

**Agilent GC/MS/MS
Pesticides and
Environmental Pollutants
(P&EP) Analyzer**

User Manual



Agilent Technologies

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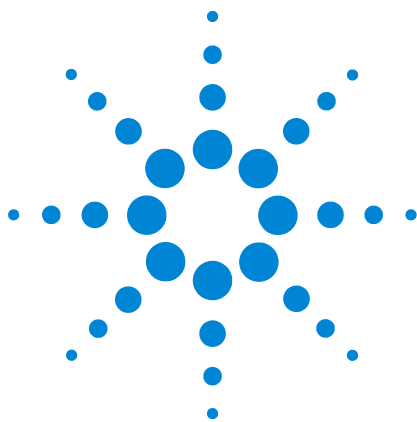
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1 Introduction

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Analyzer Configurations

Identifying and quantifying dozens (or hundreds) of pesticides or organic pollutants in a wide range of fruit, vegetable, or environmental samples is a complex task. The Agilent GC/MS/MS Analyzer is a complete system that is factory configured and chemically tested to quickly identify a broad range of commonly analyzed pesticide and pollutant residues with ultimate sensitivity. The Analyzer comes with a Multiple Reaction Monitoring (MRM) database (p/n G9250AA, rev. A.1.01) that includes information for over 1000 pesticides and organic pollutants.

The Analyzer is configured with Agilent's proprietary Capillary Flow Technology, to provide rugged, reliable GC column backflushing. Backflushing the GC column shortens run times, extends column life, reduces chemical background noise, provides consistent retention times and spectra, and helps keep the MS ionization source clean. A Multi-Mode Inlet (MMI) provides the flexibility to inject samples in cold, hot, or solvent-vent modes allowing operators to optimize injection volumes to maximize mass on column.

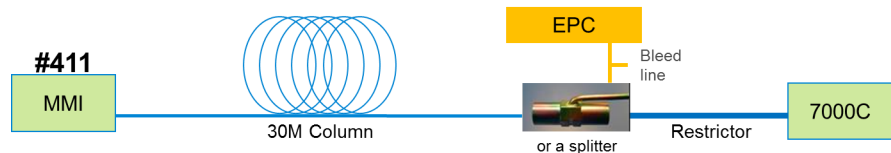
NOTE

A split/splitless UI inlet option is available for laboratories that do not require maximal limit of detection (LOD) performance (Option #114).

Each Analyzer system is tested using a 17-compound mixture and retention times for analysis locked at the factory.

Four hardware configurations are available:

G3445B-#411: Flexible Constant Pressure (CP) method: 40-min run, 30 m column x 0.5 m restrictor, post column backflush.

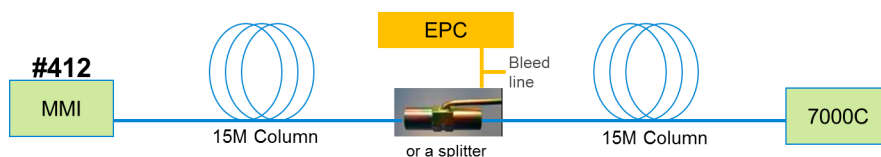


G3445B-#415: Fast CP method: 20-min run, 15 m column x 0.5 m restrictor, post column backflush.

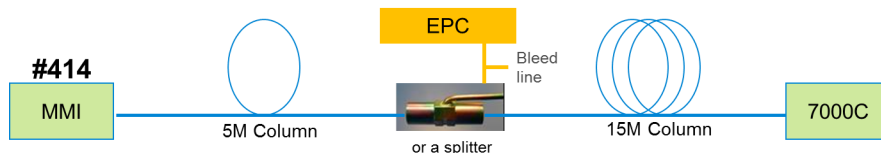


G3445B-#412: Fast Constant Flow (CF) method: 20-min run, 15 m column x 15 m column, mid column backflush.

Full screening CF method: 40-min run, 15 m column x 15 m column, mid-column backflush.



G3445B-#414: Selective CF method: 20-min, 5 m column x 15 m column, mid column backflush.



NOTE

Notes for Analyzer option # 414:

The #414 option is configured with a 240 V GC oven to allow for the rapid temperature rates in the oven and inlet programs).

Add an additional 2 minutes hold time to extend the GC analytical run for late eluters (i.e. Imibenconazol, Cinidon-ethyl, Propaquizafof, Temephos, and Fluthiacet-methyl).

The 2-mm dimpled liner (p/n 5190-2297) aids in minimizing column contamination due to non-volatile matrix deposits being retained on the dimples of the liner.

Your Analyzer was configured and checked at the factory to ensure that your system is ready to run samples of value to your operation immediately after installation in your lab. The factory test results for your Analyzer can be found on the Specials Factory Information CD/DVD that shipped with your instrument.

