Capillary GC Inlet Liner Selection Guide

Four injection techniques – split, splitless, direct, and on-column – are used in capillary gas chromatography. Each of these techniques, and their uses, are described in this guide. Also described are various designs of inlet liners for each injection technique, and injection-associated trouble-shooting tips are presented.

Key Words:
- GC systems
- GC sample delivery
- GC injection techniques
- SPME optimization

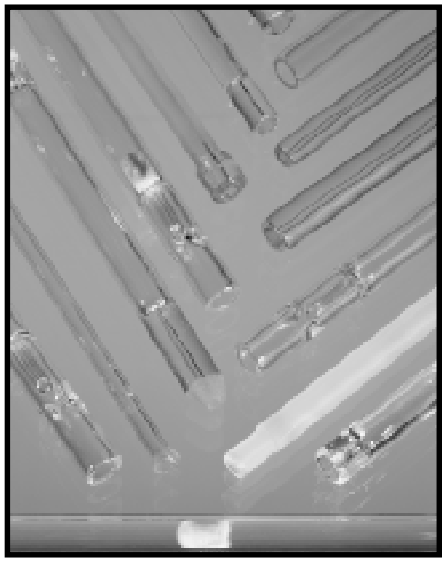
Capillary Injection Techniques

Capillary gas chromatography is an inherently high efficiency chromatographic process, primarily due to the open, narrow internal diameter of the columns used. To take full advantage of this high efficiency, a demanding and robust injection process must be used. There are four primary injection techniques in capillary GC: split, splitless, direct, and on-column injection. These processes differ mechanically and in how they are performed, but all have the same goals: to introduce the sample on to the capillary column in as narrow a band as possible, to effectively use the inherent efficiency of the column, and to ensure that the portion of the sample that reaches the column is representative of what was originally injected into the chromatographic system.

Split, splitless, and direct injection are vaporizing injections. In vaporizing injections, the carrier gas is introduced into the capillary column through the injection port, which typically contains a glass inlet liner inside the heated metal injection block. Within the liner, the injected sample is vaporized, mixed with carrier gas, and transferred to the capillary column.

In on-column injection, the sample is introduced directly into the column inlet, typically as a liquid sample. The sample is vaporized according to the temperature program of the chromatographic process (i.e., by the oven temperature), rather than by the injection port temperature.

In the vaporizing injection techniques, the inlet liner is the point of entry for the sample into the chromatographic process. It is extremely important that the appropriate inlet liner be used — it must provide the injected sample with an inert, efficient path to the capillary column. Both the design and the inertness of the liner affect overall system performance. The liner should have a proper expansion volume, to allow vaporization of the injected liquid sample according to the chosen injection technique. It also should be thoroughly deactivated, and free of contaminants, to minimize adsorption of active sample components. We recommend silanized inlet liners, and we use state-of-the-art silylation



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techniques to deactivate all of the liners we make. Other parts of the injector and detector which come in contact with samples also must be inert and free of contaminants. Additionally, Supelco liners can withstand temperatures of 300°C and higher.

In addition to the inlet liner, a key, and often overlooked, variable in performing the various injection techniques is the insertion distance for introducing the column into the injector body. This distance differs from manufacturer to manufacturer and among the four injection techniques. For successful chromatography, it is critical to follow the instrument manufacturer's recommended column insertion distances.

Split Injection

Split injection is a vaporizing-type injection and is probably the most commonly used injection technique. The technique is designed to reduce the amount of sample reaching the column. It is primarily used with highly concentrated samples, with per component quantities ranging from 0.1-20µg/µL. This technique is used because capillary columns have a very small sample capacity, relative to packed columns. Split injection provides the highest efficiency and resolution of any of the injection techniques used in capillary GC, because high carrier gas velocities are used to transfer the sample to the column. Both split and splitless injection require specialized pneumatics systems designed for use with capillary columns, ie., the so-called split/splitless injector.

In split injection, the sample is injected into a heated injection port and is vaporized in an area of very high carrier gas flow. As the vaporized sample flows through a tortuous path provided by the design of the inlet liner (splitter sleeve), it is mixed with carrier gas.

