Discover ion chromatography without manually prepared eluents

Thermo Scientific Dionex Reagent-Free Ion Chromatography Systems with Automated Eluent Generation

Keywords: Automated eluent generation, eluent generator cartridge, EGC, hydroxide, carbonate, bicarbonate, methanesulfonic acid, KMSA, dual eluent generation, RFIC, just add water

Benefits

- Simplifies operation
- Improves analytical reproducibility
- Ensures system-to-system reproducibility
- Achieves sensitive results
- Eliminates errors and variability associated with manual eluent and regenerant preparation
- Supports up to 5,000 psi pressure in RFIC-configurations to allow operation with 4 µm columns

Since the introduction of Thermo Scientific™ Dionex™ Reagent-Free™ Ion Chromatography (RFIC™) products in 1998, we have continued to simplify IC while increasing the capabilities and power of ion analysis. RFIC systems with eluent generation (RFIC-EG systems) produce consistent, precisely controlled, high-purity eluents and regenerants electrolytically. RFIC ensures increased reproducibility and eliminates any user-to-user variability introduced from manually prepared eluent preparations. The Thermo Scientific™ Dionex™ Integrion™ HPIC™ and Thermo Scientific™ Dionex™ ICS-6000 HPIC™ systems are RFIC-EG systems.

Benefits of eluent generation

RFIC-EG systems generate high-purity hydroxide, carbonate/hydrogencarbonate, or methanesulfonic acid (MSA) eluents electrolytically using Thermo Scientific™ Dionex™ EGC Eluent Generator Cartridges. Chemists no longer need to spend time manually preparing eluents as traditionally done using conventional IC systems. The eluent is generated at the concentration required for your IC application. Eluents are purified online using Thermo Scientific™ Dionex™ Continuously Regenerated Trap Columns (Dionex CR-TC 500 and 600 columns) and suppressed using electrolytically regenerated suppressors before detection, without the need to prepare regenerants. The only requirement is a source of high purity deionized water.

Simplify operation with RFIC-EG systems

RFIC-EG systems are very easy to operate. Simply install the eluent generator, attach a source of deionized water to your pump, and begin collecting data. The schematic diagram (Figure 1) illustrates the straightforward configuration of an RFIC-EG system. The compatibility chart shows what eluent generator cartridges are supported on each system.

Reproducibility of eluent generation

Electrolytic eluent generation produces amazingly consistent run-to-run eluent concentrations by eliminating errors associated with manual eluent preparation. Eluent concentration accuracy and precision translates into highly reproducible retention times and peak areas. Figure 2 shows an overlay of 100 chromatograms, illustrating the unmatched reproducibility provided by eluent generation.

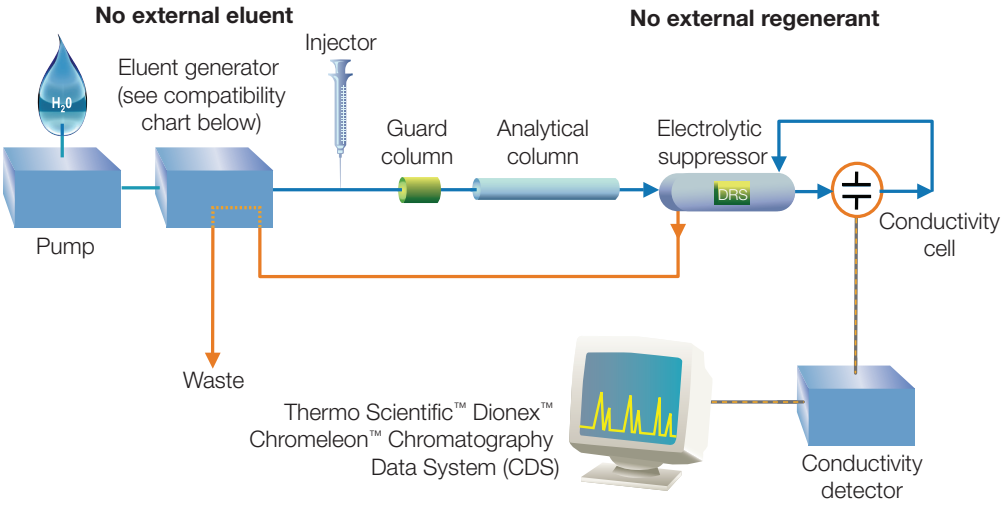

Figure 1. Reagent-free ion chromatography (RFIC) system.

