



Queen Bee

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MF-9040

INSTRUCTION MANUAL

Syringe Pump Controller

Bioanalytical
Systems, Inc

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West Lafayette
Indiana 47906

MANUFACTURER'S NOTE

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Section 1. Introduction

1.1 The Queen Bee Controller

The Queen Bee Controller (QBC) offers flexible, low-cost automated syringe pump control beyond that of standard pump controllers. It uses the BAS Baby Bee™ syringe pumps you already have, the PC already in your lab, and the Microsoft® Windows® interface that you already know. This controller is useful in many low flow-rate, controlled injection situations such as:

- microdialysis
- microinjections
- infusions
- binding studies
- dosing via an external trigger

The QBC controls up to four BAS Baby Bee syringe pumps, each operating independently. Each pump can be set to deliver for a specified time, volume, or dosage at a specific flow rate. With the QBC software's "command chain" feature, the pumps can easily be programmed to start, deliver, and stop in any order. The QBC also allows the pumps to be communicate with external devices (such as a fraction collector, for example) via external input and output channels.

1.2 Definitions

Before reading this manual you should become familiar with a few definitions and concepts used throughout.

QBC

QBC refers interchangeably to the Queen Bee Controller software that runs under Microsoft Windows and the Queen Bee Controller hardware (interface card, controller box and I/O box).

Syringe Pump Configurations

Before the QBC is used to operate a syringe pump, the user must configure the pump by specifying its syringe size, its flow rate of delivery, and its Stop Condition. A pump can also be set to sound an alarm when it reaches its Stop Condition, send signals on its external output channel at specific times or accept input from an external device. Each of the four pumps controlled by the QBC can be configured independently of the other pumps.

The QBC software stores pump configuration on disk in configuration files. With these files, users can set up the QBC for different experiments quickly after specifying the pump configurations once.

Stop Condition

Part of each syringe pump's configuration includes a limit at which the pump should automatically stop operation. This condition can be one of time, volume, or amount (dosage) delivered. For example, a pump may be set to stop after it has delivered fluid for 10 minutes, after it has delivered 5 microliters or after it has delivered a dose of 1 milligram.

Syringe Pump States

Each of the four syringe pumps is normally in one of three states:

Running: The pump is currently delivering fluid and progressing toward its Stop Condition. If external output channel events are scheduled, they are occurring. The pump will halt if it receives a Stop command.

Halted: The pump has been temporarily stopped and is no longer delivering fluid. It may return to the running state and continue towards its Stop Condition by receiving a Start command, or it may receive a Reset command.

Stopped: The pump has reached its Stop Condition and is no longer delivering fluid. The pump cannot return to the running state until it receives a Reset command.

Start, Stop, and Reset Commands

Each pump understands three commands that change its state. These commands are sent to the pumps by user input, external devices or command chains. Sections 4.6 and 4.7 describe these methods in detail.

The **Start** command runs a pump if it is halted or reset.

The **Stop** command halts the pump if it is running.

The **Reset** command prepares the pump to run again after it has reached its Stop Condition or if the pump was halted.

Command Chains

The QBC software allows users to assemble chains of syringe pump commands that can repeatedly start, stop and reset each of the four syringe pumps at specified intervals of time. Command chains provide a mechanism for the unattended execution of a series of syringe pump actions.

The QBC software stores command chains on disk in chain files. With these files, users may quickly and easily repeat different experiments after creating the command chains once.

External Input and Output Channels

Each pump has its own external input and output channels. These channels use TTL signals to let the QBC communicate with external devices. Each input channel accepts Start and Stop commands from an external device, and the output channels can be programmed to send several different kinds of signals to external devices while the pumps are running. Section 4.6.2 describes the input and output channels in detail.

Please take the time to fill out and return the registration form in the back of this manual. Registered users will be informed of updates to the QBC software.

Fax it: (317) 497-1102; or mail it: Bioanalytical Systems Inc.
QBC Registration
2701 Kent Avenue
West Lafayette, IN 47906-1382

Section 2. Hardware and Software Requirements

2.1 BAS Bee Syringe Pumps and Accessories

The Queen Bee Controller is designed to control from one to four BAS Baby Bee syringe pumps (BAS Part No. MD-1001). This unit includes the drive mechanism and mounting bracket for a single gastight syringe. An optional bracket (MD-1002) allows up to three syringes to be driven by a single Baby Bee.

The Queen Bee Controller and Baby Bee syringe pumps require gastight syringes with a 60 mm calibration length. Sizes ranging from 10 μ L to 5 mL are recommended. BAS Stingers™ are syringes specifically designed for the BAS Baby Bee. They are available in 500 μ L, 1.0 mL, and 2.5 mL sizes (MD-0050, MD-0100, and MD-0250).

The accuracy of delivery over a given time period depends heavily on syringe size. While accuracy is always best when using the smallest possible syringe, this choice must be balanced against the total time planned for the experiment and the desired flow rate. A 500 μ L syringe provides better accuracy than a 2.5mL syringe at any given flow rate. However, at a rate of 2 μ L/min, the 500 μ L syringe will limit the duration of the experiment to four hours. It is best to keep a variety of syringes available and use the smallest size whenever possible.

2.2 Host Computer

The QBC software requires an Intel® (or compatible) 386SX (or better) processor running Microsoft Windows version 3.1 (or higher). At the time of this writing, at least a 33 MHz 486DX is highly recommended.

The QBC hardware requires one free ISA expansion slot in the computer running the QBC software.

Section 3. Installation

Both the hardware and software components of the Queen Bee Controller must be installed before using the controller. The following sections describe installation of the components:

Section 3.1 The Queen Bee Controller Hardware

Section 3.2 The Queen Bee Controller Software

NOTE: You should also familiarize yourself with the operation of the BAS Baby Bee syringe pump by reading its instruction manual.

3.1 The Queen Bee Controller Hardware

The hardware components of the Queen Bee Controller are:

- 1 Queen Bee Controller Box
- 1 External I/O box
- 1 PC expansion card
- 1 Power cable
- 1 narrow ribbon cable with D-shell connector
- 1 wide ribbon cable
- 4 color-coded BAS Bee Pump cables

Figures 3.1, 3.2, 3.3, and 3.4 show these components.

Figure 3.1. The QBC controller box.



Figure 3.2. The QBC external I/O box.



Figure 3.3. The QBC PC expansion card.

