JASCO

LC-4000 Series

Integrated HPLC and UHPLC systems

A quick brief - LC-4000 Series

The LC-4000 Series is the latest in a long history of innovative HPLC systems developed by JASCO reaching all the way back to the start of commercial HPLC in the early 1970s.

The concept of the integrated LC-4000 series HPLC provides key separation platforms at 50 MPa, 70 MPa and 130 MPa which correspond to conventional HPLC, the increasingly popular Rapid Analysis (RHPLC) and sub 2 µm UHPLC, respectively.

Each platform is supplied with a dedicated pump and autosampler matched to the operating pressure and all three platforms share common detectors optimized for high-speed 100 Hz acquisition and the narrow peak shapes common to both RHPLC and UHPLC.

Advances in Solvent Delivery

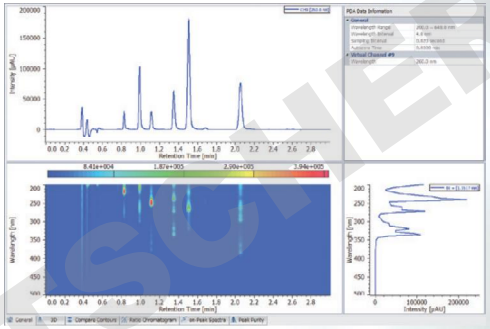
For over two decades JASCO analytical HPLC pumps have employed an asymmetric twin-piston solvent delivery system SSQD (Slow Suction, Quick Delivery) which provides significantly better flow and pressure profiles than the commonly used conventional twin-piston reciprocating design. In the LC-4000 series, SSQD has been re-developed, with a completely new solvent delivery mechanism offering the highest stability in solvent delivery across the entire analytical flow rate range used in the PU-4180/85 RHPLC and PU-4285 UHPLC pump models.

Pioneering Optical Design

As a pioneer in optical spectroscopy, JASCO has access to optical designs that few can match. Adopting designs from some of our more powerful spectrometers we have developed a range of HPLC optical detectors with unrivalled performance, like the new class leading FP-4020 fluorescence detector with S/N of over 2300:1, the latest high-speed refractive index detector with micro cell optimized for RHPLC and UHPLC and a completely revised circular dichroism detector for chiral chromatography.

New Technologies for Method Development

With the range of column technologies becoming ever more diverse - the traditional 5 µm fully porous particle is finally losing ground to some of the newer technologies such as the new superficially porous solid core (Coreshell) and the wide variety of sub-2 µm particles, the requirements for method development are becoming more demanding. The LC-4000 series has a number of newly developed accessories to help you make better separations faster, with accessories such as, flexible and stackable column ovens in a range of sizes to accommodate analytical to preparative columns and multiple columns at every scale and with options for integrated 6 or 10 solvent and column selection valves.



ChromNAV, the cross-platform chromatography data system, is evolving too. Version 2.0 now offers many new features and a great new look to make working with the LC-4000 HPLC system an even better user experience.

Compact and Easy to Use

Despite the extra power delivered by the LC-4000 series HPLC, the standard footprint is only 300 mm wide, a standard system requires only a very small amount of bench space.

For easy user-maintenance, all LC-4000 instruments feature front-access for replacing consumables such as pump components and light sources, even the autosampler consumables such as the syringe parts are easy to access.

For those users who require front-panel control, the LC-4000 series retains the popular keypad and display (with a backlit LED display as standard). Keypad control can still be configured for convenient override when under PC control.

Each LC-4000 module is designed for easy maintenance.
Front-panel access to light source and consumables

Front panel control is included as standard

The LC-4000 Series pump modules requires smaller bench space than ordinary HPLC pumps. An integrated solvent delivery system can be incorporated into a single pump module.

System Configurations

The LC-4000 series HPLC analytical and preparative HPLC systems have a number of common features

- 300 mm wide footprint
- Each system component is completely stackable into a modest height
- The system is fully integrated with complete system monitoring
- All user replaceable components are accessible through the front panel
- Vertical leak/drain system to channel away solvent
- Integrated earthquake securing option
- All detectors include 100 Hz acquistion with interchangeable flowcells

Conventional HPLC and RHPLC Analytical Systems up to 70 MPa

The LC-4000 Series 70 MPa system has been designed to future-proof your HPLC requirements. The LC-4000 70 MPa system can be used with conventional 3 and 5 µm particle size analytical columns at typical lower pressures around 10 to 20 MPa (1500 to 3000 psi) and can also be used with smaller particles such as shorter length UHPLC columns and superficially porous (SPP) or Coreshell that require slightly higher pressure solvent delivery to provide optimum linear velocity through the column.

UHPLC Analytical Systems at 130 MPa

Ten years after the new segment of the HPLC market, UHPLC has found a niche for those that need to run a large number of samplers or get results quickly. Pioneering column technology is pushing the particle size even smaller. The near 20,000 psi operation of the LC-4000 130 MPa is designed to take advantage of the separation efficiency of the very small particles couple with longer and narrower columns. The LC-4000 130 MPa system incorporates many of the same features as the 70 MPa system, but with materials designed to withstand higher pressures.

Preparative HPLC Systems

The LC-4000 preparative HPLC systems includes three platform options

- Up to 20 mL/min for columns up to 21.2 mm ID
- Up to 50 mL/min for columns up to 30 mm ID
- Up to 120 mL/min for columns up to 50 mm ID

Large column oven for multiple preparative columns and optional automatic column switching
Preparative detector options including high flow short path length flow-cells
Open-bed fraction collector with sample trays for tubes, plates or large containers
ChromNAV-FC for fraction control using time, threshold or slope from up to 4 different signals

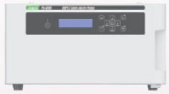
Semi-prep HPLC LC-4000 system

LC-4000 Series Extensive Range of Modules

The LC-4000 Series, enables multiple system design based on the following modules. This concept can be used to create many different system configurations to match your application.

The extensive range of detectors based on JASCO's spectroscopy technology is a key factor in providing a solution to virtually any application.

PUMPS



HPLC, RHPLC
PU-4185/80
PU-4185Binary

UHPLC
PU-4285
PU-4285Binary

PREP
PU-4086/87
PU-4086Binary

DETECTORS

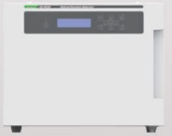
UV/Vis visible
UV-4070/75

PDA
MD-4010/15/17

Refractive Index
RI-4030/35

Fluorescence
FP-4020/25

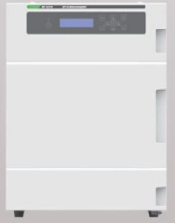
Circular Dichroism
CD-4095



Optical rotation
OR-4090

AUTOSAMPLERS

HPLC
AS-4050/50i



RHPLC
AS-4150

UHPLC
AS-4250

Preparative
AS-4058

COLUMN OVENS

CO-4061/62
compact

CO-4060
high capacity

CO-4065 Prep

RO-4068
Reaction oven

The LC-4000 Series next generation HPLC pumps with flexible expandability

The LC-4000 series HPLC pumps include expansion bays that allow a simple pump module to be transformed into a powerful solvent delivery system. Accessory modules can be installed in the LC-4000 series pump for use with virtually any solvent delivery requirement.

