AP-BLOT

SERVICE MANUAL

das srl

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Important Notes:

To avoid errors during maintenance and repairs, carefully read the entire manual before attempting any work on the instrument.

Pay particular attention to the "GENERAL SAFETY WARNINGS" in Section 1 and follow instructions for specific operations precisely as indicated in this manual.

CONTENTS

SECTION 1
GENERAL SAFETY

1.1. GENERAL SAFETY WARNINGS AND SYMBOLS

In this manual the following symbols stand for danger or warnings:

General DANGER symbol which indicates that a serious safety risk can occur if instructions and warnings are not followed.

Indicates ELECTRICAL VOLTAGE which could cause death upon contact. Covers with this symbol can only be removed and replaced by qualified personnel and only after electrical power has been disconnected.

Indicates that the instrument uses reagents and corrosive, irritating or noxious DANGEROUS CHEMICAL SUBSTANCES which could damage health.

Indicates that the instrument deals with potentially infectious samples (e.g. body fluids such as urine) which could cause INFECTION/CONTAMINATION. Always observe general safety precautions when any of these biological substances are present.

Indicates that not following the correct instructions could damage instrument and/or its proper functioning.

Indicates that important information concerning the instrument or a Section of the document should be read carefully.

1.2. INSTRUMENT USE AND CONDITIONS

The instrument is intended for use in the following working conditions:

- as In Vitro Diagnostic (IVD) medical device as specified in the technical data
- with chemical reagents and accessories supplied and/or declared compatible with instrument
- at a specific temperature and humidity levels as specified in this manual
- not to be used and powered in a potentially explosive or fire hazardous environment

This instrument should only be used as described in this manual.
Any other use has to be regarded as improper.

1.3. INTENDED USE/USERS OF THE INSTRUMENT

The instrument should only be used for the intended purpose and in perfect technical conditions, only by qualified personnel following strict safety procedures and regulations for accident prevention.
This manual contains instructions for qualified personnel:

- **Only Qualified Technicians** are entitled to service and repair the instrument with original spare parts and after appropriate training.

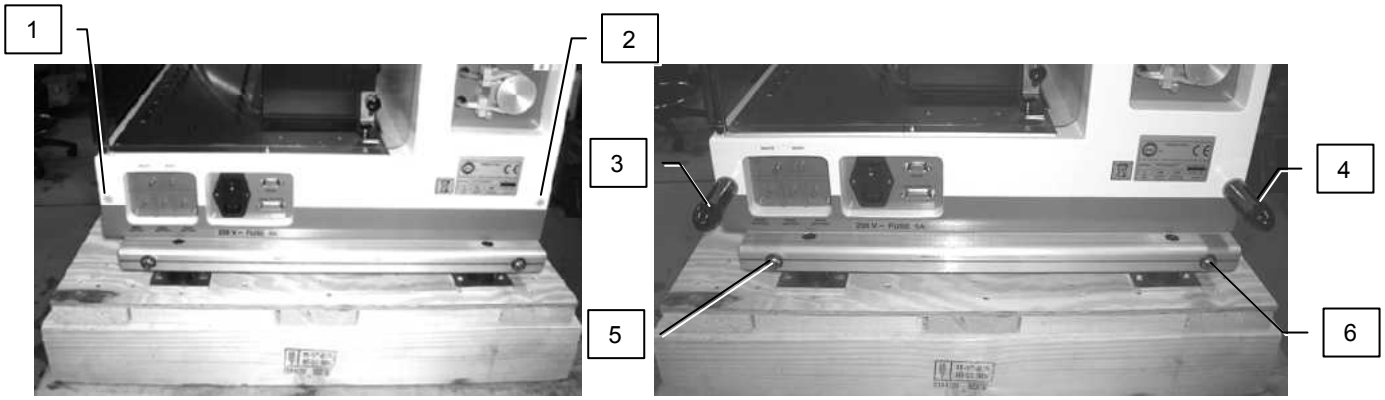
Modifications of the instrument are not allowed. The user is liable for any improper modifications and any subsequent consequences.
For extraordinary maintenance - request Specialized Technicians with authorised equipment and original spare parts from authorised service centers.

SECTION 2
INSTALLATION AND TECHNICAL SPECIFICATIONS

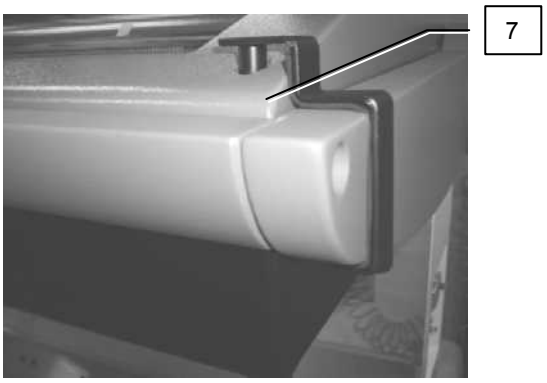
2.1. INSTALLATION

The instrument is packed with a wooden box. To unpack the instrument follow the instructions described below:

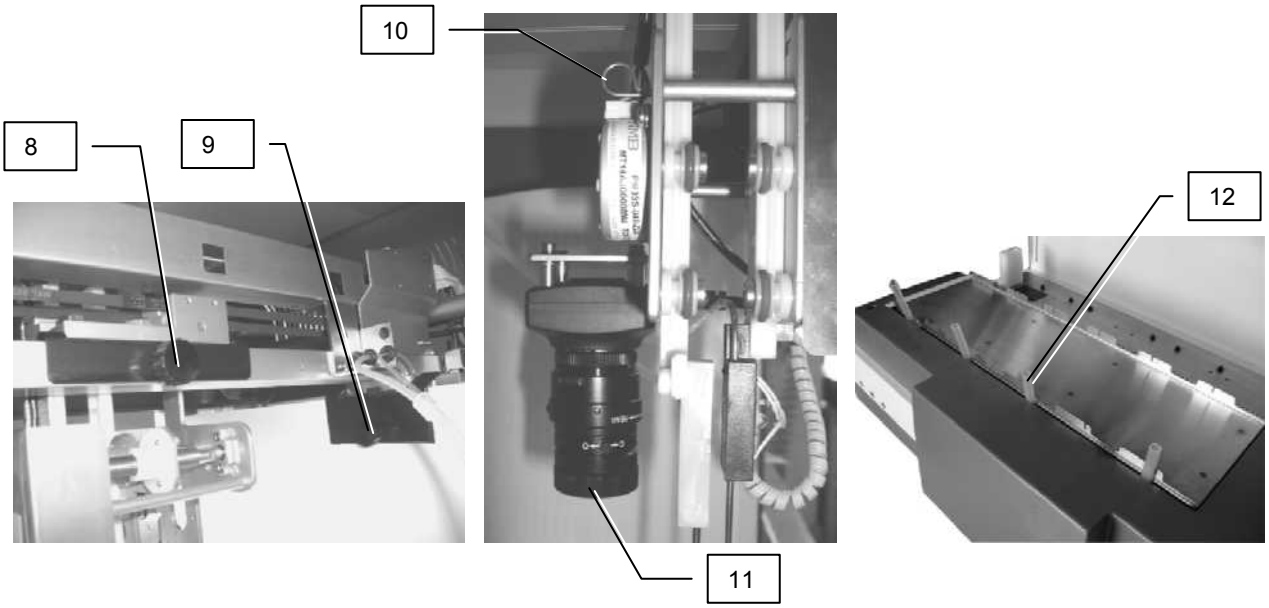
a) Remove the 2 plastic covers (1-2) from the instrument right side and the other ones from the left side. Screw in the 4 handles on both sides (3-4) for manual instrument placement. Once in position remove the handles e put back in place the plastic covers.
b) Remove the 4 screws that hold the instrument on to the wood base (5-6)
c) Remove screw and bracket (7), screw in the same place using the screw removed before



d) Remove,.- screw and bracket (7), screw in the same place the enclosed screw in the bag



e) Remove screws (8,9,10) and related brackets
f) Remove the Z block holder (11) as indicated
g) Remove the protection cap from the camera (12)
h) Remove the blocking tools (13) from the oscillating plane



2.2. WORK AREA

AP-Blot work area showing the various components:

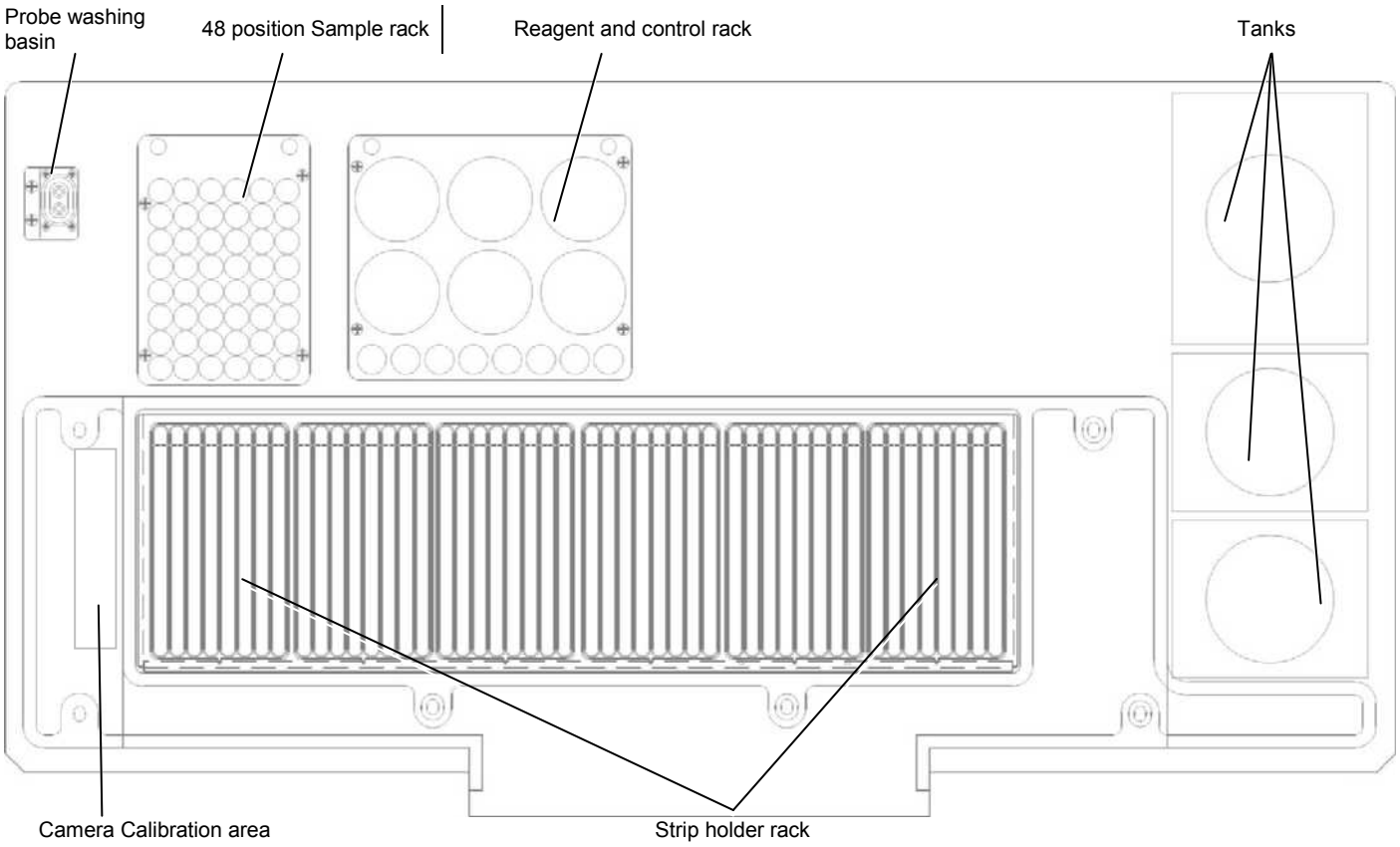


Fig. 1 - AP-Blot Work Area

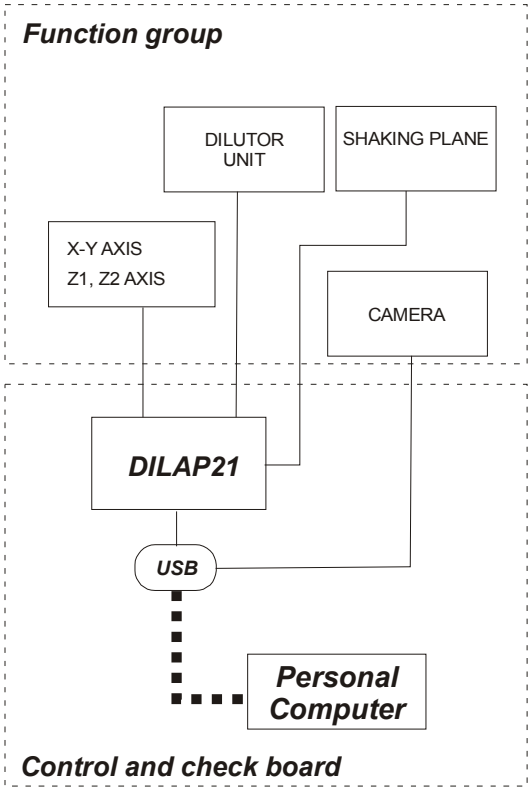
2.3. TECHNICAL SPECIFICATIONS

Sample rack	48 sample tubes (Ø 13mm)
Reagent rack	6 x 100ml vials and 8 control positions
Liquid Containers	2 tanks for wash buffer and waste. Both with liquid level sensors
Strip Holders	6 slides (8 strips per slide) to process up to strips on oscillating plane
Dispensation System	1 dispensation and 1 aspiration probe
Strip Washing	Liquid dispensation and aspiration via two instrument probes
Image acquisition system	High Resolution Colour Camera (3.3 Megapixels) mounted above Probes
Dispensation	Up to 2500 µl with a 1 µl resolution
Software	Windows 2000 and XP compatible to set up work list, reports and result archive. Loading work lists and transmit results via Host Computer interface (LIS)
Minimum PC Requirements	– 200 MB free hard disk space – CD-Rom reader – RAM 512 MB – Pentium 4 – Standard video card:VGA 1024x768 16 million colours – Free USB 2.0 port
Power Requirements	230/115 VAC, 50-60Hz, 150W
Optional	Bar Code Reader (BCR) for samples with position ID
Measurements	79 x 61 x 65 h (in cm)
Weight	71 Kg

SECTION 3
MAINTENANCE PROCEDURES

3.1 SYSTEM ARCHITECTURE

The system architecture is illustrated in the following diagram and described in table below:



Functional unit	*Description*
X – Y Axis	The X-Y axis movement mechanism moves probe arms over work area with precision
Z_1 Axis	The Z_1 axis raises and lowers dispensing probe over work area.
Z_2 Axis	The Z_2 axis raises and lowers aspiration probe over work area.
Dilutor unit	The dilutor unit aspirates and dispenses samples, calibrators, controls, and generally all reagents. It also washes Z1 axis probe internally and externally.
Shaking Plane	The shaking plane shakes the 6 slides holding the strips to be processed
Camera	The camera acquires the images of the processed strips.

The AP Blot communicates with the PC via a serial connection: between the Dilutor PCB and the PC.
The units controlled by the PCB are:

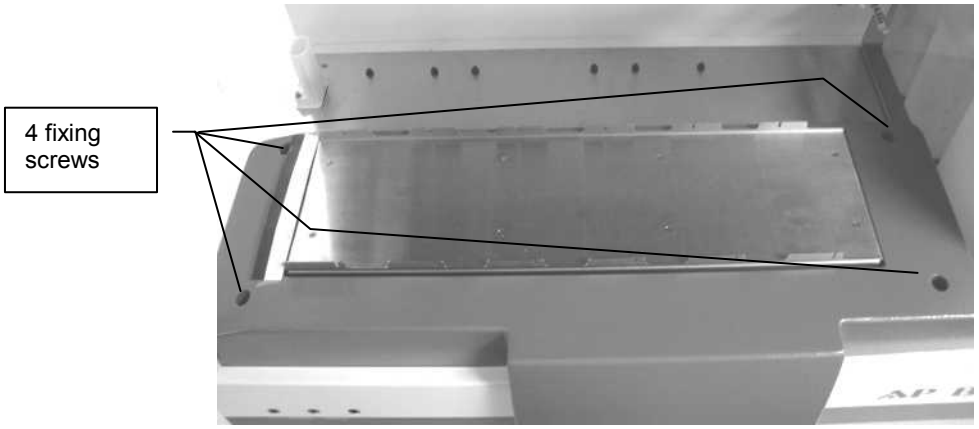
PCB	***Unit***
DILAP21	X – Y Axis
	Z_1 – Z_2 Axis
	Dilutor unit
	Shaking plane

3.2 REMOVING WORK AREA

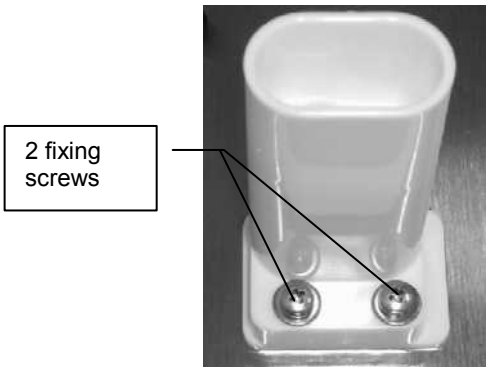
3.2.1. REMOVING WORK AREA

a) Turn off instrument

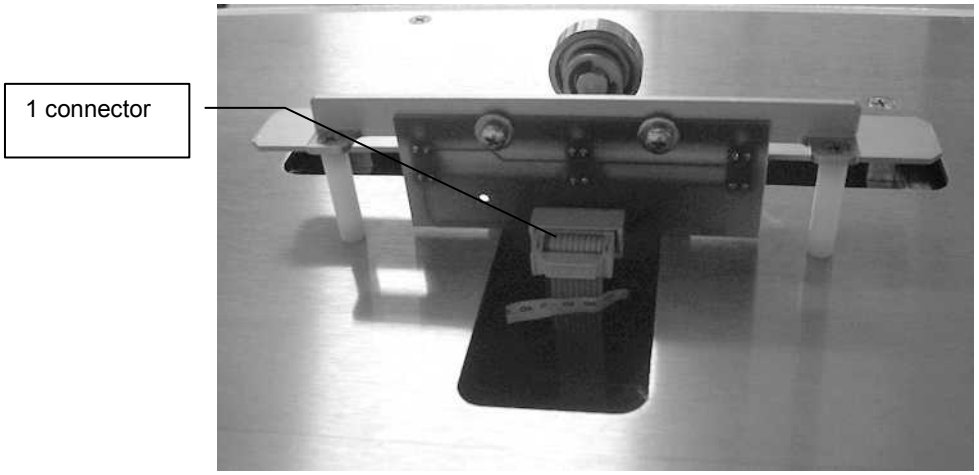
b) To remove strip holder tray plate first loosen four screws holding shaking plane



c) Remove 2 fixing screws from Probe wash basin and detach Waste (“OUT”) tube from under basin

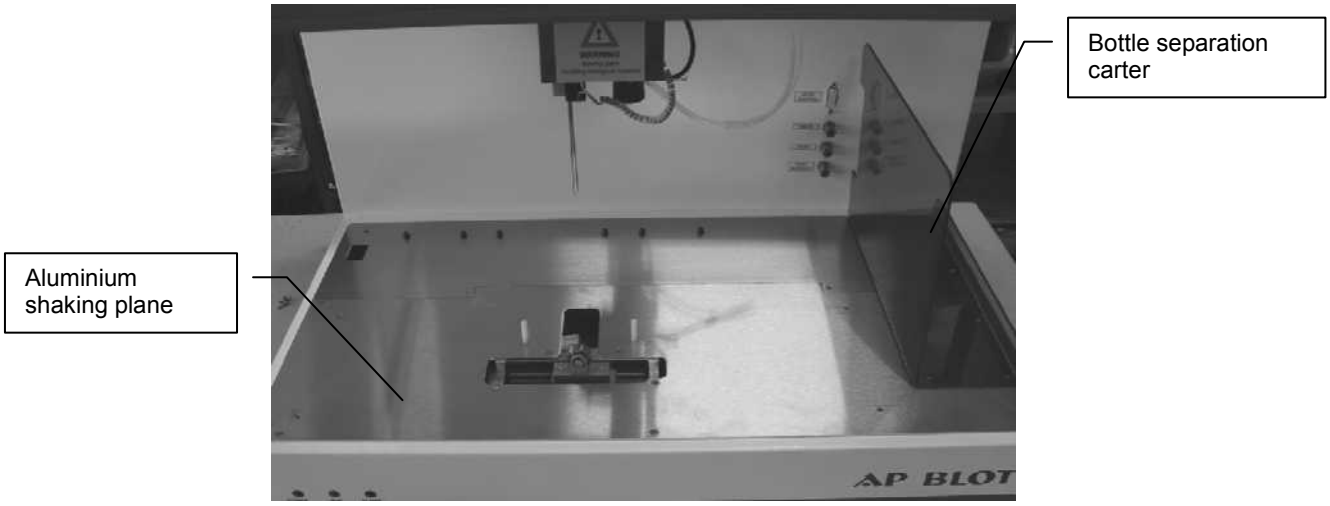


d) Remove connector from shaking plane positioning opto PCB (OP-Swing PCB)



e) Remove 8 screws from bottle separation carter

f) Remove 7 screws from aluminium shaking plane



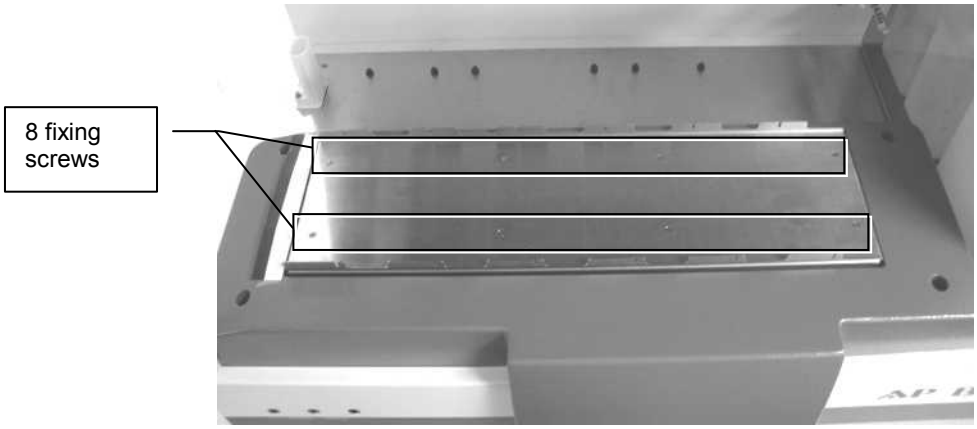
g) Lift up and detach screws holding the shaking plane movement mechanism motor

h) NB: each time shaking plane support is moved, or removed calibrate shaking plane as described Para. 4.8.4.

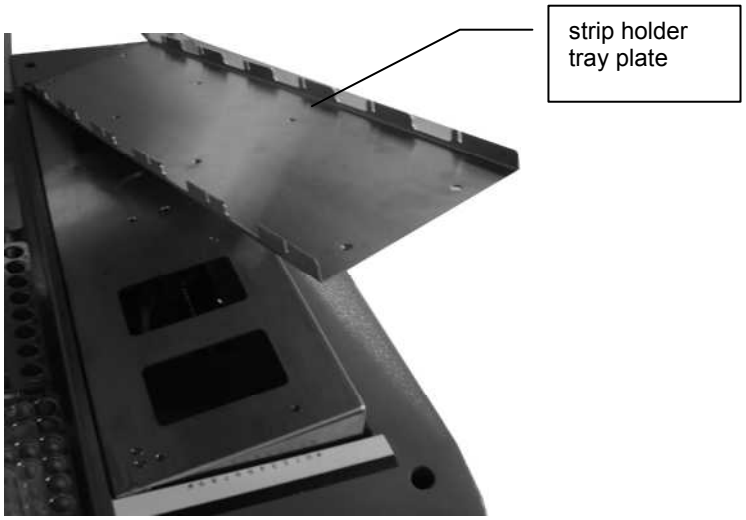
3.2.2. Removing shaking plane

a) Turn off device

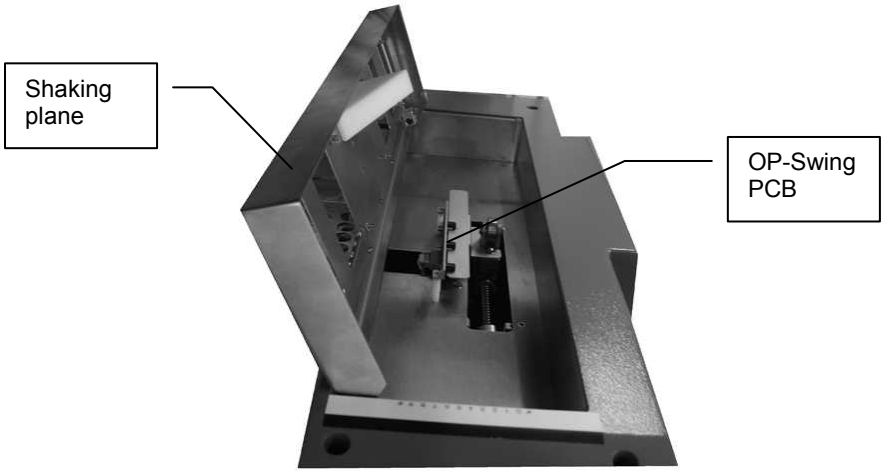
b) Remove 8 screws from strip holder tray plate.



c) Remove strip holder tray plate



d) Lift up shaking plane



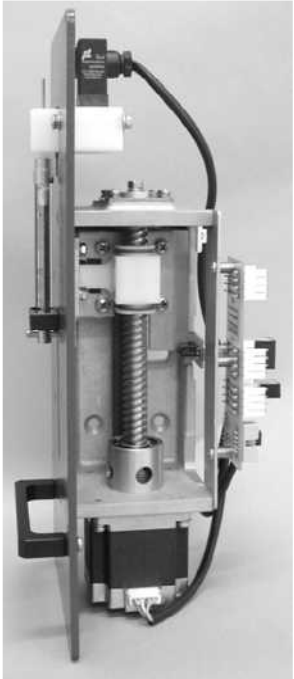
3.3 DILUTOR UNIT

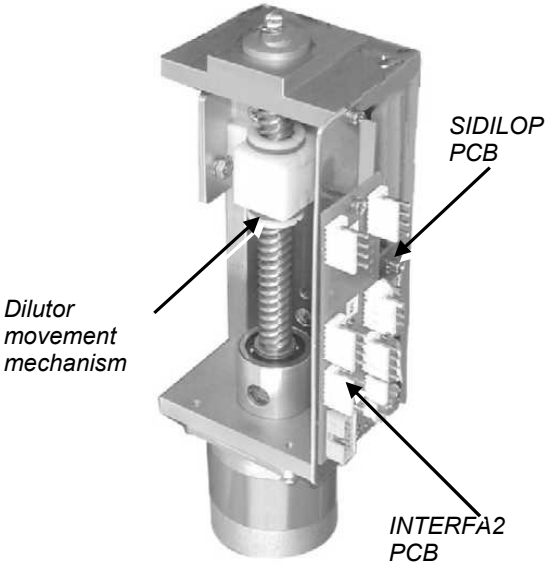
3.3.1. DESCRIPTION OF HOW IT WORKS

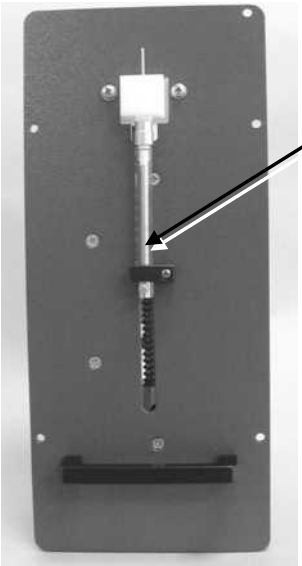
FUNCTION

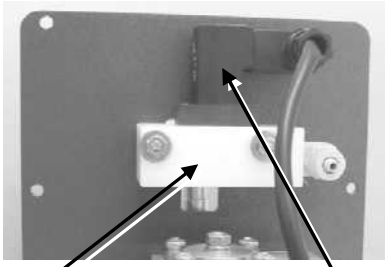
The dilutor unit aspirates and dispenses samples, calibrators, controls and all reagents, and also cleans inside of Z_1 probe.

3.3.1.1. Dilutor Unit







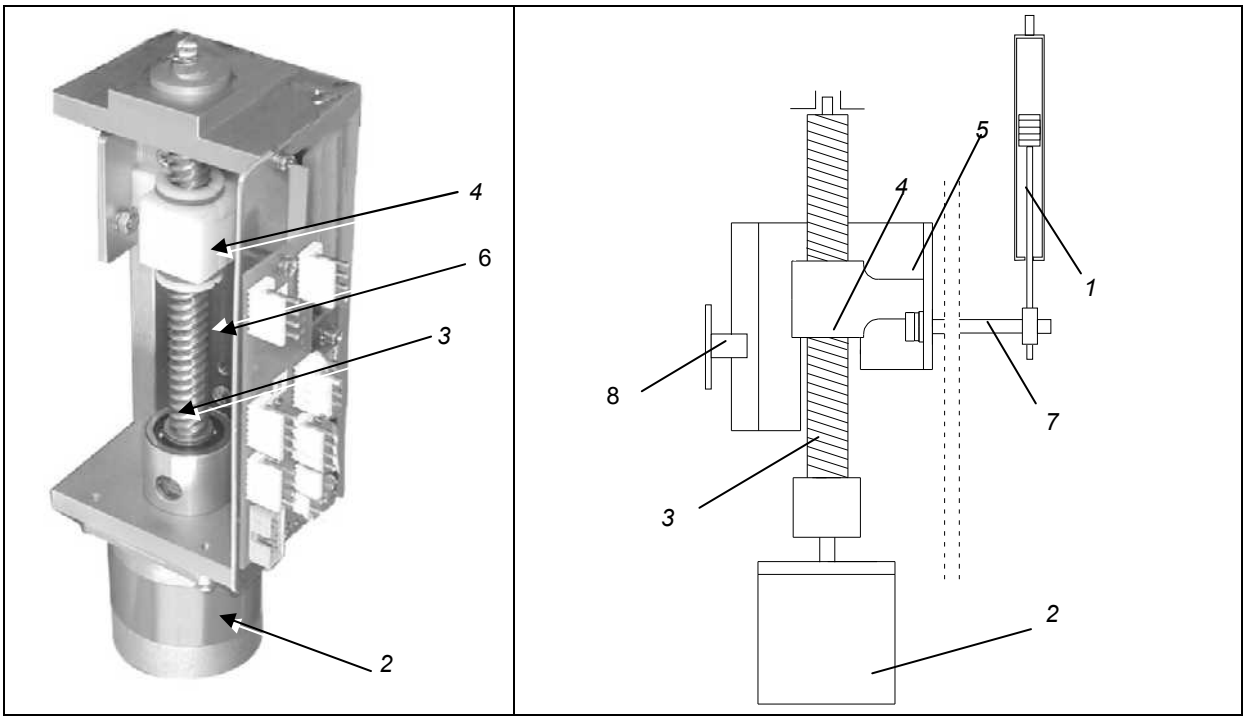


The DILUTOR UNIT is composed of following parts (clockwise direction):

1	Dilutor mechanism	Moves probe with step motor
2	2-way Electro-valve	For the aspiration of washing solution or for probe aspiration/dispensation
3	Syringe	To aspirate and dispense

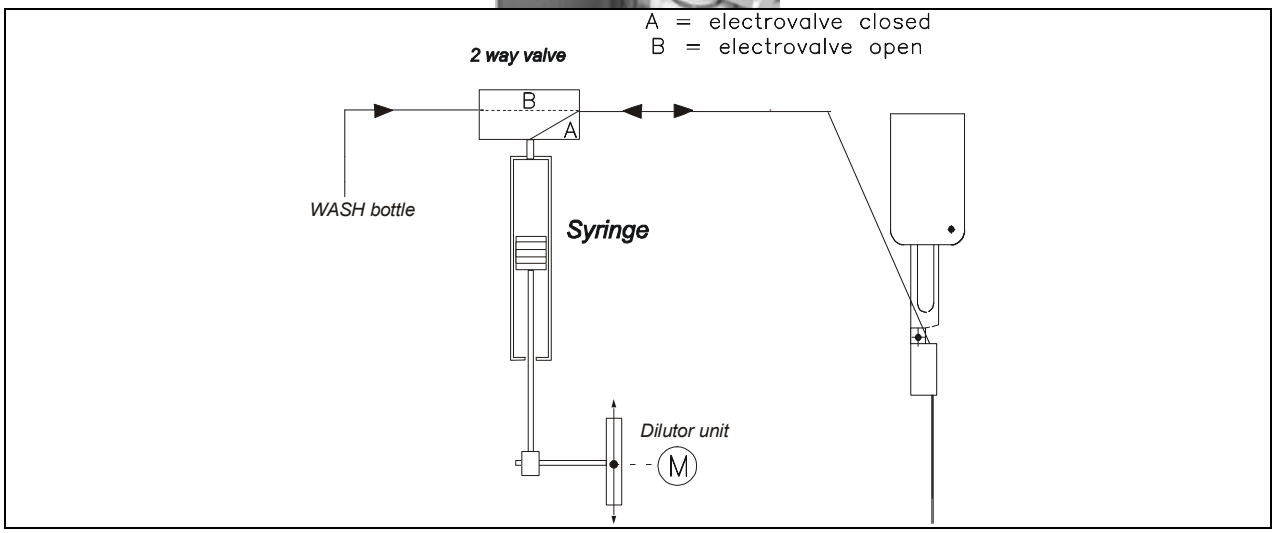
3.3.1.2. Dilutor mechanism

This mechanism moves the syringe plunger (1) up and down in small steps. The movement is generated by a step motor (2) which moves a special worm screw (3) inside a female plastic nut 4) fixed on a carriage (5) which runs along a track (6) on 4 ball bearings. A shaft is mounted on the carriage (7) which then moves the syringe plunger (1). The optic sensor (8) is mounted on the SIDILOP PCB and signals when the syringe plunger has reached the End line ("home") position.

