Fraction Collector FRAC-100 and FRAC-200

56-1046-77

Edition AL

Amersham Biosciences

Important user information

All users must read this entire manual to fully understand the safe use of Frac-100™ and Frac-200™ Fraction Collector.

Amersham Biosciences AB, which was previously known as Amersham Pharmacia Biotech AB, changed its name to the current name on 17th October 2001.

Safety symbols

The following **Warning** symbols highlights instructions that must be strictly followed in order to **avoid personal injury**. Be sure not to proceed until the instructions are clearly understood and all stated conditions are met.

WARNING! Read the instruction to avoid hazardous conditions.

Caution notices

Caution! The Caution sign highlights instructions or conditions that must be followed to **avoid damage to the product or other equipment.** Be sure not to proceed until the instructions are clearly understood and all stated conditions are met.

Notes

Note: The Note sign is used to indicate information important for trouble-free and optimal use of the product.

CE Certifying

This product meets all requirements of applicable CE-directives. A copy of the corresponding Declaration of Conformity is available on request.

The **CE** symbol and corresponding declaration of conformity, is valid for the instrument when it is:

- used as a stand-alone unit, or
- connected to other CE-marked Amersham Biosciences instruments, or
- connected to other products recommended or described in this manual, and
- used in the same state as it was delivered from Amersham Biosciences except for alterations described in this manual.

Terms and Conditions of Sale

Unless otherwise agreed in writing, all goods and services are sold subject to the terms and conditions of sale of the company within the Amersham Biosciences group which supplies them. A copy of these terms and conditions is available on request.

Should you have any comment on this product, we will be pleased to receive them at:

Amersham Biosciences AB
SE-751 84 Uppsala
Sweden

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Office Addresses

Amersham Biosciences AB
SE-751 84 Uppsala
Sweden

Amersham Biosciences UK Limited
Amersham Place
Little Chalfont
Buckinghamshire
England HP7 9NA

Amersham Biosciences Corp.
800 Centennial Avenue
P.O. Box 1327
Piscataway, NJ 08855
USA

Amersham Biosciences Europe GmbH
Munzinger Strasse 9
D-79111 Freiburg
Germany

Amersham Biosciences KK
Sanken Building
3-25-1 Hyakunincho, Shinjuku-ku
Tokyo 169–0073
Japan

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Part I

1. Introduction

The Amersham Biosciences fraction collectors, FRAC-100 (Code No. 18-1000-77) and FRAC-200 (Code No. 19-8600-02), are versatile instruments for automated fraction collection and evaluation of chromatograms. In their standard forms they can collect up to 175 fractions in 12 mm diameter tubes, up to 95 fractions in 10-18 mm diameter tubes and up to 40 fractions in 30 mm diameter vials, with the help of the racks provided or with simple accessories. When connected to a suitable monitor, they can measure peak heights, areas and retention time and indicate into which tubes the peaks have been collected. fraction collectors will also indicate into which tubes the peaks have been collected.

FRAC-200 and FRAC-100 (with its drop counting accessory) can collect fractions in a variety of different ways, based either on time, volume or drop counting, controlled via simple programs specified by the operator. For example, you can choose to collect uniform fractions of a fixed time period. The fraction collectors will collect fractions until all the tubes are used and then switch off.

In other collection sequences, you can specify a “wait” period in which the initial liquid volume is collected in a separate container, collect peaks in a smaller fraction size than the main part of the eluent, collect only peaks and allow the remainder to run into a separate container, compensate for the liquid volume between the monitor and the fraction collector and program a time, volume or drop count for the collector to shut itself, and a connected pump, off automatie or drop count for the collector to shut itself, and a connected pump, off automatically. At any time during collection you can advance to a new tube or stop the collection temporarily before continuing with the rest of the program.

These fraction collectors are designed to work with other equipment from Amersham Biosciences, including Peristaltic Pump P-1, Pump P-50, chromatography controllers, chart recorders and UV-monitors to form integrated chromatographic systems adapted to your present and future requirements.

2. General Description

2.1 Front panel

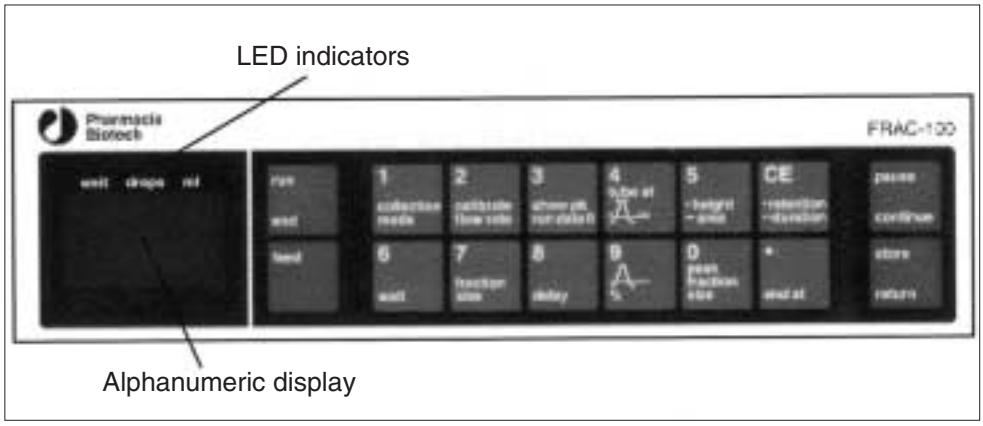


Fig. 1. Front panel.

LED Indicators

wait •

When this light is on, the collector is in a programmed wait period. A wait period is a time or volume at the beginning of a collection when an accessory valve directs the effluent to a separate container. During a wait period the time or volume remaining in the wait period before collection begins will be displayed (not available with drop counting mode).

drop •

When this light is on, collection is by drops.

ml •

When this light is on, collection is by volume. If the “drop” off, collection is by time (min).off, collection is by time (min).

Alphanumeric display

Cut

The fraction collector is in a peak cut mode and effluent is being directed to a waste container.

Cal

The pump is being calibrated.

End

“End” is displayed when the fraction collector is turned on to indicate that the program is in its end position. “End” is also displayed to indicate that parameters have been correctly entered during programming, after clearing check codes, and when the collection sequence has finished or can not continue.

Paus

The collection has been momentarily stopped. To continue from the same position press the “pause/continue” control again.

Ch.

The automatic status checking function is in operation. When the display flashes “Ch.” followed by a number, check the number in the check code list in the “Short Instruction” or Section 4 in this manual for a description of the status of the FRAC and appropriate action.

With the digital display, the instrument also presents all the peak evaluation parameters and current flow rate. If fractionation parameters need to be checked after they have been stored in the memory, the digital display will show each value as it is accessed. All these values will flash on and off while being displayed.

During a collection when no specific peak evaluation or fractionation parameter is being displayed, time or volume remaining in wait, or time, volume or drop number remaining until the next tube change will be displayed. This data does not flash.

Keyboard

There are four groups of keys on the keyboard. They are: collection mode keys, fractionation parameter keys, peak evaluation keys and control keys. Every key is multifunctional. The function performed depends on the sequence of keys pressed. The function of each key is described below.

Collection mode keys

Causes the programmed collection mode to be displayed and enables a new collection mode to be programmed. The different collection modes are described in Section 4.

Enters the number 1 in the display.

Causes the current calibration factor for the pump to be displayed and enables a new pump calibration to be performed (see Section 3). During a collection, causes the current flow rate to be displayed in volume or drop based modes.

Enters the number 2 in the display.

Fractionation parameter keys

Causes a programmed wait period (time or volume before collection in tubes begins) to be displayed and enables a new wait period to be programmed. The wait function is described in Section 4.

Enters the number 6 in the display.

Causes programmed fraction size to be displayed and enables a new fraction size to be programmed.

Enters the number 7 in the display.

Causes a programmed delay period (time, volume or drops between event mark signal and tube change) to be displayed and enables a new delay period to be programmed. The delay function is described in Section 4.

Enters the number 8 in the display.

Causes a programmed peak threshold to be displayed and enables a new value to be programmed. The peak threshold function is described in Section 4.

Enters the number 9 in the display.

Causes a programmed peak fraction size to be displayed and enables a new value to be programmed. The peak fraction size function is described in Section 4.

Enters the number 0 in the display.

Causes the programmed end of the collection sequence (time, volume or drop number) to be displayed and enables a new value to be programmed. The "end at" function is described in Section 4.

Enters a decimal point in the display.

Peak evaluation keys

Causes programmed "0" or peak number to be displayed and enables a new number to be entered (0-19). Two types of data are available. Entering 0 enables current data on the collection sequence to be displayed (see below and Section 4). Entering a peak number from 1-11 (FRAC-100) or 1-19 (FRAC-200) enables data on already collected peaks to be displayed (see below and Section 4). Printed peak reports can also be obtained from FRAC-200 by following the instructions given in Section 4.

Enters the number 3 in the display.

Causes data to be displayed for above addressed peak number or collection sequence (0).

Current data: pressed once (•), displays the number of the tube into which liquid is being delivered; pressed twice (••), displays the number of complete peaks for which data is stored.

Peak data: pressed once (•), displays the tube number where collection of the peak begins; pressed twice(••), displays the tube number where the peak maximum is located; pressed three times(•••), displays the tube number where collection of the peak ends.

Enters the number 4 in the display.

Causes stored data to be displayed for collection sequence (0) or above addressed peak number.

Current data: displays the monitor signal as% Full Scale Deflection.

Peak data: pressed once, displays the peak height as% Full Scale Deflection; pressed twice, displays the peak area as the product of time, volume or drop number and% Full Scale Deflection.

Enters the number 5 in the display.

Current data: pressed once, displays the time, volume or drop number from the start of the collection to the most recent power failure.

Peak data: pressed once, displays the time, volume or drop from the start of collection to the peak maximum; pressed twice, displays the total time, volume or drop number for the peak's collection.

Clears incorrect entries in a program.

Control Keys

Starts and stops a collection. When collection is stopped, all data remains stored in the memory until "run/end" is pressed again to start a new collection. When collection starts, all peak evaluation data is cleared from the memory and the tube counter returns to #1.

Advances the next tube. During wait, cut and delay, tubes are not fed immediately when "feed" is pressed. This ensures that recorded event marks are synchronized with tube changes (see Section 4.3, Delay). If a delay time is programmed and the fraction collector is in the middle of a fraction when feed is pressed, the time resets and counts down from the delay time before a tube is fed. This ensures that eluent remaining in the tubing between the

monitor and the outlet at the time “feed” is pressed is collected in this last tube. If delay has begun, the instrument completes the delay before feeding a new tube. No tube feed occurs during “wait” and “cut” periods.

pause/ continue recycle

Provides a pause in collection and evaluation at any time. The pump is turned off and the instrument stops. When “pause/cont” is pressed again the collection continues from the point of interruption. Peak memory is not cleared when “pause/cont” is used.

Recycling (FRAC-200 only) can be operated either manually or by remote control, at the end of a collection programme; please refer to Section 4.9.

store return

Stores in memory all information entered in fractionation parameters, collection mode and peak evaluation. Clears check codes.