Because of differences in the carrier gas flow rate to the column and through the split vent, a small portion of the sample is transferred to the capillary column and the bulk of the sample exits through the split vent port. The difference in flows establishes the split ratio. The typical calculation for determining the split ratio and setting a split ratio of 100:1 is:

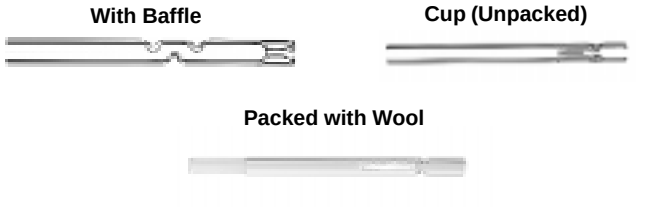
$$\text{Split Ratio} = \frac{\text{column flow + split vent flow + septum purge flow}}{\text{column flow}}$$

$$= \frac{\text{1cc/min + 97cc/min + 2cc/min}}{\text{1cc/min}}$$

$$\text{Split Ratio} = 100:1$$

Because of the very high injector carrier gas flow velocities and rapid transfer of the sample to the column, which are important in providing the high efficiencies for split injection, discrimination can occur in split injection. This occurs when a sample contains components with a very broad molecular weight distribution. Due to slight differences in vaporization rates, the higher molecular weight components require slightly more time to vaporize and thus may not be thoroughly vaporized prior to the split. Another key point of split injection is that since it is a vaporizing-type injection, thermally labile components can break down. It is also important to make the injection as rapidly as possible. If injection is slow, band broadening will occur, reducing some of the inherent efficiency of this injection technique.

Figure A. Typical Inlet Liners for Split Injection



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Inlet Liners for Split Injection

Examples of split injection inlet liners are shown in Figure A. The cup liner is one of the most commonly used designs. Key design features of all split injection liners provide rapid, efficient heat transfer to the sample so it is properly vaporized, and a large-volume sample expansion area followed by a constricted area. In the expansion area, the sample vaporizes and begins to mix with carrier gas. Turbulent flow is established in the constricted area, to aid in mixing the vaporized sample before it reaches the split point and column inlet. Proper mixing ensures that a representative part of the sample enters the column. The design minimizes or prevents nonvolatile sample residue from reaching the column, and the glass is inert to the sample components, to prevent their adsorption or catalytical decomposition.

Baffle Liner — Turbulent flow is created by internal baffles.

Uses:
- General
- Analytes with narrow range of boiling points

Benefits:
- Moderately priced
- Can be cleaned

Disadvantages:
- Nonvolatiles and septum fragments can get into the column
- Inlet discrimination

Fritted Liner — A high surface area and complex flow path through a porous ceramic frit create the turbulent flow needed for sample volatilization.

Uses:
- General

Benefits:
- Minimizes sample discrimination
- Effectively traps particles and nonvolatiles

Disadvantages:
- Expensive
- Ceramic frit can adsorb analytes or contribute to their decomposition
- Cannot be cleaned easily

Cup Liner — Complex flow path enhances volatilization of high molecular weight compounds. Can be packed with wool to trap nonvolatiles.

Uses:
- High analyte concentrations
- High molecular weight analytes
- Large sample volumes (up to 5µL)
- Dual column applications

Benefits:
- Inlet discrimination is minimized
- Design enhances resolution

Disadvantages:
- Expensive
- Hard to clean

Straight Liner Packed with Wool — The large expansion volume and surface area of wool enhance the mixing and vaporization of the sample and trap septum fragments and nonvolatiles in dirty samples.

Uses:
- General and autosampler use
- Use with a wide range of molecular weight analytes

Benefits:
- Easy to use (clean or replace dirty wool)
- Inexpensive

Disadvantages:
- Wool could adsorb analytes or contribute to analyte decomposition

Splitless Injection

Splitless injection is a sample-vaporizing injection technique based on using a split/splitless injection system in the non-splitting mode (i.e., with the split vent closed) for a part of the analysis time. It is used primarily for trace level analysis of sample components and when components elute closely after the solvent peak. Analyses incorporating this injection technique are temperature programmed.

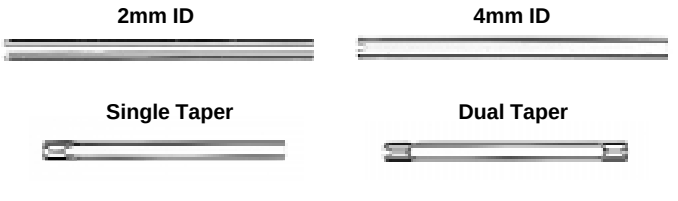
In splitless injection, a large amount of dilute sample is injected into a heated inlet liner, where it is vaporized, and a low flow of carrier gas sweeps most of the vaporized sample into the column. During the injection step in classical splitless injection, the column temperature is kept 10°-20°C below the boiling point of the sample solvent matrix, so that the vaporized sample entering the column recondenses or "focuses" in a tight band at the column inlet. Focusing is critical to a successful analysis. If the sample does not recondense in a tight band in the column inlet, the resulting peak widths will reflect the volume of the injection port rather than the efficiency of the column. After approximately 1.5 to 2 inlet liner volumes of carrier gas have passed through the inlet liner and into the column, the split vent valve is opened and any residual sample remaining in the liner is vented through the split vent port. Timing is important. The internal diameter of the inlet liner, the carrier gas volumetric flow rate, and the sample volume are a few of the key variables in determining the time to open the valve. After a predetermined period of time, the oven temperature is programmed upward, initiating sample component elution through the column. The chromatographic process continues as a typical temperature programmed analysis.

