Service Handbook

HP 1046A
Programmable Fluorescence Detector

HEWLETT PACKARD

Waldbronn Analytical Division, Postfach 1280, D-7517 Waldbronn,
Federal Republic of Germany

Part Number 01046-90100
Microfiche 01046-90800

July 1989
Printed in the Federal Republic of Germany

Table of Contents

Table of Contents

Safety Information 0.0

WARNING

Solvents or samples used in applications with fluorescence are in many cases very toxic and/or acidic. Take special care, when handling or repairing the instrument.

WARNING

Always disconnect the line-power cord from the line-power socket at the rear of the HP 1046A before opening the instrument.

CAUTION:

The grating assembly is very sensitive to mechanical shocks, since a slight misadjustment will damage the optical alignment. Take care to avoid mechanical shock (e.g. dropping a tool) to the grating.

WARNING

When replacing the power supply boards please note that there is still high voltage on some capacitors unless the instrument has been turned-OFF for at least 5 minutes.

WARNING

NEVER remove or replace printed circuit boards while the HP1046A is turned-ON. Always use your antistatic workstation! Components are highly sensitive to antistatic discharge and will be damaged if you do not follow the procedure given on page 3-1.

0.0 Safety Information

WARNING

Do not thouch the grating.
Do not attempt to clean the grating.

WARNING

The lamp is under high internal pressure. Handle with care. Wear suitable protective devices to prevent possible injury, especially to hand and face areas.

Introduction 1.0

This manual provides service information about the Hewlett-Packard HP 1046A Programmable Fluorescence Detector. An instrument overview is followed by detailed descriptions of the electronical and mechanical components. Because you will carry out reports only on subassembly level, only blockdiagrams are provided. You will find illustrated part- breakdowns, interconnection tables, connector configurations, as well as replacement procedures in this manual. A detailed diagnostic section offers information about possible failures and appropriate troubleshooting.

You can find the following descriptions in the Operator's Handbook (01046-90000):
General function of the instrument, description of assemblies, performance check, troubleshooting and replacement procedures which are also of interest to the customer.

A binder is available (part number 9282-1061 in USA, part number 9282-1037 in Europe) in which you can file these handbook.

1.1 Brief description of HP 1046A

The HP 1046A Programmable Fluorescence Detector is a stand-alone fluorescence, phosphorescence and chemoluminescence detector which may be connected to any high performance liquid chromatograph.
The user interface is a functional keyboard and a 32 character vacuum fluorescent display.

Note that names for signals which are negative true logic end with a "-" sign.

ANALOG OUT Connector:

You may connect any integrator, recorder or analog to digital converter which accepts 0 to 1000 mV (source impedance of the HP 1046A is 1K Ω) or 0 to 100 mV (source impedance of the HP 1046A is 100 Ω) to the ANALOG OUT connector of the HP 1046A. You may select both voltage ranges on the digital to analog converter board (DAC).

REMOTE Input/Output Connector:

You may connect a shut down relay (SHTDN, contact closure to DGND) to an LC instrument to shut it down in case a leak occurs in the HP 1046A.

In case you want the LC instrument to wait when the HP 1046A is not ready for another analysis you may use the READY output line (contact closure to DGND).

You can use the START- and STOP- inputs to enable synchronous time-programming of the HP 1046A.

You may apply the prepare input (PREP-) from an external instrument to turn-ON the lamp before the START- signal is issued when you work with negative LAMP= values. This prevents a calibration of the integrator at a time when the lamp is not yet turned-ON i.e. the analog out signal does not yet carry valid data.

Note, that all lines of the two REMOTE connectors at the rear of the HP 1046A have identical pin configuration in order to connect several instruments in line, without using a signal distribution module. For more information refer to Operator's Handbook (01046-90000).

Abbreviations 1.2

Names for signals which are negative true logic end with a "-" sign.

+5V	+5 V line
+19R	+19 V raw voltage line
+19F	+19 V fine voltage line
24GND	ground line of the 24 V supply for flashlamp power supply board (FPS)
A/D	analog to digital
A2	one of 16 address lines
ADC	analog to digital converter
ADCS-	chip select of analog to digital converter (ADC) on photomultiplier power and control board (PPC)
AGND	analog ground
D/A	digital to analog
D2	one of 8 data lines
DAC	digital to analog converter
DACOUT	analog output
DIS-	disable ROM on fluorescence detector controller board (FDC) DGND digital ground
DKAS-	display keyboard address stable line
DKRD-	display keyboard address read line
EMPA	line to phase A of stepper motor (emission grating assembly)
EMPB	line to phase B of stepper motor (emission grating assembly)
EMREF	line to reference position (emission grating assembly)
EMS	emission grating assembly sensor board
EXPA	line to phase A of stepper motor (excitation grating assembly)
EXPB	line to phase A of stepper motor (excitation grating assembly)
EXREF	line to reference position (excitation grating assembly)
EXS	excitation grating assembly sensor board
FDC	fluorescence detector controller
FDM	fluorescence detector motherboard
FDAC0-	Chip select of digital to analog converter (DAC) on digital to analog converter board (DAC board)

1.2 Abbreviations

FDAC1-	not used
FDI	fluorescence detector interface
FIL	filament voltage line
FLASH-	flash trigger signal line
FPLA	field programmable logic arrays
FPS	flashlamp power supply
GAIN	line to switch gain on photomultiplier power and control board (PPC)
HOLD	hold line for track and hold circuit
HV	high voltage label on flashlamp power supply board (FPS)
INTG	integrate line (to integrating track and hold circuit)
IOS0-	input/output select for fluorescence detector interface board (FDI)
IOS1-	input/output select for fluorescence detector interface board (FDI)
IRQ-	interrupt request line
KDM	keyboard and display module
LKIN	line to leak sensor
LKDIS-	leak detection circuit disable line
LKRD-	leak detection circuit read line
LKWR-	leak detection circuit write line
MPS	main power supply
MRDY-	memory ready line
NTC	negative temperature coefficient resistor
PA2	address line of peripheral address bus
PD2	data line of peripheral data bus
PDAC-	enable line for digital to analog converter (DAC) on photomultiplier power and control board (PPC)
PMT S5	photomultiplier, 200 to 650 nm
POF-	power fail interrupt
POP-	power ON pulse (reset)
PPC	photomultiplier power and control
PREP-	input to turn-ON lamp externally before START- signal
PTC	positive temperature coefficient resistor
READY	ready output
RAM2-	not used
ROM1E-	chip select for external ROM on fluorescence detector interface board (FDI)

ROM2E-	chip select for external ROM on fluorescence detector interface board (FDI)
R/W-	read/write line
S1	switch S1 on excitation or emission grating assembly sensor board
$S1_1$	first switch included in switch S1
$S1_2$	second switch included in switch S1
START-	start run input
SHTDN	output to turn-OFF external device
STOP-	stop run input
VCO	voltage controlled oscillator
Xe	Xenon

1.3 Repair Policy

The HP 1046A is designed that you can access all components easily. You do not need to recalibrate or perform difficult adjustments. Customers are able to repair certain parts of the HP 1046A, see Operator's Handbook (01046-90000).

Electronic items with their exchange part number:

Assembly	Part Number	Exchange Part Number
MPS board	01046-66501	01046-69501
FPS board	01046-66502	01046-69502
FOC board	01046-66503	01046-69503
PPC board	01046-66504	01046-69504
DAC board	01046-66505	01046-69505
KDM	01046-66508	01046-69508
FDI board	01046-66509	01046-69509
FDM board	01046-66500	
Trigger assembly	01046-60007	
Xenon lamp	2140-0549	
Photomultiplier	1970-0201	
Leak sensor assembly	01046-61602	

You can only repair failures on the excitation grating assembly sensor board (EXS) or the emission grating assembly sensor board (EMS) by exchanging the respective grating assembly, because you cannot adjust them in the field.

Mechanical items with their exchange part number:

Assembly	Part Number	Exchange Part Number
Excitation grating assembly	01046-60012	01046-69012
Emission grating assembly	01046-60013	01046-69013
Cell assembly	01046-60010	
Lens assembly	01046-66504	
Inlet capillary assembly	01046-87301	
Outlet capillary assembly	01046-87302	

The flow-cell windows will not leak up to a pressure of 80 bar at the inlet of the HP 1046A. If a pressure higher than 80 bars is applied, the flow-cell may leak. You may have to clean the lenses and windows. Windows may break with pressure shocks or pressures higher than 100 bar. For replacement of the windows and cleaning of the lenses and windows, see Operator's Handbook (01046-90000).

The contents of the previous tables may change in the future, because assemblies may be taken out of the Blue Stripe Exchange System. Waldbronn Analytical Division will document changes by Service Note.

Hardware Description 2.0

The following sections will given you detailed information about the instrumental hardware. For the general functions of the instrument and the design of the flow cell please refer to the HP 1046A Operator's Handbook (01046-90000).

On the following pages you will find an instrument overview. This will you guide you through the main functions of the instrument on block diagramm level. The description follows a logical path through the instrument i.e. it starts with the flash generation and follows the light path and signal path to the analog output. You will find the same order for the detailed descriptions of the boards, i.e. the description of the keyboard display module (KDM) is followed by the description of the fluorescence detector controller board (FDC), then comes the main power supply board (MPS), the flashlamp power supply board (FPS), the grating assemblies etc. This order of description will help you to find information in this manual easily.

2.1 Instrument Overview

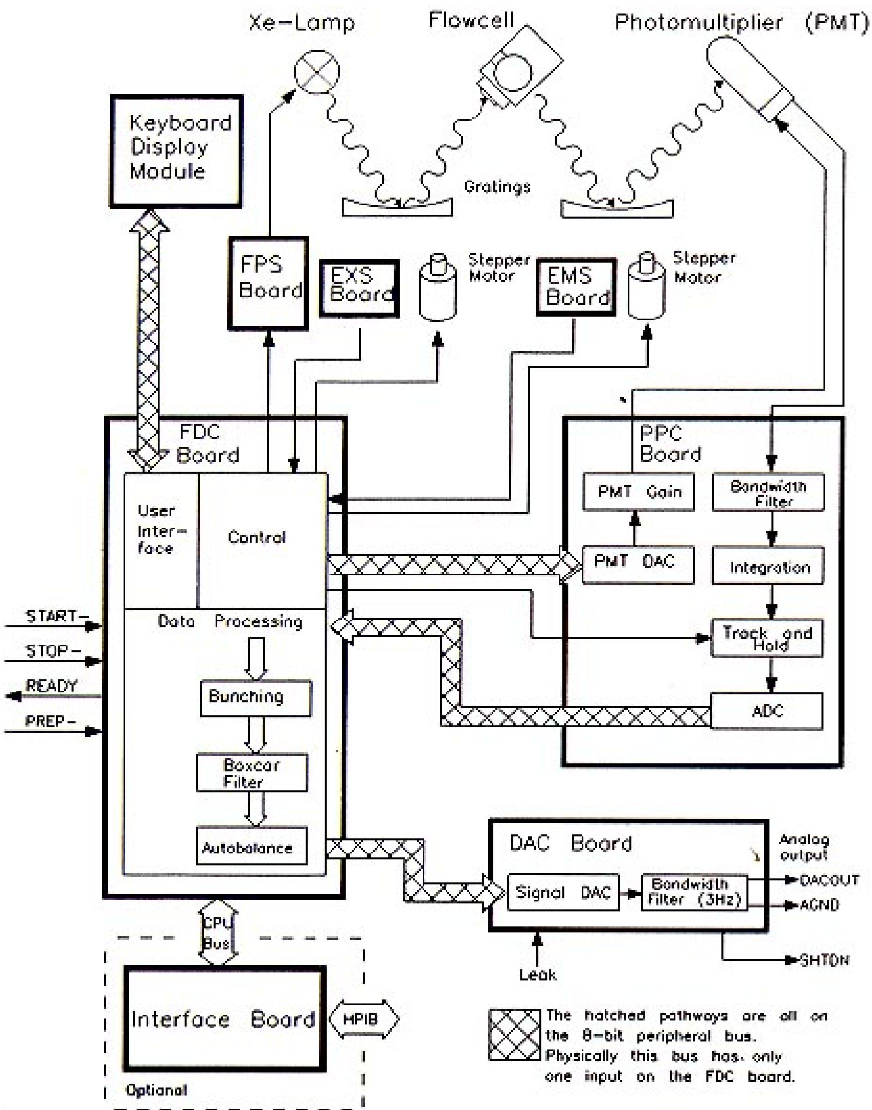


Figure 2.1-1

Flash Generation (flashlamp power supply board (FPS)):

The flashlamp power supply board (FPS) produces the voltage for the Xe flashlamp. The fluorescence detector controller board (FDC) creates a trigger signal which ignites the flashlamp at a frequency of 220 Hz, 110 Hz or 55 Hz, depending on the setpoint LAMP= , see HP 1046A Operator's Handbook.

Radiation from the flashlamp falls on the exit slit of the excitation monochromator via an excitation grating. The exit slit is imaged by a micro-lens into the flow-cell (optical parts are shown in the illustrated part breakdown, see page 3-7). A processor controlled stepper motor drives the excitation grating assembly. The correct motor position is calculated by firmware, according to the setpoint EX= , see Operator's Handbook (01046-90000). The reference position (zero order) is found with the help of a micro-switch and a lightswitch, which are located on the excitation grating assembly sensor (EXS) board.

Fluorescing light from the flow-cell is focused by a second micro-lens on the entrance slit of the emission monochromator. This slit is imaged via the grating of the emission monochromator onto the exit slit. The photomultiplier is located behind the exit slit of the emission monochromator.
The designs of the excitation and emission gratings are different, i.e. you cannot exchange the gratings. As already described for the excitation grating assembly sensor board (EXS), the reference position (zero order) is found with the help of a micro-switch and a lightswitch. Both are located on the emission grating assembly sensor board (EMS).

The photomultiplier (PMT) contains 9 dynodes which are driven with a variable voltage from 250 V to 1100 V to select different amplification factors. This allows measurements to be made with different sensitivities.

2.1 Instrument Overview

Data Acquisition (photomultiplier power and control board (PPC)):

Figure 2.1-2 shows a typical energy distribution curve for a flash. The electrical response I of the PMT is shown versus the time t.

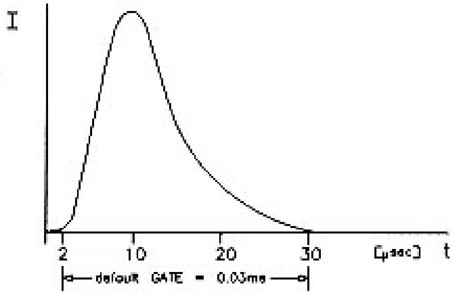


Figure 2.1-2

A bandwidth filter of 100 kHz cuts off all high frequency noise to prevent pick up from external electrical sources up to the gigahertz range. The fourier transform may look like that shown in Figure 2.1-3. With the 100 kHz filter, 95% to 98% of the curve (I verses f) is still available.

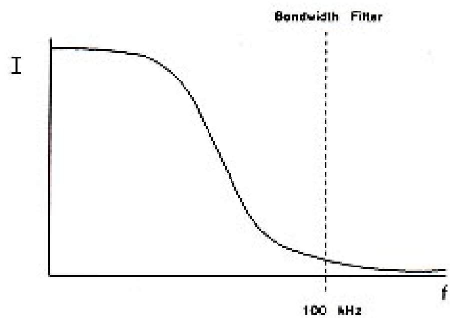


Figure 2.1-3

Figure 2.1-4 shows the energy distribution curve of the Xenon flashlamp. The jitter is caused by nonreproducible ionization of the lamp and is approximately 200 ns wide, see Figure 2.1-4.

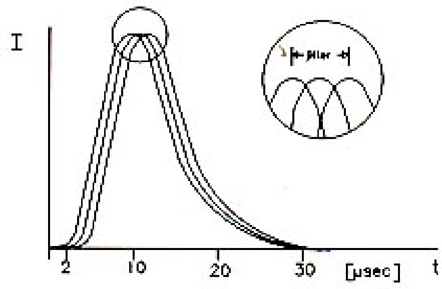


Figure 2.1-4

Flash Generation (flashlamp power supply board (FPS)):

The flashlamp power supply board (FPS) produces the voltage for the Xe flashlamp. The fluorescence detector controller board (FDC) creates a trigger signal which ignites the flashlamp at a frequency of 220 Hz, 110 Hz or 55 Hz, depending on the setpoint LAMP= , see HP 1046A Operator's Handbook.

Radiation from the flashlamp falls on the exit slit of the excitation monochromator via an excitation grating. The exit slit is imaged by a micro-lens into the flow-cell (optical parts are shown in the illustrated part breakdown, see page 3-7). A processor controlled stepper motor drives the excitation grating assembly. The correct motor position is calculated by firmware, according to the setpoint EX= , see Operator's Handbook (01046-90000). The reference position (zero order) is found with the help of a micro-switch and a lightswitch, which are located on the excitation grating assembly sensor (EXS) board.

Fluorescing light from the flow-cell is focused by a second micro-lens on the entrance slit of the emission monochromator. This slit is imaged via the grating of the emission monochromator onto the exit slit. The photomultiplier is located behind the exit slit of the emission monochromator.
The designs of the excitation and emission gratings are different, i.e. you cannot exchange the gratings. As already described for the excitation grating assembly sensor board (EXS), the reference position (zero order) is found with the help of a micro-switch and a lightswitch. Both are located on the emission grating assembly sensor board (EMS).

The photomultiplier (PMT) contains 9 dynodes which are driven with a variable voltage from 250 V to 1100 V to select different amplification factors. This allows measurements to be made with different sensitivities.

2.1 Instrument Overview

Data Acquisition (photomultiplier power and control board (PPC)):

Figure 2.1-2 shows a typical energy distribution curve for a flash. The electrical response I of the PMT is shown versus the time t.

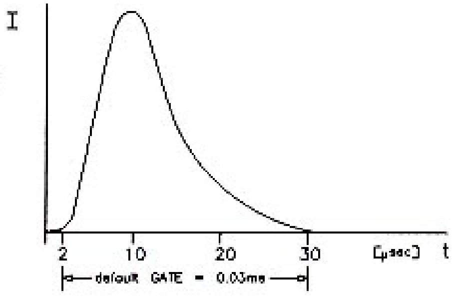


Figure 2.1-2

A bandwidth filter of 100 kHz cuts off all high frequency noise to prevent pick up from external electrical sources up to the gigahertz range. The fourier transform may look like that shown in Figure 2.1-3. With the 100 kHz filter, 95% to 98% of the curve (I verses f) is still available.

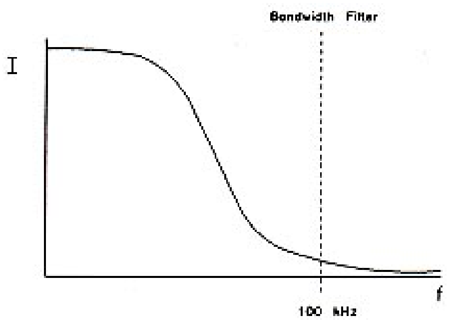


Figure 2.1-3

Figure 2.1-4 shows the energy distribution curve of the Xenon flashlamp. The jitter is caused by nonreproducible ionization of the lamp and is approximately 200 ns wide, see Figure 2.1-4.

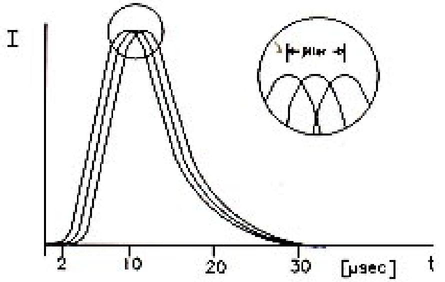


Figure 2.1-4

Integration is implemented to prevent influences on the signal from jitter of the lamp. Because the amplitudes of the jittering curves are the same at the hold point of the track-and-hold circuit, the measured values for all three curves are the same. This results in a suppression of jitter, see Figure 2.1-5. The GATE= command determines the length of the integration time. Working in phosphorescence mode, the DELAY= command delays the integration until the flash is OFF again, i.e. you have to set a delay time which is greater than the duration of the flash, see Operator's Handbook (01046-90000).

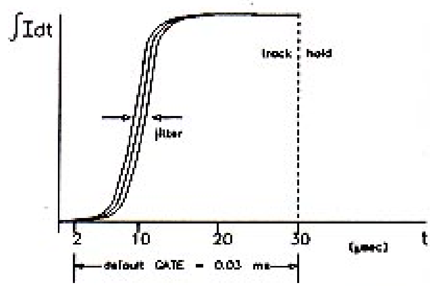


Figure 2.1-5

After the gate time has elapsed, the track-and-hold circuit, see Figure 2.1-1, stores the integrated analog signal on a capacitor while the A/D converter performs the analog to digital conversion.

The track-and-hold circuit takes sampling points from the signal which is not continuous i.e. every time a conversion cycle is finished, the integrator and the track-and-hold circuit is reset, a new flash is ignited, a new integration starts, the signal is held and the next A/D conversion takes place, see Figure 2.1-6 (a constant analog signal is taken as example).

