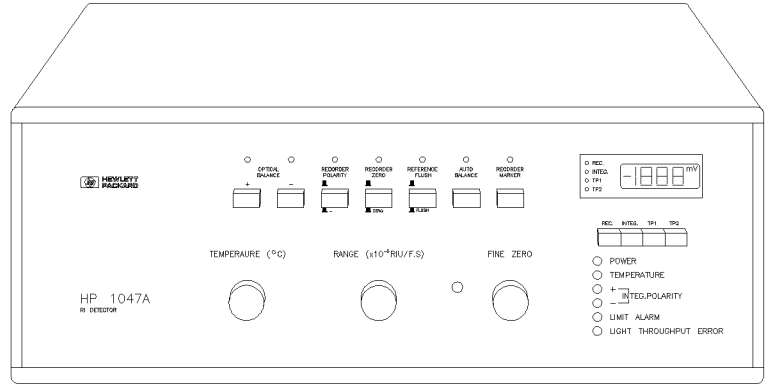
HP 1047A

Service Handbook

Refractive Index Detector (RID)



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Notice

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General Information

Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements.

General

This is a Safety Class I instrument (provided with terminal for protective earthing) and has been manufactured and tested according to international safety standards.

Operation - before applying power

comply with the installation section. Additionally the following shall be observed:

Do not remove instrument covers when operating. Before the instrument is switched on, all protective earth terminals, extension cords, auto-transformers and devices connected to it should be connected to a protective earth via a ground socket. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in serious personal injury. Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any intended operation.

Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuseholders must be avoided.

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

Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible, and when inevitable, should be carried out by a skilled person who is aware of the hazard involved. Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation is present. Do not replace components with power cable connected.

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

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

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

Dangerous voltages, capable of causing serious personal injury, are present in this instrument. Use extreme caution when handling, testing and adjusting.

Safety Symbols

Below you will find some symbols that are used on the instrument and throughout the documentation.

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

Indicates dangerous voltages.

Indicates a protected earth 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 injury or loss of life. 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 equipment. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

HP 1047A related warnings

Warning 

Always take care that the LC system does not have excessive restriction downstream of the HP 1047A. Downstream restriction of greater than 2 bar (29 psi) will damage the HP 1047A.

Warning 

Always disconnect the line power cord before removing the top cover of the detector. Line power should also be disconnected before removing/replacing any electrical component.

Warning 

Certain alignment procedures require that the top cover be off while power is connected to the instrument. Beware of the hazardous voltages that exist.

Warning 

Always observe proper anti-static precautions.

Warning 

Solvents or samples used in detector applications may be very toxic and/or acidic. Take special care when handling the detector.

About this Manual

This handbook provides service information for the HP 1047A Refractive Index Detector. The handbook has been divided into the informational sections outlined in the table of contents.

Repair Policy

All printed circuit boards are replaced on the board level. Certain other electronic components may be replaced on the component level.

The Optical Unit may be replaced as an assembly or repaired on the component level, depending on the failure mode.

Certain replacements require subsequent mechanical and electrical adjustements. These adjustments are documented in this handbook.

The components and assemblies available for replacement parts are described in *Section 6: Parts Identification* of this handbook.

The following parts are available as EXCHANGE items:

Table 1-1. Exchange Parts

Description	Part Number
Optical Unit (without AB motor)	01047-69018
Flow Cell Assembly	01037-69003

Warranty

Hewlett Packard Analytical Group warranty policies and procedures apply.

Specifications

HP 1047A specifications for noise, drift and wander are made under the following conditions:

Flow of 1 ml/min of adaquately degassed HPLC grade water. 24 hour warm-up time at detector temperature of 40°C and ambient temperature < 25°C. Detector response time 0.8 seconds. For Hewlett Packard integrators, peak width 0.04.

Table 1-2. Specifications of HP 1047A RID

Signals	RI range 1 to 1.75; measurement range 1/64 $\times 10^{-5}$ DELTA RIU to 32 $\times 10^{-5}$ DELTA RIU (full scale).
Noise	$< \pm 2.5 \times 10^{-9}$ DELTA RIU peak-to-peak, flowing water at 1 ml/min, 0.8 second response time (10-90%).
Wander	$< \pm 1 \times 10^{-8}$ DELTA RIU
Drift	$< 2.5 \times 10^{-7}$ DELTA RIU/hour, after warm-up.
Response Time	0.3, 0.8, or 5 seconds (10-90%).
Flow Cell	7 μl volume with 7 bar (103 psi) maximum pressure.
Recommended pH range	2.3 to 9.5 standard. Solvents with a pH between 1.0 and 2.3 must not contain acids which attack stainless steel.
Temperature Control	30, 35, 40, 45, 50°C.
Display	Single line, 4 1/2 digit display with real time display of output voltage (recorder or integrator.

Table 1-2. Specifications of HP 1047A RID (continued)

Analog Outputs	One output integrator output 2 V maximum (32 mV/10^{-5} DELTA RIU); two recorder outputs (0-1 mV and 0-10 mV).	
Communications	Four control inputs (marker, flush, balance not ready).	
Environment	Temperature range:	0 to 40°C
	Humidity:	< 85% (non-condensing)
Power Requirements	Line voltage:	100, 120, 220, 240 VAC (+5%, -10%)
	Line frequency:	48-66 Hz
	Power consumption:	120 VA 410 BTU/hour
Dimensions	Height:	150 mm (5.9 inch)
	Width:	430 mm (17.0 inch)
	Depth:	370 mm (14.6 inch)
	Weight:	19 kg (41.6 lb)

Pressure contribution of detector

Typically the pressure contribution of the detector (**NOT SPECIFIED**) is no greater than 35 bar at 5 ml/min IPA. The difference between VALVE-ON and VALVE-OFF mode is no greater than 1 bar.

$$Pressure\ Contribution = \Delta Py - \Delta Px$$

Figure 1-1 shows how the pressure is measured.

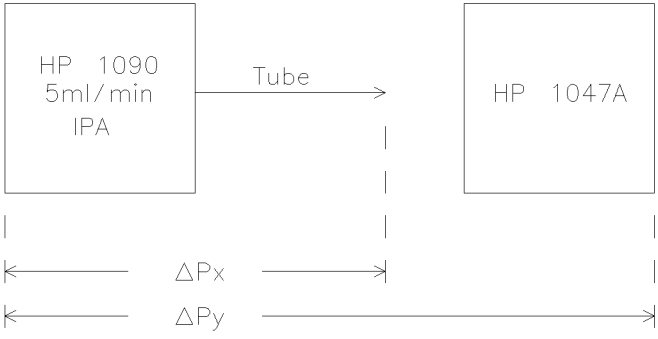

Figure 1-1. Pressure Diagram

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Hardware

Detection principle, optical system and detector flow path

Refer to the HP 1047A Operator's Handbook (01047-90000). The section *OVERVIEW* of the Operator's Handbook contains detailed information on the detection principle, optical system and flow path of the HP 1047A.

Signal Path Overview

Figure 2-1 and Figure 2-2 show the functional signal path block diagram for the HP 1047A. More detailed block diagrams and fundamental circuit explanations will be found in the following text.

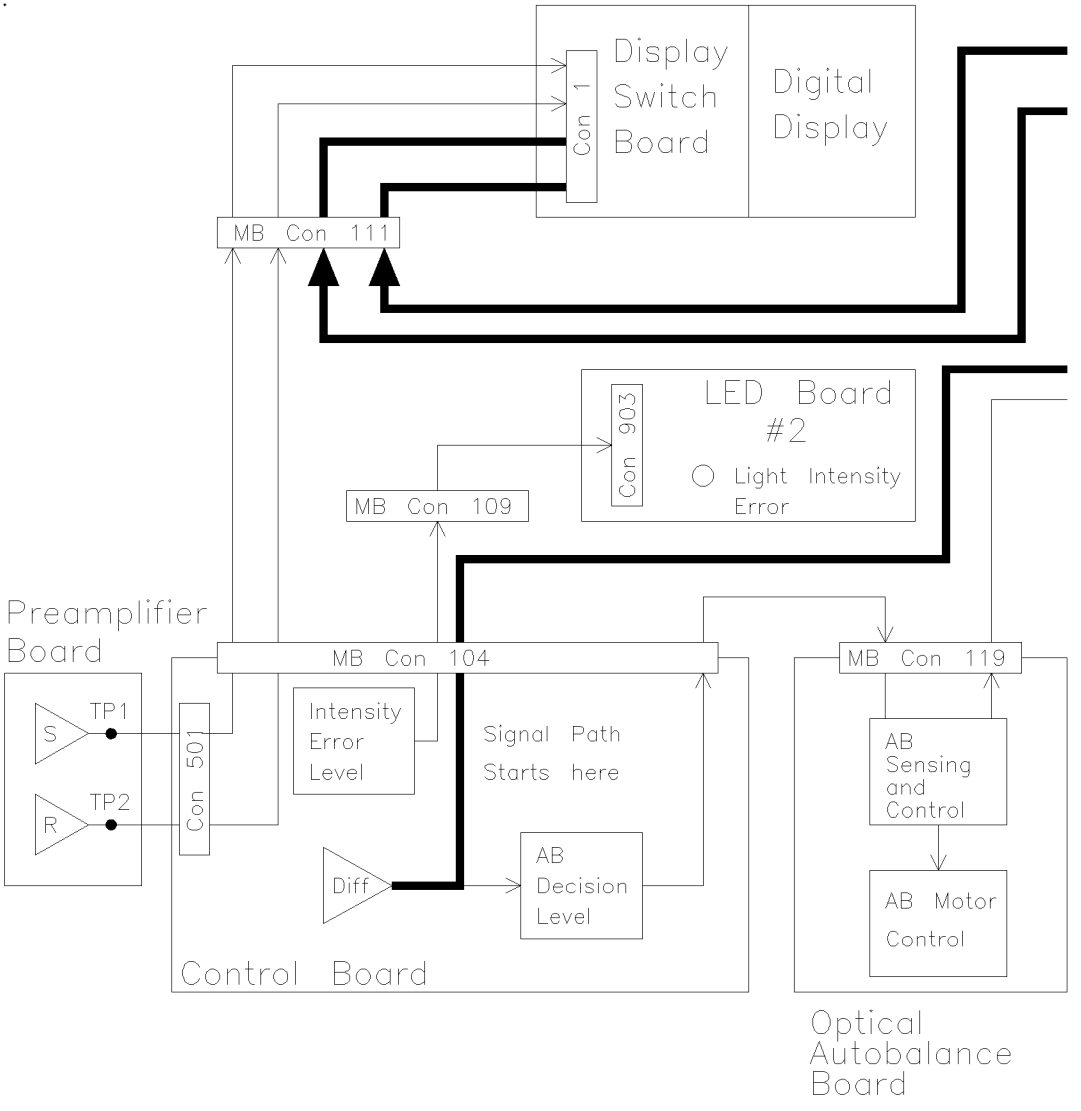

Figure 2-1. Signal Path Overview

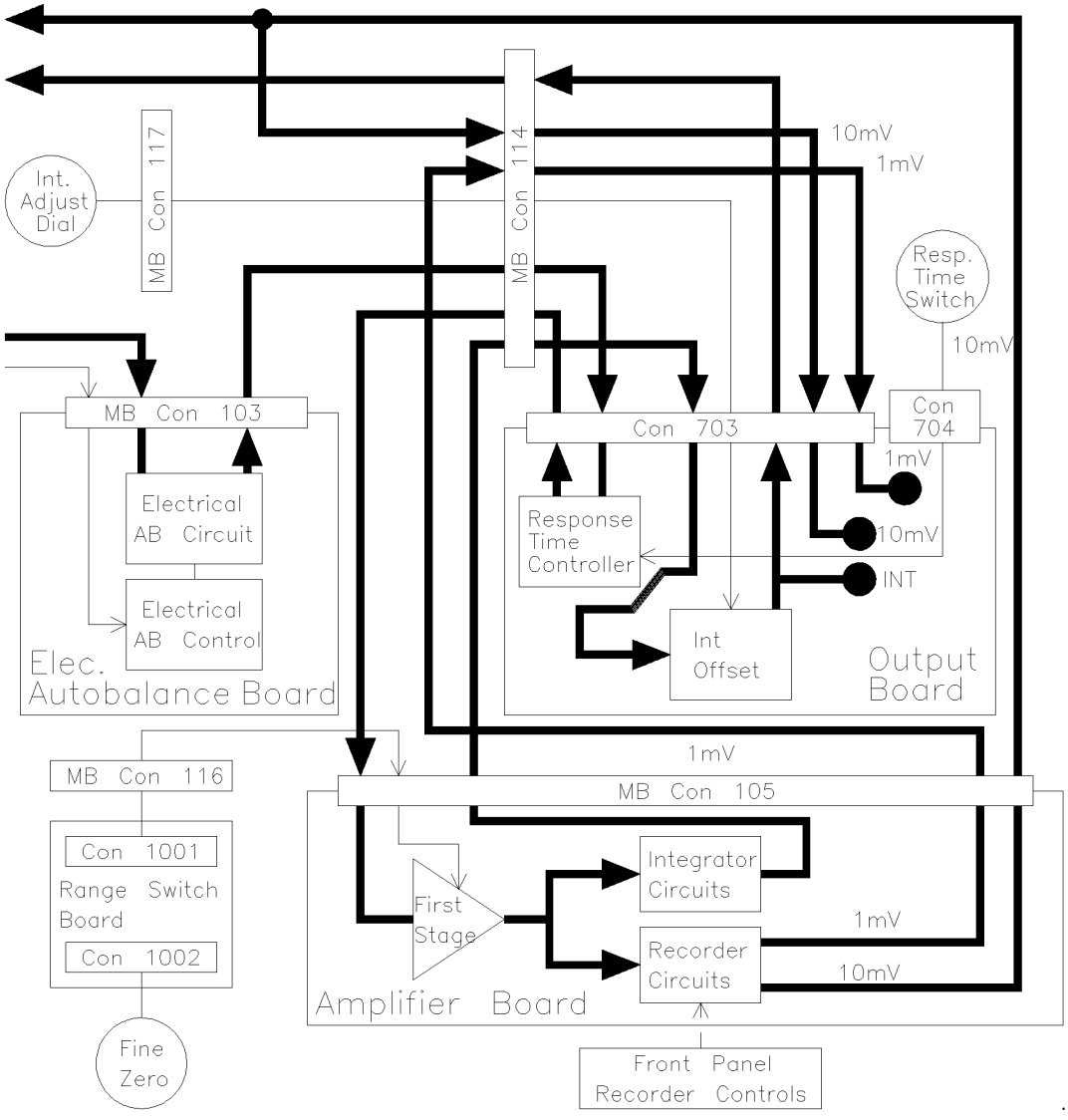

Figure 2-2. Signal Path Overview

On the Preamplifier board, S and R each produce a voltage output proportional to the light reaching it's photodiode. These voltages are representitive of light intensity, and are useful in detector troubleshooting.

The intensity voltages are first taken to the CONTROL board. From the CONTROL board (Figure 2-3) they are taken directly to the front panel DIGITAL DISPLAY, where S or R can be selected as TP1 or TP2, respectively, at the display.

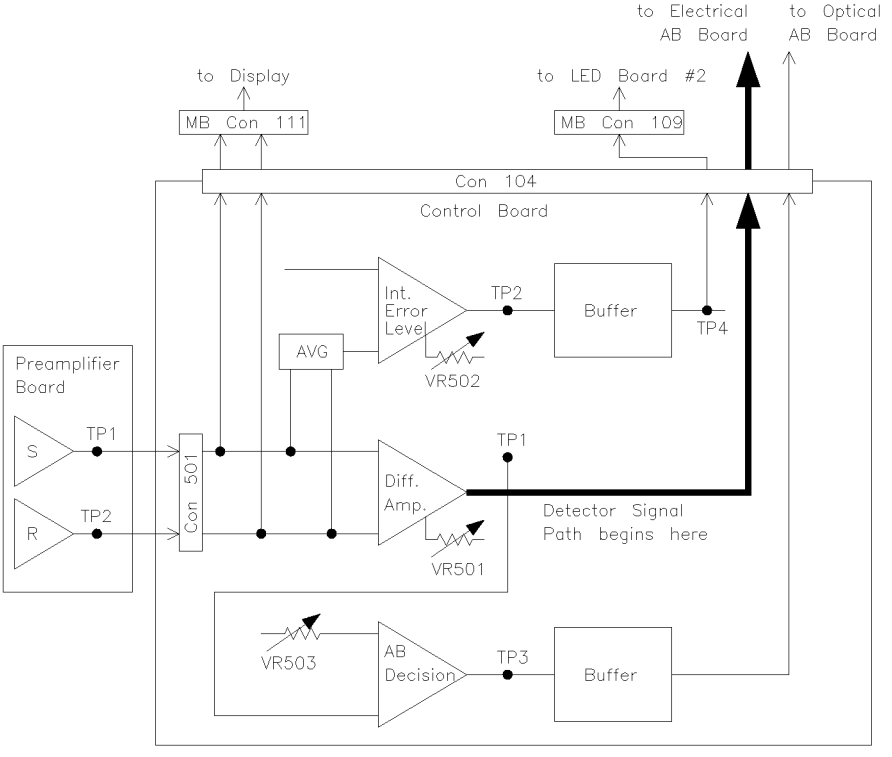

Figure 2-3. Control Board

Next, the average intensity (typically between -4.0 and -5.5) is taken to the CONTROL board INTENSITY ERROR threshhold circuit. Measuring TP2, VR502 is adjusted such that the INTENSITY ERROR is set if the original (factory) intensity changes by (approx.) 25%. TP4 is normally HIGH, and LOW for error.

The detector signal path actually begins at the output of the DIFF AMP. With the detector on and the lamp wires disconnected from the LAMP VALVE terminal, the offset of the DIFF AMP should be 0 ±5 mV; measured at TP1, adjusted with VR501. The output of the DIFF AMP is first taken to the AB (autobalance) DECISION threshold circuit. Measuring TP3, VR503 is adjusted such that the AB DECISION threshold is 16 $\times 10^{-5}$ RIU. The output of the AB DECISION threshold circuit is then taken from the CONTROL board to the input of the OPTICAL AUTOBALANCE board (Figure 2-4). The DIFF AMP output is also taken from the CONTROL board to the input of the ELECTRICAL AUTOBALANCE board's (Figure 2-5) ELECTRICAL AB CIRCUITS.

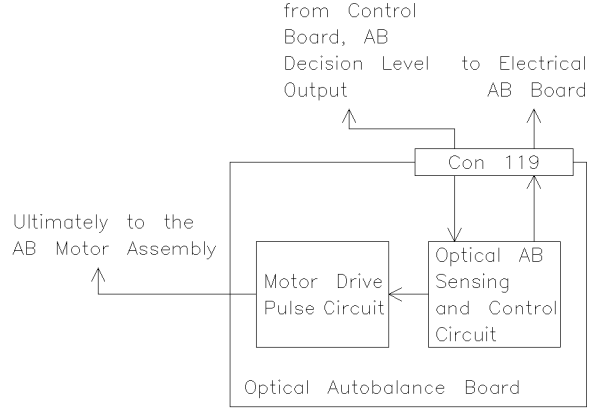

Figure 2-4. Optical Balance Board

When a BALANCE is initiated, the OPTICAL AUTOBALANCE board judges the signal from the CONTROL board AB DECISION threshold circuit. If the signal is below the AB threshold, then only an electrical balance is done.

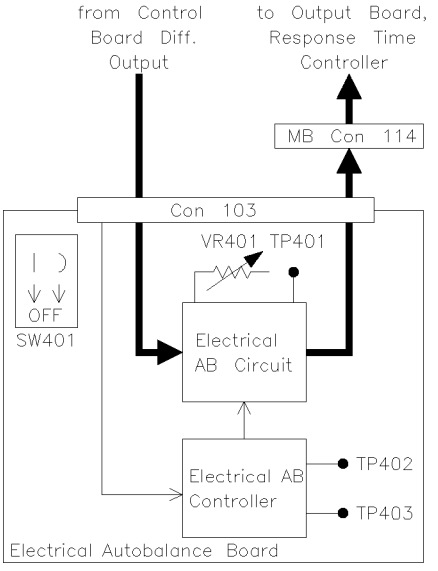

Figure 2-5. Electrical Autobalance Board

During an electrical autobalance, the ELECTRICAL AUTOBALANCE BOARD sets the output of it's ELECTRICAL AB CIRCUITS to zero. An electrical balance does not zero the DIFF AMP output. If the AB decision signal exceeds threshold, an optical balance is also done. This means that the OPTICAL AUTOBALANCE board (indirectly) moves the Optical Balance Glass until the output of the DIFF AMP is zero. The optical balance is then followed by an electrical balance. Refer to the *AB MOTOR CONTROL* for details of the optical unit and autobalance motor control.

Note

On the ELECTRICAL AUTOBALANCE board, both poles of SW401 must be OFF! If these switches are pushed ON, the ELECTRICAL AB CIRCUITS output will be held constantly to zero. The ON position of these switches is for adjusting the offset of the ELECTRICAL AB CIRCUIT output; VR401 is adjusted so that TP401 is 0 VDC ±0.3 mV.

When SW401 is OFF:

TP402	HIGH normally; LOW during balance
TP403	HIGH normally; LOW when balance command initiated

The detector signal path continues at the output of the ELECTRICAL AUTOBALANCE board. The signal goes through the RESPONSE TIME circuit, and is then taken to the input of the AMPLIFIER board (Figure 2-6 and Figure 2-7). The first stage of the AMPLIFIER board is influenced by the front panel FINE ZERO dial. After the first stage, the signal divides into two separate paths; INTEGRATOR AND RECORDER. The INTEGRATOR path consists of the INT OUTPUT SPAN, POLARITY CONTROL and INT OFFSET stages. INT OUTPUT SPAN is adjusted by VR613. POLARITY can (only) be changed from the detector rear panel. INT OFFSET is influenced by the front panel INTEGRATOR dial, and by VR701 on the OUTPUT board (Figure 2-8). The output of the INT OFFSET stage is taken to both the digital display and the INT analog output at the rear panel. The INT analog output is calibrated (OUTPUT SPAN) such that 32 mV equals 1 $\times 10^{-5}$ RIU.

