PAL User Manual
Installation and Operation

COMBI PAL / PAL LHX
PAL COMBI-*xt* / PAL LHX-*xt*

Printing History

Edition 1	January 1999	Software Version 2.0
Edition 2	April 2003	Software Version 2.0
Edition 3	August 2005	Software Version 2.0
Edition 4	October 2009	Software Version 2.5 to 4.1.X
Edition 5	March 2010	Software Version 2.5 to 4.1.X
Edition 6	June 2010	Software Version 2.5 to 4.1.X

Original Instructions

CTC Analytics AG reserves the right to make improvements and/or changes to the product described at any time without notice.

CTC Analytics AG makes no warranty of any kind with regard to this product, including but not limited to implied warranties of merchantability and suitability for a particular purpose.

In no case shall CTC Analytics AG be liable for any coincidental or consequential damage in connection with or arising from the use of this document.

© 2009 CTC Analytics AG. All rights reserved. Neither this publication nor any part hereof may be copied, photocopied, reproduced, translated or reduced to electronic medium or machine readable form without the prior written permission of CTC Analytics AG, except as allowed under copyright laws.

CTC Analytics AG acknowledges all trade names and trademarks used as the property of their respective owners.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

A. Safety Information

General Considerations

The PAL System User Manual and the corresponding "Addendum" for a specific module must be consulted by the user under all circumstances before a unit is put in use.

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 may be impaired.

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

When using the PAL System in the field of chromatographic analysis, if a change in the retention of a particular compound, in the resolution between two compounds, or in peak shape is observed, immediately determine the reason for the changes. Do not rely on the separation results until you determine the cause of a change.

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.

Use only 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.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

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 using a grounding cable connected on one side at the Injection Valve, Loop or any other suitable direct metallic contact, and on the other side at an appropriate ground point on 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.).
Ensure that the power supply/controller unit is always placed on a dry and clean position. Avoid any spill of liquids.

Always disconnect the power cord(s) from the power supply or from the various 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.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

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 are 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 supplies for the PAL Instrument, the Stack Cooler DW, Stack Cooler MT and Tray Cooler have the symbols I/0 on the label for the power switch to switch ON/OFF.

Any additional power supply for other devices, such as a Valve Module, exhibits the symbols as shown below on the label for the power switch:

Power ON

Power OFF

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

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

If a Stack Cooler DW, Stack Cooler MT or a Tray Cooler is installed in combination with a PAL System, then a second power supply is installed in the complete system. Turning OFF the power supplies or pulling the two power cords in an emergency will stop the complete PAL System.

It is important that the power supply (ies) be 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.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

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 handling solvents, changing tubing, or operating the PAL System. Know the physical and chemical properties of the solvents you use. See the Material Safety Data Sheets from the manufacturer of the solvents being used.

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 no PEEK or Tefzel tubing when using tetrahydrofuran (THF), dimethylsulfoxid (DMSO), chlorinated organic solvents, concentrated mineral acids, such as nitric, phosphoric or sulfuric acids, or any compounds related to the above.

Do not use vials without a sealing cap, microtiter or deepwell plates without a plate seal. Vapor phase from organic solvents can be hazardous and flammable. Acidic vapor phase can cause corrosion to critical mechanical parts.

Disposal

Do not dispose of this equipment or parts thereof unsorted in municipal waste. Follow local municipal waste ordinances for proper disposal provisions to reduce the environmental impact of waste electrical and electronic equipment (WEEE).
European Union customers: Call your local customer service representative responsible for the PAL System for complimentary equipment pick-up and recycling.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

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
	Electrical Power ON Used with Main PAL Power Supply
	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)
	Disposal, Do not dispose in municipal waste. Follow local waste regulations to reduce electrical and electronic waste (WEEE).

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

B. Table of Contents

A. Safety Information 2
B. Table of Contents 7
C. List of Figures 10
D. How to Use this Manual 12
E. COMBI PAL Operating Instructions 13
1. Using the Control Terminal 13
1.1. Menu Screens 13
1.2. Function Keys 14
1.3. ESCape and STOP Keys 14
1.4. Scroll Knob and ENTER Button 14
2. Methods 15
2.1. Creating Methods 15
2.2. Edit / View Methods 16
2.3. Delete Methods 16
3. Job and Job Queue 17
3.1. Building and Starting a Job Queue 17
3.2. Aborting a Job Queue 18
3.3. Restarting an aborted Job Queue 19
4. Utility Functions 19
4.1. Syringe 20
4.2. Tray 21
4.3. Injector 22
4.4. Wash Station 22
4.5. Vial 23
4.6. Dilutors 23
4.7. Tools 24
5. Logfile 24
6. Info Functions 25
6.1. Hardware 25
6.2. Software 25
6.3. Maintenance 26
6.4. Free Objects / Free Items 26
7. Setup Functions 26
7.1. Sounds 27
7.2. Time 27
7.3. Objects 27

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

Table of Contents (contd.)

F. COMBI PAL Description and Installation 28

1. General System Overview 28

1.1. Specifications 29

1.3. Electrical Specifications 30

1.4. Physical Specifications 31

1.5. Operating and Environmental Requirements 31

1.6. Sound Pressure Level 31

1.7. Hardware and Software Requirements 32

1.8. Regulatory Compliance Requirements 32

2. Product Warranty 33

2.1. Statement of Limited Product Warranty 33

3. Installation 35

3.1. Unpacking the Components 35

3.2 Assembling the COMBI PAL 35

3.3. Electrical Connections 42

4. COMBI PAL Object Positions 43

4.1. Defining Object Positions 43

4.2. Description of Object Positions 46

5. Syringes 54

5.1. Selecting Syringes 54

5.2. Syringe Priming (for Liquid Syringe Types only) 54

5.3 Installing a Syringe for Liquid Injections 54

5.4. Removing a Syringe for Liquid Injections 56

5.5. Installing a Syringe for Headspace Injections 56

5.6. Removing a Syringe for Headspace Injections 57

6. Interfacing the COMBI PAL to Other Devices 58

6.1. Synchronization and Output Signals 58

7. PAL System Software 60

7.1. PAL Loader Software 60

7.2. PAL Object Manager Software 61

8. Establishing Communication with Computer 62

8.1 COM Port Settings 62

8.2 Setting up LAN Communication 63

8.3 Troubleshooting for Serial or LAN Communication 66

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

Table of Contents (contd.)

9. Special Functions 67
9.1. How to Access "Extended User Mode" 67
9.2. Section "F3-Setup" 68
9.3. Section "F3-Setup" / Objects 72
G. Troubleshooting PAL and PAL-*xt* System 80
H. Replacing Parts 82
1. MOTIO Board 82
2. CPU Board 84
3. Control-*xt* Board 85
4. Agitator 86
5. Injection Unit 86
6. Wash Station 86
I. Maintaining the PAL System 87
J. Appendices 88
1. Definition of Terms 88
2. Naming Convention 91
3. COMBI PAL and –*xt* Injection Cycles 92
3.1. COMBI PAL "GC-Inj" Cycle 92
3.2. GC PAL "GC-InjS" Cycle 94
3.3. COMBI PAL "HS-Inj" Cycle 96
3.4. COMBI PAL "GC-Dual" Cycle 98
4. PAL Firmware Overview 100
4.1. COMBI PAL Flow Chart based on PAL Firmware Version 2.5.X. 100
4.2. PAL COMBI-*xt* PAL System Flow Chart based on PAL Firmware Version 4.1.X 104
5. External Connectors for PAL and -*xt* System 108
6. Intended Use for PAL System 112
6.1. Introduction 112
6.2. Intended Use 112
6.3. Disclaimer and Restrictions on Use 112
7. PAL Accessories 113

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

C. List of Figures

Figure 1 PAL Control Terminal and Conventions
Figure 2 Accessing a Method Screen
Figure 3 Verifying Tray with corresponding Tray Type
Figure 4 Example of Job Queue Screen
Figure 5 Selecting Utilities Functions
Figure 6 Selecting Info Functions
Figure 7 Selecting Setup Functions
Figure 8 COMBI PAL Major System Components
Figure 9 Attachment of Mounting Claws
Figure 10 Attaching the PAL Injection Unit
Figure 11 Connecting the Injection Unit Ribbon Cable
Figure 12 Inserting the Injection Unit Mounting Torx Screws
Figure 13 COMBI PAL with Injection Unit and Standalone Supports
Figure 14 Installing the Keypad Terminal
Figure 15 Installing the Flush Gas Regulator
Figure 16 Installing the Wash Station
Figure 17 Installing the Agitator
Figure 18 Installing a Tray Holder
Figure 19 Electrical Connections for Combi PAL System
Figure 20 Electrical Connections for PAL COMBI-*xt* System
Figure 21 Object Reference Position
Figure 22 Menu Screen Object Tray Holder
Figure 23 Inclined Tray, Corrections for X-,Y-,Z-Axes
Figure 24 Tray Holder Reference Position
Figure 25 Demonstrating a possible Inclination of Tray in X-,Y-,Z-Axes.
Figure 26 Tray Type VT 32
Figure 27 Tray Type DW96
Figure 28 Utilities Function “Trays”
Figure 29 Adjusting “Offset X,Y, Z” for Tray Position 001
Figure 30 Adjusting Row Inclination at Second Tray Corner Position
Figure 31 Adjusting Column Inclination at Third Tray Corner Position
Figure 32 Wash Station Wash1/Wash2 Reference Point
Figure 33 Wash Station Waste/Waste2 Reference Position
Figure 34 Wash Station Standard Reference Position
Figure 35 GC Injectors (e.g. GC Inj1) Reference Position
Figure 36 Agitator Reference Position
Figure 37 Syringe and Syringe Adapter for Liquid Injections
Figure 38 Installing and Removing a Syringe for Liquid Injections
Figure 39 Headspace Syringe and heated Syringe Adapter
Figure 40 Installing and Removing a Headspace Syringe
Figure 41 Removing a Headspace Syringe from the Heated Syringe Adapter
Figure 42 COM Port Settings
Figure 43 Reading MAC Address from Ethernet Communication Port
Figure 44 PAL-*xt* Communication Settings
Figure 45 Setting Communication Mode

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

List of Figures (contd.)

Figure 46 Selecting “Setup” in Extended User Mode
Figure 47 Selecting “Objects” in Extended User Mode
Figure 48 Pattern Tray Type “Regular”
Figure 49 Pattern Tray Type “Staggered+”
Figure 50 Pattern Tray Type “Staggered-“
Figure 51 Replacing MOTIO Board
Figure 52 Replacing CPU Board
Figure 53 Replacing Control-*xt* Board
Figure 54 COMBI PAL Firmware Overview, Page 1
Figure 55 COMBI PAL Firmware Overview, Page 2
Figure 56 COMBI PAL Firmware Overview, Page 3
Figure 57 COMBI PAL Firmware Overview, Page 4
Figure 58 PAL COMBI-*xt* Firmware Overview, Page 1
Figure 59 PAL COMBI-*xt* Firmware Overview, Page 2
Figure 60 PAL COMBI-*xt* Firmware Overview, Page 3
Figure 61 PAL COMBI-*xt* Firmware Overview, Page 4

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

D. How to Use this Manual

note

*This User Manual covers the COMBI PAL and PAL COMBI-**xt** Systems. Issues specific to the PAL COMBI-**xt** model have been emphasized as such.*

Follow the description given in this manual to Install and operate the PAL model "LHX PAL," which differs only by its X-axis length of 120 cm as compared to 80 cm for the COMBI PAL model and thus is not handled separately. Thus, model PAL LHX-*xt* is also not handled separately.

Unless stated otherwise, this manual refers to all COMBI PAL models.

The manual is divided into following major sections:

- Safety Information
- COMBI PAL Operating Instructions
- Specifications
- Product Warranty
- COMBI PAL Description and Installation
- Troubleshooting
- Replacing Parts
- Maintaining PAL System
- Appendices

The "COMBI PAL Operating Instructions" in section E are intended for infrequent PAL users or new users who already have experience using automated systems to perform standard analytical methods.

note

The COMBI PAL must be installed and set up properly before the Operating Instructions in Section E can be used.

Users who are installing a COMBI PAL system or COMBI PAL accessories, or who need to adjust an installed system, should consult "COMBI PAL Description and Installation" in Section F.

The Appendices provide useful information such as the Software Flow Chart, Definition of Terms, Injection Cycle parameter descriptions, or the COMBI PAL accessories guide.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

E. COMBI 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 COMBI PAL. They are intended to provide an overview for new users and a reminder for infrequent users. The COMBI PAL and all accessories should be installed with Objects defined correctly. A syringe of the specific type called for by a particular method should also be installed.

Figure 1 illustrates the PAL control terminal and the conventions used to enter, edit, and view information.

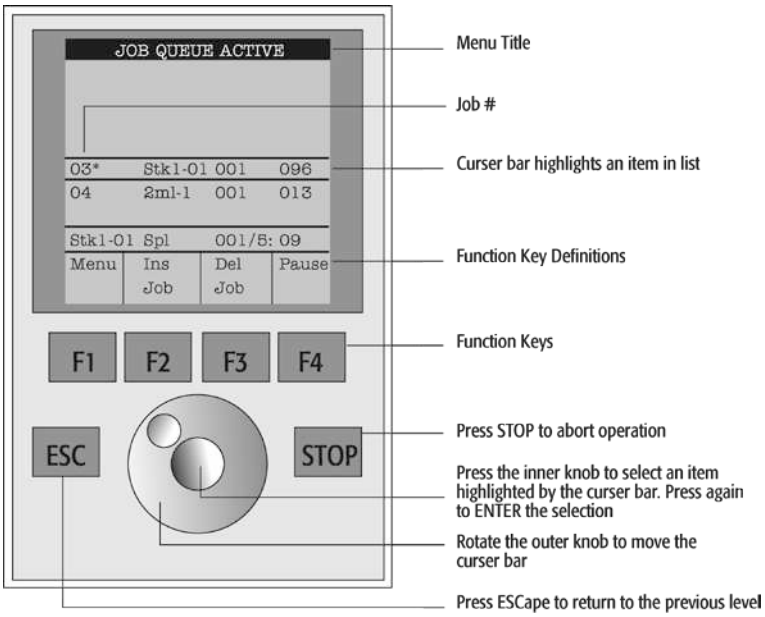


Figure 1. PAL Control Terminal and Conventions

1.1. Menu Screens

Different menu screens are displayed, depending on the COMBI 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 status, are shown in the highlighted area above the Function key labels on the bottom of the screen.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

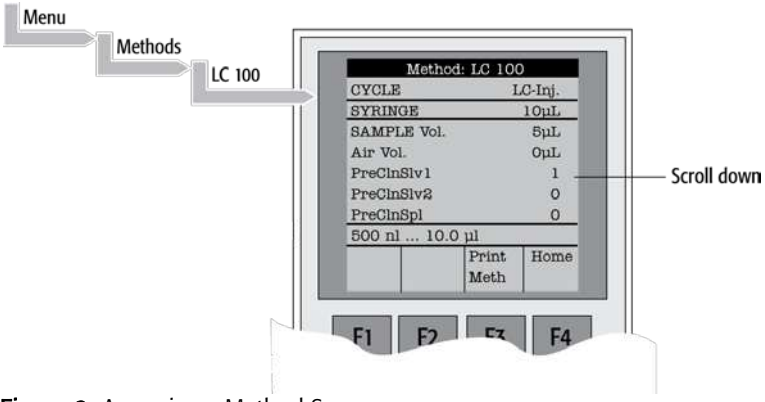


Figure 2. Accessing a Method Screen

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 labeled **Home** will always return to 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.

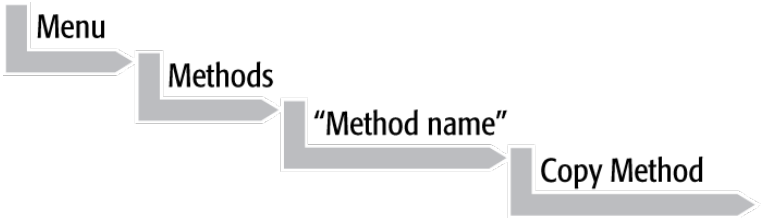
PAL is a registered trademark of **CTC** Analytics AG | Switzerland

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 Methods menu. Methods can be viewed (but not edited) from the Job Queue menus.

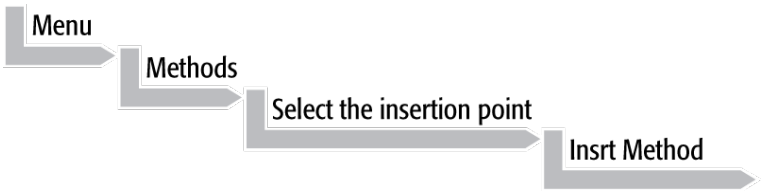
Methods are created by either copying an existing Method or creating a new Method.



To copy a **Method**, complete the sequence as follows.
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. Assign and enter a new Method name as above. After a copy of the Method has been created, the Method parameters will display and can be edited. The Cycle and Syringe entries cannot be changed;

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

3. Select the specific Syringe to be used by the Method;

note — *Once a Method has been created and saved, the Cycle and Syringe cannot be changed. To use a different Cycle or Syringe, a new Method must be created.*

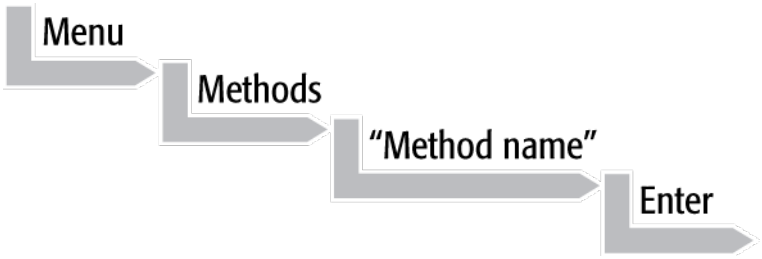
4. Assign Parameter values according to the application requirements. Consult Appendix point 3, COMBI PAL "Injection Cycle Parameters" for details on specific items;

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

2.2. Edit / View Methods

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

Complete the following menu selections:



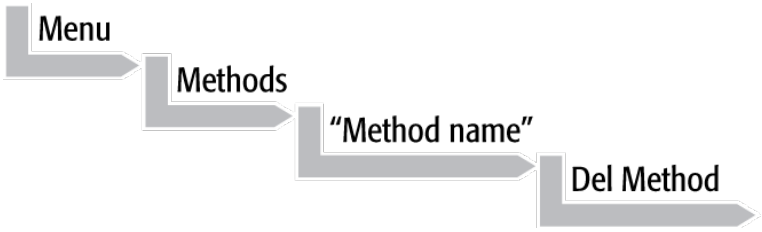
1. Scroll to and select the parameter to be changed. Assign the new value and press the **ENTER** key;

2. 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;

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

2.3. Delete Methods

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



PAL is a registered trademark of **CTC** Analytics AG | Switzerland

3. Job and Job Queue

A **Job** bundles the specified Tray with the designated vials (samples) and with the Method to run those samples. Another term often used for "Job" in the chromatographic field is "sequence".
If more than one Job is prepared, the term **Job Queue** is used.

Before a Job can be activated the operator must verify that the Tray Type matches the specified Tray and vial size (type). This step is done in **Utilities** class.

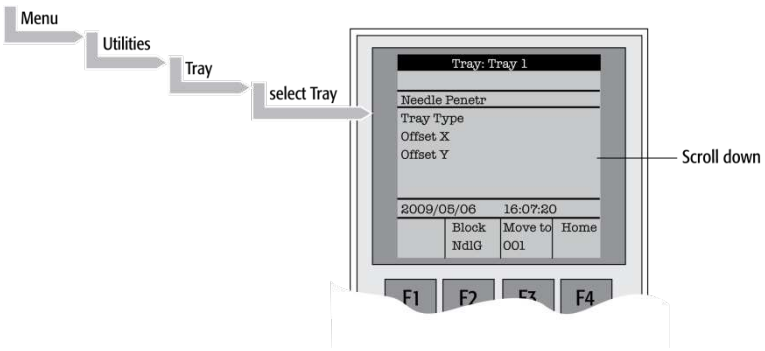


Figure 3. Verifying Tray with corresponding Tray Type

Select the corresponding Tray Type. By activating function key "F3" the injection unit can be moved to the first position and to another two corner positions to verify the correct selection of the Tray Type and teaching position.

3.1. Building and Starting a Job Queue

1. Power up the COMBI PAL. The **JOB QUEUE** screen is displayed;

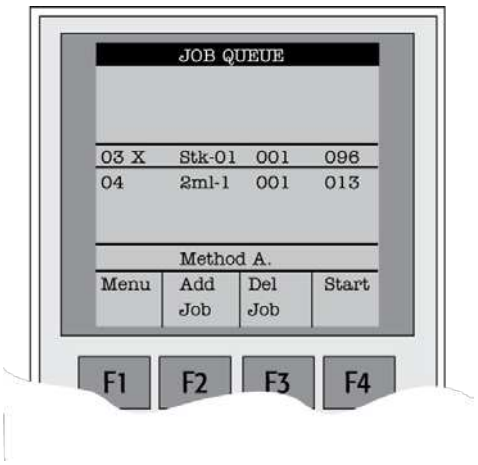


Figure 4. Example of Job Queue Screen

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

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

note

If a sample Tray contains 10 mL sample vials and the "HS-Inj" cycle is used, insert the supplied adapters into the Agitator sample positions.

3. Add a new Job for the Tray. Press the **Add Job** key to bring up the default Job;

4. For TRAY, select the Tray name (e.g. Tray1) 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. To add additional samples to be processed, repeat steps 2 – 7;

9. If necessary, replace and/or clean the syringe (liquid versions only). Press the Menu key to see the available options for changing (**F1 Change Syringe**) and cleaning **F2 Clean Syringe**). To completely remove air bubbles, the syringe should be primed manually; (See Section F. "Description and Installation", point 5.2, "Syringe Priming".)

10. If only one Job is to be processed, select the 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 one aborted.)

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** if there is a problem with only the current sample. Processing will resume with the next sample;

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

5. Select **Job** to abort processing 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 **Resume** option. 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 the Wash Station. 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.*

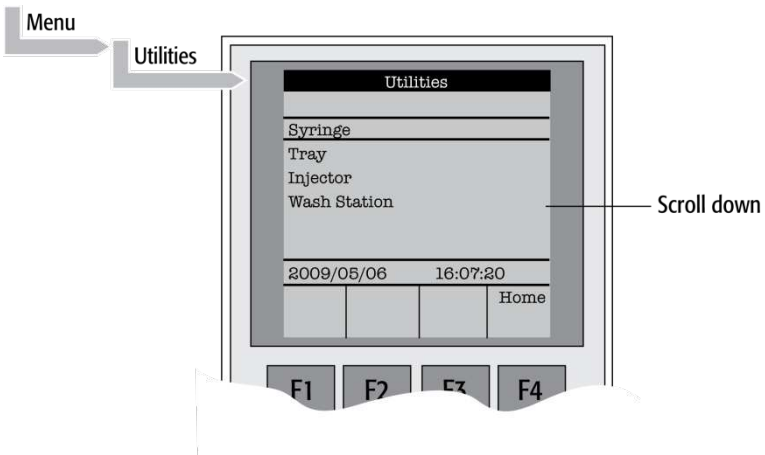


Figure 5. Selecting Utilities Functions

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

4.1. Syringe

The following functions are available by pressing a Function Key:

Function Key	Description
F1 Chang Syr	The syringe is moved to a position in which the syringe assembly can be completely lowered to facilitate removal of the syringe adapter. The syringe can then be removed from the adapter and replaced. A prompt will be displayed to specify the new syringe. The syringe must be installed before pressing **Enter**. (See Section F. "Description and Installation", point 5 "Syringes".)
F2 Clean Syr	This Function is used to clean or prime the syringe prior to use. After selecting **F2** either Wash1 or Wash2 can be selected.
F3 Set Pos	Set Pos is used to define the Chang Syr position.
F4 HOME	The Injection Unit moves to its HOME position and the Job Queue Menu is displayed.

The following Syringe items 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 message "Syringe: No syringe" is displayed.
Fill Volume	This parameter serves to control the filling of the syringe. It can occur 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 can 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	By using this item a delay time can be selected between sample pullup and ejection while filling the syringe. When the plunger reaches the zero position during the fill strokes, the system waits half the Pullup Del time. This allows for an air bubble to float away from the needle tip. This feature is especially useful for removing any air bubble in the syringe and handling viscous fluids.
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. Typically used for "Fill Strokes".
Standby Temp*	Sets the temperature for a heated syringe during standby mode, (e.g. before or after a Job/Job Queue is processed).
Actual Temp *	Indicates the actual (current) syringe temperature
Plunger Chnge Pos	Plunger position during Chang Syr 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.

* Available for Agitator only

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

4.2. Tray

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

Function Key	Description
F1 Start Agi *	F1 starts the spinning motion of the agitator. It may be used to test the agitator function or to optimize the spinning speed for particular applications.
F2 Block NdlG	F2 activates Needle Guide blocking. The option after activation is "Rel NdlG", releasing Needle Guide Blocking. It may be used to test the functionality of the solenoid that blocks the needle guide.
F3 Movto nnn	This function serves as a quick check to determine if the X,Y,Z coordinates are defined correctly for the selected Tray. To use this utility the selected Tray, including the sample vials, 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.
F4 HOME	The Injection Unit moves to its HOME position and the Job Queue Menu is displayed.

*Available for Agitator only.

