



GD Environmental Supplies, Inc.

NUTECH[®] 2100
CANISTER CLEAN SYSTEM
OPERATION MANUAL

Version 1.1
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GD Environmental Supplies, Inc.



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1. Introduction

Nutech 2100 is a system designed to clean SUMMA or silica coated canisters or other air sampling containers (using canisters to represent all those in all the following description). By repeatedly filling zero air or other pure gases into the canisters followed by withdrawing air out and keeping vacuum for a period of time the canisters canister will be thoroughly cleaned. The device adopts programmable logic control which enables to easily modify cleaning times, time limit, vacuum control range and zero air-filling pressure control range, it is ideal for cleaning smaller vessels and generating vacuum.

2. Technical Standards

Maximum vacuum pressure: 50motorr (absolute pressure)

Maximum air-filling pressure: 35psi (surface pressure)

Maximum display vacuum pressure: 0.75mtorr

Temperature under: 4~40°C

Humidity under: <80%

Magnetic field intension: <30Gs

Power voltage: AC110V 50Hz or AC220V 50Hz

Consumption power: 1.0KW

3. System composition

The system is composed of vacuum pump, Vacuum pressure gauge, Pressure switch, High Vacuum gauge, Canister , electromagnetic

valves V1~V5 and Programmable Logic Control (PLC) together with Touch Screen Panel TP170.

The system is controlled by two modes: manually control or automatically control.

When manually operation, Pumping, Wet or Dry gas filling can be done by single Step operation.

When automatically, the system can run automatically step by step following predefined requirements (including vacuum pressure limit, Wet gas clean cycle counts, Dry gas clean cycle counts, Vent Off-Delay.) No manually operation is necessary and running status can be displayed through indicator light and high vacuum gauge. In the automatic cycle, vacuum pump keeps running and merely various valves need to be switched on or off as required.

Switching between automatic and manual control is processed by pressing different touch switches, manually operations include Run-m, Pumping, Fill wet gas, Fill Dry gas, Reset and Return touch keys. Under auto mode it can be started by pressing Run-A touch key. Reset key is used to break and reset when the system is running. P1~P3 are display pressure/vacuum values state, which are pre-set (Note: zero air-filling pressure limit for P1 is 30 psi, P2 means vacuum limit for pumping conversion to next filling, P3—final vacuum pressure value), and can be modified when needed. Cycle Value and Vent

Off-Delay Value all can be modified if really necessary, these can be done in “Set” menu.

4. Instruction for Installation

The following preparations need to be done before installation:

1. A working table or desk in 2.5 ~3 feet high and 5~6 feet long which should be used to install mainframe and Manifold;
2. Necessary tools for installation;
3. 110 VAC/220V, 2KW Power for mainframe and 4 heating strip (if heating oven used the power supplier for oven is required);
4. Super pure water (chromatogram level);
5. Super zero air or high pure nitrogen, pressure over 35 psi.

Warning: helium is not allowed to use as it will damage the high vacuum gauge.

Unpack the case: First check if case is damaged then unpack the case to count if certain apparatus is missing. Full set of Nutech 2100A&B Canister Cleaning kit includes:

1. Nutech 2100A or B Canister Cleaning mainframe;
2. Manifold and stand;
3. Vacuum pump;
4. 2 feet KF16 stainless stretchable joint pipe for connection between vacuum pump and mainframe;
5. 3 feet KF16 stainless steel stretchable joint pipe for connection

between manifold and mainframe;

6. The system includes 4 stainless steel stretchable joint pipe for connecting the canister. These pipes connect canister and manifold at each end.

7. Humidifier: It has 2 1/8 inch outlets, which connect zero air supply line and zero air entrance of mainframe. The humidifier needs to be filled with super pure water at half level.

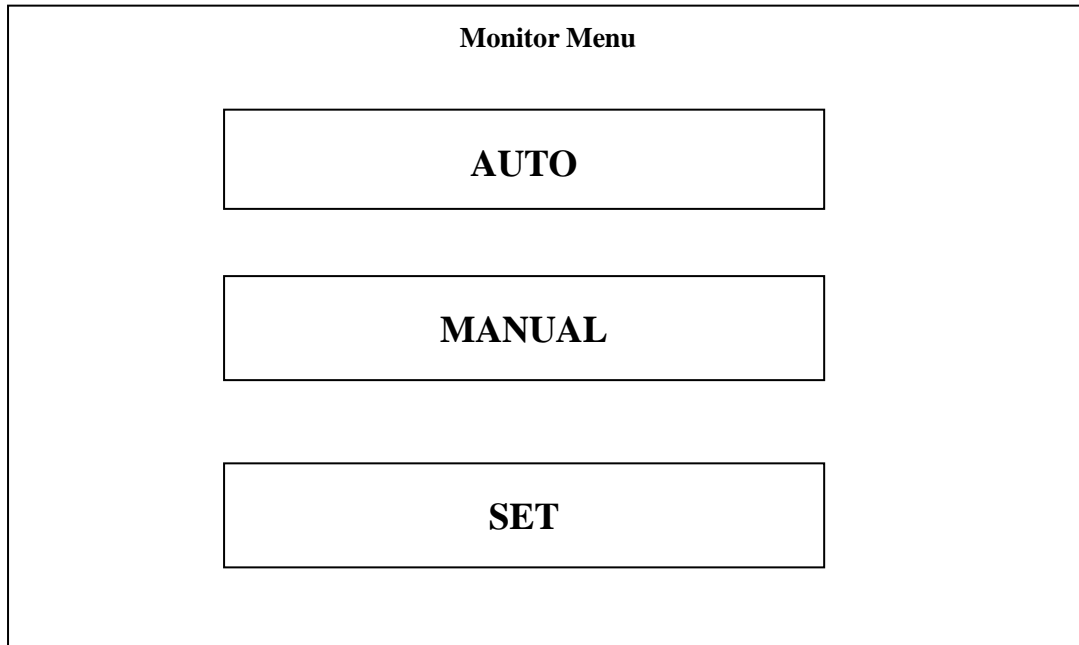
Check if canister body, inner parts and pump is damaged or join pipe is filled with stuff. If everything remains fine, first remove block of the pipe, then connect the pipe and wire. Mount the stand before connecting the pipe, secondly connect pipe wire for air route as required. Pipe wire must be firmly connected to ensure all the tie-ins are air-proof (Note: Make sure there is no stuff in the pipe before connecting pipe wires or it will spoil the pump). Then connect intake pipe for zero air, and set pressure of zero air at about 35 psi through regulator (it is recommended that air should be purified by purifier before being filled to keep air clean) After connecting air route pipes, plug in 110VAC/220 VAC as instructed.

5. Basic operations

A. Introduction of touch screen operation menu

The system adopts touch screen for operation and control, it includes 4 screens as shown below: Screen 1 is main menu which contains 3

buttons AUTO, MANUAL and Set. When a certain button is pressed, the next an operation screen will be displayed accordingly.



Screen 2: Automatic operation menu

Auto Operation		
Run-A	Wet gas Cycle	0
Start	Dry gas cycle	0
Reset		Return

It contains 4 buttons and 2 feedback variable status boxes, automatic operation will start when Run-A and Start are pressed (press Run-A first then Start), Wet gas Cycle box will now display wet gas clean cycle value; Dry gas Cycle box will now display dry gas clean cycle value; When two cycle is completed, 1 will be incremented in the box. When all cycles are done until the set value is reached, the counting will stop and vacuum pump will keeps running. When vacuum degree reaches the set value (P3), the system will give an alarm which indicates that canisters have been thoroughly cleaned and close the valve of the canisters. Now press “Return” to return to main menu.

Screen3: Manual operation menu

Manual Operation		
Run-M	P1	OFF
Pump	P2	OFF
Fill wet gas	P3	OFF
Fill Dry gas		Reset
		Return

It contains 6 buttons and 3 feedback variable status boxes. Press “Run-M” to start manually operation and then continue other necessary operations. “Reset” is used to reset the operation and “Return” is to return to main menu.

Screen 4: Parameter modification menu

Parameter Set	
Vent Off-Delay	100
Wet Gas Cycle	3
Dry Gas Cycle	2
Return	

It contains 1 timing units Vent Off-Delay and 2 counting units Wet Gas Cycle, Dry Gas Cycle. The value in the display box is default value, press “Return” is to return to main menu. In case data in a certain

display box needs to be modified, a keyboard screen will display by simply pressing the corresponding display box, a desired value can be selected and press “Enter” button, modification process is completed.

B. Preparations for operation

1) Check if pipes are correctly connected, and check if electrical wiring is correct and power voltage is 110VAC or 220VAC. Then correctly plug in power. Check if power for upper side vacuum pump return switch is connected.

2) Turn on power switch and warm up high vacuum gauge for 10 minutes.

3) Make sure if all parameters need to be modified. (Including wet gas and dry gas cycle times, all vacuum degree set values P2, P3.)

Parameters. The default values of the parameters are: wet gas cycle =3 dry gas cycle =2, P2=500mtorr, P3=200mtorr). If change is needed, open main menu and select “Set” screen, then modify the needed parameters.

4) Close the valve of the canisters, select “Manual” screen, start vacuum pump manually, conduct a vacuum pumping test and see if the system is airproof as required.

C. Instructions for manual operations

1) Select “Manual” in the main menu screen and open manual operation menu.

- 2) Press “Run-M” and enter manual operation status.
- 3) Press “Pump” button and start pumping vacuum. Make sure canister valve is opened.
- 4) Press “Fill wet gas” or “Fill dry gas ” button and start filling wet or dry zero air, when filling pressure $P1 \geq 30\text{Psi}$, the system will automatically shut down air valve.
- 5) Repeat step 3 and 4 until cleaning process is completed. Press “Reset” to return to default status and exit the operation.

D. Instructions for automatic operation

- 1) Open main menu, select Auto button and open the “Auto Operation Menu”.
- 2) Press “Run-A ” and enter automatic operation status, press “Start” to start auto operation process. The system first enters wet zero air filling process. canisters is filled with wet zero air, The vent valve has been open when air filling pressure reaches $P1$ ($P1=30\text{Psi}$), then the vacuum pump valve open. The system enters wet gas clean cycle.
- 3) When the system reaches set vacuum pressure value, that is $P2 \leq$ set value ($P2$ default value is 500mtorr, it is changeable when needed), the process is shifted to wet zero air filling process.
- 4) When the system enters wet gas filling process, canister is filled with wet zero air(dry zero air pass through Humidifier get humidity), air

filling pressure P1 of the system is being constantly monitored, when $P1 \geq 30\text{Psi}$, it shifts to next air pumping cycle (Note: during the cycle process, vacuum pump keeps running) .

5) The program runs in cycles repeatedly, after several cycles, when Wet gas cycles value is equal to preset value (Wet gas cycles value default value is 3, it is changeable when needed), it runs enters dry gas cycle. When Dry gas cycles value is equal to preset value toward the end, when P3 value is less than or equal to set value (P5 default value is 200mtorr, it is changeable when needed), the system will give an alarm to indicate that cleaning is thoroughly completed.

E. Modification of preset parameters

1) Modification of P1 value

P1 value is controlled by Pressure Switch, The default value is 30Psi. P1 Value can be changed by inserting the needle to another place. This should be done by specialist, it is recommend that the user should not change it by himself.

2) Setting and modification of P2 and P3 values

Setting and modification of P2 and P3 values can be done through SVG-1TM high vacuum gauge. Each pressure value has its upper and lower range limit, take P2 for example its default value is $5.0\text{E}2=500\text{mtorr}$, and its pressure range limit is from $5.0\text{E}2=550\text{mtorr}$ to $5.5\text{E}2=500\text{mtorr}$, the upper limit is 550mtorr and lower limit is 500mtorr.

Please note that the upper and lower limits can be changeable while the upper value should not be less than the lower limit.

Example of modification of P2 and P3 values is as follows: when the vacuum gauge is displaying the measured value, press “Function” button to enter input status of vacuum pressure control value, “0” indicates that the lower limit data is at input status, then press “Function” to display a upper limit value of P2 previously set, (its default value is set as $5.5E2=550\text{mtorr}$), in the meanwhile the number at first digit flashes (integer digit), use “Set digit” to input flash digit, each time “Set digit” is pressed, the number will increment by 1, until it reaches “9”, and press “Set digit” again, it will return to “0” (it is a cycling process). Input the value and then press “Function”, the second digit flashes (fraction digit), use “Set digit” to input the needed data the same way, then press “Function”, make the third digit flash (sign digit), use “Set digit” to enable change from “E-” to “E”, or from “E” to “E-”, input the sign digit (here it refers to E), then press “Function” the fourth digit flash (exponent digit), press “Set digit” to input the value in the same way. Then press “Function”, display “1”, it indicates the upper limit of “P2” vacuum pressure value will enter input status, input the lower limit value of “P2” the same way as above (the default value is $5.0E2=500\text{mtorr}$). Accordingly “2” and “3” will be displayed, set the lower and upper limit value for “P3” the same way, (the upper default value of P3 is already

set as 2.2E2=220mtorr, the lower default value is set as 2.0E2=200mtorr). After setting all the values, then press “Function” to enter working status. During the operation above, if “Reset” is pressed, then measuring status is entered.

3) Setting and modification of PLC parameters

As human-friendly monitoring screen TP170 is adopted, it is very easy to modify PLC parameters, this can be done by selecting “Set” button and opening Parameter Set. Screen of Menu 4 It contains all the parameters available, if a parameter is to be changed, just press the corresponding display box and a keyboard screen will be displayed, select the number key in the keyboard and press enter to modify the parameter.

A	1	2	3	ESC
B	4	5	6	DEL
C	7	8	9	+/-
D	E	F	O	,
←	→			↵

6. Maintenance and common debugs.

1. Make sure the power supplier's voltage is match the instrument.

2. Avoid intense vibration when the system is working. Do not put stuff on the machine and the top, so that the heat can easily scatter.
3. The main equipments should put aside from strong magnetic field. The good ground is necessary for instrument operating.
4. It is forbidden to pull out electrified socket or wires so that inner apparatus will not be damaged.
5. It is forbidden to change PLC parameters without permit. If change is needed, it only can be done by specialists.
6. Ensure the plug in power for vacuum pump is 220VAC, it is forbidden to use 110 VAC power.
7. Please refer to attached “Instructions for use of vacuum pump” for maintenance and common debugs for vacuum pump.



Restek's ProFLOW 6000 Electronic Flowmeter

Users Manual
Version 5.5
for cat.# 22656

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1.0 Introduction

Restek's ProFLOW 6000 Flowmeter is specifically designed for use with gas chromatography (GC) systems. The probe is applied directly to the gas flow stream and the measured flow rate is presented on the LCD screen. Units of flow are measured in mL/min.

This unit provides continuous real-time measurements of gas streams ranging from 0.50 mL/min to 500 mL/min. Because the technology uses volumetric flow measurement, the unit is compatible with all laboratory gases.

CAUTION: Do NOT exceed maximum operating flow rates. Recalibration may be required if the unit has been subjected to extreme flow rates.

Always use appropriate laboratory safety practices when operating this device. Wear laboratory safety goggles when operating this unit.

2.0 Specifications

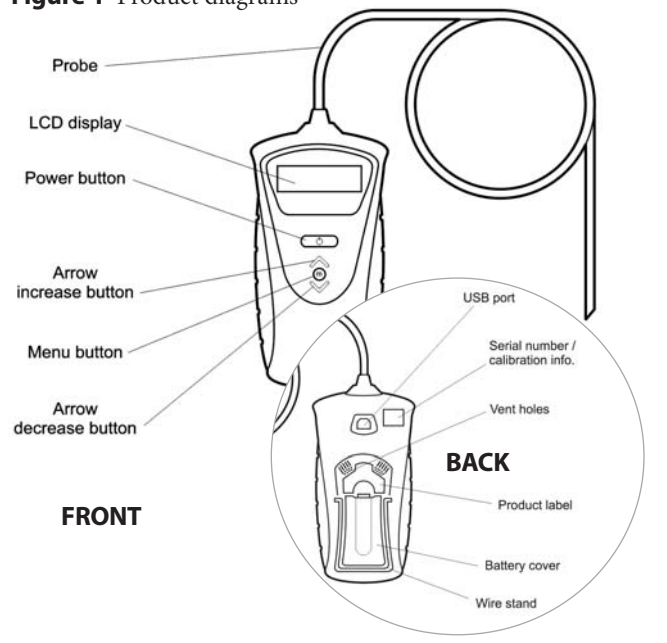
Table I

Type of measurement	Volumetric flow
Accuracy of measurements	$\pm 2\%$ flow or ± 0.2 mL/min., whichever is greater
Power requirements	2 AA Alkaline Batteries 1.5VDC each/3VDC 200ma
Operating flow range	0.50 to 500 mL/min.
Operating temperature range	32°-120°F (0°- 48°C)
Available communication	USB data port
Warranty	one year
Calibration	NIST traceable. Yearly recalibration is recommended.
Certifications	CE, Ex (see section 10.0)
Compliance	WEEE, RoHS (see section 10.0)

NOTE: There are no serviceable parts in this unit. Opening the device—other than to change the batteries—or tampering with the internal parts will void the factory warranty.

NOTE: To ensure accurate measurements and effective clearance of the flow gas from the unit, DO NOT obstruct the vent holes on the back of the unit.

Figure 1 Product diagrams



3.0 Installing the batteries

This unit uses 2 AA alkaline batteries.

To install batteries, extend the wire stand. Open the cover. Insert the batteries with the polarity (⊕ and ⊖) correctly aligned. Close the cover. (Figures 2 and 3)

Precautions for battery replacement:

- Load the new batteries with their polarity (⊕ and ⊖) aligned correctly.
- Do not use rechargeable batteries.



4.0 Battery power consumption

4.1 Battery lifetime

The battery lifetime is dependant on the number of options the user has enabled.

The unit is shipped with the most energy demanding options disabled (Table II).

The power saving functions can be changed.

- See Section 8.2: Adjust LCD Character Contrast (p.9).
- See Section 8.3: USB Activation (p.10).
- See Section 8.4: Adjust LCD Image Backlight (p.10).
- See Section 8.7: Adjust Auto Shutoff Duration (p.12).

4.2 Battery charge indicator

The unit includes a battery charge indicator. Replace batteries as needed.

- See Section 8.5: Show Battery Charge Indicator (p.11).

Figure 2 Extend the wire stand before opening battery door.



Figure 3
Insert the batteries as marked.

Table II Default settings for the ProFLOW 6000

Auto shutoff duration	6 minutes
LCD backlight	0 (off)
LCD character contrast	5
USB port	disabled


NOTE: Store your ProFLOW 6000 in its protective storage case following use. Keep the manual under the unit; placing the manual on top can result in the unit being turned on when the lid is closed.

5.0 Operating instructions



CAUTION: Do not exceed maximum operating flow rates. Recalibration may be required if the unit has been subjected to extreme flow rates.

Connect the white probe end tip to the output of the gas flow line to be measured. Be sure the probe tip connection is completely sealed around the flow source outlet and is free of leaks (Figure 4).

Press and hold the  (power) button until the unit responds with a regular clicking sound. The ProFLOW will immediately begin to provide flow measurements (Figure 5). Wait for the measured values to stabilize. It takes a few seconds for the unit to reach a steady state with the gas flow line.

To power down the unit press and hold the  (power) button until the unit stops clicking.

The unit is equipped with a timed auto shutoff option (Default: 6 minutes).

→ See Section 8.7: Adjust Auto Shutoff Duration (p.12).

Figure 4 Probe connected to a GC gas outlet.



Figure 5 LED displays the measured flow value.



6.0 Interpreting results

The unit has an operating range of 0.50mL/min. to 500mL/min. (Figure 7). If the flow is less than 0.50mL/min., the display will read “under range”.

If the flow exceeds 515mL/min., the display will read “over range”. Excessively high flow rates may damage this unit.

NOTE: units of mL/min. are equivalent to ccm.

6.1 Flow range display

The unit automatically adjusts the resolution of the display depending on the flow range being measured. Table III shows the resolution of the flow ranges.

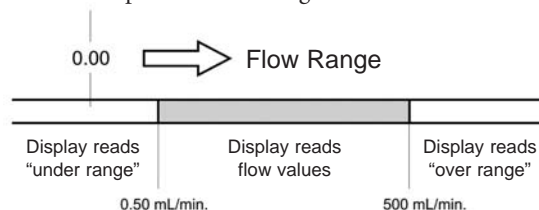
Table III Display resolution vs. flow range.

Flow range	Display resolution (mL/min.)
0.50 – 9.99	0.01
10.0 – 99.9	0.1
100 – 500	1

Figure 6 Example flow value.



Figure 7 Description of flow ranges.



7.0 Data collection on the PC



WARNING: ONLY connect USB cable to USB port while unit is OFF.

The ProFLOW 6000 provides you with a data stream of real time flow values via the USB port (Figure 1, p. 3). In order to use this feature, you must first install the appropriate FTDI Virtual Com Port (VCP) Driver available at:

<http://www.ftdichip.com/Drivers/VCP.htm>

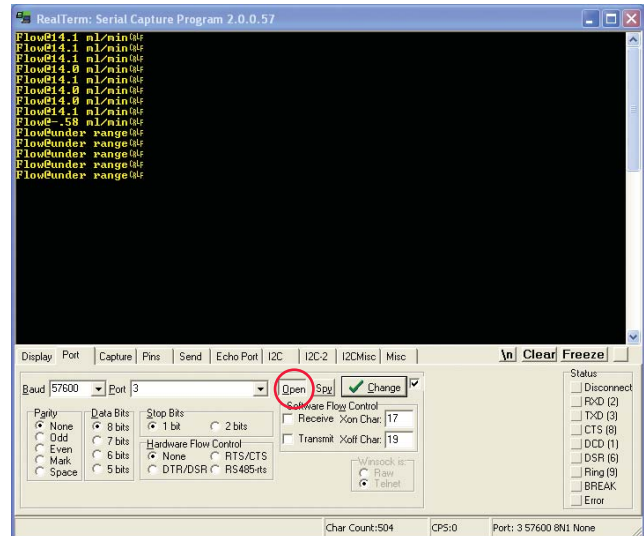
The VCP driver will cause the ProFLOW to appear as a standard RS-232 port. This will work on any operating system for which there is an FTDI VCP driver. After installing the driver, connecting the device, and determining which port it creates, you can access the data stream through any programmatical means, or by using any serial terminal software.

For Windows systems:

To determine which port the ProFLOW is using, go to the Control Panel and open System. Go to the Hardware tab and click the Device Manager button. Expand the Ports (COM & LPT) entry. Make sure the VCP driver is installed, then connect a powered ProFLOW 6000 to the USB port. You will see the new COM port appear. Open your serial terminal.

→ See Section 8.3: USB Activation (p.10).

Figure 8 Screen capture of data collection.



If you do not already have serial terminal software, free, open source options are available online (i.e. RealTerm, etc.). You can download RealTerm* software from:

<http://realterm.sourceforge.net/>

After installation, click the Port tab and set the following:

Baud: 57600

Port: the appropriate VCP for your ProFLOW

Parity: None

Data Bits: 8 bits

Stop Bits: 1 bit

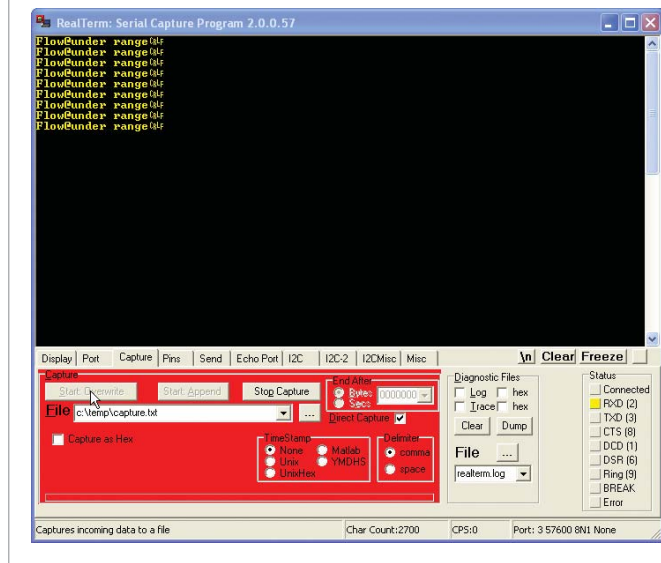
HardwareFlow Control: None

Go to the USB menu entry in the ProFLOW and turn the transmission on. Finally, click **Open** on the Port tab in RealTerm and you will see the serial data stream begin in the terminal window (Figure 8).

If you would like to log the flow data, this can be done by clicking on the Capture tab. Set File to the name and location of the log file that you would like to save and click either the **Start: Overwrite** or **Start: Append** buttons appropriately (Figure 9).

**This software is not supplied or supported by Restek. User assumes all responsibility for the downloading and use of the program.*

Figure 9 Screen capture of data collection.



8.0 ProFLOW 6000 menu structure

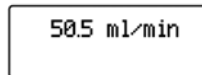
8.1 Unit power up/power down

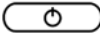
Press the  (power) button:

The LCD screen will display the device intro screen:



Followed by measured flow data:



To power off, press and hold the  (power) button:

Other messages encountered at power up

Calibration
-expired-


Appears temporarily if the unit's calibration has expired (>1 year).



→ See Section 14.0: Calibration and Service

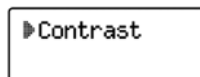
under range

If the unit is hooked up to a flow stream with a flow rate less than 0.50 mL/min. the unit will report an "under range" status for the flow. This message will appear until the flow rate exceeds 0.50 mL/min.



8.2 Adjust LCD character contrast


Press the  (menu) button.


Use the 
 (arrow) keys to select the contrast menu:




Press the  (menu) button again to enter the value select screen.



Use the 
 (arrow) keys to select the contrast value.
Contrast Values: 1 (lightest) and 5 (darkest).

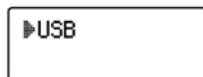
To return to the main menu screen, press the  (menu) button.

To exit and return to measuring flow, press the  (menu) button again.



8.3 USB activation


To enable the USB, press the  (menu) button.


Use the   (arrow) keys to select the USB menu:



Press the  (menu) button again to enter the value select screen.


Use the   (arrow) keys to toggle between USB 'on' and 'off'.



To return to the main menu screen, press the  (menu) button.

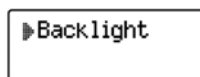
To exit and return to measuring flow, press the  (menu) button again.

→ See Section 7.0: Data Collection on the PC



8.4 Adjust LCD image backlight


Press the  (menu) button.


Use the   (arrow) keys to select the backlight menu:




Press the  (menu) button again to enter the value select screen.


Use the   (arrow) keys to select the backlight value.
Backlight Values: 0 (off) and 5 (maximum).

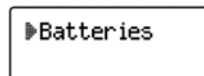
To return to the main menu screen, press the  (menu) button.

To exit and return to measuring flow, press the  (menu) button again.

8.5 Show battery charge indicator

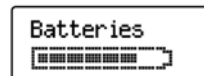
Press the  (menu) button.


Use the  (arrow) keys to select the Batteries menu:




Press the  (menu) button again.


The battery life is displayed.




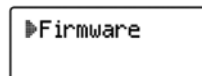
To return to the main menu screen, press the  (menu) button.

To exit and return to measuring flow, press the  (menu) button again.

8.6 Firmware version information

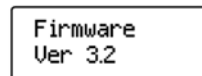
Press the  (menu) button.


Use the  (arrow) keys to select the Firmware menu:




Press the  (menu) button again.


The most recent version of Firmware is displayed.




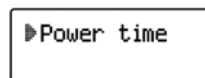
To return to the main menu screen, press the  (menu) button.

To exit and return to measuring flow, press the  (menu) button again.


8.7 Adjust auto shutoff duration


To conserve battery life, the unit automatically turns off after 6 minutes. To customize the auto shutoff setting, press the  (menu) button.


Use the  (arrow) keys to select the Power time menu:



Press the  (menu) button again to enter the value select screen.

Use the  (arrow) keys to select the auto shutoff setting.
Values: 1–59 minutes or ‘constant on’ (max.)

To return to the main menu screen, press the  (menu) button.

To exit and return to measuring flow, press the  (menu) button again.

9.0 Troubleshooting

Problem	Possible Cause(s)	Suggested Solution(s)
Multiple readings are not giving reproducible results.	<ul style="list-style-type: none">• Unit is out of calibration• Value is being compared to a bubble flowmeter	<ul style="list-style-type: none">• Return the unit to Restek for recalibration*• See Section 12.0 for a discussion of the weaknesses of bubble flowmeters
Unit does not power up	<ul style="list-style-type: none">• Dead batteries	<ul style="list-style-type: none">• Replace with 2 new AA alkaline batteries
Flow value display is erratic/jumpy	<ul style="list-style-type: none">• The ProFLOW 6000 is very sensitive to small changes in flow	<ul style="list-style-type: none">• Allow more time for flow to stabilize

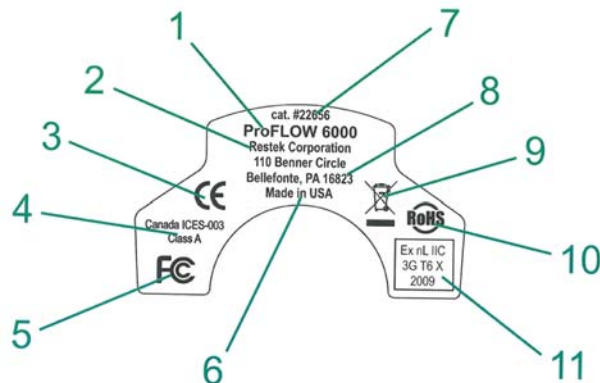
*Contact Restek or your Restek representative for return instructions for servicing a damaged unit. Additional charges may apply if the warranty has expired or the unit is damaged due to misuse.

Call Technical Service at 800-356-1688 or 814-353-1300, ext. 4 (or your Restek representative) if you have any questions about this product or any other Restek product.

10.0 Product back label legend

Description

- 1 Product name
- 2 Company name
- 3 This unit conforms to EU/EMC Directive 2004/108/EC; standards to which conformity is declared include 61326:1997 w/A3 Class A.
- 4 This Class A digital apparatus complies with Canadian ICES-003.
- 5 This complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.
- 6 Country of origin
- 7 Product catalog number
- 8 Company address
- 9 This unit is WEEE compliant.
- 10 This unit is RoHS compliant.
- 11



Ex nL	EN60079-0: 2006; Electrical apparatus for explosive gas atmospheres- Part 0: General Requirements. EN60079-15: 2005; Electrical apparatus for explosive gas atmospheres- Part 15: Construction, test and marking of type of protection "nL" energy limited apparatus.
IIC	Group II applies to areas above ground environments. Gas Group IIC relates to hydrogen and related gas types.
3G	Category 3 relating to gas analysis; normal safety measure. Sufficient safety during normal operation. Normal operation described as measuring flows of flammable or explosive gases in a nonflammable environment.
T6	During testing neither internal nor external elements exceed 85°C.
X	Additional information: Operating range: $32^{\circ}\text{F} \leq \text{Tamb} \leq 120^{\circ}\text{F}$ $0^{\circ}\text{C} \leq \text{Tamb} \leq 48^{\circ}\text{C}$ Not intended for outdoor use or wet locations.
2009	Year of product design release.



www.restek.com



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11.0 Volumetric vs. mass flow measurements

The Restek ProFLOW 6000 is a volumetric flow measurement device. Volumetric flow is the measurement of the volume of gas through a conveyance per quantity of time. Standard units of measure for this parameter are given in mL/min. The advantage of measuring volumetric flow is its independence to the composition of the flow gas. It is not necessary to correct the flow values based on the gas composition, as is required for mass flow devices.

Mass flow measures the weight of the gas flowing through the instrument per quantity of time. Mass flow units of measure are commonly g/sec.

12.0 Bubble flowmeter measurements

If you employ bubble flowmeters in your laboratory, you may find they give slightly different flow rate values than the Restek ProFLOW 6000. This error is due to technology limitations inherent in the bubble flowmeter device; error from variances in air humidity within the bubble chamber and its direct contribution to the measured flow rate. In the event a bubble flowmeter is used to measure flow gas where the gas is at elevated temperatures, the error due to humidity contributions can be extreme. For the most accurate measurement of laboratory gas flow rates, we recommend using the Restek ProFLOW 6000 over bubble flowmeters.

13.0 Product case specifications



14.0 Calibration and service

The Restek ProFLOW 6000 comes factory calibrated and carries a one year warranty from time of purchase. All units are calibrated to NIST traceable standards.

Recommended schedule for recalibration is once every year from time of purchase. Customers will need to return the unit to Restek for recalibration. At that time, preventative maintenance services can also be performed. A fee will be charged for recalibration and servicing of the unit. Prolonged failure to recalibrate the instrument may result in increased error.

**Call Technical Service at 800-356-1688 or 814-353-1300, ext. 4 (or your Restek representative)
if you have any questions about this product or any other Restek product.**

Please have the serial number available when calling Restek with any concerns you may have.
Additional charges may apply if the warranty is expired or the damage is due to misuse.

This manual is also available in electronic format at **www.restek.com**.



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Restek's Electronic Leak Detector

(cat.# 22839)

Instruction Manual



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ECHnology Pty Ltd

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Restek Electronic Leak Detector

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Operating Instructions

1.0 Introduction

Restek's portable Leak Detector is specifically designed for use with gas chromatography (GC) systems. It detects minute leaks of any gas with a thermal conductivity different from air. The reference gas inlet (Figure 1) draws in ambient air for comparison to air drawn into the sample probe. A leak is indicated by both an LED light display and an audible alarm.

Restek's Leak Detector is manufactured by Restek so you are assured of the same Restek quality and service you have come to recognize with the Restek name.

Should you require assistance at anytime regarding our Leak Detector, please contact Restek Technical Service at 1-800-356-1688 or 814-353-1300, ext. 4.

2.0 Battery Charging:

Only use the universal charger provided. The Leak Detector should be fully charged prior to use. When the unit's charge is low, the green battery indicator LED light will begin to blink when the unit is powered up (Figure 1). The Leak Detector cannot be used during the charging cycle.

Unit status while engaged with the wall charger	Charge LED Condition
Pre-charge qualification (immediately following plug-in)	1Hz flash
Unit is charging	Continuous on
Unit is fully charged	Off

NOTE: Replacement of the rechargeable cells in this unit is performed at the factory. There are no serviceable parts in this unit. Opening the case or tampering with the internal parts will void the factory warranty.

3.0 Powering Up

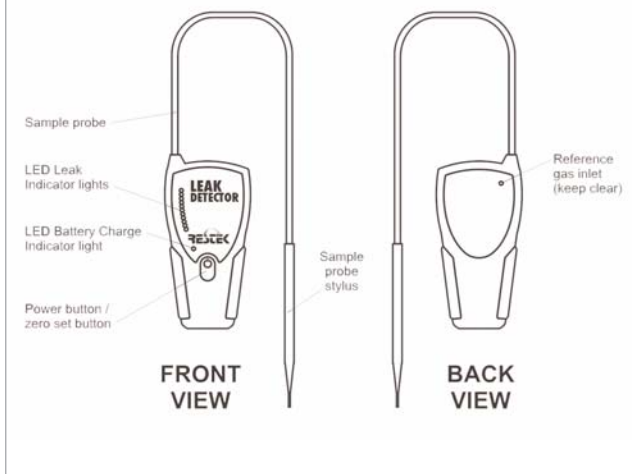
Depress and hold the power button (Figure 1) until the unit responds with the wake-up mode. The leak detector will run through a self-calibration sequence for approximately 15 seconds. During this time **DO NOT** attempt to zero the unit.

4.0 Zeroing the Unit

After the LED lights stop flashing, the unit is ready for use. The instrument may need to be zeroed periodically between uses, especially if it is moved from room to room, or between areas of differing temperature or humidity. Do not attempt to zero the unit while the probe is stored in the holder. The probe **MUST** be removed from the storage container before zeroing the unit. To re-zero, press the Zero switch. The unit will run a self-calibration sequence for approximately 4 seconds. When all LED lights stop flashing and the green LED light is lit, the unit is ready for use.

NOTE: To avoid false readings, do not attempt to use the unit while the self calibration sequence is in progress.

Figure 1 Leak Detector schematic.



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5.0 Prior to Operation

Verify the operation of the Leak Detector before each use by sampling gas from a GC split vent, or other source of hydrogen or helium. Also, visually inspect the probe tip, reference gas inlet, and exhaust port for obstructions (Figure 1).

IMPORTANT: *Fittings being checked must be clean and dry; liquid leak detecting agents, dust, and other debris may damage the Leak Detector if drawn into the probe.*

The Leak Detector responds to almost any gas you can smell, and many gases that you can't smell. Solvent vapors, split vent exhaust, or even strong air currents around the probe or reference inlet can cause instability or false positive readings. Be careful not to breathe into the reference inlet when checking for leaks or to cover/block the inlet with your hand.

6.0 Detecting Leaks

Slowly move the probe tip around fittings and other potential leak sources. If the Leak Detector senses a gas other than air, the LED bar graph will begin to light, and an alarm will sound when the last LED light illuminates. The red LED lights indicate helium and hydrogen leaks. The yellow LED lights indicate a nitrogen, argon, or carbon dioxide leak. Remove the probe from the vicinity of the leak and allow the unit to return to zero. If a large amount of gas has entered the probe, it may take a few seconds for the instrument to clear itself. Please do not attempt to zero the unit while it is clearing out the gas from the probe. This may cause the unit to malfunction. Place the probe near the leak again to confirm its location. The reference gas inlet (Figure 1) must not be restricted or the unit will not operate correctly. Similarly, the exhaust port allows the gas being tested to exit the Leak Detector and must remain unobstructed. The exhaust port is located in the probe docking station.

CAUTION: *This unit is **NOT** designed for determining leaks of combustible gases. A combustible gas detector should be used for determining combustible gas leaks in a hazardous environment.*

7.0 Specifications

Power Rating: 12 Volts DC (battery charger supplied)

Battery Rating: 6 hours normal operation

Operating Temp. Range: 32°–120°F (0°–48°C)

Humidity Range: 0–97%

Warranty: One year warranty.

Certifications: CE and Japan

Compliance: WEEE, RoHS

8.0 Maintenance

Avoid spilling liquids onto the unit or it may malfunction. If a liquid is spilled onto the unit, turn off the power immediately, remove heavy liquids with a dry towel, and let the unit sit until the liquid dries. Dust and debris can enter the probe tip of the Leak Detector and, over time, can clog the small-bore tubing inside the unit. To prevent this, clean the probe tip periodically. To clean the probe tip, unscrew the cap to expose the brush (Figures 2 and 3). Gently clean the probe, using a small brush or your fingers to remove dust and debris, then replace the cap. Do not use liquids to clean the probe. Liquids can damage the Leak Detector if drawn in through the probe.

Information on where to have the unit sent for maintenance or service is listed at the end of this document.

Figure 2 Cap unscrewed and partially removed.



Figure 3 Cap removed, exposing probe tip brush for cleaning.



9.0 Troubleshooting

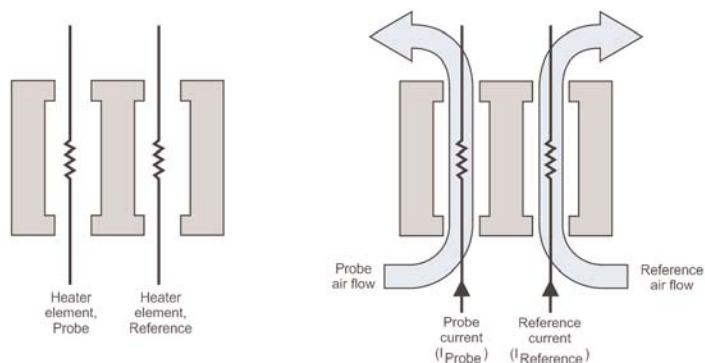
Problem	Possible Cause	Suggested Solution
Sensitivity decreased	Probe clogged Probe line punctured Weak battery	Clean the probe tip to remove any debris Visually inspect probe line for holes* Recharge or return to Restek for battery replacement*
Response decreased	Detector not zeroed	Re-zero detector
LED bar graph stays lit during operation	Detector re-zeroed before unit was purged out Reference gas inlet covered by hand or other object	Allow adequate time for detector to purge, then re-zero Remove obstruction

**Contact Restek or your Restek representative for return instructions for servicing a damaged unit. Additional charges may apply if the warranty has expired or the unit is damaged due to misuse.*

10.0 Technology

The Leak Detector measurement is based on thermal conductivity comparisons between the probe air and a reference air. The device employs a dual thermistor technology which measures the ratio of [probe]:[reference] heat exchange values and displays the results on an LED scale (Figure 4). Under ideal operating conditions, a ratio of 1:1 indicates identical air samples for both [probe] and [reference], and therefore no leak is present.

Figure 4 Schematic layout of the Leak Detector technology.



LEFT: Dual analysis is achieved with heater elements positioned in separate flow chambers.

RIGHT: Probe and reference air streams are simultaneously monitored for thermal conductivity. Differences in air composition are indicated by differences in the heater element currents.

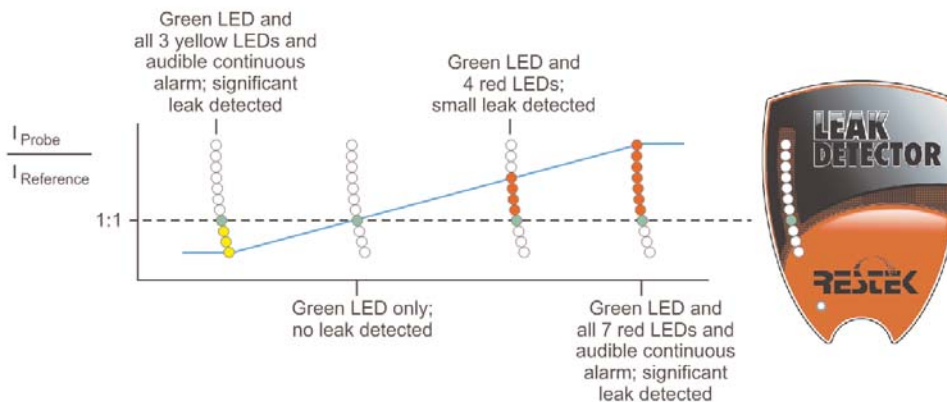
Because of slight differences in air temperature and/or humidity between the reference inlet (Figure 1) and the probe tip, a small response indicated by a single red or yellow LED light is generally insufficient to positively identify a gas leak. Small to moderate leaks are reliably indicated with four red LED lights, larger leaks are indicated with all red LED lights or yellow LED lights lit and the continuous alarm is audible.

11.0 Interpreting the Results

Figure 5 illustrates the Leak Detector's LED light response range. The greater the number of red or yellow LED lights lit correlates in general to the size of the leak. **NOTE:** The Leak Detector is not a quantitative device, rather it is designed to detect leaks in gas line connections commonly associated with laboratory equipment

Gas	Minimum Detectable Leak Rate (atm cc / sec.)	Indicating LED Light Color
Helium	1.0×10^{-5}	Red
Hydrogen**	1.0×10^{-5}	Red
Nitrogen	1.4×10^{-3}	Yellow
Argon	1.0×10^{-4}	Yellow
Carbon dioxide	1.0×10^{-4}	Yellow

Figure 5 LED light response chart for the Leak Detector. A 1:1 ratio of $I_{\text{Probe}} : I_{\text{Reference}}$ indicates no leak present. Red LED lights indicate the presence of one or more of the following gases: helium or hydrogen. Yellow LED lights indicate the presence of one or more of the following gases: nitrogen, argon, or carbon dioxide.



**This unit is NOT designed for determining leaks of combustible gases. A combustible gas detector should be used for determining combustible gas leaks in a hazardous environment.

Tip drift

Tip drift is the phenomenon when a false LED light response is registered as the unit is quickly turned or swept in dramatic arc movements. Tip drift is inherent to all dual thermistor leak detector technology and is based in large part on the asymmetry of the flow cells; shaking or tipping the unit influences the air flow profiles which impacts the rates of heat exchange. If the device is functioning normally, the LED light signal will return to zero in 3-5 seconds after the unit is held still. In extreme cases, the unit may require another 'zero' cycle before using. To avoid tip drift, be sure to hold the unit steady while making measurements.

12.0 Service

The Restek Leak Detector carries a one year limited warranty from time of purchase. Please have the Leak Detector serial number available when calling Restek with any concerns you may have. Additional charges may apply if the warranty is expired or the damage is due to misuse.

Expected battery lifetime is two years from time of purchase. Customers will need to return the unit to Restek for battery replacement. At that time, preventative maintenance services can also be performed on the unit. A fee will be charged for servicing the unit.

For questions, problems, repair services:

Within the USA:

Call Restek Technical Service at 800-356-1688 or 814-353-1300, ext. 4

Outside the USA:

Contact your Restek representative





GC-LC Innovations

PeakSimple Data Systems

With 1, 4, or 6 Channels of Data Acquisition

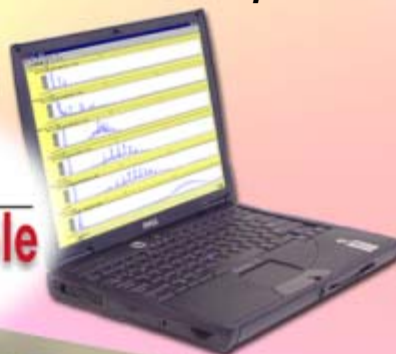
**Standard in every SRI
GC and HPLC system**

For any Windows™ computer



USB or serial port

PeakSimple

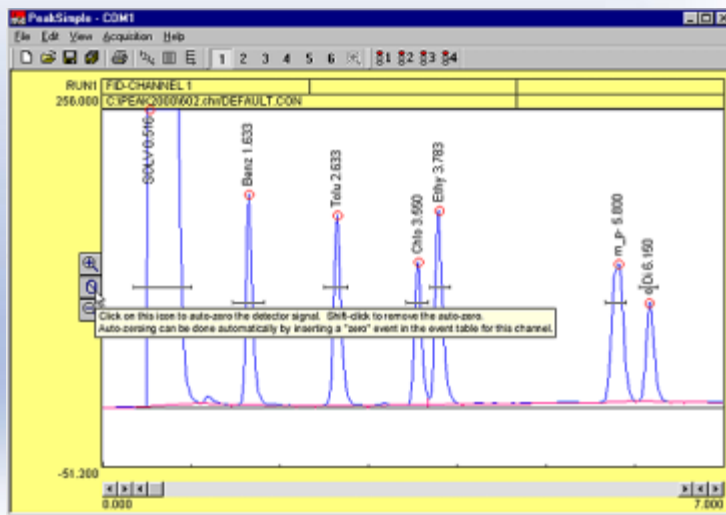


Available as a stand alone unit


SRI's PeakSimple Chromatography Data System is included with every SRI GC and HPLC system, and is also available as a convenient stand-alone data system for any other manufacturer's GC or HPLC. PeakSimple software has been continuously developed, refined and improved since 1988 by the same dedicated team of working chromatographers who use the software on a daily basis, and strive to simplify and enhance every aspect of PeakSimple so our customers will benefit. New features are added to PeakSimple several times per year and the latest version is always FREE to download online, along with helpful tutorials. Tech support at SRI is "old fashioned!" When you call, a knowledgeable technician will answer your questions right away. No complicated phone menus, and no waiting on hold!

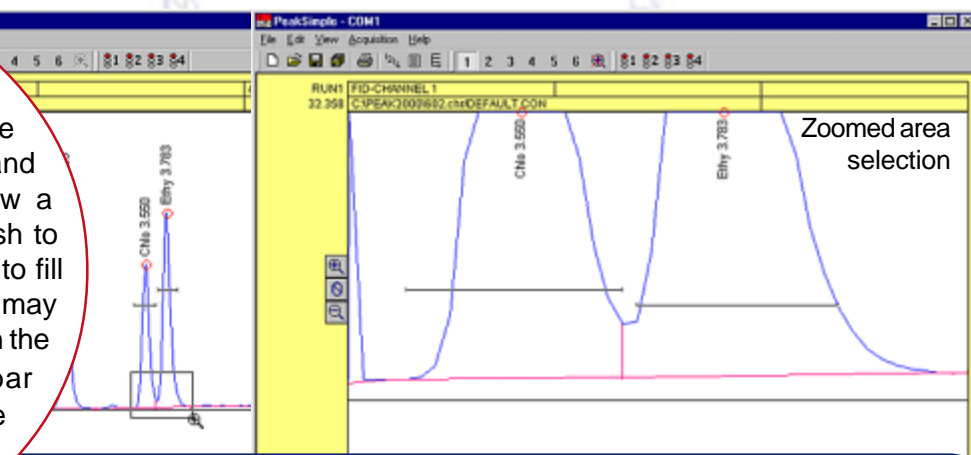
Easy to Learn, Easy to Use Software for all Windows™ Computers



Most PeakSimple functions are launched from the chromatogram window, and are so user friendly that most operators can produce results almost immediately. ToolTips makes learning your way around PeakSimple even easier—just hold your mouse cursor over any icon or checkbox to read the onscreen How-To instructions in one of many available languages.

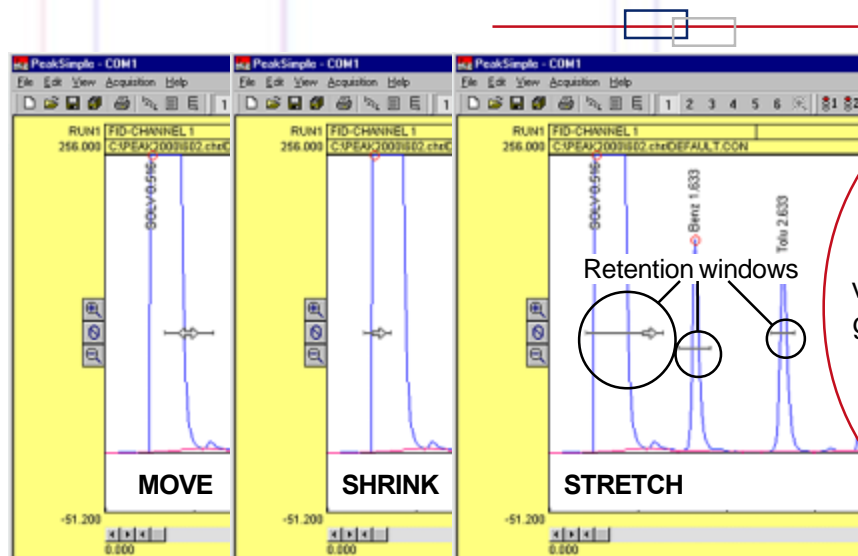


TAKE A CLOSER LOOK AT YOUR DATA

PeakSimple gives you two ways to closely examine data in the chromatogram window. Click and drag the mouse cursor to draw a rectangle around the area you wish to enlarge, and that area will expand to fill the chromatogram window. This may be done multiple times. Clicking on the Unzoom  icon in the toolbar unzooms one level at a time until you return to the original resolution.



A mouse click on one icon  vertically enlarges the peaks in the chromatogram, decreasing the y-axis display limits by a factor of two. A click on another icon  increases the y-axis display limits by a factor of two, which vertically shrinks the chromatogram peaks.



CLICK & DRAG RETENTION WINDOWS

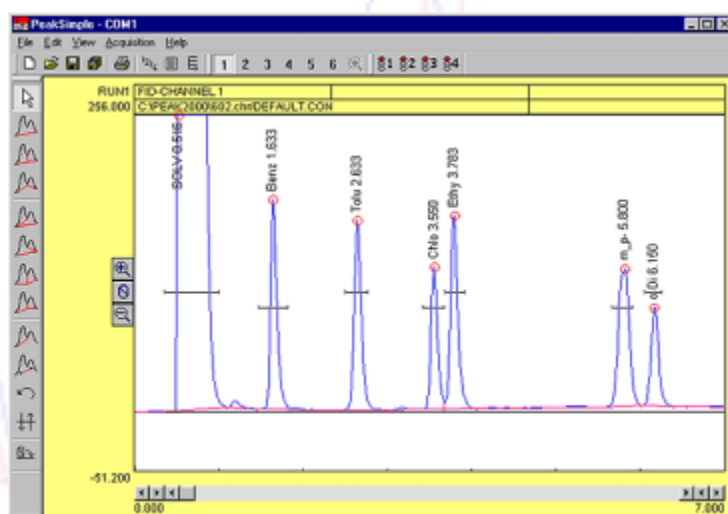
Retention window brackets are visible onscreen, and may be grabbed, dragged onto a peak, widened, or narrowed. The component table is automatically updated when a retention window is graphically moved or modified.

MANUAL INTEGRATION

Manual integration tools permit you to refine the integration method applied to any peak. The manual integration toolbox is available at a click of the mouse. Baseline projection may be “rubber-banded” from point to point, forced to a valley, dropped vertically, skimmed, etc.



The Manual Integration toolbox may be placed above (as shown at right) or to the left of the chromatogram window. It may also be dragged “off” the chromatogram window to float as an independent, move-able window.

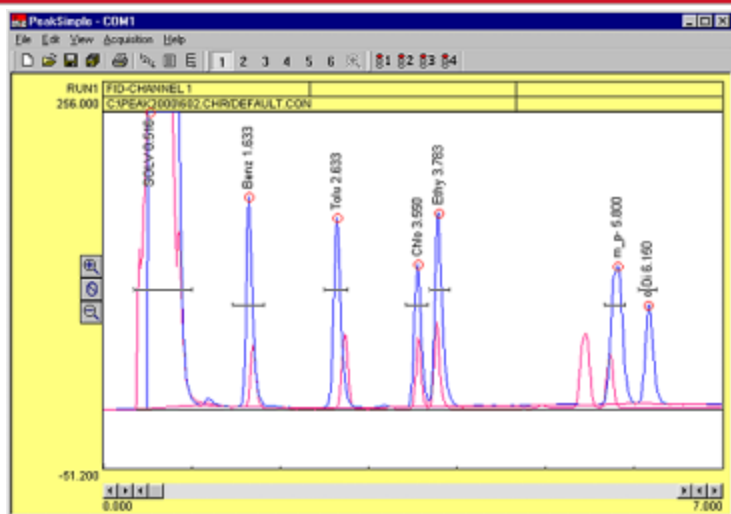


OVERLAY CHROMATOGRAMS

Overlay the data in any channel onto any other channel for retention time comparison or multi-detector correlation.



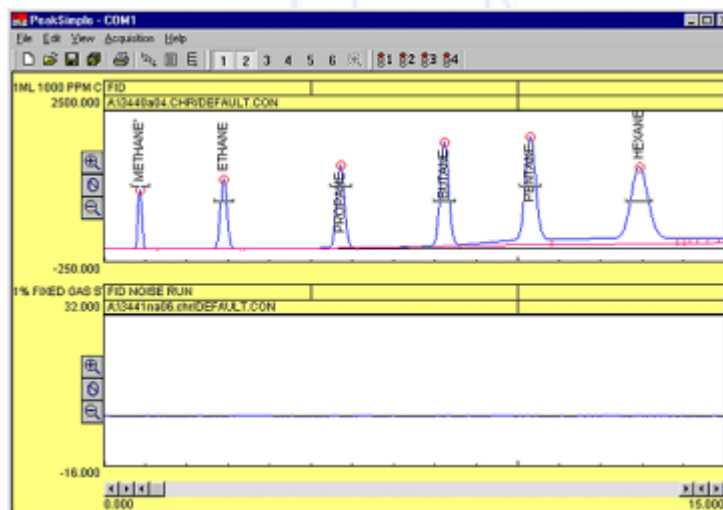
The Overlay Adjust feature lets you stretch and shift overlaid data to facilitate pattern matching.



BASELINE SUBTRACTION and DATA SMOOTHING

Blank baseline subtraction is useful to compensate for baseline drifting due to column bleed and temperature ramping. PeakSimple lets you subtract baselines in real time as data is collected or post run.

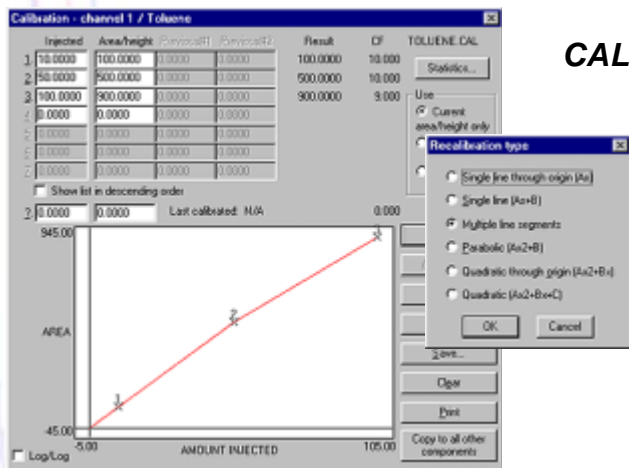
Noisy detector signals can be smoothed manually or automatically at the end of a run. Smoothing algorithms include Olympian, Moving Average, and Savitsky-Golay.



CALIBRATION

Multi-Level Calibration Curves

Calibrate peaks six ways (multi-line, quadratic, parabolic, etc.) using single or averaged data at up to seven concentration levels. Statistics for evaluating line fit quality, modification date audit trail, and curve printout help to ensure defensible results.



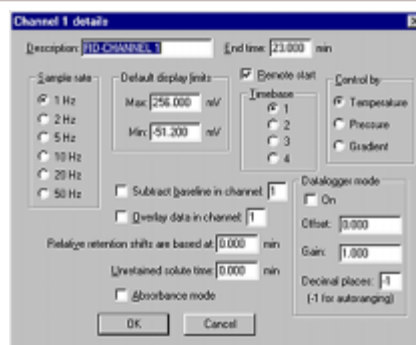
Calibration Averaging

PeakSimple allows up to three replicate calibration standards at seven levels of concentration to be averaged when constructing calibration curves.

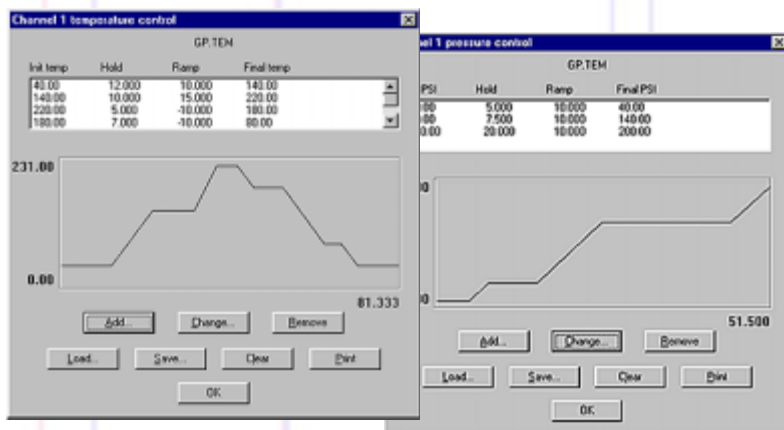


CHANNEL DETAILS

Each channel has a Channel details dialog box which allows users to set parameters for that particular channel. From the Channel details dialog box, you can set your sampling rate and default millivolt display limits; choose temperature, pressure, or gradient control; subtract the baseline from another channel; overlay the data from another channel; turn Data-logger mode ON or OFF; designate a start time to compensate for relative retention shifts, and more.



TEMPERATURE PROGRAMMING

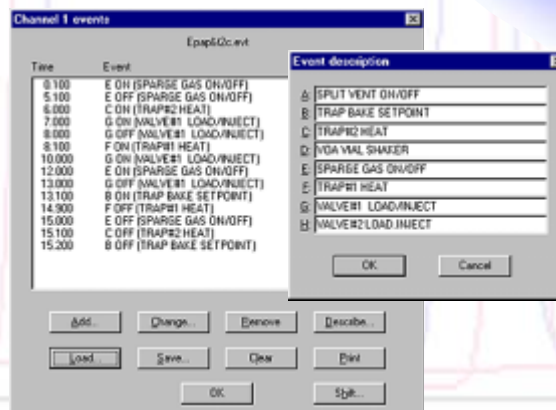


EPC & HPLC GRADIENT PROGRAMMING

“Temperature,” “Pressure,” and “Gradient” channel control options all use the same simple dialog box, and each may be programmed with unlimited ramps and holds. Program one or two SRI GC column ovens from ambient to 400°C with 0.01 degree resolution and negative programming. Program the carrier gas pressure on SRI GCs equipped with electronic pressure control. Form binary HPLC gradients for low-cost pump control.

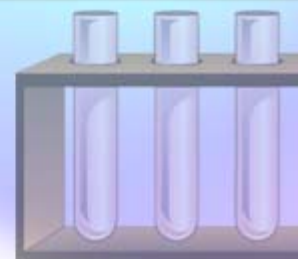
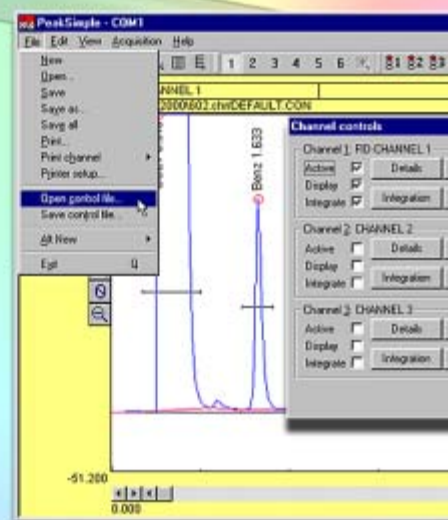
MANUAL/AUTOMATIC EXTERNAL EVENT CONTROL

In addition to performing timed integration events, control up to eight external contact closure relay outputs to actuate sampling valves, autosamplers, solenoids, pumps, or any external device using TTL or relay contact closure triggers.