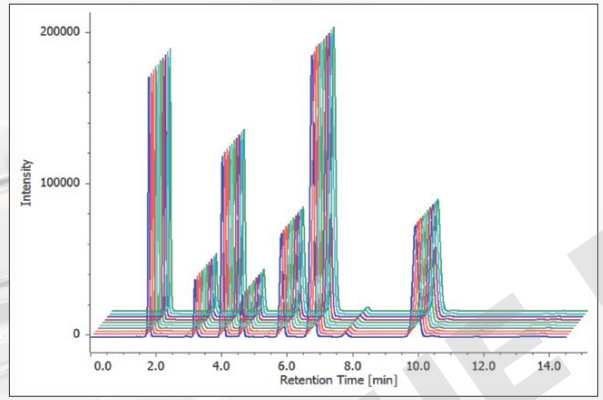
PU-4180
Analytical pump platform

Upgrade and Expansion

The unique expansion bays in the pump platform can be fitted with plug-in modules to quickly and easily transform a simple isocratic pumping system into a sophisticated multi-solvent delivery system by installing a second pump, degasser, quaternary gradient unit, solvent selection valve or dynamic mixer without increasing the footprint.

Adding a second pump module enables an isocratic pump to be upgraded to a dual pump system for either binary gradient or two isocratic flows.

A powerful configuration of the single-unit design is the quaternary gradient solvent delivery system including degasser, with a post-column reagent pump configured in a compact chassis only 300 mm wide.



PU-4180 Flow rate accuracy (1.0 mL/min, n=10)

Mobile phase:	Acetonitrile/Water (80/20)
Flow Rate:	1.0 mL/min
Column:	CrestPak C18S (4.6 mmI.D. x 150 mm, 5 µm)
Column temerature:	40 deg C
Detection wave length:	260nm, Response; 1 sec
Sample:	Polycyclic aromatic hydrocarbon (10 µg/mL each) (Naphthalene, Fluorene, Anthracene, Pyrene, Chrysene, Benzo[a]pyrene)
Injection:	10 µL

Retention time reproducibility (n=10)

#	Naphthalene	Fluorene	Anthracene	Pyrene	Chrysene	Benzo[a]pyrene
1	3,1400	3,3967	4,5002	5,6283	6,4934	9,4267
2	3,1417	3,3983	4,5017	5,6317	6,4950	9,4300
3	3,1417	3,3967	4,5000	5,6300	6,4933	9,4283
4	3,1400	3,3967	4,5002	5,6283	6,4950	9,4283
5	3,1400	3,3967	4,5000	5,6283	6,4950	9,4283
6	3,1400	3,3967	4,5000	5,6300	6,4933	9,4283
7	3,1418	3,3983	4,5016	5,6317	6,4967	9,4317
8	3,1400	3,3967	4,5000	5,6300	6,4950	9,4317
9	3,1400	3,3967	4,5000	5,6300	6,4949	9,4317
10	3,1400	3,3967	4,5017	5,6301	6,4950	9,4317
Average	3,1406	3,3970	4,5005	5,6299	6,4947	9,4297
Standard deviation (n-1)	0,001	0,001	0,001	0,001	0,001	0,002
CV% (n-1)	0,025	0,018	0,017	0,022	0,016	0,020

PU-4185
Semi micro pump platform

Eliminating pulsation

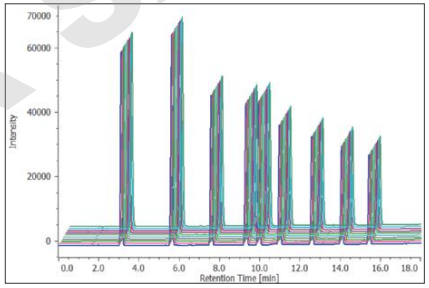
The problems caused by pressure variations in solvent delivery when switching between the two pump heads has been improved with a new design that precisely controls the plunger drive. The LC-4000 series analytical pumps offer flow rate precision with RSDs of better than 0.05 % (difficult to achieve with commercially available pumps). The PU-4180 and 4185 pumps operate at pressures up to 70 MPa, designed mainly for use with RHPLC for core-shell columns or similar micro packing materials as well as working at pressures commonly used for conventional HPLC.

The PU-4285 UHPLC pump provides precise flow at pressures up to 130 MPa; for columns with particle sizes of less than 2 µm. The LC-4000 series UHPLC system can also be used for rapid analysis HPLC (RHPLC) and conventional HPLC.

Pump Configurations

The PU-4180/85 and PU-4285 analytical pumps can be configured for both single pump gradient and multiple pump gradient operation. The single pump quaternary gradient module offers excellent gradient formation for up to four solvents. The newly designed 4-way solvent valve for switching the four solvents is synchronized to the operation of the pump motor control - variable cycle adaption optimizes delivery according to gradient resolution and flow rate. This highly efficient quaternary gradient mode can be applied to a wide flow-rate range from low to high flow rates.
Two and three pump binary or ternary gradient modules with optional built-in degasser are available for fast cycle high-resolution gradient formation; the response time is superior to the single pump quaternary gradient system.

PU-4185Binary pump
Two pump binary gradient



PU-4180 Quaternary gradient mixing performance (1.0mL/min, n=10)

Solvent Mixing

Multi-pump gradient mixing is done using a variable speed dynamic mixer with a range of a small volume mixing chambers incorporating a micro-stirrer to provide the smallest possible dead volume, offering higher mixing efficiencies for all HPLC solvents.

The optional in-line TERA Mixer is a turbulent-flow solvent mixer uniquely designed to offer high efficiency mixing with minimal dead volume.

Solvent Degassing

The in-line vacuum degasser module uses a new Teflon AF membrane with a hold-up volume of only 400 µL (per solvent line); this offers very quick solvent replacement with minimal waste. Despite its small size, the new degasser offers more effective and stable degassing than larger previous generation models. A degasser for preparative-HPLC is also available.

