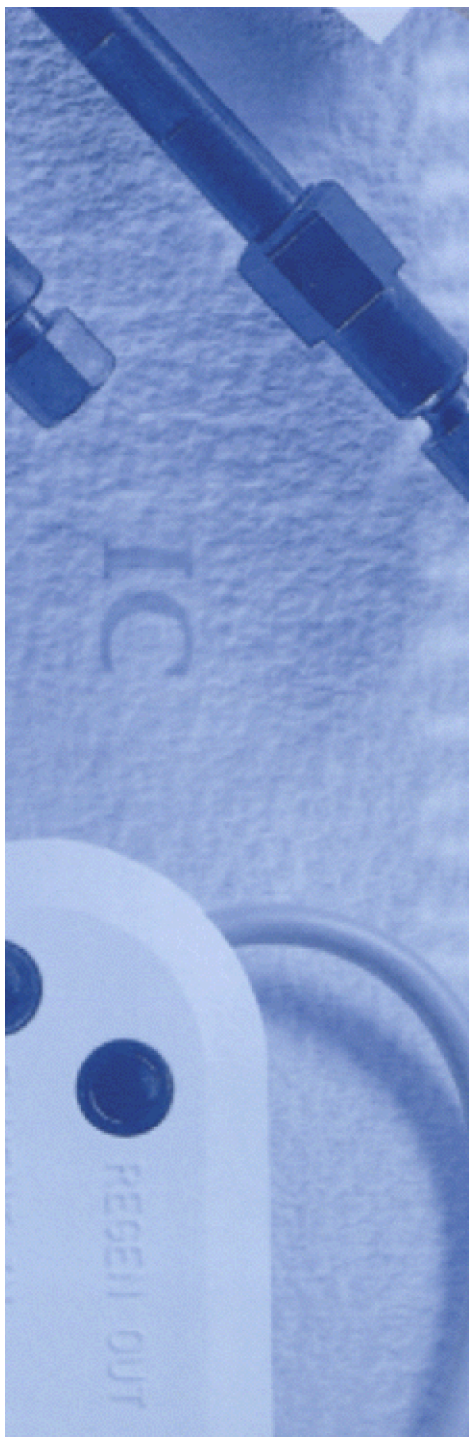


Errata

Product Manual for EG40, EGC-KOH and EGC-MSA
031373-06

For new orders of the following parts discussed in this manual, please use the updated part numbers listed below.

Part	Old Part Number in this manual	Updated Part Number to use for new orders
<i>ASSY,DG,EG40</i>	<i>053721</i>	<i>AAA-053721</i>
<i>ASSY,COIL,2ML/MIN 500PSI,EG40</i>	<i>053762</i>	<i>AAA-053762</i>
<i>ASSY,COIL,2ML/MIN,1000PSI,EG40</i>	<i>053763</i>	<i>AAA-053763</i>



PRODUCT MANUAL

EG40 ELUENT GENERATOR SYSTEM

EG40 ELUENT GENERATOR MODULE (P/N 053920)

ELUGEN™ HYDROXIDE CARTRIDGE (EGC-KOH) (P/N 053921)

ELUGEN™ METHANESULFONIC ACID CARTRIDGE (EGC-MSA) (P/N 053922)

Now sold under the
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Revision 06
8 July 2002

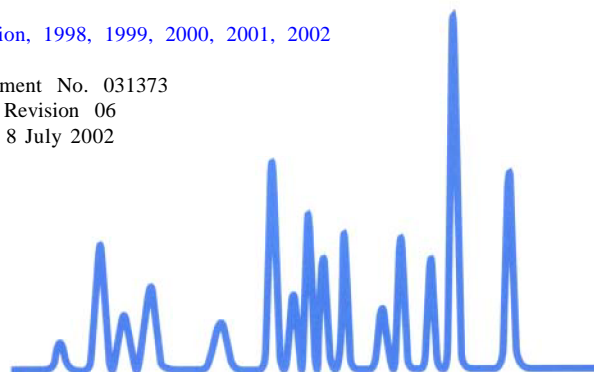


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SECTION 1 - INTRODUCTION TO THE EG40 ELUENT GENERATOR SYSTEM

The EG40 eluent generator is a patent pending device that is capable of generating high purity acid or base eluents on-line at the point of use utilizing only deionized water as the carrier. The EG40 eluent generator consists of four major components: a high precision programmable current source (power supply), a DX-LAN automation interface, a high pressure gas removal device, and a disposable eluent generator cartridge. The EG40 eluent generator can be configured with either an EluGen™ EGC-KOH Cartridge (P/N 053921) for generation of potassium hydroxide (KOH) eluent for anion separations or an EluGen EGC-MSA Cartridge (P/N 053922) for generation of methanesulfonic acid (MSA) eluent for cation separations.

The use of eluent generators in ion chromatography has several significant advantages. Separations can be performed using only deionized water as the carrier. The need to prepare eluent is eliminated because the base or acid eluent is generated on-line at the point of use. Eluent generators produce high purity, contaminant free acid and base eluents on-line. The use of these high purity eluents can significantly improve the performance of ion chromatography methods.

Traditionally, the acid or base eluents are prepared off-line by dilution from reagent-grade chemicals. This process can be tedious, prone to operator errors, and often introduces contaminants. The preparation of carbonate-free NaOH or KOH eluents, which are widely used as eluents in the ion chromatographic separation of anions, is difficult because carbonate can be introduced as an impurity from the source chemical, from the reagent water, or by adsorption of carbon dioxide from air. The presence of carbonate in NaOH eluents can compromise the performance of an ion chromatographic method by causing undesirable chromatographic baseline drift during the hydroxide gradient and even irreproducible retention times for analytes. The use of the EG40 Eluent Generator System eliminates these problems.

Another advantage of the EG40 is the convenience of eluent generator control. Gradient separations can be performed using electrical current to generate gradients with minimal delay. In addition, the use of the EG40 can reduce the maintenance costs of the pumping system since the pump need only pump deionized water instead of the more corrosive acid or base solution.

1.1 ELUGEN EGC-KOH CARTRIDGE PRINCIPLE OF OPERATION

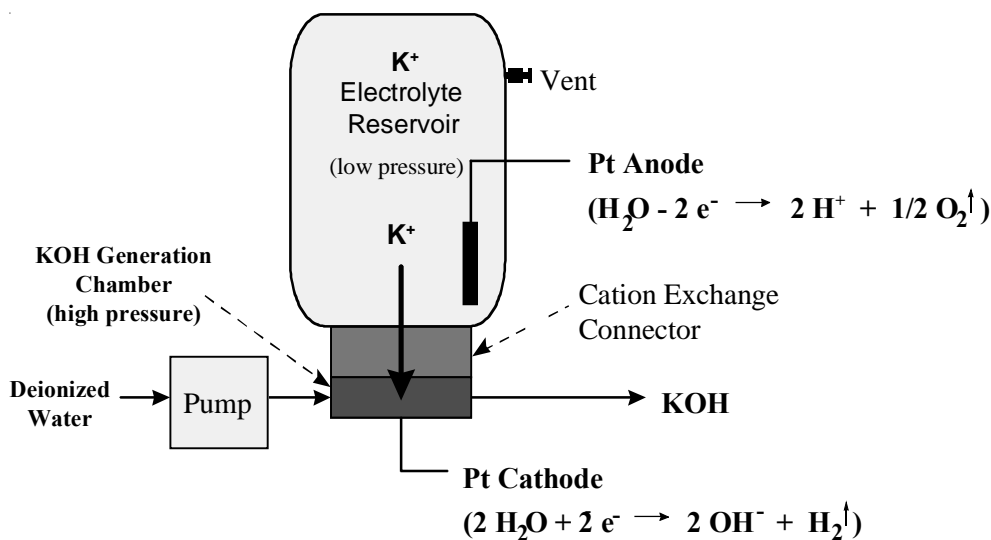
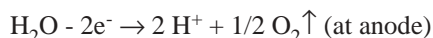


Figure 1
EluGen EGC-KOH Cartridge for
Potassium Hydroxide (KOH) Generation

The eluent generator cartridge is the heart of the eluent generation process. Figure 1, “EluGen EGC-KOH Cartridge for Potassium Hydroxide (KOH) Generation,” illustrates the operation principle of an EluGen EGC-KOH cartridge. The cartridge consists of a high pressure KOH generation chamber and a low pressure K^+ ion electrolyte reservoir. The KOH generation chamber contains a perforated platinum (Pt) cathode where hydroxide ions are formed. The K^+ ion electrolyte reservoir contains a Pt anode and an electrolyte solution of K^+ ions. The KOH generation chamber is connected to the electrolyte reservoir by means of a cation exchange connector which permits the passage of K^+ ions from the electrolyte reservoir into the high pressure generation chamber, while preventing the passage of anions from the K^+ ion electrolyte reservoir into the generation chamber. The cation exchange connector also serves the critical role of a high pressure physical barrier between the low pressure electrolyte reservoir and the high pressure generation chamber.

To generate a KOH eluent, deionized water is pumped through the KOH generation chamber and a DC current is applied between the anode and cathode of the EluGen cartridge. Under the applied field, the electrolysis of water occurs at both the anode and cathode of the device. As shown below, water is oxidized to form H^+ ions and oxygen gas at the anode in the K^+ electrolyte reservoir.



Water is reduced to form OH^- ions and hydrogen gas at the cathode in the KOH generation chamber,



As H^+ ions, generated at the anode, displace K^+ ions in the electrolyte reservoir, the displaced K^+ ions migrate across the cation exchange connector into the KOH generation chamber. These K^+ ions combine with OH^- ions generated at the cathode to produce the KOH solution, which is used as the eluent for anion exchange chromatography. The concentration of generated KOH is determined by the current applied to the KOH generator and the carrier water flow rate through the KOH generation chamber. Therefore, given the carrier flow rate, the EG40 will precisely control the applied current to accurately and reproducibly generate KOH at the desired concentration.

1.2 ELUGEN EGC-MSA CARTRIDGE PRINCIPLE OF OPERATION

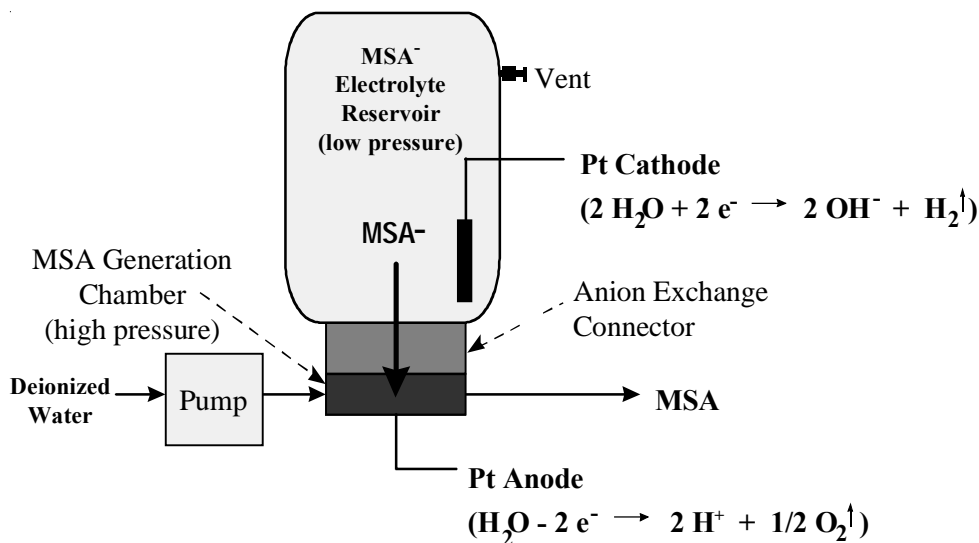
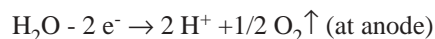


Figure 2
EluGen EGC-MSA Cartridge for
Methanesulfonic Acid (MSA) Eluent Generation

The concept described for the generation of KOH can be applied to the generation of acid. Figure 2, “EluGen EGC-MSA Cartridge for Methanesulfonic Acid (MSA) Eluent Generation,” illustrates the operation principle of an EluGen EGC-MSA cartridge. The cartridge consists of a high pressure methanesulfonic acid (MSA) generation chamber and a low pressure methanesulfonate (MSA⁻) ion electrolyte reservoir. The generation chamber contains a perforated platinum (Pt) anode. The electrolyte reservoir contains a Pt cathode and an electrolyte solution of MSA⁻ ions. The generation chamber is connected to the MSA⁻ ion electrolyte reservoir using an anion exchange connector which permits the passage of MSA⁻ ions from the electrolyte reservoir into the high pressure generation chamber, while preventing the passage of cations. The anion exchange connector also serves the critical role of a high pressure physical barrier between the low pressure electrolyte reservoir and the high pressure generation chamber.

To generate a MSA eluent, deionized water is pumped through the MSA generation chamber and a DC current is applied between the anode and cathode of the eluent generator cartridge. Under the applied field, the electrolysis of water occurs at the anode and cathode of the device. Water is oxidized to form H⁺ ions and oxygen gas at the anode in the MSA generation chamber as shown below.



Water is reduced to form OH⁻ ions and hydrogen gas at the cathode in the MSA⁻ electrolyte reservoir.



As the OH⁻ ions, generated at the cathode, displace MSA⁻ ions in the electrolyte reservoir, MSA⁻ ions migrate across the anion exchange connector into the MSA electrolysis chamber. The MSA⁻ ions combine with H⁺ ions generated at the anode to produce a methanesulfonic acid (MSA) solution, which is used as the eluent for cation exchange chromatography. The concentration of MSA generated is determined by the current applied to the MSA generator and the carrier flow rate through the MSA generation chamber. Therefore, given the carrier flow rate, the EG40 will control the applied current in order to accurately and reproducibly generate MSA at the desired concentration.

1.3 SYSTEM FLOW DIAGRAM

The use of the EG40 Eluent Generator in a typical ion chromatography system is shown in Figure 3, “System Flow Diagram using EG40 Eluent Generator.” The EG40 Module is placed between the outlet of the GP40 or GP50 pump and the inlet of the sample injector. Deionized water is used as the carrier for the EG40 Eluent Generator. For anion analysis, an Anion Trap Column (ATC-HC, P/N 059604), should be placed at the pump outlet to remove dissolved carbon dioxide and other anionic contaminants from the deionized water. The high pressure degas tubing assembly is located between the outlet of the EluGen cartridge and the inlet of the sample injector to remove electrolysis gases generated during the eluent generation process. After exiting the degas tubing assembly, the high purity KOH or MSA eluent passes through the injector, the column, suppressor, and finally to the detector. Depending on the pressure drop across the guard and analytical column, an optional pressure restrictor can be installed between the outlet of the high pressure degas tubing assembly and the inlet of the sample injector for optimal system performance. When using suppressed conductivity detection, the suppressor regenerant effluent is directed to flow through the degas tubing assembly to remove any released hydrogen or oxygen gas, See Figure 3, “System Flow Diagram for Ion Exchange Applications Using the EG40 Eluent Generator.” When using UV detection, the detector effluent is directed to flow through the degas tubing assembly to remove any released hydrogen or oxygen gas. For carbohydrate analysis, the cell effluent is directed to waste and the system is set up to vacuum degas the EG40 generated eluent prior to entering the column, See Figure 3, “System Flow Diagram for Carbohydrate Applications Using the EG40 Eluent Generator.”

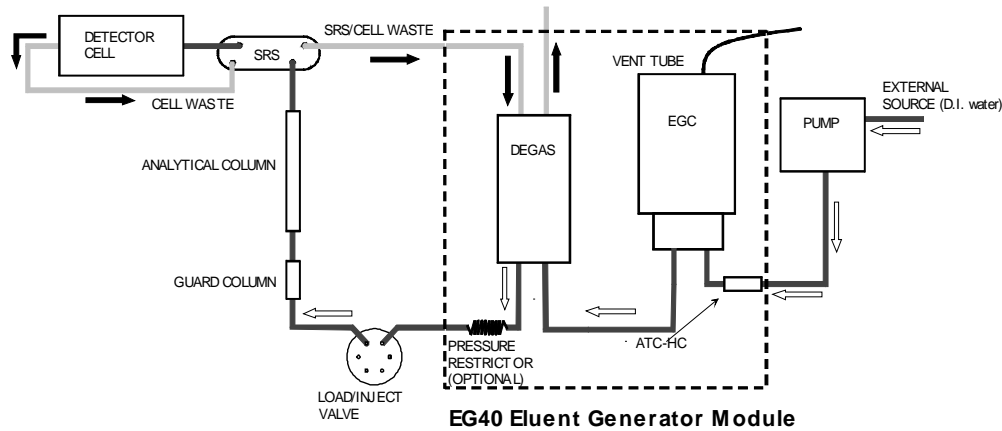


Figure 3
System Flow Diagram for Ion Exchange Applications Using the EG40 Eluent Generator

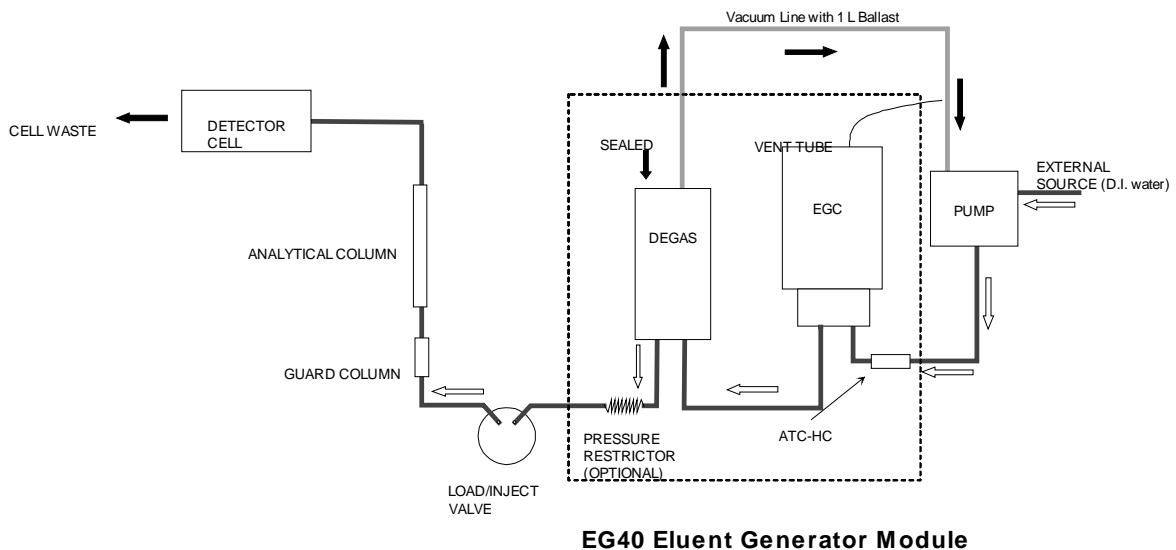


Figure 4
System Flow Diagram for Carbohydrate Applications Using the EG40 Eluent Generator

1.4 EG40 ELUENT GENERATOR MODULE

The EG40 Eluent Generator module includes a power supply, a built-in LAN card, a high pressure gas removal device, and a bracket for mounting the EluGen cartridge.

1.4.1 EG40 MODULE FRONT PANEL

1. The main power switch controls the power to the EG40 Module.
2. The power LED indicator beside the push-button switch is illuminated when the power is turned on.
3. The Leak LED indicator is illuminated when the leak sensor detects liquid leaks inside the EG40 Module.
4. The Fault LED indicator is illuminated when the eluent generator current or voltage output is too low or too high.
5. The small viewing port displays the EG40 system waste line. During operation, the waste line will contain a steady flow of bubbles which are visible through the viewing port.
6. The reservoir container on top of the EG40 module holds two 1-liter (P/N 044128) plastic reservoirs, two 2-liter (P/N 044129) plastic reservoirs, or one reservoir of each size. Place either deionized water or eluents in the reservoirs.

NOTE

Eluent reservoirs are purchased separately.