RFIC eluent generator (EG) instrument compatibility chart.*

Instrument	Anions			Cations
	Gradient or Isocratic Hydroxide EG	**Isocratic Carbonate EG**	**Isocratic Carbonate/ Bicarbonate EG**	**Gradient or Isocratic MSA EG**
Thermo Scientific™ Dionex™ Integrion™ HPIC™ System	Dionex EGC III KOH Eluent Generator Cartridge, Dionex EGC 500 KOH Eluent Generator Cartridge, Dionex EGC III NaOH Eluent Generator Cartridge*, Dionex EGC III LiOH Eluent Generator Cartridge*	Dionex EGC 500 K_2CO_3 Eluent Generator Cartridge	Dionex EGC 500 K_2CO_3 Eluent Generator Cartridge + Dionex EPM 500 Electrolytic pH Modifier	Dionex EGC III MSA Eluent Generator Cartridge, Dionex EGC 500 MSA Eluent Generator Cartridge
Thermo Scientific™ Dionex™ ICS-6000 HPIC™ System	Dionex EGC III KOH Eluent Generator Cartridge, Dionex EGC 500 KOH Eluent Generator Cartridge, Dionex EGC III NaOH Eluent Generator Cartridge, Dionex EGC III LiOH Eluent Generator Cartridge, Dionex EGC 500 KOH Eluent Generator Cartridge, Dionex EGC 400 KOH Eluent Generator Cartridge	Dionex EGC 500 K_2CO_3 Eluent Generator Cartridge	Dionex EGC 500 K_2CO_3 Eluent Generator Cartridge + Dionex EPM 500 Electrolytic pH Modifier	Dionex EGC III MSA Eluent Generator Cartridge, Dionex EGC 500 MSA Eluent Generator Cartridge, Dionex EGC 500 MSA Eluent Generator Cartridge, Dionex EGC 400 MSA Eluent Generator Cartridge

*Contact your local Thermo Fisher Scientific products representative for software requirements.

Simplify method transfer

With RFIC-EG systems, the ability to transfer methods from one lab to another is simplified. Whether the lab is next door or in another country, RFIC eluent generators ensure that your analytical results are consistent and can be seamlessly transferred.

Achieve sensitive results

RFIC eluent generators make trace-level analysis routine. The ultrapure eluent produced by our eluent generator cartridges results in a stable baseline that makes peak integration more reliable. In addition to lower background, electrolytically generated gradients provide minimal baseline shifts compared to conventional gradients.

Accuracy of RFIC eluent generators

The eluent concentration generated by an RFIC-EG system is extremely accurate and reproducible. This patented eluent generation technology follows Faraday's Law. Therefore, the eluent concentration is directly proportional to the applied current from the eluent generator and inversely proportional to the eluent flow rate. Because both of these parameters can be precisely controlled, the resulting eluent concentrations are more precise than manually prepared eluents. This consistency is achieved from run-to-run, system-to-system, and lab-to-lab.

Eluent generation is fully supported by Thermo Scientific OQ/PQ validation tools to ensure that your laboratory meets even the most rigorous regulatory requirements.

Dual EGC mode

The Dual EGC mode of operation is available on the Dionex ICS-6000 HPIC system to support the analysis of complex carbohydrates using RFIC-EG-generated eluent. In this mode, a pair of eluent generator cartridges (MSA and KOH) are connected in series to generate KOH/potassium methanesulfonate (KMSA) eluents.