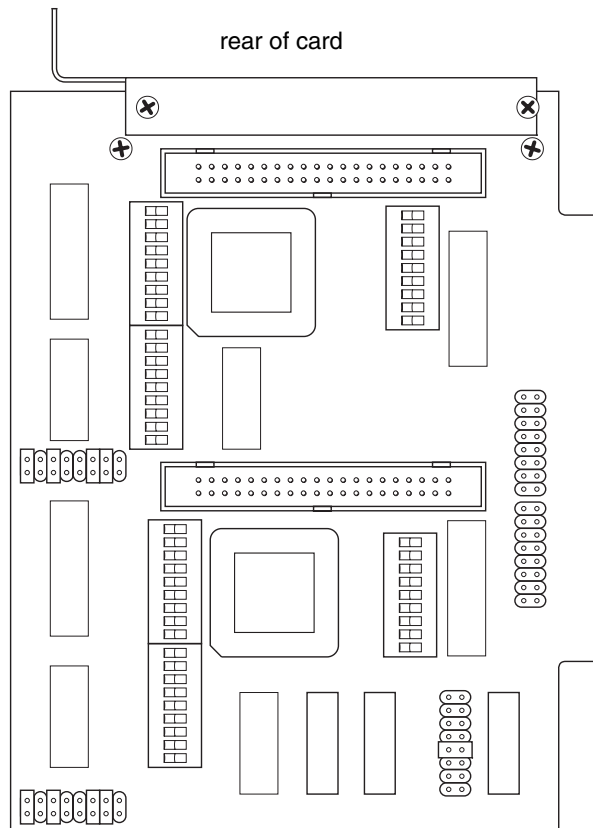
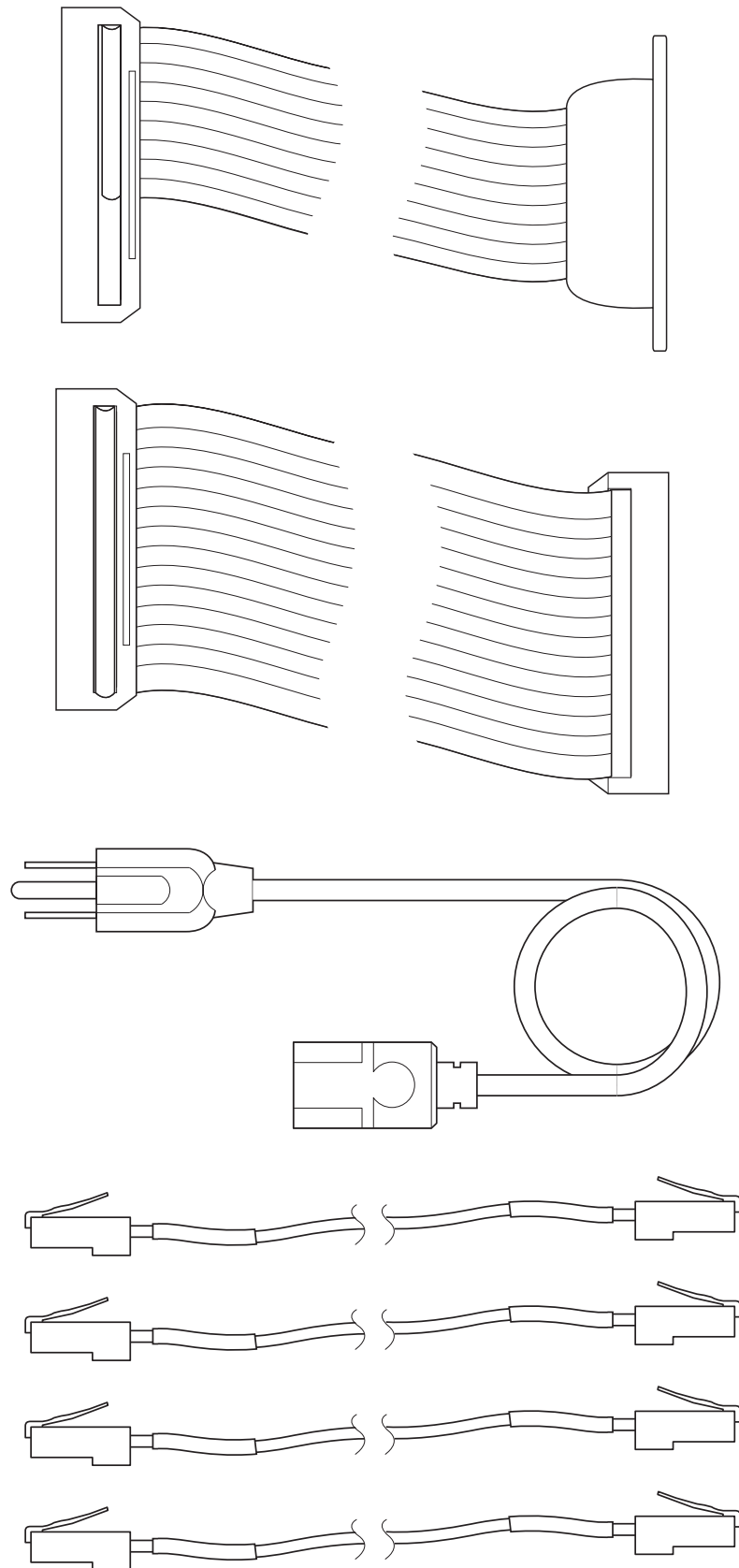


Figure 3.4. The QBC hardware cables.



The QBC hardware installation requires a Phillip's head screwdriver, one free ISA expansion slot in the PC and at least one BAS Baby Bee syringe pump.

CAUTION: Before installing the QBC hardware or any other electronic components, be certain to guard against electrostatic discharge by wearing an anti-static wrist strap or otherwise grounding yourself. Do not take the PC expansion card out of its static shield bag until you are ready to install the card. Be certain to disconnect all power cables from your PC before installing any expansion cards or other peripherals.

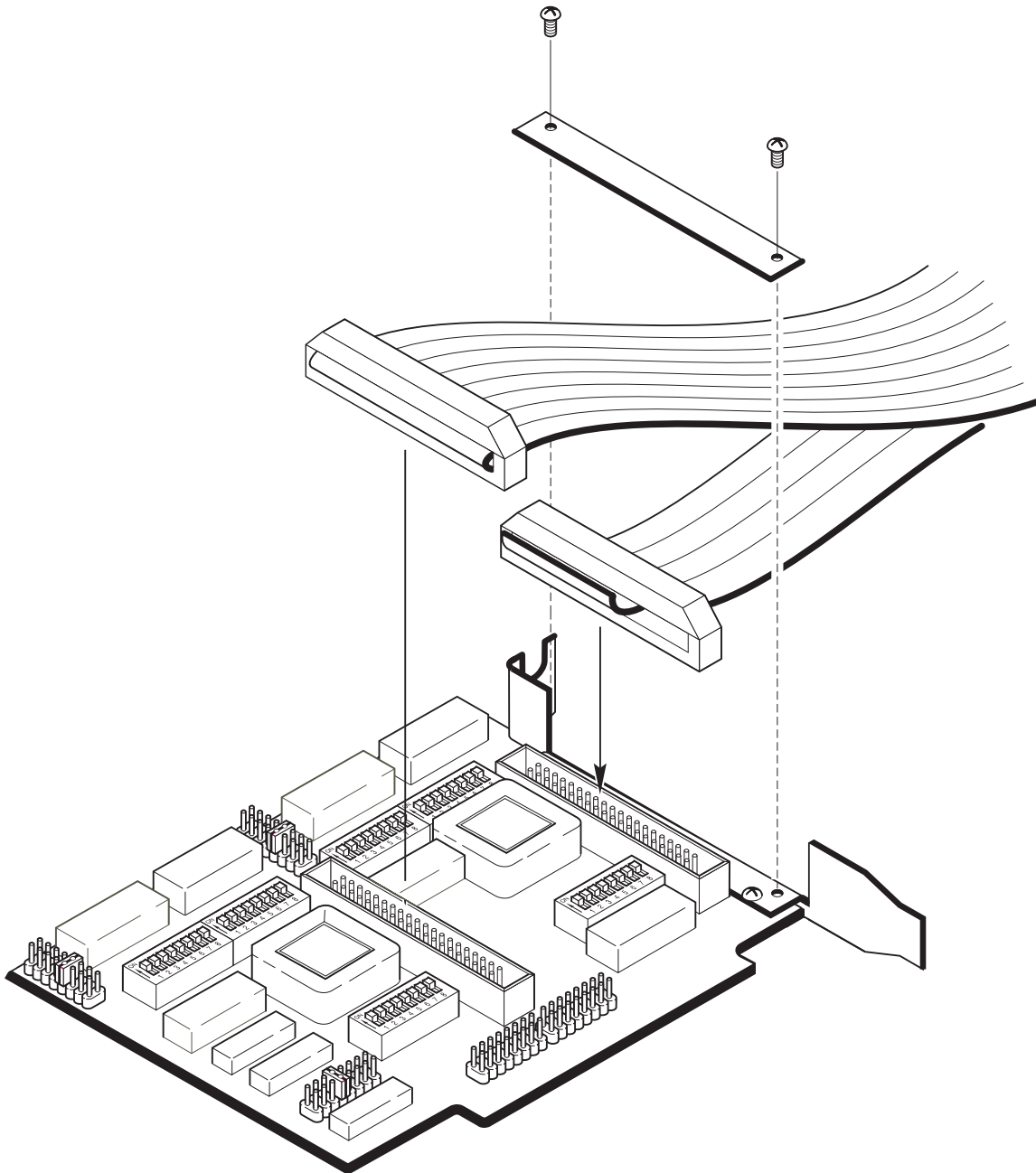
NOTE: Before beginning the installation process, please read Section 6.7 of this manual, which discusses I/O card configuration details.

1. Remove the two screws holding the padded metal strip at the rear of the PC expansion card (see Figure 3.3). Save the screws and the metal strip.
2. Attach the white plug on the narrow ribbon cable to the connector **nearest to the rear** of the expansion card. The connector will only fit in one direction. Make certain the plug is firmly seated.

NOTE: Due to the width of the D-shell connector on the narrow ribbon cable, it may be necessary to thread the cable's white plug through the card slot opening on the back of the PC before attaching it to the expansion card.

