Procedure	5-2
	5-17.	Laser Tube Current Adjustment	5-4
VI	**REPLACEABLE PARTS**		6-1
	6-1.	Introduction	6-1
	6-4.	Exchange Assemblies	6-1
	6-6.	Abbreviations and Reference Designations	6-1
	6-8.	Ordering Information	6-1
	6-11.	Direct Mail Order System	6-2
VII	**MANUAL CHANGES**		7-1
	7-1.	Introduction	7-1
	7-3.	Newer Instruments	7-1
VIII	**SERVICE**		8-1
	8-1.	Introduction	8-1
	8-3.	Theory of Operation	8-1
	8-5.	Recommended Test Equipment	8-1
	8-7.	Service Aids	8-1
	8-9.	Schematic Diagram Symbols and Reference Designations	8-1
	8-12.	Safety Considerations	8-3
	8-14.	Safety Symbols	8-4
	8-16.	Before and After Service Product Safety Checks	8-5
	8-18.	Laser Head Block Diagram Description	8-5
	8-26.	Laser Tuning	8-6
	8-29.	Warmup Mode Tuning	8-6
	8-34.	Optical Mode Tuning	8-8
	8-40.	Laser Assembly Optics	8-11
	8-42.	Reference Receiver	8-11
	8-44.	Shutter Mechanism	8-11
	8-46.	Assembly/Schematic Locations of HP 5501B Block Diagram Elements	8-11
	8-47.	Rear Panel LED Indicators	8-11
	8-49.	Built-in Test Aids	8-11
	8-52.	Assembly Removal Instructions	8-13
	8-62.	Trouble Isolation	8-18
	8-63.	Quick Tuning Checkout Procedure	8-18
	8-67.	Testing the Liquid Crystal Switch	8-20

8-36. The power in each laser frequency component is measured by sampling some of the laser light with a pair of non-polarizing beam splitters (see *Figure 8-7*) and passing one of the laser frequency components, then the other, through an optical switch and onto a photodiode. The beam splitters are part of the A6 Sampler Assembly and the photodiode is mounted on the A4 Sampler Board. A liquid crystal and a polarizer comprise the optical switch.

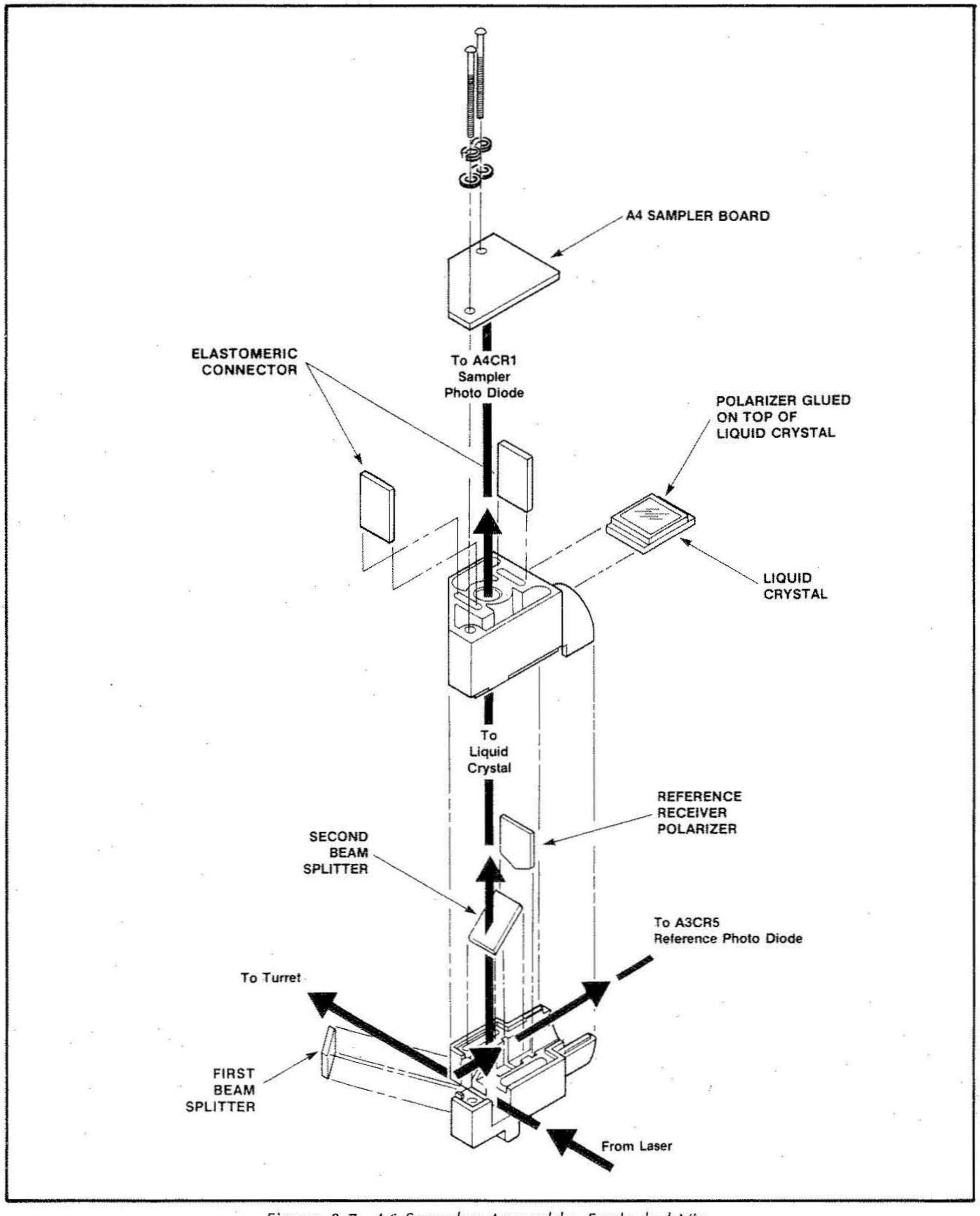


Figure 8-7. A6 Sampler Assembly, Exploded View

8-37. When the state machine excites the liquid crystal into its active state (see *Figure 8-8*), the laser beam passes through the liquid crystal unaltered. The polarizer blocks the horizontal component and passes the vertical component onto the photodiode. The photodiode current is proportional to the power in the vertical component and is amplified and converted to a voltage by the photodiode amplifier. The voltage is held on the positive input of the subtracting sample and hold circuit.

8-38. When the state machine places the liquid crystal in its passive state, the liquid crystal rotates the polarization of both components by 90 degrees. In this state, the polarizer blocks the vertical component and passes the horizontal component. The voltage out of the photodiode amplifier is proportional to the horizontal component and is held by the negative input of the subtracting sample and hold circuit. The error signal output of the subtracting sample and hold circuit is proportional to any difference in power between the two components.

NOTE

A TILDE ("~") PRECEDING ALL SIGNALS INDICATES NEGATIVE-TRUE LOGIC.

8-39. After the optical mode tuning has stabilized, LOCKED TUNED OPTICAL (LTO) signal is held true enabling the reference frequency output. Proper laser tuning and reference receiver operation is indicated by ~REF ON true. ~REF ON false will cause the state machine to reset to the warmup mode.

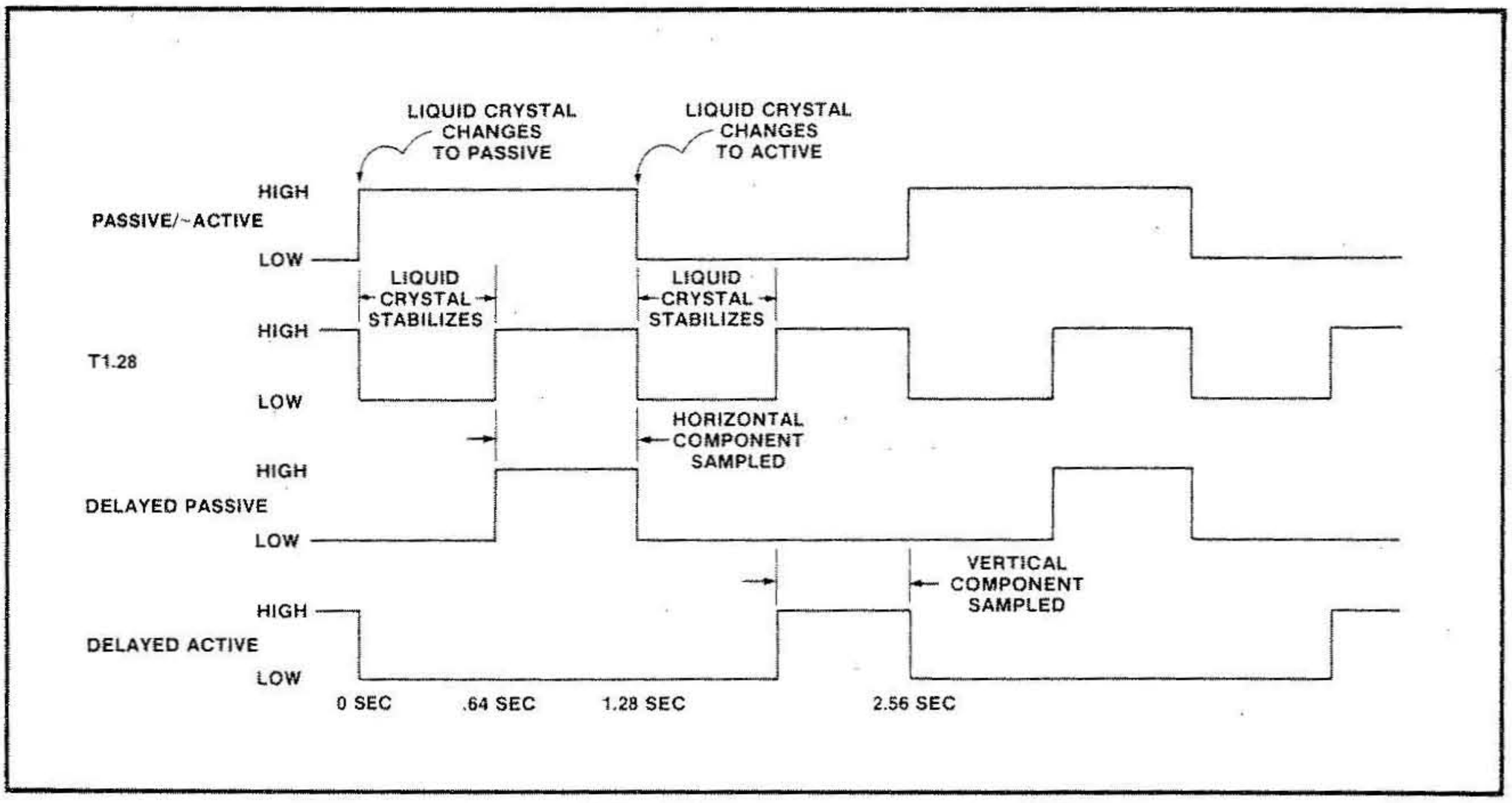


Figure 8-8. Liquid Crystal Timing Diagram (Optical Mode)

8-40. Laser Assembly Optics

8-41. The laser assembly optics ensure correct laser frequency polarizations and also collimate the laser beam. When the laser beam leaves the laser assembly, the horizontal component is polarized parallel to the base of the HP 5501B. The vertical component is polarized perpendicular to the horizontal component. The laser beam is collimated to minimize variations in beam diameter as it travels away from the laser head.

8-42. Reference Receiver

8-43. The beam splitters of the A6 Sampler Assembly direct some of the laser light through a second 45° polarizer and onto another photodiode. Because of the polarization orientation, the beam power after this polarizer varies sinusoidally at the difference frequency of the two laser frequency components. The beam power at the difference frequency is converted to current by the photodiode and amplified to TTL levels. The frequency of the TTL output is the reference frequency. The reference receiver electronics also provide a digital signal called REFERENCE RECEIVER ON (REF ON) that tells the state machine the laser is working properly.

8-44. Shutter Mechanism

8-45. The exit aperture shutter of the shutter (turret) assembly has three positions. The first blocks the laser beam entirely; the second allows a small diameter laser beam to exit for optical alignment purposes; and the third passes the entire laser beam.

8-46. ASSEMBLY/SCHEMATIC LOCATIONS OF HP 5501B BLOCK DIAGRAM ELEMENTS

ELEMENT	HP 5501B ASSEMBLY
Control Electronics	A3 and A4
Power Amplifier	A1 and A3
Warmup Error Amplifier	A3
Subtracting Sample & Hold	A3
Photodiode & Amplifier	A4 and A3
Clock and State Machine	A3
Laser Assembly	A5
Sampler Assembly	A6
Reference Receiver	A3 and A6

8-47. REAR PANEL LED INDICATORS

8-48. The diagnostic LEDs, mounted on the HP 5501B's rear panel, provide status information on power supply input (±15 Volts), fuses, laser output and tuning, and the reference frequency output. See *Figure 3-2* for a more detailed description of the LEDs.