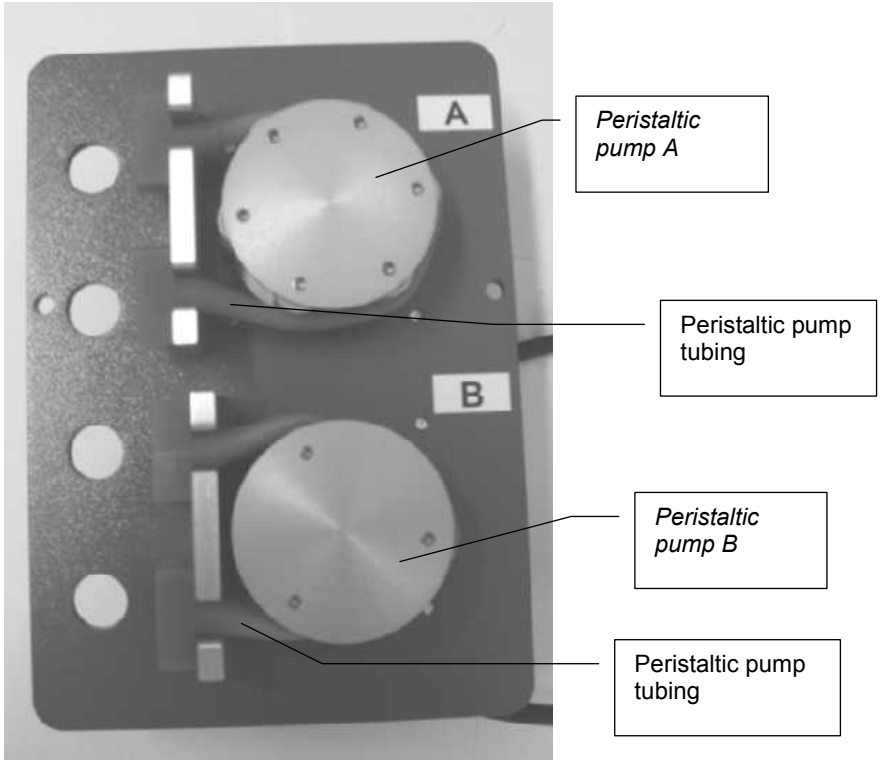


3.3.1.3. Valve mechanism/Syringe

The valve mechanism connects the Wash bottle to the rest of the hydraulic syringe-probe circuit through the peristaltic pump.
The syringe movement is generated by the dilutor unit and the syringe is connected to the dispensing probe



3.3.1.4. Pump Unit



The pump unit is made up of 2 peristaltic pumps composed of:

- rotating wheel
- stand
- peristaltic pump tubing
- step motor

Note:

- Pump A washes dispensation probe internally and externally and regulates WASH liquid flow during STRIP WASH phase.

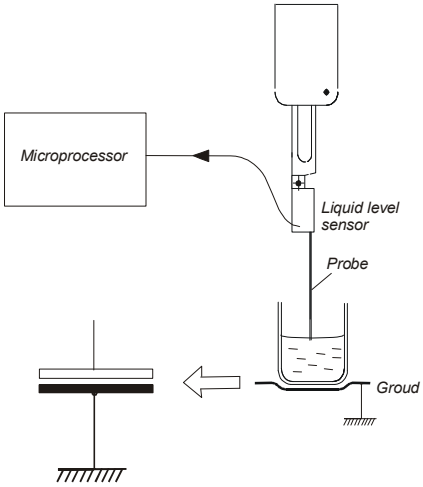
3.3.1.5. Probe

The probe has two functions:

- Liquid aspiration and dispensation
- Liquid sensor (for liquid level)

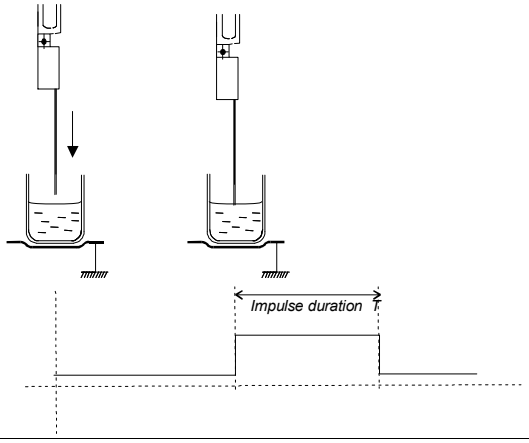
Aspiration and dispensation

The probe aspirates and dispenses controls, samples, etc.



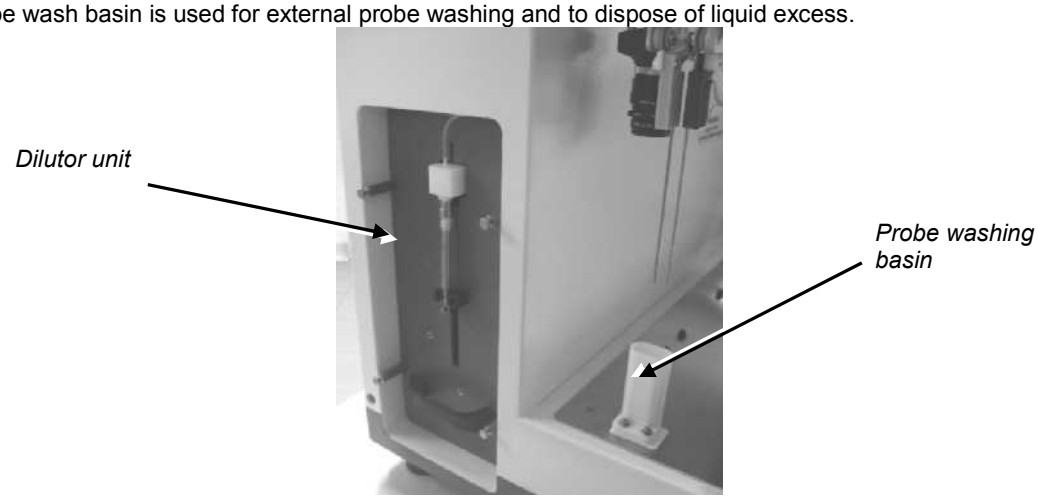
Liquid Sensor

The probe is fitted with a liquid sensor which regulates its movements near the liquid to be aspired.
This sensor reads the variations of the electrical capacity of the circuit which consists of probe – liquid – ground.
The sensor circuit emits a low signal (level 0) until the probe touches the liquid.
A high signal (level 1) is emitted to indicate when the probe touches the liquid for duration 'T' in proportion to the variation of the circuit capacity.
Adjusting probe sensitivity is based on the duration/bandwidth of this impulse. (Below a certain value this impulse is only considered noise and not valid as a liquid surface signal).



3.3.1.6. Probe Wash Basin

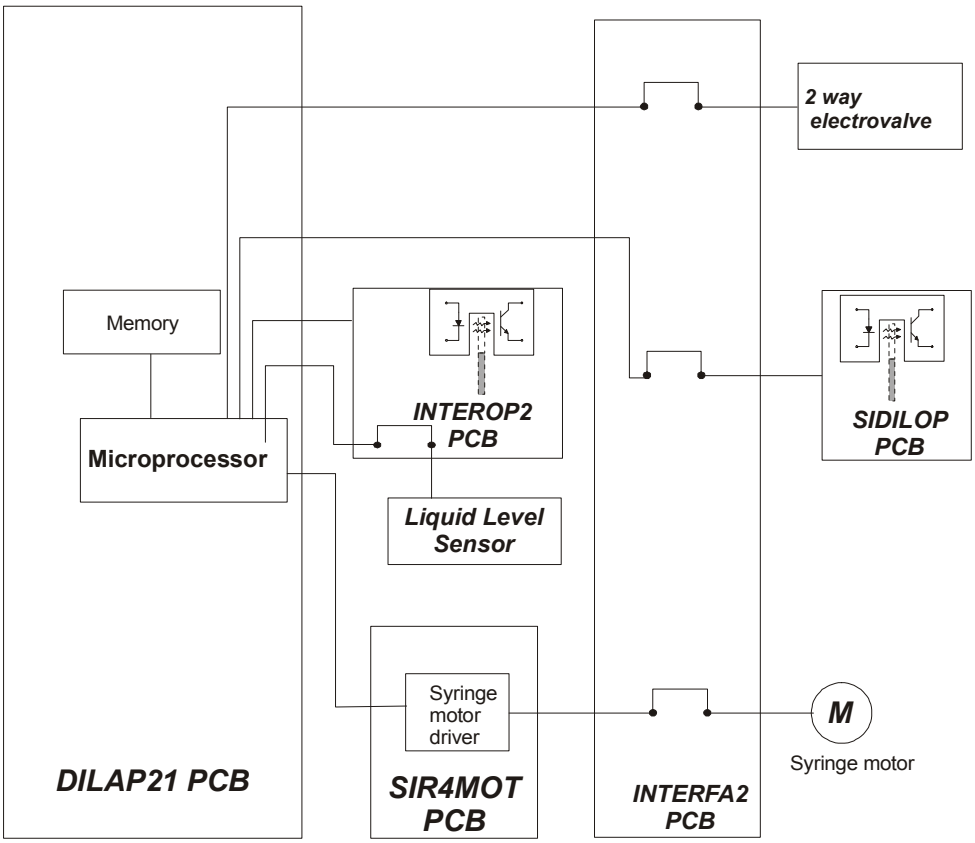
The probe wash basin is used for external probe washing and to dispose of liquid excess.



3.3.1.7. Dilutor Unit PCB Electrical Diagram

The table below describes each PCB and the various dilutor unit components they control and the diagram shows the PCBs and the dilutor unit electrical circuit.

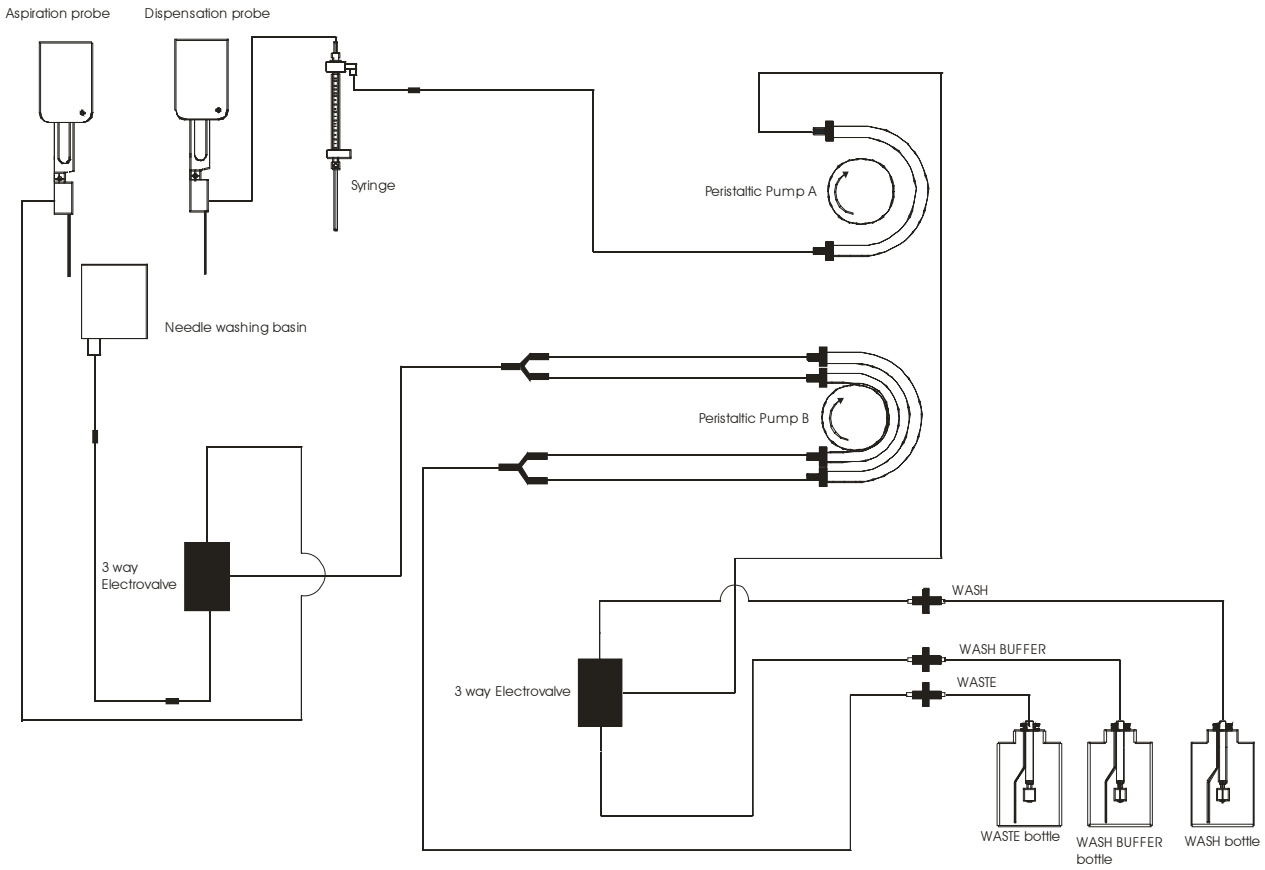
DILAP21 (Dilutor) PCB	*a micro-processor, a memory and electro-valve driver*
SIR4MOT PCB	*syringe motor driver.*
SIDILOP PCB	*optical sensor which senses when syringe has reached end line ("home") position.*
INTEROP2 PCB	*Support for liquid level sensor and cable distribution*
INTERFA2 PCB	*Connects wire cables*
Liquid Level Sensor	*Electronic circuit in a small container mounted on probe which signals contact with liquid surface (level)*
Syringe Motor	*A step motor which moves syringe plunger (with special "worm" screw inside the plastic nut).*
Dilutor 2-way Electro-valve	*Manages washing solution aspiration or probe aspiration/dispensation.*



3.3.1.8. Dilutor unit hydraulic component diagram

The table below describes the different functions of the dilutor unit hydraulic components.
The diagram shows how the dilutor unit circuit is set up to work.

WASH bottle	*Contains probe-washing liquid, 5 litre capacity*
Level Sensor	*Sensor for the three different bottles and connecting cables and connectors*
Probe washing pump	*Peristaltic pump A for washing probe, internally and externally, driven by step motor*
Probe wash basin	*For external probe wash and draining any excess liquid*
Syringe	*For aspirating and dispensing liquid through probe*



3.3.2. REGULAR DILUTOR UNIT MAINTENANCE

1	Visually check the following components: – Tubing connecting Valve – Probe. – Syringe plunger – Syringe – Peristaltic Pump tubing – Shaking plane – Calibration Strip – Camera	Every 4 months	Ref. para. 3.3.2.1.

3.3.2.1. Visual checks

- *Tubing connecting Valve – Probe:*

Check that there is no narrowing or kinks or obstructions on any of this tubing.

If these faults are found the tubing can be substituted as described in para. 3.3.3.1.

- *Syringe plunger:*

Check that the syringe plunger and tip are in good condition (they should be clean and without any liquid dripping from syringe bottom).

If condition is unsatisfactory, substitute plunger following procedure described in para. 4.8.5.

- *Syringe:*

Check that syringe glass is in good condition. If any damage can be seen then substitute syringe following procedure described in paragraph 4.8.5.

- *Peristaltic pump tubing:*

Check that tubing is in good condition and more specifically check that there are no traces of rubber around pump area. If condition or area is unsatisfactory change this rubber tubing as described in para. 3.3.3.5.

- *Shaking plane:*

Check that shaking movement is smooth, with no obstructions or hesitations. If movement is unsatisfactory check shaking mechanism as described in Para. 3.6.1.1.

- *Camera Calibration strip:*

Check that camera calibration strip is clean and intact. If condition is unsatisfactory, clean off strip with a clean cloth and/or substitute strip.

- *Camera:*

Check that electrical cable is correctly plugged in

3.3.3. SUBSTITUTING DILUTOR UNIT COMPONENTS

To substitute syringe and syringe plunger refer to para. 4.8.5.

The following table lists procedures and paragraphs relevant to these substitutions.

Substituting valve – syringe – dispensation probe tubing	Ref. para. 3.3.3.1
Substituting valve mechanism	Ref. para. 3.3.3.2
Substituting 3-way Electro valve	Ref. para. 3.3.3.3
Substituting 3-way valve mechanism	Ref. para. 3.3.3.4
Substituting Peristaltic Pump Tubing	Ref. para. 3.3.3.5
Substituting Dilutor Motor	Ref. para. 3.3.3.6
Substituting Opto SIDILOP PCB	Ref. para. 3.3.3.7
Substituting INTERFA2 PCB	Ref. para. 3.3.3.8
Substituting probe wash basin	Ref. para. 3.3.3.9

3.3.3.1. Substituting valve – syringe – dispensation probe tubing

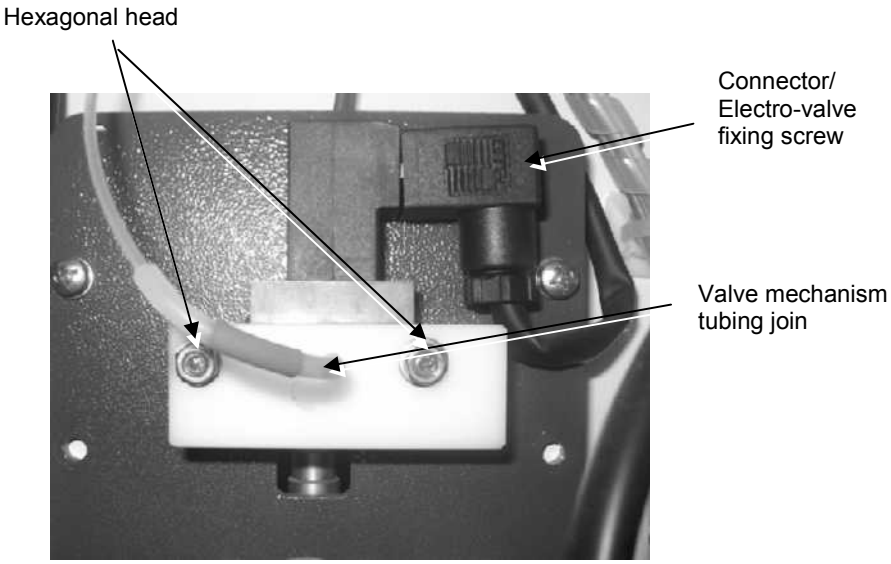
a) Disconnect AWG15 tubing from probe

AWG15 tubing

b) The old tubing (to be replaced) should be used as a guide or ‘driver’/track
c) Join the ends of the old and new tubing together with adhesive tape.
d) Slowly pull old tubing.
e) Separate new tubing from the original “driver” tubing and join the new tubing to the valve unit joint and probe.

3.3.3.2. Substituting valve mechanism

a) Turn on instrument. Run XCalib Program (See Section 4). From “Dilutor” pulldown menu select “Calibrate syringe” and follow instructions.
b) Click on “Remove syringe” to fully open syringe plunger.
c) Turn off machine
d) Remove AWG 15 tubing from valve joint
e) Unscrew syringe from valve mechanism in an anti-clockwise direction and extract it
f) Remove tubing joined to valve mechanism
g) Remove valve connector by undoing fixing screw



h) Remove valve mechanism by undoing 2 fixing nuts
i) Insert new valve mechanism and re-block it with 2 fixing nuts.
j) Replace valve and connector
k) Replace hydraulic connections
l) Replace syringe in movement shaft and screw it back into valve mechanism in a clockwise direction.
m) Turn on instrument again and run a prime to rinse hydraulic circuit

3.3.3.3. Substituting 3-way Electro valve

Note: to replace electro valve follow procedure described in para. 3.11.2.1.

3.3.3.4. Substituting 3-way valve mechanism

Note: to replace valve mechanism follow procedure described in para.3.11.2.1.

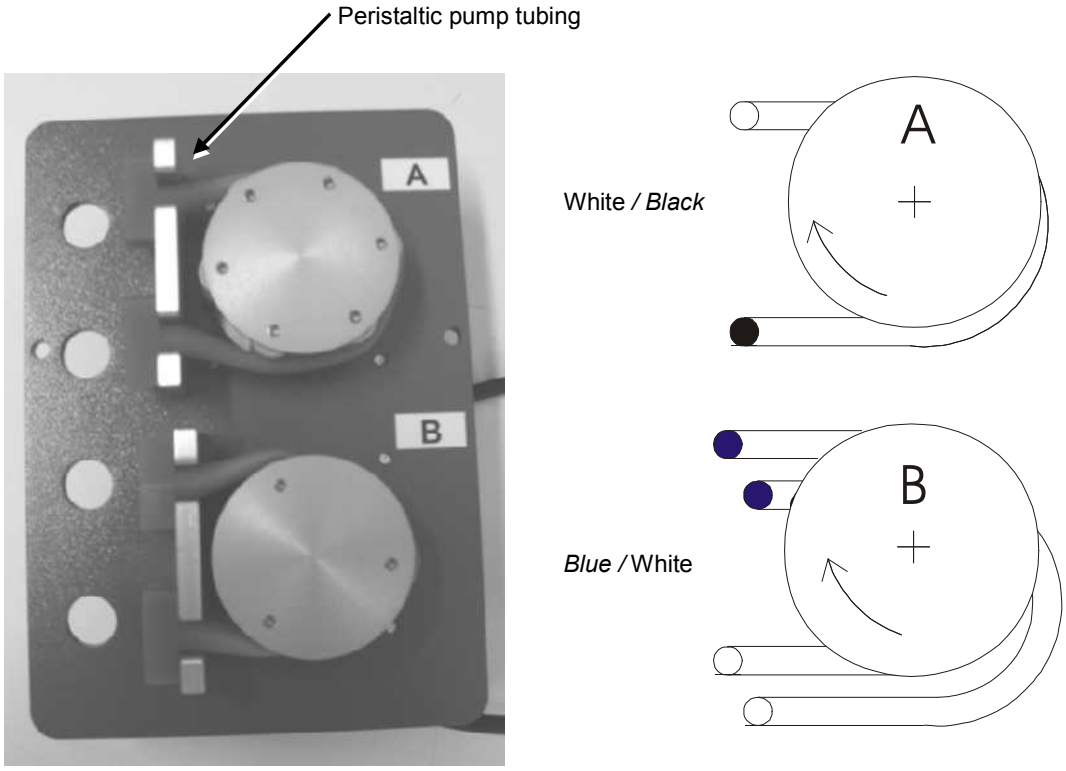
3.3.3.5. Substituting Peristaltic Pump Tubing

a) Turn on instrument. Run XCalib program. From “Dilutor” menu select “Prime”

b) Detach wash loading and buffer tubing from their bottles

c) Set prime for at least 60 seconds to empty hydraulic circuit. Select ‘Prime’

d) After this prime rinse, detach tubing and then slip tubing off pumps.



e) Place new peristaltic tubing into position and re-connect it up following the diagram sticker on device.

f) Reconnect both Wash loading and Buffer tubing to their respective bottles.

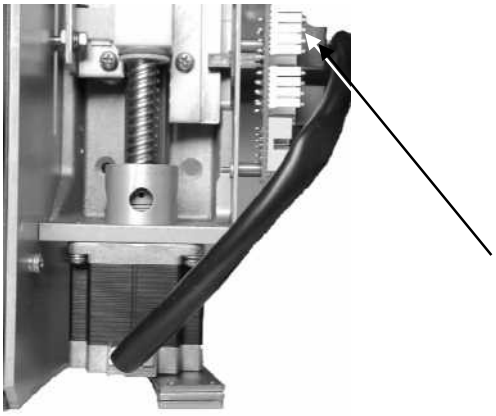
g) Run another prime by selecting “Prime” option to rinse hydraulic circuits again

3.3.3.6. Substituting Dilutor Motor

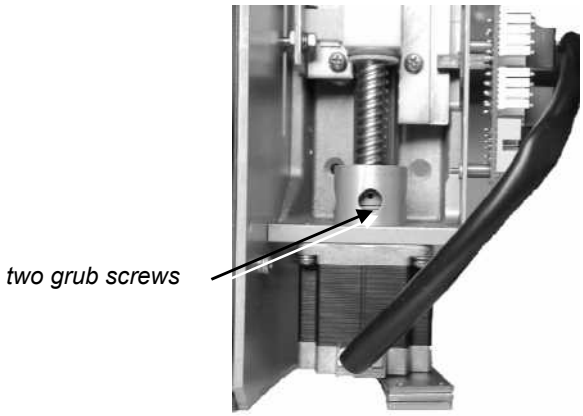
a) Remove AWG15 tubing.

b) Remove 4 screws from dilutor unit stand.

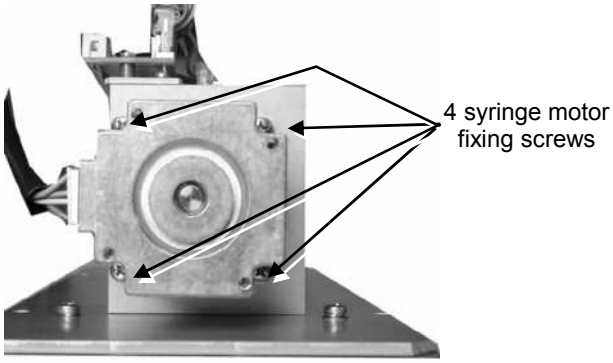
c) Remove connector that joins dilutor motor to INTERFA2 PCB



d) Loosen two grub screws that block motor axis mechanism .



e) Remove the motor by loosening the 4 fixing screws



f) Re-position new motor and block it in position with 4 motor fixing screws and tighten grub screws that were previously loosened (in step ‘d’)

g) Restore motor and INTERFA2 – PCB connections.

3.3.3.7. Substituting Opto SIDILOP PCB

a) Remove AWG15 tubing.
b) Remove 4 screws from dilutor panel.
c) Remove connector between SIDILOP PCB and INTERFA2 PCB.
d) Unscrew fixing screws.
e) Re-position new PCB and attach it with fixing screws
f) Re-connect new SIDILOP and INTERFA2 PCB.

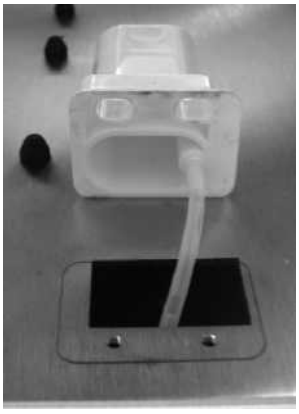
3.3.3.8. Substituting INTERFA2 PCB

a) Remove AWG15 tubing.
b) Remove 4 screws from dilutor panel.
c) Remove connectors from INTERFA2 PCB and two screws attaching it to the plate.
d) Substitute PCB and re-attach it with the 2 screws; follow numbering to re-position connectors correctly.
e) Replace dilutor unit in position.