7. Fluid line slots are located on each side of the EG40 module to allow easy connection of lines between modules.

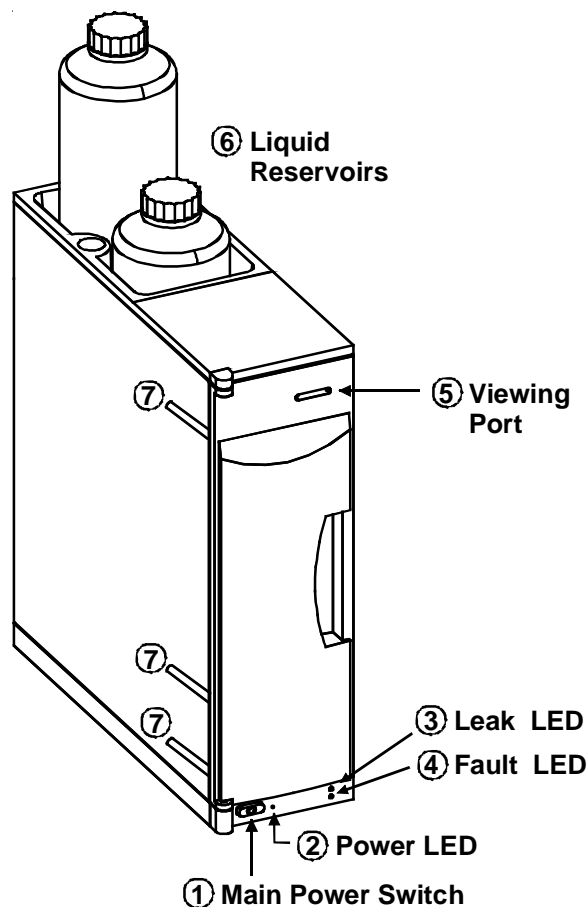


Figure 5
EG40 Module Front Panel

1.4.2 EG40 MODULE MECHANICAL COMPONENTS

The following text is a discussion of the EG40 Module mechanical components illustrated in Figure 6, “EG40 Module Interior”:

1. The EG40 is operated with one of two EluGen cartridges: either an EGC-KOH (P/N 053921) for anion separations or an EGC-MSA (P/N 053922) for cation separations. Each EGC cartridge contains 1 liter of the appropriate electrolyte solution for eluent generation.
2. The high pressure degas tubing assembly (P/N 053721) purges the electrolysis gas from the freshly-generated eluent before it is directed into the analytical column.
3. The column clips hold an ATC-HC anion trap column (P/N 059604). For anion separations, Dionex recommends installing an ATC-HC anion trap column to remove carbonate (dissolved carbon dioxide) from the deionized water. A trap column is not required for cation separations.
4. The leak sensor detects liquid leaks inside the EG40 Module and sends a signal to illuminate the LED on the front panel and also activates a PeakNet warning.
5. The EG40 power supply and printed circuit boards are located at the back of the EG40 module.

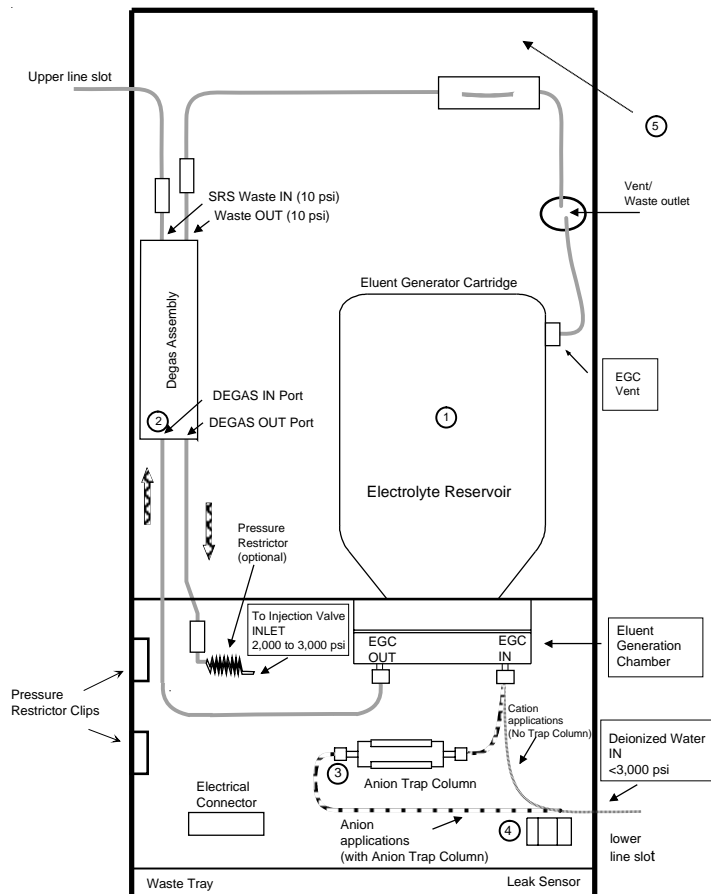


Figure 6
EG40 Module Interior

1.4.3 EG40 MODULE REAR PANEL

- DX-LAN Connection:** Attach a connector “T” to the DX-LAN connector at the rear panel of the EG40. Connect the DX-LAN cable (P/N 960404) from the PeakNet workstation to the BNC connector (see Figure 7, “EG40 Module Rear Panel”).
- Electrical Connections:** The main power receptacle includes a fuse holder with two IEC 127 fuses (P/N 954745) rated at 3.15 amps at 250 VAC. A modular power cord (IEC 320 C13) is required.

HIGH VOLTAGE

Accessing the EG40 Module electronics compartment by removing the rear panel of the EG40 will expose users to high voltage. There are no user-serviceable components in the electronics compartment.

CAUTION

The power cord is used as the main disconnect device. Make sure a socket-outlet is located near the EG40 Module and is easily accessible.

- TTL Inputs:** The two TTL inputs can be connected to devices capable of providing TTL signals such as an AS3500, AS40, or AS50 autosampler.

TTL 1 IN turns the EG40 on and off.
TTL 2 IN starts the EG40 method.

- TTL Outputs:** EG40 currently provides one TTL output (TTL 1 OUT) to control an external device that can be controlled via TTL signals (such as an autosampler or other DX-500 module). TTL 2 OUT is not functional and is reserved for future feature expansion.

- Drip Tray Drain Line:** Liquid spills in the drip tray are removed from the EG40 via the clear corrugated drip tray waste line.

- Gas Waste Line:** Two waste lines exit the EG40 via the vent service chase. The clear tubing is the gas tubing that discharges the electrolysis gas which has been vented from the EGC electrolyte reservoir.

Gas Generation: The EG40 Module generates eluent by means of electrolysis which results in the production of small amounts of oxygen or hydrogen (up to 2 mL/min at ambient pressure and temperature). Install the SRS Gas Separator Waste Tube,

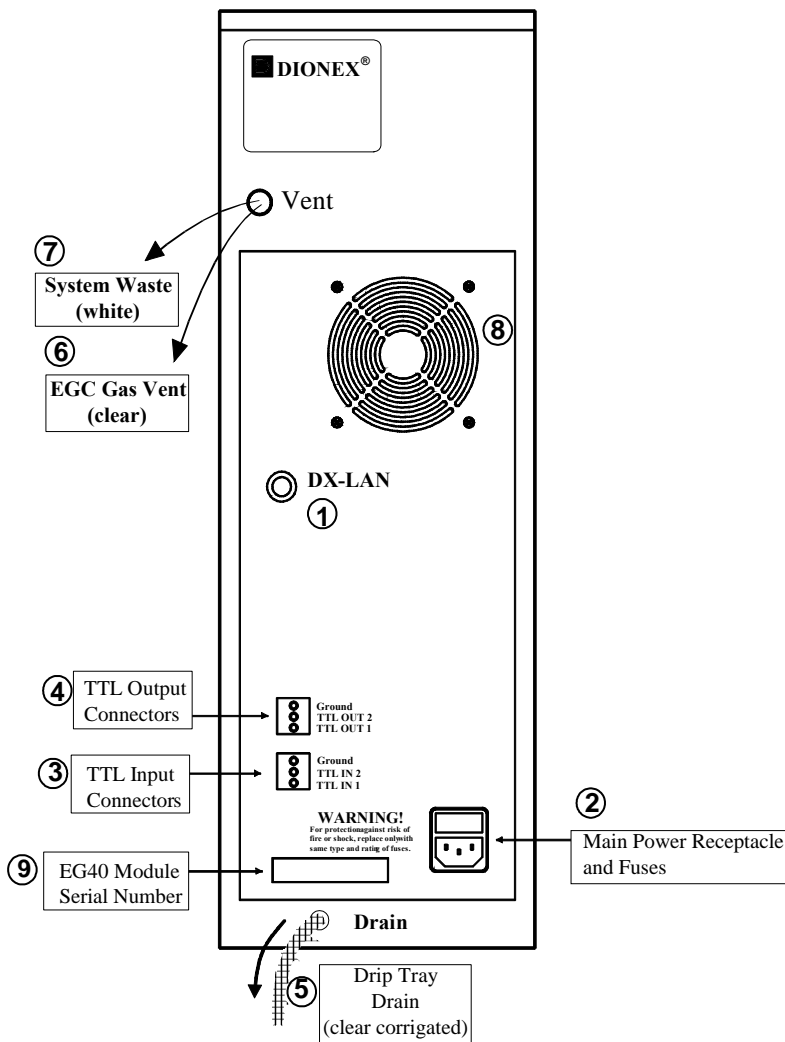


Figure 7
EG40 Module Rear Panel

provided with your conductivity detector, according to the instructions that come with the liquid-waste/gas separator. To prevent H₂ and O₂ build-up, operate the EG40 module in properly ventilated areas only. The System Waste Line should be connected to the SRS Gas Separator Waste Tube provided in the detector ship kit.

7. **System Eluent Waste Line:** The system waste line (white tubing) discharges the liquid and gas waste from the high pressure degas tubing assembly and the SRS Suppressor. This line is marked WASTE OUT inside the EG40 module.
 8. **Exhaust Fan:** The exhaust fan cools the interior of the EG40 and exhausts any stray hydrogen and oxygen gases that may escape during operation.
-

SECTION 2 - INSTALLATION

2.1 FACILITY REQUIREMENTS

Power	85 to 265 VAC, 47 to 63 Hz; operates across the entire voltage and frequency range without any switching required
Ambient Temperature	4 to 40°C (39 to 104°F)
Humidity	10 to 90% relative humidity, noncondensing
Deionized Water	ASTM Type I reagent-grade water with a resistivity of 18 MW -cm
Room Air Circulation	To prevent the buildup of hydrogen and oxygen gases, install the EG40 in a well-ventilated site.

2.2 INSTALLING PEAKNET SOFTWARE

Refer to “Installing the Dionex PeakNet System” (Document No. 034941) for software installation instructions. PeakNet 5.1 or higher is required for EG40 Eluent Generator operation.

2.3 EG40 SPECIFICATIONS

Dimensions the EG40 is required	50 high x 14 wide x 42 cm deep (20 x 5.6 x 16.8 in); at least 5 cm (2 in) clearance behind
Weight	11 kg (25 lbs)
System Operating Pressure	Minimum: 2000 psi (14 MPa) Maximum : 3,000 psi (21 MPa)
Concentration	0.1 to 100 mM at flow rate of 0.1 to 1.0 mL/min
Range min	0.1 to X mM at flow rate of 1.0 to 3.0 mL/min; where X mM = 100/ Flow Rate in mL/
Delay Volume	User-settable from 0 to 2000 µL; Default setting is 400 µL
Decibel Level	<50 dBA

SAFETY COMPLIANCE

The EG40 Eluent Generator meets European, EMC, and safety requirements per Council Directives 73/23/EEC and 89/336/EEC, EN 61010-1:1993 (safety), EN 50082-1:1992 (susceptibility), and EN 55011:1991 (emissions). The CE safety label on the EG40 attests to compliance with these standards.

The EG40 Eluent Generator is designed for ion exchange and HPLC applications and should not be used for any other purpose. If there is a question regarding appropriate usage, contact Dionex before proceeding.

2.4 EG40 MODULE INSTALLATION

2.4.1 Module Arrangement

Dionex DX-500 System modules are designed to be stacked on top of each other up to a maximum height of four units. The EG40 is three units high and is designed to be the top module. No modules should be stacked on top of the EG40. Figure 8, “Typical System Configuration,” illustrates a typical system configuration.

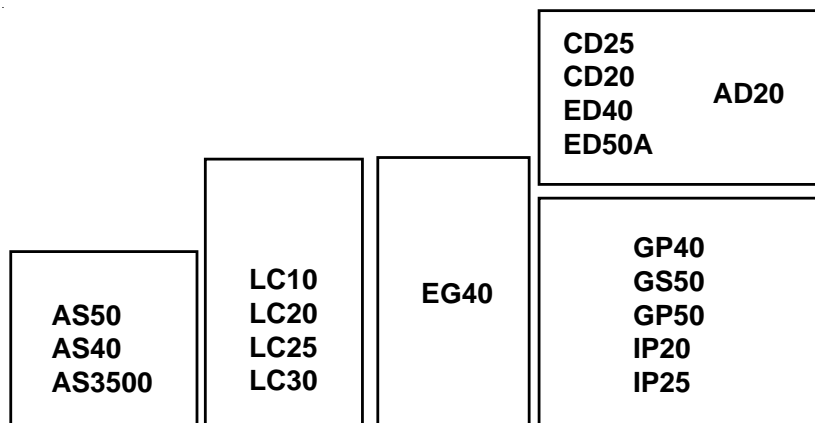


Figure 8
Typical System Configuration

2.4.2 Power Connections

Connect the 3-prong (grounded) main power cord (P/N 960708) to the receptacle on the rear panel. Connect the other end of the cord to the correct AC power source.

CAUTION

The power cord is used as the main disconnect device. Make sure a socket-outlet is located near the EG40 Module and is easily accessible.

2.4.3 Waste Lines

The EG40 requires a system waste line and a drip tray drain line. The EG40 Module generates eluent by means of electrolysis which results in the production of small amounts of oxygen or hydrogen (up to 2 mL/min at ambient pressure and temperature). Install the SRS Gas Separator Waste Tube, provided with your conductivity detector, onto the end of the system waste line according to the instructions that come with the liquid-waste/gas separator. Operate the EG40 module in properly ventilated areas only. The System Waste Line should be connected to the SRS Gas Separator Waste Tube. Place the free end of the system waste line (located at the back of the EG40) into a waste container below the level of the EG40. Make sure the tubing is not bent, pinched, or elevated at any point. Rest the corrugated drip tray drain line (located at the lower back of the EG40) on the tabletop and direct the line into a waste container. The drip tray line should not be pushed into the EG40.

2.4.4 DX-LAN Cable

Attach a connector “T” to the LAN connector located at the back of the EG40 Module compartment. The connector “T” and the DX-LAN cable (P/N 960404) is supplied in the EG40 Module ship kit. Connect the DX-LAN cable from the PeakNet Workstation BNC connector (or other PC) to the EG40 “T” connector. Twist the rotating sleeve of the BNC connector until a locking click is heard or felt. All system modules are connected together with DX-LAN cables. The system computer BNC may have a green terminator or be connected to a second system with a DX-LAN cable.

2.4.5 TTL Connections and Control

See Section 8 for TTL connections and control instructions.

2.5 ELUGEN CARTRIDGE INSTALLATION

2.5.1 Optional Pressure Restrictor Tubing

The degas tubing assembly requires at least 2,000 psi (14 MPa) of back pressure for optimal removal of electrolysis gas from the eluent produced by the EluGen cartridge. The degas tubing is functional at pressures below 2,000 psi (14 MPa) but this low system pressure may result in high baseline noise as the eluent concentration increases in the gradient. If a restrictor is required, the following procedure will assist in determining the correct back pressure restrictor tubing to use (see Table 1).

1. Configure the appropriate DX-500 or DX-600 chromatography system, by configuring PeakNet for the appropriate EluGen cartridge, analytical and guard columns, and suppressor. Program PeakNet to deliver the eluent required in your method.
2. Turn the pump on. Confirm the eluent flow at the desired flow rate. If the method is a gradient method, it should be run to completion.
3. Monitor the pump pressure throughout the method, noting the maximum and minimum system pressures for the duration of the method.
4. If the maximum and minimum pressures are between 2,000 and 3,000 psi, the system back pressure is adequate.
5. If the maximum pressure exceeds 3,000 psi, the method will terminate prematurely. Locate the source of the excessive pressure and eliminate it. Several analytical and guard columns generate system pressures above 3,000 psi, especially when solvents are used in the eluent. The eluent generator can not be used with these columns unless the flow rate is reduced so that the maximum system pressure is between 2,000 and 3,000 psi.
6. If the minimum system pressure is below 2,000 psi, a pressure restrictor should be used. Table 1, “Optional Back Pressure Restrictors,” below can be used to determine the appropriate pressure restrictor to adjust the system pressure between 2,000 to 3,000 psi (14-21 MPa).
7. The backpressure restrictors listed in Table 1, “Optional Back Pressure Restrictors”, are supplied in the EG40 Module shipkit. Install the back pressure restrictor between the degas assembly “DEGAS OUT” port and the injection valve. The back pressure restrictor tubing may be installed directly into the injection valve “IN” port. Two coil clips are provided on the left lower wall of the EG40 Module to secure the back pressure restrictor coils.

Table 1
Optional Back Pressure Restrictors

Part Number	Description	Flow Rate	Approximate Back Pressure Added	Flow Rate	Approximate Back Pressure Added
053763	4-mm Pressure Restrictor	2.0 mL/min	1,000 psi (7 MPa)	1.0 mL/min	500 psi (3.5 MPa)
053762	4-mm Pressure Restrictor	2.0 mL/min	500 psi (3.5 MPa)	1.0 mL/min	250 psi (1.75 MPa)
053765	2-mm Pressure Restrictor	0.5 mL/min	1,000 psi (7 MPa)	0.25 mL/min	500 psi (3.5 MPa)
053764	2-mm Pressure Restrictor	0.5 mL/min	500 psi (3.5 MPa)	0.25 mL/min	250 psi (1.75 MPa)

2.5.2 CARTRIDGE INSTALLATION

1. Unbox the EG40 Cartridge (EGC-KOH, P/N 053921 or EGC-MSA, P/N 053922). Save the box and foam for future storage.
2. Place the EluGen Cartridge on a flat surface in front of the EG40 Module with the Electrolysis chamber and EGC “IN” and “OUT” fittings facing up.
3. **For anion applications (EGC-KOH):** Prepare the Anion Trap Column for use by flushing with 200 mL of 2.0 N NaOH or KOH at 2 mL/min. Rinse the ATC column with degassed DI water for 20 minutes at 2 mL/min.

Connect the pump pressure transducer outlet to the Anion Trap Column (ATC-HC) inlet using the PEEK tubing connected to the exit of the pump pressure transducer. Guide the tubing through the rubber line slot at the lower edge of the EG40 module. Connect the outlet of the ATC-HC to the inlet of the EluGen Cartridge using the PEEK tubing labeled “Pump/ATC OUT” at one end and “EGC IN” at the other end. The ATC-HC is mounted in the lower bracket below the EluGen Cartridge shelf. Leave it free until the EluGen Cartridge is placed on the shelf.

4. **For cation applications (EGC-MSA):** The ATC-HC should not be used. Connect the pump pressure transducer outlet directly to the inlet of the EluGen Cartridge using the PEEK tubing labeled “Pump/ATC OUT” at one end and “EGC IN” at the other end.
5. **For all systems:** Connect the PEEK tubing, labeled, “EGC OUT”, extending from the Degas Assembly to the outlet of the EluGen Cartridge.