Where to Find More Information about Using your Pesticide Analyzer

MRM Database DVD (G9250AA)

The Pesticides and Environmental Pollutants MRM Database (G9250AA rev. A.1.01) now incorporates a new User Interface to provide a more streamlined approach to building a customizable Target List. From this list, the user interface then uses the information selected from the Database to develop an MRM acquisition method or MRM quantitation method.

This exclusive 1074-compound MRM Database is included with your Analyzer as a separate DVD. The Database DVD also includes a few different documents and guides that outline the utility and operation of the Database.

The G9250AA Rev. A.1.01 User Manual (G9250AA-90000.pdf) provides a tutorial of the new User Interface (see [Figure 1](#) on page 9) that includes the following functions:

- Building a Target Compound List
- Developing an MRM Table
- Exporting the MRM data to the CLA for acquisition optimization
- Developing a Quant Method
- Previous Functionality of the database

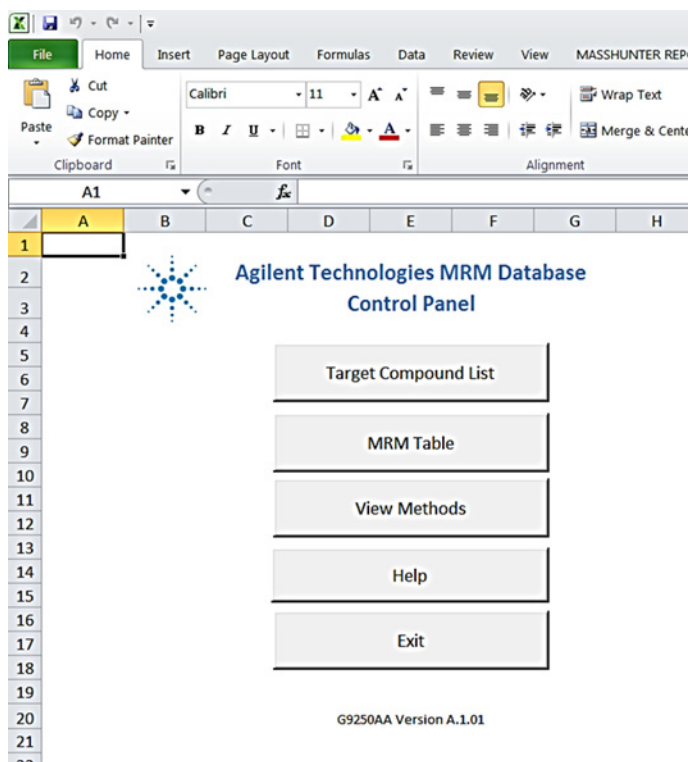


Figure 1 The P&EP MRM Database new User Interface Home Screen Control Panel

Application Notes and publications

You can find more information about pesticide analysis in the application notes and publications included with your Specials Factory Information CD ROM.

Alternatively, visit: <http://www.chem.agilent.com/> and select the “Literature Library” under the Quick Links.

QuEChERS extraction procedures and ready-to-use kits

The QuEChERS extraction procedure for pesticide residues in fruits and vegetables is being used by labs around the world. For a training video, references, and ready-to-use kits for performing QuEChERS extractions, go to the following Agilent web site:

<http://quechersselectiontool.chem.agilent.com/>

Alternatively, visit: <http://www.chem.agilent.com/> and type QuEChERS into the search field.

What's on the Specials Factory Information CD ROM

Your Pesticide Analyzer comes with a CD that contains the following information specific to your Analyzer Configuration:

Analytical methods

- The GC/MS/MS checkout methods:
 - 411_checkout_PCSL.M
 - 412_checkout_PCSL.M
 - 414_checkout_SV.M
 - 415_checkout_PCSL.M

(These methods are either a pulsed-cold-splitless or a solvent-vent MRM method with 17 analytes and is retention time locked at the factory.)

NOTE

Another GC/MS/MS method is included as a reference (415_checkout_HSL.m). This is a hot-splitless MRM method with 17 analytes and is NOT retention time locked at the factory.

- The GC/MS/MS general pesticide analysis methods:
 - Pulsed_cold_splitless.M
 - Hot_splitless.M
 - 414_SV.M
 - 415_PCSL.M or 415_HSL.M

NOTE

If you do not have a MultiMode Inlet (MMI) installed, you should use the hot-splitless method (Hot_splitless.m) instead of the pulsed-cold-splitless method for the inert split/splitless inlet.

