Thermo Scientific Reagent-Free Ion Chromatography Systems with Eluent Generation for IC Without Manually Prepared Eluents

Since the introduction of Reagent-Free™ Ion Chromatography (RFIC™) products in 1995, 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. Not only is the eluent preparation labor decreased, but reproducibility is increased. The Thermo Scientific™ Dionex™ ICS-2100, Dionex ICS-4000, and Dionex ICS-5000+ systems are integrated RFIC-EG systems. The Thermo Scientific™ Dionex™ RFC-30 Reagent-Free Controller can be used to convert most other Dionex IC systems into RFIC-EG systems.

Benefits of Eluent Generation

RFIC-EG systems generate high-purity hydroxide, carbonate, or methanesulfonic acid (MSA) eluents electrolytically using Thermo Scientific™ Dionex™ Eluent Generation Cartridges (EGC). 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 on-line using Thermo Scientific™ Dionex™ Continuously Regenerated Trap Columns (Dionex CR-TC 500), and suppressed electrolytically before detection, without the need to prepare regenerants. The only requirement is a high-purity source of deionized water.

Key benefits:

- Simplifies operation; no need to prepare eluents or regenerants
- Improves analytical reproducibility, day-to-day, week-to-week, month-to-month
- Ensures system-to-system reproducibility and lab-to-lab consistency
- Achieves sensitive results with pure, uncontaminated eluent
- Eliminates errors and variability associated with manual eluent and regenerant preparation
- Achieves the power of hydroxide and MSA gradient separation with an isocratic pump
- Reduces operator exposure to hazardous chemicals
- Reduces pump maintenance because pump is exposed only to deionized (DI) water
- Supports capillary-scale flow rates to reduce eluent and EGC consumption.
- Supports up to 5,000 psi pressure (Dionex EGC 500 and EGC (Capillary) cartridges only) to allow operation with 4 µm columns.

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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 just how easy operation is with RFIC-EG systems. The compatibility chart to the right 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.

Make Your Methods Portable

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. RFIC eluent generators are so precise that you can expect less than 1% deviation from lab to lab under most analytical conditions.

Achieve Sensitive Results

RFIC eluent generators make trace-level analysis routine. The ultrapure eluent produced by our full line of eluent generator cartridges, results in a stable baseline that makes peak integration more accurate and 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. The eluent concentration is, therefore, 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 true 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.

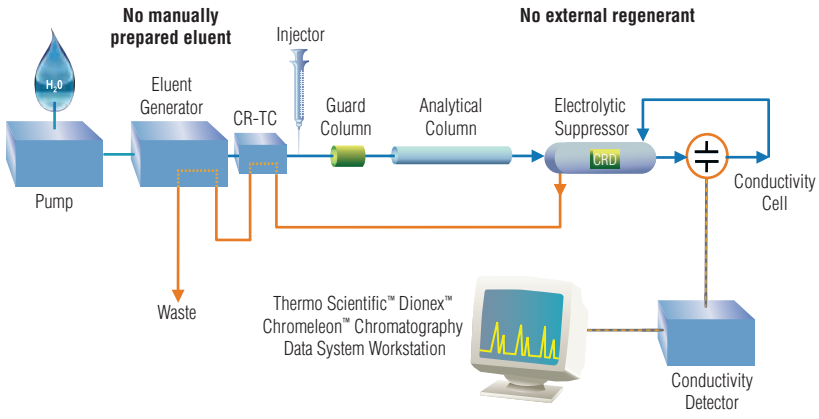

Figure 1. RFIC-EG systems schematic diagram.

