5 PHASE GC COLUMNS

DISCOVER NEW OPTIONS
Choosing the Correct 5 Phase Column

- Equivalent to USP Phase G27
- Low bleed (MS Certified) especially suited to high sensitivity work using GC/MS (Individually Tested)
- Intense QC specifications ensure column-to-column performance

There are many different 5 phase GC column variations on the market. All utilize one of two main types of bonded phases: 5 %-Phenyl or 5 %-Phenyl-Arylene. The differences between the two phases can be slight but significant to the chromatographic result.

In Phenyl-Arylene phases, the phenyl ring is incorporated into the polymer backbone creating a web-like network in which compounds must negotiate in order to interact with the phenyl in the stationary phase. Since the access to the phenyl rings is more limited, compounds with a geometry that “fits” into the polymer network will tend to interact more strongly.

Due to their rigid structure, resolution differences are most commonly observed when analyzing multi-ring aromatics, such as PAHs and PCBs. However, resolution difference can also be observed for other aromatic compounds.

There are two main types of bonding: Pendant and Arylene.

<table>
<thead>
<tr>
<th>Pendant</th>
<th>Arylene</th>
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</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Pendant" /></td>
<td><img src="image2.png" alt="Arylene" /></td>
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</table>
There are 4 options: ZB-5, ZB-5HT, ZB-5MSi & ZB-5ms

**ZB-5**
- **Phase/Temperature Limits:** 5% – Phenyl – 95% – Dimethylpolysiloxane
- **Temp Limits:** -60 to 360/370 °C
- **Features:** High stability. Low bleed phase (MS Certified).
- **Benefits:** Versatile, low cost column for general applications with various detectors.
- **Equivalent to:** DB-5, HP-5, Rtx-5, HP-PAS-5, MDN-5, Equity-5, SPB-5, OV-5, 007-5, AT-5, BZX5, SE-54, BPS, Ultra 2, EC-5, HP-5 Trace Analysis, CP-SIL 8 CB

**ZB-5HT**
- **Phase/Temperature Limits:** 5% – Phenyl – 95% – Dimethylpolysiloxane
- **Temp Limits:** -60 to 400/430 °C
- **Features:** Award winning 430 °C stable phase. Improved polyimide coating = flexible tubing after prolonged use above 400 °C. Low bleed phase (MS Certified).
- **Benefits:** Increased temperature stability leads to improved column lifetime – saving time & money. Remove contaminants using high temperature bake outs. Replaces problematic metal columns.
- **Equivalent to:** DB-5ht, VF-5ht, HT-5, Stx-5HT, XTI-5HT

**ZB-5MSi**
- **Phase/Temperature Limits:** 5% – Phenyl – 95% – Dimethylpolysiloxane
- **Temp Limits:** -60 to 360/370 °C
- **Features:** New proprietary deactivation process decreases column activity. Aggressive phase crosslinking results in very low bleed levels (MS Certified).
- **Benefits:** Improved peak shape for acids, bases, and drug compounds. Extend performance for active compounds. Higher temperature limits allow for removal of column contamination.
- **Equivalent to:** DB-5, MDN-5S, HP-5ms, HP-5msi, Rxi-5ms, Rtx-5ms, Rtx-5Amine

**ZB-5ms**
- **Phase/Temperature Limits:** 5% – Phenyl-Arylene – 95 % – Dimethylpolysiloxane
- **Temp Limits:** -60 to 325/350 °C
- **Features:** Arylene Matrix Technology® (AMT) provides highly stable crosslinked phenyl-arylene phase. Slightly different selectivity to non-arylene 5-type phases. Highly deactivated (MS Certified).
- **Benefits:** Phase chemistry reduces “back-biting” and lowers column bleed. Phenyl-Arylene bonded phase improves resolution of aromatic compounds. Reduced activity for acidic and basic compounds leads to better quantitation.
- **Equivalent to:** DB-5ms, VF-5ms, CP-SIL 8 CB MS, DB-5.625, DB-5ms EVDX, Rtx-5SilMS

*Thicker films (≥1.0 um df) are rated to 340/360 °C (Isothermal / TPGC).