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

Item	Description
Needle Penetr	Needle penetration depth into the sample vial. 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 the use of different Tray Types it can be changed at this position.
Tray Offset X	If necessary, a correction to the ideal X-position of "Position 1" can be made by using "Tray Offset X".
Tray Offset Y	If necessary, a correction to the ideal Y-position of "Position 1" can be made by using "Tray Offset Y".
Tray Offset Z	If necessary, a correction to the ideal Z-position of "Position 1" can be made by using "Tray Offset Z".
dxRow	Correction of any inclination of a Tray (plate) in the X-axis of a row (see Fig. 25 for details).
dyRow	Correction of any inclination of a Tray (plate) in the Y-axis of a row (see Fig. 25 for details).
dzRow	Correction of any inclination of a Tray (plate) in the Z-axis of a row (see Fig. 25 for details).
dxCol	Correction of any inclination of a Tray (plate) in the X-axis of a column (see Fig. 25 for details).
dyCol	Correction of any inclination of a Tray (plate) in the Y-axis of a column (see Fig. 25 for details).
dzCol	Correction of any inclination of a Tray (plate) in the Z-axis of a column (see Fig. 25 for details).
Standby Temp*	Sets the temperature for the Agitator during standby mode, (e.g. before or after a Job/Job Queue is processed).
Actual Temp *	Indicates the actual agitator temperature.
Speed *	Sets the Agitator spinning speed. Usually it has to be set as high as possible, but not so high that the liquid does not move up to the septum. Check the correct speed by inserting a spacer below the vial inside the agitator so the liquid level is visible. Try different speeds and monitor the liquid level.
Agi On Time *	Sets how long the Agitator spins in one direction.
Agi Off Time *	Sets how long the Agitator stops before it reverses the direction of spin. If this value is set to 0, only the clockwise direction with no interrupts will be used.

*Available for Agitator only
Items displayed in "italic" are available beginning with PAL Firmware Version 4.1.X.

note

A "staggered pattern" is selectable in firmware class "Tray Type". For details see section F. "Description and Installation", point 9.3.1 "Tray Type".

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

4.3. Injector

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

Function Key	Description
F3 Movto Inj	The Injection Unit moves to the selected injector position. With this function, e.g. the injectors GC-Inj1, Waste, Waste2 and Flush can be accessed. By selecting the parameter "Needle Penetr" on the same screen, the Injector Needle Penetration value can be checked or changed.
F4 HOME	The Injection Unit moves to its HOME position and the Job Queue Menu is displayed.

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

Item	Description
Needle Penetr	By selecting the parameter "Needle Penetr" the Injector Needle Penetration value can be checked and/or changed. To ensure reproducible sample injections and minimize carryover it is critical that the needle penetration depth be accurately set.

4.4. Wash Station

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

Function Key	Description
F3 Movto Wash	The injection unit moves to the selected Wash Station port. By selecting the Parameter "Needle Penetr" on the same screen the Wash Station Needle Penetration value can be checked or changed.
F4 HOME	The injection unit moves to its HOME position and the Job Queue Menu is displayed.

Item	Description
Needle Penetr	By selecting the Parameter "Needle Penetr" the Wash Station Needle Penetration value can be checked and/or changed.
Rinse Time	If rinse time is activated (value > 0), the solenoid of a Fast or Active Washstation opens for the specified time after the syringe needle has been removed from the wash port (after completion of the syringe wash cycle). The solvent flows into the wash port without the restriction of the needle; be aware of higher solvent consumption.

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

Item	Description
Needle Penetr	By selecting the parameter "Needle Penetr" the Wash Station needle penetration value can be checked and/or changed.
Rinse Time	If rinse time is activated (value > 0), the solenoid of a Fast or Active Washstation opens for the specified time after the syringe needle has been removed from the wash port (after completion of the syringe wash cycle). The solvent flows into the wash port without the restriction of the needle; be aware of higher solvent consumption.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

4.5. Vial

After selecting the specific Vial type*, the following functions are available:

Function Key	Description
F3 Movto Vial	The injection unit moves to the selected vial type. By selecting the parameter "Needle Penetr" on the same screen, the Wash Station Needle Penetration value can be checked or changed.
F4 HOME	The Injection Unit moves to its HOME position and the Job Queue Menu is displayed.

* Available Vial types:
- Standard: Vial in Standard Washstation for GC (front position).
- Fiber Exp: Position to block needle guide.
  Mainly used for SPME application. See SPME User Manual.

Item	Description
Needle Penetr	By selecting the parameter "Needle Penetr" the wash station needle penetration value can be checked and/or changed.

4.6. Dilutors

After selecting the specific Dilutor, the following functions are available:

Function Key	Description
F1 Prime	The Dilutor syringe is primed with solvent after activating the F1 function.
F2 Chang DSyr	Activating F2 moves the plunger of the Dilutor Syringe to standby position to allow easy access to change the syringe.
F4 HOME	The Injection Unit moves to its HOME position and the Job Queue Menu is displayed.

The following Dilutor items can be changed by selecting the particular item:

Item	Description
Syringe	Indicates the Dilutor side-port syringe inserted in the Z-axis. This function allows selecting another syringe size.
Syr Dilut Pos	Activating this function moves the plunger of the side port syringe up by the specified distance. This allows adjustment of the plunger tip of the side port syringe exactly above the lower side port (solvent inlet). This fine tuning is necessary after changing a side port syringe to allow unrestricted solvent flow.
Dilutor Syr	Indicates Dilutor Syringe is installed. If the syringe size is changed, this item must be adapted accordingly. The syringe-specific dimensions are coordinated by this function.
Prime Volume	A volume to prime the Dilutor Syringe can be specified. The allowed range can be fourfold higher than the actual syringe volume. This allows filling and emptying a dilutor syringe more often than just once.
Pullup Delay	Using this item permits selecting a delay time between solvent filling and ejection while filling (or priming) the syringe.
Fill Speed	Speed of plunger movement of Dilutor Syringe used in all syringe filling operations.
Eject Speed	Speed of Dilutor Syringe plunger movement used in all dilutor syringe eject operations.
Eject Delay	Using this item permits selecting a delay time between solvent ejection and filling while filling (or priming) the syringe.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

4.7. Tools

note

The Object class "Tools" is available with PAL Firmware version 3.0.X , 4.1.X. or higher.

After selecting the specific tool, the following functions become available:

Function Key	Description
F1 Chk Offs	The item "Check Offset" can be used to verify the offset from the syringe needle tip to the tool tip. This item is mainly used for the MALDI tool; it is not active for the MHE tool.
F4 HOME	The injection unit moves to its HOME position and the Job Queue Menu is displayed.

The following tool items may be changed by selecting the particular item:

Item	Description
Teach Point	The reference point at which to teach the Object (Tool; MHETool) is selectable. In the case of the MHETool, no extra position is necessary. The Parking Station is the fix point. Select "None."
ToolOffset X	If necessary, a correction to the ideal X-position of the MHETool can be made by using "ToolOffsetXX".
ToolOffset Y	If necessary, a correction to the ideal Y-position of the MHETool can be made by using "ToolOffsetY"
ToolOffset Z	If necessary, a correction to the ideal Z-position of the MHETool can be made by using "ToolOffsetZ" A "ToolOffsetZ" of -48.0 mm is necessary to position the MHETool on the sample vial.

5. Logfile

The PAL logfile cannot be read-out directly on the terminal display. However, the function key "F3" does allow a print out. A serial printer has to be connected to port "SER2" for the PAL System and to the port "SER1" for PAL-*xt* System. If a serial printer is not available use a serial/parallel converter.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

6. Info Functions

Info functions, selectable from the Menu screen, provide quick access to information to be viewed. These info functions are available for the Hardware, Software Maintenance, Free Objects, and Free Items.
All items with the exception of "Maintenance" are read only.

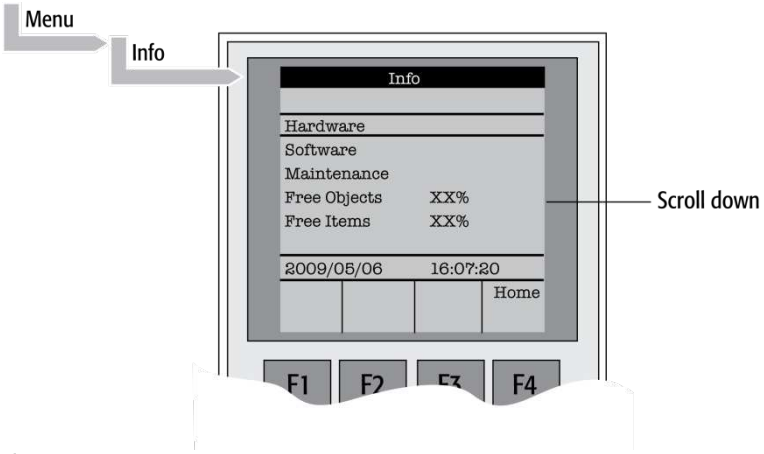


Figure 6. Selecting Info Functions

6.1. Hardware

Item	Description
CPU SNo	The serial number (SNo.) of the PCB "APR CPU" is displayed-
CPU ID	Version number of the PCB "APR CPU".
MOTIO ID	Version number of the PCB "APR CPU".

6.2. Software

Item	Description
PAL Firmware	Firmware version of PAL System.
Head Firmware	Firmware version PAL Injection Unit.
Terminal FW	Firmware version PAL Terminal.
Altera Firmware	Firmware version of the Altera component.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

6.3. Maintenance

Item	Description
PlgStrokeCnt	This is a counter for syringe plunger movements. The actual number of strokes is displayed. If the counter reaches the set limit (PlgStrkeLim), a warning is displayed at the next start of a job (run). The system continues but signals the user to verify syringe conditions. The counter can be set back to zero to restart. There is only one counter for a syringe. If syringe types are changed the system continues to count as if it were the same type.
PlgStrokeLim	An upper limit for the syringe plunger strokes can be set.
Inject Count	This counter monitors the number of injections. The number of penetrations into the GC injector is a helpful tool for the user to decide on a replacement of the injector system. The actual number of injections is displayed. If the counter reaches the set limit (PlgStrokeLim), a warning is displayed at the next start of a job (run) (Inject Limit). The same counter is used for valve switches (HPLC technique).
Inject Limit	An upper limit for the number of injections can be set.

note *Counters for the plunger movement and injector penetrations are available with PAL Firmware version 2.5.X or higher.*

6.4. Free Objects / Free Items

In addition to the core software, the PAL Firmware contains data for the "Firmware Objects". There are different classes of Objects, such as Syringes, Trays, Tray Holders, etc. Each class of Objects contains "Items". The items contain the actual data such as X-, Y-, Z-positions.
The data are stored in a flash memory backed up by a battery.
To optimize RAM and Flash memory use, a certain section of memory has been reserved by the software for each of the Objects and Object Items.
The percentage shown in the "Info" section provides an indication as to how much of the reserved software space is still available.

7. Setup Functions

The **Setup** functions, selectable from the Menu screen, allow accessing various functions for the PAL System. The "Sound", "Time" and "Objects" are basic functions used at installation or if changes have been made over time.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

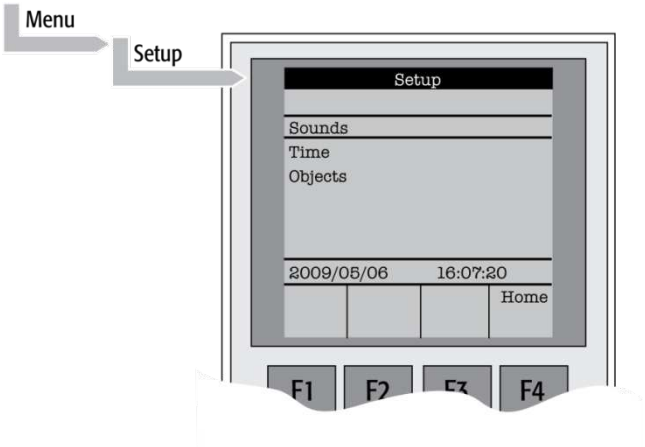


Figure 7. Selecting Setup Functions

7.1. Sounds

Item	Description
Message Box	A specific dual beep tone signals that a pop-up window (Message Box) for user intervention appears on the screen. This beep signal can be turned on or off.
Warn Move	A beep sound is heard at the start of the PAL movement. It is advisable to keep this function turned on for safety reasons.
End Cycle	A beep sound is heard at the end of a cycle. Select as desired.
End Job	A beep sound is heard at the end of a cycle. Select as desired.

7.2. Time

Item	Description
Year	The "year" can be set for the PAL internal clock
Month	The "month" can be set for the PAL internal clock.
Day of Month	The "day" can be set for the PAL internal clock.
Hours	The "hours" can be set for the PAL internal clock.
Minutes	The "minutes" can be set for the PAL internal clock.
Seconds	The "seconds" can be set for the PAL internal clock.

After setting or resetting the date and time, use the function key "**F1**" "Set Time" to store.

7.3. Objects

The various PAL Firmware Object classes can be selected and the functions most used by the user are directly accessible. For detailed listing see PAL Firmware overview in the appendices.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

F. COMBI PAL Description and Installation

1. General System Overview

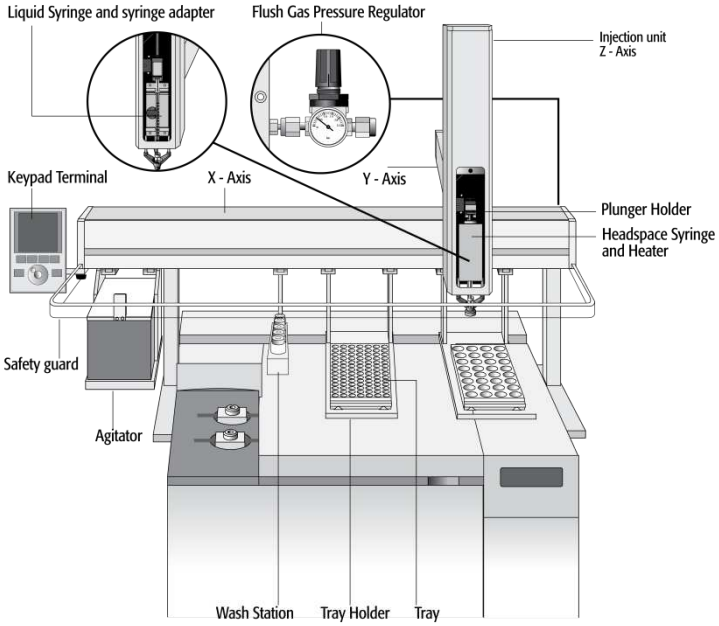


Figure 8. COMBI PAL Major System Components

The standard COMBI PAL includes the following hardware:

1 X-, Y-axes assembly
1 Injection Unit, Z-axis
1 Flush Gas Pressure Regulator
1 Tray Holder/Tray for 1 mL / 2 mL vials
1 Tray Holder/Tray for 10 mL / 20 mL vials
1 Syringe kit for liquid injections
1 Syringe kit for heated Syringes
1 Heated, six-position Agitator
1 Wash Station for two different solvents
1 Keypad terminal
1 Safety Guard
1 GC mounting kit (optional)

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

1.1. Specifications

1.1.1. Sample Capacity

- 98 x 2 mL vials per Tray
- 200 x 1 mL vials per Tray
- 32 x 10 mL / 20 mL vials per Tray
  (up to three Trays can be configured)

- 108 x 2 mL vials per Stack Cooler 2 DW (2 x 54 vials)
- 216 x 2 mL vials per Stack 4 DW (without cooling/heating)
- 2 Micro- Deepwell plates per Stack Cooler 2 DW
- 4 Micro- Deepwell plates per Stack 4 DW

1.1.2. Thermostatted Sample Tray

- Tray Cooler, optional, 4 °C – 70 °C
- Stack Cooler 2 DW, optional, 4 °C – 40 °C

1.1.3. Liquid Injection Range

- 1 µL – 10 µL with standard 10 µL syringe
- Down to 0.1 µL with sandwich technique or
- Optional 1.2 µL syringe
- Up to 50 – 500 µL with optional 500 µL syringe

1.1.4. Headspace Injection Range

- 250 – 2500 µL with standard 2.5 mL heated syringe
- Down to 100 µL with optional 1.0 mL heated syringe
- Up to 5000 µL with optional 5.0 mL heated syringe

1.1.5. Heated Syringe Temperature

- 35 °C – 150 °C selectable in 1 °C increments

1.1.6. Incubator (Agitator)

- Six heated vial positions for 2 / 10 / 20 mL vials
- Temperature range 35 °C – 200 °C, selectable in 1 °C increments
- Orbital interval shaking, speed 250 – 750 rpm

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

1.1.7. Replicate Injections

- 1 – 99 from one vial

1.1.8. Minimum Sample Volume

- 1 µL from a 3 µL sample in 1 mL tapered micro vial in liquid injection mode

1.2. Performance Specification

The performance specifications are available as part of a specific, separate document.

1.3. Electrical Specifications

Parameter	Requirement
Protection class[a]	Class I
Over voltage category[b]	Category II
Pollution degree[c]	2
Moisture protection[d]	Normal (IPXO)
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

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 Degree 2:
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.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

1.4. Physical Specifications

Parameter	Requirements
COMBI PAL Systems	
Height	648 mm (25.5 in)
Depth	385 mm (14.1 in.)
Width	828 mm (32.6 in.)
Weight	10 kg (22 lbs.) without accessories

1.5. Operating and Environmental Requirements

Parameter	Requirements
Operating temperature range	4 to 40 °C (39 to 104 °F)
Maximum relative humidity	75%, non-condensing
Bench space	At least 16 cm (6 in.) at the rear. Access to power switch(es) and power cord(s). Clean, level and smooth surface. Solid bench plate.
Vibration	Negligible
Static electricity	Negligible

1.6. Sound Pressure Level

Parameter	Requirements
Sound Pressure Level	Measured value: 62 dBA (PAL System used for measurement) One meter from the equipment in the direction of maximum sound pressure level. According to UL 610107A-1, 1st Edition, clause 12.5. Limit < 85 dBA dBA = "A weighted" sound pressure level

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

1.7. Hardware and Software Requirements

1.7.1. Hardware Requirements

In order to operate a PAL System, the electronic control board must be compatible with the corresponding PAL System.

- PAL System operated with PAL Firmware version 2.X.X. or 3.0.X: either the combination of 'APR CPU' and 'APR MOTIO' or the 'APR Control' boards can be used.
- PAL-*xt* systems operating with PAL Firmware version 4.1.X or higher: 'APR Control-*xt*' board must be installed.

A PAL System can be upgraded to a PAL-*xt* System; for details contact your CTC Analytics representative.

For specific PAL hardware Modules, a minimum PAL Firmware version is required. For example, a PAL Dilutor Option requires the PAL Firmware version 2.3.X or higher, and a PAL DLW Option requires the PAL Firmware version 4.1.X or higher. Details are given either in the corresponding 'Addendum to PAL User Manual' or in the 'Addendum to PAL User Manual for PAL Object Manager Software'.

1.7.2. Software Requirements

The various PAL Software programs, such as PAL Loader or PAL Object Manager, are operated with Microsoft Windows Operating systems, such as Windows XP and Vista. For details, see the corresponding 'Addendum to the PAL User Manual'.

The PAL System can be controlled using PAL control software, the Cycle Composer, or any data system software that controls the PAL using the Cycle Editor for PAL ICC interpretation (e.g. Analyst, ChemStation, Empower, EZChrom, MassLynx, Xcalibur).

For details on software requirements for integration of the PAL System with other data handling systems (CDS), contact your CTC Analytics representative or the manufacturer's representative of the other CDS software program.

1.8. Regulatory Compliance Requirements

As of the date of publication, this product is compliant with current RoHS and WEEE regulations.

- Directive 2002/95EC, RoHS
- Directive 2002/96/EC, WEEE

note *CTC Analytics AG reserves the right to make improvements and/or changes to the product specifications without notice.*

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

2. Product Warranty

2.1. Statement of Limited Product Warranty

What does this Warranty cover?
CTC Analytics AG warrants only that its products comply with CTC Analytics AG specifications.

This warranty covers defects in or failures of the Autosampler and major accessories, such as Agitator, Stack Coolers, or Valve Drives, occurring as a result of normal use or manufacturing defect.

What is NOT covered by this warranty?
This warranty does not cover defects or failures resulting from damage caused by accident, misuse or abuse, such as:

- Improper or unauthorized service or repair.
- Failure to follow the operating instructions provided by CTC Analytics AG.
- Improper or insufficient ventilation.
- *Force Majeure*: No liability for events beyond its reasonable control, including, but not limited to, fire, storm, flood, earthquake, explosions, riots, strikes, labor disputes, transportation embargoes or other contingencies beyond the control of CTC Analytics AG. (i.e. acts of God" or "*Force Majeure*").
- Exposure to corrosive compounds.
- The warranty does not cover parts exposed directly to liquids, such as valves, valve rotors or other valve components, tubing or syringes or any other parts considered consumables and wear parts.

What is the Period of Coverage?
This warranty remains in effect for a period of one year from the date of installation.

What will CTC Analytics do to correct Problems?
CTC Analytics AG is represented by an authorized distributing or OEM partner in the respective country. These partners must be contacted to request technical assistance by phone to diagnose the nature and probable cause of any malfunction. If we determine that the problem is due to the result of a defect in the instrument or a module, any replacement module(s) that has (have) been determined to be necessary to correct the problem will be sent to user's location, shipping costs at previously agreed conditions.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

What will CTC Analytics NOT Do?

A service representative will not be sent to perform service at customer's location prior to a determination by the responsible CTC Analytics representative that such is necessary.
Only after telephone support and replacement of any modules sent to user's site have failed to resolve the problem will we send a service representative on site. CTC Analytics AG will not replace "consumable" parts, as explained above.

How can you get Technical Assistance?

To obtain technical assistance, call the responsible CTC Analytics representative from whom the instrument was originally purchased.
Please be prepared to provide the serial number of the instrument and discuss the problem in detail, and be willing to perform recommended tests and adjustments to help us determine the probable cause of and solution to the problem.

What must you do to keep the Warranty in Effect?

To keep this warranty in effect, the user must take care to avoid accidents, misuse and abuse, as described above under "What is Not covered by this Warranty?".
The maintenance guidelines outlined in the PAL User Manual must be followed. Preventative Maintenance (PM) or any service or repair task on the instrument must be carried out by CTC Analytics authorized personnel only.

Normal Responsibilities of the Buyer

The user must report any problem with the equipment to the responsible representative of CTC Analytics AG and assist the technical support representative in diagnosing and attempting to resolve the malfunction of the instrument. It is expected that the user will cooperate and will install any replacement parts (modules) that have been sent and will return any exchanges or unused replacement parts to the responsible representative of CTC Analytics AG at previously agreed conditions.

How does the LAW of various Countries or States relate to this Warranty?

This warranty gives you specific legal rights, and you may also have other rights which vary from country to country or from state to state.

How does this Warranty relate to Warranty Statements of various Distributing or OEM Partners?

This warranty statement from CTC Analytics AG gives the user specific legal rights. If the warranty statement from your purchaser, distributor, or OEM is broader, the added value of that warranty will be valid for the user. This, however, this is not the responsibility of CTC Analytics AG, but solely that of the particular distributor or OEM partner.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

3. Installation

3.1. Unpacking the Components

A COMBI PAL system is shipped in one box. The box contains the X-,Y-axes assembly, the Injection Unit, the heated Agitator, the Keypad Terminal, GC mounting kit (optional), connecting cables, power supply, (heated) Syringe kits, Tray Holders, Trays, Wash Station assembly, Safety Guard and miscellaneous parts.

1. Open the box and first remove the accessory boxes and the Injection Unit before attempting to remove the X-, Y-axes assembly;

2. Carefully lift the X-,Y-axes assembly and remove it from the box. Hold the Y-axis in place while the assembly is being removed from the box. Set the X-,Y-axes assembly on a bench;

3. Unpack the remaining small boxes and any other accessories;

4. When placing the COMBI PAL onto a GC, make sure that no objects interfere with either the Y-axis or the Injection Unit throughout the entire range of potential movement.

3.2 Assembling the COMBI PAL

note

During headspace operation, the syringe is cleaned after each injection with clean, inert gas (e.g. N_2 or He). Therefore, a 1/8 inch gas supply line must be available close to the COMBI PAL.

1. First mount the correct GC mounting kit onto the GC;

2. Loosen the two mounting clamp Torx screws of the vertical legs;

3. Place the X-, Y-axes assembly on top and fit the mounting kit legs into the groove in the X- axis. Be sure that the clamps fit completely into the grooves. Alternately tighten the two Torx screws until the legs are firmly in place;

4. Double check whether the leg claws are correctly attached to the X-axis (see Fig. 9).

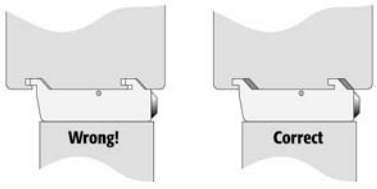


Figure 9. Attachment of Mounting Claws

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

3.2.1. 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.