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
Dionex ICS-2100	Dionex EGC III KOH, NaOH*, LiOH*	Dionex EGC III K_2CO_3	Dionex EGC III K_2CO_3 + EPM III	Dionex EGC III MSA Cartridge
Dionex ICS-5000+ (Analytical)	Dionex EGC III KOH, NaOH, LiOH, EGC 500 KOH	Dionex EGC III K_2CO_3	Dionex EGC III K_2CO_3 + EPM III	Dionex EGC III MSA Cartridge, EGC 500 MSA
Dionex ICS-4000 and ICS-5000+ (Capillary)	Dionex EGC KOH (Capillary)	not available	not available	Dionex EGC MSA (Capillary)
Dionex RFC-30	Dionex EGC III KOH	not available	not available	Dionex EGC III MSA

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

Column:	Thermo Scientific™ Dionex™ IonPac™ AS22, (4 × 250 mm)
Eluent:	4.5 mM K_2CO_3/1.4 mM $KHCO_3$
Eluent Source:	Dionex EGC II K_2CO_3 + Electrolytic pH Modifier (EPM)
Temperature:	30 °C
Flow Rate:	1.2 mL/min
Inj. Volume:	10 µL
Detection:	Suppressed conductivity, Thermo Scientific™ Dionex™ ASRS™ 300 Anion Self-Regenerating Suppressor™ 4 mm, Thermo Scientific™ Dionex™ AutoSuppression™ device, recycle mode

Analytes:	RT RSD	Area RSD
Fluoride	0.08	1.4
Chloride	0.76	0.2
Nitrite	0.05	0.4
Bromide	0.04	0.09
Nitrate	0.04	0.15
Phosphate	0.05	0.14
Sulfate	0.13	0.11

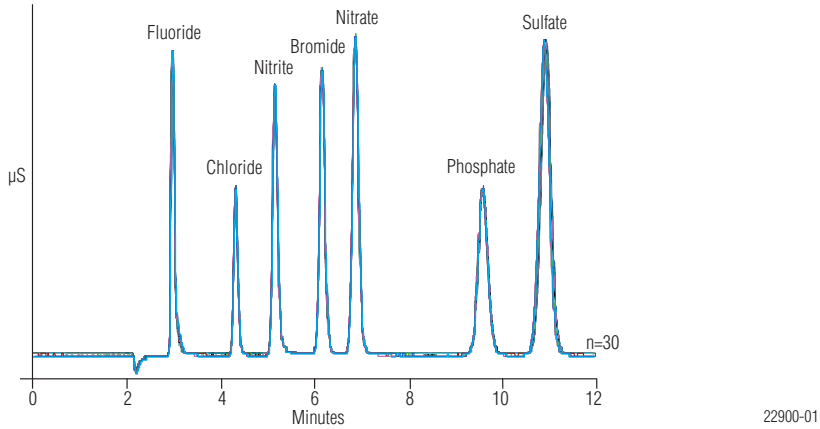

Figure 2. Systems using eluent generation produce extremely reproducible retention times and peak areas, as demonstrated with this overlay of 30 injections of an anion standard on a Dionex ICS-2000 RFIC-EG system using an electrolytically generated carbonate/bicarbonate eluent.

Compatible with High Pressure IC Systems

The new Dionex EGC 500 cartridge allows operation at pressures up to 5,000 psi (34.5 MPa) when installed on a High-Pressure IC (HPIC) system such as the Dionex ICS-5000+ system. This enables compatibility with high flow rates and columns utilizing 4µm beads, for high resolution and high throughput.

Other than the backpressure rating, the Dionex EGC 500 has identical operational parameters as the Dionex EGC III, making it fully compatible with existing methods.

Labor Savings

Labor savings alone justify the purchase of a 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, etc. 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. Simply 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 even more time. Table 1 illustrates the potential labor savings of RFIC eluent generators.

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)						
$15.00	$375.00	$750.00	$1500.00	$15.00	$360.00	$735.00	$1485.00
$25.00	$625.00	$1250.00	$2500.00	$25.00	$600.00	$1225.00	$2475.00
$35.00	$875.00	$1750.00	$3500.00	$35.00	$840.00	$1715.00	$3465.00
$45.00	$1125.00	$2250.00	$4500.00	$45.00	$1080.00	$2205.00	$4455.00

*Quality Assurance Report conditions

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. Table 2 shows some examples of calculations of Dionex EGC III KOH, Dionex EGC III K_2CO_3, and Dionex EGC III MSA cartridge lifetimes based on different column applications. The Dionex EGC 500 has identical operational lifetime than the Dionex EGC III. But with higher flow rates, HPIC systems typically can run more samples in the same period of time. This gives the Dionex EGC 500 cartridge a cost of ownership advantage over the Dionex EGC III.