3. Plug either end of the wide ribbon cable into the connector **farthest from the rear** of the expansion card. The connector will only fit in one direction. Make certain the plug is firmly seated.
4. Pull both ribbon cables so that they lie flat against the padded metal edge at the rear of the expansion card. Re-attach the padded metal strip so that it clamps the ribbon cables flat. Tighten both screws on the padded metal strip. Figure 3.5 shows the expansion card/ribbon cable assembly.

Figure 3.5. The card/ribbon cable assembly.



5. Install the expansion card in the PC (See the PC's manual for instructions on installing expansion cards.) After installation of the card, the two ribbon cables should come out through the opening for the expansion card.
6. Connect the D-shell connector on the thin ribbon cable to its port on the side of the Queen Bee Controller box. The connector will only fit in one direction. Make certain the connector is firmly seated.
7. Connect the wide ribbon cable to its socket on the external I/O box. The connector will only fit in one direction and will click into place when fully seated.
8. Connect the syringe pumps to the controller box ports with the Bee Pump cables. Both cable ends can connect to either the controller box or the syringe pump. The colored bands on the cables are for convenience when determining which pump is connected to which port.
9. Connect the female end of the power cable to the controller box. Before plugging the cable into an outlet, make certain the power switch on the back of the box is in the 'Off' (O) position. Plug the power cable into a grounded outlet.
10. Flip the power switch to the 'On' (I) position. The red LED on top of the controller box should light, and the green LEDs on the syringe pumps should begin to flash slowly, indicating a power interrupt. When you start the QBC software, the pump LEDs will stop flashing.

See Section 5 of this manual for operational and functional specifications of the QBC hardware.

3.2 The Queen Bee Controller Software

The QBC software installation process should take less than 5 minutes. When installed, the QBC software will use less than 1 MB of disk space.

NOTE: You need to be familiar with the basics of Microsoft Windows, such as mouse operations and choosing commands, before using the QBC software. See the Windows manual or follow the on-line tutorial from the Help Menu in the Windows 3.1 Program Manager (or the "How To" section of the Help item in the Windows 95 Start menu) to learn basic Windows skills.

NOTE: The QBC Installer will create a directory called \QBC on the destination drive. If a \QBC directory already exists on that drive, The QBC Installer will attempt to install the QBC software there. Therefore, you may wish to rename the existing directory before installing the QBC software to avoid confusion.

1. Insert the diskette containing the QBC software into the PC's diskette drive.
2. Select Run from the File Menu of Windows Program Manager (or the Windows 95 Start menu). In the text box, type "a:\setup" (if the diskette is in the a: drive) or "b:\setup" (if the disk is in the b: drive). Click the OK button or press <Enter>.

OR

Double click on the "setup.exe" file from Windows File Manager (or from the Windows 95 Explorer or file folder window).

3. The QBC Installer window (Figure 3.6) will appear.

Figure 3.6. The QBC Installer window.



4. Choose a Source Disk (the diskette containing the QBC software) and a Destination Disk (usually a hard drive). The defaults are A: and C:, respectively.
5. Click the Install button. A message in the installer window will describe what the QBC Installer is doing.
6. When the software has been completely installed, click the Exit button. A new Windows group window called "BAS Programs" will have been created (if it was not already present), with the QBC program icon in it (Figure 3.7). Under Windows 95, a folder titled BAS Programs containing the QBC program will appear in the Programs folder on the Start menu.

See Section 4 of this manual, "QBC Software Functions" for instructions on operating the QBC software.

Figure 3.7. The BAS group window with the QBC icon.



3.2.1 Removing the QBC Software from Your Computer

To remove (uninstall) the QBC software from the computer, delete the \QBC directory and all of its items from the drive on which the software was installed. Then delete the QBC icon from its Program Manager group. If the BAS Programs group is empty, it may also be deleted from Program Manager. Under Windows 95, delete the \QBC directory and all of its items from the drive on which you installed the software. Then delete the QBC program icon and (if empty) the BAS Programs folder from the Start menu by selecting the "Taskbar..." item under "Settings" on the Start menu.

Deleting the \QBC directory and its contents and removing the Program Manager/Taskbar references to the QBC program completely removes the QBC software from the computer. The QBC software does not keep any files in the \WINDOWS or \WINDOWS\SYSTEM directory, and it does not create any file associations or keep information in WIN.INI or the Windows System Registry.

The contents of the \QBC directory installed by the QBC Installer are:

QBC.EXE QBC.HLP QBCINI.QBC

Files with the extension .QBC are configuration files belonging to the QBC software. Files with the extension .QCH are QBC command chain files, and the file QBC.RPT is a text file generated by the QBC Report feature. These files should be backed up and/or deleted after removing the QBC software.

Section 4. Queen Bee Controller Software Functions

GETTING STARTED: Before running the QBC software, switch the controller box 'On' (I). Double-click the QBC icon in the BAS group window to start the QBC program (under Windows 95, select it from the Start menu). The QBC main window (see Figure 4.3) will appear on the screen.

NOTE: You need to be familiar with the basics of Microsoft Windows, such as mouse operations and choosing commands, before using the QBC software. See the Windows manual or follow the on-line tutorial from the Help Menu in the Windows 3.1 Program Manager (or the "How To" section of the Help item in the Windows 95 Start menu) to learn basic Windows skills.

The QBC software functions are described in the following sections:

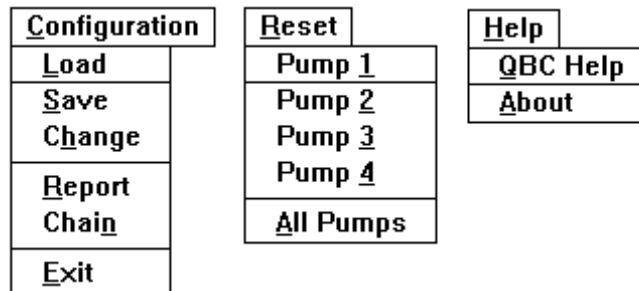
- 4.1 The QBC Menu System
- 4.2 The QBC Main Dialog
- 4.3 Syringe Pump Configuration
- 4.4 Syringe Pump Chaining

4.1 The QBC Menu System

The QBC software uses a standard Windows pull-down menu system (see the Windows manual for an explanation of this kind of structure). Figure 4.1 is a menu tree showing each selection from the QBC main dialog's menu system.

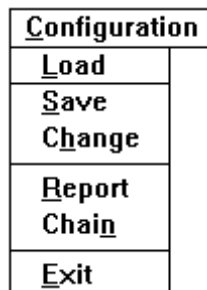
Many menu system functions are duplicated by toolbar buttons on the QBC main window (see Section 4.2.1).

Figure 4.1. The QBC menu structure.



NOTE: If one or more of the syringe pumps are running, all of the menu system and toolbar functions, except for Help, Report, Clear Alarm, and Reset (for non-running pumps), will be unavailable. To make the functions available again, send Stop commands to all running syringe pumps as described in Section 4.2.3.

4.1.1 The Configuration Menu



The Configuration menu contains six selections:

Load: This selection activates a standard Windows Open dialog. The configuration file selected in this dialog will define the new pump configurations, and the new configuration values will be displayed in the QBC main window.

NOTE: By default, the Open dialog searches for and displays only configuration files with the file extension .QBC. However, configuration files may be assigned any file extension and can be displayed in the Open dialog by selecting "Any (*.*)" in the "List Files of Type" field.

NOTE: The QBC software does not recognize Windows 95's long file names.

Save: This selection activates a standard Windows Save As dialog. The current pump configurations will be saved in the configuration file specified in this dialog.

NOTE: If no file extension is specified in the "File Name" field of the File Save dialog, the configuration file will be assigned the extension .QBC by default.