CONTROL

Eliminate the need to repeat... simply by opening a control file. Maximize reproducibility—it does chromatograph because the control parameters. Save any change you make post-run actions, even color choices, to a control file for each method of analysis that control files you can have is limited only by you.





INTEGRATION

Use the Integration button to determine how PeakSimple integrates the data peaks in the chromatogram. Set peak detection sensitivity, area reject and standard weight. Specify a spike channel, merge results from another channel, and correct for sample weight and dilution.

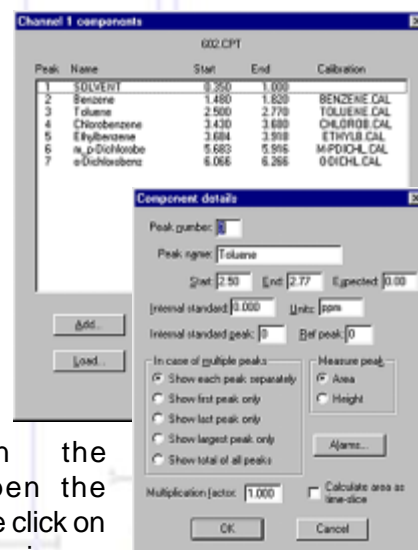
DL FILES

Specify run parameters before beginning an analysis. It doesn't matter who is operating the files contain all the necessary run parameters in the analysis, from channel details to control file and use it again and again. Create a file that your lab typically performs. The number of files on your disk space.



COMPONENTS

Create, save and edit component tables with an unlimited number of compounds. Enter expected retention times, control peak display, and more! Component details may be viewed and edited by double-clicking on any retention window in the chromatogram. Or, open the Component table and double click on any component in the list to view or edit that component's details.

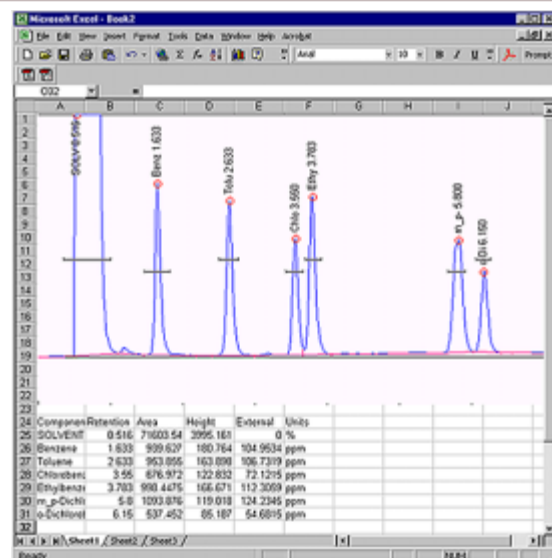


POSTRUN

PeakSimple can perform a variety of postrun actions to help you maintain and organize your data. Specify how data will be saved, and automatically add the results of the run to the results log for that channel. You can set PeakSimple to automatically print the results at the end of a run, and update your DDE link. Execute a command, specify a recalibration level, and restart the run after a given amount of time. You can even have PeakSimple smooth the data before copying it into another channel.

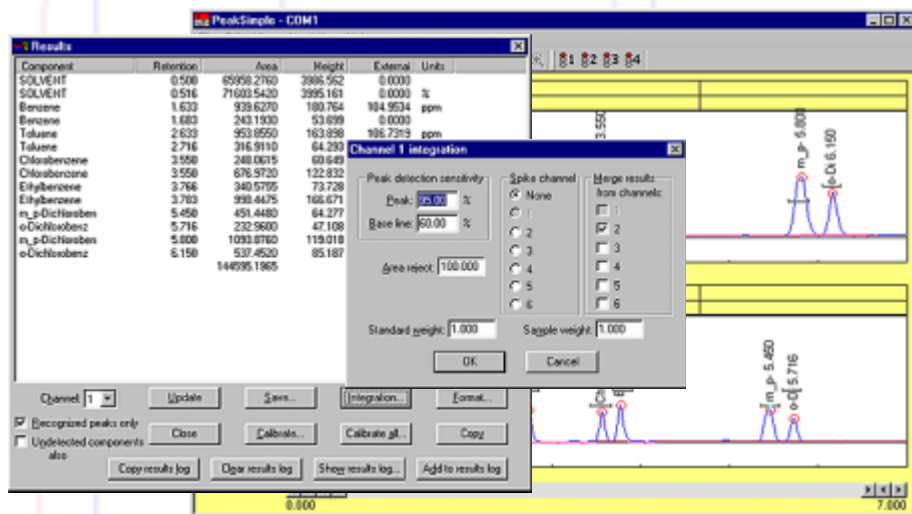
DYNAMIC DATA EXCHANGE

Link PeakSimple to your DDE compatible spreadsheet or word processor (Excel, Word, 123, etc.). Analytical results are automatically transferred after every run, or can be accumulated within PeakSimple and copied as a block of data. Use the Copy Picture option to paste the chromatogram itself into Excel, etc. along with the results.

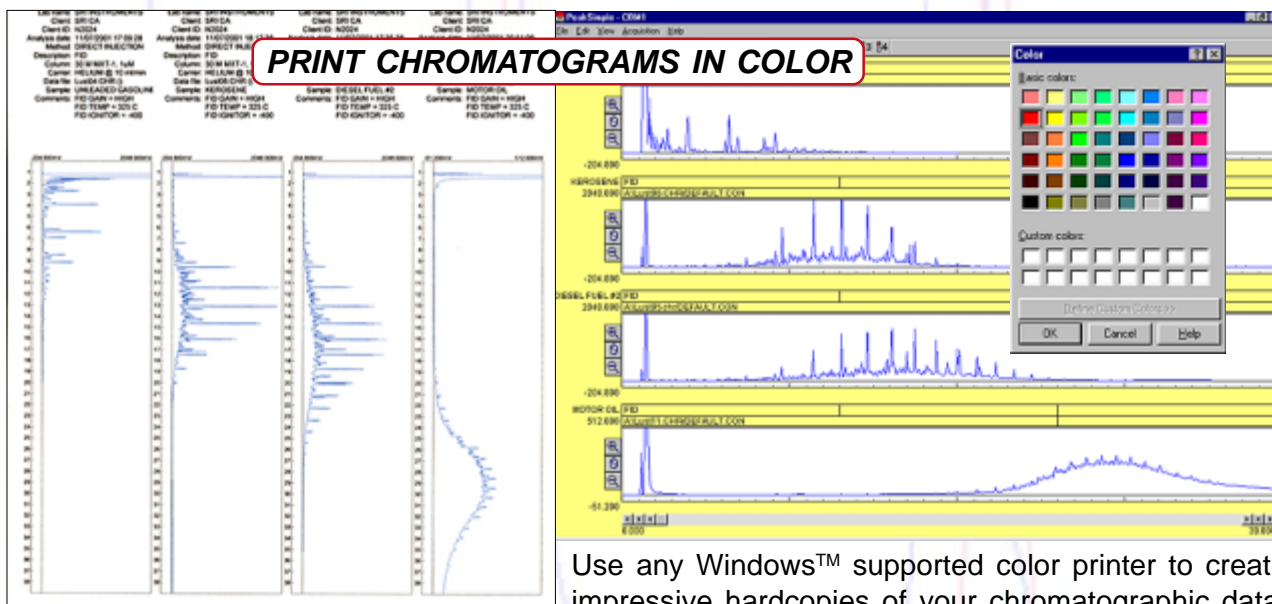


MERGE RESULTS FROM MULTIPLE CHANNELS

PeakSimple lets you merge the results from any channel or all channels into one report. This feature is handy when you're combining results from different detectors into a single report for export to Excel or other data analysis programs.



PRINT CHROMATOGRAMS IN COLOR



Use any Windows™ supported color printer to create impressive hardcopies of your chromatographic data.

Print multiple chromatograms per page for easy detector-to-detector comparisons and paperwork consolidation. Print overlaid data in contrasting colors with adjustable line weight.

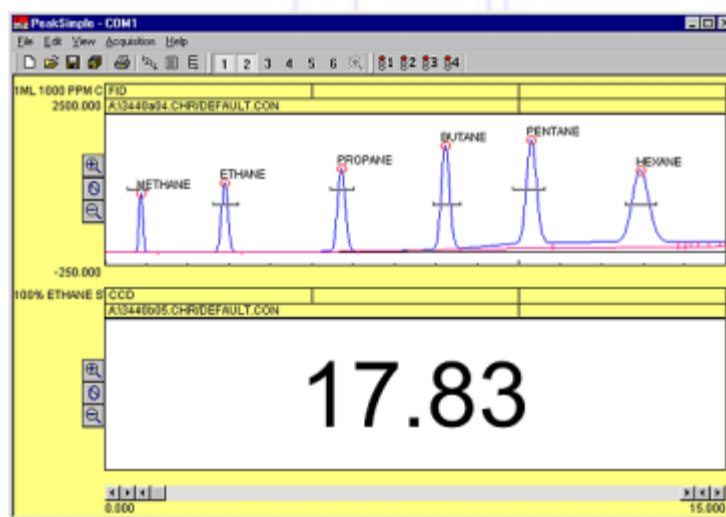


AUTOSAMPLER QUEUE and BATCH REPROCESSING

Create customized autosampler sequences for liquid injections, purge and trap autosamplers, gas sampling valves, and stream selectors including unique predefined sample information, auto-calibration and batch reprocessing of previously run samples.

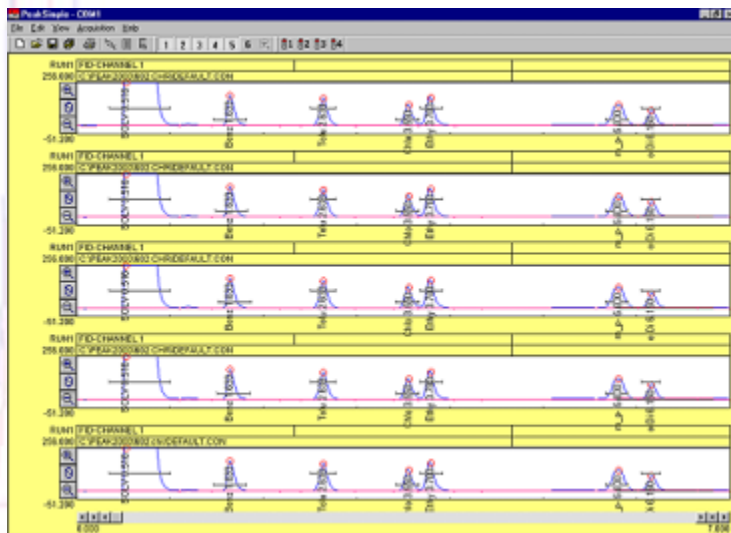
DATA LOGGER MODE

Peak Simple's Data Logger Mode allows you to display a scaled and calibrated result in large numbers instead of the usual strip chart data presentation. Data Logger Mode is especially useful when monitoring total hydrocarbons on one channel while performing a separation on another channel.



SELF-VALIDATING HARDWARE

PeakSimple will play back and re-acquire any chromatogram multiple times, establishing the precision and accuracy of the data system using real data, not "canned" chromatograms. PeakSimple's validation can be performed by the user anytime without extra hardware.



SRI PeakSimple Data Systems

Serial Port

Models 202 and 203 connect to your computer with a serial port cable. Windows™ computers with two available serial ports can operate dual **203** systems, a **202** and **203** together, or dual **202** systems for a total of up to eight data channels and four time bases. Temperature and pressure control outputs are available for connection to a GC or HPLC. PeakSimple software works with each of the following hardware options, serial or USB port, and is included with each unit.

Model 203 has one channel capable of acquiring data at up to 50Hz. Its eight TTL outputs can be optionally wired to a bank of eight single-pole, dual-throw mechanical relays with screw terminals for easy connection to any user device which operates from a contact closure. A remote start input allows run initiation from the user's GC or HPLC system. The 220VAC system is supplied with a UL, CSA, and CE/VDE approved universal voltage input which will operate on any 100-250 volt power supply.

Model 203



Approximately 8" wide x
8" deep x 1.75" high

Model 202 has four channels. Data can be acquired at up to 50Hz with one channel active, 10Hz with two channels, or 5Hz with all four channels activated. assigned to one of two times for two entirely allow run initiation from the user's GC or HPLC system. Model 202 includes the bank of eight single-pole, dual-throw mechanical relays with screw terminals for easy connection to any device that operates from a contact closure.

Discontinued

Model 202

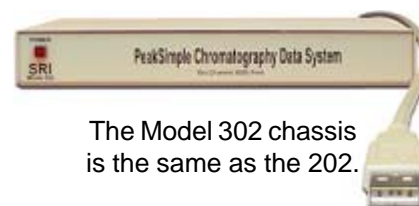


Approximately 15" wide x
11" deep x 2" high

USB

Model 302 is for analysts who prefer the hot-swappable, plug-and-play capabilities of Universal Serial Bus devices. Four remote start inputs allow run initiation from the user's GC or HPLC system. The six channels of data can be randomly assigned to one of four time bases which provides independent start and stop times for 4 entirely separate instruments. Data can be acquired at up to 50Hz per channel with 4 channels active, and up to 20Hz with all 6 channels activated and acquiring data. The Plug and Play peripheral connection of choice, USB is supported by Microsoft Windows 98, 98SE, ME, XP, and 2000.

Model 302



The Model 302 chassis
is the same as the 202.

8600-1055	Model 203 Single Channel Data System with PeakSimple software	\$ 1,395.00
8600-1255	Model 203 220VAC	\$ 1,495.00
8600-4055	Model 202 Four Channel Data System with PeakSimple software	\$ 2,395.00
8600-4255	Model 202 220VAC	\$ 2,395.00
8600-6055	Model 302 Six Channel USB Data System with PeakSimple software	\$ 2,595.00
8600-6255	Model 302 220VAC	\$ 2,595.00

SRI Instruments • 310-214-5092 • Fax 310-214-5097 • 20720 Earl St. Torrance, CA 90503 • www.srigc.com

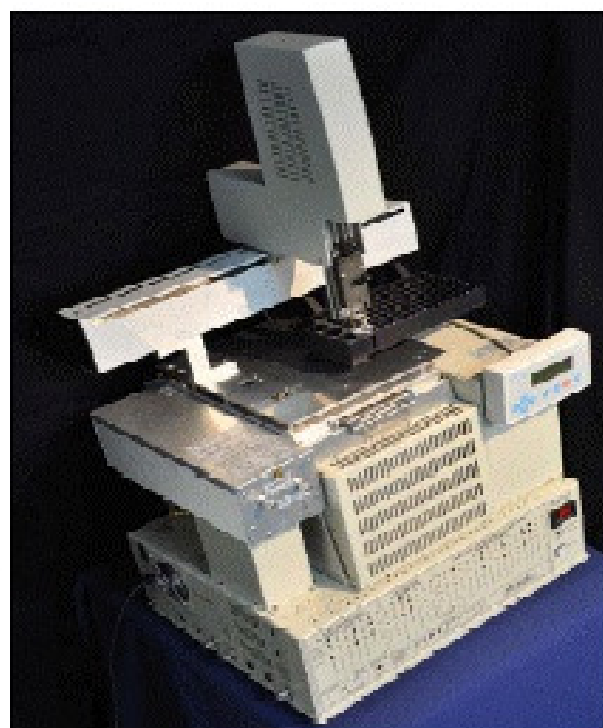
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SRI ←
8610V ←
and ¶

Cobra ←
Autosampler ¶

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Gas Chromatograph and Cobra Autosampler

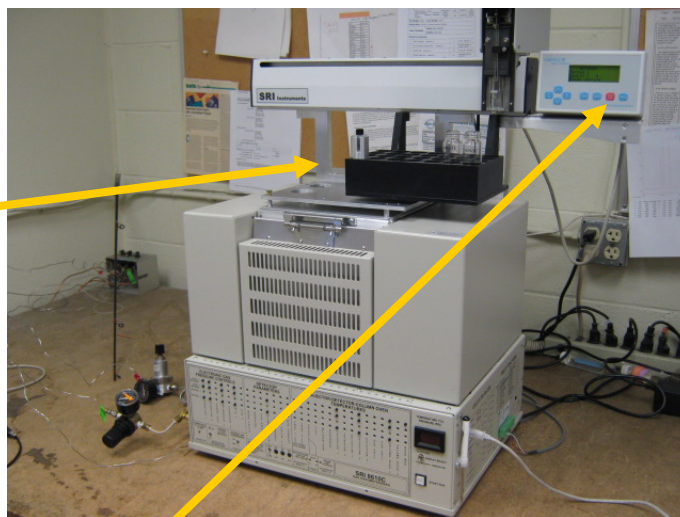


Includes: ¶

110 vial Liquid Autosampler ←
Flame ionization detector (FID) ←
On-column injector ←
400C column oven ←
15meter capillary column ←
PeakSimple Data System ←
Field Portable system -2 packing Crates ←
Heavy duty shipping containers ←
Low power consumption (<1000watts) ←
Ships easily by FedEx/UPS ←
Small footprint for crowded lab bench ←
Many detector/injector options ←
same options as 8610C GC ←
Free training ←
Two Year Warranty ←
Made in USA ←
Complete system

Operation of the Cobra Autosampler on the 8610V gas chromatograph

The Cobra Autosampler mounts on the top of the 8610V GC.

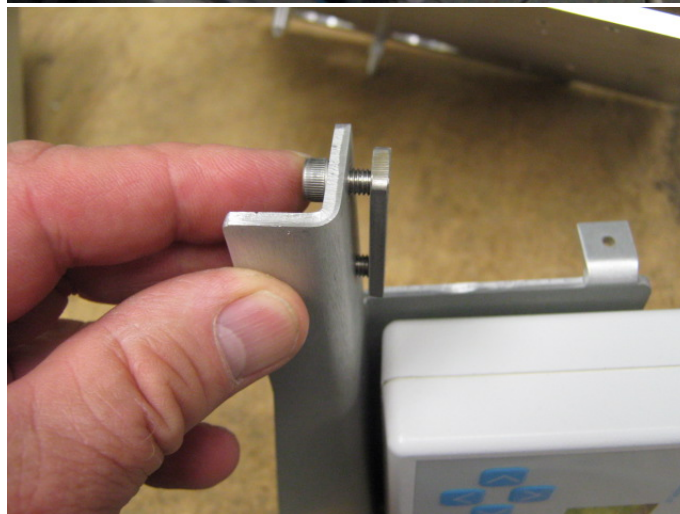


The Cobra keypad should be attached to the autosampler as shown.



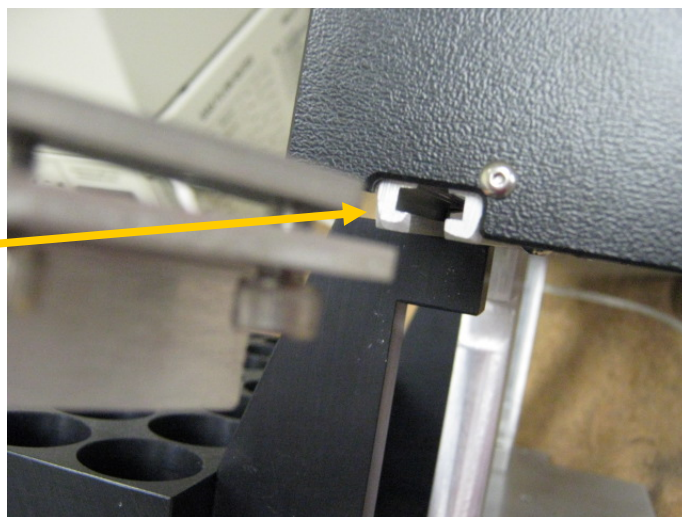
There is a clamping bracket on the keypad. Loosen the two 5/32" hex screws holding the clamping bracket so there is a slight gap.

5/32" hex wrench

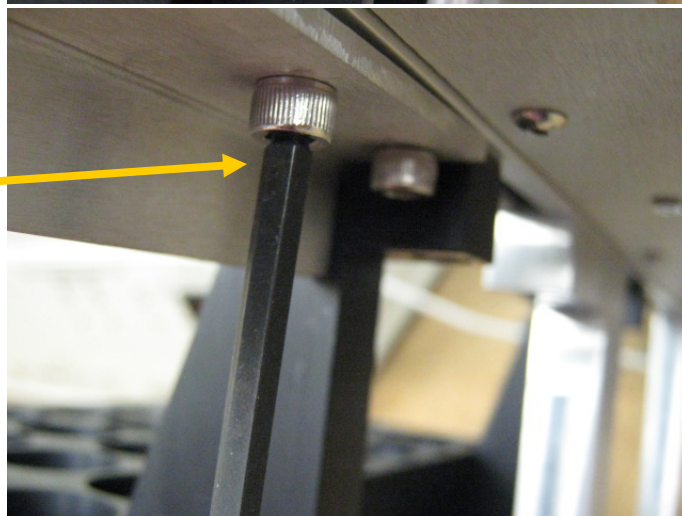


Operation of the Cobra Autosampler on the 8610V gas chromatograph

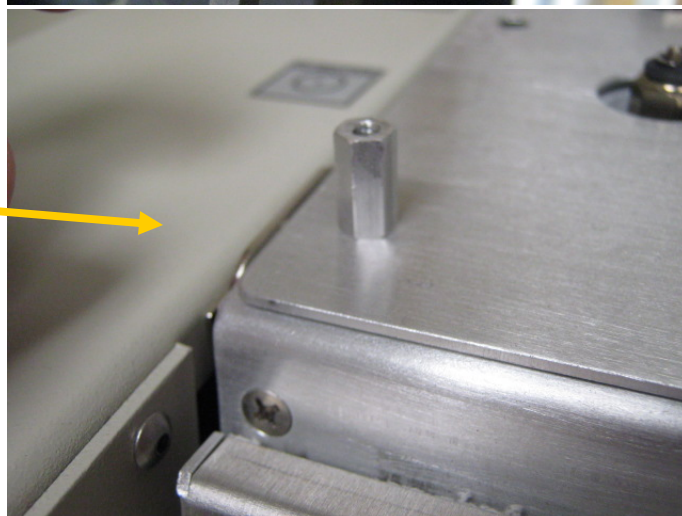
Slide the keypad into the track.



Use the 5/32" hex wrench to tighten the clamping basket.

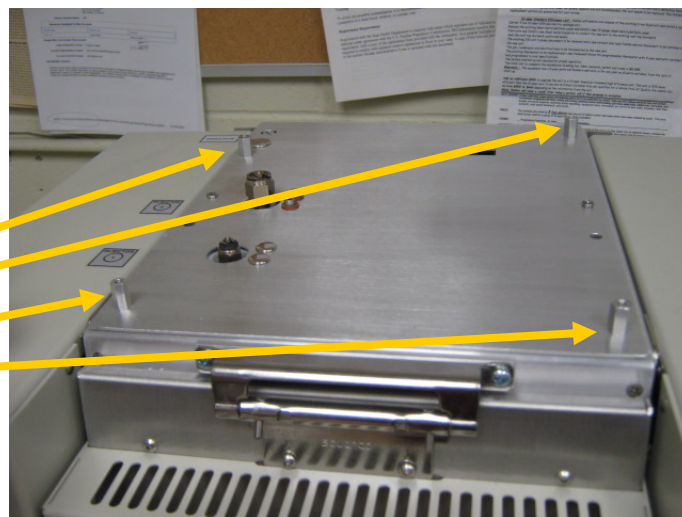


If they are not already mounted, attached the four standoffs to the top plate of the 8610V GC

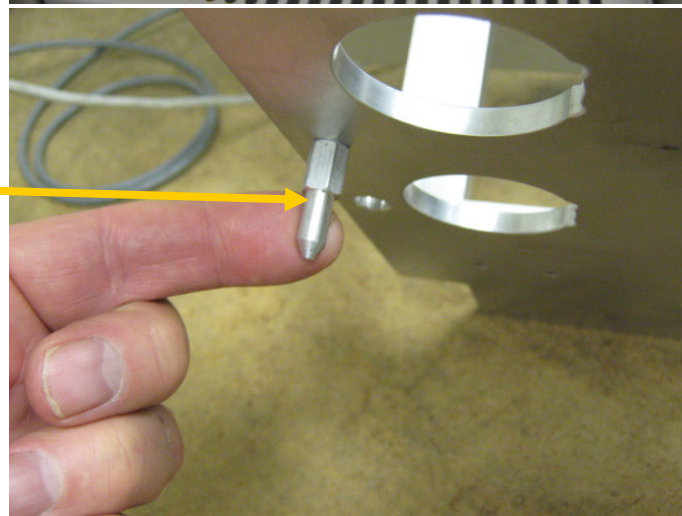


Operation of the Cobra Autosampler on the 8610V gas chromatograph

There are four identical standoffs



The autosampler plate has two locating pins.

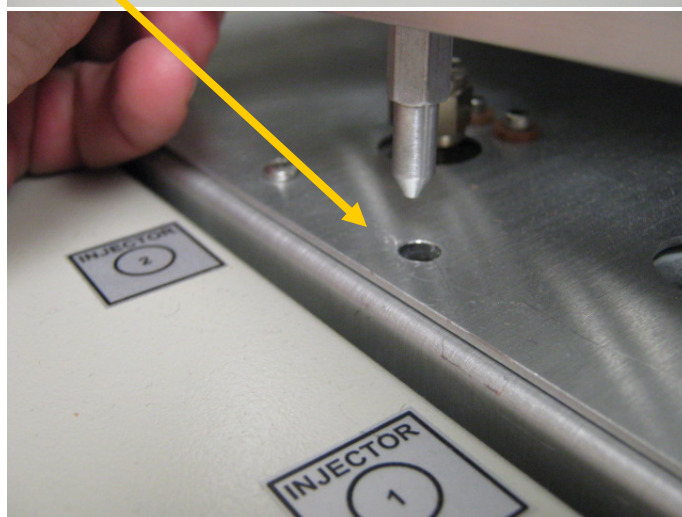
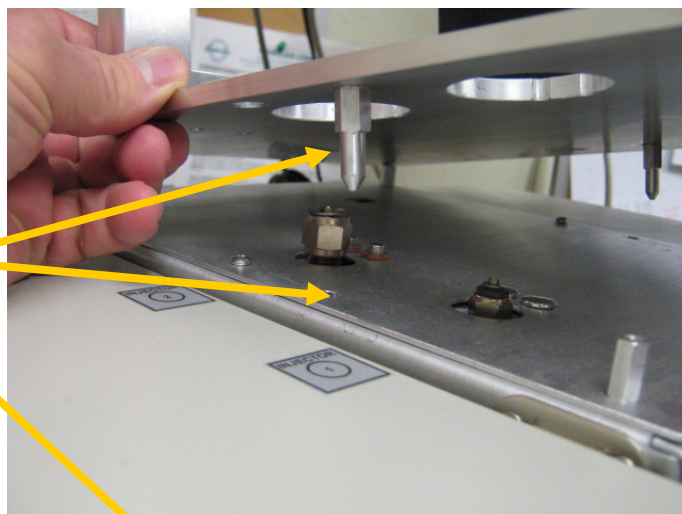


Lift the autosampler and plate onto the top of the 8610V GC.

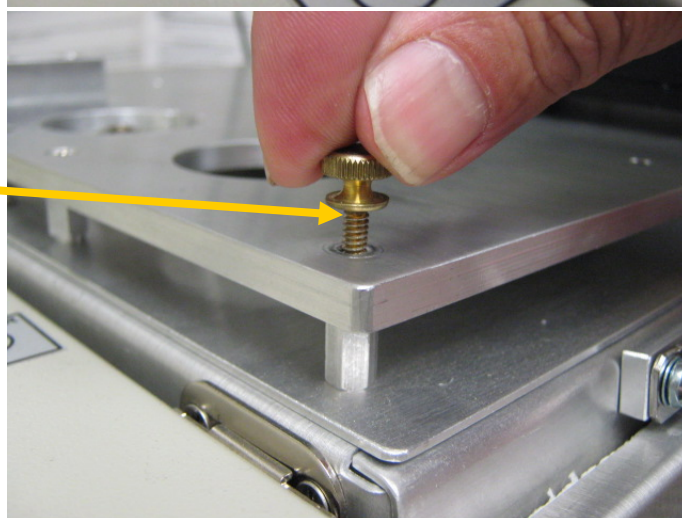


Operation of the Cobra Autosampler on the 8610V gas chromatograph

Align the pins with the mating holes in the top of the GC.

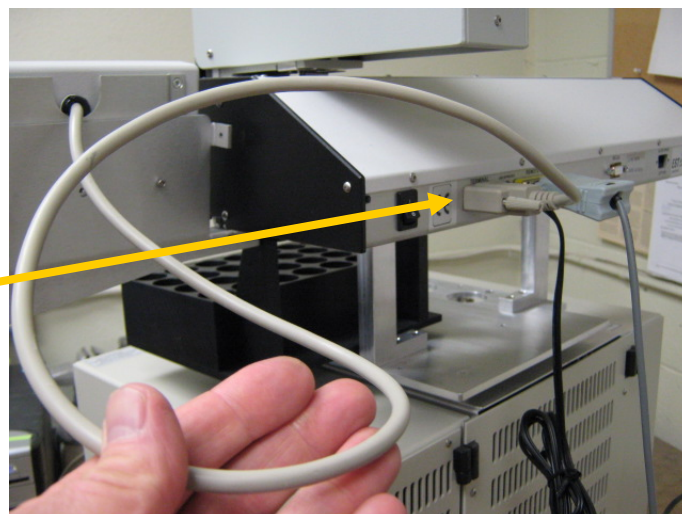


Secure the autosampler plate to the standoffs with the four brass thumbscrews.

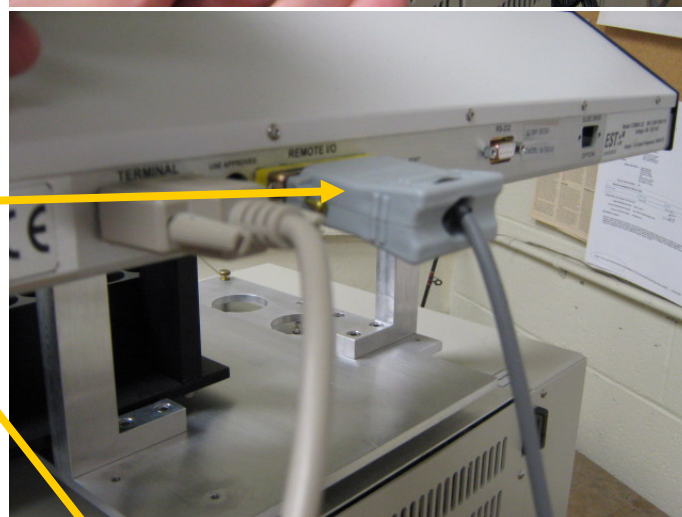


Operation of the Cobra Autosampler on the 8610V gas chromatograph

Connect the keypad to the jack on the back of the Cobra.

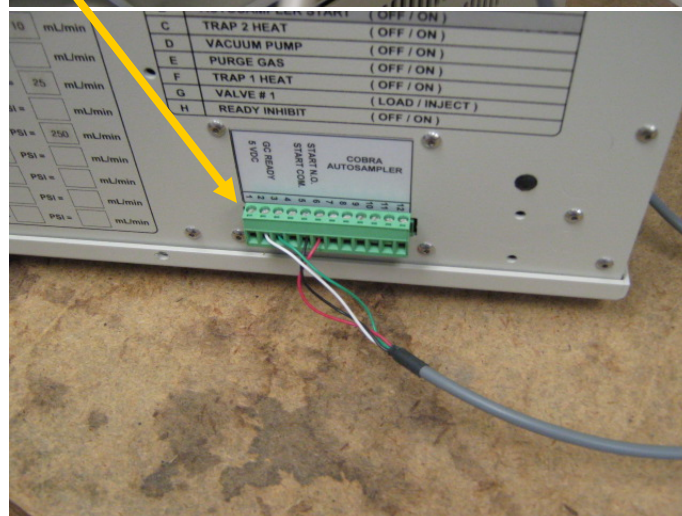
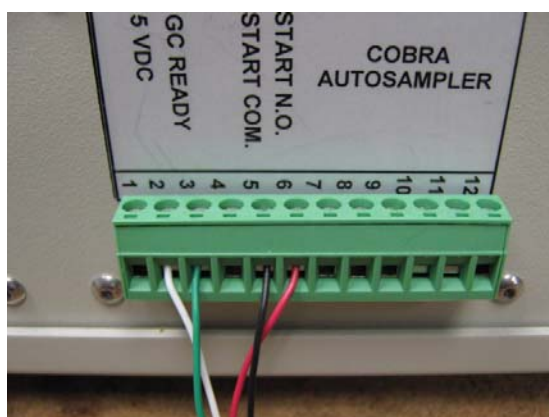


Connect the remote control cable to the jack on the back of the Cobra.



Connect the other end of the remote control cable to the jack on the GC.

The remote control cable should be wired as shown.

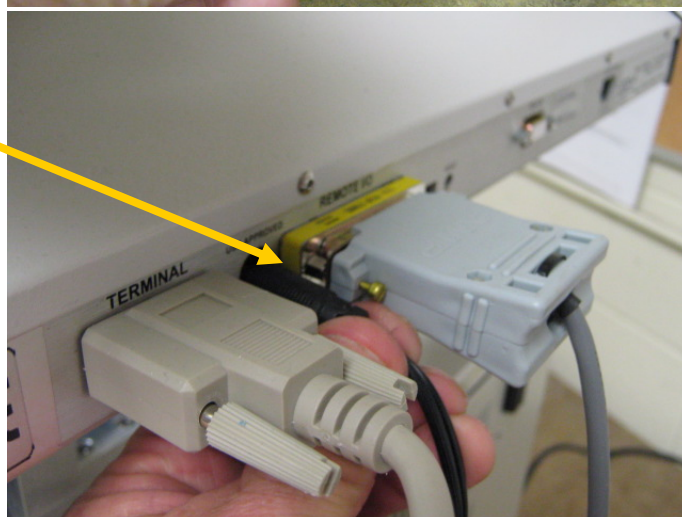


Operation of the Cobra Autosampler on the 8610V gas chromatograph

Connect the power supply

The power jack is on the back of the Cobra between the remote and keypad jacks.

Any 24volt power supply can be used with the specifications shown.

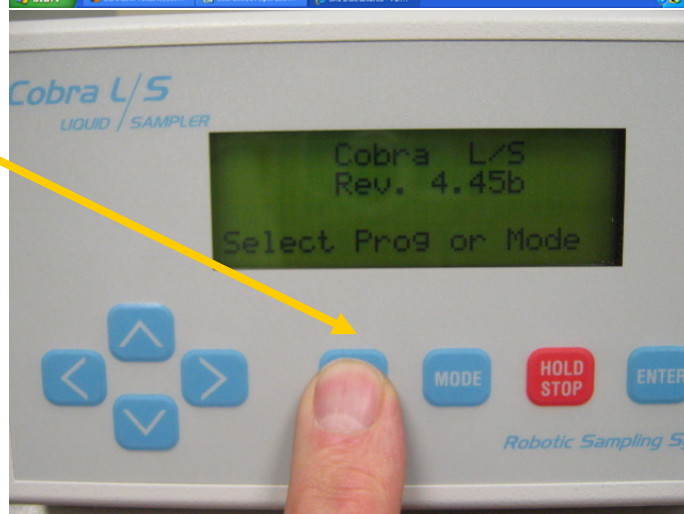
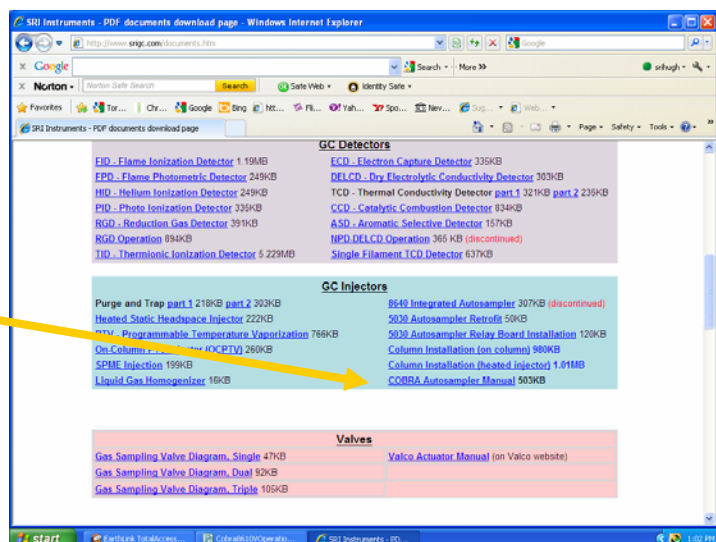


Operation of the Cobra Autosampler on the 8610V gas chromatograph

Download the Cobra manual from the SRI website www.srigc.com

Use the keypad to configure the Cobra to your particular GC. You will have to tell the autosampler the position of the injector, sample bottles, waste and rinse bottles etc. The Cobra manual explains the meanings of the various parameters.

Before inserting the syringe, verify that the Cobra is aligned properly. Otherwise the syringe needle can be bent.

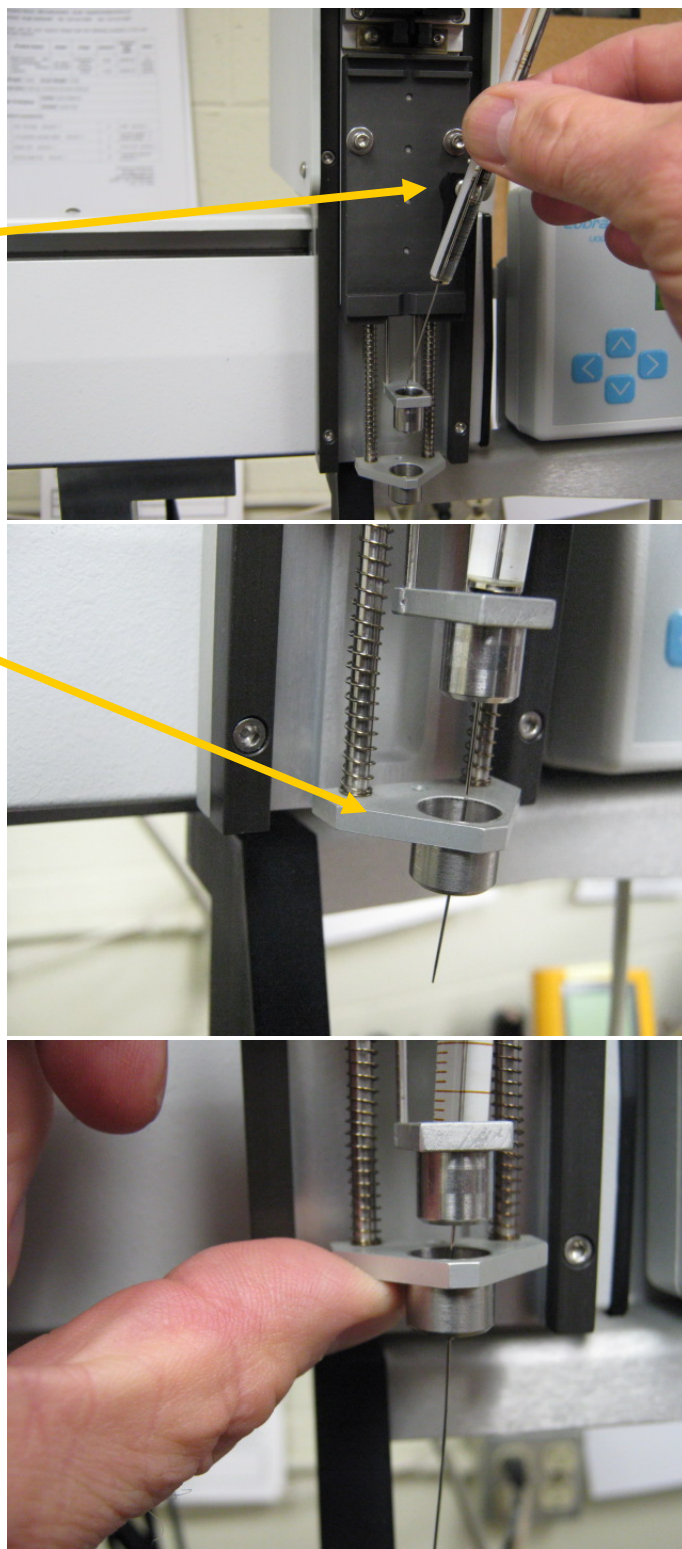


Operation of the Cobra Autosampler on the 8610V gas chromatograph

Insert the 10ul syringe in the syringe holder. The syringe is SRI part#8640-0003.

Wiggle the needle into the holes in the center and lower needle supports. The holes are small so you have to move the needle around until you feel the needle fall into the hole of the lower support.

Use a finger to lift the lower needle support so the needle can not escape while performing the rest of the syringe installation.

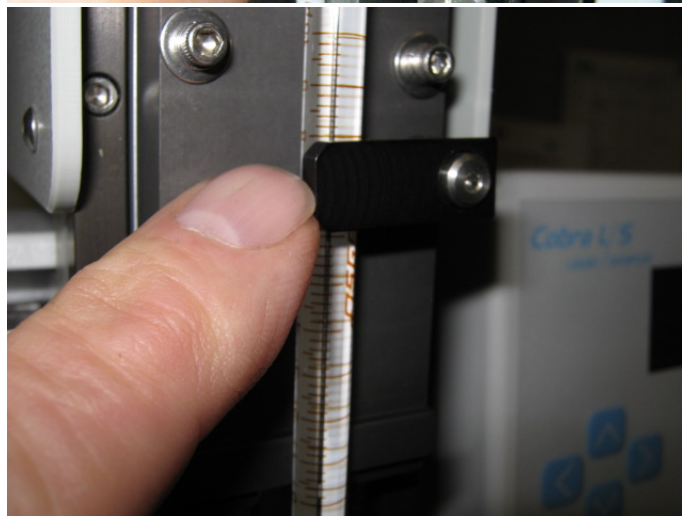
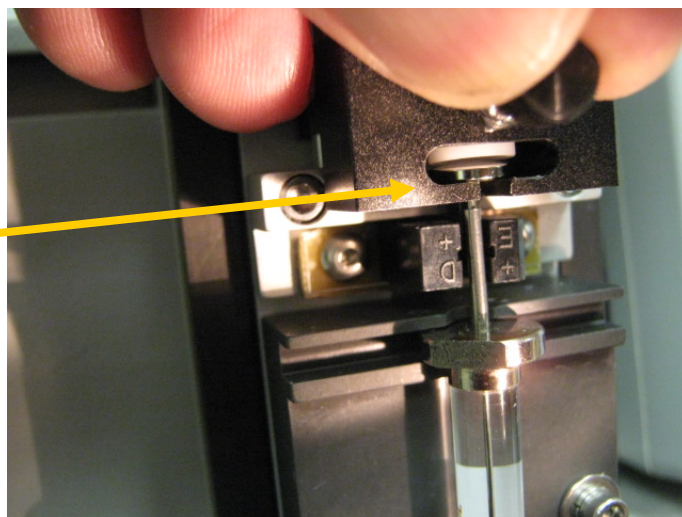


Operation of the Cobra Autosampler on the 8610V gas chromatograph

Loosen the thumbscrew of the plunger retainer. Lift the thumbscrew slightly and wiggle the head of the syringe plunger into the slot. Then tighten the thumbscrew. This is slightly awkward and it may help to have a second person the first time you do this.

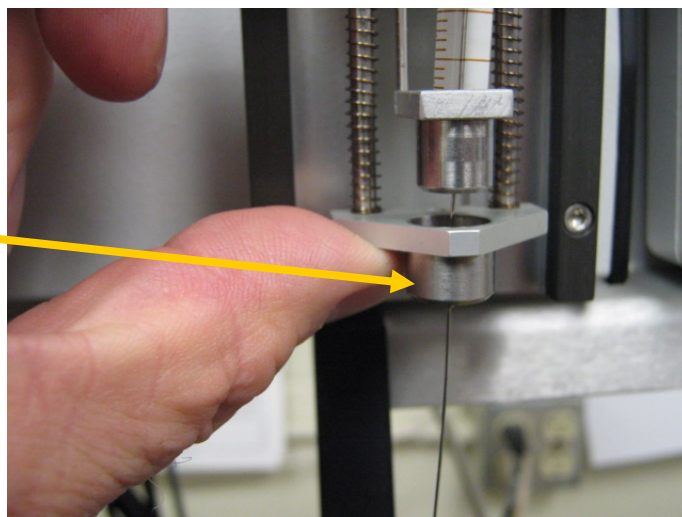
Position the syringe flange in the slot. Rotate the syringe so the graduations along the glass barrel are visible.

Rotate the clamp to secure the syringe in place.

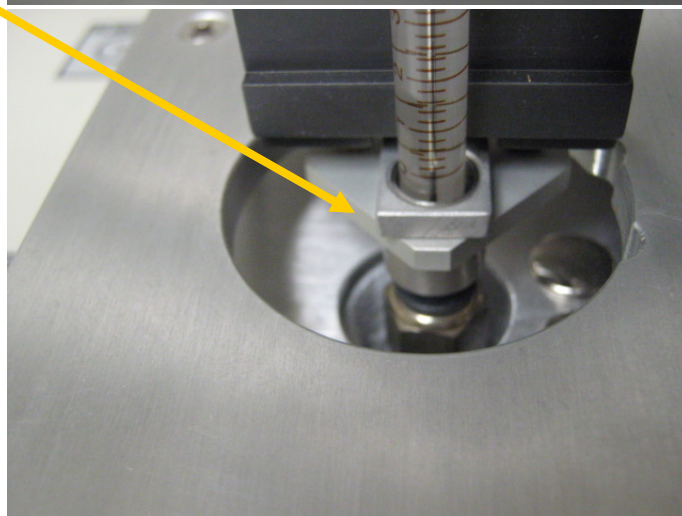
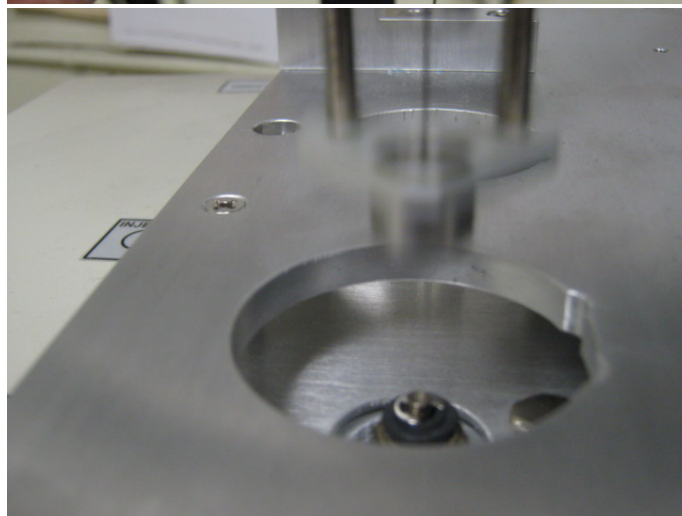


Operation of the Cobra Autosampler on the 8610V gas chromatograph

Verify that the lower needle support moves freely and that the syringe needle is still aligned in the lower support's guide hole.



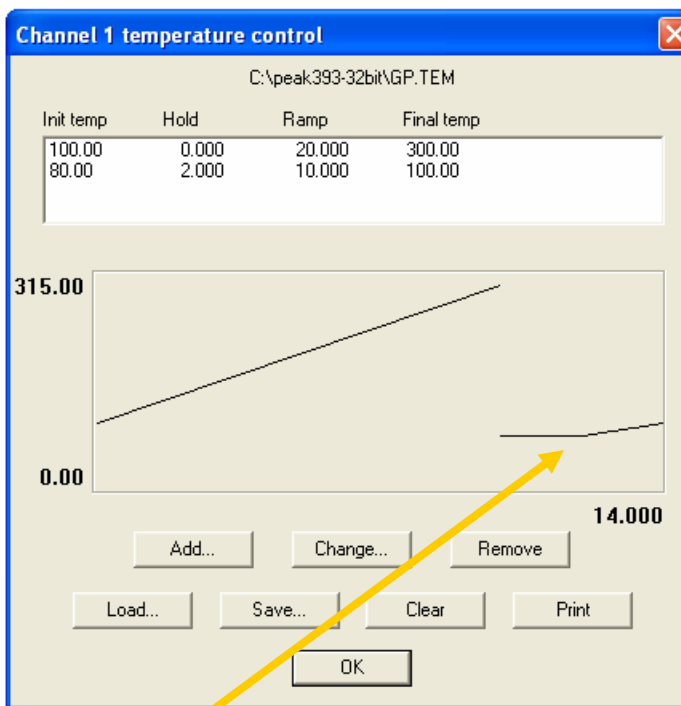
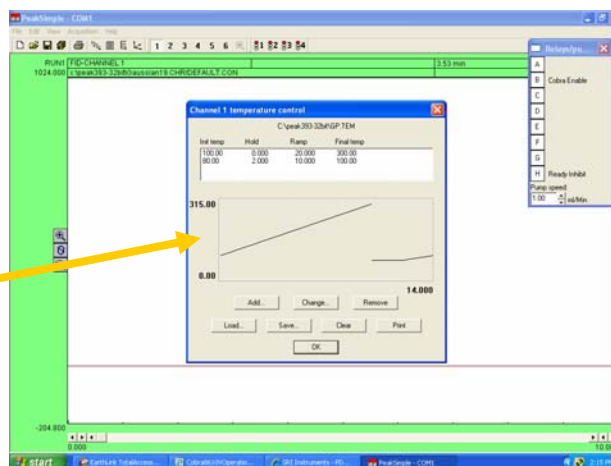
Verify that the syringe needle finds the injector, sample, waste and rinse bottles. Be sure you have lined things up before you put the syringe in since any mis-alignment will result in a bent syringe needle.



Operation of the Cobra Autosampler on the 8610V gas chromatograph

Set up the temperature program in PeakSimple software. See the detailed tutorial and instructions at www.srigc.com for additional information.

The 8610V GC has powerful cooling fans which turn on to bring the column oven temperature down to the starting temperature at the end of the temperature program. There are also some smaller cooling fans which blow air into the column oven to stabilize the temperature below 100C. A gate closes at 100C which stops the smaller fans from blowing the cooling air. For this reason, it is recommended that as part of the temperature program you add an additional segment which allows the oven to cool down below the starting temperature and then to ramp up slowly. This prevents the oven from overshooting the starting temperature due to heat stored in the oven's metal structure. In the example at right, the oven is told to cool to 80C for 2 minutes, then ramp up to 100C (the starting temperature) at 10 degrees per minute.



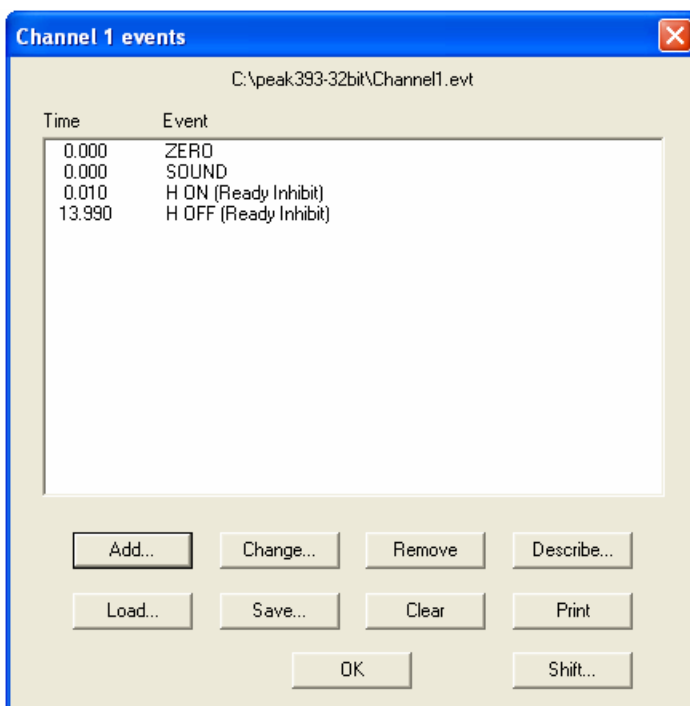
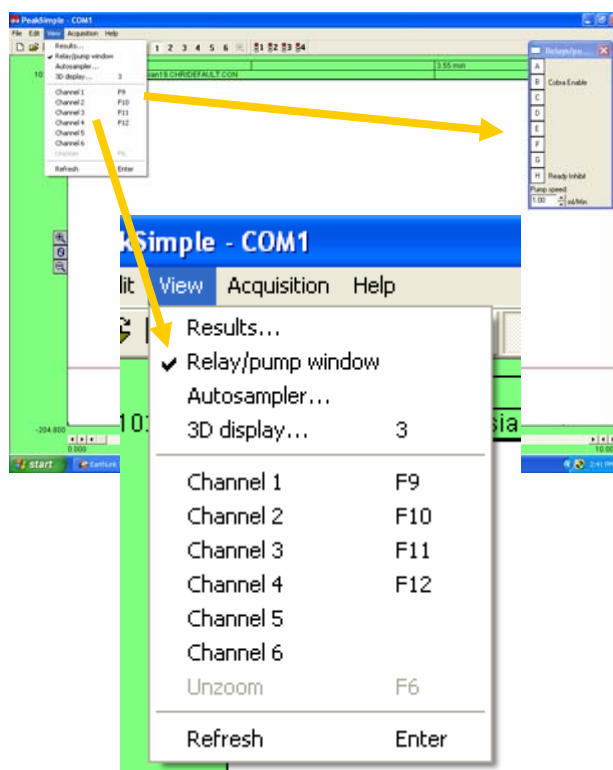
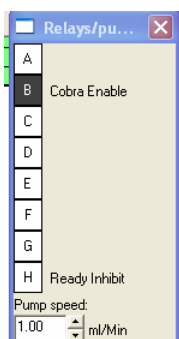
Note the end time of the temperature program (14 minutes)

Operation of the Cobra Autosampler on the 8610V gas chromatograph

Click View/Relay/pump window to display the status window which shows the state of the eight available relays. The Cobra autosampler uses Relay B and Relay H. Relay B is the Cobra enable control. When you click on Relay B with your mouse the Cobra is enabled. If Relay B is not clicked the Cobra will not operate.

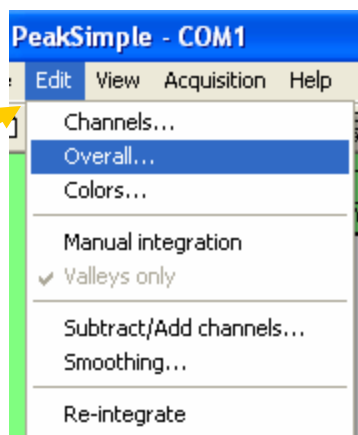
Relay H inhibits the GCs ready light from coming on. The Cobra starts its injection sequence when the GC ready light comes on. If the ready light is not inhibited during the analysis the Cobra may start another sequence in the middle of the analysis.

Enter an Event table similar to the one at right. Note that Relay H is turned on at .01 minutes and turned off at 13.99 minutes (just before the analysis end time according to the example on the previous page). If your analysis time is different you will have to adjust the time Relay H turns off to just before the analysis ends.



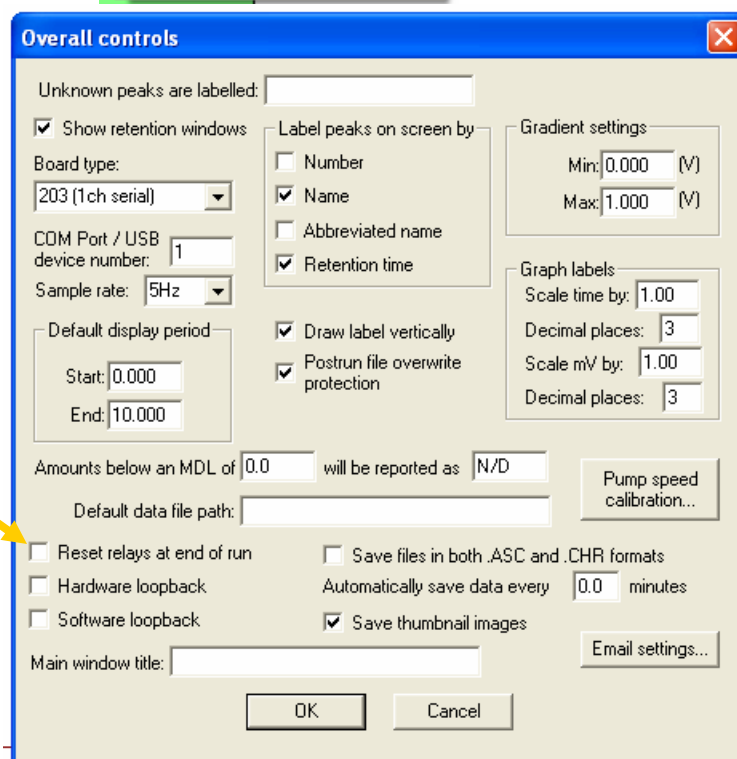
Operation of the Cobra Autosampler on the 8610V gas chromatograph

Click Edit/Overall to display the Overall Controls screen.



Remove the check mark from "Reset relays at end of run"

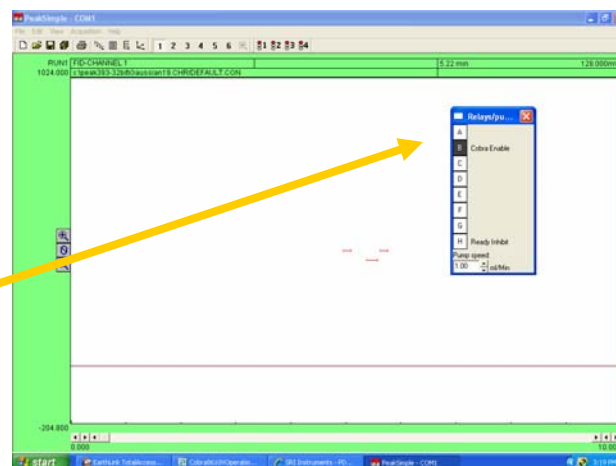
If you don't do this then Relay B will be turned off and the Cobra will not continue to run samples.



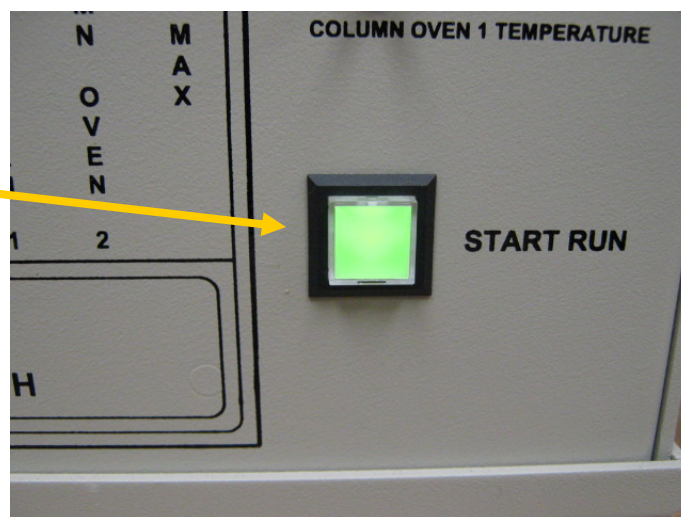
Operation of the Cobra Autosampler on the 8610V gas chromatograph

The Cobra and 8610V GC are now setup, so the sequence is as follows:

1) Operator clicks Relay B on PeakSimple screen.

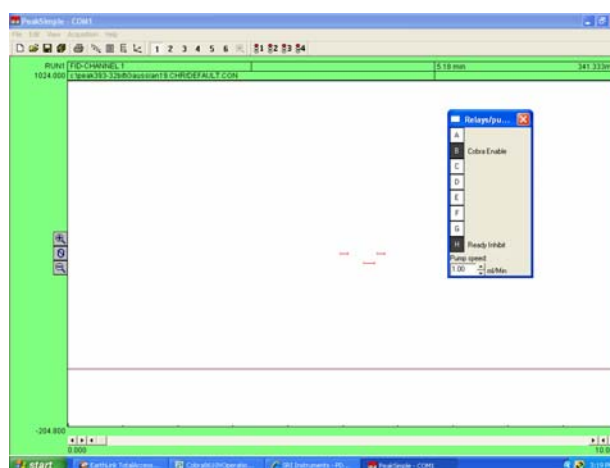


2) GC ready light comes on. This tells Cobra to begin injection sequence.



3) At the moment the Cobra syringe enters the GC injection port, the analysis begins. PeakSimple turns on Relay H which inhibits the Cobra from beginning another injection.

4) Relay H turns off just before analysis ends. GC cools down and stabilizes. When the GC ready light turns on again the next sample is injected. This is repeated until all the samples are injected.



