SHIMADZU
Excellence in Science

High-Performance Liquid Chromatograph

Prominence

High Performance Liquid Chromatograph

Prominence

How HPLC Should Be

High-performance liquid chromatography (HPLC) is widely used in diverse fields such as pharmaceuticals, and biochemistry to chemistry, the environment, and food products.
The Shimadzu Prominence high-performance liquid chromatograph achieves an exceptional level of performance in each of these fields.
Prominence HPLC offers exceptional reliability and great expandability to support diverse applications from ultra-fast liquid chromatography to preparative LC, gel permeation chromatography (GPC), ion chromatography, and LC/MS.

Prominence
Superb Performance and Expandability

Prominence keeps becoming more advanced.
By incorporating state-of-the-art improvements developed based on feedback, Prominence systems offer customers an analytical system with high reliability, in addition to exceptional performance and expandability.

■ Key Improvements

Pump
- Check valve improvements provide more stable solvent delivery

Quaternary gradient unit
- Stronger support for buffer solutions with high salt concentrations

Autosampler
- Multi-rinse function (max. two solutions) achieves even lower carryover

System controller
- Remotely monitor instrument status using a portable terminal, such as an iPad
- Overlapping injection function results in shorter analysis times

Photodiode array detector
- More sensitive variable optical path length preparative cell and improved baseline stability
- Enables complete separation of unseparated peaks or visualization of tiny peaks hidden behind primary components (i-PDeA/i-DReC functions)

Fluorescence detector
- Data acquisition using multi-wavelength mode

Column oven
- Improved leakage detection (leak sensor)
- Improved separation in simultaneous analysis of multiple components by simultaneous control of up to four units

■ Wide Variety of Application Systems Available

Several application-specific systems are available that take advantage of the remarkable expandability of Prominence systems. These systems represent a consolidation of our extensive instrument and analytical experience cultivated together with customers thus far. Examples of analysis using these application systems are available in our application database and featured in Application News bulletins and the member website Solutions Navigator.

Foods
Food components   Additives
Residual pesticides   Fragrances

Chemical Industry
Plastics   Solvents   Paints
Fiber and paper

Environment
Atmosphere   Drinking water   Soil   Biofuels

Pharmaceuticals
Drug ingredients   Antibiotics and antimicrobials
Herbal medicines, natural products
Veterinary pharmaceuticals

- Amino Acid Analysis System
- Organic Acid Analysis System
- Reducing Sugar Analysis System
- Carbamate Analysis System
- Iminoctadine Analysis System

- Synthetic Antimicrobial Analysis System
- Bromate Analysis System
- Cyanide Analysis System
- Anionic Surfactant Analysis System
- Aldehyde Analysis System

- GPC System
- GPC Cleanup System
- Preparative System
- Co-Sense Series

Strong Support for Ensuring the Reliability of Analysis Data and Enhancing Productivity

In analytical laboratories, it is necessary to ensure that there have been no errors or irregularities in the procedures used to obtain results from the acquired data. Confirming test results and maintaining accurate analysis operational logs are also required. This is in order to ensure both the accuracy of the acquired data and the reliability of analysis data.

LabSolutions Report Set visualizes software operations to ensure the reliability of analysis data. At the same time, the amount of time needed to confirm analysis results can be reduced to 1/2 or 1/3.

1. Visualization of the Sequence of Analysis Operations Ensures Reliability and Reduces the Burden of Confirmation Procedures

Information from a sequence of analyses (batch analysis), analysis results and conditions, and even the entire operational log from the start to the end of analysis procedures are summarized in a single PDF file (Report Set). This simplifies confirmation of analysis results and operations, thereby ensuring reliability and reducing the burden of confirmation procedures.

2. The Sequence of Analysis Results Is Automatically Protected Against Tampering

Editing of the sequence of analysis results subject to visualization is automatically disabled, preventing the revision, substitution, or tampering of results.
As a result, revision, substitution and other forms of tampering with the analysis results is prevented. In addition, the visualized Report Set and the sequence of analysis results are linked, allowing individual analysis results data sets to be searched and checked easily.

3. Digitization of the Confirmation Process for the Analysis Results Report Enhances Productivity

A report confirmation record can be left at any point in the analysis results report output as a PDF file. If any items have not been checked, an error is issued, preventing omissions in the report confirmation process. In addition, electronic signatures can be used for the confirmation of the Report Set. These functions simplify on-screen confirmation, enabling paperless operations and heightening productivity.
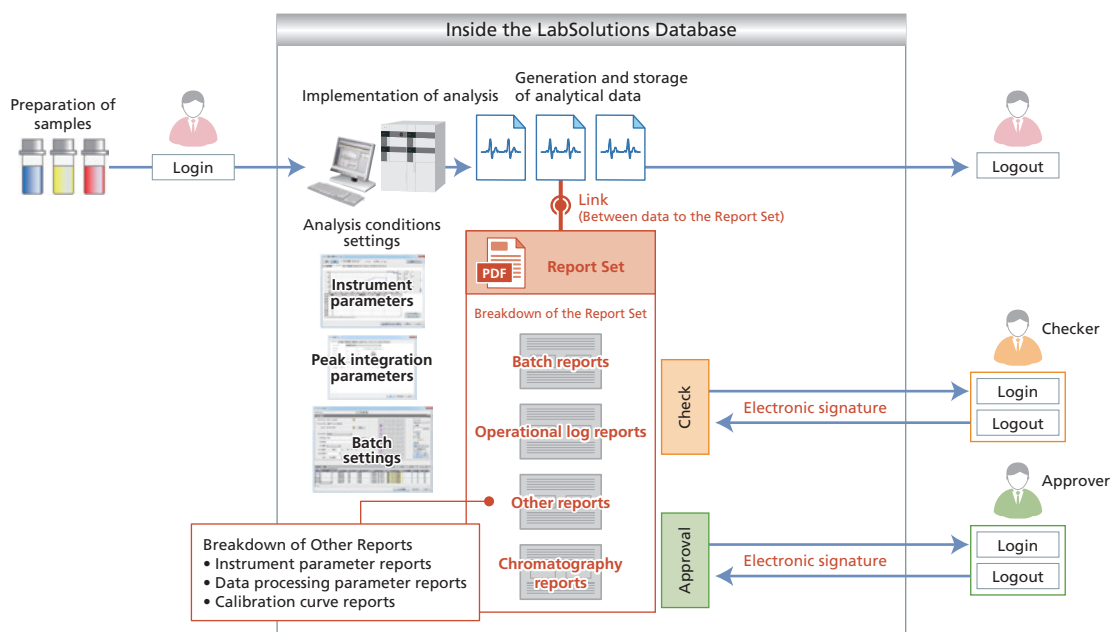
- Report Set is a PDF file that gathers operational information (human-mediated operations and settings) scattered within the software, as well as batch (sequential analysis) reports and chromatography reports, and summarizes them in a single report. This Report Set can be created with a single operation.
- As with analytical data and method files, the PDF Report Set is produced and stored in a security-controlled database. Also, the software that creates the PDF Report Set is incorporated in LabSolutions, so there is no need to apply separate validation for PDF creation software.

Note: The LabSolutions Report Set function is intended for LabSolutions CS and LabSolutions DB.

Solvent Delivery Units

LC-20AD

Superior Solvent Delivery Performance

The LC-20AD offers the fastest solvent delivery performance in the world. With an automatic pulsation-correction mechanism and high-speed micro plunger driving, it achieves pulse-free solvent delivery. Thanks to improvements in solvent-delivery control firmware, solvent-delivery performance in the micro-flow-rate range below 50 μL/min has been significantly improved.

LC-20AB

Binary Solvent Delivery Unit

The LC-20AB is a binary, high-pressure gradient solvent delivery unit that incorporates two sets of LC-20AD systems. Its space-saving design can be used to create a two-solvent high-pressure gradient.
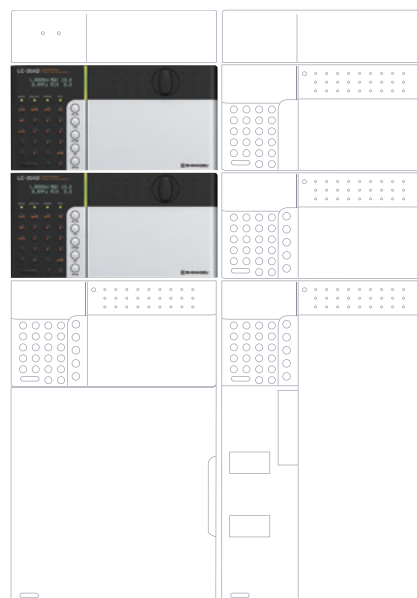
LC-20AT

Superior Maintainability

The LC-20AT possesses a high level of maintainability while delivering high performance. The ability to remove bubbles has been improved by modifying the pump-head structure and the flow line.

LC-20Ai

Solvent Delivery Unit for Inert LC Unit

Wetted parts are made from plastic, such as PEEK, without metal. Therefore it is corrosion-resistant to halogen ion, such as sodium chloride often used for biological polymer analysis. This unit is useful for analyze chemical compounds with metal materials that change in activity by contact with metal.


‣ Low-Pressure Gradient Unit

The optional low-pressure gradient unit can be incorporated in the LC-20AD/20AT, enabling gradient elution in a compact space with a small void volume. Automatic matching adjustment of the solenoid valve and pump gives concentration accuracies of ±1.0%.
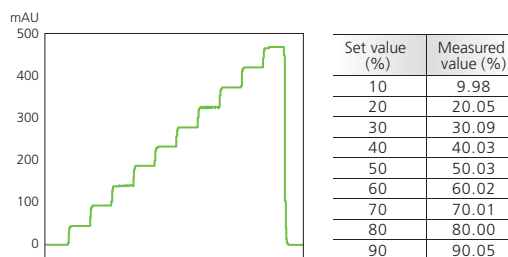
A new type of plunger made with a technique that reflects consideration of the material structure and a precise plunger-holding mechanism help to increase the service life of plunger seals and enable stable solvent delivery over long periods.

Plunger supported by floating mechanism

Plunger seal and center in alignment
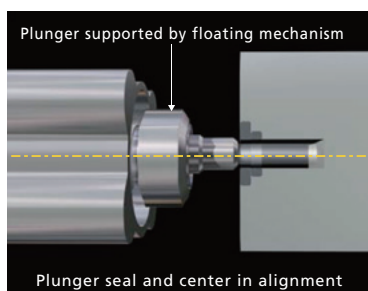
‣ Accurate Gradient Solvent Delivery

By harmonizing two solvent delivery systems, the LC-20AB delivers solvent with an accurate concentration across a wide range from the micro flow rate region to the conventional flow rate region.