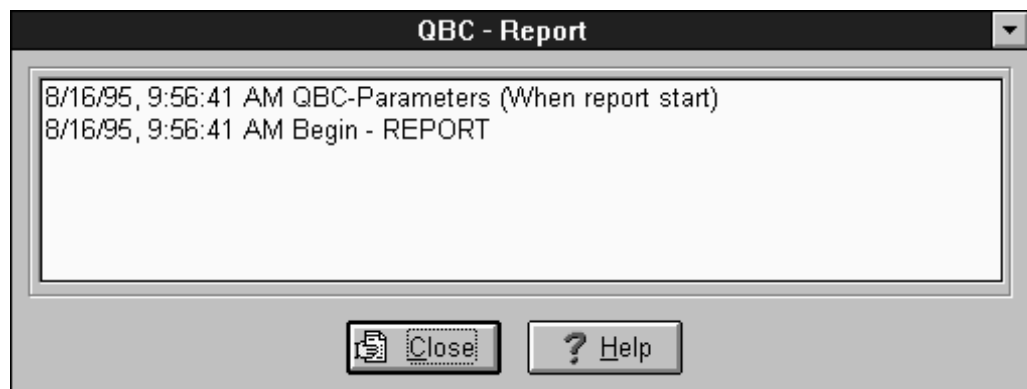
NOTE: The QBC software does not recognize Windows 95's long file names.

Change: Selecting this option activates the Bee Pump Configuration dialog, described in Section 4.3.2.

Report: This selection activates the QBC Report window, shown in Figure 4.2. A record of all QBC actions--configuration changes, Run, Stop and Reset commands, and events on the external I/O channels--will appear in this scrollable window. Clicking the minimize button in the upper right-hand corner of the window causes the QBC Report window to become an icon (see the Windows manual or on-line help for an explanation of minimizing and maximizing windows). Clicking the Close button in the QBC Report window causes the contents of the window to be written to a file named QBC.RPT, which is found in the directory where the QBC software is installed. The QBC.RPT file may be viewed with any text editor or word processor. Clicking the Help button brings up QBC's on-line help for the Report option.

NOTE: The next time the QBC Report window is opened, the QBC.RPT file will be rewritten. If the QBC Report window is opened more than once during a single session with the QBC software, the Report Window may still contain text from the previous report. The old text will not be written to the QBC.RPT file, however.

Figure 4.2. The QBC Report window.



Chain: This selection activates the QBC Chain dialog, described in Section 4.4.1.

Exit: This selection activates a dialog that asks if the user wants to exit the QBC program. Clicking Yes terminates the QBC program. This does not close any other BAS software running on the computer. Clicking No returns control to the QBC main window.

4.1.2 The Reset Menu

R eset
P ump <u>1</u>
P ump <u>2</u>
P ump <u>3</u>
P ump <u>4</u>
A ll Pumps

When a pump reaches its Stop Condition, the pump is shut off, its Run/Stop button (see Section 4.2.3) indicates that the pump is now stopped, the indicator light beneath the button turns red and the LED on the Baby Bee turns off. If an alarm was set for the pump (see Section 4.3.2), it will begin to sound at this time. Before this pump may be used again, it must receive a Reset command.

For example: You configure Pump 1 to stop after it has delivered 2mL and then run the pump so that it delivers the 2 mL and stops (reaches its Stop Condition). If you want to deliver another 2 mL with that pump, you must send a Reset command to Pump 1.

NOTE: A pump may not be reset while it is running. It must first be halted by receiving a Stop command.

NOTE: If an alarm is sounding for an individual pump, resetting that pump will not clear the alarm.

The Reset menu contains five selections:

Reset Pump 1, 2, 3, or 4: The first four options under the Reset menu are labeled Pump 1, Pump 2, Pump 3, and Pump 4. Selecting one of these options sends a Reset command to the respective pump and updates the information displayed for that pump in the QBC main window.

Reset All Pumps: Selecting this option sends Reset commands to all active pumps and updates the information displayed in the QBC main window.

4.1.3 The Help Menu

H elp
Q BC Help
A bout

The QBC software uses a standard Windows help structure. See your Windows manual for details on the Windows Help system.

4.2 The QBC Main Window

Figure 4.3 shows the QBC main window, which appears upon starting the QBC software. From this window you can monitor the progress and configuration of each syringe pump, send Run, Stop and Reset commands to the pumps, clear pump alarms, and access other QBC functions and dialogs.

Figure 4.3. The QBC main window.



In addition to the menu system (described in Section 4.1), the QBC main window has three major functional areas, described below.

4.2.1 The Toolbar

The toolbar runs along the top of the QBC main window, directly beneath the menu system. Resting the mouse cursor on any toolbar item for one second or longer will display a hint that describes the item's function.

Several of the toolbar items duplicate menu system functions. The bold text is that item's hint.



Exit: This button duplicates the Exit menu selection described in Section 4.1.1.



Load a Configuration: This button duplicates the Load menu selection described in Section 4.1.1.



Save this Configuration: This button duplicates the Save menu selection described in Section 4.1.1.



Change Configuration: This button duplicates the Change menu selection as described in Section 4.1.1.



Standby - Chain: This button duplicates the Chain menu selection as described in Section 4.1.1.



This button displays the About dialog box.

The toolbar also features two items that are not found in the menu system:



Current time: This item shows the current time according to the PC's clock.



Clear Alarm: This button is inactive until a pump alarm goes off. Pushing this button while it is flashing clears all pump alarms.

NOTE: If one or more of the syringe pumps are running, all of the menu system and toolbar functions, except for Help, Report, Clear Alarm, and Reset (for non-running pumps), will be unavailable. To make the functions available again, send Stop commands to all running syringe pumps as described in Section 4.2.3.

4.2.2 The Pump Status Display

The pump status display is found directly beneath the toolbar on the QBC main window. The display features a column of configuration settings for each of the four pumps. The values in this display are set in the Bee Pump Configuration dialog, which is described in Section 4.3.2. These values cannot be modified from the QBC main window.

NOTE: If a pump has been marked as active in the Bee Pump Configuration dialog, its column is displayed in blue text. Inactive pumps are displayed in gray text.

User: The name of the person using the pump, or a brief description of the experiment involving the pump. This field may be blank.

Control: QUEEN indicates that Start and Stop commands for the pump come from the Queen Bee Controller. REMOTE indicates that a signal on the pump's external input channel is enabled to send Start and Stop commands to the pump.

Event Out: YES indicates that events have been scheduled to occur on the pump's external output channel while the pump is running. NO indicates that no events have been scheduled.

Syringe: The size of the syringe in the pump.

Flow Rate: The flow rate (volume/unit time) for the pump.

Stop At: The pump's Stop Condition, in units of time, volume, or amount.

Alarm: YES indicates that an alarm will sound when the pump reaches its Stop Condition. NO indicates that no alarm has been set for this pump.

Conc.: If the Stop Condition for this pump is measured by amount, this displays the concentration (amount/unit of volume) of substance in the syringe. For Stop Conditions measured by time or volume, this is blank (---).

Completed: This value is updated while the pump is running and indicates the pump's progress toward its Stop Condition.

4.2.3 The Run/Stop Buttons

The five buttons at the bottom of the QBC main dialog send Start and Stop commands to the syringe pumps:

All: If one or more pumps are currently running, clicking this button will send Stop commands to all running pumps. If all four pumps are halted or stopped, clicking this button will send Start commands to all active pumps.

Individual Pump Buttons: The four buttons next to the All button icon control individual pumps. If a pump is not marked as active in the Bee Pump Configuration dialog, its button will be inactive.

While a pump is running, its button's text says "Run", the indicator beneath the button blinks green, the "Completed" value in the pump's display column is updated as the pump runs and the LED on the BAS Baby Bee is lit. Clicking a pump's button while it is running will send a Stop command to the pump.

When a pump is halted, its button's text says "Stop", the indicator beneath the button is lit solid red and the LED on the BAS Baby Bee shuts off. Clicking a pump's button while it is halted will send a Start command to the pump, and the pump will continue toward its Stop Condition.

Once a pump has reached its Stop Condition, its button's text says "Stop", the indicator beneath the button lights solid red and the LED on the BAS Baby Bee shuts off. Clicking a pump's button after the pump has reached its Stop Condition will have no effect until the pump has received a Reset command, except to restart the alarm for that pump if it has been set.

NOTE: If a syringe pump reaches its physical limit (that is, the pump carriage is at the end of its travel path), the green LED on the syringe pump will begin to flash rapidly, and a warning dialog will appear on the screen. You will need to physically move the pump carriage away from the end of travel position. After this is done, clicking OK in the warning dialog leaves the pump in the halted state.

CAUTION: The Run/Stop buttons may be used to send Start and Stop commands to pumps that are marked for external control. However, the device sending signals over the external input channel will not be aware of these commands, and it is therefore possible for the external control signal to have the wrong effect.

