

## P680 HPLC Pumps



*Dionex offers six P680 pumps for use with the Summit® HPLC or any other HPLC system. The isocratic P680 pumps—analytical or semipreparative—are reliable workhorses for all isocratic applications. The quaternary Low-Pressure Gradient (LPG) P680 Pump offers flexible eluent proportioning (four eluents) for all routine and*

*method development applications and includes a built-in vacuum degasser. The Dual Low-Pressure Gradient P680 Pump includes two ternary gradient pumps in one enclosure and therefore reduces bench space requirements. Use this pump for applications requiring two gradient pumps (e.g., enrichment method). The binary High-*

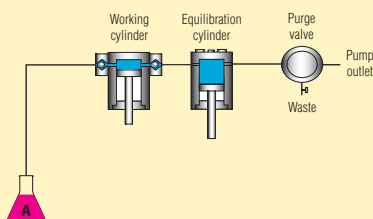
*Pressure Gradient P680 Pump is ideal for all applications requiring ultrahigh gradient accuracy—especially at low flow rates. For short gradient delay times, the gradient delay volume can be reduced to less than 70  $\mu\text{L}$ . The binary Semipreparative High-Pressure Gradient P680 Pump is ideal for small-scale purification applications.*



## Expect More from a P680 Pump

- SmartFlow™ technology provides excellent flow and gradient performance, and minimal residual pulsation for all common eluents at any settable flow rate— independent of system pressure.
- Don't waste additional bench space running more complex applications— use the Dual Low-Pressure Gradient P680 Pump (incorporates two independent ternary gradient pumps).
- Robust mechanical design, standard active rear-seal wash system, and optimized system architecture ensure excellent reliability and performance.
- Requires no additional bench space —the P680 stacks neatly on the ASI-100™ Autosampler, TCC-100 Thermostatted Column Compartment, and PDA-100 Photodiode Array Detector.
- A flip-up front panel gives direct access to all flow path components, making routine maintenance easy.
- All P680 models are equipped with four freely programmable relays, integrated USB hub with three USB ports, and an interface for control of the solvent rack SOR-100 with incorporated degasser channels.
- System wellness functions ensure that the P680 operates under optimal conditions. Warning messages inform the user of piston seal leaks, insufficient vacuum degassing, low wash solution, etc.
- For thorough eluent mixing, a dynamic mixer is standard on all gradient versions. Additional mixing options add flexibility to accommodate specific application requirements (e.g., for lowest gradient delay volume or most complete mixing of poorly miscible eluents).

## Isocratic Analytical and Semipreparative P680 Pumps



### Application Area

These pumps serve as workhorses for isocratic applications.

### Features

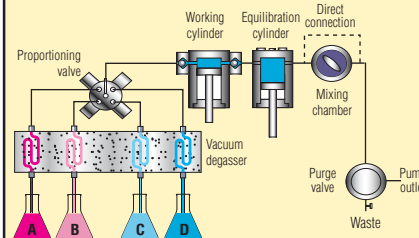
- Rugged and easy to use
- Wide flow rate range up to 10 mL/min (analytical) and up to 50 mL/min (semipreparative)
- Optional solvent saver
- Can be operated in stand-alone mode or with Chromeleon software

### Pump Architecture

Serial dual-piston design with SmartFlow technology increases flow rate stability, resulting in reliable and reproducible chromatography. An active rear-seal wash system prolongs the lifetime of pistons and seals.

- Automated validation procedures make the pump compliant with regulatory requirements when operated with the Chromeleon® Chromatography Management System.
- Vacuum degasser, a costly option in other manufacturers' pumps, is standard in the LPG version.
- Optimized flow paths minimize gradient delay volume, reducing analysis time in low flow rate gradient runs.
- USB and Ethernet interfaces ensure ease of installation and compatibility with modern communication interfaces.

## Low-Pressure Gradient P680 Pump



### Application Area

This versatile model is for a wide range of research and routine applications, and is ideal for method development.

