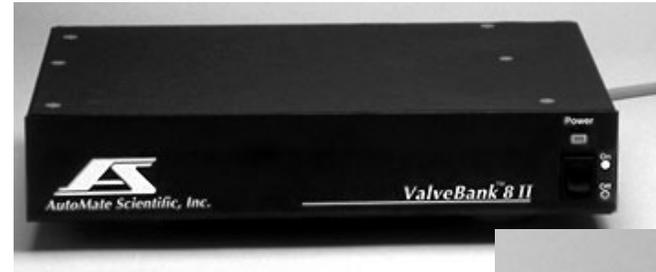


# **ValveBank™ 4 & 8 II**

---



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## **User's Manual**

Version II 1.4



---

**AutoMate Scientific, Inc.**

ValveBank4 & 8 - Part #s 01-01 & 01-08

For indoor use only from 5° to 40° C.

Do not get wet or subject to visible condensation.

Clean with a mild soap solution with a damp cloth only.

This equipment must be earth grounded. Use any of the screws on the bottom or side of the case. See page 15.



Do not unplug valves while on!

Do not attempt to repeatedly cycle valves on and off in under 10 milliseconds.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Supply voltage:

ValveBank controller = 12 V AC up to 2.4 Amps @ 50-60 Hz

External power supplies:

USA & Japan = 110 V AC up to 0.26 Amps @ 60 Hz

European = 220 V AC up to 0.17 Amps @ 50 Hz

Internal battery type: 3V Lithium coin battery  
type BR2325 coin or CR2032

23mm x 165mAh

Please replace fuse with standard 2.5 Amp (M) medium-time / blow fuse.



European CE Technical Representative:  
AutoMate Scientific  
Elisenstr. 16, Leverkusen 51373, Germany

# ValveBank™ 4 & 8 II



## User's Manual

### Version II 1.4

**For research use only.**

Josef Kewekordes II, Heath Lukatch  
David Ilstrup, Gabriel Stern, Brian Greenstone, EPP



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All rights reserved.

## **WARNINGS!**

**Do Not** Unplug Valves while Energized!  
The resulting voltage spike is much like a car spark plug, and will destroy circuit board components.

**Do Not** Clean the ValveBank Screen With Paper Towels – It Will Scratch! Use a cloth with a 50% alcohol solution.

This equipment **must** be earth grounded. Use any of the screws on the bottom or side of the case.

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*The ValveBank is intended for research use only.*

*The ValveBank line is dedicated to the memory of Victor A. Rivas.*

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PLEASE SET ASIDE SOME TIME TO READ THIS MANUAL  
BEFORE USING YOUR NEW VALVEBANK SYSTEM.

The ValveBank is a very unique and sophisticated programmable instrument. It will be difficult for you to get the most out of its features without reading this manual. Thanks!

FOR RESEARCH USE ONLY

The ValveBank is designed for solution-switching use in research applications ONLY. AutoMate Scientific, Inc. cannot be responsible for injury or death resulting from medical or pharmacological use.

**Hardware Overview**

The ValveBank™4 and 8 are stand-alone, programmable, valve and pump controllers with 10 millisecond accuracy. Programming and manual control is accomplished through a 16-key membrane keypad; back-lit, liquid-crystal display; and easy, menu-driven user interface. The user can store up to 36 programs (18 for a ValveBank8), totaling 64K of battery backed-up (stored even when unplugged) RAM memory.

The ValveBank is designed to drive 12 volt DC solenoid valves plugged into RCA jacks on the back of the box. Four TTL **outputs** are provided for interfacing the ValveBank with external devices which receive 0 /+5 volt signals. These TTL channels can be programmed to turn devices, such as peristaltic pumps or recorders, on and off. Four additional TTL **inputs** can monitor such instruments as UV/VIS detectors, flow meters, and level sensors. These inputs can be programmed to trigger valve or TTL output activity. A user-created computer program can also use these inputs to control valves through the ValveBank. See the *Computer Interfacing* chapter. NOTE: The ValveBank8 has only four TTL in and outputs.

\* TTL stands for Transistor-Transistor Logic, a +5/0 volt standard for representing on and off – used by the ValveBank to control and monitor external devices. See the *Configuration-Technical Notes* chapter for more information and uses.

## ValveBank Laboratory Applications

### Perfusion

One or more ValveBanks can be programmed to precisely switch solutions perfusing over biological samples for physiological research. The ValveBank's circuitry is designed to open valves with low noise for electro-physiology amplification. Several advanced features have been built into the ValveBank's Manual Mode specifically for perfusion use.

### Washing

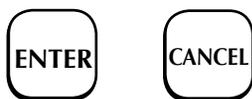
Combined with an AutoMate ported washing tray, one or two ValveBanks can automate washing of electrophoresis gels and blots, and developing of x-ray or photographic film or prints. You have complete control over which washing steps of your Western, Northern, Southern, Coomassie Blue and Silver staining runs are automated and which are handled conventionally. Unattended washing can save a busy lab countless hours of tedious monitoring.

### Liquid Chromatography

A ValveBank can be easily programmed to automate solution selection in multi-step ion exchange, gel filtration or affinity chromatography runs with excellent reproducibility. The ValveBank is especially useful in preparative work when a protocol has been established and programmed to repetitively isolate your valuable molecule.

### User's guide notation

Throughout this manual, ValveBank keys for the user to press are shown in bold type: <Enter> or <Cancel> or as keys:



### Care of your ValveBank screen

Avoid scratching the screen cover by cleaning it with a 50% alcohol/water solution using a cloth – never paper towels.

## Mounting Options & Assembly

We would like to explain the small items in the plastic bag included with your ValveBank. The first difference in the new ValveBank8 you may notice if you were familiar with the previous generation, is that the keypad and liquid crystal screen are now separated by cable from the main unit in what we call the "calc." Now your ValveBank can be mounted away from your experiment area (even rack-mounted), but its control can be placed nearby. We have included four rubber feet, six inches of Velcro, and six inches of adhesive magnetic tape for several calc mounting options. These three choices are left for you to decide how to best mount the calc for your use: on a tabletop with feet, or 'stuck' to any surface with removable Velcro or magnetic tape.

The ValveBank main unit also has two options. Four additional feet are included for simply leaving the ValveBank on the bench top; or rack-mounting brackets and screws can also be purchased separately.

## ValveBank Accessories

AutoMate Scientific offers a number of products which compliment the ValveLink8.2 controller: valves, pressure upgrades, Perfusion Pencils®, ThermoClamp™ temperature controllers, perfusion chambers, manipulators, rack mounting brackets, BNC cables and entire perfusion systems.



Oocyte Chamber  
Part # OPC-1



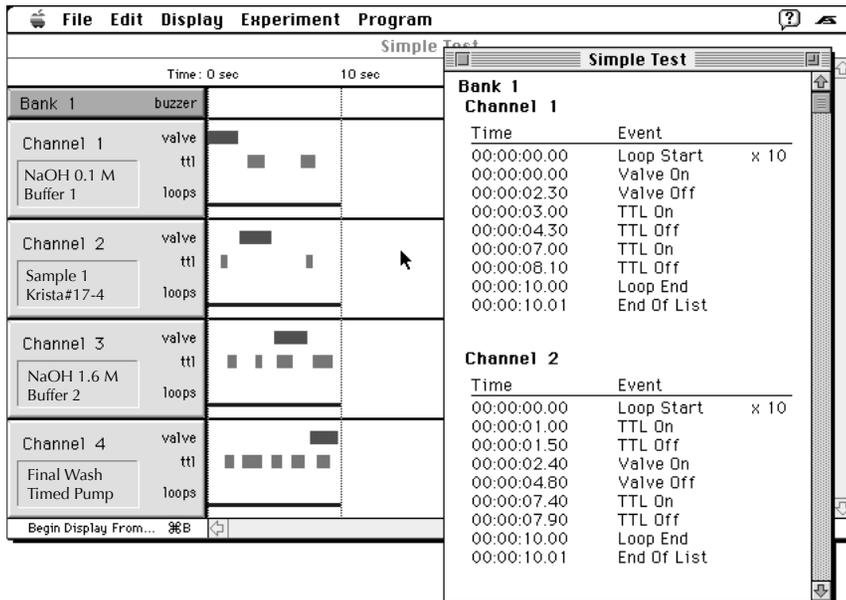
Petri Dish Chamber  
Part # PCP-1



Pinch Valves (set of 4)  
Part # 02-pp-04

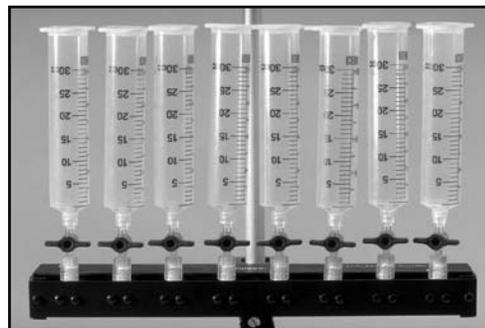
## EasyCode™ Software for Macintosh and IBM-PC

AutoMate Scientific's *EasyCode* software for the Macintosh and IBM-PC compatibles allows you to program On/Off sequences through a simple, graphic timeline interface, and then send and receive these programs to the ValveBank through its serial port. See page 47.



## Luer lock Valves & Syringe Reservoirs

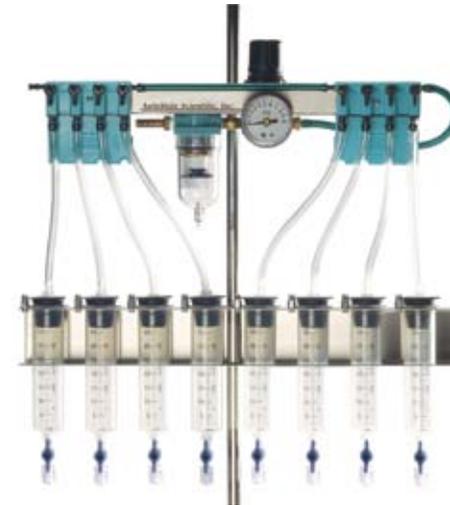
AutoMate also offers valves with luer lock fittings for direct connection of syringes. This method eliminates wasted solution in tubing between the reservoirs and valves. Small 2-way stopcocks are included when this option is ordered.



## Pressure Regulated Perfusion System

AutoMate Scientific offers a Pressurized Perfusion Upgrade with four, eight or sixteen channels for:

- Faster switching
- Microliter fine delivery
- Small diameter pipette delivery
- Steady flow-rate
- Microinjecting



The package can be added to any new or existing perfusion rig - from AutoMate Scientific, any third-party manufacturer, or even homemade. Connect to house air, tank, or compressor (30 to 100 psi). Precision regulator delivers zero to 10 psi to pressurized syringe reservoirs.

