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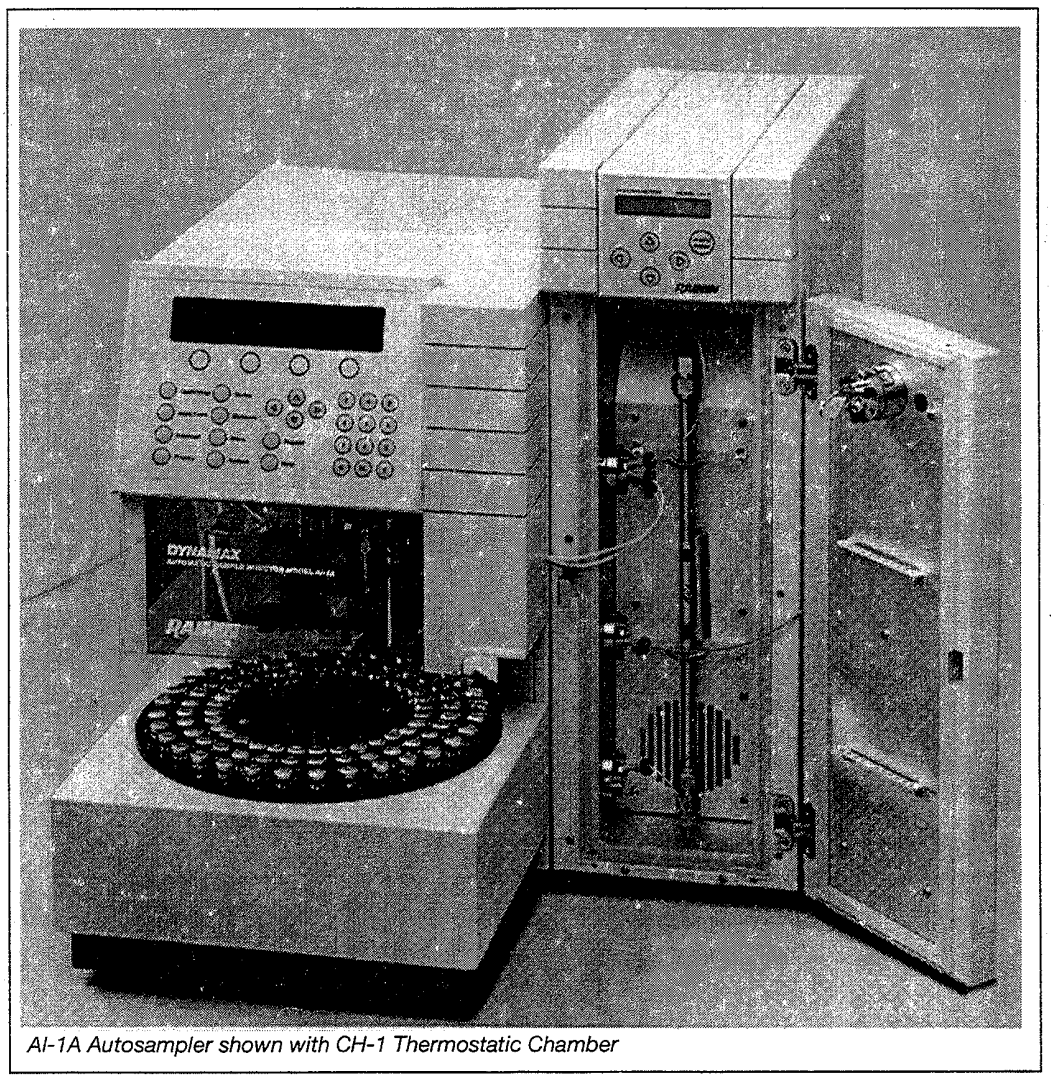
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RAININ
LC & SUPPLIES

Dynamax® AI-1A Autosampler

Cat. Nos. 88-001A and 88-003A



AI-1A Autosampler shown with CH-1 Thermostatic Chamber

User Guide

9920-142 Rev A

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This User Guide uses pictograms to alert the user to possibly unsafe conditions or other information: **"DANGER", "WARNING", "CAUTION", "ATTENTION", and "NOTE". These signs** have specific meanings, described below:



DANGER: (alerts you to a dangerous condition)

HAZARDOUS CONDITION. DISREGARDING A **DANGER SIGN** MAY RESULT IN PERSONAL INJURY OR LOSS OF LIFE. Equipment damage may also result from disregarding a DANGER SIGN. Do not proceed beyond a DANGER SIGN until the indicated conditions are fully understood and met.



WARNING

WARNING: (alerts you to a potentially dangerous condition)

DISREGARDING A **WARNING** MAY RESULT IN PERSONAL INJURY. Equipment damage may also result from disregarding a WARNING. Do not pass a WARNING until you fully understand and comply with the indicated conditions.



CAUTION

CAUTION: (information provided to prevent equipment damage)

Disregarding a **CAUTION** may cause damage to electrical or mechanical components, but personal injury is unlikely.



ATTENTION: (information helpful to a procedure)

Disregarding an ATTENTION sign may cause delay or inconvenience, but should not result in equipment damage or personal injury.



NOTE: (information provided to make a procedure easier or clearer)

Disregarding a **NOTE** may cause delay or inconvenience, but should not result in equipment damage or personal injury.

Please read this manual carefully before starting to use the Model AI-1A autosampler.

Chapters 1 and 2 describe the Model AI-1A and the three types of injection methods. Chapter 3 contains information on how to install the Model AI-1A and how to replace spare parts. Connecting the Model AI-1A to an HPLC system and connecting other components to the Model AI-1A are also described in that chapter.
Chapter 4 describes all programming utilities of the Model AI-1A. It is important that when you install the Model AI-1A for the first time, the SYSTEM SETTINGS must be programmed according to your configuration.

Using the Model AI-1A without regard to these instructions may cause unsafe operation.

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The Model AI-1A uses the following safety symbol:



This sticker warns of the sharp needle and the moving needle arm. Handle with care, to prevent injury or damage to these parts.

SAFETY PRACTICES

GENERAL

The following safety practices are intended for safe operation of the equipment.



Electrical Hazards

1. Removal of some panels exposes potentially dangerous voltages. Disconnect the instrument from all power sources before removing protective panels.
2. Replace blown fuses with size and rating stipulated on the fuse panel or holder.
3. Replace or repair faulty or frayed insulation on power cords.
4. Check actual line voltage to confirm it is the value for which this instrument is wired. Be sure power cords are plugged into correct voltage sources.



General Precautions

1. Perform periodic leak checks on supply lines.
2. Do not allow flammable and/or toxic solvents to accumulate. Follow a regulated, approved waste disposal program. Never dispose of such products down the drain.

CONVENTIONS

KEYBOARD:

FUNCTION KEYS: Function keys are printed in text between square brackets.
[Start/Stop], [Hold/Cont.], [Interrupt], [Priority], [Series], [Methods], [Menu], [System], [Escape], [Help], [Clear] and [Enter].

SOFT-FUNCTION KEYS: Soft-function keys are printed in the text between chevrons brackets. Example: <ADVANCE>

CURSOR KEYS: The cursor keys are printed in the text as follows: left-arrow, right-arrow, up-arrow, down-arrow.

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SPECIFICATIONS

GENERAL

Sound pressure level	<70 dB
Working temperature	10 - 35 °C
Installation category	Category II (according to IEC 1010)
Pollution degree	Degree 2 (according to IEC 1010)
Sample capacity	96 vials of 1.5 mL (STD), 12 vials per segment.
	72 vials of 4.0 mL (LSV), 9 vials per segment.
	160 microvials of 0.5 mL, 20 vials per segment.
	32 vials of 10.0 mL, 4 vials per segment.
Vial dimensions	Maximum vial height: 47 mm inclusive cap.
	Minimum vial height: 32 mm inclusive cap.
Loop volume	5 - 1000 µL
Injection volume	1 µL - 1 mL, with 1 µL increment
Injections per vial	max. 9 (Volumes are programmable for each injection)
Analysis time	max. 9 hr 59 min 59 sec
Injection methods	Flushed loop injections
	Partial loopfill injections
	µL pick-up injections (without sample loss)
Needle wash	Programmable:
	Wash between injections
	Wash between vials
	Wash at end of series
Wash solvent	250 mL internal wash solvent bottle
Dispenser syringe	100 µL, 250 µL (standard), 500 µL or 1000 µL
Vial detection	Missing vial detection by vial sensor.
Sample access	<10 seconds.
Headspace pressure	Built-in compressor.
Pre-puncturing septa	With air needle, dual needle action.
Switching time injection valve	electrically <100 msec.
Piercing precision needle	± 0.25 mm
Priority sample	Free programmable

ANALYTICAL PERFORMANCE

Reproducibility	RSD <= 0.3 % for flushed loop injections
	RSD <= 0.5 % for partial loopfill injections, injection vols > 5 µL
	RSD <= 1.0 % for µL pick-up injections, injection volumes > 5 µL
Memory effect	< 0.01 % with programmable needle wash

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ELECTRICAL

Power requirements	115 VAC; ±10%; 50 Hz/ 60 Hz; 150 VA
	230 VAC; ±10%; 50 Hz/ 60 Hz; 250 VA
Fuses	For 115 VAC; two 5.0 AT-fuses (slow, ¼" x 1¼", UL/CSA).
	For 230 VAC; two 2.5 AT- fuses (slow, 5 x 20 mm, IEC127).

PHYSICAL

Dimensions (W x D x H)	280 mm x 540 mm x 440 mm
	11 in x 21.3 in x 17.3 in
Weight	22 kg (48 lbs.)
	30 kg (66 lbs.) with cool option.

COMMUNICATIONS

OUTPUTS	Inject marker(Relays & TTL)
	Vial marker(Relays & TTL)
	Labeled vial marker(Relays & TTL)
	Stop I/O(Relays & TTL)
	BCD output(TTL)
	4 Auxiliary outputs(Relays)
	4 programmable outputs(Relays)
	4 bit time base(TTL)
INPUTS	Next injection marker
	Next vial marker
	Freeze
	Stop I/O
	4 programmable inputs
SERIAL COMMS PORT	RS232C

OPTIONS

Sample cooling	Built-in Peltier cooling
	Range: 4°C - 40°C
	Accuracy: ± 2°C
	Cool capacity: Ambient - 20°C
	Ring temperature at relative humidity of 80% and ambient temperature of 31°C, decreasing to 50% at 40°C
Integrated stream switching	(ISS) Two optional high pressure 6-port valves
Optional trays	LSV-tray: 9 vials of 4.0 mL per segment.
	Micro-tray: 20 micro vials per segment.
	Super LSV-tray: 4 vials of 10 mL per segment.
Column oven	Model CH-3 column oven. The injection valve and optional high pressure valves fit into the column oven.

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Chapter 1 Introduction

The Model AI-1A autosampler is an upgradeable instrument for both routine analysis and method development purposes. It combines easy menu-driven system programming with flexibility for many sample-handling purposes such as sampling, diluting, mixing and precolumn derivatization in one instrument.

Thanks to the modular approach, it is very easy to upgrade the basic instrument with optional modules such as stream-switching valves and a peltier cooled tray.

The Model AI-1A has standard advanced programming options which can be enabled in the system settings. As a standard these options are disabled. The advanced options are:

- Reagent-mix methods, with advanced sample manipulations, to perform pre-column derivatization, internal standard addition and dilution.
- Time based methods to control the optional ISS valves and other devices of the HPLC system with contact closures or TTL signals.
- User definable method programming. In this programming mode all actions of the Model AI-1A can be individually programmed. It allows the user to make a specific sample handling sequence for his application that differs from the standard routines in the regular methods.
- Protection code, methods and system settings can be protected against unwanted changes.

The standard serial RS232 interface allows communication with a wide range of other chromatographic systems.

The Model AI-1A has almost no limits in the use of vials. Four types of tray segments and a vial height detection guarantee a perfect injection from a wide range of vials.

A special feature of the Model AI-1A is the possibility to combine the Model AI-1A with the Model CH-3 column thermostat. The injection valve and the optional stream-switching valves slide into the oven compartment of the CH-3 for optimum temperature control.

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Chapter 2 Instrument Description

2.1 GENERAL DESCRIPTION

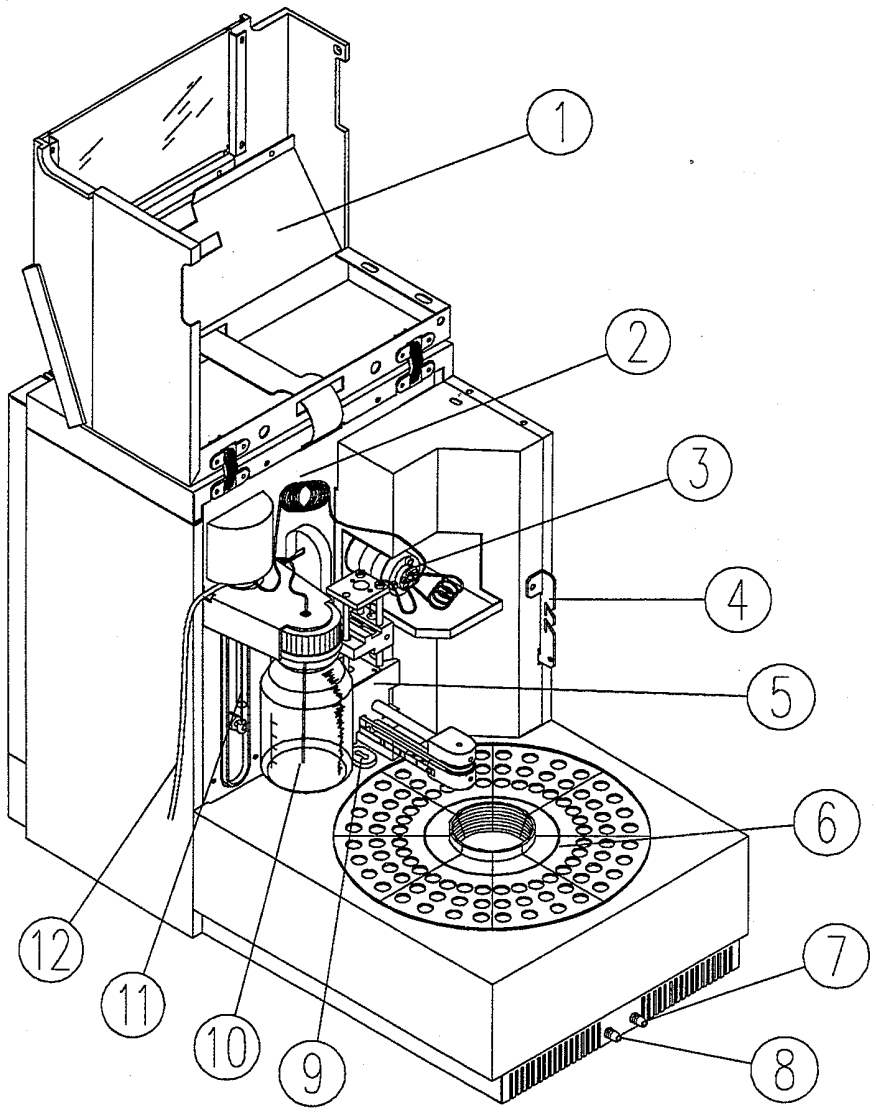


Figure 2-1 AI-1A autosampler

1	Cover in open position	5	Needle arm	9	Wash position
2	Buffer tubing	6	Tray segment	10	Wash solvent bottle
3	High pressure valve	7	Drain	11	Syringe
4	Tubing holder	8	Waste	12	Syringe waste

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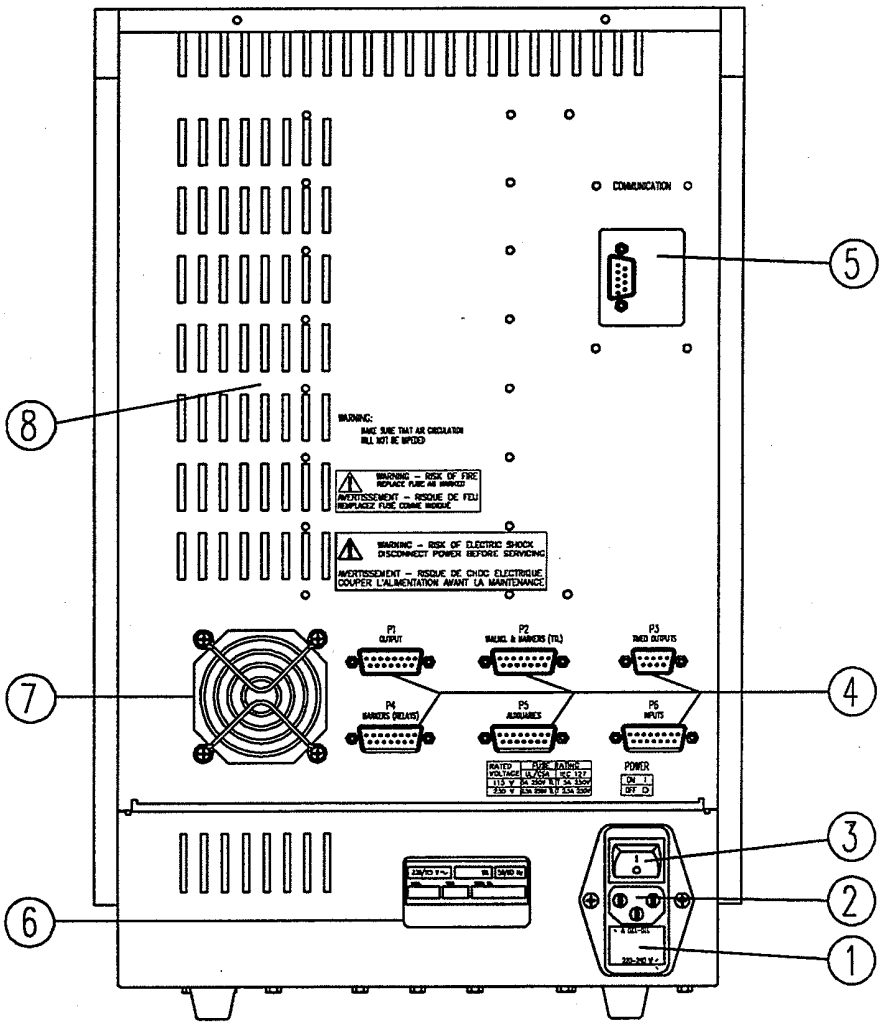


Figure 2-2 Rear side of the AI-1A

1	Fuses & voltage selector	4	I/O connectors	7	Fan (tray cooling option only)
2	Mains power receptacle	5	Communications	8	Ventilation
3	High pressure valve	6	Serial label		

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2.2 INJECTION PRINCIPLE

A unique sequence of valve switching and syringe-dispenser-controlled sample withdrawal enables the Model AI-1A to inject sample volumes in a range from a few microliters to milliliters in a simple and reproducible manner.

Therefore three different methods for injection can be selected:

- Flushed loop: The sample loop is completely (quantitatively) filled with sample resulting in extremely good reproducibility (better than 0.3%).
- Partial loopfill: The sample loop is partially filled with sample; low sample loss and programmable injection volumes.
- µL pick-up: After aspiration from the vial the sample volume is transported into the loop with transport liquid (mobile phase) from another vial; no sample loss. With this method 1 µL of sample may be injected from 5 - 10 µL.

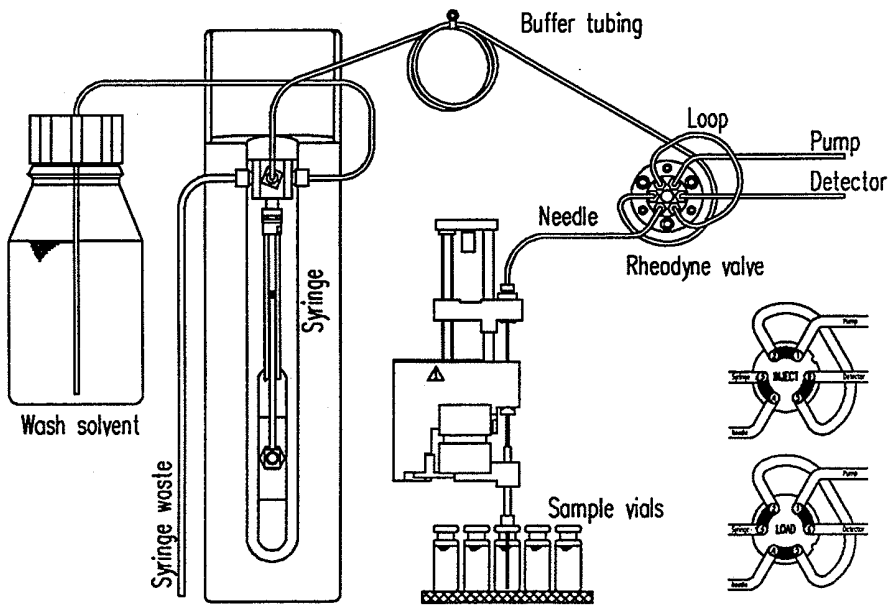


Figure 2-3: Fluid Connections

The Model AI-1A uses a syringe to aspirate the sample from a vial into the sample loop. To prevent contamination of the syringe the Model AI-1A is equipped with a buffer tubing between the syringe and the injection valve.

The wash solvent is used to remove the sample from the buffer tubing and sample needle and rinse the buffer tubing and sample needle.

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2.2.1 FLUSHED LOOP INJECTIONS

The switching sequence for a flushed loop injection is shown in the following figures:

Figure 2-4
*The initial situation: the injection valve is in **INJECT** position. The sample needle has entered the vial after the air needle has pre-punctured the septum. The headspace pressure, applied through the outer air needle, ensures that no air or vapor bubbles are formed during sample withdrawal.*

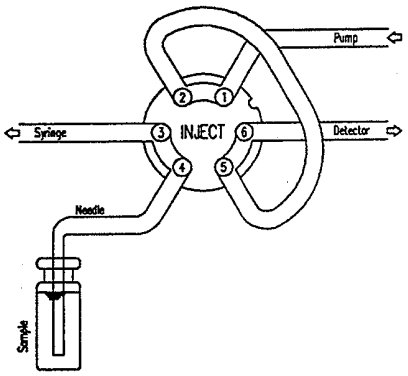


Figure 2-5
The syringe dispenser withdraws the "flush volume" from the sample vial to fill the sample line with sample and remove wash solvents.

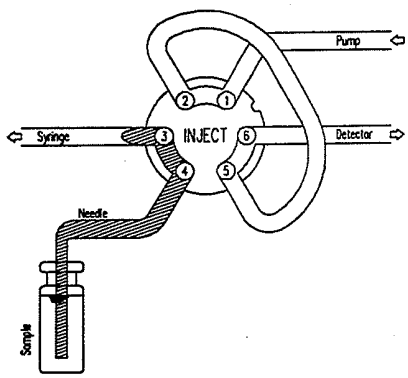


Figure 2-6
*The injection valve is switched into **LOAD** position, placing a "sharp" sample front at the very inlet of the sample loop.*

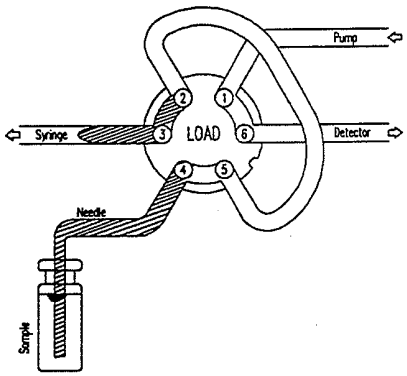
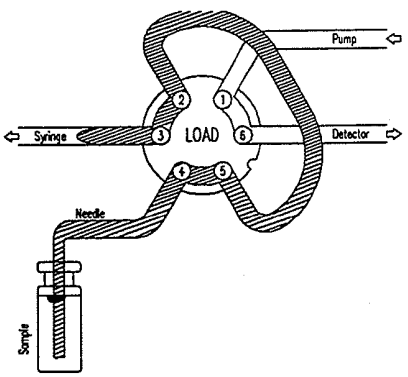
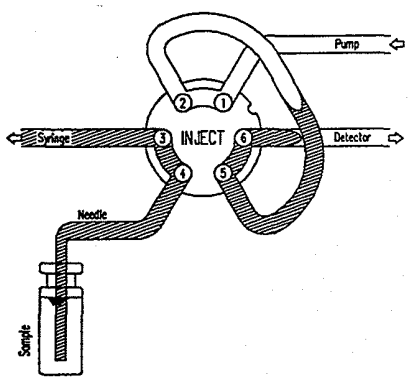


Figure 2-7
For flushed loop injections the sample loop is quantitatively filled by transporting two or more times the loop volume through the loop.



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Figure 2-8
*The injection valve switches into the **INJECT** position. The sample loop is now part of the HPLC mobile phase flow path: sample is transported to the column. The analysis time starts.*



If one injection is to be made out of each vial or a wash routine has to be performed after every injection: the needle withdraws from the vial directly after the injection and, if programmed, directly performs a wash. After the analysis time a new sequence is started.

If more than one injection is to be made out of the same sample vial without performing a wash routine, after the analysis time the Model AI-1A withdraws a flush volume to compensate for diffusion of mobile phase from the rotor groove into the front of the sample line during the analysis time. The flush volume between injections is not programmable and is always 50% of the programmed flush volume. If the total amount of sample withdrawn with the next injection from the vial will exceed the total volume of the buffer tubing, the buffer tubing is emptied into the wash position before the next injection. The next fill sequence will then start with a full flush volume.

Air segment

An air segment can be used to reduce the amount of flush volume. This air segment is at the front of the flush volume and will not be injected and therefore will not influence the injection. The air segment may be selected in the system settings (ON/OFF)

With a standard needle the flush volumes must be: minimal 30 µL for injections with air segment and 35 µL for injections without air segment. If the samples are highly viscous it may be necessary to program larger flush volumes and reduce the syringe speed for better performance.

