

# HPLC Systems

Front-End Automation  
for LC / LC-MS Systems



High Throughput  
Screening


Proteome Biomarker  
Discovery


Preclinical Research  
Metabolomics


Drug Metabolism  
Pharmacokinetics

Environmental, Food  
Forensics


LC-MS Automation

 Syringe only concept, no tubing in sample path  
for clean and transparent sample processing

 Reliability and ruggedness for unattended  
24 hour/day chromatography

 High sample capacity combined with flexible  
instrument configurations and fast injection cycles

 Temperature controlled sample storage from  
4°C up to 70°C

 Third party instrument drivers for all leading LC-MS systems  
enables single keyboard operation

## Front-End Automation Systems for Liquid Chromatography

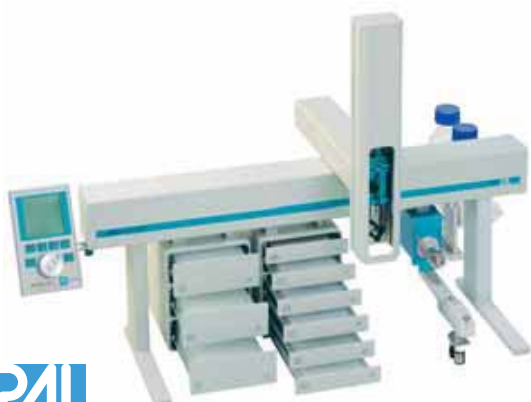


High-End System XL

### HTX PAL

The HTX PAL fits into the high throughput analysis market where huge numbers of samples have to be characterized in a short period of time.

- Extended X length of 120cm
- Injection onto FIA/MS, parallel HPLC or MUX systems
- Built for unattended 24 hour/day Mass Spec analysis
- Various accessories and options available
- Perfect sample introduction for high throughput environment



High-End System

### HTS PAL

Besides 96/384 MT or Deepwell plates the HTS PAL injects samples out of 1ml/2ml/10ml/20ml vials or various types of test tubes directly into the LC valve.

- High-End model in 80cm length
- 4-valve operation for parallel or staggered sample analysis
- 2- or 3-valve operation for multidimensional chromatography
- Upgradable with the PAL Dilutor module
- Perfect sample introduction for flexible analysis requirements



Mid-Range System

### HTC PAL

The HTC PAL provides outstanding performance and maximum flexibility for any LC sample processing system. Sample capacity of 24 microplates within 50cm of benchspace are unmatched in the industry.

- Mid-Range model in 50cm length
- Variable instrument setups in a compact size
- Open architecture for easy access to samples, valve and syringe
- Software control by all leading LC-MS systems
- Perfect sample introduction in limited benchspace situations



Entry-Level System

### LC PAL

The syringe only concept of the LC PAL combines the manual sample injection procedure of a LC chromatographer with the precision and throughput of a robotic liquid handling system.

- Entry-Level model in 50cm length
- Fixed configuration and compact size
- Microplate and sample vial processing
- Three different Syringe Washstations available
- Perfect sample introduction for daily routine analysis

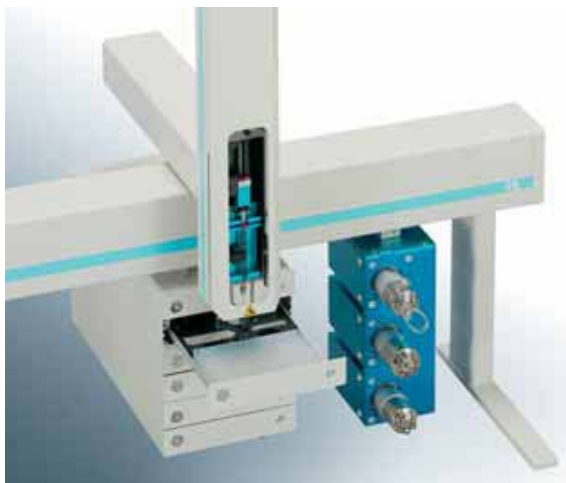
## PAL Accessories and Options a concept you can grow with



### UPLC Chromatography

Ultra performance liquid chromatography (UPLC) is a category of liquid chromatography where pressures up to 15'000psi (1000 bar) are used. Researchers benefit from increased resolution, speed, and sensitivity in a variety of applications. These advantages result from packing columns with  $< 2.0 \mu\text{m}$  particles and HPLC instrumentation that are optimized for such conditions. In order to take advantage of this new technology, samples are introduced via ultra high pressure injection valves into the corresponding UPLC chromatography system. All PAL HPLC sample loaders can be equipped with injection valves built for pressures up to 15'000psi (1000 bar). Various valve models are available e.g. 6 - or 10-port design and different bore sizes for nano- and micro applications

