



Prep and Load Platform

# HPLC-*xt* Systems

Front-End Automation  
for LC / LC-MS Systems and  
Options



High Throughput Screening  
Environmental, Food Safety, Forensics  
Preclinical Research, Metabolomics  
Drug Metabolism, Pharmacokinetics  
Protein Biomarker Discovery



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# PAL SYSTEM

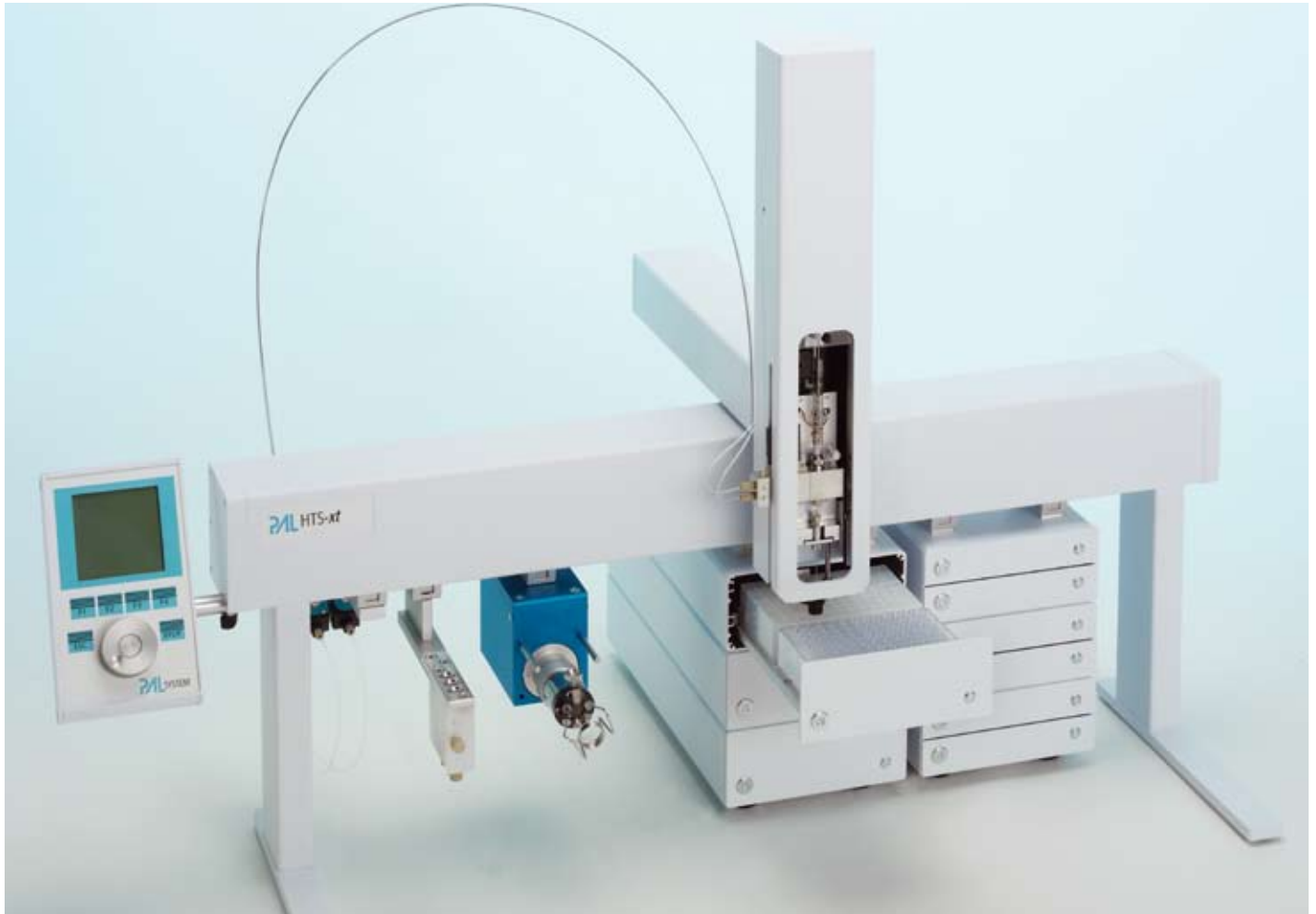
Prep and Load Platform

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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 PAL System distributor.



PAL HTS-*xt* equipped with Stacks for 12 standard and for 6 deepwell microplates

# PAL HPLC System-*xt*

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Open and modular architecture

Fast cycles and near zero carryover due to DLW option

Precise and Accurate sample Loading for high throughput environment, flexible analysis requirements and limited bench space situations