The Thermo Scientific™ Dionex™ EGC 400 Eluent Generator Cartridge is designed to enable operation at flow rates between 20 µL/min and 200 µL/min. This fills the flow rate gap between the Thermo Scientific™ Dionex™ EGC (Capillary) (1 µL/min–30 µL/min) and the Thermo Scientific™ Dionex™ EGC 500 (100 µL/min–3,000 µL/min) Eluent Generator Cartridges. The Dionex EGC 400 eluent generator cartridge is a complementary product to the Dionex EGC 500 and Dionex EGC (capillary) eluent generator cartridge.

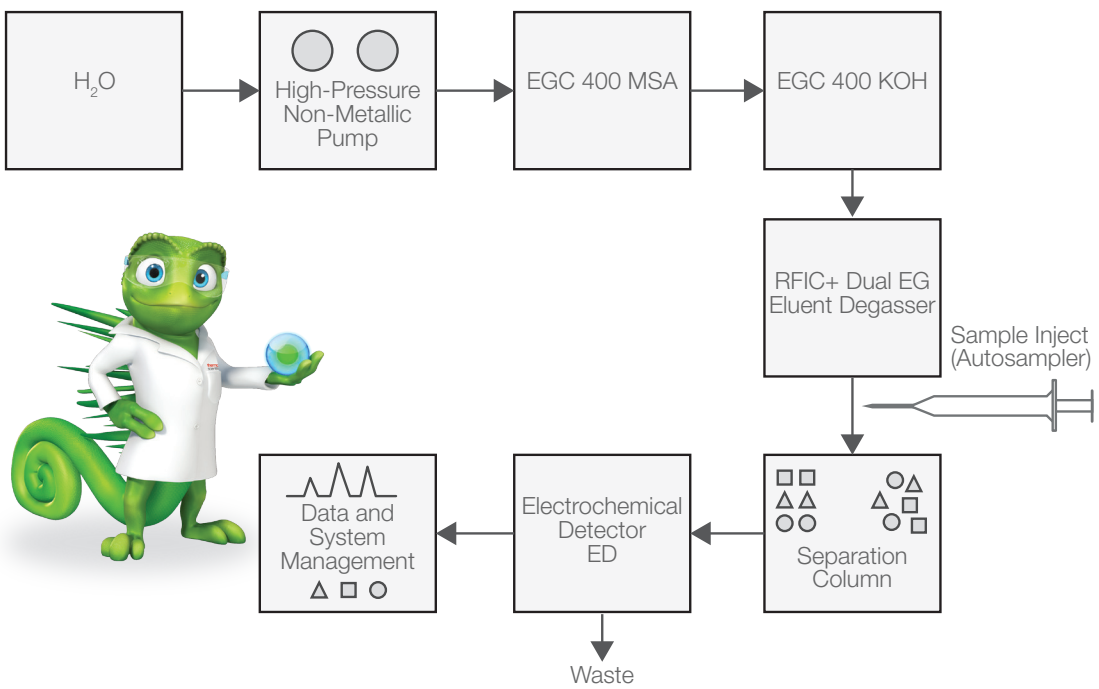

Figure 2. Dual EGC systems schematic diagram.

