Models 241 & 241 MC

Polarimeters

Operator's Manual

B 403 – A 3 – M 427/4.81 Printed in West Germany 994 993

PERKIN-ELMER

ATTENTION

BEFORE USING THIS INSTRUMENT IT IS ESSENTIAL TO READ THE MANUAL CAREFULLY AND TO PAY PARTICULAR ATTENTION TO ANY ADVICE IT CONTAINS CONCERNING POTENTIAL HAZARDS THAT MAY ARISE FROM THE USE OF ELECTRICITY.

This advice is intended to supplement, not supersede, the normal safety code of behaviour prevailing in the user's country.

ELECTRICITY

If any part of the instrument is not installed by a Perkin-Elmer Service Engineer, ensure that the line power plug is wired correctly:

Brown lead to live terminal,

Blue lead to neutral terminal,

Green/yellow lead to earth terminal.

To ensure satisfactory operation of the instrument it is essential that the green/yellow lead of the line power cable is connected to true electrical earth.

Even with the POWER switch off, line power voltages can still be present within the instrument; the instrument must therefore be unplugged at the line power supply before any work is undertaken inside it.

Servicing should be carried out only by a Perkin-Elmer Service Representative or similarly authorized person.

WARNING: This instrument is not designed for operation in an explosive atmosphere.

LAMPS

Do not touch a hot lamp or the adjacent area with unprotected hands. RISK OF BURNS.

Do not gaze into a lighted lamp to avoid possible DAMAGE TO THE EYES.

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1. INTRODUCTION

The Model 241 and 241 MC Polarimeters are compact, high performance instruments for the automatic measurement of the optical rotation of optically active substances. High accuracy, virtually fully automatic function and simple operation make the instruments ideally suitable for both research and routine applications.

The polarimeters operate according to the automatic optical null principle. Monochromatic light passes through the polarizer, the sample compartment and the analyzer to the photomultiplier. The polarizer and analyzer are orientated normally to one another in optical null position. When an optically active sample is introduced into the beam path, the analyzer is rotated by the servo system until optical null is again reached. The angle of rotation is measured by an optical encoder and the result is displayed on illuminated digits.

Additionally, optical rotatory dispersion (ORD) curves can be obtained in the Model 241 MC by manually selecting each wavelength successively.

It is not possible within the scope of this manual to give a detailed account of polarimetry. We therefore refer our readers to the works listed below.

Optical Rotatory Power.
T. Martin Lowry,
Dover Publications Inc., New York 1964

Grundlagen der Polarimetrie.
J. Flügge,
De Gruyter, Berlin 1970

Optical Rotatery Dispersion.
Carl Djerassi,
McGraw - Hill, New York 1960

Optical Rotatory Dispersion and Circular Dichroism in Organic Chemistry
G. Snatzke,
Heyden & Son, London 1967

Optical Rotatory Power and Circular Dichroism in Organic Chemistry
P. Crabbé,
Holden-Day, San Francisco 1965

Polarimetry, Saccharimetry and the Sugars.
Frederick S. Bates and Associates,
Circular of the National Bureau of Standards C440,
United States Government Printing Office, Washington 1942

ICUMSA Methods of Sugar Analysis.
H.C.J. de Whalley ed.,
Elsevier Publishing Company,
Amsterdam, London, New York 1964

ICUMSA
Report of the Proceedings of the 14th Session 1966

1.1. Equipment Provided

The Models 241 and 241 MC are delivered complete with all essential accessories and additional accessories according to choice. Please check your order against this list to ensure that it is complete and that no parts have been damaged in transit. In the event of damaged or missing parts please inform Perkin-Elmer and the authorized forwarding agent as quickly as possible.

For the Model 241 the delivery consists of:

1	Model 241 Polarimeter for either 50 Hz or 60 Hz operation as specified	
1	Dust cover	066 063
1	Set of hexagon (Allen) keys	019 061
10	Fuses 3.15A, slow blow (for 206-240 V operation)	061 975
10	Fuses 6.3 A, slow blow (for 115 V operation)	008 628
2	Hose connecting unions with retaining nuts	059 044; 057 375
5	Lamps, 6 V, for pushbuttons	059 764
3	Button caps, white	059 569
1	Button cap, red	059 570
1	Button cap, green	072 658
2	Snap-on hose connectors female	023 491
1	Instrument operating manual	094 993

For the Model 241 MC the delivery consists of:

1	Model 241 MC Polarimeter for either 50 Hz or 60 Hz operation as specified	
1	Mount for sodium lamp, complete with lamp	066 144
1	Mount for deuterium lamp, complete with lamp	066 155
1	Mount for halogen lamp, complete with lamp	066 166
1	Dust cover	066 064
10	Fuses, 3.15A, slow blow (for 206-240V operation)	061 975
10	Fuses 6.3 A, slow blow (for 115 V operation)	008 628
1	Set of hexagon (Allen) keys	019 061
1	Punch (for removing electrical connections on lamp mount)	067 432
2	Hose connecting unions with retaining nuts	059 044; 057 375
5	Lamps, 6 V, for pushbuttons	059 764

3	Button caps, white	059 569
1	Button cap, red	059 570
1	Button cap, green	072 658
2	Snap-on hose connectors female	023 491
1	Instrument operating manual	094 993

2. DESCRIPTION

2.1. Technical Data

Principle	Automatic polarimeter with optical null balance and automatic gain control.
Light sources	
Model 241:	Hg high pressure lamp; Na gas discharge lamp.
Model 241 MC:	Permanently mounted in lamp compartment: Hg high pressure lamp. Mounted on pre-aligned rapid change mounts: Na gas discharge lamp; deuterium arc lamp; halogen lamp.
Spectral lines	
Model 241:	Selectable with filter wheel; Hg 365 nm, Hg 436 nm, Hg 546 nm, Hg 578 nm, and Na 589 nm. Other filters on request.
Model 241 MC:	Na lamp (nm) 588.995 and 589.592 Hg lamp (nm) 253.652, 265.3 *, 280.350, 289.360, 296.764, 302.2 *, 312.566, 313.17 *, 334.148, 365.015, 365.483, 366.328, 404.66 *, 407.783, 434.750, 435.834, 546.074, 576.960, 579.066. (* effective centre of unresolved multiplets) Deuterium lamp 250 nm to 420 nm Halogen lamp 350 nm to 650 nm
Monochromator (Model 241 MC)	Littrow configuration with echelette grating 1440 lines/mm. Blaze wavelength 200 nm. Wavelength accuracy better than ± 0.5 nm. Reciprocal linear dispersion at 250 nm 1.7 nm/mm and at 600 nm 1.5 nm/mm. Slit width continuously variable from 0.005 mm to 3 mm. Automatic filter insertion above 530 nm.
Detector	Photomultiplier RCA 1 P 28 A 9902-9318 (RCA) 9902-9334 (Hamamatsu) CR34-0379 (Hamamatsu)
Polarizer and analyzer	Calcite Glan prisms
Modulation	by means of oscillating polarizer (50 Hz or 60 Hz); oscillating angle ± 0.7° approx.

Rotatory range	± 80°
Balance speed	1.3° per sec. (50 Hz) 1.5° per sec. (60 Hz)
Accuracy	± 0.002° for rotations < 1°, ± 0.2% for rotations ≧ 1°.
Sensitivity	Better than 0.002°
Reproducibility	Better than 0.002° (for zero and measurement reading)
Baseline deviation (241 MC)	± 0.006° over the entire spectral range.
Zero setting	Electronically by pushbutton at any desired point in the measurement range.
Readout	Five-digit seven bar 14 mm electronic display with polarity. Presentation in degrees of arc.
Readout accuracy	0.001°
Integration times	1 s, 5 s, 20 s and 50 s.
Printer output	Six decades (5 digits and sign) in BCD 8-4-2-1 positive code for TTL-compatible printers. Print command manual or automatic.
Recorder output (optional accessory)	Recorder readout unit with digital-to-analog conversion for connection of a chart recorder (10 mV or 10 V). Recording ranges ± 50°, ± 5°, ± 0.5°, 0.05°. Resolution 0.1%, or 1% for ± 0.05° range. Cyclic repeatability in all ranges.
Power requirements	115/206/220/240 V AC ± 10%; 50 ± 0.5 Hz or 60 ± 0.5 Hz; 350 W
Dimensions and weight	
Model 241:	950 mm wide x 280 mm high x 350 mm deep (37.5 in x 11 in x 14 in) approx. 50 kg
Model 241 MC:	1200 mm wide x 280 mm high x 590 mm deep (47.25 in x 11 in x 23.25 in) approx. 75 kg

2.2. Operating Principle

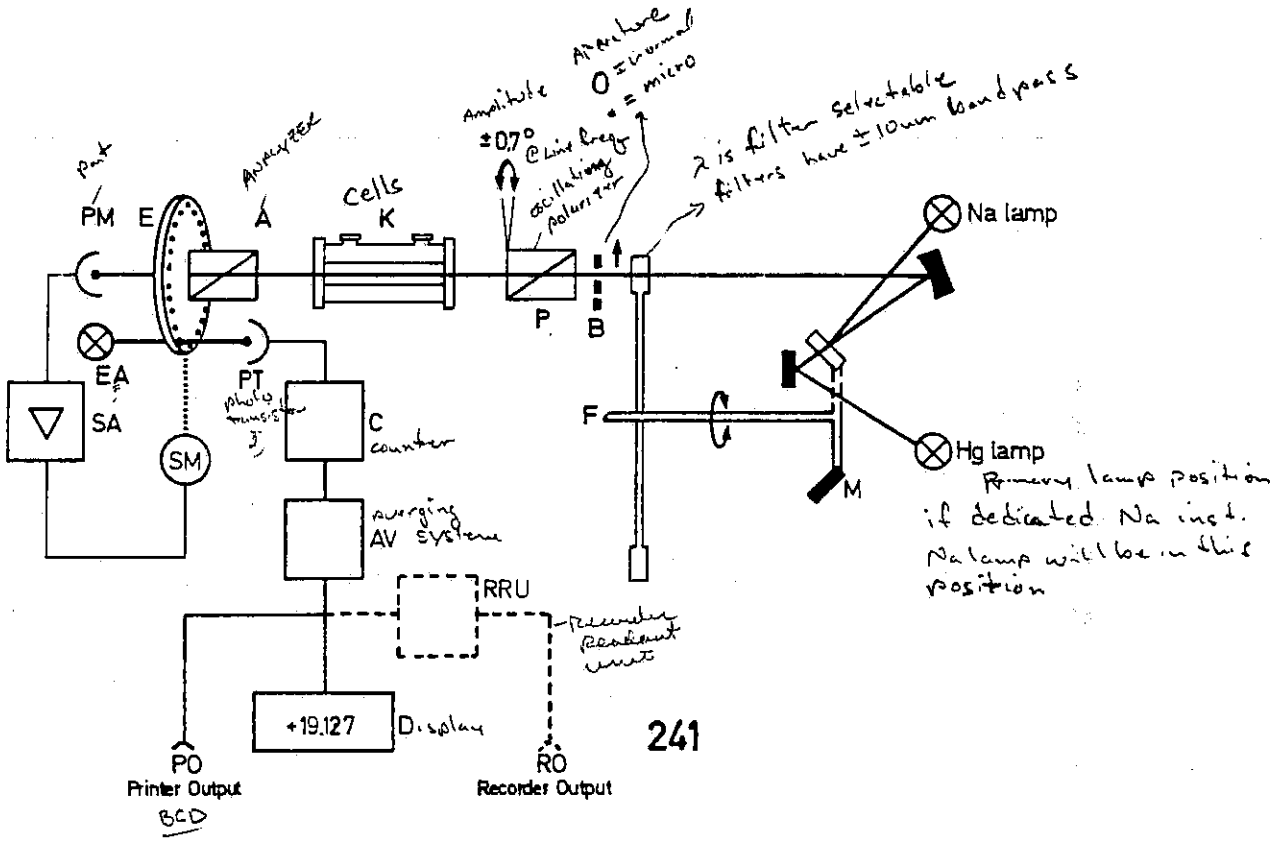


Figure 2-1. Block diagram of the Model 241 Polarimeter

The Model 241 is an automatic polarimeter operating on the optical null principle. Light from the mercury or sodium lamp is passed through a filter to select the desired wavelength. The mirror M is coupled to the filter wheel F so that upon selection of a filter the light beam of the corresponding lamp is automatically reflected along the optical path. The light beam then passes through the aperture B (selectable for standard or micro cells) to the polarizer P. The plane polarized light leaving the polarizer travels through cell K containing the sample and then through the analyzer A to the photomultiplier PM.

The polarizer oscillates with an amplitude of approx. $\pm$ 0.7° at the line frequency (50 Hz or 60 Hz). In optical null position the analyzer is orientated at 90° to the dynamic centre of the polarizer oscillation. As a result, the intensity of the light beam passing from the analyzer to the photomultiplier alters with a frequency of 100 Hz or 120 Hz respectively.

When an optically active substance is introduced into the beam, the mean direction of polarization is altered according to the optical rotation of the sample. The analyzer is then no longer at 90° to the mean direction of polarization of the incident light. In addition to the 100 Hz (or 120 Hz) signal at the photomultiplier, a 50 Hz (or 60 Hz) signal will appear whose size is dependent upon the optical rotation of the sample.

This 50 Hz (or 60 Hz) signal is selectively amplified at SA and used to drive the servo motor SM which rotates the analyzer until the 50 Hz (or 60 Hz) signal is cancelled, i.e. until the analyzer is at 90° to the new mean direction of polarization. The direction of rotation of the sample determines the phase position of this signal and hence the direction of rotation of the servo motor and analyzer. The gain of the servo system is automatically regulated via the supply voltage of the photomultiplier. Normally the supply voltage is controlled by the 100 Hz (or 120 Hz) component of the signal. At larger deviations from optical null position, the DC component of the photomultiplier output takes over the control in order to protect the photomultiplier from damage due to excessive irradiation.

Mechanically connected to the servo motor is a simple optical encoder formed from a perforated disc E, two lamps EA and two phototransistors PT. This encoder generates one pulse for every millidegree rotation of the analyzer. An up-down counter C counts these pulses with respect to the direction of rotation. The contents of the counter are automatically averaged by the signal averaging logic AV which, taking into account the response time of the servo system, calculates the integral of the rotation over the selected integration time. The absolute value and sign of the optical rotation are displayed in degrees of arc on the illuminated digital display D (+ for dextro rotatory and - for levo rotatory samples).

At the same time the displayed information is available at the printer output PO in BCD 8-4-2-1 positive code for TTL - compatible printers. Additionally, the information can be converted by an optional digital to analogue converter RRU (recorder readout unit) for the analogue readout on a 10 mV or 10 V strip chart recorder connected to the recorder output RO.

With samples having very high optical rotations (exceeding about 85°) the polarimeter will normally read the supplement. The opposite direction of rotation will then be indicated and the displayed value will be the difference between the actual value and 180°.

