Printing History

Edition 1   August 1999   Software Version 2.0
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The PAL System may be operated with another level of firmware. Details of the current level are given with the leaflet "Firmware Overview" which is placed in the front of this binder.

Safety Information

Declaration of Conformity   See Declaration of Conformity sheet enclosed with the instrument

General Considerations

⚠

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

The user shall be made aware that if the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment my be impaired.

When you use the PAL System, follow the generally accepted procedures for quality control and methods development.

When you use the PAL System in the field of chromatographic analysis and you observe a change in the retention of a particular compound, in the resolution between two compounds, or in peak shape, immediately determine the reason for the changes. Until you determine the cause of a change, do not rely on the separation results.

Electrical Hazards

Every analytical instrument has specific hazards, so be sure to read and comply with the following precautions. They will help ensure the safe, long-term use of your PAL System.

The Installation Category (Over voltage Category) for this instrument is Level II.
The Level II Category pertains to equipment that receives its electrical power from the local level, such as an electrical wall outlet.

Only use fuses of the type and current rating specified. Do not use repaired fuses and do not short-circuit the fuse holder.

The supplied power cord must be inserted into a power outlet with a protective earth contact (ground). When using an extension cord, make sure that the cord also has an earth contact.

Do not change the external or internal grounding connections. Tampering with or disconnecting these connections could endanger you and/or damage the PAL System.

The instrument is properly grounded in accordance with these regulations when shipped. You do not need to make any changes to the electrical connections or the instrument's chassis to ensure safe operation.

The combination of a PAL System with a LC/MS System does require the safety measure as described by the LC/MS System manufacturer. Detailed instructions for the safety grounding on the LC/MS system are outlined in the corresponding operating/installation manual.
CTC Analytics recommends to use a grounding cable connected on one side at the Injection Valve, Loop or any other suitable direct metallic contact and the other side at an appropriate grounding point at the LC/MS System. This supplementary grounding measure will support the safety strategy of the LC/MS System manufacturer.

Do not turn the instrument on if you suspect that it has incurred any kind of electrical damage. Instead disconnect the power cord and contact a CTC Analytics representative for a product evaluation. Do not attempt to use the instrument until it has been evaluated. Electrical damage may have occurred if the PAL System shows visible signs of damage, exposure to any liquids or has been transported under severe stress.

Damage can also result if the instrument is stored for prolonged periods under unfavorable conditions (e.g. subjected to heat, water, etc.).

In any case disconnect the power cord(s) from the power supply or from the different power supplies if optional devices are installed before attempting any type of maintenance.

Capacitors inside the instrument may still be charged even if the instrument is turned off.

To avoid damaging electrical parts, do not disconnect an electrical assembly while power is applied to the PAL system. Once the power is turned off, wait approximately 30 seconds before you disconnect an assembly.

The instrument includes a number of integrated circuits. These circuits may be damaged if exposed to excessive line voltage fluctuations and/or power surges.

⚠

Never try to repair or replace any components of the instrument that is not described in this manual without the assistance of a CTC Analytics representative.

There are no operator-serviceable or replaceable parts inside the power supply(ies) or in the PAL System. If a power supply is not functioning, contact a CTC Analytics representative.

⚠

The power supply for the PAL Instrument has the symbols **1/0** on the label for the power switch to switch ON/OFF.
Any additional power supply for other devices like, Cooled Stack or a Valve Module shows the symbols as shown below on the label for the power switch:

Power ON   Power OFF

The symbols shall warn the user that in a emergency case more than one power supply has to be turned OFF or more than one power cord has to be pulled from power supply or from the wall outlet to shut down the complete PAL System.

If the basic PAL System is installed, than a single power supply is installed only. Turning OFF the power supply or pulling this single power cord in an emergency case will stop the complete PAL System.

It is important that the power supply (ies) are in a location where the power ON and OFF switch is accessible and easy to operate, and where it is possible to unplug the AC power cord from the power supply/wall outlet in case of emergency.

Other Hazards

To avoid injury during PAL System operation, keep your hands away from the syringe.

Do not operate the PAL System without the safety shield. The safety shield must be installed for safe operation.

To avoid injury, observe safe laboratory practice when you handle solvents, change tubing, or operate the PAL System. Know the physical and chemical properties of the solvents you use. See the Material Safety Sheets from the manufacturer for the solvents in use.

Use caution when working with any polymer tubing under pressure:
- Always wear eye protection when near pressurized polymer tubing.
- Do not use polymer tubing that has been severely stressed or kinked.
- Do not use polymer tubing, in particular not PEEK or Tefzel tubing, with Tetrahydrofuran (THF), Dimethylsulfoxid (DMSO), chlorinated organic solvents, concentrated mineral acids, such as Nitric, Phosphoric or Sulfuric acids, or any related compounds to above listings.

Lithium battery

⚠

An onboard lithium battery buffers the electronic memories, when the instrument is turned off. Replace it only with the same or equivalent type recommended by the equipment manufacturer.
Battery: Panasonic VL 2330, soldered directly on the electronic board.
Discharged lithium batteries shall be disposed off locally according to national waste disposal regulations for batteries.

There are no operator-serviceable parts on the electronic boards.
If an electronic board fails, contact a CTC Analytics representative.

Commonly Used Symbols

⚠	Caution or refer to User Manual
	Caution, Risk of Needle-Stick Puncture
	Caution, Hot Surface or High Temperature
	Direct Current
∼	Alternating Current
	Protective Conductor Terminal, Ground
	Fuse
1	Electrical Power ON. Used with Main PAL Power Supply.
0	Electrical Power OFF. Used with Main PAL Power Supply.
⊙	Electrical Power ON for Only Part of the System. Used with Optional Device(s)
	Electrical Power OFF for Only Part of the System. Used with Optional Device(s)
	Caution, Risk of Electrical shock (high voltage)

LC PAL Operating Manual

General Information

A.   LC PAL Operating Instructions 13

B.   LC PAL Description and Installation 22

List of Figures

How to Use this Manual

The manual is divided into three major sections

LC PAL Operating Instructions Section A

LC PAL Description and Installation Section B

Appendices

The "LC PAL Operating instructions" in Section A are intended for infrequent PAL users or new users that are experienced in using automated systems to perform existing analytical methods.

note ! — **The LC PAL must be installed and set up properly before the Operating Instructions in Section A can be used.**

Users who are installing a LC PAL system, LC PAL accessories or who need to make adjustments to an installed system should consult "LC PAL Description and Installation" in Section B.

The Appendices provide useful information such as the Software Flow Chart, Definition of Terms or the LC PAL Accessories catalog.

A. LC PAL Operating Instructions

1. Using the Control Terminal

The following procedures present the key steps required to set up and process multiple groups of samples with the LC PAL. It is intended to provide an overview for new users and a reminder for infrequent users. The LC PAL and all accessories should be installed and Objects defined correctly. A Syringe of the type called for in any Method to be used should also be installed.

Figure 1 illustrates the PAL Control Terminal and the conventions used to enter, edit, and view information.
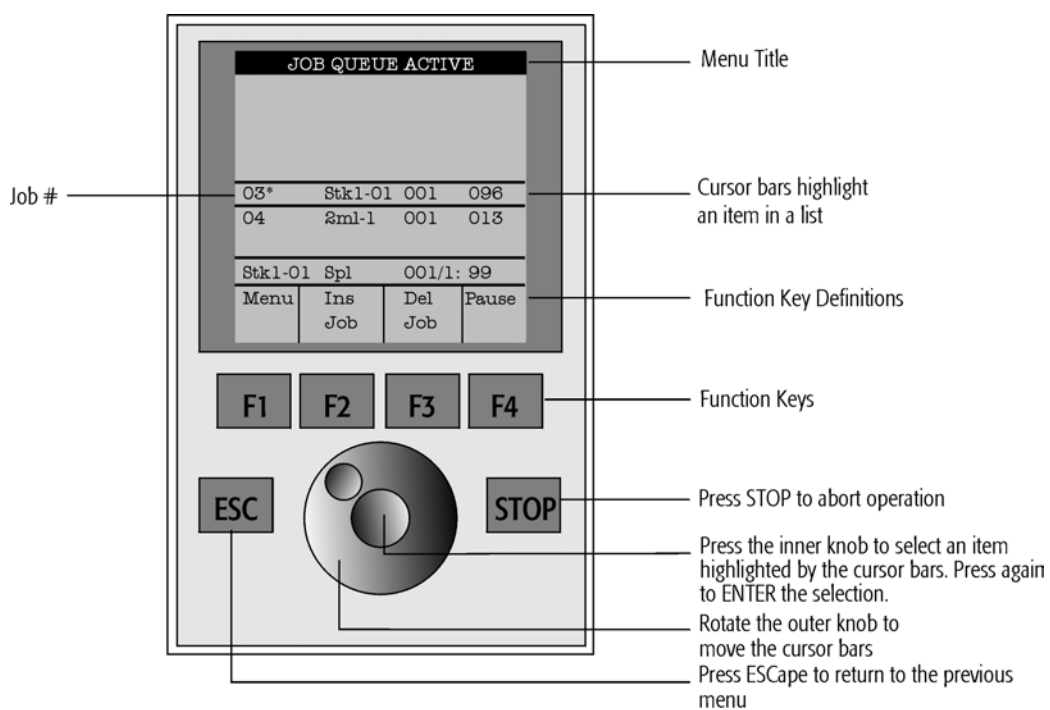
Figure 1. PAL Control Terminal and Conventions

1.1 Menu Screens

Different menu screens are displayed depending on the LC PAL operating state and the particular function being accessed by the operator. All menu screens have the same basic format. The menu title is displayed at the top of the screen. A list of items is displayed below the title. The date and time or a status is shown in the highlighted area above the Function key labels on the bottom of the screen.
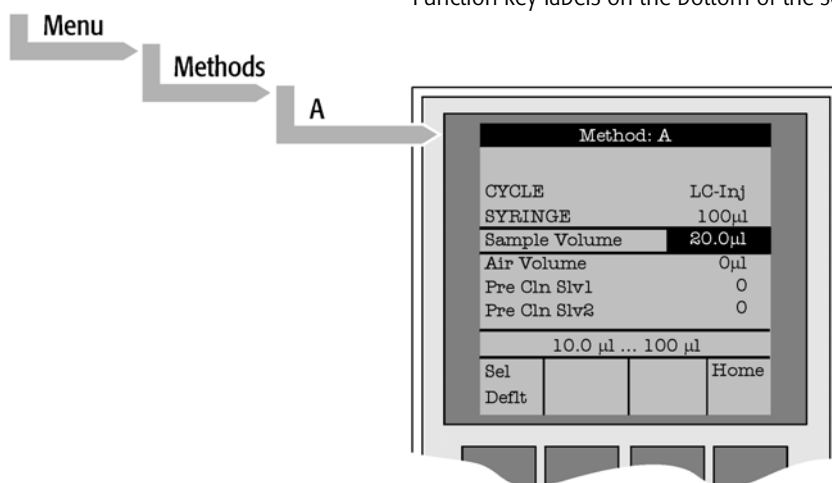
Figure 2. Accessing a Method Screen

1.2 Function Keys

Options for a particular menu are assigned to the corresponding function keys (**F1, F2, F3** and **F4**) directly below each function key label.

Pressing the function key defined as **Home** will always return to the highest level, the Job Queue menu.

1.3 ESCape and STOP Keys

Press the **ESC**ape key to return to the previous menu. Press the **STOP** key to abort the current Cycle, Job, or Job Queue.

1.4 Scroll Knob and ENTER Button

Rotate the outer knob to scroll through items in a menu list. To select a highlighted item press the central knob (ENTER button). Then use the outer knob to scroll through available options for that item or to change a numeric value. Then press the inner knob again to **ENTER** the displayed option. The inner knob is also used for other operations that require an **ENTER** operation to continue or complete an operation.

2. Methods

2.1 Creating Methods

Methods can be defined by the user and assigned names up to eight characters in length. Methods can be created, copied, edited, and viewed from the Method menu. Methods can be viewed but not edited from the Job menu.

Methods are created by either copying an existing Method or creating a new Method.

To **copy** a Method, complete the following sequence:

1
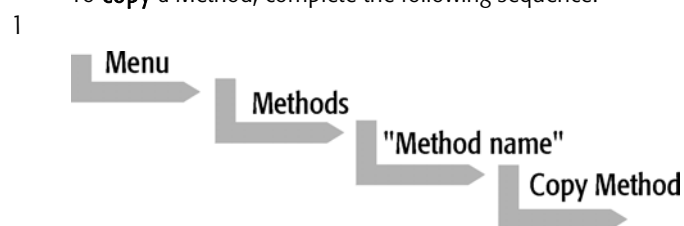
2   You will be prompted to enter a name for the new Method.

Use the scroll knob and the left-right arrow function keys (**F2** and **F3**) to select among alphanumeric characters and spaces. Press the **ENTER** function key (**F4**) to accept the name.

To **create** a new Method, complete the following steps:

1
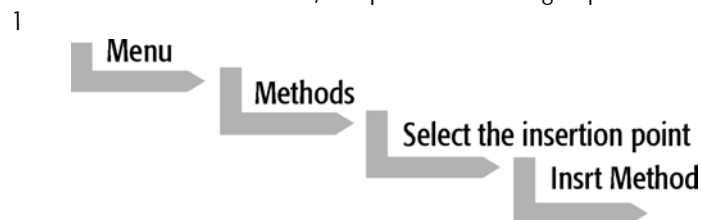
2   Assign and enter a new Method name as above.

After a copy of the Method has been created, the Method parameters will be displayed and can be edited. The Cycle and Syringe entries cannot be changed.

3   If the Method is new (i.e. added), select and enter a Cycle that is appropriate for the application.

4   Select the specific Syringe to be used by the Method.

note !

Once a Method has been created and saved, the Cycle and Syringe can not be changed. To use a different Cycle or Syringe, a new Method must be created.

5   Assign Parameter values according to the application requirements.
Consult Appendix C "LC PAL LC-Inj Cycle Parameter" for details of the specific items.

2.2 Edit / View Methods

Method parameters (excluding Cycle and Syringe) can be viewed and changed from the Method menu as follows:

1
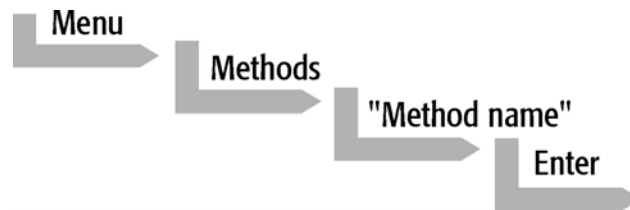
2   Scroll to and select the Parameter to be changed. Assign the new value and press the **ENTER** key.

3   Exit from Parameter List by pressing either the **Home** function key (**F4**) to return to the top-level Job Queue menu or the **ESC**ape key to return to the previous menu.

4   Method contents may be viewed from the Job Queue display by selecting the desired Job, pressing **ENTER**, and the View Method function key.