Mobile phase:A;	Water, B; Acetonitrile
Gradient:	(A/B) (65/35) → (5/95) Linear Gradient
Flow rate:	1.0 mL/min
Column:	CrestPak C18S (4.6 mmI.D. x 150 mm, 5 µm)
Column temerature:	40 deg C
Detection wave length:	254 nm, Response; 1 sec
Sample:	Alkylphenon 10 µg/mL (Acetanilide, Acetophenone, Propiophenone, Butyrophenone, Valerophenone, Hexanophenone, Heptanophenone,Octanophenone, Benzophenone (5 µg/mL))
Injection:	10 µL

PU-4180
(compact quaternary gradient pump with micro-volume degasser) *Option

Retention time reproducibility (n=10)

#	Acetanilide	Acetophenone	Propiophenone	Butyrophenone	Benzophenone	Valerophenone	Hexanophenone	Heptanophenone	Octanophenone
1	3,117	5,617	7,590	9,303	9,950	10,950	12,583	14,267	15,430
2	3,117	5,617	7,590	9,307	9,950	10,953	12,587	14,267	15,433
3	3,113	5,617	7,590	9,307	9,950	10,953	12,587	14,267	15,433
4	3,117	5,617	7,590	9,307	9,953	10,953	12,587	14,267	15,433
5	3,117	5,617	7,590	9,307	9,953	10,953	12,587	14,267	15,433
6	3,117	5,620	7,593	9,310	9,953	10,957	12,587	14,267	15,433
7	3,117	5,620	7,590	9,307	9,953	10,953	12,587	14,267	15,433
8	3,117	5,617	7,590	9,310	9,953	10,957	12,590	14,267	15,433
9	3,117	5,617	7,593	9,310	9,957	10,957	12,593	14,273	15,437
10	3,117	5,620	7,593	9,313	9,957	10,960	12,593	14,273	15,437
Average	3,116	5,618	7,591	9,308	9,953	10,955	12,588	14,270	15,434
Standard deviation (n-1)	0,001	0,002	0,002	0,003	0,002	0,003	0,003	0,002	0,003
CV% (n-1)	0,034	0,029	0,021	0,030	0,025	0,026	0,026	0,016	0,012

Preparative and Semi-preparative Pumps

The LC-4000 Preparative-HPLC System includes pumps at three scales. The PU-4086 pump offers flow rates up to 20 mL/min, the PU-4087 pump up to 50 mL/min and the PU-4088 up to 120 mL/min. Both single and multi-pump gradient modes can be used with the PU-4086 pump platform whilst the PU-4087 and PU-4088 are used in multi-pump mode only. Solvents can be delivered at higher flow rates and higher pressures for use with longer preparative HPLC columns that generate more back pressure and for faster and more productive preparative separations. Dynamic mixers, solvent selection valves and the prep degasser can be installed in the expansion bays in both the PU-4086 and PU-4087 modules.

PU-4086 semi prep pump
Recycling inlet switching unit, Recycling valve unit (Option)

A comprehensive range of high performance optical detectors

With JASCO's long history of spectrometer development, you will find that each detector is well designed; these next generation detectors employ the latest optical and electronic technologies for high sensitivity, excellent stability and easy maintenance.

MD-4010 PDA

MD-4010, MD-4015 and MD-4017 PDA Detectors

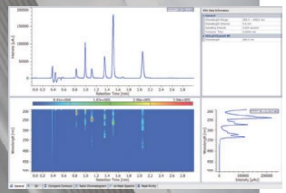
The LC-4000 Series includes three PDA detectors. The MD-4017 is a useful replacement for a single wavelength detector, the MD-4015 is the workhorse for UV-visible detection in the range 200 to 600 nm and the MD-4010 is designed for high sensitivity and high spectral and time resolution.

The MD-4010 PDA detector offers the highest detection sensitivity, equivalent to a single wavelength detector. Making use of a 1024 element photometric diode array, the measurement wavelength range is from 190 nm to 900 nm with a resolution of 1 nm and fast spectrum acquisition rate of up to 100 spectra/sec. When used with the new temperature controlled SP type semi-micro flow cell the MD-4010 is well suited to the narrower peaks typically found with UHPLC or RHPLC separations. The MD-4010 is fitted with an internal mercury lamp for automatic wavelength calibration.

The MD-4015 PDA detector is the routine detector for conventional HPLC, RHPLC and UHPLC. The sensitivity is almost equivalent to that of the MD-4010 but only covers the wavelength range from 200 nm to 600 nm using a 512 element PDA for 1 nm resolution and with high speed 100 Hz spectrum acquisition.

The MD-4017 detector has a price-point comparable to a typical single wavelength detector and has been designed for the user only interested in the UV region from 200-400 nm, the resolution is excellent at 1 nm and the maximum spectrum acquisition is 20 spectra per second (20 Hz), useful for peak widths as small as 1 to 2 seconds.

When used with ChromNAV 2.0 CDS the PDA detector offers multi-functional analysis with a variety of functions such as spectral analysis, library search for peak identification, peak purity and multi-wavelength quantitation.



ChromNAV PDA data processing included as standard

Front panel access for easy lamp replacement

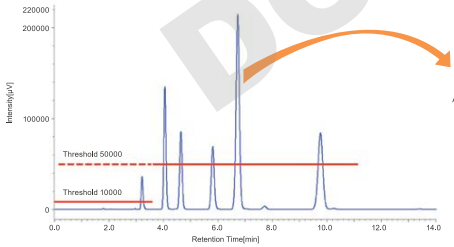
UV-4070 UV Visible

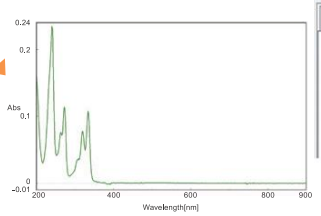
UV-4070/4075 UV-Visible Detectors

Using the advanced Czerny-Turner monochromator design with optimization of the optical system, baseline change due to refractive index is minimized. Baseline fluctuation from changes in environmental temperature is reduced with a temperature-controlled cell, baseline drift caused by temperature fluctuation in the light source is also reduced with a temperature controlled light source. The result is excellent stability with the noise level +/- 0.2×10^{-5} AU and drift 1×10^{-4} AU/h. Both detectors offer simultaneous dual-wavelength data acquisition and spectral scanning. User maintenance can be done without removing the module from the system. Front-panel access is used for light source replacement and automatic wavelength calibration can be carried out using a mercury lamp. Both detectors include high speed data acquisition at up to 100 Hz and can be used for conventional HPLC with the standard flow cell and for UHPLC/RHPLC when used with the SP type semi-micro cell.

UV spectra auto-scan

Automatic spectral scannning can be controlled using ChromNAV, when a peak exceeds a set threshold a scan is executed automatically.





Spectral measurement view

Initial Condition | Time Program

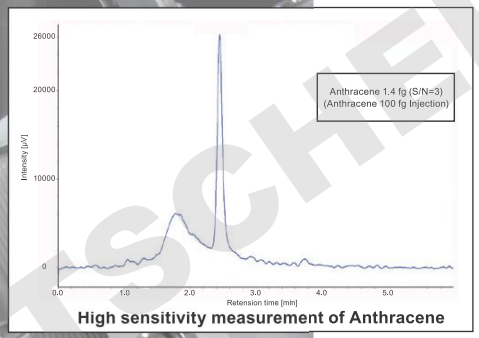
#	Time	Function	Value#1
1	0.50	Baseline Spectrum	
2	3.00	Start Auto scan	10000
3	3.50	Stop Auto scan	
4	3.60	Start Auto scan	50000
5	12.00	Stop Auto scan	
6			

