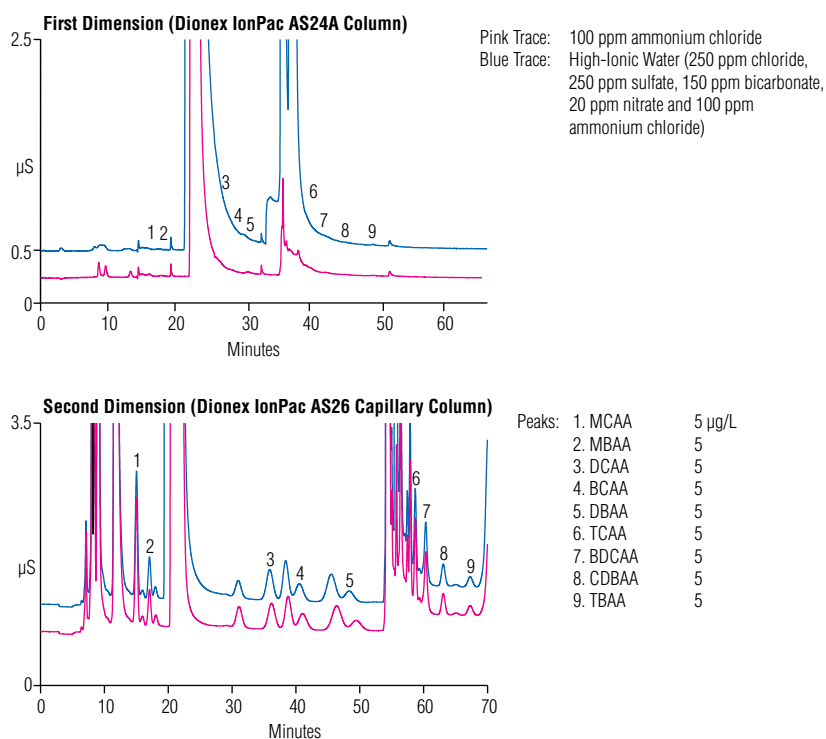


Thermo Scientific Dionex IonPac AS24A Anion-Exchange Column

Thermo Scientific™ Dionex™ IonPac™ AS24A anion-exchange column is designed for the separation of haloacetic acid (HAA) anions in drinking water. When used with the 2D-IC method and suppressed conductivity detection, low $\mu\text{g/L}$ (ppb) detection levels can be obtained.

Analysis of HAAs in Reagent and High-Ionic-Strength Water Using Two Dimensional Ion Chromatography (2D-IC)



The Dionex IonPac AS24A column is a high-capacity, hydroxide selective anion-exchange column recommended for the separation of haloacetic acid anions in drinking water samples. Minimal baseline shifts and enhanced analyte sensitivity are obtained using the Thermo Scientific™ Dionex™ AERS™ 500 Anion Electrolytically Regenerated Suppressor. Reagent-Free™ IC (RFIC™) systems provide simple, reproducible operation with eluent generation, requiring only a deionized water source to produce consistent, accurate potassium hydroxide (KOH) eluent.

The 2D-IC method for the analysis of HAAs uses the Dionex IonPac AS24A standard bore column in the first dimension, while the Dionex IonPac AS26 Capillary column is used in the second dimension. The 2D-IC method allows for the analysis of high-ionic-strength samples without sample pretreatment. The Dionex IonPac AS24A column is available in standard bore (4 mm i.d.), microbore (2 mm i.d.) and capillary (0.4 i.d.) formats allowing flow rates from 2.0 to 0.010 mL/min.