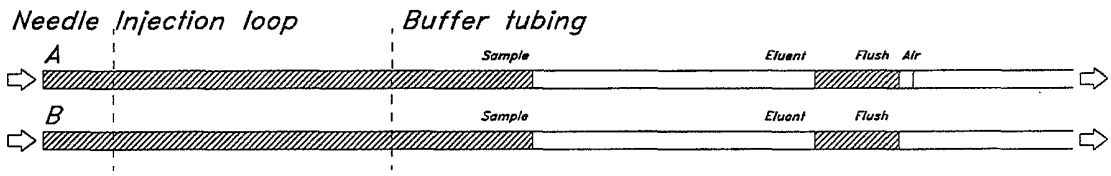


Figure 2-9: Flushed loop injections with (A) or without (B) Air Segment

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2.2.2 PARTIAL LOOPFILL INJECTIONS

The switching sequence for a partial loopfill injection is shown in the following figures:

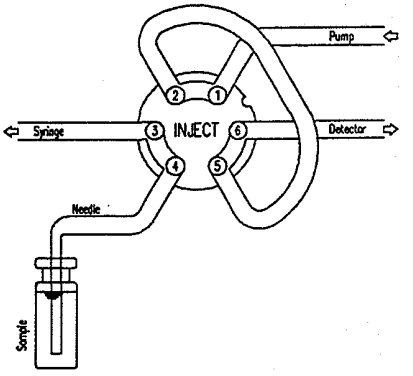


Figure 2-10
*The initial situation: the injection valve is in **INJECT** position. The sample needle has entered the vial after the air needle has pre-punctured the septum. The headspace pressure, applied through the outer air needle, ensures that no air or vapor bubbles are formed during sample withdrawal.*

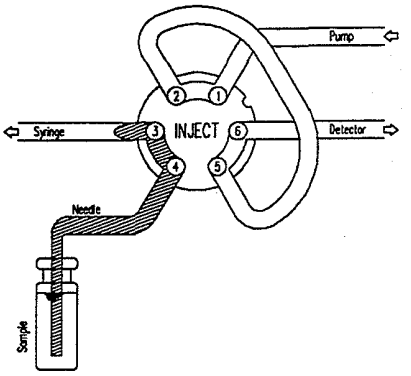


Figure 2-11
The syringe dispenser withdraws the "flush volume" from the sample vial to fill the sample line with sample and remove wash solvents.

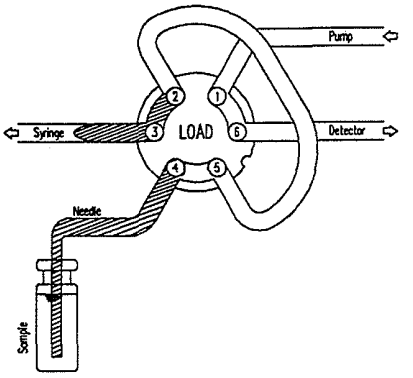


Figure 2-12
*The injection valve is switched into **LOAD** position, placing a "sharp" sample front at the very inlet of the sample loop.*

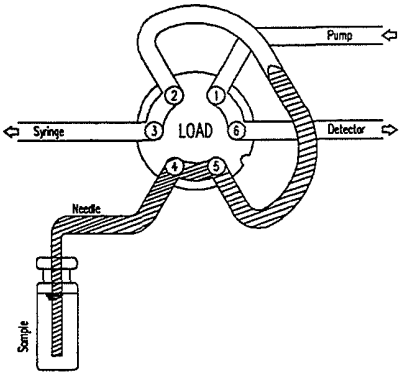
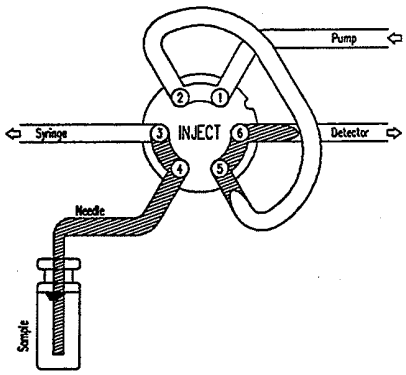


Figure 2-:13
For partial loopfill injections the sample loop is filled by transporting the programmed injection volume into the sample loop.

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Figure 2-14
*The injection valve switches into the **INJECT** position. The sample loop is now part of the HPLC mobile phase flow path: sample is transported to the column. The analysis time starts.*



The next injection sequence will start with a flush of 50% of the programmed flush volume, in case an injection from the same vial and no wash routine is programmed. Otherwise it will start with a flush of the programmed flush volume. If the withdrawal of sample for the next injection will exceed the total volume of the sample buffer tubing, the buffer tubing is emptied before the next injection. The next injection will start with the programmed flush, see also the flushed loop injections.

Air segment

An air segment can be used to reduce the amount of flush volume. This air segment is at the front of the flush volume and will not be injected. The air segment can be selected in system settings (ON/OFF).

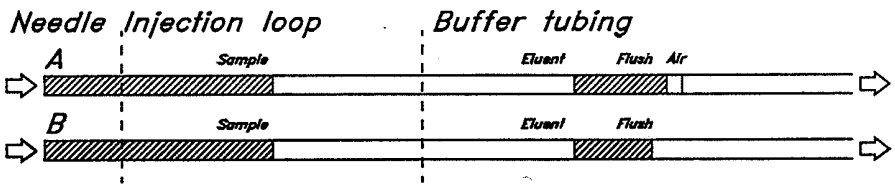


Figure 2-15 Partial loopfill injections with (A) or without (B) air segment

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2.2.3 µL PICK UP INJECTIONS

The switching sequence for a µL pick-up injection is schematically shown in the following figures:

Figure 2-16
*The initial situation: the injection valve is in **INJECT** position. The sample needle has entered the vial of mobile phase after the air needle has pre-punctured the septum. The headspace pressure, applied through the outer air needle, ensures that no air or vapor bubbles are formed during wash solvent aspiration.*

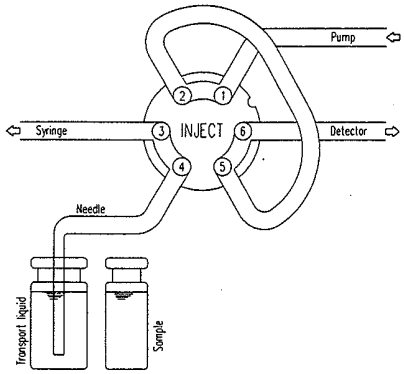


Figure 2-17
For the first injection, after a was or after emping the buffer tubing. The syringe dispenser aspirates mobile phase from the mobile phase vial to fill the sample line with mobile phase and remove wash solvents.

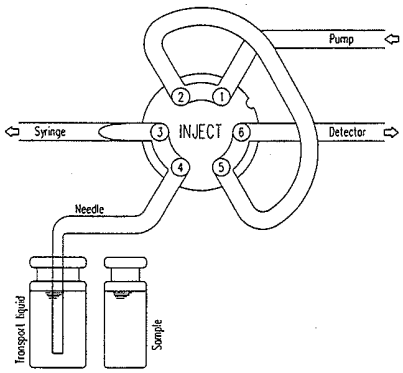


Figure 2-18
*The needle moves from the mobile phase vial to the sample vial. The injection valve is switched into **LOAD** position.*

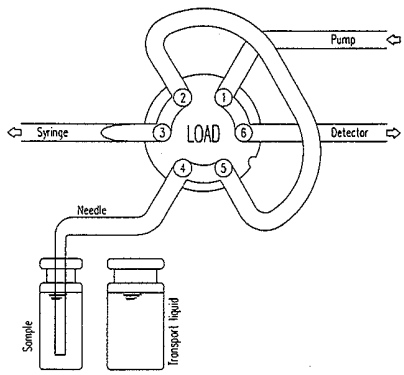
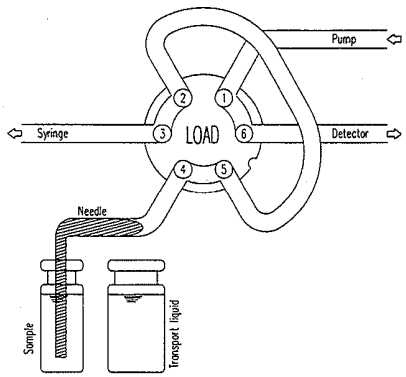


Figure 2-19
The programmed injection volume is aspirated from the sample vial.



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Figure 2-20
The sample needle moves back to the mobile phase vial. The sample is quantitatively transported into the loop, with 30 µL of mobile phase.

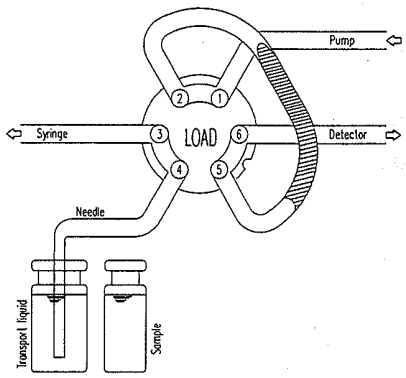
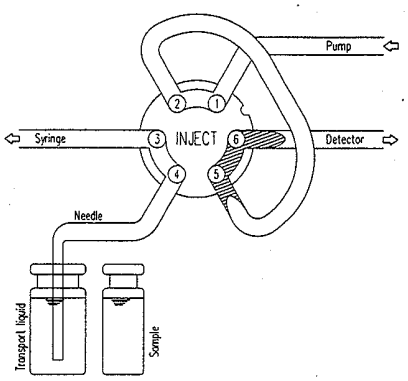


Figure 2-21
*The injection valve switches into the **INJECT** position. The sample loop is now part of the HPLC mobile phase flow path: sample is transported to the column. The analysis time starts.*



The next sequence will skip the first withdrawal of mobile phase, unless a wash routine is performed or the Model AI-1A has emptied the buffer tubing into the waste. In those cases the sequence is completely repeated.

Air segment

If an air segment has been programmed, it appears at the front of the first plug of transport liquid and at the front of every sample plug. An air segment can be programmed in the system settings.

The air segment at the front of the sample plug is injected into the HPLC system.

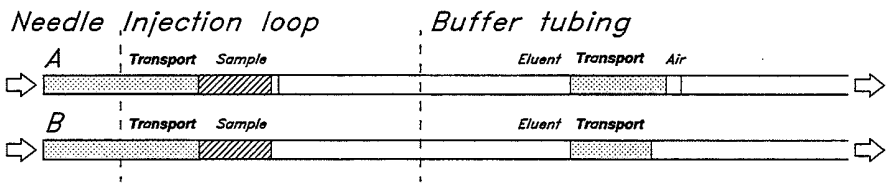


Fig 2-22 µL pick up injections with (A) or without air bubble (B).

In case of µL pick-up injections, there will be no air pressure (headspace pressure) on the sample vial, to eliminate sample errors due to air expansion during vial exchange from the sample vial to the transport solvent vial.

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Chapter 3 Installation

3.1 RECEIVING INSPECTION AND UNPACKING

Inspect the Model AI-1A for indications of damage. Damage that occurs to the Model AI-1A in transit, indicated by damaged containers, is the responsibility of the carrier and should be reported to the carrier immediately. Shipping containers should be inspected by the carrier if a claim is filed.

For contents of shipping containers see the packing list in container.

Before using the Model AI-1A for the first time, remove labeled security screw from the bottom of the autosampler and allow the instrument to acclimatize for a period of 1 hour.

It is recommended to store the shipping container of the Model AI-1A. It can be used if it should be necessary to ship the Model AI-1A for service purposes. If you have to transport the Model AI-1A re-insert the safety screw into the bottom of the Model AI-1A.

Lift the Model AI-1A as shown below in Figure 3.1.

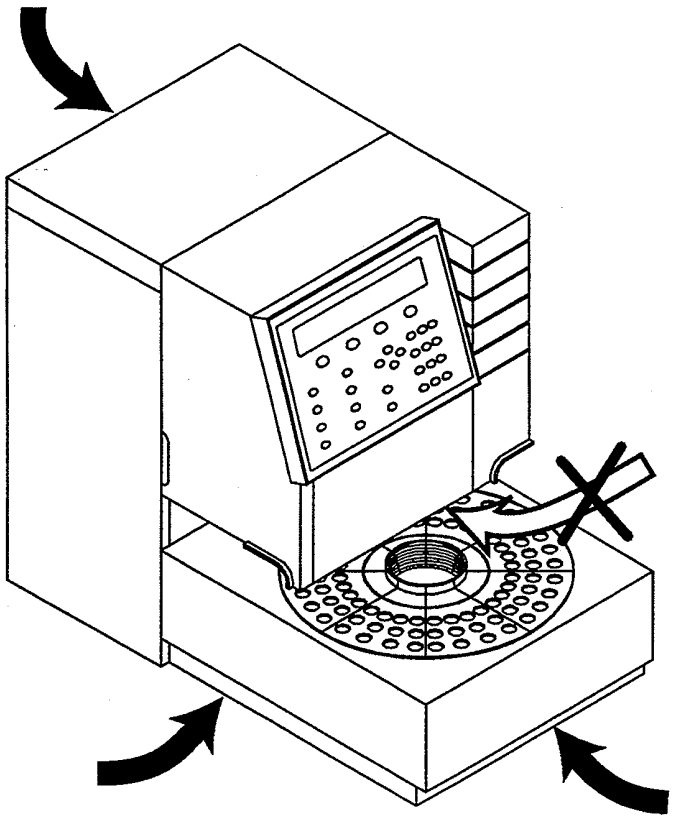


Figure 3-1 Model AI-1A Lifting Instructions

Lift the Model AI-1A with both hands under the Model AI-1A or with one hand under the front of the Model AI-1A and the other hand grasping the rear top of the Model AI-1A.

ARNING

Do NOT lift the Model AI-1A at the front cover of the Model AI-1A.

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3.2 LOCATION OF THE AUTOSAMPLER

The Model AI-1A needs approximately 28 cm (11 inches) of bench space and one power supply (230 V or 110 V, 50/60 Hz).

The best place to put your Model AI-1A is to the right side of your HPLC system, next to your HPLC pump and detector. Be sure that none of the ventilation holes are blocked. Blockage of the ventilation holes can cause malfunctioning of the Model AI-1A autosampler or even damage the electronics inside the Model AI-1A.

Do not install the Model AI-1A in areas subject to excessive dust, direct sunlight or shocks and do not place it near any other source of heat, this will disturb the cooling of the tray when installed.

3.3 POWER CONNECTIONS

Before plugging in the power cable, check voltage settings of the modules at the input socket on the rear panel.

Make sure that the voltage settings of the modules are identical with the voltage of your local power supply.

Use only a supply appliance with protective grounding.

If the indicated voltage is not correct, then select the proper voltage by removing, inverting, and then re-inserting the voltage selector. (See Figure 2.2)

When the voltage selection and fuses are correct for your power source, plug in power cables.

The correct fuses should be installed.

For 115 VAC ± 10%, use two 5 AT-fuses (slow, 1/4" x 1", UL/CSA).

For 230 VAC ± 10%, use two 2.5 AT-fuses (slow, 5 x 20 mm, IEC127).



WARNING

RISK OF FIRE, REPLACE FUSES AS MARKED.

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3.4 FLUID CONNECTIONS

The Model AI-1A is factory installed with a 250 µL syringe, a 100 µL loop, 500 µL buffer tubing and a stainless steel sample needle. A schematic presentation of all liquid contact parts is shown below. To get access to the fluidics, you need to open the front cover of the Model AI-1A, therefore remove the screw on the right-hand side of the Model AI-1A cover. See Table 1 for the dimension of the standard installed tubing.

To obtain an optimal performance of the Model AI-1A, a correct combination of syringe, loop and buffer tubing should be installed. (See section 3.6)

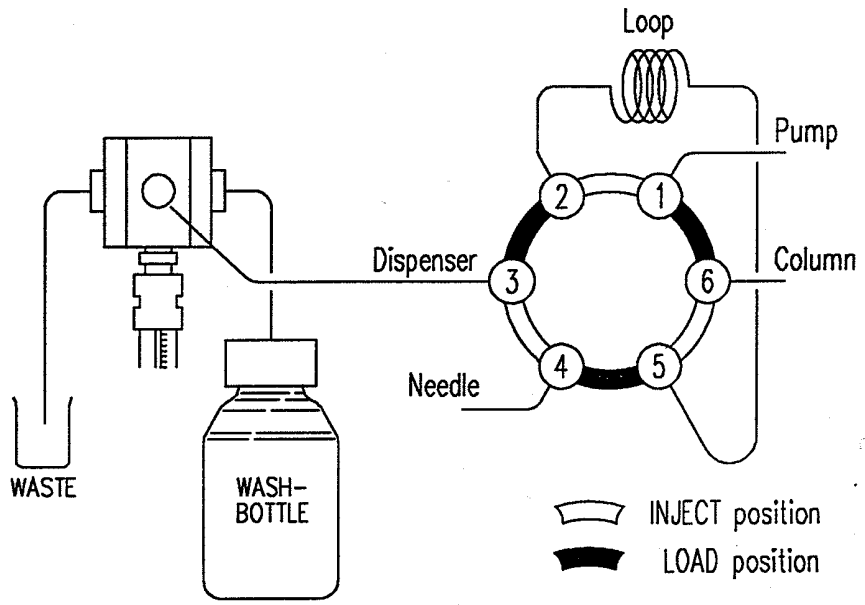


Figure 3-2 Fluid Connections for the Model AI-1A

Table 3-1 Standard Tubing Installed in the Model AI-1A

Tubing	***Material & Dimensions***
Standard sample needle and tubing	*SS tubing, 135 mm x 0.5 mm OD x .25 mm ID* *Tefzel Tubing: 140 mm x 1/16-in OD x 0.25 mm ID (volume 15 µL)*
Buffer tubing from high pressure valve to syringe valve	*PTFE tubing: 640 mm x 1/16-in OD x 1.0 mm ID (volume 500 µL)*
Tubing syringe valve to wash solvent bottle	*PTFE tubing: 300 mm x 1/16-in OD x 1.0 mm ID*
Tubing syringe valve to waste	*PTFE tubing: 400 mm x 1/8-in OD x 1.6 mm ID*

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3.4.1 HPLC CONNECTIONS

For reproducible injections the following connections should be made to your HPLC system:

- Connect the HPLC pump to port 1 of the Rheodyne injection valve.
- Connect the HPLC column to port 6 of the Rheodyne injection valve.

The instrument has been tested with isopropanol: make sure that the mobile phase of your HPLC system is miscible with isopropanol. If not start up with an intermediate solvent as mobile phase (disconnect the HPLC column)

It's essential that the contents of the sample loop are injected in back flush onto the column, therefore: Do not exchange column and pump connections at the injection valve.

3.4.2 WASTE TUBING

Syringe waste:

Place the syringe waste tubing into a small bottle next to the Model AI-1A. If no injection volumes are programmed that are larger than the buffer tubing can contain, the syringe waste will only be wash solvent.

General waste:

Connect the drain tubing (in the ship kit of the Model AI-1A) to the right-hand drain hose connector of the Model AI-1A and put it in a bottle which is placed on the floor. Through this drain all the liquid dispensed into the wash position, behind the tray, is removed.

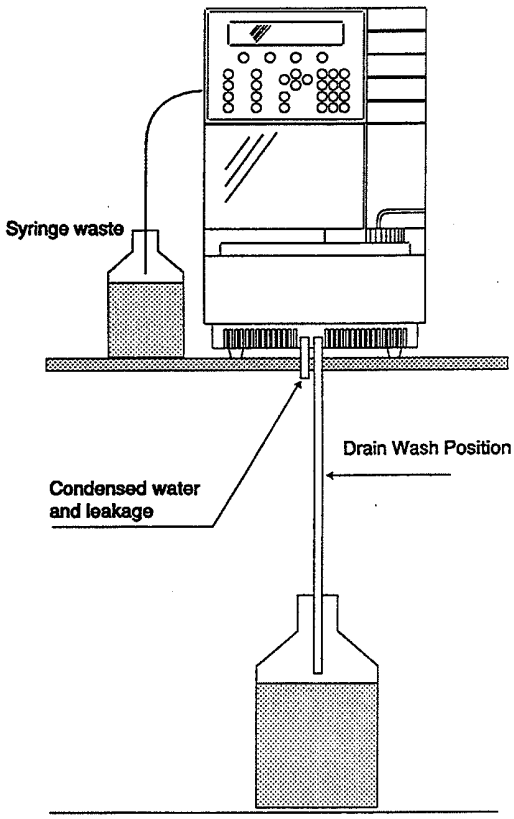


Figure 3-3 Drain and waste tubing

Sample which is not injected is also removed through this tubing.

All solvent leakage (and condensed water in the case of the optional Peltier tray cooling) is drained through the left hose connector. If the optional Peltier tray cooling is installed, it is advisable to connect this hose connector to a waste container on the floor.

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3.4.3 WASH SOLVENT

The Model AI-1A has a built-in wash solvent reservoir of 250 mL.

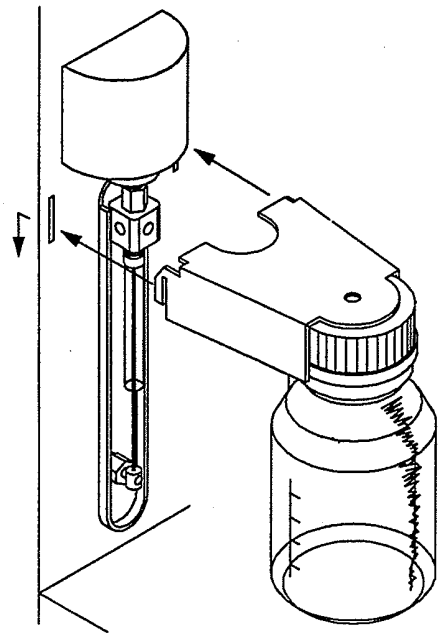


Figure 3-4: Placing the wash solvent bottle

How to place the wash solvent bottle:

- Fill the wash solvent bottle with the appropriate wash solvent.

It is recommended to use methanol or a mixture of water and isopropanol as wash solvent. Before using the wash solvent, degas the solvent with Helium or an ultrasonic bath.

- Screw the bottle in the wash solvent holder and place the holder in the Model AI-1A.
- Put the wash solvent tubing in the wash solvent bottle.
- Fill the tubing using the Model AI-1A soft-function keys **<SYR END>** and **<SYR HOME>**

With the **<SYR END>** soft-function key a syringe volume of wash solvent is aspirated from the wash solvent bottle and the wash solvent tubing is filled. With the **<SYR HOME>** soft-function key the syringe contents will be dispensed to the syringe waste. Repeat this action until the wash solvent tubing is completely filled.

The wash solvent bottle is now ready for use.

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If you have an application that requires more than 250 mL of wash solvent for a complete run, you can replace the wash solvent tubing by a longer tubing with one end flanged for the valve fitting and place a larger bottle outside the Model AI-1A. To fill this wash solvent tubing repeat the previous fill procedure a few times.

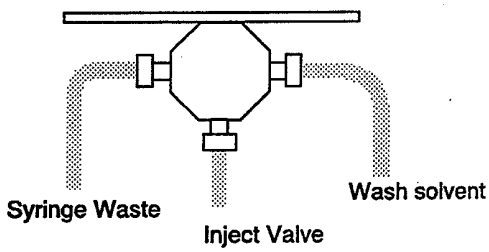


Figure 3-5 Top view of the syringe valve

3.4.4 SYRINGE

The Model AI-1A is factory equipped with a 250 µL syringe, but can also be equipped with a 100, 500 or 1000 µL syringe. To install another syringe proceed as follows: (Do not disconnect the power supply of the Model AI-1A, it is needed to move the syringe.)

■ Move the syringe to the end position by pressing the **<SYR END>** soft-function key.

■ Unscrew the syringe from syringe valve, be sure that the Luer connector in the valve remains in place.

■ Disconnect the plunger from the syringe drive.

■ Fill the new syringe with wash solvent, be sure most air bubbles are removed from the syringe.

■ Connect the plunger of the filled syringe to the syringe drive and connect the syringe with the Luer connector at the syringe valve.

■ Screw the syringe firmly into the Luer connector.

■ Remove the air from the syringe by pressing the **<SYR HOME>** soft-function key. The syringe will move to its HOME position and dispense its contents to the syringe waste.

■ *If some air remains in the syringe press the* **<SYR END>** *soft-function key again. The syringe is filled with wash solvent. Press the* **<SYR HOME>** *soft-function key to dispense the wash solvent to waste. If there is still air in the syringe, repeat the previous action and tick softly against the syringe as the wash solvent is dispensed to the syringe waste.*

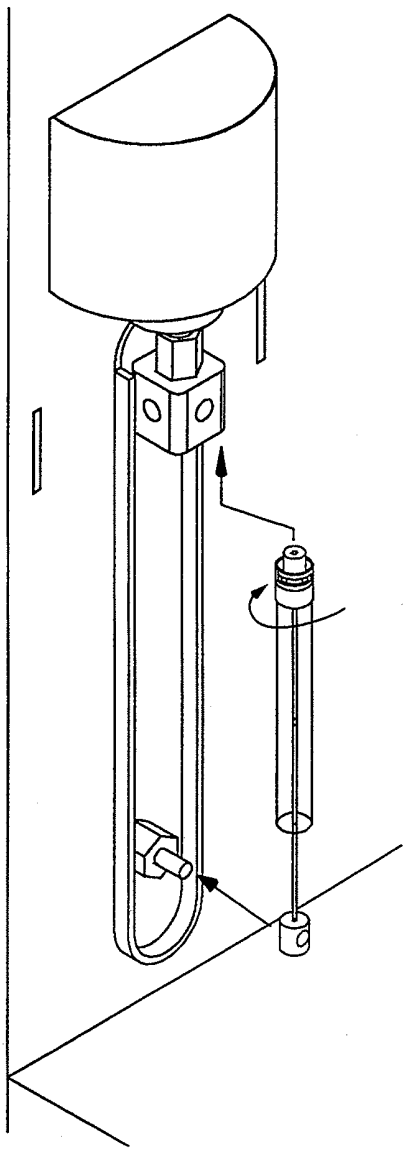


Figure 3-6 Changing the syringe

■ Press the **<WASH>** soft-function key to perform a standard wash routine. All tubing connected to the syringe valve will be refilled and flushed. The Model AI-1A is now ready for use.

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3.5 NEEDLES AND VIAL SENSOR

The Model AI-1A has separate needles for puncturing and sampling; the air needle, which punctures the septum of the vial and provides the headspace pressure in the vial, and the sample needle for transporting the sample from the vial into the loop of the valve.