New design

Various accessories and options available

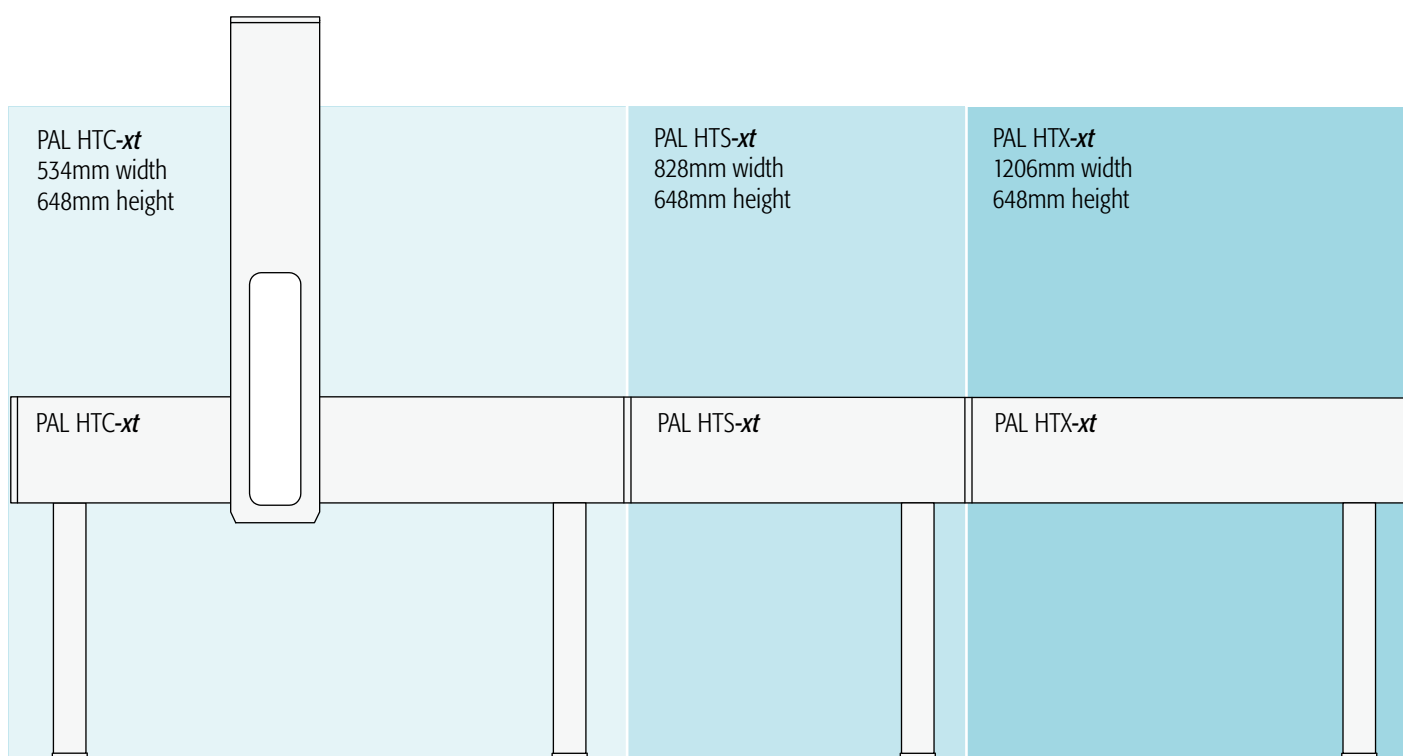
## PAL HPLC System-*xt*

To meet the demand for increased sample throughput and flexibility CTC introduces the PAL HPLC-*xt* product Line. Built on the successful PAL product line, the new PAL HPLC-*xt* offers faster speed plus a completely new single PCB –based electronic which offers more memory, RS232 and LAN communication and of course easier serviceability. The new DLW option (only available with PAL-*xt* Systems) offers near zero carryover and up to 4 times faster cleaning cycles compared to the standard Fast Washing Process.

The open and modular architecture of the PAL-*xt* makes it the most flexible Autosampler for every HPLC and LC-MS System.

The PAL-*xt* can be controlled by most of today's Chromatography Data Systems from all the major instrument manufacturers.

	PAL HTC- <i>xt</i>	PAL HTS- <i>xt</i>	PAL HTX- <i>xt</i>
Dimensions	Width: 534mm Depth: 385mm Height: 648mm	Width: 828mm Depth: 385mm Height: 648mm	Width: 1206mm Depth: 385mm Height: 648mm
Injection Valves	1	up to 2	up to 2
Additional Switching Valves	up to 3	up to 6	up to 9
4 -fold Injection Valve Drive	no	yes	yes
0.15mm Nano Injection Valve	yes	yes	yes
1200 bar UPLC Valve	yes	yes	yes
Column Selector Valve	no	yes	yes
PAL Dilutor Option	no	yes	yes
PAL Active Washstation	yes	yes	yes
PAL DLW Option	yes	yes	yes
PAL MALDI Spotter / Fraction Collection	yes	yes	yes
Injection Volume	0.1 µl - 5000 µl	0.1 µl - 5000 µl	0.1 µl - 5000 µl
Sample Capacity	400 1ml vials 648 2ml vials 64 10/20ml vials 24 MT Plates 12 DW Plates	600 1ml vials 972 2ml vials 96 10/20ml vials 24 MT Plates 18 DW Plates	1400 1ml vials 1296 2ml vials 224 10/20ml vials 24 MT Plates 24 DW Plates
Sample Capacity Thermostatted	200 1ml vials 324 2ml vials 32 10/20ml vials 12 MT Plates 6 DW Plates	400 1ml vials 648 2ml vials 64 10/20ml vials 24 MT Plates 12 DW Plates	800 1ml vials 1296 2ml vials 128 10/20ml vials 24 MT Plates 24 DW Plates





PAL HTC-*xt* equipped with 1 Stack Cooler and Active washstation

# PAL HTC-*xt*

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## PAL HTC-*xt* Entry-Level System

Entry-Level model in 50 cm 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

Precise and Accurate sample Loading in limited bench space situations

The PAL HTC-*xt* offers the smallest footprints in the industry standard range of PAL-*xt* Autosamplers but still provides major sample capacity. Load up to 12 deepwell microplates, 24 standard microplates or 648 2ml vials or even mix up the loads to meet your workload.

The PAL HTC-*xt* provides outstanding performance and maximum flexibility for any LC sample processing system. Injection volumes from 100nl to 5ml enhance the flexibility and the DLW Option reduces carryover to near zero levels. Cycle times of 20-30 seconds from inject to inject ensure compatibility with LC-MS and FIA-MS.



PAL HTC-xt equipped with 3 valves



PAL HTC-xt equipped with Sample Tray for 98 2ml vials





PAL HTS-*xt* equipped with DLW Option and 2 Stack Cooler DW

# PAL HTS-*xt*

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## PAL HTS-*xt* High Throughput System

High-Throughput 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

Precise and Accurate sample Loading for flexible analysis requirements and high throughput

The PAL HTS-*xt* is designed to meet requirements in terms of speed, capacity and precision in chromatography Front End automation. The PAL HTS-*xt* is the ideal platform for high throughput applications.

Besides 96/384 standard or deepwell microplates the PAL HTS-*xt* injects samples out of 1ml/2ml/10ml/20ml vials or various types of test tubes directly into the LC valve.





PAL HTS-*xt* aspirates samples from a standard microplate in a Stack



PAL HTS-*xt* equipped with DLW Option and a 6 port Injection valve (1000bar)



PAL HTX-xt equipped with 4 Stack Coolers DW

# PAL HTX-xt

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## PAL HTX-xt Ultra High Throughput System

Extended X-axis 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

Precise and Accurate sample Loading for ultra high throughput environment

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

The HTX-xt version has an extended X-axis allowing up to 4 PAL Stack6DW or 4 PAL StkCoolers to be easily installed. Compatible with all major LC/LC-MS Systems the PAL HTX-xt has all the flexibility you would expect from a PAL System.