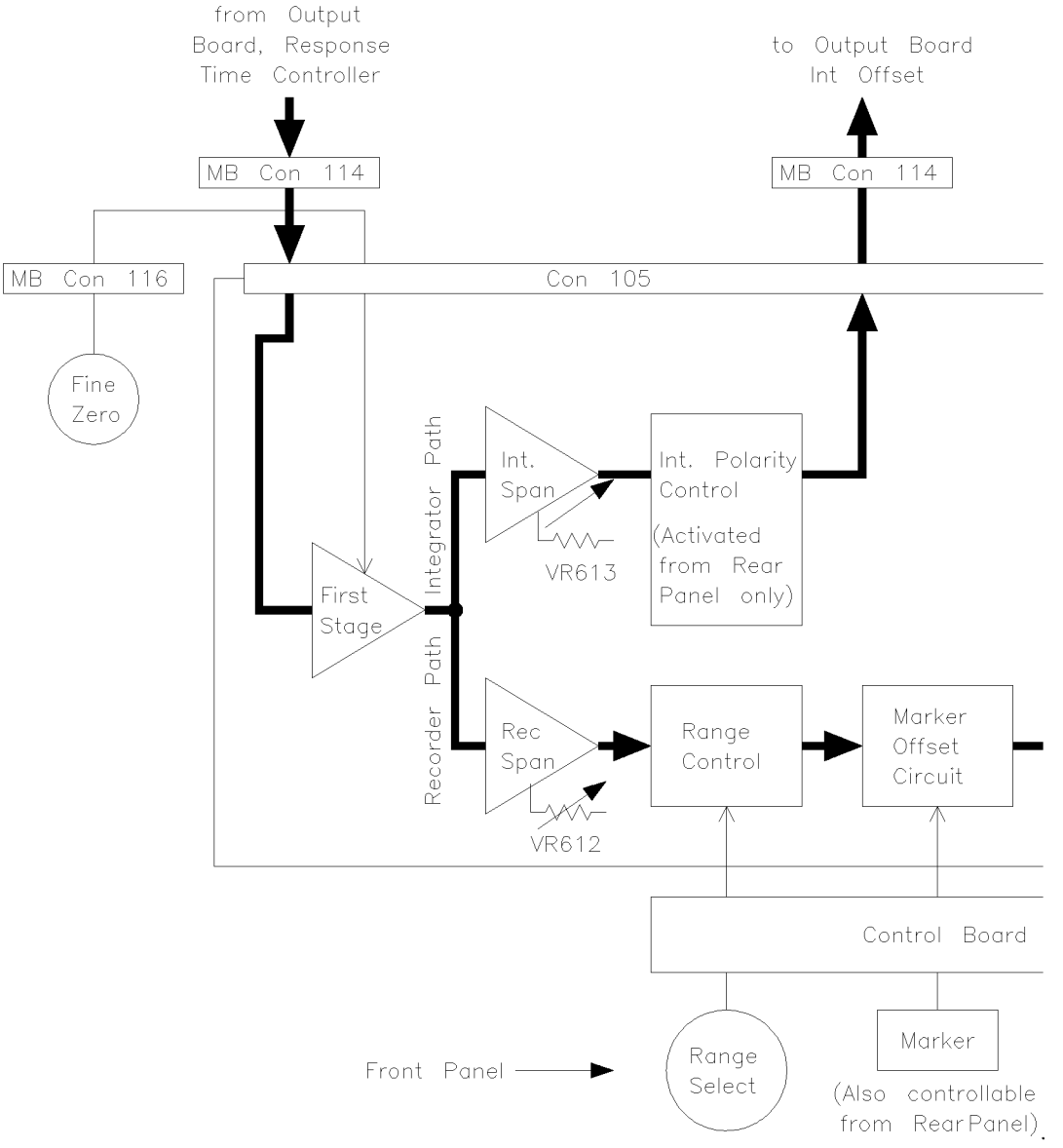

Figure 2-6. Amplifier Board

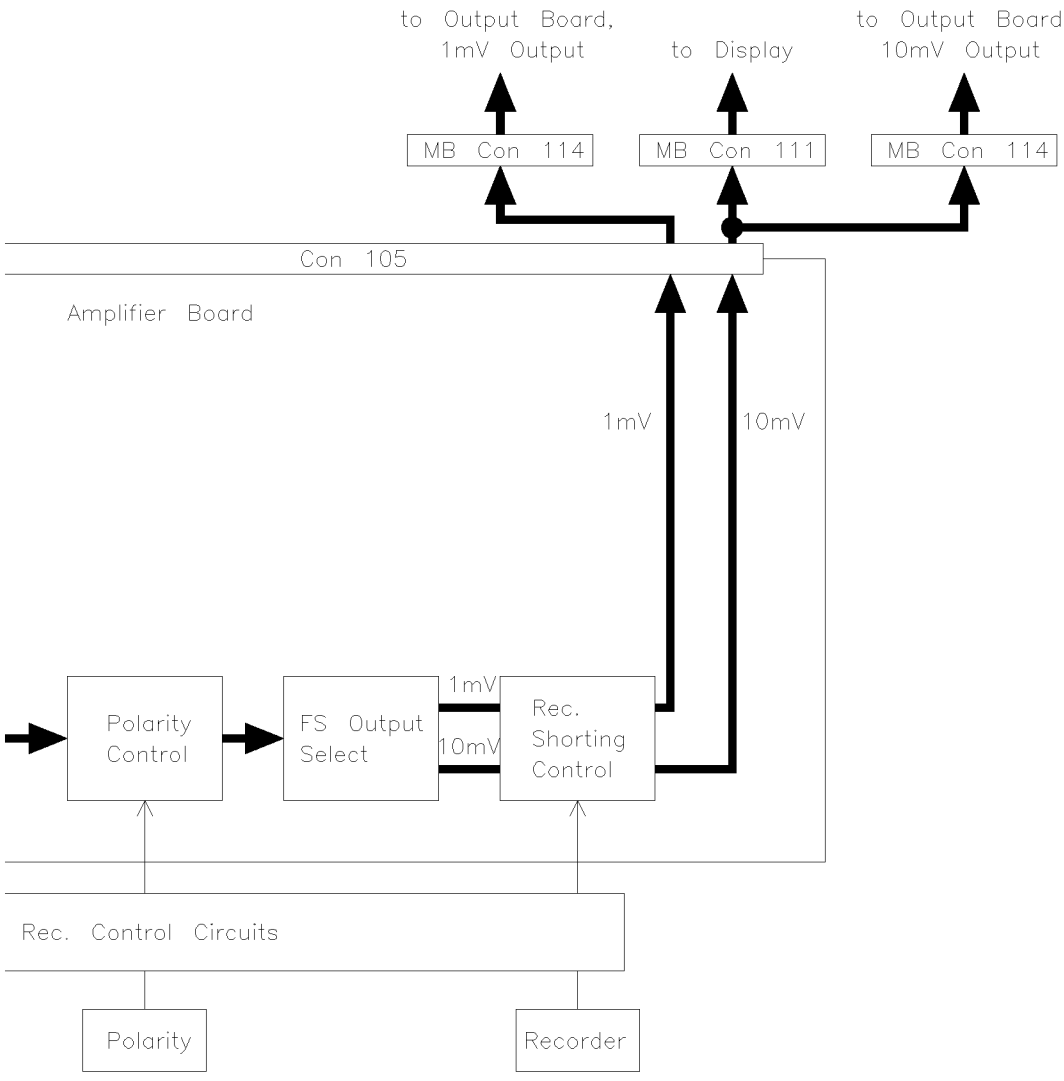

Figure 2-7. Amplifier Board

The RECORDER signal path consists of the REC OUTPUT SPAN, RANGE CONTROL, MARKER OFFSET, POLARITY CONTROL, FS OUTPUT SELECT and REC SHORTING CONTROL stages. REC OUTPUT SPAN is adjusted by VR612.

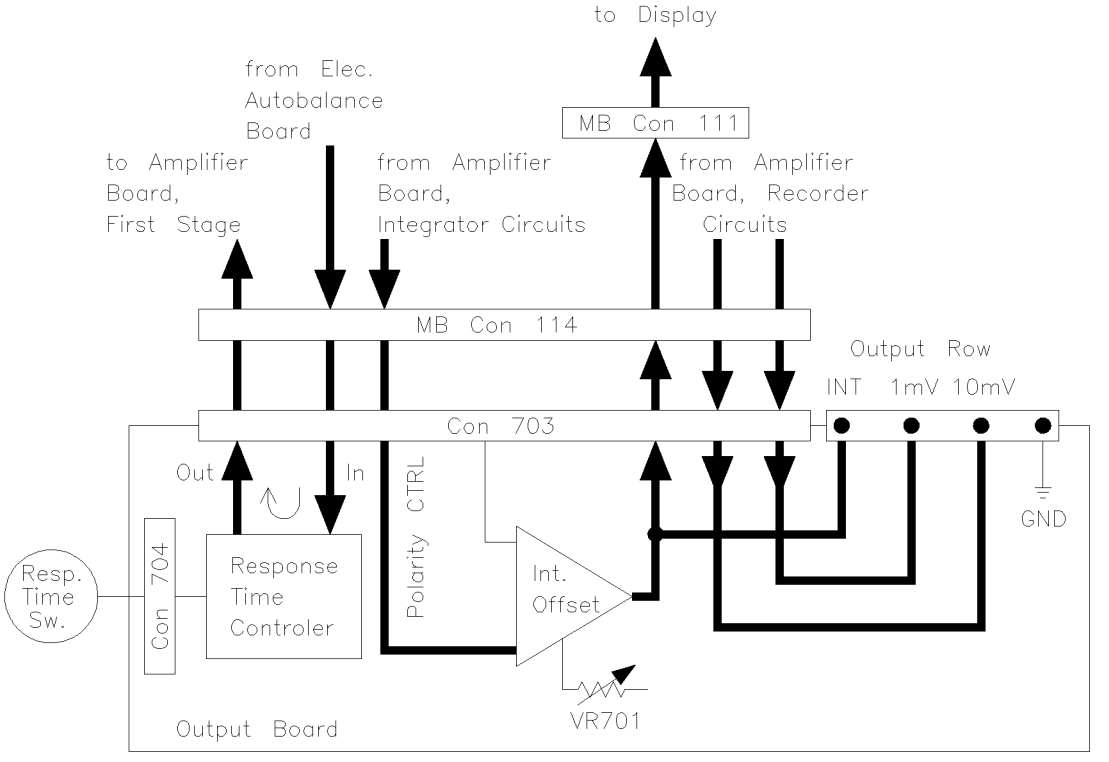

Figure 2-8. Output Board

The RANGE CONTROL is set by the user from the front panel. The MARKER OFFSET applies a voltage spike to the recorder signal for the purpose of marking the start of a chromatogram on a stripchart recorder.

The MARKER OFFSET can be applied maually from the front panel or automatically from rear panel. Recorder POLARITY can be changed (only) from the front panel. FS OUTPUT SELECT is the beginning of the separate 1 mV and 10 mV full scale recorder outputs. The REC SHORTING CONTROL provides an easy means of shorting (zeroing) the recorder outputs so that a stripchart recorder may be mechanically zeroed without disconnecting the detector. The 1 mV recorder output is taken directly to the 1 mV recorder analog output at the rear panel. The 10 mV recorder output is taken to both the digital display and the rear panel. The voltage/RIU relationsp for the recorder outputs is determined by the RANGE SWITCH setting.

Important points in the signal path block diagram:

- When a BALANCE is done, the ELECTRICAL AUTOBALANCE board does set the output of ELECTRICAL AB CIRCUITS to zero. However, the actual signal outputs of the detector will be whatever value has been set by the position of the front panel FINE ZERO and INTEGRATOR dials.
- The front panel FINE ZERO dial influences both RECORDER and INTEGRATOR outputs. The front panel INTEGRATOR dial influences only the INTEGRATOR output.
- At the display, selecting functions TP1 and TP2 displays the actual signal present at PREAMPLIFIER board TP1 and TP2 respectively.
- At the display, selecting functions TP1 and TP2 simultaneously displays the average of TP1 and TP2.

Power Distribution

AC Power

Figure 2-9 shows details the AC power distibution of the HP 1047A. AC secondary voltages may be measured at motherboard CON110 as shown. The 100 VAC secondary for the heater may be measured at CON202 of the TEMP and MOTOR CONTROL board. The rear panel TEMP switch must be on for this measurement.

Note

The present AC power supply only employs two primary windings; 115 VAC (orn) and 240 VAC (blu) as shown. In older instruments, a rotary voltage selector switch was used which employed four primary windings; 100 VAC, 115 VAC, 220 VAC and 240 VAC. In the current wiring scheme, the 100 VAC wire (red) and the 220 VAC wire (yel) are not used. These wires are capped and tied out of the way.

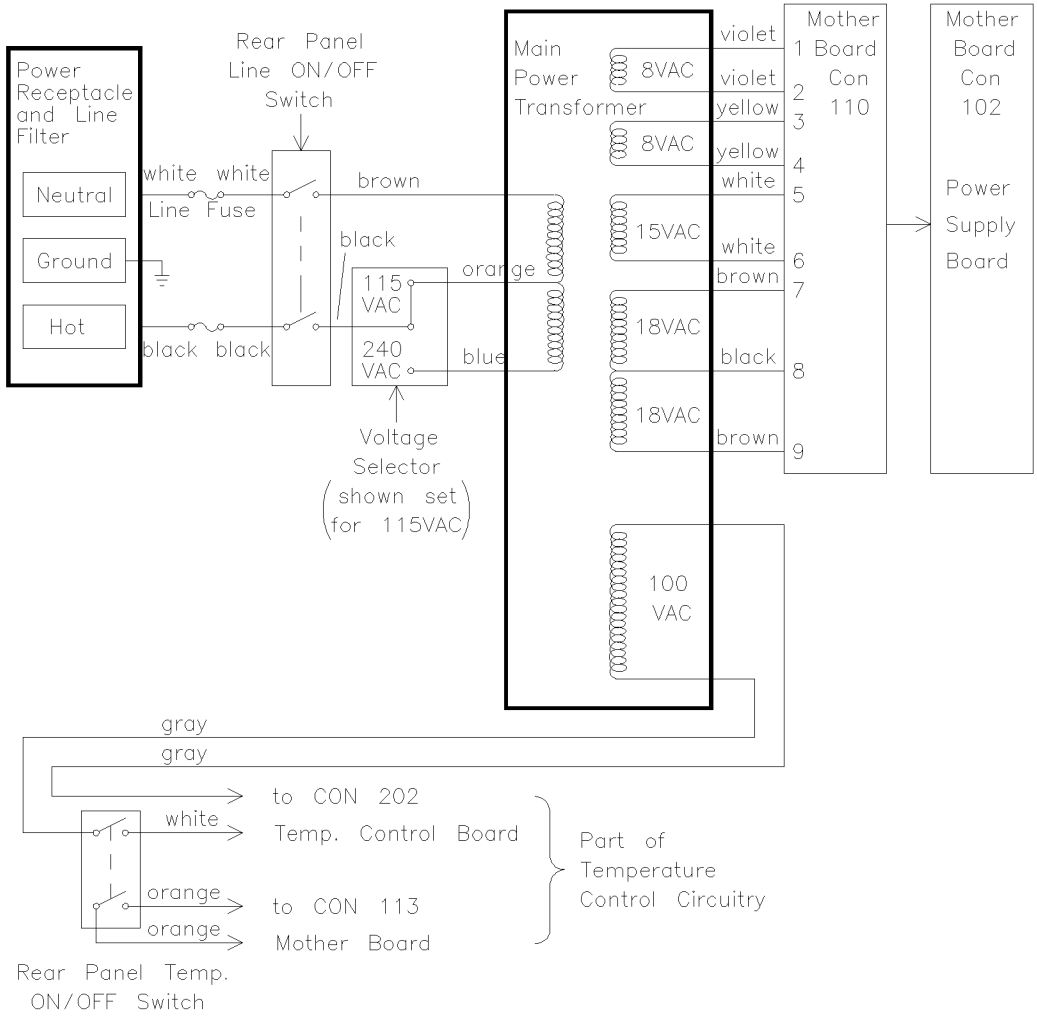

Figure 2-9. AC Power Distribution

DC Power Distribution

Figure 2-10 provides an overview of DC power production and distribution. All test points are clearly labeled across the top of the POWER SUPPLY board.

The REGULATOR SET is mounted on the rear panel. These regulators contribute to the production of the +5 VDC LAMP supply and the +12 VDC supply. The REGULATOR SET cable is connected to MOTHERBOARD CON107. To check the performance of the REGULATOR SET, DC measurements can be made directly at the wires of CON107:

+5 VDC lamp

TP 302 to BLU (com)	almost zero, GND
TP 302 to WHITE (in)	8.3 VDC
TP 302 to RED (out)	5 VDC

+12 VDC

TP 306 to ORN (com)	almost zero, GND
TP 306 to YEL (in)	19 VDC
TP 306 to BRN (out)	+12 VDC

Lamp voltage is supplied to the LAMP as soon as the rear panel LINE switch is turned on. Circuits on the CONTROL board apply +12 VDC to the FLUSH VALVE when a FLUSH command is initiated

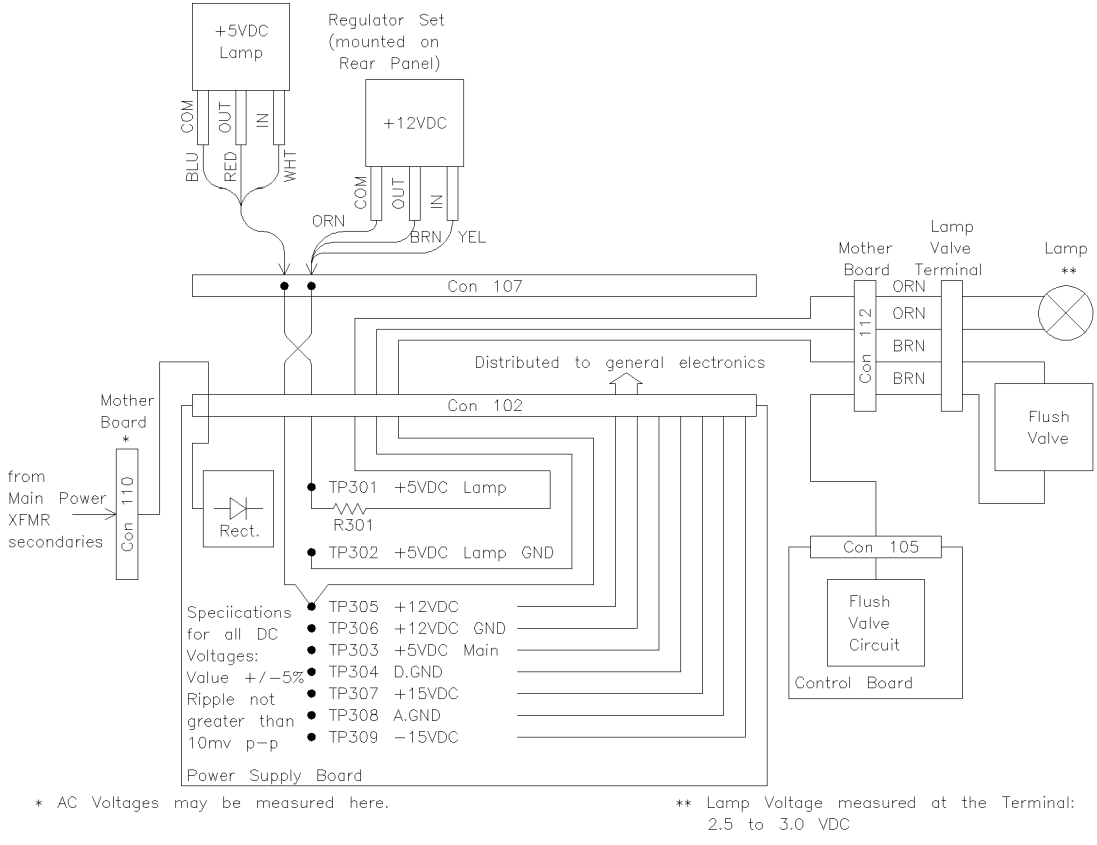

Figure 2-10. DC Power Distribution

Power Supply Area Wiring Diagram

Figure 2-11 shows details the wiring of the power supply area. This figure should be used when a power supply component needs to be replaced.

Table 2-1. Legenda Power Supply Wiring

Term	Description
1	To TEMP AND MOTOR CONTROL board CON202.
2	To MOTHERBOARD CON113.
3	To MOTHEBOARD CON110.
4	Orange; to top/botton right posts of TEMP switch.
5	Gray; to transformer.
6	White; to top left post of TEMP switch.
7	Gray; to bottom left post of TEMP switch.
8	Orange; from top post of voltage selector to transformer.
9	Black; from middle post of voltage selector to bottom right post of LINE switch.
10	Blue; from bottom post of voltage selector to transformer.
11	White; from top left post of LINE switch to line fuse.
12	White; from line fuse to left post of line filter.
13	Brown; from bottom left post of LINE switch to transformer.
14	Black; from top right post of LINE switch to line fuse.
15	Black; from line fuse to right post of line filter.
16	Grn/Yelllow; to ground.
17	Red wire and Yellow wire; un-used.

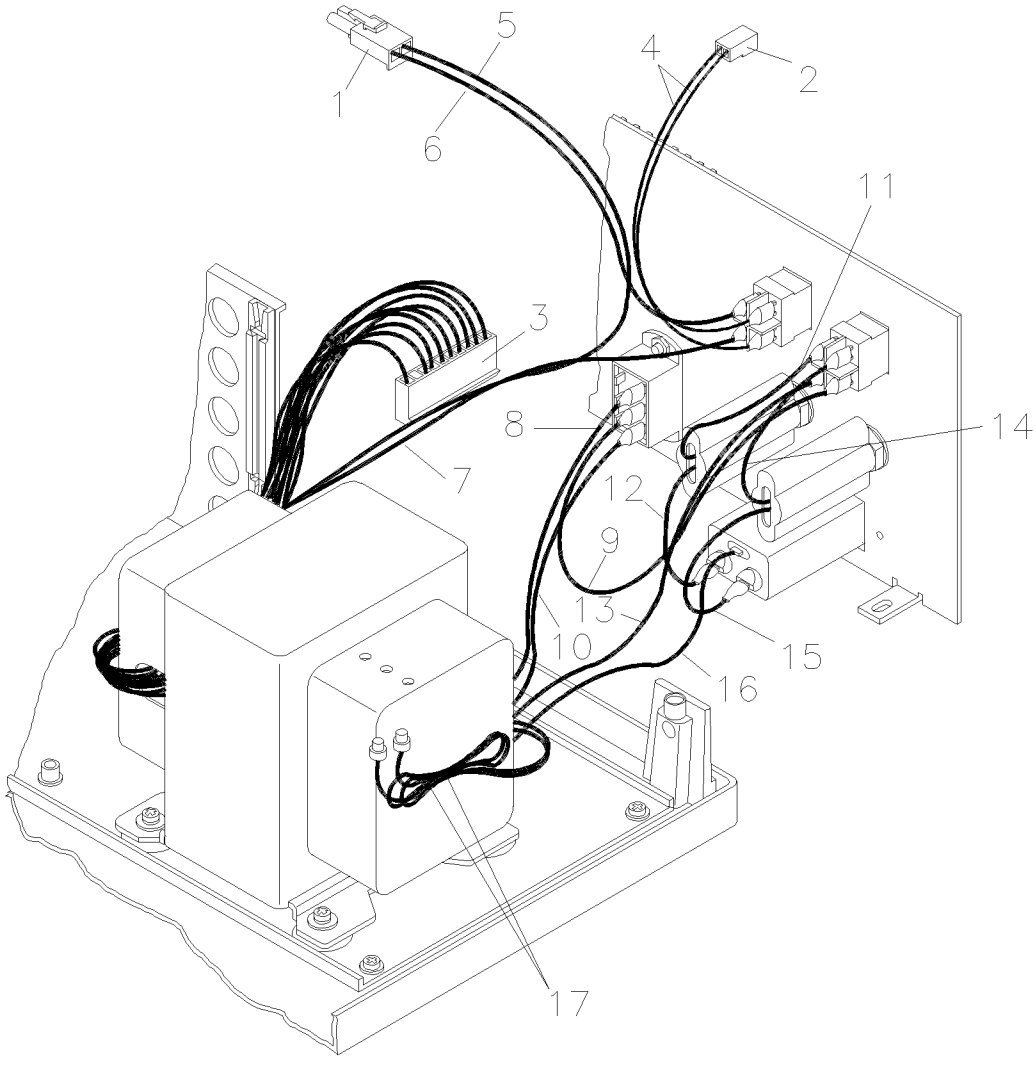

Figure 2-11. Power Supply Wiring

Motherboard

Figure 2-12 shows the layout of the motherboard. Also shown is legenda referred to in the cables termination table.

There are no like connectors on the motherboard. This greatly reduces the possibility of connection errors. Each individual connector is keyed so that it's cable may be inserted only in the correct way. The PC board connectors are also keyed so that a board may not be inserted in the wrong location. Be careful to note, however, that it is possible to remove these keys from the motherboard connectors.

Table 2-2. Cables termination

Term	Description
A	Motherboard holding screws; six total.
B	To the REGULATOR SET mounted on the rear panel.
C	To the main power transformer; secondaries connector.
D	To the AB MOTOR assembly.
E	To the VALVE LAMP terminal.
F	To the GROUND connector cable attached to the rear panel.
G	TEMPERATURE AND MOTOR CONTROL board
H	POWER SUPPLY board
I	OPTICAL AUTOBALANCE board
J	ELECTRICAL AUTOBALANCE board
K	CONTROL board
L	AMPLIFIER board
M	To DISPLAY SELECT SWITCH board; CON2.
O	To OUTPUT board; CON703.
P	To front panel INTEGRATOR dial.
Q	To front panel TEMPERATURE select switch.
R	To RANGE SWITCH board; CON1001.
S	To LED BOARD #2; CON903.
T	To rear panel TEMP switch.

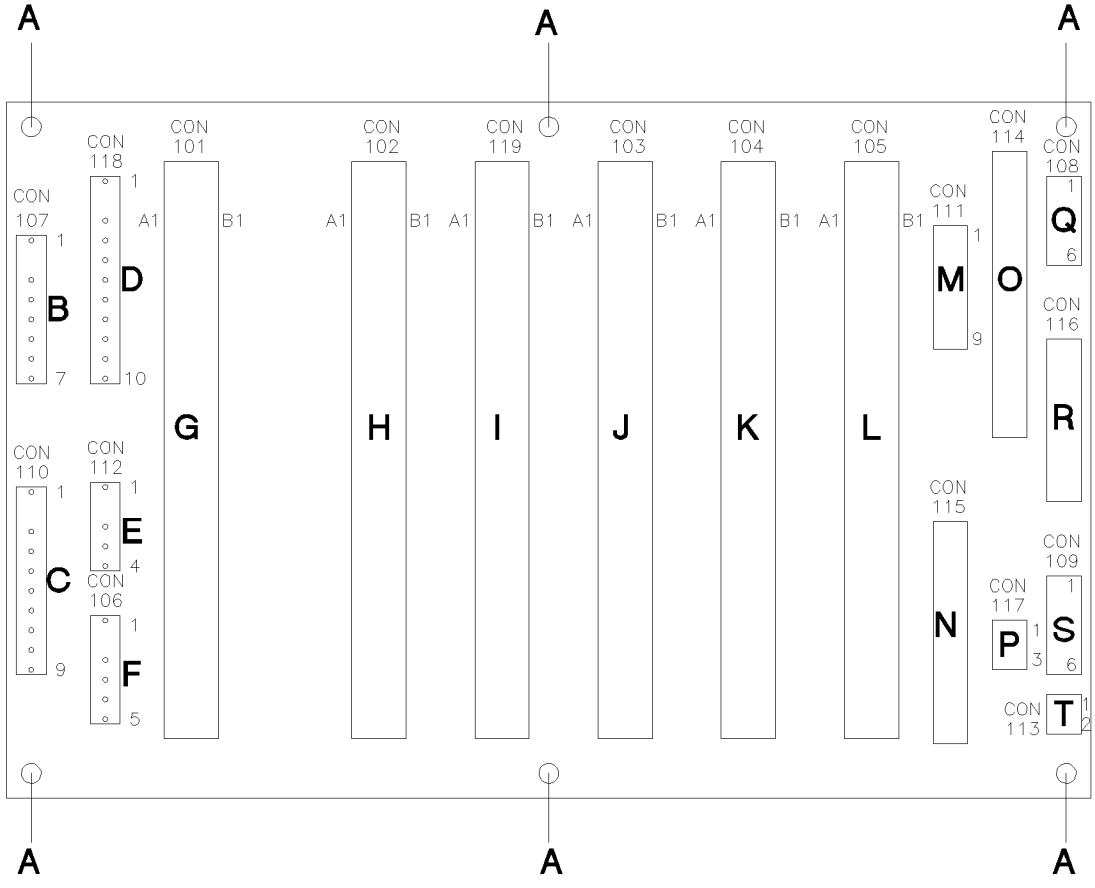

Figure 2-12. Motherbard Layout

AB Motor Control

Figure 2-13 shows the relationship of the Optical Balance Motor to the Optical Unit.