4.3 Syringe Pump Configuration

Before the QBC is used to operate a syringe pump, the user must configure the pump by specifying its syringe size, its flow rate of delivery, and its Stop Condition. A pump can also be set to sound an alarm when it reaches its Stop Condition, send signals on its external output channel at specific times or accept input from an external device. Each of the four pumps controlled by the QBC can be configured independently of the other pumps.

The QBC software stores pump configuration on disk in configuration files. With these files, users can set up the QBC for different experiments quickly after specifying the pump configurations once.

4.3.1 The QBCINI.QBC File

When the QBC program starts, it reads the initial pump configurations from a configuration file named QBCINI.QBC, which is stored in the same directory where the QBC software was installed. The QBC program maintains QBCINI.QBC, so users should take care not to create other configuration files with that name. If the QBC program cannot find QBCINI.QBC, it will create the file using default settings.

When the QBC program terminates, the current pump configurations are saved in the QBCINI.QBC configuration file. The next time the QBC program is started, it reads those configurations from QBCINI.QBC.

NOTE: The QBC program always reads its initial pump configurations from the QBCINI.QBC file. If you load another configuration file and then exit the QBC program, that configuration is stored in QBCINI.QBC. The next time the QBC program runs, it may appear as if it has read from the other configuration file, but it has actually read the pump configurations from QBCINI.QBC.

NOTE: QBCINI.QBC may be loaded from the Configuration menu or toolbar at any time (see Section 4.1.1), just like any other configuration file.

4.3.2 The Bee Pump Configuration Dialog

Choosing the Change option from the Configuration menu or clicking the Change Configuration button in the toolbar displays the Bee Pump Configuration dialog, shown in Figure 4.4.

Figure 4.4. The Bee Pump Configuration dialog.

The screenshot shows the 'QBC Configuration [test.qbc]' dialog box. It features a title bar and several control sections. The top section includes text fields for 'User Name' (Dr. A), 'Syringe' (100 uL), 'Flow Rate' (0.1 uL/min), and 'Stop At' (75 pmole). Below these are checkboxes for 'Stop after' (Time, Volume, Amount checked) and 'Completed'. A table section has columns for 'Concentration' (1 pmole/mL), 'Units' (pmole/mL), and 'Name' (Drug_1). Further down are controls for 'Event Out At' (75 pmole), 'Initial Level' (Hi checked, Low unchecked), and 'Event Type' (Pulse checked, FlipFlop unchecked). There are 'Add', 'Clear', and 'Repeat' buttons. The bottom section has checkboxes for 'Pump Active' (checked), 'Alarm' (checked), and 'External (input) Control' (unchecked). At the bottom are four tabs for 'Pump 1', 'Pump 2', 'Pump 3', and 'Pump 4'. The dialog concludes with 'Help', 'Cancel', and 'Ok' buttons.

The dialog's title bar lists the name of the current configuration file. Each of the four pumps has a page of controls in this dialog, which are selected by clicking the tabs at the bottom of the dialog. Each page contains the following controls:

Ok: Clicking the OK button configures the pumps as specified in the dialog and returns control to the QBC main window.

NOTE: Changing the configuration of the pump does not change its state or the information about the pump in the QBC main window's pump status display. The pump's information will remain as it was when the pump was last halted or stopped until the pump receives a Reset command. At that time, the pump status display will be updated with the new configuration settings.

Cancel: Clicking the CANCEL button returns control to the QBC main window without making any changes to the pump configurations.

User Name: This field specifies the pump's user or gives a description of the experiment associated with the pump. The field may contain up to 20 characters for display.

Syringe: This field specifies the size of the syringe in the pump. The following selections are available:

10 μ L	1 mL
100 μ L	2 mL
250 μ L	2.5 mL
500 μ L	5 mL

These choices refer to syringes with 60 mm calibration lengths. Changing the volume of the syringe will change the available flow rates in the Flow Rate field.

Flow Rate: This field specifies the flow rate of the pump, measured in μ L/min. The flow rates listed in this list box require syringes with 60 mm calibration lengths and are dependent on the syringe size specified in the Syringe field.

Stop After (Time, Volume, or Amount): This set of check boxes sets the criterion by which the pump's Stop Condition is determined. Only one criterion can be selected for each pump, though each pump's setting is independent of the other pumps.

Time: The pump will stop after it has delivered for the time (in minutes) specified in the Stop At field.

Volume: The pump will stop after it has delivered the volume (in microliters) specified in the Stop At field.

Amount: The pump will stop after it has delivered the dosage specified in the Stop At field. The proper concentration and concentration units must be specified in the Concentration and Units fields.

Stop At: This field specifies the level (in units of time, volume, or amount) at which the pump will automatically stop running. The value in this field is set using the arrows next to the field or by typing in a value, and can be set no lower than 1 unit. The units in this field automatically change according to the criterion selected in the Stop After field.

Concentration: This field specifies the concentration for the substance in the syringe. The concentration units are specified in the Units field. The concentration level is set using the arrows next to the Concentration field or by typing in a value. This field is only active if the pump's Stop Condition is set to Amount in the Stop After check boxes.

Units: This field specifies the concentration units (in amount/volume) for the substance in the syringe. This field is only active if the pump's Stop Condition is set to Amount in the Stop After check boxes.

Name: This field serves as a reminder of the contents of a syringe. The field may contain up to 20 characters for display. This field is only active if the pump's Stop Condition is set to Amount in the Stop After check boxes.

Event Out At: If the Event Out At check box is selected, then the QBC can be set to generate signals on the pump's external output channel while running. Up to four one-time events or three repeated events can be scheduled for each pump. Events may be scheduled to occur anytime between the start of delivery and when the pump reaches its Stop Condition. When a pump is reset, the schedule of events is also reset.

Event “times” are measured in the same units as the pump’s Stop Condition. These times are set in the Event Out At time field by using the arrows next to the box or by typing in a value. The value in the Event Out At time field cannot exceed the value in the Stop At field. For example, if Pump 3 is set to stop after 2 mL, events scheduled for Pump 3 are scheduled according to volume; 1 mL or 2 mL would be valid event “times,” but not 3 mL, as that exceeds the pump’s Stop Condition.

NOTE: Events will occur no more than one second after they are scheduled. To increase the accuracy of event timing, close as many Windows applications as possible when running the QBC software.

Initial Level (High or Low): This field is only active if the Event Out At check box is selected. If the High box is checked, the pump’s external output channel is set to TTL High when the pump is reset. If the Low box is checked, the pump’s external output channel is set to TTL Low.

Event Type (Pulse or FlipFlop): This field is only active if the Event Out At check box is selected.

If the Pulse box is checked, a pulse signal of at least .5 s will be sent on the pump’s external output channel for the event. For example, if the current state of Pump 2’s channel is TTL High, the channel will go to TTL Low for at least .5 s when the event occurs and then return to TTL High.

If the FlipFlop box is checked, the external output channel will switch from its current state to the opposite state for the event. For example, if the current state of Pump 2’s channel is TTL Low, the channel will switch to TTL High when the event occurs.

Add: This button is only active if the Event Out At check box is selected. Clicking this button adds the current event setting (Pulse or FlipFlop) to the schedule of events at the time specified in the Event Out At time field. Events are sorted from earliest to latest time as they are added.

Clear: This button is only active if the Event Out At check box is selected. When this button is clicked, the schedule of events for the pump is erased. If no events are scheduled, no events will occur when the pump is running, even if the Event Out At check box is selected.

Repeat: This button is only active if the Event Out At check box is selected. Clicking this button will add a Repeat All event to the schedule of events. When a Repeat All event is added to the schedule, any events before the Repeat All are repeated in cycle.

Repeat All events can be added to the schedule under the following circumstances:

- The Repeat All event must be added to the schedule last. No events may be added after adding a Repeat All event.
- If there are more than three events already scheduled, no Repeat All events may be added.
- If there are no events scheduled, a Repeat All event can be added first to the list, but it will have no effect (and prevent the addition of other events).

For example, if you schedule a Pulse event at 1 minute and a FlipFlop event at 7 minutes for Pump 4, and then schedule a Repeat All event on Pump 4, a Pulse event will occur

once every minute and a FlipFlop event will occur every 7 minutes that Pump 4 is running. Without the Repeat All command, each event would occur only once.