- The signal-to-noise data analysis methods:
 - 411_signal-to-noise.M
 - 412_signal-to-noise.M
 - 414_signal-to-noise.M
 - 415_signal-to-noise.M

Copy the Factory Methods and Test Results to the Hard Drive **D:\MassHunter\GCMS\1\ Method.**

NOTE

Edit the Msdchem.ini file in the **C:\GCMS\msexe** folder to show, for example: `_METHFILES=411_checkout_PCSL.m`, so this method will be loaded as you bring up the 7000 acquisition software, without going through Method Resolution.

NOTE

The qqqacqmethod.xml file in each method folder has all the MRM transitions for the method.

Data files and reports

- Checkout sample data files:
 - 411_checkout_PCSL_1 μ L.D
 - 412_checkout_PCSL_1 μ L.D
 - 414_checkout_SV_1 μ L.D
 - 415_checkout_PCSL_1 μ L.D

Copy the checkout data file from the Specials Factory Information CD ROM to **D:\MassHunter\GCMS\1\Data**.

- Report, QuantReport_ESTD_ResultsSummary.xlsx, obtained at the factory for a 1- μ L injection of the 100 ppb GC/MS/MS Analyzer Checkout Sample (p/n 5190-0494)

Reference materials

- Agilent Application Notes that discuss pesticide analysis
- A copy of this User Manual
- Corresponding technical guides and tutorials
- A list of target pesticides (G9250AA_pesticide_MRM_database_compound_list.pdf)

MRM database and Excel spreadsheet

- The G9250AA (rev. A.1.01) Pesticides and Environmental Pollutants MRM database
- The Excel spreadsheet (RT_locking_calculator.xlsx) for calculating the proper inlet flow to relock the Chlorpyrifos Methyl peak for the method of choice is still included for optional use

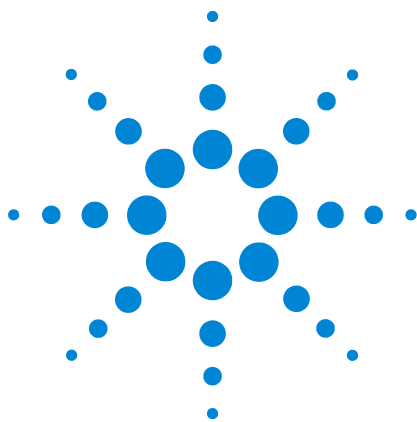
See Also

Document files:

- MRM Database G9250AA Rev. A.1.01 Help file:
G9250AA_Help.pdf
- MRM Database G9250AA Rev. A.1.01 ReadMe file:
G9250AA_ReadMe.pdf
- MRM Database G9250AA Rev. A.1.01 Quick Start Guide:
G9250-90010.pdf
- MRM Database G9250AA Rev. A.1.01 User Manual:
G9250-90000.pdf
- The Pesticides and Environmental Pollutants (P&EP)
GC/MS/MS 3.0 Application Note: 5991-4419EN.pdf

Tutorial video:

Adding Compounds (Adding Compounds.MP4; located on G2950AA MRM Database DVD)



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Relocking the Data Acquisition Method

Mass Hunter GC-MS Acquisition software Rev. B.07.00 SP2, or later, can perform the automated Retention Time Locking (RTL) calibration for constant flow methods.

With the release of the P&EP 3.0, the automated Retention Time Locking (RTL) calibration process includes both RT Locking for both constant pressure (CP) and constant flow (CF) methods.

NOTE

The RT_locking_calculator.xlsx is being supplied with the Analyzer CD/DVD for informative purposes only. The calculator spreadsheet does not need to be used for relocking the method and has not been used during the instrument checkout in the factory.

Relocking

Following replacement or trimming of the GC column, Agilent recommends that you relock you analyzer method to eliminate the need for time segment adjustments in your acquisition method.

- 1 To relock a method, select **Relock Method...** from the GC/MS/MS data acquisition **Method** menu and enter the required information to start a run. The target retention time for the Chlorpyrifos Methyl peak is 16.593, 9.143, 8.524, or 8.297 minute. See [Table 1](#) on page 17 for corresponding methods and retention times.
- 2 Follow the steps to obtain the lock pressure/flow.
- 3 Enter the lock pressure/flow from the above relocking process into your acquisition methods.
- 4 Save the method with the new locked pressure/flow.

NOTE

The use of RT_locking_calculator.xlsx is not needed with current GC/MS Acquisition software; but it is still supplied for informative purposes. If used:

- 1 Obtain the RTLOCK data files in Method (.M) folder.
- 2 Write down the retention times and pressures/flows of Chlorpyrifos Methyl (transition ion(s) 208,93).
- 3 Record the retention time and pressure/flow of data file that was just obtained. (For the flow calculations, use Column 1 to set the RTs).
- 4 Enter the recorded values into their respected cells in the calculator. (Note: make sure the “Desired Locking RT” is accurate for the method of choice; see [Table 1](#) on page 17.)
- 5 Enter the calculated locking RT pressure/flow into the Method for column 1. (Note: for a constant flow method, the column 2 flow setting = column 1 + 0.2 mL/min)

Auto Retention Time Locking (RTL)

This Analyzer’s Chromatographic analysis is retention time locked at the factory.