3.3.3.9. Substituting probe wash basin

a) Unscrew probe wash basin from work area.

b) Lift up basin and disconnect Waste (“OUT”) tubing



c) Substitute probe wash basin

d) Reconnect “OUT” tubing to probe wash basin .

e) Replace basin on work area with screws removed previously and proceed to centering procedure for probe 1 as described in para. 4.8.1

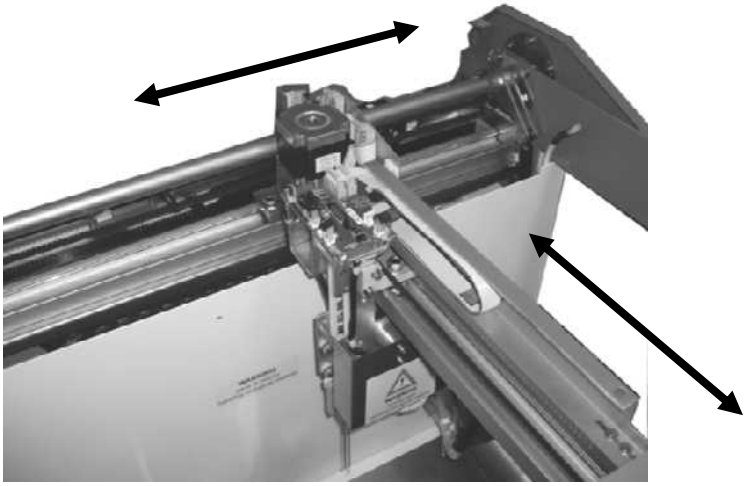
3.4. X–Y AXIS

3.4.1. DESCRIPTION OF HOW IT WORKS

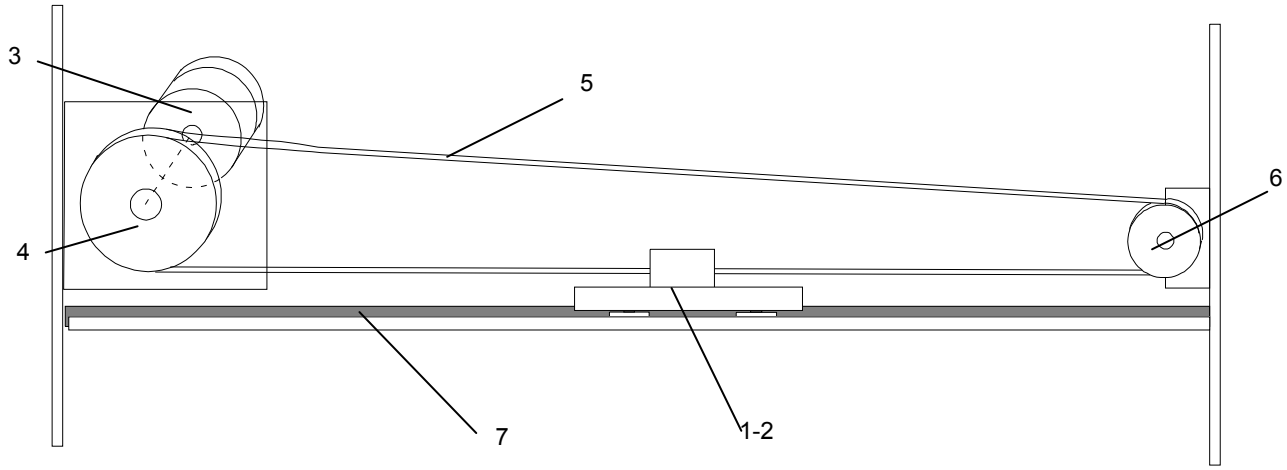
3.4.1.1. X – Y axis movement mechanism

FUNCTION:

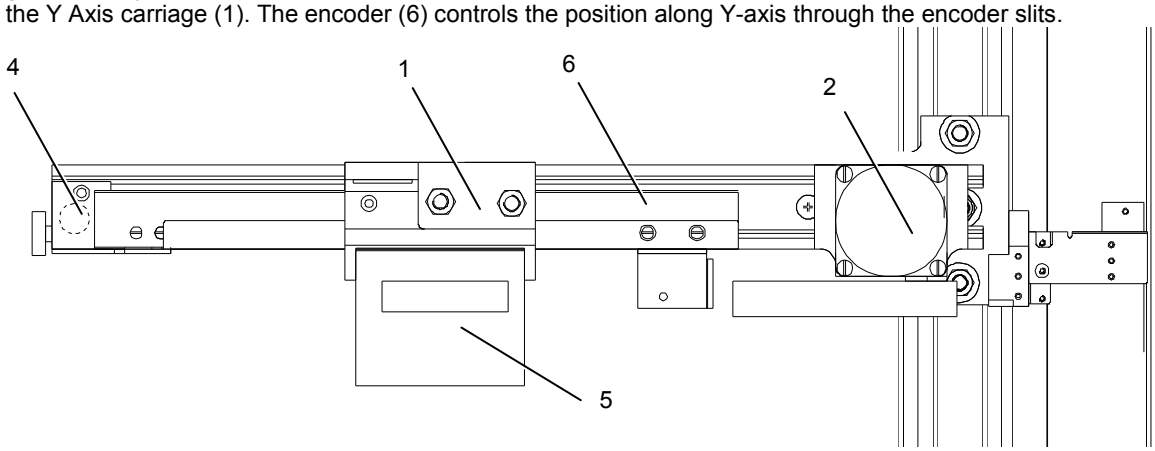
The X – Y axis movement mechanism moves probe arm precisely over work area.



The X axis movement mechanism moves the X axis carriage (1). The Y axis is fastened on the carriage (2). The movement is generated by a motor (3) and a pulley (4), a serrated belt (5) and an idle wheel (6). The XGOLAV opto PCB is mounted on the X axis carriage (1). The encoder (7) controls the position along X-axis through encoder slits.



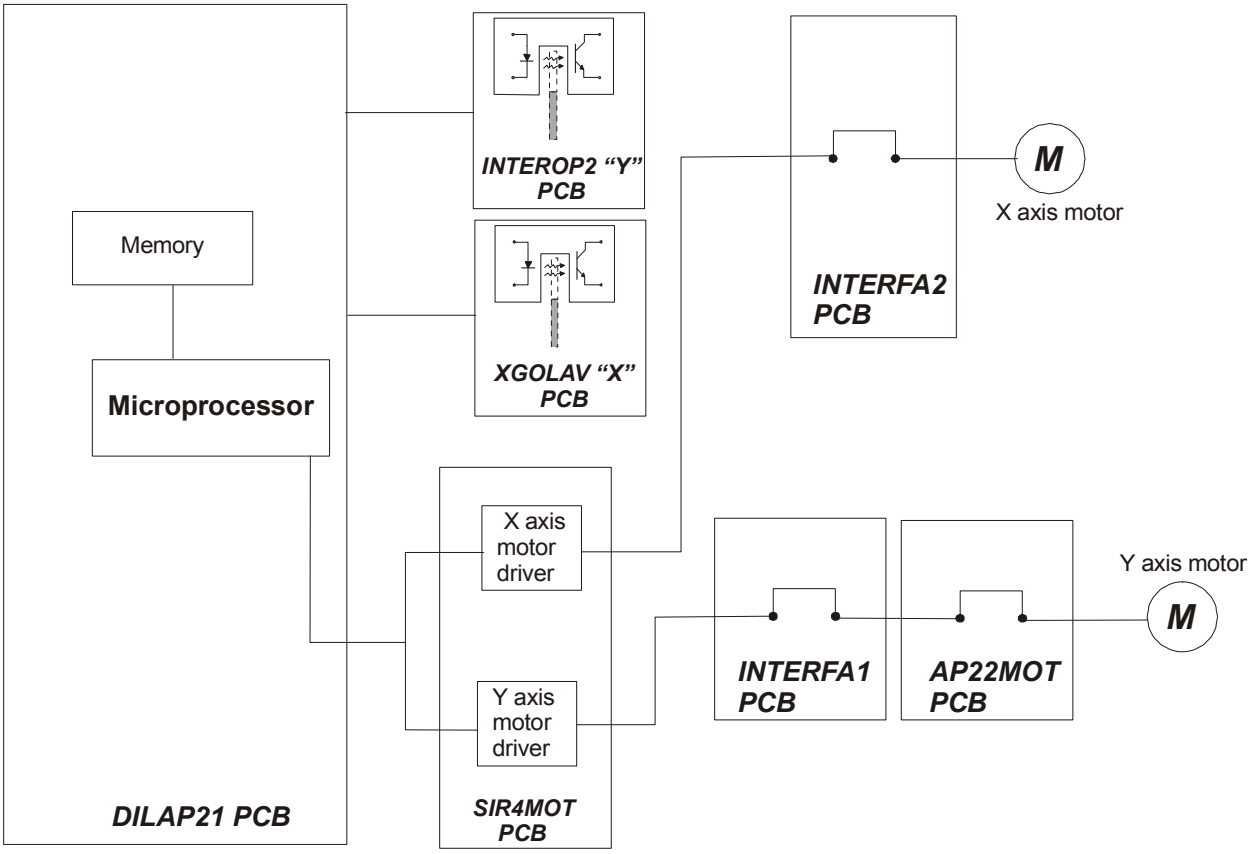
The Y axis mechanism moves carriage along Y Axis (1) on which the Z_1 and Z_2 axis are fixed. The movement is generated by step motor (2) with a serrated belt (3) and an idle wheel (4). The INTEROP2 PCB (5) is mounted on the Y Axis carriage (1). The encoder (6) controls the position along Y-axis through the encoder slits.



3.4.1.2. X- Y axis Electrical Functions Diagram

The table below describes the electrical components of each PCB which effects the movement of the X-Y axis. The arrangement is shown in the diagram.

DILAP21 PCB	*Microprocessor and memory.*
SIR4MOT PCB	*Controls X - Y axis.*
XGOLAV "X" PCB	*Controls opto with which the encoder controls axis position.*
INTEROP2 "Y" PCB *Opto couplers*	*The Opto couplers, together with the selectors, control:* *1) Y probe position* *2) Z1 and Z2 probes position* *3) ZZ probe position*
INTERFA1 PCB	*Connectors for wiring.*
INTERFA2 PCB	*Connectors for wiring.*
AP22MOT PCB	*Connectors for wiring.*
X axis motor	*Step motor*
Y axis motor	*Step motor*



3.4.2. REGULAR MAINTENANCE FOR X–Y AXIS

Cleaning X-Y axis tracks	Every 6 months	Ref. para. 3.4.2.1
Check belt tension	Every 6 months	Ref. para. 3.4.2.2
Check condition of flat cables	Every 6 months	Ref. para. 3.4.2.3

3.4.2.1. Cleaning X-Y axis tracks

a) Use a sponge/clean cloth to wipe dust off and clean up any other dirty residue.
b) Uniformly spread the grease along the tracks with the same slightly damp sponge/cloth.

3.4.2.2. Check belt tension

a) If there is an excessive vibration when X and Y axis moves, then adjust the tension of the belts (Ref. Para. 3.4.3.1.).
b) If X and Y axis block during their movement check that belts are not too tight (Ref. Para. 3.4.3.1.).

3.4.2.3. Check condition of flat cables

a) Check that flat cables are not touching any metal parts.
b) Check that cables maintain their original folds.

3.4.3. CALIBRATING X–Y AXIS SETTINGS

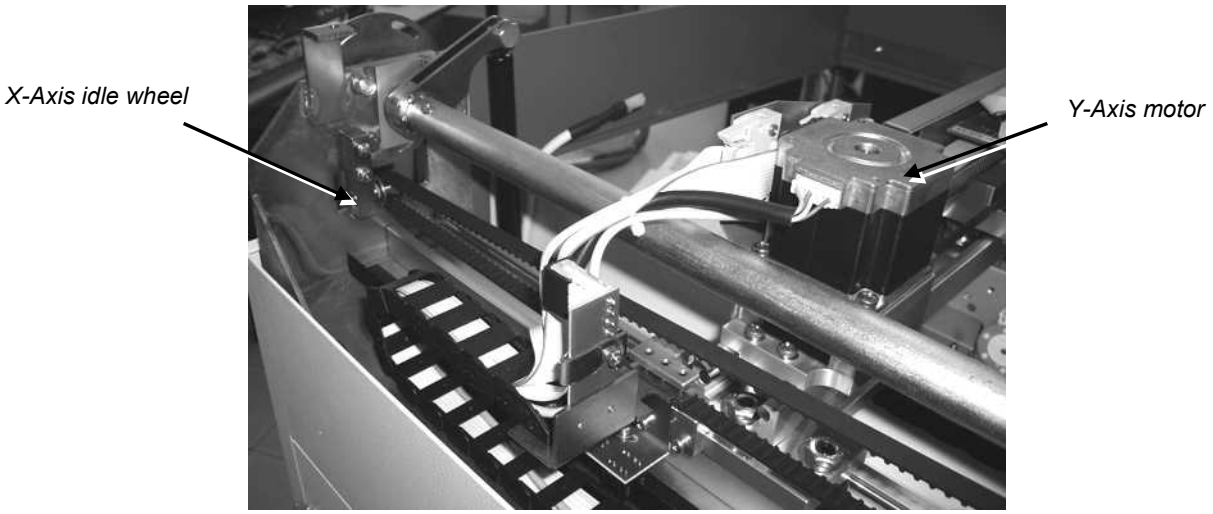
To center X-Y-axis refer to para. 4.8.1.

The following table lists the relevant paragraphs describing the different possible calibrations

Errore. L'origine riferimento non è stata trovata.	Every 6 months	Ref. para. 4.8.1.2
X and Y axis belt tension	Every 6 months	Ref. para. 3.4.3.1

3.4.3.1. X and Y axis belt tension

a) Regulate X axis belt tension by turning idle wheel.
b) Regulate Y axis belt tension by loosening the fixing screws from the Y axis motor, move the motor along in the Y direction until the belt has reached the correct tension
c) Once the correct tension has been achieved, tighten the fixing screws.

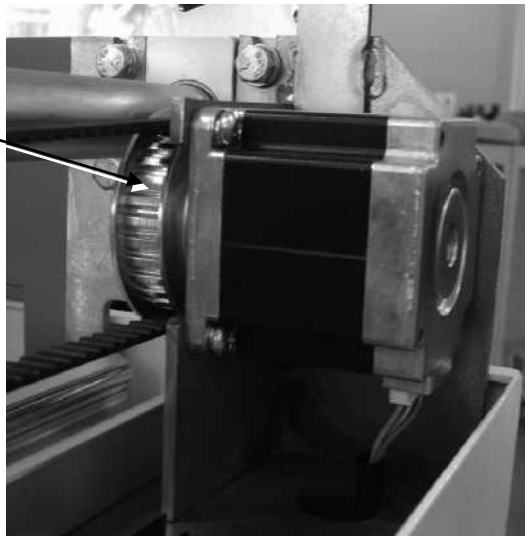


3.4.4. Substituting X–Y AXIS PARTS

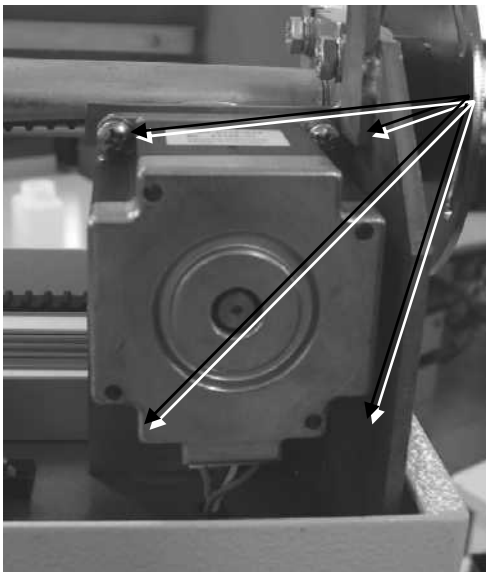
Substituting X-axis Movement Motor	Ref. para. 3.4.4.1
Substituting Y-axis Movement Probe motor	Ref. para. 3.4.4.2
Substituting Opto XGOLAV (X-axis movement)	Ref. para. 3.4.4.3
Substituting X-axis movement belt	Ref. para. 3.4.4.4
Substituting Flat Cables	Ref. para. 3.4.4.5
Substituting X-Y axis movement flat cables	Ref. para. 3.4.4.6
Substituting INTEROP2 PCB (Y-axis movement)	Ref. para. 3.4.4.7

3.4.4.1. Substituting X-axis Movement Motor

a) Remove protective cover from device by loosening the screws on top.
b) Remove motor connector from INTERFA2 PCB.
c) Loosen 2 dowels on wheel which sustains the belt.



d) Remove motor by loosening 4 fixing screws.



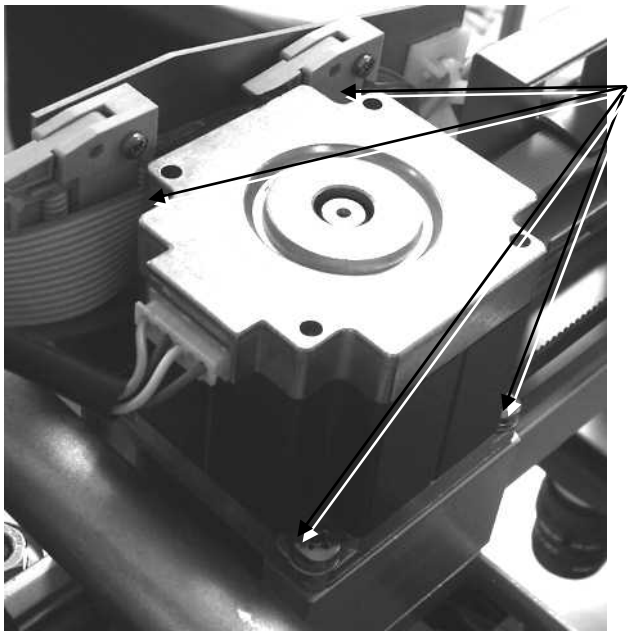
e) Position new motor, and secure it by tightening the 2 dowels.
f) Reconnect connector to INTERFA2 PCB.
g) Replace cover.

3.4.4.2. Substituting Y-axis Movement Probe Motor

a) Remove top cover by undoing screws on top of device.

b) Remove connector which joins motor to AP22MOT PCB

c) Remove motor after loosening 4 fixing screws.



d) Place new motor in position and fix in place with 4 screws.

e) Check belt tension.

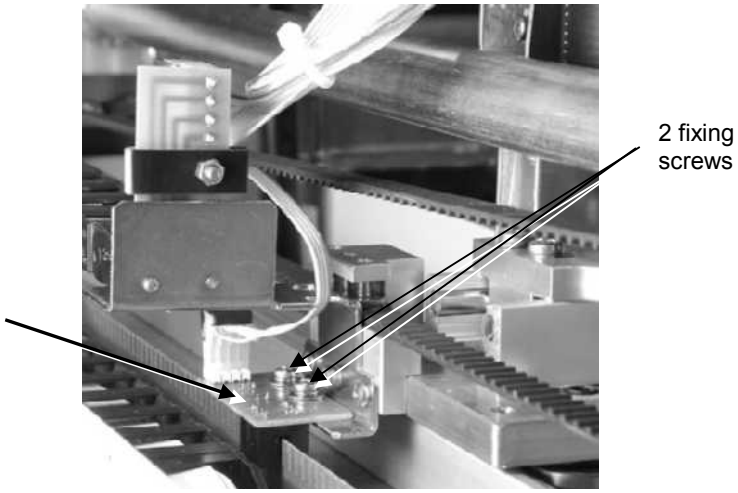
f) Reconnect motor to AP22MOT PCB with connector

3.4.4.3. Substituting Opto XGOLAV (X-axis movement) PCB

a) Remove top cover after undoing screws on top.

b) Remove connector attached to XGOLAV PCB.

c) To substitute it unscrew PCB from plate.



d) Place new PCB in position and screw it to the plate with two fixing screws

e) Re-insert connector onto PCB.

f) Check centering of X axis (see para. 4.8)

g) Replace top cover.

3.4.4.4. Substituting X-axis movement belt

a) Remove screws fixing instrument cover to remove cover.

b) Loosen 3 grub screws fixing both ends of belt.

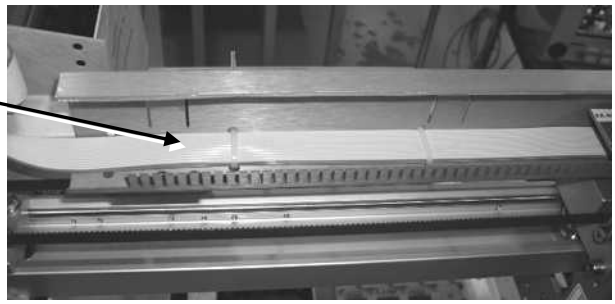
c) Replace belt and then tighten 3 grub screws which fixed the 2 ends of belt.

d) Check that belt is correctly tightened.

e) Remount cover

3.4.4.5. Substituting Flat Cables

a) The flat cables are held in position by plastic cable holder bands.



b) Remove PCB connectors 6

c) Remove cable holder bands and gently pull out flat cable.

d) Insert new flat cable and replace all previous cable holder bands.

e) Carefully re-insert connectors in correct positions.

3.4.4.6. Substituting X-Y axis movement flat cables

a) Remove device top cover after undoing top screws

b) Remove connectors between Y axis motor and AP22MOT PCB

c) Remove all plastic cable holder bands.

d) Remove cable blocking plates PIASTRINE CHE BLOCCANO I CAVI DI MOVIMENTO

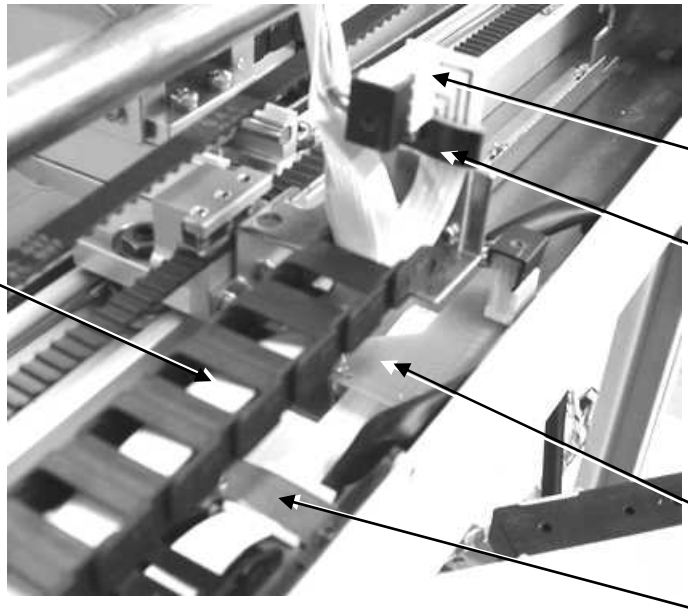
e) Dismount INTERFA1 PCB from base of frame

f) Remove black blocking plate and then undo 2 fixing screws from AP22MOT PCB

g) After removing all remaining protection - replace chain with AP22MOT and INTERFA1 PCBs on each end

h) Remount new cable with PCBs and reposition all cable holder bands

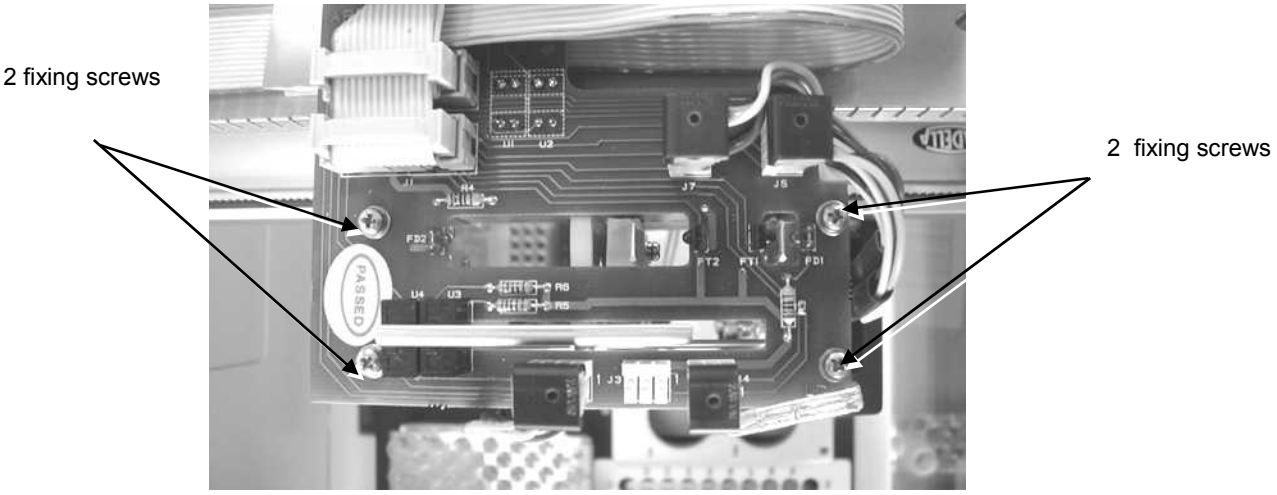
i) Remount cover



3.4.4.7. Substituting INTEROP2 PCB (Y-axis movement)

a) Undo fixing screws to remove device top cover

b) Detach connectors from INTEROP2 PCB and remove 4 fixing screws.



c) Reposition new PCB and secure it with 4 fixing screws.

d) Reinsert connectors.

e) Check Y-axis centering

f) Check Z maximum value.

g) Reposition cover and screw back screws

3.5. Z1 - Z2 AXIS

3.5.1. DESCRIPTION OF HOW IT WORKS

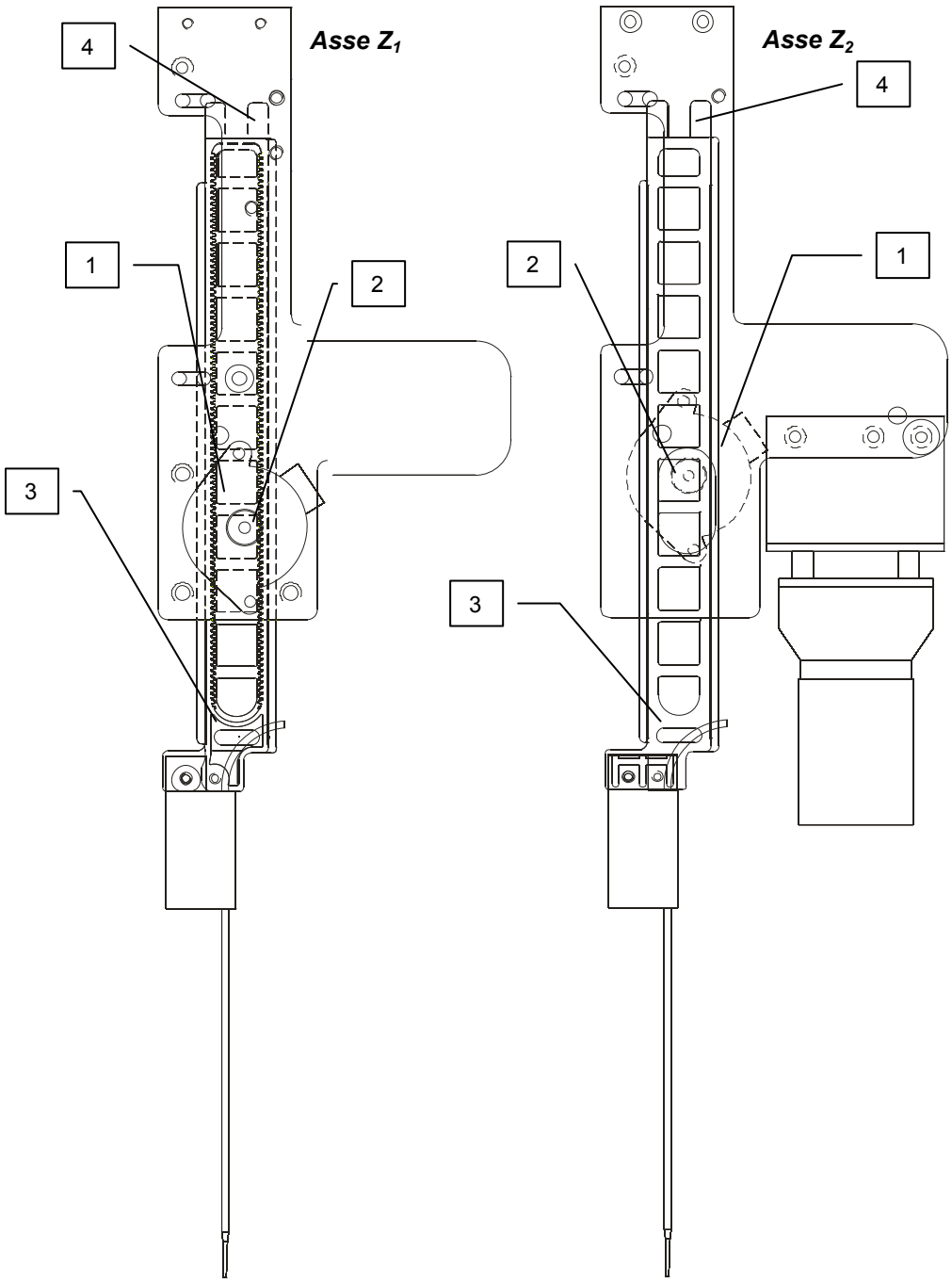
3.5.1.1. Z1 - Z2 axis movement mechanism

FUNCTION OF *Z_1* AXIS *(dispensation)*

Z_1 Axis moves the dispensation probe up and down over the instrument work area. This movement is driven by a step motor (1) with a pinion mounted on its shaft (2) that transmits the movement to the carriage (3).
The optical sensor, by means of the carriage encoder (4), detects the probe End line ("home") position.

FUNCTION OF *Z_2* AXIS *(aspiration)*

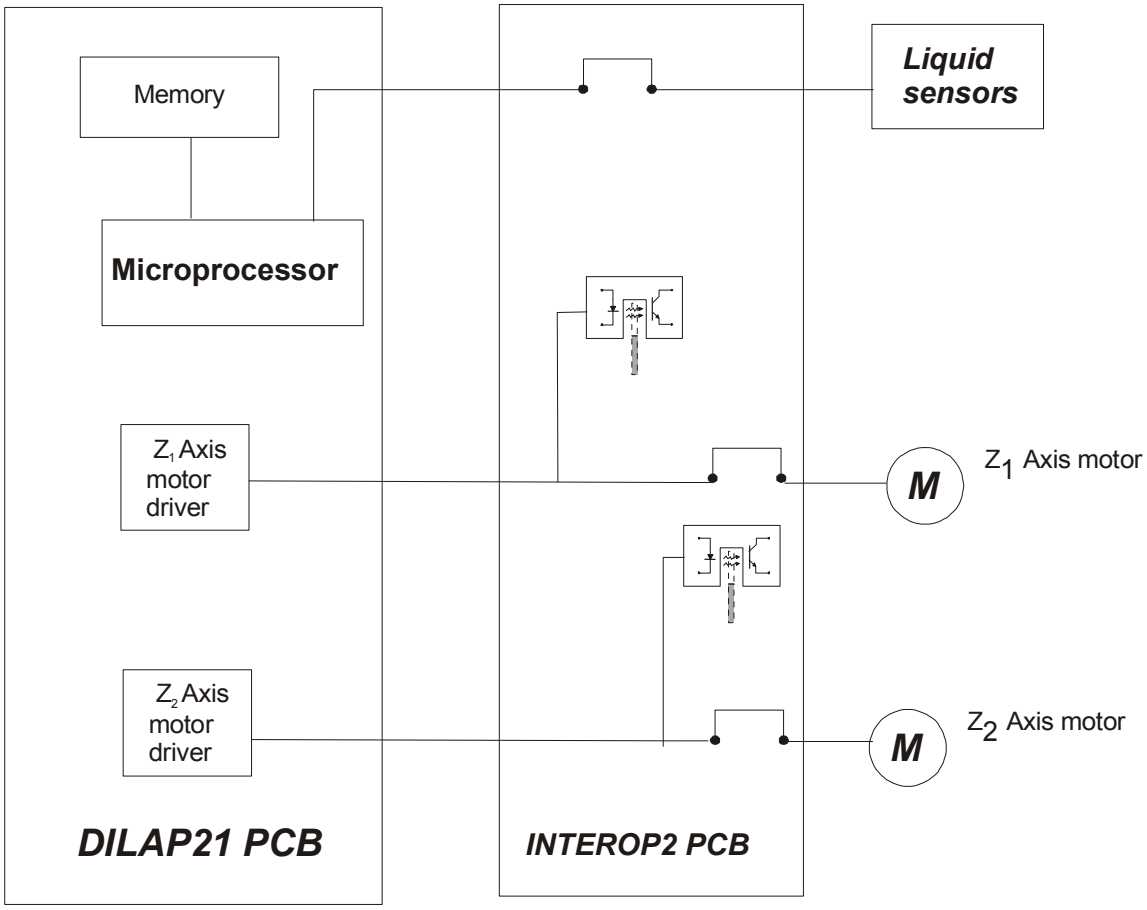
Z_2 Axis moves the aspiration probe up and down over work area.
The movement is driven by a step motor (1) with a pinion mounted on its shaft (2) that transmits the movement to the carriage (3).
The optical sensor, by means of the carriage encoder (4) detects probe home position.
The camera is mounted on back plate and is used to acquire images.



3.5.1.2. Z axis electrical circuit diagram

The diagram shows the different electronic functions with the relevant PCBs for the Z axis, followed by a brief description and the following table lists the various PCBs and their components.