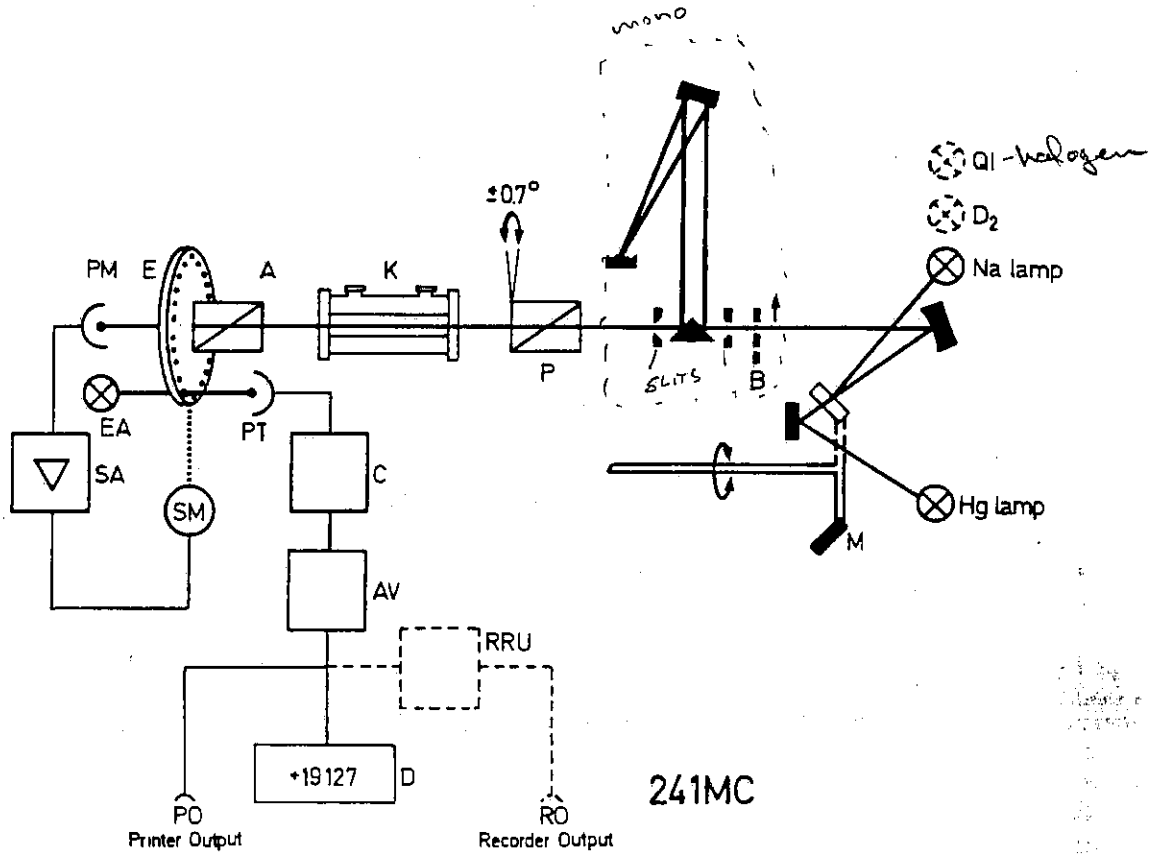


Figure 2-2. Block diagram of the Model 241 MC Polarimeter

The Model 241 MC is an automatic polarimeter operating on the optical null principle in an identical manner to the Model 241. Light from the chosen source is passed to a monochromator to select the desired wavelength. The mercury lamp is permanently built in; the sodium, deuterium and halogen lamps are mounted on pre-aligned rapid change mounts. The mirror M is coupled to the source selector so that the light beam of the corresponding lamp is automatically reflected along the optical path. The light beam then passes through the aperture B (selectable for standard and micro cells) to the monochromator where it is dispersed. At wavelengths above 530 nm a filter automatically swings into the light beam to eliminate higher grating orders.

2.3. Special Features of the Polarimeter

2.3.1. Automatic Gain Control

Gain control proceeds fully automatically within the instrument. The operator has no initial controls to set nor adjustments to make during a series of analyses.

2.3.2. Automatic Balance Control

Balancing of the instrument for stable and precise operation at very low light levels proceeds automatically when the sample compartment cover is opened. After closing the cover the control function is automatically repeated every three minutes and lasts for approximately seven seconds.

During measurements the balancing procedure will stop the analyzer servo for 7 seconds every three minutes. The continuously illuminated update lamp will then indicate that balancing is in progress and that the digital values should be ignored. At the end of the balancing procedure the analyzer will automatically continue to approach optical null.

2.3.3. Selectable Integration Times

Four selectable integration times are provided.

For normal work the 1 second integration mode is sufficient. With noisy signals, caused by strongly absorbing samples for example, the 5 sec. or 20 sec. integration modes should be employed. The 50 sec. integration mode is most conveniently used in conjunction with automatic printout (see below).

During rapid changes in optical rotation the instrument switches automatically to 1 sec. integration for the duration of the balancing.

2.3.4. Printer Output

The printer output is a standard provision on the Models 241 and 241 MC. The output, via a 30 pole receptacle on the rear panel, is in BCD 8-4-2-1 positive code for TTL-compatible printers.

Two modes of data printout are provided:

When the MAN. button (Pos. 8) is pushed the momentary value appearing on the display is printed once.

When the AUTO button (Pos. 7) is pushed the rotational values are printed out at the updating frequency (i.e. once a second in 1 sec. mode or once every 50 secs. in 50 sec. mode). Printout is stopped by releasing the button.

Except for fast kinetic reactions where rapid printout is required, the 50 sec. mode is recommended to prevent excessive printout of unrequired data.

2.3.5. Recorder Output *

Connections are provided on the rear of the instrument for 10 mV and 10 V recorders.

The recorder readout unit permits ranges of $\pm$ 0.05°, $\pm$ 0.5°, $\pm$ 5° and $\pm$ 50° to be selected for recorder full scale deflection.

Resolution is 1×10^{-3} for the $\pm$ 0.5°, $\pm$ 5° and $\pm$ 50° ranges and 3×10^{-3} for the $\pm$ 0.05° range. Apart from resolution limits, recorder readout is with the same accuracy as on the digital display. All ranges are cyclically repeated as explained under Section 4.8.3.

* The recorder readout unit is an optional accessory (it can also be retrofitted). On instruments not equipped with this option, the position on the front panel is blank.

2.3.6. Test Deflection

The test deflection is a positive and simple check of instrument performance and enables the instrument to be utilized in critical applications to its extreme performance limits.

Since with very strongly absorbing samples (i.e. energy meter reading close to zero) the performance of polarimeters gradually decreases, difficulties may arise in deciding whether the analyzer is correctly reaching optical null. By introducing a momentary deflection, the correct performance of the instrument can be positively and easily checked.

2.3.7. Automatic Lamp Ignition

The desired source lamp is switched on simply by pushing the corresponding button. Lamp ignition takes place automatically and the button lights when the lamp is burning.

NOTE: When the mercury lamp is switched off it must cool down before reignition is possible. If the lamp is switched on earlier, automatic ignition may take some time.

2.4. Operating Controls

Pos. 1	POWER	Pushbutton; power on/off. Button lights when power on.
Pos. 2	Na/CONT	Pushbutton; Na/CONT lamp on/off. Button light indicates lamp ignition.
Pos. 3	Hg	Pushbutton; Hg lamp on/off. Button light indicates lamp ignition.
Pos. 4	APERTURE	Two position control to select the aperture. 0 for standard cells; ° for micro cells.
Pos. 5	SOURCE/FILTER	Control wheel to select the desired source (Na or Hg lamp) and wavelength (Model 241). In position 0 the light beam is blocked.
Pos. 6	ZERO	Pushbutton; digital display (and where applicable recorder and printer) set to zero. Readout may be zeroed at any desired point in the measurement range.
Pos. 7	PRINTER CONTROL AUTO	Pushbutton; automatic printer control on/off. Display reading is automatically printed out at the updating frequency. Button lights in on position.
Pos. 8	PRINTER CONTROL MAN	Pushbutton; manual printer control. Momentary display is printed once.
Pos. 9	TEST DEFLECTION RIGHT	Pushbutton; introduces a small deflection of the analyzer to the right.
Pos. 10	TEST DEFLECTION LEFT	Pushbutton; introduces a small deflection of the analyzer to the left.
Pos. 11	ENERGY	Meter; indicates the light intensity falling on the photomultiplier.
Pos. 12	DEGREES	Seven-bar digits; actual rotation in degrees of arc displayed. + sign for dextro rotatory and - sign for levo rotatory samples.
Pos. 13		Illuminated indicator; indicates updating. The newest rotational value is displayed when the indicator goes out. The readout should be ignored when the indicator is illuminated.

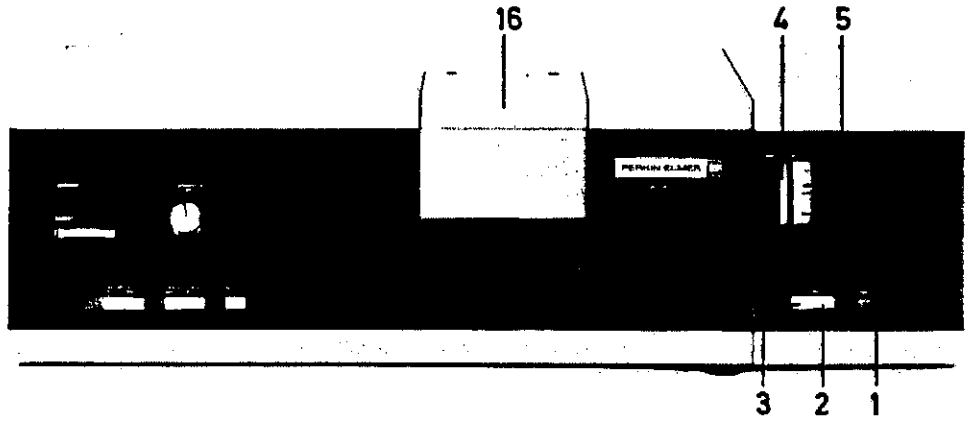


Figure 2-3. Model 241 Polarimeter

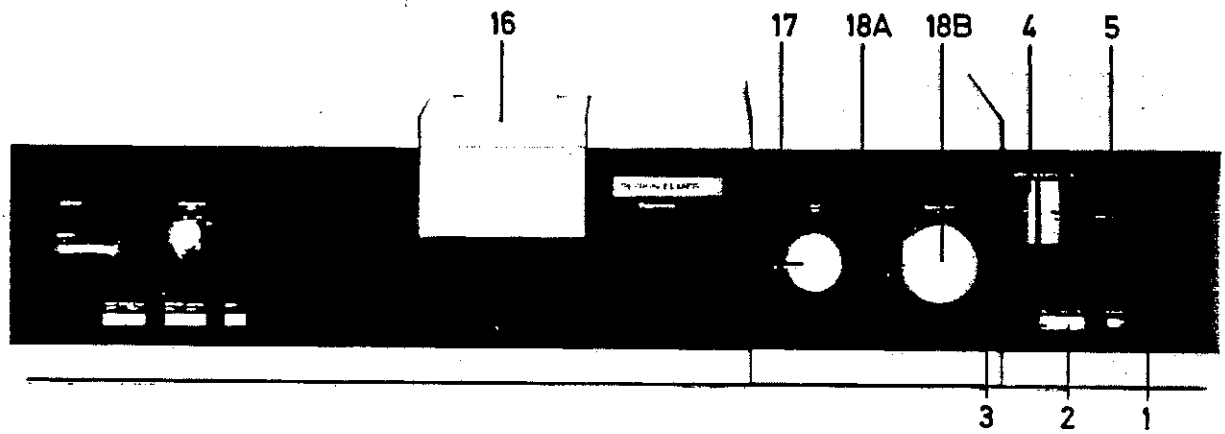


Figure 2-4. Model 241 MC Polarimeter

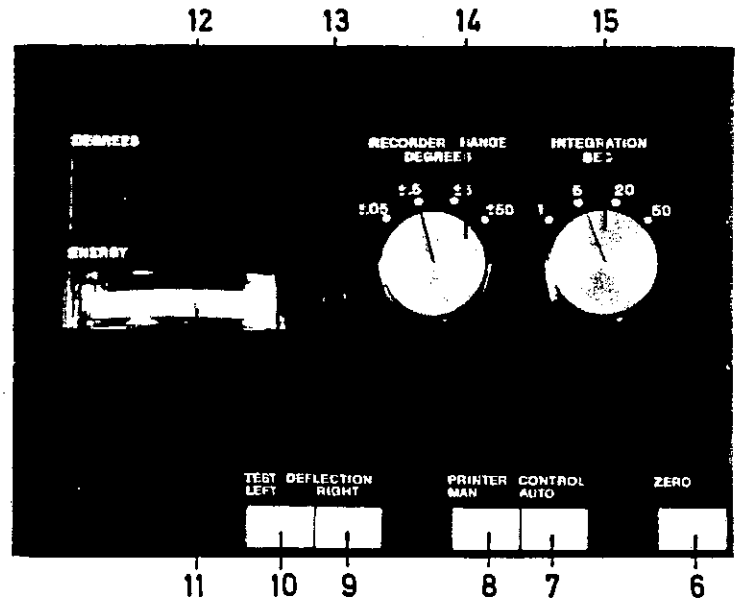


Figure 2-5. Front panel controls including recorder control

Pos. 14	RECORDER CONTROL *	Four-position rotary switch; selects recording ranges of $\pm$ 0.05°, $\pm$ 0.5°, $\pm$ 5° and $\pm$ 50°. (* Optional accessory. This position is blank on instruments not equipped with a recorder readout unit.)
Pos. 15	INTEGRATION	Four-position rotary switch; selects integration times (signal averaging) of 1 s, 5 s, 20 s or 50 s.
Pos. 16		Sample compartment cover. May be exchanged to accommodate certain sample handling accessories.
Pos. 17	SLIT	Slit control; variable control to select slit width continuously between 0.005 mm and 3 mm.
Pos. 18A	WAVELENGTH COARSE	Wavelength control; variable control for selecting wavelength between 250 nm and 650 nm.
Pos. 18B	WAVELENGTH FINE	Variable control for fine wavlength setting.

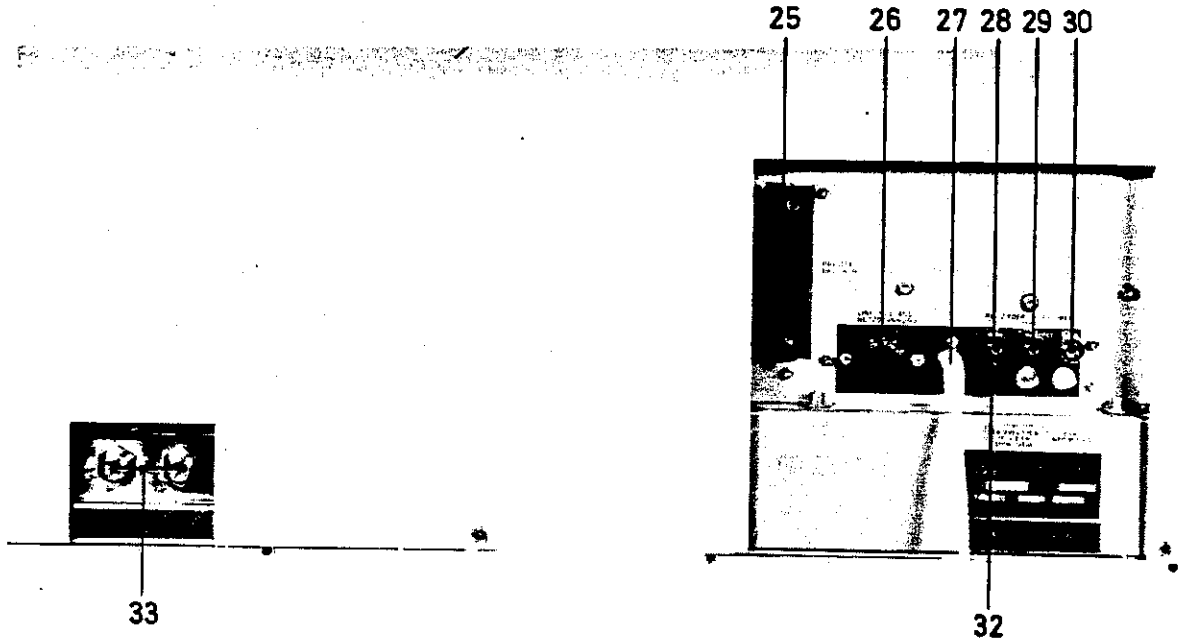


Figure 2-6. Rear panel connectors

Pos. 25	PRINTER	Output receptacle used to connect parallel BCD coded values to suitable accessory printers, etc.
Pos. 26	LINE VOLTAGE	Line voltage selector for 115, 206, 220, 230 Volts.
Pos. 27		Captive line power cable.
Pos. 28	RECORDER 10 V	Jack terminal for 10 V recorder.
Pos. 29	RECORDER 10 mV	Jack terminal for 10 mV recorder.
Pos. 30	RECORDER 0	Jack terminal, common ground for recorder.
Pos. 32		Line power fuse.
Pos. 33		Hose unions, for connection of a circulatory liquid thermostat.