The retention time of the Analyzer can be automatically locked using either a full-scan method or an MRM method.

To lock a method, select **Acquire RTLock Calibration Data...** from the GC/MS/MS data acquisition **Method** menu.

The system will automatically make 5 injections with varying inlet pressures or flows to change the retention time of a locking compound.

If you are using an MRM method, make sure the locking compound transitions are in all the time segments where the peak will show up due to the adjustment of inlet pressure or flow.

Specify acquired ion(s) from scan (125,286) or MRM (208,93) in the RTL process if the locking compound is Chlorpyrifos Methyl.

Running the Checkout Sample

At the factory, your system was chemically tested by making 1- μ L injections of a 100 ppb 17 compound checkout standard. The Specials Factory Information CD ROM contains a copy of the exact method used during factory checkout:

- 411_checkout_PCSL.M
- 412_checkout_PCSL.M
- 414_checkout_SV.M
- 415_checkout_PCSL.M

Chromatography for your specific method was retention time locked (RTL) at the factory. At installation, Agilent's service engineer will verify chromatographic performance and relock the method.

The Analyzer Checkout Sample contains 17 pesticides shown in Table 1. The concentration of each pesticide is 100 ppb (100 pg/ μ L) in acetone. Please note that most of the pesticides used to make up this sample were >97% pure, meaning that there are some small impurities or isomers of the major components may be present.

To run the checkout sample:

- 1** Load the specified checkout method:
 - 411_checkout_PCSL.M
 - 412_checkout_PCSL.M
 - 414_checkout_SV.M
 - 415_checkout_PCSL.M
- 2** Make a 1- μ L Injection of the 100-ppb Checkout Sample (p/n 5190-0494).
- 3** Name the Data File:
 - 411_checkout_PCSL_1 μ L.D
 - 412_checkout_PCSL_1 μ L.D
 - 414_checkout_SV_1 μ L.D
 - 415_checkout_PCSL_1 μ L.D
- 4** Save the files in **D:\MassHunter\GCMS\1\Data**.

Table 1 Pesticides contained in the 100 pg/μL checkout sample (p/n 5190-0494)

Name	CAS #	Retention Time (min)				
		Opt # 411	Opt #412		Opt # 414	Opt # 415
		~40 min	~40 min	~20 min	~20 min	~20 min
Dichlorvos	62-73-7	5.831	6.188	4.679	4.032	2.915
Mevinphos	7786-34-7	7.595	9.070	5.610	4.845	3.803
Ethalfuralin	55283-68-6	11.283	13.590	7.139	6.383	5.654
Trifluralin	1582-09-8	11.637	13.945	7.247	6.511	5.831
Atrazine	1912-24-9	13.159	15.321	7.887	7.149	6.576
Chlorpyrifos Methyl (Locking Compound)	5598-13-0	16.593	18.110	9.143	8.524	8.297
Heptachlor	76-44-8	16.796	18.299	9.339	8.663	8.387
Malathion	121-75-5	18.800	19.654	9.729	9.289	9.404
Dieldrin	60-57-1	23.870	23.391	11.717	11.438	11.940
p,p'-DDE	72-55-9	24.021	23.418	11.612	11.441	12.018
Hexazinone	51235-04-2	27.385	26.665	13.195	13.349	13.703
Propargite	2312-35-8	27.725	27.033	13.318	13.572	13.876
Mirex	2385-85-5	29.835	29.633	14.872	14.624	14.944
Fenarimol	60168-88-9	30.403	30.320	15.084	14.831	15.237
Coumaphos	56-72-4	31.667	31.979	15.853	15.410	15.871
Etofenprox (Ethofenprox)	80844-07-1	33.203	33.912	16.777	16.245	16.650
Deltamethrin	52918-63-5	36.001	36.506	18.117	17.582	18.048

Reviewing Data and Generating a Report

- 1 Open MassHunter Qualitative Analysis (Qual).
- 2 Select **File > Open Data File...** to load the data file:
 - 411_checkout_PCSL_1 μ L.D
 - 412_checkout_PCSL_1 μ L.D
 - 414_checkout_SV_1 μ L.D
 - 415_checkout_PCSL_1 μ L.D
- 3 Select **Method > Open...** to load the signal-to-noise method:
 - 411_signal-to-noise.M
 - 412_signal-to-noise.M
 - 414_signal-to-noise.M
 - 415_signal-to-noise.M
- 4 Select **Actions > Run the Worklist Actions.**
- 5 Open the PDF report in the Reports folder within the data file folder. If all signal-to-noise ratios (of Mirex) are greater than 2500, this system is ready for running samples.
- 6 Compare your report with the factory report for the checkout sample generated for this specific Analyzer. The results from the factory are on the Specials Factory Information CD ROM.

