

Installation Instruction for a Low-Pressure Gradient System

The Low-Pressure Gradient is a Professional IC system for the fully automatic determination of anions or cations with suppression, using gradient elution created by time-controlled valve shifts. It safely masters all routine tasks in ion chromatography, is simple to use, flexible, and reliable.

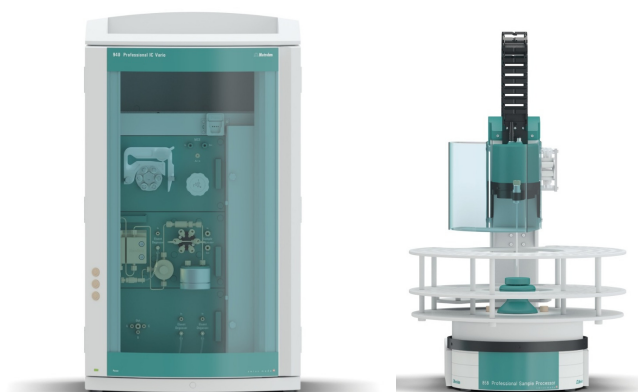


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1. Recommended equipment

No.	Article no.	Article designation
Instruments		
1	2.940.1550	940 Professional IC Vario ONE/SeS/PP/LPG
or		
1	2.940.1450	940 Professional IC Vario ONE/SeS/LPG
1	2.850.9010	IC Conductivity Detector
1	2.858.0020	858 Professional Sample Processor - Pump
Software		
1	6.6059.4*	MagIC Net 4.* Professional (* newest MagIC Net version)

Optional depending on analysis

1	6.2041.440	Sample rack 148 × 11 mL + 3 × 300 mL
1	6.2041.760	Sample rack 54 × 11 mL + 1 × 300 mL
1	6.2743.050	Sample tubes 11 mL
1	6.2743.070	Stopper with perforation
1	6.xxxx	Metrosep A Supp column depending on application
1	6.xxxx	resp. Metrosep A Supp Guard column
1	6.xxxx	Metrosep C Supp column depending on application
1	6.xxxx	resp. Metrosep C Supp Guard column
1	6.1014.000	Metrosep A Trap 1 - 100/4.0
1	6.1015.000	Metrosep C Trap 1 - 100/4.0
1	6.2832.000	MSM Rotor A
1	6.2842.000	MSM-HC Rotor A
1	6.2842.200	MSM-HC Rotor C
1	6.2842.020	Adapter sleeve, MSM
1	2.941.0010	Eluent Production Module
1	6.5330.090	IC Equipment: Additional eluent for 941
1	6.5330.130	IC Equipment: LQH Station, left
1	6.5330.190	IC Equipment: Dosino Regeneration

2. Parts used for Low-Pressure Gradient installation (included in scope of delivery of 940)

2	6.1602.160	Eluent bottle cap GL 45
2	6.16008.070	Eluent bottle / 2 L / GL 45
2	6.1609.000	Adsorbing tube, large and bent
2	6.1834.080	Aspiration tubing, 2 m
1	6.1834.120	Tubing connection Degasser – mixing valve, 215 mm
2	6.2023.020	Clip for SGJ 14/15
2	6.2744.210	Tubing adaptor for aspiration filter
1	6.2758.020	Mixing coil for low pressure gradients
2	6.2821.090	Aspiration filter

Up to three different eluents can be mixed using the low-pressure gradient. The three valves are normally closed. The valves are opened long enough during each pump cycle so that the desired portion of eluent flows and then the valves are closed again. This also results in all of the valves audibly opening and closing if 100% of a solution is being pumped.

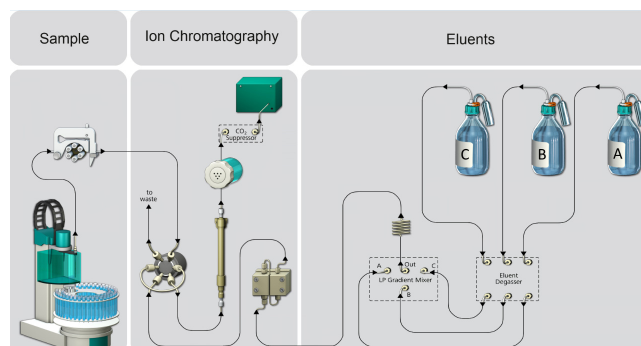
The eluent gradient generated in the mixing valve is aspirated by the high-pressure pump and led into the IC system. Due to the physical limitations of the mixing valve, the flow cannot exceed 3 mL/min when using a low-pressure gradient.