The sample needle enters a vial as follows:

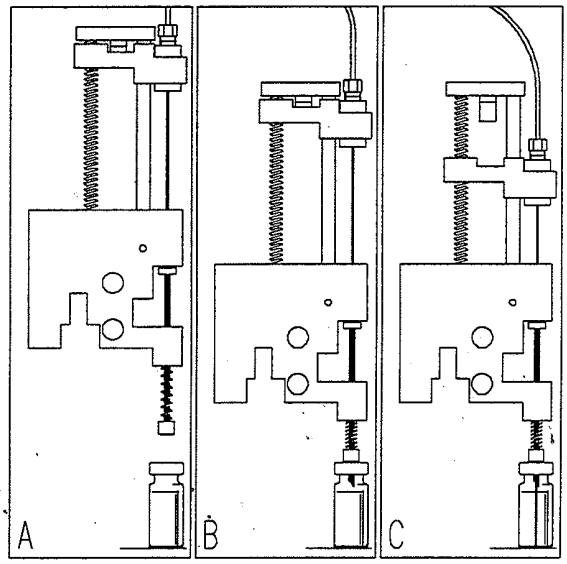


Figure 3-7 Model AI-1A Needle movement

A: Initial position.

B: First the air/pre-puncturing needle (9, Figure 3.8) is lowered, by moving the complete needle arm downward. The vial sensor (10, Figure 3.8) detects if there is a vial and at the same time measures the vial height. If no vial is detected the needle arm is moved upwards and the Model AI-1A will stop or go to the next vial depending on the system settings. As soon as the Model AI-1A detects a vial the lowering speed of the arm is decreased to provide enough force to puncture the septum of the vial. After forcing the air/pre-puncturing needle into the vial, air is provided to the vial. The air outlet nut (8, Figure 3.8) reduces the pressure in the vial to approximately 0.5 bar. The difference between outer diameter of the sample needle and inner diameter is representative for the pressure in the vial. If a sample needle with another outer diameter is used, it is recommended to use another air outlet nut matching to the used sample needle.

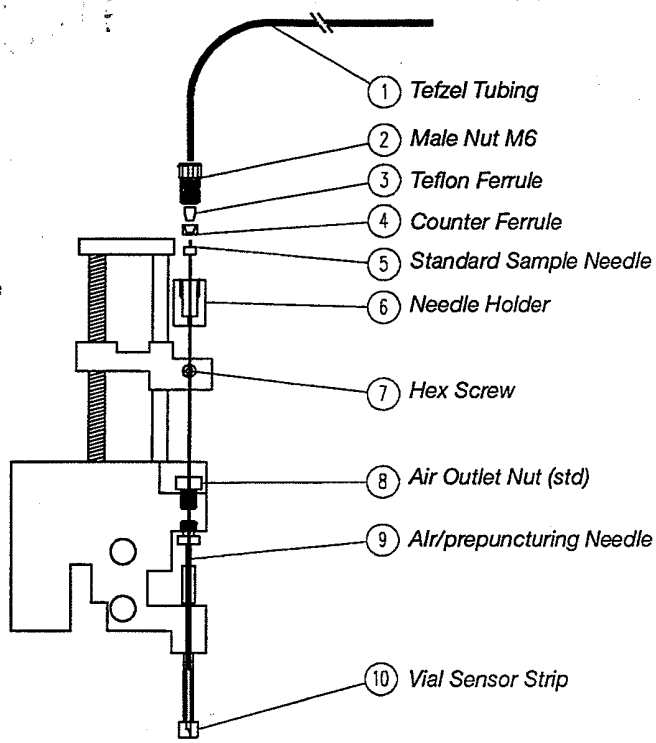


Figure 3-8 Sample needle

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C: Finally the sample needle is lowered into the vial to the desired depth, programmed in the system settings. Now the Model AI-1A is ready for the first injection from this vial.

3.5.1 REPLACING THE SAMPLE NEEDLE

To replace the sample needle proceed as follows: (see Figure 3.8)

- Loosen needle connection nut (2) that connects the Tefzel tubing (1) to the sample needle (5).
- Loosen Rheodyne Rheflex nut that connects the Tefzel tubing to the injection valve.
- Remove sample needle and tubing by pulling it out of its fitting with the Tefzel tubing that usually sticks to the needle.
- Put in new needle/tubing assembly.
- Connect the needle tubing to the Tefzel tubing in the needle holder (6) with the needle connection nut (2).
- Connect loose end of needle connection tubing to port 4 of injection valve (use a Rheodyne ferrule!).



Do not tighten excessively; it may block the tubing!

- Check the sample needle height. If this is not correct adjust the sample needle height as described in the system settings, section 4.5.
- Perform a wash routine to clean the new needle by pressing the <WASH> soft- function key.

3.5.2 INSTALLING SERUM SAMPLE NEEDLE

To install the serum sample needle proceed as follows (see Figure 3.8):

- Remove sample needle as described in section 3.5.1
- Remove standard air outlet nut (8) and replace it by the air outlet nut supplied with the serum needle.
- Install the serum sample needle as described in section 3.5.1
- After installing the serum needle, adjust in the system setting the volume of the tubing from the needle to the valve (See section 4.5.1).

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3.6 SYRINGE, SAMPLE LOOP AND BUFFER TUBING COMBINATIONS

Four sizes of syringes are available for the dispenser: 100, 250, 500 and 1000 µL.

The 250 µL syringe is the standard syringe; with the standard 500 µL buffer and the standard 100 µL sample loop, the following injection volume range is available for the various injection modes:

Flushed loop: 100 µL
Partial loopfill: 1 - 50 µL
µL pick-up: 1 - 25 µL



NOTE THAT:

Flushed loop gives maximum possible reproducibility, but not maximum accuracy, since loop volume is specified with an accuracy of ± 10%.
Minimum sample loss = 230 µL (2 x loop overfill + flush volume for needle).

Partial loopfill gives maximum accuracy (dependent on syringe accuracy) plus reproducibility better than 0.5% RSD for injection volumes > 5 µL
Minimum sample loss (Flush volume) = 30 µL

µL Pick-up offers zero sample loss, maximum accuracy (same as partial loop fill), but slightly less reproducibility: RSD better than 1% for injection volumes > 5 µL. 5 µL of AIR is injected together with the sample, in case an air segment is selected in the system settings.

SOMETIMES OTHER COMBINATIONS OF SYRINGE, LOOP AND/OR BUFFER ARE ADVISED:

Injection volumes smaller than 5 µL:

Partial loopfill:

Install a 100 µL syringe for maximum reproducibility and accuracy. Preferably install a 20 µL sample loop to avoid loss of accuracy due to expansion of the loop content when switching from inject to load position prior to sample loading. Specially when working with high pressure (200 bar), this loss may be in the order of 0.1 - 0.5 µL for a 100 µL loop. Note that the minimum sample loss in partial loop fill mode is 30 µL (minimum flush volume) for the first injection and an additional 15 (always half the programmed flush volume) for additional injections from the same vial. If a wash between injections has been programmed, sample loss is 30 µL for every injection. For zero sample loss injections, use the µL-pick injection mode.

µL Pick-up:

Install a 100 µL syringe for optimum accuracy and reproducibility.
DO NOT INSTALL A SMALLER SAMPLE LOOP!
The sample plug is transported into the loop, preceded by a programmable air segment of 5 µL, with a plug of transport liquid which equals 2.5 times the programmed needle tubing volume. The 20 µL loop is too small to guarantee quantitative injection.

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Injection volumes up to twice the standard:

With the standard 250 µL syringe, the standard needle with tubing (15 µL) and the standard 500 µL buffer, but with a 200 µL sample loop, the maximum injection volumes are:

Flushed loop: 200 µL (sample loss remains 230 µL since loops > 100 µL need only one loop volume overfill)

Partial loopfill: 100 µL

µL Pick-up: 77 µL



Smaller volumes than 10 µL may be injected, but reproducibility and accuracy may not be < 0.5% for partial loop fill or < 1% for µL pick-up!

For volumes larger than 200 µL:

Install the 2000 µL buffer, install the appropriate sample loop size and the appropriate syringe: Syringe volume > 2 x injection volume. Injection volumes larger than 500 µL are possible, but the sample may contaminate the syringe. Program sufficient wash after use!

The maximum injection volumes are:

Flushed loop: injection volume = loop volume

Partial loopfill: max. injection volume = 50% of loop volume

µL pick- up: max. injection volume = (loop volume - 3 x needle volume) / 2

Table 3-2 Syringes and Buffer Tubing

Syringe	Buffer Tubing
100 µL	500 µL buffer tubing
250 µL	500 µL buffer tubing
500 µL	2000 µL buffer tubing
1000 µL	2000 µL buffer tubing

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3.7 PREPARATION OF VIALS

3.7.1 VIAL DIMENSIONS

The Model AI-1A is very flexible in the use of vials and septa. Almost every type of vial can be used from micro vials (0.5 mL) to super LSV vials (10 mL). With the use of inserts the vial volumes of standard vials can be reduced.

To hold all those types of vials the Model AI-1A can be equipped with four types of tray segments, each tray segment for vials with a specific diameter, see Figure 3.9.

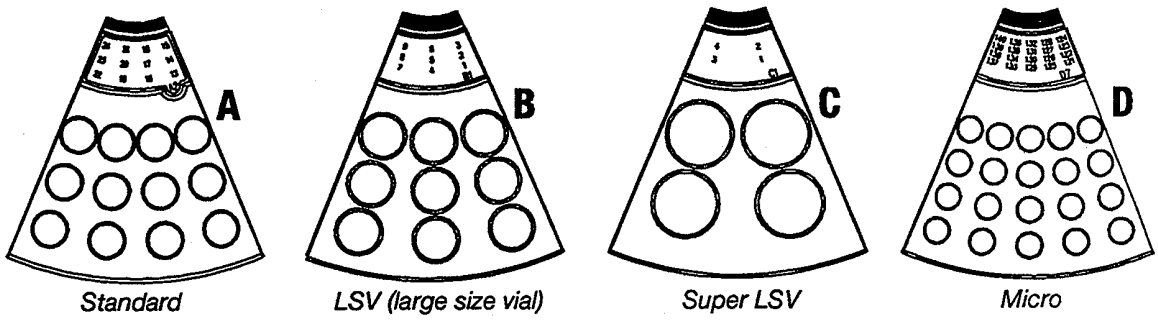


Figure 3-9 Type of tray segments

The Model AI-1A allows you to use more than one type of segments in the same tray, this can be programmed in the system settings (see Figure 4-5).

Vial dimensions are:

Maximum vial height, including cap : 47 mm
Minimum vial height, including cap : 32 mm

Maximum vial diameter:

Standard tray	(Type-A)	12 mm
LSV tray	(Type-B)	15 mm
Super LSV	(Type-C)	22 mm
Micro tray	(Type-D)	7 mm

It is not possible to use EPPENDORF vials with debased caps! The air/pre-puncturing needle is not able to pierce those caps due to the depth of the cap.

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3.7.2 CHROMACOL VIALS

The following Chromacol vials can be used in the Model AI-1A. The Chromacol ref. number is given.

Type A (Standard) tray segment

Outer vial diameter: 12 mm.

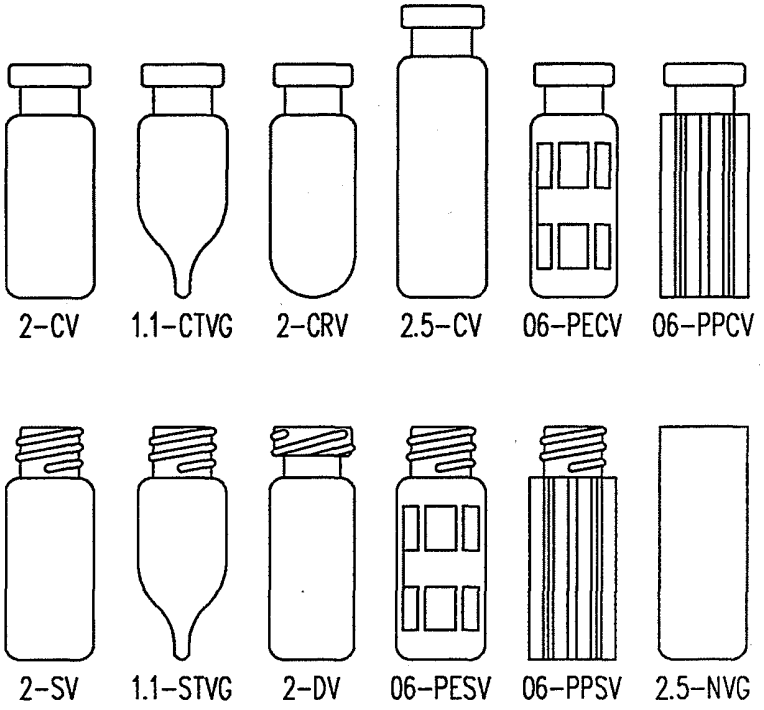


Figure 3-10 Vials for Type A (Standard) tray segment

To reduce the volume of standard vials use a Chromacol inserts (03-MTV, 02-MTV and 02-MTVWG) in combination with the appropriate vial and support sleeve or spring.

LSV tray segment (Type-B):

Outer vial diameter: 15 mm.

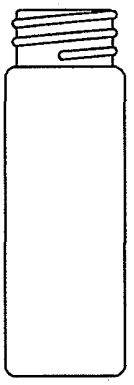


Figure 3-11 Vial for Type B (LSV) tray segment

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Super LSV tray segment (Type-C):

Outer vial diameter: 22 mm.

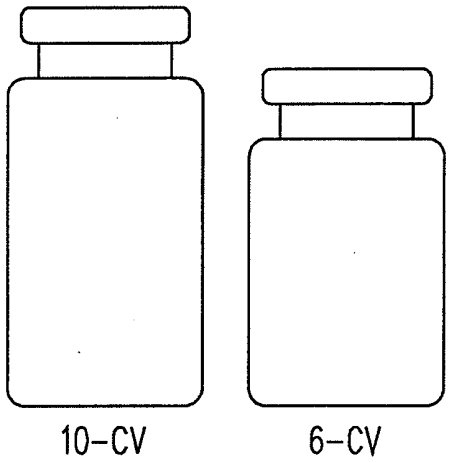


Figure 3-12 Vials for Type C (Super LSV) tray segment

Micro tray segment (Type-D):

Outer vial diameter: 7 mm.

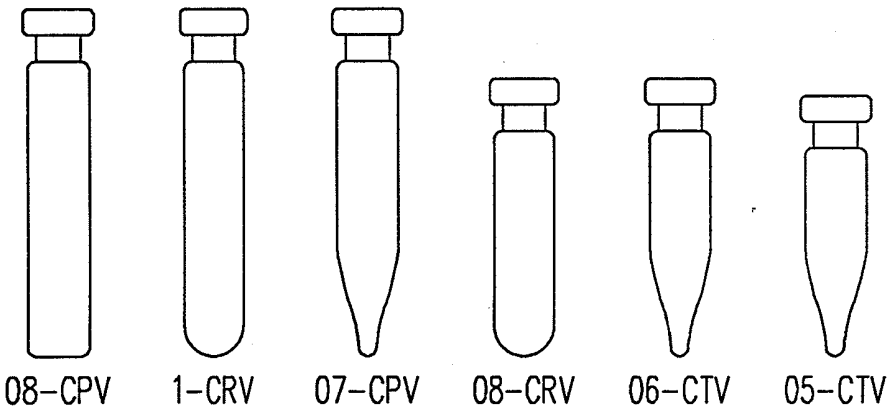


Figure 3-13 Vials for Type D (Micro) tray segment

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3.7.3 FILLING AND SEALING THE VIALS

The standard vials, as well as the conical vials, can best be filled by means of a narrow-end pipette to allow air to escape when filling the vial.

Do not fill vials to the edge! In that case sample will be forced into the air needle, risking extra cross-contamination of samples and fouling of the needle pair.

It is important that the seal is airtight, to maintain a pressure on the vial for air bubble prevention and to prevent evaporation of volatile samples.



Do not re-use a sample vial frequently without replacing its cap or septum.

Check seal after crimping: if the cap can be turned easily, the seal is not airtight (re-adjust hand-crimper.)

3.7.4 LOADING THE SAMPLE TRAY

The tray segments may be randomly positioned on the Model AI-1A tray. The tray segment types used must be entered in the system settings.

It is not necessary that all segments are available on the tray at the start of a run.

To place a segment on the tray there must be an open position in the front half of the tray. The tray can be rotated if the Model AI-1A is not running by pressing the <ADVANCE> soft-function key. Place the tray segment on front half of the tray.



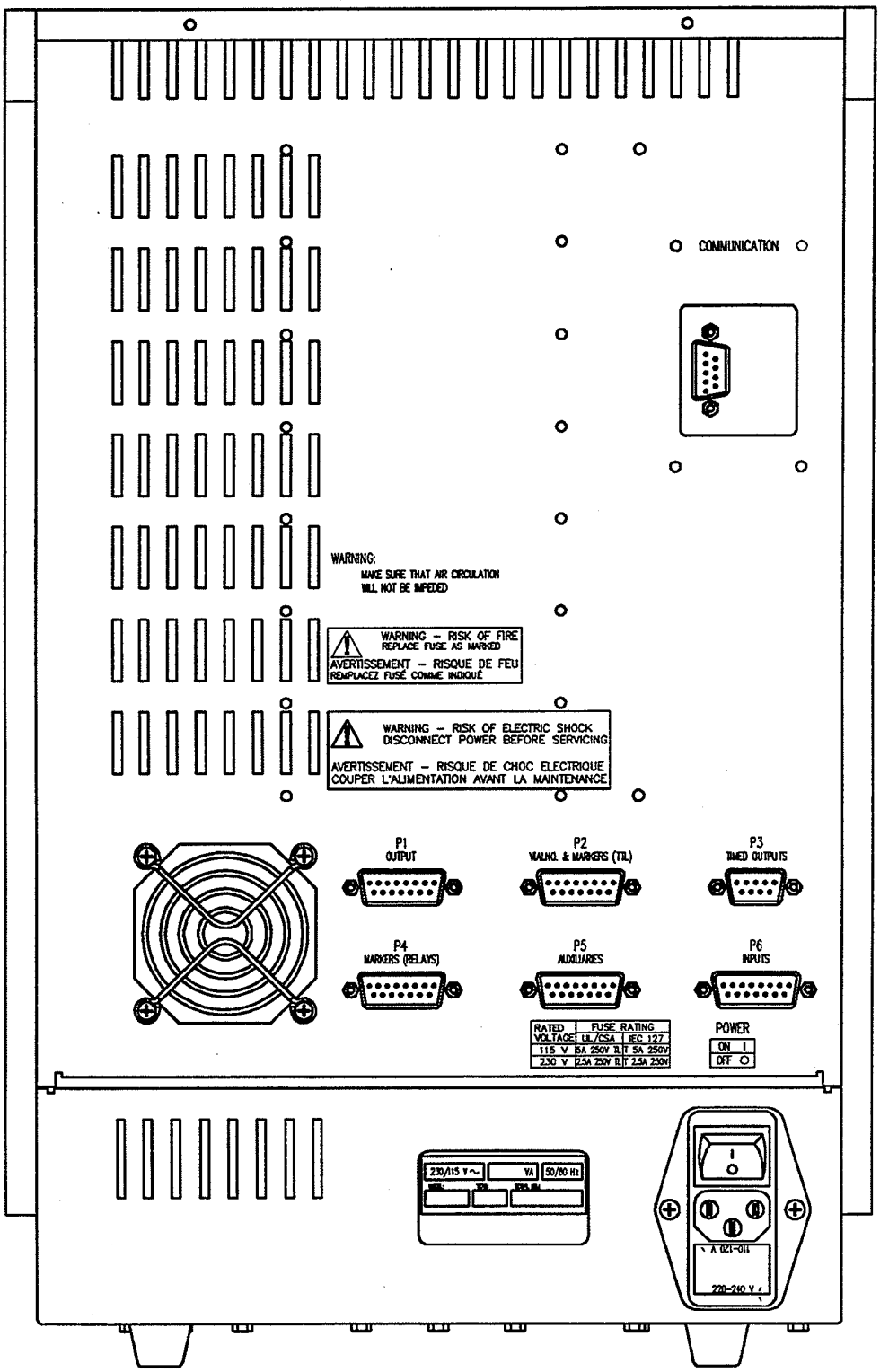
CAUTION

Do not place or remove a tray segment at the rear half of the Model AI-1A tray, this may cause damage to the tray sensors.

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3.8 CONTROL I/O CONNECTIONS

The Model AI-1A has six standard I/O connectors on the rear side; five OUTPUT connectors and one INPUT connector. See Figure 3.14 for positions of connectors.



COMMUNICATIONS

P1 OUTPUT

P2 VIALNO & MARKER

P3 TIMED OUTPUTS

P4 MARKERS (RELAYS)

P5 AUXILIARIES

P6 INPUTS

Figure 3-14 Model AI-1A Connectors

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The communication connector is standard RS422/485 communication interface connector. The configuration of the I/O connector is described in the following tables.

WARNING

Rainin Instrument Company will not accept any liability for damages directly or indirectly caused by connecting this machine to instruments which do not meet relevant safety standards.

CONTACT CLOSURES OUTPUTS

The following three tables with programmable outputs (P1), marker outputs (P4) and auxiliary outputs (P5) are contact closures outputs (floating NO/NC contact), see Figure 3.15.

P1 OUTPUTS: Two programmable outputs and alarm output

1	OUT 1 - Normally open	9	Spare
2	OUT 1 - Common	10	Alarm output - Normally open
3	OUT 1 - Normally closed	11	Alarm output - Common
4	OUT 2 - Normally open	12	Alarm output - Normally closed
5	OUT 2 - Common	13	24 VDC
6	OUT 2 - Normally closed	14	Power ground
7	Spare	15	Power ground
8	Spare		

The Alarm output: this output will be activated whenever an error occurs, see appendix B for a description of the error codes of the Model AI-1A.

P4 MARKERS

1	Inject marker - Normally open	9	Labeled vial marker - Normally closed
2	Inject marker - Common	10	STOP I/O - Normally open
3	Inject marker - Normally closed	11	STOP I/O - Common
4	Vial marker - Normally open	12	STOP I/O - Normally closed
5	Vial marker - Common	13	24 VDC
6	Vial marker - Normally closed	14	Power ground
7	Labeled vial marker - Normally open	15	Power ground
8	Labeled vial marker - Common		

$V_{MAX} = 28\ V_{DC} / V_{AC}$, $I_{MAX} = 0.25$ A

P5 AUXILIARIES

1	AUX 1 - Normally open	9	AUX 3 - Normally closed
2	AUX 1 - Common	10	AUX 4 - Normally open
3	AUX 1 - Normally closed	11	AUX 4 - Common
4	AUX 2 - Normally open	12	AUX 4 - Normally closed
5	AUX 2 - Common	13	24 VDC
6	AUX 2 - Normally closed	14	Power ground
7	AUX 3 - Normally open	15	Power ground
8	AUX 3 - Common		

$V_{MAX} = 28\ V_{DC} / V_{AC}$, $I_{MAX} = 0.25$ A

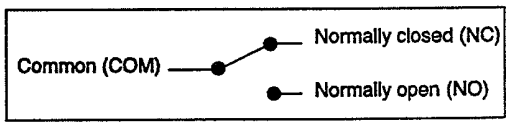


Figure 3-15 Contact closures outputs

Maximum current for 24 $_{VDC}$ supply is 0.5 A total.

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TTL OUTPUTS

The following two tables show the 8 bit vial number and marker outputs (P2) and a 4 bit time base code output (P3), programmable in a time base method. Both connectors are TTL level outputs, a connection diagram is shown in Figure 3.16.

P2 VIAL NO & MARKERS (TTL)

1	INJECT MARKER	9	D 4 (BCD OR HEX) (10 or 16)
2	VIAL MARKER	10	D 5 (BCD OR HEX) (20 or 32)
3	LABELED VIAL MARKER	11	D 6 (BCD OR HEX) (40 or 64)
4	STOP I/O	12	D 7 (BCD OR HEX) (80 or 128)
5	D 0 (BCD OR HEX) (1)	13	Signal ground
6	D 1 (BCD OR HEX) (2)	14	Signal ground
7	D 2 (BCD OR HEX) (4)	15	Signal ground
8	D 3 (BCD OR HEX) (8)		

V_{MAX} = 5.5 V, Logical 1 > 3.5 V, logical 0 < 1.0 V. DC output source / sink current ± 20 mA.

BCD: BINARY CODED DECIMAL

The 2-digit vial number on the BCD output is represented as two four bits nibbles, where D3-D0 represent the ones (0-9) and D7-D4 represents the tenths. The highest possible vial number is therefore 99 (see Table 7).

Value	Output			
● = ON	D0 (1)	D1 (2)	D2 (4)	D3 (8)
0				
1	●			
2		●		
3	●	●		
4			●	
5	●		●	
6		●	●	
7	●	●	●	
8				●
9	●			●

Table : BCD OUTPUT conversion

In case micro segments are used the value may exceed the value 99. In that case the BCD outputs will not represent the correct vial number for vial numbers larger then 99. Use the hexadecimal (HEX) vial number outputs.

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BCD	Tens				Ones				Vial number
	D7 (8)	D6 (4)	D5 (2)	D4 (1)	D3 (8)	D2 (4)	D1 (2)	D0 (1)	
Output	1	0	0	1	0	1	1	0	**96**
	9 × 10 (10^1)				6 × 1 (10^0)				90 + 6
Output	0	1	0	1	1	0	0	1	**59**
	5 × 10 (10^1)				9 × 1 (10^0)				50 + 9
Output	0	0	0	1	0	0	0	0	**10**
	1 × 10 (10^1)				0 × 1 (10^0)				10 + 0

Table 3-8: Examples of BCD vial number output

HEX: HEXADECIMAL CODE

The hexadecimal output represents the vial number as 8 bits by assigning values of 1, 2, 4, 8, 16, 32, 64 and 128 to every single bit (D0-D7), for examples see Table 9.

HEX	D7 (128)	D6 (64)	D5 (32)	D4 (16)	D3 (8)	D2 (4)	D1 (2)	D0 (1)	Vial number
Output	1	0	0	1	0	1	1	0	**150**
	128 + 16 + 4 + 2								
Output	0	1	1	0	0	0	0	0	**96**
	64 + 32								
Output	0	1	0	1	0	1	0	1	**85**
	64 + 16 + 4 + 1								
Output	0	0	1	1	1	0	1	1	**59**
	32 + 16 + 8 + 2 + 1								

Table 3-9: Examples of hexadecimal (HEX) vial number output

P3 OUTPUTS: 4-bit time base code output

1 TB 0 (HEX) (1)
2 TB 1 (HEX) (2)
3 TB 2 (HEX) (4)
4 TB 3 (HEX) (8)
5 not used
6 Signal ground
7 Signal ground
8 Signal ground
9 Signal ground

V_{MAX} = 5.5 V, Logical 1 > 3.5 V, logical 0 < 1.0 V. DC output source / sink current ± 20 mA.