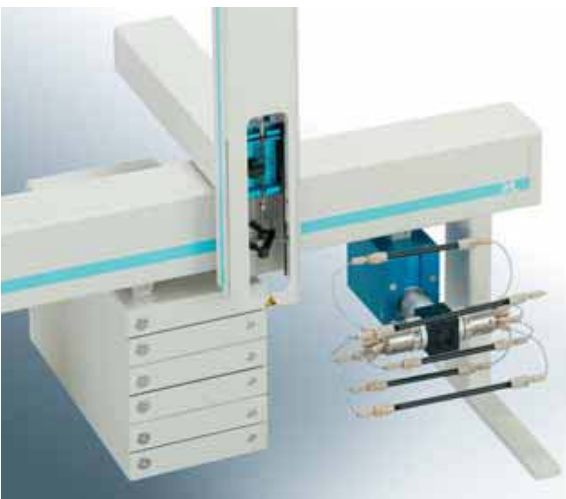
- Ultra high pressure valves up to 15'000psi (1000 bar)
- 6 - or 10-port design available
- Various bore sizes for nano- and micro applications



### Valve Switching Modules

PAL valve drive modules consist of 2 or 3 individually controlled multiposition valve drives arranged in a vertical stack. The top valve acts usually as injection valve, while the remaining one or two valves are used as switching valves. Typical applications are pre-column SPE, pre-column cleanup, sample desalting, etc. For increased sample throughput the accessory can be used for time staggered "heart-cuts" of two independent gradient systems. Important chromatogram parts only reach the detector just in time using a selector valve, while the front- and end-cut goes to waste. The compact valve module arrangement results in a space saving setup with very short connection lines. The modules are compatible either with 4- 6- 8- or 10-port valves and can be mixed on the same valve drive module.

- Pre-column sample cleanup, desalting or pre-column SPE
- Alternate column regeneration
- 4 - 6 - 8 - or 10 - port valves individually arranged in a vertical stack



### Column Selector Valve

Column selection helps to develop reproducible, rugged methods in the shortest possible time. With a variety of columns from which to choose, any method development lab can optimize selectivity, resolution and analysis time. The PAL Column Selector option allows a single or multiple users to select methods using the appropriate column for their assay. Columns are stored in the storage solvent of choice requiring no manual changes. Different types of samples can be run over night using different columns resulting in better utilization of existing equipment. In a validated environment, PAL column selection option can be used for column to column reproducibility, method ruggedness or long-term stability.

- Column selection valve for up to 6 columns
- Automated method development using different columns
- Column to column reproducibility, method ruggedness, long-term stability

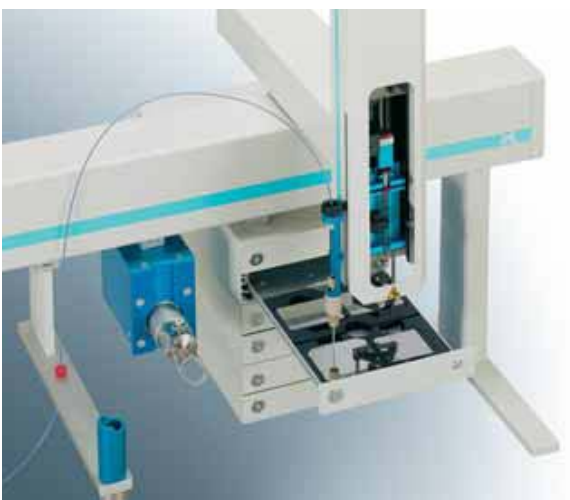
## Open and modular architecture delivers customized solutions



### 4 Valve Option for automated parallel LC-MS analysis

The PAL 4-fold valve option was developed for automated parallel LC-MS analysis, especially required for multiplexed LC-MS interfaces. The accessory consists of 4 injection valves which are loaded in serial mode and switched to inject simultaneously. This allows to work with 4 LC columns in parallel which results in enhanced throughput. CTC's single syringe design allows even for parallel analysis the "cherry picking" sampling mode (random plate access to single wells). Additionally the 4-valve option can be combined with a 8-port stream selector valve for staggered sample injections. Important chromatogram parts can be cut-out and reach the LC-MS inlet. Beside enhanced throughput, this feature helps to keep clean the MS inlet for a prolonged period of time.

