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# Signal Handling

Signal is the GC output to a data handling device, analog or digital. It can be a detector output or the output from temperature, flow, or pressure sensors. Two signal output channels are provided.

Signal output can be either analog or digital, depending on your data handling device. Analog output is available at either of two speeds, suitable to peaks with minimum widths of 0.004 minutes (fast data rate) or 0.01 minutes (normal rate). Analog output ranges are 0 to 1 V, 0 to 10 V, and 0 to 1 mV.

Digital output to Cerity and ChemStation software is available at 11 speeds ranging from 0.1 Hz to 200 Hz, capable of handling peaks from 0.001 to 2 minutes wide. Set this rate from your Cerity or ChemStation software.

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## Using the signal control tables

### Signal type

When assigning detector signals, use the [Mode/Type] key and choose from the Signal Type control table, or press a key or combination of keys. [Front], [Back], [-], [Col Comp 1], and [Col Comp 2] will work — alone or in combination. For example, press [Back] for back detector or [Back] [-][Front] for back detector minus front detector.

The nondetector signals are test plot, thermal, pneumatic, and diagnostic. Access them by pressing [Mode/Type]. Diagnostic signals are for use by your service representative and are not described in detail here.

Signal type can be programmed as a run time event. See ["Run time programming"](#) for details.

### Value

Value on the signal control table is the same as Output on the detector control table if your signal type is Front or Back. If you are subtracting one signal from another (as in Front - Back), the signal Value will be the difference. You cannot enter a setpoint for Value.

A conversion factor may be involved when interpreting Value—for example, one FID unit is one picoamp; one ECD unit is 1 Hz. The units for detector and other signals are listed below.

**Table 19 Signal Conversions**

Signal type	1 display unit is equivalent to:
Detector:	
FID, NPD	1.0 pA ( $1.0 \times 10^{-12}$ A)
FPD	150pA ( $150 \times 10^{-12}$ A)
TCD	25 mV ( $2.5 \times 10^{-5}$ V)
μ-ECD	1 Hz
Analog input board (use to connect GC to non-Agilent detector)	15 μV
Nondetector:	
Thermal	1° C
Pneumatic:	
Flow	1 mL/min
Pressure	1 pressure display unit (psi, bar, or kPa)
Diagnostic	Mixed, some unscaled

Press [Signal 1] or [Signal 2]

SIGNAL 1	
Type:	Front <
Value	0.0
Zero	0.0
Range	0
Attn	0

Many choices, see **change signal type** below

Actual output value

For analog output signals only

To **change signal type**, press [Mode/Type]:

SIGNAL 1 TYPE	
*Front	<
Back	
Front - col comp 1	
Front - col comp 2	
Back - col comp 1	
Back - col comp 2	
Col comp 1	
Col comp 2	
Test plot	
Thermal Signals	
Pneumatic Signals	
Diagnostic Signals	

Detector signals.  
Scroll to the appropriate signal type and press [Enter].

Test Pilot

Nondetector signals. Scroll to one of these lines and press [Enter] to get the expanded list of signals- see next page.

**Figure 20** Signal control table

### Thermal signals:

SIGNAL	1	TYPE
Oven temp	<	
Front inlet temp		
Front det temp		
Aux 1 temp		

### Pneumatic signals:

SIGNAL	1	TYPE
Column 1 flow	<	
Column 2 flow		
Column 1 pres		
Column 2 pres		
F inlet flow		
F inlet pres		
F det H2 pres		
F det air pres		
F det makeup pres		
F det air flow		
F det makeup flow		

Only installed items are listed in submenus.

### Diagnostic signals:

SIGNAL	1	TYPE
Test signal	<	
Atm pressure		
+5V monitor		
+24V monitor		
+15V monitor		
-15V monitor		
Line sense		
F det ignitor V		
Raw ADC reading		
ADC reading noise		
Mux ADC noise		
Mux ADC offset		
Pneu 10 volts		
Pneu adc offset		
Attn out 1		
Attn out 2		
DAC out 1		
DAC out 2		
F det 1st order		
F det 2nd order		
B det 1st order		
B det 2nd order		
B TCD bridge V		
B TCD valve V		
F det data		
B det data		
F det offset		
B det offset		
Finl module temp		
B inl module temp		
F det module temp		
B det module temp		
Aux module temp		
F inl gas voltage		
Oven rtd reading		
F det rtd reading		
B det rtd reading		
F inl rtd reading		
B inl rtd reading		
Aux 1 rtd reading		
Aux 2 rtd reading		

## Analog output settings—zero, range, and attenuation

If you use an analog recorder, you may need to adjust the signal to make it more usable. Zero, Range, and Attn in the Signal control table do this.