2.3 Delete Methods

Methods can be deleted from the Method menu. Methods in use by an active Job cannot be deleted. Complete the following menu selections to delete a Method.
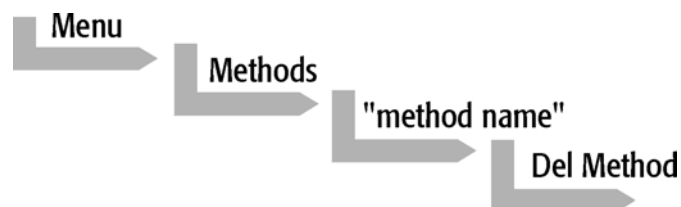
3. Job and Job Queue

3.1 Building and Starting a Job Queue

1   Power up the LC PAL. The JOB QUEUE screen is displayed.
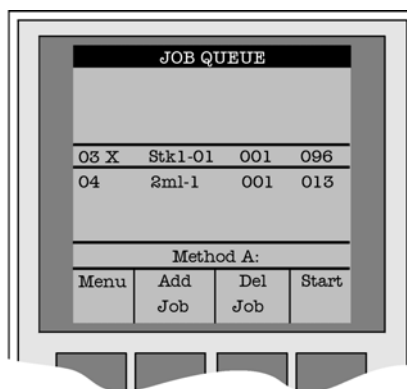
Figure 3. Example Job Queue Screen

2   Load a sample Tray onto an available location in the Tray Holder. Note the corresponding Tray name.

3   Add a new Job for the Tray. Press the **Add Job** key to bring up the default Job. Press Append or Insert (Abort)

4   For **TRAY** select the Tray Name (e.g. Stk1-01) that corresponds to the location of the Tray that was just loaded.

5   Enter the **First** and **Last** sample number for this Job.

6   Select and enter the sample processing **Method** for this Job.

7   Press the **Home** function key (**F4**) to return to the JOB QUEUE screen.

8   If necessary, replace and/or clean the Syringe. Press the **Menu** key to see the available options for changing (**F1** - **Change Syr**inge) and cleaning (**F2** - **Clean Syr**inge). To completely remove air bubbles, the Syringe should be primed manually (see chapter 8.2, page 37, "Syringe priming")

9   If only one Job will be processed, select that Job with the scroll knob. Press **Start** key. In the dialog box "Select Job(s) to Process" select one of the following options:
- **All**   (Entire Job Queue starting from the top)
- **Selected**   (Job selected with the cursor bars)
- **Resume**   (Continue with the next Job after the aborted one)

3.2 Aborting a Job Queue

1   Press STOP

2   Select one of the available options
     (**Continue, Sample, Job,** or **Job Queue**).

3   Select **Continue** to resume processing with the current sample.

4   Select **Sample** to abort processing of the current sample. Processing will resume with the
     next sample.

5   Select **Job** to abort processing of all samples in the current Job. Processing will resume
     with the next Job. The aborted Job is marked with an **X.**

6   Select **Job Queue** to abort processing of all Jobs. The JOB QUEUE screen will be
     displayed. The aborted Job is marked with an **X.**

3.3 Restarting an Aborted Job Queue

1   Press the **START** key.

2   Select the option "**Resume**". The job after the last one marked as aborted will be started.

4. Utility Functions

Utility functions, selectable from the **Menu** screen, provide quick access to checking operations and parameters that may need to be changed. These functions are available for the actual Syringe, Trays, Injectors, and Wash Stations. They allow access to key functions without having to set up and execute a Method and Job.

note ! — If an item is used in the sample processing cycle, the appropriate Utility value will be overwritten by the Method value.

4.1 Syringes

By pressing a Function Key the following functions are available:

Function Key		Description
F1	Chang Syr	The syringe is moved to a position, where the syringe assembly can be completely lowered to facilitate removal of the syringe adapter. The syringe can then be removed and replaced. A prompt will be displayed to specify the new syringe. The syringe must be installed before pressing **Enter**. (see Chapter 8 "Syringes")
F2	Clean Syr	This Function is used to clean or prime the syringe prior use. After selecting **F2** either Wash1 or Wash2 can be selected.
F3	Set Pos	Set Pos is used to define the Chang Syringe position
F4	HOME	The Injection Unit moves to its HOME position and the Job Queue Menu is displayed.

The following Syringe Parameters may be changed by selecting the particular item:

Item	Description
Actual Id	Indicates the Identification number (ID) of the currently inserted syringe. If the syringe detection system is set to manual, the extension "man" is displayed. This value can not be changed.
Fill Volume	This parameter serves to control the filling of the syringe. It may happen that air bubbles remain below the plunger after the first pull up. If the plunger is moved up and down several times (see Fill Strokes), these air bubbles are worked out. With this operation the syringe may be completely filled even when using very small sample volumes.
Fill Strokes	Number of Fill Strokes. All Fill Strokes, except the last one, use the selected Fill Volume. If the selected Sample volume is higher than the Fill Volume, the Sample Volume is used for all Fill Strokes. If zero is selected the plunger is pulled up only once using the Sample volume value.
Pullup Del	Using this item a delay time between sample pullup and ejection while filling the syringe can be selected. The same delay time is used after the last plunger pullup until the syringe needle is moved out of the sample vial/well. It is only used if more than one Fill Stroke is selected. This feature is especially useful for handling viscous fluids or syringe sizes >100µl.
Fill Speed	Speed of plunger movement used in all syringe filling operations.
Eject Speed	Speed of plunger movement used in all syringe eject operations except sample injection.
Inject Speed	Speed of plunger movement for sample injection.
Plunger Pos	Plunger position during Chang Syringe operation. The syringe plunger is moved to a position, where the syringe can be removed and replaced. The value may be changed for different types of syringes.

4.2 Tray

After selecting the particular Tray to be accessed, the following Functions are available:

Function Key		Description
F3	Movto nnn	This function serves as a quick check to determine if the XYZ coordinates are defined correctly for the selected Tray. To use this utility the selected Tray including the sample vials or Microplate must be present. After pressing "Movto 001" the Injection Unit moves to sample position no.1. This procedure can be repeated for the last sample position in the first row and the last sample position in the last row.
F4	HOME	The Injection Unit moves to its HOME position and the Job Queue Menu is displayed.

The following Tray Parameters may be changed by selecting the particular item:

Item	Description
Needle Penetr	Needle penetration depth into the sample vial. The stored default values for each Sample Tray Type are approx. 2mm above the sample vial/Microplate bottom. The needle penetration depth for the selected Tray may be changed by entering the desired value.
Tray Type	The Tray Type, which is selected for the Tray, is shown. If the Tray enables use of different Tray Types, it can be changed here. (Alternate use of Microtiter or Deepwell plates.)

4.3 Injector

After selecting the particular Injector (Valve) to be accessed, the following Functions are available:

Function Key		Description
F2	Act Valve	F2 switches the LC injection valve between the Load and Inject position. It may be used to test the valve drive function or to perform manual injections.
F3	Movto Inj	The Injection Unit moves to the injection valve position. By selecting the Parameter "Needle Penetr" on the same screen the Injection Valve Needle Penetration value may be checked or changed. (see chapter 9.3)
F4	HOME	The Injection Unit moves to its HOME position and the Job Queue Menu is displayed.

The following Injector Parameter may be changed by selecting the particular item:

Item	Description
Needle Penetr	By selecting the Parameter "Needle Penetr" the Injection Valve Needle Penetration value may be checked and/or changed. To ensure reproducible sample injection and minimize carryover it is critical that the needle penetration depth is set accurately. (see chapter 9.3 Injection Valve Needle Penetration)

4.4 Wash Station

4.4.1 Standard Wash Station

After selecting the specific Wash Station, the following Functions are available:

Function Key		Description
F3	Move to Wash	The injection unit moves to the selected Wash position.
F4	HOME	The Injection Unit moves to its HOME position and the Job Queue Menu is displayed.

The following Wash Station Parameter may be changed by selecting the particular item:

Item	Description
Needle Penetr	By selecting the Parameter "Needle Penetr" the Wash Station Needle Penetration value may be checked and/or changed. To minimize carryover it is critical that the needle penetration depth is set accurately.

4.4.2 Fast Wash Station

After selecting the specific Wash Station, the following Functions are available:

Function Key		Description
F2	Act Valve	F2 switches the selected Wash Station valve between the Open and Close position. It may be used to check the valve function or to prime the wash solvent lines.
F3	Move to Wash	The injection unit moves to the selected Wash position.
F4	HOME	The Injection Unit moves to its HOME position and the Job Queue Menu is displayed.

The following Wash Station Parameter may be changed by selecting the particular item:

Item	Description
Needle Penetr	By selecting the Parameter "Needle Penetr" the Wash Station Needle Penetration value may be checked and/or changed..
Rinse Time	"Rinse Time" may be used to expand the solvent flow time through the wash station glass liners after the last wash stroke is performed and the needle is retracted. If "Rinse Time" is set to 0, the wash station valve is closed immediately after the last wash stroke.

B. LC PAL Description and Installation

5. General System Overview
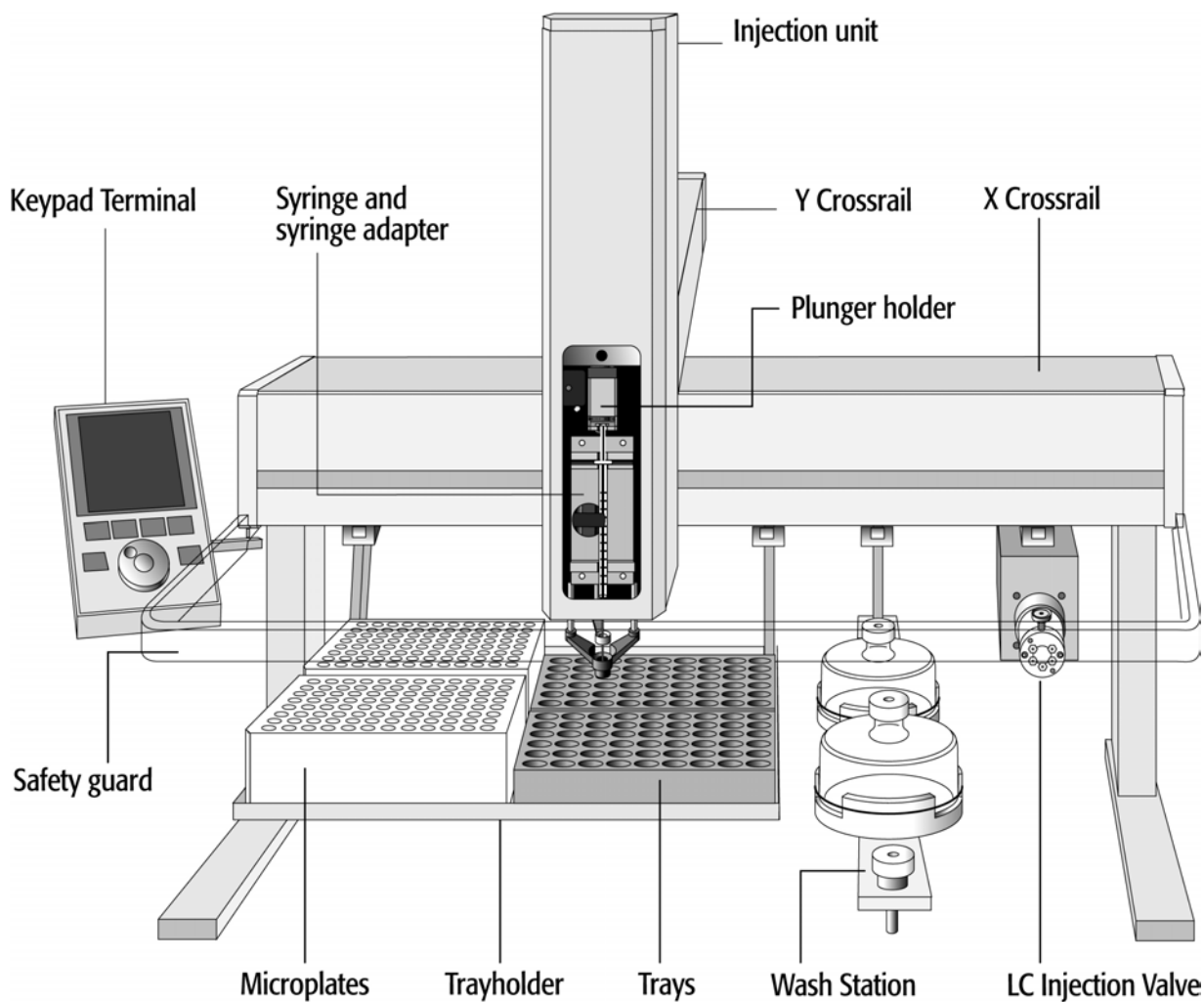
Figure 4. LC PAL - Major System Components

The LC PAL includes a 6-port LC Injection Valve and a Wash Station. The Tray Holder has a capacity for 4 Microtiter-Plates (96/384) or 4 Deepwell Plates (96/384) or 4 Trays for 2 ml vials (4 x 54).
A Fast Wash Station is optional available.

5.1 Specifications

Sample capacity	Tray Holder for up to: 4 Standard Microplates (96/384) or 4 Deepwell Plates (96/384) or 216 x 2ml vials per Tray (4 x 54)
LC Injector	Electrically actuated fast switching 6 port valve Valco / VICI Cheminert Type. Valco Type W optional available.
Syringe Sizes	10, 25, 100, 250, 1000, 2500 and 5000 µl
Standard Configuration	100 µl Syringe / 20 µl Loop
Injection volume range	from 1 µl to up to 5000µl depending on loop and syringe sizes. Down to 0.5µl with solvent sandwich injection. Down to 0.5µl with optional 4-port internal loop configuration.
Replicate injections	1 - 99 from one vial
Wash Station	2 different wash solvents
Precision	Typically < 0.5% RSD of peak area from 10µl - 100µl Typically < 1.0% RSD of peak area from < 10µl
Carryover	Typically < 0.1%
Injection cycle time	Typically 20 - 60 sec. depending on plunger speeds, injection volume and wash cycles

Electrical Specifications

Parameter	Requirement
Protection Class[a]	Class I
Over Voltage Category[b]	Category II
Pollution Degree[c]	2
Moisture Protection[d]	Normal (IPXO)

a: Protection Class I:

Protection class describes the insulating scheme used in the instrument to protect the user from electrical shock. Class I identifies a single level of insulation between live parts (wires) and exposed conductive parts (metal panels), in which the exposed conductive parts are connected to a grounding system. In turn this grounding system is connected to the third pin (ground pin) on the electrical power plug.

b: Over Voltage Category II:

Over Voltage category II pertains to instruments that receive their electrical power from a local level such as an electrical wall outlet.

c: Pollution Degree2:

This is a measure of pollution on electrical circuits that may produce a reduction of the dielectric strength or surface resistivity.
Degree 2 refers to normally only non-conductive pollution.
Occasionally, however, a temporary conductivity caused by condensation must be expected.

d: Moisture Protection:

Normal (IPXO) – IPXO means that there is NO Ingress Protection against any type of dripping or sprayed water. The X is a place holder to identify protection against dust if applicable.

Electrical Specifications (Continued)

Parameter	Requirements
PAL System	
Voltage	36 VDC
Current	3.2 A
Fuse	T6.3 A/250 V
PAL System Power Supply	
Input Line Voltage	Grounded AC, 100 to 240 V
Input Line Frequency	50/60 Hz
Input Power	4 A
Output Voltage	36 VDC
Output Current	4.16 A

Physical Specifications

Parameter	Requirements
LC PAL Systems	
Height	534 mm (21.0 in)
Depth	385 mm (14.1 in.)
Width	545 mm (13.8 in.)
Weight	8 kg 182 lbs) without accessories

Operating and Environmental Requirements

Parameter	Requirements
Operating Temperature Range	4 to 40 $^{\circ}$C (39 to 104 $^{\circ}$F)
Maximum Relative Humidity	75%, non-condensing
Bench Space	At least 16 cm (6 in.) at the rear, space for fluid waste container below the instrument and solvent containers next to the instrument. Access to power switch(es) and power cord(s). Clean, level and smooth surface. Solid bench plate.
Vibration	Negligible
Static electricity	Negligible

6. Installation

6.1 Unpacking the Components

A LC PAL system is shipped in one box. The box contains the X/Y Crossrail assembly, the injection unit, the keypad terminal, standalone supports, connecting cables, power supply, syringe kit, the tray holder, the injection valve, the wash station assembly, safety guard and miscellaneous parts.

1   First, remove the Injection Unit and the accessory boxes before attempting to remove the X/Y Crossrail assembly.

2   Remove any loose foam packing around the X/Y Crossrail. Carefully lift the X/Y Crossrail and remove it from the box. Hold the Y Crossrail in place as the assembly is removed from the box. Set the X/Y Crossrail assembly on a bench and remove the foam pieces from each end.

3   Unpack the remaining small boxes and any other containers.

4   Place the LC PAL onto a stable surface. Make sure that no objects will interfere with either the Y Crossrail or Injection Unit throughout the entire range of potential movements.

6.2 Assembling the LC PAL

Before beginning the assembly process, determine approximately where the LC injection valve and keypad terminal will be located. The terminal can be mounted on either side of the X Crossrail. As a reference see Figure 4, page 16 and Figure 10, page 22.

note !