2.2 Rear panel

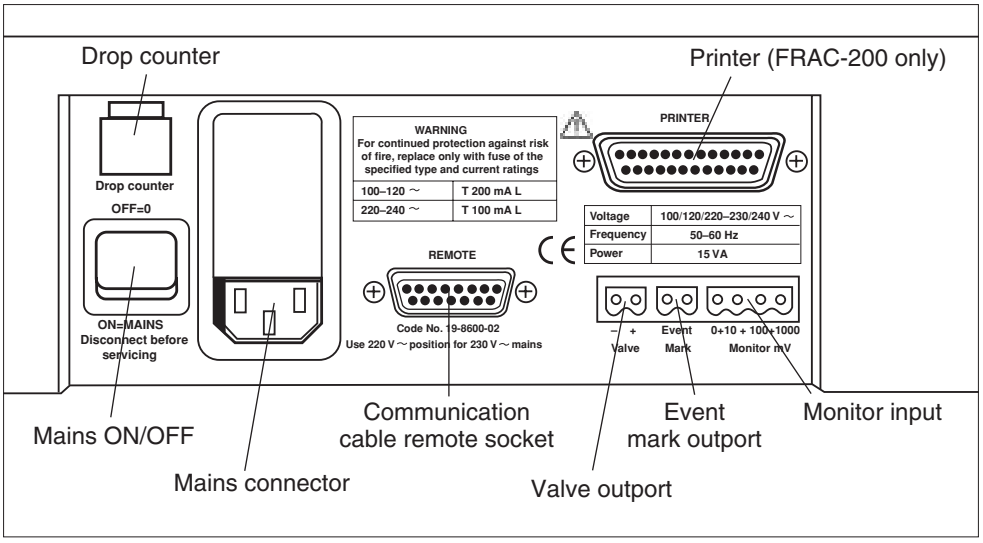


Fig. 2. Rear panel

Mains - ON/OFF switch. Turns the instrument on or off.

Mains connection - Mains power connection, fuse, fuse holder and a rotary selector switch that adapts the instrument to different mains voltage (100/120/220-230/240 V ~).

Remote - A 15-pin connector for operation of the instrument from a remote source or for control of a pump, e.g. Peristaltic Pump P-1. See Section 3.

Valve - Removable plug with screw contacts for connecting an accessory valve e.g. Valve PSV-50. Note: switch the instrument off before attempting to connect or disconnect a valve.

Event mark - Removable plug with screw contacts for connecting an event mark operated by contact closure, 0.2 s.

Monitor - Removable plug with screw contacts for connecting a monitor giving a signal of 10, 100 or 1000 mV.

Drop counter - Socket for drop counter and tube sensor cable from delivery arm.

Also suitable for drop counter option for FRAC-100.

Printer - A 25-pin female D-type connector (FRAC-200 only).

2.3 Short instruction

A Short Instruction panel for day-to-day guidance in the operation of the fraction collector is mounted directly under the keyboard.

2.4 Delivery arm

Figures 3 and 4.

The delivery arm positions the delivery tubing over tubes in the rack. A tube is located by a tube sensor which rests against the top of the tube (see Section 3). The pressure of the sensor against the tube operates a switch which sends a signal to the control circuit. The sensor has two positions, a large white circle for use with large diameter tubes and a smaller circle for use with for smaller diameter tubes. These can be chosen by turning the red control on the top of the delivery arm to position the liquid flow directly over the center of the collection tube. The delivery arm is spring-loaded and presses inwards to the center of the rack when there are no more tubes to be located or when tubes are missing. The height of the arm can be adjusted after releasing the lock knob. The tension that the arm exerts on the collection tubes can also be adjusted; please refer to Section 3.5. The arm can be held in two positions outside the rack by pulling it gently outwards until it passes over one of the stops.

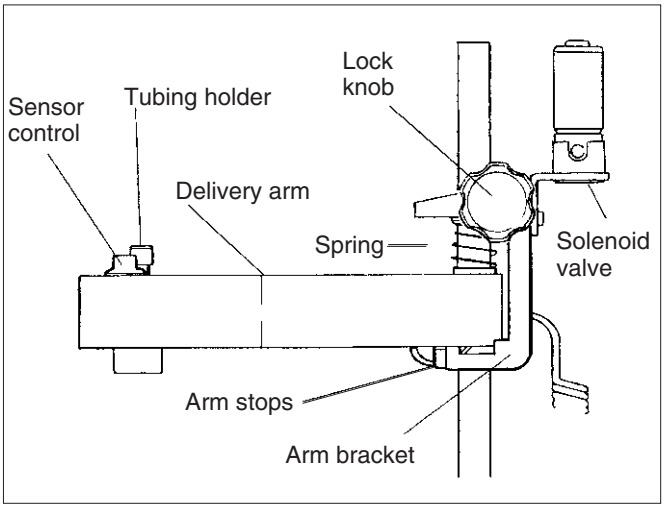


Fig. 3. Delivery arm.

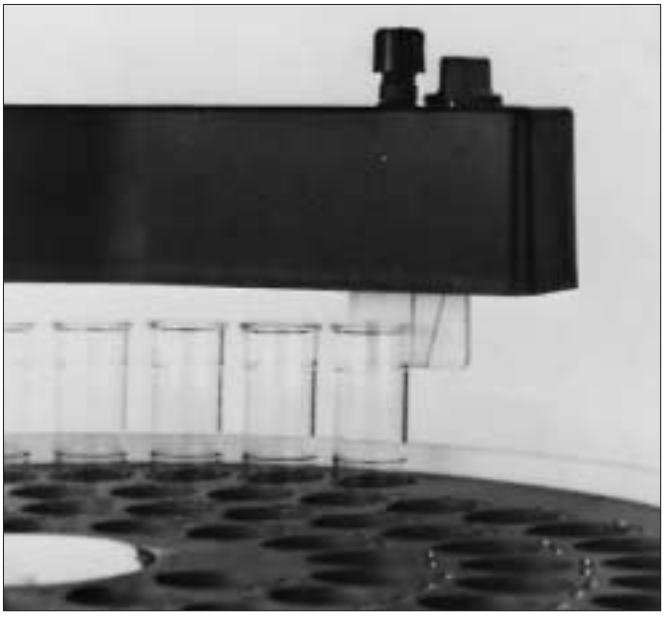


Fig. 4. Correct positioning of tube with tube sensor. The tube should always be below the horizontal marking on the tube sensor.

Important! Mid-way along the delivery arm is a tubing length guide for use with the drop counter. It is important to obtain the correct length of tubing so that drops form in the correct position with respect to the drop sensor. The tubing must be first passed through the tubing holder and then placed into the guide to its full length. The tubing holder may then be tightened and the complete assembly replaced in its correct position at the end of the delivery arm.

An accessory, Valve PSV-50, can be mounted on the arm bracket with the kit supplied with the instrument (Fig 8 and Section 3.7).

2.5 Tube racks

Figures 5 and 6.

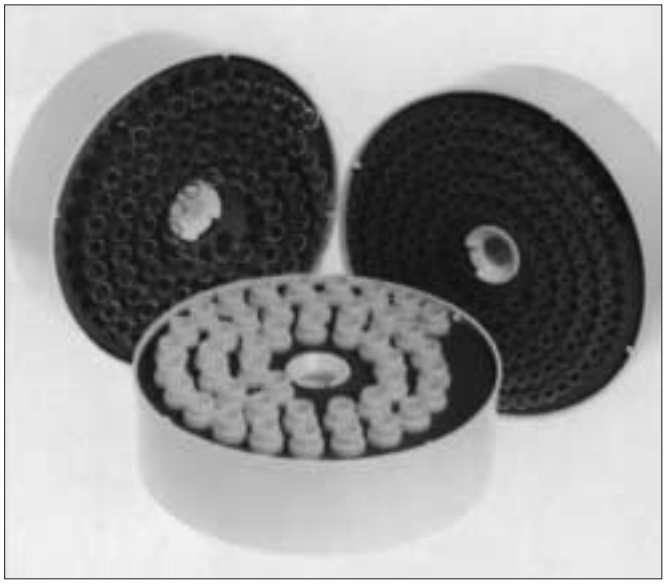


Fig. 5. Tube racks.

The tube rack consists of a bowl into which a tube support, a tube guide and a tube holder fit. The 12 mm rack can hold up to 175 tubes with diameters of 12 mm and lengths of 50-180 mm. A further accessory for use with this support is a double-ended Eppendorf tube holder. In one end 1.5 ml Eppendorf tubes can be used and in the other 0.5 ml Eppendorf tubes. Two further racks are available to increase the range of tube sizes compatible with the fraction collectors. See figure 5.

i) 18 mm rack: 95 tubes of diameter 10-18 mm and lengths of 50-180 mm.

ii) 30 mm rack: 40 tubes of diameter 30 mm and lengths of 30-180 mm e.g., scintillation vials.

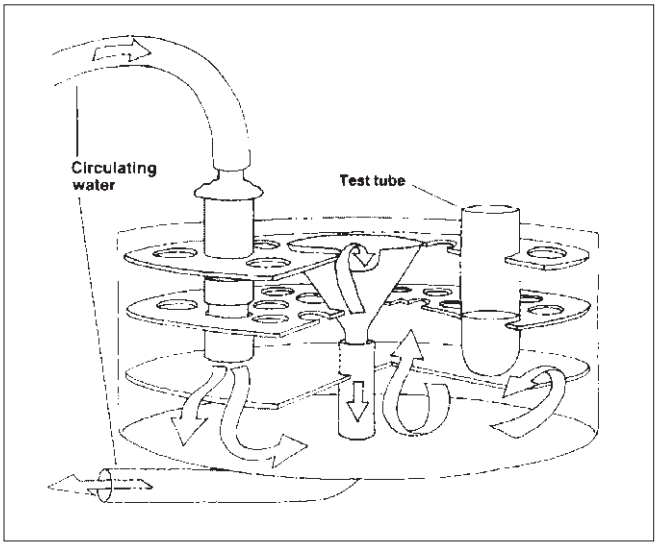


Fig. 6. An external cooling system can be connected to the 18 mm rack

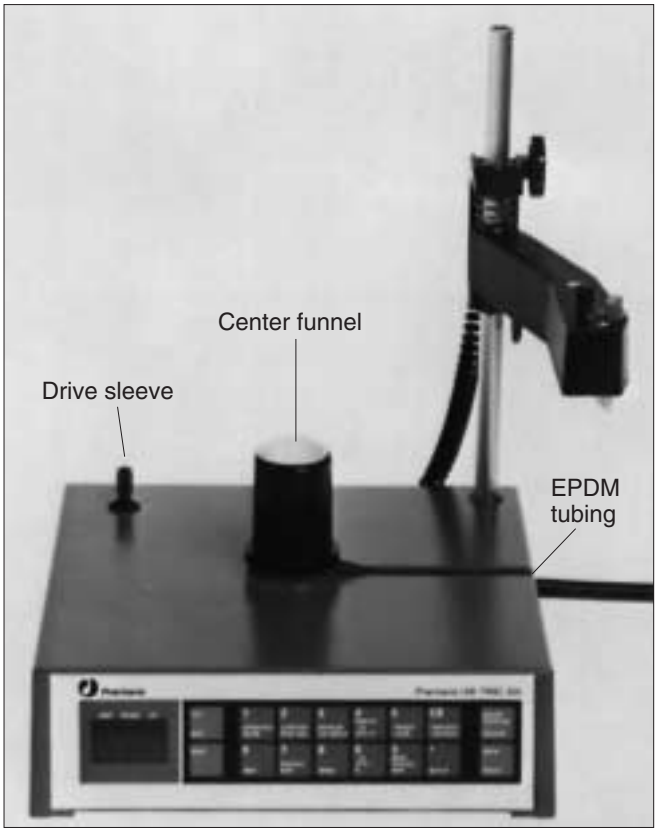


Fig. 7. Center funnel for drainage to waste or separate container

Tubes are held securely in the correct position in the tube holder by stainless steel spring clips. The tube support and tube guide can be placed at different heights in the bowl to allow tubes of different lengths to be accommodated. All the tubes in a collection sequence must be of the same size for proper operation.

Note: In the 18 mm rack, tube heights greater than 100 mm should have diameters which are 1/10 of the height of the tube. Otherwise, the tension from the delivery arm can force the top of the tube towards the rack's center.