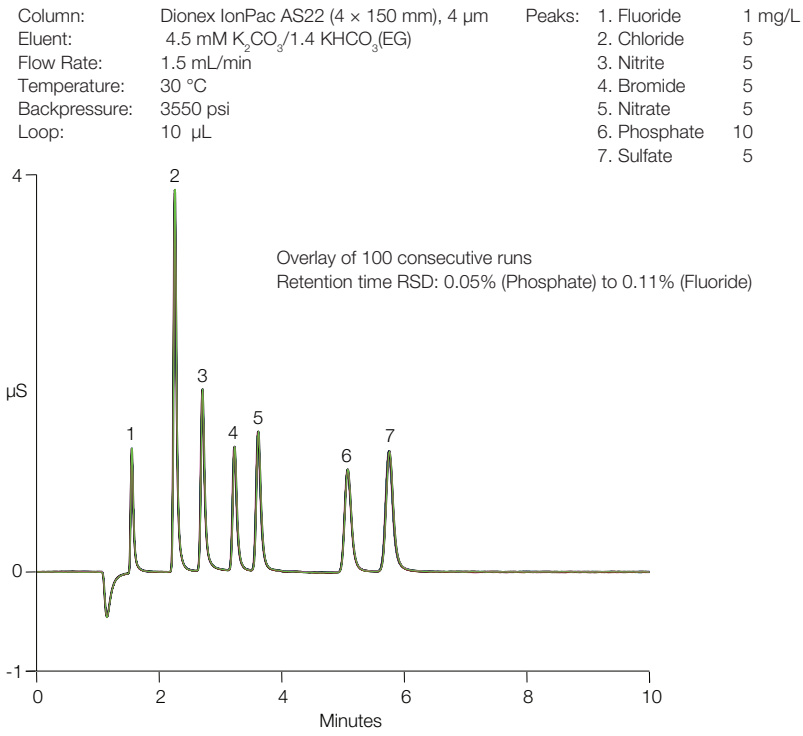

Figure 3. Separation of seven common anions on a 4 mm Dionex IonPac AS22 column (4 µm) using a Dionex EGC 500 K_2CO_3 cartridge and a Thermo Scientific™ Dionex™ Electrolytic pH Modifier (EPM) 500 device.

For 1 mm operation, a Thermo Scientific™ Dionex™ EGC 400 MSA Eluent Generator Cartridge is connected in series to a Thermo Scientific™ Dionex™ EGC 400 KOH Eluent Generator Cartridge to generate KMSA up to 200 mM at flow rates of 20–63 µL/min, and up to 63 mM at flow rates up to 200 µL/min.

Deionized water is pumped into the Dionex EGC 400 MSA cartridge to generate methanesulfonic acid. The methanesulfonic acid solution is then passed into the Dionex EGC 400 KOH cartridge to generate KMSA. By balancing the concentration of the two cartridges, pure KMSA can be generated. By generating an excess of KOH compared to MSA, a basic solution of KMSA plus KOH can be generated (Basic Eluent Mode). By generating an excess of MSA compared to KOH, an acidic solution of KMSA plus MSA can be generated (Acidic Eluent Mode). The system can be switched between these two modes as needed.

Compatible with high-pressure IC systems

The Dionex EGC 500 Eluent Generator Cartridge allows operation at pressures up to 5,000 psi (34.5 MPa) installed on a high-pressure IC (HPIC) system such as the Dionex ICS-6000 or Dionex Integrion HPIC systems. This enables compatibility with high flow rates and columns with 4 µm beads, for high chromatographic resolution and high throughput.

Other than the backpressure rating, the Dionex EGC 500 cartridge has identical operational parameters as the Thermo Scientific™ Dionex™ EGC III Cartridge, making it fully compatible with existing methods. The Thermo Scientific™ Dionex™ EGC 500 KOH and Thermo Scientific™ Dionex™ EGC 500 MSA Cartridges are only compatible with HPIC systems such as the Dionex ICS-6000 and Integrion HPIC systems. The Thermo Scientific™ Dionex™ EGC 500 K_2CO_3 Cartridge is compatible with HPIC systems and standard RFIC systems, but is limited to 3,000 psi when coupled with a non-HPIC RFIC system.

Labor savings

Labor savings alone justify the purchase of a RFIC set-up and Dionex EGC cartridge. Manual eluent preparation typically consists of a long list of tasks that can include weighing or pipetting chemicals, diluting, filtering, mixing stock solutions, transferring, dispensing, priming, degassing, filling bottles. This list does not take into consideration potential errors associated with eluent makeup or time required for system equilibration. Eluent generation simplifies IC by making the eluent for you. Just add water to the system and begin collecting data. In addition, with an RFIC-EG system, no additional chemicals or reagents are needed for the suppressor, which saves additional time. Table 1 illustrates the potential labor savings of RFIC eluent generators.