UV detector Auto scan parameters

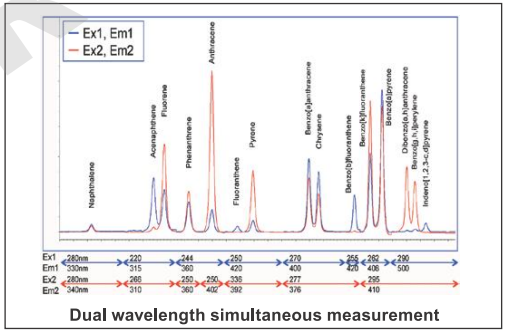
FP-4020 Fluorescence

FP-4020/4025 Fluorescence detector

The FP-4020 fluorescence detector has been designed for the pursuit of extreme sensitivity. Re-designing the optics and electronics from the ground up, as well as removing the effects of ambient temperature with a new temperature-regulated cell body has led to the highest sensitivity with stable detection. These changes have resulted in a giant leap in sensitivity for the FP-4020 to achieve a signal noise ratio of 2300:1 or higher (based on the water Raman peak). The FP-4025 is an excellent routine fluorescence detector that has a slightly lower specification with a water Raman S/N of 1400:1 .
Both detectors can be used for simultaneous detection at two wavelength pairs; excitation and emission wavelengths can be changed during the acquisition using a time program and automatic spectra scanning can be triggered manually, by time or automatically by threshold. A built-in mercury lamp enables automatic wavelength correction and the front-access design allows easy replacement of the flow cell assembly and light source.



High sensitivity measurement of Anthracene



Dual wavelength simultaneous measurement

RI-4030 Refractive Index

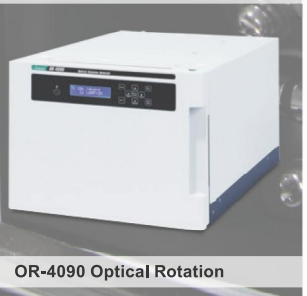
Refractive Index detector RI-4030/4035

The Refractive Index detectors include the optical system mounted in a precisely temperature-regulated housing to eliminate the influence of changes in ambient temperature. The RI-4030 and 4035 detectors are fully stable just one hour after powering on. The RI-4030 can be used for both analytical and preparative scales. In preparative mode the maximum flow rate is 120 ml/min. The RI-4035 is a dedicated semi-micro RI detector with a micro-volume flow cell designed for use with semi-micro GPC analysis using GPC columns with a fine pore size. The 100 Hz data acquisition rate makes the RI-4035 suitable for RHPLC and UHPLC separations. The LED light source in both detectors has a long life time (over 10,000 hours) for low maintenance operation. Both the RI-4030 and RI-4035 detectors can be fitted with an optional pressure release safety-valve to prevent damage to the flow cell in the event blockage.

CD-4095 Circular Dichroism

Circular Dichroism detector CD-4095

The CD-4095 is a unique HPLC detector for measuring circular dichroism developed from the market leading J-Series circular dichroism spectrometers. Optically active compounds with a chromophore close to a chiral center absorb differently left and right circularly polarized light, which can be detected with excellent sensitivity and selectivity. When chiral compounds are measured using a UV-Visible detector, the elution order of d- and l- enantiomers cannot be easily predicted even when separated by a chiral column. The CD-4095 circular dichroism detector makes it possible to positively distinguish between the d- and l- enantiomers by measuring their positive and negative peaks. It is also possible to quantify the d- and l-forms even when they are not separated, a calibration curve based on the g-factor can be used to determine the enantiomeric ratio. The ChromNAV CDS can be used to simultaneously measure the CD, g-factor data and UV-visible signal. The CD spectra of eluted compounds can be measured by triggering scanning manually, by timed program or automatically by threshold.



OR-4090 Optical Rotation

Chiral detector OR-4090

The OR-4090 Chiral detector measures the angle of rotation of plane polarized light caused by optical active isomers and is useful for chiral compounds even in the case they do not show absorption bands. The OR-4090 uses a high intensity Hg-Xe arc lamp (150 W) providing a strong output in the UV/Visible region where the largest optical rotations offer the highest sensitivity. The OR-4090 is therefore a general purpose detector suitable for a wide variety of chiral samples.

Autosamplers

The LC-4000 Series autosamplers provide a range of options to suit any sample injection requirements, from the AS-4050 entry-level model, to the AS-4250 UHPLC model or the AS-4058 preparative scale autosampler.

The AS-4050 is a 60 sample autosampler for use with conventional HPLC with options for analytical and semi-preparative injection volumes. The AS-4150 and AS-4250 are high-capacity, high performance autosamplers designed for RHPLC (up to 70 MPa) and UHPLC (up to 130 MPa), respectively, with a minimum injection cycle-time of only 30 seconds. Peltier cooling is available for all autosamplers and light protection for photo-labile samples is available on the higher level models.

Pre-injection sample preparation is available on the high performance autosamplers with programmable options for sample dilution and pre-column derivitization.

The injection mode can be switched between full loop injection and partial loop injections.

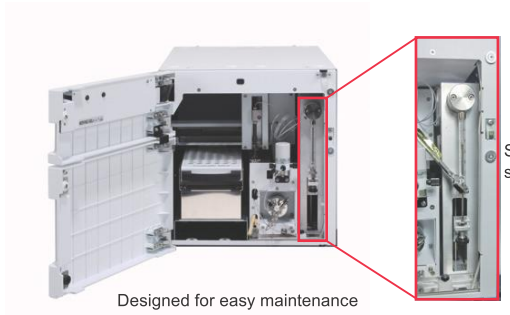
Up to 5 different washing solvents can be used to achieve excellent carry-over at less than 0.005 %.
An optional degasser can be installed for degassing up to 5 flushing solvents.

The AS-4058 is the LC-4000 Series largest volume autosampler with injection volumes up to 5 mL as standard (up to 10 mL as an option). The AS-4058 is typically used in combination with either a PU-4086, PU-4087 or PU-4088 pump for preparative separations.

All LC-4000 series autosamplers share the same simple maintenance features, with consumable parts such as injection ports, rotor seals, and loops accessible from the front panel for easy replacement.

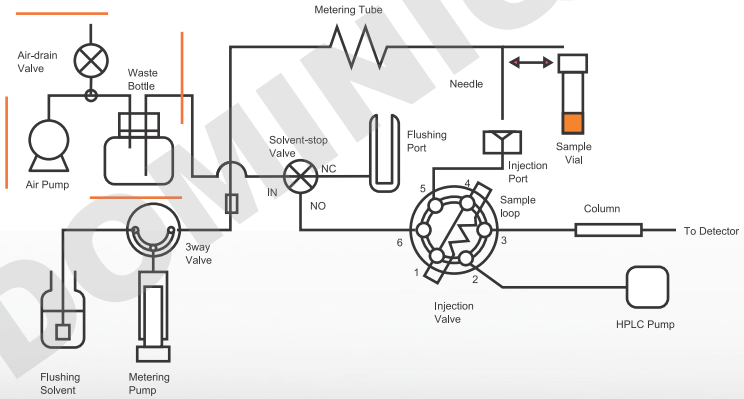
AS-4050
60 sample HPLC autosampler

AS-4250
High capacity UHPLC autosampler



Simple replacement of syringe in AS-4050

Designed for easy maintenance



AS-4050/4150/4250/4058 flow diagram (loop injection)

Column Ovens

CO-4061

CO-4060

The LC-4000 Series column ovens have been designed to provide excellent utility for a wide range of different user requirements. For simple requirements the stackable CO-4061 can be used with column lengths up to 200 mm (or up to 300 mm with an optional extension).