Support the Crossrail in a suitable manner (a sturdy cardboard box can be used) before attempting to install the legs.

1   Install the legs near the ends of the X Crossrail. Loosen the Torx screws on the mounting clamps and then fit one leg into the grooves in the X Crossrail. Be sure that the clamps fit completely into the grooves. Tighten the Torx screws until the legs are firmly in place.

2   Double check if the legs and stack claws are correctly attached to the X Crossrail (see Figure 5, page 19).
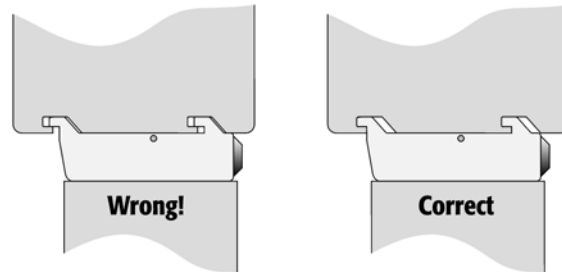
Figure 5. Attachment of Mounting Claws

Installing the Injection Unit

note ! Installation of the Injection Unit should be done carefully. When installing it for the first time, have someone hold it in place while the mounting screws are inserted (see Figure 8).
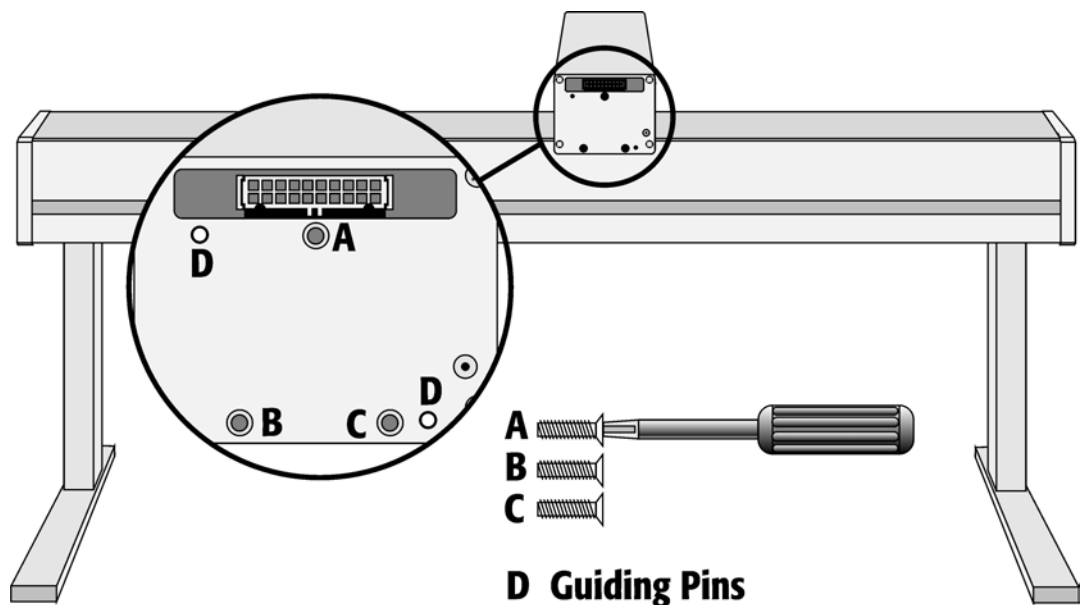
Figure 6. Attaching the PAL Injection Unit

1   Remove the 3 Torx mounting screws **A, B** and **C** that will be used to fix the Injection Unit to the Y Crossrail. Place one of the screws onto the end of the supplied Torx driver. Slide the clear plastic cover on the Injection Unit all the way to the top.

2   Connect the flat ribbon cable A protruding from the front end of the Y Crossrail to the corresponding connector on the Injection Unit (see Figure 7).
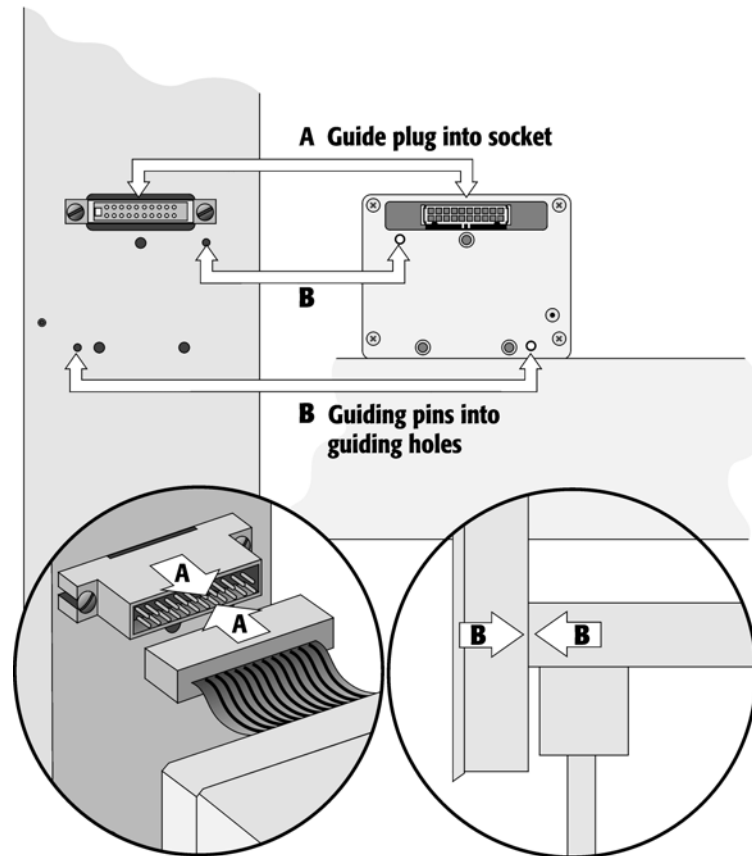
Figure 7. Connecting the Injection Unit Flat Cable

3   Hold the Injection Unit in place against the Y Crossrail. Make sure the two locating pins on the Y Crossrail fit into the two guiding pin holes on the Injection Unit.

4   Position the LC PAL at the edge of the table. The extended Injection Unit will be lower then the table surface. Extend the slider of the Z-Crossrail to the full stop. Locate the three large holes behind the flat ribbon cable, above the black anodized frame (slider) in the back-panel of the Z-Crossrail. Insert and securely tighten the Torx screw **A** (see Figure 8).
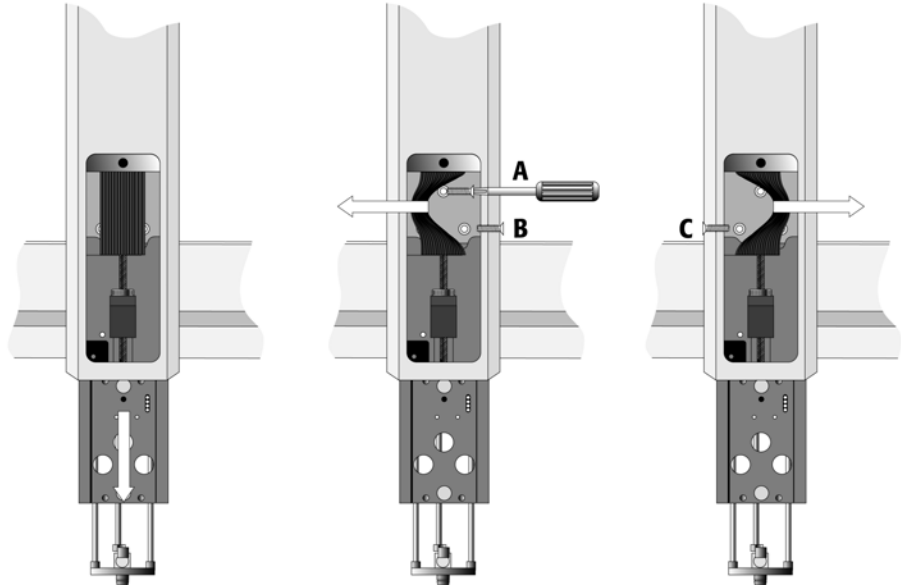
Figure 8. Inserting the Injection Unit Mounting Torx Screws

5   Install the two remaining Torx screws **B** and **C** in the left and right mounting holes, respectively. It may be necessary to move the flat ribbon cable slightly to insert the Torx screws (see figure 8).
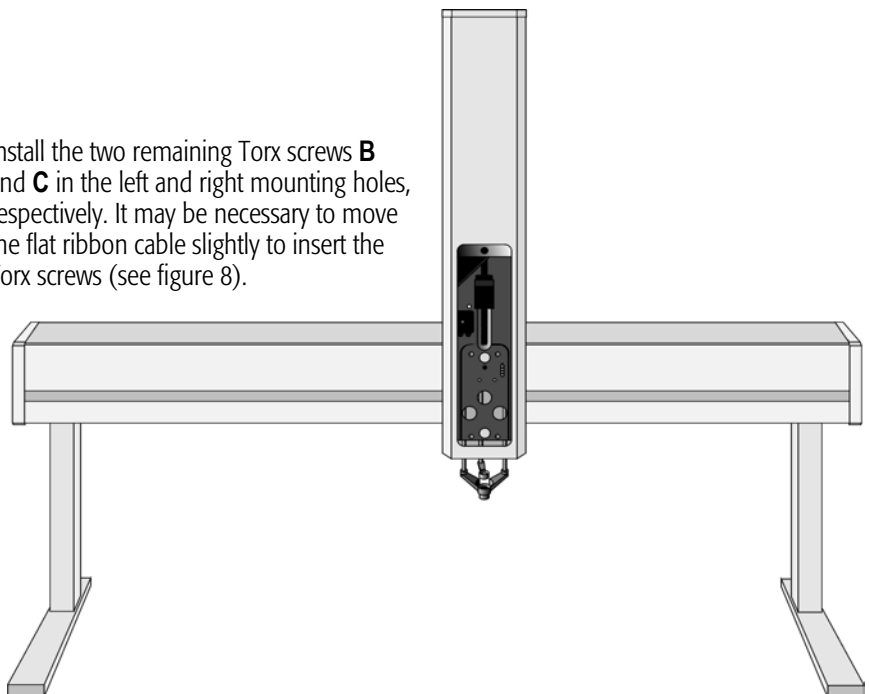
Figure 9. LC PAL with Injection Unit and Standalone Supports

Installing the Keypad Terminal and Safety Shield
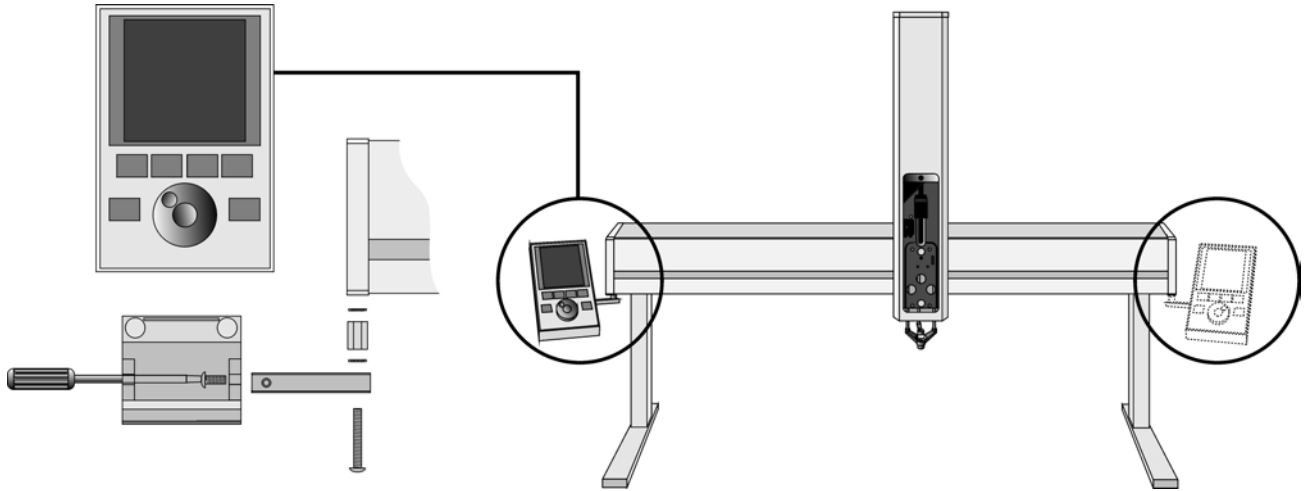
Figure 10. Installing Keypad Terminal

1   Install the Safety Shield on the left and right sides to the outside of the X-Axis.
    Use the provided longer thumbscrew on the side where you plan to install the keypad.

2   Install the Keypad mounting bracket on either the right or left side of the X Crossrail.

3   Connect one end of the white coiled cable (Part SS8J-700) to the Keypad and the other
    end to the **SER3** interface jack on the rear side of the X Crossrail.

4   Place the Keypad terminal onto it's mounting bracket.

Installing the Power Supply

1   Locate the power supply (Part MN04-00), and the AC power cable.

2   Set the power supply switch to the **OFF** position.

3   Connect the open end of the DC power cable to the **POWER** connector at the rear side of
    the X-Crossrail.

4   Connect the female end of the AC power cable to the power supply. Then connect the
    male end to an AC power outlet.

5   Set the switch on the power supply to the **ON** position.

6   Observe the Keypad display. The model name LC PAL will be displayed along with the
    software version number. The Job Queue menu screen will then be displayed.

note !   **Before proceeding with the remaining steps, switch OFF power to the LC PAL.**

Installing the LC Objects

The LC PAL system gives to the user the flexibility to install a Standard or a
Fast Wash Station dedicated for high trough-put analysis.
Installing the Objects it is advisable to observe following guidelines:

1   **Standard Wash Station:**
     Start with the installation of the injection valve at the right hand side of the X-Crossrail.
     Continue with the wash station to the left side of the valve. See Figure 4, page 16..

2   **Fast Wash Station:**
     Start with the Fast Wash Station at the right hand side of the X-Crossrail. Continue with
     the injection valve to the left side of the wash station.

3   **Tray Holder:**
     After the installation of the injection valve and the selected wash station, position the Tray
     Holder to the left hand side of the X-Crossrail.
     Note, that the Tray Holder shall not be positioned to the very left side. Shift the Tray
     Holder as far to the right side as possible. This is extremely important if one uses a 384
     position Microtiter Plate. The far left row of sample position could be out of the allowed
     range for the X-Crossrail, X-axis range: -205 / +193 mm.

Installing the LC Injection Valve

1   Locate the blue, valve drive. It will have one clamp that is identical to other object clamps. Loosen the clamp as above (see Figure 11).
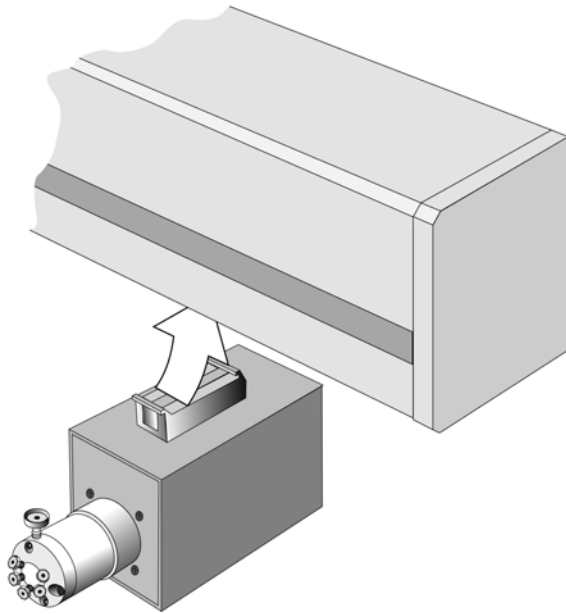
Figure 11. Installing the Injection Valve Drive

2   Attach the valve drive to the X Crossrail and tighten the mounting screw.
Note the different positions if you use a Standard Wash Station or A Fast Wash Station.
The positions and the order of installing the LC Objects are described above.

note ! ──────────────────── **To minimize void volume between sample injection point and detection, the injection valve should be located near the detection device.**

3   Connect the control cable from the valve drive to **AUX**.

4   The injection valve and rotor is pre-installed on the valve drive.

Installing the Wash Station

The LC PAL can be equipped with two different types of wash station:

1   Standard Wash Station with two wash solvent bottles and one common waste port.

2   Fast Wash Station dedicated for high throughput application equipped with two Wash solvent bottles and one common waste port.