RFIC EGC lifetime

The life expectancy of an analytical Dionex EGC cartridge is a function of a number of user-selectable parameters. Based on eluent concentration and flow rate, the number of expected operating hours for the cartridge can be determined. The Dionex EGC 400 cartridge typically lasts for 18 months of cumulative operation at 55 mM and 63 µL/min. Table 2 shows some examples of Dionex EGC III KOH calculations, Dionex EGC 500 K_2CO_3, and Dionex EGC III MSA cartridge lifetimes based on different column applications. The Dionex EGC 500 cartridge has an identical operational lifetime as the Dionex EGC III cartridge, but with higher flow rates, HPIC systems typically can run more samples in the same time. This gives the Dionex EGC 500 cartridge a cost of ownership advantage over the Dionex EGC III cartridge.

Under most conditions, the Dionex EGC cartridge (capillary) will last 18 months regardless of use, allowing "Always-On" operation without concern for accelerated consumption of the Dionex EGC cartridge.

Table 1. Labor savings.

Cost of Manual Preparation*				Time to Start Up System for Life of Cartridge	Labor Savings with Eluent Generation		
Hourly Labor Rate	0.5 h	1.0 h	2.0 h	1 h	0.5 h	1.0 h	2.0 h
	(Hours spent per 5-day week preparing eluent. Calculations based on 50 weeks)						
$15	$375	$750	$1500	$15	$360	$735	$1485
$25	$625	$1250	$2500	$25	$600	$1225	$2475
$35	$875	$1750	$3500	$35	$840	$1715	$3465
$45	$1125	$2250	$4500	$45	$1080	$2205	$4455

*Quality Assurance Report conditions.

Table 2. Example calculations of cartridge lifetime.

Dionex IonPac Column*	Eluent	Conc. (mM)	Flow (mL/min)	*i* (current required)	Hours	Days (8 h/day)	Weeks (5 days/week)
AS23 (4 mm)	K_2CO_3, $KHCO_3$	4.5, 0.8	1.0	17	2547	318	64
AS23 (2 mm)	K_2CO_3, $KHCO_3$	4.5, 0.8	0.25	4.3	10190	1274	255
AS22 (4 mm)	K_2CO_3, $KHCO_3$	4.5, 1.4	1.2	23	1906	238	48
AS22 (2 mm)	K_2CO_3, $KHCO_3$	4.5, 1.4	0.3	5.7	7627	953	191
AS19 (0.4 mm)	KOH	20	0.01	0.322	13140	547[1]	78[1]
AS18 (4 mm)	KOH	39	1.0	62.7	1282	160	32
AS18 (2 mm)	KOH	39	0.25	15.7	5128	641	128
AS18-Fast (0.4 mm)	KOH	39	0.01	0.627	13140	547[1]	78[1]
AS15 (3 mm)	KOH	40	0.5	32.2	2500	313	63
AS14 (4 mm)	K_2CO_3, $KHCO_3$	3.5, 1.0	1.2	17	2500	313	63
AS9-HC (4 mm)	K_2CO_3	9.0	1.0	29	1500	188	38
CS12A (4 mm)	MSA	18	1.0	28.9	1389	174	35
CS12A (0.4 mm)	MSA	20	0.01	0.321	13140	547[1]	78[1]
CS16 (4 mm)	MSA	30	1.0	48.2	833	104	21
CS17 (2 mm)	MSA	6	0.25	2.4	16666	2083	420

*Quality Assurance Report conditions.
[1]Non-stop operation (examples show calculations of EGC 500, EGC III, and capillary cartridges).

Dionex EGC capillary cartridges provide months of eluent generation, and provide the ability to run KOH or MSA gradients, and isocratic carbonate/bicarbonate eluents without the need to manually prepare eluents.

