SERVICE MANUAL

MS330IA031203

INDEX

1. INTRODUCTION

This instrument instrument, due to its compact design and the reduced number of components, is a simple, easy-to-maintain one. The computer design has allowed to study the tolerance of all the optical block’s components, making unnecessary any mechanical adjustment. Most of its parts are aluminum or plastic-injected and so a maximum simplicity with reduced maintenance requirements has been achieved.

Electronic adjustments are also avoided because of the modern, high-integrated circuits used. A powerful software allows the adjustment of most of the parameters used. Corrections are made via software, using reference tools or calibrators.

All the electronic parts are located in two printed circuit boards (PCB’s), and the software has a lot of check programs to make easy the search and diagnosis of failures.

This manual is not only a guide for maintenance but a document for Technical Assistance Service staff’s training. The running principles as well as the electronic circuits are explained in order to get a global view of the instrument.

Note: Throughout this manual, the Absorbance Unit is abbreviated as "Abs" instead of "A", in order to avoid confusion with the electric current unit, the Ampere, represented as "A".

2. FUNCTIONAL PARTS DESCRIPTION

This instrument is composed of the following functional parts:

a) An optical system to carry out the readings.

b) An aspiration system based on a peristaltic pump, to introduce the sample in the flow cuvette.

c) A thermostatic system to carry out reactions into the cuvettes at a constant temperature, when needed.

d) A communications interface, allowing the connection to a host computer by means of a proper software.

e) A microcontroller-based system, wich controls most of funtional parts.

The next sections describe each one of the functional parts.

2.1. Optical system

2.1.1. Constitutive parts

Figure 2.1. shows the optical system. It consists in:

a) An halogen lamp (1)
b) A diaphragm (2)
c) A first plano-convex lens (3)
d) An interference filter (4)
e) A second plano-convex lens (5)
f) A cuvette (6)
g) A silicon photodiode (7)

2.1.2. System description

The first component is the light source: one halogen lamp (1). The diaphragm (2) delimits a light solid angle that is collected by the first lens (3). It sends a parallel beam to an interference filter (4). This is one of the nine possible ones located in the wheel. One stepper motor drives this wheel and, controlled by the program, place the proper filter in the optical axis, in front of the light beam. Each filter monochromes one wavelength with the characteristics described in section I.1.

A second lens (5) focuses the monochromatic beam in the cuvette center (6). In case of flow cuvettes, the light path hole itself behaves as a diaphragm, decreasing the sensitivity, that it is lower than in the common cuvettes. The light beam goes through the cuvette as far as a light sensor (7), that converts the light beam into electric current.

2.1.3. Physical description

The optical system (figure 2.2) consists in an injected-aluminum holder (1) where there are mounted the following components:

- A heat sink shape aluminium block (2) containing a lamp-holder (3). That block includes a diaphragm (figure 2.3 (1)) that delimits the a light solid angle.

- A lens holder (4) that contains the first lens.

- A filters wheel (5), with capacity for 9 filters. This filters must be mounted in special holders (6). This wheel is moved through a belt (8) by a stepper motor (7). A photointerrupter (9) allows the detection of a stem (10) that indicates the filters wheel home position.

- A lens holder (11) that contains the second lens.

- A light protector (12), fitted together the second lens holder, avoids the parasite light interference.

- A cuvette-holder (13) holds both the cuvette and the photodiode detector. The thermostatic system is fitted together (see section 2.3.).

2.1.4. Signal conditioning

(See figure 2.4) The photodiode (1) gives an electric current (I_f) directly proportional to the received light. This current goes to the input I_1 of the LOG-100 logarithmic amplifier (2). A reference current I_r (3) (nominal 100 nA) is introduced by input I_2. The output voltage of LOG-100 is:

$$V_0 = k \times \log \frac{I_f}{I_r}$$

In this case, k=1 and V_0 = 1 volt/Abs.

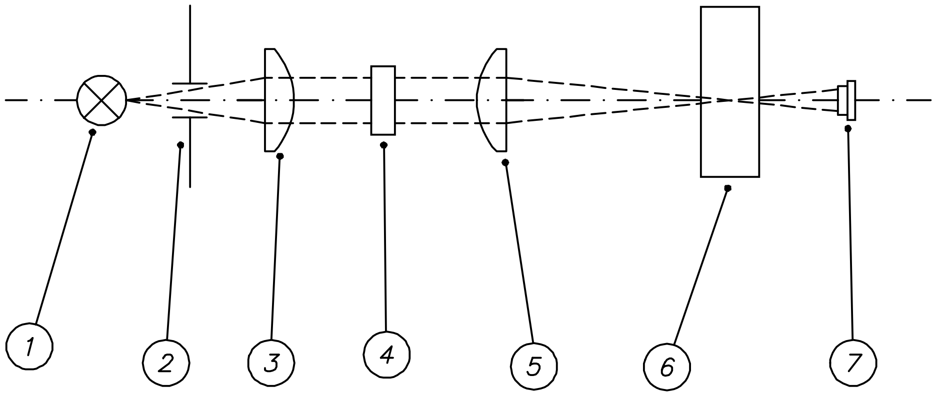


Fig. 2.1

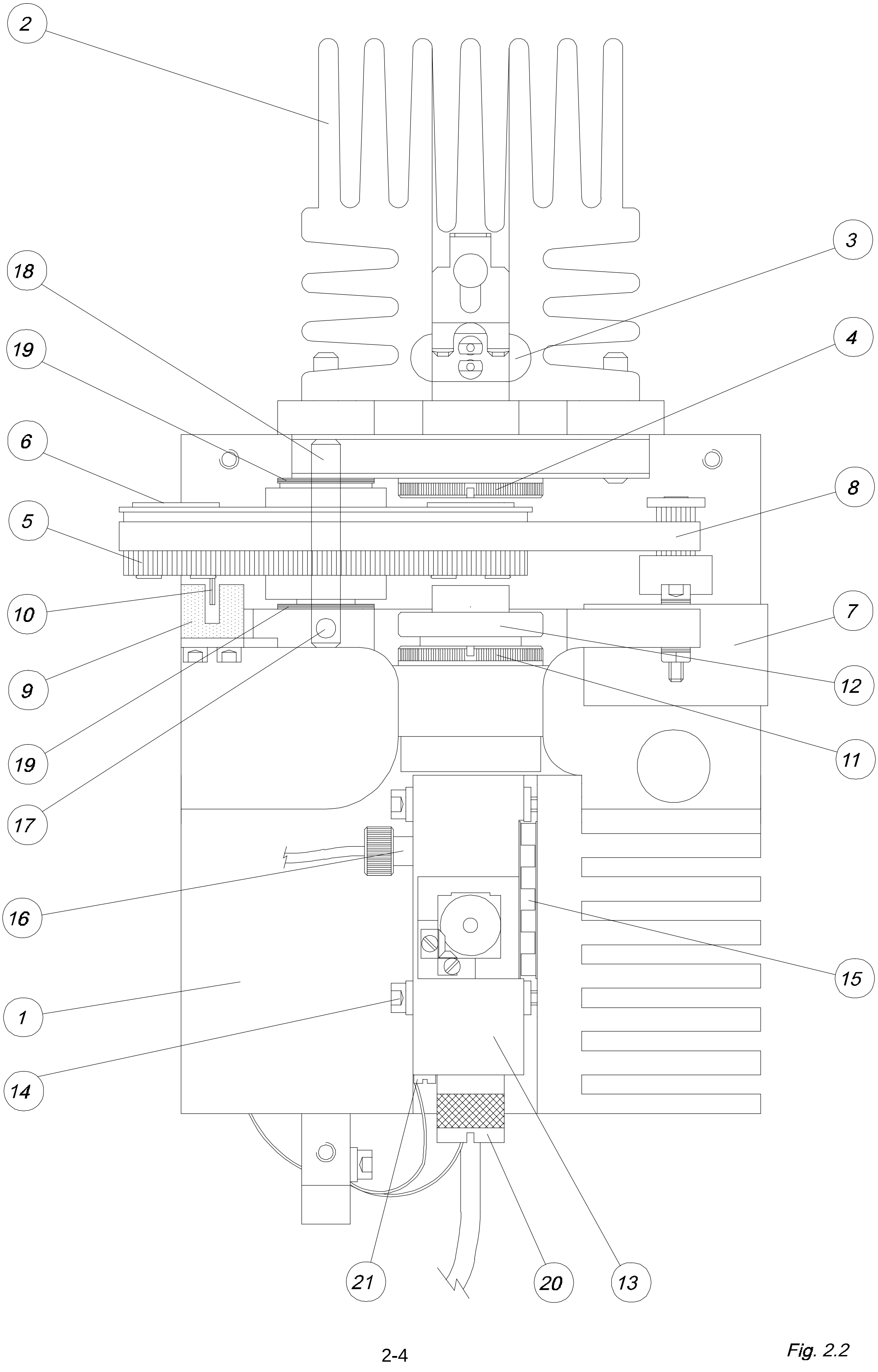


Fig. 2.2

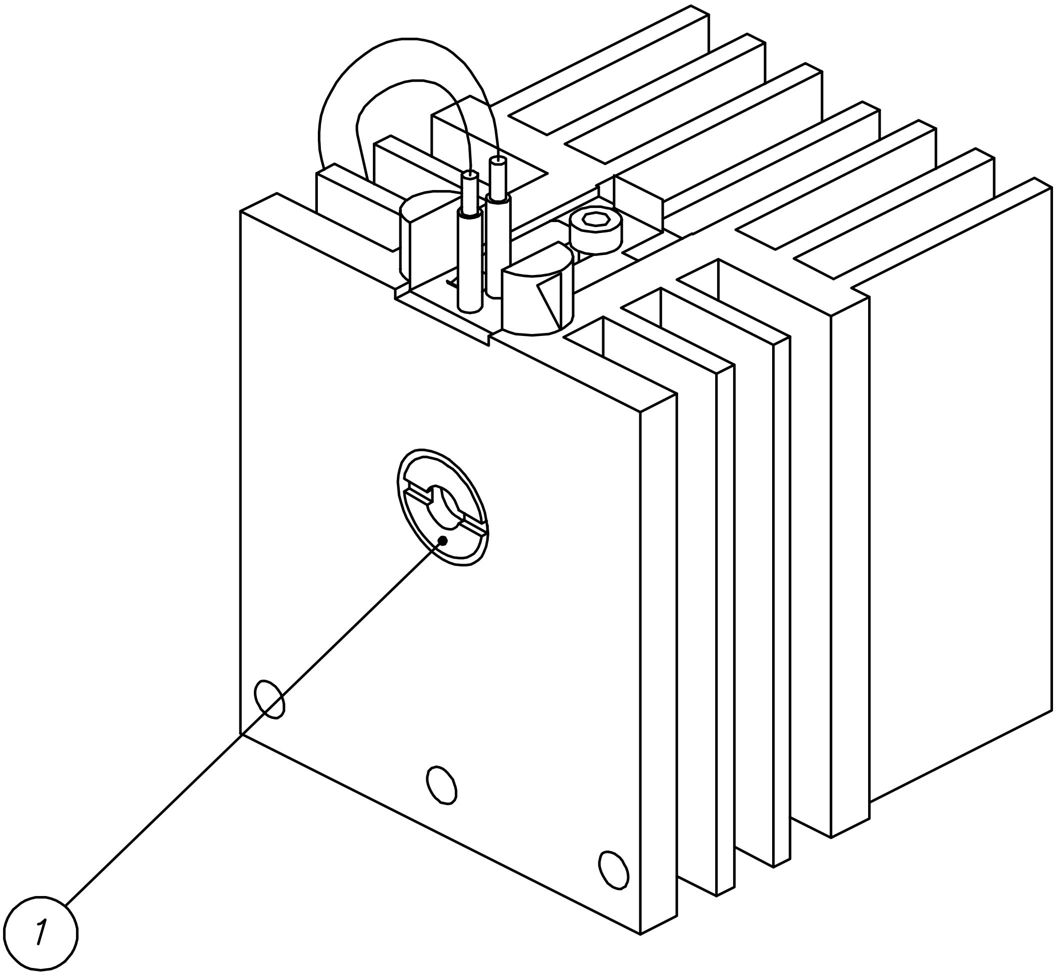


Fig. 2.3

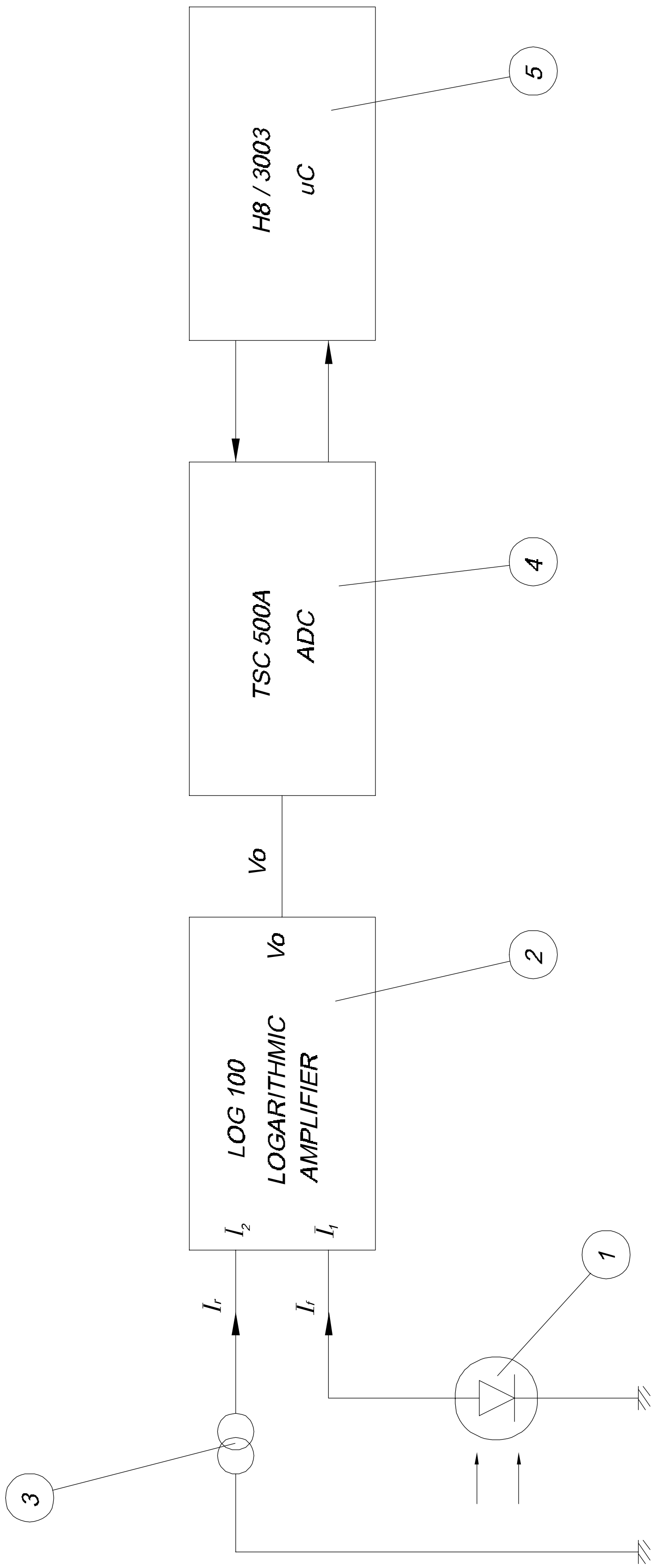

H8 / 3003
uC
TSC 500A
ADC
Vo
LOG 100
LOGARITHMIC
AMPLIFIER
Vo
I2
I1
Ir
If
1
2
3
4
5

Fig. 2.4

V_0 is digitalized by the double-ramp converter TSC500A (4) with a resolution of 10,000 counts per volt. The conversion time depends on the absorbance value and increases together with it; for instance, 2 Abs time is 0.15 sec. This converter is controlled by the microcontroller (5).

2.1.5. Adjustment

The global system (optical system, amplifier and converter) is not strictly linear due to the components tolerance, so that it is necessary to do some adjustments to compensate the inherent deviations of the system.

The photometric adjustment is performed in ranges; between 0 and 2 Abs. Several value ranges are determined and different correction factors are applied depending on the range. As deviation also depends on the wavelength, it is necessary to adjust with different filters. Adjustment process is described in section 3.2.

2.1.6. Precautions and maintenance

Maintenance of the optical system should be carried out according to the instructions given in section 5.20.

2.2. Aspiration system

2.2.1. Components

The aspiration system is composed of the following parts (figure 2.5):

a) Sipping tubing (1)
b) Flow cuvette (2)
c) Peristaltic pump (3)
d) Waste bottle (4)

2.2.2. System description

The sample is sipped by the sipping tubing (1). This tubing, Teflon made, has a standard length and the system is adjusted in accordance with it. The sipped sample enters into the flow cuvette (2), where readings take place. Sipping is performed through a silicone tube by means of a peristaltic pump (3), made up of a four-rollered rotor that is contolled by a stepper motor. Finally, the sample ends into the waste bottle (4).

2.2.3. Physical description

The sipping tubing (figures 2.6 and 2.7) is placed on the cuvette-holder tray. The silicone tube (1), that crosses the case through a steel guiding tube (2), is fixed to this guiding tube by means of a silicone connector (3) and to the cuvette (4) by means of an inlet adapter (5). The teflon tube (6) is connected to the cuvette by an outlet adapter (7), placed in the peristaltic pump (8) and finally connected to the waste outlet (9).

The waste bottle (1) (figure 2.8) is connected to the outlet (2) in the back of the instrument by means of a silicone tube (3).

2.2.4. Programmable parameters

Three parameters control the sipper functioning and they must be programmed to obtain the expected performance characteristics. Their programming is explained in the user’s manual.

a) SAMPLE VOLUME. It is a number that indicates the volume of sample to be sipped, in μl.

b) PUMP DELAY. It is the number of seconds the pump will wait since the sipping finishes till the pump is activated again to position the sample into the flow cuvette.

c) POSITIONING. It is the number of steps that the peristaltic pump’s motor gives to set the sample into the flow cuvette, ensuring that it is suitably positioned in order to be read.

2.2.5. Programming

The aspiration system’s programming must be performed in order to indicate the instrument the volume, in microlitres, to be sipped.