We recommend using the low-pressure gradient for eluent portions of 10% to 90%.

3. Installation

Following is a detailed description of how to install a Low-Pressure Gradient system.

At the end of installation procedures, the whole setup should resemble this illustration:



We strongly recommend that the individual steps are carried out in the order given below.

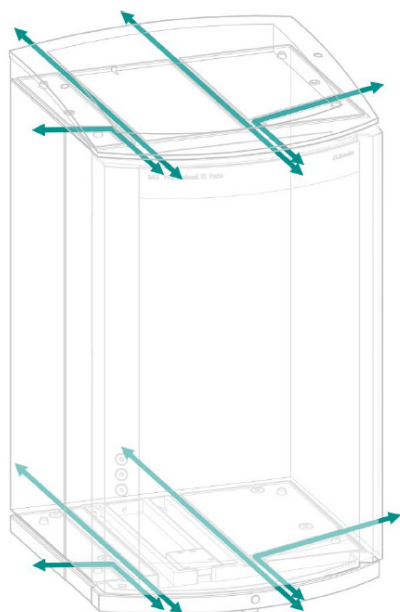
3.1. Installation of the software

All programs must be shut down first. Make sure no Metrohm instrument is connected to the PC. Install MagIC Net. All standard directories proposed by the program should be accepted.

From now on, every new Metrohm instrument connected to the PC will automatically be recognized and its driver will be installed. A window will pop up in MagIC Net asking if you would like to store this device in your configuration. The names will be checked later in this installation instruction, but it is recommended to use the proposed instrument names.

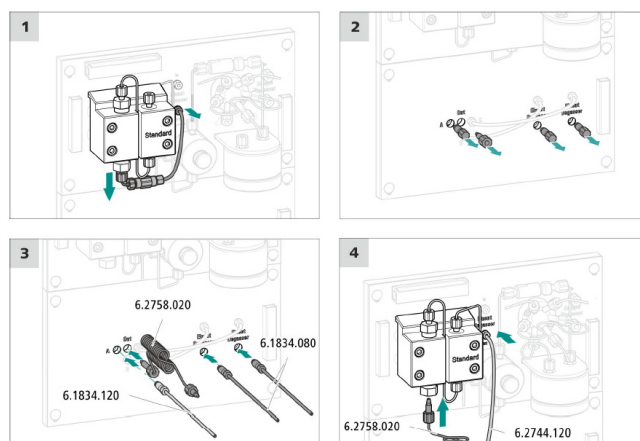
3.2. Installation of the eluent tubing of eluent B and C and connection to the high-pressure pump

Both additional eluent tubings (6.1834.080) have to be installed on the IC first. For this, connect them to the Eluent Degassers B and C, then lead the tubing to the back of the instrument, using one of the many feed-throughs (shown in green below).



The eluent degasser outlets (from all three eluent degassers) need to be connected to the low-pressure valve using the connection tubing (6.1834.110).

The single outlet of the low-pressure valve is led to the mixing coil for low pressure gradients (6.2758.020) which then leads to the high-pressure pump inlet check valve holder. Refer to the Manual of your LPG device for details.



3.3. Accessory Kit: Vario/Flex Basic (6.5000.000)

Using the Accessory Kit Vario/Flex Basic, install the 940 Professional IC Vario. Place the detector block in the instrument and connect the detector cable to the back of the instrument. Remove the transport locking screws, connect the leak sensor cable, and connect the drainage tubing.

Remove the transport locking screws

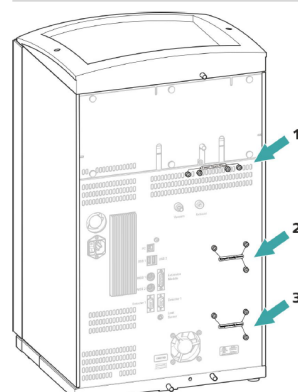


Figure 6 Removing the transport locking screws

1 Transport locking screws

For the vacuum pump.

2 Transport locking screws

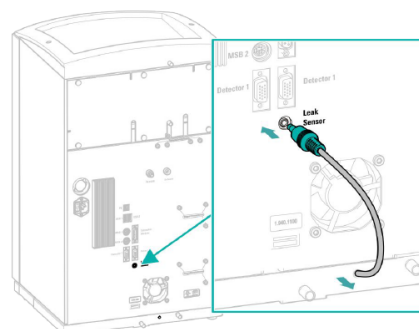
For the high-pressure pump.