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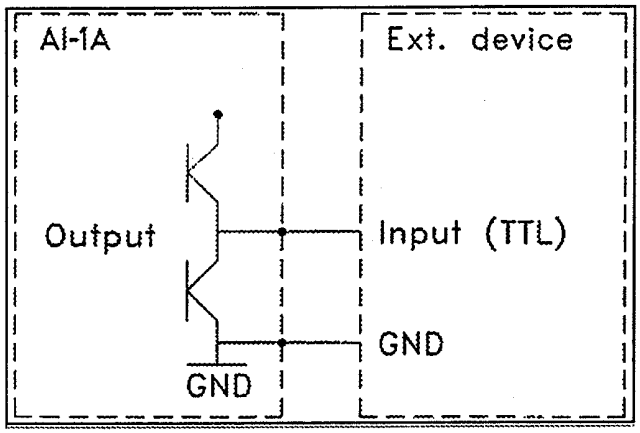


Figure 3-17 TTL Output

TTL INPUTS:

The following connector is an active high or active low TTL input, user definable in the SYSTEM SETTINGS. The NEXT INJECTION MARKER and the NEXT VIAL MARKER can be used when the Model AI-1A works in REMOTE CONTROL. The FREEZE and STOP I/O input can be used to control the Model AI-1A by other devices. The four inputs (INPUT 1 to 4) can only be used in the user definable method, e.g. to control the sequence of the steps in this method. A connection diagram is shown in Figure 3.17.

P6 Inputs (TTL)

1	NEXT INJECTION MARKER	9	Signal ground
2	NEXT VIAL MARKER	10	Signal ground
3	FREEZE	11	Signal ground
4	STOP I/O	12	Signal ground
5	INPUT 1	13	Signal ground
6	INPUT 2	14	Signal ground
7	INPUT 3	15	Signal ground
8	INPUT 4		

NEXT INJECTION MARKER:

This marker will start the next injection sequence when the Model AI-1A is started in remote control. After finishing the injection sequence the Model AI-1A will wait for the next input.

From the READY screen a NEXT INJECTION MARKER will start the latest programmed series. In this case the Model AI-1A will not wait for the NEXT INJECTION MARKER before continuing with the next injection. The Model AI-1A will execute the complete RUN as if it was started with the [Start/Stop]-key.

NEXT VIAL MARKER:

With this marker the Model AI-1A will perform the next injection from the next vial, even if not all injections from that vial in the programmed injection method are done.

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FREEZE:

The Model AI-1A will freeze the analysis time for the time this input is active. If the FREEZE input is activated while the analysis time is not running, the Model AI-1A will perform all programmed pre-injection sample handling (mix method and loading part of the injection method). But the Model AI-1A will wait with injecting the sample until the freeze input is no longer active.

STOP I/O:

With this input the run of the Model AI-1A is immediately aborted and return to the READY screen. In case the Model AI-1A is in remote control, the run of the Model AI-1A is immediately aborted but the Model AI-1A remains in remote control and can not be re-started with a NEXT INJECTION MARKER.

INPUT 1-4:

Programmable input, can be used in the user definable method.

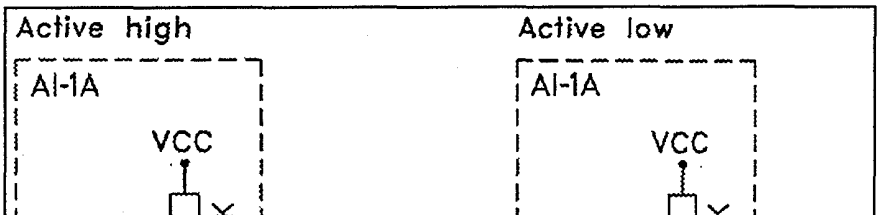


Figure 3-17 TTL Input

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Chapter 4 Operation

This part of the manual describes the operation and programming of the Model AI-1A.

For controlled sample handling the Model AI-1A uses **SERIES** in which vials are linked to methods. The Model AI-1A has five types of methods for the different parts of the sample handling routine.

INJECTION METHODS:	containing information on the injection routine and the analysis time.
WASH METHODS:	describing when a wash method must be performed.
MIX METHODS:	pre-injection method in which some additional sample handling can be performed. E.g. pre-column derivatization.
TIME BASE METHOD:	post-injection method in which outputs to other devices, e.g. integrator or pump, and the switching of ISS valves is controlled.
USER DEFINABLE METHOD:	step-by-step programming of all actions possible by the AI-1A. Creates a custom method

As the number of methods grows, the chance of making mistakes while combining methods with vials will increase. To reduce the chances of errors, the Model AI-1A offers use of TEMPLATES in which combinations of methods are stored.

The Model AI-1A offers the user three ways to program the autosampler.

Assigning individual methods to series

Flexible but laborious; all methods can be combined with vials in the series. The advantage of this way is that you can choose the combination of methods when you program a series. But the combination of methods is not stored. This can be useful for method development.

Create method combinations

The routine way is less flexible than the first, but does not reduce the capabilities of the Model AI-1A. Now the combination of a mix method, injection method, wash method and time base method is pre-defined in a template. In a series the a template can be linked to a range of vials.

The advantage of this way of programming is, that a complete analysis, using an injection method with mix method, wash method and time base method is stored in one template in battery backup memory.

The chance of making mistakes, when the analyst links the methods with the vials in the series, is reduced, so this is the best way of programming for routine laboratories.

User definable method programming

This is the most flexible way. An user definable method is a combination of all the possible methods in which the user defines when the individual actions should take place and in what order. In this program almost any injection sequence is possible.

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4.1 HOW TO USE THE KEYBOARD

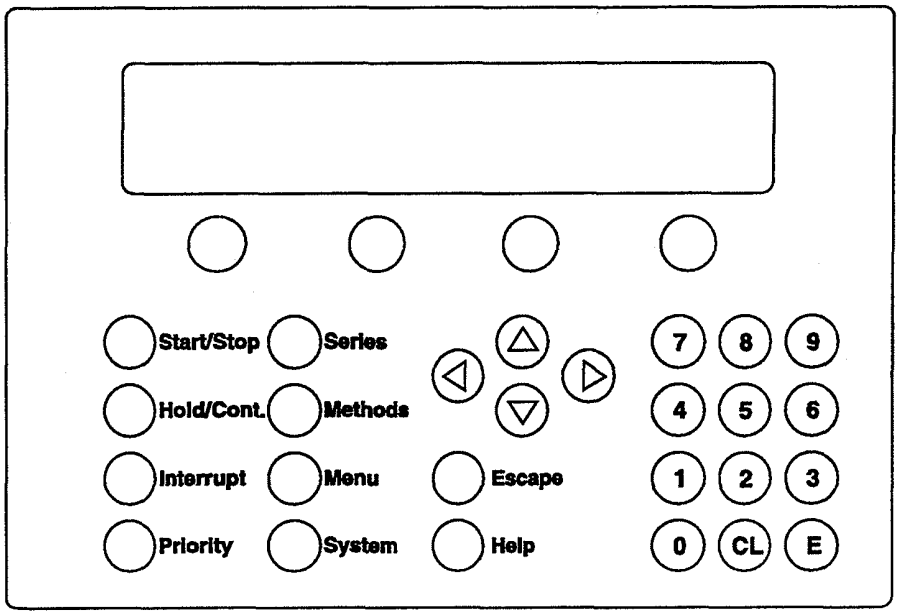


Figure 4-1: Keyboard

The keyboard consists of 30 keys, which can be described in four major groups.

1. The first group on the right side of the keyboard are the numeric keys; 0 to 9, the **[Clear]** key **(CL)** and the **[Enter]** key **(E).**

2. On the left side of the keyboard are ten function keys.
   Four keys to start and control the Model AI-1A during a run:
   [Start/Stop], [Hold/Cont.], [Interrupt], [Priority].
   Four keys to program the Model AI-1A:
   [Series], [Methods], [Menu], [System].
   The last two function keys are:
   [Help] key to show relevant help information and
   [Escape] key: leave programming, go to a previous level, or return to READY screen.

3. Below the display are four soft-function keys, which have different functions, depending on the status of the Model AI-1A and indicated on the lower display line. In this manual these soft-function keys are printed as follows: **<** **>**, with the function in between.

4. In the middle of the keyboard are four arrow keys, to increase or decrease numeric values or to select programmable fields.

The keyboard lets the user enter a numeric value in two ways. The first way is to enter the value with the numeric keys and press the **[Enter]** key. The second way is to use the arrow cursor keys. Move with the left- and right-arrow keys to the desired programming field. The numeric value can be increased with the up-arrow key and decreased with the down-arrow key. When the correct value is reached, enter that value by pressing the **[Enter]** key.

The AI-1A limits the values within their programmable range using the up- and down-arrows.

Blinking values or fields on the display indicate that they can be changed by the user. The active fields can be changed with the left- and right-arrow keys.

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4.2 KEY FUNCTIONS

[Start/Stop] Start and stop automatic processing.

[Hold/Cont.] Hold or continue the countdown of the analysis time. The analysis time is extended with the time that Hold is active.

[Interrupt] Not used.

[Priority] This key can be used to interrupt a sample run to process an emergency sample prior to the next sample of the programmed sample series.

After the priority sample the sample run is continued. A priority sample is a series of one vial with an injection method, a wash method and a time based method with a template.



Priority samples can only be programmed when the use of mix methods and the user program is disabled in the system settings.

[Series] This key can be used to enter the Series programming mode. In the series vials are linked to methods or templates.

[Methods] This key can be used to enter the Methods programming mode.

[Menu] The [Menu] key is only active when "[MENU]" appears in the right top corner of the display. In that case there are more than four soft-function keys available. With the [Menu] key it is possible to toggle between the available screens and thereby change the soft- function keys.

[System] This key can be used to enter the System settings programming mode. In the system settings the configuration of the Model AI-1A is defined.

[Escape] This key can be used to return to the previous programming level when you are in programming mode, the programmed parameters are checked and stored in battery backup memory.

[Help] By pressing the [Help] key the Model AI-1A will show screen-relevant help information.

◁ ▷ The left and right cursor key can be used to go to the programmable fields in a screen.

△ ▽ The up and down cursor keys can be used to increase or decrease the active programmable value. The cursor key does not allow to exceed the range of valid values.

[Clear] (CL) This key removes the actual value of the active programmable parameter. In some case the value NONE or AUTO will be displayed.

[Enter] (E) This key can be used to enter and check all values in a screen. If all values are valid the next programming screen will be displayed.

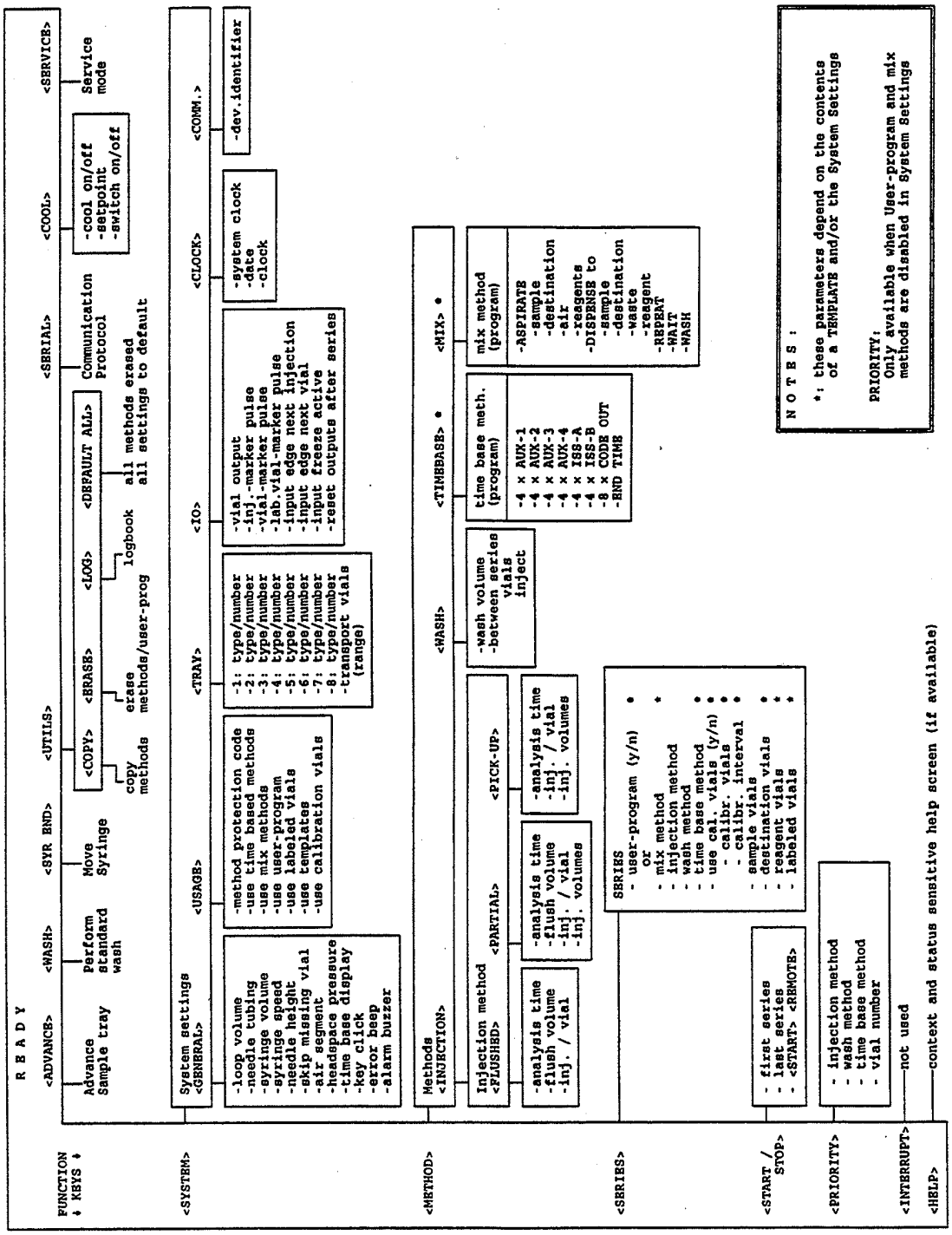
0 – 9 Numeric keys; used to enter values for programming parameters. The values are stored when going to the next parameter with [Enter] or when leaving a programming mode with [Escape], [Series] or [Methods] keys.

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4.3 PROGRAMMING CHARTS

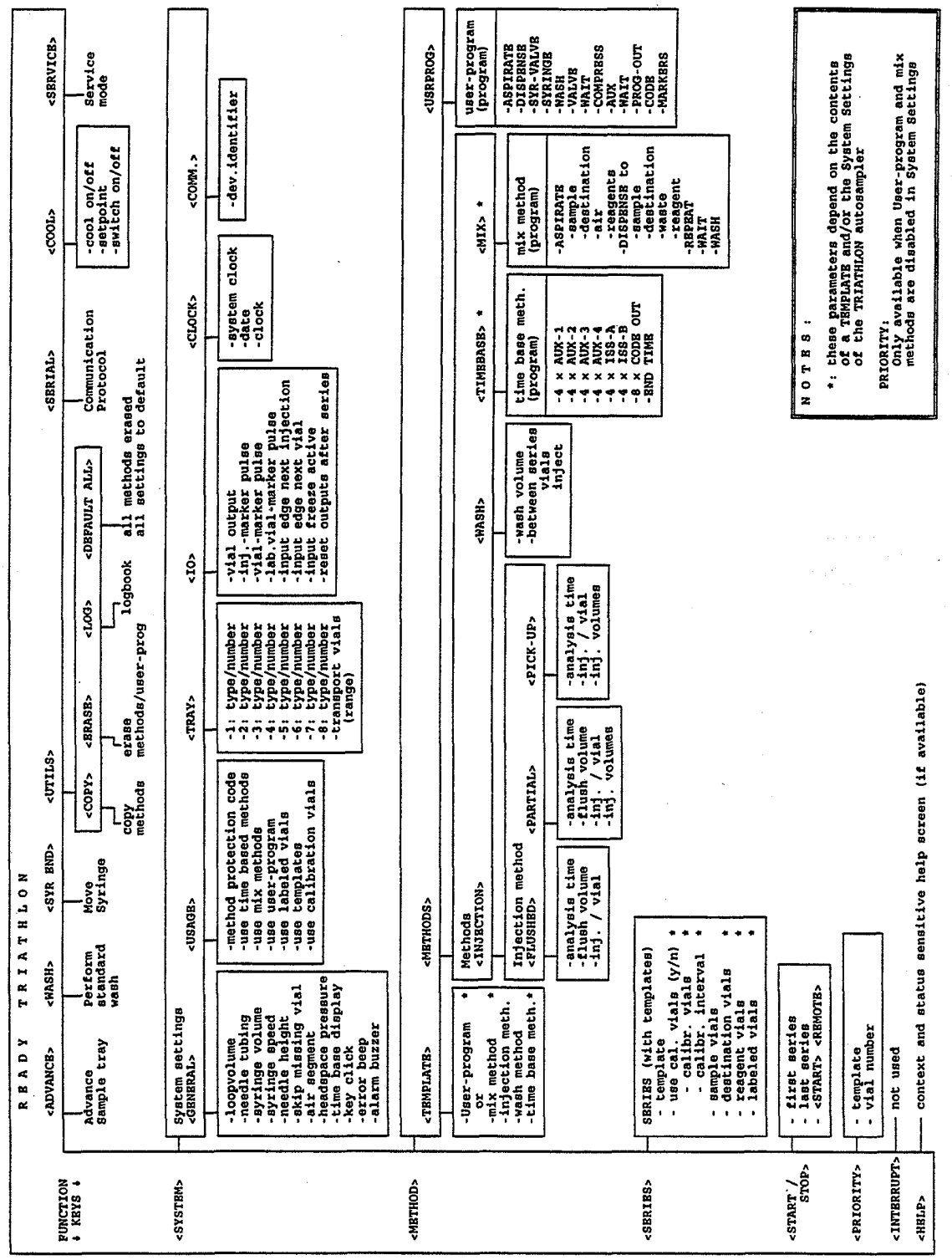
The following two programming charts show the programming possibilities with the Model AI-1A in a schematic overview.

Programming overview chart without the use of templates and user-definable programming:



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Programming overview chart with the use of templates and user-definable programming:



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4.4 READY SCREEN FUNCTIONS

After switching on the power with the mains switch, the Model AI-1A will run an initiation routine in which everything is set to its default positions, then return with the READY display.

```
17:10   FRIDAY FEBRUARY 10-95        [MENU]
              READY  (x.xx)            --°C

<ADVANCE>    <WASH>    <SYR END>   <UTILS>
```

```
17:10   FRIDAY FEBRUARY 10-95        [MENU]
              READY  (x.xx)            --°C

<SERIAL>    <COOL>                  <SERVICE>
```

The **READY** display shows the actual date and time on the first line of the screen. The second line shows the number of the software revision (firmware number) and the temperature of the sample tray if the Peltier cool option is installed.

The bottom line shows the available soft-function keys, with the **[Menu]** key it is possible to toggle between soft-function keys. The functions will be described in the following sections.

4.4.1 ADVANCING THE TRAY

The **<ADVANCE>** soft-function key rotates the tray of the Model AI-1A. This enables you to fill the tray with segments by placing the segment at a free position in the front half of the tray.

4.4.2 MANUAL WASH ROUTINE

With the **<WASH>** soft-function key, it is possible to start a standard wash routine. All tubing, the needle and the syringe of Model AI-1A will be rinsed.

4.4.3 MOVING THE SYRINGE

This built-in function makes the exchange of syringes and filling of wash solvent tubing an easy job.

See also section **3.4.4 SYRINGE** *for detailed information.*

With the **<SYR END>** soft-function key, it is possible to move the syringe to its end position, thereby aspirating wash solvent into the tubing and syringe. At the end of the routine the syringe valve will be switched toward the syringe waste port. The screen will display the following message.

```
STATUS: SYRINGE IN END POSITION

                        <SYR HOME>
```


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With the **<SYR HOME>** soft-function key, the syringe returns to its home position, dispensing the wash solvent to waste.

After changing a syringe the tubing can be rinsed with the manual wash routine described in the following section.

4.4.4 UTILITIES

Four useful utilities are accessed with the **<UTILS>** key.

- Two handle your method data ir a convenient way; copying methods, erasing methods, templates and user-program.
- A third shows the logbook of all kinds of handling, such as error messages, operation times and a counter for valves.
- The last utility enables the user to reset the Model AI-1A to its initial settings.

The first utility screen will show the four possibilities.

```
UTILITIES

<COPY>    <ERASE>    <LOG>   <DEFAULT ALL>
```

By pressing the **[Escape]** key the Model AI-1A will return from the utility mode to the **READY** screen.

4.4.4.1 Copy methods

After pressing the **<COPY>** soft-function key the Model AI-1A asks for the type of method to copy (the source) and the method number. After pressing the enter key the Model AI-1A will ask for the number of the method to copy to (the destination).

```
SELECT SOURCE METHOD   :
METHOD TYPE :    INJECTION    NUMBER 01

<MIX>    <INJECTION>    <WASH>   <TIMEBASE>
```

```
SELECT DESTINATION METHOD   :
COPY INJECTION 01 TO NUMBER: 02
```

After a new method number is chosen, press **[Enter].** The method will be copied, the method you copy to will be replaced by the new method.

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4.4.4.2 Erase methods

With the erase utility methods, templates and the user-definable method can be erased.

After pressing the **<ERASE>** soft-function key the Model AI-1A will display the screen shown below.

This screen will only appear if template and/or user-definable method is enabled in the system settings. If both are disabled the AI-1A will return directly with the first erasing screen for methods.

```
ERASE: SELECT ITEM:

<TEMPLATE>  <METHODS>  <USRPROG>
```

Erase a template:

If the **<TEMPLATE>** soft-function key is pressed, the following screen, is displayed.

```
SELECT TEMPLATE TO ERASE: :
TEMPLATE NUMBER :01
```

Enter the number of the template to erase and press **[Enter].** *The template will be erased.*

Erase a method:

If the **<METHODS>** soft-function key is pressed, the screen as shown appears.

If both the use of templates and user-program are disabled in the system settings, the following screen will also be the first screen of the erasing utility.

```
SELECT METHOD TO ERASE
METHOD TYPE: INJECTION NUMBER: 01

<MIX>  <INJECTION>  <WASH>  <TIMEBASE>
```

Select the type and entering the number of the method to erase and press **[Enter].** The method will be erased.

Erase the user program:

The user program can be erased by pressing the **<USRPROG>** soft-function key, which leads you to the following screen:

```
USER-PROGRAM TO ERASE:
PRESS CL TO ERASE USER-PROGRAM
```

Press the **[Clear]** key to erase the user-definable method.

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4.4.4.3 Logbook

The Model AI-1A keeps a logbook of system relevant events and counts the actions of valves and the syringe movements. The logbook will be displayed by pressing the <LOG> soft-function key:

```
UTILITIES: VIEW EVENTS LOG
POWER ON AT 95/1/25  17:10

<NEXT>    <PREVIOUS>              <COUNTS>
```

With the **<NEXT>** and **<PREVIOUS>** soft-function keys you can scroll through the logbook.

With the **<COUNTS>** soft-function key you can switch to the second part of the logbook in which a record of the valve actions, the syringe movements and the operating time of the Model AI-1A is kept.

The first screen of the counts log will be displayed.

```
UTILITIES: VIEW COUNTS LOG
TIME POWER ON    0 DAYS   00:00

<NEXT>    <PREVIOUS>              <EVENTS>
```

The types of counts kept by the Model AI-1A are listed below:

POWER ON TIME:	0 DAYS 00:00	Total operation time of the Model AI-1A.
INJECTOR VALVE:	00000000	The total number of injections.
ISS-A VALVE:	00000000	Total number of operations for the optional ISS vale. A switch from position 1-6 to 1-2 and back is one count.
ISS-B VALVE:	00000000	See above.
SYRINGE VALVE:	00000000	Total number of operations of the syringe valve.
SYRINGE:	00000000	Total number of movements of the syringe.

With the **<EVENTS>** soft-function key you can return to the events log.

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4.4.4.4 Model AI-1A defaults

With the **<DEFAULT ALL>** soft-function key the settings of the Model AI-1A will be reset to the software default values.

```
UTILITIES: DEFAULTS (LOSE ALL DATA)
PRESS CL TO SET ALL DEFAULTS
```

After pressing the **[Clear]** key all series, methods, templates and the user-program will be erased. The system settings will be set to its default values, listed below:

General:	
Loop volume	100 µL
Needle tubing	15 µL
Syringe volume	250 µL
Syringe speed	NORMAL
Needle height	2 mm
Skip missing vials	YES
Air segment	YES
Headspace pressure	YES
Time base display	HH:MM:SS
Key click	YES
Error beep	YES
Alarm buzzer	YES

TRAY
1: SEGMENT TYPE A_NUMBER: 1
2: SEGMENT TYPE A_NUMBER: 2
3: SEGMENT TYPE A_NUMBER: 3
4: SEGMENT TYPE A_NUMBER: 4
5: SEGMENT TYPE A_NUMBER: 5
6: SEGMENT TYPE A_NUMBER: 6
7: SEGMENT TYPE A_NUMBER: 7
8: SEGMENT TYPE A_NUMBER: 8
Transport vials NONE

COMM	
Device identifier	20

USAGE:	
Method protection code	NONE
Time base methods	DISABLED
Mix methods	DISABLED
User-program	DISABLED
Labeled vials	DISABLED
Templates	DISABLED
Calibration vials	DISABLED

I/O:	
Vial output	BCD
Inject marker pulse	1.0 sec
Vial marker pulse	1.0 sec
Labeled vial marker pulse	1.0 sec
Input edge next injection	FALLING
Input edge next vial	FALLING
Input freeze active	LOW



If you have used the DEFAULT ALL utilities, check your Model AI-1A hardware configuration with the SYSTEM SETTINGS. If necessary change the SYSTEM SETTINGS, see section 4.5.