Highlights

- Separation of haloacetic acid anions in drinking water samples
- Low $\mu\text{g/L}$ (ppb) levels of HAAs can be determined using the 2D-IC method
- Determine HAAs in high-ionic-strength samples without sample pretreatment

High-Efficiency Particle Structure

The Dionex IonPac AS24A column has been developed using a unique polymer synthesis technology. The stationary phase consists of a novel, hyper-branched anion-exchange condensation polymer, electrostatically attached to the surface of a sulfonated wide-pore polymeric substrate (Figure 1). The resin capacity is controlled through the number of alternating coating cycles and Aggregate Monolith Technology, which uses resin agglomerates produced by combining two oppositely charged resins, then packing these resin agglomerates into a column before adding the final two layers of the monomer and amine. This achieves higher-capacity while still maintaining high chromatographic efficiency and reasonable column pressure. The Dionex IonPac AS24A 4 mm column uses a high-capacity resin (520 μeq per column) with optimized selectivity for the haloacetic acids and other anions in drinking water.

Determination of Haloacetic Acids in Drinking Water Using Conductivity Detection

Haloacetic acids containing chlorine and bromine are formed during the chlorination disinfection of drinking water. The presence of haloacetic acids in drinking water has been linked to several adverse effects including bladder, kidney, and colorectal cancer.

The Dionex IonPac AS24A column can separate the following HAAs:

- Monochloroacetic acid (MCAA)
- Dichloroacetic acid (DCAA)
- Trichloroacetic acid (TCAA)
- Monobromoacetic acid (MBAA)
- Dibromoacetic acid (DBAA)
- Tribromoacetic acid (TBAA)
- Bromochloroacetic acid (BCAA)
- Dibromochloroacetic acid (DBCAA)
- Dichlorobromoacetic acid (DCBAA)

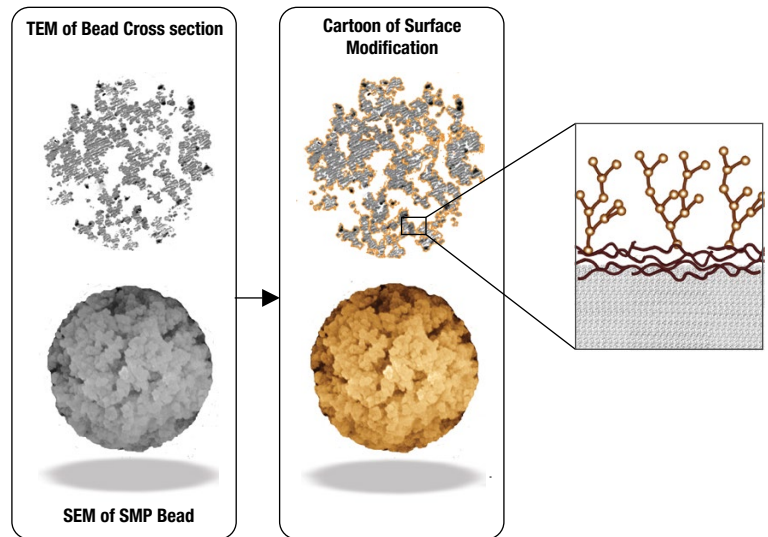


Figure 1. Structure of a Dionex IonPac AS24A column packing particle.

First Dimension Conditions

Column: Dionex IonPac AS24A/AG24A 4 mm
 Eluent: KOH: 7 mM from 0 to 12 min,
 7 to 18 mM from 12 to 42 min,
 step to 65 mM at 42 min
 Eluent Source: Thermo Scientific Dionex
 EGC III KOH Cartridge
 Flow Rate: 1.0 mL/min
 Inj. Volume: 500 μL
 Temperature: 15 $^{\circ}\text{C}$
 Detection: Suppressed conductivity,
 Dionex ASRS 300 Suppressor,
 Thermo Scientific™ Dionex™
 AutoSuppression™ device,
 external water mode