- Automated parallel or staggered injections with 4 valves
- Stream selector valve for staggered sample injection mode
- Single syringe design enables "cherry picking mode"



### PAL MALDI Option

Rapid and accurate identification and quantification of proteins is one of the goals of today's proteomics research. The challenge is to achieve high sensitivity with limited sample amount. The micro fraction collection/MALDI spotting option meets this task. It is an ideal tool for single or multidimensional chromatographic separation of complex peptide and protein mixtures for subsequent analysis by MALDI and/or ESI mass spectrometry. It offers flexible LC/MALDI spotting on various target types from different vendors as well as fraction collection into 96 or 384 well plates. Precise probe positioning control enables reproducible and robust collection of small fraction volumes from nL to the  $\mu$ L range.

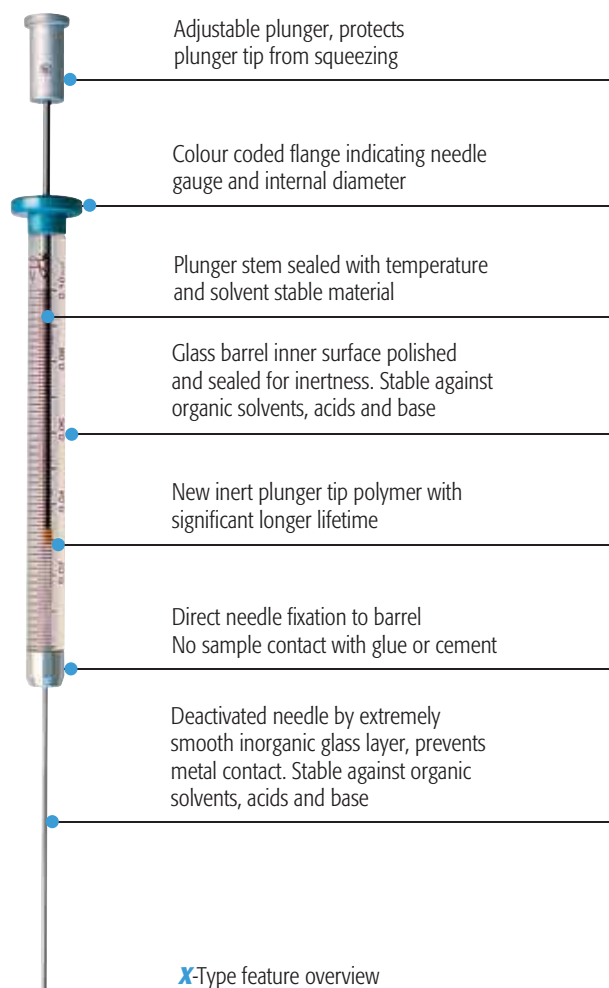
- LC separations coupled with micro fraction collection
- No dead volume, column outlet directly attached to the spotting tip
- Various MALDI target vendors supported



### PAL Dilutor

Adding the Dilutor to a PAL extends its sample prep capabilities. It can be used to dispense liquid prior sample injection and combines the "add liquid" and "inject" steps without user intervention or syringe change. Typical applications are dilutions, derivatisations, sample spiking or standard additions. Dilutor syringes up to 10ml ensure large dilution ratios. Another important Dilutor application concerns the injection valve and syringe wash procedure in LC-MS high throughput systems. Replacing the standard Fast Wash Station, the Dilutor can be used to clean the injection syringe as well as the injection valve at the same time. This results in shorter cycle times, which is the key factor in today's screening labs.

- Sample derivatisation, dilutions, spiking, standard additions
- Large dispense volume combined with small injection volume
- Accelerated wash steps, cleans syringe and valve at the same time