### Features

- Accurate and precise proportioning of four eluents
- Wide flow rate range up to 10 mL/min
- Low gradient delay volume (<400 µL), independent of system pressure
- Fully programmable in stand-alone mode or with Chromeleon software

### Pump Architecture

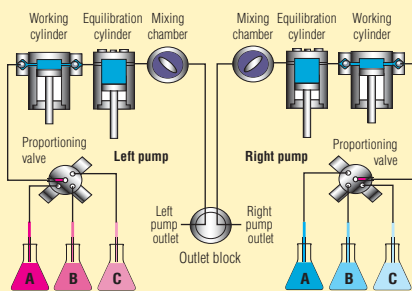
Has built-in vacuum degasser. Up to four solvents are proportioned through a low-pressure, high-speed valve to form a quaternary mixture, which then undergoes intensive mixing. Innovative pump architecture ensures a low gradient delay volume. SmartFlow eliminates the need for a pulse damper. An active rear-seal wash system prolongs the lifetime of pistons and seals.

- High-Pressure Gradient (HPG) P680 Pump ensures optimal performance for low flow rate applications (e.g., LC-MS with the MSQ™ Mass Spectrometric Detector).

### Pulse-Free Eluent Delivery, Superior Flow, and Gradient Performance

SmartFlow technology ensures superior eluent delivery and gradient formation for all eluent mixtures. An intelligent motor control algorithm compensates the effects of changing eluent compressibility, system pressure, and system temperature. SmartFlow optimizes eluent compressibility parameters without the need for manual adjustments.

## Dual Low-Pressure Gradient P680 Pump



### Application Area

This pump is ideal for all applications that require two gradient pumps. Use the dual LPG pump for on-line sample preparation to enhance selectivity or for enrichment methods to maximize sensitivity. Shorten cycle times and increase sample throughput by equilibrating one column while the other is used for analysis (2-column tandem operation).

### Features

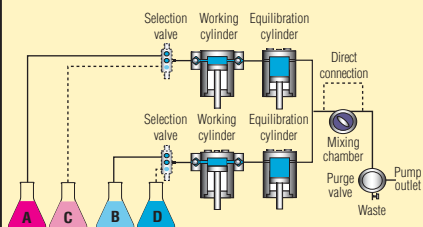
- Two ternary low-pressure gradient pumps in one enclosure
- Wide flow rate range up to 10 mL/min
- Low gradient delay volume (<400  $\mu\text{L}$ ), independent of system pressure
- Fully programmable in stand-alone mode or with Chromeleon software

### Pump Architecture

Innovative pump architecture allows operation of two independent gradient pumps in one housing. Up to three solvents per pump block are proportioned using a low-pressure, high-speed valve to form independent ternary mixtures, which then undergo intensive mixing. SmartFlow eliminates the need for a pulse damper. An active rear-seal wash system prolongs the lifetime of pistons and seals.

Furthermore, with SmartFlow, the P680 does not require a pulse damper for virtually pulse-free eluent delivery (Figure 1). The disadvantages of pulse dampers (large, system-pressure-dependant delay volume, shifting retention times) are avoided. Tachometer-controlled dc motors provide precise gradients with 0.5% resolution, even at a flow rate of just 100  $\mu\text{L}/\text{min}$ .

## High-Pressure Gradient P680 Pump



### Application Area

This pump is ideal for low flow rate applications using narrow-bore or microbore columns (e.g., in combination with a mass spectrometer). The P680 HPG provides the most precise gradient formation.

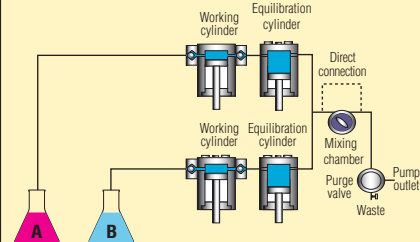
### Features

- Pulse-free eluent delivery without a pulse damper, independent of system pressure and eluent composition
- Wide flow rate range up to 20 mL/min
- Gradient delay volumes of less than 150  $\mu\text{L}$  with standard mixer and less than 70  $\mu\text{L}$  with microflow kit
- Fully programmable in stand-alone mode or with Chromeleon software

### Pump Architecture

Includes two serial dual-piston pumps in one housing. Two solvents are mixed to form a high-pressure gradient. With SmartFlow technology, changes in eluent compressibility during gradient runs are compensated for automatically and instantaneously. A dynamic mixer ensures thorough eluent mixing.

## Semipreparative High-Pressure Gradient P680 Pump



### Application Area

This pump is for semipreparative HPLC and fractionation.