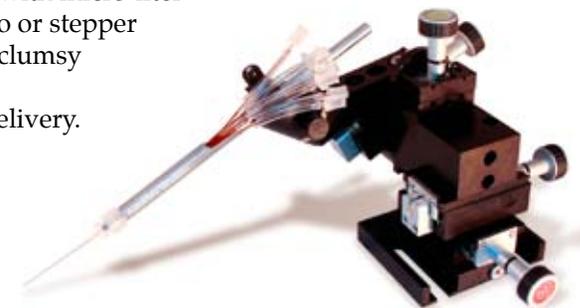
- Part #09-04 4-channel
- Part #09-08 8-channel
- Part #09-16 16-channel

## For Single-cell or Whole-cell Superfusion

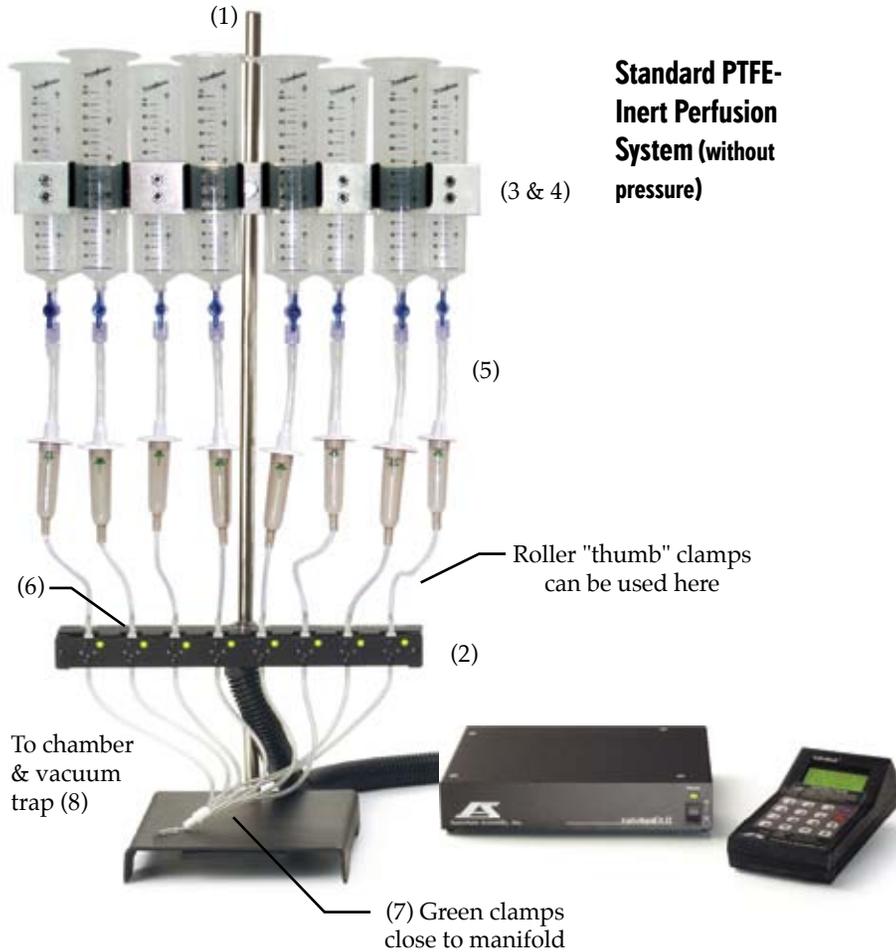
### Perfusion Pencil® Multi-Barrel Manifold Tip

4-16 micro-bore tubes into 1 outflow

- Rapid solution change with micro-liter dead volume. No piezo or stepper motor translation. No clumsy rotating valves.
- Single-cell and patch delivery. For mounting on any micromanipulator.
- 100, 250 & 360µm removable tips available



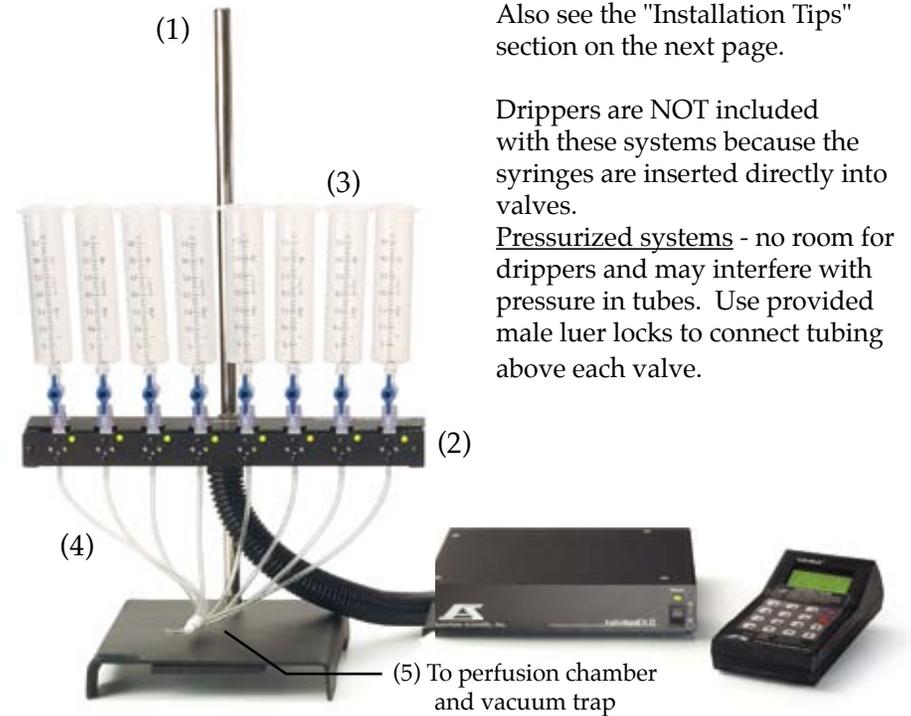
## System Set-up Diagrams



- 1) Assemble ringstand rod and base.
- 2) Attach valve unit.
- 3) Attach reservoir bracket(s).
- 4) Insert syringes with stopcocks.
- 5) Insert short pieces of 3/16" i.d. tubing over tops of drippers, then insert over syringe fittings.
- 6) Attach dripper tubing to upper valve barb. Cut as desired, but leave long enough to move reservoirs.
- 7) Insert green clamps on pieces of 1/16" tubing between bottom valve barbs and manifold.
- 8) Connect manifold outflow into your perfusion chamber.
- 9) Plug numbered valve cables into ValveBank ports.

## Pinch Valve, Pressurized and Luer-Lock Perfusion Systems

Instructions on this page are for pinch valve perfusion systems, PTFE-Inert luer lock valves, or pressurized systems. Regular hose barb PTFE-Inert perfusion systems please see the previous page. Luer lock systems should also see the photo on page 6. Find additional photos and diagrams of the pressure system on pages 7 and 13.



- 1) Assemble ringstand base and rod.
  - 2) Attach valve unit.
  - 3) Insert syringes with stopcocks.
  - 4) Connect tubing between bottom valve tube and manifold.
  - 5) Connect manifold outflow into your perfusion chamber.
  - 6) Plug numbered valve cables into ValveBank ports.
- Pinch valves have no fittings. Simply slide larger tubing over small pinch valve tube above and below the valves.

## Installation Tips

- Flow rate is adjusted by the relative height of reservoirs and manifold flow regulator plus optional air pressure.
- Leave the tubing between the reservoirs and valves long enough to raise and lower the reservoirs.
- Unused lines should be replaced with plugs on manifold, or temporarily clamped-off just above manifold to avoid back bleeding into empty lines. They **MUST** also be filled with solution.
- Priming one line at a time reduces bubbles.
- Connect your vacuum trap line directly to the outflow of the manifold for running cleaning solutions and drying your lines quickly.
- Determine dead volume from the manifold to prep by measuring time and volume required to flush a colored liquid with a clear one. Calibrate flow rates by running one line into a graduated cylinder for a fixed period of time.
- Filter solutions down to 5-10 microns when using PTFE or Lee valves.
- See more tips in the "Techniques" chapter later in this manual.

## Bubbles and Degassing

Bubbles are often caused by outgassing. This is particularly true when media is stored cold overnight and allowed to warm to room temperature in the perfusion system tubing. Since warm liquids hold less gas, bubbles will form in the tubing and valves as gas leaves the media. The best solution is to pre-warm your solutions by at least 2-3 degrees above room temperature even if you are adding gas (CO<sub>2</sub>, Carbogen, etc.) to your reagents. If you are using an inline heater like the ThermoClamp, it is a good idea to warm solutions 2-3 degrees above your inline heater temperature to prevent bubbles from forming there. If possible, keep the solutions in the reservoirs at this higher temperature all day using reservoir heaters.

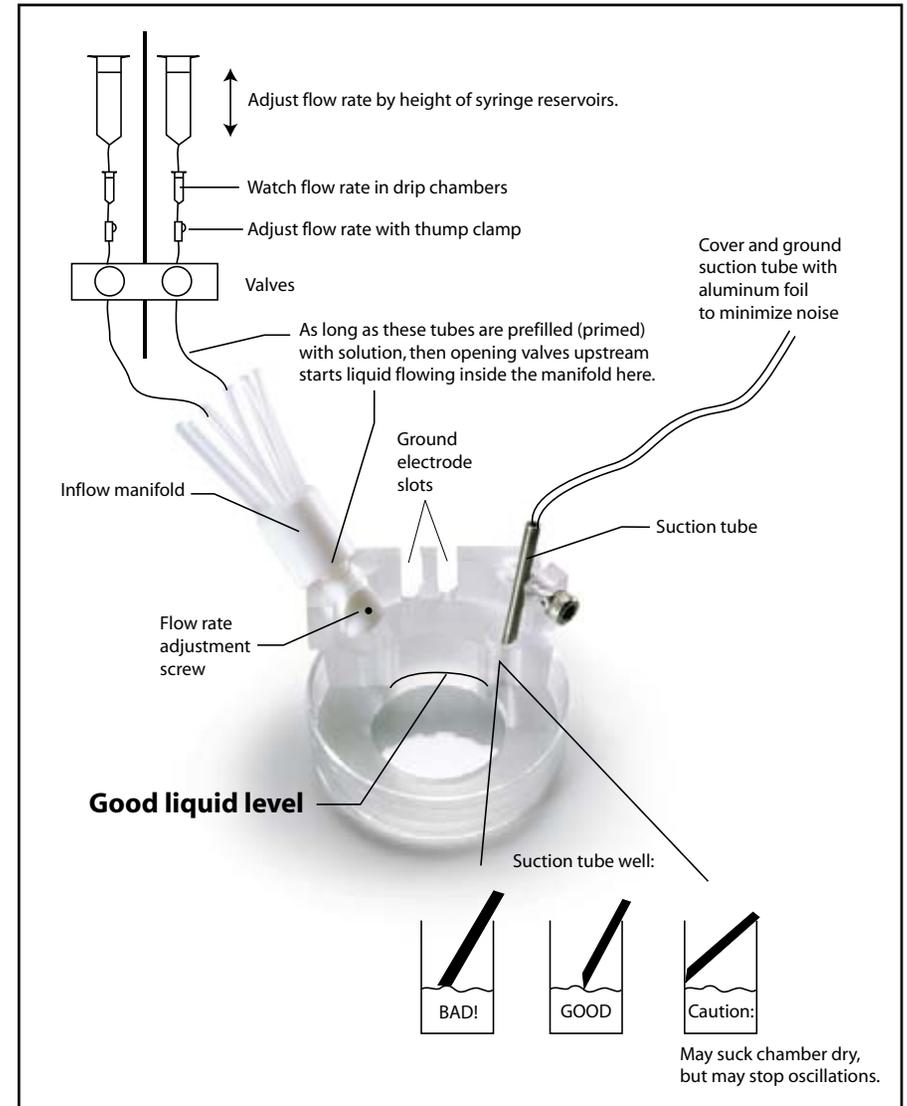
Degassing can also be facilitated by applying a slight vacuum to the reservoirs, although this is not recommended if you are purposely gassing your media.