Installing the Standard Wash Station
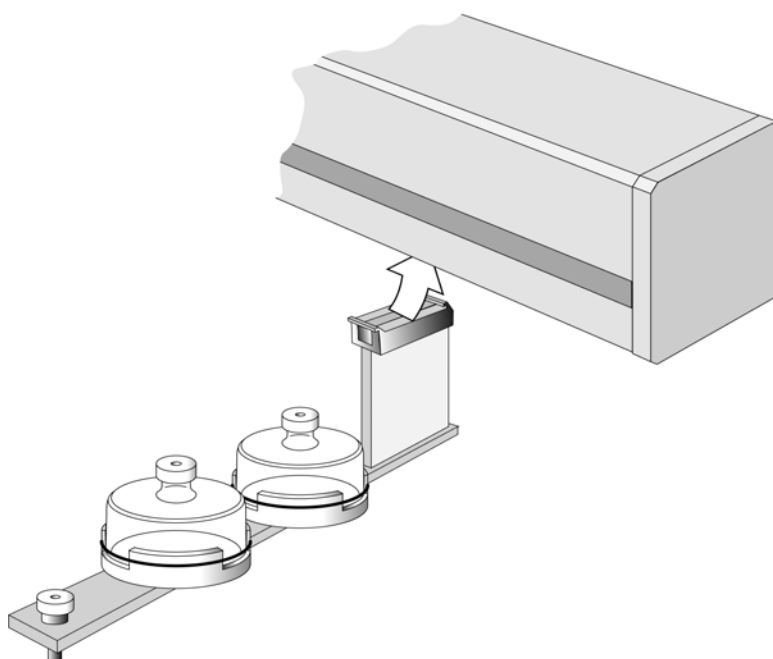
Figure 12. Installing the Standard Wash Station

1   Loosen the screw on the Wash Station mounting clamp.

2   Attach the Wash Station to the X-Crossrail as close as possible to the left edge of the injection valve.
This will minimize the time required to move between the two positions.

3   Tighten the mounting screw.

4   Place the solvent reservoir bottles onto their holders.

5   Attach one end of the supplied waste tubing to the Wash Station waste port. Place the
        other end of tubing into waste reservoir (not supplied), which is **lower** positioned than
        the Wash Station assembly. Stretch the tubing to make sure that no used wash solvent is
        trapped before the Waste Reservoir.
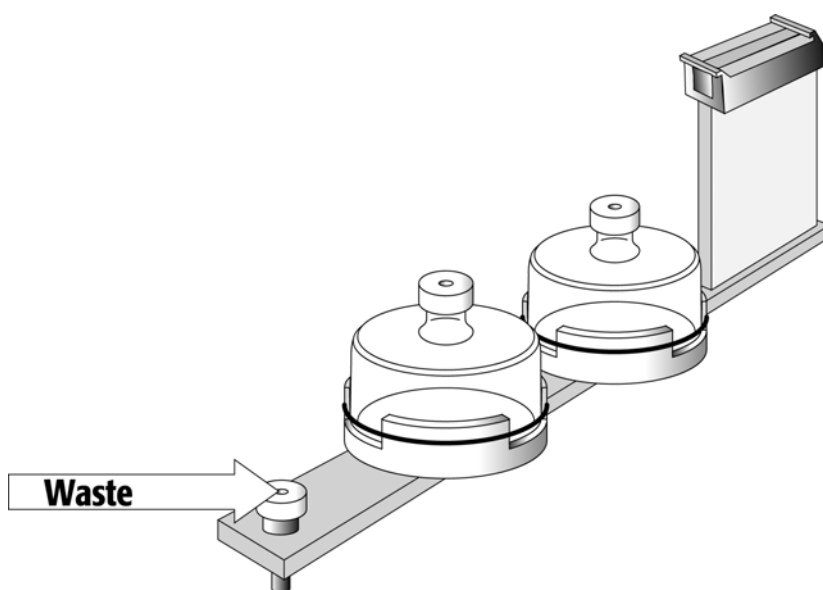
Figure 13. LC Standard Wash Station, Waste Position

note !   The waste reservoir MUST be placed in a lower position than the Wash Station
                                                    assembly.

Installing the Fast Wash Station

1   Attach the Wash Station assembly to the Solvent bottle holder.
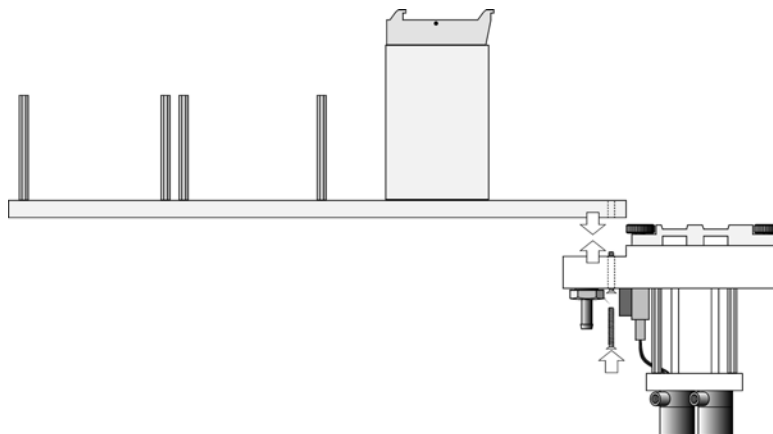
Figure 14. Installing the Fast Wash Station

2   Loosen the screw on the Fast Wash Station mounting clamp.

3   Attach the Fast Wash Station to the X Crossrail as close as possible to the right hand side of the X-Crossrail. In combination with the Injector Valve will this position minimize the time required to move between the two objects.

4   Tighten the mounting screw   .
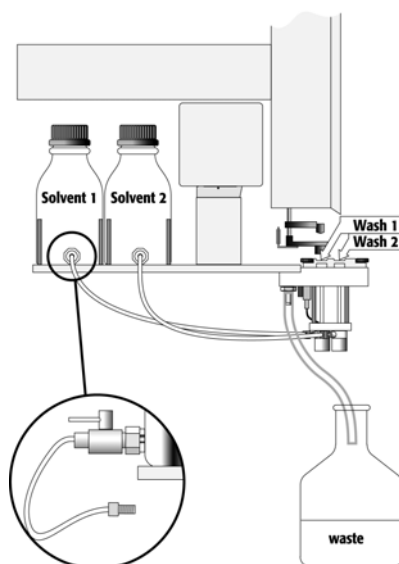
Figure 15. Fast Wash Station Assembly

5   Locate the white Teflon fittings and two lengths of Teflon tubing that connect the Wash Station valves to the wash solvent reservoirs.

6   Place the reservoirs onto their holders and attach the tubing and fittings.

7   Attach one end of the supplied waste tubing to the Wash station waste port. Place the other end of tubing into a waste reservoir (not supplied), which is **lower** positioned than the Wash station assembly. Stretch the waste tubing to make sure that no used wash solvent is trapped before the Waste Reservoir.

note !   The waste reservoir MUST be placed in a lower position than the Wash Station assembly.

8   Connect the control cable between **WASHSTATION** and the four-pronged connector located on the Fast Wash Station assembly.
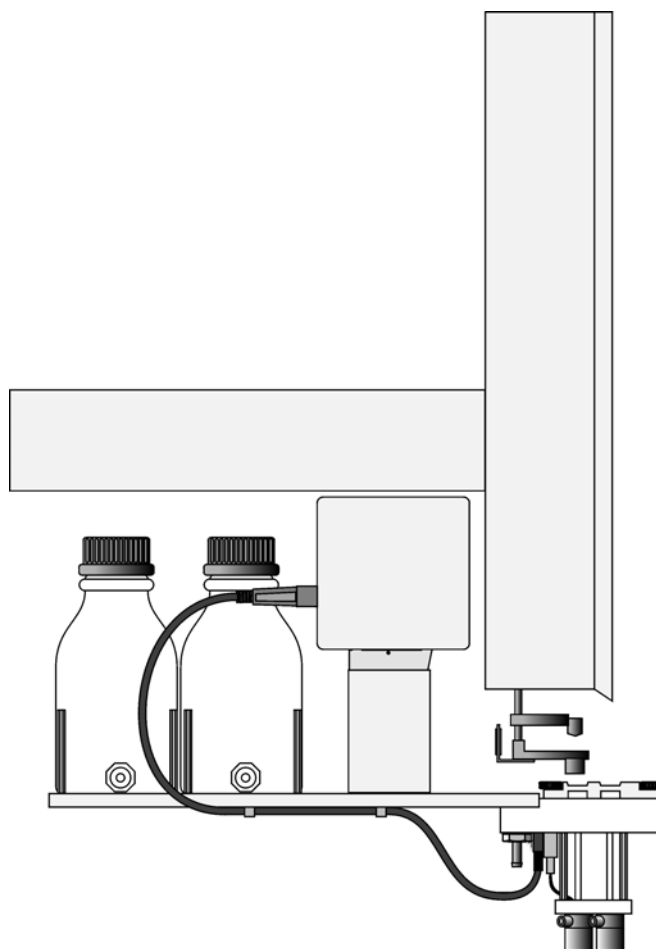
Figure 16. Electrical Connection Fast Wash Station

Installing a Trayholder

1   The Trayholder shipped with the LC PAL is a single plate designed to hold 4 blocks of Microtiter- or Deepwell-Plates or 4 Trays for 2 ml vials.
Loosen the two Torx screws on the two mounting clamps located on top of the Trayholder legs.
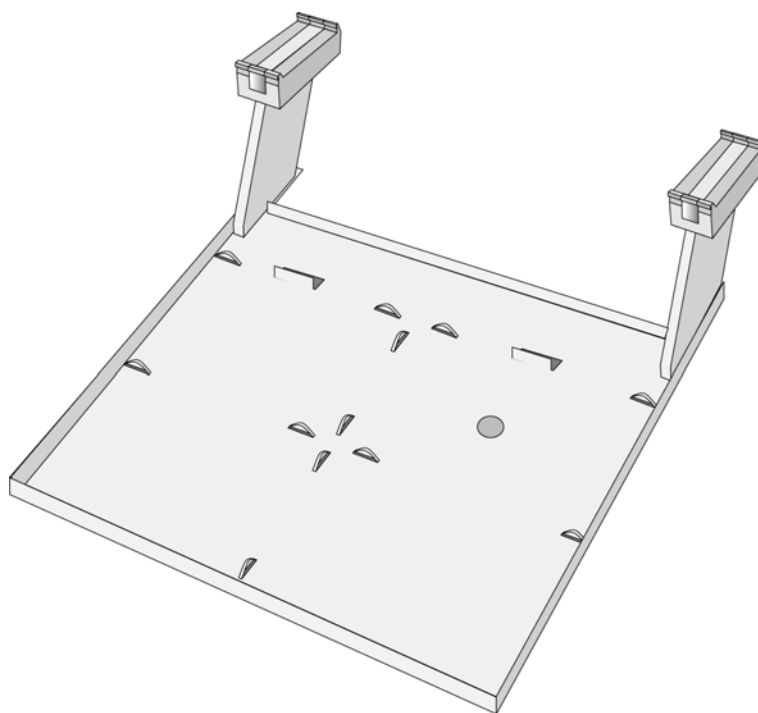
Figure 17. Installing a Trayholder

2   Install the Trayholder with the mounting clamp teeth fitting into the grooves on the bottom of the X Crossrail. The Trayholder should be at the left hand side of the X-Crossrail. For positioning see details described on page 23 (Installing LC Objects).

3   Be sure that the clamps fit completely into the grooves. Alternately tighten the two Torx screws until the two mounting clamps are firmly in place.

4   Double check if the two Trayholder clamps are correctly attached to the X Crossrail (see Figure 5).

6.3 Electrical connections

Before defining the LC PAL object positions, make sure the LC Injection Valve, Fast Wash Station and Keypad Terminal are correctly connected to the LC PAL X-axis rear side (see Figure 18).
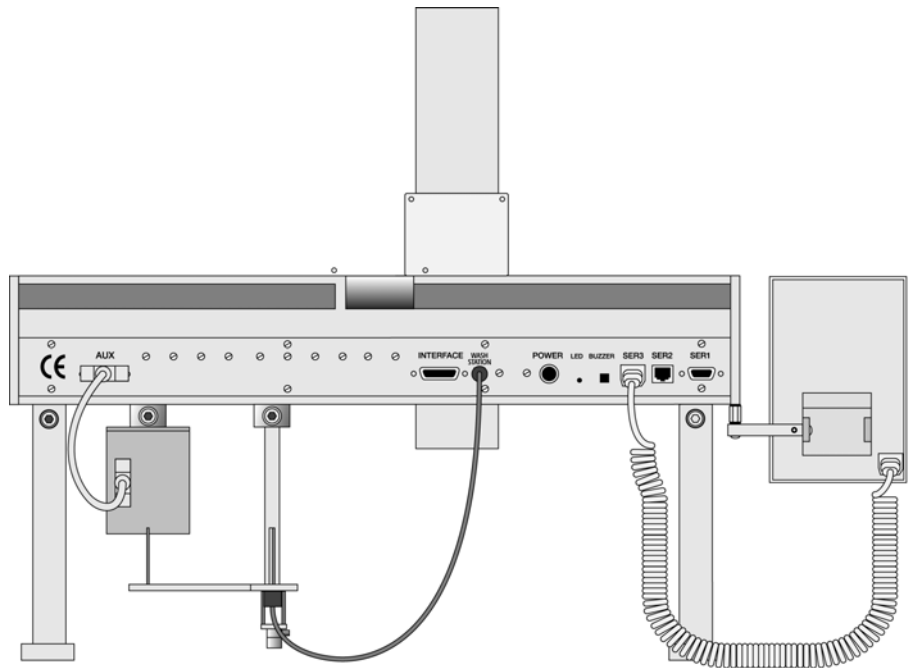
Figure 18. LC PAL Electrical Connections

note !

Always switch OFF the PAL power supply before connecting or disconnecting any LC PAL accessories cable!