3. INSTALLATION

3.1. Facilities Required

The Models 241 and 241 MC Polarimeters can be operated in any room under normal lighting, temperature and humidity conditions. For maximum stability and minimum maintenance, the instrument should preferably be installed in an area free from dust, smoke and corrosive fumes.

The Polarimeter should be placed on a sturdy bench. The working surface should be flat, reasonably level, clean, dry, and close to a suitable line power source. Bench space required by the Polarimeter and optional accessories is as follows (width x depth):

Model 241	950 mm x 350 mm
Model 241 MC	1200 mm x 590 mm
Strip Chart Recorder	500 mm x 500 mm approx.

Additional space is desirable to permit access to the rear of the instrument, and the accommodation of cables and possible future accessories. The Model 241 Polarimeter weighs about 50 kg and the Model 241 MC about 75 kg. Suitable benches are offered by Perkin-Elmer.

Electrical power should preferably be available at a proper earth-grounded 3-wire electrical outlet. Refer to the technical data for the electrical ratings of the instrument.

3.2. Unpacking and Inspection

The Polarimeter should preferably be unpacked and installed by a factory-trained dealer representative. After all items have been unpacked, check the contents against the packing list supplied. Save the shipping cartons and packing materials for possible future storage or re-shipment. Inspect the equipment and packing materials for signs of damage in shipment, and as soon as possible, make an operational check. If there is indication of damage, file a complaint with the carrier immediately, and contact your nearest Perkin-Elmer sales office or representative.

After the instrument has been unpacked, check the exterior and interior for possible damage as follows:

Check the entire outer cabinet for damage. Check that terminals, fuse holders, etc. are not damaged.

Open the sample compartment cover, checking that it operates freely without binding. The sample compartment must be free of dust or other foreign matter.

3.3. Installation Procedures

3.3.1. General

IMPORTANT: Do not connect the Polarimeter or accessories to the electrical power supply until instructed to do so.

The location chosen for the Polarimeter should be such that rays of sunlight or artificial light cannot shine directly into the sample compartment. A room well illuminated by diffuse light is the most suitable.

3.3.2. Electrical

Instruments are shipped from the manufacturing site as follows:

50 Hz instruments are set at 220 V, fuse 1 x 3.15 A and fitted with a German norm safety plug.

60 Hz instruments are set at 115 V, fuse 1 x 6.3 A and fitted with a U.S. standard parallel blade grounding type plug.

Check the specifications plate on the rear panel of the instrument to see that the frequency rating corresponds to the prevailing line frequency. Should this not be the case, contact your nearest Perkin-Elmer sales office or authorized dealer immediately.

Set the voltage selector on the rear panel to the prevailing line voltage as required.

Check that the correct power fuse is fitted in the holder.

The correct ratings are:

206 - 230 V	1 x 3.15 A, slow blow
115 V	1 x 6.3 A, slow blow

Check that the plug fitted to the line power cable is suitable for the local electrical outlets. Should this not be the case, remove the plug and fit an earthed plug conforming to the local regulations.

(Color code: Brown = live; blue = neutral; green/yellow = earth.)

3.3.3. Removing Shipping Clamp

Before the instrument can be put into operation, the shipping clamp must be removed (refer to figure 3-1).

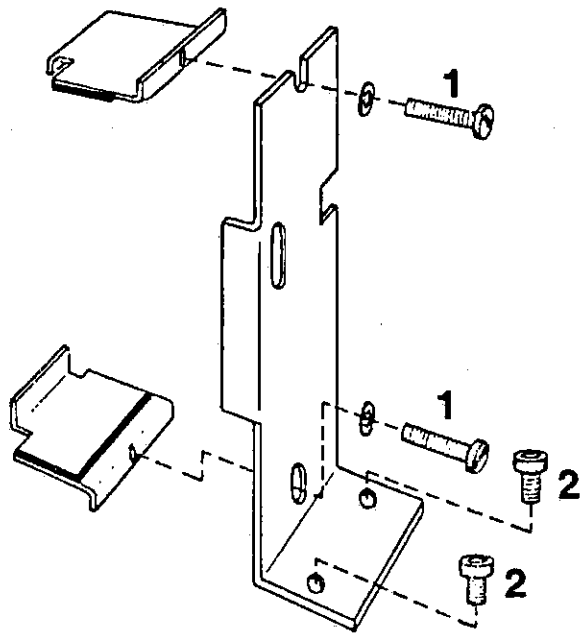


Figure 3-1. Shipping clamp

Pull off the left-hand decorative strip on the front panel.

Loosen the securing screws on the side and rear of the main instrument cover and then lift the cover vertically upwards.

Remove the rubber bands holding the worm drive gear assembly to the red shipping clamp.

Loosen the two screws 1 and slide the clamping plates away from the photomultiplier housing.

Undo the two bolts 2 and carefully remove the shipping clamp from the instrument.

Replace and secure the instrument cover.

Replace the decorative strip.

NOTE: The shipping clamp should be safely stored. If at any time the Polarimeter is to be transported or returned to the factory, the clamp should be replaced (see Section 7.3) to protect the sensitive analyzer drive system.

3.3.4. Connection of a Circulatory Thermostat

An external circulatory thermostat bath can be permanently connected to the Polarimeter by means of suitable hoses to the two hose unions on the rear panel (pos. 33). All hoses should be secured with hose clips.

The hose unions lead to two quick release fittings in the sample compartment. Snap-on connectors (Part No. 023 491) can be pushed onto the fittings to connect a cell to the thermostatting circuit (see figures 4-1 and 4-2). Valves in the fittings prevent leakage when the connectors are removed.

Further snap-on connectors and a circulatory thermostat bath are offered as optional accessories.

3.3.5. Connection of a Printer

Parallel to the reading on the instrument's digital display, data is available in BCD 8-4-2-1 positive code at the PRINTER outlet on the rear panel. The output is suitable for all BCD printers with TTL compatible positive true logic.

A Perkin-Elmer Model ES-6 Printer can be connected directly to the Models 241 and 241 MC Polarimeters. A connecting cable assembly 108 767 is required.

Connect the Model ES-6 Printer as follows:

Place the Printer in a convenient position adjacent to the Polarimeter.

Connect cable assembly 108 767 to the PCB edge connector at the rear of the Printer.

Lead the cable conveniently to the Polarimeter's rear panel and insert the connector into PRINTER receptacle.

IMPORTANT: Before connecting or disconnecting the Printer, always switch OFF Polarimeter and Printer and remove plugs from the electrical supply.

NOTE: To prevent inadvertent actuation of the Printer due to switching pulses, always switch ON the Polarimeter before the Printer, and switch the Printer OFF before the Polarimeter.

To connect other BCD printers to the Polarimeter, refer to the notes in Section 7.1.

3.3.6. Connection of a Chart Recorder

A laboratory chart recorder can be connected to instruments fitted with the optional recorder readout unit. Terminal jacks are provided at the rear of the Polarimeter for connection of 10 mV or 10 V potentiometric recorders.

Perkin-Elmer Model 56 Recorders are particularly suitable for use with the Models 241 and 241 MC Polarimeters. A connecting cable assembly 040 485 is required.

Connect a Model 56 Recorder as follows:

Insert banana plugs of the cable assembly into jack terminals on the Recorder as follows:

Red to H

Black to L

Green to G

Connect spade terminals of the cable assembly to the jacks at the rear of the Polarimeter as follows:

Red to 10 mV or 10 V jack (according to recorder range)

Black to 0 jack

Connect other recorders as follows:

Connect the positive lead of 10 V recorders to the 10 V jack (pos. 28).

Connect the positive lead of 10 mV recorders to the 10 mV jack (pos. 29).

Connect the recorder negative lead to the common jack 0 (pos. 30).

Perform any further installation procedures as detailed in the recorder manufacturer's instructions.

3.4. Available Cell Types

The following cells are offered for use in the Models 241 and 241 MC Polarimeters.

Type	Pathlength mm	Volume ml	Material	Part No.	Recommended use
Beaker cell (not thermostattable)	100	50	Glass	017 041	For rapid work at limited accuracy requirements where sufficient sample is available. The cells can be filled directly from a beaker. No syringe necessary.
Beaker cell (not thermostattable)	100	50	Quartz	023 363	
Standard cell	100	6.2	Glass	041 693	For normal work where sufficient sample is available.
Short path cell	10	0.50	Glass	017 052	For samples showing strong optical activity or absorption.
Short path cell	1	0.25	Glass	017 057	
Microcell	100	1	Glass	017 047	When little sample material is available. Quartz for UV range ($\lambda < 365$ nm).
Microcell	100	1	Quartz	023 365	
Short path microcell	10	0.1	Quartz	046 230	For samples showing strong optical activity or absorption when little material is available. Also for UV range.
Flowcell (not thermostattable)	100	5	Glass	017 050	For flow-through applications.
Flowcell (thermostattable)	100	5	Glass	017 054	For flow-through applications.
Funnel flowcell (thermostattable)	100	9	Quartz windows	086 157	For rapid and precise routine measurements when sufficient sample is available, and for flow-through applications.

Type	Pathlength mm	Volume ml	Material	Part No.	Recommended use
Pressure flow-cell (thermo-stattable)	100	9	Quartz windows	089 922	Special stainless steel version available for flowcell measurements at increased pressure.
ORD cells	0.2	0.25	All cells quartz	037 634	For critical applications requiring special path lengths, for measurements at 365 nm, or for measurements at increased temperatures (max. 200 °C)
	0.5	0.25		037 635	
	1	0.25		022 091	
	2	0.35		022 090	
	5	0.90		022 089	
	10	0.60		022 088	
	20	1.30		022 087	
	50	3.40		022 086	
	100	6.20		041 696	

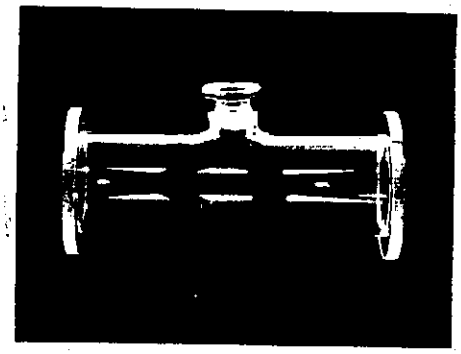


Figure 3-2. Beaker cell

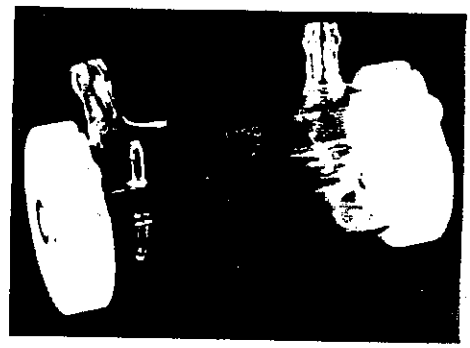


Figure 3-3. Standard cell

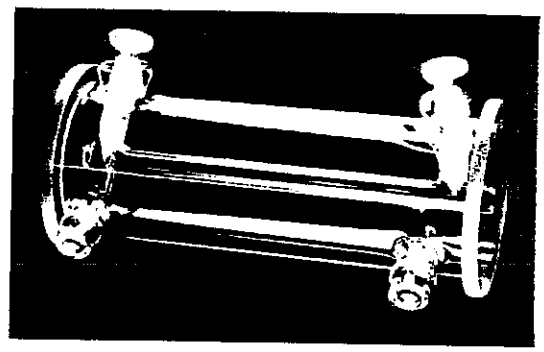


Figure 3-4. Microcell

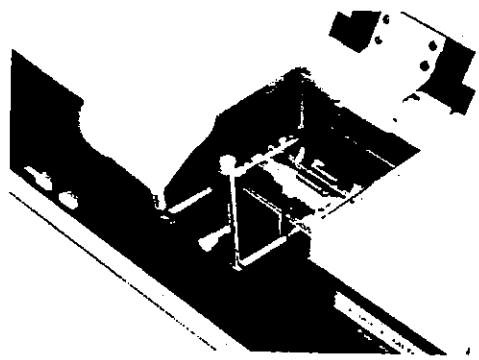


Figure 3-5. Funnel flowcell

4. SYSTEM SETUP AND OPERATION

4.1. General

Before operating the instrument for the first time, it is suggested that the analyst familiarizes himself with the operating controls, the handling of cells, and other aspects of the analysis.

It is assumed, in each of the operating procedures presented below, that the instrument is properly installed.

4.2. Initial Procedures

To put the Polarimeter into operation, proceed as follows:

Connect the Polarimeter to a suitable electrical outlet.

Press the red POWER button to switch the instrument on. The button lights. With the exception of the lamps the complete instrument is then energized.

When POWER is on the lamps can be switched on. Both source lamps can be switched on and operated simultaneously. Ignition of gas discharge lamps proceeds automatically.

To switch a lamp on proceed as follows:

Sodium or continuous lamp *	Push Na/CONT button. The button lights when the lamp is burning.
Mercury lamp	Push Hg button. The button lights when the lamp is burning.

* Continuous lamp only with Model 241 MC.

IMPORTANT: Allow 30 minutes warm-up time for Polarimeter and source lamps to reach temperature equilibrium.

NOTE: When the mercury lamp is switched off it requires 4 to 5 minutes to cool down before reignition is possible. If the lamp is switched on earlier, automatic ignition may take some time.

At the start of each working day (or work period) the Polarimeter should be put into operation as described above.

4.3. Handling of Cells

Cleanliness of the cell windows is of the utmost importance for highly accurate results. Finger marks and dust deposits due to static charges can lead to erroneous results. A list of cell handling rules is given in Section 5.1. For a detailed procedure for cell cleaning, please refer to Section 5.2.

Quartz cells should be used in the UV range ($\lambda < 365$ nm).

4.4. Cell Preparation Procedures

4.4.1. Filling the Cell

For precise polarimetric measurements correct cell filling is very important since streaks, temperature differences, and scattering at bubbles will lead to erroneous results.

Check the cell for cleanliness.

Fill the cell until liquid is about halfway up the filling port using a syringe. (No syringe required for beaker cells.)

Stopper the filling ports. Do not push the stoppers in forcefully, since otherwise the windows may burst.

Remove bubbles from cell walls and windows by tilting the cell.

Wait for several minutes to allow temperature differences between the cell and the sample to equalize.

Check for birefringent streaks and inhomogenity by looking through the cell. The view must be undistorted.

Check the cell periodically for bubbles if the sample is kept in the cell for any length of time.

4.4.2. Installing the Cell

Open the sample compartment cover.

Swing the lock catch to the rear and the retaining bar to the front.

Place the cell onto the sample compartment rails such that the notches point upwards to the rear.

Swing the retaining bar back and rotate the cell until the bar detents in the notches.

Slide the cell to the right hand stop.

Pull the lock catch forwards and engage over the retaining bar (refer to figure 4-2).

If thermostatting is required, push the snap-on connectors onto the fittings in the sample compartment, or lead the hoses through the guides in the sample compartment cover (refer to Section 4.4.3.).

