GL Sciences

OPTIC-4 Multimode GC Inlet

User's Guide:

Installation and

Operation

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CE Declaration of Conformity

Manufacturer:	GL Sciences B.V. De Sleutel 9, 5652 AS Eindhoven, The Netherlands Tel: +31 (0)40 254 95 31 www.glsciences.eu, info@glsciences.eu
Product:	OPTIC-4, all models
Type of Equipment:	Multimode GC Inlet System
Application of Council Directives:	2014/35/EC (Low Voltage Directive) 2014/30/EC (EMC Directive)
Certification Body:	Dijkstra Advies, Research & EMC Consultancy B.V., Woerden, The Netherlands
Product compliant to:	EN 61010-1 (2010) EN 61326-1 (2013) Class B EN 61326-1 (2013) Basic EN 61000-3-2 (2014) EN 61000-3-3 (2013)
Certificates:	Certificates of Conformity to Low Voltage Directive No. **11C00201CRT01** **13C00959CRT01** Certificate of Conformity to EMC Directive No. **11C00200CRT01**

GL Sciences B.V. hereby declares under our sole responsibility that our OPTIC-4 Multimode GC Inlet System when installed in accordance with installation specifications is in conformity with the above Directives and Standards:

N. Gribov
Product Development Manager

Date: April 13, 2017

Warranty Information

GL Sciences provides the following warranty for this instrument.

1. Period:

One year from the date of shipment or six months after repair.

2. Terms:

GL Sciences will provide free replacement parts for, or repair free of charge, any instrument that fails during the warranty period. The warranty covers manufacturing defects only.

3. Exclusions:

GL Sciences does not guarantee that the operation of this product will be uninterrupted or error-free. GL Sciences is not responsible for damage that occurs as a result of your failure to follow the instructions intended for this instrument. The warranty does not apply to consumable parts and does not extend to any product, which was damaged or lost as a result of:

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2) operation outside the usage parameters stated in the user documentation that shipped with the product;
3) improper site preparation or maintenance;
4) loss or damage in transit;
5) modification or service by anyone other than GL Sciences or an GL Sciences authorized representative;

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Replacement Part Availability

Replacement parts for this instrument will be available for period of seven (7) years after the discontinuation of the product. Beyond this period such parts may not be available.

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1. Precautions and Warnings

This section explains the warnings and cautions that should be observed when installing or operating OPTIC-4.

Safety information is covered at relevant points throughout the manual. Please read this manual in its entirety before installing or operating the instrument. Should any point remain unclear, contact your supplier for assistance before proceeding.

NOTE:

Warnings, precautions and other items of interest are indicated by the following conventions:

WARNING! Indicates a potentially hazardous situation, which, if not avoided, could result in moderate to serious injury or possibly death.

CAUTION! Indicates a potentially hazardous situation, which, if not avoided, could result in minor injury or equipment damage.

NOTE Emphasizes additional information that is provided to ensure proper use of this instrument.

1.1 General Precautions and Warnings

1. Use OPTIC-4 for specified types of analyses only.

2. Follow the procedures as written in this manual.

3. Do not modify or disassemble instrument without an express approval of GL Sciences B.V. or its authorized representative as this may compromise safety.

1.2 Installation Precautions and Warnings

OPTIC-4 is designed for installation and use in a laboratory environment by suitably trained personnel. All relevant safety aspects should be assessed in accordance with the local regulations before installing and commissioning the instrument.

1. An GL Sciences representative must perform instrument installation and configuration. To prevent potential injuries, contact an GL Sciences representative if the instrument must be moved after installation.

2. OPTIC-4 is intended for use in appropriately equipped analytical laboratories. Solvents used for analysis are flammable and toxic. Install the instrument in a very well ventilated room.

Provisions must be made for the storage of solvents in flame-proof cabinets and personnel must wear protective clothing and eye protection at all times.

3. The OPTIC-4 controller must be powered from an earthed (grounded) mains outlet.

   Power Requirements: AC Single Phase 100-240V, Frequency 50-60 Hz
   Typical power consumption: 150VA
   Maximum power consumption: 450 VA

4. Both the OPTIC-4 controller and the host GC must be disconnected from the mains power outlet until installation of the equipment is completed.

5. The Optic-4 controller power switch is located at the rear of the instrument. Leave enough space behind the controller to ensure unrestricted access to the power switch.

6. Do not use power cords others than those supplied with the instrument as this may cause fire or electric shock.

7. It is important that a good electrical connection is made between the inlet power cable and the inlet power terminals. A bad connection can result in poor operation and the connection(s) can become excessively hot.

   Ambient Environment: Temperature range: 18 - 40°C
   Humidity: 40 - 70%

5. The OPTIC-4 EFC's are not designed for operation with explosive (besides Hydrogen), corrosive or toxic gases.

   Carrier Gases: Helium, Nitrogen or Hydrogen
   Supply Pressure: 300 - 700 kPa
   Purity: 99.995% or greater

6. The use of Hydrogen as a GC carrier gas is potentially dangerous. It is potentially explosive. Take extreme care when using Hydrogen as the GC carrier gas in a GC or GC/MS system.

7. OPTIC-4 inlet is cooled using compressed air. A cooling valve will be damaged when the source pressure exceeds specification. Do not exceed maximum source pressure of 700 kPa.

   Cooling Air: Oil- and water-free compressed air
   Supply Pressure: 700 kPa

1.3 Operation Precautions and Warnings

1. Most organic solvents are toxic to some degree. Substantial amounts of solvent vapor may emerge from the exhaust port. It is highly recommended that these vapors are ducted to a fume hood, or an active carbon trap is fitted to the exhaust port. However, the flow through this port should not be restricted as this might impede normal functioning of the instrument.

2. When leak testing gas line connections, use a suitable electronic leak detector. Under no circumstances should a soap solution or similar be used as this will contaminate the inlet and the column.

3. There are potentially hazardous voltages present inside the OPTIC-4 control unit. To prevent injuries and instrument damage, do not disassemble or modify it, or perform internal repairs.

4. When working with glass liners, it is important to wear the necessary protective glasses to shield eyes and skin from injury if the liner breaks or shatters on impact.

5. When working with capillary column, it is important to wear the necessary protective glasses to shield eyes from injury if the column breaks or shatters on impact.

6. The operation of the GC inlet requires that it heats up rapidly to high temperatures. Parts of the inlet may remain hot for some time after the unit is switched off or hangs up due to internal fault. Care must be taken when working in the area of the inlet. It is especially important to ensure that the inlet is cold (below 40°C) before changing inlet liners.

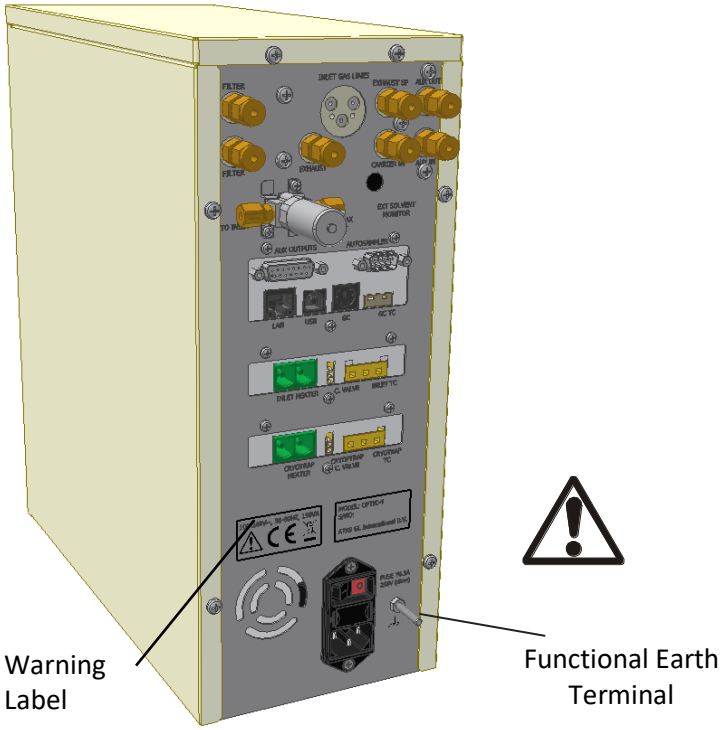
7. Do not tight or lose the top boss or the inlet bottom nut when inlet is at high temperature. The threads can be easily damaged.

8. The OPTIC-4 EFC will be damaged when the inlet pressure exceeds specification. Do not exceed maximum source pressure of 700 kPa.

9. Heating the column above the upper limits can significantly reduce column life. Make sure that you are aware about the GC column maximum temperature limit.

1.4 Warnings Signs

HIGH VOLTAGE: Disconnect power cable before removing any units cover.



1.5 Cryogenic Trap Precautions and Warnings

The following cautions and warnings relate to the cryotrap fitted to OPTIC-4SC and OPTIC-4DC.

1. The cryotrap cannot be used with a metal column. The metal column will short-circuit the trap heater, causing severe damaged to the trap. A glass capillary pre-column is advised to avoid problems.

2. It is strongly advised not to hold the trap at subambient temperature for longer than 20 minutes. The ice is formed on the points of column near the trap ends if trap is kept cold for a long time. This penomenon can cause analytical problems and also can bring damage to the column coating!

3. The cryotrap uses cryogenic liquids (CO_2 and liquid nitrogen) to cool down trap to sub-ambient temperatures. Personnel must be thoroughly familiar with properties and safety considerations before being allowed to handle cryogenic liquids and the cryogenic trap.

4. Cryogenic liquids can cause serious burns. Hand protection and goggles (not safety glasses) are to be worn at all times when handling it. Never allow any unprotected part of the body to come in contact with un-insulated tubing or parts that contain cryogenic products. The

extremely cold metal will cause the flesh to stick rapidly and tear when you attempt to withdraw.

5. Cryogenic liquids, when returned to the gaseous state, can displace oxygen from the air under the right conditions. It is strongly recommended to use and store cryogenic liquids in well ventilated areas only. It may also be prudent to install oxygen monitors in areas where liquid nitrogen is stored and ventilation is minimal.

6. The CO2 cooling option is supplied with a cryogenic valve that can hold maximum pressure of 1000 psi. In order not to exceed this pressure limit, the CO2 cylinder must be kept at the temperature not higher than 25 °C.

7. Dewar with liquid Nitrogen should be handled and stored in an upright position. Do not drop Dewar or tip it on its sides.

1. Waarschuwingen en aandachtspunten

Dit hoofdstuk beschrijft de waarschuwingen die in acht dienen te worden genomen tijdens het installeren en bedienen van de OPTIC-4.

Veiligheid informatie wordt behandeld op de relevante onderdelen in de handleiding. Lees eerst de handleiding in zijn geheel voordat u een installatie of bediening gaat uitvoeren. Blijft er een punt onduidelijk, neem dan altijd eerst contact op met uw leverancier.

1.1 Algemene OPTIC-4 waarschuwingen en aandachtspunten

De OPTIC-4 is ontwikkeld voor installatie en gebruik in een laboratorium omgeving door goed geschoold personeel. Alle lokale relevante veiligheid aspecten moeten in acht worden genomen voordat er aan de installatie van het instrument wordt begonnen.

1.1.1 Algemene OPTIC-4 waarschuwingen

1. De OPTIC-4 is bedoeld voor het gebruik in goed voorziene chemische analytische laboratoria. Voor de opslag van oplosmiddelen moet een vlam dovende kast aanwezig zijn en het personeel moet ten alle tijden beschermende kleding en bril dragen.

2. Zowel de GC en de OPTIC-4 moeten afgekoppeld zijn van de netspanning totdat de installatie is afgerond. De OPTIC-4 moet worden aangesloten op een geaarde netspanning.

3. In de bedieningsunit van de OPTIC-4 zijn gevaarlijke hoogspanningen aanwezig. Schakel de unit uit voordat u een van de zijplaten wilt verwijderen.

4. Voor de werking van de inlet is het nodig dat deze snel kan verwarmen naar hoge temperaturen. De inlet kan enige tijd warm blijven nadat de unit is uitgeschakeld. Let goed op wanneer er gewerkt word in de omgeving van de inlet. Het is vooral belangrijk dat de inlet is afgekoeld tot een temperatuur lager dan 40°C en de unit is uitgeschakeld voordat er liners worden gewisseld.

5. De meeste organische oplosmiddelen zijn giftig, de een meer dan de andere. Een hoeveelheid damp van het oplosmiddel komt uit de "exhaust" port van de unit. Het is aanbevolen deze dampen af te voeren via een afzuiging of op te vangen in een actief kool filter. Hierbij is het wel van belang dat er geen restrictie optreed, waardoor de analyse wordt beïnvloed.

6. De OPTIC-4 gas controle unit is niet ontworpen om te werken met explosieve, corrosieve en giftige gassen (behalve Waterstof).

7. Het gebruik van waterstof als dragergas is kan gevaarlijk zijn vanwege de explosiviteit. Let daarom extra goed op bij het gebruik van waterstof als draaggas bij een GC of GC/MS systeem.

1.1.2 Algemene OPTIC-4 aandachtspunten

1. Het is van belang dat er een juiste verbinding wordt gemaakt tussen de inlet power kabels en de inlet zelf. Een slechte verbinding kan een slechte werking veroorzaken en de verbindingen kunnen extreem heet worden.

2. Tijdens het zoeken naar een lek is het van belang dat er gewerkt word met een geschikte elektronische lekdetector. Onder geen enkele voorwaarde mag er een zeepoplossing of een vergelijkbare oplossing worden gebruikt, dit zal de inlet vervuilen.

3. De inlet bedieningsunit mag niet worden aangezet wanneer de inlet niet is aangesloten, dit kan onherstelbare schade aan de unit veroorzaken.

1.2 Waarschuwingen en aandachtspunten voor de OPTIC-4 Cryotrap

De volgende waarschuwingen en aandachtspunten zijn gerelateerd aan de OPTIC-4-SC en OPTIC-4-DC.

1.2.1 Waarschuwingen voor de OPTIC-4 Cryotrap

1. De Cryotrap gebruikt vloeibare stikstof om koud gas te maken voor de lage gebruikstemperaturen. De gebruiker moet goed bekend zijn met de eigenschappen en veiligheidsregels voor het gebruik van vloeibare stikstof en de Cryotrap.

2. Vloeibare stikstof kan ernstige brandwonden veroorzaken. Handschoenen en een goed aansluitende veiligheidsbril moeten te allen tijde gedragen worden wanneer er gewerkt wordt met vloeibare stikstof. Zorg er voor dat de huid nooit in contact komt met een ongeïsoleerde leiding van het cryo systeem. Het extreme koude metaal zorgt er voor dat de huid aan het metaal plakt en wanneer men probeert los te komen trekt men de huid kapot.

3. Dewars (vat met vloeibare stikstof) dient men rechtop te vervoeren en te plaatsen. Gooi nooit een Dewar om.

1.2.2 Aandachtspunten voor de OPTIC-4 Cryotrap

Zorg ervoor dat er een gas stroom door de warmtewisselaar loopt voordat deze in de vloeibare stikstof wordt geplaatst of wanneer deze voor een langere tijd in de stikstof blijft staan. Dit is om te voorkomen dat de warmtewisselaar bevriest door de aanwezigheid van water damp in de aanwezige lucht.

1. Sicherheitshinweise und Warnungen

Dieses Kapitel enthält Erläuterungen zu den bei Installation und Betrieb von OPTIC-4 zu beachtenden Sicherheitshinweisen und Warnungen.

Sicherheitshinweise werden an allen relevanten Stellen im Handbuch gegeben. Bitte lesen Sie dieses Handbuch komplett durch, bevor Sie OPTIC-4 installieren oder in Betrieb nehmen. Bei etwaigen Unklarheiten kontaktieren Sie bitte vor der Ingebrauchnahme Ihren Lieferanten.

1.1 OPTIC-4 - Allgemeine Sicherheitshinweise und Warnungen

OPTIC-4 wurde für die Installation und den Gebrauch durch entsprechend geschultes Personal in Laboratorien entwickelt. Vor Installation und Ingebrauchnahme sind sämtliche relevanten Sicherheitsaspekte unter Berücksichtigung der lokalen Vorschriften zu überprüfen.

1.1.1 OPTIC-4 - Allgemeine Warnungen

OPTIC-4 ist für die Benutzung in entsprechend ausgestatteten Laboratorien für chemische Analytik entwickelt. Es ist sicherzustellen, dass Lösungsmittel in feuersicheren Behältnissen aufbewahrt werden und Mitarbeiter zu allen Zeiten Schutzkleidung und Augenschutz tragen.

Sowohl OPTIC-4 als auch der GC sind von der Hauptstromzufuhr abzutrennen, solange die Anlage noch nicht komplett installiert ist. OPTIC-4 ist an eine geerdete Steckdose anzuschließen.

Im Innern des OPTIC-4 Steuerteils befinden sich Teile mit potentiell gefährlicher Betriebsspannung. Schalten Sie den Steuerteil ab und unterbrechen Sie die Hauptstromzufuhr, bevor Sie das Gehäuse des Steuerteils entfernen.

Betrieb des Injektors erfordert, dass er schnell auf hohe Temperaturen erhitzt wird. Teile des Injektors können noch heiß sein, nachdem das Teil abgeschaltet wurde. Beim Arbeiten in der Nähe des Injektors ist Vorsicht geboten. Es ist sicher zu stellen, dass der Injektor (unter 40°C) abgekühlt und ausgeschaltet ist, bevor die Injektor-Liner ausgewechselt werden.

Fast alle organischen Lösungsmittel sind bis zu einem gewissen Grad giftig. Da aus dem Auslassport hohe Mengen an Lösungsmitteldämpfen austreten können, wird dringend empfohlen, diese Dämpfe in eine Abzugshaube zu leiten oder einen Aktivkohlenfilter am Port anzubringen. Dadurch darf jedoch der Fließvorgang durch diesen Port nicht beeinträchtigt werden um korrekten Verlauf der Analyse zu gewährleisten.

Die OPTIC-4 Gaskontrollen sind nicht für Betrieb mit Explosivstoffen, (abgesehen von Hydrogen), Schadgasen oder toxischen Gasen gedacht.

Der Gebrauch von Hydrogen als GC-Trägergas ist gefährlich. Beim Gebrauch von Hydrogen als GC-Trägergas in einem GC- oder GC/MS-System besteht Explosionsgefahr – daher ist äußerste Vorsicht geboten.

1.1.2 OPTIC-4 - Allgemeine Warnungen

Es ist wichtig, dass eine gute Verbindung zwischen dem Injektor-Niedrigspannungskabel und dem Injektor hergestellt wird, da eine schlechte Verbindung die Leistung herabsetzen und die Verbindung extrem heiß werden lassen kann.

Beim Überprüfen der Verbindungen auf Lecks sollte ein geeigneter elektronischer Leckdetektor oder eine 50/50 Lösung aus -Propanol und Wasser benutzt werden. Keinesfalls Seifenlauge oder Ähnliches benutzen, da dies den Injektor kontaminiert.

Der Steuerteil des Injektors darf nicht angeschaltet werden, solange der Injektor nicht angeschlossen wurde, da dies das Instrument schwer beschädigen kann.

1.2 Sicherheitshinweise und Warnungen betreffend die OPTIC-4 Kühlfalle

Die folgenden Sicherheitshinweise und Warnungen betreffen die an OPTIC-4-SC und OPTIC-4-DC angebrachte Kühlfalle.

1.2.1 Warnungen betreffend die OPTIC-4 Kühlfalle

Die Kühlfalle wird mit flüssigen Stickstoff betrieben um das kalte Gas für Niedrigtemperatur-Betrieb zu erzeugen. Vor der Benutzung ist sicherzustellen, dass das Bedienungspersonal mit den Eigenschaften flüssigen Stickstoffs und den Sicherheitsanforderungen betreffend die Kühlfalle eingehend vertraut ist.

Flüssiger Stickstoff kann schwere Verbrennungen verursachen. Beim Umgang damit sind grundsätzlich Handschutz und Vollsichtbrillen (keine Schutzbrillen) zu tragen. Ungeschützte Körperteile dürfen keinesfalls mit nicht-lierten Leitungen oder Teilen in Kontakt kommen, die Tieftemperaturprodukte enthalten, da die Haut unverzüglich am extrem kalten Metall kleben bleibt und beim Zurückziehen abgerissen wird.

Dewarbehälter mit flüssigem Stickstoff sind senkrecht zu hantieren und zu lagern. Dewarbehälter nicht fallen lassen oder umdrehen.

1.2.2 Warnungen betreffend die OPTIC-4 Kühlfalle

Stellen Sie sicher, dass Gas durch die Rohrschlange des Kühlfallen- Wärmetauschers fließt, wenn sie ihn in den flüssigen Stickstoff tauchen oder für lange Zeit im Dewarbehälter lassen um Vereisung des Wasserdampfes in der Luft zu verhindern, was den Gasfluss durch den Wärmetauscher unterbrechen würde.

1. 注意事项与警告

本节将说明在安装或操作 OPTIC-4 时应当遵守的警告和注意事项。

安全信息已在手册的相关要点中进行说明。安装或操作仪器前，请完整阅读本手册。如有任何疑点，请在操作前联系供应商以获取帮助。

备注：

警告、注意事项和其他相关事项的含义约定如下：

警告！ 表示具有潜在危险，若不加以避免，可能导致中度至严重人身伤害或死亡。

小心！ 表示具有潜在危险，若不加以避免，可能导致轻度人身伤害或设备损坏。

注意事项 强调额外信息，提供此类信息目的是确保合理正确使用此仪器。

1.1 一般注意事项与警告

4. OPTIC-4 仅用于分析指定的类型。

5. 请按照本手册中描述的流程进行操作。

6. 未经 GL Sciences B.V.或其授权代表批准，请勿改造或拆卸仪器，否则可能会形成安全隐患。

1.2 安装注意事项与警告

OPTIC-4 专为在实验室环境中安装和使用而设计，由经过适当培训的人员操作。安装和调试仪器前，所有相关的安全事宜均应当按照当地法规进行评估。

8. GL Sciences 代表必须履行仪器安装和配置职责。若仪器安装后必须移动，为防止发生潜在损坏，应当联系 GL Sciences 代表。

9. OPTIC-4 设计用于配备了适当设施的分析实验室。分析中使用的溶剂为可燃、有毒溶剂。请将仪器安装在通风良好的室内。贮存溶剂时必须采取预防措施，将其存放在防火柜中，员工必须始终穿着防护服并佩戴护目用具。

10. OPTIC-4 控制器必须使用通地（接地）电源插座供电。

功率要求： 100-240V 交流单相，频率 50-60 Hz。
一般功率消耗： 150VA
最大功率消耗： 450 VA

11. OPTIC-4 控制器和主机 GC 均应当断开供电电源，直到设备安装完成。

12. Optic-4 控制器电源开关位于仪器后面。控制器后面应当留下足够的空间，以方便接触电源开关。

13. 请勿使用非仪器配用电源线，否则可能导致火灾或触电。

14. 请务必保持进口电力电缆和进口电力终端之间的导电连接良好。连接不良可能导致难以操作，且可能导致连接件过热。

周围环境： 温度范围： 18 - 40°C
湿度： 40 - 70%

8. OPTIC-4 EFC 并非设计使用爆炸性气体（包括氢气）、腐蚀性气体或有毒气体进行操作。

载气： 氦气、氮气或氢气
供气压力： 300 - 700 kPa
含量： 99.995% 或以上

9. 将氢气用作 GC 载气时存在潜在危险，有可能发生爆炸。在 GC 或 GC/MS 系统中将氢气用作 GC 载气时，应当格外小心。

10. OPTIC-4 进口通过压缩空气冷却。当气源压力超过规定的压力时，冷却阀可能受损。请勿超过最大气源压力 700 kPa。

冷却空气： 无油无水压缩空气
供气压力： 700 kPa

1.3 操作注意事项与警告

10. 大多数有机溶剂都有一定的毒性。大量溶剂蒸汽可能从排气口排出。我们强烈建议，使用管道将这些蒸汽输送到排气口配备的通风橱或活性碳阱。但是，不得限制气体从此排气口排出，以免阻碍仪器的正常运行。
11. 当进行输气管道连接泄露测试时，应当使用适当的电子检漏仪。任何情况下都不能将肥皂液或类似溶液用作电子检漏仪溶液，否则会污染进口和柱。

12. OPTIC-4 控制装置内存在潜在危险电压。为防止受到人身伤害和仪器损坏，不得拆卸或改造仪器，亦不得进行内部维修。

13. 操作玻璃内胆时，请务必佩戴必要的防护眼镜，如果内胆因受到冲击而破裂或破碎，可防止眼睛和皮肤受伤。

14. 操作毛细管柱时，请务必佩戴必要的防护眼镜，如果柱因受到冲击而破裂或破碎，可防止眼睛受伤。

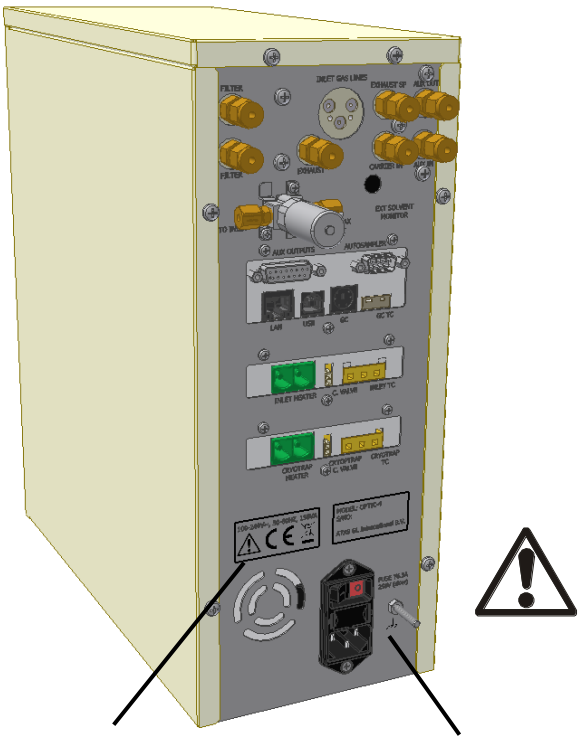
15. 操作 GC 进口时，进口需要迅速加热至高温。装置关闭或因内部故障而停机后，进口零件的余温可能保持一段时间。在进口周围作业时，必须小心。更换进口内胆前，请务必确保进口已冷却（低于 40°C）。

16. 当进口处于高温时，请勿拧紧或拧松顶部凸台或进口底部螺母。螺纹极易受损。

17. 当进口压力超过规定的压力时，OPTIC-4 EFC 可能会损坏。请勿超过最大气源压力 700 kPa。

1.4 警告标识

高压： 移除任何装置盖子前，请先断开电力电缆。



1.5 冷阱注意事项与警告

以下注意事项与警告涉及 OPTIC-4SC 和 OPTIC-4DC 配备的冷阱。

8. 冷阱不得与金属柱共同使用。金属柱会使冷阱加热器短路，造成冷阱严重损坏。建议使用玻璃毛细管前置柱，以避免出现问题。

9. 冷阱使用低温液体（二氧化碳和液氮）冷却冷阱，使温度低于室温。员工必须完全熟悉其特性和安全措施才可处理低温液体和冷阱。

10. 低温液体可能造成严重烧伤。处理低温液体时，员工应当始终佩戴防护手套和护目镜（非安全眼镜）。严禁无保护措施的身体部位接触未绝缘的管子或包含低温产品的零件。温度极低的金属会迅速粘住皮肤，如果您试图撤离，皮肤会撕裂。

11. 当低温液体恢复气态时，在合适的条件下，可取代空气中的氧气。强烈建议仅在通风良好的区域使用和贮存低温液体。建议在贮存液氮的区域和通风不良的区域安装氧气监测仪。

12. 二氧化碳冷却选项配备一个低温阀，可承受的最大压力达 1000 psi。为避免超过此压力限制，二氧化碳瓶必须保存在温度低于 25°C 的环境中。

13. 含液氮的杜瓦瓶应当直立处理和贮存。不得使杜瓦瓶倒下或倾斜。

1. Mises en garde et précautions d'emploi

Cette section expose les mises en garde et les précautions d'emploi à observer lors de l'installation ou du fonctionnement d'OPTIC-4.

Les informations relatives à la sécurité sont présentées en différents endroits du manuel lorsque ce point s'impose. Nous vous prions donc de lire le manuel dans son intégralité avant d'installer ou de faire fonctionner l'appareil. Si des points manquent de clarté, veuillez solliciter l'aide de votre fournisseur avant de procéder à la mise en marche de l'appareil.

1.1 Mises en garde et précautions d'emploi générales concernant OPTIC-4

OPTIC-4 est conçu pour être installé et utilisé en laboratoire par un personnel formé à cet effet. Tous les aspects de la sécurité doivent être déterminés en fonction des règles en vigueur dans les lieux concernés avant d'installer et de mettre en service l'appareil.

1.1.1 Mises en garde générales concernant OPTIC-4

OPTIC-4 est destiné à l'utilisation dans des laboratoires d'analyses chimiques correctement équipés. Des dispositions doivent être notamment prises pour que les solvants soient entreposés dans un lieu de rangement ininflammable et pour que le personnel porte en permanence des vêtements et des lunettes de protection.