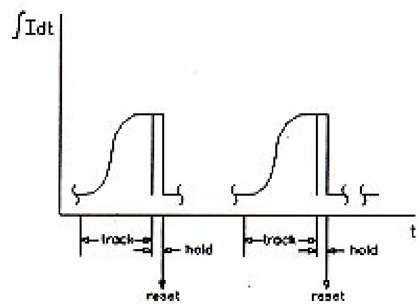


Figure 2.1-6

The ADC, see Figure 2.1-1, has 12-bit resolution. It delivers the digital data to the fluorescence-detector controller board (FDC).

2.1 Instrument Overview

Data Processing (fluorescence detector controller board (FDC)):

Data is delivered to the controller on the fluorescence detector controller board (FDC). Data processing tasks include data bunching, boxcar filtering and offset adjustment.

Data bunching stage averages a certain number of datapoints. The number depends on the flashing frequency of the Xe flashlamp.

The boxcar filter, see Figure 2.1-7, takes a certain number of bunched data points (in this example 3) from the bunched signal and averages them to form the first boxcar filtered data point. The boxcar filter then leaves out the first bunched data point, adds the next bunched data point (n+1) and calculates a new average i.e. a new boxcar filtered data point. The length of the boxcar filter is called n. The resulting signal therefore contains the same number of data points as the originally bunched signal, because no data was discarded.

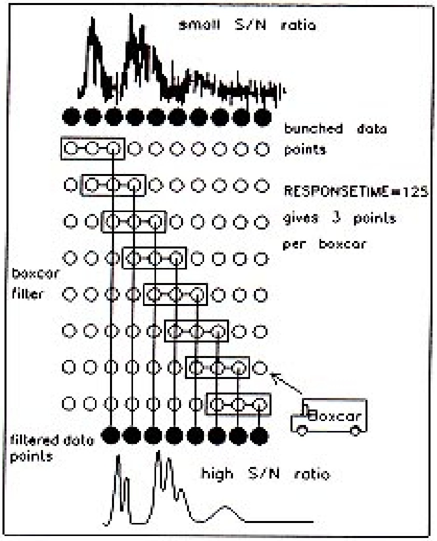


Figure 2.1-7

To compensate for different intensities, when switching the wavelength or PMT gain by timetable, the processor performs an autobalance, see Operator's Handbook (01046-90000).

Digital to Analog Conversion (digital to analog converter board (DAC board)):

The signal DAC (16 bit) converts digital data into an analog signal. A 3 Hz bandwidth filter prevents digitation noise on the analog output. With switch S17 on the digital to analog converter board (DAC) you may select an output voltage range between 0 mV to 1000 mV (source impedance 1 KΩ) and 0 mV to 100 mV (source impedance 100 Ω).

Fluorescence Detector Interface board (FDI):

The FDI board combines the functions required for the HP-IB communication to a remote controller (e.g. LC ChemStation). The remote controller can set detector parameters, read actual parameter values and detector status information. In addition the HP-IB interface is cabable to transfer the signal and scans created by the detector to the remote computer.

2.2 KDM

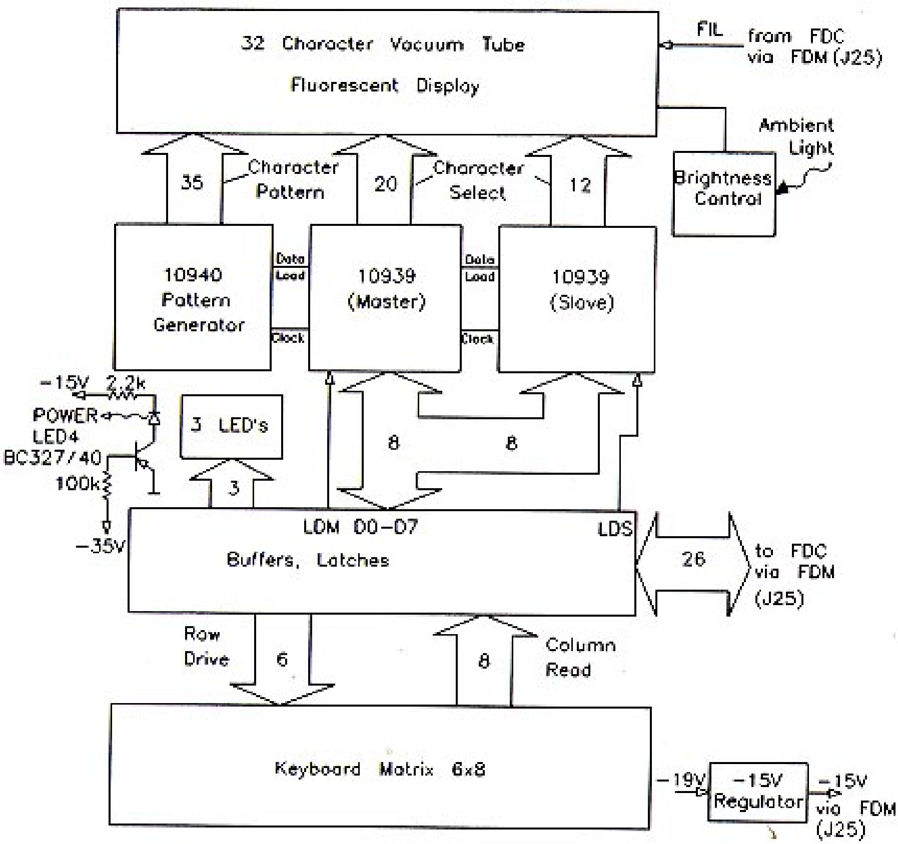


Figure 2.2-1

Keyboard and Display Module (01046-66508)

You will find the keyboard and display module (KDM) behind the front panel of the instrument.

Two grid drivers (10939, see figure 2.2-1) select the position of the character to be displayed and drive the 32-character vacuum tube fluorescant display. The controller loads them sequentially from the data bus (D0-D7) via buffer, using the load master (LDM) and load slave (LDS) lines.
The pattern generator (10940 see figure 2.2-1) determines which character pattern will be displayed. It is loaded from the grid drivers.

The fluorescence detector controller board (FDC) supplies the filament voltage (FIL) with a frequency of 22 kHz. A phototransistor which varies the cathode voltage in the range of about - 28 V to - 38 V depending on ambient light, controls the brightness of the display.

Latches drive the RUN LED, ERROR LED and NOT READY LED, whereas the POWER LED is connected to the -35 V line.

Buffers drive the keyboard matrix through 6 lines (row drive) and the controller reads the keyboard matrix through 8 lines (column read).

2.3 FDC board

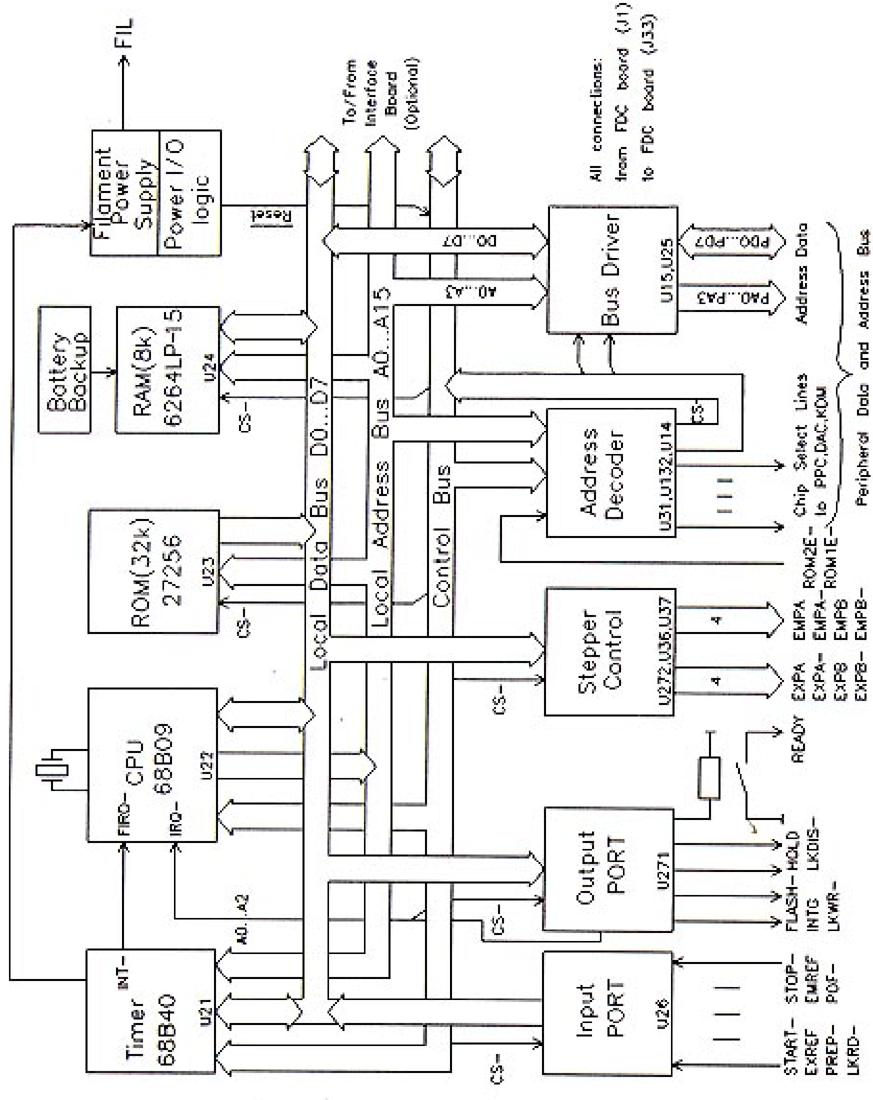


Figure 2.3-1

Fluorescence Detector Controller Board (01046-66503)

The heart of the controller hardware is the 6809 processor (U22), which is located on the fluorescence detector controller board (FDC). The local bus system consisting of a Control Bus, a 16 bit Address Bus and an 8 bit Data Bus connects all functional groups on this board. It will also be used on the fluorescence detector interface board (FDI) which you may install in the future. The Peripheral Data and Address Bus which is buffered by the bus drivers U15, U25 connects the following boards: digital to analog converter board (DAC), photomultiplier power and control board (PPC) and keyboard and display module (KDM).

The firmware is stored permanently in a 32 Kbyte ROM (U23).
Data are stored temporarily in an 8 Kbyte RAM (U24) which has battery back up to prevent loss of setpoints if the instrument is turned-OFF. Only if the fluorescence detector controller board (FDC) is taken out of the instrument, will stored setpoints be lost. The battery back up functions only as long as the fuorescence detector controller board (FDC) remains installed. This feature is designed to protect the battery from discharging while storing the board.

The field programmable logic arrays (U31, U132, U14) and an 8-input-NAND (U31) do the address decoding for all functional groups on this board and for all peripheral boards.

The power-ON Logic supplies a reset to the processor when the power supply comes ON. It also gives a reset, if undervoltage spikes occur on the 5 V power line.

The programmable timer 6840 (U21) delivers an input to the CPU with a frequency of 220 Hz. The timer also controls timing of the filament power supply, which drives the filament of the vacuum tube fluorescent display at a rate of 22 KHz and 6 V_{RMS}.

The stepper Control (U272, U36, U37) outputs two 4-bit signals to drive the stepper motors of the excitation grating and of the emission grating, respectively.

2.3 FDC board

The output port (U271) delivers the following signals:

- FLASH- to ignite the Xe flashlamp;
- HOLD and INTG for track and hold circuit on photomultiplier power and control board (PPC);
- READY for the ready relay (contact closure);
- LKWR- leads to the input from leak detection circuit. A pulse of 10 µs duty cycle is delivered from the processor approximately every 0.6 seconds. (For more information about the leak detection self check, see section, 2.8 Digital to Analog Converter Board (DAC);
- LKDIS- to disable leak detection circuit for 1 minute after power-ON.

The input port (U26) senses:

- External contacts: START- and STOP- (TTL level);
- PREP- turnes-ON the Xe lamp, if setpoint LAMP= has a negative value. The signal is used to prepare the HP 1046A for the next analysis, see Operator's Handbook (01046-90000).
- EXREF for reference position of the excitation grating;
- EMREF for reference position of the emission grating;
- LKRD- from output of leak detection circuit: response from leak detection circuit is read on this line. If LKRD- does not follow LKWR- the leak detection circuit is defective. For more information about the leak detection self check, see section 2.8 Digital to Analog Converter Board (DAC).

LED's:

- If green LED labeled IRQ- is ON, all interrupts have been served (if LED is OFF, CPU has a lock up);
- If green LED labeled +5 V is ON, +5 V is supplied to the fluorescence detector controller board (FDC).

The major activity of the controller is the processing of the data from the photomultiplier. Data processing consists mainly of filtering and offset adjustment of the PMT signal, and is described on page 2-6.

2.4 MPS board

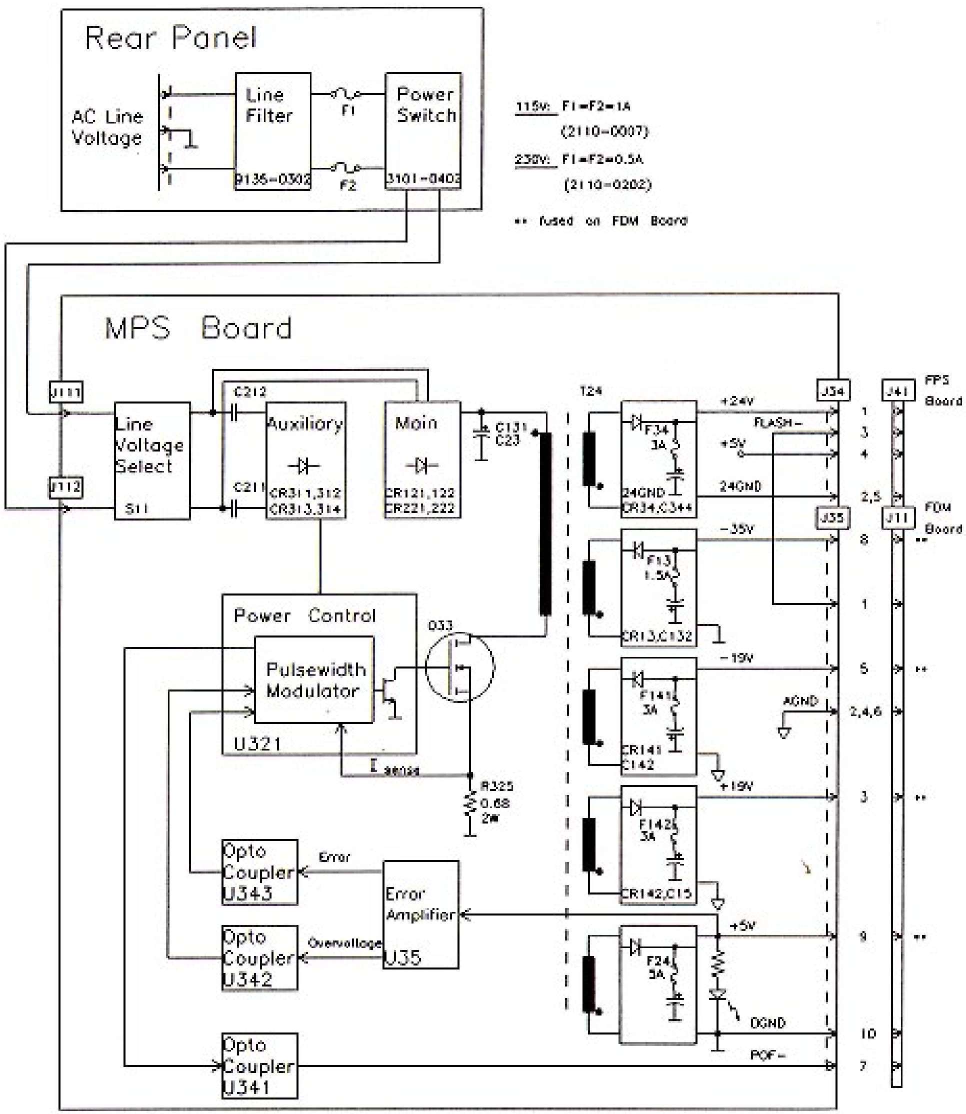


Figure 2.4-1

Main Power Supply Board (01046-66501)

The Main Power Supply (MPS) works with a switching frequency of 50 kHz and is covered with sheet metal to prevent high frequency radiation and shock hazard.

The line voltage is routed through the line filter, line fuses and power switch to the main power supply board (MPS). Values of the fuses are:

115V operation:	1 A (2110-0007)
230V operation:	0.5 A (2110-0202)

2.41 Voltage Distribution

All boards with analog circuits have their own +15 Volt regulators. Depending on the requirements of the analog circuits, the +19 Volt line from the main power supply board (MPS) splits into a +19 Volt raw voltage line (+19R) and a +19 Volt fine voltage line (+19F), see section 2.9 fluorescence detector mother board (FDM). The GND line separates on the main power supply board (MPS) and forms an analog GND line (AGND) and a digital GND line (DGNG). The flashlamp power supply board (FPS) has its own +24 Volt supply with a separate GND line (24GND) to prevent distortion on the common GND, when the Xe flashlamp is ignited.

The table below shows where voltages are generated, and where they are used:

	Voltages (in V)						
Board	+5	+19	+19R	+19F	-19	+24	-35
MPS	G	G			G	G	G
FPS						U	
FDM	U	U	G	G	U		U
FDC	U		U				
KDM	U				U		U
PPC	U		U	U	U		
DAC	U			U	U		
EMS	U		U				
EXS	U		U				

Key:		
	G	Voltage is generated on this board;
	U	Voltage is used on this board;
	F	Fine voltage used for analog circuits;
	R	Raw voltage;
	AGND	Analog GND;
	DGND	Digital GND.

2.4 MPS board

You can measure the following voltages on the **fluorescence detector motherboard (FDM)** respectively the **flashlamp power supply board (FPS):**

Voltage	Specification	Ref. Design.	Location
+5V	+10%	F1	on FDM board
+19V	+10%	F2	on FDM board
-19V	-10%	F3	on FDM board
-35V	-15%	F4	on FDM board
+24V	+10%	J41	on FPS board

For information about part numbers and values of fuses please refer to section 2.9 Fluorescence Detector Motherboard (FDM), page 2-41 respectively section 2.5.2 Flashlamp Power Supply board (FPS), page 2-21.

2.42 MPS board

The line voltage selector switch selects either 230 V or 115 V . Full-wave rectification is performed on the former, whereas half-wave rectification is performed on the latter, with capacitors following the rectifier being switched to parallel.

The switching power supply contains a power control circuit (U321) which functions generally as a pulse-width modulator and drives the current through the switching transformer T24. The output voltage on the secondary side of the switching transformer depends on the duty cycle of the pulse-width modulated signal. Regulation reacts on the power control circuit (pulse-width modulator) and influences the duty cycle of the pulse-width signal.

A main rectifier supplies the switching transformer, whereas a second auxiliary rectifier supplies the regulation circuit.

Regulation is implemented only for the +5 Volt DC line. Regulation of other DC voltages depends on power coupling by the transformer core. These DC voltages are regulated on the respective boards.

The error amplifier U35 senses the +5 Volt DC line. It has PID characteristics because of noise on the +5 Volt. The sense line is fed into U35 and compared with a reference voltage. U35 generates an error signal and feeds it through an analog opto coupler into the error sense input of the power control circuit (U321) where it is used to influence the duty cycle of the pulse-width modulated signal. The pulse width is inversely proportional to the error signal and has a less than 45 % duty cycle. No more than 45 % duty cycle is used to prevent the transformer working at saturation, causing current spikes which may destroy components.

The power control circuit (U321) limits the current through the switching transformer with the help of the sense line from R325. It sense the voltage drop on R325 and compares it with a reference voltage. As soon as it reaches an overcurrent condition, the pulse-width signal at the output of the control circuit is shortened. This results in a limited current through the switching transformer.

The error amplifier U35 senses an overvoltage condition on the +5 Volt line. Overvoltage turns-OFF the power control circuit (U321). After a short delay the power control circuit (U321) turns-ON again. If the over voltage condition remains it turns-OFF again. The oscillating frequency is approximately 1Hz which you can observe at the green LED (CR15).

The power control circuit (U321) senses an undervoltage condition on the auxiliary rectifier. The power control circuit turns-OFF, as long as its supply voltage is below +9 Volt. When sensing this undervoltage condition the power control circuit (U321) generates the power fail signal (POF-) and leads it through an opto coupler to the input latch on the fluorescence detector controller board (FDC). If power fails, the controller stores all setpoints in the battery backed-up memory.

2.4 MPS board

The main power supply board (MPS) contains on-board fuses in each secondary power line. You will find a list below, which fuses are used and where. The fuses are only built in, to prevent damage to components of the board, in case one of the smoothing capacitors has a short circuit. Fast acting fuses which are located on the fluorescence detector mother board (FDM) protect all power lines, so that under normal circumstances an on-board fuse will never blow. An exception is made for the +24 Volt line, for which the fast acting fuse is located on the flashlamp power supply board (FPS) and not on the fluorescence detector motherboard (FDM).