Close the sample compartment cover.

NOTE: To protect the photomultiplier, the high voltage supply is switched off when the sample compartment cover is opened. The Polarimeter is immediately ready for operation when the cover is closed.

NOTE: When working with an empty sample compartment, swing the lock catch to the rear to prevent it obstructing the light beam.

A drain in the sample compartment will run off any spilt liquids. A sheet of thick filter paper can be placed under the instrument.

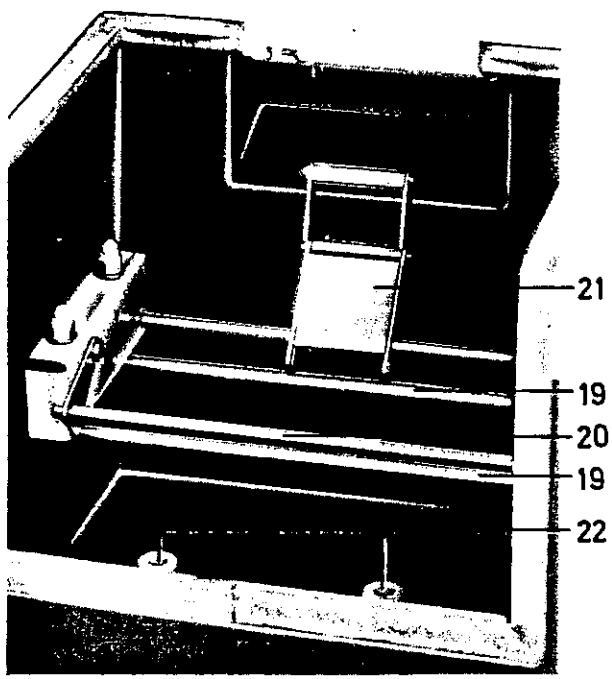


Figure 4-1. Sample compartment

Pos. 19 Sample compartment rails

Pos. 20 Retaining bar

Pos. 21 Lock catch

Pos. 22 Quick release fittings

4.4.3. Thermostatting the Cell

Optical activity is temperature dependent. For highly accurate analyses therefore, the cell must be thermostatted.

The cells are jacketed and can be connected to an external thermostat bath via the quick release fittings in the sample compartment. Valves in the fittings prevent leakage when the connectors are removed. Additionally, two guides are provided in the sample compartment cover through which hoses can be directly led to the outside. This is useful if, for instance, a sample connected to a second bath at a different temperature is to be measured, or if interruption of a thermostatting circuit must be avoided. The guides also permit flowcells to be installed in the sample compartment.

When not in use the guides should be closed with the sliding shutter (pos. 24) to prevent extraneous light from reaching the photomultiplier.

At higher temperatures (especially with volatile solvents) use bored stoppers, or leave one port unstoppered. Otherwise pressure build-up in the cell may cause the windows to burst. Avoid rapid changes in temperature. Please remember that gas or vapour bubbles can cause interferences to the measurement.

At temperatures below ambient, check the windows periodically for fogging.

IMPORTANT: Cells should be thermostatted for 10 or 15 minutes before measurements are made to allow temperature equilibrium to be reached.

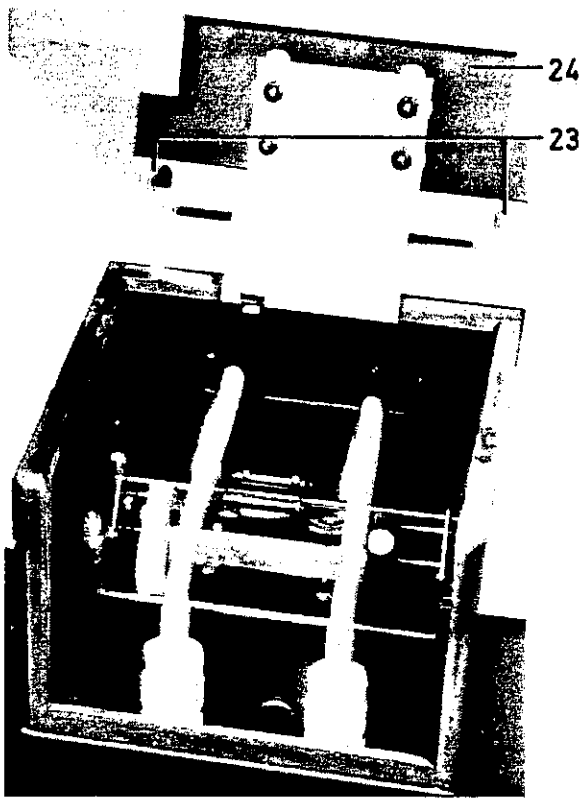


Figure 4-2. Cell installed in the sample compartment

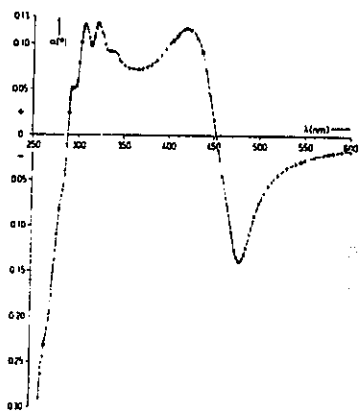
Pos. 23 Hose guides

Pos. 24 Sliding shutter

4.5. Selection of Source and Wavelength

For general analyses the use of the mercury lamp is recommended because of its very intense and precise spectral lines which permit accurate measurements even with more strongly absorbing samples. Use of the sodium lamp is mainly recommended when the results are to be compared with literature values based on the Na_D line. The Model 241 MC, besides having a larger choice of available spectral lines, offers additional continuous sources which emit radiation at all wavelengths within fixed ranges. These continuous sources are mainly used for the point-wise determination of ORD curves. The halogen lamp is employed in the range 650 nm to 350 nm and the deuterium lamp in the range 420 nm to 250 nm.

Please observe that for steep ORD curves the values obtained with a continuous lamp can be influenced by the limited accuracy of $\pm$ 0.5 nm of the monochromator calibration. In the case of samples with strongly wavelength dependent absorption, stray light can cause additional interferences. For exact determinations it is therefore recommended to double check the obtained ORD curve with spectral lines of the mercury lamp.



x = values measured with continuous source

o = values measured at mercury emission lines

Figure 4-3. ORD curve of an aqueous solution of d-camphor-quinone-10-sulphonic acid

4.5.1. Selection of Source and Wavelength: Model 241

Source and wavelength selection are combined on the same control wheel (pos. 5).

To select the sodium line, rotate the wheel to position Na.

To select one of the four mercury emission lines, rotate the wheel to positions 365, 436, 546 or 578 as desired.

In the position o the light beam is blocked.

Two spare positions marked Hg are provided on the wheel for other filters (see under Section 7.2 Additional Filters).

4.5.2. Selection of Source: Model 241 MC

The mercury lamp is permanently built in. To select the mercury lamp rotate the selector wheel (pos. 5) to position Hg.

The sodium, deuterium and halogen lamps are mounted on rapid change mounts. To install and select one of these lamps, proceed as follows:

Release the Na/CONT button to switch off a lamp already in use.

Press the lock button at the top of the panel on the right hand side of the lamp compartment and remove the panel.

Loosen the retaining thumb screw (pos. 45, figure 4-4) and withdraw the lamp mount.

CAUTION: The lamp may be hot. RISK OF BURNS.

Slide the mount with the selected lamp fully into the guide channel and tighten up the retaining thumb screw (see figure 4-4).

Replace the side panel and press the lock button.

Push the Na/CONT button to ignite the lamp.

Rotate the selector wheel (pos. 5) to position CONT-Na.

4.5.3. Selection of Wavelength: Model 241 MC

a) Spectral Lamps

The exact wavelength is set employing the intensity maximum of the respective spectral line. The sample compartment should preferably be empty.

Set APERTURE control to 0.

Set a slit width of approximately 0.5 mm to 0.1 mm with SLIT control (pos. 17) so that the exact setting of the desired wavelength is not influenced by neighbouring spectral lines (see table 4-1). If possible, reduce the slit width further to obtain a medium reading on the ENERGY meter (pos. 11) at the line maximum.

Set the desired wavelength with COARSE wavelength control (pos. 18A).

Carefully rotate the FINE wavelength control (pos. 18B) backwards and forwards to observe maximum reading on the ENERGY meter. Then adjust the control to obtain maximum reading, approaching the setting from the higher wavelength direction.

NOTE: Setting the wavelength by the above method is more accurate than using the wavelength scale directly since this can have a calibration error of approximately ± 0.5 nm.

NOTE: When several spectral lines are close together, scanning the appropriate range several times to identify the required line is recommended before performing the final setting.

b) Continuous Lamps

To compensate for slight backlash in the monochromator drive, the desired wavelength should always be approached from the higher wavelength direction.

Using COARSE wavelength control, set a value slightly above the desired wavelength.

Rotate the FINE control to bring the wavelength to the desired value on the scale for each individual measurement.

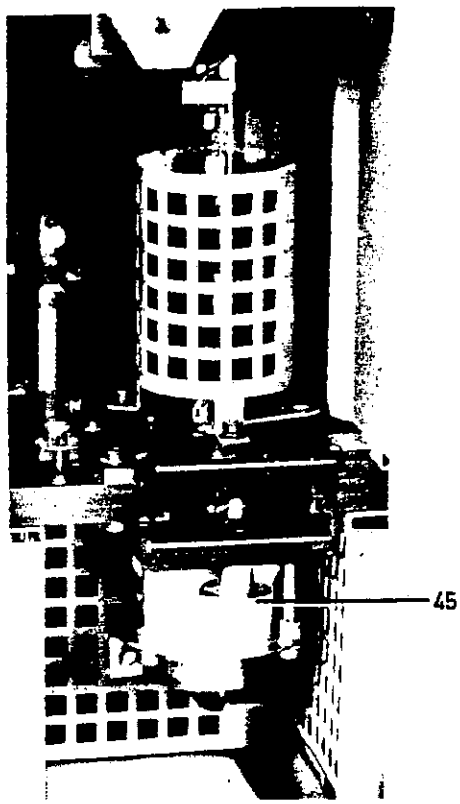


Figure 4-4. Sodium lamp installed in Model 241 MC

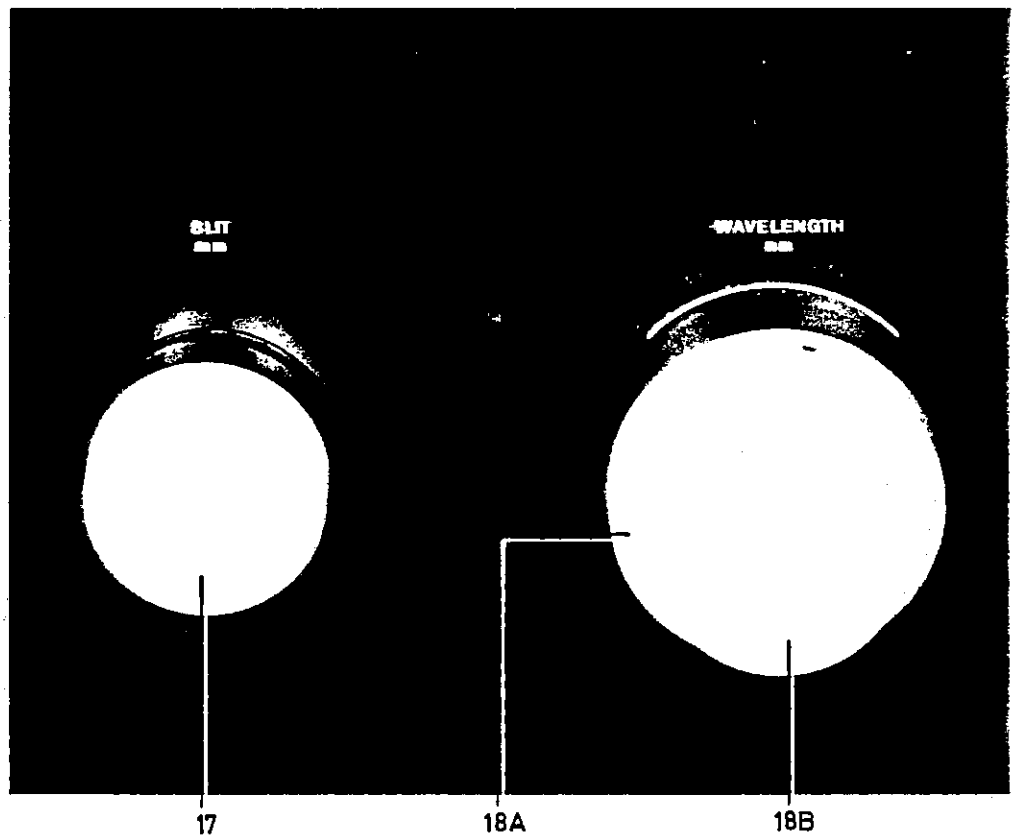


Figure 4-5. Slit and wavelength controls of Model 241 MC

4.5.4. Selection of Slit: Model 241 MC

The slit width can be set continuously from 0.005 mm to 3 mm with SLIT control (pos. 17). The required setting depends on the determination to be performed. To prevent errors, the following recommendations should be carefully observed.

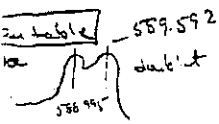
a) Spectral Lamps

Table 4-1. Maximum recommended slit widths for individual spectral lines:

Hg line nm	Slit width mm	Hg line nm	Slit width mm	Na line nm	Slit width mm
253.652	0.4	365.015	0.25		
265.3	3.0	365.483	0.25	588.995	* 0.5
280.350	3.0	366.328	0.45		
289.360	2.4	404.66	1.8	589.592	* 0.5
296.764	3.0	407.783	1.8		
302.2	3.0	434.750	0.5		(or 3 mm see text below)
312.566	0.3	435.834	0.6		
313.17	0.3	546.074	3.0		
334.148	3.0	576.960	1.4		
		579.066	1.4		

These slit widths should not be exceeded with samples having strong rotatory dispersion. With larger slit widths, neighbouring spectral lines can cause a shift in the centre of gravity wavelength, which in turn may result in noticeable measurement errors. For this reason, the minimum slit width in keeping with the available intensity should in general be chosen.

NOTE: When using the micro aperture the wavelength must be set with the greatest of care.



For normal use consider Na line @ 589.

* In most cases separation of the sodium lines is not required since measurements are mainly for comparison to reference values based on the doublet. The wavelength should then be set to the common maximum of both spectral lines by using a slit width which does not separate the two lines (generally greater than 1.5 mm). After the wavelength has been set the slit width should be increased to maximum (3 mm) to utilize full source energy. energy w/ .5mm slit will be <50
" " 3mm slit " " ≈80-60

** When using the micro aperture the slit width should not be wider than 1 mm.

b) Deuterium Lamp

The maximum slit width of 3 mm should be chosen to fully utilize the limited light intensity of the deuterium lamp. For samples that only show weak absorption the slit can be advantageously reduced in keeping with the available intensity.

When using the micro aperture the slit width should not be wider than 1 mm. The deuterium lamp is thus of limited use for measurements employing microcells.

c) Halogen Lamp

At wavelengths below 530 nm, slit widths of 0.5 mm to 1 mm are recommended for use with the halogen lamp. Narrower slit widths are only suitable for samples showing very low absorption. Wider slit widths can be employed, but the utilization of the resulting higher intensity reserves is not recommended for samples having strongly wavelength dependent absorption since the ratio of desired light to stray light usually becomes more unfavourable with increasing absorption.

At wavelengths above 530 nm the full slit width can be utilized since the automatic filter to remove higher grating orders also removes short wavelength stray light.

When using the micro aperture the slit width should not be wider than 1 mm.