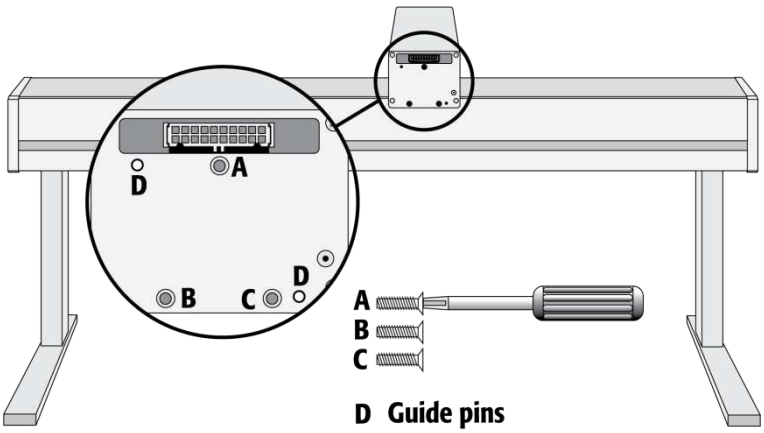


Figure 10. Attaching the PAL Injection Unit

1. Remove the three Torx mounting screws **A, B,** and **C**, used to fix the Injection Unit to the Y-axis;

2. Connect the ribbon cable A protruding from the front end of the Y-axis to the corresponding connector on the Injection Unit (see Fig. 11);

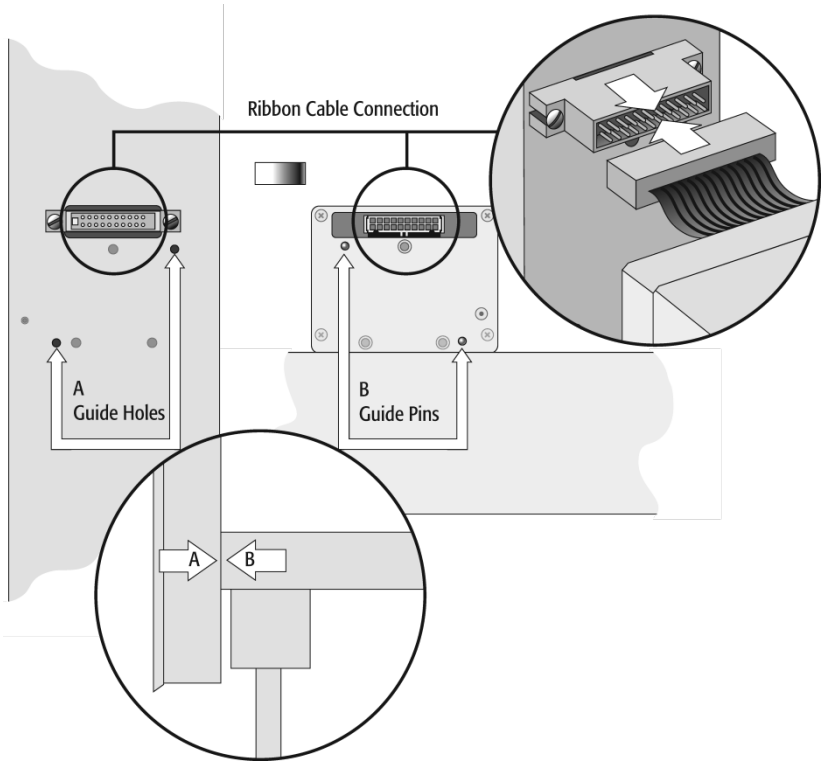


Figure 11. Connecting the Injection Unit Ribbon Cable

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

3. Hold the Injection Unit in place against the Y-axis. Make sure the two locating pins on the Y-axis fit into the two guide pin holes on the Injection Unit;

4. 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. Locate the three large holes in the black anodized frame attached to the Z-axis inside the Injection Unit. Slide the frame upwards until the top hole is centered on the top threaded hole at the end of the Y-axis. Insert and securely tighten the Torx screw A. (See Fig. 12.);

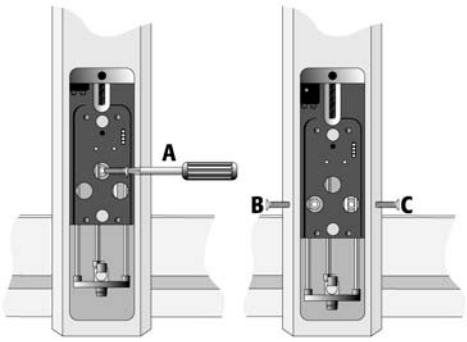


Figure 12. Inserting the Injection Unit Mounting Torx Screws

5. Install the two remaining Torx screws **B, C** in the left and right mounting holes, respectively. It may be necessary to move the elastic cord slightly to the left to insert the Torx screw **C** into the right-hand hole.

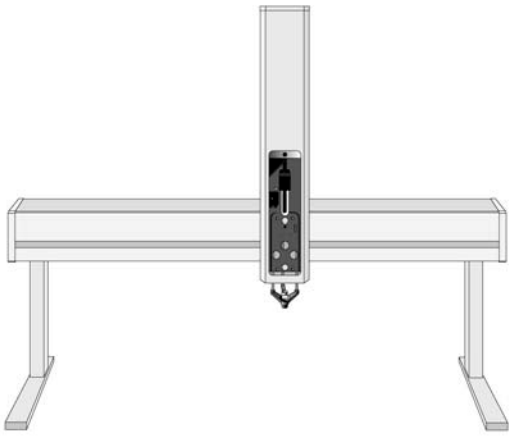


Figure 13. COMBI PAL with Injection Unit and Standalone Supports

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

3.2.2. Installing the Keypad Terminal

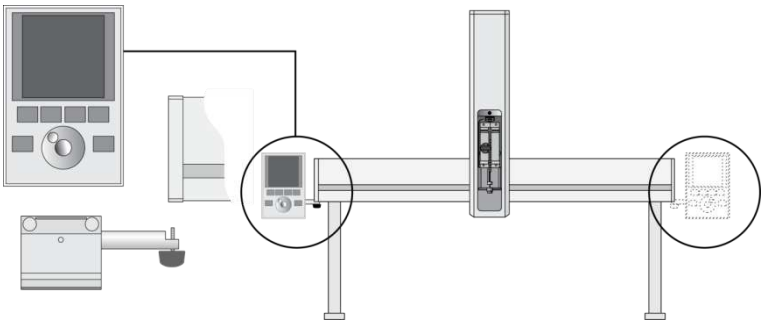


Figure 14. Installing the Keypad Terminal

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-axis;

3. Connect one end of the white coiled cable (Part No. SS8J-700) to the Keypad and the other end to the TERMINAL (SER3) interface jack on the rear side of the X-axis. For details see Figures 19 or 20;

note *Do not interchange the Terminal with LAN cable connectors.*

4. Place the Keypad terminal onto its mounting bracket.

3.2.3. Installing the Power Supply

1. Locate the power supply, the DC power cable (Part No. RS3M-2000), and the AC power cable;

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

3. Connect one end of the DC power cable to the power supply and the other end to the POWER connector at the rear side of the X-axis;

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

note *Before proceeding with the remaining steps, make sure the power to the PAL System is switched off.*

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

3.2.4. Installing the Flush Gas Pressure Regulator

note — *Safety Warning: Use an inert gas, such as helium or nitrogen, for the flush gas. Hydrogen is highly flammable and explosive at certain concentrations.*

1. Attach the OUT-side of the supplied pressure regulator at rear right hand side of the COMBI PAL. (See Fig. 15.);

2. Connect a 1/8 inch clean gas supply line to the IN-side of the pressure regulator. Use a separate gas line to avoid any pressure drop on other equipment (e.g. GC);

3. Adjust the pressure of the gas supply source to 1.0 – 1.5 bar.
   If a gas line is teed-up from an installed gas chromatograph, the preset secondary pressure will be approx. 5 bar;

4. Adjust the COMBI PAL gas pressure regulator to approx. 0.5 bar;

note — *Pressure higher than 0.5 bar will not yield higher flow rates through the heated syringe. The syringe needle is the point of flow restriction in the gas flow system.*

note — *The body of the pressure regulator can withstand up to 10 bar.*

5. Check the installed Flush Gas pressure regulator connections for leaks. Avoid any contamination of the pneumatic system (gas flow) by using liquid soap or similar leak detection aids;

6. Verify the Flush Gas pressure again during the flush period in a Headspace Cycle.

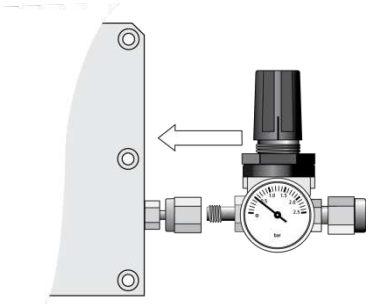


Figure 15. Installing the Flush Gas Regulator

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

3.2.5. Installing the Wash Station

Attach the Wash Station assembly to the X-axis.

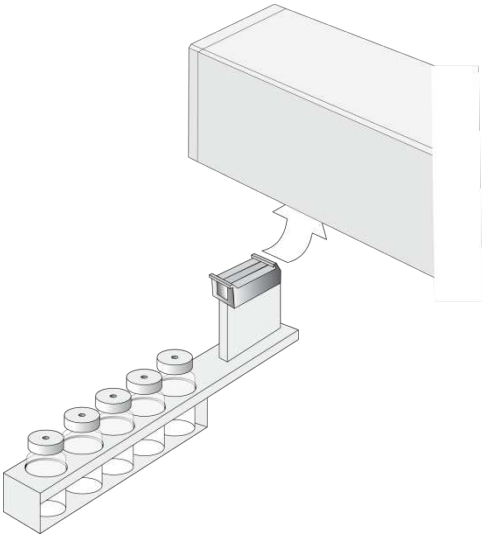


Figure 16. Installing the Wash Station

note

If other types of Wash Stations are installed, follow the instructions in the HTS PAL User Manual for the Fast Wash Station or for other types, such as Active Washstation, in the specific Addendum of the PAL User Manual. Observe safety measures if a waste line has to be installed in combination with a gas chromatograph. Do not position the waste line above a heated zone.

3.2.6. Installing the Agitator

1. Loosen the two Torx screws on the two Agitator mounting brackets;

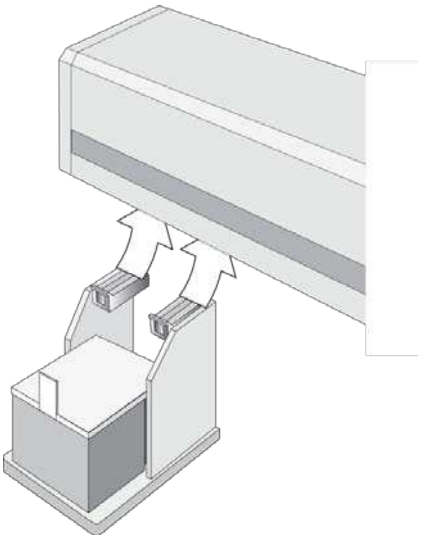


Figure 17. Installing the Agitator

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

2. Attach the Agitator to the left or right end of the X-axis. Install it with the mounting clamp teeth fit into the grooves on the bottom of the X-axis;

note

Do not position the Agitator in the middle of the X-axis. The Agitator must be installed on the right or left side. Crossing-over the Agitator with a 20 ml vial would cause a collision.

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 whether the Agitator clamps are correctly attached to the X-axis. (See Fig. 9.);

5. Connect the supplied Agitator control cable from **AUX1** to the connector on the rear side of the Agitator.

3.2.7. Installing a Tray Holder

1. Loosen the two Torx screws on the two mounting clamps located on top of the Tray Holder legs;

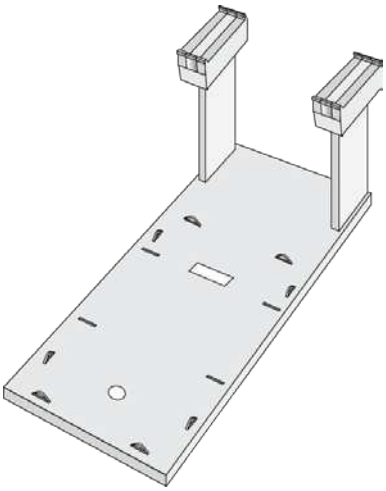


Figure 18. Installing a Tray Holder

2. Install the Tray Holder with the mounting clamp teeth fit into the grooves on the bottom of the X-axis;

3. Be sure 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 Tray Holder clamps are correctly attached to the X-axis.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

3.3. Electrical Connections

note

Always switch OFF the PAL power supply before connecting or disconnecting any COMBI PAL accessories cable! Do not interchange the Terminal with LAN cable connectors.

Before defining the COMBI PAL object positions, make sure the Agitator and Keypad Terminal are correctly connected to the COMBI PAL X-axis rear side. (See Figures 19 or 20).

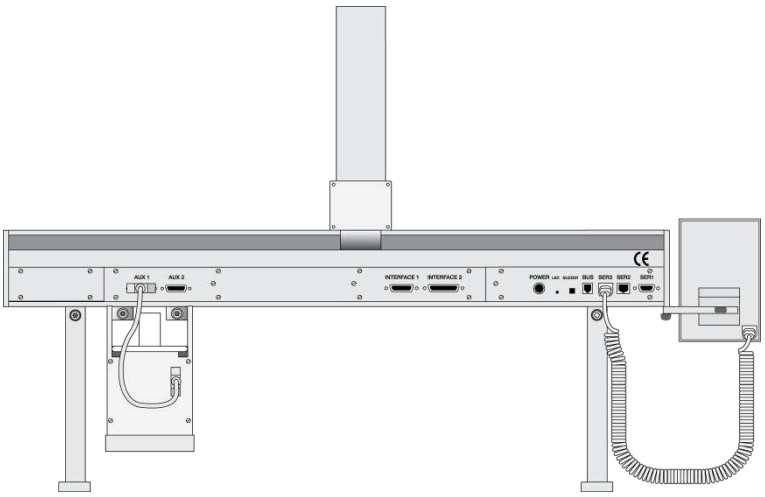


Figure 19. Electrical Connections for COMBI PAL System

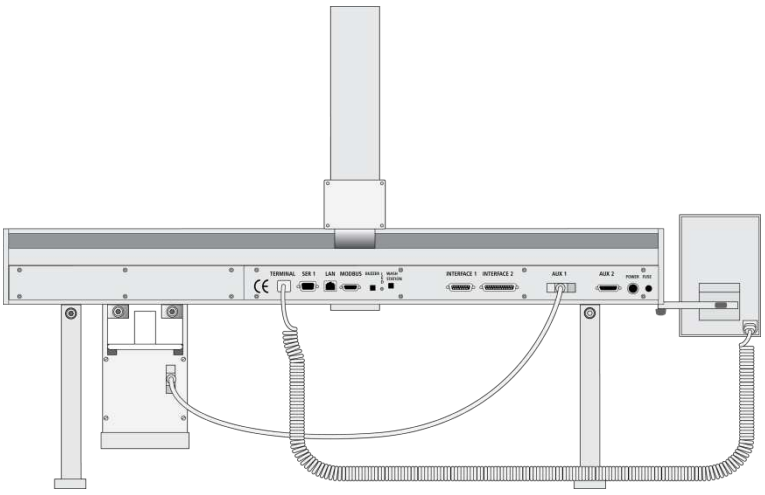


Figure 20. Electrical Connections for PAL COMBI-*xt* System

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

4. COMBI PAL Object Positions

4.1. Defining Object Positions

note

Remove the Syringe Adapter from the Injection Unit before performing the following steps.

The objective is to define the Reference Positions for all COMBI PAL Objects. Make sure the Tray Holder(s), Agitator and Wash Station are properly mounted to the PAL X-axis. The following description is an example of how to teach the reference position for a Tray Holder. The described procedure is common to all COMBI PAL Objects.

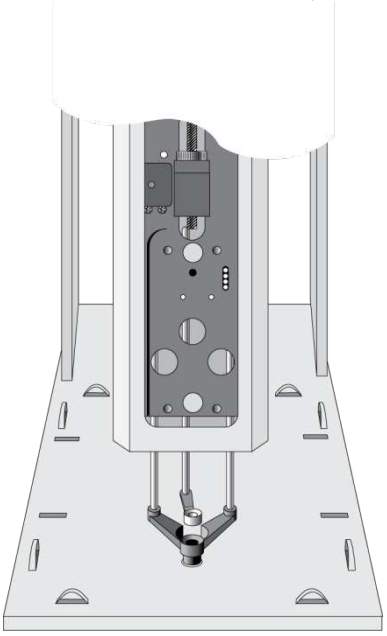


Figure 21. Object Reference Position

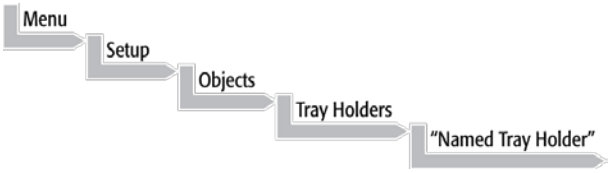
For a Tray Holder, the reference position is a hole (slightly larger than the lower needle guide) in the base plate of the holder. The lower needle guide should be centered in the hole with the bottom of the needle guide flush with the bottom of the base plate (see Fig. 21).

1. Switch ON the PAL power supply;

2. Observe the keypad display. The model name COMBI PAL will display along with the software version number. The Job Queue menu screen will then display;

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

3. When the "Job Queue" menu displays, complete the following sequence (common to all objects):



where "Named Tray Holder" represents a predefined Tray Holder, (e.g. THldr1);

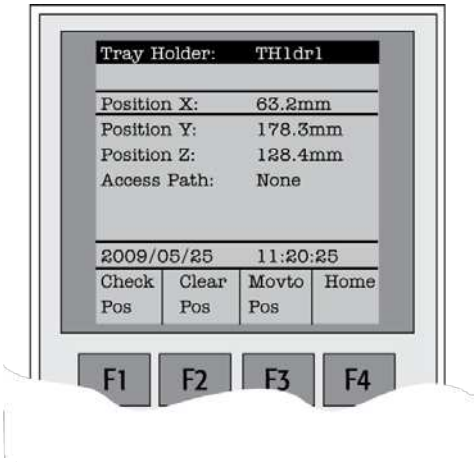


Figure 22. Menu Screen Object Tray Holder

4. After selecting "Named Tray Holder", the X-, Y-, Z- positions associated with the object will be displayed (see Fig. 22);

5. Highlight item **Position X** with the cursor bar and press **ENTER**. The Injection Unit will move to the previously defined X-axis position;

6. Rotate the outer knob to adjust the X-axis position to the Tray Holder reference position (see Fig. 21);

7. Press the inner knob to **ENTER** the position X value;

8. Repeat steps 5 – 7 for **Position Y** and **Position Z**;

9. If the F3 button "**Moveto Zero**" is activated, the Injection Unit will move to the HOME position;

10. Verify the defined X-, Y-, Z-positions by pressing F1 "**Check Pos**".

note

PAL Firmware verson 3.0.X permits correcting for an inclined surface, for example a Tray Holder or Tray where the Z-axis position in front differs from the rear position. For applications such as the PAL MALDI Option, perfect alignment of the MALDI tip is vital. This compensation for the Z-axis position is provided in the firmware class "Tool".

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

For the device "PAL MHE Tool" the PAL Firmware Object Class "Tool" is also required. See specific Addendum to PAL User Manual.

The release of PAL Firmware version 4.1.X makes possible the correction of all three axes, X-, Y-, Z, in the firmware class "Tray." The correction of the inclination can be made for a tilted Tray in the direction of the row and/or the column. Teaching is possible in the "Utilities" section by using the path:

Menu/Utilities/ Trays.

Figure 23 illustrates possibilities of correction. Details for teaching are given below.

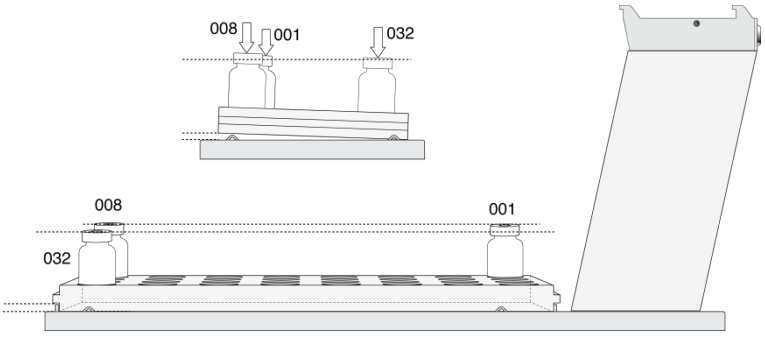


Figure 23. Inclined Tray, Corrections for X-,Y-,Z-Axes

Note that these functions are not available for the GOMBI PAL if operated solely on PAL Firmware version 2.4.X or higher, but neither with firmware version 3.X.X. nor with version 4.X.X.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

4.2. Description of Object Positions

4.2.1. Tray Holder (e.g. THldr1)

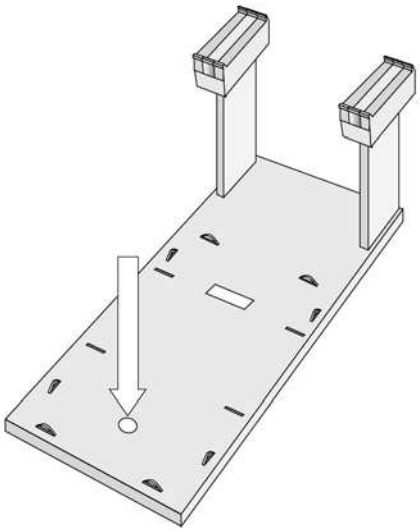


Figure 24. Tray Holder Reference Position

For a Tray Holder, 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.
Figure 24 shows the example of a Tray Holder for a single Tray, e.g. "THldr1" for "Tray 1" with Tray Type "VT98".

4.2.2. Trays

In general it is not necessary to teach a Tray position. The Tray Holder has a teaching position, as described above. A Tray is assigned to the Tray Holder. The numbers (values) for the relevant items are stored in the firmware object "Tray". To complete the combination of a Tray Holder and a Tray, it is necessary to assign the corresponding "Tray Type" to the "Tray."
The "Tray Type" contains the geometric data for the Tray and information such as how many samples are in a row and a column in the Tray. A Tray Type defines the pattern and sampling sequence of sample location within a Tray. For details see below.

As described above, the Tray is physically placed in the Tray Holder, the firmware assigns the Tray to the Tray Holder and the Tray Type to the Tray. This is routine procedure as long as no special circumstances need be considered, such as customized Trays or Tray Types.

PAL Firmware version 4.1.X now makes a correction possible if the Tray surface is not exactly horizontal and planar but is inclined in one or more axes. At version 4.1.X this is standard and a dialog window pops up the moment the Tray has been checked-out at the corners to verify vial positions and heights. How to correct a possible inclination is explained below.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

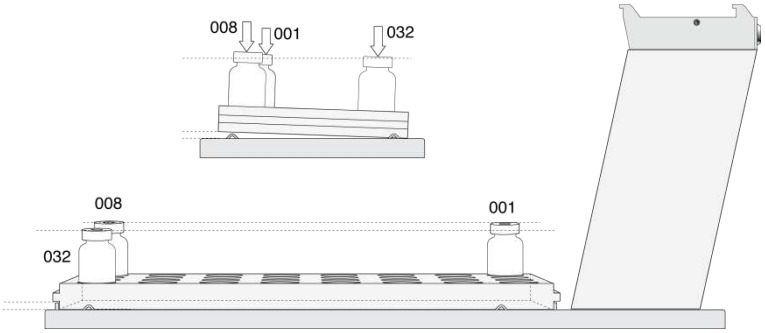


Figure 25. Demonstrating a possible Inclination of Tray in X-,Y-,Z-Axes.

4.2.2.1. Definition of a Tray Row and Column

The PAL System defines **Rows** and **Columns** by the order in which samples are treated. A "Row" is not associated with an X- or Y-axis. The definition is visualized below with Tray Type VT32 and DW96:

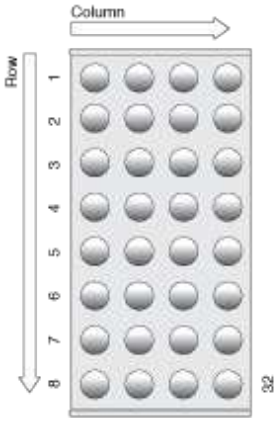


Figure 26. Tray Type VT32

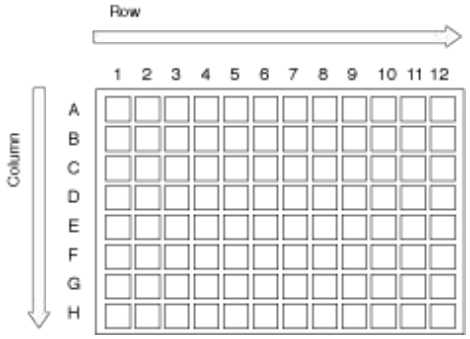
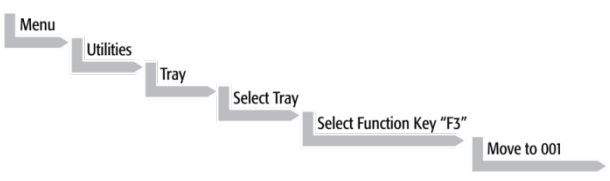


Figure 27. Tray Type DW96

4.2.2.2. Correction for Sample Position in X-, Y- or Z-Axes PAL Firmware Version 2.X.X.

The following description of the correction is done by using the path to the "Utilities" section.

After selecting the Utilities function "Trays", verify whether the Tray Type assigned corresponds to the Tray placed into the Tray Holder. If this is verified, the vial positions can be checked at the three corners of the Tray. This is activated by the "F3" function key.