DILAP21 PCB	*Contains the microprocessor, memory and Z-axis motor drivers*
INTEROP2 PCB	*Contains optical sensor to detect probe end line run ("home") position.*
Z1 – Z2 axis motor	*Step motor which moves Z_1 – Z_2 axis probes*



3.5.2. REGULAR Z AXIS MAINTENANCE

3.5.2.1. Z_2 axis movement control

a) Turn on device and run **XCalib** programme. From “Dilutor” pulldown menu select “Calibrate height” then select a strip holder plate and select probe 1, Select “Go down” option

b) Check that movements are smooth and linear

c) Repeat movement control also on probe 2.

d) If movements are not smooth or/and linear check pinion or carriage and replace parts if necessary

e) If any parts are substituted verify movements as in point (b)

3.5.3. Z-AXIS CALIBRATION

To calibrate Z-axis refer to para. 4.8.

The following table lists the relevant paragraphs describing different possible calibrations

Calibrate probe height	Para. 4.8.2
Calibrate LT	Para. 4.8.3
Calibrate SUL	Para. 4.8.6

3.5.4. SUBSTITUTING Z_1 and Z_2 AXIS PARTS

Substituting Z1 Axis probe	Para. 3.5.4.1
Substituting Z1 Axis probe motor	Para. 3.5.4.2
Substituting Z2 Axis probe	Para. 3.5.4.3
Substituting Z2 Axis probe motor	Para. 3.5.4.4

3.5.4.1. Substituting Z_1 Axis probe

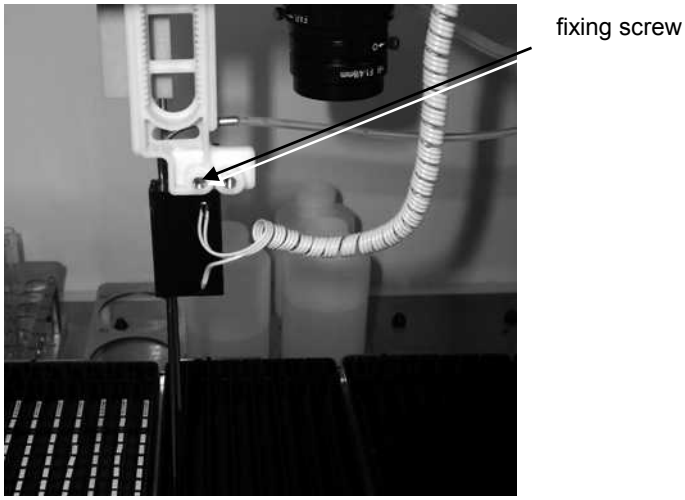
a) Remove instrument cover

b) Remove protective carter by unscrewing two fixing screws

c) Detach AWG15 tubing from Probe

d) Remove liquid sensor cable connector from INTEROP2 PCB

e) Remove screw that fixes probe to stand



f) Replace probe with new probe and tighten fixing screw

g) Reconnect probe and liquid sensor connector (NON CE SU VERSIONE ITaliana) to INTEROP2 PCB and reposition AWG15 tubing to Probe

h) Check Z axis settings: Z steps and LT parameter

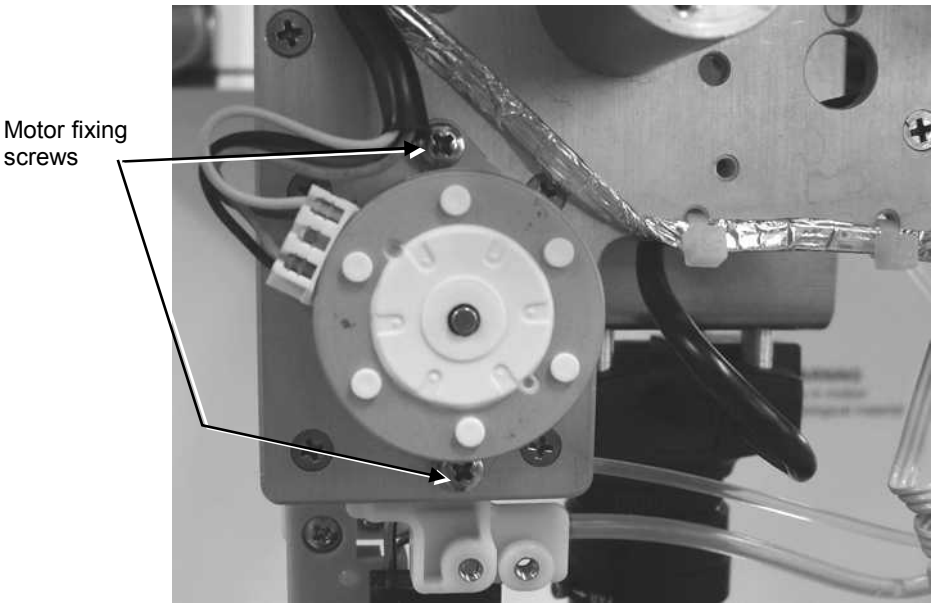
i) Check X-Y centering

3.5.4.2. Substituting Z_1 Axis probe motor

a) Remove instrument cover

b) Remove Z_1 axis protective carter by unscrewing two fixing screws

c) Remove motor connector from INTEROP2 PCB and remove cable holder bands



d) Remove motor fixing screws

e) Replace motor and all connections between PCB and motor, re-position cable holder bands

f) Check that Z axis movements are smooth

g) Check Z_1 axis steps

h) Check X-Y axis centering.

3.5.4.3. Substituting Z_2 Axis probe

a) Remove silicon tubing connected to probe

b) Unscrew probe fixing screw

c) Replace probe and tighten fixing screw

d) Check centering of dispensation probe

e) Check distance between probes in home position (HH command with DIL PCB) is about 1 mm. If distance is incorrect, remove instrument cover and adjust encoder on INTEROP2 PCB until probes are 1 mm distance apart.

f) Check Z axis step setting .

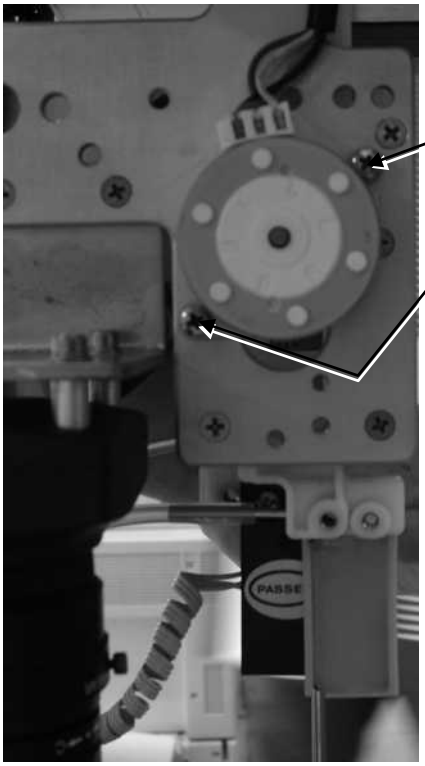
3.5.4.4. Substituting Z_2 Axis probe motor

a) Remove Z_1 protective carter after undoing two fixing screws

2 fixing screws

b) Remove motor connector from INTEROP2 PCB and remove cable holder bands

c) Remove fixing screws and change motor



Motor fixing screws

d) Reconnect motor to PCB and replace cable holder bands

e) Check that Z2 axis movement is smooth.

f) Check Z1 movements and steps.

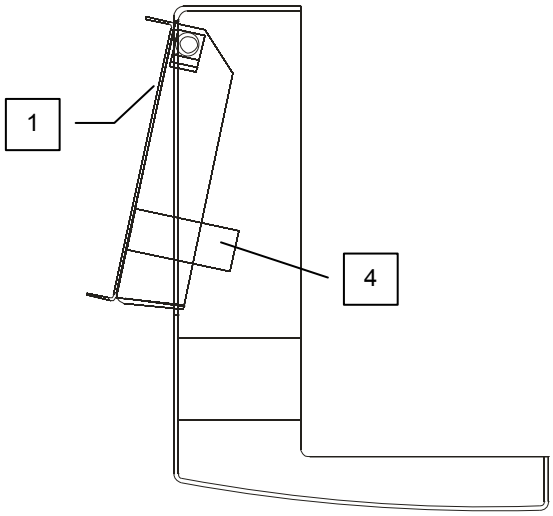
g) Check X-Y centering as described in para. 3.4.3.1.

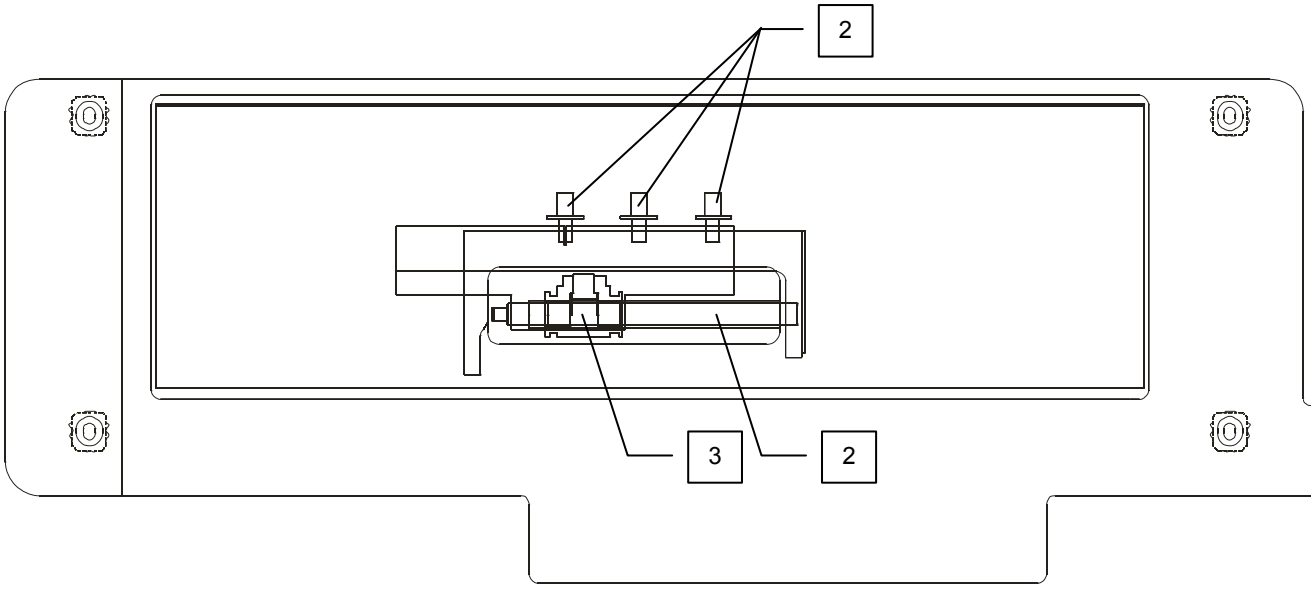
3.6. SHAKING PLANE

3.6.1. DESCRIPTION OF HOW IT WORKS

3.6.1.1. Shaking plane movement mechanism

The shaking plane moves (shakes) the slides with the strips to be processed. The slides are placed on the 'hinged' shaking plane (1) and the movement is driven by a worm screw (2) on a ball-bearing (3) which moves along a wedge (4) mounted under the shaking plane. The ball-bearing moves back and forth on the wedge generating the up and down movement of the plane.
The minimum and maximum shaking excursion is controlled by 3 opto positioning sensors (5).

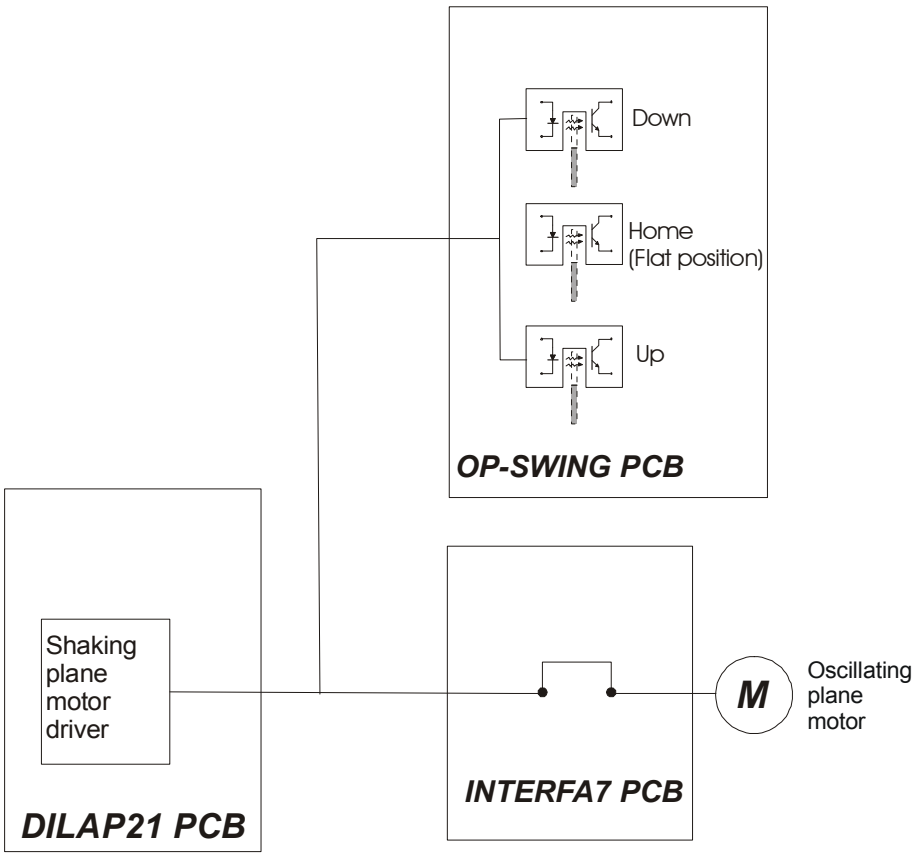




3.6.1.2. Shaking plane circuit diagram

The table lists the PCBs and the electrical components that move the Shaking plane.
This is followed by a diagram of the mechanism.

APE-IF-DIL-AP21 PCB	Z1 and Z2 axis motor drivers
OP-SWING PCB	Shaking plane optical sensors that control movement
Shaking plane Motor	Step Motor that moves worm screw and ball bearing for shaking plane movement



3.6.2. MAINTENANCE AND SHAKING PLANE CALIBRATION

For calibration and maintenance of shaking plane refer to para. 4.8.4.

The following table lists the calibration procedures described in the relevant paragraphs.

3.6.3. SUBSTITUTING SHAKING PLANE COMPONENTS

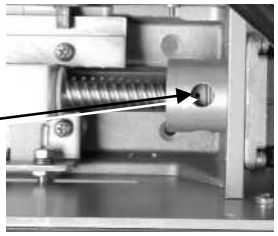
Substituting Shaking Plane Motor	Para. 3.6.3.1
Substituting opto PCBs	Para. 3.6.3.2

3.6.3.1. Substituting Shaking Plane Motor

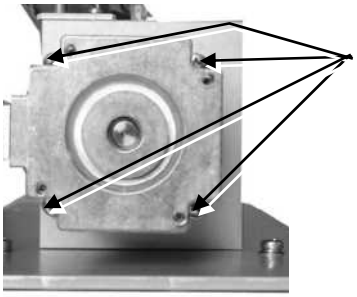
a) Remove aluminium work area as described in Para. 3.1.

b) Estrarre il piano di lavoro in alluminio

c) Loosen two nuts blocking motor axis.



d) Undo 4 fixing screws to remove motor



e) Position new motor, replace and tighten 4 fixing screws and nuts

f) Replace aluminium work area.

g) Proceed with calibrating shaking plane para 4.8.4.

3.6.3.2. Substituting opto PCBs

a) Remove work area as described in Para. 3.2.1.

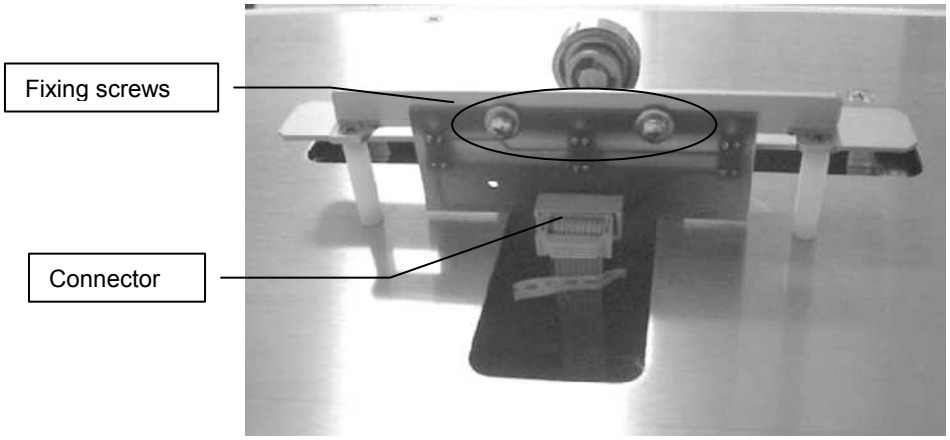
b) Detach connector from Opto PCB to be substituted

c) Remove fixing screws to undo PCB

d) Reposition new PCB check that the Opto is not touching the encoder and replace the connector

e) Reposition work area

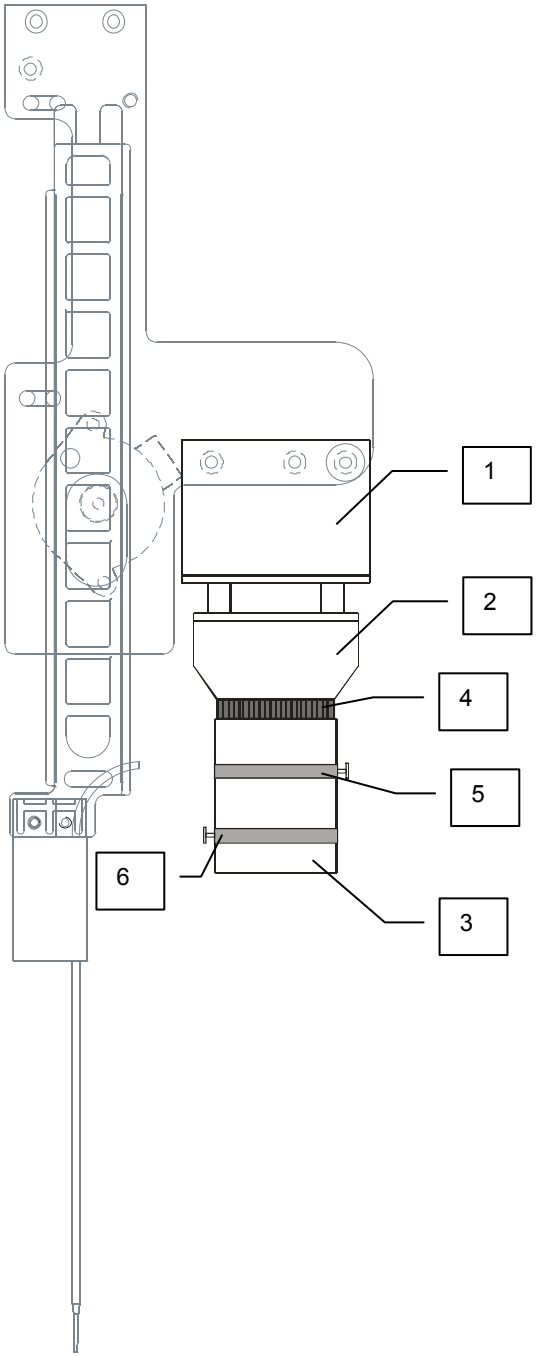
f) Calibrate shaking plane



3.7. CAMERA

3.7.1. DESCRIPTION OF HOW IT WORKS

The camera is used to acquire digital images of each single strip. These images are then automatically elaborated by the software and each single blot is analysed.
The camera is mounted on a stand (1) next to the probe unit.
The Optical Unit is made up of the camera (2) and lens (3).
The lens is screwed on the camera with a 5mm mount (4).
There are two rings with screw threads: one can be turned to focus (5) and the other (6) regulates the aperture.
For camera calibration see Para. 4.8.9



3.7.2. CAMERA MAINTENANCE

Check USB cable connection	Para. 3.7.2.1
Lens cleaning	Para. 3.7.2.2

3.7.2.1. Checking USB cable connection

a) Check that USB cable is correctly connected to the camera. When cable is correctly connected then check that the camera is communicating with PC

b) Turn on device. Run *XCalib* program . From “Dilutor” menu select “Calibrate Camera” and check that images of the work area are correctly being visualised by the camera and displayed.

3.7.2.2. Cleaning lens

a) Clean lens with a soft cloth lightly dampened with alcohol.

3.7.3. CALIBRATE CAMERA

To calibrate camera refer to para. 4.8.9.

The table below lists the calibration procedures described in the relevant paragraphs.

3.7.4. SUBSTITUTING CAMERA AND/OR PARTS

Substituting camera	Para. 3.7.4.1
Substituting camera lens	Para. 3.7.4.2
Substituting camera USB cable	Para. 3.7.4.3
Substituting LED light bar	Para. 3.7.4.4

3.7.4.1. Substituting camera

a) Turn off instrument
b) Manually move the Z axis unit out of the way to ensure free access to camera
c) Detach USB cable from camera
d) Remove 3 hexagonal screws that hold camera to stand
e) Unscrew lens in clock-wise direction and remove it
f) Screw lens to new camera and reposition it on the stand and fix it with the 3 hexagonal screws.
g) Insert USB cable
h) Calibrate new camera as described in Para. 4.8.9

3.7.4.2. Substituting camera lens

a) Turn off device
b) Manually move Z-axis unit *out of the way* to ensure free access to lens
c) Detach USB cable from camera
d) Remove 3 hexagonal head screws fixing camera to stand
e) Unscrew lens in clockwise direction then remove it
f) Screw in a new lens onto camera and block it to the stand with the 3 hexagonal head screws
g) Insert USB cable
h) Calibrate camera as described in Para. 4.8.9.

3.7.4.3. Substituting camera USB cable

a) Turn off device.
b) Undo fixing screws above cover and then remove cover.
c) Open left flap
d) Detach camera USB cable
e) Carefully pull out cable from X and Y axis plastic box chain
f) Detach USB connector from the USB hub on the left flap
g) Pull out USB cable
h) Insert new cable by repeating above procedures in reverse (from point g to point a)
i) Calibrate camera as described in Para. 4.8.9.
j)

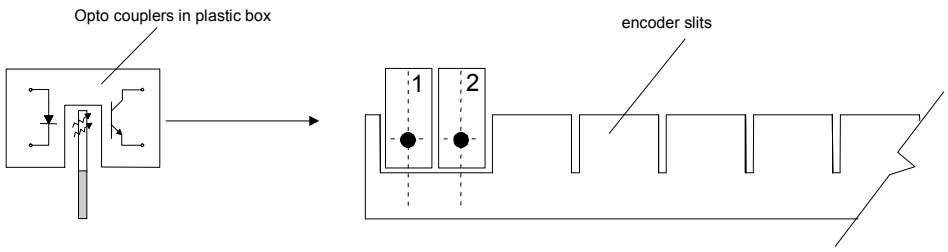
3.7.4.4. Substituting LED light bar

a) Turn off device
b) Undo fixing screws to then remove cover.
c) Remove two plastic screws fixing LED light bar
d) Undo Panduit connection behind Y axis motor
e) Position new LED light bar
f) Reconnect all electrical connections
g) Replace cover

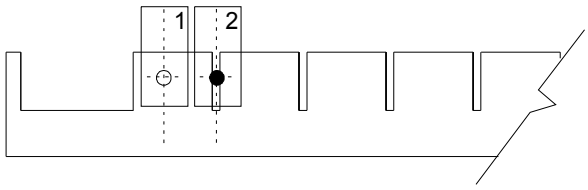
3.8. OPTICAL SENSORS

3.8.1. DESCRIPTION OF HOW OPTICAL SENSORS FUNCTION

The optical sensors detect the position or movement of a mechanism and translates this information into an electrical signal. The sensor consists of an infrared diode emitter and a photosensitive receiver, in a single container.
Sensor 1 is utilized for the zero position; Sensor 2 is utilized for detecting the position of the first well or first filter.



Encoder zero position



1° well position

1 = Zero LED

2 = Signal LED

3.8.2. REGULAR MAINTENANCE

3.8.2.1. Cleaning opto

Clean opto sensors around every 6 months using a soft brush to remove any traces of dirt or dust.

3.8.2.2. Checking procedure

The various opto PCBs function in different units. The following table lists these different units, the PCBs and the relevant paragraph to refer to for replacement procedures.

UNIT	***PCB***	***Ref. procedure***
Dilutor	SIDILOP	Para. 3.3.3.7
X axis	XGOLAV (X movement)	Para. 3.4.4.3
Y axis	INTEROP2	Para. 3.4.4.7
Z axis	INTEROP2	Para. 3.4.4.7

3.8.3. CHECKING DISTANCE FOR OPTO COUPLERS (X AXIS)

a) Click on Tcom exe icon to open Tcom program

b) Select DIL PCB.

c) Type in HH to position probe in Home position.

d) TypeMX5

e) Type XKX.

f) First display should show **Signal led=0** (uncovered opto) and **zero led=1** (covered opto) - select X key until these values change into **signal led=1** and **zero led=0**.

g) Note how many steps are required until **signal led=1** and **zero led=1** (sequence A).

h) Continue selecting X key until both signals indicate a value of "1".

i) Note how many steps are required until **signal led=1** and **zero led=1** (sequence B).

j) The difference in steps between sequence A and sequence B should not be more than 3 steps.

X AXIS TEST

```
hh
D=> gd1
D=> xkx  Select X to repeat, other keys to exit
X: signal LED = 0  zero LED = 1
X: signal LED = 0  zero LED = 1
X: signal LED = 0  zero LED = 1
X: signal LED = 0  zero LED = 1
X: signal LED = 0  zero LED = 1
X: signal LED = 0  zero LED = 1
X: signal LED = 0  zero LED = 1
X: signal LED = 0  zero LED = 1
X: signal LED = 0  zero LED = 1
X: signal LED = 0  zero LED = 1

X: signal LED = 1  zero LED = 1
X: signal LED = 1  zero LED = 1
X: signal LED = 1  zero LED = 1
X: signal LED = 1  zero LED = 1
X: signal LED = 1  zero LED = 1
X: signal LED = 1  zero LED = 1
X: signal LED = 1  zero LED = 1
```

Sequenza "A "

```
X: signal LED = 1  zero LED = 0
X: signal LED = 1  zero LED = 0
X: signal LED = 1  zero LED = 0
X: signal LED = 1  zero LED = 0
X: signal LED = 1  zero LED = 0
X: signal LED = 1  zero LED = 0
X: signal LED = 1  zero LED = 0
X: signal LED = 1  zero LED = 0
X: signal LED = 1  zero LED = 0
X: signal LED = 1  zero LED = 0
X: signal LED = 1  zero LED = 0
X: signal LED = 1  zero LED = 0

X: signal LED = 1  zero LED = 1
X: signal LED = 1  zero LED = 1
X: signal LED = 1  zero LED = 1
X: signal LED = 1  zero LED = 1
X: signal LED = 1  zero LED = 1
X: signal LED = 1  zero LED = 1
X: signal LED = 1  zero LED = 1
```

Sequenza "B "

```
X: signal LED = 0  zero LED = 1
X: signal LED = 0  zero LED = 1
X: signal LED = 0  zero LED = 1
X: signal LED = 0  zero LED = 1
```

3.8.4. CHECKING DISTANCE FOR OPTO COUPLERS (Y AXIS)

a) Click on Tcom exe icon to open Tcom program

b) Select DIL PCB.

c) Type in HH to position probe in Home position.

d) TypeMY5

e) Type XKY.

f) First display should show **Signal led=0** (uncovered opto) and **zero led=1** (covered opto) - select Y key until these values change into **signal led=1** and **zero led=0**.

g) Note how many steps are required until **signal led=1** and **zero led=1** (sequence A).

h) Continue selecting Y key until both signals indicate a value of "1".

i) Note how many steps are required until **signal led=1** and **zero led=1** (sequence B).

j) The difference in steps between sequence A and sequence B should not be more than 3 steps.

Y AXIS TEST

```
hh
D=> gd1
D=> xky  Select X to repeat, other keys to exit
Y: signal LED = 0  zero LED = 1
Y: signal LED = 0  zero LED = 1
Y: signal LED = 0  zero LED = 1
Y: signal LED = 0  zero LED = 1
Y: signal LED = 0  zero LED = 1
Y: signal LED = 0  zero LED = 1
Y: signal LED = 0  zero LED = 1
Y: signal LED = 0  zero LED = 1

Y: signal LED = 1  zero LED = 1
Y: signal LED = 1  zero LED = 1
Y: signal LED = 1  zero LED = 1
Y: signal LED = 1  zero LED = 1
Y: signal LED = 1  zero LED = 1
Y: signal LED = 1  zero LED = 1
Y: signal LED = 1  zero LED = 1

Y: signal LED = 1  zero LED = 0
Y: signal LED = 1  zero LED = 0
Y: signal LED = 1  zero LED = 0
Y: signal LED = 1  zero LED = 0
Y: signal LED = 1  zero LED = 0
Y: signal LED = 1  zero LED = 0
Y: signal LED = 1  zero LED = 0
Y: signal LED = 1  zero LED = 0
Y: signal LED = 1  zero LED = 0
Y: signal LED = 1  zero LED = 0
Y: signal LED = 1  zero LED = 0
Y: signal LED = 1  zero LED = 0
Y: signal LED = 1  zero LED = 0
Y: signal LED = 1  zero LED = 0
Y: signal LED = 1  zero LED = 0

Y: signal LED = 1  zero LED = 1
Y: signal LED = 1  zero LED = 1
Y: signal LED = 1  zero LED = 1
Y: signal LED = 1  zero LED = 1
Y: signal LED = 1  zero LED = 1
Y: signal LED = 1  zero LED = 1
Y: signal LED = 1  zero LED = 1

Y: signal LED = 0  zero LED = 1
Y: signal LED = 0  zero LED = 1
Y: signal LED = 0  zero LED = 1
Y: signal LED = 0  zero LED = 1
Y: signal LED = 0  zero LED = 1
-------------------------------------------------------
```

Sequenza "A"

Sequenza "B"

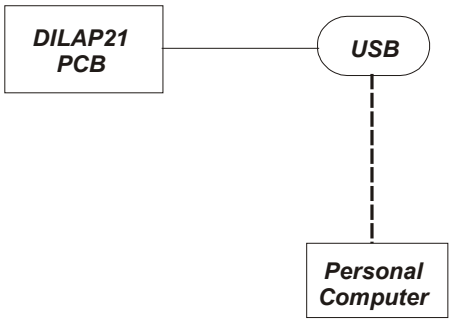
3.9. USB COMMUNICATION

3.9.1. DESCRIPTION OF HOW IT WORKS

FUNCTION

The instrument and PC can communicate through a USB connection.