3 Transport locking screws

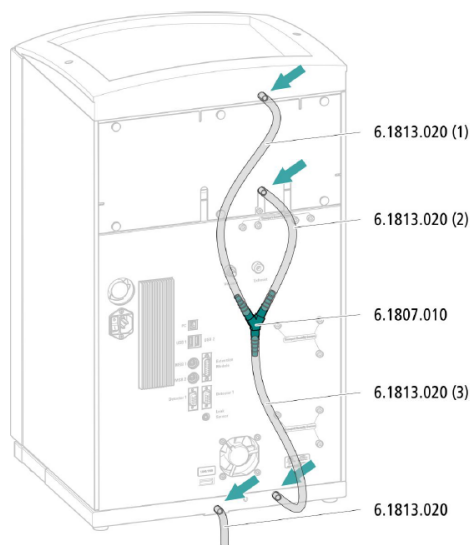
For an additional high-pressure pump in the bottom drawer.

Plugging in the leak sensor connection cable

The leak sensor connection cable is coiled up in the base tray.



Connecting the drainage tubing

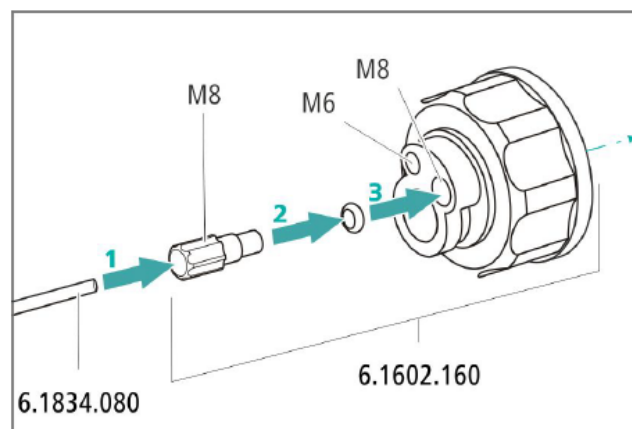


Afterwards, set up the waste collector by assembling the cap and screwing it onto the vessel. Then hang the waste collector with its holder on one of the sides of the IC. Make sure you have an unobstructed view of the collector, so you can later observe the droplets coming out of the capillaries connected to the collector. Attach the waste tube to the vessel and lead it to the waste canister. If the tube is too long, please shorten it, because it is important to have a high level difference for the liquid to drain properly.

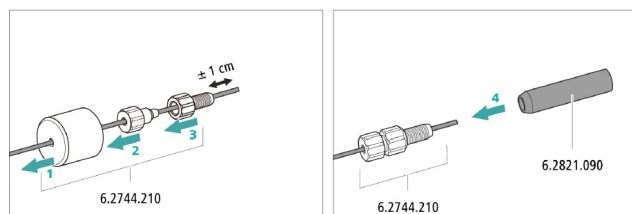
The power cable and USB cable for connection of the IC to the PC (6.2151.020) are plugged into the rear of the Professional IC Vario. Please don't switch on the instrument yet. This step will follow after the completed installation.

3.4. Accessory Kit: Vario/Flex ONE (6.5000.010)

In the box with the Accessory Kit ONE, you will find all the accessories for setting up one eluent bottle. The accessories for the other two eluent bottles can be found in the scope of delivery of the 940 Professional IC Vario. Please lead the aspiration tubes for the eluent through the M8 stoppers, the O-rings and the eluent caps.



Then fix the white weights (6.2744.210), the adapters (6.2744.210) and the aspiration filters (6.2821.090) to the eluent aspiration tubes, while at the same time being careful not to touch the filters and its connections with your bare hands to avoid cross-contamination.