4.6. Measurement of Sample Rotation

4.6.1. Selection of Aperture

Two apertures can be selected with the APERTURE control.

Select position O for standard cells. The beam diameter in the sample compartment is 6 mm.

Select position • for microcells. The beam diameter in the sample compartment is 2 mm, thus preventing cell wall reflections.

NOTE: When using the micro aperture, slit widths greater than 1 mm should not be selected in the Model 241 MC.

4.6.2. Selection of Integration Time

Four integration times can be selected with the INTEGRATION switch giving signal averaging over 1 s, 5 s, 20 s or 50 s.

Select 1 s integration mode for all normal samples.

Select 5 s or 20 s integration modes for samples which give rise to noisy signals.

Select 50 s integration mode mainly for use in conjunction with automatic printout.

NOTE: When switching to longer integration times the running signal averaging period is rapidly terminated. During rapid changes in optical rotation the instrument switches automatically to 1 s integration for the duration of balancing.

4.6.3. Measurement of Cell and Solvent Rotations

Many of the cells and solvents used in polarimetry have a small but nevertheless significant residual rotation. This rotation should be determined before the actual sample rotation when high accuracy is required.

Since residual rotation is also wavelength dependent, in principle it should be determined at all wavelengths at which the sample is to be measured. In practice, however, larger wavelength intervals than those at which the sample is measured may be chosen.

* P-E mfg cells do not have residual rotation due to extended design.

Select the same source, wavelength and aperture (and slit with the Model 241 MC) to be used for measuring the sample rotation.

Check for empty sample compartment, close the sample compartment cover and allow the instrument to come to optical null position.

Press the ZERO button to reset display to zero.

Install the cell (empty or filled with solvent) as given under Section 4.4.2.

Close the cover. Allow the analyzer to reach optical null position again and then note the reading for reference.

If the same cell is to be used for all subsequent measurements, press the ZERO button to zero the display. The cell or combined cell-solvent rotation is then automatically subtracted from all further measurements.

NOTE: When the cell is then removed and the cover closed, the analyzer will return to optical null position. The display will indicate the cell rotation, but with opposite sign.

NOTE: It is good practice to check the cell rotation periodically. Alterations in the rotation are often indications of contamination.

cells are mfg fo. P-E by Helma

4.6.4. Measurement of the Sample Rotation

Select source, wavelength and aperture (and slit with the Model 241 MC), allow the instrument to come to optical null position. Press the ZERO button if measurement of cell rotation has been omitted.

Fill the cell with sample and install it into the sample compartment.

Close the cover and allow the instrument to come to opticall null position. While the analyzer is rotating, the instrument operates in 1 s integration mode and changes automatically to the preselected mode when optical null position is reached.

Wait for temperature equilibrium to be reached if the cell is thermostatted.

Take the reading on the display. Correct the reading for cell rotation if necessary.

If the sample rotation is to be determined at more than one wavelength, set the next wavelength (change source if necessary) and allow the instrument to come to optical null position.

4.6.5. Use of the Test Deflection

With very highly absorbing samples (i.e. energy meter reading approaching zero) difficulties may arise in deciding whether optical null position has been correctly reached. This can be checked with the test deflection.

Proceed as follows:

1. For positive rotations.

   Briefly press the LEFT button (pos. 10).
   Note the stable value to which the display returns.

   Briefly press the RIGHT button (pos. 9).
   Note the stable value to which the display returns.
   If the display remains stationary and does not run back, press the RIGHT button again.

2. For negative rotations.

   As for 1 except that the RIGHT button is pressed first.

Interpretation of the test:

A) Digital display returns within noise limits to the same value from both directions. Energy sufficient and correct optical null reached.

B) Digital display does not return to the same value from both directions:

a) Energy too low, correct optical null not reached. Reduce the concentration or use a shorter pathlength and repeat the measurement.

b) When recommendations given under a) are not possible, estimation of the rotation can nevertheless be made. The stable values give the lower and upper approach limits to optical null. The mean of these values usually gives a good approximation to the sample rotation.

Due to small asymmetries in the servo system however, the correct rotational value will not necessarily be the exact mean. The half interval must be taken as the uncertainty factor.

4.6.6. Rotations Exceeding the Rotatory Range

The rotatory range of the Polarimeter is $\pm$ 80° for unambiguous readout on the display. Nevertheless, the analyzer can rotate approximately $\pm$ 130°, thus permitting samples with rotations of greater than 80° to be measured. With samples having very high optical rotations (exceeding about 85°) the Polarimeter will normally read the supplement. The opposite direction of rotation will then be indicated and the displayed value will be the difference between the actual value and 180°.

For rotations up to about 130°, supplement presentation can be avoided by a stepwise approach to the end value. By first using a second, intermediate sample, a displayed rotation not exceeding 80° but not differing from the actual sample by more than 80° is obtained (e.g. an intermediate value of 40 - 80° for an expected final value of 120°).

Following the digit 9, letters A, b, C, d appear in the first column to represent 10, 11, 12, 13 respectively (hexadecimal presentation).

At the end of the measurement the procedure must be performed in reverse to permit the analyzer to return to zero.

When working outside the normal range of $\pm$ 80° the analyzer drive may "bump" against the end stop and start to oscillate noticeably. Although this will not damage the instrument, it should not be allowed to continue. Re-establishment of normal operating conditions is simple, but requires a degree of caution.

Proceed as follows:

Immediately remove the sample.

Rotate the SOURCE/FILTER selector to 0 to block the light beam.

Operate both TEST DEFLECTION buttons to determine which one brings the analyzer away from the end stop.

Push the appropriate TEST DEFLECTION button for about 30 seconds to bring the analyzer away from the end stop.

Return the SOURCE/FILTER selector to the previous setting and check that the analyzer comes to optical null setting correctly.

If necessary, press the same TEST DEFLECTION button again for several seconds.

4.7. Operation with a Printer

It is assumed that the Printer has been installed and connected as given in Section 3.3.5. Controls on the Printer should be operated according to the manufacturer's instructions.

For manual printout of the reading, press the MAN. button. The momentary display value is printed once.

For automatic printout of the readings, press the AUTO button. The button lights and the displayed values are printed out automatically at the updating frequency.

To stop printout, press the AUTO button to release.

If a higher printing frequency is required for kinetic studies, the print interval can be reduced by selecting a shorter integration time.

Only the actual reading appearing on the display is printed. If the display has been zeroed by pressing the ZERO button, zero is the value correspondingly printed.

NOTE: The ES-6 prints a minus (-) sign but not a plus (+) sign. The readings of levo rotatory samples are prefixed by a minus; the readings from dextro rotatory samples are printed without polarity.

4.8. Operation with a Recorder

4.8.1. General

A strip chart recorder is the most convenient way of recording changes of optical activity with time. A recorder can be connected to instruments equipped with the optional recorder readout unit. This unit will be field installed by a Perkin-Elmer service engineer if bought at a later date than the Polarimeter.

In the procedures presented below, it is assumed that the Recorder has been correctly installed and connected as detailed in Section 3.3.6. Recorders should be operated in accordance with their manufacturer's instructions.

4.8.2. Recording the Optical Rotation

Set the Recorder zero and 100% as given in the manufacturer's instructions (disconnect the Recorder from the Polarimeter if necessary).

Select the desired recording range with RANGE control on the Polarimeter.

The displayed Polarimeter zero then corresponds to 50% scale on the strip chart, with equal ranges for both positive and negative rotations. Rotational values exceeding the selected range will be recorded cyclically (see Section 4.8.3).

Only the actual reading appearing on the display is recorded. If the display is zeroed by pressing the ZERO button, the recorder pen goes automatically to scale centre.

With multirange recorders, baseline shift to extend the recording range in a particular direction is possible with the recorder's range and zero controls. However, please note that this results in a somewhat poorer relation between the resolution limits of the readout unit and the recorder scale. Also, cyclic recording is no longer possible.

4.8.3. Cyclic Recording

Rotatory values exceeding the selected recorder range will be automatically recorded in cyclic mode. The following examples demonstrate cyclic recording.

Example 1:

Assume that the optical rotation of a sample changes with time as shown in figure 4-6a and that the selected recorder range on the Polarimeter is $\pm$ 0.5°.

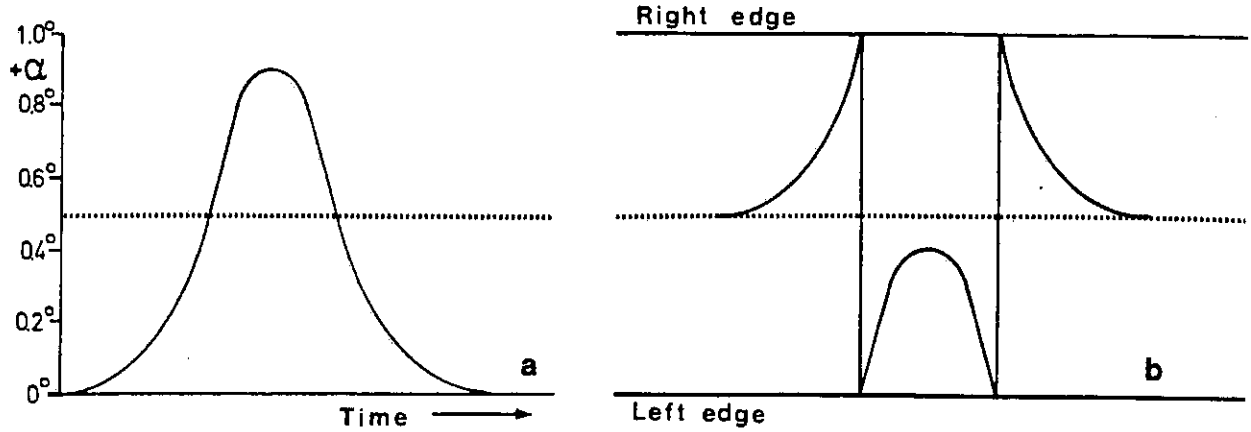


Figure 4-6. Principle of cyclic recording

Starting from the initial value on the display (in the particular example 0°), the recorder pen follows the increasing rotation until it reaches the right-hand edge of the chart. As soon as the rotation exceeds + 0.5°, the pen traverses to the left-hand edge and then continues to follow the change in rotation with the left-hand edge as the + 0.5° line. When the rotation decreases to + 0.5° again, the pen returns to the right-hand edge and continues to follow the rotation (depicted in figure 4-6b).

Full scale traverse of the pen always takes place when it reaches one of the chart edges (assuming correct setting of zero and 100% on the Recorder). Cyclic mode is very useful for recording small changes of relatively large rotations. These would otherwise require the selection of a larger recorder range, thus involving difficulties with baseline shift and with the accuracy and resolution.

Example 2:

Assume that the rotation of a sample varies with time as depicted in figure 4-7a and that a recorder range of + 0.5° has been selected on the Polarimeter. The optical rotation of the sample after a given time period, t, is to be determined.

Figure 4-7b depicts the tracing obtained on the chart. The tracing is divided into 1° intervals (an interval is the full width of the chart). To obtain the actual rotation at time t, proceed as follows:

Starting from the initial rotational value, follow the tracing until it reaches one edge of the chart. Then transfer the value corresponding to this edge to the other edge of the chart. This then acts as the basis for the next interval (in the example + 0.5°).

Continue this process until the interval containing the desired time point, t, is reached.

Read the rotation at the given point with respect to the obtained basis (in the example: basis + 0.5°; rotational value + 0.8°).

IMPORTANT: Please observe that for the recording ranges ± 0.05°, ± 0.5°, ± 5°, ± 50°, the length of the intervals are 0.1°, 1°, 10° and 100° respectively.

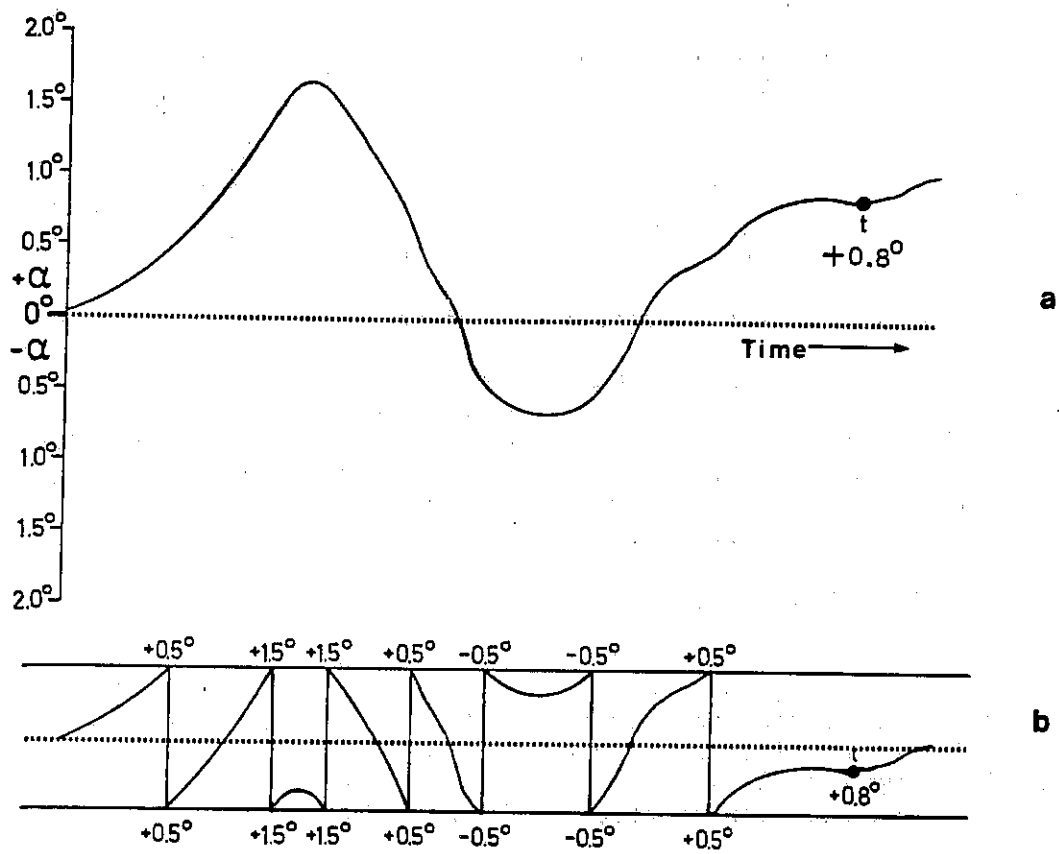


Figure 4-7. Determination of optical rotation from a cyclic recording

Example 3:

When a larger rotation is measured with a reduced recording range, initially the recorder pen will traverse so rapidly from edge to edge that the intervals can no longer be counted with certainty. When the change in rotation comes within the selected recorder range, the pen ceases to traverse rapidly and follows the change. The displayed reading on the Polarimeter at an arbitrary time point t_1 is taken (in this example + 51.624°) to establish the basis value of the interval (with a recorder range of $\pm$ 0.5° the basis value will be 51.5°). The desired rotational value can then be read from the chart (for example 52.10°).