PAL is a registered trademark of **CTC** Analytics AG | Switzerland

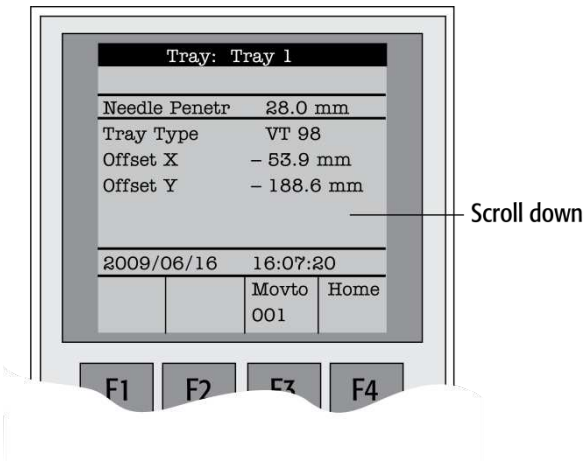


Figure 28. Utilities Function "Trays"

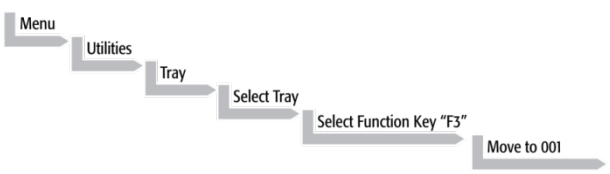
The Injection Unit moves to Tray position no. 001. With the help of the inserted syringe is it possible to check the optimized position of the needle tip matching with the vial or well position.
In case the position is off, make corrections in X-, Y- or Z-positions.
Continue with function key "F3" to move to the next corner to verify this position. If the position matches, continue with function key "F3" to move the unit to the third corner position.
If a deviation of the ideal position is observed in second or third corner, the corrections have to be made on the position no. 001. The offset is bound to position no. 001.

note *Activating one of the parameters Offset X-, Y-, or Z-axis at the positions of second or third corner can bend the syringe needle.*

4.2.2.3. Correction for Inclination in X-, Y- or Z-Axes PAL Firmware Version 4.1.X or higher

The following description of the correction is done by using the path to the "Utilities" section.

After selecting the Utilities function "Trays", verify whether the Tray Type assigned corresponds to the Tray placed into the Tray Holder. If this is verified, the vial positions can be checked at the three corners of the Tray. This is activated by the "F3" function key.



PAL is a registered trademark of **CTC** Analytics AG | Switzerland

A dialog window opens, displaying a note to "Adjust offset X-, Y-, Z for position 001". Continuing in this dialog will provide the user the opportunity to adjust all three axes perfectly by the top of the vial. Please note that this step is only valid for position number 001.

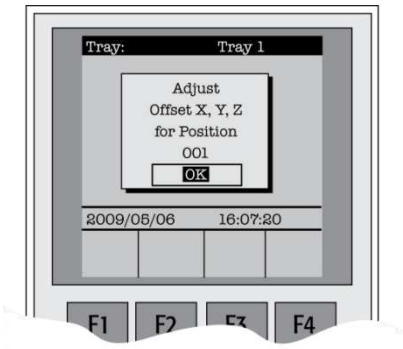


Figure 29. Adjusting "Offset X,Y,Z" for Tray Position 001

To check the next corner of the Tray, activate function key "F3" again, example Tray Type "VT32", position 008.

The next information provided by the pop-up window asks to correct a possible inclination of the "Row". Continuing the dialog provides the user the opportunity to adjust the three axes perfectly to match the vial top – or in case of a well-plate, the top of the plate.

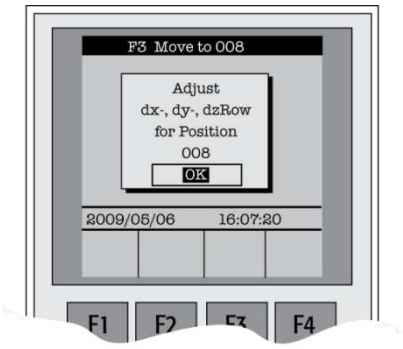


Figure 30. Adjusting Row Inclination at second Tray corner position

The last step will be to move to the next corner of the Tray by again activating function key "F3". This will be position 32 in the example of Tray Type "VT32".

A possible inclination of the Tray column can be corrected in the same manner as described above.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

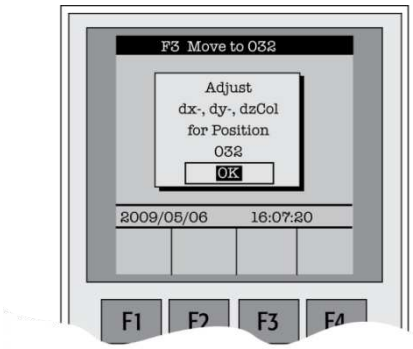


Figure 31. Adjusting Column Inclination at Third Tray Corner Position

The three corner points are now adjusted for a possible inclination of the Tray in any axis. A possible deviation from an ideal axis position for the other vials, caused by variance from the horizontal, is interpolated by the system without further teaching.

note

For routine work using standard vials it is not necessary to compensate for a possible inclination as long as the vial detection is within the "Z-Tolerance" range.

4.2.3. Wash Station: Wash1/Wash2 Reference Point

note

If positions of other types of Wash Stations have to be taught, follow the instructions in the HTS PAL User manual for the Fast Wash Station or for other types, such as Active Washstation, in the specific Addendum of the PAL User Manual.
Observe safety measures if a waste line has to be installed in combination with a gas chromatograph. Do not position the waste line above a heated zone.

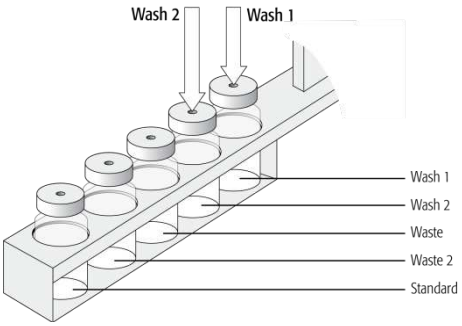


Figure 32. Wash Station Wash1/Wash2 Reference Point

For the Wash Station, the reference positions are the two holes in the wash vial caps (see Fig. 32, Wash1 and Wash2). The lower needle guide should be centered in these holes with the bottom of the lower needle guide lightly touching the surface of the caps.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

4.2.4. Wash Station: Waste/Waste2 Reference Point

Injectors (Waste / Waste2)

note

The Waste positions represent an "Injector" within the PAL software. It is defined in the Object class "Injectors".

For **Waste / Waste2** the reference positions are the two holes in the wash vial caps (see Fig. 33). The lower needle guide should be centered in these holes with the bottom of the lower needle guide lightly touching the surface of the caps.

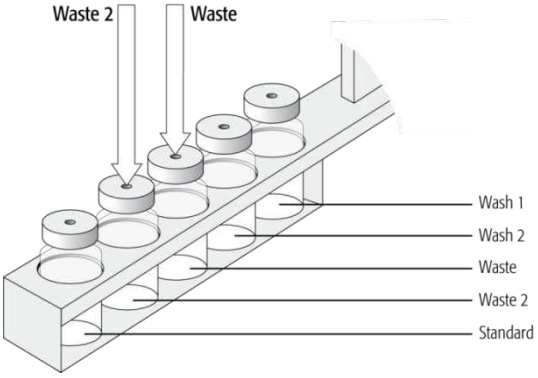


Figure 33. Wash Station Waste/Waste2 Reference Position

4.2.5. Vials (e.g. "Standard" Position in Wash Station)

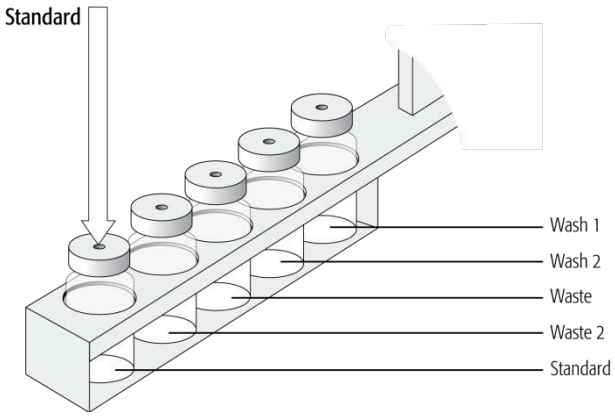


Figure 34. Wash Station Standard Reference Position

The position "**Standard"** on the Standard GC Wash Station is defined in the PAL Firmware class "Vials".
This position can be used for a standard, an internal standard, a reagent solution, a calibrator solution or any other type of solution. The advantage to the user is that a large quantity of solution is available and can be defined by "Job" (conventionally known as "Sample List" or "Sequence" in other systems).

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

The reference position is the hole in the vial cap. Teaching this position is identical for Wash or Waste vials.

4.2.6. Injectors (e.g. GC-Inj1)

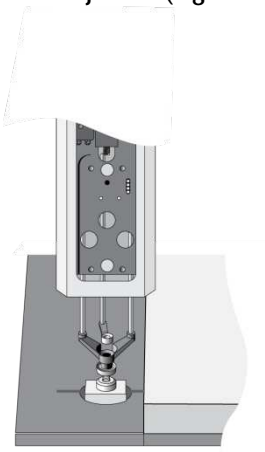


Figure 35. GC Injectors (e.g. GC Inj1) Reference Position

note

For certain GC models, centering rings are provided with the GC mounting kit. If such a centering ring is available, it should not only be used for teaching the injector position but also for routine work. The ring stabilizes the needle guide of the PAL Injection Unit at the moment of needle penetration. It acts as a guide tool and prevents needle bending.

For the GC Inj1 (GC Inj2) the reference position is the appropriate GC Injection port. The lower needle guide should be centered on the port with the bottom of the lower needle guide lightly touching its surface.

4.2.7. Agitator Reference Position

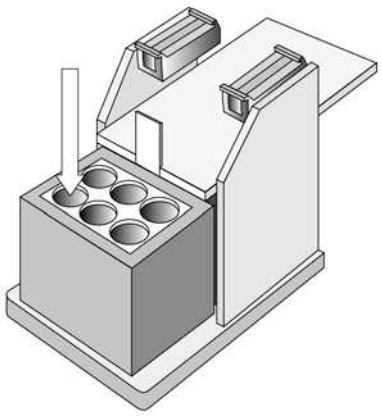
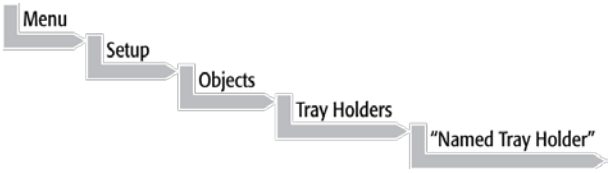


Figure 36. Agitator Reference Position

The Agitator **Reference Position** is located as indicated in Figure 36.
To define the position, complete the following steps:

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

1. When the "Job Queue" menu is displayed complete the following sequence;



2. Select **"AgiHldr"** and scroll to **Access Path / Restore Path;**

3. If the Agitator is located on the left side, choose **AgiOpnL / AgiClsL**
   If the Agitator is located on the right side, choose **AgiOpnR / AgiClsR;**

note *Steps 2+3 are obsolete beginning with Firmware version 2.2.0 or higher.*

4. Open the white Agitator cover manually and block it open with a screwdriver, fitting it into the side of the cover;

5. Insert a 20 mL vial in sample position No. 1;

6. Attach the red vial transport ring to the lower needle guide;

7. Define the X-, Y-, Z- positions common to all objects as described in topic 4.1. The reference position is located at the hole in the steel vial cap. The lower needle guide should be centered on the vial cap and should touch the cap;

8. Remove the screwdriver and close the Agitator cover.

note *After all positions have been set, perform a firmware backup of the existing configuration by using the PAL Loader software. For instructions, see below.*

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

5. Syringes

5.1. Selecting Syringes

The standard COMBI PAL is shipped with two syringe kits:

One PAL SyrGC10µL Kit GC Syringe 10 µL for COMBI PAL,
consisting of:
1 pc syringe adapter
1 pc plunger holder
2 pcs syringe SYRC L10-26S-AS or
2 pcs syringes SYRC L10-23S-AS
(in combination with Shimadzu GC.)

1 PAL SyrHS2.5mL Kit HS Syringe 2.5 mL for COMBI PAL,
consisting of:
1 pc syringe heater
1 pc plunger holder
2 pcs syringe SYRC HS2.5-23-5 or
2 pcs syringe SYRC HS1.0-23-5
(in combination with a Varian GC)

The supplied syringe kits cover the standard liquid and headspace GC injection techniques. However, certain applications may require different syringe sizes. Consult "COMBI PAL Accessories" for detail.

5.2. Syringe Priming (for Liquid Syringe Types only)

It is critical that syringes be primed before beginning sample preparation. Prime every liquid syringe first manually before inserting into the PAL system. Afterwards, the syringe can be primed and tested by using the Utility function **"Clean Syr"**.

5.3 Installing a Syringe for Liquid Injections

note

*Before a syringe is inserted, the position "***Change Syr***" should first be verified. The position "Change Syringe" should not be located above an object where the needle could collide with a vial, as for example.*

Path:
Menu/Utilities/Syringe/function key "F3" "Change Pos".

Move the PAL Injection Unit to a location where a collision cannot occur by selecting the X- and Y- axes. The value for the Z-axis is given as a default and a change of this position is not necessary in standard operation.

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

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

2. Place the blue plunger holder into the injection unit;

3. Place the syringe in the appropriate syringe adapter. Pull the plunger out to approximately 20% of its length. (See Fig. 37.);

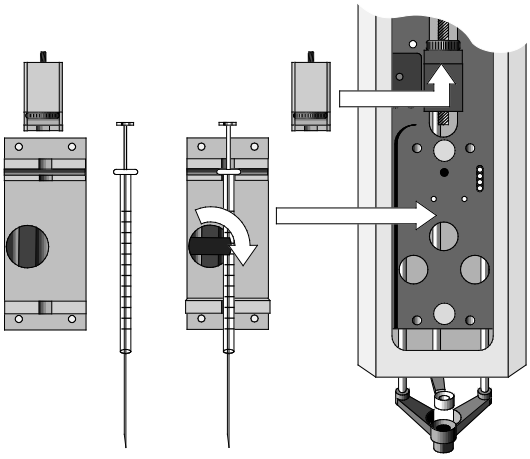


Figure 37. Syringe and Syringe Adapter for Liquid Injections

4. If necessary, loosen the plunger retaining screw in the plunger holder;

5. Move the syringe, installed in the syringe adapter, partially into the Injection Unit. First, guide the needle into the upper needle guide and then into the lower needle guide. (. Fig. 38);

6. Insert 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 **"Home".** The plunger moves down until it hits the mechanical stop. This position is stored as the syringe's zero volume position. The Injection Unit then returns to the HOME position.

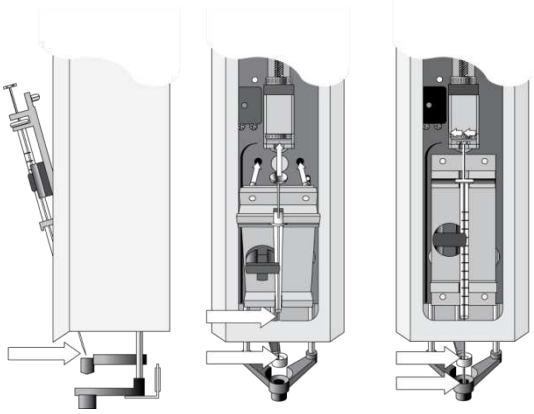


Figure 38. Installing and Removing a Syringe for Liquid Injections

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

5.4. Removing a Syringe for Liquid Injections

1. Select "Menu" and press **F1/Chang Syr**. The Injection Unit will move to a location that facilitates 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 upward to remove the syringe adapter, with the syringe, from the Injection Unit.

5.5. Installing a Syringe for Headspace Injections

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

2. Fit the red plunger holder onto the plunger button;

3. Place the syringe in the appropriate heated syringe adapter. Pull the black plunger out to approximately 20% of its length. (See Fig. 39.);

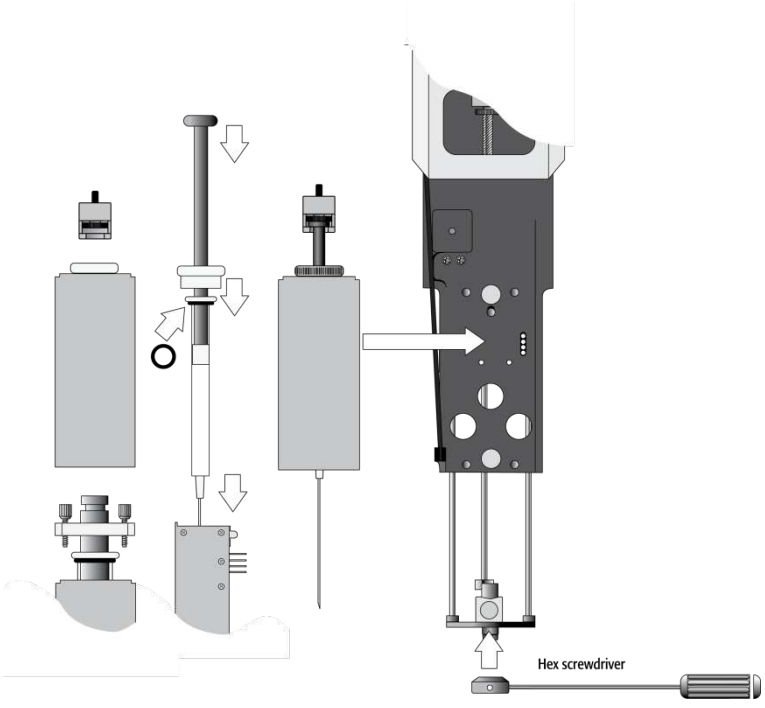


Figure 39. Headspace Syringe and heated Syringe Adapter

4. If necessary, loosen the plunger retaining screw in the red plunger holder;

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

5. Lift the lower needle guide, sliding it into the upper needle guide. Insert the syringe needle tip and match the magnetic pins of the syringe holder with the counter positions on the syringe slider. Let the lower needle guide return slowly and make sure the needle tip does not catch on the guide. (See Fig. 40.);

6. Press the heated cartridge firmly against the Z-axis slider to ensure that the Syringe heater unit engages. Move the plunger up (plunger holder) until the thread of the screw catches the thread of the plunger bushing. Tighten the screw to fix the plunger holder. (See Fig. 40.);

note *The clamp provided with the Headspace syringe kit must only be installed with a 5 mL HS-syringe. See note enclosed in the syringe kit.*

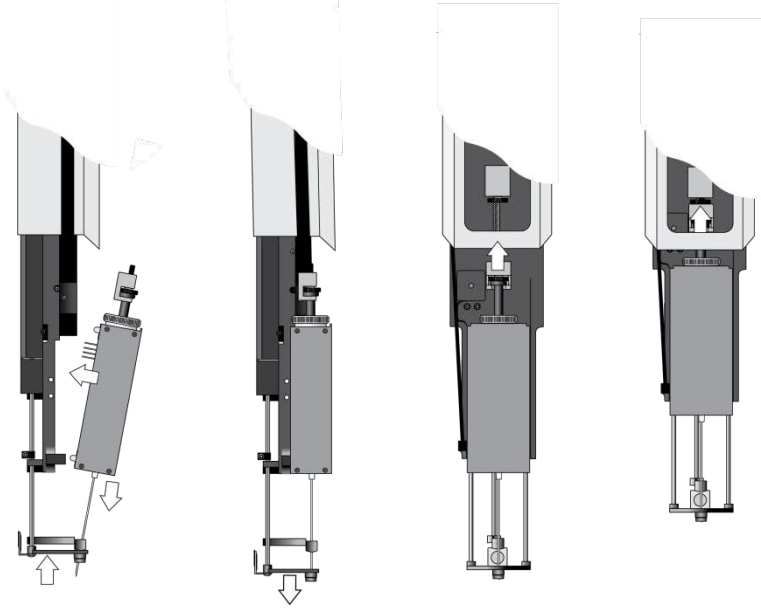


Figure 40. Installing and Removing a Headspace Syringe

7. Press "Home". 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.

5.6. Removing a Syringe for Headspace Injections

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

2. Unscrew the red plunger holder from the plunger bushing.
Move the black plunger slightly down to gain some space to be able to lift out the syringe cartridge;

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

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

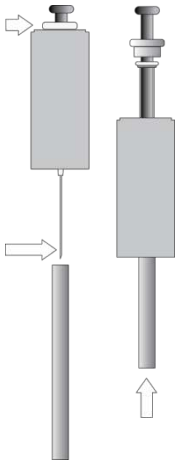


Figure 41. Removing a Headspace Syringe from the Heated Syringe Adapter

4. Unscrew the white plastic retainer;

5. Place the supplied gray plastic tube over the needle. This plastic tube protects the syringe needle at shipment, but it can be used as a syringe removal tool;

6. Using the gray plastic tube, push the Headspace Syringe through the heated Syringe Adapter.

note

Gastight Headspace syringes have very tight plungers when new. After a short operating time at elevated temperature, the plunger tip adjusts its diameter. Should the syringe be used later at lower temperatures, there will be a risk of leakage. The polymer tip never expands at lower temperatures. Therefore, a particular Headspace syringe should always be used at the same or higher temperatures.

6. Interfacing the COMBI PAL to Other Devices

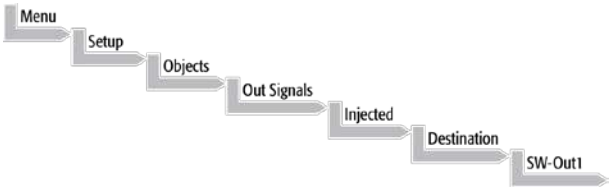
6.1. Synchronization and Output Signals

Synchronization Signals (**Sync Signals**) are inputs that tell the COMBI 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 the next table below for the PAL Events and signal assignments associated with the standard PAL **"GC-Inj", "HS-Inj"** and **"GC-Dual"** cycles.

Certain types of integration of the PAL system into data handling or control software, such as ChemStation, Xcalibur, Galaxie or Chromeleon, accomplish synchronization of the Ready/Start signal done directly via software control

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

(RS232/LAN). A synchronization cable is not required and the Sync Signal "Start" must be set to "Immediat".



To assign a physical Event (e.g. SW-Out 1) to an existing signal Object ("**Injected**"), complete the following menu selections:

PAL Systems 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 Object signal.

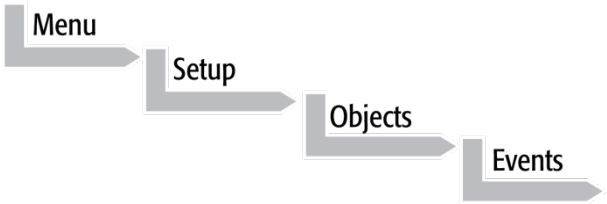
If a signal is to be ignored, then its corresponding Event must be set to **"Immediat"**.

Standard Assignment for COMBI PAL Injection Cycles		Description	Default Events	INTERFACE 1 Pin #
Start JobQueue (Sync Signal)		Start a Job Queue (Job). Prerequisite is a defined "Job" with a method assigned. Useful for automated, unattended, timed sampling.	Immediat	
Start	(Sync Signal)	Start a cycle (Input from GC or data system)	Immediat [1]	7 8(GND)
Start2	(Sync Signal)	Continue the cycle "GC-Dual" for the second sample	Immediat (Ignore)	
Inject	(Sync Signal)	Inject READY to INJECT	Immediat (Ignore)	
Inject2	(Sync Signal)	Inject the second sample for "GC-Dual" cycle	Immediat (Ignore)	
Injected	(Out Signal)	Activated at the moment the sample has been injected	SW-Out1	3 4
Injectd2	(Out Signal)	Activated at the moment the second sample has been injected	Off	
Running	(Out Signal)	Active as long as the Job Queue is being processed and the PAL is not in an error state	Off	

1) If used to synchronize with Sync cable, change setting to "TTL-In1"

If an item of the class **"Sync Signal"** is assigned to an output signal, such as "**TTL-In1**", then this TTL contact must be defined as either "**Active High**" or "**Active Low**", as expected by the GC system. This is defined in the PAL Firmware class "**Events**".

PAL is a registered trademark of **CTC** Analytics AG | Switzerland



Select the corresponding item and set the mode accordingly.

The setting is provided with the schematic description of the GC Sync Cable supplied with the specific GC Mounting Kit.

7. PAL System Software

7.1. PAL Loader Software

The purpose of PAL Loader Software is to create a backup file of the complete PAL System Firmware. The core software (firmware) and all PAL Firmware Objects, including all settings (Items), the local methods, and jobs are saved in one file.

The PAL Loader software has a second function of loading the firmware or a complete backup file to a PAL system.

The PAL Loader software has always been a part of the PAL System.
The following PAL Loader Software versions are in use:
- PAL Loader Version 1.0.1
- PAL Loader Version 1.1.1

A new PAL Loader software, "Loader" version 2.1.1 (or higher), has been developed for the PAL-*xt* system.

The PAL-*xt* system requires PAL Firmware 4.1.X or higher, which calls for the new "Loader" software.

The new PAL Loader Software is backwards compatible. The software can be used for all PAL Firmware versions.

The name of the *.exe file has been changed intentionally to avoid conflicts when old and new versions are installed on the same computer:

- PAL Loader version 1.1.1: PALLOAD.exe
  PAL Firmware version up to and including 3.X.X

- PAL Loader version 2.1.X: PALoader.exe
  PAL Firmware version as of 4.1.X
  but backwards compatible with lower versions.

Details are described in: "Addendum to PAL User Manual, PAL Loader Software Version 2.1.X, Installation and Operation".

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

7.2. PAL Object Manager Software

The PAL Object Manager software is used to load a new PAL Firmware Object to a system after a new module (hardware module) has been added to the PAL System.

The PAL Object Manager software is the software used to handle the so-called PAL Object List.