2.2.6. Adjustment

The pump’s nominal flow is 110 μL/revolution, nevertheless, the accuracy of this figure depends on the tolerances in length and diameter of the sipping tube, that may be affected by the aging of the tube itself; this is why this value should be adjusted from time to time. The adjustment process is explained in section 3.5. As it can be also done by the user, it is also explained in the user's manual.

2.2.7. Precautions and maintenance

The general rules for the aspiration system's maintenance are the same as the ones given in section 5.24.

Weekly adjustment of the aspiration system is strongly recommended.

2.3. Thermostatization system

2.3.1. Components

Figure 2.9 shows an schema of the thermostatization system, that is composed by the following parts:

a) A cuvette-holder (1)
b) A temperature sensor (2)
c) An amplifier of the temperature sensor (3)
d) The microcontrollers' A/D converter (4).
e) A Peltier Cell's in-circuit power driver(5).
f) A Peltier Cell (6)
g) A heat sink block (optical system holder) (7).

2.3.2. System description

The cuvette with the reaction mixture to be thermostatized is placed in its holder (1). Thermal contact is settled between the cuvette and the holder.

The cuvette-holder is isolated from the optical system holder (7) and contacts one of the Peltier Cell's faces (6). The other cell's face is in contact with the optical system holder.

The Peltier Cell pumps heat from one face to the other, depending on the current sense. The power control circuit (5) is in charge of making that current circulate in the adequate sense inside the Cell, in order to heat or cool depending on the microcontroller's instructions.

When heating, heat is pumped from the environment (taken from the optical system holder) to the cuvette-holder and when cooling the opposite is done. The optical system holder has a heat sink block to cool the heat coming from the cuvette-holder. A temperature sensor (2) gives a small voltage, directly proportional to the cuvette-holder's temperature, that is conditioned by one amplifier (3) and read by the microcontroller's A/D converter (4). The microcontroller's thermostatization program, depending on the programmed temperature and the read value, activates the power control (5) heating or cooling as required.

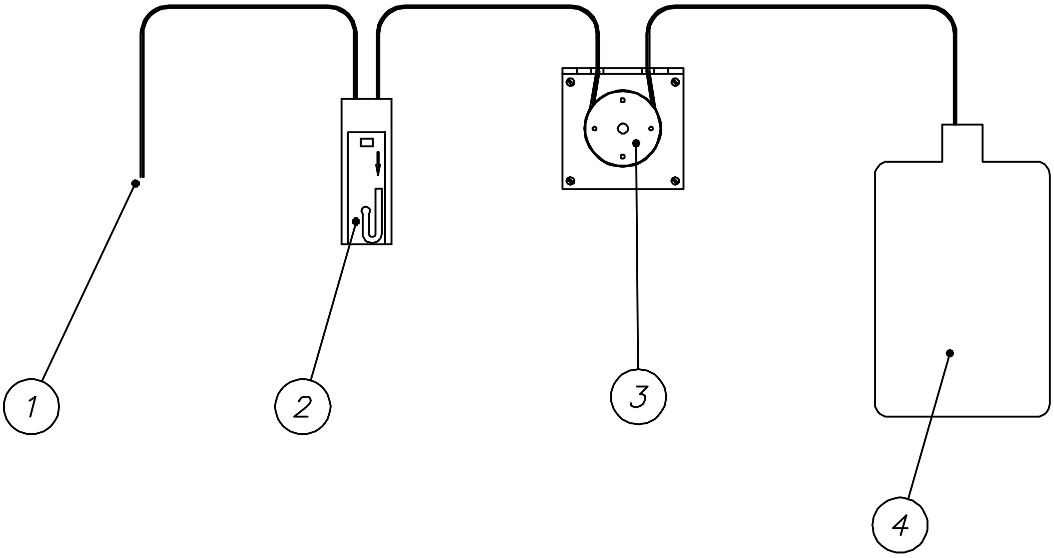


Fig. 2.5

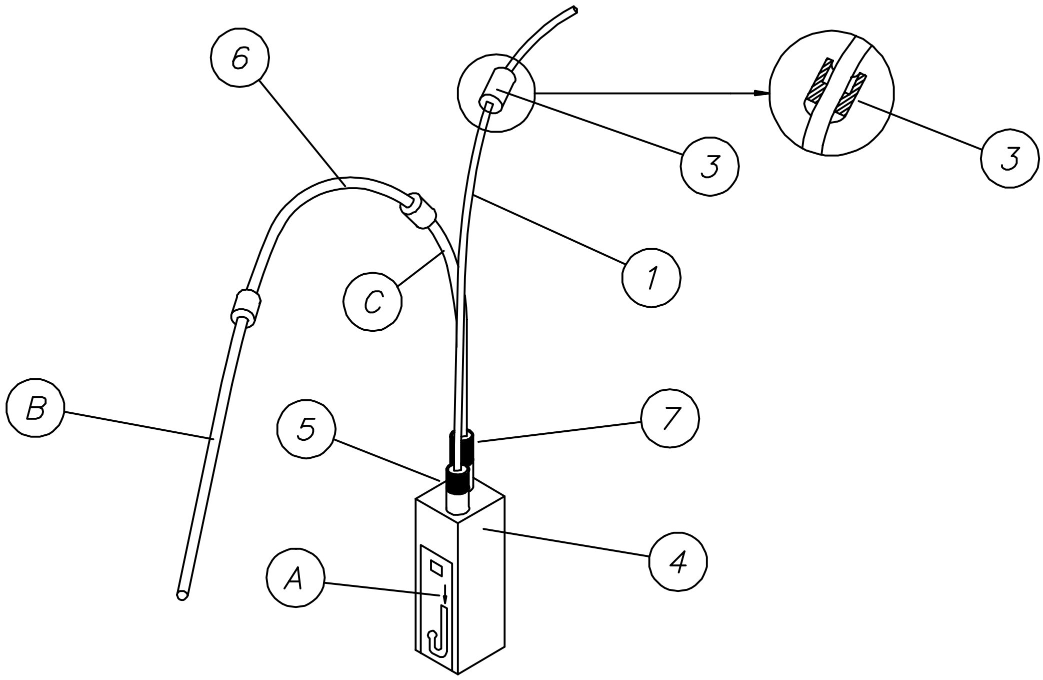


Fig. 2.6

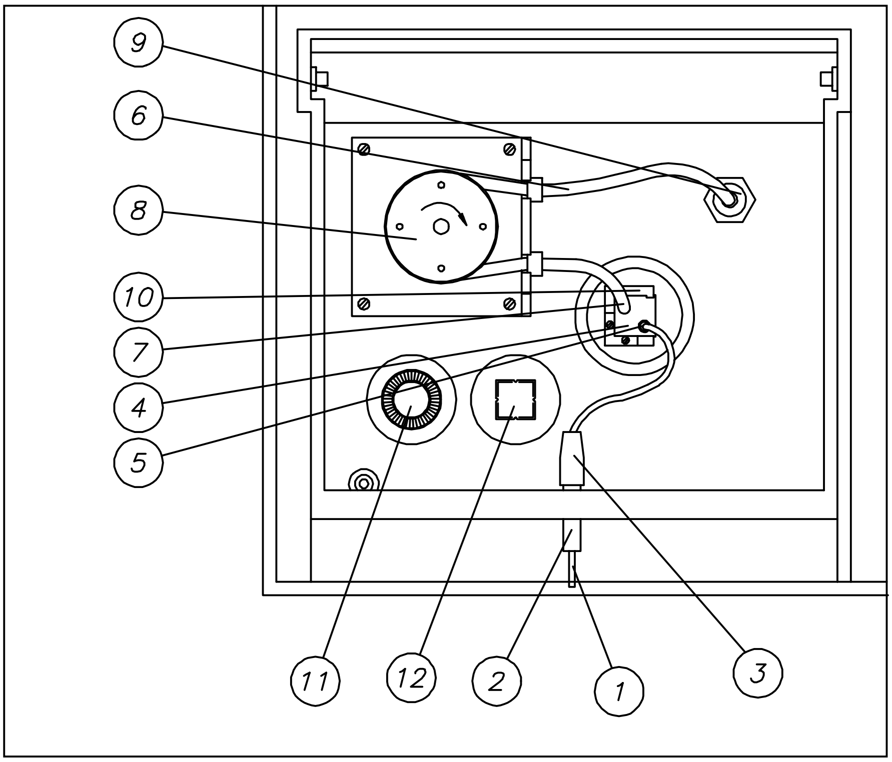


Fig. 2.7

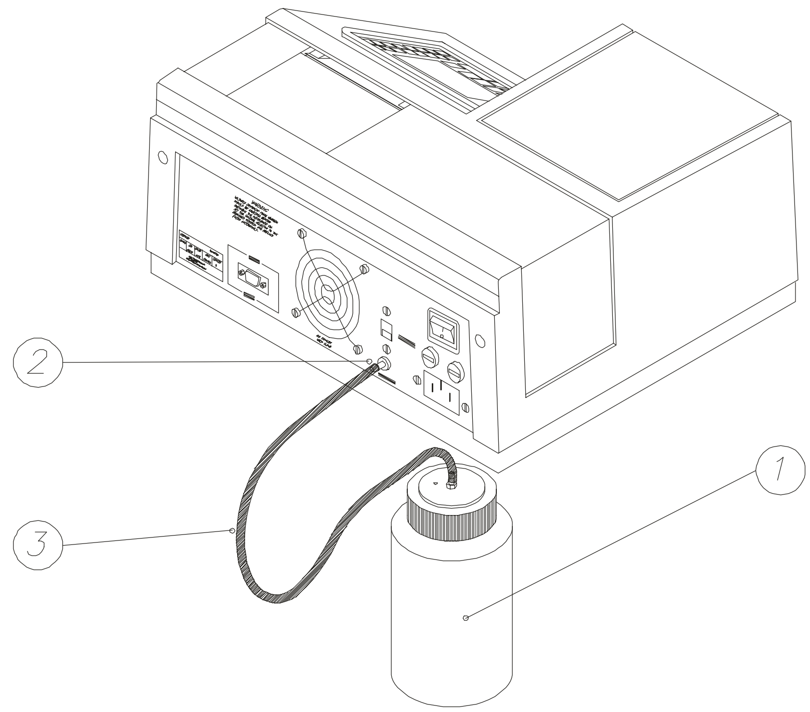


Fig 2.8

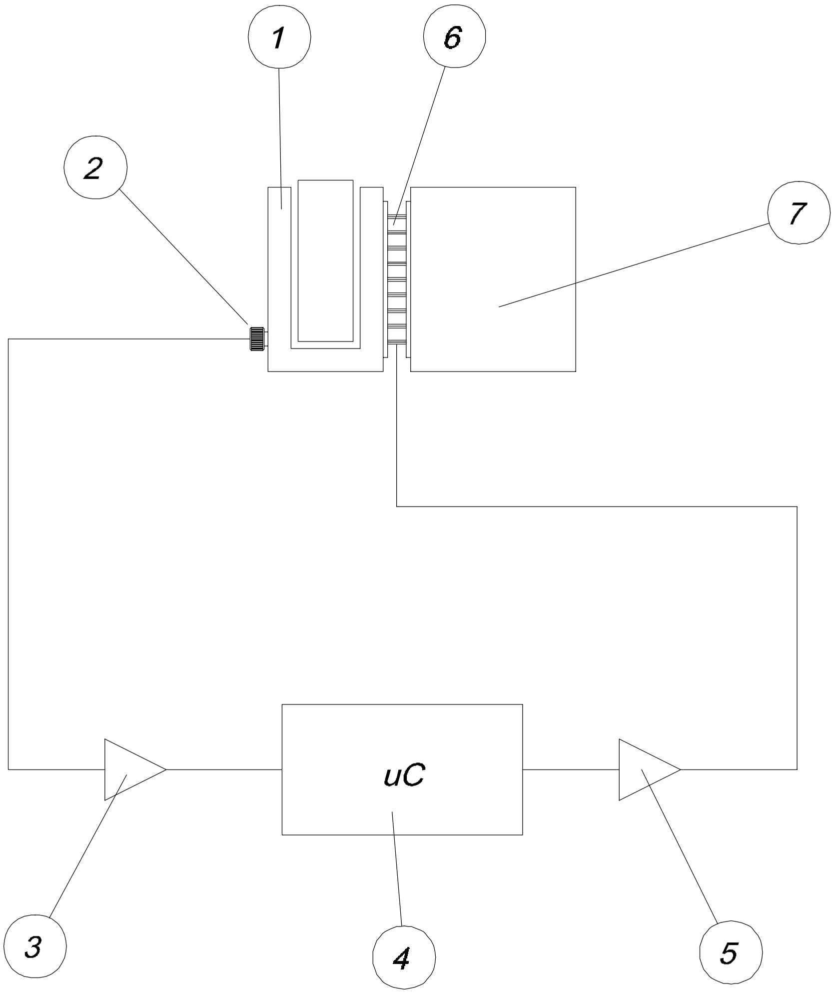


Fig. 2.9

2.3.3. Physical description

The cuvette-holder (13) (figure 2.2) is fixed to the optical system holder (1) by means of four screws (14) thermally isolated. The Peltier Cell (15) is located between the cuvette-holder (13) and the optical system holder (1). The temperature sensor, located in a plastic holder (16) is fixed to the cuvette-holder by a thread.

2.3.4. Programming

Programming the thermostatization system consists in indicating the instrument which temperature is desired for the reaction mixture. This value may introduced in several program's points.

2.3.5. Adjustment

Components' tolerance produce a deviation between the programmed temperature and the real one, so it is necessary an adjustment procedure to compensate such deviations. The thermostatization adjustment procedure is described in section 3.3.

2.3.6. Precautions and maintenance

The thermostatization system has two critical points: the good thermal contact between both faces of the Peltier Cell with the optical system holder and the cuvette-holder, and the good thermal contact between the temperature sensor and the cuvette-holder.

To ensure proper conditions in both points, the following cautions should be taken into account:

a) A thin, uniform layer of silicone must be placed in each face of the Peltier Cell, covering the whole surface.

b) The silicone layer should neither go beyond the surface of the Cell, nor go inside between its two faces; it would result in a thermal short-crossing that would reduce the system's performance.

c) The temperature sensor should have a silicone layer in order to make a good thermal contact with the bottom of its lodging.

For assembling these components, follow the procedures described in sections 5.11. (changing the Peltier Cell) and 5.14. (changing the temperature sensor).

2.4. Communications system

This instrument is equipped with a communication channel allowing connection with computers. The operation of this communication channel depends on the program release and the computer's application software.

2.4.1. Channel type

The communication channel is a RS-232, and uses the following connection lines:

RxD: Receiver Data
TxD: Transmitter Data
GND: Ground (0 volts)

The connector is located in the instrument's back side, rounded by a box labeled COM 1. The signals' electric level meets the E.I.A. RS-232 standard. Figure 2.10 describes the connector's signals.

2.4.2. Channel characteristics

The serial channel is pre-programmed by the manufacturer with next default parameters:

Baud rate: 9600
Timeout:: 0
Terminal number: 0

2.4.3. Information transmitted

The communications procedure uses a 'sending & waiting' protocol. Every time the transmitter sends a message, it waits for an 'ok' from the receiver. If the 'ok' message is not received, after a programmable timeout period the message is sended again. The CRC-16 error-detection code is used to check the received messages.

The communications procedure works using a MASTER-SLAVE method, so it is possible to communicate several instruments at one time. To achieve this, every instrument has to be configured with a different identification terminal number. This parameter is configured in the CONFIGURATION / COMMUNICATIONS menu.

Communications are always started by the MASTER (the computer). The SLAVE (the instrument) is in a 'hearing' mode, and only sends information when it is required by the MASTER.

The instrument can send the information below:

- Quality control values
- Concentration values

In order to get the communication between the computer and the instrument, a proper computer-running software is needed. This program save the data received from the instrument into the computer hard disk. These data are stored in an EXCEL compatible format.

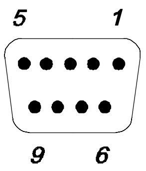
The file format used is showed in figure 2.11.

2.4.4. Programming

In order to get a suitable communication with a computer through the serial channel, it is necessary to fit the configuration parameters with the computer ones. If the computer parameters are not known, refer to its manual. Usually they are likewise programmable, in most cases from the application programs themselves.

The instrument can be programmed with the next parameters: transmission speed (bauds), timeout and terminal number. In the user's manual is explained how to program these parameters.

SERIAL PORT
COM 1



PIN	SIGNAL
1	NC
2	RXD
3	TXD
4	NC
5	GND
6	NC
7	NC
8	NC
9	NC

- Quality control values:

Test’s name		
Control 1 or Control 2		
Control’s name		
Control’s lot		
Concentration	Date	Alarm
Concentration 1	Date 1	Alarm 1
Concentration 2	Date 2	Alarm 2
Concentration n	Date n	Alarm n

Concentration values:

Test’s name	Sample’s number or patient’s code	Blank	Factor	Control-1, Control-2 or sample id.	Concentration	Units	Date

Fig.2.11

2.5. Block diagram

The block diagram (figure 2.12) is intended to give a general overview of the the electronic circuit's different parts.

2.5.1. Logarithmic amplifier

It converts the electric current coming from the photodiode in a voltage equal to its logarithm (section 2.1.4.).

2.5.2. Analog to digital converter

It digitalizes the voltage coming from the logarithmic amplifier for its further treatment by the microcontroller.

2.5.3. Lamp control

It supplies the regulated 12V that the lamp needs to work properly.

2.5.4. Filters wheel detector

It is a photointerrupter to detect the filters wheel home position. Allows the microcontroller to know the location of each filter thus being able to position them in front of the light beam.

2.5.5. Filters wheel motor control

This is a circuit that, by means of the microcontroller's logic control, supplies power to the stepper motor that moves the filters wheel.

2.5.6. Temperature sensor amplifier

This is a circuit to make the signal conditioning for the temperature sensor's voltage level in order to be measured by the microcontroller's 10-bits analog to digital converter, with a resolution enough to adjust the system.

2.5.7. Peltier cell control

This is a microcontroller-controlled power circuit that supplies the Peltier cell the adequate current to heat or cool the cell-holder.

2.5.8. Pump motor control

This is a circuit that, by means of the microcontroller's logic control, supplies the needed power to the stepper motor that moves the peristaltic pump.