## Networking multiple ValveBanks

Designate one ValveBank as the 'Master' and all others as 'Slave' units. Connect the ValveBank's together with the provided cable with plug #1 to the master's TTL In/Out Port and plug #2 in the secondary unit. Make a note of which ValveBank is master – it will be used to start all slave units. See the Configuration/ Technical chapter for more details.

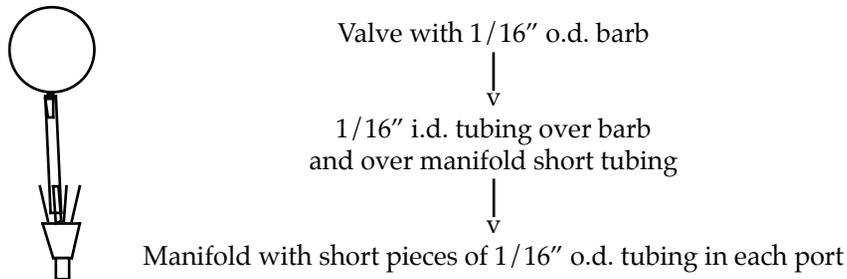
## Perfusion Cheat Sheet

Your perfusion system may not include optional drip chambers, thumb clamps or the Petri dish chamber, but these hints from Woods Hole may still help.

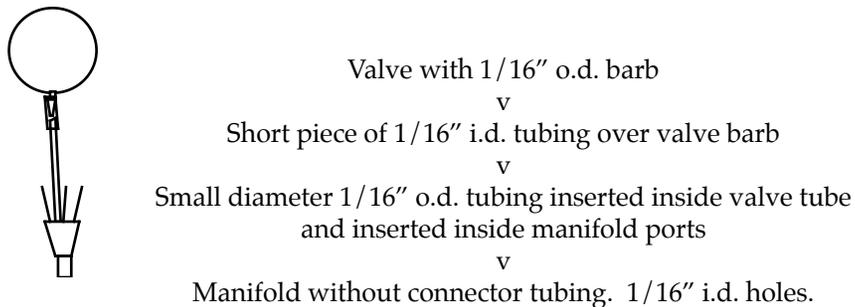


## PTFE-Inert Micro-manifold Use

Your valves should be equipped or retrofitted with 1/16" o.d. outflow hose barbs. Micro-manifolds are shipped with a short piece of 1/16" o.d. tubing in each hole (inputs and outflow). You can either connect the valves to manifold inports with a piece of 1/16" i.d. tubing over both the valve barbs and short pieces of manifold tubing:



... or, for even **less dead volume**, use a short piece of 1/16" i.d. tubing over the valve barb, and piece of smaller 1/16" o.d. tubing inserted inside the valve tubing and manifold ports (you may need to supply extra small tubing for this option):

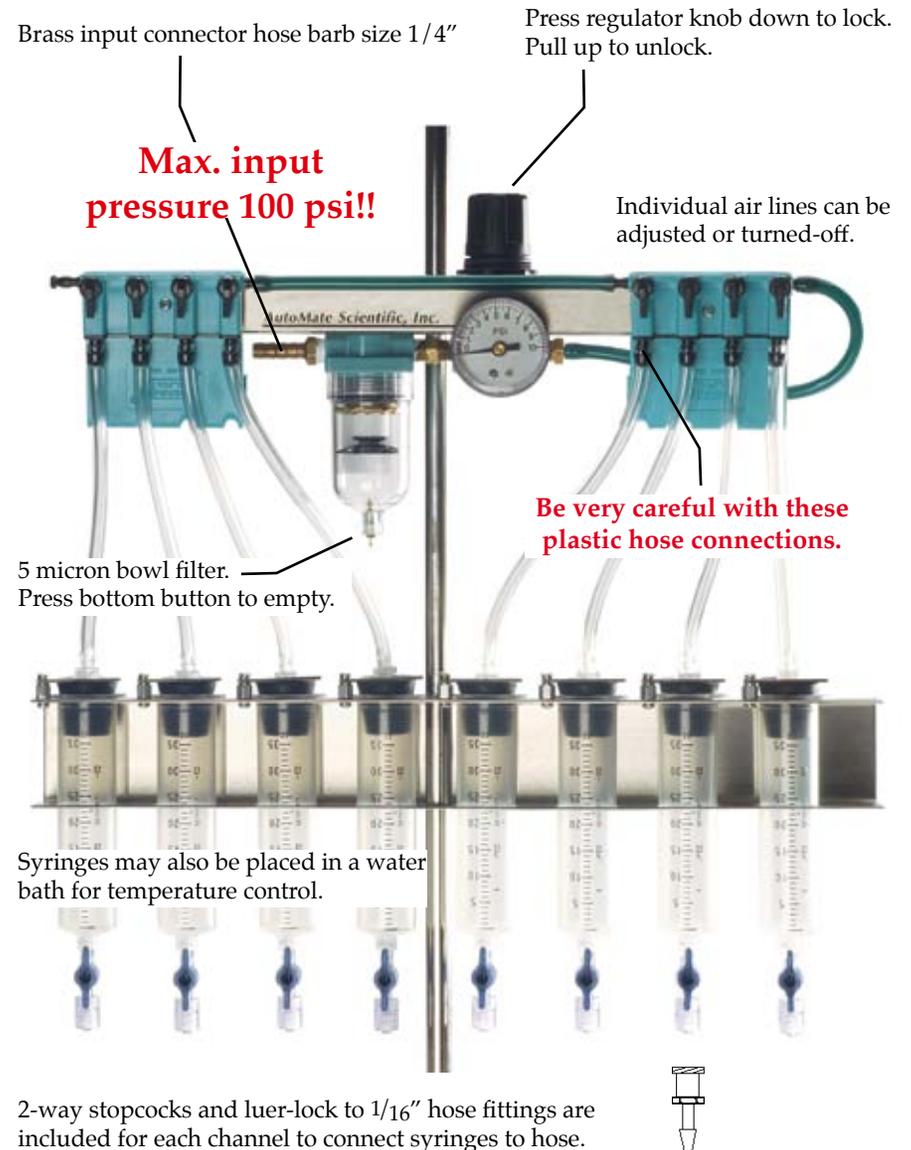


Cutting the tubing at an angle will make insertion easier. Cutting the tubing square, however, will minimize dead volume when inserted as far as possible into the manifold – being careful not to block at the point of convergence.

Remember to keep all tubing as short as possible.

## Perfusion Pressure Kit

(Sold separately)



Hoses should continue from syringes to valves.

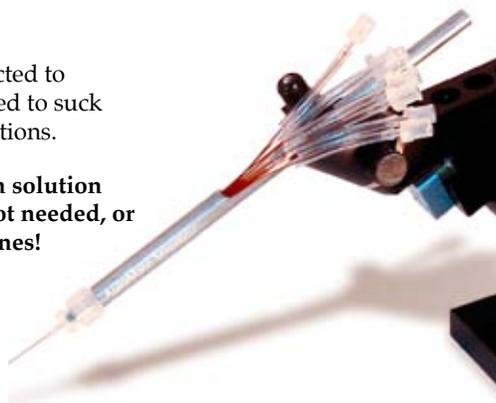
## Perfusion Pencil Multi-barrel Manifold

(Sold separately)

One of the eight lines may be connected to vacuum through a valve programmed to suck the dead-volume clear between solutions.

**All inflow tubes must be filled with solution before use even if some lines are not needed, or liquids will backflow into empty lines!**

Tighten removable tip for minimum dead volume.



### Chemical Information

The tubing inside the manifold body is polyimide (nylon). The removable tips include a polycarbonate luer lock fitting with a fused silica (quartz) needle coated with polyimide. These materials are resistant to most acids, bases and organic solvents. To avoid dust contamination, we recommend pre-rinsing the Perfusion Pencil and tip with distilled water. Also, it is good practice to discard the first few microliters of solution before using the device. The Perfusion Pencil and removable tips are shipped non-sterile. They can be chemically sterilized or autoclaved. However, repeated autoclaving may weaken the adhesive bond between the luer lock fitting and the needle.

### Maintenance

You can expect several years of useful lifetime for your tip if you wash it daily. Use a syringe or vacuum to pull water, then alcohol three times each through the tip. If the Perfusion Pencil is filled with pure salt solution, leaving it in the syringe overnight will not usually cause the tip to block. However, if it is used for high viscosity fluids, flushing after each use is recommended.

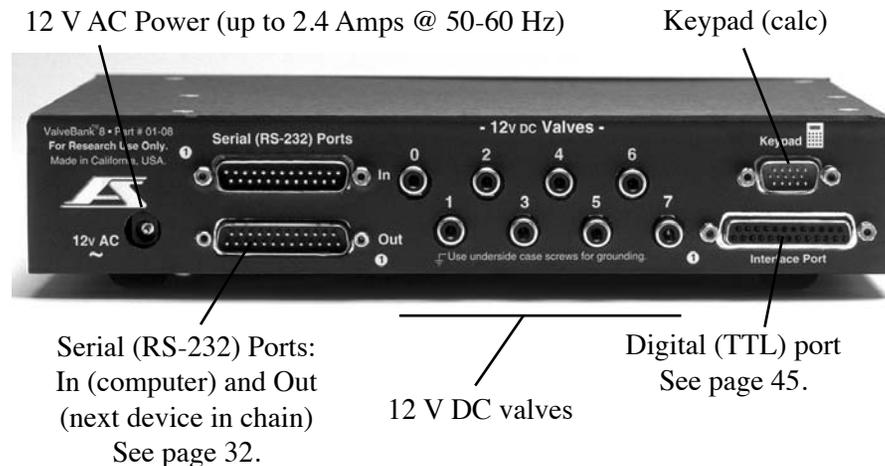
### Cutting

The removable tips are shipped with 0.5" (1 cm) length polyimide needles. They can be cut shorter by rolling a razor blade on them against a hard surface. However, this may leave a small crack or barb on the tip. To get a flat cut, score the coating of the needle with a ceramic cleaving stone or a diamond cutter and pull directly apart, making sure not to pull at an angle. You may notice a larger outer tube enclosing the lower part of our smaller, 100 $\mu$ m needles. This is simply for added rigidity, and can be cut if needed.