Press [Signal 1] or [Signal 2].

Type:	Front
Value	0.0
SIGNAL 1	
Zero	0.0 <
Range	0
Attn	0

Subtracts value entered from baseline (press [On] to set to current Value or [Off] to cancel)

Scales data coming from the detector (Valid setpoints are 0 to 13, depending on detector type)

Scales presentation of output to strip chart recorders (Valid setpoints are 0 to 10)

### Analog zero

This is used to correct baseline elevation or offsets. A common application is to correct a baseline shift that occurs as the result of a valve operation. After zeroing, the analog output signal is equal to the Value line of the control table minus the Zero setpoint.

Zero can be programmed as a run time event. For details, see ["Procedure: Programming run time events"](#).

#### Procedure: Zeroing signal output

1. Verify that the detector is on and in a ready state.
2. Press [Signal 1] or [Signal 2] to access the signal control table.

SIGNAL 1	
Type:	Front
Value	15
Zero	0.0 <
Range	0
Attn	0

Press [On] to set the current signal (15 in this case) or enter a number.

3. Scroll to Zero.

4. Press [On] to set **Zero** at the current signal value,  
*or*  
Enter a number between -500000 and +500000. A value smaller than the current **Zero** shifts baseline up.

### Range—for analog outputs only

Range is also referred to as gain, scaling, or sizing. It sizes the data coming from the detector to the analog signal circuits to avoid overloading the circuits (clamping). Range scales all analog signals (1 mV, 1 V, etc.).

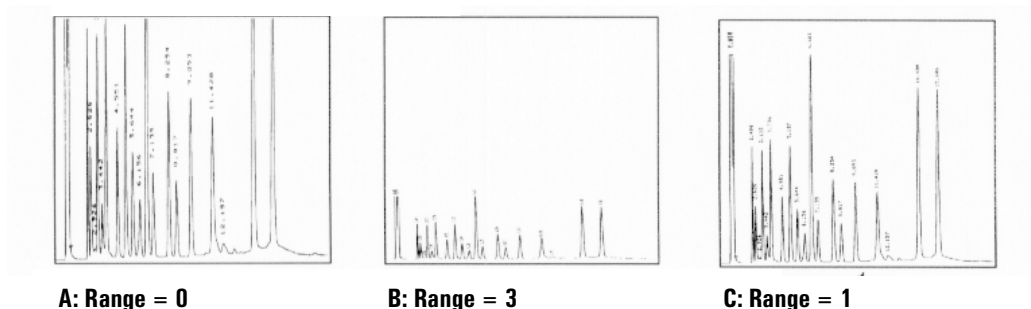
If a chromatogram looks like A or B in [Figure 21](#), the data needs to be scaled (as in C) so that all peaks are visible on the paper.

Valid setpoints are from 0 to 13 and represent  $2^0$  (1) to  $2^{13}$  (8192). Changing a setpoint by 1 changes the width of the chromatogram by a factor of 2. The chromatograms in [Figure 21](#) illustrate this. Use the smallest possible value to minimize integration error.

See [Table 20](#) for output scaling.

**Table 20 Output Scaling**

Analog	One display unit =	Digital	One display count =
0 to 1 mV	$1\text{mV}/(2^{\text{Range}} \times 2^{\text{Attn}})$	Cerity and ChemStation software	1 height count



**Figure 21 Effect of range setting on chromatogram**

There are limits to usable range settings for some detectors. The table below lists the valid range setpoints by detector.

Detector	Usable range settings (2 <sup>x</sup> )
FID	0 to 13
NPD	0 to 13
FPD	0 to 13
TCD	0 to 6
μ-ECD	0 to 6
Analog input	0 to 7

Range may be run time programmed. See ["Procedure: Programming run time events"](#) for details.