8-49. BUILT-IN TEST AIDS

NOTE

A TILDE ("~") PRECEDING A SIGNAL INDICATES NEGATIVE-TRUE LOGIC.

8-50. Several jumpers are included to aid in testing. The RESET jumper, JMP 1, places the state machine in a repetitive mode to allow signature measurements. The ~REF ON jumper, JMP 2, sets the ~REF ON signal so that U17 cannot influence the state machine. LIQ CRYS jumper, JMP 3, places the liquid crystal in either the active or passive state. The HTR OK jumper, JMP 4, sets the HTR OK signal so that U15 cannot influence the state machine. JMP 5, PHOTO DIODE, substitutes a known current for the photodiode and is used for testing the photodiode amplifier and the subtracting sample and hold circuits. JMP 6, POWER AMP, supplies ±100 mV to U13 (Pin 3) to test the power amplifier. JMP 7, HEATER, disables the power amplifier. The CLK FREQ, JMP 8, allows the clock circuitry to generate either of the following three clock rates: NRM = 100 Hz, HI = 1000 Hz, and with the jumper removed completely = 75 kHz. Test IC U9 is dummy 16-pin DIP package with no integrated circuit. All of the important digital signals connect to U9 so that a logic clip can be used for monitoring.

NOTE

There are two "LO" positions for the REF ON jumper, and two "UP" positions for the POWER AMP jumper. For proper placement, refer to the schematics for A3 when using these jumpers.

8-51. The following is a summary of the signal functions on U9:

Table 8-1. A3 U9 Test IC Signal Summary

PIN	PURPOSE
1, 2, 3, 4	Timing of sample and hold during optical mode.
5, 6	Timing of sample and hold during warmup mode.
7, 10	Liquid crystal drive
9	Presets digital circuitry
11, 12, 13	Indicates state of the state machine
14, 15	Inputs to the state machine

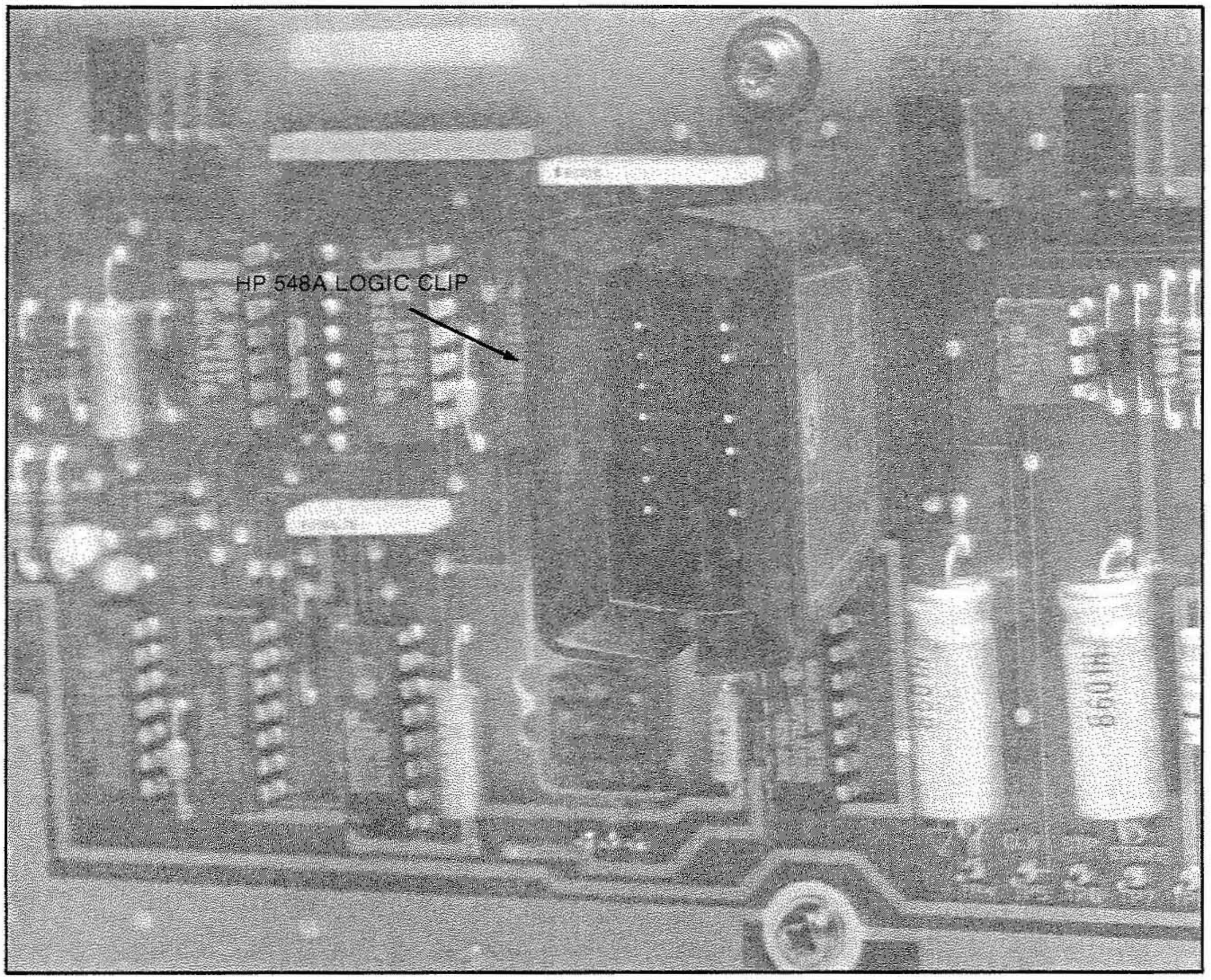


Figure 8-9. Logic Clip Monitoring of Test IC U9

8-52. ASSEMBLY REMOVAL INSTRUCTIONS

8-53. *Figure 6-1*, the exploded view diagram in Section VI, shows the HP 5501B assembly locations, provides access and removal information, and gives assembly part number references.

8-54. 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 COVERS OF THE LASER HEAD CONTROL A SAFETY INTERLOCK SWITCH (A1S1) 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.

8-55. To remove the front panel and side covers from the laser head, perform the following procedure:

a. Remove ±15 Volt power from HP 5501B Laser Head.

b. 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.

c. Using a suitable screwdriver, rotate the fastener 1/4-turn in the counterclockwise direction (see *Figure 8-10*).

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

e. 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.

f. To install the front panel and side covers, perform the reverse of the removal procedure.

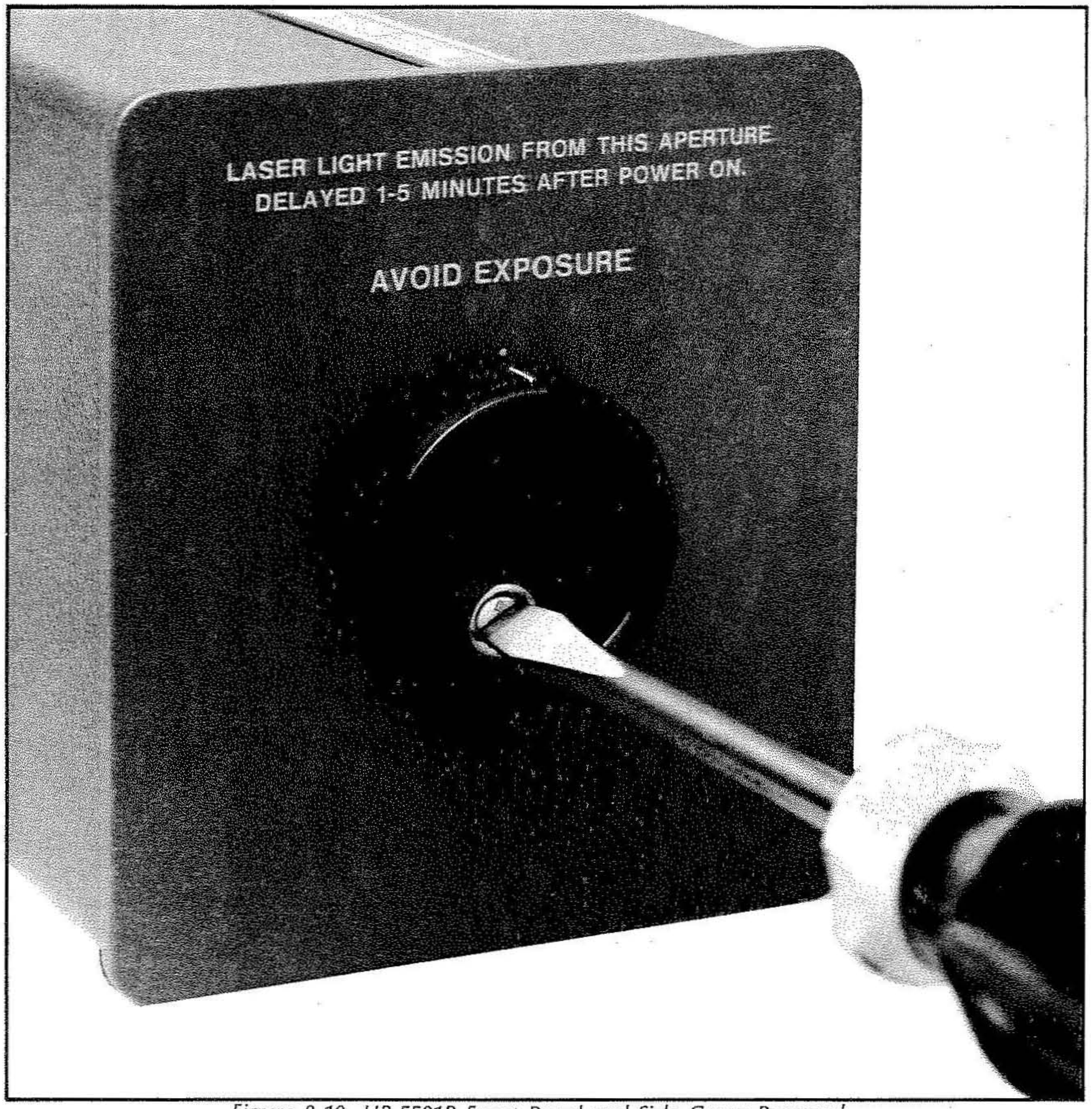


Figure 8-10. HP 5501B Front Panel and Side Cover Removal

8-56. To remove the A1 Connector Board Assembly from the HP 5501B chassis, perform the following procedure.

a. Remove ±15 Volt power from HP 5501B Laser Head.

b. Remove front panel and side covers as described in paragraph 8-55.

c. Remove two Pozidriv screws (H7) that secure rear panel (MP4) to laser base (MP2).

d. Remove four Pozidriv screws (H10) that secure A1 Connector board to rear panel assembly (MP4).

e. Remove A3 Reference/Controller Board Assembly as described in paragraph 8-58.

f. Disconnect A2 High Voltage Power Supply and A5 Laser Assembly cabling from A1 Connector Board. These wires connect to A1J3 and A1J4 respectively.

g. Remove A1 Connector Board Assembly.

h. To install the A1 Connector board Assembly, perform the reverse of the removal procedure.

8-57. To remove the A2 High Voltage Power Supply from the HP 5501B chassis, perform the following procedure.

a. Remove ±15 Volt power from HP 5501B Laser Head.

b. Remove front panel and side covers as described in paragraph 8-55.

c. Remove the A5 Laser Assembly as described in paragraph 8-60.

d. Disconnect A2 High Voltage Power Supply cable connector A2P1 from connector A1J3.

e. Remove two Pozidriv screws (H9) that fasten the A2 assembly to the laser base (MP2).

f. Remove A2 High Voltage Power Supply from laser head chassis.

g. To install the laser assembly, perform the reverse of the removal procedure.

8-58. To remove the A3 Reference/Controller Board Assembly from the HP 5501B chassis, perform the following procedure.

a. Remove ±15 Volts from HP 5501B Laser Head.

b. Remove front panel and side covers as described in paragraph 8-55.

c. Remove Pozidriv screw (H5) and flat washer (H14) that secures voltage regulator A3U7 to the shield.

d. Remove four Pozidriv screws (H5) with flat washers (H14) that secures A3 assembly to the shield.

e. Gently extend front-panel end of A3 away from shield in order to disengage A3J2 from A4P1 and also for A3 to clear the A4 Sampler Board tab. Disengage A3J1 from A1J1 and remove A3 from HP 5501B chassis.

f. To install the laser assembly, perform the reverse of the removal procedure.