0.53 mm ID columns are rated to 400 °C max operational temperature.
ZB-5 GC Columns

A fantastic general purpose column for both MS & non-MS detectors.

- Temperature Limits: -60 to 360/370 °C (Isothermal/TPGC)*
- Versatile low polarity column
- Resilient to dirty samples - long column life
- Great column for unknown samples

**Phthlate Esters: EPA Method 606**

- **Column:** Zebron ZB-5
- **Dimensions:** 30 meter x 0.53 mm x 1.50 μm
- **Part No.:** 7HK-G002-28
- **Injection:** Split 20:1 @ 300 °C, 1 µL
- **Carrier Gas:** Helium @ 12.9 mL/min (Constant Flow)
- **Oven Program:** 40 °C for 6 min to 300 °C @ 10 °C/min for 15 min
- **Detector:** FID @ 300 °C
- **Sample:**
  1. Dimethyl Phthalate
  2. Diethyl Phthalate
  3. Di-n-butyl Phthalate
  4. Butyl Benzyl Phthalate
  5. Bis(2-ethylhexyl) Phthalate
  6. Di-n-octyl Phthalate

*Thicker films (≥ 1.0 μm df) are rated to 340/360 °C (Isothermal/TPGC).
ZB-5MSi GC Columns

A deactivated, inert column specially designed to provide enhanced peak shapes for active acidic/basic compounds, whilst maintaining MS certified bleed levels.

- Temperature Limits: -60 to 360/370 °C (Isothermal/TPGC)
- Highly inert - improved peak shape for acidic/basic compounds
- ESC bonding results in phase stability and high temperature limits
- Traditional bonding chemistry provides the same selectivity as the ZB-5 columns

Applications

- Drugs of Abuse
- FAMEs
- Pesticides
- Nitrosamines
- Phenols
- EPA Methods

Column Profile

- Low
- High

- Polarity
- Bleed
- Temperature Limits
- Stability

Alternative to Any 5 %-Phenyl- 95 %-Dimethylpolysiloxane Phase:

- DB-5
- Rtx-5ms
- MDN-5S
- HP-5ms
- Rtx-5Amine
- HP-5msi
- Rxi-5ms

Applications

- Drugs of Abuse
- FAMEs
- Pesticides
- Nitrosamines
- Phenols
- EPA Methods

Column: Zebon ZB-5MSi

Dimensions: 30 meter x 0.25 mm x 0.25 μm

Part No.: 7HG-G018-11

Injection: Split 5:1 @ 240 °C, 1 μL

Carrier Gas: Helium @ 1.2 mL/min (Constant Flow)

Oven Program:
- 60 °C to 140 °C @ 5 °C/min to 280 °C @ 10 °C/min

Detector: MSD @ 230 °C; 45-450 amu

Sample:

1. Phenol
2. 2-Chlorophenol
3. 2-Methylphenol
4. 4-Methylphenol
5. 3-Methylphenol
6. 2.6-Dimethylphenol
7. 2-Nitrophenol
8. 2-Ethylphenol
9. 2,4-Dimethylphenol
10. 3,5-Dimethylphenol
11. 2,5-Dimethylphenol
12. 4-Ethylphenol
13. 3-Ethylphenol
14. 2,4-Dichlorophenol
15. Benzoic Acid
16. 2,3-Dimethylphenol
17. 3,4-Dimethylphenol
18. 2,6-Dichlorophenol
19. 4-Chloro-3-methylphenol
20. 2,4,6-Trichlorophenol
21. 2,4,5-Trichlorophenol
22. 2,4-Dinitrophenol
23. 4-Nitrophenol
24. 2,3,4,6-Tetrachlorophenol
25. 4,6-Dinitro-2-methylphenol
26. Pentachlorophenol
27. Dinoseb
ZB-5MSi GC Columns (continued)