Part No.  
#04-04-xxx 4-into-1 Pencil with tip  
#04-08-xxx 8-into-1 Pencil with tip  
#04-16-xxx 16-into-1 Pencil with tip  
(xxx = 100, 250, or 360 $\mu$ m)

**Replacement Tips:**  
#04-xxx Specify i.d. size:  
100, 250, or 360 $\mu$ m

## Back Panel



### Case & Valve Grounding

This equipment must be earth grounded. Use any screws on the bottom or side of the ValveBank case for grounding. Order AutoMate part no. 01-05 "Low noise, valve and case grounding package" for an extra grounding wire attached to each individual valve extending back to the controller. Each of this item grounds four (4) valves. Please order two for eight channel perfusion systems. This item must be ordered at the same time as the valves. Connect the ground wire from the valves to a screw on the bottom or side of the controller case.

## Main Menu

Select Function:  
Run Mode

This notation is used throughout the manual to represent the ValveBank's liquid crystal display. The ValveBank8 uses a 4-line by 16 character screen, so examples will differ slightly.

The ValveBank displays two introduction screens every time it is turned on. These can be advanced by pressing any key.



<Up/Dn Arrow> keys  
Scroll through 6 menu choices.

|               |  |
|---------------|--|
| Run Mode      | Run an existing program                          |
| Manual Mode   | Open/close valves manually                       |
| Edit Program  | Write a new program or edit an existing one      |
| File Mode     | Copy and erase programs                          |
| Serial Mode   | Transfer programs to/from your personal computer |
| Configuration | Adjust preferences                               |

Each Mode is discussed in its own chapter later in the manual.



<Enter> key  
Selects current menu choice.

### ValveBank

```

=== AutoMate ===
T Manual Mode V
1C 2C 3C 4C
5C 6C 7C 8C
            
```

**Manual Valve Commands**

|               |  |
|---------------|--|
| <b>CANCEL</b> | Pause / End Program + ALL Valves Close   |
| <b>ENTER</b>  | Resume + Buzzer Off + Special Features   |
| /             | Toggle 1-8 Control Valves or TTL outputs |
| <b>1 - 8</b>  | Open/Close Valve or TTL outputs          |
| <b>9 / 0</b>  | ALL Open / Close                         |

|   |   |   |        |
|---|---|---|--------|
| 1 | 2 | 3 | ENTER  |
| 4 | 5 | 6 | CANCEL |
| 7 | 8 | 9 | ↓      |
| 0 | ← | → | ↑      |

**Menus:**    **ARROWS** change selection  
                  **ENTER** makes selection  
                  **CANCEL** returns to last screen

**AutoMate Scientific, Inc.**

## Manual Mode

Manual mode allows user control of valves and TTL outputs for easy set-up, testing, calibration, and cleaning.

MANUAL MODE V  
1CL 2CL 3CL 4CL ← Status Bar (see below for explanation)

### Follow instructions printed on the ValveBank.

A low click from valves indicates opening or closing. A hum from a valve indicates that it is holding open at the appropriate voltage.



Toggle between 'V' alves and 'T'TL Mode  
Look for a **V** or **T** in upper **right** corner. Selects whether ALL Open/Closed ('9' and '0') commands affect valves or TTL outputs.



Leave Manual Mode [**Emergency ALL CLOSED**]  
Closes all valves and sets all TTL outputs to Low



Toggle "One-at-a-time" Mode on/off. When on, an 'O' appears in upper right corner, and opening a valve will close all others (for perfusion use).



Manual Mode Special Features Menu  
(see next page)

### Status Bar

This 'T' means **Timed** Manual Mode is in use (see next page)

'V' alve or 'T'TL Mode for all on/off (see above)  
'O'ne-at-a-time Mode on/off (see <Lt/Rt Arrows> above)  
Inverted number is a **Master** channel (see next page)

T Manual Mode 0V  
| 1CL 2CL 3CL **4CL** |

#VT — T = TTL state .....(H)igh / (L)ow  
          V = Valve state .....(O)pen / (C)losed  
          # = Channel # .....1 through 4 or 8

## Manual Mode Special Features Menu



Makes selection.  
Jumps to next screen.



Returns to Manual Mode.

Run a program?  
Yes >No

Answer Yes to run a user program from Manual Mode. The current valve and TTL state is preserved (may be changed later by your program). Control is returned to Manual Mode after the program is completed or aborted (again, with opened valves and TTL's remaining open). Useful for running a protocol after establishing a stable baseline or pre-programmed wash-outs and line priming.

Edit master ch?  
Yes >No

Choose a master:  
1 2< 3 4

Using a **Master channel** insures at least one valve is always open. When you close the last open valve, the Master valve will open.

Master channel does NOT open after pressing #0 for All Closed.

Use Timed Open?  
Yes >No

>> T=00:00:20.00  
Enter Duration

Timed valves:  
1Y 2N 3N 4Y

When **Timed Manual Mode** is turned on, any valves designated will remain open only for pre-set amount of time then close again (opening the Master channel [above] if also being used). A Master channel may also be timed, but if it is the only valve open, it will not close.

Timed channels will NOT turn off after pressing #9 All Open.

**One-at-a-Time Mode** insures that no more than one valve is open at a time. Opening any valve closes all others.

Pressing #9 for All Open ignores One-at-a-Time Mode.



## Editing a Program

Line number (see <Up/Dn Arrows> below)

|     |               |                                   |
|-----|---------------|-----------------------------------|
| 01  | T=00:00:00.00 | <- Time line (HH:MM:SS.00)        |
| Ch1 | END OF LIST   | <- Current channel & command line |

Time line: Set time value using arrows and digits  
Represents time event will occur - NOT duration


 Move the cursor up/down one line at a time  
 When cursor is on the line number:  
 Browse up/down two lines (one event) at a time  
 Note: You cannot scroll past the END OF LIST.


 Time line: Move between time digits & line number  
 Cmd. line: Change commands (see next chapter)




After programming each channel, press <Enter> or <Cancel> to return to the **Select Channel** screen and repeat the programming process for all four channels in a program.

 <Cancel> from Select Channel returns to the **Save Program** screen if you have made any changes.

### Saving a Program - Save often entering long programs!

None of the changes you make are permanent until you save them. When you finish editing a program, the ValveBank will ask you if you want to save the changes:

|              |                                    |
|--------------|------------------------------------|
| Save Program | <Enter> to make selection          |
| > YES NO     | <Cancel> return to previous screen |
|              | <Lt/Rt Arrows> change selection    |

If the program number already contains a program, the user will be asked for confirmation to overwrite:

|               |                                     |
|---------------|-------------------------------------|
| Overwrite OK? | <Enter> to make selection           |
| > YES NO      | <Cancel> returns to previous screen |
|               | <Lt/Rt Arrows> change selection     |

After a successful save, the ValveBank displays a confirmation message and returns the user to the main menu.

### Next Time/Command Prediction

In order to speed your programming, the ValveBank automatically predicts the next time and command you will use and fills them in on the next programming line for you. For the time line, it uses the time that the previous command will finish. Then it predicts the compliment of the previous command (Valve Off after Valve On, Buzzer Off after Buzzer On, etc.) You can always change the time and command that it guesses – it just makes programming easier. The ValveBank only predicts after you've changed the previous line.

### Total Loop Time Calculation

Loop structures are explained in the next chapter on *Commands*. As you enter a program with a loop and finish entering its LOOP END command with a time, the ValveBank calculates the total length of the loop multiplied by the number of iterations you have entered and enters this finishing time on the next programming line. If you change the loop start, loop end or iterations later, you may need to revise subsequent command times accordingly.

### Example:

|     |               |
|-----|---------------|
| 04  | T=00:00:10.00 |
| Ch1 | LOOP STRT 12  |

When you finish entering the LOOP END command shown, the ValveBank determines when the loop will be completed and enters this time on the next command line.

|     |               |
|-----|---------------|
| 09  | T=00:00:20.00 |
| Ch1 | LOOP END      |

|     |               |
|-----|---------------|
| 10  | T=00:02:10.00 |
| Ch1 | VALVE ON      |

Remember that the first pass through the loop counts as its first iteration.

## Programming Example

Write a new program which opens valve one for five minutes, then valve three for six hours (follow the underline cursor in the examples!)

| Progressive display                 | Keys Pressed  | Result (see next screen)  |
|-------------------------------------|---------------|---|
| Select Channel<br>Channel=1         |               | Start new program.<br>Begin with channel 1                          |
| 01 T=00:00:00.00<br>Ch1 END OF LIST |               | Move right and down<br>to edit first command                        |
| 01 T=00:00:00.00<br>Ch1 END OF LIST | Several times | Scroll through<br>commands to Valve On                              |
| 01 T=00:00:00.00<br>Ch1 VALVE ON    |               | Next line   |
| 02 T=00:00:00.00<br>Ch1 END OF LIST | Several times | Move to minutes digit   |
| 02 T=00:00:00.00<br>Ch1 END OF LIST |               | Enter time (5 minutes)<br>then move down<br>Valve Off auto selected |
| 02 T=00:05:00.00<br>Ch1 VALVE OFF   |               | Done, now <Cancel><br>to program other channel.                     |
| Select Channel<br>Channel=2         |               | Select next channel   |
| 01 T=00:00:00.00<br>Ch2 END OF LIST | Several times | Change times and<br>commands as above                               |
| 01 T=00:05:00.00<br>Ch2 VALVE ON    |               | Move to next line, enter<br>time and command                        |
| 02 T=06:05:00.00<br>Ch2 VALVE OFF   |               | Type <Cancel> 2x to jump<br>to "Save program" screen                |
| Save Program<br>> YES NO            |               | Type <Enter> to finish<br>saving program<br><Cancel> always aborts  |

## Commands

### Warning:

Time values for each event in a channel must be greater than or equal to the previous event's time.

|              |             |                   |
|--------------|-------------|-------------------|
| 01 VALVE ON  | 00:00:10.00 |                   |
| 02 BEEP      | 00:00:10.00 | Legal structure   |
| 03 VALVE OFF | 00:00:20.00 |                   |
| 01 VALVE ON  | 00:00:20.00 |                   |
| 02 VALVE OFF | 00:00:01.00 | Illegal structure |

Error checking is built into the Save Program screen to check for these illegal structures.

### Note:

Times represent **when** event will occur, NOT durations.

|             |   |
|-------------|---|
| VALVE ON    | Turn valve on at the specified time   |
| VALVE OFF   | Turn valve off at the specified time  |
| TTL ON      | Turn TTL output on at the specified time  |
| TTL OFF     | Turn TTL output off at the specified time   |
| BUZZER ON   | Turn buzzer on at the specified time  |
| BUZZER OFF  | Turn buzzer off at the specified time   |
|             | (Example: sound buzzer for several minutes if you must be alerted for a particular step, but may be away from your experiment for a few minutes.) |
|             | After entering an On/Off command, its counterpart is automatically 'guessed' on the next command line.  |
| BEEP        | Sound buzzer for 1/4 second<br>(needs no Off command)   |
| INSERT LINE | Moves current line down and inserts a new line in its place for adding new commands in existing programs. Leaves a "BLANK" placeholder.           |
| DELETE LINE | Deletes the current program line and moves next line up. <b><u>This is permanent!</u></b>   |

END OF LIST Automatically inserted by the ValveBank after the last user command; or can be entered by the user to **erase** an existing channel. Represents the last line of a channel's programming. A running program finishes when it reaches the END OF LIST in all four channels.