The motor shaft and the optical balance glass control shaft are joined together by a sleeve coupling. The motor can be commanded to go to it's mechanical center position. Ideally, the mechanical center position of the of the motor should cause the optical balance glass to be perpendicular to the beam, as shown in the figure. The optical balance glass is then in it's "null" position.

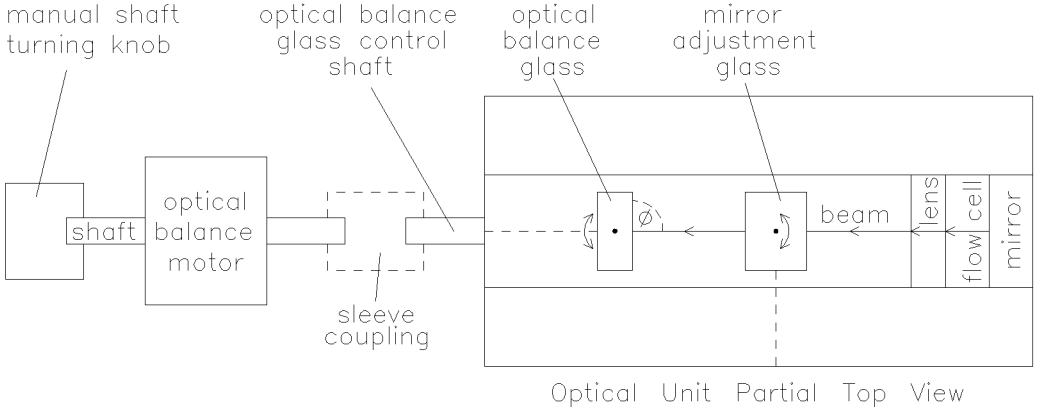

Figure 2-13. Relationship Optical Balance Motor/Optical Unit

Figure 2-14 shows the electronic control circuits of the optical balance motor.

Legenda for Figure 2-14

A Commands for motor drive circuit
B Motor drive pulses
C Actual motor position signal

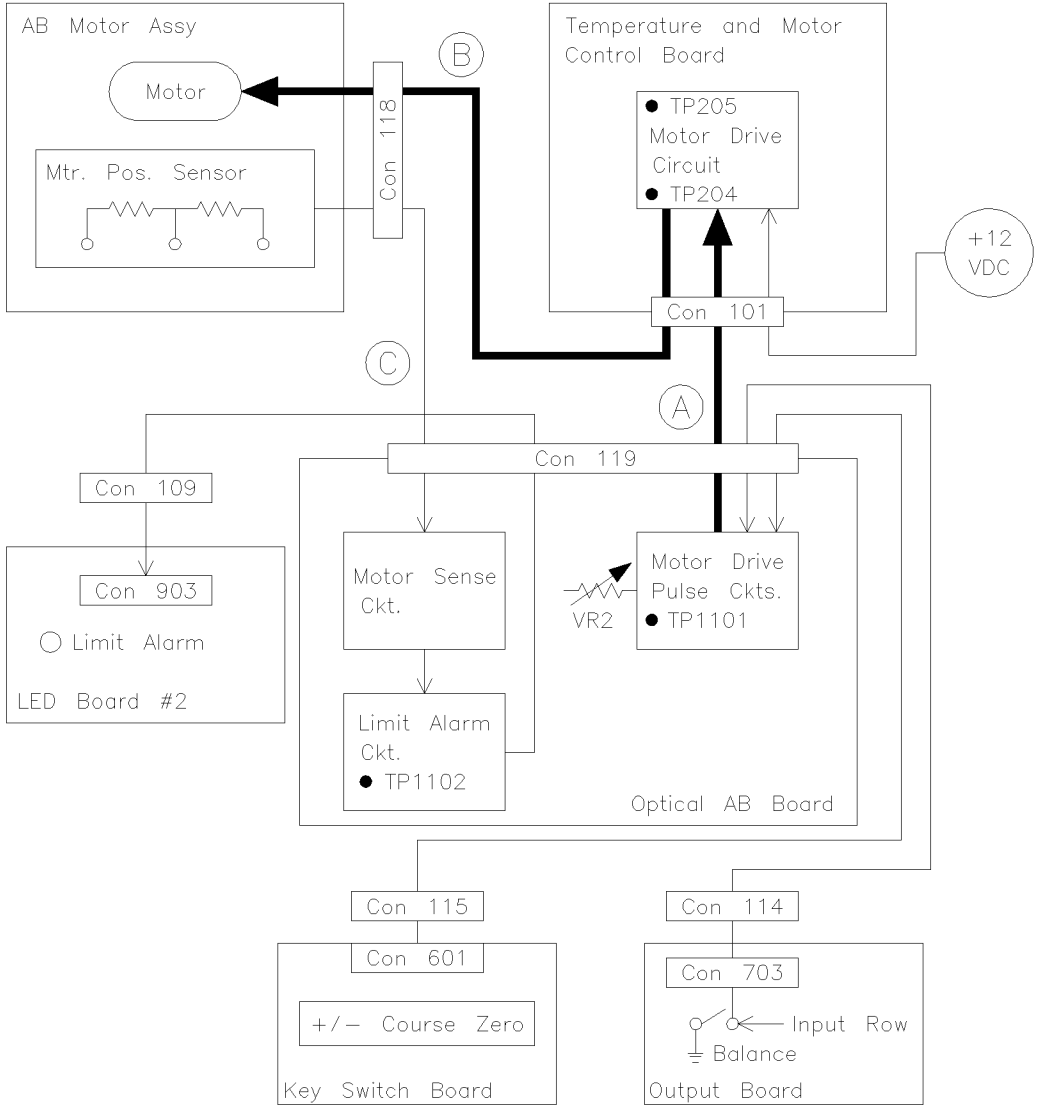

Figure 2-14. Control Circuits of Optical Balance Motor

The motor can be moved either by the front panel + and - COURSE ZERO buttons or, under certain conditions,by initiating a BALANCE.

The OPTICAL AUTOBALANCE board produces the initial drive command pulses for the motor. The correct frequency of these pulses, 250 Hz ±10 Hz, is critical for proper operation of the motor. Frequency can be measured at TP1101 (normally LOW, pulsing 250 Hz for motor operation) and adjusted with VR2.

The motor driver circuits of The TEMP AND MOTOR CONTROL board recieve the drive command pulses from the OPTICAL AUTOBALANCE board. On the TEMP AND MOTOR CONTROL board, the operation of the motor driver circuits can be measured at TP204; normally LO, pulsing 250 Hz for motor operation. TP205 should be constantly +5 VDC. TP204/205 are near CON201. Finally, the drive command pulses are converted to +12 VDC pulses and delivered to the windings of the motor.

The actual mechanical position of the motor is sensed by the motor position sensor potentiometer circuitry on the OPTICAL AUTOBALANCE board. If the motor drives too far in either direction, the front panel LIMIT ALARM indcator LED turns on. TP1102: normally HIGH, LOW for LIMIT ALARM.

From the LIMIT ALARM state,the AB Motor can be commanded to move to it's mechanical center position by pressing the front panel + and - COURSE ZERO buttons simultaneously. The motor will then move in the appropriate direction until it's center position is sensed. A BALANCE is NOT automatically done after this movement.

Temperature Control Electronics

Figure 2-15 is a functional block diagram of the HP 1047A heater control electronics.

Actual heating power is provided by the main power transformer 100 VAC secondary, which can be measured at CON202 of the TEMP AND MOTOR CONTROL board. A TEMPERATURE REGULATOR delivers power to the optical unit HEATER. The optical unit TEMP SENSOR reports the actual optical unit temperature to the TEMPERATURE CONTROL circuit. Required heater voltage is determined by a comparison between the actual optical unit temperature and the temperature setpoint.

Note

Both poles of switch SW201 must be OFF for correct operation of the heater control circuitry. The ON position of these poles is used by the factory and will disable operation of the heater circuit.

The HEATER is protected by a thermal fuse which opens at about 76°C. The heater circuit is protected by a 2 A fuse.

Resistance of the HEATER: about 190 ohms cold. Resistance of the TEMP SENSOR: about 5.2 kohms cold, about 2.8 kohms at 40°C.

Overall circuit performance is best determined by measuring HEATER voltage power directly at CON201 of the TEMP AND MOTOR CONTROL board, and by observing the state of the front panel temperature indicator LED:

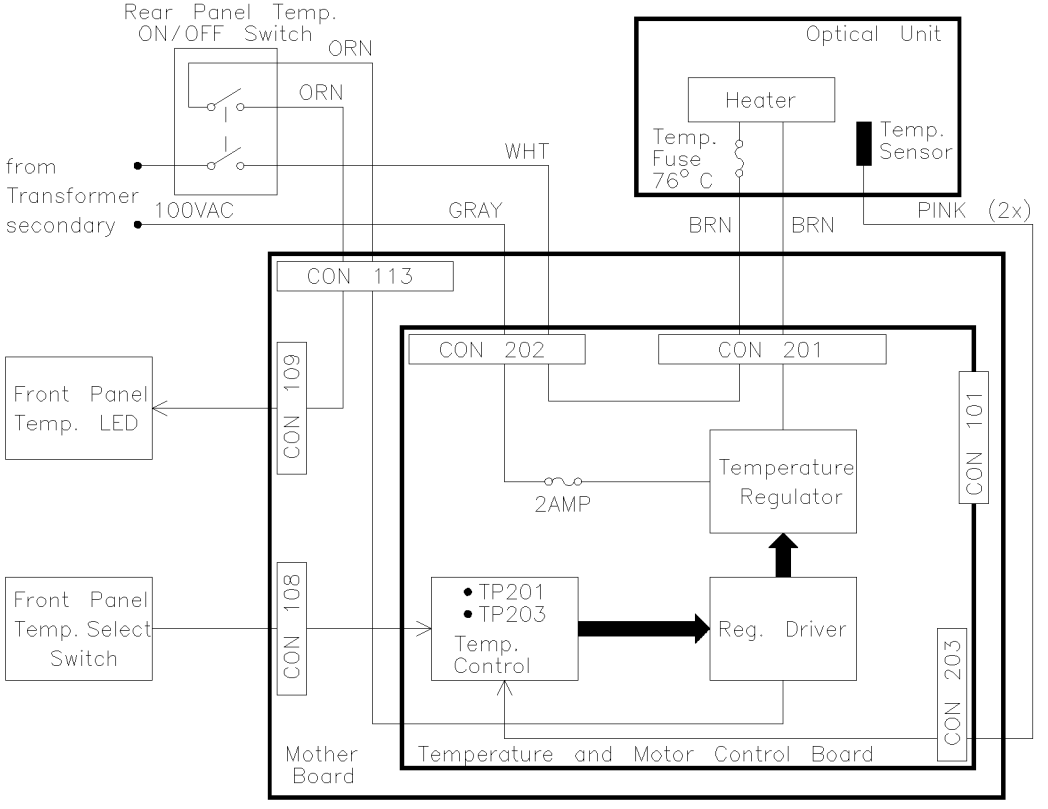

Figure 2-15. Heater Control Electronics

- TEMP SWITCH off; 0 VAC with indicator LED off.
- While heating up to setpoint; full power (about 100 VAC), indicator LED solidly on.
- While regulating at the setpoint; about 1/2 power, indicator LED flashing.
- Actual temperature greater than setpoint; nearly 0 VAC, indicator LED off.

A broken connection from either the TEMPERATURE SELECT SWITCH or the TEMP SENSOR will immediately disable power to CON201 and turn off the temperature indicator LED. In addition, these TEMPERATURE AND MOTOR CONTROL board test points are useful:

TP201 (upper right corner)

- Pulsing (approx. 2.5 VDC) while temperature is controlling at the setpoint.
- +14 VDC while actual temp is less than setpoint.
- -14 VDC while actual temp is greater than setpoint

  or

  TEMP SELECT SWITCH is disconnected.

TP203 (under CON201)

- HIGH (+5 VDC) during any normal operation.
- LOW if TEMP SENSOR is disconnected.

Flush Valve Control Electronics

Figure 2-16 outlies both the manual and remote operation of the FLUSH VALVE.

+12 VDC is applied to the LAMP VALVE terminal (valve wires) for valve turn-on. +12 VDC is removed for valve turn-off.

The front panel FLUSH button must be off if the rear panel remote input is to be used. The remote input needs a contact closure (short) for activation. The first contact turns on the valve, the next contact closure turns off the valve.

The front panel FLUSH button will be disabled if the remote input is held in the constantly short state.

CONTROL BOARD	TP506 LOW for valve off HIGH for valve on
POWER SUPPLY BOARD	TP305 (to TP306) +12 VDC

The front panel FLUSH light comes on when the valve is turned on either from the front panel or the rear panel. The light only indicates that the valve has been commanded to turn on, it DOES NOT quarantee that the valve itself is functioning correctly.

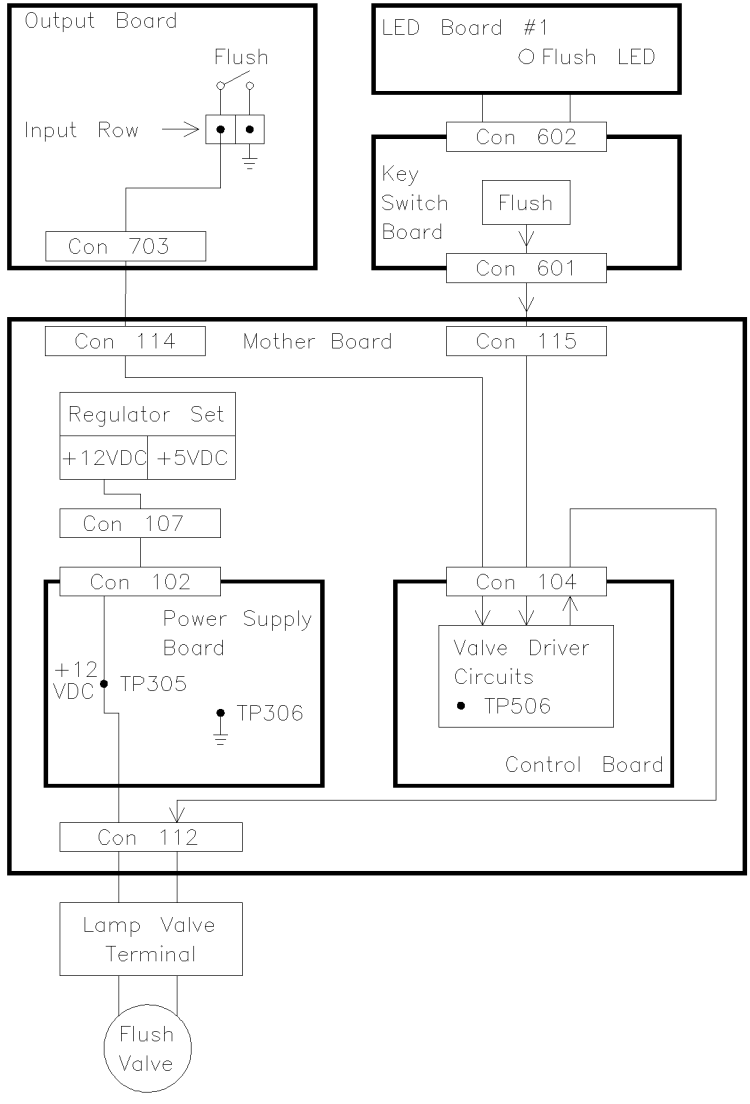

Figure 2-16. Flush Valve Control Electronics

Remote Control Function Electronics

The detector rear panel is arranged into an INPUT row and an OUTPUT row.

The Outputs

Light Intensity Error and Balance Not Ready

For both of these functions, the appropriate pin pair is normally open. The Light Intensity Error pair is closed as long as the error exists, and opens again when the error clears. The Balance Not Ready pair is closed for the duration of the BALANCE.

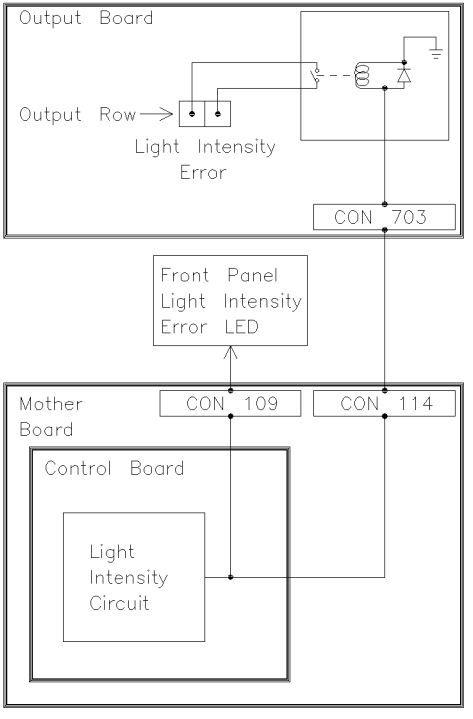

Figure 2-17. Block Diagram Light Intensity Error

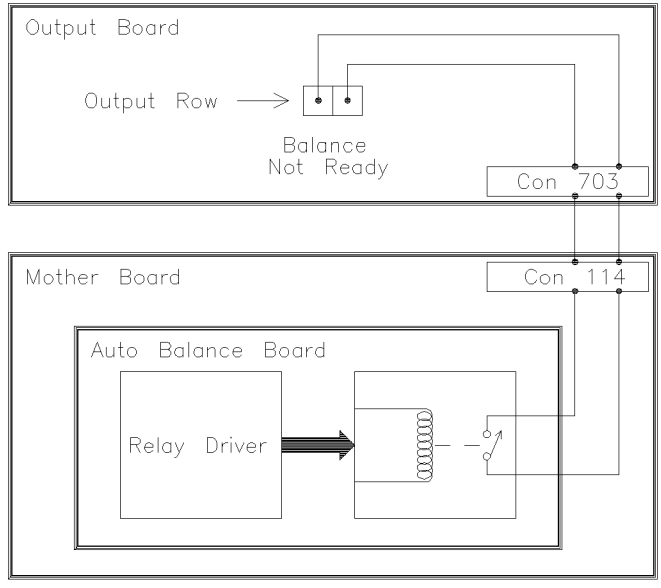

Figure 2-18. Block Diagram Balance Not Ready

The Inputs

Balance

A BALANCE is initiated by applying a short to the BALANCE pin pair, or by the front panel BALANCE button.

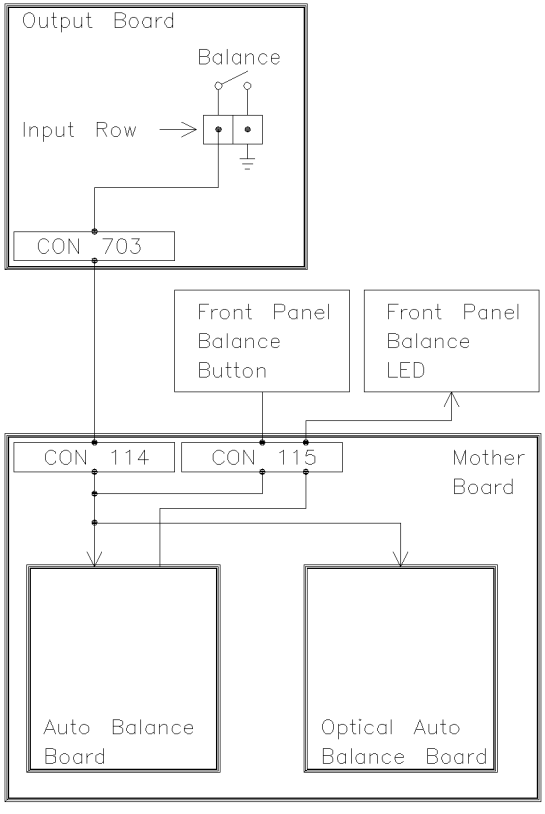

Figure 2-19. Block Diagram Balance Input

INTEGRATOR POLARITY

The INTEGRATOR POLARITY can only be changed by applying a short to the POLARITY pin pair. Alternating shorts change INTEGRATOR POLARITY from plus to minus. The current INTEGRATOR POLARITY is shown under the front panel digital display.

Note

This is not to be confused with the recorder outputs polarity light above the front panel (recorder) POLARITY button. A change in polarity will also cause a BALANCE to occur.

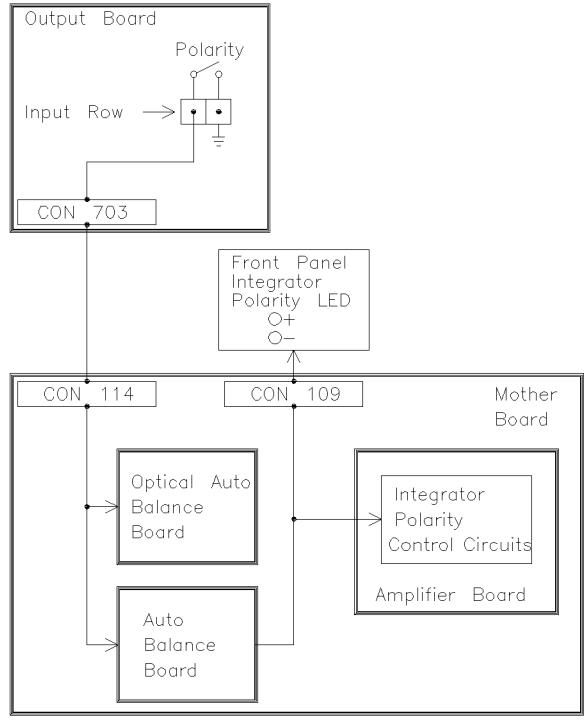

Figure 2-20. Block Diagram Integrator Polarity

MARKER

The MARKER applies a voltage spike to the recorder outputs so that the start of a chromatogram may be noted on a stripchart recorder. A MARKER can be initiated from the front panel, or by applying a short to the MARKER pin pair.

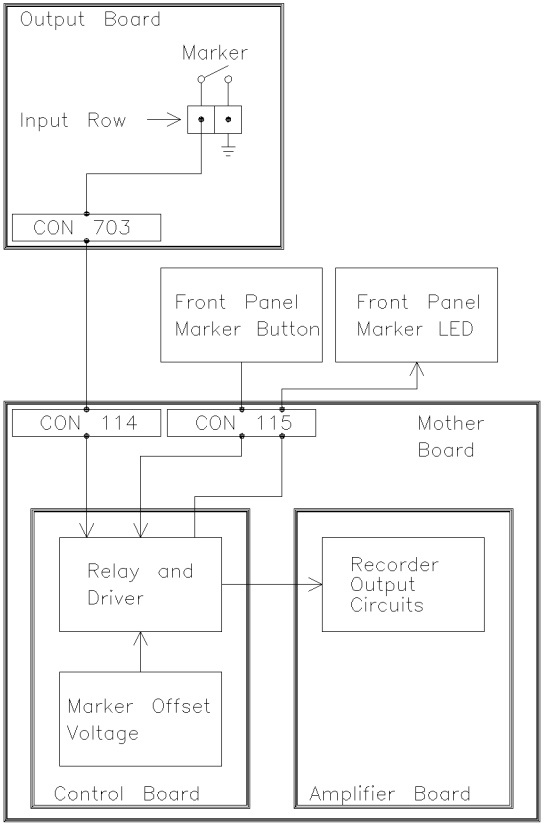

Figure 2-21. Marker

Flush Valve

Refer to *Flush Valve Control*.

Recorder Control Electronics

Figure 2-22 is a functional block diagram of the recorder control electronics.

All recorder outputs circuits reside on the AMPLIFIER board. Some of these circuits are adjustable on the board. The recorder output circuits are controlled by the recorder control circuits of the CONTROL board.

The RANGE switch sets the sensitivity of the detector (signal voltage vs. RIU). Refer to the PERFORMANCE VERIFICATION section for details.

The POLARITY control changes the polarity of both recorder outputs from positive to negative. The POLARITY INDICATOR led is ON for negative polarity. This control does not affect the integrator output.

The RECORDER control, when pushed to "zero", disables (short to gnd) both recorder outputs. This allows a stripchart recorder to be mechanically zeroed without disconnecting the detector signal cable. The RECORDER indicator LED is ON for this mode.

Note

Make sure that the RECORDER indicator LED is OFF for normal operation!

The MARKER button applies a 1 mV short-duration offset to both recorder outputs. This produces a deflection on the stripchart to mark the beginning of a chromatogram. MARKER may also be initiated from the rear panel remote control inputs.

Refer to *REMOTE CONTROL FUNCTION ELECTRONICS*. The MARKER indicator LED is ON for the duration of the offset.