Set value (%)	Measured value (%)
10	9.98
20	20.05
30	30.09
40	40.03
50	50.03
60	60.02
70	70.01
80	80.00
90	90.05

‣ Continued Improvements to Solvent Delivery Specifications

The flow rate accuracy and precision in the micro flow rate region have been improved thanks to the adoption of a new type of check valve and modifications to the solvent-delivery control method. Nonpolar organic solvents, such as hexane, can be delivered stably.

Flow-Rate Accuracy	
Set value (mL/min)	Measured value, n=6 (mL/min)
0.010	0.010
0.050	0.050
0.200	0.201
1.000	1.000

Flow-Rate Precision	
Set value (mL/min)	Flow-rate reproducibility, n=6 (RSD%)
0.010	0.49
0.050	0.08
0.200	0.08
1.000	0.01

LC-20AR / 20AP

Supporting from Analytical to Preparative Scales

The preparative LC system supports both analysis and fractionation (including gradient analysis and fractionation), which permits efficient scaling up with a single instrument and single operating environment. The solvent delivery unit LC-20AR can handle flow rates ranging from those used in accurate analytical scale to those used in semi-preparative. It enables semi-preparative recycling by using a recycle kit.
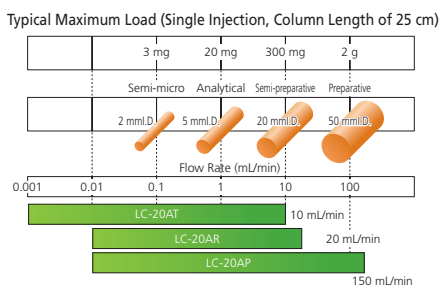
The high solvent delivery performance of the LC-20AP permits an accurate and efficient environment for scaling up, in both the preparative and analytical flow rate ranges.

The LC-20AP Quaternary which is combined the LC-20AP with a dedicated FCV-200AL low-pressure gradient unit, allows gradient fractionation to be performed in a single unit, thereby saving equipment costs.
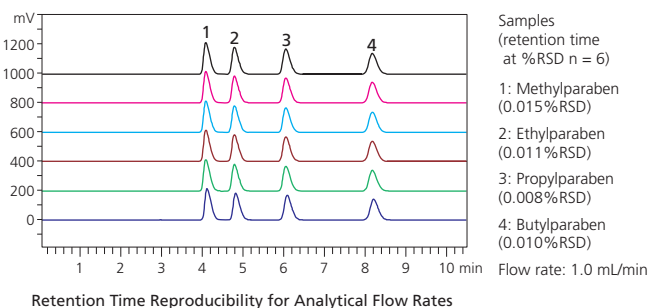
‣ Supports from Parameter Investigation to Scaling Up

Typical values of the total component weight for a single injection performed by a 250 mm column, where the target component is (1) highly soluble in the mobile phase, (2) separated from contaminating components, and (3) subjected to ion suppression, are indicated on the right. With isocratic elution, these values are basically proportional to the volume of the column.

Typical Maximum Load (Single Injection, Column Length of 25 cm)

	3 mg	20 mg	300 mg	2 g
	Semi-micro	Analytical	Semi-preparative	Preparative
	2 mm.I.D.	5 mm.I.D.	20 mm.I.D.	50 mm.I.D.

Flow Rate (mL/min)

0.001   0.01   0.1   1   10   100

LC-20AT — 10 mL/min
LC-20AR — 20 mL/min
LC-20AP — 150 mL/min

‣ High-Precision Delivery Performance

A redesigned plunger actuation mechanism and improved pulse correction and check valves offers significantly improved flow rate accuracy and flow rate precision. High retention time reproducibility for analytical flow rates improves reliability when scaling up and verifying purity.

Samples (retention time at %RSD n = 6)

1: Methylparaben (0.015%RSD)
2: Ethylparaben (0.011%RSD)
3: Propylparaben (0.008%RSD)
4: Butylparaben (0.010%RSD)

Flow rate: 1.0 mL/min

Retention Time Reproducibility for Analytical Flow Rates

‣ LC-20AP Quaternary Enables Fractionation as a Low-Pressure Gradient System

The LC-20AP Quaternary flow rate range is 1 to 50 mL/min and the instrument can handle up to four mobile phases simultaneously. It considerably reduces the effort required to investigate mobile phases during method development.
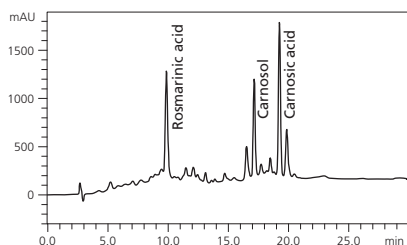
Column	Shim-pack PREP-ODS 250 mmL. × 20 mmI.D., 15 µm
Mobile phases	A: Water B: Methanol C: 2 % aqueous formic acid solution
Gradient program	B. Conc. 30 % (0 min) to 95 % (15 to 30 min) C. Conc. 5 %
Column temperature	Room temperature
Injection volume	200 µL
Flow rate	20.0 mL/min
Detection	UV 230 nm
Sample	Rosemary extract

Degassing Units DGU-20A3R / 20A5R

The DGU-20A3R/20A5R is an on-line degassing unit that uses fluoroethylene membrane. The internal capacity is small at 0.4 mL, only 1/25th of that for existing Shimadzu models, and the waiting time at mobile-phase replacement or stabilization can be significantly reduced. The degassing efficiency has also been improved, ensuring thorough degassing even at high flow rates.

● Number of degassed solvents for DGU-20A3R : 3
● Number of degassed solvents for DGU-20A5R : 5

Autosamplers

SIL-20A / 20AHT

Supporting High-Throughput Analysis

The SIL-20A is a total-volume injection-type Autosampler that enables high-speed injection and multi-sample processing. It was designed to ensure greater stability, with improved durability attained through modifications in valves and sample loops.

SIL-20AC / 20ACHT

Equipped with Cooling Function

The SIL-20AC is equipped with a sample cooler that incorporates a dehumidifying function. Samples can be maintained at a fixed temperature in the range of 4 to 40°C. The high cooling speed makes it possible to keep easily decomposed sample constituents in a stable condition.

Rack Changer II

Supporting Multi-sample Processing

Maximum 12 microplates can be set. The robot arm in the rack changer automatically loads both micro-plates and racks for standard 1.5 mL vials into the autosamplers. It is a powerful tool for the analysis of a large number of samples.
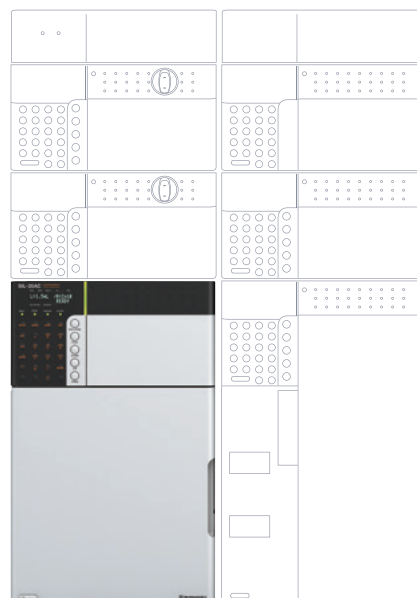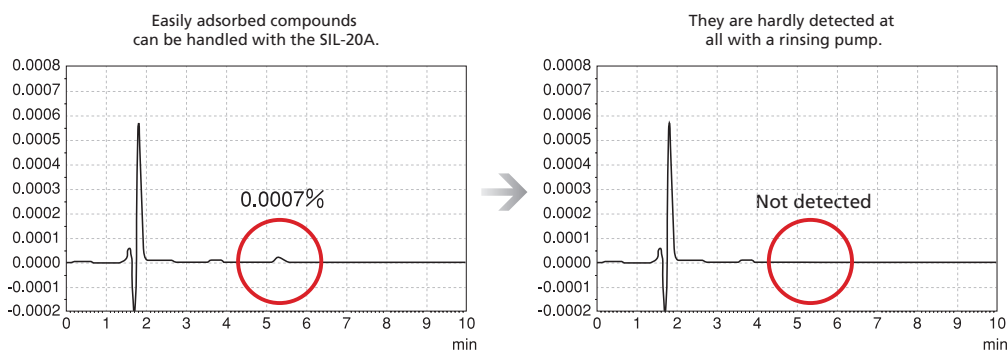
‣ Sample Carryover Reduced to an Absolute Minimum

Adsorption of sample constituents has been reduced to an absolute minimum by using a special processing technology for the sampling needle (patent pending) and rethinking the structure of the needle seal and the materials used in flow-line parts. As a result, there is hardly any sample carryover. Also, the adoption of a PEEK rotor seal allows use over a wide pH range, from strongly acidic conditions to strongly basic conditions. Using the optional rinse kit (228-43042-91)
makes it possible to rinse the sampling needle with two different solvents, selected in accordance with the purpose.

Easily adsorbed compounds can be handled with the SIL-20A.
0.0007%

They are hardly detected at all with a rinsing pump.
Not detected

Cross-contamination Test for Chlorhexidine

‣ Precise Sample Injection

Greater accuracy has been attained by incorporating a high-performance sampling device that can measure out the samples with high precision. The design reflects an emphasis on basic performance as well as functionality. Also, using direct injection means valuable samples are not wasted.

Injection-Volume Accuracy

Set value (µL)	Measured value (µL)
1	0.99
2	1.99
5	5.01
10	10.00
20	19.92
50	49.90
100	99.70

Injection-Volume Precision

Injection volume (µL)	Area reproducibility (%RSD)
1	0.43
2	0.25
5	0.06
10	0.04
20	0.03
50	0.10
100	0.11

▸ Rack Changer II: Increasing the Number of Processed Samples

A rack changer is an optional product that can be used to change the microplates in the autosampler's racks and thereby facilitate serial analysis. Up to 12 plates can be mounted in the rack changer.
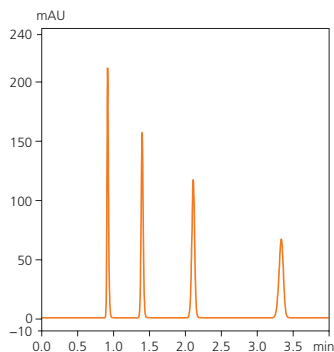This model incorporates a cooling function. When the samples have been prepared, simply set them in the rack changer to perform continuous sample processing.