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4.4.5 SAMPLE TRAY COOLING (OPTIONAL)

The optional Peltier tray cooling offers the possibility to thermostat the sample temperature at 4°C up to 40°C. If the tray cooling is not installed, this function will not be available.

After pressing the **<COOL>** soft-function key the Model AI-1A will enter the programming mode of the Peltier sample tray cooling. The Model AI-1A will ask for the setpoint of the Peltier tray cooling, the time to start the tray cooling and ON/OFF switching of the tray cooling.

```
PROGRAMMING COOL SETTINGS:
COOLING OFF SETPOINT 25°C

<OFF>      <ON>
```

In the first programming screen the cooling is switched **<ON>** or **<OFF>** with the soft-function keys. The setpoint temperature is programmed with the numeric or the cursor keys, the new programmed setpoint has to be entered with the [Enter] key.

Depending on the status (ON or OFF) of the temperature control, the Model AI-1A will ask for the moment of switching OFF or switching ON the temperature control.

If the temperature control is ON the Model AI-1A will display the following screen, after the [Enter] key is pressed in the above screen of the cool settings.

```
PROGRAMMING COOL SETTINGS:
SWITCH OFF: MANUAL

<MANUAL>  <AUTOMATIC>  <DATE-TIME>
```

There are three ways to switch OFF the temperature control; select one of the following soft-function keys:

<MANUAL> The temperature control will stay ON until it is switched OFF by the user.

<AUTOMATIC> The temperature control will be switched OFF after all programmed series have been executed.

<DATE-TIME> The temperature control will be switched OFF at a programmed date and time. In this case you have to program a date and time, see below.

```
PROGRAMMING COOL SETTINGS:
SWITCH OFF: (Y/M/D H:M):  95/1/21 17:10

<MANUAL>   <AUTOMATIC>  <DATE-TIME>
```

With the **[Enter]** key you will now return to the first screen of the cool settings.

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If the temperature control is OFF the Model AI-1A will display the following screen, after the **[Enter]** key is pressed in the first screen of the cool settings.

```
PROGRAMMING COOL SETTINGS:
SWITCH ON: MANUAL

<MANUAL>                    <DATE-TIME>
```

There are two ways to switch ON the temperature control, therefore select one of the following soft-function keys:

<MANUAL> The temperature control will stay OFF until it is switched ON by the user.

<DATE-TIME> The temperature control will be switched ON at a programmed date and time. In this case you have to program a date and time, see below.

```
PROGRAMMING COOL SETTINGS:
SWITCH ON: (Y/M/D H:M):    95/1/21  17:10

<MANUAL>                    <DATE-TIME>
```

Press the **[Enter]** key to return to the first screen of the cool settings.

The cool settings mode can be left at any time by pressing the **[Escape]** key, the programmed values will be stored in battery backup memory.

If the cool-setting programming mode is left without programming a switch ON/OFF parameter, this parameter will be default <MANUAL>.



The programmable temperature range is from 4°C up to 40°C. The maximum cool capacity is 20°C below ambient.



Connect the left-hand hose connector to a waste container on the floor to drain the condensed water of the cool ring.

4.4.6 SERIAL COMMUNICATION MODE

The Model AI-1A can be controlled by a personal computer. Refer to the separate software manual for operating instructions. To enter the serial mode press the **<SERIAL>** soft-function key. The AI-1A will return with the serial mode screen, see screen below.

```
            SERIAL MODE

                              <EXIT>
```

When the Model AI-1A is set in serial mode it can only be controlled via the RS422 communication port.See Appendix D and the software manual for details. To leave the serial mode press the **<EXIT>** soft-function key. The Model AI-1A will return to the **READY** screen and can be operated normally.

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4.4.7 SERVICE MODE

After pressing the **<SERVICE>** soft-function key the Model AI-1A will ask for a special service entry-code before you get access to the SERVICE mode. This code is exclusively for the use of Rainin's authorized service personnel.

```
ENTER SERVICE CODE THEN PRESS ENTER
```

Press the **[Escape]** key to return to READY screen without entering SERVICE MODE.

4.5 SYSTEM SETTINGS

From the READY screen the system configuration of the is defined via the SYSTEM SETTINGS. Press the **[System]** key. The AI-1A will return with the menu screen of the SYSTEM SETTINGS. From here you can enter the six sub-sections of the SYSTEM SETTINGS:

1. General system settings
2. Usage system settings (enabling and disabling the use of types of methods and templates)
3. Tray configuration
4. Clock settings
5. Configuration of the I/O ports
6. Service mode. (Exclusively for the use of Rainin's authorized service personnel.)

With the [Menu] key you can toggle between the soft-function keys.

After programming the correct SYSTEM SETTINGS, leave the SYSTEM SETTINGS mode by pressing the **[Escape]** key. System settings are stored in battery backup memory.

```
PROGRAMMING SYSTEM SETTINGS:     [MENU]
WHICH SYSTEM SETTINGS: GENERAL

<GENERAL>      <USAGE>  <TRAY>      <IO>
```

```
PROGRAMMING SYSTEM SETTINGS:        [MENU]
WHICH SYSTEM SETTINGS: GENERAL

<CLOCK>      <COMM.>
```


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4.5.1 GENERAL SYSTEM SETTINGS

After pressing the **<GENERAL>** soft-function key and the **[Enter]** key you enter the first screen of the GENERAL SYSTEM SETTINGS. Every time the **[Enter]** key is pressed, the actual value is saved and the next screen appears.

```
PROGRAMMING SYSTEM SETTINGS:: GENERAL
VOLUME OF INSTALLED LOOP: 0100 µL
```

The first screen asks for the volume of the installed loop. The AI-1A checks every programmed injection volume against this value, so no illegal injection volumes can be programmed. In case of flushed loop injections the AI-1A will dispense the correct number of loop volumes necessary to fill the loop completely. For partial loopfill injections only 50% of the programmed loop volume can be injected.

```
PROGRAMMING SYSTEM SETTINGS:: GENERAL
VOLUME OF TUBING NEEDLE - VALVE: 015 µL
```

This screen asks for the volume of the needle and tubing. This parameter has to be programmed, because it is possible to equip the Model AI-1A with a different needle and tubing with a different volume. Different volumes require different minimum flush volumes. The flush volume is fixed and is equal to twice the volume of needle and the tubing.

```
PROGRAMMING SYSTEM SETTINGS:: GENERAL
SYRINGE VOLUME: 0250 µL (BUFFER = 0500)

<100>      <250>  <500>        <1000>
```

The volume of the installed syringe must be entered here. Incorrect values will result in incorrect injection volumes.

If a 100 or 250 µL syringe is installed it is necessary to equip the Model AI-1A with 500 µL-buffer tubing. If a 500 or 1000 µL syringe is installed, 2000 µL buffer tubing should be installed.

```
PROGRAMMING SYSTEM SETTINGS:: GENERAL
SYRINGE SPEED : NORMAL

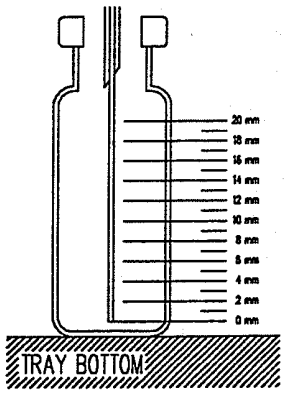
<LOW>      <NORMAL>          <HIGH>
```

The aspirating speed of the syringe used in injection methods can be programmed in this screen. For the corresponding flows, see below. The speed of the syringe during the wash or the rinsing of the buffer are not affected by this setting.

SPEED	**100 µL Syringe**	**250 µL Syringe**	**500 µL Syringe**	**1000 µL Syringe**
LOW	125 µL/min	315 µL/min	625 µL/min	1250 µL/min
NORMAL	250 µL/min	625 µL/min	1250 µL/min	2500 µL/min
HIGH	375 µL/min	940 µL/min	1875 µL/min	3750 µL/min
Syringe speeds during Wash				
Through needle	1370 µL/min	3430 µL/min	5330 µL/min	5485 µL/min
From wash solvent and to waste	1370 µL/min	3430 µL/min	6860 µL/min	13715 µL/min

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```
PROGRAMMING SYSTEM SETTINGS:: GENERAL
SAMPLE NEEDLE HEIGHT: 0.2 mm
```



In this screen the distance between the needle point and the bottom of the sample tray (not the bottom of the vial, see Figure 4.2) can be programmed. The value in the system settings is only used in injection methods, for mix methods this value is programmable in the method itself.

CAUTION

A height of 0 mm is not the bottom of the tray, but a reference value related to a point above the bottom of the tray. Check sample needle height with an empty vial.

```
PROGRAMMING SYSTEM SETTINGS: GENERAL
SKIP MISSING VIALS: YES

<YES>              <NO>
```

In this screen you can program whether the Model AI-1A must continue or stop if a vial is not found on the tray. If you choose **<YES>** the Model AI-1A will proceed with the next programmed vial if a vial is not found. If you program **<NO>** the Model AI-1A will stop and generate an ERROR message.

```
PROGRAMMING SYSTEM SETTINGS: GENERAL
AIR SEGMENT: YES

<YES>              <NO>
```

With the Model AI-1A it is possible to inject a sample with or without an air segment between the sample and the wash solvent. If the air segment is ON the Model AI-1A will draw an air segment of 5 µL before the flush volume prior to an injection. The air segment will not be injected in the analytical system. In case of µL pick-up the sample will be preceded by an air segment, which will be injected in the analytical system. See section 2.2.3, Air segment.

```
PROGRAMMING SYSTEM SETTINGS: GENERAL
HEADSPACE PRESSURE: YES

<YES>              <NO>
```

The Model AI-1A normally uses headspace pressure in combination with the syringe to transport sample in to the loop. In this screen the use of the headspace pressure can be selected **<YES>**, or not, **<NO>**. The compressor will still be used in the wash position of the AI-1A. The accuracy and reproducibility of the AI-1A can decrease because of the switched off headspace pressure.

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```
PROGRAMMING SYSTEM SETTINGS: GENERAL
TIME BASE DISPLAY: H:MM:SS

<H:MM:SS>          <H:MM:mm>
```

The Model AI-1A offers a choice between two types of analysis time representations. The first, **<H:MM:SS>,** displays hours, minutes and seconds. The second, **<H:MM.mm>**, displays hours, minutes and decimal minutes.

```
PROGRAMMING SYSTEM SETTINGS: GENERAL
KEY CLICK: ON

<ON>        <OFF>
```

The beep, whenever a key is pressed, can be turned **<ON>** or **<OFF>** in this screen.

```
PROGRAMMING SYSTEM SETTINGS: GENERAL
ERROR BEEP: ON

<ON>        <OFF>
```

The error beep, given when an incorrect value is entered or an incorrect key is pressed, can be turned **<ON>** or **<OFF>** in this screen.

```
PROGRAMMING SYSTEM SETTINGS: GENERAL
ALARM BUZZER: ON

<ON>        <OFF>
```

The alarm, given when an error occurs during a run, can be turned **<ON>** or **<OFF>** in this screen.

After programming the correct GENERAL SYSTEM SETTINGS, you can return to the menu screen of the SYSTEM SETTINGS mode by pressing the **[Escape]** key. The new settings are stored in the battery backup memory.

4.5.2 USAGE MODE

In this part of the SYSTEM SETTINGS you can enable and disable advanced features of the AI-1A, so that only information relevant to your system setup will be asked for. In the SYSTEM SETTINGS you can also program a protection code, to protect methods and system settings against unauthorized changes.

```
PROGRAMMING SYSTEM SETTINGS: USAGE
METHOD PROTECTION CODE:  <NONE>
```

The method protection code can be activated by entering a six digit number code. This code must be entered each time the system settings or a method programming mode is entered. Without the protection code no changes can be made. When a code is entered the following screen is displayed.

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```
PROGRAMMING SYSTEM SETTINGS: USAGE
METHOD PROTECTION CODE:  123456
```

The protection code can be erased by pressing the **[Clear]** key.

Without the protection code it is IMPOSSIBLE to enter the SYSTEM SETTINGS and method programming mode!

In the following screens you can enable or disable the different Model AI-1A features, press **[Enter]** to go to the next screen.

```
PROGRAMMING SYSTEM SETTINGS: USAGE
USE OF TIMEBASE METHODS: DISABLED

<DISABLED>       <ENABLED>
```

Enable or disable the use of timebase methods by pressing the **<ENABLE>** or **<DISABLE>** soft-function key and press **[Enter]** to go to the next screen.

```
PROGRAMMING SYSTEM SETTINGS: USAGE
USE OF MIX METHODS: DISABLED

<DISABLED>       <ENABLED>
```

Enable or disable the use of mix methods by pressing the **<ENABLE>** or **<DISABLE>** soft-function key and press **[Enter]** to go to the next screen.



If the use of mix methods or the user program is enabled in the SYSTEM SETTINGS, it is no longer possible to program a priority sample during the run of the Model AI-1A.

```
PROGRAMMING SYSTEM SETTINGS: USAGE
USE OF USER PROGRAM: DISABLED

<DISABLED>       <ENABLED>
```

Enable or disable the use of the user program by pressing the**<ENABLE>** or **<DISABLE>** soft-function key and press **[Enter]** to go to the next screen.

```
PROGRAMMING SYSTEM SETTINGS:: USAGE
USE OF LABELED VIALS: DISABLED

<DISABLED>       <ENABLED>
```

Enable or disable the use of labeled vials by pressing the **<ENABLE>** or **<DISABLE>** soft-function key and press **[Enter]** to go to the next screen.

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```
PROGRAMMING SYSTEM SETTINGS:: USAGE
USE OF TEMPLATES: DISABLED

<DISABLED>        <ENABLED>
```

Enable or disable the use of templates by pressing the **<ENABLE>** or **<DISABLE>** soft-function key and press **[Enter]** to go to the next screen.

```
PROGRAMMING SYSTEM SETTINGS:: USAGE
USE OF CALIBRATION VIALS: DISABLED

<DISABLED>        <ENABLED>
```

Enable or disable the use of calibration vials by pressing the **<ENABLE>** or **<DISABLE>** soft- function key and press **[Enter]** to go to the next screen.

After programming the correct USAGE SYSTEM SETTINGS, you can return to the menu screen of the SYSTEM SETTINGS mode by pressing the **[Escape]** key. The new settings now are stored in the battery backup memory.

4.5.3 TRAY CONFIGURATION

Because it is possible to equip the Model AI-1A with four types of tray segments (See Figure 4.3) and the tray may be a mix of all types of segments, it is necessary to define the tray configuration in this part of the SYSTEM SETTINGS of the Model AI-1A.

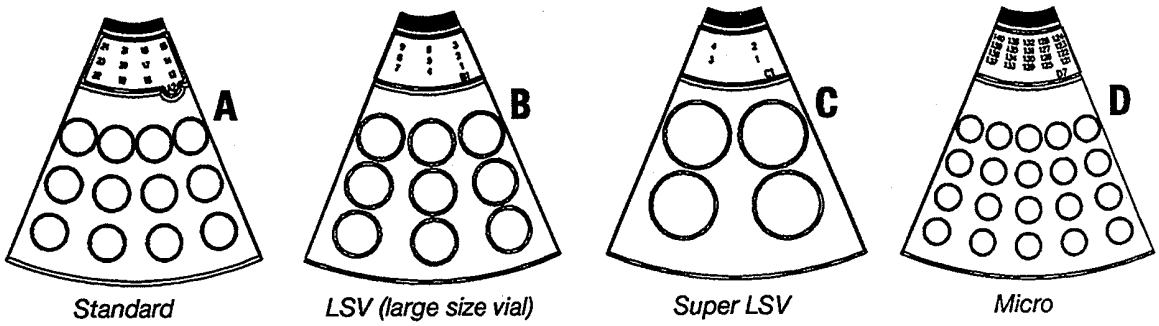


Figure 4.3 Types of tray segment

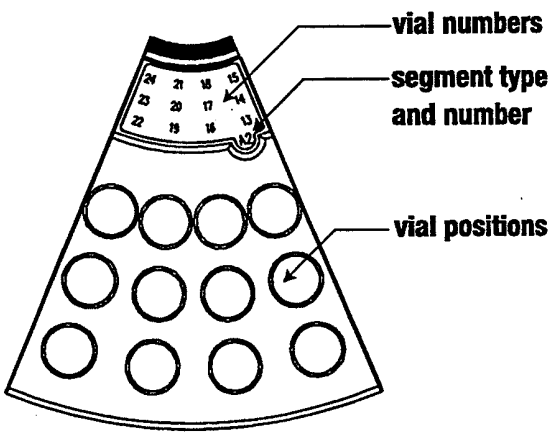


Table 15: Vial volumes for each tray size

Type A	1.5 mL
Type B	4.0 mL
Type C	10.0 mL
Type D	0.8 mL

Figure 4.4 Tray segment description

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A tray segment contains information on the segment type and segment number, e.g. A1 means segment number 1 of segment type A. Further more, it has the number of all the vials shown on the inside ring.

The Model AI-1A can withdraw up to 80% of the vial volumes, summarized in Table 15, for the different tray segment types.

After pressing the **<TRAY>** soft-function key and the **[Enter]** key you enter the first of eight screens in which the tray configuration is defined.

```
PROGRAMMING SYSTEM SETTINGS:: TRAY
1 SEGMENT: TYPE_A NUMBER: 1

<TYPE_A>  <TYPE_B>  <TYPE_C>  <TYPE_D>
```

The second line is the programming line where the segment types and numbers must be programmed. The first number indicates which line you are programming, NOT which segment because segments may be entered in random order. The first programmable field is the type of segment and the second programmable field is the segment number. These values can be found on the segment, see Figure 4.4.

TRAY EXAMPLE:

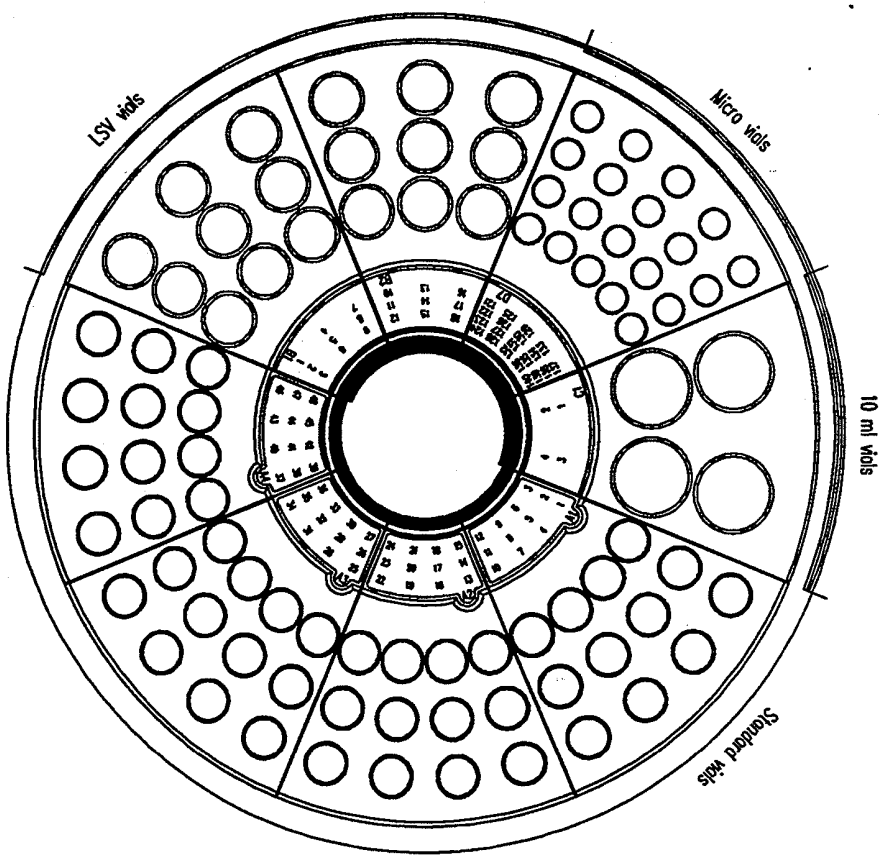


Figure 4.5: Mixed tray segments:

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Your tray configuration must be programmed as follows:

Table 16 Tray System Settings

1	SEGMENT:	TYPE_A	NUMBER: 1	5	SEGMENT:	TYPE_B	NUMBER: 1
2	SEGMENT:	TYPE_A	NUMBER: 2	6	SEGMENT:	TYPE_B	NUMBER: 2
3	SEGMENT:	TYPE_A	NUMBER: 3	7	SEGMENT:	TYPE_D	NUMBER: 7
4	SEGMENT:	TYPE_A	NUMBER: 4	8	SEGMENT:	TYPE_C	NUMBER: 1

The sequence of programming the segments does not have to be the same as the sequence of the segments in the AI-1A, because the segments may be positioned randomly. Duplicate segment numbers of one type are not allowed, e.g. two times segment A2 cannot be programmed.

If you will be using the µL pick-up injection method it is necessary to define the positions of the vials with transport solvent. All the vials with transport solvent must be of one type, because the software calculates with the vial volumes, see Table 15.

```
PROGRAMMING SYSTEM SETTINGS:: TRAY
TYPE OF TRANSPORT VIALS: NONE

<TYPE_A>  <TYPE_B>  <TYPE_C>  <TYPE_D>
```

Enter the type of transport vial and press **[Enter]** to go to the next screen.

```
PROGRAMMING SYSTEM SETTINGS:: TRAY
FIRST TRANSPORT VIAL: C 25
```

Enter the number of the first transport vial and press **[Enter]** to go to the next screen.

```
PROGRAMMING SYSTEM SETTINGS:: TRAY
LAST TRANSPORT VIAL: C 28
```

Enter the number of the last transport vial and press **[Enter]** to go to the next screen.

If no vials with transport solvent are on the tray, press the **[Clear]** key to delete the programmed segment type. The message NONE will be displayed on the screen and the previous two screens will be skipped.

After the correct tray configuration has been programmed, you can return to the menu screen of the SYSTEM SETTINGS mode by pressing the **[Escape]** key. The new settings are stored in the battery backup memory.

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4.5.4 I/O CONFIGURATION

After pressing the **<IO>** soft-function key and the **[Enter]** key, you enter the first screen of the I/O configuration mode of the SYSTEM SETTINGS.

```
PROGRAMMING SYSTEM SETTINGS:: IO
VIAL OUTPUT: BCD

  <BCD>    <HEX>
```

Define the vial number output to be **<BCD>** (Binary coded decimal) or **<HEX>** (hexadecimal), press **[Enter].**

```
PROGRAMMING SYSTEM SETTINGS:: IO
INJECT MARKER PULSE LENGTH: 1.0 s
```

Define the length of the injection marker pulse, press **[Enter].**

```
PROGRAMMING SYSTEM SETTINGS:: IO
VIAL MARKER PULSE LENGTH: 1.0 s
```

Define the length of the vial marker pulse, press **[Enter].**

```
PROGRAMMING SYSTEM SETTINGS:: IO
LABELED VIALS MARKER PULSE LENGTH: 1.0 s
```

Define the length of the labeled vials marker pulse, press **[Enter].**

```
PROGRAMMING SYSTEM SETTINGS:: IO
INPUT EDGE NEXT INJECTION: FALLING
```

Define the edge sensitive inputs, **<FALLING>** ↓ or **<RISING>** ↑ , press **[Enter].**

```
PROGRAMMING SYSTEM SETTINGS:: IO
INPUT EDGE NEXT VIAL: FALLING
```

Define the edge sensitive inputs, **<FALLING>** ↓ or **<RISING>** ↑ , press **[Enter].**

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```
PROGRAMMING SYSTEM SETTINGS:: IO
FREEZE INPUT ACTIVE: LOW
```

Define the level to activate the freeze function, **<LOW>** or **<HIGH>**, press **[Enter].**



If the freeze input is set HIGH, the time base will freeze if the input is not connected to another device.

Consequently: the Model AI-1A will not start!

```
PROGRAMMING SYSTEM SETTINGS:: IO
RESET OUPUTS AFTER LAST SERIES: YES

<YES>          <NO>
```

Define if the outputs (auxiliaries, BCD output, vial number output, etc.) should be reset to the default settings after finishing the last series, **<YES>** or **<NO>.**

Also, if a run is stopped with the **[Start/Stop]** key, the outputs will be reset as after the last series.

Only in case of a panic stop, pressing the **[Start/Stop]** key twice, the outputs will always be reset, independent of these system settings.

After programming the correct I/O SYSTEM SETTINGS, you can return to the menu screen of the SYSTEM SETTINGS mode by pressing the **[Escape]** key, the settings are stored in the battery back-up memory.

4.5.5 CLOCK SETUP

After pressing the **<CLOCK>** soft-function key and the [Enter] key you enter the first screen of the CLOCK SETUP mode of the SYSTEM SETTINGS. In this part of the SYSTEM SETTINGS the calendar of the Model AI-1A can be adjusted to your local time and the clock can be enabled or disabled.



When you install the Model AI-1A for the first time the system clock will be <OFF>.

```
PROGRAMMING SYSTEM SETTINGS:: CLOCK
SYSTEM CLOCK: ON

 <ON>      <OFF>
```

To activate the system clock, press the **<ON>** soft-function key and press **[Enter].**

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```
PROGRAMMING SYSTEM SETTINGS:: CLOCK
DATE: (YY/MM/DD):  95/1/31
```

Enter the correct date, therefore switch between the year, month and date field with the left and right cursor keys. The value can be entered with the numeric keys or with the up and down cursor keys. After all correct values have been programmed press **[Enter].**

```
PROGRAMMING SYSTEM SETTINGS:: CLOCK
TIME: (HH/MM):  17:32
```

Program the actual time, use the left and right cursor keys to toggle between the hours and minutes fields.

After the correct clock values have been programmed, you can return to the menu screen of the SYSTEM SETTINGS mode by pressing the **[Escape]** key, the programmed time and date are stored in the battery backup memory.

4.5.6 COMMUNICATION SETUP

After pressing the **<COMM>** soft-function key and the **[Enter]** key you enter the screen of the COMMUNICATION SETUP mode of the SYSTEM SETTINGS. In this part of the SYSTEM SETTINGS the device identifier of the Model AI-1A used with the SparkLink protocol can be adjusted to your demands.

```
PROGRAMMING SYSTEM SETTINGS:: COMM
DEVICE IDENTIFIER:     20
```

Enter the device identifier number, default 20 and programmable from 20 to 29, press **[Enter].**

After the selected value has been programmed, you can return to the menu screen of the SYSTEM SETTINGS mode by pressing the **[Escape]** key, the device identifier number is stored in the battery backup memory.