**Warning:** User can never scroll down past a END OF LIST command; therefore, any commands below an inserted END OF LIST will be inaccessible & lost.

If END OF LIST is entered accidentally:

- (1) Press <Cancel>
- (2) Do **not** Save Program
- (3) Return to Select Program screen
- (4) Re-load the last saved version of your program

**Note** - This will erase any changes made since the last time the program was saved but will recover any programming the END OF LIST erased. Decide whether lines lost are worth recovering first.

BLANK A place-holder command which performs no function when executed by a program.

### Loops

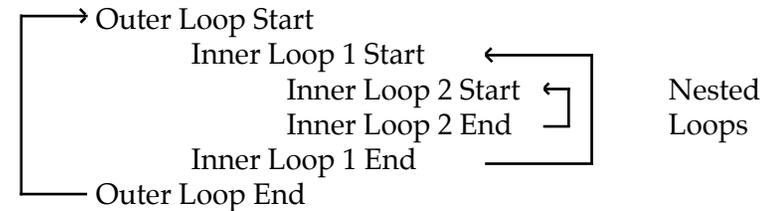
LOOP STRT X01 Set start time for an upcoming LOOP END command and number of iterations.

LOOP END Set loop ending time.

|                                      |            |   |
|--------------------------------------|------------|---|
| 06 T=00:12:04.00<br>Ch1 LOOP STRT 01 | ↓          | <Dn Arrow> to access number of iterations |
| 06 T=00:12:04.00<br>Ch1 LOOP STRT 01 | 1 3        | <Digit keys> to set                       |
| 06 T=00:12:04.00<br>Ch1 LOOP STRT 13 | ENTER or ↓ | <Enter> or <Down Arrow> to finish         |

### Loop Structures

Loops provide a powerful means of grouping repeated operations. The ValveBank is limited to only 64 commands per channel, so heavily used VALVE ON/OFF and TTL ON/OFF combinations should be programmed as loops to avoid filling-up all of the available program lines. Loops on the ValveBank can also be nested (used inside one another) up to four deep.



**Each channel is limited to 16 loops.**

### Multi-channel Loops

You may want to repeat command sequences from several channels. To do this, you must include a LOOP START and END combination at exactly the same times in all channels to be included.

| <u>Channel 1</u> |             | <u>Channel 2</u> |                        |
|------------------|-------------|------------------|------------------------|
| LOOP START       | 00:00:00.00 | —                | LOOP START 00:00:00.00 |
| VALVE ON         | 00:00:00.00 |                  |                        |
| VALVE OFF        | 00:00:05.00 |                  | VALVE ON 00:00:05.00   |
|                  |             |                  | VALVE OFF 00:00:10.00  |
| LOOP END         | 00:00:12.00 | —                | LOOP END 00:00:12.00   |

### TTL-Input Commands

TTL RESPOND Valve will 'mirror' its channel's TTL input after the specified time: while TTL input is High, valve will be Open, TTL Low = Closed. See *Configuration* to invert High/Low logic.

TTL IGNORE Valve ignores TTL inputs after specified time. (Turns off a TTL RESPOND command).

**TRIGGER ON** Must be followed by a TRIG LENGTH command (which is automatically inserted and deleted by the ValveBank). The TRIGGER ON command instructs the ValveBank to begin watching the TTL input associated with its channel. When that TTL input goes High, that channel's valve will open (like a TTL RESPOND command), but only for the amount of time specified by the following TRIG LENGTH command. If the TTL input is already High when the TRIGGER ON command is processed, the valve is opened immediately and timed according to the TRIG LENGTH as usual. TRIGGER ON only triggers once. Use loops to repeat trigger.

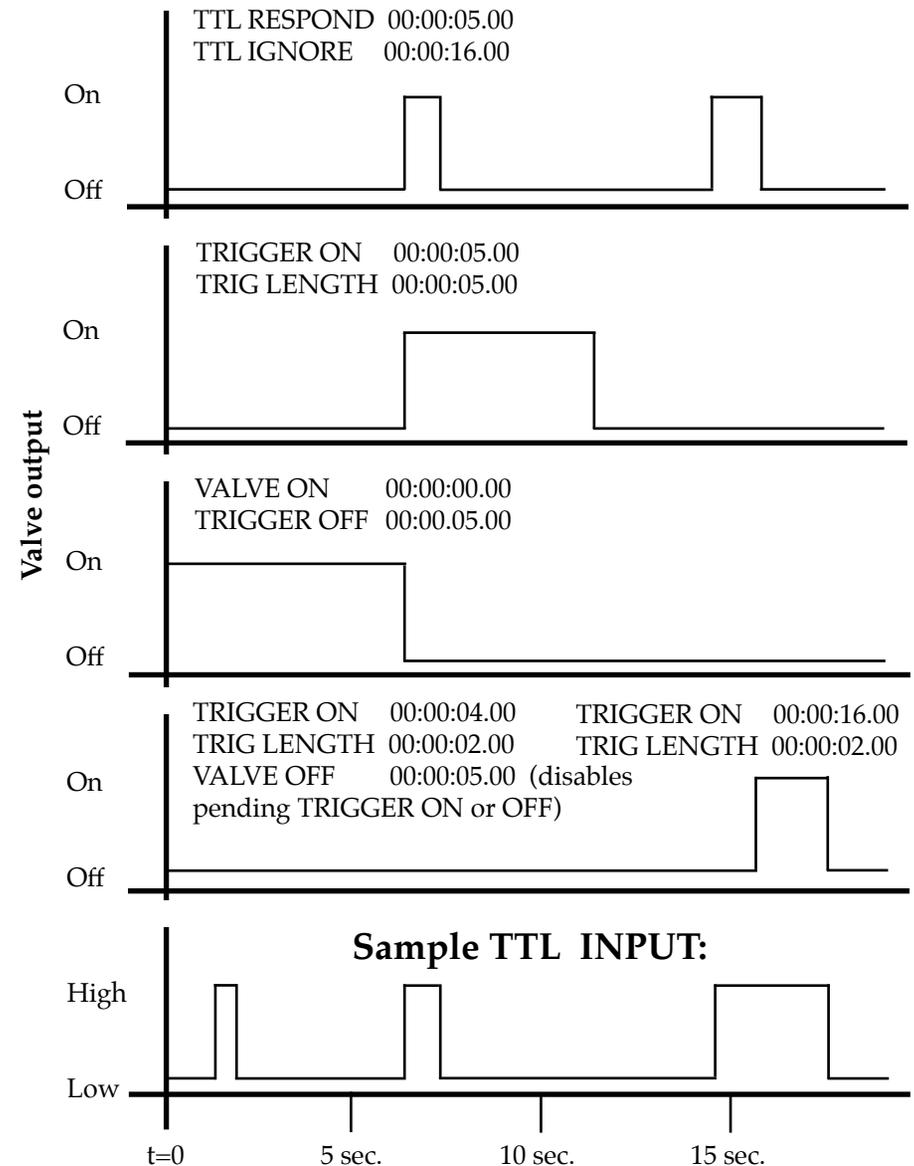
Either a VALVE ON or VALVE OFF command will discontinue a pending TRIGGER ON command and override any TRIG LENGTH time remaining.

**TRIG LENGTH** Cannot be entered by itself. Automatically inserted (or removed) by the ValveBank following a TRIGGER ON command. Specifies amount of time to hold a valve open when TRIGGERed. Cannot be deleted, changed or separated from its TRIGGER ON partner with an INSERT LINE. You must change or delete its TRIGGER ON to remove it.

**TRIGGER OFF** To be useful, TRIGGER OFF must be preceded by a VALVE ON command. Once encountered, the TRIGGER OFF command instructs the ValveBank to watch its TTL input (like a TRIGGER ON). But, when the TTL input goes High, the ValveBank *closes* that channel's valve (assuming it was open). TRIGGER OFF is discontinued by a VALVE ON or OFF just like TRIGGER ON.

See the Timing Diagram on the next page, and the *Computer Interfacing* chapter for more TTL input information.

### Timing diagrams (Sample TTL input is bottom graph)



## Run Mode

Select Program  
Program=01

<Enter> to Select Program  
<Cancel> return to Main Menu  
Enter 2 digit program number (1-36)

Press A Key To  
Start Program

<Enter> to begin execution  
<Cancel> to abort

## Networking multiple ValveBanks

If you are using multiple ValveBanks, all *Slave* units will display:

Waiting For  
Master Start

<Cancel> to abort  
(see *Configuration* chapter p. 43)

A pulse from the *Master* ValveBank will now start programs running on all properly wired *Slave* units waiting on this screen.

## Running Programs

While a program is executing, the current time and valve/TTL output status is displayed. (Fractions of seconds are not displayed)

01 T=00:13:08 V  
10H 2CL X0L 4CL

← Time line (See *Manual Mode*  
← Status bar chapter for status codes)

While a program is running, all manual key commands are functional except <Enter> to access the Manual Mode Special Features Menu. See the *Manual Mode* chapter (p. 18) for information on commands available and a description of the status bar. An additional code appears on the status bar while a program is running:

'X' Channel is done – reached its END OF LIST command.  
Program is completed when all four channels are done.

Additional manual commands while a program is executing:



1st press: Pauses any running program  
All valves and TTL's remain open or closed as they were when paused  
2nd press: Closes all valves, returns TTL's to Low  
Returns to Main Menu



Buzzer OFF  
Resumes paused program

When the program is completed, the display will be left showing the final time (including fractions of seconds).

01 T=07:36:11.84  
Program Finished

All valves Closed (unless run from Manual Mode) and completion time shown.



Press <Cancel> to return to Main Menu.

## Single Repeat Running - Microinjecting



Press key <1> twice after a program ends to run it again – useful for microinjecting repeatedly.

See Repeat Run in *Configuration* for rapid repeating.

## Manual Mode Special Features

Special Manual Mode Features (One-at-a-Time, Master and Timed Modes) are **IGNORED** by VALVE ON and OFF commands, but still work for manually toggling valves open and closed. (See pg. 19 for descriptions) They must be turned on and off in Manual Mode since <Enter> will not access the Special Features Menu while running a program.

## Serial Mode

Serial mode is used to transfer programs back and forth between the ValveBank and a computer running the AutoMate graphic programming package, *EasyCode*. Programs can be entered and edited on a PC or Macintosh, then downloaded into the ValveBank's battery memory for running, further editing or future use.

Likewise, programs written or modified in the ValveBank can be sent back to a host computer for storage, editing or printing.

|                                    |   |
|------------------------------------|---|
| Select Transfer:<br>> SEND RECEIVE | <Lt / Rt Arrows> move cursor<br><Enter> select menu option<br><Cancel> abort to Main Menu |
|------------------------------------|---|

Follow the instruction found in the *EasyCode* manual for preparing your computer to send or receive information with the ValveBank. Press <Enter> on the ValveBank when *EasyCode* tells you it is ready.