8-59. To remove the A4 Sampler Board and/or the A6 Sampler Assembly from the HP 5501B chassis, perform the following procedure.

a. Remove ±15 Volt power from HP 5501B Laser Head.

b. Remove front panel and side covers as described in paragraph 8-55.

c. Remove A3 Reference/Controller Board Assembly as described in paragraph 8-58.

d. Remove two Pozidriv screws (H2), lock washers (H12), and flat washers (H14) that fasten the A4 Sampler board and Sampler Assembly to the sampler mount (MP1).

e. Gently remove the A4 Sampler board and sampler assembly.

f. To install the A4 Sampler board and/or the sampler assembly, perform the reverse of the removal procedure.

NOTE

Sampler Mount (MP1) is adjusted at the factory to ensure that the laser beam is not truncated as it exits the laser head. Two screws (H5) secure the Sampler Mount to the shield (MP10).

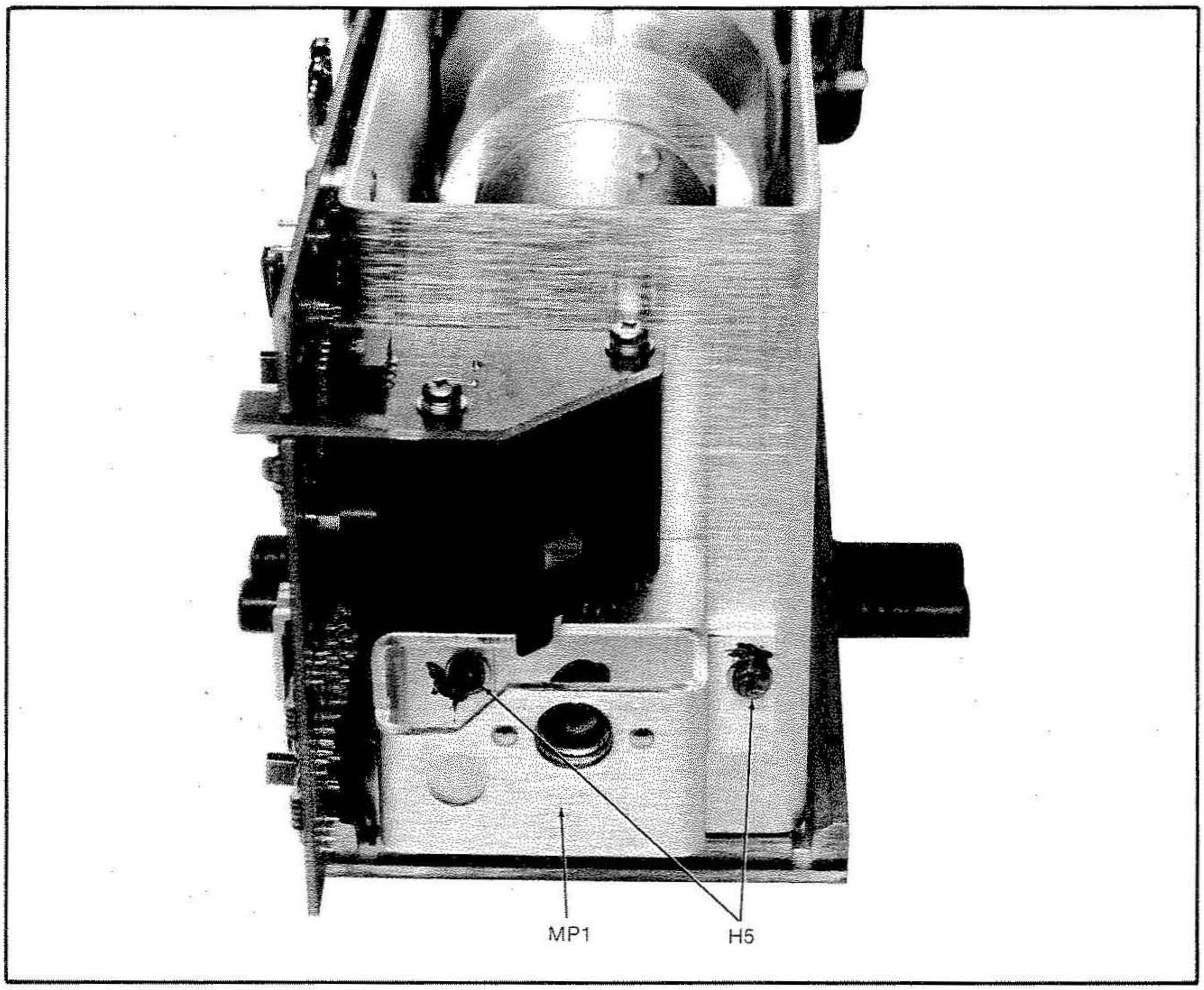


Figure 8-11. Factory-adjusted Sampler Mount (MP1)

8-60. To remove the A5 Laser Assembly (HP Part No. 05501-60102) from the HP 5501B chassis, perform the following procedure.

a. Remove ±15 Volt power from HP 5501B Laser Head.

b. Remove front panel and side covers as described in paragraph 8-55.

c. Disconnect laser assembly connector A5P1 from A1J4.

d. Remove two Pozidriv screws (H7) that secures rear panel (MP4) to laser base (MP2).

e. Remove four Pozidriv screws (H10) that secure A1 Connector board to rear panel assembly (MP4).

f. With rear of laser head facing you, tilt the top edge of the A1 assembly toward you. This will give ample clearance to remove the laser assembly.

g. Remove two Pozidriv screws (H8) from laser base. Secure the laser assembly to ensure that it doesn't move. Remove two set screws (H3), associated lock washers (H13), and flat washers (H15) using a 3.0 mm Allen wrench.

h. Remove laser assembly from laser head chassis.

i. Disconnect the tube's high voltage power supply lead from the A2 High Voltage Power Supply by rotating the black, knurled fastener in the counterclockwise direction; prevent the wire's rotation as you unscrew the fastener.

j. To install the laser assembly, perform the reverse of the removal procedure.

CAUTION

ENSURE A2 HIGH VOLTAGE POWER SUPPLY CABLES ARE NOT PINCHED BETWEEN A5 LASER ASSEMBLY AND LASER BASE DURING REINSTALLATION OF LASER ASSEMBLY.

8-61. The laser assembly consists of an aluminum housing, laser tube, magnets, telescope and the quarter-wave/half-wave plate assembly. The telescope expands and collimates the beam. The quarter-wave plate and half-wave plate establish the orientation of the two laser beam components.

8-62. TROUBLE ISOLATION

8-63. Quick Tuning Checkout Procedure

8-64. The following procedure provides a means to quickly check the entire optical tuning subsystem of the laser head. Before performing the procedure, read the information in paragraphs 8-26 through 8-39 to gain the necessary background information to aid in interpreting the test results. *Figure 8-12* illustrates the effects of mirror spacing on F1 and F2.

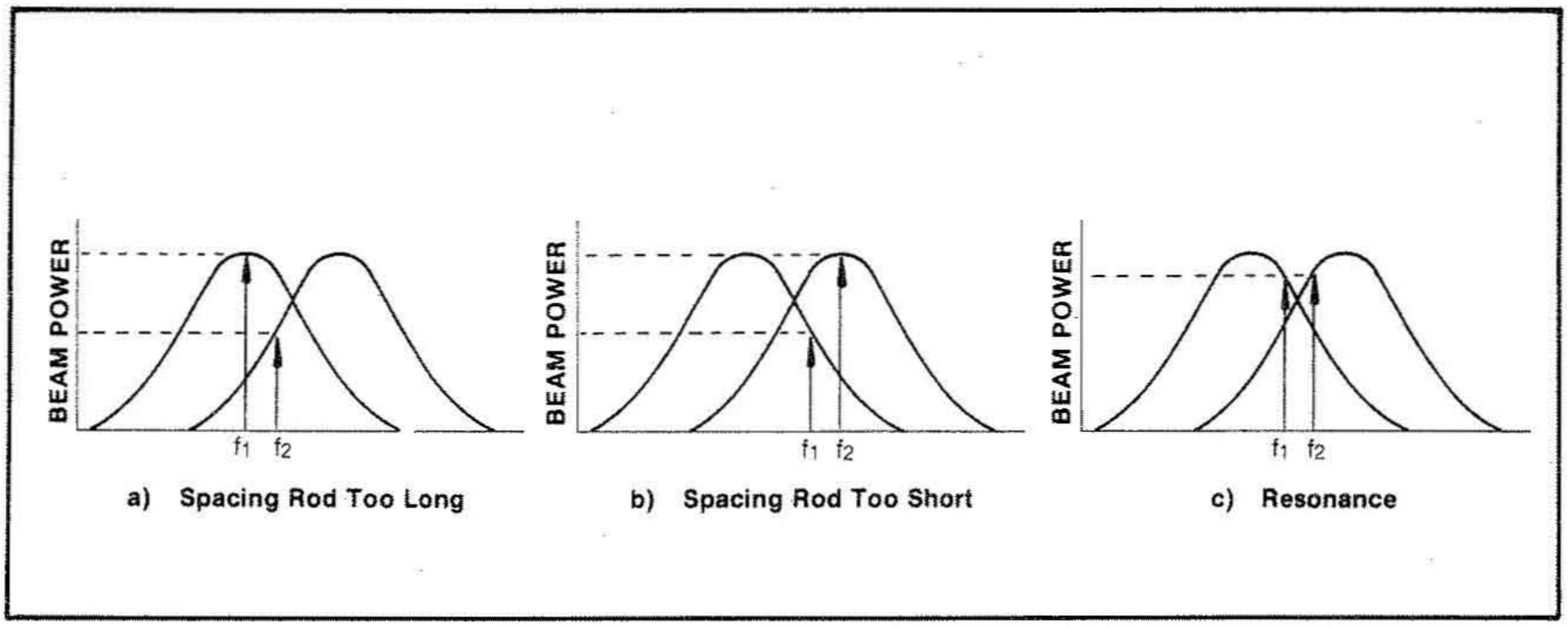


Figure 8-12. Laser Tube Tuning Characteristics

TABLE OF CONTENTS (Continued)

Section	Title		Page
VIII	**SERVICE (Continued)**		
	8-70.	HP 5501B Trouble Isolation Procedure	8-22
	8-72.	Procedure	8-23
	8-73.	A1 Connector Board Circuit Theory	8-25
	8-76.	High Voltage Power Supply Switch (A1Q3 and A1Q4)	8-25
	8-79.	Power Distribution	8-25
	8-83.	A1 Connector Board Troubleshooting	8-26
	8-85.	Rear Panel LED Operational Check	8-26
	8-87.	A2 High Voltage Power Supply Circuit Theory	8-28
	8-89.	High Voltage Power Supply Troubleshooting	8-28
	8-91.	A3 Controller/Reference Board and A4 Sampler Board Circuit Theory	8-31
	8-92.	Introduction	8-31
	8-95.	Clock Ⓐ	8-31
	8-97.	Dividers Ⓑ	8-31
	8-99.	State Machine Ⓕ	8-32
	8-105.	Liquid Crystal Ⓓ	8-33
	8-109.	Photodiode and Amplifier Ⓔ	8-33
	8-111.	Warmup Error Amplifier and Comparator Ⓙ	8-33
	8-114.	Subtracting Sample and Hold Ⓗ	8-33
	8-118.	A1/A3 Power Amplifier Ⓘ	8-34
	8-121.	Reference Receiver Ⓛ	8-35
	8-125.	Line Driver Ⓚ	8-35
	8-127.	Power-On Reset (POR) Ⓖ	8-35
	8-129.	Laser Head Power Ⓒ	8-35
	8-131.	A4 Sampler Board	8-35
	8-133.	A3 Controller/Reference Board Troubleshooting	8-36
	8-135.	Standard Troubleshooting Procedures	8-36
	8-137.	Digital Troubleshooting	8-37
	8-140.	Photodiode and Amplifier Troubleshooting	8-40
	8-142.	Liquid Crystal Troubleshooting	8-41
	8-144.	Subtracting Sample and Hold Troubleshooting	8-41
	8-146.	Power Amplifier Troubleshooting	8-43
	8-148.	Warm-Up Error Amplifier Troubleshooting	8-45
	8-150.	Power Supply Troubleshooting	8-45
	8-152.	Reference Receiver Troubleshooting	8-46

8-65. This procedure consists of monitoring test point TP16 on A3 with an oscilloscope to determine the relative amplitudes of F1 and F2 with the heater turned off. If the sampler, photodiode, and amplifier are functioning properly and the heater is turned off, the traces on the oscilloscope will show switching to different levels as it monitors the sampling of F1 and F2. With continued observation of the trace switching, these levels which correspond to F1 and F2 will change amplitudes since the tuning is uncontrolled.

8-66. To perform the quick isolation procedure, proceed as follows:

a. Observe the READY LED on the rear panel of the HP 5501B. If after approximately 6 minutes from power-up (cold start), the LED begins flashing, you can assume that the clock, dividers, state machine, warmup and power amplifier stages are working properly.

b. Remove the HP 5501B covers as described in paragraph 8-55.

c. Connect a dc-coupled oscilloscope to A3TP16 on A3 as shown in *Figure 8-13*. Also see *Figure 8-24* (Component Locator) for test point locations.