On-board fuses on main power supply board (MPS):

Ref. Des.	Part Number	Fuse
F13	2110-0423	1.5A
F141	2110-0447	3A
F142	2110-0447	3A
F24	2110-0548	5A
F34	2110-0447	3A

2.5 FPS board

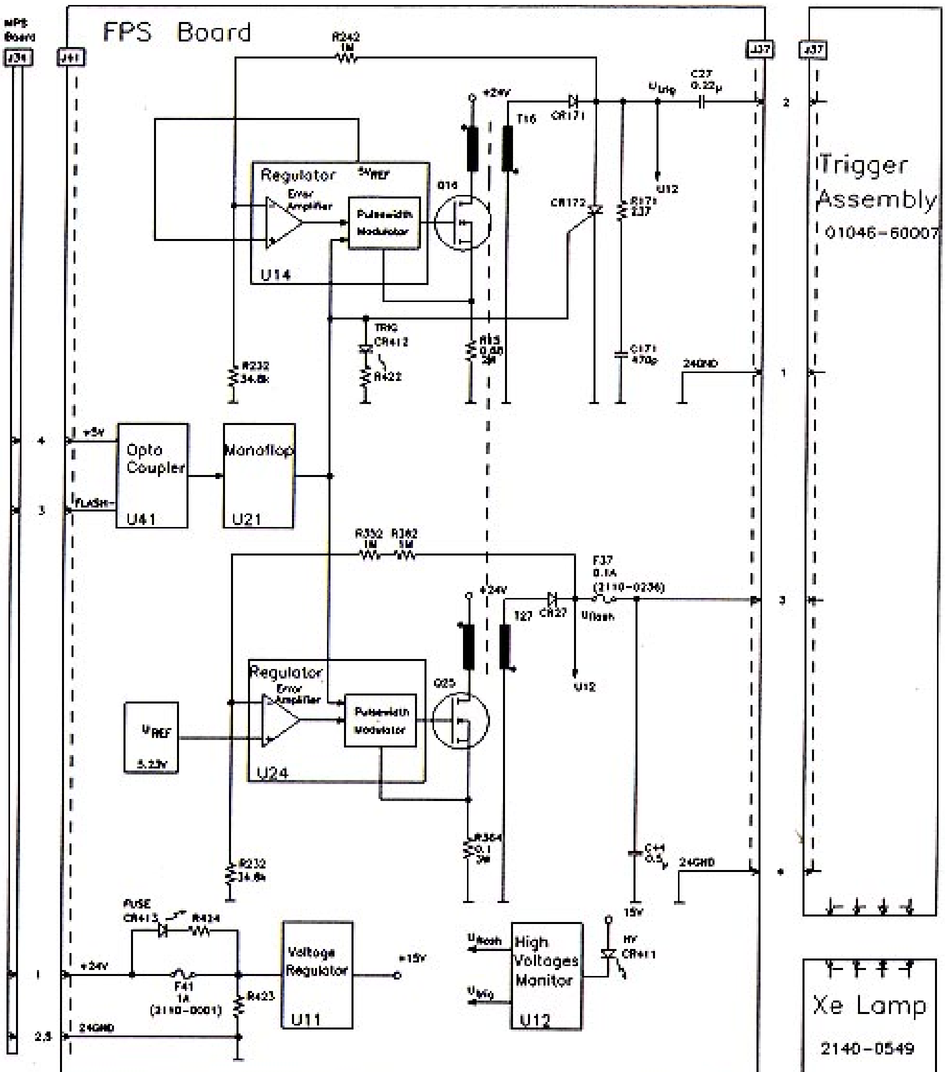


Figure 2.5-1

Flashlamp Power Supply board (01046-66502)

2.5.1 Xenon flashlamp

The Xe flashlamp (2140-0549) consists of a glass bulb, containing anode, cathode and a trigger electrode.

As long as the lamp is in a deionized state, there is a high impedance between anode and cathode. The voltage between anode and cathode is typically in the range of 300 to 1500 V DC and stored in an external capacitor on the flashlamp power supply board (FPS). To ignite the lamp, a trigger pulse, typically in the range of 10 to 20 kV has to be applied to the trigger electrode. The trigger electrode is located close to the path between anode and cathode, see figure 2.5-2.

With the help of the trigger assembly (01046-60007) containing a high voltage transformer and a resistor divider, a voltage gradient is formed, see Figure 2.5-2. This voltage gradient is applied to the trigger electrode. Xenon atoms between cathode and the trigger electrode ionize, forming a low impedance path i.e. an arc. Then xenon atoms between the trigger electrode and the anode ionize that the arc expands between anode and cathode. All energy that had been stored in the capacitor on the flashlamp power supply board (FPS) has been used after a short time (30µs), so that the current through the lamp drops and de-ionization starts.

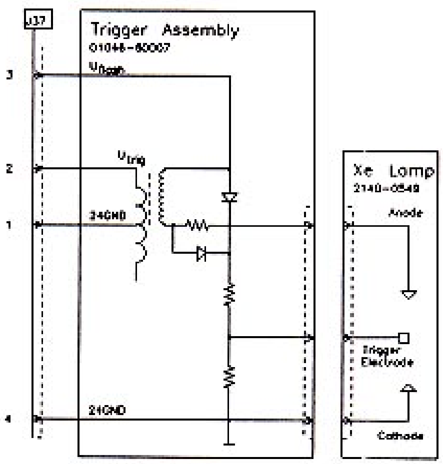


Figure 2.5-2

For the next flash, the capacitor on the flashlamp power supply board (FPS) recharges and the trigger pulse is applied to the trigger assembly to ignite the xenon lamp, resulting in the next flash.

> **WARNING**
>
> The lamp is under high internal pressure. Handle with care. Wear suitable protective devices to prevent possible injury, especially to hand and face areas.

2.5 FPS board

2.5.2 FPS board

The Xe flashlamp plugs into the trigger assembly containing the trigger pack, which receives a flash voltage (U_{flash}) of 320 V max and a trigger voltage (U_{trig}) of -120 V min. The trigger pack transformes the trigger voltage to the 10 kV to 20 kV. The trigger voltage and the flash voltage are regulated with a switching power supply. A trigger signal FLASH- from the processor is used to initiate the flash.
Flashing frequency is settable to 55 Hz, 110 Hz and 220 Hz using the LAMP= command, see HP 1046A Operator's Handbook. A typical waveform from the trigger voltage (U_{trig}) and flash voltage (U_{flash}) for a flashing frequency of 220 Hz is shown in Figure 2.5-3.

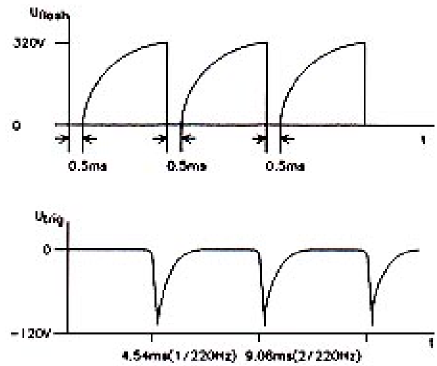


Figure 2.5-3

After a delay of about 0.5 ms, the storing capacitor C44 charges up until the flash voltage (U_{flash}) reaches 320 V. At the same time, C171 is charged up via R171 until it reaches -120 V. In case of a flashing frequency of 220 Hz, the FLASH- signal is delivered from the processor after 4.55 ms. FLASH- is routed through optocoupler U41 and monoflop U21 and used to ignite thyristor CR172. This results in a negative spike on the AC-coupled trigger voltage U_{trig} which is delivered to the trigger assembly.

When the lamp is ignited, the 320 V flash voltage line is pulled to GND. To prevent the trigger voltage regulator (U14) and the flash voltage regulator (U24) from high power consumption, they are turned-OFF by the FLASH- signal at the time when the thyristor is ignited. The lamp then has time to de-ionize completely.

After approximately 0.5 ms the monoflop (U21) turns-ON both regulators (U14, U24) and the whole cycle starts again.

The charge on the capacitor C44 determines the duration of the flash (30µs).

Note that the FLASH- signal is originated on fluorescence detector controller board (FDC), but routed through main power supply board (MPS).

The regulation for flash voltage (U_{flash}) and trigger voltage (U_{trig}) is done with two switching regulators using the same control circuit U14 and U24 respectively. Oscillators of both controllers are locked with a frequency of approximately 50 kHz.

Regulation of the trigger voltage (U_{trig}):

The control circuit U14 outputs a pulse-width modulated signal with a maximum 50% duty cycle to drive the current through the switching transformer (T16) by FET Q16. Voltage at C27/R171 is sensed and fed back through voltage dividers to a comparator inside the control circuit U14, where it is compared with a reference voltage. The resulting error signal influences the duty cycle of the pulse-width modulated signal used at FET (Q16).

Current is sensed on R15 and fed back into the control circuit U14. If the current through R15 is too high, the control circuit (U14) reduces the duty cycle of the pulse-width modulated signal for FET (Q16).

Regulation of flash voltage (U_{flash}):

A similar design is used as described above. The voltage at C44/CR27 is sensed and fed back into U24 where it is compared with the reference voltage.

2.5 FPS board

LED's:

- The green LED (CR411) driven by three comparators (U12), and labelled HV (high voltage) indicates if flash voltage or trigger voltage are not available. The LED is OFF if voltage is missing. It does not indicate if fuse F37 is blown.
- The green LED (CR412), labelled TRIG is ON if trigger pulses are delivered to thyristor CR172.
- The red LED (CR413), labelled FUSE is ON in case fuse F41 is blown and indicates that 24 V is available from the main power supply board (MPS).

If one of the green LED's is ON, 24 V supply voltage from the main power supply board (MPS) is available. For more information see section 4.0 Diagnostics, page 4-1.

Fuses:

- A fuse (1 A), F41 (2110-0001) located on this board, protects the 24 V power line, comming from the main power supply board (MPS). For a correct reading of the red LED labelled FUSE, see above.
- A fuse (0.1 A), F37 (2110-0236) protects the flash voltage supply.

2.6 Grating Assemblies

Excitation Grating Assembly (01046-60012)

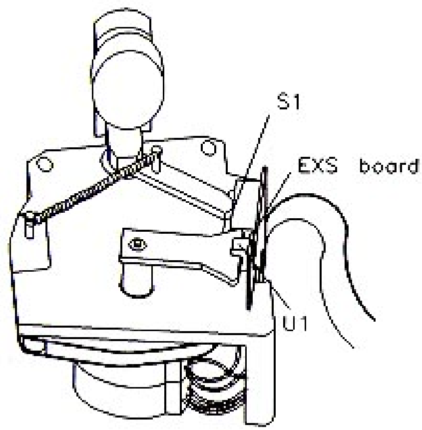


Figure 2.6-1

Emission Grating Assembly (01046-60013)

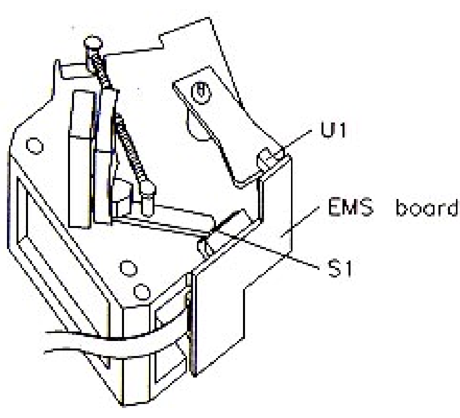


Figure 2.6-2

Excitation Grating Assembly (01046-60012)

Emission Grating Assembly (01046-60013)

The emission and excitation grating assemblies have a similar design. There are minor mechanical differences between the assemblies, because they are mounted into different positions in the optical path of the HP 1046A. For example, the zero order position of the emission grating is located opposite of the position of the excitation grating. Therefore the locations of components on the boards which sense the reference positions (zero order) are different, although they have the same electronic design. The board located on the excitation grating assembly is named excitation grating assembly sensor board (EXS), whereas the one mounted on the emission grating assembly is named emission grating assembly sensor board (EMS). **Note that you must not exchange those boards onsite, as the grating assembly will need adjustment, which can only be carried out in the factory.** In case a board is defective or the grating assembly is misadjusted, exchange the complete grating assembly.

You will find a figure of both grating assemblies on the opposite page. Each grating assembly has a stepper motor which turns the grating through a gearbox. The motors are electrically connected to their respective grating assembly sensor boards (EXS) J2 and (EMS) J2. The controller calculates the number of steps necessary for a given wavelength position of the grating from the setpoint. The relationship between the angle of the grating and the wavelength has a sine characteristic, therefore the firmware contains a table for the calculation of the correct position. A micro-switch and a lightswitch sense the reference position (zero order). A sheet metal bar is mounted on the axis of the grating. When this bar activates the microswitch, the grating is roughly in the reference position. The spring on the bar is used to compensate for backlash in the gearbox. Fine sensing of the reference position is done with the lightswitch U1 and a sheet metal bar mounted on the axis of the stepper motor. If the bar is located in the lightswitch after the rough reference position was sensed by the microswitch, the exact reference position of the grating is found.

2.6 Grating Assemblies

In Figure 2.6-3 you will find the circuit diagram of the exitation grating assembly sensor board (EXS). As long as the grating is not in the reference position, the microswitch which include $S1_1$ and $S2_2$ is not activated ($S1_1$ is open and $S1_2$ is closed). The photodiode is not lit and the switch $S1_2$ pulls the EXREF line to LOW. When the bar mounted on the axis of the grating activates the microswitch, $S1_1$ closes, the lightswitch is active and $S1_2$ opens. Because the bar from the motor axis is not in the lightswitch yet, EXREF is still LOW. A spike, which may occur while the microswitch is switching, is filtered with C1 and a software filter. As soon as the reference position is reached, the bar which is mounted on the axis of the steppermotor is in the lightswitch. This results in an open EXREF line, which is pulled to HIGH with a pull up resistor on fluorescence detector controller board (FDC).

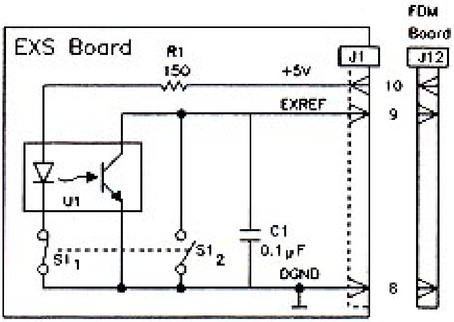


Figure 2.6-3

The above written description is also valid for the function of the emission grating assembly sensor board (EMS) together with the emission grating assembly.

Selfcheck

The controller is able to detect a mechanical or electronical malfunction of the excitation or emission grating assembly. In case of a malfunction (short circuit excluded), the EXREF (EMREF) line is pulled HIGH. To differentiate between the reference position and an error condition, the controller drives the grating out of the reference position. The controller now expects a LOW on the EXREF (EMREF) line. If it failed to drive the grating out of the reference position, no LOW occurs. There must be a mechanical or electronical malfunction on the respective grating assembly. The selfcheck is initiated by the CTRL 1 command or stop run, see Operator's Handbook (01046-90000), and during power-ON procedure.

Wavelength Calibration

The software allows a wavelength calibration by redefining a certain grating location to a different wavelength. For the procedure, see page 3-15.

2.7 PPC board

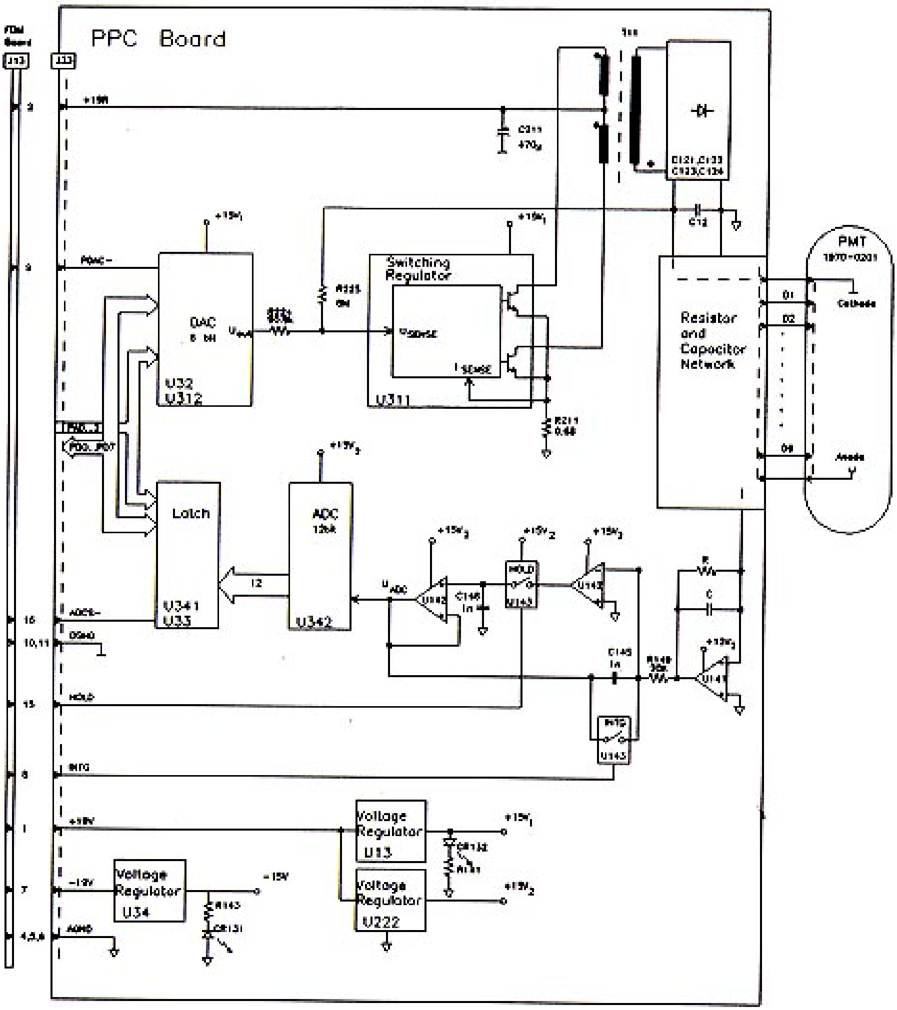


Figure 2.7-1

Photomultiplier Power and Control board (01046-66504)

2.7.1 Photomultiplier

The HP 1046A uses a side-on photomultiplier (PMT) with a circular cage structure (1970-0201).
You can select a voltage between the anode and the cathode in the range of 250 V to 1100 V with the PMTGAIN= command, see Operator's Handbook (01046-90000).

Photons which fall on the cathode result in an emission of electrons. These electrons strike the first of 9 dynodes (only photomultipliers with 9 dynodes are used in the HP 1046A) and produce emission of additional secondary electrons. A high current amplification is achieved when this avalanche effect is repeated for all available dynodes. The gain between two dynodes depends on the voltage between them. It can be expressed with the secondary electron emission factor d, defined by:

$$d = A \times E^{a}$$

where:

- A is a numerical constant [1/V];
- E is dynode voltage or interstage voltage [V];
- a is a constant of the dynode (0.7 to 0.8; depending on material and geometry).

The total gain G of the photomultiplier is given by:

$$G = (A \times E^{a})^{n}$$

$$= K \times U^{a.n}$$

where:

- K is a numerical constant [1/V], in this case approximately 0.2;
- U is the voltage between cathode and anode [V];
- n is the number of dynodes.

2.7 PPC board

The photomultipliers which are used in the HP 1046A have 9 dynodes, so the anode sensitivity varies approximately with the 9th power of the voltage change between anode and cathode. The factor between minimum and maximum sensitivity is then approximately 50,000.

To apply voltage between each dynode, a voltage divider network is used with the schematic shown in Figure 2.7-2. This network is incorporated in the socket assembly, which is mounted on the photomultiplier power and control board (PPC). Capacitors are built in for operation with light pulses.

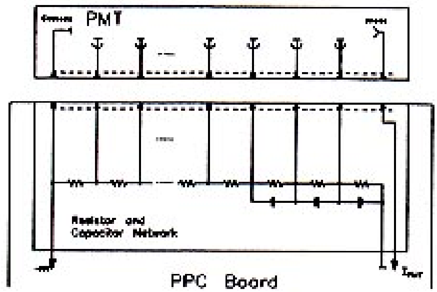


Figure 2.7-2

2.7.2 PPC board

The photomultiplier power and control circuit consists mainly of two functional groups:

1) Variable regulated power supply to drive the photomultiplier at different sensitivities.
2) Data acquisition part including gain switching, track-and-hold and a 12-bit ADC.

1) Variable Regulated Power Supply

The switching power supply produces a cathode voltage to drive the photomultiplier. The cathode voltage is variable to allow the photomultiplier to operate at different sensitivities. Setpoints are selectable with the PMTGAIN= command, see Operator's Handbook (01046-90000). Depending on the desired sensitivity, voltage between cathode and GND is in the range from -250 to -1100 V.

The voltage is produced by a switching regulator (U311) which receives setpoints from the processor via an 8-bit DAC (U32,U312). The setpoints control the sensitivity of the photomultiplier. The actual voltage on C12 is fed back into the switching regulator (U311) together with the output of the DAC (U32). A pulse-width modulated signal is derived which switches the current through both primary windings of transformer T11 via two driver transistors with opposite phases.

Current is sensed on R211 and the corresponding voltage is fed into the regulation circuit U311, to protect against a short circuit.

The output voltage of the transformer is rectified to form the cathode voltage for the photomultiplier and fed into the resistor-capacitor network, which is incorporated in the socket of the photomultiplier. Here the voltage is split up into the appropriate dynode voltages.