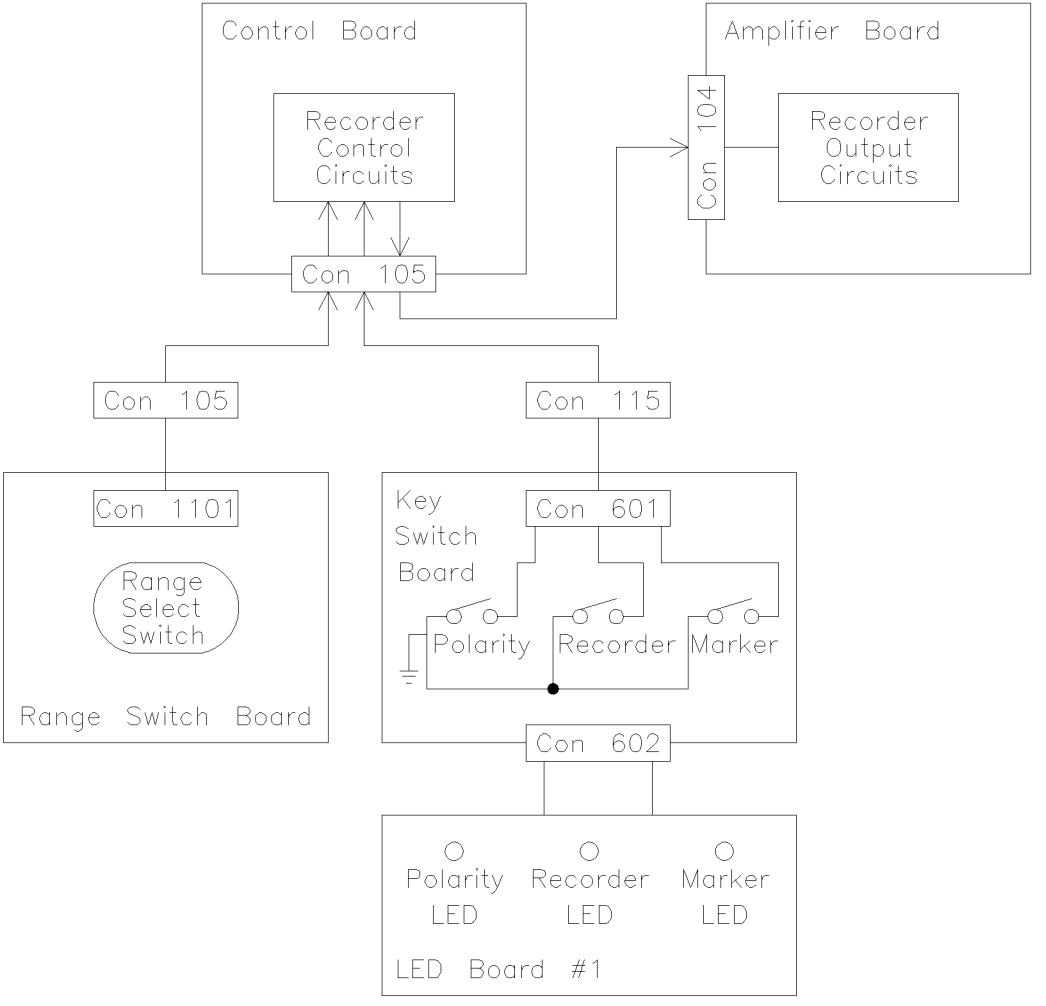

Figure 2-22. Recorder Control Electronics

Summary of Switches and Potentiometers

There are many potentiometers throughout the detector boards. Some of these are used during normal Hewlett Packard service calibrations, but many are not. These are pre-set at the factory, and should not be misadjusted. The following information, board by board, is meant to provide information on potentiometers, switches and certain testpoints. This information may be used in the event that a user has misadjusted a potentiometer or changed a switch position. If, for some reason, a particular circuit cannot be re-adjusted correctly, a new board must be ordered.

Any test points which are not mentioned in this manual are used by the factory in testing and have no practical value in board-level detector repair.

Temperature and Motor Control Board

- SW201 - Both poles must be OFF; see HEATER CONTROL ELECTRONICS for details.
- TP201 (upper right corner) - see HEATER CONTROL ELECTRONICS for details.
- TP203 (under CON201) - see HEATER CONTROL ELECTRONICS for details.
- TP204/205 (left of CON201) - see AB MOTOR CONTROL for details.

Power Supply Board

All testpoints are clearly labeled across the top of the board. See POWER DISTRIBUTION for details.

Optical Autobalance Board

- VR2, TP1101/1102 - See *AB MOTOR CONTROL* for details.

Electrical Autobalance Board

- SW401 - Both poles must be OFF; see *SIGNAL PATH OVERVIEW* for details.
- TP401/402/403 - see *SIGNAL PATH OVERVIEW* for details.

Control Board

Test points extend out to the rear for convenience.

- VR501, TP1/4 - See *SIGNAL PATH OVERVIEW* for details.
- VR502/503, TP2/3 - See *SIGNAL PATH OVERVIEW* and *SECTION 3: ELECTRICAL CALIBRATIONS* for details.

Output Board

- VR701 - See *SIGNAL PATH OVERVIEW* and *SECTION 3: ELECTRICAL CALIBRATIONS* for details.

Amplifier Board

- Figure 2-23 is a simplified diagram describing the potentiometers on the AMPLIFIER BOARD. This diagram describes the current board (8 pots). If the old board (14 pots) is present, it should be discarded and a new board ordered. On the board, test points extend out to the rear for convenience.
- VR612/613 - See *SIGNAL PATH OVERVIEW* and *SECTION 3: ELECTRICAL CALIBRATIONS* for details.

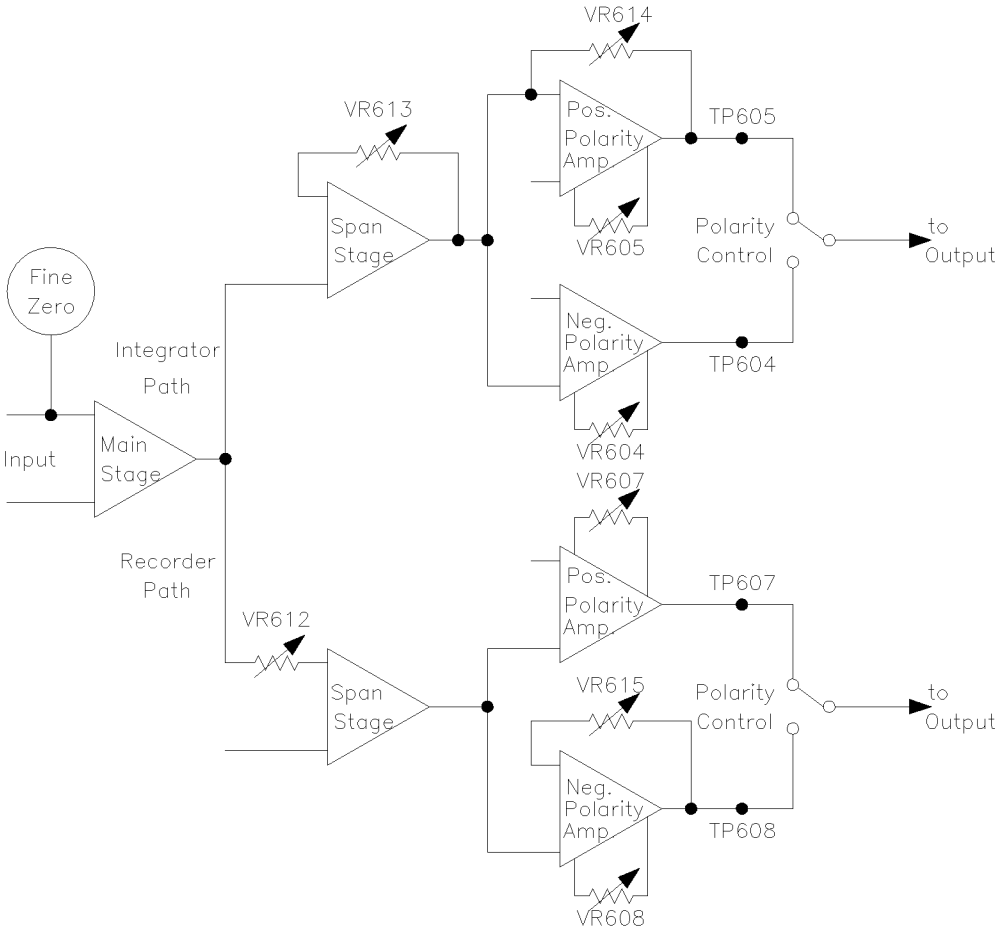

Figure 2-23. Amplifier Board Potentiometers

- The remaining six potentiometers should be adjusted together. The detector should be equilibrated at 40°C for at least 90 minutes. All DC measurements are with respect to chassis GND.

When the detector is equilibrated, adjust the potentiometers in the order, and by the procedures, which follow:

1. Set the front panel FINE ZERO dial to it's mid position - five turns. Set the front panel INTEGRATOR dial fully clockwise.
2. On the ELECTRICAL AUTOBALANCE BOARD, set both poles of SW401 to ON.
3. Using VR604, adjust TP604 (visible) to measure 0 VDC ±1 mV.
4. Using VR605, adjust TP605 (visible) to measure 0 VDC ±1 mV.
5. Using VR607, adjust TP607 (under VR605) to measure 0 VDC ±1 mV.
6. Using VR608, adjust TP608 (under VR607) to measure 0 VDC ±1 mV.
7. On the ELECTRICAL AUTOBALANCE BOARD, set both poles of SW401 to OFF.
8. Adjust VR615 as follows:
   a. Set the front panel RANGE dial to 32 and make sure the front panel recorder POLARITY button is OFF; set to positive recorder polarity. Press BALANCE.
   b. Measure TP607 (under VR605). Use the front panel +COURSE ZERO button to make TP607 measure +2.5 VDC.
   c. Now, measure TP608 (under VR607). Using VR615, adjust TP608 to measure -2.5 VDC.
   d. Test this calibration by using the front panel recorder POLARITY button and observing the front panel REC display. The -REC value should equal the +REC value. If needed, use VR615 to fine tune the -REC value.

9. Adjust VR614 as follows:

   a. Make sure the front panel integrator POLARITY leds indicates positive integrator polarity. (integrator polarity is switchable only at the rear panel)

   b. The front panel FINE ZERO and INTEGRATOR dials should be set as described in step 1 above.

   c. At the front panel, select the INT display. Press BALANCE. Use the FINE ZERO and INTEGRATOR dials to make the INT display read 0.00 and press BALANCE again.

   d. Measure TP604 (visible). Use the front panel +COURSE ZERO button to make TP604 read -2.5 VDC. This is near the maximum possible output for TP604. The front panel INT display will usually blank out before -2.5 VDC is reached. However, TP604 must reach -2.5 VDC before the front panel LIMIT ALARM is set.

   e. Now measure TP605 (visible). Using VR614, adjust TP605 to measure +2.5 VDC.

   f. Press BALANCE; the INT display should return to 0.00. To test this calibration:

      i. Locate the manual shaft turning knob on the OPTICAL BALANCE MOTOR. If needed, see page 3-15, Figure 3-7, item C.

      ii. Carefully turn the manual shaft turning knob exactly two full turns in the counter-clockwise direction. The value of the INT display should be increasing in the positive direction.

      iii. Note the value of the INT display at the "two turns" position.

iv. At the rear panel, change the integrator POLARITY to negative by shorting the two POLARITY pins in the INPUT row. This will initiate a balance, and the INT display should return to 0.00. The front panel integrator POLARITY leds should now indicate negative integrator polarity.

v. Again carefully turn the manual shaft turning knob exactly two full turns in the counter-clockwise direction. The value of the INT display should now be increasing in the negative direction.

vi. In value of the INT display should now be the same as the value in step 3 above, but with a negative polarity.

10. Perform the complete program of electrical calibrations described in *SECTION 3: Procedures* from page 3-39 to page 3-45.

Digital Display Switch Board

On this board, the INT display and REC display offsets are calibrated. Procede as follows:

1. Set the front panel FINE ZERO dial to it's mid position; 5 turns. Set the front panel INTEGRATOR dial fully clockwise. Both INTEGRATOR and RECORDER polarity should be set to positive.
2. With the detector on, disconnect one of the lamp wires from the VALVE LAMP termianl block. This will cause a LIGHT INTENSITY ERROR.
3. At the front panel, select the INT display and press BALANCE. Using VR1302 (closest potentiometer to the optical unit), adjust the INT display to read 0 VDC ± 1 mV.

4. At the front panel, select the REC display and press BALANCE. Using VR1301 (closest potentiometer to the display) adjust the REC display to read 0 VDC ±0.02 mV.
5. Re-connect the lamp wire. The LIGHT INTENSITY ERROR should clear and the baseline controls should function normally.

Digital Display Board

On this board, the display span is calibrated. Procede as follows:

1. Set the front panel FINE ZERO dial to it's mid position 5 turns. Set the front panel INTEGRATOR dial fully clockwise. Both INTEGRATOR and RECORDER polarity should be set to positive.
2. At the front panel, select the INT display and BALANCE.
3. Observe the DISPLAY SWITCH BOARD. The circuit side of the switch board is viewed from the top. There is only one test pin on the switch board, labeled TP1 (the label may not be present on very old detectors). TP1 is used for the DIGITAL DISPLAY BOARD span calibration.
4. Measure TP1 (with respect to chassis GND). At the front panel, use the +COURSE ZERO button to make TP1 read -180 mV.
5. VR1201 is the only potentiometer on the DIGITAL DISPLAY BOARD. By adjusting VR1201, make the INT display read +1800 mV. In other words, the INT display should read 10 times the value of TP1, with the opposite polarity.

3

Procedures

General Information - Read this first!

- The Figures in *SECTION 6: Parts Identification* may be used as needed as instructions for the removal of certain HP 1047A sub-assemblies and parts. Several of these procedures refer to Section 6.
- The top cover of the HP 1047A is removed as shown in Figure 3-1. The top cover must be removed for most of the procedures described herin.

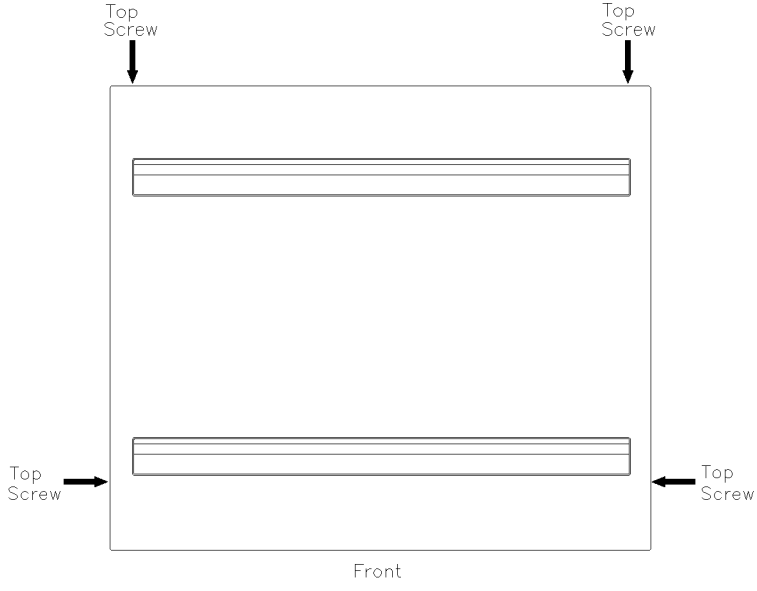

Figure 3-1. Top Cover

- ALWAYS DISCONNECT POWER before removing any board or disconnecting any cable in the HP 1047A. This basic advice will be assumed for all written procedures!
- Remember that solvents and samples used in Liquid Chromatography are often TOXIC and DANGEROUS. Always determine if the detector is filled with any harmful liquid before beginning a repair.
- ALWAYS USE ANTI-STATIC PRECAUTIONS when working on the HP 1047A.
- Certain adjustment and calibration procedures require that the detector cover be removed while the detector is powered on. BE VERY CAREFUL WHILE PERFORMING THESE PROCEDURES. Hazardous voltages are present. This warning will be assumed for all written procedures!

Board and Front Panel Controls Replacement

Refer to Figure 6-1, *SECTION 6: Parts Identification*, for board locations. Each board is keyed to it's particular location. The key is inserted into the particular Motherboard connector. Be careful not to remove this key.

Caution

Do not touch any potentiometer or switch on any board that is not described in the *Electrical Calibration* procedures. These potentiometers and switches are pre-set at the vendor's factory and may not be touched without risk to the proper operation of the board!

Caution

Always disconnect power before removing/replacing any board!

Temperature and Motor Control Board

Remove the defective board and insert the replacement board. Make sure that the three connections for the board - CON201, 202 and 203, are correctly attached. Each connector is unique and cannot be put into an incorrect position. No electrical calibrations are needed. Both poles of SW201 should be OFF.

Power Supply Board

Remove the defective board and insert the replacement board. No electrical calibrations are needed.

Optical Auto Balance Board

Note

DO NOT TOUCH VR2.

Remove the defective board and insert the replacement board. No electrical calibrations are needed.

Auto Balance Board

Note

DO NOT TOUCH VR401.

Remove the defective board and insert the replacement board. No electrical calibrations are needed. Both poles of SW401 should be OFF.

Control Board

Note

DO NOT TOUCH VR501.

Remove the defective board and insert the replacement board. Make sure to connect the ribbon cable (from the pre-amplifier board) to CON501 correctly. Perform the complete program of electrical calibrations described in *Electrical Calibrations*.

Amplifier Board

Note

DO NOT TOUCH VR615, 608, 607, 614, 605 or 604.

Remove the defective board and insert the replacement board. Perform the complete program of electrical calibrations described in *Electrical Calibrations*.

Note

In older detectors, the original AMPLIFIER board may have 14 potentiometers. The current AMPLIFIER board has only 8 potentiometers. The current AMPLIFIER board is a direct replacement for the original board.

Preamplifier Board

1. Disconnect the Preamplifier board ribbon cable from CON501 of the CONTROL board.
2. Refer to *SECTION 6: Parts Identification*, Figure 6-2, item 33 (pre-amp support plate). Remove the two screws which hold the support plate to the cardcage. Then, pull the complete assembly up for access. Be CAREFUL - the Preamplifier board is still attached to the Optical Unit by the Photodiode assembly cable.
3. Remove the plexiglass safety cover from the Preamplifier board.
4. The three wires of the photodiode assembly cable (white, clear and green are soldered to the Preamplifier board. Note the location of these wires on the board.
5. At the Preamplifier board, carefully un-solder the three wires of the photodiode cable.
6. Remove the standoffs which fix the Preamplifier board to it's support plate, then remove the board.
7. Attach the replacement Preamplifier board to the support plate. Carefully solder the three wires of the photodiode cable to the new Preamplifier board. If needed, refer to Figure 3-2.
8. Replace the plexiglass safety cover, then re-attach the complete Preamplifier board assembly to the cardcage. Re-connect the Preamplifier board ribbon cable to CON501 of the CONTROL board.

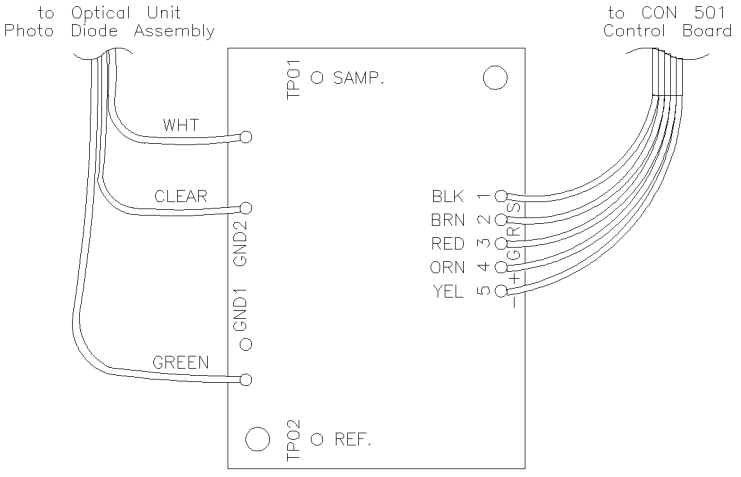

Figure 3-2. Preamplifier Board

9. No electrical calibrations are needed. However, the polarity of the Preamplifier board output should be checked, as follows:

   a. Turn on the detector; turn on should be normal. Then, BALANCE the detector.

   b. Select INT at the display. The voltage should represent a normal balance, based on the position of the front panel FINE ZERO and INTEGRATOR dials.

   c. Press and hold the + COURSE ZERO button. The display voltage must increase in the positive direction. If the voltage increases in the negative direction, re-check the position of the white and green wires on the Preamplifier board.

Output Board

Note

DO NOT TOUCH VR701.

Refer to *SECTION 6: Parts Identification*, Figure 6-4, and procede as follows:

1. Disconnect the large ribbon cable (item 1) from the OUTPUT board (the other end of this cable goes to Motherboard CON114).
2. Disconnect the 4-wire ribbon cable from the OUTPUT board (this cable is part of the Response Time Switch assembly, item 4).
3. Working from the outboard side of the rear panel, remove the board holding clamps (item 3). These clamps are located on each side of both the INPUTS and OUTPUTS terminal blocks.
4. The OUTPUT board may now be removed. To remove the board, It will be necessary to bend the rear panel (item 6) slightly outward. (You may also decide that it is more convenient to remove the six boards from the cardcage).
5. Install the replacement OUTPUT board. Re-attach the holding clamps and re-connect both ribbon cables.
6. Turn on the detector; turn on should be normal. Verify that each function of the OUTPUT board works correctly.
7. No electrical calibrations are necessary. However, refer to *Electrical Calibrations: Verify Operation of Baseline Controls and Autobalance* (step 2) for information on when OUTPUT board VR701 may need adjustment.

Motherboard

1. Remove the six boards from the detector cardcage.
2. Disconnect all cables from the motherboard.
3. Remove the six screws which secure the motherboard and remove it.
4. Install the replacement motherboard and secure it with it's six screws. Re-connect all cables; refer to *SECTION 2: Hardware*, Figure 2-12, if necessary.
5. Replace the six cardcage boards, then check for proper turn on and operation. No calibrations are needed.

All boards and controls located in the front panel

A. Remove the detector top cover.

B. Refer to *SECTION 6: Parts Identification*, Figure 6-2. Remove the side panels (items 3 and 15) by removing screws item 4. Disconnect the tubes connected to the IN OUT block (item 17).

Note

Re-connecting these tubes incorrectly will destroy the flow cell! Refer to Figure 3-5 for correct plumbing.

C. Figure 3-3 represents a top view of the detector with the detector top cover removed. Remove the eight screws indicated in the figure. Carefully pull the front panel assembly forward to gain easy access to the front panel components. It will probably be more convenient to disconnect the flush valve wires from the VALVE LAMP terminal block.

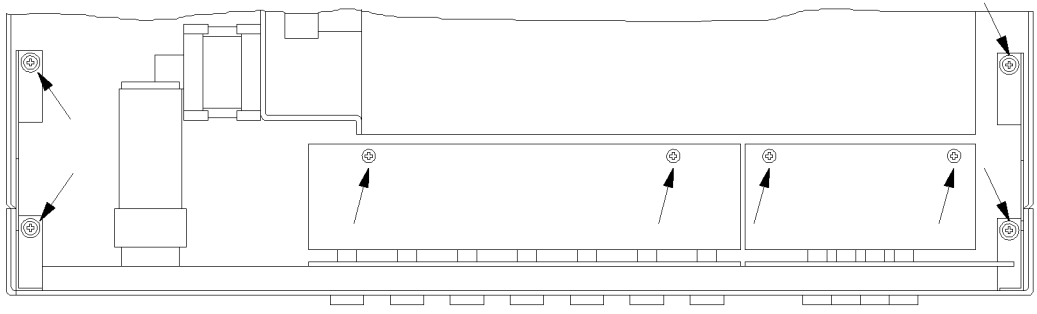

Figure 3-3. Top view with front cover removed

D. Figure 3-4 identifies the various components of the front panel assembly. The figure also indicates those screws which secure a board, and provides cabling information.

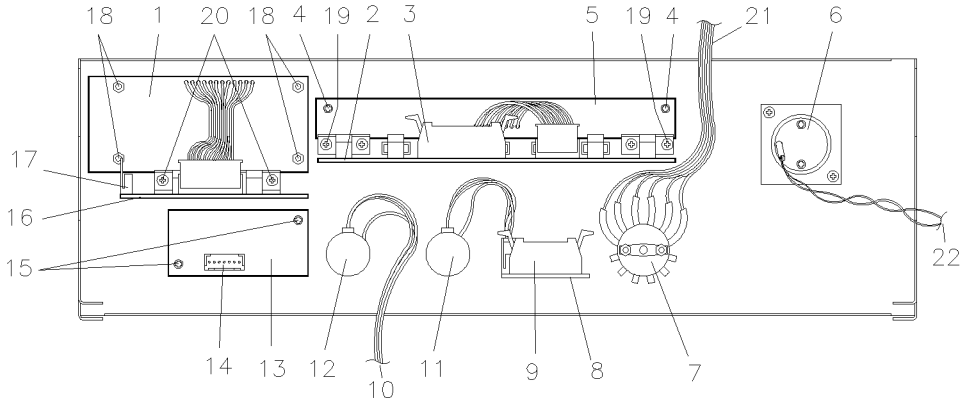

Figure 3-4. Front Panel Assembly

Table 3-1. Legenda Front Panel Assembly

Term	Description	Term	Description
1	Digital Display Board	12	Integrator Adjust Assembly
2	Key Switch Board	13	LED Board #2
3	Ribbon Cable; to Motherboard CON115	14	Ribbon Cable; to Motherboard CON109
4	Holding Screws for LED Board #1	15	Holding Screws for LED Board #2
5	LED Board #1	16	Display Switch Board
6	Flush Valve	17	Ribbon Cable; to Motherboard CON111
7	Temperature Select Switch Assembly	18	Holding Screws for Digital Display Board
8	Range Switch Board Assembly	19	Holding Screws for Key Switch Board
9	Ribbon Cable; to Motherboard CON116	20	Holding Screws for Display Switch Board
10	to Motherboard CON117	21	to Motherboard CON108
11	Fine Zero Adjust Assembly	22	to VALVE LAMP Terminal Block

Use the figure as a guide for the replacement of a particular front panel component as described in the two generalized procedures below:

1. TEMPERATURE SELECT SWITCH assembly, RANGE SWITCH/BOARD assembly, FINE ZERO ADJUST assembly or INTEGRATOR ADJUST assembly

   a. Disconnect any cables associated with the assembly to be removed. Refer to Figure 3-4 for the locations of these cables.

   b. Refer to *SECTION 6: Parts Identification*, Figure 6-3. Working from the front, remove the appropriate dial (item 1) and nut. The assembly may now be removed from the front panel.

   c. Install the replacement assembly and re-connect any cables associated with the assembly.

   d. No calibrations are needed. Re-assemble the detector and check for proper operation.