OPTIC-4 tout comme le GC hôte doivent être déconnectés du réseau électrique tant que l'installation de l'appareil n'est pas terminée. OPTIC-4 doit être alimenté à partir d'une prise de terre.

Il peut y avoir des voltages dangereux présents dans l'unité de commande d'OPTIC-4. Eteignez l'unité de commande et débranchez-la avant d'enlever le couvercle.

Le fonctionnement de l'injecteur implique son réchauffement rapide afin d'atteindre des températures élevées. C'est pourquoi des éléments de l'injecteur peuvent rester très chauds une fois celui-ci éteint. Il faut donc faire attention lorsqu'on travaille à proximité de l'injecteur. Il est particulièrement important de s'assurer que l'injecteur est refroidi (au-dessous de 40°C) et éteint avant de procéder à toute opération de remplacement.

La plupart des solvants organiques sont dans une certaine mesure toxiques et une quantité non négligeable de vapeur de solvant peut sortir de la soupape d'échappement. Il est fortement recommandé de faire en sorte que ces vapeurs soient canalisées vers une hotte d'aération ou un filtre à charbon actif adapté à la soupape. Il ne faut toutefois pas restreindre l'évacuation qui se fait par cette soupape, ceci risquant de fausser les analyses.
Les commandes de gaz d'OPTIC-4 ne sont pas conçues pour un fonctionnement avec des gaz explosifs (à l'exception de l'hydrogène), corrosifs ou toxiques.

L'utilisation d'hydrogène en tant que gaz vecteur GC peut être dangereux puisqu'il s'agit d'un gaz potentiellement explosif. Vous devez prendre des mesures de précautions extrêmes lorsque vous utilisez de l'hydrogène en tant que gaz vecteur dans le système GC ou GC/SM.

1.1.2 Précautions d'emploi générales concernant OPTIC-4

La qualité du raccordement entre le câble électrique de l'injecteur et l'injecteur et très importante. Une mauvaise connexion peut entraîner un mauvais fonctionnement ainsi qu'un échauffement extrême de celle-ci.

Pour les tests de détections de fuites sur les connexions, utilisez un détecteur de fuite électronique approprié ou une solution 50/50 d'propanol et d'eau. Il ne faut en aucun cas utiliser une solution savonneuse ou une solution semblable qui contaminera l'injecteur.

La boîte de commande de l'injecteur ne doit pas être allumée lorsque l'injecteur est déconnecté sous peine de grandement endommager l'appareil.

1.2 Mises en garde et précautions d'emploi concernant le piège cryogénique d' OPTIC4

Les mises en garde et précautions d'emploi suivantes concernent le piège cryogénique dont sont équipés OPTIC-4-SC et OPTIC-4-DC.

1.2.1 Mises en garde concernant le piège cryogénique d'OPTIC-4

Le piège cryogénique utilise de l'azote liquide pour produire le gaz froid nécessaire aux opérations à basses températures. Le personnel devra connaître parfaitement les propriétés et les mesures de sécurité avant d'être autorisé à manipuler l'azote liquide et le piège cryogénique.

L'azote liquide peut causer de graves brûlures. Il faut donc porter des gants et des lunettes à pourtour étanche (et non pas de simples lunettes de protection) tout le temps qu'on utilise ce produit. Il ne faut jamais laisser une partie non protégée du corps entrer en contact avec des tuyaux non lés ou avec des éléments contenant des produits cryogéniques. La température extrêmement froide du métal fera que la peau y adhérera et se déchirera lorsqu'on tentera de se dégager.

Les dewars contenant de l'azote liquide devront être manipulés et entreposés en position verticale. Il ne faut pas laisser tomber les dewars ou les basculer sur le côté.

1.2.2 Précautions d'emploi concernant le piège cryogénique d'OPTIC-4

Assurez-vous que le gaz circule bien dans le serpentin de l'échangeur thermique du piège cryogénique lorsque vous l'immergez dans l'azote liquide ou lorsque vous le laissez longtemps dans le dewar. Ceci afin d'éviter que la vapeur d'eau présente dans l'air ne givre ce qui bloquerait la circulation du gaz dans l'échangeur thermique.

1. Advertencias y precauciones

En esta sección se explican las advertencias y precauciones que deben observarse a la hora de instalar o manipular el OPTIC-4.

A lo largo del manual existen distintos apartados que contienen información relacionada con la seguridad. Así, pues, le recomendamos que lea detenidamente todo el manual antes de instalar o manipular el instrumento. Si tras su lectura tuviese alguna duda, le rogamos que se ponga en contacto con su proveedor.

1.1 Advertencias y precauciones generales relacionadas con el OPTIC-4

OPTIC-4 está diseñado para que se instale y utilice en un laboratorio por personas convenientemente capacitadas. Antes de instalarlo o ponerlo en funcionamiento es imprescindible que se valoren los aspectos relativos a la seguridad en el contexto de las normas locales.

1.1.1 Advertencias generales en torno al OPTIC-4

OPTIC-4 debe utilizarse en laboratorios de análisis de sustancias químicas debidamente equipados y, en este sentido, es necesario tomar medidas para almacenar los dlventes en armarios refractarios y para que el personal lleve ropa protectora y gafas en todo momento.

Hasta que finalice la instalación es imprescindible desconectar de la toma eléctrica tanto el OPTIC-4 como el GC huésped. En cuanto al OPTIC-4 es necesario que reciba la corriente de una toma con conexión a tierra.

La unidad de control del OPTIC-4 contiene varias tensiones potencialmente peligrosas, por lo que antes de retirar la cubierta es necesario desconectar la unidad de control y también la fuente de alimentación eléctrica.

Para que el inyector funcione adecuadamente es necesario que se caliente rápidamente y alcance altas temperaturas. Se prestará mucha atención cuando se trabaje en la zona del inyector pues sus piezas podrían seguir estando calientes tiempo después de haber desconectado la unidad. Es especialmente importante asegurarse de que el inyector esté frío (por debajo de los 40°C) y desconectado antes de cambiar los revestimientos del inyector.

La mayoría de los dlventes orgánicos son relativamente tóxicos y es posible que salgan vapores por el orificio de escape. Se recomienda encarecidamente dirigir dichos vapores a una campana de humos o instalar un separador de carbono activo en el orificio. Por otro lado, conviene no restringir el flujo a través del orificio puesto que algo así podría interferir en los análisis.

Los controles de gases del OPTIC-4 no están pensados para trabajar con gases explosivos (aparte de hidrógeno), corrosivos o tóxicos.

La utilización de hidrógeno como gas portador de GC es, en principio, peligroso dada su explosividad. Se debe prestar sumo cuidado y atención cuando se utilice hidrógeno como gas portador de GC en un sistema GC/MS.

1.1.2 Precauciones generales OPTIC-4

Es importante que la conexión entre el cable eléctrico del inyector y el inyector sea buena, de lo contrario, el funcionamiento no sería óptimo y, además, la conexión podría calentarse en exceso.

Cuando se realicen pruebas de fugas en las conexiones se utilizará un detector de fugas electrónico adecuado o una solución al 50% de propanol y agua. En ningún caso se utilizará solución jabonosa o un producto similar ya que contaminaría el inyector.

No debe conectarse la caja de control del inyector cuando éste esté desconectado dado que se dañaría gravemente el instrumento.

1.2 Advertencias y precauciones relacionadas con el crioseparador OPTIC-4

Las advertencias y precauciones siguientes guardan relación con el crioseparador instalado en el OPTIC-4 y el OPTIC-4-DC.

1.2.1 Advertencias relacionadas con el crioseparador del OPTIC-4

El crioseparador utiliza nitrógeno liquido para producir el gas frío necesario para que el instrumento funcione a baja temperatura. Es esencial que el personal esté debidamente familiarizado con las propiedades y las consideraciones en torno a la seguridad antes de que manipulen el nitrógeno líquido y el crioseparador.

El nitrógeno líquido puede provocar graves quemaduras, de ahí que sea necesario portar en todo momento cuando se manipule gafas protectoras (no gafas de seguridad) y guantes. Nunca permitir que zonas desnudas del cuerpo entren en contacto con tuberías no aisladas o piezas que puedan contener productos criogénicos. El metal extremadamente frío hará que la piel se pegue rápidamente, rasgándola cuando se intente separarla.

Los frascos Dewar con nitrógeno liquido se manipularán y almacenarán en posición vertical. No verterlos ni volcarlos sobre los costados.

1.2.2 Precauciones relacionadas con el crioseparador del OPTIC-4

Es necesario asegurarse de que el gas esté fluyendo a través de la bobina del tubo del termointercambiador del crioseparador cuando se sumerja o saque del nitrógeno líquido. Con esta medida se pretende evitar que se congele el vapor de agua presente en el aire, lo cual bloquearía el flujo de gas a través del citado termointercambiador.

1. Avvertenze e precauzioni

In questo paragrafo vengono esposte le avvertenze e le precauzioni da osservare per l'istallazione e il funzionamento dell' OPTIC-4.

Lungo tutto il manuale vengono trattati gli aspetti essenziali dell'informazione per la sicurezza. Si prega gentilmente di leggere tutto il manuale prima di procedere all'istallazione e al funzionamento dell'apparecchio. Se qualche punto dovesse rimanere poco chiaro, si prega di prendere contatto col vostro fornitore per dei chiarimenti prima di procedere.

1.1 Avvertenze e precauzioni generali dell' OPTIC-4

L'OPTIC-4 é stato progettato per essere istallato e usato in un ambiente di laboratorio da personale adeguatamente preparato. Tutti gli aspetti relativi alla sicurezza devono essere in accordo alle norme locali prima che si proceda all'istallazione e alla commisione dell'apparecchio.

1.1.1 Avvertenze generali dell' OPTIC-4

L'OPTIC-4 é stato creato per essere usato in laboratori di analisi chimica appropriatamente equipaggiati. In particolare, devono essere presi dei provvedimenti riguardo al magazzinaggio dei solventi che vanno conservati in mobili anti-infiammabili e al personale che deve sempre indossare degli indumenti e degli occhiali di protezione.

Sia l'OPTIC-4 che l'host GC non devono essere collegati ai principali generatori di corrente fino a ultimazione dell'istallazione dell'apparecchiatura. L'OPTIC-4 deve essere alimentato da una presa interrata.

All'interno dell'unità di controllo dell'OPTIC-4 sono presenti dei voltaggi potenzialmente pericolosi. Prima di rimuovere il coperchio dell'unità di controllo spegnere l'unità di controllo e disinserire i principali alimentatori di corrente.

La messa in funzione dell'iniettore richiede un riscaldamento rapido fino al raggiungimento di temperature elevate. Parti dell'iniettore potrebbero rimanere calde anche molto tempo dopo lo spegnimento dell'unità. Bgna procedere con cautela quando si lavora attorno all'area dell'iniettore. Prima del cambio dei rivestimenti dell'iniettore (liners) bgna assicurarsi che questi si sia raffreddato (al di sotto dei 40°C) e che sia spento.

La maggior parte dei solventi organici sono relativamente tossici e una notevole quantità di questi vapori potrebbero fuoriuscire dall'orificio di scarico. Si consiglia vivamente di canalizzare questi vapori in un cappuccio del vapore, oppure di

applicare una presa del carbonio attivo all'orificio di scarico. Ad ogni modo il flusso attraverso l'orificio di scarico non deve essere impedito in quanto cio potrebbe interferire con le analisi.

I sistemi di controllo dei gas dell'OPITIC 3 non sono stati progettati per procedimenti con esplosivi (eccetto l'idrogeno), gas corrosivi o tossici.

L'uso dell'idrogeno come gas trasportatore GC é pericoloso in quanto per sua natura potenzialmente esplosivo. Procedere con estrema cautela durante l'uso dell'idrogeno come gas trasportatore GC in un sistema GC o GC/MS.

1.1.2 Precauzioni generali dell' OPTIC-4

E' importante collegare bene il cavo elettrico dell'iniettore all'iniettore. Un collegamento sbagliato puo causarne il cattivo funzionamento e un surriscladamento dello stesso collegamento.

Quando si effettua una prova per la rilevazione di perdite dei collegamenti, fare uso di un rivelatore di perdite elettronico oppure di una soluzione al 50/50 di -propanolo e acqua. In nessun caso va usata una soluzione detergente o dello stesso tipo in quanto cio contaminerebbe l'iniettore.

La cassetta di controllo dell'iniettore non deve essere accesa quando l'iniettore é staccato in quanto cio potrebbe danneggiare seriamente la strumentazione.

1.2 Avvertenze e precauzioni relative al cryotrap dell'OPTIC-4

Le seguenti avvertenze e precauzioni riguardano il cryotrap inserito all'OPTIC-4-SC e all'OPTIC-4-DC.

1.2.1 Avvertenze relative al cryotrap dell'OPTIC-4

Il cryotrap fa uso di azoto liquido per la produzione di gas freddo per operazioni a basse temperature. Il personale addetto deve essere a conoscenza delle proprietà e delle considerazioni di sicurezza prima di essere autorizzato all'uso dell'azoto liquido e del cryotrap.

L'azoto liquido puo causare delle gravi bruciature. Indossare sempre delle protezioni per le mani e degli occhiali di protezione (non usare degli occhiali di sicurezza) durante il suo maneggiamento. Non permettere a nessuna parte del corpo non protetta di entrare in contatto con la tubazione non lata o delle parti che contengano prodotti criogenici. La temperatura estremamente fredda del metallo causa l'aderenza immediata della pelle ad esso e lo strappo nel tentativo di rimuoverla.

I dewars di azoto liquido dovrebbero essere maneggiati e conservati in posizione eretta. Non lasciar cadere i dewars o inclinarli di lato.

1.2.2 Precauzioni relative all'OPTIC-4 cryotrap

Assicurarsi che vi sia del gas che scorre lungo la bobina del tubo dello scambiatore di calore del cryotrap quando lo si immerge nell'azoto liquido o lo si lascia nel dewar per molto tempo. Tale precauzione va presa per evitare il congelamento del vapore acqueo presente nell'aria, che bloccherebbe la fuoriuscita del gas attraverso lo scambiatore di calore.

2. System Overview

Most of the gas chromatographs (GC's) are fitted with basic inlets offering few operating features. OPTIC-4 is a highly advanced multimode inlet with sophisticated temperature and gas flow control that can be used for the most demanding GC analyses. This important GC component offers single inlet capabilities that would typically require two or more inlets. Whether one needs to increase the GC system sensitivity with the OPTIC-4 large-volume injection capabilities, thermally desorb volatiles or semi-volatiles from a solid sample, pyrolyze polymers or inject dirty samples, OPTIC-4 can perform all of these tasks while still allowing standard injections usually performed with a split/splitless inlet.

A standard OPTIC-4 system consists of an inlet, a control unit and the Evolution Workstation control software. The control software should be installed on a PC running Microsoft Windows 7 or Windows 10.

The standard system is always supplied with a standard inlet which accepts 5 mm OD x 81 mm long liners. There is also a ¼ inch version of the inlet, wich works with the ¼ x 3.2 inch thermal desorption tubes.

OPTIC-4 can be delivered in one of the five configurations. The basic model is OPTIC-4S. It includes an inlet and a stand-alone electronic controller with the built-in temperature and electronic flow controls (EFC). OPTIC-4D has an optional auxiliary flow control channel. OPTIC-4SC and OPTIC-4DC feature an optional cryogenic trap. OPTIC-4PTV is a simplified version of OPTIC-4S, delivered without any gas control channel.

The main part of this guide contains information, which you are likely to refer to regularly. Information, which is only occasionally referred to is included in the appendices. Detailed installation information is also covered in the separate installation guides.

2.1 High Performance

OPTIC-4, when correctly set up, offers a minimum of sample discrimination. Reproducibility is comparable to on-column injection but offers excellent tolerance of "dirty" samples. Thermal degradation is less severe than with conventional hot split and splitless inlets and the analyst has much greater control over the way in which the sample is introduced into the gas chromatograph.

2.2 Advanced Electronic Flow Control

One of the features that sets OPTIC-4 apart from other inlets is its sophisticated gas control system. OPTIC-4S and OPTIC-4SC have a main flow control unit only, while OPTIC-4-D and OPTIC-4-DC also have an auxiliary flow control unit.

Main flow control unit has an electronic flow control channel used to control the total carrier gas flow through the system. It also has a pressure controller to control the inlet pressure. Together, they are used to control the split flow and the column flow. There is a separate flow control channel used to control the septum purge flow. Since technically it is extremely difficult to control the column flow directly, it is programmed using the pressure controller. This is based on the measured inlet pressure, carrier gas properties, column parameters, and GC oven temperature. Unlike many

other inlet systems, OPTIC-4 has its own GC oven temperature sensor to increase the accuracy of the column flow calculations.

Auxiliary EFC unit is a single flow control channel typically used for control of the inlet backflush flow.

2.3 Improved Flexibility

OPTIC-4 can be used for hot-split, hot-splitless, cold-split, cold-splitless and on-column injections. These techniques are discussed in greater details in Section 7 "Defining and Running Methods". Facilities such as large volume sampling, thermal desorption, and pyrolysis are standard features.

OPTIC-4 offers far greater control over the fate of the sample in the inlet than conventional systems. When the sample is injected, the analyst can select the temperature, the column flow and the split flow. It is also possible to inject under static gas flow conditions. Consequently, it is possible to develop many novel approaches to sample injection. OPTIC-4 also features interfaces for the GC and autosampler and auxiliary connections for interfacing to other external equipment.

2.4 Compatibility

OPTIC-4 is designed to be compatible with most popular makes and models of GC and GC-MS. Once installed, OPTIC-4 should be fully compatible with an auto-sampler. Please visit our web site at www.glsciences.eu or contact your local OPTIC-4 distributor if you have any questions concerning compatibility.

The interfaces are discussed in greater detail in the hardware and configuration sections of this manual, and the appendices.

3. Hardware

The OPTIC-4 hardware consists of a bench-top control unit, an inlet and an optional cryogenic trap that are installed on a host gas chromatograph.

3.1 Control Unit

The control unit (Fig. 3.1) contains microprocessor, inlet temperature and gas flow control systems, user interface, power supply's, interfaces to the PC, GC, autosampler and auxiliary equipment, and optional cryotrap control (OPTIC-4SC and OPTIC-4DC only).

Figure 3.1 OPTIC-4 Controller

3.2 Keypad

OPTIC-4 has a simple keypad on the front panel of the unit. Two keys, **RUN/END RUN** and **STANDBY** are used for local control of the initialized and running methods. **RUN/END RUN** key allows to override the standard procedure and run a method while it is being initialized or is in "Waiting for Ready In" or "Waiting for Run In" state. The same key allows interrupting running method and forcing the system to initialize it again. **STANDBY** key allows switching the system into the standby state while the method is being initialized or is in "Waiting for Ready In" or "Waiting for Run In"

state. More extensive control is provided by the Evolution Workstation software running on a host PC. A diagram of the front panel is shown in Figure 3.2.

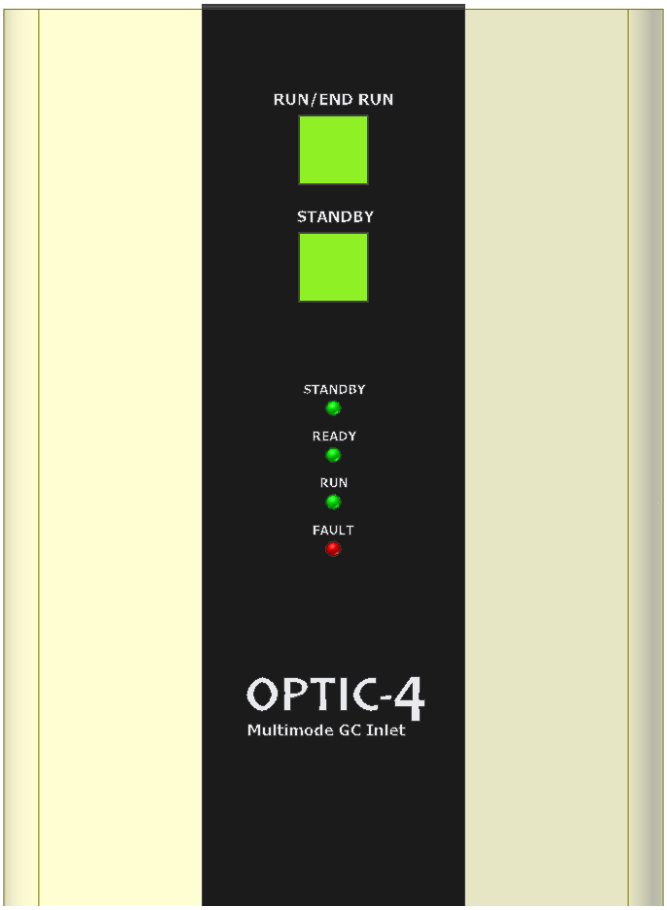


Figure 3.2 OPTIC-4 Control Unit Front Panel

3.3 Status LED's

System status information is presented to the user via the status LED's:

- **STANDBY** – indicates that the system is in Standby state and maintains parameters set via the Standby Parameters dialog in the Evolution Workstation software.
- **Blinking READY** - indicates that either method is being initialized or the system waits for **Ready In** signal from GC or autosampler.
- **READY** – indicates that the initial parameters of method are set and the system is ready for run.
- **Blinking RUN** – indicates that the system waits for **Run In** signal either from a GC or an autosampler.

- **RUN** – indicates that method is being run.
- **FAULT** – indicates that the system is the error state and requires rebooting.

3.4 Rear Panel

The rear panel (Figure 3.3) provides gas and electrical connections for inlet, host GC, autosampler, optional auxiliary equipment, PC, and mains power. The mains power inlet is integrated with the mains fuses.

The "**Carrier In**" coupling is used to connect the unit to the carrier gas supply. The "**Inlet Gas Lines**" ports provide connections to the Carrier, Split, and Septum Purge gas lines of the inlet.

The "**Exhaust**" and **"SP Exhaust"** couplings are the exhaust outlets from the gas control system and should be left open. Alternatively, the exhaust flows can be ducted to an extraction system, but this should not restrict the flow.

The **"Filter"** couplings are used to connect the split line filter.

The "**Aux In**" and "**Aux Out**" couplings on the OPTIC-4-D and OPTIC-4-DC are used for the second (auxiliary) gas channel. This channel can be used, for example, for the inlet backflush flow control.

The "**Air In**" coupling is connected to the cooling air supply for the inlet. The "**To Inlet**" coupling is connected to the cooling pipe of the inlet, using the PTFE tubing supplied.

The "**Inlet TC**" and "**Inlet Heater**" connections are used to connect the control unit to the inlet. The "**C. Valve**" connection is used to connect the inlet cooling valve.

The "**GC TC**" connection is for the thermocouple (supplied with OPTIC-4) used to measure the GC oven temperature.

Fused Mains power inlet is located in the right lower corner of the rear panel. Next to it, there is a safety earth terminal used to connect the external equipment including the OPTIC inlet to the system safety earth.

The OPTIC-4 control unit communicates with the PC running the control software using either a USB or LAN (Ethernet) connection, as selected in the Configuration Menu accessed from the control software (see chapter 5 "Software Installation and Configuration").

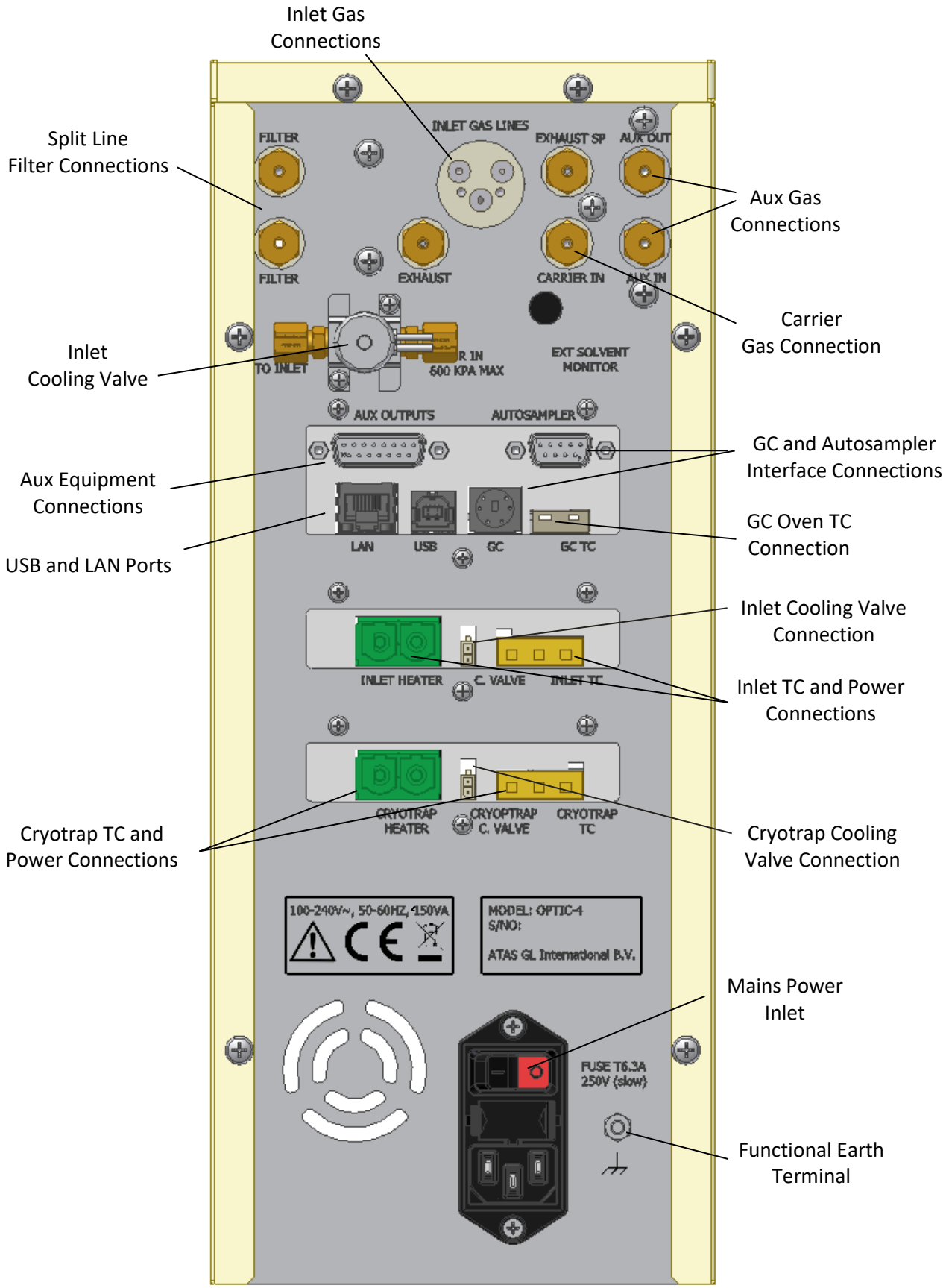


Figure 3.3 OPTIC-4-DC Rear Panel.

There are also connections for the gas chromatograph, autosampler, and auxiliary outputs. These are configured in the **Configuration Menu** and **I/O Menu** accessed from the control software on the PC (see the help file for the control software). The pin-outs of the connectors are described in Appendix B "Rear Panel Connections".

OPTIC-4-SC and OPTIC-4-DC have a "**Cryotrap C. Valve**" coupling for the cryotrap cooling valve control. "**Cryotrap TC**" and "**Cryotrap Heater**" connections are used to connect the trap to the control unit.

3.5 Flow Control System

Figure 3.4 shows a schematic diagram of the OPTIC-4 gas flow control system. Only OPTIC-4-D and OPTIC-4-DC have the auxiliary gas flow control system.