NOTE

Relock the method if the Chlorpyrifos Methyl peak is more than ± 0.015 minute different than the method's locking compound retention time of 16.593, 9.143, 8.524, or 8.297 minute (see [Table 1](#) on page 17 for corresponding methods and retention times). See "[Relocking the Data Acquisition Method](#)" on page 14.

Columns and Supplies

Table 2 Columns and column accessories

Description	Part number	installed	extra
Siltek deactivated Fused Silica 5 m x 0.15 mm, flow restrictor (# 411 and # 415 Analyzers)	160-7626-5	0.7 m	4.3 m
Agilent J&W HP-5ms Ultra Inert GC Column, 30 m x 0.25 mm x 0.25 µm (# 411 Analyzer)	19091S-433 UI	1	0
Agilent J&W HP-5ms Ultra Inert GC Column, 15 m x 0.25 mm x 0.25 µm (# 414 and # 415 Analyzers)	19091S-431 UI	1	0
Agilent J&W HP-5ms Ultra Inert GC Column, 15 m x 0.25 mm x 0.25 µm (# 412 Analyzer)	19091S-431 UI	2	0
Agilent J&W HP-5ms Ultra Inert GC Column, 5 m x 0.25 mm x 0.25 µm (# 414 Analyzer)	G3903-61005	1	0
Column ferrule, MMI, graphite (10/pkg)	5080-8853	1	1 pkg
Column nut, GC capillary (2/pkg)	5181-8830	1	1
Swaging nut for MS interface OR	G2855-20555	1	0
Column nut for MS interface	05988-20066	1	0
MS interface ferrule (15% graphite/85% Vespel) 0.25 mm (10/pkg)	5062-3508	1	1 pkg
GC inlet and instrument supplies			
Inlet liner (4-mm Ultra Inert liner, Splitless, single taper, wool – hot splitless injections)	5190-2293	1	0
Inlet liner (2-mm Ultra Inert liner, Splitless, single taper, dimpled – cold splitless injections)	5190-2297	1	0
O-ring, inlet liner, non-stick (10/pkg)	5188-5365	1	1 pkg
Septum, advanced green (50/pkg)	5183-4759	1	1 pkg

Operations

Table 2 Columns and column accessories (continued)

Description	Part number	installed	extra
Big universal trap for helium purification	RMSH-2	2	0
Universal/External split vent trap (includes 3 cartridges)	RDT-1020	0	0
Split Vent Trap PM kit	5188-6495	0	0
Backflush and capillary flow device supplies			
Internal nut for capillary flow device (installed on purged ultimate union)	G2855-20530	2	2 (plugs)
Flexible metal ferrule, UltiMetal Plus, 0.4 mm id, for 0.1 to 0.25 mm ID (10/pkg)	G3188-27501	2	1 pkg
1/16-inch Brass Swagelok tee	0100-0680	1	0
Bleed line, 0.0625-in OD × 0.010-in ID × 100 cm, 316SS tubing	0100-2354	1	0
Bleed tee ferrule, 1/16-inch Vespel (10/pkg)	0100-1329	3	7 pieces
Useful tools and chemical standards			
Column installation tool	G1099-20030	0	1
Capillary tubing cutter (4/pkg)	5181-8836	0	1
Pesticide analyzer checkout sample (17 pesticides at 100 pg/μL each in acetone)	5190-0494	0	1
Sample preparation			
QuEChERS EN method sample pack	5982-7000	0	1
QuEChERS AOAC method sample pack	5982-7005	0	1

Additional QuEChERS extraction supplies at www.agilent.com/chem/quechers.

Troubleshooting

Use existing Data files to Lock

If you have acquired all calibration runs and there was a problem of picking up the integrated peak, etc., you can simulate the retention time locking process without rerunning the complete RTL data set:

- 1 Load the method.
- 2 Use Qual to evaluate all data files inside the RTLOCK folder, select 1-2 representative ions of the locking compound.
- 3 Make sure the locking compound EIC can be properly integrated.
- 4 In command line type: `acqlock 1,1` (there is a space before 1,1).
- 5 You will see normal RTL message box and also the message that previous RTL datafiles will be lost. This command simulated the locking process and you should answer Yes. It will use existing data files in the evaluation.
- 6 Next, you should see normal locking screens, complete these and the method is locked.