Liquid AutoSampler for GC

FULL Featured - Reasonable Cost - DIY Installation

Operating and Instruction Manual for Cobra L/S Autosampler

Designed for use for GCs with Vertically Mounted Injection Ports (1 or 2 position)

Different Mounting Brackets for Different GCs are Required

CURRENT GCs

SRI New model ONLY SRI 8610V . . . NOT 8610C or earlier models
Factory installed by SRI (on NEW GC) - Full Warranty GC + Cobra

GowMAC 600
HP 5890
HP 6890

Coming : DPS 600 GC (NOT Companion GC)

Limited Warranty

EST Analytical hereby warrants the equipment supplied herewith to be free from defects in material and workmanship at the time of shipment. EST (the manufacturer), agrees to either repair or replace at our sole option, free of parts and labor charges at our factory, any parts of such equipment which under normal conditions of use prove defective within twelve (12) months (one year) from the date of shipment to the end user. EST has the option of inspecting the goods claimed defective at the Buyer's place of business or having the defective equipment returned to EST, transportation charges prepaid, for inspection. If an item is found defective under warranty, the repaired or replaced item will be returned to the buyer via the same mode of transportation by which it was received. This warranty does not cover equipment or parts of equipment which are modified by the Buyer. The following goods are warranted for the periods set forth only:

- (a) Items produced by third party manufacturers shall carry that warranty provided to EST by said third party manufacturers. Such warranty shall be passed by EST, to the Buyer.
- (b) This warranty does not apply to items consumed in the ordinary course of use of the goods, such as, but not limited to septa, vials, caps, syringes and needles.
- (c) This warranty does not cover bent, broken, or plugged needles, glass breakage, or the replacement or repair of parts due to accident, misuse or contamination, or loss or damage to equipment sustained in transit. Claims for damage sustained in transit must be filed with the transit agency. **Notice: All instruments should be insured with the shipping carrier prior to shipping, even if the repair is covered under warranty. The insurance must be purchased by the customer, not by EST Analytical.**

The foregoing warranty and remedy are exclusive and expressly in lieu of all other warranties, expressed or implied, including but not limited to any warranty of fitness for purpose or any warranty of merchantability.

Safety Information

CAUTION!

The Auto Sampler system will move rapidly to inject the sample into the gas chromatograph. This movement may prove hazardous if untrained personnel are utilizing the system. The system should be operated with all covers and latches secure. The syringe may move at any time. Make certain that all movement paths are clear at all times before powering on the system. Additionally, the syringe or needle may be bent broken very easily if proper setup instructions are not followed EXACTLY. Only trained personnel should attempt to operate the AutoSampler.

The Auto Sampler may operate on 110 VAC to 240 VAC, 50 to 60 Hz, electrical voltage only. This level of voltage may be life threatening if contacted. There are no user serviceable parts located within the housing of the Auto Sampler or power supply. If electrical problems are suspected contact the factory.

Conventions

This manual uses the following conventions:

Bold indicates emphasis or a minor heading.

Italics indicates the current function on the display that is being emphasized. It is usually a display parameter that will be changing as the AutoSampler performs a task.

CAUTION! messages precede warnings of procedures or practices which, if not followed correctly, could cause serious personal injury or damage to instrumentation.

Symbols as Marked on the Equipment or in the Operators Manual.



Protective ground (earth) terminal.



ATTENTION

This symbol is indicating special care should be given to this section of the manual.



CAUTION

This symbol is indication any incorrect operation could result in an error or damage to the instrument.



WARNING

This symbol is indication any incorrect operation could result in personal injury or damage to the instrument.

- ◆ All safety precautions **MUST** be adhered to when installing and operating the Auto Sampler.
- ◆ Please read this manual thoroughly before proceeding to install or operate the Auto Sampler.
- ◆ Be certain all personal in the laboratory are trained and are familiar with the operation of the Auto Sampler.
- ◆ When replacement parts are ordered, use only EST Analytical parts and part numbers.

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1.0 Introduction

1.1 Product Description

The Cobra L/S Auto Sampler combines state-of-the-art component technology with easy-to-use operating features that meet routine as well as research level autosampling requirements.

The Cobra L/S is an all-electric, stepper motor driven autosampler providing rugged reliability and pinpoint injection accuracy. The syringe mechanism moves back-and-forth and in-and-out across the sample tray to access sample vials, multiple solvent vials, standards, etc.

Variable inject volumes, injection speed, needle dwell times, number of samples per vial, multiple methods per run, solvent flush, air gaging, dual column operation and a host of other autosampling options are all standard and easily programmed on the Cobra L/S's menu driven keypad.

The unit uses screw-cap or crimp-top septum vials and easily interfaces with your GC system with all the remote inputs/outputs—ready signal, injection mark, etc.—plus RS 232 for direct communication with an IBM or compatible personal computer. Mounting is easy and allows for quick changes between GC's if desired. Syringe/injector alignment is via the keypad. The control module mounts on either side of the autosampler for easy access.

1.2 Key Features

- Direct Syringe Injection: Uses 1.5µl - 100µl syringes for minimum sample volume and maximum flexibility.
- All Electric: No additional cost for gases.
- Priority Manual Sample feature allows the current analysis to be interrupted for RUSH samples.
- Variable Sample Fill Rate for viscous samples.
- Variable Injection Rate to optimize chromatography based on injector type and analytes of interest.
- Dual Injector Operation allows maximum productivity from GC with dual injectors and columns.
- Programmable Injector Alignment: No manual adjustments to align injection ports.
- Variable Dwell Time for hot needle injection techniques.

- Post Solvent Rinse user definable with two separate rinse solutions.
- Internal Standard Injection
- Two Solvent Rinse capability minimizes cross contamination.
- Easy To Operate Menu-driven system simplifies method setup and allows for multiple method linking. Up to 10 different methods available.
- A sample may be run from any position in the sample tray in Manual or Auto mode.
- Large 120 or 200 position sample tray for overnight operation that lifts off for easy loading.
- The syringe may be programmed for simple or complex injection sequences through a simple keypad entry system allowing for any type of sample handling with one system.
- Totally controlled sequences of syringe purging and rinsing allowing improved peak resolution and minimum compound carry over.
- Fast easy programming from the touch pad keyboard terminal.
- Easily readable backlit LCD display.
- Compact size, requires less space than other autosampler systems.
- Easy hook up and installation.

1.3 Specifications

- Tray Capacity: 120 sample vials — 2 ml, 12 mm x 32 mm vials; 2 Solvent, 1 or 2 Waste, 10 ml vials
- Sample Size Reproducibility Typically 1% or better.
- Minimum Sample Size: 1% of Syringe Volume
- Sample Injections per Vial: 1 to 100; or sample vial capacity.
- Standard Injection: 1% to 100% of syringe capacity (standard volume plus sample volume cannot exceed the syringe volume).
- Operating Temperature: 15° to 35°C Storage Temperature: 0° C to 85° C
- Relative Humidity: 10 to 90%
- Line Voltage: 100-240 VAC; 50-60 Hz, 115-160 VA

- Weight: Auto Sampler Unit - 17 lbs 3 oz.: 7.8 Kilograms
- Size: Auto Sampler Unit - 25 x 10 x 17 inches : 63.5 cm x 35.5 cm x 43.2 cm

2.0 Installation

2.1 Installation Protocol

The complete installation of the Cobra L/S includes the following steps:

1. Unpack the Auto Sampler and make certain all parts and supplies are available.
2. Install the mounting bracket to the GC per separate instructions.
3. Install the Auto Sampler onto the mounting bracket.
4. Install the cable from the Display/Keypad Terminal box to the rear of the Cobra L/S, see Figure 2.0.
5. Connect the Remote I/O cable between the Auto Sampler and the GC or data system. See Section 9.0.
6. Connect the power supply power cord to the rear of the Auto Sampler and then plug the main power cord into a grounded AC power source.
7. Install the syringe assembly. See Section 4.1.
8. Perform the Setup and Target Setup procedures (some of these may require removal of the syringe.) Verify the initial mounting bracket alignment to the injection port on the chromatograph. See Section 5.0.

2.2 Unpacking the Auto Sampler

Carefully unpack and inspect the Auto Sampler. Inspect the instrument for possible shipping damage. If damage is discovered, immediately notify the shipping carrier and then EST Analytical. Do not return the instrument without first notifying EST Analytical and obtaining a Return Goods (RG) authorization number. If possible, please store the shipping cartons and all packing material for possible future use.

2.3 Parts and Materials

The following parts list is included in the accessory kit.

- Sample Tray
- Power Cord w/ Power supply
- Sample Syringe
- Optional Mount Bracket (This must be purchased separately)
- I/O Cable (comes with bracket)
- 4 Solvent / Waste Vials (10 ml)
- 4 Solvent / Waste Caps with Septa
- 4 extra Waste/Solvent Septa
- Operators Manual

2.4 Power Requirements



The Auto Sampler is an all electric system with only a maximum of 24 VDC present in the cabinet . No gases or other energy sources are required. The power requirement for the system is an input to the power supply of 100-224 volts and a line frequency of 50 to 60 Hz.. Make certain the electrical voltage is a constant source with no severe drops or spikes in the voltage. If the power source is not certain, install a power conditioner on the electrical line.

2.5 Interfacing to an Analyzer



To properly interface the Auto Sampler to the GC, the GC ready (or Analyzer Ready) signal and the remote start signal must be located on the GC and or Data Collection Device. Each GC is different and it may be necessary to refer to the instrument's manual, or contact a representative for the correct location of the ready and start signals. Connection points on gas chromatographs are unique to each system, therefore, a specially wired cable is required. To insure correct operation of the system follow the wiring schematic supplied with each cable. If a problem exists please consult the factory.

The Auto Sampler may also be operated in the Local mode if a GC ready signal is not available. The Local mode allows the Auto Sampler to inject a sample based on a cycle time setting without receiving a ready signal . See Method Parameters Section for more details.

The connections will be from the Auto Sampler's Remote I/O connector (25 Pin D), located on the rear of Cobra L/S, to the chromatograph's I/O "D" connector or appropriate terminal block connector(s).

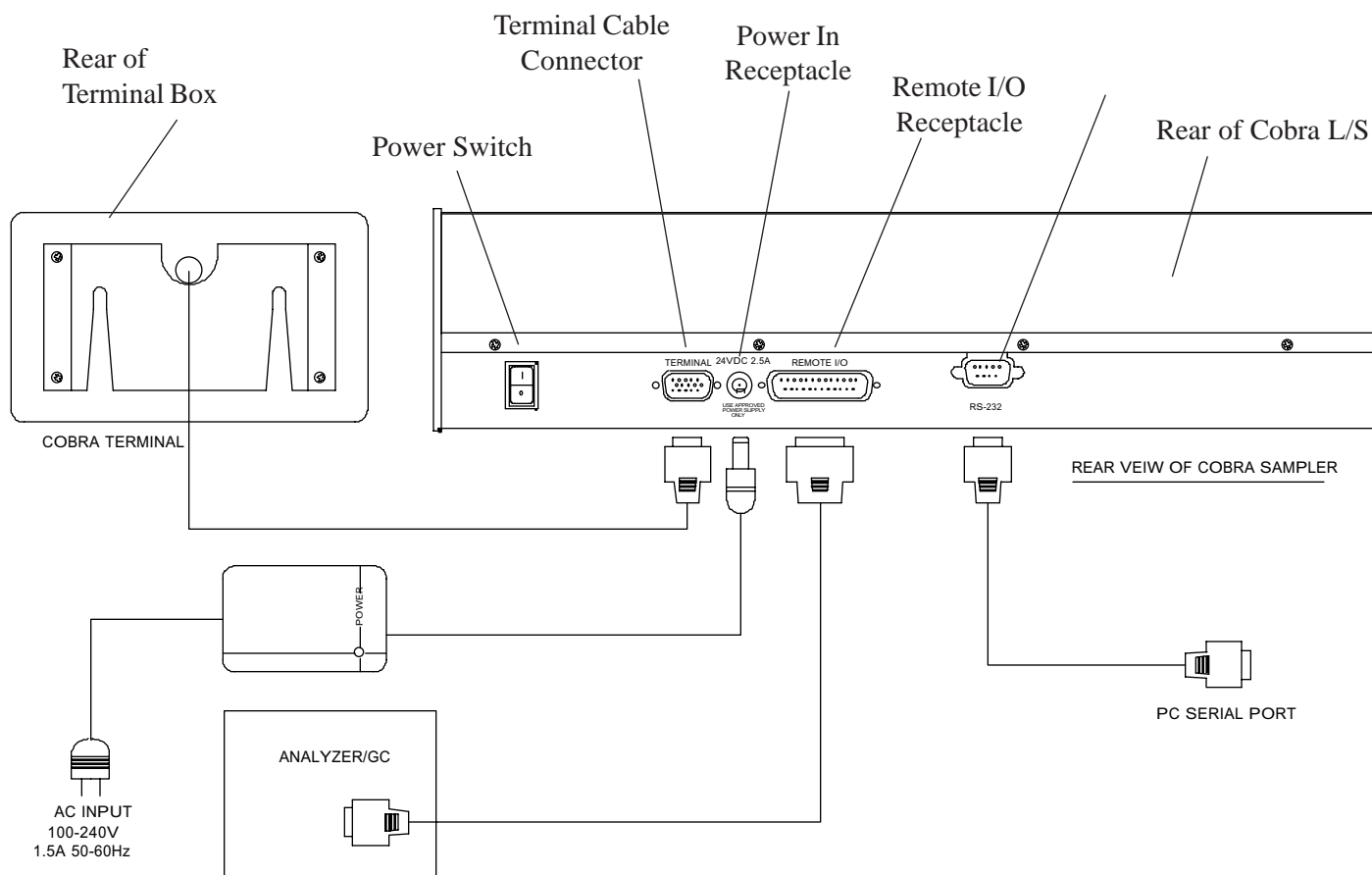
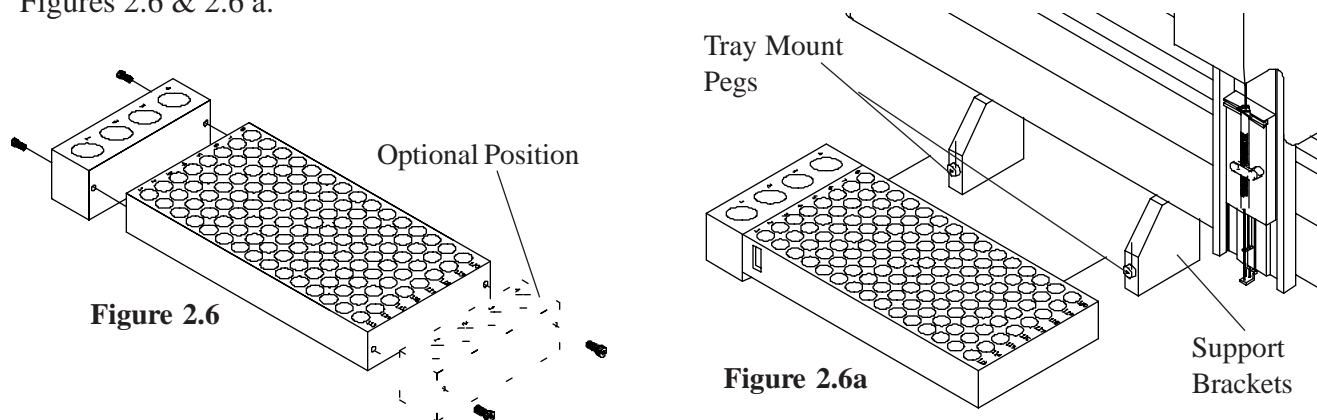


Figure 2.0

Figure 2.0 shows the complete installation of cables to the GC and for RS 232 remote control. **Be certain all cable connections are made before the power to the Cobra L/S is turned on.**

2.6 Sample Tray Installation

Unwrap the sample tray and place it onto the sample tray brackets. The tray will only mount in one direction as there are alignment pegs on the holder brackets and corresponding alignment slots in the tray. Once installed, place an empty vial with cap and septa in vial position #1 and the waste / solvent locations to be used. Be certain the waste/solvent tray is located on the correct side of the sample tray for your GC. Note, the waste / solvent tray may be located on either side of the sample tray, see Figures 2.6 & 2.6 a.



3.0 Keyboard Definition

The keyboard provides for a complete entry of all Setup, Method, Configuration, Diagnostics as well as motor operations. The keys perform the following operations. (See Operational Keys, Section 7.0, for a complete description of Key Functions.)

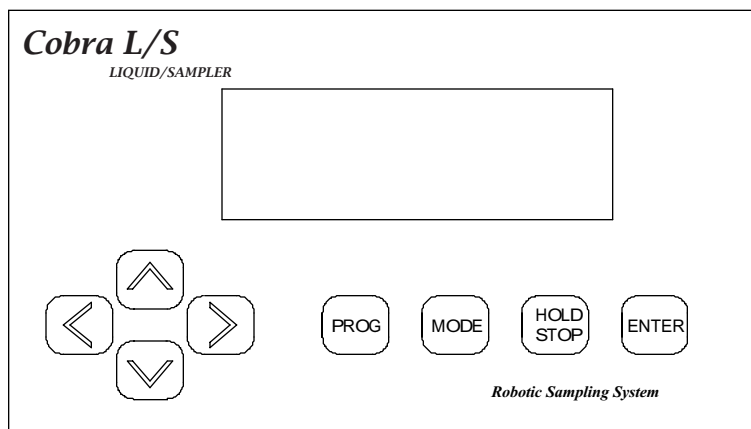
Hold/Stop Key: Provides both a "Hold" in the current operation and/or a complete abort of the current operation and allows for an exit out of a menu.

Mode Key: Selects the desired Mode of operation: Automatic, Manual or Flush.

Program (Prog) Key: Provides access to: Methods, Configure and Diagnostics menus.

Enter Key: Accepts the numeric value entry and/or menu item selection. It also scrolls to the next data entry item in applicable situations.

Arrow Keys: Allows for selection of all data, the L/R keys allow for increasing or decreasing numerical values and the U/D for scrolling within a menu or parameter.



4.0 Syringe Setup

The Cobra L/S will accept most manufacturers syringes however, a SGE 10µl, FN (P/N 506303) is shipped as standard. NOTE: If another syringe brand is used there may be some adjustment required to the lower needle guide.

Select the "Configure" menu using the "Prog" key and follow the instructions for "Syringe Setup".

4.1 Syringe Installation



1. Loosen the syringe plunger thumbscrew (1) and the two 4-40 socket head screws (4) securing the holder.
2. Insert the syringe needle (10) into the mid needle guide (9) and then down into the lower guide (11).
3. Insert the syringe flange (3) into the notch (4) in the upper section of the syringe holder (8).

Raise the plunger thumbscrew (1), holding it up, insert the syringe plunger thumbpiece (3) into the T-slot in the plunger retainer. Lower the plunger retainer thumbscrew and tighten securely. Rotate the syringe clamp (6), 90 degrees, to hold the syringe (7) in place.

4. Set the plunger to its zero position by sliding the holder (8) up until it touches the needle, **then back it down about 1/64"** and tightening the two 4-40 socket head screws (4).
5. Verify that the needle (10) does not extend beyond the lower needle guide (11). Place your finger under the lower needle guide and check. The needle tip should not be felt. If the needle tip can be felt, the needle guide requires adjustment, consult factory.

4.2 Syringe Calibration

The syringe plunger must be properly calibrated to insure injection accuracy. The procedure is performed in the "Cobra Setup" section of the control program. Press the "Prog" key and select the "Cobra Setup" menu, press the Enter key and select the "Configuration" Menu line, press Enter. Now, with the down arrow key select "Vol Calib", press Enter. The "Syringe Setup" screen is now showing.

Manually adjust the plunger to zero (if required) by adjusting the holder up, until the syringe plunger touches the bottom of the syringe, then back it down about 1/64", tighten the two 4-40 socket head screws, press the Enter key.

The next screen adjusts the maximum stroke of the plunger. With the Left/Right arrow keys, move the plunger up, such that the end of the plunger is on the maximum graduation mark of the syringe installed. (Note, record the value show on the line "Volume" for future use). Press the Enter key. Next, using the Left/Right arrow keys, adjust the plunger stroke to the maximum position allowed on the syringe barrel. This is generally about 10% above the syringe volume. Press the Enter key.

NOTE: If the plunger motor "chatters", the syringe holder is set too high not allowing the plunger sensor to be reached. Loosen the two 4-40 socket head screws and slowly lower the holder until the motor stops chattering. The plunger sensor has now been homed. Look at the plunger to be sure it is at the "0" mark.

The plunger has now been set to the maximum graduation (100%) mark on the syringe scale. This will allow the software to properly calculate the sample and rinse volume parameters.

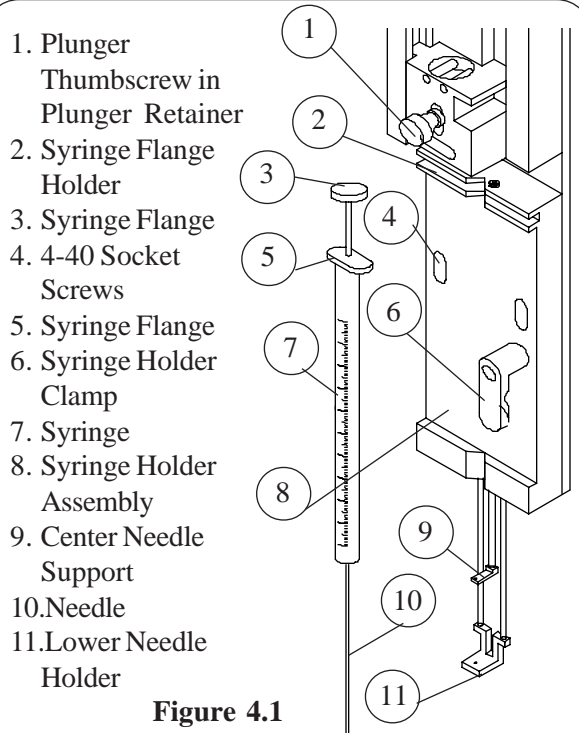


Figure 4.1

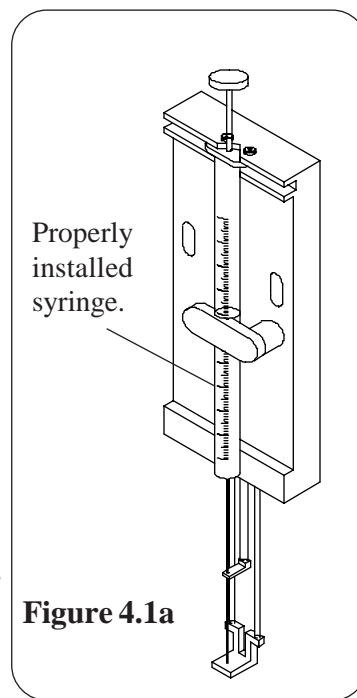


Figure 4.1a

5.0 Target Setup

CAUTION: *Severe damage can occur to the Syringe, Sample Vials, and/or Chromatography Instrumentation if incorrect parameters are set. Remove the syringe from the holder.*

CAUTION: *The mounting bracket must be correctly installed before attempting Target Setup.*

5.1 Target Setup Protocol

The Auto Sampler is designed to inject from up to 220 samples from .8 ml sample vials, however, the 120 position 2 ml vial tray is standard, into most types of GC septum injection ports. Two injection ports may be established anywhere along the travel length of the syringe arm.

Target Setup involves completing the following steps.

1. Installing the Mount Bracket and Auto Sampler to the analyzer.
2. Installing the Syringe Holder and Sample Tray with the Waste / Solvent installed on the correct side for you GC inlet configuration.
3. Syringe Installation and Calibration (**be certain the syringe is removed before beginning Target Setup**).
4. Selecting the Sample Tray Style.
5. Calibrating the sample vial #1 position. **Note, never allow the needle to pierce the septum of an empty vial. Always have liquid in the vial. This will help lubricate the needle in the septum.**
6. Setting Flush Vertical and Waste Vertical positions.
7. Calibrating the syringe to the injection port(s) location(s).

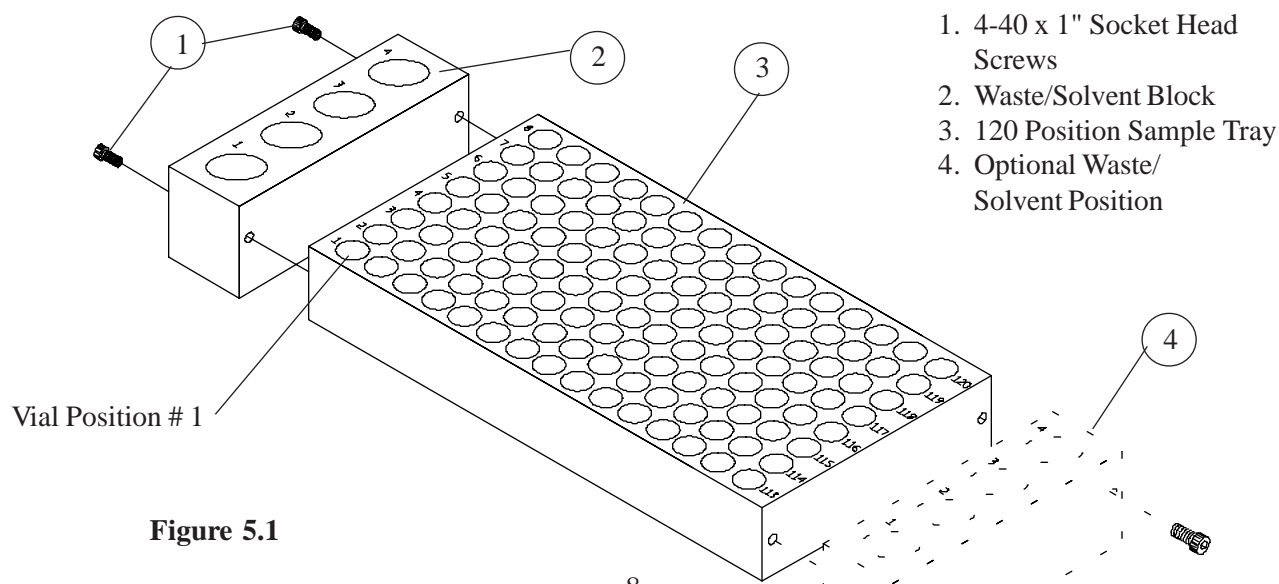


Figure 5.1

5.2 Motor Positioning Guidelines



When setting up the Sample Tray and Injection Inlet positions the arrow keys act as a directional input for axis movement (Left / Right arrow keys for Left / Right movement and the Up / Down arrow keys for Front / Rear movement). This movement is achieved when the operator "**taps**" or pushes a directional arrow key momentarily. If the movement is not "fine" enough, the step rate may be changed from "Continuous" to "Jog", and the number of steps per movement may be changed.

To access this menu, from the "Target Coordinate Setup" menu, move the head to a target and then press the "Mode" key. The "Select:" menu comes up, from here, the type of movement, either Jog or Continuous may be set, also the number of steps per movement. Changes are made by pressing the "Mode" key or the arrow keys. The default step rate is factory set at 10. To exit the menu press the Stop key.

5.3 Target Coordinate Setup



Press the "Prog" key and select "Cobra Setup." Select the "Configuration" menu line and press Enter. Scroll to the "Sample 1" line and press Enter. Press Enter and the syringe arm will move slightly to the left and out. The arrow keys are now used to move the syringe arm over to the center of vial #1. Press either the Left or Right arrow key to move the arm to the approximate center position of the first row of vials. Using the Up or Down arrow key, toggle to the "For/Back" menu line, use the Left or Right arrows to move the arm to the approximate center of vial #1. Toggle to the "Vertical" menu line and with the Right arrow key, lower the syringe arm to just above the vial cap. Install the syringe and make the final adjustments to the needle position. **The needle must be positioned down into the vial to not hit the bottom!.** After the setup is complete write down the number coordinates for future use.

Press the Enter key and the arm will move to home, toggle to the next menu line "Waste", press Enter. The same X-Y-Z coordinates must now be established for the Waste (1 & 2) and for Rinse (1 & 2) and for the injection Inlets A & B. The procedure for these settings is the same as for Sample #1. The only difference is the inlets will require a finer adjustment than the vials. Once all the coordinates have been established install the syringe and recheck the target locations.

6.0 Method Definition

6.1 Method Editing

The Cobra L/S allows 10 methods to be saved into memory. To edit a method, press the "Prog" key, select "Method Edit", enter the method number and press Enter. The next menu will allow entry into the selected Method. Press the Enter key and the parameters will be displayed. The Method parameters will then cycle through with each touch of the Enter key or Up\Down arrow, allowing changes to be made. The method editing may be exited at any time by pressing "Prog" or the Hold\Stop key. If the Enter key has been pressed changes will automatically be saved. If an invalid entry is made, the system will not save the entry. Refer to the following parameter list for values for each parameter. The parameter values are in brackets [xxx].

6.2 Method Parameters

Parameter	Range	Description
First Vial	[1 to 120]	The first sample vial to be injected.
Last Vial	[1 to 120]	The last sample vial to be injected.
#Inject/Sample	[1-100]	The number of injections to be performed on each individual sample.
#Rinse/Solv #1	[0-20]	After a sample is injected, the syringe will be rinsed this number of times using Solvent #1.
#Rinse/Solv #2	[0-20]	After a sample is injected, the syringe will be rinsed this number of times using Solvent #2.
Rinse Volume %	[0-100%]	The percentage of the total volume of the syringe to be used in rinsing, i.e... a setting of 50% when utilizing a 10 µl syringe would allow 5 µl of rinse solution to be drawn into the syringe for every rinse.
Rinse Fill Rate %	[0-100%]	The plunger stepper motor speed will be adjusted to a speed rating per the input value. Use a lower number if more viscous solvents are being used to avoid air bubbles.
Standard Volume %	[0-100%]	The percentage of the total syringe volume used when adding a standard to a sample, i.e... a setting of 10% (when utilizing a 10µl syringe) would cause 1µl of standard solution to be drawn into the syringe each time a sample was to be injected. If this parameter is used, each sample injection will have standard added to the syringe along with the sample. Note, the standard is always drawn into the syringe first and the sum of the standard volume and sample cannot exceed 100%.
Sample Volume %	[0-100%]	The percentage of the total syringe volume used, i.e... a setting of 10% (when utilizing a 10µl syringe) will inject 1µl of sample solution.

Sample Rinse	[0-10]	The number of times the syringe is filled with sample and "emptied" to the waste vial. The volume of sample loaded into the syringe will be according to the Sample Volume % Parameter.
Sample Pumps	[0-10]	The syringe will be flushed this number of times with standard/sample solution before the final standard / sample solution is drawn into the syringe prior to injection. The syringe will remain in the sample vial for this process. This helps to purge air bubbles from the syringe before drawing in the final sample to be injected.
Sample Fill Rate %	[0-100%]	The plunger motor fill rate speed will may be controlled with this value. Use 100% for the fastest plunger operation. Use a lower number if more viscous samples are being used to avoid bubble formation.
Sample Inj Rate %	[0-100%]	The plunger injection speed is controlled with this parameter. Use a lower number if more viscous samples are being used to increase reproducibility. Use 100% for the fastest injection speed.
Syringe Offset %	[0-20%]	The syringe offset determines what volume of sample remains in the syringe at the completion of an injection. A value of 10% to 20% may be useful in avoiding volume errors due to bubbles caused by certain sample types. The offset is ignored during the rinse cycle. This parameter MUST be set to if the Pre-Fill air parameter is being used.
PreFill Air %	[0-100%]	The amount of air to be drawn into the syringe before drawing in the standard/sample. This provides a head space of air to help purge the syringe of the entire sample during injection. The value entered is a percentage of the total syringe volume, i.e. a setting of 10% (when utilizing a 10µl syringe) will draw 1µl of air into the syringe. See "Syringe Offset Parameter" . Note, the sum of the standard volume & sample volume & Prefill Air % cannot exceed 100% of the syringe capacity.

MidFill Air %	[0-100%]	The amount of air to be drawn into the syringe after drawing the sample/standard volume. This air space will be utilized as a buffer between the two different solutions in the syringe. The value entered is a percentage of the total syringe volume i.e. a setting of 10% (when utilizing a 10µl syringe) will draw 1µl of air into the syringe each time a standard solution is drawn into the syringe. This parameter is not used if the Standard Volume is set to “0”.
PostFill Air %	[0-100%]	The amount of air to be drawn into the syringe after the sample is drawn into the syringe. This air volume can reduce “needle burn off” of sample in the injection port. The value entered is a percentage of the total syringe volume, i.e. a setting of 10% (when utilizing a 10µl syringe) will cause 1µl of air to be drawn into the syringe after the sample solution is drawn into the syringe.
Start Delay	[0-999 min.]	This parameter allows the autosampler to begin its sampling sequence at a future time, up to 999 minutes from the start point.
PreInj Delay	[0-600 sec.]	The number of seconds to pause after the syringe needle has entered the sample injection port. In systems where “needle burn” occurs this value can help separate the initial solvent injection from the main sample injection.
PostInj Delay	[0-600 sec.]	The number of seconds to pause (Dwell) after the sample has been injected. This feature allows the sample, time to completely leave the needle, before the needle is withdrawn from the injection port. GC Start and Data Start signals have been activated.
Inject Target	[A, B, A&B, A+B]	There are two injection targets possible, “A” and “B”. The sample will be injected into the assigned target(s). The position of the inlets does not matter, they can be left/right or front/rear. Multiple targets may be selected by entering one of the A, B combination values. The Left/Right arrow keys will scroll through the selections available.

	[A&B]	All volume of standard/sample is drawn into the syringe for both inlet injections. Injection of the sample volume is made into port A and then the syringe goes directly to port B and injects the remaining volume. The injection volume per inlet, is whatever percent was programmed.
	[A+B]	The programmed standard/sample volume is drawn into the syringe and injected into port A. Without rinsing, the syringe returns to the standard/sample vial and draws the programmed volume of standard/sample solution, this is then injected into port B.
PostFill Delay	[0-60 sec.]	This parameter allows a pause after the plunger has pulled the programmed sample volume into the syringe barrel. This delay, in seconds, allows viscous samples to completely fill the syringe barrel before the syringe needle is removed from the sample vial.
Operate Mode	[Remote / Internal]	Remote or Local operating modes are selectable by using the Left/Right arrow keys. In the Local mode, the Cobra L/S operates according to the Cycle Time Parameter. In the Remote mode, a GC Ready or Start signal must be received, and the Cycle Timer must be at "0" before the injection can begin.
Cycle Time Minutes	[0-999 min.]	Begins counting time from when the injection is made, (plunger is depressed). The next sample injection process will not start until this amount of time has elapsed. The syringe will however be rinsed, after the injection, according to the number of Rinses programmed. If the duration of post-rinse sequences requires a longer time period than the Cycle time, this parameter is not the determining time between injection cycles. This parameter is only required when running in the Local mode.
Aux. Time Minutes	[0-999 min.]	The auxiliary timer begins marking time when the sampling sequence begins. At the end of the programmed time, the Auxiliary Output switch is pulsed.

Methods may be linked together allowing the Cobra L\S to run multiple methods in a continuous process. Note: Circular linkage of a single method is allowed providing for continuous sample operations. When the method parameter is set to "0", the Cobra L\S will only run the one selected method.

See Section 6.3.2 for an example of **Method Parameter Setup** values. The Method example may be used for most sample situations.

6.3 Utilizing Standard Solutions

The Cobra L/S allows standard solutions to be automatically added to the sample injection. The syringe will first fill with standard solution and then move to the sample vial and pull up the sample into the syringe. Both sample and standard will then be injected as one "sample".

Standards are loaded into the tray in the far right vial column, vial positions 113 to 120. When a Standard Volume is programmed, the syringe will move to the standard vial position along each row of sample. As an example, all samples processed in vial row #1 will use position # 113 as the standard location. All samples in row # 2 will use position # 114 as the standard location. This pattern is used all the way to row # 8 Standard position # 120. What this means is samples **CANNOT** be loaded in locations 113 -120, this is reserved for Standards **ONLY**!

This method works well for injection methods into single injectors and in the dual inject mode [A+B] (see Inject Target parameter in Section 6.2). It does not work in the dual inject mode [A&B] because the sample and standard are not sufficiently mixed in the syringe.

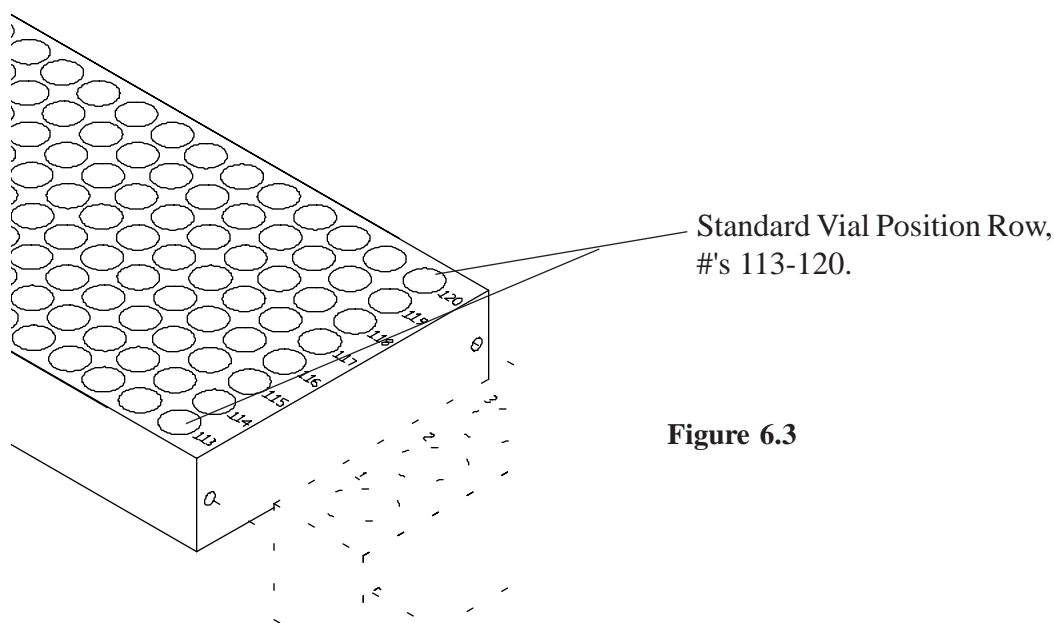


Figure 6.3

6.4 Suggested Method Parameter Values Utilizing Hexane and Methylene Chloride

Use the following as an example to setup Method Parameter Values. These values are suggested for solvents such as Hexane and Methylene Chloride. This Method is with a 5µl syringe installed. The sample is 1 µl, with a .25 µl offset injecting into inlet A. The syringe will be rinsed with 5µl of rinse #1 twice and #2 once. Prior to injection, it will dump the rinse twice, into waste, and then flush in the vial 5 times. This should eliminate any bubble problems with any solvent.

<u>Method Parameter</u>	<u>Initial Value</u>
# Inject/Sample	1
# Rinse/Solvent #1	2
# Rinse/Solvent #2	1
Rinse Volume %	100
Rinse Fill Rate %	10
Sample Volume %	20
# Dumps/Inject	2
# Flushes/Inject	5
Sample Fill Rate	10
Sample Inject Rate	100
Syringe Offset	5
Operating Mode	Remote

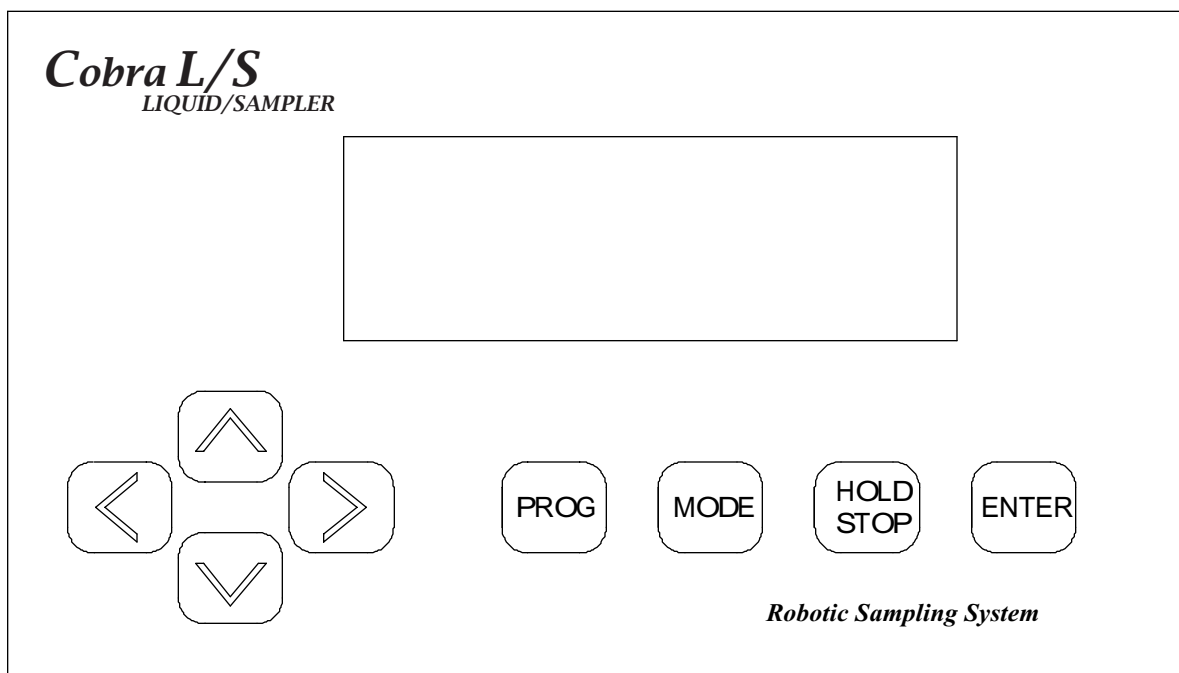
7.0 Operational Keys

7.1 Hold/Stop Key

The Pause/Stop Key performs two (2) functions:

1. Pause the current Auto Sampler operation at its completion. **The sampling continues until a complete sample injection cycle is completed.** The method parameters and/or the system parameters may then be edited or a priority **Manual Injection** may be performed. The system may then resume the AutoRun (where it paused) and complete the method.
2. Abort the current AutoRun or other function. The Syringe contents may be dumped to waste and/or immediately returned to its “Home” position and the AutoRun **may not** be resumed from the point it was stopped.

NOTE: The EndPause can be turned off at any point before it is actually executed by pressing the Enter Key.



Cobra L/S Keyboard Overlay

Press Hold/Stop Key - One Time.

During any operation of the Auto Sampler the **“Hold/Stop” Key** may be pressed. Hold the key down until the “End Pause” message appears. For an operation pause, the screen will display the prompt **“End Pause”**. The Auto Sampler will continue until the current injection cycle is completed.

At this point practically any aspect of the Auto Sampler may be updated. Methods may be edited, a Priority Manual Sample may be performed or any of the System parameters may be changed. To resume the AutoRun from the point it was paused, press the **“Enter” Key**.

Press Hold/Stop Key - Two Times.

Pressing the **“Hold/Stop” Key** the second time will immediately stop the motors. A prompt will appear on the screen to allow the syringe contents to be dumped to the waste vial before returning the syringe to its home position and reset. The method or AutoRun cannot be resumed from the position it was stopped without editing the method and changing the “First Vial Position”. If the syringe contains any solution at this point, press the **“Enter” Key** to allow it to be dumped into the waste vial before returning the syringe to its home position.

CAUTION: Syringe contents will be emptied where the syringe is currently positioned if the "Hold/Stop" key is pressed instead of the “Enter” Key. This could cause hazardous and/or corrosive chemicals to be dispensed into the atmosphere and/or onto the Auto Sampler and Analyzer.

7.2 Prog (Program) Key

The Prog Key is used to access the Cobra L/S Method Edit and Setup menus. The user must select either the Method Edit or Setup screen with the Up/Down arrow keys and press Enter. If Method Edit is selected, enter with the Left/Right keys, a method number from #1-10 and press the Enter Key. The display will change to the method number entered allowing for editing or review.

If the Setup menu line is selected, the next screen allows access to the "Configuration, Maintenance, Diagnostics and Motor Speeds" menus. These menus will be discussed in detail in Section 8.

To exit the "Prog" key selection press the Hold/Stop key.

7.3 Mode Key

The mode key allows the user to begin running samples. Press the "Mode" key and the next screen will display the selection of "Auto Run" or "Manual Run." The user can select either mode with the Up/Down arrow keys. If the Auto Run is desired enter the method number, with the Left/Right arrow keys, then press Enter. This will immediately begin the sampling sequence per the Method selected.

If the Manual mode is selected, the next screen allows the user to run a single sample or rinse the syringe. If a sample is to be run the user must enter the Method number and the sample vial number to run. The Left/Right arrow keys are used to enter this data. Press the Enter key and the sequence begins.

If Sample Rinse is selected, the next screen allows the user to enter the Method number to run the rinse syringe sequence. Press the Enter key to begin the sequence.

NOTE: The Auto Sampler will rinse the syringe according to the parameters in the Method number selected. It is advised that a Method be dedicated to the desired syringe flushing cycle and stored for future use.

8.0 Cobra L/S Setup Menus

The Setup Menu allows the user to access the Cobra L/S Configuration, Maintenance, Diagnostics and Motor Speed menus. These menus provide complete setup and diagnostic tools for installation and performance setup. **Note: Several of the menus in this section are intended only for a service technician.**

8.1 Configuration Menu

Configuration menu allows the setup of the sample tray and all needle targets (these were discussed in detail in Sections 4.0 and 5.0).

8.2 Maintenance Menu

Maintenance menu displays the current Firmware revision code and the Plunger count. This is useful in knowing the life cycle of a Teflon tip style syringe plunger. The count can be reset by using the Left/Right arrow keys. To exit the menu press the Hold/Stop key.

8.3 Diagnostics Menu



CAUTION: *Only trained personnel should operate the Cobra L/S whenever the Diagnostics menu is accessed. Damage to the syringe, sample vials and/or chromatography instrument could be severe if untrained personnel attempt to use this menu without a complete understanding of its purpose!*

This menu will allow the *trained* operator to move the Front/Back, Vertical, Plunger and Right/Left axis. Additionally, the motor movement parameters may be changed. These are the beginning and ending ramping and the final speed settings. **NOTE: If this menu has been accessed, the menu line "Enter To Test", will cause each axis to move until the Stop key is pressed!**

8.3.1 Relay Output Testing

Additional diagnostic information is available for relay testing. These are the GC/Data, Auxiliary and Spare Output relays and the Input signal data. This information is useful for determining if one of the output relays is not working. Relays maybe wired for normally open or normally closed, the closure is for .5 seconds. The default setting is in the N.O. mode.

From the Diagnostics menu, scroll, using the UP/Down arrow keys, to the relay desired for testing, press the enter key. The display will show the selected output, i.e....GC/DATA Start, Enter to test, Stop to exit.

To preform the test be certain the I/O cable is properly connected or a VOM meter is set to the correct position to test the output. Follow the instructions on the display.

8.3.2 Input Signal Test

This screen allows the GC ready signal to be tested. The normal state should be OFF, once an input signal is received, the OFF will toggle to ON. The screen line "Spare 7" is an indicator showing that the spare (these are signal line inputs for future use) signals are floating "high."

8.3.3 Motor Delay



CAUTION: *Only trained service personnel should operate the Cobra L/S whenever this Diagnostics menu is accessed. Damage to the syringe, sample vials and/or chromatography instrument could be severe if untrained personnel attempt to use this menu without a complete understanding of its purpose! This menu is intended for the service technician.*

This menu allows the stepper motor delay time (in milliseconds) to be changed. This time is the duration of pause at the end of one motor movement and the start of the next motor movement. The factory default is 100 ms. The Left/Right arrows will change the value. Press Enter to exit.

To test the new time setting you must scroll to one of the motor axis movement menu lines. The best one is probably the Left/Right axis, follow the screen prompts to access moving "all" motors.

8.3.4 Motor Speeds



This screen allows the service technician access to settings for all the motor speeds. This information should be used for reference only. ***ONLY TRAINED SERVICE TECHNICIANS SHOULD ATTEMPT TO MAKE MOTOR SETTING CHANGES!*** The Motor speed settings are set and confirmed when the individual axis menu is selected.

In the Motor Speeds menu, each axis can be moved for testing, and if necessary, the speed values changed. This allows each of the movement parameters to be altered, ramping for beginning and ending (F; delay between steps for starting rate), (R; delay between steps for final rate), (S; acceleration or ramping speed). Once these settings are entered the Motor Speed menu will allow the user to check the settings.

The settings are:

Speed...this is the final speed of the motor.

Initial Rate (Inirat)...this is the plunger's initial movement speed.

Acceleration (Accel)...this is the speed for beginning (accelerate) and ending (decelerate) motor speeds for the balance of the motors.

9.0 External I/O Connections

The Cobra L/S has a 25 pin "D" connector on the rear of the cabinet for External I/O connections, i.e. GC Ready, GC Start, Data Start, etc. The following is a list and pin locations for the signals. Note: The Cobra L/S is supplied with an External I/O cable that will be specific to your GC system however, not all functions shown will be wired in your cable. Be certain the cable you received is correct for your system, see Figure 9.0 for complete cable connections.

<u>Pin #</u>	<u>Signal</u>
1.	Signal Ground
2.	In 1 Ground
3.	In 2 Ground
4.	In 3 Ground
5.	GC Start N/O
6.	GC Start N/C
7.	Data Start Com
8.	Auxiliary N/O
9.	Auxiliary N/C
14.	GC Ready Input
18.	GC Start Com
19.	Data Start N/O
20.	Data Start N/C
21.	Auxiliary Com
22.	Spare Out N/O
23.	Spare Out N/C
24.	Ground
25.	5 VDC Out

10.0 Remote Control (RS 232 Serial Link)

The Cobra L/S can be Remote Controlled through its Serial Interface Link, labeled "RS 232." This may be accomplished in either the "Remote or Local" Mode (this is programmed in the Methods). Commands may be received from either the Host PC or the keypad, however the keypad is LOCKED out with a message on the LCD while the PC is programming. The Cobra L/S is started by a signal generated by either the GC Ready signal, the Host PC or the keypad.

The Cobra L/S requires a 9 conductor cable to Receive, Transmit and Ground, fed straight through. If you do not have a cable consult the factory. Plug the cable into the 9 position "D" connector on the rear of the Cobra L/S labeled "RS 232" and then into the 9 pin serial connector on the rear of your PC.

10.1 Data Format

The Data Transmission from the host to the Cobra L/S and from the Cobra L/S to the host use the same data format. Communications are RS 232 as follows: 19200 baud, no parity, 8 bits, 1 stop bit and no handshaking.

10.2 Command Summary from Host to Cobra L/S

All Commands require 3 bytes, followed by a CR. Shorter commands should be padded with a CR to make them 4 bytes long, total.

Q Get Cobra's attention (Cobra will stop running, and echo ok) and print "PC Host active" on line 4 of the LCD screen. When the PC host releases control, "PC link Idle", will appear on line 4 of the LCD, if the Cobra L/S was idle, otherwise, the run will continue from where it was interrupted, unless an Rn or Gn command had been issued by the host. Note that parameters updated with the MWn command will not take effect until the batch is started the next time.

Attempts to communicate with the Cobra L/S while it is performing a manually initiated rinse will be ignored.

After the Cobra L/S has responded to the Q command, the following commands are available:

Note...For commands with a method parameter, the examples use method 1. In the Mode After column, remote indicates the PC Host stays in control after the command is executed, and the Cobra keypad is disabled. Local means control has transferred back to the Cobra.

<u>Command</u>	<u>Example</u>	<u>Mode After</u>	<u>Description</u>
MWn	77 87 01 13	Remote	Program method parameters (requires parameter string to follow)
SW	83 87 13 13	Remote	Program system parameters (requires parameter string to follow)
Rn	82 01 13 13	Remote	Start running method n
V0	86 48 13 13	Local	Turn off Verbose mode, no status messages will be sent while the Cobra is running
V1	86 49 13 13	Local	Turn on Verbose mode, "PC Host active" LCD message changes to "Linked to host"
MRn	77 82 01 13	Remote	Request Method parameters for method n
SR	87 82 13 13	Remote	Request System parameters
ST	87 84 13 13	Local	Request Current status. One of the following series of two binary bytes, followed by CR will be sent: 1-10, 1-12 0-Running method, sample 0, 101 - Manual mode, 0, 102 - Idle
GO	71 79 13 13	Local	Resume running if a method was interrupted, or return to local control if Cobra was not running.

GN	71 78 13 13	Local	Resume running at beginning of current cycle, after dumping syringe contents to waste, or return to local control.
AB	65 66 13 13	Local	Abort current method, dump syringe and return to local control
Q	81 13 13 13	Remote	Echo "ok", useful for synchronizing with Cobra, works to establish communications initially, and does no harm if communications are already working
<ESC>	27 13 13 13	Remote	Return cobra to local keypad control, and continue method if one was interrupted (Same effect as GO)

For both Rn and Gn, the Cobra will transmit "Run Complete" CR when the method is complete. The system will wait for a keypad press, or any character over the serial link, and then return control to the Cobra. A remote program will have to re-send Q to get back to control. All commands should be terminated with a Carriage Return (binary 13). All method #'s (n) should be binary, not ASCII value, i.e. 77 82 49 01 for MR1, except the Rn command, in which the n can be either the ASCII equivalent, or the binary value, i.e. 82 01 13 13 and 82 49 13 13 will both start Run 1.

10.3 Cobra L/S Command Details

To program a method remotely from a host PC:

- 1) PC sends a Q to get sampler's attention
- 2) PC waits for ok, indicating Cobra is ready
- 3) PC sends "MWn" CR, to indicate method is to be programmed.
- 4) PC waits for ok CR, indicating the Cobra is ready
- 5) PC sends the following binary string, all word (2 byte) values:

<u>Byte#</u>	<u>#Bytes</u>	<u>Content</u>	<u>Allowed Range</u>
(PC code must enforce these limits)			
0	2	First Vial	1-120
2	2	Last Vial	1-120
4	2	Num of repeats/sample	1-100
6	2	# of rinse ones	0-20
8	2	# of rinse twos	0-20
10	2	rinse volume	0-100%
12	2	Rinse fill rate	0-100%
14	2	Standard Volume	0-100%
16	2	Sample Volume	0-100%
18	2	Num of solvent dumps/inject	0-10
20	2	Num of solv. flushes/inject	0-100

22	2	Sample Fill Rate	0-100%
24	2	Sample dispense rate	0-100%
26	2	Syringe Offset	0-20%
28	2	Prefill Air	0-100%
30	2	MidFill Air	0-100%
32	2	Postfill Air	0-100%
34	2	Start delay (seconds)	0-999
36	2	Pause before sample dispense	0-600
38	2	Pause after sample dispense	0-600
40	2	Target	0-3 (0-A, 1-B, 2-A&B 3-A+B)
42	2	Pause after sample fill	0-60
44	2	Operation mode	0-1 (0-continuous, 1-GC trigger)
46	2	Cycle time (secs) when Opmode=0	0-999
48	2	Seconds till auxiliary relay closure	0-999 (clock starts at cycle start)
50	2	Link to method # on method completion	0-10 0 for no link
52	1	CR	

6) Cobra will respond with ok

7) Host sends Rn to start method n. Cobra will respond by starting method. For example, sending R1 (binary 82 49 13 13) starts method 1, whether or not it was just programmed. To start Cobra in Verbose mode, where status reports are sent while running, send the V (86 49 13 13) command first.

10.4 Program System Parameters

1. PC sends a Q to get sampler's attention
2. PC waits for ok, indicating Cobra is ready
3. PC sends "SW" (binary 83 87) to indicate system parameters are to be programmed.
4. PC sends the following binary string:

<u>Byte#</u>	<u>#Bytes</u>	<u>Content</u>	<u>Allowed Range</u>
0	2	Right/Left Final Speed	0-999
2	2	Forward/Back Speed	0-999
4	2	Vertical Final Speed	0-999
6	2	Plunger Final Speed	0-999
8	2	Plunger Initial Rate	0-999
10	1	Plunger Acceleration	0-255
11	1	Normal Acceleration	0-255

12	1	Vertical Acceleration	0-255
13	1	Tray Size	0-3 (only 0 currently supported)

5. Cobra will respond with ok.

10.5 System Errors

Undefined commands will get a response "Undefined command"

All parameters must be in their allowed range, Cobra will not edit incoming values.

Cobra will wait for an enter key press (ASCII 13) to continue after an error.

10.6 Error codes

- # 1 Undefined command
- # 2 Invalid value
- # 3 Not yet supported
- # 4 Current run must be aborted first

11.0 Cobra L/S Installation of Cables and Mounting Hardware

The following section details the Cobra L/S mounting bracket hardware and I/O cable installation. Refer to the drawings for detail.