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4.6 METHODS

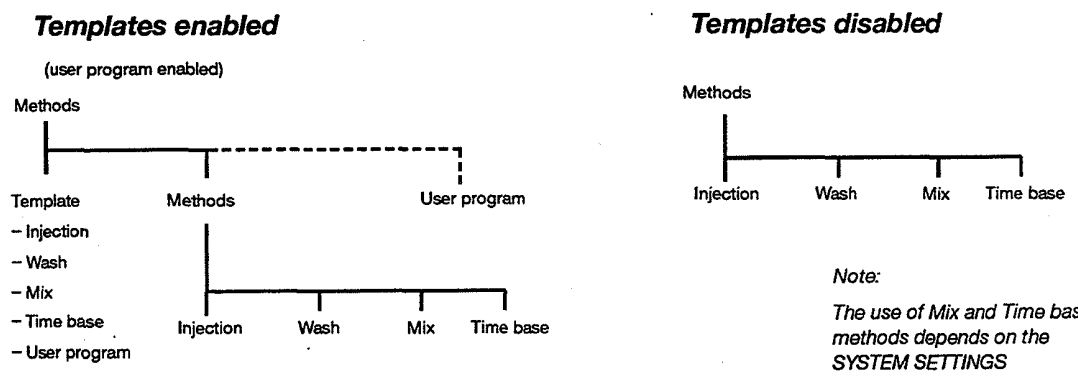
The Model AI-1A has six types of programmable methods:

1. 24 templates 2, 24 injection 3, 5 wash 4, 5 time base 5. 9 mix methods 6. 1 user program.

A template is a programmable combination of an injection method, a wash method, a time base method and a mix method. Either all types of methods or just one type may be present in a template.

When the user program is enabled a template can consist of the user program only.

In the SYSTEM SETTINGS of the Model AI-1A it's possible to define how the method programming mode will be organized. You can choose to use templates or not, this will only affect the structure of the methods programming mode, not the possibilities of the Model AI-1A as shown below:



The advantage of using templates is that you can make pre-defined combinations of methods, which are stored in the battery backup memory.

In series it is no longer necessary to program each separate method, you can now directly program the template to be used. By doing so you can define a complete analysis in one template. Templates are therefore particularly useful for routine analysis.

PROGRAMMING METHODS WITH TEMPLATES AND USER DEFINABLE METHODS DISABLED:

This way of programming gives you a lot of flexibility in combining the four pre-defined methods in the series. But due to this flexible way of programming it takes more time to make your series.

From the READY screen the method programming mode can be entered be pressing the [Methods] key. The Model AI-1A will show the first screen of the programming mode. In case of disabled templates and user definable methods the first screen displayed will be:

```
SELECT METHOD TO PROGRAM:
METHOD TYPE: INJECTION NUMBER: 01

<INJECTION>  <WASH>  <TIMEBASE>  <MIX>
```

From this screen you can directly program a method, after selecting a type of method and entering the correct number, press the **[Enter]** key to go to the programming mode of the selected method.

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PROGRAMMING METHODS WITH TEMPLATES AND USER DEFINABLE METHODS ENABLED:

If user definable templates are enabled, the first screen will be:

```
SELECT ITEM:

<TEMPLATE>   <METHODS>   <USRPROG>
```

This screen displays three options; templates **<TEMPLATE>,** pre-defined methods **<METHODS>** or user definable methods **<USRPROG>.**

Press the [Methods] key or the **<METHODS>** soft-function key, to enter the method programming mode. The Model AI-1A returns with the following screen, in which you can select a method you want to program.

```
SELECT METHOD TO PROGRAM:
METHOD TYPE: INJECTION NUMBER: 01

<MIX>  <INJECTION> <WASH>  <TIMEBASE>
```

After selecting a type of method and entering the correct number, you may press the **[Enter]** key to go to the programming mode of the selected method.

4.6.1 TEMPLATE

In the template programming mode you have access to 24 programmable templates.

A template is a user definable combination of an injection method, a wash method, a time base method and a mix method. It is not necessary that all the methods are present in a template. A template may also consist of only one of the methods. Templates are designed to give the user a tool to store complete analysis methods.

From the first screen of the programming mode a template can be programmed by pressing the **<TEMPLATE>** soft-function key. You enter the first screen of template programming:

```
PROGRAMMING TEMPLATE   :
WHICH TEMPLATE NUMBER: 01
```

Enter the desired number and press **[Enter].** Now the Model AI-1A will ask you to define which injection-, wash-, time base- and mix-method must be executed when using this template.

If the mix or the time base methods are disabled in the SYSTEM SETTINGS, then it is not possible to program those methods in a template.

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If a mix or time base method which is used in a template is disabled in the SYSTEM SETTINGS after programming this template, the method will be removed from that template.

If no method is disabled in the SYSTEM SETTINGS the Model AI-1A will ask for the following four method numbers.

```
PROGRAMMING TEMPLATE   :
USER PROGRAM INSTEAD OF METHODS: NO

<NO>        <YES>
```

Enter if the user definable program should be used instead of the standard methods, **<YES>** or **<NO>** and press **[Enter]** to go to the next screen.

This screen will only appear if the use of the user definable method is enabled in the system setting.

When entering **<YES>** the following four screens are skipped.

```
PROGRAMMING TEMPLATE   :
USE MIX METHOD NUMBER: 01
```

Enter the number of the mix method and press **[Enter]** to go to the next screen.

```
PROGRAMMING TEMPLATE   :
USE INJECTION METHOD NUMBER: 01
```

Enter the number of the injection method and press **[Enter]** to go to the next screen.

```
PROGRAMMING TEMPLATE   :
USE WASH METHOD NUMBER: 01
```

Enter the number of the wash method and press **[Enter]** to go to the next screen.

```
PROGRAMMING TEMPLATE   :
USE TIME BASE METHOD NUMBER: 01
```

Enter the number of the time base method and press **[Enter]** to go to the next screen.

If a method does not need to be programmed, press the **[Clear]** key and the value NONE will be displayed to indicate that no method of that kind will be executed by this template.

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After programming the correct methods in this template, go back to the previous level by pressing the **[Escape]** key or go to the next template by pressing the **[Methods]** key.

The templates are stored in the battery backup memory.

4.6.2 INJECTION METHODS

From the method menu screen, the injection method programming mode is entered by pressing the **[Enter]** key after you have chosen **<INJECTION>** and the desired number. You can program 24 injection methods.

If the method of your choice is locked by the Model AI-1A, because of changes in the system settings after programming the method, the word "LOCK" is displayed to indicate that if the method is entered it must be unlocked by programming valid values.

After you have entered the injection method programming mode, the Model AI-1A will ask you what type of injection must be performed: flushed loop, partial loopfill or µL pick-up injections.

```
PROGRAMMING INJECTION METHOD: 01
INJECTION MODE: FLUSHED LOOP

<FLUSHED>  <PARTIAL>   <PICK-UP>
```

After selecting the desired injection method, the Model AI-1A will ask for the relevant injection parameters. Not every injection method needs all programming screens.

```
PROGRAMMING INJECTION METHOD: 01
ANALYSIS TIME:   0:00:00
```

Enter the analysis time. This is the time between switching the injection valve to inject and the start of processing the next sample. Press **[Enter].**

```
PROGRAMMING INJECTION METHOD: 01
NUMBER OF INJECTIONS PER VIAL: 1
```

Enter the flush volume: the amount of sample taken from a vial before the loop is filled with sample. The minimum flush volume is 30 µL of sample. Press **[Enter].** Enter the number of injections per vial. The maximum number of injections per vial is nine. Press **[Enter].**

The next screens will ask for the amount of sample that has to be injected. The number of times this will be asked equals the number of injections per vial programmed in the previous screen.

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```
PROGRAMMING INJECTION METHOD: 01
1 INJECTION VOLUME: 0010 µL
```

```
PROGRAMMING INJECTION METHOD: 01
9 INJECTION VOLUME: 0010 µL
```

The maximum programmable injection volumes are:



Partial loopfill injections:	50% of the programmed loop volume
µL pick-up injections:	injection volume = (loop volume - 3 x needle volume)/2
Flushed loop injections:	Not programmable, is equal to the loop volume but needs more sample to fill the loop completely. (3 x loop for loops < 100 µL, 2 x loop for loops > 100 µL)

After all the values have been entered press **[Enter]** to return to the first screen of the injection method programming mode. To return to the previous programming level press the **[Escape]** key or the **[Methods]** key. In both cases you return to the method menu screen, but in case the **[Methods]** key is used the injection method number is increased by one automatically.

Injection methods are stored in the battery backup memory.

4.6.3 WASH METHODS

From the method menu screen, the wash method programming mode is entered by pressing the **[Enter]** key after you have selected **<WASH>** and the desired number. Five wash methods can be programmed. A wash method consists of two parameters; the moment of executing the wash and the amount of wash solvent to be used.

```
PROGRAMMING WASH METHOD: 01
WASH BETWEEN: SERIES

<INJECTION>      <VIALS>     <SERIES>
```

The first screen will ask when the wash has to be carried out. If you choose wash between series, a wash is performed after each series. If you choose wash between vials, a wash is performed after every vial. The last option, wash between injections, performs a wash after every injection.



If a wash method is used in a series with this wash method being the only method in that series, then program a wash between series, otherwise the series (wash) will not be executed.

```
PROGRAMMING WASH METHOD: 01
WASH VOLUME: 0300 µL
```

The last screen of the wash method asks for the amount of wash solvent to be used. The minimum programmable amount is 300 µL.

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After the wash volume has been entered Model AI-1A will return to the first screen. To return to the previous programming level press the **[Escape]** key or the **[Methods]** key. In both cases you return to the method menu screen, but in case the **[Methods]** key is used the wash method number is increased by one automatically.

Wash methods are stored in the battery backup memory.

4.6.4 TIMEBASE METHODS

This type of method enables you to control optional ISS valves and other devices via auxiliary (contact closures) or a binary output (BCD or HEX).

From the method menu screen, the time base method programming mode is entered by pressing the [Enter] key after you have chosen **<TIMEBASE>** and the desired number. Five time base methods can be programmed.

The first screen shows the soft-function keys for the time base parameters: auxiliaries, ISS-valves, code-output and END time, see Table 17.

```
PROGRAMMING TIME BASE METHOD: 01
1 ISS-A 6-1 AT TIME : <NONE>

<AUX>      <ISS>      <CODE>     <END>
```

You can scroll through all the program lines of the time base method by pressing the [Enter] key or step to a particular parameter section by pressing the relevant soft-function key.

By pressing the **<AUX>** soft-function key you step to the first line of auxiliary 1 (Contact closure), see previous screen. Pressing the **<AUX>** soft-function key again you move to the next auxiliary, AUX-2. After auxiliary 8 you return to auxiliary 1 by pressing the **<AUX>** soft-function key. Every auxiliary can be set to ON four times and four times to OFF at a programmed time. It is not possible to program the same auxiliary to ON and OFF at the same time, this is checked for when the time base method is left by pressing the **[Escape]** key or the **[Methods]** key.

Press the **<ISS>** soft-function key (if available) to go to the next screen:

The ISS valve can only be programmed if the optional ISS valves are installed. 6-1 and 1-2 indicate the interconnected ports of the valves, see Figure 4.6.

The auxiliary and ISS timed events only need a time at which the action must be performed.

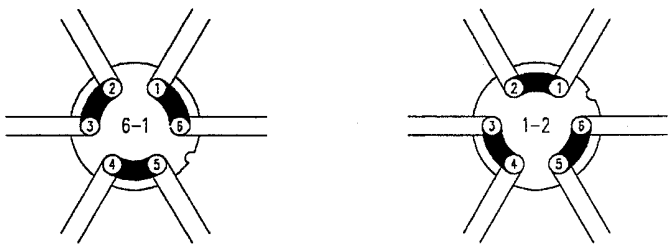


Figure 4-6 ISS valves; interconected ports

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Press the **<CODE>** soft-function key to go to the following screen:

```
PROGRAMMING TIME BASE METHOD: 01
1 CODE-OUT VALUE: 00 AT TIME: <NONE>

<AUX>      <ISS>      <CODE>      <END>
```

The code events need a time and a value between 0 and 15, hexadecimal output. Because both are numeric values, only one of the two is active for programming, indicated by blinking of the value. You can switch between the two values with the left-arrow and right-arrow key.

Press the **<END>** soft-function key to go to the following screen:

```
PROGRAMMING TIME BASE METHOD: 01
END OF TIMED EVENTS AT : <AUTO>

<AUX>      <ISS>      <CODE>      <END>
```

The END time of the timed events can be programmed or will be automatically generated by the Model AI-1A. The latter can be accomplished by pressing the **[Clear]** key, the display will show the message AUTO. In this case the END time is equal to the analysis time programmed in the injection method used in the same series. If the END time exceeds the programmed analysis time, this END time overrules the analysis time.

It is possible to program events after the END time, but these events are not carried out during a run.

After all events have been programmed you can save the method and return to the previous programming level by pressing the **[Escape]** key or the **[Methods]** key. In both cases you return to the method menu screen, but in case you use the **[Methods]** key the time base method number is increased by one automatically.

Before the Model AI-1A stores a time base method in the battery backup memory, it is checked for duplicate events and events programmed after the END time.

If the AI-1A finds a duplicate event the following warning message is displayed with the first duplicate event. You can erase all duplicate events at one time by pressing **[Escape]** key and going to the previous programming level or continue to edit the time base method at the first duplicate event.

```
PROGRAMMING TIME BASE METHOD: 01
3 AUX-1 OFF AT TIME : 0:10:00
<WARNING> DUPLICATE EVENTS (ESC=ERASE)
<AUX>      <ISS>    <CODE>    <END>
```

If the AI-1A finds an event programmed after the END time, the following warning is displayed. You can accept the time base method by pressing **[Escape]** and go to the previous programming level or continue to edit this time base method. Events programmed after the END time are not performed during the run of the Model AI-1A.

```
PROGRAMMING TIME BASE METHOD: 01
END TIME OF TIMED EVENTS: 0:59:00
<WARNING> EVENTS AFTER END (ESC=ACCEPT)
<AUX>      <ISS>    <CODE>    <END>
```


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A complete list of all time base method parameters is show below in Table 17.

Table 17: Time base Method Parameters

AUXILIARIES

```
1 AUX-1 ON  AT TIME : 0:00:00
1 AUX-1 OFF AT TIME : 0:00:00
2 AUX-1 ON  AT TIME : 0:00:00
2 AUX-1 OFF AT TIME : 0:00:00
3 AUX-1 ON  AT TIME : 0:00:00
3 AUX-1 OFF AT TIME : 0:00:00
4 AUX-1 ON  AT TIME : 0:00:00
4 AUX-1 OFF AT TIME : 0:00:00

1 AUX-2 ON  AT TIME : 0:00:00
1 AUX-2 OFF AT TIME : 0:00:00
2 AUX-2 ON  AT TIME : 0:00:00
2 AUX-2 OFF AT TIME : 0:00:00
3 AUX-2 ON  AT TIME : 0:00:00
3 AUX-2 OFF AT TIME : 0:00:00
4 AUX-2 ON  AT TIME : 0:00:00
4 AUX-2 OFF AT TIME : 0:00:00

1 AUX-3 ON  AT TIME : 0:00:00
1 AUX-3 OFF AT TIME : 0:00:00
2 AUX-3 ON  AT TIME : 0:00:00
2 AUX-3 OFF AT TIME : 0:00:00
3 AUX-3 ON  AT TIME : 0:00:00
3 AUX-3 OFF AT TIME : 0:00:00
4 AUX-3 ON  AT TIME : 0:00:00
4 AUX-3 OFF AT TIME : 0:00:00

1 AUX-1 ON  AT TIME : 0:00:00
1 AUX-1 OFF AT TIME : 0:00:00
2 AUX-1 ON  AT TIME : 0:00:00
2 AUX-1 OFF AT TIME : 0:00:00
3 AUX-1 ON  AT TIME : 0:00:00
3 AUX-1 OFF AT TIME : 0:00:00
4 AUX-1 ON  AT TIME : 0:00:00
4 AUX-1 OFF AT TIME : 0:00:00
```

ISS VALVES (OPTIONAL)

```
1 ISS-A POSITION 6-1 AT TIME : 0:00:00
1 ISS-A POSITION 1-2 AT TIME : 0:00:00
2 ISS-A POSITION 6-1 AT TIME : 0:00:00
2 ISS-A POSITION 1-2 AT TIME : 0:00:00
3 ISS-A POSITION 6-1 AT TIME : 0:00:00
3 ISS-A POSITION 1-2 AT TIME : 0:00:00
4 ISS-A POSITION 6-1 AT TIME : 0:00:00
4 ISS-A POSITION 1-2 AT TIME : 0:00:00

1 ISS-B POSITION 6-1 AT TIME : 0:00:00
1 ISS-B POSITION 1-2 AT TIME : 0:00:00
2 ISS-B POSITION 6-1 AT TIME : 0:00:00
2 ISS-B POSITION 1-2 AT TIME : 0:00:00
3 ISS-B POSITION 6-1 AT TIME : 0:00:00
3 ISS-B POSITION 1-2 AT TIME : 0:00:00
4 ISS-B POSITION 6-1 AT TIME : 0:00:00
4 ISS-B POSITION 1-2 AT TIME : 0:00:00
```

IO OUTPUT CODES

```
1 CODE-OUT VALUE: 00 AT TIME : 0:00:00
2 CODE-OUT VALUE: 00 AT TIME : 0:00:00
3 CODE-OUT VALUE: 00 AT TIME : 0:00:00
4 CODE-OUT VALUE: 00 AT TIME : 0:00:00
5 CODE-OUT VALUE: 00 AT TIME : 0:00:00
6 CODE-OUT VALUE: 00 AT TIME : 0:00:00
7 CODE-OUT VALUE: 00 AT TIME : 0:00:00
8 CODE-OUT VALUE: 00 AT TIME : 0:00:00
```

END TIME OF TIME BASE METHOD

```
END TIME OF TIMED EVENTS AT: <AUTO>
```


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4.6.5 MIX METHODS

A mix method is a convenient tool to perform pre-injection sample handling, e.g. pre-column derivatization, dilution or adding of internal standard.

From the method menu screen, the mix method programming mode is entered by pressing the **[Enter]** key after you have selected **<MIX>** and the desired number. Nine mix methods can be programmed. There is no limit to the number of steps in a mix method. Only the total number of steps in the nine mix methods and the user definable method together may not exceed 240 steps.

If you enter mix method programming the following screen will appear.

```
PROGRAMMING MIX METHOD: 1 STEP 001
END OF MIX METHOD

<EDIT>     <INSERT>     <DELETE>
```

If the first step is **"END OF MIX METHOD"**, shown on the second line of the screen, then an empty mix method is chosen.

If an existing mix method is chosen, the first step of the mix method is displayed.

With the up- or down-arrow keys you can scroll through your mix method. With the soft- function keys; **<EDIT>, <INSERT>** or **<DELETE>**, you can edit the displayed step, insert a new step or delete the displayed step.

If you choose to insert a new step the Model AI-1A will ask for an action.

```
PROGRAMMING MIX METHOD: 1 STEP 001(MENU)
SELECT ACTION

<ASPIRATE> <DISPENSE>  <WAIT>  <REPEAT>
```

```
PROGRAMMING MIX METHOD: 1 STEP 001(MENU)
SELECT ACTION

<WASH>
```

A mix method has five possible actions, which can be selected by pressing the corresponding soft-function key.

Within an action the numeric value can be entered with the numeric keys or with the up and down cursor keys. The cursor keys will automatically limit the programming range. If more than one numeric field can be entered, the left and the right cursor keys are used to switch between the entering fields. The position where an aspirate or dispense action has to take place can be programmed with a soft-function key.

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Table 18: Mix Method Programmable Actions

Action	Value	Place	Speed	Height
ASPIRATE	xxxx µL	Sample Destination Air Reagent A-D	x	xx mm
DISPENSE	xxxx µL	Sample Destination Waste Reagent A-D	x	xx mm
WAIT	X:XX:XX			
NEEDLE WASH	xxxx µL			
REPEAT	xx lines	x times		

Table19: Syringe speed in a mix method

	Syringe				
Speed	100 µL	250 µL	500 µL	1000 µL	
1	50 µL	125 µL	250 µL	500 µL	
2	125 µL	315 µL	630 µL	1255 µL	
3	250 µL	625 µL	1250 µL	2495 µL	
4	375 µL	940 µL	1880 µL	3765 µL	
5	770 µL	1920 µL	3840 µL	7680 µL	
6	1070 µL	2675 µL	5335 µL	10665 µL	
7	1370 µL	3430 µL	6855 µL	13710 µL	
8	1745 µL	4365 µL	8725 µL	17450 µL	
9	2135 µL	5335 µL	10670 µL	21335 µL	

UTION

During the dispense action the pressure in the buffer tubing will increase. To prevent buffer tubing damage, the flow should not exceed the value of 6 mL/min for water. (Maximum speed 9 for 100 µL and 250 µL syringes, speed 6 for a 500 µL syringe and speed 4 for 1000 µL syringe. If more viscous liquids are used the speeds should be reduced proportionally.

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ASPIRATE

With ASPIRATE you can aspirate a programmed amount from your sample vial, destination vial, ambient air or one of your reagent vials into the buffer tubing. The speed of the syringe can be selected in a scale from 1 to 9, see Table 19. The height is the distance reference to the bottom of the tray segment in millimeters. The Model AI-1A will display the following screens.

```
PROGRAMMING MIX METHOD: 1 STEP 001[MENU]
ASPIRATE 0250 µL SAMPLE SPEED: 2 H:00 mm

<SAMPLE>   <AIR> <DESTINATION>
```

```
PROGRAMMING MIX METHOD: 1 STEP 001[MENU]
ASPIRATE 0250 µL SAMPLE SPEED: 2 H:00 mm

<REAG-A>  <REAG-B>  <REAG-C>  <REAG-D>
```

The maximum amount which can be aspirated is the total volume of the syringe. If more than one consecutive aspirating action is programmed the total volume of the consecutive aspirating actions cannot exceed the volume of the syringe.

DISPENSE

With DISPENSE you can dispense a programmed amount from the buffer tubing into your sample vial, destination vial, the waste position or one of your reagent vials. The speed of the syringe can be selected in a scale from 1 to 9, see Table 19. The height is the distance reference to the bottom of the tray segment in millimeters. The Model AI-1A will display the following screens.

```
PROGRAMMING MIX METHOD: 1 STEP 001(MENU)
DISPENSE 0250 µL SAMPLE SPEED: 2 H:00 mm

<SAMPLE>   <WASTE>  <DESTINATION>
```

```
PROGRAMMING MIX METHOD: 1 STEP 001(MENU)
DISPENSE 0250 µL SAMPLE SPEED: 2 H:00 mm

<REAG-A>  <REAG-B>  <REAG-C>  <REAG-D>
```

It is possible to dispense a larger volume than the volume aspirated in previous actions. The aspirated amount will be complemented with liquid from the wash solvent bottle to total the dispensed volume programmed.

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WAIT

The WAIT action can be used to let the Model AI-1A wait for a programmed time with a maximum of 9 hours 59 minutes and 59 seconds. This can be used as reaction time in case of pre-column derivatization.

```
PROGRAMMING MIX METHOD: 1 STEP 001
WAIT 0:00:00
```



During WAIT the needle will leave the actual position if the next action is not at the same position. Should the needle have to stay at the actual position, it is necessary to program a dummy step after the WAIT in which an ASPIRATE or DISPENSE action of 0 µL is programmed at the actual position.

REPEAT

With the REPEAT action the last number of steps can be repeated for a number of times, this will reduced programming time and is particularly useful when using sequential consecutive ASPIRATE or DISPENSE actions for reagent mixing. In this programming screen the Model AI-1A will ask for the number of lines to be repeated and the number of repetitions.

```
PROGRAMMING MIX METHOD: 1 STEP 001
REPEAT LAST 03 STEP(S) 1X
```

Within the repetition the total amount of sample drawn into the buffer cannot exceed the volume of the syringe.

WASH

With this action a needle wash can be performed, similar to the standard wash method. Enter the amount of wash solvent used to wash the needle after the buffer is rinsed into the waste position.

```
PROGRAMMING MIX METHOD: 1 STEP 001
NEEDLE WASH VOLUME OF 0300 µL
```

After you have programmed the correct actions in this mix method, you can go back to the previous level by pressing the **[Escape]** key or go to the next mix method by pressing the **[Methods]** key.

The mix methods are stored in the battery backup memory.

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4.6.6 USER DEFINABLE METHOD

User programs allow the programming of every mechanical movement of the AI-1A autosampler. As a result, the programs involve some detailed and complex programming steps. Please contact HPLC Technical Services at 1-800-FOR-HPLC for assistance in writing user programs.

All possible individual programming actions are set in a user program: aspirating or dispensing, moving the syringe, switching the compressor ON or OFF, switching the syringe valve, injection valve and optional ISS valves, wait and programming all inputs and outputs. The User program is entered by pressing the **<USRPROG>** soft-function key. There is no limit to the number of steps programmed in the User program, but the total number of steps in the nine mix methods and the user program may not exceed 240 steps.

If you enter an empty user-program the following screen will appear.

```
PROGRAMMING USER-PROGRAM: 1 STEP 001
END OF USER PROGRAM

<EDIT>     <INSERT>     <DELETE>
```

If the User definable method is empty, then the first step is END OF USER-PROGRAM, shown on the second line of the screen.

If the User definable method is programmed, the first step of the User definable method is displayed.

With the up- and down-arrow keys you can step through the program. With the soft-function keys; **<EDIT>, <INSERT>** or **<DELETE>,** you can edit the displayed step, insert a new step or delete the displayed step.

When the **<INSERT>** soft-function key is pressed the following screens will be displayed. The **[Menu]** key can be used to scroll through the four screens. The desired action can be chosen be pressing the corresponding soft-function key.