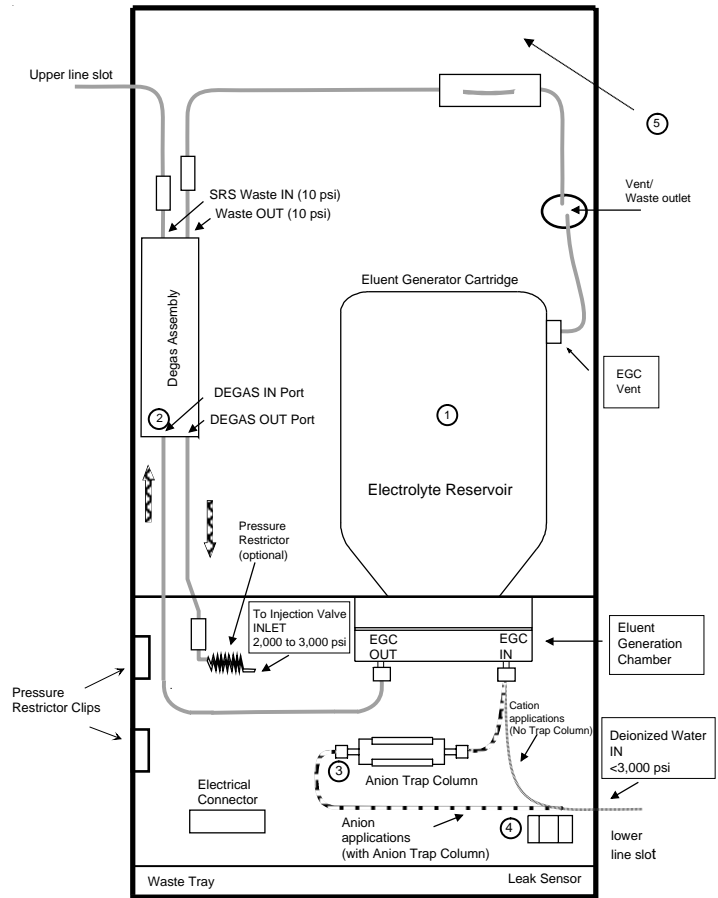


Figure 9
EG40 Flow Path Diagram

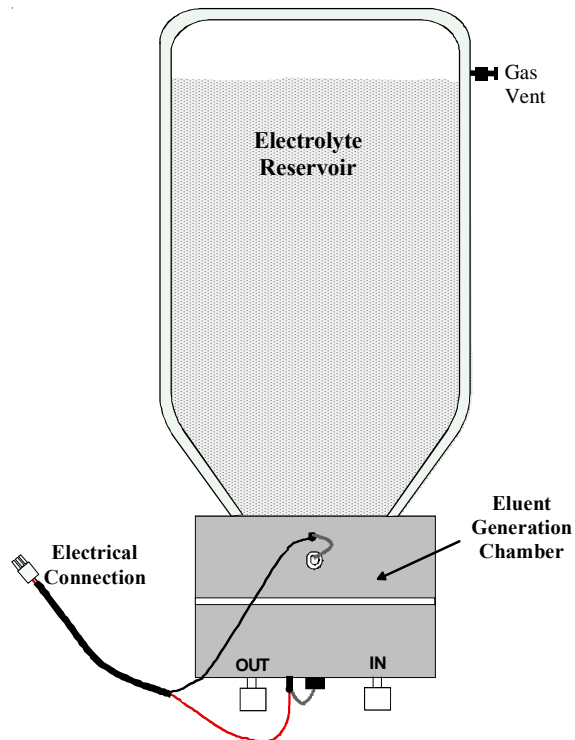


Figure 10
EGC Cartridge

6. **IMPORTANT. Invert the EluGen Cartridge with the Eluent Generation Chamber downward as shown in Figure 10, “EGC Cartridge.” Shake the EluGen Cartridge vigorously, and tap the eluent generation chamber with the palm of your hand 10 to 15 times. Watch to be sure all bubbles trapped in the eluent generation chamber are dislodged. Be sure to repeat this process each time the EGC cartridge is turned with the eluent generation chamber upward.**
7. Position the EluGen Cartridge in the EG40 Module with the eluent generation chamber downward by positioning the PEEK chamber just below the shelf and the reservoir just above the shelf and sliding the cartridge through the opening in the shelf.
8. Using the PEEK tubing attached to the “DEGAS OUT” port and labeled “INJ VALVE IN”, connect the Degas Assembly outlet to port 2 of the Rheodyne injection valve. (The port number may vary depending on the injection valve type.) You may need to use a backpressure restrictor to obtain a system pressure of 2,000 - 3,000 psi. See Section 2.5.1.
9. Plumb the SRS Suppressor “REGEN OUT” port to the Degas Assembly “SRS WASTE IN” tubing (located at the upper front of the degas assembly). See Figures 10, 11, and 12 in Section 2.9 and 2.10 for plumbing diagrams.
10. The EG40 requires a system waste line. The EG40 Module generates eluent by means of electrolysis which results in the production of small amounts of oxygen or hydrogen (up to 2 mL/min at ambient pressure and temperature). Install the SRS Gas Separator Waste Tube, provided with your conductivity detector, according to the instructions that come with the liquid-waste/gas separator. Operate the EG40 module in properly ventilated areas only. The System Waste Line should be connected to the SRS Gas Separator Waste Tube. Place the free end of the system waste line (located at the back of the EG40) into a waste container below the level of the EG40 to maintain a positive siphon. Make sure the tubing is not bent, pinched, or elevated at any point. Be sure the system waste line is directed to the Gas Separator Waste Tube provided with your conductivity detector.
11. The EG40 requires a drip tray drain line. Rest the corrugated drip tray drain line (located at the lower back of the EG40) on the tabletop and direct the line into a waste container. The drip tray line should not be pushed into the EG40.
12. The EluGen Cartridge is shipped with a Luer adaptor (P/N 053980) and a Luer cap (P/N 053981) installed in the gas vent port of the EGC electrolyte reservoir. Remove the black cap by pulling outward. While using a wrench to hold the Luer connector in place, remove the 1/4-28 Luer cap with your fingers. Store the cap and black cover in the drip tray until required for disposal or storage of the EluGen Cartridge. Connect the EluGen Cartridge Vent to the EG40 Module “Vent Line.” Position the EluGen Cartridge with the gas vent pointing toward the right front corner of the EG40 Module with the gas waste line draped along the side of the module. You may need to feed additional waste line into the module to reach the Luer connection.
13. Connect the EluGen Cartridge electrical connector to the EG40 Module connector. The connection is a three prong keyed connection located inside the EG40 Module compartment below the cartridge shelf (see Figure 6, “EG40 Module Interior”). Hold the EluGen Cartridge connector in your hand with the release tab facing upward. Gently slid the connector into the EG40 slot.
14. The EluGen Cartridge is now installed and ready for operation. Configure PeakNet as described in Section 2.6.

2.6 PEAKNET CONTROL

PeakNet software 5.1 (or higher) provides control and status monitoring of all EG40 functions. New PeakNet users should refer to the PeakNet User’s Guide or on-line Help for step-by-step instructions on PeakNet control of the EG40. A summary of the typical sequence of events is outlined in this section.

2.6.1 CONFIGURE PEAKNET

1. Turn power ON to all modules and configure the system.
2. One EG40, one (and only one) pump, and up to 4 detectors may be configured in one system. The “pump” may be any of the following: a GS50 Gradient Pump, GP50 Gradient Pump, GP40 Gradient Pump, IP25 Isocratic Pump, or IP20 Isocratic Pump.
3. Configure the EG40 to PeakNet, using the Configuration Editor. Enter the EGC cartridge serial number.

2.6.2 DEVELOP AN EG40 METHOD

1. **Setup Dialog Box.** If you have not previously created a Method, open the Setup dialog box for the EG40 and pump by double-clicking on the icon for either module in the Method program. Use the controls in the Setup dialog box to set the initial conditions for both modules.

The EG40 initial conditions are detailed below:

Offset Volume To duplicate the gradient separation methods developed using the GP40 or GP50 gradient pump, the delay in the EG40 program allows the solvent gradient produced by the gradient pump to be synchronized with the concentration gradient produced by the EG40 module. Since the EluGen cartridge is located just before the injection valve, the eluent concentration produced by the EG40 reaches the column head more quickly than the eluent concentration from conventional pump eluent delivery. The offset volume can be specified in the PeakNet EG40 method as 0-2,000 μL . The default value is 400 μL ; however, the actual offset volume may be different depending on the configuration of the system. The PeakNet Run program uses this value to calculate the time delay in starting the EG40 gradient program and EG40 timed events. The offset volume has no effect when using isocratic operation and can be set to 0.00 μL . See Section 4.1.4 for instructions on determining the offset volume value.

Eluent Label Label can be any desired text (up to 39 characters).

TTL Output Label Label can be any desired text (up to 15 characters).

2. **Editor Dialog Box.** Click OK to accept the above selections and the Editor dialog box for both the EG40 and pump will automatically open. Although timed event steps for the EG40 and the pump are combined in one dialog box, each timed event for each module is treated independently. A separate ENTER button for each module is used to enter each timed event step.

The EG40 timed event parameters include:

Time	Specifies the time (0 to 999.99 minutes) at which the selected operating conditions go into effect. Each time entry is a separate step in the timed events table.
Eluent Concentration	Specifies the eluent concentration from 0.0 to 100 mM in 0.1 mM increments. The maximum concentration (X) is dependant on the pump flow rate and is calculated as: (0.1 to X mM at 1.0 to 3.0 mL/min; where X mM = 100/ Flow Rate in mL/min)
TTL 1	TTL 1 OUT can be used to control an external device.
Curve	Applies a curvilinear gradient to the preceding gradient segment. For an increasing eluent, gradient curves 1 through 4 are convex, curve 5 (the default) is linear, and curves 6 through 9 are concave. This capability is disabled when the timed event step is Init or 0.0.
Comment	Text can be any desired text (up to 29 characters), including spaces and punctuation. A comment may be entered for each step.

When operating the Eluent Generator system, the pump's timed-event parameters are limited to:

High Pressure Limit Portions of the Eluent Generator can be damaged by excessive pressure. To prevent this, the default high-pressure limit is 3000 psi (21 MPa). This setting can be decreased if desired.

Low Pressure Limit If the pump flow rate inadvertently falls to zero and the Eluent Generator system continues to create eluent, the EluGen cartridge temperature will rise and the cartridge may be damaged. To prevent this, the default low-pressure is 200 psi (1.4 MPa). This setting can be increased if desired.

When the pump operates within these limits, the Eluent Generator will produce eluent concentrations as follows:

Concentration (mM) For flow rates below 1.0 mL/min., the maximum eluent concentration is 100 mM. For flow rates over 1.0 mL/min., the maximum allowed eluent concentration decreases inversely with the flow rate, as the following table illustrates:

Flow Rate	Maximum Concentration
1.0 mL/min	100 mM
1.2 mL/min	83.3 mM
2.0 mL/min	50 mM
3.0 mL/min	33.3 mM

2.7 EGC-KOH START-UP

Perform the following gradient to condition the EluGen cartridge: 1 to 60 mN KOH in 20 minutes then 60 mN KOH for 40 minutes at 1.0 mL/min. Cut and install a length of 0.005" PEEK tubing to provide a backpressure of ~ 2,000 psi. Direct the eluent directly to waste.

ATC Use with Gradient Elution

If you plan to use gradient elution, install a conditioned ATC-HC immediately after the pump proportioning valve. See the instructions below for conditioning procedure. Using the ATC-HC after the proportioning valve will minimize the background shift during the gradient due to carbonate.

Installation and Conditioning of the ATC-HC Anion Trap Column

1. Remove the ATC-1 or exhausted ATC-HC column installed between the pump outlet and the inlet of the EluGen Cartridge located in the EG40 module (See Figure 1, "System Flow Diagram for Dionex IC Systems Using the EG40 Eluent Generator").
2. Install the new or regenerated ATC-HC column in the IC system by connecting the line from the gradient pump pressure transducer to the ATC-HC column inlet port. Connect a liquid line from the outlet port of the ATC-HC column and direct it to a waste container.
3. Condition the ATC-HC column by pumping approximately 100 mL of deionized water through the ATC-HC column at a flow rate of 2-3 mL/min.
4. After the conditioning of the ATC-HC column, connect the outlet of the ATC-HC column to the inlet of the EluGen Cartridge located in the EG40 module (See Figure 1, "System Flow Diagram for Dionex IC Systems Using the EG40 Eluent Generator").
5. Turn on the IC system and allow it to equilibrate prior to starting your gradient analysis.

Regeneration/Clean-up of an Exhausted ATC-HC Anion Trap Column

Under normal operating conditions the ATC-HC column has sufficient capacity to continuously remove trace anionic contaminants present in the deionized water for an extended period of time (greater than one month) if the quality of the fed deionized water is 18.2 megohm-cm. The ATC-HC column should be regenerated when the total background conductivity during the hydroxide gradient is greater than 1.0 μ S. The regeneration of the ATC-HC column restores the column to the hydroxide form and its ability to remove anionic contaminants from the deionized water.

Use the Dionex Trap Column/Suppressor Clean-up Kit (P/N 059659) for the regeneration of the ATC-HC column (See Figure 2). Refer to Document No. 031835, "Installation Instructions and Operation Manual for the Trap Column/Suppressor Clean-up Kit," for complete installation and operation instructions.

Regeneration/Clean-up of an Exhausted ATC-HC Anion Trap Column to the Hydroxide Form

1. Prepare a fresh 2.0 M KOH solution from a 45% w/w KOH solution available from Fisher Scientific (Catalogue No. SP236) with the following purity specifications: iron < 5 ppm, chloride \leq 0.005%, and potassium carbonate \leq 0.5%. Concentrated potassium hydroxide solutions from other vendors with the same purity specifications may be used.
2. Use the Trap Column/Suppressor Clean-up Kit to deliver 200 mL of 2.0 M KOH solution through the exhausted ATC-HC column (See Figure 2).

3. Install the ATC-HC column in the IC system and pump 50 mL of deionized water through the ATC-HC column at a flow rate of 2-3 mL/min. Direct the column effluent to a waste container.
4. After rinsing the ATC-HC column with deionized water, connect the outlet of the ATC-HC column to the inlet of the EluGen Cartridge located in the EG40 module.
5. Turn on the IC system and allow it to equilibrate prior to starting your gradient analysis.

CAUTION

Wear appropriate gloves and eye protection when handling concentrated potassium hydroxide solutions

2.8 EGC-MSA START-UP

Perform the following gradient to condition the EluGen cartridge: 1 to 60 mN MSA in 20 minutes then 60 mN MSA for 40 minutes at 1.0 mL/min. Cut and install a length of 0.005" PEEK tubing to provide a backpressure of ~ 2,000 psi. Direct the eluent directly to waste.

2.9 OPERATING THE EG40 WITH A CONDUCTIVITY DETECTOR

The Self-Regenerating Suppressor may be operated in the SRS Recycle Mode or in the External Water Mode. See the SRS Operating Manual for details. Be sure the entire system is plumbed according to one of the two diagrams below.

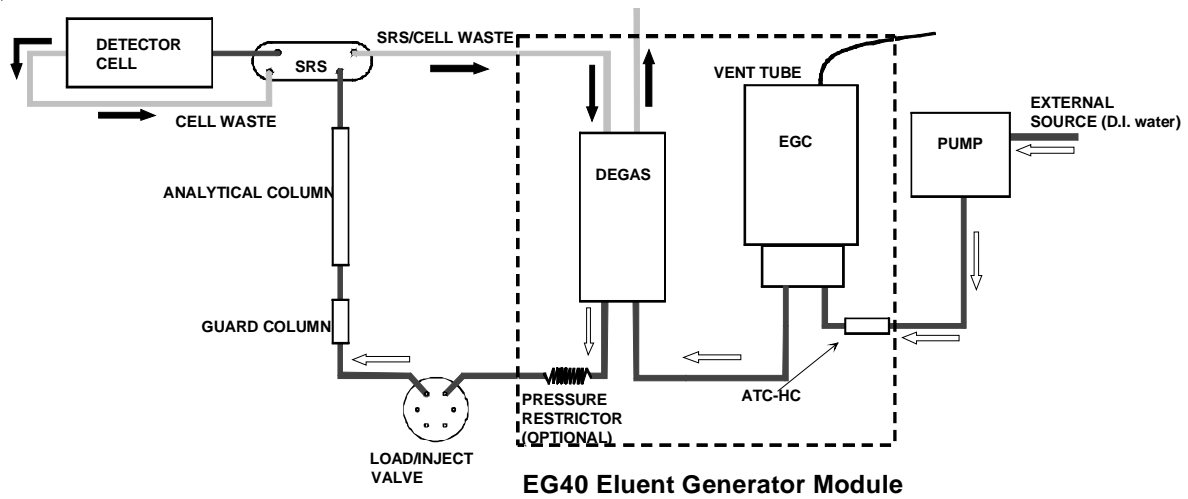


Figure 11
Plumbing Diagram for System using SRS Recycle Mode

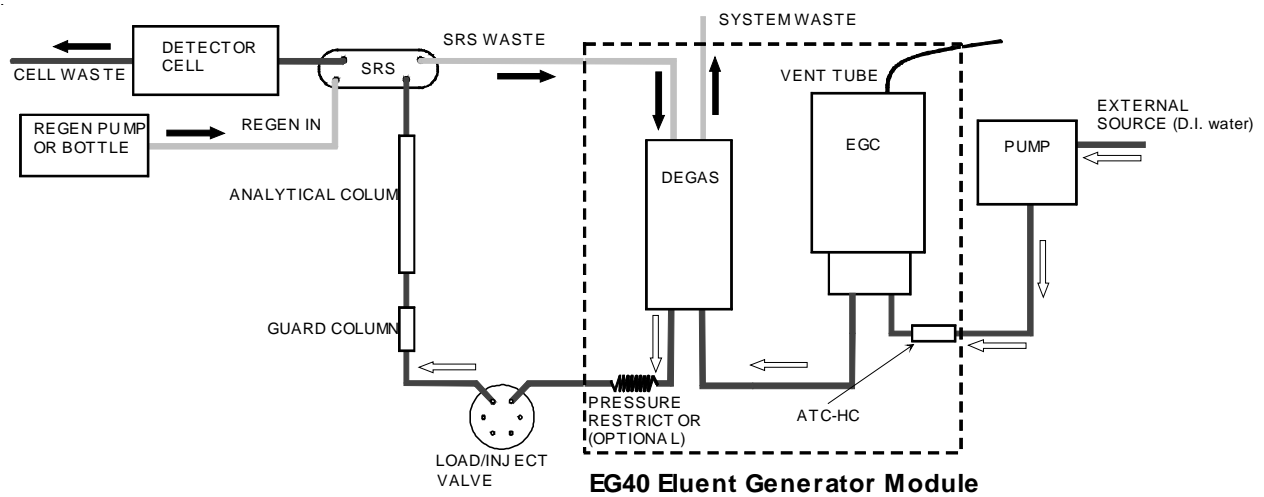


Figure 12
Plumbing Diagram for System using SRS External Water Mode

2.10 OPERATING THE EG40 WITH AN AMPEROMETRIC OR UV/VISIBLE DETECTOR

The plumbing for a system using an amperometric or a UV/Visible detector is outlined below.

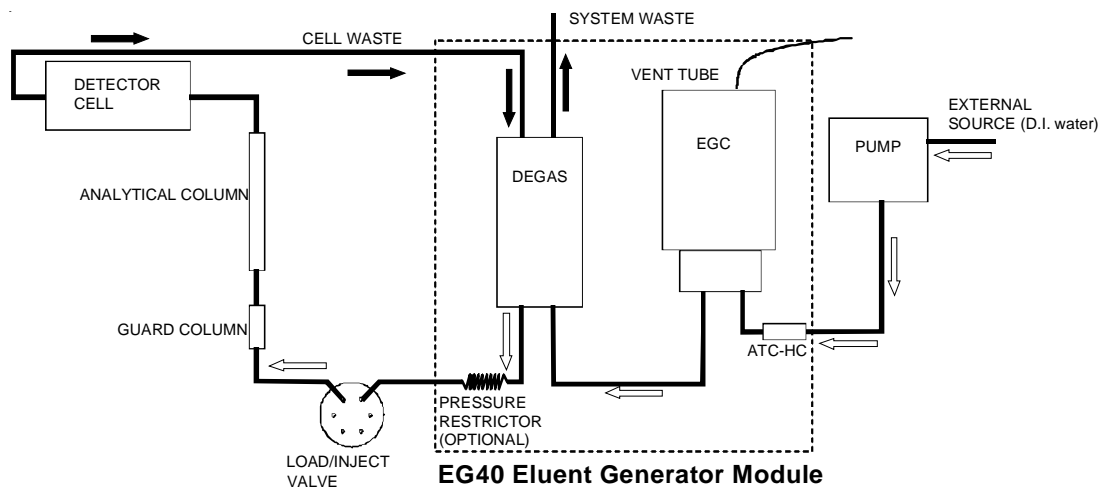


Figure 13
Plumbing Diagram for a System using an Amperometric or UV/Visible Detector

SECTION 3 - OPERATION

3.1 ROUTINE OPERATION

Routine operation consists of running the PeakNet Methods and Schedules that control the EG40. For an overview of the EG40 status during operation (EluGen serial number, EluGen expiration date, and EluGen cartridge lifetime), check the system status window in the Run program.

For routine operation, the recommended system backpressure is 2000 - 3000 psi (14 - 21 MPa). If necessary, add a backpressure restrictor to increase the pressure. The pressure restrictor tubing is located in the EG40 ship kit. See Section 2.5.1 for instructions.

3.2 OPERATING PRECAUTIONS

CAUTIONS

The EG40 Module generates eluent by means of electrolysis which results in the production of small amounts of oxygen or hydrogen gas. Ensure that the Gas Separator Waste Tube, provided with your conductivity detector, is installed. Operate the EG40 in properly ventilated areas only.