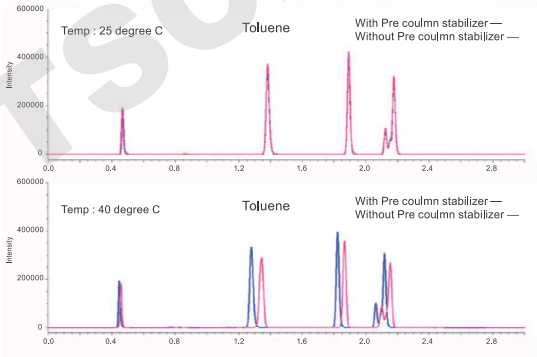
For RHPLC and UHPLC the CO-4062 has capacity for up to six 150 mm length columns, with optional one or two internally mounted automatic switching valves for 2 or 6 column selection.

For GPC and larger preparative columns, select either of the two high-capacity CO-4060 or CO-4065 ovens. The CO-4060 can accommodate columns with lengths up to 300 mm or larger ID preparative columns. The CO-4065 can accommodate up to 10 columns with lengths up to 300 mm and a pair of column selection valves can be equipped (option).

All column ovens have built-in electronic cooling for controlling column temperature at sub-ambient temperatures.

The CO-4062 and CO-4061 block-heater type ovens can be fitted with an optional micro-volume pre-heating unit for pre-heating the mobile phase before the column to improve resolution and peak shape.

The RO-4068 reaction oven is used for high temperature post-column sample processing with capacity for columns and reaction coils.



Efficiency comparison of stabilizer

Column	X-Presspak VC18-W (3 mmI.D. x 50 mmL, 2 μm)
Eluent	Water / Acetonitrile (Gradient)
Flow Rate	1.0 mL/min
Sample	Gasoline Oxidization Products

Analysis conditions

Room Temp.	Oven Temp.	Pre-Column Stabilizer	Theoretical	Peak Width	tR(min)
21 °C	25 °C	With	56095	0.019	1.893
		Without	54747	0.019	1.887
	40 °C	With	46021	0.020	1.799
		Without	36402	0.023	1.851

Comparison of Toluene peaks

UniFinePak HPLC Columns

UniFinePak is a new type of column that uses a hybrid packing material. Compared with traditional packing materials that use silica as the base material, UniFinePak columns can be used with a wider pH range from alkali to acid. UniFinePak columns offer an extended analysis range due to its chemical strength and resilience to high pressure operation.
The entire range of UniFinePak columns uses a common packing material in a range of particle sizes from semi-micro to analytical to semi preparative scales, which simplifies method development when scaling-up separations from analytical to semi-preparative .

Method Conversion Program

Optional Preparative HPLC fraction collection kit

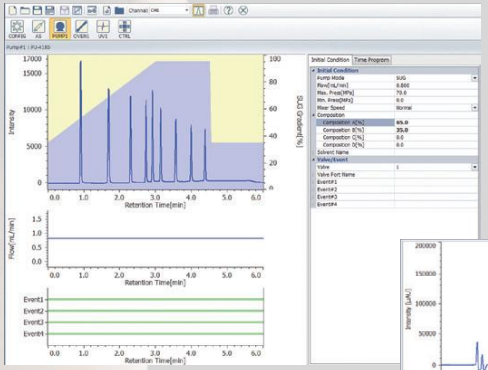
The LC-4000 series preparative system fraction collection kit includes
- Fraction collector
- Flow divertor valve
- ChromNAV FC fraction control program for ChromNAV

ChromNAV 2.0 The 'PowerTool' for HPLC Analysis

ChromNAV 2.0 (and ChromNAV-CFR 2.0) are JASCO's next generation CDS developed from the powerful and easy-to-use ChromNAV 1.0 with a host of exciting new features.

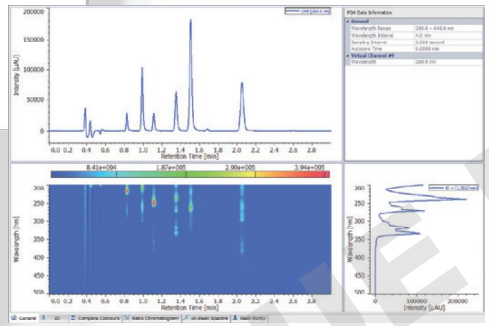
With a customizable graphical-user-interface (GUI), the user can set-up the system to display only the functions necessary for their application. This latest intuitive GUI allows the user to quickly learn the operation and explore the extensive functionality for data processing.

ChromNAV 2.0 is a universal CDS which can be used with any type of separation - HPLC, UHPLC, RHPLC, prep-HPLC, analytical SFC and prep-SFC. ChromNAV can also satisfiy the demands of dedicated analysis and multi-purpose systems.



Control method

The pump flow rate and gradient profile display is flexible and can be overlaid with a chromatogram for adjusting gradient conditions.



PDA analysis

PDA data processing is included as standard. Data is displayed in 2D contour plot and 3D with simultaneous overlay of spectra and chromatograms.Extract chromatograms at single or multiple wavelengths for quantitation

ChromNAV 2.0 offers powerful system control and data acquisition with options for 2D (or up to 4D) gradient control and multi-zone oven control with control of up to 3 column ovens for method development. Solvent and column selection control is increased to include up to 10 positions for both.

During acquisition, the run-time for a chromatogram can be increased to capture later eluting peaks which may exceed the set run-time.

Previously acquired chromatograms can be overlaid for visual comparison with the data currently being acquired, as a quick indicator to the user of current separation performance.

Data acquisition and analysis for a PDA detector are included as standard in ChromNAV.

The fluorescence and UV-visible detectors include spectral scanning as standard, which can be triggered manually, by time or by threshold.

A newly added feature of ChromNAV 2.0 is the automatic message that can be emailed to your PC or smartphone to give an update on the progress of the sequence.

With the increasing requirements for Green Energy, the LC-4000 series has the facility not only to power off and save lamp life at the end of the run, but also a 'soft-off' function to automatically power off a module at the end of the sequence.

ChromNav 2.0 standard features

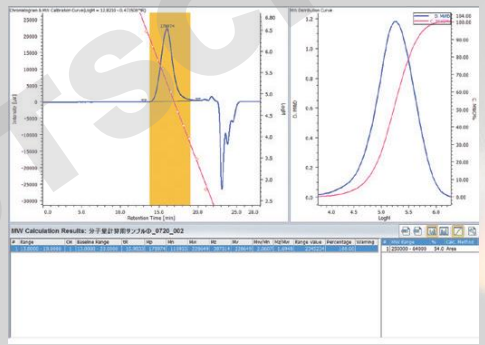
- Peak integration and peak identification
- Peak grouping
- Linear and non-linear quantitation
- 3D chromatogram analysis,
- Spectral analysis for UV-visible, Fluorescence and PDA detectors
- Style report generator
- User calculation

All raw data is protected and saved; which can then be analyzed and re-analyzed, reported and saved with both the raw data and with any data processing from the user's analysis.