### Attenuation—for analog outputs only

Attenuation(Attn) scales the presentation of output on 0- to 1-mV strip chart recorders. Valid setpoints are from 0 to 10 and represent 2<sup>0</sup> to 2<sup>10</sup>. As with range, each higher setpoint value reduces the size of the chromatogram by one half, while each higher setpoint doubles the size.

Attenuation is in addition to range. Thus, the total scaling factor is:

$$2^{\text{Range}} \times 2^{\text{Attenuation}}$$

Attenuation may be run time programmed. See ["Procedure: Programming run time events"](#) for details.

### Data rates

Your integrator or recorder must be fast enough to process data coming from the GC. If it cannot keep up with the GC, the data may be damaged. This usually shows up as broadened peaks and loss of resolution.

Speed is measured in terms of bandwidth. Your recorder or integrator should have a bandwidth twice that of the signal you are measuring.

The GC allows you to operate at two speeds. The faster speed—to be used only with the FID, FPD, and NPD—allows minimum peak widths of 0.004 minutes



(8 Hz bandwidth), while the standard speed—which can be used with all detectors— allows minimum peak widths of 0.01 minutes (1.6 Hz bandwidth).

If you use the *fast peaks* feature, your integrator should operate at around 15 Hz.

### Procedure: Selecting fast peaks

1. Press [Config][Signal 1] or [Config][Signal2].



2. Press [ON] (FID only).

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## Digital data handling

### Digital zero

Digital signal outputs respond to the `Zero` command by subtracting the signal level at the time of the command from all future values.

### Baseline level shifts

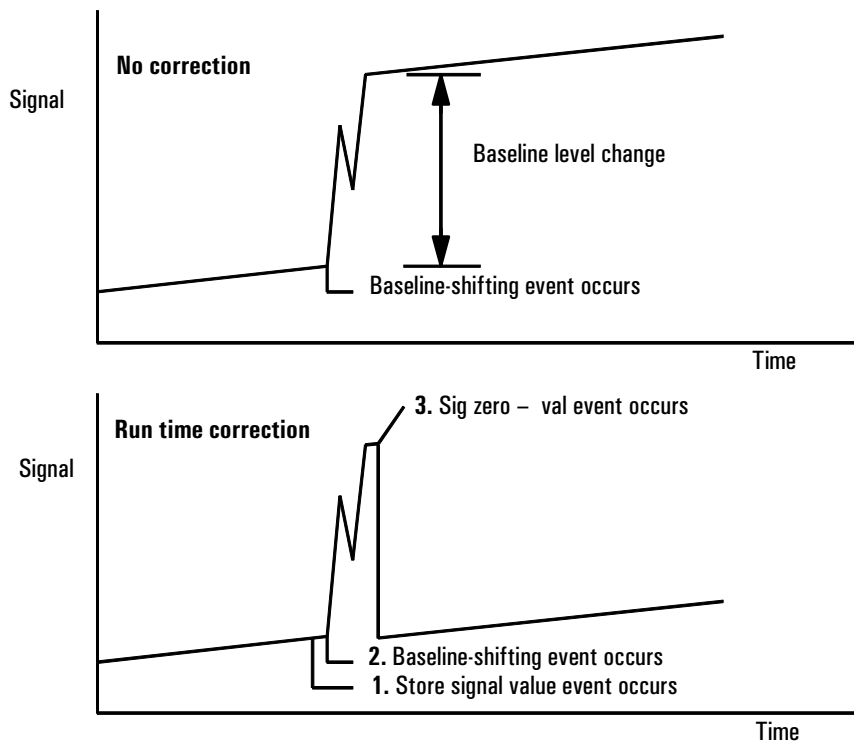
Some run time operations, such as changing signal assignment or switching a valve, can produce large changes in the signal baseline position. This can complicate signal processing by external devices. The GC provides two run table commands to minimize such problems—see ["Run time programming"](#).

`Store signal value` Saves the value of the signal at the time of the command.

`Sig zero - value` Creates a new zero by subtracting the stored value from the current value of the signal and applies this zero to all future values.

When these commands surround a baseline-shifting command, the effect is to bring the new baseline to the previous level, as shown in [Figure 22](#).