Under most conditions, the Dionex EGC (Capillary) will last 18 months regardless of use, allowing *Always on* operation without concern for accelerated consumption of the Dionex EGC cartridge.

Table 2. Cartridge life.

Dionex IonPac Column*	Eluent	Flow (mL/min)	Conc. (mM)	I (current required)	Hours	Days (8 h/day)	Weeks (5 days/week)
AS23 (4 mm)	K_2CO_3:$KHCO_3$	1.0	4.5:0.8	17	2547	318	64
AS23 (2 mm)	K_2CO_3:$KHCO_3$	0.25	4.5:0.8	4.3	10190	1274	255
AS22 (4 mm)	K_2CO_3:$KHCO_3$	1.2	4.5:1.4	23	1906	238	48
AS22 (2 mm)	K_2CO_3:$KHCO_3$	0.3	4.5:1.4	5.7	7627	953	191
AS19 (0.4 mm)	KOH	10 µL/min	20	0.322	13,140	547[1]	78[1]
AS18 (4 mm)	KOH	1.0	39	62.7	1282	160	32
AS18 (2 mm)	KOH	0.25	39	15.7	5128	641	128
AS18-Fast (0.4 mm)	KOH	10 µL/ min	39	0.627	13,140	547[1]	78[1]
AS15 (3 mm)	KOH	0.5	40	32.2	2500	313	63
AS14 (4 mm)	K_2CO_3:$KHCO_3$	1.2	3.5:1.0	17	2500	313	63
AS9-HC (4 mm)	K_2CO_3	1.0	9.0	29	1500	188	38
CS12A (4 mm)	MSA	1.0	18	28.9	1389	174	35
CS12A (0.4 mm)	MSA	10 µL/min	20	0.321	13,140	547[1]	78[1]
CS16 (4 mm)	MSA	1.0	30	48.2	833	104	21
CS17 (2 mm)	MSA	0.25	6	2.4	16666	2083	420

*Quality Assurance Report conditions
[1]Non-stop operation

Dionex RFC-30: Upgrade IC Systems to RFIC-EG Systems

The Reagent-Free Controller (Dionex RFC-30) is an economical way to upgrade an existing Dionex DX-120, DX-320, DX-500, DX-600, or ICS-2500 IC system to an RFIC-EG system. The Dionex RFC-30 is a stand-alone eluent generation system that does not require software. This controller and Dionex EGC cartridge can deliver isocratic or simple gradient eluents. The Dionex RFC-30 includes an eluent generator, an electrolytic suppressor controller Thermo Scientific™ Dionex™ AES™ Atlas™ Electrolytic Suppressor and Thermo Scientific™ Dionex™ ERS 500 Electrolytically Regenerated Suppressor, and control for the Dionex CR-TC Continuously Regenerated Trap Columns (Dionex CR-TC 500).

Dionex EGC Capillary cartridges provide months or even years 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 500 Specifications	
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 III Specifications	
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 Dionex EGC III K_2CO_3–no solvents
Dionex EGC (Capillary) Specifications	
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
Dionex EGC 500 Specifications	
Cartridge Dimensions (h × w × d):	23 × 7 × 10 (9 × 2.75 × 4 in)
Cartridge Weight:	1.6 kg (3.5 lb)
Concentration Range:	0.1–100 mM
Flow Rate:	0.10–3.0 mL/min
Max. Operating Pressure:	34.5 MPa (5,000 psi)
Max. Solvent Concentration:	Dionex EGC 500 KOH–25% methanol Dionex EGC 500 MSA–no solvents
RFIC Dionex CR-ATC 500 and Dionex CR-CTC 500 Specifications	
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-EG COMPONENT SPECIFICATIONS (CONT.)