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

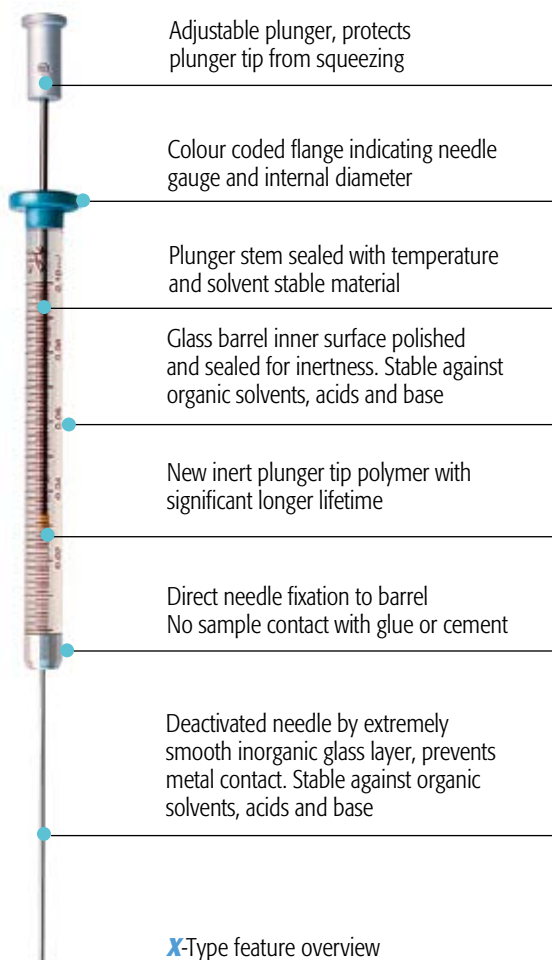
Large dispense volume combined with small injection volume

Accelerated wash steps, cleans syringe and valve at the same time



## PAL Dilutor Option

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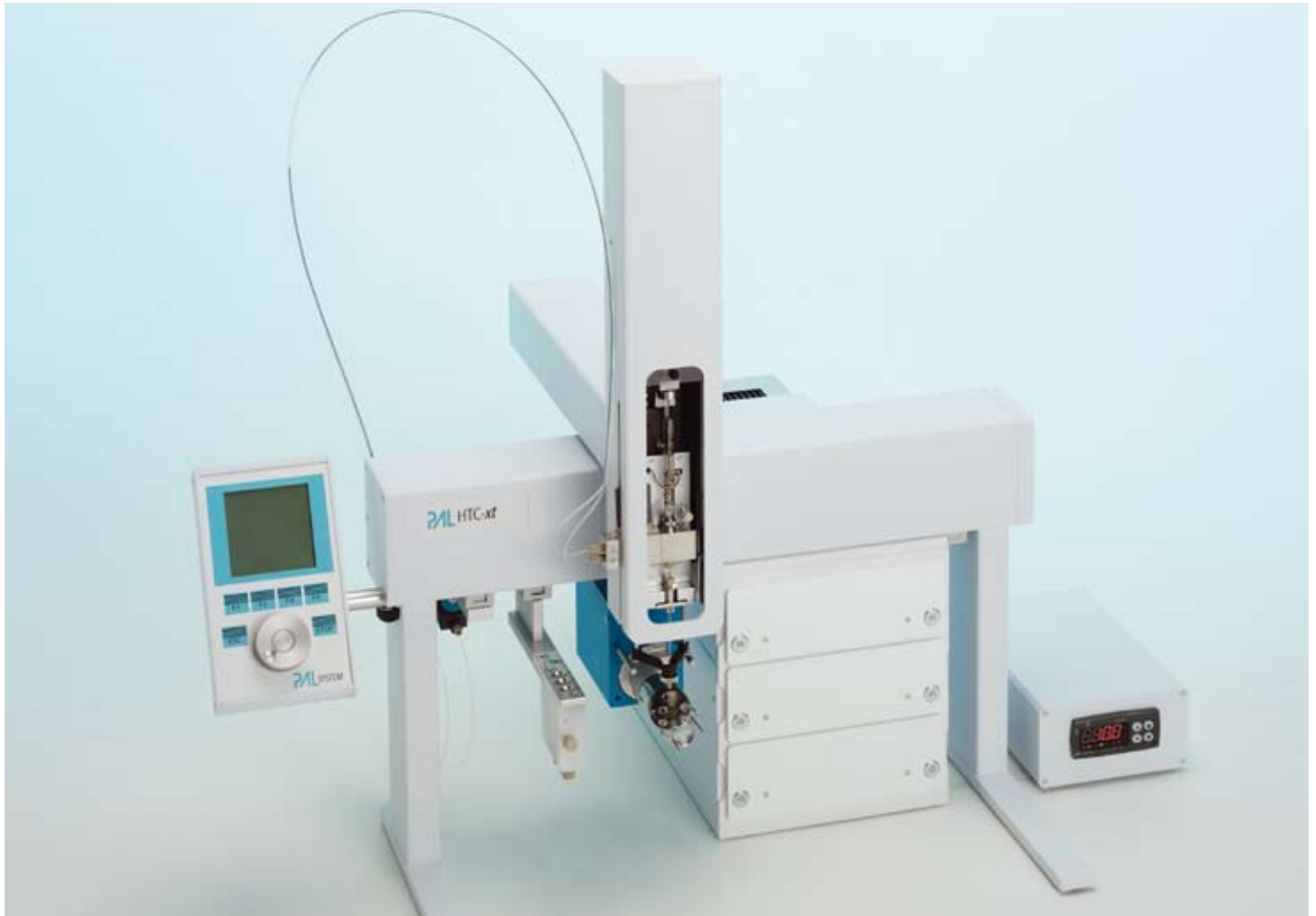
X-Type feature overview

### X-Type Syringe Technology developed for the most sensitive LC-MS Systems

CTC Analytic's developed a high performance generation of HPLC microliter syringes. The main features are near zero carryover and a long-lasting plunger. Tests with critical samples like phospholipids, basic molecules and peptides have shown that carryover can be reduced by a factor of 10 depending on the sample. The life cycle of the plunger is improved as well



X-Type Syringes are available in volumes of 25, 50 and 100µl and various sizes



PAL HTC-xt equipped with DLW and Stack Cooler DW

# PAL DLW Option

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Clean and efficient removal of carryover in the entire flow path