The bowl has a capacity of about 3.5 liters, exclusive of tubes, to ensure that inadvertently spilled liquid, for example from a broken tube, is safely contained. Since the bowl is self-contained it can be filled with ice or ice water to form a cooling bath. When using the 18 mm rack the spring clips holding the tubes in place ensure that the tubes will not float when using a liquid-filled bowl. A water bath connector can be used to link the 18 mm rack to an external cooling system (Fig 6), especially useful with labile fractions. In the center of the fraction collector there is a funnel that acts as a drain for effluent between collections (Fig 7). Liquid from the funnel is drained to the outside through EPDM tubing and collected in a separate container.

The tube rack is driven by the drive sleeve (Fig 7) at the rear of the instrument. An automatic safety feature stops collection if movement of the tube rack is hindered (See Section 4.8).

2.6 Event mark cable

Optional accessory

To connect the fraction collector with the event mark input of a recorder use the optional accessory Signal cable (see Section 8, Accessories and Spare Parts, for ordering information). This gives an event mark on the chromatogram when a tube change occurs.

2.7 Signal cable

Optional accessory

To connect the fraction collector with the output from a monitor for automatic peak cutting and evaluation, use the optional accessory Signal cable (see Section 8, Accessories and Spare Parts, for ordering information).

2.8 Communication cables

Optional accessory for remote control

The fraction collector can be connected to a pump, e.g. Pump P-1, Pump P-50, or a Controller, for remote operation. Connecting the fraction collector directly to a pump allows the following operations to be performed: pump can be stopped, started, and paused from the control panel of the fraction collector.

Connection to a controller allows automatic control over run, end and the recycling function (FRAC-200 only).

Optional accessory for printer (FRAC-200 only)

FRAC-200 can be connected to a printer using Communication Cable, 25P-P (see Section 8, Accessories and Spare Parts, for ordering information). This cable is used for print-out of collection parameters and peak integration data (peak report).

Fig. 8. Accessory valve PSV-50, mounted on the back of the arm bracket

2.9 Valve PSV-50

Optional accessory

(Valve PSV-50, Code No. 19-1994-01).

The Valve PSV-50 allows the following functions to be used:

1. Wait; during the programmed wait period liquid is directed to a separate container.
2. Peak cutting; liquid between peaks is directed to a separate container.
3. Flow diversion between tubes; during tube changes liquid is redirected to a separate container. This minimizes spilling during tube changes even at very high flow rates.

The minimal valve resistance is 100 ohm.

2.10 Remote control adaptor

Optional accessory

(Remote Control Adaptor, Code No. 19-6008-01). The Remote Control Adaptor allows the following equipment to be connected to the fraction collector:

1. Pumps other than Amersham Biosciences P-1, P-50 and P-500 pumps that have a suitable output frequency.
2. Chart recorders. This is useful for turning the chart drive on and off during a run.
3. System controllers, other than Amersham Biosciences GP-250 Plus and LCC-501 Plus.

For connection to pumps, check the Instruction Manual for the pump concerned to be sure the output frequency does not exceed the specifications of the fraction collector.

3. Installation

3.1 Unpacking

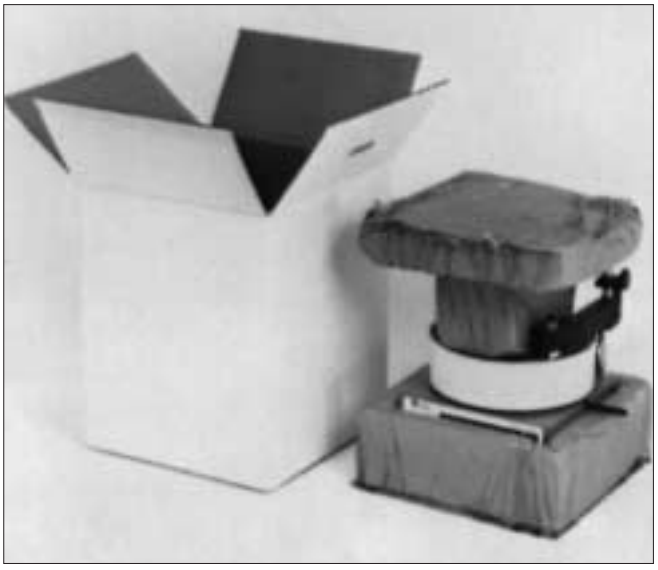


Fig. 9. Unpacking the FRAC-100/FRAC-200

Carefully unpack the FRAC-100 or FRAC-200. Check the contents against the packing lists supplied. Inspect for any damage that may have occurred during transit. Report any damage immediately to the local Amersham Biosciences representative and to the transport company concerned. Save the packing material if future transport can be foreseen.

3.2 Assembling the tube rack

Tube rack, 12 mm and Tube rack, 18 mm

Figures 10 and 11.

Tube lengths 50-85 mm (Fig 10)

Insert the tube support in the bowl by engaging the L-shaped cutouts in the ribs round the edge of the bowl. The support should be in the lower of the two positions and the circular marks on the support plate face the inside bottom of the bowl.

Insert the tube guide in the bowl, with the tube numbers uppermost, by engaging the single cutouts in the ribs. The guide should come to rest about 1 cm above the support. Insert the tube holder in the bowl so that tube position 1 is directly above tube position 1 in the tube guide. The bowl is flexible. To insert the tube holder, push out at each rib and snap the holder under the top overlip of the rib. Do not force the holder into place as this may damage the overlip. The surface of the holder should be level when correctly inserted (Fig 11).

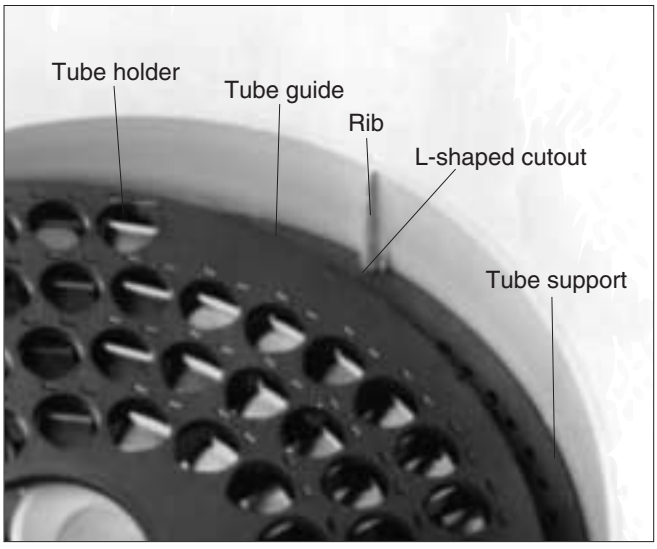


Fig.10. Tube rack assembly for tube lengths

Fig. 11. Snapping the tube holder into place

Tube lengths 85-180 mm

Remove the tube support; it is not required.

Insert the tube guide into the bowl, tube numbers uppermost, by engaging the L-shaped cutouts in the ribs. The guide should be in the lower of the two positions.

Insert the tube holder so that tube position 1 is directly above tube position 1 in the tube guide (Fig 11).

Tube rack, 30 mm

Figures 12, 13 and 14.

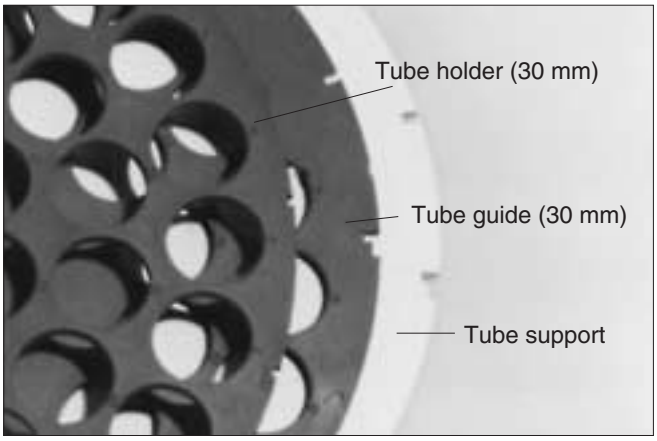


Fig.12. Tube rack 30 mm, assembly for tube lengths 30-50 mm

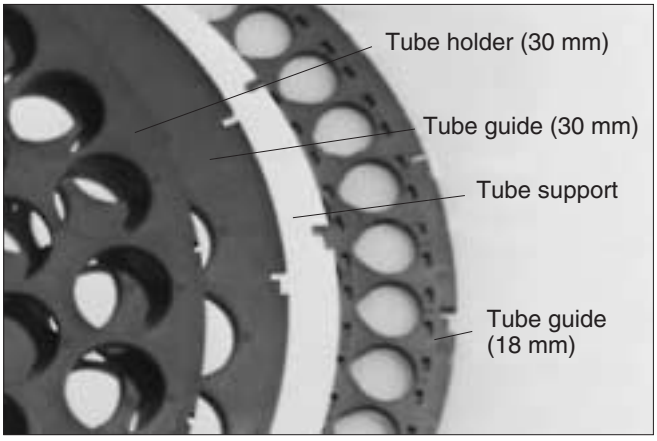


Fig.13. Tube rack 30 mm, assembly for tube lengths 50-85 mm

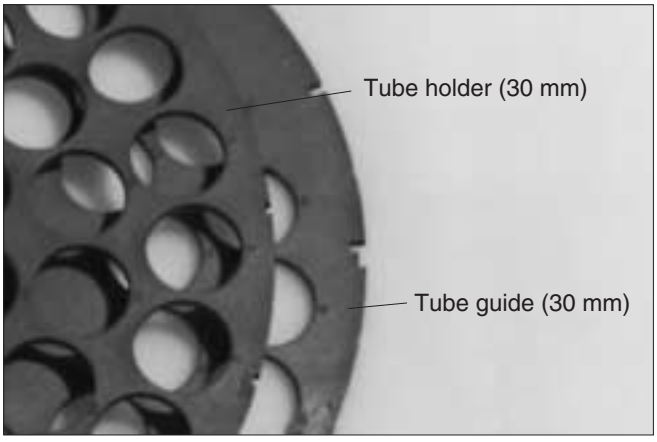


Fig.14. Tube rack 30 mm, assembly for tube lengths 85-100 mm

Tube lengths 30-50 mm (Fig. 12)

Insert the tube guide from the standard rack by engaging the single cutouts in the ribs. On top of that insert the tube support, which comes with the standard rack, by engaging the single cutouts in the ribs. Layering the tube guide and tube support on top of each other gives the extra height necessary to use short tubes.

Insert the rack tube guide by engaging the single cutouts in the ribs.

The tube guide has both single and L-shaped cutouts on it. Finally insert the tube holder for the accessory rack onto the top of the bowl. Tube position 1 should be directly above tube position 1 in the tube guide.

Tube lengths 50-85 mm (Fig 13)

Insert the tube support into the bowl by engaging the L-shaped cutouts in the ribs around the edge of the bowl. The tube support should be in the lower of the two positions.

Insert the accessory tube guide into the bowl, with the tube numbers uppermost, by engaging the single cutouts in the ribs.

Insert the tube holder into the bowl so that tube position 1 is directly above tube position 1 in the tube guide.

Tube lengths 85-180 mm (Fig 14)

Remove tube support; it is not required.

Insert the tube guide into the bowl, by engaging the L-shaped cutouts in the ribs. The guide should be in the lower of the two positions.

Insert the tube holder so that tube position 1 is directly above tube position 1 in the tube guide.

Custom Tube Racks

When there are special requirements for a collection, such as an unusual number of tubes or odd tube sizes, a custom rack can be made from block styrofoam or by drilling tube holders from appropriately sized plastic plates. The important characteristic of these custom racks is that the tube changes must be made smoothly, i.e. the angle and distance between tubes are not too great.