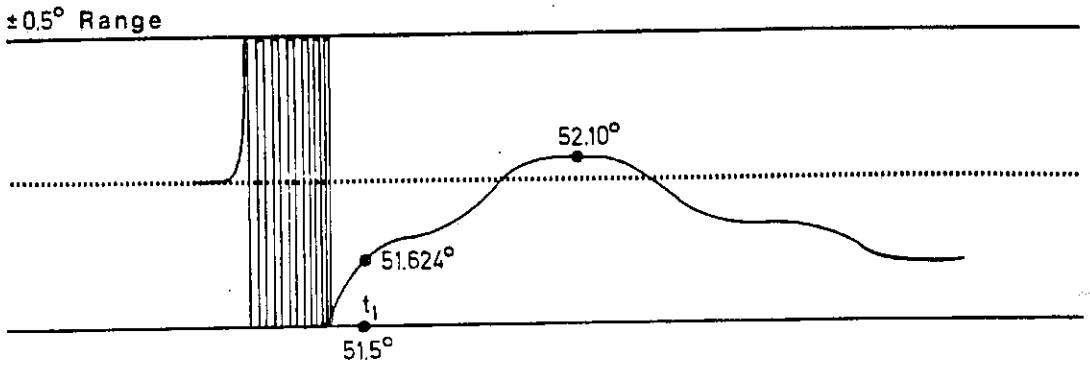


Figure 4-8. Recorder tracing of a large rotation

5. OPERATION NOTES

5.1. Use and Care of Cells

A good Polarimeter cell is an optical device, forming a part of the optical system of the instrument with which it is used. It must be accorded the same careful treatment applied to any optical component. Optical faults of a minor nature, scratches, lint, fingermarks, etc., can easily introduce substantial analytical errors.

The following list of cell handling rules must be followed to prevent analytical errors and achieve the utmost precision.

Only hold cells by non-optical surfaces.

Protect cells from scratches and never permit them to rub against one another or against other hard surfaces.

Avoid abrasive or stain-producing cleaning agents, and make certain that the exposed surfaces of cells are optically clean.

Always wipe the optical surfaces of cells dry and free of fingermarks, using a soft cloth or cleaning tissue, just before placing them in the sample compartment.

When measuring cold solutions, always bear in mind that condensation can form on the cell windows.

Make certain that no bubbles cling to the inner surface of the cell, particularly when handling cold solutions.

5.2. Cell Cleaning Procedures

Cells should be cleaned after every analysis to remove sample residues. The cleaning procedure will depend upon the nature of sample and solvent. The following procedures are general recommendations only.

In general, the cell should be thoroughly rinsed out with the same solvent as used for the sample, and then dried. This is especially valid for organic solvents.

Aqueous solutions are best washed out with a stream of luke-warm water. The cell should finally be rinsed with deionized water to prevent drying marks.

After the analysis of proteins, the cell should first be washed out with an 0.5% solution of hydrochloric acid (pH 1 to 2) containing a pepsin additive of 1 g per 100 ml.

Heavy metal residues are effectively removed by washing the cell with slightly warm (but no hotter), analytical grade nitric acid. (Initial washing of the cell with water is essential.) Subsequently, the cell should be washed with deionized, heavy-metal-free water.

For cells that have became contaminated, cleaning in chromic acid is recommended. The following procedure should be performed with caution, taking into account the safety requirements for handling chromic acid.

WARNING: To prevent damage to the cell and risk of injury to yourself, never pour water into chromic acid.

WARNING: To protect the highly polished cell windows from damage, never leave the cell in chromic acid for longer than 1 hour and never place the cell in hot acid (max. 35 °C).

Empty the cell and wash well with water.

Dry the cell thoroughly (considerable heat is liberated when chromic acid contacts water).

Place the cell in an acid bath (max. 1 hour). If required, rinse the inside of the cell separately with acid.

Remove the cell from the bath, empty and allow most of the acid to drain off.

Rinse the cell thoroughly in a stream of running cold water.

Rinse the cell well with deionized water and then dry with dust and oil free air.

Flush the outsides of the windows with alcohol and dry with a soft, lintless cloth or lens tissue.

For storage, always place the end caps on the cell, and replace the stoppers to prevent dust reaching the inside of the cell.

6. MAINTENANCE

6.1. Daily Care

The instrument is carefully contructed with high quality components and requires little maintenance other than to keep it clean and free of dust.

The instrument finish is resistant to dilute acids and alkalies, aromatic and aliphatic solvents, and to a lesser extent to strong acids and alkalies, and ketones. The digital display and pushbuttons should not come into contact with ketones.

To protect the optical system from dust and fumes, the sample compartment cover should be kept closed when no work is being carried out in the compartment.

The following practices form a daily care routine which will maintain the instrument in good condition.

Immediately clean all spilled materials from the affected area and wipe it dry with lintless paper or cloth.

Do not leave samples, particularly those given to evaporation or fuming, in the sample compartment for longer than is necessary.

When the instrument is not in use for longer periods (e.g. overnight), put on the dust cover.

NOTE: Always make certain that the Polarimeter is switched OFF before putting on the dust cover.

6.2. Cleaning the Sample Compartment

The sample compartment should be cleaned every time anything is spilled into it to preserve the black matt finish and to prevent corrosion or contamination. The bottom of the compartment is equipped with a drain which will run liquids off to the bench top underneath the instrument. A sheet of thick filter paper can be placed under the instrument.

First remove the cell or other sampling accessory in the sample compartment.

Using a soft cloth and soapy solution, lightly scrub away all foreign material. Using a clean soft cloth dampened with water, rinse the cleaned surfaces thoroughly. Dry with a lintless cloth or tissue.

6.3. Source Lamp Replacement

This operation should only be performed by suitably qualified personnel. In case of difficulties, contact your nearest Perkin-Elmer service department.

WARNING: Switch OFF the Polarimeter and remove the plug from the electrical supply before starting these procedures.

6.3.1. Mercury Lamp Replacement: Models 241 and 241 MC

Refer to the figures on page 6 - 5.

Loosen the securing screws to the side and rear of the lamp compartment cover and carefully lift the cover off vertically.

If the old lamp was lighted, allow it to cool down before proceeding with the replacement.

Undo socket head bolts (pos. 37) and remove the cover plate.

Undo socket head bolts (pos. 39) and remove the metal shield cylinder (pos. 38).

Unscrew the haxagon posts (pos. 40) and remove the centering plate (pos. 41).

Push the mercury lamp down into the bayonet holder, turn it counter-clockwise and withdraw it.

Holding the new mercury lamp in a soft cloth to prevent finger marks, push it lightly into the bayonet socket and turn clockwise to the stop. The lamp must be so inserted that the support bar must point away from the source mirror (pos. 43).

Wipe the lamp bulb with a soft cloth moistened with alcohol to remove any dirt, since this would subsequently be burned into the quartz bulb.

Replace the centering plate and screw in the two hexagon posts.

Replace the metal shield cylinder, but do not secure the socket head bolts.

Replace the cover plate and tighten up the two socket head bolts.

Connect the Polarimeter to the electrical supply and switch ON.

WARNING: Electrical components that constitute a SHOCK HAZARD are exposed when the lamp compartment cover is removed. When performing alignment procedures, do not touch electrical components to PREVENT INJURY to yourself and damage to the instrument.

WARNING: Do not gaze into a lighted lamp to prevent possible INJURY TO THE EYES.

Turn the metal shield cylinder so that the source mirror (pos. 43) and especially the lamp compartment exit aperture are fully illuminated.

Secure the two socket head bolts (pos. 39).

Switch OFF the Polarimeter and remove the plug from the electrical supply.

Replace the lamp compartment cover and tighten the securing screws.

This completes the installation of the mercury lamp.

6.3.2. Sodium Lamp Replacement: Models 241 and 241 MC

For the Model 241, loosen the securing screws to the side and rear of the lamp compartment cover and carefully lift the cover off vertically.

For the Model 241 MC, remove the lamp compartment cover panel, loosen the securing thumb screw and draw out the lamp mount.

Unscrew the old lamp (pos. 34) from its ceramic holder (pos. 35). If the old lamp was lighted, allow it to cool down before proceeding with the replacement.

Holding the new lamp in a soft cloth to prevent fingermarks, carefully push it down through the support springs and screw it into the ceramic socket.

The electrode support rod in the lamp must not obstruct the light path. If required, loosen clamp screw (pos. 44) and turn the ceramic holder.

Wipe the lamp with a soft cloth moistened with alcohol to remove any dirt, since this would subsequently be burned into the glass.

For the Model 241 MC, install the lamp in the lamp compartment.

Connect the Polarimeter to the electrical supply and switch ON.

WARNING: Electrical components that constitute a SHOCK HAZARD are exposed when the lamp compartment cover is removed. When performing lamp alignment procedures, do not touch electrical components to PREVENT INJURY to yourself and damage to the instrument.

WARNING: Do not gaze into a lighted lamp to prevent possible INJURY TO THE EYES.

Allow the lamp 10 to 15 minutes to warm up. The lamp should exhibit a homogeneous light distribution between the electrodes.

Set SOURCE/FILTER selector to Na, and APERTURE control to micro aperture.

For the Model 241 MC select the wavelength of the Na doublet and 1 mm slit.

Check that the source mirror (pos. 43) and especially the lamp compartment exit aperture are fully illuminated.

Lightly loosen clamp screw 44 if this has not already been done.

Grip the white holder 35 and adjust the lamp vertically and rotationally to obtain maximum reading on the ENERGY meter.

Retighten clamp screw 44.

Switch OFF the instrument and remove the plug from the electrical supply.

Replace the lamp compartment cover and tighten the securing screws.

This completes the installation of the sodium lamp.

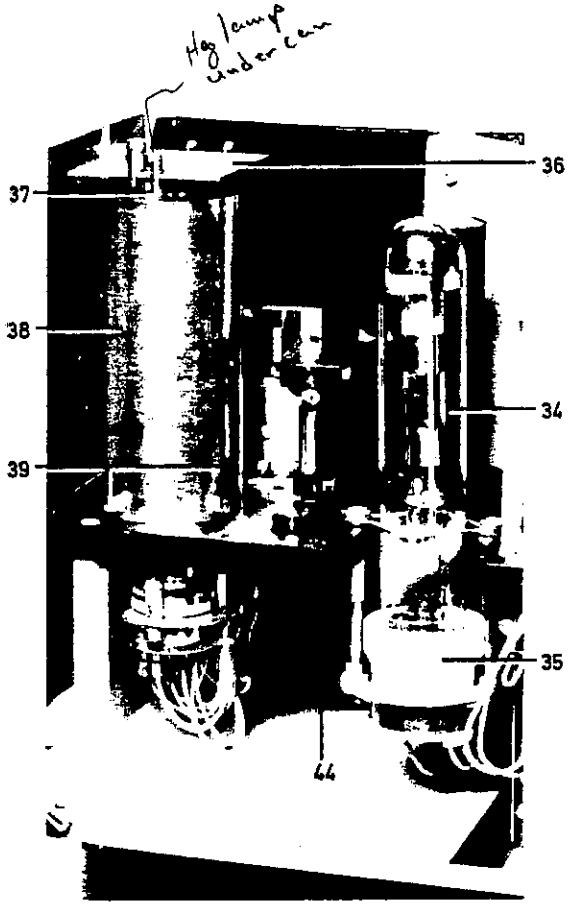


Figure 6-1. Lamp compartment with Hg and Na lamps

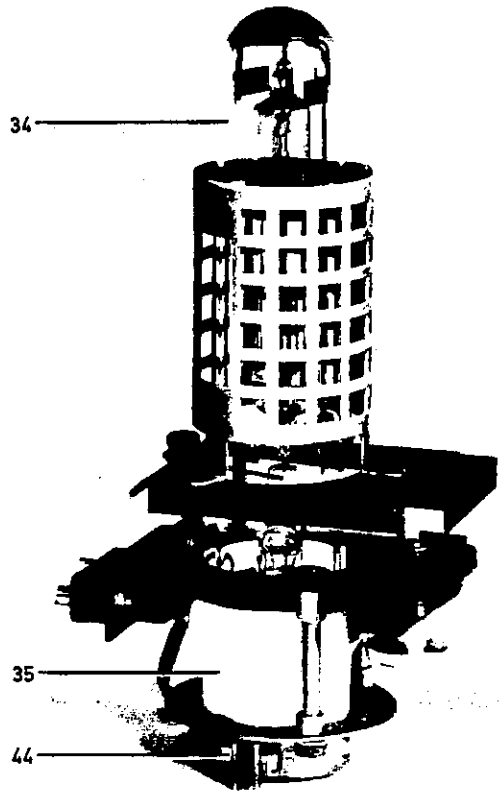


Figure 6-2. Sodium lamp on its mount for Model 241 MC

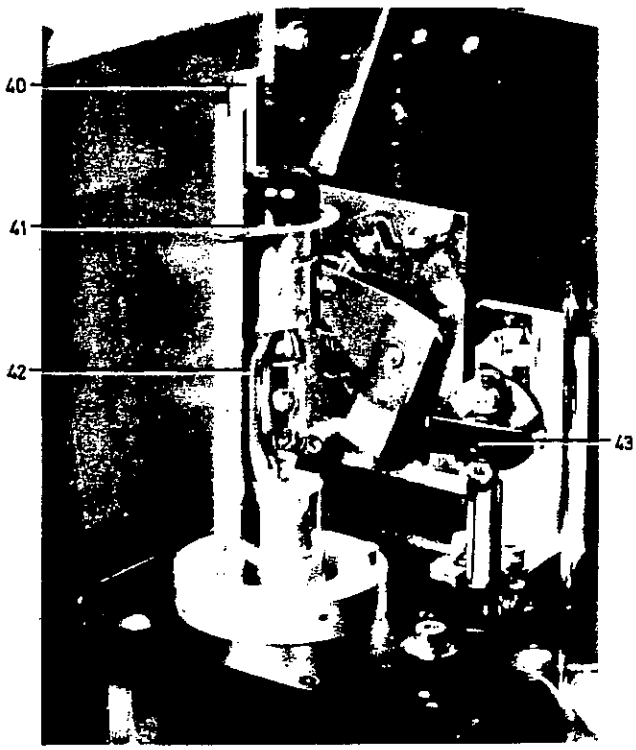


Figure 6-3. Mercury lamp

Pos. 34 Sodium lamp
Pos. 35 Lamp holder
Pos. 36 Cover plate
Pos. 37 Securing bolts
Pos. 38 Mu-metal shield cylinder
Pos. 39 Shield cylinder securing bolts
Pos. 40 Hexagon posts
Pos. 41 Centering plate
Pos. 42 Mercury lamp
Pos. 43 Source mirror
Pos. 44 Clamp screw

6.3.3. Replacing the D_2 Lamp: Model 241 MC

Switch OFF both source lamps.

Rove the lamp compartment cover panel, loosen the thumb screw and draw out the deuterium lamp mount.

Wait for the old lamp to cool before proceeding with the replacement.

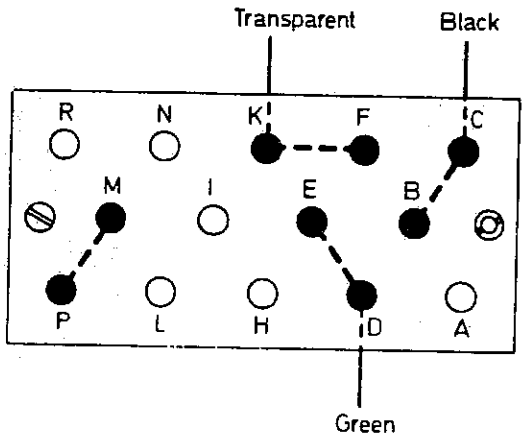


Figure 6-4. Connector on deuterium lamp mount (seen from the front)

Press the punch (in accessories) over each of the pins C, B, D, E, K and F on the connector in turn and withdraw the pins to the rear.

Undo the three socket head bolts securing the lamp shield cylinder and remove the cylinder. (Refer to figure 6-6).

Loosen the two screws 46 on the clamp and withdraw the old lamp from beneath.

The new deuterium lamp is supplied complete with contact pins and wire bridges. Holding the lamp in a soft cloth to prevent finger marks, push it carefully from beneath into the clamp. Ensure that the light exit window inside the lamp is opposite to the vertical support rod and approximately half way between screws46 and 47 in height.

Lightly tighten the screws 46 but not so tight that the lamp cannot be moved.