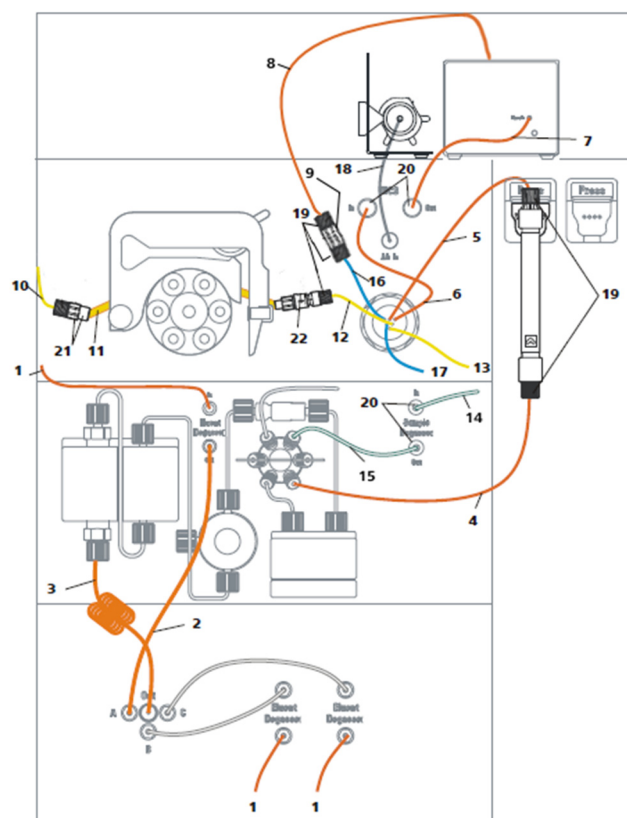
Also fix the filled adsorber tubes on the eluent caps. Please refer to the 940 Professional IC Vario manual for a detailed description.

3.5. 940 Professional IC Vario

Capillaries are connected according to the following list and the following diagram. In this case, the suppressor is regenerated via peristaltic pumps; if the Dosino Regeneration is applied, please refer to Application Bulletin AB-395:

1. Connection to the eluent bottles (Eluent A, B, C)
2. Connection from Eluent Degasser (Eluent A)
3. Mixing Capillary
4. Connecting Capillary from Injection Valve to Separation Column
5. Connecting Capillary from Separation Column to Suppressor
6. MSM outlet capillary – labeled with *Out*, which has to be connected to the MCS with a long PEEK pressure screw (6.2477.090)
7. Capillary from MCS to anion detector, a long PEEK pressure screw (6.2744.090) is used for the MCS connection
8. Detector outlet capillary connected to the MSM inlet capillary (16) – labeled with *rinsing solution*

9. Coupling (6.2744.040) Capillary from Regenerant Solution
10. Regeneration solution aspiration capillary – PTFE, 0.5 mm ID, connected to the bottle with 100 mmol/L sulfuric acid
11. Peristaltic pump tubing with orange/yellow stoppers (6.1803.030)
12. MSM regeneration inlet capillary – labeled with 'regenerant'
13. MSM regeneration solution outlet capillary – labeled with 'waste reg.' to be connected to the waste collector
14. Connecting Capillary (6.1831.160) from Sample Processor peristaltic pump to Sample Degasser (Note: installation of Sample Degasser is optional and not recommended!)
15. Connecting Capillary from Sample Degasser to Injection Valve (Note: installation of Sample Degasser is optional and not recommended!)
16. MSM rinsing solution inlet capillary – labeled with 'rinsing solution'
17. MSM rinsing solution outlet capillary – labeled with 'waste rins.' to be connected to the waste collector
18. Connecting Capillary from Cartridge to MCS
19. High-Pressure PEEK Screws
20. MCS and Sample Degasser In-/Outlet
21. Tubing Olives
22. Tubing Olives with inline filter



Make sure that all outlet capillaries are put into the waste collector and prepare the appropriate eluents for your column and gradient choice. Fill them into the respective 2 L eluent bottles. Likewise, prepare the regeneration solution for the MSM and fill it into the 1 L bottle to be aspirated via the peristaltic pump tubing to the suppressor.

3.6. 858 Professional Sample Processor

It is recommended to work with a Sample Processor when operating an instrument with a gradient. It is of uttermost importance that the injection of the sample always happens at exactly the same moment in the gradient profile. This can only be guaranteed when using the appropriate sample transfer.

3.6.1. Cable connections

In the back of the 858 Professional Sample Processor, please plug in the controller cable (6.2151.000, Cable USB A – mini-DIN 8-pin) into the corresponding Contr. plug. This cable is then plugged into a USB port on the back of the IC.

Then, plug in the Swing Head connection cable on the tower, connect the power cable, and turn on the IC.

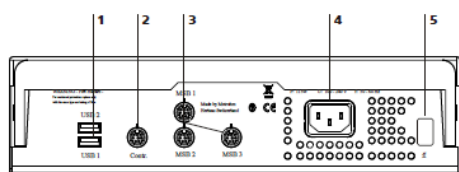


Figure 4 Connector strip

1 USB connectors	2 Controller connector For the connection to the PC or Touch Control.
3 MSB connector For stirrers, dosing devices, Remote Box.	4 Mains connection
5 Type plate Contains specifications concerning mains voltage and serial number.	