RFIC-EG component specifications

Dionex EGC 400 Cartridge	
Cartridge dimensions (h x diam):	25.4 × 10.8 cm (10 × 4.25 in)
Cartridge weight:	1.4 Kg (3.0 lb)
Concentration range:	0.1–200 mM*
Flow rate:	20 µL/min to 200 µL/min
Max. operating pressure:	34.5 MPa (5000 psi)
Max. solvent concentration:	No solvents recommended
Dionex EGC 500 Cartridge	
Cartridge dimensions (h × diam.):	25.4 × 10.8 cm (10 × 4.25 in)
Cartridge weight:	1.4 kg (3.0 lb)
Concentration range:	0.1–100 mM
Flow rate:	0.10–3.00 mL/min*
Max. operating pressure:	34.5 MPa (5000 psi)
Max. solvent concentration:	Dionex EGC 500 KOH–25% methanol Dionex EGC 500 MSA–no solvents Dionex EGC 500 K_2CO_3–no solvents Dionex EPM 500–no solvents
Dionex EGC III Cartridge	
Cartridge dimensions (h × w × d):	23 × 7 × 10 cm (9 × 2.75 × 4 in)
Cartridge weight:	1.6 kg (3.5 lb)
Concentration range:	0.1–100 mM (0.1–80 mM Dionex EGC-LiOH)*
Flow rate:	0.10–3.00 mL/min
Max. operating pressure:	21 MPa (3000 psi)
Max. solvent concentration:	Dionex EGC III KOH–25% methanol Dionex EGC III MSA–no solvents

RFIC-EG component specifications (Cont.)

Dionex EGC Cartridge (Capillary)	
Cartridge dimensions (h × diam.):	15 cm × 6.4 cm (6 in × 2.5 in)
Cartridge weight:	0.375 kg (0.83 lb)
Concentration range:	0.1–200 mM
Flow rate:	1–30 µL/min (0.001–0.030 mL/min)
Max. operating pressure:	34.5 MPa (5,000 psi)
Max. solvent concentration:	Dionex EGC KOH (Capillary)–25% methanol Dionex EGC MSA (Capillary)–no solvents
RFIC Dionex CR-ATC 500 and Dionex CR-CTC 500 Columns	
Dimensions (h × w × l):	5.1 cm × 5.5 cm × 8.4 cm (2.0 in × 2.15 in × 3.3 in)
Weight:	60 g (0.13 lb)
Current output (Analytical):	< 125 mA
Void volume (Analytical):	< 100 µL
Constant voltage (Analytical):	24 V dc
Current output (Capillary):	1 mA
Void volume (Capillary):	<2 µL
Constant voltage (Capillary):	12 V dc
RFIC Suppressors	
Thermo Scientific™ Dionex™ ADRS 600 Anion Dynamically Regnerated Suppressor, Thermo Scientific™ Dionex™ CDRS 600 Cation Dynamically Regenerated Suppressor and Thermo Scientific™ Dionex™ AERS™ 500 Carbonate Anion Electrolytically Regenerated Suppressor for Carbonate Eluents.	
Dimensions:	12.1 × 4.5 × 4.8 cm (4.25 × 1.8 × 1.9 in)
Void volume:	4 mm: < 50 µL, 2 mm: < 15 µL
Weight:	295 g (0.65 lb)
Current range:	0–500 mA for 4 mm, 0–100 mA for 2 mm (Dionex ERS 500 suppressor) 0-125 mA for 4 mm, 0-30 mA for 2 mm (Dionex AERS 500 carbonate suppressor)

*Maximum concentration is dependent of flow rate.

Ordering information

In the U.S., call (800) 346-6390 or contact the Thermo Fisher Scientific Regional Office nearest you. Outside the U.S., order through your local Thermo Fisher Scientific office or distributor. Refer to the following part numbers.