The `Store` event must occur before the event that shifts the baseline, and the `zero - value` event must occur after the baseline has stabilized at the shifted level.



**Figure 22 Correcting baseline level shifts in digital signals**  
**Cerity\ChemStation**

The GC can process data at 11 different data rates, each corresponding to a minimum peak width. The table shows the effect of data rate selection.

**Table 21 Cerity\ChemStation Signal Processing**

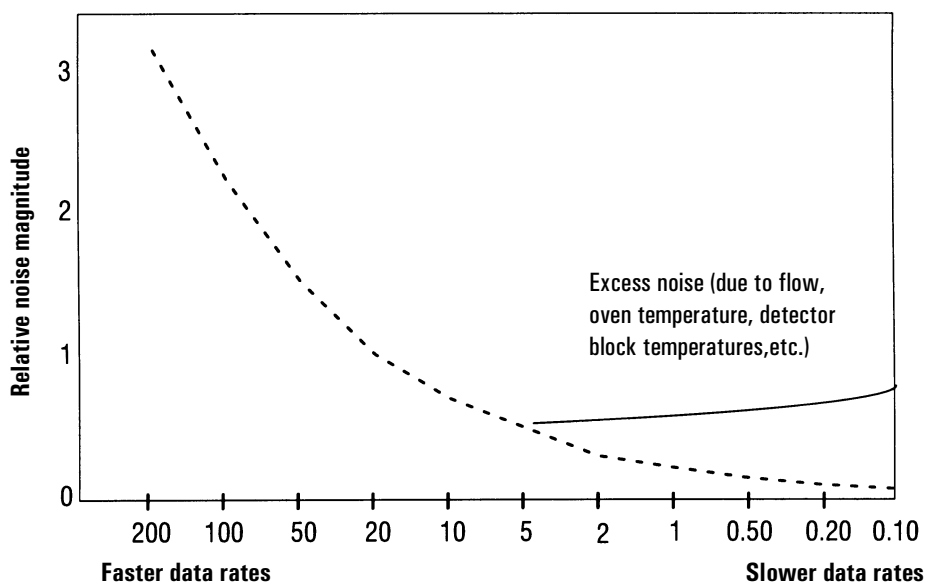
<b>Data rate</b>	<b>Minimum peak width</b>			
<b>(Hz)</b>	<b>(minutes)</b>	<b>Relative noise</b>	<b>Detector</b>	<b>Column type</b>
200	0.001	3.1		Narrow-bore (50 $\mu$ m)
100	0.002	2.2	FID/FPD/NPD only	capillary
50	0.004	1.6		
20	0.01	1		
10	0.02	0.7		
5	0.04	0.5		to
2	0.1	0.3	All types	
1	0.2	0.22		
0.5	0.4	0.16		
0.2	1.0	0.10		
0.1	2.0	0.07		Slow packed

You cannot change the data rate during a run.

You will see higher relative noise at the faster sampling rates. Doubling the data rate can double peak height while the relative noise increases by 40%. Although noise increases, the signal-to-noise ratio is better at the faster rates.

This benefit only occurs if the original rate was too low, leading to peak broadening and reduced resolution. We suggest that rates be chosen so that the product of data rate and peak width in seconds is about 10 to 20.

[Figure 23](#) shows the relationship between relative noise and data rates. Noise decreases as the data rate decreases until you get to data rates of around 5 Hz. As the sampling rate slows, other factors such as thermal noise increase noise levels.