● Rack changer II (228-45164-XX)

Compatible plates: 96-well MTPs, 96-well DWPs
384-well MTPs, 384-well DWPs
1.5 mL vial plate (54 vials)
Number of processed plates: 12
Sample cooler: Block cooling/heating, used together with dehumidifying function, 4 to 40°C

▸ Prominence UFLC Offers Ultra Fast HPLC Analysis

The SIL-20AHT / 20ACHT autosamplers used with the Prominence UFLC system permit ultra-fast analysis while maintaining the injection accuracy and durability requirements demanded of an HPLC system. As shown in the right, the retention time reproducibility and injection volume reproducibility are within 0.3 % after endurance testing over 100,000 cycles, results similar to those achieved with standard HPLC.


Components	Retention Time		Area	
	Average	%RSD	Average	%RSD
Acetophenone	0.916	0.089	312,670	0.059
Propiophenone	1.398	0.058	315,739	0.045
Butyrophenone	2.111	0.030	336,428	0.063
Valerophenone	3.341	0.031	296,609	0.040

(5 µL injection, n=6)

Repeatability for 4 Alkyl Phenones After Finishing 100,000 Cycle Endurance Test

▸ Combination with LCMS for Ultra Fast Analysis

Combining Prominence UFLC with a Shimadzu mass spectrometer, which features ultra-fast polarity switching between positive/negative ion modes (UFswitching), superb sensitivity due to the newly-developed Qarray™ ion optical system (UFsensitivity), and an ultra-fast scanning speed (UFscanning), enables ultra-fast analyses that produce peak widths in just a few seconds and highly reliable data.
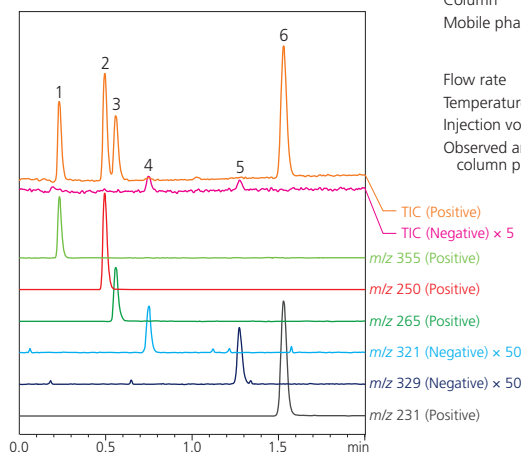
Detection : ESI-Positive mode; LCMS-2020
Column : Shim-pack XR-ODS (30 mmL. × 3.0 mmI.D.)
Mobile phase : A) 0.1% aqueous solution of formic acid
B) Acetonitrile
B.Conc.: 20% (0 min.) → 35% (2.0 min.)
Flow rate : 0.5 mL/min.
Temperature : 50°C
Injection volume : 1 µL
Observed analysis
  column pressure : 14 MPa

TIC (Positive)
TIC (Negative) × 5
m/z 355 (Positive)
m/z 250 (Positive)
m/z 265 (Positive)
m/z 321 (Negative) × 50
m/z 329 (Negative) × 50
m/z 231 (Positive)

Peaks
1: Yohimbine, [M+H]+ m/z 355
2: Alprenolol, [M+H]+ m/z 250
3: Tetracaine, [M+H]+ m/z 265
4: Chloramphenicol, [M−H]− m/z 321
5: Furosemide, [M−H]− m/z 329
6: Isopropylantipyrine, [M+H]+ m/z 231

Ultra-High-Speed Analysis of 6 Pharmaceutical Ingredients

Prominence
High Performance Liquid Chromatograph

System Controllers

▸ Web Server Functionality Allows the HPLC System to Directly Create a Network.

CBM-20A/20Alite is connected to a computer by Ethernet. The LAN cable connections allow the instrument and computer to be located in separated positions. Monitoring, simple operation control, and confirmation of the operation status can be performed on a mobile device.
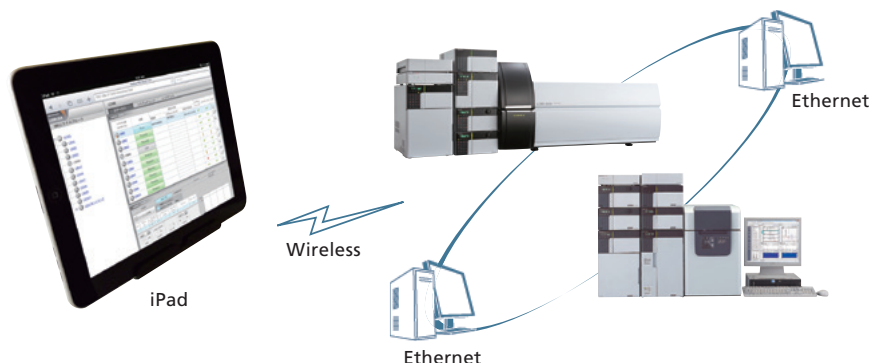
- Simultaneously monitor multiple systems on the same network
- Maintenance data on consumables can be acquired without impeding analysis
- Using an Apple® iPad, monitor and use simple HPLC controls from anywhere

▸ Assess the Status of Lab Instruments in Real Time

Instrument maintenance data can be assessed at a glance. If parts in use exceed their control lifetimes, they are flagged with a "!" mark. Even more detailed information can be confirmed by logging in to the corresponding instrument.
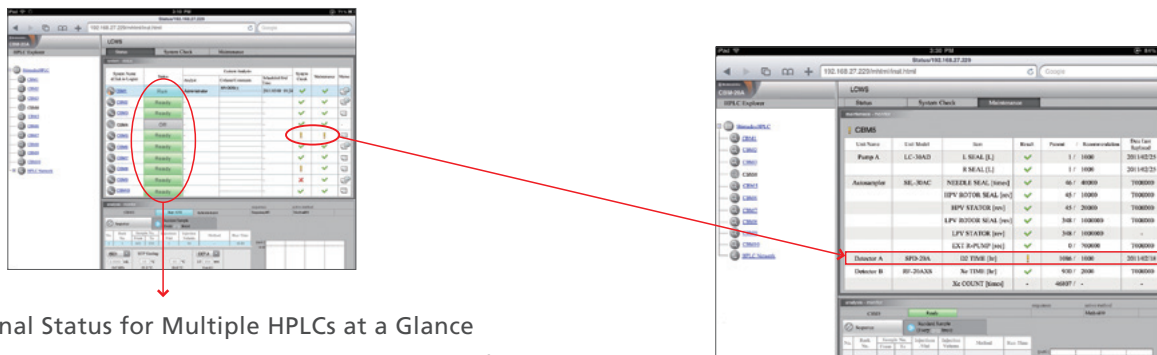
Operational Status for Multiple HPLCs at a Glance

Using an iPad, operational status can be easily assessed, even from a separate room. Having an iPad at your desk allows you to devote yourself to other projects with peace of mind, knowing that you can quickly retrieve information about completed analyses or errors that have occurred, all without visiting the lab.

▸ Control over a Network

Maintaining a clean LC system and analysis column is important in order to obtain highly reliable data. The Shimadzu LC system Web server functionality provides a control environment in addition to system monitoring. Remotely control column cleaning and conditioning from your iPad or desktop PC.

Note: iPad is a registered trademark of Apple Inc.

Column Ovens

The column oven precisely controls the temperature around the column to support stable analysis that is unaffected by changes in ambient temperature.
It can contain various units and parts in addition to the column, including a manual injector (CTO-20A/20AC), gradient mixer, and high-pressure flow-line selection valves.

CTO-30A

Supports high-temperature analysis up to 150°C

The CTO-30A is a block-heating type column oven. It offers temperature control up to 150°C and the intelligent heat balance mechanism extracts maximum performance from a high-efficiency column.

CTO-20A / 20AC

Accommodates multiple columns

The CTO-20A is a forced-air circulation-type column oven. It offers temperature control from 10°C below room temperature to 85°C.
It allows setting of complex temperature programs, such as linear-wise or step-wise heating and cooling. The CTO-20AC incorporates a cooling function. This electronic cooler offers temperature control from –10°C below room temperature to 85°C.
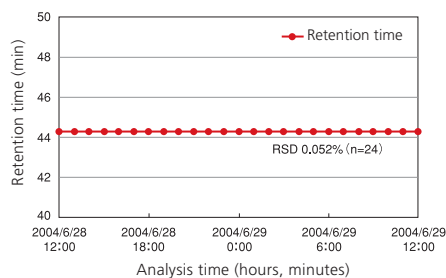
‣ Precise Temperature Regulation

The interior of the oven is precisely regulated with a high-performance thermistor. Also, the temperature is calibrated at two different temperatures to ensure a high level of accuracy.
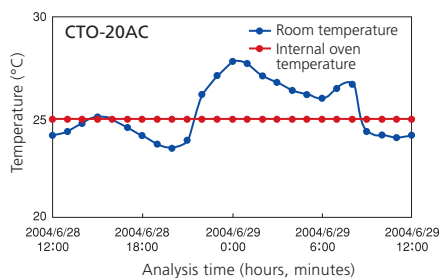
Changes in Room Temperature and
Internal Oven Temperature in One Day

Changes in Room Temperature and
Stability of Retention Time for Vitamin A Acetate in One Day

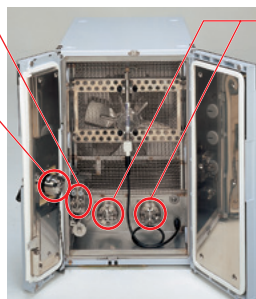## ‣ Built-In Flow-Line Selection Valves

The CTO-20A/20AC can incorporate up to two flow-line selection valves, a manual injector, and a gradient mixer.
The CTO-30A can also incorporate a flow-line selection valve and gradient mixer.

### Incorporation of Flow-Line Selection Valve

Mixer
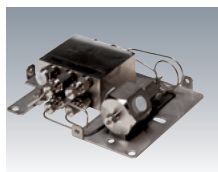
Manual injector

Flow-line selection valve

The FCV-12AH/14AH/32AH/34AH
High-pressure flow-line selection valve can be incorporated and controlled. Position display is also possible.