Second Dimension Conditions

Column: Dionex IonPac AS26/AG26 Capillary
 Eluent: KOH: 6 mM from 0 to 50 min,
 step to 160 mM at 50 min,
 160 mM from 50 to 57 min,
 step to 130 mM at 57 min
 Eluent Source: Dionex EGC-KOH (Capillary) Cartridge
 Flow Rate: 12 $\mu\text{L}/\text{min}$
 Concentrator: Thermo Scientific™ Dionex™ IonSwift™
 MAC-200
 Temperature: 15 $^{\circ}\text{C}$
 Detection: Suppressed conductivity,
 Dionex ACES 300 Suppressor, Dionex
 AutoSuppression device, external water mode

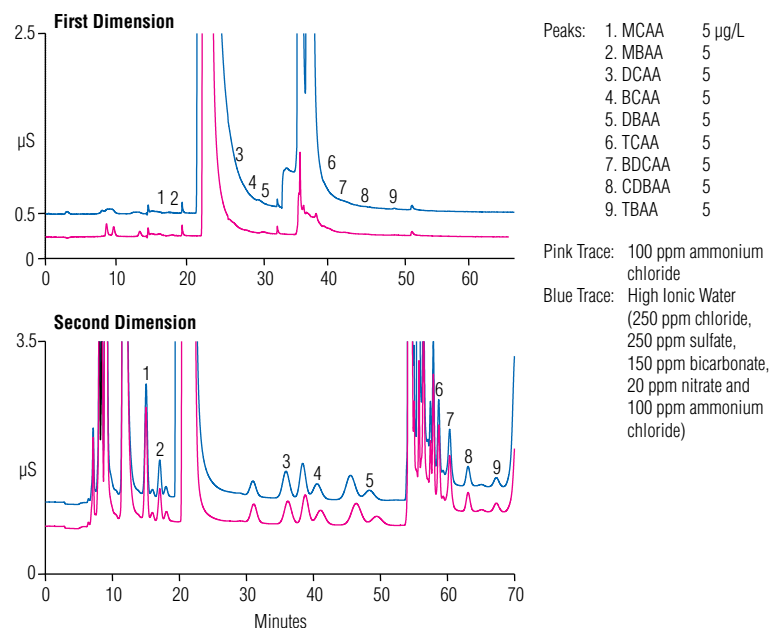


Figure 2. Determination of haloacetic acids using the Dionex IonPac AS24A and Dionex IonPac AS26 columns and 2D-IC.

Five HAAs including MCAA, DCAA, TCAA, Five HAAs including MCAA, DCAA, TCAA, MBAA, and DBAA are cited in the US EPA haloacetic acid regulation. This regulation requires that the total of these five HAAs does not exceed a maximum concentration limit (MCL) of 60 µg/L.¹ All drinking water plants in the United States must have a method to determine HAA levels in drinking water.

The Dionex IonPac AS24A 4 mm column is designed for analysis of HAAs by 2D-IC in high-ionic-strength matrices. In the first dimension, the Dionex IonPac AS24A column provides the initial separation between the HAA anions and the major matrix ions, such as chloride, sulfate and carbonate. The matrix ions are diverted to waste while the HAA anions are concentrated on the Dionex IonSwift MAC-200 Monolith Anion Concentrator column. In the second dimension, the Dionex IonPac AS26 Capillary column provides the final separation of the HAAs prior to suppressed conductivity detection. Figure 2 shows determination of HAAs in a drinking water sample using a potassium hydroxide gradient delivered by the Eluent Generator (EG). Low µg/L (ppb) levels of haloacetic acids can easily be determined using 2D-IC.

MBAA, CDBAA, and TBAA degrade readily at a high pH. The reaction is temperature dependent. To minimize sample degradation, the separation is performed at sub-ambient temperature, specifically at 15 °C. For optimal performance set both the DC lower compartment temperature and the Dionex IC Cube temperature to 15 °C. The DC upper compartment temperature must be reduced in order for the Thermo Scientific™ Dionex™ IC Cube™ to maintain 15 °C. A cooled autosampler capable of maintaining samples at a temperature less than or equal to 10 °C is also recommended. For further detail on the instrument setup for 2D-IC analysis of HAAs, see the Product Manual for Thermo Scientific Dionex IonPac AS24A Column, Document No. 065464.