### Features

- Flow rates up to 50 mL/min in gradient mode and 100 mL/min in isocratic mode
- Adaptable mixing volume up to 1600  $\mu\text{L}$
- Fully programmable in stand-alone mode or with Chromeleon software

### Pump Architecture

Includes binary high-pressure gradient pump in one housing. A dynamic mixer ensures thorough eluent mixing.

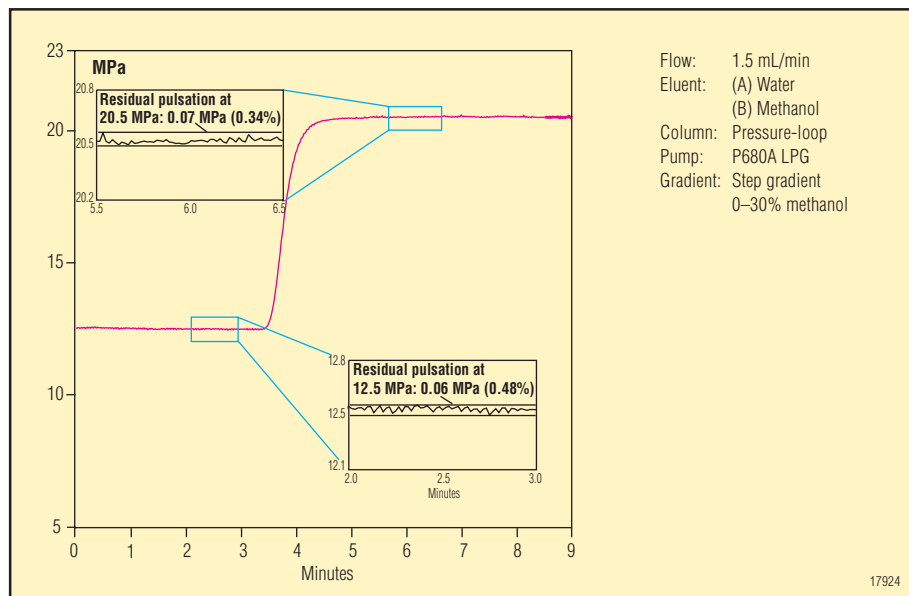


Figure 1. SmartFlow technology compensates the effects of changing eluent compressibility and system pressure, and provides virtually pulse-free eluent delivery. Pressure diagram of a 0-30% methanol step gradient.

## Robust Design for Built-In Reliability

A rugged cam design, powerful dc motors, and internal mechanics are optimized for maximum precision and durability, resulting in minimal wear of maintenance parts. A standard active rear-seal wash system prolongs the lifetime of pistons and seals, and ensures maximum system reliability and lower cost of ownership. The P680 system architecture strictly separates fluidic components from electronics. Front panel access to all parts, by tilting up the faceplate, provides easy pump maintenance.

## Operation Always Under Optimal Conditions

System wellness technology ensures operation of the P680 under optimal conditions and prevents unexpected failure. The risk of sample loss and the need for sample reanalysis are minimized. System wellness checks include:

- Instrument self-test upon start-up
- Rear-seal wash solution monitoring
- Piston seal leak detection (patented)
- Degasser vacuum monitoring
- Flow path blockage detection between pump cylinders reduces the risk of damaging the pump when contamination blocks the flow path
- Flow path and pump system leak detection
- Upper and lower pressure limits

## Mixing Device Options

P680 gradient models feature a variable volume mixer, allowing you to optimize your system to suit your application. For low flow rate applications, a microflow kit reduces the gradient delay volume to less than 70  $\mu\text{L}$  for the HPG pump and less than 300  $\mu\text{L}$  for the LPG pump. Mixer extensions are available for both pump versions and enhance mixing of poorly miscible eluents. Figure 2 demonstrates the gradient delay volume of different pump versions.