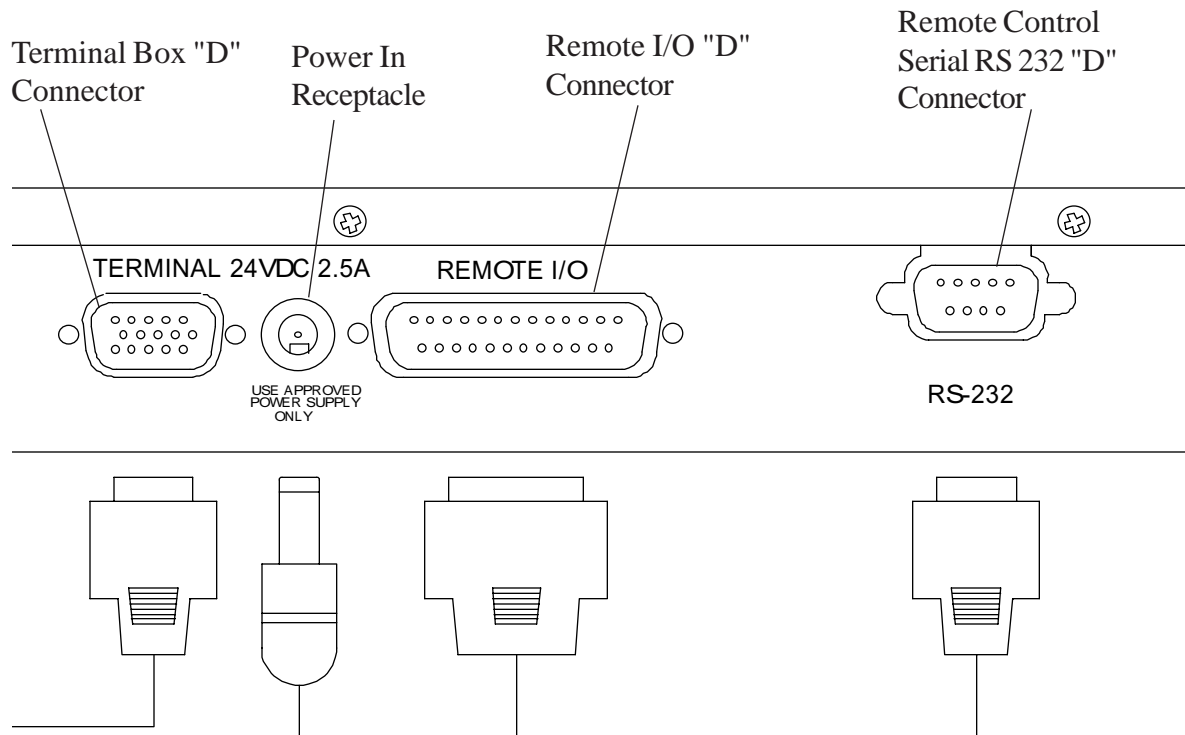
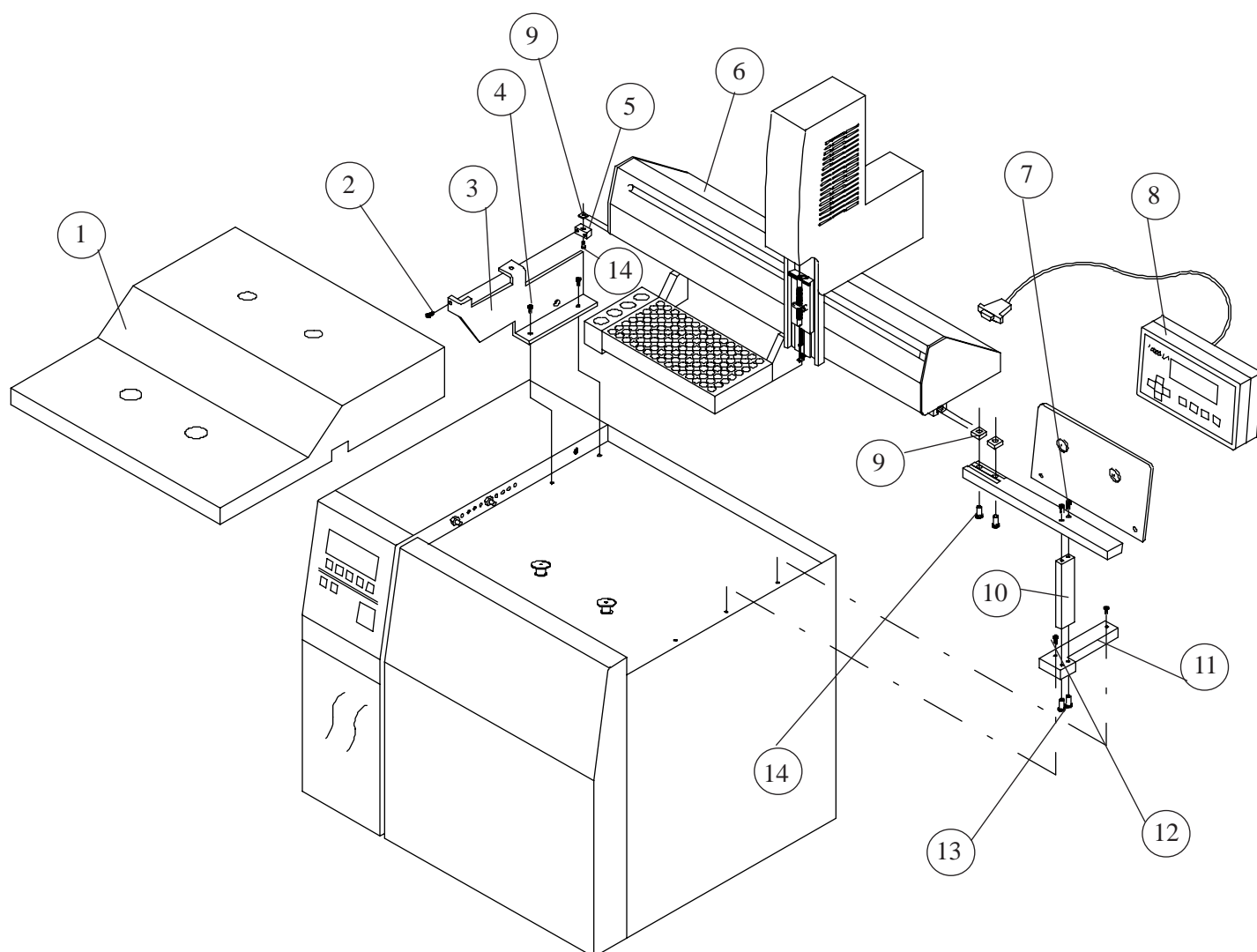


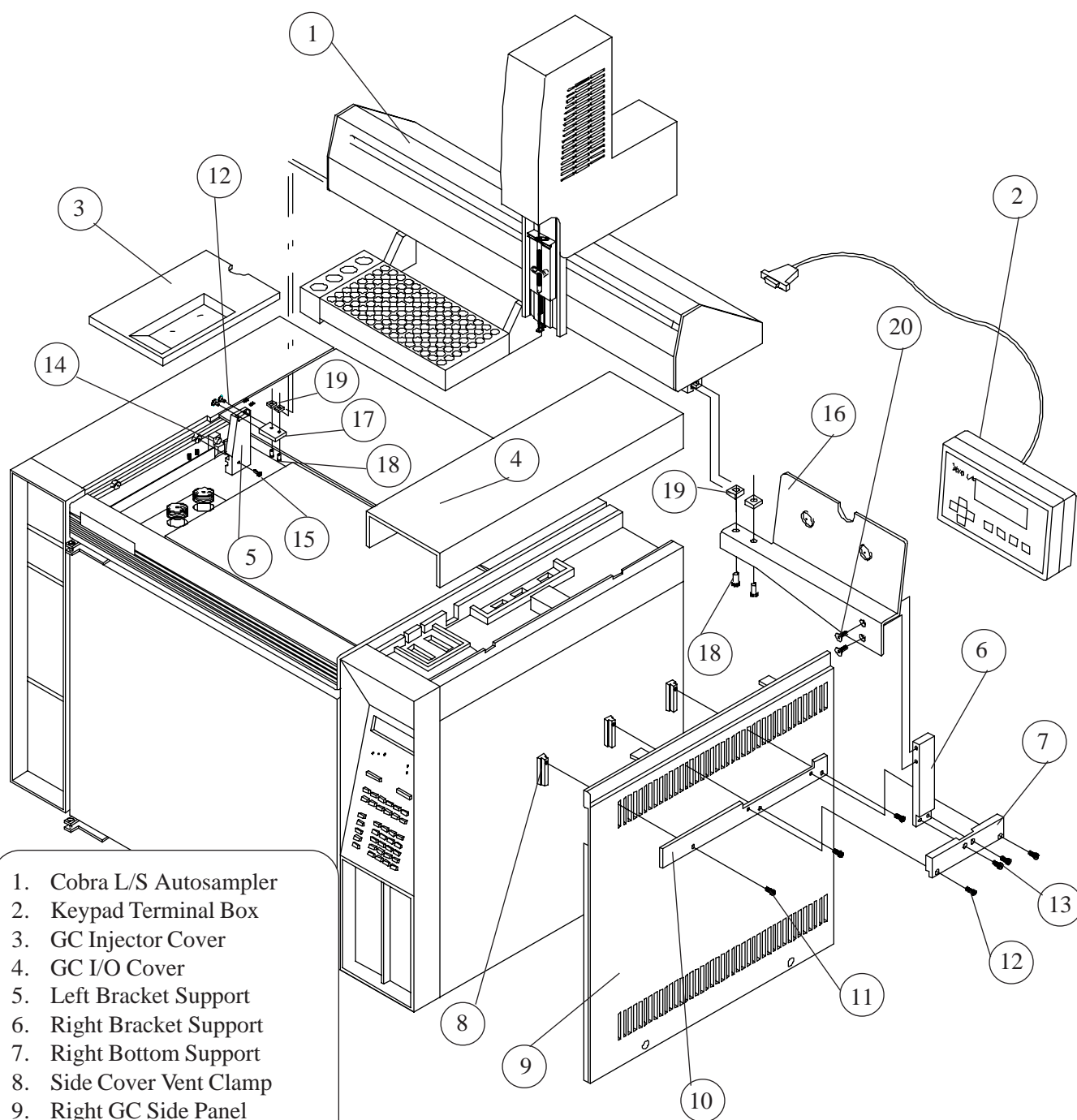
Figure 11.0
Cobra L/S Rear Panel

11.1 Installation of the Cobra L/S to the Gow-Mac 600 Gas Chromatograph



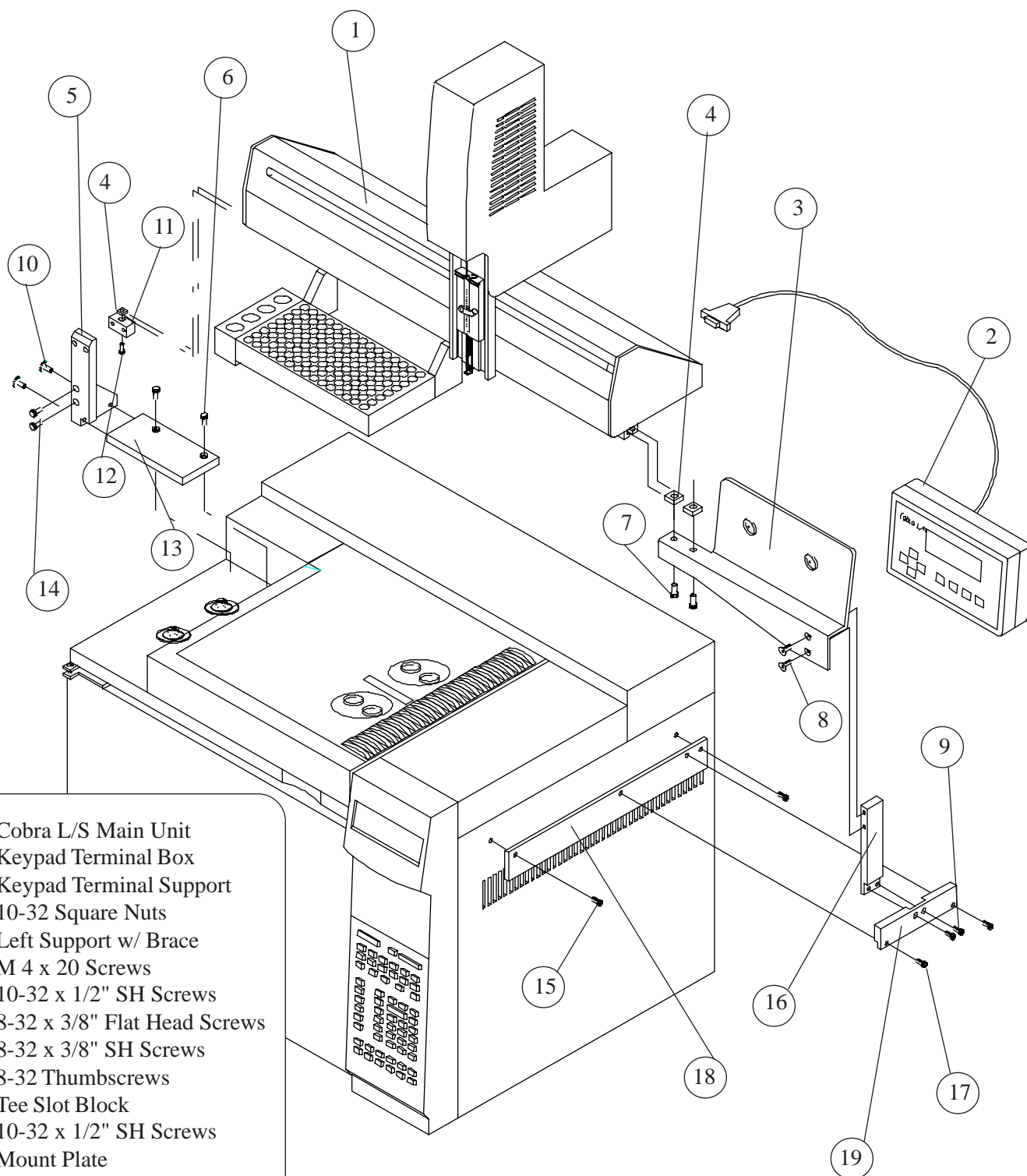
1. GC Oven Top
2. 6-32 x 1/2" SH Screw W/ #6 Lockwashers
3. Left Mount Bracket
4. 10-32 x 1/2" SH Screws W/ #10 Lockwashers
5. Bracket Mount Block
6. Cobra L/S
7. 8-32 x 1/2 SH Screws
8. Keypad Terminal
9. 10-32 Square Nuts
10. Right Vertical Mount Block
11. Right Bottom Mount Block
12. M4 x 20mm Screws
13. 8-32 x 1/2 SH Screws W/ #8 Lockwashers
14. 10-32 x 1/2" SH Screws

11.2 Installation of the Cobra L/S to the HP 5890 Gas Chromatograph



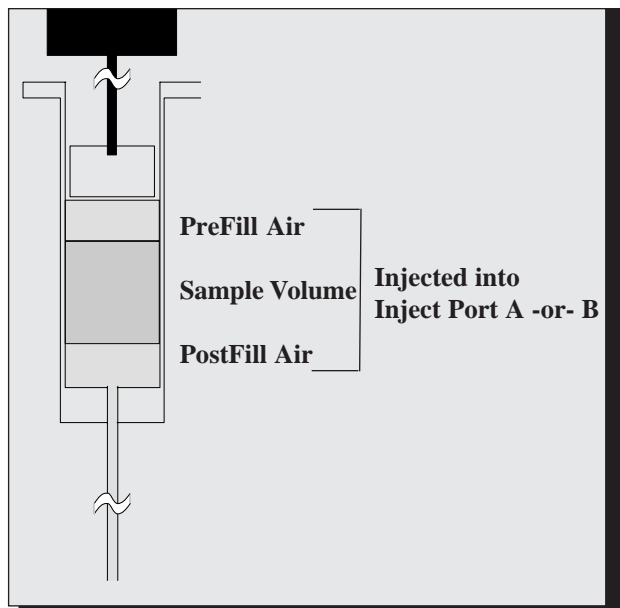
1. Cobra L/S Autosampler
2. Keypad Terminal Box
3. GC Injector Cover
4. GC I/O Cover
5. Left Bracket Support
6. Right Bracket Support
7. Right Bottom Support
8. Side Cover Vent Clamp
9. Right GC Side Panel
10. Side Panel Bracket Support
11. 6-32 x 1/2" SH Screws
12. 8-32 x 1/2" SH Screws
13. 8-32 x 3/8" SH Screws
14. Boss Extension on GC
15. 8-32 x 3/4" SH Screws
16. Keypad Terminal Support
17. Left Tee Slot Block
18. 10-32 x 1/2" SH Screws
19. 10-32 Square Nuts
20. 8-32 x 3/8" Flat Head Screw

11.3 Installation of the Cobra L/S to the HP 6890 Gas Chromatograph

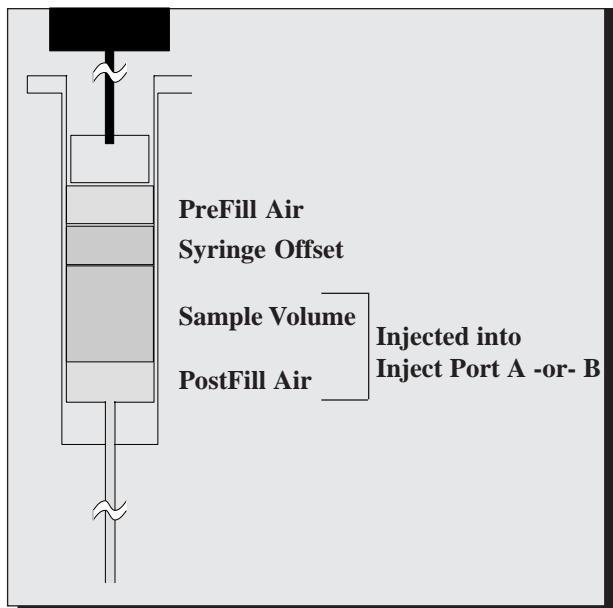


1. Cobra L/S Main Unit
- 2.. Keypad Terminal Box
3. Keypad Terminal Support
4. 10-32 Square Nuts
5. Left Support w/ Brace
6. M 4 x 20 Screws
7. 10-32 x 1/2" SH Screws
8. 8-32 x 3/8" Flat Head Screws
9. 8-32 x 3/8" SH Screws
10. 8-32 Thumbscrews
11. Tee Slot Block
12. 10-32 x 1/2" SH Screws
13. Mount Plate
14. 10-32 x 1/2" SH Screws
15. M 4 x 20 Screws
16. Right Support
17. 8-32 x 1/2 SH Screws
18. Right GC Mount Plate
19. Right Mount Bar

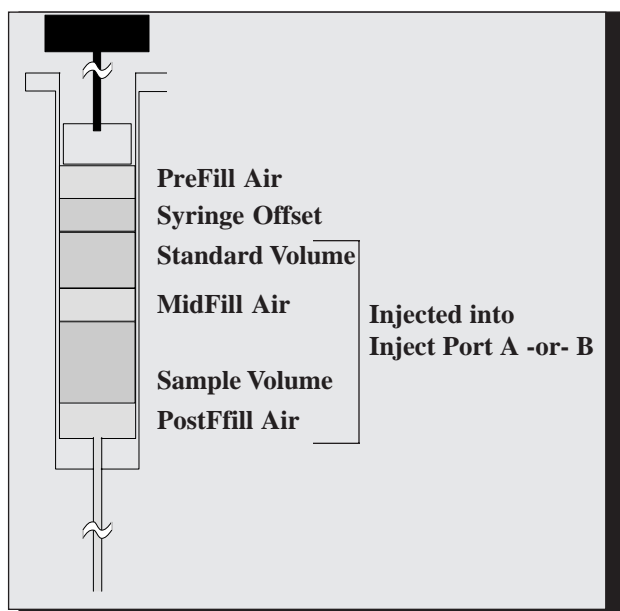
Appendix: Syringe Operation Drawings



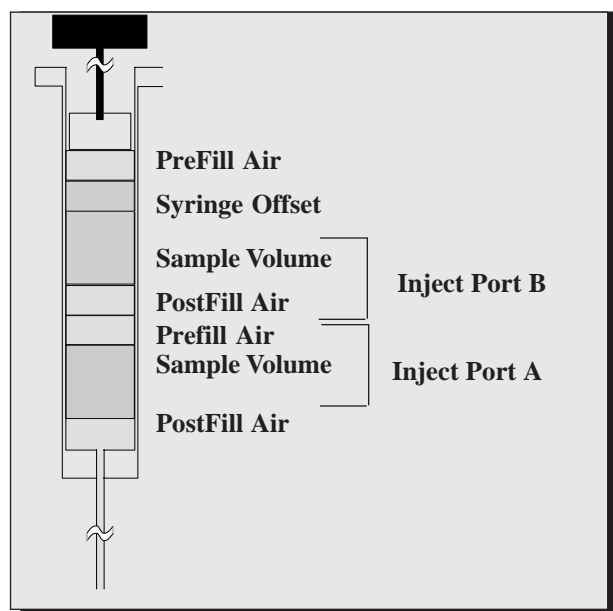
Example 1 - Standard Injection Setup



Example 2 - Syringe Offset Used

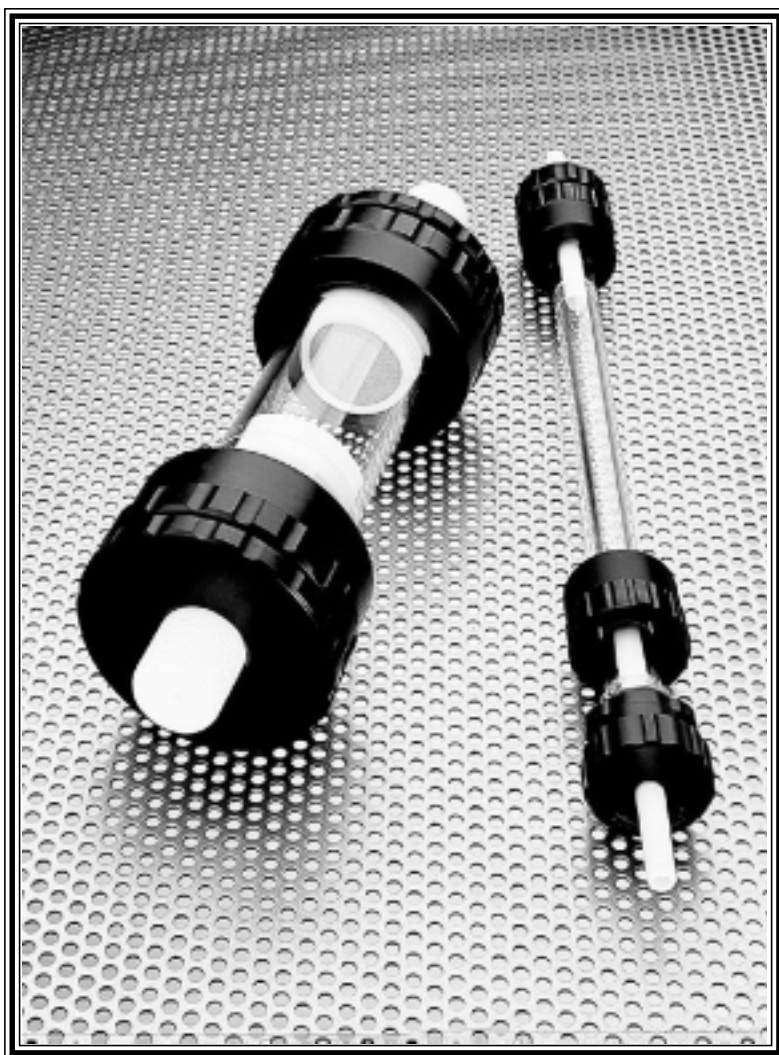


Example 3 - Using Syringe Offset and Standard Offset



Example 4 - Using Syringe Offset and Inject Mode = A&B

[illegible]



essentialLife Solutions

Econoline® Column Manual

INTRODUCTION

ECONOLINE® is a multipurpose column for almost all types of liquid chromatography application. Adjustable length plungers at both ends and a totally inert triple chevron sealing system support the complete range of applications from classical normal phase and reversed phase chromatography right through to biochromatography.

The Quick-Lock™ connection system makes it possible to open and reseal the column simply and quickly.

ECONOLINE® glass columns are available in two versions. The solvent resistant (SR) version is equipped with the triple chevron sealing system, whereas the aqueous buffer (AB) version is provided with ethylene polymer elastomer sealing rings, which ensure that the column will work perfectly even at low temperatures.

EXTENT OF SUPPLY AND SPECIFICATION

Number	Name	Material
1	column body	borosilicate glass
2	variable pistons	Teflon (SR) or polyethylene (AB)
2	bayonet system locks	Delrin
2	frits (pressed into column piston body)	glass or steel (SR); polyethylene (AB)
2 x 2	locking rings 1/16" + 1/8"	Tefzel
2 x 2	fixing screws 1/16" + 1/8"	Delrin
2	coupling units 1/4"-28->M6	Tefzel
2 x 2	connecting tubes 1/16" + 1/8"	Tefzel
1	frit ejector	steel / Delrin

RECOMMENDED ACCESSORIES

Number	Name	Material	P/N
1 pk./10 pcs.	stoppers	Tefzel	KP311
1	coupling unit	Tefzel	KP630

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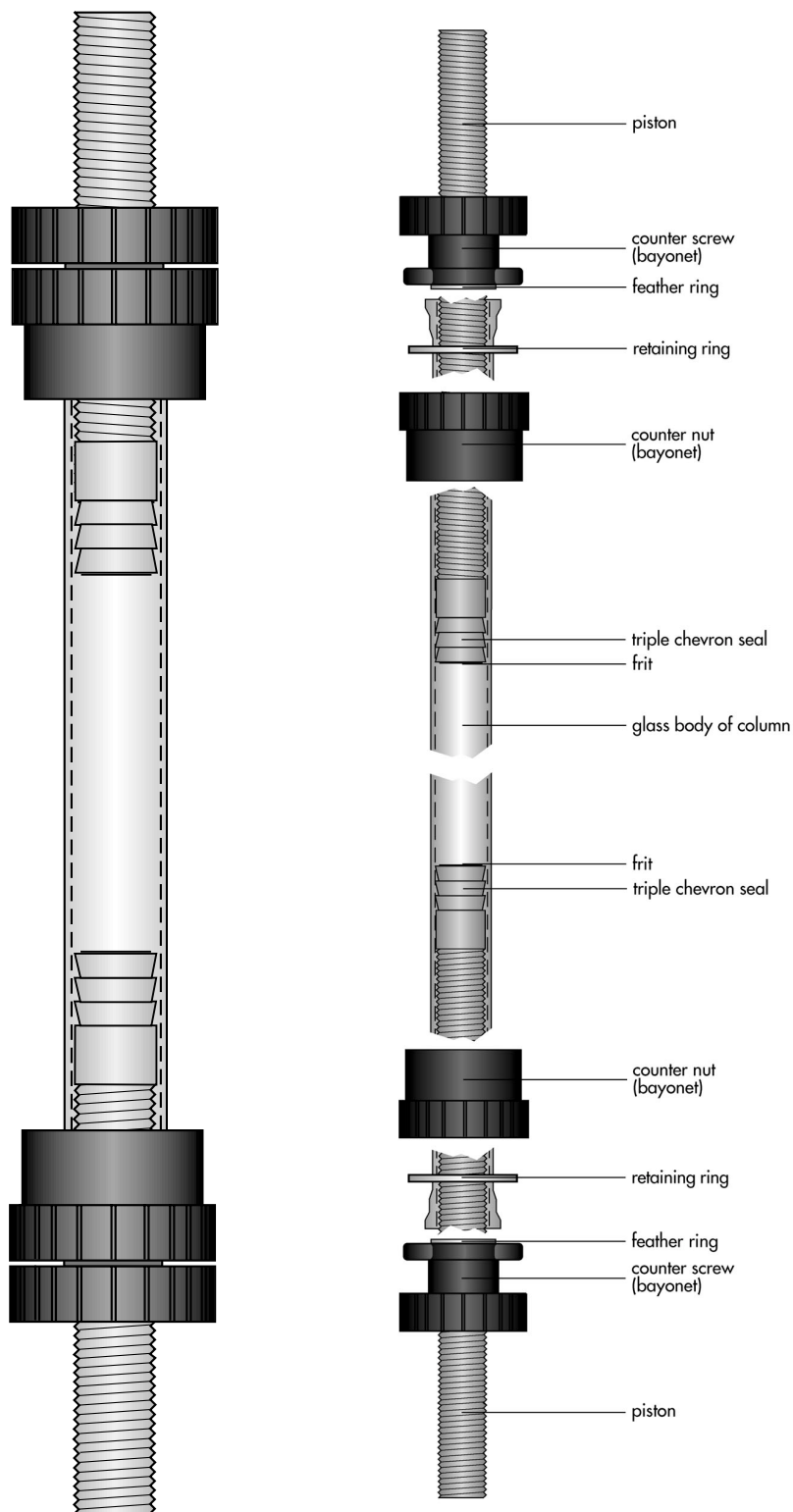
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The general conditions and the Essential Life Solutions Ltd warranty conditions apply in the version that is valid in each case. All information contained within this manual is without obligation, as it is subject to technical changes resulting in product improvement.

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**ECONOLINE
COLUMN**



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1. REMOVAL/INSERTION OF THE PISTON

Opening the lock

To open the lock, the counter nut and counter screw are pressed gently towards each other and the screw is turned a quarter turn anticlockwise. This frees the piston, so that it and the counter screw can be removed as a single piece from the column.

Resealing the column

Gently insert the piston, with the counter screw attached, into the column body, ensuring that it goes in straight and not at an angle. Bring the counter screw and the counter nut into position by turning them in such a way that the stopper of the bayonet lock fits into the opening of the counter nut. The column is sealed by turning the counter screw a quarter turn clockwise. The bayonet lock will engage audibly.



PLEASE NOTE: When inserting the piston, it is absolutely essential that it goes straight in and not at an angle. The inner glass surface and the seals must be clean, and the seals should be moistened with solvent. Both the O-rings on the AB version and the Teflon triple chevron seals on the SR version can be damaged by foreign particles or by incorrect insertion, rendering the seal useless.

The column can only be used with correctly locked end fittings, otherwise the pistons will be forced out of the column by the pressure inside. Please make sure you hear the bayonet lock click, which means that it is locked correctly.

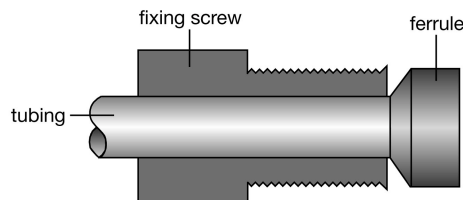
2. FRIT REPLACEMENT

1. *Eject the old frit with the frit ejector supplied.*
2. *Insertion of new frit: the Teflon piston end can be protected by heating it (to a maximum of 121°C) before the new frit is pressed into position. Before the piston can be inserted into the column, it must be cooled back down to the temperature of its surroundings.*

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3. ASSEMBLY OF Essential Life Solutions Ltd. MPLC-FITTINGS



These assembly instructions are for tubing with an outer diameter of 1.6mm or 3.2 mm.

1. *The end of the tubing is cut square with a knife or a tubing cutter.*



PLEASE NOTE: Do not cut with scissors, as the tubing will be squashed. It is important to cut the tubing at 90°, as the cut edge forms part of the sealing area.

2. *The fixing screw is pushed onto the tubing.*
3. *The ferrule is pushed onto the tubing with the conical end towards the fixing screw. If the tubing cannot be inserted into the ferrule, the conical end can be widened slightly with a suitable instrument (e.g. a scriber).*
4. *The fitting can now be inserted into the desired position. The screws should be tightened until the pressure can be felt, after which they should be tightened by another half turn.*



PLEASE NOTE: When the fittings are screwed into the Teflon thread, care should be taken to screw them in straight and fasten them carefully, to avoid damaging the Teflon thread.

4. ELIMINATION OF DEAD VOLUME

Dead volume which occurs at the column inlet can be remedied simply without needing to open the column:

1. *Turn off the pump.*
2. *Turn the column lock anticlockwise.*



PLEASE NOTE: The piston should only touch the surface of the stationary phase. If it is pressed into the stationary phase, the packing may be destroyed.

5. OPERATION OF THE COLUMN

Putting the column into operation

The pistons, frits and glass body must be cleaned thoroughly before the column is used for the first time. In some cases it may be worth dismantling the column and washing the parts in a sonic bath for a few minutes. After cleaning, all parts must be rinsed in double-distilled water and assembled as described in the second part of point 1 (page 5). Care must be taken that the piston is straight when inserted into the column body, because if it is inserted at an angle, the seal might be damaged.

To operate the column, it must be attached to an appropriate chromatography system or pump using the fittings supplied. Take care when selecting the tubing: tubing diameter must be appropriate to the flow rate to be applied, and the tubing itself must not react with the solvent in question. Should the column bed shrink during use, dead volume can easily be eliminated by moving the variable piston downwards.



PLEASE NOTE: only use degassed and pre-filtered solvents. Particles in the solvent may clog the frits or damage the column packing. Make sure that the particle size of the chromatography material in question is considerably greater than the porosity of the frits!

Hints for operation

1. *Storage of the packed column: open the sealing stoppers by one complete turn in order to compensate for temperature-related changes in pressure.*



IMPORTANT: Protect moistened columns from intense heat and direct sunlight. The heat induces evaporation of highly volatile solvents, and the resulting pressure can crack the column.

2. *We recommend eluting the column from bottom to top so that any air present can escape more quickly. As a result, the column is conditioned more quickly, so less solvent is necessary.*
3. *Before sample application, please ensure that no dead volume has occurred at the column inlet during the conditioning phase. (For removal of dead volume, see page 6).*

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6. SOLVENT RESISTANCE

For the storage of packed columns, we recommend 20% ethanol in H₂O, possibly buffered neutrally with up to 1 M NaCl, or a neutral buffer with 0.03% sodium azide. Normal and reversed phase columns should be stored in the solution they are used with, but with a minimum proportion of 10% organic solvent. All solvents used should be filtered through at least 0.45µm, or preferably through 0.22µm filters.

In general the following solvents and additives can be used. However, we do not recommend using any of them for longer periods of time or for storage. For further information please contact Essential Life Solutions Ltd.

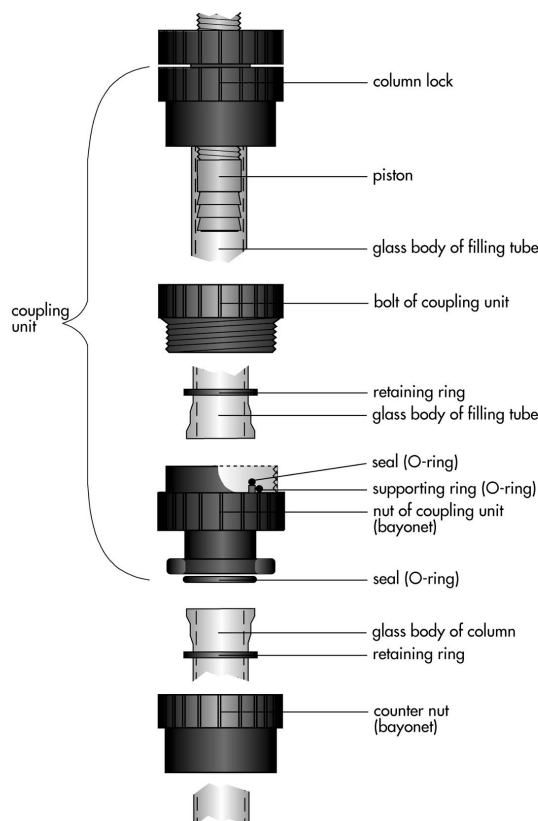
- W** Resistant to all common organic solvents such as:
ethanol, methanol, propanol, isopropanol, acetonitrile
- U** Please note that the AB version is only resistant to organic solvents to a limited extent
- W** Resistant to all common aqueous buffers
- W** Salts in aqueous solutions such as: NaCl, (NH₄)₂SO₄, MgCl₂, CaCl₂, etc.
- W** pH 1-14
- W** 2 M NaOH
- W** 1 M HCl
- W** 75% acetic acid
- W** Detergents (≤ 2%) such as SDS, Triton, etc.
- W** 6 M guanidinium-HCl, 8 M urea
- W** Working temperature range:
with Teflon piston / triple chevron sealing system:
16-40° C (SR version)
with polyethylene piston / O-Ring-seals:
4-40° C (AB version)

7. PACKING INSTRUCTIONS

This packing method is a general recommendation, which usually gives good results in terms of reproducibility and resolution. Best results can be achieved by using a filling tube when packing the column. If you only require a short bed length or relatively low packing quality, the column can also be packed directly and the slurry can also be topped up during packing if necessary. In individual cases, we advise optimising the methods depending on the specific media or application in question.

Assembling the packing device

The glass column body is sealed at one end with the piston. The filling tube is attached to the column funnel with the coupling unit. Care should be taken to position the O-rings and the frits correctly. The packing device must be screwed on tightly, to prevent foreign bodies from coming between the seals and the glass column body or getting caught inside.



Producing the slurry

A suitable solvent or buffer is added to the appropriate amount of packing material until it reaches the total volume of the packing device or the column (see instructions on packing material). The slurry is gently shaken until it has a uniform consistency (never use a magnetic stirrer) and degassed thoroughly just before packing.

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7. PACKING INSTRUCTIONS

Safety tip

Glass columns must never be packed under gas pressure without the appropriate protection equipment. You should always keep within the stated pressure limits for columns and related equipment. Appropriate clothing for the laboratory and safety glasses are essential.



PLEASE NOTE: A glass column should never be used under gas pressure. Even small stresses in the body of the column are sufficient to cause the column to explode, thus freeing the expansion energy of the gas and causing the shards of glass to act like projectiles. If the glass body shatters under the pressure of a liquid, on the other hand, there is no danger, since liquids are much less compressible and have virtually no expansion energy.

Packing the column with rigid media

Introduce a few ml of solvent or buffer (see instructions on packing material) into the packing device, so that the lower frit is moistened and free from air bubbles. Next the slurry is shaken carefully until it has a uniform consistency and quickly poured into the packing device without introducing any air bubbles. The slurry container must not have any air bubbles at all in it. If necessary, it can be topped up with solvent. The packing device is then sealed and packed as quickly as possible using a pump: this means that the flow rate should be set at the pressure limit of the column, so if necessary packing is carried out at the pump's maximum flow rate. A narrow PEEK capillary at the column outlet may improve packing quality, as it will act like a back-pressure regulator and prevent the slurry entering the column too quickly at first. Pumping must continue at least until a constant pressure is reached. The flow rate during packing should always be considerably higher (>20%) than the flow rate needed for later use. After packing, the filling tube is unscrewed. Care must be taken when opening the column outlet so that any remaining pressure is released completely.

The piston is introduced carefully, without allowing any particles to get between the glass and the piston seal. The column is now re-attached to the pump, the pump is started at low pressure and the flow gradually increased to the pressure limit of the column. At this point dead volume may occur between the variable piston and the column bed, which can be removed by moving the variable piston towards the column bed. For this, the column must not be under pressure, i.e. the pump must be turned off and the column inlet opened. Next the column is conditioned with the relevant eluents and is ready to be used.

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7. PACKING INSTRUCTIONS

Packing the column with soft gels

Only degassed and filtered solvents or buffers may be used when packing chromatography columns.

The lower frit is dampened and covered with approx. 1cm solvent. Next the slurry is introduced carefully and quickly, ensuring that no air bubbles occur. The column outlet should be open while the column is being filled; the solvent can also be sucked from the column outlet with a peristaltic pump at the same time. When the slurry has all been poured in, the gel must be allowed to settle and the solvent sink to approx. 0.5 – 1cm above the packing level in the gel bed. The gel bed must not be allowed to run dry. The column outlet is closed or the peristaltic pump stopped. Next the variable piston is inserted, without allowing particles to come between the seal and the column body. By turning the lock slowly, the piston can be moved towards the gel bed. At the same time, all the air above the gel bed should be forced out of the column inlet. It is essential that the gel bed is not compressed when moving the piston towards it. Now the column can be equilibrated with the appropriate buffer or solvent. Dead volume can occur between the gel bed and the piston during normal use, but this can be removed by moving the piston inwards.

Quality control

We recommend that you determine plate count and peak symmetry with a suitable (non-adsorbent) test substance after packing the column. By repeating this test frequently, the quality and durability of the packing material can be recorded efficiently.

Amount of theoretical plates (N):

$$N = 5.54 \times (T_r / W_{1/2})^2$$

T_r : retention time (sec)
 $W_{1/2}$: peak width (sec) at half peak height

$$HETP = L / N$$

L : column length in mm

Peak symmetry (S):

$$S = W_{1/2,r} / W_{1/2,l}$$

$W_{1/2,r}$: peak width to the right of the peak median
 $W_{1/2,l}$: peak width to the left of the peak median

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8. CLEANING INSTRUCTIONS FOR PACKED COLUMNS (CIP)

The cleaning of a chromatography column involves the following three stages: regeneration of the column packing, sterilisation and depyrogenation.

Regeneration removes chemical and organic contamination that becomes non-specifically attached to the chromatography material, considerably reducing the capacity and resolution of the column. This kind of contamination is usually caused by lipids and pyrogens, protein aggregates, pigments, polyphenols and metal complexes.

Sterilisation is the removal and/or denaturing of micro-organisms and spores, which could contaminate the purified product, by chemical treatment. The most frequently used sterilisation method is treatment with sodium hydroxide, acetic acid or ethanol solutions containing sodium hydroxide or acetic acid.

Depyrogenation includes the breaking-down of endotoxins that have become attached to the chromatography material or the column hardware (frits, tubing etc.) and can soil the target compounds in question by being washed gradually through the column. Often the methods used to sterilise equipment will also break down pyrogens.

Chromatography columns can be purified and sterilised by taking the following steps:

The column is dismantled and the individual parts (column body, pistons, end fittings, frits) are washed in a dilute solution of caustic soda or sodium hypochloride (0.5 N NaOH or dilute NaOCl); the frits should be left in the same solution for 30-60 minutes. Before the column is re-assembled, all parts should be washed in a sterile, pyrogen-free solution.

The column must be packed in a sterile environment. All solvents and solutions used for the column must be sterile and pyrogen-free. We recommend in-line filtration through a 0.22 µm filter.



PLEASE NOTE: Check carefully that all moistened parts of the column are stable with all reagents used. If in doubt, contact Essential Life.

8. CLEANING INSTRUCTIONS FOR PACKED COLUMNS (CIP)

There is a range of cleaning methods, according to the nature of the substance to be removed. Please refer to the instructions given for the column packing in question!

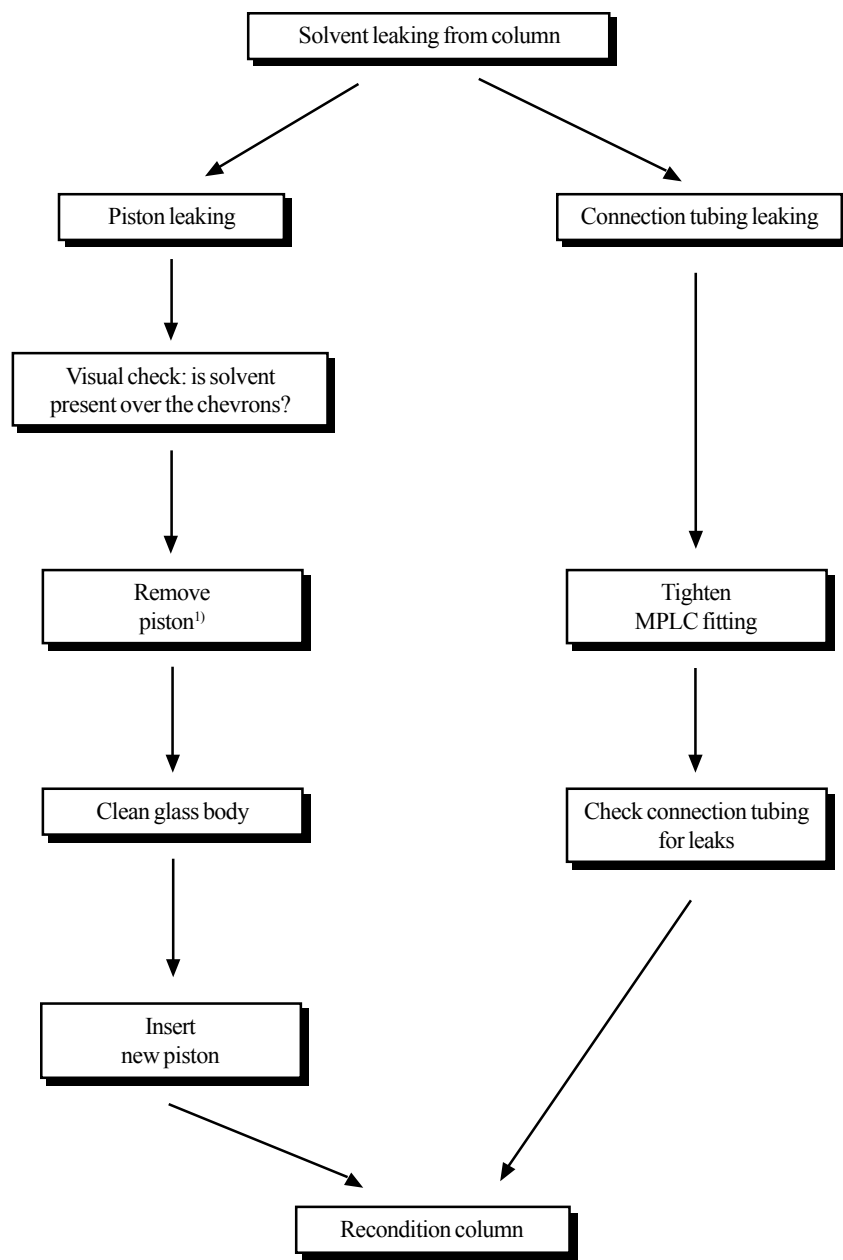
Treatment	Contamination	Sterilization	Depyrogenation
1-2 M NaCl	Highly charged molecules	Ineffective	Ineffective
Buffer pH 3-5	Highly charged molecules	Ineffective	Ineffective
Treatment with pronase at a neutral pH, calcium ions	Hydrolysis of adsorbed proteins	Ineffective	Ineffective
Treatment with pepsin, pH 1.5-2	Hydrolysis of adsorbed proteins	Ineffective	Ineffective
Non-ionic detergents (e.g. Triton X-100, Tween 80)	Removal of hydrophobic proteins and lipids	Ineffective	Ineffective
Cationic detergents pH 9-11	Removal of hydrophobic proteins and lipids	Ineffective	Partial
Non-ionic detergents pH 3 (acetic acid)	Removal of hydrophobic proteins and lipids	Ineffective	Partial
Urea 6-8 M	Removal of protein aggregates	Ineffective	Unknown
1-100 mM EDTA in neutral or slightly acidic solution	Removal of metal complexes	Ineffective	Ineffective
2-3 M NaCl in 0.1-1 M HCl	Removal of various small, charged molecules and pigments	Ineffective	Effective
0.1-1 M NaOH	In particular the removal of bonded hydrophobic proteins and lipopolysaccharides	Effective	Effective
0.5-1 M acetic acid in 60% ethanol	Removal of lipids, pigments, lipo-poly-saccharides and other lipophilic substances	Very effective	Effective
1500 ppm peracetic acid in 0.5 M sodium acetate, pH 5	Removal/denaturing of spores, viruses and bacteria	Very effective	Unknown
50-80% acetic acid	Dissolving and removal of precipitated proteins	Unknown	Unknown
40-60% ethanol	Removal of various proteins and lipids	Unknown	Unknown
Isopropanol-gradient up to 100% in water	Removal of non polar lipids	Ineffective	Unknown
0.1-1 M mineral or organic acids	Removal of various charged molecules and hydrolysis of bonded substances	Unknown	Unknown
0.1 M - 1 M HCl in 60% ethanol	Removal of various charged molecules and lipids	Unknown	Effective

Revision 2.0
1/1/02

9. TROUBLESHOOTING

Problem	Cause	Remedy
1. Peak shape of eluted substances deteriorates	1. Dead volume at column inlet 2. Inlet frit partially blocked 3. Outlet frit partially blocked 4. Separation efficiency of stationary phase affected by contamination 5. Stationary phase damaged mechanically	1. see point 4 on page 6: elimination of dead volume 2. Remove and dismantle piston, replace frit, reassemble and re-insert piston. The column will need to be reconditioned. 3. Remove piston, replace frit, reassemble and re-insert piston. The column will need to be reconditioned. 4. Repack column 5. Repack column
2. "Air" in the column	Gas evolution or solvent evaporation during storage	Recondition column
3. Abnormal pressure increase during operation	1. Incorrect valve position 2. Blocked frit 3. Fittings tightened too much	1. Check valve position 2. see above, 1. 2. 3. Replace fittings and ferrules, re-cut the end of the tubing.
4. Pressure drop during operation	1. Leak in tubing or fitting between pump and column 2. Solvent supply has run out	1. Check tubing and connections 2. Refill solvent
5. Solvents leaking from column	See diagram on following page	See diagram on following page

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1/1/02



¹⁾ CAUTION: Open connection tubing first to prevent cracking of the packing due to vacuum originated by removal of the piston.

Thank you for your purchase of this column. Please do not hesitate to contact our office with any questions or comments you may have relative to the use and maintenance of your column.

We at Essential Life Solutions Ltd. appreciate your business!

ESSENTIAL LIFE SOLUTIONS LTD.

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How to Condition a New Capillary GC Column

by Alan Sensue, Restek Technical Services Chemist

So, you've just purchased a new capillary column and you need to install it into your GC?

While many analysts have a routine that they perform, there are many new users who might not know the proper procedure. Here, we summarize proper column installation and conditioning. Note that detailed information about installing a capillary GC column is available in the article [Restek Capillary Column Installation Guide](#) on this website.

To begin, cool your GC and remove the old column. Don't discard it just yet – you might need it to troubleshoot the system if you encounter problems after installing the new column. Cap the ends of the old column with capillary column caps, or with pieces of used injection port septum, and put it aside.

Cut off the flame-sealed ends of the new column, work a fitting and ferrule 6-8 inches onto the injection port end of the column (the end at the front of the column cage as you are reading the column tag) and remove an additional 4 inches of column. This will remove any remaining stationary phase that had been heat-damaged during the flame sealing process, and eliminate ferrule fragments introduced into the column while you were installing the ferrule. Carefully insert the appropriate length of column into the injection port, as instructed in your instrument manual, tighten the fitting, turn on the carrier gas, and adjust the flow rate to the desired value (see Table 1). Confirm that there is flow through the column by submerging approximately 1 inch of the free end of the column in methanol, or other solvent compatible with the stationary phase in the column, and verify that a steady stream of bubbles is produced. Remove the end of the column from the solvent, then purge the column for 10-40 minutes at the appropriate carrier gas flow rate. When using helium or hydrogen as the carrier gas, purge as recommended in Table 1.

Table 1 Flow rates for purging capillary GC columns with helium or hydrogen carrier gas

Column ID (mm)	Minimum Flow Rate (mL/min.)	Minimum Purge Time (min.)
0.53	5.0	10
0.32	1.5	20
0.25	1.0	25
0.18	0.8	30
0.10	0.5	40

Purging will remove all traces of air (oxygen) from the injection port and column, which must be done before you heat the column. At elevated temperatures, even trace levels of oxygen will quickly cause irreversible damage to the stationary phase. During this purge, CHECK FOR LEAKS using an [electronic leak detector](#). To prevent oxygen from entering the system and damaging the column, the system must be completely leak free. In addition, the carrier gas must be passed through a [high-quality oxygen trap](#).

After purging, the column is ready to be conditioned. Do NOT connect the capillary column to the detector at this time. Conditioning time and temperature depend on several factors, including stationary phase chemistry, stationary phase thickness, the intended application for the column, and the type of detector you will be using. The following instructions should enable you to properly condition your new column. Note that the column conditioning times in Table 2 are **approximate**. The general rule is to condition the column only long enough to achieve a stable baseline and an acceptable signal-to-noise ratio for the compound peaks anticipated in the analysis. If you have questions, please call [Restek Technical Service](#) at 800-356-1688, ext. 4. We will help you to determine the best conditioning procedure for your new column – even if it isn't a Restek column.

Overnight conditioning is only recommended in a few situations. When a column will be used at its maximum operating temperature limit for extended periods of time (such as with simulated distillation analysis),

ALSO OF INTEREST

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or when a thick-film column will be coupled to a very high sensitivity detector (such as an electron capture detector or mass spectrometer), overnight conditioning might be necessary to achieve a stable baseline. Note, however, that operating capillary columns at their maximum temperatures over a long period of time will shorten the lifetime of the column.

In most situations, we recommend that a new column be installed first thing in the morning, purged and leak checked as described above, and conditioned as follows:

1. Set your GC oven temperature to 40°C, and set a temperature ramp rate of 10°C/minute.
2. Program the oven either to 20°C above the final temperature called for in the analysis or to the column's maximum ISOTHERMAL temperature – whichever is lower.
3. While the oven temperature begins its ramp, heat the injection port to the appropriate temperature.
4. After the oven temperature reaches the set point, hold this temperature for the time listed in Table 2.
5. With carrier gas still flowing, cool the oven, install a fitting and ferrule onto the detector end of the column as outlined above, connect the column to the detector, and repeat steps 1-4.

Your column should now be conditioned. As mentioned above, if you are using a high sensitivity detector, such as a mass spectrometer or an electron capture detector, the column might need additional conditioning to ensure a stable baseline. Consult the instrument manual for information.

Because column connections are a common source of leaks, if you plan to do dual-column analysis, you should install, condition, and test each column individually. Only after the performance of both columns has been proven to be acceptable should they be connected in common to a guard column, using a SeCure Y, or similar connector.

Proper column conditioning is essential for optimal column performance. Once you establish a conditioning procedure that works well for you, record this information in your laboratory notebook or equipment logbook for future reference. If you encounter problems during column installation or conditioning, or at any other point in your analysis, remember that the Restek Technical Service chemists are only a phone call or e-mail message away.

Table 2 Conditioning times for capillary GC columns

For these columns:

MXT®-1, MXT®-1HT, MXT®-1SimDist, MXT®-500

Rtx®-1, Rtx®-1MS, Rtx®-1PONA, Rtx®-5, Rtx®-5MS, Rtx®-5SiIMS, Rtx®-5Amine, Rtx®-XLB, Rtx®-440, Rtx®-PCB, Rtx®-2887, Rtx®-G27, Rtx®-TNT, Rtx®-TNT2

Rxi -1ms, Rxi -5ms

Stx -500

XTI®-5

Column Length (meters)	Film Thickness (µm)	Approx. Time	
		(min.)	(hr.)
≤15	0.1 - 0.25	15	0.25
	0.5 - 1.0	30	0.5
	1.0 - 1.5	60	1
	1.5 - 3.0	90	1.5
30	0.1 - 0.25	30	0.5
	0.5 - 1.0	45	0.75
	1.0 - 1.5	60	1
	1.5 - 3.0	90	1.5
≥60	0.1 - 0.25	60	1
	0.5 - 1.0	90	1.5
	1.0 - 1.5	120	2
	1.5 - 3.0	150	2.5

For these columns:

MXT®-35, MXT®-50, MXT®-65, MXT®-65TG, MXT®-200, MXT®-624, MXT®-1301, MXT®-1701, MXT®-502.2, MXT®-Volatiles

Rtx®-17, Rtx®-20, Rtx®-35, Rtx®-35MS, Rtx®-35 Amine, Rtx®-50, Rtx®-65, Rtx®-65TG, Rtx®-200, Rtx®-200MS, Rtx®-624, Rtx®-1301, Rtx®-1701, Rtx®-BAC1, Rtx®-BAC2, Rtx®-CLPesticides, Rtx®-CLPesticides2, Rtx®-Dioxin, Rtx®-Dioxin2, Rtx®-OPPesticides, Rtx®-OPPesticides2, Rtx®-G43, Rtx®-502.2, Rtx®-VMS, Rtx®-VGC, Rtx®-VRX, Rtx®-Volatiles

Stx -CLPesticides, Stx -CLPesticides2

Column Length (meters)	Film Thickness (µm)	Approx. Time	
		(min.)	(hr.)
≤15	0.1 - 0.25	20	0.3
	0.5 - 1.0	40	0.7
	1.0 - 1.5	60	1
	1.5 - 3.0	80	1.3
30	0.1 - 0.25	40	0.7
	0.5 - 1.0	60	1
	1.0 - 1.5	80	1.3
	1.5 - 3.0	100	1.7
≥60	0.1 - 0.25	80	1.3
	0.5 - 1.0	120	2
	1.0 - 1.5	160	2.7
	1.5 - 3.0	200	3.3

For these columns:

DEX chiral phases

FAMEWAX

MXT®-WAX

Rt-CW20M F&F, Rt-2560, Rt-TCEP

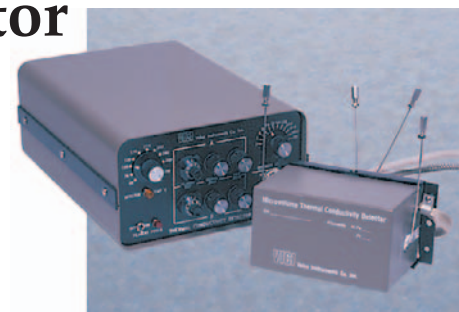
Rtx®-225, Rtx®-2330, Rtx®-WAX

Stabilwax®, Stabilwax®-DA, Stabilwax®-DB

Column Length (meters)	Film Thickness (µm)	Approx. Time	
		(min.)	(hr.)
≤15	0.1 - 0.25	30	0.5
	0.5 - 1.0	45	0.75
	1.0 - 1.5	60	1
	1.5 - 3.0	90	1.5
30	0.1 - 0.25	60	1
	0.5 - 1.0	90	1.5
	1.0 - 1.5	120	2
	1.5 - 3.0	150	2.5
≥60	0.1 - 0.25	80	1.3
	0.5 - 1.0	120	2
	1.0 - 1.5	160	2.7
	1.5 - 3.0	200	3.3

Dual Cell Microvolume Thermal Conductivity Detector

- Stand-alone unit
- Optimized for capillary chromatography
- Thermal stability to $\pm 0.02^\circ\text{C}$
- Dual filaments capable of independent or referenced (differential) operation



The Valco Microvolume Thermal Conductivity Detector (TCD) is useful in a wide variety of capillary and packed column applications. Constant filament temperature control provides a linear dynamic range permitting measurement of a wide range of concentrations without the need for multiple standards or sample dilution.

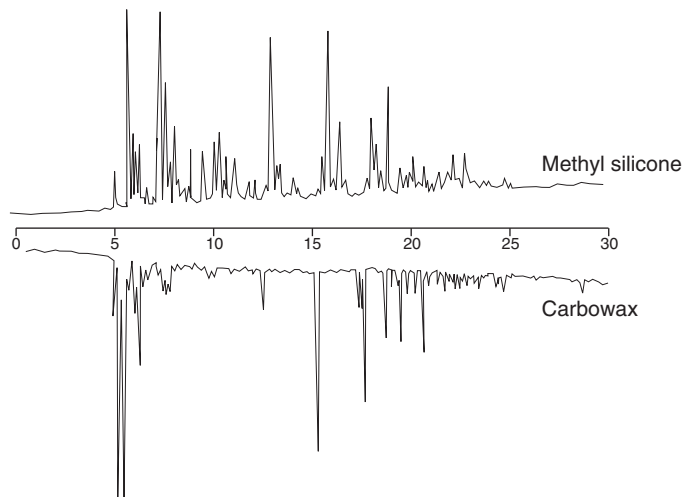
Since the detector is non-destructive of the sample and contributes virtually no band spreading, it can be used in series with other detectors without affecting the performance characteristics of either.

Description

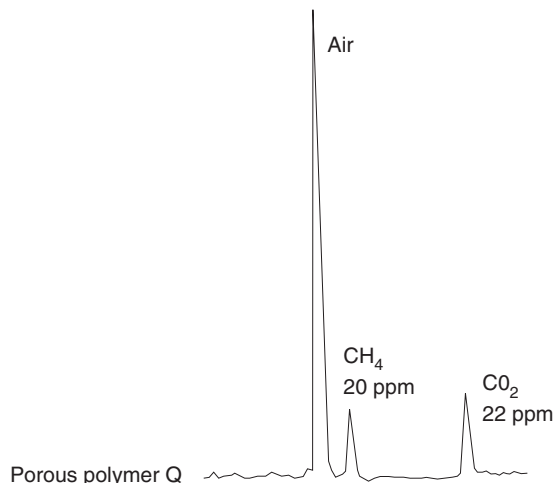
The detector consists of the cell housing and the electronics controller. The cell design permits mounting in virtually any orientation with no effect on performance. It can be installed easily on virtually any gas chromatograph, comprising a stand-alone unit requiring nothing else for operation but carrier gas flow.

Each of the two cell chambers is independent of the other, except for block temperature. Filaments can be replaced individually. Front panel controls set the temperature for the cell and for each filament. Since each detector cell can be operated separately or simultaneously, two analyses can be run using a single Valco TCD.

To insure compatibility with any system, two outputs are provided: 0-1 mV full scale attenuated output for recorders, and 0-10 V full scale unattenuated output for integrators and data acquisition systems.



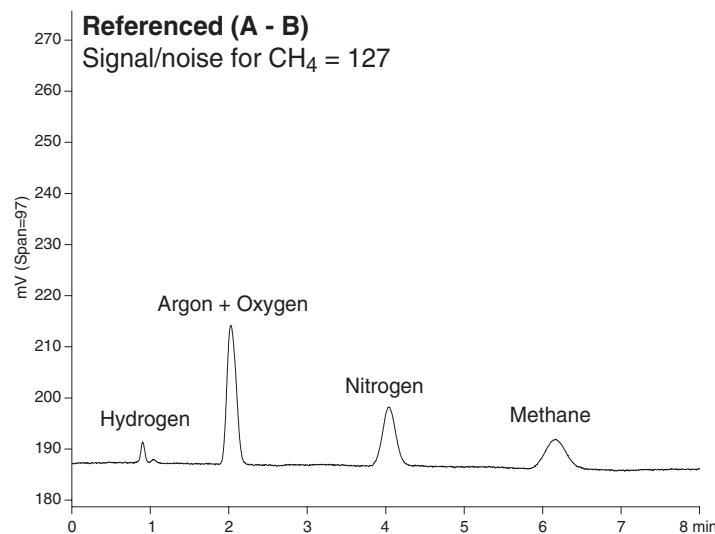
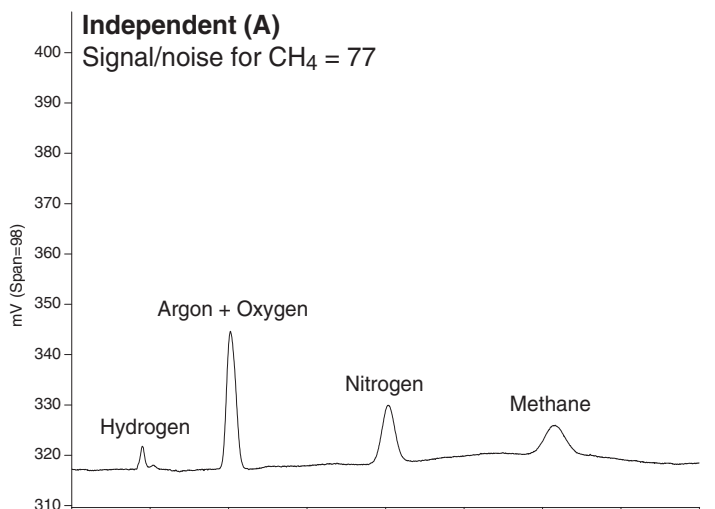
Unleaded Gasoline
50 m x 320 micron columns, 0.06 μl valve injection



Gas Standard
30 m x 530 micron PLOT column, 100 μl valve injection

Independent vs. referenced operation

Specifications



Helium Blend

Sample size: 250 µl
 Sample concentration: 100 ppm each
 Column: 10' x 1/16" OD x 0.040" ID
 Molesieve 5Å, micropacked
 Column temp: 65°C
 Detector temp: 100°C
 Filament temp setting: 5.0
 Flow rate
 Channel A: 5.5 ml/min
 Channel B: 5.42 ml/min

Overall

Linear range 1 nanogram to 3 micrograms nC₄
 Minimum detectable approx. 50 picograms n-butane quantity
 Time constant < 150 milliseconds
 Cell temperature Automatic proportional control with control
 ±0.02°C stability
 Maximum cell 300°C
 temperature

Detector assembly

Dimensions 3.12" x 6" x 3.75" high
 (8 cm x 15 cm x 9 cm)
 Gas connections Valco 1/16" zero dead volume fittings
 Single multi-pin 5 foot cable supplied
 connector

Control unit

Dimensions 12" x 8" x 5" high
 (30 cm x 20 cm x 13 cm)
 Electrical connections... Single multi-pin connector
 Operator controls Cell temperature control (40-400°C)
 10-turn filament temperature
 potentiometers (A & B)
 10-turn coarse and fine baseline
 adjustment potentiometers (A & B)
 12 position recorder attenuator output
 switch (A, B, or A-B)
 Filament power on/off switch
 Indicator LEDs Detector heater "on"
 Filament power "on"
 Power requirements Universal 100-250 VAC
 50/60 Hz, 100W maximum

Product numbers

	110 VAC	230 VAC
Dual cell microvolume TCD with:		
nickel/iron filaments	TCD2-NIFE	TCD2-NIFE-220
tungsten/rhenium filaments	TCD2-WRE	TCD2-WRE-220

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Microvolume Thermal Conductivity Detector Instruction Manual

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Introduction

Description and Operating Principle

The Thermal Conductivity Detector (TCD) has been one of the most popular GC detectors since the 1950's, second perhaps only to the Flame Ionization Detector (FID). The principal of operation is based on the relative change in the thermal conductivity of the gas passing across the detector filament as components elute from the column. Heat is lost continuously by the filament through the carrier gas to the cell wall of the detector. By measuring the amount of current required to maintain a constant filament temperature as gases of varying thermal conductivities cross the filament, a chromatographic signal is produced. This process is nondestructive of the sample and is concentration dependent.