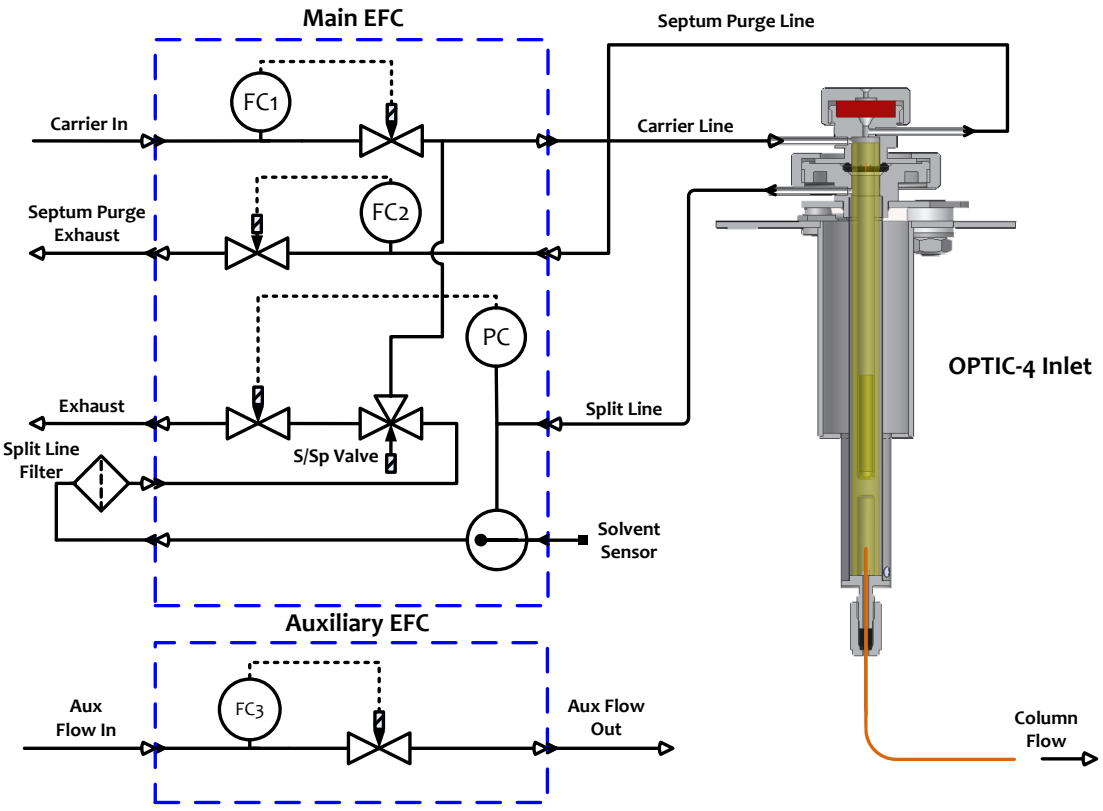
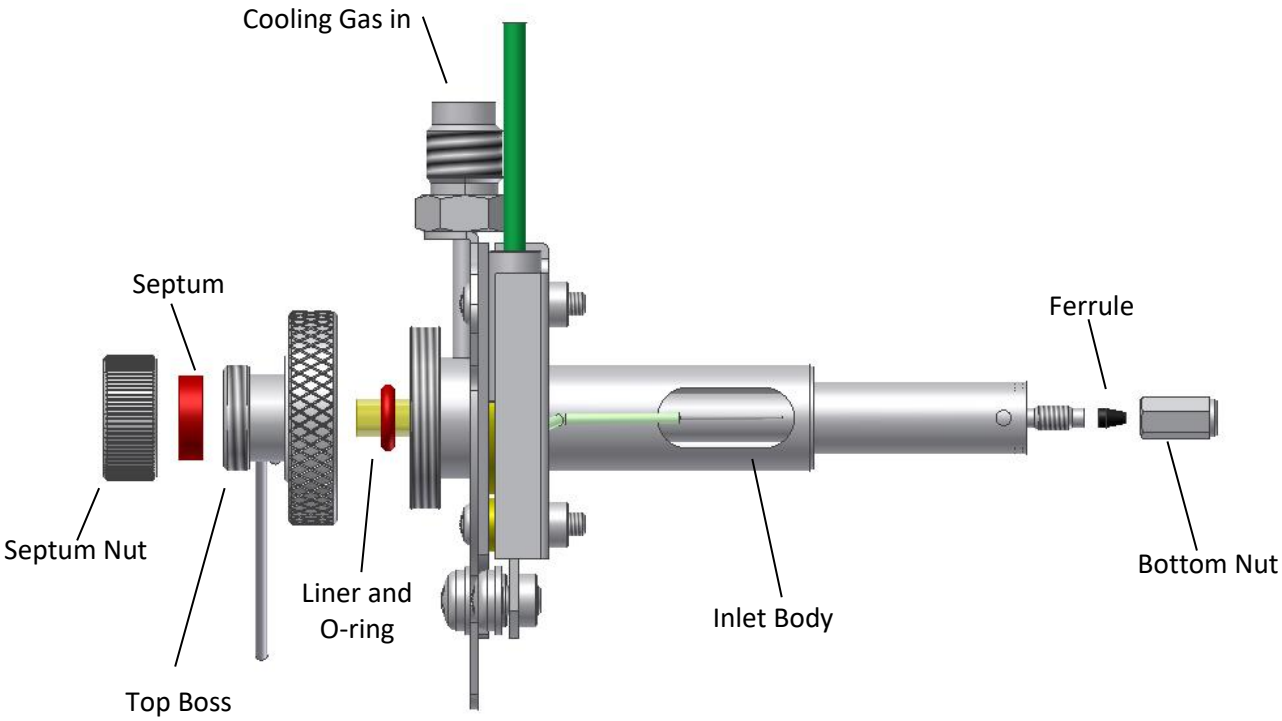


Figure 3.4 OPTIC-4 Gas Control System

3.6 Inlet Hardware

The OPTIC-4 inlet assembly is installed on the host GC and is connected to the control unit by gas lines and electrical cables. The installation of the inlet on the host GC is described in Chapter 4 "Hardware Installation", and Figure 3.5 shows the details of the inlet.

Side view



Top view

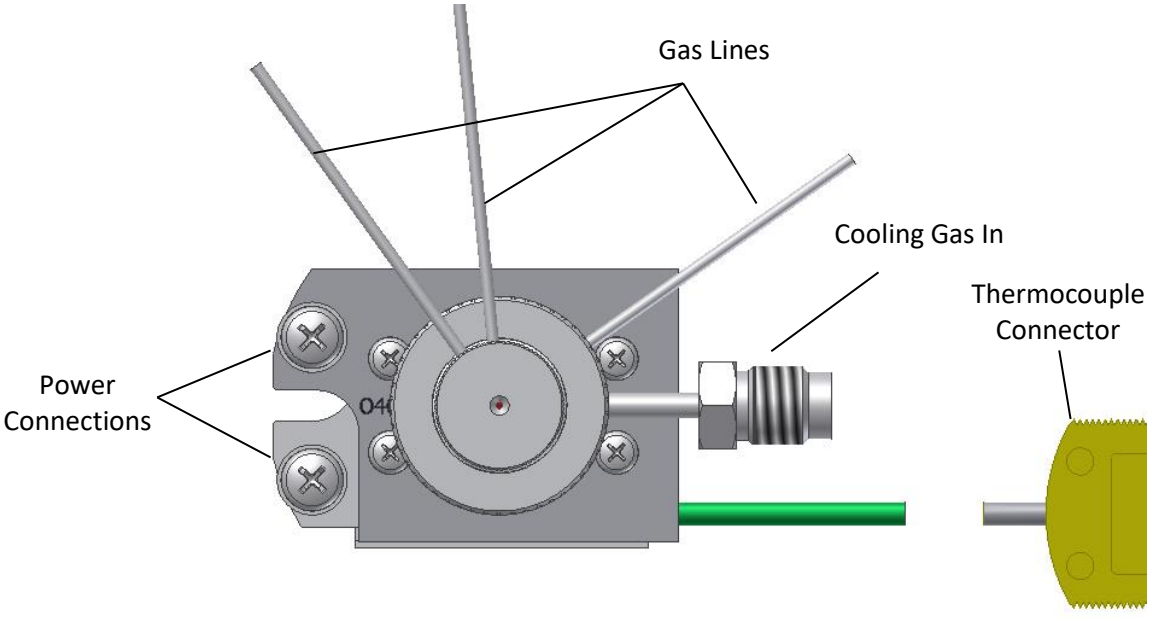


Figure 3.5 Inlet Port

3.7 OPTIC-4 Local Control

OPTIC-4 provides simple local control features. For more extensive control and the method definition and development, the Evolution Workstation software running on a host PC is required.

The two buttons keypad of the OPTIC-4 control unit provides basic control to:

- Override the standard procedure to run the method that is being initialized or stop the running method.
- Put the system into the standby state by pressing subsequently **END RUN** and **STANDBY** buttons.
- Switch system into the firmware update state.

When power is applied to OPTIC-4, a system initialization sequence is performed. During this time all the status LED's are burning. On completion of the initialization sequence only the LED "STANDBY" remains switched on.

3.8 OPTIC-4 Keypad

Two keys of the OPTIC-4 local keypad perform the following functions:

RUN/END RUN - overrides the standard procedure and runs a method while it is being initialized or is in "Waiting for Ready In" or "Waiting for Run In" state. It also allows interrupting running method and forcing the system to initialize the same method again.

STANDBY - switches the system into the standby state while the method is being initialized or is in "Waiting for Ready In" or "Waiting for Run In" state. It is done by pressing subsequently **END RUN** and **STANDBY** buttons.

Pressing simultaneously and holding RUN and STANDBY buttons during 15 sec while rebooting the unit, brings the system into the firmware update mode. This is required for the firmware update via the USB communication line.

3.9 Status LED's

System status information is presented to the user via status LED's:

- **STANDBY** – indicates that the system is in Standby state and programmed to maintain parameters set via the Standby Parameters dialog in the Evolution Workstation software.
- **Blinking READY** - indicates that either method is being initialized or the system waits for **Ready In** signal from GC or autosampler.
- **READY** – indicates that the initial parameters of method are set and the system is ready for run.
- **Blinking RUN** – indicates that the system waits for **Run In** signal either from a GC or an autosampler.
- **RUN** – indicates that method is being run.
- **FAULT** – indicates that the system is the error state and requires rebooting.

3.10 PC Control

OPTIC-4 can be controlled remotely from a host PC using the Evolution Workstation software supplied with the instrument. Furthermore, methods can only be defined using this software.

3.11 Cryogenic Trap Options

The OPTIC-4 cryotrap is designed to solve problems with peak tailing and band broadening in capillary gas chromatography. The trap can be used to focus volatile components in a narrow band at the head of the column by cooling a short section of the column. Rapid cooling and heating ensures an optimum peak shape and reproducibility.

There are two different version of the cryogenic trap options available – CO_2 and direct LN_2 (liquid Nitrogen) cooled traps. Each option comprises a trap, a trap control board, and a cryogenic valve kit. The trap is installed in the oven of the host GC and is connected to the control unit and either the CO_2 bottle or the LN_2 pressurized vessel (not supplied). The cryotrap is fitted to OPTIC-4SC and OPTIC-4DC and is available as an accessory for all other OPTIC-4 models.

NOTE:

Specific cryogenic valves supplied with the CO_2 or LN_2 cooling options cannot be used for other coolants than specified.

3.11.1 Cryotrap Hardware

The cryotrap option consists of a control board inside the OPTIC-4 control unit, a trap, a cryogenic valve, an isolated hose and a control cable. The heart of the trap is a small low thermal mass heating device placed in a cooling chamber. It can be cooled to sub-ambient temperatures and rapidly heated up to 350°C with 60 °C/sec. The trap is cooled either with CO_2 or liquid Nitrogen. After trapping, the sample is released by a rapid resistive heating. The cooling and heating of the trap are controlled by the OPTIC-4 control unit.

3.11.2 Trap Rear Panel Connections

The OPTIC-4 rear panel (Fig. 3.3) has connections for a trap heater ("**Cryotrap Heater**"), a trap temperature sensor ("**Cryotrap TC**") and a trap cooling valve **("Cryotrap C. Valve"**).

3.12 Auxiliary EFC Unit

The OPTIC-4D and OPTIC-4DC version are supplied with an auxiliary flow control unit. The "**Aux In**" port is used connected to the auxiliary gas supply. "**Aux Out**" port is the exhaust outlet from the auxiliary gas control channel and should be connected to target like the inlet backflush.

3.13 Master/Slave Mode

Depending on the way it is connected to the GC and autosampler, OPTIC-4 can be set to act as the system "master" or system "slave" via the configuration menu in the Evolution Workstation software. By default, OPTIC-4 is configured as a "Master".

OPTIC-4 "Master" Mode

When OPTIC-4 is configured as the "Master" then once the initial conditions of the method are reached, it waits for the "Ready In" (1) signal from GC (Fig. 3.7).

When the "Ready In" signal is received, OPTIC-4 waits for the equilibration time to elapse and then sends the "Ready Out" (2) signal to the autosampler. After the injection is completed, OPTIC receives a "Run In" (3) signal from the autosampler and OPTIC then sends "Run Out" (4) to GC and performs the actions defined in the method.

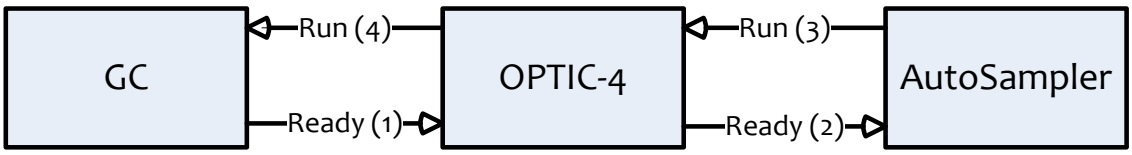


Figure 3.7 OPTIC-4 state diagram in "Master" mode

The operator can manually give the "Run In" signal from the keypad or control software at any time. In this case OPTIC-4 ends all current actions and starts the method run.

OPTIC-4 "Slave" Mode

When OPTIC-4 is configured as a "Slave" then once the initial conditions of the method are reached, it does not wait for "Ready In" signal from GC (Fig. 3.8) but immediately enters the equilibration state.

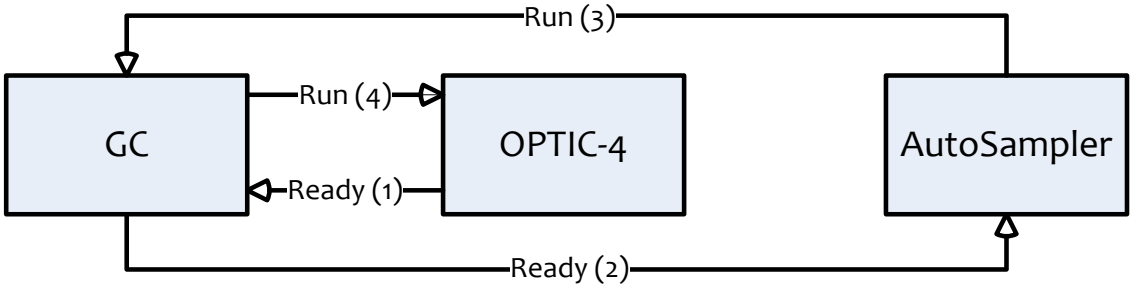


Figure 3.8 OPTIC-4 state diagram in "Slave" mode

When the equilibration time is elapsed, OPTIC-4 sets the "Ready Out" (1) signal to the GC. After the injection is completed, OPTIC-4 receives a "Run In" (4) signal from the GC (autosampler) and performs the actions defined in the method.

4. Hardware Installation

This section should be read carefully in conjunction with any specific instructions supplied with the installation kit. Please follow these instructions with particular care if you are installing the OPTIC-4 on an instrument for which a dedicated installation kit is not available. Do not hesitate to contact the supplier should you have any questions.

The installation of OPTIC-4 on a GC can be divided into the following steps:

- Installation of the inlet onto the chromatograph oven.
- Connection of the inlet to the EFC unit.
- Electrical connections.
- Installation of an appropriate liner and column.
- Installation of the cryogenic trap (OPTIC-4-SC and OPTIC-4-DC).

WARNING!

An GL Sciences representative must perform instrument installation and configuration. To prevent potential injuries, contact an GL Sciences representative if the instrument must be moved after installation.

WARNING!

It is important that both OPTIC-4 and the host GC are disconnected from the mains supply until the installation is completed.

4.1 Installing the Inlet

To achieve the best results with OPTIC-4, the inlet should be installed directly into the oven insulation, rather than into an inlet block. Fitting OPTIC-4 in this way ensures that it cools rapidly to the required initial temperature.

4.1.1 Inlet Location

If OPTIC-4 is to be used for manual injection only, it can be fitted anywhere on the top of the oven away from the standard GC inlet and detector blocks. The most convenient location is an existing hole in the GC oven's inner skin. If OPTIC-4 is to be used with an autosampler, extra care is needed in deciding upon the location. In many cases the removal or relocation of an existing inlet port will be required. Ensure that the new inlet is aligned in all three axes such that its septum cap is co-incident with that of the standard inlet.

OPTIC-4 Inlet body must be grounded to the GC's chassis with the cable provided or to the oven base plate, depending on the installation kit.

NOTE:

The removal of an inlet port entails the removal of inlet heater and temperature sensor. Some GC's will treat the absence of the sensor as a fault. In such cases a resistor has to be fitted in place of the sensor (refer to the OPTIC installation kit for details) and the GC's inlet control must be switched off at all times.

4.1.2 Inlet Installation

1. Determine the location for the OPTIC-4 inlet and if necessary remove or relocate the existing inlet port.

2. Fit the inlet body directly onto the GC inlet mounting bracket (Agilent 6890/7890) or onto the mounting plate provided with the installation kit.

3. Identify the inlet gas lines by their labels and decide on the best routes for them. Uncoil the pipes as well as all the electrical leads.

4. Inside the column oven, pack mineral wool insulation tightly around the inlet in order to ensure that hot air from the oven cannot leak out around the newly installed inlet.

5. Connect the inlet thermocouple to the "Inlet TC" connector on the rear panel of OPTIC-4.

6. If required the OPTIC-4 external solvent monitor should be installed in the split line. Connect the solvent monitor cable to the "External Solvent Monitor" connector on the rear panel.

7. Install the GC oven thermocouple supplied with the OPTIC-4 installation kit into the GC oven as close as possible to the GC's own oven temperature sensor. Connect the thermocouple to the "GC TC" connector on the OPTIC-4 rear panel.

8. OPTIC-4-SC and OPTIC-4-DC only: the installation and connection of the cryotrap are described in Section 4.6 "OPTIC-4 Cryotrap Installation".

9. The connection of the OPTIC-4 to the host GC and autosampler is described in Section 1.3 of this chapter and in the manual supplied with the trap installation kit.

4.2 Gas Lines Connections

Most of the gas line connections to the OPTIC-4 control unit rear panel are made using 1/8" pneumatic fittings. The inlet gas lines are connected to the EFC using a special plate with o-ring seals.

A standard OPTIC-4S control unit has the following gas line connections on the rear panel:

- Carrier Gas In (from cylinder or other carrier gas supply source)
- Inlet Gas Lines
- Exhaust
- SP (Septum Purge) Exhaust
- Cooling Air In

- Cooling Air Out

OPTIC-4D has the following additional gas connections:

- Auxiliary Gas In
- Auxiliary Gas Out

4.2.1 Carrier Gas Line

OPTIC-4 needs a carrier gas supply which conforms to the following requirements:

Carrier Gas Type: **Helium, Nitrogen or Hydrogen**
Supply Pressure: **300- 700 kPa**
Purity: **99.995%**

The pressure and the column flow range vary accordingly to the supply pressure. To achieve maximum specified pressure and flow settings a supply pressure of 700 kPa is necessary.

The gas supply can be provided by a cylinder with a pressure regulator or a laboratory gas supply system. The carrier gas supply should be connected to the "**Carrier In**" port on the OPTIC-4 rear panel (Fig. 4.1).

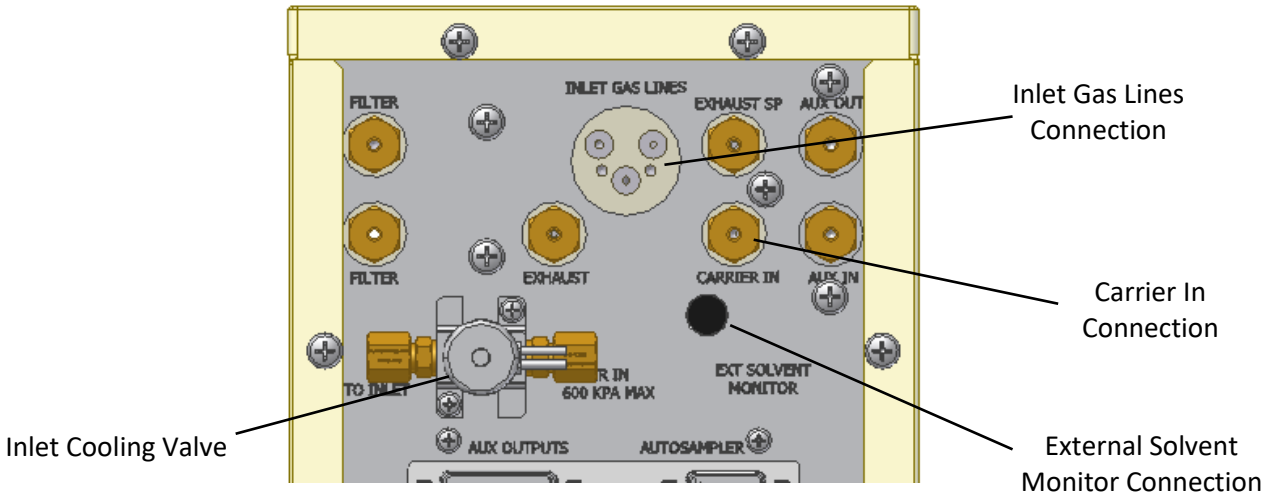


Figure 4.1 OPTIC-4 Rear Panel Gas Lines Connections

4.2.2 Inlet Gas Lines

The carrier, split, and septum purge lines of the OPTIC-4 inlet are attached to an EFC connection plate. This plate ensures simple and leak free connections of the inlet gas lines to the OPTIC-4 EFC. Remove blanking plate from the **"Inlet Gas Lines"** port (Fig. 4.1) on the back of the instrument and screw the inlet EFC connection plate instead. Make sure that the sealing o-rings are in place. Check if the gas line designations correspond to the connection designation on the EFC side (Fig. 4.2).

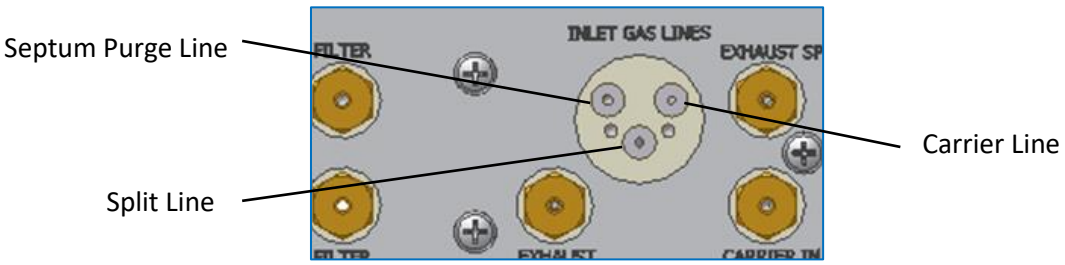


Figure 4.2 Inlet Gas Lines Connections Designation

4.2.3 Split Line Filter

An active carbon filter is installed in the split line in order to protect the EFC from contamination by residual sovent vented through this line. The filter is mounted on the EFC manifold using standard compression fittings and is installed at the factory. The filter does not have a breakthrough indicator warning about its saturation. In order to avoid the work with the saturated filter, it must be replaced every 6 months. The filter is always supplied with a label tag attached to it (Fig. 4.3). The installation date must be written on the tag during initial installation as well as after the filter replacement.

Figure 4.3 Split Line Filter Tag

CAUTION!

Do not apply excessive force while replacing the filter as it can lead to the filter thread damage. Tighten the filter by hand until its o-ring makes contact with the EFC manifold and then use a wrench to turn it additionally quarter of a turn.

4.2.4 External solvent Monitor

NOTE!

Do not place the external solvent monitor above surface which may become very warm or hot as this may disrupt the sensor readings.

The OPTIC-4PTV version is delivered with an external solvent monitor. It should be installed into the inlet split line using the pneumatic fittings and seals supplied with the External Monitor Kit. In order to prevent the monitor's signal drift, it should be placed as far as possible from the GC hot zone. Preferably, the monitor should be installed above the gas control compartment.

The solvent monitor electrical signal cable should be connected to the **"Ext Solvent Monitor"** connector on the rear panel of the instrument (Fig. 4.1).

4.2.5 Exhaust and SP Exhaust Ports

The EFC **"Exhaust"** and **"SP Exhaust"** ports are carrier gas and also part of the sample during sample injection. To ensure correct operation of the instrument, the "**Exhaust**" and **"SP Exhaust"** ports should not be blocked. If necessary, the ports may be ducted to a lab exhaust system, but this should not restrict the flow.

4.2.6 Inlet Cooling

OPTIC-4 system provides multiple cooling options for the inlet. In the standard configuration, OPTIC-4 is supplied with the compressed air inlet cooling. If requires, the inlet can be cooled down to sub-ambient temperature. In this case either CO_2 (-50 °C) or liquid N_2 (-180 °) cooling option should be used.

For optimum cooling efficiency, standard OPTIC-4 inlet requires a supply of the compressed air at least 500 kPa. A lower pressure supply can be used, but the inlet cooling will work slower.

While analytical grade air is not needed, the air supply should be filtered to be free of moisture, oil and particulates.

1. Connect the compressed air supply to the "**Air In**" coupling of the solenoid valve (Fig. 4.1) on the OPTIC-4 rear panel.

2. Connect a piece of the PTFE tubing between the "**To Inlet**" port of the solenoid valve and the inlet cooling connection (Fig. 4.4).

For installation of the CO_2 and liquid Nitrogen inlet cooling options refer to the installation guides supplied with the kits.

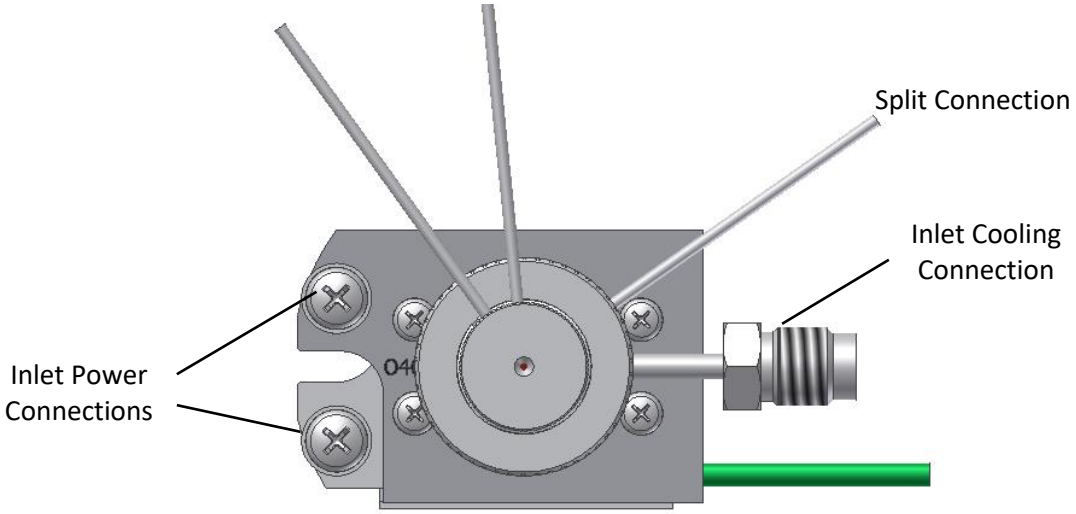


Figure 4.4 OPTIC-4 Inlet Top View

4.3 Electrical Connections

4.3.1 Inlet Power Connection

1. Connect the inlet power leads to the inlet power terminals (Fig. 4.3). Use only flat washers supplied with the inlet. Screw the connections tightly. The power lead marked with a yellow marker should be connected to the inlet base plate (upper electrode).

CAUTION!

It is important that good connections are made between the inlet power cable and the inlet power terminals. A bad connection can result in a poor inlet operation and the connection may become excessively hot.

2. The OPTIC-4PTV external solvent monitor is installed in the split line. Connect the solvent monitor cable to the **"Ext Solvent Monitor**" connector on the rear panel.

3. Connect the inlet thermocouple to the "**Inlet TC**" connector on the rear panel of the instrument.

4. Install the oven thermocouple supplied with the OPTIC-4 installation kit in the GC oven as close as possible to the oven temperature sensor. Connect the thermocouple to the "**GC TC**" connector on the OPTIC-4 rear panel.

CAUTION!

Do not confuse the GC oven thermocouple with the inlet thermocouple. This can lead to a severe damage of the inlet.

4.4 External Equipment

OPTIC-4 has a full range of external equipment interfaces and control functions, which permit system integration with GC, autosampler and other equipment like valves or pumps. The connections are provided on D-type and mini-DIN connectors on the rear panel of the control unit. The connection pin-outs are specified in Appendix B "Rear Panel Connections". Instructions for the connection of OPTIC-4 to the host GC and autosampler are included in the dedicated installation kit for your GC.

4.5 Connection to Host PC

The OPTIC-4 control unit should be connected to a PC running the Evolution Workstation software. This software is used to control and configure the system and to define and develop the analytical methods, which are then started directly from the PC. USB and LAN communication interfaces are available. OPTIC-4 automatically checks both USB and LAN ports to detect the connection to the host PC. Note that if OPTIC-4 is connected to a LAN via a switch or a hub, a standard network cable should be used. If the instrument is connected directly to the PC via a LAN port, a crossed network cable is required. For remote communication to be established the Evolution Workstation software communication parameters should match the communication parameters set in the control unit. The details of the communication interface configuration are described in Chapter 5 "Software Installation and Configuration".

4.6 Liner and Column Installation

The ways, in which the column should be installed and the type of the liner required depend upon the application of the OPTIC-4.

4.6.1 Liner Installation

Normally the inlet is delivered without liner. To install or to change the liner, follow the procedure below:

1. Cool the inlet to temperature below 40°C.
2. Unscrew the larger knurled nut by hand (top boss clamping nut) that clamps the inlet top assembly to the inlet body. Lift the top assembly carefully aside. Care should be taken not to stress the gas lines connected to the top boss and not to break the liner if there is the one in the inlet.
3. Take out the existing liner with the o-ring in place.
4. Insert the new liner with o-ring.
5. Replace the top assembly and tighten the nut finger-tight. Do not use a spanner or wrench, as this is likely to damage the inlet.