COMPOSITION



3.9.2. CHECK FUNCTIONALITY

a) Start TCom program and set up communication port - type “VE” to display Dilutor PCB firmware version

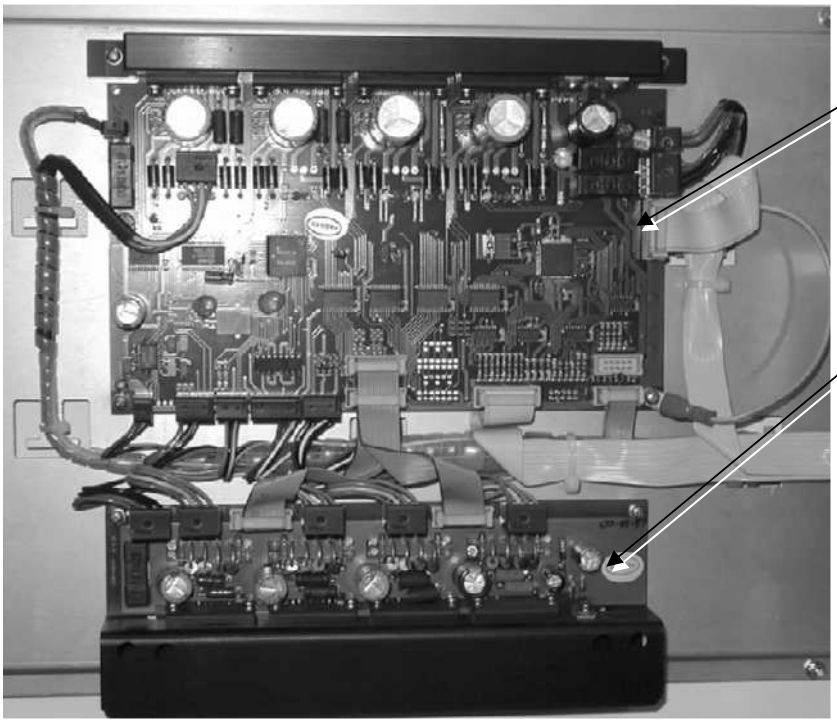
b) If access to Control Panel is not possible then follow the connection diagram as follows:

PCBs APE-IF-DIL-AP21 connector J15

c) If connection sequence is correct, then substitute the PCB which is not communicating properly

3.9.3. REPLACING DILAP21 and SIR4MOT PCBs

a) To remove right back panel undo two fixing screws



b) Locate DILAP21 or SIR4MOT2 PCBs and remove all connectors
c) Undo 4 fixing screws to remove PCB
d) Replace PCB and reposition connectors
e) Close right back panel and replace fixing screws

3.10. DILUTOR COMMAND LIST

#SN	Sets serial number (maximum 8 characters). The character ' ' is not considered.
|	Closes TEST MODE and returns to command mode
'	All characters followed by ";" or "CR" are not considered because this command allows comments to be introduced inside the command file
An1	Aspirates 'n1' microlitres from Probe 1. Syringe speed is set by SVA command, or SGA of individual work area parameters.
Bh	Creates 12 ul default bubble from syringe 'h' (h = 1 syr1).
Cn1	Aspires 'n1' microlitres from probe 1 moving Z1 axis at the same time. Speed of the combination is regulated by SGC command while syringe speed is regulated by SVA command and SGA individual work area parameters.
DC1	Display Check1 signal status
DBAn	Shakes shaking plane within 'n' range (where 0>=n<=9 and 0 corrisponds to flat position and 9 is the maximum UP or DOWN excursion)
DBDn	Moves plane down below the zero position 'n' (where 0>=n<=9 and 0 corrisponds to flat position and 9 is the maximum excursion)
DBUn	Moves the plane up above the zero position 'n' (where 0>=n<=9 and 0 corrisponds to flat position and 9 is the maximum excursion)
DBFa,b,c	Sets motor acceleration ramp, where a= min. freq, b=max. freq, c=number of steps (default 100,1400,40)
DBH	Returns plane to zero (flat/even) position
DBLA	Turns on 220Vac lamplight
DBLS	Turns off the 220Vac lamplight
DD	Moves Z1 until it touches liquid with a maximum number of motor steps defined for work area.
DLn1	Moves Z1 until it touches liquid with a maximum number of motor steps defined as 'n1'. Creates a separation bubble according to the last work phase. This bubble is created if number of steps along the Z axis is more than 0.
DP	Displays all stored values excluding work area values
DXn	Moves Z axis defined by 'n' (where n=1 along Z1 axis) until the liquid level is reached for a maximum number of motor steps defined by the work area minus 30 steps. Error messages, break on error function (see commands SEE and SED) and the buzzer are disactivated and then restored at the end of the command. The FD command must always follow this DXn command .
DYa	Displays all work area 'a' parameters.
DZAn	Displays aspiration frequency in work area 'n'
DZBn	Displays volume of separation bubble in work area 'n'
DZCn	Displays the combined value in work area 'n'
DZDn	Displays dispensation frequency in work area 'n'
DZEn	Displays break on error status in work area 'n'
DZZ1n	Displays maximum number of steps for Z1 axis in work area 'n'
DZZ2	Displays maximum number of steps for Z2 axis in work area 'n'
EA	Activates liquid error display (default)
ES	Disables liquid error display
FDn1	Dispenses 'n1' microlitres from probe 1. Each single syringe movement is combined with the connected Z axis. The Z combination speed is set by SGC command in the work area. The syringe speed is set by SVD or SGD commands in work area. If after DX command is given, no liquid is detected, Z axis does not move for first 200 µL dispensed. The next are dispensed in combination. If after DX command liquid is detected, the FD command dispenses liquid in combination.
Fn1	Dispenses 'n1' microlitres from probe 1. Syringe speed is given by SVD command, or SGD work area parameters.

G0	Takes X and Y axis to Home position.
GA	Takes X and Y axis to Home position, moving ZZ to slit 1 and Z1 and Z2 along steps defined by HA command.
GOh{a..z}{a-b}x,y,z	Moves X and Y axis to 'x' and 'y' coordinates and moves ZZ axis to encoder slit z. 'h' determines the selected probe. {a..z} chooses one of the 26 work areas. {a-b} selects further 56 work areas where it is possible to add coordinates, decimal values between 1 - 9 to position within encoder slit. The liquid control is activated to selected probe if bubble volume is greater than 0.
HA	Sets up steps for Z axis used by GA command.
HH	X, Y , Z1, Z2axis reset
HX	X axis reset to zero position
HY	Y axis reset to zero position
Ih	Takes 'h' syringe back to zero position (h = 1 syr1). Syringe speed is regulated by command SVD or SGD work area parameters.
Jh	Returns syringe to zero position but last 20 ul are dispensed at a reduced speed (h = 1 syr1). Syringe speed is regulated by SVD command or SGD work area parameters.
K-	sets negative (backwards) direction for X,Y and Z axis
K+	sets positive (forwards) direction for X,Y and Z axis
KVhn.n	Sets calibration factor to correct conversion of microlitres to motor steps for syringe h (h =1).
KX	Moves X axis one motor step. The direction is determined by K+ and K- commands
KY	Move Y axis by one motor step. The direction is determined by K+ and K- commands
LAL	Activates display warning about wash bottle status alarm, 0 = full, 1 = empty
LAB1	Buffer1 bottle alarm, 1 = empty, 0 = full
LAB2	Buffer2 bottle alarm, 1 = empty, 0 = full
LAS	Waste bottle alarm, 1 = empty, 0 = full
LAT	Restores all bottles to initial states (6 characters maximum format ending with 'CR'). Character 1 = buffer 1 (1 = empty, 0 = full) Character 2 = buffer 2 (1 = empty, 0 = full) Character 3 = Wash bottle (0 = full, 1 = empty) Character 4 = Waste bottle (1 = empty, 0 = full)
LEA	Turns on Led error
LES	Turns Led error off
LLA	Activates cycle counts for each liquid sensor.
LLS	Disactivates LLA command functions.
LRA	Turns on 'run' Led
LRS	Turns off 'run' Led
LSM	Code contained inside the serial chip
LT1,n1	Sets number of cycles required to accept signals from Z1 axis liquid sensors.
M c	Executes commands defined by macro 'c' (c = 0 … 9)
MXn	Moves X axis along 'n' number of encoder slits (-32768 <= n <= 32767).
MYn	Moves Y axis along 'n' number of encoder slits
MZn1,n2	Moves Z1 axis along 'n1' number of motor steps and Z2 along 'n2' number motor steps.
MZSn	Moves Z axis along 'n' motor steps.

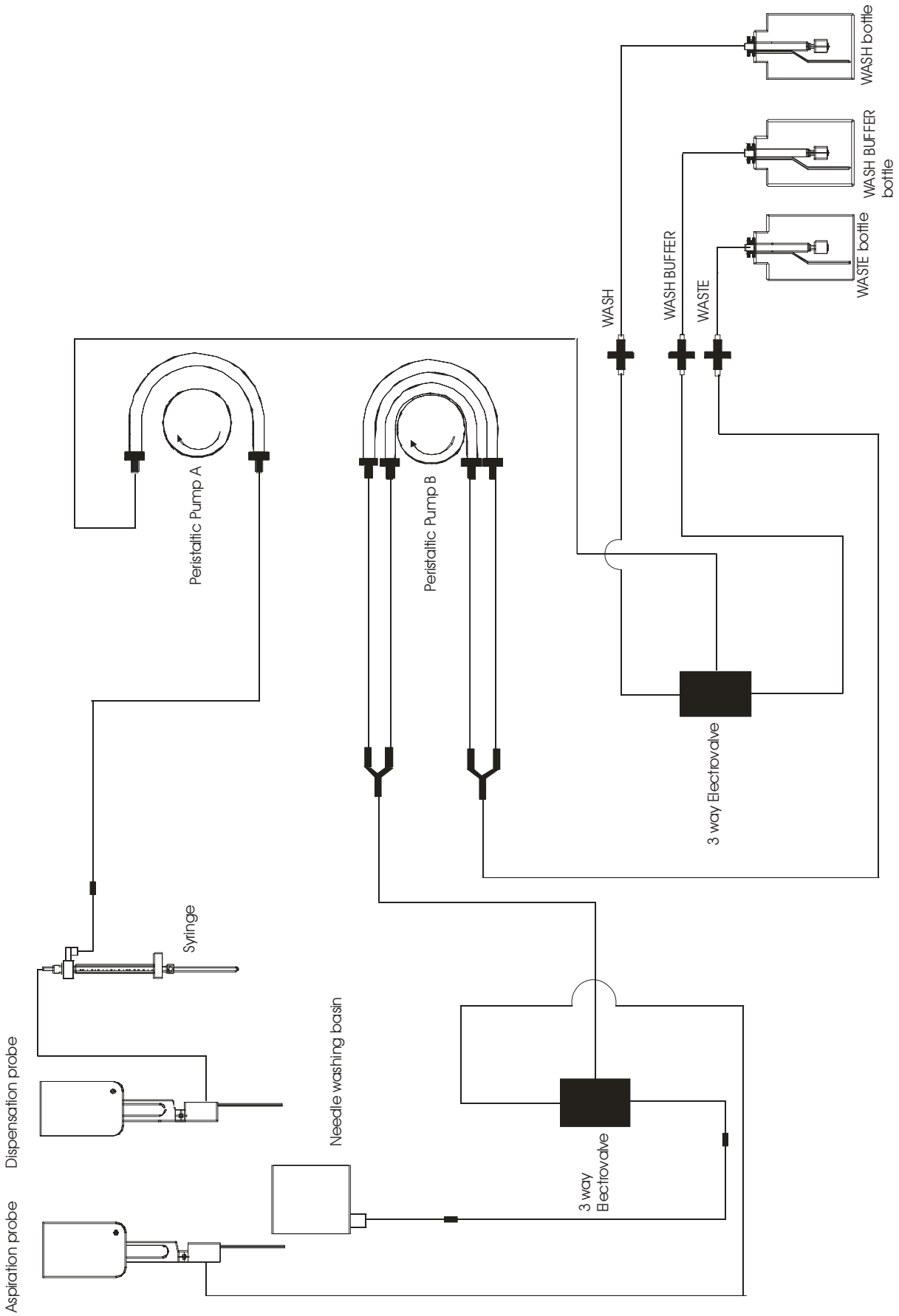
OF	Turns off all motors
P2A	Turns on waste pump
P2S	Turns off waste pump
PA	Turns on aspiration pump, waste pump 2 and opens aspiration electro-valve on the wash basin
PB1	Creates a logic signal of 100 msecs. on busy 1.
PS	Turns off peristaltic pump, waste pump and turns off waste electro-valve, connecting it with the aspiration probe.
PVn	Sets peristaltic pump rotation speed.
RAc,v	Sets the semi-period 'v' in microseconds in 'c' variable of ramp table.
RB1	Puts logic level 0 the busy signal 1.
RCc,v	Sets the semiperiod 'v' in microseconds in 'c' variable of ramp table..
RMc n	repeats 'c' macro for 'n' times ($0 \leq n \leq 65535$)
RN	Displays command echo and serial number (format = 10 characters)
RSa,b,c	Defines brake ramp where 'a' = start frequency, 'b' = stop frequency and 'c' = number of points along ramp. Valid for both syringes
RXa,b,c	Calculates acceleration and brake ramp, where 'a' = start frequency, 'b' = stop frequency and 'c' = number of ramp elements (default a = 125, b = 2500, c = 240).
RYa,b,c	Calculates acceleration and brake ramp, where 'a' = start frequency, 'b' = stop frequency and 'c' = number of ramp elements (default a = 400, b = 4000, c = 250).
RZa,b,c	Defines acceleration ramp and brake, where 'a' = start frequency, 'b' = stop frequency and 'c' = number of ramp elements valid for Z1 and Z2 axis (default a = 200, b = 4000, c = 200).
SA0	Disables bottle alarm
SA1	Activates display warning whenever any bottle changes status.
SB1	Puts logic level 0 the busy signal 1.
SE0	Disables instrument pause if a liquid error is detected (break on error).
SE1	Activates instrument pause and returns axis Z1 to zero position if break on error is detected.
SE2	Disables break on error and liquid error message
SGA{a..z}n	Sets aspiration speed for both probes (default 3000hz).
SGB{a..z}n	Sets bubble volume valid for both Z axis.
SGC{a..z}n	Sets combined speed for both Z axis.
SGD{a..z}n	Sets dispensation speed for both probes (default 3000hz).
SGE{a..z}n	Sets liquid alarm status (see SE0, SE1, SE2 commands).
SGZ1{a..z}n	Sets Z1 maximum height
SGZ2{a..z}n	Sets Z2 maximum height
ST	Takes timer 1 to zero and restarts
SUL	Corrisponds to how long valve is open (in milliseconds) for probe to dispense 1ml
SVAn1	Sets probe speed in aspiration phase, 'n1' sets probe 1 motor speed (default 3000 Hz).
SVDn1	Dispensation phase probe speed, 'n1' sets probe 1 motor speed (default 3000 Hz).

T0	clears timer 2
TC c,i,j	Memorises 'c' variable from a vector of 50 elements (1 ≤c ≤ 50). Average difference between timer 2 vector elements 'i' to element 'j'.
TD n	Sets 'n' seconds time delay (0 <= n <= 65535)
TE c	Sets 'c' * 10 millisecs. Time delay (0 <= n <= 65535)
TM	Goes to TEST MODE
TS c	Memorises 'c' variable from timer 2 vector of 48 elements. The timer 2 actual value 1 ≤c ≤ 48
TT	Displays all 50 averages calculated by TC command
TW c	Waits for time delay 'c' (1 ≤c ≤ 48) set by TS command. Compared to timer 2 value.
TX ccc..c	Serial transmission of characters 'c' until ';' or 'CR'
TY	Transmits all 48 elements of the table, memorised with TS command
U	Updates firmware
VA	Activates wash/buffer electro-valve to communicate with buffer . This command is not direct and should always be followed by a PA command.
VBn	Changes bubble volume (default = 12 ul).
VE	Displays name and firmware version
VIh	Open 'h' valve (h = 1 syr. valve 1)
VOh	Closed 'h' valve (h = 1 syr. valve 1)
VS	Disactivates communication between wash/buffer bottle electro-valve and wash bottle
VUL	Displays SUL value command after '*'
WB1	Waits for signal 1 from busy 1 of reader/washer PCB .
Wc…#	Enables creation of 10 macro commands (c = 0 ... 9) with a maximum 250 commands
WA	Activates the bottle waste valve in aspiration.
WS	Disables the waste valve to aspire from aspiration probe tip.
WT n	Waits for 'n' seconds from ST command (timer 1)
WWh,n	Dispensation of 'n' buffer wash microlitres from probes (0 <= n <= 32768) related to 'h' combination of needles to be washed. This command also includes X and Y axis movements in washing basin, pump action, probe basin immersion, opening syringe valve for period calculated depending on 'n' microlitres for SUL command value and lastly, sets syringe position. The probe which has not been activated remains over wash basin. If 'n'=0 then axis movement of wash basin and syringe position are executed.
WX	Wait or delay in "*X" command before executing commands stored in buffer
YD	Disactivates Z1 and Z2 commands of next GO command, only for Y movement axis. This command is always disactivated after GO command.
ZU	Takes axis to zero position.

Quick Short-Cut Commands

***C**	Are there any commands to execute? (answer: y / n)
***E**	Exits from wait time (see time commands)
***F**	Displays wash bottle status
***G**	Displays buffer bottle status
***I**	Ignores liquid error handling set by SEE command
***K**	Shows last typed command
***P**	Stops executing commands
***Q**	Restarts executing commands
***R**	Resets PCB
***S**	Displays logic status signal of probe position (location)
***T**	Activates time display one time only through commands: WT and TW
***X**	Starts executing commands in memory “buffer” (see the WX command)
***Y1**	Displays Check1 signal status
***YL**	Turns off error LED
***YR**	Reset Busy1
***YS**	Set busy1
***YY**	Disables error LED until next reset
***W**	Displays waste bottle status
***Z**	Deletes status value set by *S

3.11. HYDRAULIC CIRCUIT DIAGRAM



3.11.1. REGULAR MAINTENANCE

For correct maintenance of all hydraulic circuit parts refer to paras. 4.7.1. and 4.8.8.

The next table shows the sections dealing with routine maintenance checks

Prime	Para. 4.8.8
Tank level Sensors	Para. 4.7.1

3.11.2. SUBSTITUTING HYDRAULIC CIRCUIT COMPONENTS

3.11.2.1. Electro-valve substitution

a) Remove front work area
b) Locate electro-valve to be changed
c) Disconnect tubing and remove valve
d) Position new valve and reconnect everything

3.12. SUMMARY OF REGULAR MAINTENANCE

3.12.1. DILUTOR UNIT

Operation	*How often*	*Reference*
Visual checks	Every 4 months	Para. 3.3.2.1

3.12.2. X–Y AXIS

Operation	*How often*	*Reference*
Cleaning X-Y axis tracks	Every 6 months	Para. 3.4.2.1
Check belt tension	Every 6 months	Para. 3.4.2.2
Check condition of flat cables	Every 6 months	Para. 3.4.2.3

3.12.3. Z2 AXIS

Operation	*How often*	*Reference*
Z1 - Z2 axis movement mechanism	Every 6 months	Par. 3.5.1.1

3.12.4. SHAKING PLANE

Operation	*How often*	*Reference*
Calibrate shaking plane	Every 6 months	Para. 4.8.4

3.12.5. CAMERA

Operation	*How often*	*Reference*
Checking USB cable connection	Every 6 months	Para. 3.7.2.1
Cleaning lens	Every 6 months	Para. 3.7.2.2

3.12.6. OPTICAL SENSOR

Operation	*How often*	*Reference*
Cleaning opto	Every 6 months	Para. 3.8.2.1

3.12.7. HYDRAULIC CIRCUIT

Operation	*How often*	*Reference*
Prime	Every 6 months	Para. 4.8.8
Tank level Sensors	Every 6 months	Para. 4.7.1

SECTION 4
CALIBRATION PROCEDURES (XCALIB)

XCALIB is the service software to set up and check all AP-Blot parameters. This software is complementary to the main AP-Blot management software.

4.1. INSTALLING SOFTWARE

Close down all applications and insert “APEX software” CD in PC. The APEX software is self-installing. If the installation procedure does not start up automatically then launch it by clicking the **setup.exe** folder which is displayed on the desktop.

When installation process begins then choose language (English or *Italiano*). *Please Note:* this selection is only valid for installation.

Click “Next”. Insert User Name and Company Name.

Click “Next”. Select where installation file should be saved. The Default path is: **C:\Programmi\APEXSuite** folder.

Click “Next”. Select programme to be installed – for this procedure it is “XCALIB”

Click “Next” and then “Install”. When software has been installed then install USB driver as described in User Manual (para. 4.7.4.)

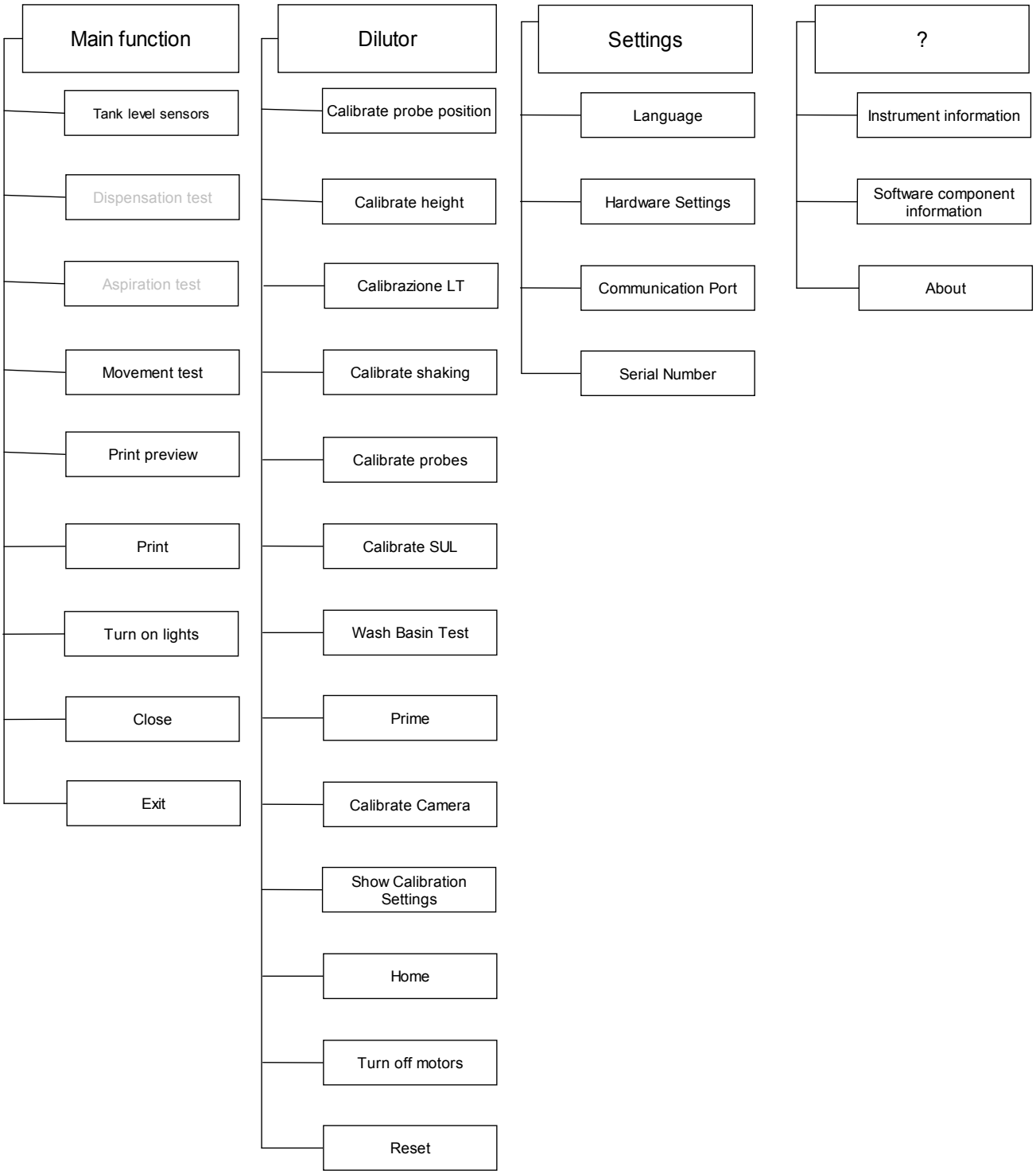
When installation is over, click on XCALIB icon on desktop to launch XCALIB software in the “APEX Suite” group of the programme (go to “Start”> “All programmes”> APEX Suite).

CALIBRATION requirements

- Microsoft Windows 2000 or XP
- 200 MB free on hard disk
- CD-Rom
- 512 MB RAM
- Pentium 4 -2 GHz processor
- Standard VGA 1024x768 16 million colours
- 2.0 USB port
- Printer

4.2. OPERATING MENU

This table shows how the software is set up and the different functions.



4.3. DESCRIPTION OF MENU FUNCTIONS

Menu	Description
Main functions	
Tank level sensors	Checks tank level sensors
Dispensation Test	Only enabled for APE set up
Dilution Test	Only enabled for APE set up
Movement Test	Starts test
Print Preview	Displays calibration settings
Print	Prints out calibration settings
Turn on lights	Turns internal lights on/off
Close	Closes calibration
Exit	Exits programme
Dilutor	
Calibrate probe position	Check and calibrate probe centering over work area.
Calibrate probe height	Check and calibrate maximum probe height
Calibrate LT	Check and calibrate liquid sensor levels (LT)
Calibrate shaking plane	Calibrate shaking plane
Calibrate syringe	Removing syringe, check and calibrate syringe, tip positions, check aspiration and dispensation.
Calibrate SUL	Tests and calibrates SUL settings.
Test wash basin	Tests peristaltic pump and electro-valve workings.
Prime	Primes dilutor unit hydraulic circuit
Calibrate camera	Calibrate camera
Calibration settings	Displays calibration settings
Home	Returns all different instrument parts to Home position
Turn motors off	Turns off all motors
Reset	Resets all PCBs
Settings	
Language	Setting language for display
Hardware configuration	Setting work area
Communication Port	To set up communication port
Serial Number	To set up /check serial number
?	
Instrument information	Displays installed firmware version
Information additional components	Displays installed software component versions
About	Displays XCALIB version and manufacturer details

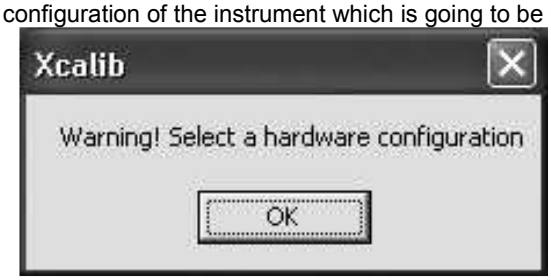
4.4. INSTRUMENT BAR

	Home	Re-sets all parts to Home position – keeping all functions active
	Turning motors off	Turns off all motors
	Calibrate probe height	Calibrates Z maximum height
	Turning lights on	Turns on/off internal lights
	Hardware configuration	Accesses hardware configuration
	Print Preview	Displays calibration settings
	Print	Prints calibration settings.
	Dilutor parameter report	Displays dilutor PCB calibration settings
	Close function	Closes active function and opens main display
	Reset	Stops current active procedure and reset PCBs

4.5. SETTINGS

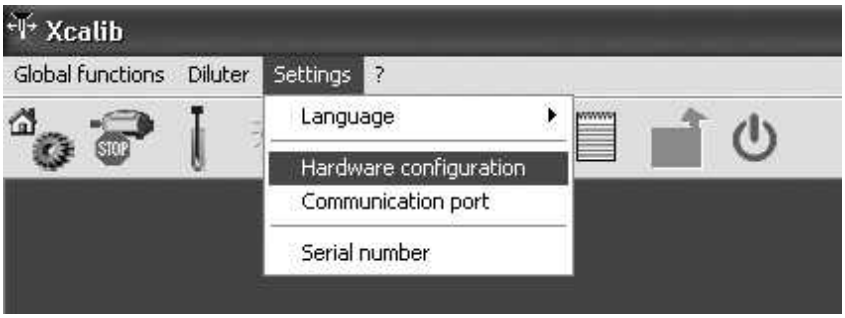
4.5.1. HARDWARE CONFIGURATION

The Xcalib requests a hardware configuration of the instrument which is going to be used to be input.

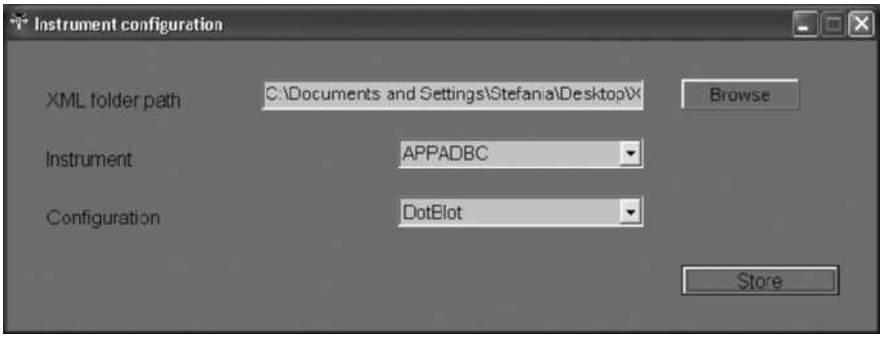


All calibration procedures are disactived until the configuration is successfully loaded.

From "***Settings***" menu select "***Hardware configuration***" or directly click on  icon on main instrument bar.



The following display will appear:



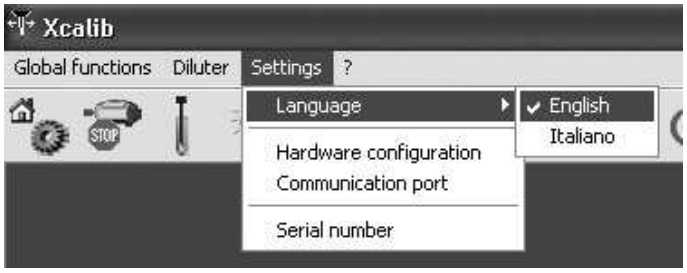
This display can be used to set-up the following:

- which path the XML folder will be associated with this configuration (which can be chosen from a list by clicking Browse button);
- which instrument configuration can be calibrated (from the pull-down menu);
- which type of configuration will be associated with the device to be calibrated (from the pull-down menu).

To store the configuration settings click on "***Store***" and the programme displays a confirmation message for the User as shown here:

4.5.2. Language

From "***Settings***" menu select "***Language*** ".

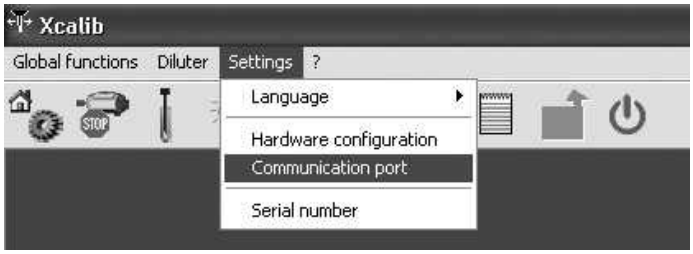


Here choose which language is displayed:

- Italian
- English

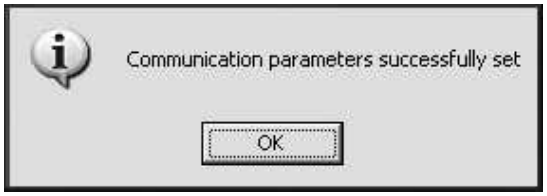
4.5.3. Communication port

From "***Settings***" menu select "***Communication port***".



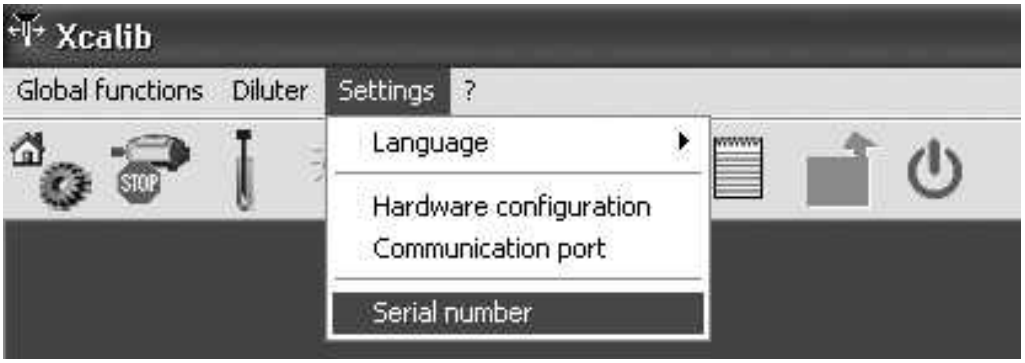
The following display will appear:

This display shows the possible active communication ports open by the PC from a pull down menu.
Confirm communication port by clicking on **SET** and the programme displays a confirmation message for the User.