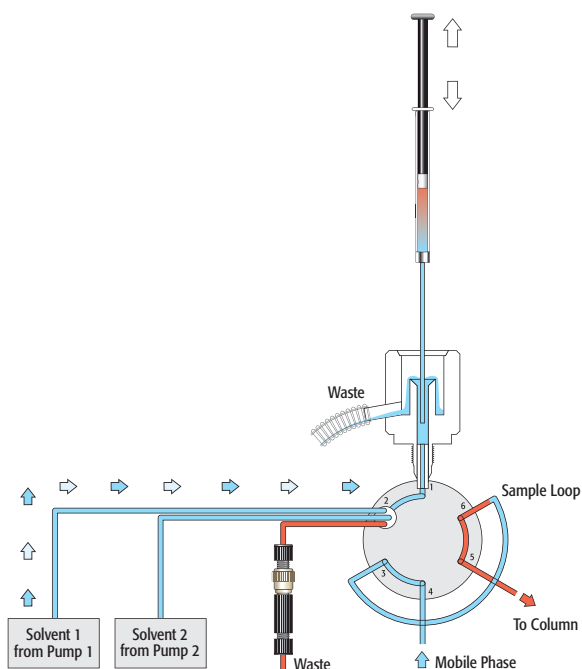


## Technology developed for the most sensitive LC-MS Systems

CTC Analytics developed a high performance generation of HPLC microliter syringes. The main features are near zero carry-over and a long-lasting plunger. Tests with critical samples like phospholipids, basic molecules and peptides have shown that carry-over can be reduced by a factor of 10 depending on the sample. The life cycle of the plunger is improved as well by a factor of at least 10 compared to a standard syringe. **X-Type** Syringes are available in volumes of 25, 50 and 100µl.



**X-Type** syringes available in various sizes



Pumps activated, simultaneous valve and syringe cleaning

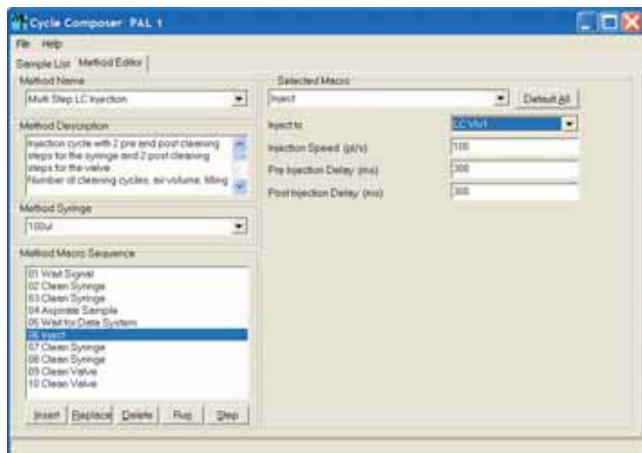
### Active Washstation for LC-MS applications

- Integrated pumps for active wash solvent delivery
- Entire flow path cleaning in backflush direction
- Rinses valve engravings, needle seal and syringe (Patent pending)
- High throughput, cleans valve and syringe at the same time
- Selectable wash cycle strokes for organic and aqueous solvents
- Upgradable to any existing PAL

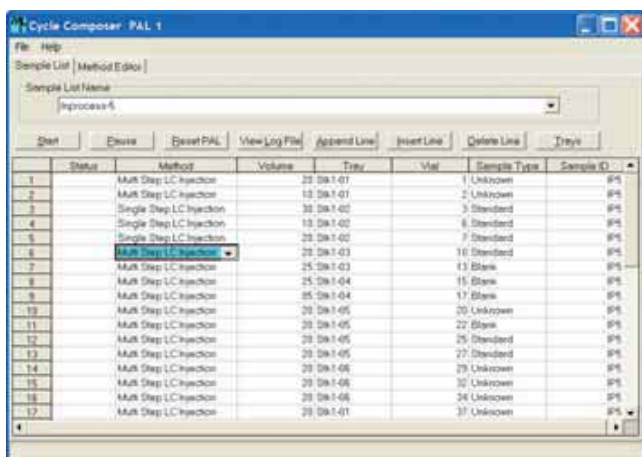


Active Washstation Module

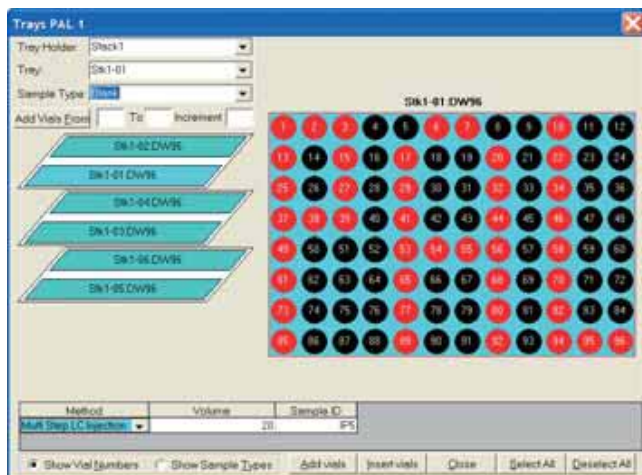
# Software control for all leading LC / LC-MS Systems



Method Editor: Setup and edit customized cycles



Sample List: Setup, edit and run injection sequences



Trays: Graphical sample list generator

## Intelligent Automation

The Windows 2000/XP software Cycle Composer provides remote control for the PAL family of chromatography front-end liquid handling systems. The Cycle Composer software allows the operator to easily setup, edit and run PAL System methods for even very complex "Prep and Load" applications.