RFIC Suppressor Specifications

Thermo Scientific™ Dionex™ AERS 500 Anion Electrolytically Regnerated Suppressor and Thermo Scientific™ Dionex™ CERS 500 Cation Electrolytically Regenerated Suppressor	
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
Thermo Scientific™ Dionex™ AAES Atlas Anion Electrolytic Suppressor and Thermo Scientific™ Dionex™ CAES Cation Atlas™ Electrolytic Suppressor	
Dimensions:	4.9 × 4.4 × 10.2 cm (1.9 × 1.8 × 4.0 in)
Void Volume:	< 35 µL
Weight:	120 g (0.3 lb)
Thermo Scientific™ Dionex™ ACES™ Anion Capillary Electrolytic Suppressor 300 and Thermo Scientific™ Dionex™ CCES™ 300 Cation Capillary Electrolytic Suppressor	
Dimensions:	9.4 × 3.1 × 10.3 cm (3.7 × 1.2 × 4.1 in)
Void Volume:	< 1.5 µL
Weight:	150 g (0.33 lb)
Current Range:	0–25 mA

DIONEX RFC-30 REAGENT-FREE CONTROLLER SPECIFICATIONS

TTL Inputs:	Two independent 0–5 V, 0V = On, 5V = Off; ac control
Dimensions (h × w × d):	12.4 × 16.2 × 28.8 cm (4.9 × 6.4 × 11.3 in)
Weight:	2.5 kg (5.5 lb)
Power Requirements:	Consumption, 500 VA max.; voltage, 100–240 V ac; frequency, 50/60 Hz
Operating Temperature Range:	4–40 °C
Operating Humidity Range:	5–95% relative, noncondensing

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 III KOH Cartridge	074532
Dionex EGC III MSA Cartridge	074535
Dionex EGC III K_2CO_3 Cartridge	074536
Dionex EPM III Electrolytic pH Modifier (needed to generate K_2CO_3/$KHCO_3$ eluent)	080135
Carbonate mixer kit (2 mm)	074908
Carbonate mixer kit (4 mm)	074907
Dionex EGC III NaOH Cartridge	074533
Dionex EGC III LiOH Cartridge	074534
Splitter/Mixer (used to operate Dionex EGC III NaOH and Dionex EGC III LiOH cartridges in dual-mode for Dionex IonPac Cryptand A1 column chemistry)	063049
Dionex EGC-KOH (Capillary) Cartridge	072076
Dionex EGC-MSA (Capillary) Cartridge	072077
Dionex EGC 500 KOH Cartridge	075778
Dionex EGC 500 MSA Cartridge	075779
Electrolytic Suppressors	**Part Number**
Dionex AERS 500 (4 mm) Anion Electrolytically Regenerated Suppressor	082540
Dionex AERS 500 (2 mm) Anion Electrolytically Regenerated Suppressor	082541
Dionex CERS 500 (4 mm) Cation Electrolytically Regenerated Suppressor	082542
Dionex CERS 500 (2 mm) Cation Electrolytically Regenerated Suppressor	082543
Dionex AAES Anion Atlas Electrolytic Suppressor	056116
Dionex CAES Cation Atlas Electrolytic Suppressor	056118
Dionex ACES 300 Anion Capillary Electrolytic Suppressor	072052
Dionex CCES 300 Cation Capillary Electrolytic Suppressor	072053
Eluent Purification	**Part Number**
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
Sample Purifications	**Part Number**
For Hydroxide Eluents:	
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
Reagent-Free Controller	**Part Number**
Dionex RFC-30 Reagent-Free Controller (Dionex EGC III KOH, Dionex CR-ATC 500)	060667
Dionex RFC-30 Reagent-Free Controller (Dionex EGC III MSA, Dionex CR-CTC 500)	060668
Dionex RFC-30 (Dionex MSA, Dionex CR-CTC 500, CTS-10) for Dionex DX-120 Only	061414
Dionex RFC-30 (Dionex KOH, Dionex CR-ATC 500, CTS-10) for Dionex DX-120 Only	061413

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