2) Data acquisition

U141 converts the anode current from the photomultiplier to a voltage. The feedback capacitor C of U141 serves as 100 kHz bandwidth filter to cut off all high frequency noise which may be picked up from external sources.

The integrating track-and-hold is accomplished with two operational amplifiers (U142) and two analog switches (U143). They are switched as shown in the timing diagram see, Figure 2.7-3. After FLASH- is issued, the integration starts with a minimum delay of 1 µs. After 30 µs, the signal is held (with hold switch U143) for the duration of the conversion time of the 12 bit A/D (U342). During this time the integration capacitor is already discharged by the INTG switch (U143) to prepare the next measurement. Before the next measurement, the hold switch (U143) is also closed to reset all components of the circuit to their initial values. The starting point of integration can be set using the DELAY= command to allow measurements of fluorescence and phosphorescence respectively, see Operator's Handbook (01046-90000).

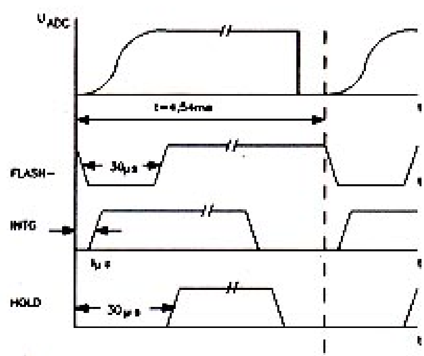
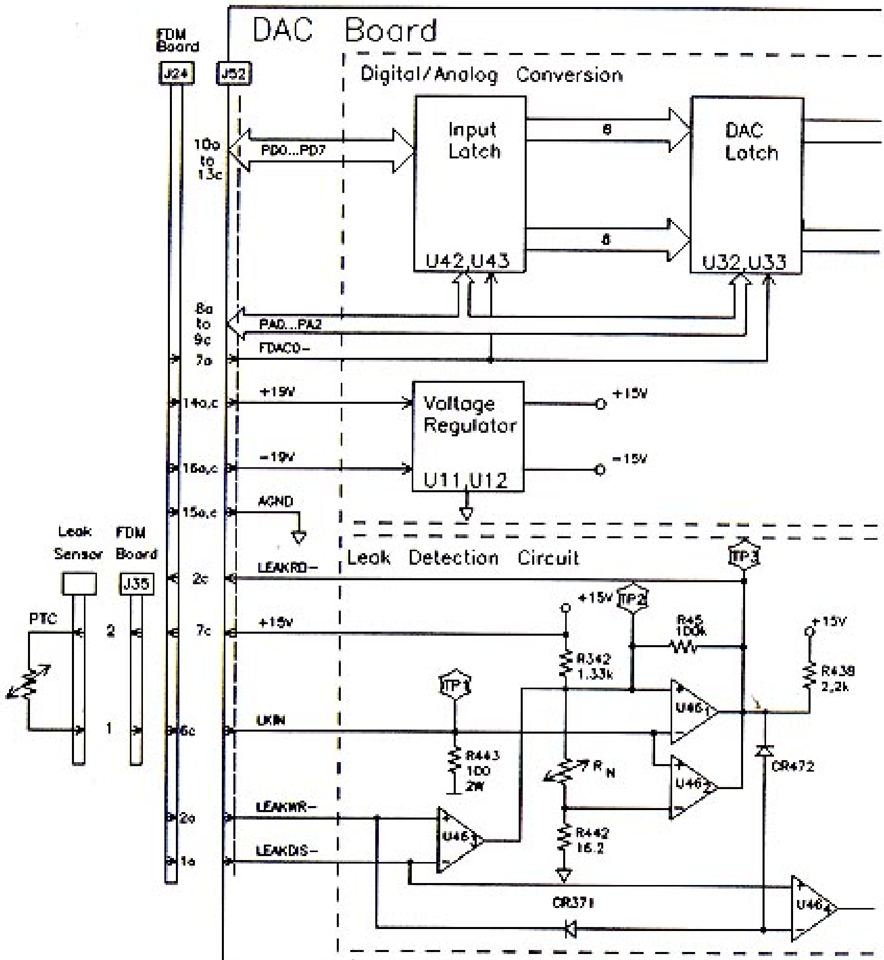


Figure 2.7-3

2.8 DAC board



DAC Board
FDM Board
J24
J52
Digital/Analog Conversion
Input Latch
U42,U43
DAC Latch
U32,U33
8
8
10a to 13c
PD0...PD7
8a to 9c
PA0...PA2
FDAC0–
7a
+19V
14a,c
-19V
16a,c
15a,c
AGND
Voltage Regulator
U11,U12
+15V
-15V
Leak Detection Circuit
Leak Sensor
FDM Board
J35
PTC
2
1
2c
LEAKRD–
7c
+15V
TP3
TP2
TP1
R45 100k
R342 1.33k
R438 2,2k
LKIN
6c
R443 100 2W
U46
CR472
R N
LEAKWR–
2a
LEAKDIS–
1a
R442 16.2
CR371

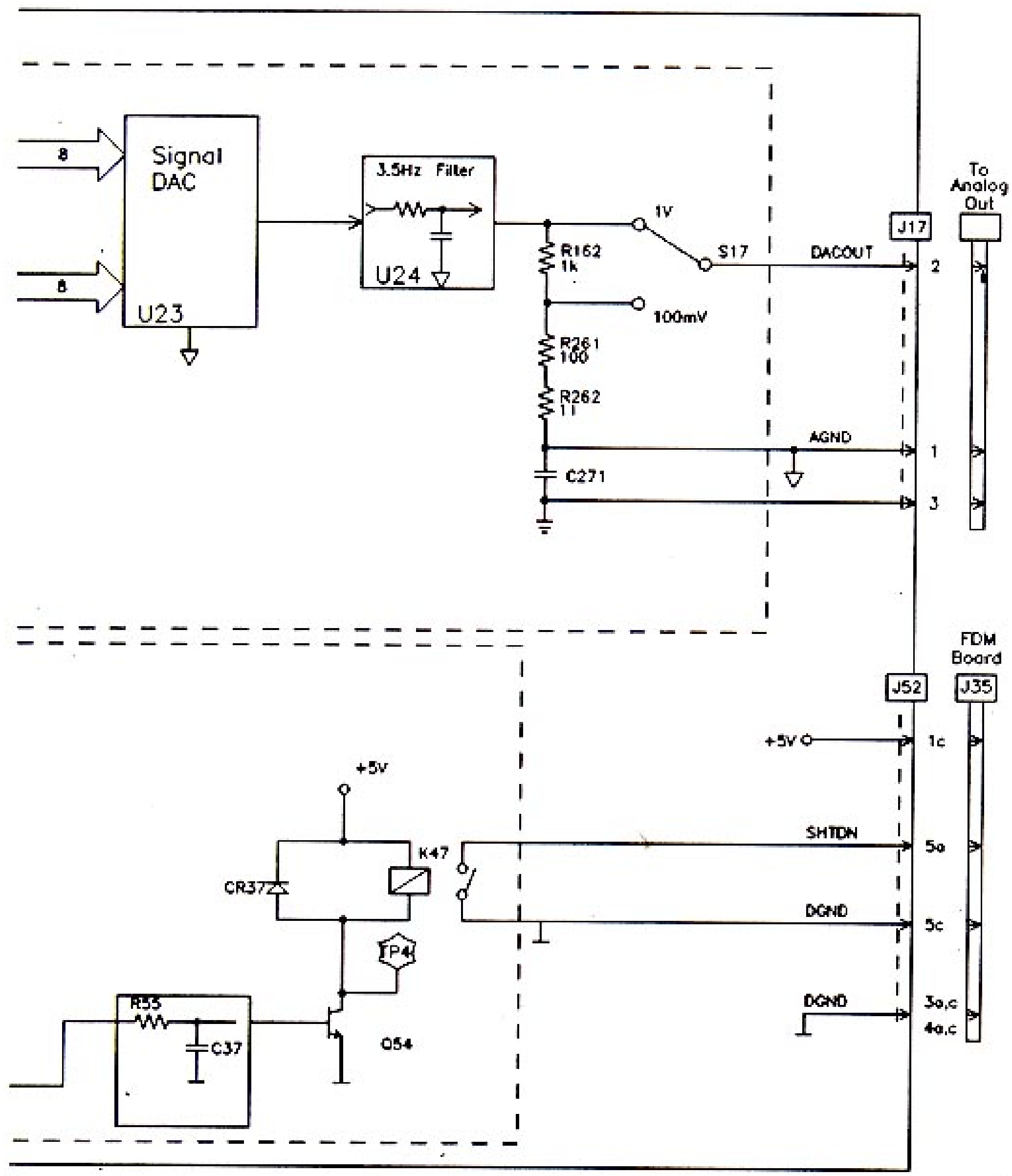

8
8
Signal DAC
U23
3.5Hz Filter
U24
R162
1k
R261
100
R262
11
C271
1V
S17
100mV
DACOUT
AGND
J17
To Analog Out
2
1
3
FDM Board
J52
J35
+5V
1c
SHTDN
5a
DGND
5c
DGND
3a,c
4a,c
+5V
K47
CR37
TP4
R55
C37
Q54

Figure 2.8-1

Digital to Analog Converter board (01046-66505)

Digital to analog conversion

The input latch (U42, U43) loads two 8-bit data words sequentially. The DAC latch (U32, U33) stores the resulting 16-bit data word until it is delivered to the 16 bit signal DAC (U23) for conversion.
The analog output receives the signal through a 3.5 Hz active filter (U24) and a resistor divider (R162, R261, R262).
With the switch S17 you can select an output range of either 0 V to 1 V (source impedance 1 kΩ) for integrators or 0 V to 100 mV (source impedance 100 Ω) for recorders.

The Analog Out signal is provided at the BNC connector at the rear of the HP 1046A.

Leak detection

The leak detection circuit uses a PTC resistor as leak sensor. The sensor is part of the leak sensor assembly (01046-61602) and it is installed in the flow cell compartment. The leak sensor assembly is connected to J35 on fluorescence detector motherboard (FDM).

If there is a leak, the PTC cools down and the resistance of the PTC decreases. Hence a cooled PTC results in an increased voltage at TP1. As soon as the voltage exceeds the one applied with the resistor divider R342, RN, R442 to the positive input of comparator $U46_1$, its output goes LOW (TP3). In case the PTC is disconnected or any connection to it is broken, comparator $U46_2$ provides a low going output signal at TP3, since the voltage at R443 is lower than the voltage applied to the negative input of $U46_2$. Outputs of $U46_1$ and $U46_2$ are read via LKRD- line from the processor.

2.8 DAC board

- LKRD- is LOW (TP3), if the voltage on TP1 is smaller than 80 mV (defective or disconnected) or if the voltage on TP1 is higher than 5.8 V (leak).
- LKRD- (TP3) delivers pulses from LKWR-, if the voltage on TP1 is in the range of 150 mV to 4.4 V.

If LKRD- line is LOW (TP3), the processor generates the error message: ERROR: leak detected .

In addition the LKRD- signal is used to switch relay K47 via $U46_4$ and Q54 (TP4). The relay (contact closure in case of leak) can be used to turn-OFF external instruments because of the leak (e.g. LC pumps). The relay acts independently from the controller. RN is a NTC and used for ambient temperature compensation.

An automatic selfcheck is implemented in the leak detection circuit. The processor sends a LKWR- signal of 10 µs pulse width and a repetition rate of 0.6 seconds. This signal (TP2) is fed into $U46_1$ to simulate a leak for the duration of the pulse. The processor which reads the LKRD- line is able to decide if the leak detection circuit is functioning properly.
The 10 µs pulses have no effect on relay K47 as they are filtered out with low pass filter R55, C37.

LKDIS- line inhibits leak detection circuit for the first minute after power-ON to ensure proper operation.

2.9 FDM board

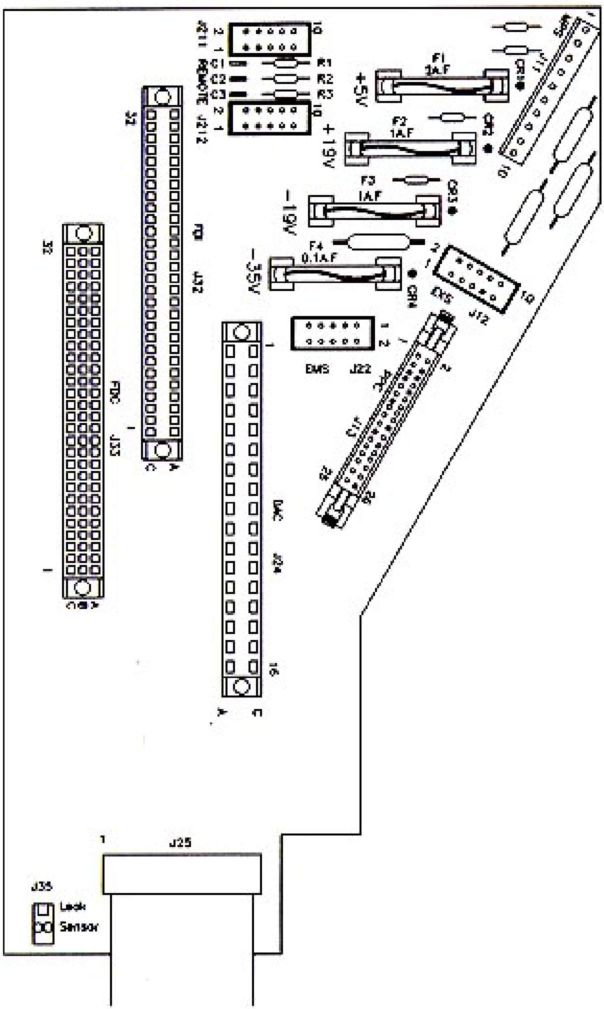


Figure 2.9-1

Fluorescence Detector Motherboard (01046-66500)

All DC power lines are fused on the fluorescence detector motherboard (FDM) except for the 24 V line, which is fused on the flashlamp power supply board (FPS).

Voltage	Fuse	Part Number	Ref. Des.	Location
+5V	2A	2110-0002	F1	FDM board
+19V *	1A	2110-0001	F2	FDM board
-19V	1A	2110-0001	F3	FDM board
-35V	0.1A	2110-0236	F4	FDM board
+24V	1A	2110-0001	F41	FPS board

* The +19 Volt voltage line is separated to form the +19 Volt raw voltage line (+19R) and the +19 Volt line voltage line (+19F).

If a red LED on fluorescence detector motherboard (FDM) is ON, it indicates a blown fuse of the respective power line and that there is still power on the line from the main power supply board (MPS). For more information, see section 4.0 Diagnostics, page 4-1.

The following boards plug onto the fluorescence detector motherboard (FDM):

- fluorescence detector controller board (FDC) 01046-66503 at J33
- digital to analog converter board (DAC) 01046-66505 at J24
- fluorescence detector interface board (FDI) 01046-66509 at J32 (for future use).

The flashlamp power supply board (FPS) is connected directly to the main power supply board (MPS). For pin assignment refer to page 2-20 or page 2-14.

2.9 FDM board

Connections are made from fluorescence detector motherboard (FDM) to:

- Main power supply board (MPS) 01046-66501 at J11
- Photomultiplier power and control board (PPC) 01046-66504 at J13
- Keyboard and display module (KDM) 01046-66508 at J25
- Excitation grating assembly (excitation grating assembly sensor board (EXS)) 01046-60012 at J12
- Emission grating assembly (emission grating assembly sensor board (EMS) 01046-60013 at J22
- Leak sensor assembly 01046-61602 at J35
- Remote connector assemblies 01046-61604 at J211, J212

For more detailed information, refer to the tables on the following pages.
The pin assignment of the remote connector and the analog out connector is described in section 5. Connectors and Cables.

Note that names for signals which are negative true logic end with a "-" sign.

Connector J11 to MPS board (J35)

Source J11	
FLASH-	1
AGND	2
+19V	3
AGND	4
-19V	5
AGND	6
POF-	7
-35V	8
5V	9
DGND	10

Connector J211 or 212 to REMOTE connector

Source J211		Destination
DGND	1	J11-10
spare	2	
PREP-	3	J33-17c, via RC combination
READY	4	J33-13a
START-	5	J33-14a, via RC combination
STOP-	6	J33-14b, via RC combination
SHTDN	7	J24-5a
N.C.	8	
DGND	9	J11-1b
N.C.	10	

For information about pin assignment of the REMOTE connector, see page 5-5.

2.9 FDM board

Connector J12 to EXS board

Source J12		Destination
N.C.	1	
EXPB-	2	J33-2b
EXPB	3	J33-2a
EXPA	4	J33-1a
+19R	5	J11-3
+19R	6	J11-3
EXPA-	7	J33-1b
DGND	8	J11-10
EXREF	9	J33-14c
+5V	10	J11-9

Connector J22 to EMS board

Source J22		Destination
spare	1	
EMPB-	2	J33-4b
EMPB	3	J33-4a
EMPA-	4	J33-3b
+19R	5	J11-3
+19R	6	J11-3
EMPA	7	J33-3a
DGND	8	J11-10
EMREF	9	J33-15c
+5V	10	J11-9

Connector J24 to DAC board (J52)

Destination	a	Source J24		b	Destination
J33-15b	1	LKDIS-	+5V	1	J11-9
J33-13b	2	LKWR-	LKRD-	2	J33-16c
J11-10	3	DGND	DGND	3	J11-10
J11-10	4	DGND	DGND	4	J11-10
J21-7	5	SHTDN	DGND	5	J11-10
J33-11b	6	FDAC1-	LKIN	6	J35-1
JFDAC0-*	7	FDAC0-	+15V	7	J35-2
J33-9a	8	PA3	PA2	8	J33-8c
J33-8b	9	PA1	PA0	9	J33-8a
J33-7c	10	PD7	PD6	10	J33-7b
J33-7a	11	PD5	PD4	11	J33-6c
J33-6b	12	PD3	PD2	12	J33-6a
J33-5b	13	PD1	PD0	13	J33-5a
J11-3	14	+19F	+19F	14	J11-3
J11-2, 4, 6	15	AGND	AGND	15	J11-2, 4, 6
J11-5	16	-19V	-19V	16	J11-5

Connector J35 to Leak Sensor

Source J35		Destination
LKIN	1	J24-6c
+15V	2	J24-7c

2.9 FDM board

Connector J13 to PPC board (J33)

Destination	Source J13				Destination
J11-3	1	+19F	+19R	2	J11-3
	3	N.C.	AGND	4	J11-2, 4, 6
J11-2, 4, 6	5	AGND	AGND	6	J11-2, 4, 6
J11-5	7	-19V	INTG	8	J33-12c
J33-10c	9	PDAC-	DGND	10	J11-10
J11-10	11	DGND	PA0	12	J33-5a
J33-13c	13	N.C.	+5V	14	J11-9
J33-12b	15	HOLD	ADCS-	16	J33-11a
J33-8b	17	PA1	PA2	18	J33-8c
J33-7a	19	PD5	PD6	20	J33-7b
J33-6c	21	PD4	PD2	22	J33-6a
J33-7c	23	PD7	PD3	24	J33-6b
J33-5b	25	PD1	PD0	26	J33-5a

Connector J25 to KDM

Destination	Source J25				Destination
J24-13c	1	PD0	PD1	2	J24-13a
J24-12c	3	PD2	DGND	4	J11-10
J24-12a	5	PD3	PD4	6	J24-11c
J24-11a	7	PD5	DGND	8	J11-10
J24-10c	9	PD6	PD7	10	J24-10a
J24-9c	11	PA0	DGND	12	J11-10
J24-9a	13	PA1	PA2	14	J24-8c
J33-9b	15	DKAS-	DGND	16	J11-10
J33-9c	17	DKRD-	POP-	18	J33-10a
J11-9	19	+5V	DGND	20	J11-10
J11-9	21	+5V	DGND	22	J11-10
J11-5	23	-19V	DGND	24	J11-10
J11-8	25	-35V	FIL	26	J33-1c

Connector J33 to FDC board (J1)

* These lines are each routed through an RC combination.