3.3 Mounting the rack

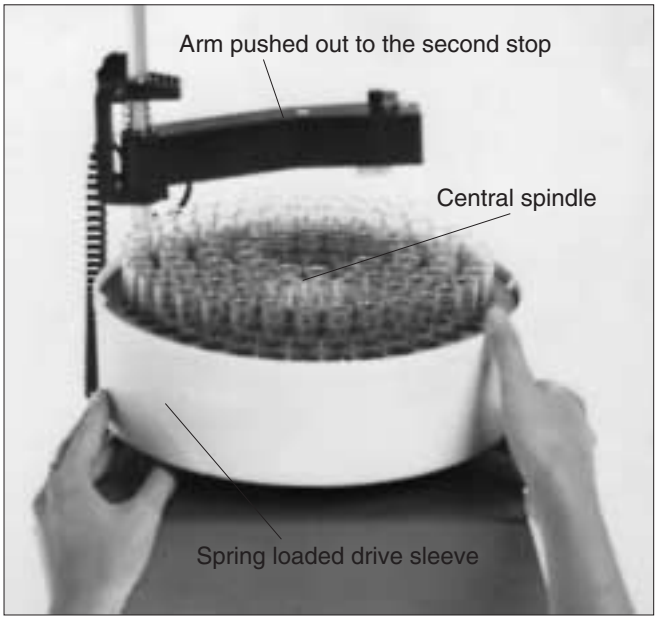


Fig.15. Mounting the tube rack on to the fraction collector

Move the delivery arm gently out of the second stop. Place the rack over the central spindle and pull the spring-loaded drive sleeve out so that the rack comes to rest.

3.4 Inserting collection

Insert sufficient collection tubes into the rack, starting from position 1, pushing them down as far as they will go. All the tubes must be of the same length and diameter for proper operation and there should be no empty spaces in the sequence.

3.5 Adjusting the delivery arm

Figures 3 and 4.

Move the arm to the center position and lower the arm bracket so that the bottom of the white tube sensor is about 5 mm below the top of the tubes. Lock the arm bracket at this height with the lock knob. Lift the arm up carefully from underneath the spring, so that the sensor clears the collection tubes, and move the arm out over the edge of the rack. Lower the arm and allow it to move in so that the sensor touches the collection tubes in the track furthest from the center. Rotate the rack by hand, anticlockwise, until the sensor rests against tube 1 exactly as shown in Fig 4.

Check that the sensor is in the appropriate position for the tube size. The eluent tubing should be over the center of the collection tube so that the drops collect directly into the tube.

Adjusting the spring tension of the delivery arm

Improper spring tension can cause the fraction collector to skip tubes. It tends to have the greatest effect as the arm moves in towards the center.

Spring tension is affected by temperature. Low temperature will reduce the tension. Therefore, it may be necessary to re-adjust the tension if the collector is used in a cold room.

1. Pull out the arm bracket from the stand of the fraction collector (Fig 3).
2. Dismantle the delivery arm from the arm bracket.
3. The top of the spring is in one of two holes at the top of the arm bracket. Looking at the arm bracket from the front of the unit:

   If the top of the spring is in the right hole, moving it to the left-hand hole will increase the tension;

   If it is in the left-hand hole, moving it to the right hole will decrease the tension.

   To adjust the top of the spring, hold the spring near the top and pull or prise it down and out of the top hole. Insert the top of the spring into the other hole.
4. The bottom of the spring is in one of 4 holes equally spaced 1/4 turn apart. To adjust the bottom of the spring, hold it near the lower end and lift or prise the bottom of the spring out of hole.
   - To increase the tension, turn the spring anti-clockwise.
   - To decrease the tension, turn the spring clockwise and insert it into the next hole.

3.6 Remote connection

Optional

Connect the communication cable to the remote socket on the rear panel (Fig 2). The following functions and signals are available. All signals are TTL compatible.

Name	Active voltage	Function	Pin
INPUTS (all with 4.7 kohm pull-up)			
Pump frequency	–	Motor frequency from pump	13
Operable (in)	0	Indicates that the remote unit, connected, is operable	10
Feed	0	Gives one tube change. Minimum pulse width 50 ms. Operable (pin 10) must be active.	3
Run	0	Holds collector in run as long as the signal is active. End cannot be given via the keyboard. Minimum pulse width 50 ms. Operable (pin 10) must be active.	2
Pause	0	Holds collector in pause as long as the signal is active. Continue cannot be given via the keyboard. Minimum pulse width 50 ms. Operable (pin 10) must be active.	1
Recycle (FRAC-200 only)	0	Activates recycle function	5
OUTPUTS (all open-collector)			
Operable (out)	0	Indicates that the collector is operable.	9
Event mark	0	Pulse at tube change. Pulse width 0.2 s.	6
Error	0	FRAC is stopped (e.g. out of tubes) and at PAUSE if PAUSE activated from keyboard. Indicates when memory backup not working.	11
Pump stop, chart drive	0	Stops the pump or chart at “End” and at “Pause”.	12
Ground	–	Signal ground.	15
Pins 4, 7, 8 and 14 are not used.			

3.7 Installing accessory valve

Optional

The flow diversion Valve PSV-50 is mounted on the rear of the arm bracket. Screw the valve holder, supplied with the fraction collector, to the back of the delivery arm using the screws provided. Attach the flow diversion valve PSV-50 to the valve holder (Fig. 16).

Before connecting or disconnecting any valve to or from the rear panel, disconnect the fraction collector from the mains to avoid possible damage to the microprocessor caused by voltage surges.

Connect the valve to a green 2-pole connector, supplied with the fraction collector. The polarity does not matter.

Plug the green connector into the socket marked “valve outport” on the rear panel of the instrument.

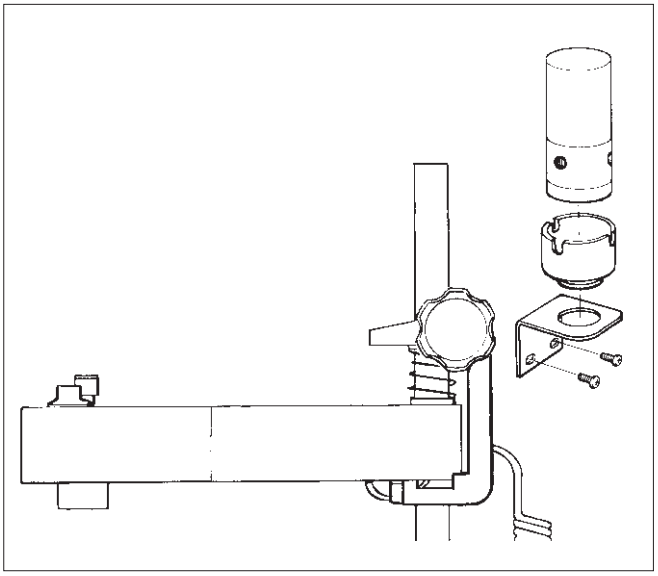


Fig.16. Mounting the flow diversion valve.

There are three outlets from the valve. The tubing connections that should be made with the fraction collector are:

1. NO (normally open) – tubing goes to waste or separate collection vessel
2. NC (normally closed) – tubing goes to delivery arm
3. COMM (common) – tubing goes to column outlet or monitor flow cell.

3.8 Connection to a pump

Connect the 15-pin communication cable between the remote socket on the rear panel (Fig 2) and the remote socket on the pump. Switch the pump on. The pump will run only when the fraction collector is collecting. There are two ways to operate the pump at other times. The fraction collector may be switched off and then the pump control comes directly from the ON/OFF switch on the pump. Alternatively, leave the fraction collector switched on and program a “wait” period of 9999 min or ml. If the long wait period is programmed, the pump can be started or stopped from the fraction collector by pressing “run/end”. Remember to re-program “wait” before starting a collection sequence.

During a collection sequence the pump starts when “run/end” is pressed or when “continue” is pressed after a pause. During a run the pump stops at a programmed “end at” or when “run/end” or “pause” is pressed. In volume and drop counting modes, the flow rate may be changed without affecting the volume collected in each fraction. This applies only to pumps connected via a communication cable.

3.9 Pump calibration

Connect the pump tubing to an eluent reservoir and fill the pump tubing with liquid. Connect the pump to the fraction collector as described above.

Push the delivery arm out to the second stop.

Place a graduated cylinder under the outlet tubing and start calibration by pressing “cal” and then “run/end”. Collect about 5 ml of liquid. Press “run/end”, enter the exact volume of liquid collected and store the value by pressing “store/return”. The pump is now calibrated. Flow rate may be varied at any time without recalibration. Put the delivery arm in the start position before starting to collect fractions.

3.10 Connection to a monitor

The fraction collector is connected in parallel with the monitor. Connect the signal cables from the monitor to the 4-pole connector provided with the instrument by loosening the connection screws and inserting the cable wires for the correct output voltage (Fig 2). Observe the polarity! Tighten the connection screws and ensure that the wires are properly connected by pulling them gently. Insert into the socket outlet marked “monitor” in the rear panel. The monitor signal should be 0-10, 0-100, or 0-1000 mV for 100% FSD.

3.11 Mains installation

Figures 2 and 17.

Before connecting this instrument to the mains supply, installation read the following instructions carefully:

1. Two Mains Kits are supplied with the instrument, one for 100-120 V and one for 220-240 V. Choose the kit appropriate to your mains supply voltage, and discard the other kit.

Installing the wrong mains kit can endanger personal safety and cause irreparable damage to the pump. Always connect the instrument to a properly grounded mains supply.

2. Remove the yellow warning label covering the fuse/voltage selector on the rear panel.
3. Open the fuse/voltage selector with the key provided or with a thin screwdriwer (Fig. 17a).
4. Place the fuse appropriate to your mains supply voltage in the fuse holder and insert it into the right-hand position (Fig. 17b). The left hand position is a holder for a spare fuse (included in the Mains Kit).
5. Remove the voltage selector switch, select the correct voltage, and replace the switch with the correct voltage showing (Fig. 17c).
6. Close the fuse/voltage selector cover and make sure the chosen voltage is shown in the window.

Note: Use 220 V position for 230 V mains supply.

7. Connect the instrument to a grounded mains supply using the cable included in the Mains Kit.

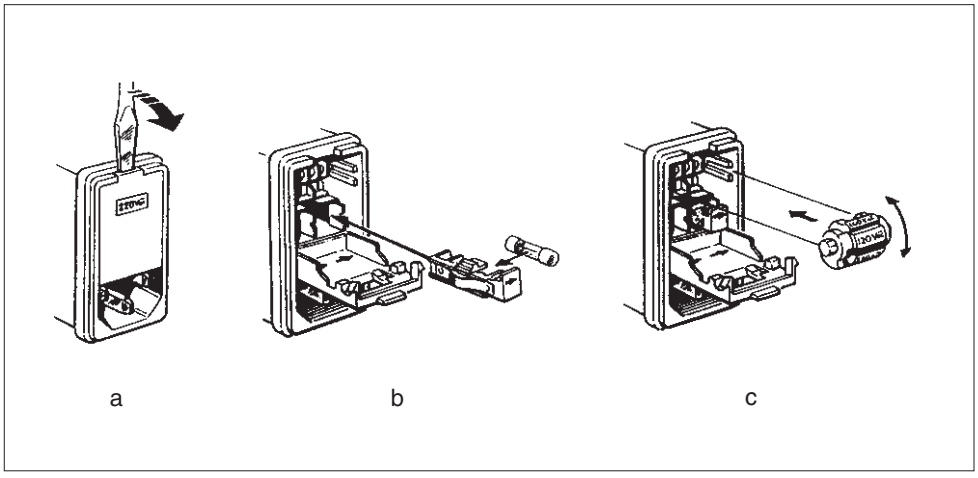


Fig. 17. Setting the correct mains voltage.