4.6.2 Column Installation

1. Install a column using proper ferrule and the column mounting tool. Push the column through the inlet nut and ferrule (Fig. 4.5). **The cone of the ferrule should go into the nut!** Avoid the use of the Vespel ferrules as these are likely to cause leaks.

2. Insert the end of the column into the column mounting tool so that it protrudes approx. 10 mm from the end. Tight the nut by hand, or use a key supplied with a standard kit, and cut the protruding end of the column flash with the end of the tool.

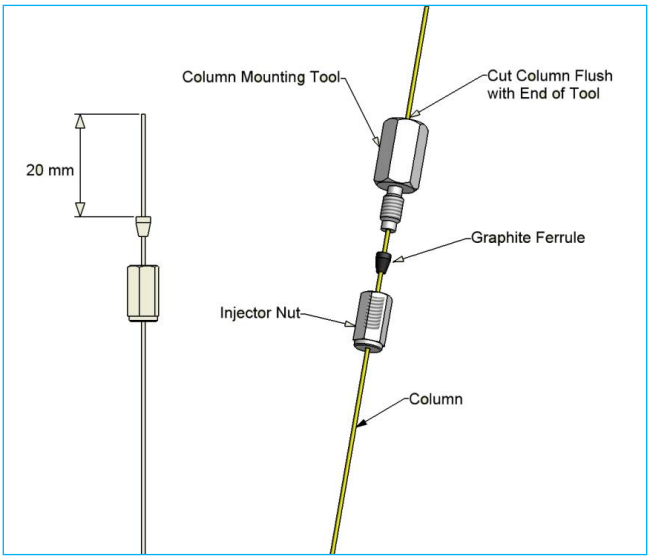


Figure 4.5 Column Installation

3. Remove the capillary column from the tool. Insert the column into the inlet and secure it by hand tightening the nut. Use the wrench supplied to turn it additionally half a turn.

4. On-column insert is fitted with the restriction towards the top of the inlet and the column should be introduced into the inlet until the column tip engages in the bottom of the insert restriction. Tighten the nut at the base of the inlet until the column is retained within the inlet. Use the wrench supplied.

CAUTION!

Do not to tighten the base nut excessively. The inlet base is very fragile and can be damaged easily. Never use Vespel ferrules.

5. When installation is completed, all connections should be leak tested with an electronic gas leak detector (e. g. p/no 2702-19340 (LD239)).

CAUTION!

Under no circumstances should a soap solution or similar be used, as this would contaminate the inlet and the column.

4.7 Cryotrap Installation

This section should be read carefully, in conjunction with any specific instructions supplied with the cryotrap installation kit. Should you intend to install the cryotrap onto an instrument for which a dedicated installation kit is not available please follow these instructions with particular care. The installation should only be carried out by personnel familiar with the relevant safety regulations and cryogenic operations.

The installation of the trap includes four steps:

1. Installation of the cryotrap control board.
2. Installation of the trap into the gas chromatograph oven.
3. Connections of the trap to a gas supply.
4. Electrical connections.

4.7.1 Installation of Cryotrap Control Board

Normally OPTIC-4SC or OPTIC-4DC Injection Systems are supplied with the cryotrap board installed. If an OPTIC-4S or OPTIC-4D is to be extended with the cryotrap option, refer to the instructions supplied with the cryotrap installation kit for installation details. Please follow these instructions with particular care and do not hesitate to contact the supplier should you have any questions.

4.7.2 Installation of Cryotrap into GC Oven

WARNING!

It is essential that both the OPTIC-4 control unit and the host GC are disconnected from the mains supply until the installation is completed.

The trap can be mounted either vertically or horizontally inside the gas chromatograph oven. To mount the trap, a mounting stand (see Fig. 4.7) is supplied with the trap. Ideally, the trap should be installed in a location that makes it possible to run the trap hose (cooling line/cables) through the existing holes in the inner and outer panels of the GC oven (e.g. holes for a second inlet or a detector). If there are no such holes available, they will need to be made after choosing their locations carefully.

To install the trap, perform the following steps:

1. Determine location for the trap and, if necessary, remove or relocate the inlet or the detector (if fitted).

2. Since the diameter of the trap hose is smaller than 15 mm, in most cases, it can be run through one of the existing holes in the GC oven inner and outer panels. If this is not possible, make the holes after choosing their locations carefully.

3. Fix the trap body to the mounting bracket. The spring-loaded screw should be screwed into one of the two holes in the trap body (Fig. 4-6). Use 8 mm spanner to tighten the screw.

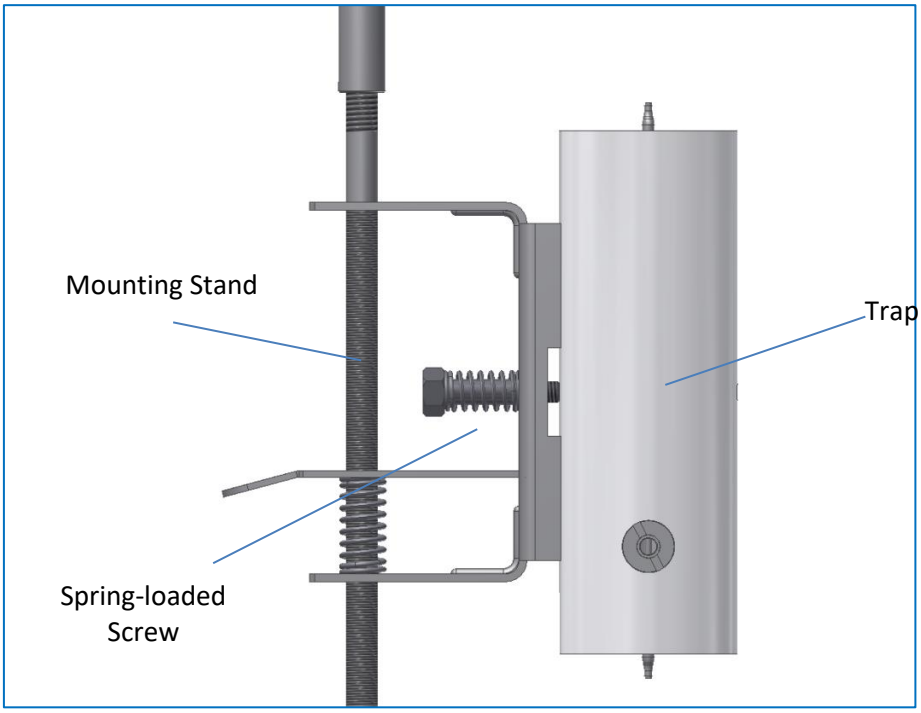


Figure 4.6

4. The trap can be positioned either "vertically" – trap axis is parallel to the mounting stand, or "horizontally" – trap axis is perpendicular to the mounting stand. To change the trap orientation, pull the trap off the mounting bracket, turn it 90 degrees and release it. The exact trap orientation should be determined during the installation.

5. Carefully guide the trap hose that includes the coolant inlet tube, the thermocouple and the heater cables (Fig. 4-7) through the holes in the GC oven panels. If needed, remove the green connector from the power cable to facilitate the installation. **Do not forget to mount the connector back when the installation is finished! Tighten the connector screws!**

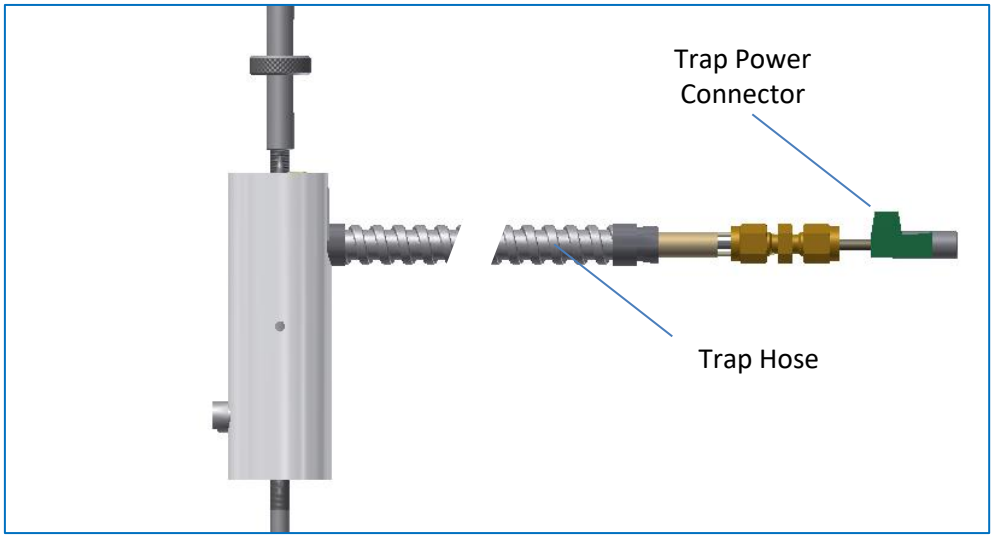


Figure 4.7

6. Position the trap/mounting stand assembly (Fig. 4.8) within the oven in a way that suits the installation configuration. The trap mounting stand can be positioned either vertically or horizontally. While holding both lower and upper stands, turn the adjustment knob till the stand pads are fixed firmly against the oven side or top/bottom panels.

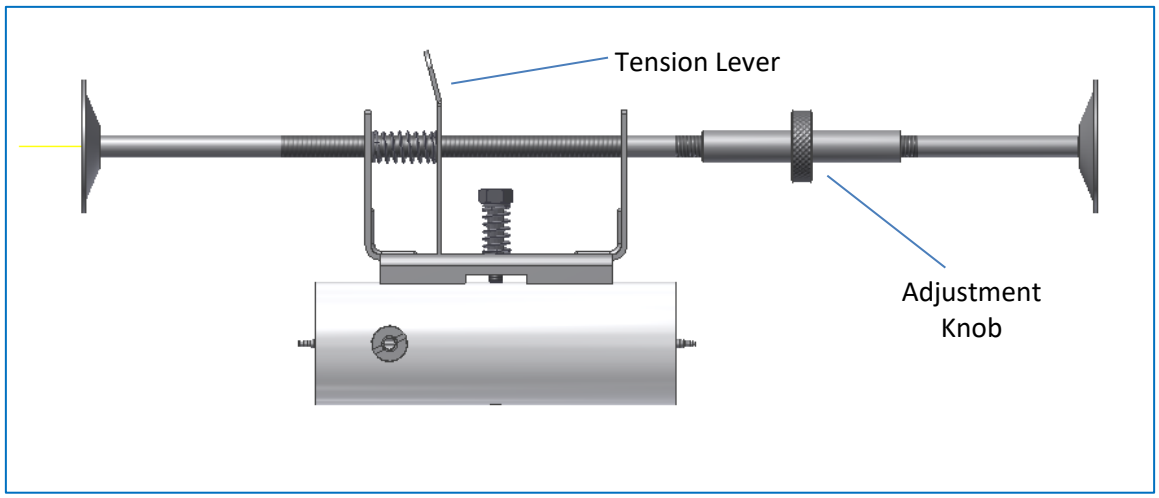


Fig. 4.8

7. To change the trap position along the stand, move the trap while pushing the tension lever. Release the lever when trap is in the desired position.

8. Fix the flexible Exhaust Pipe to the Exhhaust using the set screw supplied with the trap (4.9). Band the pipe in such way that its end can be brought outside the GC.

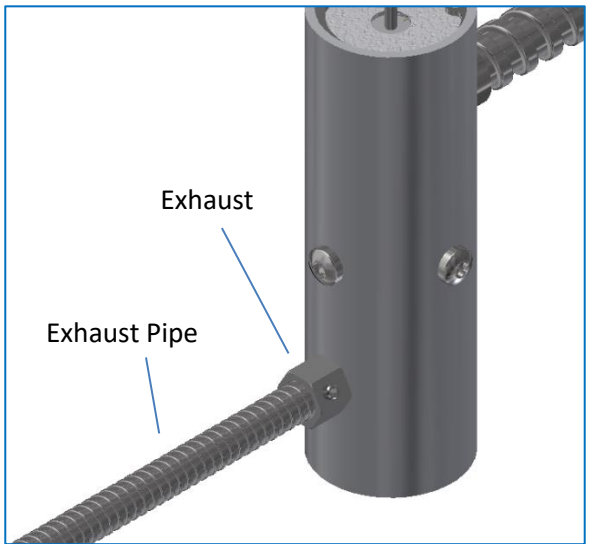


Fig. 4.9

4.7.3 GC Column Installation

CAUTION!

The cryotrap cannot be used with a metal column. The metal column will short-circuit the trap heater causing severe damaged to the trap. A glass capillary pre-column is advised to avoid problems.

The column installation depends upon the role that the cryotrap and the GC are to perform.

1. The trap position can be adjusted to facilitate the column installation. Refer to the previous chapter for the trap adjustment details.

2. Guide the end of the column through the central tube of the trap.

3. Connect the column to the GC inlet following the instructions from section 4.6.2.

CAUTION!

Do not tighten the inlet base nut excessively. The inlet base is very fragile and can be damaged easily.

4. When installation is completed, all connections should be leak tested with an electronic gas leak detector (e. g. p/no 2702-19340 (LD239)). Under no circumstances should a soap solution or similar be used, as this would contaminate the inlet and the column.

5. Inside the column oven, pack mineral wool insulation tightly around the trap hose to ensure that hot air cannot leak out of the oven.

4.7.4 Connecting Cooling Media Supply

The CryoFocus-4 trap is cooled directly either by liquid nitrogen or liquid CO_2 supplied from a pressurized LN_2 vessel (not supplied) or a high pressure CO_2 cylinder (not supplied). The high pressure CO_2 cylinder should be equipped with an appropriate siphon tube. In case of LN_2 cooling, in order to achieve fast cooling rate, pressure in the LN_2 vessel should be between 100 to 200 kPa.

CAUTION!
The CO2 cooling option is supplied with a cryogenic valve that can hold maximum pressure of 1000 psi. In order not to exceed this pressure limit, the CO2 cylinder must be kept at the temperature not higher than 25 °C.

CAUTION!

Do not extend the length of the cooling lines and do not bend the lines sharply as this may dramatically worsen the trap cooling performance.

The CryoFocus-4 trap cooling gas supply diagrams for LN2 and CO2 versions are shown in Appendixes A and B to this guide.

Refer to the respective connection diagram while performing the steps described below:

LN2 Cooling Option:

1. Connect the "OUT" port of the cryogenic valve assembly (2406-4306) to the trap.
2. Isolate a part of the trap hose between the GC outer panel and the valve with a piece of the polyolefin foam pipe 12 mm ID (2406-2623) of a required length.
3. Connect one end of the ¼ inch copper tube to the "IN" port of the cryogenic valve assembly using the reducing fitting (usually pre-installed). Isolate the tube with the polyolefin foam pipe (2406-2605).
4. Decide on the LN2 vessel location and bend the assembled line accordingly. Do not bend the line sharply as this may dramatically worsen the trap cooling performance.
5. Isolate the valve with a piece of the polyolefin foam pipe 22 mm ID (2406-2624) supplied with the kit.
6. Connect a free end of just built tube/valve assembly to the LN2 vessel.

CO2 Cooling Option:

1. Connect one end of the 1/8 inch, 1.5 meter tube (2406-2606) to the trap using 1/8 inch union.
2. Isolate the tube with a piece of the polyolefin foam pipe (2406-2605) of a required length.
3. Isolate a part of the trap hose between the GC outer panel and the valve with a piece of the polyolefin foam pipe 12 mm ID (2406-2623) of a required length.
4. Connect the 1/16 to 1/8 inch reducing fitting (2406-2614) to a free end of the 1/8 inch tube.
5. Next, connect one end of the 1/16 inch tube (2406-2608) to the reducing fitting. Isolate the tube with a piece of the polyolefin foam isolation.
6. Connect the "OUT" port of the CO_2 cryogenic valve assembly (2406-4307) to a free end of the 1/16 inch tube.
7. Connect the "IN" port of the valve assembly to one end of a short piece of the 1/8 inch tube (2406-2607). Isolate the tube with the remaining part of the polyolefin foam pipe.
7. Decide on the cylinder location and bend the assembly accordingly. Do not bend the line sharply as this may dramatically worsen the trap cooling performance.
8. Isolate the valve with a piece of the polyolefin foam pipe 22 mm ID (2406-2624) supplied with the kit.
9. Connect free end of the tube/valve assembly to the CO2 cylinder.

4.7.5 Cryotrap Electrical Connections

WARNING!

The control unit should be disconnected from the mains supply until all the electrical connections are made.

1. Connect the trap assembly to the CryoFocus-4 control unit using a cryotrap power cable and a thermocouple extension cable (2406-4043) supplied with the instrument.

2. Connect '**Cryptrap C. Valve'** port on the back of CryoFocus-4 controller to the cryogenic valve. Use the cryogenic valve extension cable supplied with the system (2406-4112).

For more details, refer to the instructions supplied with the cryotrap installation kit.

5. Software Installation and Configuration

5.1 Introduction

The Evolution Workstation software (also referred to in this guide as 'control software') is an integral part of the OPTIC-4 inlet system. It is designed to perform the following basic functions:

- Instrument configuration and control
- Method and sequence definition and development
- Run time parameters display

In addition, Evolution Workstation offers the following features: generation of the parameter optimization sequences, direct control of the instrument in the standby mode, system run log file. The software also includes an extensive help function.

5.2 PC Requirements

Most modern PCs will meet the minimum requirements for the Evolution Workstation software:

- Windows 7, 8, 10
- 512 MB of RAM
- 20 MB free hard disk space
- USB and Ethernet ports for connection to the OPTIC-4 control unit
- User must have administration rights

5.3 Installing Evolution Workstation Software

To install the Evolution Workstation:

- User must have administration rights
- Place the CD-ROM in the CD-ROM drive
- Select the CD-ROM drive in Windows Explorer
- Double click Evolution Workstation x.x Setup.exe
- The InstallShield wizard will guide you through the installation process. You can specify the location where the program should be installed. Please note that it should not be installed on a network drive.

The program is installed in "ATAS" program directory on the system C drive. This directory contains two subdirectories for the methods files (file extension MTH) and the sequence files (file extension SEQ). These subdirectories are fixed and cannot be moved to other location.

NOTE:

If Evolution Workstation is to be uninstalled or updated to a newer version, the sub-directories "Methods" and "Sequences" and also their content remain intact.

5.4 Communication Parameters

After setting up the OPTIC-4 hardware and installing the PC software, they must first be configured to communicate. Either a USB or a LAN (Ethernet) interface may be used.

The OPTIC-4 controller automatically checks both USB and LAN ports to detect the connection to the host PC. The communication is established if the communication parameters within the controller (USB Serial Port number or IP address) match the external communication parameters set in the Evolution Workstation. In most cases the USB communication should be established first in order to be able to switch to the LAN communication. It is needed to set a valid IP address.

5.4.1 USB Communication

Plug the USB cable connected to the OPTIC-4 controller into an available USB port of the computer. In case a first-time installation, Windows detects the new device and will initiate the Found New Hardware Wizard prompting you to install the USB driver:

1. When the **'Found New Hardware Wizard'** opens, click next to **'No, not at this time'** and then on '**Next'** button.

2. Click **'Install from a list or specific location'**, then click the **'Next'** (Fig. 5.1).

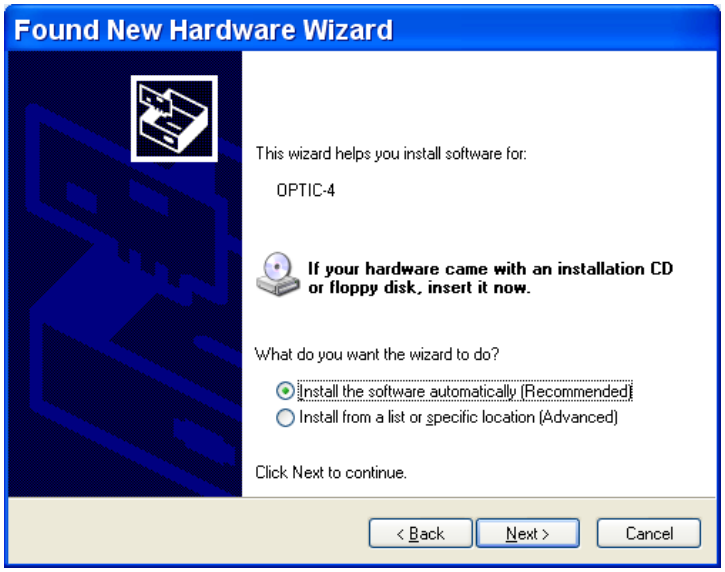


Figure 5.1

3. When prompted for the driver location of the device, browse to the Evolution Workstation CD directory "USB Serial Drivers". Click **'Next'** to continue. Windows should detect the driver as the USB Serial Converter. The driver will be installed. Click **Finish** to continue.

4. Once the installation of the USB Serial Converter is completed, Windows will prompt you for the installation of a USB Serial Port driver with a new **'Found New Hardware Wizard'**. Click the button next to **'No, not at this time'** and '**Next'**. Choose again **'Install from a list or specific location'**, then click the **'Next'.**

5. When prompted for the driver location of the device, browse to the same directory on the Evolution Workstation CD ("USB Serial Drivers"). Click **'Next'** to continue. Windows should detect the driver as the USB Serial Port. The driver will be installed. Click **Finish** to continue.

Go to the Device Manager (Control Panel/System/Hardware) to find out the USB serial port number assigned for OPTIC-4 communication (Fig. 5.2). Alternatively, **"USB Serial Loopback"** application can be used to detect the serial port number while connecting OPTIC-4 to the computer after driver installation. The application is supplied on the OPTIC-4 software CD.

Note that if port number is greater than 9, it should be manually reassigned to another free port with a lower number. For this right click on **USB Serial Port** entry and select **Properties**. A new dialog appears . Select **Port Settings > Advanced** (Fig. 5.2a)**.** In a new dialog change port number assignment to any free port with the number lower than 10. Click **OK** to confirm. If warning massage appears, click **OK** to continue.

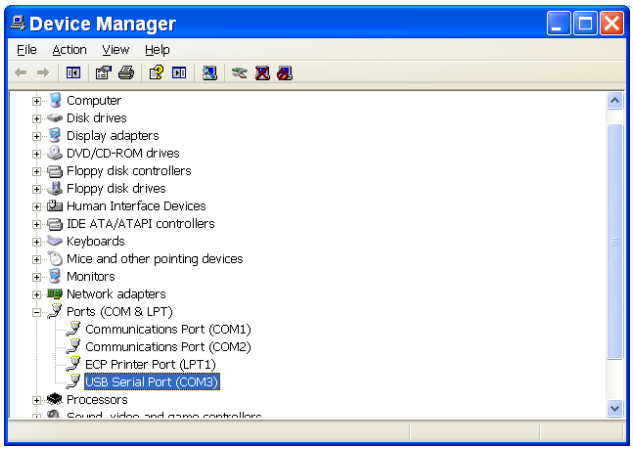


Figure 5.2

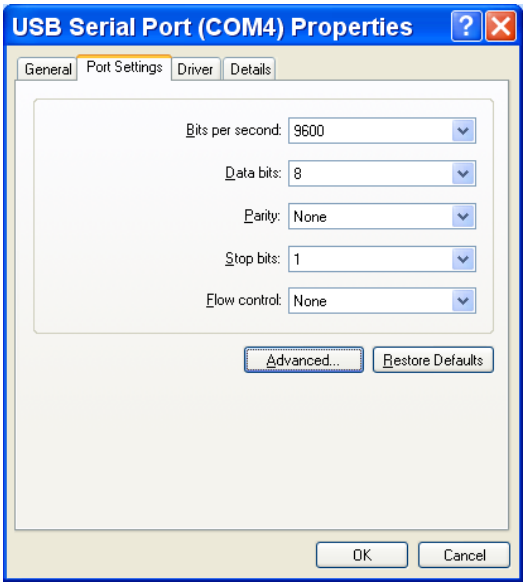


Fig. 5.2a

6. Normally, Evolution Workstation automatically detects the USB serial port number and connects to OPTIC. If due to some reason this does not happen, open the Evolution Workstation software to set the external communication configuration. Select **Configuration/ External Communication** in the main menu bar and click on the radio button next to 'USB Serial Port' (Fig. 5.3). Select a port number below and click on 'OK' button. The Evolution Workstation should now connect to OPTIC-4 controller.

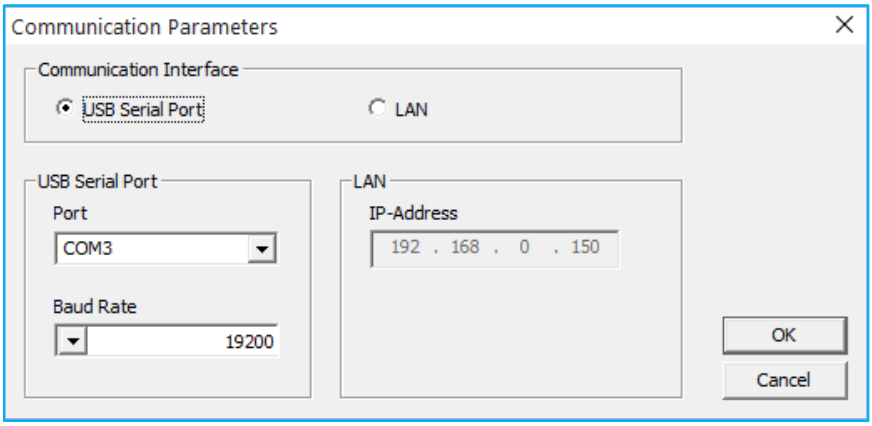


Figure 5.3

5.4.2 LAN Communication

The default OPTIC-4 IP address is set to 192.168.0.150. This address can be used for direct OPTIC-4 to PC LAN communication only. The cross-linked LAN cable should be used in this case. The sub-net mask should be set to 255.255.255.0 and the proxy server settings should be disabled.

In order to be able to communicate with OPTIC-4 via a LAN switch or a hub, the IP address should be changed. The first three segments of a new address should be the same as in the local area network address. The subnet mask should be set to 255.255.255.0 .

To change the default IP address:

1. Connect the OPTIC-4 controller to a host PC via USB interface as it is described in the section 5.4.1.

2. Start Evolution Workstation software and select Configuration**/ System Communication.**

3. Type a new IP address (Fig. 5.4) and click 'OK' button. The new address will be sent to the device and the OPTIC-4 controller will reboot. The system configuration dialog will stay open for approx. 15 seconds until controller is rebooted.

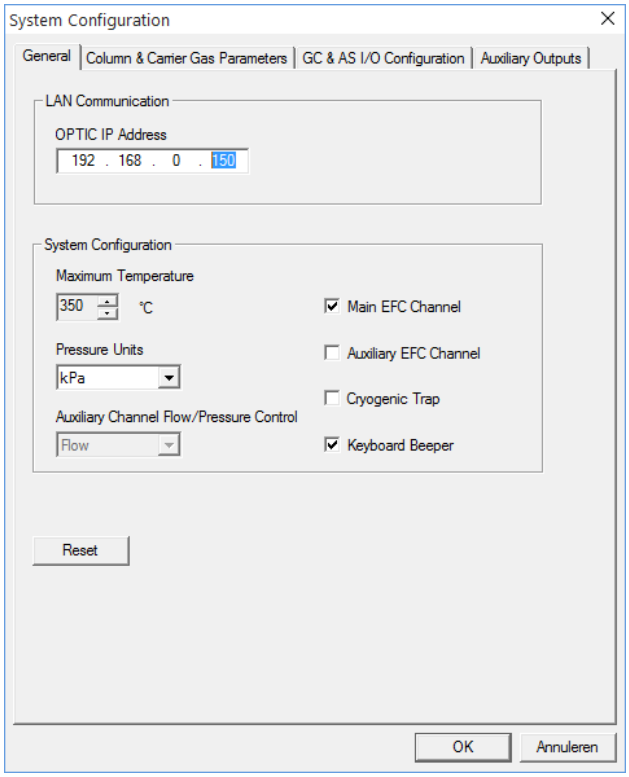


Figure 5.4

4. Wait until the OPTIC-4 is rebooted. Disconnect the USB cable and connect a LAN cable to the unit.

5. Select **Configuration/ External Communication** in the Evolution Workstation main menu bar and click on the radio button next to 'LAN' (Fig. 5.3). Click on 'OK' button. The Evolution Workstation should now connect to OPTIC-4 controller.

5.5 Configuration Parameters

It is probably a good idea to start Evolution Workstation on your PC and go through all the configuration options as you are reading this manual. Under **Configuration** on the menu bar at the top of the Evolution Workstation window, you will find the following parameters:

5.5.1 Standby Parameters

Select **Configuration/ Standby Parameters** to set the parameters that system will maintain during standby state. Fig. 5.5 shows **General** tab of the standby parameters configuration dialog. Parameters like Inlet Temperature, Column Flow, Split Flow, Standby Timeout etc. can be set via this dialog. The complete list of the standby parameters is included in Appendix A "OPTIC-4 Default Parameters".
Most of the parameters are obvious and do not require explanation, but some of them are system specific and should be made clear.