If you want to relock the method by using an existing data file, you can simulate this as well:

- 1 Load the method.
- 2 Make sure that data file name and folder is assigned in run method screen.
- 3 In command line type: `acqlock 2,1`. Before executing the command, make sure that the method is loaded and data file name and data path are entered properly.
- 4 You will see normal relock windows and following these complete the locking.

Auto RTL failed

Incomplete RTL Calibration information

Ion signals too weak – MassHunter cannot integrate them

Use MassHunter Qual to examine all 5 locking data files inside the method folder. Use > 1 ppm standards or set a higher electron multiplier Gain value if the ion signals are weak.

The r2 value is less than 0.95

Use MassHunter Qual to examine all 5 locking data files inside the method folder. Make sure the locking compound exists in all 5 runs. If not, make sure the locking compound transitions exist in all relevant time segments.

The ions entered for MassHunter identification are incorrect

Use MassHunter Qual to review the RTL data files and identify the ions acquired and then execute `acqlock 1,1` in GC/MS/MS Acquisition command line to lock. This command will reprocess the 5 previously collected data files.

More troubleshooting

Complaint: files take up a lot of space

Remember that every data file includes the acquisition method; so if the method is locked, each data file also includes the six calibration files.

Workaround:

- Backup the `D:/masshunter/gcms/1/hst.ini` file
- Open the original `hst.ini` file in the notepad and modify following line
 - `[copymethod]`
 - `enabled=0`
- Save the `hst.ini` file
- Method is not saved under the data files anymore

If instrument is reconfigured, this file is overwritten.

The GC never comes ready or the sequence halted

Make sure all pressure setpoints can be reached or are properly ignored.

Fix all leaks, increase gas supply pressure, and configure the purged ultimate union to Ignore Ready = True.

Checking for leaks

Checking air leaks at MS transfer line connection

Spray the MS transfer line nut with a fluorinated aerosol duster, for example, Miller-Stephenson MS-222N Aero-Duster, and look for ions 69 and 83 from 1,1,1,2-Tetrafluoroethane, CAS 811-97-2.

Leak free connections

UltiMetal Plus Flexible Ferrules provide a leak-free seal using less torque, reducing column breakage, and are treated with UltiMetal Plus deactivation for an inert flow path.

See also

- Flexible Metal Ferrule Touchless Package Video Wide opening and new dial pack design allows Touchless installation as column is threaded through ferrule easily

<http://www.chem.agilent.com/en-US/products-services/Parts-Supplies/Chromatography-Spectrometry/GC-and-GC-MS/UltiMetal-Plus-Flexible-Metal-Ferrules/Pages/PackageInstructions.aspx>

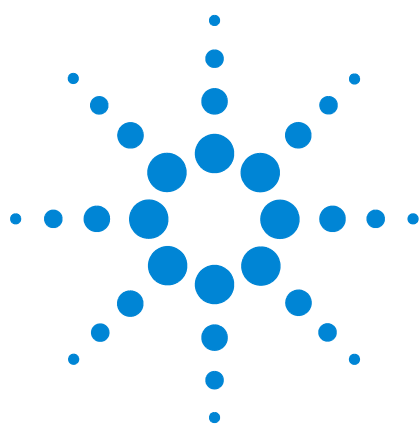
- Flexible Metal Ferrule Column Connections Video

<http://www.chem.agilent.com/en-US/products-services/Parts-Supplies/Chromatography-Spectrometry/GC-and-GC-MS/UltiMetal-Plus-Flexible-Metal-Ferrules/Pages/flexiferruleprestag.aspx> or <http://youtu.be/3GkmiVvydeI>

This video demonstrates column connections using the Agilent UltiMetal Plus Flexible Metal Ferrules.

Three steps are presented:

- 1 Pre-swaging.
- 2 Column trimming and quality inspection.
- 3 Connecting to capillary flow devices.



Appendix A – UltiMetal Plus Flexible Metal Ferrules Swaging Guide

Parts Supplied

The available UltiMetal Plus Flexible Metal ferrule packages are listed in [Table 3](#) and [Figure 2](#).

Table 3 Available UltiMetal Plus Flexible Metal ferrule packages

Item	Part number	Ferrule description
1	G3188-27501	0.1 – 0.25 mm column id, 10/pk
2	G3188-27502	0.32 mm column id, 10/pk
3	G3188-27503	0.45 – 0.53 mm column id, 10/pk
4	G3188-27504	Plug, 10/pk
5	G3188-27505	0.25 – 0.32 mm UltiMetal column id, 10/pk
6	G3188-27506	0.53 mm UltiMetal column id, 10/pk



Figure 2 UltiMetal Plus Flexible Metal ferrules

Each UltiMetal Plus Flexible Metal ferrule part number is uniquely designed to prevent inventory mix-ups, and to help you find the ferrule you need quickly. Color variations between ferrules are a normal result of the UltiMetal coating.