Destination	a	Source J33		b	Destination	J33 c		Destination
J12-4	1	EXPA	EXPA-	1	J12-7	FIL	1	J25-26
J12-3	2	EXPB	EXPB-	2	J12-2	+19R	1	J11-3
J22-7	3	EMPA	EMPA-	3	J22-4	+19R	3	J11-3
J22-3	4	EMPB	EMPB-	4	J22-2	DGND	4	J11-10
J25-1	5	PD0	PD1	5	J25-2	DGND	5	J11-10
J25-3	6	PD2	PD3	6	J25-5	PD4	6	J25-6
J25-7	7	PD5	PD6	7	J25-9	PD7	7	J25-10
J25-11	8	PA0	PA1	8	J25-13	PA2	5	J25-14
J24-8	9	PA3	DKAS-	9	J25-15	DKRD-	5	J25-17
J32-18a	10	POP-	FDAC0-	10	J24-7	PDAC-	10	J13-9
J13-16	11	ADCS-	FDAC1-	11	J24-6	IOS1-	11	J32-18c
J11-1	12	FLASH-	HOLD	12	J13-15	INTG	12	J13-8
J21-4	13	READY	LKWR-	13	J24-2a	N.C.	13	J13-13
J33-14a*	14	START-	STOP-	14	J33-14b*	EXREF	14	J12-9
J11-7	15	POF-	LKDIS-	15	J24-1a	EMREF	15	J22-9
J32-1a	16	IOS0-	+5V	16	J11-9	LKRD-	16	J24-2c
J32-2a	17	ROM2E-	+5V	17	J11-9	PREP-	17	J33-17c*
J32-3a	18	ROM1E-	+5V	18	J11-9	RAM2-	18	J32-3c
J32-4a	19	MRDY-	+5V	19	J11-9	DIS-	19	J32-4c
J32-5a	20	IRQ-	+5V	20	J11-9	R/W-	20	J32-5c
J32-6a	21	A3	DGND	21	J11-10	D3	21	J32-6c
J32-7a	22	A4	DGND	22	J11-10	D4	22	J32-7c
J32-8a	23	A5	DGND	23	J11-10	D5	23	J32-8c
J32-9a	24	A6	DGND	24	J11-10	D6	24	J32-9c
J32-10a	25	A7	DGND	25	J11-10	D7	25	J32-10c
J32-11a	26	A12	DGND	26	J11-10	A10	26	J32-11c
J32-12a	27	A9	DGND	27	J11-10	A11	27	J32-12c
J32-13a	28	A15	DGND	28	J11-10	A8	28	J32-13c
J32-14a	29	A14	DGND	29	J11-10	A13	29	J32-14c
J32-15a	30	D1	DGND	30	J11-10	D2	30	J32-15c
J32-16a	31	A0	DGND	31	J11-10	D0	31	J32-16c
J32-17a	32	A2	DGND	32	J11-10	A1	32	J32-17c

2.9 FDM board

Connector J32 to Interface board (J33)

Destination	a	Source J32		b	Destination
J33-16a	1	IOS0-	IOS1-	1	J33-16c
J33-17a	2	ROM2E-	POP-	2	J33-17c
J33-18a	3	ROM1E-	RAM2-	3	J33-18c
J33-19a	4	MRDY-	DIS-	4	J33-19c
J33-20a	5	IRQ-	R/W-	5	J33-20c
J33-21a	6	A3	D3	6	J33-21c
J33-22a	7	A4	D4	7	J33-22c
J33-23a	8	A5	D5	8	J33-23c
J33-24a	9	A6	D6	9	J33-24c
J33-25a	10	A7	D7	10	J33-25c
J33-26a	11	A12	A10	11	J33-26c
J33-27a	12	A9	A11	12	J33-27c
J33-28a	13	A15	A8	13	J33-28c
J33-29a	14	A14	A13	14	J33-29c
J33-30a	15	D1	D2	15	J33-30c
J33-31a	16	A0	D0	16	J33-31c
J33-32a	17	A2	A1	17	J33-32c
J11-3	18	+19R	+19R	18	J11-5, 7
J11-10	19	DGND	DGND	19	J11-6, 8, 10
J11-9	20	+5V	+5V	20	J11-9
J11-9	21	+5V	+5V	21	J11-9
J11-9	22	+5V	+5V	22	J11-9
J11-9	23	+5V	+5V	23	J11-9
J11-9	24	+5V	+5V	24	J11-9
J11-10	25	DGND	DGND	25	J11-10
J11-10	26	DGND	DGND	26	J11-10
J11-10	27	DGND	DGND	27	J11-10
J11-10	28	DGND	DGND	28	J11-10
J11-10	29	DGND	DGND	29	J11-10
J11-10	30	DGND	DGND	30	J11-10
J11-10	31	DGND	DGND	31	J11-10
J11-10	32	DGND	DGND	32	J11-10

Fluorescence Detector Interface board (01046-66509)

Two HP 1046A options are available. A standalone instrument without HP-IB control and a detector equipped with HP-IB control and data output. The FDI board combines the functions required for the HP-IB communication, and is installed only in detectors with the HP-IB interface.

The default HP-IB address of the HP 1046A is 12. The address switch is located on the FDI board. The main hardware blocks on the FDI board are 64 kbyte EPROM, 24 kbyte RAM and a HP-IB controller. The electronics is connected directly to the Data, Address and Control bus of the FDC board. See figure 2.10-1.

The Firmware on the FDI board is automatically activated when the board is inserted to the instrument. A detector without HP-IB interface can be upgraded to the HP-IB version by inserting the FDI board and connecting the HP-IB cable assembly to the HP 1046A rear panel. The FDI board can be removed from the detector. The instrument works now in ‚analog' mode.

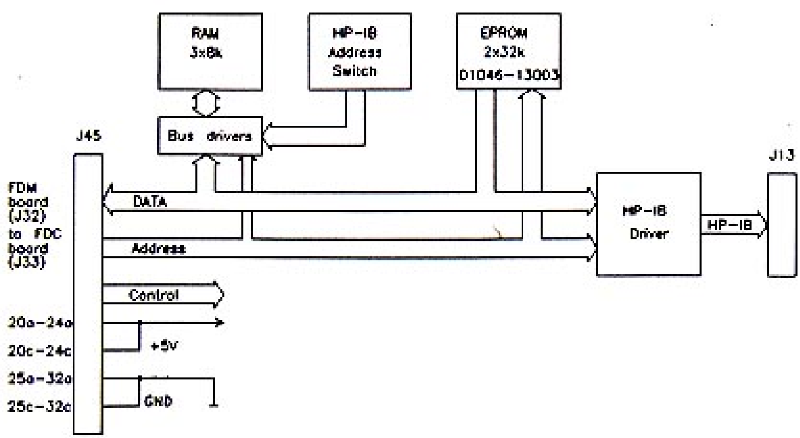


Figure 2.10-1

Part number	Assembly	Current Rev.	Changes
01046-13001	FDC Firmware	D-2630	(no changes)
01046-13003	FDI Firmware	A-2718	(no changes)
01046-60007	Trigger Pack		Enhanced grounding, all detectors updated
01046-60012	EX-Grating		Resistor value changes, s/n break > 2702G00760
01046-60013	EM-Grating		- " -
01046-66500	FDM	B	Remote connector pin 6 disconnected from DGND s/n break > 2702G00300
01046-66501	MPS	A	Component changes only
01046-66502	FPS	B	Board size and component changes, only prototype detectors with Rev. A board
01046-66503	FDC	A	1. Additional parts (enhanced battery lifetime) s/n break > 2702G00760 2. RAMs with integrated backup battery; Battery removed (June 1989)
01046-66504	PPC	B	Enhanced ESD protection, s/n break > 2702G00760
01046-66505	DAC	B	(no changes)
01046-66508	KDM	A	(no changes)
01046-66509	FDI	B	(no changes)

Replacing Parts 3.0

The below listed replacement procedures are described in the HP 1046A Operator's Handbook (01046-90000).

- Maintenance of the flowcell;
- Replacing the flashlamp;

> **WARNING**
>
> Always turn-Off the line power and disconnect the line-power cord from the line-power socket at the rear of the HP 1046A before opening the instrument.

Follow the steps below, when replacing electronic items inside the HP 1046A.

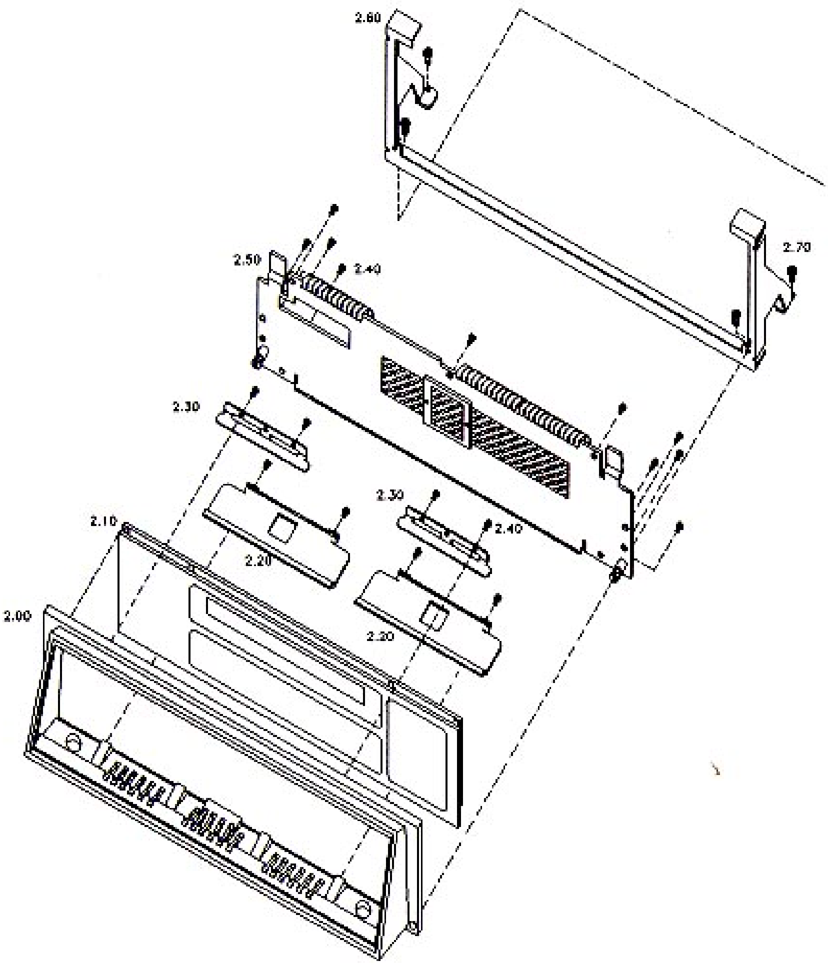
1. Remove any HP 1046A covers, panels and protecting covers to get access to the respective item.
2. Connect the portable grounding kit and wrist strap (9300-0794) to the base plate of the HP 1046A.
3. Remove respective item and place on the portable grounding kit.
4. Remove the new item from the service kit and unpack on portable grounding kit.
5. Install the new item, turn-ON the line power using the line power switch at the rear of the HP 1046A and start-up as described in your HP 1046A Operator's Handbook (01046-90000). Check that the new item is working properly.

After PPC board (01046-66504) exchange verify and adjust the dark current compensation :

Turn-Off the lamp. Set PMT GAIN = 1 and GATE = 10. The displayed C value should be 5...10. If necessary adjust using the potentiometer on the PPC board. Increase the PMT GAIN to 15. Verify that the C Value remains < 15.

Detailed information on the respective items are given in the following pages.

3.1 Illustrated Parts Breakdown



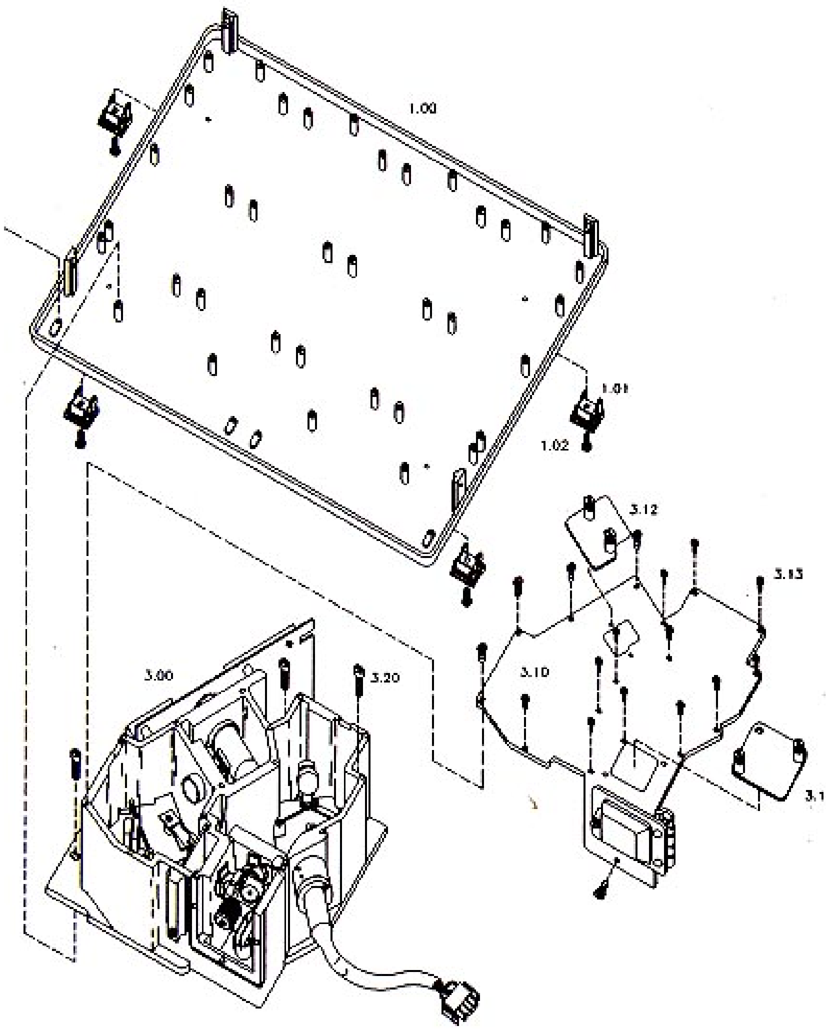
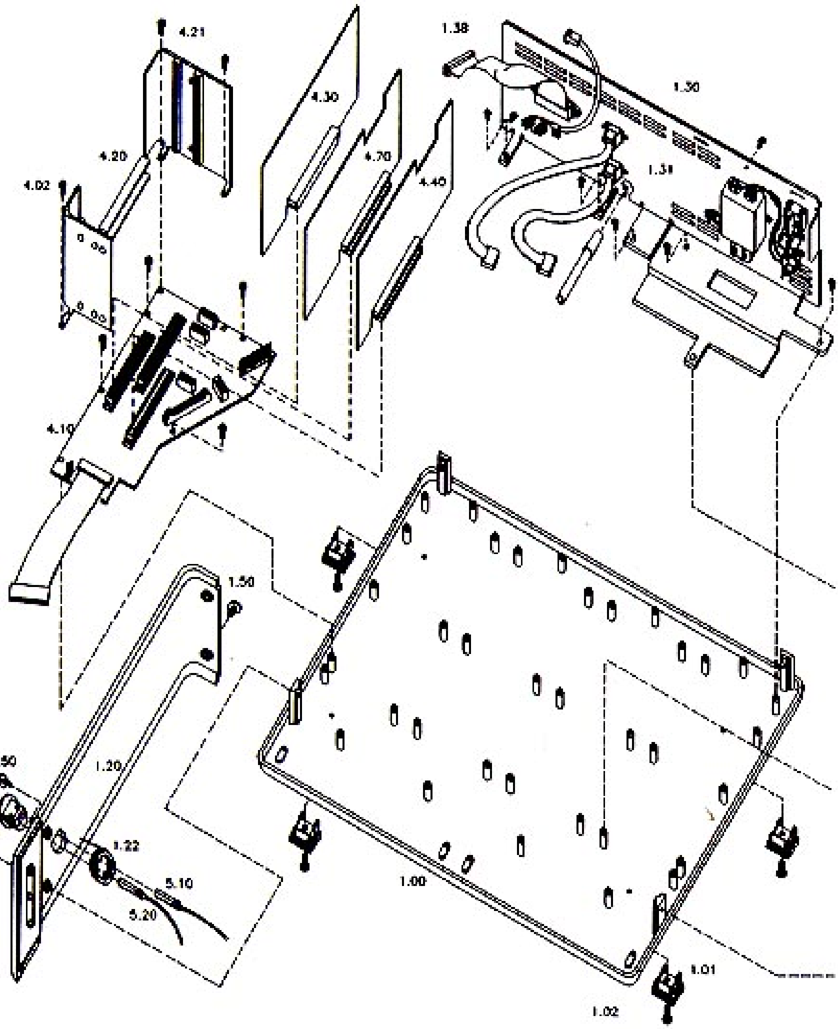


Figure 3.1-1

3.1 Illustrated Parts Breakdown



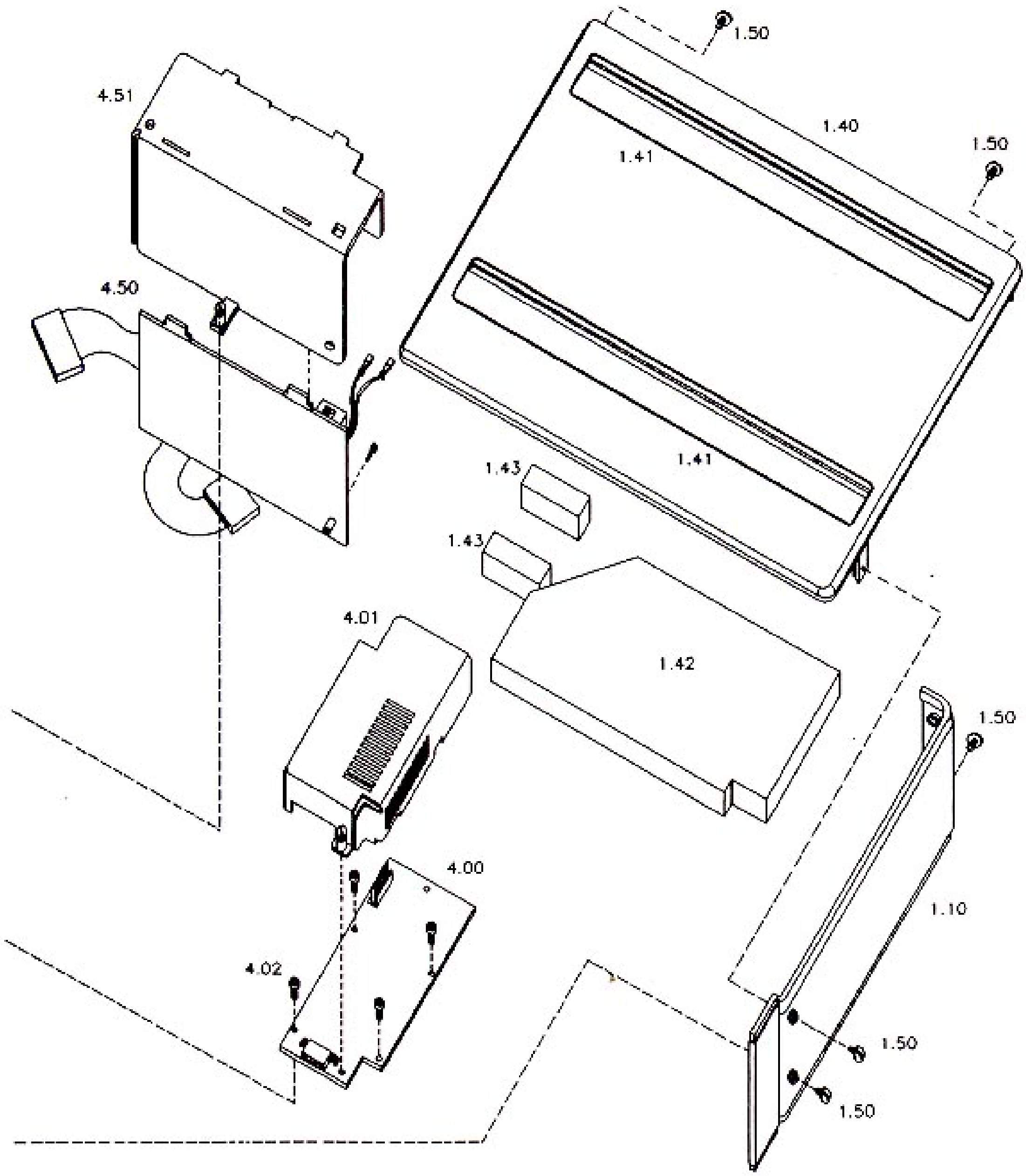
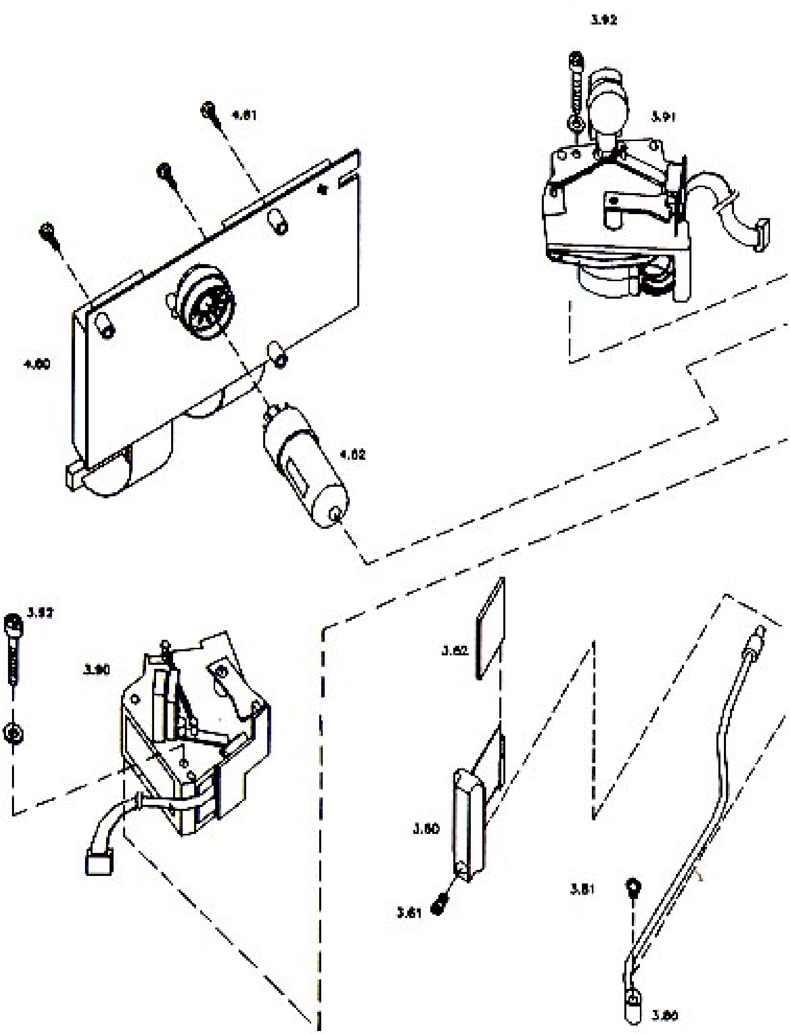