2. LED BOARD#1, KEY SWITCH BOARD, LED BOARD#2, DIGITAL DISPLAY BOARD or DISPLAY SWITCH BOARD.

Note  Do not touch the position of any potentiometers.

---

   a. Disconnect any cables associated with the board. Refer to Figure 3-4for the locations of these cables.

   b. Remove the screws which secure the board (Figure 3-4) and remove the board.

   c. Install the replacement board and re-connect the associated cables.

   d. No calibrations are needed. Re-assemble the detector and check for proper operation.

Flush Valve Replacement

1. Disconnect the flush valve wires from their locations at the VALVE LAMP terminal block. Remove the two screws that secure the valve and remove it.
2. Install the replacement flush valve.
3. Connect the valve wires to their locations at the VALVE LAMP terminal block. There is no polarity; either wire can be attached to either location.
4. **Important:** If the flush valve is incorrectly plumbed, the detector flow cell may be destroyed! Make sure that the flush valve is plumbed according to the diagram in Figure 3-5:

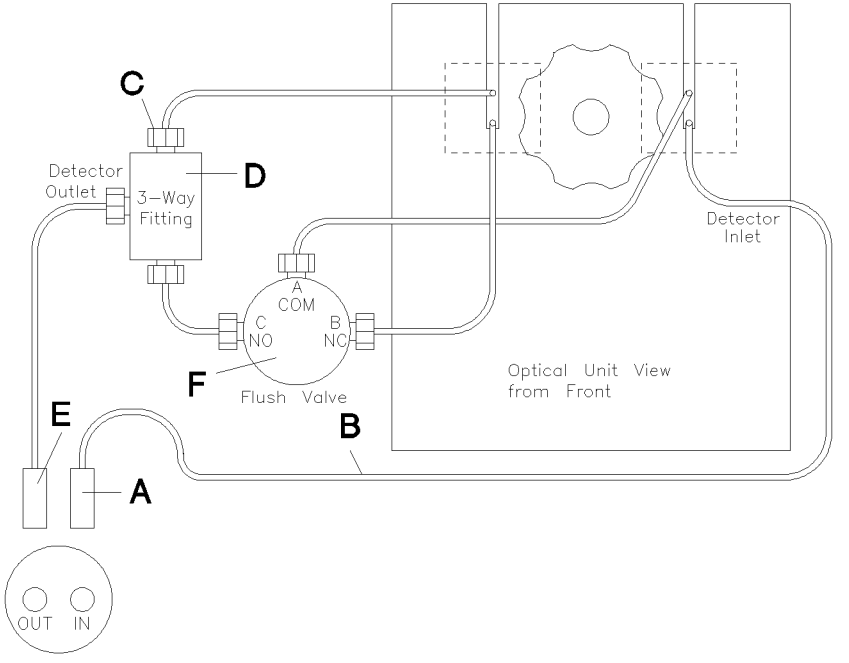

Figure 3-5. Flush Valve Plumbing

Table 3-2. Legenda Flush Valve Plumbing

Term	Description
	See the HP 1047A Operator's Handbook for details of Flow System Operation. Read these notes first..
A	This is a standard zero dead volume 1/16 inch union (0100-0900).
B	The inlet capillary tube **MUST** be plumbed as shown. Failure to do so will rupture the flow cell. The inlet capillary has an ID of 0.25 mm. All other tubes have an ID of 0.8 mm. The inlet capillary is **usually** on the bottom, as shown - but always check the ID of the tube to be certain. **The flow cell has a backpressure rating of only 7 bar**.
C	Both the Fush Valve and the 3-Way Fitting can accept SWAGELOK nuts and ferrules. Swage depth is 3.5 mm.
D	Internally, the 3-Way Fitting is a "T". Internal diameters are large to minimize restriction. **DO NOT** substitute a zero dead volume "T" for the 3-Way Fitting.
E	This is a WIDE ID 1/16 inch union. **DO NOT** substitute a standard zero dead volume union for this part; excessive restriction might rupture the Flush Valve or the Flow Cell.
F	**The Flush Valve has a backpressure rating of only 2 bar**.

AB Motor Assembly Replacement and Adjustment

Replacement

A. Remove the detector top cover. Refer to *SECTION 6:Parts Identification*, Figure 6-2, and remove the left side cover (item 15) by removing screws (item 4). Disconnect the tubes attached to the IN OUT block.

B. Figure 3-6 and Figure 3-7 identify the important details of the AB Motor assembly.

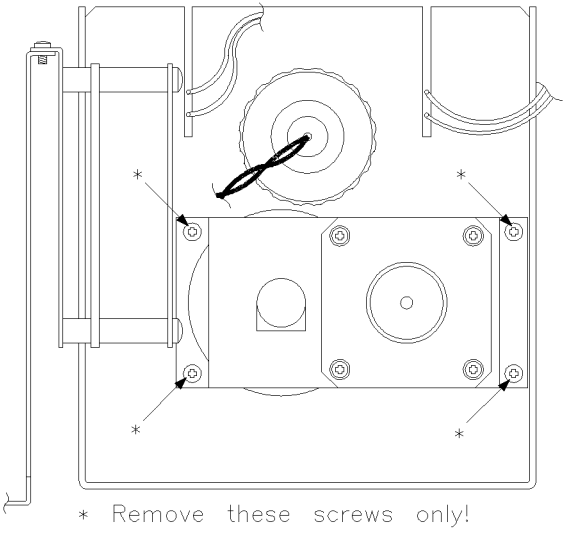

Figure 3-6. AB Motor Assembly Screws

C. Refer to Figure 3-6. Procede as follows:

1. Disconnect the AB motor assembly cable.
2. Remove the four screws (marked *) which hold the AB motor assembly to the Optical Unit. Pull the

AB motor assembly away from the Optical Unit and out of the detector.

3. With power still off, re-connect the cable of the replacement AB motor assembly.

   DO NOT yet connect the replacment AB motor assembly to the optical unit. Instead, place the motor assembly outside the detector in such a way that the motor will be able to turn freely and safely.

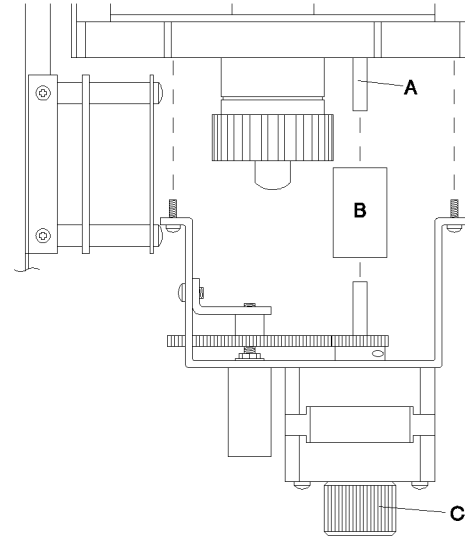

Figure 3-7. AB Motor Assembly Parts

Legenda:

A. Optical Balance Glass Control Shaft
B. Sleeve Coupling
C. Manual Shaft Turning Knob

Adjustment

A. Turn on detector power. Turn on should be normal and the LIGHT INTENSITY ERROR should not be on. By hand, adjust the optical balance glass control shaft so that TP1 and TP2 (display) are equal. This means that the optical balance glass is in it's null position.

B. At the front panel, press and hold the + COURSE ZERO button until the AB motor reaches it's limit (counter-clockwise) and the LIMIT ALARM indicator is on.

C. While the LIMIT ALARM indicator is on, press the + and - COURSE ZERO buttons simultaneously. The AB motor will now seek it's mechanical center position. The LIMIT ALARM indicator will be flashing during this movement.

D. At this time, the optical balance glass is in it's null position and the AB motor is in it's mechanical center position. Now, the balance glass and the AB motor may be joined together! As carefully as possible, push the AB motor assembly onto the optical unit, allowing the sleeve coupling to join the optical balance glass control shaft to the AB motor shaft. Make sure that the sleeve coupling has a firm hold on both sides! Fasten the AB motor to the optical unit with the original four screws.

E. This question is often asked: After step D above, how close must TP1 and TP2 be to each other? In other words, how may the relationship between the AB motor and the optical balance glass be checked?

   To check for the correct relationship between the AB motor and the optical balance glass, procede as follows:

1. Select INT at the display. Turn the front panel INTEGRATOR dial fully clockwise. Center the front panel FINE ZERO dial (5 turns).
2. BALANCE the detector, then use the FINE ZERO dial to make the INT display read 0.00.
3. Press and hold the + COURSE ZERO button. The AB motor should be moving in the counter-clockwise direction and the display reading must be increasing in the positive direction. Make sure the sleeve coupling is firmly holding both the AB motor shaft and the optical balance glass control shaft.
4. Watch the INT display. The display must reach 2 volts (and go blank) BEFORE the LIMIT ALARM indicator comes on.
5. While the detector is in the LIMIT ALARM state, center the AB motor (step C above). When the motor has reached it's center position, BALANCE the detector. The INT display should return to the value established in step E.2 above.
6. Press and hold the - COURSE ZERO button. The AB motor should be moving in the clockwise direction and the display reading must be increasing in the negative direction.
7. Again watch the INT display. The display must reach -2 volts (and go blank) BEFORE the LIMIT ALARM indicator comes on.
8. Finally, again center the AB motor and balance the detector.

If this test is NOT successful:

a. Repeat the AB motor adjustment procedure,

or

b. Has the optical unit mirror been adjusted recently? Incorrect use of the mirror adjust glass may be a cause. Refer to *Mirror Adjustment* for the mirror adjustment procedure.

or

c. Has the photodiode assembly been replaced recently? It is possible that the new photodiode assembly requires a re-adjustment of the mirror. Refer to *Mirror Adjustment* for the mirror adjustment procedure.

9. Replace the detector left side cover and reconnect the tubes of the flush valve.

Note

If the flush valve is incorrectly plumbed, the detector flow cell may be destroyed. Make sure the flush valve is plumbed according to Figure 3-5, in *Flush Valve Replacement*.

10. It is suggested to verify the program of electrical calibrations described in *Electrical Calibrations*.

Power Supply Component Replacement

Refer to *SECTION 6: Parts Identification*, Figure 6-4. With the exception of the main power transformer and the POWER SUPPLY board, all the components of the power supply are shown here.

Refer to *SECTION 2: Hardware*, Figure 2-11. Using this wiring diagram, replace the defective component.

Note

If you are replacing an old style rotary voltage selector with the current slide type, re-wire as shown in Figure 2-11.

Optical Unit Replacement

The replacement optical unit is available either with AB Motor assembly or without AB Motor assembly. This procedure assumes that the replacement optical unit DOES NOT include the AB motor assembly.

1. Refer to *SECTION 6: Parts Identification*, Figure 6-2. Remove the detector top cover. Remove the left side cover (item 15) by removing screws item 4. Disconnect the tubes from the IN OUT block (item 17) so that the side cover can be completely removed. Remove the right side cover (item 3), also by removing screws item 4.
2. Again referring to Figure 6-2, remove the Preamplifier board safety cover (item 34). Carefully un-solder from the preamplifier board the three wires (white, green, clear) of the photodiode assembly cable. This cable can be seen coming from the the front of the optical unit beneath the lamp. Make a note of the position of each wire before un-soldering.
3. Disconnect the AB motor assembly cable.
4. Disconnect the lamp wires from their positions on the VALVE LAMP terminal block.
5. Disconnect the remaining flow cell capillary tubes; one from the three-way fitting and two from the flush valve.
6. At the rear of the optical unit, disconnect the leak drain tubing from the optical unit leak drain fitting.
7. At the Temp and Motor Control board, disconnect the optical unit heater wires from CON201 and the optical unit temp sensor from CON203.
8. Carefully raise the detector to gain access to the optical unit holding screws under the detector. Again refer to Figure 6-2. Completely remove both

of the locking screws (item 32). Then, carefully remove the four nuts which secure the optical unit support feet (item 7).

9. Carefully pull the optical unit free of the detector.
10. Remove the AB Motor assembly from the optical unit. It will eventually be attached to the replacement optical unit (see Figure 3-6).
11. Carefully place the new optical unit into the detector. At this time, secure the optical unit by replacing the four nuts which secure the optical unit support feet. The two locking screws should be screwed into their holes, but not tightened.
12. Carefully re-solder to the preamplifier board the three wires of the optical unit photodiode assembly cable. If you did not make a note of the correct position of the three wires, refer to Figure 3-2. Then, replace the safety cover.
13. Reconnect the optical unit leak drain tube to the leak drain fitting at the rear of the optical unit.
14. Connect the heater and temp sensor of the replacement optical unit to their positions on the Temp and Motor control board.
15. Connect the lamp wires to the VALVE LAMP terminal block.
16. The replacement optical unit is now installed in the detector. At this time, turn on the detector. Turn on should be normal. If the LIGHT INTENSITY ERROR is on, it will be necessary to re-plumb the flow path so that the flow cell can be flushed to eliminate the LIGHT INTENSITY ERROR. If the LIGHT INTENSITY ERROR is not on, we will re-plumb the flow path later.

Important: Incorrect plumbing may destroy the flow cell! Make sure that the flow path is plumbed as shown in Figure 3-5.

17. The original AB motor assembly may now be installed on the replacement optical unit. Refer to *AB Motor Assembly Replacement and Adjustment*. Replace and adjust the AB motor assembly as described.

18. Replace the left and right detector covers. If you have not already done so, re-plumb the flow path.

    Important: Incorrect plumbing of the flow path may destroy the flow cell! Make sure that the flow path is plumbed as shown in Figure 3-5.

19. Turn on the detector, and set detector temperature to 40°C.

    After the detector has equilibrated at 40°C for 90 minutes, perform the complete electrical calibration program described in *Electrical Calibrations*.

Inside the Optical Unit

Lamp Replacement/Intensity Adjustment

The replacement lamp assembly (01037-60002) consists of the bulb and it's holder. The bulb is pre-set into the holder, but the position of the bulb MAY need re-adjustment, as described in the intensity adjustment procedure below.

The replacement bulb should be cleaned with alcohol and clean cloth. Care must be taken not to get fingerprints on the bulb.

1. Remove the detector top cover. If needed, refer to *SECTION 6: Parts Identification*, Figure 6-1, to identify the optical unit and lamp.
2. Refer to *SECTION 6: Parts Identification*, Figure 6-5. Remove the optical unit top cover (item 13), insulation (item 9) and optics cover (item 12). Removing these covers will expose the optics, as shown in Figure 3-8.

Table 3-3. Legenda Inside Optical Unit

Term	Description
1	Mirror Assembly
2	Mirror Pitch Screw (2 mm HEX)
3	Mirror Holding Screws
4	Cell Assembly
5	Slit/Lens Assembly
6	Slit/Lens Assembly Screws
7	Mirror Adjust Glass Access Hole
8	Mirror Adjust Glass
9	Optical Balance Glass
10	Lamp Holding Collar Set Screw (1.5 mm HEX)
11	Lamp Assembly
12	Lamp Holding Collar

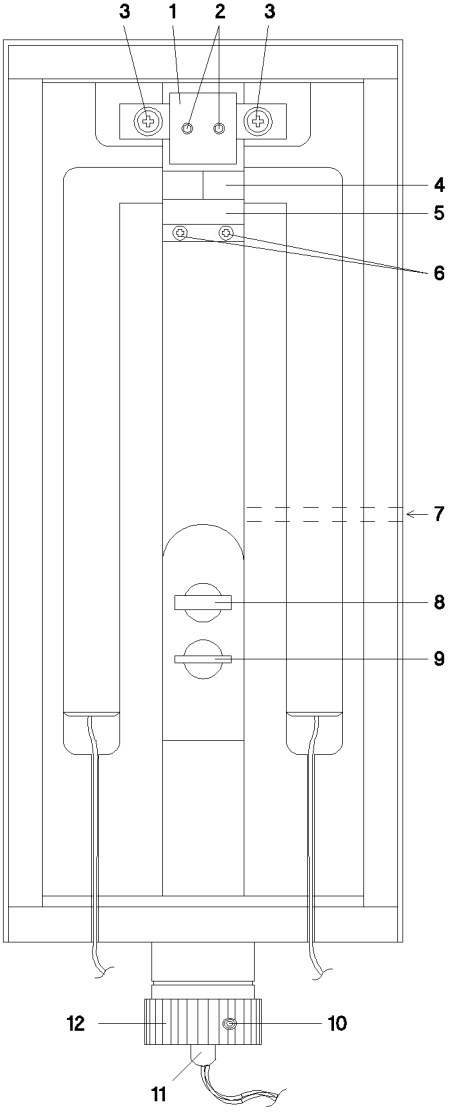

Figure 3-8. Inside the Optical Unit

3. Disconnect the existing lamp wires from their locations at the VALVE LAMP terminal block. Loosen the lamp holding collar; note that the collar is secured by set screws (1.5 mm hex) located in the collar. Remove the lamp holding collar and remove the lamp assembly.
4. Fix the replacement lamp assembly into the lamp holding collar. Insert the lamp into the optical unit, and loosely screw the lamp into place with the holding collar. Do not tighten the collar at this time. Connect the lamp wires to their positions at the VALVE LAMP terminal block. There is no polarity; either wire can be connected to either position.
5. Turn on detector power. Refer to Figure 3-8. The light from the lamp should be clearly seen in the area of the slit. Now, rotate the lamp until the slit is completely covered by the light, as shown in Figure 3-9.

Note 

If it seems not to be possible to correctly adjust the lamp, see the special information note below step 8.

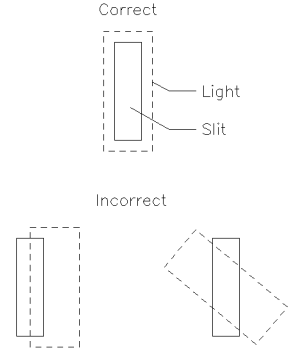

Figure 3-9. Light on Slit

6. When the lamp is correctly adjusted, carefully tighten the holding collar so that there is no danger of the lamp changing position. Tighten the set screw in the collar.
7. Replace the optical unit top covers and insulation. If all else is correct (mirror adjusted ok, no air in flow cell, etc.), display TP1/2 can be used to determine the light intensity. The average light intensity (TP1/2 pressed together) must be NO LESS THAN -3.5. Typical intensity values are between -4.0 and -5.5. Maximum intensity should be the goal of lamp adjustment.
8. Perform the complete program of electrical calibrations described in *Electrical Calibrations*.

Note

It sometimes happens that a new lamp assembly cannot be correctly adjusted. This is due to the fact that the orientation of the bulb in the bulb holder does not provide even one position where correct adjustment can be achieved. The bulb is positioned in the holder by three set screws. Loosen two of these screws, and introduce a small change in the orientation of the bulb/holder as shown in Figure 3-10. Repeat this procedure until the replacement lamp can be correctly adjusted in the detector.

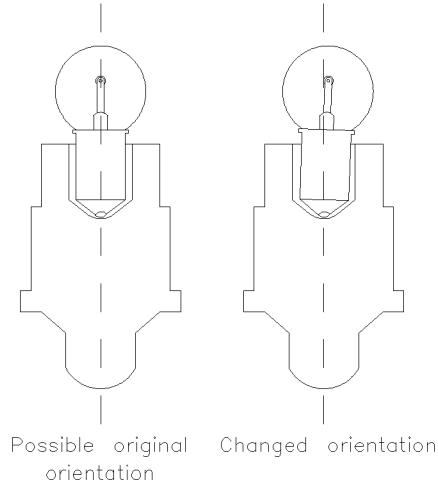

Figure 3-10. Orientation of Bulb Holder

Flow Cell Replacement

The Flow Cell Assembly (01037-60003) may be used in either the HP 1047A or the obsolete HP 1037A. The four capillary tubes of the flow cell are not fitted with screws/ferrules at the time of shipment. Included with the flow cell assembly is a bag which contains a set of fittings for the HP 1047A and a set of fittings for the HP 1037A. Select the fittings required (see Figure 3-5).

The optical surfaces of the flow cell itself are protected by a piece of clear plastic tape. Remove this tape, and clean the optical surfaces with alcohol and a cotton swab.

Note

Failure to remove this protective tape will result in insufficient light intensity.

The lamp should be correctly adjusted at this time. If not, refer to *Lamp Replacement/Intensity Adjustment* directly preceding.

1. Refer to *SECTION 6: Parts Identification*.
2. Remove the detector top cover. If needed, refer to Figure 6-1 to identify the optical unit.
3. Refere to Figure 6-5. Remove the optical unit top cover (item 13), insulation (item 9) and optics cover (item 12).
4. Refer to Figure 3-8 to identify the flow cell assembly as it appears in the uncovered optical unit. Also note the location of the mirror.

Note  Do not disturb the mirror pitch screws!

---

5. Remove the two mirror holding screws. BE CAREFUL NOT TO TOUCH THE SURFACE OF THE MIRROR! Carefully remove the mirror and put it in a safe place. If the detector is turned on now, the LIGHT INTENSITY ERROR will come on.
6. The two screws which hold the flow cell in place are hidden under the mirror. With the mirror removed, these screws can now be seen. Remove the two flow cell holding screws - but do not attempt to remove the flow cell assembly now.
7. The four capillary tubes from the flow cell assembly can be seen coming from the front of the optical unit. One of the tubes goes to the detector inlet. Two of the tubes go to the flush valve. The last tube goes to the 3-way fitting. Now, disconnect these four capillary tubes.
8. Refer again to *SECTION 6: Parts Identification*, Figure 6-5. Carefully extract the complete flow cell assembly (item 6) as indicated in the figure. This may be tedious. As the flow cell assembly is pulled upward, two thin pieces of insulation (covering the capillary tubes) will be displaced.

9. Apply a small amount of thermal compound (part number 6040-0454) to the replacement flow cell assembly. Usually, the residual thermal compound from the original flow cell assembly is enough to use on the new assembly.

10. Carefully press the new flow cell assembly into place in the optical unit. Take care to position the flow cell tubes correctly. Take care to replace the thin pieces of insulation which originally covered the capillary tubes. Secure the flow cell in place with the two flow cell holding screws.

Note  Incorrect plumbing will destroy the flow cell!

---

11. Re-plumb the flow cell assembly capillary tubes as shown in Figure 3-5.

12. Carefully replace the mirror. Screw the two mirror holding screws into place, but do not tighten them down at this time.

13. Perform the *Mirror Adjustment* procedure.

Mirror Replacement

The lamp should be correctly adjusted at this time. If it is not, refer to *Lamp Replacement/Intensity Adjustment*.

If the mirror has not yet been removed, begin with step (1) below. If the mirror has already been removed, and is now loosely back in place, begin immediately with *Mirror Adjustment*.

1. Remove the detector top cover. If needed, refer to *SECTION 6: Parts Identification*, Figure 6-1 to identify the optical unit.

2. Refer to Figure 6-5. Remove the optical unit top cover (item 13), the insulation (item 9) and the optics cover (item 12).

3. To identify the mirror, refer to Figure 3-8 preceding.

Note

Do not touch the pitch screws!

4. Remove the two mirror holding screws. BE CAREFUL NOT TO TOUCH THE SURFACE OF THE MIRROR! Carefully remove the mirror and put it in a safe place. If the detector is turned on now, the LIGHT INTENSITY ERROR will come on.
5. Carefully install the replacement mirror and insert the two mirror holding screws. Do not tighten the mirror holding screws at this time - instead, procede with the mirror adjustment procedure described in the next steps.

Mirror Adjustment

This is a tedious adjustment that requires patience. The mirror must be correctly adjusted to ensure proper operation of the detector.

1. Activate the flush valve and flush the flow cell with pure isopropanol at a flow rate of between 4 and 5 ml/min. This is to make sure that there are no air bubbles in the flow cell. **Remember**, since the mirror is now mis-adjusted, display TP1/2 are not functional.

Note

Make sure that there is no restriction downstream of the detector. The flow cell can be destroyed by excessive backpressure.

2. Fill both halves of the flow cell with pure, well degassed HPLC-grade water. Set the detector temperature to 40°C and allow the detector to equilibrate at 40°C for ninety minutes.

   90 minutes yet?

3. Refer to Figure 3-8 preceding. Set both the optical balance glass and the mirror adjust glass to be perpendicular to the light beam ... best estimation by eye is ok. Note that the mirror adjust glass movement is accessed through a hole in the side of the optical unit. This hole may be reached by removing the front panel cosmetic plug (*SECTION 6: Parts Identification*, Figure 6-3 item 3). For this purose, use a a long, flat blade screwdriver with a blade no more than 4 mm wide.

4. Figure 3-11 shows the location of the photodiodes inside the optical unit. The photodiodes can be seen by looking from the rear of the optical unit as shown. The Figure also shows the possible movements of the mirror during adjustment.