DO NOT CAP THE WASTE RESERVOIR!

The small amount of gas generated by the EG40 and the SRS is not dangerous unless the gas is trapped in a closed container and allowed to concentrate. The Gas Separator Waste Tube must be open to the atmosphere in order to operate properly.

Do not operate a chromatography system where the Eluent Generator is plumbed into the system, but not included in that system's PeakNet configuration. The excessive pressures that are allowed in systems without an Eluent Generator can damage components of the Eluent Generator.

-
1. The recommended maximum operating pressure for the EG40 Module is 3000 psi (21 MPa). This pressure limit protects the degas tubing assembly from mechanical failure.

Due to the high backpressure, do not use solvents when operating with the following columns: the IonPac AS11-HC or CarboPac PA10. Excessive backpressure may cause the degas tubing assembly to rupture.

NOTE

Solvents may be used if the flow rate is reduced sufficiently to reduce the system pressure to less than 3,000 psi (21 MPa).

-
2. Due to the high backpressure, do not operate the EG40 with the following columns: the IonPac AS5A, IonPac AS10, OmniPac PAX-100, or OmniPac PAX-500 unless the flow rate has been reduced to lower the system pressure to less than 3,000 psi (21 MPa). Excessive backpressure may cause the degas tubing assembly to rupture.
 3. Do not operate the EluGen KOH cartridge with solvents other than methanol (maximum 25%) for anion separations. Solvents cannot be used with the EluGen MSA Cartridge for cation separations.
 4. To prevent the buildup of hydrogen and oxygen gases, install the EG40 Module in a well-ventilated site.
-

5. Make sure the SRS Gas Separator Waste Tube (P/N 045460) is correctly installed. The tube is used to dissipate the small amounts of hydrogen and oxygen gases that are generated during EG40 and SRS (Self-Regenerating Suppressor) operation.

3.3 DIRECT CONTROL OPERATION

The Eluent Generator system can be operated directly (without running a Method or Schedule) from the PeakNet Direct Control dialog box. Direct Control is typically used for system diagnosis and not for sample analysis. Opening the Direct Control dialog box sets the Eluent Generator system and the other modules included in the same system to Direct Control mode.

Direct Control is always available before a Method is loaded to the system. Direct Control normally is also available after a Method is loaded as long as the run has not started. (NOTE: If the external signal that starts a run is selected after the Method is loaded, then the run will start and Direct Control will no longer be available.)

From the Direct Control dialog box, you can set the eluent concentration and/or the EG40 TTL output. After selecting a new concentration and/or turning the TTL on or off, click the Apply button. The new setting goes into effect immediately.

3.4 SYSTEM SHUT-DOWN

3.4.1 Short Term Shut-down

Dionex recommends continuous operation of your IC system for the most trouble-free operation. A microbore system will provide the most economical operation.

The EluGen cartridge may be left in the EG40 Module for short-term storage up to three months. The system should be shut-down using the following methods:

1. Turn System OFF Completely:
By using either a Method or from direct control, turn the pump, EG40, and SRS off. Before leaving the system be sure the current to the EG40 cartridge and to the SRS is off. To restart the system, download your method from PeakNet or use direct control to apply the required system settings. Allow the system to equilibrate for 30-45 minutes prior to collecting data.

If the system has been shut down for more than 3-4 days, the suppressor should be hydrated. See the appropriate SRS manual for SRS start-up details.

2. Low Flow Rate Methods and Cautions:

CAUTION

Dionex does not recommend operating the EG40 at low flow rates that allow the system pressure to drop below 2,000 psi (14 MPa). The degas assembly will not properly degas the eluent if the system pressure is below 2,000 psi and gas will build up on the analytical column.

If you enter a lower flow rate into your method, note the following: The Eluent Generator continues to generate eluent at the concentration set in the last step of the last Method. If the low flow rate Method does not include the Eluent Generator system, the EG40 will continue to generate eluent at the rate required for the higher flow rate set in the last Method. If this occurs, the eluent concentration will increase (in proportion to the decrease in the flow rate). In extreme cases, excessive heat build-up can occur, causing damage to the EluGen cartridge.

CAUTION

For anion exchange separations, carbonate may accumulate on the columns at low hydroxide concentrations. This accumulated carbonate will elute from the column when the hydroxide concentration is increased.

3.4.2 Long Term Shut-down

For long-term storage, the EluGen cartridge may be left in the EG40 module. If you need to remove the cartridge and store it, follow the directions in Section 5.4. Cap all vents and liquid connections. The pump may be used for conventional delivery of eluents by connecting the outlet of the pump pressure transducer to the “inj in” port on the Rheodyne injection valve.

SECTION 4 - APPLICATIONS

4.1 PRINCIPLES OF OPERATION

4.1.1 Anion Exchange Applications

The EluGen Cartridges may be used to generate isocratic or gradient eluents. The EluGen EGC-KOH (P/N 053921) can generate up to 100 mN KOH at 1.0 mL/min. Eluent concentrations up to 50 mN KOH can be produced at 2.0 mL/min. Up to 25% methanol may be used in the eluent.

4.1.2 Cation Exchange Applications

The EluGen EGC-MSA (P/N 053922) can generate up to 100 mN methanesulfonic acid (MSA) at a flow rate of 1.0 mL/min. Eluent concentrations up to 50 mN MSA can be produced at 2.0 mL/min. Solvents should not be used in the eluent.

4.1.3 EluGen Operating Conditions

The EGC-KOH and EGC-MSA Cartridges may be used with the columns and eluent conditions listed below. Verify the performance of the entire system by duplicating the column test chromatogram.

EG40 Operating Conditions and Applications

Maximum Flow Rate (4-mm operation):	3.0 mL/min
Maximum Flow Rate (2-mm operation):	0.75 mL/min
Maximum System Pressure:	3,000 psi (21 mPa)
Minimum Recommended System Pressure:	2,000 psi (14 mPa); use optional Pressure Restrictor as required

Anion Exchange

Concentration Range for 4-mm operation:	Concentrations up to 100 mM KOH at 1.0 mL/min; 50 mM at 2.0 mL/min
Concentration Range for 2-mm operation:	Concentrations up to 100 mM KOH at 0.25 mL/min; 100 mM at 0.5 mL/min
Solvent Concentration Range:	Up to 25% Methanol
Columns:	IonPac AS11, AS11-HC, AS15, AS15-5 μ m, AS16, AS17, CarboPac PA1 and CarboPac PA10

NOTE

The IonPac AS5A or AS10 may be used with the EG40 if the flow rate is reduced so that system pressure is less than 3,000 psi (21 MPa).

Cation Exchange

Concentration Range for 4-mm operation:	Concentrations up to 100 mM MSA at 1.0 mL/min; 50 mM at 2.0 mL/min
Concentration Range for 2-mm operation:	Concentrations up to 100 mM MSA at 0.25 mL/min; 100 mM at 0.5 mL/min
Solvent Concentration Range:	No solvents allowed
Columns:	IonPac CS12, CS12A, CS14, CS15, CS16 without solvents, CS11 or CS10 (without DAP-HCl)

4.1.4 Duplication of Conventional GP40, GP50, or GS50 Gradient Methods using the Offset Volume

If the Eluent Generator system is connected to a gradient pump, gradients can be generated from both the pump and from the Eluent Generator system. Because the Eluent Generator system is downstream from the pump, gradients generated by the Eluent Generator system reach the column faster than gradients generated at the pump. PeakNet software can automatically compensate for this timing difference by using an offset volume value. The offset volume is the fluid volume between the pump gradient mixing chamber outlet and the Eluent Generator outlet. Once this value is determined and entered into the PeakNet Method, PeakNet can synchronize pump and Eluent Generator system operation, allowing gradients from both the pump and the Eluent Generator system to reach the column at the same time.

We recommend you use an offset volume of 0 μL for most applications. However, users may specify offset volumes of 0 - 2000 μL in the PeakNet Eluent Generator system Method. The default value is 400 μL . The actual offset volume may be different depending on the system configuration (tubing lengths, and whether the system is 2 mm or 4 mm). To determine the volume, follow the instructions below.

The offset volume has no effect when using isocratic eluent generation but does delay the Eluent Generator system timed events. For isocratic Methods the offset volume value may be set to 0 μL .

Determining the Offset Volume Value:

Before starting this procedure, set up the system for normal operation.

1. Fill pump reservoir A with 100% deionized water.
2. Fill a reservoir with 10 mM KOH or MSA (whichever eluent the Eluent Generator system will be generating) and connect the reservoir to the pump as reservoir B.
3. In the PeakNet pump/Eluent Generator system Method Setup dialog box, enter an Offset Volume of 0 μL .
4. In the Method Editor dialog box, set the same concentration step change for both the pump and the Eluent Generator system to start at the same timed event. The step change should be large enough to affect the detector output readings, but not so large that the output goes off scale.

For example:

At time INIT, select 100% from reservoir A (deionized water) for the pump eluent and 0 mM for the Eluent Generator system generated eluent.

At time 0.0, select 10% from reservoir B (a 1.0 mM solution of eluent) and select 1.0 mM for the Eluent Generator system eluent concentration.

5. Connect the pump outlet directly to a length of 0.005" ID tubing which generates a system back pressure of about 2,000 psi (14 MPa) at the chosen flow rate (e.g. 1.0 mL/min) Connect to the inlet of the conductivity cell.
6. Monitor the conductivity detector response.
 - a. The first increase in detector response is the new eluent concentration arriving from the Eluent Generator system. Note the time this occurs.
 - b. The second increase in detector response is the new eluent concentration arriving from the pump. Note the time this occurs.
 - c. Calculate the time difference between the first and second increases in detector response.
 - d. Multiply the time difference (in minutes) by the flow rate (in mL/min x 1,000) to get the offset volume value (in μL).
7. After calculating the offset volume, enter its value into the pump/Eluent Generator system Method Setup dialog box.

4.2 VERIFYING THE SYSTEM CONFIGURATION

After configuring the system, run the standard chromatogram for your column. Be sure to run the analysis at the temperature given for the chromatogram, if one is listed. If no temperature is listed, the chromatogram should be run at room temperature.

1. If the chromatogram obtained matches the test chromatogram included with the column, the system is operating correctly for that set of system operating parameters.
2. If the chromatogram obtained does not match the sample chromatogram, see "Section 6" for troubleshooting information.

4.3 USING THE ELUGEN EGC-KOH CARTRIDGE FOR IONPAC AS11 HYDROXIDE GRADIENTS

This application demonstrates the comparison of an IonPac AS11 gradient separation using conventional gradient pump delivery with the gradient separation using EG40 gradient delivery. Figure 14, “Conventional Hydroxide Gradient on the IonPac AS11”, illustrates the use of a conventional pump method. Since the EG40 is located close to the injection valve, the gradient reaches the head of the column more quickly resulting in a shift in the gradient as shown in Figure 15, “EluGen EGC-KOH Gradient on the IonPac AS11.” Figure 15 illustrates the use of the EG40 with an identical gradient program using the default OFFSET VOLUME of 0 µL. In Figure 16, “EluGen EGC-KOH Gradient on the IonPac AS11 (OFFSET VOLUME = 400 µL),” the default value for the OFFSET VOLUME (400 µL) is used. PeakNet uses this value to delay the EG40 gradient program by 0.2 minutes (0.400 mL / 2 mL per minute). Note that the baseline shift using the gradient pump is approximately 1.5 µS. Using the EG40 to generate carbonate-free hydroxide reduces the baseline shift to approximately 50 nS.

Trap Column:	ATC-1, (Located between pump and injection valve); NOTE: The ATC-1 Trap Column should be replaced with an ATC-HC Trap Column after the pump.	
Sample Volume:	10 µL	
Column:	IonPac AS11 analytical and AG11 guard (4-mm)	
Eluent:	See table of conditions	
Eluent Flow Rate:	2.0 mL/min	
Suppressor:	Anion Self-Regenerating Suppressor-ULTRA (4-mm) AutoSuppression® Recycle Mode (300 mA)	
Expected Background Conductivity:		
(GP40 or GP50)	0.5 mM NaOH: 1 µS	35 mM NaOH: 2.5 µS
(EG40)	0.5 mM NaOH: 0.7 µS	35 mM NaOH: 0.75 µS
Typical Operating Back Pressure:		
(GP40 or GP50)	1850 psi (12.75 MPa)	
(EG40)	2200 psi (15.15 MPa)	
	Pressure Restrictor, (P/N 53762) was used with the EG40	

Analyte	mg/L(ppm)
1. Quinate	5
2. Fluoride	1
3. Acetate	5
4. Propionate	5
5. Formate	5
6. Methylsulfonate	5
7. Pyruvate	5
8. Valerate	5
9. Monochloroacetate	5
10. Bromate	5
11. Chloride	2
12. Nitrite	5
13. Trifluoroacetate	5
14. Bromide	3
15. Nitrate	3
16. Chlorate	3
17. Selenite	5
18. Carbonate	trace
19. Malonate	5
20. Maleate	5
21. Sulfate	5
22. Oxalate	5
23. Tungstate	10
24. Phthalate	10
25. Phosphate	10
26. Chromate	10
27. Citrate	10
28. Tricarballylate	10
29. Isocitrate	10
30. cis-Aconitate]—10
31. trans-Aconita	

GP40 Conditions

E1: Deionized water
 E2: 5.0 mM NaOH
 E3: 100 mM NaOH

Time (min)	%E1	%E2	%E3	Comments
Equilibration				
0	90	10	0	0.5 mM NaOH for 7 min
7.0	90	10	0	
Analysis				
0.0	90	10	0	0.5 mM NaOH, Inject
0.2	90	10	0	Inject Valve to Load Position
2.5	90	10	0	0.5-5.0 mM NaOH in 3.5 min
6.0	0	100	0	5.0-38.25 mM NaOH in 12 min
18.0	0	65	35	

EG40 Conditions

Eluent: Deionized water

Time (min)	Eluent Conc. (mM)	Comments
Equilibration		
0	0.5	0.5 mM KOH for 7 min
7.0	0.5	
Analysis		
0.0	0.5	0.5 mM KOH, Inject
0.2	0.5	Inject Valve to Load Position
2.5	0.5	0.5-5.0 mM KOH in 3.5 min
6.0	5.0	5.0-38.3 mM KOH in 12 min
18.0	38.3	

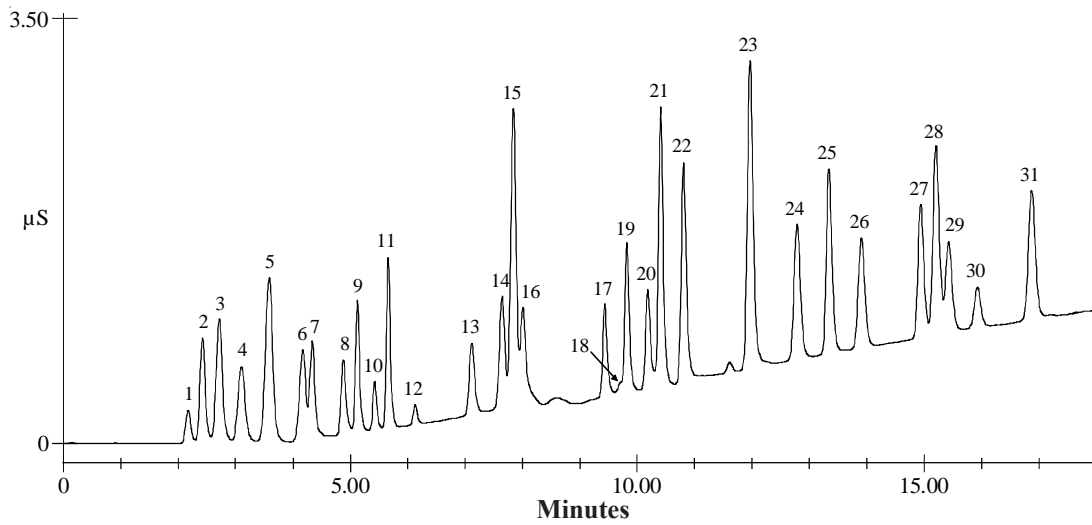


Figure 14
Conventional Hydroxide Gradient on the IonPac AS11

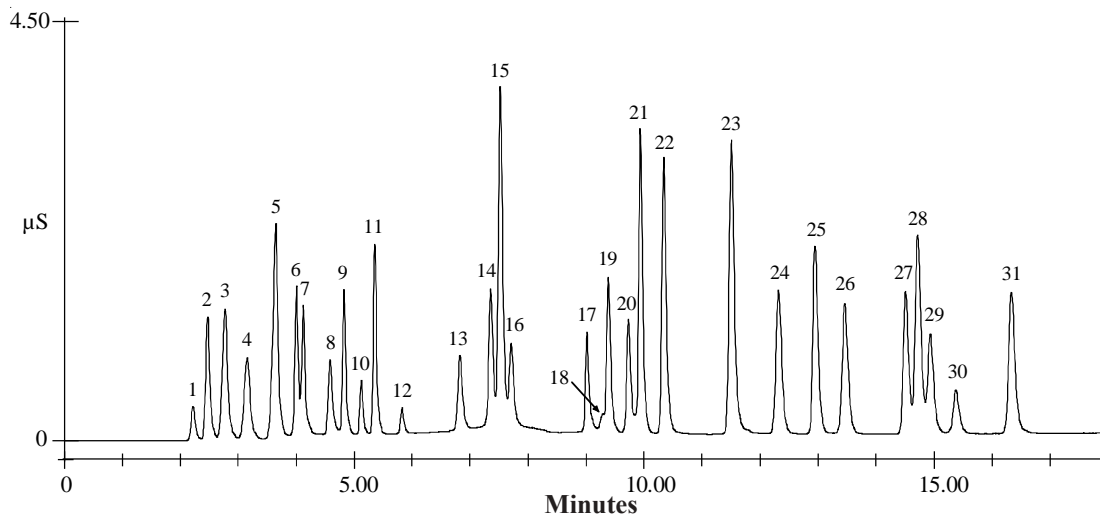


Figure 15
EluGen EGC-KOH Gradient on the IonPac AS11 (OFFSET VOLUME = 0 μL)

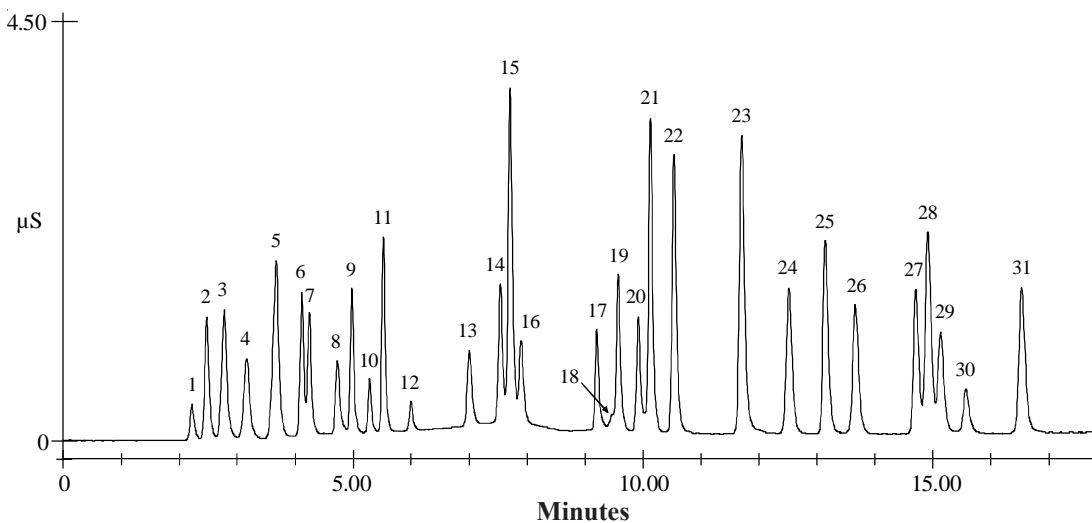


Figure 16
EluGen EGC-KOH Gradient on the IonPac AS11 (OFFSET VOLUME = 400 μL)

4.4 USING THE ELUGEN EGC-KOH CARTRIDGE FOR IONPAC AS15 ISOCRATIC ELUTION

This application demonstrates the comparison of an IonPac AS15 isocratic separation using conventional pump delivery to EG40 eluent delivery. Figure 17, “Conventional Hydroxide Eluent on the IonPac AS15,” illustrates use of a conventional method. Figure 18, “EluGen EGC-KOH Eluent on the IonPac AS15,” illustrates the use of the EG40 with an identical isocratic program using an OFFSET VOLUME of 400 µL. The offset volume has no effect on isocratic EG40 eluent delivery. In Figure 17, the chromatogram generated using the GP50 with conventional delivery of KOH was contaminated from carbonate in the D.I. reagent water used to make the KOH eluent. This contamination decreases the pH of the eluent and causes phosphate to coelute with nitrate. Use of the EG40 eliminates the eluent contamination problem, resulting in baseline resolution of nitrate and phosphate.