1.50
4.51
1.40
1.41
1.50
4.50
1.41
1.43
1.43
4.01
1.42
1.50
4.00
1.10
4.02
1.50
1.50

Figure 3.1-2

3.1 Illustrated Parts Breakdown



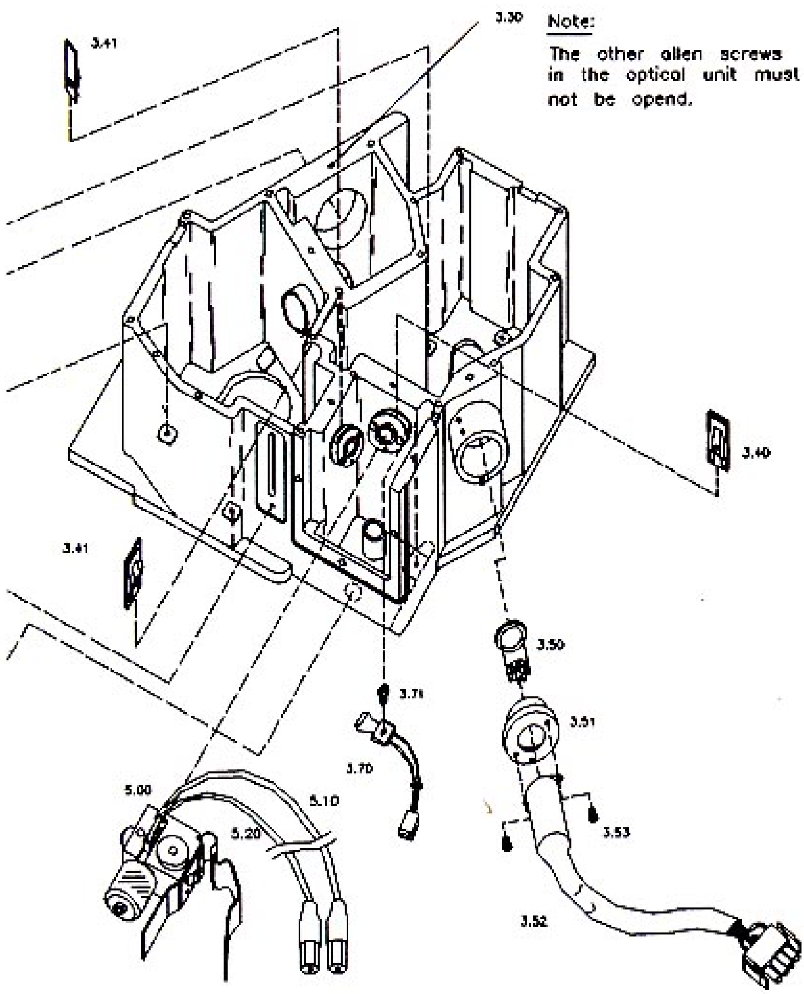

3.41
3.30
Note:
The other allen screws in the optical unit must not be opend.
3.40
3.41
3.50
3.71
3.51
3.70
5.00
5.10
5.20
3.53
3.52

Figure 3.1-3

3.1 Illustrated Parts Breakdown

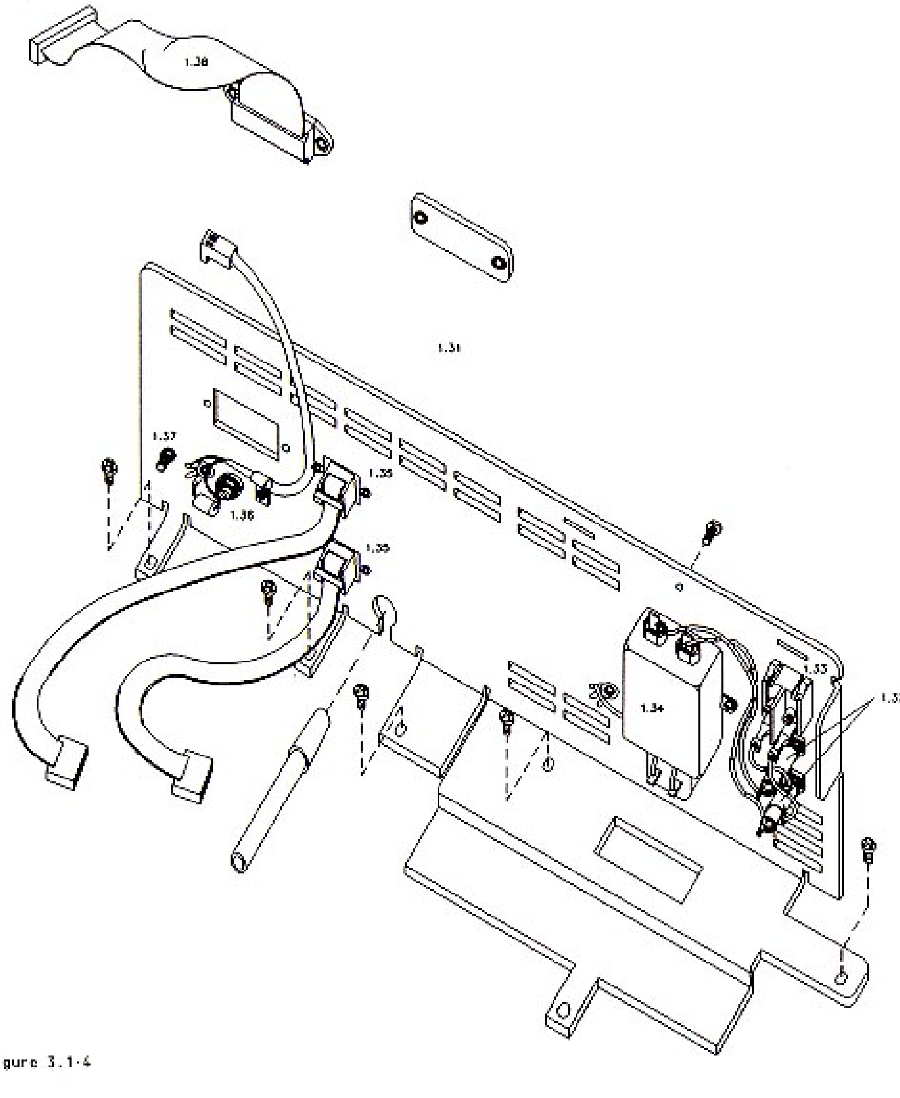


Figure 3.1-4

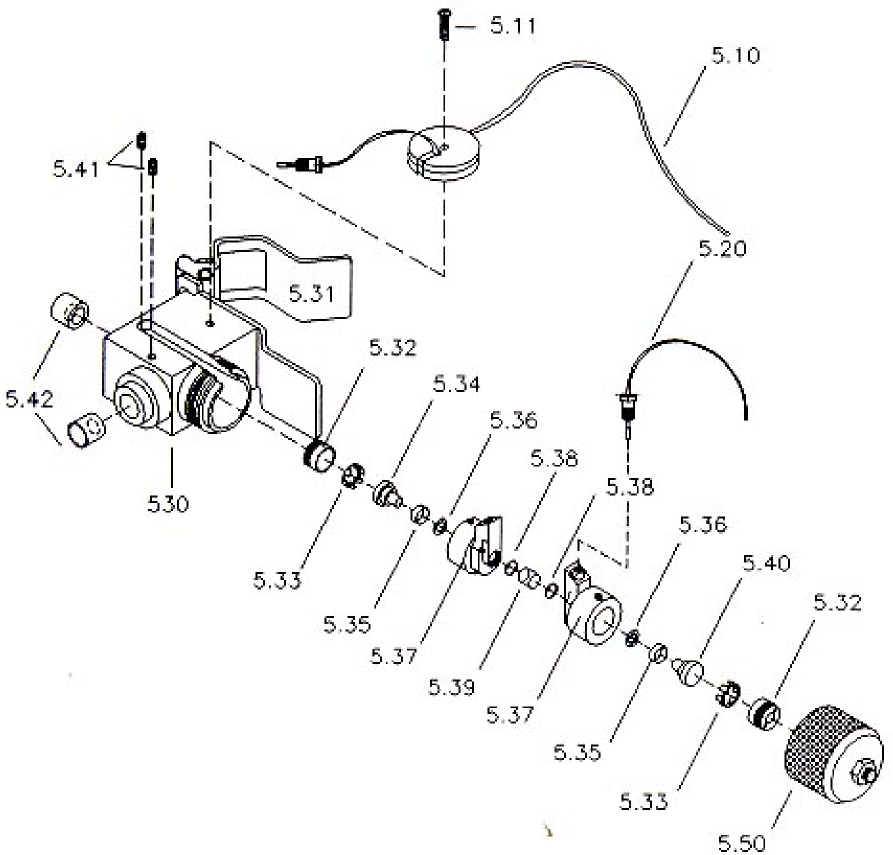

5.11
5.10
5.41
5.20
5.31
5.32
5.34
5.42
5.36
5.38
5.38
530
5.36
5.40
5.33
5.32
5.35
5.37
5.39
5.37
5.35
5.33
5.50

Figure 3.1-5

3.1.1 Parts Identification

Item		Description	Part Number
1.00		Cover, bottom	0050-2115
	1.01	Foot (4x)	4040-2098
	1.02	Screw 5x16 (4x)	0515-0562
1.10		Cover, side	5060-1822
1.20		Side panel, bulkhead	01046-00203
	1.21	Capholder	01040-22301
	1.22	Nut bulkhead	01046-25701
1.30		**Rear panel assembly**	**01046-60015**
		Note : Power wires soldered	
	1.31	Panel assembly	
		Rear panel	01046-00202
		HP-IB plate	01046-04108
		Screw, 4-40	2200-0105
		Screw, 3x0.5 6mm	0515-0886
	1.32	Fuse holder cap	2110-0565
		Fuse holder	2110-0610
		Nut hex plastic	2110-0569
	1.33	Line switch	3101-2913
	1.34	Line filter	9135-0302
	1.35	Remote connector	
		Cable assembly	01046-61604
		Screws, lock	1252-1516
	1.36	BNC connector	
		BNC cable assembly	01046-61605
		Cable holder	
		Clamp cable 0.625	1400-0024
		Nut hex	0535-0025
		Washer	3050-0227
		Screw 3x0.5 6mm	0515-0886
		Term-Lug SLDR	0360-1190
		Wash-Lock Int. 3/8"	2190-0016
		Nut hex 0.375-32	2950-0043
		Connector BNC BLKHD	1250-0001
		Insulation	5040-0702
		Capacitor 10 nF 200V (Rev. B)	0160-0161
	1.37	Grounding	
		BDG Post 0.812 LG	1510-0038
		Nut hex 0.25-32	2950-0072
		Wash-Lock Int. 1/4"	2190-0084
	1.38	HP-IB Cable asembly	5061-3352
1.40		Cover, top	0050-2116
	1.41	Insert, top	5040-1181
	1.42	Foam	01046-00205
	1.43	Foam	01046-00206
1.50		Screw 5x9 (8x)	0515-0750

Item		Description	Part Number
		Front panel assembly	**01046-60014**
2.00		Front panel	01046-40201
2.10		Keyboard Display Module (KDM)	01046-66508
2.20		Holder lower (2x)	01046-02302
2.30		Holder upper (2x)	01046-02301
		Contact element (2x)	01046-01003
2.40		Screw 3x6 (18x)	0515-0886
2.50		Cover, front panel	01046-60018
		Screw, Fstnr-cptve, (2x)	1390-0591
2.60		U-frame	01046-00502
2.70		Screw 3.5x6 (4x)	0515-0544
3.00		**Optical unit**	**01046-60011**
3.10		Cover optical unit	01046-00204
		Door cell compartment	79881-00302
		Gasket door	5041-2156
		Gasket optical unit	5041-2157
	3.11	Cover cell area	01046-04109
		Gasket cell	5041-2158
	3.12	Cover PMT	01046-04107
		Gasket PMT	5041-2159
	3.13	Screw 3X0.5 6MM (18x)	0515-0924
3.20		Screw 3.5x16 (3x)	0515-0548
3.30		Allen screw	0515-0236
		Slit, 1mm	01046-60021
3.40		Slit, 2mm	01046-60022
3.41		Slit, 4mm	01046-60023
3.50		Flash lamp	2140-0549
	3.51	Lamp holder	01046-22308
		Adapter ring	01046-22309
	3.52	Trigger assembly	01046-60007
	3.53	Screw 3x0.5 6mm (2x)	0515-0924
3.60		Filter holder assembly	01046-62701
	3.61	Screw Machine	0515-0757
	3.62	Cut-off filter 280nm	5061-3351
		Cut-off filter 370nm	1000-0822
		Cut-off filter kit1 (supplies)	5061-3327
		Cut-off filter kit2 (supplies)	5061-3328
		Cut-off filter kit3 (supplies)	5061-3329

3.1.1 Parts Identification

Item		Description	Part Number
3.70		Leak sensor assembly	01046-61602
	3.71	Screw	0515-1695
3.80		Waste tube	01046-67601
	3.81	Waste screw	79846-22403
3.90		Emission grating assembly	01046-60013
3.91		Excitation grating assembly	01046-60012
	3.92	Hex screw	0515-1695
		Washer	3050-0521
4.00		FPS board	01046-66502
	4.01	Cover FPS	01046-04102
	4.02	Screw 3.5x6 (19x)	0515-0544
4.10		FDM board	01046-66500
4.20		Card cage	01046-04104
	4.21	PC-guide	79881-03101
4.30		FDC board	01046-66503
		FDC firmware	01046-13001
		Battery	1420-0361
4.40		DAC board	01046-66505
4.50		MPS board	01046-66501
	4.51	Cover MPS	01046-04101
4.60		PPC board	01046-66504
	4.61	Screw 3x10 (3x)	0515-0539
	4.62	Photomultiplier tube	1970-0201
4.70		FDI board	01046-66509
		FDI firmware	01046-13003

Item		Description	Part Number
5.00		**Cell assembly**	**01046-60010**
5.10		Inlet capillary assembly	01046-67301
		includes Zero volume union	0100-0900
		includes Cap. ay, 0.12 id.	79881-67301
	5.11	Screw	0515-1759
5.20		Outlet capillary assembly	01046-67302
		includes Zero volume union	0100-0900
		includes Cap. ay, 0.25 id.	79881-67302
5.30		Cell cartridge	01046-24501
	5.31	Cell clamp	01046-61201
		Cell parts :	
	5.32	Cell screw	79881-22403
	5.33	Cell spring	79881-09103
	5.34	Stepwindow, transparent	01046-28101
	5.35	Guide ring	01046-27103
	5.36	Gasket, stepwindow	01046-27101
	5.37	Cell cap	01046-24500
	5.38	Gasket, cell	01046-27102
	5.39	Flow chamber	01046-28102
	5.40	Stepwindow, black	01046-28103
	5.41	Screw, hex	0515-0142
	5.42	Lens assembly	
		Lens	1000-0805
		Lens screw	01046-22403
		Lens housing	01046-25201
5.50		Lock cartridge assembly	
		Screw, 3x0.5	0515-1111
		Spring	1460-2118
		Pressure plate	01046-24104
		Lock cartridge	01046-22402

3.2 Replacement of Grating Assembly

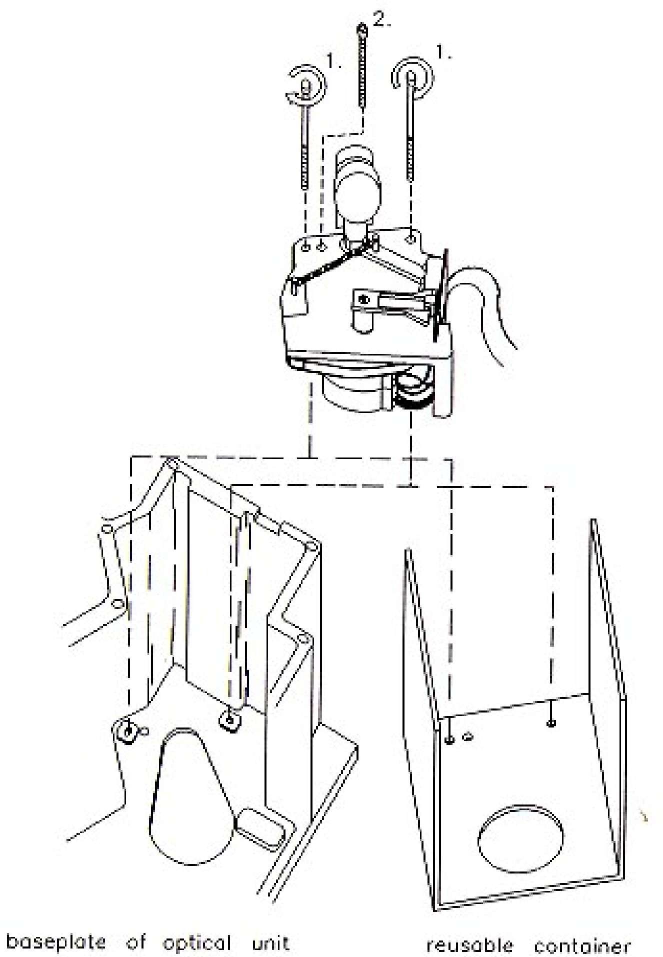


Figure 3.2-1

Excitation Grating Assembly (01046-60012)
Emission Grating Assembly (01046-60013)

1. Open the cover the of optical unit.
2. Unplug the cable, connecting the grating assembly to the fluorescence detector motherboard (FDM).
3. Unscrew the hexagonal screw (item 2 in figure 3.2-1), located on top of the grating assembly.

> **WARNING**
>
> Do not touch the grating.
> Do not attempt to clean the grating.

4. Take the two hexagonal screws (item 1 in figure 3.2-1) (0515-0827) from the product support package. Insert them into the holes as shown in figure 3-2.1. Using them as a handle, move the grating assembly slightly backwards and forewards and then remove the grating assembly. Place the grating assembly carefully on the bench, see figure 3.2-1.

> **CAUTION:**
>
> The grating assembly is very sensitive to mechanical shocks, since a slight misadjustment will damage the optical alignment. Take care to avoid mechanical shock (e.g. dropping a tool) to the grating.

5. Open the reusable container of the new grating assembly. Unscrew the hexagonal screw (item 2) located on top of the grating assembly before removing the grating from the packing material.

3.2 Replacement of Grating Assembly

6. Fit the new grating assembly into the optical unit with the help of the two hexagonal screws (item 1 in figure 3.2-1). Twist it counter clockwise while you are fixing it with the hexagonal screw. NEVER use mechanical force, to install the grating. This will cause misadjustment leading to a damaged optical unit.

7. Plug cable from the grating assembly into the fluorescence detector motherboard (FDM).

8. Push cable into the recess of the optical unit. This will prevent straylight, when the cover of the optical unit is closed.

9. To check that the new grating assembly is working correctly, enter a wavelength setpoint and observe the movement of the grating. To check if the grating assembly finds the zero order position, enter CTRL1 ENTER .

10. Close the cover of the optical unit, fix two or three screws and apply the wavelength calibration procedure, which is described on the next page.

11. Remove the two hexagonal screws (item 1 in figure 3.2-1) from the grating assembly and close the cover of the optical unit. Secure screws on top of optical unit crosswise, before you fix the screw in the front.

12. Put the old grating assembly into the reusable container and secure it with the hexagonal screw, (item 2 in figure 3.2-1).

13. Pack the grating assembly into a plastic bag to protect from dust.

14. Ensure that the grating assembly is well packed to prevent damage by mechanical shocks during transportation.

Before you begin, you must install the HP 1046A test cell and the correct slits.

1. Turn-OFF the HP 1046A
2. Follow the procedure given in the Operator's Handbook (01046-90000) exchanging the slits. Insert 1 x 1 mm slits (3 pcs) in the optical unit.
3. Remove the flow cell.
4. Insert the HP 1046A test cell, 01046-60017 into the flow cell compartment and shut the flow-cell compartment door.
5. Turn-ON the HP1046A.

You can now proceed to set the correct parameters for measurement.