Pump Active: If this check box is selected, then the pump is active and either the Queen Bee Controller or an external control signal can be used to control the pump. If this check box is not selected, the pump is considered inactive and cannot be run, stopped, or reset.

Alarm: If this check box is selected, then an audible and visible alarm will start when the pump reaches its Stop Condition. If this box is not selected, no alarm is set. Separate alarms can be set for each pump.

NOTE: Alarms are not cleared by resetting the pumps whose alarms have gone off. Alarms can only be cleared by clicking the Clear Alarm button on the QBC main dialog toolbar or the QBC Chain dialog box.

External (input) Control: If this check box is selected, then the pump starts and stops according to a signal change on its external input channel.

When the QBC program starts, the state of each pump's external input channel is examined. If a pump is selected for external control, then a state change on the pump's input channel (TTL low to high or TTL high to low) has the same effect as clicking on the pump's Run/Stop button.

CAUTION: The Run/Stop buttons may be used to send Start and Stop commands to pumps that are marked for external control. However, the device sending signals over the external input channel will not be aware of these commands, and it is therefore possible for the external control signal to have the wrong effect.

NOTE: If there is no device connected to a pump's external input channel, then the state of the channel is indeterminate and the pump should not be selected for external control.

Help: Clicking this button brings up QBC's on-line help for the Bee Pump Configuration dialog.

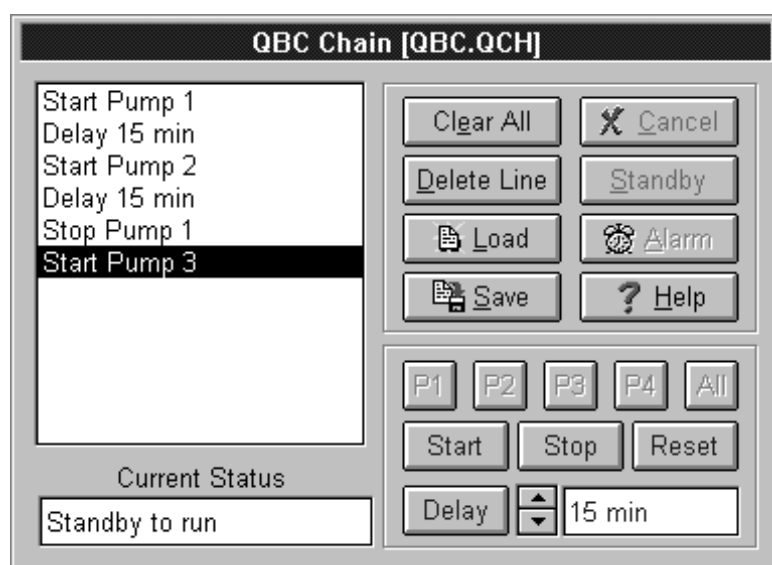
4.4 Syringe Pump Chaining

The QBC software features “command chains” that can repeatedly start, stop, and reset each of the four syringe pumps at specified intervals of time. This allows for the assembly and unattended execution of series of syringe pump actions. Command chains can be stored on disk in chain files. These files allow experiments to be set up quickly and easily after creating the chains once.

4.4.1 The QBC Chain Dialog

Choosing the Chain option from the Configuration menu or clicking the Standby-Chain button in the toolbar will display the QBC Chain dialog, shown in Figure 4.5.

Figure 4.5. The QBC Chain dialog.



The QBC Chain dialog has two modes: entry and execution. When a command chain is executing, the dialog is in execution mode and no controls are available except CANCEL (to stop execution of the chain). Otherwise, the dialog is in entry mode and all the controls are available for you to create, execute, load, and save command chains.

The QBC Chain dialog contains the following controls:

Command Chain List Box: This box lists the commands in the current chain. This list is updated as lines are added and deleted. Lines in the list box are selected for insertion or deletion by clicking on them.

Current Status: This box shows the current status of the chain. It is updated as chains are created and executed.

Standby: Clicking this button starts execution of the commands listed. All other controls in the dialog become inactive, except for Cancel. The command chain begins execution with the first command in the list, highlighting each command as it is executed. During

execution, the Current Status field displays a message for each command. After the last command has executed, all pumps are sent a Stop command, the dialog returns to entry mode and the Current Status field says "End - Chain and Standby."

If there are no commands in the list, clicking this button has no effect.

NOTE: The last action any command chain takes is to send Stop commands to all four pumps.

Cancel: Clicking this button while a command chain is executing halts execution of the chain, sends Stop commands to all four pumps, and returns the dialog to entry mode. The Cancel button flashes while a command chain is executing.

Clicking this button while the dialog is in entry mode returns control to the QBC main window without executing the command chain. Any commands currently in the list will remain in the list until they are deleted or the list is cleared.

Load: Clicking this button activates a standard Windows Open dialog. The chain file selected in this dialog appears in the command list and is ready to execute.

NOTE: By default, the Open dialog searches for and displays only files with the file extension .QCH. Chain files may, however, be given any file extension and can then be displayed in the Open dialog by selecting "Any (*.*)" in the "List Files of Type" field.

NOTE: The QBC software does not recognize Windows 95's long file names.

Save: Clicking this button activates a standard Windows Save dialog. The commands currently in the list will be saved in the chain file specified in this dialog.

NOTE: If no file extension is specified in the "File Name" field of the Save dialog, the configuration file will be assigned an extension of .QCH by default.

NOTE: The QBC software does not recognize Windows 95's long file names.

Clear Alarm: While the command chain is executing, alarms may go off as syringe pumps reach their Stop Conditions, if alarms have been set in the Bee Pump Configuration dialog (see Section 4.6.2). Clicking this button clears any alarms that go off.

Help: Clicking this button brings up QBC's on-line help for the QBC Chain dialog.

4.4.2. Creating Command Chains

The QBC Chain dialog controls listed below are used to create command chains by adding and deleting commands and Delay statements to the list displayed in the dialog's list box. As lines are added to the chain, the most recently added line is highlighted in the text box, and all further commands are inserted into the chain after the highlighted line. To move the insertion point to another line, click on that line in the list. The highlighted line is also the line affected by the Delete Line button (see below).

NOTE: Command chains can contain no more than 100 lines.

P1, P2, P3, P4, and All: These buttons act as the "arguments" for the Start, Stop and Reset buttons, and are inactive unless one of those buttons was the last button clicked.

Clicking P1, P2, P3, or P4 specifies that a command should be applied to Pump 1, 2, 3, and 4, respectively. Clicking the All button specifies that a command should be applied to all four pumps.

Start: Clicking this button adds a Start command to the list. After clicking this button, all other controls in the dialog will become inactive, except for the P1, P2, P3, P4 and All buttons. Clicking one of the argument buttons specifies which pump (or if all pumps) should receive a Start command.

When executed, the Start command runs the specified pump. If the pump was not reset before it receives a Start command, and it has not reached its Stop Condition, it will begin operation from the point at which it was last halted.

Stop: Clicking this button adds a Stop command to the list. After clicking this button, all other controls in the dialog will become inactive, except for the P1, P2, P3, P4 and All buttons. Clicking one of the argument buttons to specifies which pump (or if all pumps) should receive a Stop command.

When executed, the Stop command halts the specified pump. This command does not reset the halted pump.

Reset: Clicking this button adds a Reset command to the list. After clicking this button, all other controls in the dialog will become inactive, except for the P1, P2, P3, P4 and All buttons. Clicking one of the argument buttons to specifies which pump (or if all pumps) should receive a Reset command.

When executed, the Reset command resets the specified pump. If the pump does not receive a Stop command before it receives a Reset command, the Reset command will have no effect.

CAUTION: Start and Stop commands may be sent to pumps that are marked for external control. However, the device sending signals over the external input channel will not be aware that these commands have been sent from the command chain, and it is therefore possible for the external control signal to have the wrong effect.

Delay: Clicking this button adds a Delay statement to the list. The Delay statement takes as its argument the number of minutes specified in the Delay time field. The Delay time field is set using the arrows next to the field, and has a minimum value of 0 minutes.

When executed, the Delay statement will cause the command chain to wait for the specified amount of time before executing the next line.

Clear All: Clicking this button will erase all lines from the list. The Current Status field will read "No Chain List to Run."

Delete Line: Clicking this button will delete the highlighted line in the list. Lines in the list are highlighted by clicking on them.