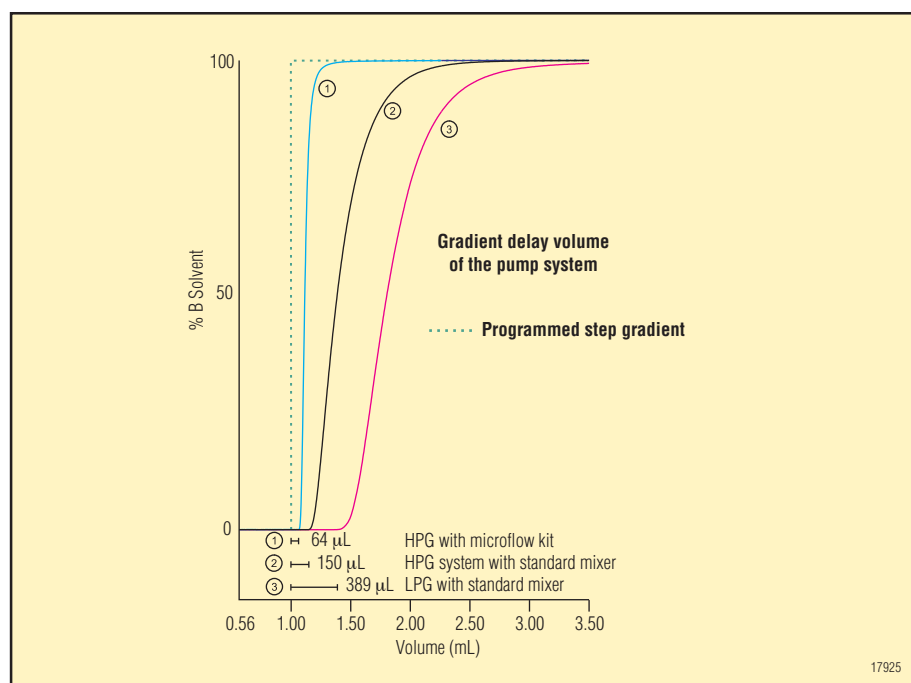


Figure 2. Delay volumes of P680A LPG and P680A HPG, with and without standard mixer.

## Fast and Convenient Validation

Validation of the P680 pump system is fast and easy with Chromeleon AutoQ™. AutoQ provides comprehensive support for instrument Installation Qualification (IQ), Operational Qualification (OQ), Performance Qualification (PQ), and System Suitability Testing (SST). OQ and PQ are highly automated, qualifying important instrument parameters, including flow precision, proportioning accuracy and precision, and pump-related ripple. Chromeleon's system suitability tests provide alerts, and can even stop further analysis if suitability criteria (e.g., a maximum retention time deviation) are not met, thereby preventing sample loss, wasted eluent, and lost run time.

## PC Interface

USB and Ethernet (RJ-45) interfaces ensure standardized PC compatibility. An integrated three-port USB hub allows other Summit modules to connect directly to the pump.

## The Low-Pressure Gradient P680 Pump

### Accurate and Precise Gradients

The best way to test the ability of a pump to perform accurate and precise gradients is to run a gradient profile with very small gradient steps. Figure 3 shows an overlay of 3 gradient runs of an LPG pump. The 1% steps are clearly defined, accurate, and reproducible; the maximum step deviation is less than 0.5%. The reproducibility is better than 0.2% standard deviation (SD) for all steps. This incredible performance is achieved thanks to SmartFlow technology and the high precision of the pump's proportioning valve.

### Minimal Gradient Delay Volume

Because the P680 pump eliminates pulsation at its source, additional pulse-dampening devices are not required. Thus the gradient delay volume, even for the LPG configuration with a standard mixer, is less than 400  $\mu\text{L}$ , including the integral dynamic mixing chamber (see also Figure 2). Unlike pulse-damper equipped systems, the delay volume is totally independent of the system pressure. Minimal gradient delay volume and the small-volume dynamic mixer make even fast gradients highly reproducible.

### Retention Time Reproducibility

Figure 4 shows the reproducibility of an LPG run at 1.5 mL/min in an application example. The numbers above the peaks indicate the relative standard deviation (RSD) of peak retention time.

### Fast and Convenient Method Development

Eluent proportioning of up to four eluents ensures maximum flexibility in method development. With programmable rinse cycles, the pump can wash out buffers automatically before shutting down the system, thus preventing blockages of capillaries and tubing.