Tools Required

- Two 1/4-inch open-end wrenches
- Column cutting tool
- Swaging wrench

Preparing the Column Ends

- 1 Pass the column end through the internal nut, the ferrule, and the swaging wrench (see [Figure 3](#)).

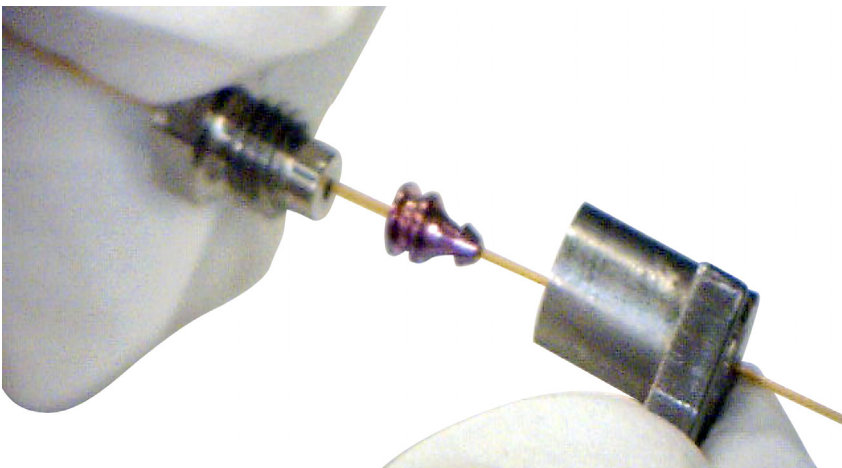


Figure 3 Thread the column through the internal nut, ferrule, and swaging wrench

- 2 Thread the internal nut into the swaging wrench with the column protruding out of the back of the wrench (see [Figure 4](#)).

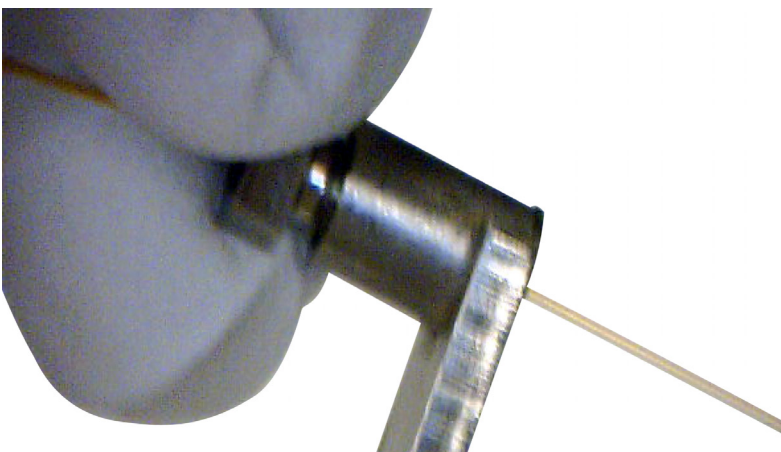


Figure 4 Thread the internal nut onto the swaging wrench

- 3** Begin to swage the ferrule to the column using a 1/4-inch open-ended wrench.

The design of UltiMetal Plus Flexible Metal ferrules reduces the probability of column breakage and minimizes the damage to the thread of the corresponding fittings.

Unlike other ferrule designs, a reliable leak-free seal is best made by tightening the internal nut to a recommended number of degrees, not by applying more force. Applying excessive force will not provide a better seal. Also, compressing the flexible ferrule less minimizes damage to fittings.

To swage the ferrule to the column:

- a** Find your ferrule type in [Table 4](#) and note the range of degrees to tighten the internal nut.
- b** Tighten the internal nut clockwise to the lower end of your ferrule's range.
- c** Check if the ferrule is gripping the column. If yes, stop. If not, continue to tighten the internal nut in small 5- to 15-degree increments. Check after each increment to see if the ferrule is gripping the column. Stop as soon as gripping occurs (see [Figure 5](#) on page 28).