ZB-5MSi Comparative Application Data

**Zebron™ ZB-5MSi**

Aromatic Amines

- **Column:** Zebron ZB-5MSi
- **Dimensions:** 30 meter x 0.25 mm x 0.50 μm
- **Part No.:** 7HG-G018-17
- **Injection:** Split 15:1 @ 220 °C, 1 μL
- **Carrier Gas:** Hydrogen @ 1.7 mL/min (Constant Flow)
- **Oven Program:** 90 °C for 4 min to 220 °C @ 10 °C to 320 °C @ 8 °C/min
- **Detector:** FID @ 325 °C
- **Sample:**
  1. Piperidine
  2. 2-Methylpiperidine
  3. Aniline
  4. Benzylamine
  5. α-Phenethylamine
  6. N-Methylaniline
  7. o-Toluidine
  8. m-Toluidine
  9. N,N-Dimethylaniline
  10. β-Phenylethylamine

**Zebron™ ZB-5MSi vs. Restek® Rxi®-5ms & Agilent® HP-5msi Column Performance Evaluation**

**Conditions for all columns:**
- **Dimensions:** 30 meter x 0.25 mm x 0.25 μm
- **Injection:** Split 83:1 @ 250 °C, 2.0 μL
- **Carrier Gas:** Hydrogen @ 40 cm/sec (Constant Flow)
- **Oven Program:** 135 °C to 220 °C @ 10 °C to 320 °C @ 8 °C/min
- **Detector:** FID @ 325 °C
- **Sample:**
  1. Ibuprofen
  2. Glutethamide
  3. Dimenhydrinate
  4. Desipramine
  5. Oxymorphone
  6. Quinidine
  7. Alprazolam

**Zebron™ ZB-5MSi for Basic Compounds**

**Restek® Rxi®-5ms**

**Agilent® Technologies HP-5msi**

**Increased Activity**

**Increased Activity**

**Phenomenex | Web: www.phenomenex.com**
ZB-5HT Inferno™ GC Columns

A high temperature column allowing reproducible analysis of higher boiling compounds with very low bleed.

- Temperature Limits: -60 to 400/430 °C (Isothermal/TPGC)*
- First non-metal columns stable to 430 °C
- Rugged high temperature, polyimide coated, fused silica tubing
- Provides robust column performance for high temperature bake outs

Applications

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<tr>
<th>High Boiling Petroleum Products</th>
<th>Polymers/Plastics</th>
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<td>Triglycerides</td>
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<td>Long-chained Hydrocarbons</td>
<td>Motor Oils</td>
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<tr>
<td>High Molecular Weight Waxes</td>
<td>Surfactants</td>
</tr>
</tbody>
</table>

*0.53 mm ID columns are rated to 400 °C maximum operational temperature.

Stable and Durable Even When Pushed to 430 °C

To demonstrate the ultra-high temperature performance of the Zebron™ Inferno™ columns, we tested the Zebron ZB-5HT under extreme conditions (23 hours at 430 °C) and compared the difference in retention time. Under these harsh conditions, the difference in retention of pentacontane between the 1st and 125th chromatograms was only 1.5 %! With the Zebron Inferno column’s improved endurance and extended temperature range, expect to get precise, dependable results for extended periods.

Column Profile

<table>
<thead>
<tr>
<th>Polarity</th>
<th>Bleed</th>
<th>Temperature Limits</th>
<th>Stability</th>
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<tr>
<td>High</td>
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Alternative to Any 5 %-Phenyl-95 %-Dimethylpolysiloxane

High-temperature Phase:

| DB-5ht | VF-5ht | HT-5 | Sx-5ht | XTI-5ht |

Paraffin Wax

- **Column**: Zebron™ ZB-5HT Inferno™
- **Dimensions**: 15 meter x 0.32 mm x 0.10 μm
- **Part No.**: 7EM-G015-02
- **Injection**: Direct on column @ 43 °C, 0.1 μL
- **Carrier Gas**: Helium @ 1.9 mL/min (35 cm/sec) (Constant Flow)
- **Oven Program**: 40 °C for 2 min to 430 °C @ 20 °C for 10 min
- **Detector**: FID @ 430 °C
- **Sample**: Paraffin Wax

Only 1.5 % retention difference after 23 hours in extreme conditions

[Graph and chart showing chromatograms]
ZB-Inferno™ GC Columns

Special High Temperature Polyimide Coating
Capillary GC columns are externally coated with a thermoplastic polymer known as polyimide resin. It stabilises the internal glass capillary tubing and allows the columns to be flexible even at elevated temperatures. Standard polyimide resin pyrolyzes at temperatures above 380 °C making the tubing unstable. The Zebron ZB-1HT and -5HT Inferno columns utilize a polyimide resin material that shows minimal thermal degradation even at programmed temperatures up to 430 °C. The new resin material is also the reason for the graphite black appearance of the capillary tubing. However, unlike traditional tubing that darkens due to oxidation, this tubing will provide long lifetime even at 430 °C.