Determination of Haloacetic Acids Using Suppressed Conductivity Detection

The Dionex IonPac AS24A (4 × 250 mm) column is optimized for separation of haloacetic acids in drinking water matrices with suppressed conductivity detection. Figure 3 shows the determination of haloacetic acids using the Dionex IonPac AS24A 4 mm column.

Column:	Dionex IonPac AG24A/AS24A, 4 mm	Peaks:	1. MCAA	100 µg/L (ppb)
Eluent:	KOH Gradient		2. MBAA	100
	7 mM KOH from 0 to 12 min		3. DCAA	100
	7 mM to 18 mM KOH from 12 to 32 min		4. BCAA	100
	65 mM KOH from 32 to 60 min		5. DBAA	100
Eluent Source:	Dionex EGC III KOH Cartridge		6. TCAA	100
Flow Rate:	1.0 mL/min		7. BDCAA	100
Injection Volume:	1000 µL		8. CDBAA	100
Temperature:	15 °C		9. TBAA	100
Detection:	Suppressed conductivity, Dionex ASRS 300 Suppressor, 4 mm, Dionex AutoSuppression device, recycle mode			

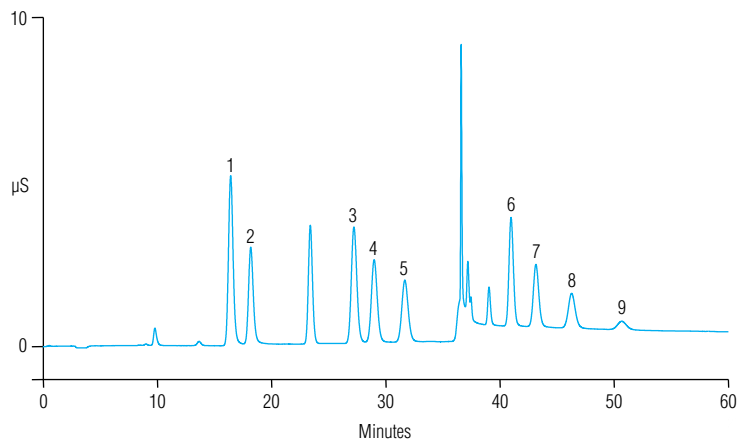


Figure 3. Determination of HAAs using the Dionex IonPac AS24A 4 mm column and suppressed conductivity detection.

Column:	Dionex IonPac AG24A/AS24A, 4 mm	Peaks:	1. Fluoride	5 mg/L (ppm)
Eluent:	KOH Gradient		2. Acetate	15
	5 mM to 15 mM KOH from 0 to 10 min		3. Formate	15
	15 mM to 30 mM KOH from 10 to 20 min		4. Chlorite	15
	30 mM to 60 mM KOH from 20 to 38 min		5. Bromate	15
Eluent Source:	Dionex EGC III KOH Cartridge		6. Chloride	15
Flow Rate:	1.2 mL/min		7. Trifluoroacetate	15
Injection Volume:	10 µL		8. Nitrite	15
Temperature:	15 °C		9. Sulfate	15
Detection:	Suppressed conductivity, Dionex ASRS 300 Suppressor, 4 mm, Dionex AutoSuppression device, recycle mode		10. Chlorate	25
			11. Bromide	25
			12. Oxalate	25
			13. Nitrate	25
			14. Phosphate	40
			15. Arsenate	40
			16. Thiosulfate	40
			17. Chromate	40
			18. Citrate	40