4. Operation

4.1 Programming instructions

Simple time-based collection

1. Fill the rack with sufficient tubes and place the delivery arm in the start position.
2. Clear previously programmed fractionation parameters by pressing “1, 9, store/return”.
3. Select, enter and store the fraction size (min per fraction) by pressing:
   1. “7/fraction size”
   2. number of min per fraction,
   3. “store/return”.
4. Press “run/end” to start collecting fractions.

   Press “run/end” again to stop collection.

Programming any collection sequence

1. Connect accessory equipment (pump, event mark, valve, monitor) as required, fill the rack with sufficient tubes and place the delivery arm in the stand-by position.

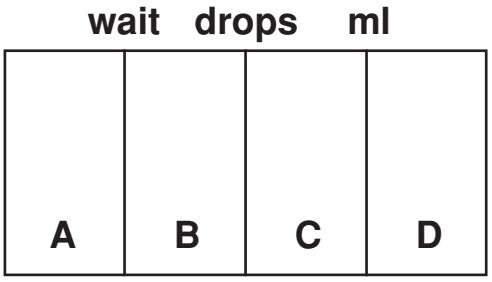
   An accessory valve must be connected to use flow diversion between tube changes, a wait period peak cutting modes.
2. Clear previous fractionation parameters by pressing “1, 9, store/return”.
3. Calibrate the pump for volume-based modes (see Section 3.9).
4. Choose the desired collection mode by pressing “1, mode number (see section 4.2), store/return”. (See also Section 4.3 for filter constant).
5. Select fraction size, enter and store for all modes.
6. Select, enter and store optional parameters: “wait, delay, peak threshold, peak fraction size, end at” as required.

   See Section 4.3.
7. Select peak threshold, enter and store for modes with peak cutting or programs with a peak fraction size.
8. Start collection by pressing “run/end”.

4.2 Programming collection modes

These fraction collectors are versatile instruments capable of collecting fractions by time, by volume, or by drops (FRAC-100 requires optional drop counter). Simple programming- clear memory, collection mode, fraction size, run- will give a fast, easy start to collections. More complex programs can be considered, such as peak cutting, diversion of liquid to a separate container between tubes, filtering the monitor signal etc. as your needs demand.

To program a collection mode: press “1/collection mode”, the number of the desired mode (see below) and “store/return”. The collection mode can only be programmed before starting a run; it cannot be changed during a run.



Using the 4 digit alphanumeric display screen on the keyboard and labelling the 4 positions A, B, C and D, a definition of the collection modes would be as follows:

Entries in column D	define collection by time, volume or drop counting, with or without peak cutting function
Entries in column C	define drop synchronization with or without flow diversion during tube changes
Entries in column B	define the filter constant.

Display column A is not used for collection mode programming.

Combining these defined factors the choice of collection mode is reviewed in the following table.

The following explanations may be useful.

Time-based modes are defined as minutes per fraction.

Volume-based modes are defined as milliliters per fraction.

Drop-based modes are defined as number of drops per fraction.

Drop synchronization mode	will only allow a tube change 50 ms after the drop has passed the drop counter, thus ensuring safe collection prior to tube change and minimizing spillage. Maximum drop rate is approximately 15 drops/s.
Flow diversion mode	an accessory valve (PSV-50 or similar) must be used. The valve can be activated to divert the flow to waste during a tube change minimizing spillage even at high flow rates.
Peak-cutting mode	communication with the monitoring system allows the FRAC to recognize and collect only peak effluent. An accessory valve (PSV-50 or similar) must be used to divert unwanted effluent to waste and divert recognized peaks to the collection tubes. A peak threshold value must be programmed.

	Collection mode number			
Collection mode	No drop synchronization No flow diversion	No drop synchronization Flow diversion during the tube change	Drop synchronization No flow diversion	Drop synchronization Flow diversion during the tube change
Time	0	10	20	30
Time + peak cut	1	11	21	31
Volume	2	12	22	32
Volume + peak cut	3	13	23	33
Drop count	4	14	24	34
Drop count + peak cut	5	15	25	35

4.3 Programming fractionation parameters

The following parameters can be programmed: wait, fraction size, delay, peak threshold, peak fraction size, end at, and filter constant. Peak threshold is defined as% Full Scale Deflection (FSD); all other parameters are defined as minutes, milliliters or drop number depending on whether a time-based, a volume-based or a drop-based collection mode has been selected.

Wait: wait is an optional parameter which defines a period at the beginning of a collection sequence in which liquid is diverted by an accessory valve to a separate container. This saves glassware by making it unnecessary to collect the void volume and other dispensable portions of liquid at the beginning of a run.

Program wait by pressing: “wait”, the desired duration (min or ml) of the wait period, and “store/return”. It is unnecessary to program “wait” in peak cutting modes. This function is not available in drop count mode.

Fraction size: defines the basic size of the collected fractions in min, ml or number of drops.

Program fraction size by pressing: “fraction size” , the desired fraction size (min or mil or drop), and “store/return”.

Note: Fraction size must be programmed for all runs.

Delay: synchronizes the recorded event mark with the actual delivery of liquid into tubes. It also operates in peak collection to make sure that all of the peak material is collected separately from other fractions. A delay time corresponds to the time taken for liquid in the cell of the monitor to reach the outlet above the tube in which it is collected. A delay volume is the volume in the tubing between the cell and the outlet. A delay drop number is the number of drops contained in the tubing between the cell and the outlet.

Measure the delay time in your system by timing a small air bubble between the monitor cell and the outlet.

Measure the delay volume by first emptying the tubing from the cell to the outlet and then refilling it with a measured volume of liquid from a syringe.

Measure the delay drop number by counting the number of drops contained in the liquid in the tubing between the monitor cell and the outlet.

Program “delay” by pressing: “delay”, the measured delay time or volume, “store/return”.

The delay period must be smaller than both fraction size and peak fraction size.

Peak threshold: defines the monitor signal, in% FSD, at which the fraction collector marks the start or end of a peak by an event mark. The monitor signal is recognized as a peak when its value rises above the programmed peak threshold. Peak end is defined as when the value is below the programmed peak threshold, i.e. a hysteresis of 2% FSD.

A programmable filter is provided to make the fraction collector less sensitive to chromatographic and electrical disturbances. The filter constant is variable and can be programmed to meet the needs of the separation (see below).

If the signal is above the peak threshold and passes through a minimum, a new peak will be recorded when the signal reaches 1.5% FSD above the minimum. A minimum is defined as a signal that is more than 1.5% FSD below the previous maximum.

Program peak threshold by pressing: “peak threshold”, the desired monitor signal in% FSD, and “store/return”.

Peak fraction size: allows the instrument to collect fractions during peaks which are a of different size than the programmed fraction size (key 7). To use peak fraction size, peak threshold must be programmed.

To program peak fraction size: press “peak fraction size”, the desired size, and “store/return”.

End at: “End at” defines the time, volume or drop count at which fraction collection will end automatically. A pump connected to the back panel of the fraction collector will also stop. If no “end at” is programmed, collection will continue until all the tubes have been filled. The delivery arm will then swing into the middle of the rack, the pump will stop automatically and any further liquid will drain into the center funnel.

If the fraction collector runs out of the tubes before reaching the programmed “end at”, it will continue to evaluate peaks and store data but effluent will drain into the center funnel or be diverted via the PSV-50 valve.

Note: A programmed "end at" is ignored in drop mode if the FRAC runs out of tubes (it cannot count drops after valve is switched to waste).

To program the end of the fractionation, press “end at”, the desired end of fractionation time, volume or drop count, and “store/return”.

Filter constant: corresponds to a filter rise time of the monitor filter. If the filter constant is properly matched with flow rates and peak durations then the fraction collector will ignore disturbances with shorter duration than the peaks, e.g. electrical disturbances and in some cases air bubbles.

If the peaks in a certain chromatographic run have short durations, then a short filter constant should be used, so a minimum amount of the peak is lost. If the peak durations are very large then a longer filter constant may be used.

To program a filter constant it is necessary to refer to the alphanumeric display. There are four character positions for various figures in the display. When programming a collection mode, position B is used for the filter constant, position C and position D are for the collections mode codes (see Section 4.2).

Programmed Filter constant	Filter time (seconds)
0	0.5
1	1
2	2
3	4
4	8
5	16
6	32
7	64
8	128
9	256

The filter constant takes the last sample and the last filtered value to compute the new filtered value. 0 gives no filtering and 9 gives the strongest filtering.

For filter constants 1–9 the following formula is used:

$$X_n = \frac{X_{n-1}\ (2^c\text{-}1) + X_{av}}{2^c}$$

X_{n-1} = last filtered value

X_n = new filtered value for store and check for peaks

X_{av} = average of two last monitor input readings

c = filter constant

The fraction collector is programmed with filter constant 0 (filter time 0.5 s) upon delivery. For programming filter constant see PART II, point 1.3.

4.4 Changing a program

It is not necessary to repeat the whole programming sequence before every run. Simply recall the fractionation parameters and check them one-by-one. Delete any unwanted values by pressing “CE” (clear entry) or change them by entering a new value and pressing “store/return”.

The collection mode can only be changed when collection is not in progress. Other parameters can be changed during fraction collection; the new value will apply to the next occasion the parameter is used e.g. a changed fraction size will apply to the next fraction, the present fraction will be completed at the previous setting.

4.5 Viewing run data

The fraction collector can display a variety of data about a chromatographic run while the run is in progress.

Current fractionation parameters can be checked at any time. Press the key corresponding to the chosen parameter and the present value will be displayed. Press “store/return” after checking any parameter to record the parameter in memory.

During the run the display normally shows the time, volume or drop number remaining in the current fraction, except at certain times during peak cutting modes. In peak cutting modes, when the monitor signal is below the programmed peak threshold, “Cut” is shown.

Note: When drop mode is used together with peak cutting then retention time data will be incorrect. During peak cutting, the flow is diverted to waste so that no drops will pass the sensor and thus, will not be counted. Data concerning the peaks will be correct since the flow passes the sensor.

When “pause/cont” is pressed to stop a collection temporarily, “PAUSE” will be displayed.

Other data available from the current run are described below.

To obtain these data, 1) press “run data/0”, 2) “enter 0”, 3) press “store/return”. Then press the various keys below for required information. Press “store/return” each time after retrieving the information.

Display content	Data key	Notes
Flow rate ml/min and drops/min	cal. flow rate: press once	Only available in volume- and drop based modes. Updated to nearest 0.1 ml/min or 10 drops/min every 6 s and to the nearest 0.01 ml/min or 1 drop every minute
Number of tube in which liquid is now being collected	tube at: press once	Updated at each tube change
Number of peaks detected	tube at: press twice	All peaks will be counted, but data will only be stored for the first 11 (19 for FRAC-200). Updated at each peak
Current monitor signal as% Full Scale Deflection	height/area: press once	Updated every 0.2 seconds
Time, volume or drop count of fraction collection since start	retention/duration: press once	Updated continuously. Time, volume or drop count lapsed during “pause" is not counted
Time, volume or drop count, elapsed from start to the time of the most recent power failure	retention/duration:	Check code 60 is displayed when power returns

4.6 Viewing peak data

The fraction collector also displays quantitative data about the peaks in the chromatogram and identifies the tubes in which they have been collected. Data from the monitor is evaluated and stored for up to 11 peaks (19 peaks with FRAC-200). To obtain a peak report using FRAC-200 and a printer please refer to Section 4.7.

Peak data can be displayed as described below.

To obtain these data, 1.) press “show peak”, 2.) enter peak number to be evaluated, 3.) press “store/return”. Press “store/return” after retrieving the information to secure the data in the memory.