4.4.3 Command Chain Example

Let's say you have four syringe pumps attached to the Queen Bee Controller and configured to deliver at specific flow rates. Each syringe needs to deliver its contents for a specific length of time, and the substances need to be delivered in a specific order. However, you also need to be out of the lab when this experiment is going on, and you won't be able to watch the progress and send the Start and Stop commands yourself. This is a perfect situation for QBC's command chains.

1. After you've configured the pumps for the correct delivery flow rates, syringe volumes, event schedules, etc., and set Stop Conditions so that the pumps deliver for the correct lengths of time, click on the "Standby - Chain" button in the toolbar or select the Chain option under the Configuration menu. The QBC Chain dialog will appear.
2. If there are any commands in the list, click the Save button to store them in a chain file if you want to save them. Whether you save them or not, click the Clear All button to erase them and make room for a new command chain.

To guarantee that all the pumps are ready to run, you can send a Reset command to each pump.

3. Click the Reset button and then the All button. A "Reset All Pumps" command is added to the list.

The experiment needs Pump 1 to deliver first.

4. Click the Start button and then the P1 button. A "Start Pump 1" command is added to the list.

Twenty minutes later, you need to stop Pump 1 and start Pump 2.

5. Click the arrows next to the Delay time field until it reads 20 min. Click the Delay button. A "Delay 20 min" statement is added to the list.
6. Click the Stop button and then the P1 button. A "Stop Pump 1" command is added to the list.
7. Click the Start button and then the P2 button. A "Start Pump 2" command is added to the list.

After another 15 minutes, you need to start Pump 3 and Pump 4.

8. Click the arrows next to the Delay time field until it reads 15 min. Click the Delay button. A "Delay 15 min" statement is added to the list.
9. Click the Start button and then the P3 button. A "Start Pump 3" command is added to the list.
10. Click the Start button and then the P4 button. A "Start Pump 4" command is added to the list.

Two minutes after Pumps 3 and 4 have started, you need to shut down Pump 2 if it is still running.

11. Click the arrows next to the Delay time field until it reads 2 min. Click the Delay button. A "Delay 2 min" statement is added to the list.
12. Click the Stop button and then the P2 button. A "Stop Pump 2" command is added to the list.

Pumps 3 and 4 should be left to run for an hour and then shut off.

13. Click the arrows next to the Delay time field until it reads 60 min. Click the Delay button. A "Delay 60 min" statement is added to the list.

14. You can explicitly stop the pumps by clicking Stop, P3, Stop, and then P4.

OR

14. You can explicitly stop the pumps by clicking Stop then All.

OR

14. You can stop adding commands here, since all command chains send Stop commands to all four pumps when they stop execution.

At this point, you are ready to execute the command chain.

15. Click Standby. All the controls except Cancel will be disabled and the commands in the list will be highlighted as they execute. The Start, Stop and Reset commands will execute faster than most people can notice, but for each Delay statement a timer will appear in the Current Status field.

If you need to interrupt the chain, click the Cancel button. Remember that the command chain will start at the first command if you hit Standby again.

After the chain has finished execution, you may decide you want to store the command chain for future use.

16. Click the Save button and give the chain a file name. Remember that chain files have the file extension .QCH by default.

Later, you decide you want to use that command chain again.

17. Click the Load button in the QBC Chain dialog and select the file you saved before.

But before you run it, you decide you don't need to start Pump 4.

18. Highlight the "Start Pump 4" command in the list by clicking on it. Then click the Delete Line button. The command is removed from the chain. If you want to store the modified command chain, click the Save button.
19. When you are finished executing command chains, click Cancel to return to the QBC main dialog.

Section 5. Queen Bee Controller Hardware Functions

The two pieces of QBC hardware most often worked with are the controller box and external I/O board. The following sections describe these hardware components in detail:

Section 5.1 The Controller Box

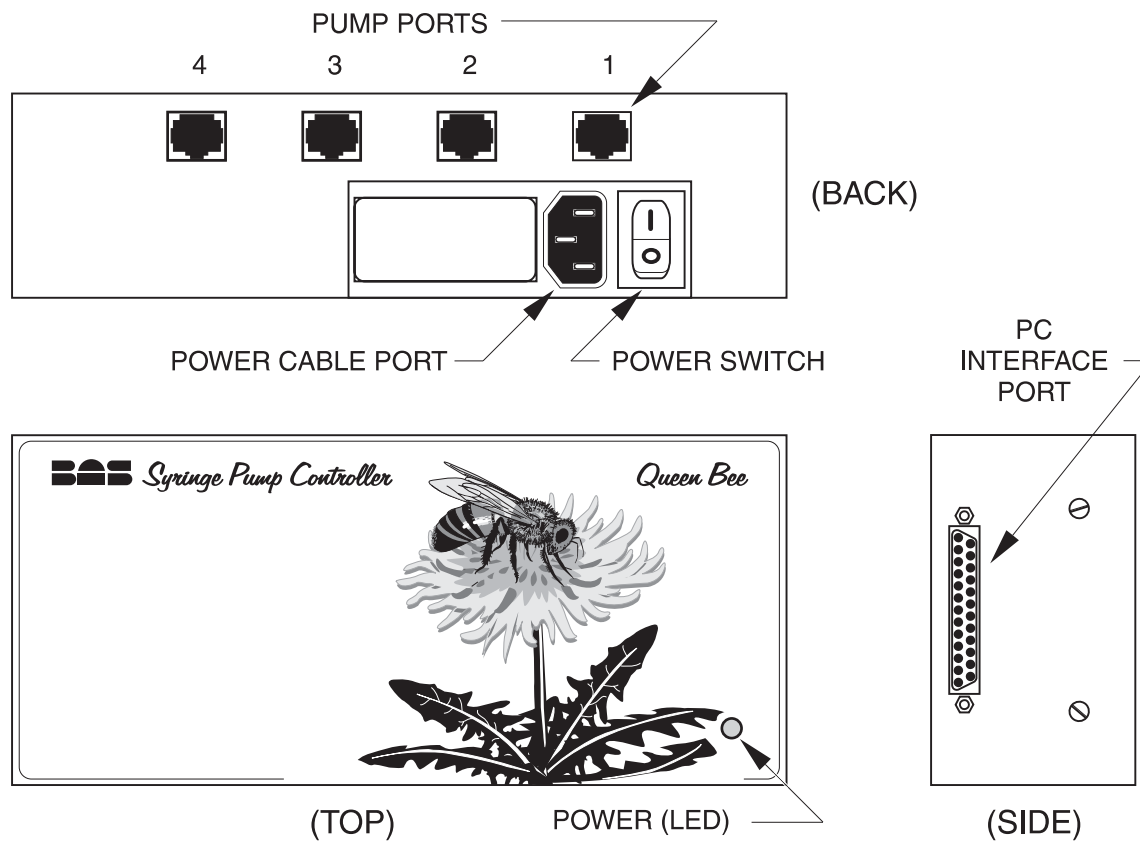
Section 5.2 The External I/O Board

Section 5.3 QBC Technical Specifications

5.1 The Controller Box

The controller box, shown in Figure 5.1, connects to the PC via an expansion card and connects to up to four BAS Baby Bee syringe pumps via color-coded cables. The controller is operated using the QBC software for Windows on the PC.

Figure 5.1. The Controller Box.



The controller box has 5 features, which are described below.

5.1.1 Power Cable Port

The female end of the power cable included with the QBC should be attached to the three-pronged port on the back side of the controller box. The other end of the power cable should only be plugged into a grounded outlet.

5.1.2 Power Switch

When this switch on the back side of the controller box is in the 'On' (I) position, power is delivered to the controller box and any attached syringe pumps. The controller box should be connected to the PC and syringe pumps and then turned on before starting the QBC software. When the controller is turned on, the green LEDs on the attached syringe pumps will blink slowly. When the QBC software is started, the LEDs on the pumps will shut off.

NOTE: If the power to the controller box or any attached pump is interrupted at any time (by switching the power switch to the 'Off' (O) position, unplugging the power cable, or disconnecting the pump from the controller box), you must exit the QBC software, resume power to the controller box or pump, and then restart the QBC software.

5.1.3 Power LED

The red LED on top of the controller box will light when the power switch is in the 'On' (I) position and the power cable is plugged into an outlet.