Keypad Terminal	SER3 / Terminal
LC Injection Valve	AUX
Fast Wash Station	WASH STATION

7. LC PAL Object Positions

7.1 Defining Object Reference Positions

note ! —————————————— **Remove the Syringe Adapter from the Injection Unit before performing the following steps.**

The objective is to define the Reference Positions for standard LC PAL Objects. Make sure the Trayholder, Valve and Wash (Station Standard or Fast Wash Station) are properly mounted to the PAL X-axis. The following description is an example how to teach the Reference Position for a Trayholder. The described procedure is **common** to all LC PAL Objects.
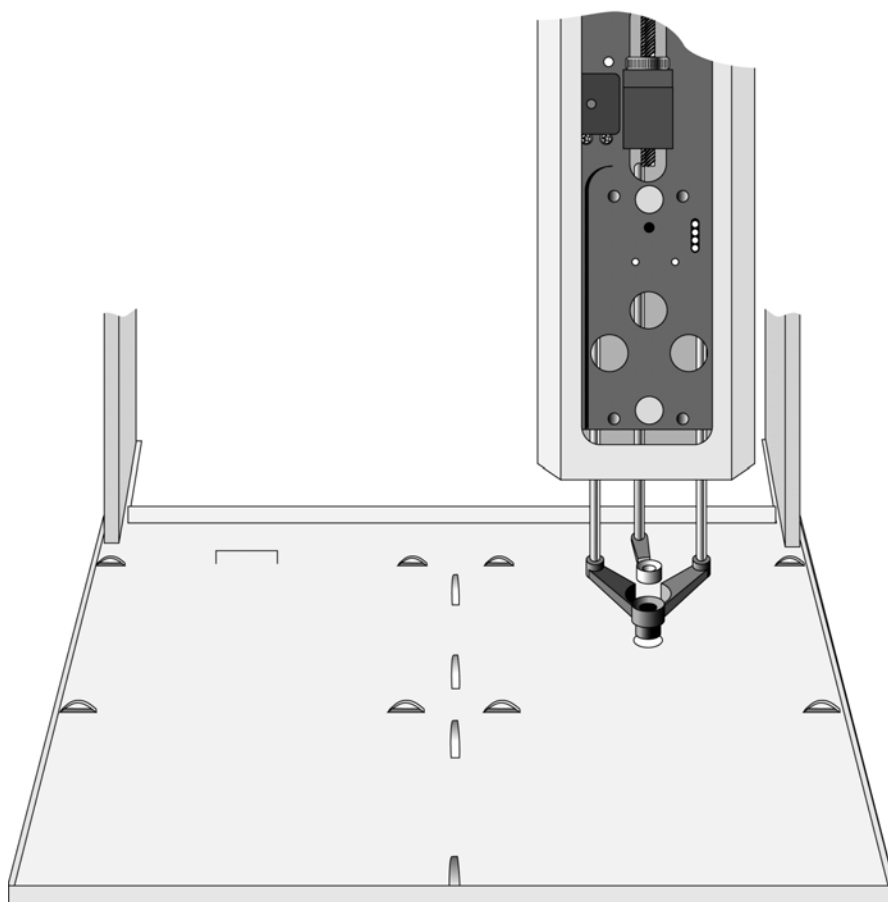
Figure. 19. Object Reference Position

For Trayholder, the **Reference Position** is a hole (slightly larger than the lower needle guide) in the base plate of the Holder. The lower needle guide should be centered in the hole with the bottom of the needle guide flush with the bottom of the base plate.

1   Switch ON the LC PAL power supply.

2   Observe the Keypad Terminal display. The model name LC PAL will be displayed along with the serial and software version number.

3   The injection unit will position itself and defines the reference points for X-Y-Z Zero-Position. The LC Injection Valve performs a position check (red LED, Standard Valve, Cheminert only).

4   When the "Job Queue" menu is displayed, complete the following sequence (common to all objects):
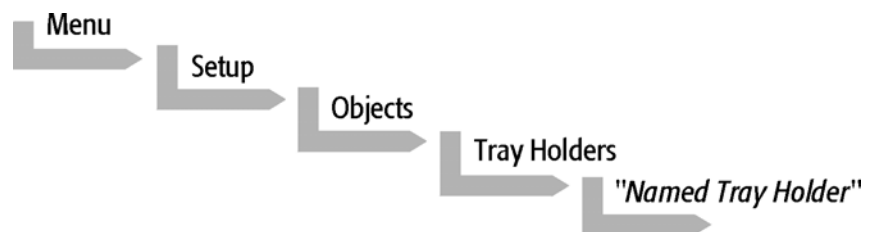
where "Named Tray Holder" represents a predefined Trayholder, THldr1.
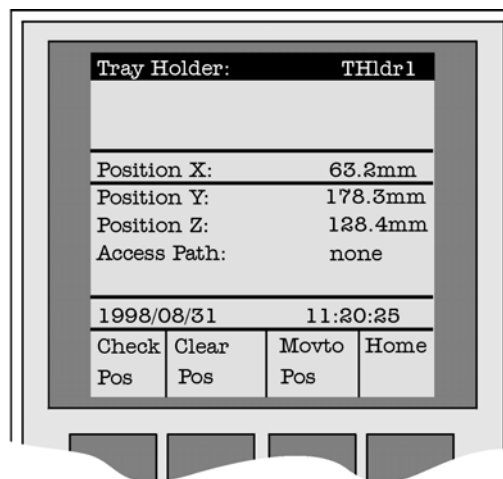
Figure 20. Menu Screen Object Trayholder

1   After selecting "Named Tray Holder", THldr1, the **X Y Z** positions for the selected object will be displayed (see Figure 20).

2   Highlight the item **Position X** with the cursor bars and press ENTER. The Injection Unit will move to the previous defined X-axis position.

3   Rotate the outer knob to adjust the X- axis position to the Trayholder **Reference Position** (see Figure19).

4   Press the inner knob to ENTER the **Position X** value.

5   Repeat steps 3-5 for **Position Y** and **Position Z**.

6   Verify the defined **X Y Z Positions** by pressing **F1** "Check Pos".

7   Press twice ESC and continue to position other objects.

note !————————————— Pressing the F3 button "Movto Zero" will move the injection unit to the Zero-Position.

7.2   Description of Object Reference Positions

Trayholder, THldr1.
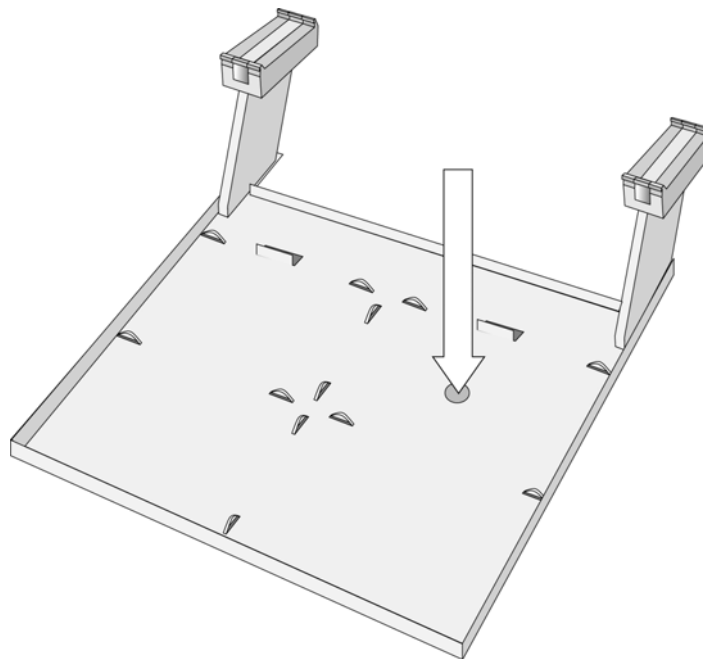
Figure 21. Trayholder Reference Position

For Trayholder, the **Reference Position** is a hole in the base plate of the Holder. The lower needle guide should be centered in the hole with the bottom of the needle guide flush with the bottom of the base plate.

Standard Wash Station (Wash1 or Wash2)
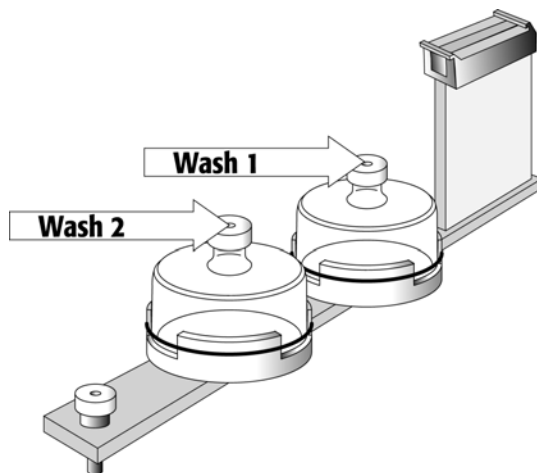
Figure 22. Standard Wash Station Reference Positions

For a Standard Wash Station the reference positions are two holes in the solvent reservoir caps (see Figure 22, Wash1 and Wash 2). The lower needle guide should be centered in these holes with the bottom of the lower needle guide slightly touching the surface of the Wash Station assembly.
Follow the path: Objects/Wash Stations/e.g. Wash1.

note !

The Waste position represents an "Injector" within the PAL software. It is defined in the Object class "Injectors" (see Fig. 24).

Fast Wash Station (Wash1 or Wash2)
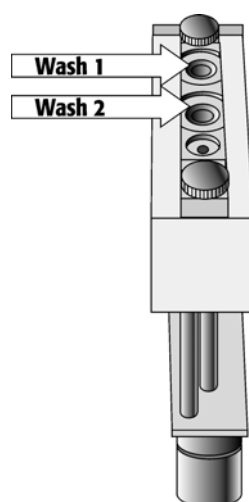
Figure 23. Fast Wash Station Reference Positions

For a Fast Wash Station the reference positions are two holes above the Wash Station glass liners (see Figure 23, Wash1 and Wash 2). The lower needle guide should be centered in these holes with the bottom of the lower needle guide slightly touching the surface of the Wash Station assembly.
Follow the path: Objects/Wash Stations/e.g. Wash).

note ! ——————————— The Waste position represents an "Injector" within the PAL software. It is defined in the Object class "Injectors" (see Fig. 24 and 25).

Injectors (e.g. LC Vlv1 or Waste)

Waste, Standard Wash Station
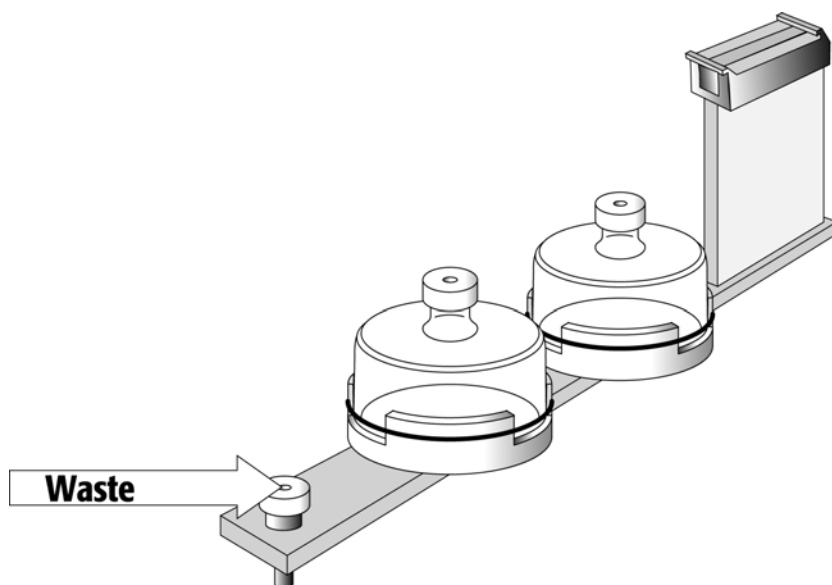
Figure 24. Standard Wash Station Waste Reference Point

For the **Waste Port** the reference position is a hole in the waste hole cap.
(see Figure 24). The lower needle guide should be centered in this hole with the bottom of the lower needle guide lightly touching the surface of the Wash Station assembly.

note ! ——————————— To adjust the Valve Needle Penetration value, see chapter 9.3.

Waste, Fast Wash Station and LC Valve
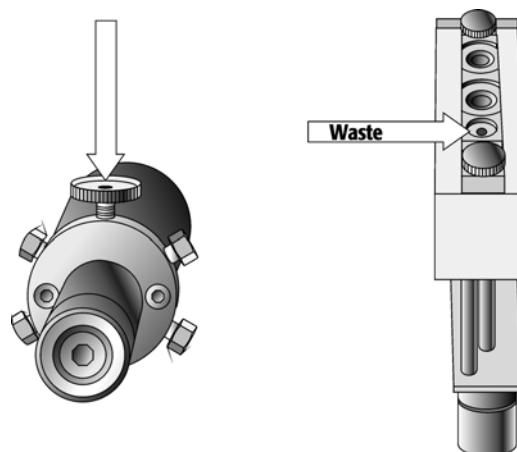
Figure 25. LC Valve and Waste Reference Position for Fast Wash Station

For an **LC Valve** the reference position is the valve needle guide fitting mounted on the top valve port (see Figure 25). The lower needle guide of the Injection Unit should be centered in the valve needle guide fitting. Adjust the Z Position that the bottom of the lower needle guide is just touching the surface of the valve needle guide fitting.
Then reduce the value by 2.0 mm.
For the **Waste Port** the reference position is a hole (slightly larger than the needle guide) in front of Wash2 (see Figure 25). The lower needle guide should be centered in this hole with the bottom of the lower needle guide lightly touching the surface of the Wash Station assembly.

note !

The LC PAL has been pre-configured at the factory with the corresponding objects, in particular with the ordered valve setting.
Positioning the reference point for the LC Valve one gets access to the Valve selection line. Do not change the settings for the Valve Type. Valve Types are explained below.
Path: Menu/Setup/Objects/Injectors/LCVlv1/Valve... .

LC PAL Valve Code	Valve Type
C2V-06-01	Standard LC PAL Valve, Valco/VICI Cheminert, 6-Port two position switching valve
DC4-1-C	Optional Valve, Valco Type W 4-Port two position switching valve
DC6-1-C	Optional LC PAL Injection, Valve Valco Type W 6-Port two position switching valve
DC-10-1-C	Optional Valve, Valco Type W 10-Port two position switching valve.

note !

To adjust the Valve Needle Penetration value, see chapter 9.3.

8. Syringes

8.1 Selecting Syringes

The LC PAL is shipped with

1 PAL SyrLC100µl	Kit LC Syringe 100µl for LC PAL, consisting of:
	1 pc syringe adapter
	1 pc plunger holder
	2 pc syringe SYRC G100-22S-3

The SYRC G100-22S-3 Syringe gastight 100µl for LC PAL, equipped with 22 gauge needles, is appropriate for injection into the standard CTC injection valve. However, certain applications may require different syringe sizes. Consult the PAL Accessories catalog in **Appendix F**.

8.2 Syringe Priming

It is critical that syringes be primed before beginning sample preparation. Prime the syringe by using the Utility function **"Clean Syr"**. For fixed needle syringes, priming may also be achieved by using an adequate number of filling strokes in a LC PAL Method. Gas-tight syringes must be primed manually. Remove the plunger and fill the syringe from the top of the barrel until solvent either overflows or forms a "bead" at the top of the syringe. Then insert the plunger.
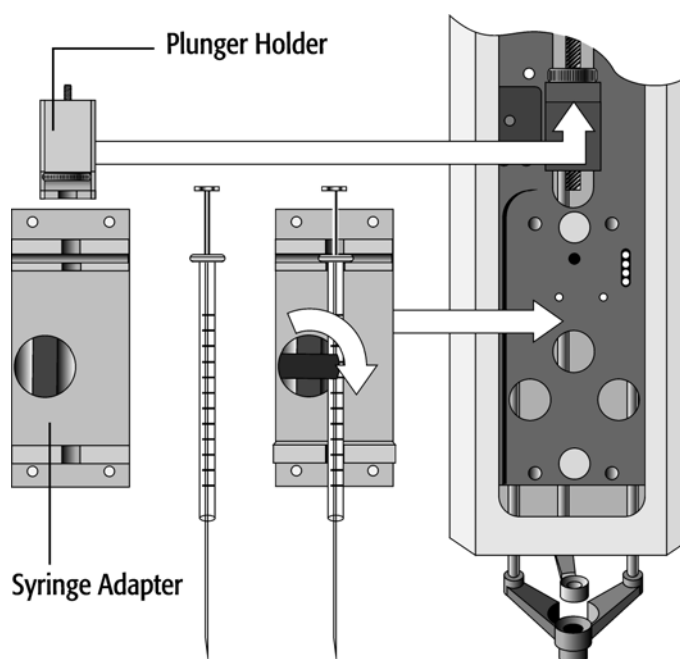
Figure 26. Syringe and Syringe Adapter

8.3 Installing a Syringe

1   Select Menu and press **F1/Chang Syr**. The Injection Unit will move to a location that will facilitate installation of the syringe.

2   Install the plunger holder.

3   Place the syringe in the appropriate syringe adapter. Make sure that the syringe scale is visible from the front of the instrument.
     Pull the plunger out to approximately 25% of it's length.

4   If necessary, loosen the plunger retaining screw in the plunger holder (see Figure 26).

5   Move the syringe, installed in the syringe adapter, partially into the Injection Unit. Guide the needle first into the upper needle guide and then into the lower needle guide. Lift up manually the lower needle guide to check the position of the needle tip.

6   Place the plunger button into the plunger holder. Allow the syringe adapter to "click" into place by magnetic force, against the syringe carrier.