2.5.9. Keyboard circuit

This circuit basically consists in the keyboard itself and some protection diodes.

2.5.10. Printer control

It consists in the power circuits that allow the orders coming from the microcontroller to act on the printer, either moving the motors or heating the thermal head points.

2.5.11. Display circuit

This circuit consists in the display itself, the control and supply lines, one inverter circuit for the CFL backlight and one circuit to control the LCD contrast adjustment.

2.5.12. RS-232 channel circuit

It is formed by the circuits needed to make the signal conditioning from TTL voltage level to the RS-232 standard. The ACIA is integrated in the microcontroller itself.

2.5.13. Fan control

This is a circuit that measures the temperature in the power supply's heat sink and changes the fan's speed according to the cooling necessity. A more silent working conditions are thus achieved.

2.5.14. Microcontroller

By means of its program, it is in charge of linking and controlling almost all the instrument systems. Only the fan's circuit and the lamp's one are not controlled by the microcontroller.

2.5.15. Power supply

It is in charge of supplying the needed voltages to the different instrument parts.

2.5.16. Reset and battery-backup supervisory circuit

When the instrument is turned on, this circuit is in charge of keeping the microcontroller and other chips (like memories) in a ‘reset state’ until the supply voltage reaches the proper working level, avoiding undesired effects when the instrument is powered on, as well as protecting the RAM against erroneous writings during the on / off voltage transitions.

Also, this circuit provides a batery backup switchover every time the instrument is switched ON/OFF

2.6. Electronic circuit description

This section describes the different electronic parts, following the functional structure given in section 2.5.

2.6.1. Logarithmic amplifier

(See schema E33001A, sheet 1)

The logarithmic amplifier is formed by the hybrid circuit LOG-100 (U16). Its supply voltage is $\pm$ 15 V. C90, C91, C96 and C97 are bypass capacitors that store electrical charge that is released to the power line whenever a transient voltage spike occurs. The photodiode is connected between ground and the input I1 (1/U16). A reference current (section 2.1.4.) is generated in the 2.5 V voltage regulator TL431CD (U15) and the T-circuit formed by R45, R51 and R52. Its nominal value is 100 nA. The LOG-100 has the output OUT (7/U16) connected to the pin K1 (3/U16), thus being the logarithmic conversion constant (K) equal to 1. The capacitor C92 is for circuit stability.

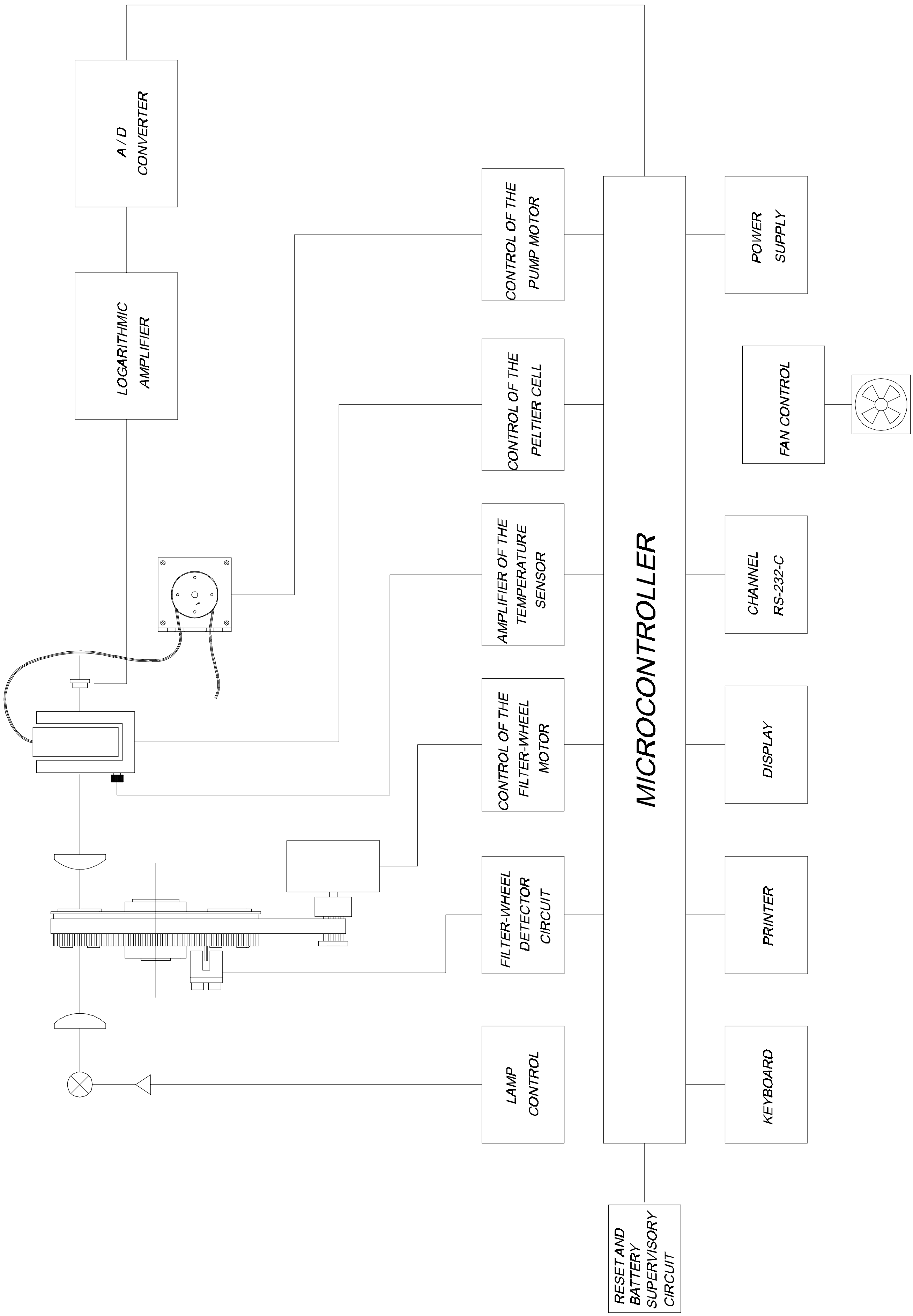

A / D CONVERTER
LOGARITHMIC AMPLIFIER
CONTROL OF THE PUMP MOTOR
CONTROL OF THE PELTIER CELL
AMPLIFIER OF THE TEMPERATURE SENSOR
CONTROL OF THE FILTER-WHEEL MOTOR
FILTER-WHEEL DETECTOR CIRCUIT
LAMP CONTROL
MICROCONTROLLER
POWER SUPPLY
FAN CONTROL
CHANNEL RS-232-C
DISPLAY
PRINTER
KEYBOARD
RESET AND BATTERY SUPERVISORY CIRCUIT

Fig. 2.12

2.6.2. Analog to digital converter

(See schema E33001A, sheet n. 1)

The logarithmic amplifier's output voltage (7/U16) is applied to the A/D converter's input VIN(+) (11/U19) through a RC net formed by R56 and C93. This converter takes as a reference the U15 2.5 V voltage and is supplied at ±5 V. The voltages are reached from ±15 V by means of the D16 and D17 zeners and bypassed using the capacitors C80, C81, C83 and C84. The capacitors C99, C100, C101 and the resistor R60 belong to the converter circuit. This capacitors must be of polypropylene type in order to have very low leakage currents.

As the voltage in 7/U16 can vary in the ±15 V range while the input voltage of 11/U19 cannot exceed the U19 supply voltage (5 V), the circuit formed by D8, D9, D10, D12, R43 and R44 protect it against overvoltages.

2.6.3. Lamp control

(See schema E33001A, sheet n. 2)

The lamp's power supply is done through the circuit formed by the RG1 regulator. It receives the non-regulated voltage from the 0-15 Vac transformer's coiling. This voltage is rectified by the bridge D2 and filtered by C14 and C15 (C17 is the bypass capacitor). The 12V output voltage is given by the resistors R19 and R20.

2.6.4. Filter wheel detector

(See schemes E33009A and E33001A, sheet n. 1)

The wheel detector consists in the photointerrupter MCT-81 according to the schema E33009A and it is mounted on the printed circuit reference 1363. The schema E33001A shows the resistor R46 connected to the emitter photodiode's anode, as a power supply, and the resistor R41 connected to the collector, as a load. From this point the logic signal is taken and read by the microcontroller pin PC4 (15/U13).

Under normal conditions, the photodiode's infra-red light reaches the phototransistor, which starts to work in saturation mode and the signal in its collector is a logic "0". When the filters wheel turns and the detection stem interrupts the light from the photodiode, the transistor stops conducing and the signal in its collector is a logic "1".

2.6.5. Filters wheel motor control

(See schema E33001A, sheet n. 2)

The filters wheel stepper motor control is achieved by two integrated circuits PBL3717A (U5 and U6). These circuits are constant current stepper motor drivers. Each one supplies the current to one of the motor coils. This current depends of the reference voltage applied in the REF pins (11/U5 and 11/U6). This voltage is generated by the 12 V zener D3, the resistors R23 (in U5) and R24 (in U6) and the internal voltage dividers of these circuits. C13 and C36 are bypass capacitors for the +5 V supply voltage of these circuits. The other connected components complete its operation.

2.6.6. Temperature sensor amplifier

(See schema E33001A, sheet n. 1)

The temperature sensor generates a voltage proportional to the temperature expressed in Kelvin degrees (Celsius + 273), equal to 0.01 V/°K. So, for instance,

at 25°C VT = (25+273) x 0.01 = 2.98 V
at 37°C VT = (37+273) x 0.01 = 3.10 V

The U20 amplifier and its associated circuit make these voltages adequate to be read with the maximum resolution by the 10-bit A/D converter of the Hitachi H8/3003 microcontroller. The adequate voltage exits by 6/U20 and it is applied to the microcontroller's input AN0 (86/U13) through the resistor R47.

As the voltage coming from 6/U20 can vary in the range ±15 V and the input voltage of 86/U13 cannot exceed the converter reference voltage applied to AVCC (84/U13) (5 V), the circuit formed by D11, D13, D14, D15 and R50 is in charge of keeping this input between this value and ground.

2.6.7. Peltier Cell control

(See schema E33001A, sheets n. 1 and 2)

A low-voltage, full-wave rectified voltage is applied to the Peltier Cell, in the sense adequate for heating or cooling. Although the use of this current lowers the performance of the cell, its use is justified by the simplicity of the circuit.

The full-wave rectification in both senses is achieved using two triacs and a center-tapped coiling. Each triac can let a positive or negative half-wave pass, when convenient. The circuit formed by the amplifier TL072CD (U3A), that works as a comparator, and the transistor BC548 (T5), that makes the output

1/U3A (±15 V) adequate to logic level (0 at +5 V), form a polarity detector for the alternating voltage that supplies the power control circuit.

This signal is applied to the microcontroller by the pin P71 (87/U13) in order to know which triac and when should be activated. The microcontroller activates the triacs by means of two signals leaving by pins PA6 (111/U13) and PA7 (112/U13) and that, together with the polarity detection signal (collector T5) are applied to the programmable logic circuit XC9572-PC84 (U9) to generate the two triacs‘ control signals (77/U9 and 6/U9) and avoid a simultaneous activation caused by a program error. Circuits 2/U1A, 4/U1B and the transistors T1 and T3 form the triacs’ activation circuit. Should it occur, the fuses F3 and F4 in the common coil protect the transformer.

The result of this procedure is that each triac supplies the Peltier Cell a half-wave, in the same sense, depending on the heating or cooling requirements.

2.6.8. Pump motor control

(See schema E33001A, sheet n. 2)

This circuit, formed by the integrated circuits U2 and U4, is similar to the one used for the filters wheel control; the only difference between them is the R8 and R10 resistor values, because the current in this motor is different. Thus refer to section 2.6.5. for its description.

2.6.9. Keyboard circuit

(See schemes E33005A, E33003A and E33001A, sheet n. 1)

The membrane-type keyboard forms a contact matrix and detects the pressed key by scanning (schema E33005A). The keyboard is connected to the printed circuit I33004 by J10. The lines of this connector pass directly to the connector J5 (schema E33003A) that carries them to the printed circuit I33002.

The scanning is generated in the lines referenced KBD[0..9] (pins 65, 63, 62, 61, 58, 57, 56, 55, 54 and 53) of U9 (XC9572-PC84) by the microcontroller, that sends control commands to U9 using the data bus (DB[0..7] and the address bus (ADD[0..23]). The line quiescent mode is the logic 1. Only one of them is activated by the logic 0 at one time. The keyboard status is read by means of the lines KBD0 a KBD4 (65, 63, 62 and 61 of U9). If there is no key pressed, the status is the logic high level because of the pull-up resistor array AR2. When a key is pressed, it is produced a contact with one of the scanning lines and logic low level is leaded to the associated read line. The microcontroller detects the pressed keys by means of U9 using the data bus.

Diodes D4 to D8 prevent from undesired short circuits between one scan line at "0" and other at "1" when pressing two keys at the same reading line simultaneously.

2.6.10. Printer control

(See schemes E33003A and E33001A, sheet n. 1)

The thermal printer is controlled by means of its two own unipolar stepper motors. One moves the head and the other the paper feed.

Eight thermal points form the printer head and a micro-switch detects the head's initial position (HOME). This micro-switch has a pull-up resistor (AR1) and the signal is read by the microcontroller pin P60 (66/U13).

Both motors and thermal points are controlled by the microcontroller by means of U9 (eschema E33001A). The motors are controlled using the bus MTR[0..7] and the thermal points through the bus PRT[0..7]. These logic signals are powered by the drivers ULN2803A (U1 and U3). The capacitors C12, C13, C15, C17, C24 and C25 are the bypass ones.

2.6.11. Display circuit

(See schema E33003A and E33001A sheet n. 1)

As a screen, it is used a graphic liquid crystal display (Hitachi LMG7520RPFC) with a CFL backlight. Its resolution is 320 x 240 dots. The LCD is connected to J2 in the printed circuit I33004A. Both control signals and data are sent to the display by U9, according microcontroller control commands.

The J2's pin 4 (VDD) is directly connected to +5V (Vcc) supply voltage. The capacitors C7 and C9 are for bypassing.

The LCD contrast is controlled by means of a negative adjustable voltage from 0 to –22V through the VEE (P6/J2) line. This adjustable voltage Vee is generated by the switching regulator LT1111 (U2). The switching regulator output voltage is controlled by the duty cycle of the PWM signal sent by the microcontroller (P4/U13):

PWM : 1-3 KHz
- 0% Duty Cycle: 0V
- 100% Duty Cycle: -25V

The LCD backlight supply voltage is connected to J8. The backlight supply voltage is generated from Vpm (+5V) by the inverter circuit (see the block in wich the TRF1 transformer is).

Look out: **The backlight supply voltage (J8) is up to 300Vrms, 85 KHz and 6mArms. The lamp start voltage is 1000V minimum.**

2.6.12. RS-232 channel circuit

(See schema E33001A, sheet nº 1)

The serial communication is achieved by one of the two ACIA integrated in the microcontroller. It supplies all the necessary functions and the communication uses two lines, TxD2(transmitter data, 20/U13) and RxD (receiver data 22/U13).

The lines' logic level is TTL. The signal conditioning to the RS-232-C E.I.A. standard is made by the integrated circuit MAX202CSE (U17) and a set of associated capacitors. They generate the needed positive and negative voltages. The communication lines enter and exit through the J15 connector (Figure 2.10).

2.6.13. Fan control

(See schema E33001A, sheet n. 2 and 3)

The fan's power supply is done by an independent circuit, formed by the 24 V transformer coiling, the rectifier bridge D6 and the capacitors C38 and C52 that generate a non-regulated voltage. The voltage to apply to the fan is controlled by the regulator RG6. The output voltage is given by the voltage divider formed by R29 and NTC1, wich is in contact whith the power supply heat sink and makes the voltage increase when it becomes hot. In this way, the higher is the load or the external temperature, the faster is the fan's operation, thus achieving a more silent function under normal conditions.

2.6.14. Microcontroller

(See schema E33001A, sheet n. 1)

The microcontroller circuit is formed by the H8/3003 Hitachi microcontroller (U13). It is a last-generation microcontroller, incorporating peripherics such as I/O lines, counters, ACIA's, and a 10-bit A/D converter with eight analog channels, among others, thus minimizing circuitry.

The microcontroller has internal memory and control signals to connect external memories.

Both code and data are stored in the 2 Mbytes FLASH memory (U11). A 512 Kbytes RAM (U12) is also used. This RAM is provided with a battery powered supply voltage (Vbat).

The chip select signals ared decoded in the CPLD (U9).

U10 is intended to connect a EPROM 27C4001. If the jumper JP2 is closed, the microcontroller seeks for the code in the EPROM (U10) instead of in the FLASH (U11).

Usually U10 is used only by the manufacturer to load the monitor program in U11 the first time. Afterwards, it is no longer usefull at all.

2.6.15. Power supply

(See schema E33001A, sheet n. 2)

The power supply is in charge of supplying the voltages and currents needed in the different parts of the circuit. The lamp supply has been described in section 2.6.3. and the fan supply in section 2.6.13.

Besides these power supplies, there is the ±15 V one, formed by the regulators RG2 and RG3 with their associated circuits, and the +5 V one. This power supply departs from a 0 to 9 V transformer coiling. The alternate voltage is rectified by the bridge D4, filtered by C39 and C40 and the high-frequency is bypassed by C50. The regulated voltage obtained in this way is applied to three regulators. RG4 generates the +5 V to supply the thermal head of the printer, RG5 supplies its motors and RG7 generates the +5 V for the logic circuits.

2.6.16. Microcontroller supervisory and reset circuit

(See schema E33001A, sheet n. 1 y 3)

The microcontroller supervisory and reset circuit is formed by the integrated circuit MAX691A (U7). This chip measures the supply voltage and when it is below a certain reset-threshold voltage, the signals /RESET y CCE are active. The /RESET signal makes the microcontroller start again and the CCE signal joined to the U8A gate protect the RAM against undesired writings during the powering transitions.

This chip provides also a backup-battery switchover. P2/U7 is the Vout pin. When Vcc is greater than Vbatt and above the reset threshold, Vout connects to Vcc. When Vcc falls below Vbatt and is below the reset-threshold, Vout connects to Vbatt.