Sample Volume: 25 µL
 Column: IonPac AS15 analytical (4-mm) and AG15 guard (4-mm)
 Eluent: 40 mM KOH
 Eluent Flow Rate: 2.0 mL/min
 Suppressor: Anion Self-Regenerating Suppressor-ULTRA (4-mm)
 Temperatures: 30°C
 Expected Background Conductivity: AutoSuppression® Recycle Mode (300 mA)
 0.8-1.2 µS (EG40) 2-3 µS (GP40, GP50, or GS50)
 Typical Operating Back Pressure: 2100 psi (EG40) 1700 psi (GP40, GP50, or GS50)
 Back pressure restrictor was not used with the EG40

Analyte	mg/L (ppm)
1. Fluoride	2.0
2. Acetate	2.0
3. Chloride	5.0
4. Carbonate	10.0
5. Nitrite	10.0
6. Sulfate	10.0
7. Bromide	20.0
8. Nitrate	20.0
9. Phosphate	30.0

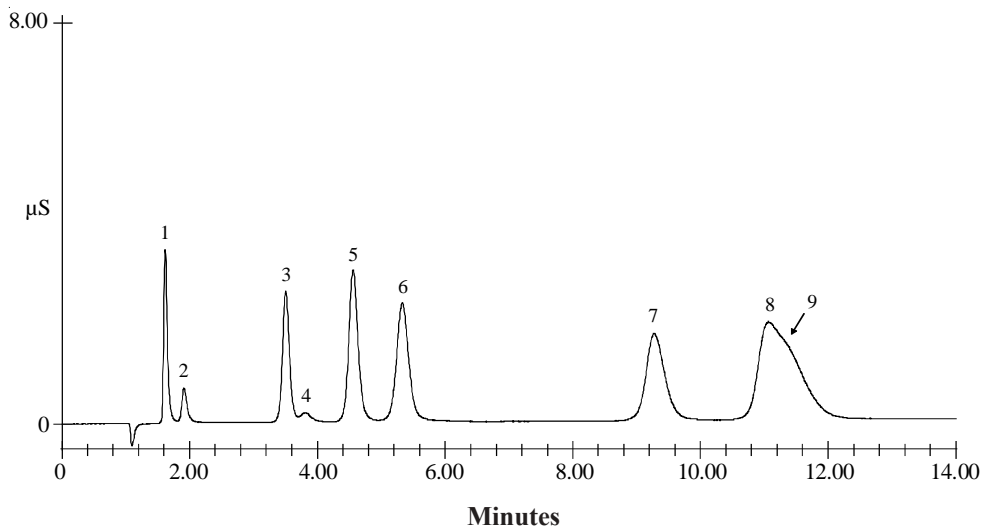


Figure 17
 Conventional Hydroxide Eluent on the IonPac AS15

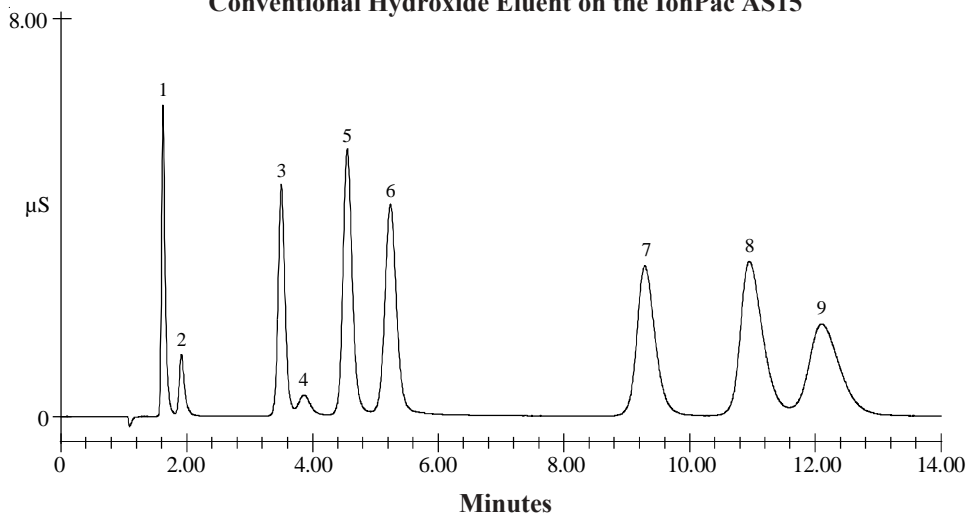


Figure 18
 EluGen EGC-KOH Eluent on the IonPac AS15

4.5 COMPARISON OF CONVENTIONAL BOTTLE ELUENT SYSTEM AND EG40 ELUENT GENERATOR SYSTEM FOR THE IONPAC AS15

The following example illustrates a comparison of a gradient delivered using conventional pump delivery and using the EG40 Eluent Generator system. When using the conventional gradient delivery, dissolved carbonate causes a baseline shift of approximately 1 μS . The carbonate-free potassium hydroxide gradient produced by the EG40 results in a very low baseline shift ($< 0.1 \mu\text{S}$). This low baseline shift allows easy integration of trace components.

Sample Loop Volume: 2 mL
 Trap Columns: IonPac ATC-1 (2), 1 after pump; 1 between EG40 degas assembly and injector. NOTE: The ATC-1 Trap Columns should be replaced with one ATC-HC Trap Column after the pump.
 Column: IonPac AS15 + IonPac AG15 (4-mm)
 Eluent: See Chromatogram
 Eluent Source: See chromatogram
 Eluent Flow Rate: 1.6 mL/min.
 Temperature: 30° C
 Suppressor*: Anion Self-Regenerating Suppressor-ULTRA
 AutoSuppression Recycle Mode, (300 mA)
 Expected Background Conductivity: EG40 eluent: 0.8-1.2 μS
 Bottle eluent: 2-3 μS

* An Anion MicroMembrane Suppressor (AMMS III) may be used in place of the ASRS-ULTRA. The Regenerant is 50 mN H_2SO_4 and the Regenerant Flow Rate is 10-15 mL/min.

Analyte	Example A $\mu\text{g/L}$ (ppb)	Example B $\mu\text{g/L}$ (ppb)
1. Fluoride	1.08	2.0
2. Glycolate	3.35	4.0
3. Acetate	3.86	4.0
4. Formate	3.63	2.0
5. Chloride	1.03	2.0
6. Carbonate	-	-
7. Nitrite	1.17	2.0
8. Sulfate	0.91	2.0
9. Oxalate	0.97	2.0
10. Bromide	2.87	4.0
11. Nitrate	0.89	4.0
12. Phosphate	3.07	6.0

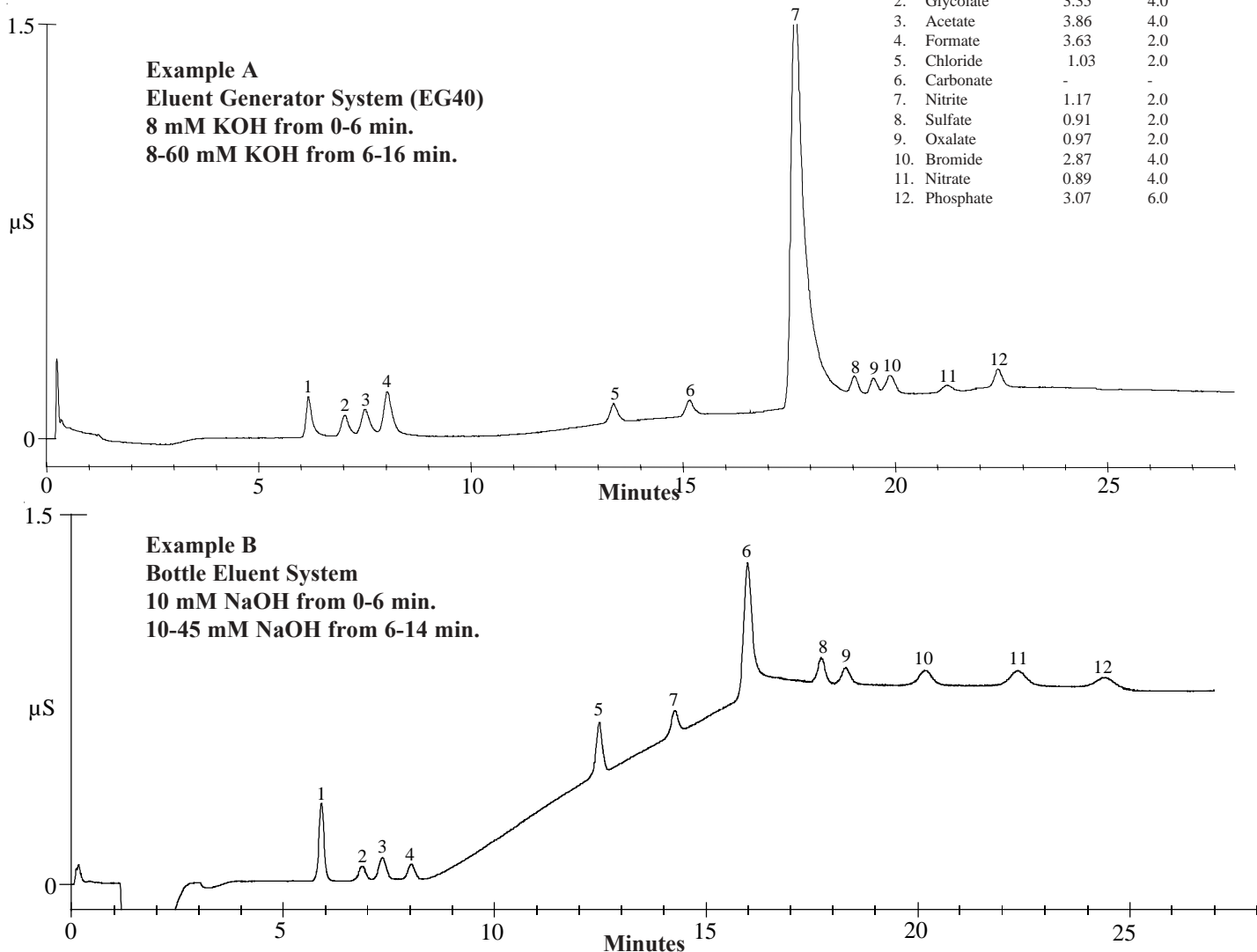


Figure 19
 Comparison of Eluent Generator System with Conventional Bottle Eluent System

4.6 LARGE LOOP INJECTION FOR µg/L (PPB) LEVEL ANALYSIS ON 2-mm AS15

High capacity of the AS15 column allows for the determination of trace inorganic anions and low molecular weight organic acids in high purity water matrices using a large loop injection. This chromatogram illustrates the separation of inorganic anions and low molecular weight organic acids in a high purity water sample using a large loop injection with a hydroxide linear gradient coupled with suppressed conductivity detection. Low ppb levels of these analytes can easily be determined using a 1 mL injection loop on a 2-mm AS15 column. Notice the much lower baseline shift produced when using the EG40 as the eluent source. To ensure reproducible retention times, the AS15 column must be operated at an elevated temperature (30° C).

Sample Loop Volume: 1 mL
 Trap Columns: IonPac ATC-1 (2), 1 after pump; 1 between EG40 degas assembly and injector. NOTE: The ATC-1 Trap Columns should be replaced with one ATC-HC Trap Column after the pump.
 Column: IonPac AS15 + IonPac AG15 (2-mm)
 Eluent Source: EG40
 Eluent: 8 mM KOH (0-6 min.)
 8-60 mM KOH (6-16 min.)
 Eluent Flow Rate: 0.5 mL/min.
 Temperature: 30° C
 Suppressor*: Anion Self-Regenerating Suppressor-ULTRA
 AutoSuppression External Water Mode, (100 mA)
 Expected Background Conductivity: 0.8-1.2 µS

* An Anion MicroMembrane Suppressor (AMMS III) may be used in place of the ASRS-ULTRA. The Regenerant is 50 mN H₂SO₄ and the Regenerant Flow Rate is 10-15 mL/min.

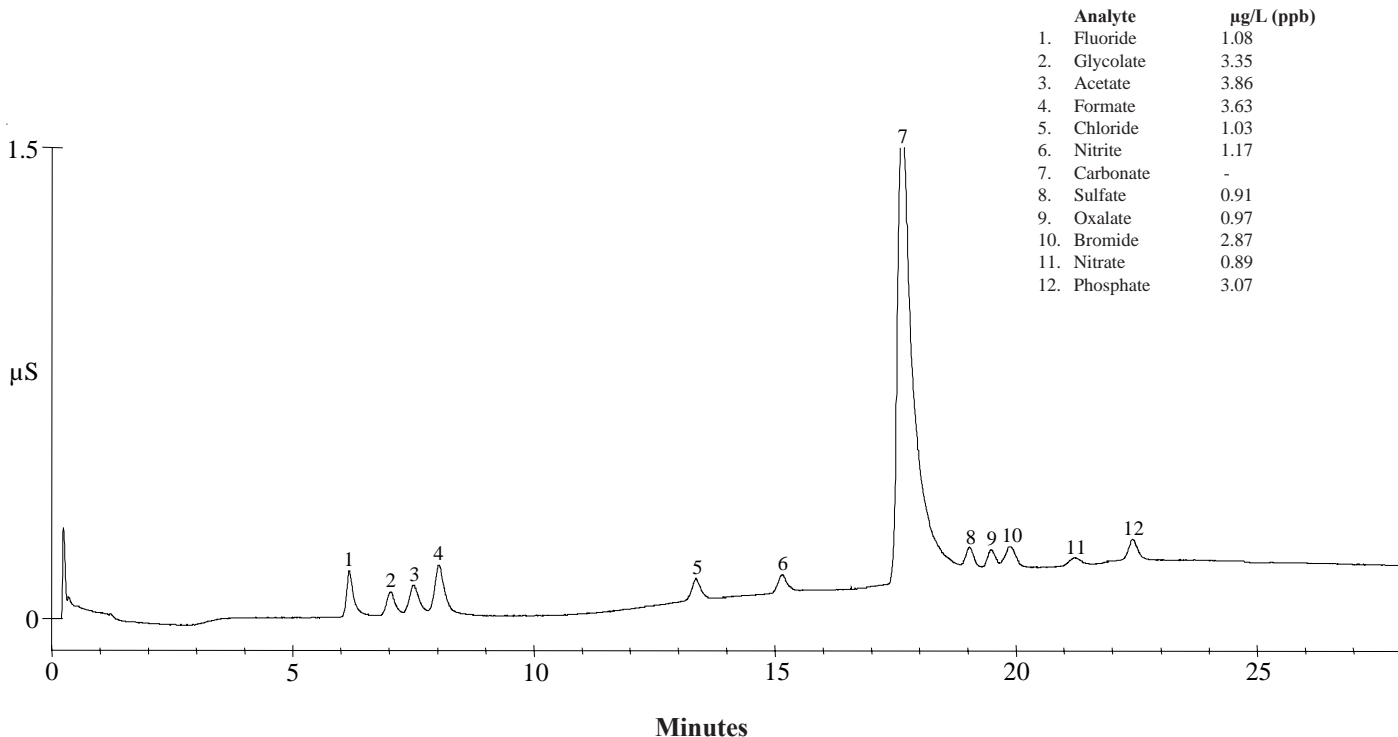


Figure 20
 Large Loop Injection for µg/L (ppb) analysis on 2-mm AS15

4.7 COMPARISON OF CONVENTIONAL ELUENT SYSTEM AND EG40 FOR GRADIENT ELUTION ON THE IONPAC AS16

Figure 21, “Separation of Polarizable Anions and Inorganic Anions using Gradient Elution,” illustrates the separation of a wide variety of inorganic anions including polarizable anions. Weakly retained anions such as acetate, propionate, and formate are resolved using an isocratic hydroxide eluent and the highly retained anions such as thiosulfate, thiocyanate, and perchlorate are eluted with a hydroxide gradient. Peak shape and efficiency are greatly improved for the polarizable anions on the IonPac AS16 column.

The following example also illustrates a comparison of a gradient delivered using a bottle eluent system and using the EG40 Eluent Generator system. When using the conventional bottle eluent delivery, dissolved carbonate causes a baseline shift of approximately 1 μ S. The carbonate free potassium hydroxide gradient produced by the EG40 results in a very low baseline shift (<0.3 μ S). This low baseline shift allows easy integration of trace components.

Trap Column:	Bottle Eluent System, ATC-1 located after pump. NOTE: The ATC-1 Trap Column should be replaced with an ATC-3 (4-mm) Trap Column (P/N 059660). EG40 system, ATC-1 (2), 1 located after pump; 1 located between EG40 degas assembly and injector. NOTE: The ATC-1 Trap Columns should be replaced with one ATC-HC Trap Column after the pump.
Sample Volume:	10 μ L
Column:	IonPac AS16 4-mm analytical and AG16 4-mm guard
Eluent:	E1: 5.0 mM NaOH E2: Deionized water E3: 100 mM NaOH
Eluent Flow Rate:	1.5 mL/min
Operating Temperature:	30° C
Suppressor*:	Anion Self-Regenerating Suppressor-ULTRA (4-mm) AutoSuppression® Recycle Mode
Expected Background Conductivity:	1.5 mM NaOH: 1 μ S 55 mM NaOH: 2.5 - 3.5 μ S
Typical Operating Back Pressure:	2,300 psi (15.15 MPa)

* In 4-mm systems, an Anion MicroMembrane Suppressor (AMMS-II) may be used in place of the ASRS-ULTRA (4-mm). The Regenerant is 50 mN H₂SO₄ and the Regenerant Flow Rate is 7 mL/min.