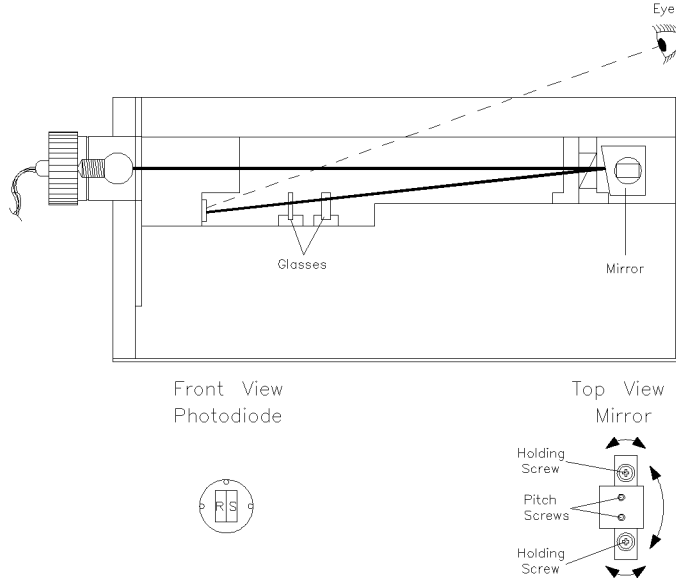

Figure 3-11. Location of Photodiodes

5. Turn on the detector, and look at the photodiode area. By hand, move the mirror such that the light beam falls equally on the photodiodes as shown in Figure 3-12. Before you start, read the general information below for an overview of the job, and some helpful hints.

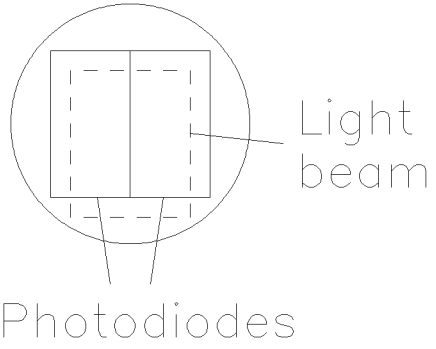

Figure 3-12. Lightbeam on Photodiodes

The basic task

As you adjust the mirror by hand, use display TP1 and TP2. The goal of the mirror adjustment is twofold; TP1 and TP2 should both be as high as possible, and TP1 and TP2 must be as close together as possible!

Average intensity (TP1/2 buttons pressed together) must be no less than -3.5, but you should strive for the maximum intensity. Typical intensities are from -4.0 to -5.5. When TP1 and TP2 are within 0.2 of each other, you may use the mirror adjust glass (Figure 3-8) to make them equal. DO NOT use the mirror adjust glass to compensate for a difference greater than 0.2!

Helpful hints

- It could be helpful to slightly tighten the mirror holding screws, then use a lever, such as a small screwdriver or needle-nose pliers, to adjust the mirror. This provides for a finer resolution of adjustment.
- The mirror can move in several directions, as shown in Figure 3-11. This means that a very clear procedure for moving the mirror is not really possible. You must find the mirror position which best meets the requirements of maximum intensity and photodiode equality.
- Once the correct position for the mirror has been established, tightening the holding screws can be a problem. The position of the mirror tends to change as the screws are tightened. To avoid this, place your finger on top of the mirror and gently begin to press. If the position of the mirror does not change (TP1/2 unchanged), then tighten the holding screws while pressing the mirror.
- Mirror adjustment can be done with the optical unit completely uncovered, but stray light will cause some instability of TP1/2. After the mirror is finally tightened, cover the optical unit. Then the mirror adjust glass can be used to make TP1/2 equal.

If it seems not possible to adjust the mirror:

- Is there an air bubble in the flow cell?
- Has the flow cell been replaced recently? If yes, has the clear protective tape been removed from the flow cell?
- Did you get fingerprints or dirt on the optical balance or mirror adjust glass?
- Is the mirror a new replacement part? If yes, it could be that an additional step is needed for mirror adjustment. See Figure 3-13.

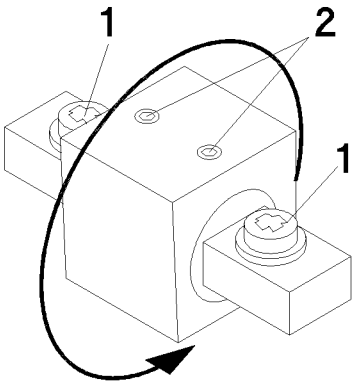

Figure 3-13. Mirror Screws

Legenda:

1. Mirror Holding Screws
2. Mirror Pitch Screws (2 mm HEX)

Ordinarily, the pitch screws should not be loosened. However, if the mirror is a new part, the pitch of the mirror may also need adjustment. Procede as follows:

a. Loosen the mirror holding screws. Establish the mirror position at midway between full left and full right. Then, tighten the holding screws.
b. Loosen the pitch screws. Adjust the mirror pitch so that the beam is related to the photodiodes as shown in Figure 3-12. Then, re-tighten the pitch screws.
c. Repeat the mirror adjustment procedure.

- Replace the optical unit covers and insulation.
- Perform the complete program of electrical calibrations described in *Electrical Calibrations*.

Photodiode Replacement/Adjustment

The Photodiode Assembly (01047-60013) actually consists of the photodiode package and the 1st lens/slit group. This assembly can be used either in the HP 1047A or in the obsolete HP 1037A.

Note

Never attempt to further disassemble the Photodiode Assembly. The relationship of the internal parts are critical, and these are pre-adjusted at the factory.

Replacement

1. Refer to *SECTION 6: Parts Identification*.
2. Remove the detector top cover. Refer to Figure 6-5. Remove the optical unit top cover (item 13), the insulation (item 9) and the optics cover (item 12).
3. Locate the Preamplifier board. Refer to Figure 6-1 if needed.
4. Carefully un-solder from the Preamplifier board the three wires (white, green, clear) from the photodiode assembly cable. This cable can be seen coming from the optical unit, directly under the lamp. Before un-soldering, note the position of the three wires.
5. Refer to *All Boards and Control located ...* , Figure 3-3. This figure shows the holding screws for the detector front panel assembly. Remove these screws, then carefully allow the front panel assembly to fall away - it is not necessary to remove any cables or tubes, but make sure that nothing is damaged!
6. Figure Figure 3-14 shows a side view of the optical unit as viewed from the front of the detector. The Figure also shows how the photodiode assembly will be removed from the optical unit.

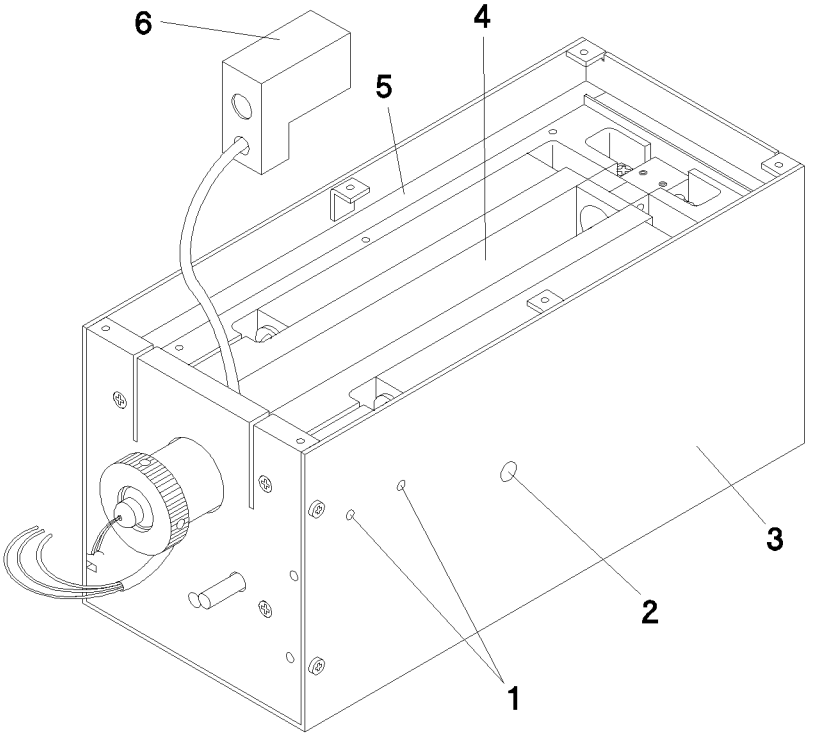

Figure 3-14. Optical Block

Table 3-4. Legenda Optical Block

Term	Description
1	Photodiode Assembly Setscrew Access Holes (1.5 mm HEX)
2	Mirror Adjust Glass Access Hole
3	Optical Unit Outer Case
4	Optics Block
5	Foam Insulation
6	Photodiode Assembly

7. At this time, observe how the photodiode assembly is seated in the optical unit.
8. The photodiode assembly is secured by two 1.5 mm hex set screws. These screws can be loosened through the access holes with a 1.5 mm hex wrench. Push a hex wrench through the foam insulation into the access holes in the optics block. Loosen both set screws.
9. The complete photodiode assembly can now be pulled out of the optics block as shown in Figure 3-14.
10. Install the replacement photodiode assembly. Make sure to guide the photodiode cable through the correct hole in the front plate - the hole directly under the lamp. Make sure the new photodiode assembly is adjusted correctly - it should be pushed against the front plate, and sitting flatly on the floor of the optics block. Then, tighten the set screws.
11. Solder the three wires of the photodiode cable to their correct positions on the Preamplifier board. If you did not note their original positions, refer to Figure 3-2.
12. Replace the optical unit top covers and insulation. Replace the detector front panel assembly.

Adjustments and Calibrations

How much work needs to be done depends upon how closely the new photodiode assembly matches the original photodiode assembly. Procede as follows:

1. Turn on the detector. The INTENSITY ERROR should not be on. The average intensity (display TP1/2 pressed together) MUST be no less than -3.5. However, remember that typical intensity values range from -4.0 to -5.5. TP 1/2 must also be within 0.2 of each other.

2. In your best judgement ...

   If step 1 above is satisfactory, immediately perform the complete calibration program described in *Electrical Calibrations*.

   If step 1 above is NOT satisfactory then

   a. Is there an air bubble in the flow cell? Try flushing the flow cell.

      or

   b. Is the new photodiode assembly correctly installed? Is it adjusted correctly? Are the photodiode wires correctly soldered to the Preamplifier board?

      or

   c. The new photodiode assembly requires a re-adjustment of the mirror. Refer to *Mirror Replacement and Adjustment* and re-adjust the mirror.

Optical Unit Heater/Temperature Sensor

The optical unit heater (or it's thermal fuse) and temperature sensor ARE NOT replaceable on the component level. If these components become defective, the complete optical unit must be replaced.

Refer to *Optical Unit Replacement*.

Electrical Calibrations

Correct electrical calibration is essential to the proper operation of the HP 1047A. These calibrations must be performed if:

1. The original, factory-set light intensity is altered; eg., by changing the lamp or re-adjusting the mirror.
2. A critical board which is replaced; eg., the AMPLIFIER or CONTROL board.

The calibrations MUST BE PERFORMED IN THE ORDER IN WHICH THEY ARE GIVEN BELOW. Pure, well degassed HPLC-grade water should be in both halves of the flow cell during calibrations. The detector should be equilibrated at 40°C for ninety minutes. Average light intensity (TP1/2 select buttons pressed together) MUST be no less than -3.5.

NULL the detector output:

1. Turn on the detector and make sure that the LIGHT INTENSITY ERROR is not present.
2. At the front panel, turn the INTEGRATOR dial fully clockwise and turn the FINE ZERO dial to it's mid position (5 turns).
3. Press and hold the front panel + COURSE ZERO button until the LIMIT ALARM indicator comes on.
4. With the LIMIT ALARM on, set the optical balance glass to it's null position by pressing the + and - COURSE ZERO buttons simultaneously. The LIMIT ALARM indicator will flash as the optical balance glass moves to it's null position.
5. Press the BALANCE button. After the balance is done, select the INT display. Use the FINE ZERO

dial to make the INT display as close to 0.00 as possible.

The detector output is now nulled.

Calibrate the LIGHT INTENSITY ERROR THRESHOLD:

1. The detector output should still be nulled.
2. Refer to Figure 3-15. In the detector, locate the CONTROL board. Locate VR502 and TP2 on the CONTROL board.

Note

On the CONTROL board, the test points extend out from the rear of the board for easy access. With a DC Voltmeter, prepare to measure TP2 with respect to chassis GND. The 20 VDC range is sufficient.

3. Adjust VR502 so that TP2 reads 7.5 VDC.

   The detector is now calibrated such that the LIGHT INTENSITY ERROR will come on if the current light intensity, as seen by the photodiodes, deviates by approximately 25% from the original factory intensity.

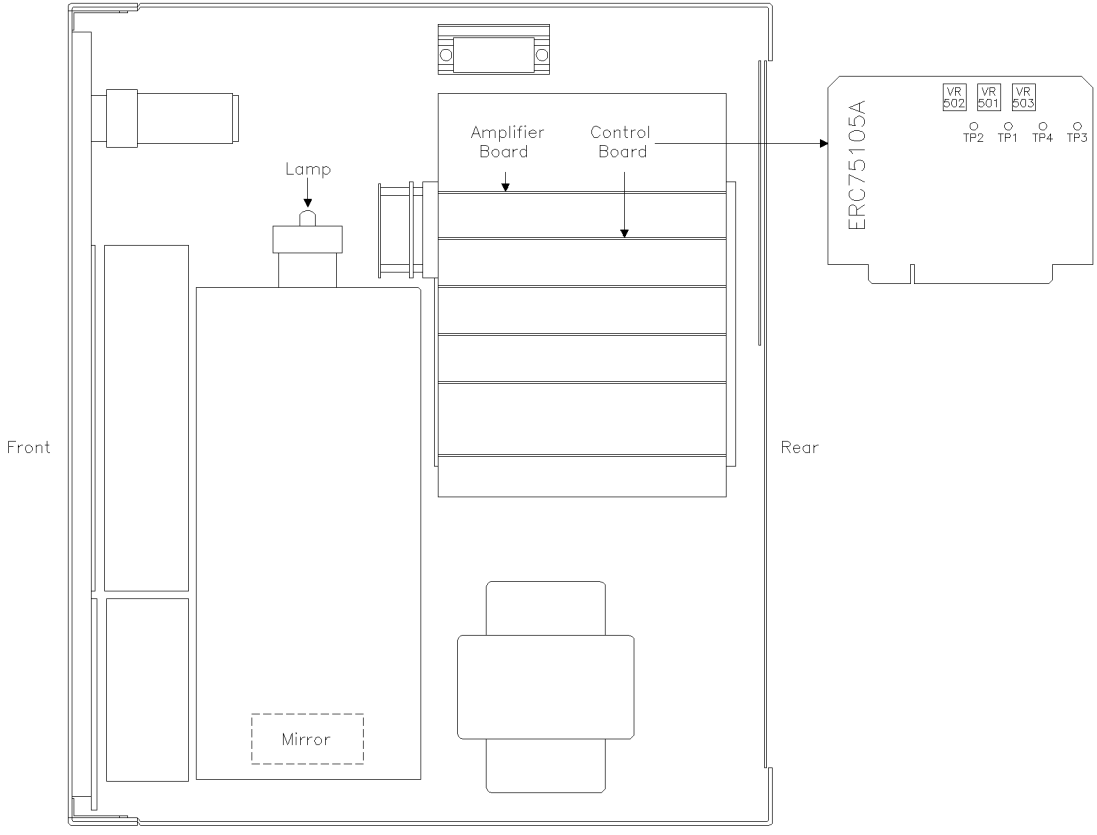

Figure 3-15. Location of Boards

Calibrate the INTEGRATOR OUTPUT SPAN:

1. The detector output should still be nulled.
2. Locate the manual shaft turning knob on the front of the AB Motor assembly (if needed, refer to Figure 3-7).
3. As carefully as possible, turn the AB Motor assembly shaft exactly TWO FULL TURNS in the COUNTER-CLOCKWISE direction. As the motor shaft is turned, the INT display should be increasing in the positive direction.

Note

Two counter-clockwise turns of the shaft equals a beam displacement of 16×10^{-5} RIU. Mechanically introducing a known RIU is more reliable and convenient than the classic method of preparing an RI solution for injection into the cell.

4. Use Figure 3-15 to locate the AMPLIFIER board. On the AMPLIFIER board, locate VR613. VR613 is clearly labeled on the board.

   Adjust VR613 so that the INT display reads as close to 512 mV as possible. The tolerance for this adjustment is 512 mV $\pm$10%.

   The INTEGRATOR OUTPUT SPAN is now calibrated such that 32 mV equals 1×10^{-5} RIU.

Calibrate the RECORDER OUTPUT SPAN:

1. The AB Motor shaft should still be adjusted to two full turns counter-clockwise, with the INT display reading 512 mV.
2. Set the front panel RANGE switch to 32. Select the REC display.

3. Locate VR612 on the AMPLIFIER board; it is clearly labeled. Adjust VR612 so that the REC display reads as close to 5 mV as possible. The tolerance for this adjustment is 5 mV ±10%.

Calibrate the AUTOBALANCE DECISION THRESHOLD:

1. The AB Motor shaft should still be adjusted to two full turns counter-clockwise, with the INT and REC OUTPUT SPANS correctly calibrated.
2. Locate VR503 and TP3 on the CONTROL board. Set up the DC Voltmeter to measure TP3 with respect to chassis GND.
3. Adjust VR503 so that TP3 reads -0.5 VDC.

   The detector Autobalance circuit is now adjusted so that the Electrical/Optical Autobalance decision threshold is 4×10^{-5} RIU.

Verify the operation of the BASELINE CONTROLS and AUTOBALANCE

1. The AB motor shaft should still be adjusted to two full turns counter-clockwise. The front panel INTEGRATOR dial should be set fully clockwise and the FINE ZERO dial should be at it's mid position (5 turns). The RANGE knob should be set to 32.
2. Press BALANCE. After the balance, both the REC and the INT displays should be (theoretically) 0.00. The FINE ZERO dial (which affects both INT and REC) should provide similar baseline range in both the + and - direction. The INTEGRATOR dial, when turned fully counter-clockwise, should add +10 mV to the existing value of the INT display. The REC display is not affected by the INTEGRATOR dial.

Note

If the relationship between the INT display and REC display is not correct, refer to the procedure *Calibrating OUTPUT board VR701*.

3. Select the INT display and use the baseline control dials to set the INT display to a baseline value of 0.00.
4. Press and hold the + COURSE ZERO button until the INT display reads between 100 and 110 mV. (This is below the AB decision threshold)
5. Press BALANCE. Only an electrical autobalance should be done; the AB Motor should not move. The INT display should return to 0.00, as originally set.
6. Again press and hold the + COURSE ZERO button; this time until the INT display reads between 150 and 160 mV. (This is above the AB decision threshold)
7. Again press BALANCE. This time, the AB Motor should move to it's null position as an optical autobalance is done. Then, an electrical autobalance should return the INT display to 0.00, as originally set.

Note

It is important to realize that a BALANCE will return the baseline to the value set by the FINE ZERO and INTEGRATOR dials. A BALANCE does not return the baseline to 0.00 unless, as in the test above, the actual set value is 0.00.

Calibration of OUTPUT board VR701

Optional step!

Ordinarily, VR701 of the OUTPUT board need not be calibrated. Perform this procedure only if the relationship between the INT display and the REC display is not correct, refer to *Verify the Operation of*

the Baseline Controls and Autobalance (step 2) is not correct.

1. The OUTPUT BOARD is located on the detector rear panel assembly. VR701 is at the top of the board, clearly labeled.
2. NULL the detector as described in *Null the detector output*.
3. Set the front panel RANGE switch to 32. Select the REC display, and use the FINE ZERO dial to make the REC display read 0.00.
4. Select the INT display. Adjust VR701 so that the INT display reads 0.00.

   The FINE ZERO dial should now be able to simultaneously zero the REC and INT displays. The INTEGRATOR dial should add +10 mV to the existing INT display.

Verify that the detector has adaquate ± RANGE:

1. For proper operation, the detector must have adaquate range in both the + and - directions.

   Refer to *AB Motor Assembly Replacement and Adjustment*. The procedure for checking the relationship between the AB Motor and the optical balance glass actually does make sure that the detector has adaquate range in both directions.

Note

If the detector does not have adaquate range in both directions, the most likely cause is incorrect adjustment of the mirror - particularly, incorrect use of the mirror adjustment glass. Refer to *Mirror Adjustment*.

4

Performance Verification

This section is meant to assist in determining the actual performance of the HP 1047A.

Specification Verification

- For the integrator output
  - calculating integrator deflection
  - verifying the noise specification
  - verifying the drift specification
  - verifying the wander specification
- For the recorder outputs
  - the range knob and recorder outputs
  - the recorder full scale deflection setting
  - calculating recorder deflection
  - verifying the noise specification
  - verifying the drift specification
  - verifying the wander specification
- For the ChemStation
  - calculating noise and drift

HP 1047A Specifications Verification

The specifications of the HP 1047A can be found in *Section 1: General Information.*

For the integrator output

The integrator output of the HP 1047A is calibrated such that 32 mV equals 1×10^{-5} DELTA RIU. Verifying HP 1047A specifications is a question of converting the specifications to an allowable deflection (noise, drift or wander) on the integrator at a specific integrator attenuation.

Calculating allowable integrator deflection

The formula for calculating allowable deflection in mm at a specific integrator attenuation:

$$\text{deflection in mm} = \frac{\text{spec}}{\text{RIU/mm}}$$

where:

spec	specification of detector
deflection	allowable deflection in mm
RIU/mm	scaling factor at a specific attenuation

See Table 4-1 for the RIU scaling factor of Hewlett Packard integrators.

For other integrators, refer to the manual for that integrator. Look up the signal input required for FULL SCALE DEFLECTION at the specific attenuation, then calculate the signal required for 1 mm deflection at that attenuation with this formula:

$$\text{signal} = \frac{\text{signal FS}}{\text{INT FS}}$$

where:

signal	signal for 1 mm deflection
signal FS	signal for full scale deflection
INT FS	integrator full scale deflection in mm

The HP 1047A integrator output is calibrated such that 32 mV = 1×10^{-5} RIU. Calculate the RIU/mm SCALING FACTOR for the integrator at the specific integrator attenuation.

Example of RIU/mm scaling factor calculation:

Assume that the integrator needs a signal input of 32 mV for a full scale deflection at ATTENUATION 5. This means a HP 1047A signal of 1×10^{-5} RIU will cause a FULL SCALE DEFLECTION of the integrator at ATTENUATION 5. Assume that the integrator has a full scale deflection of 150 mm.

$$\text{signal} = \frac{1 \times 10^{-5}\ \text{RIU}}{150\ \text{mm}} = 6.6 \times 10^{-8}\ \text{RIU}$$

At attenuation 5, the scaling factor for this integrator is 1×10^{-5} RIU FS, or 6.6×10^{-8} RIU/mm.

For the table below the full scale deflection on the HP 3390/2/3 is a 75mm and on the HP 3394/6 is 150mm.

Table 4-1.
RIU Scaling Factors for HP Integrators

Attn	339XA RIU/FS	3390/2/3 RIU/mm	3394/6 RIU/mm
- 5	1.00×10^{-8}	1.3×10^{-10}	6.5×10^{-11}
- 4	1.97×10^{-8}	2.6×10^{-10}	1.3×10^{-10}
- 3	3.91×10^{-8}	5.2×10^{-10}	2.6×10^{-10}
- 2	7.81×10^{-8}	1.0×10^{-9}	5.2×10^{-10}
- 1	1.56×10^{-7}	2.8×10^{-9}	1.4×10^{-9}
0	3.13×10^{-7}	4.2×10^{-9}	2.1×10^{-9}
1	6.25×10^{-7}	8.3×10^{-9}	4.2×10^{-9}
2	1.25×10^{-6}	1.7×10^{-8}	8.5×10^{-9}
3	2.50×10^{-6}	3.3×10^{-8}	1.7×10^{-8}
4	5.00×10^{-6}	6.7×10^{-8}	3.4×10^{-8}
5	1.00×10^{-5}	1.3×10^{-7}	6.5×10^{-8}
6	2.00×10^{-5}	2.6×10^{-7}	1.4×10^{-7}
7	4.00×10^{-5}	5.3×10^{-7}	2.7×10^{-7}
8	8.00×10^{-5}	1.3×10^{-6}	5.3×10^{-7}
9	1.60×10^{-4}	2.1×10^{-6}	1.0×10^{-6}
10	3.20×10^{-4}	4.3×10^{-6}	2.2×10^{-6}

Verifying the noise specification

1. Noise Specification: $\pm$ 2.5 $\times$ 10^{-9} RIU P/P. (equivalent to 5 $\times$ 10^{-9} RIU P/P)
2. For HP 3390/2/3 at ATTENUATION - 2:

$$\text{noise} = \frac{5 \times 10^{-9}\ \text{RIU p/p}}{1 \times 10^{-9}\ \text{RIU/mm}}$$

Allowable Noise at attenuation - 2 = 5 mm P/P for HP 3390/2/3.

3. For HP 3394/6 at ATTENUATION - 2:

$$\text{noise} = \frac{5 \times 10^{-9}\ \text{RIU p/p}}{0.5 \times 10^{-9}\ \text{RIU/mm}}$$

Allowable Noise at attenuation - 2 = 10 mm P/P for HP 3394/6.

Verifying the drift specification

1. Drift Specification: 2.5×10^{-7} RIU/HR equal to 250×10^{-9} RIU/HR.
2. For HP 3390/2/3 at ATTENUATION 1:

$$\text{drift} = \frac{250 \times 10^{-9}\ \text{RIU}}{8.3 \times 10^{-9}\ \text{RIU/mm}}$$

Allowable drift at attenuation 1 = 30 mm/HR for HP 3390/2/3.