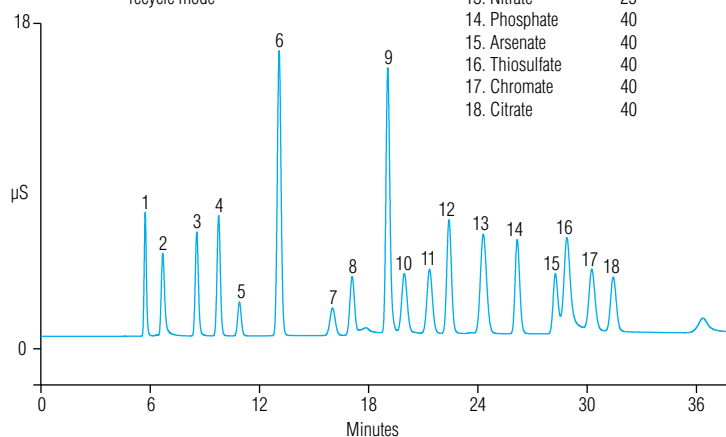


Figure 4. Separation of various anions including inorganic anions, organic acids, oxyanions, and oxyhalides using a Dionex IonPac AS24A 4 mm column and potassium hydroxide eluent delivered by an EG cartridge.

Extended Application Capabilities

The unique selectivity and high-capacity of the Dionex IonPac AS24A column makes it ideal for the development of specialized applications, providing excellent separation of environmental anions including inorganic anions, oxyhalides, oxyanions, and organic acids using potassium hydroxide eluent. Using gradient elution, these analytes are easily separated in < 37 min as shown in Figure 4. The separation of inorganic anions and oxyhalides using the Dionex IonPac AS24A Capillary column is shown in Figure 5.

System Requirements

The Dionex IonPac AS24A column is designed for use with the Thermo Scientific Dionex ICS-5000+ RFIC system equipped with an eluent generator. The Dionex IonPac AS24A column can also be used with older Dionex IC systems equipped with an EG or Thermo Scientific Dionex RFC-30 Reagent-Free Controller. The EG is used to automatically produce potassium hydroxide gradients from deionized water. The haloacetic acids MBAA, CDBAA and TBAA degrade under basic conditions at higher temperatures. The use of a column oven capable of maintaining 15 °C and an autosampler capable of maintaining 10 °C is required for optimal performance.

Suppressor Recommendations

For optimum ease-of-use and economy, the Dionex IonPac AS24A column should be used with the Thermo Scientific™ Dionex™ AERS™ 500 Anion Electrolytically Regenerated Suppressor or the Thermo Scientific™ Dionex™ ACES™ 300 Anion Capillary Electrolytic Suppressor.

Anion Trap Columns

When using the EG for eluent delivery, a Thermo Scientific Dionex CR-ATC Continuously Regenerated Anion Trap Column should be installed between the EG cartridge and the EG degas module. As an alternative for 4 mm and 2 mm systems, a Dionex IonPac ATC-HC Anion Trap Column with Hydroxide Eluent Column can be installed between the pump outlet and inlet of the EG cartridge in the eluent generator module. Alternately, when performing sodium hydroxide gradient anion-exchange applications with the Dionex IonPac AS24A column using hand-prepared eluents, the Thermo Scientific Dionex IonPac ATC-3 Anion Trap column should be installed between the gradient pump and the injection valve to remove anionic contaminants from the eluent.

Column:	Dionex IonPac AG24A, AS24A (0.4 × 250 mm)	Peaks:	mg/L (ppm)
Eluent:	KOH Gradient 10 mM KOH from 0 to 10 min 10 mM to 45 mM KOH from 10 to 25 min 45 mM KOH from 25 to 30 min	1. Fluoride	0.8
Eluent Source:	Dionex EGC-KOH (Capillary) Cartridge with Dionex CR-ATC Continuously Regenerated Anion Trap Column	2. Formate	—
Flow Rate:	12 µL/min	3. Chlorite	2.5
Inj. volume:	0.4 µL	4. Bromate	5.0
Temperature:	15 °C	5. Chloride	1.5
Detection:	Suppressed conductivity, Dionex ACES 300 Suppressor, Dionex AutoSuppression device, recycle mode	6. Nitrite	3.8
		7. Sulfate	7.5
		8. Chlorate	6.3
		9. Bromide	6.3
		10. Phosphate	10.0
		11. Nitrate	6.3