Still Flexible After 23 Hours at 430 °C*
At temperatures above 380 °C, conventional fused silica tubing will become brittle and randomly break. Our special new tubing is manufactured using a novel High Temperature Polyimide Resin material that shows minimal thermal degradation even at programmed temperatures up to 430 °C.

*430 °C TPGC Stability Test
Evaluated by performing 185 programmed temperature runs, total 23 hours at 430 °C. Polyimide tubing was still flexible as shown here.

EN 141 05: Free and Total Glycerin Analysis in Biodiesel

Column: Zebron ZB-5HT Inferno
Dimension: 15 meter x 0.32 mm x 0.10 μm
Part No.: 7EM-G015-02
Injection: On-Column @ 50 ºC, 1 μL
Carrier Gas: Helium @ 5.79 cm/sec (Constant Flow)
Oven Program: 50 °C for 1 min to 180 °C @ 15 °C/min to 230 °C @ 7 °C/min to 370 °C @ 10 °C/min (hold 5 min)
Detector: FID @ 380 ºC
Note: A 5 m x 0.53 mm guard column was connected to the analytical column.

1. Glycerol
2. Butanetriol
3. Monoolein
4. Tricarpin
5. Diolein
6. Triolein
ZB-Inferno™ GC Columns (continued)

**Alternatives**

**Traditional GC Capillary Columns Fall Short in High Temperature Analysis**

Various GC analyses require a capillary GC column capable of withstanding high oven temperatures. However, finding such a column has been difficult. Gas chromatographers using traditional polyimide columns for high temperature analysis face many challenges:

- **Traditional Polyimide Columns Break**
  After prolonged exposure to temperatures above 360 °C, traditional polyimide columns become brittle, inflexible, and are prone to breakage.

- **Costly to Replace**
  Constantly replacing broken or brittle columns is inconvenient and expensive.

- **Inhibit Productivity**
  Analysts spend too much time performing system maintenance and column changes due to column brittleness and breakage.

- **Problems Separating High Molecular Weight Compounds**
  Analyzing high molecular weight compounds, such as long-chained hydrocarbons, heavy PAHs, and triglycerides, requires capillary GC columns that perform well at high GC oven temperatures. Traditional polyimide columns aren’t tough enough to withstand such conditions.

![Figure 1. Traditional capillary columns break easily with prolonged exposure to GC oven temperatures above 360 °C](image1)

![Figure 2. Comparison of retention of Pentadecane between the Zebron ZB-5HT Inferno column versus a traditional 5 % - Phenyl - 95 % - dimethylpolysiloxane column. Note that the 5 % - Phenyl column died around 40 hours at 400 °C whereas the Zebron ZB-5HT Inferno column maintained great retention of Pentadecane over 100 hours.](image2)

**Metal GC Columns Present Tough Challenges**

When working at high temperatures, the only other alternative to using traditional capillary columns is using a metal column. Metal columns, however, have several major drawbacks:

- **Hard to Use**
  Metal columns are inflexible and require special tubing cutters for installation.

- **Develop Leaks**
  Metal columns develop leaks due to expansion and contraction when heating.

- **High Column Activity for Acids and Bases**
  It’s difficult to get good peak shape with acids and bases using metal columns due to their high activity for these compounds.

- **Incompatible with MS Detectors**
  Metal columns are incompatible with Mass Spectrometer (MS) detectors.
**ZB-5ms GC Columns**

Utilizes Arylene Matrix Technology™ to provide enhanced resolution of polyaromatic hydrocarbons (PAHs) and other multi-ring aromatic compounds.