3.6.2. Hardware installations

For a detailed installation description, please refer to the 858 Professional Sample Processor manual. In general, as soon as the IC is powered on and recognized by the software, the sample processor initializes and lifts its Swing Head.

Afterwards, the sample needle (6.2846.010) is installed together with the needle holder (6.2833.030) on the Swing Head of the 858 Professional Sample Processor.

Now, mount the retaining plate and the safety shield (for detailed instructions, please refer to the 858 Professional Sample Processor manual).

3.6.3. Liquid Handling

Insert the pump tubing (white/white 6.1826.360) into the peristaltic pump and connect the aspiration side to the needle via a PEEK capillary (6.1831.160) (also see the 858 manual).

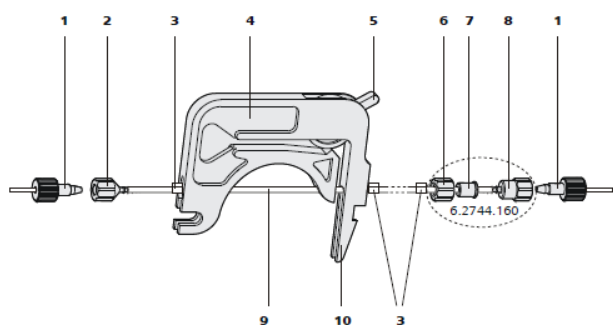


Figure 31 Installing the pump tubing

1 PEEK pressure screws, short (6.2744.070)	2 Tubing olive (6.2744.030)
3 Stopper The colors of the stopper indicate the inner diameter of the pump tubing.	4 Tubing cartridge (6.2755.000)
5 Contact pressure lever	6 Union nut
7 Adapter	8 Tubing olive
9 Pump tubing	10 Snap-action lever

4. MagIC Net configuration

The instruments are connected to the computer via controller cables and their power is turned on. The drivers of the instruments are automatically installed.

Connected USB devices are automatically recognized when MagIC Net is started. After confirmation of the pop-up windows, the devices and columns are stored in the configuration. The devices in most methods are predefined as "940 Professional IC Vario 1" and "858 Professional Sample Processor 1". Name them accordingly, if other names appear in your configuration (e.g., due to changed settings on your computer). The column can be named freely.

Add and define the eluents and the suppressor solution in the configuration window and register the rotor with its serial number.

4.1. 858 Professional Sample Processor

For the rack, the work and shift positions need to be defined. For this purpose, open the rack data of the sample processor and adapt the rack parameters according to the numbers here below.

Also define one or more special beakers for rinsing the needle. Fill the appropriate beaker(s) with ultrapure water and place it/them at the defined position(s) on the rack.

Rack data

Rack name: 6.2041.760
 Rack code: 001101
 Number of positions: 55

Special beaker	Rack position	Work position Tower 1	Work position Tower 2	Beaker radius	Beaker sensor
1	55	125	0	off	off
2	0	0	0	off	off
3	0	0	0	off	off
4	0	0	0	off	off
5	0	0	0	off	off
6	0	0	0	off	off
7	0	0	0	off	off
8	0	0	0	off	off
9	0	0	0	off	off
10	0	0	0	off	off
11	0	0	0	off	off
12	0	0	0	off	off
13	0	0	0	off	off
14	0	0	0	off	off
15	0	0	0	off	off
16	0	0	0	off	off

940 Professional IC Vario - Pump - Gradient

Flow: 0.7 mL/min
 P_{inj}: 0.00 MPa
 P_{max}: 35.00 MPa

Start-up time: 1 min

Eluent A: not defined
 Eluent B: not defined
 Eluent C: not defined

As soon as the method is started with “Start HW”, the high-pressure pump will already aspirate the eluents with the proportions entered in these fields.

The gradient profile will later be started in the time program:

Insert new line

Commands: Device independent, 940 Professional IC Vario, Pump, Gradient, On/Off, Flow, Measure pressure, Release, Injector, Peristaltic, MSM, MCS, Degasser, Thermostat, Conductivity detector 1, 858 Professional Sample Processor

Description: Starts a gradient program of the gradient pump.

4.2. Import of a Gradient method

Import a gradient method (ask your Metrohm representative for information) into MagIC Net.

Transferring a gradient profile from one technique (e.g., High-Pressure Gradient) to a Low-Pressure Gradient profile is not as simple as one may think. It is therefore recommended to begin directly with a Low-Pressure Gradient profile as a starting point.