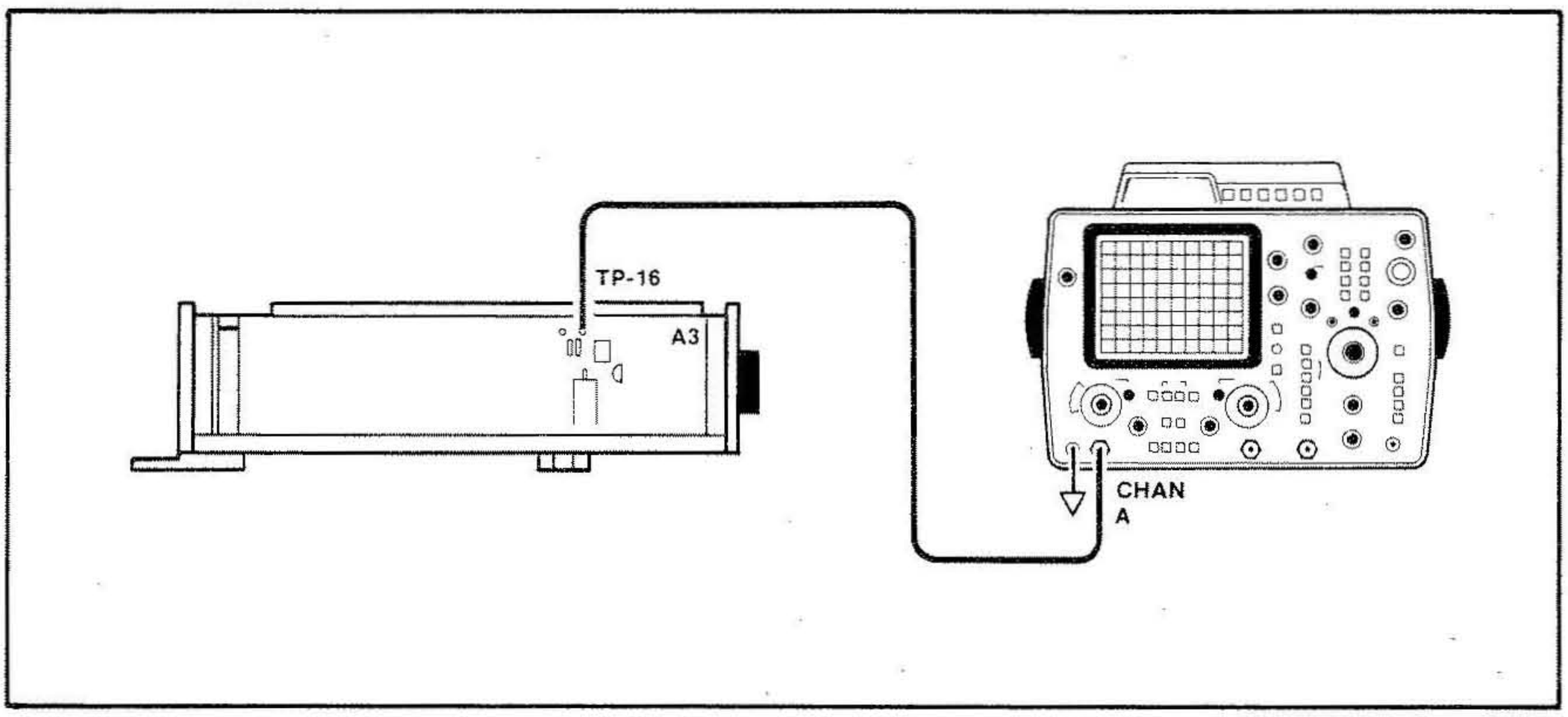


Figure 8-13. Quick Tuning Check Test Setup

d. Enable the laser high voltage section by setting the TEST-NORMAL switch (A1S2) on A1 Connector board to TEST.

e. On A3, change HEATER jumper, JMP 7 from NRM to OFF.

f. Set oscilloscope controls as follows:

1. Timebase to 2 milliseconds/division or faster.

2. Trigger to normal. Adjust the triggering for minimum flickering of the trace.

3. Vertical attenuator to 0.05V/division for X10 probe use or to 0.5V/division when using a direct probe. Set coupling to dc.

g. To simulate a failure to observe how the waveforms at TP16 behave, move JMP 3 LIQ CRYS jumper to ACT. Note that the scope trace wanders up and down in a very smooth continuous manner with varying speed. If this occurs in step h, the liquid crystal switch or A3U11 is defective. Return JMP 3 LIQ CRYS jumper to original position.

h. If the sampler, photodiode, and amplifier are working properly, the oscilloscope display will show the trace switch between two distinct levels. See *Figure 8-14* below. With continued observation these levels, which correspond to F1 and F2, will change amplitudes since the tuning is uncontrolled. The difference between the levels varies with time between a maximum difference and a minimum difference.

NOTE

WAVEFORM WILL APPEAR AS A "FLAT" LINE AND WILL MOVE UP AND DOWN ON THE DISPLAY DURING NORMAL OPERATION.

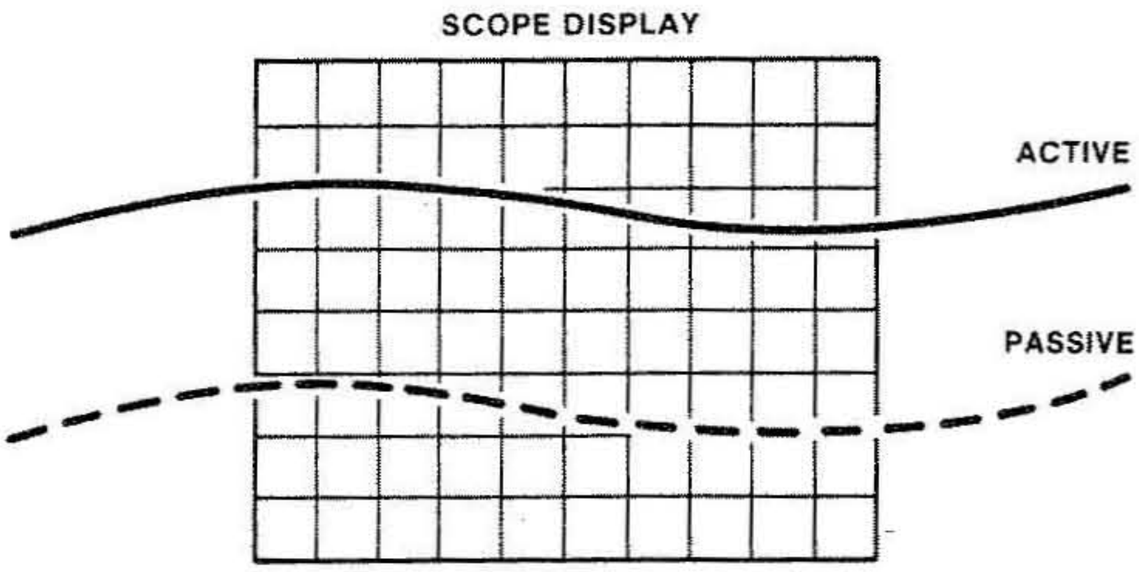


Figure 8-14. Quick Tuning Check Waveform Display

i. Disconnect the test equipment and set HEATER jumper JMP 7 to NRM. Set TEST-NORM switch to NORM and replace HP 5501B covers.

8-67. Testing the Liquid Crystal Switch

8-68. The following material and test equipment is required for the test:

a. A white piece of cardboard.

b. 50 Hz Square Wave Generator (TTL Level)

c. Test Polarizer (HP Part Number 1000-0616)

8-69. To test the liquid crystal, proceed as follows:

a. Remove the liquid crystal from the sampler assembly as shown in *Figure 8-15* below:

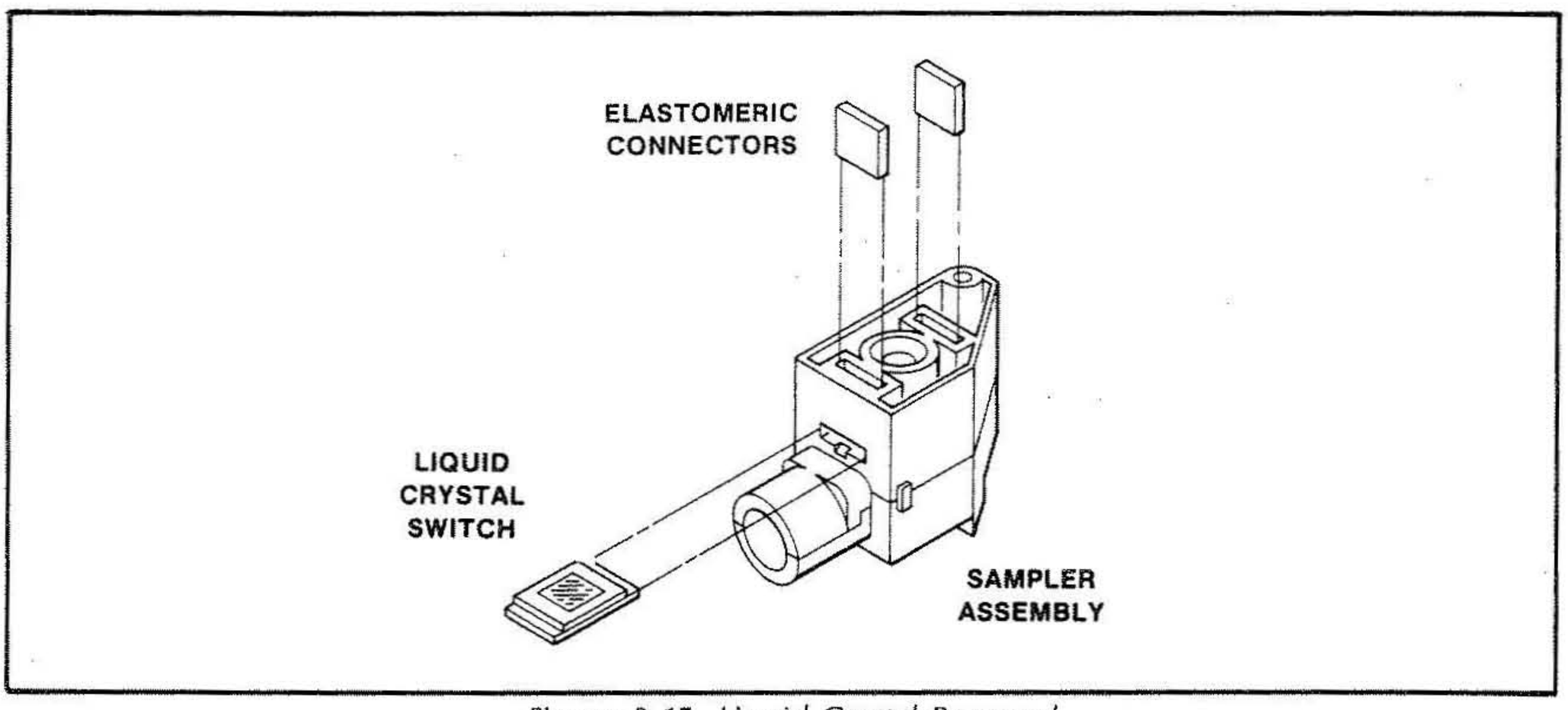


Figure 8-15. Liquid Crystal Removal

b. Place the liquid crystal in the test setup shown in *Figure 8-16* below:

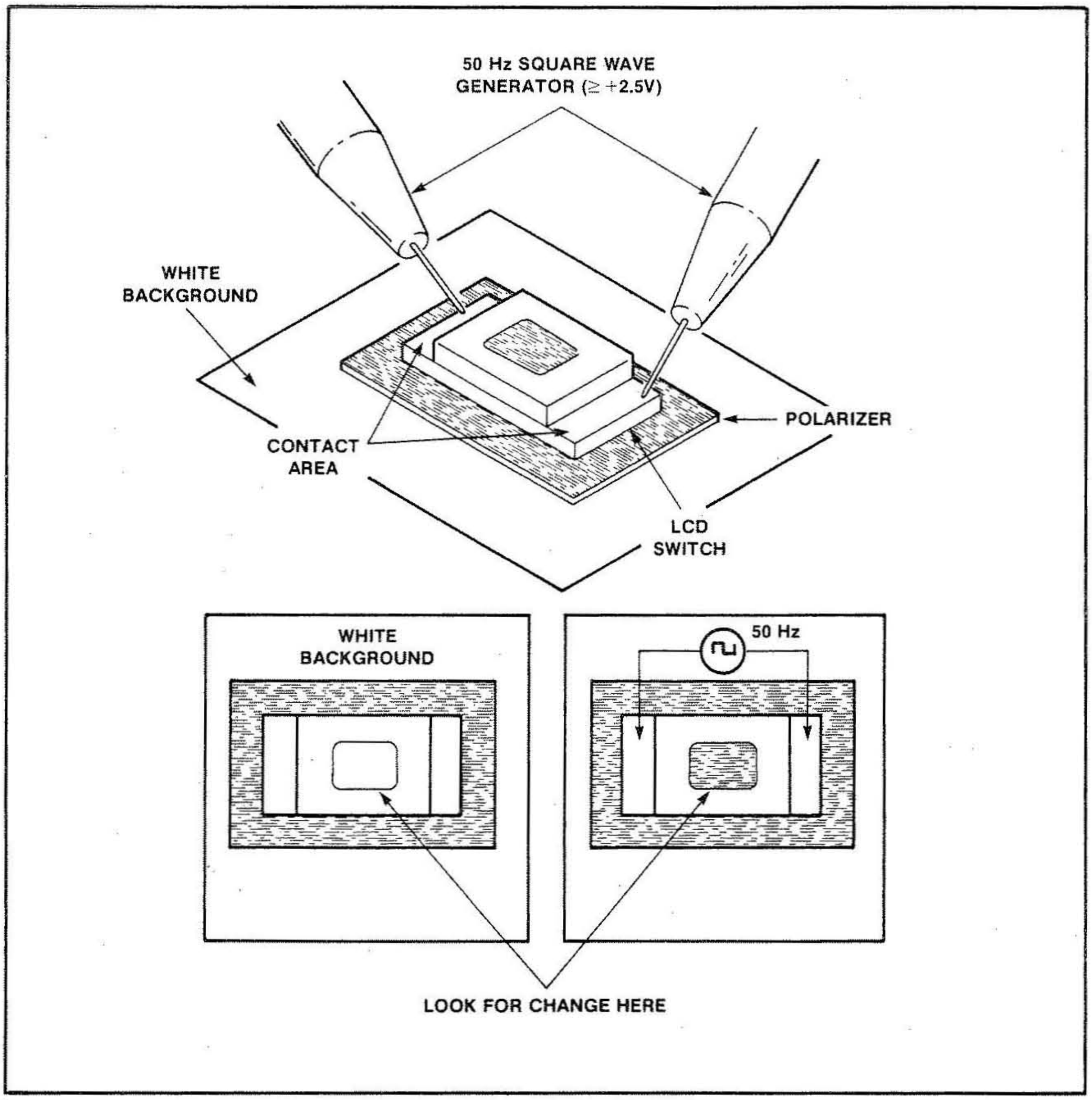


Figure 8-16. Liquid Crystal Test Setup

CAUTION

Do not apply DC voltages across the liquid crystal switch. Sustained dc current flow through the liquid crystal may damage the device.

c. Gently place the probes of the 50 Hz signal source on the end shoulders of the liquid crystal as shown in *Figure 8-16* and observe the window area, it should go from light to dark while probing the device. A faint change of color or no change indicates a faulty liquid crystal. The replacement HP part number for the liquid crystal is 1990-0768.

8-70. HP 5501B Trouble Isolation Procedure

8-71. Before HP 5501B trouble isolation is attempted, the Laser Head Block Diagram Description (paragraphs 8-18 through 8-45) should be read. All electronic tests can be performed using an HP 5005A/B Signature Multimeter.

WARNING

WITH THE HP 5501B COVERS REMOVED AND A1S2 SET TO THE TEST POSITION, VOLTAGES OF UP TO 12 KV WILL BE PRESENT AT THE OUTPUT OF THE HIGH VOLTAGE POWER SUPPLY ASSEMBLY A2.

NOTE

After servicing the HP 5501B, be sure to set A1S2 to the NORM position, otherwise power will be disconnected.

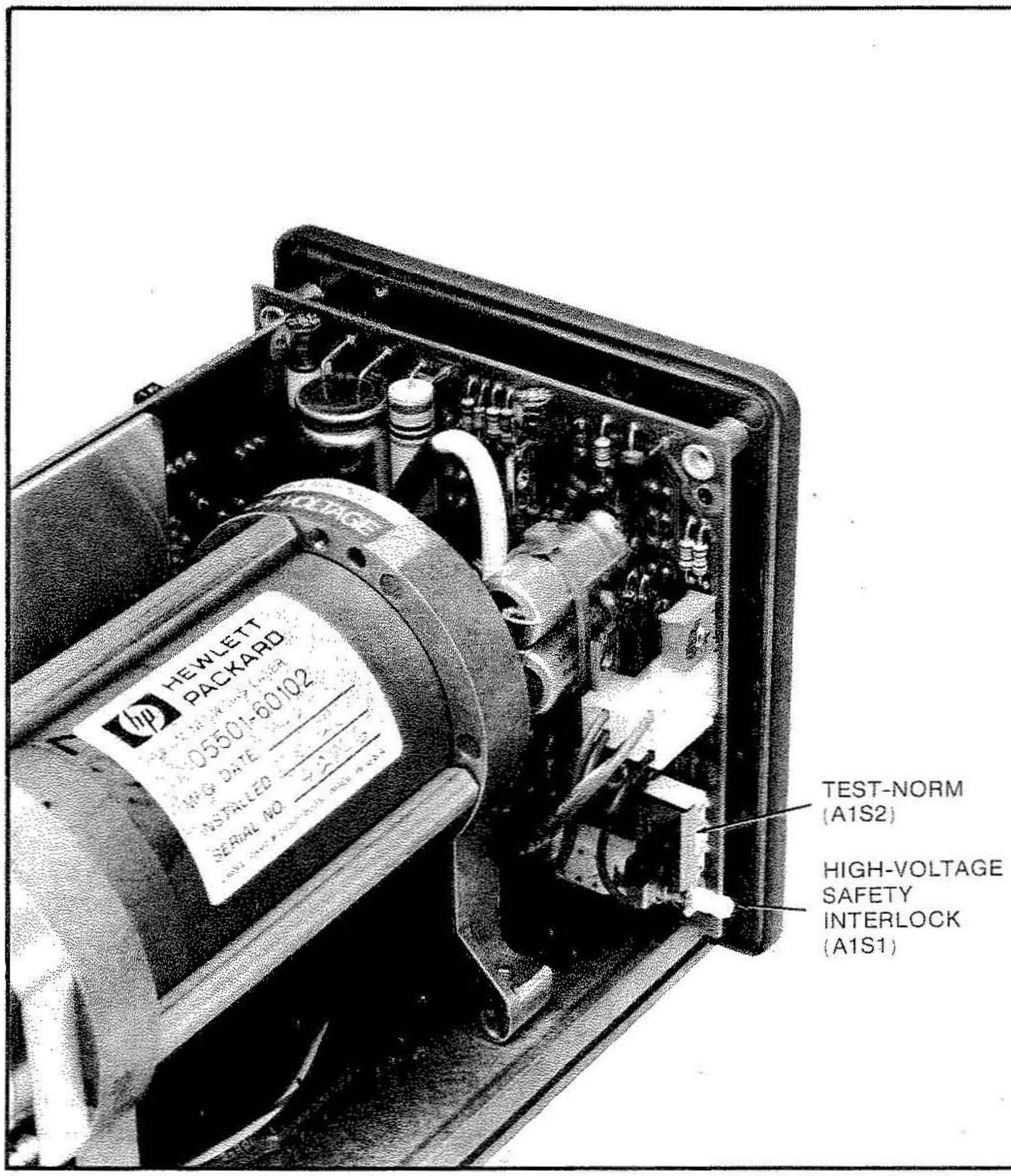


Figure 8-17. HP 5501B TEST-NORM Switch A1S2

8-72. Procedure

a. Apply power to the HP 5501B.

b. Wait until rear panel LEDs finish sequencing (see *Table 3-1*). The LEDs should reflect the following status.

+15V SUPPLY UNBALANCE	OFF	+15V POWER ON	ON
-15V SUPPLY UNBALANCE	OFF	-15V POWER ON	ON
+15V FUSE	OFF	READY	ON
-15V FUSE	OFF	LASER ON	ON

c. If laser light is not emitted from the laser head, check that the exit shutter is open. Otherwise, see High Voltage Power Supply Troubleshooting in paragraph 8-89. Within 10 minutes of turn-on, the HP 5501B's READY LED indicator should turn on continuously, and the REFerence frequency signal should have been applied to the rear panel REFERENCE SIGNAL connector. Otherwise proceed with step d of this procedure. If the failure mode occurs after the 5501B has reached the optical tuning mode (normal operation), skip steps d through k of this procedure. Steps d through k address failures that prevent the laser from reaching stable tuning.

d. Disconnect power and remove the covers of the HP 5501B. Set A1S2 to TEST and verify that all boards are seated correctly and all test jumpers on the A3 board are in the left-most position (NRM).

e. Connect power. Check the following voltages. If any are incorrect, see Power Supply Troubleshooting in A3 Troubleshooting Procedures (paragraph 8-151 or see A1 Connector Board Troubleshooting Procedures (paragraph 8-84):

WARNING

WITH A1S2 IN THE TEST POSITION, THE HP 5501B HIGH VOLTAGE POWER SUPPLY IS ENABLED WHEN THE LASER HEAD IS IN OPTICAL MODE.

A3TP8: +14.7V to +15.3V

A3TP9: +4.75V to +5.25V

A3TP10: -14.7V to -15.3V

f. Disconnect power for a few seconds, then reconnect. Observe READY LED on the HP 5501B. Find the READY LED description in steps g through j that matches your observation and follow that step.

g. READY LED (green) takes longer than 6 minutes to start to blink. Either the digital section is not working or the heater is not being heated properly. Check the following procedures:

- A3 Digital Section
- A3 Power Amplifier
- A3 Warm-Up Error Amplifier
- A3 Subtracting Sample and Hold

h. READY LED (green) blinks within 6 minutes, blinks for less than approximately 150 seconds, goes off, then repeats this action. This indicates that the warmup mode feedback is not properly controlling the heater voltage. Check the following procedures:

- A3 Power Amplifier
- A3 Warm-Up Error Amplifier
- A3 Digital Section
- A3 Subtracting Sample and Hold

i. READY LED (green) blinks within 6 minutes, blinks for less than approximately 150 seconds, comes on for one second (twice as long as when it is blinking) then goes off briefly. This action is then repeated. (An equivalent observation is LTO line [A3U9 (Pin 11)] comes on for 1 second every few minutes). Either the optical mode feedback is not working or the reference receiver is defective. See Quick Tuning Checkout Procedure, paragraph 8-64, and Reference Receiver Troubleshooting, paragraph 8-152.

j. READY LED (green) blinks within 5 or 10 seconds, comes on for a few minutes after approximately 3 minutes, then starts blinking again. Check A1/A3 Power Amplifier section; especially A3U20 and A1Q5-9.

k. Any other READY LED (green) observation indicates a defective digital section. See A3 Digital Section Troubleshooting, paragraph 8-138.

l. If a REFerence frequency signal error is indicated after the laser has successfully reached normal operation (READY LED on continuously and REFerence frequency signal output) make the following observation. Does the READY LED extinguish when the failure occurs? If so, the optical tuning may be failing or the reference receiver may be resetting the state machine due to marginal signal strength. Use the Laser Power Output Test (paragraph 4-11) as a check of the laser assembly and Quick Tuning Checkout Procedure to get an indication of the function of the optical tuning subsystem before proceeding with lower level testing. Use the Reference Receiver Troubleshooting Procedure, paragraph 8-152, to check signal level if the laser assembly and tuning circuits appear to be functioning properly. If the READY LED does not extinguish, spurious errors may be occurring on the REFerence frequency signal. Various internal and external noise or interference may be responsible. Check A3 ground connections and Vcc coupling capacitors. Check that the HP 5501B covers are fastened securely. Marginal optical signal to the reference receiver may aggravate noise problems. Check for adequate signal according to Reference Receiver Troubleshooting, paragraph 8-152. Improper system grounding may also cause noise problems, see Section II.

8-73. A1 CONNECTOR BOARD CIRCUIT THEORY

8-74. The A1 Connector Board interconnects the main laser cable, laser tube heater and power amp, laser power supply, and the A3 Controller/Reference Board. The schematic diagram for A1 is shown in *Figure 8-23*. Additional information covering heater power amp control circuitry can be found in paragraph 8-119.

8-75. Capacitors A1C1 through A1C4 serve to filter out noise on the ±15 Volt power supply lines. Capacitors A1C6 and A1C7 and inductors A1L1 and A1L2 filter current spikes created by the high voltage power supply and the switching power amplifier. Diodes A1CR1 and A1CR2 provide reverse voltage protection. Switch A1S1 is a safety interlock which removes power from the laser high voltage power supply when the HP 5501B covers are removed. Switch A1S2 bypasses the interlock so that the laser can be serviced. A1S1 and A1S2 are wired in such a way that the interlock must be enabled before replacing the covers. A1F1 and A1F2 protect the system against laser power supply failures. A1J4 is the connector for the laser tube heater and cathode. A1DS3 and A1DS4, +15V POWER ON and -15V POWER ON LEDs respectively, turn on when the power cable is connected to POWER connector A1J5. A1DS7 (LASER ON LED) lights when the high voltage supply is powered. A1DS8 (READY LED) lights when the HP 5501B is ready for use. A1R12 is used to adjust laser current as per the adjustment procedures in Section V.