The software version 2.2.1 or higher has been developed for the PAL-*xt* System that, in addition to serial communication, also permits LAN communication (TCP/IP). The software is backwards compatible and can be used for all PAL Firmware versions.

The PAL Object Lists have to match the corresponding PAL Firmware version, as shown in the list below:

- PAL System — Firmware Versions 2.X.X
  PAL Object Lists Rev. K (or higher)
- PAL System — Firmware Version 3.0.X
  PAL Object Lists Rev. K (or higher)
  See specific Object Lists for this FW Version 3.0.X.
- PAL-*xt* System — Firmware Version 4.1.X (or higher)
  PAL-*xt* Object Lists Rev. B (or higher)

The two Object Lists for the PAL and PAL-*xt* Systems can be loaded with the same PAL Object Manager software. This simplifies the handling in cases where the PAL and PAL-*xt* Systems are in use within the same working environment.

Detailed information is available in the 'Addendum to PAL User Manual PAL Object Manager Software'.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

8. Establishing Communication with Computer

The PAL System allows a serial communication protocol with a PC. As a new feature, the PAL-*xt* System provides LAN communication, also referred to as "TCP/IP" or "Ethernet".
The PAL-*xt* System requires a dedicated "APR Control-*xt*" board and PAL Firmware version 4.1.X or higher.

8.1 COM Port Settings

The port settings are normally defined in:
Windows\Control Panel\Device Manager\Ports.
The standard settings for the serial communication are shown in Figure 45.
It is important to understand that the application (e.g. PAL Loader Software) does actively set the communication parameters, and the baud rate is set for optimized use.

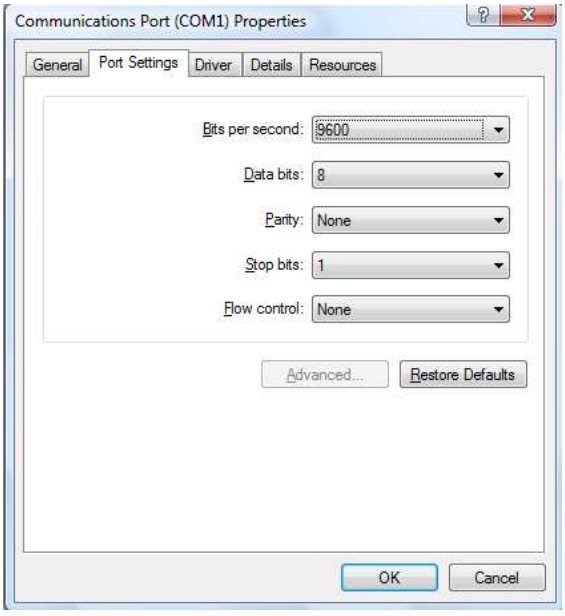


Figure 42. COM Port Settings

A quick way to check whether serial communication with the PAL System can be established is to use the PAL Loader software. For details see "Addendum to PAL User Manual PAL Loader Software".

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

8.2 Setting up LAN Communication

Select the firmware "Communication" class by the following path:

Menu/ F3-Setup/Communication

note — *Menu/ F3-Setup/Communication*
See detailed description below under point 10.

The system automatically searches for the MAC address when the "Setup Communication" window is accessed.

Figure 43. Reading the MAC Address from the Ethernet Communication Port

This search for and reading of the MAC address takes approximately 10 to 15 seconds. If successful, the MAC Address is stored in the system firmware and can be viewed on the terminal as follows.

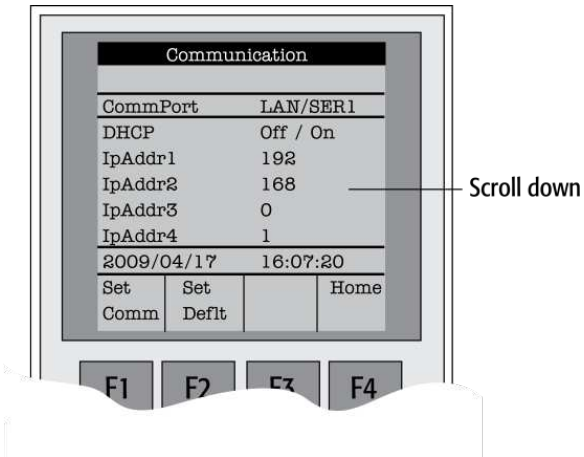


Figure 44. PAL-*xt* Communication Settings

Pressing function key "F1", "Set Comm" sets the selected communication mode. The same is achieved by pressing "ESC" or "Home".

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

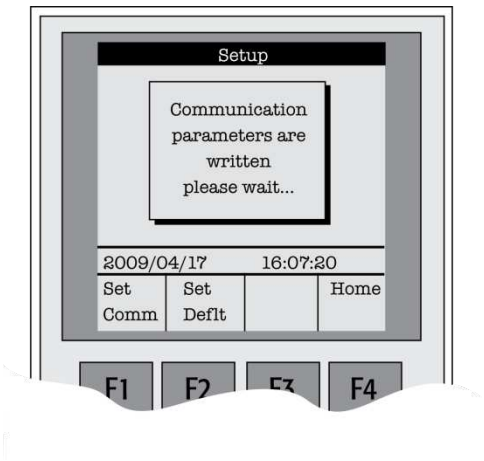


Figure 45. Setting Communication Mode

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

8.2.1. Explanations for the various settings for the Communication Protocol

Parameter	Explanation	Remarks
CommPort	Setup for serial (SER1) or LAN communication.	If serial communication is selected, all other parameters in PAL-*xt* Firmware "Communication" class are ignored.
DHCP	= Dynamic Host Configuration Protocol. If set to "Off", the IP address is provided by the user, see IPAddr1 to 4. The user can ask the network administrator for a suitable IP address. If set to "On", an IP address is dynamically sought throughout the provided network.	It is advisable to use a fixed IP address, set the "DHCP" parameter to "Off". In this mode the PAL-*xt* System always has the same fixed IP address. Troubleshooting is easier for the network administrator. See also special remarks below.
IPAddr1 to 4	Enter the IP address divided into four blocks, example IP default Address: 192.168.0.1.	The IP address is a fixed PAL-*xt* System address. The IP address is often provided by the network administrator.
SubNet1 to 4	SubNet mask for network configuration.	The SubNet mask must be provided by the network administrator.
TCPPort	This parameter is read only, no changes possible.	The network administrator must be informed about this setting. The port must be cleared of firewall protection to enable communication.
StdGateway 1 to 4	If Gateway is used in network, the Gateway IP address (switch, hub) has to be entered.	Gateway is used if independent networks need to communicate interactively. Communication within the network is provided by a hub or switch, defined as "Gateway".
MACAddr1 to6	The unique MAC Address for the PAL-*xt* System is read and entered into this PAL-*xt* communication protocol. This is a read only parameter field.	The MAC address is provided by the Ethernet communication hardware. The address is also visible beside the read-out from the terminal on the label affixed to the Ethernet module on the PCB "APR Control-*xt*".

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

8.2.2. Special Remarks to the above listed Parameters

DHCP:
If "DHCP" mode is active, an automatic search for the IP address is activated. If a free IP address is found, the communication between the PAL-*xt* System and the network becomes established. The new IP address (found through "DHCP" search) is immediately entered into the PAL-*xt* Communication protocol as seen from the local terminal. The parameters "IPAddr1 to 4" are not updated until one opens the communication menu again.

The Setup for the PAL Loader software requires entering the IP address or hostname. The dynamically provided IP address is displayed on the local terminal. As an alternative, the following setup procedure can be used:

Prerequisite: PAL-*xt* setting in "Communication" class: DHCP = On.

Open the "Setup" window and enter the following name in the "Hostname or IP Address" field: CXXXXXX. The "Xs" being the last six characters of the MAC address, which is known from the parameter "MacAddr4, MacAddr5, and MacAddr6.

If a MAC address only consists of one character, insert a 0 in front of it. If, for example, MacAddr4=BA, MacAddr5=35 and macAddr=3, enter CBA3503 and not CBA353.

8.3 Troubleshooting for Serial or LAN Communication

Both communication protocols are described in detail in the "Addendum to PAL User Manual PAL Loader Software".

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

9. Special Functions

This section describes special functions which can be activated by the "PAL Extended User Mode".
The purpose of having two software access levels is to display discrete items and sections of the firmware at each level. Settings which need to be done rarely, perhaps at the time of installation of the PAL System, are hidden at level 1(User Level) and revealed at level 2 (Extended User Level). This also protects the PAL System in group use. Nevertheless, the important points should be known by the user and are described below.

9.1. How to Access "Extended User Mode"

Extended User Mode can be accessed by the following path:

The above path as shown is an abbreviation for the following steps:

- Menu/ scroll the cursor to "**Setup**" /
- Press function key "**F3**" /
- Activate "**Setup**" by pressing the center of the selector knob.

In this PAL User Manual or in technical notes, only the following will be referred to:

Menu/F3-Setup/.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

9.2. Section "F3-Setup"

The path to access this section is shown below.
This "Setup" section at the Extended User Level provides various options to access other classes which are not visible at the User level. Some classes are known but may show some new items. Details are described below.

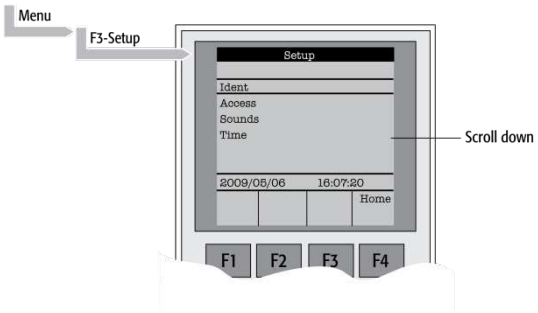


Figure 46. Selecting "Setup" in Extended User Mode

Object	Description
Ident	The "Identification" of the system provides the opportunity to assign Users, site, and system names. The serial number of the PAL System can be entered at this level. Remark: After loading a fresh PAL Firmware Backup file, the SNo. Is displayed as "XXXXXX".
Access	Access can be selectively opened or limited to different users for the "Job", "Method" or "Setup".
Sounds	The "Beep" sound can be adjusted to specific needs. For safety reasons it is advisable to keep the default settings, especially the "Warn Move," turned ON to signal the start of the PAL System to the user.
Time	The PAL internal clock can be set. Remark: If the clock is fast, reset all items, from "Year" to "Seconds" and use the mandatory function key "F1" "Set Time".
Communication	The communication mode serial or LAN can be selected and conditions are defined. For details see above point 8 or Addendum PAL Loader Software.
System	Basic parameters can be predefined for specific needs. Details see below.
Service	Basic service tests can be activated. Details see below.
Objects	Accessing the PAL Firmware class "Objects" in the Extended User mode provides more detailed possibilities for object items. At this level an Object can be copied or deleted by using the specific function keys. This provides quick access to add e.g. a second or third injector.

Items displayed in *"italic"* are available beginning with PAL Firmware Version 4.1.X.
Items displayed in "**bold**" are explained in detail below.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

9.2.1. System

The following "System" Items can be changed by selecting the particular item. Beginning with PAL Firmware version 4.1.X, an intermediate step was added. After selecting "System", the new "Settings" level follows. Activating "Settings" opens up the described Items below.

Item	Description
Syr Detect	The syringe detection can be turned off in cases of sensor failure or if a special syringe with unknown ID is installed. Turning OFF the syringe identification sensor automatically displays a dialog box enabling the selection of syringe identification manually.
Start Ref	This item provides the choice of referencing all axes at the start of the system or suppressing the referencing. It is advisable to use this function actively to detect a possible loss of steps.
Stop XY Error	This function allows turning off the automatic recovery of the PAL system after detection of a collision (loss of steps of a stepper motor). **Stop XY Error = ON**: Automated recovery turned OFF **Stop XY Error = OFF**: Automated recovery turned ON In PAL Firmware version 2.3.X the new feature that recovers automatically after detecting a collision has been implemented. Firmware version 2.6.2 provides the possibility of disabling automated recovery. If recovery is turned OFF, the PAL system always checks its position before moving to the injection port for injection. This can lead to an extra move, crossing over the X-,Y-axes sensors – if the injection port is at the opposite end of the X-axis relative to the sample location, (zero X-axis position in-between sample location and injection port). For **critical application** fields, e.g. clinical analyses, it is advisable to turn off the automated recovery; **Stop XY Error= ON**.
PlgPathCheck	The plunger travel path is monitored to ensure that the plunger tip reaches the syringe zero point in all cases – compared to original plunger referencing and defining the syringe zero point. If an error is detected, the PAL System stops operation. This feature is useful if sample solutions with particles need to be handled, or if the syringe type is not adequate for the solution composition, or if the syringe plunger is blocked or even bent, such an error will be recognized and the system will come to an emergency stop.
PlgChnge Pos	Changing a syringe using the Menu function "Chnge Syr" moves the plunger up to the position specified by this item. For normal use, accept the default values.
Init Syr at	The syringe plunger can be initialized (referenced) at "Home" or "Waste" position. If samples with a high danger of toxicity are treated, it is advisable to use the "Waste" position for referencing.
Inj Signal	An Autosampler is usually the master in a total chromatographic system. The other components send a "Ready" signal to enable a start of the Autosampler. At the moment of injection a Start signal is sent from the PAL System to the other component(-s) of the entire system. With this "Inj Signal" item the status at which the signal is sent out can be defined. The syringe is filled with the defined sample volume. **PlgUp** = Start signal at the moment the plunger starts moving down for injection. **PlgDown** = Start signal at the moment the plunger reached zero point from syringe. (recommended for large volume injection, but not in combination with Agilent Chemstation.) **ValveSw** = Start signal sent at the moment the injection valve is switched, HPLC technique. **PreInj** = Start signal sent at a time before injection, as with a sample preparation device started before a GC or LC system. Minus time relative to chromatographic start time.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

Vial PrePress	This item can be activated to avoid a vacuum if a relatively large amount of sample is taken out of a small volume vial. If e.g. a volume of 50 µL is specified for injection, the PAL system first takes 50 µL ambient air and "injects" this volume into the sealed vial, causing overpressure in the vial. After this step, the sample volume can be aspirated without forming a vacuum. This functionality is only valid for liquid sampling, not for the Headspace technique. Starting with PAL Firmware version 4.01X this item is also active in combination with Cycle Composer.
LC-Inj	Standard cycle for HPLC technique. Details on method parameters see Appendices, point 3, "Injection Cycles" and point 4, Flow Chart "Firmware Overview"
LC-Cut	Cycle for column switching with two valves, HPLC technique. Both valve drives have to be controlled through "AUX" interfaces. Details on method parameters, see Appendices, point 4, Flow Chart "Firmware Overview"
GC-Inj	Standard cycle for GC technique. Details on method parameters, see Appendices, point 3, "Injection Cycles" and point 4, Flow Chart "Firmware Overview".
GC-InS	Standard cycle covering GC Sandwich technique. Details on method parameters, see Appendices, point 3, "Injection Cycles" and point 4, Flow Chart "Firmware Overview".
GC-Dual	Cycle for GC technique which allows injecting two samples in two different injectors. The start signal is sent after injection of both sample solutions. Details on method parameters, see Appendices, point 3, "Injection Cycles" and point 4, Flow Chart "Firmware Overview".
HS-Inj	Standard cyle for GC headspace technique. Details on method parameters, see Appendices, point 3, "Injection Cycles" and point 4, Flow Chart "Firmware Overview"
SPME	Standard cycle for GC SPME technique, Solid Phase Micro Extraction, Fiber technique. Details on method parameters, see Appendices, point 4, Flow Chart "Firmware Overview"
TTS Sotax	The two cycles are dedicated cycles for "dissolution applications". TTS cycle is used for transdermal patches and the Sotax cycle is used for tablet dissolution

Items displayed in *"italic"* are available beginning with PAL Firmware Version 4.1.X.

note *Standard injection cycles are selectable and activated directly from the PAL System. Any deviation from a standard cycle, a Cycle Composer Macro or Cycle Editor (ICC-CE) Cycle must be programmed for customized requirements.*

note *In PAL Firmware versions < 4.0 the standard cycles are grouped in Item "Cycles".*

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

9.2.2. Service

The following "Service" items may be changed by selecting the particular item:

Item	Description
Check Motors	Every stepper motor can be moved separately. This function is useful to check out a specific motor or to perform an endurance test after a repair. The Start and Stop positions of the test path can be selected. The motor Current, Speed, and Acceleration are selectable (accept default value if not secure). A Pause time can be specified. A Cycle Limit and Actual Cycle Counter are useful tools for endurance tests.
Test Head [1]	This tests the functionality of the PAL Injection Unit **("Head").** Two tests can be activated by the function keys: "**F1" Check Plg:** The stepper motor of the plunger drive is tested. Sensor check. "**F2" Check Z**: The vial detection sensor and "Needle Guide Blocking" function is tested. These tests are only required if any erratic behavior of the PAL System is observed. In such cases contact a representative of CTC Analytics AG.
Test Switches	**X-Limit** = Actual status of X-axis sensor. Move the X-Y-Carriage manually across the limit switch to verify activation of the sensor. **Y-Limit** = Actual status of X-axis sensor. Move the Y-axis manually to the Y-zero point (at X-axis), crossing over the limit switch to verify activation of the sensor. **Z-Limit =** Actual status of Z-axis sensor. Move the syringe slider assembly manually up to the zero Z-axis point, crossing over the limit switch to verify activation of the sensor. **Aux1 Limit** = Actual status of Aux1 limit sensor **Aux2 Limit** = Actual status of Aux2 limit sensor **Plg –Pos** = Actual status of Plg –Pos **Needle Guide** = Actual status of needle guide sensor

Items displayed in "*italic*" are available beginning with PAL Firmware version 4.1.X.

[1] Please note that the service test 'Test Head' is executed in the same way, independent of the PAL Firmware version. However the test evaluation is different between firmware versions 2 - 3 and version 4.
The updated PAL Service Manual, Edition 1.1, will include the PAL-*xt* System and will explain these differences.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

9.3. Section "F3-Setup" / Objects

For the section "Objects" opened in Extended User Mode the same applies as is described above. New classes are visualized and known classes may contain new items accessible only on the level of the Extended User Mode. To open this level, use the following path:

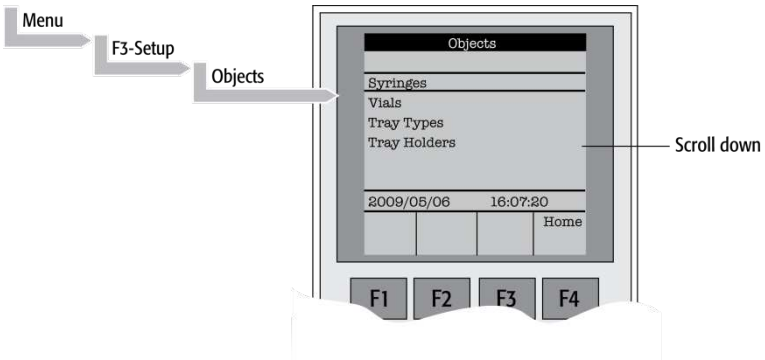


Figure 47. Selecting "Objects" in Extended User Mode

Object	Description
Syringes	At this level all loaded syringes are selectable. At the "**Utilities**" user level only the active syringe is visible.
Vials	The Firmware Objects accessed on the PAL Extended User Mode have more specific items selectable than at the User level. Tolerances or ranges such as, e.g. "Maximum Penetration" can be defined and limited for the user such that this value cannot be exceeded. In the Object "**Tray Types**", details for the various Items are described more closely.
Tray Types	The object class "Tray Type" is only accessible via the PAL Extended User Level. All loaded **Tray Types** are visible and selectable. Details, see below.
Tray Holders	The Firmware Objects accessed on the PAL Extended User Level have more specific items selectable than at the User level. Depending on the type of Tray Holder, e.g. an Access and Restore Path or a Heater and Agitator (Motor) is assigned. Typical example, the Tray Holder "Agitator".
Trays	All loaded Trays are visible and accessible. A Tray must be assigned to a Tray Holder. A "**TrayTypeGroup**" identification checks if the specified Tray Type is allowed in this combination. The offsets X-,Y-, Z and the inclination corrections for a row or column are explained in the "Utilities Functions" section. The "Path Offset X-, Y-, Z-" is used only if a "Path" is assigned to the specified Tray Holder, typically a Stack or Agitator uses a Path.
Wash Stations	The Wash station and its positions "**Wash1**" and "**Wash2**" are visible and selectable. Details , see below.
Injectors	The Firmware Objects accessed on the PAL Extended User Mode have more specific items selectable than at the User level. Tolerances or ranges such as "Maximum Penetration" can be defined and limited for the user so that this value cannot be exceeded. In the "**Tray Types**" Object details for the various Items are described. Furthermore, in this Firmware Object class a "**Valve**" and/or a "**Heater**" can be assigned. Note that the Wash Station Positions "**Waste**" and "**Waste2**" are listed in this "**Injectors"** class.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

Valves	The Valves and Valve Drives connected and controlled by an "AUX" interface are listed in this object class. For more details, see the Valves and Valve Drives Addendum. Note that the valves controlled by serial communication (Serial Valves or Multiposition Valves) are in the PAL Firmware Object class "**Serial Valves**".
Agitators	At this level items such as "Motor Drive", "**Minimum Speed**" and "Maximum **Speed**" are selectable for the "Agitator" Object. The range can be set for the speed. The other items are available directly as Method parameters.
Dilutors	The Firmware Objects accessed in the PAL Extended User Mode have more specific items selectable than at the User level. Tolerances or ranges such as "**Maximum Fill Speed**" can be defined and limited for the user so that this value cannot be exceeded. Items such as "**Prime Volume**", **"Waste to**", "**Motor Drives**", or "**Scale Length**" are specific items that remain hidden at the User levels.
Tools	The Object class "**Tools**" is used to handle another device, such as the **MHE-Tool** (Multiple Headspace Extraction Tool) or **MALDI Tool**. For details, see the specific Addendum for the PAL User Manual.
Positions	The various positions used with the PAL System are selectable at this level. Positions such as "**Home**", "**Change Syringe**", or a Path Point, reference the Paths for a specified Tray Holder directly, such as "**Agitator**" or "**Stack"**. Selecting an item, e.g. "**Home**" will provide the function key "**F1", Check Pos**" on the screen. Activating this function provides the possibility of verifying X-, Y-, Z-axes values for this particular position.
Paths	A Path defines specific movements for the Injection Unit, which represent a repetitive task assigned to a Tray Holder. Typical examples are opening and closing a drawer from a Stack or opening the lid of an Agitator. The Path is composed of several steps (points) which are added up in a sequence. Each individual step (point) can be positioned by teaching X-, Y-, Z-axes. In most cases the return path is in the reverse order of the starting path. Example "**AgiOpn**L" and "**AgiClsL**". If one setting of a point is changed, this change will be valid for the return path as well.
Sync Signals	The various synchronization signals are described above in Section F. "Description and Installation", point 6.1. At this level no other functionality, as shown at the user level, is provided.
Out Signals	The various Out-Signals are described above in Section F. "Description and Installation", point 6.1. At this level no other functionality, as shown at the User level, is provided.
Events	The various synchronization signals are described above in Section F. "Description and Installation", point 6.1. At this level no other functionality, as shown at the user level, is provided. Three events are newly available on this extended user level: **Pwr-Out1, Pwr-Out2** and **FlushVlv.** The main purpose of these three power-out signals is to activate a solenoid, such as for the Wash station or the Gas Flush Valve. At this level the functionality of the signal can be tested.
Serial Valves	Serial Valves, or "Multiposition Valve Drives", are powered and controlled by the serial (RS232) control and not through the "AUX" interface. With firmware version 4.1.X a "***Mode***" is now selectable. The mode refers to the setting of the Valve Drive, whether the current for the motor is set to "**High Speed**" or "**High Torque**". For more details, see Addendum to PAL User Manual "Valve and Valve Drive".
Out Exp Box	The "Out Expansion Box" provides 8 TTL contacts and 8 relay contacts (24 V contact closure). The optional module (box) is connected and controlled by "Interface 2". For more details, see Out Expansion Box Addendum to PAL User Manual.
RS232	This Object allows selecting the serial ports for the specific needs. Choices are: Remote, Terminal, Printer, Barcode, ExtDev, VICI-Vlv (for serial valve drives), or None.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

Motors	In the class '**Motors**', the Objects '**Motor-Y**' and '**Motor-Z**' are accessible, to enable the user to select specific motor parameters in case a specific application requires an adjustment. ***Motor-Y*** **Strategy** Three different settings are selectable for the Y-Motor movement strategy: **Rectang** = normal movement as used for PAL system. (On firmware version < 4.01X this mode was called "Auto".) ***XY-Simul*** = X,-Y-axes move simultaneously, which allows movement in a diagonal direction. (At firmware version < 4.1.X this mode was called 'Rectang', but it was not active at lower versions.) **Retract** = Y-axis moves from any point first to zero Y (back to the x-axis) before the X-movement is started. This mode allows bypassing an object (such as a large GC detector) which is in the travel path if the mode 'Rectang' is used. **Path Speed** = Y-axis motor speed in conjunction with a "Path", example opening and closing a drawer of a Stack. In certain situations it is necessary to slow down the speed to open and close a drawer. Typical application example is fraction collection, collecting directly into a well plate. If the liquid level is high, the liquid can wash over into the next row if drawer movement is too fast. Remark: At PAL Firmware version 4.1.X these items of the Y motor have been made available at the Extended User Level. **Motor-Z** For the 'Motor-Z', following speeds are selectable: **Penetr Speed** = This is the speed used to penetrate the syringe needle into any object, with the exception of the injector. Example: Vial penetration. **Inj Penet Spd** = Injector Penetration Speed. With PAL Firmware version 2.X and 3.0 the injector penetration speed is identical to the injector retraction speed. **Inj Retr Spd** = Injector Retract Speed. With PAL Firmware version 4.1.X, the injector speed was separated into a penetration and a retraction speed. This allows safe penetration of a vial by any type and diameter of syringe needle without bending through the septum of the GC injector. The needle retraction speed can be increased to speed up the entire injection process. This new feature enables the user to avoid uncontrolled evaporation of any remaining sample solution in the needle. The visibility of the Motor-Z parameters at the Extended User Level' was introduced with PAL Firmware version 4.1.3.