A comprehensive audit trail records the acquisition method along with a history of instrument performance indicators in each sample data file, which provides the user a snap-shot of the condition of the system during the run and can warn about requirements for impending maintenance.

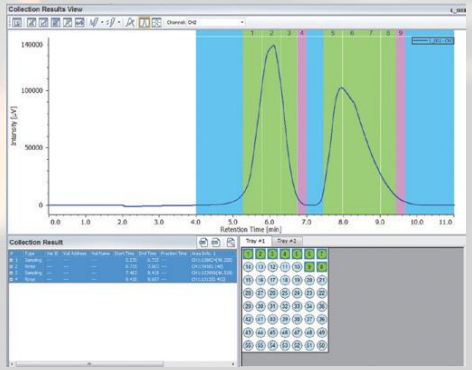
ChromNAV 2.0 Optional Applications

- ChromNAV CFR for 21 CFR Part 11 compliance and electronic registration of data
- GPC molecular weight dispersion
- Molecular weight dispersion of low molecular weight heparin
- FUMI theory (Function of Mutual Information) for theoretical precision analysis



ChromNAV-GPC

Molecular weight distribution program (Option)
ChromNAV GPC/SEC calculation program for GPC analysis



ChromNAV- FC Collection view window (Option)

ChromNAV-FC fraction collector control for the CHF-122SC fraction collector

ChromNAV-FC for preparative HPLC

The optional ChromNAV-FC fraction collector control is available as part of the Prep-HPLC kit and provides ChromNAV with the capability to control the LC-4000 Series preparative HPLC system for fraction collection.

ChromNAV-FC offers control for two different capacity fraction collectors, with sophisticated fractionation control with several methods for peak collection, such as time, threshold and slope, and can even be programmed to use data collected simultaneously from multiple detectors such as UV-visible, refractive index or circular dichroism. Fraction simulation is applied to an acquired chromatogram to optimize the fraction collection parameters and the graphical display can be used to locate peaks of interest in the fraction collector tray.

ChromNAV-FC also supports additional functions for prep-HPLC applications, including automatic multi-channel fractions, fraction repeat and fraction re-cycle.

*1: ChromNAV CFR is an optional software package for ChromNAV.

Specifications

Pumps

Model	PU-4185	PU-4180	PU-4285
Flow rate setting range	0.001 ~ 4.0 mL/min	0.001 ~ 10.0 mL/min	0.001 ~ 2.0 mL/min
Applicable flow rate range	0.05 ~ 3.0 mL/min (~ 70 MPa) ~ 4.0 mL/min (~ 40 MPa)	0.5 ~ 6.0 mL/min (~ 70 MPa) ~ 10.0 mL/min (~ 35 MPa)	0.050 ~ 1.5 mL/min (~ 130 MPa) 1.501 ~ 2.0mL/min (~ 100 MPa)
Maximum pressure	70 MPa (~ 3.0 mL/min) 40 MPa (~ 4.0 mL/min)	70 MPa (~ 6.0 mL/min) 35 MPa (~ 10.0 mL/min)	130.0 MPa (~ 1.5 mL/min) 100.0 MPa (~ 2.0 mL/min)
Flow rate accuracy	+/- 1% or +/- 2 µL/min, whichever is larger. (0.1 ~ 4.0 mL/min)	+/- 1% or +/- 2 µL/min, whichever is larger. (0.2 ~ 8.0 mL/min)	+/- 1% or +/- 2 µL/min, whichever is larger. (0.05 ~ 2.0 mL/min)
Flow rate precision	0.05% RSD or +/- 0.04min SD, whichever is larger. (0.05 ~ 4.0 mL/min) (measurement by chromatogram)	0.05% RSD or +/- 0.04min SD, whichever is larger. (0.5 ~ 5.0 mL/min) (measurement by chromatogram)	0.05 % RSD or +/- 0.04 min SD, whichever is larger. (0.1 ~ 2.0 mL/min) (measurement by chromatogram)
Dimensions, weight	300(W) x 470(D) x 150(H) mm, 13 kg	300(W) x 470(D) x 150(H) mm, 13 kg	300(W) x 470(D) x 150(H) mm, 14.5 kg
Power requirement	AC 100 ~ 240 V, 50/60 Hz, 80 VA	AC 100 ~ 240V, 50/60 Hz, 80 VA	AC 100 ~ 240V, 50/60 Hz, 60 VA

Gradient mode with low-pressure gradient unit			
Mixing accuracy	+/-0.6% (5 ~ 95%, 0.2 ~ 1.0 mL/min) +/-1.2% (5 ~ 95%, ~ 4.0 mL/min)	+/-0.8% (5 ~ 95%, 0.5 ~ 5.0 mL/min)	+/-0.6% (5 ~ 95%, 0.2 ~ 1.0 mL/min) +/-1.2% (5 ~ 95%, ~ 2.0 mL/min)
Mixing precision	0.15% RSD or +/- 0.01min, whichever is larger. (0.2 ~ 4.0 mL/min) (measurement by chromatogram)	0.25% RSD or +/-0.02min, whichever is larger. (0.5 ~ 5.0 mL/min) (measurement by chromatogram)	0.15% RSD or +/-0.01min, whichever is larger. (0.2 ~ 2.0 mL/min) (measurement by chromatogram)

Binary pump	PU-4185-Binary		PU-4285-Binary
Gradient mode			
Mixing accuracy	+/-0.4% (5 ~ 95%, 0.2 ~ 4.0 mL/min)	-	+/-0.4% (5 ~ 95%, 0.2 ~ 2.0 mL/min)
Mixing precision	0.15% RSD or +/-0.01 min, whichever is larger. (0.2 ~ 4.0 mL/min) (measurement by chromatogram)	-	0.15% RSD or +/-0.01 min, whichever is larger. (0.2 ~ 2.0 mL/min) (measurement by chromatogram)
Dimensions, weight	300(W) x 470(D) x 150(H) mm, 19.5 kg	-	300(W) x 470(D) x 150(H) mm, 22.5 kg
Power requirement	AC 100 ~ 240 V, 50/60 Hz, 130 VA	-	AC 100 ~ 240 V, 50/60 Hz, 110 VA