Holding loop for effective rinsing of the complete sample path

Integrated pumps for active wash solvent delivery

Selectable wash time for organic and aqueous solvents

Spring loaded syringe needle positioning in needle guide – no dead volume

Existing PAL Systems can be upgraded

X-Type Syringe based

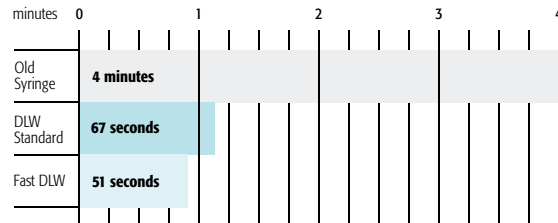
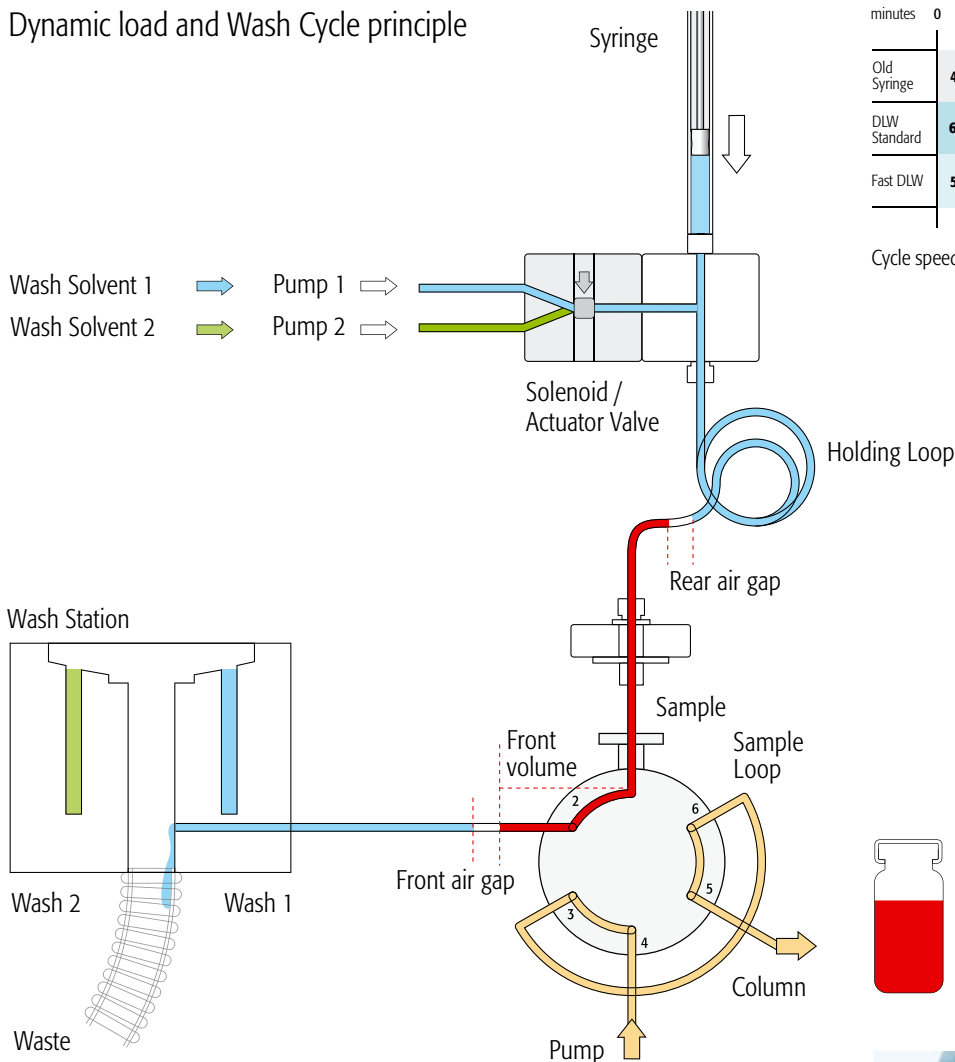
## Near Zero Carryover – Fast Cycles and exceptional reproducibility

Today's Mass Spectrometers are so sensitive that carryover becomes an issue again. To meet today's requirements for fast, clean and reproducible LC-MS injection, CTC developed the DLW Option for the PAL System (Dynamic Load and Wash).

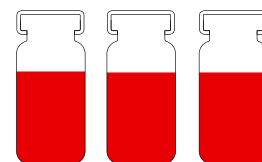
Now the sample is no longer in contact with the syringe but it is aspirated into a holding loop. The syringe only acts as an aspirator and dispenser device in order to exactly measure the amount of sample which needs to be injected this yields excellent reproducibility. After injection, the whole sample path including the valve and needle is washed from the rear with up to 2 different solvents. Active micro pumps deliver the required quantity of solvent fast and reliable. An active solenoid valve precisely stops solvent delivery or switches between solvents. At the end of the injection cycle all parts which have been in contact with the sample are completely clean. As a result, near zero carryover is achieved for most components.

To learn more about the unique Dynamic Load & Wash feature download the special PAL DLW Option brochure.

# Dynamic load and Wash Cycle principle



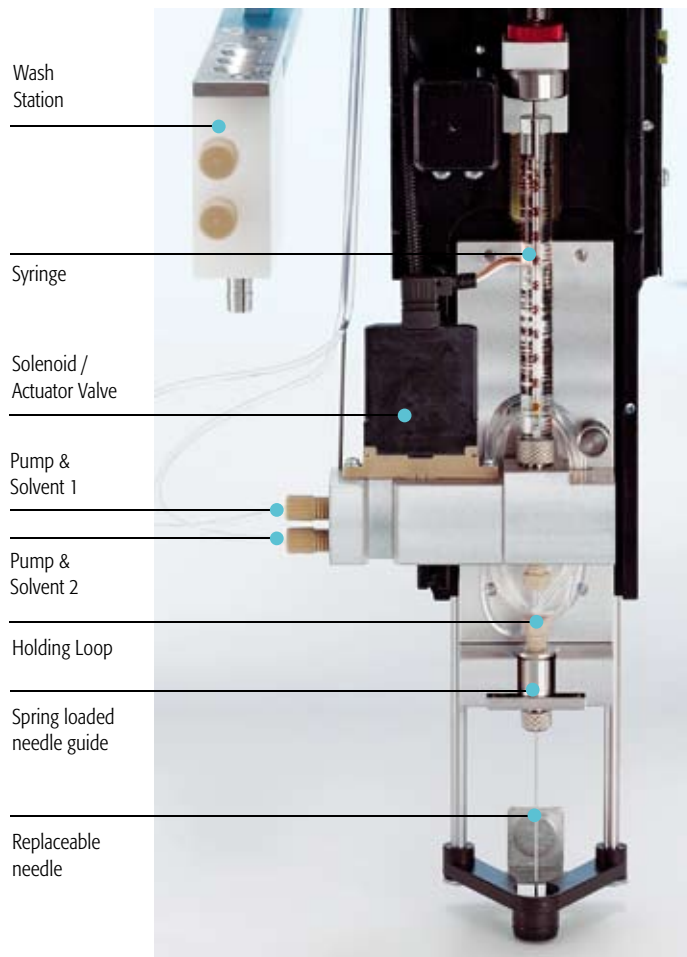
Cycle speed comparison



Download pdf  
 Standard Cycle  
 Fast Cycle  
 Stator Wash Cycle  
[www.palsystem.com](http://www.palsystem.com)