Method manager

Name	A	Saved	User	Full name	Version	Signed	Method comment
1	AMM_ProfIC_Vario_15_Anion_Logical	2014-04-07 16:32:4...	sc	Stefanie Czymbara	2	no	Example method for ProfIC_15_Anion (MP1: Me...
2	AMM_ProfIC_Vario_15_Anion_Logical	2014-04-07 16:32:0...	sc	Stefanie Czymbara	2	no	Example method for ProfIC_15_Anion (MP1: Me...
3	AMM_ProfIC_Vario_1_Anion_Chec...	2014-04-02 10:56:0...	sc	Stefanie Czymbara	3	no	Example method for ProfIC_1_Anion. The correct...
4	AMM_ProfIC_Vario_1_Anion_Chec...	2014-04-02 12:56:4...	sc	Stefanie Czymbara	4	no	Example method for ProfIC_1_Anion. The correct...
5	AMM_ProfIC_Vario_2_An_HighLow	2014-04-03 17:21:5...	sc	Stefanie Czymbara	1	no	Example method for ProfIC_2_Anion (Ultrafibrac...
6	AMM_ProfIC_Vario_2_An_HighLo...	2014-04-07 10:45:0...	sc	Stefanie Czymbara	3	no	Example method for ProfIC_2_Anion (Ultrafibrac...
7	AMM_ProfIC_Vario_2_An_Method...	2014-04-02 17:13:3...	sc	Stefanie Czymbara	3	no	Example method for ProfIC_2_Anion (Ultrafibrac...
8	AMM_ProfIC_Vario_2_An_Method...	2014-04-02 17:00:1...	sc	Stefanie Czymbara	2	no	Example method for ProfIC_2_Anion (Ultrafibrac...
9	AMM_ProfIC_Vario_2_An_Mixed...	2014-04-03 12:33:4...	sc	Stefanie Czymbara	2	no	Example method for ProfIC_2_Anion (Ultrafibrac...
10	AMM_ProfIC_Vario_2_An_Mixed...	2014-04-08 16:02:0...	sc	Stefanie Czymbara	3	no	Example method for ProfIC_2_Anion (Ultrafibrac...
11	AMM_ProfIC_Vario_9_Anion_9H1...	2014-04-08 14:26:1...	sc	Stefanie Czymbara	1	no	Example method for ProfIC_Vario 9 Anion (IMPCT...
12	AMM_ProfIC_Vario_9_Anion_9H1...	2014-04-08 14:27:0...	sc	Stefanie Czymbara	1	no	Example method for ProfIC_Vario 9 Anion (IMPCT...
13	AW_1058_Ivo_calibration_dilution	2011-03-17 16:54:0...	sc	Stefanie Czymbara	2	no	Example method for ProfIC_Vario 9 Anion (IMPCT...
14	Combustion Module Analysis	2013-05-29 16:54:3...	Metrohm	Metrohm	1	no	Example method for Combustion IC analysis (Beu...
15	Combustion Module Analysis Nest...	2013-05-29 16:53:0...	Metrohm	Metrohm	1	no	Example method for Combustion IC analysis nest...

Adapt the method to your system by adjustment of the instrument type(s) and name(s).

In the device window of your method, you can enter the start parameters of your gradient:

Example of a Low-Pressure Gradient profile:

940 Professional IC Vario - Pump - Gradient

Time: 0.0 min

Time [min]	Eluent A [%]	Eluent B [%]	Eluent C [%]	Curve	Flow
1	Start	70	20	10	0.7
2	10.0	40	50	10	0.7
3	15.0	25	50	25	0.7
4	20.0	70	20	10	Step 0.7
5	30.0	70	20	10	Linear 0.7
6					

The start parameters of the gradient profile should be the same as the ones defined in the “devices” section of the method. Different curve types exist—either linear or step gradients—which will change the eluent gradually or abruptly,

or four concave and convex curve options each, which will change the eluent composition by using a logarithmic curve.

It is also recommended to come back to the starting eluent mix for 7–10 minutes before starting the next determination. This helps to avoid retention time shifts due to the full equilibration back to the standard eluent.

4.3. Purge of the system

Before inserting the column, disconnect the “Out” capillary of the suppressor connection piece from the MCS or from the detector and put it into a waste beaker. The suppressor needs to be rinsed with the system first and its waste should not pass through the sensitive MCS and/or detector in the beginning, as loose particles could be flushed out.