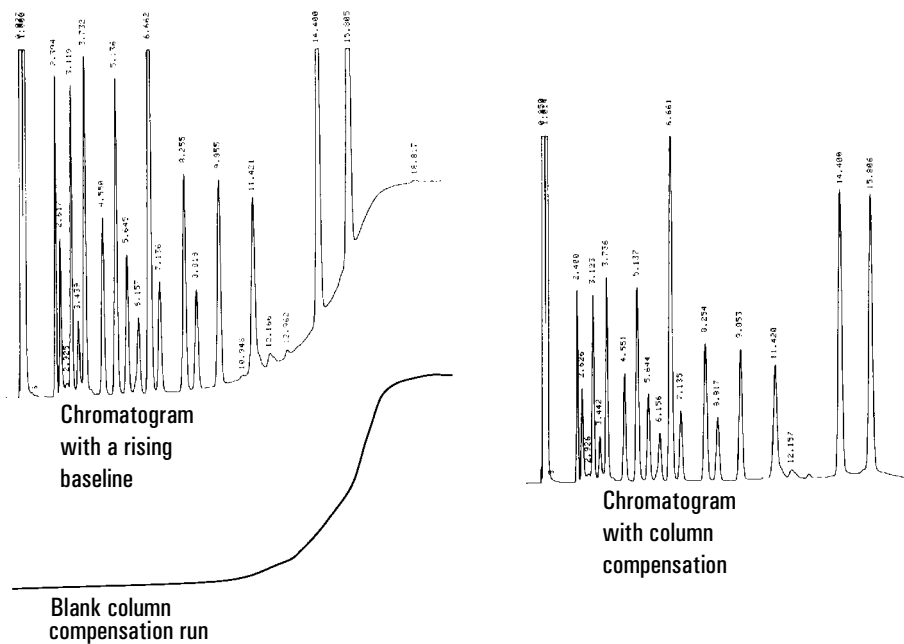
**Figure 23 Relationship of noise to data rates**

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## Column compensation

Peaks are integrated more accurately and repeatably on a flat baseline than on a rising baseline. Column compensation corrects for baseline rise during temperature programming. This is done by making a blank run—one with no sample injected. This run is stored and subtracted from the *real* run to produce a flat baseline. [Figure 24](#) illustrates the concept.

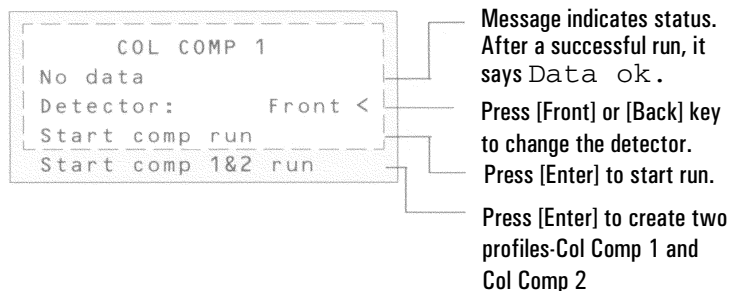
All conditions must be identical in the column compensation run and the *real* run. The same detector and column must be used, operating under the same temperature and gas flow conditions. Two baseline profiles may be stored (as [Col Comp 1] and [Col Comp 2]).



**Figure 24 Column compensation**

### Procedure: Creating a column compensation profile

1. Set up the instrument for a run.
2. Make a blank run to verify that the baseline is clean. This is particularly important for new conditions or if the GC has been idle for several hours.
3. Press [Col Comp 1] or [Col Comp 2] to open the control table.
4. Press [Front] or [Back] depending on the detector you are using.



5. Select Start comp run or Start comp 1&2 run. Press [Enter].
  - a. Start comp run creates one profile.
  - b. Start comp 1&2 run creates two profiles (using different detectors and columns but the same oven temperature program).
6. If the run is successful, the first line of the control table will say Data ok, and a time and date will appear at the bottom.

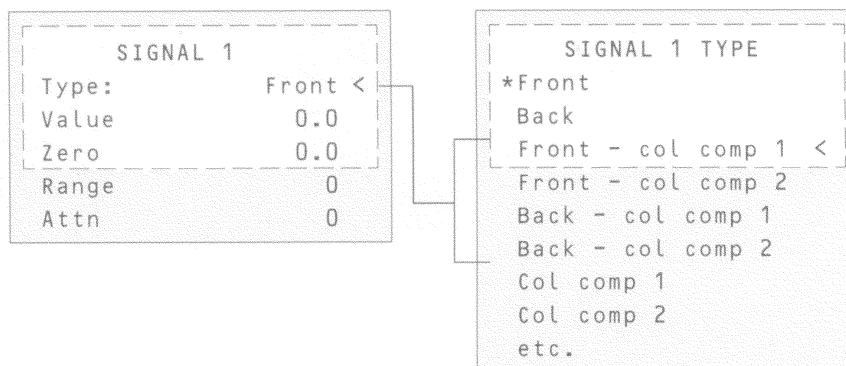
### Procedure: Making a run using column compensation

1. Set the up chromatographic conditions. They must be identical to those in the stored column compensation run except that Final time in the last ramp of the oven program can be longer or shorter.
2. Press [Signal 1] or [Signal 2] to access the signal control table.