### Save Valuable Bench Space

Use the bench space of one pump housing to perform applications requiring two pumps. The Dual Low-Pressure Gradient P680 Pump features two independent gradient pumps. Use this pump to enhance selectivity with online sample preparation or to maximize sensitivity with enrichment methods. Shorten cycle times and increase sample throughput by equilibrating one column while using a second column for analysis (i.e., 2-column tandem operation).

### The High-Pressure Gradient P680 Pump

#### Low Flow Rates

For low flow gradients, HPG formation is the clear choice, offering significantly reduced delay volume and superior proportioning precision. Adaptation of LPG pumps (e.g., with variable piston stroke volumes) cannot match the enhanced performance of HPG. With two independent pumps housed in one unit, the HPG pump provides accurate and precise high-pressure gradient formation at any flow rate. The HPG pump is the ideal choice for all narrow-bore and microbore applications, and is the preferred pump for LC-MS applications. Figure 5 shows the retention time reproducibility of a protein digest sample at a flow rate of 50  $\mu$ L/min.

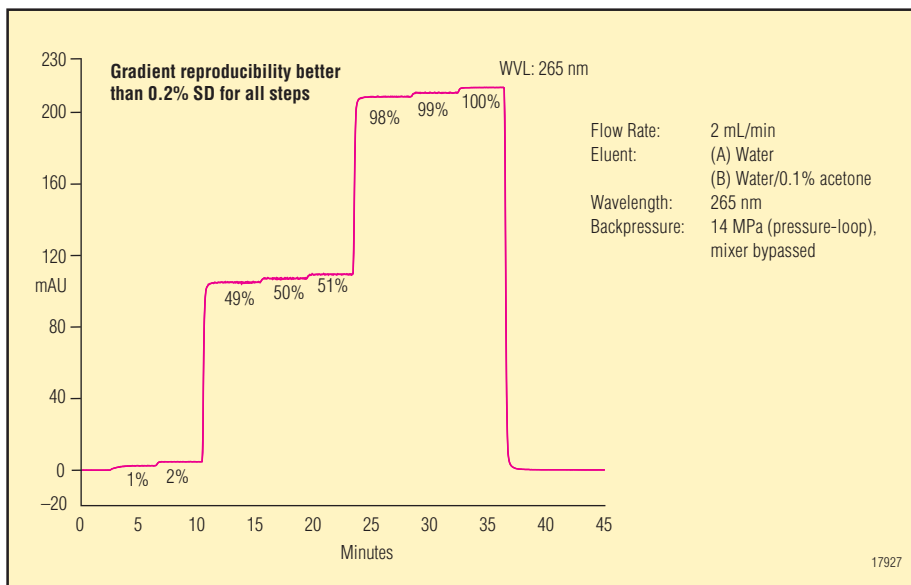


Figure 3. P680A LPG step-gradient profile; three replicates overlaid.

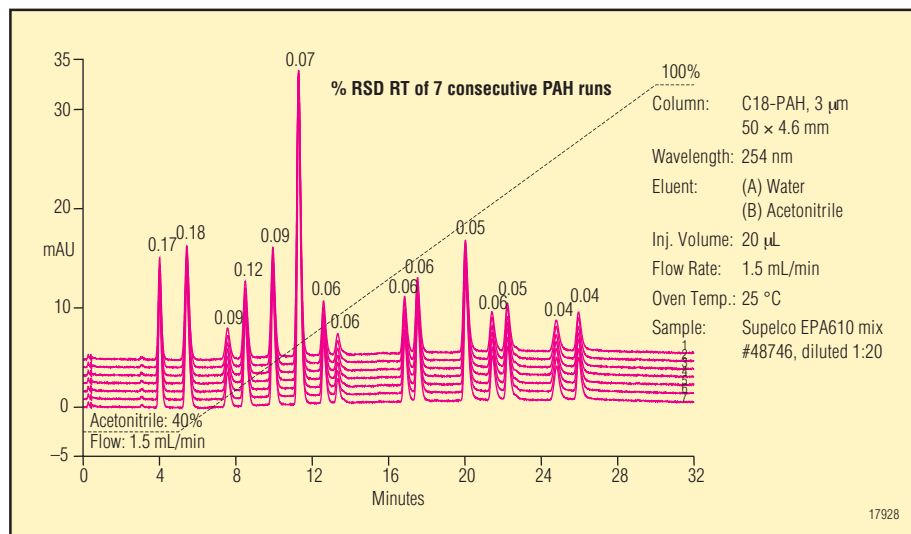


Figure 4. Relative standard deviation of retention times in an LPG application (PAH, polyaromatic hydrocarbons); seven replicates overlaid.