## Specifications DLW Option

Wetted parts material:	Stainless steel, PEEK
Syringe Size:	100µl
Reproducibility (partial loop):	better than 1 % RSD (under specific conditions)
Carryover:	Typically less than 0.003% (30ppm)
Typical Clean Cycle Time:	less than 1 Minute (Fast Cycle)







PAL HTS-xt equipped with Maldi Option, Stacks for standard and deepwell microplates

# PAL Maldi Option

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## On-line Fraction Collection onto MALDI Targets or microplates

Nano, capillary and microbore LC coupled with fraction collection onto MALDI targets or microplates

Single device for LC separation, fraction collection and re-injection of collected fractions

Accommodates column sizes down to 75 $\mu$ m and flow rates up to 300 $\mu$ l/min

All major MALDI Target vendors supported

Optional on-line matrix addition via Nano Y-connector

Rapid and accurate identification and quantification of proteins is one of the goals of today's proteomics research. One key requirement for this approach is the ability to resolve the individual components of peptide mixtures prior to MS analysis. The challenge is to achieve high sensitivity with limited sample amount. This requires equipment that is specifically designed for separation at low flow rates and that allows the collection of small fraction volumes, even on MALDI targets.

The micro collection/spotting system PAL MALDI Option meets this challenge. 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. The offline combination of LC separation with MALDI MS analysis gives scientists significant advantages over the widespread online ESI/MS approach. LC/MALDI "freezes" the LC separation on the MALDI plate and allows MS/MS experiments without any time constraints. Intelligent decisions can now be made during analysis, allowing results-driven analysis without rerunning the sample. Decoupling the separation from the analysis gives the opportunity to optimize the separation performance and the total sample throughput. Flexibility for LC/MALDI spotting on various target types from different vendors as well as collection into well plates (96 and 384). Probe positioning control of 0.1mm enables reproducible and robust collection of small fraction volumes from nl to the lower  $\mu$ l range. Matrix addition can be done either offline or online by premixing the matrix with the eluent.



Maldi Spotter

## Specifications PAL MALDI Option

Compatible PAL instruments  
 PAL HTC-xt / PAL HTS-xt / PAL HTX-xt

Fraction vessel capacity  
 PAL HTS/HTX-xt 23 MTP or 11 deepwell or 594 2ml vials  
 (96 and 384 wells)  
 PAL HTC-xt 11 MTP or 5 deepwell or 270 2ml vials  
 (96 and 384 wells)  
 (optional cooling to 4°C available)

MALDI Target Capacity  
 up to 46 depending on PAL instrument type and target vendor

Spotting Tip  
 Hydrophobic coated fused silica capillary

Spotting frequency  
 min. 3 seconds (20 spots per minute)

Delay volume  
 approx. 3µl with 1 meter PEEK Tubing ID 65µm (column in LC system)  
 approx. 10nl if column is installed inside MALDI Tool  
 (\* lower delay volume requires tubing ID <65µm)

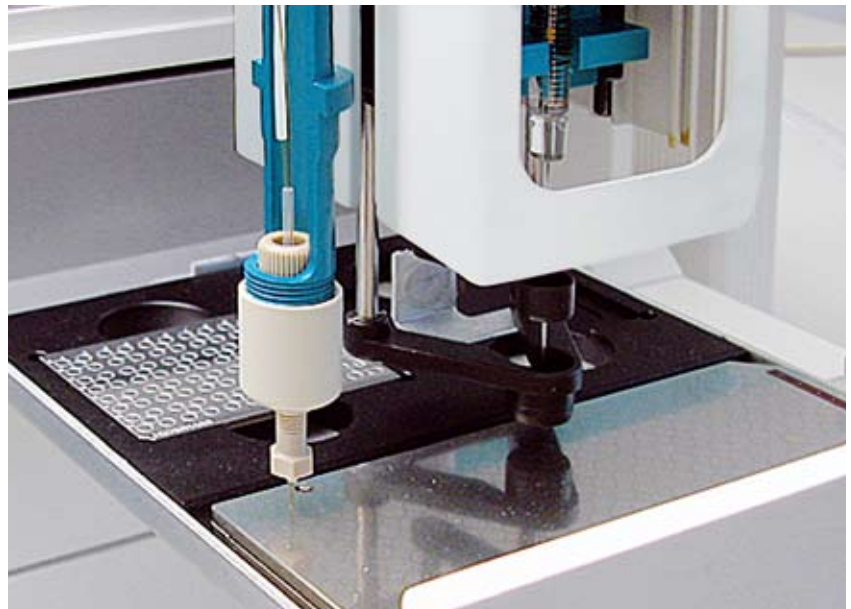
Flow Rate  
 20nl - 300µl

Transfer tubing kit  
 PEEK tubing ID 65µm / OD 1/16 inch  
 PEEK Nano Y-connector for 2 pcs. 360µm capillary tubing

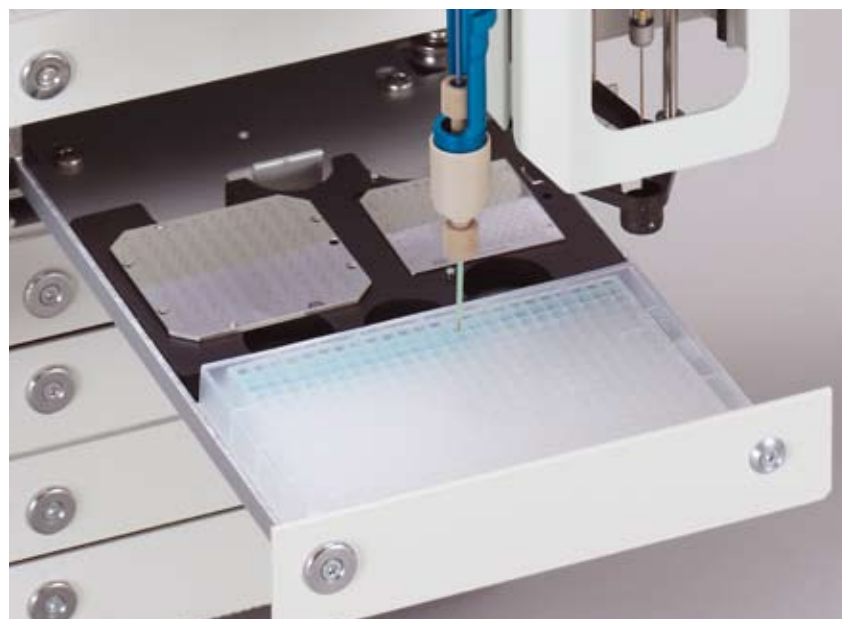
Software control  
 Cycle Composer 1.5.3 or higher\*  
 PAL Firmware 3.0 or higher  
 (\*including example macros for Injection, Fraction Collection and Spotting)