4.5.4. Serial number

From "***Settings***" menu select "***Serial Number***".

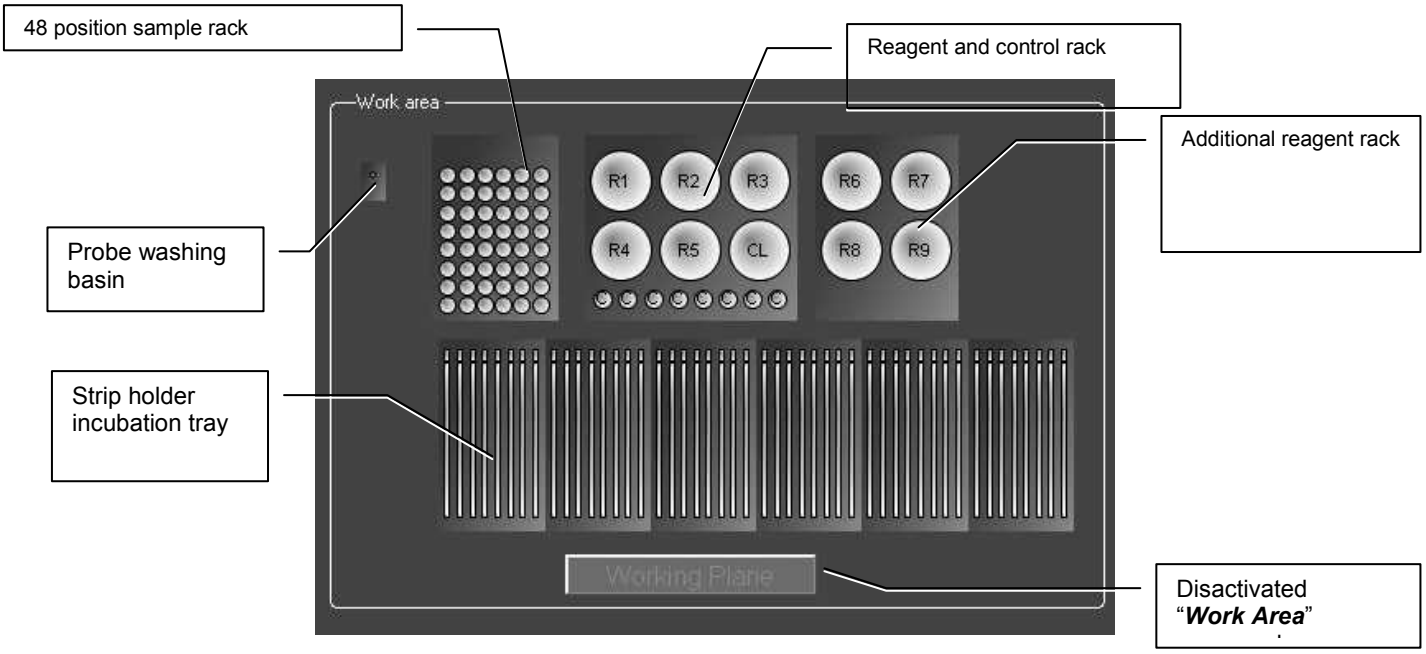


The following display will appear:

Click on "***Current value***" to display actual number setting.
To change serial number type in new number and click on "***Store***" and when this new number has been successfully stored the programme displays a confirmation message for the User.

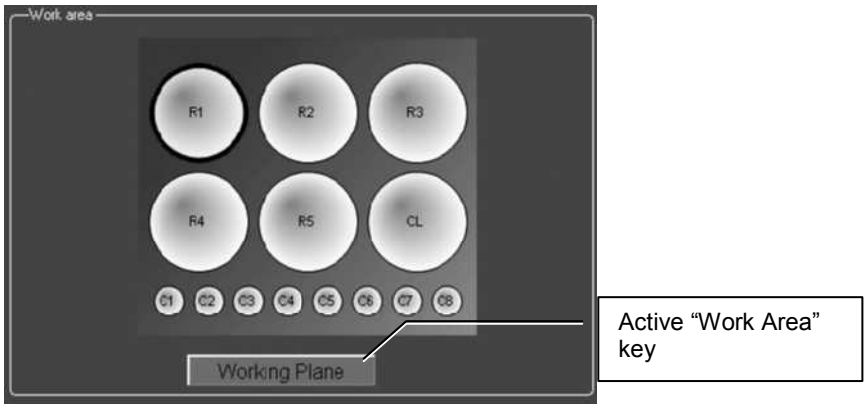
4.6. WORK AREA

This display shows the standard Work Area lay-out:



The "Work Area" is:

- Disactivated when whole layout is displayed
- Activate when a specific part of Work Area is selected to return to overall lay-out of Work Area as shown

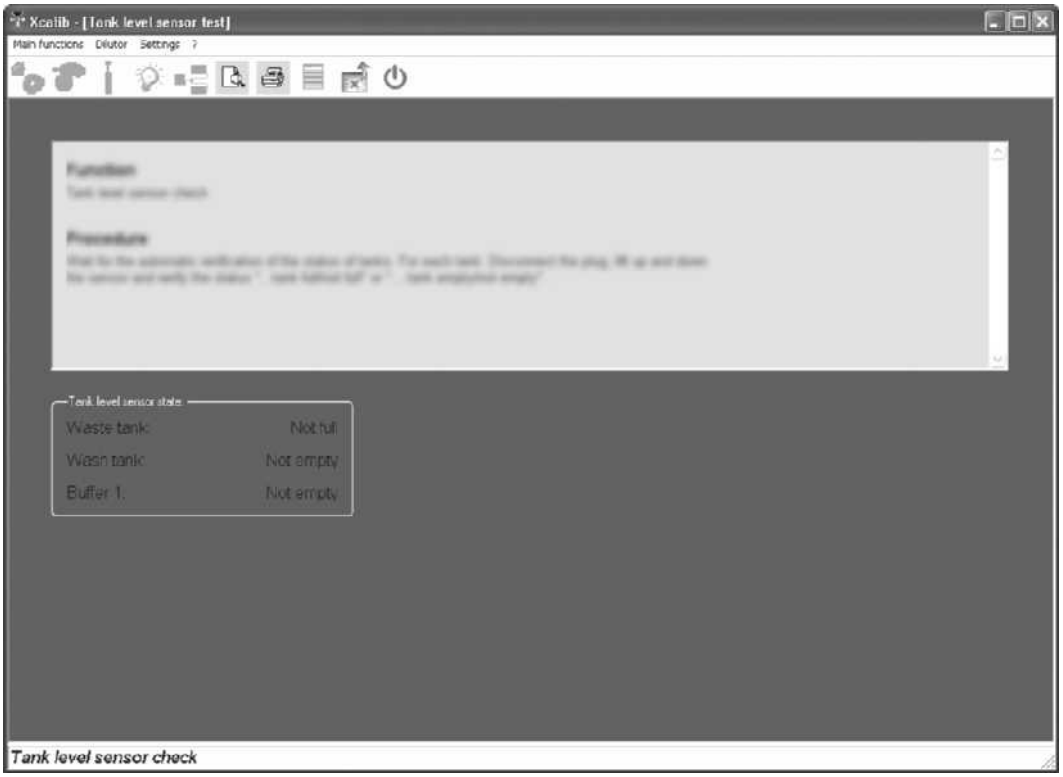


4.7. MAIN FUNCTIONS

4.7.1. Tank level Sensors

From "***Main Functions***" pull down menu select "***Tank level sensors***" to check that system is functioning correctly

The following window is displayed:



The condition of each tank will be automatically updated in some seconds and then displayed.

To check that sensors are correctly functioning:
1 Take off cap
2 Turn cap upside down to lower the level sensors (white cylinder)
3 Check condition of tanks "**Not full/not empty** " which is updated each time the sensor moves up or down.

If no sensor update occurs then check the following:

- Check that level sensor floater is not blocked or obstructed,
- Check that level sensor cables are correctly connected to the PCBs
- Replace Dilutor PCB (see ref. para. 3.8.3.).

4.7.2. Dispensation Test

Only enabled for APE set up

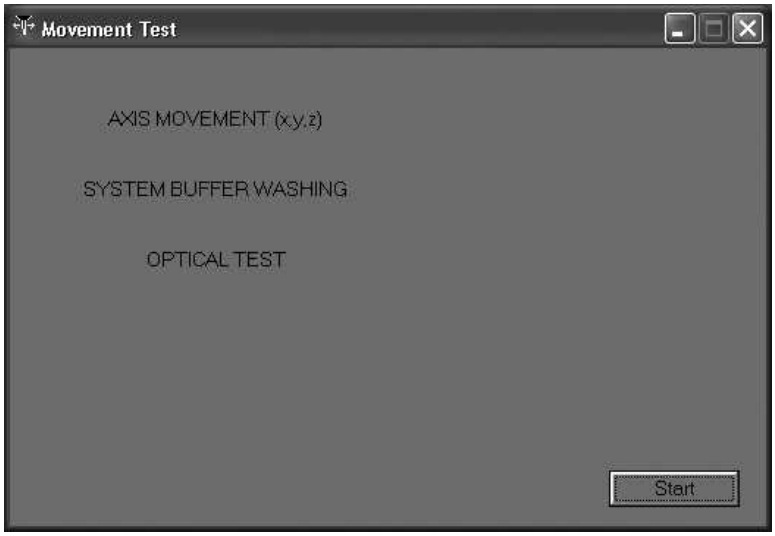
4.7.3. Dilution Test

Only enabled for APE set up

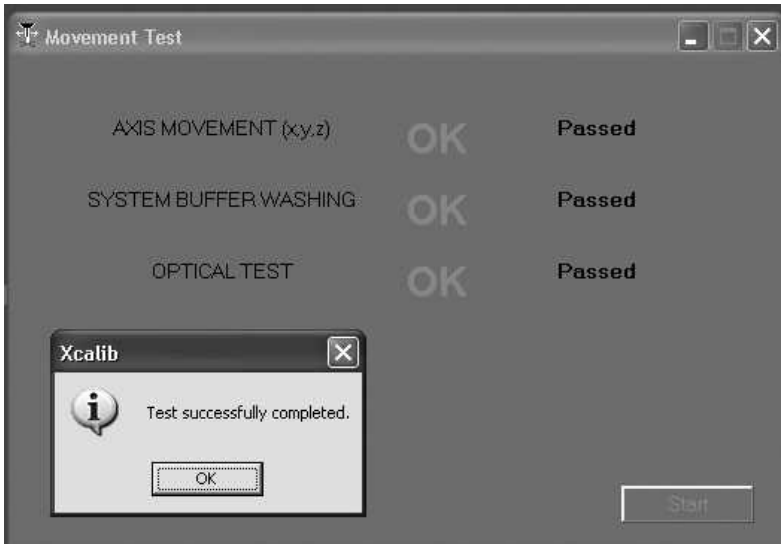
4.7.4. Movement Test

From "***Main Functions***" pull down menu select "***Movement Test***" to check that the different moving parts are functioning correctly

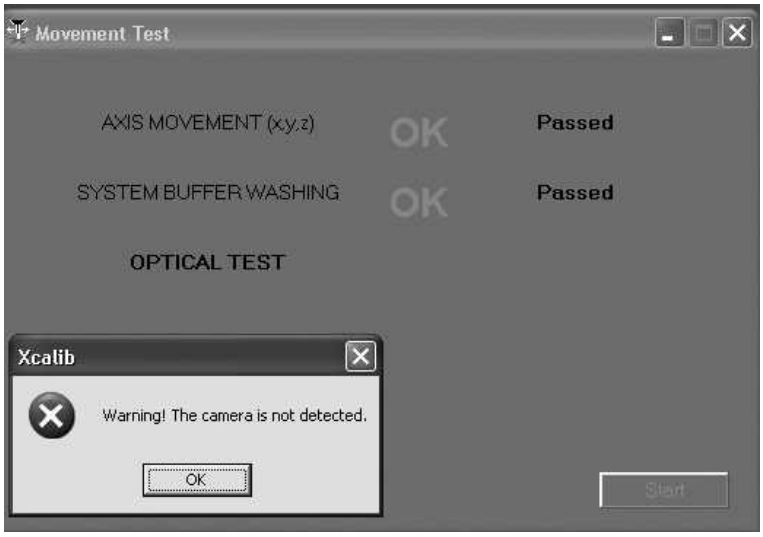
This opens the following display:



Click on "***Start***" to run test.
The test automatically checks movement in the X-Y-Z axis, the shaking plane movement, primes hydraulic circuit and checks communication with the camera.
If all the controls are positive at the end of the test, the following display appears.



If one or more of the control results are negative an error message will be displayed specifying the problem.
Here is an example of a negative test result where the camera has not been found – showing that communication with the camera is probably faulty:



If "*Dilutor Error: X-Axis movement failed!*" appears – check that:

- relevant connections are correct
- belt tension is correct (ref. para.3.4.2.2..)
- relevant motor is functioning correctly
- relevant PCB is functioning correctly

If "*Dilutor Error: Y-Axis movement failed!*" appears – check that:

- relevant connections are correct
- belt tension is correct (ref. para.3.4.2.2.)
- relevant motor is functioning correctly
- relevant PCB is functioning correctly

If "*Dilutor Error: Z-Axis movement 1-2 probe failed!*" appears – check that:

- relevant connections are correct
- relevant motor is functioning correctly
- relevant PCB is functioning correctly

If "*Dilutor Error: Blot Shaker failed!*" appears – check that:

- relevant connections are correct
- relevant motor is functioning correctly
- relevant PCB is functioning correctly

If "*Dilutor Error: buffer system wash failed!*" appears – check that:

- connections are correct
- PCBs are functioning correctly
- Peristaltic pumps are functioning correctly

If "*Dilutor Error : camera test failed!*" *or*
"Dilutor Error: camera set-up test failed!" or
"Attention! The camera has not been found" are displayed check that:

- connections are correct
- PCBs are functioning correctly

4.7.5. Print Preview

From "***Main Functions***" pull down menu select "***Print preview***".

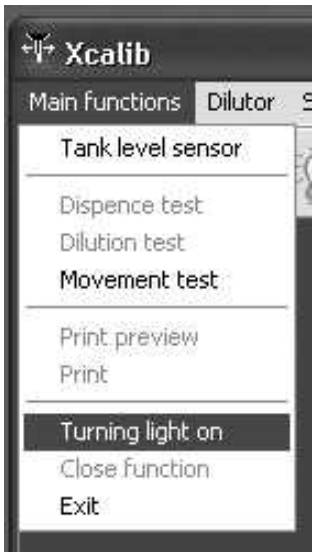
Print preview can only be selected to display the section of the Calibration function which is currently active. This function is only active when a calibration is taking place.

4.7.6. Print

From "***Main Functions***" pull down menu select "***Print*** ".

The Print function is enabled only when Calibrate function is active and prints out current functions.

4.7.7. Turn Light On



From "***Main functions***" pull down menu select "***Turn light on***" to check that internal lights are functioning correctly for reading phase

If light does not come on check (and possibly substitute) the following - in order:

1) connections are correct
2) 2) Colight PCB.
3) 3) LED light bar (see ref. para. 3.7.4.4.).

4.7.8. Close Function

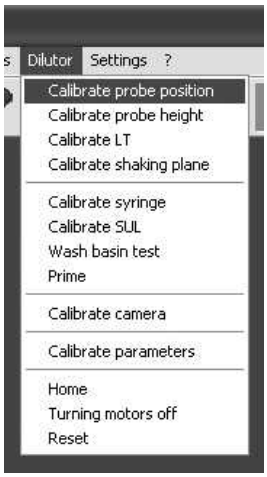
From "***Main functions***" pull down menu select "***Close function***" to close active functions and return to initial display.

4.7.9. Exit

From "***Main Functions***" pull down menu select "***Exit***" to leave XCALIB programme.

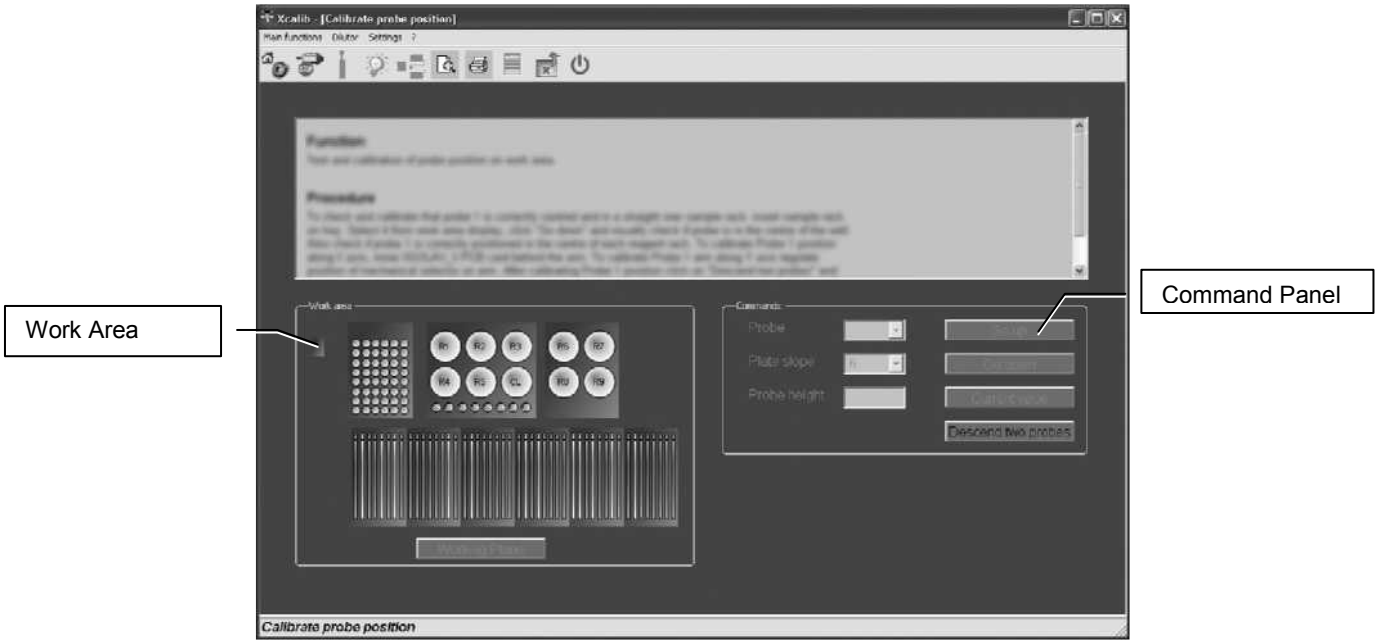
4.8. DILUTOR

4.8.1. Calibrate probe positions



From "***Dilutor***" menu select "***Calibrate probe positions***".

The following display will appear:



Any part of the Work Area can be selected with a mouse click on it. The probes will automatically move into the first position over the selected area. Different commands of panel are activated/disactivated depending on which section of the Work Area is selected.

Checking perpendicular positioning of probes 1 and 2

1 Turn off motors
2 Position probe 1 over Work Area until it touches surface
3 Check that probe 1 is perpendicular with tool PAM 26370-F as shown in following photo.

4 When this procedure is completed return to Home position

If it is not perpendicular then turn fixing screw on probe Z axis carriage until correctly perpendicular.
When this procedure is completed return to Home position.

Checking Probe Distance

1 Click "***Go down***"
2 Check that distance between probes is 9 mm
3 Return to Home position

If distance is incorrect manually re-position probe 2.
When procedure is completed return to Home position.

Centering probes 1 and 2

Check and calibrate probe positions over work area

Checks
It is advisable to calibrate using one of the smaller diameter phials for the sample and reagent areas.
Here is the standard calibration procedure for the Work Area:

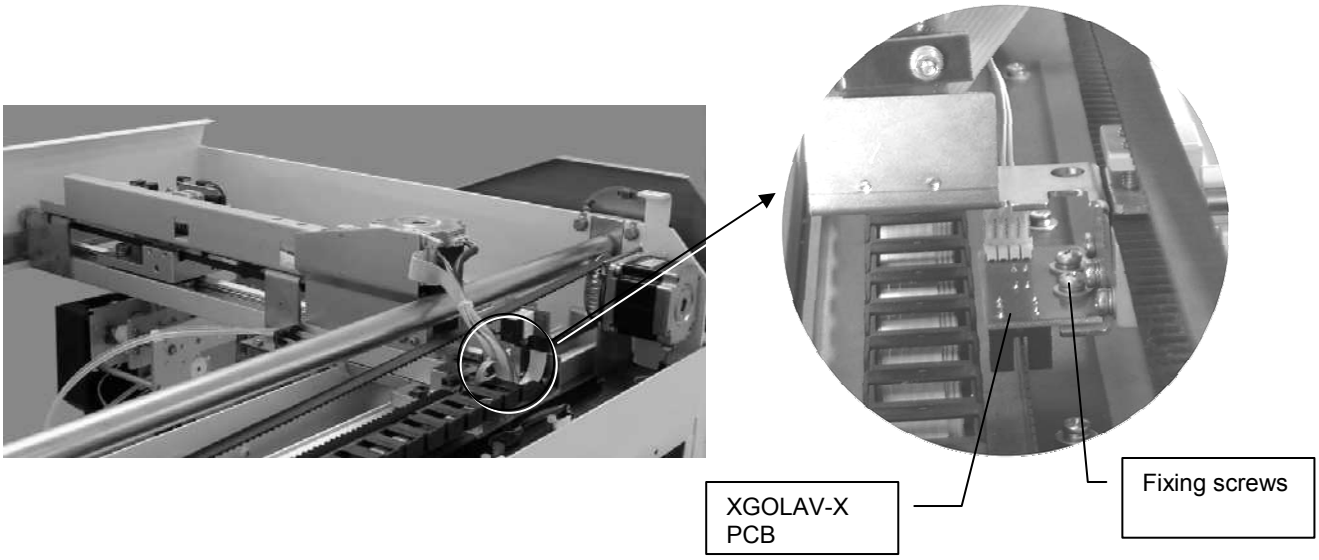
1 Select ***Sample Rack*** from Work Area display
2 The first position is automatically selected and the last setting for Z maximum height is displayed in "***Probe height***" box
3 Select position to be calibrated with a click
4 Select "***Go down***" **Lower** to move probe tip down to the bottom of the well the same number of steps shown in the "***Probe height***" box and check that probe tip is correctly centered.
5 If the centering is not satisfactory follow calibration procedures described later
6 At the end of this process Probe **returns to Home position**

Calibration

X-axis Calibration

Centering the Dispensation Probe along X-axis over the Work Area is a mechanical calibration procedure where the OPTO PCB with the optic sensors is moved together with the **APX-XGOLAV-X** on the X carriage at the back of the device as shown in fig. 1.

1. Remove device top cover
2. Loosen fixing screws on APX-XGOLAV-X PCB
3. Move PCB manually to bring the probe directly over the center of the reference point and then tighten the screws on the PCB
4. Select "***Go up***" to lift probe up and then click on icon to turn off motors
5. Move arm that controls optic sensors so that it now moves freely over the encoder
6. Return to Home position
7. Select "***Go down***" and check that probe is correctly in position
8. Repeat this procedure from point (2) until position is correctly centered



Y-Axis Calibration

Y-axis calibration is a mechanical procedure which requires moving the encoder along the support (fig. 2)

1. Remove top cover
2. Loosen screws at both ends of the encoder
3. Move encoder manually until the probe is in the centre of the reference point and then tighten the screws
4. Select "***Go up***" to bring probe up and turn off motors
5. Move the probe unit along the Y-axis to check that Optic sensors move freely along the encoder
6. Return to Home position
7. Select "***Go down***" and check that probe is correctly centered
8. Repeat procedure from point (2) until position is satisfactory

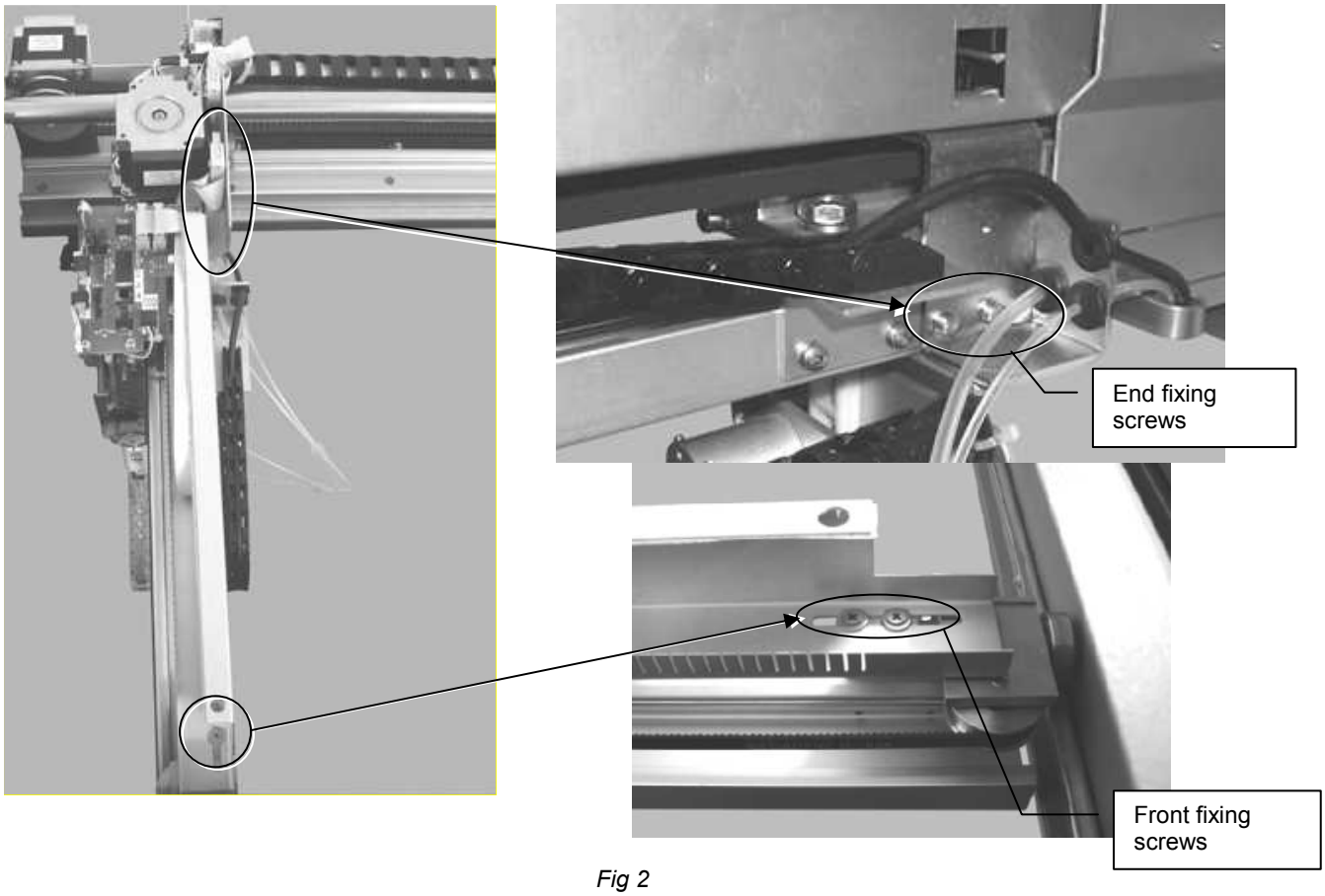


Fig 2

Aligning Shaking Plane

Check

1 Click on first strip holder incubation tray to select it (Tray 1) from Work Area display
2 Select probe 2 from the command panel and then "***Go down***" command without changing the other two values ("*Plate slope*" and "*Z maximum height*")
3 Check that probe is in the centre of the aspiration well
4 Click on Work Area command to display Work Area and select last Strip Plate (Plate 8)
5 Select this last aspiration well and check that probe 2 is correctly centered
6 When this procedure is over return to Home position and display Work Area
7 If probe is not centered in both positions continue with calibration procedure as described:

Calibration

1 Select first strip holder incubation tray (Tray 1)
2 Select probe 2 from command panel and click on "***Go down***"
3 Loosen the four fixing screws on the base of the shaking plane support (Fig. 2)

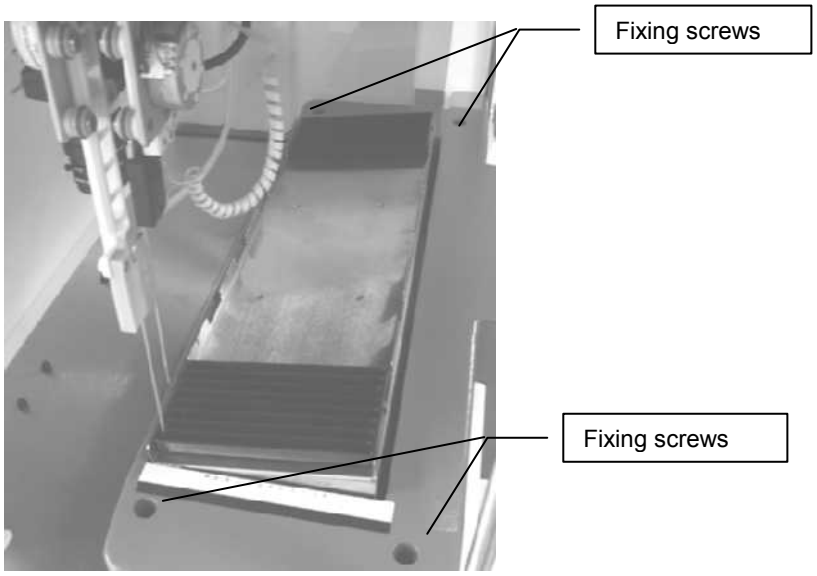
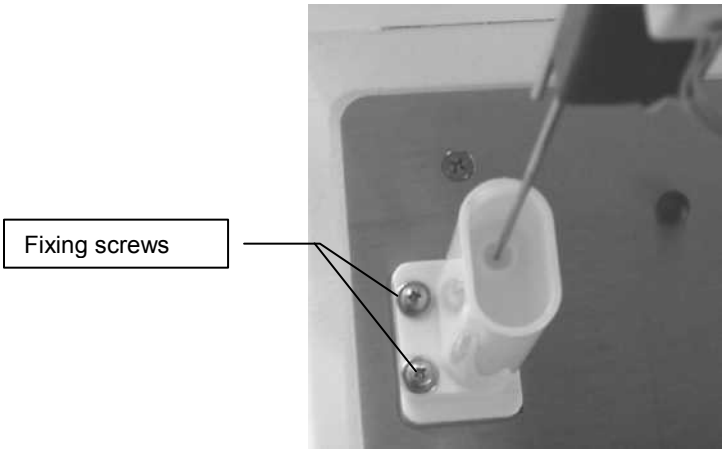


Fig. 2

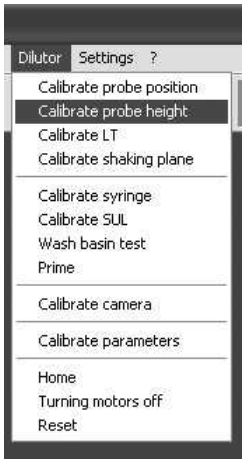
4 Move the base of the stand to regulate position of probe and center it in aspiration well
5 Return to Work Area and select last well (Plate 8)
6 Select last aspiration well and repeat procedure from point (4)
7 Tighten fixings at base of stand
8 Return to Home position and Work Area display

Centering probes over wash basin

1 Select wash basin on Work Area and then select "***Go down***". Check that probe is centered inside the well inside the tray
2 If probe 1 is not centered in X- or Y-Axis then regulate position with the two basin fixing screws **tray**, until probe is not sufficiently centered.