NOTE:

When setting Main Gas Control Parameters, make sure that the total flow value (Column Flow + Split Flow + Septum Purge Flow) is no less than 6 ml/min. This is a minimum required for a stable flow/pressure control.

Take also into account that a minimum inlet pressure required for stable column flow control is 7 kPa.

Inlet Zero Pressure: When enabled, the parameter sets the inlet pressure (column flow), the split and the septum purge flows to zero. This is needed when using a manually controlled LINEX head.

Standby Timeout: It is a waiting time for an external or internal Ready or Run signal. During the method run, the "waiting" state is canceled if a Ready or Run input is not received. When the standby timeout is elapsed, OPTIC-4 goes into the standby state. If timeout is set to 0.0 then OPTIC will never go to the standby state but will remain waiting for the signal indefinitely.

Run/Ready Signal Through Function: If enabled, this option forces OPTIC in the standby state to transfer the Ready and Run (start) signals from the host GC to the autosampler and vice versa.

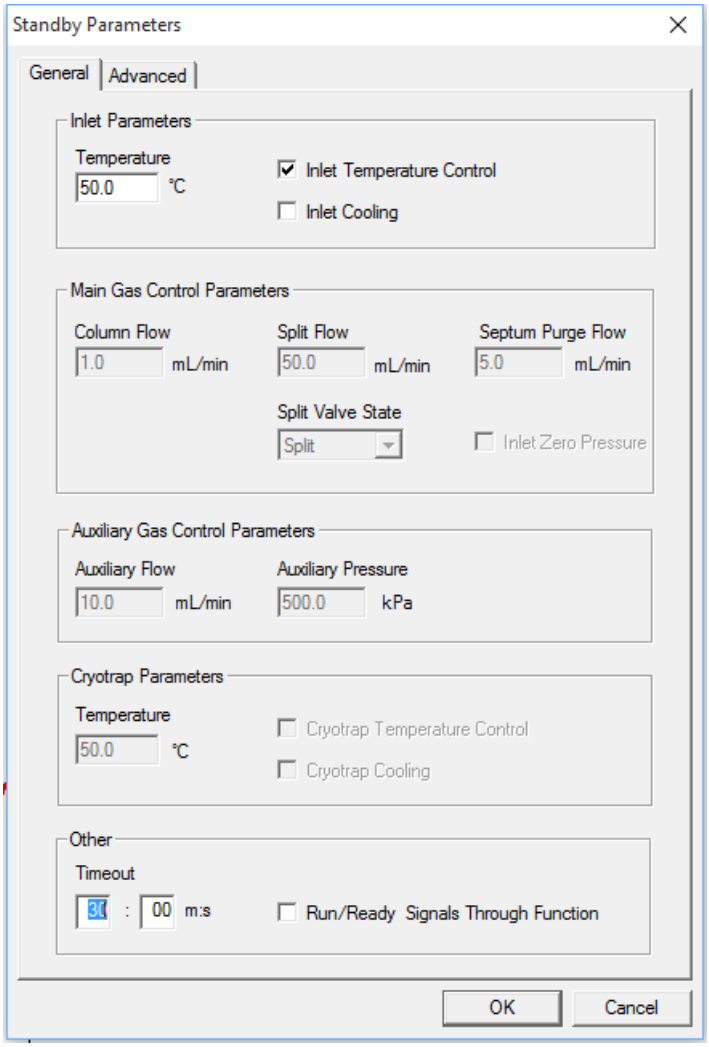


Figure 5.5

5.5.2 System Configuration Parameters

Select **Configuration/ System Configuration** to set the system configuration parameters. Fig. 5.6 shows **General** tab of the system configuration dialog. Parameters IP Address, Maximum Inlet Temperature, etc. can be set via this dialog.

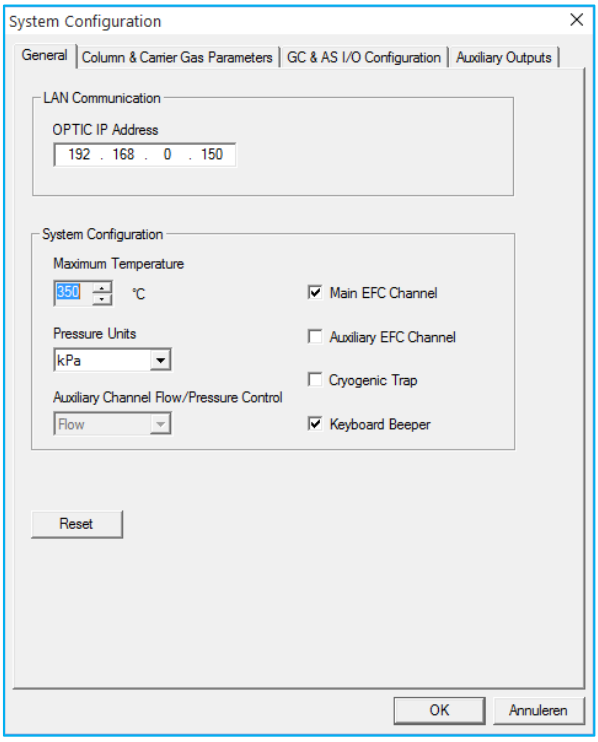


Figure 5.6

Parameters related to the host GC column, carrier gas type, outlet pressure etc. can be set via **Column and Carrier Gas Parameters** tab (Fig. 5.7)

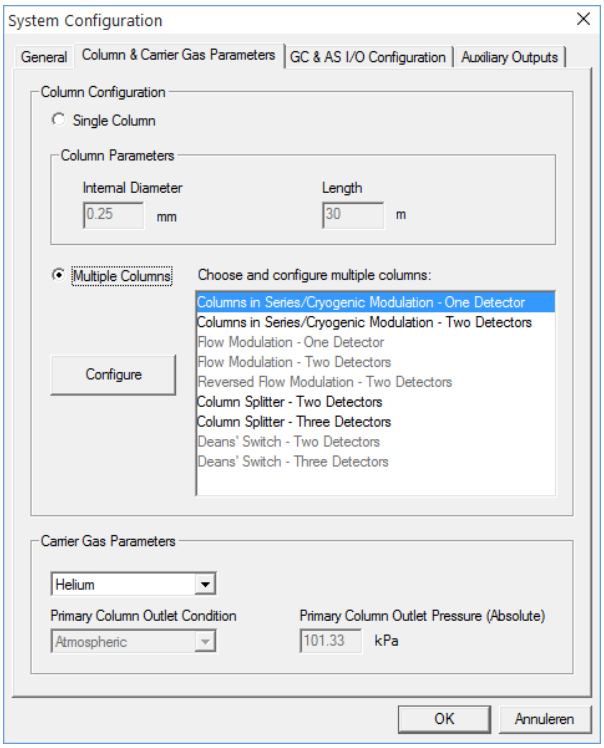


Figure 5.7

As it can be seen from the **Column and Carrier Gas Parameters** dialog, OPTIC-4 can handle the GC's not only with a single but also with the multiple columns. More information about multicolumn configurations can be found in section 9 **Advanced OPTIC-4 Features.**

Tab **GC & AS I/O Configuration** (Fig. 5.8) allows to set OPTIC-4 either to **Master** or **Slave** mode and chose a correct **Ready** and **Run** signals logic level, matching it with the ready and start signals configuration of the host GC and an autosampler (if fitted). The **Run Out Timing** parameter defines the moment when the Start signal to the host GC is set. The signal can be set either at the moment when OPTIC-4 starts heating the inlet (Run on Inlet Ramp) or the cryotrap (Run on Cryotrap Ramp) if the cryogenic trap option is fitted.

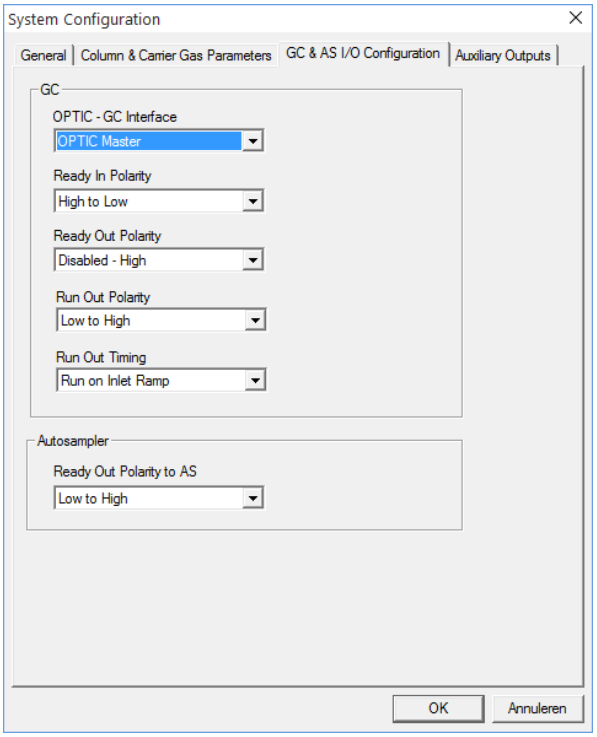


Figure 5.8

Select **Configuration/ System Configuration** and go to **Auxiliary Outputs tab** to enable/disable the auxiliary outputs to be used in method (Fig. 5.9). Name of the output can be typed in. This name will be used in the status graph and the method printouts.

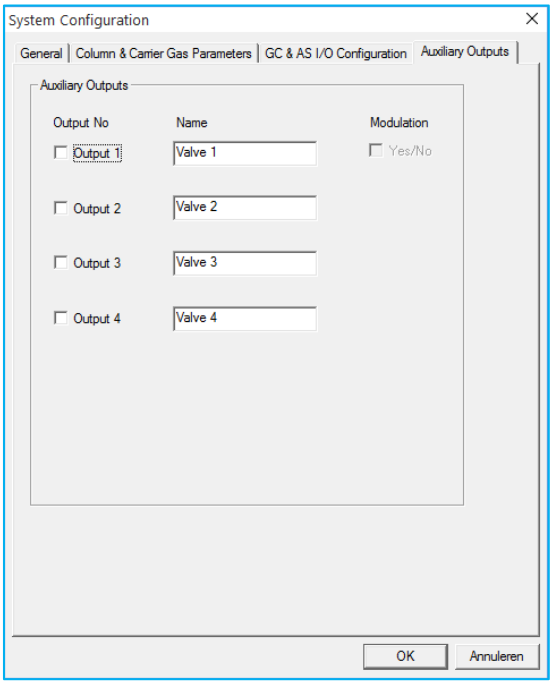


Figure 5.9

The **Modulation** option in the **Auxiliary Outputs** tab allows to use the **Auxiliary Output 1** for control of a flow modulation valve. When this option is enabled, the Modulation Valve group of parameters will appear in every new method opened in the Evolution Workstation control software.
The complete list of the system parameters is included in Appendix A "OPTIC-4 Default Parameters".

5.5.3 External Communication

Select **Configuration/ External Communication** to choose the communication interface to OPTIC-4 (Fig. 5.3). Either USB or LAN interface can be chosen. The IP address for the LAN communication is grayed-out. It should be set via the system configuration dialog (Fig. 5.6).

NOTE:

When using Evolution Workstation software, please take into account that some options will only be available (enabled) if there is communication between the software and the OPTIC-4 control unit.

5.5.4 Access Control

Select **Configuration/ Access Control** to enable the software access control (Fig. 5.10)**.**

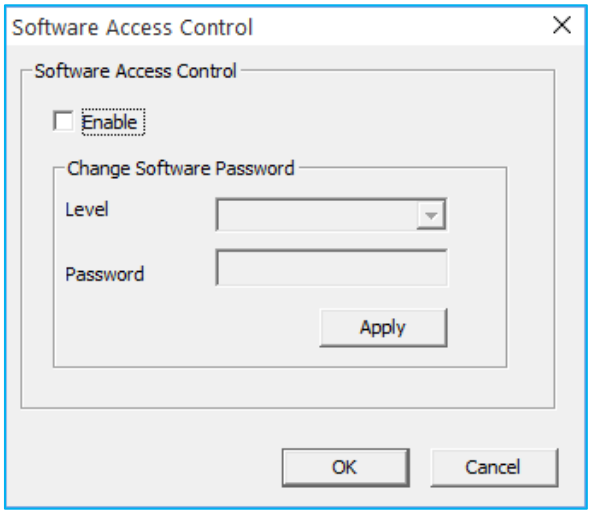


Figure 5.10

5.5.5 Set Calibration Parameters (Locked)

This configuration option is password protected and is intended for the service purposes only.

5.5.6 Save Run-time Parameters Data

This option, if enabled, allows to save all the run time parameter displayed in the status graphs of the Evolution Workstation control software. The data are saved to the method directory and can be viewed using an Excel macro (unsupported) supplied on the system CD.

6. Basic Operation

6.1 Instrument Parameters

The OPTIC-4 instrument parameters maintained during the standby state are set from the PC via the Evolution Workstation software. For specific details see section 5.6 of this manual. The run time parameters, including inlet temperature, column flow etc., are set via Evolution Workstation methods. The method parameters are saved in the "Methods" directory in a file with an extension "mth". Method files can be loaded into the software for a later use. The details of the method definition and development are described in chapter 7.

6.2 Instrument Startup and Shutdown

To start the instrument:

1. Turn on the carrier gas. For this, open the main valve of the carrier gas cylinder. Check if the supply pressure is at least 300 kPa. Note that the OPTIC-4 pressure and the column flow range vary accordingly to the supply pressure. To achieve maximum specified pressure and flow settings a supply pressure of 700 kPa is necessary.

2. Ensure that the inlet port contains a glass liner appropriate for your application. For a list of the OPTIC-4 liners refer to Appendix E of this manual.

3. Check it the GC capillary column is connected to the inlet. For details of the column installation refer to section 4.6.2 of this user's guide.

4. Turn on the instrument. Wait until only **STANDBY** LED remains burning.

5. Turn on the PC and monitor.

6. Start the Evolution Workstation Software. In case the access control is enable, the login dialog is displayed. The Evolution Workstation software starts up and the status window is displayed (Fig. 6.1).

7. When connection between PC and OPTIC-4 controller is established, the status window should display the actual values and set points of the system standby parameters. To perform analytical run, open a new method, define the parameters and run the method. For details on defining and running methods see chapter 7 of this guide.

6.3 Evolution Workstation Status View

An example of the Evolution Workstation Status View is shown in Fig. 6.1 below.

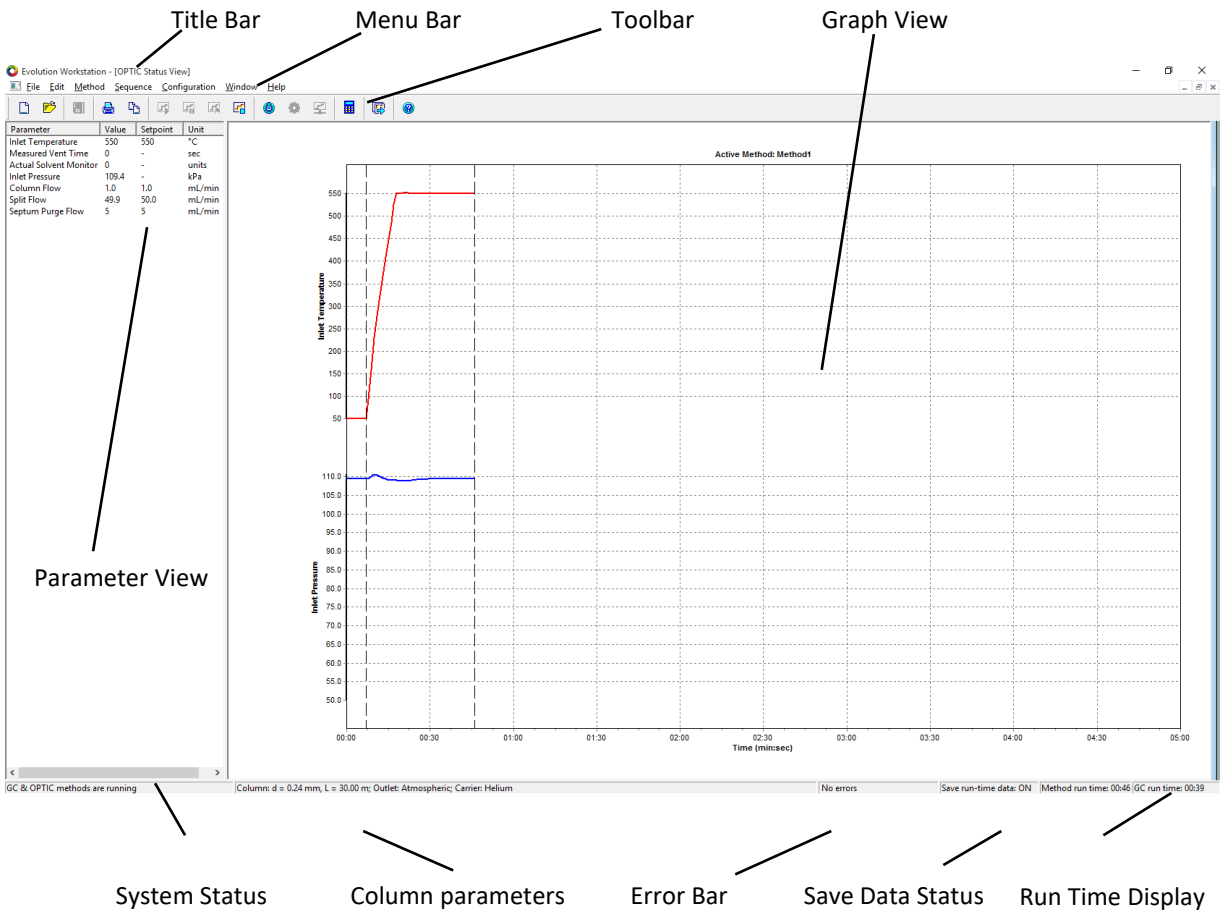


Figure 6.1 Example of EW Status Window

Left side of the window displays actual values and set points for a number of system parameters. Right side of the window displays the run time graphs for the parameters listed in the status parameter list on the left. The status pane at the bottom of the window displays status information of the system as well as information about the error state, the method and GC run times. It also shows whether the "Save Run-Time Data" option is enabled or disabled.

Note, that the run time parameters are displayed in the real time without any filtering. The only limiting factor is the precision with which the data are represented. Due to this limitation the curves can sometimes show steps, especially if the displayed parameter range is small. Also in this case, the displayed parameter irregularities are still within the technical specifications of the instrument.

Run time data can be saved on the hard drive. It can be enabled via Configuration/Save Run-Time Data menu option. The data are save into the corresponding method directory.

7. Defining and Running Methods

7.1 Introduction

The OPTIC-4 methods are defined using the Evolution Workstation software running on a host PC connected to the OPTIC-4 control unit. They can either directly initiated from the PC or saved for a later use. Refer, to the Evolution Workstation on-line help for more information about defining and running OPTIC-4 methods.

7.2 Method Types

OPTIC-4 supports five predefined methods of a different type:

1. Split
2. Splitless
3. Large Volume Injection
4. LINEX
5. Expert (full control of all parameters)

7.2.1 Split Methods

OPTIC-4 can be used for both hot split and cold split injections. In virtually all cases, better results will be obtained using the cold split approach. Cold split injection assumes that analysis starts with the inlet temperature below boiling point of the solvent. Next temperature is programmed to temperature usually 50 °C above the maximum elution temperature of the sample. This has the following advantages:

- Syringe needle discrimination is eliminated, thus ensuring that the fraction of the sample, which enters the column, is truly representative of the sample as a whole.
- Milder temperature regime experienced by the sample reduces thermal degradation especially when lower inlet temperature ramp rates are used.
- Better run-to-run reproducibility.

7.2.2 Splitless Methods

OPTIC-4 can be used for both hot splitless and cold splitless injections. In virtually all cases, better results will be obtained using the cold splitless injection technique for reasons identical to those described above. The quality of results obtained should be comparable to on-column injection in all respects but with the added advantage of preventing involatile and particulate matter from reaching the column. Cold splitless injection is therefore better suited to the analysis of "dirty" samples.

7.2.3 Large Volume Injection Method

In the past, analysts have been used to injecting samples of no more than 2 µl into the GC. Since split/splitless inlets generally have an internal capacity of approximately 2 ml, and 1 µl of solvent

gives rise to approximately 1 ml of vapor, the total amount of sample that can be injected into a split or splitless inlet is around 2 µl.

When an injection is made into a PTV inlet, the evaporation of the solvent is a controllable process and therefore restrictions on the volume of solvent that can be injected are much less severe.

The OPTIC-4 large volume method is designed to implement the rapid large volume injection (LVI) technique. This enables injections up to 100 µl to be made routinely, at-once, and with a minimum of optimization. The technique is compatible with most auto-samplers and is very robust, making it suitable for routine applications. Other large volume sampling techniques, such as speed programmed injection, may also be accommodated.

In large volume injection, the sample is introduced with the inlet at near ambient temperature. The solvent is allowed to evaporate into the carrier stream and pass out through the split line. At an appropriate point, the split line is closed and the inlet is heated. The sample is then transferred onto the column. Simple optimization of the parameters enables components with a very wide volatility range to be analyzed by this technique.

The advantages of this method are very significant:

- An improvement in detection limits of up to 100 times that of conventional splitless injection.
- Much greater flexibility in the design of sample preparation procedures.
- Easier on-line interfacing with sample preparation accessories (such as automated solid phase extraction instruments).

7.2.4 LINEX Method

OPTIC-4 can be used for an automated thermal desorption analysis of gas and solid samples and also real world samples with complex dirty matrixes.

Gas phase samples can be collected off-line using GL Sciences TD liners or adsorption tubes packed with a suitable sorbent. Alternatively, on-line analysis is possible with the sample being collected directly into the liner placed in the inlet.

DMI enables sample introduction into GC column to be performed from a disposable container (sample insert) placed inside the inlet liner. This has a great advantage over traditional injection because large volumes (up to 30 µl) of dirty sample extracts or even row samples can be introduced directly into GC or GC/MS. Using the principle of selective exclusion, the volatiles and semi-volatiles are thermally desorbed and transferred onto the column, while non-volatile residues are retained in the sample insert, which is disposed after analysis. The DMI method permits also the use of the built-in solvent monitor, facilitating the optimization of the solvent vent time.

Thermal desorption using the OPTIC-4 TD or DMI methods is distinguished from conventional thermal desorption by the way the liner with the sample or the adsorption tube is closely coupled to the column. This has the following advantages:

- The analysis of very active components is possible since the opportunities for adsorptive losses are greatly reduced.

- The analysis of components with a very high boiling point (such as polymer additives) is possible.

- The very short time-cycle associated with desorption makes it possible to obtain results quickly.

7.2.5 Expert Method

Eight modes of operation described above are designed to cover the most common ways in which OPTIC-4 can be used. The Expert mode is designed to cater for many other possibilities.

In an Expert method, up to nine segments for the inlet temperature profile can be programmed including segments with a negative temperature ramp when the inlet heater is switched off and cooling is on. Up to nine segments for column flow as well as split flow profiles can be set. In addition, four external channels of timed events can be programmed in any sequence.

Flow control of an auxiliary gas supply channel is also possible.

Some of the special features of these methods are introduced in Chapter ~~6~~ 9 "Advanced OPTIC-4 features".

7.3 Method Definition

To open any of these preprogrammed methods, select **File/New** menu option. Choose 'Method' and click 'OK' button. A list of the OPTIC-4 predefined methods will appear on the screen (Fig. 7.1).

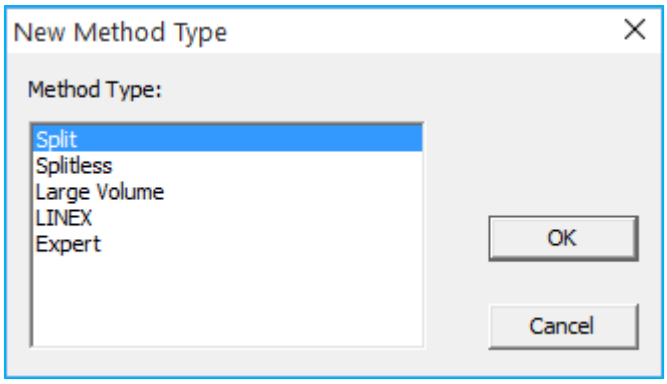


Figure 7.1

Choose a method which is the most appropriate for your application and click 'OK'. A method window with the parameter list and the parameters profiles will appear on the on the screen (Fig. 7.2). The left side of the method window displays the method parameters list. The right side of the window shows parameters profiles.

See Appendix D "Examples of OPTIC-4 Method Profiles" for all the method types.

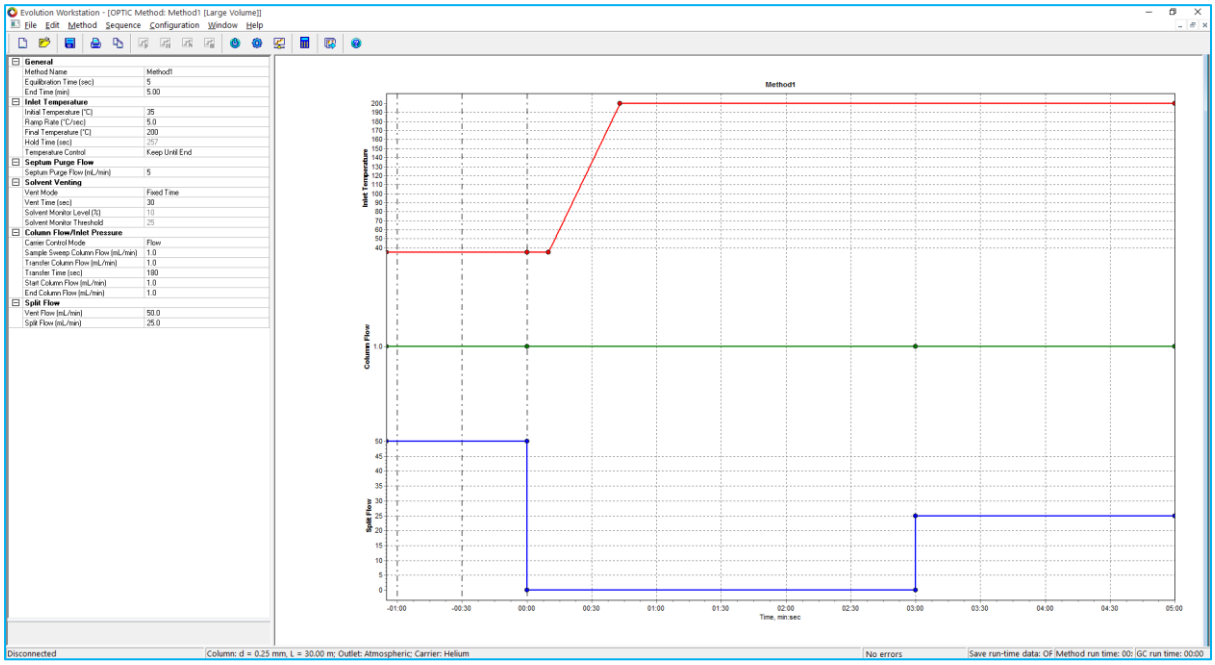


Figure 7.2 Example of OPTIC-4 LVI Method

Set up the method parameters within the method window. Save the method for the later use or send it to OPTIC for immediate execution by selecting **Method - Execute**. Method that is being run can still be edited, but the changes will not have any effect on the running method. To use the changed method, execute it again.

When saving a method, you can give it a name of at most 11 characters. By default, methods are saved in the 'Methods' subdirectory of the Evolution Workstation directory.

Method parameters can be changed in the parameter list and in the graph. The values of some parameters depend on the value of other parameters, e.g. the value of the **Final Inlet Temperature** cannot be less than the value of the **Initial Inlet Temperature** and in the Split method the **End Time** cannot be less than the **Transfer Time**. Note that times must be entered in seconds and are displayed in min:sec format in the graph.

Parameters can be changed in the graph by dragging the control points. Some points, e.g. the end points, cannot be dragged, and some can only be dragged vertically or horizontally. While dragging the parameter value in the parameter list will be updated.

Note:

When a parameter is selected in the Parameter View, the background of the name of the parameter is grayed out. Even though the cursor is not visible, values can be entered. To confirm the value, press 'Tab' or 'Enter'. In order to restore the old value press 'ESC'. Changing drop-down list box values can be done with the 'Arrow Right' and 'Arrow Left' keys.

Evolution Workstation has an extensive Help function, which includes much of the information contained in this section of the manual.

7.4 Method Parameters

The functions of all parameters are explained below. When a new method is created, the parameter tables are filled with the default parameters. The parameter tables for each particular method include only the parameters relevant to it.

NOTE:

When setting Gas Control Parameters, make sure that the total flow value (Column Flow + Split Flow + Septum Purge Flow) is no less than 6 ml/min. This is a minimum required for a stable flow/pressure control.

Take also into account that a minimum inlet pressure required for stable column flow control is 7 kPa.

7.4.1 General Method Parameters

Method Name

This parameter identifies the method. The user enters it when the method is first saved. Until the user enters a name, Evolution Workstation will use a temporary name (e.g. Method1). A method name can be at most 11 characters long.

Equilibration Time

This parameter is used to ensure the stability of the initial method conditions prior to OPTIC-4 entering the **Ready** state.