Model	PU-4086	PU-4087
Flow rate setting range	0.001 ~ 20.0 mL/min	0.01 ~ 50.0 mL/min
Applicable flow rate range	0.5 ~ 20.0 mL/min (0 ~ 50 MPa)	5.0 ~ 30.0 mL/min (~ 50 MPa) 30.01 ~ 40.0 mL/min (~ 40 MPa) 40.01 ~ 50.0 mL/min (~ 30 MPa)
Maximum pressure	50 MPa	50 MPa (~ 30.0 mL/min) 40 MPa (~ 40.0 mL/min) 30 MPa (~ 50.0 mL/min)
Flow rate accuracy	+/- 1% or +/- 10 µL/min, whichever is larger. (0.5 ~ 20.0 mL/min)	+/- 1% or +/- 50 µL/min, whichever is larger. (5.0 ~ 50.0 mL/min)
Flow rate precision	0.05% RSD or +/- 0.04min SD, whichever is larger. (0.5 ~ 20.0 mL/min) (measurement by chromatogram)	0.1% RSD or +/- 0.04min SD, whichever is larger. (5 ~ 40 mL/min) (measurement by chromatogram)
Dimensions, weight	300(W) x 470(D) x 150(H) mm, 14.5 kg	300(W) x 470(D) x 150(H) mm, 18 kg
Power requirement	AC 100 ~ 240 V, 50/60 Hz, 90 VA	AC 100 ~ 240 V, 50/60 Hz, 120 VA

Binary pump	PU-4086-Binary	
Gradient		
Mixing accuracy	+/-0.75% (5 ~ 95%, 0.5 ~ 20.0 mL/min)	-
Mixing precision	0.2% RSD or +/-0.03min, whichever is larger. (0.5 ~ 20.0mL/min)	-
Dimensions, weight	300(W) x 470(D) x 150(H) mm, 21.5 kg	-
Power requirement	AC 100 ~ 240 V, 50/60 Hz, 100 VA	-

Detectors

Model	MD-4010	MD-4015	MD-4017
Light source	D2 & WI lamp	D2 lamp	D2 lamp
Measurement range	190 ~ 900 nm	200 ~ 600 nm	200 ~ 400 nm
PDA element number	1024 ch	512 ch	512 ch
Slit width	1, 4, 8 nm	4 nm	4 nm
Data acquisition rate	Maximum 100 spectra/sec (full range)	Maximum 100 spectra/sec (full range)	Maximum 20 spectra/sec (full range)
Noise level	+/- 3.0 x 10^{-6} AU (specified conditions)	+/- 3.0 x 10^{-6} AU (specified conditions)	+/- 7.0 x 10^{-6} AU (specified conditions)
Drift	< 0.5 x 10^{-6} AU/h (specified conditions)	< 0.5 x 10^{-6} AU/h (specified conditions)	< 1.0 x 10^{-6} AU/h (specified conditions)
Linearity	2.0 AU or more (specified conditions)	2.0 AU or more (specified conditions)	2.0 AU or more (specified conditions)
Flow cell	Path length: 10 mm, front loading cassette type	Path length: 10 mm, front loading cassette type	Path length: 10 mm, front loading cassette type
PC communication	USB2.0	USB2.0	USB2.0
Dimensions, weight	300(W) x 470(D) x 150(H) mm, 14.5 kg	300(W) x 470(D) x 150(H) mm, 13.5 kg	300(W) x 470(D) x 150(H) mm, 13.5 kg
Power requirement	AC 100 ~ 240 V, 50/60 Hz, 180 VA	AC 100 ~ 240 V, 50/60 Hz, 150 VA	AC 100 ~ 240 V, 50/60 Hz, 120 VA

Model	UV-4070 / UV-4075
Light source	D2 lamp + WI lamp (UV-4070)
	D2 lamp (UV-4075)
Wavelength range	190 ~ 900 nm (UV-4070)
	190 ~ 600 nm (UV-4075)
Monochromator	Czerny-Turner mount
Spectral bandwidth	8 nm
Noise level	+/-0.2 x 10^{-5} AU (230 nm, 1.5 sec)
Drift	1 x 10^{-4} AU/h (250 nm, constant room temperature)
Data output	Maximum 100 Hz
Flow cell	Front loading cassette cell (temperature controlled), tapered. Path length: 10 mm
Spectrum measurement	200 ~ 900 nm (D2 & WI), 200 & 370 nm (D2), 371 ~ 900 nm (WI) (UV-4070)
(On-flow measurement)	200 ~ 600 nm (D2) (UV-4075), applicable measurement range: fixed
Two-wavelengths monitoring	Any two wavelengths in 190 ~ 370 nm, 371 ~ 700 nm, 701 ~ 900 nm (UV-4070) Any two wavelengths in 190 ~ 370 nm, 371 ~ 600 nm (UV-4075)
Dimensions, weight	300(W) x 470(D) x 150(H) mm, 10 kg
Power requirement	AC100 ~ 240 V, 50/60 Hz, 175VA (UV-4070), 110VA (UV-4075)

Model	FP-4020 (high performance model) / FP-4025 (standard model)
Light source	Xenon short arc lamp
Wavelength setting range	200 ~ 900 nm (both EX and EM)
(measurement range)	220 ~ 700 nm (both EX and EM), 200 ~ 900 nm (both EX and EM, option)
Spectral bandwidth	EX: 20 nm, EM: 20, 40 nm (switchable)
Sensitivity	Raman peak of water, S/N > 2300 (FP-4020), S/N > 1400 (FP-4025) (EX wavelength; 350 nm)
Data output	Maximum 100 Hz
Flow cell	Front loading cassette cell
Temperature control	Available setting: OFF, 4 ~ 40°C, applicable range: [ambient -10°C] ~ 40°C (only for FP-4020)
Spectrum measurement	Ex and Em spectrum measurement, spectrum output, output of subtracted spectrum
Two-wavelength monitoring	Two sets of Ex/Em wavelength setting, maximum wavelength difference: 200 nm or shorter.
Dimensions, weight	300(W) x 470(D) x 225(H) mm, 20 kg
Power requirement	AC 100 ~ 240 V, 50/60 Hz, 270VA (FP-4020), 230VA (FP-4025)

Model	RI-4030	RI-4035
Measurement system	Deflection type	
Refractive index range	1.00 ~ 1.75	
Linearity	5.0 x 10^{-5} RIU (HIGH) 5.0 x 10^{-4} RIU (STD) 5.0 x 10^{-3} RIU (LOW) (H2O)	5.0 x 10^{-5} RIU (HIGH) 5.0 x 10^{-4} RIU (STD) (H2O)
Noise level	0.20 x 10^{-6} RIU or less (HIGH, STD)	0.50 x 10^{-6} RIU or less (HIGH, STD)
Cell capacity	10 µL	2.7 µL
Maximum usable flow-rate	10 mL/min (Low Flow Rate tubing) 120 mL/min (High Flow Rate	1.2 mL/min (H_2O)
Maximum pressure	0.1 MPa (Low Flow Rate tubing) 0.3 MPa (High Flow Rate tubing)	0.1 MPa
Temperature control	Ambient +10°C ~ ambient +25°C (setting range: 0 ~ 60°C)	
Dimensions, weight	300(W) x 470(D) x 150(H) mm, 14 kg	
Power requirement	AC 100 ~ 240 V, 50/60 Hz, 80 VA	