```
PROGRAMMING USER PROGRAM:1 STEP 001[MENU]
SELECT ACTION

<ASPIRATE> <DISPENSE>  <SYR-VALVE> <SYR>
```

```
PROGRAMMING USER PROGRAM:1 STEP 001[MENU]
SELECT ACTION

<WASH>    <VALVE>    <WAIT>   <COMPRES>
```

```
PROGRAMMING USER PROGRAM:1 STEP 001[MENU]
SELECT ACTION

<AUX>       <WAIT-IN>    <PROG-OUT>   <CODE>
```

```
PROGRAMMING USER PROGRAM:1 STEP 001[MENU]
SELECT ACTION

<MARKERS>
```


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Table 20: User Definable Method Programmable Actions

Action	Value	Place	Speed	Height
ASPIRATE	xxxx µL	Sample Destination Air Reagent A-D	x	xx mm
DISPENSE	xxxx µL	Sample Destination Waste Reagent A-D	x	xx mm
SYRINGE VALVE	NEEDLE WASH WASTE			
SYRINGE	LOAD UNLOAD	XXXX µL		
NEEDLE WASH	xxxx µL			
VALVE	INJECTOR ISS-A ISS-B	LOAD INJECT 1-2 6-1		
WAIT	X:XX:XX			
COMPRESS	ON OFF			
AUXILIARIES	X	ON OFF		
WAIT INPUT	X	HIGH LOW		
PROGRAM OUTPUT	X	ON OFF		
CODE OUTPUT	XX			
MARKERS	INJECT VIAL LABELED			

Within an action the numeric value can be entered with the numeric keys or with the up and down cursor keys. The cursor keys will automatically limit the programming range. If more than one numeric field can be entered, the left and right cursor keys are used to switch between the entering fields.

The following sections will describe the various programmable actions.

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ASPIRATE

With ASPIRATE you can aspirate a programmed amount from your sample vial, destination vial, an ambient air or one of your reagent vials into the buffer tubing. The speed of the syringe can be selected in a scale from 1 to 9, see Table 19. The height is the distance reference to the bottom of the tray segment in millimeters. The Model AI-1A will display the following screens.

```
PROGRAMMING USER PROGRAM: STEP 001[MENU]
ASPIRATE 0250 µL SAMPLE SPEED: 2 H:00 mm

<SAMPLE>  <AIR>  <DESTINATION>  <WASH>
```

```
PROGRAMMING USER PROGRAM: STEP 001[MENU]
ASPIRATE 0250 µL SAMPLE SPEED: 2 H:00 mm

<REAG-A>  <REAG-B>  <REAG-C>  <REAG-D>
```

The maximum volume which can be aspirated is the total volume of the syringe. If more than one consecutive aspirating action is programmed the total amount of the consecutive aspirating actions cannot exceed the volume of the syringe.

DISPENSE

With DISPENSE you can dispense a programmed amount from the buffer tubing into your sample vial, destination vial, the waste position or one of your reagent vials. The speed of the syringe can be selected in a scale from 1 to 9, see Table 19. The height is the distance reference to the bottom of the tray segment in millimeters. The Model AI-1A will display the following screens.

```
PROGRAMMING USER PROGRAM: STEP 001[MENU]
DISPENSE 0250 µL SAMPLE SPEED: 2 H:00 mm

<SAMPLE>  <WASTE> <DESTINATION>  <WASH>
```

```
PROGRAMMING USER PROGRAM: STEP 001[MENU]
DISPENSE 0250 µL SAMPLE SPEED: 2 H:00 mm

<REAG-A>  <REAG-B>  <REAG-C>  <REAG-D>
```

It is possible to dispense a larger volume than the volume aspirated in previous actions. The aspirated amount will be complemented with liquid from the wash solvent bottle to total the programmed volume to dispense.


CAUTION

During the dispense action the pressure in the buffer tubing will increase. To prevent damage of the buffer tubing, the flow should not exceed the value of 6 mL/min for water. (Maximum speed 9 for 100 µL and 250 µL-syringes, speed 6 for a 500 µL syringe and speed 4 for 1000 µL syringe.) If more viscous liquids are used the speeds should be reduced.

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SYR-VALVE

This action controls the connections of the syringe to its three ports:

```
PROGRAM USER PROGRAM: 1 STEP 001
SYRINGE VALVE POSITION: NEEDLE

<NEEDLE>   <WASH>      <WASTE>
```

Syringe valve ports (see Figure 4.7):

NEEDLE: connection to the sample needle.

WASH: connection to the wash solvent bottle.

WASTE: connection to the syringe waste tubing.

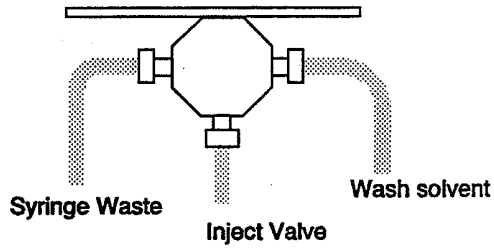


Figure 4-7 Syringe valve connections

SYRINGE

This action controls the movement of the syringe.

```
PROGRAM USER PROGRAM: 1 STEP 001
LOAD SYRINGE VOLUME: 0250 SPEED: 3

<LOAD>     <UNLOAD>
```

WASH

With this action a needle wash can be performed, this is similar to the standard wash method. The amount programmed is the amount of wash solvent used to wash the needle after the buffer is rinsed into the waste position.

```
PROGRAMMING USER PROGRAM: 1 STEP 001
NEEDLE WASH VOLUME OF 0300 µL
```

VALVE

The positions of the installed high pressure valves are controlled by this action. The injector valves have two positions; **<INJECT>** and **<LOAD>**. If the ISS option is installed, the two valves have the two positions; **<1-6>** and **<1-2>**, see Figure 4.6.

```
PROGRAM USER PROGRAM: STEP 001
INJECTOR VALVE POSITION: INJECT

<INJECTOR>  <ISS-A>  <ISS-B>  <LOAD>
```


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WAIT

The WAIT action can be used to let the Model AI-1A wait for a programmed time with a maximum of 9 hours 59 minutes and 59 seconds. This can be used as reaction time in case of post-column derivatization.

```
PROGRAMMING USER PROGRAM: STEP 001
WAIT 0:00:00
```



During WAIT the needle will leave the actual position if the next action is not at the same position. Should the needle have to stay at the actual position, it is necessary to program a dummy step after the WAIT in which an ASPIRATE or DISPENSE action of 0 µL is programmed at the actual position.

COMPRESS

With the COMPRESS action the compressor is activated. The compressor provides air pressure to the vial headspace. The compressor will stay active until it is switched off. The compressor will only be switched off at the end of the needle wash routine if a needle wash is used.

```
PROGRAMMING USER PROGRAM: STEP 1
COMPRESSOR: OFF

<ON>        <OFF>
```

The following five actions control the outputs and inputs used in the user definable method. Also the markers must be programmed, because they are not automatically generated like in the regular injection method. See section 3.8 for the connection of cables.

AUX

In this screen the four standard auxiliaries (contact closures) can be controlled, see section 3.8.

```
PROGRAMMING USER PROGRAM: STEP 1
AUXILIARY PORT 1 OFF

  <ON>           <OFF>
```

Select auxiliary and status, press **[Enter]**.

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WAIT-IN

The Model AI-1A will wait for one of the four inputs to become **<HIGH>** or **<LOW>**, see section 3.8.

```
PROGRAMMING USER PROGRAM: STEP 1
WAIT FOR INPUT 1 TO BECOME LOW

<HIGH>            <LOW>
```

Select input and status, press **[Enter].**

PROG-OUT

Program the two programmable outputs (contact closures). The functions of these outputs are similar to the auxiliaries, but only available in the user definable method, see section 3.8.

```
PROGRAMMING USER PROGRAM: STEP 1
PROGRAMMED OUTPUT 1 OFF

<ON>        <OFF>
```

Select output and status, press **[Enter].**

CODE

Program the output to the connector P3 TIMED OUTPUTS. This is a HEX or BCD output in the range from 0 to 15, see section 3.8.

```
PROGRAMMING USER PROGRAM: STEP 1
CODE OUTPUT:00
```

Select code output and value, press **[Enter].**

MARKERS

The markers normally generated by the Model AI-1A are not active in the user definable method, but can be activated in this screen, see section 3.8.

```
PROGRAMMING USER PROGRAM: STEP 1
PULSE ON INJECT-MARKER

<INJECT>   <VIAL>       <LABELED>
```

Select marker and status, press **[Enter].**

After you have programmed the correct actions in the user definable method, you can go back to the previous level by pressing the **[Escape]** key.

The user definable method is stored in the battery backup memory.

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4.7 SERIES

The run sequence of the Model AI-1A autosampler is defined in a series. It contains information on vials and methods or templates to be used.

From the READY screen the series programming mode can be entered by pressing the **[Series]** key. Now one of 24 series can be selected to be programmed. This can be done by choosing a value with the numeric keys and pressing the **[Enter]** key to confirm the value or by increasing or decreasing the displayed value with the up or the down cursor key. When the correct value is reached press the [Enter] key to confirm the selected number.

A third manner to select a series number is to increase the number by pressing the **[Series]** key. Every time the key is pressed the series number is increased by one. Enter the selected series by pressing the **[Enter]** key.

```
PROGRAMMING SERIES
WHICH SERIES NUMBER
```

A series contains information about the methods to be used. This can be a template, individual methods or the user definable method, and the vials to be used. Extra information on the vials, labeled vials or the use of calibration vials, is also programmed in a series.



Series are always executed in numerical order!



It is not necessary to program all series before starting in a run. Series can be (re-)programmed during the run, but only series with a higher number than the one currently running will be processed according to the new program. The current series can be changed, but this will not effect the running series.

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Table 21: Series Parameters

Without templates	***With templates***
○ Use User-Program Yes/No	● Template Number
● Injection Method Number	
● Wash Method Number	
○ Time Base Method Number	
○ Mix Method Number	
Time base and mix methods are only available if enabled in System Settings	
○ Use Calibration Files Yes/No	
○ First Calibration File	
○ Last Calibration File	
○ Number of samples between calibration	
Calibration files are only available if enabled in System Settings	
● First Sample Vial	
● Last Sample Vial	
○ First Destination Vial	
○ Vial Reagent-A	
○ Vial Reagent-B	
○ Vial Reagent-C	
○ Vial Reagent-D	
Only if mix method is programmed	
○ Labeled Vial No. 1	
○ Labeled Vial No. 2	
○ Labeled Vial No. 3	
○ Labeled Vial No. 4	
Only if labeled vial use is enabled in System Settings	
● these questions are always asked in series	
○ these questions depend on the used methods and the system settings	

The contents of a series depends on SYSTEM SETTINGS and the template or methods being used.

In case of disabled templates, the Model AI-1A will display the following screens.

```
PROGRAMMING SERIES: 01
USER PROGRAM INSTEAD OF METHODS: NO

<NO>        <YES>
```

Enter **<YES>** if this series should use the user program instead of regular methods and press **[Enter].**

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In case of **<YES>**, use user program instead of methods, the Model AI-1A will skip the following four screens.

```
PROGRAMMING SERIES: 01
MIX METHOD NUMBER: NONE
```

Enter the selected method number and press **[Enter]** to go to the next screen.

```
PROGRAMMING SERIES: 01
INJECTION METHOD NUMBER: NONE
```

Enter the selected method number and press **[Enter]** to go to the next screen.

```
PROGRAMMING SERIES: 01
WASH METHOD NUMBER: NONE
```

Enter the selected method number and press **[Enter]** to go to the next screen.

```
PROGRAMMING SERIES: 01
TIMEBASE METHOD NUMBER: NONE
```

In these previous screens the methods to be executed in this series are programmed. In case the use of time base methods, mix methods and user-program is disabled in the SYSTEM SETTINGS the first, second and last screens are skipped.



If a wash method is used in a series with this wash method being the only method in that series, program a wash between series, otherwise the series (wash) will not be executed. See section 4.6.3.

In case of enabled templates, the previous five screens are replaced by one screen in which the template number has to be entered.

```
PROGRAMMING SERIES: 01
TEMPLATE NUMBER: NONE
```

Enter the selected template number and press **[Enter]** to go to the next screen.

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Depending on the programmed method or the contents of the template and the system settings the following screens with information on the vials to be used are displayed.

If the use of calibration vials is enabled in the system settings the Model AI-1A first asks if this option must be used in this series.

```
PROGRAMMING SERIES: 01
USE CALIBRATION VIALS: NO:

<NO>        <YES>
```

If the use of calibration vial is answered with **<NO>,** the following three screens are skipped.

In case calibration is required during the series the Model AI-1A needs to know the position of the calibration vials and the number of samples between which the calibration is repeated.

```
PROGRAMMING SERIES: 01
FIRST CALIBRATION VIAL: A 01

<TYPE_A>  <TYPE_B>  <TYPE_C>  <TYPE_D>
```

Define what type of vial is used for the calibration range. It is not necessary that the calibration vials are of the same type as the sample vials.

Enter the first sample vial number and press **[Enter]** to go to the next screen.

```
PROGRAMMING SERIES: 01
LAST CALIBRATION VIAL: A 03
```

Enter the last calibration vial number and press **[Enter]** to go to the next screen.

```
PROGRAMMING SERIES: 01
NO. OF SAMPLES BETWEEN CALIBRATION:05
```

Enter the number of sample vials between every calibration and press **[Enter]** to go to the next screen. The series will always start with a calibration.

A programmed MIX METHOD is not performed on a calibration vial!

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The above programmed calibration sequence will result in the following injection sequence of the Model AI-1A, see Figure 4.8.

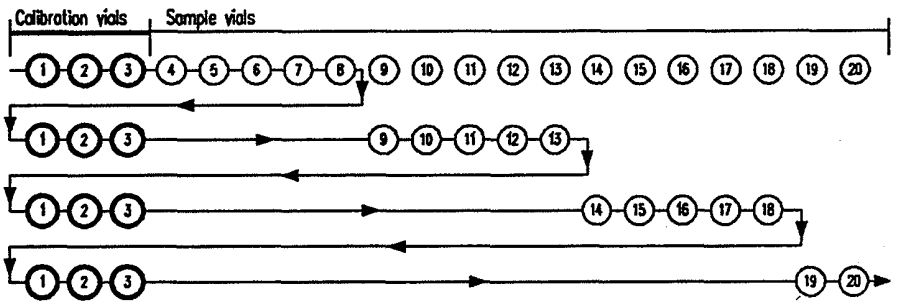


Figure 4-8 Injection sequence with 3 calibration vials between every 5 vials

If an injection method or mix method is used, the next two screens ask for the range of the sample vials.

```
PROGRAMMING SERIES: 01
FIRST SAMPLE VIAL: A 01

<TYPE_A>  <TYPE_B>  <TYPE_C>  <TYPE_D>
```

Define what type of vial is used for the sample range. It is not possible to define a range over two types of segments. In that case you have to divide the vials over two or more series.

Enter the first sample vial number and press **[Enter]** to go to the next screen.

```
PROGRAMMING SERIES: 01
LAST SAMPLE VIAL: A 03
```

Enter the last sample vial number and press **[Enter]** to go to the next screen.

If a mix method is programmed, the Model AI-1A asks for a destination vial range and the position o every reagent type used.

If destination vials are used, only the first destination vial has to be programmed, the last vial is calculated on the basis of the programmed number of sample vials.

```
PROGRAMMING SERIES: 01
FIRST DESTINATION VIAL: A 11

<TYPE_A>  <TYPE_B>  <TYPE_C>  <TYPE_D>
```



Sample vials and destination vials must be placed sequentially.

Sample vials and destination vials cannot be the same.

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Depending on the reagents specified in the mix method the following screens appear for Reagent-A, Reagent-B, Reagent_C and Reagent-D.

```
PROGRAMMING SERIES: 01
REAGENT_A VIAL: C 01

<TYPE_A>  <TYPE_B>  <TYPE_C>  <TYPE_D>
```

```
PROGRAMMING SERIES: 01
REAGENT_D VIAL: C 04

<TYPE_A>  <TYPE_B>  <TYPE_C>  <TYPE_D>
```

If the use of labeled vials is enabled, you can program four labeled vials per series. The labeled vial marker is given with every injection from a labeled vial, at the moment of switching the injection valve to inject.

```
PROGRAMMING SERIES: 01
LABELED VIAL NR 1: NONE
```

```
PROGRAMMING SERIES: 01
LABELED VIAL NR 4: NONE
```

Labeled vials must have the value of one of the sample vials or the value NONE.

After all values have been entered, you will return to the first screen of this series.

To return to the READY screen press the **[Escape]** key or if you want to program the next series press the **[Series]** key. You will enter the first series programming screen with the series number increased by one.

It is not possible to leave a series without programming all values, the **[Escape]** key is not available until all values have been programmed.



Series are NOT stored in the battery backup memory.

After switching ON the Model AI-1A all series are empty.

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4.8 RUNNING SERIES

Series can be run from the READY screen of the Model AI-1A by pressing the **[Start/Stop]** key.

Program the range of series to be executed.

```
START AT SERIES: 01
```

Enter the first series number to execute and press **[Enter]** to go to the next screen.

```
STOP AFTER SERIES: 01
```

Enter the last series number to execute and press **[Enter]** to go to the next screen.

After the range of series is programmed, the Model AI-1A will ask for the start conditions.

```
EXECUTE SERIES 01

<START>     <REMOTE>
```

If you press the **<START>** soft-function key the Model AI-1A will start immediately with the programmed series.

During the run the display shows actual run information.

If the use of templates is disabled the run screen will display the following information:

```
STATUS: SEARCHING          TIME:0:00:00
SERIES: 01 SAMPLE:  A01 INJ:1/9    23°C
METHOD:01  MIX:0    WASH:1  TIMEBASE: 1
AUX:___   CODE:00  ISS-A:6-1  ISS-B:1-6
```

The first line of the run screen shows the status of the Model AI-1A and the elapsed analysis time.

The second line of the run screen shows the series number, the vial number and the injection number with the total number of injections from this vial. The temperature of the tray will be displayed only if the Peltier cool option is installed. The third line shows the methods used in this series. The last line gives information about time base programmable events; auxiliaries, code output and ISS valves, if installed.

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If the use of templates is enabled the run screen will display the following information.

```
STATUS: RUNNING              TIME:0:00:50
SERIES: 01 SAMPLE: A01 INJ:1/9     21°C
TEMPLATE:01
AUX:___   CODE:00   ISS-A:6-1   ISS-B:1-6
```

The only difference in the run screen is line three, it now shows the number of the template used in this series in stead of the methods.

```
PROGRAMMING SERIES: 01
USE CALIBRATION VIALS: NO:

<NO>        <YES>
```



Series are always executed in numerical order!

Empty series will be skipped!

You can stop a run by pressing the **[Start/Stop]** key. The Model AI-1A will execute a shutdown sequence by removing all the sample from the buffer and performing a standard wash routine.

If you want to stop the Model AI-1A immediately (panic stop), without performing a buffer clean up, press the **[Start/Stop]** key twice. Remember to perform a wash routine to clean up the tubing before you start the Model AI-1A again.



AUTION

A panic stop does not remove the sample from the buffer.
Before starting again perform a wash sequence.

4.9 REMOTE CONTROL

```
EXECUTE SERIES 01

<START>          <REMOTE>
```

After the range of series is programmed, as described in the previous section, the Model AI-1A will ask for the start conditions.

Pressing the **<REMOTE>** soft-function key the Model AI-1A will switch the Model AI-1A to the REMOTE CONTROL mode.

The Model AI-1A will now operate as slave of another device and can be controlled with the NEXT INJECTION INPUT and the NEXT VIAL INPUT.

NEXT INJECTION INPUT: With this input the Model AI-1A will start the next injection in the series. If the series was completed, it starts the next injection from the next series, until al series are completed.

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NEXT VIAL INPUT: With this input the Model AI-1A will start the first injection from the next vial in the series. If the series was completed, it starts the first injection from the first vial of the next series, until al series are executed.

```
STATUS: SEARCHING              TIME:0:00:00
SERIES: 01 SAMPLE:  A01 INJ:1/9     23°C
METHOD:01    MIX:0   WASH:1    TIMEBASE: 1
r  AUX:___ CODE:00   ISS-A:6-1 ISS-B:1-6
```



The difference between the NEXT INJECTION INPUT and the NEXT VIAL INPUT is, that the NEXT VIAL INPUT directly starts the first injection from the next vial, even if not all programmed injections from the previous vial were executed.

To indicate that the remote control is activated, in the fourth line a "r" is displayed.

4.10 PROGRAMMING DURING THE RUN

During the run it is possible to program series and methods. Press the **[Series]** or **[Methods]** key during the run of the Model AI-1A. The programming possibilities are the same as if the Model AI-1A is not running.

If a series or method is changed, the new values are active the next time the Model AI-1A starts a series. The current running series is not affected by changes.

It is not possible to add series to the run, but you can program empty series in a run. As long as the empty series are not executed, they can be (re-)programmed. In this way series with vials can be added later to the run.

4.11 PROGRAMMING A PRIORITY SAMPLE

For a sudden emergency sample that has a high priority of being analyzed, the Model AI-1A offers you the possibility to analyze it immediately without stopping the current run.

Press the **[Priority]** key. You will enter the priority programming mode. This is similar to the series programming mode, the only difference is that instead of a range of vials only one vial position needs to be defined and it is not possible to program calibration vials.

Again the list of parameters depends on the methods or templates used. If you use a template the Model AI-1A will display the following screen.

```
PROGRAMMING PRIORITY:
TEMPLATE METHOD NUMBER: 01
```


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Enter the template number and press **[Enter]** to go to the vial number screen.

If you use a regular methods; injection methods, wash methods and time base methods, the Model AI-1A will display the following screens.

```
PROGRAMMING PRIORITY:
INJECTION METHOD NUMBER: NONE
```

Enter the injection method number and press **[Enter]** to go to next screen.

```
PROGRAMMING PRIORITY:
WASH METHOD NUMBER: NONE
```

Enter the wash method number and press **[Enter]** to go to next screen.

```
PROGRAMMING PRIORITY:
TIMEBASE METHOD NUMBER: NONE
```

Enter the time base method number and press **[Enter]** to go to next screen.

```
PROGRAMMING PRIORITY:
PRIORITY VIAL: A 06

<TYPE_A>  <TYPE_B>  <TYPE_C>  <TYPE_D>
```

Enter the segment type and the vial number and press **[Enter]** to go back to the first screen.

After the priority vial has been programmed press the **[Escape]** key to return to the run screen. The priority sample will be processed after the current sample has been processed. After the priority sample the current run will proceed.