8-76. High Voltage Power Supply Switch (A1Q3 and A1Q4)

8-77. When optical mode begins, the laser beam should be on. This is accomplished by applying the ~WARMUP logic line through current limiting resistor A1R10 to the base of transistor A1Q4. A1Q4 saturates which, in turn causes A1Q3 to turn on and saturate. The high voltage power supply senses ground through saturated A1Q3, thus turns on.

8-78. If the HP 5501B left and right covers are placed on the unit prior to resetting the TEST-NORM switch (A1S2) to NORM, both SUPPLY UNBALANCE LEDs will turn on. When power is applied, A1 transistors Q1 and Q2 sample the heater switching voltage through ac voltage divider A1R23 and A1R24. A1C5 ensures that transistor bases of A1Q2 and A1Q2 remain at "virtual" dc ground so that the unbalance circuits operate normally.

8-79. Power Distribution

8-80. When +15 Vdc and -15 Vdc are applied to the laser head, the ±15V POWER ON light-emitting diode indicator (on the A1 Connector Board) are forward biased and illuminate. The dc input potentials also produce a virtual ground level at the junction of two 14.7K Ohm resistors. This balanced condition results in an open circuit at transistors A1Q1 and A1Q2. 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 forward biasing of A1Q1 or A1Q2 thus placing the anode of LED DS5 or DS6 (±15V SUPPLY UNBALANCE) at "virtual" ground potential. *Table 8-2* lists the unbalanced DC voltage conditions and the resulting unbalanced indications.

Table 8-2. DC Unbalanced Failures

DC INPUT VOLTAGE	UNBALANCED CONDITION	UNBALANCED INDICATORS	
		+15V SUPPLY UNBALANCE	-15V SUPPLY UNBALANCE
+15 Vdc	High (more positive) Low (less positive)	ON OFF	OFF ON
-15 Vdc	High (more negative) Low (less negative)	OFF ON	ON OFF

8-81. If either the +15 Vdc or -15 Vdc 1.5 Amp fuse opens, the difference in potential that results (across DS1 or DS2) will forward bias the associated LED indicator, turning that fuse indicator on.

8-82. System operating power is distributed to the laser head and other transducer units via the connector board. Safety switch A1S1 opens when the laser head covers are removed. This disconnects -15 Vdc from the high voltage power supply. As a result, this power supply becomes inoperative. The +15 Vdc input is applied to regulator A3U7 on the A3 Reference/Control Board. This regulator provides +5 Volts for use within the laser head. The +5 Volts is used to drive laser head's logic circuitry, READY LED (A1DS8), and as a reference for the high voltage power supply switch.

8-83. A1 CONNECTOR BOARD TROUBLESHOOTING

WARNING

HIGH VOLTAGE IS PRESENT ON A1J4 IF THE LASER IS ON AND THE TUBE CONNECTOR IS NOT CONNECTED TO A1J4.

8-84. Use the schematic diagram *Figure 8-23*, an ohmmeter, and a voltmeter to troubleshoot A1. Check to see if A1F1 is blown. Check for proper transmission of power supply voltages. Check for proper diode action across A1CR1 and A1CR2. Check A1C1 through A1C5 for shorts. Check switches A1S1 and A2S2. Check A1R3 and A1R4.

8-85. Rear Panel LED Operational Check

WARNING

MAINTENANCE DESCRIBED HEREIN IS PERFORMED WITH POWER SUPPLIED TO THE EQUIPMENT AND WITH THE PROTECTIVE COVERS REMOVED. SUCH MAINTENANCE SHOULD BE PERFORMED ONLY BY SERVICE-TRAINED PERSONNEL WHO ARE AWARE OF THE HAZARDS INVOLVED (FOR EXAMPLE, FIRE AND ELECTRIC SHOCK). WHERE MAINTENANCE CAN BE PERFORMED WITHOUT POWER APPLIED, THE POWER TO THE EQUIPMENT SHOULD BE REMOVED.

WARNING

FROM 1.2 KILOVOLTS TO 12 KILOVOLTS DC IS PRESENT ON THE ANODE OF THE LASER TUBE IN THE HP 5501B. EXERCISE EXTREME CAUTION WHEN WORKING INSIDE THE INSTRUMENT. THE HIGH VOLTAGE COULD CAUSE SERIOUS PERSONAL INJURY IF CONTACTED. THE INSTRUMENT SERVICE SHOULD BE PERFORMED BY SERVICE-TRAINED PERSONNEL ONLY.

8-86. The following procedure can be used as an operational check of the rear panel LEDs. Perform only if a problem is suspected.

a. Remove HP 5501B instrument covers as described in paragraph 8-55.

b. Leave TEST-NORM switch (A1S2) set to NORM.

c. Apply power to laser head as per *Figure 4-1.* (Use HP 6255A Dual DC Power Supply or its equivalent.)

d. Within 10 minutes of applying power to the laser head, the rear panel LEDs should reflect the following status.

+15V SUPPLY UNBALANCE	ON	+15V POWER ON	ON
-15V SUPPLY UNBALANCE	ON	-15V POWER ON	ON
+15V FUSE	OFF	READY	OFF or FLASHING
-15V FUSE	OFF	LASER ON	OFF

e. Disconnect power from laser head.

f. Using a pair of insulated long-nose pliers, CAREFULLY remove -15 Volt fuse from A1 board. Pull fuse straight out: DO NOT TWIST.

g. Reapply power to laser head.

h. The rear panel LEDs should reflect the following status.

+15V SUPPLY UNBALANCE	ON	+15V POWER ON	ON
-15V SUPPLY UNBALANCE	OFF	-15V POWER ON	OFF
+15V FUSE	OFF	READY	OFF
-15V FUSE	ON	LASER ON	OFF

i. Disconnect power from laser head.

j. Using a pair of insulated long-nose pliers, CAREFULLY return -15V fuse to its A1 board location. Remove +15V fuse. Pull fuse straight out: DO NOT TWIST.

k. Reapply power to laser head.

l. The rear panel LEDs should reflect the following status.

+15V SUPPLY UNBALANCE	OFF	+15V POWER ON	OFF
-15V SUPPLY UNBALANCE	ON	-15V POWER ON	OFF
+15V FUSE	OFF	READY	OFF
-15V FUSE	ON	LASER ON	OFF

m. Disconnect power from laser head.

n. Replace both fuses in A1 Connector board sockets.

o. Reapply ±15 Volts to rear panel POWER connector.

p. Set TEST-NORM switch (A1S1) to TEST to re-enable the High Voltage Power Supply.

q. Wait until the rear panel LEDs reflect the following status.

+15V SUPPLY UNBALANCE	OFF	+15V POWER ON	ON
-15V SUPPLY UNBALANCE	OFF	-15V POWER ON	ON
+15V FUSE	OFF	READY	ON
-15V FUSE	OFF	LASER ON	ON

r. Adjust +15 Volt supply to +17 Volts.

s. +15V SUPPLY UNBALANCE LED should turn on at a maximum of +16.6 Volts.

t. Adjust +15 Volt supply to +13 Volts.

u. –15V SUPPLY UNBALANCE should turn on at a maximum of +13.4 Volts.

v. Readjust ±15 Volt supplies to |15V| ± 0.3 Volts.

8-87. A2 HIGH VOLTAGE POWER SUPPLY CIRCUIT THEORY

8-88. The High Voltage Power Supply (*Figure 8-18*) receives –15V from the system power supplies through A1F2 and A1Q3. A1R11 and A1R12 set the high voltage output current limit. The laser discharge current passes through the high-voltage connector and ballast resistor to the laser anode and from the laser cathode to A1J4 (Pin 1). The High Voltage Power Supply switch also requires the +5 Volt supply (see *Figure 8-18*).

WARNING

NEVER REMOVE A1J4 WITH THE HIGH VOLTAGE SUPPLY ON. DANGEROUS HIGH VOLTAGE EXIST.

8-89. HIGH VOLTAGE POWER SUPPLY TROUBLESHOOTING

WARNING

LASER RADIATION IS ACCESSIBLE WHEN THE 5501B COVERS ARE REMOVED AND THE TEST-NORM SWITCH A1S2 IS IN THE TEST POSITION.

FROM 1.2 KILOVOLTS TO 12 KILOVOLTS DC IS PRESENT ON THE ANODE OF THE LASER TUBE IN THE HP 5501B. EXERCISE EXTREME CAUTION WHEN WORKING INSIDE THE INSTRUMENT. THE HIGH VOLTAGE COULD CAUSE SERIOUS PERSONAL INJURY IF CONTACTED. ANY MAINTENANCE SHOULD BE PERFORMED BY SERVICE TRAINED PERSONNEL ONLY.

8-90. Various conditions result from a faulty HV power supply.

a. No laser light is emitted.

1. Check that A1S2 is set to NORM when HP 5501B covers are on or TEST when the covers are off.

2. Check high voltage connectors (A1J3 and A1J4).

3. Check voltage at transistor A1Q3's emitter. With High Voltage Power Supply on, this voltage should approach zero.

4. Check that A1F1 and A1F2 are OK and that the voltages are +15V and –15V respectively.

If rear panel LASER ON LED is on but the laser beam remains off, there is a high probability that the HVPS is defective.

LIST OF TABLES

Table	Title	Page
1-1.	HP 5501B Laser Head Specifications and Performance Characteristics	1-4
1-2.	Recommended Test Equipment	1-5
2-1.	Laser Head System Signal Chart	2-6
2-2.	HP 5501B Power Supply Requirements	2-7
3-1.	Proper 5501B Rear Panel LED Power-up Sequence	3-5
3-1.	Program Modifications for Table 4-12 in the HP 5501A System Manual	3-8
3-2.	Program Modifications for Table 4-13 in the HP 5501A System Manual	3-9
3-3.	Modified HP 10745A HP-IB Interface Program	3-10
3-4.	Modified HP 10746A Binary Interface Program	3-11
4-1.	Input Voltage	4-1
6-1.	Exchange Assemblies	6-1
6-2.	Reference Designations and Abbreviations	6-3
6-3.	5501B Board Assemblies Replaceable Parts	6-4
6-3.	5501B Miscellaneous Chassis Parts	6-14
6-4.	Manufacturer's Code List	6-16
8-1.	A3 U9 Test IC Signal Summary	8-12
8-2.	DC Unbalanced Failures	8-25
8-3.	IC A3U4 and A3U6 Divider Check	8-38
8-4.	Signature Table	8-40
8-5.	Voltage Testpoints and Limits	8-45
8-6.	A3U17 Reference Receiver Test Voltages	8-47

5. Turn the power off and disconnect the high voltage connector. Carefully connect a high voltage probe, (you will need to make a jumper to extend the probe into the high voltage connector).

6. Turn power back on and perform an open circuit voltage test. Before performing the open circuit voltage test, wait until the laser is in optical mode. This is indicated when LED A3DS2 is on. If A3DS2 is off, check A3 logic circuitry. A3DS2 should turn off approximately 100 seconds after reapplying power. The voltage should be 10 kV to 12 kV. If not, replace the high voltage power supply. If the laser still doesn't work then replace the laser assembly.

WARNING

AFTER TESTING, THE POWER SUPPLY MAY TAKE UP TO 3 MINUTES FOR THE OPEN-CIRCUIT VOLTAGE TO DECAY. THEREFORE, SHORT ANODE TO GROUND IMMEDIATELY.

b. Laser light is emitted but flashes or causes a REF Error.

1. Turn power off and disconnect A1J4. Insert a 1K, 1%, 0.5 Watt resistor (R_t) between the J4 (Pin 1) connector. [Leave J4 (Pin 2) disconnected].

2. Connect an oscilloscope across R_t.

3. Turn on power and allow the laser to warm up.

4. Observe DC test voltage. It should be between 3 and 4 Volts. If not, perform the current adjustment procedure in section 5-18 of this manual.

5. Set the oscilloscope to view the AC component and calculate the percent ripple. There should be less than 3% ripple in the test voltage. If not, replace the HV power supply. If the ballast resistor is bad, the test voltage might be an aperiodic intermittent voltage. If this is the case, replace laser tube assembly.

6. Disconnect external ±15 Volt power supplies from laser head.

7. Remove resistor R_t and replace connector to A1J4.

NOTE

If a power supply problem seems intermittent, gently tapping the HVPS with a screwdriver will induce the problem for test purposes.