Dionex EGC Cartridges	Part Number
Dionex EGC 400 KOH Eluent Generator Cartridge	302766
Dionex EGC 400 MSA Eluent Generator Cartridge	302767
Dionex EGC-KOH (Capillary) Eluent Generator Cartridge	072076
Dionex EGC-MSA (Capillary) Eluent Generator Cartridge	072077
Dionex EGC III KOH Eluent Generator Cartridge	074532
Dionex EGC III MSA Eluent Generator Cartridge	074535
Dionex EGC 500 K_2CO_3 Eluent Generator Cartridge	088453
Dionex EPM 500 Electrolytic pH Modifier (needed to generate K_2CO_3/$KHCO_3$ eluent)	088471
Dionex EGC 500 Carbonate Mixer Kit (2 mm)	088467
Dionex EGC 500 Carbonate Mixer Kit (4 mm)	088468
Dionex EGC III NaOH Eluent Generator Cartridge	074533
Dionex EGC III LiOH Eluent Generator Cartridge	074534
Splitter/Mixer (used to operate Dionex EGC III NaOH and Dionex EGC III LiOH Eluent Generator Cartridges in dual-mode for Dionex IonPac Cryptand A1 column chemistry)	063049
Dionex EGC-KOH (Capillary) Eluent Generator Cartridge	072076
Dionex EGC-MSA (Capillary) Eluent Generator Cartridge	072077
Dionex EGC 500 KOH Eluent Generator Cartridge	075778
Dionex EGC 500 MSA Eluent Generator Cartridge	075779

Electrolytic Suppressors	Part Number
Dionex ADRS 600 (2 mm) Anion Dynamically Regenerated Suppressor	088667
Dionex ADRS 600 (4 mm) Anion Dynamically Regenerated Suppressor	088666
Dionex CDRS 600 (2 mm) Cation Dynamically Regenerated Suppressor	088670
Dionex CDRS 600 (4 mm) Cation Dynamically Regenerated Suppressor	088668
Dionex AERS 500 Carbonate (4 mm) Anion Electrolytically Regenerated Suppressor for Carbonate Eluents	085029
Dionex AERS 500 Carbonate (2 mm) Anion Electrolytically Regenerated Suppressor for Carbonate Eluents	085028
Dionex AERS 500e (4 mm) Anion Electrolytically Regenerated Suppressor for External Water Mode	302661
Dionex AERS 500e (2 mm) Anion Electrolytically Regenerated Suppressor for External Water Mode	302662
Dionex CERS 500e (4 mm) Cation Electrolytically Regenerated Suppressor for External Water Mode	302663
Dionex CERS 500e (2 mm) Cation Electrolytically Regenerated Suppressor for External Water Mode	302664

Eluent Purifications	Part Number
Dionex CR-ATC 600 Continously Regenerated Anion Trap Column	088662
Dionex CR-CTC 600 Continously Regenerated Cation Trap Column	088663
Dionex CR-ATC 500 Continuously Regenerated Anion Trap Column	075550
Dionex CR-CTC 500 Continuously Regenerated Cation Trap Column	075551
Dionex CR-ATC (Capillary) Continuously Regenerated Anion Trap Column	072078
Dionex CR-CTC (Capillary) Continuously Regenerated Cation Trap Column	072079

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Ordering Information (cont.)

Sample and Eluent Purifications	Part Number
For Hydroxide Eluents:	
Dionex CR-ATC 600 Continously Regenerated Anion Trap Column	088662
Dionex CR-CTC 600 Continously Regenerated Cation Trap Column	088663
Dionex CRD 200 (4 mm) Carbonate Removal Device	062983
Dionex CRD 200 (2 mm) Carbonate Removal Device	062986
Dionex CRD 200 (Capillary) Carbonate Removal Device	072054
Dionex CRD 180 (Capillary) Carbonate Removal Device	079960
For Carbonate Eluents:	
Dionex CRD 300 (4 mm) Carbonate Removal Device	064637
Dionex CRD 300 (2 mm) Carbonate Removal Device	064638

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