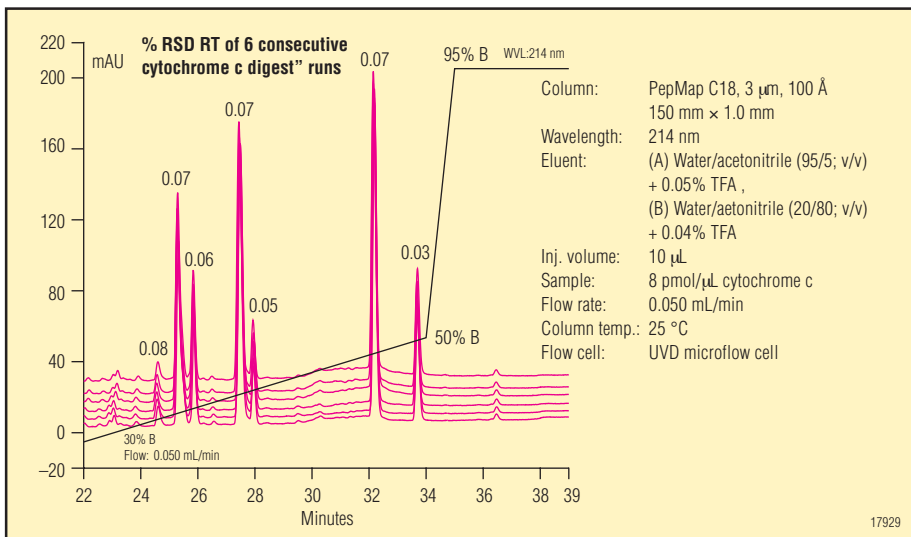


Figure 5. Reproducibility of an HPG run at 50  $\mu$ L/min.

## High-Pressure Gradients

Two independent tachometer-controlled dc motors allow ultraprecise flow settings, significantly enhancing gradient accuracy (gradients are formed by gradually changing the flow of pump blocks A and B). Figure 6 shows a step gradient of 1% steps. The reproducibility for all steps is better than 0.02% RSD; gradient step accuracy is better than 0.06% for all steps. The dynamic mixing chamber ensures homogenous mixing of solvents. Even at high solvent absorption, the detection limits of the system are not affected by incomplete mixing.

## Low-Pressure Pulsation

The P680's unique in-stroke optimization algorithms synchronize the movement of all pistons to compensate for variations in changing eluent compressibilities during a gradient run. This synchronization is made possible by three pressure transducers (one for each pump block and one for the system pressure).

## Variable Volume Mixing Chamber

The HPG pump is equipped with a variable volume mixing chamber. The standard configuration provides a gradient delay volume of less than 150  $\mu\text{L}$ . For low flow rates (e.g., <100  $\mu\text{L}/\text{min}$ ) a microflow kit reduces the gradient delay volume to less than 70  $\mu\text{L}$ . For poorly miscible eluents, higher flow rates, or special applications, an extended mixer kit ensures complete eluent mixing. For HPG formation, excellent mixing is crucial to ensure low baseline noise.

## Fast Gradient Applications

Fast gradient runs are particularly challenging for an HPLC pump. They require highest gradient accuracy and precision and a small gradient delay volume. Figure 7 shows a 2.7-min gradient run with the High-Pressure Gradient P680 Pump. All peaks show a relative standard deviation for retention time of less than 0.25% (seven runs).