When the instrument is powered, the battery is always charging through R30. When mains supply falls, Vbatt supplies a backup-voltage to the RAM and to the timekeeper chip U14.

3. CHECKS AND ADJUSTMENTS

In order to simplify the failure's diagnosis and adjustments, there is included a set of test programs that allow the checking and adjustment of most of the functional parts.

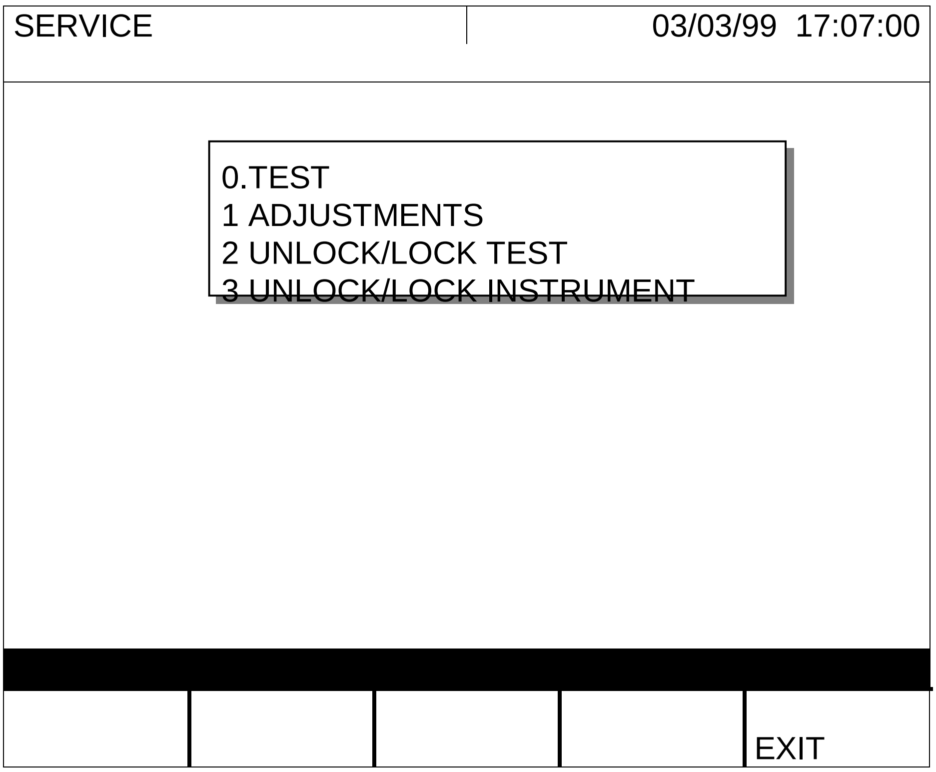
With the only exception of the peristaltic pump adjustment, accessible to the user, the access to these programs is done through the menu UTILITIES/SERVICE. Then, a password is required:

PASSWORD ... =

Input the password (Appendix VII). The display shows asterisks while typping. In case of mistake, press "C" to repeat.

3.1. Service menu

When selecting this option, the following is displayed:



3.1.1. Option TEST

By selecting this option, one can access to the diverse tests available for failure diagnosis, that appear in the following list. Its function is described in Section 4.

- SCREEN
- BUZZER
- KEYBOARD

- PRINTER
- SERIAL PORT
- MOTORS
  - PUMP STEPS LOSS
  - FILTER STEPS LOSS
- CUVETTE TEMPERATURE
- CARRY OVER
- PHOTOMETRIC
  - FILTERS SENSITIVITY
  - ELECTRONIC NOISE READINGS STABILITY
  - PRECISION
  - ACCURACY
- UNLOCK/LOCK QC TESTS

3.1.2. Option ADJUSTMENTS

By selecting this option, one can access to the utility programs to perform the adjustments of the photometry, temperature control, filter wheel and peristaltic pump.

The diverse adjustment programs are described in Section 3.2.

3.1.3. Option UNLOCK/LOCK TESTS

This option allows opening and closing the diverse tests, by selecting them either individually or all together.

The closed tests are not available to the user.

3.1.4. Option UNLOCK/LOCK instrument

This option allows opening or closing the instrument's programming. When activated, the option PROGRAMMING disappears from the main menu, thus making impossible for the user to modify the test and the units. When the instrument is re-opened, the options allowing modification of tests and units are available again.

3.2. ADJUSTMENTS

3.2.1. Photometric adjustment

The aim of this procedure is to correct the absorbance values in the range 0 – 3 A, with neutral filters previously calibrated, in order to obtain results the same as with a reference spectrophotometer. The final target is to obtain results within the tolerance range between 340 and 900 nm in the previously mentioned range of absorbances.

3.2.1.1. Materials needed

- Verified calibration neutral filters.
- Rubber bulb.
- Cotton ear picks.
- Alcohol + ether (50/50) solution.

3.2.1.2. General remarks

- Switch the instrument on 20 minutes before beginning the adjustment.
- Before beginning, take dust away from the neutral filters using the rubber bulb.

3.2.1.3. Procedure

- Enter in the UTILITIES / SERVICE (Password...) / ADJUSTMENTS / PHOTOMETRIC menu
- Program the values requested in the first display.
- Press the function key CHECK VALUES
- Press the function key EDIT VALUES and then input all the standard values for each filter. When the last value for each filter is input, the display automatically changes to the next filter. When the last filter is completed, the program exits the Edit mode (the Edit mode can be left at any time by pressing the key EXIT). In case of mistake while entering the values, press C to delete the value and key it in again.

Proceed as follows to correct previously validated values:

Exit the Edit mode by the function key EXIT (taking care of previously validating with ENTER the last value).

Enter again in the Edit mode if the erroneous value is still on the screen. Otherwise, use the cursor –up and –down keys until the desired values appear on the screen.

Press ENTER until the cursor is located on the standard to be edited. (Another option is to enter in the Edit mode with the first standard of the first filter and to press repeatedly ENTER until the cursor is located on the standard to be edited).

Press the function key ADJUST. The program will request the standard values to be introduced. Once the standards read, an automatic printing process starts, in which the following data appear for each wavelength and standard: the absorbance read, the expected absorbance, the relative and absolute errors. The tolerances appear in Table II.1 of Appendix II.

Press the function key EXIT. The program asks if the adjustment is to be saved. Answer YES if the relative errors obtained are within the tolerance ranges.

If there is no accomplishment with the tolerance ranges, repeat the procedure in order to discard a mistake due to factors like errors during the procedure, in the calibrators and/or instability of the electric supply.

Once all these external factors discarded, if the instrument does not accomplish the ranges and presents abnormal values in the upper part or the absorbance range, check the photodiode wire and the welding in the analog part of the printed circuit board.

3.2.2. Thermostatic system adjustment

This procedure describes the way to adjust the thermostatic circuit of the cuvette-holder. Both the cuvette-holder temperature sensor and its associated electronic circuit have some tolerances that must be compensated in order to have the cuvette temperature as programmed. The adjustment allows, using a thermometer, the calculation of the correction coefficients needed to perform this compensation.

3.2.2.1. Materials needed

Calibrated digital thermometer and temperature probe.

3.2.2.2. General remarks

- Switch the instrument on at least 20 minutes before beginning the adjustment.
- It is very important to take into account the corrections indicated in the digital thermometer when registering the temperatures.

3.2.2.3. Procedure

- Enter in the UTILITIES / SERVICE (Password...) / ADJUSTMENTS / HEATING menu
- Press the function key ADJUSTMENTS. The message “Insert the temp. probe and press ENTER” is displayed.
- Insert the calibrated digital thermometer’s temperature probe into the cuvette-holder and press ENTER. The message “Heating” is displayed with a time counter going down.
- When the time reaches zero, the message “Input cuvette temperature at 25ºC” appears. Input the temperature measured by the thermometer (corrected) and press ENTER. The message “Heating” with a time counter going down is displayed again.
- When the time reaches zero, the message “Input cuvette temperature at 37ºC” appears. Input the temperature measured by the thermometer (corrected) and press ENTER.

Press the function key EXIT. The program asks if the adjustment is to be saved. Answer YES if the results obtained are within the tolerance ranges.

3.2.2.4. Explanation of the list parameters

- STEP: Each of the adjustment phases.

- READ TEMPERATURE: Theoretical temperature that is read before applying the correction factors.

- CURRENT TEMPERATURE: Temperature indicated by the thermometer, that must be typped by means of the keyboard.

- ABSOLUTE ERROR: Difference in degrees between the read and real temperatures.

$$E = T_{real} - T_{read}$$

- RELATIVE ERROR: Percentage of deviation of the real temperature with regards to the temperature read.

$$E_{relative} = \frac{T_{real} - T_{read}}{T_{read}}$$

- OFFSET: Additive correction factor.

- SLOPE: Multiplicative correction factor.

3.2.2.4. Option CHECK

Allows the accuracy's checking at a given temperature. To select this option, press the function key CHECK in the UTILITIES / SERVICE (Password...) / ADJUSTMENTS / HEATING menu. The cursor appears in the line:

TEMPERATURE TO CHECK: ____

Insert the calibrated digital thermometer's temperature probe into the cuvette-holder, Input the temperature to be checked and press ENTER. The message "Heating" is displayed with a time counter going down.

After the five minutes, the screen's prompt asks for a new temperature. Check the reached temperature in the external thermometer.

3.2.3. Filters wheel adjustment

This procedure describes the way to adjust the optimal position of the filters in the optical path of the reading group. The theoretical position is established by the wheel reference photodetector but, because of the mechanical tolerances, a further correction is necessary to optimize centering.

3.2.3.1. Materials needed

- Soft paper WYPALL LITE (56 g/cm^2) (SCOTT).
- Washing solution (Code 20103).
- Alcohol + Ether (50/50) solution.
- Assay tubes.
- Distilled water.
- Closed circuit flow-thru cuvette.

3.2.3.2. General remarks

- Switch the instrument on at least 20 minutes before beginning the adjustment.
- This procedure can be performer either automatic or manually. The automatic procedure is recommended.
- The adjustment is performed with the filter in the position nº 1 (340 nm).
- Clean the outer faces of the cuvette with the ethanol/ether solution, and dry with the WYPALL LITE paper.
- Insert the cuvette into its holder.
- Wash the inside of the cuvette by performing a washing with 1 mL washing solution and then abundant distilled water with the key “WASH”.
- Check the absence of air bubbles in the inside of the cuvette, by taking if out of its lodging and looking through.

3.2.3.3. Manual mode

When entering in this menu (UTILITIES / SERVICE (Password...) / ADJUSTMENTS / FILTERS WHEEL), the display shows the programmed values. Their meaning is as follows:

SENSITIVITY : indicates the current reading of the photometric sensitivity in the current filter position.

STEP: indicates the number of steps that the wheel has done from the reference photodetector until the current position of the filter nº 1. The increase or decrease regarding to the number without correction is indicated between brackets.

- Press the function key MANUAL and, using the up- and down- cursor keys increase or decrease the steps until the maximum sensitivity position. If several consecutive steps give the same sensitivity, leave it in the center of the range.

- Validation criteria: Check that the increase or decrease in steps in within the range indicated in Table II.2 in Appendix II. Otherwise, repeat the procedure.

- Once the adjustment completed, press the function key EXIT and answer YES to the question “Save values ?”. To exit the process without saving, thus keeping the former values, answer NO or press ESC instead of EXIT.

- Press the function key EXIT again. Select the sensitivity test, by the following path: UTILITIES / SERVICE (Password) / TESTS / PHOTOMETRIC / FILTERS SENSITIVITY.

  WARNING: Check that the test is performed with the cover closed.

- The reading process for each filter begins. A list of the sensitivity (nA) obtained for each filter is printed. The orientative ranges appear in table II.6 of Appendix II. In the case the results are considered not valid, verify the following points:

- The cuvette model is adequate, and the distance between the light path hole and the base of the cuvette is Z = 8,5 mm.

- The inside and outside of the cuvette is clean.

- There are no bubbles inside the cuvette.

- The connections of tubing and adaptors are tight.

- The teflon tubing is not strangled.

- The filters wheel is properly positioned.

Press the function key EXIT, wash with distilled water and air the flow-thru cuvette, by pressing the key WASH, put it in the stand-by position and loosen the peristaltic pump silicone tubing.

3.2.3.4. Automatic mode

When entering in this menu (UTILITIES / SERVICE (Password...) / ADJUSTMENTS / FILTERS WHEEL), the display shows the programmed values. Their meaning is as follows:

SENSITIVITY : indicates the current reading of the photometric sensitivity in the current filter position.

STEP: indicates the number of steps that the wheel has done from the reference photodetector until the current position of the filter nº 1. The increase or decrease regarding to the number without correction is indicated between brackets.

- Press the function key AUTOMATIC. The instrument with look for the position with maximum sensitivity.

- Validation criteria: Check that the increase or decrease in steps in within the range indicated in Table II.2 in Appendix II. Otherwise, repeat the procedure.

- Once the adjustment completed, press the function key EXIT and answer YES to the question “Save values ?”. To exit the process without saving, thus keeping the former values, answer NO or press ESC instead of EXIT.

- Press the function key EXIT again. Select the sensitivity test, by the following path: UTILITIES / SERVICE (Password) / TESTS / PHOTOMETRIC / FILTERS SENSITIVITY.

  WARNING: Check that the test is performed with the cover closed.

- The reading process for each filter begins. A list of the sensitivity (nA) obtained for each filter is printed. The orientative ranges appear in table II.6 of Appendix II. In the case the results are considered not valid, verify the following points:

- The cuvette model is adequate, and the distance between the light path hole and the base of the cuvette is Z = 8,5 mm.

- The inside and outside of the cuvette is clean.

- There are no bubbles inside the cuvette.

- The connections of tubing and adaptors are tight.

- The teflon tubing is not strangled.

- The filters wheel is properly positioned.

Press the function key EXIT, wash with distilled water and air the flow-thru cuvette, by pressing the key WASH, put it in the stand-by position and loosen the peristaltic pump silicone tubing.

3.2.4. Peristaltic pump adjustment

This procedure describes the way to adjust the flow of the peristaltic pump and the positioning of the sample in the cuvette. The pump flow depends on the number of steps done by the motor and on the internal diameter of the peristaltic tubing. Slight differences in the internal diameter in the different tubes may result in variations in the flow, that can also be affected by slight deformations caused by repeated use. Also slight differences in length or diameter can affect the positioning of the sample. This adjustment is intended to compensate the variations due to these tolerances and the aging of the tubing.

3.2.4.1. Materials needed

- Volume adjustment tool.
- 5 mL pipette (0.05 mL / mark).
- Analytical balance (optional).
- Caliper square (optional)

3.2.4.2. General remarks

- Switch the instrument on at least 20 minutes before beginning the adjustment.

- This procedure can be performer either automatic or manually. The automatic procedure is recommended.

- The function CHECK allows input of a volume between 100 and 5000 • l, that are checked by aspiration cycles. When selecting this option, the cursor appears in the line:

  CHECK VOLUME (• L): ____

- Input in the volume in • L to be checked and press ENTER. The message "Insert tube with water and press PUMP" is displayed.

- Insert a tube with water in position of aspiration and press PUMP.

3.2.4.3. Check method

SAMPLE VOLUME: Fill an assay tube with distilled water and weigh it in an analytical balance. Weigh it again after an aspiration cycle. The difference in grams is equal to the volumen in mL.

POSITIONING: When the aspiration cycle is completed, check that there is a 5 mm-tail (0 – 10 mm) of the sample that has not yet entered the cuvette. Use the caliper square if necessary.

3.2.4.4. Manual mode

- Insert the flow-thru cuvette in its holder, making sure that its position is correct.

- SAMPLE VOLUME: It corresponds to the adjustment of the sipped volume. Insert the number of quarters of step that the pump must perform to sip 5 mL and press ENTER. The theoretical value is 18340, equivalent to 1.09 • L per step (the motor works with quarters of step: 0.2725 • l per each quarter of step). The number to input is an estimate and should be determined by "error and trial", using the function CHECK of the menu ADJUST PUMP.

- POSITIONING: It corresponds to the adjustment of the positioning of the sample. Input the number of quarters of step needed for the sample to be positioned into the cuvette with a tail of only 5 mm (0 – 10 mm) without entering into the cuvette and press ENTER. The theoretical value is 600 quarters of step. The number is an estimate and should be determined by "error and trial", using the function CHECK of the menu ADJUST PUMP.

- PUMP DELAY: It corresponds to the elapsed time between the aspiration cycle and the positioning into the cuvette. Input the number of seconds (recommended 2) and press ENTER.

The manual adjustment is completed. To check it, use the volume adjustment tool, filled with water until the upper mark (3 mL).

- Press the function key CHECK.

- Input 2000 (2 mL) as sample volume.

- Perform an aspiration cycle with the volume adjustment tool and check that:

    a) The sample tail that has not entered the cuvette is 0 – 10 mm long.

    b) The level of water remaining in the tool is between the two lower marks (equivalent to 1 mL $\pm$ tolerance)

- Press EXIT and answer YES or NO to save the adjustment parameters or not. Press ENTER. Press EXIT again to go back to the main menu.

3.2.4.5. Automatic mode

- Insert the flow-thru cuvette in its holder, making sure that its position is correct.

- Press the function key AUTOMATIC.

- Press the function key SAMPLE VOLUME. The message "Put a tube with 5 mL water and press PUMP" is displayed.

- Pipet precisely 5 mL distilled water into an assay tube and proceed as requested, taking special care that the end of the sipping tubing reaches the bottom of the assay tube.

- Approximately 4 mL are sipped at normal speed and then continues slowly. The following message appears: "After sipping the last drop press ENTER".

- Look carefully at the bottom of the tube and proceed as requested.

- Press the function key POSITION. The message "Insert tube with water and press PUMP" is displayed.

- Proceed as requested. The pump sips the water and, a few seconds later, the following message appears: “Remove the tube and press ENTER”.

- Proceed as requested. The pump works and the instrument calculates the positioning. During this process the instrument performs photometric readings, and therefore the cover must be closed. The whole process takes 70 seconds.

- Press the function key CHECK.

- Input 2000 as sample volume (2 mL).

- Perform an aspiration cycle with the volume adjustment tool filled with water until the upper mark (3 mL) and check that:

  a) The sample tail that has not entered the cuvette is 0 – 10 mm long.

  c) The level of water remaining in the tool is between the two lower marks (equivalent to 1 mL $\pm$ tolerance).