- **Temperature Limits:** -60 to 325/350 °C (Isothermal/TPGC)
- **Arylene Matrix Technology (AMT)**
- **Fully conditioned within 35 minutes**
- **The perfect choice for EPA Methods 525, 610, 625, 8100, and 8270**

**Arylene Matrix Technology™**

The Zebron ZB-5ms is the accumulation of more than 15 years of GC column manufacturing experience! We have applied our proprietary Engineered Self Cross-linking™ (ESC) bonding to an Arylene polymer chemistry and created the new Arylene Matrix Technology. The resulting columns have long lifetime, enhanced selectivity and lower bleed than traditional Arylene products.

**Low Bleed / Fast Conditioning**

Achieves MS-Certified bleed level after only 35 minutes! Little to no change in bleed after an additional 30 minutes of conditioning!

**Applications**

- **Acids**
- **EPA Methods**
- **Pesticides/Herbicides**
- **Alkaloids**
- **Essential Oils/Flavors**
- **Amines**
- **FAMEs**
- **Residual Solvents**
- **Dioxines**
- **Halo-hydrocarbons**
- **Semi-volatiles**
- **Drugs**
- **PCBs/Aroclors**
- **Solvent Impurities**

**Column Profile**

- **Polarity: 8**
- **Temperature Limits:**
  - Low: 8
  - High: 15
- **Stability:**
  - Low: 8
  - High: 15

**Long Lifetime**

Consistent response after more than 700 samples at pH 2!

**Reproducible Results**

- **Column:** Zebron ZB-5ms
- **Dimensions:** 30 meter x 0.25 mm x 0.25 µm
- **Part No.:** 7HG-G010-11
- **Injection:** Split 1:100 @ 250 °C, 1.4 µL
- **Carrier Gas:** Hydrogen @ 140 °C, 40 cm/sec
- **Oven Program:** 140 °C (Isothermal)
- **Detector:** FID @ 325 °C
- **Sample:**
  - 1. Decane
  - 2. 2-Ethylhexanoic Acid
  - 3. 1,6-Hexanediol
  - 4. 4-Chlorophenol
  - 5. Tridecane
  - 6. 1-Methylnaphthalene
  - 7. 1-Undecanol
  - 8. Tetradecane
  - 9. Dicyclohexylamine
  - 10. Pentadecane

**Applications**

- **Acids**
- **EPA Methods**
- **Pesticides/Herbicides**
- **Alkaloids**
- **Essential Oils/Flavors**
- **Amines**
- **FAMEs**
- **Residual Solvents**
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- **Halo-hydrocarbons**
- **Semi-volatiles**
- **Drugs**
- **PCBs/Aroclors**
- **Solvent Impurities**
ZB-5ms GC Columns (continued)

EPA Method 8100:
Polynuclear Aromatic Hydrocarbons

Column: Zebon ZB-5ms
Dimensions: 10 meter x 0.10 mm x 0.10 µm
Part No: 7CB-G010-02
Oven Program: 100 °C to 200 °C @ 33 °C/min to 320 °C @ 25 °C/min
Carrier Gas: Helium @ 0.6 mL/min (Constant Flow)
Injection: Split 20:1 @ 320 °C, 1 µL
Detector: FID @ 330 °C
Note: Analytes were 50 ppm

Sample:
1. Naphthalene
2. 2-Methylnaphthalene
3. Acenaphthalene
4. Acenaphthene
5. Fluorene
6. Phenanthrene
7. Anthracene
8. Fluoranthene
9. Pyrene
10. Benz[a]anthracene
11. Chrysene
12. Benzo[b]fluoranthene
13. Benzo[k]fluoranthene
14. Benzo[a]pyrene
15. Indeno[1,2,3-cd]pyrene
16. Dibenzo[a,h]anthracene
17. Benzo[g,h,i]perylene
Optimized Run Times

The added resolution offered by the Arylene Matrix Technology™ allows run times to be shortened by at least 20-30%.

EPA Method 8270C: Semivolatile Organic Analysis

Conditions for both columns:
- **Dimensions:** 30 meter x 0.25 mm x 0.50 μm
- **Injection:** Splitless @ 250 °C, 1 μL
- **Carrier Gas:** Helium @ 50 °C, 64 cm/sec
- **Oven Program:**
  - 50 °C (hold 3 min) 50-325 °C @ 9 °C/min, (hold 2 min)
- **Detector:** MSD @ 300 °C
- **Sample:** Semivolatile Organics

**Results Done in 15 mins!**

EPA Method 8270C: Done in 15 Minutes vs. 35 Minutes!