Items displayed in "*italic*" are available beginning at PAL Firmware Version 4.1.X.
Items displayed in "**bold**" are explained in detail below.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

9.3.1. Tray Type

The following object "Tray Type" Items may be changed by selecting the particular item. First select the desired **Tray Type**, such as "**VT32-20**".

note

The definition of Row and Column is given above in Section F. "Description and Installation, point 4.2.2.1.
By reversing the first six entries, the order of injection can be changed. Example: Tray Type "VT32-20" has a "Row Length Y" and a "Col Length X" defined. Reversing to "Row Length X" and "Col Length Y" would start with sampling from left to right, as used e.g. with Tray Type "DW96".
The values of the items "Spl Per Row" and "Spl Per Col" must also be reversed.

Item	Description
Row Length X	Defines the Row length in the X-direction from the center of the first to the center of the last vial position, measured in mm.
Row Length Y	Defines the Row length in the Y-direction from the center of the first to the center of the last vial position, measured in mm.
Col Length X	Defines the Column length in the X-direction from the center of the first to the center of the last vial position, measured in mm.
Col Length Y	Defines the Column length in the Y-direction from the center of the first to the center of the last vial position, measured in mm.
Spl Per Row	Number of samples per Row.
Spl Per Col	Number of samples per Column
Pattern	The pattern of the Row or Column arrangement has to be defined. Regular = square arrangement (standard) Staggrd+ = Rows are arranged in staggered pattern. Offset of second Row is shifted by +50% of hole pattern. Staggrd-= Rows are arranged in staggered pattern. Offset of second Row is shifted by -50% of hole pattern. See Graphics below.
TrayTypeGroup	Software protection so that not every Tray Type can be placed on any Tray Holder. Example: VT32-20 cannot be fit into a Stack.
Plate Thickn	Thickness of Tray plate bottom (not the total height of the Tray). Measured in mm.
Vial Height	Total height of the vial including cap to seal if applicable. Measured in mm. Remark: The sum of the plate thickness and vial height adds up to the total height This is the point where the Injection Unit expects an object.
Vial Trnsprt	The mode to transport a vial is defined by: **None** = No transport required. Example liquid sampling. **Magnet** = Magnetic Transport. Requires magnetic vial caps. The Injection Unit moves to the side to wipe off the vial when moved away. **Needle** = Device is transported with the syringe needle inserted. Example: special vials where a magnetic cap cannot be crimped, e.g. "Vacutainer". Remark: This item became active beginning at PAL Firmware version 2.5.X.
ZSlideOffRetr	If magnetic transport is selected, the distance can be defined to move the syringe slider up (Z-direction), lifting up the vial by magnetic force. Measured in mm.
YSlideOffDist	If magnetic transport is selected, the distance can be defined to move the Injection Unit to the side, Y-direction, to wipe off the vial. Measured in mm.
Barcode	If a Barcode Reader is installed, the mode has to be set for "**AutoFix**". **None** = No Barcode Reader option requested for this Tray Type.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

Z Tolerance	A tolerance window to give a plus/minus range (expressed in mm) where the Injection Unit must expect an object. If the value of this item is > 0, this is a relative detection mode and the sensor from the Injection Unit needle guide is active. If the value of this item is set to "0" the sensor of the needle guide is turned off and the syringe slider moves to an absolute value, Z-axis position as specified in the object.
Z Retract	The distance to lift up the syringe slider before the Y-, Z-axes assembly moves across the unit can be specified, expressed in mm.
Max Penetr	The maximum allowed Needle Penetration can be defined as a safety so that the user cannot destroy the needle tip by going too far down. The Tray Type is prepared for a specific vial size; this value is therefore unique to this combination. The maximum needle penetration must not exceed the length of the syringe needle, considering the loss due to needle guide, etc.. Typical needle length is 51 mm, maximum penetration must not exceed 48 mm.
Needle Penetr	This item is identical to that used on the User level or if available as a method parameter of a local cycle. The value defined on these levels is mirrored to the Extended User Level.
Spl1 Offset X	The "X" offset is defined as the distance from the outer edge of the Tray in the X-direction to the center of the vial position 1. Measured in mm.
Spl1 Offset Y	The "Y" offset is defined as the distance from the outer edge of the Tray in Y-direction to the center of the vial position 1. Measured in mm.
Spl1 Offset Z	The "Z" offset can be selected for special cases where e.g. the syringe needle has to reach a deeper point before penetration into a vial. A "Z" offset value = 0 considers the Tray surface or vial top as the reference point. Measured in mm.

Items displayed in "*italic*" are available beginning with PAL Firmware Version 4.1.X.

note

The dimensions used for Row/Column Length or X-, Y-, Z-Offsets for Sample Number 1, are specific for a particular Tray Type. If a general adjustment for a Tray from a specific vendor – e.g. for a Deepwell Plate – has to be made, this should be done in the "Tray Type" class of Object. For fine tuning, the Offset items from the class "Trays" can be used.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

Explanation for various Patterns in Tray Type:

1. Pattern Type "Regular".
   The sample or well positions are equal distributed.

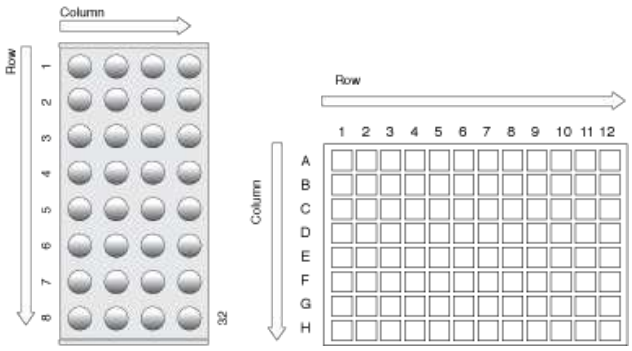


Figure 48. Pattern Tray Type "Regular"

2. Pattern Type "Staggrd+.
   The sample or well positions are arranged in a staggered pattern.
   Offset of second Row is shifted by + 50% of hole pattern.

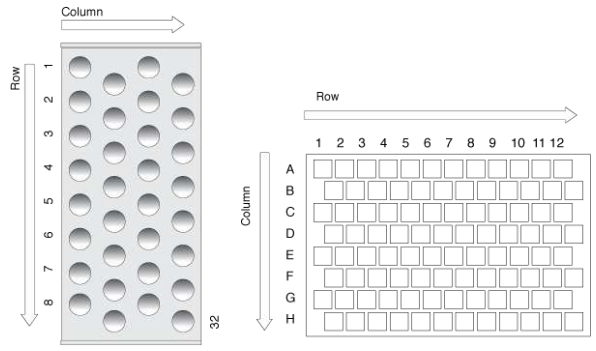


Figure 49. Pattern Tray Type "Staggered+"

3. Pattern Type "Staggrd-.
   The sample or well positions are arranged in a staggered pattern.
   Offset of second Row is shifted by - 50% of hole pattern.

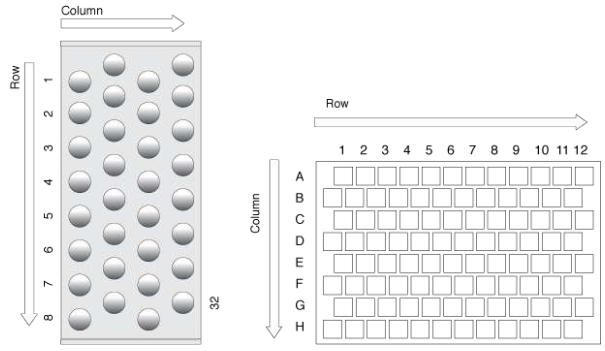


Figure 50. Pattern Tray Type "Staggered-"

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

9.3.2. Trays

The following object "**Tray**" Items can be changed by selecting the particular item. First select the desired Tray, such as "**Tray1**".

Item	Description
Tray Holder	The Tray Holder to which the Tray is assigned is specified.
TrayTypeGroup	All Tray Type Groups which are allowed for this particular combination of Tray and Tray Holder are displayed. The "TrayTypeGroup" for the Tray Type itself is specified for each Tray Type.
Tray Type	The Tray Type to be used is linked to the Tray. This item is usually set at User level in "Utilities/Trays". See above.
Offset X	The "X" offset is defined as the distance from the center of the teaching position from the Tray Holder to the edge of the Tray in X-direction. Measured in mm. This item is available at User level in section "Utilities/Tray" and can be used for fine tuning a Tray installed in a Tray Holder. Important for well-plates 384 installed in a Stack. Remark: Position#1 is the only correction point.
Offset Y	The "Y" offset is defined as the distance from the center of the teaching position from the Tray Holder to the edge of the Tray in Y-direction. Measured in mm. This item is available at User level in section "Utilities/Tray" and can be used for fine tuning a Tray installed in a Tray Holder. Important for well-plates 384 installed in a Stack. Remark: Position#1 is the only correction point.
Offset Z	The "Z" offset is defined as the distance from the plate surface of the Tray Holder to the teaching point, black needle guide flush underneath plate of Tray Holder (which corresponds to plate thickness of Tray Holder). Measured in mm. This item is available at User level in section "Utilities/Tray" and can be used for fine tuning a Tray installed in a Tray Holder. Important for well-plates 384 installed in a Stack. Remark: Position#1 is the only correction point.
Path Offset X	The Path Offset "X" can be specific for a Tray, adjustment in X-direction. Expressed in mm. Remark: This item is only valid if a Path is assigned to the Tray Holder as specified in this combination.
Path Offset Y	The Path Offset "Y" can be specific for a Tray, adjustment in Y-direction. Expressed in mm. Remark: This item is only valid if a Path is assigned to the Tray Holder as specified in this combination.
Path Offset Z	The Path Offset "Z" can be specific for a Tray, adjustment in Z-direction. Expressed in mm. Remark: This item is only valid if a Path is assigned to the Tray Holder as specified in this combination.
dxRow	Correction for inclination of a Tray in X-Row direction. For details, see Section 4.1.2.2 above.
dYRow	Correction for inclination of a Tray in Y-Row direction. For details, see Section 4.1.2.2 above.
dzRow	Correction for inclination of a Tray in Z-Row direction. For details, see Section F. "Description and Installation", point 4.1.2.2 above.
dxCol	Correction for inclination of a Tray in X-Column direction. For details, see Section F. "Description and Installation", point 4.1.2.2 above.
dyCol	Correction for inclination of a Tray in Y-Column direction. For details, see Section F. "Description and Installation", point 4.1.2.2 above.
dzCol	Correction for inclination of a Tray in Z-Column direction. For details, see Section F. "Description and Installation", point 4.1.2.2 above.

Items displayed in *"italic"* are available beginning with PAL Firmware Version 4.1.X.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

9.3.3. Wash Stations

The following object "Wash Station" items may be changed by selecting the particular item. First select first the desired Wash Station, such as "**Wash1**".

Item	Description
Position X	X-axis position for Wash Station.
Position Y	Y-axis position for Wash Station.
Position Z	Z-axis position for Wash Station.
Z Tolerance	A tolerance window for a plus/minus range (expressed in mm) where the Injection Unit has to expect an object. If the value of this item is > 0, this is a relative detection mode and the sensor from the Injection Unit needle guide is active. If the value of this item is set to "0" the sensor of the needle guide is turned off and the syringe slider moves to an absolute value, Z-axis position as specified in the object.
Z Retract	The distance to lift up the syringe slider before the Y-, Z-axes assembly moves across the unit can be specified, expressed in mm.
Max Penetrat	The maximum allowed Needle Penetration can be defined as a safety so that the user cannot destroy the needle tip by going too far down. The maximum needle penetration must not exceed the length of the syringe needle, considering the loss due to needle guide, etc.. Typical needle length is 51 mm, maximum penetration must not exceed 48 mm.
Needle Penetr	This item is identical to that at the User level. The value defined at this level is mirrored to the Extended User Level.
Type	The specific mode for the Wash station in use has to be defined: **Standard** = Standard Wash Station. Syringe is filled with wash solvent and expelled into Waste. **Pulse** = A pulsed signal is sent to activate the device. Used for the "Fast Wash Station" and "Active Wash Station". See Type 'Active' for details. **Flow** = Continuous flow of liquid by gravity. No electrical contact required for a solenoid. ***DLW***= Dynamic Load & Wash. Item used to activate specific solenoid for DLW Wash Station. ***Active***= Used for Active Wash Station in conjunction with the Wash Station Print with PNo. 'APR WASHPUMP B.A.' (Revision B). Simplified print, activation of pumps is controlled by PAL Firmware. Requires Object Lists 'PAL WashActive_Rev. B'. Remark: Type 'Active' is not used for Fast Wash Station operation and cannot be used for first generation Active Wash Station with print Revision A installed. For these cases is the type 'Pulse' required.
Flow Control	The power source to activate a Wash Station is specified. For the Fast, Active Wash Station and DLW the Event "Power-Out1" and "Power-Out2" is used.
Ndl Cln Path	A Path can be assigned to the Wash Station.
Waste to	The Waste position is assigned to the Wash Station.
Clean Volume	A percentage of the syringe maximum volume is defined for the cleaning step.
Clean Count	The counter monitors the number of wash cycles. The setting in the method has the same functionality and the value is mirrored to the Extended User Level.
Max Fill Spd	The fill speed for the syringe is defined with this item. If the maximum value of the Fill Speed (10.0 mL/s) is selected, the system takes the injection syringe Fill Speed as defined in the method.
Max Eject Spd	The Eject Speed is the speed used to eject the wash solvent during the wash cycle. This speed is usually higher than the Fill Speed. If the maximum value of the Eject Speed (10.0 mL/s) is selected, the system takes the injection syringe Eject Speed as defined in the object class "Syringe".
Rinse Time	Rinse is the time to rinse the wash port with wash solvent after the wash cycle of the syringe has been finished. In the case of Fast/Active Wash Station, the syringe needle is pulled out of the wash port. The wash solvent flows without restriction. As a result, higher solvent consumption has to be taken into consideration.

Items displayed in "*italic*" are available beginning with PAL Firmware Version 4.1.X.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

G. Troubleshooting PAL and PAL-*xt* System

note

The Combi PAL always represents one of several total components in a chromatography system. The following Troubleshooting Guide is limited to the COMBI PAL or PAL -xt only.

Symptom or Error Message	Possible Cause	Recommended Action
No or very low detector signal is observed.	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 section 4.2).
	Sample volume too low.	Increase sample volume.
Syringe does not fill properly.	Air bubbles below Syringe plunger. It can happen that air bubbles remain below the plunger after the first pull up. If the plunger is moved up and down several times, these air bubbles are worked out.	Increase method parameter "Fill Strokes".
Sample peaks/responses are not reproducible.	Dirty syringe.	Increase Pst Cln Slv1/Slv2 values in method. Use PreClnSlv1/Slv2 and PreClnSpl.
	Syringe pressure differences.	Increase Pullup Delay value.
	Vacuum created in sample vial.	Reduce sample volume in sample vial. Use setting under "F3-Setup/System/PrePressureVial".
	Highly volatile solvent.	Use gastight syringe and sample tray cooling.
	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.
	Method Parameters	Check recommended Method Parameters in Flow Chart "Firmware Overview", Appendix 4. The following parameters are crucial and should be verified first: - Fill speed - Pullup delay - Injection Speed - Post Inj Delay
Excessive carryover between samples.	Dirty syringe.	Increase Pst Inj Slv1/Slv2 values in method. Use PreClnSlv1/Slv2 and PreClnSpl. Check and, if necessary, replace vial septa from Wash/Waste vials.
	Inappropriate wash solvent(s).	Use appropriate wash solvent(s).
	Wash Solvent and Waste vial septa too tight.	Check if the syringe fills completely when washing. If several cleaning cycles are programmed and many samples are processed, then vacuum in the Wash Solvent vials and overpressure in the Waste vials may build up. Cut away a segment of the Solvent and Waste septa to assure equalization of pressure.
Unexplained collisions of the Injection Unit.	Object(s) not defined correctly.	Define Object(s) correctly. (See section F. "Describing and Installing", point 4.1 "Defining Object Positions").
Error Message "Object Not Detected".	Incorrect Z value for the affected Object (e.g. GC Inj1, THldr1 or Agitator).	Redefine Z value for the affected Object. (See section F. "Describing and Installing", point 4.1 "Defining Object Positions").
Error Message "Invalid Motor Status Motor Aux1".	Agitator not connected.	Switch OFF PAL and check connection between PAL and Agitator.
	Agitator Connection cable.	Change connection cable.
	MOTIO Board defective.	Replace MOTIO or Control-*xt* Board.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

Headspace specific Symptoms	Possible Cause	Recommended Action
Sample peaks or responses are not reproducible.	Dirty syringe.	Increase method value "Syr Flushing" Set method value "Syringe Temp" 10 °C above "Incubat Temp"
	Syringe pressure differences.	Increase Pullup delay value
	Vacuum created in sample vial.	Reduce sample volume
	Improperly crimped vials.	Check vial cap by attempting to rotate manually. Loose caps may cause selective loss of more volatile components from sample. Adjust crimping tool correctly.
	None or too low Syringe flush gas pressure	Check pressure at flush gas regulator (0.5 bar) during syringe flushing period. Check gas flow at syringe needle tip.
	Method Parameters.	Check recommended Method Parameters in Flow Chart "Firmware Overview", Appendix 4. The following parameters are crucial and should be verified first: - Fill Speed - Pullup Delay - Injection Speed - Post Inj Delay
Peak distortion or tailing.	Method Parameters.	See recommended actions above.
	Needle penetration speed in GC injector.	Check the parameters for injection technique. If all changes give no positive result, check the 'Injector Retract Speed'. See F3-setup/Objects/Motors/Motor-Z.
	Solvent not suitable for application.	Check the boiling point of the solvent and try to change the solvent.
	GC Injector liner not suitable.	Check the liner geometry according to recommendations of the GC manufacturer.
	GC related parameters.	Any parameter like injector, oven or detector temperature can contribute to bad peak shape. Check the column type and connections (square cut connections). Check the troubleshooting guide of the GC Manufacturer.
Excessive carryover between samples.	Dirty syringe.	Increase method value "Syr Flushing" Set method value "Syringe Temp" 10 °C above "Incubat Temp"
	None or too low Syringe Flush gas pressure.	Check pressure at flush gas regulator (0.5 bar) during Syringe Flushing period. Check gas flow at syringe needle tip.
Unexplained chromatographic peaks.	Dirty flush gas.	Check flush gas for impurities.
Faulty temperature read-out. e.g. value: -99 °C.	HS-syringe Cartridge (holder) temperature heater probe or sensor broken. Agitator temperature heater probe or sensor broken.	Contact your CTC Analytics representative.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

H. Replacing Parts

note

Safety Warning
Always disconnect the power cord(s) from the power supply or from the various power supplies if optional devices are installed before attempting any type of maintenance.
Capacitors inside the instrument may still remain 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.

1. MOTIO Board

PNo.: APR Motio

1. Follow the sequence shown in Figure 51 to detach and release the MOTIO board from its position inside the X-axis.
   As shown, remove the dummy cover first.
   Slide the MOTIO board to the left side. This is necessary because the board mates on its right side with the connector on the CPU board;

2. Carefully pull the two ribbon cable connectors upwards to free them from the board;

3. Install the replacement board in the reverse order.

note

After reconnecting the two ribbon cables to the board, ensure that the cables are folded flat and can slide inside the X-axis without damage.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

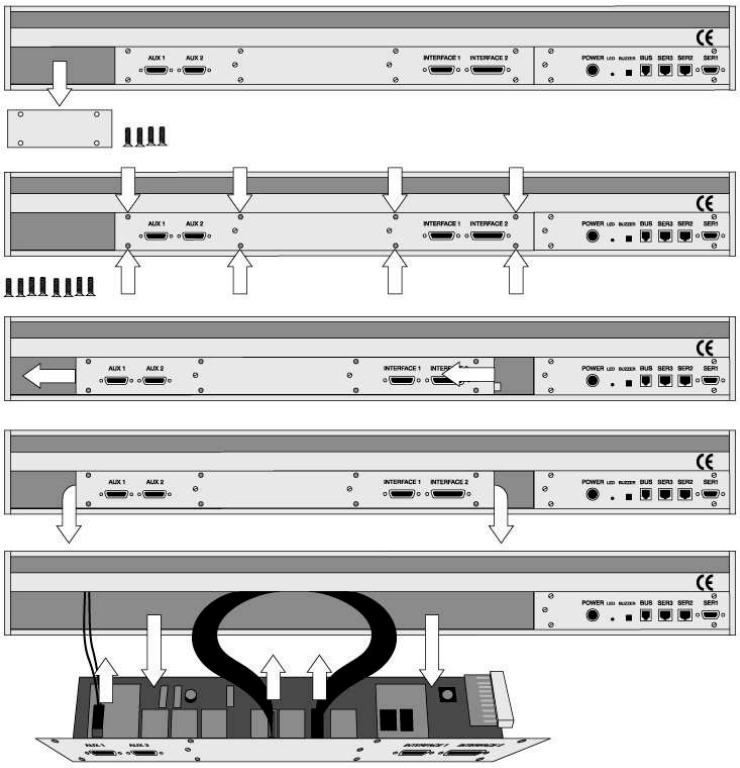


Figure 51. Replacing MOTIO Board

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

2. CPU Board

PNo.: APR CPU

1. Remove the right end cover of the X-axis (facing the rear of the chassis).
   Remark: This step is only necessary if the CPU board needs to be removed and the MOTIO Board remains in the system;

2. Slide the CPU board out and towards the right end of the X-axis. This is necessary because the CPU board mates on its left side with a connector on the MOTIO board;

3. Install the replacement board in the reverse order.

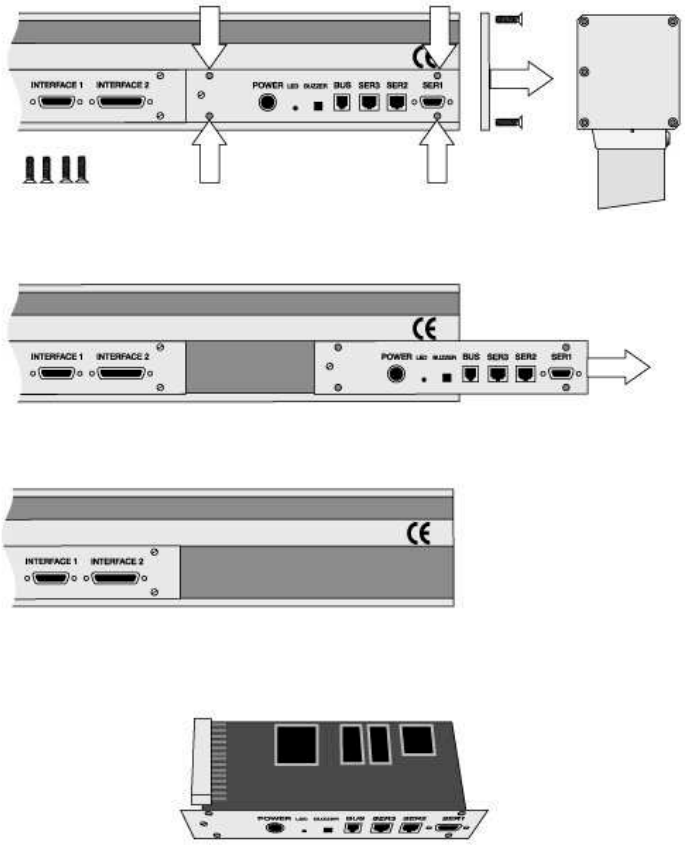


Figure 52. Replacing CPU Board

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

3. Control-*xt* Board

PNo.: APR Control-*xt*

note

The Control-xt board combines the MOTIO and the CPU boards in a single control board.
This board is required for the PAL COMBI-xt System and operates only at PAL Firmware Version 4.1.X or higher.

1. Follow the sequence shown in Figure 45 to detach and release the Control-*xt* board from its position inside the X-axis.
   As shown, remove the dummy cover first;

2. Carefully pull the two ribbon cable connectors upwards to free it from the board;

3. Install the replacement board in the reverse order.

note

After reconnecting the two ribbon cables to the board, ensure that the cables are folded flat and can slide inside the X-axis without damage.