Analyte	mg/L (ppm)	Gradient Conditions			
		with bottle eluent system			Comments
		TIME (min)	%E1	%E2	
1. Fluoride	2.0				
2. Acetate	10.0				
3. Propionate	10.0				
4. Formate	10.0				
5. Chlorite	10.0				
6. Bromate	10.0				
7. Chloride	5.0				
8. Nitrite	10.0				
9. Nitrate	10.0				
10. Selenite	10.0				
11. Carbonate	20.0				
12. Sulfate	10.0				
13. Selenate	10.0				
14. Iodide	20.0				
15. Thiosulfate	10.0				
16. Chromate	20.0				
17. Phosphate	20.0				
18. Arsenate	20.0				
19. Thiocyanate	20.0				
20. Perchlorate	30.0				

EG40 Conditions			
Eluent: Deionized water			
Offset volume = 0.0 μ L			
Time (min)	Eluent Conc. (mM)	Comments	
Equilibration			
0	1.5	1.5 mM KOH for 7 min	
7.0	1.5		
Analysis			
7.1	1.5	Start isocratic analysis	
7.5	1.5	Inject Valve to Load Position	
15.3	1.5	End Isocratic analysis, Begin Gradient analysis	
21.3	10.0		
31.3	55.0		

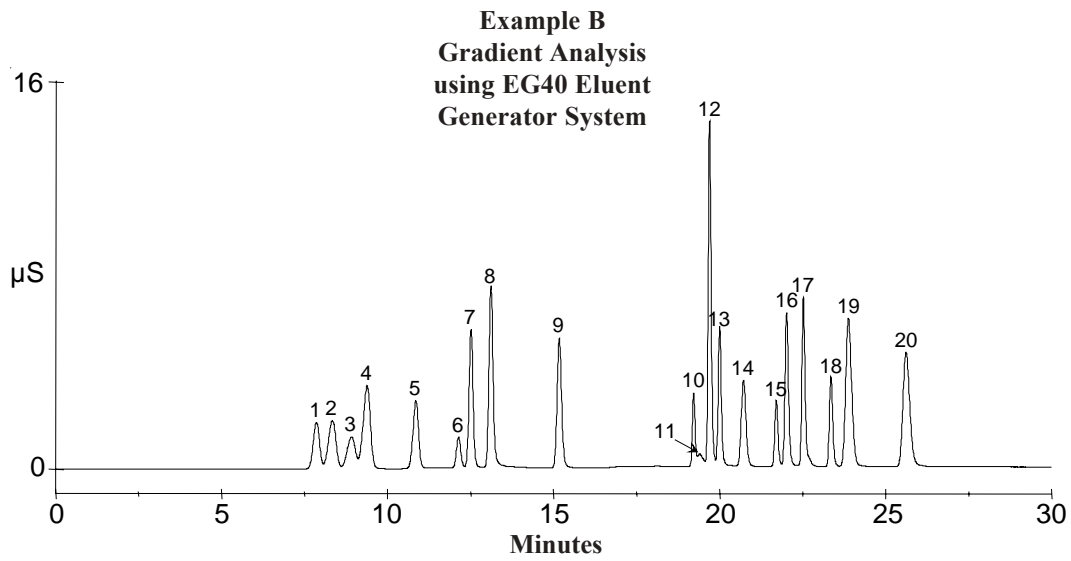
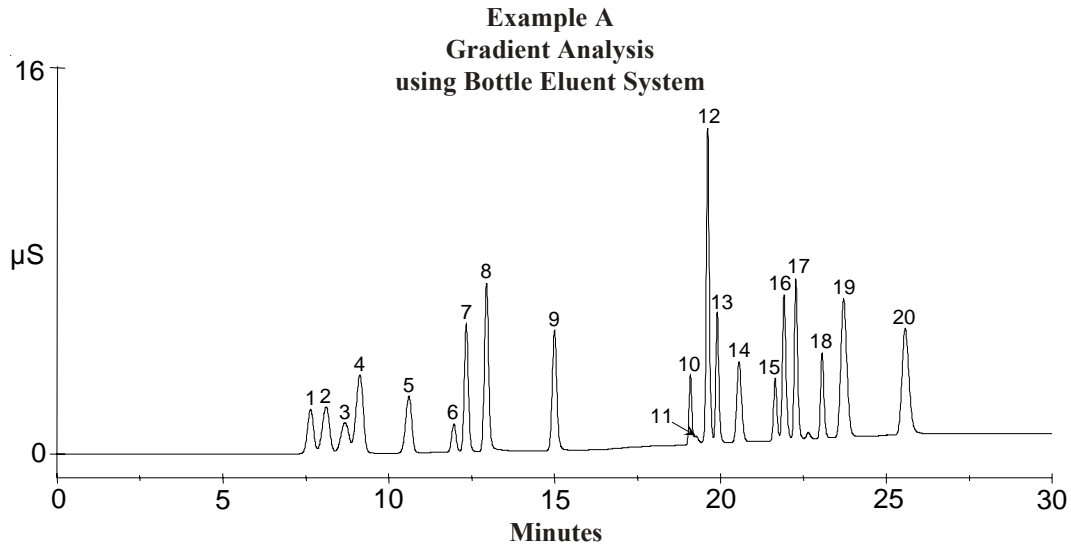


Figure 21
Separation of Polarizable Anions and
Inorganic Anions using Gradient Elution

4.8 USING THE EG40 FOR KOH ELUTION OF INORGANIC ANIONS, OXYHALIDES, AND ORGANIC ACIDS ON THE IONPAC AS17

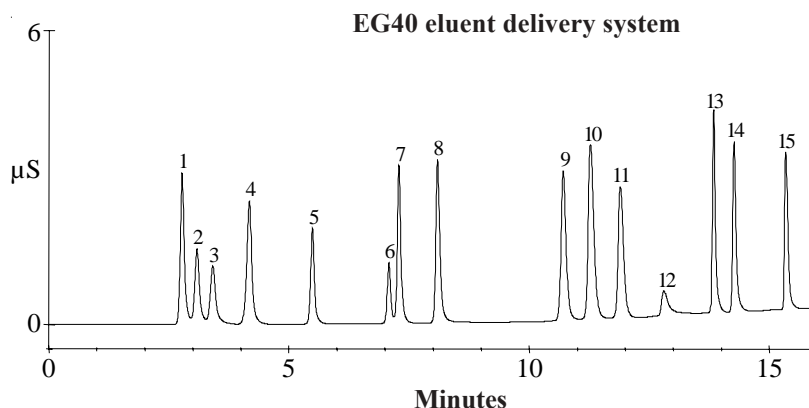
The following chromatograms compare the EG40 eluent delivery system with the bottle eluent delivery system at room temperature (22°C) for the determination of inorganic anions, oxyhalides, and organic acids. Notice, due to the large system void volume with the bottle eluent system, a longer equilibration time is required before injection.

Trap Column:	Bottle Eluent System, ATC-1 located after pump. NOTE: The ATC-1 Trap Column should be replaced with an ATC-3 (4-mm) Trap Column (P/N 059660). EG40 Eluent System, ATC-1 (2), 1 located after pump; 1 located at eluent outlet of EG40 degas assembly and before injector. NOTE: The ATC-1 Trap Columns should be replaced with one ATC-HC Trap Column after the pump.		
Sample Volume:	4-mm: 10 µL Loop + 0.8 µL Injection valve dead volume		
Column:	IonPac® AG17, AS17 4-mm		
Eluent Source:	See table	Analyte	mg/L(ppm)
Eluent:	See table	1. Fluoride	2.0
Eluent Flow Rate:	1.5 mL/min (4-mm)	2. Acetate	5.0
Temperature:	Room temperature (22°C)	3. Propionate	5.0
Suppressor*:	Anion Self-Regenerating Suppressor-ULTRA (4-mm) AutoSuppression® Recycle Mode (300 mA)	4. Formate	5.0
Expected Background Conductivity:	0.5-1.0 µS	5. Chlorite	5.0
Storage Solution:	Eluent	6. Bromate	5.0
		7. Chloride	3.0
		8. Nitrite	5.0
		9. Bromide	10.0
		10. Nitrate	10.0
		11. Chlorate	10.0
		12. Carbonate	20.0
		13. Sulfate	5.0
		14. Oxalate	5.0
		15. Phosphate	10.0

* In 4-mm systems, an Anion MicroMembrane Suppressor (AMMS-II) may be used in place of the ASRS-ULTRA. The Regenerant is 50 mM H₂SO₄ and the Regenerant Flow Rate is 7-10 mL/min.

Eluent: Deionized water
Offset volume = 0.0 µL

Time (min)	Eluent Conc. (mM)	Comments
Equilibration		
0	1.0	1.0 mM KOH for 4 min
4.0	1.0	
Analysis		
4.1	1.0	Start isocratic analysis
4.5	1.0	Inject valve to load position
7.0	1.0	Begin gradient analysis
14.0	10.0	
18.0	35.0	End gradient



Gradient Conditions:

- E1: 5 mM NaOH
- E2: DI water
- E3: 100 mM NaOH

TIME (min)	%E1	%E2	%E3	Comments
Equilibration				
0	20	80	0	1.0 mM NaOH for 5 min
5.0	20	80	0	
Analysis				
5.1	20	80	0	Start isocratic analysis
5.5	20	80	0	Inject valve to load position
7.0	20	80	0	Begin gradient analysis
14.0	0	90	10	
18.0	0	65	35	End gradient

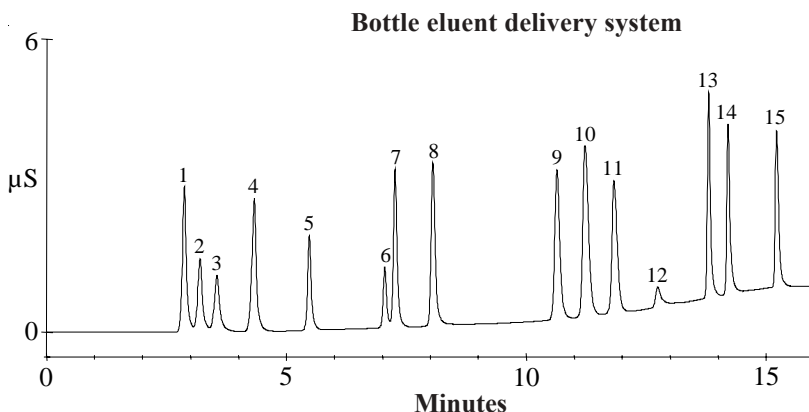


Figure 22
Determination of Inorganic Anions, Oxyhalides, and Organic Acids at Room Temperature

4.9 USING THE ELUGEN EGC-MSA CARTRIDGE FOR IONPAC CS12A ISOCRATIC MSA ELUTION ON THE IONPAC CS12A

This application demonstrates the comparison of an IonPac CS12A isocratic separation using conventional isocratic pump delivery with EG40 isocratic delivery. Figure 23, “Conventional MSA Isocratic Elution on the IonPac CS12A,” illustrates the use of a conventional pump method. Figure 24, “EluGen EGC-MSA Isocratic Elution on the IonPac CS12A,” illustrates the use of the EG40 with an identical isocratic program using an OFFSET VOLUME of 0.0 µL.

Sample Volume:	25 µL	
Column:	IonPac CS12A analytical (4-mm) and CG12A guard (4-mm)	
Eluent:	18 mM MSA	
Eluent Flow Rate:	1.0 mL/min	
Oven Temperature:	30° C	
Cell Temperature:	35° C	
Suppressor:	Cation Self-Regenerating Suppressor-ULTRA (4-mm) AutoSuppression® Recycle Mode (100 mA)	
Expected Background Conductivity:	0.3 µS (EG40)	0.4 µS (GP40, GP50, or GS50)
Typical Operating Back Pressure:	1980 psi (EG40)	970 psi (GP40, GP50, or GS50)

Back pressure restrictor (P/N 53763) was used with the EG40

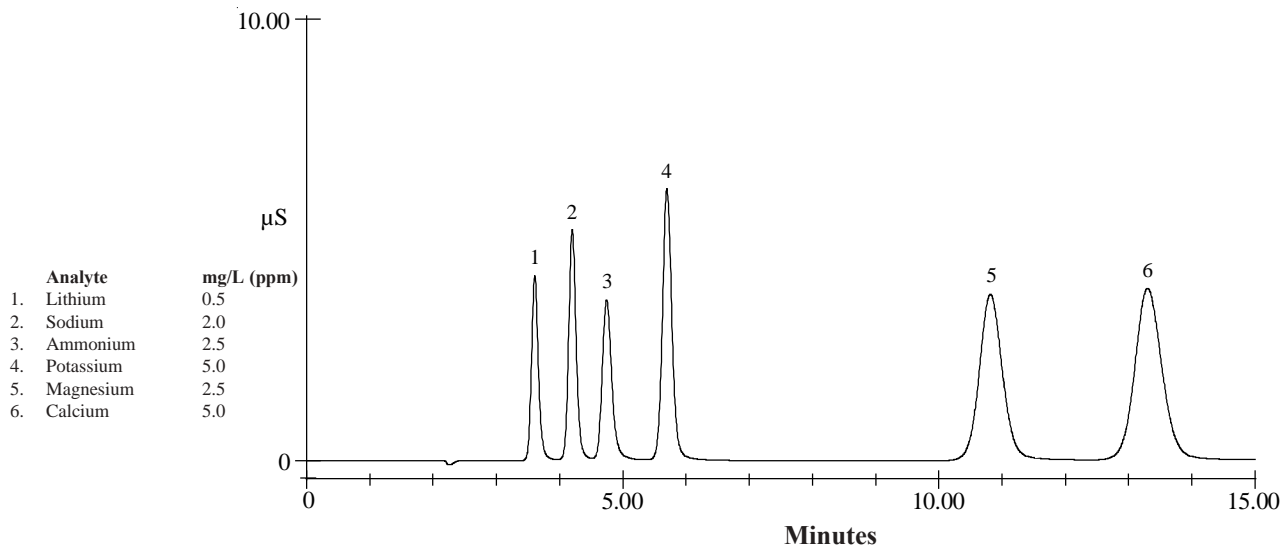


Figure 23
Conventional MSA Isocratic Elution on the IonPac CS12A.

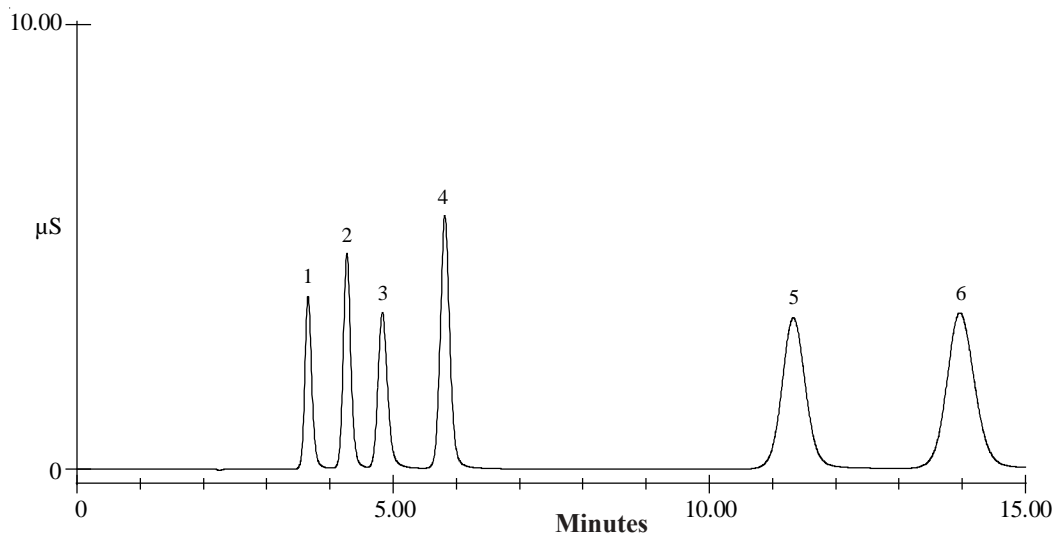


Figure 24
EluGen EGC-MSA Isocratic Elution on the IonPac CS12A.

4.10 USING THE ELUGEN EGC-MSA CARTRIDGE FOR IONPAC CS12A MSA GRADIENT

This application demonstrates the comparison of an IonPac CS12A gradient separation using conventional gradient pump delivery to the gradient separation using EG40 gradient delivery. Figure 25, "Conventional MSA Linear Gradient on the IonPac CS12A," illustrates the use of a conventional pump method. Figure 26, "EluGen EGC-MSA Linear Gradient on the IonPac CS12A," illustrates the use of the EG40 with an identical gradient program using the OFFSET VOLUME of 0 μ L. Note the smaller baseline shift during the gradient when using the EG40. Since the EG40 delivers the gradient with a much smaller delay volume, the peaks elute more quickly. By increasing the OFFSET VOLUME from 0 μ L to 400 μ L, the start of the gradient will be delayed 0.2 minutes and the retention times of the peaks eluted by the gradient will increase.

NOTE

Solvents should not be used with the EluGen EC-MSA cartridge.

Sample Volume:	25 μ L
Column:	IonPac CS12A analytical and CG12A guard (4-mm)
Eluent:	See table of conditions
Eluent Flow Rate:	1.0 mL/min
Cell Temperature:	35° C
Oven Temperature:	30° C
Suppressor:	Cation Self-Regenerating Suppressor-ULTRA (4-mm) AutoSuppression® Recycle Mode (300 mA)
Expected Background Conductivity:	(GP40 or GP50) 11 mM MSA: 0.4 μ S 57 mM MSA: 0.8 μ S (EG40) 11 mM MSA: 0.4 μ S 57 mM MSA: 0.44 μ S
Typical Operating Back Pressure:	(GP40 or GP50) 960 psi (6.61 MPa) (EG40) 1880 psi (12.95 MPa)
Offset Volume:	Pressure Restrictor, (P/N 53763) was used with the EG40 0.0 μ L

Analytes	mg/L (ppm)
1. Lithium	0.5
2. Sodium	2.0
3. Ammonium	5.0
4. Potassium	5.0
5. 5-Amino-1-pentanol	20.0
6. Morpholine	15.0
7. Magnesium	2.5
8. Calcium	5.0
9. 3-Dimethylamino-propylamine	10.0

GP40 Conditions

E1: Deionized water

E2: 100 mM MSA

Time (min)	%E1	%E2	Comments
------------	-----	-----	----------

Equilibration

0	89	11	11 mM MSA for 7 min.
7.0	89	11	

Analysis

0.0	89	11	11 mM MSA
0.1	89	11	Inject Valve to Load Position
9.1	55	45	Step change to 45 mM MSA
14.0	55	45	45-57 mM MSA in 3.0 min.
17.0	43	57	57 mM MSA
20.0	43	57	57 mM MSA (end)

EG40 Conditions

Eluent: Deionized water

Time (min)	Eluent conc. (mM)	Comments
------------	-------------------	----------

Equilibration

0	11	11 mM MSA for 7 min.
7.0	11	

Analysis

0.0	11	11 mM MSA
0.1	11	Inject Valve to Load Position
9.1	45	Step change to 45 mM MSA
14.0	45	45-57 mM MSA in 3.0 min.
17.0	57	57 mM MSA
20.0	57	57 mM MSA (end)

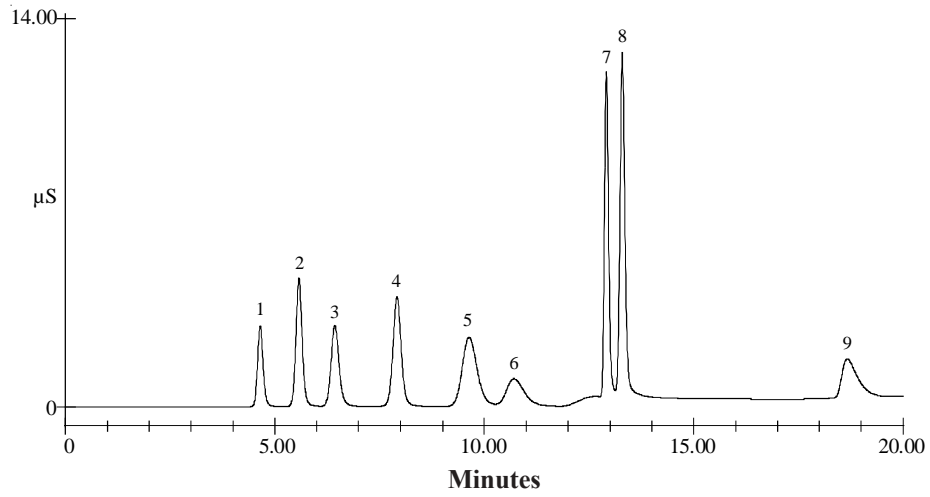


Figure 25
Conventional MSA Linear Gradient on the IonPac CS12A.

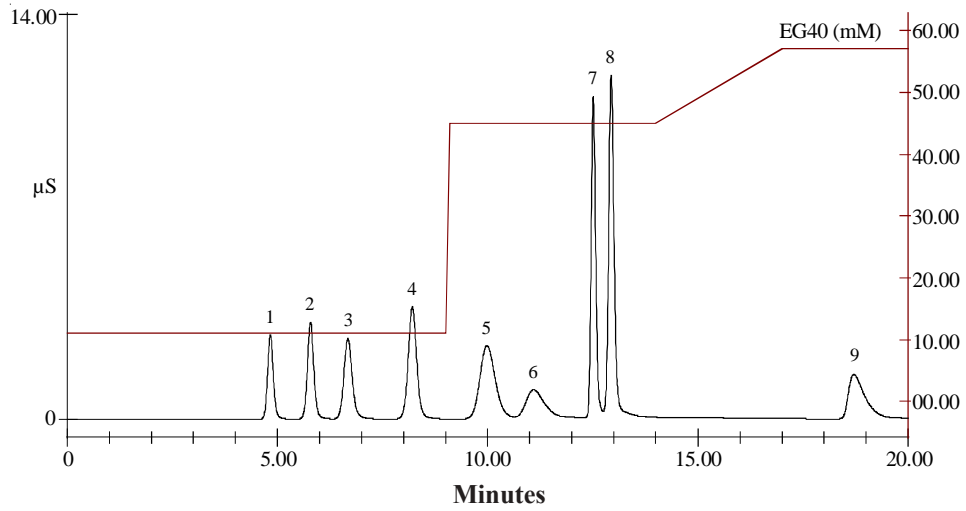


Figure 26
EluGen EGC-MSA Linear Gradient on the IonPac CS12A.