6. Set the following on your HP 1046A:

```
RESPONSETIME = 1 ; 125 msec
PMTGAIN      = 10 ;
LAMP         = 1 ; 125 msec
ZERO         = 0
DELAY        = 0
GATE         = 0
SCANSPEED    = 1 ; 1.5 nm/sec
```

7. Set the following on your integrator:

```
ATTN        = 10
ZERO        = 10
CHARTSPEED  = 5
```

3.2.1 Calibrating a Monochromator

Excitation monochromator

The excitation monochromator is calibrated with the help of the test cell which contains a fluorescing glass. For the excitation and emission spectrum see figure 3.2.1-1 and 3.2.1-2. The excitation spectrum is used for the wavelength calibration with a fixed emission wavelength of 445 nm. The following procedure describes how to calibrate the monochromator on the first apex in the spectrum at 231 nm, see figure 3.2.1-1.

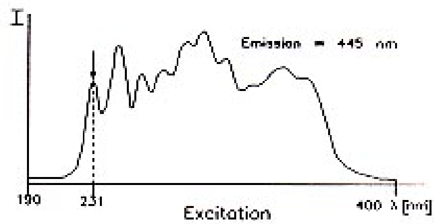


Figure 3.2.1-1

8. Enter a calibration constant of 0 for the exitation monochromator

   EXCALIB = 0 ; nm

9. Set the excitation monochromator at

   EXCITATION = 220 ; 220 nm

   and the emission monochromator at

   EMISSION = 445 ; 445 nm

10. Select the MONITOR display line and Using the ↓ or ↑ keys, scan the excitation wavelength up to 245 nm in 1 nm steps. After each step observe the F = intensity readings. You may have to adjust the PMT gain setpoint to get a proper intensity reading. If you have an HP 3390 Series Integrator the plot function may help you to find the maximum intensity.

11. The maximum intensity for excitation of the test cell should be at 231 nm. If your HP 1046A measures higher intensity at another wavelength, you need to enter a calibration constant. For example, if you have a maximum at 229 nm, then the difference between the actual value (229 nm) and the expected value (231 nm) is -2 nm.

12. Enter the new calibration constant for the excitation monochromator, see Operator's Handbook (01046-90000).

    EXCALIB = -2 ; nm

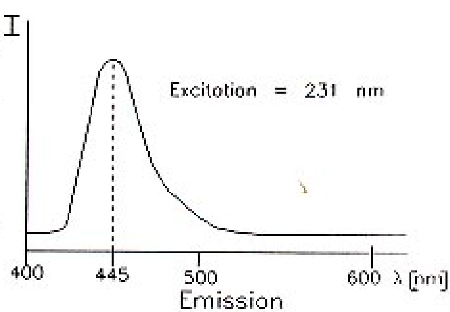


Figure 3.2.1-2

Emission Monochromator

Before you can calibrate the emission monochromator, you must first calibrate the excitation monochromator, see previous page.

The emission monochromator is calibrated with the help of stray light originated in the opaque glass body of the test cell. Figure 3.2.1-3 shows a stray light measurement with the excitation monochromator being held at 445 nm. The maximum stray light occurs when both monochromators select the same wavelength.

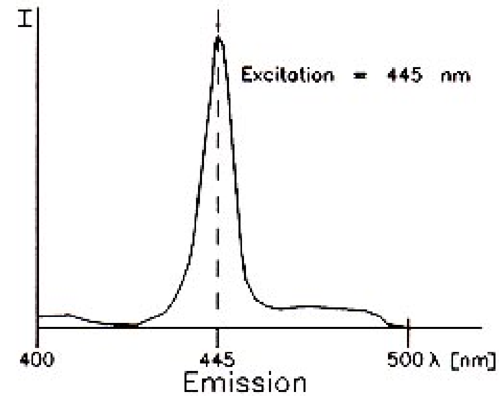


Figure 3.2.1-3

To calibrate the emission monochromator

13. Enter a calibration constant of 0 for the emission monochromator

```
EMCALIB     =     0  ;  nm
```

14. Set the excitation monochromator at

```
EXCITATION = 445    ; 445 nm
```

and the emission monochromator at

```
EMISSION    = 435   ; 231 nm
PMTGAIN     =  15   ;
```

15. Select the MONITOR display line and Using the ↓ or ↑ keys, scan the emission wavelength up to 455 nm in 1 nm steps. After each step observe the `F =` intensity readings. You may have to adjust the PMT gain setpoint to get a proper intensity reading. If you have an HP 3390 Series integrator, the plot function may help you to find the maximum intensity.

16. The maximum intensity for emission of the test cell should be at 445 nm. If your HP 1046A measures more at another wavelength, you need to enter a calibration constant. For example, if you have a maximum at 449 nm, then the difference between the actual value (449 nm) and the expected value (445 nm) is 4 nm.

17. Enter the new calibration constant for the excitation monochromator, see Operator's Handbook (01046-90000).

```
EMCALIB     =     4  ;  nm
```

Diagnostic 4.0

This section will give you general troubleshooting information. Please read this section carefully before you perform the troubleshooting procedures.

Power Distribution

All power lines except for the 24 V line have fuses on the fluorescence detector motherboard (FDM) and passive LED's (red) which light-up if a fuse is blown and voltage is still supplied from the main power supply board (MPS). Additionally, there are active LED's (green) on different boards to show which voltages are present. For more information, see LED Status on the next page.

The 24 V line is fused on the flashlamp power supply board (FPS). A passive LED (red) lights-up if the fuse is blown and voltage is still available from the main power supply board (MPS). If there is no voltage on the 24 V line supplied from the main power supply board (MPS), the Xe flashlamp will not flash and the two green LED's (TRIG and HV) on the flashlamp power supply board (FPS) will be OFF.

WARNING

When replacing the power supply boards please note that there is still high voltage on some capacitors unless the instrument has been turned-OFF for at least 5 minutes.

4.0 Diagnostic

Status LEDs

If the main power supply board (MPS) functions properly the following LED readings will be visible:

LED	Color	Location	Status
-35 V	green	KDM *	ON
+19 V	green	PPC board	ON
-19 V	green	PPC board	ON
+5 V	green	FDC board	ON
+24 V	green **	FPS board	ON
all	red LEDs		OFF

* POWER LED on the front panel;

** One of the green LED's on flashlamp power supply board (FPS) must be ON when 24 V are available.

Any other LED reading shows that there is a problem which may be traced back to the defective part. Refer to the first two troubleshooting procedures.

Controller

If the green LED, labeled IRQ-, on the fluorescence detector controller board (FDC) is OFF, a lock up has occurred in the CPU. If reset fails, follow second troubleshooting procedure.

> **WARNING**
>
> NEVER remove or replace printed circuit boards while the HP 1046A is turned-ON. Always use your antistatic workstation! Components are highly sensitive to antistatic discharge and will be damaged if you do not follow the procedure given on page 3-1.

The optical signal path can be followed from the lamp to the PMT step by step to isolate the defective item.

Lamp :

When the lamp power supply (FPS) and the lamp function properly, it is possible to hear the characteristic sound of the flash lamp. The lamp lifetime is typically > 1500 hours. The lamp glass window is gradually covered with a non transparent (metal) surface and the lamp intensity decreases slowly. The lamp intensity effects the detector signal to noise ratio. The **Sensitivity Performance check-out** procedure can be used to verify the detector performance.

Intensity of new lamps from stock may decrease rapidly 30% during the first 10 hours of operation. After 24 hours the lamp intensity drift is less than 0.3% hour. Therefore burn-in time of 24 hours after a lamp exchange is recommended.

> **WARNING**
>
> The lamp is under high internal pressure. Handle with care. Wear suitable protective devices to prevent possible injury, especially to hand and face areas.

EX Grating :

If the grating is not moving or if the position sensors have failed a clear error messages are shown on the display. The zero order position is verified every time after 'Stop Run' function. Use 'Stop Run' to troubleshoot the grating assembly. The 'Initialize Monocromators' function should not be used for troubleshooting, since all failure modes may not be detected. For diagnostics of the motor driver electronics the EX and EM grating cables can be interchanged to see if the problem moves (-> grating failed) or if it appears at the same grating (-> motor driver on the controller board failed).

4.0 Diagnostic

To check for correct zero order position set EX =0 (zero order), remove the flow cell, insert the test cell and open the upper cover of the cell compartment. The test cell transmits visible blue/white light. If no test cell is available put a piece of white paper in the cell compartment. A bright white light spot should be visible.

Flow cell :

Leaks or air bubbles may cause a weak or unstable signal. Remove the cell and check against light.

EM Grating :

See EX Grating diagnostic.

PMT and PPC board :

PMT or PPC board failures may cause a decrease of the sensitivity and signal to noise ratio of the detector.

There is almost no change that the PMT can become damaged in normal use. If the optical unit is opened when the instrument is turned-ON the performance of the PMT may degrade. Depending on the light intensity the damage may be permanent or the PMT will recover within a few hours.

The signal level of different photomultipliers may vary from instrument to instrument. Therefore only signal to noise ratio should be used to verify the instrument performance.

Verification of the signal to noise ratio and a short check of the sensitivity (using the test cell) is described in the section 4.2 .

The following troubleshooting procedures describe possible problems, conditions under which the problem may have arose, and activities which are recommended to solve the problem. Activities are listed in a way which has been kept as simple and precise as possible, i.e. if an activity fails to solve the problem, proceed with the next.

Problem: **General problems; any red LED ON**

Fuse of respective power line has blown. Main power supply board (MPS) still supplies voltage to this line.

1. Remove all boards in question. The list in chapter 2.4 (MPS) shows which voltages are used on which boards. Disconnect the leak sensor connector. (Short circuit of the leak sensor cable to the detector ground may cause the +19 V fuse to blow, when HP-IB is grounded via other devices.)
2. Replace fuse.
3. Insert one board after the other until you find the defective one. Exchange board and fuse.
4. Connect the leak sensor cable. If the fuse blows now, exchange the leak sensor assembly.

Problem: **General problems; LED's and/or display OFF**

- If the green LED (5V) on main power supply board (MPS) is OFF :
    1. Check line fuses.
    2. Exchange main power supply board (MPS), **see WARNING on page 4-1.**

- If the green LED (5V) on the main power supply board (MPS) is blinking there is an overvoltage condition on the 5V power line.
    1. Disconnect all boards and plug them in again until you find the detective one.
    2. Exchange main power supply board (MPS), **see WARNING on page 4-1.**

- If the green LED (5 V) on the main power supply board (MPS) is ON :
    1. Check green LED's on all boards: In case one LED is OFF, it indicates that the respective power line is defective on the main power supply board (MPS). Exchange main power supply board (MPS), **see WARNING on page 4-1.**
    2. Exchange fluorescence detector controller board (FDC).
    3. Exchange keyboard and display module (KDM).

4.1 Troubleshooting Procedures

Problem: `ERROR: leak detected;` however no leak

1. Leak sensor is touching nearby metal.
2. Exchange digital to analog converter board (DAC).
3. Exchange leak sensor.

Problem: `ERROR: leaksensor failed`

1. Exchange digital to analog converter board (DAC).
2. Exchange leak sensor.

Problem: **Leak contact closure without leak error message**

1. Exchange digital to analog converter board (DAC).
2. Exchange fluorescence detector controller board (FDC).

Problem: **Parameters lost when instrument turned-OFF, Battery backup failed**

1. Exchange battery (1420-0361) on the fluorescence detector controller board (FDC).
2. Exchange fluorescence detector controller board.

Problem: **HP-IB communication problems**

1. Check all HP-IB cable contacts.
2. Check for correct grounding.
3. Check the HP-IB cable contacts inside the HP1046A.
4. If intermittent HP1046A HP-IB timeout error messages are shown (Application error -138), exchange the main power supply (MPS).
5. Exchange the FDI board.
6. Exchange the FDC board.
7. Check other HP-IB interface boards and power supplies (LC, DAD ADC).

Problem: **No signal on integrator or recorder**

1. If a higher setpoint for ZERO does not result in a baseline shift on your integrator or recorder, measure the analog output voltage. If the signal does not follow the zero setting, exchange the digital to analog converter board (DAC). If the analog signal changes, but the integrator does not react the integrator or recorder or cables may be defective.
2. If the integrator follows the zero setting but peaks are missing or too low continue to the procedure : **Bad signal to noise ratio.**

Problem: `ERROR: EX/EM reference position`

There are two conditions for a HIGH on EXREF or EMREF input of the FDC. Only one of them indicates that an error was detected. If a HIGH is detected on the EXREF or EMREF line, either the reference position of a grating was found properly (no error condition), or a mechanical or electronical malfunction of the respective grating assembly occurred.
To differentiate between the reference position and a defective grating assembly, the controller tries to drive the grating out of the reference position. The controller now expects a LOW on the EXREF or EMREF line. If no LOW occurs, the sensor board of the respective grating assembly must be defective. To exchange it, see chapter 3.2.

1. Interchange cables from the excitation grating assembly and the emission grating assembly on the fluorescence detector motherboard (FDM) and observe operation (J12 and J22 are compatible). Do not forget to turn-OFF the HP 1046A before you exchange the cables.
2. If the same error occurs again, exchange fluorescence detector controller board (FDC).
3. If the error message occurs for the other grating assembly now, look for contact problems in the line between the grating assembly and the fluorescence detector controller board (FDC).
4. Exchange the grating assembly in question and perform a wavelength calibration. For more information, see chapter 3.2.

4.1 Troubleshooting Procedures

Problem: **Xe lamp does not flash or lamp intensity too low**

> **WARNING**
>
> There may be high voltage and charge on the Lamp Power Supply (FPS) board unless the instrument has been turned-OFF for at least 5 minutes.

> **WARNING**
>
> The lamp is under high internal pressure. Handle with care. Wear suitable protective devices to prevent possible injury, especially to hand and face areas.

> **WARNING**
>
> UV-light may injure your eyes ! Before you turn-ON instrument always insert the lamp to optical unit or cover it so that you can not look into it directly.

When the lamp and lamp power supply function correctly you can hear the characteristic sound of the lamp. To see if the light reaches the flow cell set the EX Grating to zero order position (**EX=0**), remove the flow cell and put a piece of paper in the cell compartment. A bright white light spot should be visible.

If the red LED on flashlamp power supply board (FPS) is ON, refer to troubleshooting procedure: **Any red LED ON**. Before you remove the lamp or lamp power supply read the safety information above.

Check the two green LED's on the flashlamp power supply board (FPS), see list below:

TRIG LED	HV LED	
OFF	OFF	1. Check NPS board for 5V LED. 2. Replace FPS board.
ON	OFF	1. Disconnect the Xe flashlamp and trigger assembly from FPS board. If the HV LED is ON now, exchange trigger assembly and lamp one by one to find the defective item. 2. Replace FPS board.
OFF	ON	1. Exchange FDC board. 2. Exchange FPS board.
ON	ON	1. Check the fuse F37 on the FPS board. 2. Exchange lamp, trigger pack and FPS board one by one to find the defective item. 3. If the lamp emits weak blue light instead of bright white light, exchange the lamp, trigger assembly and FPS board one by one to find the detective item.

If window of a lamp is covered with a whitesurface, attempt to clean the window with water and 2-Propanol first. If this is not successful exchange the lamp.

4.1 Troubleshooting Procedures

Problem: **Wavelength calibration entries exceed range which can be entered**

- Excitation grating assembly:

  1. Select zero order position for the excitation monochromator and remove the flow cell. Put a piece of white paper in the cell compartment to check if white light is imaged through the exit slit of the excitation monochromator. **Do not look into the light beam directly because it may injure your eyes.** If you do not see white light, loosen the hexagonal screw located on top of the excitation grating assembly, twist it a little clockwise or counter clockwise. Tighten the hexagonal screw, when you see maximum intensity on your piece of paper. Perform a wavelength calibration, described in chapter 3.2.

- Emission grating assembly:

  1. Loosen the hexagonal screw, located on top of the emission grating assembly, twist it a little clockwise or counter clockwise, tighten the hexagonal screw again. Perform the wavelength calibration, described in chapter 3.2. If the problem is not solved, go through the procedure again, twisting the emission grating assembly to the opposite direction.
  2. Exchange the grating assembly and perform a wavelength calibration. For more information, see chapter 3.2.

Problem: **Peaks saturated**

1. Verify that the PMT GAIN is not too high. Maximum signal is 99.99 F units (corresponds 1V or 100mV at analog output).
2. Verify the ZERO setting. ZERO values higher than 0 reduce the detector dynamic range (maximum analog signal remains 1V or 100mV).
3. If it is not possible to increase the signal on the detector display to 99.99 (e.g. the maximum signal is 30 F units) the PPC board may be defective. Exchange the PPC board.

Problem: **Bad signal to noise ratio or too high baseline level**

1. Check that the Xe lamp is flashing (characteristic sound). If the sound is not audible see procedure : **Xe flashlamp does not flash.**
2. Check for air bubbles or leaks in the flow cell. Hold the cell against the light to see whether there is a leak or whether air bubbles are in the cell.
3. Verify the cut-off filter wavelength. **The cut-off wavelength must be between EX and EM wavelengths.** See Operarator's Handbook, Appendix C and D.
4. Verify the PPC dark current compensation. Proceed as follows : Close the instrument cover. Turn the lamp-OFF.
   Set `GATE=10`, and `PMT GAIN=1`.
   The displayed C value should be now between 5 and 15. Now increase the PMT GAIN to 15. The C value should remain < 15. Increase the PMT GAIN to 18. Now the C value may slightly increase (stray light), but should still remain < 20 (in normal room temperature). If the C value does not remain stable when the PMT GAIN is increased, adjust the dark current compensation potentiometer on the PPC board. If the adjustment is not possible exchange the PPC board.

5. Check sensitivity of the detector :

5a. **If a Test Cell (01046-60017) is available:**
Insert the test cell. Insert slits : EX=2mm, EM1 and EM2=4 mm.
Enter the wavelengths:
`EX=250nm`, `EM=445nm`.
Increase the PMT GAIN until the displayed F value is between 50 and 100. Typical PMT GAIN value that is required is in the range 3 to 6.

If it is not possible to increase the F value up to 99.99 by increasing the PMT GAIN (signal saturated), exchange the PPC board.

If higher gain (PMT GAIN > 7) is required to reach 99.99 F units, exchange the lamp first and then the PPC board.

4.1 Troubleshooting Procedures

Problem: **Bad signal to noise ratio** (continued)

5b. **If the Test cell is not available :**
Use the **Sensitivity Performance Check-Out** (see chapter 4.2) to verify the detector sensitivity.

If it is not possible to increase the signal to 99.99 F units (see 4.2), exchange the PPC board.

If the signal to noise ratio is not as specified, exchange the lamp first and then the PPC board.

6. Verify the EX-Grating alignment. See procedure : **Wavelength calibration entries exceed the range which can be entered.**

Problem: **Instable or drifting peak areas**

1. Check solvent purity and degassing. Note that for example Oxygen (air) may suppress fluorescence (quenching).
2. Check that the wavelength and PMT GAIN time programming is adapted to retention time changes.
3. Check for air bubbles and leaks in the flow cell.
4. The intensity of a new lamp may decrease rapidly during the first 10 hours of operation (up to 30%). After 24 hours the intensity drift is < 0.3 % hour.
5. Verify that there are no intermittent EX or EM Grating positioning problems (error messages).
6. If the EX wavelength is 250nm +/- 25nm, peak area decrease may be caused by Ozone production in the optical unit. Let the lamp ON continuously.

This procedure describes how to check and verify the sensitivity performance of the detector in the field. The isocratic standard sample, 01080-68704, diluted in pure water has been chosen to keep the procedure as simple as possible. The procedure is independent of the used LC. A column or special solvents are not necessary.

In principle the check-out is based on measuring the emission of biphenyl spiked water against baseline noise obtained with pure water. To set suitable signal level the standard isocratic sample is diluted in concentration 1:10000 (vol.) in water. This corresponds approximately 8 μg biphenyl in 1 liter water (or 40 pg in the 5 μl flow cell).

The resulting signal to noise ratio must be greater than 40. The test has been designed to be conservative. Therefore the measured signal to noise ratio may be above 200.

In the published HP 1046A specifications the instrument signal to noise characteristics is specified in terms of amount of Anthracene which gives a signal equivalent to noise. This chek-out procedure is not identical to the Antharacene test. However, the signal to noise limit of this test has been selected so that detector which will pass this test will meet the specification.

This example procedure was developed for HP 1046A, HP 1090M LC system (ChemStation) or for HP 1090L with 339xA Integrator. However, it can be modified easily for HP 1046A and any other LC and/or integrator.

NOTE

Use HPLC pump to pump solvent through the detector. It is difficult to flush air bubbles out of the flow cell using a syringe.

If the measured signal to noise ratio is less than 40, check for air bubbles or leaks in the flow cell. Impure solvents (water) and incorrect cut-off filter increase the noise level as well.

To troubleshoot the hardware follow the optical signal path from lamp to PPC board to locate the defective item. See troubleshooting procedures (chapter 3.1).

4.2 Performance Check-Out

Preparation :

1. Check that the LC flow rate is stable. Use bidistilled water and flow rate of 1 ml/min. Flush all channels properly.

2. If you are using integrator or recorder as output device, connect analog signal and start/stop between the HP 1046A and the output device. Set the analog output voltage range to 1 Volt (switch on the DAC board).

   If you are using the LC ChemStation, connect the HP 1046A and LC HP-IB cables and configure the system.

3. The HP 1046A must have the following optical configuration :

Exitation slit	2x2 mm
Emission slit #1	4x4 mm
Emission slit #2	4x4 mm
Cut-off filter	280 nm

4. Connect the HP 1046A to the HP 1090 heat exchanger outlet using a capillary (at least 60 cm long) of maximum 0.25 mm i.d.