Display content	Data key	Notes
Number of first tube in which peak material was collected	tube at: press once	If first tube is given as 0, then that peak number has not been completed or stored in memory yet
Number of tube in which peak maximum was collected	tube at: press twice	If last tube is given as 0, fraction collection was terminated before the end of the peak
Number of last tube in which peak was collected	tube at: press three times	
Monitor signal as% FSD at peak maximum	height/area: press once	
Peak area	height/area: press twice	Area is given as the product of min, ml or drop number and % FSD
Retention time, volume or drop count	CE: press once	Time volume or drop count measure from start of “run" to peak max. For a peak with a plateau-like top, the retention is taken when the monitor signal begins to decrease.
Peak duration, time, volume or drop count	CE: press twice	

4.7 Printing a peak report

(FRAC-200 only)

Programmed parameters and peak integration data may be obtained using a printer, printer/plotter or computer to print a peak report at the end of a programmed method.

A peak report may be obtained automatically after each run or manually when needed, according to different programming steps. Information is stored on up to 19 peaks per run and is printed using a 40-column width with an empty line following each fifth peak.

During the printing the letter “P” will be displayed. If a printer is not connected a check code will be displayed after 2 s and the FRAC-200 will return to the “end” position. If a printer is connected but cannot receive the data a check code will appear after 15 seconds.

Important! When using a printer it is necessary to check the parity and follow the instructions below.

For printer with zero parity, peak reports are obtained as described below using a factor of 100 or 101.

For printer set with even parity, use the factor 200 or 201.

For printer set with odd parity, use the factor 300 or 301.

Automatic report printing

1. Enter “show peak”
2. Enter 100, 200 or 300
3. Enter “store/return”

A peak report will be printed automatically at the completion of each subsequent run until the instruction is altered or removed.

Periodic report printing

1. Enter “show peak”
2. Enter 101, 201 or 301
3. Enter “store/return”

A peak report will be printed immediately if a run has been completed, or at the end of the present run if it is not yet completed.

Note: After a peak report the factors 101, 201 or 301 are automatically cleared from the memory. For a new print report a new factor has to be entered.

4.8 Check codes

The fraction collector is equipped with a powerful status checking facility which continually checks the status of the fraction collector and equipment connected to it. In the event of deviation from proper operation, the display will flash a check code. If a check code is displayed, look to see what it means from the list below, or in the Short Instruction, and take the appropriate action.

Start-up: when the instrument is switched on, the display flashes for 2 s as a self-diagnostic test circuit checks that the fraction collector is operating properly. When the check is completed satisfactorily, “End” is displayed.

Most check codes are of the form “Ch. 01”. The significance of each is shown below.

All check codes are cleared by pressing “store/return”.

Code No.	Explanation	Action
01	(1) No more tubes left or tubes missing or (2) delivery arm in stand-by position or (3) rack movement jammed. Fraction collection has stopped.	(1) Add more tubes if required and reposition delivery arm. (2) Position arm correctly. (3) Check for loose cables or other obstructions to free movement of the rack and remove them.
02	Same as Ch. 01, but evaluation continues until programmed “end at" is reached. When a valve is used the flow is diverted to waste.	Fractionation may be stopped by pressing “run/end".
03	Collection stopped at programmed “end at".	Remove fractions of further interest.
04	Collection stopped as pulse frequency is too high.	Reduce the set flow rate until a permissible frequency is reached or change to a pump giving the desired flow rate at a lower frequency. Pump P-1 is recommended.
05	Peak evaluation stopped as memory is full. Data can only be stored for 11 peaks (FRAC-100) or 19 peaks (FRAC- 200).	Evaluate subsequent peaks by alternative methods.
06	“Feed" is not possible during wait, cut, or delay.	In emergency, an unprogrammed tube feed can always be made by manually turning the rack clockwise to the next tube.
07	All data has been obtained from this key.	Press "store/return". More data is available though other peak evaluation keys.
08	Flow rate cannot be displayed in time-based modes.	Measure flow rate by alternative methods.

Code No.	Explanation	Action
09	Data cannot be changed during fraction collection.	If data must be changed before continuing the experiment, end collection by pressing “run/end" and make the desired changes.
10	Entries cannot be made in this mode.	See Section 4.2.
11	No decimal point can be entered for this parameter.	Use only integer numbers.
12	Maximum number of peaks for which data is stored is 11 (FRAC-100) or 19 (FRAC-200) or wrong print dump code.	Evaluate peaks after peak 11 or 19 by alternative methods. Check correct print dump code.
13	Only FRAC-200. RS232 receiver busy more than 15 s. Peak data dump terminated.	See section 4.7.
14	No decimal point can be entered for this parameter.	Use only integer numbers.
20	(1) Pump is not calibrated or (2) calibration value was too low. At least 10 pulses must be collected per 0.1 ml pumped.	For (1) calibrate pump. For (2) peristaltic pumps: change tubing to smaller inner diameter. Other pumps: use a pump with higher pulse frequency, or recalibrate the pump and multiply the calibration factor by 10. Enter his value manually, divide all fractionation parameters by 10 before entering them in a program e.g. to obtain 1.2 ml fraction size, enter 0.12. Then remember all evaluation parameters must be multiplied by 10 for the correct values.
21	Pump was connected during calibration, but is not connected to the fraction collector now.	Check the “remote" connections on the pump and on the back panel of the collector. Check mains connection of pump and check that pump is turned on.
22	”Wait" cannot be used in drop counting mode.	See Sections 4.2 and 4.3.
23	Non-existent collection mode.	See Sections 4.2 and 4.3 for a description of correct collection modes.
24	Define fraction size.	Program a fraction size for every collection sequence.
25	Delay is greater than fraction size.	Either increase the fraction size or reduce the length of tubing from the detector to the delivery arm.
26	Delay is greater than peak fraction size.	Either increase the peak fraction size or reduce the length of tubing (= reduced delay) from the detector to the delivery arm.
27	Define peak threshold in peak cutting modes.	See 4.3 for a description of programming.
28	Drop counter is dirty or not connected.	Gently wipe drop sensor and check connections between back panel and collector arm.
30	Calibration stopped as the volume collected was too large.	Repeat the calibration procedure, collecting a smaller volume.
31	Calibration stopped as the volume collected was entered as 0.	Repeat the calibration procedure.
32	Calibration stopped as the calibration value was too high.	Peristaltic pumps: change to pump tubing with larger inner diameter. Other pumps: pulse frequency per volume delivered is too high. Use different pump. Recalibrate the pump and divide calibration by 10. Enter this value manually. All collection parameters must be multiplied by 10 before being entered e.g. to obtain 1.2 ml fraction size, enter 12.0. Then remember all evaluation parameters must be divided by 10 for correct values.

Code No.	Explanation	Action
33	Calibration stopped. (1) old value was not cleared or (2) wrong calibration procedure followed.	(1) Clear old value by pressing CE and repeat the calibration procedure or (2) see 3.9 for correct calibration procedure.
34	Calibration stopped; power failure.	Repeat the calibration procedure.
35	Calibration stopped; pulse frequency (flow rate) is too high.	Reduce the set flow rate of change to a pump giving the desired flow rate at a lower pulse frequency. Pump P-1 is recommended.
40	Collector under remote control: “run/end" not in operation.	Start and stop from the remote controller only.
41	Collector under remote control; “pause/cont" not in operation.	Pause or continue from the remote controller only.
42	Paused. Remote run when already running.	Disconnect the remote control. Press continue.
49	Pump operable or remote operable status changed.	See Sections 3.6 and 3.8.
60	Power failure.	Time, volume or drop number from start to power failure available. See Section 4.5.
61	Severe power disturbance has destroyed stored data; memory cleared.	Re-program the fraction collector and repeat the run.
70	Memory has been cleared, no memory protection while power off.	Memory protection will work again 20 seconds after power up.
71	Memory protection does not work.	Wait 20 seconds then try again.

Some check codes show other flashing symbols; their explanation is given below.

Code No.	Explanation	Action
- - - -	(1) Serious electrical disturbance has stopped the collector or (2) PROM failure.	Turn power OFF and then ON. If check code persists, there is a PROM failure. Contact a service technician.
]]]]	RAM failure.	Turn power OFF and then ON. If check code persists, there is a RAM failure. Contact a service technician.
P	Peak data dump in progress (FRAC-200 only).	Wait until dump is completed.

4.9 Recycle Explanation

(FRAC-200 only)

The recycle function can be used only when the FRAC-200 is not collecting.

Recycling is possible by activating pin-5 on the remote connector, or by pressing the key “pause-cont/recycle”.

The FRAC-200 rotates the bowl backwards until the first tube of the collection sequence is found, passes tube 1 and then changes rotation again to find tube 1 from the same direction as when collecting in order to get the exact position above the tube.

5. Maintenance

The fraction collector should be kept clean and spilled liquid should be wiped up before it dries. The arm should be positioned over the center when the fraction collector is not in operation.

No regular maintenance is required.

The surface of the instrument may be wiped with mild aqueous cleaning fluids or with ethanol.

6. Trouble-shooting

Problem	Solution
No tube change	a) The fractionation has reached the programmed ”end at”. b) Press ”feed”, if motor does not start and Ch. 01 or Ch. 02 appears, contact a service technician. c) Push the delivery arm out to one of the safety stops. Press ”feed”, if the motor starts press the tube sensor together and the motor should stop without a check code. If a check code does appear, then check the connection in the arm as described below. If this looks OK then the sensor connection or sensor itself is faulty; contact a service technician.
No peak detection	a) Check to see if the monitor is connected to the detection fraction collector correctly (observe polarity!). b) Filter constant is greater than the peak duration; decrease the filter constant. c) Peaks are very small; set the monitor on a higher sensitivity range. d) Peak threshold is greater than the peak height; decrease the peak threshold. e) Contact a service technician.
Volume is not counted	a) See if pump is turned on. b) See if communication cable is connected. c) Recalibrate the pump and be sure to enter the correct volume collected.

6.1 Testing the tube sensor operation

1. Remove the tubing from the arm of the fraction collector so that buffer does not drip on your hand.
2. Enter this program into the fraction collector

   Press [1 collection mode] [9 %] and [store return]

   Press [7 fraction size], enter 0.1 and press [store return].

   The fraction collector should now display END.
3. Move the arm to its outermost rest position.
4. Press [run end]. When the motor starts, immediately pinch the tounge of the tube sensor between your thumb and forefinger. The motor should stop the instant the tounge is pinched.

   * If it does, the tube sensor is OK.

   Release and pinch the tounge on the tube sensor about 10–20 times. The motor should stop and start each time.

   Note: You must pinch within two seconds after releasing the tounge or **CH.01** will appear.

   * If the motor does not stop instantly when the sensor is pinched within 2 seconds, either:

   a. the tube sensor is defective – follow steps 1–7 below to confirm.

   b. there is another electronic failure, contact a service technician.

To confirm a tube sensor failure

1. Remove the bowl from the fraction collector.
2. Turn the fraction collector on its left side (looking from the front) so that you can see underneath the delivery arm.
3. Disconnect the plate you can see underneath the delivery arm by:
   a. Pulling out the black cable going into the delivery arm.
   b. Untightening the three screws and pulling out the plate.
4. Notice the two pins. These pins are plugged into a tube sensor at a blue 4-pin connector.
5. Note which holes in the blue connector the two pins go into.
6. Pull each pin out of its hole in the blue connector (use forceps).
7. Have someone press [run end]. When the motor starts, immediately touch the two pins together. The motor should stop.

   * If the motor runs when the two ends are apart and stops each time the two pins are touched together (remember, the motor will only run for 2 seconds before giving the chech code **CH.01**), you have confirmed the failure of the tube sensor.

   * If you cannot make the motor stop and start by touching the pins together, another type of electronic failure is indicated. Contact a service technician.