Now flush the system for approximately 10 minutes and get rid of air bubbles by using the purge valve and syringe. During these 10 minutes, step the MSM three times to flush all three chambers.

As soon as the whole system is purged, reconnect the suppressor “Out” capillary back to the MCS or the detector.

Now insert and rinse the guard column for 10 minutes by leading the outlet directly into the waste. Afterwards connect the analytical column and flush it likewise for 10 minutes. Only afterward the column is completely connected to the flow path of the eluent (also see the 940 manual). Start the peristaltic pump and adjust the pressure of the lever on the tubing to see the droplets of suppressor regeneration solution drop into the waste collector.

To start the equilibration, go to the window workplace, load the method, and press “Start HW”.

Equilibrate the system until the baseline is stable.

4.4. Starting a determination series

First put the analyte solutions on the rack.

In the window workplace in MagIC Net, set up a “determination series”, describing your samples by ident, sample position, and sample type (e.g., standard, blank, or sample etc.).

When running a gradient with IC it is recommended to always run a Blank/UPW sample as the first line of the sample series. This run is needed additionally for equilibration purposes.

For evaluation and after recording the first standard chromatogram, check the retention times of your components. Since they depend on the performance of your column, you may have to adjust them in your method.

To improve the mixing performance, there is the possibility to install a trap column right in between the high-pressure pump and the pulsation dampener. This will result in a slightly increased dead volume, but the mixing performance is notably improved.

5. Optional equipment

5.1. Liquid Handling Station

The Liquid Handling Station (LQH Station) consists of two functional units: the rinsing and the dilution unit. As an add-on, it is mainly helpful for rinsing the needle both from the inside and on the outside, thus minimizing contamination.

The following kit is needed:

Nr	Article no.	Article designation
1	6.5330.130	IC Equipment: LQH Station, left



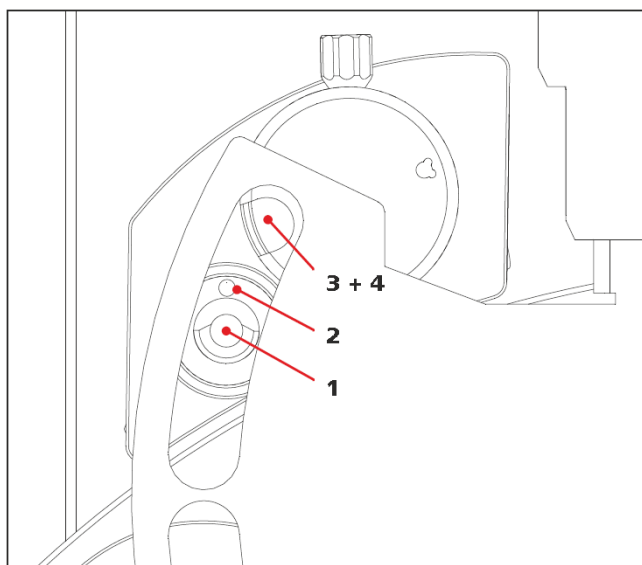
The kit includes:

Nr	Article no.	Article designation
1	6.1014.200	Metrosep I Trap 1 - 100/4.0
1	6.1602.160	Eluent bottle cap GL 45
1	6.1608.070	Eluent bottle /2 L / GL 45
1	6.1619.000	Adsorber tube for 807 Dosing Unit
1	6.1624.000	Adapter SGJ 14
1	6.1826.390	Pump tubing LFL (yellow/yellow) 3 stoppers
1	6.1831.180	PEEK capillary ID 0.5 mm, 3 m
1	6.2744.010	Pressure screw 5×
1	6.2744.034	Coupling nozzle UNF 10/32
1	6.2841.120	Liquid Handling Station, left

The installation of the LQH Station is done in two steps. First, mount and align the Liquid Handling Station on the left-hand side of the Sample Processor. To accomplish this, remove the sample rack and place the Liquid Handling Station on the

black rail of the Sample Processor. Secure it temporarily in place with the screw and then loosen the small screws of the foot. The rack is replaced on the Sample Processor and the small screws are fixed in a way that the approximate distance between LHS and rack is 0.5–1 mm.