7   Tighten the plunger retaining screw against the plunger button.

8   Press "Continue".
     The plunger moves down until it hits the mechanical stop. This position is stored as the syringes zero volume position. Then the Injection Unit returns to the **HOME** position.

9   Press "Home"

note ! ──────────── **After replacing a syringe, always check the needle penetration in the LC valve (see chapter 9.3, Injection Valve Needle Penetration).**
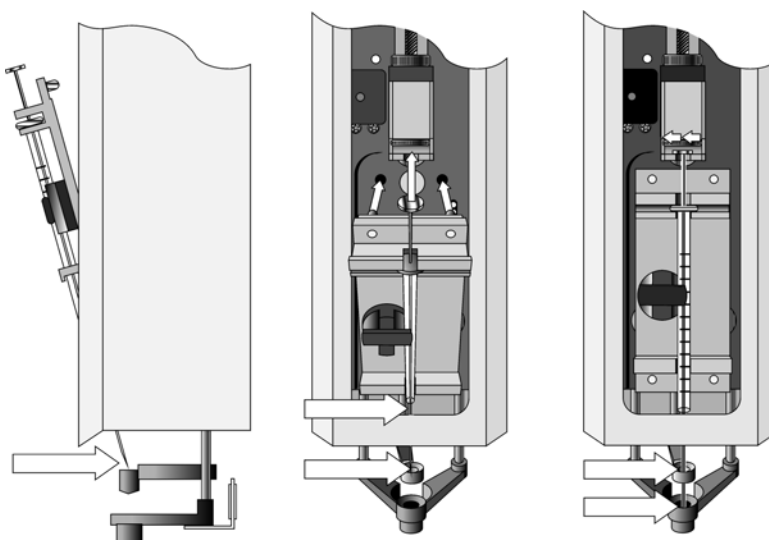
Figure 27. Installing and Removing a Syringe

8.4 Removing a Syringe

1   Select "Menu" and **press F1/Chang Syr**. The Injection Unit will move to a location that will facilitate removal of the syringe.

2   Loosen the plunger retaining screw. Move the plunger slightly out of the plunger holder.

3   Pull the syringe adapter out and then carefully up to remove the syringe adapter with the syringe from the Injection Unit.

9. Injection valve

9.1 Injection Valve Flow Path

The LC PAL can be equipped with 2 different LC Injection valves.
As a standard configuration is the Valco / VICI Cheminert Type Valve installed. On customers demand CTC Analytics can also supply the Valco W-Type valve.

9.1.1 Standard LC Injection Valve, Valco /VICI Cheminert

The 6-port valve is connected to the detection system according the flow path showed in Figure 28.
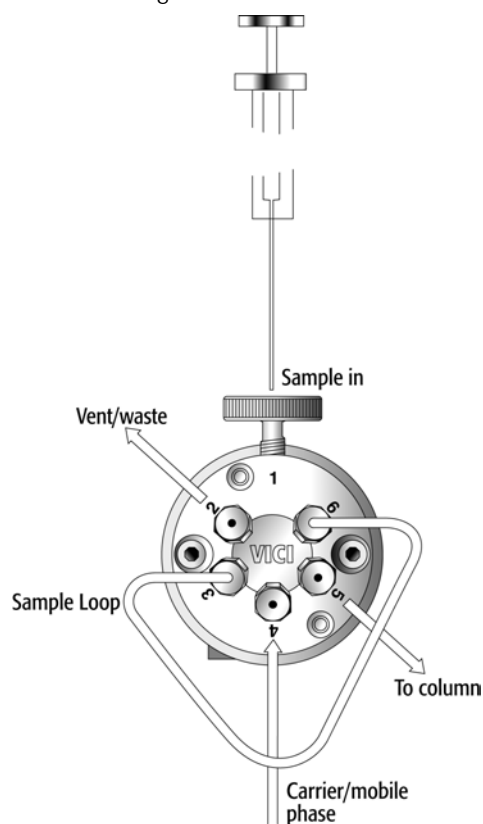
Figure 28. Standard LC Injection Valve Flow Path, Valco / VICI Cheminert Valve

The standard LC Injection Valve is a 6-port two way switching Valve with a special needle guide.

Valco / VICI Cheminert Flat Plate Rotary Valve
Stator Material: Stainless steel 316
Rotor Material: Valcon H (inert mix-ploymer)
Port Size: 1/16 inch
Fittings: Valco 1/16 inch Ferrules and Nuts
Actuator: Micro-Electric Actuator
Loop Size: 20 µl (shipped)

9.1.2 LC Injection Valve, Valco Type W
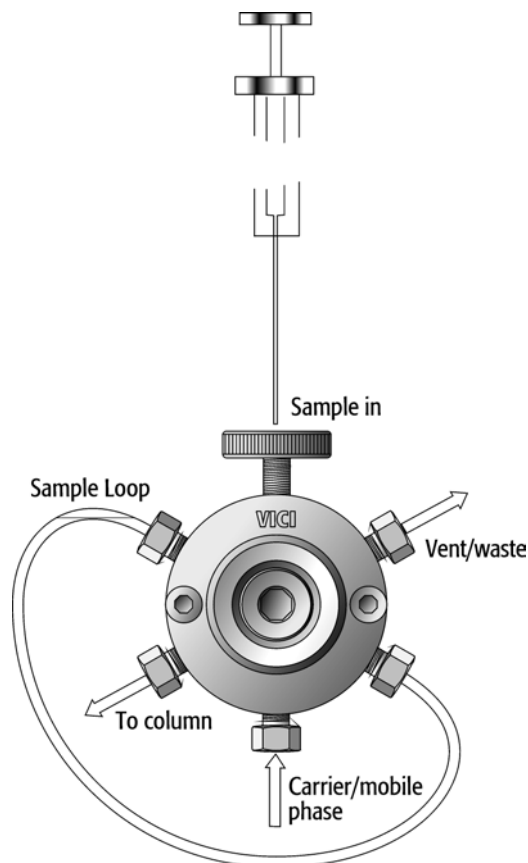
Figure 29. LC Injection Valve Flow Path for Valco Valve Type W.

The LC Injection valve, Valco Type W, Conical Rotary Valves
6-port two way switching valve with the special needle guide.

Stator Material:	Stainless steel 316
Rotor Material:	Valcon H (inert mix-polymer)
Port Size:	1/16 inch
Fittings:	Valco 1/16 inch Ferrules and Nuts
Actuator:	Micro-Electric Actuator
Loop Size:	20 µl (shipped)

note ! ────────── **Sample loops of the two different valves are not interchangeable**

9.2 Valve Needle Guide

The two valves are equipped with a special valve needle guide fitting (Part MV 30-12A). This fitting has a wide diameter to mate with the syringe needle guide on the injection unit. The valve needle guide also has a countersunk hole to facilitate insertion of the syringe needle into the injection port.
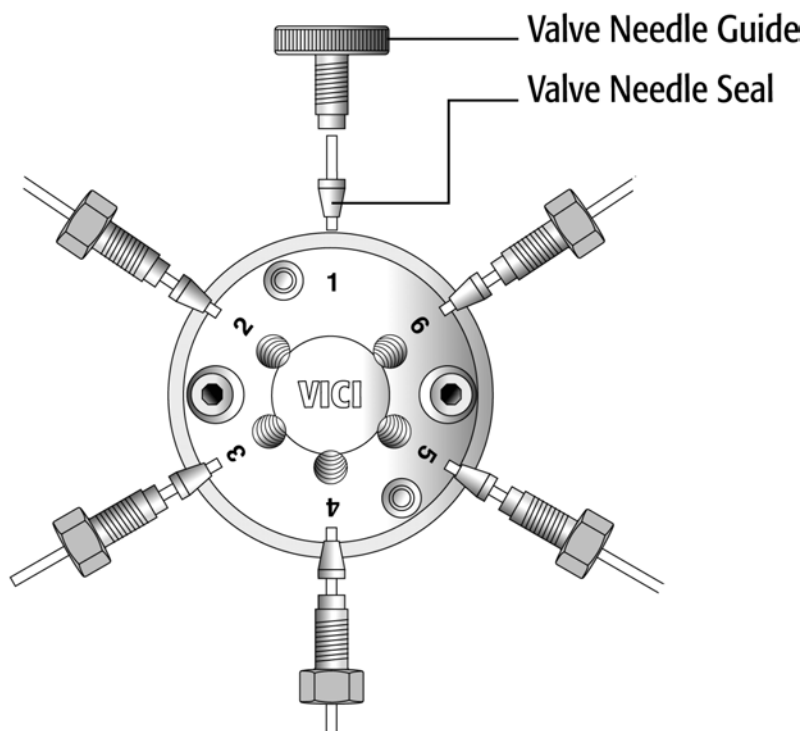
Figure 30. Valve Needle Guide and Valve Needle Seal
Example: Valco/VICI Cheminert Valve
(Needle Guide and seal for Valco Valve type W is identical).

The valve needle guide holds the needle seal. The needle seal, which is a short length of Teflon® tubing, forms the seal around the syringe needle. A stainless steel ferrule is tightened around the Teflon® sleeve to ensure a leak-proof fit.

note !

To ensure reproducible sample injection and minimize carryover it is critical that:
- The valve needle guide and the valve needle seal are installed properly.
  (P/N PAL NdlSeal, pkg 0f 10)
- The valve needle seal is changed every 1500-2000 penetrations.
- The needle penetration depth is set accurately (see chapter 9.3,
  Injection Valve Needle Penetration).

9.3 Injection Valve Needle Penetration

**Before performing the following steps, make sure the Object Position X Y Z for
LC Vlv1 is properly defined and a syringe adapter including a syringe is inserted in
the Injection Unit (see chapter 7.2 and 8.3).**

Complete the following steps to define the Valve Needle Penetration Depth:

1   In the Object Class "Injectors" choose the Object LC Vlv1. The following screen is displayed:
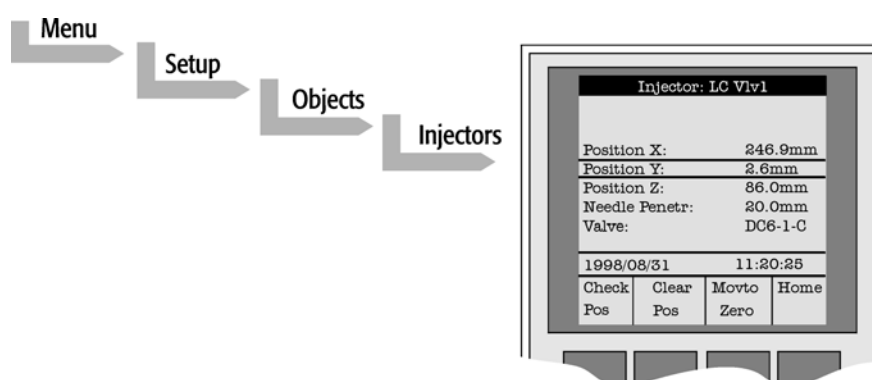
Figure 31. Menu Screen Valve Needle Penetration Depth

2   Press the **F1** button "Check Pos". The Injection Unit moves to the previous defined
LC Vlv1position.

3   Highlight the item **Needle Penetr:** with the cursor bars and press ENTER.

4   **Slowly** rotate the outer knob to adjust the Needle Penetration Depth. The syringe moves
down stepwise into the Injection port.

5   When the syringe needle tip enters the valve needle guide, **slow down** the Z movement
again. Always observe the syringe needle during this operation step.

6   Move single step wise down until you notice a **"click"** sound inside the Injection Unit.
STOP immediately the Z down movement.

7   Rotate the outer knob **two steps** (0.2 mm) in the opposite direction and press **ENTER**
to save the Needle Penetration Depth value.

8   Press **F3** "Movto Zero".

9   Verify the defined Needle Penetration Depth value by repeating Step 2 and 3.

**After all positions have been set and the Valve Needle Penetration has been adjusted
perform a backup of the existing configuration. (see Chapter 11 PAL Loader Program)**

10. Interfacing the LC PAL to Other Devices

10.1 Synchronization and Output Signals

Synchronization Signals **(Sync Signals)** are inputs that tell the LC PAL when to wait or proceed with a sample processing step. Output Signals **(Out Signals)** are sent from the PAL to external devices to indicate status or completion of particular processing steps. These signals are classified as Objects. Physical Events (e.g.TTL-In1) are also Objects and may be assigned to named signals. PAL Cycles require that certain signals such as **"Start"**, **"Inject"**, and **"Injected"** be defined. See Table below for the PAL Events and signal assignments associated with the standard PAL **"LC-Inj"** Cycle.

To assign a physical Event (e.g. SW-Out 1) to an existing signal Object ("Injected") complete the following menu selections:
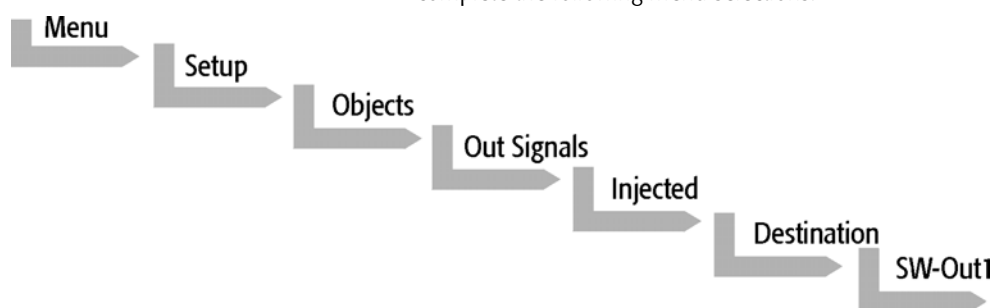
PAL's are shipped with all Cycle events pre-defined as shown in the table below. If a different physical signal needs to be used, then it will be necessary to assign a new Event to the signal Object.

If a signal is to be ignored, then it's corresponding Event must be set to **"Immediate"**.

Standard Assignment for LC PAL Injection Cycles		Description	Default Events	INTERFACE Pin #
Start	(Sync Signal)	Start a cycle (Input from LC or data system)	Immediat	7 8(GND)
Inject	(Sync Signal)	Inject READY to INJECT	Immediat (Ignore)	
Injected	(Out Signal)	Is activated at the moment when the sample has been injected	SW-Out1	3 4
Running	(Out Signal)	Active as long as the Job Queue is being processed and the PAL is not in an error state	Off	

note ! — After completing the installation procedure for the LC PAL system the synchronization of the remote signal has to be configured, e.g. change the Event "Start" to : TTL-In1. Check the complete system for synchronization of the READY Signal from the slave-system.

11. PAL Loader Program

The following procedures require a PC with Windows 95/98/NT/2000/XP Operating System, the supplied PAL Loader program (Version 1.1 or higher), the supplied gray cable (Part RS9B-3000), and the correct version of the PAL firmware to be loaded.

11.1 Backing Up the PAL Control Program

note !

The following procedure should be performed after the installation of a new PAL System is completed. Furthermore, periodically System backups ensures that an updated configuration of the PAL is available any time.

Recommended practice is to create the following directory structure to store PAL firmware updates and backups:

Directory Path	Contents
C:\ProgramFiles\PAL\Loader\Backup\	Full backup files of current and previous PAL configurations; includes firmware and parameter settings; maintained for archival purposes
C:\ProgramFiles\PAL\Loader\Update\	Extracted "Update" files in Loader format (*.sss); may include firmware only or firmware and parameter settings

1   Shut off power to the PAL and the computer. Connect the supplied gray cable between the PAL **(SER1)** and a PC serial port.