- Press EXIT and answer YES or NO to save the adjustment parameters or not. Press ENTER. Press EXIT again to go back to the main menu.

3.3. Transformer and power supply checking

Before connecting the instrument to the mains:

a) Check that the voltage selector is that of the supply voltage (rear part of the instrument). If not, select the correct one by slipping the selector (with the help of a screw-driver).

b) Check the ground connection. With the mains wire unplugged, connect the ohmmeter between the ground connection terminal in the power socket and the checkpoint TP4 in the main board and check that the resistance is lower than 0.1 ohm.

c) Disconnect the connector J4 of the main board (transformer) and plug the instrument. Using a voltmeter, read the alternating voltages in the transformer windings and check that they are within the tolerance limits in the table of Section II.4.

d) Unplug the instrument and connect J4. Plug the instrument again.

3.4. – Fan checking

a) Check that the airflow is outward propelled.

b) Take a measurement of the voltage in the connector J8 (positive pin: 1; negative pin: 3) and check that it is into the values showed in section II.8. If they are not correct, look at the monocard heat sink silicone and the properly fan condition.

3.5. – Optical system checking

If the optical system has been disassembled in order to replace one of its parts (lens, Peltier cell, etc.) or by any other cause, once assembled again the alignment must be checked.

a) Take the case away.

b) Take the photodiode away from its lodgement.

c) Insert the light beam centering checking tool into the cuvette holder. The screen side must be faced towards the lamp.

d) Switch the instrument on.

e) Look at the tool screen through the photodiode lodgement.

f) Check that the light spot is into the outer circle (the inner circle simulates the 1.5 mm light pass in the flow cuvette).

g) If the step f is correct, it means that the reading group is centered, then jump to the step n, else continue from the next step.

h) Remove the lamp-holder set. Take note of its current position.

i) According to the point of view of deepness and inclination, check if the lamp is properly positioned. In this case, place it again rotating it 180 degrees and check the light spot again (see step f).

j) If there were problems with the lamp-holder set, fix them up, place it again in the last position and check again the light spot (see step f). If the problems persist, change the lamp position and jump to step f.

k) If the problems persist in spite of all the above handling, change the lamp for a new one and jump to step f.

l) Place the photodiode in its lodgement again, taking care of its cleanness.

m) Close the instrument.

n) At the end, a functional checking of the optical axis light beam centering is done by a sensitivity test with a flow-cuvette with distilled water (or a macro-cuvette with distilled water)

3.6. Check of the sensitivity with flow cuvette

a) Switch the instrument on.

b) Clean the external faces of the cuvette with a mixture of ethylic alcohol and ether, then dry it with a soft paper (Section 2.1.6).

c) Insert the flow cuvette and its connections.

d) Wash the cuvette with 1 mL washing solution and then with abundant distilled water, by means of the “WASH” key.

e) Make sure that the instrument is on for at least 20 minutes.

f) Fill the cuvette with distilled water, by means of the “WASH” key. Check the absence of air bubbles inside the cuvette.

g) With the cuvette filled with water measure the sensitivity of each filter. To do it, go to the menu:

   UTILITIES / SERVICE / TESTS / PHOTOMETRIC / FILTERS SENSITIVITY

- Make sure that, during the test, the cover is closed.

h) The reading process for each filter begins. A list of sensitivities (expressed in nA) for each filter is printed.

i) Once the list is completed, check that the values fall within the ranges appearing in the table of Section II.6.

   Otherwise, check that:
   - The inside and outside of the cuvette is clean.
   - There are no bubbles inside the cuvette.
   - The tubing connections are tight.
   - The teflon tube is not strangled anywhere.
   - The filter wheel is correctly positioned.

4. CHECK TESTS

4.1. Activation of a test

The program includes a set of test programs allowing the performance's verification of diverse parts of the instrument and help in trouble-shooting. To perform a test, follow the path:

UTILITIES / SERVICE (Password) / TESTS

The tests available are described in the following sections.

4.2. Screen

When this test is carried out, each time the key ENTER is pressed a different action is done on the screen. Check that the actions are uniform and there is no anomalous function of the display.

4.3. Buzzer

When performing this test, the internal beeper sounds several times.

4.4. Keyboard

Each time a key is pressed, the beeper sounds and the key is displayed. Press EXIT twice to exit.

4.5. Printer

A set of characters is printed and then 10 rows of asterisks with the 10 programmable intensities.

Check that the characters listed are clear and legible and that the scale of intensities is growing and regular.

4.6. Serial Port RS-232

This test sends the key being pressed by the line TxD (pin 5 of the COM1 connector) (Fig. 2.7) and should be received by the line RxD (pin 3 of the COM1 connector). To do this, it is necessary to make a bridge between these lines. Each time a key is pressed, the corresponding character is showed in the section of the display corresponding to the characters sent, and the same character should appear in the section of characters received. Exit by pressing

F5. From this test it is possible to modify the communication configuration parameters.

4.7. Motors

This menu allows checking two motors: the peristaltic pump motor and the filters wheel motor.

4.7.1. Loss of steps of the peristaltic pump

Proceed as follows:

a) Turn the pump rotor by hand, until the arrow is in front of that of its support.

b) Press ENTER. The pump operates for some seconds.

c) Check that the rotor turns without eccentricities or abnormal noises.

d) When stopped again, check that the two arrows keep the same original position.

4.7.2. Loss of steps of the filters wheel

The filters wheel performs several movements. Afterwards, the instrument displays “PASSED” if a loss of steps is not detected or “NOT PASSED” otherwise.

4.8. Cuvette temperature

Allows the accuracy’s checking at a given temperature. To select this option, press the function key CHECK in the UTILITIES / SERVICE (Password...) / ADJUSTMENTS / HEATING menu. The cursor appears in the line:

TEMPERATURE TO CHECK: ____

Insert the calibrated digital thermometer’s temperature probe into the cuvette-holder, Input the temperature to be checked and press ENTER. The message “Heating” is displayed with a time counter going down.

After the five minutes, the screen’s prompt asks for a new temperature. Check the reached temperature in the external thermometer.

4.9. Carry Over

This check allows studying the cross-contamination that happens in case of consecutive readings of samples that strongly differ in absorbance (usually the first with high absorbance and the second with low absorbance).

The instrument requests:

- Reading filter
- Stabilization time
- Sample volume

Press F1 to begin readings. Insert the baseline and then 5 times the first sample (R1 to R5) and 5 times the second (R6 to R10). The contamination is calculated according to the formula:

$$\text{Contamination} = \left(\frac{R6}{X\ av} - 1 \right) \times 100$$

$$\text{Where } X\ av = \frac{R7 + R8 + R9 + R10}{4}$$

4.10. Photometry

4.10.1. Filter sensitivity

This test allows knowing the current generated in the photodiode for a given amount of light, as a measurement of the sensitivity of the instrument for each filter.

The sensitivity is read for all the filters programmed in the filters table. This test can be performed without cuvette (sensitivity with air) or with cuvette. In this last case it is necessary to fill it with water by performing a WASH cycle.
The sensitivities read should fall within the ranges indicated in the table of Appendix II, Section 4 (for sensitivity without cuvette) or in the table of Appendix II, Section 6, for sensitivity with flow cuvette filled with water.

4.10.2. Electric noise

This test allows knowing the noise detected by the converter in the signal coming from the logarithmic amplifier.

Check that the case and cover are closed to avoid entrance of light.

The instrument selects the 340 nm filter and zeroes. After approximately 1 minunte, the results are displayed. They must be within the tolerance ranges of the table of Section II.5.

4.10.3. Stability of the readings

This test allows analyzing the stability of a set of repeated readings done with the same sample.

When beginning, the instrument requests the following:

- Reading filter (340)
- Stabilization time (1)
- Sample volume (400)
- Interval time (1)
- Number of intervals (30)

Values between brackets are those recommended for a routine test.

Program all these parameters, depending on the sample. The duration of the test will be the result of the interval time and the number of intervals.

Press F1 to begin. The instrument requests the baseline and then the sample. If the sample is the same as the baseline, the zero stability can be checked.

For a routine test, make the BASELINE with the calibrator nº 0 of the calibration kit (SERVICE TOOLS, code 005) and use calibrator nº 4 as the SAMPLE.

The number of the reading, the time and the absorbance are printed. At the end, the statistical data are printed: average, maximum and minimum absorbance.

4.10.4. Precision

This test performs successive readings of different samples of the same liquid (repetitivity between identical samples).

The instrument requests:

- Reading filter.
- Stabilization time.
- Sample volume.
- Number of intervals.

Press F1 to begin the test.

The instrument request the baseline and then as many samples as intervals programmed. At the end, the statistical data are printed: average, coefficient of variation, maximum and minimum absorbance.

4.10.5. Accuracy

This test allows checking the accuracy when reading a sample of know absorbance.

WARNING: The reliability of this test requires a sample absorbance value determined precisely with a reference method.

When beginning the test, the instrument requests:

- Reading filter.
- Stabilization time
- Sample volume

Press F1 to begin the tst.

Insert the baseline. Then the instrument asks for the reference value. Insert the theoretical value by means of the numeric keyboard. Insert the sample when requested. The instrument prints the following data:

- Reading number.
- Absorbance applying the calibration.
- Absorbance without applying the calibration.
- Reference value (theoretical value of the sample).
- Absolute and relative errors applying the calibration.
- Absolute and relative errors without applying the calibration.

4.11. Unlock / Lock QC techniques

When leaving the factory, some memory locations contain the techniques used for the in-house quality control. They are de-activated; if they are activated again, the names of this techniques will appear again in the list of programmed tests.

This option is for internal use and has no interest for the Technical Assistance Service.

5. MAINTENANCE

5.1. Case replacement

If a case's replacement is needed or it must be removed to operate the instrument's inside, proceed as follows (figure 5.1):

a) With the instrument turned off, remove the supply wire.

b) Remove the printer paper roll and take the aspiration tube out its guiding tube.

c) Remove the two screws (1) located in the lower part of the instrument.

d) Remove the two screws (2) located in the rear part of the instrument.

e) Carefully lift the case, inclining it a bit to the right side, and disconnect the supply strip (J7) as soon as you have room enough to introduce your hand to the inside (in PCB version I33002A080499 also disconnect the J11 flat band). Then incline the case to the right side totally, taking care that the connecting strip that joins it to the main board is not stretched.

f) In case it to be fully removed, disconnect the flat bands (J19 and J10) from the main board, and the printer and display ground tab-in terminals (12 from fig. 5.2).

It is recommended to remove the cuvette holder cover to avoid it falling down.

To place the case again or to put a new one:

a) Connect the flat bands (J9 and J10) again and the tab-in terminals.

b) Place the case again carefully, connecting the supply strip (J7) before closing the case (in PCB version I33002A080499 also connect the J11 flat band).

c) Screw the fixing screws.

d) Place the printer paper again and the aspiration tube (figures 2.6 and 2.7).

e) Place the cuvette-holder cover, if it was removed.

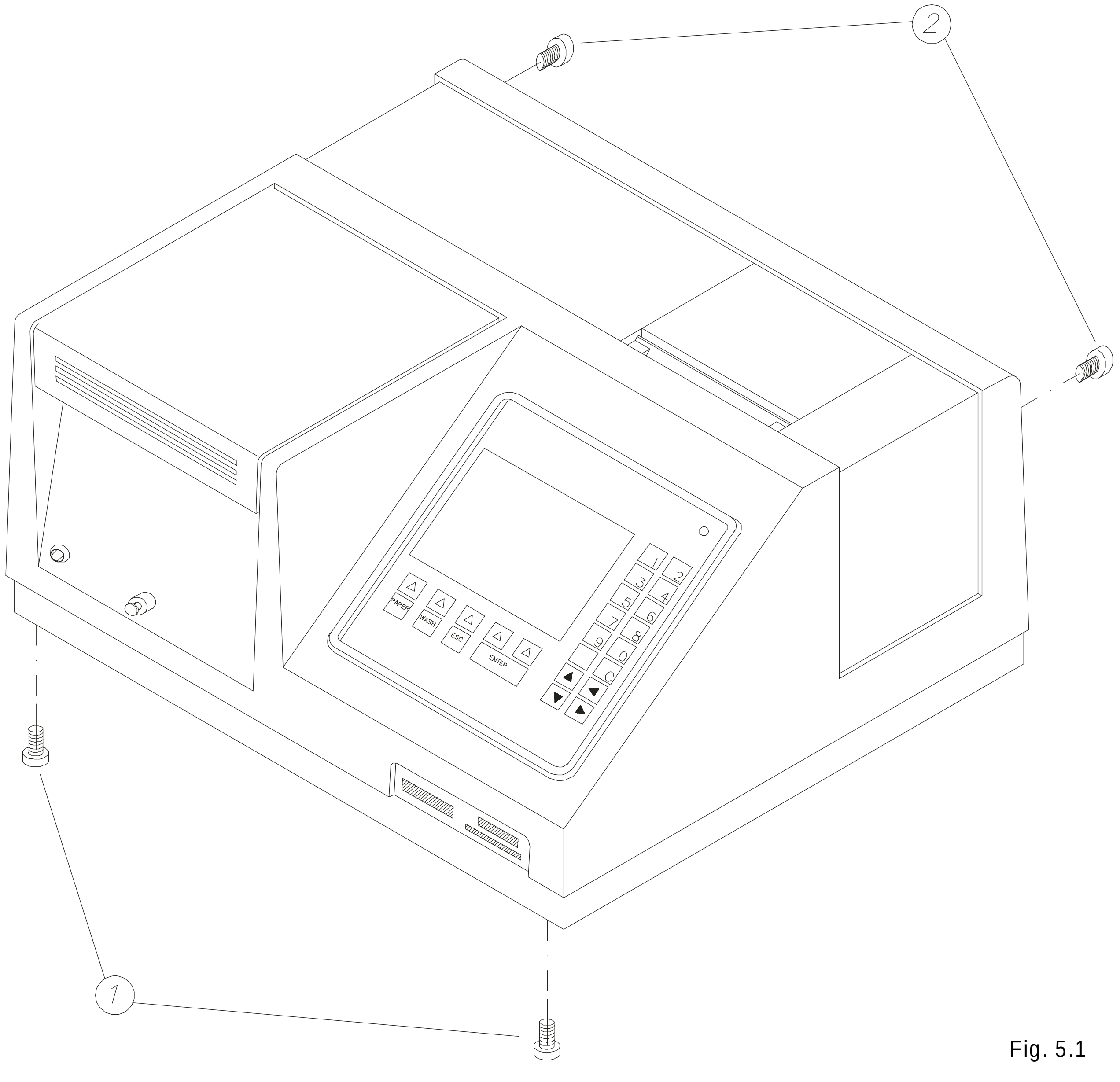


Fig. 5.1

5.2. Main board replacement

See figure 5.2

a) Disconnect all the strips reaching the board.

b) Cut the clamp that fixes the photodiode cable.

c) Unsolder the photodiode cable.

d) Remove the 5 Allen screws (1) fixing the radiator to the base.

e) Remove the three screws (2) fixing the main board to the respective separators.

To mount the board again, proceed as follows:

a) Put a thin and uniform silicone layer in the lower part of the heat sink (3).

b) Place the board again and fix it with the five Allen screws (1) and the three screws (2).

c) Solder the photodiode wire thoroughly cleaning the solder resin with alcohol. Resin remaining in this point may cause instability of the reading system.

d) Fix the photodiode wire to the board with a plastic clamp.

e) Connect all the strips again.

5.3. Change of the display board

See figure 5.3

a) Disconnect in the board itself, the keyboard band (J10) and the printer connectors (J4, J6 and J7).

b) Disconnect the flat bands (J1 and J5), supply connector (J3) and the led connector (J9) (not available in PCB version I3300A080499).

c) Remove the 4 screws (1) and the board.

d) To place the printed circuit board again, proceed as below:

e) Place the board taking into account that the LED should be properly placed.

f) Fix the board with the 4 screws (1).

g) Connect the keyboard strip (J10) and the printer connectors (J4, J6 and J7).

h) Connect the flat bands (J1 and J5), the led connector (J9) (not available in PCB version I3300A080499) and the supply connector (J3).