Wetted Parts  
 All liquids compatible with PEEK, Fused Silica

Supported Targets  
 Bruker, ABI Sciex, Waters, Agilent, Shimadzu

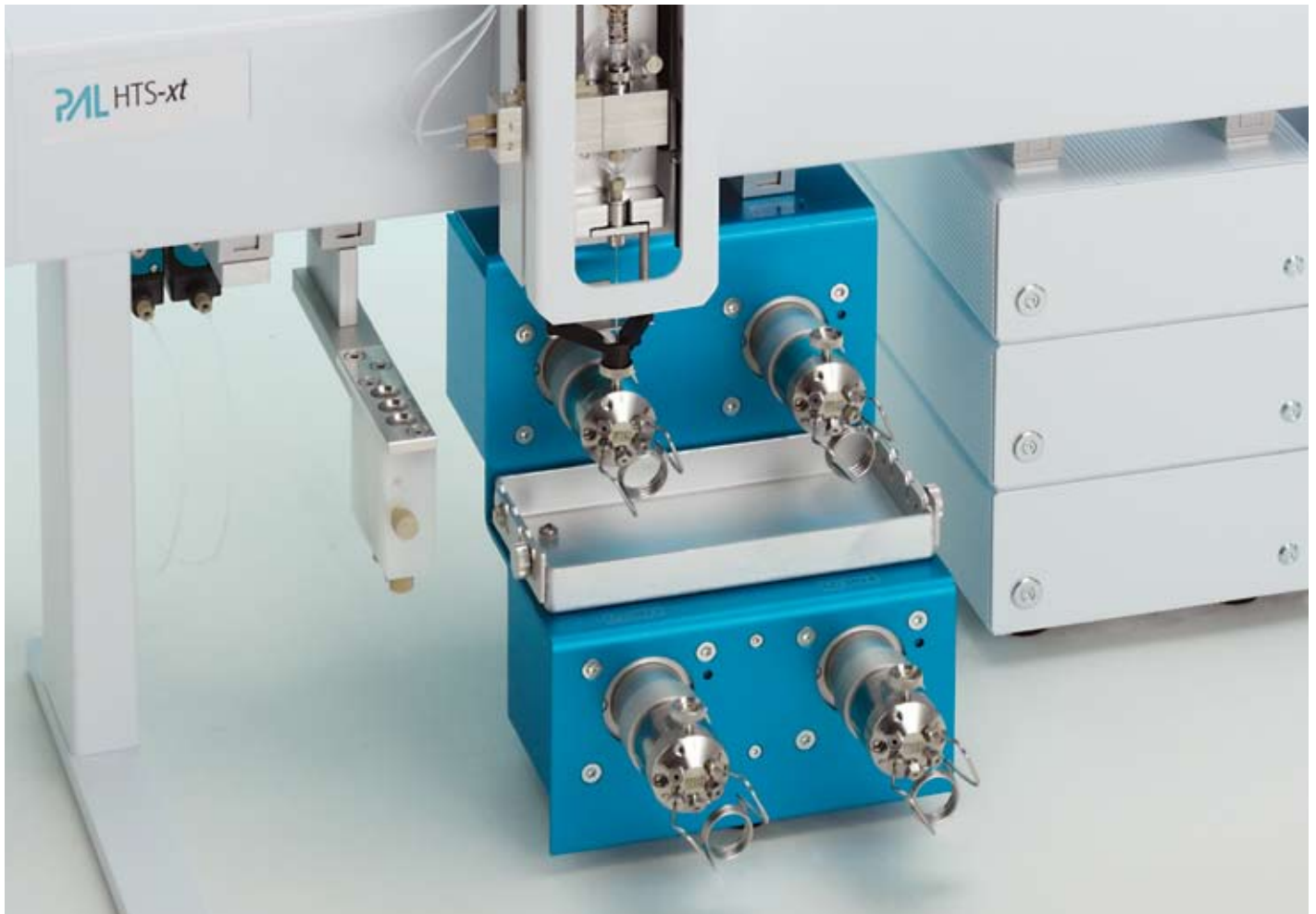


Fraction collection onto Maldi target



Fraction collection into 384 microplate





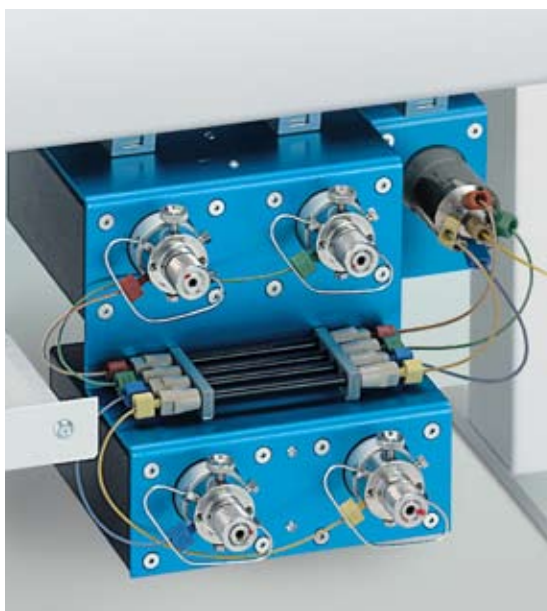
PAL HTS-xt equipped with 4-fold valve Drive

# PAL Valve Options

Prep and Load Platform

## 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 areas can be cut-out and reach the LC-MS inlet. Beside enhanced throughput, this feature helps to keep the MS inlet clean 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"



## UPLC Chromatography

Ultra performance liquid chromatography (UPLC) is a category of liquid chromatography where pressures up to 17'000psi (1200bar) 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 17'000psi (1200bar). 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 17'000psi (1200 bar)