The Valco Microvolume TCD is unique in its implementation. Since changes in conductivity are measured only by the change in current required to keep the filament at a constant temperature, each of the two filaments can be operated independently without referencing these changes to a matched filament with reference gas. This constant temperature provides longer filament life and safeguards it from the extremely high temperatures and oxidation which can occur with high concentrations of oxidative or corrosive components. Optional signal referencing is provided to minimize background variables such as column bleed and temperature programming.

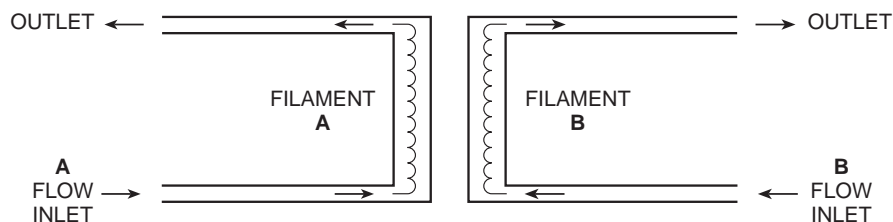


Figure 1: Unique dual filament design

Cell volume has been minimized to accommodate capillary column chromatography and optimize the sensitivity of the detector at low flow rates. (Carrier flow rates of 1 - 10 mL/min are recommended for best sensitivity.) Thermal stability is maintained in the detector cell to within 0.010°C drift, giving the detector a stable, noise-free signal.

The Model TCD2 is a stand-alone system which can be easily added to any chromatograph. It consists of a detector and a control module which incorporates the electrometer and temperature controls. The detector cell includes two separate filaments, capable of independent or referenced (differential) operation. Output signal is provided as 0-1 and 0-10 volt attenuated for chart recorders and 0-1 and 0-10 volts unattenuated for integrators and data systems.

Safety Notes and Information

Symbols

**HOT SURFACE**

The surface of the detector body may be hot while in operation (possibly in excess of 250°C). Observe caution.

**ATTENTION**

Refer to the manual.

**PROTECTIVE EARTH**

This internal connection provides protection against electric shock from mains voltages and should not be removed.

Installation Category

This equipment has been designed for installation category (overvoltage category) II, pollution degree 2. It has been approved for use only in heavy industrial environments and may not be used in the residential, commercial, or light-industrial environment.

Safety

This instrument has been designed and tested in accordance with the product safety standard, EN61010. It has left the factory in a safe condition. This instruction manual contains important information and warnings which must be followed by the user to insure safe operation and to retain the instrument in a safe condition. The case, chassis, and measuring terminals are connected to the protective earth contact of the mains inlet. The instrument operates with a three-conductor power cord having a protective earthing conductor and a plug with an earthing contact. The mains (line) plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord without a protective conductor. Use only with an approved mains supply cord having a rating of 2A, 250V, or greater. Do not use this equipment in a manner not specified herein.

Maintenance

The exterior of the instrument should be cleaned regularly with a dusting brush. If necessary, the casing can be cleaned with a moistened cloth (99% water + 1% mild detergent). Spirit or petroleum ether can be used to remove greasy dirt. Any other cleaning agents can attack the plastic and painted surfaces.

Under no circumstances should the cleaning fluid get into the instrument. Petroleum ether is flammable, and care should be taken in its use.

The detector must be returned to the factory when filament replacement is required. Call VICI Tech Support for return authorization.

Components of the Detector Systems

Components of the detector system are listed in **Tables 1** and **2**. Check the contents of the packages to verify that everything is present. Contact the factory if anything is missing or damaged. (NOTE: damaged shipments must remain with the original packaging for freight company inspection.)

Description	Quantity	Product number
Detector cell, Nickel-Iron filament	1	TCD2-NIFED
Controller unit with power cord	1	TCD2-C
<i>Includes:</i> Cable, output	2	I-24010
1/16" zero dead volume union	2	ZU1C
Fused silica adapter for 0.53 mm ID x 0.8 mm OD capillary column	2	FS1R.8
1/16" zero dead volume nut	2	ZN1
1/16" zero dead volume ferrule	2	ZF1

Table 1: Components of the TCD2-NIFE system

Description	Quantity	Product number
Detector cell, Tungsten-Rhenium filament	1	TCD2-WRE
Controller unit with power cord	1	TCD2-C
<i>Includes:</i> Cable, output	2	I-24010
1/16" zero dead volume union	2	ZU1C
Fused silica adapter for 0.53 mm ID x 0.8 mm OD capillary column	2	FS1R.8
1/16" zero dead volume nut	2	ZN1
1/16" zero dead volume ferrule	2	ZF1

Table 2: Components of the TCD2-WRE system

Specifications

Mains (line):	115/230 V~50/60 Hz, 175 VA
Fuse:	2 A, time-delay, 5 x 20 mm
Pressure:	6.9 kPa (1 psi) operating, 6.9 MPa (1000 psi) max. working
Maximum temperature	300°C
Heater power:	60 W max., 48 V, PWM
Output impedance:	100 Ω

Description of Controls and Connectors

Controls and connectors are indicated in **Figures 2** and **4**.

MAINS switch (rear panel)

Controls mains (line) voltage to the controller unit. When this switch is on (|), the unit is operational except for the detector filaments (see next paragraph) and the detector heater will operate if connected.

FILAMENT switch and indicator

Controls power to the detector filaments; when the switch is on, current passes through the filaments. The indicator will light even if the detector is not connected to the controller.

DETECTOR TEMPERATURE control and indicator

Sets the temperature (°C) of the detector heater block. The indicator is steadily on when maximum power is being applied to the heater, steadily off when no power is applied, and regularly blinking on/off when the set temperature has been established.

Note that due to the fail-safe mechanism designed into the temperature controller, the heater will not operate if mains power is applied before the heater is connected or if the detector is too cold ($< 0^{\circ}\text{C}$). If the heater is disconnected with mains on, the unit must first be turned off to restore control of the heater; if the unit is operated in a very cold environment, the detector should first be gently warmed without power applied.

The fail-safe mechanism will also act under any condition resulting from loss of control (e.g., over-heating, RTD failure, etc.). If proper procedures have been followed and the controller will not heat the detector, there is cause to suspect that the fail-safe mechanism has been activated. Consult the factory or an authorized representative. Note that the maximum temperature for operation of the TCD2 is 300°C .

FILAMENT TEMPERATURE switch

Separate 10-turn knobs control Filaments A and B. The value displayed corresponds to temperatures indicated in **Figure 3** for nickel/iron filaments.

COARSE ZERO control

Once filament temperature has been applied, the Coarse Zero knob makes coarse adjustments of the zeroing voltage supplied for establishing the baseline zero on both the strip chart output and the integrator outputs.

FINE ZERO control

Once coarse adjustments have been made, the Fine Zero control is used to make fine adjustments in the output signals.

ATTENUATION control

The Attenuation control determines the attenuation of the signal for the chart output.

RECORDER switch

The Recorder switch selects which signal is directed to the chart output. The choices are **A**, **B**, or **A - B** (or A minus B, which is conventional differential operation with the B channel representing the reference.) The selected output signal is displayed in the LCD display.

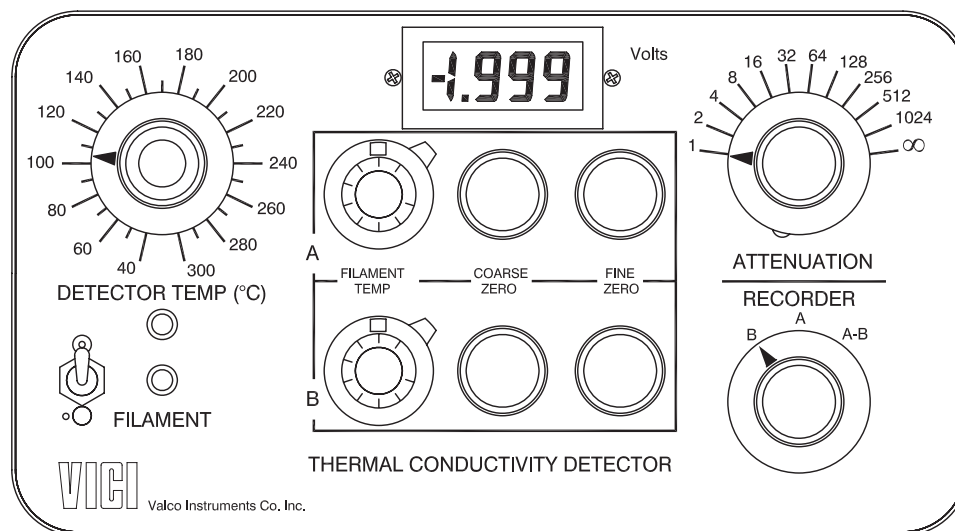


Figure 2: Front panel controls

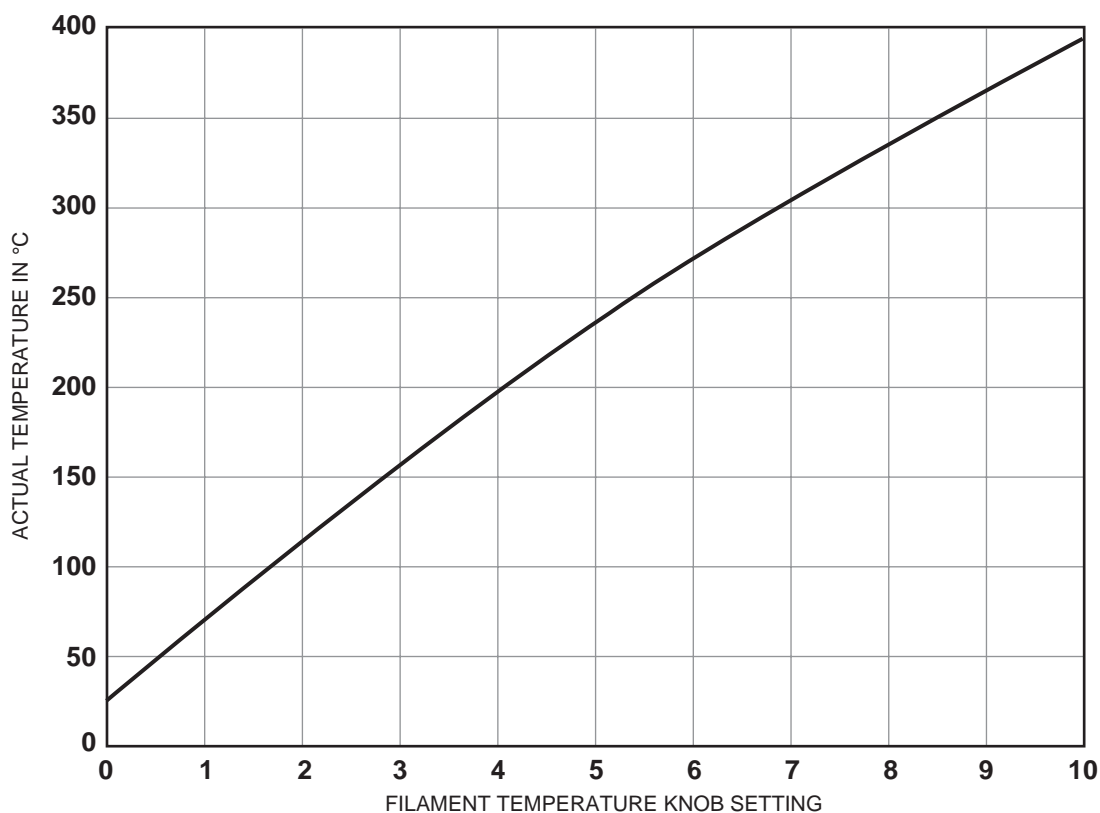


Figure 3: Actual filament temperature vs. filament temperature knob settings

MAINS POWER connector

For connection to 115/230 VAC source.

CHART OUTPUT connector

Normally connected to a strip chart recorder. This output has an attenuated range of 0-1 volt and 0 - 10 volts, with the signal scaled by the attenuation factor set on the front panel. The output also has an internal signal reference (-) at zero volts. For best noise performance, the shield (earth) and signal reference (-) should not be connected together.

UNATTENUATED OUTPUT connector

Normally connected to a data acquisition system or other recording means. For convenience, full-scale 0 - 1V and 0 - 10V outputs are provided, with an internal signal reference (-) at zero volts. For best noise performance, the shield (earth) and signal reference (-) should not be connected together.

DETECTOR connector

For connection to the detector control and heating system.



NOTE: These terminals are for connection only to equipment having no accessible live parts.

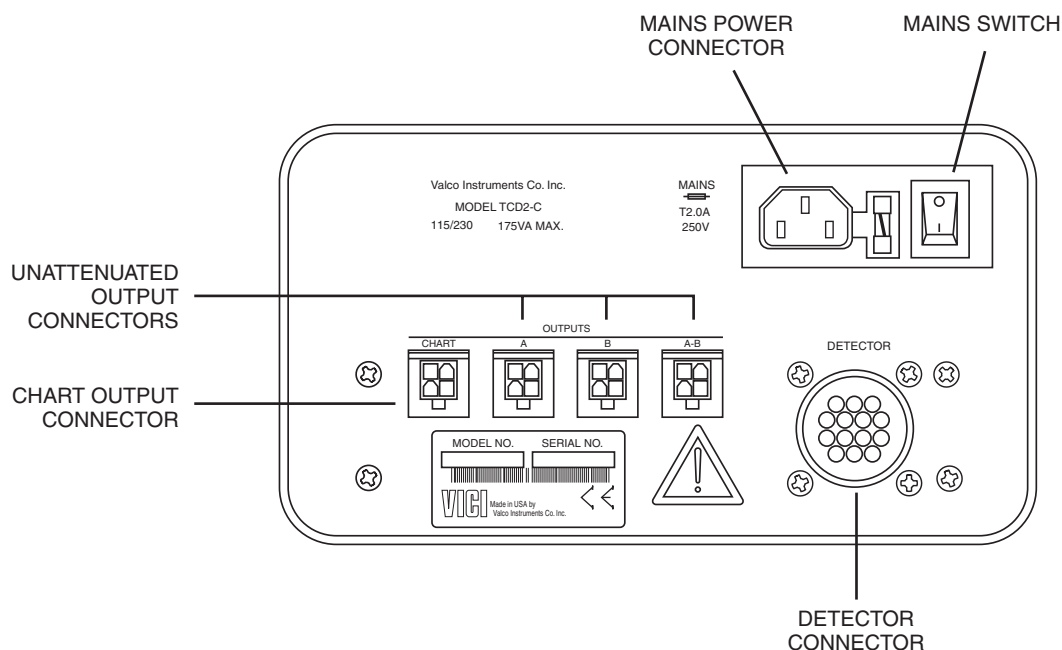


Figure 4: Rear panel connectors

System Requirements

Components Not Included with the Detector System

- Carrier gas (99.999% purity is recommended)
- Ultra high purity grade gas pressure regulator with stainless steel diaphragm (recommended)
- Any special adapters required for connection to the gas regulator
- Flow measuring device
- Flow regulating device

System Purity

Since detection of low concentrations depends in part on the purity of the carrier, the purest carrier available must be used in order to achieve the lowest possible detection limit. To maintain carrier purity, extra care must be taken to assure that the delivery system is clean and free of leaks. Use stainless steel tubing (cleaned to removed manufacturing solvents) instead of nylon or Teflon® tubing, which can diffuse contaminants into the carrier.

Recommended Carrier Gas Purifiers

The Valco Helium Purifier (product number HP2) and Nitrogen Purifier (product number NP2), which utilize a rare earth gettering alloy to effectively remove contaminants, are recommended for ppm level analysis of permanent gases. For other applications, economical and convenient VICI Mat/Sen purifiers are appropriate. Order the P300-1 for nitrogen, P200-1 for hydrogen, or the P100-1 for helium and other inert carrier gases.

Carrier Gas Selection

The detector's response to a component is based upon the difference between the thermal conductivities of the component and the carrier gas: the greater the difference, the greater the response. The table below shows thermal conductivities for a variety of light gases.

Hydrogen	45.9
Helium	36.9
Neon	11.8
Methane	8.6
Oxygen	6.6
Air	6.4
Nitrogen	6.4
Carbon monoxide	6.2
Water	4.5
Argon	4.5
Carbon dioxide	4.2

As an example, note in the table that the thermal conductivity of hydrogen is 46 and helium is 37, while nitrogen is only 6 and argon is even lower at 4. Since the largest difference in thermal conductivity yields the best response, detection of small amounts of hydrogen is better done with argon or nitrogen carrier than with helium.

However, while nitrogen as a carrier yields excellent response to hydrogen, the response to oxygen and carbon dioxide is diminished compared to the levels that could be achieved with helium or hydrogen. Argon would yield poor response to carbon dioxide and water, but would be adequate for other components.

There is no absolute "best choice" of carrier gas. For any situation, the choice must take into account all of the parameters involved: column characteristics, components of interest and their concentrations, safety considerations, carrier cost, etc.

GC Column Selection

Cell volume has been minimized to accommodate capillary, megabore, and micropacked columns, and to optimize the sensitivity of the detector at low flow rates. However, standard packed columns may also be used if sensitivity is not an issue.

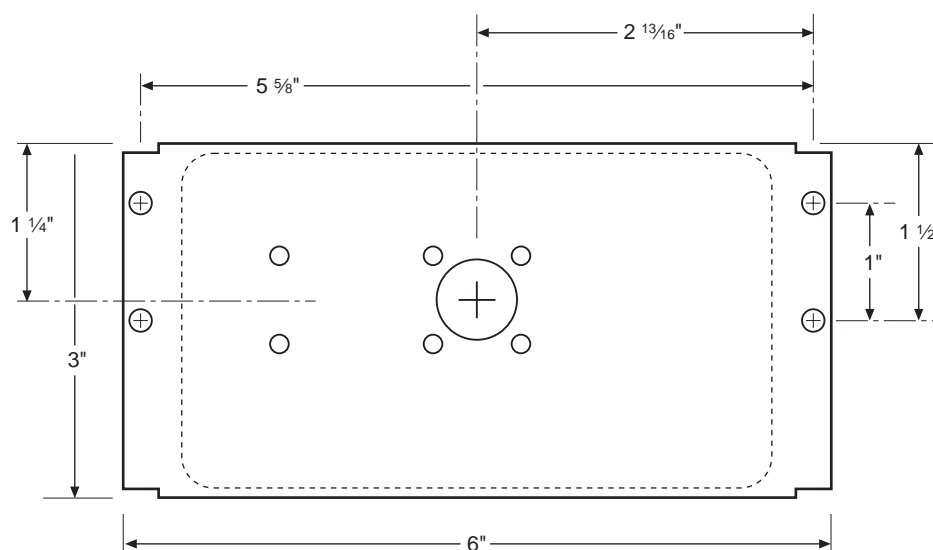


Figure 5: Detector assembly mounting dimensions

Installation

The detector is usually mounted on top of the GC column oven. The power cord for the controller is 1.8 m (6') long; the detector cable and the signal output cables (attenuated and unattenuated) are 1.2 m (4') long.

General Precautions

- Do not turn the unit on until the carrier gas is flowing through the detector.
- Do not shut off or disconnect the carrier gas when the detector is hot, even if the unit is turned off. Turn off the power switch on the back of the controller and allow the detector to cool down naturally before disconnecting or shutting off the carrier gas.
- Position the controller unit where the mains switch on the rear panel can be reached easily.

Mounting the Detector on the GC

Vertical Mounting

The detector has no particular orientation requirements, but it should have adequate thermal isolation from the column oven and injection port. Most GCs have an existing opening which will allow the TCD2 to sit vertically on top of the column oven with the column inlet extending into the oven. If you are replacing an existing detector, you can usually just remove it and set the TCD2 in its place. If not, use a drill or chassis punch to drill a hole of the proper size, and set the detector in position.

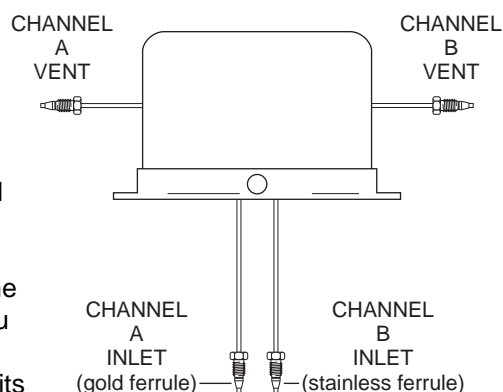


Figure 6: Detector connections

While trying to match base plate mounting holes to every GC on the market is impractical, we have located the mounting holes so that at least two of them will coincide with existing holes on the GC. (Refer to **Figure 5**.)

Orient the detector to allow for easy cable and gas connections. The inlet lines installed into the detector must enter the column oven and permit column connection. Temperature loss between the column outlet and the detector should be minimized to prevent possible condensation of the sample.



CAUTION: Do not mount the detector near the column oven cool-down vents.

Horizontal Mounting

Some older GCs have access to the column oven through the side of the GC. This does not present a problem as far as operation of the TCD2 is concerned. Drill a hole at the appropriate location, orient the detector for convenient connection, and mark the position of the mounting holes. Drill the mounting holes and secure the detector to the side of the GC with four sheet metal screws (not supplied).

Gas Connections

Remember these three points discussed earlier: (1) all surfaces that contact the gas stream must be glass or stainless steel; (2) do not use copper tubing or brass fittings; and (3) all tubes must be thoroughly cleaned and baked before use. The installation instructions below assume that the detector carrier will be supplied from a nearby cylinder. If your installation is different, you may need to modify the instructions appropriately. Consult the VICI catalog or vici.com for any fittings and tubing required.

The figures below illustrate gas connections for a typical TCD2 detector system, in referenced and unreferenced modes. Since the distance from the carrier supply to the GC varies from installation to installation, we do not supply tubing to go from that point to the GC.

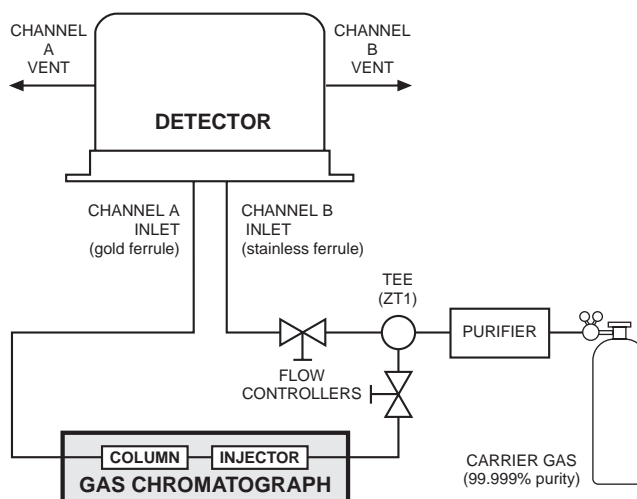


Figure 7: Referenced mode (A - B)

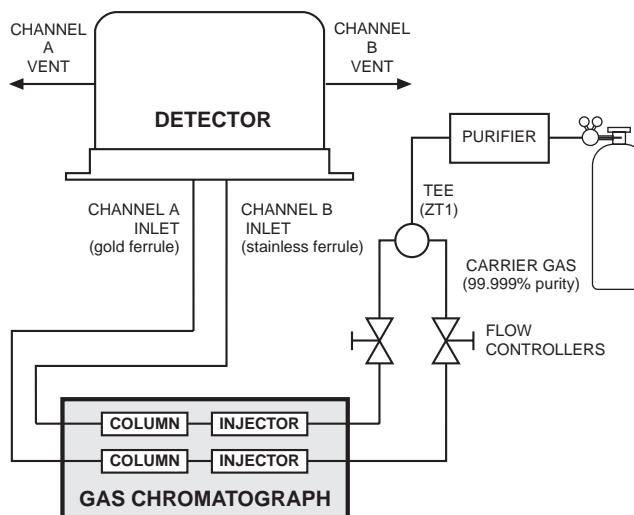


Figure 8: Unreferenced mode

Installing and Purging the Gas Regulator

1. Make sure the on/off valve on the helium cylinder is completely closed. Screw the CGA fitting nut of the regulator into the helium cylinder. Go beyond finger-tight, but do not tighten the nut all the way – some leakage is required for the purging operation.
2. Turn the output pressure regulating knob completely counterclockwise.
3. Open the cylinder on/off valve *slightly* and quickly close it again.
4. Adjust the tightness of the regulator connecting nut to allow a pressure reduction of ~690 kPa/sec (100 psi/sec). With a new bottle, the gauge should start out at about 14 MPa (2000 psi).
5. When the pressure drops into the 1.4 - 3.4 MPa (200 - 500 psi) range, open the cylinder on/off valve slightly and quickly close it again.
6. Repeat Step 5 eight or ten times to be certain that all the air is purged. On the final purge, tighten the regulator connecting nut very securely as the pressure approaches the 2.1 - 3.4 MPa (300 - 500 psi) range.
7. Open the cylinder valve to pressurize the regulator once again, then close it and observe the high pressure gauge needle for 15 minutes. If it doesn't move, there is no critical leak on the high pressure side of the regulator.



CAUTION: Never use leak detecting fluids on any part of this system.

Installing and Purging a Purifier



1. If the pressure regulator has a 1/8" *male* cone-type outlet port, install the Valco 1/8" external to 1/16" internal reducer (EZR21); if it has a 1/4" *male* cone-type outlet port, install the Valco 1/4" external to 1/16" internal reducer (EZR41). For other regulator outlet fittings, a wide variety of Valco adapters are available.
2. Remove the cap from the inlet tube of the Valco helium purifier and insert the tube fitting into the 1/16" reducer port. (Keep the outlet tube capped.) Use a 1/4" wrench to turn the nut one-quarter turn past the point where the ferrule first starts to grab the tubing. Do not remove the fitting. When made up properly, it should be leak-tight.
3. Turn the output pressure regulating knob clockwise until the gauge registers 345 KPA (50 psi).
4. Allow five minutes for equilibration, then turn the regulating knob all the way counterclockwise.
5. Observe the needle of the output pressure gauge for 15 minutes. There will be a slight initial drop, but if it doesn't move after that, consider that all the connections are tight.
6. If necessary, use an electronic leak detector to locate any leaks. If a leak detector is not available, tighten all the fittings (including the output pressure gauge), and repressurize the system for another test.
7. Upcap the outlet tube of the purifier and purge the system for 15 to 30 minutes at 60 - 80 mL/min to eliminate air from the purifier getter material.

Column Connection



To prevent detector contamination, we strongly recommend disconnecting the column from the detector during column bakeout procedures.

Referenced mode

In the referenced mode, the column is connected to the Channel A inlet, and the carrier gas stream is split and used as a reference in channel B. The gas flow rate from both channels must be the same (flow balanced). This mode of operation provides the best baseline stability and the least background noise.

Unreferenced mode

In the unreferenced mode, Channels A and B are used independently. One column connects to the Channel A inlet, and the other to Channel B. The carrier gas must be the same for both channels.

It is also possible to use only one channel with the other capped off, as long as the filament temperature control knob of the unused channel is set to zero.

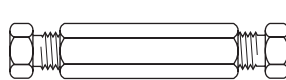
The unreferenced mode has certain limitations: there is a possibility of detector cross-talk (interference) if compound concentrations exceed 1%, and baseline drift and background noise are greater than with the referenced mode.

To make column connection as convenient as possible, each TCD is shipped with two Valco 1/16" unions (Product No. ZU1C) complete with nuts and ferrules (Product Nos. ZN1 and ZF1). Also included are two fused silica adapters (FSR1.8) for use with .53 mm ID wide bore capillary columns (.8 mm OD). Refer to the information below to determine the correct Valco fitting for use with other columns.

Column Connection Fittings

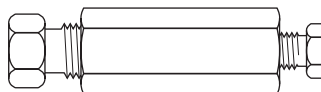
Packed Columns

A 1/16" packed column requires only the ZU1C which comes with the TCD. For 1/8" columns, order a ZRU21.



ZU1C

Used with 1/16" column

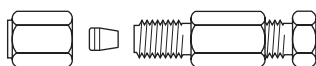


ZRU21

Used with 1/8" column

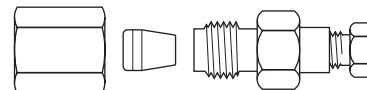
Packed Columns with Swagelok®-type Female Nut

The connection of these columns is similar to that for standard packed columns, but requires a union which adapts the female nut to the Valco fitting.



EZU1

Used with 1/16" column



EZRU21

Used with 1/8" column

Capillary Columns

Connection of these columns requires the use of the ZU1C with the appropriate fused silica adapter. For a .53 mm ID x .8 mm OD column, use the FSR1.8 supplied with the TCD. For other sizes, use this table to determine the proper adapter:

Column size	Adapter required
.32 mm ID x .5 mm OD	FS1R.5
.25 mm ID x .4 mm OD	FS1R.4
< .2 mm ID	FS1R.2



ZU1C with fused silica adapter

Testing for Leaks

It is critical for the system to be leak-tight, and an additional check at this point can save many headaches later on. To test for leaks:

1. Insure that both outlets are capped.
2. Pressurize the entire system with helium to 138 kPa (20 psi).
3. If the system does not hold pressure, check all the fittings with an electronic helium leak detector. DO NOT use leak detecting liquids.

Electrical Connections



Before connecting the detector cable to the control module, make sure that the control module power cord is unplugged.

1. The heater and filament connections from the detector to the rear panel of the controller are made up in one cable. After making sure that the control module power cord is not plugged in, connect this detector cable to the connector on the control module. The cable connector should be firmly seated by turning the coupling ring clockwise until the detent is felt.



For best detector performance, the cable and connector should not be allowed to move while measurements are being made. If the cable is disconnected, exercise care to keep the connecting pins in each connector clean.

2. Connect the data output(s). The A / B / A - B outputs are used with an integrator or PC-based data acquisition system; the chart output is for a strip chart recorder. Polarities and full scale range are indicated in the figure below. (Set the recorder/DAQ for the same voltage scale.)
3. Connect the main power cord.

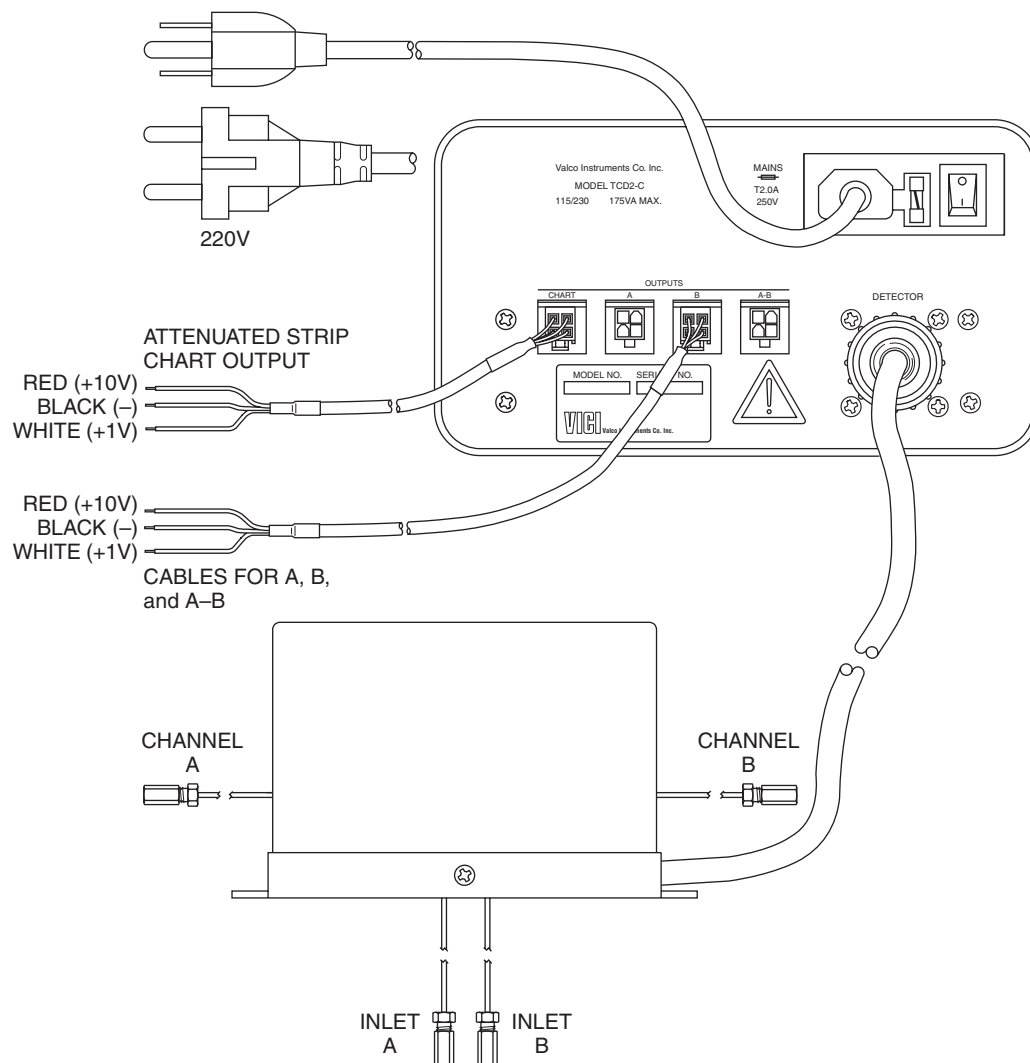


Figure 9: Electrical connections

Initial Power-Up

Since the TCD is a concentration-dependent detector, the lower the flow rate through the detector, the higher the sensitivity. Column diameter will determine the optimum column flow rate.

The microvolume TCD is designed for the lower flow rates typical for capillary columns, and achieves best sensitivity at rates below 10 ml/min. Since the filaments are maintained at constant temperature, the detector can be operated at extremely low flow rates (less than 0.5 ml/min) without damage to the filaments.

A - B referenced mode

Flow Rate Settings

1. Measure the column flow at the detector's Channel A out. The optimum flow rate is in the range of 4 - 20 mL/min, with the actual rate dependent on the type of column used.
2. Measure the reference gas flow at Channel B out. It should be as close as possible to the GC column flow. Use a fixed flow restrictor or a good quality flow controller to match the the carrier gas and reference gas flows.
3. Once the flows have been established, make sure the filament switch and the main power switch are in the OFF position, and plug the power cord into an AC main outlet.

Initial Conditioning

4. Turn on the control module main power switch and set the detector temperature to 220°C.
5. Turn on the filament power switch and set both filament temperature knobs at 8.0.
6. Condition the detector by allowing it to bake at these settings for at least 12 hours.

Temperature Settings

7. After the initial bakeout period, set the detector temperature at 100°C or at the column temperature plus 30°, whichever is higher.
8. Set the filament temperatures at least 50° and as much as 100° higher than the detector temperature. Refer to **Figure 3** on page 5, which outlines the relationship between the filament temperature knob settings and the actual filament temperature.

Detector sensitivity increases as the temperature differential between the detector and the filaments increases, but filament life decreases as its temperature increases. Thus, the detector temperature should be set as low as possible, determined by the boiling point of the highest boiling component of the sample.

9. Once all temperatures are set, allow plenty of time for the system to equilibrate, evidenced by a stable baseline. Typical equilibration time for going from a cold start-up to 130°C detector temperature is approximately five hours. Detector temperature changes take much longer to equilibrate than do filament temperature changes.

The test chromatogram accompanying your TCD was obtained under the following conditions:

Sample:	~100 ppm blend in Helium balance
Sample volume:	250 µl
Column:	10' x 1/16" x 0.040" molecular sieve 5Å micropacked
Column flow:	6 mL/min
Reference flow:	6 mL/min
Column temperature:	65°C
Detector temperature:	100°C
Filament temperature:	230°C (a setting of 5.0)
Carrier gas:	Helium

Balancing the Channels using LCD Display

The LCD display indicates the signal level from the recorder/chart output.

10. Set the recorder switch to A, and use the coarse and fine controls for Channel A to adjust the signal level to about 300 mv.
11. Set the recorder switch to B and repeat the same process to adjust the signal level to about 200 mv.
12. Set the recorder switch to A-B. The display should read about 100 mv. If the signal levels drifts below zero, readjust the A & B channels.

The detector is now ready for analytical use.

Balancing the Channels using Recorder/Chart Output

10. Use the zero (or shunt) setting on the recorder to set the true zero on the recorder.
11. Set the Recorder switch to A, and use the coarse and fine zero controls for Channel A to bring the recorder pen on scale and to a position approximately 1-2 cm above zero.
12. Set the Recorder switch to B, and repeat the same process, bringing the pen to a position *half* as far above zero as the pen for Channel A.
13. Set the Recorder switch to A - B, and observe the recorder pen position. It should be above the true zero position, but below the position for Channel A. If the pen drifts below zero, readjust the A and B channels.

The detector is now ready for analytical use.

Balancing the Channels using Unattenuated Outputs

10. Connect the output cable to the A connector, and use the coarse and fine zero controls for Channel A to bring the baseline signal on scale and to a position approximately 100 mV above zero.
11. Move the output cable to the B connector, and use the coarse and fine zero controls for Channel B to bring the baseline to a position half as far above zero as for Channel A (the value of A minus B).
12. Move the output cable to the A - B connector, and observe the baseline signal. It should be above the true zero position. If the signal drifts below zero, readjust the A and B channels.

The detector is now ready for analytical use.

Single filament mode

The basic procedures and temperature settings described for referenced mode operation can also be applied to operation in the single filament or independent mode. Both channels must have the same carrier gas; you cannot use helium carrier in one channel and nitrogen in the other. Also be aware of the possibility of detector cross-talk when components elute from

Troubleshooting

Troubleshooting Chart

<i>Problem</i>	<i>Possible Cause</i>	<i>Refer to page:</i>
No signal	Main or filament power switch off	4
	Filament temperature too low	4
	Fuse blown	3
	Output cable in the wrong connector	14
Signal reversed	Signal wires reversed	14
Noisy signal	Dirty system or leaking fittings	7, 13, 19
	Bad flow controller in system	15
	Cell/filament differential too small	15
	Filament damaged	2
Cannot zero the signal	Recorder/Int. not zeroed	16
	Voltage incompatibility	14
	Main or filament power switch off	4
Excessive drift*	Block temperature not stabilized	15
	Heater fault	17
Cell doesn't heat properly	Heater/sensor cable unplugged/ heater fail safe mechanism	17
	Heater fault	17
	Fuse blown	3

For technical assistance from Valco Instruments, call (713) 688-9345 or email tech_usa@vici.com.

*Try referenced mode, page 12

Heater Fault Determination

The heater control circuit is designed to disable itself in the event of a fault such as over-temperature, shorted heater, short/open temperature sensor, etc. Once disabled, circuit operation is restored by turning off the controller, disconnecting and reconnecting the detector cable, and then turning the controller back on. *E.g.*, if mains power is applied before the detector is connected to the controller, the heater circuit will not operate until mains power is removed, the detector connected, and mains power restored.

Under normal circumstances, the amber temperature indicator light will flash once after mains power is applied, before control is established. If the light fails to flash, it indicates that a fault has been detected or (less likely) the heater supply fuse has failed.

Detector Fault Determination

Electrical faults in the detector are most easily discovered by making resistance measurements between pins of the detector cable connector. The table below shows the pin numbering and connections for the detector cable (view into pins). Nominal resistance values (in ohms) at 25°C are shown. Unshaded boxed without numbers represent open circuits, and should in no case be blow 1 MΩ. Resistance values given should be within ±10% of the nominal values.

Pin	2	3	4	5	6	8	9	11	12	13	14
1			0	25							
2										0	
3					108						
4				25							
5											
6											
8							0		25		
9									25		
11											50
12											
13											

Maintenance

Cleaning the Enclosure

The exterior of the instrument should be cleaned regularly with a dusting brush. If necessary, the casing can be cleaned with a moistened cloth (99% water + 1% mild detergent). Spirit or petroleum ether can be used to remove greasy dirt. Any other cleaning agents can attack the plastic and painted surfaces.

Under no circumstances should the cleaning fluid get into the instrument. Petroleum ether is flammable, and care should be taken in its use.

Bake Out Procedure

Under normal conditions, the TCD requires no routine maintenance. However, if the detector is exposed to chemicals which may condense or polymerize within the detector and adversely affect performance, the detector cell can be baked out at elevated temperatures (up to 300°C). Inert carrier gas flow (other than hydrogen, oxygen, or air) should be maintained during the reconditioning procedure. Filament temperature should also be increased to approximate the setpoint of the bake out temperature.

If a 24 hour bake out is not sufficient to remove the contamination, the unit must be returned to be factory for disassembly and cleaning.

Warranty

This Limited Warranty gives the Buyer specific legal rights, and a Buyer may also have other rights that vary from state to state. For a period of 365 calendar days from the date of shipment, Valco Instruments Company, Inc. (hereinafter Seller) warrants the goods to be free from defect in material and workmanship to the original purchaser. During the warranty period, Seller agrees to repair or replace defective and/or nonconforming goods or parts without charge for material or labor, or, at the Seller's option, demand return of the goods and tender repayment of the price. Buyer's exclusive remedy is repair or replacement of defective and nonconforming goods, or, at Seller's option, the repayment of the price.

Seller excludes and disclaims any liability for lost profits, personal injury, interruption of service, or for consequential incidental or special damages arising out of, resulting from, or relating in any manner to these goods

This Limited Warranty does not cover defects, damage, or nonconformity resulting from abuse, misuse, neglect, lack of reasonable care, modification, or the attachment of improper devices to the goods. This Limited Warranty does not cover expendable items. This warranty is VOID when repairs are performed by a nonauthorized service center or representative. For information about authorized service centers or representatives, write Customer Repairs, Valco Instruments Company, Inc, P.O. Box 55603, Houston, Texas 77255, or phone (713) 688-9345. At Seller's option, repairs or replacements will be made on site or at the factory. If repairs or replacements are to be made at the factory, Buyer shall return the goods prepaid and bear all the risks of loss until delivered to the factory. If Seller returns the goods, they will be delivered prepaid and Seller will bear all risks of loss until delivery to Buyer. Buyer and Seller agree that this Limited Warranty shall be governed by and construed in accordance with the laws of the State of Texas.

The warranties contained in this agreement are in lieu of all other warranties expressed or implied, including the warranties of merchantability and fitness for a particular purpose.

This Limited Warranty supercedes all prior proposals or representations oral or written and constitutes the entire understanding regarding the warranties made by Seller to Buyer. This Limited Warranty may not be expanded or modified except in writing signed by the parties hereto.



Valco Instruments Co. Inc.

Microvolume Thermal Conductivity Detector Instruction Manual

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Introduction

Description and Operating Principle

The Thermal Conductivity Detector (TCD) has been one of the most popular GC detectors since the 1950's, second perhaps only to the Flame Ionization Detector (FID). The principal of operation is based on the relative change in the thermal conductivity of the gas passing across the detector filament as components elute from the column. Heat is lost continuously by the filament through the carrier gas to the cell wall of the detector. By measuring the amount of current required to maintain a constant filament temperature as gases of varying thermal conductivities cross the filament, a chromatographic signal is produced. This process is nondestructive of the sample and is concentration dependent.

The Valco Microvolume TCD is unique in its implementation. Since changes in conductivity are measured only by the change in current required to keep the filament at a constant temperature, each of the two filaments can be operated independently without referencing these changes to a matched filament with reference gas. This constant temperature provides longer filament life and safeguards it from the extremely high temperatures and oxidation which can occur with high concentrations of oxidative or corrosive components. Optional signal referencing is provided to minimize background variables such as column bleed and temperature programming.

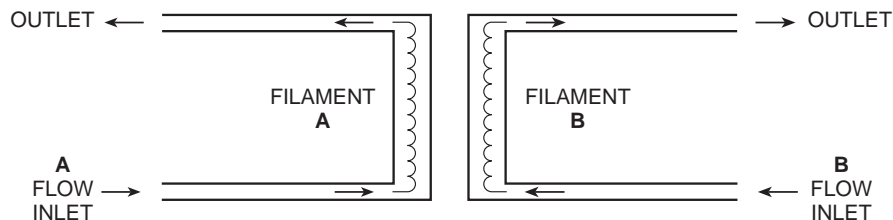


Figure 1: Unique dual filament design

Cell volume has been minimized to accommodate capillary column chromatography and optimize the sensitivity of the detector at low flow rates. (Carrier flow rates of 1 - 10 mL/min are recommended for best sensitivity.) Thermal stability is maintained in the detector cell to within 0.010°C drift, giving the detector a stable, noise-free signal.

The Model TCD2 is a stand-alone system which can be easily added to any chromatograph. It consists of a detector and a control module which incorporates the electrometer and temperature controls. The detector cell includes two separate filaments, capable of independent or referenced (differential) operation. Output signal is provided as 0-1 and 0-10 volt attenuated for chart recorders and 0-1 and 0-10 volts unattenuated for integrators and data systems.

Safety Notes and Information

Symbols

**HOT SURFACE**

The surface of the detector body may be hot while in operation (possibly in excess of 250°C). Observe caution.

**ATTENTION**

Refer to the manual.

**PROTECTIVE EARTH**

This internal connection provides protection against electric shock from mains voltages and should not be removed.

Installation Category

This equipment has been designed for installation category (overvoltage category) II, pollution degree 2. It has been approved for use only in heavy industrial environments and may not be used in the residential, commercial, or light-industrial environment.

Safety

This instrument has been designed and tested in accordance with the product safety standard, EN61010. It has left the factory in a safe condition. This instruction manual contains important information and warnings which must be followed by the user to insure safe operation and to retain the instrument in a safe condition. The case, chassis, and measuring terminals are connected to the protective earth contact of the mains inlet. The instrument operates with a three-conductor power cord having a protective earthing conductor and a plug with an earthing contact. The mains (line) plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord without a protective conductor. Use only with an approved mains supply cord having a rating of 2A, 250V, or greater. Do not use this equipment in a manner not specified herein.

Maintenance

The exterior of the instrument should be cleaned regularly with a dusting brush. If necessary, the casing can be cleaned with a moistened cloth (99% water + 1% mild detergent). Spirit or petroleum ether can be used to remove greasy dirt. Any other cleaning agents can attack the plastic and painted surfaces.

Under no circumstances should the cleaning fluid get into the instrument. Petroleum ether is flammable, and care should be taken in its use.

The detector must be returned to the factory when filament replacement is required. Call VICI Tech Support for return authorization.

Components of the Detector Systems

Components of the detector system are listed in **Tables 1** and **2**. Check the contents of the packages to verify that everything is present. Contact the factory if anything is missing or damaged. (NOTE: damaged shipments must remain with the original packaging for freight company inspection.)

Description	Quantity	Product number
Detector cell, Nickel-Iron filament	1	TCD2-NIFED
Controller unit with power cord	1	TCD2-C
<i>Includes:</i> Cable, output	2	I-24010
1/16" zero dead volume union	2	ZU1C
Fused silica adapter for 0.53 mm ID x 0.8 mm OD capillary column	2	FS1R.8
1/16" zero dead volume nut	2	ZN1
1/16" zero dead volume ferrule	2	ZF1

Table 1: Components of the TCD2-NIFE system

Description	Quantity	Product number
Detector cell, Tungsten-Rhenium filament	1	TCD2-WRE
Controller unit with power cord	1	TCD2-C
<i>Includes:</i> Cable, output	2	I-24010
1/16" zero dead volume union	2	ZU1C
Fused silica adapter for 0.53 mm ID x 0.8 mm OD capillary column	2	FS1R.8
1/16" zero dead volume nut	2	ZN1
1/16" zero dead volume ferrule	2	ZF1

Table 2: Components of the TCD2-WRE system

Specifications

Mains (line):	115/230 V~50/60 Hz, 175 VA
Fuse:	2 A, time-delay, 5 x 20 mm
Pressure:	6.9 kPa (1 psi) operating, 6.9 MPa (1000 psi) max. working
Maximum temperature	300°C
Heater power:	60 W max., 48 V, PWM
Output impedance:	100 Ω

Description of Controls and Connectors

Controls and connectors are indicated in **Figures 2** and **4**.

MAINS switch (rear panel)

Controls mains (line) voltage to the controller unit. When this switch is on (|), the unit is operational except for the detector filaments (see next paragraph) and the detector heater will operate if connected.

FILAMENT switch and indicator

Controls power to the detector filaments; when the switch is on, current passes through the filaments. The indicator will light even if the detector is not connected to the controller.

DETECTOR TEMPERATURE control and indicator

Sets the temperature (°C) of the detector heater block. The indicator is steadily on when maximum power is being applied to the heater, steadily off when no power is applied, and regularly blinking on/off when the set temperature has been established.

Note that due to the fail-safe mechanism designed into the temperature controller, the heater will not operate if mains power is applied before the heater is connected or if the detector is too cold ($< 0^{\circ}\text{C}$). If the heater is disconnected with mains on, the unit must first be turned off to restore control of the heater; if the unit is operated in a very cold environment, the detector should first be gently warmed without power applied.

The fail-safe mechanism will also act under any condition resulting from loss of control (e.g., over-heating, RTD failure, etc.). If proper procedures have been followed and the controller will not heat the detector, there is cause to suspect that the fail-safe mechanism has been activated. Consult the factory or an authorized representative. Note that the maximum temperature for operation of the TCD2 is 300°C .

FILAMENT TEMPERATURE switch

Separate 10-turn knobs control Filaments A and B. The value displayed corresponds to temperatures indicated in **Figure 3** for nickel/iron filaments.

COARSE ZERO control

Once filament temperature has been applied, the Coarse Zero knob makes coarse adjustments of the zeroing voltage supplied for establishing the baseline zero on both the strip chart output and the integrator outputs.

FINE ZERO control

Once coarse adjustments have been made, the Fine Zero control is used to make fine adjustments in the output signals.

ATTENUATION control

The Attenuation control determines the attenuation of the signal for the chart output.

RECORDER switch

The Recorder switch selects which signal is directed to the chart output. The choices are **A**, **B**, or **A - B** (or A minus B, which is conventional differential operation with the B channel representing the reference.) The selected output signal is displayed in the LCD display.

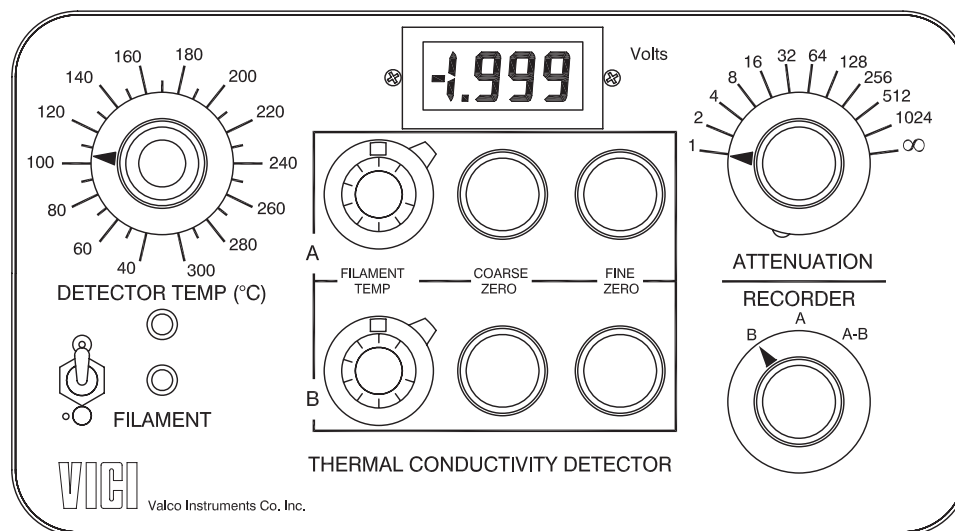


Figure 2: Front panel controls

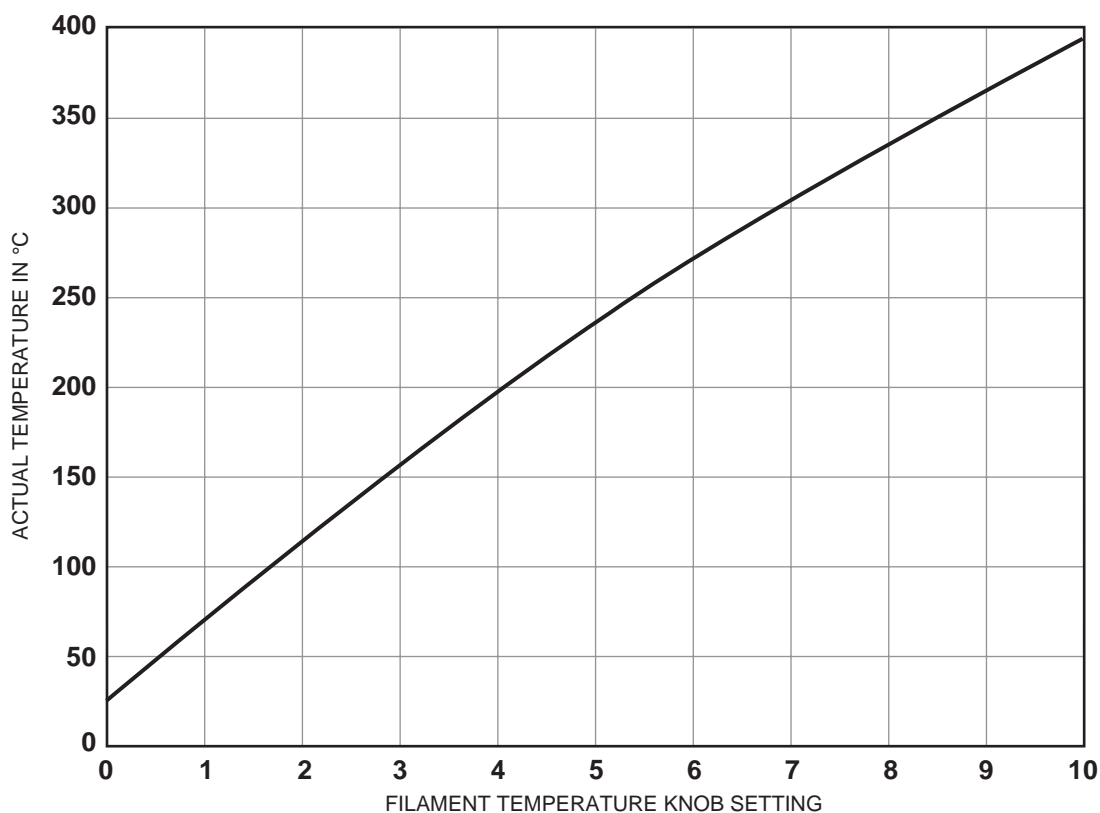


Figure 3: Actual filament temperature vs. filament temperature knob settings

MAINS POWER connector

For connection to 115/230 VAC source.

CHART OUTPUT connector

Normally connected to a strip chart recorder. This output has an attenuated range of 0-1 volt and 0 - 10 volts, with the signal scaled by the attenuation factor set on the front panel. The output also has an internal signal reference (-) at zero volts. For best noise performance, the shield (earth) and signal reference (-) should not be connected together.

UNATTENUATED OUTPUT connector

Normally connected to a data acquisition system or other recording means. For convenience, full-scale 0 - 1V and 0 - 10V outputs are provided, with an internal signal reference (-) at zero volts. For best noise performance, the shield (earth) and signal reference (-) should not be connected together.

DETECTOR connector

For connection to the detector control and heating system.



NOTE: These terminals are for connection only to equipment having no accessible live parts.

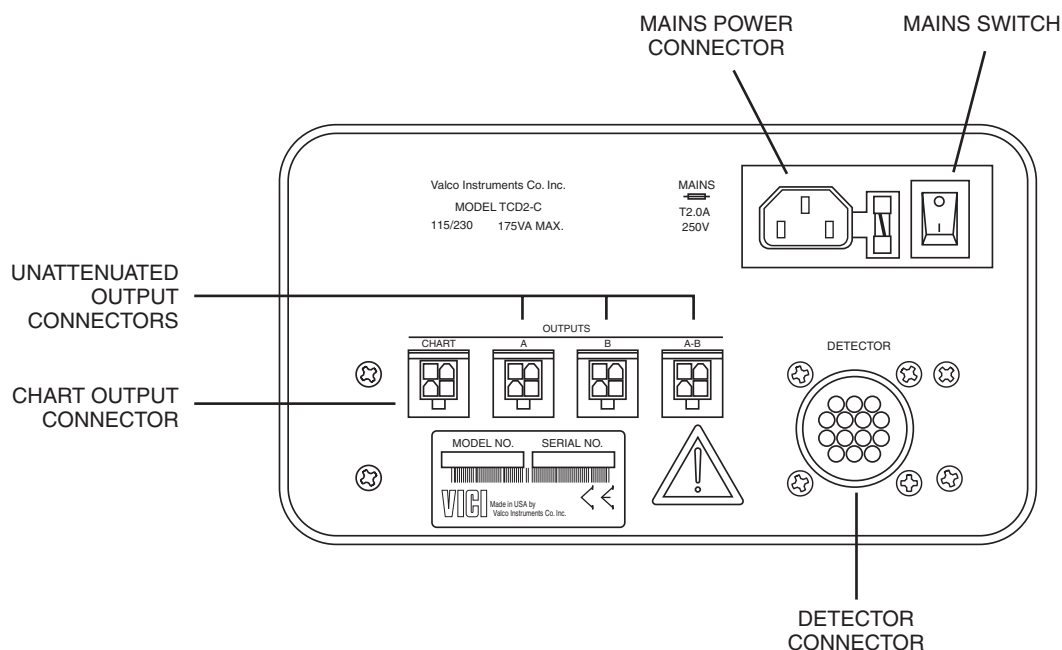


Figure 4: Rear panel connectors

System Requirements

Components Not Included with the Detector System

- Carrier gas (99.999% purity is recommended)
- Ultra high purity grade gas pressure regulator with stainless steel diaphragm (recommended)
- Any special adapters required for connection to the gas regulator
- Flow measuring device
- Flow regulating device

System Purity

Since detection of low concentrations depends in part on the purity of the carrier, the purest carrier available must be used in order to achieve the lowest possible detection limit. To maintain carrier purity, extra care must be taken to assure that the delivery system is clean and free of leaks. Use stainless steel tubing (cleaned to removed manufacturing solvents) instead of nylon or Teflon® tubing, which can diffuse contaminants into the carrier.

Recommended Carrier Gas Purifiers

The Valco Helium Purifier (product number HP2) and Nitrogen Purifier (product number NP2), which utilize a rare earth gettering alloy to effectively remove contaminants, are recommended for ppm level analysis of permanent gases. For other applications, economical and convenient VICI Mat/Sen purifiers are appropriate. Order the P300-1 for nitrogen, P200-1 for hydrogen, or the P100-1 for helium and other inert carrier gases.

Carrier Gas Selection

The detector's response to a component is based upon the difference between the thermal conductivities of the component and the carrier gas: the greater the difference, the greater the response. The table below shows thermal conductivities for a variety of light gases.

Hydrogen	45.9
Helium	36.9
Neon	11.8
Methane	8.6
Oxygen	6.6
Air	6.4
Nitrogen	6.4
Carbon monoxide	6.2
Water	4.5
Argon	4.5
Carbon dioxide	4.2

As an example, note in the table that the thermal conductivity of hydrogen is 46 and helium is 37, while nitrogen is only 6 and argon is even lower at 4. Since the largest difference in thermal conductivity yields the best response, detection of small amounts of hydrogen is better done with argon or nitrogen carrier than with helium.

However, while nitrogen as a carrier yields excellent response to hydrogen, the response to oxygen and carbon dioxide is diminished compared to the levels that could be achieved with helium or hydrogen. Argon would yield poor response to carbon dioxide and water, but would be adequate for other components.

There is no absolute "best choice" of carrier gas. For any situation, the choice must take into account all of the parameters involved: column characteristics, components of interest and their concentrations, safety considerations, carrier cost, etc.

GC Column Selection

Cell volume has been minimized to accommodate capillary, megabore, and micropacked columns, and to optimize the sensitivity of the detector at low flow rates. However, standard packed columns may also be used if sensitivity is not an issue.

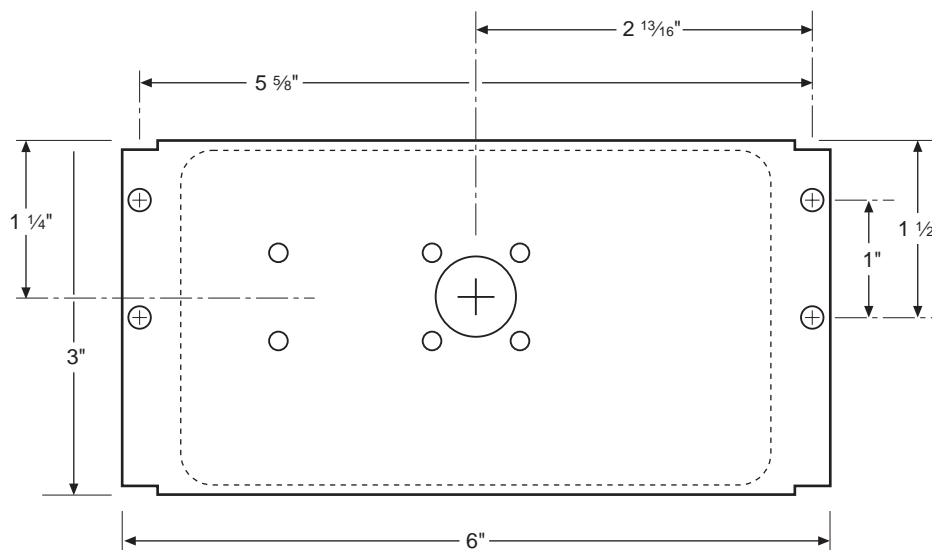


Figure 5: Detector assembly mounting dimensions

Installation

The detector is usually mounted on top of the GC column oven. The power cord for the controller is 1.8 m (6') long; the detector cable and the signal output cables (attenuated and unattenuated) are 1.2 m (4') long.