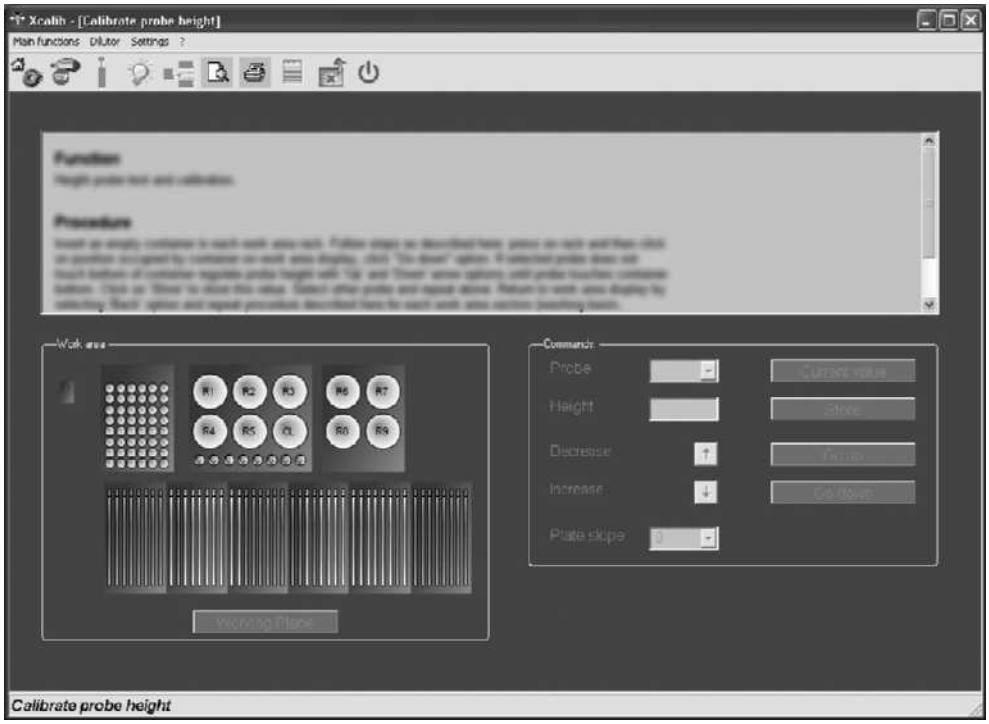


4.8.2. Calibrate probe height



From "***Dilutor***" pull down menu select "***Calibrate probe height***".
Height Calibration determines the safe distance between the probe tips and the bottom of the wells in each section of the Work Area– this the number of maximum steps that a probe can go down (Z maximum height)

The following display appears:



Calibration
The number of steps - Z maximum height - should be calculated for each section of the Work Area:

Sample and reagent section

1. Insert an empty test-tube in position 1 of sample rack
2. Insert empty bottle in reagents rack in following positions: R1 (dilutor area), R2 (reagent area), in CL (cleaning solution area) and C1 (control area)
3. By selecting sample rack in Work Area, position 1 and the last stored maximum height value are also automatically selected
4. Select "***Go down***" command. The probe will go down the number of steps shown in the "***Height***" box.
5. Now check if probe is:

   <u>*If probe is touching bottom of well*</u> : type in 100 less steps from the current value displayed in "***Height***" box
   Repeat procedure from point (4)
   <u>*If probe is NOT touching bottom of well*</u> : select the "***Increase***" arrow and probe will automatically return to home position and then go down again with an additional 10 steps.
   Repeat procedure until probe touches bottom of well
   Select "***Store***". 10 steps will be automatically subtracted from previous height and new value will be stored (e.g.: 1690 => 1680).

6. To return to Work Area select "***Work Area"*** key
7. Select reagent area and repeat procedure for positions R1 (dilutor area), R2 (reagents) CL (cleaning solution) and C1 (control area)

Incubation Tray

Both Probe 1 and Probe 2 should be calibrated separately.

Probe 1:

1. Click on Work Area to select Strip Holder plate 1 and the first position is also automatically selected
2. Type in "- 6" value in "***Plate Slope***" box and select Probe 1 from "Probe" pull down menu
3. Set-up initial value of 800 steps in "***Height***" box
4. Select "***Go down***" and probe will go down the number of steps shown in "***Height***" box. The shaking plane will tilt as set up in "***Plate Slope***" pull down menu.
5. Check probe position:
6.

   If probe is touching bottom of well : manually type in 100 steps less in the "**Height"** box. Repeat procedure from point (4)

   If probe is NOT touching bottom of well: *If probe is NOT touching bottom of well* : select the "***Increase***" arrow and probe will automatically return to home position and then go down again with an additional 10 steps.
   Repeat procedure until probe touches bottom of well

8. Select "***Store***". 200 steps will be automatically subtracted from previous height to set correct distance for dispensation
9. Select "***Work Area"*** key to return to Home position and Work Area display

Probe 2:

7. Click on Work Area to select Strip Holder plate 1 and the first position is also automatically selected
8. Type in "6" value in "***Plate Slope***" box and select Probe 2 from "Probe" pull down menu
9. Set-up initial value of 800 steps in "***Height***" box
10. Select "***Go down***" and probe will go down the number of steps shown in "***Height***" box. The shaking plane will tilt as set up in "***Plate Slope***" pull down menu.
11. Check probe position:

    If probe is touching bottom of well: manually type in 100 steps less than initial value in the "**Height"** box. Repeat procedure from point (4)

    If probe is NOT touching bottom of well: select the "***Increase***" arrow and probe will automatically return to home position and then go down again with an additional 10 steps.
    Repeat procedure until probe touches bottom of well

10. Select "***Store***". 10 steps will be automatically subtracted from previous height to set correct distance for aspiration
11. Select "***Work Area"*** key to return to Home position and Work Area display

Probe Washing Basin

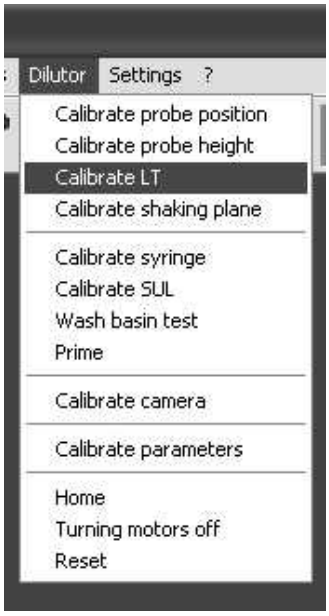
1. Click on Work Area to select Probe Washing Basin
2. Type in "950" steps as initial "***Height***" value in box
3. Select "***Go down***" command. The probe will go down into the probe washing basin the number of steps shown in the "***Height***" box
4. Check probe position:

   If probe is touching bottom of probe washing basin: manually type in 100 steps less than initial value in the "**Height"** box. Repeat procedure from point (4)

   If probe is NOT touching bottom of probe washing basin: click on "***Increase***" arrow and probe will automatically return to home position and then go down again with an additional 10 steps.
   Repeat procedure until probe touches bottom of probe washing basin

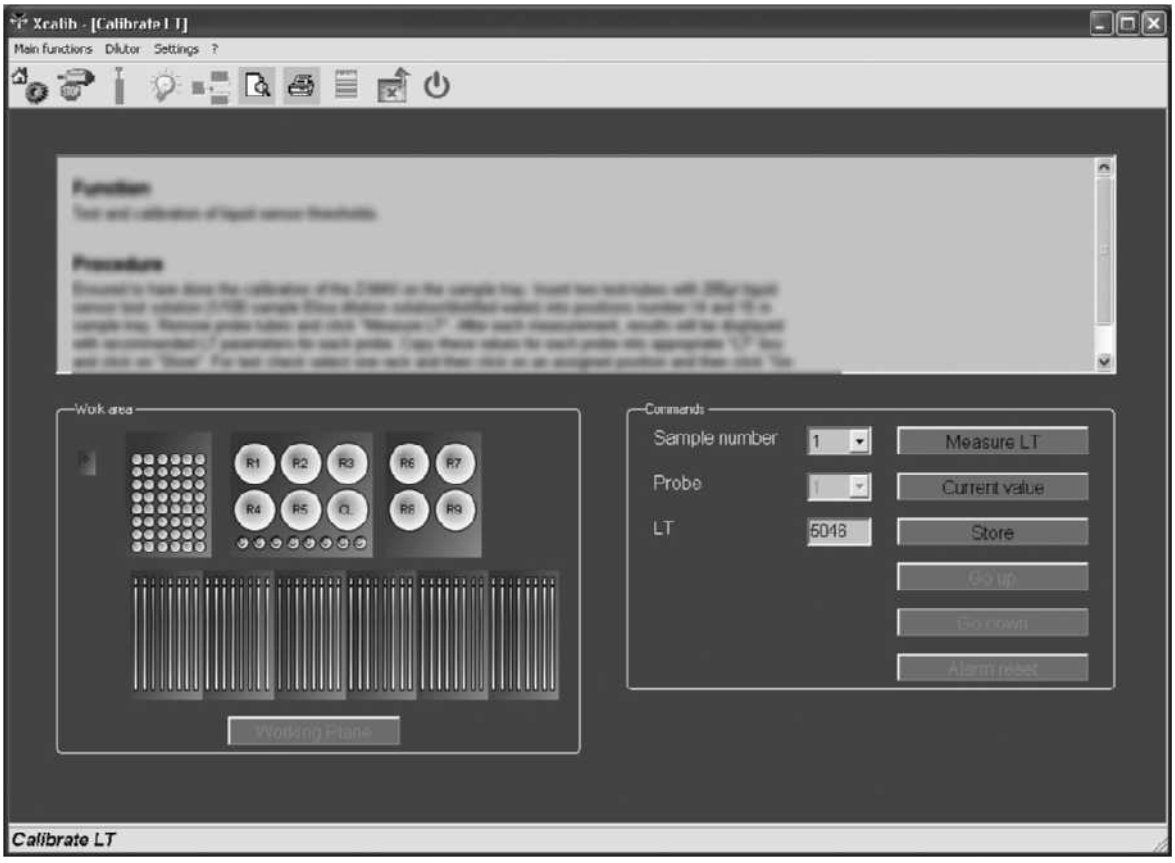
5. Select "***Store***". 30 steps will be automatically subtracted from previous height to set correct distance for wash
6. Select "***Work Area"*** key to return to Home position and Work Area

4.8.3. Calibrate LT



From "***Dilutor***" pull down menu select "***Calibrate LT***" .

The following display will appear:



Check and Calibrate LT liquid sensor

1. Ensure that sample rack heights have been correctly calibrated.
2. Prepare test solution: distilled water and dilutor liquid in 1/100 ratio
3. Insert test-tube with 200µl liquid sensor solution anywhere in sample rack.
4. Remove probe 1 tube.
5. From "***Sample number***" box type in or pull down value of position where test-tube with liquid is inserted
6. Select "***Measure LT***" command
7. The probe will automatically go down 10 steps inside the test-tube to measure and evaluate LT settings
8. When measurements are completed, a report with all 10 results is displayed.
9. Reinsert tube in Probe 1

Setting LT values

The report will display the following:

- "Probe 1 signal": **sensitivity measurements**;
- "Probe 1 height": steps required to reach Z maximum height (to the liquid surface);
- Average values and CV% of measurements;
- Current values: Current LT settings
- Advisable values: LT values as advised by software

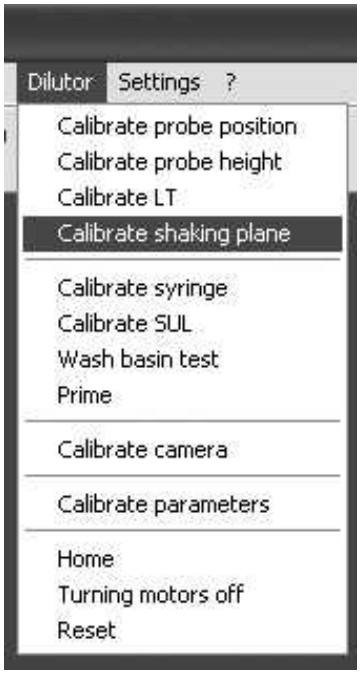
LT Value advised by software is equal to half of the minimum sensitivity measurements.
For standard Calibrations this value should be set up in "LT" box.
Select ***Close function***" icon to return to initial display and copy the LT parameter to set up in "LT" box.
Select "***Store***".

Check LT value setting

To check LT setting on different types of phials:

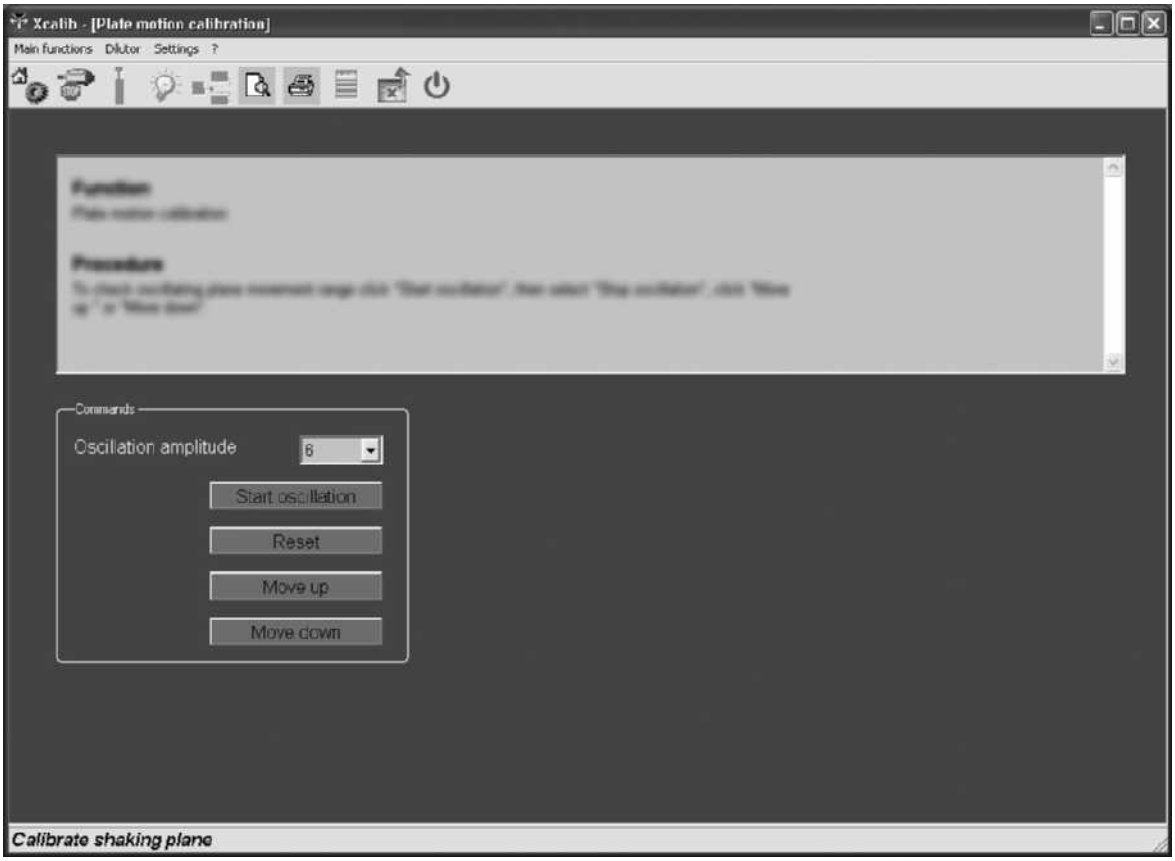
- select a section of Work Area;
- insert phial used with at least 200 µl test solution in the required position of the relevant rack;
- Select "***Go down***" command;
- Check if Probe senses liquid and stops going down before contact with liquid surface without emitting any alarm signal.

4.8.4. Calibrate shaking plane



From "***Diluter***" pull down menu select "***Calibrate shaking plane***" .

The following display will appear:



Control shaking plane movement

1) Set up shaking range from pull down menu (default value is 6) and select "***Start shaking"***. To interrupt movement select "***Reset***" and the shaking plane goes back to home position (flat).
2) Check that shaking movement is smooth and not obstructed. Click on "***Move up***" and "***Move down***" commands to check that up and down movements are correct. The shaking plane will automatically move within the range as set up (minimum 1 and maximum 9)
3) If movement is not smooth - check that:
   - Shaking mechanism unit is complete.
   - Opto PCB (OP-Swing under the shaking plane) is functioning correctly.

Check horizontal position:

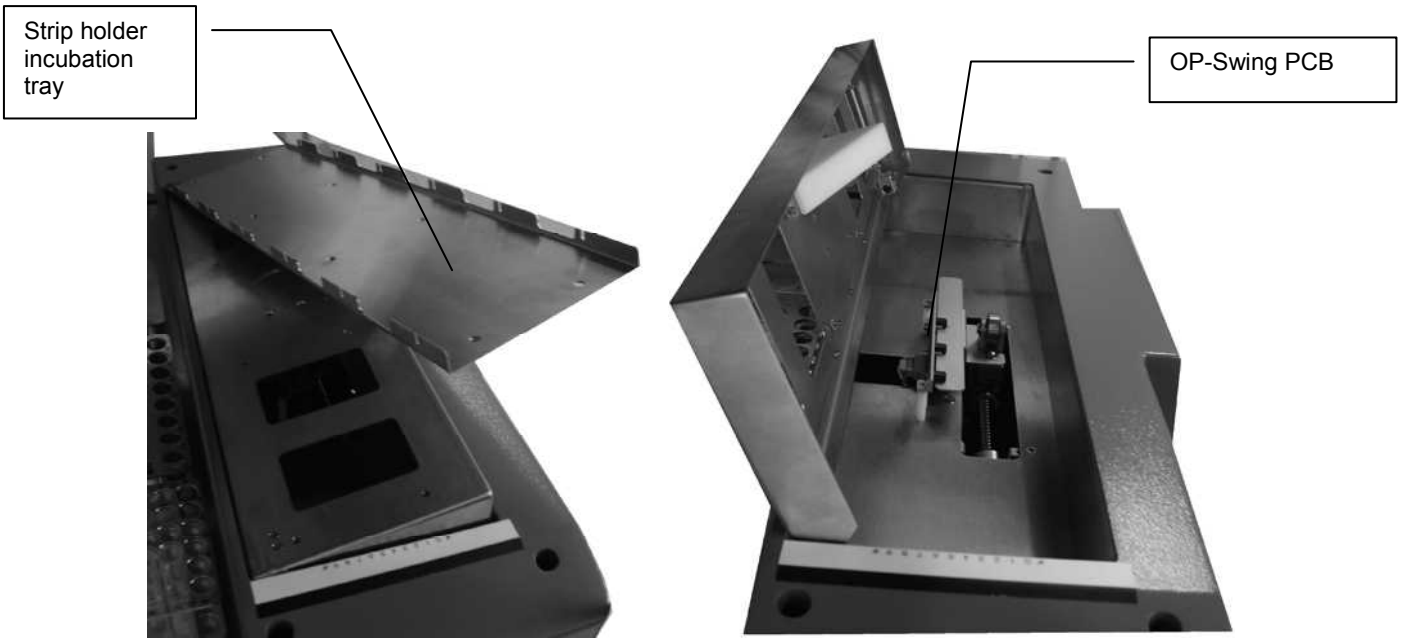
- Click on "***Move up***" and then "***Reset***" to return shaking plane to the Home (flat) position
- Use a spirit level to check that shaking plane is level horizontally along both X- and Y-Axis

If uneven or not level, proceed with Calibration procedure described here:

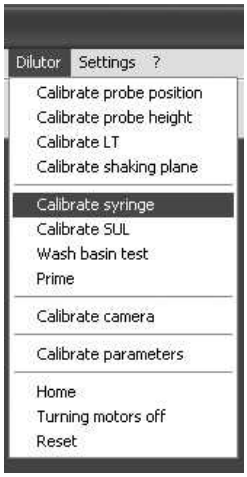
Calibration
Remove all strip holder plates from shaking plane and use a spirit level to check that shaking plane is level, both for X and Y axis
Regulate Swing PCB opto (under shaking plane) if not level (ref. para.3.3.6.1.).

Horizontal Position Calibration

- Remove Plate Holder (Fig.X)
- Life off shaking plane and loosen fixing screws of the OP-Swing PCB (Fig. X)
- Move the PCB to mechanically regulate the shaking plane home position
- Lower the shaking plane and repeat the procedure to check horizontal level of shaking plane
- When this procedure is completed replace the strip holder plate correctly

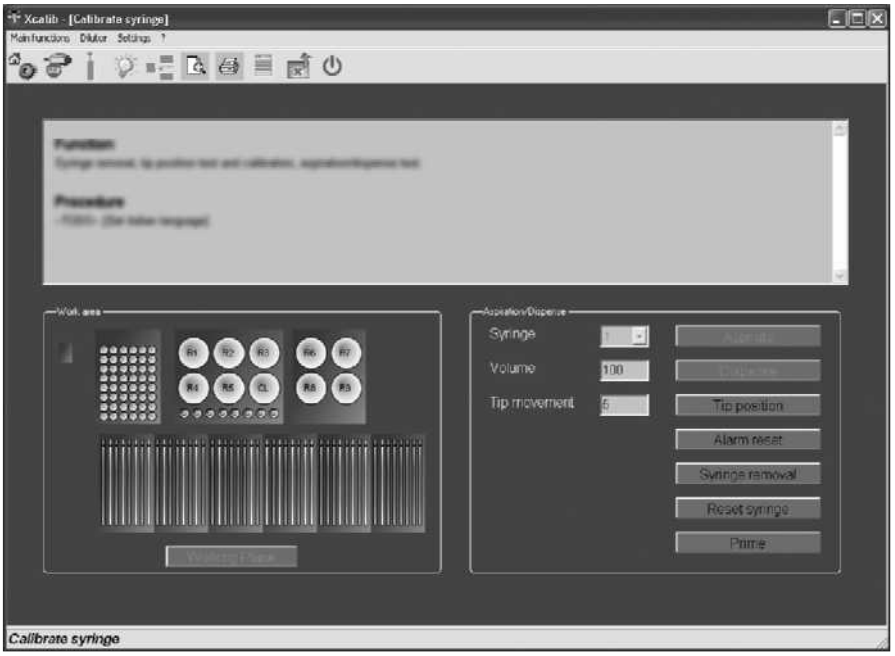


4.8.5. Calibrate syringe



From "***Dilutor***" pull down menu select "***Calibrate syringe***".

The following display will appear:



Calibration

This procedure aims to regulate the distance between the syringe Tip and syringe mount is circa 1mm (fig. 1).

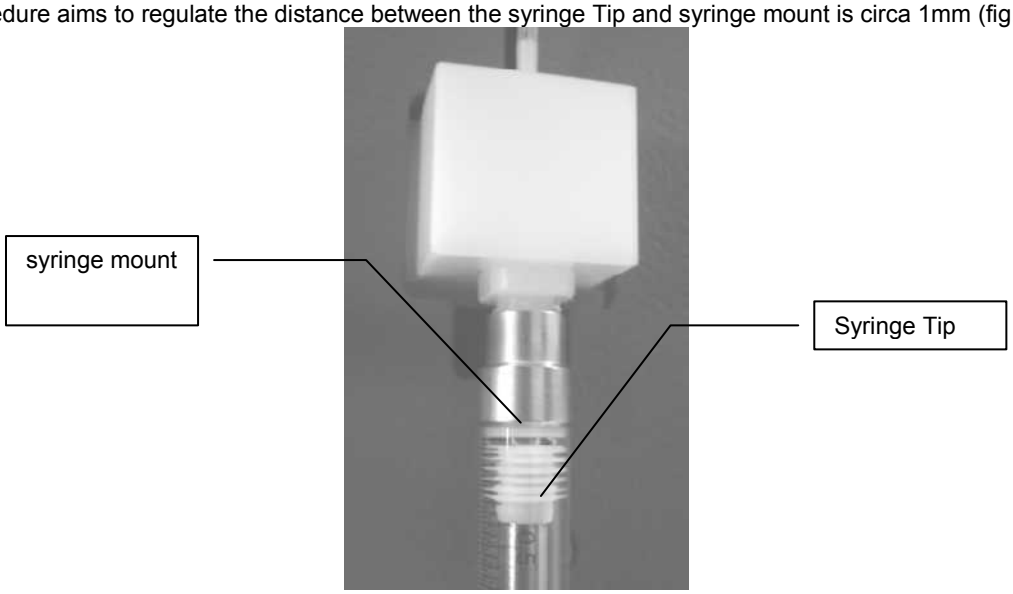


Fig. 1

1. Set number of syringe movements in the “Tip Movement” box (between each movement there is a 3 second interval and the default movement setting is for 5 movements);
2. Click on “Tip Position”;

To regulate Tip position use SIDILOP PCB behind Dilutor unit. (Fig. 2). Dilutor Unit can be accessed behind back panel

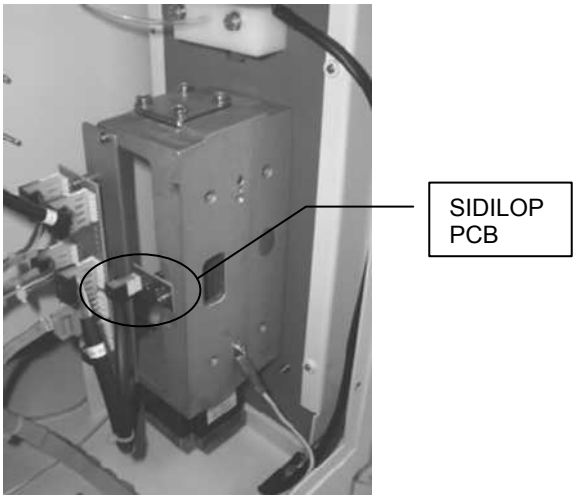


Fig. 2

Check that changes on the PCB show that repeated syringe movement is in the circa 1mm range as previously set up.

Substitute syringe

1) Disconnect Wash and Wash Buffer 1 tubes from instrument before substituting syringe
2) Select ***Prime*** from ***Calibrate probes*** display to empty whole hydraulic circuit
3) Select ***Syringe Removal*** key. The plunger lowers and the syringe can be removed by twisting it anticlockwise
4) Insert new syringe. Twist it clockwise back into syringe valve unit; select "***Reset syringe***”
5) Check Tip Position by referring to Calibration procedure described earlier
6) Reconnect WASH and WASH Buffer 1 tubes

Substitute plunger

1) Disconnect Wash and Wash Buffer 1 tubes
2) Select ***Prime*** from ***Calibrate probes*** display to empty whole hydraulic circuit
3) Select ***Syringe Removal*** key. The plunger lowers and the syringe can be removed by twisting it anticlockwise
4) Pull out syringe plunger from holder and insert new plunger;
5) Insert syringe and twist it clockwise back into syringe valve unit; select "***Reset syringe***”
6) Check Tip Position by referring to Calibration procedure described earlier;
7) Reconnect WASH and WASH Buffer 1 tubes

To check aspiration and dispensation

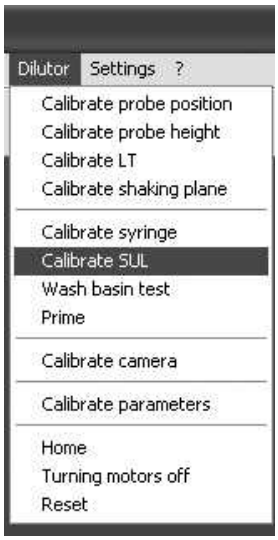
1. Visually check Waste tank is not full and that WASH basin is not empty.
2. Select "***Prime***" to rinse/prime circuit.
3. Set up ***Volume*** value for how much liquid should be aspired (default volume: 100µl).
4. Insert a test-tube with at least 1ml of liquid distilled water and sample dilutor in a ratio of 1/100;
5. Insert the test-tube in the required position on the sample rack;
6. Insert an empty test-tube in a different position in the sample rack;
7. Select sample rack on work area and then the specific position of the test-tube with liquid.;
8. Select "***Aspire***" key – the probe will move down to just above the liquid and will aspirate the set volume of liquid.
9. On the work area display select the empty test-tube position on sample rack;
10. Select "***Dispensation***" key – the probe will move to selected position and go down to Z-maximum height and dispense the set amount of liquid
11. Check with a teat pipette that the amount of dispensed liquid corresponds to amount set up previously in point (3)

If the volume is incorrect check that:

1. Check for possible Air in the hydraulic circuit:
    - By checking that Prime phase is correct;
    - Check that peristaltic pumps are correctly functioning;
    - Check that all hydraulic circuit (internal and external) tubes are correctly connected;
    - Check that syringe tip is not aspirating air;

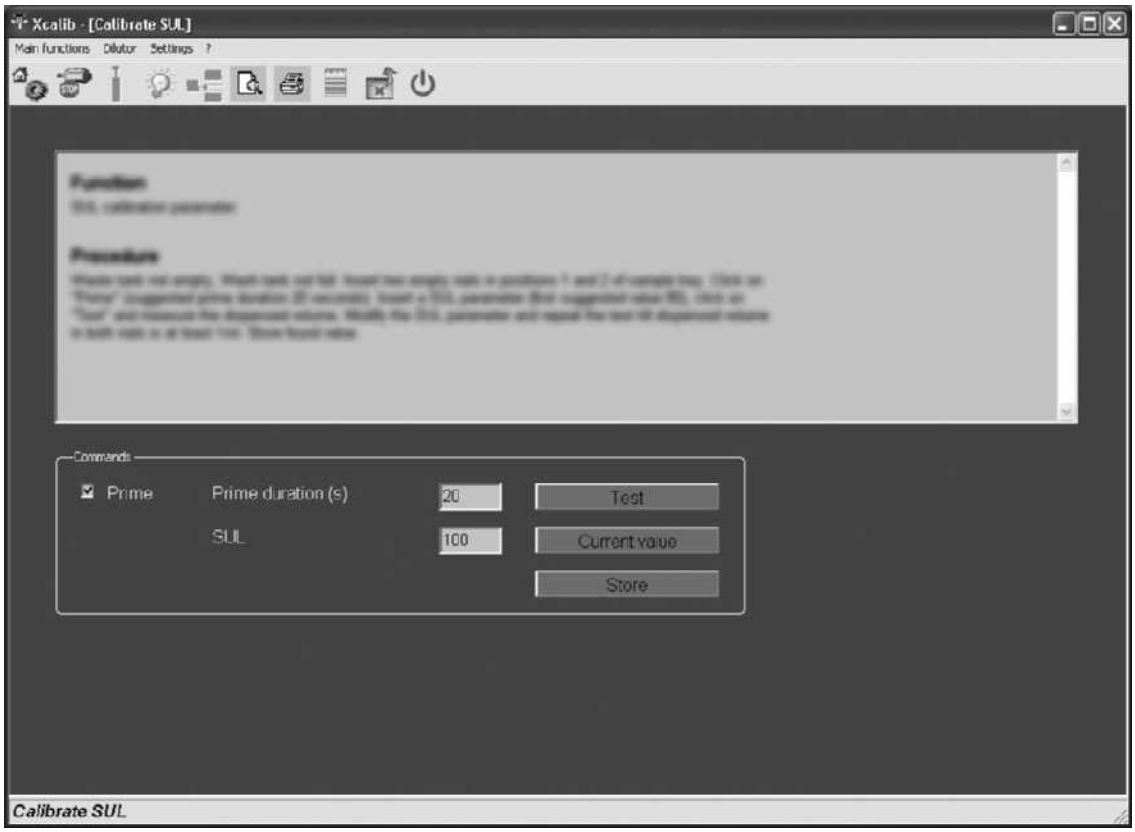
2. To check that syringe is not aspirating air:
    - Check that needle tip reaches liquid surface **(**ref. LT Calibration section);
    - Check that needle tip is correctly following liquid during aspiratation

4.8.6. Calibrate SUL



From "***Dilutor***" pull down menu select "***Calibrate SUL***".