4.11 GLYCOCONJUGATE MONOSACCHARIDE ANALYSIS WITH THE EG40 KOH GENERATOR

This application demonstrates the use of the EGC-KOH generator for resolving glycoconjugate-derived monosaccharides in the Biotechnology and Pharmaceutical industries. The conventional method, using manual or pump-generated eluent, requires a step to 200 mM NaOH for 10 minutes to remove carbonate from the column, followed by a 15 minute re-equilibration to force a 50 minute cycle time. The EGC-KOH method, (see Figure 27, “Analysis of Monosaccharide Standards Showing a Fast Cycle Time with EG40-Generated Carbonate-Free Eluent”) employs a 5 minute step at 80 mM to remove amino acids or late eluting components, and a short re-equilibration to support a 30 minute cycle time. This demonstrates that control of carbonate anion results in a 40% gain in throughput for this application.

Sample: 10 μ L, 20 μ M standards
Eluent: Deionized Water
Column: CarboPac PA10 (Analytical) and AminoTrap
Flow: 1.0 mL/min
Pressure: 2,800 psi

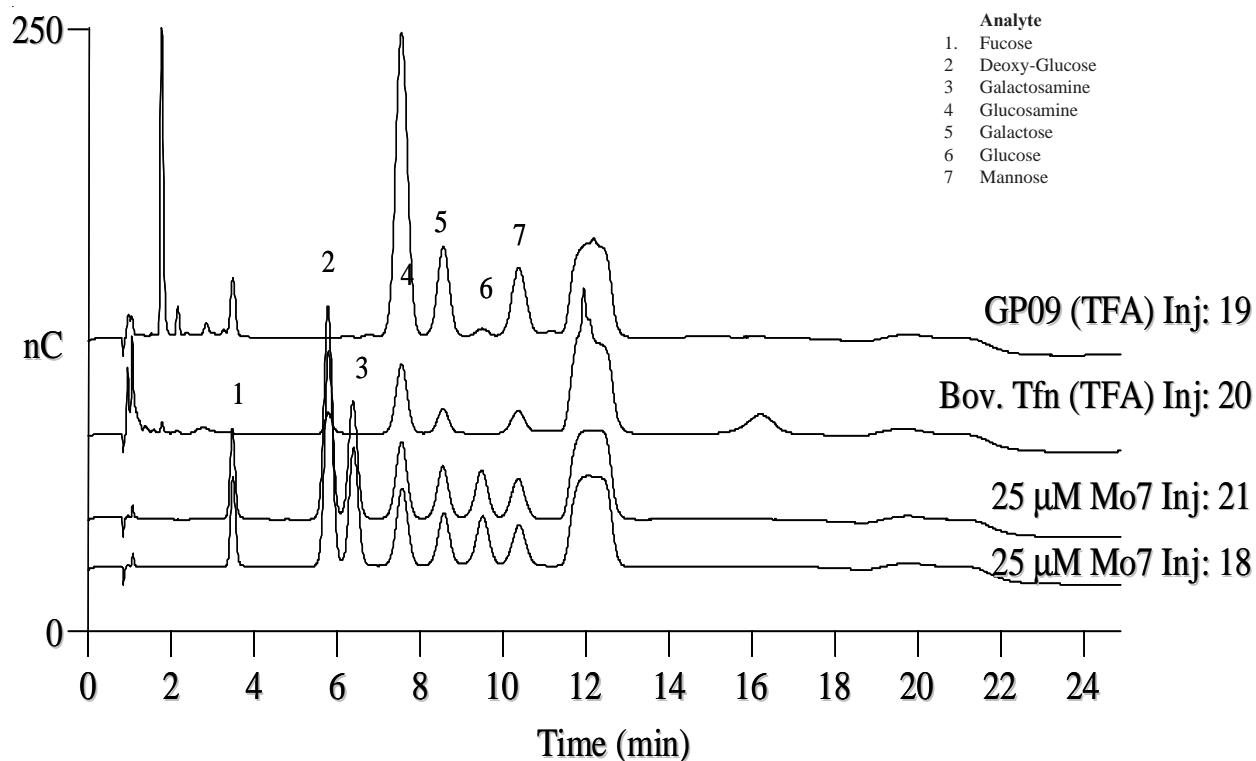


Figure 27

Analysis of Monosaccharide Standards Showing a Fast Cycle Time with EG40-Generated Carbonate-Free Eluent

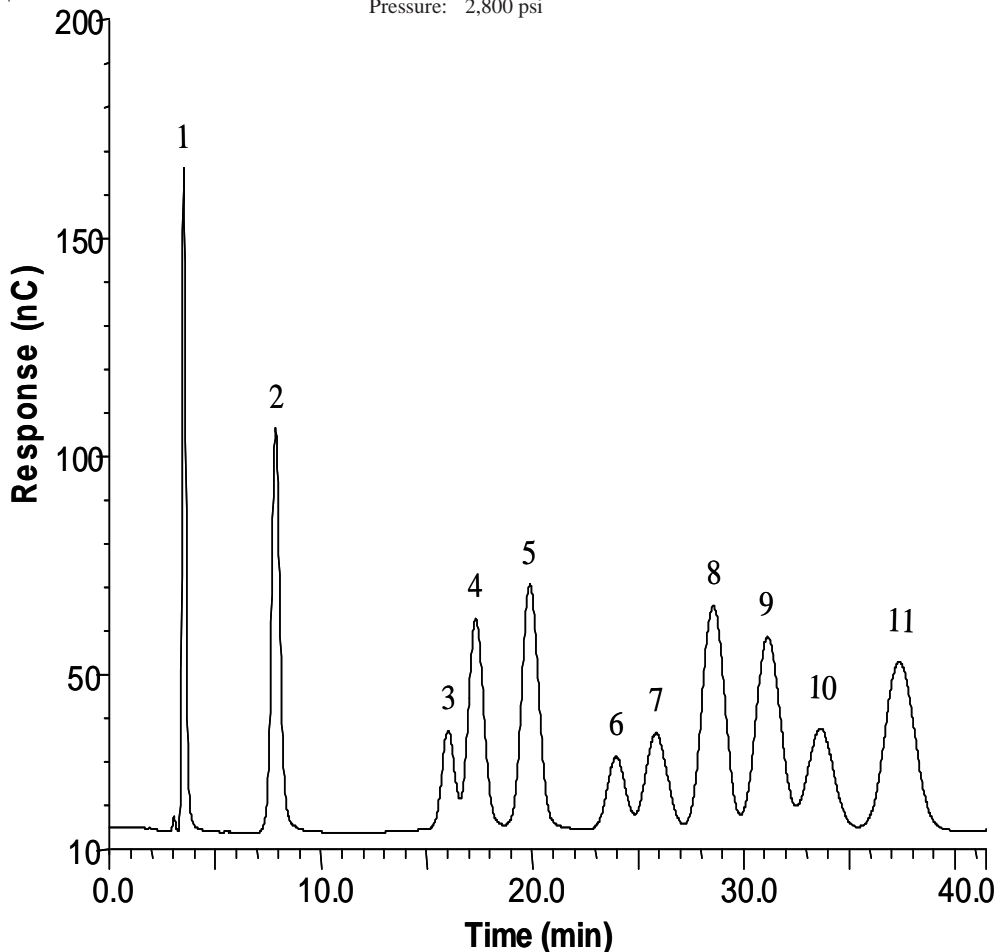
4.12 ANALYSIS OF MONO- AND DISACCHARIDES FOUND IN FOODS AND BEVERAGES USING THE EG40-GENERATED KOH AS ELUENT

This application demonstrates the use of the EGC-KOH generator for resolving carbohydrates found in foods and beverages (Figure 28, “Analysis of Monosaccharides in Foods and Beverages with the EG40-Generated Carbonate-Free Eluent”). Resolution of galactose, glucose, mannose and xylose, as well as other carbohydrates, is impacted by carbonate ion. This divalent anion is present to varying degrees in hydroxide-containing eluents due to dissolution of carbon dioxide in the basic eluent. Use of KOH, generated electrolytically at the time of use, prevents the application and accumulation of carbonate on the column. When hydroxide-containing eluents in system reservoirs are used, separation of these carbohydrates can only be accomplished following the completion of the following steps: (1) 15 min wash with 300 mM NaOH to remove carbonate from the column, (2) 15 min rinse with DI water. The sample can then be injected.

When 2.3 mM KOH is generated by the EGC-KOH cartridge, these carbohydrates are well resolved by a system that requires neither post-column base addition, nor preparation of caustic eluents. A 5 min step to 100 mM KOH at the end of the carbohydrate elution window is employed to remove organic acids and other late eluting compounds. With the step and time for equilibration, cycle time is reduced from 80 min to 60 min, demonstrating that control of carbonate results in a 33% gain in throughput.

Sample: 10 µL, 20 µM standards
 Eluent: Deionized Water
 Column: CarboPac PA10 (4 x 250 mm) + AminoTrap (4 x 50 mm)
 Flow: 1.0 mL/min
 Pressure: 2,800 psi

Method:	(EG40 Program)
Time	[KOH]
0.0	2.3 mM
39.5	2.3 mM
40.0	100 mM
45.0	100 mM
45.5	2.3 mM



Peak	Component
1	Mannitol
2	Fucose
3	Arabinose
4	Rhamnose
5	Galactose
6	Glucose
7	Sucrose
8	Xylose
9	Mannose
10	Fructose
11	Ribose

Figure 28
 Analysis of Monosaccharides in Foods and Beverages with EG40-Generated Carbonate-Free Eluent

SECTION 5 - MAINTENANCE

5.1 ROUTINE MAINTENANCE

1. Locate and repair leaks (see Section 6.2) and clean up spills. Rinse dried eluents off system components with deionized water. Rinse the EG40 drip tray with DI water to prevent formation of salt crystals and then dry it. Rinse and dry the leak sensor.
2. Periodically check all air and liquid lines for crimping. Move or reroute pinched lines and replace damaged lines (see Section 7).

5.2 CALIBRATING THE LEAK SENSOR

After eliminating the cause of a liquid leak inside the EG40 (see Section 6.2), the leak sensor may need to be recalibrated. Complete the following procedure:

1. Open the PeakNet Configuration Editor.
2. Select Calibrate EG40 Leak Sensor from the Configure menu. A message box will appear. After following the preliminary instructions in the message box, click the Start button to begin the calibration procedure or click the Exit button to abort it. Exit is disabled once the procedure has begun.
3. Upon completion of the calibration procedure, a message box indicating the result is displayed. If the leak sensor was not successfully calibrated, contact Dionex for help. In the U.S., call 1-800-DIONEX-0 (1-800-346-6390). Outside the U.S., contact the nearest Dionex office.

5.3 MONITORING THE ELUGEN CARTRIDGE LIFETIME

The Module Status Display in the PeakNet Run program displays important information about the EluGen cartridge currently being used by the EG40.

1. **EluGen Serial Number:**
This number is a unique 12-digit number that identifies the cartridge.
2. **Remaining EluGen Lifetime:**
This value is expressed as a percentage and counted down in 1% increments. At 10%, Run displays a warning each time an EG40 Method or Schedule is loaded. After the cartridge has expired (0%), RUN can no longer load an EG40 Method or Schedule until the EluGen Cartridge is replaced.
3. **EluGen Expiration Date:**
This date is 2 years from the date of manufacture. One month before expiration, RUN displays a warning each time an EG40 Method or Schedule is loaded. On the expiration date, RUN displays a message that the cartridge has expired, however, you may continue operation with this cartridge provided EluGen lifetime remains. Be aware that use beyond the expiration date may effect your chromatographic results.
4. **EluGen Cartridge Properties:**
The EluGen cartridge properties for all EluGen Cartridges that have been utilized on a system can be viewed by selecting "View the EluGen Properties."

NOTE

To disable these messages, and all advisory messages, select Confirmation from the View menu in Run.

5.4 REPLACING THE ELUGEN CARTRIDGE

The EluGen cartridge must be replaced when the cartridge is expended, when it leaks, or in order to switch between anion and cation separations with a single EG40 Module.

The label on the inside of the EG40 door illustrates the tubing connections to the cartridge.

To remove the old cartridge:

1. Turn off the EG40 pump flow either manually or via direct control in PeakNet. The power to the EluGen Cartridge and SRS suppressor will automatically shut off.
2. Open the door of the EG40.
4. The electrical connector cable for the cartridge is plugged into a connector below the EluGen Cartridge shelf. Depress the catch on top of the plug and pull it straight out of the connector.
5. Unscrew the gas vent line from the barbed fitting at the top corner of the EGC electrolyte reservoir. At the same time, use a wrench to prevent the connector in the gas vent port from becoming unscrewed.
6. Install the 1/4-28 Luer cap (P/N 053981) in the gas vent port. Use the cap removed from the port during initial installation of the EG40. The cap should be in the drip tray.
7. With the eluent lines still attached, and the electrical contacts facing you, lift the EluGen Cartridge from the EG40 Cartridge shelf and turn it so that the electrolysis chamber and liquid line fittings are upward.
8. Unscrew the cartridge inlet line from the EluGen Cartridge “IN” fitting. This line leads to the pump transducer or to the anion trap column, (if present). Unscrew the cartridge outlet line from the “OUT” fitting on the EluGen Cartridge.
9. Prepare an expanded cartridge for disposal by completing the following: Hold the cartridge with the generator chamber upward, unscrew the eluent generation chamber from the electrolyte reservoir, and pour the remaining electrolyte solution into an appropriate hazardous waste container. Refer to the Material Safety Data Sheet (MSDS) shipped with the EluGen Cartridge for the chemical description.

Rinse the electrolyte reservoir and membranes with DI water three times. Rinsing should render the reservoir and the membranes nonhazardous; however, check with local, state, and federal regulatory agency regulations for proper disposal.

10. If the cartridge is not expended, plug all fittings and store the cartridge in a standing position (with the electrolyte reservoir at top) at 4 to 40°C (39 to 104°F) until its next use. The cartridge may be stored for up to two years. To reinstall the cartridge, follow the start-up instructions in Section 2.5.2.
11. To install a new cartridge, follow the procedure in Section 2.5.2
12. The next time you load a Method or Schedule, or begin a run via Direct Control, a dialog box will prompt you to enter a new serial number for the cartridge. Run will verify the valid serial number entry.

NOTE

When switching between anion and cation separations on the same system, flush the entire system (excluding the EluGen Cartridge, column, and suppressor, but including the high pressure degas tubing assembly) with 5 to 10 mL of DI water at 1.0 or 2.0 mL/min before connecting the new cartridge, column, and suppressor.

5.5 REPLACING THE ELUGEN CARTRIDGE OUTLET FRIT

1. If the source of the system high backpressure is isolated to the EluGen Cartridge, the outlet frit should be replaced. The EluGen cartridge should add < 100 psi of backpressure.
 2. Turn off the EG40 pump flow. The power to the EG40 and the SRS will automatically shut off.
 3. With the eluent lines and electrical connects still attached, lift the EluGen Cartridge from the cartridge shelf, and turn it so the eluent generation chamber and liquid line fittings are upward.
 4. Unscrew the cartridge outlet line from the “OUT” fitting on the EluGen Cartridge. The outlet frit is located in the electrolysis chamber at the base of this fitting. Using a sharp or pointed tool, such as the mini screwdriver (P/N 46985), carefully puncture and remove the frit body and seal ring. Replace with a new frit assembly (P/N 42310) provided with the EluGen cartridge.
 5. Reattach the outlet line.
 6. **IMPORTANT. Invert the EluGen Cartridge with the Eluent Generation Chamber downward as shown in Figure 10, “EGC Cartridge.” Shake the EluGen Cartridge vigorously, and tap the eluent generation chamber with the palm of your hand 10 to 15 times. Watch to be sure all bubbles trapped in the electrolysis chamber are dislodged. Be sure to repeat this process each time the EGC cartridge is turned with the eluent generation chamber upward.**
 7. Position the EluGen Cartridge in the EG40 Module with the eluent generation chamber downward by positioning the PEEK chamber just below the shelf and sliding the cartridge through the opening in the shelf.
-

SECTION 6 - TROUBLESHOOTING GUIDE

The purpose of the Troubleshooting Guide is to help solve operating problems that may arise while using the EG40 Eluent Generator. For more information on problems that originate with the Ion Chromatograph (IC), column, or suppressor, refer to the Troubleshooting Guide in the appropriate operator's manual. If you cannot solve the problem on your own, contact the DIONEX North America Technical Call Center at 1-800-DIONEX-0 (1-800-346-6390) or the nearest DIONEX Office (see "DIONEX Worldwide Offices").

6.1 EG40 ERROR CODES IN PEAKNET

PeakNet may report the following error messages for the EG40 in the Run Program. The following table lists the cause of each error code. This information may be helpful in troubleshooting the cause of the EG40 internal abort problem.

Table 2
EG40 Error Codes

Error Code	PeakNet message*	Cause of Error
8526	The pump is not responding	No communication with pump
8527	The pump's flow rate is less than 0.1 mL/min.	Pump flow rate is < 0.1 mL/min.
8528	There is a pump and pressure alarm condition	Pump pressure alarm
8529	Pump leak condition has been detected	A pump leak condition
8530	The pump motor has failed	Pump motor failed

* These messages will only appear if you have the PeakNet 5.01d patch or higher version installed. If you do not have the patch installed the error message will read, a "Unknown Error."

6.2 EG40 TROUBLESHOOTING

Table 3, "EG40 Troubleshooting," is a troubleshooting summary, listing an observed problem when operating the EG40 Module, one or more causes for the problem, and the appropriate corrective action.

Table 3
EG40 Troubleshooting Summary

Observation	Cause	Action
Leak LED Indicator is illuminated (This error does not shut off the EG40.)	<p>Leaking fitting</p> <p>Blocked or improperly installed waste line</p> <p>EluGen cartridge leaks</p> <p>Degas assembly leaks</p> <p>Leak sensor is not calibrated</p>	<p>Locate the source of the leak. Tighten or replace liquid line connections. See Section 7.2 for details on making line fittings.</p> <p>Check the waste lines to be sure they are not crimped or otherwise blocked. Make sure the lines are not elevated at any point after they exit the EG40.</p> <p>The cartridge must be replaced (see Section 5.4). After replacing the cartridge, recalibrate the leak sensor (see Section 5.2).</p> <p>The degas assembly must be replaced See Section 7.3</p> <p>Calibrate the leak sensor (see Section 5.2).</p>
Fault LED Indicator is illuminated (This error shuts off the EG40.)	<p>EluGen Cartridge electrical connection is open</p> <p>EluGen Cartridge input electrical connection has shorted out.</p> <p>EG40 Module electrical error.</p>	<p>Tug gently on the EluGen Cartridge cable; the locking connector should hold the cable in place. If the cable is fully seated and the problem persists, the cartridge is defective and must be replaced. See Section 5.4 for instructions</p> <p>The cartridge must be replaced. See Section 5.4 for instructions</p> <p>This is an EG40 Module error.</p> <p>PeakNet has a diagnostic procedure intended for use by DIONEX Service Personnel only. The procedure reports the EG40 current and voltage stability. Use this service command only when instructed to by a DIONEX Service Representative</p>
Power LED is not illuminated	No power	<p>Make sure the EG40 module main power cord is plugged in.</p> <p>Make sure the wall outlet has power.</p> <p>Make sure the power switch is in the depressed position.</p> <p>If the Power LED fails to illuminate, contact the DIONEX North America Technical Call Center at 1-800-DIONEX-0 (1-800-346-6390) or the nearest DIONEX Office (see "DIONEX Worldwide Offices").</p>
No eluent flow	<p>Pump is not operating</p> <p>High pressure degas tubing assembly ruptured</p>	<p>Make sure the main power to the pump is turned on. Reprime the pump and then resume operation. Refer to the pump manual for priming instructions.</p> <p>The pump pressure limit has been tripped. Refer to the troubleshooting instructions in the pump manual.</p> <p>If there is no flow through the columns, although flow from the waste line remains normal, the degas tubing assembly has ruptured and must be replaced. See Section 7.3 for instructions.</p>

EG40 Troubleshooting Summary (cont.)