General Precautions

- Do not turn the unit on until the carrier gas is flowing through the detector.
- Do not shut off or disconnect the carrier gas when the detector is hot, even if the unit is turned off. Turn off the power switch on the back of the controller and allow the detector to cool down naturally before disconnecting or shutting off the carrier gas.
- Position the controller unit where the mains switch on the rear panel can be reached easily.

Mounting the Detector on the GC

Vertical Mounting

The detector has no particular orientation requirements, but it should have adequate thermal isolation from the column oven and injection port. Most GCs have an existing opening which will allow the TCD2 to sit vertically on top of the column oven with the column inlet extending into the oven. If you are replacing an existing detector, you can usually just remove it and set the TCD2 in its place. If not, use a drill or chassis punch to drill a hole of the proper size, and set the detector in position.

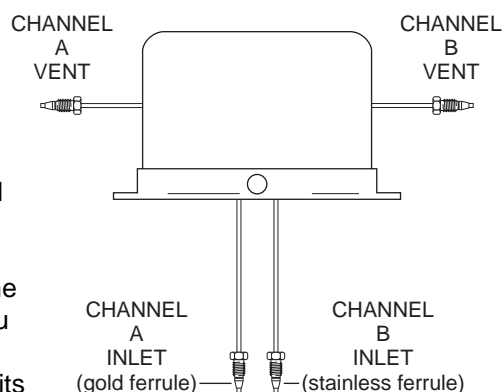


Figure 6: Detector connections

While trying to match base plate mounting holes to every GC on the market is impractical, we have located the mounting holes so that at least two of them will coincide with existing holes on the GC. (Refer to **Figure 5**.)

Orient the detector to allow for easy cable and gas connections. The inlet lines installed into the detector must enter the column oven and permit column connection. Temperature loss between the column outlet and the detector should be minimized to prevent possible condensation of the sample.



CAUTION: Do not mount the detector near the column oven cool-down vents.

Horizontal Mounting

Some older GCs have access to the column oven through the side of the GC. This does not present a problem as far as operation of the TCD2 is concerned. Drill a hole at the appropriate location, orient the detector for convenient connection, and mark the position of the mounting holes. Drill the mounting holes and secure the detector to the side of the GC with four sheet metal screws (not supplied).

Gas Connections

Remember these three points discussed earlier: (1) all surfaces that contact the gas stream must be glass or stainless steel; (2) do not use copper tubing or brass fittings; and (3) all tubes must be thoroughly cleaned and baked before use. The installation instructions below assume that the detector carrier will be supplied from a nearby cylinder. If your installation is different, you may need to modify the instructions appropriately. Consult the VICI catalog or vici.com for any fittings and tubing required.

The figures below illustrate gas connections for a typical TCD2 detector system, in referenced and unreferenced modes. Since the distance from the carrier supply to the GC varies from installation to installation, we do not supply tubing to go from that point to the GC.

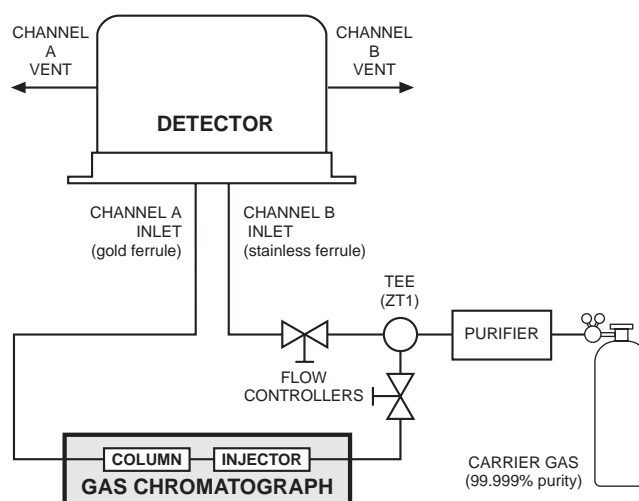


Figure 7: Referenced mode (A - B)

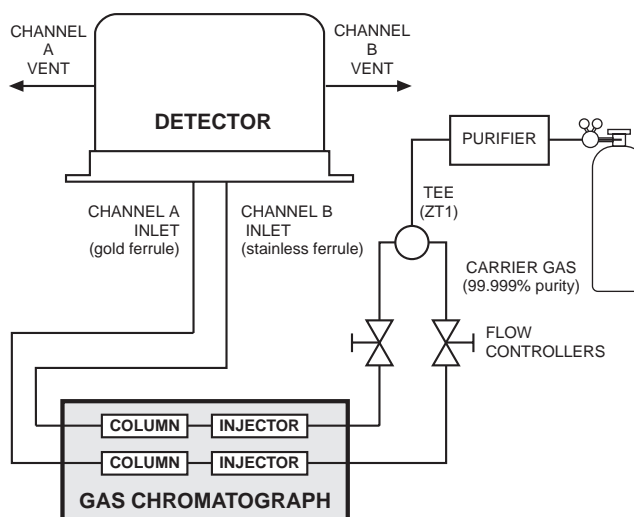


Figure 8: Unreferenced mode

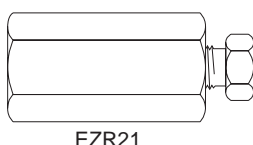
Installing and Purging the Gas Regulator

1. Make sure the on/off valve on the helium cylinder is completely closed. Screw the CGA fitting nut of the regulator into the helium cylinder. Go beyond finger-tight, but do not tighten the nut all the way – some leakage is required for the purging operation.
2. Turn the output pressure regulating knob completely counterclockwise.
3. Open the cylinder on/off valve *slightly* and quickly close it again.
4. Adjust the tightness of the regulator connecting nut to allow a pressure reduction of ~690 kPa/sec (100 psi/sec). With a new bottle, the gauge should start out at about 14 MPa (2000 psi).
5. When the pressure drops into the 1.4 - 3.4 MPa (200 - 500 psi) range, open the cylinder on/off valve slightly and quickly close it again.
6. Repeat Step 5 eight or ten times to be certain that all the air is purged. On the final purge, tighten the regulator connecting nut very securely as the pressure approaches the 2.1 - 3.4 MPa (300 - 500 psi) range.
7. Open the cylinder valve to pressurize the regulator once again, then close it and observe the high pressure gauge needle for 15 minutes. If it doesn't move, there is no critical leak on the high pressure side of the regulator.



CAUTION: Never use leak detecting fluids on any part of this system.

Installing and Purging a Purifier



1. If the pressure regulator has a 1/8" *male* cone-type outlet port, install the Valco 1/8" external to 1/16" internal reducer (EZR21); if it has a 1/4" *male* cone-type outlet port, install the Valco 1/4" external to 1/16" internal reducer (EZR41). For other regulator outlet fittings, a wide variety of Valco adapters are available.
2. Remove the cap from the inlet tube of the Valco helium purifier and insert the tube fitting into the 1/16" reducer port. (Keep the outlet tube capped.) Use a 1/4" wrench to turn the nut one-quarter turn past the point where the ferrule first starts to grab the tubing. Do not remove the fitting. When made up properly, it should be leak-tight.
3. Turn the output pressure regulating knob clockwise until the gauge registers 345 KPA (50 psi).
4. Allow five minutes for equilibration, then turn the regulating knob all the way counterclockwise.
5. Observe the needle of the output pressure gauge for 15 minutes. There will be a slight initial drop, but if it doesn't move after that, consider that all the connections are tight.
6. If necessary, use an electronic leak detector to locate any leaks. If a leak detector is not available, tighten all the fittings (including the output pressure gauge), and repressurize the system for another test.
7. Upcap the outlet tube of the purifier and purge the system for 15 to 30 minutes at 60 - 80 mL/min to eliminate air from the purifier getter material.

Column Connection



To prevent detector contamination, we strongly recommend disconnecting the column from the detector during column bakeout procedures.

Referenced mode

In the referenced mode, the column is connected to the Channel A inlet, and the carrier gas stream is split and used as a reference in channel B. The gas flow rate from both channels must be the same (flow balanced). This mode of operation provides the best baseline stability and the least background noise.

Unreferenced mode

In the unreferenced mode, Channels A and B are used independently. One column connects to the Channel A inlet, and the other to Channel B. The carrier gas must be the same for both channels.

It is also possible to use only one channel with the other capped off, as long as the filament temperature control knob of the unused channel is set to zero.

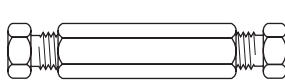
The unreferenced mode has certain limitations: there is a possibility of detector cross-talk (interference) if compound concentrations exceed 1%, and baseline drift and background noise are greater than with the referenced mode.

To make column connection as convenient as possible, each TCD is shipped with two Valco 1/16" unions (Product No. ZU1C) complete with nuts and ferrules (Product Nos. ZN1 and ZF1). Also included are two fused silica adapters (FSR1.8) for use with .53 mm ID wide bore capillary columns (.8 mm OD). Refer to the information below to determine the correct Valco fitting for use with other columns.

Column Connection Fittings

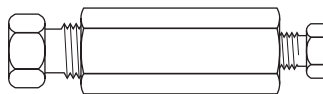
Packed Columns

A 1/16" packed column requires only the ZU1C which comes with the TCD. For 1/8" columns, order a ZRU21.



ZU1C

Used with 1/16" column

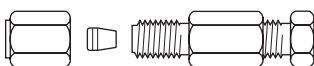


ZRU21

Used with 1/8" column

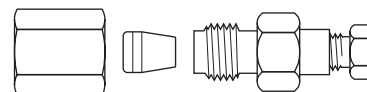
Packed Columns with Swagelok®-type Female Nut

The connection of these columns is similar to that for standard packed columns, but requires a union which adapts the female nut to the Valco fitting.



EZU1

Used with 1/16" column



EZRU21

Used with 1/8" column

Capillary Columns

Connection of these columns requires the use of the ZU1C with the appropriate fused silica adapter. For a .53 mm ID x .8 mm OD column, use the FSR1.8 supplied with the TCD. For other sizes, use this table to determine the proper adapter:

Column size	Adapter required
.32 mm ID x .5 mm OD	FS1R.5
.25 mm ID x .4 mm OD	FS1R.4
< .2 mm ID	FS1R.2



ZU1C with fused silica adapter

Testing for Leaks

It is critical for the system to be leak-tight, and an additional check at this point can save many headaches later on. To test for leaks:

1. Insure that both outlets are capped.
2. Pressurize the entire system with helium to 138 kPa (20 psi).
3. If the system does not hold pressure, check all the fittings with an electronic helium leak detector. DO NOT use leak detecting liquids.

Electrical Connections



Before connecting the detector cable to the control module, make sure that the control module power cord is unplugged.

1. The heater and filament connections from the detector to the rear panel of the controller are made up in one cable. After making sure that the control module power cord is not plugged in, connect this detector cable to the connector on the control module. The cable connector should be firmly seated by turning the coupling ring clockwise until the detent is felt.



For best detector performance, the cable and connector should not be allowed to move while measurements are being made. If the cable is disconnected, exercise care to keep the connecting pins in each connector clean.

2. Connect the data output(s). The A / B / A - B outputs are used with an integrator or PC-based data acquisition system; the chart output is for a strip chart recorder. Polarities and full scale range are indicated in the figure below. (Set the recorder/DAQ for the same voltage scale.)
3. Connect the main power cord.

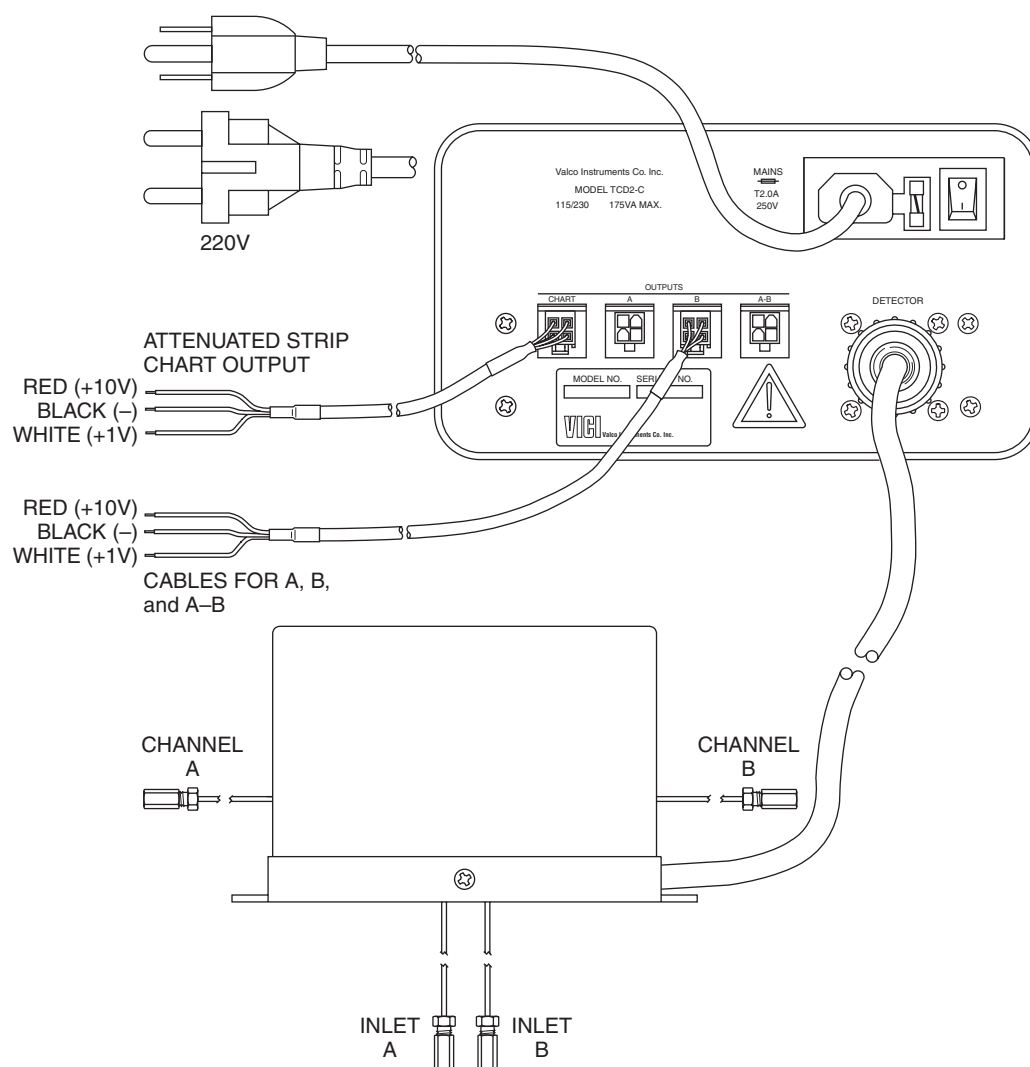


Figure 9: Electrical connections

Initial Power-Up

Since the TCD is a concentration-dependent detector, the lower the flow rate through the detector, the higher the sensitivity. Column diameter will determine the optimum column flow rate.

The microvolume TCD is designed for the lower flow rates typical for capillary columns, and achieves best sensitivity at rates below 10 ml/min. Since the filaments are maintained at constant temperature, the detector can be operated at extremely low flow rates (less than 0.5 ml/min) without damage to the filaments.

A - B referenced mode

Flow Rate Settings

1. Measure the column flow at the detector's Channel A out. The optimum flow rate is in the range of 4 - 20 mL/min, with the actual rate dependent on the type of column used.
2. Measure the reference gas flow at Channel B out. It should be as close as possible to the GC column flow. Use a fixed flow restrictor or a good quality flow controller to match the the carrier gas and reference gas flows.
3. Once the flows have been established, make sure the filament switch and the main power switch are in the OFF position, and plug the power cord into an AC main outlet.

Initial Conditioning

4. Turn on the control module main power switch and set the detector temperature to 220°C.
5. Turn on the filament power switch and set both filament temperature knobs at 8.0.
6. Condition the detector by allowing it to bake at these settings for at least 12 hours.

Temperature Settings

7. After the initial bakeout period, set the detector temperature at 100°C or at the column temperature plus 30°, whichever is higher.
8. Set the filament temperatures at least 50° and as much as 100° higher than the detector temperature. Refer to **Figure 3** on page 5, which outlines the relationship between the filament temperature knob settings and the actual filament temperature.

Detector sensitivity increases as the temperature differential between the detector and the filaments increases, but filament life decreases as its temperature increases. Thus, the detector temperature should be set as low as possible, determined by the boiling point of the highest boiling component of the sample.

9. Once all temperatures are set, allow plenty of time for the system to equilibrate, evidenced by a stable baseline. Typical equilibration time for going from a cold start-up to 130°C detector temperature is approximately five hours. Detector temperature changes take much longer to equilibrate than do filament temperature changes.

The test chromatogram accompanying your TCD was obtained under the following conditions:

Sample:	~100 ppm blend in Helium balance
Sample volume:	250 µl
Column:	10' x 1/16" x 0.040" molecular sieve 5Å micropacked
Column flow:	6 mL/min
Reference flow:	6 mL/min
Column temperature:	65°C
Detector temperature:	100°C
Filament temperature:	230°C (a setting of 5.0)
Carrier gas:	Helium

Balancing the Channels using LCD Display

The LCD display indicates the signal level from the recorder/chart output.

10. Set the recorder switch to A, and use the coarse and fine controls for Channel A to adjust the signal level to about 300 mv.
11. Set the recorder switch to B and repeat the same process to adjust the signal level to about 200 mv.
12. Set the recorder switch to A-B. The display should read about 100 mv. If the signal levels drifts below zero, readjust the A & B channels.

The detector is now ready for analytical use.

Balancing the Channels using Recorder/Chart Output

10. Use the zero (or shunt) setting on the recorder to set the true zero on the recorder.
11. Set the Recorder switch to A, and use the coarse and fine zero controls for Channel A to bring the recorder pen on scale and to a position approximately 1-2 cm above zero.
12. Set the Recorder switch to B, and repeat the same process, bringing the pen to a position *half* as far above zero as the pen for Channel A.
13. Set the Recorder switch to A - B, and observe the recorder pen position. It should be above the true zero position, but below the position for Channel A. If the pen drifts below zero, readjust the A and B channels.

The detector is now ready for analytical use.

Balancing the Channels using Unattenuated Outputs

10. Connect the output cable to the A connector, and use the coarse and fine zero controls for Channel A to bring the baseline signal on scale and to a position approximately 100 mV above zero.
11. Move the output cable to the B connector, and use the coarse and fine zero controls for Channel B to bring the baseline to a position half as far above zero as for Channel A (the value of A minus B).
12. Move the output cable to the A - B connector, and observe the baseline signal. It should be above the true zero position. If the signal drifts below zero, readjust the A and B channels.

The detector is now ready for analytical use.

Single filament mode

The basic procedures and temperature settings described for referenced mode operation can also be applied to operation in the single filament or independent mode. Both channels must have the same carrier gas; you cannot use helium carrier in one channel and nitrogen in the other. Also be aware of the possibility of detector cross-talk when components elute from

Troubleshooting

Troubleshooting Chart

<i>Problem</i>	<i>Possible Cause</i>	<i>Refer to page:</i>
No signal	Main or filament power switch off	4
	Filament temperature too low	4
	Fuse blown	3
	Output cable in the wrong connector	14
Signal reversed	Signal wires reversed	14
Noisy signal	Dirty system or leaking fittings	7, 13, 19
	Bad flow controller in system	15
	Cell/filament differential too small	15
	Filament damaged	2
Cannot zero the signal	Recorder/Int. not zeroed	16
	Voltage incompatibility	14
	Main or filament power switch off	4
Excessive drift*	Block temperature not stabilized	15
	Heater fault	17
Cell doesn't heat properly	Heater/sensor cable unplugged/ heater fail safe mechanism	17
	Heater fault	17
	Fuse blown	3

For technical assistance from Valco Instruments, call (713) 688-9345 or email tech_usa@vici.com.

*Try referenced mode, page 12

Heater Fault Determination

The heater control circuit is designed to disable itself in the event of a fault such as over-temperature, shorted heater, short/open temperature sensor, etc. Once disabled, circuit operation is restored by turning off the controller, disconnecting and reconnecting the detector cable, and then turning the controller back on. *E.g.*, if mains power is applied before the detector is connected to the controller, the heater circuit will not operate until mains power is removed, the detector connected, and mains power restored.

Under normal circumstances, the amber temperature indicator light will flash once after mains power is applied, before control is established. If the light fails to flash, it indicates that a fault has been detected or (less likely) the heater supply fuse has failed.

Detector Fault Determination

Electrical faults in the detector are most easily discovered by making resistance measurements between pins of the detector cable connector. The table below shows the pin numbering and connections for the detector cable (view into pins). Nominal resistance values (in ohms) at 25°C are shown. Unshaded boxed without numbers represent open circuits, and should in no case be blow 1 MΩ. Resistance values given should be within ±10% of the nominal values.

Pin	2	3	4	5	6	8	9	11	12	13	14
1			0	25							
2										0	
3					108						
4				25							
5											
6											
8							0		25		
9									25		
11											50
12											
13											

Maintenance

Cleaning the Enclosure

The exterior of the instrument should be cleaned regularly with a dusting brush. If necessary, the casing can be cleaned with a moistened cloth (99% water + 1% mild detergent). Spirit or petroleum ether can be used to remove greasy dirt. Any other cleaning agents can attack the plastic and painted surfaces.

Under no circumstances should the cleaning fluid get into the instrument. Petroleum ether is flammable, and care should be taken in its use.

Bake Out Procedure

Under normal conditions, the TCD requires no routine maintenance. However, if the detector is exposed to chemicals which may condense or polymerize within the detector and adversely affect performance, the detector cell can be baked out at elevated temperatures (up to 300°C). Inert carrier gas flow (other than hydrogen, oxygen, or air) should be maintained during the reconditioning procedure. Filament temperature should also be increased to approximate the setpoint of the bake out temperature.

If a 24 hour bake out is not sufficient to remove the contamination, the unit must be returned to be factory for disassembly and cleaning.

Warranty

This Limited Warranty gives the Buyer specific legal rights, and a Buyer may also have other rights that vary from state to state. For a period of 365 calendar days from the date of shipment, Valco Instruments Company, Inc. (hereinafter Seller) warrants the goods to be free from defect in material and workmanship to the original purchaser. During the warranty period, Seller agrees to repair or replace defective and/or nonconforming goods or parts without charge for material or labor, or, at the Seller's option, demand return of the goods and tender repayment of the price. Buyer's exclusive remedy is repair or replacement of defective and nonconforming goods, or, at Seller's option, the repayment of the price.

Seller excludes and disclaims any liability for lost profits, personal injury, interruption of service, or for consequential incidental or special damages arising out of, resulting from, or relating in any manner to these goods

This Limited Warranty does not cover defects, damage, or nonconformity resulting from abuse, misuse, neglect, lack of reasonable care, modification, or the attachment of improper devices to the goods. This Limited Warranty does not cover expendable items. This warranty is VOID when repairs are performed by a nonauthorized service center or representative. For information about authorized service centers or representatives, write Customer Repairs, Valco Instruments Company, Inc, P.O. Box 55603, Houston, Texas 77255, or phone (713) 688-9345. At Seller's option, repairs or replacements will be made on site or at the factory. If repairs or replacements are to be made at the factory, Buyer shall return the goods prepaid and bear all the risks of loss until delivered to the factory. If Seller returns the goods, they will be delivered prepaid and Seller will bear all risks of loss until delivery to Buyer. Buyer and Seller agree that this Limited Warranty shall be governed by and construed in accordance with the laws of the State of Texas.

The warranties contained in this agreement are in lieu of all other warranties expressed or implied, including the warranties of merchantability and fitness for a particular purpose.

This Limited Warranty supercedes all prior proposals or representations oral or written and constitutes the entire understanding regarding the warranties made by Seller to Buyer. This Limited Warranty may not be expanded or modified except in writing signed by the parties hereto.

Valco Instruments Co. Inc.

VICI

**Universal Electric
Actuator
Instruction Manual
Models EUH, EUD, and EUT**

Rev 2/13

North America, South America, and Australia/Oceania contact:
Valco Instruments Co. Inc.
800 - 367 - 8424

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Europe, Asia, and Africa contact::

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Introduction

Description

The VICI universal actuator models are designed to work with both two position and multiposition valves, with any number of ports. This is accomplished through simple programming via the manual remote or the optional serial, BCD, or USB interface. The actuator consists of a single unit housing a stepper motor/gearbox assembly and the control components, a universal AC input (100-240 VAC, 50-60 Hz) to 24 VDC power supply, a manual remote, and the interconnecting cables.

Getting Started

Mounting

The actuator should be oriented so that any potential leakage of liquid from the valve or fittings flows away from rather than into the actuator.

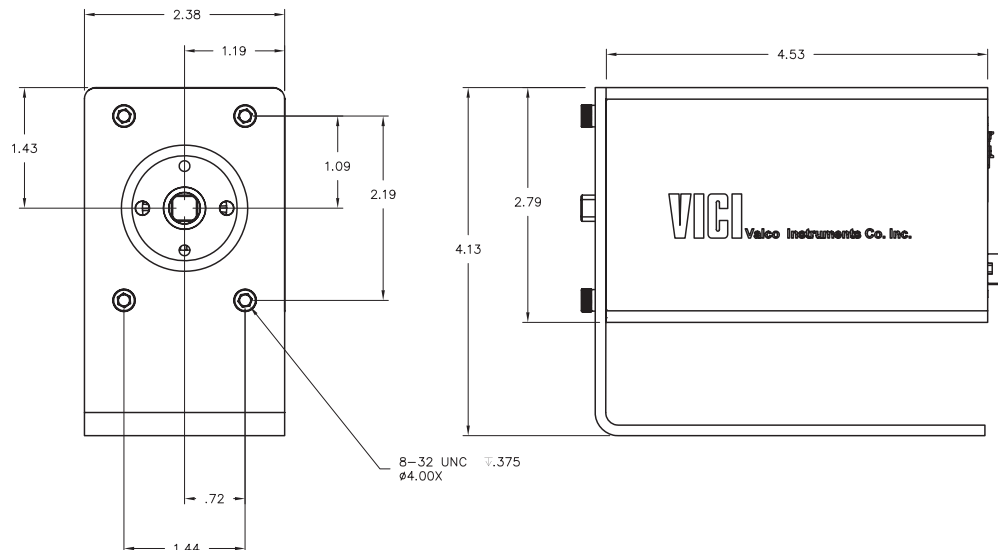


Figure 1: Universal actuator mounting dimensions

Power Connector

Input power (24-28 VDC) is supplied through a coaxial connector: the inner pin is + voltage and the outer pin is ground. The average current requirement is 2.1 amps; standby current draw is 60 milliamps.

The actuator should not share a power supply with other noise-sensitive electronics, as the high current draw could cause problems.

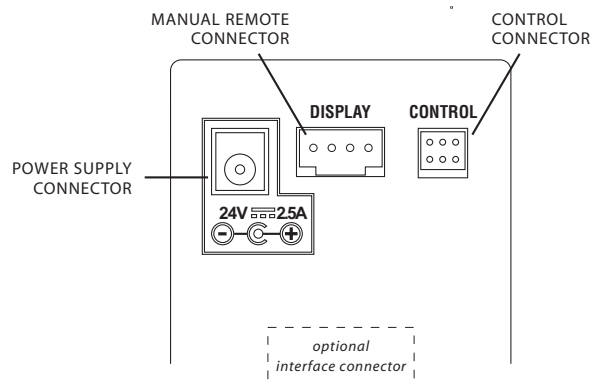


Figure 2: Connections on rear panel

Basic Operation of the Manual Remote

The manual remote provides simple valve positioning capabilities, but in the configuration mode, it can be used to perform extensive actuator setup functions. For information on using the manual remote to configure the actuator, refer to "Using the Manual Remote to Configure the Actuator" beginning on the next page.

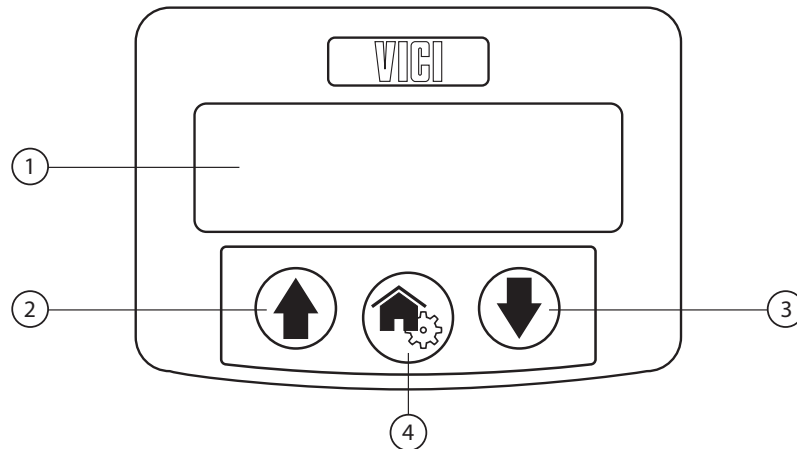


Figure 3: Universal actuator manual remote

1. **Display**

2. **UP** arrow button

In *two position* configuration, pressing the UP arrow button moves the actuator to Position B. If it is already in Position B, nothing happens.

In *multiposition* configuration, pressing the UP arrow button advances the actuator one position; i.e., from 1 to 2, 4 to 5, etc.

3. **DOWN** arrow button

In *two position* configuration, pressing the DOWN arrow button moves the actuator to Position A. If it is already in Position A, nothing happens.

In *multiposition* configuration, pressing the DOWN arrow button reverses the actuator one position; i.e., from 2 to 1, 5 to 4, etc.

4. **HOME/SETUP** button

In *two position* configuration, pressing the HOME button moves the actuator to Position A. If it is already in Position A, nothing happens.

In *multiposition* configuration, pressing the HOME button sends the actuator to Position 1.

In either configuration, pressing and holding the HOME button for 5 seconds sends the manual remote into the configuration mode. Refer to "Using the Manual Remote to Configure the Actuator" beginning on the next page.

Using the Manual Remote to Configure the Actuator

In the absence of an optional RS-232, USB, or serial interface, the manual remote can be used to perform extensive actuator setup functions.

Accessing the Configuration Mode

To access the configuration mode, press and hold the HOME/SETUP button for 5 seconds.

Button Functions

- When a screen appears, a line will be highlighted. Use the UP and DOWN arrow keys to highlight a different line.
- When the desired line is highlighted, press the HOME/SETUP button to enter that value.
- For parameters such as number of ports or positions, use the arrow keys to toggle up and down to the desired value, which is then entered by pressing the HOME/SETUP button.
- Only two menus—the Interface Setup and Baudrate—have more than three options. Use the arrow keys to scroll down to additional screens to select the desired value or parameter.
- The UP arrow key also functions as a back button.

A complete menu tree appears on the next page.

Examples

To configure the actuator for a 10 position multiposition valve:

1. On the main menu, use the arrow buttons to highlight Valve Setup. Press the HOME/SETUP button.
2. Use the DOWN arrow button to highlight Multiposition. Press the HOME/SETUP button.
3. Use the UP and DOWN arrow buttons to move through the numbers until 10 is showing. Press the HOME/SETUP button.

Main Menu	
1. Valve Setup	
2. Interface Setup	
3. Information	

Valve Menu	
1. Two position	
2. Multiposition	
3. Move Direction	

Set positions:	
10	

In the multiposition mode, “counterclockwise” means that the actuator moves in the “positive” direction—position 1 to position 2. The clockwise direction is “negative”, moving in the direction of position 2 to position 1.

To set our just-configured 10 position actuator to move in a clockwise direction:

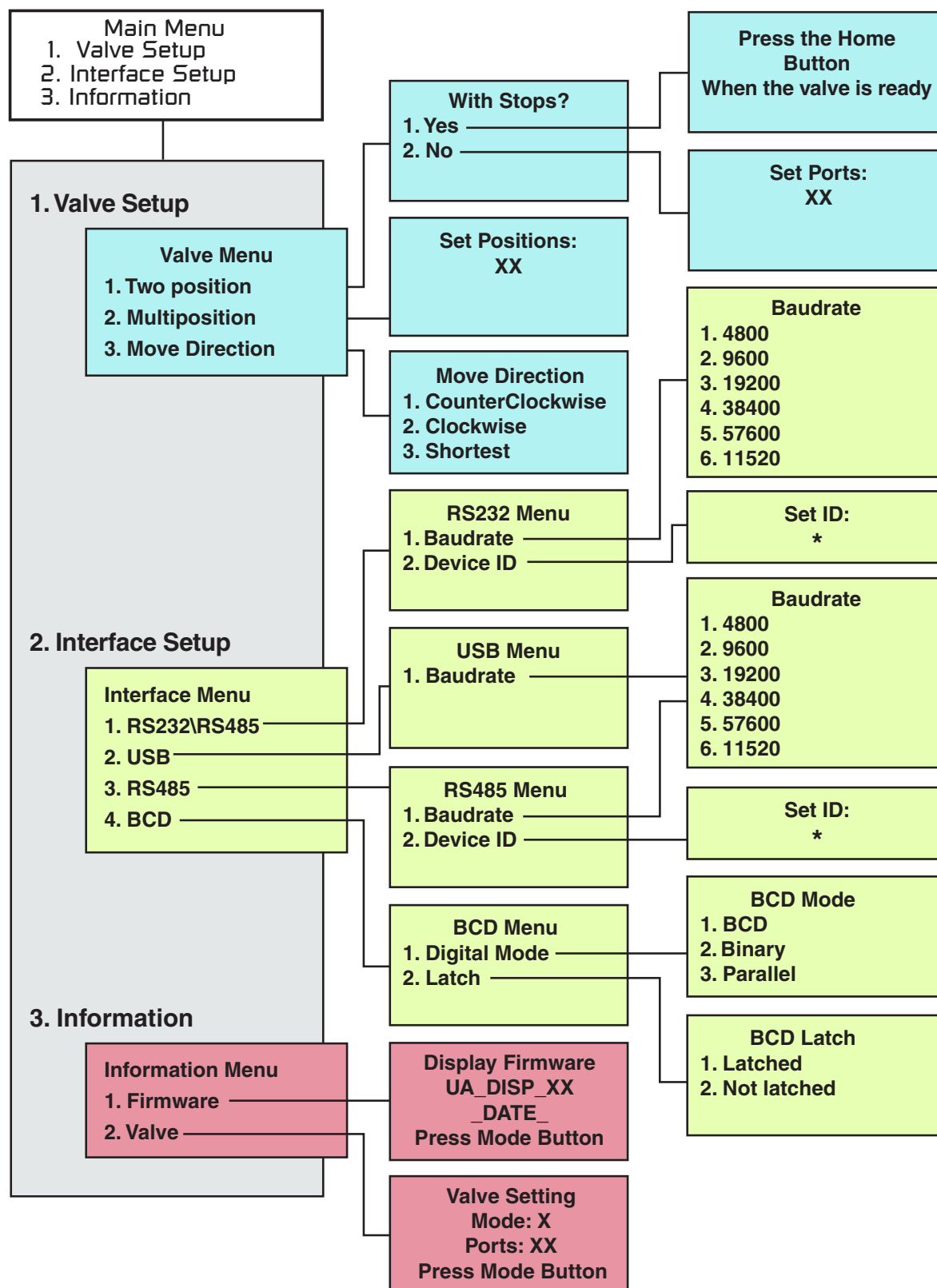
1. On the main menu, use the arrow buttons to highlight Valve Setup. Press the HOME/SETUP button.
2. Use the DOWN arrow button to highlight Move Direction. Press the HOME/SETUP button.
3. Use the DOWN arrow button to highlight Clockwise. Press the HOME/SETUP button.

Main Menu	
1. Valve Setup	
2. Interface Setup	
3. Information	

Valve Menu	
1. Two position	
2. Multiposition	
3. Move Direction	

Move Direction	
1. CounterClockwise	
2. Clockwise	
3. Shortest	

Menu Tree



Basic Control Functions with the Standard Interface

Basic actuator control functionality facilitates position switching in two position modes, and step and home functions in the multiposition mode. This is done via direct input signals from switch closures, relay contacts, or TTL-compatible interfaces. The control cable has six pins: however, only five are used.

If the actuator has none of the optional interfaces, the manual remote must be used to change the mode, direction of rotation, or number of positions. Refer to "Using the Manual Remote to Configure the Actuator" on page 3.

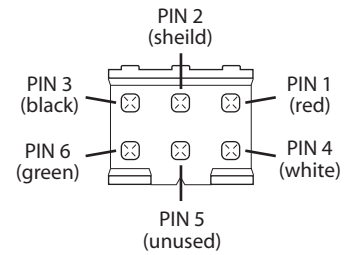


Figure 4:
Standard interface connector
(colors reference cable I-25176)

Two position modes

Pins 4 and 6 are digital inputs for switching to Position A and Position B. They can be driven either by 5 volt TTL/CMOS logic or by contact closure to ground (pin 2). In other words, applying a connection (20 msec minimum) between the "A contact" and common moves the injector to position A (inject). The injector does not move when the connection is released. Likewise, providing a contact between the "B contact" and common moves the injector to the B (load) position. Connections must be released before the opposite closure can be applied.

Position feedback is obtained from the A and B outputs. These are 5 volt tolerant, 3.3 volt logic outputs, sourcing and sinking a maximum of 10 milliamperes each. An output will go high (+3.3V) when the valve reaches the respective position.

Pin #	Function
1	A output (3.3 VDC)
2	Common
3	B output (3.3 VDC)
4	A contact
5	Unused
6	B contact

Figure 5: Two position pin assignments

Multiposition mode

Step Command

Applying a connection (20 msec minimum) between the common and "Step" pin causes the actuator to move to the next position in the currently-set direction of rotation. The connection must be opened before another step can be made.

Home Command

Applying a connection between the common and "Home" pins causes the actuator to go to the HOME position (position 1), moving in the currently-set direction of rotation. The connection must be opened before another step can be made.

Pin #	Function
1	Unused
2	Common
3	Unused
4	Home
5	Unused
6	Step

Figure 6: Multiposition pin assignments

Optional Serial Interface

Note: Serial versions of the actuator are set up for RS-232 as the factory default. For information on RS-485 operation, refer to “Serial Control: RS-485 Option” on page 9.

Establishing Serial Communication

Serial communication requires a terminal emulation or communication software (such as HyperTerminal®, included with Windows®) running on a PC-compatible computer. Set the serial port at 9600 baud, no parity, 8 data bits, 1 stop bit, no hardware or software handshaking.

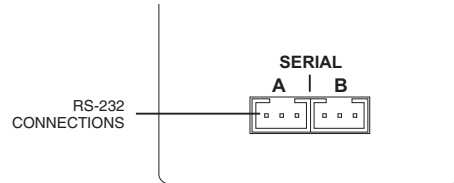


Figure 7: Serial connectors on rear panel

With the software running, check the bi-directional communication link between the keyboard/monitor of the computer and the serial port by typing `/?`<enter>. If the link is functioning, the following menu will appear on your monitor:

Control Command List

GO[nn]	- Move to nn position
HM	- Move to the first Position
CW[nn]	- Move Clockwise to nn Position
CC[nn]	- Move Counter Clockwise to nn Position
TO	- Toggle Position to Opposite
TT	- Timed Toggle
DT[nnnnn]	- Set Delay time for TT Command
CP	- Returns Current Position
AM[n]	- Sets the Actuator Mode [1] Two Position With Stops, [2] Two Position Without Stops, [3] Multi Position
SB[nnnnn]	- Set the Baud Rate to nnnnn
ID[nn]	- Set Device ID nn=(0-9, A-Z)
ID	- Reset ID to none
NP[nn]	- Set the Number of Positions to nn
SM[n]	- Set the Direction [F]orward, [R]everse, [A]uto
LRN	- Learn Stops Location
CNT[nnnnn]	- Set Cycle Counter
VR	- Firmware Version(s)
/?	- Displays This List

Using the Device ID Feature

Actuators are shipped from the factory in the RS-232 mode, with the ID feature disabled. When an ID is set, the actuator responds only to commands which begin with the correct ID prefix, and its transmit output is disabled when not in use. This allows up to 10 actuators to be controlled from one computer RS-232 port. A single command can be broadcast to all actuators by using an asterisk (*) as the command prefix. NOTE: Any broadcast command which elicits a response from the serial port (such as *VR or *ID) will elicit a combined and unintelligible response.

For permanent multidrop applications, the RS-485 mode (page 6) is the preferred solution. However, just as RS-232 control requires the host to have an RS-232 serial port, the PC host or control system must have an RS-485 port to communicate with the actuator in the RS-485 mode. Plug-in PCI cards with RS-485 ports or adaptors that change an RS-232 signal to an RS-485 signal are available from several common electronic manufacturers. If your computer lacks a serial port, adaptors which convert USB ports to RS-232 or to RS-485 are also readily available.



Caution: When installing or replacing actuators on a shared serial port, make sure that no two devices have been set to the same ID number.

1. Remove all of the actuators from the serial daisy chain except the one for which you are setting the ID.
2. To *set* an ID, type **IDn**<enter>, where *n* is the new ID, from 0 to 9 or A to Z.
To *change* an ID, type **iIDn**<enter>, where *i* is the current ID and *n* is the new ID.
To *disable* the ID feature, type **iID***<enter>, where *i* is the current ID.

Setting the Operation Mode

This section employs some simple serial commands to complete a basic configuration of the valve/actuator combination. A more advanced discussion of serial control begins in the next section.

Mode 1: Two Position With Stops (factory default)

This is the proper mode for most two position applications. (*Note exceptions in the next section.*) In this mode, the actuator automatically finds the correct positions using a combination of the valve's mechanical stops and the actuator's quadrature encoder.

To set up the actuator in this mode:

1. Make sure that the valve is mounted on the actuator with the stop pin all the way against the Position A stop. You can check by loosening the clamp ring and turning the valve counterclockwise by hand, then tightening the clamp ring. (For orientation, refer to the **Figure 8** at the bottom of the next page.) If it will not move, it was already against the stop.
2. Type **AM1**<enter> to set the actuator to Mode 1, Two Position With Stops.
3. Type **LRN**<enter>. The actuator will search for the valve stops, "learning" and recording the locations. When the process is completed, the valve is set to position A.

Mode 2: Two Position Without Stops

In this mode the actuator uses only the encoder to find the correct position. This mode is used for the Cheminert Model C32 valve and for custom applications involving on/off valves or any other two position valve that literally has no mechanical stops.



Note: Installing a valve with mechanical stops while in this mode could damage the actuator.

To set up the actuator in this mode:

1. Make sure that the valve is already mounted on the actuator.
2. Type **AM2**<enter> to set the actuator to Mode 2, Two Position without Stops.
3. Type **NPn**<enter>, where *n* is the number of ports the valve has. For example, **NP6**<enter> tells the actuator that the valve has 6 ports, so the actuator can calculate the appropriate number of degrees from position A to position B. In this example, that distance is 60 degrees (360 / 6 ports).

Mode 3: Multiposition

Select this mode for any Valco or Cheminert multiposition valve or selector with up to 32 positions. The actuator will use its encoder to calculate the proper rotation to find each position.



Note: Installing a valve with mechanical stops while in this mode could damage the actuator.

1. Make sure that the valve is already mounted on the actuator.
2. Type **AM3**<enter> to set the actuator to Mode 3, Multiposition.
3. Type **NPnn**<enter>, where *nn* is the number of positions the valve has (must be an even number between 2 and 40). For example, for a 10 position valve, type **NP10**<enter> to set the number of positions to 10.



Do not confuse the number of positions with the number of ports. Many multiposition valves have more than one port associated with each position.

4. Type **HM**<enter> to send the valve to its HOME position (position 1).

In this mode, counterclockwise moves the actuator in the “positive” direction—position 1 to position 2. The clockwise direction is “negative”, moving in the direction of position 2 to position 1.

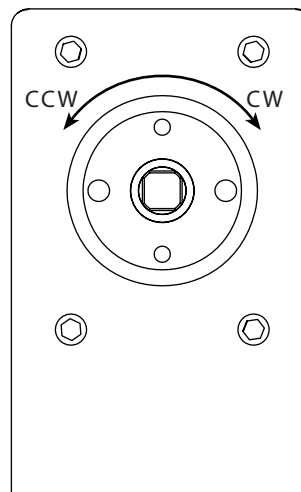


Figure 8: Actuator orientation

RS-485 Option

When the serial port configuration switch is set to the “485” position, the serial port output is changed to the RS-485 mode. If the actuator has had an ID set previously, that ID will be recalled and retained. Otherwise, the ID will be set to the factory default value of “Z”.

Note: All RS-485 communications use an ID and must be preceded with a '/':
i.e, **/ZVR**<enter>

Setting the Serial Port Configuration Switch

1. Remove the 4 screws from the front (valve side) of the actuator.
2. Carefully slide the assembly out of the enclosure. We recommend that the enclosure be opened in a static-free environment following all proper ESD protection techniques.
3. Locate the slide switch marked “232 <– –> 485”, and set it to 485.

Note: The switch labeled “Termination On <– –> Off” is typically left in the Off position. Unless the wiring from the host control to the device is very long and it is the last device at the end of a signal chain of devices, it is recommended that this switch is left in the Off position.

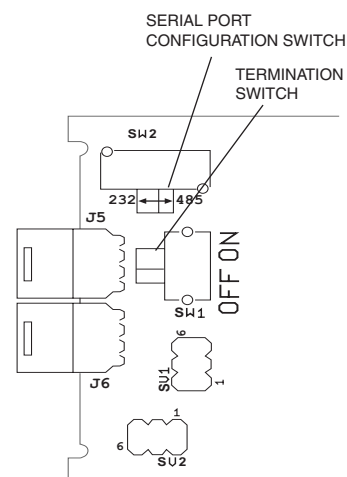


Figure 9: Serial port configuration switch

USB Option

The USB interface installs as a virtual COM port (VCP). The VCP driver causes the universal actuator to appear as an additional COM port available to the PC, so application software can access the actuator in the same way it accesses a standard COM port. Refer to “Appendix A: Installing USB Drivers”, on page 21.

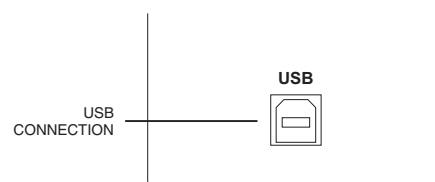


Figure 10: USB connector on rear panel

Serial Communication Protocol

Serial communication is based on an ASCII string protocol. Carriage Return (OD hex) and Line Feed (OA hex) characters parse the communications by defining the end of each command. A three-pin connector is used for the serial interface: pin assignments are indicated below. Software flow control (Xon/Xoff) and hardware handshaking are not supported. The table on the next page describes and explains all the commands available. A fuller explanation follows.

Pin #	RS-232	RS-485	DB9*
1	Ground	Ground	5
2	Transmit to host	B (+)	2
3	Receive from host	A (-)	3

*For VICI cable I-22697

Serial Commands		
Command	Modes*	Description
AM <enter>	1, 2, 3	Displays the current actuator mode
AM <i>n</i> <enter>	1, 2, 3	Sets the actuator mode to [1] two position with stops, [2] two position without stops, or [3] multiposition
CC <enter>	1, 2	Sends the actuator to Position B
CC <i>nn</i> <enter>	3	Sends the actuator counterclockwise to position <i>nn</i> (from 1 to NP)
CNT <enter>	1, 2, 3	Displays the current value in the actuation counter
CNT <i>nnnnn</i> <enter>	1, 2, 3	Sets the actuation counter from 0 to 65535. (For example, to reset the counter, type CNT0 <enter>)
CP <enter>	1, 2, 3	Displays the current position
CW <enter>	1, 2	Sends the actuator to Position A
CW <i>nn</i> <enter>	3	Sends the actuator clockwise to position <i>nn</i> (from 1 to NP)
DEL <i>n</i> <enter>	1, 2, 3	Sets the command delimiter to [1] CR (default), [2] LF, or [3] CRLF
DT <enter>	1, 2	Displays the current delay time in milliseconds
DT <i>nnnnn</i> <enter>	1, 2	Sets the delay time from 0 to 65,000 milliseconds
GO <i>nn</i> <enter>	1, 2	Sends the actuator to position <i>n</i> , where <i>n</i> is A or B
	3	Sends the actuator to position <i>nn</i> (from 1 to NP) via the shortest route
HM <enter>	3	Moves the valve to position 1 (home)
ID / <enter>	1, 2, 3	Sets the ID of the actuator to / (Must be 0-9 or A-Z)
ID <enter>	1, 2, 3	Resets the ID to None
IFM <i>n</i> <enter>	1, 2, 3	Sets the interface response mode to [0] no response string when an action command is sent, [1] basic response to action commands, or [2] extended response to action commands (needed for BCD interface)
LG <i>n</i> <enter>	1, 2, 3	Sets the interface response mode to [0] no extra characters, or [1] longer response string to be fully backwards compatible with VICI microelectric actuators
LRN <enter>	1	Forces the actuator to find the stops on a newly installed valve. (Note: The valve must be installed before this command is sent.)
NP <enter>	1, 2, 3	Displays the number of positions the actuator is currently set to index
NP <i>nn</i> <enter>	2	Sets the number of ports (<i>nn</i>) for the current valve. (Must be an even number between 2 and 40)
	3	Sets the number of positions (<i>nn</i>) for the current valve. (Must be an even number between 2 and 40)
SB <enter>	1, 2, 3	Displays the current baud rate
SB <i>nnnn</i> <enter>	1, 2, 3	Sets the baud rate to 48(00), 96(00), 192(00), 384(00), 576(00), or 1152(00). The parity setting, number of data bits, and number of stop bits cannot be changed.
SM <enter>	3	Displays the current default rotational direction
SM / <enter>	3	Sets the default rotational direction to [F] for forward rotation, [R] for reverse rotation, or [A] to automatically choose the shortest route.
SO <enter>	1, 2, 3	Displays the current offset value
SO <i>nn</i> <enter>	1, 2, 3	Sets the offset value of the first position to be any number from 1 to 96 minus the total number of positions. Example: for a 10 position valve, the offset can be set from 1 to 86.
STAT <enter>	1, 2, 3	Displays the status of the actuator
TM <enter>	1, 2, 3	Displays the amount of time required for the previous move, in milliseconds
TO <enter>	1, 2	Toggles the actuator to the opposite position
TT <enter>	1, 2	Toggles the actuator to the opposite position, waits a preset delay time, then rotates back to the original position.
VR <i>n</i> <enter>	1, 2, 3	Displays the current firmware version for [NULL], the main PCB, or [2] the serial interface PCB.
/? <enter>	1, 2, 3	Displays a list of valid commands

* Modes are described on pages 4-5.

Notes

Command Reference

- AM**[*n*] Sets the actuator mode or displays the current mode,
 where *n* = 1 = two position with stops (factory default)
 2 = two position without stops
 3 = multiposition
 NULL = returns (via the serial port) the current mode
- Modes available: All (modes are discussed on pages 3 and 4)
- Examples**
 Command: **AM1**<enter>
 Sets the actuator mode to two position with stops
- Command: **AM**<enter>
 Returns: **AMn** [0x0D] (*n* = current mode setting)
- CC**[*nn*] Moves the actuator in a counterclockwise direction,
 where *nn* = 1 to NP (See also **NP** command)
- Modes available: All (with restrictions – in two position modes, *nn* is not allowed)
- Examples** (multiposition, mode 3)
 Command: **CC3**<enter>
 Moves the actuator counterclockwise to position 3
- Command: **CC**<enter>
 Moves the actuator counterclockwise one position
- Example** (two position, modes 1 and 2)
 Command: **CC**<Enter>
 Moves the actuator from position A to position B. If the actuator
 is already in Position B, the command is ignored.
- CNT**[*nnnnn*] Displays the current number of actuation cycles, or resets the counter to zero,
 where *nnnnn* = 0 to 65535
- Modes available: All
- In two position modes (1 and 2), the counter is incremented every time the valve moves.
 In the multiposition mode (3), the counter is incremented by the number of positions the
 valve moves; *i.e.*, moving from position 2 to position 4 increments the cycle count by 2.
- Examples**
 Command: **CNT**<enter>
 Returns: **CNTnnnnn** [0x0D] (*nnnnn* = current valve of counter)
- Command: **CNT0**<enter>
 Resets the cycle counter to 0 (zero)
- Command: **CNT100**<enter>
 Sets the cycle counter to 100
- CP** Displays the current position of the actuator
- Modes available: All (see below)
- Example** (two position, modes 1 and 2)
 Command: **CP**<enter>
 Returns: **CP** [0x0D] (*n* = 'A' or 'B') (*l* = current position)
- Example** (multiposition, mode 3)
 Command: **CP**<enter>
 Returns: **CPnn** [0x0D] (*nn* = current position)

- CW**[*nn*] Moves the actuator in a clockwise direction, where *nn* = 1 to NP (see also **NP** command)
- Modes available: All (with restrictions – in two position modes, *nn* is not allowed)
- Examples** (multiposition, mode 3)
- Command: **CW**<enter>
Moves the actuator clockwise one position
- Command: **CW3**<enter>
Moves the actuator clockwise position 3
- Example** (two position, modes 1 and 2)
- Command: **CW**<Enter>
Moves the actuator from position B to position A. If the actuator is already in Position A, the command is ignored.
- DT**[*nnnn*] Sets a delay interval before the actuator automatically returns to its previous position, where *nnnn* = 0 – 65535 (milliseconds) (See also **TT** command)
- Modes available: Two position (1 and 2)
- Examples**
- Command: **DT**<enter>
Returns **DTnnnn** [0x0D] (*nnnn* = current delay setting)
- Command: **DT0**<enter>
Sets the delay time to 0 and disables the TT command
- Command: **DT1000**<enter>
Sets the delay timer to 1000 milliseconds (1 second)
- GO**[*nn*] Tells the actuator to go to position *nn*,
Where *nn* = 1 to NP (multiposition, mode 3)
= 'A' or 'B' (two position, modes 1 and 2)
(See also **NP** and **SM** commands)
- Modes available: All (see below)
- Examples** (two position, modes 1 and 2)
- Command: **GO**<enter>
Toggles the actuator to the other position
- Command: **GOB**<enter>
Moves the actuator from position A to position B
- Examples** (multiposition, mode 3)
- Command: **GO**<enter>
Advances the actuator to the next position
- Command: **GO3**<enter>
Moves the actuator to position 3 in the direction set by the SM command
- HM** Moves the actuator to position 1. If the actuator is already in position 1, the command is ignored.
- Modes available: Multiposition (3)
- Example**
- Command: **HM**<enter>
Moves the actuator from the current position to position 1

If an actuator set to F (forward direction) is in position 4 and the command is sent to go to position 3, it will go all the way around until it reaches position 3 instead of taking one step backwards. For the actuator to calculate the direction which involves the least movement, the direction must be set to A (shortest route).

Modes available: Multiposition (3)

Examples

Command: **SM**<enter>
Returns: **SM** [0x0D] (*I* = current rotation direction)

Command: **SMF**<enter>
Sets the actuator to only move in the forward direction

SO[*nn*] Sets the offset value of the first position to be any number from 1 – 96, where *nn* = 1 – 96.

This feature makes it possible to control more than one actuator with a single computer. The actuator's SO value can be set from "1" to "96", minus the current NP value (the number of positions the actuator is set to index). Once an SO value is set, that value is the first (or lowest) position an actuator will recognize. The factory SO setting is "1", so an actuator with an NP value of 10 responds to move commands for positions "1" to "10". If the SO value is changed to "10", the actuator will respond only to move commands for positions "10" through "19". For any setting of SO and NP, the lowest valid position will be the SO value and the highest valid position will be the SO value plus the NP value minus 1; i.e., the actuator will respond to commands for position SO through position {SO + NP - 1}. Refer to "Using the Offset Feature" on page 19.

Modes available: All (but used primarily in mode 3, multiposition)

Examples

Command: **SO**<enter>
Returns: **SO***nn* [0x0D] (*nn* = current offset value)

Command: **SO10**<enter>
Sets the offset value to 10. The valve will now start counting as if 10 = position 1

STAT Returns (via the serial port) the following information,
CP = current position
AM = current mode
NP = number of ports (modes 1 and 2) or positions (mode 3) on the current valve

(See also **CP**, **AM**, and **NP** commands)

Modes available: All

Example

Command: **STAT**<enter>
Returns: Current status of the actuator

TM Returns the amount of time, in milliseconds, required by the previous move

Modes available: All

Example

Command: **TM**<enter>
Returns: Number of milliseconds taken to move from the previous position to the current position

- TO** Toggles the actuator to the opposite position from its current position; *i.e.*, if the actuator is currently in Position B, it will toggle to Position A.
- Modes available: Two position (1 and 2)
- Example**
 Command: **TO**<enter>
 Causes the actuator to toggle from one position to the other
- TT** Timed toggle: the actuator will toggle from its current position to the opposite, wait for a programmed amount of time, then toggle back to its original position.
 Note: This command is ignored if DT=0. (See also **DT** command)
- Modes available: Two position (1 and 2)
- Example**
 Command: **TT**<enter>
 The actuator will initiate the timed toggle procedure
- VR_n** Reports the current firmware version,
 where $n = [\text{null}]$ for the main PCB, or $n = 2$ for the serial interface PCB.
- Modes available: All
- Examples**
 Command: **VR**<enter>
 Returns: Current revision of the main PCB firmware
- Command: **VR2**<enter>
 Returns: Current revision of the serial PCB firmware
- /?** Displays the list of the primary commands for the actuator. The list is similar to the serial command table above but is not inclusive of all the commands.
- Modes available: All
- Example**
 Command: **/?**<enter>
 Returns: The list of commands for the actuator

Optional BCD Interface

Hardware Input / Output Protocols

The digital interface is made through a 26 pin connector which also provides power (+5 volts/100 ma maximum) and ground outputs. The ground should be connected to the control system to maintain commonality between the actuator and the controlling device. If you intend to provide your own power supply, make sure that it has an isolated output or that it shares a common ground with the controlling system.

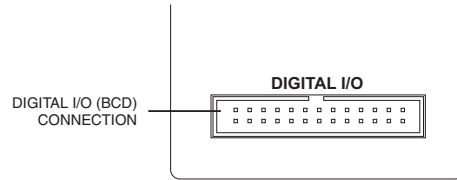


Figure 11: Digital I/O connector on rear panel

Digital input/output control of the actuator is designed for simplicity and flexibility of function. The simplest control of the actuator can be accomplished in modes 1 and 2 with a single control line for the STEP function. Mode 3 requires only two output control lines – STEP and HOME. The chart on the next page lists other control options.

The inputs are held to a logical high (+5 volts) by pull-up resistors, and are designed to be driven low either by contact closure, 5 volt digital logic, or open collector transistor outputs. The signal polarity is defined as “negative true” – asserting the signal involves shorting the signal (in the case of contact closure) or driving it (in the case of logic or transistor signals) to within 0.8 volts of ground potential. These input signals must be at least 30 milliseconds in duration.

The outputs are also “negative true” signals driven by standard high speed CMOS gates, capable of driving standard logic input gates. They include the BCD position, motor run, rotational direction, and error signals. If the actuator stops out of position due to a stuck valve, the BCD output is set to “0” (all lines high for a negative true output).

Digital Input Protocols

The input modes are selected during factory setup/programming.

Binary Coded Decimal (BCD) input mode (default)

For the 96 possible input positions, all 8 digital input data lines are required. Refer to the chart on the next page for the signal line definitions.

Parallel Input Mode

In this mode, the data input lines are redefined so that each input line equates to only one actuator position; any and all combinations of data input lines are invalid. This mode can support only 8 positions: 1 BCD = position 1; 2 BCD = position 2; 4 BCD = position 3; 8 BCD = position 4; 10 BCD = position 5; 20 BCD = position 6; 40 BCD = position 7; and 80 BCD = position 8. The offset value SO is set to 1, and since the number of positions is limited to 8, any user-set NP value greater than 8 will revert to 8. (See the chart on the next page for more explanation of NP and SO.)

Binary Input Mode

This mode allows up to 128 possible input positions. All 8 digital input data lines are required. Refer to the chart on the next page for the signal line definitions.