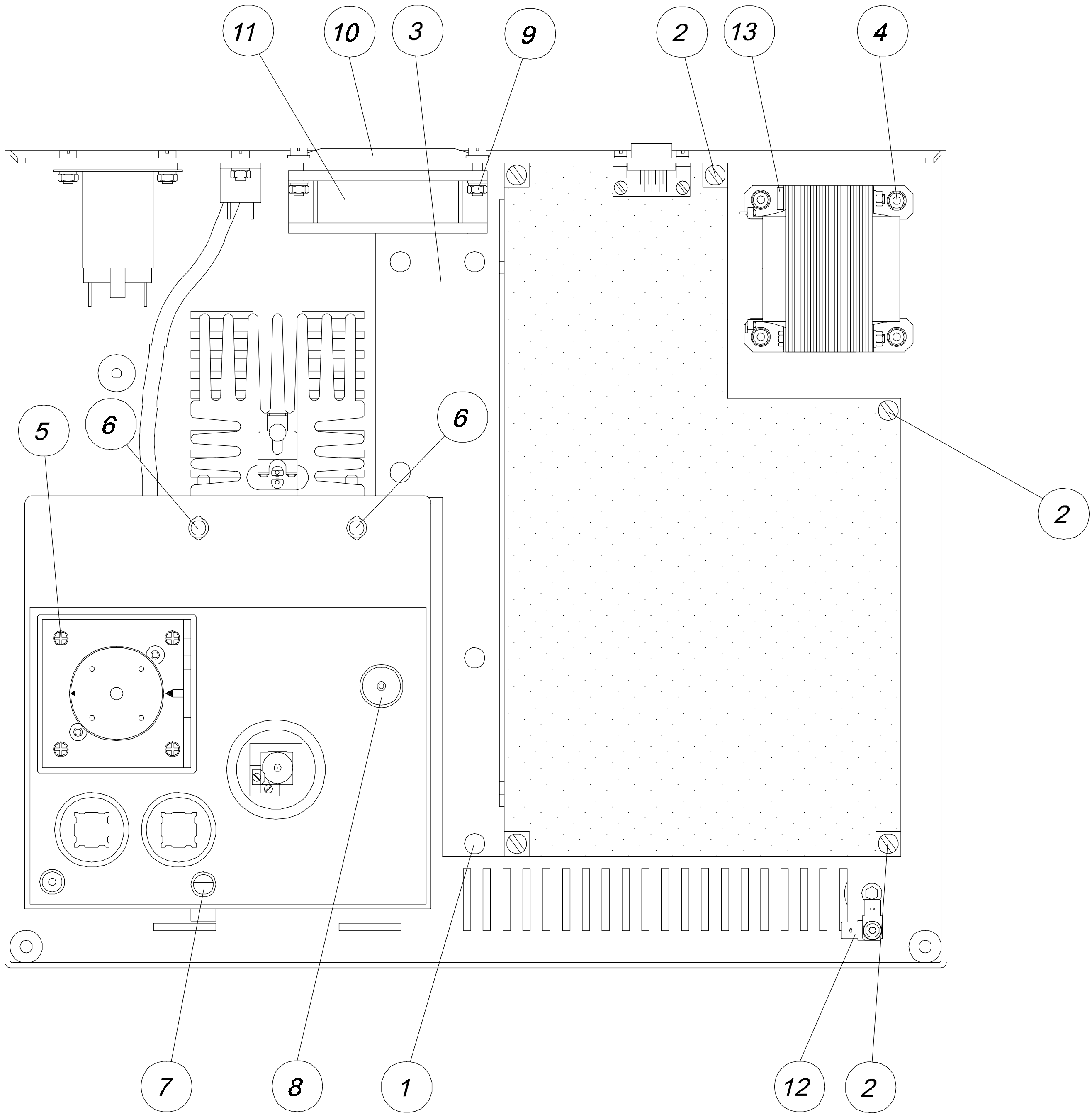


Fig. 5.2

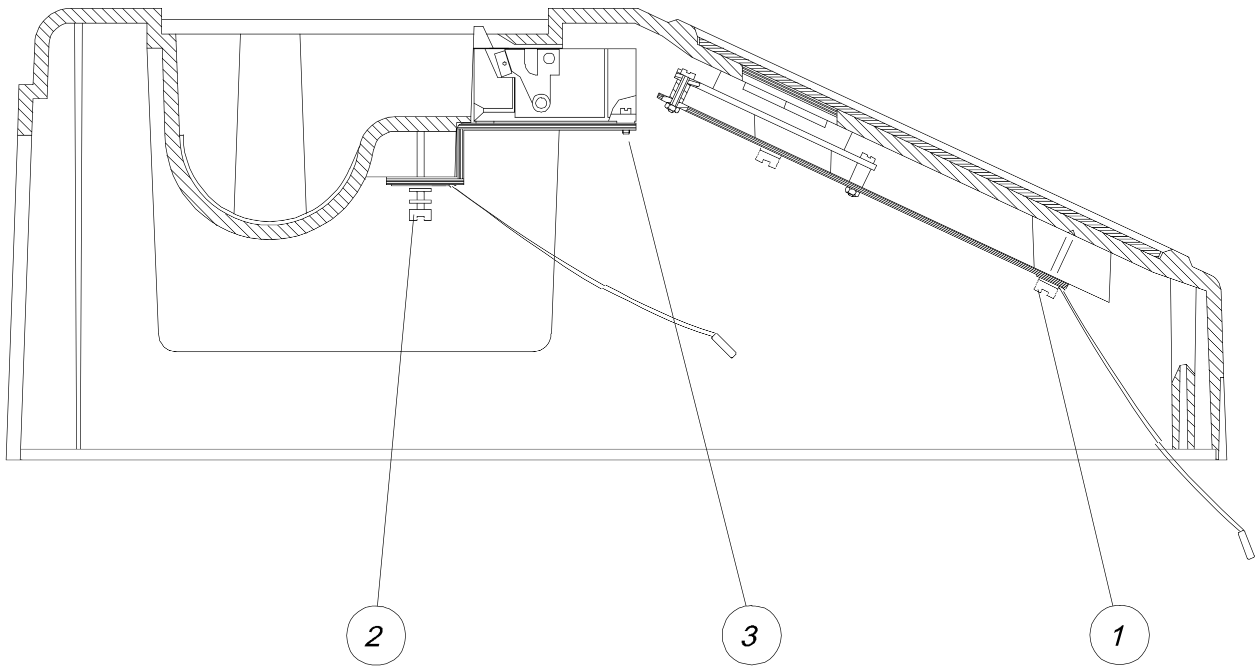


Fig. 5.3

5.4. Printer replacement

The printer is fixed to the case by means of a metallic support. To change the printer proceed as follows (see figure 5.3):

a) Disconnect the connectors J4, J6 and J7 from the display board.

b) Remove the two screws (2).

c) Remove the four screws (3).

To place the printer again, proceed as follows:

a) Fix the printer to the metallic support with the 4 screws (3).

b) Fix the support to the case with the 2 screws (2).

c) Connect the connectors J4, J6 and J7 of the display board.

5.5. Keyboard replacement

The keyboard is glued to the case and, when removed, it cannot be used again. Because of this, be sure that really it doesn’s work properly before replacing it. To change it, proceed as follows (see figure 5.4):

a) Disconnect the keyboard band from the display board (J10).

b) Carefully unstick the keyboard from the case.

c) Clean the remainded glue with alcohol.

d) Fix the new keyboard.

e) Connect the new keyboard to the display board (J10).

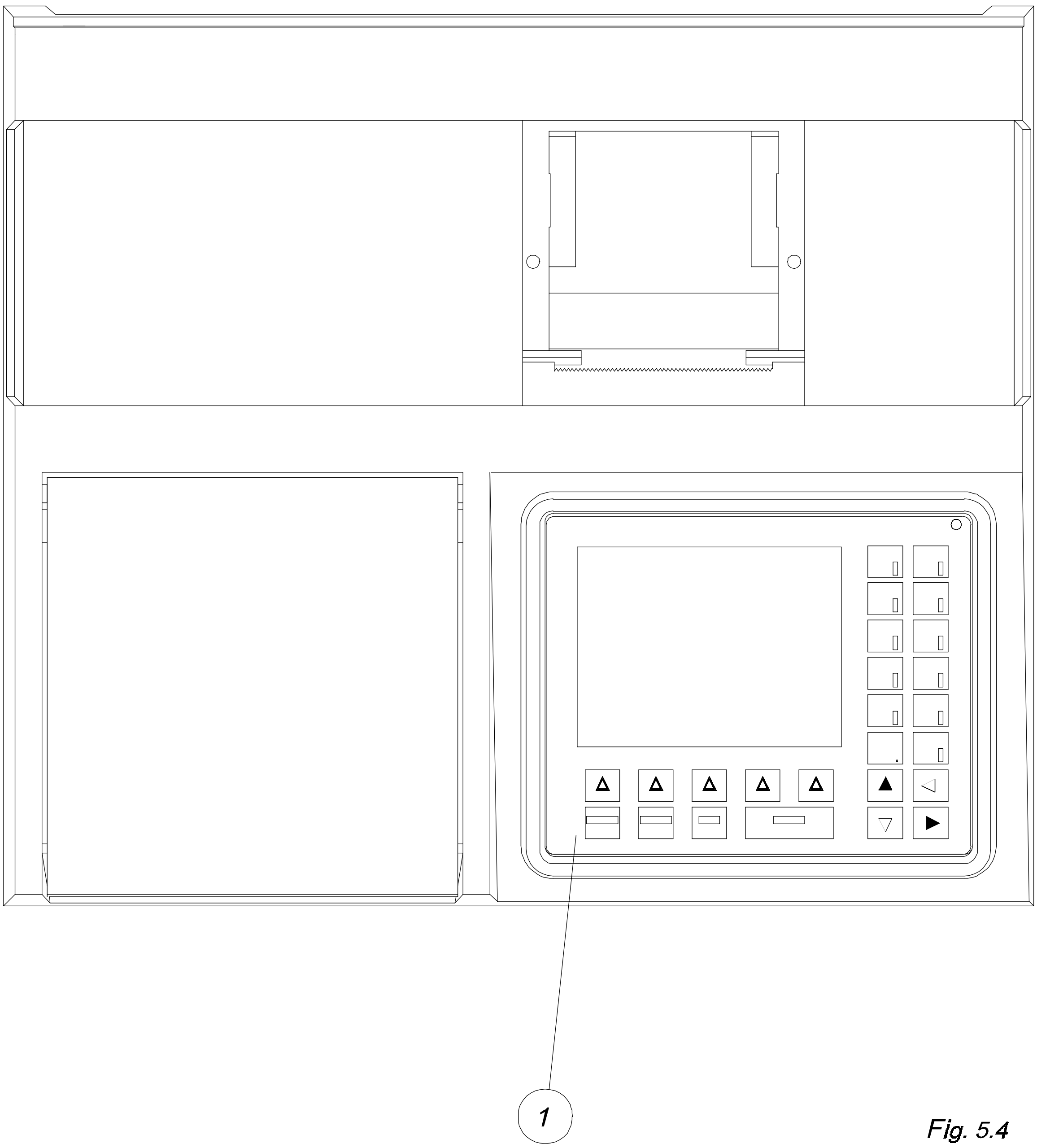


Fig. 5.4

5.6. Transformer replacement

The transformer is fixed to the base. To change it proceed as follows (see figure 5.2):

a) Unsolder the supply wires.

b) Disconnect the main board's connector (J4) and the tab-in terminal (13).

c) Remove the four screws (4).

d) Place the new transformer fixing it to the base with the four screws (4).

e) Solder the supply wires (see schemes E33000A and E33001A).

f) Connect J4 to the main board and the ground tab-in terminal (13).

<u>Very important:</u> In order to meet the electrical safety standards, (CE mark requirements) the solderings must be hook-type made, and the ground connections must be properly done.

The manufacturer declines all responsibility due improper handling made without following the above instructions.

5.7. Cuvette holder tray removal

To manipulate certain elements of the optical system it is necessary to remove the tray that supports the pump. Proceed as follows (see figure 5.2):

a) Remove the case (see section 5.1.).

b) Remove the waste tube from the outlet (8) in the lower part of the tray.

c) Disconnect the peristaltic pump motor strip (J3) from the main board.

d) Remove the 2 screws (6) and the screw (7) that fixes it to the optical support.

e) Remove the tray.

To place the tray again:

a) Place the tray and fix it to the optical support with the 2 screws (6) and the screw (7).

b) Connect the peristaltic pump motor strip (J3) to the main board.

c) Connect the waste tube to the outlet (8) in the lower part of the tray.

5.8.Filters wheel replacement

To manipulate the filters wheel, proceed very carefully in order to avoid scratching or soiling the filters. It is strongly recommeded to remove the filters holders from the wheel previously. Proceed as follows (see figure 2.2.):

a) Remove the cuvette-holder tray as described in section 5.7.

b) Loosen the Allen screw (17).

c) Remove the shaft (18).

d) Remove the wheel (5).

To place the wheel again, proceed as follows:

a) Put the wheel (5) in its place, taking into account to position the belt (8) and the two washer’s (19) as indicated in the figure.

b) Place the shaft (18).

c) Tighten the screw (17).

If the filter holders were removed, place them again in the same order as they were. If order is changed, the filters table must be re-programmed.

5.9. Filters wheel motor replacement

See figure 5.5.

a) Remove the cuvette holder tray as indicated in section 5.7.

b) Disconnect the strip of the motor from the main board (J6).

c) Remove the screws (1).

d) Change the motor (2) placing the belt (3) as indicated in the figure.

e) Place the motor and fix the screws (1).

f) The screw lodgings have a little slackness to allow stretching the belt. Avoid excess stretching.

5.10. Peristaltic pump replacement

(See figure 5.2)

a) Disconnect the peristaltic pump motor strip (J3) from the main board.

b) Remove the 4 screws (5).

c) Remove the pump and substitute it fixing the new one with the 4 screws (5).

d) Connect the peristaltic pump motor strip (J3) to the main board again.

5.11. Peltier Cell replacement

(See figure 5.2)

a) Remove the cuvette holder tray as described in section 5.7.

b) Remove the temperature sensor (16).

c) Remove the photodiode (20).

d) Disconnect J2 from the main board.

e) Unsolder the Peltier Cell wires from those going to the connector (J2).

f) Remove the 4 screws (4).

g) Carefully remove the cuvette holder (13).

h) Remove the Peltier Cell (15).

i) Take a new cell and place a thin and uniform silicone layer on both faces.

j) Place the cell in its position taking into account that its black cable should be in the front part of the optical system.

k) Place the cuvette holder and fix it with the 4 screws (14). During this operation, take special care to maintain the cuvette holder parallel to the cell, and the cell parallel to the optical support, and progressively screw the four screws, in order to avoid breakage of the ceramic faces of the cell.

l) Once the cell is positioned, check that no silicone overflows that could thermally short-circuit the two faces of the cell. Thus the case, clean it carefully.

m) Solder the cell wires again to those of the connector J2, according to the colour codes.

n) Place the temperature sensor (16).

o) Place the photodiode (20).

p) Place the cuvette holder tray again, as described in section 10.7.

5.12. Change of the photodiode

(See figure 5.2)

a) Remove the case as indicated in section 5.1.

b) Remove the screw fixing the ground terminal (21) to the cuvette holder.

c) Remove the photodiode set, unscrewing the support (20).

If a change of the photodiode is necessary, proceed as follows (see figure 5.6.):

d) Take the support (3) and the separator (2) away, backwards.

e) Remove the insulating ring (5).

f) Unsolder the wire from the photodiode pins (7).

g) Solder the new photodiode (1).

h) Place the insulating ring again (5).

i) Move the support (3) forward until the separator (2) contacts the photodiode.

j) Screw the set again to the cuvette holder.

k) Fix the ground wire (6) to the cuvette holder again.

l) Place the case again, as explained in section 5.1.

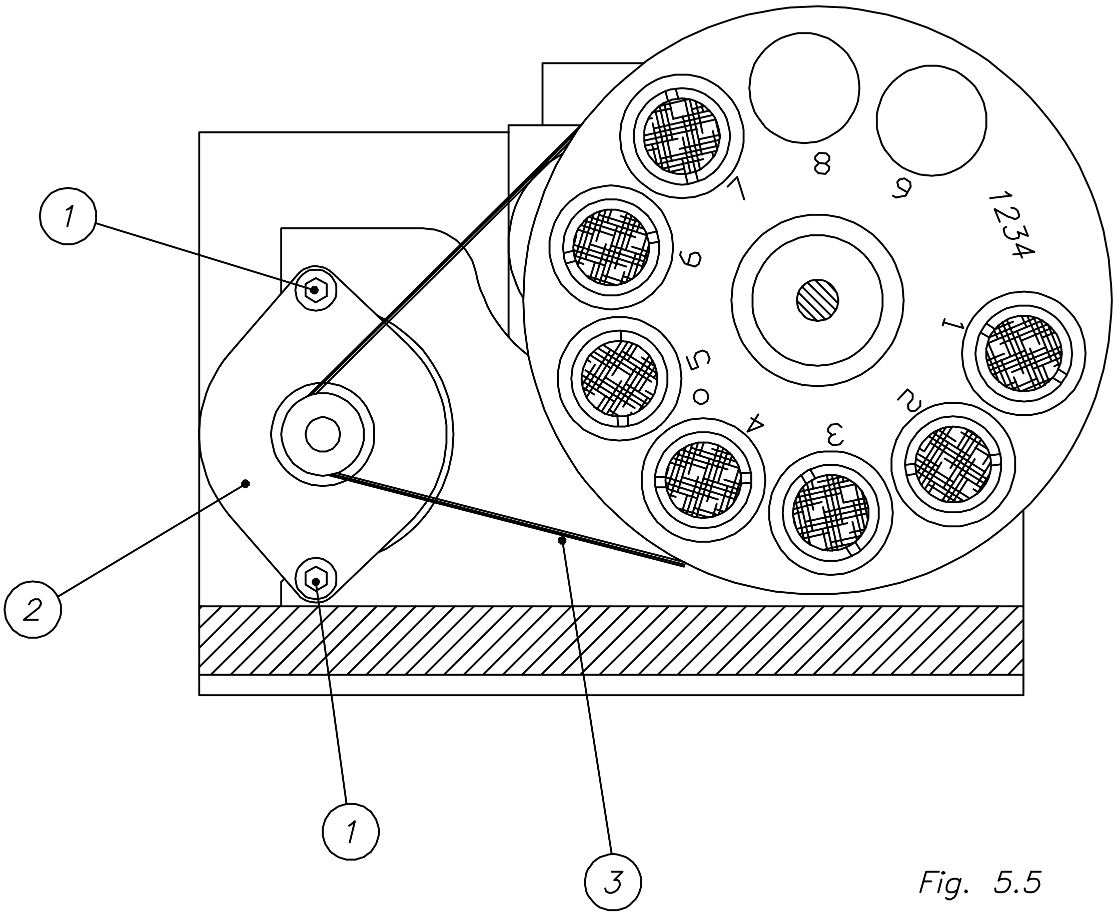


Fig. 5.5

5.13. Fan replacement

(See figure 5.2)

a) Remove the case as indicated in section 5.1.

b) Disconnect J8 from the main board.

c) Remove the 4 nuts (9).

d) Remove the grid (10).

e) Remove the fan.

f) Place a new fan, taking into account that the air flux is outwards.

g) Place the grid again (10) and fix the set with the 4 screws and nuts (9).

h) Connect J8 again to the main board.

i) Place the case again, as explained in section 5.1.

<u>Very important:</u> In order to meet the electrical safety standards, (CE mark requirements), the fan grid resistance to ground must be equal or less than 0.1Ω

The manufacturer declines all responsibility due improper handling made without following the above instructions.

5.14. Temperature sensor replacement

(See figure 5.2)

a) Remove the case as indicated in section 5.1.

b) Remove the temperature sensor (16).

(See figure 5.7)

c) Take the support (3) and the separator (2) away, backwards.

d) Unsolder the wire from the sensor pins (4).

e) Solder the new sensor (1).

f) Move the support (3) forward until the separator (2) contacts the photodiode.

g) Put silicone in the sensor's edge.

h) Screw the set again to the cuvette holder.

l) Place the case again, as explained in section 5.1.