Sample introduction in splitless injection typically is slow, compared to the rapid injections used in split injection. A slow injection is required because the inlet liner volume is limited – a typical 2 or 4mm ID splitless inlet liner (7 to 12cm in length) has an internal volume between 0.2 and 1.5cc. Depending on the amount of sample introduced and the expansion coefficient of the solvent matrix, this internal volume potentially can be overloaded, causing sample to be forced back into the carrier gas lines. Since, under proper conditions, the injected vaporized sample is recondensed as a tight band at the column inlet, the analyst should not see any decrease in column efficiency due to the slower injection process.

Inlet liners for Splitless Injection

A splitless injection inlet liner typically is a simple, straight 2mm or 4mm ID tube (Figure B). Although it has none of the intricate constrictions of sleeves for split injection, the design is important to overall performance. A narrow internal diameter and correspondingly small internal volume are critical to transferring as much sample to the column as possible before opening the split vent. If the internal volume is too large, an excessive purge time will be needed to transfer sufficient sample to the column. The inertness of the liner also is critical. A vaporized sample spends significantly longer time in a splitless injection liner than in a split injection liner, increasing the opportunity for adsorption of active sample components.

Figure B. Typical Inlet Liners for Splitless Injection



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Straight Tube Configuration — Use a small internal volume for slow manual injections and a larger volume for fast autosampler injections. For maximum reproducibility, wool-packed liners are recommended for fast injections. Narrow-bore 0.75mm ID liners can be used for low-volume gas or low-volume headspace injections, or with solid phase microextraction (see next page).

Benefits:

- Inexpensive

Disadvantages:

- Discrimination of high molecular weight compounds
- Decomposition of active compounds
- Sample flashback

Single- & Dual-Tapered Configurations — These inlet liners feature a tapered restriction that helps vaporize the sample in the deactivated glass of the liner. This minimizes breakdown of compounds that are sensitive to the metal inlet surfaces present in some GCs. The single taper can be packed with wool.

Benefits:

- High efficiency
- Reduced breakdown of active compounds
- Less sample flashback than straight liners

Disadvantages:

- Higher cost

Direct Injection

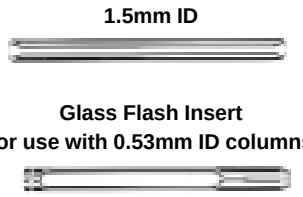
Direct injection is a sample-vaporizing injection technique typically used with packed column gas chromatographs that have been converted for use with wide bore capillary columns (ID ≥ 0.53mm). (For information on the conversion procedure, refer to the Supelco catalog.) The technique is analogous to the flash vaporization injection technique used in packed column GC. Analyses can be either isothermal or temperature programmed. In direct injection, the sample is injected slowly into the heated inlet liner, vaporized, then transported in its entirety to the column. No splitting or specialized pneumatics are required, but a low-flow mass flow controller might be needed to ensure proper control of the low volumetric flow rates typically used with these columns. Since all of the sample is transferred to the column, sample discrimination is eliminated, and direct injection is ideal for quantitative analysis. Thermally labile samples still can be decomposed in this process, however.

In direct injection, it is important to use a slightly reduced injection speed. The inlet liner has a limited volume and, if the liner is overloaded, the vaporizing sample could backflash onto the face of the septum or into the carrier gas inlet lines, and recondense. This will produce broad, tailing peaks, especially for the solvent.

Inlet Liners for Direct Injection

There are several designs for direct injection liners. Key attributes of these liners are that they provide a suitable expansion area for sample vaporization and that they be well deactivated, to minimize sample adsorption or catalytic breakdown. Examples of direct injection liners are shown in Figure C.