UV-VIS Detectors / Photodiode Array Detectors

The lineup includes SPD-20A/20AV dual-wavelength absorbance detectors and SPD-M20A/M30A photodiode array detectors. The SPD-M30A incorporates a new type of capillary cell to offer higher sensitivity and lower dispersion. All models offer temperature control for increased baseline stability with respect to temperature fluctuations and improved data reliability.
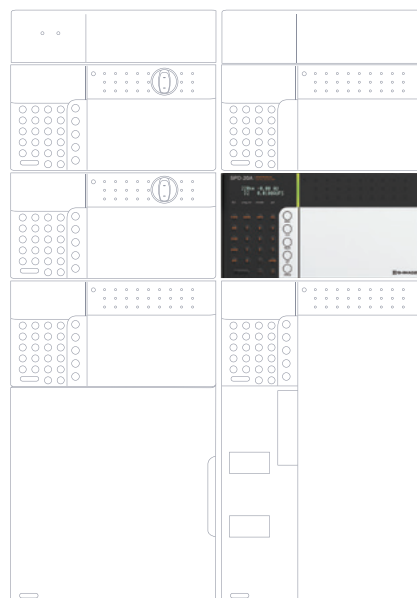
SPD-M30A Photodiode Array Detector

Supports diverse applications from HPLC to UHPLC

This detector achieves a $0.4×10^{-5}$ AU noise level. The SR-Cell (Sensitivity and Resolution Cell) significantly cuts peak dispersion. This model supports analysis from conventional LC to ultra-fast and UHPLC analysis. The optional high-sensitivity cell has an 85 mm optical path length and is able to detect trace components that were conventionally difficult to detect. The TC-Optics function further improves baseline stability.

SPD-M20A Photodiode Array Detector

General-purpose model

The SPD-M20A is a general-purpose model incorporating a deuterium lamp. The light-source compensation function achieves a noise level of $0.6×10^{-5}$ AU. Cell temperature control ensures baseline stability.

SPD-20A / 20AV   UV-VIS Detectors

Offering dual-wavelength mode

These UV-VIS detectors can measure two wavelengths simultaneously. The SPD-20AV offers a mode that lights the deuterium lamp and tungsten lamp simultaneously and permits highly sensitive wavelength-programming detection across the ultraviolet and visible regions.

‣ Extensive Range of Linearity

Superior signal processing technology maintains the detector linearity to the ASTM standard:
- SPD-20A/20AV : 2.5 AU
- SPD-M20A/M30A : 2.0 AU

This range is a powerful attribute for batch analysis demanding a wide range of linearity, such as the purity testing of reagents.
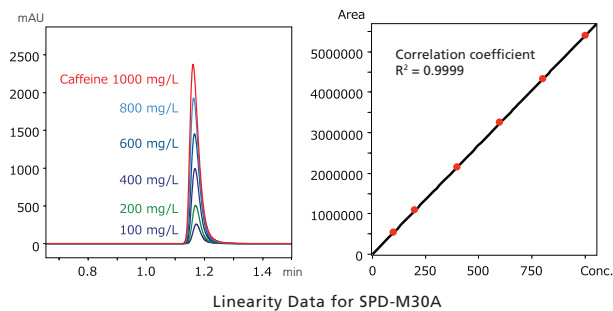
Linearity Data for SPD-M30A

‣ Temperature Control Provides Baseline Stability and Reliable Analysis Data

The SPD-M30A detector employs TC-Optics (temperature-controlled optics) and uses SR-Cells (low-dispersion cells optimized for heat transfer at the cell inlet). This successfully achieves the low peak dispersion required for ultra-fast analysis and rapid baseline stabilization. The M20A cell temperature control function also provides baseline stability with respect to temperature fluctuations.
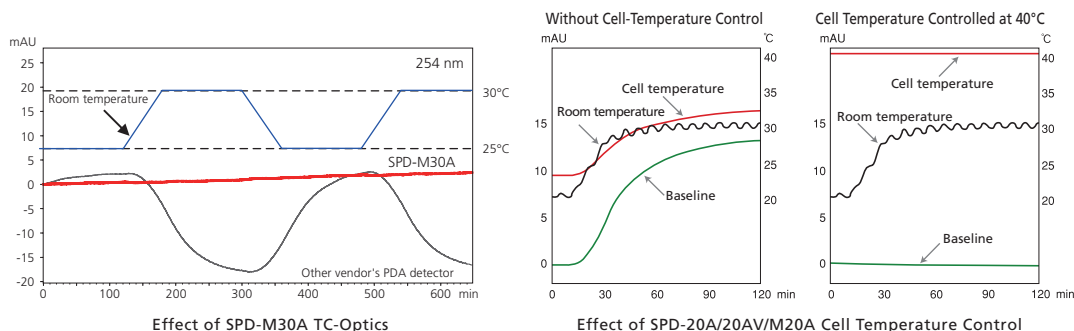

Effect of SPD-M30A TC-Optics

Effect of SPD-20A/20AV/M20A Cell Temperature Control

▶ High-Sensitivity Cell (Option)

A high-sensitivity cell with an 85 mm optical path length is available as an option for the SPD-M30A. It enables detection of trace impurities that were conventionally difficult to detect and can be used for a wide range of analyses, from general analysis to ultra-fast and UHPLC analysis.
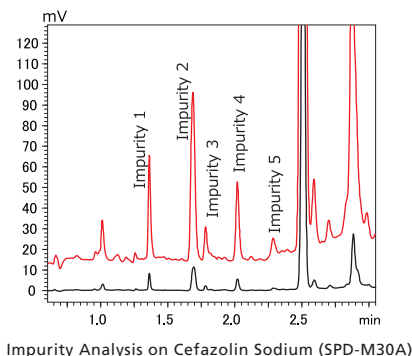
Signal Intensity

	High-sensitivity cell	Standard cell
Impurity 1	49109	7931
Impurity 2	81339	11438
Impurity 3	16345	2290
Impurity 4	37922	5548
Impurity 5	7726	968

─── : Standard cell (Optical path length: 10 mm)
─── : High-sensitivity cell (Optical path length: 85 mm)

Impurity Analysis on Cefazolin Sodium (SPD-M30A)

▶ 85 mm Optical Path Length Significantly Enhances Sensitivity

The SPD-M30A high-sensitivity cell is also effective under HPLC conditions. The analysis below shows a comparison of measurements of caffeine in a commercial soft drink using the SPD-M20A and SPD-M30A. It is apparent that the SPD-M30A improves the S/N ratio by up to eleven times.

─── : SPD-M20A (Standard cell)
─── : SPD-M30A (High-sensitivity cell)
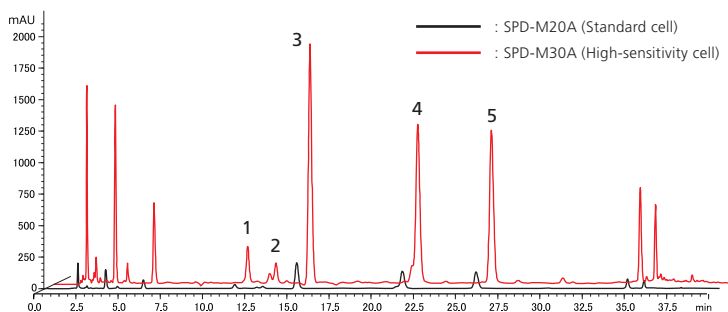
	SPD-M20A (Standard cell)	SPD-M30A (High-sensitivity cell)	S/N Relative Ratio
1	2794	26814	9.60
2	1527	15021	9.84
3	16153	179070	11.09
4	10894	118523	10.88
5	10394	113870	10.96

Mobile phase A: 0.1% aqueous solution of phosphoric acid
Mobile phase B: Acetonitrile
Flow rate: 1 mL/min
Column: Shim-pack VP-ODS 150 mmL. × 4.6 mmI.D.

## ▶ New Analytical Techniques to Better Utilize PDA Detector Data

Separation of Unseparated Peaks (*i*-PDeA*)
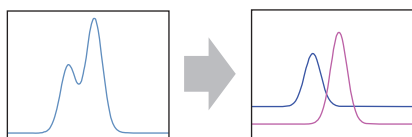
This technique fully separates unseparated peaks and visualizes small peaks hidden by a principal component. It is convenient when poor separation occurs under conditions for accelerated analysis and for quantitation of small peaks overlapped by a principal component peak.

* *i*-PDeA: Intelligent Peak Deconvolution Analysis

Extending the Dynamic Range (*i*-DReC**)
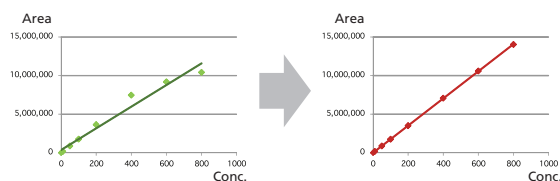
This powerful technique permits quantitation of samples in the high-concentration range. It enables the simultaneous analysis of high- and ultra-low-concentration samples and the creation of calibration curves across a broad concentration range.

** *i*-DReC: Intelligent Dynamic Range Extension Calculator

See the separate technical reports for more details about *i*-PDeA and *i*-DReC.

Prominence
High Performance Liquid Chromatograph

Fluorescence Detectors

The RF-20A/20Axs fluorescence detectors offer world-leading sensitivity* and ease-of-maintenance. The RF-20Axs is a high-sensitivity model that incorporates a temperature-controlled cell with a cooling function as standard.

RF-20A

Standard model

The RF-20A, which offers best-in-class sensitivity, features a water Raman S/N ratio of at least 1200, as well as excellent ease-of-use with such features as maintenance from the front panel and adoption of a long-life lamp.
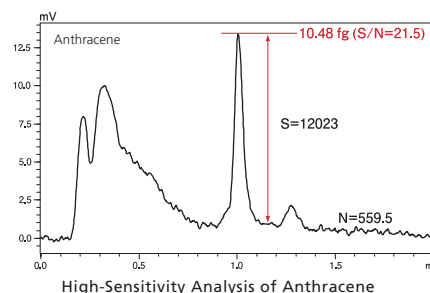
RF-20Axs

Achieves World-Leading Sensitivity*

Offering world-class levels of sensitivity* and easy maintenance, the RF-20Axs features a water Raman S/N ratio of at least 2000 and a temperature-controlled cell with a cooling function. This maintains a constant detector cell temperature, even if the room temperature fluctuates significantly, to ensure superb reproducibility with no drop in sensitivity. In addition, the RF-20Axs incorporates an automatic wavelength accuracy check function using an internal low-pressure mercury lamp to provide simple confirmation of the wavelength accuracy for validation.

▸ Achieves World-Leading Sensitivity*

A powerful tool for the detection of ultra-trace components, the RF-20Axs achieved a 21.5 S/N ratio for an injection of 10.48 fg anthracene. This is equivalent to an approx. 1.5 fg detection limit (S/N ratio = 3) and indicates superb sensitivity.