5.15. Lamp replacement

This instrument in equipped with a 12-volt, 20-watt, halogen lamp, with an estimated shelf life of 2,000 hours. When a change of the lamp is needed, proceed as follows (see figure 5.11):

a) Remove the case as indicated in section 5.1.

b) Wait until the lamp radiator is cold, before removing the lamp holder.

c) Loosen the Allen screw (1) of the lamp radiator.

d) Pull back the flange (2) fixing the lamp holder.

e) Remove the lamp holder (4), loosen the Allen screw (3) and remove the lamp.

f) Insert the new lamp (5), fully introducing the pins. Tighten the Allen screw (3) until the lamp is tightly secured. Do not touch the glass bulb with the fingers; to manipulate the lamp, the cover itself may be used, cutting it by the terminals side and pressing until they come out.

g) Re-insert the lamp holder in its place. Position the flange (2) and tighten the Allen Screw (3).

h) Place the case again, as explained in section 5.1.

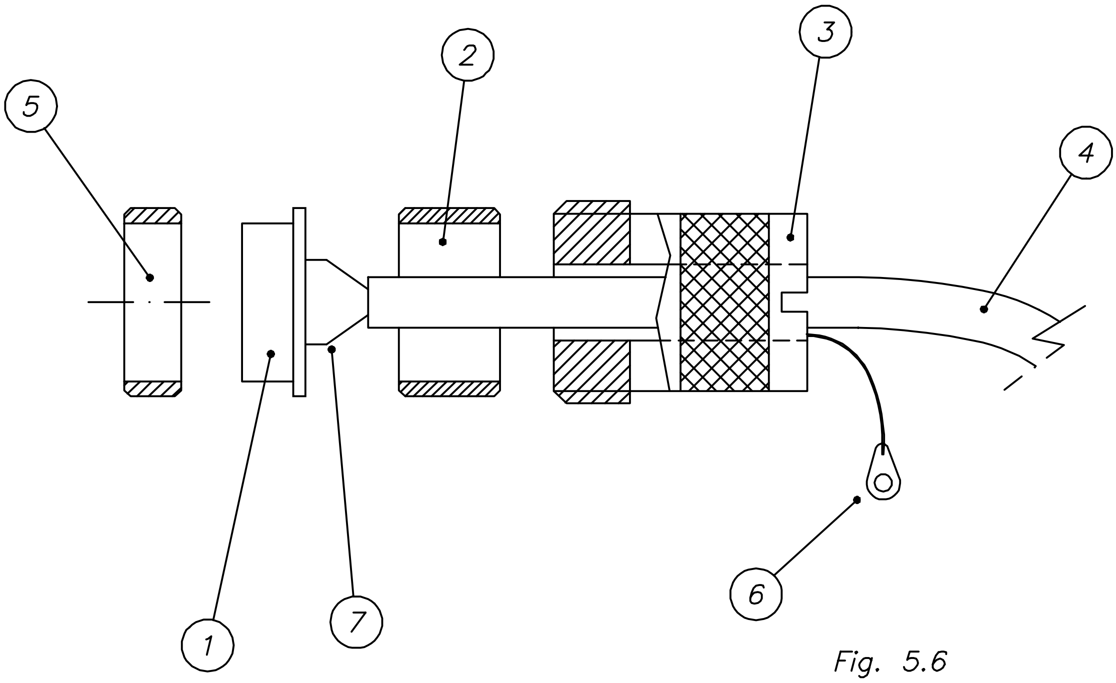


Fig. 5.6

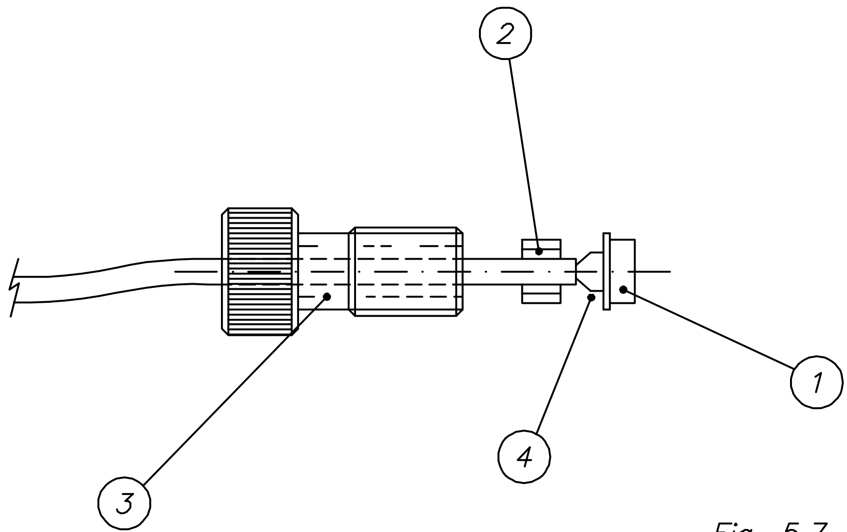


Fig. 5.7

5.16. Filters replacement

If a new filter must be installed, it should be inserted in one of the two free positions of the filters wheel. The filter will come fitted in a filter holder, marked with the corresponding wavelength and thus it is only necessary to manipulate the filter holder. Proceed as follows (see figure 5.8):

a) Remove the case as indicated in section 5.1.

b) Insert the filter holder (1) in one of the free positions, by simply pressing it.

Warning: do not touch the filter faces with the fingers.

c) Place the case again, as explained in section 5.1.

d) Now it is necessary to add the new filter into the FILTERS TABLE. To do it, switch the instrument on and select the path: UTILITIES / SET UP FILTERS and add the wavelength value in the position where it has been inserted. The filter is thus ready to be used.

If by any reason it is necessary to take the filter away from its holder, proceed as follows (see figure 5.9):

e) Using the corresponding tool (4) from the SERVICE TOOLS KIT (code 005), unscrew the filter subjection ring (3).

f) Take the filter (2) away from its holder taking care not to touch the faces with the fingers.

g) Insert the new filter, taking into account the direction of the arrow (5), and fix it to the holder by means of the screwed ring, using the tool indicated in point e).

5.17. Lenses replacement

Lenses are mounted in holders to make it easier to handling them. To change a lens holder set proceed as follows (see figure 5.2):

a) Remove the case as indicated in section 5.1.

b) Remove the cuvette holder tray as indicated in section 5.7.

c) Remove the filters wheel as indicated in section 5.8.

d) Remove the light guide (12).

e) Using the corresponding tool from the SERVICE TOOLS KIT (code 005), unscrew the lens holder set to be removed (4 or 11).

To place it again, proceed in the opposite order.

If it is necessary to take the lens away from the inside of the filter holder set, proceed as follows (see figure 5.10):

f) Using the corresponding tool (4) from the SERVICE TOOLS KIT (code 005), unscrew its fixation ring (3).

g) Remove the lens (2) from its holder (1) taking care not to touch its faces with the fingers.

h) Insert the new lens and fix it in the holder with the screwed ring using the tool indicated in point f).

5.18. General care

In order to get an optimal operation of this instrument it is necessary to follow some minimal maintenance rules.

a) Never use detergents or abrasive products for cleaning the outside of the instrument. Use only a cloth with water and neutral soap.

b) If a reagent or any corrosive product is spilt on the apparatus, clean it immediately with a damp cloth and water.

c) The cuvette holder tray is equipped with watertight joint in order to prevent penetration of liquid into the inner part of the instrument. If liquid is spilt into the tray, clean it with damp paper or cloth. A drainage hole connected to the outside by silicone tubing is in the front left part of the tray to facilitate drainage of poured liquid.

d) If a cuvette breaks into the cuvette holder or for any reason liquid pours into it, the holder has a drainage hole connected to the outside. It will, however, be necessary to rinse and dry the inside of the cuvette holder.

e) Cover the instrument with its dust cover when not in use.

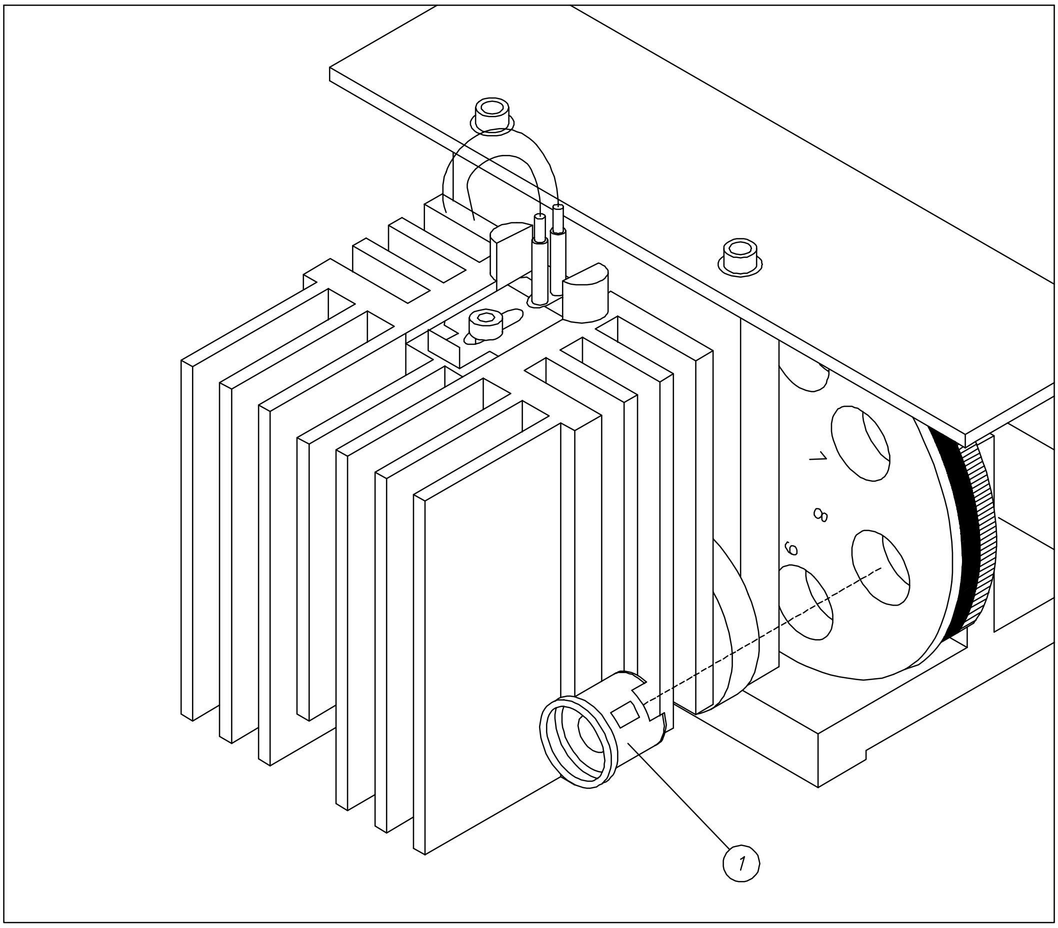


Fig. 5.8

5.19. Cleaning of the optical components

The following indications should be taken into account for the cleaning of the optical components:

a) Optical components to be considered: lamp, lenses, filters and photodiode.

b) Recommended material:

- Paper WYPALL LITE (56 gr./m^2) SCOTT
- Alcohol + ether (50/50) solution
- Cotton ear picks
- Lens cleaner (blower type)

c) For a proper manipulation of the optical components, the following general precautions should be taken into account:

- The area for manipulating the instrument should be clean and in order.

- As the components are fragile, they should be treated carefully; a fall could result in breakage.

- Avoid touching the active areas with the fingers. Lenses, filters and photodiode should be held by their sides, lamps by the connecting terminals.

- To clean the components, first take dust away using the rubber bulb; thus scratches caused by small particles on the surface can be avoided, when rubbing with paper.

- In the case of persistent or greasy dirt, clean with a paper soaked with the alcohol/ether solution and then with a dry paper. Sometimes, for instance when cleaning the filters or the photodiode window, the cotton ear picks may be helpful together with the paper in the most delicate parts.

- After any cleaning it is convenient to repeat blowing with the rubber-bulb thus eliminating any residual paper or cotton nap.

- When mounting or dismounting any component take into account the corresponding tools and procedures, as they are thought to avoid manipulation problems.

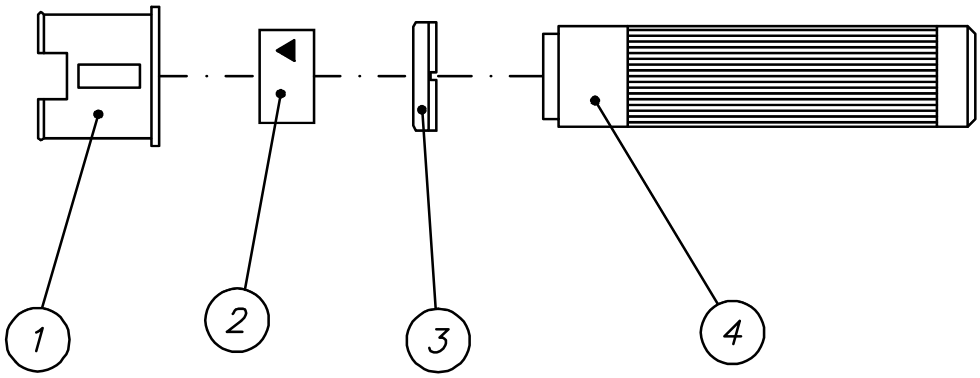


Fig. 5.9

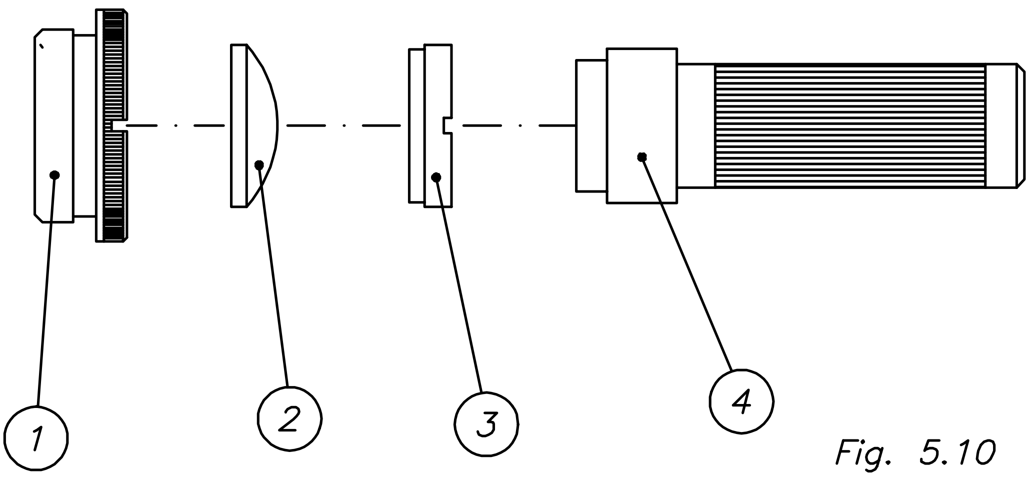


Fig. 5.10

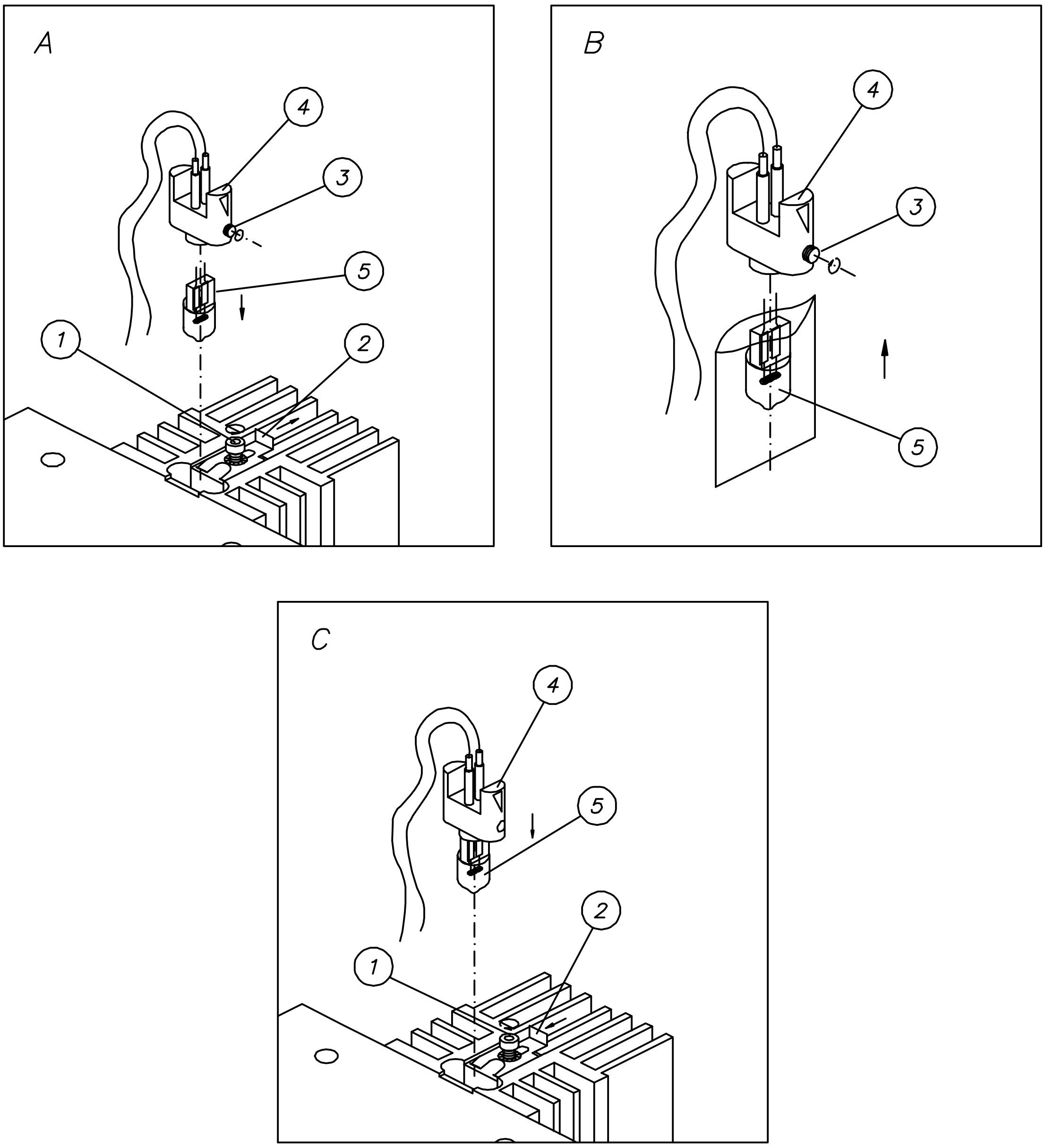


Fig. 5.11

5.20. Cleaning the filters

a) Dismount the filter holders from the wheel and take the filters away as indicated in section 5.16.

b) Clean them as indicated in section 5.20.

c) Mount them again in their holders and the holders in the wheel as indicated in section 5.16.