Wipe the lamp with a soft cloth moistened with alcohol to remove dirt, since this would otherwise be subsequently burned into the quartz bulb.

Replace the shield cylinder.

Insert the contact pins fully into the connector from the rear according to the following schematic:

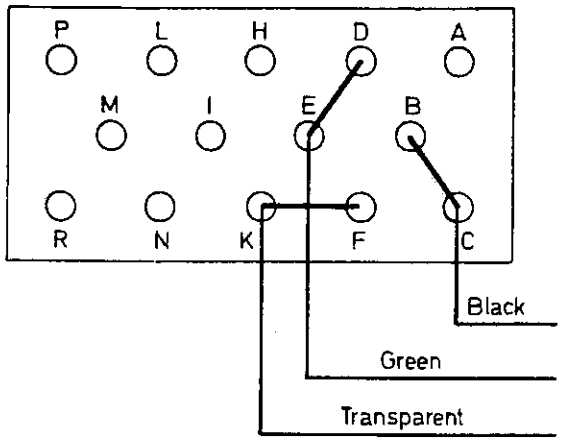


Figure 6-5. Connector seen from the rear with lamp mount inverted

Check that the lamp holder slides freely on the vertical support rod (do not press on the lamp).

Install the lamp mount in the Polarimeter.

Switch the instrument back ON and push the Na/CONT button to ignite the lamp.

Select standard aperture on APERTURE control and CONT-Na on SOURCE control.

Set the WAVELENGTH to between 250 nm and 300 nm (intensity maximum for D_2 lamp) and the SLIT to 3 mm.

By looking along the optical axis slightly to the left of source mirror 43 the aperture can be seen.

WARNING: Do not gaze into the lamp to avoid possible INJURY TO THE EYES.

Make fine adjustments alternately to the vertical screw 47 and the horizontal screw 48 until the aperture is symmetrically and fully illuminated.

If the adjustment range of the screws is insufficient, switch off the lamp and move it in the clamp somewhat.

WARNING: The lamp soon becomes hot. Do not touch with bare fingers. RISK OF BURNS.

Carefully tighten up the two screws 46.

Finally make alternate adjustments with vertical screw 47 and horizontal screw 48 to obtain maximum reading on the ENERGY meter.

This completes the installation of the deuterium lamp.

NOTE: Allow the lamp several minutes to warm up before making the final adjustment.

It is good practice to check the alignment of the lamp from time to time.

6.3.4. Replacing the Halogen Lamp: Model 241 MC

Switch OFF both source lamps.

Rove the lamp compartment cover panel, loosen the thumb screw and draw out the halogen lamp mount.

Wait for the old lamp to cool before proceeding with the replacement.

Undo the two socket head bolts 49 to remove the lamp shield.

Pull the old lamp from its socket.

Holding the new halogen lamp with a soft cloth, carefully insert it into the socket.

Wipe the lamp with a soft cloth moistened with alcohol to remove any dirt, since this would subsequently be burned into the quartz bulb.

Replace the lamp shield and tighten up screws 49.

Check that the lamp holder slides freely on the vertical support rod (do not press on the lamp).

Install the lamp mount in the Polarimeter.

Switch the instrument ON and push the Na/CONT button to ignite the lamp.

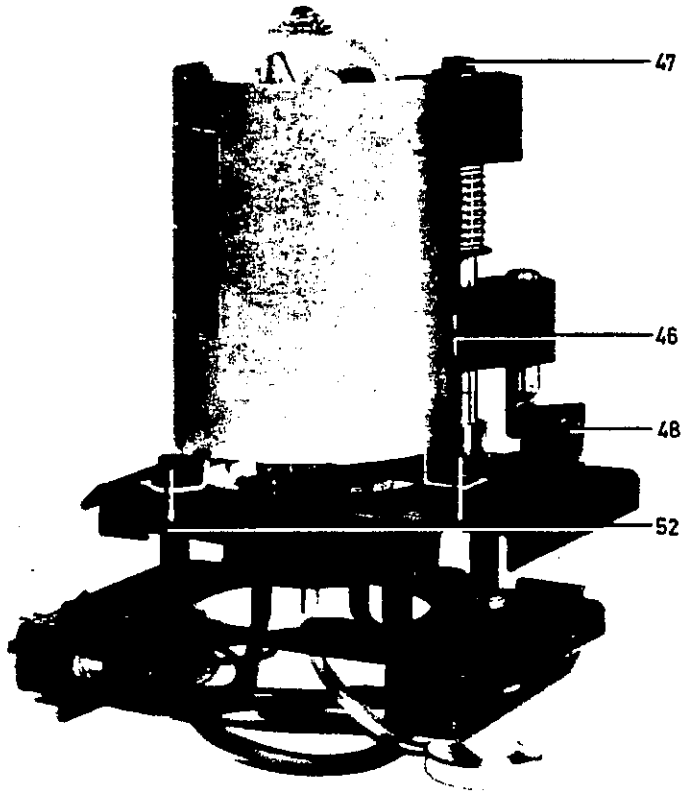
Select standard aperture on APERTURE control and CONT-Na on SOURCE control.

Set the WAVELENGTH to between 500 nm and 550 nm (intensity maximum of halogen lamp).

By looking along the optical axis slightly to the left of source mirror 43 the projected image of the lamp filament on the aperture can be seen.

Make fine adjustments alternately to the vertical screw 50 and the horizontal screw 51 until the aperture is symmetrically and fully illuminated.

Set the SLIT to obtain a medium reading on the ENERGY meter (generally around 0.5 mm).

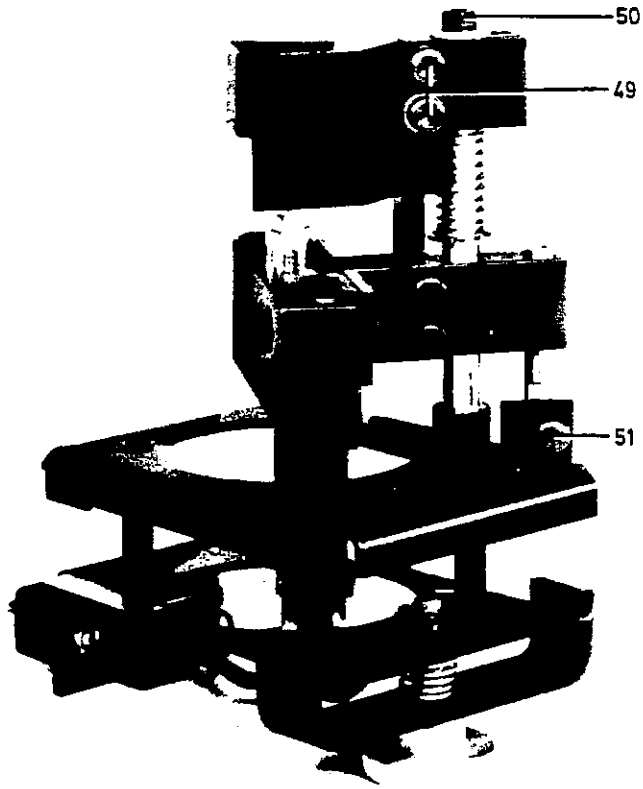


Pos. 46 Lamp holder clamp screws

Pos. 47 Vertical adjust screw

Pos. 48 Horizontal adjust screw

Figure 6-6. Deuterium lamp on its mount for Model 241 MC



Pos. 49 Shield retaining bolts

Pos. 50 Vertical adjust screw

Pos. 51 Horizontal adjust screw

Figure 6-7. Halogen lamp on its mount for Model 241 MC

Finally make alternate adjustments with vertical screw 50 and horizontal screw 51 to obtain maximum reading on the ENERGY meter.

This completes the installation of the halogen lamp.

NOTE: The correct alignment of the halogen lamp should be checked from time to time.

6.4. Lubrication

The moving parts of the polarimeter should be occasionally lubricated.

The gears and worm of the analyzer drive assembly should be very sparingly greased with a resin-free grease.

The shafts of the APERTURE and SOURCE controls should be very lightly oiled.

CAUTION: Avoid contaminating optical and electronic components with grease or oil.

7. SUPPLEMENTARY INSTALLATION PROCEDURES

7.1. Printer Connection

A Perkin-Elmer Model ES-6 Printer can be connected directly to the Polarimeter as detailed in Section 3.3.5. The following information is for the connection of another suitable BCD Printer.

IMPORTANT: Other printers must be connected by suitably qualified personnel. Perkin-Elmer can accept no responsibility for damage caused through the connection of unsuitable instruments or through false connection.

The printer output on the Models 241 and 241 MC is in BCD 8-4-2-1 code, positive true logic, for the connection of TTL compatible printers.

The 30-pole PRINTER receptacle on the rear panel corresponds to DIN 41622 (Siemens type C 42334-A 44-A 6). To connect another printer, a 30-pole connector to DIN 41622 is required (for example, Siemens type C 42334 - A 44 - A 5 with housing, type C 42334 - A 228 - A 845).

If difficulties arise in obtaining a suitable connector, please contact Perkin-Elmer.

The values appearing on the instrument's digital display are available in BCD code at the PRINTER outlet on the rear panel. Any ancillary printer must be capable of accepting BCD data and must be TTL compatible (positive logic; $H \geq 2.4$ V, $L \leq 0.8$ V).

In BCD code, every digit is reproduced by a combination of four signals D, C, B and A. These signals have the significant values 8, 4, 2, 1 respectively (refer to the table in figure 7-1). Figure 7-1 depicts the contacts on PRINTER receptacle Bu 4 at which the individual signals are available. The digits, counted from right to left, indicate the columns on the digital display. (For example, D 1 indicates that a signal of significant value 8 is available in the last column; A 5 indicates that a signal of significant value 1 is available in the first column.) The data outputs must be connected to the corresponding printer inputs (refer to the technical data for the printer).

The Polarimeter delivers a single signal for the polarity sign (H for +, L for - on contact c3, or inverted L for +, H for - on contact c6 of Bu 4). All further signal combinations required by the printer for printout of the polarity sign in a given column must be permanently wired at the printer input independent of the Polarimeter (refer to the technical data for the printer).

A signal for the decimal point is not provided by the Polarimeter since its position remains constant. If printout of the decimal point (or comma) is required with the data, it must be coded independently between columns 3 and 4 (counting from the right) at the printer input (refer to the technical data for the printer).

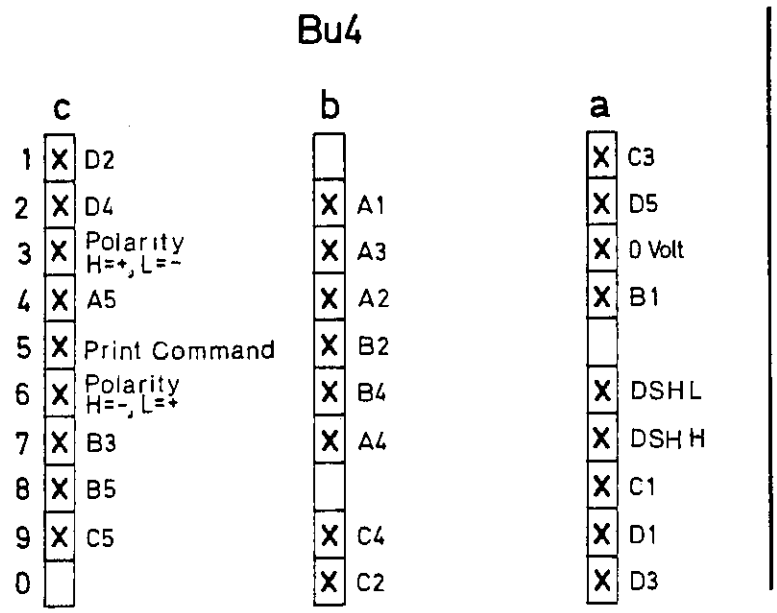
Print command with signal H is available for a period of 20 ms on contact c5 of Bu. A shielded cable to prevent interferences must be used.

A data source hold signal from the printer, which locks the data on the Polarimeter during printout, can be inputted to the Polarimeter via contacts a6 or a7 of Bu 4. Depending on the printer, the data source hold signal can be with L to contact a6 or with H to contact a7. The hold time must be at least as long as the time required to print out the data. A shielded cable to prevent interferences must be used.

IMPORTANT: Connect 0 Volt potential of Polarimeter and printer with a separate lead. Do not use a cable shield. Shields should only be connected to 0 V at the printer.

The connecting cable between the Polarimeter and printer should not be longer than about 2 m.

For further installation and operation procedures of the printer, the manufacturer's instructions should be followed.



Digit	BCD Code 8 4 2 1 D C B A
0	L L L L
1	L L L H
2	L L H L
3	L L H H
4	L H L L
5	L H L H
6	L H H L
7	L H H H
8	H L L L
9	H L L H

Figure 7-1. Schematic of occupied contacts on PRINTER receptacle Bu 4

Positive logic; High (H) $\geqq$ 2.4 V; Low (L) $\leqq$ 0.8 V
Letters: Significant values in BCD code
Digits: Columns (counted from right to left)
DSH: Data Source Hold signal (Hold Time)

In principle, the Polarimeter can be connected to data handling systems, using an interface where necessary. Your Perkin-Elmer sales office or representative will be pleased to provide you with further information.

7.2. Additional Filters (Model 241 only)

Additional filters for the Model 241 are listed in Section 8.5.

Two positions marked Hg are provided on the filter wheel for extra filters.

The upper position is blanked off, and a stop screw normally prevents the lower position from being rotated into the light beam.

Insert a filter as follows:

Switch OFF the Polarimeter and remove the plug from the electrical supply.

Loosen the securing screws to the side and rear of the lamp compartment cover and lift the cover off vertically.

To use the upper position, remove the blank with a small screwdriver and push the filter in.

To use the lower position, remove the stop screw and replace it in the next position. Insert the filter into the provided hole.

Replace the lamp compartment cover and tighten the securing screws.

IMPORTANT: Take care not to damage or contaminate the optical surfaces in any way.

7.3. Replacing the Shipping Clamp

The shipping clamp securing the photomultiplier housing should be replaced if the Polarimeter is to be transported or returned to the factory. This is necessary to protect the analyzer drive assembly.

Switch the Polarimeter OFF and remove the plug from the electrical supply.

Pull off the decorative strip on the front panel.

Loosen the securing screws on the side and rear of the main instrument cover and then carefully lift off the cover vertically.

Holding the photomultiplier housing with one hand to prevent it tipping, tilt the worm drive assembly towards the rear with the other hand (direction of arrow in figure 4-6) until the worm gear no longer engages in the large pinion.

Rotate the photomultiplier housing to the vertical position with the long end upwards and then carefully re-engage the worm gear in this position.

Place the shipping clamp against the photomultiplier housing and loosely screw in the socket head bolts 2, but do not secure them.

By carefully rotating one of the gear wheels on top of the worm drive assembly, turn the photomultiplier housing until it sits absolutely flat against the clamp. Tighten the bolts 2.

Replace the two clamping plates and tighten up the screws 1.

Place rubber bands around the shipping clamp and worm drive assembly.

Replace the main instrument cover and the decorative strip.