End Time

This parameter determines the time between the start and end of the GC method run. It should be set to the total run-time for the GC analysis, so that the cooling of the inlet and resetting of column and split flow parameters coincide with the end of the GC run.

7.4.2 Temperature Parameters

Initial Temperature

This parameter determines the inlet temperature at the start of the method run.

Ramp Rate

This parameter determines the rate of increase of the inlet temperature.

Final Temperature

This parameter determines the inlet temperature at the end of the temperature ramp.

Hold Time

Hold Time is time, during which the inlet temperature is maintained constant. If the Temperature Control is set to 'Floating' then the inlet temperature stops being controlled at the end of the thermal segment.

Temperature Control

This parameter determines if the inlet temperature is maintained to the end, or it is allowed to float at the end of the Hold Time.

Solvent Cooling Effect

This parameter determines whether or not a solvent cooling effect (rapid cooling during the solvent evaporation) should be used during solvent elimination (Expert Method only). For more information about this feature you are referred to Section 9.2 "Solvent cooling effect".

Cooling Valve Mode

This parameter determines if inlet cooling is switched on or off during the method run time (Expert Method only). When it is set to "No", cooling is switched off and the inlet temperature is maintained by the inlet heater controller.

7.4.3 Column Flow Parameters

Carrier Control Mode

This parameter determines the carrier gas control mode. When it is set to "Pressure", the carrier gas flow through the column is controlled using the inlet pressure as a parameter. In case of "Flow", the column volumetric flow is used as the main parameter to determine the carrier gas flow.

Transfer Time

This parameter determines the time during which the transfer flow is maintained after the start of the method run.

Transfer Column Flow/Inlet Pressure

This parameter enables the user to set the column flow (inlet pressure) used to transfer the sample from the inlet onto the column (a higher flow (inlet pressure) gives a faster transfer).

Start Column Flow/Inlet Pressure

This parameter determines the carrier gas flow (inlet pressure) after the transfer time has elapsed, i.e. the column flow (inlet pressure) at the start of the actual analysis segment.

End Column Flow/Inlet Pressure

This parameter determines the carrier gas flow (inlet pressure) at the end of the method run.

Sample Sweep Column Flow/Inlet Pressure

This parameter determines the column flow (inlet pressure) used to sweep the sample with carrier gas prior to desorption (LINEX-TD and LINEX-DMI) or transfer (LVI).

Desorption Column Flow/Inlet Pressure

This parameter determines the flow during desorption time in LINEX-TD and LINEX-DMI methods.

Desorption Time

This parameter determines the length of the desorption segment.

7.4.4 Solvent Venting Parameters

Vent Mode

This parameter determines whether solvent venting is carried out during a user-specified fixed time or using the built-in solvent monitor (SM). The solvent monitor vent time control can be based on the absolute (SM Threshold, 0 - 4095 arbitrary units) or relative (SM Level, 1 - 90%) output signal. Both solvent monitor output modes are discussed in greater detail in Section 9.1 "Automated Solvent Vent Mode".

Vent Time

In the Fixed Time mode, this parameter determines the vent time during split injection.

Solvent Monitor Threshold

In the absolute vent mode, this parameter determines the solvent monitor level (expressed in arbitrary units) below which split valve closes.

Solvent Monitor Level

In the relative vent mode, this parameter determines the solvent monitor threshold relative to the measured maximum of the SM signal (expressed in %) below which split valve closes.

7.4.5 Split Flow Parameters

Vent Flow

This parameter determines the split flow during solvent venting.

Split Flow

This parameter determines the split flow after a sample transfer. It can be set lower than the Split Flow to reduce the carrier gas use.

7.4.6 Auxiliary Outputs

Any of the auxiliary outputs can be used in any of the OPTIC-4 method types. Each output can switch at nine user-specified times during a method run.

To keep the Evolution Workstation screens uncluttered, the auxiliary outputs are only shown in the method parameter tables if they have first been selected in **Configuration - System configuration - Auxiliary Outputs**.

7.4.7 Expert Method Parameters

Expert methods allow the user to set the profiles for any method parameter with up to nine individually configured segments. This makes it possible to develop advanced temperature and gas flow profiles.

Note:

The profiles in the Expert method could contain up to nine time segments. To add a time segment, click the right mouse button pointing on the profile line where the segment should start. Select "Add Step", the segment will be added the graph and the parameters in the parameter list will be updated. To remove a segment, press the right mouse button and select "Remove Step".

The relevant method parameters are divided in groups as for the other above described methods. The groups which contain parameters specific for the Expert method are:

Inlet Temperature group:

- Initial Inlet Temperature
- Delay Time (used to ensure equilibration of the gas flow parameters due to a rapid inlet pressure change after the injection)
- Ramp Rate 1 - 9
- Hold Temperature 1 - 9
- Hold Time 1 - 9

Note that both positive and negative temperature ramps can be set (see also Section 9.4 "Negative temperature ramps in Expert Methods").

Column Flow group:

- Carrier Control Mode: Flow or Pressure
- Start Column Flow 1 - 9
- Column Flow Time 1 - 9
- End Column Flow 1 - 9

Split Flow group:

- Initial Split Flow
- Split Flow 1 - 9
- Split Flow Time 1 - 9

Auxiliary Flow group:

- Start Auxiliary Flow 1 - 9
- Auxiliary Gas Control Time 1 - 9
- End Auxiliary Flow/Pressure 1 - 9

Any of the auxiliary outputs can be used in the Expert method. Each output can switch at nine user-specified times during method run.

7.5 Running Methods

Figure 7.1 illustrates the states that OPTIC-4 goes through as it runs a method.

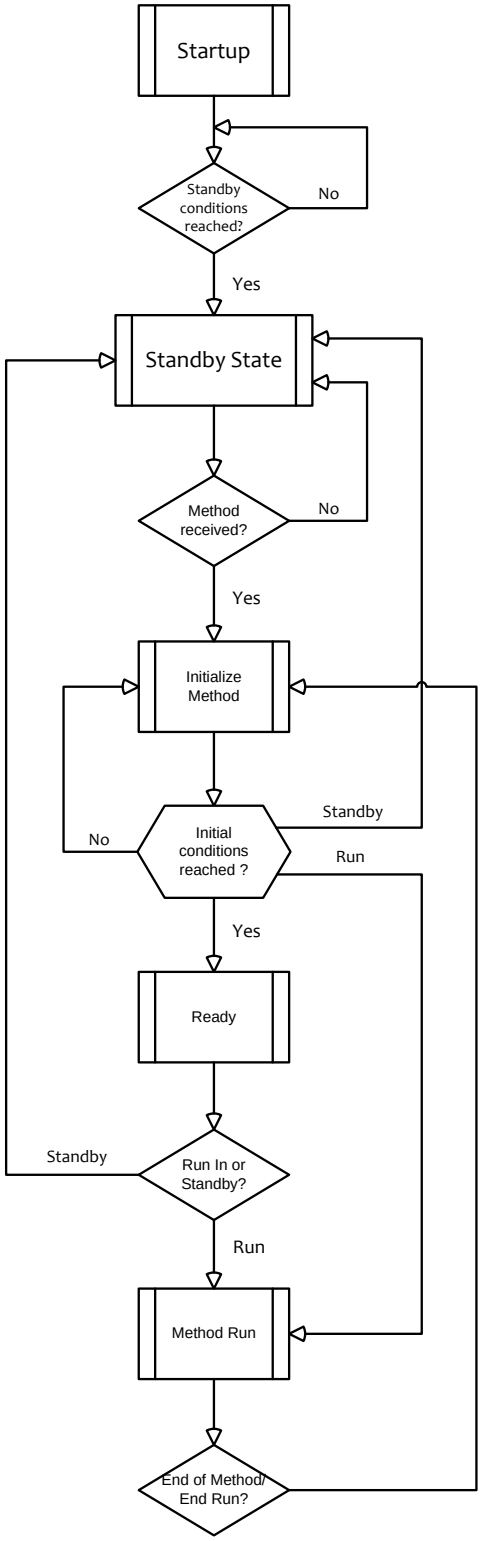


Figure 7.1 OPTIC-4 State Transition Diagram

When you select **File - New - Method** - **[method type]** the relevant parameters and their default values will be displayed for the selected method type. You can now adjust the parameters as required and save the method with a name of at most 11 characters.

7.5.1 Running Method from Evolution Workstation

Once a method has been saved, you can select **Method - Execute** menu option to send it to the OPTIC-4 control unit. It will start the method run on OPTIC-4. If you use manual injection, wait for OPTIC-4 to enter the **Waiting for Run In** state, then inject the sample and select **Method – Run** menu option or press **RUN** button on the local interface. The Evolution Workstation status graph will start displaying the instrument parameters when the run state changes to **Running**.

Note:

In order to prevent unintended method interruption, it is recommended to disable the PC sleep mode. Please, refer to Power Options with the Windows' Control Panel on how to disable the sleep mode.

7.5.2 Stopping Method from Evolution Workstation

While the Instrument is in the **Initialize Method, Waiting for Ready In, Equilibrating** or **Waiting for Run In** state the method can be stopped by selecting **Method – Standby** menu option or by pressing button **STANDBY** on the local interface. The Instrument will return to the Standby state. If the Instrument is in the **Running OPTIC Method** or the **Running OPTIC & GC Methods** state, the current run can be ended by selecting **Method - End Run** menu option or by pressing button **END RUN** on the local interface. The current run will be stopped; the instrument will be returned to the **Initialize Method** state and a new run with the same method will be started.

7.6 Optimizing Method

Some method parameters may have to be optimized by varying a parameter value within a certain range. The Evolution Workstation makes it possible to create a sequence of methods to perform such an optimization. The optimization sequence is created automatically after a sequence name, parameter to be optimized, its minimum and maximum values and a step size in the sequence are defined.

To create an optimization sequence:

- Select **Method – New Optimization Sequence**.
- Enter the name of the sequence and the directory it should be stored in.
- Choose the parameter to be optimized, its minimum and maximum values and the step size.
- Select 'OK' to save the sequence.

The Sequence window will then be displayed where you can modify the sequence as required. For more information about sequences you are referred to Chapter 8 "Defining and running sequences".

7.7 Converting Method to an Expert Method

Any type of method can be converted to an Expert Method if you want greater control over the method parameters. Select **Method/Convert to Export Method** menu option.

8. Defining and Running Sequences

A sequence is a combination of a number of methods. Each method can be run automatically a predefined number of times within a sequence. Sequences can be defined and run using the Evolution Workstation software.

8.1 Defining Sequences using Evolution Workstation Software

Select **File/New/Sequence**. Click **Insert** to insert any previously defined method. You can also specify the number of times it should be executed. This is done by clicking the method and then using the **Repeat** up/down arrows on the right of the screen. Once the number of repeats has been selected, press **Apply** to confirm. To move a method up or down in the sequence, click to select it and then click **Up** or **Down** to move it up or down in the list. Similarly, you can remove a method from the sequence. The sequence can also be looped by checking the relevant box. Once it has been created the sequence is saved by selecting **File, Save**.

8.2 Running Sequences using Evolution Workstation Software

Once a sequence has been created with the software, it can be activated, executed, stopped, etc. by selecting **Sequence** and the relevant option.

Select **Execute** to upload and start the first method in the sequence.

9. Advanced OPTIC-4 Features

9.1 Automated Solvent Vent Mode

One of the frequently used gas chromatography injection techniques is a large volume injection. In this technique the sample is injected with the split line open at an inlet temperature below the solvent boiling point. After the injection, the solvent front passes across the head of the capillary GC column and is vented through the split line. This solvent elimination step is largely completed in approximately 5 to 80 seconds, depending on the solvent type and injection volume and vent flow. The optimization of the vent time is straightforward but can be time-consuming. OPTIC-4 has a solvent monitor (SM) built in the split line of the inlet, which makes it easier to determine the solvent elimination time during the vent transfer. Depending on the value of Vent Mode parameter the vent time is determined manually (Vent Mode = Fixed Time) or automatically by the solvent monitor (Vent Mode = SM Threshold or SM Level). The diagram below illustrates the automatic absolute and relative modes.

In the absolute mode (Vent Mode = SM Threshold) the split line is closed when the solvent monitor signal drops below the SM Threshold set point defined by the user (Fig. 9.1). In the relative mode (Vent Mode = SM Level) the system calculates the SM Threshold at which the split line is closed. For this purpose, OPTIC-4 measures the solvent monitor zero (baseline) level (point A in the diagram) and the maximum value of the solvent peak ΔR. The SM Threshold is then calculated as $\Delta R \times$ SM Level.

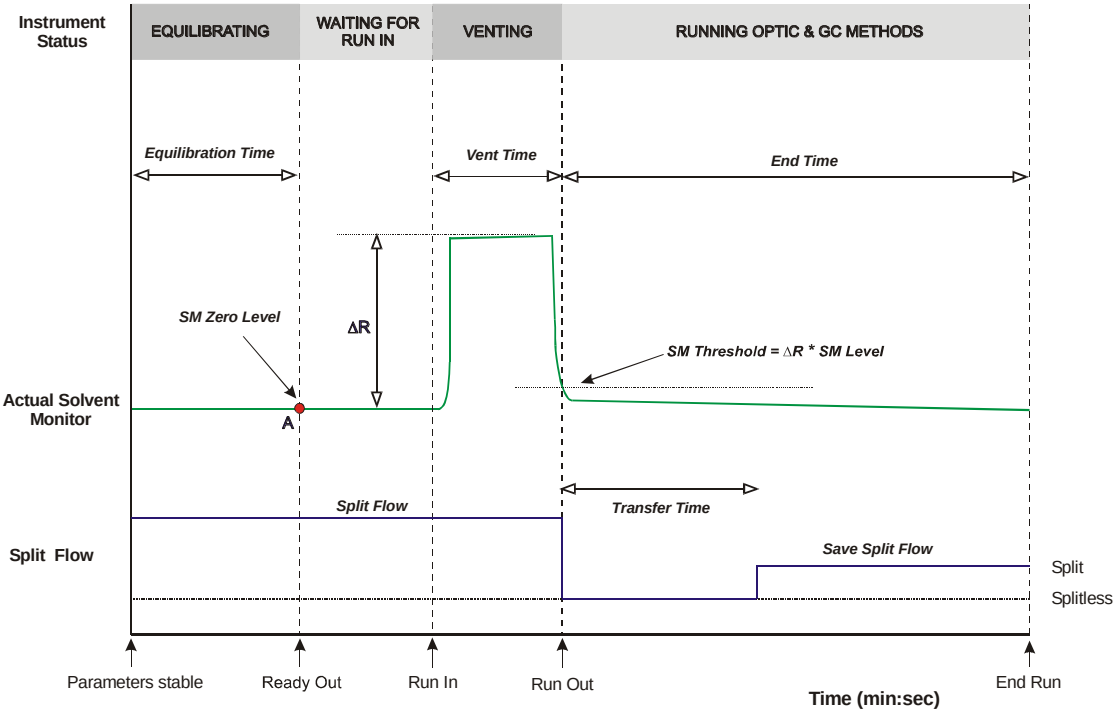


Figure 9.1 Solvent monitor signal in absolute and relative vent modes

9.2 Solvent Cooling Effect

During the solvent vent injection, the solvent passes across the head of the capillary GC column and is vented through the split line. The evaporation of solvent can cause considerable cooling of the inlet liner. Cooling occurs because the heat capacity of the packing of the liner and the liner itself is low and the heat transfer from the liner to the evaporation site is slow. For some applications the solvent cooling could be beneficial. OPTIC-4 has the option of switching the inlet heater off while eliminating the solvent to exploit the effect. This option is available in expert method only. It can be enabled by setting the 'Solvent Cooling Effect' parameter to Yes. The diagram below illustrates a possible modification (dashed line) of a method temperature profile resulting from the solvent cooling effect.

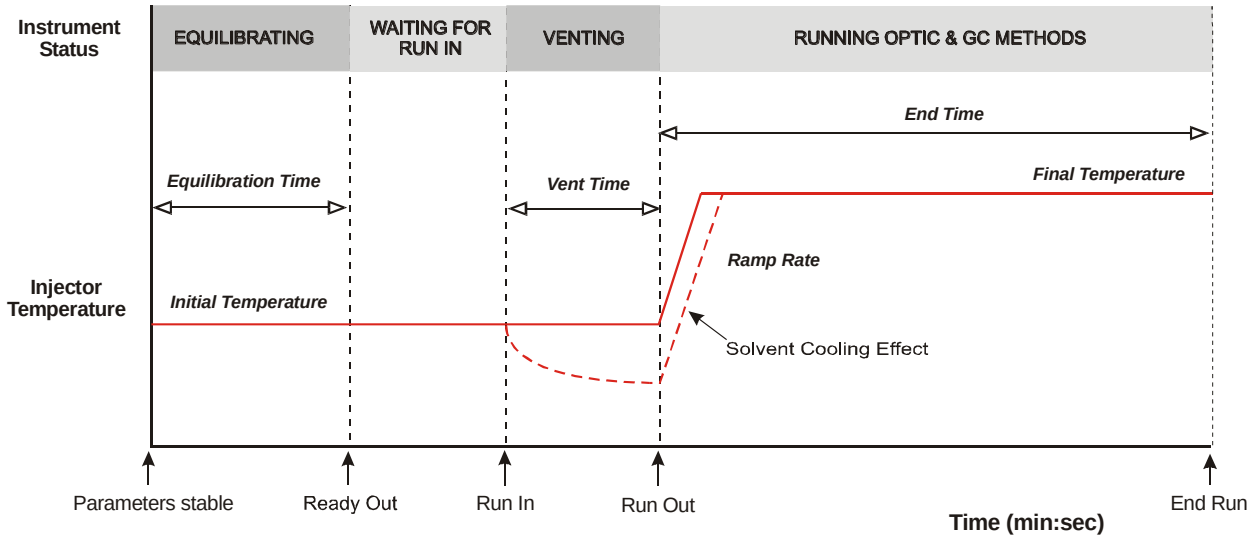


Figure 9.2 Solvent Cooling Effect

9.3 Floating Final Temperature

By default, in all OPTIC-4 methods the final inlet temperature is maintained at a constant value until the end of the method. OPTIC-4 has the option of setting the final temperature to 'floating' after a specified interval (Hold Time) has elapsed. It is enabled by setting the Temperature Control parameter to 'Floating' and the Hold Time to an appropriate value, smaller than the End Time. The diagram below shows an example of an inlet temperature profile with a floating segment (dashed line). The graphical display of the method will show a setpoint as the software has to show something, but temperature will float.

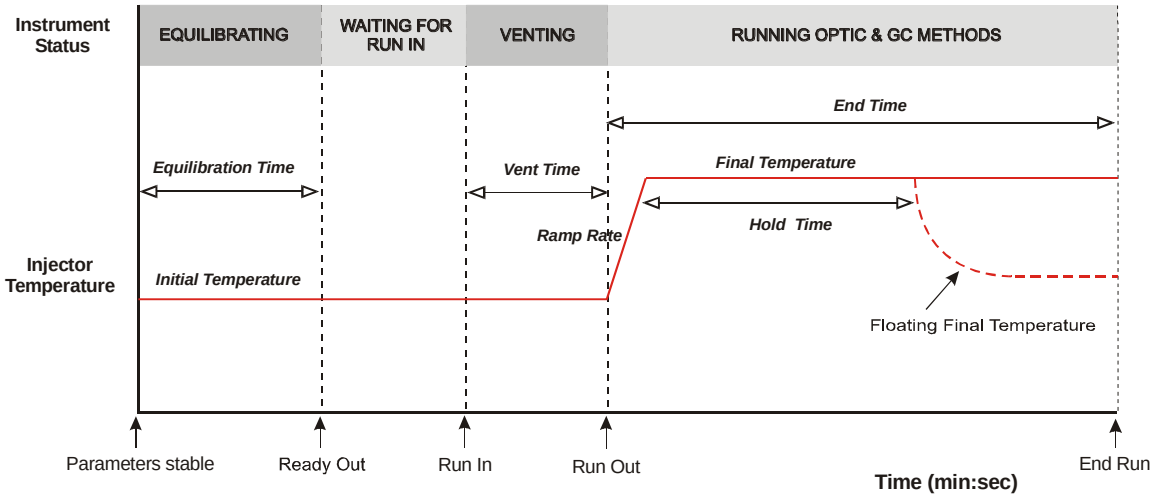


Figure 9.3 Floating Final Temperature

9.4 Negative Temperature Ramps in Expert Method

The OPTIC-4 Expert Methods make it possible to set both positive and negative temperature ramps for the inlet temperature profile (see default Expert Method profiles). The ramp rate can only be specified for positive temperature ramps, not for negative ramps. Furthermore, the Hold Time for negative ramp segments is also set differently than for positive segments. The specified temperature should be above the expected GC oven temperature during the method run.

9.5 Cooling Valve Mode

OPTIC-4 has the option of switching inlet cooling on and off during the method run time. The method parameter Cooling Valve Mode can be set to Yes or No only in the Expert Method. When it is set to No, cooling is switched off and the inlet temperature is maintained by the inlet heater controller.

9.6 Auxiliary Outputs

OPTIC-4 has four auxiliary outputs. These are normally open relays under software control for external devices. Any of the auxiliary outputs can be used in any of the OPTIC-4 methods. To keep the Evolution Workstation screens uncluttered, the auxiliary outputs are only shown in the methods if they have first been selected in **Configuration-System Configuration-Auxiliary Outputs**.

9.7 Cryotrap Control

OPTIC-4-SC and OPTIC-4-DC have control facilities for an GL Sciences Cryogenic Trap. The trap can be used to collect the sample in a narrow band at the head of the capillary GC column by cooling a short section of the column. The electronic control board and the trap itself are designed for rapid cooling and subsequent re-heating to ensure an excellent peak shape and reproducibility. The trap can be used with any of the OPTIC-4 standard method types. An example of the cryotrap temperature profile, incorporated in a method, is shown below.

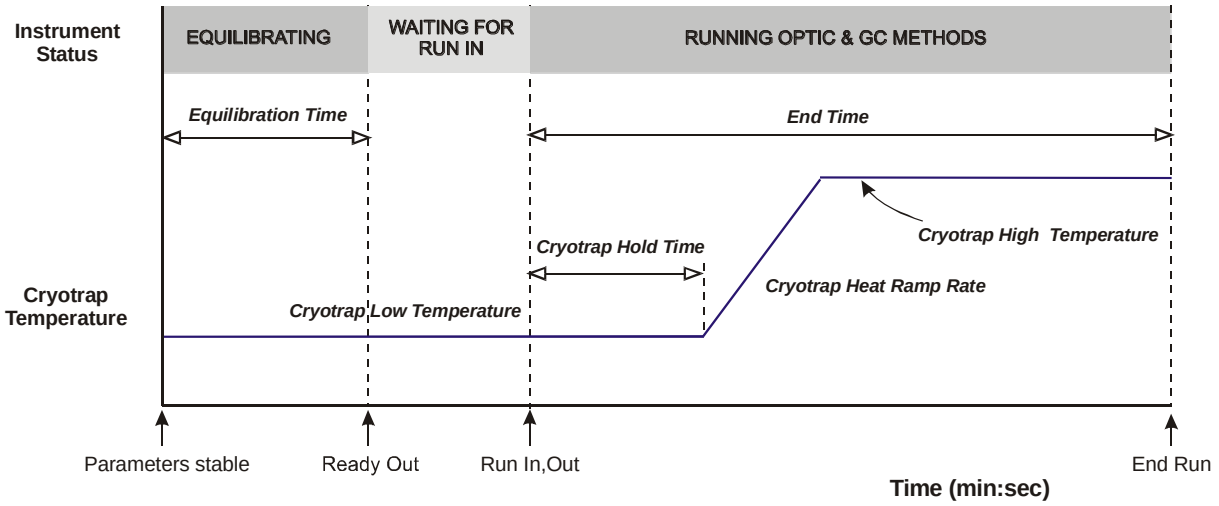


Figure 9.4 Cryotrap temperature profile.

9.8 Technical Notes

For a range of technical notes about the OPTIC-4 inlet and other GL Sciences products, please visit www.glsciences.eu

10. Operating Cryogenic Trap

10.1 Configuring Cryotrap

The cryotrap can be used with any of the OPTIC-4 standard method types. Prior to that, it should be enabled in the system configuration. This can be done through the Evolution Workstation software.

Ensure that the OPTIC-4 control unit is switched on and communicating with the Evolution Workstation software on the PC. Select **Configuration - System Configuration - General.** Check the cryotrap option. Click on OK to confirm the configuration.

10.2 Cryotrap Temperature Profile

When the cryotrap is enabled, the trap temperature profile will be added to any method you create. An example is shown in Chapter 9 "Advanced OPTIC-4 features".

The following parameters can be set in the profile:

Cryo Low Temperature:

This is the initial temperature, or cryo-focusing temperature, to cold-trap the analytes of interest. Any temperature between –150 °C and +350 °C may be set but this temperature will normally be in the range –150 °C to 0 °C.

Cryo Hold Time:

This is the time required after receiving a run signal for the sample to be fully transferred from the inlet to the cryotrap.

NOTE:

If sample is introduced via a splitless injection system, "Cryo Hold Time" should be a bit longer than "Transfer Time". The available time setting range is 00.00 to 120:00 minutes, but it is convenient to set "Cryo Hold Time" in the range 1:00 to 5:00 minutes.`

CAUTION!

It is strongly advised not to hold the trap at subambient temperature for longer than 20 minutes. The ice is formed on the points of column near the trap ends if trap is kept cold for a long time. This penomenon can cause analytical problems and can also bring damage to the column coating!

Cryo Heat Ramp Rate:

This is temperature ramp rate in degrees Celsius per second (°C/sec) at which the trap heats from the **Cryo Low Temperature** to the **Cryo High Temperature**. Currently the range available is 1 to 60°C/sec

Cryo High Temperature:

This is the final temperature, or desorption temperature, to transfer the analytes from the trap to the column. Any temperature between -150 °C and +350 °C may be set but it is usual to set a temperature in the range +100 °C to +350 °C.

CAUTION!

It is important not to set this temperature above the maximum operation temperature of the capillary column otherwise a permanent damage to the column will result and column bleed will be seen in the resultant chromatogram.

11. Maintenance

OPTIC-4 needs little routine maintenance other than replacing consumables. In some cases, the inlet may be affected by contamination and require cleaning. If there are any problems with the operation of the system, please see Chapter 12 "Troubleshooting and Diagnostics".

WARNING!

Read and follow the maintenance procedures described in this section to prevent accidents. Switch off the OPTIC-4 control unit and GC before performing maintenance.

11.1 Routine Maintenance

OPTIC-4 does not need any special routine maintenance other than that required by Good Laboratory Practice for GC equipment:

- The liner should be inspected regularly and, if contaminated, should be re-packed or replaced. Especially important to inspect liner before starting a new series of analysis.
- The septum should be changed regularly. The guideline for replacement is approx. 100 injections.
- Replace the O-ring when replacing the liner or when there is a leak.
- Replace the ferrule when the gas leak cannot be eliminated by tightening.
- Replace the split filter every 6 months. Write on the filter tag the first installation date or its replacement date.
- Clean the inlet regularly using a procedure described in the next section.

11.2 Inlet Cleaning

If carryover or background contamination is evident in the chromatogram, and the problem has been traced to the OPTIC-4 inlet, it should be cleaned as described below.

In general, it is advisable to establish a cleaning schedule for your inlet on a regular basis. Depending on the cleanliness of the sample, the cleaning frequency can range from a few weeks for dirty samples to a few months for clean samples.

1. Cool the inlet and the host GC oven to the ambient temperature.

2. Turn the OPTIC-4 controller and the host GC off.

3. Remove the inlet top boss, take out the liner and disconnect the column from the inlet bottom.

4. Take a cotton swab, moisture it with solvent and wipe the inlet inside repeatedly. Start from the inlet bottom and move it up to the top. Take a clean swab and repeat the procedure again. Change the cotton swab several times until it remains clean after the inlet is wiped.

5. Take a beaker or other glass container and place it underneath the inlet. Rinse the inlet with a small amount of clean solvent several times. Use a laboratory pipette or a syringe. Only the inlet bore should be rinsed. Avoid solvent on the other parts of the inlet.

6. Wait until the inlet is dry. Insert a clean empty liner in the inlet, screw the top boss on and connect your regular column to the inlet bottom.

7. Enter the following standby parameters in the Evolution Workstation software by selecting **Configuration - Standby**:

   - *Split valve state:* *Split*
   - *Inlet temperature:* *450 °C*
   - *Column flow:* *as low as possible*
   - *Split flow:* *200 mL/min*

   Activate these parameters and purge the inlet for 30 minutes.

8. Test the system to see if the carryover has disappeared.

9. If carryover is still present, repeat steps 1 to 7.

10. If carryover is still present contact your supplier.

11.3 Carrier Gas Leak Check

A gas leak in a GC system affects reproducibility and increases consumption of the carrier gas. To check for carrier gas leaks, use an electronic leak detector (GL Sciences p/no 2702-19340 or similar commercial detector).

To facilitate the search for a leak, follow the procedure below:

1. Set OPTIC-4 into standby mode.

2. Wait until GC oven and inlet temperature is below 40 °C.

3. Remove the capillary column from the inlet and blank the inlet with a no-hole graphite ferrule (2406-1019, OPTIC Graphite Ferrule, no-hole, pk/10).