<u>**Very important:**</u> **In order to meet the electrical safety and electromagnetic compatibility standards, the handling instructions given in every section must be strictly followed, and it is extremely important to assure that the length of the wires and strips as well as the connections are exactly as the schemes indicate.**

The manufacturer declines all responsibility due improper handling made without following the above instructions.

5.21. Cleaning the lenses

a) Dismount the lens holder from the optical support and take the lenses away as indicated in section 5.17.

b) Clean them as indicated in section 5.20.

c) Mount them again in their holder and the holders in the optical support, as indicated in section 5.17.

5.22. Cleaning the photodiode

a) Dismount the photodiode as indicated in section 5.12.

b) Clean them as indicated in section 5.20.

c) Mount the photodiode again (section 5.12.).

5.23. Cleaning the aspiration system

a) It is necessary to clean the sipping circuit properly after each series of measurements and at the end of the day.

On finishing a series of measurements, wash the sipping circuit with abundant distilled water.

At the end of the working day, wash thoroughly with a detergent solution such as the one provided with the instrument. Lastly, rinse with distilled water and empty the circuit by performing wash cycles with air.

Finally, to maximise the life of the peristaltic tubing, it is advisable to take it out from its mounting, so that it remains loose and without tension. On starting a new work session, re-insert it in its place.

b) If the outside end of the sip tubing has deteriorated, a few millimetres may be cut making a perpendicular and clean cut. In this case, the POSITIONING parameter must be re-calibrated.

c) Replace tubing by a new one in case of deterioration. Always use original parts.

5.24. Cleaning the flow-cuvette

Cleanness of both the outside and the inside of the flow-cuvette is very important. Proceed as follows:

a) To clean the inside, proceed as described in section 5.24.

b) To clean the outside, use alcohol and then dry with a soft paper (section 5.19).

5.25. General cleaning of the instrument

It is important to avoid dust in the instrument that could affect the optical system. Carefully remove dust from the inside of the instrument, especially from the fan vanes.

APPENDIX I. TECHNICAL SPECIFICATIONS

I.1. Optical system

Measurement range: 0 to 2.2 A at 340 nm
0 to 3.0 A from 405 nm
Spectral range: 340 to 900 nm
Resolution: 0.0001 A
Stability: ±0.005 A in 30’
Repeatability: cv ≤ 1.2 % at 505 nm between 0.05 and 0.1 A (20 readings)
cv ≤ 0.1 % at 505 nm between 1.7 and 2.0 A (20 readings)
Accuracyr: Error at 340, 405 and 505 nm:
± 5% at 0.100 A
± 2% at 1.000 A
± 2% at 2.000 A
± 5% at 3.000 A (405 and 505 nm)
Light source: Halogen lamp 20W-12V
Detector: Silicon photodiode
Bandwidth: 10 nm ± 2 nm

I.2. Thermostatic control

- Peltier system
- Temperature range: 23 to 40°C
- Programming steps: 1°C
- Stability: ± 0.2°C

Temperature sensor

- Resolution: 10 mV/°C
- Output voltage: 10 (mV) x T (°Kelvin)

at 25°C ..... 2.98 V
at 37°C ..... 3.10 V

I.3. Printer

- Type: thermal, bi-directional
- Characters per line: 40
- Print speed: 40 characters per second
- Paper: thermo-sensitive, 80 mm wide

I.4. Display

- Type: 320 x 240 dots graphic LCD, with CFL backlight.

I.5. Electronics

- Microcontroller H8/3003, 16/32 bits at 16 MHz
- FLASH memory up to 2 Mbytes
- RAM memory up to 512 Kbytes

Amplifier

- Logarithmic amplifier: hybrid circuit LOG-100
- Scale factor K=1V/Abs
- Without analog adjustments

A/D Converter

- Type: dual slope
- Resolution: 10,000 counts/Abs
- Conversion time: 150 ms at 2 Abs

Adjustments by software

I.6. Communications

- Serial connection channel, bi-directional, RS-232
- Baud rate: 110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200.

I.7. Installation

- Voltage: 115 V (tolerance from 99 to 137 V)
230 V (tolerance from 198 to 264 V)
- Frequency: 50/60 Hz
- Maximum apparent power: 126 VA
- Installation category (Overvoltage category): II
- Class A, criterion C

I.8. Dimensions and weight

- Height: 150 mm (5,9 in)
- Width: 387 mm (15,2 in)
- Depth: 337 mm (13,3 in)
- Weight: 9.5 Kg (21 lb)

I.9. Cuvette systems

Flow cuvette: 18 µL
Common cuvettes: macro, semi-micro and micro
Round tubes: ∅12   75 mm max. height

I.10. Flow system

Peristaltic pump

- System: tube stretching
- Peristaltic tubing: silicone, density = 60 shore
- Rotor: 4 rollers
- Motor: * Stepping
  * 100 steps/turn
  * Supply 1 A constant current

Volume programmable: from 100 to 4,000 μL
Flow cuvette: 18 μL
Carry-over: see table I.1.

SAMPLE VOLUME	CARRY-OVER (%)
150 • L 250 • L 400 • L	2.25 - 2.70 0.75 - 1.50 0.05 - 0.25

Table I.1

I.11.- Environmental conditions

Indoor use
Temperature: 15 ºC to 35 ºC
Maximum relative humidity: 75 %
Pollution degree: 2

APPENDIX II. ADJUSTMENT TOLERANCES TABLES

II.1. Photometric adjustment tolerances

Filter	Calibrator	Relative error tolerance	
340	1	-7.0%	+5.0%
	2	-6.0%	+5.0%
	3	-5.0%	+5.0%
	4	-5.0%	+5.0%
405	1	-7.0%	+5.0%
	2	-6.0%	+5.0%
	3	-5.0%	+5.0%
	4	-5.0%	+5.0%
505	1	-7.0%	+5.0%
	2	-6.0%	+5.0%
	3	-5.0%	+5.0%
	4	-5.0%	+5.0%

II.2. Filters wheel adjustment

Steps number without adjustment to put the first filter = 208

Adjustment steps:

Maximum: +40
Minimum: -20

Minimum sensitivity at 340 nm: 30 nA

II.3. AC voltage in the Transformer Secondaries

VOLTAGE	MINIMUM VALUE (V)	MAXIMUM VALUE (V)
1/J4 to 3/J4	9,4	10,8
4/J4 to 6/J4	19,2	20,2
5/J4 to 6/J4	19,2	20,2
7/J4 to 8/J4	4,1	4,4
9/J4 to 8/J4	4,1	4,4
10/J4 to 11/J4	16,1	16,8
12/J4 to 13/J4	25,5	26,9

II.4. Filters sensitivity without flow cuvette

FILTER (nm)	MINIMUM VALUE (nA)	MAXIMUM VALUE (nA)
340	50	250
405	200	1500
420	400	2000
450	1000	3500
492	1500	5500
505	1500	8000
530	2000	9000
546	3000	1100
578	4000	16500
600	5000	17500
630	6000	20000
670	7000	26000

II.5. Electric Noise

PARAMETER	MINIMUM VALUE	MAXIMUM VALUE
AVERAGE VALUE	- 400 mV	+ 400 mV
NORMAL VALUE (BIAS)	0 mV	2 mV
MAXIMUM PEAK	0 mV	2 mV
MINIMUM PEAK	- 2 mV	0 mV

II.6. Filters sensitivity with flow cuvette

FILTER (nm)	MINIMUM VALUE (nA)	MAXIMUM VALUE (nA)
340	20	125
405	60	800
420	100	1000
450	200	2000
492	300	8000
505	500	4000
530	750	5000
546	800	5500
578	900	9000
600	1000	10000
630	1750	13000
670	2000	14000

II.7. Fan voltage control

Maximum: 24 v
Minimum: 15 v

II.8. Zero-currents for the sensitivity test

Maximum: 30000 nA
Minimum : 10 nA

II.9. Heating adjustment

Once thermostatization is adjusted, the temperature should have a stability of $\pm$ 0.2°C.

II.10. Peristaltic pump adjustment

The trail of the sample that remains in the aspiration tubing before entering into the cuvette should be between 0 and 10 mm.

If those values are not reached, follow the MANUAL procedure.

NOTE: All the values are statistical and can suffer variations when new production series will be released. Thus the case, this appendix will be updated.

APPENDIX III. DEFAULT PARAMETERS

PERSONALIZATION

LABORATORY NAME . VOID
LANGUAGE .... ENGLISH
PRINTER .... THERMAL PRINTER
PRINTER CONTRAST 7
WASH MODE .... CONTINUOUS
LIST HEADING .... COMPLETE

FILTERS TABLE

1................................... 340
2................................... 405
3................................... 420
4................................... 505
5................................... 546
6................................... 578
7................................... 670
8................................... ---
9................................... ---

UNITS TABLE

0.	mg/dL
1.	U/L
2.	g/L
3.	• kat/L
4.	• mol/L
5.	mmol/L
6.	• g/L
7.	nkat/L
8.	g/dL
9	• g/dL
10.	UI/mL
11.	%

COMMUNICATIONS

CONFIG. RS-232:

Bauds........................... 9600

APPENDIX IV. MAINTENANCE PLAN

In order to maintain the proper operation conditions, it is recommended to carry out an annual revision by the Technical Assistance Service.

The following operations are to done, in the same order as follows:

IV.1. Cleaning

- General cleaning of the inside (section 5.26.) (1)
- Filters (section 5.21.)
- Lenses (section 5.22.)
- Photodiode (section 5.23.)
- Flow cuvette (section 5.25.)

IV.2. Change

- Aspiration tubing
- Peristaltic tubing
- Inner waste outlet tubing
- Outer waste outlet tubing
- Lamp (if blackened)

IV.3. Review

- Keyboard (Section 4.4.)
- Beeper (Section 4.3.)
- Display (Section 4.2.)
- Printer (Section 4.5.)
- Peristaltic Pump Motor (Section 4.7.1.)
- Filters Wheel Motor (Section 4.7.2.)
- Filters Sensitivity, without cuvette (Section 4.10.1.)
- Electronic Noise (Section 4.10.2.)
- Reading Stability (Section 4.10.3)

IV.4. Check

- Photometric Accuracy (Section 4.10.5.)
- Calibration of the Aspiration System (Section 3.2.4.)
- Calibration of the Filters Wheel (Section 3.2.3.)
- Calibration of the Temperature (Section 3.2.2.)

(1) Remove filters, lenses and photodiode and proceed with the general cleaning.

APPENDIX V. SPARE PARTS AND ACCESSORIES

V.1. Accessories

Code	Description
	User's Manual
AC4460	Paper Lodgment Cover
AC964	Paper Roll TB 50 KS 4AO mtp 401
AC3778	Flow Cuvette Hellma 178, 712-OS 8.5 mm
AC944	Cuvette, Hellma 6030
TU2791	Teflon Tubing, Hellma 040.203
AC3594	Cuvette Outlet Connector
TU1643	Cylindrical Silicone Connector
AC3486	Peristaltic Tubing
AC3114	Silicone Tubing 3x6 (200 cm)
AC3495	Adapter for test tubes
AC3703	Waste Bottle
***	Bottle 100 mL washing solution
FU656	Fuse, 1 A
AC3097	Fuse, 2 A
***	Supply Cable
AC4461	Dust-Proof Cover 810
LA2151	Halogen Lamp, 12 v, 20 w
FI4649	Filter Set, 340 nm
FI4650	Filter Set, 405 nm
FI4651	Filter Set, 420 nm
FI4658	Filter Set, 492 nm
FI4652	Filter Set, 505 nm
FI4653	Filter Set, 546 nm
FI4654	Filter Set, 600 nm
FI4659	Filter Set, 620 nm
FI4655	Filter Set, 670 nm
FI5557	Filter Set, 578 nm

V.2. Authorized Spare Parts

***	Cover
**	P.C. Board Micro I33002
ME7762	Optical Set Complet F. BTS-330
DI2964	Photodetector S-1336-8BQ
IN4342	Switch EATON E30M11J01
ZO648	Fuse Holder D (06.26)
VA4343	Supply Filter FD-1Z
DI844	Diode LM-335
MO3560	Approved fan
ME3215	Fan Grid

TR6813	Transformer E33007A
IN4345	Tension Selector 18-000-0016
VA1467	Terminal MOLEX 4809
ZO476	Connector, 2.54 H 4
ZO474	Connector, 2.54 H 3
ZO4648	Mechanized Lamp Holder
DI4438	Wheel Photodetector, mounted
PC6825	P.C. Board Display I33004A
IM3559	Printer SEIKO STP312-F256 B
VA4413	Display Protector
***	Keyboard
AC4290	Calibration Box

(***) Consult the Technical Assistance Service

APPENDIX VI. PASSWORD

The PASSWORD to access the SERVICE menu is:

251297

APENDIX VII: SOFTWARE VERSIONS

Version 1.0

In this version, the next errors have been reported:

- The Portuguese language does not work properly.
- The concentration results in the multistandard decreasing mode appear in negative.
- While doing kinetic tests, in some cases, there are unexpected jumps in the absorbance results.

Version 1.1

In this version, the errors reported for the previous version are solved, except the jumps in the kinetics.

Errors reported:

- The peristaltic pump's led does not work when doing a base line in tests with temperature.

Version 1.2

This version solves the problem with the peristaltic pump's led reported in the last version.

Errors reported:

- Error when calibrating the peristaltic pump in Portuguese.

Version 1.3

This version solves the unexpected jumps in the kinetic tests.

Errors reported:

- Error when calibrating the peristaltic pump in Portuguese.

Version 2.0

- Chinese language included.
- New kinetic points editing mode added.

Warnings:

- The internal calibration's data structure has been changed. It is necessary to calibrate the BTS-330 when upgrading to this new version from lower ones.
- Now, two EPROM's are needed to load the software.

Errors reported:

- Error when calibrating the peristaltic pump in Portuguese.
- Alignment, centring and length errors in texts of some languages (French, Russian, Portuguese and Bulgarian)

Version 2.1

- All the above mistakes are solved.

Warnings:

- It is necessary to calibrate the BTS-330 when upgrading to this new version from versions 1.x.

Errors reported:

- When programming the "%" symbol as a unit, it turns to "???" when saving.
- Data alignment error in the printer test report.
- There are errors when typing the serial number.

Version 2.2

- All the above mistakes are solved.

Warnings:

- It is necessary to calibrate the BTS-330 when upgrading to this new version from versions 1.x.

Errors reported:

- The calibrator absorbance in the fixed time mode is printed with a negative symbol.

Version 2.3

The next improvements have been added:

- Korean language is added.
- Czech language is added.
- In the kinetic, fixed time and multiple tests, the initial absorbance (Ao) is printed.
- Every time that a test is started, the sample number is reset to 1.
- The instrument doesn't begin to read absorbances until the printer doesn't finish to print the header report.

This version solves the next reported errors:

- The mistake about printed negative symbols in the calibrator's absorbance in fixed time tests is solved.
- In any rare circumstances, the printer could stop the timer and the test was blocked. This version solves this problem.

Version 2.4

The next improvements have been added:

- Included a new calculus mode: diferential mode with multicalibrator.
- In kinetic mode will show the delta values
- Yugoslavian language is included

This version solves the next reported errors:

- The configuration and quality control data will save in flash memory.
- Solve the problem when push the WASH key at the end of thermostating process, the device reset.

Versión 2.5

This version solves the next reported errors:

- Solve the problem with the WASH key and absorbance menu. In this case the sip cycle cut up the sample.

Versión 2.6

The next improvements have been added:

- Polish language is included

This version solves the next reported errors:

- When quality control was made in the kinetic mode will take all the following samples as a quality control.
- When the key WASH was pressed and thermostating process is working, at the end of the cycle the device reset.
- When at the same time work the printer, the thermostating process and the key WASH was pressed, the device will block.

<u>Versión 2.7</u>

The next improvements have been added:

- Save the memorised values of blank and factor in flash memory.
- Save the result values (concentration) in the flash memory. Added in the menu "tools/default values", a soft key to delete in a manual maner all the concentration values
- Print the checksum values in the autotest.

This version solves the next reported errors:

- When quality control was made in the kinetic mode the next sample is delayed while is saving the data
- When Chinese language is selected, there was a communication error.

<u>Versión 2.8</u>

This version solves the next reported errors:

- From test number 10 there weren't the filters wheel initialisation. Now this initialisation is done when the equipment is switched on.
- Only in the Chinese language; when was edited a name with a character code 181, then this character will change to a letter mu (μ). Now the error is corrected.
- When you switch on the equipment and enters immediately in the menu absorbance, the read filter had a zero value, now is initialised at 340.

APPENDIX VIII: COMPATIBILITY TABLE TO UPDATE SOFTWARE VERSIONS

This table show the different way to update the software versions.

There are two ways to update the version. One is save the program from the EPROMS memories. The second one is from the PC through a serial channel.

The first column shows the actual version of the program. The first row shows the version you want to update. Each cells shows how you can update the version.

	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8
2.0	Eprom	Eprom	Eprom	Eprom	Eprom	Eprom	Eprom	Eprom
2.1		Eprom	Eprom	Eprom	Eprom	Eprom	Eprom	Eprom
2.2			Eprom	Eprom	Eprom	Eprom	Eprom	Eprom
2.3				Eprom	Eprom	Eprom	Eprom	Eprom
2.4					Eprom/PC	Eprom/PC	Eprom/PC	Eprom/PC
2.5						Eprom/PC	Eprom/PC	Eprom/PC
2.6							Eprom/PC	Eprom/PC
2.7								Eprom/PC