3. For HP 3394/6 at ATTENUATION 1:

$$\text{drift} = \frac{250 \times 10^{-9}\ \text{RIU}}{4.2 \times 10^{-9}\ \text{RIU/mm}}$$

Allowable drift at attenuation 1 = 60 mm/HR for HP 3394/6

Verifying the wander specification

1. Wander Specification: $\pm$ 1 $\times$ 10^{-8} RIU equal to 2 $\times$ 10^{-8} RIU (equivalent to 20 $\times$ 10^{-9} RIU).
2. For HP 3390/2/3 at ATTENUATION 0:

$$\text{wander} = \frac{20 \times 10^{-9}\ \text{RIU}}{4.2 \times 10^{-9}\ \text{RIU/mm}}$$

   Allowable Wander = Approx. 5 mm for HP 3390/2/3.

3. For HP 3394/6 at ATTENUATION 0:

$$\text{wander} = \frac{20 \times 10^{-9}\ \text{RIU}}{2.1 \times 10^{-9}\ \text{RIU/mm}}$$

   Allowable Wander = approx. 10 mm for HP 3394/6.

For the recorder outputs

Verifying HP 1047A specifications using recorder outputs is a question of converting the specifications (noise, drift, wander) to an allowable RECORDER DEFLECTION at a particular HP 1047A RANGE setting. For this, it is necessary to understand the relationship between the HP 1047A RECORDER OUTPUTS (1 mV and 10 mV), the HP 1047A RANGE dial and the full scale deflection setting of the recorder.

The range dial and recorder outputs

Assume that the HP 1047A RANGE dial is set to 2 $\times$ 10^{-5} RIU. At this RANGE setting, 2 $\times$ 10^{-5} RIU of detector response will produce a signal of 10 mV at the 10 mV RECORDER OUTPUT and a signal of 1 mV at the 1 mV RECORDER OUTPUT.

The least sensitive RANGE setting is 10 mV and 1 mV of signal output for 32×10^{-5} RIU increment of detector response.

The most sensitive RANGE setting is 10 mV and 1 mV of signal output for $1/64 \times 10^{-5}$ RIU increment of detector response.

The recorder full scale deflection setting

Most recorders have a variable FULL SCALE DEFLECTION setting. 1 mV, 10 mV and 1V are most popular.

Ideally, the RECORDER FULL SCALE DEFLECTION setting should be matched to the detector recorder output. For example, if the 10 mV RECORDER OUTPUT of the HP 1047A is connected to a recorder, the recorder's FULL SCALE DEFLECTION should be set to 10 mV. In this way, the detector response needed for a FULL SCALE DEFLECTION of the recorder is determined by the detector RANGE setting. Peak height can be converted to detector response by it's percentage of FULL SCALE DEFLECTION.

Example:

The HP 1047A 1 mV RECORDER OUTPUT is connected to the recorder. The recorder FULL SCALE DEFLECTION is set for 1 mV. The HP 1047A RANGE dial is set to 16×10^{-5} RIU. The chromatogram contains one peak, which is 50% FULL SCALE DEFLECTION. This peak then represents a detector response of 8×10^{-5} RIU.

Note

If it is not possible to properly match the detector recorder output and the recorder full scale deflection setting, then the error will have to be taken into account during quantitation or specifications verification.

Calculating recorder deflection

The formula for calculating allowable deflection in mm at a specific detector RANGE setting is:

$$\text{rec defl} = \frac{\text{spec}}{\text{range}} \times \text{rec FS}$$

where:

rec defl	recorder deflection in mm
spec	specification
range	range setting
rec FS	recorder full scale in mm

For the following examples we assume a recorder FULL SCALE DEFLECTION of 250 mm and a correct detector/recorder matching.

Verifying the noise specification

1. Noise Specification: $\pm$ 2.5 $\times$ 10^{-9} RIU P/P. (equivalent to 5 $\times$ 10^{-9} RIU P/P)
2. HP 1047A RANGE setting to 1/64 $\times$ 10^{-5} RIU (equivalent to 156.25 $\times$ 10^{-9} RIU)
3. Calculate:

$$\text{noise} = \frac{5 \times 10^{-9}\ \text{RIU}}{156.25 \times 10^{-9}\ \text{RIU}} \times 250\ \text{mm} = 8\ \text{mm}$$

Allowable noise at range setting 1/64 is 8 mm P/P

Verifying the drift specification

1. Drift Specification: 2.5×10^{-7} RIU/HR
2. HP 1047A RANGE setting to $1/64 \times 10^{-5}$ RIU (equivalent to 1.5625×10^{-7})
3. Calculate:

$$\text{drift} = \frac{2.5 \times 10^{-7}\ \text{RIU}}{1.5625 \times 10^{-7}\ \text{RIU}} \times 250\ \text{mm} = 400\ \text{mm}$$

Allowable drift at range setting 1/64 is 40 cm/HR, or 7 cm over 10 minutes.

Verifying the wander specification

1. Wander Specification: $\pm\ 1 \times 10^{-8}$ RIU (equivalent to 2×10^{-8} RIU)
2. HP 1047A RANGE setting to $1/64 \times 10^{-5}$ RIU. (equivalent to 15.625×10^{-8})
3. Calculate:

$$\text{wander} = \frac{2 \times 10^{-8}\ \text{RIU}}{15.625 \times 10^{-8}\ \text{RIU}} \times 250\ \text{mm} = 32\ \text{mm}$$

Allowable wander at range setting 1/64 is 3.2 cm

For the ChemStation

In the ChemStation, full scale range is set in μV.

Example: Calculating the noise

1. The HP 1047A integrator output (1×10^{-5} RIU = 32000 μV) is connected to the A/D Converter.
2. The Noise Specification is 5×10^{-9} RIU/P-P. ($5 \times 10^{-9} = 0.0005 \times 10^{-5}$)
3. The allowable Noise output is 16 μV/P-P.

Example: Calculating the drift

1. See (1) above.
2. The Drift Specification is 2.5×10^{-7} RIU/HR. ($2.5 \times 10^{-7} = 0.025 \times 10^{-5}$)
3. The allowable Drift output is 800 μV/HR.

5

Troubleshooting

The following sub-sections are guides for troubleshooting general categories of hardware problems. These guides are meant to be used in conjunction with the detailed descriptions found in *SECTION 2: Hardware*.

- Hardware Troubleshooting
  - Detector turn on problems
  - Light intensity problems
  - Lamp turn on problems
  - Limit alarm, AB motor and balance problems
  - Flush valve problems
  - Temperature control problems
  - Flow cell problems
  - Loss of sensitivity
- Chromatographic Troubleshooting

Hardware Troubleshooting

Detector turn on problems

Table 5-1. Detector turn on problems

Problem	Check
Rear line switch turned on; no response or incorrect detector turn on	■ Is the line switch functional? ■ Is the line power setting correct? ■ Are all cables in place and tight? ■ Measure test points on POWER SUPPLY board for correct output. If test point measurements are NOT correct: a. Replace POWER SUPPLY board. b. Replace POWER REGULATOR set.

Light intensity problems

When operating correctly, the LIGHT INTENSITY ERROR indicator on the front panel will come on when the light intensity reaching the photodiodes differs from the original (factory) intensity by about 25% Ordinarily, a LIGHT INTENSITY ERROR is caused by a reduction in intensity. However, an intensity increase (as seen by the detector signal electronics) will also cause the error. The detector also gives a contact closure output (rear panel) while a LIGHT INTENSITY ERROR is present.

Actual light intensity can be displayed by TP1 (sample photodiode) and TP2 (reference photodiode) on the front panel. Pressing TP1 and TP2 together will display the average intensity of the two photodiodes.

The average intensity must be at least -3.5. Typical intensity values range from about -4 to -5.5, depending on optical unit cleanliness, age, and whether or not certain optical alignments were ever performed on site.

Table 5-2. Light Intensity Problems

Possible Problem	Actions
Air in flow cell; this is the most common cause of the error. In this case, the intensity average as displayed by TP1/2 will usually be near zero.	Activate the flush valve and flush with a flow rate higher than the analytical flow rate. Many times it will be necessary to flush with pure methanol, or even isopropanol, to purge the air bubbles.
Flow cell defective; leaking internally between compartments or leaking externally.	Replace the flow cell, and perform the alignments and calibrations described in *SECTION 3: Procedures*.
Flush valve defective; the user has attempted to purge air bubbles, but half of the cell retains air because the valve is defective.	See *Flush Valve Problems*.

Table 5-2. Light Intensity Problems (continued)

Possible Problem	Actions
Flow cell dirty; optical surfaces are coated with an opaque material. In this case, the TP1/2 intensities will be abnormally low, but not zero.	1. Perform an appropriate flushing procedure. 2. Has the flow cell just been replaced? If so, has the protective clear tape around the the cell been removed? If not, remove the tape.
Lamp does not turn on when the line switch is turned on. In this case, TP1/2 intensities will be zero.	See *Lamp Turn On Problems*.
Lamp not correctly adjusted. In this case, TP1/2 intensities will be abnormally low, or zero, depending on the degree of misadjustment.	Has the lamp just been replaced? If so, refer to the "Lamp intensity adjustemt" procedure.
INTENSITY ERROR THRESHOLD CALIBRATION incorrect. In this case, the actual light intensity is sufficient, but the intensity error circuit is incorrectly calibrated. The TP1/2 intensities seem correct, but the INTENSITY ERROR indicator is on.	Have any optical unit repairs just been made? Review the calibrations that may be needed when repairs are made to the optical unit. If calibrations seem correct, likely failures are: 1. CONTROL board. 2. DIGITAL DISPLAY board.
PREAMPLIFIER board ribbbon cable not securely connected to CONTROL board CON501. In this case, TP1/2 readings will be 0.00.	Connect the ribbon cable securely.

Lamp turn on problems

Table 5-3. Lamp turn on problems

Possible Problem	Possible Causes
The lamp does not turn on when the line switch is turned on (the detector itself turns on normally).	Lamp is defective. Replace the lamp and perform the lamp intensity adjustment. Lamp voltage is absent. Measure the DC voltage supply to the lamp wires at the valve lamp terminal. Should be in the range of 2.5 to 3.0 VDC. If the supply is absent: 1. Replace POWER SUPPLY board. 2. Replace POWER REGULATOR set.

Limit alarm, AB motor drive and balance problems

These three areas are very closely related in the detector electronics.

The AB motor position is sensed by a feedback potentiometer which is connected to the motor shaft. If the motor is driven too far in either direction, the front panel LIMIT ALARM indicator is turned on. From the LIMIT ALARM state, the motor can be driven to it's true center (mid way) position by simultaneously pressing the - COURSE and + COURSE buttons on the front panel. The LIMIT alarm indicator flashes during this movement. This centering of the motor does NOT cause a balance to occur. If the relationship between the AB motor and the optical unit balance glass control shaft is correct, this centering of the AB motor will result in a good optical null. That is, TP1 and TP2 will be similar in value. A BALANCE command will then correctly establish the baseline.

Table 5-4. Limit alarm, AB motor and balance problems

Possible Problem	Actions
Limit alarm is on, but the AB motor does not respond to the centering command. OR The AB motor does not respond to movement commands generally.	1. Check that all cables are connected correctly and tight, check that all boards are seated securely. 2. Replace the AB MOTOR assembly. 3. Try the following boards: a. TEMP AND MOTOR CONTROL board b. OPTICAL AB board c. AB board d. POWER SUPPLY board e. KEY SWITCH board

Table 5-4. Limit alarm, AB motor and balance problems (continued)

Possible Problem	Actions
TP1/TP2 values do not respond to the movement of the AB motor. **Note:** This symptom often occurs if the detector is transported without tightening the locking screws.	Make sure that the motor is turning the optical unit balance glass control shaft. Replace or adjust the coupling sleeve as Then, perform the alignment procedure for the AB motor assy.
The AB motor can be correctly centered from the LIMIT ALARM state, but the LIMIT ALARM error occurs after a BALANCE is done.	Make sure that the flow cell is free of air bubbles. Make sure that the INTENSITY ERROR is not present. Purge the cell of bubbles if needed. If the detector intensity is normal, replace the AB board and OPTICAL AB board.
BALANCE command initiated from the rear panel remote input does not work.	Does the front panel BALANCE button work correctly? If yes: 1. Make sure that the remote signal being applied is a contact closure; nornally open, closed for BALANCE. 2. Check the OUTPUT board ribbon cable - in this case, other remote control functions are likely to also be defective. 3. Replace the OUTPUT board. If no: Replace the AB board and the OPTICAL AB board.

Table 5-4. Limit alarm, AB motor and balance problems (continued)

Possible Problem	Actions
BALANCE command initiated from the front panel does not work.	Does the rear panel BALANCE remote input work correctly? If yes: 1. Check the KEY SWITCH board ribbon cable. In this case, other front panel functions are likely to also be defective. 2. Replace the KEY SWITCH board. If no: Replace the AB board and the OPTICAL AB board.
The AB motor reaches it's mechanical limit, but the LIMIT ALARM does not turn on. The motor sits vibrating at it's mechanical stop. In all other ways, the AB motor and BALANCE functions are normal.	1. Replace the OPTICAL AB board. 2. Replace the AB MOTOR assembly. **NOTE:** The vibrations may have disturbed the AB MOTOR/OPTICAL BALANCE GLASS relationship. Verify this relationship (page 3-16, step E).

Flush valve problems

Note

- Normally, a quiet “click” can be heard when the valve activates.
- The FLUSH indicator led on the front panel only indicates that a flush command has been made. The indicator DOES NOT sense the actual position of the valve. Therefore, the indicator cannot be taken as proof that the valve is actually in one position or the other.
- If the valve is activated from the front panel, the rear panel remote input is disabled. If the valve is activated from the rear panel remote input, the front panel FLUSH button is disabled.

Table 5-5. Flush valve problems

Possible Problem	Actions
Valve leaks liquid externally. **WARNING: The pressure rating of the valve is only 2 bar!**	Replace the valve. This is most often caused by excessive restriction downstream of the valve. Check for downstream restrictions inside the detector. Check for excessive restriction downstream of the detector itself. **Note:** If the HP 1090 LC is being used, the detector outlet SHOULD NOT be plumbed to the HP 1090 injector wash input.
Valve has an internal cross port leak. This symptom will most likely be noticed in the form of a baseline drift while the valve is in the normal position. The drift stops when the valve is activated.	Replace the valve.

Table 5-5. Flush valve problems (continued)

Possible Problem	Actions
Valve cannot be activated from the rear panel remote input.	Can the valve be activated and deactivated normally from the front panel? If yes: 1. The front panel FLUSH button must be off to use the rear panel remote input. 2. Make sure that a contact closure is being applied to the remote control input; normally open, closed for activate/deactivate. 3. Check the OUTPUT board ribbon cable. In this case, other remote control functions will likely also be defective. 4. Replace the OUTPUT board. If no: Is the FLUSH command applying + 12 VDC as needed to the valve drive wires? If yes, replace the valve. If no: 1. Replace the CONTROL board. 2. Replace the POWER SUPPLY board.

Table 5-5. Flush valve problems (continued)

Possible Problem	Actions
Valve cannot be activated from the front panel FLUSH button.	Can the valve be activated and deactivated normally from the rear panel remote input? If yes: 1. Deactivate the valve from the rear panel, then check for correct front panel operation. 2. Check the KEY SWITCH board ribbon cable. In this case, other front panel functions are likely to also be defective. 3. Replace the KEY SWITCH board. If no: Is the flush command applying + 12 VDC as needed to the drive wires of the valve? If yes, replace the valve. If no: 1. Replace the CONTROL board. 2. Replace the POWER SUPPLY board.
Valve is stuck in the activated position. The manifestation of this problem will be that each movement on the chromatogram will now have a counterpart of the opposite polarity. For example, a negative solvent front will be followed by a large positive offset, and all positive peaks will be immediately followed by negative peaks. **Note** that the negative peaks will be broad due to the large post-sample cell volume of the detector. In the case of a chromatogram with peaks close together, it will be difficult to determine that this is what is actually happening.	Is the + 12 VDC being continuously applied to the drive wires of the valve? If no, replace the valve. If yes: 1. Try to deactivate the valve from the rear panel, then from the front panel. 2. Replace the CONTROL board. 3. Replace the POWER SUPPLY board.

Temperature control problems

When the circuit is working normally, the front panel TEMPERATURE indicator led is:

- Solidly ON when both rear panel switches are first turned on.
- FLASHING when the actual temperature (as measured by the Optical Unit temp sensor) equals the temperature setpoint.
- OFF if the actual temperature exceeds the temperature setpoint.

Note

Moderately sensitive work can be done after 90 minutes of temperature equilibration. However, sensitive work, or specification verification, requires at least 24 hours of temperature equilibration.

Table 5-6. Temperature control problems

Possible Problem	Possible Causes and Actions
The Temperature Control circuit seems to be functioning normally, but the no-flow detector baseline is unacceptable.	1. The ambient environment is too erratic for good temperature control. Consult page 3-7 of the HP 1047A Operator's Handbook. Make sure the detector environment is acceptable. 2. The detector temperature setting is not high enough. Make sure that the temperature setting is at least 10°C above ambient temperature. 3. The TEMP AND MOTOR CONTROL board is defective. Replace the board. 4. The Optical Unit heater or temperature sensor is defective. Replace the Optical Unit.

Table 5-6. Temperature control problems (continued)

Possible Problem	Possible Causes and Actions
The front panel TEMPERATURE indicator led does not turn on when the rear panel TEMP switch is turned on.	1. Check the following connections for tightness: a. CON203 on the TEMP AND MOTOR CONTROL board. This is the temp sensor connection. b. CON108 on the MOTHERBOARD. This is the connection from the TEMP SELECT SWITCH assembly. 2. Check the integrity of the rear panel TEMP switch. 3. Check resistance through the temperature sensor - if open, replace the Optical Unit. 4. Replace the TEMP AND MOTOR CONTROL board. 5. Replace the TEMP SELECT SWITCH assembly.

Table 5-6. Temperature control problems (continued)

Possible Problem	Possible Causes and Actions
The front panel TEMPERATURE indicator led turns on normally, but never begins to flash. This means that the actual temperature, as measured by the temp sensor, never reaches the setpoint.	1. Check the following connections for tightness: a. CON202 on the TEMP AND MOTOR CONTROL board. This is the input for the 100 VAC heating power. b. CON201 on the TEMP AND MOTOR CONTROL board. This is the connection to the Optical Unit heater. 2. Check the 2 A fuse on the TEMP AND MOTOR CONTROL board. Replace fuse if open. 3. Check for 100 VAC heater voltage at CON202 of the TEMP AND MOTOR CONTROL board. This voltage should be steadily applied as long as both rear panel switches are on. If voltage is absent, check the PRIMARY and AC POWER DISTRIBUTION areas. 4. Check resistance through the Optical Unit heater. If open, replace the Optical Unit. 5. Replace the TEMPERATURE AND MOTOR CONTROL board. 6. Replace the TEMP SELECT SWITCH assembly. 7. The Optical Unit temp sensor may have resistance, but be defective. Replace the Optical Unit.

Flow Cell Problems

Flow cell problems can present the following symptoms:

Table 5-7. Flow cell problems

Possible Problem	Actions
External leaks: This is usually caused by excessive restriction downstream of the cell. Liquid may be seen coming from the contingency leak drain on the right side of the detector. The leak may also cause light intensity problems, and baseline problems such as noise, drift and wander. **Note:** **The backpressure rating of the flow cell is only 7 bar!**	Replace the flow cell. Refer to *Flow Cell Replacement*.
Internal, cross-compartment leaks, or u-cracks which aspirate. In this case, an external leak may not be observed. This defect often causes light intensity problems, and baseline problems such as noise, drift and wander	Same as above.

Loss of sensitivity

This complaint is usually expressed as an observed diminishment in peak height under the "identical" chromatographic conditions which previously produced satisfactory results.

When this complaint is made, IMMEDIATELY verify that the INTEGRATOR and RECORDER OUTPUT SPANS are are correctly calibrated.

A low OUTPUT SPAN will result in diminished peak height. If the OUTPUT SPANS are low, determine what has caused the loss in detector light intensity. Correct the intensity loss, then perform the complete program of eletrical calibrations described in *SECTION 3: Electrical Calibrations*.

If the OUTPUT SPANS are correct, there is a small possiblity that the flow cell is defective. However, it is most likely that the loss of sensitivity is related to the chromatographic method, the Liquid Chromatograph or a worsening detector environment.

Chromatographic Troubleshooting Guide

General characteristics of RI detector

Because they respond to all solutes, RI detectors have excellent versatility. Generally speaking, success depends upon how carefully certain mobile phase and environmental requirements are observed.

For maximum sensitivity, the mobile phase and the sample solute should have different an RI as possible. However, even under optimum conditions the RI detector has only modest sensitivity when compared to the UV detector. The RI detector is generally never used for trace analysis. A limitation to the real sensitivity of RI detectors is their susceptibility to the environment; temperature changes being the biggest problem. To even begin to achieve the theoretical sensitivity of the detector, the ambient environment and the chromatographic system parameters (temperature, flow, etc.) must be kept under close control. These factors most often result in baseline problems which interfere with accurate quantitation, and even with automation.

Another severe limitation of RI detectors is that they are impractical to use in gradient analysis. It is extremely difficult to adaquately match the RI of sample and reference strems during gradient formation.

Refer to the HP 1047A Operator's Handbook (01047-90000). Pages 3-7 to 3-9 describe certain key points to observe when optimizing the HP 1047A system for best performance.

Troubleshooting the chromatogram

1. Rule number one: Turn off the flow, and determine what portion of the problem (noise, drift, wander etc.) is eliminated!

   Most problems in the RI system are chromatographic in nature, and it is important to determine what contribution the liquid chromatograph is making to the problem.

Note 

Certain defects in the flush valve can resemble flow problems. Refer to "flush valve problems" to see if your specific symptom is described.

Note 

Defects in the flow cell can resemble chromatographic problems. Refer to "flow cell problems" to see if your specific symptom is described.

2. Refer to section 5 of the HP 1047A Operator's Handbook (01047-90000) for specific information

Troubleshooting an instable baseline

1. Verify that the optical unit locking screws are open.
2. The bench must be absolutely vibration free.
3. The environment temperature must be stable (no open windows, ventilation, ...).
4. The capillaries and column must be shielded against temperature changes and air flow.

6

Parts Identification

This section provides diagrams for parts identification and the complete parts listings respectively.

- Major Components
- Major Assemblies
- Front Panel Assembly
- Rear Panel Assembly
- Optical Unit
- Cables
- Inlet/Outlet Tubes
- Screws

Major Components

The following table identifies the major components of the HP 1047A, with top cover removed, as shown in Figure 6-1.

Table 6-1. Major Components

#	Description	ERC number	Part number
N/A	Optical Unit		See Page 6-4
1	LED Board#1	ERC75008A	01047-66510
2	Key Switch Board	ERC75006B	01047-66509
3	Display Select Sw. Board	ERC75013	01047-66514
4	Digital Display Board	ERC75012	01047-66513
5	Preamp Board	ERC75100H	01047-66502
6	Mother Board	ERC75201A	01047-66508
7	Amplifier Board	ERC75106A	01047-66507
8	Control Board	ERC75105A	01047-66506
9	Auto Balance Board	ERC57104A	01047-66505
10	Optical Auto Bal. Board	ERC75011A	01047-66501
11	Power Supply Board	ERC75103A	01047-66504
12	Temperature and AB Motor Control Board	ERC75102A	01047-66503
13	Output Board	ERC75007B	01047-66515
14	Main Power Transformer		01047-61101
15	Lamp Assembly		01037-60002
16	Optical Balance Motor Assembly (includes complete assembly plus mounting bracket)		01047-60016
17	Solenoid (flush) Valve Assembly		01047-60008

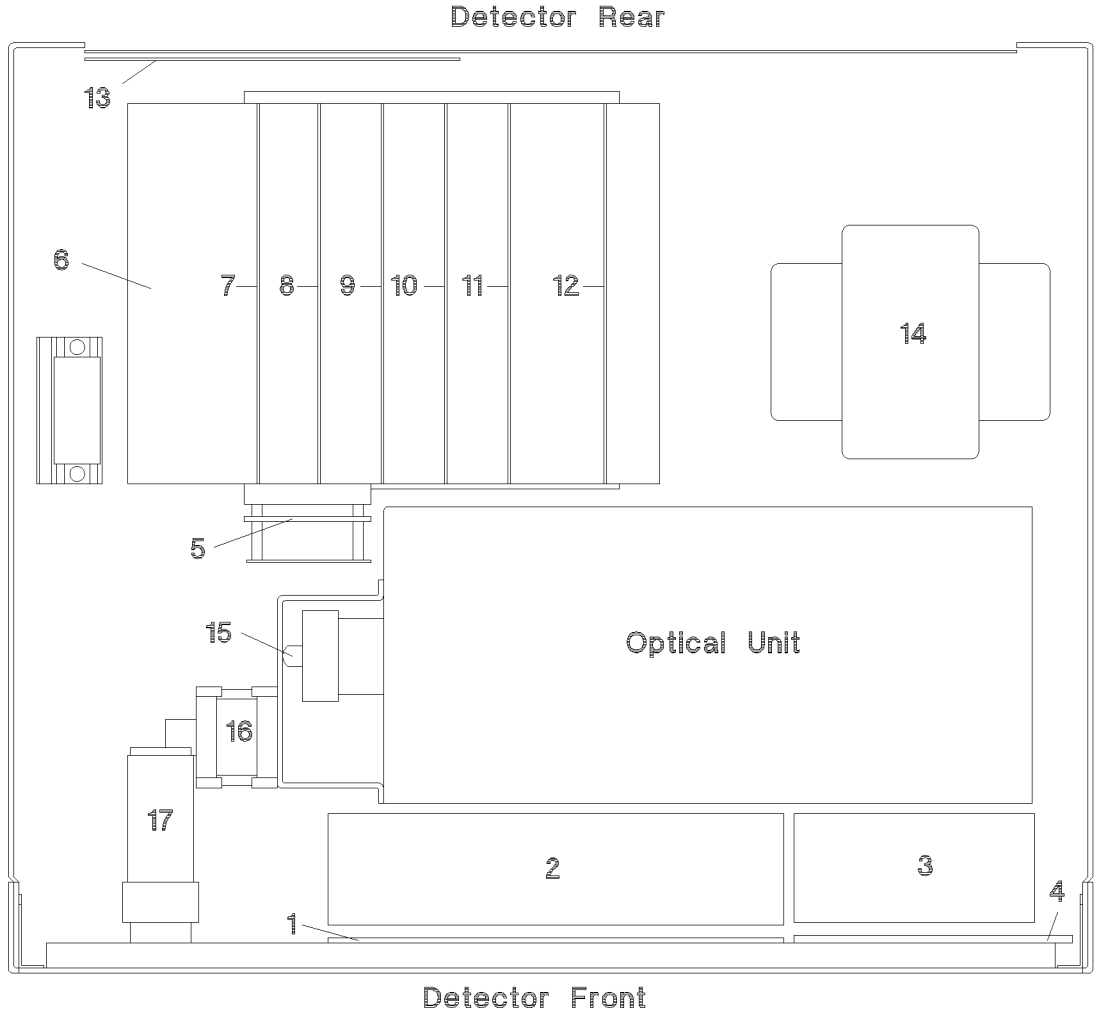

Figure 6-1. Major Components

Major Assemblies

The following table identifies the major assemblies shown in Figure 6-2.