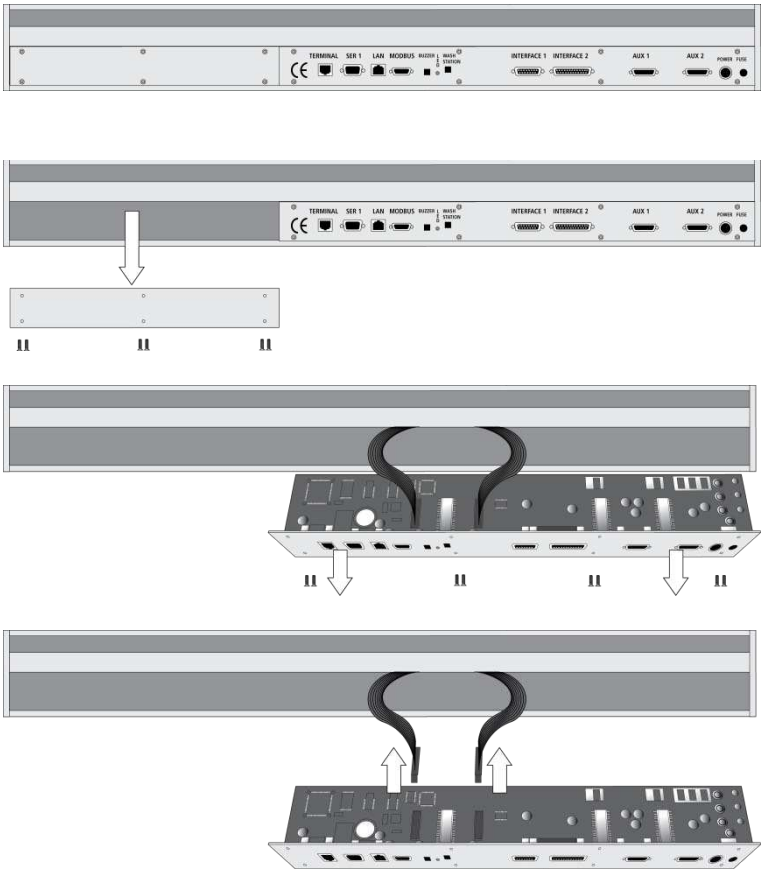


Figure 53. Replacing Control-*xt* Board

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

4. Agitator

Follow the sequence of steps shown in section F. “Description and Installation”, point 3.2, “Assembling the COMBI PAL”.

5. Injection Unit

Follow the sequence of steps shown in section F. “Description and Installation”, point 3.2, “Assembling the COMBI PAL”.

6. Wash Station

Follow the sequence of steps shown in section F. “Description and Installation”, point 3.2, “Assembling the COMBI PAL”.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

I. Maintaining the PAL System

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

Maintenance Step	Interval
Use only a soft lint-free cloth dampened with mild soap and water.	Weekly or as needed
Clean Instrument, syringe and surfaces	Weekly or as needed.
Replace the syringe plunger	Syringe Plunger for a liquid syringe (Metal Plunger sealing against glass) should be cleaned on a regular basis with an aqueous alcohol solution. Be aware that this plunger type should not be used for samples with a high amount of matrices, for clinical or residue analysis. A polymer plunger tip would be more suitable. Syringe Plunger for a gas tight syringe (polymer tip) has to be replaced on a regular basis. 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 basis to gain experience with the application.
Wash and Waste Solvent reservoirs	Weekly or as needed. Replace the Septum as well to avoid carry over.

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 must be changed annually.

- PM Kit1 for HPLC technique
- PM Kit2 for GC technique

Contact your CTC Analytics representative to perform an annual preventative maintenance on the PAL System.

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

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

J. Appendices

1. 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 define 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 consists 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.

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 eight 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.

Tray Holder

A Tray Holder can hold one or more trays. Each Tray Holder has a reference position (X-, Y-, Z-coordinates) that defines its location.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

Tray

A Tray holds multiple samples. Trays are defined by designating the Tray Type (see below) and the Tray Holder. 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.

Stack

A Stack is a particular type of Tray Holder that is designed to hold microplates.
A six-drawer Stack holds 12 standard micro-plates, two in each drawer.
A three-drawer Stack holds six deep-well micro-plates, two in each drawer.

PAL Object Manager

Software to load a PAL Object List to an instrument if a Module (hardware module) has been added to the PAL System. In a special mode Object Manager can also be used to create and maintain Object Lists.

PAL Object List

If a PAL Module (hardware) is added to an instrument, several Objects have to be loaded into the firmware. These Objects are collected in an Object List and stored in a file with the extension "*.pol".
Object Lists are delivered together with Object Manager Software and are grouped into folders for the different kind of Modules (e.g. Syringes, Tray Holders, Valve Drives). The name of an Object List starts with the Module part number with variants added (e.g. first or second Stack). The name of the root folder includes the revision which is dependent on the firmware version (e.g. "Object Lists Rev. K" for firmware 2.X and 3.X).

Object Class

Each Object belongs to an Object Class (e.g. Syringes, Trays, Injectors).
The Object Class defines the Items of an Object.

Object Item

An Object contains several Items which can be numerical values with a physical unit (e.g. X-, Y-, Z-Position, Penetration, Syringe Scale Length, Syringe Volume) or references to other objects.
Note that the term "Parameter" is reserved for "ATOM Parameter" (PAL Firmware commands to be used for a PAL Cycle or Macro).

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

Objects

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

Module

PAL hardware module, either part of a standard PAL configuration (e.g. COMBI PAL, HTS PAL) or an optional addition (e.g. Cooled Stack, MALDI Tool, Dilutor). The term “Module” is intentionally used to differentiate from “Object”, which is reserved for the PAL Firmware Object.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

2. Naming Convention

This section recommends the standard naming convention for COMBI PAL Trays, Tray Types, and Tray holders. Following these conventions will allow the COMBI PAL 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
VT200	Vial Tray, 200 positions (10 x 20) For 7 mm micro-vials, 1 mL
VT98	Vial Trays, 98 positions (7 x 14) For 12 mm vials, 2 mL
VT78	Vial Tray, 78 positions (6 x 13) For 7 mm micro-vials, 1 mL (opposite side of 98 positions Tray)
VT54	Vial Tray, 54 positions (6 x 9) For 12 mm vials, 2 mL
VT21	Vial Tray, 21 Positions (7 x 14) For 12 mm vials, 2 mL (opposite side of 32 positions Tray)
VT32-10	Vial Tray, 32 positions (4 x 8) For 23 mm headspace vials, 10 mL
VT32-20	Vial Tray, 32 positions (4 x 8) For 23 mm headspace vials, 20 mL
MT96	Standard 96-position shallow microplate
DW96	Deep well 96-position microplate
MT384	High density 384-position shallow microplate

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

3. COMBI PAL and *–xt* Injection Cycles

3.1. COMBI PAL "GC-Inj" Cycle

No.	Processing Step	Method Parameter	Object	(Class)	Used Object Value
1	Reference X,- Y-, Z-axes 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	Clean syringe with solvent from Wash1 selected number of times	Pre Cln Slv1	SYRINGE Wash1 Waste	(Syringes) (Wash Stations) (Injectors)	Fill Speed Eject Speed Needle Penetr Clean Volume Needle Penetr
5	Clean syringe with solvent from Wash2 selected number of times	Pre Cln Slv2	SYRINGE Wash2 Waste2	(Syringes) (Wash Stations) (Injectors)	Fill Speed Eject Speed Needle Penetr Clean Volume Needle Penetr
6	Rinse syringe with sample selected number of times	Pre Cln Spl Sample Volume Fill Volume Fill Speed Pullup Delay	SYRINGE TRAY Waste	(Syringes) (Tray Type) (Injectors)	Eject Speed 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 Volume Fill Speed Fill Strokes Pullup Del	SYRINGE TRAY	(Syringes) (Tray Type)	Eject Speed Overfill Needle Penetr
8	Wait for Inject signal		Inject	(Sync Signals)	
9	Move to Injector	Inject to			
10	Drive needle to penetration depth	Inject to	 Motor Z	(Injectors) (Motors)	Needle Penetr Inj Penet Spd
11	Delay	Pre Inj Del			
12	Activate Injected signal		Injected	(Out Signals)	Pulse Time
13	Activate Injectd+ signal		Injectd+	(Out Signal)	Pulse Time
14	Dispense syringe contents into GC Injector	Inject Speed			
15	Delay	Pst Inj Del			
16	Retract needle from injector		Motor Z	(Motors)	Inj Penet Spd
17	Clean syringe with solvent from Wash1 selected number of times	Pst Cln Slv1	SYRINGE Wash1 Waste	(Syringes) (Wash Stations) (Injectors)	Fill Speed Eject Speed Needle Penetr Clean Volume Needle Penetr
18	Clean syringe with solvent from Wash2 selected number of times	Pst Cln Slv2	SYRINGE Wash2 Waste2	(Syringes) (Wash Stations) (Injectors)	Fill Speed Eject Speed Needle Penetr Clean Volume Needle Penetr
19	Move to Home position		Home	(Positions)	

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

3.1.1. "GC-Inj" Cycle Method Parameter Description

Parameter	Description
CYCLE	GC-Inj
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 1
Pre Cln Slv2	Pre injection syringe wash strokes with Solvent 2
Pre Cln Spl	Pre injection syringe wash strokes with Sample
Fill Volume	Fill Volume used for all filling strokes except the last one
Fill Speed	Speed of plunger movement used in all syringe filling operations
Fill Strokes	Number of fill strokes
Pullup Del	Delay time between sample pullup and ejection
Inject to	Selected Injector
Inject Speed	Speed of plunger movement used during sample injection
Pre Inj Del	Delay time prior to sample injection
Pst Inj Del	Delay time after sample injection
Pst Cln Slv1	Post injection syringe wash strokes with Solvent 1
Pst Cln Slv2	Post injection syringe wash strokes with Solvent 2

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

3.2. GC PAL "GC-InjS" Cycle

No.	Processing Step	Method Parameter	Object	(Class)	Used Object Value
1	Wait for Start signal		Start	(Sync Signals)	
2	Reference X,Y,Z-axes and syringe plunger		(System)		Start Ref=ON
3	Read Barcode if enabled		TRAY	(Tray Type)	Barcode ≠ None
4	Clean syringe with solvent from Wash1 selected number of times	Pre Cln Slv1	SYRINGE Wash1 Waste	(Syringes) (Wash Stations) (Injectors)	Fill Speed Eject Speed Needle Penetr Clean Volume Needle Penetr
5	Clean syringe with solvent from Wash2 selected number of times	Pre Cln Slv2	SYRINGE Wash2 Waste2	(Syringes) (Wash Stations) (Injectors)	Fill Speed Eject Speed Needle Penetr Clean Volume Needle Penetr
6	Rinse syringe with sample selected number of times	Pre Cln Spl Sample Volume Fill Volume Fill Speed Pullup Delay	SYRINGE TRAY Waste	(Syringes) (Tray Type) (Injectors)	Eject Speed Needle Penetr Needle Penetr
7	Fill syringe with Solvent Plug from Slv Source; aspirate air outside of vial if Air Gap(s) <> 0	Solvent Plug Slv Source Air Gap(s) Fill Speed Pullup Del	SYRINGE (Wash Stations, Vials)	(Syringes)	Fill Speed Overfill Needle Penetr
8	Fill syringe with IntStd from Std Source; aspirate air outside of vial if air gap(s) <> 0	IntStd Std Source Air Gap(s) Fill Speed Pullup Del	SYRINGE (Wash Stations, Vials)	(Syringes)	Fill Speed Overfill Needle Penetr
9	Fill syringe with sample volume; aspirate air outside of vial if AirVolumeNdl <> 0	Sample Volume AirVolumeNdl Fill Speed Pullup Del	SYRINGE TRAY	(Syringes) (Tray Type)	Fill Speed Overfill Needle Penetr
10	Wait for Inject signal		Inject	(Sync Signals)	
11	Move to Injector	Inject to			
12	Drive needle to penetration depth	Inject to	Motor Z	(Injectors) (Motors)	Needle Penetr Inj Penet Spd
13	Delay	Pre Inj Del			
14	Activate Injected signal		Injected	(Out Signals)	Pulse Time
14	Activate Injectd+ signal		Injectd+	(Out Signals)	Pulse Time
15	Dispense syringe contents into GC Injector	Inject Speed			
16	Delay	Pst Inj Del			
17	Retract needle from injector		Motor Z	(Motors)	Inj Penet Spd
18	Clean syringe with solvent from Wash1 selected number of times	Pst Cln Slv1	SYRINGE Wash1 Waste	(Syringes) (Wash Stations) (Injectors)	Fill Speed Eject Speed Needle Penetr Clean Volume Needle Penetr
19	Clean syringe with solvent from Wash2 selected number of times	Pst Cln Slv2	SYRINGE Wash2 Waste2	(Syringes) (Wash Stations) (Injectors)	Fill Speed Eject Speed Needle Penetr Clean Volume Needle Penetr
20	Move to Home position		Home	(Positions)	

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

3.2.1. GC-InjS" Cycle Parameter Description

Parameter	Description
CYCLE	GC-InjS
SYRINGE	Selected syringe
Sample Volume	Selected sample volume
Solvent Plug	Volume aspirated to form sandwich with Solvent Plug
Slv Source	Source Vial for Solvent Plug
IntStd	Volume aspirated to form sandwich with Internal Standard or Reagent
Std Source	Source Vial for Internal Standard or Reagent
Air Gap(s)	Air Gap(-s) to separate Solvent Plug/IntStd/Reagent/Sample
AirVolumeNdl	Volume aspirated after syringe needle is moved out of the sample liquid
Pre Cln Slv1	Pre injection syringe wash strokes with Solvent 1
Pre Cln Slv2	Pre injection syringe wash strokes with Solvent 2
Pre Cln Spl	Pre injection syringe wash strokes with Sample
Fill Speed	Speed of plunger movement used in all syringe filling operations
Pullup Del	Delay time between sample pullup and ejection
Inject to	Selected Injector
Inject Speed	Speed of plunger movement used during sample injection
Pre Inj Del	Delay time prior to sample injection
Pst Inj Del	Delay time after sample injection
Pst Cln Slv1	Post injection syringe wash strokes with Solvent 1
Pst Cln Slv2	Post injection syringe wash strokes with Solvent 2

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

3.3. COMBI PAL "HS-Inj" Cycle

No.	Processing Step	Method Parameter	Object	(Class)	Used Object Value
1	Wait for Start signal (This is only checked at job start)		Start	(Sync Signals)	
2	Wait for Agitator Temperature	Incubat Temp	Agitator	(Trays)	
3	Wait for Syringe Temperature	Syringe Temp	SYRINGE	(Syringes)	
4	Transfer sample vial from Tray to Agitator		TRAY Agitator	(Tray Type) (Tray Type)	Transport Mode Transport Mode
5	Move to flush position		Flush	(Injectors)	Needle Penetr
6	Activate Agitator	Agi Speed Agi On Time Agi Off Time	Agitator	(Trays)	
7	Wait for Incubation timer	Incubat Time			
8	Wait for Start Signal		Start	Sync Signal	
9	Fill syringe with sample using several filling strokes	Sample Volume Fill Speed Fill Strokes Pullup Del	SYRINGE Agitator	(Syringes) (Trays)	Eject Speed Overfill Needle Penetr
10	Move to Injector	Inject to		(Injectors)	
11	Wait for Inject signal		Inject	(Sync Signals)	
12	Drive needle to penetration depth	Inject to	 Motor Z	(Injectors) (Motors)	Needle Penetr Inj Penet Spd
13	Delay before injection	Pre Inj Del			
14	Dispense syringe contents into Injector	Inject Speed			
15*	Activate Injected signal		Injected	(Out Signals)	Pulse Time
16*	Activate Injectd+ signal		Injectd+	(Out Signal)	Pulse Time
17	Delay after injection	Pst Inj Del			
18	Retract needle from injector		Motor Z	(Motors)	Inj Penet Spd
19	Transfer sample vial from Agitator to Tray		Agitator TRAY	(Tray Type) (Tray Type)	Transport Mode Transport Mode
20	Move syringe to Flush position (Move to Home position and skip remaining steps if Syr Flushing = 0)		Flush	(Injectors)	Needle Penetr
21	Move plunger to open flush inlet and activate syringe flush valve		SYRINGE	(Syringes)	Fill Speed
22	Delay	Syr Flushing			
23	Close syringe flush valve				

note

** Steps 15 and 16 can be activated before Step 14.*
Depending on the parameter setting, "Inj Signal", selection "PlgUp" or" PlgDown" in class "System". Path: Menu/F3-Setup/System.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

3.3.1. "HS-Inj" Cycle Method Parameter Description

Parameter	Description
CYCLE	HS-Inj
SYRINGE	Selected syringe
Sample Volume	Sample volume
Incubat Temp	Temperature during incubation time
Incubat Time	Incubation time
Agi Speed	Agitator speed during incubation time
Agi On Time	On interval time during incubation time
Agi Off Time	Off interval time during incubation time
Syringe Temp	Syringe temperature
Fill Speed	Speed of plunger movement used in all syringe filling operations
Pullup Del	Delay time between sample pullup and ejection
Inject to	Selected Injector
Inject Speed	Speed of plunger movement used during sample injection
Pre Inj Del	Delay time prior to sample injection
Syr Flushing	Syringe flush time
GC-Runtime	GC-Runtime (calculated from GC ready to GC ready)

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

3.4. COMBI PAL "GC-Dual" Cycle

No.	Processing Step	Method Parameter	Object	(Class)	Used Object Value
1	Reference X-, Y-, Z-axes 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	Clean syringe with solvent from Wash1 selected number of times	Pre Cln Slv1	SYRINGE Wash1 Waste	(Syringes) (Wash Stations) (Injectors)	Fill Speed Eject Speed Needle Penetr Clean Volume Needle Penetr
5	Clean syringe with solvent from Wash2 selected number of times	Pre Cln Slv2	SYRINGE Wash2 Waste2	(Syringes) (Wash Stations) (Injectors)	Fill Speed Eject Speed Needle Penetr Clean Volume Needle Penetr
6	Rinse syringe with sample selected number of times	Pre Cln Spl Sample Volume Fill Volume Fill Speed Pullup Delay	SYRINGE TRAY Waste	(Syringes) (Tray Type) (Injectors)	Eject Speed Needle Penetr Needle Penetr
7	Fill syringe with sample using several filling strokes; aspirate air outside of vial if Air Volume = 0	1. Sample Vol 1. Air Vol Fill Volume Fill Speed Fill Strokes Pullup Del	SYRINGE TRAY	(Syringes) (Tray Type)	Eject Speed Overfill Needle Penetr
8	Wait for Inject signal		Inject	(Sync Signals)	
9	Move to Injector	1. Inject to			
10	Drive needle to penetration depth	1. Inject to	 Motor Z	(Injectors) (Motors)	Needle Penetr Inj Penet Spd
11	Delay	Pre Inj Del			
12	Activate Injected signal		Injected	(Out Signals)	Pulse Time
13	Activate Injectd+ signal		Injectd+	(Out Signal)	Pulse Time
14	Dispense syringe contents into first GC Injector	Inject Speed			
15	Delay	Pst Inj Del			
16	Retract needle from injector		Motor Z	(Motors)	Inj Penet Spd
17	Clean syringe with solvent from Wash1 selected number of times	Int Cln Slv1	SYRINGE Wash1 Waste	(Syringes) (Wash Stations) (Injectors)	Fill Speed Eject Speed Needle Penetr Clean Volume Needle Penetr
18	Clean syringe with solvent from Wash2 selected number of times	Int Cln Slv2	SYRINGE Wash2 Waste2	(Syringes) (Wash Stations) (Injectors)	Fill Speed Eject Speed Needle Penetr Clean Volume Needle Penetr
19	Fill syringe with sample from job sample number incremented by 2. Sample Offs using several filling strokes; aspirate air outside of vial if Air Volume = 0	2. Sample Offs 2. Sample Vol 2. Air Vol Fill Volume Fill Speed Fill Strokes Pullup Del	SYRINGE TRAY	(Syringes) (Tray Type)	Eject Speed Overfill Needle Penetr
20	Wait for Inject2 signal		Inject2	(Sync Signals)	
21	Move to second GC Injector	2. Inject to			
22	Wait for time since first injection	Inj Time Diff			
223	Drive needle to penetration depth	2. Inject to	 Motor Z	(Injectors) (Motors)	Needle Penetr Inj Penet Spd
24	Delay	Pre Inj Del			
25	Activate Injectd2 signal		Injectd2	(Out Signals)	Pulse Time

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

26	Dispense syringe contents into second GC Injector	Inject Speed			
27	Delay	Pst Inj Del			
28	Retract needle from injector		Motor Z	(Motors)	Inj Penet Spd
29	Clean syringe and needle with solvent 1	Pst Cln Slv1	SYRINGE Wash1 Waste	(Syringes) (Wash Stations) (Injectors)	Fill Speed Eject Speed Needle Penetr Needle Penetr
30	Clean syringe and needle with solvent 2	Pst Cln Slv2	SYRINGE Wash2 Waste2	(Syringes) (Wash Stations) (Injectors)	Fill Speed Eject Speed Needle Penetr Needle Penetr
31	Move to Home position		Home	(Positions)	

3.4.1. "GC-Dual" Cycle Method Parameter Description

Parameter	Description
CYCLE	GC-Dual
SYRINGE	Selected syringe
1. Sample Vol	Sample volume for first injection
1. Air Vol	Volume aspirated after the syringe needle is moved out of the sample liquid
1. Inject to	Injector used for first injection
Inj Time Diff	Time difference between first and second injection
2. Sample Offs	Offset from first sample number to second sample number
2. Sample Vol	Sample volume for first injection
2. Air Vol	Volume aspirated after the syringe needle is moved out of the sample liquid
2. Inject to	Injector used for second injection
Pre Cln Slv1	Wash cycles with Wash1 before first sample is aspirated
Pre Cln Slv2	Wash cycles with Wash2 before first sample is aspirated
Pre Cln Spl	Rinse cycles with sample before first sample is aspirated
Int Cln Slv1	Wash cycles with Wash1 before second sample is aspirated
Int Cln Slv2	Wash cycles with Wash2 before second sample is aspirated
Pst Cln Slv1	Wash cycles with Wash1 after second sample is aspirated
Pst Cln Slv2	Wash cycles with Wash2 after second sample is aspirated
Fill Volume	Fill Volume used for all Filling strokes except the last one
Fill Speed	Speed of plunger movement used to aspirate sample
Fill Strokes	Number of filling strokes
Pullup Del	Delay time between sample pullup and ejection
Inject Speed	Speed of plunger movement used during sample injection
Pre Inj Del	Delay time prior to sample injection
Pst Inj Del	Delay time after sample injection