7. Technical Specifications

Tube racks	Diameter range	Height range	Max. number per rack
12 mm rack	12 mm	50-180 mm	175
18 mm rack	10-18 mm	50-180 mm *	95
30 mm rack	30 mm	30-180 mm	40

*If >100 mm, diameter must be 10% of height

Tubing	1.7-2 mm outer diameter
Tube change time	Maximum tube change times for each track (outer to inner tracks)
Tube rack 12 mm	Track 1 0.2 sec Track 3 0.3 sec Track 5 0.4 sec
Tube rack 18 mm	Track 1 0.3 sec Track 2 0.4 sec Track 3 0.5 sec Track 4 0.6 sec
Tube rack 28 mm	Track 1 0.4 sec Track 2 0.55 sec Track 3 0.7 sec
Fraction size	
Time	0.01-99.99 min (0.01 min increments) 100-999.9 min (0.1 min increments) 1 000-9 999 min (1 min increments) within an accuracy of ± 0.02%
Volume	0.01-99.99 ml (0.01 ml increments) 100-999.9 ml (0.1 ml increments) 1 000-9 999 ml (1 ml increments) within and accuracy of ± 0.02%
Drops	1-9 999 (1 drop increments) FRAC-100 requires optional accessory
Max drop rate	approximately 15 drops/s
Peak memory	Stores up to 11 peaks (FRAC-100), or 19 peaks (FRAC-200)
Peak evaluation	Displays peak height (% Full Scale Deflection, FSD), peak area (min% FSD or ml% FSD or drop% FSD); elution time (min), volume (ml) or drop number at peak maximum; duration in time, volume or drops of peak; tube number of first and last tubes containing peak and tube at peak maximum
Run evaluation	Displays time, volume or drop number remaining in current fraction; tube number, time, volume or drop number from start; flow rate (ml, drops/min only), monitor signal (% FSD) total number of peaks collected; time, volume or drop number of last power failure
Memory protection	Programmed parameters and stored data are guaranteed for at least 1 hour after the instrument is switched off or in the event of a power failure. Under normal conditions at least 4 4 days storage can be expected

Event mark	0.2 s for both contact closure and TTL outport in remote socket (see Section 3.6). Programmable delay (see Section 4.3)
Chemical resistance	The bowl and the racks are made of PBT (Valox) which is generally resistant to: • weak bases: e.g. diluted solutions of ammonium, amines etc. • alcohols: e.g. methyl-, ethyl-, propylalcohol etc. and some glycols. PBT is also resistant to cleaning detergents and chemicals, hot water, UV-radiation. Avoid contact the following groups of chemicals; should spillage occur clean immediately: • Oxidizing components, e.g. nitric acid peroxides. • Strong bases, e.g. sodium or other metal hydroxides, some amines. • Chlorinated solvents, e.g. methylene chloride, ethylene chloride, trichlorethane. • Esters e.g. acetates. • Aromatic hydrocarbons, e.g. ketones and aldehydes.
Remote control	15-pin female D-type connector, TTL compatible signals (see Section 3.6) Inport: recycle (FRAC-200), flow rate, run, pause, feed, remote controller operable Outport: event mark, stop pump, FRAC operable
Printer output	25-pin female D-type connector; RS 232 C serial interface; Baud rate 9600 with 8 bits and 1 stop bit. FRAC-200 only
Valve output	Nominal 24 V/0.24 A output, screw contacts
Monitor input	10, 100 or 1000 mV; 5 readings/s; screw contacts
Voltage	100/120 /220-230/240 V~
Frequency	48-62 Hz
Power consumption	15 VA
Environment	+4 to +40°C, 20-95% relative humidity, 84-106 kPa (840-1060 mbar) atmospheric pressure
Dimensions	290x300x390 mm (WxDxH)
Weight	5.5 kg (12 lb)

8. Accessories and Spare Parts

Please order accessories and spare parts according to the designation and code numbers given below.

Refer to figure 18 for position number.

Position No.	Designation	Code No.	No./Pack
Drop Counter Kit (FRAC-100)		18-1012-05	1
1	Tube holder and guide, 12 mm	19-7242-02	2
2	Tube holder and guide, 18 mm	19-8689-02	2
3	Tube holder and guide, 30 mm	18-1124-68	2
4	Tube support	18-3054-02	1
5	Bowl SR	18-3051-03	1
6	Tube rack complete, 12 mm	19-8684-03	1
7	Tube rack complete, 18 mm	18-3050-03	1
8	Tube rack complete, 30 mm	18-1124-67	1
9	Tube spring (metal)*	19-6057-01	10
10	Solenoid Valve, PSV-50	19-1994-01	1
11	Valve bracket kit	19-1994-50	1
12	Tubing holder	18-6464-01	1
13	Tube sensor kit	19-7815-02	1
14	Funnel	19-6044-01	1
15	Funnel tubing 12/8, 250 mm	18-3020-01	2
16	Drive sleeve	19-6067-02	5
18	Short instruction FRAC-100/FRAC-200	19-8603-01	1
19	Spiral cable	19-8638-01	1
20	Sensor positioning kit	18-6470-01	1

* Only for Tube holder/guide, 18 mm.

Accessories available but not illustrated

Position No.	Code No.	No./Pack
Communication cable, 15 P		
Pump P-1, GP-250, LCC-500 and LCC-501 controllers	19-6005-02	1
Signal cable	19-6006-01	1
Communication cable, 25 P-P	19-8226-01	1
Remote control adaptor	19-6008-01	1
Tube holder, conversion kit	18-8522-01	100
Water bath connector*	18-3152-01	1
Mains cable 120 V	19-2447-01	1
Mains cable 220 V	19-2448-01	1
Fuse 200 mA SB 5x20 (120 V)	19-6125-01	2
Connector 4-pole female	18-0863-01	1
Fuse holder 5x20	19-8654-01	1
Fuse holder 6,3x32	18-0847-01	1

*Only for Tube rack 18 mm.

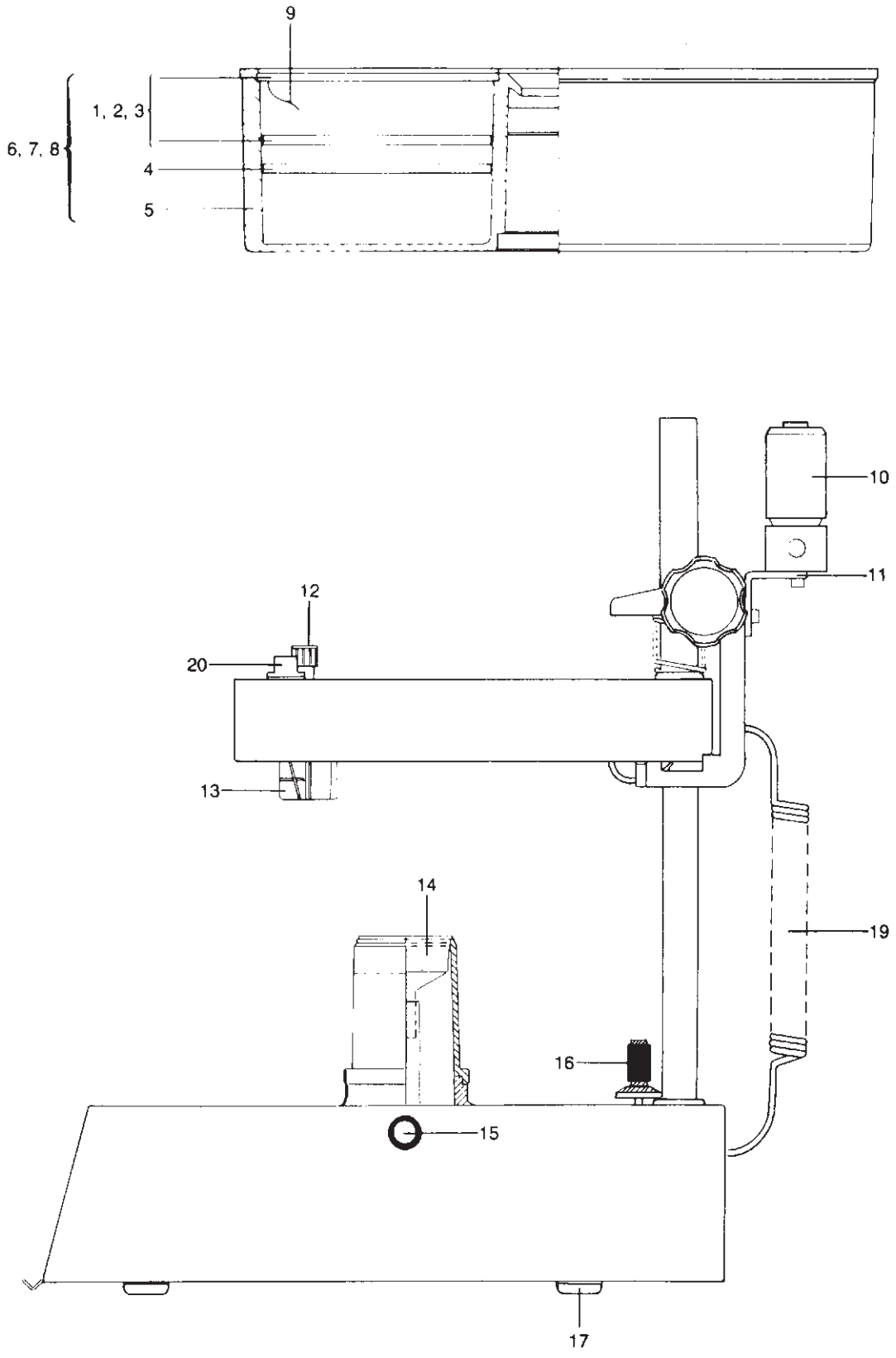


Fig. 18

Part II

1. Application examples

This instrument can be programmed in different ways to suit different fractionation schemes. The instrument's versatility allows one to obtain the maximum amount of reliable information from a run in the most convenient way. The examples below show the results obtained with different programs.

1.1 Simple drop-based collection

Collection mode	4
Fraction size	20 drops

Please refer to figure 19. The FRAC-200, or FRAC-100 with the drop counter option, will collect fractions, each of 20 drops, until it runs out of tubes. After the last tube, the delivery arm moves to the center funnel so all effluent can be directed to waste or collected in a separate container.

1.2 Volume-based collection with drop synchronization and no delay period

Collection mode	22
Fraction size	2.0 ml
Peak threshold	5% FS
Peak fraction size	1.0 ml
End at	16.0 ml

Please refer to figure 20. Three fractions of 2 ml are collected before the first peak appears. During the collection of fraction 4, the monitor signal rises above the peak threshold (a) and a tube change occurs here. The next fraction (tube 5) is 1 ml (peak fraction size). Until the monitor signal passes below the peak threshold, the fractions collected will be 1 ml fractions (peak fractions size).

When the signal finally goes below the peak threshold, another tube change occurs at (b). Then the collection of 2 ml fractions (fraction size) proceeds as before until the next peak is detected.

The fractionation stops at the programmed "end at" (16 ml).

The pump stops running and the fraction collector is in "END" position.