Figure C. Typical Inlet Liners for Direct Injection



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Benefits:

- Low cost
- Can be used with isothermal- or temperature-programmed injections
- No specialized pneumatics are required
- No splitter discrimination

Disadvantages:

- Decomposition of thermally labile compounds
- Easy to overload
- Sample flashback
- Can allow column contamination

GC Injection for SPME

Solid phase microextraction (SPME) is a solventless extraction method in which a coated fused silica fiber extracts analytes from a sample. The heated injection port of the GC thermally desorbs analytes from the fiber directly on to the column. Typically, splitless or direct injection is used with SPME. Since no solvent is used and no split is employed in SPME/GC injection, a narrow-bore 0.75mm ID inlet liner can be used.

Replacing the standard 2mm ID splitless liner in the splitless/split GC injection port with a 0.75mm ID liner improves peak shape and height. Reduced volume in this liner increases the linear velocity through the liner and rapidly introduces analytes onto the column in a narrow band. This technique will also improve linearity for lower concentrations of analytes and shorten analysis time. The sharp peaks obtained with the 0.75mm ID liner also demonstrate that the compounds are rapidly desorbed from the fiber.

Inlet Liner for SPME/GC

The main feature of this inlet liner (Figure D) is its narrow-bore internal diameter — as small as 0.75mm. Liners for SPME/GC are deactivated and high-temperature resistant like other liners, but are narrower, to quickly desorb and focus analytes from an SPME fiber directly into a column. These liners also can be used with low-volume gas or low-volume headspace injections.

Figure D. Inlet Liner for SPME/GC

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Benefits:

- Low cost
- No band broadening
- Sharper peaks without cryofocusing
- No inlet discrimination

Disadvantages:

- None

On-Column Injection

In cold (or cool) on-column injection the liquid sample is directly deposited at the inlet of the column. The analysis must be temperature programmed — the oven temperature vaporizes the sample components and begins the elution process. A specialized injection system and a syringe with a narrow OD needle are required to introduce the sample onto a narrow bore column (ID $\leq$ 0.32mm). A special liner is required to guide the needle onto a 0.53mm ID column, and a standard 26-gauge needle can be used.

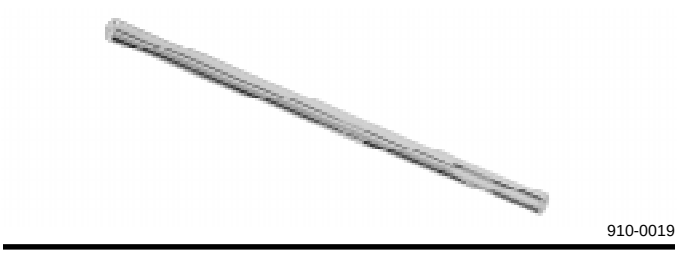
Because this is a nonvaporizing injection technique, and all sample components are quantitatively deposited directly onto the column, cold on-column injection is ideal for use with thermally labile analytes and provides the best results in quantitative analyses. It is important to inject the sample slowly, to eliminate the potential for aerosol formation which would broaden peaks and counterbalance some of the efficiency of the column. Secondary cooling of the entire column, or of a short section of the column inlet, also can be used to aid in condensing the injected sample into a tight band at the column inlet.

Inlet liners for Cold On-Column Injection

Figure E shows an example of a cold on-column inlet liner for use with 0.53mm ID capillary columns. The key attribute of this liner is the elongated, tapered region where the end of the column is seated to seal it to the injector. This section of the liner helps guide the needle into the column. A flare or chamfer at the liner's inlet helps guide the needle into the liner.

By incorporating the tapered seal of the column within the heated zone of a converted packed column injection port, versions of this liner can be used for hot on-column injection onto a 0.53mm ID column. This technique differs from cool on-column injection in that the sample is deposited in the column within the heated injector zone, rather than in the oven.

Figure E. Inlet Liner for Cold On-Column Injection



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Uses:

- Thermally labile compound analysis

Benefits:

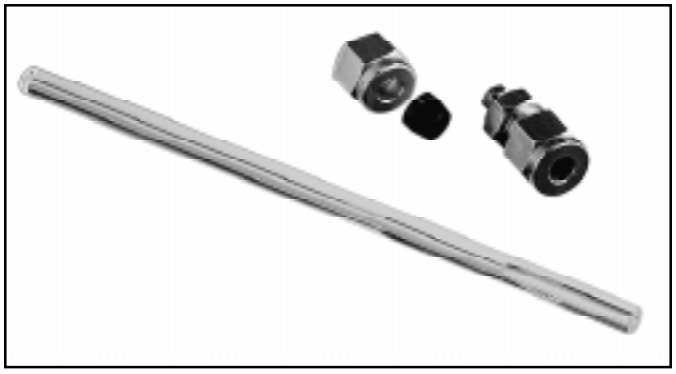
- High analytical precision

Disadvantages:

- Band broadening
- Column overload
- Potential column contamination (should not be used with dirty samples or samples containing nonvolatiles)

Cool On-Column Injection Liner Kit

The Cool On-Column liner was designed for use with 0.53mm ID fused silica columns, but can be used with a 0.75mm ID glass column if the column is attached to a 0.53mm ID fused silica line. A syringe with a 6" (15.24cm) needle is required to deposit samples properly within the sleeve.



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Description	Cat. No.
Cool On-Column Injection Sleeve Kit (injection sleeve plus connecting hardware)	**23630**
Cool On-Column Injection Sleeve	**20476**
Replacement Reducing Union	**23633**
Replacement Male Nuts, 1/16", pk. of 4	**23805**
Knurled Male Nuts, Pk. of 2	**23812**
Hamilton® 701N Syringe, 6"/15.24cm fixed needle	**21574**

Care and Maintenance of Inlet Liners

With use, inlet liners become contaminated. Samples passing through the liner leave behind nonvolatile components, such as salts, derivatizing reagents, and high molecular weight compounds. As these residues accumulate in the liner, they affect chromatography by adsorbing sample components of interest to the analyst. Adsorption manifests as poor peak shape, reduced peak height and, sometimes, "extra" peaks in the chromatogram. **To eliminate the possibility of contaminants interfering with the chromatography, inlet liners should be routinely inspected and replaced or cleaned.** Replacement frequency depends on the sample matrix and the number of samples analyzed. Cracked or chipped liners also should be replaced.

Generally, capillary inlet liners are considered consumables. In an emergency, when an inlet liner becomes contaminated and a replacement is not available, acceptable levels of performance often can be obtained by cleaning and deactivating the contaminated liner. Always handle inlet liners carefully, with clean gloves or forceps, to prevent contamination by oils or other materials on your fingers. Allow the injector to cool, then remove the liner and examine it. If it contains ferrule, septum, or column fragments, use a stream of *clean,* compressed gas to blow these particulate contaminants out. (Note: Gas from house compressed air lines usually contains trace amounts of oils which can contaminate the liner and worsen the problem.) A pipe cleaner or fine brush sometimes can be used to dislodge fragments stuck to the liner wall, if the configuration will allow this.

Nonparticulate sample residue must be removed by rinsing the liner with methylene chloride or acetone, then drying it with clean compressed gas. An extremely dirty liner may require the use of a laboratory glass detergent or mineral acid. After such treatment, the liner must be thoroughly rinsed, dried, and re-deactivated. To restore an acceptable level of performance via this process takes time and experience, and the cost of effort and materials should be evaluated against the cost of simply replacing the liner. Some inlet liners, such as cup splitters and fritted designs, may be difficult or impossible to restore without special equipment and/or techniques.

For additional help with troubleshooting capillary GC systems, request free Bulletin 853 (*Capillary Troubleshooting Guide*). Ask for publication 112853.

For more information on the effect of inlet liners on SPME/GC, request Application Note 136 (Publication 397136).

We can custom prepare inlet sleeves to your specifications. Call our Ordering and Customer Service Department for a quote.

911-0250

Trademarks

Chromosorb — Celite Corp.
Hamilton — Hamilton Co.
OV — Ohio Valley Specialty Chemical Co.
SUPELCOPORT — Sigma-Aldrich Co.

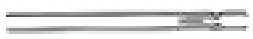
Supelco inlet liners feature:

- High temperature silanization, to ensure inertness
- Consistent dimensions, tolerances and quality
- In-house manufacturing that meets or exceeds instrument manufacturer's specifications

These liners provide an exceptional value:

Save 20% on a pack of 5
Save 35% on a pack of 25

We can also manufacture replacement liners for other instruments or unique liners from your own design. Just call for a quote.