## Easy to use

The Cycle Composer affords complete control over liquid handling steps, thereby increasing throughput and productivity of the PAL System. The "Point and click" operation quickly directs the user through programming steps that configure instrument setup, methods and sample lists. For routine daily use, no special programming skills are needed. The Cycle Composer contains a library of common liquid handling procedures including sample transfer, reagent / standard addition, mixing and dilution steps.

## Customize your PAL instrument

As with the PAL hardware concept the Cycle Composer is already prepared for individual application requirements. Additional flexibility can be assigned by using the powerful Cycle Composer macro language.

## Single Keyboard Control

The Cycle Composer can be used as an independent standalone software platform or if required fully integrated into leading LC-MS or GC-MS data acquisition systems. Currently a wide variety of control drivers are available either through CTC Analytics or the instrument vendor.

## Specifications Cycle Composer

### PC requirements

- Pentium 4 processor 1.6GHz
- 512 MB RAM
- 1 serial interface RS232C (or USB to RS232C converter)
- 1 DVD / CD-ROM drive
- installed Windows 2000 SP4 / XP SP2
- 10 MB free hard drive space

### Compatible PAL Instruments

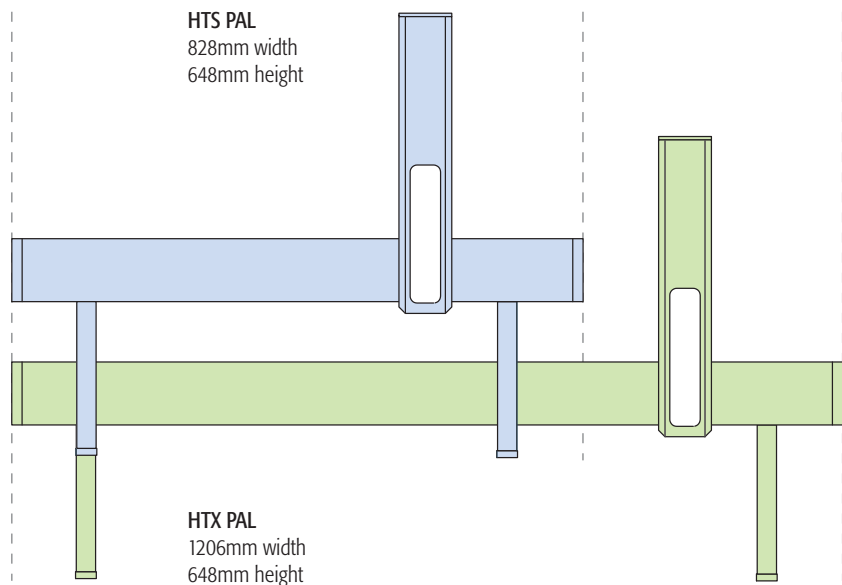
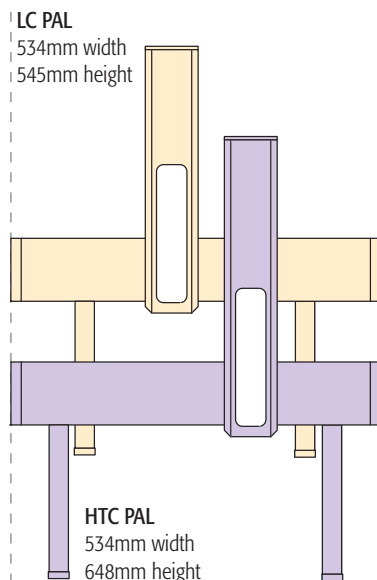
HTX PAL / HTS PAL / HTC PAL / LC PAL / Combi PAL / GC PAL / LHX PAL (Firmware 2.5 or higher installed)

### Third Party Instrument Drivers

Drivers are available either through CTC Analytics or the instrument vendor

- Agilent ChemStation
- Agilent EZChrom
- Applied Biosystems Analyst
- Bruker Daltonics Compass
- DataApex Clarity
- Dionex Chromeleon
- Justice Software Chromperfect
- Shimadzu LCMSSolution
- Shimadzu LCSolution
- Thermo Xcalibur
- Varian Galaxie
- Waters Masslynx
- Waters Empower