* As of August 2009, Survey by Shimadzu

High-Sensitivity Analysis of Anthracene

▸ Cell Temperature Control Further Enhances Reproducibility (RF-20Axs)

The fluorescence intensity drops as the temperature rises. A fluctuation of about 1°C near room temperature may result in approximately 5% intensity fluctuations for some compounds.
To prevent this, the RF-20Axs features a temperature-controlled cell with a cooling function. It maintains a constant detector cell temperature, even if the room temperature fluctuates significantly, to ensure superb reproducibility with no drop in sensitivity.

With cell temperature control   No cell temperature control
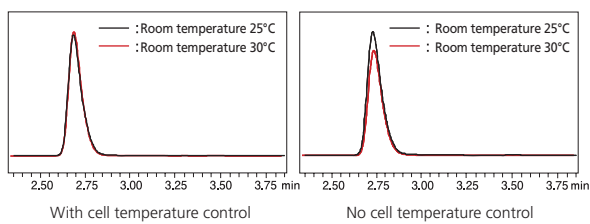
Effect of Temperature-Controlled Cell (Acridine)

	Rate of Change (%)	%RSD
RF-20Axs (With cell temperature control)	0.64	0.29
RF-20A (No cell temperature control)	−17.45	6.30

%RSD — Consecutive analysis is performed while changing the room temperature from 25°C to 30°C, and the %RSD value is determined from the analysis data (n = 6). It is used to confirm the effect of room-temperature fluctuations during the analysis.

Rate of Change — Consecutive analyses are performed at 25°C and 30°C room temperature. The rate of change shows the change in the peak area, taking the average peak area value at 25°C as 1. It is used to confirm the effect of long-term fluctuations in room temperature due to the passage of the seasons.

▸ Easy Maintenance

The Xenon lamp and flow cell can be replaced at the front panel. No positional adjustment is required when replacing the Xenon lamp, and no tools are required to replace the flow cell. The standard flow cell or semimicro flow cell can be rapidly switched. In addition, the Xenon lamp life has been extended to 2000 hours, four times longer than previous Shimadzu lamps.

▶ Support for Ultra Fast Analysis

Switch from Conventional LC to Ultra Fast LC

Fast response is required to follow the sharp peaks obtained in ultra fast LC analysis. The 10 ms response of the RF-20A/20Axs permits ultra fast LC analysis with no loss of separation. In this analysis example, the analysis time was reduced by a factor of more than three, while maintaining the separation.

Analysis Conditions

Mobile phase	Hexane / 2-propanol = 100 / 0.5 (v/v)
Flow rate	1.0 mL/min (Conventional) 0.8 mL/min (UFLC)
Column	Shim-pack CLC-SIL(M) (150 mmL. × 4.6 mmI.D., 5 μm: Conventional) Shim-pack XR-SIL (75 mmL. × 3 mmI.D., 2.2 μm: UFLC)
Temperature	30°C
Detection	298 nm excitation wavelength, 325 nm emission wavelength

Conventional LC (N for Peak δ = 11,708)

UFLC (N for Peak δ = 10,623)
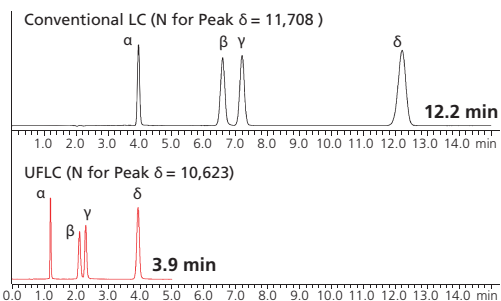
Switching from Conventional LC to UFLC Analysis of α-, β-, γ-, δ-Tocopherols

Multi-Component, High-Sensitivity UFLC Analysis

The highly sensitive simultaneous analysis of multiple components requires detection at the optimal wavelengths.
The RF-20A/20Axs permit ultra fast, high-sensitivity multi-component analysis using wavelength switching by time program.
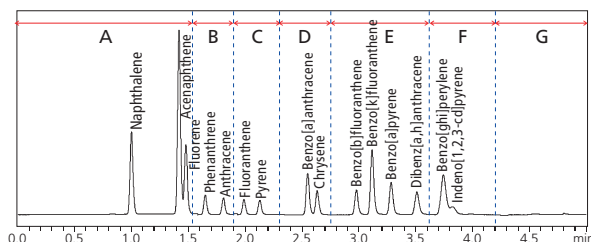
Ultra Fast Simultaneous Analysis of 15 Polycyclic Aromatics

A	270 nm excitation wavelength, 330 nm emission wavelength
B	250 nm excitation wavelength, 370 nm emission wavelength
C	330 nm excitation wavelength, 430 nm emission wavelength
D	270 nm excitation wavelength, 390 nm emission wavelength
E	290 nm excitation wavelength, 430 nm emission wavelength
F	370 nm excitation wavelength, 460 nm emission wavelength
G	270 nm excitation wavelength, 330 nm emission wavelength

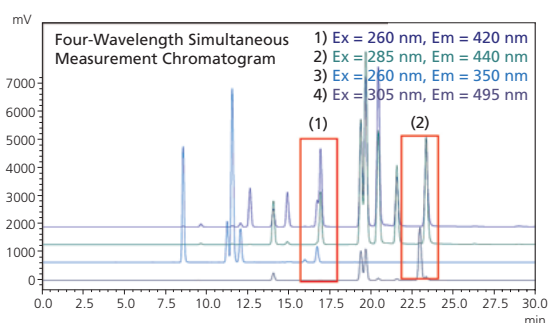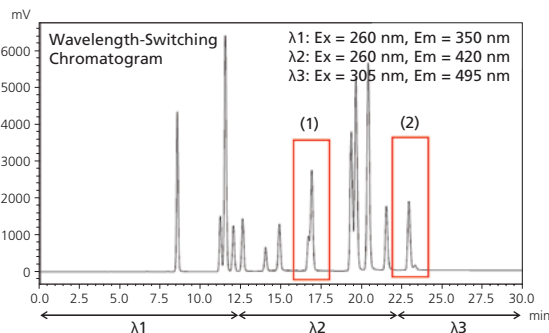# ▶ Support for Improved Quantitative Analysis Accuracy

Utility of Four-Wavelength Measurement Function

Using detection at a single wavelength when performing multicomponent simultaneous analysis of components with different optimal detection wavelengths necessitates sacrificing sensitivity for certain components.
The RF-20A/20Axs detectors eliminate this issue by incorporating a four-wavelength measurement function that permits detection of each component at the optimal wavelength.
Detection using wavelength switching in the left-hand diagram exhibits incomplete separation in area (1) and one peak of reduced size in area (2). In such a case, setting up to four optimal wavelengths enhances the quantitative analysis accuracy by reducing the effects of adjacent peaks and improving sensitivity.

Wavelength-Switching Chromatogram
λ1: Ex = 260 nm, Em = 350 nm
λ2: Ex = 260 nm, Em = 420 nm
λ3: Ex = 305 nm, Em = 495 nm

Four-Wavelength Simultaneous Measurement Chromatogram
1) Ex = 260 nm, Em = 420 nm
2) Ex = 285 nm, Em = 440 nm
3) Ex = 260 nm, Em = 350 nm
4) Ex = 305 nm, Em = 495 nm

Analysis of Polycyclic Aromatics by Four-Wavelength Simultaneous Measurement (Elution sequence shown in previous diagram)
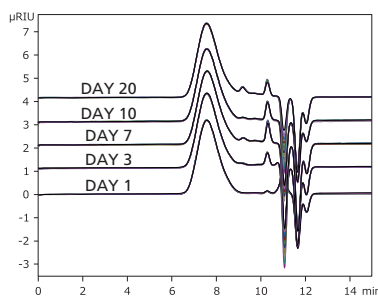
Refractive Index Detector

RID-20A

The RID-20A incorporates an auto purge function of the reference cell and a validation support function, inheriting the stability and expandability of Prominence HPLC series.
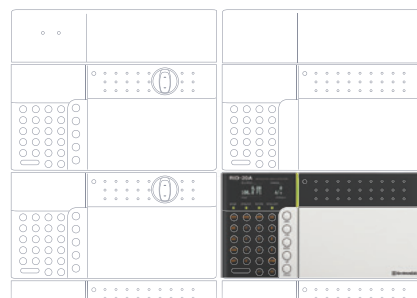
‣ Excellent Reproducibility in Molecular Weight Distribution Analysis

The RID-20A differential refractive index detector allows productivity improvements in GPC analysis.


	Retention time	Retention time reproducibility (%RSD)
DAY 1	7.575	0.023
DAY 3	7.577	0.020
DAY 7	7.576	0.029
DAY 10	7.593	0.041
DAY 20	7.587	0.041
Ave.	7.582	0.031

‣ Excellent Baseline Stability

Generally speaking, differential refractive index detectors tend to be easily affected by changes in room temperature. The optical system of the RID-20A, however, has a dual temperature control function that absorbs the effects of changes in room temperature, which ensures excellent stability. The RID-20A achieves shorter baseline stabilization time after turning ON the power through improved dual-temperature control of the optical system and superior lamp performance.
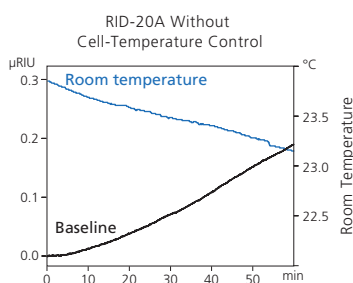
Excellent baseline stability during changes in room temperature
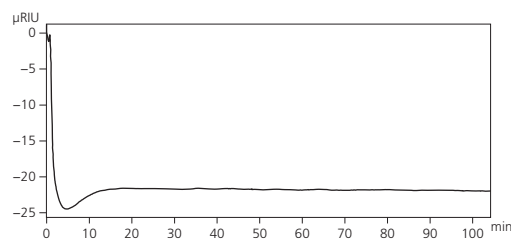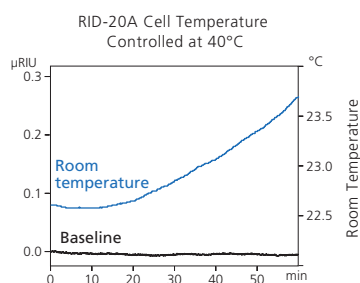
Elapsed time after power ON

‣ Shimadzu's Proprietary Technology Supports Highly Sensitive Analysis to Preparative Analysis Applications

The four-partition photodetector in the RID-20A allows a wide refractive index range (0.01 to 5000 µRIU). The single detector supports all applications from highly sensitive measurements to preparative measurements using the three operation modes shown below.