Mfr./ Inj. Type	Length x OD x ID• (mm, unless otherwise noted)	Applications	Mfr. Part #	Qty.	Cat. No.
Finnigan	**Models 4100 & 5100 (See HP liners for Model 9001)**				
Split	For Model 5100  87 x 6.6 x 4	High & low MW analytes	1005-40040	1 5 25	**26340,01** **26340,05** **26340,25**
Splitless	For Model 5100  87 x 6.6 x 2	Trace analytes	10005-40030	1 5 25	**26341,01** **26341,05** **26341,25**
	For Model 4100 112 x 4.5 x 3	Trace analytes	96100-20330	1 5 25	**26342,01** **26342,05** **26342,25**
Fisons/ Carlo Erba	**Model 6000 Series**				
Splitless	HS glass  79.5 x 5.5 x 2	Trace analytes	45300300	1 5 25	**26320,01** **26320,05** **26320,25**
	HS glass  79.5 x 5.5 x 4	Trace analytes	45300400	1 5 25	**26321,01** **26321,05** **26321,25**
	 99 x 5.5 x 4 (with slot)	High & low MW analytes	45320010	1 5 25	**26323,01** **26323,05** **26323,25**
	 99 x 5.5 x 1.8 (with slot)	Trace analytes	45320020	1 5 25	**26324,01** **26324,05** **26324,25**
Hewlett-Packard	**Models 5880, 5980 Series, 6890, and Finnigan Model 9001**				
Split	Cup (unpacked)  78.5 x 6.3	High & low MW analytes	18740-80190	1 5 25	**20510,01** **20510,05** **20510,25**
	Cup (wool packed)  78.5 x 6.3	Dirty samples	18740-80190▲	1 5 25	**20482,01** **20482,05** **20482,25**

▲Supelco version has been modified to enhance performance. • Liners not shown to scale.

913-0259, 0255, 0244, 0271, 0268, 0274, 0242, 0260, 0250

Mfr./ Inj. Type	Length x OD x ID• (mm, unless otherwise noted)	Applications	Mfr. Part #	Qty.	Cat. No.
Hewlett-Packard (contd.)					
Split	Cup (packed w/ 10% OV®-1 on Chromosorb®-W HP)  78.5 x 6.3	Dirty samples Traps non-volatiles Decreases discrimination	18740-60840	1 5 25	**20551,01** **20551,05** **20551,25**
	Split/splitless  78.5 x 6.3 x 4 (wool packed)	General For 7673 autosampler	19251-60540	1 5 25	**20486,01** **20486,05** **20486,25**
Spitless	 78.5 x 6.5 x 2	Trace analytes Samples <2µL	18740-80220■ 5181-8818	1 5 25	**20513,01** **20513,05** **20513,25**
	Dual-tapered  78.5 x 6.5	Active analytes in trace quantities	5181-3315	1 5 25	**20485,01** **20485,05** **20485,25**
	Tapered (unpacked)  78.5 x 6.5	Active analytes in trace quantities	5181-3316	1 5 25	**20466,01** **20466,05** **20466,25**
	Tapered (wool packed)  78.5 x 6.5	General For 7673 autosampler	5062-3587	1 5 25	**20478,01** **20478,05** **20478,25**
Direct/SPME	 78.5 x 6.3 x 0.75	SPME Small volume	no equivalent	1 5 25	**26375,01** **26375,05** **26375,25**
	 78.5 x 6.5 x 1.5	Headspace & purge/trap devices	18740-80200	1 5 25	**20517,01** **20517,05** **20517,25**
Perkin-Elmer	**Models 2000, 8000**				
Split	wide bore  100 x 5 x 4	General purpose Dirty samples	0330-5181	1 5 25	**26303,01** **26303,05** **26303,25**
Splitless	narrow bore  100 x 5 x 2	Trace analytes	0330-5180	1 5 25	**26304,01** **26304,05** **26304,25**
PTV Injection	Glass (unpacked) 88 x 2	For high linearity	N600-2017	1 5 25	**26306,01** **26306,05** **26306,25**

■ Instrument manufacturer's nondeactivated part number. •Liners not shown to scale.