2   Switch on power to the PAL. When the PAL Job Menu is displayed, start up the computer.

3   Double-click the PAL Loader icon, the PAL Loader screen appears.

Figure 32. PAL Loader Menu Screen

4   Click the "Backup" button. A dialog box entitled "Backup Target Memory" will be displayed. The path (storage location) and file name to be assigned to the new backup will be shown. A customized path and/or filename may be entered.
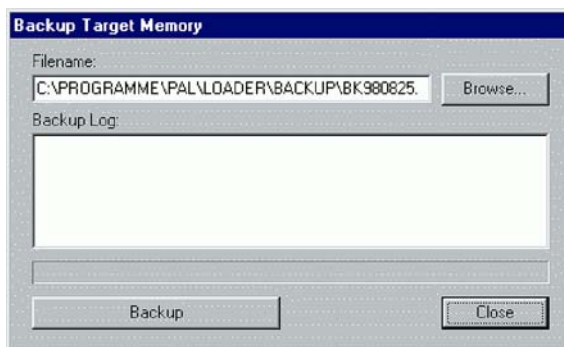
Figure 33. PAL Loader Backup Target Memory

5   Click the "Backup" button.

6   Backup will proceed and information on the backed up components will be displayed in the "Backup Log:" window. The process will take several minutes. The message **"Backup of Target Memory succeeded"** indicates a successful backup.

7   Click the "Close" button to exit the "Backup" dialog box. Click the **"Start PAL"** button to terminate control by the Loader program. On the Keypad terminal, the Job Queue screen is displayed.

8   Disconnect the RS-232 cable from the PAL.

11.2 Reloading a Backup

note !

This operation can potentially overwrite existing parameter settings.
Methods created by the user will be lost.

The firmware file to be loaded must reside on the PC hard drive. The file cannot be loaded from a floppy drive. A full update (including parameter settings) will not fit on a single floppy diskette in the PAL Loader format. It must be transferred to the PC hard drive in compressed (*.zip) format and extracted into the "*.sss" file, which is the PAL Loader format.

Complete the following steps to reload a PAL backup:

1   Shut off power to the PAL and the computer. Connect the grey null modem cable between the PAL (SER1) and a PC serial port.

2   Switch on power to the PAL. When the PAL Job Menu is displayed, start up the computer.

3   Double-click the PAL Loader icon, the PAL Loader screen appears.

4   Click the "Update" button.

5   Click the "Browse" button and select the appropriate .sss backup file.

6   Click the "Open" button. The "Update Flash Memory" window will be displayed. The path and filename for the update file will be shown in the "Filename:" entry box.

7   Click the "Update" button to load the new firmware. The process will take several minutes. If the update is successfully completed, the message. **"Update of target memory succeeded"** will be displayed.

8   Click the "Close" button to exit the "Backup" dialog box. Click the **"Start PAL"** button to terminate control by the Loader program. On the Keypad terminal, the Job Queue screen is displayed.

9   Disconnect the RS-232 cable from the PAL.

12. Troubleshooting

The LC PAL represents always one of several components in a chromatography system. The following Troubleshooting Guide is limited to the LC PAL only.

Symptom or Error Message	Possible Cause	Recommended Action
No or very low detector signal is observed.	The valve needle guide and / or needle seal are not properly installed.	Check valve needle guide and seal (see chapter 9.2, Valve Needle Guide).
	The valve ports are not plumbed correctly to the pump and/or detection system.	Check plumbing connections (see chapter 9.1, Injection valve flow path).
	Wrong valve type specified.	Check valve type by pressing Menu/Setup/Objects/Injectors/ LC Vlv1/Valve.
	Clogged syringe.	Remove syringe and aspirate/dispense liquid manually. Clean syringe.
	Bent needle.	Inspect and/or change syringe.
	No sample liquid is injected.	Check and/or adjust Needle penetration into sample vial (see chapter 4.2).
	Sample volume too low.	Increase sample volume.
Mobile phase and/or sample flows out of the wrong ports on the LC injection valve.	The valve rotor is reversed (180° out of alignment).	Remove the rotor and reinstall in the correct position. Look for a letter (e.g. "H") stamped on the rotor. The letter must be on the lower half of the rotor (see chapter 13.2., Valve Rotor).
Sample is backing up on the valve needle guide.	Syringe needle OD too small.	Check the syringe needle for gauge 22.
	Valve needle seal leaks.	Change Valve needle seal (see chapter 9.2, Valve needle Guide).
	The needle penetration depth for the injection valve is not set correctly.	Adjust the Injection Valve Needle Penetration (see chapter 9.3).
	The Syringe Plunger Speed is too high resulting in excessive pressure in inlet.	Reduce Inject Speed in method.
Poor reproducibility	Syringe pressure differences when filling the syringe.	Increase Pullup Delay value.
	Vacuum created in sample vial.	Reduce sample volume in sample vial.
	High volatile solvent.	Use gastight syringe and sample tray cooling. Increase Pullup Delay value. Reduce Filling Speed in method.
	Not properly crimped vials.	Check vial cap by attempting to rotate by hand. Loose caps may cause selective loss of lighter components from sample. Adjust crimping tool correctly

Excessive carryover between samples	Dirty syringe and/or valve injection port.	Increase Pst Inj Slv1 and or/ Vlv Cln Slv1 values in method. Use PreClnSlv1 and PreClnSpl.
	Waste tubing I.D. at Injection valve is too small causing waste liquid to be pulled back, by capillary action, into the rotor groove.	Replace the waste tubing with larger I.D. tubing.
	Damaged or grooved valve rotor.	Replace valve rotor (see chapter 13.2, Valve Rotor).
	Valve needle seal leaks. Inappropriate wash solvent.	Change Valve needle seal (see chapter 9.2, Valve needle Guide). Use appropriate wash solvent.
Unexplained chromatographic peaks	Air is being introduced into the injection loop. Needle penetration depths may be inadequate causing air to be pulled into syringe.	Check and/or adjust Needle Penetration into sample vial (see chapter 4.2). Make sure the "Air Volume" Method parameter is set to zero.
First Injection of a series shows a higher concentration	The syringe was not primed before the first injection	Use the Utilities Function to prime the syringe. (see chapter 4.1).
Unexplained collisions of the Injection Unit	Object(s) not defined correctly.	Define Object(s) correctly (see chapter 7.1, Defining Object Positions).
Error Message "Object" Not Detected (Object e.g. Tray1, LCVlv1)	Incorrect Z value for the affected Object (e.g. LC Vlv1 or Tray1).	Redefine Z value for the affected Object (see chapter 7.1, Defining Object positions).
	Missing sample vial Deepwell or Microplate.	Insert sample vial, Deepwell or Microplate.
Error Message "Object" Collision before Z Tolerance ("Object" e.g. Tray1, LCVlv1)	Incorrect Z value for the affected Object (e.g. LC Vlv1 or Tray1).	Redefine Z value for the affected Object (see chapter 7.1, Defining Object positions).
Error Message Motor AUX failed	Injection valve drive not connected.	Switch OFF PAL and check connection between PAL and LC Vlv1 (see chapter 6.3).
	Defective LC Vlv1 Connection cable	Change connection cable
	Control Board defective.	Replace Control Board (see chapter 13.1, Control Board).

13. Replacing Parts

13.1 Control Board

1   Follow the sequence shown in Figure 34 to detach and release the Control board from its position inside the X Crossrail.

2   Carefully pull the two flat cable connectors upwards to free from the board.

3   Install the replacement board in the reverse order.

note ! **After reconnecting the two flat cables to the board ensure that the cables are folded flat and can be slid inside the cross-rail without damage.**
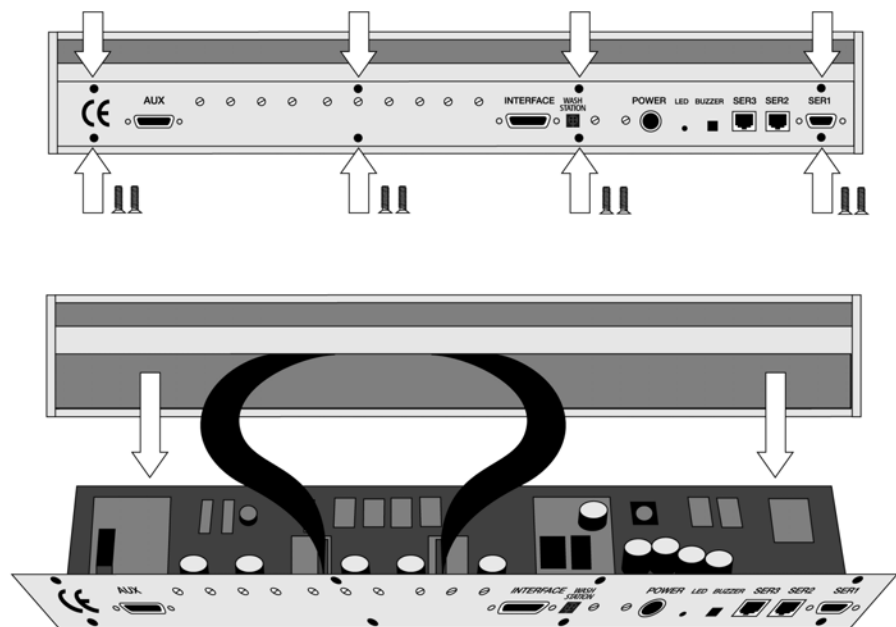
Figure 34. Replacing Control Board

13.2 Injection Valve and Valve Rotor

13.2.1 Standard LC Injection valve
Valco /VICI Cheminert, Flat Plate Rotary Valve.

To replace and/or clean the Cheminert injection valve follow the steps as shown in Figure 35.
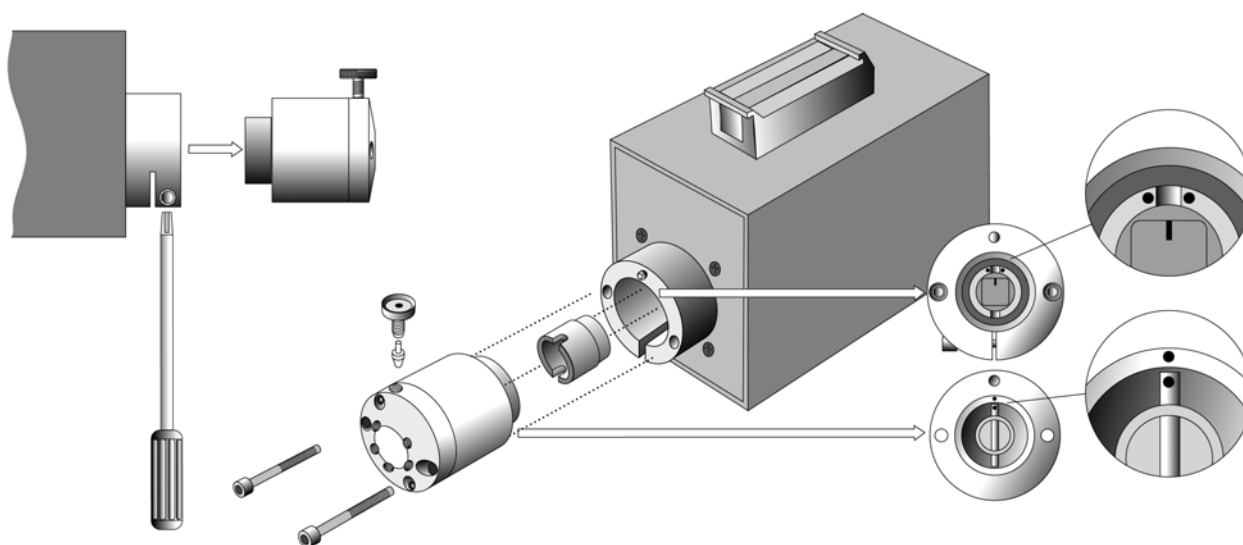
Figure 35. Replacing the Standard LC Injection Valve, Valco/VICI Cheminert

1   Remove the sample loop, needle guide fitting and connection tubes from the valve body.
    See Figure 35, left picture.
    (It is a good practice to label the connection tubes before removal.)

2   Unscrew to the hex screw, which holds the valve to the valve drive

3   Check that the valve guiding pin remains at it's position

4   Install the replacement valve in the reverse order

Valve Rotor LC Standard Valve
Valco/VICI Cheminert, Flat Plate Rotary Valve

To replace and/or clean the Cheminert valve rotor follow the steps shown in Figure 36
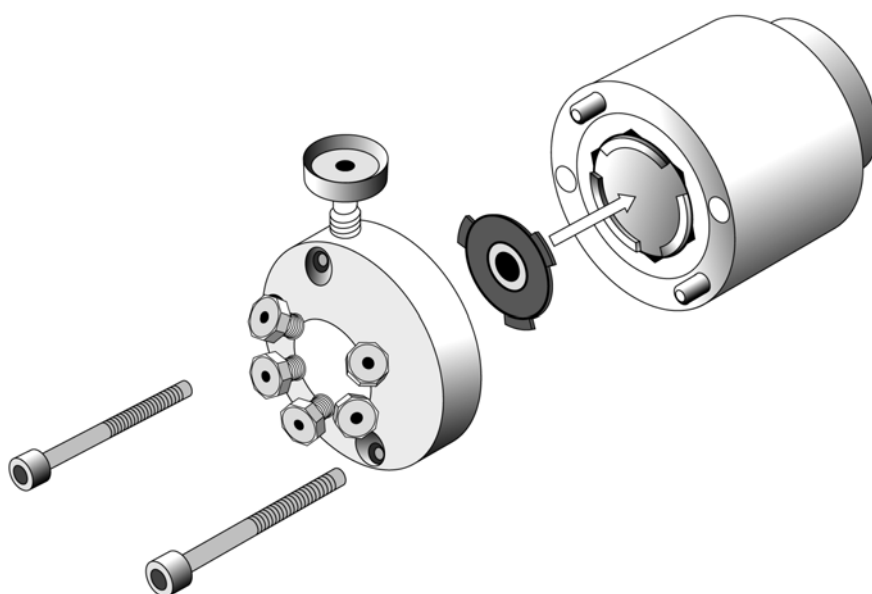
Figure 36. Replacing Cheminert Valve Rotor

1   Unscrew the two hex screws retaining the stator.

2   Remove the old rotor with an appropriate tool.

3   If necessary clean the surfaces without scratching the metal parts.

4   Insert the new rotor, press the polymer disk carefully into position.

5   Put the stator back on, tighten the two hex screws.
     The valve is ready for use at the factory-set pressure.

note !

In the event of damage of the stator, replacements or factory refinishing are available.
The rotor material is Valcon H for HPLC use. The type of material is not marked on the valve.

13.2.2 Valco Injection Valve Type W

Conical Rotary Valve

To replace and/or clean the injection valve follow the steps shown in Figure 37.
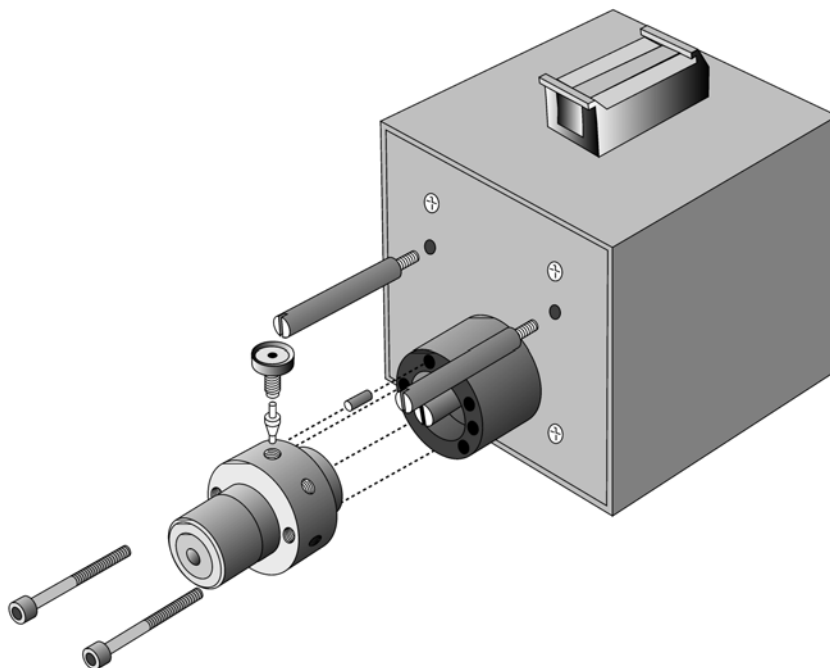
Figure 37. Replacing the Injection Valve, Valco Type W

1   Remove the sample loop, needle guide fitting and connection tubes from the valve body.

2   Unscrew to the hex screws, which hold the valve to the valve drive

3   Check that the valve guiding pin remains at it's position

4   Install the replacement valve in the reverse order

Valve Rotor

To replace and/or clean the valve rotor follow the steps shown in Figure 38

Enlargement from the back
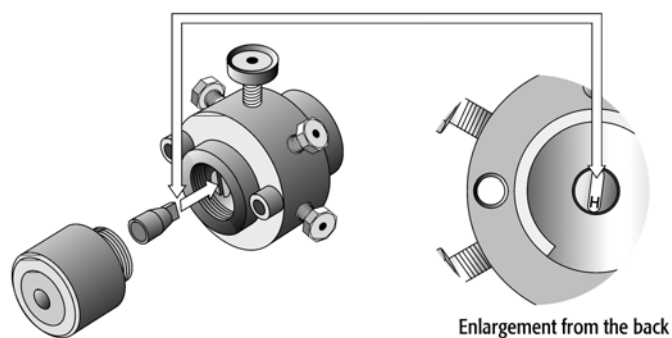
Figure 38. Replacing Valve Rotor for Valco Type W

1   Do not remove the valve from the valve drive or any tubing or the loop

2   Unscrew the knurled pre-load assembly. Do not tamper with the preset socket adjustment screw.

3   Engage the end of the rotor with a magnet or a pair of tweezers.

4   Locate the letter (e.g. "H") stamped on the new or cleaned rotor and orient the letter to the lower half of the valve.