Pin	Color	Signal	Direction	Pin	Color	Signal	Direction
1	brown	Home	Input	14	yellow	4 BCD	Output
2	red	Motor run	Output	15	green	20 BCD	Output
3	orange	Step	Input	16	blue	2 BCD	Output
4	yellow	Error	Output	17	violet	10 BCD	Output
5	green	Manual Dir.	Input	18	gray	1 BCD	Output
6	blue	Direction	Output	19	white	80 BCD	Input
7	violet	Auto Dir.	Input	20	black	8 BCD	Input
8	gray	Data latch	Input	21	brown	40 BCD	Input
9	white	+5 VDC 100 ma	Output	22	red	4 BCD	Input
10	black	Ground	Output	23	orange	20 BCD	Input
11	brown	80 BCD	Output	24	yellow	2 BCD	Input
12	red	8 BCD	Output	25	green	10 BCD	Input
13	orange	40 BCD	Output	26	blue	1 BCD	Input

Pin signal definitions for the Digital Input/Output cable

Mode:	SD0	SD2	SD3	Data Input Lines							
Input type:	BCD	Parallel	Binary	1 BCD	2 BCD	4 BCD	8 BCD	10 BCD	20 BCD	40 BCD	80 BCD
Position:	1	1	1	X	—	—	—	—	—	—	—
	2	2	2	—	X	—	—	—	—	—	—
	3	*	3	X	X	—	—	—	—	—	—
	4	3	4	—	—	X	—	—	—	—	—
	5	*	5	X	—	X	—	—	—	—	—
	6	*	6	—	X	X	—	—	—	—	—
	7	*	7	X	X	X	—	—	—	—	—
	8	4	8	—	—	—	X	—	—	—	—
	9	*	9	X	—	—	X	—	—	—	—
	*	*	10	—	X	—	X	—	—	—	—
	*	*	11	X	X	—	X	—	—	—	—
	*	*	12	—	—	X	X	—	—	—	—
	*	*	13	X	—	X	X	—	—	—	—
	*	*	14	—	X	X	X	—	—	—	—
	*	*	15	X	X	X	X	—	—	—	—
	10	5	16	—	—	—	—	X	—	—	—
	11	*	17	X	—	—	—	X	—	—	—
	12	*	18	—	X	—	—	X	—	—	—
	13	*	19	X	X	—	—	X	—	—	—
	14	*	20	—	—	X	—	X	—	—	—
	15	*	21	X	—	X	—	X	—	—	—
	16	*	22	—	X	X	—	X	—	—	—
	17	*	23	X	X	X	—	X	—	—	—
	18	*	24	—	—	—	X	X	—	—	—
	19	*	25	X	—	—	X	X	—	—	—
	*	*	26	—	X	—	X	X	—	—	—
	*	*	27	X	X	—	X	X	—	—	—
	*	*	28	—	—	X	X	X	—	—	—
	*	*	29	X	—	X	X	X	—	—	—
	*	*	30	—	X	X	X	X	—	—	—
	*	*	31	X	X	X	X	X	—	—	—
	20	6	32	—	—	—	—	—	X	—	—
	Code sequence break										
	40	7	64	—	—	—	—	—	—	X	—
	Code sequence break										
	80	8	128	—	—	—	—	—	—	—	X

Pin signal definitions for the various input modes

Additional Digital Input and Output Signals

Data Latch *(input)*

Toggling this signal from high to low (hold the signal low for a minimum of 5 ms) will cause the actuator to read the BCD Input signals. Once the signals are read, the actuator will then attempt to move to the position indicated on the BCD Input signals.

BCD Signals *(output)*

These represent the current position data in the same format used as the Input protocol.

Note: The BCD Output Signals are only updated after the motor has finished moving (see **Motor Run** below) and if there is no error (see **Error** below).

Step *(input)*

Toggling this line from high to low (hold the signal low for a minimum of 5 ms) causes the actuator to advance one position.

Home *(input)*

Toggling this line from high to low (hold the signal low for a minimum of 5 ms) moves the actuator to the Home (or first) position.

Manual Direction *(input)*

When the signal is high, the actuator will move in a forward direction. For example, when moving from position 3 to position 4, it will move the shortest distance between the two positions. When the signal is low the actuator will move in a reverse direction; when moving from position 3 to position 4, it will move the longest distance between the two positions.

Auto Direction *(input)*

When the signal is high, the Manual Direction signal dictates how the actuator moves to different positions. When the signal is low, the actuator will calculate the shortest direction between two positions and move in that direction.

Motor Run *(output)*

When the signal is high, the motor is in an Off state. When the signal is low, the motor is in an On state (moving).

Error *(output)*

When the signal is low, the actuator encountered an error with the last move request. When the signal is high, no error was detected.

Notes:

The system considers a move request for the current position to be an error, since the motor does not move.

Error signals are cleared after the next successful move.

Direction *(output)* – Factory test output.

Using the Offset Feature

This feature makes it possible to control more than one actuator without increasing the number of BCD or serial input lines. The actuator's SO value can be set from "1" to "96", minus the current NP value (the number of positions the actuator is set to index). Once an SO value is set, that value is the first (or lowest) position an actuator will recognize. The factory SO setting is "1", so an actuator with an NP value of 10 responds to move commands for positions "1" to "10". If the SO value is changed to "10", the actuator will respond only to move commands for positions "10" through "19". For any setting of SO and NP, the lowest valid position will be the SO value and the highest valid position will be the SO value plus the NP value minus 1; i.e., the actuator will respond to commands for position SO through position {SO + NP - 1}.

The examples below describe a system that will step sequentially from 1 through 31 with a single instruction. However, note that when positions are selected in a random sequence, position 16 must always be requested before any positions higher than 16 are selected. **Figure 12** helps illustrate this: since both actuators respond to a command to go to position 16, stream 16 will flow through valve 1/port 1, out the common port of valve 2, into valve 1/port 16, and out of the common port of valve 1. Thereafter, any stream select command that is above 16 will move only valve 2; when a move command for a position less than 16 is given, valve 1 will move and cut off all flow from valve 2.

With BCD Control

Here is how this can be feature can be used to set up a 31-stream stream selection system using six dedicated BCD lines and two 16-position valves and actuators. Refer to "Using the Manual Remote to Configure the Actuator" on page 3 as required.

1. Use the manual remote to enable the auto-latching feature on both actuators. This eliminates the need for a data latch signal.
2. Use the manual remote to assign the second actuator an offset value of "16", giving it a valid position range of 16 to 31.
3. Use a piece of tubing to connect port 16 of the first valve (on the actuator still carrying the factory-default offset value of "1") to the common port of the valve on the second actuator (which now has an offset value of "16").
4. Connect streams 1 through 15 to ports 1 through 15 on the first valve, and streams 16 through 31 to ports 1 through 15 on the second valve.

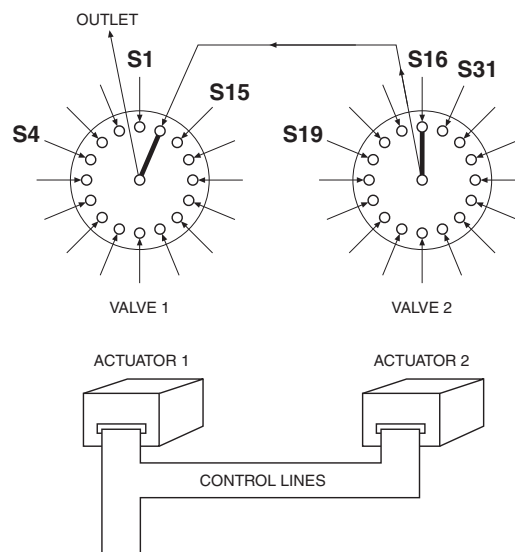


Figure 12: Using the Offset feature

With Serial Control

Here is how this can be feature can be used to set up a 31-stream stream selection system using two 16-position valves and two actuators serially daisy-chained together. Refer to the chapter entitled "Optional Serial Interface" (beginning on page 6) as required.

1. Configure the second actuator using the command **SO16**, giving it a valid position range of 16 to 31.
2. Use a piece of tubing to connect port 16 of the first valve (on the actuator still carrying the factory-default offset valve of "1") to the common port of the valve on the second actuator (which now has an offset value of "16").
3. Connect streams 1 through 15 to ports 1 through 15 on the first valve, and streams 16 through 31 to ports 1 through 15 on the second valve.

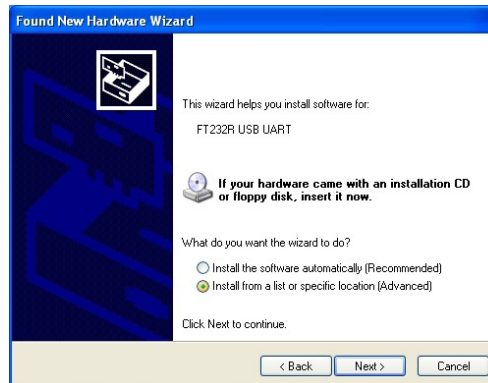
Appendix 1: Installing USB Drivers

Windows XP

1. Connect the actuator to a USB port on your PC. The Found New Hardware Wizard will pop up on your screen.



2. Select "Install from a list or specific location (Advanced)" as shown below. Click Next to continue.



3. Select "Search for the best driver in these locations" and enter the file path in the combo box or browse to it by clicking the browse button. Once the file path has been entered in the box, click Next to proceed.



4. When Windows XP has found the required files, the screen below will be displayed while the files are being copied.



5. Windows should then display a message indicating that the installation was successful. Click Finish to complete the first part of the installation.



6. The Found New Hardware Wizard will launch automatically to install the COM port emulation drivers. As above, select "No, not at this time" from the options, then click Next to proceed.



7. Repeat steps 2 - 6 to install the COM port emulation drivers.

Warranty

This Limited Warranty gives the Buyer specific legal rights, and a Buyer may also have other rights that vary from state to state. For a period of 90 calendar days from the date of shipment, VICI Metronics Inc. (hereinafter Seller) warrants the goods to be free from defect in material and workmanship to the original purchaser. During the warranty period, Seller agrees to repair or replace at Seller's option defective and/or non-conforming goods or parts (exclusions noted below) without charge for material or labor, subject to inspection FOB VICI Metronics Inc. factory. Buyer's exclusive remedy is repair or replacement of defective and nonconforming goods.

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- damage due to improper use
- damage due to modifications or alterations
- damage due to improper maintenance.

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This Limited Warranty supercedes all prior proposals or representations oral or written and constitutes the entire understanding regarding the warranties made by Seller to Buyer. This Limited Warranty may not be expanded or modified except in writing signed by the parties hereto.

Valco Instruments Co. Inc.

VICI

**Universal Electric
Actuator
Instruction Manual
Models EUH, EUD, and EUT**

Rev 2/13

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Introduction

Description

The VICI universal actuator models are designed to work with both two position and multiposition valves, with any number of ports. This is accomplished through simple programming via the manual remote or the optional serial, BCD, or USB interface. The actuator consists of a single unit housing a stepper motor/gearbox assembly and the control components, a universal AC input (100-240 VAC, 50-60 Hz) to 24 VDC power supply, a manual remote, and the interconnecting cables.

Getting Started

Mounting

The actuator should be oriented so that any potential leakage of liquid from the valve or fittings flows away from rather than into the actuator.

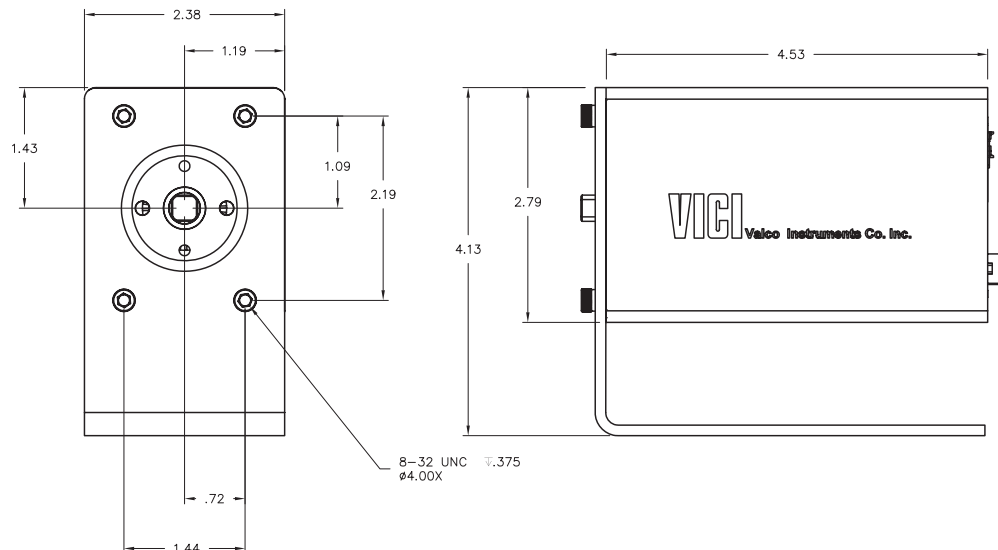


Figure 1: Universal actuator mounting dimensions

Power Connector

Input power (24-28 VDC) is supplied through a coaxial connector: the inner pin is + voltage and the outer pin is ground. The average current requirement is 2.1 amps; standby current draw is 60 milliamps.

The actuator should not share a power supply with other noise-sensitive electronics, as the high current draw could cause problems.

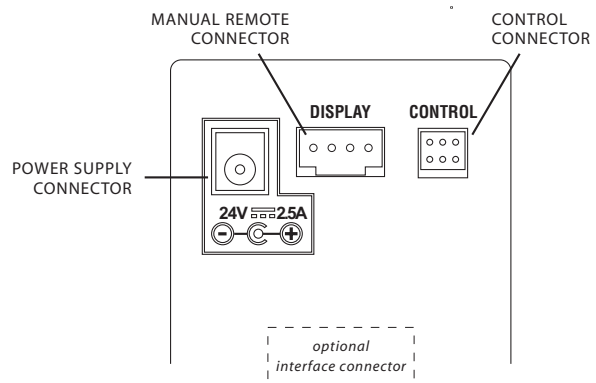


Figure 2: Connections on rear panel

Basic Operation of the Manual Remote

The manual remote provides simple valve positioning capabilities, but in the configuration mode, it can be used to perform extensive actuator setup functions. For information on using the manual remote to configure the actuator, refer to "Using the Manual Remote to Configure the Actuator" beginning on the next page.

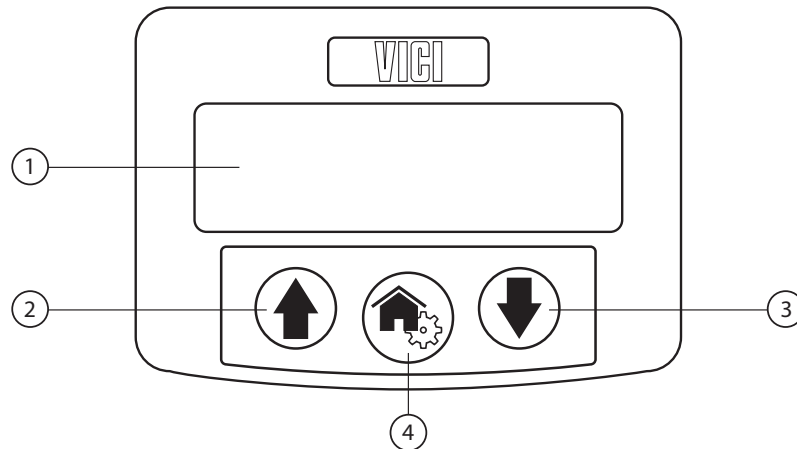


Figure 3: Universal actuator manual remote

1. Display

2. **UP** arrow button

In *two position* configuration, pressing the UP arrow button moves the actuator to Position B. If it is already in Position B, nothing happens.

In *multiposition* configuration, pressing the UP arrow button advances the actuator one position; i.e., from 1 to 2, 4 to 5, etc.

3. **DOWN** arrow button

In *two position* configuration, pressing the DOWN arrow button moves the actuator to Position A. If it is already in Position A, nothing happens.

In *multiposition* configuration, pressing the DOWN arrow button reverses the actuator one position; i.e., from 2 to 1, 5 to 4, etc.

4. **HOME/SETUP** button

In *two position* configuration, pressing the HOME button moves the actuator to Position A. If it is already in Position A, nothing happens.

In *multiposition* configuration, pressing the HOME button sends the actuator to Position 1.

In either configuration, pressing and holding the HOME button for 5 seconds sends the manual remote into the configuration mode. Refer to "Using the Manual Remote to Configure the Actuator" beginning on the next page.

Using the Manual Remote to Configure the Actuator

In the absence of an optional RS-232, USB, or serial interface, the manual remote can be used to perform extensive actuator setup functions.

Accessing the Configuration Mode

To access the configuration mode, press and hold the HOME/SETUP button for 5 seconds.

Button Functions

- When a screen appears, a line will be highlighted. Use the UP and DOWN arrow keys to highlight a different line.
- When the desired line is highlighted, press the HOME/SETUP button to enter that value.
- For parameters such as number of ports or positions, use the arrow keys to toggle up and down to the desired value, which is then entered by pressing the HOME/SETUP button.
- Only two menus—the Interface Setup and Baudrate—have more than three options. Use the arrow keys to scroll down to additional screens to select the desired value or parameter.
- The UP arrow key also functions as a back button.

A complete menu tree appears on the next page.

Examples

To configure the actuator for a 10 position multiposition valve:

1. On the main menu, use the arrow buttons to highlight Valve Setup. Press the HOME/SETUP button.
2. Use the DOWN arrow button to highlight Multiposition. Press the HOME/SETUP button.
3. Use the UP and DOWN arrow buttons to move through the numbers until 10 is showing. Press the HOME/SETUP button.

Main Menu	
1. Valve Setup	
2. Interface Setup	
3. Information	

Valve Menu	
1. Two position	
2. Multiposition	
3. Move Direction	

Set positions:	
10	

In the multiposition mode, “counterclockwise” means that the actuator moves in the “positive” direction—position 1 to position 2. The clockwise direction is “negative”, moving in the direction of position 2 to position 1.

To set our just-configured 10 position actuator to move in a clockwise direction:

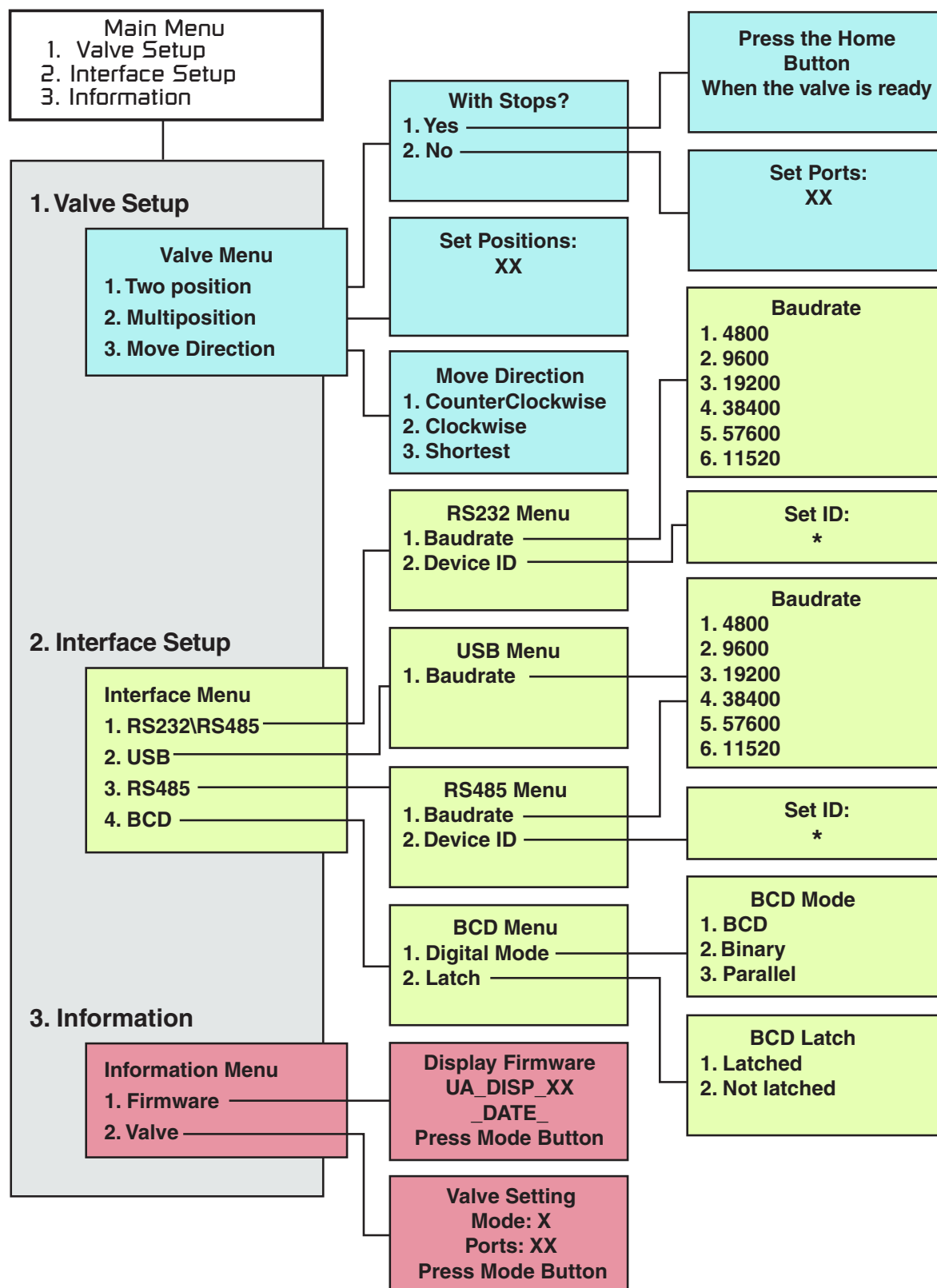
1. On the main menu, use the arrow buttons to highlight Valve Setup. Press the HOME/SETUP button.
2. Use the DOWN arrow button to highlight Move Direction. Press the HOME/SETUP button.
3. Use the DOWN arrow button to highlight Clockwise. Press the HOME/SETUP button.

Main Menu	
1. Valve Setup	
2. Interface Setup	
3. Information	

Valve Menu	
1. Two position	
2. Multiposition	
3. Move Direction	

Move Direction	
1. CounterClockwise	
2. Clockwise	
3. Shortest	

Menu Tree



Basic Control Functions with the Standard Interface

Basic actuator control functionality facilitates position switching in two position modes, and step and home functions in the multiposition mode. This is done via direct input signals from switch closures, relay contacts, or TTL-compatible interfaces. The control cable has six pins: however, only five are used.

If the actuator has none of the optional interfaces, the manual remote must be used to change the mode, direction of rotation, or number of positions. Refer to "Using the Manual Remote to Configure the Actuator" on page 3.

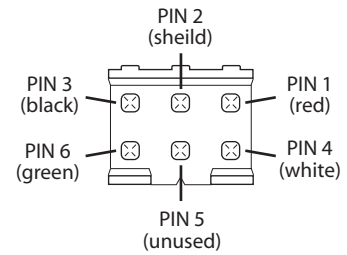


Figure 4:
Standard interface connector
(colors reference cable I-25176)

Two position modes

Pins 4 and 6 are digital inputs for switching to Position A and Position B. They can be driven either by 5 volt TTL/CMOS logic or by contact closure to ground (pin 2). In other words, applying a connection (20 msec minimum) between the "A contact" and common moves the injector to position A (inject). The injector does not move when the connection is released. Likewise, providing a contact between the "B contact" and common moves the injector to the B (load) position. Connections must be released before the opposite closure can be applied.

Position feedback is obtained from the A and B outputs. These are 5 volt tolerant, 3.3 volt logic outputs, sourcing and sinking a maximum of 10 milliamperes each. An output will go high (+3.3V) when the valve reaches the respective position.

Pin #	Function
1	A output (3.3 VDC)
2	Common
3	B output (3.3 VDC)
4	A contact
5	Unused
6	B contact

Figure 5: Two position pin assignments

Multiposition mode

Step Command

Applying a connection (20 msec minimum) between the common and "Step" pin causes the actuator to move to the next position in the currently-set direction of rotation. The connection must be opened before another step can be made.

Home Command

Applying a connection between the common and "Home" pins causes the actuator to go to the HOME position (position 1), moving in the currently-set direction of rotation. The connection must be opened before another step can be made.

Pin #	Function
1	Unused
2	Common
3	Unused
4	Home
5	Unused
6	Step

Figure 6: Multiposition pin assignments

Optional Serial Interface

Note: Serial versions of the actuator are set up for RS-232 as the factory default. For information on RS-485 operation, refer to “Serial Control: RS-485 Option” on page 9.

Establishing Serial Communication

Serial communication requires a terminal emulation or communication software (such as HyperTerminal®, included with Windows®) running on a PC-compatible computer. Set the serial port at 9600 baud, no parity, 8 data bits, 1 stop bit, no hardware or software handshaking.

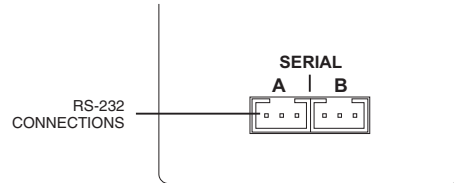


Figure 7: Serial connectors on rear panel

With the software running, check the bi-directional communication link between the keyboard/monitor of the computer and the serial port by typing `/?`<enter>. If the link is functioning, the following menu will appear on your monitor:

Control Command List

GO[nn]	- Move to nn position
HM	- Move to the first Position
CW[nn]	- Move Clockwise to nn Position
CC[nn]	- Move Counter Clockwise to nn Position
TO	- Toggle Position to Opposite
TT	- Timed Toggle
DT[nnnnn]	- Set Delay time for TT Command
CP	- Returns Current Position
AM[n]	- Sets the Actuator Mode [1] Two Position With Stops, [2] Two Position Without Stops, [3] Multi Position
SB[nnnnn]	- Set the Baud Rate to nnnnn
ID[nn]	- Set Device ID nn=(0-9, A-Z)
ID	- Reset ID to none
NP[nn]	- Set the Number of Positions to nn
SM[n]	- Set the Direction [F]orward, [R]everse, [A]uto
LRN	- Learn Stops Location
CNT[nnnnn]	- Set Cycle Counter
VR	- Firmware Version(s)
/?	- Displays This List

Using the Device ID Feature

Actuators are shipped from the factory in the RS-232 mode, with the ID feature disabled. When an ID is set, the actuator responds only to commands which begin with the correct ID prefix, and its transmit output is disabled when not in use. This allows up to 10 actuators to be controlled from one computer RS-232 port. A single command can be broadcast to all actuators by using an asterisk (*) as the command prefix. NOTE: Any broadcast command which elicits a response from the serial port (such as *VR or *ID) will elicit a combined and unintelligible response.

For permanent multidrop applications, the RS-485 mode (page 6) is the preferred solution. However, just as RS-232 control requires the host to have an RS-232 serial port, the PC host or control system must have an RS-485 port to communicate with the actuator in the RS-485 mode. Plug-in PCI cards with RS-485 ports or adaptors that change an RS-232 signal to an RS-485 signal are available from several common electronic manufacturers. If your computer lacks a serial port, adaptors which convert USB ports to RS-232 or to RS-485 are also readily available.



Caution: When installing or replacing actuators on a shared serial port, make sure that no two devices have been set to the same ID number.

1. Remove all of the actuators from the serial daisy chain except the one for which you are setting the ID.
2. To *set* an ID, type **IDn**<enter>, where *n* is the new ID, from 0 to 9 or A to Z.
To *change* an ID, type **iIDn**<enter>, where *i* is the current ID and *n* is the new ID.
To *disable* the ID feature, type **iID***<enter>, where *i* is the current ID.

Setting the Operation Mode

This section employs some simple serial commands to complete a basic configuration of the valve/actuator combination. A more advanced discussion of serial control begins in the next section.

Mode 1: Two Position With Stops (factory default)

This is the proper mode for most two position applications. (*Note exceptions in the next section.*) In this mode, the actuator automatically finds the correct positions using a combination of the valve's mechanical stops and the actuator's quadrature encoder.

To set up the actuator in this mode:

1. Make sure that the valve is mounted on the actuator with the stop pin all the way against the Position A stop. You can check by loosening the clamp ring and turning the valve counterclockwise by hand, then tightening the clamp ring. (For orientation, refer to the **Figure 8** at the bottom of the next page.) If it will not move, it was already against the stop.
2. Type **AM1**<enter> to set the actuator to Mode 1, Two Position With Stops.
3. Type **LRN**<enter>. The actuator will search for the valve stops, "learning" and recording the locations. When the process is completed, the valve is set to position A.

Mode 2: Two Position Without Stops

In this mode the actuator uses only the encoder to find the correct position. This mode is used for the Cheminert Model C32 valve and for custom applications involving on/off valves or any other two position valve that literally has no mechanical stops.



Note: Installing a valve with mechanical stops while in this mode could damage the actuator.

To set up the actuator in this mode:

1. Make sure that the valve is already mounted on the actuator.
2. Type **AM2**<enter> to set the actuator to Mode 2, Two Position without Stops.
3. Type **NPn**<enter>, where *n* is the number of ports the valve has. For example, **NP6**<enter> tells the actuator that the valve has 6 ports, so the actuator can calculate the appropriate number of degrees from position A to position B. In this example, that distance is 60 degrees (360 / 6 ports).

Mode 3: Multiposition

Select this mode for any Valco or Cheminert multiposition valve or selector with up to 32 positions. The actuator will use its encoder to calculate the proper rotation to find each position.



Note: Installing a valve with mechanical stops while in this mode could damage the actuator.

1. Make sure that the valve is already mounted on the actuator.
2. Type **AM3**<enter> to set the actuator to Mode 3, Multiposition.
3. Type **NPnn**<enter>, where *nn* is the number of positions the valve has (must be an even number between 2 and 40). For example, for a 10 position valve, type **NP10**<enter> to set the number of positions to 10.



Do not confuse the number of positions with the number of ports. Many multiposition valves have more than one port associated with each position.

4. Type **HM**<enter> to send the valve to its HOME position (position 1).

In this mode, counterclockwise moves the actuator in the “positive” direction—position 1 to position 2. The clockwise direction is “negative”, moving in the direction of position 2 to position 1.

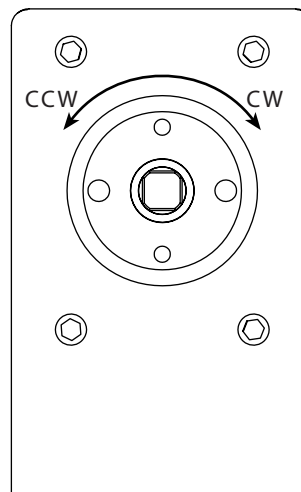


Figure 8: Actuator orientation

RS-485 Option

When the serial port configuration switch is set to the “485” position, the serial port output is changed to the RS-485 mode. If the actuator has had an ID set previously, that ID will be recalled and retained. Otherwise, the ID will be set to the factory default value of “Z”.

Note: All RS-485 communications use an ID and must be preceded with a ‘/’:
i.e, **/ZVR**<enter>

Setting the Serial Port Configuration Switch

1. Remove the 4 screws from the front (valve side) of the actuator.
2. Carefully slide the assembly out of the enclosure. We recommend that the enclosure be opened in a static-free environment following all proper ESD protection techniques.
3. Locate the slide switch marked “232 <– –> 485”, and set it to 485.

Note: The switch labeled “Termination On <– –> Off” is typically left in the Off position. Unless the wiring from the host control to the device is very long and it is the last device at the end of a signal chain of devices, it is recommended that this switch is left in the Off position.

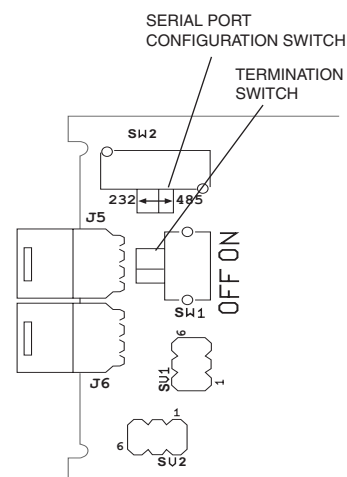


Figure 9: Serial port configuration switch

USB Option

The USB interface installs as a virtual COM port (VCP). The VCP driver causes the universal actuator to appear as an additional COM port available to the PC, so application software can access the actuator in the same way it accesses a standard COM port. Refer to “Appendix A: Installing USB Drivers”, on page 21.

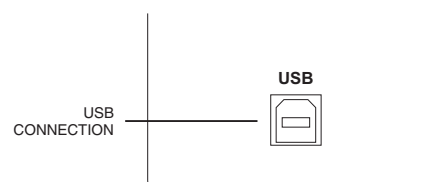


Figure 10: USB connector on rear panel

Serial Communication Protocol

Serial communication is based on an ASCII string protocol. Carriage Return (OD hex) and Line Feed (OA hex) characters parse the communications by defining the end of each command. A three-pin connector is used for the serial interface: pin assignments are indicated below. Software flow control (Xon/Xoff) and hardware handshaking are not supported. The table on the next page describes and explains all the commands available. A fuller explanation follows.

Pin #	RS-232	RS-485	DB9*
1	Ground	Ground	5
2	Transmit to host	B (+)	2
3	Receive from host	A (-)	3

*For VICI cable I-22697

Serial Commands		
Command	Modes*	Description
AM <enter>	1, 2, 3	Displays the current actuator mode
AM <i>n</i> <enter>	1, 2, 3	Sets the actuator mode to [1] two position with stops, [2] two position without stops, or [3] multiposition
CC <enter>	1, 2	Sends the actuator to Position B
CC <i>nn</i> <enter>	3	Sends the actuator counterclockwise to position <i>nn</i> (from 1 to NP)
CNT <enter>	1, 2, 3	Displays the current value in the actuation counter
CNT <i>nnnnn</i> <enter>	1, 2, 3	Sets the actuation counter from 0 to 65535. (For example, to reset the counter, type CNT0 <enter>)
CP <enter>	1, 2, 3	Displays the current position
CW <enter>	1, 2	Sends the actuator to Position A
CW <i>nn</i> <enter>	3	Sends the actuator clockwise to position <i>nn</i> (from 1 to NP)
DEL <i>n</i> <enter>	1, 2, 3	Sets the command delimiter to [1] CR (default), [2] LF, or [3] CRLF
DT <enter>	1, 2	Displays the current delay time in milliseconds
DT <i>nnnnn</i> <enter>	1, 2	Sets the delay time from 0 to 65,000 milliseconds
GO <i>nn</i> <enter>	1, 2	Sends the actuator to position <i>n</i> , where <i>n</i> is A or B
	3	Sends the actuator to position <i>nn</i> (from 1 to NP) via the shortest route
HM <enter>	3	Moves the valve to position 1 (home)
ID / <enter>	1, 2, 3	Sets the ID of the actuator to / (Must be 0-9 or A-Z)
ID <enter>	1, 2, 3	Resets the ID to None
IFM <i>n</i> <enter>	1, 2, 3	Sets the interface response mode to [0] no response string when an action command is sent, [1] basic response to action commands, or [2] extended response to action commands (needed for BCD interface)
LG <i>n</i> <enter>	1, 2, 3	Sets the interface response mode to [0] no extra characters, or [1] longer response string to be fully backwards compatible with VICI microelectric actuators
LRN <enter>	1	Forces the actuator to find the stops on a newly installed valve. (Note: The valve must be installed before this command is sent.)
NP <enter>	1, 2, 3	Displays the number of positions the actuator is currently set to index
NP <i>nn</i> <enter>	2	Sets the number of ports (<i>nn</i>) for the current valve. (Must be an even number between 2 and 40)
	3	Sets the number of positions (<i>nn</i>) for the current valve. (Must be an even number between 2 and 40)
SB <enter>	1, 2, 3	Displays the current baud rate
SB <i>nnnn</i> <enter>	1, 2, 3	Sets the baud rate to 48(00), 96(00), 192(00), 384(00), 576(00), or 1152(00). The parity setting, number of data bits, and number of stop bits cannot be changed.
SM <enter>	3	Displays the current default rotational direction
SM / <enter>	3	Sets the default rotational direction to [F] for forward rotation, [R] for reverse rotation, or [A] to automatically choose the shortest route.
SO <enter>	1, 2, 3	Displays the current offset value
SO <i>nn</i> <enter>	1, 2, 3	Sets the offset value of the first position to be any number from 1 to 96 minus the total number of positions. Example: for a 10 position valve, the offset can be set from 1 to 86.
STAT <enter>	1, 2, 3	Displays the status of the actuator
TM <enter>	1, 2, 3	Displays the amount of time required for the previous move, in milliseconds
TO <enter>	1, 2	Toggles the actuator to the opposite position
TT <enter>	1, 2	Toggles the actuator to the opposite position, waits a preset delay time, then rotates back to the original position.
VR <i>n</i> <enter>	1, 2, 3	Displays the current firmware version for [NULL], the main PCB, or [2] the serial interface PCB.
/? <enter>	1, 2, 3	Displays a list of valid commands

* Modes are described on pages 4-5.

Notes

Command Reference

- AM[n]** Sets the actuator mode or displays the current mode,
 where $n =$ 1 = two position with stops (factory default)
 2 = two position without stops
 3 = multiposition
 NULL = returns (via the serial port) the current mode
 Modes available: All (modes are discussed on pages 3 and 4)
- Examples**
 Command: **AM1**<enter>
 Sets the actuator mode to two position with stops
 Command: **AM**<enter>
 Returns: **AMn** [0x0D] (n = current mode setting)
- CC[nn]** Moves the actuator in a counterclockwise direction,
 where $nn =$ 1 to NP (See also **NP** command)
 Modes available: All (with restrictions – in two position modes, nn is not allowed)
- Examples** (multiposition, mode 3)
 Command: **CC3**<enter>
 Moves the actuator counterclockwise to position 3
 Command: **CC**<enter>
 Moves the actuator counterclockwise one position
- Example** (two position, modes 1 and 2)
 Command: **CC**<Enter>
 Moves the actuator from position A to position B. If the actuator is already in Position B, the command is ignored.
- CNT[nnnnn]** Displays the current number of actuation cycles, or resets the counter to zero,
 where $nnnnn =$ 0 to 65535
 Modes available: All
 In two position modes (1 and 2), the counter is incremented every time the valve moves.
 In the multiposition mode (3), the counter is incremented by the number of positions the valve moves; *i.e.*, moving from position 2 to position 4 increments the cycle count by 2.
- Examples**
 Command: **CNT**<enter>
 Returns: **CNTnnnnn** [0x0D] ($nnnnn$ = current valve of counter)
 Command: **CNT0**<enter>
 Resets the cycle counter to 0 (zero)
 Command: **CNT100**<enter>
 Sets the cycle counter to 100
- CP** Displays the current position of the actuator
 Modes available: All (see below)
- Example** (two position, modes 1 and 2)
 Command: **CP**<enter>
 Returns: **CP/** [0x0D] ($n =$ 'A' or 'B') (l = current position)
- Example** (multiposition, mode 3)
 Command: **CP**<enter>
 Returns: **CPnn** [0x0D] (nn = current position)

- CW**[*nn*] Moves the actuator in a clockwise direction, where *nn* = 1 to NP (see also **NP** command)
- Modes available: All (with restrictions – in two position modes, *nn* is not allowed)
- Examples** (multiposition, mode 3)
- Command: **CW**<enter>
Moves the actuator clockwise one position
- Command: **CW3**<enter>
Moves the actuator clockwise position 3
- Example** (two position, modes 1 and 2)
- Command: **CW**<Enter>
Moves the actuator from position B to position A. If the actuator is already in Position A, the command is ignored.
- DT**[*nnnn*] Sets a delay interval before the actuator automatically returns to its previous position, where *nnnn* = 0 – 65535 (milliseconds) (See also **TT** command)
- Modes available: Two position (1 and 2)
- Examples**
- Command: **DT**<enter>
Returns **DTnnnn** [0x0D] (*nnnn* = current delay setting)
- Command: **DT0**<enter>
Sets the delay time to 0 and disables the TT command
- Command: **DT1000**<enter>
Sets the delay timer to 1000 milliseconds (1 second)
- GO**[*nn*] Tells the actuator to go to position *nn*,
Where *nn* = 1 to NP (multiposition, mode 3)
= 'A' or 'B' (two position, modes 1 and 2)
(See also **NP** and **SM** commands)
- Modes available: All (see below)
- Examples** (two position, modes 1 and 2)
- Command: **GO**<enter>
Toggles the actuator to the other position
- Command: **GOB**<enter>
Moves the actuator from position A to position B
- Examples** (multiposition, mode 3)
- Command: **GO**<enter>
Advances the actuator to the next position
- Command: **GO3**<enter>
Moves the actuator to position 3 in the direction set by the SM command
- HM** Moves the actuator to position 1. If the actuator is already in position 1, the command is ignored.
- Modes available: Multiposition (3)
- Example**
- Command: **HM**<enter>
Moves the actuator from the current position to position 1

- IFM**[*n*] Sets the actuator response mode to [*n*], determining how the actuator responds to action commands, where *n* = 0 = no response string
 1 = basic response string
 2 = extended response string (required for BCD interface)
- Modes available: All
- Example**
 Command: **IFM0**<enter>
 Turns off all responses to action commands
- LG**[*n*] Sets the actuator response mode to [*n*],
 where *n* = 0 = no extra characters in the response string
 1 = response includes " = ", to emulate a VICI microelectric actuator
- Modes available: All
- Example**
 Command: **LG1**<enter>
 Sets response to include extra characters
- LRN** Causes the actuator to "learn" and record the locations of a two position valve's physical stops. When the process is completed, the valve is set to position A.
- Modes available: Two position with stops (mode 1) (factory default)
 See also **AM** command
- Example**
 Command: **LRN**<enter>
 Initiates the learning process
- NP**[*nn*] Sets or displays the current setting for the number of ports (two position) or positions (multiposition) on the valve attached to the actuator, where *nn* = 2 – 40 (must be an even number).
- Modes available: Two position without stops (2), multiposition (3)
- Example** (two position, mode 2)
 Command: **NP**<enter>
 Returns: **NPnn** [0x0D] (*nn* = current setting for number of ports)
- Example** (multiposition, mode 3)
 Command: **NP6**<enter>
 Sets the number of positions to 6
- SB**[*nnnn*] Sets the baud rate of the serial port, where *nnnn* = 48, 96, 192, 384, 576, or 1152
- Modes available: All
- Example**
 Command: **SB192**<enter>
 Sets the baud rate for the serial port to 19200
- SM**[/] Sets the direction of rotation for the actuator,
 where / = F = Forward (toward the next highest numeric position)
 R = Reverse (toward the next lowest numeric position)
 A = Auto (shortest route)

If an actuator set to F (forward direction) is in position 4 and the command is sent to go to position 3, it will go all the way around until it reaches position 3 instead of taking one step backwards. For the actuator to calculate the direction which involves the least movement, the direction must be set to A (shortest route).

Modes available: Multiposition (3)

Examples

Command: **SM**<enter>
Returns: **SM** [0x0D] (*I* = current rotation direction)

Command: **SMF**<enter>
Sets the actuator to only move in the forward direction

SO[*nn*] Sets the offset value of the first position to be any number from 1 – 96, where *nn* = 1 – 96.

This feature makes it possible to control more than one actuator with a single computer. The actuator's SO value can be set from "1" to "96", minus the current NP value (the number of positions the actuator is set to index). Once an SO value is set, that value is the first (or lowest) position an actuator will recognize. The factory SO setting is "1", so an actuator with an NP value of 10 responds to move commands for positions "1" to "10". If the SO value is changed to "10", the actuator will respond only to move commands for positions "10" through "19". For any setting of SO and NP, the lowest valid position will be the SO value and the highest valid position will be the SO value plus the NP value minus 1; i.e., the actuator will respond to commands for position SO through position {SO + NP - 1}. Refer to "Using the Offset Feature" on page 19.

Modes available: All (but used primarily in mode 3, multiposition)

Examples

Command: **SO**<enter>
Returns: **SO***nn* [0x0D] (*nn* = current offset value)

Command: **SO10**<enter>
Sets the offset value to 10. The valve will now start counting as if 10 = position 1

STAT Returns (via the serial port) the following information,
CP = current position
AM = current mode
NP = number of ports (modes 1 and 2) or positions (mode 3) on the current valve

(See also **CP**, **AM**, and **NP** commands)

Modes available: All

Example

Command: **STAT**<enter>
Returns: Current status of the actuator

TM Returns the amount of time, in milliseconds, required by the previous move

Modes available: All

Example

Command: **TM**<enter>
Returns: Number of milliseconds taken to move from the previous position to the current position

- TO** Toggles the actuator to the opposite position from its current position; *i.e.*, if the actuator is currently in Position B, it will toggle to Position A.
- Modes available: Two position (1 and 2)
- Example**
 Command: **TO**<enter>
 Causes the actuator to toggle from one position to the other
- TT** Timed toggle: the actuator will toggle from its current position to the opposite, wait for a programmed amount of time, then toggle back to its original position.
 Note: This command is ignored if DT=0. (See also **DT** command)
- Modes available: Two position (1 and 2)
- Example**
 Command: **TT**<enter>
 The actuator will initiate the timed toggle procedure
- VR_n** Reports the current firmware version,
 where $n = [\text{null}]$ for the main PCB, or $n = 2$ for the serial interface PCB.
- Modes available: All
- Examples**
 Command: **VR**<enter>
 Returns: Current revision of the main PCB firmware
 Command: **VR2**<enter>
 Returns: Current revision of the serial PCB firmware
- /?** Displays the list of the primary commands for the actuator. The list is similar to the serial command table above but is not inclusive of all the commands.
- Modes available: All
- Example**
 Command: **/?**<enter>
 Returns: The list of commands for the actuator

Optional BCD Interface

Hardware Input / Output Protocols

The digital interface is made through a 26 pin connector which also provides power (+5 volts/100 ma maximum) and ground outputs. The ground should be connected to the control system to maintain commonality between the actuator and the controlling device. If you intend to provide your own power supply, make sure that it has an isolated output or that it shares a common ground with the controlling system.

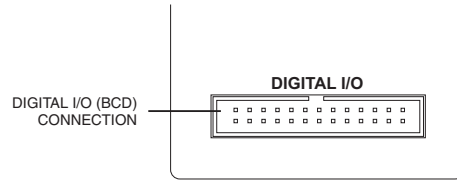


Figure 11: Digital I/O connector on rear panel

Digital input/output control of the actuator is designed for simplicity and flexibility of function. The simplest control of the actuator can be accomplished in modes 1 and 2 with a single control line for the STEP function. Mode 3 requires only two output control lines – STEP and HOME. The chart on the next page lists other control options.

The inputs are held to a logical high (+5 volts) by pull-up resistors, and are designed to be driven low either by contact closure, 5 volt digital logic, or open collector transistor outputs. The signal polarity is defined as “negative true” – asserting the signal involves shorting the signal (in the case of contact closure) or driving it (in the case of logic or transistor signals) to within 0.8 volts of ground potential. These input signals must be at least 30 milliseconds in duration.

The outputs are also “negative true” signals driven by standard high speed CMOS gates, capable of driving standard logic input gates. They include the BCD position, motor run, rotational direction, and error signals. If the actuator stops out of position due to a stuck valve, the BCD output is set to “0” (all lines high for a negative true output).

Digital Input Protocols

The input modes are selected during factory setup/programming.

Binary Coded Decimal (BCD) input mode (default)

For the 96 possible input positions, all 8 digital input data lines are required. Refer to the chart on the next page for the signal line definitions.

Parallel Input Mode

In this mode, the data input lines are redefined so that each input line equates to only one actuator position; any and all combinations of data input lines are invalid. This mode can support only 8 positions: 1 BCD = position 1; 2 BCD = position 2; 4 BCD = position 3; 8 BCD = position 4; 10 BCD = position 5; 20 BCD = position 6; 40 BCD = position 7; and 80 BCD = position 8. The offset value SO is set to 1, and since the number of positions is limited to 8, any user-set NP value greater than 8 will revert to 8. (See the chart on the next page for more explanation of NP and SO.)

Binary Input Mode

This mode allows up to 128 possible input positions. All 8 digital input data lines are required. Refer to the chart on the next page for the signal line definitions.

Pin	Color	Signal	Direction	Pin	Color	Signal	Direction
1	brown	Home	Input	14	yellow	4 BCD	Output
2	red	Motor run	Output	15	green	20 BCD	Output
3	orange	Step	Input	16	blue	2 BCD	Output
4	yellow	Error	Output	17	violet	10 BCD	Output
5	green	Manual Dir.	Input	18	gray	1 BCD	Output
6	blue	Direction	Output	19	white	80 BCD	Input
7	violet	Auto Dir.	Input	20	black	8 BCD	Input
8	gray	Data latch	Input	21	brown	40 BCD	Input
9	white	+5 VDC 100 ma	Output	22	red	4 BCD	Input
10	black	Ground	Output	23	orange	20 BCD	Input
11	brown	80 BCD	Output	24	yellow	2 BCD	Input
12	red	8 BCD	Output	25	green	10 BCD	Input
13	orange	40 BCD	Output	26	blue	1 BCD	Input

Pin signal definitions for the Digital Input/Output cable

Mode:	SD0	SD2	SD3	Data Input Lines							
Input type:	BCD	Parallel	Binary	1 BCD	2 BCD	4 BCD	8 BCD	10 BCD	20 BCD	40 BCD	80 BCD
Position:	1	1	1	X	—	—	—	—	—	—	—
	2	2	2	—	X	—	—	—	—	—	—
	3	*	3	X	X	—	—	—	—	—	—
	4	3	4	—	—	X	—	—	—	—	—
	5	*	5	X	—	X	—	—	—	—	—
	6	*	6	—	X	X	—	—	—	—	—
	7	*	7	X	X	X	—	—	—	—	—
	8	4	8	—	—	—	X	—	—	—	—
	9	*	9	X	—	—	X	—	—	—	—
	*	*	10	—	X	—	X	—	—	—	—
	*	*	11	X	X	—	X	—	—	—	—
	*	*	12	—	—	X	X	—	—	—	—
	*	*	13	X	—	X	X	—	—	—	—
	*	*	14	—	X	X	X	—	—	—	—
	*	*	15	X	X	X	X	—	—	—	—
	10	5	16	—	—	—	—	X	—	—	—
	11	*	17	X	—	—	—	X	—	—	—
	12	*	18	—	X	—	—	X	—	—	—
	13	*	19	X	X	—	—	X	—	—	—
	14	*	20	—	—	X	—	X	—	—	—
	15	*	21	X	—	X	—	X	—	—	—
	16	*	22	—	X	X	—	X	—	—	—
	17	*	23	X	X	X	—	X	—	—	—
	18	*	24	—	—	—	X	X	—	—	—
	19	*	25	X	—	—	X	X	—	—	—
	*	*	26	—	X	—	X	X	—	—	—
	*	*	27	X	X	—	X	X	—	—	—
	*	*	28	—	—	X	X	X	—	—	—
	*	*	29	X	—	X	X	X	—	—	—
	*	*	30	—	X	X	X	X	—	—	—
	*	*	31	X	X	X	X	X	—	—	—
	20	6	32	—	—	—	—	—	X	—	—
	Code sequence break										
	40	7	64	—	—	—	—	—	—	X	—
	Code sequence break										
	80	8	128	—	—	—	—	—	—	—	X

Pin signal definitions for the various input modes

Additional Digital Input and Output Signals

Data Latch *(input)*

Toggling this signal from high to low (hold the signal low for a minimum of 5 ms) will cause the actuator to read the BCD Input signals. Once the signals are read, the actuator will then attempt to move to the position indicated on the BCD Input signals.

BCD Signals *(output)*

These represent the current position data in the same format used as the Input protocol.

Note: The BCD Output Signals are only updated after the motor has finished moving (see **Motor Run** below) and if there is no error (see **Error** below).

Step *(input)*

Toggling this line from high to low (hold the signal low for a minimum of 5 ms) causes the actuator to advance one position.

Home *(input)*

Toggling this line from high to low (hold the signal low for a minimum of 5 ms) moves the actuator to the Home (or first) position.

Manual Direction *(input)*

When the signal is high, the actuator will move in a forward direction. For example, when moving from position 3 to position 4, it will move the shortest distance between the two positions. When the signal is low the actuator will move in a reverse direction; when moving from position 3 to position 4, it will move the longest distance between the two positions.

Auto Direction *(input)*

When the signal is high, the Manual Direction signal dictates how the actuator moves to different positions. When the signal is low, the actuator will calculate the shortest direction between two positions and move in that direction.

Motor Run *(output)*

When the signal is high, the motor is in an Off state. When the signal is low, the motor is in an On state (moving).

Error *(output)*

When the signal is low, the actuator encountered an error with the last move request. When the signal is high, no error was detected.

Notes:

The system considers a move request for the current position to be an error, since the motor does not move.

Error signals are cleared after the next successful move.

Direction *(output)* – Factory test output.

Using the Offset Feature

This feature makes it possible to control more than one actuator without increasing the number of BCD or serial input lines. The actuator's SO value can be set from "1" to "96", minus the current NP value (the number of positions the actuator is set to index). Once an SO value is set, that value is the first (or lowest) position an actuator will recognize. The factory SO setting is "1", so an actuator with an NP value of 10 responds to move commands for positions "1" to "10". If the SO value is changed to "10", the actuator will respond only to move commands for positions "10" through "19". For any setting of SO and NP, the lowest valid position will be the SO value and the highest valid position will be the SO value plus the NP value minus 1; i.e., the actuator will respond to commands for position SO through position {SO + NP - 1}.

The examples below describe a system that will step sequentially from 1 through 31 with a single instruction. However, note that when positions are selected in a random sequence, position 16 must always be requested before any positions higher than 16 are selected. **Figure 12** helps illustrate this: since both actuators respond to a command to go to position 16, stream 16 will flow through valve 1/port 1, out the common port of valve 2, into valve 1/port 16, and out of the common port of valve 1. Thereafter, any stream select command that is above 16 will move only valve 2; when a move command for a position less than 16 is given, valve 1 will move and cut off all flow from valve 2.

With BCD Control

Here is how this can be feature can be used to set up a 31-stream stream selection system using six dedicated BCD lines and two 16-position valves and actuators. Refer to "Using the Manual Remote to Configure the Actuator" on page 3 as required.

1. Use the manual remote to enable the auto-latching feature on both actuators. This eliminates the need for a data latch signal.
2. Use the manual remote to assign the second actuator an offset value of "16", giving it a valid position range of 16 to 31.
3. Use a piece of tubing to connect port 16 of the first valve (on the actuator still carrying the factory-default offset value of "1") to the common port of the valve on the second actuator (which now has an offset value of "16").
4. Connect streams 1 through 15 to ports 1 through 15 on the first valve, and streams 16 through 31 to ports 1 through 15 on the second valve.

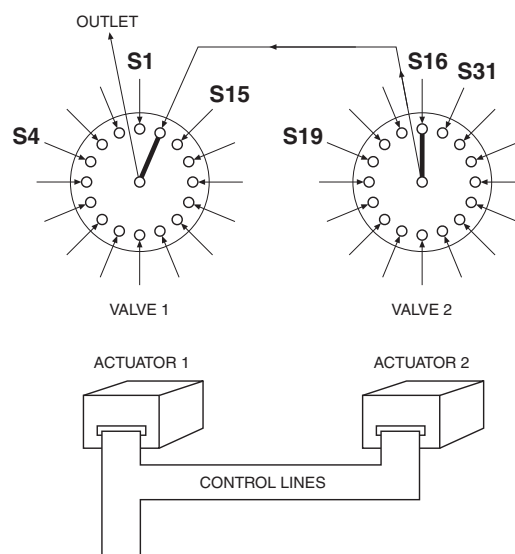


Figure 12: Using the Offset feature

With Serial Control

Here is how this can be feature can be used to set up a 31-stream stream selection system using two 16-position valves and two actuators serially daisy-chained together. Refer to the chapter entitled "Optional Serial Interface" (beginning on page 6) as required.

1. Configure the second actuator using the command **SO16**, giving it a valid position range of 16 to 31.
2. Use a piece of tubing to connect port 16 of the first valve (on the actuator still carrying the factory-default offset valve of "1") to the common port of the valve on the second actuator (which now has an offset value of "16").
3. Connect streams 1 through 15 to ports 1 through 15 on the first valve, and streams 16 through 31 to ports 1 through 15 on the second valve.

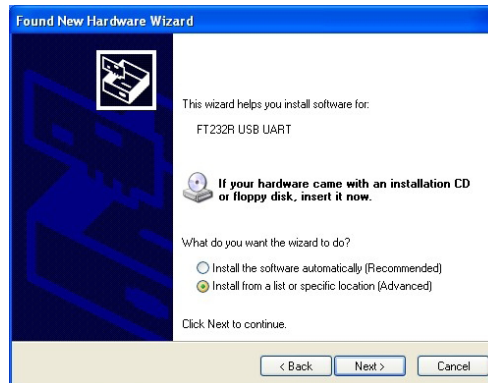
Appendix 1: Installing USB Drivers

Windows XP

1. Connect the actuator to a USB port on your PC. The Found New Hardware Wizard will pop up on your screen.



2. Select "Install from a list or specific location (Advanced)" as shown below. Click Next to continue.



3. Select "Search for the best driver in these locations" and enter the file path in the combo box or browse to it by clicking the browse button. Once the file path has been entered in the box, click Next to proceed.



4. When Windows XP has found the required files, the screen below will be displayed while the files are being copied.



5. Windows should then display a message indicating that the installation was successful. Click Finish to complete the first part of the installation.



6. The Found New Hardware Wizard will launch automatically to install the COM port emulation drivers. As above, select "No, not at this time" from the options, then click Next to proceed.



7. Repeat steps 2 - 6 to install the COM port emulation drivers.

Warranty

This Limited Warranty gives the Buyer specific legal rights, and a Buyer may also have other rights that vary from state to state. For a period of 90 calendar days from the date of shipment, VICI Metronics Inc. (hereinafter Seller) warrants the goods to be free from defect in material and workmanship to the original purchaser. During the warranty period, Seller agrees to repair or replace at Seller's option defective and/or non-conforming goods or parts (exclusions noted below) without charge for material or labor, subject to inspection FOB VICI Metronics Inc. factory. Buyer's exclusive remedy is repair or replacement of defective and nonconforming goods.

Seller excludes and disclaims any liability for lost profits, personal injury, interruption of service, or for consequential incidental or special damages arising out of, resulting from, or relating in any manner to these goods

This Limited Warranty does not cover:

- lamps or fuses
- damage due to improper shipping
- damage due to improper use
- damage due to modifications or alterations
- damage due to improper maintenance.

This Limited Warranty does not cover defects, damage, or nonconformity resulting from abuse, misuse, neglect, lack of reasonable care, modification, or the attachment of improper devices to the goods. This Limited Warranty does not cover expendable items. This warranty is VOID when repairs are performed by a nonauthorized service center or representative.

The warranties contained in this agreement are in lieu of all other warranties expressed or implied, including the warranties of merchantability and fitness for a particular purpose.

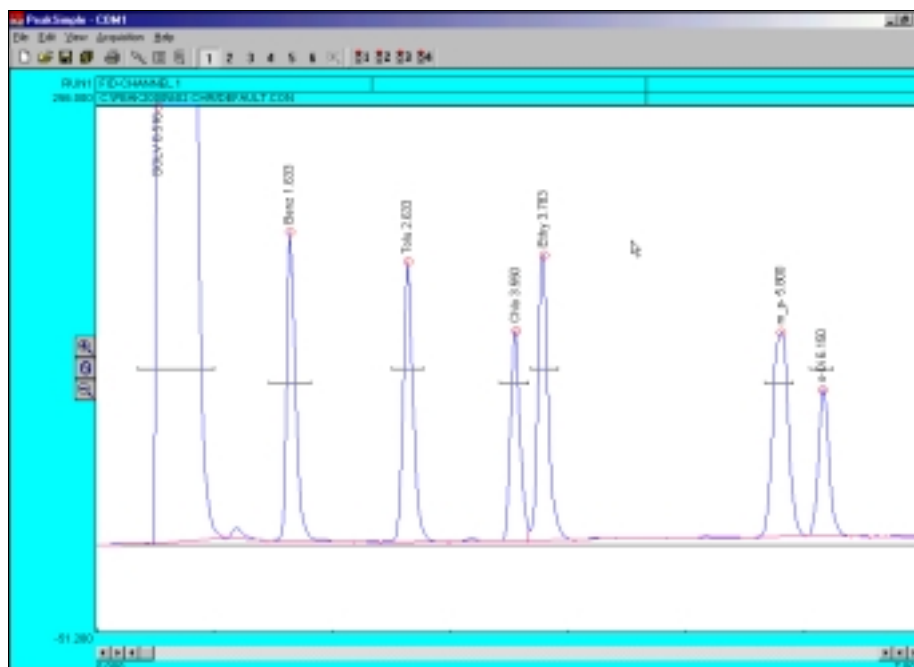
This Limited Warranty supercedes all prior proposals or representations oral or written and constitutes the entire understanding regarding the warranties made by Seller to Buyer. This Limited Warranty may not be expanded or modified except in writing signed by the parties hereto.