4. Ensure that the carrier gas supply pressure is set to 700 kPa.

5. Duct the carrier exhaust ports "Exhaust" and "SP Exhaust" away from the "Inlet Gas Lines" connection. Use short pieces of 1/8 in. PTFE tubing for this.

6. Select in Evolution Workstation **Configuration/System Configuration**. Set column parameters to: Internal Diameter - 0.25 mm, Length – 30 m.

7. Select in Evolution Workstation **Configuration/Standby Parameters**. Set standby column flow to 20 mL/min and standby split flow to 200 mL/min.

8. Wait for a few minutes and verify via the status parameter view in the Evolution Workstation that the standby column flow 20 mL/min is set.

9. Verify that the standby split flow 200 mL/min is set.

10. While the inlet port is under pressure, check for a leak with a leak detector. The most critical connections to be checked are shown in the Fig. 11.1 below:

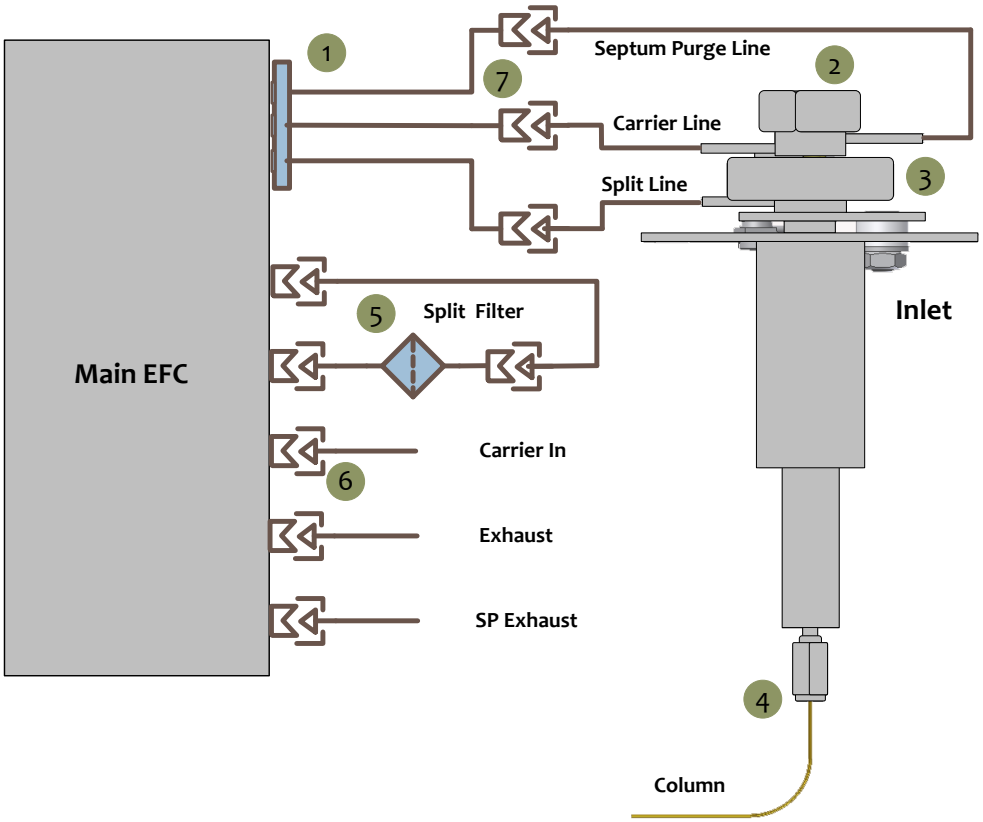


Figure 11.1 Critical Connections for Leak Checking

Connection Point	Description
1	Inlet gas lines connection
2	Septum
3	O-ring
4	Column connection
5	Split line filter connections
6	Carrier gas supply connection
7	Gas lines connection fittings

Table 11.1 List of Critical Connections for Leak Checking

CAUTION!

When leak testing connections, use a suitable electronic leak detector. Under no circumstances should a soap solution or similar be used as this will contaminate the inlet!

11. When a leak is detected, tighten the part or remove it and check for a problem. Replace the part if any problem is found.

CAUTION!

Do not to tighten the inlet base nut excessively. The inlet base is very fragile and can be damaged easily!

11.4 Servicing

The OPTIC-4 system does not normally require any servicing. If there are problems, which cannot be solved by replacing consumables, cleaning the inlet, or following the troubleshooting instructions, then please contact your supplier for further support.

If inlet is temporarily removed from the GC, block its bottom to prevent the inlet interior from contamination. Use a no-hole graphite ferrule (2406-1019, OPTIC Graphite Ferrule, no-hole, pk/10) for it.

12. Troubleshooting and Diagnostics

This chapter describes possible problems, their causes and recommended solutions. If this information does not help to solve the problem, please contact your supplier for further support.

12.1 Troubleshooting

If there is any problem during the installation or operation of OPTIC-4, please check the following issues.

12.1.1 Instrument Does Not Power Up

If instrument fails to power up, check the following:

Problem	Solution
Power lead is not fully inserted into socket	Insert power lead fully into socket
Fuse within power entry module is blown up	Replace fuse. Use the fuse with the following characteristics: Voltage rating : 250VAC, Fuse Current: 6.3A, Blowing Type: T (Slow Blow). Re-order information: p/no 2406-2257

12.1.2 Inlet Does Not Heat Up

If inlet does not heat up, check the following:

Problem	Solution
Power lead (cable) to Inlet is damaged	Replace inlet power cable
Power cable is not connected to controller or inlet	Connect power cable

12.1.3 Inlet Heats Up Slowly

If for inlet it takes an excessive time to reach the set point, check the following:

Problem	Solution
Power connection to inlet is not reliable	Ensure that power to the instrument is switched OFF. Disconnect the power leads from inlet and inspect terminals. Clean terminals and reconnect them securely to inlet.

12.1.4 INJ ERTH FAULT error is displayed.

If the error is displayed at the moment when the inlet temperature is ramped with the high ramp rate, check the following:

Problem	Solution
Inlet power connection polarity is not correct.	Ensure that power to the instrument is switched OFF. Disconnect the power leads from inlet and reconnect them properly. Clean terminals and reconnect them securely to inlet. Ensure that the terminal 2 (right) of the inlet power connector is connected to the upper inlet electrode.

12.1.5 Inlet Cools Down Slowly

If for inlet it takes an excessive time to cool down to the initial temperature set in the method, check the following:

Problem	Solution
Compressed air supply pressure is too low	Ensure that air pressure supply is at least 500 kPa
LN_2 vessel pressure is too low (for LN_2 cooling)	Ensure is that LN2 vessel pressure is at least 150 kPa

12.1.6 Flow/Pressure Set Point Can Not be Reached

If the column flow set point cannot be reached and INJ PRESSURE WARNI**NG** is displayed, check the following:

Problem	Solution
No carrier gas is supplied	Ensure that gas supply valve is opened
Supply pressure is too low	Set gas supply pressure to at least 500 - 600 kPa
Gas leaks	Check for gas leeks
Internal column diameter, column length and carrier gas type and column outlet pressure are set incorrectly	Set correct column parameters, carrier gas type and column outlet pressure

12.2 Errors and Warnings

All OPTIC-4 error and warning messages are displayed in the status pane of the Evolution Workstation. An intermittent beep will sound when an error or warning message is displayed.

12.2.1 Inlet Thermocouple Fault

The error message **INJ TC FAULT** is generated when the inlet thermocouple fails, or if the TC connection to the OPTIC-4 control unit is lost. This error is displayed in the status pane if the

problem persists for two seconds or more. The inlet heater controller is shut down. This fault is non-recoverable i.e. the fault must be addressed and the instrument powered off and then on again.

12.2.2 Inlet Earth Fault

The error message **INJ EARTH FAULT** is generated when the inlet thermocouple loses its connection to the body of the inlet, if the inlet TC connection to the OPTIC-4 control unit is lost or if the earth connection between the inlet base and GC chassis is broken. This error is displayed in the status pane if the problem persists for two seconds or more. The inlet heater controller is shut down. This fault is non-recoverable i.e. the fault must be addressed and the instrument powered off and then on again.

12.2.3 Inlet Overpower

The error message **INJ OVERPOWER** is generated when the application of full power for more than 25 sec does not bring the inlet temperature to the set point. This error is displayed in the status pane if the problem exists for two seconds or more. The inlet heater controller is shut down. This fault is non-recoverable i.e. the fault must be addressed and the instrument powered off and then on again.

12.2.4 Inlet Temperature above Maximum

The error **INJ TEMP ABOVE MAX** message is generated when the inlet temperature exceeds the maximum temperature of 650°C. This error is displayed in the status pane if the inlet temperature is above 650°C and is rising. The inlet heater controller is shut down. This fault is non-recoverable i.e. the fault must be addressed and the instrument powered off and then on again.

12.2.5 Cryotrap Thermocouple Fault

The error message **CRYO TC FAULT** is generated when the cryotrap thermocouple fails, or if the cryotrap TC connection to the OPTIC-4 control unit is lost. This error is displayed in the status pane if the problem persists for two seconds or more. The cryotrap and inlet heater controllers are shut down. This fault is non-recoverable i.e. the fault must be addressed and the instrument powered off and then on again.

12.2.6 Cryotrap Earth Fault

The error message **CRYO EARTH FAULT** is generated when the cryotrap thermocouple loses its connection to the body of the trap, if the cryotrap TC connection to the OPTIC-4 control unit is lost or if the earth connection between the cryotrap base and OPTIC controller is broken. This error is displayed in the status pane if the problem persists for two seconds or more. The cryotrap heater controller is shut down. This fault is non-recoverable i.e. the fault must be addressed and the instrument powered off and then on again.

12.2.7 Cryotrap Overpower

The error message **CRYO OVERPOWER** is generated when the application of full power for more than 25 sec does not bring the trap temperature to the set point. This error is displayed in the status

pane if the problem exists for two seconds or more. The cryotrap heater controller is shut down. This fault is non-recoverable i.e. the fault must be addressed and the instrument powered off and then on again.

12.2.8 Cryotrap Temperature above Maximum

The error CRYO TEMP ABOVE MAX message is generated when the cryotrap temperature exceeds the maximum of 400°C. This message is displayed on the local display (status line) if the cryotrap temperature is above 400°C and rising. The cryotrap heater controller is switched OFF. This fault is non-recoverable i.e. the fault must be addressed and the instrument powered off and then on again.

12.2.9 Inlet Temperature Warning

The **INJ TEMP WARNING** message is generated when inlet temperature set point cannot be reached during the method initialization, method run or standby. This message is displayed in the status line of the Evolution Workstation software. The software checks that the ramp is following its course and maintained correctly. If the actual temperature is ±50°C from the set point then **INJ TEMP WARNING** is displayed. This is a warning and is therefore recoverable.

12.2.10 Cryotrap Temperature Warning

The **CRYO TEMP WARNING** message is generated when cryotrap temperature set point cannot be reached during the method initialization, method run or standby. This message is displayed in the status line of the Evolution Workstation software. The software checks that the ramp is following its course and maintained correctly. If the actual temperature is ±50°C from the set point then **CRYO TEMP WARNING** is displayed. This is a warning and is therefore recoverable.

12.2.11 Inlet Pressure Warning

The **PRES WARNING** message is generated when the inlet pressure (column flow) set point cannot be reached during the method initialization, method run or standby. This message is displayed on the local display and the PC. The software checks that the pressure (column flow) is maintained at the set point. This message is generated if the actual pressure differs by ±2 kPa from the calculated set point (which is required to set the column flow) for two minutes. This is a warning and is therefore recoverable.

12.2.12 Inlet Pressure Error

The **PRES ERROR** message is generated when Hydrogen is used as a carrier gas and the inlet pressure (column flow) set point cannot be reached during the method initialization, method run or standby. This message is displayed on the local display and the PC. The software checks that the pressure (column flow) is maintained at the set point. This message is generated if the actual pressure differs by ±2 kPa from the calculated set point (which is required to set the column flow) for two minutes. The EFC controller is shut down. This fault is non-recoverable i.e. the fault must be addressed and the instrument powered off and then on again.

12.2.13 Auxiliary Flow Warning

The **AUX FLOW WARNING** message is generated when the auxiliary flow set point cannot be reached during the method initialization, method run or standby. This message is displayed in the status pane of the EW on the PC. The software checks that the auxiliary flow is maintained at the set point. This warning message is generated if the actual flow differs by ±20% or ±2 mL/min (whichever is higher) from the set point for two minutes. This is a warning and is therefore recoverable.

13. Technical Specifications

General

- Dimensions: 34 cm × 14 cm × 34 cm (h × w × d)
- Weight: 8.4 kg (OPTIC-4DC controller)
- Ambient temperature range: 18 - 40°C
- Ambient operating humidity: 40 - 70%
- Mains power: 100 - 240 VAC, 50-60 Hz
- Typical power consumption: 150 VA
- Maximum power consumption: 450 VA
- Conforms to safety standards:
  The European Low Voltage Directive
  The European Electromagnetic Compatibility Directive
- RoHS Compliant

Inlet

- Full electronic pressure/flow control
- Maximum operating temperature: up to 600°C at a GC oven temperature of 35°C
- Minimum operating temperature (without forced cooling): ambient temperature ± 2°C (host GC oven is OFF)
- Cooling: air (down to 35°C), LCO_2 (down to -50°C), LN_2 (down to -180°C)
- Temperature ramp rates: 0.1 - 60 °C/sec
- Up to nine temperature program ramps including negative
- Compatible with Merlin MicroSeal septum
- Compressed air for cooling: moisture and oil free air at a pressure of 500 kPa.

Electronic Flow Control

- Two EFC channels
- Full electronic control of column, split and septum purge flows
- Pressure range: 7 - 700 kPa
- Total flow range: 6 - 500 mL/min He (main channel, all models), 2 - 100 mL/min He (auxiliary channel, OPTIC-4D and OPTIC-4DC only)
- Pressure sensors:
  Accuracy: ± 1% of full scale
  Repeatability: ± 0.2% of full scale
- Flow sensors:
  Accuracy: total flow - ± 1% of full scale, septum purge flow - ± 10% of full scale (±1 mL/min)
  Repeatability: ± 0.2% of full scale
- Up to nine flow program ramps
- He, N_2 or H_2 as carrier gas at a maximum pressure of 700 kPa
- Solvent sensor in the split line
- Charcoal Filter in the split line

External Communication

- LAN
- USB
- Four auxiliary relay outputs (30V/500 mA max.)
- External 24 VDC supply connections (250 mA max.)
- Remote start/stop to GC and autosampler

Evolution Workstation Software

- Method and sequence definition and development
- Real-time system status display
- Automatically generated optimization sequences
- Direct control in Standby mode
- System run log file
- Password protection with two access levels
- HTML help file

Cryotrap Option

- Operating temperature range : -150°C to +350°C
- Temperature ramp rates: 1.0 - 60 °C/sec
- Cooling: LN_2, from pressurized (100-150 kPa) vessel
  CO_2, from high pressure cylinder with dipstick
- Compatible with any GC make

Appendix A: OPTIC-4 Default Configuration Parameters

A.1. Standby Parameters

Parameter Name	Default Value	Allowed Range
Inlet Temperature	35 °C	-180 - 600 °C
Inlet Temperature Control	Yes	Yes/No
Inlet Cooling	OFF	ON/OFF
Column Flow	1.0 mL/min	0.0 - 20.0 mL/min
Split Flow	50.0 mL/min	1.0 - 450 mL/min
Split Valve State	Split	Split/Splitless
Septum Purge Flow	5.0	1.0 - 10.0 mL/min
Inlet Zero Pressure	No	Yes/No
Auxiliary Flow (OPTIC-4D and OPTIC-4DC)	10.0	2.0 - 100 mL/min
Auxiliary Pressure (OPTIC-4D and OPTIC-4DC)	100 kPa	5.0 - 500 kPa
Cryotrap Temperature	35 °C	-150 - 350 °C
Cryotrap Temperature Control	No	Yes/No
Cryotrap Cooling	OFF	ON/OFF
Timeout	30:00 min:sec	0 - 500 min
Run/Ready Signal Through Function	No	Yes/No
Auxiliary Output 1	Open	Open/Closed
Auxiliary Output 2	Open	Open/Closed
Auxiliary Output 3	Open	Open/Closed
Auxiliary Output 4	Open	Open/Closed

A.2 General System Configuration Parameters

Parameter Name	Default Value	Allowed Range
Maximum Temperature	350 °C	100 - 600 °C
Communication Interface	USB	USB/LAN
Main EFC	Yes	Yes/No
Auxiliary EFC	No	Yes/No
Cryotrap	No	Yes/No
Pressure Unit	kPa	kPa/psi/bar
Auxiliary Channel Flow/Pressure Control	Flow	Flow/Pressure
Keyboard Beeper	Enabled	Enabled/Disabled
Reset Parameters	No	Yes/No

A.3 GC and Autosampler Input/Output Configuration

Parameter Name		Default Value	Allowed Range
OPTIC – Autosampler Ready Out		Low to High	Low to High /High to Low
OPTIC – GC Interface		OPTIC Master	Master/Slave
Master	Ready In	High to Low	Low to High /High to Low
	Ready Out	Disabled High	Disabled High/Disabled Low
Slave	Ready In	Disabled	Disabled
	Ready Out	Low to High	Low to High /High to Low
Run Out Polarity		Low to High	Low to High /High to Low
Run Out Timing		Run On Inlet Ramp	Run On Inlet Ramp/Run on Cryo Ramp

A.4 GC Column and Carrier Gas Parameters

Parameter Name		Default Value	Allowed Range
Single Column	Internal Column Diameter	0.25 mm	0 - 1 mm
	Column Length	30 m	0 - 100 m
Multiple Columns	Column in Series – One Detector	See configuration tab	
	Column in Series – Two Detectors	See configuration tab	
	Flow Modulation – One Detector	See configuration tab	
	Flow Modulation – One Detector	See configuration tab	
	Reversed Flow Modulation – Two Detectors	See configuration tab	
	Dean's Switch – Two Detectors	See configuration tab	
	Dean's Switch – Three Detectors	See configuration tab	
Carrier Gas		He	$He/N_2/H_2$
Primary Column Outlet Condition		Atm	Atm/Positive Pressure/Vacuum
Primary Column Outlet Pressure (Absolute)		101.33 kPa	0 – 700.0 kPa

A.5 Auxiliary Outputs Parameters

Parameter Name	Default Value	Allowed Range
Auxiliary Output 1	Open	Open/Closed
Auxiliary Output 2	Open	Open/Closed
Auxiliary Output 3	Open	Open/Closed
Auxiliary Output 4	Open	Open/Closed
Modulation	No	Yes/No

Appendix B: Rear Panel I/O Connections

NOTE: Any pins that are not listed in the following tables are not connected.

B.1 Gas Chromatograph Interface

The inputs and outputs to a host GC are provided on a min-DIN 6-pin female connector. Pin table is shown below.

Pin	Function	Remarks
5	Ready In	TTL In
4	Run In	External contact closure or TTL In level change. When contacts are closed or TTL level changed, OPTIC-4 enters Run state
2	Ready Out	TTL Out
1	Run Out	TTL Out is reversed for 1 sec to generate Run Out signal
3,6	GND	

B.2 GC Connector Pin Layout

Mini-DIN 6-pin female connector layout:

B.3 Autosampler Interface

The inputs and outputs to a host autosampler are provided on a sub-D 9 pin female connector. Pin table is shown below.

Pin	Function	Remarks
1	Ready Out	TTL Out
3	Run In	External contact closure. When the contacts are closed OPTIC-4 enters the Run state
5	Power output	+24V ± 20 %. Max. current 250 mA
6,7	GND	

B.4 Auxiliary Outputs

The auxiliary outputs are provided on a sub-D 15 pin female connector. Pin table is shown below.

Pin	Signal	Remarks
1	Power output	+24V ± 20 %. Max. current 250 mA
9(COM), 2(NO), 10(NC)	Auxiliary Out 1	Relay output (max. 30 V/500 mA)
3(COM), 11(NO), 4(NC)	Auxiliary Out 2	Relay output (max. 30 V/500 mA)
6(COM), 14(NO), 7(NC)	Auxiliary Out 3	Relay output (max. 30 V/500 mA)
12(COM), 5(NO), 13(NC)	Auxiliary Out 4	Relay output (max. 30 V/500 mA)
8	GND	

Appendix C: Accessories, Consumables, and Spares

C.1 Inlet liners

(or check Appendix F for a more complete list)

Part Number	Description	Pack Size	Remark
2414-1001	Fritted Liner, frit 15 mm	5	
2414-1003	Single Neck Liner	5	
2414-1005	Liner for Splitless Injections	5	
2414-1009	Baffled Liner for Splitless Injections	5	
2414-1011	Fritted Liner (20 mm) with Single Taper	5	
2414-1013	DMI Liner with Taper	5	
2414-1020	Fritted Liner Packed with Chromosorb W	5	
2414-1007	Sintered Glass Liner with Taper	5	

C.2 Consumables

3007-41125	Ultra Low Bleed Septum, ULB-S-11, 11 mm, pk/25	25	
2406-1018	Non-stick Plasma Treated O-ring, Viton, pk/10	10	
2406-1003	OPTIC Graphite Ferrule for 0.53 mm ID Column, pk/10	10	
2406-1004	OPTIC Graphite Ferrule for 0.32 mm ID Column, pk/10	10	
2406-1005	OPTIC Inlet Metal Ferrule, Column ID 0.25mm, pk/10	10	
2406-1006	OPTIC Inlet Metal Ferrule, Column ID 0.32mm, pk/10	10	
2406-1007	OPTIC Inlet Metal Ferrule, Column ID 0.53mm, pk/10	10	
2406-1019	OPTIC Graphite Ferrule, no-hole, pk/10	10	

C.3 Spares

2406-2047	OPTIC Stainless Steel Inlet Bottom Nut, pk/5	5	
2406-2048	OPTIC Key Inlet Bottom Nut	1	
2406-2049	OPTIC Inlet Bottom Nut for Metal Ferrule, pk/5	5	
2406-2010	OPTIC-4 Inlet Septum Nut Standard	1	
2406-2012	OPTIC-4 Inlet Top Boss Clamp Nut	1	
2406-2013	OPTIC-4 Inlet Clamp Nut Insulator	1	
2406-2015	OPTIC-4 Inlet Septum Nut, Shimadzu type	1	
2406-2016	OPTIC-4 Inlet Septum Nut Insert, Shimadzu type	1	
2406-4020	OPTIC-4 Solvent Monitor Assembly	1	
2406-2250	OPTIC-4 Inlet Cooling Valve	1	
2406-2051	OPTIC-4 EFC Fitting, 1/8" tubing	1	
2406-2056	Aluminum Seal Type-G, pk/10	10	
2406-2257	Fuse, Slow Blow, 250V, 6.3A	5	Suggested replacement period 3 years
2406-2269	OPTIC Inlet Bottom Insulation Cap	1	

2406-2270	GC Oven Thermocouple	1	
2406-4025	OPTIC-4 Split Line Filter Assembly	1	Suggested replacement period 6 months
2406-4005	OPTIC-4 Inlet Assembly Base	1	
2406-4016	OPTIC-4 Main EFC Channel	1	
2406-4017	OPTIC-4 Aux EFC Channel	1	

C.4 Interface Cables

2406-4034	Interface Cable for PAL Autosampler	1	
2406-4035	Interface Cable for Shimadzu GC2010	1	
2406-4036	Interface Cable for Agilent 7890	1	
2406-4037	Interface Cable for Trace GC	1	

C.5 Accessories/Upgrades

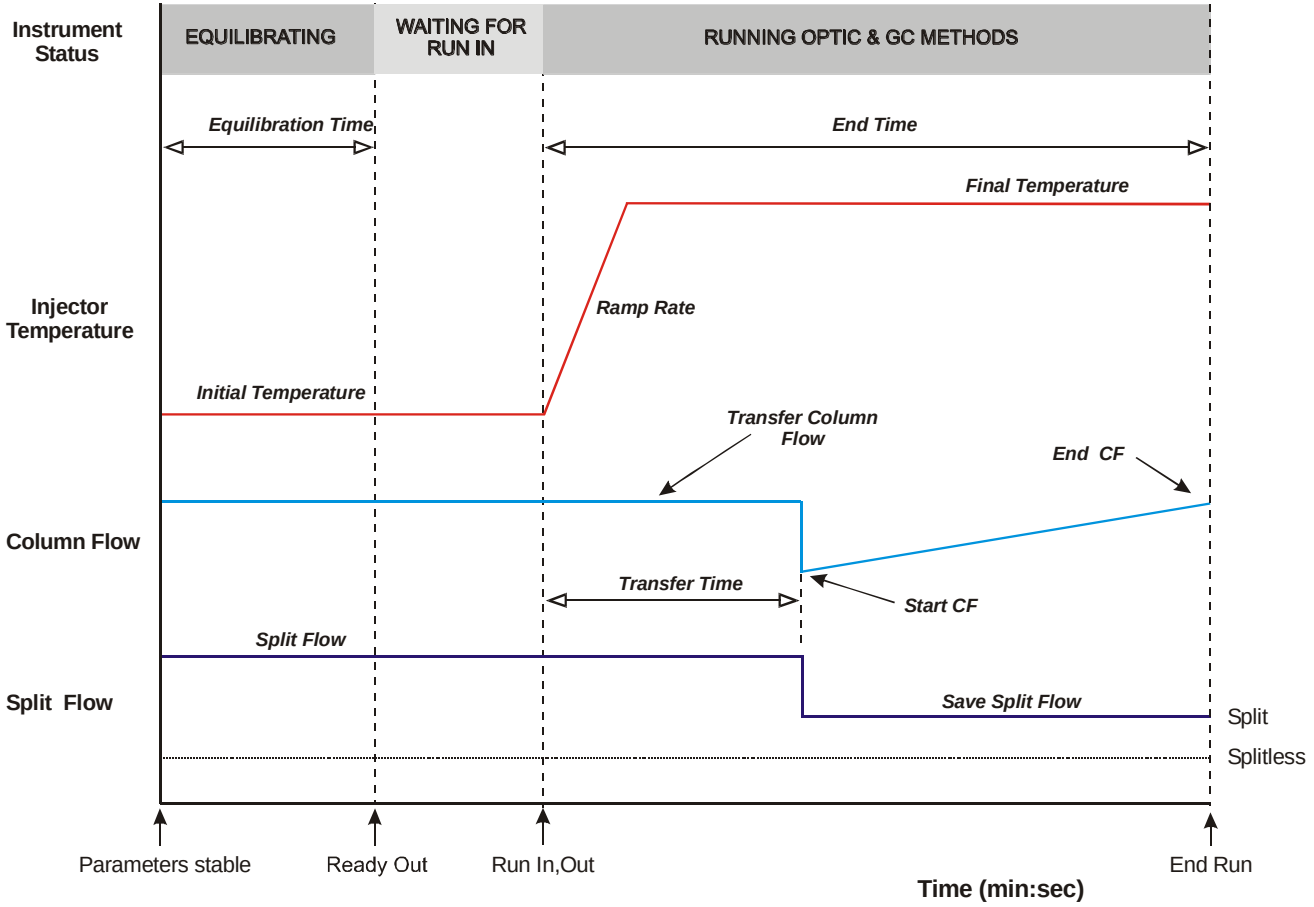
2406-4150	Upgrade kit OPTIC 4-S to OPTIC 4-D	1	
2406-4151	Upgrade kit OPTIC 4-S to OPTIC 4-SC/D	1	
2406-4152	Upgrade kit OPTIC 4-D to OPTIC 4-DC/D	1	
2406-4153	Upgrade kit OPTIC 4-S to OPTIC 4-DC/D	1	
2406-4154	Upgrade kit OPTIC 4-S to OPTIC 4-SC/CO2	1	
2406-4155	Upgrade kit OPTIC 4-D to OPTIC 4-DC/CO2	1	
2406-4156	Upgrade kit OPTIC 4-S to OPTIC 4-DC/CO2	1	
2406-4157	Inlet Heat Exchanger Cooling Option (LN2)	1	
2406-4158	Tee Joint for Inlet Backflush	1	
2406-4159	OPTIC-4 Inlet Cooling Kit, Direct LN2	1	
2406-4160	OPTIC-4 Inlet Cooling Kit, CO2	1	