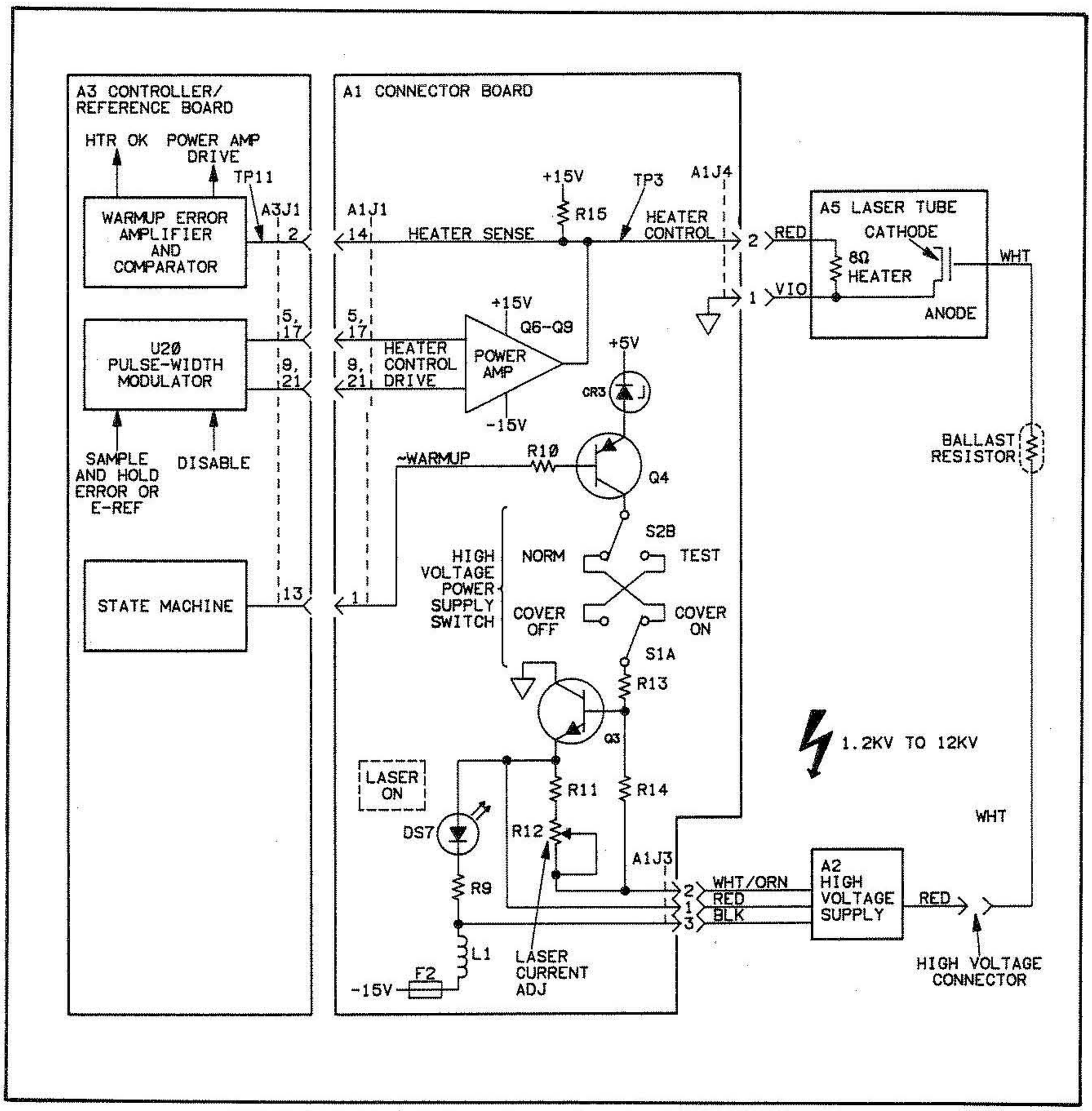


Figure 8-18. High Voltage Power Supply, Schematic Diagram

8-91. A3 CONTROLLER/REFERENCE BOARD AND A4 SAMPLER BOARD CIRCUIT THEORY

8-92. Introduction

8-93. *Figure 8-18* (two sheets) shows the schematic diagram for the A3 Controller/Reference Board and the A4 Sampler Board.

8-94. The A1, A3, and A4 boards contain the electronics for the following portions of the Laser Head Block Diagram:

- Power Amplifier
- Warmup Error Amplifier
- Photodiode and Amplifier
- Liquid Crystal
- Clock and State Machine
- Subtracting Sample and Hold
- Reference Receiver

8-95. Clock Ⓐ

8-96. The frequency of oscillator U10 is determined by timing components R8, C3, C7, and C8. For normal operation, C7 gives an output frequency of approximately 100 Hz. For testing purposes capacitors C3, C7, and C8 can be configured so that the oscillator circuit generates a 1000 Hz output (JMP 8 in HI position). To troubleshoot using signature analysis, the oscillator can be configured to run at 75 kHz (±20%) by removing the CLK FREQ jumper JMP 8 completely.

8-97. Dividers Ⓑ

8-98. The dividers, consisting of U4A and U6, convert the 100 Hz oscillator signal into the desired periods. The first stage of the divider is U6, a dual 4-bit counter, which divides the 100 Hz by 256. The last output of U6 at Pin 8 has a period of 2.56 seconds (nominal). The output of U4A at Pin 13 has a period of 5.12 seconds while the output at Pin 9 provides a period of 25.6 seconds. These two outputs are ANDed by U2C to produce a signal called DISABLE which is high 2.56 seconds out of every 25.6 seconds. DISABLE is used by the subtracting sample and hold circuit and the power amplifier.

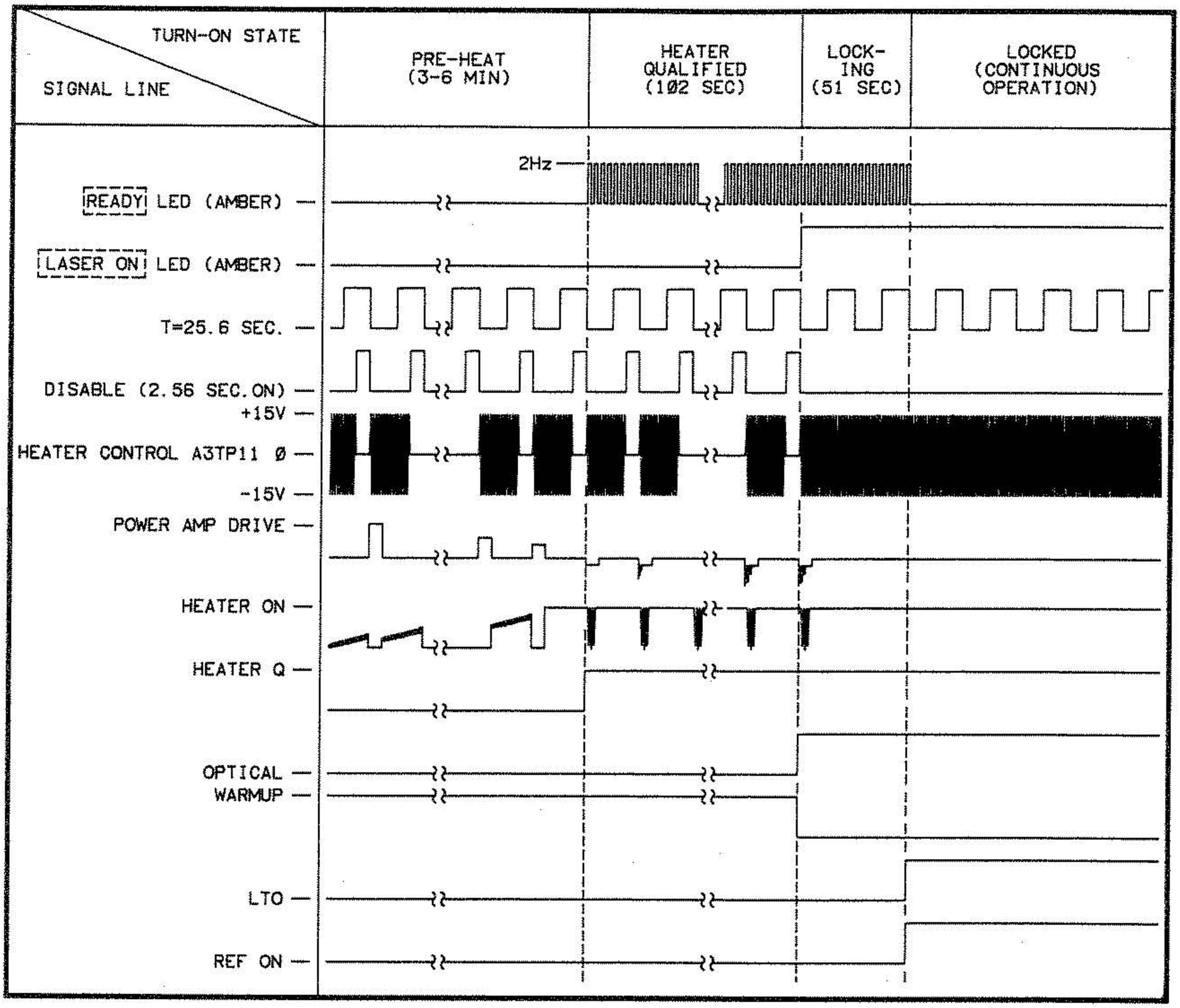


Figure 8-19. State Machine Timing Diagram

8-99. State Machine Ⓕ

8-100. The state machine, consisting of U3, U4B, and U8A, determines the four states of controller operation. The warmup mode is divided into two states, preheat and heater qualified. The optical mode is divided into locking and locked states (see *Figure 8-3*, Flow Diagram for State Machine). The sequence from preheat to locked is described in the following paragraphs.

8-101. Upon power-up, the power-on reset circuit places the state machine in the preheat state and the power amplifier turns the heater full on.

8-102. U8A samples the HTR OK signal on the falling edge of DISABLE to allow sufficient time for the heater coil to cool to the rod temperature. See *Figure 8-5*, Warmup Mode Timing Diagram. When the heater temperature rises to the proper value, the HTR OK signal from U15 causes the output of U8A, HTRQ, to go high. The state machine enters the heater qualified state and the READY LED blinks approximately twice per second. The rate of blinking is determined by the output of U6B which is gated through U2A and U19C to the READY LED. Blinking continues until the state machine enters the locked state.

8-103. When HTRQ goes high, U4B changes states from reset to count. Unless reset by HTR OK dropping low, U4B counts for 100 seconds and then clocks U3A. This sets OPTICAL high and locks HTRQ on. The 100 second period is sufficient to stabilize the heater temperature.

8-104. When OPTICAL goes high, the state machine enters the locking state and optical feedback controls the heater. After this state has been held for 50 seconds, LTO [U1F (Pin 12)] goes high and the controller enters the locked state. If REF ON (a signal from the Reference Receiver) is low, the entire circuit will be reset by the Power-On-Reset circuit. Otherwise U1F and U19E turn on the READY indicator LED indicating that the HP 5501B is ready for use.

8-105. Liquid Crystal Ⓓ

8-106. The liquid crystal, which is mounted within the A6 Sampler Assembly, connects to CMOS driver U8B via elastomeric connector strips.

8-107. When the PASSIVE/~ACTIVE signal at U6B (Pin 8) is high, both outputs of U8B are high, thereby placing zero potential across the liquid crystal. This is the passive state of the liquid crystal and causes the laser beam polarization to rotate by 90 degrees.

8-108. When PASSIVE/~ACTIVE is low, U8B produces a 50 Hz, symmetrical square wave output to configure the liquid crystal in the active state. During this state, the liquid crystal does NOT rotate the laser beam polarization.

8-109. Photodiode and Amplifier Ⓔ

8-110. The polarizing filter, which lies between the liquid crystal and the photodiode (A1CR1), allows only one of the two orthogonal components of the laser beam to strike the photodiode. During the passive state of the liquid crystal, the polarizing filter blocks the vertical component and the photodiode current is proportional to the horizontal component. During the active state, the photodiode current is proportional to the vertical component. The output of U11D (at TP16) is the photodiode current multiplied by an effective resistance of:

$$\frac{(R20 + R22)\ R17}{R20}$$

8-111. Warmup Error Amplifier and Comparator Ⓙ

8-112. The bridge formed by A1R15 and the heater on one side, and A3R16, A3R18, and A3R19 on the other, generates an error signal on the order of 1 mV/deg C because the resistance of the heater increases with increasing temperature. The Warmup Error Amplifier, A3U14, amplifies this error.

8-113. The output of the HTR OK comparator, A3U15, goes high when the error voltage nears zero. The temperature at which HTR OK occurs is set by potentiometer A3R16 as described in the Reference Temperature Adjustment in Section V.

8-114. Subtracting Sample and Hold Ⓗ

8-115. During warmup mode, A3U2C output (DISABLE high) disables the heater (via the power amp) for 2.56 seconds out of every 25.6 seconds. During the 2.56 second disable, the heater temperature stabilizes and U12B samples the output of U14. When A3U12B opens, the sampled voltage is held on A3C13 and buffered by A3U11B. Switch A3U12C connects A3C14 and the input of A3U11C to ground.