913-0258, 0256, 0245, 0267, 0261, 0262, 994-0284, 0245, 0254, 0247, 0272

Mfr./ Inj. Type	Length x OD x ID• (mm, unless otherwise noted)	Applications	Mfr. Part #	Qty.	Cat. No.
Perkin Elmer (contd.)					
PTV Injection	Glass (wool packed) 88 x 2	For high linearity Dirty samples	N600-2096	1 5 25	**26307,01** **26307,05** **26307,25**
	Quartz (unpacked) 88 x 2	For high linearity	N600-2036	1 5 25	**26308,01** **26308,05** **26308,25**
	Auto System, Model 9000 Split/Splitless Capillary Injector				
Split	 92 x 0.25" x 4	General purpose	N610-1052 N612-1001*	1 5 25	**26309,01** **26309,05** **26309,25**
	Packed (deactivated glass wool)  92 x 0.25" x 4	General purpose Dirty samples		1 5 25	**26310,01** **26310,05** **26310,25**
Splitless/SPME	 92 x 0.25" x 2	Trace analysis	N610-1372 N612-1002*	1 5 25	**26311,01** **26311,05** **26311,25**
	 92 x 0.75 ID	SPME		1 5 24	**26312,01** **26312,05** **26312,25**
	Programmed Split/Splitless Injection (PSS)				
Split	 86 x 4 x 2	General purpose for temperature programmed analyses	N612-1004*	1 5 25	**26313,01** **26313,05** **26313,25**
Splitless	 86 x 4 x 1	Trace analysis	N612-1006*	1 5 25	**26314,01** **26314,05** **26314,25**
On - Column	 86 x 4 OD	Thermolabile analytes Trace analysis	N610-1539	1 5 25	**26315,01** **26315,05** **26315,25**
Shimadzu	**Models 9A/AM/15A/16 with SPL-G9/15 Injectors**				
Split	 127 x 5 ID	High & low MW analytes	221-25822-01	1 5 25	**26330,01** **26330,05** **26330,25**

*Quantity available as made-to-order. •Liners not shown to scale.

913-0282, 0243, 997-0125, 0126, 0116, 0117, 0121, 0118, 0119, 913-0253

Mfr./ Inj. Type	Length x OD x ID• (mm, unless otherwise noted)	Applications	Mfr. Part #	Qty.	Cat. No.
Shimadzu (contd.)					
Splitless/SPME	 127 x 5 ID	Trace analytes	221-25440-03	1 5 25	**26331,01** **26331,05** **26331,25**
	 127 x 0.75 ID		SPME	1 5 25	**26329,01** **26329,05** **26329,25**
	Models 14/15A/16 with SPL-14 Injectors				
Split	 99 x 5 ID	General purpose	221-32544-01	1 5 25	**26333,01** **26333,05** **26333,25**
Splitless/SPME	 99 x 5 ID	Trace analytes	221-32544-00	1 5 25	**26334,01** **26334,05** **26334,25**
	99 x 5 x 0.75	SPME		1 5 25	**26335,01** **26335,05** **26335,25**
	Model 17A with SPL-17 Injectors				
Split	 95 x 5 ID	General purpose	221-41444-00	1 5 25	**26336,01** **26336,05** **26336,25**
	Packed (deactivated glass wool)	Dirty samples		1 5 25	**26327,01** **26327,05** **26327,25**
Splitless/SPME	 95 x 5 ID	Trace analytes	221-41544-00	1 5 25	**26337,01** **26337,05** **26337,25**
	95 x 5 x 0.75	SPME		1 5 25	**26339,01** **26339,05** **26339,25**
Wide-bore capillary	Internal taper 95 x 5 ID	Wide bore capillary columns	221-41599	1 5 25	**26338,01** **26338,05** **26338,25**

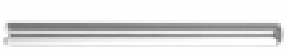
•Liners not shown to scale.

913-0239, 997-0113, 0122, 0112, 0110, 0114, 0111, 0130, 0115

Mfr./ Inj. Type	Length x OD x ID• (mm, unless otherwise noted)	Applications	Mfr. Part #	Qty.	Cat. No.
Tremetrics					
Split	 102 x 6 x 4	High & low MW analytes	116850-0001	1 5 25	**26354,01** **26354,05** **26354,25**
	 70 x 6 x 4	High & low MW analytes	118075-0001	1 5 25	**26351,01** **26351,05** **26351,25**
Splitless	 84 x 6 x 2	Trace analytes	116850-0003	1 5 25	**26352,01** **26352,05** **26352,25**
	 84 x 6 x 4	Trace analytes	116850-0004	1 5 25	**26353,01** **26353,05** **26353,25**
	 70 x 6 x 2	Trace analytes	118075-0002	1 5 25	**26350,01** **26350,05** **26350,25**
Varian	**1075/1077 Injectors**				
Split	Unpacked  72 x 6.3	High & low MW analytes	16-000830-00■	1 5 25	**26361,01** **26361,05** **26361,25**
	with frit  72 x 6.3	Dirty samples	16-000830-01■ 01-900109-03	1 5 25	**20505,01** **20505,05** **20505,25**
	Wool packed  72 x 6.3	Dirty samples	01-900109-01	1 5 25	**26360,01** **26360,05** **26360,25**
Split	Packed w/ 10% OV-101 on Chromosorb W HP 80/100  72 x 6.3 OD	Complete vaporization	03-949809-00■	1 5 25	**20555,01** **20555,05** **20555,25**
	with baffle  72 x 6.3 OD	Analytes with close boiling points	16-000829-00■ 01-900109-04	1 5 25	**20501,01** **20501,05** **20501,25**

•Liners not shown to scale.