| A (Analytical) Mode	High-sensitivity to general-purpose analysis
P (Preparative) Mode	High-concentration analysis, semi-preparative analysis (up to 20 mL/min)
L (Large-scale prep.) Mode	Flow selection block allows large-volume preparative analysis. (up to 150 mL/min)
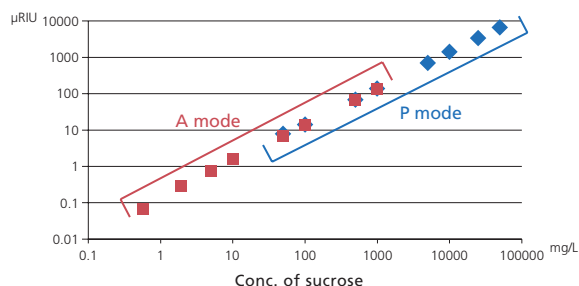
Chromatography Workstation
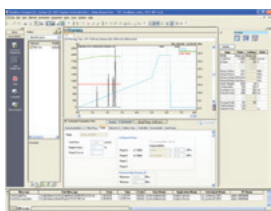
LabSolutions

▸ Flexible Instrument Access

With LabSolutions, LCs and GCs can be operated via the same interface, and up to four LC and/or GC systems can be controlled simultaneously on a single PC. Instrument information for up to 16 systems can be registered to a single PC, allowing the system to be switched between LC or GC systems connected to the network.
LabSolutions' instrument operating status monitor allows the operator to check the operating status of connected systems and the scheduled analysis end times on each instrument. Even if multiple LC and GC systems are operating at the same time, the operating status can be known at a glance, which is useful for scheduling data acquisition to effectively minimize instrument downtime.
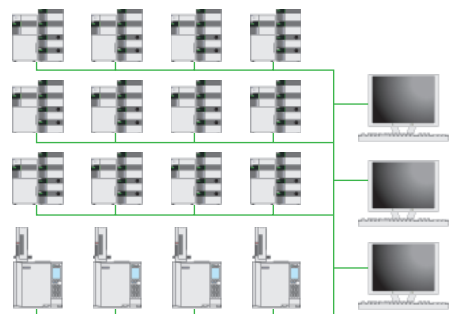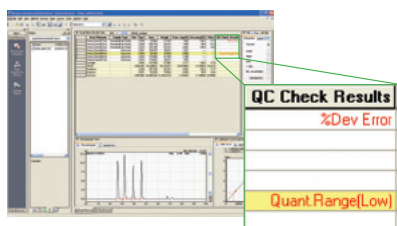

### ▸ Automation Functions for Sample Analysis

To start sample analysis, it is necessary to perform column equilibration and a noise level check, and to generate a schedule. LabSolutions enables automatic operation of these procedures, greatly improving workflow efficiency.

▸ Comprehensive Quantitative Results Window

A quantitative results window enables easy review of data results and each chromatogram. LabSolutions supports the QC check by accuracy % and the range check to see whether a quantitative value falls within the range of the calibration curve; in addition, it supports calculation of impurity peak amounts, S/N ratio, and peak valley ratio. These various functions greatly reduce the time required for data analysis.

▸ Customize the Operation Platform to Fit Your Workflow
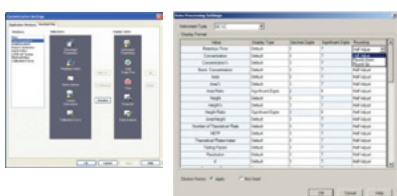
LabSolutions allows users to customize the screen icons and layouts; therefore, the graphical user interface can be adapted according to individual preferences and workflow. Even the rounding method and number of displayed digits for the calculation results, such as area, height, concentration and column performance parameters, can be defined in the system for consistency and individual laboratory requirements.

▸ Powerful Regulatory Compliance and Data Management for a Paperless Laboratory

System administration features, including system policy, user administration, log browser, and audit trail, are provided to assist users in FDA 21 CFR Part 11 compliance, which is supported and configurable on a stand-alone workstation as well as in a network environment. In addition, automatic registration of PDF files, which can be generated by LabSolutions as a standard function, into the database is available to support paperless operations in an analytical laboratory.

LabSolutions CS ▸ Freely Accessible to the Analysis Network

Since all analytical data are managed in the database of a server computer, LabSolutions CS can read data from any personal computer on a network. In addition, analysis directions and instrument monitoring and control can be performed from a personal computer (client PC) not connected to the instruments. Furthermore, it allows direct control of another vendor's LCs and GCs.

Moreover, client PC functions are performed on a server and client PCs corresponding to a Windows terminal service do not need to install LabSolutions software.

Furthermore, LabSolutions CS corresponds to Citrix XenApp and can perform more advanced server management.
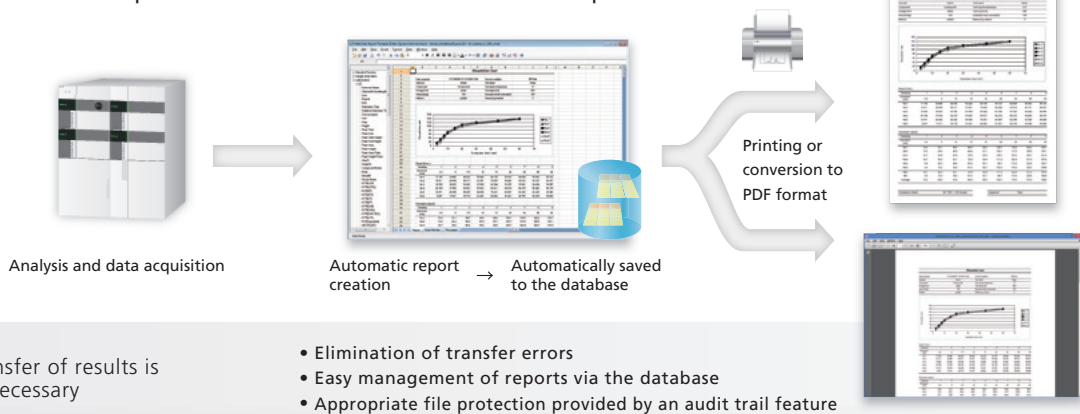
Recommended for the following customers

► Facilities with a large number of instruments and users
► Facilities interested in enhancing managerial efficiency
► Facilities interested in enhancing procedural efficiency
► Facilities where existing PCs can be used as client PCs
► Facilities interested in controlling other vendor's instruments from the same software. *4

Client PC *2   Laboratory or office   iPad *3   LabSolutions server

Acquisition controller PC *1

Shimadzu LC / Shimadzu LC / Shimadzu GC / Shimadzu LCMS / Shimadzu PPSQ / Shimadzu UV / Shimadzu FTIR / Shimadzu RF / Agilent LC / Agilent GC / Non-Shimadzu LC unit / Non-Shimadzu GC unit

Shimadzu GCMS / Shimadzu AA / Shimadzu Balances / Shimadzu TOC / Shimadzu powder and particle size analyzer / Shimadzu ICP / Shimadzu thermal analyzer / Shimadzu EDX

Combine with CLASS-Agent to enable integrated management of these instruments' data.

*1 The acquisition control PC controls analytical instruments.
It can also be used to send analytical instructions and perform postrun analysis, just like a client PC.
*2 If a terminal service is used, then LabSolutions software does not need to be installed on client PCs.
*3 If an iPad is used, then XenApp from Citrix must be installed. iPad is a trademark of Apple Inc.

▸ Reduce the Work Involved in Creating a Final Report

Do you move your analytical results to a spreadsheet program (e.g., Excel) to create a final report?
LabSolutions includes a multi-data report feature, which reduces the work involved in report creation. Analytical results are automatically entered into a spreadsheet equivalent to the one used in Excel, eliminating the need to move the data.

〈Workflow of Report Creation with the Multi-Data Report〉

Analysis and data acquisition   Automatic report creation → Automatically saved to the database   Printing or conversion to PDF format

Transfer of results is unnecessary

• Elimination of transfer errors
• Easy management of reports via the database
• Appropriate file protection provided by an audit trail feature

Note: Excel is a registered trademark of Microsoft Corporation.

Autosamplers / Column Oven / Fraction Collector

SIL-10AF / 10AP / 10Ai

SIL-10AF / 10AP   Versatile Autosamplers

The SIL-10AF and SIL-10AP injectors use the fixed-loop injection method. They can also perform sample pretreatment, including dilution and mixing, at a high speed. The SIL-10AP is a preparative autosampler that can inject up to 5 mL while offering the same level of performance and functionality as the SIL-10AF.

SIL-10Ai   Bio-inert Autosampler

This bio-inert autosampler uses PEEK resin in parts that contact liquids. It can be used for the analysis of physiologically active substances and metal ions.

CTO-10AS$_{VP}$

The CTO-10AS$_{VP}$ is a space-saving, compact and affordable oven with a block heating mechanism.
The CTO-10AS$_{VP}$ controls temperature from −15°C below room temperature to 60°C, and accommodates two manual injectors.

FRC-10A

A Fraction Collector for a Wide Variety of Fractionation Modes

The FRC-10A can be used over a wide range of flow rates, covering small and large-scale preparative work. It flexibly adapts to various applications, such as simple, manual collection performed while viewing chromatograms, and advanced, continuous and automated preparative separation and collection performed in combination with an autosampler and detector.

Prominence
High Performance Liquid Chromatograph

Conductivity Detector

CDD-10AVP

Handles a Wide Variety of Analysis Options

The CDD-10AVP conductivity detector achieves an even higher level of sensitivity and makes it possible to perform a wide variety of analysis scenarios with a single unit. An option card enables the simultaneous 2-channel measurement of anions and cations, and a suppressor option allows expansion to a suppressor system for ultra-high sensitivity work. Organic acids can be analyzed using Shimadzu's unique post-column pH-buffered electroconductivity method.

Ions	Concentration (µg/L)	RSD (%)
F	50	0.46
Cl	200	0.23
NO_2	15	5.41
Br	100	0.71
NO_3	80	0.54
PO_4	500	0.63
SO_3	200	2.30

Reproducibility in Anion Analysis
(Lower concentration limits of quantitative analysis range for 2001 edition of Water Supply Testing Methods, Japan)
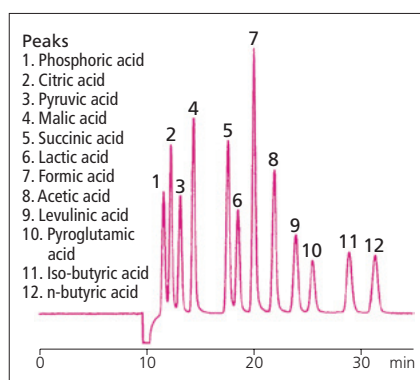
‣ Perform Analysis with Highest Sensitivity

The sensitivity of detectors that monitor weak electrical signals from analytes is affected by the inherent electrical noise of the detector itself. With the CDD-10AVP, electronic parts with low electrical noise are used, and the layout of the electronic components has been optimized in order to reduce noise levels, thereby attaining an extremely high level of sensitivity. Combining the CDD-10AVP with a suppressor unit makes it possible to perform ultra-high sensitivity ion analysis on the order of 0.25 µg/L (detection limit: S/N = 3) for Cl^-.