```
STATUS: SEARCHING              TIME:0:00:00
SERIES: 01 SAMPLE: A01 INJ:1/9       23°C
METHOD:01   MIX:0   WASH:1   TIMEBASE: 1
p  AUX:___ CODE:00  ISS-A:6-1  ISS-B:1-6
```

To indicate priority sample is programmed, in the fourth line a blinking “p” is displayed. During the processing of the priority sample a “p” is continue displayed.

The priority mode is only available if the use of mix methods and the user definable method is disabled in the system settings, see section 4.5.

If calibration vials are used the priority sample is counted as vial for the calibration interval!

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Appendix A: Accessories

Cat No.	Description
88-001A	Model AI-1A Autosampler
88-003A	Model AI-1A Autosampler, Biocompatible
88-040	Peltier cooling option (factory-installed)
88-041	Integrated Stream Switch option, two six-way valves (factory installed)
88-042	Dynamax CH-1 Thermostatic Chamber
88-043	Integrated Stream Switch option, two six-way biocompatible Rheodyne 9000 series valves (factory installed)
88-044	Tray segment, 20 positions, 0.5 mL
88-046	Tray segment, 9 positions, 4.0 mL
88-047	Tray segment, 4 positions, 10.0 mL
88-026	Tray cover
88-050	Needle wash vial
88-051	Needle body
88-052	Needle sample
88-053	Needle air/pre-puncturing
88-054	Luerlok syringe valve
88-055	Wash solvent bottle, 250 mL
88-056	Syringe 1000 µL
88-057	Syringe 100 µL
88-058	Syringe 250 µL
88-059	Syringe 500 µL
88-060	Tubing, buffer 500 µL
88-061	Tubing, buffer 2000 µL
88-062	Tubing, syringe waste
88-063	Tubing, syringe wash
88-064	Needle, large-bore, preparative

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Appendix B: Error Codes

ERROR CODE	CAUSE
INJECTION VALVE AND ISS VALVES UNIT	
<ERROR 11>	The Model AI-1A detects impossible sensor levels, injection valve is not in a legal position.
<ERROR 12>	The injection valve did not switch within 1.5 seconds.
<ERROR 13>	The switching time of the injection valve exceeds 500 msec.
<ERROR 14>	The Model AI-1A detects impossible sensor levels, ISS valve A not in a legal position.
<ERROR 15>	The ISS valve A did not switch within 1.5 seconds.
<ERROR 17>	The Model AI-1A detects impossible sensor levels, ISS valve B not in a legal position.
<ERROR 18>	The ISS valve B did not switch within 1.5 seconds.
SYRINGE DISPENSER UNIT	
<ERROR 21>	The syringe valve did not switch.
<ERROR 22>	The syringe did not reach the home position within time.
<ERROR 23>	The syringe dispenser did not make the correct number of rotations.
<ERROR 24>	The spindle does not rotate.
INJECTION NEEDLE UNIT	
<ERROR 30>	Sample needle arm did not reach or leave the home position (vertical).
<ERROR 31>	Sample needle train is in an illegal horizontal position while moving down.
<ERROR 32>	Sample needle train did not reach another gap within a certain time (horizontal).
<ERROR 33>	Sample needle train needed too much or too little steps to reach another horizontal position.
<ERROR 34>	Sample needle arm was not in vertical home position at beginning of a horizontal or vertical movement of sample needle train.
<ERROR 35>	Sample needle train is at an illegal horizontal position.
<ERROR 36>	Sample needle train detects too many gaps while moving to the next position.
<ERROR 39>	Vial sensor stuck.
<ERROR 40>	The sample needle spindle does not rotate correct.
<ERROR 41>	The sample needle did not reach or leave the home position.
<ERROR 42>	The sample needle is not at home position.
TRAY UNIT	
<ERROR 51>	Incorrect turning of the tray.
<ERROR 52>	No segment found.
VIALS	
<ERROR 60>	Missing vial. (Only when SKIP MISSING VIAL set to NO in SYSTEM SETTINGS)
<ERROR 61>	Missing segment. (Only when SKIP MISSING VIAL set to NO in SYSTEM SETTINGS)
<ERROR 62>	Missing transport vial. (Only when SKIP MISSING VIAL set to NO in SYSTEM SETTINGS)
<ERROR 63>	Missing transport segment. (Only when SKIP MISSING VIAL set to NO in SYSTEM SETTINGS)
<ERROR 69>	Not enough transport liquid available due to missing transport vials or segments.

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Appendix C: Rheodyne Injection Valve

Description and replacement/adjustment instructions of the Rheodyne model 7010 injection valve.

C.1 INTRODUCTION

The Model RH 7010 Sample Injection valve is a six-port rotary valve with removable external sample loop, designed for high performance liquid chromatography. The valve should give years of dependable performance with easy maintenance. The RH 7010 is supplied with tube fittings to permit connection of 1/16" tubing to the valve ports. Two wrenches for servicing are also supplied.

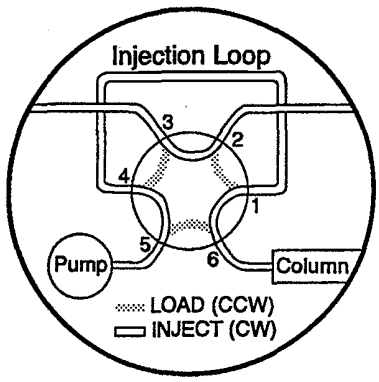


Figure C-1 Switching pattern

The following standard sample loops are available; each loop is supplied with fittings for direct connection to the valve:

Catalog number	Sample loop size microliters	Tubing bore mm	Tubing bore inch
RH 7022	20	0.51	0.020
RH 7023	50	0.51	0.020
RH 7024	100	0.51	0.020
RH 7025	200	0.76	0.030

C.2 DESCRIPTION OF MODEL RH 7010

The model RH 7010 operates by rotation of a flat rotor against a flat stator. Figure C.1 shows the port configuration and switching pattern. Rotation of the shaft through 60 degrees switches the valve from LOAD to INJECT. Figure C.2 is an exploded view of model RH 7010. The stator is type 316 stainless steel. The rotor is faced with a Vespel rotor seal. Slots in the rotor seal make flow paths between adjacent stator ports, and turning the rotor 60 degrees switches the flow paths as shown in Figure C.3. The diameter of the slots is 0.46 mm (0.018 in.). Holes in the stator are 0.61 mm (0.024 in.) in diameter and connect to the threaded tubing ports on the outside of the stator.

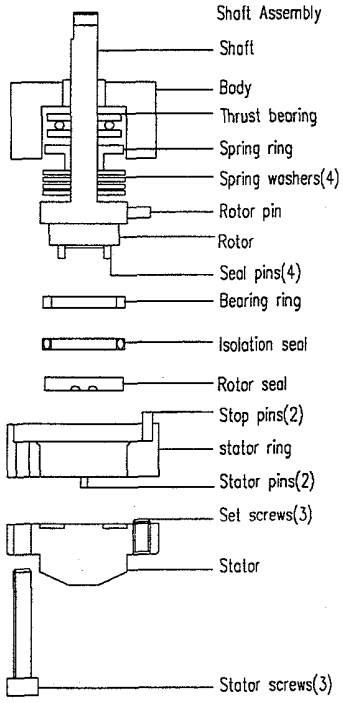


Figure C-2 Exploded View

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Two stop pins and the rotor pin limit the rotation to 60 degrees. Four conical spring washers and a thrust bearing are used to push the rotor seal against the stator face with sufficient force to hold 7000 psi liquid pressure. Three set screws in the stator are factory adjusted so that when the three stator screws are fully tightened, the force between stator and rotor is sufficient to hold 5000 psi. To increase maximum operating pressure to 7000 psi, follow the directions in section C.3.

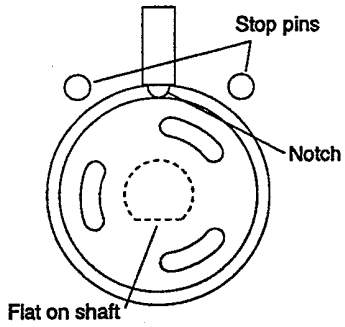


Figure C-3 Rotor seal

The isolation seal serves to prevent valve leakage from entering the spring and bearing region of the valve. It does not serve any high-pressure sealing function. The maximum operating temperature of the Model RH 7010 is 150°C

To avoid clogging of the valve passages, it is recommended that filtered solvents be used and that sample liquid be free of solids that might clog the loading tubes.

C.3 ADJUSTING FOR LEAKAGE OR HIGHER PRESSURE OPERATION

The three small set screws in the stator (see Figure C.2) are factory-calibrated so that when the three stator screws are fully tightened, the spring force between the valve rotor and stator is sufficient to hold 5000 psi. If leakage is to be corrected, or if operation up to 7000 psi is to be carried out, proceed as follows:

Loosen the three set screws about 1/20 turn each (rotate 18 degrees) and then tighten the three stator screws an equal amount each. If this new setting fails to accomplish leak-free operation at the pressure required, repeat the procedure with an additional 1/20 turn. Avoid excessive tightening, which accomplishes nothing but increases wear of the rotor seal. Should it be necessary to loosen the spring tension, either to lower operating pressure or to adjust for a new rotor seal which may be thicker than the one being replaced, reverse the above procedures, i.e. first loosen the stator screws and then tighten the set screws.

If leaks cannot be stopped by tightening the valve, or if, as a result of tightening to stop the leakage, the valve switch is significantly slower with the same air pressure, the rotor seal needs replacing.

C.4 DISASSEMBLY AND ASSEMBLY

C.4.1 DISASSEMBLY

Disassembly of the valve for servicing of the liquid end is accomplished as follows:

a. Remove the three stator screws. Do not change the setting of the three set screws in the stator.

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b. Refer to Figure C.2, and remove stator and stator ring from valve body by pulling axially to disengage the various pins.

c. Isolation seal and bearing ring are usually left in place since they rarely need changing.

C.4.2 ASSEMBLY

Reassembly of the valve requires putting all parts back together again as shown in Figure C.2, while observing the following:

a. The rotor pin can be inserted in the rotor from one side only (the side without the peened closure marks around the pin hole). Do not try to force the rotor pin in from the wrong side, and ensure that the flat on the valve shaft faces away from the protruding end of the rotor pin.

b. Ensure that the rotor seal is correctly oriented as shown in Figure C.3, with rotor seal slots facing the stator, and with the notch in the metal rim of the rotor seal in line with the rotor pin.

c. When replacing stator ring, be sure that the two stop pins are replaced in their holes in the stator ring; then push the stator ring squarely onto the rotor assembly so that the stop pins enter the mating holes in the body (with rotor pin between the two stop pins), and so that the isolation seal slips inside the stator ring without hanging up.

d. Replace the stator by first pushing it onto the two pins on the stator ring and then adding the three stator screws. Tighten each screw, a little at a time, to keep the stator surface parallel to the stator ring surface. If the three set screws in the stator where not changed, then tighten the three stator screws until all parts are firmly in their place. The three set screws will insure that the gap between stator and stator ring is uniform and exactly as it was before disassembly.

e. If the set screws need adjusting because a new rotor seal was installed, or because leakage needed to be stopped, ensure that each set screw is turned an equal amount so that after retightening the stator screws, the gap between stator and stator ring is uniform all around.

Refer also to Section C.3.

C.5 OPERATING SUGGESTIONS

C.5.1 AQUEOUS BUFFERS OR SALT SOLUTIONS

To prevent formation of salt crystals in the valve, flush out the flow passages and needle port with water after using salt solutions.

C.5.2 USE OF HIGH pH SOLUTIONS

The standard rotor seal is Vespel®, a DuPont polyimide, which is exceptionally wear-resistant. It is, however, susceptible to alkaline attack and deteriorates rapidly when used with solutions of pH 10 or higher. An alternative material is available for alkaline applications (consult Rainin LC Technical Services at 800-FOR-HPLC).

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C.5.3 CLOGGED VALVE PASSAGES

If valve passages are clogged, open them by removing the stator and cleaning the passages with a small wire (maximum diameter 0.015 in.).

C.5.4 CALIBRATING SAMPLE LOOPS

Sample loop sizes are designated by nominal values which can vary from the actual value by as much as 20%. This is due to the 0.001 inch tolerance of the tubing ID. (see table below). Since standards as well as unknowns are usually analyzed with the same loop, knowledge of absolute loop volume is rarely needed. If the actual loop volume must be known, it is best to calibrate it in place on the valve, so that the flow passages in the valve (one in the rotor, two in the stator) are also taken into account.

Tubing bore (inches)	Volume tolerance resulting from 0.001 inch bore tolerance
0.012	17 %
0.020	10 %
0.030	7 %

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Appendix D: Test Procedure

The Model AI-1A is factory tested for reproducibility, carry-over, and mixing according to the following test procedure.

D.1 ANALYTICAL SYSTEM

The Model AI-1A is tested in an analytical system under the following conditions:

Pump Flow	1.5 mL/min
Eluent:	distilled water
Detector wavelength:	254 nm
Sample	Uracil in distilled water (50 ppm)

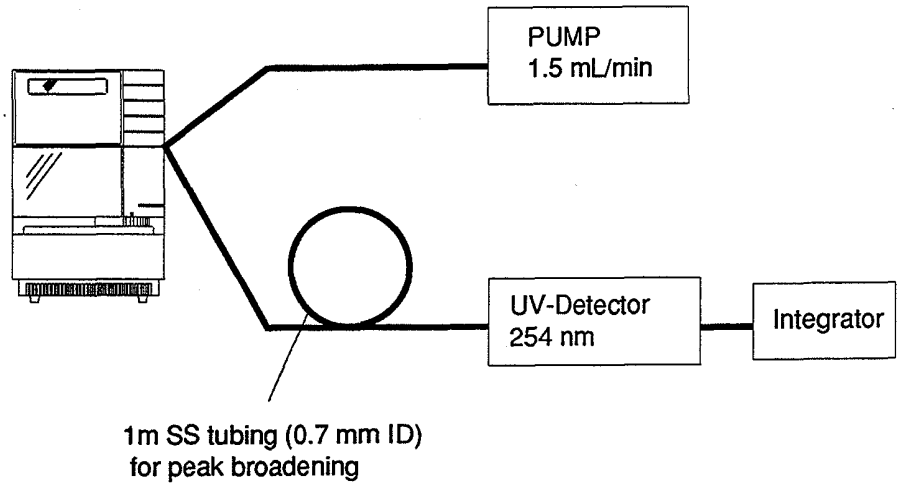


Figure D-1 Configuration for testing

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D.2 RELATIVE STANDARD DEVIATION

The formula for calculating Relative Standard Deviation are printed below:

$$\overline{Peak\ area} = \frac{\sum Peak\ area}{n}$$

$$\sigma_{n-1} = \sqrt{\frac{\sum \left(Peak\ area - \overline{Peak\ area} \right)^2}{n-1}}$$

$$RSD\% = \frac{\sigma_{n-1}}{\overline{Peak\ area}} \times 100\%$$

D.2 REPRODUCIBILITY AND CARRY-OVER TEST

System settings:

Default settings, except for the following changed settings:

GENERAL:	AIR SEGMENT	NO
TRAY:	TRANSPORT VIALS	YES

Seven vials are placed in the Model AI-1A tray. Vial 1 and vials 3 – 7 are filled with the sample (50 ppm Uracil) and vial 2 is filled with the distilled water eluent. The transport vial is also filled with eluent. The wash solvent bottle is filled with 80% water/20% isopropanol.

Test Method and Series

INJECTION METHOD	
Number	1
Type	µL pick-up
Anal. time	1:00 min
Inj/vial	3
Inj. vol 1	10 µL
Inj. vol 2	10 µL
Inj. vol 3	10 µL

WASH METHOD	
Number	1
Wash between injections	
Wash volume	300 µL

SERIES	
Number	1
First vial	A01
Last vial	A07
Inject. method	1
Wash method	1

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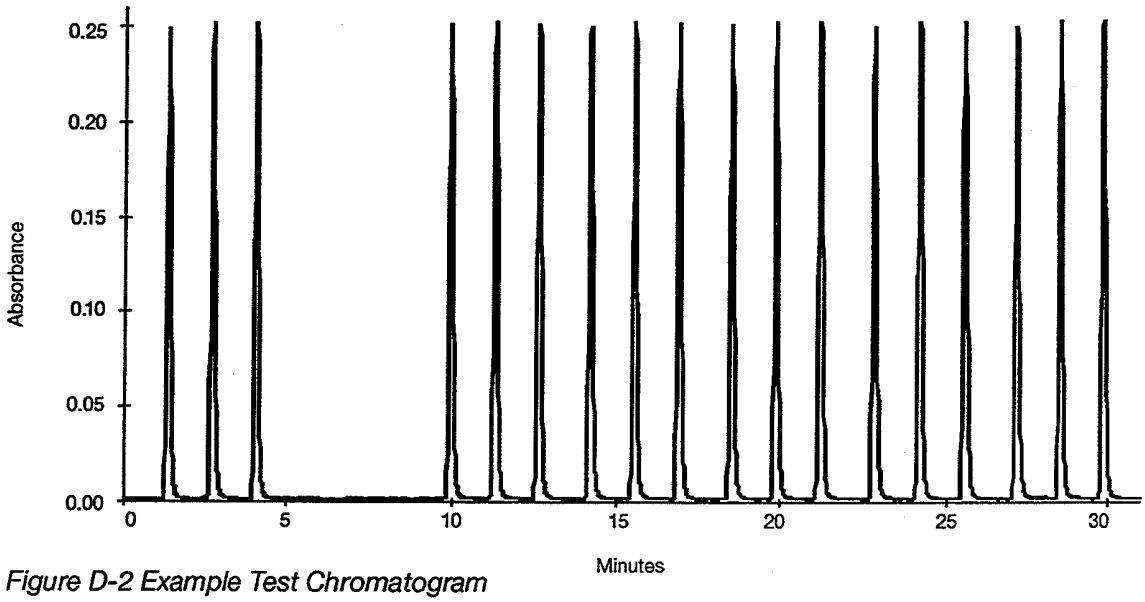


Figure D-2 Example Test Chromatogram

The Relative Standard Deviation (RSD%) and the carry-over can be calculated from the integration results.

For this example the results are:

RSD% **= 0.25%**

Carry-over **<0.5%**

Results of reproducibility test:

Peak No.	Area
1	206342
2	204773
3	205425
4	-
5	-
6	-
7	205203
8	205556
9	205568
10	206156
11	206174
12	205956
13	206165
14	205765
15	205960
16	206296
17	205617
18	205619
19	205658
20	206147
21	207070

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D.4 MIXING TEST

System settings: Default settings, except for the following change:

USAGE

Use of Mix Methods ENABLED

One sample vial (50 ppm Uracil) one empty destination vial and one Reagent_A vial are placed in the Model AI-1A tray. a 1:10 dilution of sample from the sample vial will be made in the empty destination vial. After the dilution 10µL will be injected from each vial.

Reagent_A vial is filled with distilled water.

The wash-solvent bottle is filled with 80% distilled water / 20% isopropanol.

Mixing test method and series

INJECTION METHOD		SERIES 1		SERIES 2	
Number	1	Number	1	Number	2
Type	partial loopfill	Inject. method	1	Inject method	2
Anal. time	1:00 min	Wash method	none	Wash method	none
Flush vol.	35 µL	Mix method	1	Mix method	none
Inj/vial	3	First vial	A 01	First vial	A 01
Inj. vol 1	10 µL	Last vial	A 01	Last vial A 01	
Inj. vol 2	10 µL	First dest. vial	A 02		
Inj. vol 3	10 µL	Reagent–A vial	A 03		

MIX METHOD 1

Step	Action				
1	ASPIRATE	5µL	AIR	speed: 2	
2	ASPIRATE	225 µL	REAGENT-A	speed: 2	height: 02
3	DISPENSE	180 µL	to DESTINATION	speed: 3	height: 02
4	DISPENSE	50 µL	to WASTE	speed: 5	
5	REPEAT LAST 4 STEPS 1 TIME				
6	ASPIRATE	5 µL	AIR	speed: 2	
7	ASPIRATE	60 µL	SAMPLE	speed: 2	height: 02
8	DISPENSE	40 µL	to DESTINATION	speed: 3	height: 02
9	DISPENSE	50 µL	to WASTE	speed: 5	
10	ASPIRATE	50 µL	AIR	speed: 2	
11	ASPIRATE	200 µL	from DESTINATION	speed: 3	height: 02
12	DISPENSE	200 µL	to DESTINATION	speed: 9	height: 20
13	REPEAT LAST 2 STEPS 3 TIMES				
14	END OF MIX METHOD				

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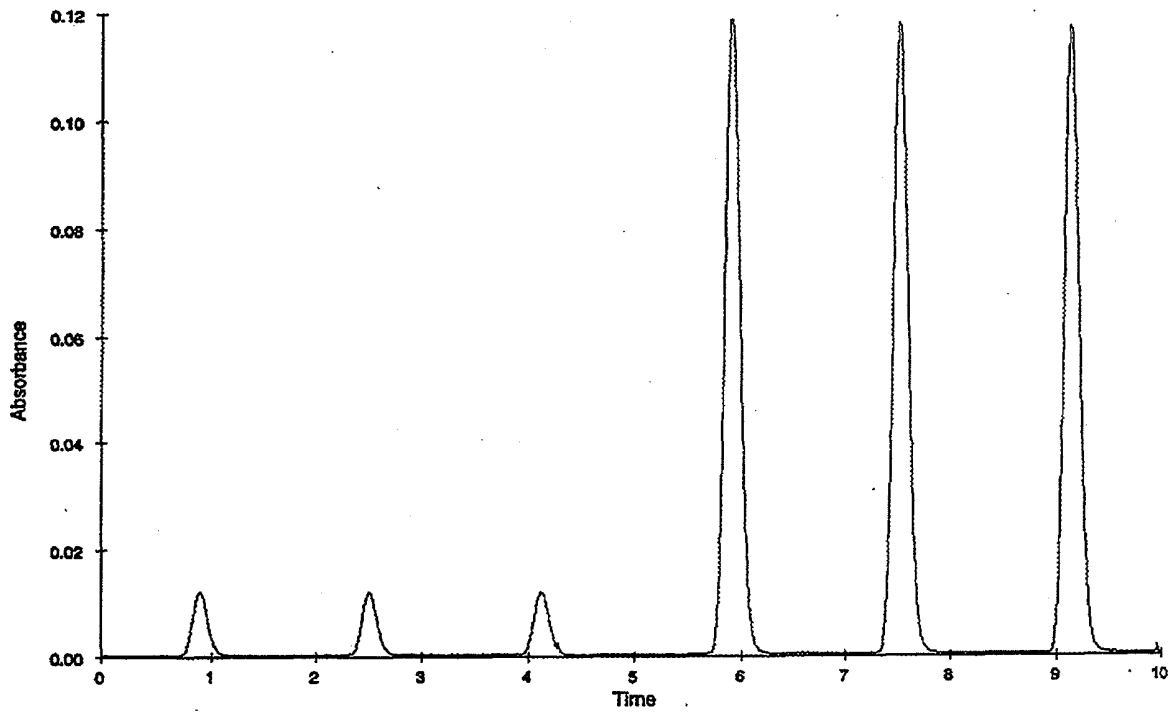


Figure D.3 Mix test chromatogram

From the integration results, the **Relative Standard Deviation (RSD%)** for the two vials can be calculated:

For this example the results are:

RSD% (vial 1, 1:10 dilution)	**= 0.37%**
RSD% (vial 2, sample)	**= 0.15%**
1:10 dilution	**= 1:10.13**

Results of the mixing test

Peak number	Area
1	38802
2	38968
3	39088
4	395258
5	394090
6	394471

Appendix E: Model AI-1A Logbook

The following pages consist of tables with which you can make your own Model AI-1A logbook. Keep in this logbook a record of your system settings and programmed methods and templates. Make copies of the following pages before completing the forms.

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Model AI-1A LOGBOOK

Customer information:

Name of user _____

Company _____

Department _____

Address _____

_____

_____

Telephone _____

Fax _____

Model AI-1A information:

Serial number _____

Firmware version _____

Purchase date _____

Installed options _____

_____

_____

_____

Comments: _____

_____

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Model AI-1A SYSTEM SETTINGS

GENERAL				
Volume of installed loop:				µl
Volume of tubing needle ⟷ valve:				mm
Syringe volume:	100 µl	250 µl	500 µl	1000 µl
Syringe speed:		LOW	NORMAL	HIGH
Sample needle height:				mm
Skip missing vials:			YES	NO
Air segment:			YES	NO
Headspace pressure:			YES	NO
Timebase display:			H:MM:SS	H:MM.mm
Key click:			ON	OFF
Error beep:			ON	OFF
Alarm buzzer:			ON	OFF

CLOCK		
System clock:	ON	OFF

USAGE		
Protection code:		
Use of time based methods:	DISABLED	ENABLED
Use of mix methods:	DISABLED	ENABLED
Use of user program:	DISABLED	ENABLED
Use of labeled vials:	DISABLED	ENABLED
Use of templates:	DISABLED	ENABLED
Use of calibration vials:	DISABLED	ENABLED

TRAY	Type	Number
Segment 1:		
Segment 2:		
Segment 3:		
Segment 4:		
Segment 5:		
Segment 6:		
Segment 7:		
Segment 8:		
Transport vials type:		
First transport vial number		
Last transport vial number:		

IO		
Vial output:	BCD	HEX
Inject marker pulse length:		sec.
Vial marker pulse length:		sec.
Labeled vial marker pulse length:		sec.
Input edge next injection:	FALLING	RISING
Input edge next vial:	FALLING	RISING
Freeze input active:	LOW	HIGH

COM	
Device identifier	

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Templates

Template number	Injection Method	Mix Method	Wash Method	Time base Method	User def. Method (Y/N)	Remarks
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						

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Injection Methods

Injection method number	Type Flushed Partial Pick-up	Anal. Time	Flush vol.	Inject. per vial	Injection volumes:									Remarks
					1	2	3	4	5	6	7	8	9	
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														
23														
24														

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Wash Methods

Wash method number	Wash between Injections / vials / series	Wash volume	Remarks:
1			
2			
3			
4			
5			

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Time Base Methods

Method number:					
	Action	Time		Action	Time
AUX 1	1 AUX-1 ON AT TIME:		ISS-A	1 ISS-A POSITION 6-1 AT TIME:	
	1 AUX-1 OFF AT TIME:			1 ISS-A POSITION 1-2 AT TIME:	
	2 AUX-1 ON AT TIME:			2 ISS-A POSITION 6-1 AT TIME:	
	2 AUX-1 OFF AT TIME:			2 ISS-A POSITION 1-2 AT TIME:	
	3 AUX-1 ON AT TIME:			3 ISS-A POSITION 6-1 AT TIME:	
	3 AUX-1 OFF AT TIME:			3 ISS-A POSITION 1-2 AT TIME:	
	4 AUX-1 ON AT TIME:			4 ISS-A POSITION 6-1 AT TIME:	
	4 AUX-1 OFF AT TIME:			4 ISS-A POSITION 1-2 AT TIME:	
AUX 2	1 AUX-2 ON AT TIME:		ISS-B	1 ISS-B POSITION 6-1 AT TIME:	
	1 AUX-2 OFF AT TIME:			1 ISS-B POSITION 1-2 AT TIME:	
	2 AUX-2 ON AT TIME:			2 ISS-B POSITION 6-1 AT TIME:	
	2 AUX-2 OFF AT TIME:			2 ISS-B POSITION 1-2 AT TIME:	
	3 AUX-2 ON AT TIME:			3 ISS-B POSITION 6-1 AT TIME:	
	3 AUX-2 OFF AT TIME:			3 ISS-B POSITION 1-2 AT TIME:	
	4 AUX-2 ON AT TIME:			4 ISS-B POSITION 6-1 AT TIME:	
	4 AUX-2 OFF AT TIME:			4 ISS-B POSITION 1-2 AT TIME:	
AUX 3	1 AUX-3 ON AT TIME:		CODE	1 CODE-OUT: AT TIME:	
	1 AUX-3 OFF AT TIME:			2 CODE-OUT: AT TIME:	
	2 AUX-3 ON AT TIME:			3 CODE-OUT: AT TIME:	
	2 AUX-3 OFF AT TIME:			4 CODE-OUT: AT TIME:	
	3 AUX 3 ON AT TIME:			5 CODE-OUT: AT TIME:	
	3 AUX 3 OFF AT TIME:			6 CODE-OUT: AT TIME:	
	4 AUX 3 ON AT TIME:			7 CODE-OUT: AT TIME:	
	4 AUX 3 OFF AT TIME:			8 CODE-OUT: AT TIME:	
AUX 4	1 AUX 4 ON AT TIME:		END	END OF TIMED EVENTS AT:	
	1 AUX 4 OFF AT TIME:				
	2 AUX 4 ON AT TIME:				
	3 AUX 4 OFF AT TIME:				
	3 AUX 4 ON AT TIME:				
	3 AUX 4 OFF AT TIME:				
	4 AUX 4 ON AT TIME:				
	4 AUX-4 OFF AT TIME:				

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Mix Methods

Method number:

Line	Action	Value	Position	Speed	Height	Line	Action	Value	Position	Speed	Height
1						41					
2						42					
3						43					
4						44					
5						45					
6						46					
7						47					
8						48					
9						49					
10						50					
11						51					
12						52					
13						53					
14						54					
15						55					
16						56					
17						57					
18						58					
19						59					
20						60					
21						61					
22						62					
23						63					
24						64					
25						65					
26						66					
27						67					
28						68					
29						69					
30						70					
31						71					
32						72					
33						73					
34						74					
35						75					
36						76					
37						77					
38						78					
39						79					
40						80					

Remarks:

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User Program

Line	Action	Value	Position	Speed	Height	Line	Action	Value	Position	Speed	Height
1						41					
2						42					
3						43					
4						44					
5						45					
6						46					
7						47					
8						48					
9						49					
10						50					
11						51					
12						52					
13						53					
14						54					
15						55					
16						56					
17						57					
18						58					
19						59					
20						60					
21						61					
22						62					
23						63					
24						64					
25						65					
26						66					
27						67					
28						68					
29						69					
30						70					
31						71					
32						72					
33						73					
34						74					
35						75					
36						76					
37						77					
38						78					
39						79					
40						80					

Remarks:

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