8-116. During the optical mode, A3U11D alternately drives one of the sample and hold circuits, then the other. One sample and hold circuit (A3U12D, A3C14, and A3U11C) samples the output of A3U11D proportional to the horizontal component. The other sample and hold circuit (A3U12A, A3C13, and A3U11B) is used for the vertical component.

8-117. The first counter (A3U6) in the divider section controls the liquid crystal and the sample and hold circuits. A sample and hold is performed once per cycle of T1.28 alternating between the vertical and horizontal components [see *Figure 8-8* (Optical Mode Timing Diagram)]. Thus each component is sampled once every 2.56 seconds. The liquid crystal is allowed to stabilize for 0.64 seconds before the switch to the sample and hold is closed. The hold cycle begins when the switch opens at the end of a cycle of T1.28 and at the end of a half cycle of PASSIVE. The present half cycle of PASSIVE/~ACTIVE determines which component is sampled. Op-amp A3U11A computes the difference between the two sample and holds.

8-118. A1/A3 Power Amplifier ①

8-119. The output of A3U11A (from Subtracting Sample and Hold) drives the Power Amplifier section which in turn, drives the laser tube heater. The frequency response of the Power Amplifier is determined by both the input filter (A3R31, A3R27 and A3C18) and the A3U13 op-amp feedback filter (A3R32, A3R33, A3R39 and A3C20). Feedback is through A3R65B and A3C37, which integrates only the positive portion of the heater voltage. This integrated signal is proportional to heater power. A3U13 drives the input of A3U20, a switching regulator, which divides the heater power between the +15V and the -15V supplies. A3R36, A3CR7, and A3R61 form a current limiter and prevents applying a negative voltage to A3U20 (Pin 9). A3R63 and A3C38 determine the switching frequency (approximately 22 kHz or 46 microsecond period) and A3C36 controls the deadtime (off) to insure that the +15V and -15V outputs are not on at the same time. A1Q8 and A1Q6 form the positive Darlington that drives the heater to +15 Volts. A1Q9 and A1Q7 form the negative Darlington that drives the heater to -15 Volts. A1Q5 provides downshifting of negative-drive voltage level. A3U20 is disabled at Pin 10 by A3U2C when the heater error voltage is sampled during the warmup mode. The resistor networks (A3R54A, A3R54B, A3R54C, A3R65A, A3R65C, A3R65D, and A3R66) drive the output Darlingtons and limit the A3U21 input voltage to +5 Volts.

NOTE

Positive and Negative Darlington-configured transistors are located on the A1 Connector board.

8-120. To maintain the +15V and -15V currents within maximum specified range and, because the High Voltage Power Supply (HVPS) turns on at the start of optical mode (using only the -15 Volt current supply), the maximum currents must be limited during each of the following three conditions:

1. +15 Volt supply current during warmup and optical mode,
2. -15 Volt supply current during warmup mode, and
3. -15 Volt supply current during optical mode (~warmup mode).

The current used by each of the two Darlingtons is proportional to the pulse length. The pulse begins at the fall of the positive rising sawtooth waveform (0.5V to 3.5V) at A3U20 (Pin 7) and, during the maximum current condition, is terminated when the sawtooth reaches the voltage at A3U20 (Pin 9), which is E REF at the base of Q7. A3CR8 provides temperature matching and separation between A3U13 and A3Q7 when current limiting is off. E REF is the output of a multiple voltage divider network (A3R68, R69, R70, R71, R72, R73, R74) set by the open collector logic network of A3U21 which monitors the Darlington "ON" states and the warmup signal line. The voltage divider resistors are set sequentially. A3R73 and R74 are set first and limit the maximum current of the -15 Volt Darlingtons during the optical mode. Next, A3R68 and R69 set the maximum current limit for the +15 Volt Darlingtons during either warmup or optical mode. And last, A3R70 and R71 set the -15 Volt Darlingtons to the maximum current limit during the warmup mode.

8-121. Reference Receiver Ⓛ

NOTE

A TILDE ("~") PRECEDING ALL SIGNALS INDICATES NEGATIVE-TRUE LOGIC.

8-122. The reference receiver consists of photodiode A3CR5, an amplifier A3U17, a transistor level shifter A3Q6, and associated passive components. The receiver amplifies and converts the sinusoidal output from A3CR5 to a square wave. When ~LTO (LOCKED TUNED OPTICAL) goes low, and the receiver amplifier has adequate signal level input, the receiver is enabled and provides a low TTL signal ~REF ON. During the warmup and locking modes, the receiver supplies no useful information and is therefore disabled (~LTO high).

8-123. A3CR5 is reverse biased to reduce its capacitance. The +15V bias voltage is filtered by A3R46 and A3C27. A polarizer, oriented at 45 degrees to both optical frequency components, passes optical power at the reference frequency onto A3CR5. The reference frequency is the difference in frequency between the two optical frequency components of the laser beam.

8-124. A3U17 contains two amplifiers. The gain of the first amplifier is set by A3R44. The gain of the second amplifier is fixed. A peak detector circuit charges A3C28 to a DC value proportional to the output of A3U17. With no current from the photodiode, the voltage on A3C28 is approximately equal to the voltage on A3C24. When photodiode current is present, the change in voltage on A3C28 is the amplitude of the signal coming out of the second amplifier. When the amplitude exceeds 100 mV, the voltage at A3U17 Pin 2 (~REF ON) drops to TTL low. A3Q6, A3CR6 and A3R45 shift the output of A3U17 to TTL levels. A3 capacitors C22, C23, C24, C26 and C29 are used for coupling and bypass. A TTL high on A3U17 Pin 11 (~LTO) gates off the reference frequency output and raises A3U17 Pin 2 to Vcc.

8-125. Line Driver Ⓚ

8-126. A3U16 provides the necessary power to output the reference frequency signal to the system electronics. A3L3 limits the current spikes in A3U16. The special grounding and decoupling of the line drivers and receivers prevent crosstalk and oscillations.

8-127. Power-On Reset (POR) Ⓖ

8-128. When power is turned on, or REF ON drops low during the locked state of the optical mode, the power-on reset circuit sets the state machine in preheat state.

8-129. Laser Head Power Ⓒ

8-130. +15V and –15V are supplied by the system power supplies via the rear panel POWER connector A1J5. The +5V is generated by A3U7. A3CR2 protects A3U7. A3C5 stabilizes A3U7 and A3C4 filters A3U7 output. Output +15V is the supply after being filtered by A3L2 and A3C11. A3L1 and A3C12 filter –15V. A3 capacitors C2, C3, C6, C16, C17, and C21 provide local decoupling of the supplies.

8-131. A4 Sampler Board

8-132. The Sampler board connects to Controller/Reference board A3. The only active component on A4 is A4CR1, a photodiode that provides a signal to U11D (Pin 13) on A3. Pads on the underside of A4 connect to

the liquid crystal via elastomeric connectors which project from the A6 Sampler Assembly. Liquid crystal operation is discussed in the A3 theory section.

8-133. A3 CONTROLLER/REFERENCE BOARD TROUBLESHOOTING

8-134. Service for A3 is divided into the following procedures, consult paragraph 8-64, HP 5501B Trouble Isolation to determine which procedure to use.

a. Digital

b. Photodiode and Amplifier

c. Liquid Crystal

d. Subtracting Sample and Hold

e. Power Amplifier

f. Warmup Error Amplifier

g. Power Supplies

h. Reference Receiver

8-135. Standard Troubleshooting Procedures

8-136. In the following tests, reference is frequently made to "localize the defective element by standard troubleshooting procedures". This consists of the following:

a. The test procedure places a group of IC's in a definite state and:

1. provides the correct values of the input and output signals characteristics

OR

2. implies use of the schematic to determine the signal characteristics

OR

3. simply states a suspected component

b. When the test procedure specifies a suspected component, replace it and run the test again.

c. When signal characteristics are known, measure the signals until a component is found that has correct inputs but erroneous outputs. Most likely this component is defective. If not, check for:

1. output loading such as a board short

2. shorted input on a downstream circuit

If inputs are incorrect, check for open traces and faulty outputs from previous stages.

d. If an erroneous signal comes from another board, perform the test procedure for the suspected board.

8-137. Digital Troubleshooting

8-138. This procedure covers the clock, dividers, power-on-reset, and state machine blocks of the A3 board. The procedure assumes that the power supplies are functioning properly. The procedure requires use of standard troubleshooting procedures which are outlined in paragraph 8-136.

8-139. Troubleshooting Strategy: Signature analysis is used in this section to isolate faulty digital components. Malfunctions in the clock, dividers, or power-on-reset blocks will not allow the signature analyzer to operate properly. Proper clock operation is verified first, then an attempt at verifying the state machine using signature analysis is made. If the signature analyzer doesn't work, the dividers and resets must be repaired and then the state machine can be verified.

CAUTION

WHEN TAKING SIGNATURES, ENSURE THAT THE TEST-NORM SWITCH (A1S2) IS SET TO NORM AND THAT HEATER TEST JUMPER IS IN THE OFF POSITION. DAMAGE TO THE HIGH VOLTAGE POWER SUPPLY OR LASER ASSEMBLY COULD RESULT IF THESE INSTRUCTIONS ARE NOT ADHERED TO.

IMPORTANT NOTE

Upon successful completion of a check, unless otherwise specified, return all test jumpers to their original position [i.e., left-most NRM position)].

a. With power disconnected, remove front panel and side covers as described in paragraph 8-55.

b. Do not bypass high voltage interlock. Leave TEST-NORM A1S2 set to NORM. Set HEATER JMP 7 to OFF. Turn power on. Position all jumpers to the left. Measure clock frequency at TP5 (CLK). If it is 100 Hz ± 20% go to step c. If not, check clock section components.

c. Remove CLK FREQ jumper completely. If clock frequency is now 75 kHz ±20%, go to step d. If not, check C3 and C7.

d. Set HTR OK to HI and ~REF ON jumper to HI. Set up signature analysis clock, start, and stop signals for falling edge detection as indicated in the lower center portion of A3. Take signatures on U9.

Pin 16 (+5 V Test Signature)	104C
Pin 2	5653
Pin 3	2333
Pin 5	3357
Pin 7	U8PU
Pin 10	F103
Pin 11	6PCP
Pin 12	0148
Pin 13	A10H

Check signature at U19 (Pin 10) = A957

If these are OK, go to step n.

If the signature analyzer will not take signatures, then there is a malfunction in the dividers or power-on-reset sections, go to step e.

If the signature analyzer works, but one or more signatures are wrong, go to step f.

e. Set HTR OK to HI, REF ON to HI, and RESET to TEST. Connect TP2, TP3, and pin X of HTR OK jumper to ground (TP1 or TP18). Verify the dividers by measuring the frequencies at the IC pins indicated in *Table 8-3* and determine if they are equal to the indicated ratios, i.e. the frequency at U6 (Pin 13) should be equal to the frequency at TP5 divided by 16. Note: The counter function of the signature analyzer may not work so a dedicated counter might be needed.

Table 8-3. IC A3U4 and A3U6 Divider Check

Measure Frequency at IC	Pin		Frequency should be equal to ratio of	If Incorrect, faulty part is:
U6	13	=	F(TP5/16) or ~ 4.8 kHz	U6
U4	15	=	F(U6 pin 13/16) or 300 Hz	U4 or U6
U4	1	=	F(U4 pin 15/10) or ~ 30 Hz	U4
U4	7	=	f(U4 pin 1/10) or ~ 3 Hz	U4

If no problem is found, proceed to step f.

f. Set HTR OK to HI, ~REF ON to HI, RESET to TEST. Connect TP2, TP3, and Pin "X" of HTR OK jumper to ground. (TP1 or TP18). Set up the signature analysis clock, start, and stop signals for falling edge detection. Using the signatures listed in step t, localize the defective element by using standard signature analysis troubleshooting. Begin with U9 and use the schematic to trace back faulty signals. Check U1 (Pin 6), U19 (Pin 10), and U2 (Pin 6) right away, they are critical points. If no trouble is found, go to step g.

g. Remove ground connection on HTR OK jumper. Is U8 (Pin 6) signature O5C5? If not, U8A or R48B is faulty. If so, go to step h or see Warm-Up Error Amplifier Troubleshooting.

h. Remove the ground connection on TP3 and leave off. Is the +5V signature (TP9) = CP5P? If not, go to step i. If so go to step k.

i. Set HTR OK to LO. Is U8 (Pin 5) low? If not, U8 is bad. If yes, go to j.

j. Is TP3 high? If yes, go to k. If no, check U4B, U5D, U19D, R5D.

k. Remove ground connection on TP2 and leave off. Set HTR OK to HI. Is +5V signature = AF7A? If yes, go to step n. If no, go to step l.

l. Remove RESET jumper. Tie center pin to +5 V. Is TP2 high? If not, replace U1, U19, or R5. If so, go to m.