Observation	Cause	Action
<p>EG40 stops operation</p>	<p>Pump is off. (When the pump is off, the EG40 and SRS are automatically turned off.)</p>	<p>Make sure the main power to the pump is turned on. Reprime the pump and then resume operation. Priming instructions are in the pump manual.</p>
	<p>Flow rate is too low or too high</p>	<p>Select a flow rate between 0. 1 and 3.0 mL/min.</p>
	<p>Pump pressure limit tripped</p>	<p>When a system includes an EG40 Module, the high pressure limit for the pump is 21 MPa (3000 psi) and the low pressure limit is 1.4 MPa (200 psi). Make sure the system pressure is within this range. For more information, refer to the troubleshooting instructions in the pump manual.</p>
	<p>No communication with pump</p>	<p>Refer to the troubleshooting instructions in the pump manual.</p>
	<p>Pump motor fails</p>	<p>Refer to the troubleshooting instructions in the pump manual.</p>
	<p>Fault error detected (Fault LED indicator is lighted)</p>	<p>To prevent damage to the EluGen cartridge, the pump automatically turns off electrical power to the cartridge when excessive current or voltage is detected. See “Fault LED Indicator” section of Table 3.</p>
	<p>EluGen cartridge is expended</p>	<p>The cartridge must be replaced. See Section 5.4 for instructions</p>
	<p>No communication with PeakNet</p>	<p>Make sure the EG40 Module is configured in PeakNet and the power is on.</p> <p>Make sure the EG40 is connected to the PeakNet workstation via a DX-LAN cable (P/N 960404). When installing the cable, do not simply push the BNC connector into place; it is critical to twist the rotating sleeve until a locking click is heard or felt. Failure to use the correct cable or correctly install the BNC connector may result in intermittent signal or ground connections</p> <p>Note: The DX-LAN cable is a 50 ohm coaxial impedance cable with a high quality twist-and-lock BNC connector. Do not substitute an inferior cable, such as a 70 ohm television coaxial cable. Fifty ohm cables are typically imprinted with “RG58U.”</p> <p>PeakNet has a diagnostic procedure intended for use by DIONEX Service Personnel only. The procedure reports the EG40 current and voltage stability. Use this service command only when instructed to do so by a DIONEX Service Representative</p>

EG40 Troubleshooting Summary (cont.)

Observation	Cause	Action
Excessive system back pressure	Restriction in the liquid line plumbing	<p>1. Begin pumping eluent through the system (including the columns) at the flow rate normally used.</p> <p>2. Work backward through the system, beginning at the cell exit. One at a time, loosen each fitting and observe the pressure. The connection at which the pressure drops abnormally indicates the point of restriction.</p> <p>3. If the EG40 Cartridge is identified as the source of the high backpressure, the outlet frit should be replaced. See Section 5.5.</p> <p>A restriction often causes such high pressure that the entire system cannot be operated. In that case, work forward through the system starting at the EG40, adding parts one at a time until an abnormal pressure increase (and hence, the restriction) is found.</p>
No Peaks	<p>EG40 current may not be on.</p> <p>The PeakNet program may not be started.</p>	<p>See "Power LED is not illuminated" section of Table 3.</p> <p>Make sure that the EG40 is configured in PeakNet and the power is turned on.</p>
Peak retention times are too short	<p>Gradient method timing is too fast or concentration settings are too high.</p> <p>Pump flow rate is low.</p> <p>The OFFSET VOLUME in the EG40 program is too small.</p>	<p>Check the PeakNet Method for correct concentration and flow rate combinations. See Section 2.3.</p> <p>Check the pump flow rate. Calibrate the pump flow rate if necessary. See the pump manual for details.</p> <p>To match the retention times from conventional gradients, methods use an OFFSET VOLUME in the EG40 setup. See Section 4.1.4 for details.</p> <p>The OFFSET VOLUME can be specified in the PeakNet EG40 system configuration as 0 - 2,000 μL. The default value for the EG40 is 400 μL but the actual value may be greater depending on the system configuration. The PeakNet Run program uses this value to calculate the time delay in starting the EG40 program and EG40 timed events.</p>

EG40 Troubleshooting Summary (cont.)

Observation	Cause	Action
Peak retention times are too long	<p>Gradient method timing is too slow or concentration settings are too low</p> <p>Pump flow rate is high</p> <p>The OFFSET VOLUME in the EG40 program is too large.</p>	<p>Check the PeakNet Method for correct concentration and flow rate combinations. See Section 2.3.</p> <p>Check the pump flow rate. Calibrate the pump flow rate if necessary. See the pump manual for details.</p> <p>Use a smaller OFFSET VOLUME in the EG40 setup. See Section 4.1.4 for details</p> <p>The OFFSET VOLUME can be specified in the PeakNet EG40 system configuration as 0 – 2,000 μL. The default value for the EG40 is 400 μL but the actual value may be greater depending on the system configuration. The PeakNet Run program uses this value to calculate the time delay in starting the EG40 program and EG40 timed events.</p>
Baseline noise	<p>Pump not primed</p> <p>System backpressure is < 2,000 psi (14 MPa)</p>	<p>Prime the pump. Refer to the pump manual for priming instructions.</p> <p>Noise increases as the gradient concentration increases Add backpressure restrictor after Degas Assembly See Section 2.5.1.</p>
High background	<p>Anion Trap Column (ATC-HC) is contaminated.</p> <p>Large carbonate peak and/or smaller chloride and sulfate peaks may appear during gradient.</p>	<p>Clean ATC-HC column. See ATC-HC manual for instructions.</p> <p>Prepare the Anion Trap Column for use by flushing with 200 mL of 2.0 N KOH at 2 mL/min. Rinse the ATC-HC column with 50 mL of DI water at 2 mL/min.</p>
Low system backpressure	<p>Loose fitting</p> <p>High pressure degas tubing assembly ruptured</p> <p>Internal EluGen Cartridge leak in the membrane barrier. (This leak will not be detected immediately by the EG40 leak sensor since the liquid leak will pass out through the vent line.)</p>	<p>Check all system fittings.</p> <p>If there is no flow through the columns, although flow from the waste line remains normal, the degas tubing assembly has ruptured and must be replaced See Section 7.3 for instructions.</p> <p>This type of leak may trip the pump pressure limit and the pump will shut off. The cartridge must be replaced. See Section 5.4.</p>

SECTION 7 - SERVICE

This section describes routine service procedures that users may perform for the EG40 Eluent Generator. Other service procedures not included here must be performed by Dionex personnel. In the U.S., call 1-800-DIONEX-0 (1-800-346-6390). Outside the U.S., call the nearest Dionex office.

NOTE

The EG40 electronics components are not user-serviceable. Any repair involving the electronics must be performed by Dionex personnel.

NOTE



The CPU card contains a lithium battery. If it is necessary to replace the CPU card, dispose of the used battery according to the manufacturer's instructions

Before repairing or replacing a mechanical part, review the troubleshooting information in Section 6 to be sure you have correctly identified the source of the operating problem. When ordering replacement parts, provide the part numbers and, when applicable, the revision numbers. Also include the EG40 model number and serial number from the data label on the rear panel.

7.1 CHANGING MAIN POWER FUSES

HIGH VOLTAGE

Disconnect the main power cord from its source and also from the EG40 rear panel.

1. Press the main power button on the front of the EG40 to turn off the power. Unplug the power cord.
2. The fuse holder is in the main power receptacle on the rear panel of the EG40 (see Figure 7, "EG40 Module Rear Panel"). Using a small screwdriver (or your fingernails), push the recessed lock on each side of the fuse holder toward the center and then release the locks; the fuse holder will pop out about 2 mm. Pull the fuse holder straight out of the compartment.
3. The fuse holder contains two fuses. Replace these with new 3.15 amp fast-blow IEC 127 fuses (P/N 954745). Always replace both fuses, even though only one is open. Because the other fuse may have been stressed, it may fail soon even under normal operation.
4. The fuse holder is keyed to fit in the compartment only in its proper orientation. After noting the orientation, reinsert the fuse holder into the compartment, applying just enough pressure evenly against the fuse holder to engage the two recessed locks. When both locks are engaged, the fuse holder is flush against the panel.
5. Reconnect the main power cord and press the main power button to turn on the power.

7.2 REPLACING TUBE FITTINGS

Liquid line connections throughout the EG40 are made with PEEK tubing, Dionex 10-32 ferrules (P/N 043276), and 10-32 fittings (P/N 043275).

7.3 REPLACING THE HIGH PRESSURE DEGAS TUBING ASSEMBLY

The degas tubing assembly may rupture if subjected to excessive pressure.

1. Turn off the pump.
2. Open the door of the EG40 Module. The degas tubing assembly is mounted on the left-hand wall (see Figure 6, “EG40 Module Interior”).
3. Disconnect the lines connected to the “SRS WASTE IN” and “WASTE OUT” fittings on the Degas Tubing Assembly.
4. Disconnect the lines connected to the “DEGAS IN” and “DEGAS OUT” fittings on the Degas Tubing Assembly.
5. Remove the two screws that secure the Degas Tubing Assembly to the wall. Retain the mounting screws. Dispose of this tubing assembly.
6. Mount the new Degas Tubing Assembly (P/N 053721) on the wall using the two screws from Step 5.
7. Complete the installation as follows (See Section 2.5.2 for details):
 - a. Connect the outlet line from the EluGen cartridge to the Degas Assembly fitting labeled “DEGAS IN”.
 - b. Connect the line from the injection valve to the Degas Assembly fitting labeled “DEGAS OUT”.
 - c. Connect the SRS waste line to the Degas Assembly fitting labeled “SRS WASTE IN”.
 - d. Connect the degas waste line to the “WASTE OUT” fitting. To prevent waste siphoning back into the system, make sure the tubing is not bent, pinched, or elevated at any point.
8. Close the EG40 door. Turn on the pump and resume operation.

7.4 RUNNING THE ELUENT GENERATOR SYSTEM DIAGNOSTIC ROUTINE

You may be asked by Dionex Service Personnel to run the Eluent generator System Diagnostic Routine. The diagnostic is run with the chromatography system configured to run an analysis method. The diagnosis routine will run the EG40 and EGC at low and high levels of eluent generation and determine whether it can detect any problems. The diagnostic routine, and its interpretation, is described below.

The diagnostic routine generates a linear ramp from 0 to 100 mM and then returns to 0 mM in a stair-step fashion, i.e., it runs isocratically for brief periods at successively lower concentrations.

CAUTION

To avoid damaging the EluGen cartridge, the pump must be operating at or above 1.0 mL/min during the diagnostic routine.

1. To start the routine, open the PeakNet Configure menu and select Eluent Generator system Service Command: “Start Eluent Generator system Diagnostic.”
 2. The diagnostic takes about 10 minutes to complete, after which a graph and table of data can be viewed. See Figure 25, “MSA Generator,” for an example of normal graph and data results.
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3. The graph shows the current generated during the routine. The current present at specific times can be read directly from the graph by placing the cursor on the graph at the desired time.
4. Normal graph results are as follows:
 - The linear ramp at the start of the graph should appear straight.
 - The level portion of each stair step should appear flat, the vertical portion straight, and the corners sharp.
5. Normal data results are as follows:
 - Except at the very lowest concentrations, the %RSD for the current should be less than 4%.
 - The voltage should be less than 25 volts at the maximum concentration.
6. Abnormal data results indicate the following:
 - %RSDs higher than 4% indicate possible damage to the programmable current generator.
 - Voltages higher than 25 volts indicate possible damage to the EluGen cartridge.
7. If abnormal results are obtained, contact Dionex for assistance.

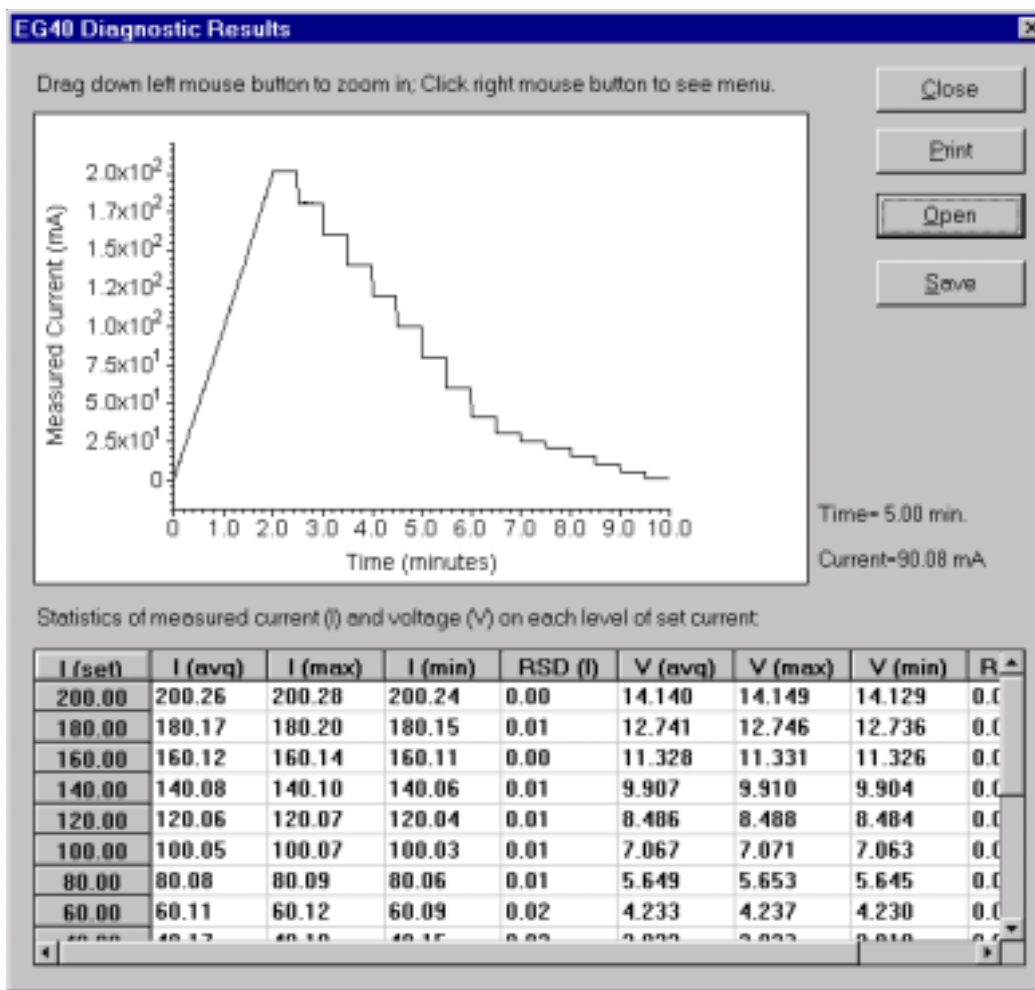


Figure 25
MSA Generator
(The Maximum Current (I) and Voltage (V) are lower for a KOH Generator)

SECTION 8 - TTL CONTROL OF THE EG40

8.1 TTL CONNECTIONS

Locate the following items in the EG40 ship kit:

Description	Part Number	Quantity
2-pin connector plug	921185	1
3-pin connector	921186	1
1 pair of twisted wires	043598	2

To connect the TTL output:

1. Plug a 2-pin plug into the GND and TTL OUT 1 connections on the rear of the EG40. (The TTL OUT 2 connector is reserved for future expansion.)
2. Note which connections on the plug are the ground (GND) and signal (TTL1) connections.
3. Remove the plug from the rear of the EG40.
4. Attach the black wire from the twisted pair to the GND connection on the 2-pin plug.
5. Attach the red wire from the twisted pair to the TTL1 connection on the 2-pin plug.
6. Connect this plug to the GND and TTL OUT 1 connections on the EG40.
7. Connect the wires from the EG40 connector to TTL, or relay connectors input pins, on the other module. Be sure to use the correct connector plug and connections on the other module. For example, for DX-500 modules, attach a second two-pin plug (provided in the other module's DX-500 ship kit).

To connect a TTL input:

1. Plug a 3-pin plug into the TTL input connections on the rear of the EG40 (GND, TTL IN 1 and TTL IN 2).
2. Note which connection on the plug is the ground (GND) and signal (TTL1 or TTL2) connections.
3. Remove the plug from the rear of the EG40.
4. Attach the black wire from the twisted pair to the GND connection on the 3-pin plug.
5. Attach the red wire from the twisted pair to the TTL1 (or TTL2) connection on the 3-pin plug.
6. Connect this plug to the TTL IN connections on the EG40.
7. Connect the wires from the EG40 input connector to TTL, or relay connector output pins, on the other module. Be sure to use the correct connector plug and connections on the other module. For example, for DX-500 modules, attach a second two-pin plug (provided in the other module's DX-500 ship kit).

NOTE

After the TTL connections are made at both ends of the twisted pair of wires, verify that the connections were made properly. To do this, verify that the black wire is connected to ground, and the red wire is connected to the signal (e.g., TTL 1 or 2). If necessary, remove wires from the plugs and reinsert them in the correct positions.

8.2 TTL-CONTROLLED OPERATION

TTL Inputs

Two TTL inputs are provided: TTL IN1 and TTL IN2.

TTL IN1

TTL IN1 operates only when the Eluent Generator system is in Direct Control mode (the Direct Control dialog box is open). TTL IN 1 controls the current to the EluGen cartridge. A falling edge (from +5 VDC to ground) turns the EluGen cartridge current on and a rising edge (from ground to +5 VDC) turns the cartridge current off, i.e., the logic type is normal edge.

Notes on using TTL IN1:

1. The falling edge must remain down, or the rising edge must remain up, for a minimum of 0.020 seconds for the transition to be recognized. (NOTE: A normal pulse can be used to control the current if the pulse's leading and trailing edges are more than 0.020 seconds apart. The normal pulse input for a DX-500 will work correctly.)
2. The TTL input requires at least 20 mA of current at standard TTL voltage levels (0 - 5 volts).
3. TTL IN1 is ignored if the Eluent Generator system is not in Direct Control; no error is sent if a signal attempts to trigger TTL IN1 while the Eluent Generator system is not in Direct Control mode.
4. While the Eluent Generator system is in Direct Control, both PeakNet and TTL IN1 can turn the current on and off. The last command from either source is the one in effect (e.g., a command from PeakNet can stop the current and then a TTL command can start it).
5. If PeakNet and TTL IN1 both send the same command to the EG40, the second command is ignored, with no error.
6. Do not use TTL control from another module to the EG40 when both modules are configured in the same DX-LAN PeakNet system.

The reason for this is as follows: PeakNet's Direct Control commands are issued at the same time for all modules in a system. PeakNet's Direct Control commands include both TTL out signals and the Eluent Generator system's concentration. If a PeakNet Direct Control command directs a module to send a TTL out signal to an EG40 TTL input, and also sends a second command directly to the same EG40, then it is difficult to predict which command will arrive first and which will arrive last. Thus, it may be difficult to predict the final state of the Eluent Generator system after both commands arrive.

However, PeakNet is intended to be the Eluent Generator system's primary control and can direct any action without TTL inputs. Thus, there is no technical requirement to control the Eluent Generator system from the TTL output of a PeakNet-controlled module.

TTL IN2

TTL IN2 operates only when the Eluent Generator system is in Method mode. The Eluent Generator system is set to Method mode whenever a Method has been loaded. TTL IN2 starts running the currently loaded Method. A falling edge (from +5 VDC to ground) starts the Method. A rising edge (from ground to +5 VDC) is ignored, i.e., the logic type is normal edge.

Notes on using TTL IN2:

1. The falling edge must remain down, or the rising edge must remain up, for a minimum of 0.020 seconds for the transition to be recognized. (NOTE: A normal pulse can be used to control the current if the pulse's leading and trailing edges are more than 0.020 seconds apart. The normal pulse input for a DX-500 will work correctly.)
 2. The TTL input requires at least 20 mA of current at standard TTL voltage levels (0 - 5 volts).
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3. TTL IN2 is ignored while the Eluent Generator system is in Direct Control; no error is sent if a signal attempts to trigger TTL IN2 while the Eluent Generator system is in Direct Control mode.
4. While the Eluent Generator system is in Method control, both PeakNet and TTL IN2 can start a Method, but only PeakNet can stop a Method.
5. If PeakNet and TTL IN1 both send the same command to the Eluent Generator system, the second command is ignored, with no error.

To use TTL input control, follow these basic steps:

1. Connect wires between the TTL input connector pins on the EG40 rear panel and TTL/relay output pins on the other module(s) in the system (see Section 8.1).
2. Create a Method for the other module that turns the EG40 TTL input function on and off at the appropriate times. For testing purposes, Direct Control can be used to turn the input on and off.
3. Run the Method.

TTL Output

TTL OUT1 drives a normal edge output signal, i.e., the transition goes from +5 VDC to ground for “on” and ground to +5 VDC for “off.” TTL OUT1 can drive up to 500 mA of current at standard TTL voltage levels (0 - 5 volts).

TTL OUT2 is not functional and is reserved for further expansion.

To use TTL output control, follow these basic steps:

1. Connect wires between the TTL output connector pins on the EG40 rear panel and the TTL/relay input pins on the other module(s) in the system (see Section 8.1).
 2. Create an Eluent Generator system Method that includes timed events for turning the TTL output on and off at the appropriate times. For testing purposes, Direct Control can also be used to turn the TTL on and off.
 3. Run the Method.
-