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

4. PAL Firmware Overview

4.1. COMBI PAL Flow Chart based on PAL Firmware Version 2.5.X.

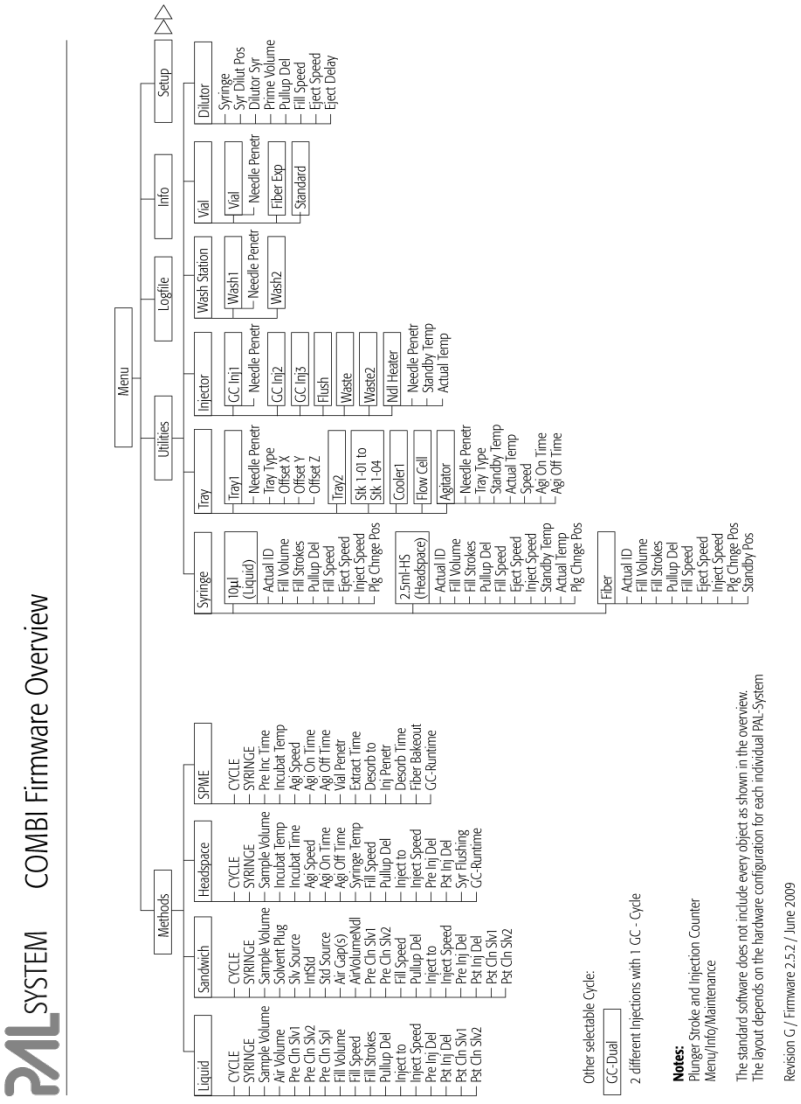


Figure 54. COMBI PAL- Firmware Overview, Page 1

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

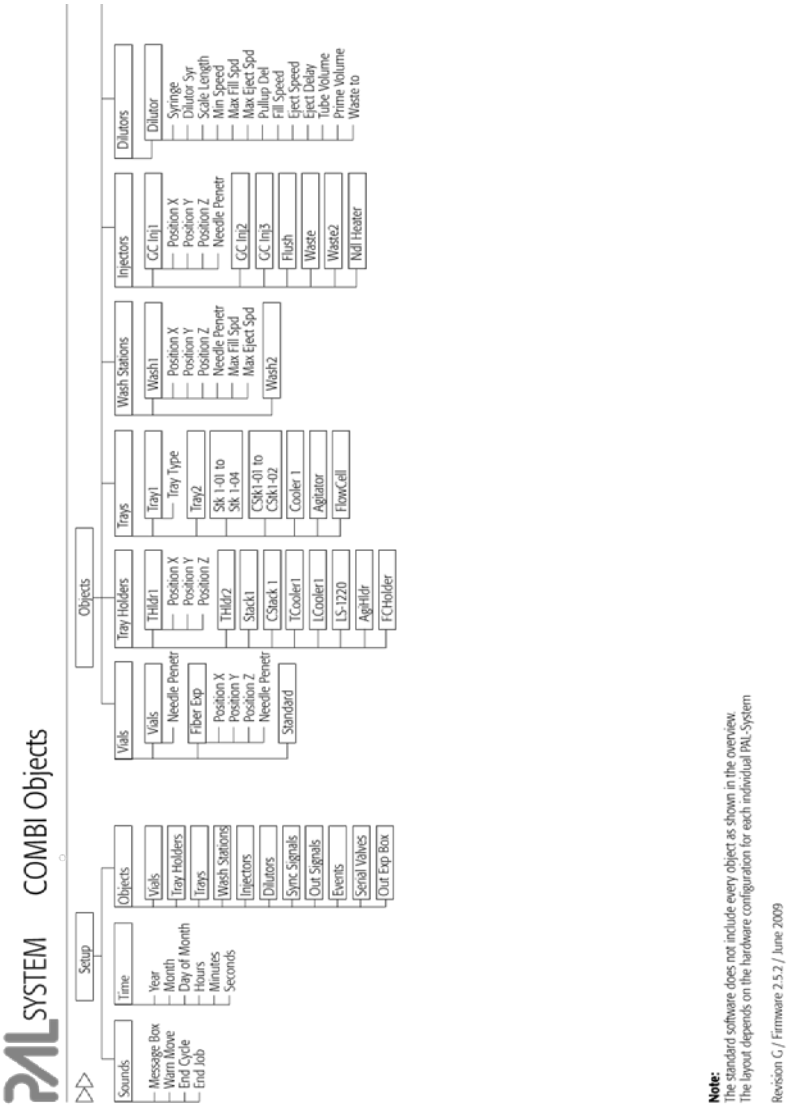


Figure 55. COMBI PAL Firmware Overview, Page 2

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

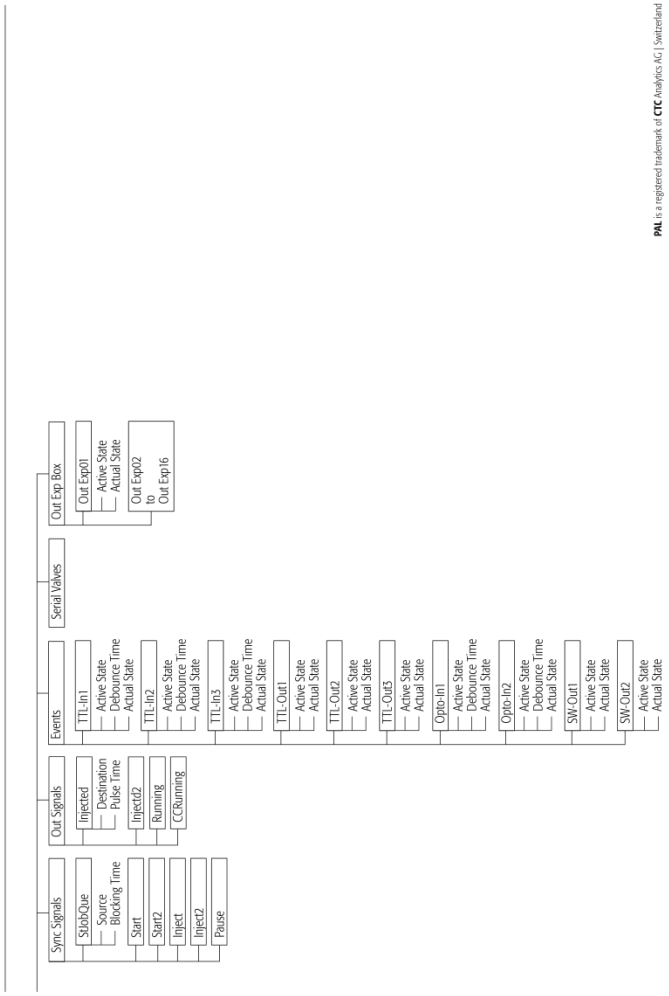


Figure 56. COMBI PAL Firmware Overview, Page 3

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

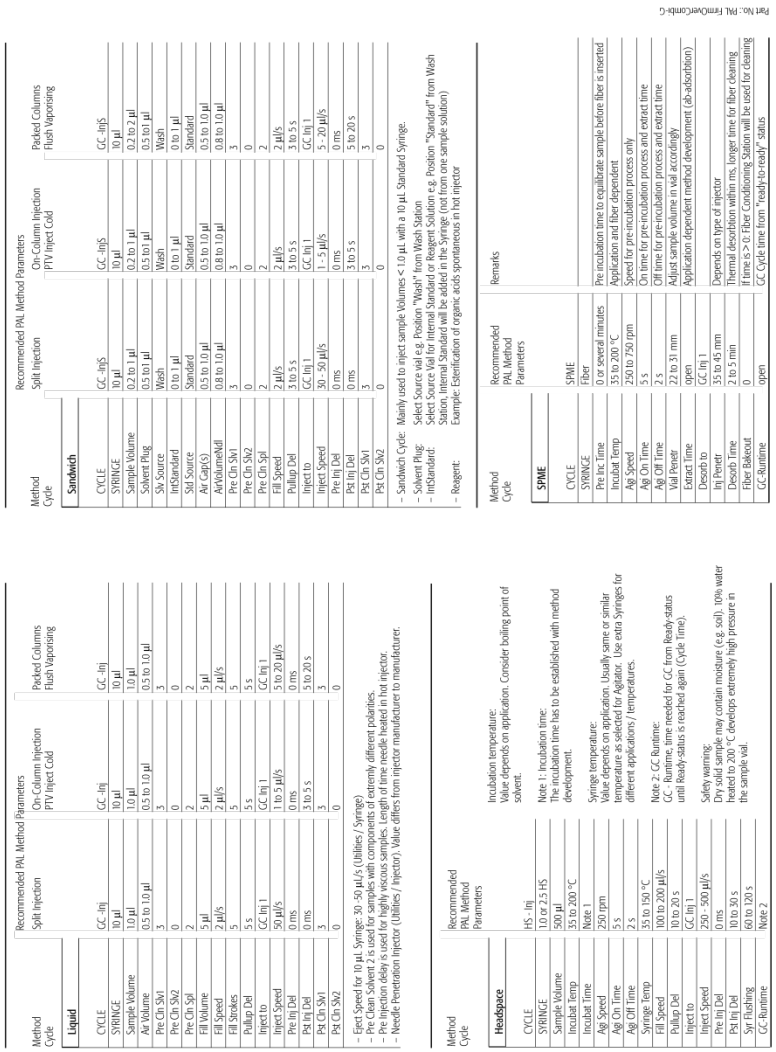


Figure 57. COMBI PAL Firmware Overview, page 4

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

4.2. PAL COMBI-*xt* PAL System Flow Chart based on PAL Firmware Version 4.1.X

note

Firmware version 4.1.X., as shown in the flow chart, corresponds to the PAL -xt System. The changes from Firmware version 2.5.X., as used for the PAL System, are emphasized in this PAL User Manual.

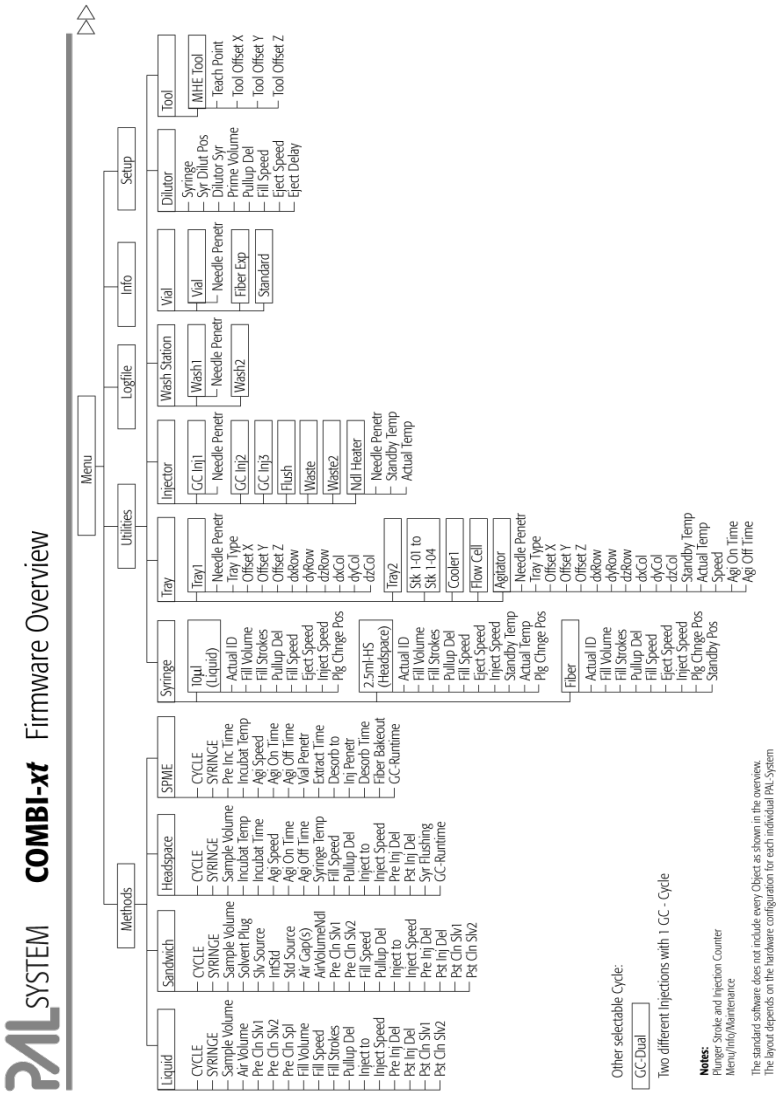


Figure 58. PAL COMBI-*xt* Firmware Overview, Page 1

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

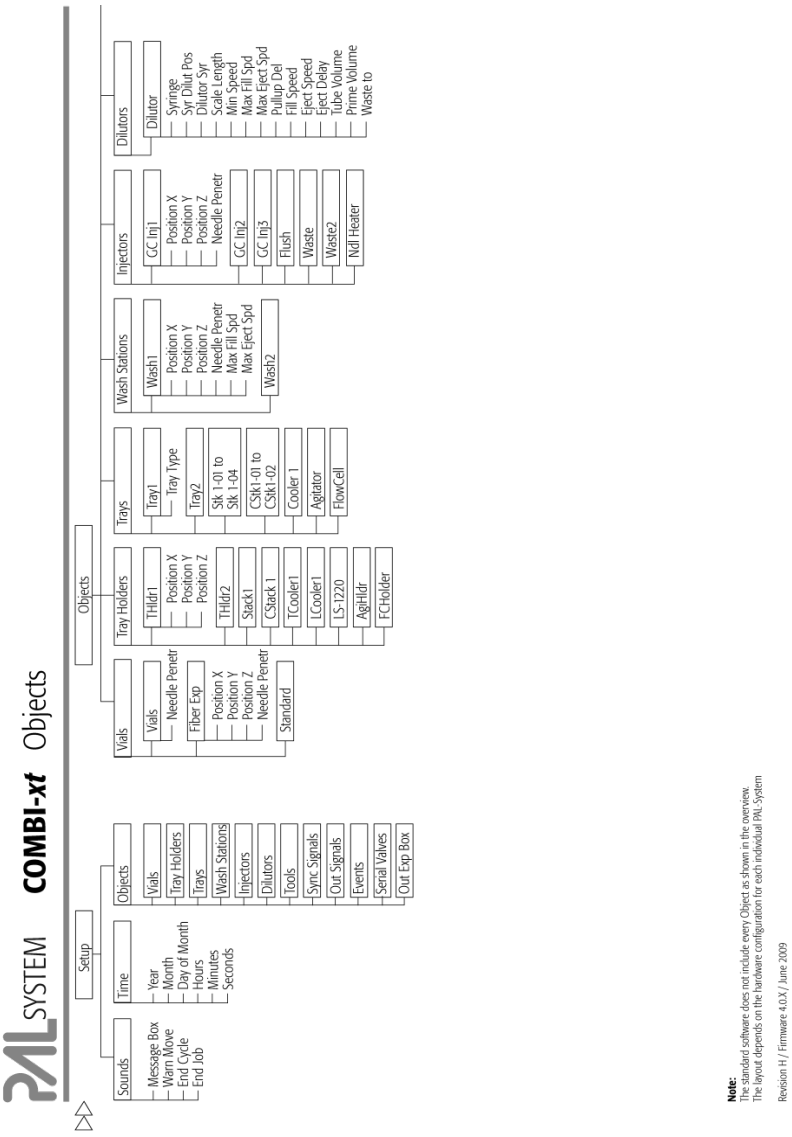


Figure 59. PAL COMBI-*xt* Firmware Overview, Page 2

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

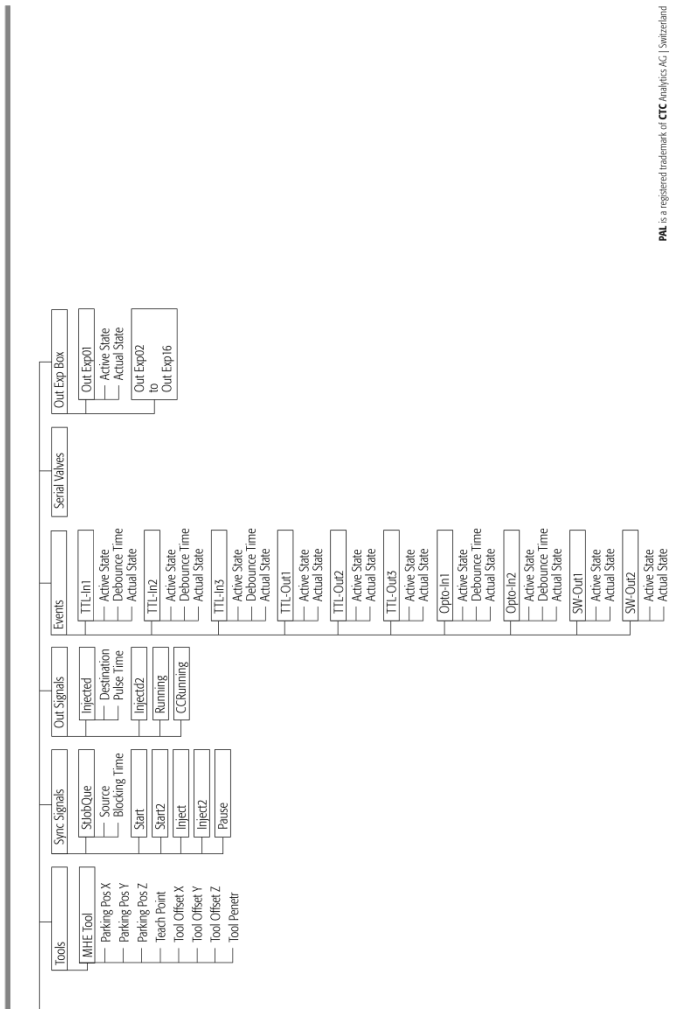


Figure 60. PAL COMBI-*xt* Firmware Overview, page 3

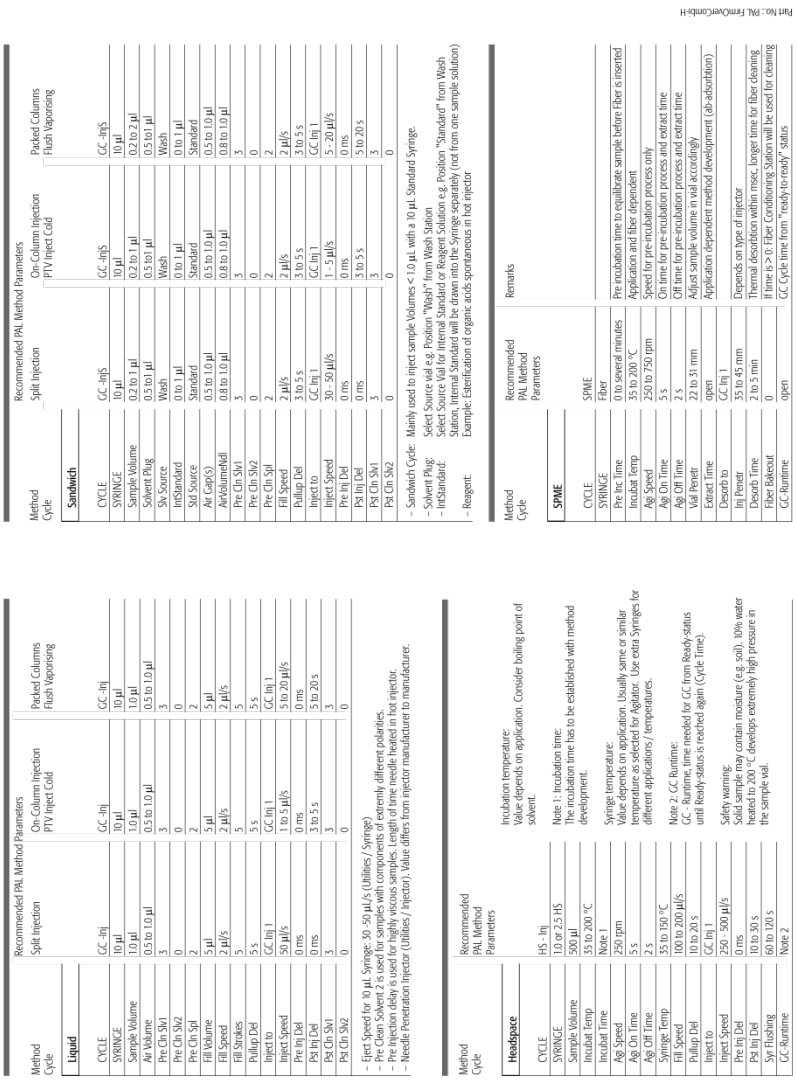
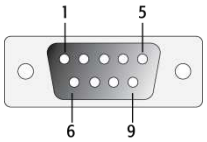


Figure 61. PAL COMBI-*xt* Firmware Overview, Page 4

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

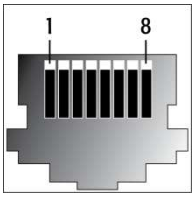
5. External Connectors for PAL and -*xt* System

Connector SER1 | PAL and -*xt* System



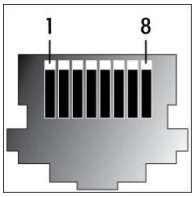
Pin	Signal Name
1	NC
2	RXD
3	TXD
4	DTR bridged with Pin7; Special grounding, do not alter.
5	GND
6	NC
7	RTS bridged with Pin 4; Do not alter.
8	NC
9	NC

Connector SER2 | PAL System



Pin	Signal Name
1	GND
2	RXD
3	TXD
4	NC
5	NC
6	+5V
7	NC
8	GND

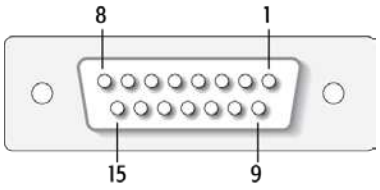
Connector TERMINAL or SER3 | PAL and -*xt* System



Pin	Signal Name
1	GND
2	RXD
3	TXD
4	NC
5	NC
6	+5V
7	NC
8	GND

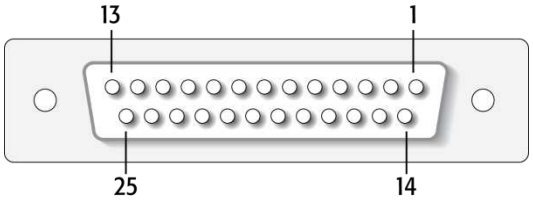
PAL is a registered trademark of **CTC** Analytics AG | Switzerland

Connector INTERFACE 1 | PAL and *-xt* System



Pin	Signal Name
1	Pwr-Out1 +
2	Pwr-Out2 +
3	SW-Out1 NO
4	SW-Out1 COM
5	SW-Out2 NO
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

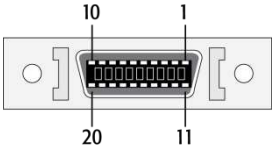
Connector INTERFACE 2 | PAL and *-xt* System



Pin	Signal Name
1	TTL-In1
2	TTL-In2
3	TTL-In3
4	TTL-Out1
5	TTL-Out2
6	TTL-Out3
7	Opto-In1 +
8	Opto-In2 +
9	SW-Out1 NO
10	SW-Out2 NO
11	Pwr-Out1 +
12	Pwr-Out2 +
13	+5V
14-19	GND
20	Opto-In1 –
21	Opto-In2 –
22	SW-Out1 COM
23	SW-Out2 COM
24	Pwr-Out1 –
25	Pwr-Out2 -

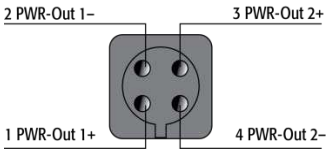
PAL is a registered trademark of **CTC** Analytics AG | Switzerland

Connector AUX1; AUX2 | PAL and *-xt* System



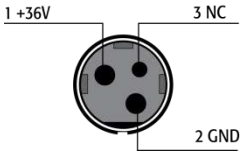
Pin	Signal Name
1,2	Motor A1
11,12	Motor A2
3,4	Motor B1
13,14	Motor B2
15,18,19	GND
6	Temp +
16	Temp -
7	Sens
17	+5V
8,9	Heater
20,10	36V

Connector Wash Station | PAL-*xt* System



Pin	Signal Name
1	PWR – Out1+
2	PWR – Out1-
3	PWR – Out2+
4	PWR – Out2-

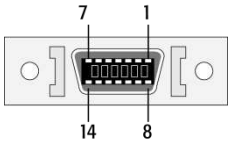
Connector Power | PAL and *-xt* System



Pin	Signal Name
1	+36 V
2	GND
3	NC

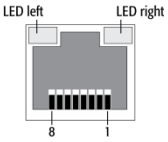
PAL is a registered trademark of **CTC** Analytics AG | Switzerland

Connector MODBUS | PAL-*xt* System



Pin	Signal Name
1	TXD
2 – 7	+36 V
8	RXD
9 – 14	GND

Connector LAN | PAL-*xt* System



Pin	Signal Name	DIR	Primary Function
1	TX+	Out	Transmit Data +
2	TX-	Out	Transmit Data -
3	RX+	In	Receive Data +
4,5,	Not used		Terminated
6	RX-	In	Receive Data -
7,8	Not used		Terminated

Connector Fuse | PAL-*xt* System

Fuse Type	FST 5x20
Rating	6.3A
Rated Voltage	250 VAC

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

6. Intended Use for PAL System

6.1. Introduction

The brand name "PAL System" represents an entire product family, the following description of intended use therefore applying to the product groups "PAL" and "PAL-*xt*", which include for example the models Combi PAL, HTS PAL or PAL Combi-*xt* and PAL HTS-*xt* together with other PAL/PAL-*xt* design-dependent subclasses.
If the PAL System is distributed through OEM partners, the product or model name can be replaced with their own name but the "Intended Use" remains valid.

6.2. Intended Use

The PAL System is an XYZ robotic system offering high flexibility and functionality. Its intended use can be described as being mainly as autosamplers or sample preparation devices for all relevant fields of application in chemical and physical analysis.

The systems will only be used by trained operators in a professional environment.

Typical fields of application for the PAL System are:

- Environmental analysis
- Quality control in the chemical and pharmaceutical industries
- Drug discovery
- Metabolism studies on agrochemicals or pharmaceutical products

The above list of typical applications is not exhaustive.

The traditional market position of CTC Analytics AG has resulted in the PAL System being mainly used as an autosampler device for the techniques of GC (gas chromatography) and HPLC (high pressure liquid chromatography).
Sample preparation steps, such as filtration, purification or separation by means of solid phase extraction (SPE), derivatization, etc., are possible in combination with chromatographic or other techniques.

Other techniques or areas of application are also possible. XYZ robotic systems are typically used where vial (sample) transport, liquid handling or sample preparation need to be automated. Known fields of application include tablet dissolution and viscosimetry.

The users will to a large extent themselves determine which substances, compounds or liquids the system will come into contact with.

6.3. Disclaimer and Restrictions on Use

The PAL System boundary represents a significant limitation of the manufacturer's responsibility. Submitting and placing samples (vials, well plates or other sample holding devices), inserting syringes, selecting reagents and wash solvents are together with any other preparative tasks solely the responsibility of the user. Any possible sample mix-up or omission of an item cannot be detected or prevented by the PAL System. The PAL or PAL-*xt* System boundary is defined when the sample is placed in the system and by the final prepared and primed system.

The use of the PAL and PAL-*xt* Systems for any invasive technique on human beings or animals is explicitly excluded.

In addition, any application in an environment where explosion protection is required is specifically prohibited for the PAL and PAL-*xt* Systems.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland

7. PAL Accessories

The accessories for the PAL System are described in the attached “PAL accessories Catalog” or on the web page: www.ctc.ch.

PAL is a registered trademark of **CTC** Analytics AG | Switzerland