The following display will appear:



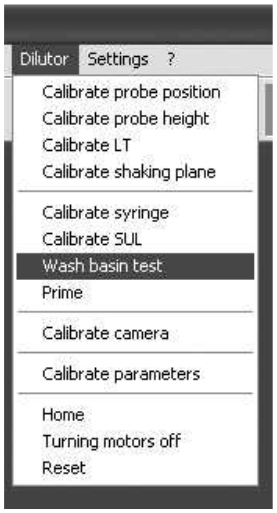
SUL parameter settings regulate how long the dilutor unit valve remains open and consequently how much liquid volume (1 ml) is dispensed by the peristaltic pumps.

1) Insert an empty test-tube in position 1 of sample rack.
2) Check that Waste basin is not full and that WASH tank is not empty.
3) Check "***Prime***" box to activate Prime function
4) Set up the duration of hydraulic circuit Prime (recommended 20 seconds) in "***Prime duration***" box
5) Input 100 as first value for SUL set-up in "SUL" box;
6) Select "***Test***". Liquid volume as selected should be dispensed in test-tube;
7) Check with a teat pipette that 1ml of liquid has been dispensed through valve opening SUL value

- *If dispensed liquid volume is more than 1ml:* reduce SUL value, disactivate Prime and repeat Test at point 6;
- *If dispensed liquid volume is less than 1ml:* increase SUL value, disactivate Prime and repeat Test at point 6;

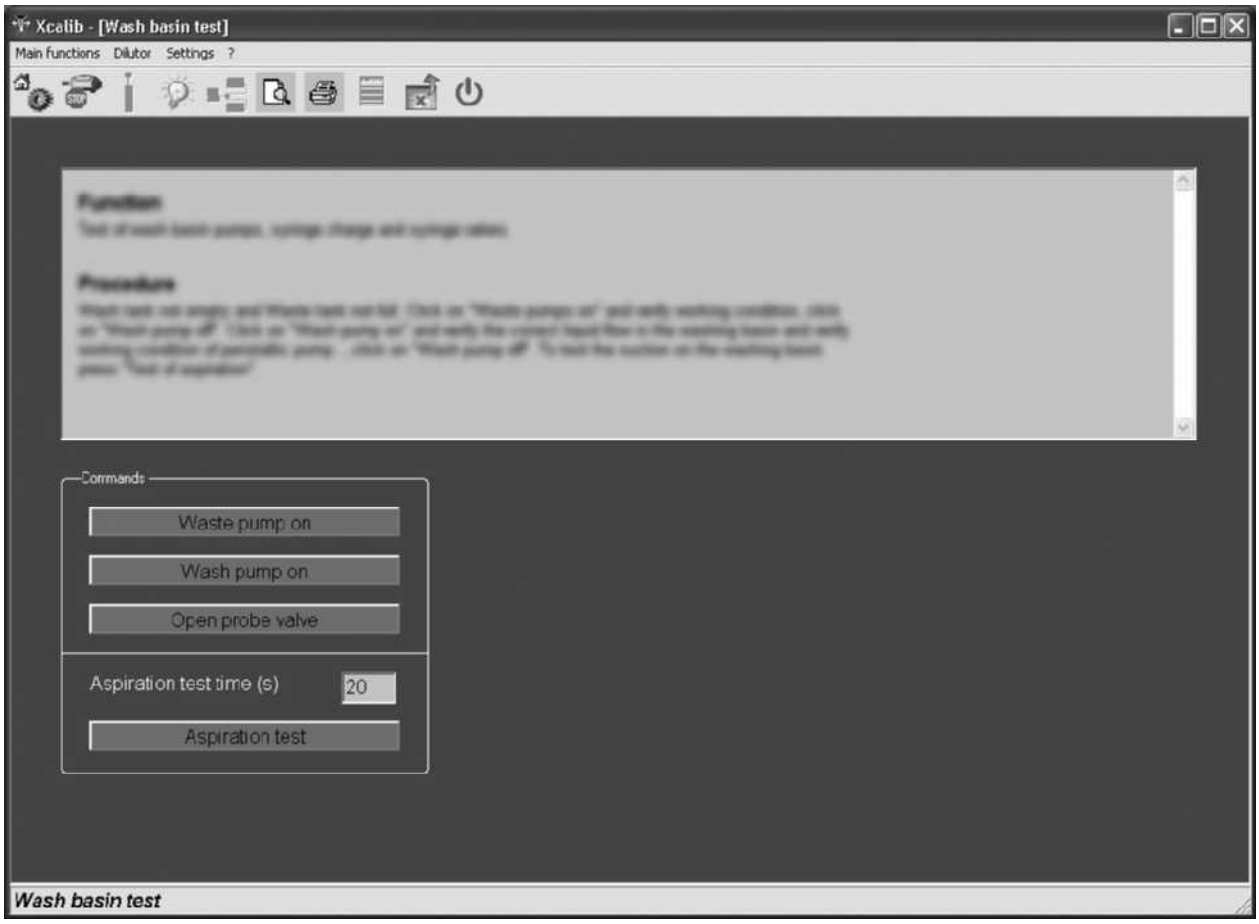
8) Select "***Store***" to save SUL value obtained.

4.8.7. Wash basin test



This test checks that the peristaltic aspiration/waste pumps and dilutor unit electro-valve are correctly functioning.
From "***Dilutor*** " pull down menu select "***Wash basin test***"

The following display will appear:



Check peristaltic pump functioning

1) Check that Waste basin is not full and that Wash basin is not empty.
2) Select "***Waste pump on***" and check that peristaltic pump "B" turns in clockwise direction.
3) Select "***Waste pump off***"
4) Select "***Wash pump on***" and check that peristaltic wheels "A" and "B" are turning and that no liquid comes out of probe 1. Select " ***Wash pump off*** "

If part of this procedure does not function correctly – check that:

- Check that peristaltic pump motors are correctly connected;
- Turn off motors (through instrument bar icon) and manually check that peristaltic pump moves freely;
- Check that relevant PCB is functioning correctly.

Check correct functioning and resistance of electro-valve
Check that probe valve is correctly functioning (open and close) through the two commands "***Open probe valve***" and "***Close probe valve***" (a click can be heard when valve opens)

If this does not ococur:

- Check that electric cable connection is 24 V DC when valve is open and is 0 V DC when valve is closed
- Check that Dilutor PCB is correctly functioning
- Substitute electro-valve

Checking electro-valve is watertight:

1) Ensure that electro-valve is closed;
2) Select "***Wash pump on***";
3) Select "***Open probe valve***";
4) Check that probe 1 dispenses liquid continuously and that wash basin correctly aspirates liquid through the pump
5) Select "***Close probe valve***";
6) Check that probe 1 and electro-valve are not dripping;
7) Select "***Wash pump off***".

If this procedure is not successful:

- Check that electro-valve is mounted correctly
- Substitute electro-valve

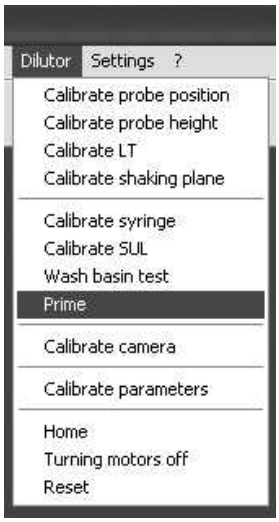
Check Wash Basin functioning

1) Ensure that Electrovave is closed;
2) Select "***Wash pump on***";
3) Select "***Open probe valve***";
4) Check that probe 1 dispenses liquid continuously and that wash basin correctly aspirates liquid through the pump
5) Select "***Wash pump off***".
6) Select "***Close probe valve***";

If any part of this procedure does not function correctly – check that

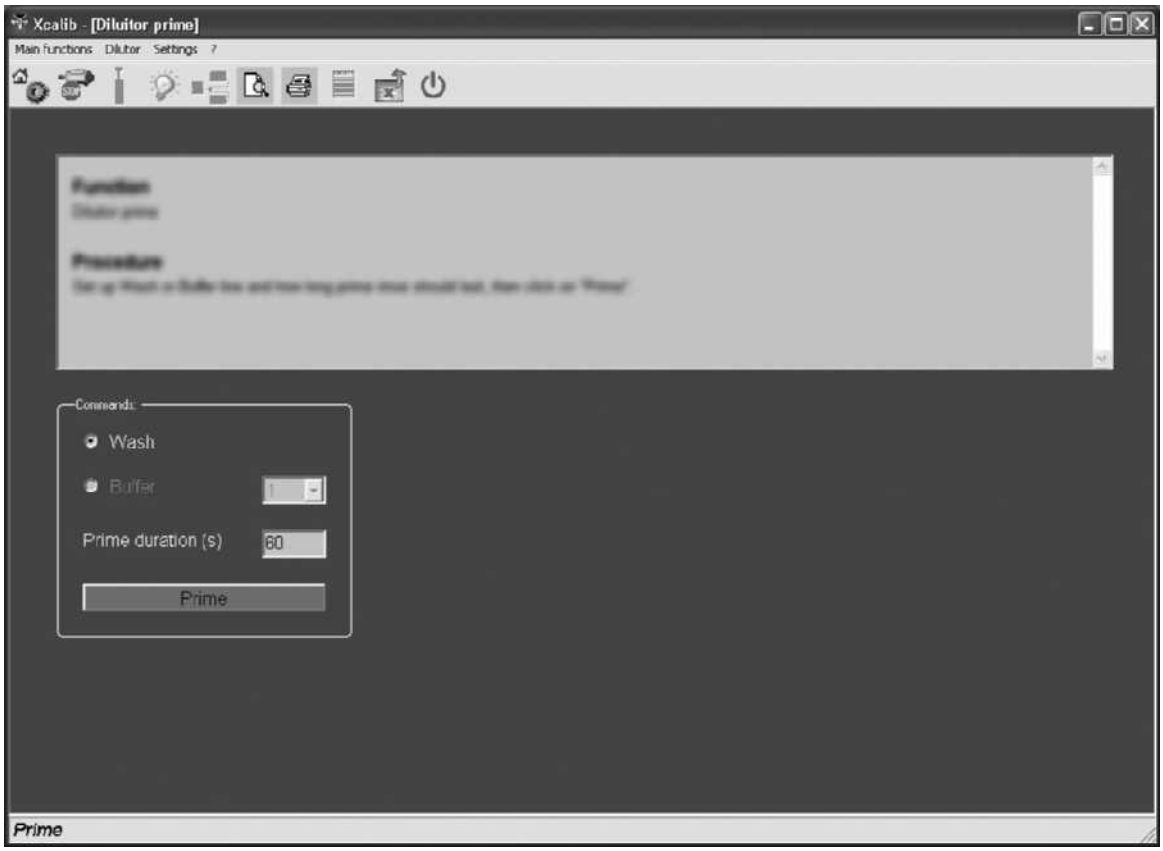
- °Waste peristaltic pump (pump B) is functioning correctly
- Relevant PCB (motor PCB) is functioning correctly.
- Wash basin waste channel is not obstructed
- No tubes are obstructed

4.8.8. Prime



From "***Dilutor***" pull down menu select "***Prime***".

The following display will appear:

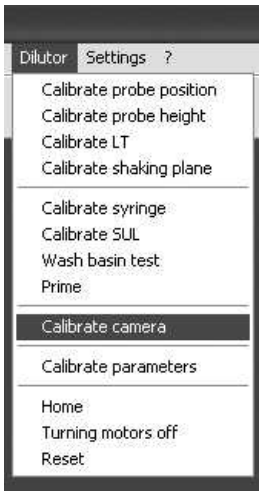


1) Check that Waste basin is not full and that Wash and Wash Buffer 1 basins are not empty.
2) Select type of prime: with WASH or with water (Wash Buffer1)
3) If Buffer is selected then remove Wash Bottle cap
4) If Wash is selected then remove top to Wash Buffer 1 bottle
5) Input amount of seconds for duration of prime in box
6) Select "***Prime***" and check that liquid is aspired from previously selected bottle

If any part of this procedure does not function correctly – check that:

- Upper and lower tubes are correctly connected to the wash tank cap
- Electro-valve "A" can correctly switch between WASH and Wash Buffer1 tubing
- Electro-valve "A" is sufficiently airtight
- No relevant tubes are obstructed
- Aspiration pump is correctly functioning

4.8.9. Calibrate camera



From "***Dilutor***" pull down menu select "***Calibrate camera***" .

The following display will appear:

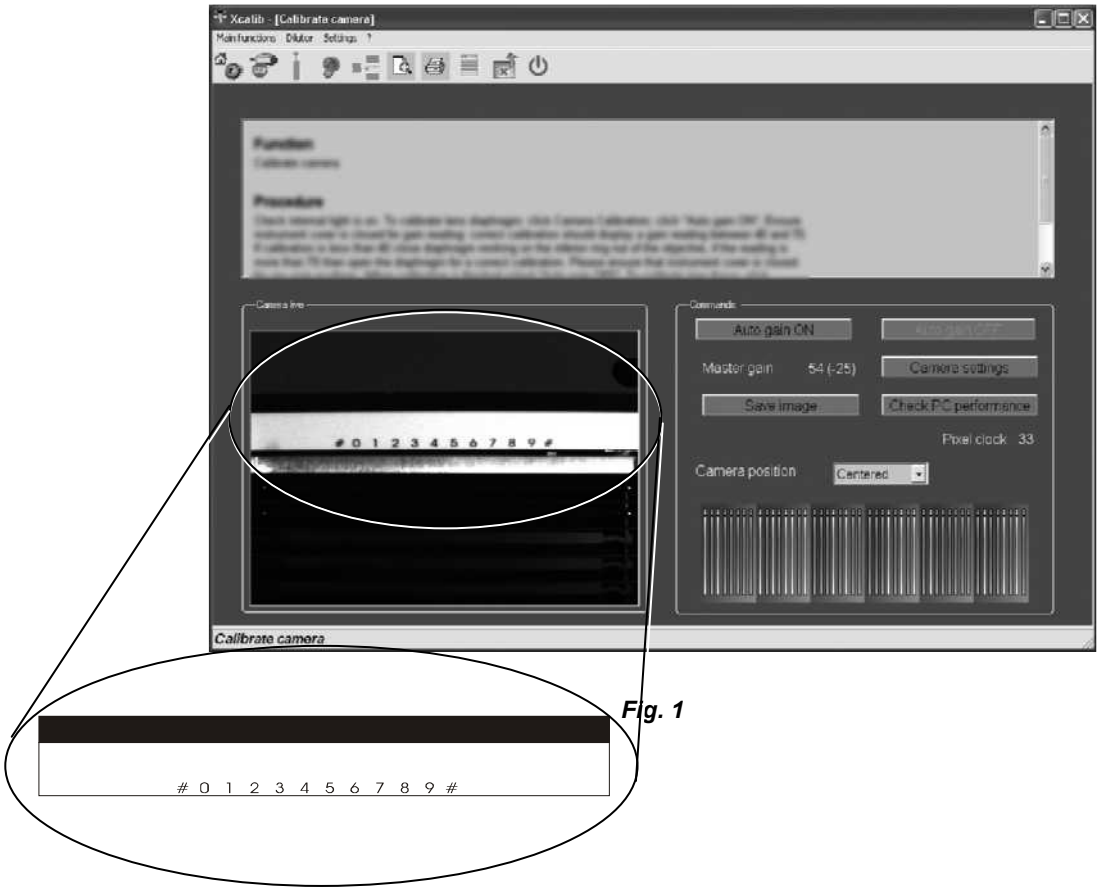


Fig. 1

Test correct gain calibration

1) Check that internal light is on, instrument cover is closed and top cover is inserted.
2) Select "***Auto Gain ON***". The camera will then move to frame the Calibration Strip (as shown in Fig 1) and will automatically set a white balance.
3) After this balance check Gain Value.
4) If Gain Value is between 40 and 60 - the diaphragm is perfectly calibrated. If not then Calibrate Gain.
5) Select " ***Auto Gain OFF***" to interrupt test

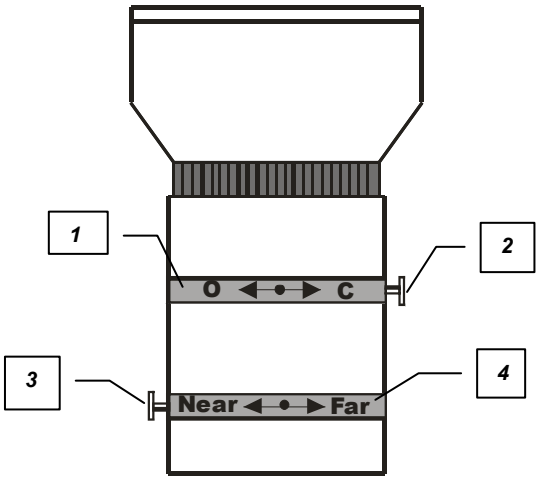
Gain Calibration

1) Check that internal light is on and that instrument shield is closed and **that upper cover** is also inserted

2) Select "Auto Gain ON". The camera will then move to frame the Calibration Strip (as shown in Fig 1) and will automatically set a white balance.
3) Open cover and unblock diaphragm ring mount by loosening block screws **(Fig. 2)**
4) Open or close diaphragm depending on which correction is required:

   To decrease gain value: open diaphragm following O direction arrow;
   To increase gain value close diaphragm in C direction arrow.

5) Close cover and check new gain value.
6) Repeat procedure from point 3 to 5 until gain value is between 40 and 60.
7) When correct gain value is obtained tighten screws to fix the ring mount – **Attention:** do not move it.
8) Check gain value again – when blocking ring mount any slight movements can alter the set up optimum gain value
9) Select "Auto Gain OFF" to interrupt Calibration process
10) A correction value (shown between brackets) will be subtracted from the obtained value to be then stored and displayed



1	Screws blocking ring mount for focussing
2	Focus ring
3	Screws blocking ring mount for gain value
4	Ring mount for gain value

Fig. 2

Correct Focus Test

1) Select "Auto Gain ON". Wait for white balance.
2) Select "Auto Gain OFF".
3) Check that camera focus is correct with reference to numbers on Calibrating strip (Fig. 1)
4) For a perfect calibration ensure that numbers on the strip are sharp
5) If numbers are not sharp, calibrate focus

Calibrating focus

*N.B. The camera must be positioned over calibration strip. If position is incorrect then select **"Auto Gain ON**". Wait some seconds for automatic white balance and then select "**Auto Gain OFF**".*

1) Open instrument cover.
2) Unblock focus ring (Fig1) by loosening blocking screws (fig2)
3) Turn focus ring until numbers on calibration strip are sharp
4) Close cover
5) Repeat procedure from point 3) until optimum focus is achieved
6) Tighten ring screws taking care not to move ring position.
7) Close cover.
8) Check focus again to ensure that last point 6) did not shift the ring and change focus

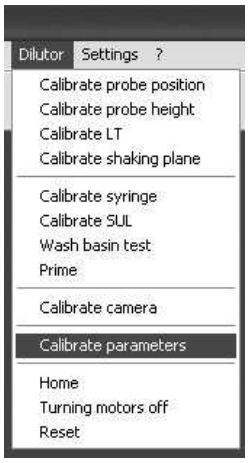
Save image
The "**Save image**" command allows images displayed to be stored in a file with a *.bmp (bitmap) format.

Camera settings
The "**Camera settings**" command stores the camera own settings in a file with an *.ini format.

Check PC performance
The "***Check PC performance***" command runs an automatic test to check that the PC has sufficient attributes to be used with these devices. At the end of the test the result is displayed.

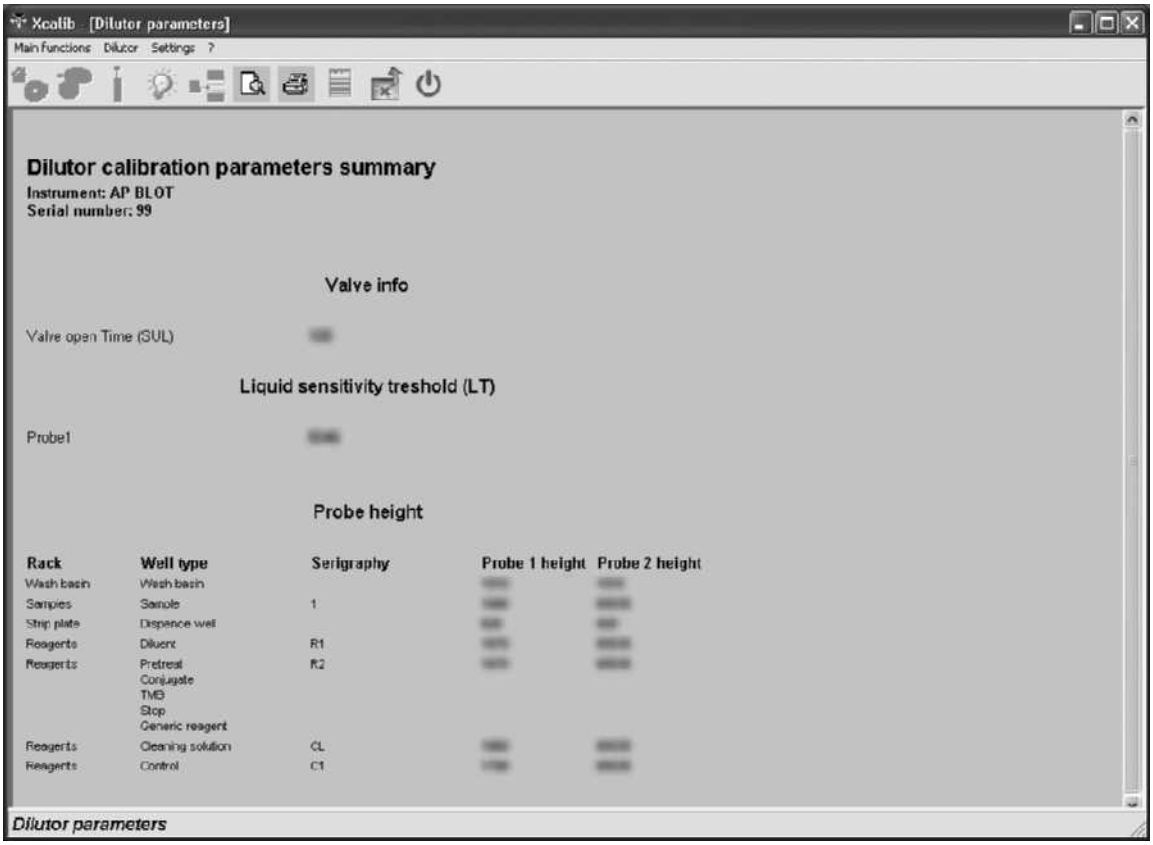
Pixel Clock
The value displayed in the ***Pixel Clock*** field is relative to the characteristics of the PC being used; if they are sufficient then the pixel clock display is over '24'.

4.8.10. Calibrate parameters



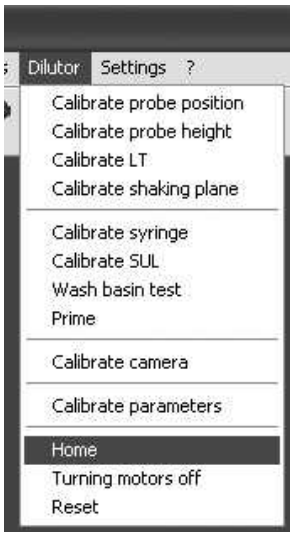
From "***Dilutor***" pull down menu select "***Calibrate parameters"***.

The following display will appear:



This Report is displayed which lists the parameter settings.

4.8.11. Home



From "***Dilutor***" pull down menu select "***Home***" .

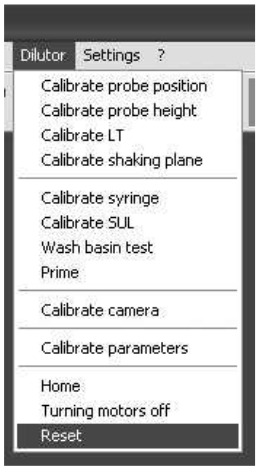
Probes are returned to Home position over probe washing basin

4.8.12. Turning motors off

From "***Dilutor***" pull down menu select "***Turning motors off*** " .

All motors are turned off and can now be moved manually.

4.8.13. Reset



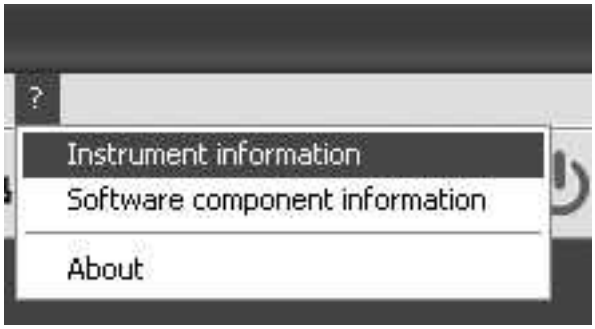
From "***Dilutor***" pull down menu select "*Reset*" .

All the PCBs are now "Reset".

4.9. ?

4.9.1. Instrument information

From "***?*** " menu select "***Instrument information***" .



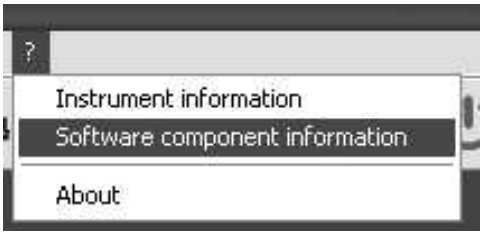
The following display will appear:

This display shows information about the firmware installed.
If any function failure occurs then an Error message is displayed, e.g.: if communication with the instrument is not successful.

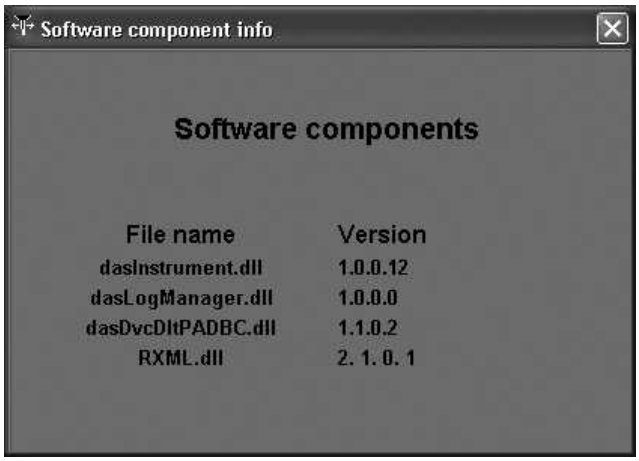
In this case check that all DILAP21 PCB connectors are correctly connected – specifically J15 connector. If all these connections are correct then substitute PCB (see ref. para. 3.8.3.).

4.9.2. Software component information

From "***?*** " menu select "***Software component information***".



The following display will appear:



This display shows the different software versions in use.

4.9.3. About

From "***?*** " menu select "***About***"

The following display will appear:

This display shows the name of the programme, the programme version and manufacturer contact details.

SECTION 5
TROUBLE SHOOTING

5.1 DILUTION / DISPENSATION

	PROBLEM	***PROBABLE CAUSE***	***SOLUTION***
a)	Liquid not dispensed	Probe not in correct position	Check motor, cable, and Dilutor card and replace parts as necessary.
		Probe goes into position but aspirates air and then liquid cannot enter container	Check tubing, attachments and syringe and replace defective parts. Check liquid level. Add if necessary.
b)	Liquid dispensed only in first positions	As probe approaches liquid container it stops at a level where it aspirates first air then liquid	Regulate LT parameter, or replace the probe (liquid sensor damaged).
c)	Probe drips	Air enters Probe	Check tubing, attachments and syringe and replace defective parts.
d)	Loss of liquid at the base of syringe	Tip worn out	Replace tip
e)	Air bubbles present in aspirated sample	Probe tubing or valve are dirty or worn out	Replace probe tubing or valve.
f)	False alarm of lack of liquid	Liquid sensor not sensitive enough	Regulate LT parameter, or replace probe (liquid sensor damaged).
g)	Tip stops before contacting liquid	Liquid sensor too sensitive	Regulate LT parameter, or replace probe (liquid sensor damaged).
h)	Syringe does not aspirate liquid	Air in circuit	Check tubing, attachments and syringe and replace defective parts.
i)	No water in the probe washing well	Peristaltic pump stopped	Check motor, cable and Dilutor card and replace damaged parts if necessary.
		Peristaltic tubing worn out	Replace peristaltic tubing
		Hydraulic circuit clogged	Check for kinks in tubing and undo them.
j)	Probe washing tank full of water	Peristaltic tubing worn out	Replace peristaltic tubing
		Hydraulic circuit clogged	Check for kinks in tubing and undo them.
k)	The aspiration probe doesn't aspirate	The 220V oscillating pump does not work Tubing disconnected or blocked	Replace 220V oscillating pump Check tubing and replace if necessary

5.2 X - Y - Z MOVEMENTS

	ARM (X / Y AXES)		
	PROBLEM	***PROBABLE CAUSE***	***SOLUTION***
a)	X-Y arm does not stop moving	Defective optic sensor	Replace XGOLAV X or XGOLAV Y opto card as appropriate.
		Flat cable damaged	Replace cable.
b)	X-Y arm does not stop in correct position	Optic sensor not regulated	Regulate XGOLAV X or XGOLAV Y opto card as appropriate.
c)	Arm does not move properly along X/Y axis	X/Y belt loose	Regulate X/Y belt tension.
		Lack of lubrication or dirty sliding pads	Clean and lubricate mechanism
d)	Arm does not move	Motor or circuit control worn out	Check motors, wiring, and SIR4MOT card and replace parts if necessary.
	NEEDLE (Z1 and Z2 axis)		
	PROBLEM	***PROBABLE CAUSE***	***SOLUTION***
a)	Z (or Z2, or ZZ) arm does not stop moving	Defective optic sensor	Replace opto INTEROP2 card
		Damaged cable	Replace cable
b)	Dispensation Probe misses steps	Silicon wheel on Z axis motor worn out	Replace silicon wheel on Z axis motor
		Wheel track is dirty	Clean surface of wheel track.
c)	Probe does not move	Motor or circuit control worn out	Check motor, wiring, and Dilutor card and replace parts if necessary.
d)	Z2 motor misses steps	Motor gear too far from its rack	Regulate motor screws to bring motor nearer to rack
	SHAKING PLANE		
	PROBLEM	***PROBABLE CAUSE***	***SOLUTION***
a)	The shaking plane does not move	Cables are not connected	Connect cables
		Motor does not work	Substitute motor
		OP-Swing PCB and/or DILAP21 PCB does not work	Substitute PCBs
b)	Positioning error	OP-Swing PCB does not work	Substitute PCB

5.3 CAMERA

	PROBLEM	***PROBABLE CAUSE***	***SOLUTION***
a)	Camera not recognised	Incorrect USB Port	Ensure that connection is a USB 2.0
		Incorrect Installation Driver	Re-install Driver
b)	Dark images from camera	Incorrect calibration	Re-calibrate using XCalib program
		Incompatible Computer	Check PC parameters with XCalib program
c)	Images overexposed or too light from camera	Incorrect calibration	Re-calibrate using XCalib program
d)	Camera is ‘absent’/does not appear	Unconnected cable	Check USB cable connection
		Worn out cable	Substitute USB cable

SECTION 6
SCHEMATIC DIAGRAMS