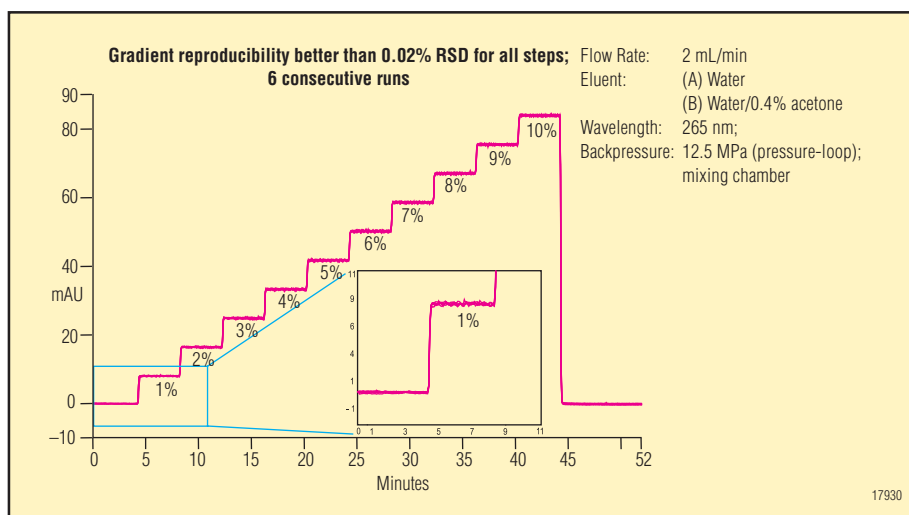


Figure 6. P680A HPG step-gradient profile.

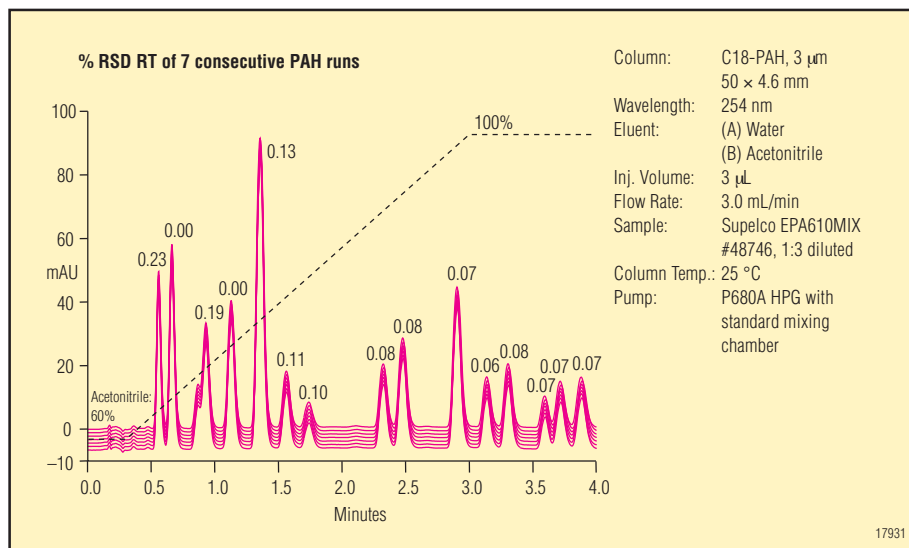


Figure 7. Reproducibility of a steep HPG run.