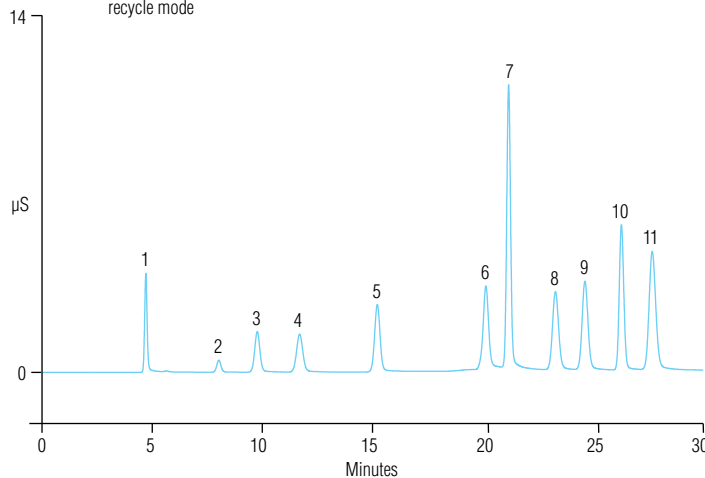


Figure 5. Separation of inorganic anions and oxyhalides using the Dionex IonPac AS24A Capillary column.

Concentrator Columns

For concentrator work with a 4 mm Dionex IonPac AS24A column, use the Dionex IonPac AG24A guard column, the Dionex IonPac UTAC-LP1, UTAC-ULP1, UTAC-XLP1, UTAC-LP2, UTAC-ULP2, or UTAC-XLP2 Ultra Trace Anion Concentrator columns; the Dionex IonPac TAC-ULP1 Trace Anion Concentrator column; or the Dionex IonPac TAC-2 Trace Anion Concentrator column, when a single piston pump such as the Thermo Scientific Dionex AXP Auxiliary Pump (pulse damper required) is used for sample delivery. Use the Dionex IonPac UTAC-LP1, UTAC-LP2 or TAC-LP1 Trace Anion Concentrator column when the sample is delivered with a syringe or with a low

pressure autosampler, such as the Thermo Scientific Dionex AS-DV Autosampler. For concentrator work with a 0.4 mm capillary column, use the Dionex IonPac AG24A Capillary Guard column or the Dionex IonSwift MAC-100 Concentrator column. For 2D-IC methods with a capillary column in the second dimension, use the Dionex IonSwift MAC-200 Concentrator column. For 2D-IC methods with the 2-mm column in the second dimension, use one of the Dionex IonPac Ultra Trace Anion Concentrator columns listed above.

References

1. Stage 1 Disinfectants and Disinfection Byproducts Rule: A Quick Reference Guide, p. 2, US EPA, 816-F-01-010

SPECIFICATIONS

Dimensions	Dionex IonPac AS24A Analytical Column: 4 × 250 mm Dionex IonPac AG24A Guard Column: 4 × 50 mm Dionex IonPac AS24A Analytical Column: 2 × 250 mm Dionex IonPac AG24A Guard Column: 2 × 50 mm Dionex IonPac AS24A Capillary Column: 0.4 × 250 mm Dionex IonPac AG24A Capillary Guard Column: 0.4 × 50 mm
Maximum Operating Pressure	3000 psi
Mobile Phase Compatibility	pH 0–14; 0–100% HPLC solvents
Substrate Characteristics	Analytical Column: Supermacroporous resin Bead diameter: 7.0 μm Pore size: 2000 Å Crosslinking: (%DVB): 55% Guard Column: Microporous resin Bead diameter: 11 μm Pore size: <10 Å Crosslinking (%DVB): 55%
Ion-Exchange Group	Functional group: alkanol quaternary ammonium ion
Functional Group Characteristics	Hydrophobicity: Ultralow
Capacity	520 μeq/column (4 × 250 mm) 6 μeq/column (4 × 50 mm) 140 μeq/column (2 × 250 mm) 1.5 μeq/column (2 × 50 mm) 5.6 μeq/column (0.4 × 250 mm) 0.06 μeq/column (0.4 × 50 mm)
Column Construction	PEEK with 10-32 threaded ferrule-style end fittings. All components are nonmetallic.