5   Insert the new rotor. Make sure the rotor tab fits into the slot in the valve drive.

6   Replace the knurled pre-load assembly.

7   Tighten the pre-load assembly. It must end up fully bottomed-out.

note !   **The loops and other parts of the two different valves are not interchangeable**

13.3 Injection Unit

Follow the sequence of steps shown in chapter 6.2 Assembling the LC PAL.

13.4 Wash Station

Follow the sequence of steps shown in chapter 6.2 Assembling the LC PAL.

14. Maintaining the PAL System

Regularly performing maintenance helps ensure accuracy and precision of the PAL System. Suggested intervals for maintenance procedures to ensure uninterrupted operation are given below.
If you use the system heavily (for example, nights and weekends), or if you use aggressive solvents, you may need to perform the maintenance procedure more frequently.

Maintenance Step	Interval
Clean the outside of the instrument. Use only a soft lint-free paper or cloth dampened with mild soap and water.	Weekly or as needed
Clean Instrument, syringe and surfaces	Weekly or as needed.
Replace the valve needle seal	Every 1500 to 2000 penetrations (Check the tightness of the needle in the needle seal)
Replace the valve rotor	Replace the valve rotor: Annually or more a year, depending on the throughput and quality of the sample solution and Mobile Phase.
Replace the syringe plunger	Syringe Plunger has to be replaced on a regular base. The interval is highly dependent on the application, throughput, quality of sample solution(particles, etc.) washing solvent. It is advisable to check the tightness of the plunger on a regular base to gain the experience with the own application.

The other steps are described in the "Preventative Maintenance Procedure".
Specific kits for the GC or the HPLC techniques are available. The kits include the parts which shall be changed annually.
PM Kit1 for HPLC and PM Kit2 for GC technique.

note ! There are no operator-serviceable or replaceable parts inside the power supply(ies) or the PAL System. In case of any failure, contact a representative of CTC Analytics.

Appendices

A. Definition of Terms

Job Queue

A Job Queue is a list of sample processing Jobs. Jobs are executed in the order displayed on the JOB QUEUE menu screens. New Jobs may be added to the queue while samples are being processed.

Job

A Job contains the information needed by the PAL to process multiple samples by the same processing steps. The elements of a Job are a Method and a Tray that defines the location of the samples to be processed. For identification, Jobs are automatically numbered from 01 to 99 and then restarting with 01 when they are added to the Job Queue.

Cycle

A Cycle consist of the specific operations necessary to process one sample. The Cycle operations are repeated for each sample within a Job. Cycles are designed for specific applications. The Standard LC PAL Cycle is named LC-Inj.

Method

A Method defines how the samples are processed. The elements of a Method are a Cycle, a Syringe and a Parameter List. Methods have names with up to 8 characters and can be edited, copied, and deleted.

Method Parameters

Method Parameters are associated with the Cycle operations. User-assigned Parameter values define how a processing operation is performed. A zero Parameter value will disable a Cycle operation. Cycle parameters are application-specific.

Object

Objects are data structures describing the properties of physical modules. Certain modules (e.g. a Wash Station) require several objects.

Trayholder

A Trayholder can hold one or more trays. Each Trayholder has a reference position (X, Y, Z co-ordinates) that defines it's location.

Tray

A Tray that holds multiple samples. Trays are defined by designating the Tray Type (see below) and the Trayholder. Tray names are used to identify the sample source within a PAL Job.

Tray Type

A Tray Type defines the pattern and sampling sequence of sample locations within a Tray. Standard Tray Types include shallow and deep-well 96-position Microplates and Trays that hold 2 ml vials.

B. Conventions of Naming

This section recommends standard naming conventions for LC PAL Trays, Tray Types, and Tray holders. Following these conventions will allow LC PAL's to be pre-configured for certain applications, will simplify software backups and application development, and will improve technical support and training.

Tray Type	Tray Description
MT96	Standard 96-position microplates
DW96	Deep well 96-position microplates
MT384	High density 384-position microplates
VT54	Vial Tray, 54 positions (6 X 9) for 12mm vials, 2.0 ml

C. LC PAL Injection Cycles

LC PAL "LC-Inj" Cycle

No.	Processing Step	Method Parameter	Object	(Class)	Used Object Value
1	Reference X, Y, Z axis and syringe plunger			(System)	Start Ref = ON
2	Wait for Start signal		Start	(Sync Signals)	
3	Read Barcode if enabled		TRAY	(Tray Type)	Barcode None
4	Syringe wash strokes with solvent from Wash1	Pre Cln Slv1	SYRINGE (Syringes) Wash1 (Wash Stations)		Fill Speed Eject Speed Needle Penetr Clean Volume Max Fill Speed Max Eject Speed
5	Syringe wash strokes with solvent from Wash2	Pre Cln Slv2	SYRINGE (Syringes) Wash2 (Wash Stations)		Fill Speed Eject Speed Needle Penetr Clean Volume Max Fill Speed Max Eject Speed
6	Rinse syringe with sample selected number of times	Pre Cln Spl Sample Volume Fill Speed Pullup Delay	SYRINGE (Syringes) TRAY (Tray Type) Waste (Injectors)		Eject Speed Fill Volume Needle Penetr Needle Penetr
7	Fill syringe with sample using several filling strokes; aspirate air outside of vial if Air Volume • 0	Sample Volume Air Volume Fill Speed Fill Strokes Pullup Del	SYRINGE (Syringes) TRAY (Tray Type)		Eject Speed Overfill Fill Volume Needle Penetr
8	Move to injection valve	Inject to			
9	Wait for Inject signal		Inject	(Sync Signals)	
10	Drive needle to penetration depth	Inject to		(Injectors)	Needle Penetr
11	Switch valve to Active position				
12	Delay	Pre Inj Del			
13	Dispense syringe contents into sample loop	Inject Speed			
14	Activate Injected signal		Injected	(Out Signals)	Pulse Time
15	Activate Injectd+ Signal		Injectd+	(Out Signals)	Pulse Time
16	Delay	Pst Inj Del			
17	Switch valve to Standby position				
18	Retract needle from injector				
19	Clean syringe and needle with solvent from Wash1	Pst Cln Slv1	SYRINGE (Syringes) Wash1 (Wash Stations)		Fill Speed Eject Speed Needle Penetr Clean Volume Max Fill Speed Max Eject Speed

20	Clean syringe and needle with solvent from Wash2	Pst Cln Slv2	SYRINGE (Syringes) Wash2 (Wash Stations)	Fill Speed Eject Speed Needle Penetr Clean Volume Max Fill Speed Max Eject Speed
21	Rinse valve inlet with solvent from Wash1	Vlv Cln Slv1	SYRINGE (Syringes) Wash1 (Wash Stations)	Fill Speed Inject Speed Needle Penetr Clean Volume Max Fill Speed Max Eject Speed
22	Rinse valve inlet with solvent from Wash2	Vlv Cln Slv2	SYRINGE (Syringes) Wash1 (Wash Stations)	Fill Speed Inject Speed Needle Penetr Clean Volume Max Fill Speed Max Eject Speed
23	Move to Home position		Home (Positions)	

"LC-Inj" Cycle Parameter Description

Parameter	Description
CYCLE	LC-Inj Cycle
SYRINGE	Selected syringe
Sample Volume	Selected sample volume
Air Volume	Volume aspirated after the syringe needle is moved out of the sample liquid
Pre Cln Slv1	Pre injection syringe wash strokes with solvent from Wash1
Pre Cln Slv2	Pre injection syringe wash strokes with solvent from Wash2
Pre Cln Spl	Pre injection syringe rinse cycles with sample
Fill Speed	Speed of plunger movement used to aspirate sample
Fill Strokes	Number of filling strokes to aspirate sample
Pullup Del	Delay time between sample pull-up and ejection
Inject to	Name of Injector used for injection
Inject Speed	Speed of plunger movement used during sample injection
Pre Inj Del	Delay time prior sample injection
Pst Inj Del	Delay time after sample injection
Pst Cln Slv1	Post injection syringe wash strokes with solvent from Wash1
Pst Cln Slv2	Post injection syringe wash strokes with solvent from Wash2
Vlv Cln Slv1	Valve rinse cycles with solvent from Wash1
Vlv Cln Slv2	Valve rinse cycles with solvent form Wash2

D. LC PAL Software Flow Chart

Menu

Methods
- Std-LC
  - CYCLE
  - SYRINGE
  - Sample Volume
  - Air Volume
  - Pre Cln Slv1
  - Pre Cln Slv2
  - Pre Cln Spl
  - Fill Speed
  - Fill Strokes
  - Pullup Del
  - Inject to
  - Inject Speed
  - Pre Inj Del
  - Pst Inj Del
  - Pst Cln Slv1
  - Pst Cln Slv2
  - Vlv Cln Slv1
  - Vlv Cln Slv2

Syringe
- Actual Id
- Fill Volume
- Fill Strokes
- Pullup Del
- Fill Speed
- Eject Speed
- Inject Speed
- Plunger Pos

Tray
- Tray01
  - Needle Penetr
  - Tray Type
    - VT54
    - MT96
    - MT384
    - DW96
    - none
- Tray02
  - Needle Penetr
  - Tray Type
    - VT54
    - MT96
    - MT384
    - DW96
    - none
- Tray03
  - Needle Penetr
  - Tray Type
    - VT54
    - MT96
    - MT384
    - DW96
    - none
- Tray04
  - Needle Penetr
  - Tray Type
    - VT54
    - MT96
    - MT384
    - DW96
    - none

Injector
- LC Vlv1
  - Needle Penetr
- Waste
  - Needle Penetr

Wash Station
- Wash 1
  - Standard Wash Station
    - Needle Penetr
  - Fast Wash Station
    - Needle Penetr
    - Rinse Time
- Wash 2
  - Standard Wash Station
    - Needle Penetr
  - Fast Wash Station
    - Needle Penetr
    - Rinse Time

Utilities

Logfile

Info

Setup
- Ident
  - Users
  - Site Name
  - System Name
  - System SNo
- Access
  - Job Key
  - Method Key
  - Setup Key
- Sounds
  - Message Box
  - Warn Move
  - End Cycle
  - End Job
- Time
  - Year
  - Month
  - Day of Month
  - Hours
  - Minutes
  - Seconds
- Objects
  - Vials
  - Tray Holders
  - Trays
  - Wash Stations
  - Injectors
  - Sync Signals
  - Out Signals
  - Events

LC PAL Objects

Objects

- **Events**
  - TTL-In1: Active State, Debounce Time, Actual State
  - TTL-In2: Active State, Debounce Time, Actual State
  - TTL-In3: Active State, Debounce Time, Actual State
  - TTL-Out1: Active State, Actual State
  - TTL-Out2: Active State, Actual State
  - TTL-Out3: Active State, Actual State
  - Opto-In1: Active State, Debounce Time, Actual State
  - Opto-In2: Active State, Debounce Time, Actual State
  - SW-Out1: Active State, Actual State
  - SW-Out2: Active State, Actual State

- **Out Signals**
  - Injected: Destination, Pulse Time
  - Injectd2: Destination, Pulse Time
  - Running: Destination, Pulse Time
  - CCRunning: Destination, Pulse Time

- **Sync Signals**
  - Start: Source, Blocking Time
  - Start 2: Source, Blocking Time
  - Inject: Source, Blocking Time
  - Inject 2: Source, Blocking Time
  - Pause: Source, Blocking Time
  - StJobQue: Source, Blocking Time

- **Injectors**
  - LC Vlv 1: Position X, Position Y, Position Z, Needle Penetr, Valve (2CV-06-1, DC4-01-C, DC6-1-C, DC10-1-C, NONE)
  - Waste: Position X, Position Y, Position Z, Needle Penetr, Valve (2CV-06-1, DC4-01-C, DC6-1-C, DC10-1-C, NONE)

- **Wash Stations**
  - Wash 1: Position X, Position Y, Position Z, Needle Penetr, Max Fill Spd 10.0 ml/s, Max Eject Spd 10.0 ml/s
  - Wash 2: Position X, Position Y, Position Z, Needle Penetr, Max Fill Spd 10.0 ml/s, Max Eject Spd 10.0 ml/s

- **Trays**
  - Tray01: VT54, MT96, MT384, DW96, none
  - Tray02: VT54, MT96, MT384, DW96, none
  - Tray03: VT54, MT96, MT384, DW96, none
  - Tray04: VT54, MT96, MT384, DW96, none

- **Tray Holders**
  - THldr1: Position X, Position Y, Position Z, Access Path, Restore Path

- **Vials**

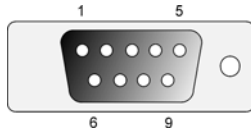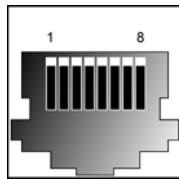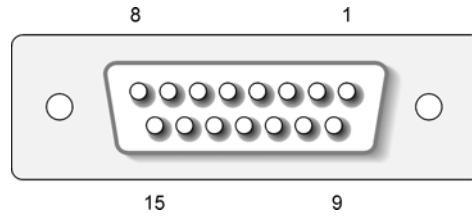## E.   External Connectors

Connector SER1

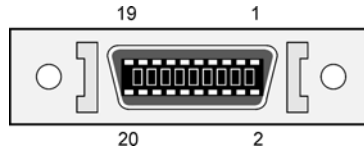| Pin	Signal Name
1	DCD
2	RXD
3	TXD
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	RI

Connector SER2 / SER3

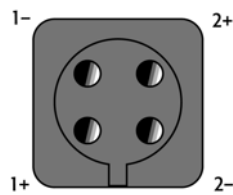| Pin	Signal Name
1	GND
2	RXD
3	TXD
4	RTS
5	CTS
6	+5V
7	reserved
8	reserved

Connector INTERFACE

Pin	Signal Name
1	Pwr-Out1 +
2	Pwr-Out2 +
3	SW-Out1 N0
4	SW-Out1 COM
5	SW-Out2 N0
6	Opto-In1 +
7	TTL-In1
8	GND
9	Pwr-Out1 -
10	Pwr-Out2 -
11	TTL-In2
12	SW-Out2 COM
13	TTL-In3
14	Opto-In1 -
15	+5V

Connector AUX

Pin	Signal Name
1,3	Motor A1
2,4	Motor A2
5,7	Motor B1
6,8	Motor B2
10,16,18	GND
11	reserved
12	reserved
13	Sens
14	+5V
15,17	reserved
19,20	+36V

Connector WASHSTATION

Pin	Signal Name
1+	Pwr-Out1+
1-	Pwr-Out1-
2+	Pwr-Out2+
2-	Pwr-Out2-

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