6 - or 10-port design available

Various bore sizes for nano- and micro applications



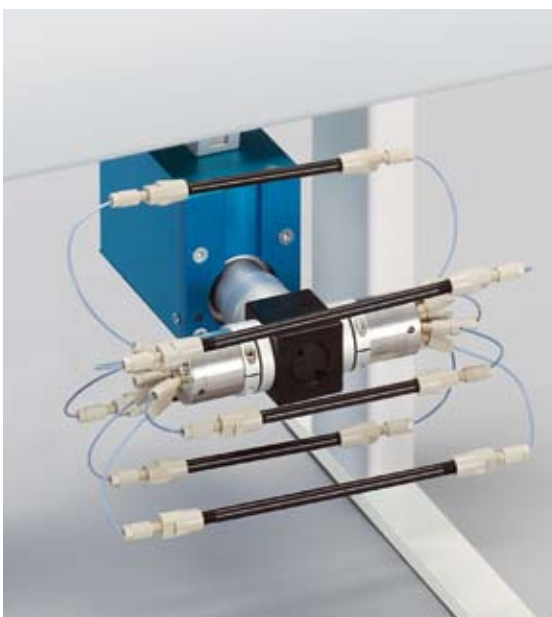
## Valve Switching Modules

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 areas 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



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

### Intelligent Automation

The Windows XP/VISTA 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

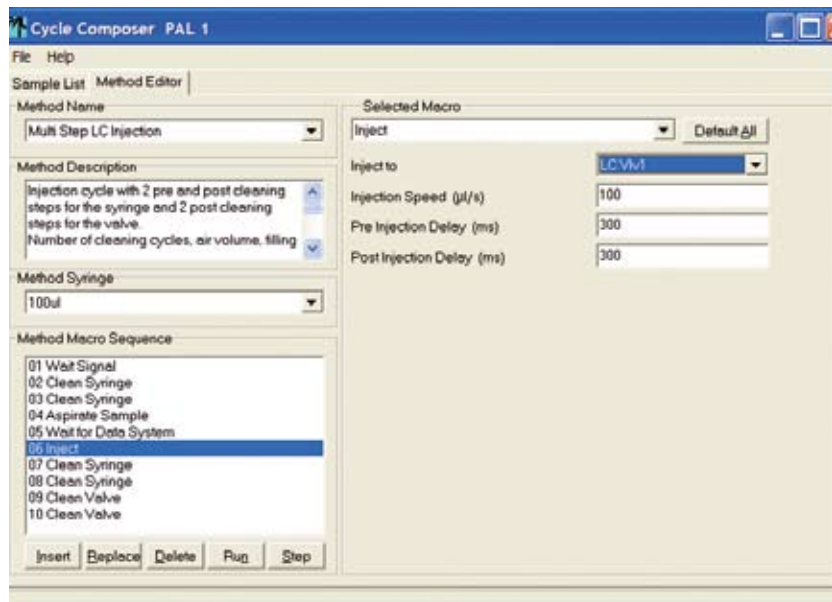
The Cycle Composer affords complete control over liquid handling steps, thereby increasing throughput and productivity of the PAL System. The "Point and click" operation quickly directs the user through programming steps that configure instrument setup, methods and sample lists. For routine daily use, 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

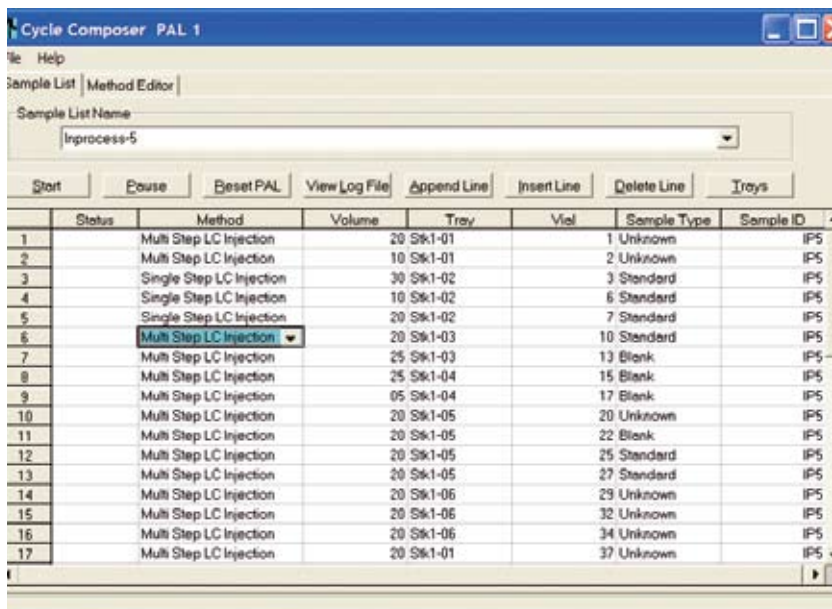
As with the PAL hardware concept the Cycle Composer is already prepared for individual application requirements. Additional flexibility can be assigned by using the powerful Cycle Composer macro language.

### 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.



Method Editor: Setup and edit customized cycles



Sample List: Setup, edit and run injection sequences

## 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

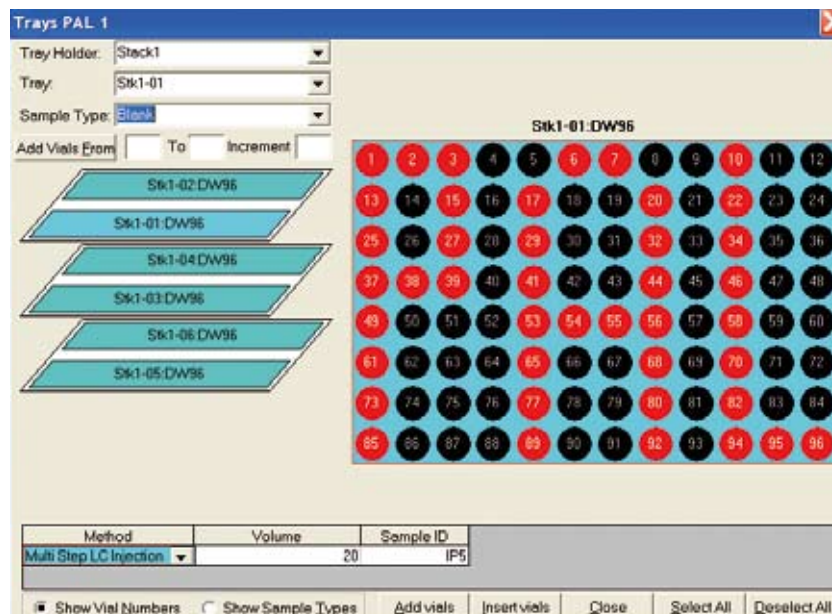
PAL HTX-xt / PAL HTS-xt / PAL HTC-xt  
(Firmware 2.5 or higher installed)