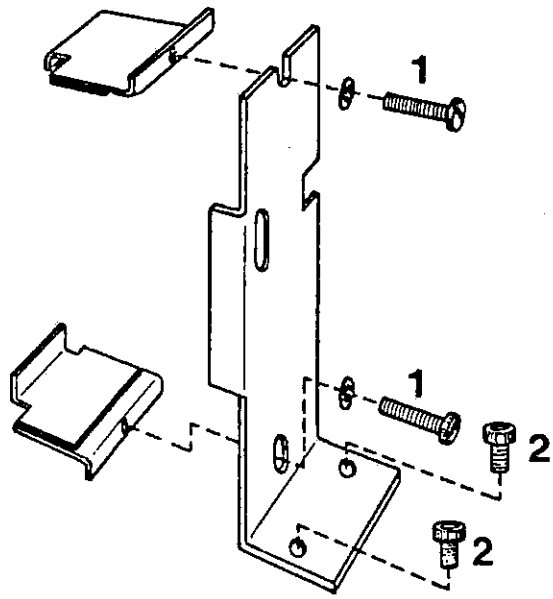


Figure 7-2. Shipping clamp

8. ACCESSORIES

8.1. Cells

Non-thermostattable cells:	Part No.
Beaker cell, 100 mm, 50 ml, glass	017 041
Beaker cell, 100 mm, 50 ml, quartz	023 363
Flowcell, 100 mm, 5 ml, glass	017 050

Thermostattable cells:			
Standard cell,	100 mm, 6.2 ml, glass		041 639
Short path cell,	10 mm, 0.5 ml, glass		017 052
Short path cell,	1 mm, 0.25 ml, glass		017 057
Microcell,	100 mm, 1.0 ml, glass		017 047
Microcell,	100 mm, 1.0 ml, quartz		023 365
Short path microcell,	10 mm, 0.1 ml, quartz		046 230
Flowcell,	100 mm, 5.0 ml, glass		017 054
Funnel flowcell,	100 mm, 9.0 ml, quartz windows		086 157
Pressure-proof flow-cell, tolerable super pressure 4 bar (400 kPa)	100 mm, 9.0 ml, quartz windows		089 922

ORD cells (thermostattable):	
100 mm, 6.2 ml, quartz	041 696
50 mm, 3.4 ml, quartz	022 086
20 mm, 1.3 ml, quartz	022 087
10 mm, 0.6 ml, quartz	022 088
5 mm, 0.9 ml, quartz	022 089
2 mm, 0.35 ml, quartz	022 090
1 mm, 0.25 ml, quartz	022 091
0.5 mm, 0.5 ml, quartz	037 635
0.2 mm, 0.25 ml, quartz	037 634

Spare stoppers:
(The diameter given is of the thinner end of the stopper)

PTFE Stopper, 10 mm long, 6 mm dia., for standard cell 041 693 and ORD cell 041 696	041 695
PTFE stopper, 10 mm long, 3 mm dia., for cells: micro 017 047, 023 365 and 046 230; short path 017 057; ORD 50 mm to 0.2 mm incl.	017 059
PTFE stopper, 15 mm long, 12 mm dia., for beaker cells 017 041 and 023 363	017 043
PTFE stopper, 15 mm long, 6 mm dia., for short path cell 017 052	017 046

	Part No.
Plastic end caps for cells (pack of 20)	076 786
Hose connector, female, quick release	023 491
Hose connector, male, quick release	023 492

Replacement parts for Funnel Flowcell and Pressure Flowcell:

Quartz window	086 467
Neoprene gasket (pack of 10)	092 574
Funnel	086 752
PTFE washer, 17.8 mm dia. for Pressure Flowcell	090 346
PTFE washer, 14 mm dia. for Pressure Flowcell	090 347
Retaining ring key for assembly of Pressure Flowcell	091 130

Quartz calibration standard, angle of rotation + 1° of arc at 589 nm (Na_D), in thermostattable holder	098 800
Quartz calibration standard, angle of rotation - 1° of arc at 589 nm (Na_D), in thermostattable holder	098 799

Quartz calibration standards for other angles of rotation, and quartz standards calibrated by the German Federal Bureau of Standards (PTB) upon request.

8.2. Printer

Perkin-Elmer Model ES-6 Printer £2600.00

Power requirements	220-240 V AC; 50 Hz; 50 W
Dimensions	195 mm wide x 115 mm high x 260 mm deep
Weight	approx. 4 kg

Connecting Cable Assembly 108 767
to connect the Printer to Models 241 and 241 MC Polarimeters £220.00

8.3. Recorder Readout

Recorder Readout Unit 066 109
for 10 mV and 10 V recorders

Recorder Signal Cable 040 485

This unit will be field installed by a Perkin-Elmer service engineer.

8.4. Conversion Kit 066 095

To convert the Model 241 into a Model 241 MC. The kit contains a grating monochromator and continuous sources with mounts.

Because of the precise optical alignment required, the polarimeter must be returned to the manufacturing site for the conversion to be carried out.

8.5. Filters

The following filters are additionally available for the Model 241 Polarimeter:

Hg 302 nm	094 404
Hg 313 nm	032 339
Hg 405 nm	062 666

Other filters on request

8.6. Instrument Benches

The benches consist of a lower drawer unit with 9 drawers and a top covered with laminated plastic. The two sections must be ordered separately.

Dimensions: 1800 mm wide x 800 mm deep x 800 mm high

Bench drawer unit	048 126
Bench top	048 127

8.7. Circulatory Thermostat

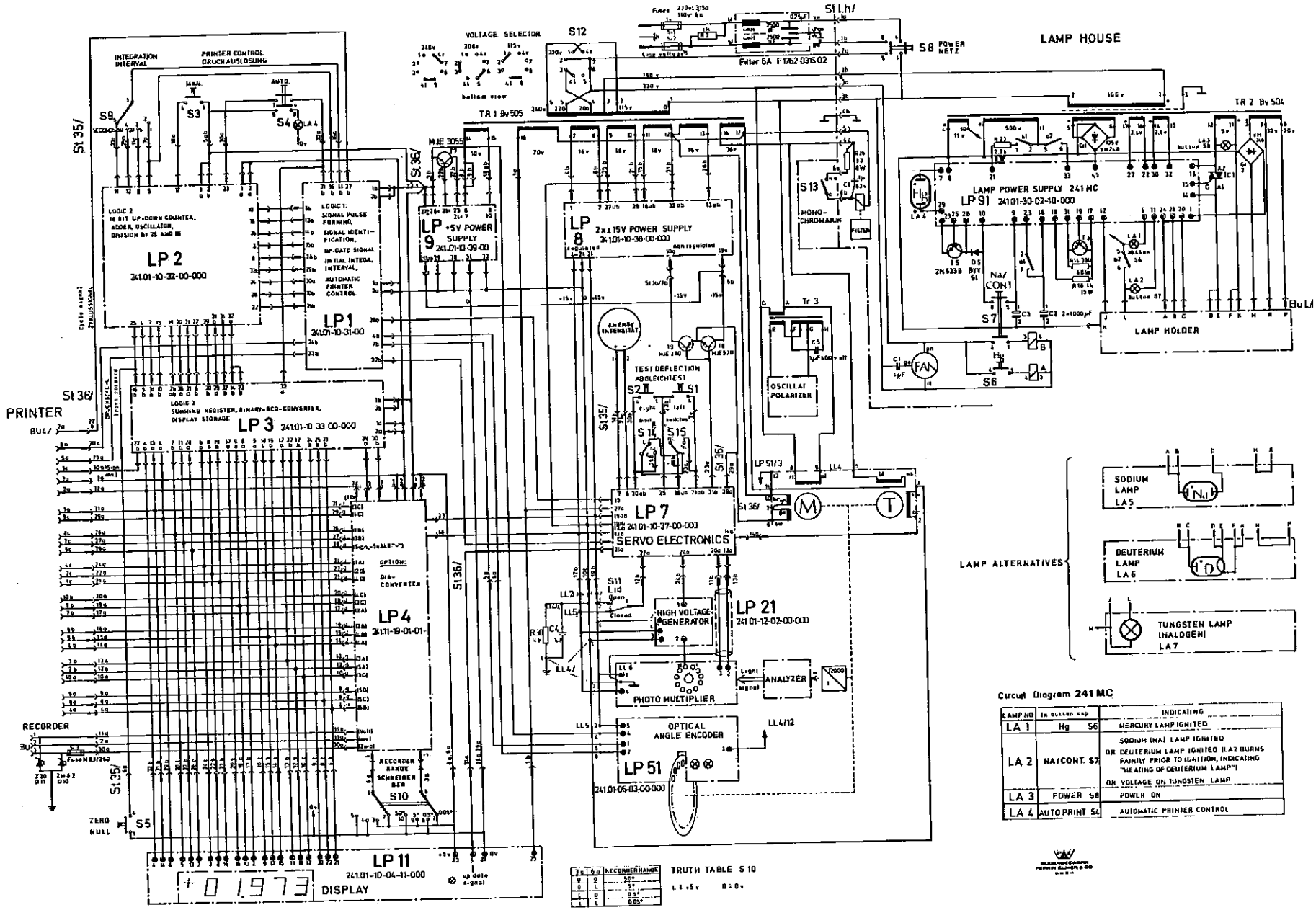
Type U3 Circulatory Thermostat	080 171

The U3 Circulatory Thermostat provides temperature regulation of water-jacketed cells by circulating water through them. Any temperature between 20 and 65 °C may be selected, and three fixed temperatures of 25, 37 and 56 °C are further provided. Temperature stability of the bath is ± 0.02 °C. Built-in cooling coils permit accurate temperature regulation at temperatures near to ambient. Includes precision thermometer and hose connectors.

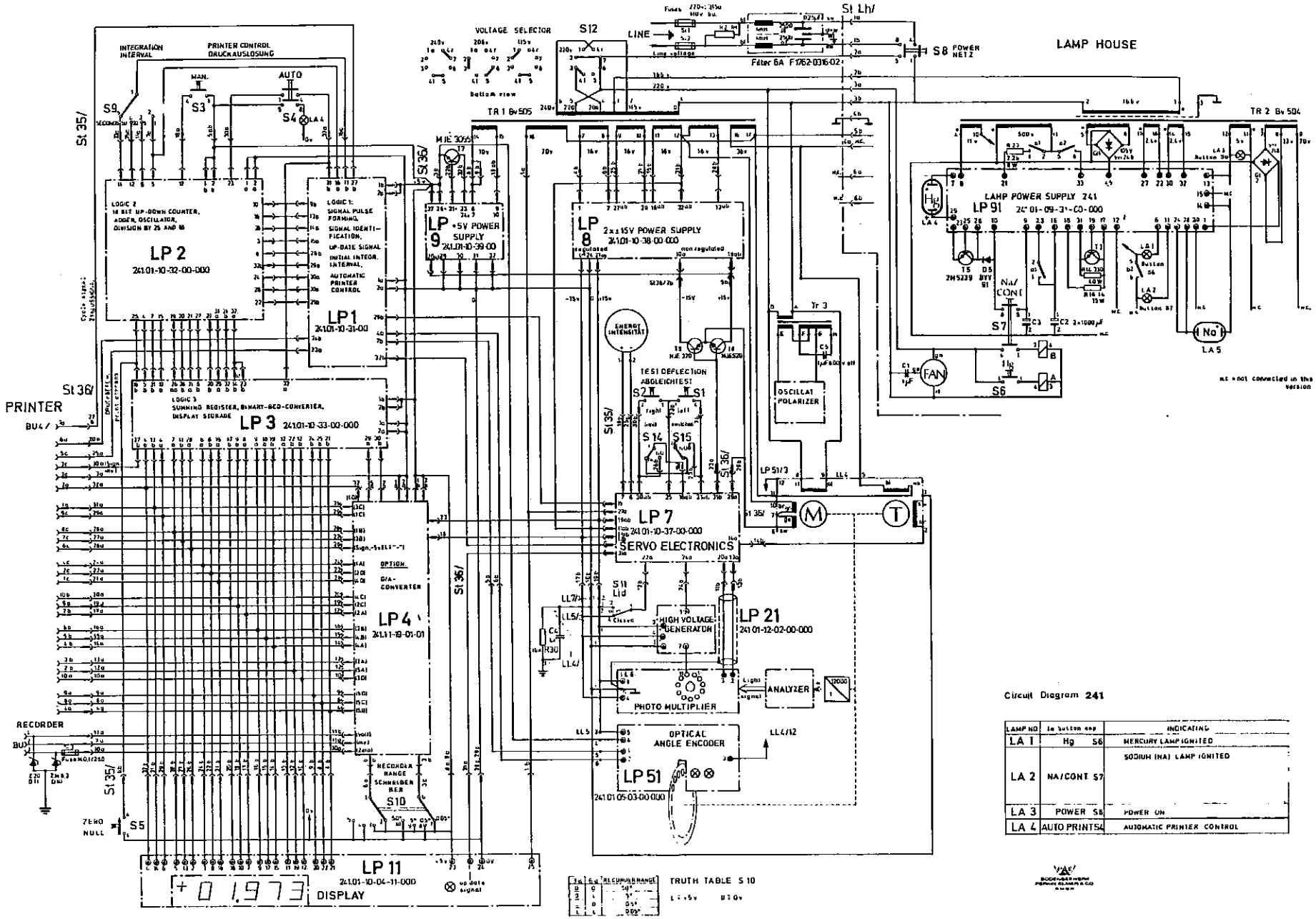
9. REPLACEMENT PARTS

	Part No.
Mercury lamp St 75	022 438
Sodium gas discharge lamp	008 754
Deuterium lamp	066 165
Halogen lamp, 12 V, 50 W	045 862
Mount for sodium lamp, complete with lamp	066 144
Mount for deuterium lamp, complete with lamp	066 155
Mount for halogen lamp, complete with lamp	066 166
Punch (for removing electrical connections on lamp mount)	067 432
Interference filter, Na 589 nm	104 948
Interference filter Hg 302 nm	094 404
Interference filter 313 nm	032 339
Interference filter UV 365 nm	067 773
Interference filter Hg 405 nm	062 666
Interference filter Hg 436 nm	067 772
Interference filter Hg 546 nm	067 771
Interference filter Hg 578 nm	067 770
Photomultiplier 1 P 28 A selected for Model 241	074 706
Photomultiplier 1 P 28 A selected for Model 241 MC	074 703
Lamp, 6 V, for pushbuttons	059 764
Button cap, white	059 569
Button cap, red	059 570
Button cap, green	072 658
Knob for rotary switch	060 541
Connector, 30-pole, to DIN 41622 (Siemens)	019 229
Housing for connector	073 040
Coding bush for connector	019 218
Coding pin for connector	019 225
Cable sleeve for connector	038 868

	Part No.
Fuses T 6.3 D, 6.3 A, slow blow (for 115 V operation)	008 628
Fuses T 3.15 D, 3.15 A, slow blow (for 206-240 V operation)	061 975
Fuse holder complete with screw cap	045 440
Hose unions for connection of a circulatory thermostat	059 044
Retaining nut for hose union	057 375
Snap-on hose connector	023 491
Quick release fitting (in sample compartment)	063 683
Dust cover for Model 241 Polarimeter	066 063
Dust cover for Model 241 MC Polarimeter	066 064
Vibratory spring for polarizer	016 797
Vibratory spring guide	016 785
Set of hexagon (Allen) keys	019 061
Wavelength table (mercury spectral lines)	067 767



LAMP NO	In button key	INDICATING
LA 1	Hg S6	MERCURY LAMP IGNITED
LA 2	NA/CONT. S7	SODIUM (NA) LAMP IGNITED OR DEUTERIUM LAMP IGNITED (LA2 BURNS FAINTLY PRIOR TO IGNITION, INDICATING "HEATING OF DEUTERIUM LAMP") OR VOLTAGE ON TUNGSTEN LAMP
LA 3	POWER S8	POWER ON
LA 4	AUTO PRINT S4	AUTOMATIC PRINTER CONTROL



Circuit Diagram 241

LAMP NO	to button on	INDICATING
LA 1	Hg S6	MERCURY LAMP IGNITED
LA 2	NA/CONT S7	SODIUM (NA) LAMP IGNITED
LA 3	POWER S8	POWER ON
LA 4	AUTO PRINT S4	AUTOMATIC PRINTER CONTROL

PERKIN-ELMER

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