Table 6-2. Major Assemblies

#	Description	ERC number	Part number
1	Front Panel Assembly		01047-60002
2	Bottom Casting		0050-2178
3	Top Cover		0050-2178
4	Screw, M5 x 9.3		0515-0750
5	Main Power Transformer		01047-61101
6	Optical Unit:		
	With AB motor		01047-60017
	Without AB Motor		01047-60018
	Without AB Motor **EXCHANGE**		**01047-69018**
7	Shock Absorbing Foot		4040-2089
8	Three Way Fitting		01047-27601
9	Capillary Tube Assembly		01047-60010
10	Capillary Tube Assembly		01047-60011
11	Preamp Board	ERC75100H	01047-66502
12	Optical Balance Motor Assembly (includes complete Assembly plus holding bracket		01047-60016
12a	Cable		01047-61608
13	Support Stand Assembly		01047-60012
14	Leak Pan		01047-43201
15	Side cover, left		01047-04103
16	Bulkhead Nut		01046-25701
17	Capillary Holder		01040-22301
18	1/16" ZDV union (INLET)		0100-0900
19	Metal Floor		01047-04110
20	Lamp/Valve Terminal Assembly		01047-60009
22a	Fuse 2A		2110-0002
21	Motherboard	ERC75201A	01047-66508
22	Temperature and AB motor Control Board	ERC75102A	01047-66503

Table 6-2. Major Assemblies (continued)

#	Description	ERC number	Part number
23	Power Supply Board	ERC75103A	01047-66504
24	Optical Auto Bal. Board	ERC75011A	01047-66501
25	Auto Balance Board	ERC75104A	01047-66505
26	Control Board	ERC75105A	01047-66506
27	Amplifier Board	ERC75106A	01047-66507
28	Top Cover		0050-2178
29	Rear Panel Assembly		01047-60007
30	Hex Set Screw		0515-0761
31	PC Guide Rail		01047-43701
32	Screw hex, M6 30 mm long, 5 mm key		0515-0094
	Flat Washer		3050-0225
33	Preamp Support Plate		01047-04101
34	Preamp Plastic Cover		01047-44101
35	Shaft Connection Sleeve		01047-03701
36	Wide bore 1/16" union, “outlet”		01047-23201
37	Screw pan-pozi, M4 6 mm long		0515-0915
	Lock washer		2190-0586
38	Screw pan-pozi, M4 8 mm long		0515-0910
	Lock washer		2190-0586
	Flat washer		3050-0893
39	Screw pan-pozi, M3 6 mm long		0515-0924
	Lock washer		2190-0108
	Flat washer		3050-0891
40	Screw pan-pozi, M4 10 mm long		0515-0926
	Lock washer		2190-0586
	Flat washer		3050-0893
41	Screw pan-pozi, M4 12 mm long		0515-0909
	Lock washer		2190-0586
42	Nut hex M6		0535-0038
	Flat washer		3050-0225
43	Screw hex, M4 3 mm long, 2 mm key		0515-0529
44	Standoff, 7 mm dia x 7 mm height		0380-0018
†	Extender board for items 22, 23, 24, 25, 26 and 27		01047-66516

† not shown in figure

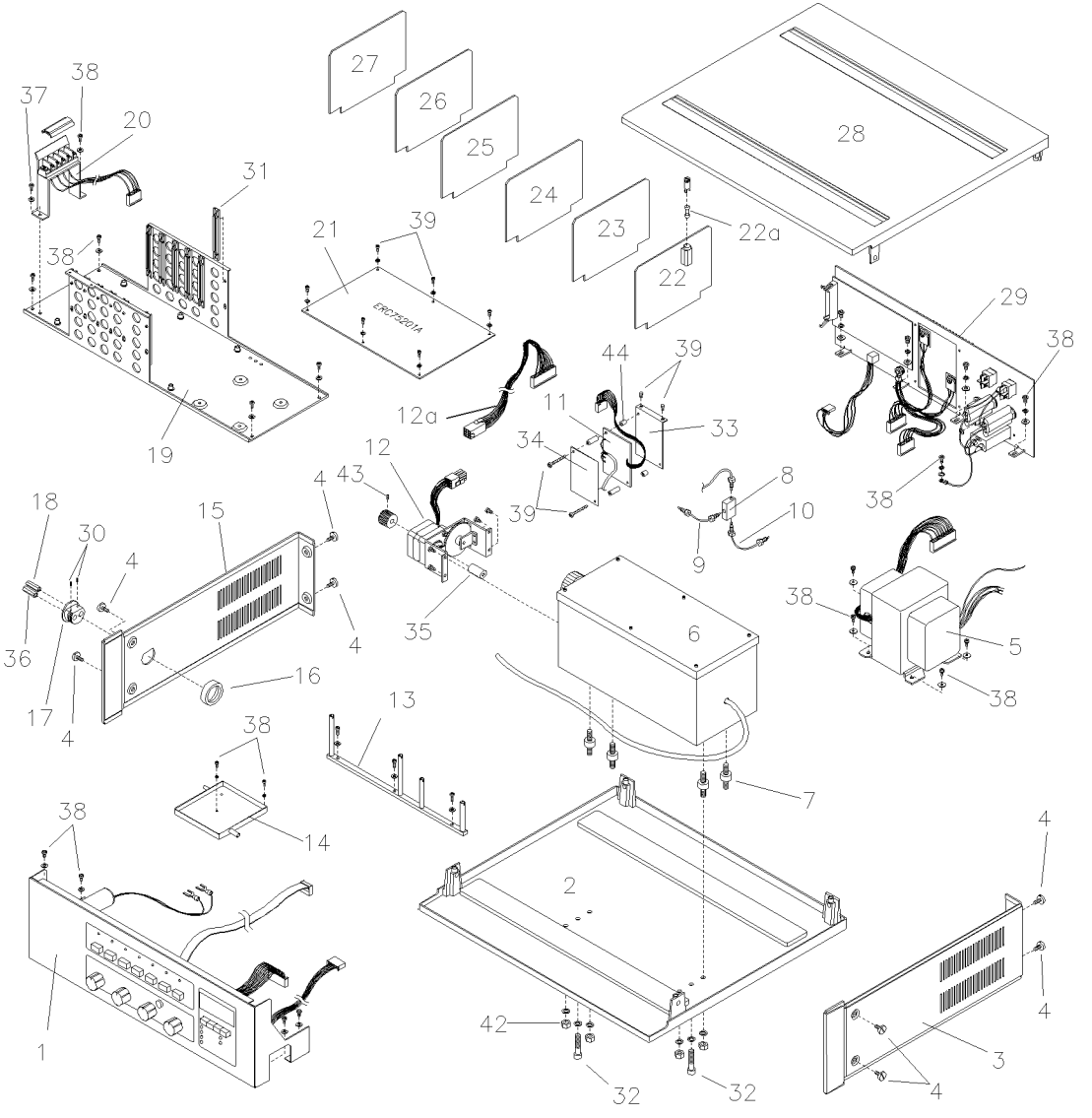

Figure 6-2. Major Assemblies

Front Panel Assembly Parts Breakdown

The following table identifies the individual parts of the Front Panel Assembly (01047-60002) as shown in Figure 6-3.

Table 6-3. Front Panel Assembly

#	Description	ERC number	Part number
1	Rotary Knob		01047-47401
2	Set Screw M4 hex, 4 mm long 2 mm key		0515-0154
3	Front Panel Cosmetic Plug		01047-47601
4	Front Panel (only)		01047-00201
5	Solenoid (flush) Valve		01047-60008
	Fasteners for solenoid valve. Same as item 22		
6	Temp. Select Switch Assembly		01047-60001
7	LED Board#1		01047-66510
8	Push Button Cap		01047-47403
9	Key Switch Board	ERC75006B	01047-66509
10	Ribbon Cable #1, from Key Switch Board CON601 to Motherboard CON115		01047-61603
11	Ribbon Cable #3, from Range Switch Board CON1001 to Motherboard CON116		01047-61605
12	Range Switch/board Assembly		01047-66512
13	Fine Zero Adjust Assembly		01047-60003
14	Integrator Adjust Assembly		01047-60004
15	Digital Display Board	ERC75012	01047-66513
16	Display Push Button Cap		01047-47402
17	LED Board#2	ERC75009B	01047-66511
18	Display Switch Board	ERC75013	01047-66514
19	Ribbon Cable #2, from LED Board#2 CON901 to Motherboard CON109		01047-61604
20	Ribbon Cable #5, from Display Switch Board CON1302 to Motherboard CON111		01047-61607
21	Nut		2950-0043
22	Screw pan-pozi, M4 8 mm long		0515-0910
	Lock washer		2190-0586
	Flat washer		3050-0893

Table 6-3. Front Panel Assembly (continued)

#	Description	ERC number	Part number
23	Screw pan-pozi, M3 6 mm long		0515-0924
	Lock washer		2190-0108
	Flat washer		3050-0891
24	Nut, M3		0535-0004
	Lock washer		2190-0108
25	Standoff, 7 mm OD x 8 mm height		0380-0005
26	Lockwasher, int tooth 10.5 mm ID, 18 mm OD		2190-0684

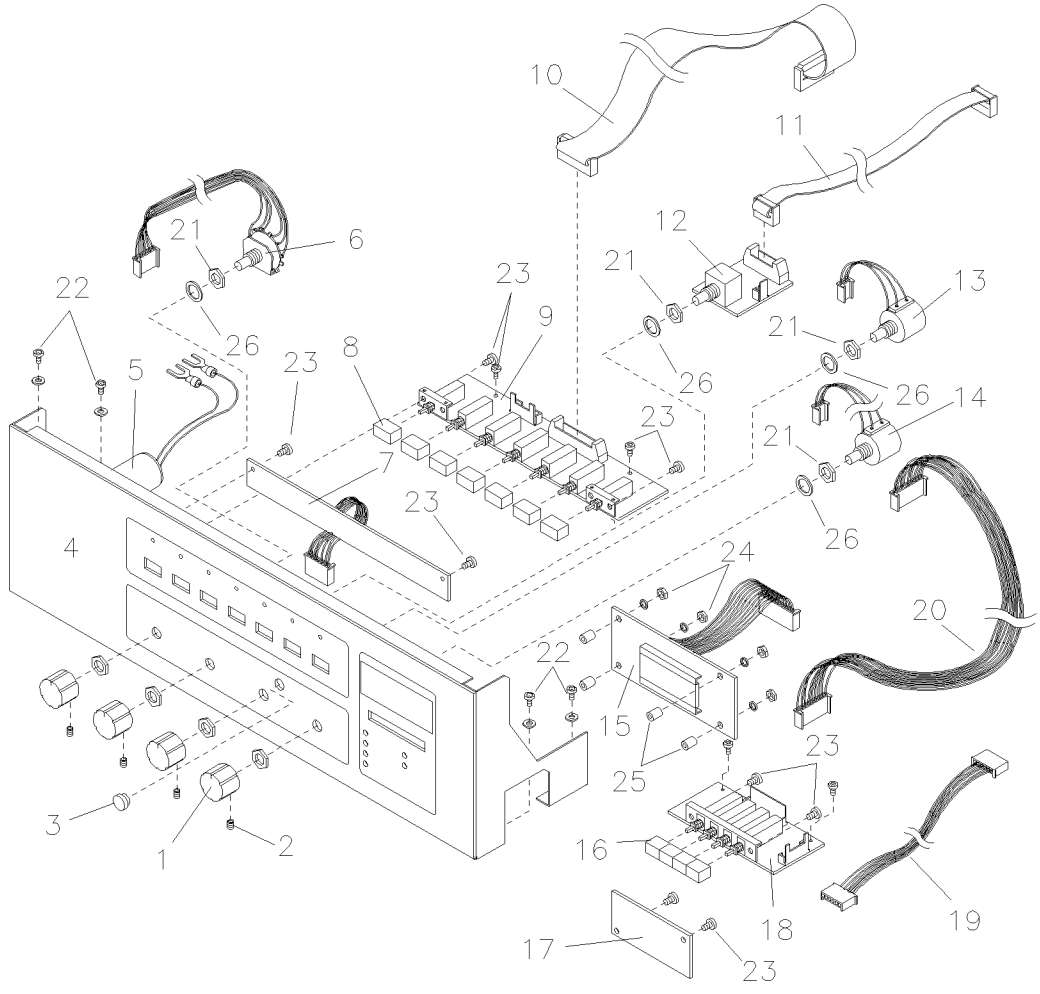

Figure 6-3. Front Panel Assemblies

Rear Panel Assembly Parts Breakdown

The following table identifies the individual parts of the Rear Panel Assembly (01047-60007) as shown in Figure 6-4.

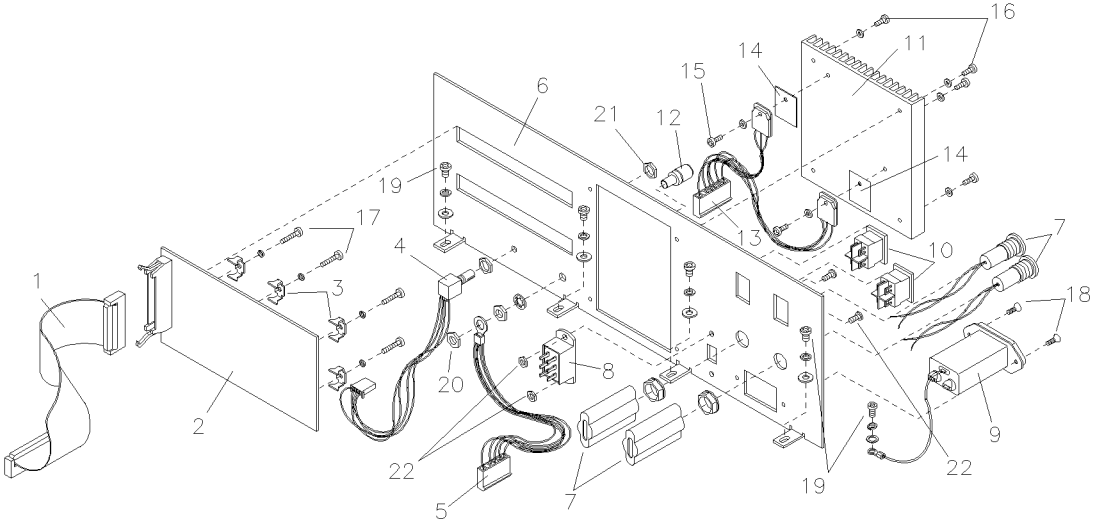

Figure 6-4. Rear Panel Assemblies

Table 6-4. Rear Panel Assembly

#	Description	ERC number	Part number
1	Ribbon Cable #4, from Output Board CON703 to Motherboard CON114		01047-61606
2	Output Board	ERC75007B	01047-66515
	includes two 9-pin terminal strips (not shown)		01047-86102
3	Output Board Holding Clamp		01047-86103
4	Response Time Switch Assembly		01047-60006
5	Ground Terminal Cable Assembly		no p/n
6	Rear Panel (only)		01047-00202
7	Fuse Holder Assembly		01047-42301
8	Voltage Selector		01047-81902
9	Power Socket		01047-85201
10	Temperature/Power Switch		01047-81901
†11	Heat Sink		01047-81101
12	Ground Terminal		01047-86101
†13	Power Regulator Set		01047-42401
†14	Power Regulator Insulator		01047-85401
15	Screw pan-pozi, M3 12mm long		0515-0911
	Lock washer		2190-0108
16	Screw pan-pozi, M3 6mm long		0515-0924
	Lock washer		2190-0108
17	Screw pan-pozi, M3 16mm long		0515-0920
	Lock washer		2190-0108
18	Screw flat-pozi, M3 8mm long		0515-0907
19	Screw pan-pozi, M4 8mm long		0515-0910
	Lock washer		2190-0586
	Flat washer		3050-0893
20	Nut		2950-0072
	Washer, int tooth		2190-0679
21	Nut		0535-0025
	Flat washer		3050-2002
22	Screw pan-pozi, M3 6mm long		0515-0924
	Lock washer		2190-0108
23	Nut, M3		0535-0004

† Heat Sink Assembly (01047-60005) consisting of items 11, 13 and 14

Optical Unit

The following table identifies the individual parts of the Optical Unit as shown in Figure 6-5.

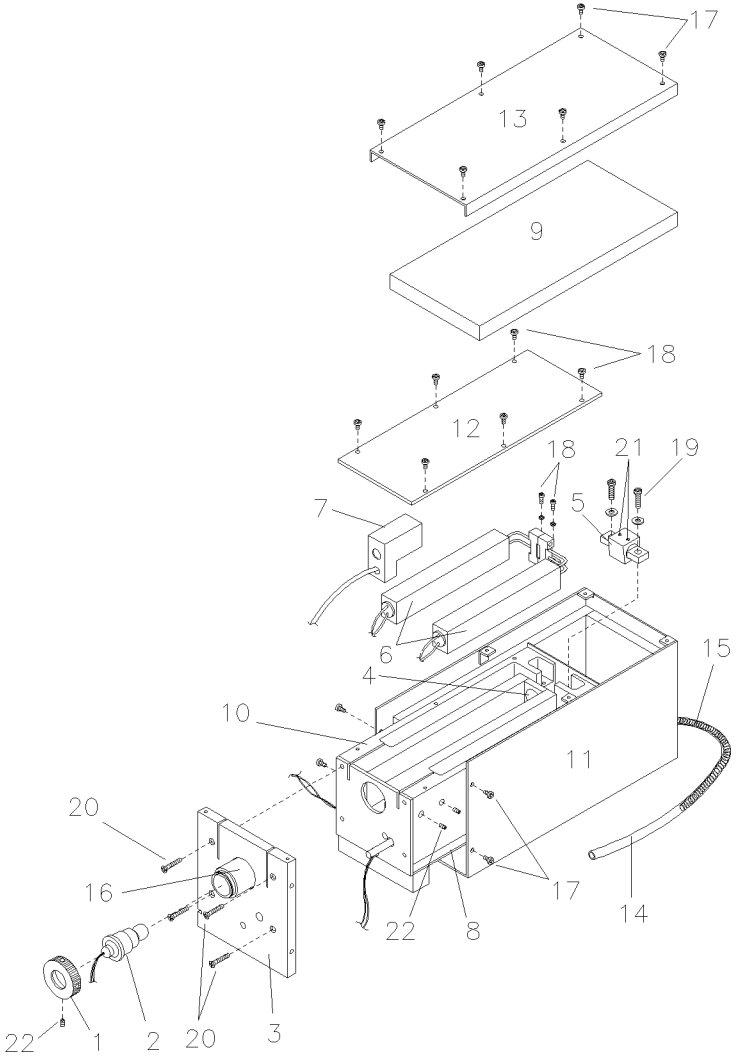

Figure 6-5. Optical Unit

Table 6-5. Optical Unit

#	Description	Part number
N/A	Complete Optical Unit	See page 6-4
1	Lamp Holding Collar	01047-22501
2	Lamp Assembly	01037-60002
3	Lamp Support Plate Assembly	01047-04104
4	Lens/Slit Assembly	01047-60014
5	Mirror Assembly	01047-60015
6	Cell Assembly	01037-60003
	Cell Assembly **EXCHANGE** includes an assortment of nuts/ferrules permitting use in either HP 1037A or HP 1047A	**01037-69003**
7	Photodiode/Lens Assembly	01047-60013
8	Insulation, 20mm thick (in 2 feet by 2 feet pieces)	01047-45403
9	Insulation, 15mm thick (in 2 feet by 2 feet pieces)	01047-45402
10	Insulation, 10mm thick (in 2 feet by 2 feet pieces)	01047-45402
11	Optical Unit Housing	01047-25201
12	Optics Cover	01047-04105
13	Optical Unit Top Cover	01047-04106
14	Teflon Drain Tube	5021-7115
15	Leak Pan Spring	01047-29101
16	Lamp socket	01047-25202
17	Holding screw for top cover and optics housing (total 12), M3 6 mm long	0515-0924
	Washer	3050-0891
18	Holding screw for optics cover, lens/slit assembly (not shown) and cell assembly (total 10), M3 8 mm long	0515-0912
	Washer	3050-0891
19	Mirror holding screw (total 2), M4 15 mm long	0515-0909
	Small washer	2190-0586
	Large Washer	3050-0894
20	Support plate holding screw (total 4), M4 18 mm long, flat-pozi	0515-1073
21	Mirror pitch set screw (total 2), M4 hex 4 mm long, 2 mm key	0515-0529
22	Set screw for photodiode assembly and lamp holding collar (total 3), M3 hex 3 mm long, 1.5 mm key	0515-0154
	Reference Valve Fixing Plate, needed only when a 01047-60018 optical unit is used to repair a HP 1037A	01047-24101

Cables

General

Refer to the HP 1047A Operator's Handbook (01047-90000) for specific information on the connection of cables. At the HP 1047A, all inputs and outputs are terminal connectors which accept "spade" type fittings or even bare wires.

Signal Cables for Hewlett Packard Data Handling Devices

Table 6-6. HP 1047A to other device

Description	Part number
HP 3390/2/3A Integrator	01040-60105
HP 3394/6A/B Integrator or HP 35900A/B/C A/D Converter	35900-60630
HP 1082/4B LC	01046-60105
Universal (strip chart recorders usually require this	01037-60105

Unique HP 1047A Cables

Table 6-7. Unique HP 1047A Cables

Figure	Description	Part number
6-6	From HP 1090 LC EVENTS to HP 1047A inputs	01047-60202
6-7	From HP 1047A Balance NR output to HP 1090 LC Remote Control Port	01047-60201

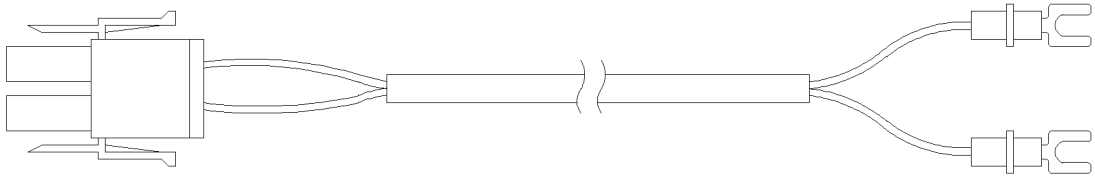

Figure 6-6. Cable from HP 1090

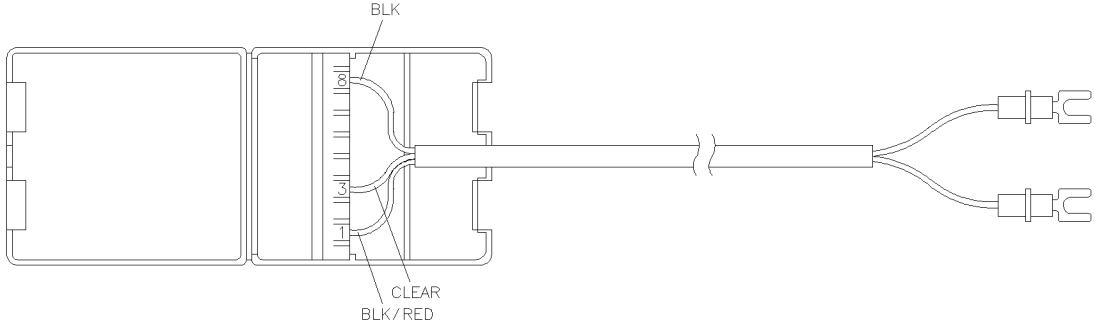

Figure 6-7. Cable from HP 1047A NR output to HP 1090

Inlet/Outlet Tubes

Table 6-8. Front Panel Assembly

Description	Part number
Insulation for inlet tube	0890-1032
Inlet Capillary Assembly 1/16 inch O.D., 88 cm by 0.12 mm I.D.	01040-87602
Inlet Capillary Assembly 1/16 inch O.D., 88 cm by 0.25 mm I.D.	01047-87301
Outlet Tubing Assembly 1/8 inch wide bore teflon tube plus 1/16 inch SST adapter fitting	01040-67602