	HTX PAL ●	HTS PAL ●	HTC PAL ●	LC PAL ●
Dimensions	Width: 1206mm Depth: 385mm Height: 648mm	Width: 828mm Depth: 385mm Height: 648mm	Width: 534mm Depth: 385mm Height: 648mm	Width: 534mm Depth: 385mm Height: 545mm
Injection Valves	up to 2	up to 2	1	1
Additional Switching Valves	up to 9	up to 6	up to 3	no
4-fold Injection Valve Drive	yes	yes	no	no
0.15mm Nano Injection Valve	yes	yes	yes	no
1000 bar UPLC Valve	yes	yes	yes	yes
Column Selector Valve	yes	yes	no	no
PAL Dilutor	yes	yes	no	no
PAL Active Washstation	yes	yes	yes	yes
Injection Volume	0.1 µl - 5000 µl	0.1 µl - 5000 µl	0.1 µl - 5000 µl	0.1 µl - 5000 µl
Sample Capacity	1400 1ml vials 1296 2ml vials 224 10/20ml vials 24 MT Plates 24 DW Plates	600 1ml vials 972 2ml vials 96 10/20ml vials 24 MT Plates 18 DW Plates	400 1ml vials 648 2ml vials 64 10/20ml vials 24 MT Plates 12 DW Plates	216 2ml vials 4 MT Plates 4 DW Plates
Sample Capacity Thermostatted	800 1ml vials 1296 2ml vials 128 10/20ml vials 24 MT Plates 24 DW Plates	400 1ml vials 648 2ml vials 64 10/20ml vials 24 MT Plates 12 DW Plates	200 1ml vials 324 2ml vials 32 10/20ml vials 12 MT Plates 6 DW Plates	no
PAL MALDI Option Fraction Collection	yes	yes	yes	no
Third Party Instrument Drivers	yes	yes	yes	yes





High End System XL



High End System



Mid Range System



Entry Level System

## PAL LC Versions General Specifications

### System Type

XYZ robot with syringe only concept, no tubing in sample path

### Local User Interface

Control panel with 4 function keys, graphical LCD display, unique scroll knob for teach functions

### Remote Control

Cycle Composer control software Windows 2000 / XP  
Third party instrument drivers for all major LC/LC-MS Systems

### Maintenance

Accessibility to all maintenance parts from front  
Preventative maintenance kits and IQ/OQ documents available

### Electrical Control

up to 2x RS232  
up to 3x TTL Input  
up to 2x Opto Coupler Input  
up to 2x Relay Output

### Power Requirements

100-240V, 120W, 50/60Hz

### Electrical Safety Standards

CAN/CSA C22.2 No. 61010-1 / ANSI/UL 61010-1 / EN 61010-1

### Environment

4°C - 40°C constant temperature, < 80% humidity (non condensing)

### Weight

~10kg (without accessories)

### Valves Types

Body materials SST 316, PEAK, Hastelloy  
Rotor materials Valcon H, Valcon T, Valcon E, RPC-10  
Bore sizes 0.1mm, 0.15mm, 0.20mm, 0.25mm, 0.4mm, 0.75mm  
Port numbers 4, 6, 8, 10 ports  
Pressure limits 3'000, 5'000, 10'000, 15'000 psi

### Syringe Sizes

10µl, 25µl, 50µl, 100µl, 250µl, 500µl, 1000µl, 2500µl, 5000µl

### Sample Trays

1ml vials 200 positions  
2ml vials 54 positions (microplate footprint for sample stacks)  
2ml vials 98 positions  
10ml vials 32 positions  
20ml vials 32 positions

### Instrument Options

PAL MALDI Spotter / Fraction Collection  
PAL Dilutor  
PAL Multi Valve Drives  
PAL Sample Stack Cooler / Tray Cooler  
4- 6- 8- 10- port Injection and Switching Valves  
UPLC Injection Valves up to 1000 bar / 15'000psi  
PAL Column Selector Valve  
PAL Barcode Reader

Specifications are subject to change without notice

## PAL LC Sample Injection Systems

perfect sample loader for leading Mass Spectrometers



Distributed by:

CTC Analytics has dedicated the last 20 years to the continued development and high reliability of advanced sample injection technology. To learn more about the unique PAL Series of LC/LC-MS sample handling systems or any of our GC/GC-MS sample injection systems contact your CTC Analytics distributor.

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...**CTC ANALYTICS**  
Where design meets performance

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