### Third Party Instrument Drivers

Drivers are available either through CTC Analytics or the instrument vendor

ABI Sciex Analyst  
Agilent ChemStation  
Agilent EZChrom  
Agilent MassHunter  
Bruker Daltonics Compass  
DataApex Clarity  
Dionex Chromeleon  
Justice Software Chromperfect  
Leco ChromaTOF  
Merck Hitachi EZChrom  
Shimadzu LC-/LCMSsolution

Thermo ChromQuest  
Thermo Cohesive  
Thermo Xcalibur  
Varian Galaxie  
Waters Masslynx  
Waters Empower2



Trays: Graphical sample list generator

## PAL HPLC-*xt* General Specifications

System Type  
XYZ robot with injection unit

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 available

Electrical Control  
1x RS232 / 1 x LAN (with optional PAL-*xt* Electronics)  
3x TTL Input  
2x Opto Coupler Input  
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, 17'000 psi (1200 bar)

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

Sample Capacity\*  
up to 1400 1 ml micro vials  
1296 2 ml vials  
224 10 ml or 20 ml vials  
24 deepwell microplate (96/384 wells)  
24 standard microplate (96/384 wells)  
(\* depends on PAL model)

Instrument Options  
PAL DLW Option  
PAL MALDI Spotter / Fraction Collection  
PAL Dilutor Option  
PAL Multi Valve Drives  
PAL Sample Stack Cooler / Tray Cooler  
4- 6- 10- port Injection and Switching Valves  
UPLC Injection Valves up to 1200 bar / 17'000psi  
PAL Column Selector Valve  
PAL Barcode Reader

# CTC Analytics

Where design meets performance

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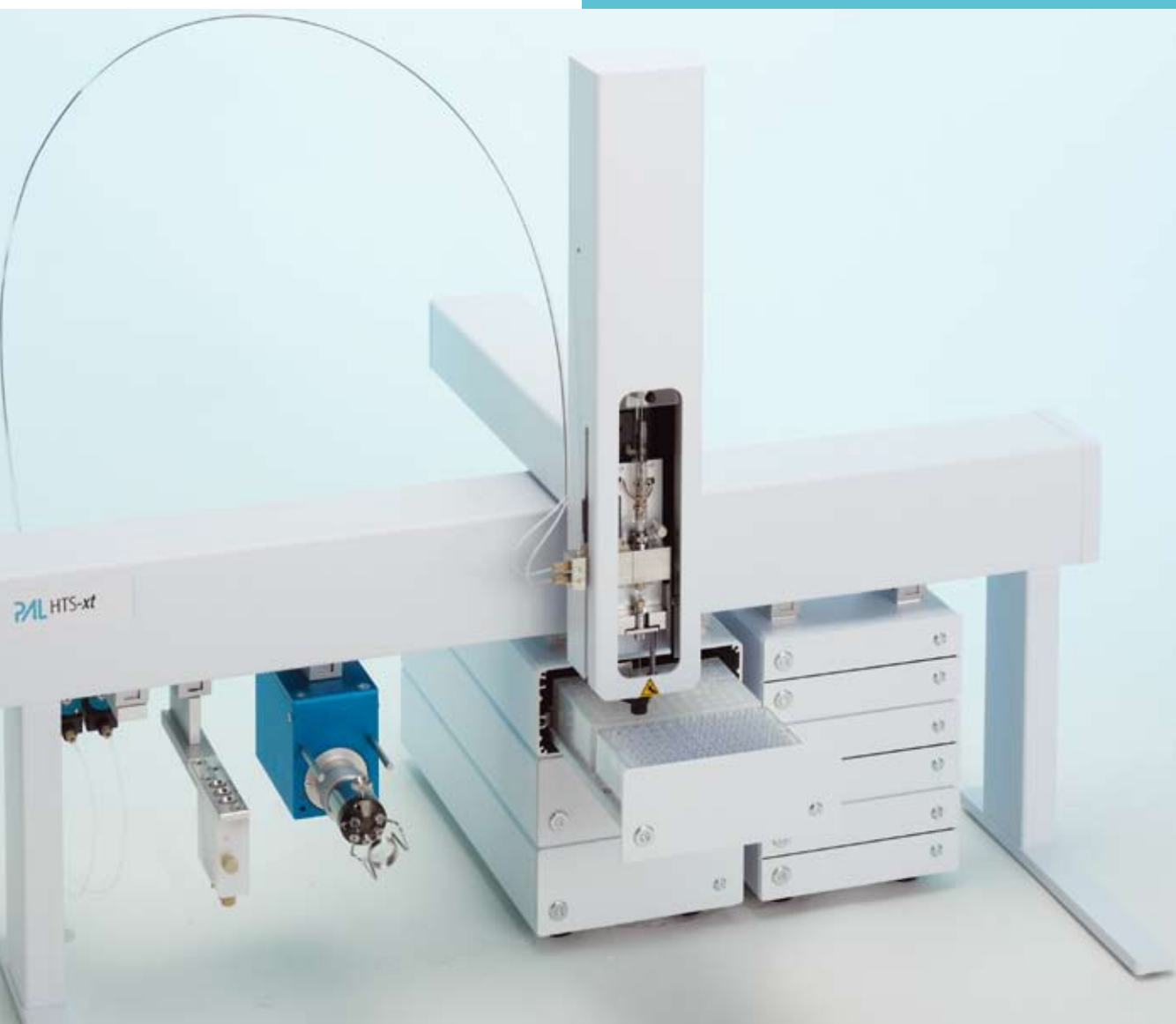


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respective owners

Specifications are subject to change without notice

Distributed by:

- Fast cycles and near zero carryover due to DLW
- Open and modular architecture – most flexible Autosampler
- High sample capacity combined with flexible instrument configurations
- Reliability and ruggedness for unattended 24 hour/day chromatography
- Temperature controlled sample storage from 4°C up to 70°C
- Third party instrument driver for all leading LC-MS Systems enables single keyboard operation



**PAL** SYSTEM

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