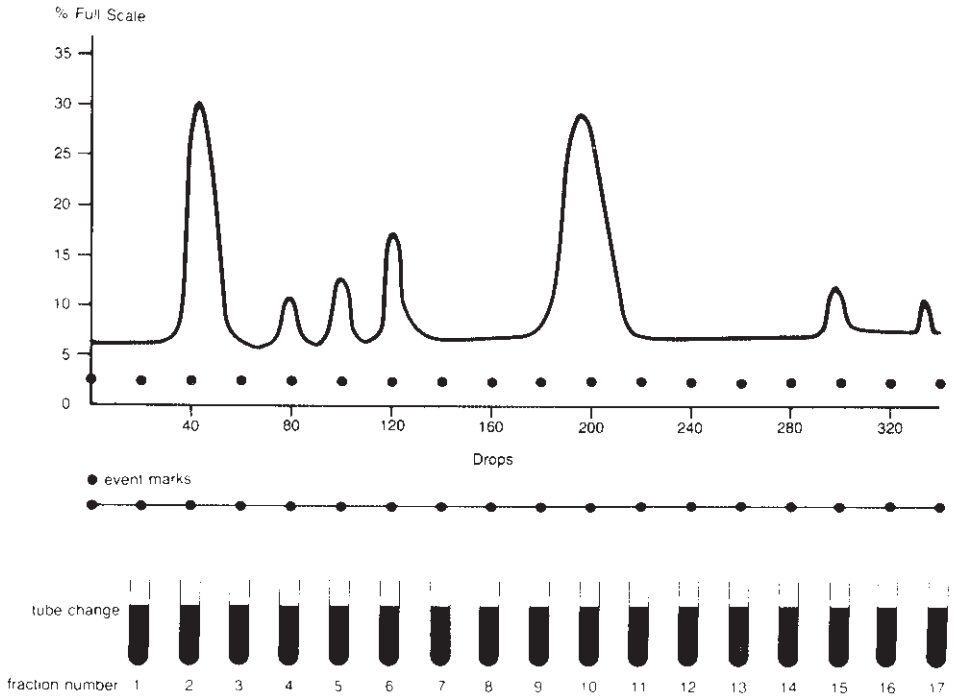


Fig. 19. Chromatogram for application example 1.1

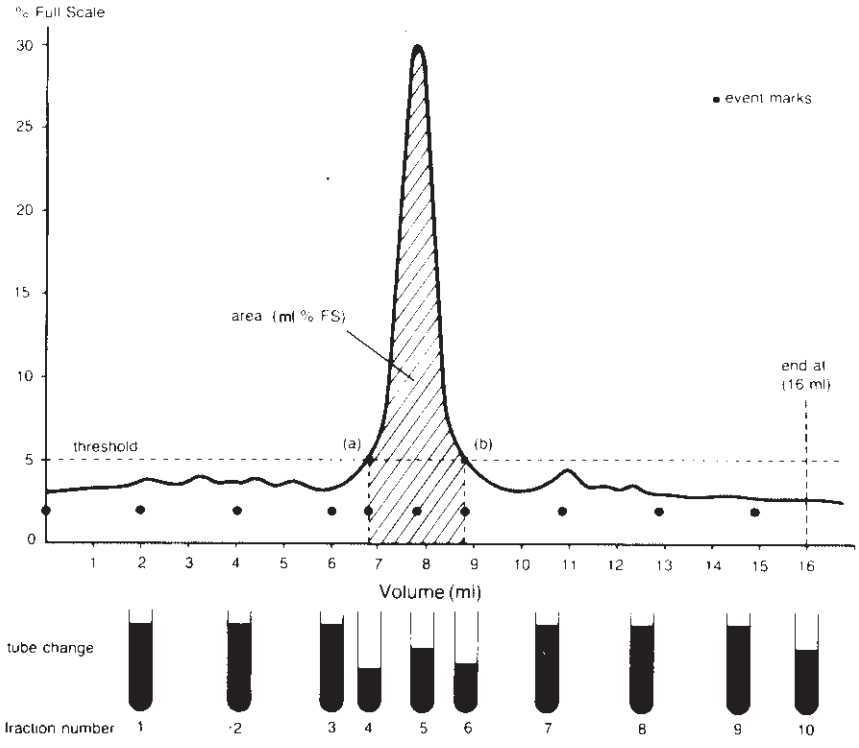


Fig. 20. Chromatogram for application example 1.2

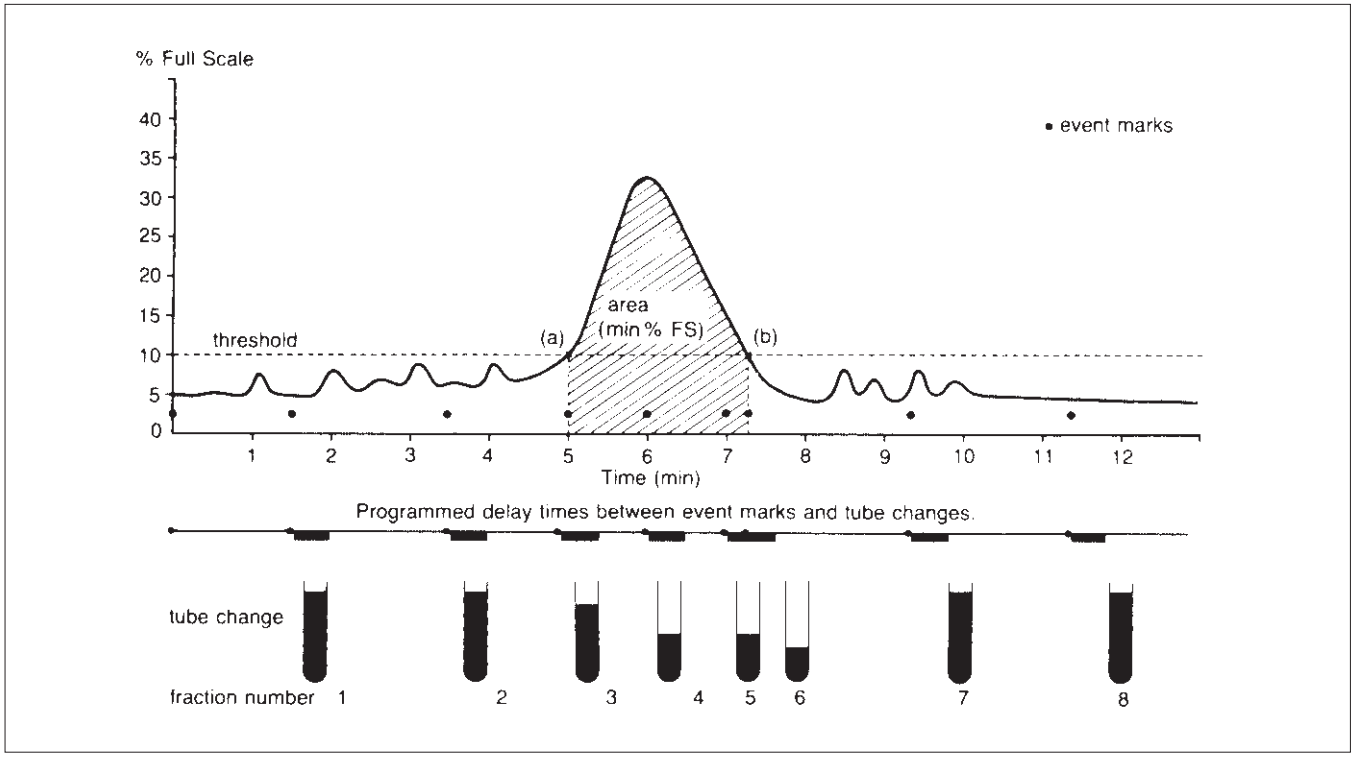


Fig. 21. Chromatogram for application example 1.3

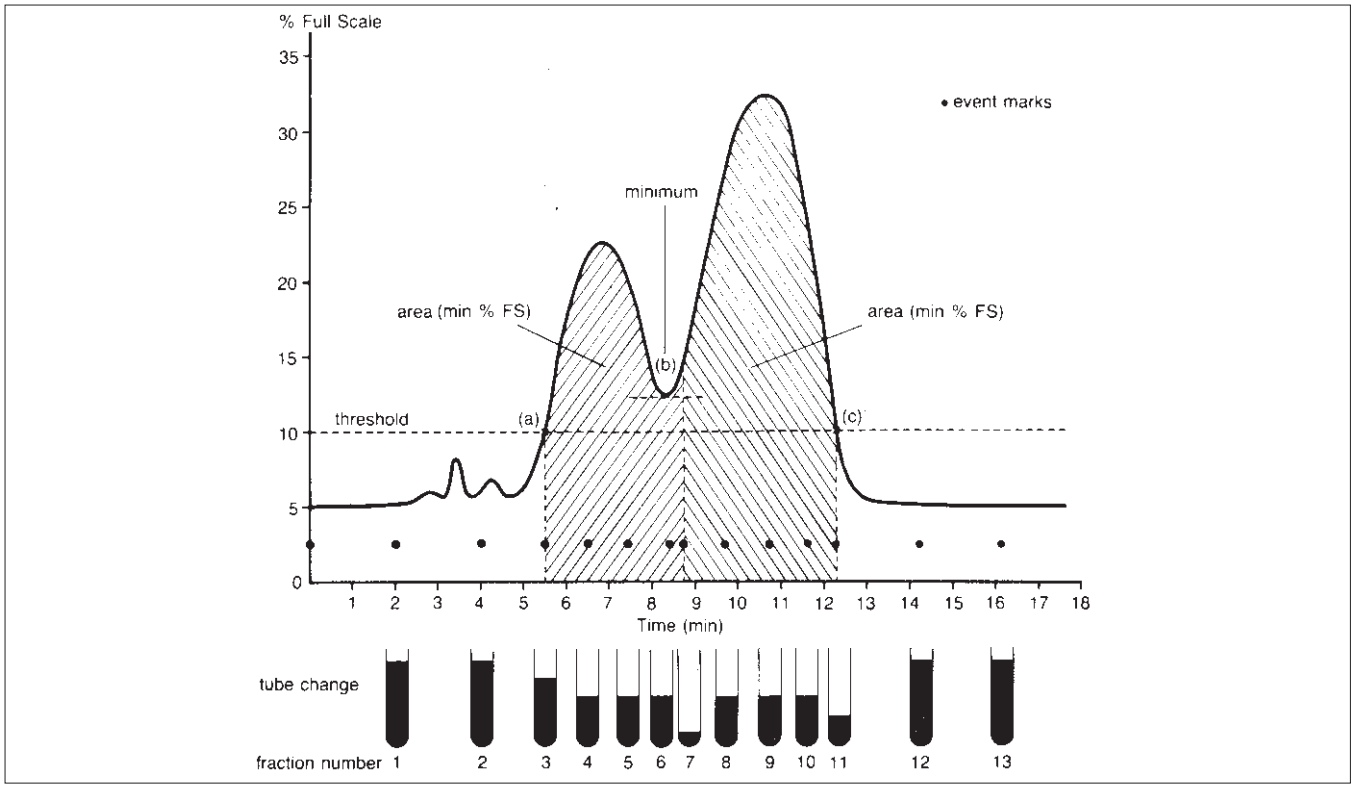


Fig. 22. Chromatogram for application example 1.4

1.3 Time-based collection with peak detection, drop synch-ronization, flow diversion between tube changes, a programmed delay and a filter constant of 8 seconds

Collection mode	430
Fraction size	2.0 min
Peak threshold	10% FSD
Peak fraction size	1.0 min
Delay	0.5 min

Please refer to figure 21. Note that event marks are given one delay period ahead of the tube change. Two 2 min fractions are collected, then, during fraction 3, the monitor signal passes through the peak threshold (a). Tube 4 is a 1 min fraction (peak fraction size).

The monitor signal decreases to below the peak threshold during the delay time corresponding to event mark 6. There is an immediate tube change at (b) and fraction 5 is slightly smaller than 1 min. Exactly one delay period is now collected in tube 6, corresponding to peak material contained in the tubing between the monitor and the outlet. When the delay time is over, another tube change occurs (tube 7) and now collection of 2 min fractions proceeds as before until the next peak is detected.

1.4 Time-based collection with peak detection (double-peak)

Collection mode	0
Fraction size	2.0 min
Peak threshold	10% FSD
Peak fraction size	1.0 min
Delay	0

Please refer to figure 22. Two fractions of 2 min are collected before the first peak appears. During the collection of fraction 3, the monitor signal rises above the peak threshold and a tube change occurs (a). The next 3 fractions are 1 min (peak fraction size). During fraction 7 the signal passes through a minimum (b). When the signal reaches 1.5% Full Scale Deflection above the minimum a tube change occurs and a new peak is collected according to peak fraction size.

Amersham
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Printed in Sweden by TK i Uppsala AB, June 2002