### ValveBank —> Computer (send)

|                                   |       |  |
|-----------------------------------|-------|--|
| Select Transfer:<br>>SEND RECEIVE | ENTER | Load a ValveBank user program then transmit it to a host computer. |
| Select SOURCE<br>Program=01       | ENTER |  |

### Computer —> ValveBank (receive) Start a receiver first.

|                                   |       |   |
|-----------------------------------|-------|---|
| Select Transfer:<br>SEND >RECEIVE | ENTER | Receive a program then save it in a ValveBank program slot. |
| Destination:<br>Program=01        | ENTER |   |

CANCEL <Cancel> will abort during transfer.

See page 45 for a serial cable diagram.

## File Mode

|                                 |        |                     |
|---------------------------------|--------|---------------------|
| > COPY Program<br>ERASE Program | ENTER  | Make selection      |
|                                 | CANCEL | Return to Main Menu |

COPY Program will request a SOURCE program (with a warning if the source is blank) and the DESTINATION program (with confirmation for Overwrite if that program slot is already being used).

ERASE Program requests the program number to erase, then asks for verification before completely erasing it.

### Clear All Memory

This command should be used with extreme care! Entering 99 on the ERASE Program screen will ask for verification to ERASE ALL MEMORY. Although AutoMate Scientific has thoroughly tested the ValveBank's internal software, like most computers, it is possible for the ValveBank to "Crash" and freeze-up. In extremely rare circumstances, a bad crash can write garbage data in random bytes across the memory. When you turn the ValveBank back on, you would find strange commands and times stored in some programs (used or unused). Again, this is very rare. However, if this occurs, you may wish to clear all memory and re-send programs stored on your Macintosh or PC in the *EasyCode* program to the ValveBank by Serial Mode (assuming you have *EasyCode*).

Clear All also resets all *Configuration* and Manual Mode Special Functions settings to their factory defaults.

## Computer Interfacing

Using the AutoMate *EasyCode* software package, a user can create ValveBank program sequences on a PC and send them to the ValveBank's memory. Programs are then run on the ValveBank. However, some users have already invested long hours in developing custom timing and data collection programs on their personal computers to automate their research. The ValveBank can still be invaluable for these users both for Manual Mode calibrating and as an advanced valve driver under computer control.

### Valve Driving

With four TTL pins from an interfacing board on a personal computer, the user can turn valves on and off through the ValveBank TTL inputs with their own custom programs.

Why not connect valves directly to your computer? Several reasons:

- 1) Most computer interfaces provide +5V signals – not strong enough to drive most valves (6 to 12V DC and up).
- 2) Computer interface signals are often too noisy for electro-physiology amplification. The ValveBank is designed with special low noise circuitry to minimize interference with high-gain amplification.
- 3) Finally, many solenoid valves are designed to be opened with a short, full-voltage pulse, then “held-in” with a lower voltage to keep the valves from heating. The ValveBank automatically provides dual-voltage hold-in even when being controlled by an external computer.

The easiest way to drive valves through the ValveBank is to write a short program with a TTL RESPOND command in each channel at time zero, and another TTL RESPOND at time 99 hours (to give the program length). Then set Repeat Run ON in the *Configuration* menu. Connect your four interface signals to the four TTL inputs on the ValveBank (see the *Technical Notes* chapter) and run this program. The ValveBank will open and close valves exactly mirroring the computer signals (with 10 millisecond accuracy).

### Feedback to a recorder

It is also possible to program the ValveBank to provide synchronization signals back to a computer or recording device to reference exactly when valves were opened or closed. Just include TTL ON commands immediately after VALVE ON's and monitor the four TTL outputs on the ValveBank.

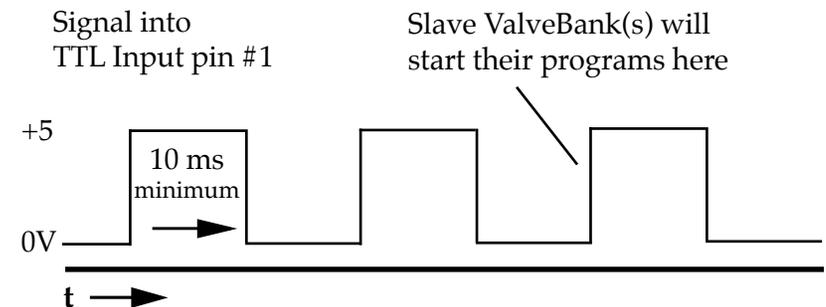
|          |                                      |
|----------|--------------------------------------|
| VALVE ON | 00:00:12.55                          |
| TTL ON   | 00:00:12.55                          |
| TTL OFF  | 00:00:13.55 (for a one second pulse) |

Use other pulses for valve closures or important timing milestones.

Both the Valve Driving and Feedback strategies discussed so far can be combined with normal ValveBank programming in separate channels.

### Slave Mode Computer Interfacing

See the next chapter about wiring multiple ValveBank's together in a Master/Slave configuration. Your computer can simulate a 'Master' ValveBank and start programs running on 'Slave' ValveBanks synchronized with other activities on your computer. Connect your computer TTL output pin to input pin number one on all ValveBanks. To activate the ValveBanks, send a three-pulse, on/off, square wave:



Note: TTL Input #1 can still be used on slave ValveBanks after their start signal.

## Techniques

### Dead Volume

Dead volume should be minimized in order to switch solutions as rapidly as possible. Dead volume for this purpose refers to the volume in the single piece of tubing between the manifold and final destination (perfusion chamber, 96-well plate, etc.) A certain amount of time must pass for a new liquid to clear the previous one from this final piece of tubing. Solution switching takes place at the manifold - assuming each channel's tubing has been primed from its valve to this point. Therefore, the manifold should be positioned as close to the ultimate destination as possible, while the valves can be some distance away. The micro-manifolds available from AutoMate Scientific are designed to be inserted without tubing directly into orifices in some perfusion chambers. This absolutely minimizes dead volume - resulting in switching times of under a second.

AutoMate Perfusion Systems include a blue disposable flow regulator which will *increase* dead volume if used improperly. The regulator can either be eliminated if controlling flow rate is not necessary, or positioned *before* the manifold to eliminate dead volume. However, this second method only controls the flow rate of individual solutions (instead of all solutions when located after the manifold). Therefore, the researcher can either limit the flow of a single liquid, or purchase flow regulators for each line. A final method for reducing dead volume is to use smaller bore tubing, although this may also reduce flow rate resulting in the same switching time as for larger tubing.

### Small-bore PTFE-Inert Tubing

AutoMate Scientific's micro-manifolds use 1/16" o.d. tube ports which can either be used with this size tubing, or enlarged up to 1/16" i.d for valve hose barb fittings. Please inquire about AutoMate's PTFE-Inert tubing and nut and ferrule valve fittings for small bore use. Also see the micro-manifold instructions on page 12. Cutting PTFE-Inert tubing at an angle makes it easier to insert.

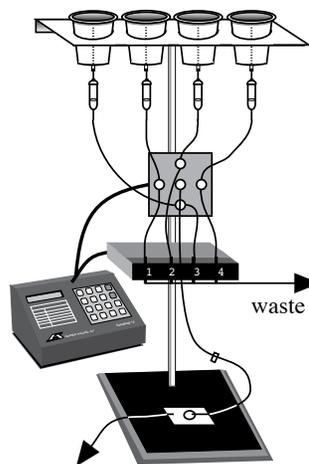
### Backflow

When a manifold is used in a plumbing arrangement, none of its ports can be left unconnected, or liquid will simply flow backwards out of the opening. Small, green hose clamps are included with AutoMate Perfusion System drippers which can be easily attached to short pieces of tubing to act as plugs for unused holes.

Likewise, one must be careful not to open any valve whose reservoir is completely empty or inflow tube is disconnected. Ordinary solution pressure in other lines will force liquid back up the outflow tubing, through the valve, and either back into the reservoir or out the disconnected inflow onto the floor. Again, clamp-off any unused lines at the manifold or be sure all valves are closed while changing connections.

### Syringe Reservoirs

AutoMate offers 30ml syringes (photo on page 6) as alternatives to its 100ml polypropylene reservoir cups. Connected directly into luer lock fittings in the valves, this method eliminates wasted solution in tubing between the reservoirs and valves. Small 2-way stopcocks are included when this option is ordered. These are placed between the syringe and valve fitting in case syringes must be disconnected before completely empty. Simply loosen the luer lock *from the valve fitting*, and remove the syringe and stopcock together. These stopcocks are also useful if there is a chance of a valve opening after its reservoir is empty (see above paragraph).



### AutoPrime™ System

The AutoPrime Perfusion System is designed to deliver oxygenated (or other gas-saturated) solutions without administering 'stale' liquid which has remained stationary in the tubing long enough to lose its oxygenation. Unless one uses 'hard-walled' (i.e. PTFE-Inert) tubing, gas will escape through the tubing leaving the stale solution with a ruined pH and gas concentration. The 8-channel AutoPrime System uses eight valves per four liquids,

with the second set used as 'flush' valves to waste. Shortly before a solution is to be switched 'on,' its flush valve opens and re-primed the upper tubing with fresh solution from the reservoir down to its delivery valve (where a tee fitting is located connected to the flush valve.) The flush valve is then closed, and the delivery valve can be opened. The previous solution in a delivery sequence can continue to flow while re-priming occurs.

### Faulty Valves

The bane of all liquid delivery apparatus! Despite AutoMate's best efforts and pursuit of high quality valve manufacturers, some valves fail. How often have space shuttle launches been delayed due to valve problems? We can only pass along our valve supplier's one year warranty with their disclaimer "Improper use or mishandling of the units, in the opinion of the manufacturer, voids this warranty!" (their exclamation mark too.) In order to minimize valve problems, please observe these guidelines:

1) Clean your valves after each use. Accumulated debris or precipitate will rapidly cause leaking valves and seals. Use an in-line filter if you expect a chance of particles (5  $\mu\text{m}$  max!) in your solutions. Put your AutoMate controller's programmability to good use by writing a washing protocol. At the end of the day, fill each reservoir with cleaning solution (distilled water or appropriate liquid), and press Start. A protocol can be easily written to flush each valve in sequence. Saline solutions allowed to dry in stainless steel valves will cause them to rust. This is considered improper use. We also recommend rinsing your valves once before their first use.

Beware of flaking PTFE-Inert tape or silicone fitting glue. Large debris are often the cause of valve failure. Try backflushing a valve that is suspected to have failed for this reason by connecting a lightly pressurized liquid to the *outflow* of the valve while it is energized. Sometimes this ejects the clog. No Draino!

2) Use appropriate valves for a given application. Use of caustic or corrosive liquids with our stainless steel valves immediately voids their warranty – and the factory will notice as soon as they open them. Please request our PTFE-Inert isolation valves if you plan on using such solutions. We even recommend isolation valves for highly conductive saline solutions and/or

elevated temperatures because of the increased probability of electrolytic corrosion.