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.

Analytical, Capillary and Guard Columns	Part Number
Dionex IonPac AS24A Analytical Column (4 × 250 mm)	076010
Dionex IonPac AG24A Guard Column (4 × 50 mm)	076011
Dionex IonPac AS24A Analytical Column (2 × 250 mm)	078112
Dionex IonPac Guard Column (2 × 50 mm)	082535
Dionex IonPac Capillary Column (0.4 × 250 mm)	082536
Dionex IonPac Capillary Guard Column (0.4 × 50 mm)	078115
Anion Trap Columns	Part Number
Dionex CR-ATC Continuously Regenerated Anion Trap Column (For use with systems equipped with an eluent generator or RFC-30 Reagent-Free Controller)	060477
Dionex CR-ATC Continuously Regenerated Anion Trap Column (for use with capillary anion columns)	072078
Dionex ATC-3 Anion Trap Column (9 × 24 mm) for use with 4 mm columns	059660
Dionex ATC-3 Anion Trap Column (4 × 35 mm) for use with the 2 mm columns	079932
Dionex ATC-HC Anion Cation Trap Column (9 × 75 mm) for use with the EG	059604
Trace Anion Concentrator Columns	Part Number
Dionex IonSwift MAC-200 Monolith Anion Concentrator (0.75 × 80 mm)	075461
Dionex IonSwift MAC-100 Monolith Anion Column (0.5 × 80 mm)	074702
Dionex IonPac TAC-LP1 Trace Anion Concentrator (4 × 35 mm)	046026
Dionex IonPac TAC-2 Trace Anion Concentrator Column (3 × 35 mm)	043101
Dionex IonPac TAC-ULP1 Trace Anion Concentrator (5 × 23 mm)	061400
Dionex IonPac UTAC-LP1 Ultra Trace Anion Concentrator Column Low Pressure (4 × 35 mm)	063079
Dionex IonPac UTAC-ULP1 Ultra Trace Anion Concentrator Column Ultra Low Pressure (5 × 23 mm)	063475
Dionex IonPac UTAC-XLP1 Ultra Trace Anion Concentrator Column Extremely Low Pressure (6 × 16 mm)	063459
Dionex IonPac UTAC-LP2 Ultra Trace Anion Concentrator Column Low Pressure (4 × 35 mm)	079917
Dionex IonPac UTAC-ULP2 Ultra Trace Anion Concentrator Column Ultra Low Pressure (5 × 23 mm)	079918
Dionex IonPac UTAC-XLP2 Ultra Trace Anion Concentrator Column Extremely Low Pressure (6 × 16 mm)	072781
Haloacetic Acid Internal Standards	Part Number
Thermo Scientific Dionex Monochloroacetic Acid MCAA-2-13C, 1000 mg/L	069406
Thermo Scientific Dionex Monobromoacetic Acid MBAA-1-13C, 1000 mg/L	069407
Thermo Scientific Dionex Dichloroacetic Acid DCAA-2-13C, 1000 mg/L	069408
Thermo Scientific Dionex Trichloroacetic Acid TCAA-2-13C, 1000 mg/L	069409

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Brazil +55 11 3731 5140	India +91 22 6742 9494	Singapore +65 6289 1190	
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Denmark +45 70 23 62 60	Japan +81 6 6885 1213	Switzerland +41 61 716 77 00	