- **Column:** Zebron ZB-5ms
- **Dimensions:** 30 meter x 0.25 mm x 0.25 μm
- **Part No.:** 7HG-G010-11
- **Injection:** Split 10:1 @ 250 °C, 1 μL
- **Carrier Gas:** Helium @ 1.4 mL/min (Constant Flow)
- **Oven Program:**
  - 40 °C for 0.5 min to 220 °C @ 22 °C/min to 325 °C @ 35 °C/min for 3 min
- **Detector:** MSD; 40-450 amu
- **Sample:**
  - 107. Benzo[b]fluoranthene
  - 108. Benzo[k]fluoranthene
  - 109. Benzo[a]pyrene
  - 110. 3-Methylcholanthrene
  - 111. Indeno[1,2,3-cd]pyrene
  - 112. Dibenz[a,h]anthracene
Improved Resolution
The ZB-5ms Arylene Matrix Technology™ provides improved resolution of the critical isomeric pair.

Zebron™ ZB-5ms vs. J&W® DB-5ms
EPA Method 610: Polyaromatic Hydrocarbons (PAHs)

Conditions for both columns:
- **Dimensions:** 30 meter x 0.25 mm x 0.25 μm
- **Injection:** Split 100:1 @ 250°C, 0.5 µL
- **Carrier Gas:** Constant Pressure Hydrogen @ 1.2 mL/min (measured @ 140 °C)
- **Oven Program:**
  - 40 °C (hold 2min) to 250 °C @ 25 °C/min, to 265 °C @ 5 °C/min, to 300 °C @ 25 °C/min (hold until last peak elutes)
- **Detector:** FID @ 325 °C
- **Sample:** EPA 610 mix @ 2,000 ppm

Almost 90% Resolution with Zebron™ ZB-5ms

84% Resolution with J&W® DB-5ms
### ZB-5 GC Columns

#### Ordering Information

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<th>ID (mm)</th>
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<td>7KG-G002-02</td>
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#### Test Mix

- Zebron ZB-5 AG0-5155

### ZB-5MSi GC Columns

#### Ordering Information

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<tr>
<td>0.18</td>
<td>0.18</td>
<td>-60 to 360 / 370</td>
<td>7CD-G018-08</td>
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#### Test Mix

- Zebron ZB-5MSi AG0-8362

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#### Test Mix

- Zebron ZB-5HT AG0-5155

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### Cool-Lock™ Nut

- Never burn your fingers again – cools with the oven
- Achieve the proper installation depth each and every time
- Hand-tightened connections means you will never search for a wrench again
- Low thermal mass ensure tracking with oven temperature – no cold/hot spots
- Patent-pending design

### Ordering Information

#### Cool-Lock GC Capillary Nut For Agilent GC Systems

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
<th>Unit</th>
<th>Price</th>
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<tbody>
<tr>
<td>AG0-8319</td>
<td>Cool-Lock GC Capillary Nut For Use With Short-Style Ferrules</td>
<td>ea</td>
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<tr>
<td>AG0-8320</td>
<td>Cool-Lock GC Capillary Nut For Use With Long-Style Ferrules</td>
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<td>AG0-8349</td>
<td>Cool-Lock GC Installation Gauge</td>
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#### Replacement Ferrules

<table>
<thead>
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<tr>
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#### Cool-Lock GC Capillary Nut for Shimadzu Systems

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
<th>Unit</th>
<th>Price</th>
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<tbody>
<tr>
<td>AG0-8419</td>
<td>Cool-Lock GC Capillary Nut For Use With Short-Style Ferrules</td>
<td>ea</td>
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<tr>
<td>AG0-8420</td>
<td>Cool-Lock Nut Installation Gauge</td>
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### For the complete range of Zebron GC Columns and Accessories contact Phenomenex for your FREE GC Selection Guide (5335)
www.phenomenex.com

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