3) Do not operate AutoMate valves with homemade controllers delivering over 12V DC, or attempt to cycle them rapidly <10ms.

4) Do not exceed the rated operating pressure (> 100psi).

Before returning any valves to us please check:

1) That it was purchased in the last 12 months (AutoMate and valve manufacturers record each by serial number.)

2) That the valve is faulty and not the controller channel – find a valve that works in a particular output channel and try the bad valve in that port to see that it still does not function.

3) If it is leaking, see #1 above and the section below.

If it qualifies for all three of the above, AutoMate will accept the valve for subsequent return to the factory. Repair or replacement is at their discretion, as AutoMate does not have the ability to open the valves to determine the cause of trouble. We may be able to loan replacement valves, which may be billed if the valve factory finds abuse on the user's part and refuses to honor the warranty.

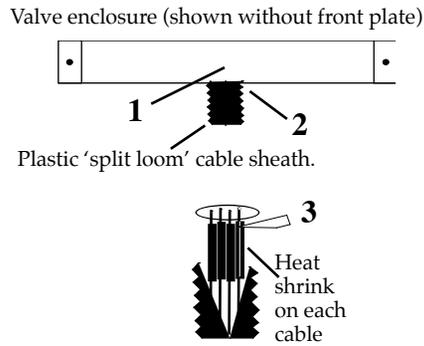
### Stuck pinch Valves

Occasionally pinch valves will stick closed. Usually this is a sign that they are about to completely fail, but sometimes they can be rejuvenated by simply prying them open. First energize (turn on) the valve; then, using a flat screwdriver, gently force the white plunger open where it normally pinches the tube closed. The valve may begin functioning normally. Also, **pinch valves will not usually work without a piece of pinch tubing installed.**

### Valve Cables

One problem that is easy to diagnose and fix is a broken cable connection. Use any ohmmeter to measure the resistance across the inner pin and outer 'barrel' of the RCA plug end of the valve cable (while unplugged from the controller.) A resistance of zero ohms indicates a short, or infinite resistance means one of the wires is broken in the cable assembly. This occurs most often at the joint between the heavy black cable and the valve lead wires – under

the heat-shrink tubing, inside the outer black sheath, a few inches from the valve itself. This can often be reached without completely disassembling the valve enclosure. Simply 1) remove the screw inside the black valve box holding the plastic sheath in its hole, 2) remove the black tape at the top of the sheath and peel it back a couple of inches, find the offending cable (trace it back from the bad valve), and 3) carefully slice its heat-shrink tubing longitudinally to remove it. The wires may have come apart or broken here, inside the next piece of electrical tape isolating the two leads, otherwise within the cable or valve itself (which can be further determined with the volt/ohmmeter). If you find the break, resolder the connection, wrap the inner wires in separate pieces of electrical tape, retest the valve, and reassemble the sheath following the above instructions in reverse order.



## Valve Returns & Replacing a Valve

If you need to return a defective valve, you may either return the entire valve assembly for repair / evaluation, or remove and return the individual valve from its case. This only involves five screws: remove the two outer plate screws holding all of the valves into the black metal case, the single screw holding the plastic 'sheath' into its underside hole, the electrical tape at the top and bottom of the sheath, the offending valve's cable from the plug end up through the valve casing, and finally, the two screws holding the valve on to the front plate.

Please package the valve(s) carefully and ship freight prepaid to AutoMate's address on the back cover of this manual. **No RMA number is needed** as long as you include a note with the following:

- 1) Your name, company / institution name, phone number, and an address to return the repair to.
- 2) Your original invoice number and date if available.
- 3) A sentence stating the nature of the problem and any steps

you have already taken to fix or identify it. Does the valve energize / click? De-energize? Open / close? Leak?

4) Whether the valve was driven by any device *other* than an AutoMate controller (and its operating and holding voltages).

5) The application used with the valve, along with the exact chemical(s) and the duty cycle (pulse) rate if used.

6) A Statement of Chemical Exposure as follows:

a) These valves have not been exposed to chemicals other than H<sub>2</sub>O except as described above. b) All applicable Safety and Handling data sheets for the above described chemicals are enclosed. c) We accept full responsibility for any injury to AutoMate employees or employees of the valves original manufacturer caused by handling of the residues of chemicals contained in or on the valves to be returned.

7) An authorized signature, title, and date.

AutoMate will gladly fax you a form with easy blanks to enter the above information. We will process your return and notify you of further information as quickly as possible.

## Leaks & Replacing valve fittings

The second bane of liquid delivery apparatus! These hints may help:

- 1) Make sure the valve is turned off! (as opposed to leaking)
- 2) See all of the guidelines in the previous "Faulty Valves" section - especially #1.
- 3) Identify whether the valve leaks constantly, under pressure, inside or outside. Try backflushing if an internal leak.
- 4) Check and replace obvious loose or worn tubing.
- 5) Outside leaks usually occur at the fittings and can be stopped with a bit of silicone glue, epoxy, super glue (Cyanoacrylate) or PTFE-Inert tape around the threads of the dry fitting screwed back into the valve. Be sure not to use too much glue or tape, as they can easily cause clogs or leaks of their own. **Overtightening can also cause the plastic fittings to leak – hand tighten.**

Glue on valve fittings is intended as a gap filler for small openings between the threads and hole, not as an adhesive. Few glues will adhere to PTFE-Inert.

## EPRM Installation Instructions

1) Open the ValveBank case as described in 'Troubleshooting' on page 46. Remove the last EPROM slowly with a flat screwdriver or IC remover noting the 'dimple' orientation (pin 1) on its left side. Insert the new chip with the same orientation – being careful not to bend any pins.

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ValveBank II 1.3 \_\_\_\_

2) Make sure that the ValveBank turns on, then turn it back off before reinstalling the case top. Save the old EPROM until you are completely satisfied with the new one.

EPROM's can be erased and recycled, and they cost several dollars each. So if you're happy with an upgrade, it's worth the few pennies stamp cost for U.S. customers to drop them in an envelope back to AutoMate. International (or busy U.S.) customers will be excused if they cannot return old eproms. :-)

## Configuration / Technical Notes

The Configuration option on the Main Menu is used to set several user-specific, hardware and software options including: multiple-ValveBank networking, normally-open or normally-closed valves, normal or inverted TTL input and output logic, and repeat-running of user programs. These settings can always be changed, and will be stored indefinitely by the ValveBank even when disconnected from power. They are factory pre-set for a standard laboratory configuration and AutoMate normally-closed valves. The user may never need to make changes to these options.

### Networking multiple ValveBanks

The 'SLAVE' option is used when two or more ValveBanks are networked together. The MASTER box sends a start pulse (see pg. 30) to synchronize all SLAVE boxes. This allows programs to be written across several ValveBanks which each control their own valves and TTL outputs. When started in sync, these ValveBanks operate as though running a single program written for many valves. Multiple ValveBanks should be connected through their TTL In/Out Ports by a cable supplied by AutoMate. See page 11 for a diagram of a double-ValveBank arrangement.

Select Box Type:  
>MASTER SLAVE

<Enter> to make selection & continue  
<Cancel> return to Main Menu  
<Lt/Rt Arrows> toggle modes

### Repeat Run

Repeat Run allows a user to run a program continuously. When activated, Repeat Run instructs any running program to start over immediately when finished. User programs are normally limited to 99 hours, so the only way to set-up a program to run for more than four days is to write a sequence (up to 99 hours long) which will be repeated indefinitely each time it finishes.

Turn Repeat Run:  
ON >OFF

<Enter> to make selection & continue  
<Cancel> return to Main Menu  
<Lt/Rt Arrows> toggle modes

## Normally Open/Closed Valves

This setting configures the ValveBank for use with user-supplied Normally-Open valves. AutoMate sells only Normally-Closed (CL) valves (valves which are closed to fluid flow when NOT powered) which is the default for this setting. Inverting a channel to Normally-Open (OP) represents that valve receiving power on a VALVE OFF command and no power when ON.

|   |   |
|---|---|
| <b>VALVES Normally:</b><br>1-4: CL CL CL CL | <Enter> continue to next screen<br><Cancel> return to Main Menu<br><1..4 (or 8) > toggle each channel |
|---|---|

### NOTE: Normally-open valves

The ValveBank must supply power continuously to keep normally-open (N/O) valves closed even while no program is running. If the Configuration setting specifies N/O valves, then the ValveBank will turn 12V on for all N/O valves as soon as it is powered-on and whenever a user program ends. This is intentional to insure solutions do not flow unexpectedly.

Therefore, N/O valves will be held closed as long as the ValveBank is on. They should not heat-up appreciably and this should not be harmful to the ValveBank; however, if your reservoirs are empty or solutions are otherwise blocked (ie. manual thumbwheel valve) you may wish to stop the ValveBank from supplying power to the valves while the ValveBank is turned on. Choose *Configuration* from the Main Menu and temporarily switch all valves to normally-closed. The ValveBank will stop supplying power to the valves thinking they are normally-closed. Set them back to normally-open before filling your reservoirs or running a program.

## 3-way Valves

The ValveBank supports 3-way, single-solenoid valves (2 wire). Program the ValveBank as you normally would for 2-way valves, after determining which of two inlets or outlets are opened with VALVE ON and VALVE OFF commands. These can be reversed with the Normally-Open/Closed Configuration settings described above.

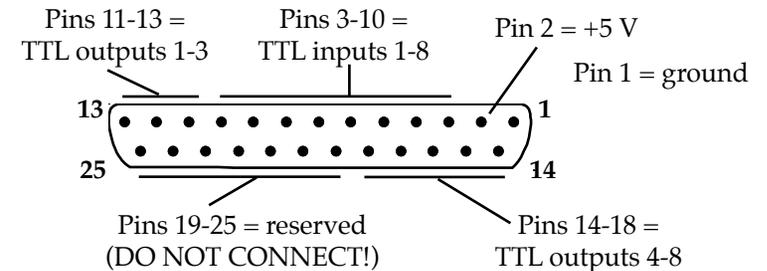
## TTL Input/Output Logic

These two settings allow the user to invert the TTL logic on incoming and outgoing TTL port signals for use with TTL ON and OFF commands and Manual Mode. TTL is an electronics abbreviation for Transistor-Transistor-Logic representing simple signals being transmitted as either 0 volts (ground) or +5 volts. Usually a +5 volt signal called 'High' represents ON or active, and 0 volts, 'Low,' represents OFF. This Configuration setting inverts the standard ON/OFF convention to Low=ON and High=OFF to suit the particular electronic needs of a custom lab arrangement.

|                                    |   |
|------------------------------------|---|
| <b>TTL Outputs:</b><br>1N 2N 3N 4N | <Enter> to next screen<br><Cancel> return to Main Menu<br><1..4> (or 8) toggle each channel |
|------------------------------------|---|

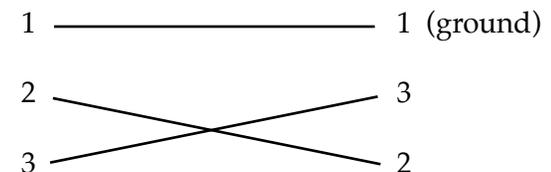
## TTL Port

Standard female DB-25 connector (diagram view – back of ValveBank).