5.1.4 PC Interface Port

The D-Shell end of the thin ribbon cable included with the QBC connects to the port on the right-hand side of the controller box. The other end of the thin ribbon cable connects to the PC expansion card as described in Section 3.1. The controller box should be connected to the PC and syringe pumps and then turned on before starting the QBC software.

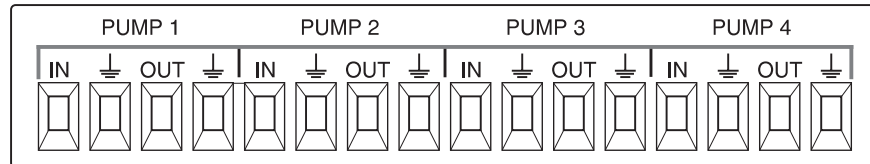
5.1.5 Pump Ports

BAS Baby Bee syringe pumps connect to the four ports on the back side of the controller using the color-coded cables included with the QBC. Either end of a pump cable can connect to the port or the pump. The pumps connected to the ports are designated (reading from right to left, facing the back side of the controller box) Pump 1, Pump 2, Pump 3, and Pump 4 in the QBC software.

5.2 The External I/O Box

The external I/O box provides access to the syringe pumps' external input and output channels through the ports on the box's front panel (see Figure 5.2). Section 4.3.2 describes the operation and use of these channels in detail. The board connects to the PC expansion card via the wide ribbon cable included with the QBC, as described in Section 3.1. The external I/O board does not have to be connected to the PC unless you plan to use the external I/O features of the QBC software.

Figure 5.2. The External I/O Ports



The external input and output channels transmit and receive TTL signals the ports' terminals. The post assignments are labeled on the top of the I/O box.

NOTE: It is possible to connect the output channel from one pump to the input channels of one or more other pumps.

Section 6. Troubleshooting

6.1 The LEDs on the Baby Bee pumps don't shut off when the software starts.

When the QBC is first turned on, the LEDs on the Baby Bee pumps will blink slowly, which indicates that they are in a "power interrupt" state. When the QBC software starts, its first action is to reset the pumps, leaving them in the Stopped state. If the LEDs remain blinking or stay lit after the QBC software is started, this is usually because power was applied to the QBC hardware after the QBC software was already running. For the QBC software to operate correctly, the QBC hardware must be turned on before starting the software. See Section 6.3 below for instructions on what to do if the power to the controller or pumps is interrupted while the QBC software is running.

6.2 The LEDs on the Baby Bee pumps are flashing rapidly.

If a syringe pump reaches its physical limit (that is, the pump carriage is at the end of its travel path), the green LED on the syringe pump will begin to flash rapidly, and a warning dialog will appear on the screen. You will need to physically move the pump carriage away from the end of travel position (see the Baby Bee manual for details). When you click OK in the warning dialog, the pump will be in the halted state.

6.3 Power was interrupted to the QBC and/or the Baby Bee Pumps.

If the power to the controller box or any attached pump is interrupted at any time (by flipping the power switch, unplugging the power cable, disconnecting the pump from the controller box, or losing electrical service), you must exit the QBC software, resume power to the controller box or pump, and then restart the QBC software.

6.4 External control signals are behaving incorrectly.

The Run/Stop buttons and command chains may be used to send Start and Stop commands to pumps that are marked for external control. However, the device sending signals over the external input channel will not be aware of these commands, and it is therefore possible for the external control signal to have the wrong effect. You should make certain that pumps under external control are not sent unplanned Run or Stop commands by the user or by a command chain.

If a pump is selected for external control, there should be a controlling device connected to the pump's external input channel on the I/O box. If there is no device connected to a pump's external input channel, then the state of the channel is indeterminate and the pump should not be selected for external control.

6.5 The pump status display is incorrect after changing a pump configuration.

Changing the configuration of the pump does not change its state or the information about the pump in the QBC main window's pump status display. The pump's information will remain as it was when the pump was last halted or stopped until the pump receives a Reset command. At that time, the pump status display will be updated with the new configuration settings.

6.6 Alarms and/or I/O events are occurring at unexpected times.

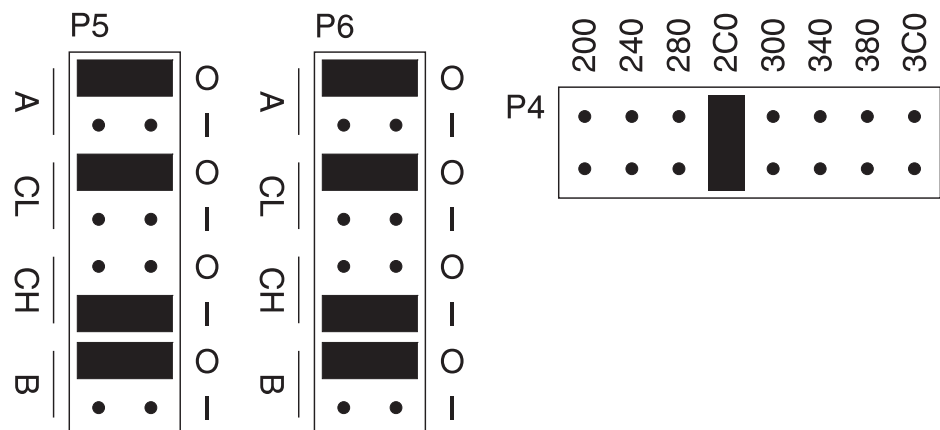
If alarms or external I/O events (especially events on the external output channel) appear to be occurring at times, volumes or dosages that are not expected, check the following conditions:

1. QBC flow rates as specified in the Bee Pump Configuration dialog require gastight syringes with a 60 mm calibration length. Syringes with calibration lengths other than 60 mm are not guaranteed to deliver at the QBC's listed flow rates. Be certain that you are using syringes with a 60 mm calibration length.
2. Be certain that the syringe volume specified in the Bee Pump Configuration dialog matches that of the actual syringe mounted on the pump. If the actual syringe volume is different from the specified volume, the correct flow rates are not guaranteed.
3. External I/O events should occur no more than one second after they are scheduled. To increase the accuracy of event timing, close as many Windows applications as possible when running the QBC software.
4. Make certain that there is no conflict between the external control of the pump and control of the pump via the Run/Stop buttons (see Section 6.4).
5. If a pump is selected for external control, there should be a controlling device connected to the pump's external input channel on the I/O box. If there is no device connected to a pump's external input channel, then the state of the channel is indeterminate and the pump should not be selected for external control.

6.7 I/O Card Configuration Issues

Before installing the QBC I/O card, you should first make certain that certain jumpers on the I/O board are configured correctly. Figure 6.1 shows the correct jumper settings for the P4, P5 and P6 banks of jumpers. The jumpers are configured as shown at the factory, and should not be changed. The QBC will not function properly if these jumper configurations are incorrect. If the jumpers are configured incorrectly, set them as shown in Figure 6.1.

Figure 6.1 The I/O card jumper configurations.



NOTE: Jumper P4 determines the base address for the I/O card. This address must be set to 2C0 as shown in Figure 6.1. The QBC will not function if the jumper is not configured as shown. If there are any other peripherals, expansion cards or other devices connected to the PC that occupy address 2C0, there will be a conflict and the QBC will not function. See the technical manuals for the PC and the conflicting devices for instructions on reconfiguring those devices to occupy other addresses. The QBC cannot be configured to occupy a different address.

Section 7. For Technical Support

BAS has a team of physiologists, chromatographers, software experts, and service engineers to help you. We also have a number of academic consultants available.

In USA/Canada, contact:

TEL: (800) 845-4246 or (317) 463-4527
FAX: (317) 497-1102
Internet E-mail: candice@bioanalytical.com

For assistance in Chinese or Japanese, contact:

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In Europe, contact:

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Fax Cover Sheet

Subject: BAS-QBC Registration

To: Bioanalytical Systems, Inc.
2701 Kent Avenue
West Lafayette, IN 47906
Tel: (317) 463-4527

Fax: (317) 497-1102

Please send me future upgrade information.

From:

Name:..... Title:

Institution:..... Dept:

Address:

City:..... State:..... ZIP:.....

Country:.....

Phone:..... FAX:.....

Optional information (check all that apply):

Keep my name on mailing list.

I currently use the following BAS products:

- BAS LC System
- BAS PKA Products
- BAS Microdialysis Products
- Other _____

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