913-0270, 0279, 0278, 0263, 0277, 0273, 0240, 0257, 0248, 0241

Mfr./ Inj. Type	Length x OD x ID• (mm, unless otherwise noted)	Applications	Mfr. Part #	Qty.	Cat. No.
Varian (contd.)					
Split	Cup (unpacked)  72 x 6.3 OD	High & low MW analytes	01-900109-02	1 5 25	**20498,01** **20498,05** **20498,25**
Splitless/ SPME	 74 x 6.3 OD	Trace analytes	03-949437-90■ 01-900109-05	1 5 25	**20502,01** **20502,05** **20502,25**
	 74 x 6.35 x 0.75	SPME Small volume	no equivalent	1 5 25	**26358,01** **26358,05** **26358,25**
Direct	Fused silica  72 x 6.3 OD	High linearity (0.25/0.32mm ID columns)	03-908725-00	1 5 25	**26362,01** **26362,05** **26362,25**
	Model 1061 Universal Flash Injector				
On - Column	Glass flash inserts  73 x 0.25" OD	For 0.53mm ID columns	03-918339-00	1 5 25	**26368,01** **26368,05** **26368,25**
	1095/96/97 Temperature Programmable Injectors				
On - Column	Glass column guide (Series 3000)  64.4 x 4.5 OD	Trace analytes Dirty samples	03-917310-00	1 5 25	**26366,01** **26366,05** **26366,25**
	Glass column guide  18.6 x 0.25" OD	Trace analytes Dirty samples	03-908701-00	1 5 25	**26367,01** **26367,05** **26367,25**
	1093-94 SPI Injector				
Direct/SPME	Glass insert (high performance)  54 x 4.6 OD	For 0.25 & 0.32mm ID columns High linearity, SPME Small volume	03-918332-01■ 01-900109-06 01-900066-18	1 5 25	**26363,01** **26363,05** **26363,25**
	Flash & on-column insert  54 x 4.6 OD	High linearity SPME For 0.53mm ID columns	03-918332-02■ 01-900109-07 01-900066-19	1 5 25	**26364,01** **26364,05** **26364,25**
	Glass insert (wool packed)  54 x 4.6 OD	Dirty samples	03-918332-03■ 01-900109-08	1 5 25	**26365,01** **26365,05** **26365,25**

•Liners not shown to scale.

994-0277, 913-0238, 994-0276, 913-0264, 0276, 0269, 0280, 0275, 0249, 0252

Mfr./ Inj. Type	Length x OD x ID• (mm, unless otherwise noted)	Applications	Mfr. Part #	Qty.	Cat. No.
Varian (contd.)	**1078/1079 Injector**				
Split	Frit  54 x 5 x 3.4	Instantaneous sample vaporization	03-918464-01	1 5 25	**26372,01** **26372,05** **26372,25**
	Unpacked  54 x 5 x 3.4	General use Can be packed according to need	03-918464-00	1 5 25	**26371,01** **26371,05** **26371,25**
	Packed  54 x 5 x 3.4	Dirty samples with broad molecular ranges	03-918956-00	1 5 25	**26373,01** **26373,05** **26373,25**
Splitless/SPME	Packed  54 x 5 x 2	Minimizes dead volume	03-918466-00	1 5 25	**26374,01** **26374,05** **26374,25**
	 54 x 5 x 0.8	SPME	03-925330-00	1 5 25	**26378,01** **26378,05** **26378,25**
Splitless Temperature Ramp Mode	 54 x 5 x 0.5	Trace analytes Thermolabile and polar compounds	03-925331-00	1 5 25	**26376,01** **26376,05** **26376,25**
	Packed (deactivated glass wool)  54 x 5 x 2	Nonpolar compounds	03-925350-00	1 5 25	**26377,01** **26377,05** **26377,25**
ATAS OPTIC 2 High Volume Injector					
	Packed (60/80 SUPELCOPORT™) 80 x 5 x 3	Large volume injections		1 5 25	**26325,01** **26325,05** **26325,25**
	Unpacked with single frit  80 x 5 x 3	Large volume injections		1 5 25	**26326,01** **26326,05** **26326,25**

•Liners not shown to scale.

997-0134, 0133, 0146, 0132, 0131, 0135, 0144, 0127, 0120

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