5. Program the HP 1046A as follows :

Exitation wavelength	246 nm
Emission wavelength	317 nm
PMT gain	14
Response time	4 (1 sec)
Lamp	1 (55 Hz)
Gate, Delay and Zero	0

   Program the HP 1090 as follows :

Flow	1 ml/min
% B	0
Number of injections	0 (no injections)

6. Turn on the solvent pump, switch the HP 1046A to the MONITOR display. Wait until the F value is stable. **Make sure that the F value is below 10.**

You may want to increase the flow rate (e.g. to 4 ml/min) to flush air bubbles out of the detector cell and speed up the flushing.

If the F value does not stabilize below 10 reduce the PMT gain to 13 or 12. If further reduction is necessary check again that there are no air bubbles or leaks in the flow cell, that the detector parameters have been set correctly and that the solvent is not contaminated.

After the F value fluctuations are less than +/- 0.15 the system is ready for the check-out.

7. During the LC and detector flushing prepare the test solvent. Add 0.01 vol. % of isocratic standard sample in bidistilled water. E.g. mix well 100 µl of the standard sample in 1 l water.

   Prepare always new solution. A sample that has been stored for longer than a few hours should not be used.

8. Set the detector PMT GAIN to suitable range:

   Place the bottle with the diluted test sample to channel B. Set %B = 100.
   (If you are using an isocratic pump, remove the bottle with pure water and replace it with with the diluted test sample.)

   Pump the test solvent through the detector until the F value is stable. The F value should be between 45 and 95. Reduce or increase the PMT gain if necessary to get the F value to the correct range. If you have to reduce or increase the PMT gain more than 2 steps check that the sample has been prepared correctly.

4.2 Performance Check-out

Check-Out Procedure :

The detector baseline noise is recorded with pure water first. After noise measurement the LC is programmed to run a step gradient from %A=100 (pure water) to %B=100 (diluted standard sample). The signal difference caused by the step gradient is measured. The signal to noise ratio is calculated based on the baseline peak to peak noise and the step height measurements.

1. Pump again pure water through the detector until the F value is stable and less than 10. The fluctuation should be less than +/- 0.15.

2. Time program the HP 1090 as follows :
   (at 3 minutes step from %A=100 to %B=100)

At 2.99 min.	%B = 0
At 3 min.	%B = 100
At 10 min.	Stop run

   If an isocratic pump is used the solvents have to be changed manually.

3. Time program the integrator as follows :
   (increase the attenuation from 6 to 10 at 2.5 minutes)

Zero	= 50	
Attenuation	= 6	(64mV/FS)
Chart speed	= 1	
Peak width	= 0.04	
Threshold	= 10	
Time 2.5 Attenuation	= 10	(1024mV/FS)
Time 2.5 Zero	= 0	

4. Start a run.

For other integrators and recorders :

Set for the noise measurement the integrator or recorder scale so that the peak to peak noise can be measured (approximately 64 mV full scale deflection). For the step response measurement set the integrator or recorder scale so that approximately 1 Volt signal causes full scale deflection. Convert the measured noise and step response to voltage and calculate the signal to noise ratio.

Data evaluation :

For HP 1090L and HP 339x integrator :

1. Measure the peak to peak noise (in mm) during the first 3 minutes of the run.

2. Measure the baseline offset (in mm) caused by the step gradient.

3. Calculate the signal to noise ratio and multiply the result with 16 (Attn 6 vs Attn 10) :

   S/N = 16 x signal [mm] / noise [mm]

   The figure 4.2-1 shows an example of signal to noise measurement.

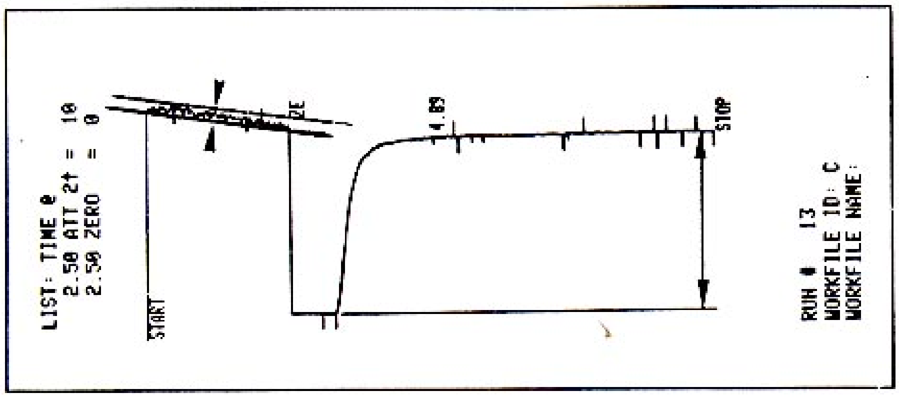


Figure 4.2-1

4.2 Performance Check-Out

For HP 1090M :

1. After run go to Data Editor and select the acquired rawdata file. Select the fluorescence signal (X) for evaluation.

2. Create a separate window in the right lower corner of the screen. (Use the DE command WINDOW 4.) See figure 4.2-2.

3. Zoom the first 3 minutes of the baseline trace to window 4. (ZOOM 4)

4. Make a copy to printer or plotter (SCREENPRINT or REDRAW).

5. Measure the peak to peak noise in window 4 (in F units). Then determine the step response between the lower and upper trace (in F units).

7. Calculate the signal to noise ratio :

   S/N = Step response [F] / Noise [F]

   Figure 4.2-2 shows an example of signal to noise calculation.

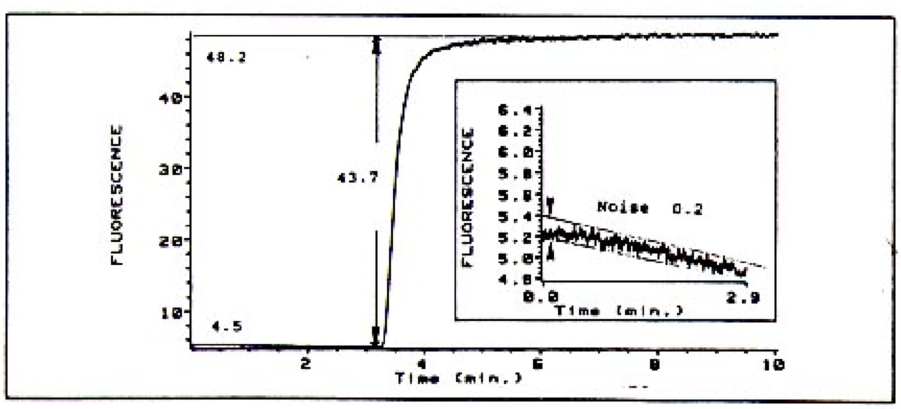


Figure 4.2-2

Connectors and Cables 5.0

ANALOG OUT

The **ANALOG OUT** connector provides either a 100 mV or a 1 V maximum signal output at the BNC connector, see section 5.0-1.

The full-scale voltage range of **ANALOG OUT** is set at the factory at 0 to 1 V. If you want to operate with a full-scale voltage range of 0 to 0.1 V, you will need to change the output range setting on the switch on the DAC board, see Operator's Handbook (01046-90000).

Available analog cables for the HP 1046A are listed below and on the following pages.

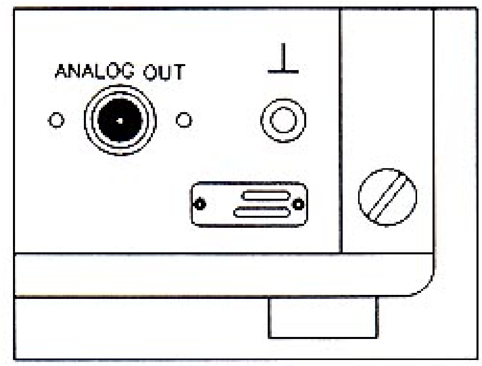
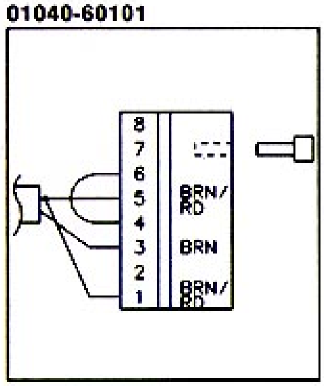


Figure 5.0-1

From HP 1046A to HP 3390/92/93A Integrator or to Signal Distribution Module 01090-60300

01040-60101

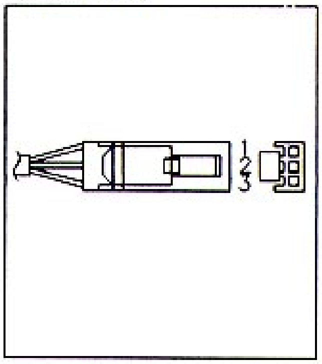


Pin 3390/2/3	Pin 1046	Signal Name
1	Shield	Ground
2		NC
3	Center	Signal +
4		connected to pin 6
5	Shield	Analog -
6		connected to pin 4
7		KEY
8		NC

5.0 Connectors and Cables

From HP 1046A to HP 3396 Integrator or to HP 35900 Dual Channel Interface

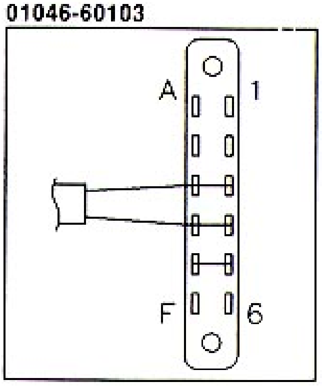
35900-60750



Pin 3394/6	Pin 1046	Signal Name
1		NC
2	Shield	Analog -
3	Center	Signal +

From HP 1046A to HP 18652A Analog to Digital Converter

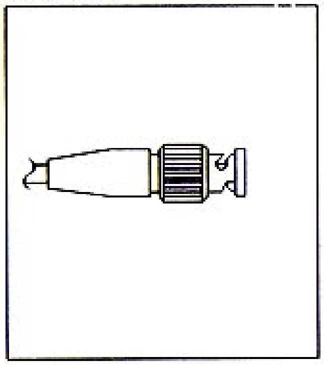
01046-60103



Pin 18562	Pin 1046	Signal Name
3	Shield	Analog -
4	Center	Signal +
F		KEY

From HP 1046A to HP 1082B/84B Liquid Chromatograph

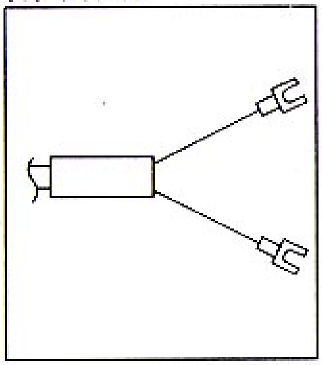
8120-1840



Pin 1084	Pin 1046	Signal Name
Shield	Shield	Analog -
Center	Center	Signal +

General purpose

01046-60105



Wire Color	Pin 1046	Signal Name
BLACK	Shield	Analog -
RED	Center	Signal +

5.0 Connectors and Cables

REMOTE

Both remote connectors are identical and connected in parallel.

The Prepare Run, Start and Stop are low active TTL level inputs.

The prepare run signal can be used with negative LAMP values to turn-ON the lamp just before a run. This prevents a calibration of the integrator at a time when the lamp is still turned-OFF, i.e. the analog out signal does not yet carry valid data.

If the detector is not ready it generates contact closure not ready signal. If the flow cell leaks, a shut-down signal is activated, which can be used to stop the solvent pump.

The table below lists signals which are used by the HP 1046A. For pin assignment see figure 5.0-3.

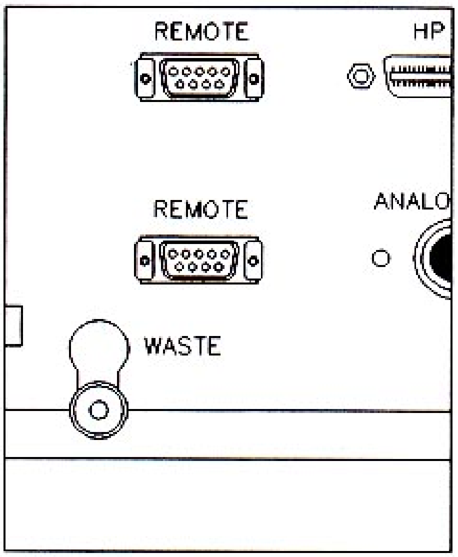


Figure 5.0-2

Pin #	Signal	
1	Digital Ground	
2	Prepare Run	Low active input
3	Start	Low active input
4	Shut Down	Contact closure output
5	N.C.	*
6	N.C.	(reserved for Power ON)
7	Ready	Contact closure output
8	Stop	Low active input
9	N.C.	(reserved for Start Request)

* on the FDM Rev. A board (HP 1046A s/n < 2702G00300) this signal was connected to the Digital Ground (DGND).

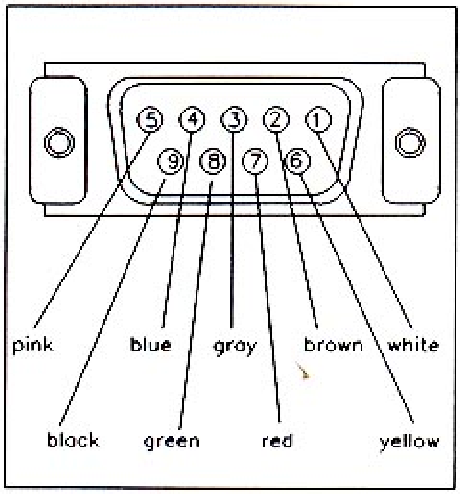
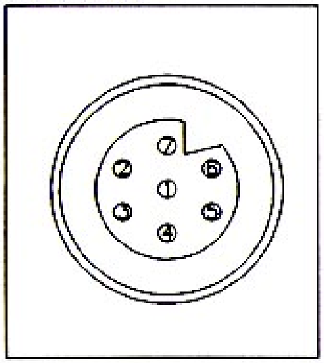


Figure 5.0-3

From HP 1046A to HP 3390A Integrator

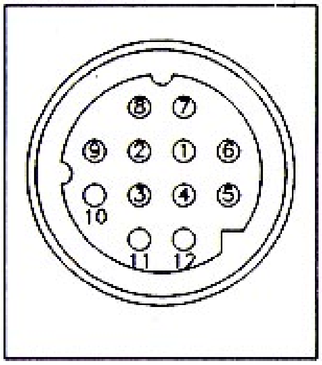
01046-60203



Pin 3390		Pin 1046	Signal Name	(Active)
2	WHT	1	Digital Ground	
NC	BRN	2	Prepare Run	(LOW)
7	GRA	3	Start	(LOW)
NC	BLU	4	Shut Down	(LOW)
NC	PNK	5	NC	
NC	YEL	6	NC	
NC	RED	7	Ready	(HIGH)
NC	GRN	8	Stop	(LOW)
NC	BLK	9	NC	

From HP 1046A to HP 3392/93A Integrator

01046-60206

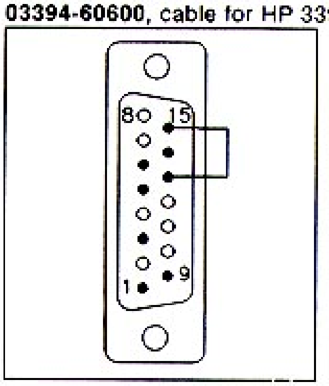


Pin 3392/3		Pin 1046	Signal Name	(Active)
3	WHT	1	Digital Ground	
NC	BRN	2	Prepare Run	(LOW)
11	GRA	3	Start	(LOW)
NC	BLU	4	Shut Down	(LOW)
NC	PNK	5	NC	
NC	YEL	6	NC	
9	RED	7	Ready	(HIGH)
1	GRN	8	Stop	(LOW)
NC	BLK	9	NC	

5.0 Connectors and Cables

From HP 1046A to HP 3394 Integrator or to HP 3396 Integrator

01046-60210, cable for HP 3394 integrator
03394-60600, cable for HP 3396 integrator

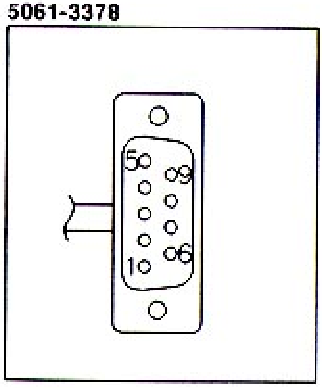


Pin 3394/6	Pin 1046	Signal Name	(Active)
9 WHT	1	Digital Ground	
NC BRN	2	Prepare Run	(LOW)
3*/3 GRA	3	Start	(LOW)
NC BLU	4	Shut Down	(LOW)
NC PNK	5	NC	
NC YEL	6	NC	
5, 14 RED	7	Ready	(HIGH)
3*/6 GRN	8	Stop	(LOW)
1 BLK	9	NC	

* HP 1046A START and STOP are connected via diodes to pin 3 of the HP 3394 .

From HP 1046A to HP 1050 HPLC Modules or to HP 35900 Dual Channel Interface

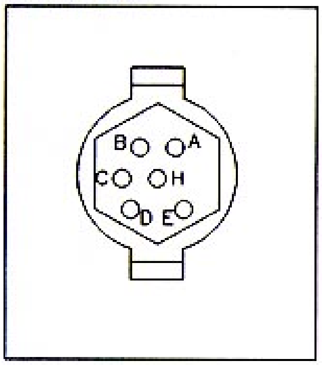
5061-3378



Pin 1050	Pin 1046	Signal Name	(Active)
1 WHT	1	Digital Ground	
2 BRN	2	Prepare Run	(LOW)
3 GRA	3	Start	(LOW)
4 BLU	4	Shut Down	(LOW)
5 PNK	5	NC	
6 YEL	6	NC	
7 RED	7	Ready	(HIGH)
8 GRN	8	Stop	(LOW)
9 BLK	9	NC	

From HP 1046A to HP 18652A Analog to Digital Converter

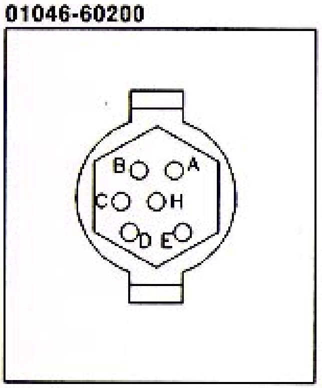
01046-60204



Pin 18562		Pin 1046	Signal Name	(Active)
B	WHT	1	Digital Ground	
NC	BRN	2	Prepare Run	(LOW)
C	GRA	3	Start	(LOW)
NC	BLU	4	Shut Down	(LOW)
NC	PNK	5	NC	
NC	YEL	6	NC	
NC	RED	7	Ready	(HIGH)
NC	GRN	8	Stop	(LOW)
NC	BLK	9	NC	

From HP 1046A to HP 1081B Liquid Chromatograph

01046-60200

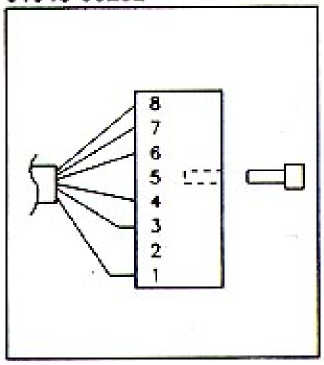


Pin 1081B		Pin 1046	Signal Name	(Active)
E	WHT	1	Digital Ground	
NC	BRN	2	Prepare Run	(LOW)
B	GRA	3	Start	(LOW)
D	BLU	4	Shut Down	(LOW)
C	PNK	5	NC	
NC	YEL	6	NC	
NC	RED	7	Ready	(HIGH)
NC	GRN	8	Stop	(LOW)
NC	BLK	9	NC	

5.0 Connectors and Cables

From HP 1046A to HP 1040 DAD, HP 1090 LC or to Signal Distribution Module 01090-60300

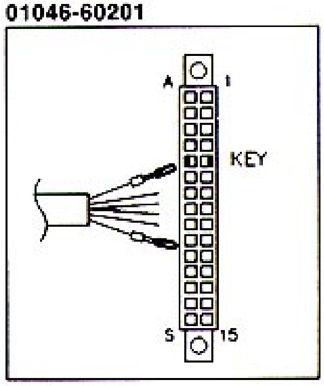
01046-60202



Pin 1090		Pin 1046	Signal Name	(Active)
1	WHT	1	Digital Ground	
NC	BRN	2	Prepare Run	(LOW)
4	GRA	3	Start	(LOW)
7	BLU	4	Shut Down	(LOW)
8	PNK	5	NC	
NC	YEL	6	NC	
3	RED	7	Ready	(HIGH)
6	GRN	8	Stop	(LOW)
NC	BLK	9	NC	

From HP 1046A to HP 1082/84 Liquid Chromatograph or General Purpose

01046-60201



Pin Universal		Pin 1046	Signal Name	(Active)
	WHT	1	Digital Ground	
	BRN	2	Prepare Run	(LOW)
	GRA	3	Start	(LOW)
	BLU	4	Shut Down	(LOW)
	PNK	5	NC	
	YEL	6	NC	
	RED	7	Ready	(HIGH)
	GRN	8	Stop	(LOW)
	BLK	9	NC	