3. Scroll to **Type:** and press [Mode/Type].

Press [Signal 1] or [Signal 2]

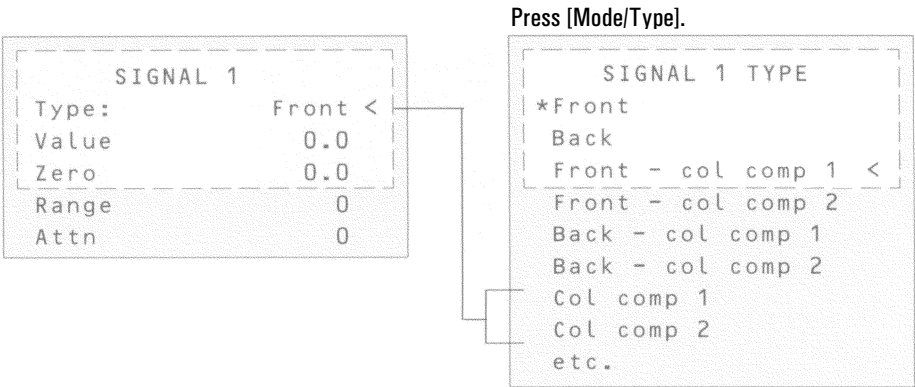
Press [Mode/Type]



4. Choose **Front - col comp 1** or one of the other three column compensation options on the list.
5. Enter setpoints for **Zero**, **Range**, and **Attn**, if applicable.
6. Start your run.

**Procedure: Plotting a stored column compensation profile**

- 1. Press [Signal 1] or [Signal 2] to open the signal control table.
- 2. Scroll to Type: and press [Mode/Type].
- 3. Choose Col comp 1 or Col comp 2.
- 4. Press [Start].



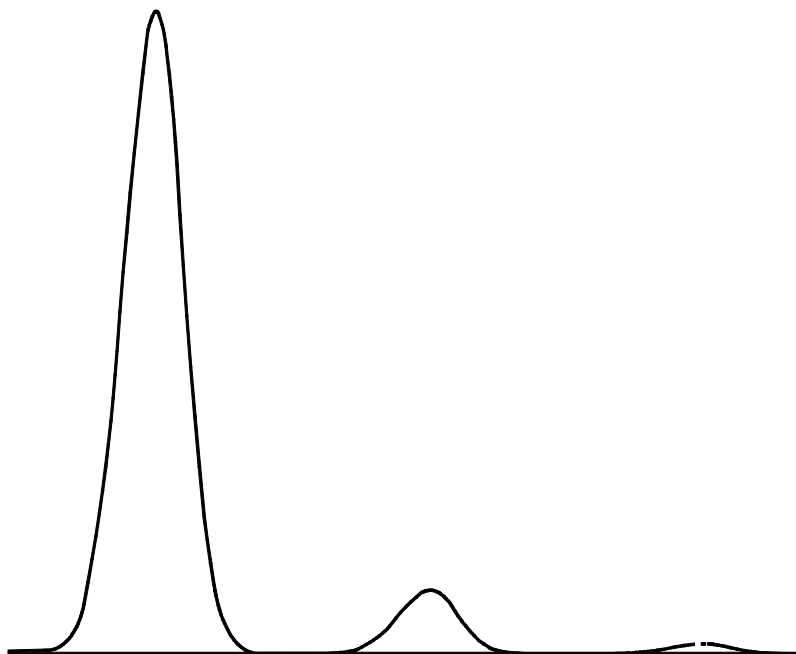
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**Test plot**

Test plot is an internally generated “chromatogram” that can be assigned to a signal output channel. It consists of three baseline-resolved, repeating peaks.



The area of the largest is approximately 1 Volt-sec, the middle one is 0.1 times the largest, and the smallest is 0.01 times the largest.



Test plot can be used to verify the operation of external data processing devices without having to perform repeated chromatographic runs. It may also be used as a stable signal to compare the results from different data processing devices.