C.6 Installation Kits

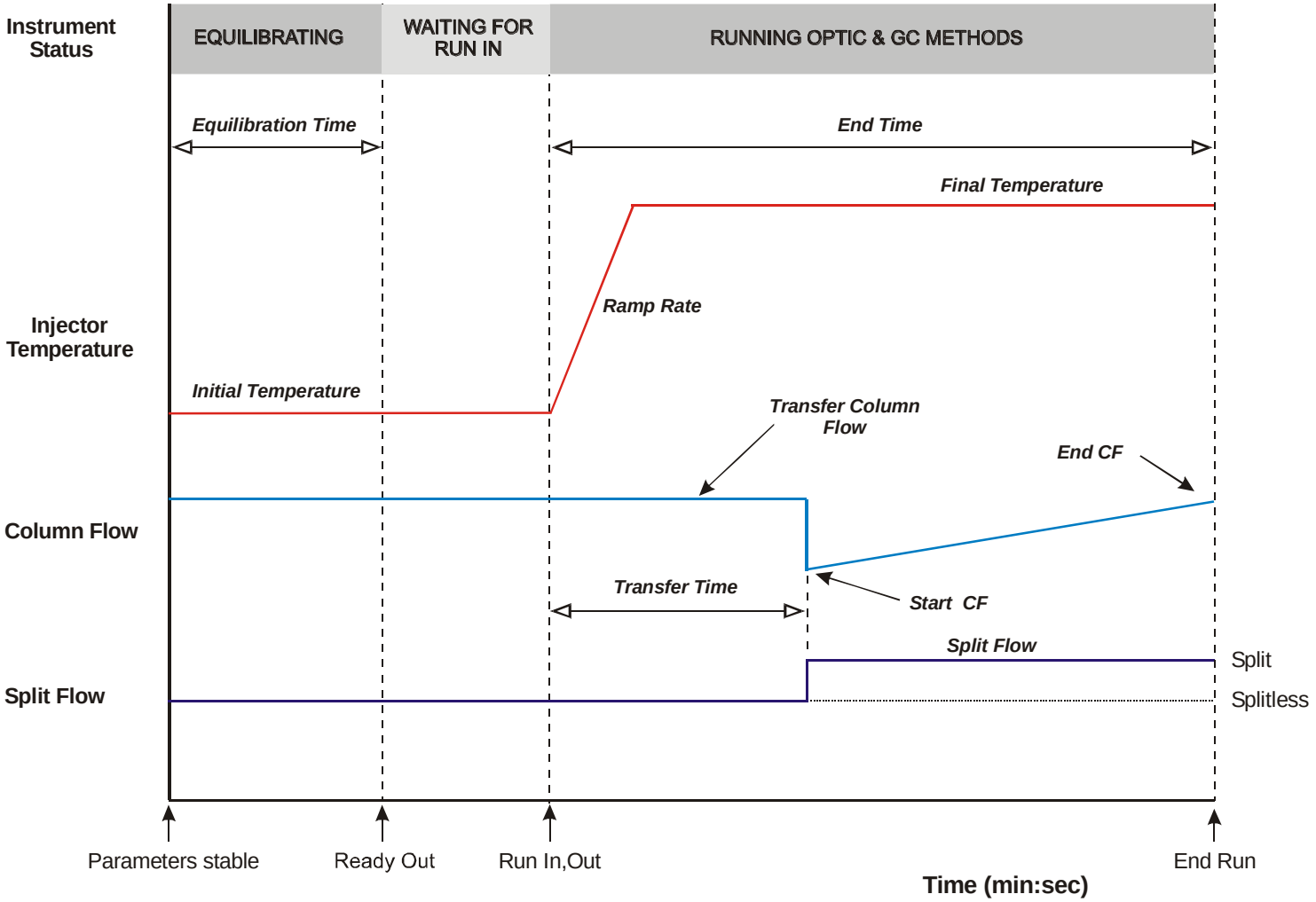
2406-4124	OPTIC-4 Installation Kit for Shimadzu 2010 GC	1	
2406-4125	OPTIC-4 Installation Kit for Agilent 7890 GC	1	
2406-4126	OPTIC-4 Installation Kit for Thermo GC	1	

Appendix D: Examples of OPTIC-4 Method Profiles

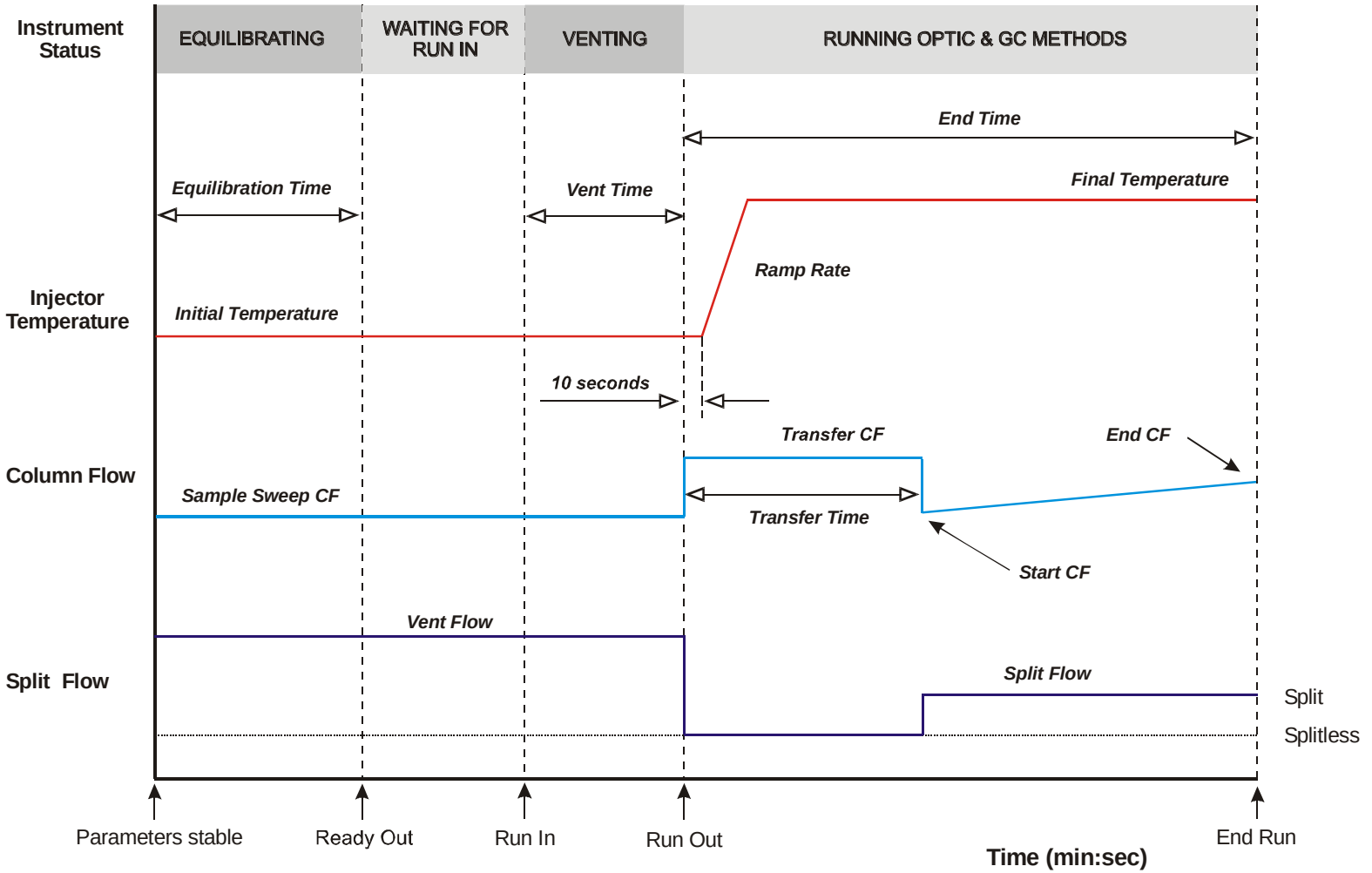
D.1 Split method



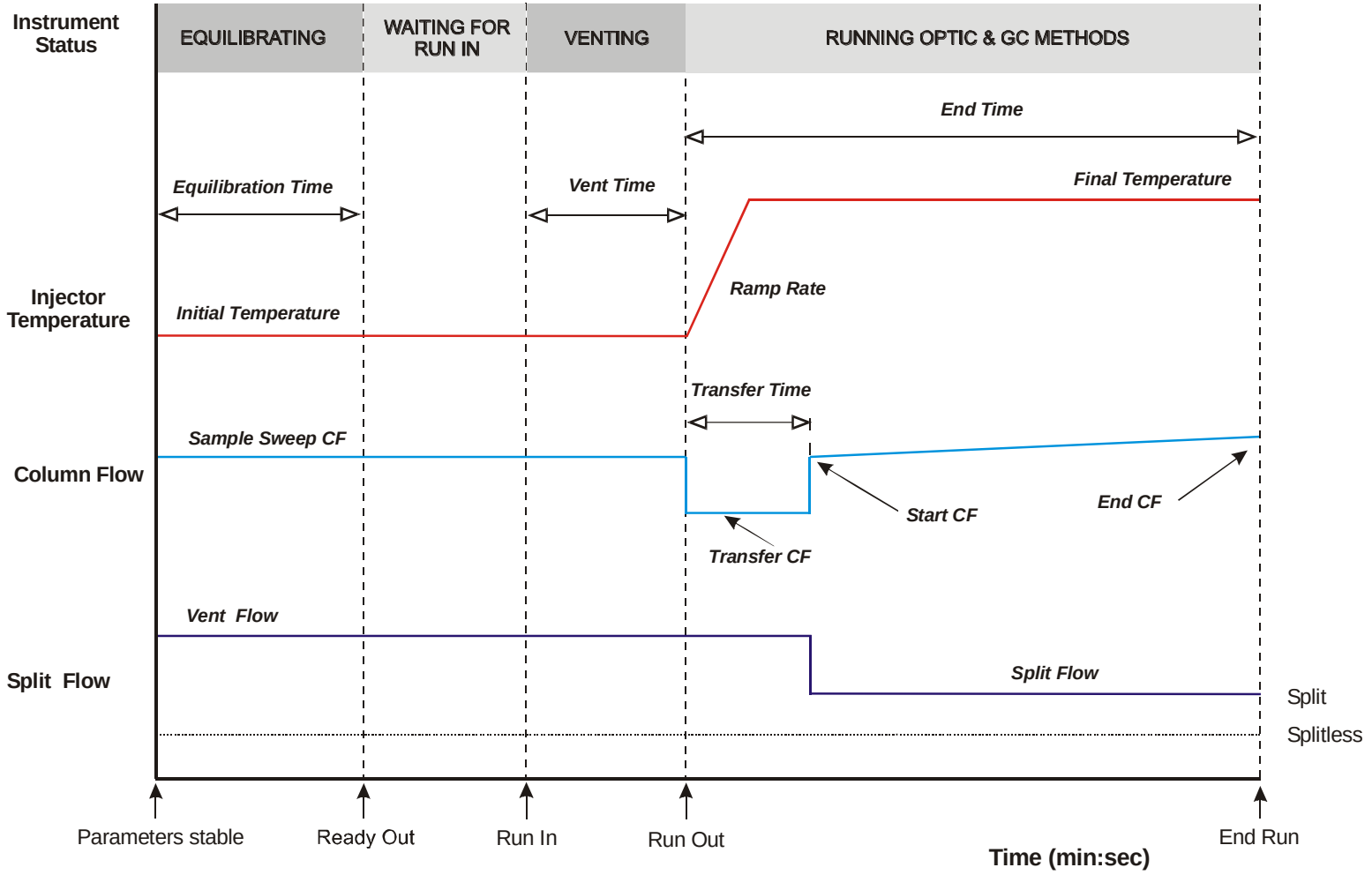
D.2 Splitless method



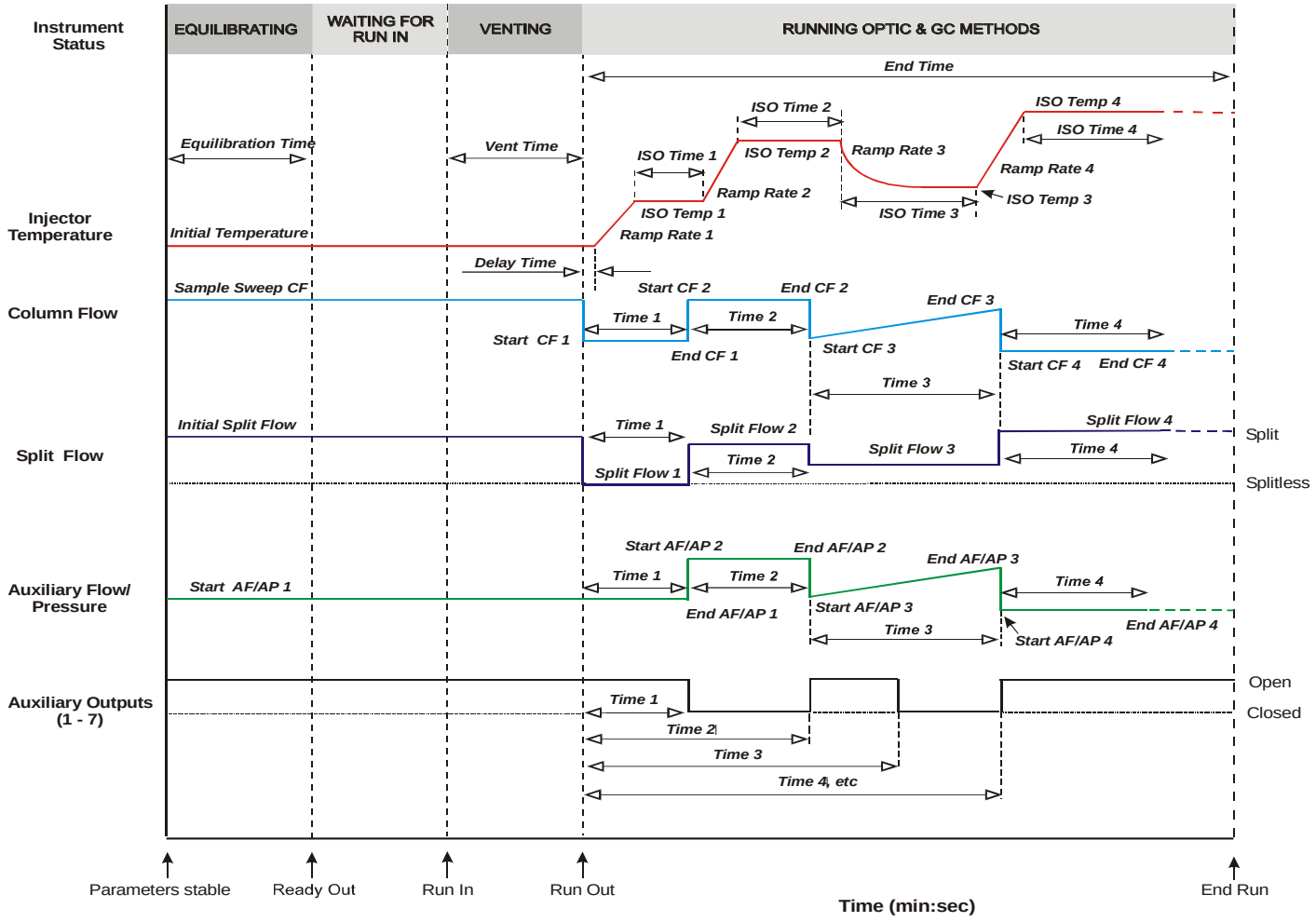
D.3 Large Volume Injection method



D.4 LINEX method

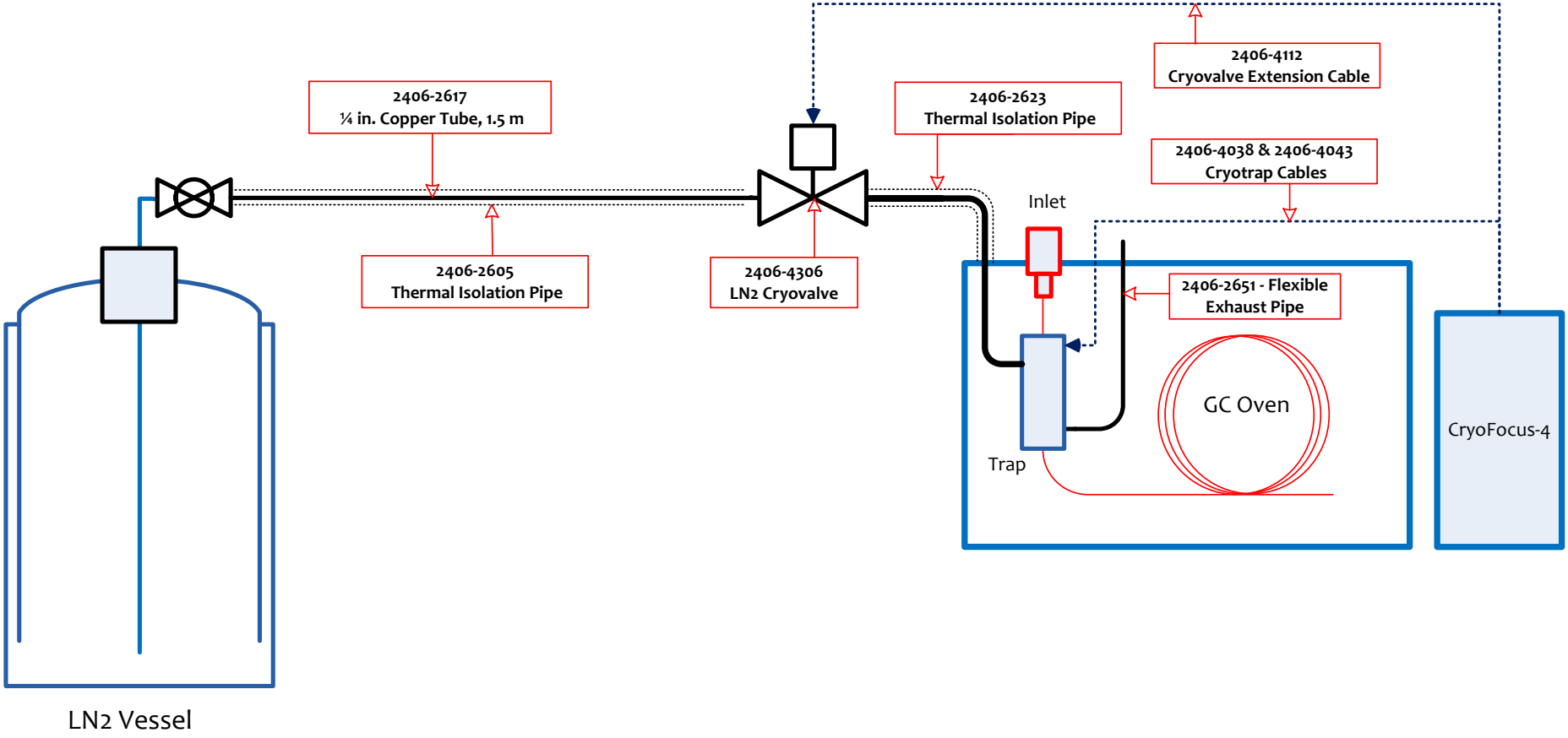


D.5 Expert method

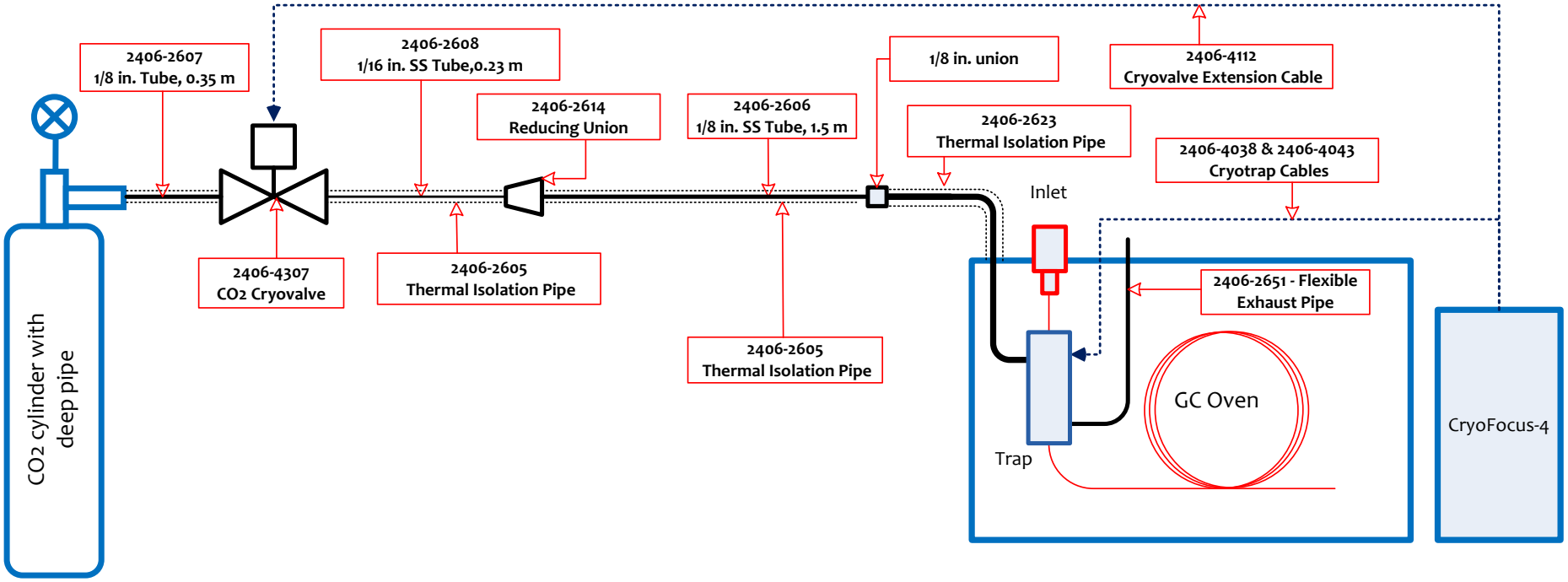


Appendix E: Cryogenic Trap Cooling Line Diagrams

E.1 LN2 Cooling Line Connection Diagram



E.2 CO2 Cooling Line Connection Diagram



Appendix F: Liner Selection Guide

Notes:

1. All the liners are compatible with the OPTIC-2, OPTIC-3 as well as with the OPTIC-4 standard inlets.
2. Deactivation of liners. The following liners can be deactivated using a high pressures silanization process: 2414-1001, 2414-1005, 2414-1007, and 2414-1013. The corresponding part numbers for the silanized liners are: 2414-1002, 2414-1006, 2414-1008, and 2414-1014. Maximum operating temperature for deactivated liner cannot exceed 320°C.

Fritted Liner, Frit at 15 mm, p/no 2414-1001

This liner contains a medium porosity frit made from a sintered glass. It can be used for hot and cold split and splitless injections. In addition, if packed with a suitable packing material, the liner can be used for the large volume injection, thermal desorption, solid sampling and pyrolysis applications. If packed, a bed depth of up to 25 mm can be employed and retained in place with a plug of deactivated glass or quartz wool. Pack size: 5 pieces.

Single-Necked Liner for Split Injections, p/no 2401-1003

This liner is made for hot or cold split injections. The liner's large internal diameter (3.4 mm) facilitates mixing of sample with the carrier gas. The liner may be packed with a glass wool if needed. Pack size: 5 pieces.

Liner for Splitless Injections, p/no 2414-1005

This liner is for hot and cold splitless injection of sample volumes below 1 µl. The narrow internal diameter of 1 mm ensures fast transfer of the sample to the column under splitless conditions. We advise this liner also for SPME techniques. Pack size: 5 pieces.

Baffled Splitless Liner, p/no 2414-1009

This liner is for hot and cold splitless injection of the sample volumes below 1 µl. The narrow internal diameter of 1 mm ensures fast transfer of the sample to the column under splitless conditions. With this liner, the sample is not injected directly to the bottom of the inlet. This liner will give better results for the high boiling components. Pack size: 5 pieces.

Fritted Liner with Single Taper and Frit on 20 mm, p/no 2411-1011,

This liner contains a medium porosity frit made from sintered glass. It can be used for hot and cold split and splitless injections. In addition, if packed with a suitable packing material the liner can be used for the large volume injections, thermal desorption, solid sampling and pyrolysis applications. If packed, a bed depth of up to 20 mm can be employed and retained in place with a plug of deactivated glass or quartz wool. The taper will improve the sensitivity for the active samples. Pack size: 5 pieces.

Liners for Large Volume Injections

These liners have properties that are very well understood. They provide a reliable solution to the majority of the LVI applications. Some liners are packed with proprietary packing materials that were developed for the large volume injections.

Fritted Liner packed with Chromosorb W, p/no 2414-1020

The liner contains a highly-deactivated packing material that combines a maximum operating temperature (320°C) with a high sample capacity (in excess of 100 µl in most cases). This liner has been found to be suitable for the following classes of compounds: PAH's, mineral oils, derivatised acid herbicides, drugs of abuse. Pack size: 5 pieces.

Sintered Glass Liner with Taper, p/no 2414-1007

This liner is both very inert and capable of operation up to 600°C. As such it is suitable for the large volume injection of high molecular weight compounds. The capacity of the liner is lower than that of a packed liner (about 50 µl, depending upon solvent used). To maximize its capacity, the liner should be used in combination with a syringe fitted with a dome tipped, side-hole needle. Pack size: 5 pieces

High Temperature Liner

Quartz Fritted Liner, Frit at 15 mm, p/no 2414-1019

This quartz liner contains a medium porosity frit made from a sintered quartz. The liner is specifically developed for the high temperature applications (> 500 °C) with a prolonged analysis time (>10-15 min) when the use of the standard borosilicate liners can be problematic. Pack size: 5 pieces.

LINEX-DMI Liners

LINEX DMI Liner, p/no 2414-1013

This liner has the small indentations made to hold a sample insert inside. The liner is used for Difficult Matrix Introduction (DMI) in combination with 2406-1010/2406-1020 sample inserts and 2414-1015 needle guide. DMI technique extends the OPTIC capability to the analysis of dirty liquid samples containing non-volatiles and/or solid-like suspended matrix. Row sample or roughly filtered extract placed into a sample insert (p/no 2406-1010 or 2406-1020) that is inserted directly into the liner. DMI Needle Guide (p/no 2414-1015) is used to ensure an accurate sample injection. Pack size: 5 pieces

LINEX DMI Needle Guide Straight, p/no 2414-1015

The needle guide used in combination with 2414-1013. Pack size: 5

OPTIC DMI Sample Insert, 30 µL, p/no 2406-1010

This 30 µL micro-vial is used as a sample container in the DMI technique. It is used in combination with 2414-1013 liner. Pack size: 100

OPTIC DMI Sample Insert, 60 µL, p/no 2406-1020

This 60 µL micro-vial is used as a sample container in the DMI technique. It is used in combination with 2414-1013 liner. Pack size: 100

LINEX-Thermal Desorption Liners

Fritted Liner with Single Taper and Frit at 20 mm, p/no 2414-1011

This liner contains a medium porosity frit made from sintered deactivated glass. It can be used for the LINEX direct (in-inlet) thermal desorption of all kind of solid samples. If packed with a suitable packing material, the liner can be used for thermal desorption of gaseous samples. If packed, a bed depth of up to 25 mm can be employed and retained in place with a plug of deactivated glass or quartz wool. Pack size: 5 pieces

Fritted Liner packed with Tenax GR, mesh 80-100, pk/5, p/no 2414-1021

Fritted Liner packed with Tenax GR, mesh 60-80, pk/5, p/no 2414-1022

Fritted Liner packed with Carbosieve , pk/5, p/no 2414-1023

Fritted Liner packed with Tenax GR and Carboxen, pk/5, p/no 2414-1024

Fritted Liner packed with Tenax TA and Carboxen, pk/5, p/no 2414-1025

Fritted Liner packed with Carbotrap, pk/5, p/no 2414-1026

Fritted Liner packed with Tenax TA, mesh 60-80, pk/5, p/no 2414-1027

Pack size: 5 pieces.

TD Tubes for OPTIC 1/4-inch Version

Thermal Desorption Tube, 1/4 x 3.5 inch, p/no 2414-1100

Pack size: 5 pieces.

TD Tube 1/4 x 3.5 inch packed with Tenax TA 35/60, 150 mg, p/no 1003-74101

TD Tube 1/4 x 3.5 inch packed with Tenax TA 60/80, 150 mg, p/no 1003-74102

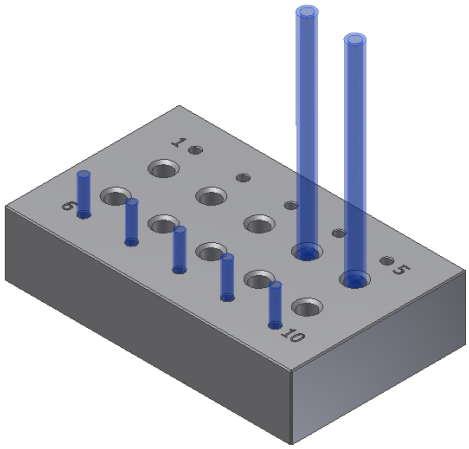
TD Tube 1/4 x 3.5 inch packed with Tenax GR 35/60, 150 mg, p/no 1003-74201

TD Tube 1/4 x 3.5 inch, packed with Carbopack B 190 mg + Carboxen 1000 140 mg, p/no 1003-74301

TD Tube 1/4 x 3.5 inch packed with Carbotrap 50 mg + Carboxen 1000 75 mg, p/no 1003-74302

Pack size: 10 pieces.

DMI Sample Preparation Block



DMI Sample Preparation Block, p/no 2406-2290

The block facilitates the sample preparation handling when using 2406-1010 - OPTIC DMI Sample Insert, 30 µL or 2406-1020 - OPTIC DMI Sample Insert, 60 µL in combination with 2414-1013 - LINEX DMI Liners. It can also be used for other types of the OPTIC liners as well.