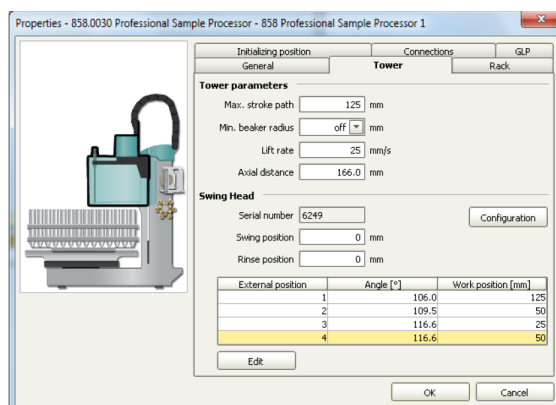
Now the Liquid Handling Station needs to be aligned with the retaining plate. For this, loosen the big screw again and move the LQH Station underneath the retaining plate. Looking from above you should now be able to see the small hole of the rinsing unit and part of the large hole of the dilution vessel, similar to the following image.



When you have found the correct position, please tighten the screw to fix the LQH Station completely to the Sample Processor.

In a second step, the work positions for the sample tube need to be defined in the configuration.

For this, go to the configuration of the Sample Processor. Under the “Tower” tab it is possible to define external positions of the Swing Head. For rinsing purposes, only the External Position 1 (small inner tube) and the External Position 2 (outer tube of rinsing unit) have to be defined. The proposed angles are only guiding values; they need to be adapted for every system separately. This can be done easily by adjusting the angles in the manual control window. As soon as you have found the correct angles, make sure to save them in the configuration. The work positions are fixed for all of the different setups.



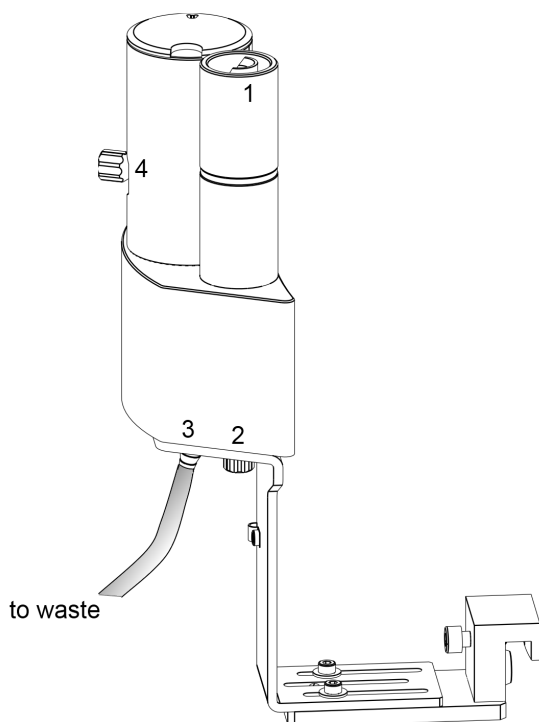
Depending on the available parts, the water supply to the Liquid Handling Station is managed differently. The inner tube of the rinsing unit is meant to be filled constantly with fresh ultrapure water, so the aspiration needle can be thoroughly cleaned from the outside.

All possibilities have the waste tube in common (Number 3 in the following image). Please fix the PVC tubing (6.1801.120) on the disposal connector on the bottom of the Liquid Handling Station.

If there is a free peristaltic pump channel, there is the possibility to connect a water bottle with a peristaltic pump tubing and lead a capillary to the PEEK pressure screw on the bottom of the Liquid Handling Station (Number 2 in the following image). Between the peristaltic pump and the LQH Station, please install an I Trap (6.1014.200) into the flow path to cleanse the water before it goes into the IC system.

Another possibility arises with a Dosino:

Similar to the setup with the peristaltic pump mentioned earlier, connect one of the Dosino ports with a capillary to the PEEK pressure screw (Number 2 in the following page) on the Liquid Handling Station. Then use the Dosino to push water from below into the rinsing unit when needed. Here, it is recommended to install an I Trap (6.1014.200) into the flow path of the water so that the water is cleansed from all impurities that could collect in the water reservoir.



Number 4 in the picture above shows the attachment point of a capillary in case of a dilution feature, and Number 1 indicates the rinsing entity.

In the time program you can treat the external positions like a special beaker: just move to the desired angle, go into work position, and start the Dosino or the peristaltic pump. Make sure to always dispose the waste in the external position 2.

5.2. Eluent Production Module

The 941 Eluent Production Module creates fresh new eluent out of eluent concentrate and ultrapure water. For installation instructions and further information, please refer to the 941 Eluent Production Module manual.

5.3. Alternative MSM rinsing and regeneration

For alternative suppressor rinsing and regeneration methods and setups, please refer to the Application Bulletin AB-395.