‣ Applicable to Both Suppressor and Non-Suppressor Systems (available in limited regions)

When used with a CTO-20AC, expansion to a full suppressor system can be realized by adding the suppressor option. Suppressor functions can be disabled when necessary, making it possible to switch between anion analysis using a suppressor system and cation analysis using a non-suppressed system. In addition to a single flow-line system, expansion to a dual flow-line system is also possible, allowing the creation of a variety of system configurations. For example, simultaneous analysis of anions and cations using a combination of suppressed and non-suppressed detection is possible.

‣ High-Sensitivity Analysis of Organic Acids

Peaks
1. Phosphoric acid
2. Citric acid
3. Pyruvic acid
4. Malic acid
5. Succinic acid
6. Lactic acid
7. Formic acid
8. Acetic acid
9. Levulinic acid
10. Pyroglutamic acid
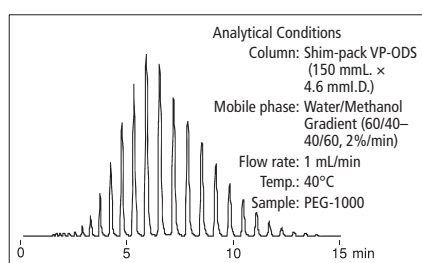11. Iso-butyric acid
12. n-butyric acid

Shimadzu's post-column pH-buffered electroconductivity method (Patent No. 2017498) enables selective, high-sensitivity analysis of organic acids. Even samples that traditionally require time-consuming pretreatment to handle unwanted constituents can be analyzed after simple pretreatment procedures such as dilution and filtration. The level of reliability attained in quantitative analysis is much higher than that attained conventionally with a low-wavelength UV method or a simple conductivity method. Superior linearity enables batch analysis in cases where constituent concentrations differ greatly and, consequently, helps reduce analysis time.

Evaporative Light-Scattering Detector

ELSD-LT ll

### Highly Versatile Detection Method

Not all compounds have a chromophore or other such structural property that allows the use of an absorbance detector. Refractive Index Detection (RID) is one option but it suffers from the inability to run gradient analysis. Evaporative Light Scattering Detection (ELSD) is a perfect alternative to RID as it is more rugged, quicker to stabilize, and gradient compatible. ELSD is ideal for applications like testing the purity of compounds, measuring the molecular weight distribution of synthetic polymers, and analyzing natural substances.

Analytical Conditions
Column: Shim-pack VP-ODS
(150 mmL. × 4.6 mmI.D.)
Mobile phase: Water/Methanol Gradient (60/40–40/60, 2%/min)
Flow rate: 1 mL/min
Temp.: 40°C
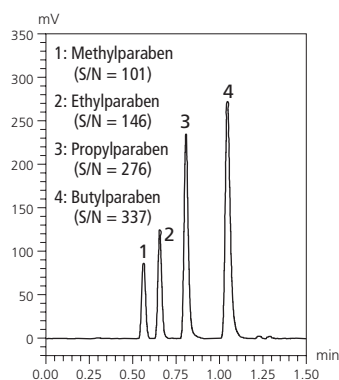Sample: PEG-1000

Chromatogram of Non-Chromophoric Compound

▶ Detects Most Compounds

With the exception of some highly volatile compounds, the ELSD-LT II is able to detect almost any compound. Unlike traditional absorbance detectors (UV-Vis, PDA, etc.), sensitivity is not dependent on the physical or structural properties of the compound, but rather the absolute quantity of the solute passing through the detector cell. Therefore, it is especially useful for detecting unknown or breakdown compounds and/or validating purity of a target compound. By this mechanism of detection the ELSD-LT II is truly a universal detector.

Photomultiplier

Light Source

Assist Gas   Assist Gas

Assist Gas Functions
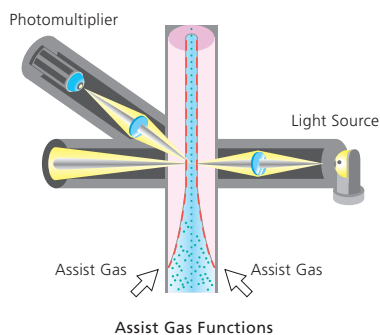
▶ High Sensitivity by Low Temperature Evaporation

The ELSD-LT II detector uses a unique nebulizer and drift tube design to achieve stable and low-temperature evaporation of mobile phases, making it possible to analyze semi-volatile and/or thermally unstable compounds.
High-sensitivity detection is achieved by focusing the sample at the detection point with assist gas flow. The ELSD-LT II offers high sensitivity with this low-temperature evaporation technology and superb detection technology. A smaller volume nebulizer and drift tube further improve sensitivity.

mV

1: Methylparaben (S/N = 101)
2: Ethylparaben (S/N = 146)
3: Propylparaben (S/N = 276)
4: Butylparaben (S/N = 337)

▶ Automated Functions

Auto-Powerdown functions for the LED light source and nebulizer gas reduce operating costs. The self-cleaning design makes maintenance of the drift tube easier.

Example of analyzing 4 semi-volatile alkyl parabens, considered difficult to analyze with conventional ELSD detectors.
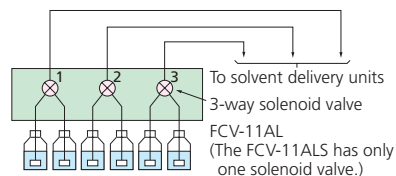
FCV Series Flow-Line Selection Valves

FCV-20AH2 (228-45015-XX)
FCV-20AH6 (228-45017-XX) — **High-Pressure Flow-Line Selection Valves**

The FCV-20AH2/20AH6 is a stand-alone, high-pressure, flow-line selection valve. The valve position is controlled by event signal input. Direct control is also possible from the unit itself.

FCV-11AL (228-45048-58)
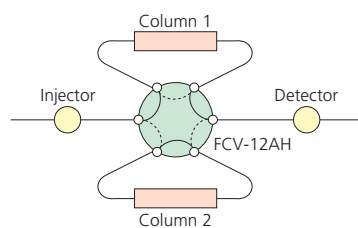**FCV-11ALS** (228-45049-58) — **Reservoir Selection Valves**

These solenoid valve units can automatically switch between two solvents (e.g., mobile phase and column rinse solvent) plumbed to one solvent delivery unit. The FCV-11AL can handle the automatic selection of solvents for up to three solvent delivery units whereas the FCV-11ALS is used for one unit.

To solvent delivery units
3-way solenoid valve
FCV-11AL
(The FCV-11ALS has only one solenoid valve.)

FCV-12AH/12AHi (228-45013-57/58)
**FCV-32AH** (228-45166-91) — **High-Pressure Flow-Line Selection Valves**

These flow-line selection valves incorporate 6-port, 2-position, high-pressure valves.
They can be used for automatic column selection and automatic pretreatment.

* The liquid contact parts of the FCV-12AHi have bio-inert specifications.

Column 1
Injector
Detector
FCV-12AH
Column 2

FCV-13AL (228-45016-58) — **Reservoir Selection Valve**

This unit performs automatic solvent selection and incorporates a 7-port, 6-position valve.
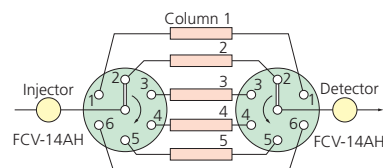It can perform the switching of up to six solvents for a stepwise gradient.

To solvent delivery unit
FCV-13AL
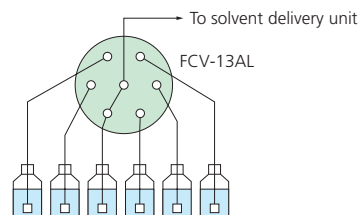
FCV-14AH/14AHi (228-45014-57/58)
FCV-34AH (228-45185-41)

Column Switching Valves

This unit performs automatic column selection and incorporates a 7-port, 6-position, high-pressure valve. It can be used for automatic multi-column switching. (Two units used.)

* The liquid contact parts of the FCV-14AHi have bio-inert specifications.

FCV-15AL (228-28418-91)

Reservoir Selection Valve with Rinsing Pump

It incorporates a pump that can continuously automatically rinse the rear side of the solvent delivery unit's plunger seals of solvent delivery unit.

The device can automatically switch between two solvents. It is convenient to automatically rinse column and flow-line.
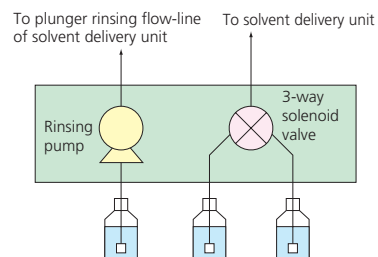
FCV-230AL (228-45163-58)

Reservoir Selection Valve

This device can switch between two solvents using a solenoid valve (option four solvents). It can be controlled from the LC-20AP or a system controller CBM-20A/20Alite or workstation. It can be extended switching between four solvents by adding 4 port option kit (228-45165-41).

* This image is with 4 port option kit

Optional Accessories

Options for Solvent Delivery Units

Automatic Rinsing Kit

- 20AD Automatic Rinsing Kit (228-45567-91)
- 20AT Automatic Rinsing Kit (228-45568-91)
- 20AB Automatic Rinsing Kit (228-18803-92)

These optional kits are used to continuously, automatically rinse the backs of the plunger seals and plunger units. They wash away the salt that is deposited on the surfaces of the seals and plungers when buffer solution is used as the mobile phase, thereby helping to prolong the service life of these parts. There are kits for use with the LC-20AD, the LC-20AT, and the LC-20AB.

* The automatic rinse kit for the LC-20AB is shown in the photograph.

Mixer
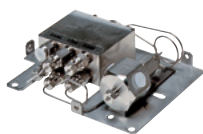
- Mixer 0.5-2.6 mL HP (228-45093-93)
- Mixer 100 μL HP (228-35830-93)
- 20A Bio-inert Mixer (228-45093-92)
- Preparative Mixer (228-20600-91)

These gradient mixers offer superior mixing performance. Mixing volumes of 0.5 mL, 1.7 mL, and 2.6 mL can be selected for the Mixer 0.5-2.6 mL HP. The mixing volume for the Mixer 100 μL HP is 100 μL. The 20A bio-inert mixer incorporates PEEK resin and ceramic for use with bio-inert systems, and two mixing volumes can be selected. There are also mixers for preparative applications.