## Serial Cable

ValveBanks communicate with EasyCode and other serial sources using a 'null' modem cable or standard serial cable with 'null modem' adapter with the following simple wiring:



## Troubleshooting

Should the ValveBank screen and power LED fail to light while power is turned on, check your power connections, source and on/off switch. Disconnect all valves to check for a short. Finally, if all else fails, unplug the ValveBank, remove the six screws on its bottom and check the fuse on the internal circuit board. Only replace the fuse with a standard (not slow-blow) 2.5 Amp fuse. One extra fuse is included on the circuit board in clips labeled "Spare."

Also see the *Techniques* chapter for more troubleshooting information on problem valves and leaks.

The ValveBank is designed to drive 12V DC 2-way solenoid valves. Its driver circuitry is overload and short circuit protected.

## EasyCode™ Macintosh & PC Software

Program your valve and pump on-off sequences with a Macintosh or IBM using graphic timebars. Save and load unlimited programs to disk, print-out program listings, then download your programs into the ValveBank's memory in one simple step. Once downloaded, the program remains in the ValveBank which can be disconnected from the computer. See *Serial Mode* on p. 32 for program transfer information.

The screenshot shows the EasyCode software interface. At the top, there is a timebar editor with a timeline from 0 to 4 minutes. Below the timeline are four channels, each with 'valve' and 'loops' sections. Channel 1 has a valve pulse at 0:00 and a loop from 0:00 to 0:30. Channel 2 has a valve pulse at 0:30 and a loop from 0:30 to 1:00. Channel 3 has a valve pulse at 1:00 and a loop from 1:00 to 1:30. Channel 4 has a valve pulse at 1:30 and a loop from 1:30 to 2:00. To the right of the timebar is a settings dialog box with the following fields and options:

- Start Time: 00:00:00.00
- End Time: 00:25:30.00
- TTL In Options:
  - TTL Enabled
  - Mirror
  - Trigger On
  - Trigger Off
- Trigger Time: 00:05:00.00
- Buttons: OK, Cancel

| Bank 1      |              |
|-------------|--------------|
| Channel 1   |              |
| Time        | Action       |
| 00:00:00.00 | Start Loop   |
| 00:00:00.00 | Valve On     |
| 00:01:00.00 | Valve Off    |
| 00:04:00.60 | End Loop     |
| 00:04:00.61 | End Of Queue |
| x 12        |              |
| Channel 2   |              |
| Time        | Action       |
| 00:00:00.00 | Start Loop   |
| 00:01:00.00 | Valve On     |
| 00:02:00.00 | Valve Off    |
| 00:03:32.40 | TTL On       |
| 00:04:00.00 | TTL Off      |
| 00:04:00.60 | End Loop     |
| 00:04:00.61 | End Of Queue |
| x 12        |              |
| Channel 3   |              |
| Time        | Action       |
| 00:00:00.00 | Start Loop   |
| 00:02:00.00 | Valve On     |
| 00:03:00.60 | Valve Off    |



Serial cable and manual included.

- Supports up to 16 channels (4 networked ValveBank4's or 2 ValveBank8's)
- Open multiple experiment windows
- Full zoom and reduce capability lets you make fine adjustments or see your entire experiment
- Double-click to enter start and stop times accurate to 0.01 seconds from the keyboard
- Cut and paste timebars or entire channels - even between several experiments
- Supports all ValveBank commands including multi-channel looping and interface triggering
- Receive programs from the ValveBank to print-out or modify
- Review ValveBank commands as text listing on screen or printed
- Requires min. Mac Plus 1 meg RAM, system 6 or greater or PC running Windows 3.1.

## Sample Programs

### Perfusion

Saline (Buffer 1) for 5 minutes  
(Channel 1)

01 T=00:00:00.00  
CH1 VALVE ON

02 T=00:05:00.00  
CH1 VALVE OFF

Glutamate (Drug 1) for 1 minute  
(Channel 2)

01 T=00:05:00.00  
CH2 VALVE ON

02 T=00:06:00.00  
CH2 VALVE OFF

Ca-free saline (Buffer 2) for 3 minutes  
(Channel 4)

01 T=00:06:00.00  
CH4 VALVE ON

02 T=00:09:00.00  
CH4 VALVE OFF

NMDA (Drug 2) for 5 seconds  
(Channel 3)

01 T=00:09:00.00  
CH3 VALVE ON

02 T=00:09:05.00  
CH3 VALVE OFF

Turn recording device on

03 T=00:09:05.00  
CH3 TTL ON

Saline (Buffer 1) continuously  
(Channel 1)

03 T=00:09:05.00  
CH1 VALVE ON

Buzzer upon completion  
(Type <Enter> to turn buzzer off  
without disturbing program)

04 T=00:09:05.00  
CH1 BUZZER ON

END OF LIST at 1 hour

05 T=01:00:00.00  
CH1 END OF LIST

Final buffer will run unattended until  
program reaches this point and ends.

## Chromatography (Ion exchange)

0.1M NaCl, pH 7.0  
(Salt 1) for 1 hour  
(Channel 1)

01 T=00:00:00.00  
CH1 VALVE ON

02 T=01:00:00.00  
CH1 VALVE OFF

0.5M NaCl, pH 7.0  
(Salt 2) for 3 hours  
(Channel 2)

01 T=01:00:00.00  
CH2 VALVE ON

02 T=04:00:00.00  
CH2 VALVE OFF

0.5M NaCl, pH 7.5  
(Salt 3) for 1 hour  
(Channel 3)

01 T=04:00:00.00  
CH3 VALVE ON

02 T=05:00:00.00  
CH3 VALVE OFF

1.0M NaCl, pH 7.2  
(Salt 4) for 2 hours  
(Channel 4)

01 T=05:00:00.00  
CH4 VALVE ON

02 T=07:00:00.00  
CH4 VALVE OFF

## Gel/Blot Washing

User must calibrate time required to fill washing tray to desired wash volume and to vacuum drain tray. In this example we use 30 seconds to fill and 20 seconds to drain.

|   |                                      |
|---|--------------------------------------|
| Fill tray with Blocking solution<br>(Channel 1) | 01 T=00:00:00.00<br>CH1 VALVE ON     |
| Wait for 12 minutes (washing)                   | 02 T=00:00:30.00<br>CH1 VALVE OFF    |
| Drain<br>(Channel 4)                            | 01 T=00:12:00.00<br>CH4 VALVE ON     |
|   | 02 T=00:12:20.00<br>CH4 VALVE OFF    |
| Prepare to repeat washes<br>(Channel 3)         | 01 T=00:12:20.00<br>CH3 LOOP STRT 03 |
| Prepare to repeat drains<br>(Channel 4)         | 03 T=00:12:20.00<br>CH4 LOOP STRT 03 |
| Fill tray with wash solution                    | 02 T=00:12:20.00<br>CH3 VALVE ON     |
| Wash for 15 minutes                             | 03 T=00:12:50.00<br>CH3 VALVE OFF    |
| Drain   | 04 T=00:27:00.00<br>CH4 VALVE ON     |
|   | 05 T=00:27:20.00<br>CH4 VALVE OFF    |
| Repeat 3 times in both channels                 | 04 T=00:27:20.00<br>CH3 LOOP END     |
|   | 06 T=00:27:20.00<br>CH4 LOOP END     |

## Safety Instructions

The following instructions pertain to the risk of fire, electric shock, or bodily injury. Please read all of these instructions carefully.

1. Follow all the instructions and warnings marked on this product or included in this manual.
2. Do not use this product on an unstable cart, stand, or table. This product may fall, causing serious damage to the product.
3. Slots and openings in the cabinet and the back are provided for ventilation. To ensure the reliable operation of your product, and to protect it from overheating, these openings must not be blocked or covered. Do not use this product on a bed, sofa, rug or other similar surfaces. This product should never be placed near or over a radiator or heat register. This product should not be placed in a built-in installation unless proper ventilation is provided.
4. Never push objects of any kind into the product through the cabinet openings, as they may touch dangerous voltage points or short-out parts that could result in fire or electric shock. Never spill liquids of any kind in the product.
5. This product should only be connected to the AC power source indicated on your product system's information label. If you are not sure of the type of AC power available, consult your dealer or local power company. Only connect this product to a power outlet that matches the power requirements of this product.
6. Do not allow anything to rest on the power cord. Do not locate this product where people will walk on the cord.
7. If you have to use an extension cord with this product, make sure that the total amperage rating of all equipment plugged into it does not exceed the amperage rating of the extension cord. Also, make sure that the total of all products plugged into the main AC power outlet does not exceed 15 Amps.
8. Unplug your product from the main electrical power before cleaning. Do not use liquid cleaner or aerosol cleaners. Use a damp cloth for cleaning.
9. Do not use this product near water.

10. Unplug this product from the main power outlet and call for service under any of the following conditions:

- A. If the power cord or plug is damaged or frayed.
- B. If liquid has been spilled into the product.
- C. If the product has been exposed to rain or water.
- D. If the product has been dropped or the cabinet has been damaged.
- E. If the product exhibits a distinct change in performance, indicating a need for service.

### STOP!!

If you ever have to remove the main system unit cover, observe the following precautions:

- A. The power supply cord must be unplugged before the main system unit cover is removed. (Separe le cordon d'alimentation et puis enleve le couvercle.)
- B. Once removed, the cover must be replaced and screwed in position before the power supply is plugged back in. (Après le couvercle en place et remettre le cordon d'alimentation.)

### Battery Warning Statement

#### CAUTION

There is a danger of explosion if the battery is replaced incorrectly. Replace only with the same or equipment type recommended by the manufacturer. Discard used batteries according to the manufacturer's instructions. See inside of front cover for battery specifications.

#### ATTENTION

Il y a danger d'explosion s'il y a remplacement incorrect de la batterie. Remplacer uniquement avec une batterie de meme type ou d'un type recommande par le constructeur. Mettre au rebutted batteries usagees conformement aux instructions du fabricant. See inside of front cover for battery specifications.

#### VORSICHT

Explosionsgefahr bei unsachgemass em Austausch der Batterie. Ersatz nur durch denselben oder einen vom Hersteller empfohlenen ahnlichen Typ. Entaorgung gebraushter Batterien nach Angaben des Herstellers. See inside of front cover for battery specifications.

AutoMate Scientific, Inc. warrants its products against defects of workmanship and/or material for **ONE YEAR** from the date of sale. Any product that fails to perform as specified may be returned, freight pre-paid to the factory (with a written explanation of the problem) for examination and repair or replacement. If it is defective, AutoMate Scientific will repair or replace (at our option) the product without charge and return it to you.

If the examination indicates that non-compatible fluid, destructive environment, accidental damage, modification or abusive practices have occurred, all labor, materials and freight costs shall be at the expense of the customer.

Due to the nature of clinical laboratory applications, AutoMate Scientific, Inc. will **NOT** accept the return of any products which have been used with **HAZARDOUS MATERIALS** or harmful environment.

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