SRI Instruments

PeakSimple 2000

Chromatography Integration Software

Basic Tutorial



Installing PeakSimple 2000 from floppy disk or CD-Rom

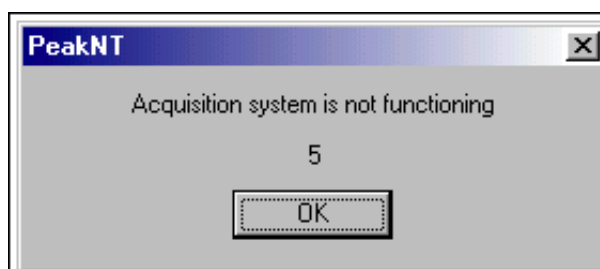
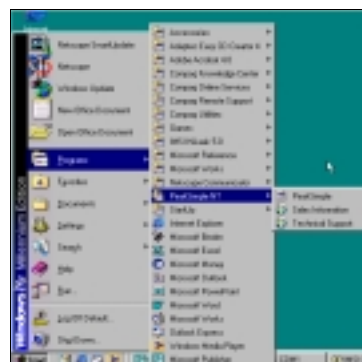
- A. Start the Windows operating system in use on your computer. (Windows 95, 98, ME, 2000)
- B. Insert the PeakSimple 2000 disk or CD into your floppy disk drive.
- C. Go to the **Start** menu in the bottom left hand corner of the windows screen and select **Run** from the set of icons.
- D. From the run menu, type **X:\setup** (where **X** is the letter of your computers disk drive).
- E. Now click on the **Continue** button with your mouse cursor or press the enter key on your keyboard to begin installation.
- F. To complete installation follow the onscreen instructions provided by the installation wizard.

Installing PeakSimple 2000 from software download

- A. Start the Windows operating system and use an online browser to access www.srigc.com.
- B. From the menu on the left hand side of the screen select **Download our Software** and then download PeakSimple 2000 from the following page.
- C. Save the file to a temporary folder and then double click on it from My Computer to allow the program to self-extract.
- D. Once all the files have been extracted successfully double-click the install file and press the **Continue** button when prompted.
- E. Follow the onscreen instructions to complete the installation of PeakSimple.

Launching PeakSimple 2000

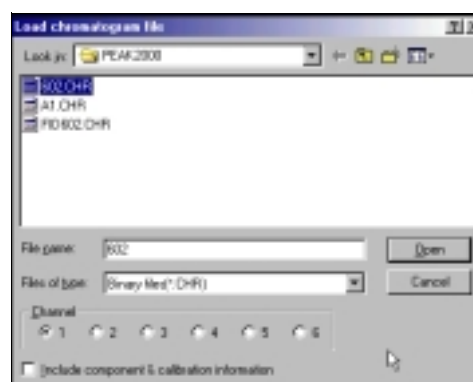
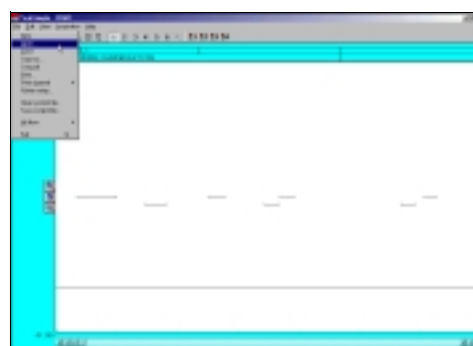
1. Click on the windows **Start** button in the bottom left-hand corner of the screen. Select **Programs** and then **PeakSimple** from the list of program groups on the screen and then click on **PeakSimple**.
2. This will launch PeakSimple and initialize the data acquisition system.
3. If PeakSimple comes up with an error message stating "Acquisition system is not functioning" with a countdown timer, it is indicating that there is a communication problem between the computer and the data system or that the data system and the hardware is not connected. Click **OK** to continue working with PeakSimple.
4. Most of the commands and options in PeakSimple are equipped with tool tips that will automatically pop up to display useful information when the mouse cursor is held over a command. To turn off the tool tips deselect the tool tips option in the Help menu.



Click this button to jump to the integration parameters screen. This is sometimes useful when reviewing the results data. For example, if the area reject caused some peaks to be skipped, you can jump right to the integration parameters and adjust the area reject number.

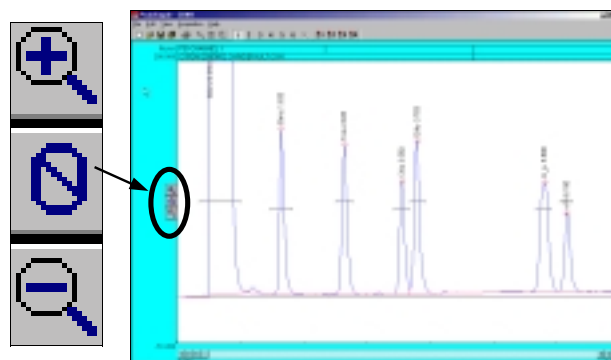
Opening a PeakSimple Data File

1. To open a PeakSimple data file or chromatogram, begin by selecting **File** in the PeakSimple menu bar and then choose **Open...** from the set of options.
2. The Load Chromatogram File window is now open. The PeakSimple software includes a number of sample chromatogram data files that can be opened, displayed, and manipulated. One file, 602.CHR, will be used throughout the rest of the tutorial. Select file **602.CHR** from the PeakSimple directory, choose **Channel 1** as a destination channel, and then select **Open** to load the file.



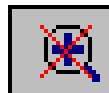
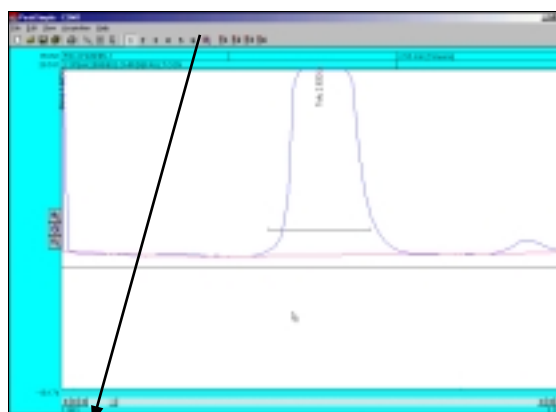
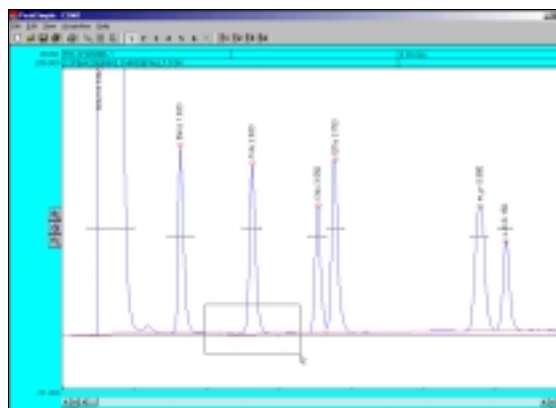
Adjusting Display Limits

1. To adjust the display limits of a chromatogram click on either the + magnifying glass icon or the - magnifying glass icon to the left of the chromatogram. This will increase or decrease the limits by a factor of two each time you click on the icons.
2. After opening chromatogram 602.CHR, practice making the display limits smaller but the peaks larger by clicking the + magnifying glass icon.
3. Practice making the display limits larger but the peaks smaller by clicking on the - magnifying glass icon.



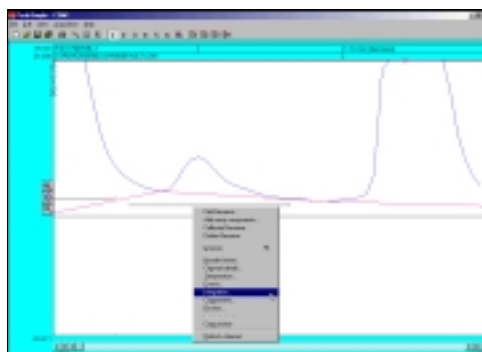
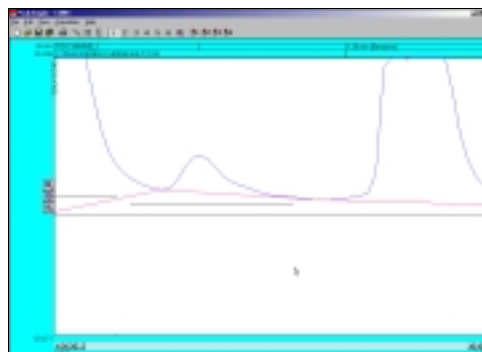
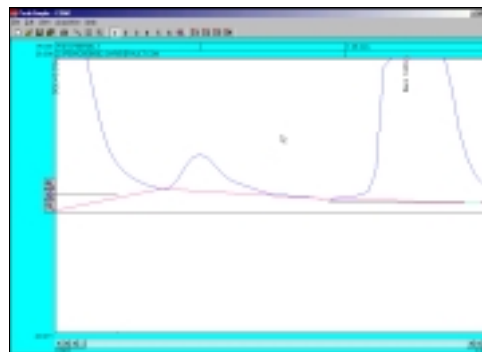
Zooming

1. To zoom in on a specific part of a PeakSimple chromatogram, click and hold the left mouse button and drag it over the desired area.
2. After opening chromatogram 602.CHR hold the left mouse button and drag it over the base of the toluene peak. Let go of the mouse button and there will be a larger view of the area that was selected.
3. To return to the original display limits of the chromatogram and unzoom the area selected press **F6** or select the unzoom icon located in the PeakSimple toolbar at the top of the screen.



Dragging Retention Windows

1. To drag a retention window bar place the mouse cursor on the bar until a double sided arrow pops up. Click on the left mouse button and hold and then drag the retention window bar to its desired place.
2. After opening the chromatogram 602.CHR zoom in on the benzene peak and the smaller peak to its left. Locate the benzene retention window bar and drag it over to the smaller unnamed peak to the left of the benzene. Because this is a small peak it is not immediately recognized.
3. Right click on the chromatogram over the unnamed peak and select **Integration** from the resulting menu.
4. From the integration window locate the **Area Reject** dialogue box, erase the 100.0 in the box, and add the number **10.0** to the dialogue box. Click **OK** and the integration window will exit.
5. Press the **Enter** or **Return** key on your keyboard and the smaller peak will now be recognized as Benzene.



Channel 1 integration

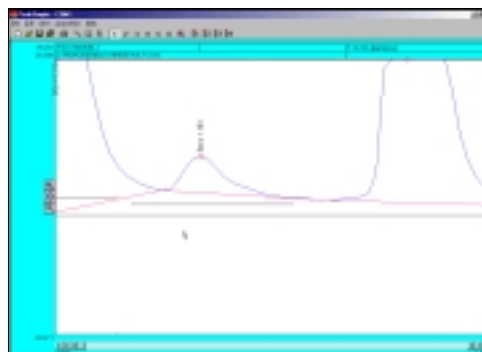
Peak detection sensitivity
 Peak: 95.00 %
 Base line: 50.00 %
 Area reject: 10.0

Spike channel
☐ None
☐ 2
☐ 3
☐ 4
☐ 5
☐ 6

Merge results non channels
☐ 2
☐ 3
☐ 4
☐ 5
☐ 6

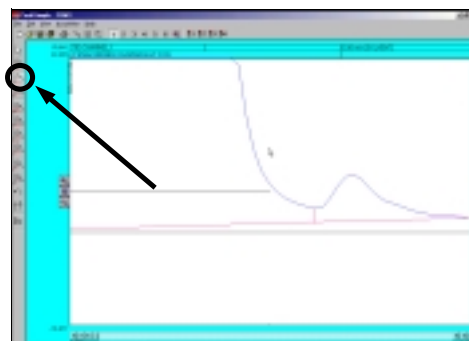
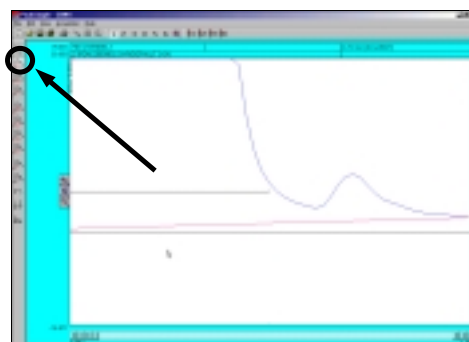
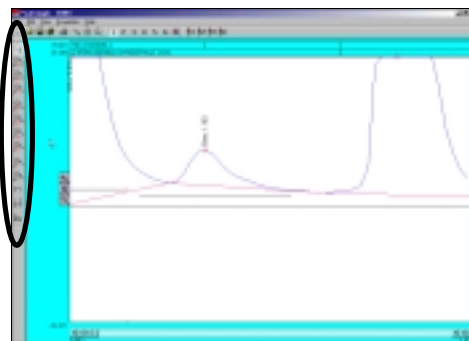
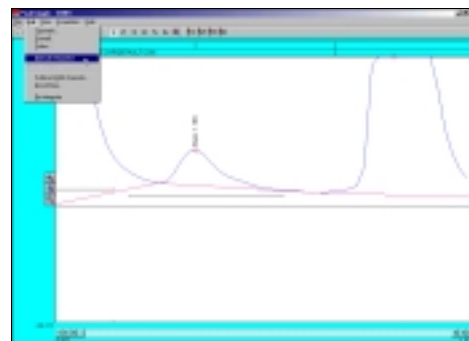
Standard weight: 1.000
 Sample weight: 1.000

OK Cancel

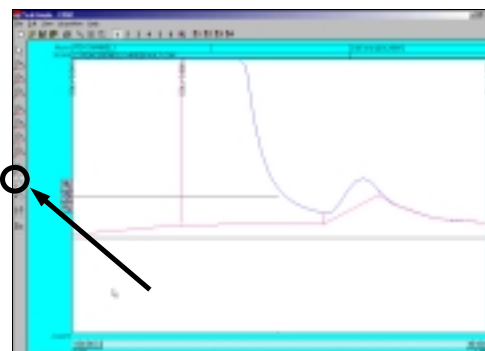
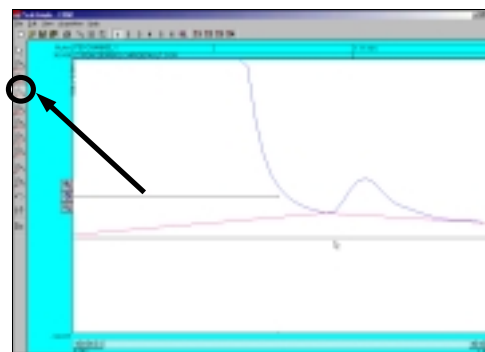


Manual Integration

1. To manually adjust the integration baseline and peak separation in a chromatogram use the manual integration toolbar provided by PeakSimple. To open up the manual integration toolbar select **Edit** in the PeakSimple menu bar and then click on the **Manual Integration** option. The manual integration toolbar will now appear to the left of the chromatograph.
2. The manual integration toolbar contains nine types of manual integration options. Four of the most commonly used options are **None** integration, **Drop** integration, **Based** integration, and **Rubber Band** integration.
3. To make a baseline ignore a peak use the None integration tool. After opening chromatogram 602.CHR and the manual integration toolbar, zoom in on the baseline of the solvent peak and the smaller unrecognized peak immediately to its right. Click on the **None** integration tool in the manual integration toolbar with the mouse cursor and then click on the valley between the two peaks where they meet the baseline. The area of the small peak is now added to the solvent peak.
4. To undo the changes made to a chromatogram at any time simply click on the **Undo** integration tool in the manual integration toolbar. After selecting this tool all integration changes made to the chromatogram will be undone.
5. Click on the **Undo** tool with your mouse cursor and select the **Drop** integration tool to enable the dropping of the baseline below the between the two peaks. After selecting the Drop tool click where the valley of the peaks meet the baseline with the cursor. The baseline should now be dropped below the base of the peaks and a line should extend from it to the baseline.

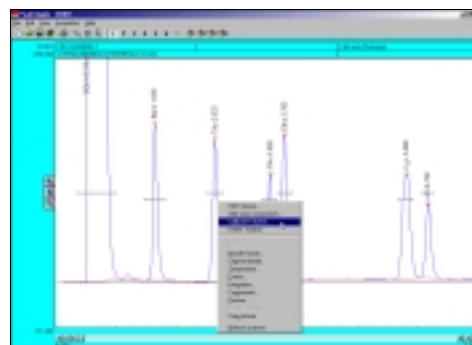


- After the manual integration between the two peaks is dropped use the **Based** integration tool to raise the baseline to the valley between the peaks. Once the Based integration tool is selected, click on the valley between the solvent peak and the smaller peak to its right with the mouse cursor. The baseline will now extend up to meet the valley of the two peaks.
- Once again click on the **Undo** tool in the manual integration toolbar to remove all changes done to the chromatogram. Select the **Rubber Band** integration tool to manually draw a baseline. Once the Rubber Band tool is selected take the mouse cursor and click on a part of the baseline. While holding down the left mouse button extend the line to another part of the baseline further to the right of the starting point and let go of the mouse button. The base line will now be drawn according to the line that was drawn using the Rubber Band integration tool.

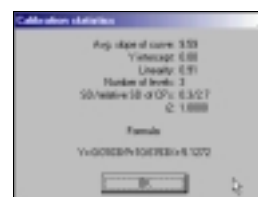
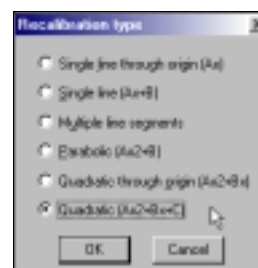
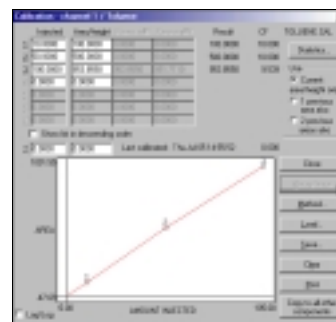


Calibration

- To turn the raw area of a peak into a real-world number the peak first needs to be calibrated. To calibrate the Toluene peak in chromatogram 602.CHR, open up the file and then right click using the mouse on the Toluene peak. After right clicking on Toluene select **Calibrate Toluene** from the resulting menu.
- From the Recalibration level window click on the third level radio button **3 (100.000)** and then select **OK** with your mouse cursor.



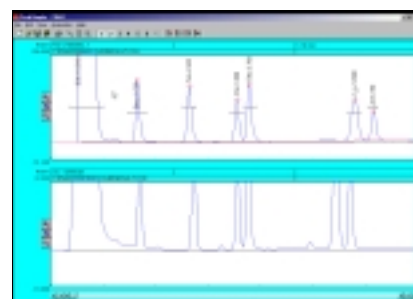
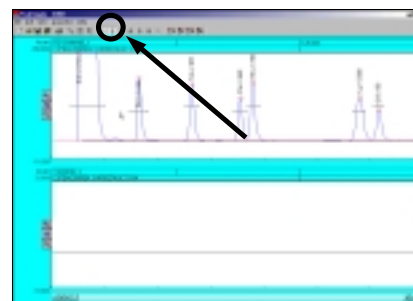
- After selecting OK from the Recalibration level menu the Calibration menu for Toluene will pop up. Check to make sure the flashing asterisk on the calibration curve is on level 3 and then click on the **Accept New** button to the right of the window.
- Once the new data is accepted, click on the **Method** button immediately below the Accept New button. The Recalibration type window will now open allowing the user to select a method of calibration. By default the calibration type is set at Multiple Line Segments. Select the **Quadratic (Ax^2+Bx+C)** radio button and then click on **OK** with the mouse cursor.
- After changing the method of calibration click on **Statistics** in the upper right hand corner of the Calibration level window. The Calibration statistics window will pop up revealing the statistics for the calibration of Toluene. Click **OK** with the mouse cursor to close the Calibration statistics window and then select **Close** from the Calibration window to finish calibrating Toluene.



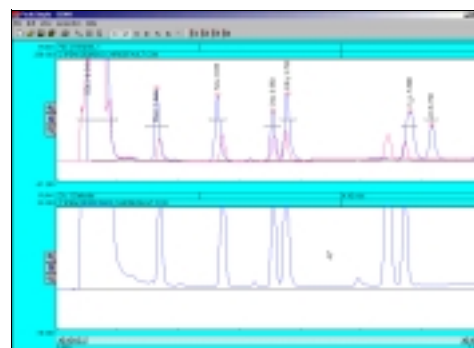
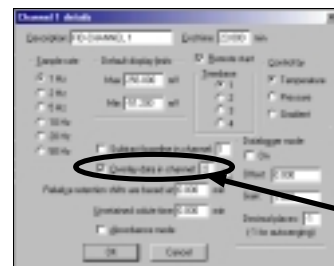
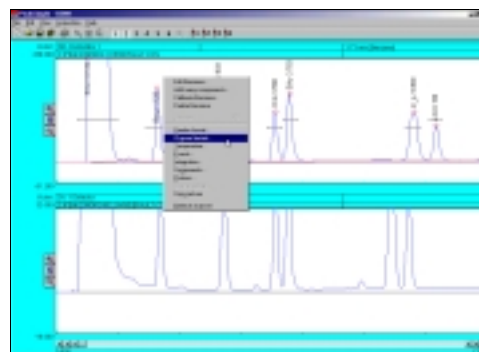
Overlay

- To compare two or more chromatograms overlay them using PeakSimple. To overlay two chromatograms first open chromatogram 602.CHR and then click on the **2** button in the PeakSimple toolbar. A second chromatogram channel is now open in the PeakSimple window.
- Once the second channel is open select **File** from the PeakSimple menu bar and then click on **Open**. The Load chromatogram file window will open up displaying a list of files to load. Select chromatogram **FID602.CHR** to load and then select the **2** channel radio button to load the chromatogram in the second channel.

2

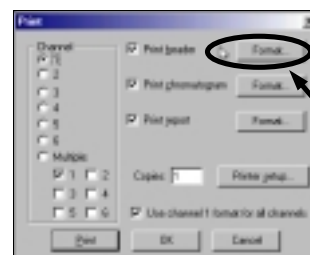
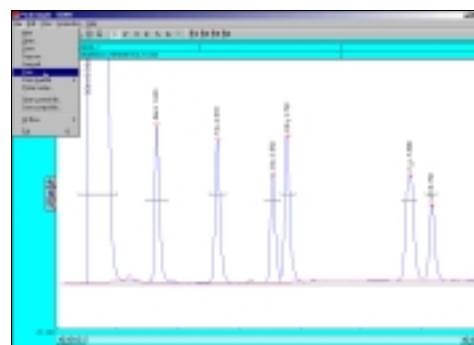


- Once FID602.CHR is open in the second channel right click using the mouse on the chromatogram in the first channel and select **Channel Details** from the list of options.
- After the Channel 1 details window appears on the screen locate the **Overlay data in channel** check box and select it. Look to the dialogue box to the right of the Overlay data in channel check box and insert the number **2** in place of the 1. Click on **OK** with the mouse cursor to exit the Channel 1 details window.
- The chromatogram FID602.CHR is now in place overlaid on top of chromatogram 602.CHR in channel 1. Chromatogram 602.CHR is in blue while FID602.CHR is in red.

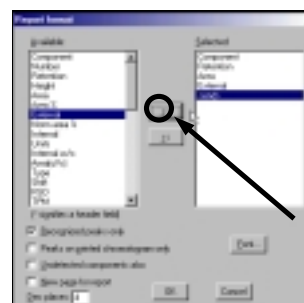
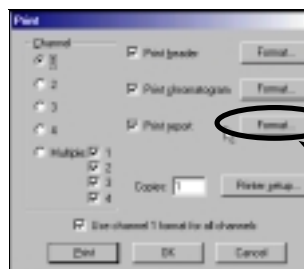
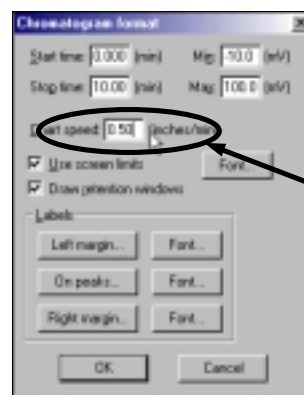


Printing a Chromatogram

- To print a chromatogram first open chromatogram 602.CHR. Once the chromatogram is open select **File** from the PeakSimple menu bar and then select **Print** from the drop-down menu.
- The Print window will open and will allow the user to customize the printing of a chromatogram. Click on the **Format** button for the Print header to open up the Header format window. Add or delete any information in the window by clicking on the fields and inserting the desired information. Click on the **OK** button when all the desired information is inputted to close the window.

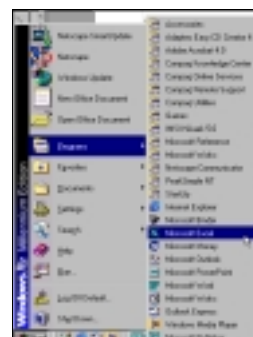
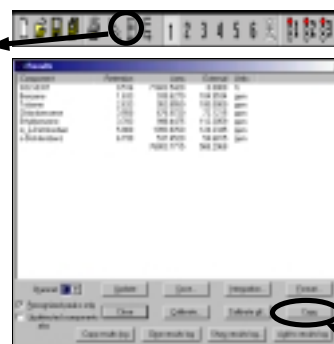


3. In the Print window click on the **Format** button for Print chromatogram to open up the Chromatogram format window. Locate the **Chart speed** dialogue box and insert the number of inches each minute on the chromatogram will take up when printed (for a nine minute run try **0.50** inches per minute). After the Chart speed is entered click on **OK** to exit the window.
4. In the Print window locate the Print report check box and click on the **Format** button to its right.
5. Once the Report format window is open click on **External** in the Available dialogue menu (on the left) and then click with the mouse cursor on the right facing arrow button to add External to the Selected dialogue box (on the right). After External is added to the Selected dialogue box click on **Units** with the mouse cursor and click on the right facing arrow button to add Units to the Selected dialogue box. Click on **OK** with the mouse cursor to exit out of the Report format window.
6. Select **Print** in the Print window to print the chromatogram or click on **OK** in the Print window to exit the window.

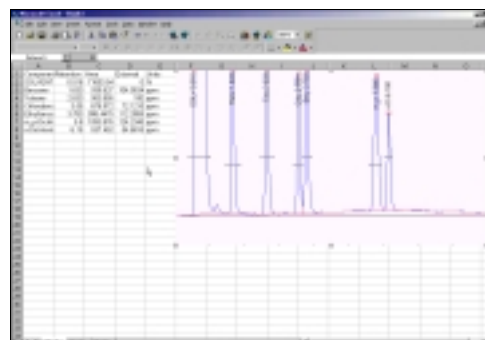
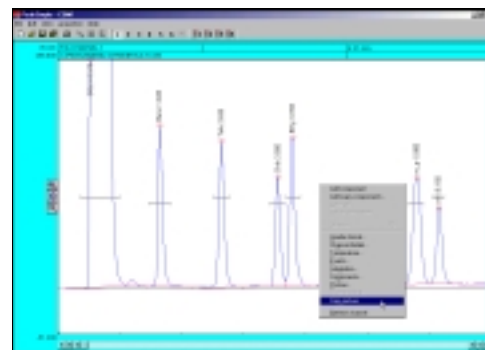
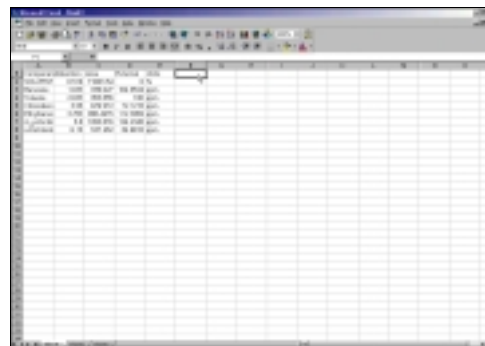


Exporting to Excel

1. In the PeakSimple toolbar click on the **Results** window button to open up the Results window. Once the Results window is open click on the **Copy** button to copy the results data to the Windows clipboard.
2. Make sure Microsoft Excel is loaded on the computer. If Excel is not loaded you can copy results data and chromatograms to Microsoft Word or PowerPoint. Open up Microsoft Excel by clicking with the mouse cursor on the **Start** button in the bottom left of the Windows screen and then **Programs** and then **Microsoft Excel** in the Windows Program menu.



6. Once Excel is opened select **Edit** from the Excel menu bar and then **Paste** from the drop down menu. The results data is now placed into the columns and rows of Excel. Using the mouse cursor, select a box to the right of the results data in the Excel spreadsheet. Go back into the PeakSimple for Windows NT program and hit **Close** to exit the Results window.
7. Right click with the mouse cursor anywhere on chromatogram 602.CHR and select **Copy picture** from the resulting menu. Go back into Excel and select **Edit** from the Excel menu bar and then **Paste** from the drop down menu. The PeakSimple chromatogram will now be displayed next to its results data in the rows and columns of Microsoft Excel.



This concludes the PeakSimple 2000 Basic Tutorial

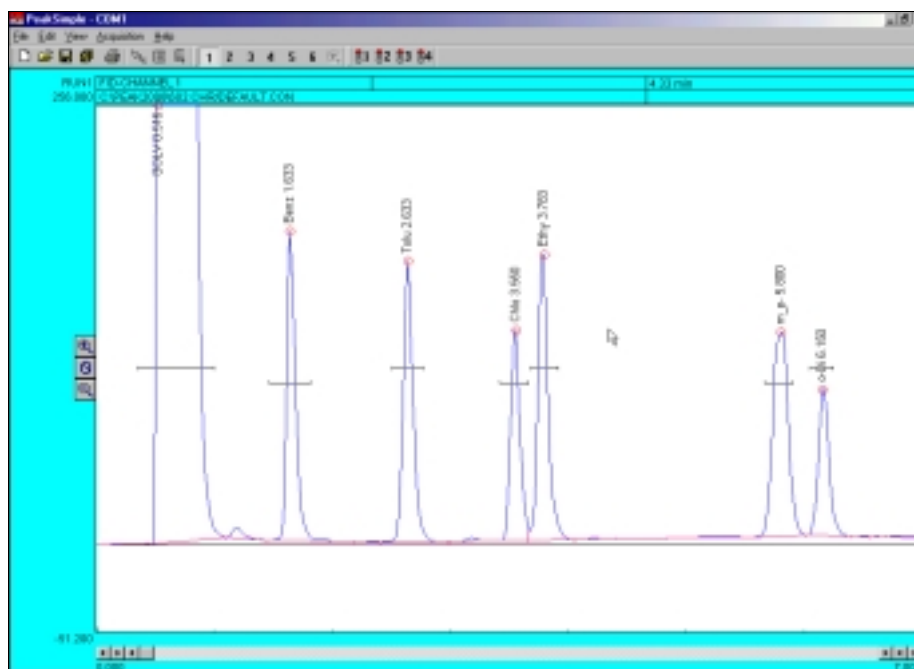
An Advanced Tutorial can be obtained by going to:
www.srigc.com online

If you have questions or would like to place an order call:
(310) 214-5092

PeakSimple 2000

Chromatography Integration Software

Advanced Tutorial



Installing PeakSimple 2000 from floppy disk or CD-Rom

- Start the Windows operating system in use on your computer. (Windows 95, 98, ME, 2000)
- Insert the PeakSimple 2000 disk or CD into your disk drive.
- Go to the **Start** menu in the bottom left hand corner of the windows screen and select **Run** from the set of icons.
- From the run menu, type **X:\setup** (where **X** is the letter of your computers disk drive).
- Now click on the **Continue** button with your mouse cursor or press the enter key on your keyboard to begin installation.
- To complete installation follow the onscreen instructions during the installation wizard.

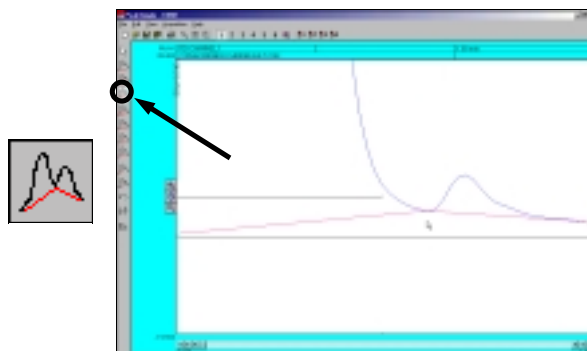
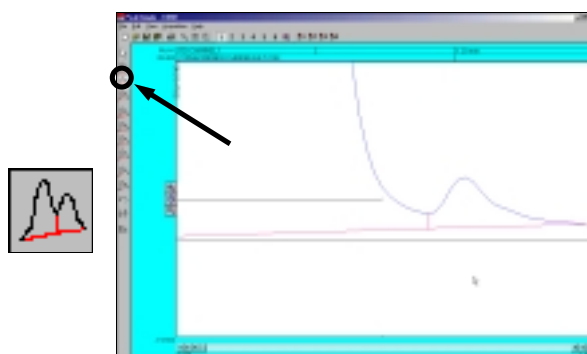
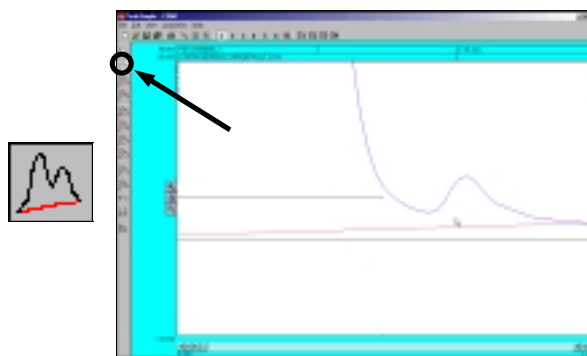
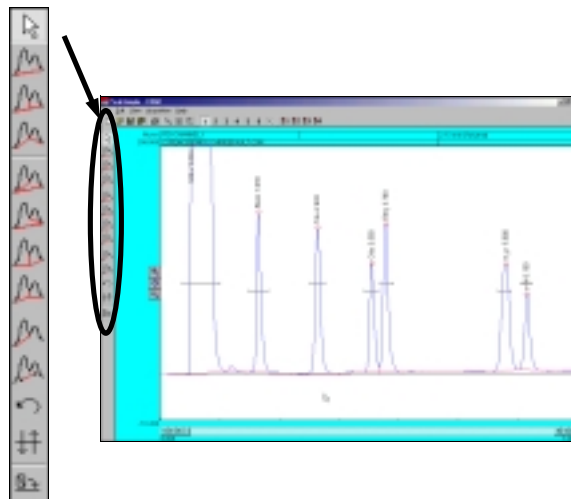
Installing PeakSimple 2000 from software download

- Start the Windows operating system and use an online browser to access www.srigc.com.
- From the menu on the left hand side of the screen select **Download our Software** and then download PeakSimple 2000 from the following page.
- Save the file to a temporary folder and then double click on it from My Computer to allow the program to self-extract.
- Once all the files have been extracted successfully double-click the install file and press the **Continue** button when prompted.
- Follow the onscreen instructions to complete the installation of PeakSimple.

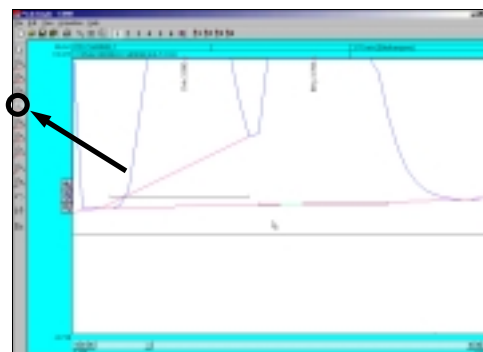
SRI Instruments 20720 Earl Street Torrance, CA 90503 U.S.A
 Telephone: (310) 214-5092 Fax: (310) 214-5097 sales@srigc.com www.srigc.com

Manual Integration

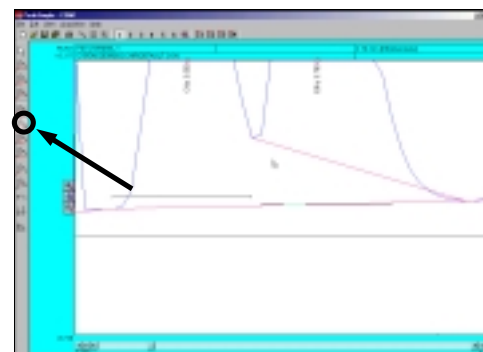
1. To manually integrate the PeakSimple baseline in a chromatogram use the manual integration tools found in the manual integration toolbar. To open the manual integration toolbar first have chromatogram 602.CHR loaded and then select **Edit** from the PeakSimple menu bar. From the drop down menu select **Manual integration** with the mouse cursor. The manual integration toolbar will now be displayed to the right of the PeakSimple toolbar in the left most part of the screen.
2. Use the None integration tool to add the area of the smaller peak to the area of the Solvent peak. First, zoom in on the solvent peak, the smaller peak to its right, and their baselines. Once the chromatogram is zoomed in select the **None** integration tool from the manual integration toolbar. With the None integration tool selected click once, using the left mouse button, on the valley between the solvent peak and the smaller peak.
3. Use the Drop integration tool to drop the baseline from the valley of the two peaks to an existing baseline. To drop the baseline select the **Drop** integration tool from the manual integration toolbar. Using the mouse cursor, click on the valley between the solvent peak and the smaller peak to drop the baseline.
4. The Based integration tool raises the baseline to the valley between two specified peaks. With the baseline dropped, click on the **Based** integration tool button and then click on the valley between the solvent peak and the smaller peak to raise the baseline to the valley.



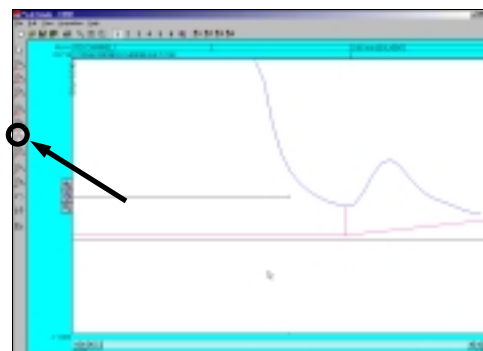
5. The Lead skim integration tool allows a peak's area to be skimmed off of the leading edge of another peak. To use the Lead skim tool first unzoom off of the solvent peak and the other smaller peak and then zoom in on the Chlorobenzene peak, the Ethylbenzene peak, and the baseline. After the chromatogram is zoomed click on the **Lead skim** integration tool button and then click on the valley between the two peaks with the mouse cursor.



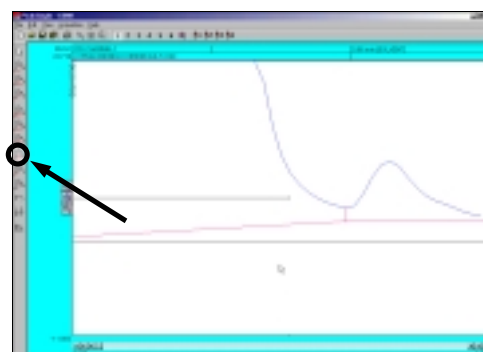
6. The Trail skim integration tool is similar to the Lead skim tool except a peak's area is now skimmed off of the trailing edge of another peak. Select the **Trail skim** tool button from the manual integration toolbar and then click on the valley between the Chlorobenzene and Ethylbenzene peaks with the mouse cursor to see the Ethylbenzene peak skimmed off of the Chlorobenzene peak.



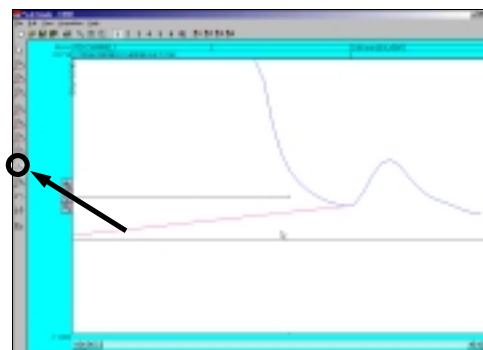
7. The Lead horizontal tool constructs the baseline horizontally for the leading peak while the trailing peak's baseline stretches from the horizontal line to the next valley. Unzoom off of the Chlorobenzene and Ethylbenzene peaks and instead zoom in on the Solvent peak, the smaller peak to its right, and the baseline. Click on the **Lead horizontal** integration tool in the manual integration toolbar and then click, using the left mouse button, on the valley between the solvent peak and the other smaller peak.



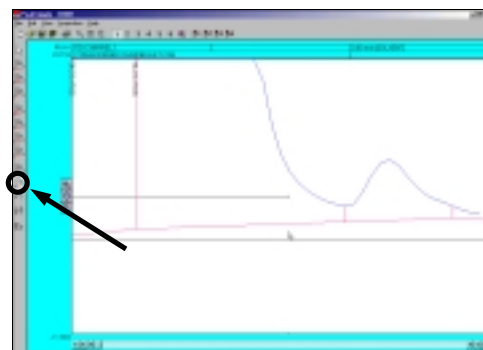
8. The Trail horizontal integration tool drops the baseline horizontally for the trailing peak while the lead peak's baseline stretches from the horizontal line to the previous valley in the chromatogram. After selecting the **Trail horizontal** tool in the manual integration toolbar click with the mouse cursor on the valley between the two zoomed in peaks.



9. The Inhibit tool ends the baseline after a valley effectively inhibiting a peak's area from being counted with the rest of the chromatogram. To use the Inhibit integration tool select the **Inhibit** tool button from the manual integration toolbar and click on the valley of the Solvent peak and the smaller peak to its right.



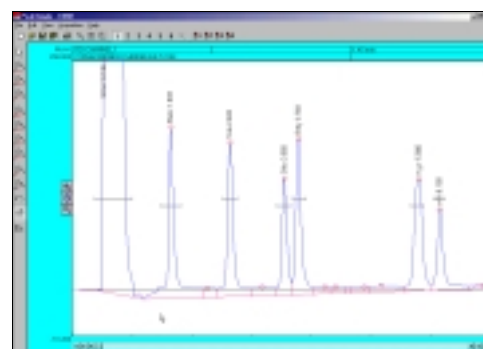
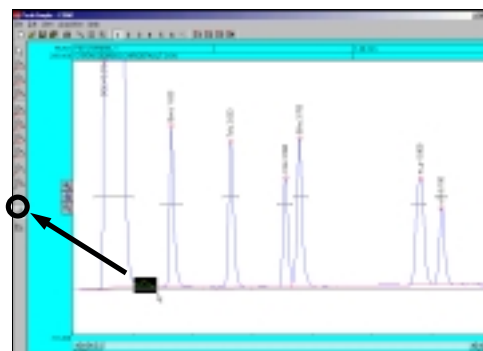
10. The Rubber Band tool is used to manually draw the baseline in a chromatogram. To use the Rubber Band tool first scroll the X-axis scrollbar all the way to the left to **0.000**. Select the **Rubber Band** tool from the manual integration toolbar and draw a line from the valley between the Solvent peak and the small peak to its left to the valley between the smaller peak to the right of the Solvent peak and the peak to its right.



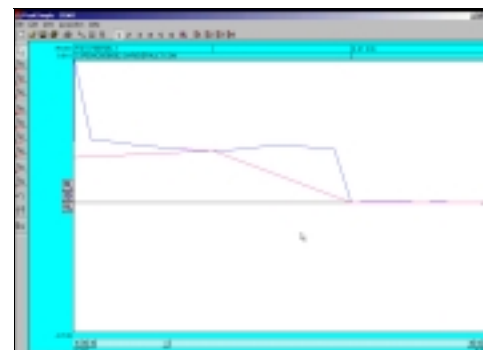
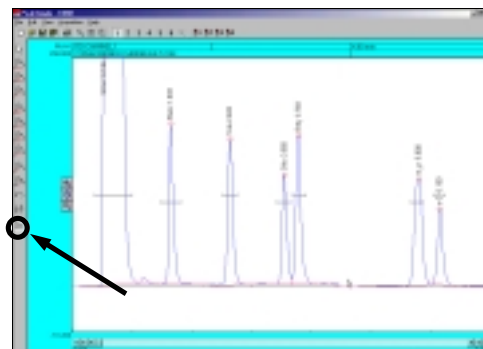
11. To undo a change made to the baseline of a chromatogram with the manual integration tools use the Undo button found in the manual integration toolbar. To undo the changes made to the baseline using the Rubber band tool click on the **Undo** button with your mouse cursor. All changes made to the baseline will now be undone.



12. The Reverse tool allows the inverting of a peak in a chromatogram. **Note:** To reverse the orientation of the X-axis in real time go to the Events table. First unzoom off of the Solvent peak and the smaller peak to its right and then select the **Reverse** tool from the manual integration toolbar and click and hold the left mouse button while the area of the chromatogram you want to reverse is dragged over with a black box. Let go of the mouse button when the desired area is selected to reverse the orientation.

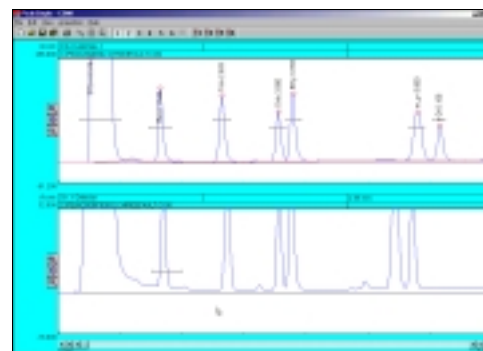
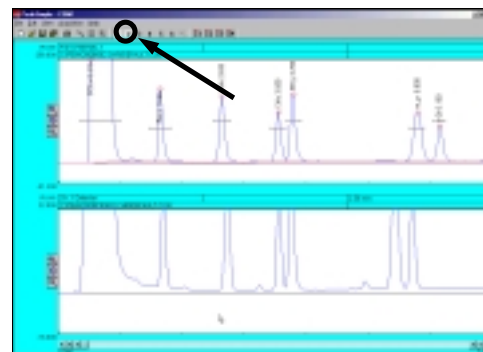


13. The Zero tool is used to set the value of the data line at a selected point and following in the chromatogram to zero. First undo the changes done to the chromatogram by the Reverse tool by reopening 602.CHR in the PeakSimple menu bar. **Note:** Changes made to a chromatogram by the Reverse tool and the Zero tool cannot be undone with the Undo tool. Once the file is reopened click on the **Zero** tool and click anywhere on the baseline between the Ethylbenzene peak and the two peaks to its right with the mouse cursor to set the data line at zero.

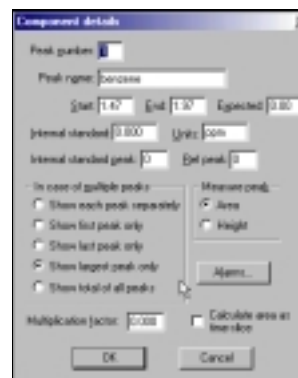


Creating Component Tables

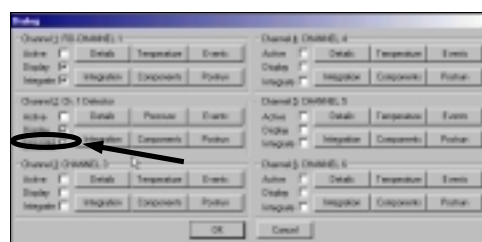
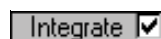
1. To create a component table from scratch open up a second channel in the PeakSimple window by clicking on the Display Channel 2 button in the PeakSimple toolbar. Once the second channel is open click on **File** and then **Open** to get to the Load chromatogram file window. Select file **FID602.CHR** from the list of files and select the Channel 2 radio button to open the file in channel 2. Click **OK** with the mouse cursor to load the file.
2. In channel 2 locate the second tall peak from the left and right click on it with the mouse cursor. From the resulting menu select **Add component** to add a retention window bar to the peak. Once again right click on the peak and select **Edit component** from the menu to open up the Component details window.



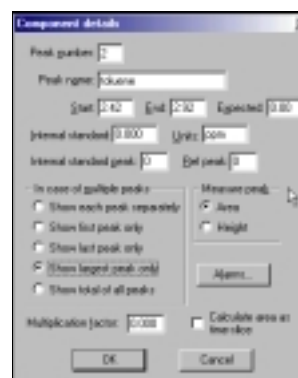
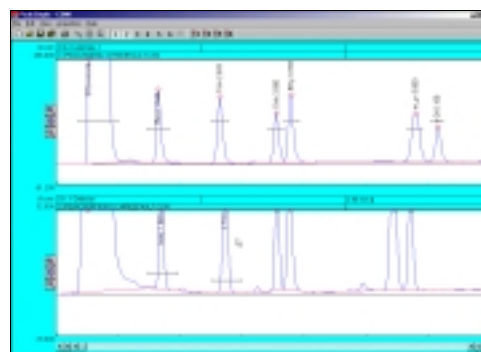
- Once the Component details window is open locate the Peak number dialogue box and add the number **1**. Immediately underneath the Peak number box is the Peak name dialogue box. In the Peak name dialogue box input **benzene** to name it. Locate the Units box and put **ppm** to make the units parts per million. Locate the In case of multiple peaks options box and select the radio button for **Show largest peak only**. Click on **OK** with the mouse cursor to close the window.



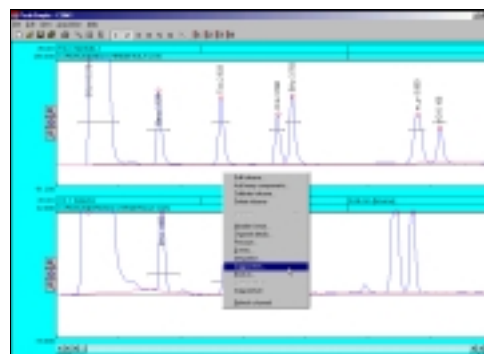
- Go to **Edit** in the PeakSimple menu bar and then **Channels** from the resulting menu. The Channel controls window is now open. Locate the Channel 2 options box and the Integrate checkbox. Check the **Integrate** checkbox and then click on **OK** with the mouse cursor to close the window. The peak in the second channel should now identify itself as benzene.



- Locate the large peak to the right of the benzene peak in the second channel. Right click and then select **Add component** to add a retention window bar to the peak. Right click again and go to **Edit component** to open up the Component details window. Change the Peak number to **2**, the Peak name to **toluene**, the Units to **ppm**, and the In case of multiple peaks options box to **Show largest peak only**. Click on **OK** with the mouse cursor to exit the window.



- Right click anywhere on the second channel and select **Components** from the list of options. Once the Channel 2 components window is open make sure all the data is correct and then click on **Save** to save the Component data to disk. Name the file **Ctable** and then click on **OK** to close the window. An unlimited number of component windows may be added to the component table.



Channel 2 components

Peak	Name	Start	End	Calibration
1	benzoin	1.000	1.500	
2	salutar	2.000	2.500	

Buttons: Add, Change, Remove, Calibrate, Load, Save, Use, Exit, OK

Temperature Programming

- To modify the temperature programming in PeakSimple first open chromatogram 602.CHR and then right click anywhere on the chromatogram. From the drop down menu select **Temperature** to open up the Temperature control window.
- In the Temperature control window click using the mouse cursor on the set of numbers in the box and select **Change** from the group of buttons below. The Temperature segment details window will open allowing the modification of the temperature programming. Locate the Hold for dialogue box and insert a **2** in the box. Click on **OK** to close the window and go back into the Temperature control window.



Temperature segment details

Initial temperature deg

Hold for min

Then ramp at deg/min

Until temperature is deg
(or for min)

Buttons: OK, Cancel

3. Select the **Add** button from the Temperature control window to open up the Temperature segment details window once again. Leave the Initial temperature at 200 and insert a 1 in the Hold for dialogue box. Change the Then ramp at dialogue box to 5 and the Until temperature is box to 250. Click on **OK** to close the window and to see the new temperature data added to the temperature box. Click on **OK** to close the window.

Temperature segment details

Initial temperature: 200 deg

Hold for: 5.000 min

Then ramp at: 10. deg/min

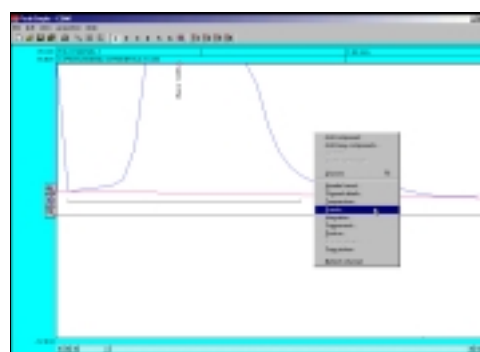
Until temperature is: 300 deg
(or for: 10.00 min)

OK Cancel



Events Table

1. To modify up the Events table in PeakSimple open up chromatogram 602.CHR and zoom in on the benzene peak, the smaller peak to its right, and the baseline. Right click anywhere on the chromatogram and select **Events** from the drop down menu. Doing this will open up the Events window where specific events can be added to the chromatogram.



2. Click using the mouse cursor on the **Add** button to view the Event details window. A list of event types are available with their radio buttons to either select or deselect the event.

Note: The event types to the left of the window are real-time and thus will only affect the chromatogram when A/D hardware is connected. The event types to the right are concerned only with integration and their changes will be immediately evident after returning to the main screen and selecting **Reintegrate** from the **Edit** menu bar.

Channel 1 events

Time: 0.000

Event details window showing a list of event types with radio buttons for selection.

Buttons: Add, Change, Remove, Reintegrate, Load, Save, Clear, Print, OK, Cancel

Event details

Event type: ☒ ADJUSTMENT DONE, ☐ GENERATE INTEGRATION

☐ STRAPLINE SETPS, ☐ INTEGRATION: None

☐ CRYSTALLINITY, ☐ INTEGRATION: Crop

☐ CHOCOLATE SHOWER, ☐ INTEGRATION: Band

☐ 8.0000000000000000, ☐ INTEGRATION: Level 1

☐ 7.0000000000000000, ☐ INTEGRATION: Level 2

☐ 6.0000000000000000, ☐ INTEGRATION: Level 3

☐ 5.0000000000000000, ☐ INTEGRATION: Level 4

☐ 4.0000000000000000, ☐ INTEGRATION: Level 5

☐ 3.0000000000000000, ☐ INTEGRATION: Level 6

☐ 2.0000000000000000, ☐ INTEGRATION: Level 7

☐ 1.0000000000000000, ☐ INTEGRATION: Level 8

☐ 0.0000000000000000, ☐ INTEGRATION: Level 9

☐ 0.0000000000000000, ☐ INTEGRATION: Level 10

☐ 0.0000000000000000, ☐ INTEGRATION: Level 11

☐ 0.0000000000000000, ☐ INTEGRATION: Level 12

☐ 0.0000000000000000, ☐ INTEGRATION: Level 13

☐ 0.0000000000000000, ☐ INTEGRATION: Level 14

☐ 0.0000000000000000, ☐ INTEGRATION: Level 15

☐ 0.0000000000000000, ☐ INTEGRATION: Level 16

☐ 0.0000000000000000, ☐ INTEGRATION: Level 17

☐ 0.0000000000000000, ☐ INTEGRATION: Level 18

☐ 0.0000000000000000, ☐ INTEGRATION: Level 19

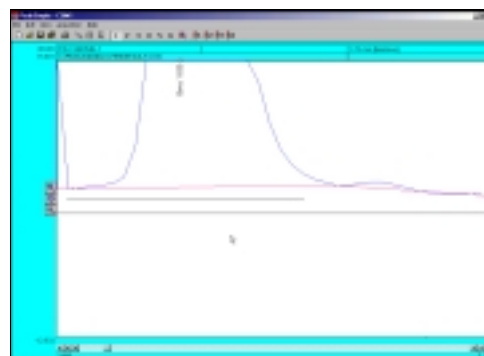
☐ 0.0000000000000000, ☐ INTEGRATION: Level 20

Buttons: OK, Cancel

3. In the Event details window locate and select the relay **G** radio button with the mouse cursor and then locate the Event time dialogue box and enter **.1** in the box. Click on **OK** to exit the window. **Note:** The relay might be used to actuate a valve when hardware is connected. The event type will now be added to the Events table. Select the **Add** button and now locate and select the **Zero** event type radio button. Leave the Event time box at 0.000 and once again click on **OK** to exit the window and add the event to the Events table. **Note:** The Zero event auto-zeros the detector signal at the beginning of the run. Click on the **Add** button again and select the **Integration-Based immediate** radio button in the Event details window and input **1.86** in the Event time dialogue box. Select **OK** to exit the window.

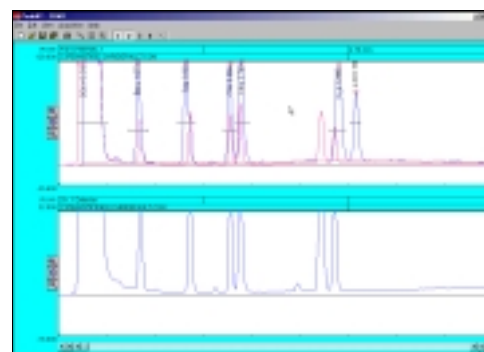
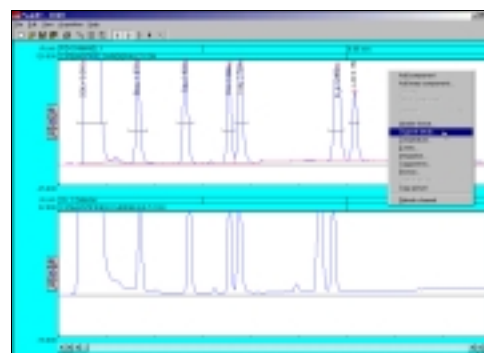


4. There are now three events in the Events table. Click on **OK** to exit the Events window and then hit the **Enter** button on the keyboard to reintegrate the baseline according to the events in the Events table. Notice that the baseline is connected to the data line at 1.86 minutes.

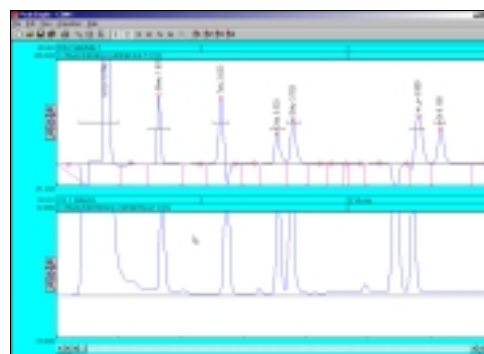
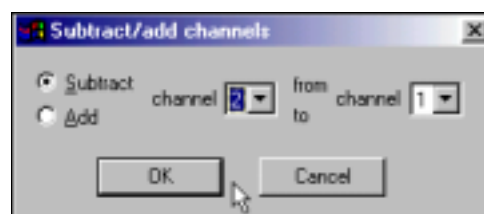


Overlay and Subtract

1. To overlay one PeakSimple chromatogram on top of another chromatogram open up a second channel in the main screen and load chromatogram 602.CHR in the first channel and chromatogram FID602.CHR in the second channel. Right click anywhere in the first channel and select **Channel details** from the drop down menu.
2. In the Channel 1 details window locate the Overlay data in channel checkbox and check it and then input a **2** in the dialogue box to the right. The chromatogram in channel 2 is now overlaid on top of the chromatogram in channel 1. The overlay appears in a different color.



- Right click anywhere on the first channel and select **Overlay adjustment** from the drop down menu. In the Overlay adjustment window locate the Factor scroll box in the X box. Experiment scrolling the X factor up or down to shift the overlaid chromatogram to its right or left. Locate the Factor scroll box in the Y box and experiment scrolling the Y factor up or down to move the overlaid chromatogram up or down. Click on the **Close** button to close the window.
- To subtract a chromatogram in one channel from another channel, right click using the mouse cursor on channel 1 and select **Channel details**. From the Channel 1 details window deselect the Overlay data in channel checkbox and then click on the **OK** button to exit the window.
- Go to the **Edit** menu bar and select **Subtract/Add channels** from the drop down menu. In the Subtract/add channels window make sure the Subtract radio button is selected and that channel 2 is being taken from channel 1. Click on the **OK** button to make the changes take effect and have channel 2 subtracted from channel 1. The normal way to use this feature is to subtract a drifting baseline from a chromatogram.

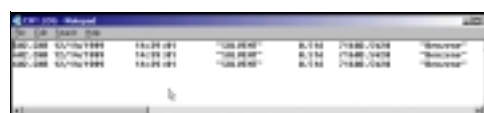
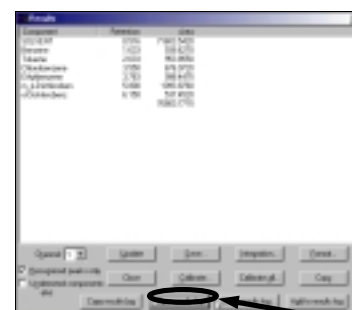


Results Log

- Open chromatogram 602.CHR in the PeakSimple main screen and then select the **Results** button from the PeakSimple toolbar. In the Results window click on the **Clear results log** button at the bottom of the window. Click on **Yes** from the resulting window to clear the results.
- Locate the **Add to results log** button and click on it three times to add the results on the screen to the Results log three times. Click on the **Show results log** button to view the results log in the Windows Notepad. Exit the Windows Notepad program by selecting **File** from the menu bar and then **Exit**.



Clear results log



3. In the Results window locate the **Copy results log** button at the bottom of the window and click on it with the mouse cursor (don't confuse the Copy button with the Copy results log button). Open up Microsoft Excel (or if Excel is not loaded Microsoft Word or Power-Point) and select **Edit** from the menu bar and then **Paste** to copy the results log to Excel.
4. Go back into PeakSimple and close the Results window by selecting the **Close** button. Right click using the mouse cursor on the chromatogram and select **Postrun** from the drop down menu to open the Post-run actions window. From the window locate the Add to results log checkbox and add a check to the box. By selecting the Add to results log checkbox all results from data analysis will automatically be added to the results log after the run is done. Click on **OK** to exit the window. In this way a summary of many analyses can be automatically created and then exported from PeakSimple.



This concludes the PeakSimple 2000 Advanced Tutorial

Further documentation can be obtained by going to:
www.srigc.com online

If you have questions or would like to place an order call:
 (310) 214-5092