Table 4 Degrees to tighten the internal nut for proper swaging

Ferrule part number	Degrees to tighten internal nut
G3188-27501	50 – 100 degrees
G3188-27502	30 – 70 degrees
G3188-27503	20 – 50 degrees
G3188-27504	60 degrees
G3188-27505	40 – 90 degrees
G3188-27506	20 – 50 degrees

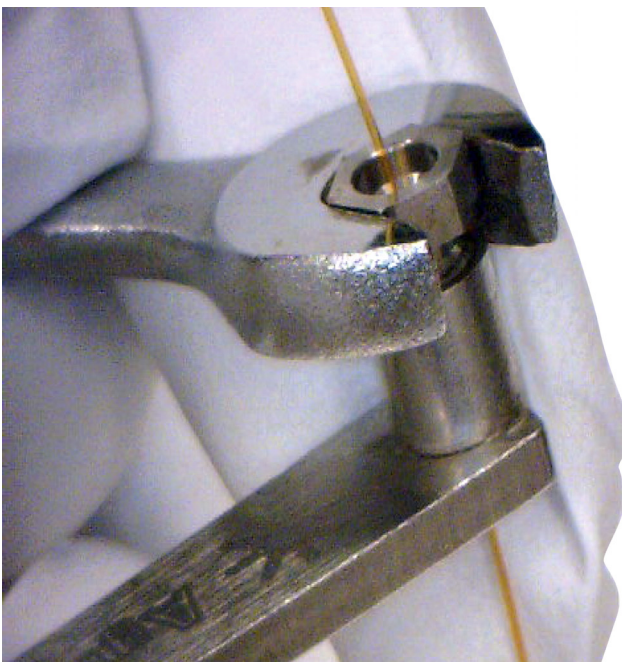


Figure 5 Tightening the internal nut

- 4 Using the 1/4-inch open-ended wrench, turn the internal nut an additional 15 to 20 degrees clockwise to ensure the ferrule is properly swaged onto the column (see [Figure 6](#)).

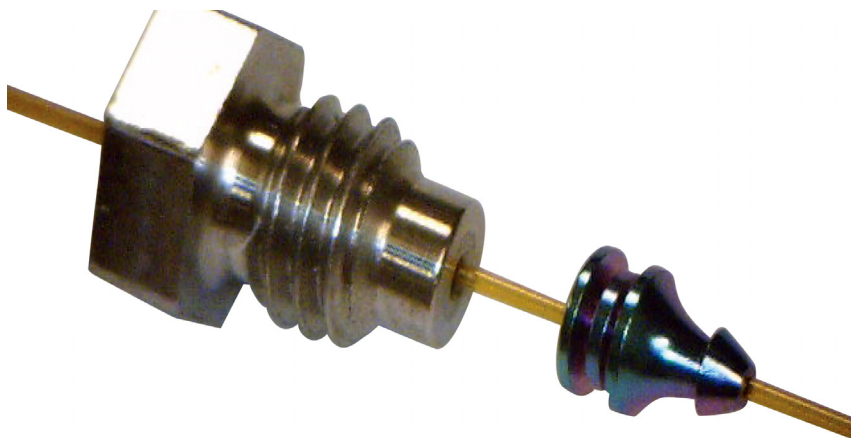


Figure 6 Ferrule swaged to column and internal nut

- 5 Using the 1/4-inch open-ended wrench, remove the internal nut from the swaging wrench and column.

- Using the column cutter, trim the column at the small end of the ferrule leaving approximately 0.3 mm of the column extending from the ferrule (Figure 7). The minimum size of the column head extending from the ferrule is 0.1 mm and the maximum is 0.5 mm. It is important to have 0.5 mm or less column head to prevent column conflict in the union.

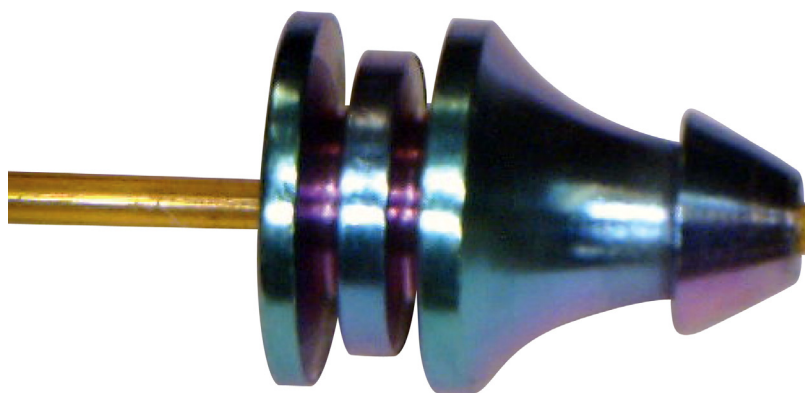


Figure 7 Properly-trimmed column and ferrule

Swaging Quality Inspection

Figure 8 shows both an incorrect and correct swaging symmetry.



Figure 8 Incorrect and correct swaging symmetry

If your column and ferrule look like the incorrect example in Figure 8 above, it is possible that your swaging wrench is defective or worn out. Try swaging with a new wrench or new nut.

Appendix A – UltiMetal Plus Flexible Metal Ferrules Swaging Guide



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