<b>SPECIFICATIONS</b>					
	<b>Isocratic Analytical P680 Pump</b>	<b>Low-Pressure Gradient P680 Pump</b>	<b>Dual Low-Pressure Gradient P680 Pump</b>	<b>High-Pressure Gradient P680 Pump</b>	<b>Semipreparative Isocratic and High-Pressure Gradient P680 Pumps</b>
Flow rate range	1–10,000 $\mu\text{L}/\text{min}$	1–10,000 $\mu\text{L}/\text{min}$	1–10,000 $\mu\text{L}/\text{min}$	1–10,000 $\mu\text{L}/\text{min}$ (gradient mode) 1–20,000 $\mu\text{L}/\text{min}$ (isocratic mode)	0.2–50 mL/min (isocratic and HPG version) 0.2–100 mL/min (HPG version in isocratic mode)
Flow rate accuracy and reproducibility	$\pm 0.1\%$ at 1 mL/min	$\pm 0.1\%$ at 1 mL/min	$\pm 0.1\%$ at 1 mL/min	$\pm 0.1\%$ at 1 mL/min	$\pm 1.0\%$ at 2 mL/min
Pressure range	0.1–50 MPa (7250 psi)	0.1–50 MPa (7250 psi)	0.1–50 MPa (7250 psi)	0.1–50 MPa (7250 psi)	1–10 MPa (1450 psi) (short-term: 15 MPa–2100 psi)
Pressure ripple	Typically <1%	Typically <1%	Typically <1%	Typically <1%	Typically <1.5%
Proportioning accuracy	N/A	$\pm 0.5\%$ at 2 mL/min	$\pm 0.5\%$ at 2 mL/min	$\pm 0.2\%$ at 2 mL/min	$\pm 0.2\%$ at 5 mL/min N/A for isocratic version
Proportioning reproducibility	N/A	$\pm 0.5\%$ at 2 mL/min	$\pm 0.5\%$ at 2 mL/min	$\pm 0.2\%$ at 2 mL/min	$\pm 0.2\%$ at 5 mL/min N/A for isocratic version
Number of solvents	One	Four	Six (three per pump block)	Two	Two One for isocratic version
Gradient delay volume (standard configuration)	N/A	<400 $\mu\text{L}$	<400 $\mu\text{L}$	<150 $\mu\text{L}$	<150 $\mu\text{L}$ N/A for isocratic version
Solvent degassing	External (optional)	Built-in 4-channel vacuum	External (optional)	External (optional)	External (optional)
PC connection	Through USB or Ethernet (RJ-45); USB hub with 3 sockets integrated				
I/O interfaces	Four programmable relays; analog output for system pressure; three digital inputs for Start, Stop, and Hold				
Additional communication ports	RS-232 port for connection of other Summit modules (e.g., ASI 100 or STH-585)				
Power requirements	100–120 V, 60 Hz; 200–240 V, 50 Hz				
Dimensions (h $\times$ w $\times$ d)	19 $\times$ 40 $\times$ 38 cm (7.5 $\times$ 15.8 $\times$ 15.0 in.)				
Weight	12.3 kg (27.1 lb)	15.8 kg (34.8 lb)	17.6 kg (38.8lb)	16.8 kg (37.0 lb)	16.8 kg (37.0 lb) 12.3 kg (27.1 lb) isocratic version

All technical specifications are subject to change without notice.

## ORDERING INFORMATION

In the U.S., call 1-800-346-6390 or contact the Dionex regional office nearest to you. Outside the U.S., order through your local Dionex office. Refer to the following part numbers:

Product Description	Part Number
P680A ISO Analytical Isocratic Pump .....	5030.0010
P680P ISO Semipreparative Isocratic Pump .....	5030.0020
P680A LPG-4 Low-Pressure Gradient Pump .....	5030.0015
P680A DGP-6 Dual Low-Pressure Gradient Pump .....	5030.0030
P680A HPG-2 High-Pressure Gradient Pump with two eluent lines .....	5030.0016
P680A HPG-4 High-Pressure Gradient Pump with built-in solvent selector valves .....	5030.0017
P680P HPG-2 Semipreparative High-Pressure Gradient Pump with two eluent lines .....	5030.0025

Accessories Description	Part Number
Solvent racks (P680A ISO, P680A HPG-2 and -4, and P680A DGP-6)	
SOR-100 Solvent Rack without degasser channels .....	5030.9200
SOR-100A-2 Solvent Rack with 2 analytical degasser channels .....	5030.9210
SOR-100A-4 Solvent Rack with 4 analytical degasser channels .....	5030.9220
SOR-100A-6 Solvent Rack with 6 analytical degasser channels .....	5030.9230
Manual injection valve kit, analytical: includes mounting bracket and 20- $\mu$ L loop for P680 pumps .....	5030.0600
Syringe, 100 $\mu$ L, for use with manual injection valve kit, analytical .....	709.7210
Manual injection valve kit, semipreparative: includes mounting bracket and 2-mL loop for P680 pumps .....	5030.0610
Syringe, 5 mL, for use with manual injection valve kit, preparative .....	709.7255
Solvent-Saver Valve-1-channel, requires Chromeleon software .....	5707.0000
Solvent-Saver Valve-2-channel, requires Chromeleon software .....	5707.0010
Microflow kit LPG, for low delay volume .....	6030.0010
Microflow kit HPG, for low delay volume .....	6030.0020
Extended mixer kit LPG/HPG, additional 600- $\mu$ L mixing volume .....	6030.0030
Extended mixer kit LPG/HPG, additional 1250- $\mu$ L mixing volume .....	6030.0040
USB extension with signal amplification, 5 m .....	8911.0004
Cutting tool for capillaries, 1/16 in. ....	2140.0001



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