* The Mixer 0.5-2.6 mL HP is shown in the photograph.

- MR 20 μL Mixer for UHPLC
- MR 40 μL Mixer for UHPLC
- MR 100 μL Mixer for UHPLC
- MR 180 μL Mixer for UHPLC

Reducing the gradient delay volume is required in ultra high speed (UHPLC) analysis. The mixer for UHPLC performed to minimize the gradient delay volume and optimize the mixing performance. When using the LC/MS system, use the MR 20 μL. When using no formic acid, acetic acid, or trifluoroacetic acid (TFA), use the MR 40 μL. When using formic acid and acetic acid, use the MR 100 μL. When using TFA, use the MR 180 μL. There are lineup of suitable mixers for purpose.

DGU-10B (228-45067-58) ———————————————— Helium Degassing Unit

This degasser purges dissolved air from the mobile phase and prevents phenomena such as bubble formation, baseline noise, and drift. The DGU-10B can degas up to four mobile phase solutions with helium gas. It is turned ON/OFF from the solvent delivery unit or system controller.

Options for Chemical Reaction Units

CRB-6A (228-45065-XX) ——————————————— Chemical Reaction Chamber

This air circulation-type reaction chamber is used for post-column derivatization.
Temperature-control range: Between 15°C above room temperature and 150°C
Temperature-control precision: ±0.1°C (100 V operation only)

Options for Sample Injection Units

Sample Injectors

- Rheodyne 7725 (228-32210-91) For general analysis
- Rheodyne 7725i (228-32210-93) For general analysis
- Rheodyne 8125 (228-23200-91) For semi-micro systems
- Rheodyne 9725 (228-32650-91) For bio-inert LC systems
- Rheodyne 9725i (228-32650-93) For bio-inert LC systems

* The Rheodyne 7725i/9725i incorporates a position-sensing switch.

Optional Loops

Volume	Material	Part Number	Volume	Material	Part Number
100 μL	SUS	228-32211-16	500 μL	SUS	228-32211-18
	PEEK	228-32651-16		PEEK	228-32651-18
200 μL	SUS	228-32211-17	1 mL	SUS	228-32211-19
	PEEK	228-32651-17		PEEK	228-32651-19

Option Box VP (228-45060-91)
Sub-controller VP (228-35308-91)

* Option Box VP is shown in the photograph.

Option Box VP can house up to two FCV-11AL(S)/12AH/13AL/14AH units. One FCV-11AL or FCV-11ALS unit, up to two FCV-12AH units, up to two FCV-13AL/14AH units, and one DGU-10B unit can be controlled from the CBM-20A or SCL-10AVP via Option Box VP.
Sub-controller VP has the same control functions as Option Box VP but has no housing capability.

Solvent Recycle Valve Kit (228-45080-91)

Using a solvent recycle valve kit during isocratic analysis allows column eluent to return to the reservoir bottle when no peaks are detected according to the set threshold level. This helps reduce consumption of the mobile phase, especially at higher flow rates.

Manual Recycle Valve (228-20401-92)

This manual switching valve is used to perform recycling operations with preparative systems.

Manual Column Switching Valve (228-13000-95)

This manual switching valve is used to switch between preparative columns, or between a preparative column and an analytical column, in an analytical-to-preparative scaleup system.

Reservoir Tray (228-45041-91)

The sturdy plastic tray will hold up to seven 1-liter reservoir bottles.

Outlet Unit (228-35327-XX)

This unit provides eight outlets (4 unswitchable, 4 switchable by CBM-20A).

Column Holder (228-45079-91)
Column Holder, SLIM (228-45203-41)

This holder supports the mounting of two columns (SLIM: Second column is optional.*) with inner diameters in the range of 20 to 50 mm, one analytical column, maximum four manual selection valves of various types (SLIM: Maximum five).

Dimensions: Column Holder   W250 × D400 × H465 mm
                     Column Holder, SLIM   W110 × D500 × H625 mm

* Optional column clamp ASSY (228-17701-94) is required separately to mount two columns.

Column Holder   Column Holder, SLIM

Prominence
High Performance Liquid Chromatograph

25

High-Performance Analytical Column for Stable Routine Analysis

With its wide selection and high quality, the Shimadzu Shim-pack series offers reliable highly stable routine analysis for various applications. The Shim-pack VP and XR models offer equivalent separation characteristics, but the scalable packing particle size ensures analytical method parameters can be reviewed smoothly, such as to improve separation or increase speed.
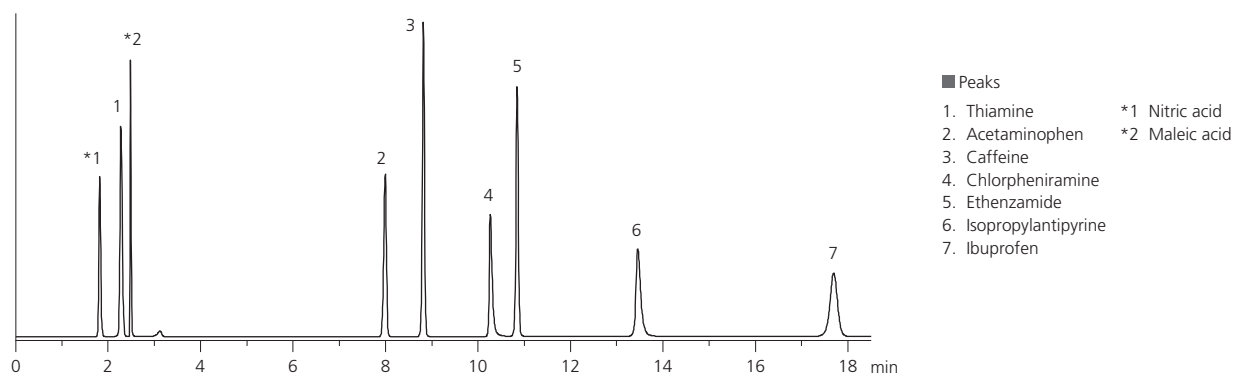
Shim-pack MAqC-ODS I

Shim-pack MAqC-ODS I reversed-phase columns are packed with a silica gel containing metal and added octadecylsilyl group. In addition to the hydrophobic characteristics of the ODS, the metal content also provides cation-exchange effects. This increases the retention of basic compounds. Therefore, this allows use with only a buffer solution as the mobile phase for analyses that previously required using an ion pair reagent and enables using gradient elution. These characteristics are especially beneficial for analyzing water soluble vitamins and pharmaceuticals that contain a large amount of basic compounds.

Example of Analyzing a Cold Remedy

Gradient elution with a Shim-pack MAqC-ODS I column was used for simultaneous analysis of components contained in an over-the-counter commercial cold remedy. The ability to use gradient elution enables the acquisition of sharp peaks, even for components that eluted slowly, similar to the water soluble vitamin and drug impurity examples above.

■ Peaks

1. Thiamine   *1 Nitric acid
2. Acetaminophen   *2 Maleic acid
3. Caffeine
4. Chlorpheniramine
5. Ethenzamide
6. Isopropylantipyrine
7. Ibuprofen

Analytical Conditions

Mobile phase	A) 20 mmol/L phosphate (Na) buffer solurion (pH 2.5) B) Acetonitrile
Time program	B Conc.1% (0 min) → 1% (2min) → 50% (8 min) → 50% (18 min) → 1% (18.01 min → 23 min)
Detection	UV 220 nm
Flow rate	1.0 mL/min
Injection volume	10 μL
Column temperature	40 °C

Shim-pack VP-ODS, C8, and Phenyl

Shim-pack VP series columns are conventional scale columns with 5 µm diameter particles. They feature extremely small variability between individual units, due to stabilized silica packing material quality, due to highly reproducible surface modification technology for injecting stationary phase functional groups and end-capping, and due to strictly controlled packing processes. They are available with an ODS, C8, or phenylpropyl group.

Shim-pack XR-ODS, C8, and Phenyl

These columns include 2.2 µm diameter packing particles and offer a careful balance between separation efficiency and pressure characteristics. Due to the high 35 MPa pressure capacity, XR columns can significantly reduce analysis times while also maintaining separation characteristics equivalent to general purpose columns (Shim-pack VP series with 5 µm diameter packing material).

Shim-pack XR-ODS II

This column features 2.2 µm diameter packing particles and a 60 MPa pressure capacity, which enables it to achieve high separation equivalent to a long column. Therefore, it offers a wider applicability range for high-speed high-separation analysis, such as analysis near room temperature.

Ghost Trap® DS

These mobile phase cleanup columns are capable of removing impurities from organic solvents. By installing the trap before the autosampler, it can eliminate mobile phase impurities online, which can cause ghost peaks.
During gradient analysis, this trap can reduce the time required for developing methods or analyzing impurities. This cost-effective cartridge model offers a pressure capacity of 35 MPa.

▶
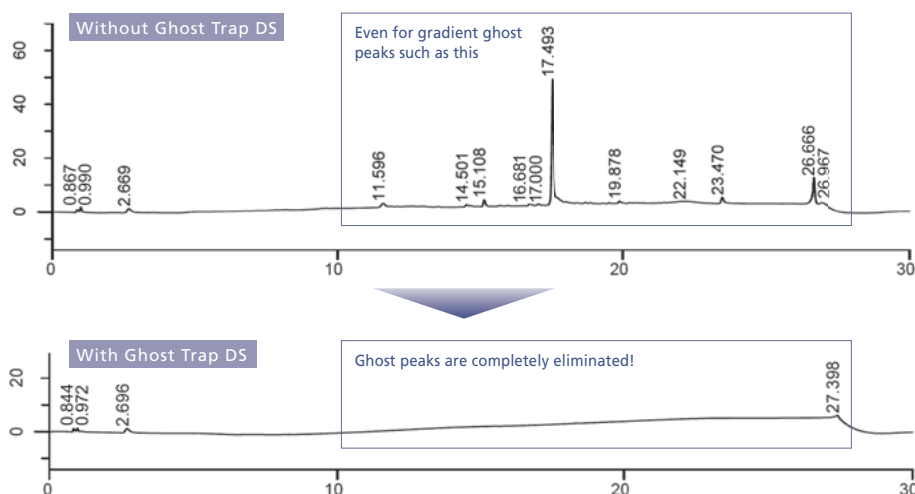
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