Model	CD-4095
Light source	150W Hg-Xe lamp
Polarizer	Glan-Taylor prism
Phase modulation	PEM (photo-elastic modulator)
Wavelength accuracy	+/- 5 nm
Wavelength reproducibility	+/- 0.5 nm
Wavelength setting range	200 ~ 460 nm
Measurement range	220 ~ 460 nm
Noise level	0.04 mdeg (at specified conditions)
Drift	0.1 mdeg/h (room temperature variation is within +/-1°C)
Data output	Maximum 100 Hz
Flow cell	Front loading cassette cell, tapered, 44 µL, 25 mmL
Spectrum measurement	200 ~ 460 nm
Dimensions, weight	300 (W) x 470 (D) x 230 (H) mm, 21 kg
Power requirement	AC 100 ~ 240V, 50/60 Hz, 210 VA

Autosamplers

Model	AS-4050/AS-4050i	AS-4150	AS-4250	AS-4058
Sample injection method	Full or partially fill loop injection (zero sample loss available)	Full or partially fill loop injection (zero sample loss available), direct line injection (option, change of flow-line is required.)	Full or partially fill loop injection (zero sample loss available), direct line injection (option, change of flow-line is required.)	Full or partially fill loop injection (zero sample loss available)
Number of samples	60 (2 mL vial)	180 (2 mL vial)	180 (2 mL vial)	40 (20 mL vial, standard)
Injection volume	0.1 ~ 100 µL (large volume injection kit: 1 ~ 1000 µL, option)	0.1 ~ 100 µL (large volume injection kit: 1 ~ 1000 µL, option)	0.1 ~ 100 µL (large volume injection kit: 1 ~ 1000 µL, option)	1 ~ 10000 µL
Injection precision	RSD 0.3 % or less (specified conditions)	RSD 0.25% or less (specified conditions)	RSD 0.25% or less (specified conditions)	RSD 1.0 % or less (2500 µL, zero sample loss) (specified conditions)
Injection accuracy	+/- 0.1% or less (with correction function)	+/- 0.1% or less (with correction function)	+/- 0.1% or less (with correction function)	+/- 0.1% or less (with correction function)
Carry over	0.01% or less (10 µL, specified conditions)	0.01% or less (2 µL) (specified conditions) 0.005% or less (with multiple solvent flushing valve) (specified conditions)	0.01% or less (2 µL) (specified conditions) 0.005% or less (with multiple solvent flushing valve) (specified conditions)	0.05% or less (2000 µL, zero sample loss) (specified conditions) 0.02% or less (with multiple solvent flushing valve) (specified conditions)
Maximum usable pressure	30 MPa (AS-4050), 34 MPa (AS-4050i)	70 MPa	130 MPa	41 MPa
Sample cooling/heating	(option) temp. range: 4 ~ 40°C	(option) temp. range: 4 ~ 40°C	(option) temp. range: 4 ~ 40°C	(option) temp. range: 4 ~ 40°C
Pre-column derivatization, etc	-	Pre-column derivatization (up to two reagents), dilution, other user programs	Pre-column derivatization (up to two reagents), dilution, other user programs	-
Dimensions, weight	300 (W) x 470 (D) x 300 (H) mm, 21 kg	300 (W) x 470 (D) x 385.5 (H) mm, 25 kg	300 (W) x 470 (D) x 385.5 (H) mm, 25 kg	300 (W) x 470 (D) x 385.5 (H) mm, 25 kg
Power requirement	AC 100 ~ 240V, 50/60 Hz, 60 VA	AC 100 ~ 240V, 50/60 Hz, 75 VA	AC 100 ~ 240V, 50/60 Hz, 75 VA	AC 100 ~ 240V, 50/60 Hz, 75 VA

Column Ovens

Model	CO-4061	CO-4062	CO-4060	CO-4065	RO-4068
Temperature range	Ambient -15°C ~ 100°C	Ambient -15°C ~ 100°C	Ambient -15°C ~ 80°C	Ambient -15°C ~ 90°C	Ambient +10°C ~ 200°C
Column compartment dimensions	270(W) x 230(D) x 60(H) mm	260(W) x 25(D) x 105(H) mm	110(W) x 105(D) x 410(H) mm	260(W) x 120(D) x 410(H) mm	43(W) x 350(D) x 75(H) mm
Safety features	Heating/cooling power shut off when unusually high temperatures or solvent leaks are detected.				
Dimensions, weight	300(W) x 470(D) x 150(H) mm, 10 kg	300(W) x 470(D) x 150(H) mm, 10 kg	150(W) x 470(D) x 475(H) mm, 16 kg	300(W) x 470(D) x 475(H) mm, 25 kg	300(W) x 470(D) x 150(H) mm, 12 kg
Power consumption	AC 100 ~ 240 V, 50/60 Hz, 160 VA	AC 100 ~ 240 V, 50/60 Hz, 200 VA	AC 100 ~ 240 V, 50/60 Hz, 350 VA	AC 100 ~ 240 V, 50/60 Hz, 530 VA	AC 100 ~ 240 V, 50/60 Hz, 325 VA

ChromNAV Ver. 2

Language	English/Japanese, selectable
Windows OS	Windows 7 Professional 32/64 bit Windows 8.1 Professional 32/64 bit
Controllable hardware	LC-4000 Series, X-LC 3000 Series, LC-2000 Series, Maximum 4 systems control, Maximum 20 systems registration
System control	Direct control of instrument by Direct Mode, Time programming by Control Method, Spectrum measurement, Prevention from unauthorized use by security key, Analog signal input, Up to 4 channel simultaneous input per one LC-Net II/ADC

JASCO INTERNATIONAL CO., LTD.
11-10, Myojin-cho 1-chome, Hachioji, Tokyo 192-0046, Japan
Tel: +81-42-649-3247 Fax: +81-42-649-3518 http://www.jascoint.co.jp/english/
Australia, China, Hong Kong, India, Indonesia, Korea, Malaysia, New Zealand, Pakistan, Philippines, Russia, Singapore, Taiwan, Thailand

JASCO INCORPORATED
28600 Mary's Court, Easton, MD 21601, U.S.A
Tel: +1-800-333-5272 +1-410-822-1220 Fax: +1-410-822-7526 http://www.jascoinc.com
U.S.A., Canada, Costa Rica, Mexico, Puerto Rico, Argentina, Brazil, Chile, Colombia, Paraguay, Peru, Uruguay, Guatemala, , Ecuador, Bolivia

JASCO EUROPE s.r.l.
Via Luigi Cadorna 1, 23894 Cremella (Lc), Italy
Tel: +39-039-9215811 Fax: +39-039-9215835 http://www.jasco-europe.com
JASCO Deutschland www.jasco.de, **JASCO UK** www.jasco.co.uk,
JASCO France www.jascofrance.fr, **JASCO Benelux** www.jasco.nl,
JASCO Spain www.jasco-spain.com
Italy, Germany, U.K., France, Netherlands, Belgium, Luxembourg, Spain, Sweden, Norway, Denmark,
Austria, Finland, Greece, Hungary, Poland, Portugal, Romania, Switzerland, Algeria, Cyprus, Egypt, Israel, Jordan, Kuwait, Lebanon, Morocco, Saudi Arabia, South Africa, Tunisia, Turkey, U.A.E., Yemen